FOUNDATION INVESTIGATION AND DESIGN REPORT
PROPOSED SEWER PIPE CROSSINGS
HWY 427 INSIDE WIDENING
FROM FASKEN DRIVE TO STEELES AVENUE
TORONTO, ONTARIO
G.W.P. 202-95-00

Geocres Number: 30M12-292

Report to

SNC-Lavalin

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of fifteen (15) proposed sewer pipe crossings under Highway 427. Installation of the sewer pipe crossings is part of the Highway 427 inside widening from Fasken Drive to Steeles Avenue in Toronto, Ontario.

The purpose of the investigation was to explore the subsurface conditions at the proposed sewer crossing locations and, based on the data obtained, to provide borehole location plans, records of boreholes, laboratory test results, stratigraphic profiles and a written description of the subsurface conditions.

Thurber carried out the investigation as a sub-consultant to SNC-Lavalin under the Ministry of Transportation Ontario (MTO) Agreement Number 2004-E-0071.

2 PROJECT AND SITE DESCRIPTION

The inside widening of Highway 427 from Fasken Drive to Steeles Avenue includes the installation of fifteen (15) sewer pipes that cross either the northbound or southbound lanes of Highway 427.

Highway 427 is currently a 6-lane highway, surrounded by industrial, commercial and residential properties along the route. The topography of this section of the highway gently increases from the south to the north. The site is situated within the South Slope physiographic region. The geology generally comprises a till plain consisting of clayey silt to silty clay (Halton Till) grading into a sandy

silt to silty sand till with depth. The underlying bedrock consists of grey shale with hard siltstone and limestone interlayers of the Georgian Bay Formation.

3 SITE INVESTIGATION AND FIELD TESTING

Site investigation and field testing for the proposed pipe crossings consisted of drilling and sampling thirty (30) boreholes, designated as PC-01 to PC-30, to approximate depths of 10 m below the ground surface. At each of the fifteen pipe crossings, one borehole was drilled near each end of the crossing as specified in the terms of reference. All boreholes were drilled within the period of December 20, 2009 to January 13, 2010.

All boreholes were drilled at night during approved lane closure times on the inside and outside shoulders of the northbound and southbound lanes of Highway 427. Lane closures and traffic control were carefully planned for drilling each borehole. Prior to commencement of drilling, utility clearances were obtained for all borehole locations.

The approximate borehole locations are shown on the Borehole Locations and Soil Strata Drawings in Appendix E. The coordinates and elevations of the boreholes are given on these drawings and on the individual Record of Borehole Sheets in Appendix A. The borehole coordinates were surveyed using a Trimble Pathfinder ProXRT differential GPS, and the approximate ground surface elevations were determined using the sewer profile drawings provided by SNC-Lavalin.

Solid stem augers were used to advance the boreholes, and 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 samples, and transported them to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Fourteen standpipe piezometers were installed at selected locations to permit monitoring of groundwater levels. The piezometers consisted of 19 mm PVC pipes with slotted screens. The locations and completion details of the piezometers are shown in Table A-1 in Appendix A. The borehole completion details are also shown in Table A-1.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and soil classification. Moisture content determinations were carried out on all soil samples. Approximately 28% of the recovered soil samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of this testing program are presented on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

This section presents a generalized summary of the subsurface conditions encountered at the borehole locations drilled for the proposed pipe crossings. Reference is made to the Record of Borehole sheets in Appendix A. Stratigraphic profiles for each pipe crossing are also presented on the Borehole Locations and Soil Strata Drawings in Appendix E. An overall description of the stratigraphy encountered in Boreholes PC-01 to PC-30 is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between borehole locations.

In general terms, the soil stratigraphy encountered along this stretch of the highway consists of asphalt pavement and fill overlying native silty clay to clayey silt till deposits. Occasional sand deposits as well as zones of sandy silt to silty sand till were also encountered in the boreholes. More detailed descriptions of the individual stratum are presented below.

5.1 Asphalt

Asphalt was present at the ground surface in the majority of the boreholes. The asphalt thickness ranged from 75 mm to 400 mm. No asphalt was encountered at Boreholes PC-19, PC-20, or PC-24. All boreholes were drilled on the shoulders of Highway 427 and therefore the asphalt thicknesses do not necessarily represent the conditions under the travelled lanes of the highway. The thickness of asphalt may also vary between and beyond the borehole locations.

5.2 Fill

Fill was encountered below the asphalt in all of the boreholes. The upper part of the fill consisted of granular material, ranging from sand with some gravel and some silt, to sand and gravel with trace silt. The granular fill was mainly encountered to depths ranging from 0.6 m to 1.3 m below the ground surface or to elevations ranging from 164.5 m to 180.7 m. Locally thicker granular fill layers were encountered at Boreholes PC-13 (4.0 m deep), PC-14 (2.2 m deep) and PC-27 (2.4 m deep). At Borehole PC-20, the upper fill encountered at the ground surface consisted of silty clay mixed with sand to 0.5 m depth (Elev. 164.9 m).

Recorded SPT N-values in the granular fill ranged from 11 to 72 blows per 0.3 m penetration, and therefore the upper fill is described as compact to very dense.

The majority of the boreholes also encountered a lower fill layer overlying the native soils. This fill mainly consisted of clayey silt and silty clay with some sand, trace gravel and trace cobbles, however some zones of sand to sandy silt fill were also encountered. The lower fill was encountered to depths ranging from 2.3 m to 9.8 m or to elevations 159.7 m to 176.3 m. The lower fill was not encountered in Boreholes PC-19 or PC-20.

The SPT N-values recorded in the clayey silt to silty clay lower fill ranged from 6 blows per 0.3 m penetration to 63 blows per 0.275 m penetration, indicating that the fill has a firm to

hard consistency. SPT N-values in the sand to sandy silt zones in the lower fill ranged from 7 to 43 blows per 0.3 m penetration, and therefore are described as loose to dense.

The natural moisture contents of the fill samples obtained generally ranged from approximately 1% to 11% in the upper fill and 4% to 33% in the lower fill.

Grain size distribution curves for fill samples tested are presented on the Record of Borehole sheets and on Figures B1 to B11 of Appendix B. Atterberg Limit test results are presented on Figures B19 to B23 of Appendix B.

The results of the laboratory gradation and Atterberg Limits tests are summarized as follows:

Upper Fill (Granular Material):

Soil Particles	(%)
Gravel	19 to 48
Sand	42 to 70
Silt and Clay	4 to 22

Lower Fill:

Soil Particles	(%)
Gravel	0 to 15
Sand	7 to 48
Silt	27 to 77
Clay	4 to 62

Index Property	(%)
Liquid Limit	22 to 49
Plastic Limit	14 to 24

The above results show that the clayey silt to silty clay lower fill is of low to intermediate plasticity with group symbols of CL-ML to CI.

5.3 Glacial Till

Native brown to grey silty clay till containing trace sand to sandy, trace gravel, and trace cobbles was encountered below the fill in all of the boreholes except for PC-21, PC-22, PC-25, and PC-26. In Boreholes PC-19, PC-20, and PC-21, silty sand till with some clay lenses and trace gravel was also encountered. The till deposits were encountered at depths ranging from 0.5 m to 9.1 m, or elevations 159.7 m to 174.2 m, and generally extended to the full depth of the boreholes at 9.8 m below the ground surface (Elev. 155.7 m to 171.2 m).

Based on SPT N-values ranging from 4 blows for 0.3 m of penetration to 50 blows per 0.075 m penetration, the silty clay till is described as firm to hard, although typically the till is stiff to hard. The silty sand till is described as compact to very dense, based on SPT N-values ranging from 18 blows per 0.3 m penetration to 82 blows per 0.275 m penetration.

The natural moisture contents of the samples recovered from glacial till deposits ranged from 7% to 33%.

Grain size distribution curves for the till samples tested are presented on the Record of Borehole sheets and on Figures B13 to B18 of Appendix B. Atterberg Limit test results are presented on Figures B24 to B28 of Appendix B.

The results of laboratory gradation and Atterberg Limits tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 10
Sand	5 to 45
Silt	29 to 60
Clay	11 to 66

Index Property	(%)
Liquid Limit	18 to 67
Plastic Limit	12 to 28

The above results show that the silty clay till ranges from low to high plasticity with group symbols of CL-ML to CH.

Occasional cobbles were encountered in the glacial till in the boreholes. Glacial tills inherently contain cobbles and boulders.

5.4 Sand

In Boreholes PC-21 to PC-24, sand deposits ranging in composition from sand with some silt to sand and gravel were encountered within the native material. The sand deposits were encountered at depths from 4.7 m to 7.3 m below the ground surface (Elev. 160.9 m to 163.6 m), and extended to depths of 8.8 m up to the full depth of the boreholes at 9.8 m below ground (Elev. 159.3 m to 159.6 m).

The SPT N-values recorded in the sand deposits ranged from 22 to 47 blows for 0.3 m of penetration, indicating that the deposits are compact to dense.

The sand deposits were observed to be moist to wet, with natural moisture contents of recovered samples ranging from 6% to 20%.

Grain size distribution curves for samples tested from the sand deposits are presented on the Record of Borehole sheets and on Figures B12 of Appendix B.

The results of the laboratory gradation tests are summarized as follows:

Soil Particles	(%)
Gravel	27 to 47
Sand	42 to 63
Silt and Clay	8 to 29

5.5 Water Levels

The groundwater level was observed in the boreholes during and upon completion of drilling. Fourteen standpipe piezometers were installed to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.1.

Table 5.1 – Measured Groundwater Levels

Borehole	Date	Water Level (m)	
		Depth	Elevation
PC-03	January 18, 2010	4.3	163.0
PC-05	January 18, 2010	5.6	159.9
PC-08	January 18, 2010	6.3	161.1
PC-09	January 18, 2010	5.3	165.8
PC-11	January 18, 2010	Dry	Dry
PC-14	January 18, 2010	5.1	167.7
PC-15	January 18, 2010	8.2	161.0
PC-18	January 18, 2010	3.2	164.4
PC-20	January 18, 2010	2.1	163.3
PC-21	January 18, 2010	5.1	163.1
PC-24	January 18, 2010	6.1	162.9
PC-25	January 18, 2010	4.3	176.9
PC-28	January 18, 2010	4.4	176.6
PC-29	January 18, 2010	5.8	174.1

The above table indicates that the groundwater levels along this stretch of Highway 427 range from Elevations 159.9 m to 176.9 m.

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

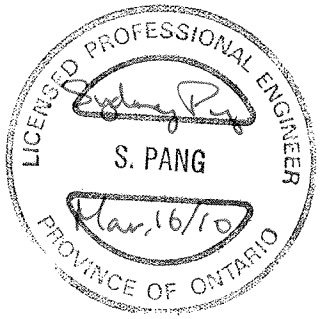
The drilling and sampling equipment was supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. Traffic control was provided by Barricade Traffic Services of Concord, Ontario. The field work was supervised on a full time basis by Ms. Eckie Siu, Mr. Luke Gilarski, Mrs. Lindsey Blaine, Mr. Stephane Loranger, and Mr. Mark Farrant of Thurber Engineering Ltd. Laboratory testing was carried out at Thurber's Laboratory in Oakville, Ontario.

Supervision of the field program was conducted by Mrs. Lindsey Blaine and Mr. Mark Farrant, P.Eng. Interpretation of the field data and preparation of the investigation report was conducted by Mr. Mark Farrant, P.Eng. and Mr. Sydney Pang, P.Eng.

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

THURBER ENGINEERING LTD.

Mark Farrant, P.Eng.
Geotechnical Engineer



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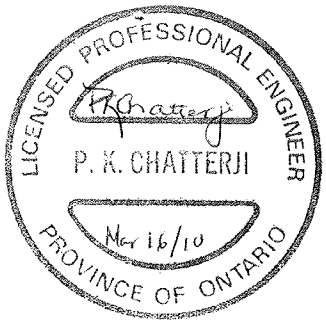

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Review Principal

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This section of the report presents foundation recommendations for the design and construction of the proposed installation of fifteen (15) sewer pipe crossings of Highway 427 by trenchless methods. The proposed sewer pipe diameters vary from 300 mm to 750 mm and they are proposed to be installed at depths ranging from 2 m to 4.3 m under the highway. The sewer pipes will be installed inside larger diameter outer liners.

The subsurface stratigraphy revealed in the boreholes drilled at the proposed pipe crossings generally consists of asphalt and granular fill overlying clayey silt to silty clay fill underlain by native silty clay glacial till. The existing ground surface elevations at the borehole locations range from 165.4 m to 181.3 m. The ground surface generally rises from the south end to the north end of the project area.

Groundwater levels measured in fourteen (14) piezometers installed at the proposed pipe crossing locations ranged from 2.1 m to 8.2 m (Elev. 159.9 m to 176.9 m) below the ground surface.

Information on the general layout of the proposed pipe crossing locations and their proposed depth of installation were provided to Thurber by SNC-Lavalin during preparation of this report. Available details of the pipe crossings are included in Table 7.1, including the soil type that each pipe is expected to be installed through. The diameters of the outer liner pipes were not available at the time of preparation of this report. The locations and depths of the proposed pipes are shown on the Borehole Locations and Soil Strata Drawings in Appendix E.

The discussion and recommendations presented in this report are based on Thurber's understanding of the project and on the factual data obtained in the course of this investigation.

Table 7.1 – Sewer Pipe Crossing Details

Borehole	Station	Pipe Invert Elevation Under Highway (m)		Length (m)	Diameter (mm)*	Soil Type Around Pipe	Pipe Cover Below Pavement (m)
		Left Side	Right Side				
PC-01, PC-02	20+557	164.5**	164.8**	29	300	Clayey Silt Fill	2.2**
PC-03, PC-04	20+635	165.3	164.9	23	375	Sandy Silt Fill	1.7
PC-05, PC-06	20+819	163.6	163.5	32	300	Silty Clay Fill	1.6 – 2.0
PC-07, PC-08	21+387	165.5	165.4	25	675	Silty Clay Fill	1.2 – 1.4
PC-09, PC-10	21+873	168.8	167.5	33	525	Silty Clay Fill	1.9 – 2.4
PC-11, PC-12	22+516	169.2	170.7	44	375	Silty Clay Fill	2.4 – 2.8
PC-13, PC-14	22+582	170.4	170.6	32	300	Gravelly Sand Fill	1.7 – 1.8
PC-15, PC-16	22+945	165.0	166.0	32	375	Silty Clay Fill/w Sand	3.2 – 3.4
PC-17, PC-18	23+155	165.1	165.3	31	450	Silty Clay Fill	1.5 – 1.7
PC-19, PC-20	23+641	162.8	162.6	25	750	Silty Clay Till	2.0
PC-21, PC-22	26+071	166.2	164.2	45	300	Silty Clay Fill	2.1 – 2.6
PC-23, PC-24	26+150	166.6	166.2	33	450	Silty Clay Fill	2.1 – 2.3
PC-25, PC-26	27+232	175.4	179.3	47	300	Silt & Sand Fill	2.2 – 3.6
PC-27, PC-28	27+375	175.5	177.4	47	300	Silt & Sand Fill	3.4 – 4.0
PC-29, PC-30	27+575	176.9	177.2	17	450	Silty Clay Fill	2.2

* It is understood that the pipes will be installed inside larger diameter steel casings. Therefore, the invert elevations may be lower than those shown in the table.

** Based on approximate pipe depth below ground surface. Profile information not available for pipe crossing at 20+557.

8 TRENCHLESS METHODS RECOMMENDATIONS

All work must be carried out in accordance with the requirements of the Non-Standard Special Provision (NSSP) "Pipe Installation by Trenchless Methods". A copy of this NSSP is attached in Appendix C.

Trenchless installation methods that are typically used to install pipes under highways include:

- Tunnelling - hand-mining or tunnel boring machine (TBM)
- Horizontal directional drilling
- Pipe ramming
- Jack and bore

Selection of an appropriate trenchless method should be the responsibility of the Contractor and will depend upon the relative costs and risks associated with each method. The experience of the Contractor is of primary importance for trenchless installation. The Contractor must submit a detailed work plan, including the proposed methodology, maintenance of alignment, and disposal of cuttings, all in accordance with the NSSP.

For this project, based on the information shown in Table 7.1, the majority of the pipe crossings under Highway 427 will be installed in cohesive silty clay or clayey silt fill. However, some pipes are also located within cohesionless soils such as sandy silt fill, gravelly sand fill, or silt and sand fill as shown in Table 7.1 above.

Tunnelling (hand-mining or TBM) is not considered practical for these crossings due to the low crown cover below the highway pavement (1.2 to 4.0 m), and due to the relatively short pipe lengths (17 to 47 m).

Horizontal directional drilling procedures are not suitable for these crossings since the method will not be able to provide temporary support of the open cavities under the highway.

Pipe ramming is not considered to be suitable for these crossings due to the potential for disturbance of the highway because of the relatively low crown cover below the highway pavement structure.

The jack and bore technique is considered feasible but the equipment must be capable of excavating and advancing through cobbles and boulders and any other obstructions that may be present in the fill and glacial till material.

In addition to the NSSP referenced above, it is strongly recommended that the Contractor be alerted to the following points, either by a further NSSP or otherwise by inclusion in the Contract Documents in an appropriate manner:

- The fill material and glacial till deposits may contain cobbles and boulders.

- The pipe installation will be done through cohesive fill and glacial till. The Contractor's equipment must be able to drill through these cohesive deposits without choking up the augers.
- A maximum distance of 600 mm should be maintained between the boring face and the pipe liner during installation to prevent sloughing or cave of cohesionless soils. Pipe installation should be continuous and no gaps should be left between the boring face and the outer liner pipe during work stoppages, i.e. overnight and weekends.
- At locations where the pipe crossings are to be installed in cohesionless soil (Station 20+635, 22+582, 22+945, 27+232, and 27+375), loss of ground (sloughing or cave) may occur in the borings. In these areas, methods which preclude caving and loss of ground, such as jack and bore with the pipe advancing closely behind the boring face, shall be employed at these locations.

A NSSP for the above is included in Appendix C.

A minimum vertical distance of 3.0 m between the top of the pavement and the top of the outer liner (or a minimum of 2.0 m below the pavement granular material) is recommended to reduce the potential for disturbance of the highway pavement structure. It is recommended that all of the pipe crossings in Table 7.1 that have less than 3.0 m cover above the crown of the outer liner should be lowered to provide adequate cover so as to prevent disturbance of the pavement structure.

SNC Lavalin has informed Thurber that the majority of the pipe crossings can be lowered to meet the above criteria with the exception of the 5 crossings located at Stations 20+635, 20+819, 21+387, 23+155, and 23+641. These crossings cannot be lowered since they will be connecting to existing outlet points on the downstream end.

The crossings at Stations 20+635, 20+819, and 23+155 involve smaller diameter pipes (300 to 450 mm), and assuming the outer liner casings are 300 mm larger in diameter than the sewer pipes, the depth of cover in these 3 locations ranges from 1.4 m to 1.8 m below the pavement surface and is at least 2 times the diameter of the casings. Since these are small diameter pipes, and the pipes will be installed through cohesive soil, the present configurations of the pipe crossings at Stations 20+635, 20+819, and 23+155 are considered to be acceptable, and therefore these 3 pipes do not need to be lowered.

The sewer pipes at Stations 21+387 and 23+641 are larger in diameter (675 to 750 mm), and since for these 2 cases the above depth of cover criteria cannot be satisfied, the present depths of installation of the 2 pipe crossings will increase the risk of damage to the pavement structure during construction. Therefore, if these 2 pipes cannot be lowered, the following alternative options are recommended in order to minimize the risk of damage to the pavement structure:

- Replace the large diameter (675 to 750 mm) sewer pipes at Sta. 21+387 and 23+647 with multiple smaller diameter pipes, which would increase the depth of cover above the outer liner casings.

- Divert all traffic away from the location of the pipe crossings during installation in order to allow the pavement to be closely monitored for evidence of settlement and repaired immediately if necessary.
- Construct these pipe crossings in an open cut and reinstate the pavement structure immediately following completion of the pipe installation.

Based on groundwater observations in the boreholes and the piezometer measurements, groundwater seepage during installation of the pipe crossings is expected to be minimal. It is anticipated that sumps and pumps should be adequate to handle groundwater entering into the excavation and launching shafts. However, the Contractor is responsible for maintaining dry excavations and tunnelling shafts.

9 INSTRUMENTATION AND MONITORING PROGRAM

The impact of the proposed installation on existing underground utilities should be assessed. A pre-construction condition survey should be carried out to document the existing condition of the highway pavement and assess the potential for damage to all facilities and underground services along the alignments of the trenchless crossings. Monitoring of the roadway surface, underground utilities, and any nearby structures should be carried out during construction.

A monitoring program and condition survey of the Hwy 427 pavement in the proximity of the pipe crossings has been prepared following MTO's Guidelines for Foundation Engineering - Tunnelling Specialty for Corridor Encroachment Permit Application.

Detailed specifications and drawings for the implementation of the monitoring program are presented in Appendix D.

10 TEMPORARY PITS AND ROADWAY PROTECTION

Temporary pit excavations at the pipe crossing locations will extend through the fill, native glacial till, and native sand deposits.

All temporary excavations must be carried out in accordance with the current Occupational Health and Safety Act (OHSA) of Ontario and local regulations. The fill and native sand are classified as Type 3 soils under OHSA, and the native glacial till is classified as a Type 2 soil.

Where excavation for the pipe installations is located in close proximity to live traffic lanes or existing buried utilities, shoring in the form of trench boxes, continuous timber sheathings and bracing, or other temporary systems should be provided.

Roadway protection systems should be designed by a licensed Professional Engineer experienced in design of shoring, with consideration of adjacent traffic loads and any sloping retained surfaces. If roadway protection is required, it should be provided as per SP539SO1, which should be included in the contract documents. Performance Level 2 is recommended as per Clause 539.04.02.01.

Use of a hydraulic excavator should be suitable for temporary pit excavation. Provision should be made for handling and removal of possible cobbles, boulders, and other obstructions in the fill and glacial till during excavation.

11 CONSTRUCTION CONCERNS

Potential construction concerns that have been identified for this project include the following:

11.1 Loss of ground

Trenchless installations at shallow depth below a highway inherently include some risk of loss of ground into the bore. If it is significant, this loss of ground can create settlement of the pavement surface and create safety hazards. The Contractor's methodology must recognize this inherent risk and contain contingency plans to manage any adverse impacts on the highway.

11.2 Obstructions

Glacial till soils typically contain cobbles and boulders, and fill placed for the highway construction may contain similar obstructions. The Contractor's equipment and methodology must be selected to handle such obstructions and successfully remove them without jeopardizing the highway.

11.3 Buried Utilities

The Contractor must accurately establish, in three dimensions, the locations of all buried utilities crossing or closely paralleling the path of the bores. Any discrepancy from the Contract Drawings must be reported to the Contract Administrator.

12 CLOSURE

Engineering analysis and preparation of the foundation design report was conducted by Mr. Mark Farrant, P.Eng. The report was reviewed by Mr. Sydney Pang, P.Eng. and Dr. P. K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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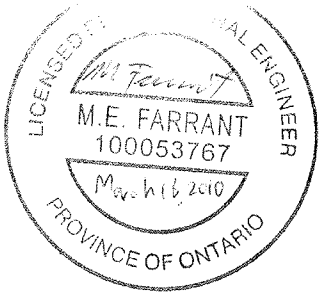

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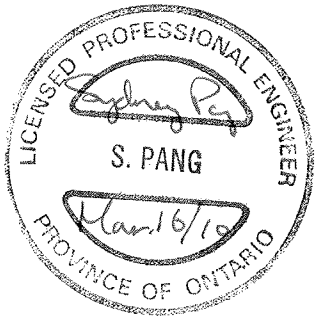

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

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

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

$\blacktriangledown$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

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

Table A-1 – Borehole Completion Details

Location	Details	
	Piezometer Tip Depth / Elevation (m)	Completion Details
PC-01	None Installed	Backfilled with bentonite holeplug to 3.2 m, cuttings to 0.1 m, and asphalt to ground surface.
PC-02	None Installed	Backfilled with bentonite holeplug to 3.0 m, cuttings to 0.2 m, concrete to 0.1 m, and asphalt to ground surface.
PC-03	9.1 / 158.2	Piezometer with 1.5 m slotted screen installed with sand filter to 6.1 m, bentonite seal from 6.1 m to 3.0 m, and cuttings to surface.
PC-04	None Installed	Backfilled with bentonite holeplug to 3.6 m, cuttings to 0.1 m, and asphalt to ground surface.
PC-05	9.1 / 156.4	Piezometer with 1.5 m slotted screen installed with sand filter to 6.6 m, bentonite seal from 6.6 m to 2.7 m, cuttings from 2.7 m to 0.15 m, and asphalt to ground surface.
PC-06	None Installed	Backfilled with bentonite holeplug to 2.7 m, cuttings to 0.1 m, and asphalt to ground surface.
PC-07	None Installed	Backfilled with bentonite holeplug to 3.0 m, cuttings to 0.3 m, sand to 0.1 m, and asphalt to ground surface.
PC-08	9.1 / 158.3	Piezometer with 1.5 m slotted screen installed with sand filter to 6.7 m, bentonite seal from 6.7 m to 3.1 m, cuttings from 3.1 m to 0.15 m, and asphalt to ground surface.
PC-09	9.1 / 162.0	Piezometer with 1.5 m slotted screen installed with sand filter to 6.1 m, bentonite seal from 6.1 m to 3.1 m, and cuttings to ground surface.
PC-10	None Installed	Backfilled with bentonite holeplug to 3.0 m, cuttings to 0.2 m, sand to 0.1 m, and asphalt to ground surface.
PC-11	9.1 / 163.9	Piezometer with 1.5 m slotted screen installed with sand filter to 6.7 m, bentonite seal from 6.7 m to 3.1 m, cuttings from 3.1 m to 0.6 m, and asphalt to ground surface.
PC-12	None Installed	Backfilled with bentonite holeplug to 2.7 m, cuttings to 0.1 m, and asphalt to ground surface.
PC-13	None Installed	Backfilled with bentonite holeplug to 3.0 m, cuttings to 0.3 m, and asphalt to ground surface.
PC-14	9.1 / 163.7	Piezometer with 1.5 m slotted screen installed with sand filter to 6.1 m, bentonite seal from 6.1 m to 3.1 m, and cuttings to ground surface.
PC-15	9.3 / 159.9	Piezometer with 1.5 m slotted screen installed with sand filter to 6.6 m, bentonite seal from 6.6 m to 1.9 m, cuttings from 1.9 m to 0.2 m, and cement to ground surface.
PC-16	None Installed	Backfilled with bentonite holeplug to 3.0 m, cuttings to 0.1 m, and asphalt to ground surface.
PC-17	None Installed	Backfilled with bentonite holeplug to 2.5 m, cuttings to 0.15 m, and asphalt to ground surface.
PC-18	9.1 / 158.5	Piezometer with 1.5 m slotted screen installed with sand filter to 6.7 m, bentonite seal from 6.7 m to 4.4 m, cuttings from 4.4 m to 0.15 m, and asphalt to ground surface.
PC-19	None Installed	Backfilled with bentonite holeplug to 3.0 m, cuttings to 0.3 m, and sand and gravel to ground surface.

PC-20	9.1 / 156.3	Piezometer with 1.5 m slotted screen installed with sand filter to 6.1 m, bentonite seal from 6.1 m to 1.8 m, and cuttings to ground surface.
PC-21	8.2 / 160.0	Piezometer with 1.5 m slotted screen installed with sand filter to 6.1 m, bentonite seal from 6.1 m to 2.0 m, cuttings from 2.0 m to 0.15 m, and asphalt to ground surface.
PC-22	None Installed	Backfilled with bentonite holeplug to 2.1 m, cuttings to 1.5 m, and asphalt to ground surface.
PC-23	None Installed	Backfilled with bentonite holeplug to 2.0 m, cuttings to 0.1 m, and asphalt to ground surface.
PC-24	7.6 / 161.4	Piezometer with 1.5 m slotted screen installed with sand filter to 5.5 m, bentonite seal from 5.5 m to 3.1 m, cuttings from 3.1 m to 0.3 m, and concrete to ground surface.
PC-25	8.8 / 172.4	Piezometer with 1.5 m slotted screen installed with sand filter to 7.0 m, bentonite seal from 7.0 m to 1.5 m, cuttings from 1.5 m to 0.15 m, and cement to ground surface.
PC-26	None Installed	Backfilled with bentonite holeplug to 1.9 m, cuttings to 0.1 m, and asphalt to ground surface.
PC-27	None Installed	Backfilled with bentonite holeplug to 3.0 m, cuttings to 0.15 m, and asphalt to ground surface.
PC-28	9.1 / 171.9	Piezometer with 1.5 m slotted screen installed with sand filter to 7.1 m, bentonite seal from 7.1 m to 2.0 m, cuttings from 2.0 m to 0.3 m, and cement to ground surface.
PC-29	9.1 / 170.8	Piezometer with 1.5 m slotted screen installed with sand filter to 7.3 m, bentonite seal from 7.3 m to 2.4 m, cuttings from 2.4 m to 0.3 m, and cement to ground surface.
PC-30	None Installed	Backfilled with bentonite holeplug to 2.6 m, cuttings to 0.2 m, and asphalt to ground surface.

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-01 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 007.7 E 296 413.9 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.24 - 2009.12.24 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.0											
0.0	**ASPHALT:** (90mm)						167				
0.1	**SAND** and **GRAVEL**, some silt Dense Brown Damp		1	SS	50				○		35 48 17 (SI+CL)
166.1	(FILL)										
1.0	Clayey **SILT**, some sand, trace gravel Very Stiff to Stiff Brown (FILL)		2	SS	26		166		○		
			3	SS	13		165		○		
164.7											
2.4	Silty **CLAY**, with sand, trace gravel Very Stiff to Hard Mottled Brown Grey (TILL)(CL to CL-ML)		4	SS	20				○⊢		4 36 40 20
			5	SS	18		164		○		
			6	SS	32		163		○		
			7	SS	35		162		○		
			8	SS	20		161		○		
			9	SS	17		160		○⊢		5 37 39 19
							159				
			10	SS	20		158		○		
157.3											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-01 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 007.7 E 296 413.9 ORIGINATED BY ES

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2009.12.24 - 2009.12.24 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.2m, THEN CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-02 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 015.8 E 296 432.7 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.20 - 2009.12.20 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.3											
0.0	**ASPHALT:** (115mm)										
0.1	Gravelly **SAND**, some silt Very Dense to Dense Brown Damp (FILL)		1	SS	62		167				27 63 10 (SI+CL)
166.2			2	SS	42						
1.1	Clayey **SILT**, some sand, trace gravel Hard to Stiff Brown (FILL)		3	SS	23		166				
			4	SS	13		165				
164.1											
3.2	Silty **SAND**, some clay, some gravel Dense Brown Damp (FILL)		5	SS	43		164				14 44 29 13
163.5											
3.8	Silty **CLAY**, sandy, trace gravel Very Stiff to Hard Brown (TILL)(CL)		6	SS	19		163				
			7	SS	57		162				
			8	SS	40		161				1 23 41 35
			9	SS	11		160				
	Stiff Becoming Grey						159				
			10	SS	30		158				
157.6											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-02 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 015.8 E 296 432.7 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.20 - 2009.12.20 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, THEN CUTTINGS TO 0.2m, THEN CONCRETE TO 0.1m, THEN ASPHALT TO SURFACE.										

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-03 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 093.7 E 296 419.2 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.20 - 2009.12.20 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.3									
0.0	**ASPHALT:** (150mm)								
0.2	Gravelly **SAND**, some silt Dense Grey Moist (FILL)		1	SS	36		167		31 54 15 (SI+CL)
166.4									
0.9	Clayey **SILT**, sandy, trace gravel Very Stiff Grey (FILL)		2	SS	22		166		
165.8									
1.5	Sandy **SILT**, some clay, trace gravel Compact to Loose Grey Moist (FILL)		3	SS	16				
			4	SS	7		165		
164.4									
2.9	Sandy **SILT**, with clayey silt pockets, trace gravel Compact Brown Moist (FILL)(CL-ML)		5	SS	14		164		6 28 52 14
			6	SS	24				
162.8							163		
4.5	Silty **CLAY**, sandy, trace gravel Stiff to Very Stiff Brown (TILL)(CL-ML)		7	SS	14				
							162		
			8	SS	24		161		
							160		
			9	SS	18				4 36 42 18
							159		
			10	SS	21		158		
157.6									
9.8	END OF BOREHOLE AT 9.8m.								

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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

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

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 9270.GPJ 1/25/10

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THURBER

RECORD OF BOREHOLE No PC-03 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 093.7 E 296 419.2 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.20 - 2009.12.20 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 4.3 163.0										

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

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

ONTMT4S 9270.GPJ 1/25/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-04 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 099.6 E 296 433.7 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.22 - 2009.12.22 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.1											
0.0	**ASPHALT:** (75mm)						167				
0.1	Sandy **SILT**, trace clay Brown Moist (FILL)		1	AS					○		9 47 31 13
166.5 0.6	Clayey **SILT**, some sand, trace gravel Very Stiff Brown Moist (FILL)		1	SS	24		166		○		
165.7 1.4	Sandy **SILT**, some clay, trace to some gravel Dense to Loose Brown Moist (FILL)		2	SS	30				○		
			3	SS	8		165		○		11 32 45 12
164.1 3.0	Sandy **SILT**, with clayey silt pockets, trace gravel Loose to Dense Brown Moist (FILL)		4	SS	9		164		○		
			5	SS	30		163		○		
162.2 4.9	Silty **CLAY**, sandy, trace gravel, with 100mm topsoil layer at 4.9m Stiff to Very Stiff Brown (TILL)(CL-ML)		6	SS	12				○ ○		
							162				
			7	SS	13		161		○		
							160				
			8	SS	12				⊖		2 31 48 19
							159				
							158				
			9	SS	26				○		
157.4 9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-04 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 099.6 E 296 433.7 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.22 - 2009.12.22 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.6m, THEN CUTTINGS TO 0.1m, THEN ASPHALT COLD PATCH TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-05 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 252.0 E 296 315.0 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.23 - 2009.12.23 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
165.5											
0.0	**ASPHALT:** (100mm)										
0.1	**SAND** and **GRAVEL**, some silt Very Dense to Compact Brown Damp (FILL)		1	SS	54		165	○	○		40 49 11 (SI+CL)
164.5			2	SS	14				○		
1.0	Clayey **SILT**, sandy, trace gravel Firm to Very Stiff Brown (FILL)		3	SS	8		164		○		
			4	SS	16		163		○		
			5	SS	17		162		○		
160.9			6	SS	27				○		4 28 55 13
4.6	Silty **CLAY**, with sand, trace gravel Very Stiff to Hard Grey to Brown (TILL)(CL-ML)		7	SS	19		161		○		
							160 ▼				
			8	SS	34		159		○		
			9	SS	21		158		○		
							157				
			10	SS	38		156		⊣		4 37 39 20
155.8											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-05 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 252.0 E 296 315.0 ORIGINATED BY ES

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2009.12.23 - 2009.12.23 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 5.6 159.9										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-06 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 260.0 E 296 340.3 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.21 - 2009.12.21 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
165.8											
0.0	**ASPHALT:** (100mm)										
0.1	**SAND** and **GRAVEL**, trace silt Very Dense to Compact Brown Damp (FILL)		1	SS	72						41 55 4 (SI+CL)
164.7			2	SS	16		165				
1.1	Silty **CLAY**, sandy, trace gravel, occasional cobbles Stiff to Hard Brown (FILL)(CI)		3	SS	11		164				0 30 44 26
			4	SS	11		163				
			5	SS	21						
			6	SS	30		162				
159.7			7	SS	20		161				
6.1	Silty **CLAY**, sandy, trace gravel Hard Brown (TILL)(CL)		8	SS	33		160				3 32 45 20
	Becoming grey		9	SS	54		159				
156.1			10	SS	36		158				
9.8	END OF BOREHOLE AT 9.8m.						157				

Continued Next Page

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

15 20 5 10 (%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-06 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 260.0 E 296 340.3 ORIGINATED BY ES

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2009.12.21 - 2009.12.21 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.7m, THEN CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-07 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 779.4 E 296 126.5 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.20 - 2009.12.20 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.6											
0.0	**ASPHALT:** (150mm)										
0.2	Gravelly **SAND**, trace silt Very Dense Brown Moist		1	SS	50/ 0.125		167				
166.9											
0.8	(FILL)		2	SS	24						
	Silty **CLAY**, sandy, trace gravel Very Stiff to Firm Grey (FILL)(CL)		3	SS	8		166				
			4	SS	6		165				2 31 45 22
			5	SS	10						
163.9							164				
3.7	Silty **CLAY**, sandy, trace gravel Very Stiff to Hard Grey (TILL)(CL)		6	SS	20						
			7	SS	17		163				1 31 46 22
	Occasional sand and gravel layers		8	SS	14		162				
	Occasional cobbles						161				
			9	SS	23		160				0 24 51 25
							159				
157.9			10	SS	35		158				
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-07 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 779.4 E 296 126.5 ORIGINATED BY LG

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2009.12.20 - 2009.12.20 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, CUTTINGS TO 0.3m, SAND TO 0.1m, THEN COLD PATCH TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-08 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 781.3 E 296 143.6 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.23 - 2009.12.23 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.4												
0.0	**ASPHALT:** (90mm)											
0.1	**SAND**, some gravel Very Dense Brown Damp		1	SS	57		167					
166.5	(FILL)											
0.9	Silty **CLAY**, sandy, trace gravel Stiff to Very Stiff Brown (FILL)(CL)		2	SS	23							5 31 40 24
			3	SS	9		166					
			4	SS	12		165					
			5	SS	14							
	Occasional cobbles		6	SS	21		164					
162.7												
4.7	Silty **CLAY**, sandy, trace gravel Very Stiff to Hard Brown to Grey (TILL)(CL)		7	SS	21		163					
							162					
			8	SS	23	▼	161					6 35 40 19
			9	SS	50/ 0.075		160					
							159					
			10	SS	46		158					
157.6												
9.8	END OF BOREHOLE AT 9.8m.											

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-08 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 839 781.3 E 296 143.6 ORIGINATED BY ES

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2009.12.23 - 2009.12.23 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 6.3 161.1										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-09 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 225.4 E 295 920.3 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.21 - 2009.12.21 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.1												
0.0	**ASPHALT:** (150mm)						171					
0.2	**SAND** and **GRAVEL**, trace silt Compact Brown Moist (FILL)		1	SS	26					○		42 54 4 (SI+CL)
170.3												
0.8	Silty **CLAY**, sandy, trace gravel Stiff Brown (FILL)(CL)		2	SS	10		170			○		
			3	SS	9		169			○⊣		3 34 42 21
			4	SS	15					○		
			5	SS	8		168			○		
			6	SS	12		167			○		
165.4							166					
5.6	Silty **CLAY**, sandy, trace gravel Stiff to Very Stiff Mottled Brown Grey (TILL)(CL)		7	SS	13		165			○		
	Becoming Brown		8	SS	19		164			○⊣		3 32 42 23
							163					
161.3			9	SS	24		162			○		
9.8	END OF BOREHOLE AT 9.8m.											

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-09 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 225.4 E 295 920.3 ORIGINATED BY LG

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2009.12.21 - 2009.12.21 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 5.3 165.8										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-10 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 227.5 E 295 937.8 ORIGINATED BY SLL
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.23 - 2009.12.23 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
170.9 / 0.0											
0.1	**ASPHALT:** (75mm)		1	SS	50/						
	Gravelly **SAND**, some silt Very Dense Brown		1	GS	0.075						21 64 15 (SI+CL)
170.2 / 0.7	Moist (FILL)										
	Silty **CLAY**, with sand, trace gravel Very Stiff to Stiff Brown (FILL)(CL)		2	SS	18		170				
			3	SS	12		169				
			4	SS	15						1 35 42 22
	Occasional fine sand seams		5	SS	21		168				
			6	SS	10		167				
			7	SS	14		166				
163.8			8	SS	12		165				4 35 39 22
7.2	Silty **CLAY**, sandy, trace gravel Stiff to Very Stiff Brown (TILL)						164				
			9	SS	13		163				
			10	SS	18		162				
161.2 / 9.8	END OF BOREHOLE AT 9.8m.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-10 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 227.5 E 295 937.8 ORIGINATED BY SLL
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.23 - 2009.12.23 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, CUTTINGS TO 0.2m, SAND TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-11 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 786.3 E 295 620.1 ORIGINATED BY LRB
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.10 - 2010.01.10 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.0							173				
0.0	**ASPHALT:** (100mm)										
0.1	Silty **SAND**, some clay, trace gravel Very Dense Brown		1	SS	71				○		
172.2	(FILL)						172				
0.8	Silty **CLAY**, with sand, some gravel Very Stiff to Stiff Grey (FILL)		2	SS	25				○		
			3	SS	22		171		○		15 39 32 14
	Becoming brown		4	SS	18				○		
			5	SS	11		170		○		
168.7			6	SS	14				○		
4.3	Silty **CLAY**, trace to some sand, trace gravel Very Stiff to Hard Brown (TILL)(Cl)		7	SS	17		169		○		1 17 29 53
							168				
			8	SS	35		167		○		
							166				
			9	SS	19		165		○		
							164				
163.2			10	SS	30				○		0 5 29 66
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No PC-11 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 786.3 E 295 620.1 ORIGINATED BY LRB
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.10 - 2010.01.10 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 Dry										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-12 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 796.8 E 295 645.0 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.22 - 2009.12.22 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.4											
0.0	**ASPHALT:** (100mm)										
0.1	Gravelly **SAND**, some silt Very Dense Brown Damp (FILL)		1	SS	63		173				32 55 13 (SI+CL)
172.1			2	SS	50						
1.3	Silty **CLAY**, some sand, trace gravel Firm to Very Stiff Brown (FILL)(CI-CL)		3	SS	8		172				
			4	SS	10		171				3 15 33 49
			5	SS	15		170				
			6	SS	14		169				
			7	SS	23						
166.2			8	SS	10		168 167				2 19 42 37
7.2	Silty **CLAY**, some sand, trace gravel Very Stiff Grey (TILL)		9	SS	18	▽	166 165				
163.6			10	SS	21		164				
9.8	END OF BOREHOLE AT 9.8m.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-12 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 796.8 E 295 645.0 ORIGINATED BY ES

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2009.12.22 - 2009.12.22 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND WATER LEVEL AT 8.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.7m, CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

20 15 10 5 (%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-13 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 848.4 E 295 594.4 ORIGINATED BY MEF
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.10 - 2010.01.10 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.6											
0.0	**ASPHALT:** (150mm)										
0.2	Gravelly **SAND**, some silt Very Dense to Compact Brown Dry (FILL)		1	AS			172		○		
			1	SS	59				○		
			2	SS	52		171		○		21 65 14 (SI+CL)
			3	SS	16		170		○		
			4	SS	20		169		○		
168.6											
4.0	Silty **CLAY**, some sand, trace gravel, trace rootlets Firm Grey (FILL)		5	SS	8				○		
			6	SS	6		168		○		4 18 32 46
166.5							167				
6.1	Silty **CLAY**, sandy, trace gravel Stiff to Very Stiff Brown (TILL)(CL)		7	SS	10		166		○		
			8	SS	22		165		○		
			9	SS	14		164		⊣○⊢		0 33 47 20
162.8							163				
9.8	END OF BOREHOLE AT 9.8m.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-13 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 848.4 E 295 594.4 ORIGINATED BY MEF
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.10 - 2010.01.10 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, THEN CUTTINGS TO 0.3m, THEN ASPHALT PATCH TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-14 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 857.8 E 295 618.1 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.22 - 2009.12.22 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.8											
0.0	**ASPHALT:** (150mm)										
0.2	**SAND**, some gravel, some silt Dense to Compact Brown Moist (FILL)		1	AS					○		
			1	SS	36		172		○		19 66 15 (SI+CL)
			2	SS	11		171		○		
170.6											
2.2	Silty **CLAY**, sandy, trace gravel Firm Brown (FILL)(CI)		3	SS	6		170		○		
			4	SS	8				⊖		2 20 38 40
			5	SS	7		169		○		
167.8			6	SS	8		168		○		
5.0	Silty **CLAY**, some sand, trace gravel Firm to Very Stiff Brown (TILL)(CL)										
			7	SS	9		167		○		
							166				
			8	SS	4		165		⊖		1 16 47 36
							164				
			9	SS	26				○		
163.1											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-14 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 840 857.8 E 295 618.1 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.22 - 2009.12.22 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 5.1 167.7										

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No PC-15 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 187.1 E 295 457.6 ORIGINATED BY SLL
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.13 - 2010.01.13 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
169.2															
0.0 / 168.7	**ASPHALT:** (400mm)						169								
0.5 / 168.5	**SAND**, some gravel Brown Moist (FILL)														
0.7	Silty **CLAY**, sandy, trace gravel Very Stiff to Hard Brown (FILL)(CI)		1	SS	36										
			2	SS	29		168								
166.6			3	SS	40		167								1 30 31 38
2.6	Silty **CLAY**, some sand to sandy, trace gravel Hard Brown (TILL)(CL)		4	SS	36		166								
			5	SS	38		165								
			6	SS	70		164								
	becoming Very Stiff to Stiff becoming Grey		7	SS	20		163								
			8	SS	13	▼	162 161								2 21 32 45
159.4			9	SS	8		160								
9.8	END OF BOREHOLE AT 9.8m.														

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-15 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 187.1 E 295 457.6 ORIGINATED BY SLL

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2010.01.13 - 2010.01.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 8.2 161.0										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-16 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 193.5 E 295 473.7 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.22 - 2009.12.22 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
169.5											
0.0	**ASPHALT:** (125mm)										
0.1	**SAND** and **GRAVEL**, some silt Very Dense to Compact Brown Damp (FILL)		1	SS	60		169		○		35 52 13 (SI+CL)
168.2			2	SS	25				○		
1.3	Silty **CLAY**, some sand, trace gravel Very Stiff Brown (FILL)(CI)		3	SS	29		168		○		
166.8	Cobble at 2.7m		4	SS	23		167		○		2 13 34 51
2.7	Silty **SAND**, some gravel, trace clay pockets, occasional cobbles Compact Brown Damp (FILL)		5	SS	27		166		○		
166.0											
3.5	Silty **CLAY**, some sand, trace gravel Very Stiff Grey (FILL)		6	SS	10		165		○		
165.6											
3.9	Silty **CLAY**, some sand, trace gravel Stiff to Very Stiff Grey (TILL)(CI) becoming Brown		7	SS	22	▽	164		○		
			8	SS	26		163		○		
			9	SS	23		162		○		0 16 32 52
			10	SS	15		161		○		
159.7							160		○		
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-16 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 193.5 E 295 473.7 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.22 - 2009.12.22 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND WATER LEVEL AT 5.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, THEN CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-17 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 380.8 E 295 374.6 ORIGINATED BY SLL
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.12 - 2010.01.12 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.3											
0.0	**ASPHALT:** (125mm)										
0.1	Gravelly **SAND**, trace silt Brown Moist (FILL)		1	GS			167		○		26 70 4 (SI+CL)
166.7											
0.6	Silty **CLAY**, sandy, trace gravel Very Stiff to Hard Brown (FILL)		1	SS	17				○		
			2	SS	24		166		○		
165.1											
2.3	Silty **CLAY**, sandy, trace gravel Hard to Very Stiff Brown to Grey (TILL)(CL to CI)		3	SS	22		165		○		
			4	SS	35		164		○		2 24 43 31
			5	SS	55				○		
			6	SS	29		163				
			7	SS	21		162				1 31 37 31
			8	SS	22		161		○		
			9	SS	48		160		○		
157.6							159				
9.8	END OF BOREHOLE AT 9.8m.						158				

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

(%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-17 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 380.8 E 295 374.6 ORIGINATED BY SLL

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2010.01.12 - 2010.01.12 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.5m, AUGER CUTTINGS TO 0.15m, AND ASPHALT PATCH TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-18 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 386.0 E 295 391.8 ORIGINATED BY ES
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.21 - 2009.12.21 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.6											
0.0	**ASPHALT:** (125mm)										
0.1	Gravelly **SAND**, trace silt, occasional cobbles		1	SS	38		167				27 63 10 (SI+CL)
166.9	Dense										
0.7	Brown		2	SS	63/ 0.275						
	Damp										
	(FILL)										
	Silty **CLAY**, trace sand, trace gravel, occasional cobbles		3	SS	27		166				0 7 31 62
	Hard to Very Stiff										
	Brown										
165.3	(FILL)(CI)										
2.3	Silty **CLAY**, sandy, trace gravel		4	SS	15		165				
	Stiff to Hard										
	Brown		5	SS	35						
	(TILL)(CL)						164				
			6	SS	31						
			7	SS	26		163				
							162				
			8	SS	13						3 26 35 36
							161				
	230mm clay layer at 7.6m		9	SS	34		160				
							159				
			10	SS	34						
157.8							158				
9.8	END OF BOREHOLE AT 9.8m.										

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

(%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-18 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 386.0 E 295 391.8 ORIGINATED BY ES

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2009.12.21 - 2009.12.21 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND WATER LEVEL AT 6.1m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 3.2 164.4										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No PC-19 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 838.0 E 295 217.3 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.21 - 2009.12.21 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
165.6											
0.0	**SAND** and **GRAVEL**, trace silt Brown Moist		1	AS					○		48 42 10
165.0	(FILL)										(SI+CL)
0.6	Silty **CLAY**, some sand, trace gravel Firm to Stiff Brown (TILL)(CI)		1	SS	7		165		○		
			2	SS	12		164		○		
			3	SS	8		163		○		0 18 30 52
			4	SS	5		162		○		
161.6											
4.0	Silty **SAND**, some clay lenses, trace gravel Compact to Very Dense Grey Moist (TILL)		5	SS	32		161		○		
			6	SS	30		160		○		
			7	SS	29		159		○		
			8	SS	82/ 0.275		158		○		10 45 34 11
	Occasional cobbles										
156.9											
8.7	Sandy **SILT**, trace gravel Compact Grey Moist		9	SS	16		157		○		
155.8							156				
9.8	END OF BOREHOLE AT 9.8m.										

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

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

ONTMT4S 9270.GPJ 1/25/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-19 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 838.0 E 295 217.3 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.21 - 2009.12.21 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, CUTTINGS TO 0.3m, THEN SAND AND GRAVEL TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/25/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-20 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 843.8 E 295 226.9 ORIGINATED BY LG
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.12.23 - 2009.12.23 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
165.4											
0.0 / 164.9	Silty **CLAY**, mixed with **SAND**, trace gravel Brown (FILL)(CL)		1	AS							4 36 27 33
0.5	Silty **CLAY**, some sand, trace gravel Stiff Brown (TILL)		1	SS	10		165		o		
			2	SS	14		164		o		
			3	SS	9		163		o		
			4	SS	13		162		o		
161.3											
4.1	Silty **SAND**, some clay lenses, trace gravel Compact to Dense Grey (TILL)(CL-ML)		5	SS	18		161		o		
			6	SS	35		160				
158.2							159		o⊣		1 27 55 17
7.2	Silty **CLAY**, trace sand, trace gravel Hard to Stiff Grey (TILL)(CL)		7	SS	40		158		o		
							157				
155.7			8	SS	14		156		⊣o		0 9 35 56
9.8	END OF BOREHOLE AT 9.8m.										

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+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 9270.GPJ 1/25/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-20 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 841 843.8 E 295 226.9 ORIGINATED BY LG

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2009.12.23 - 2009.12.23 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 2.1 163.3										

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

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

ONTMT4S 9270.GPJ 1/25/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-21 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 844 149.4 E 294 503.4 ORIGINATED BY SLL
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.21 - 2010.01.21 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
168.2											
0.0	**ASPHALT**: (180mm)										
0.2	**SAND**, some gravel Brown Moist (FILL)		1	GS			168		○		
167.5											
0.8	Silty **CLAY**, sandy, trace gravel Firm to Very Stiff Brown (FILL)(CL)		1	SS	7				○		2 28 38 32
			2	SS	19		167		○		
	wood fragments at 2.4m		3	SS	20		166		○		
164.5			4	SS	8		165		○		
3.7	Silty **CLAY**, trace sand, trace topsoil Firm Brown (FILL)		5	SS	7				○		
			6	SS	8	▼	164		○		
							163				
			7	SS	6		162		○		
160.9							161				
7.3	**SAND** and **GRAVEL**, some silt Dense Brown Wet		8	SS	34				○		47 42 11 (SI+CL)
159.4							160				
8.8	Silty **SAND**, trace clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	84		159		○		
158.5											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No PC-21 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 844 149.4 E 294 503.4 ORIGINATED BY SLL
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.21 - 2010.01.21 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.06 7.5 160.7 2010.01.18 5.1 163.1										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No PC-22 1 OF 1 METRIC

G.W.P. 202-95-00 LOCATION N 4 844 151.6 E 294 519.6 ORIGINATED BY LRB
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.10 - 2010.01.10 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.9												
0.0	**ASPHALT:** (90mm)											
0.1	**SAND** and **GRAVEL**, silty Compact Brown		1	SS	29					○		35 43 22 (SI+CL)
167.3												
0.6	Damp (FILL)											
	Silty **CLAY**, with sand, trace gravel Very Stiff to Stiff Brown (FILL)(CL)		2	SS	26		167			○		
			3	SS	16		166			○		
			4	SS	20		165			○		
	(50mm) thin sandy zone		5	SS	8					⊣○⊢		0 41 33 26
	Occasional wood pieces		6	SS	21		164			○		
163.2												
4.7	**SAND**, some silt, trace gravel Dense Grey/Brown Moist		7	SS	47		163			○		
161.8												
6.1	Gravelly **SAND**, silty Dense Brown		8	SS	42		162			○		27 44 29 (SI+CL)
161.4												
6.5	Wet											
	SAND, some silt Brown Wet						161					
160.6												
7.3	**SAND** and **GRAVEL**, some silt Dense Brown Wet		9	SS	35		160			○		
159.6												
8.4	END OF BOREHOLE AT 8.4m DUE TO AUGER REFUSAL ON POSSIBLE BOULDER OR BEDROCK. BOREHOLE OPEN AND WET UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.1m, THEN CUTTINGS TO 1.5m, THEN ASPHALT TO SURFACE.											

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No PC-23 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 844 228.9 E 294 492.0 ORIGINATED BY SLL
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.06 - 2010.01.06 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
169.4											
0.0	**ASPHALT:** (175mm)										
0.2	**SAND**, some gravel, some silt Brown Moist		1	GS			169		o		
168.7											
0.6	(FILL)										
	Silty **CLAY**, sandy, trace gravel Stiff to Hard Brown (FILL)(CL)		1	SS	11				o		
							168				
			2	SS	20				o ⊢		1 29 44 26
			3	SS	36		167		o		
166.4											
3.0	**SILT**, some clay, trace sand, trace gravel Very Stiff Brown Moist		4	SS	25		166		o		1 7 77 15
165.6											
3.7	(FILL)										
	Silty **CLAY**, some sand, trace gravel Stiff to Hard Grey (TILL)		5	SS	10	▽			o		
							165				
			6	SS	46						
163.6							164				
5.8	Gravelly **SAND**, trace silt Compact Brown Wet		7	SS	22		163		o		
			8	SS	26		162		o		27 63 10 (SI+CL)
			9	SS	23		161				
159.6							160		o		
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-23 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 844 228.9 E 294 492.0 ORIGINATED BY SLL

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2010.01.06 - 2010.01.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN TO 6.1m AND WATER LEVEL AT 4.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.0m, THEN CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-24 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 844 229.1 E 294 507.8 ORIGINATED BY MEF
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.01.10 - 2009.01.10 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
169.0											
0.0	**SAND** and **GRAVEL**, some silt Brown Dry (FILL)		1	AS			169		○		
168.3											
0.8	Silty **CLAY**, sandy, trace gravel Stiff Brown (FILL)(CL)		1	SS	9		168		○		3 33 43 21
			2	SS	11		167		○		
			3	SS	9				○		
165.7			4	SS	9		166		○		
3.4	Silty **CLAY**, some sand, trace gravel, trace shale fragments Loose to Compact Grey Dry (TILL)		5	SS	22		165		○		5 13 60 22
			6	SS	11		164		○		
162.9							163				
6.1	**SAND** and **GRAVEL**, trace silt Compact to Dense Brown Wet		7	SS	28				○		
							162				
			8	SS	35		161		○		41 51 8 (SI+CL)
	Becoming grey										
159.3			9	SS	40		160		○		
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-24 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 844 229.1 E 294 507.8 ORIGINATED BY MEF
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2009.01.10 - 2009.01.10 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN TO 7.6m, AND WET AT 6.1m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 6.1 162.9										

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-25 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 845 118.7 E 294 324.3 ORIGINATED BY LRB
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.12 - 2010.01.12 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.2											
0.0	**ASPHALT:** (225mm)										
0.2	Gravelly **SAND**, trace silt Brown Damp (FILL)						181		○		25 66 9 (SI+CL)
180.5 0.6	**SILT** and **SAND** Compact Brown Damp (FILL)		1	SS	23		180		○		
			2	SS	17		179		○		
			3	SS	20		178		○		
	trace clay		4	SS	17		177		○		0 48 48 4
	becoming Wet		5	SS	12	▼	176		○		
176.3 4.9	Silty **CLAY**, some sand, trace gravel Stiff to Very Stiff Brown (FILL)(CI)		6	SS	10		175		○		
			7	SS	13		174		○		1 18 39 42
			8	SS	13		173		○		
			9	SS	19		172		○		
171.4 9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/25/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-25

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 118.7 E 294 324.3 ORIGINATED BY LRB
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.12 - 2010.01.12 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 4.3 176.9										

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

15-⊕-5 (20 above, 10 below) (%) STRAIN AT FAILURE

ONTMT4S 9270.GPJ 1/25/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-26

METRIC

G.W.P.	202-95-00	LOCATION	N 4 845 120.9 E 294 338.7
HWY	427	BOREHOLE TYPE	Solid Stem Auger
DATUM	Geodetic	DATE	2010.01.13 - 2010.01.13
ORIGINATED BY	SLL	COMPILED BY	AN
CHECKED BY	MEF		

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
181.3 / 0.0	**ASPHALT:** (225mm)
0.2	**SAND**, some gravel Brown Moist (FILL)
180.7 / 0.6	**SILT** and **SAND**, trace to some clay, trace gravel Compact Brown Moist (FILL)
176.8 / 4.5	Silty **CLAY**, some sand, trace gravel Stiff Brown (FILL)(CI)
171.5 / 9.8	END OF BOREHOLE AT 9.8m.

SAMPLES

NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	GS		
1	SS	29	
2	SS	18	0 37 59 4
3	SS	21	
4	SS	26	
5	SS	18	1 37 50 12
6	SS	11	
7	SS	8	1 20 43 36
8	SS	12	
9	SS	12	

GROUND WATER CONDITIONS

ELEVATION SCALE: 181, 180, 179, 178, 177, 176, 175, 174, 173, 172

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

UNIT WEIGHT γ kN/m³

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-26 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 845 120.9 E 294 338.7 ORIGINATED BY SLL

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2010.01.13 - 2010.01.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.9m, THEN CUTTINGS TO 0.1m THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation Ontario

RECORD OF BOREHOLE No PC-27

METRIC

G.W.P. 202-95-00 | LOCATION N 4 845 255.6 E 294 299.8 | ORIGINATED BY LRB

HWY 427 | BOREHOLE TYPE Solid Stem Auger | COMPILED BY AN

DATUM Geodetic | DATE 2010.01.12 - 2010.01.12 | CHECKED BY MEF

ELEV / DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.6 / 0.0	ASPHALT: (125mm)						
0.1	SAND, some silt, some gravel, Compact, Brown, Damp (FILL)	1	SS	50/0.125			
					180		
		2	SS	14			
					179		
		3	SS	21			
178.2 / 2.4	Sandy SILT, some clay zones, Compact to Loose, Brown, Wet (FILL)	4	SS	16	178		
		5	SS	21			0 29 66 5
					177		
176.5 / 4.1	Silty CLAY, sandy, Very Stiff, Brown (FILL)	6	SS	8			
176.0 / 4.6	Silty CLAY, trace sand, trace gravel, Stiff to Very Stiff, Brown (FILL)	7	SS	9	176		
					175		
		8	SS	10			
					174		
					173		
		9	SS	17			
					172		
171.5 / 9.1	Silty CLAY, trace sand, trace rootlets, with 50mm topsoil layer, Stiff, Brown (TILL)(CH)	10	SS	12	171		0 6 34 60
170.9 / 9.8	END OF BOREHOLE AT 9.8m.						

Continued Next Page

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE (20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20 40 60); UNIT WEIGHT γ kN/m³

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-27 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 845 255.6 E 294 299.8 ORIGINATED BY LRB
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.12 - 2010.01.12 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, AUGER CUTTINGS TO 0.15m AND ASPHALT PATCH TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-28 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 845 257.0 E 294 318.8 ORIGINATED BY SLL
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.13 - 2010.01.13 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.0							181				
0.0	**ASPHALT:** (225mm)										
0.2	Gravelly **SAND**, some silt Brown Moist		1	GS					○		31 57 12 (SI+CL)
180.4	(FILL)										
0.6	**SILT** and **SAND**, trace clay, trace gravel Compact Brown Moist (FILL)		1	SS	29		180		○		
			2	SS	26		179		○		
			3	SS	16		178		○		
			4	SS	20				○		0 41 51 8
177.2							177				
3.7	Silty **CLAY**, trace gravel, with some sand seams Stiff to Very Stiff Brown (FILL)		5	SS	11	▼			○		
			6	SS	16		176		○		
			7	SS	15		175		○		
			8	SS	13		174		○		
	trace shale fragments						173		○		
171.9							172				
9.1	Silty **CLAY**, some sand, trace rootlets and wood fragments, with 50mm topsoil layer Very Stiff Brown (TILL)(CH)	TOPSOIL	9	SS	19				⊢●		0 10 51 39
171.2											
9.8											

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-28 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 845 257.0 E 294 318.8 ORIGINATED BY SLL

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2010.01.13 - 2010.01.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	END OF BOREHOLE AT 9.8m. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 4.4 176.6										

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-29 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 845 453.6 E 294 280.2 ORIGINATED BY LRB
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.12 - 2010.01.12 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.9											
0.0	**ASPHALT:** (125mm)										
0.1	**SAND**, some silt, trace gravel Brown Damp (FILL)										
178.8			1	SS	23		179				
1.0	Silty **CLAY**, some sand, trace gravel Very Stiff to Stiff Grey/Brown (FILL)(CL)		2	SS	12		178				
			3	SS	5						0 20 40 40
			4	SS	4		177				
			5	SS	7		176				
175.3											
4.6	**SILT**, some sand to sandy, some clay, trace gravel Compact Brown Moist (FILL)		6	SS	27		175				1 18 66 15
173.8						▼	174				
6.1	Silty **CLAY**, sandy, trace gravel Stiff to Hard Brown (TILL)(CL)		7	SS	12						
			8	SS	19		173				
							172				
							171				
170.1			9	SS	31						1 23 42 34
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-29 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 845 453.6 E 294 280.2 ORIGINATED BY LRB

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2010.01.12 - 2010.01.12 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.01.18 5.8 174.1										

ONTMT4S 9270.GPJ 1/22/10

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-30 1 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 845 453.9 E 294 289.8 ORIGINATED BY SLL
HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
DATUM Geodetic DATE 2010.01.04 - 2010.01.04 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.0											
0.0	**ASPHALT:** (135mm)						180				
0.1	**SAND**, some gravel, some silt Brown Moist (FILL)		1	GS							
179.4											
0.6	Silty **CLAY**, sandy, trace gravel Stiff to Firm Grey (FILL)(CL)		1	SS	13		179				
			2	SS	10		178				
			3	SS	7						
			4	SS	8		177				0 30 44 26
175.7			5	SS	6		176				
4.3	Sandy **SILT**, trace clay Compact Brown to Grey Moist to Wet (FILL)		6	SS	28						0 29 67 4
174.2							175				
5.8	Silty **CLAY**, some sand, trace gravel Stiff Grey (TILL)		7	SS	9		174				
172.6							173				
7.4	Sandy **SILT** Brown										
172.2	Moist										
7.8	Silty **CLAY**, sandy, trace gravel Very Stiff to Hard Brown (TILL)(CL)		8	SS	18		172				
			9	SS	40		171				2 34 44 20
170.2											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

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

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

ONTMT4S 9270.GPJ 1/22/10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PC-30 2 OF 2 METRIC

G.W.P. 202-95-00 LOCATION N 4 845 453.9 E 294 289.8 ORIGINATED BY SLL

HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN

DATUM Geodetic DATE 2010.01.04 - 2010.01.04 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN TO 5.2m, DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.6m, THEN CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 9270.GPJ 1/22/10

Appendix B

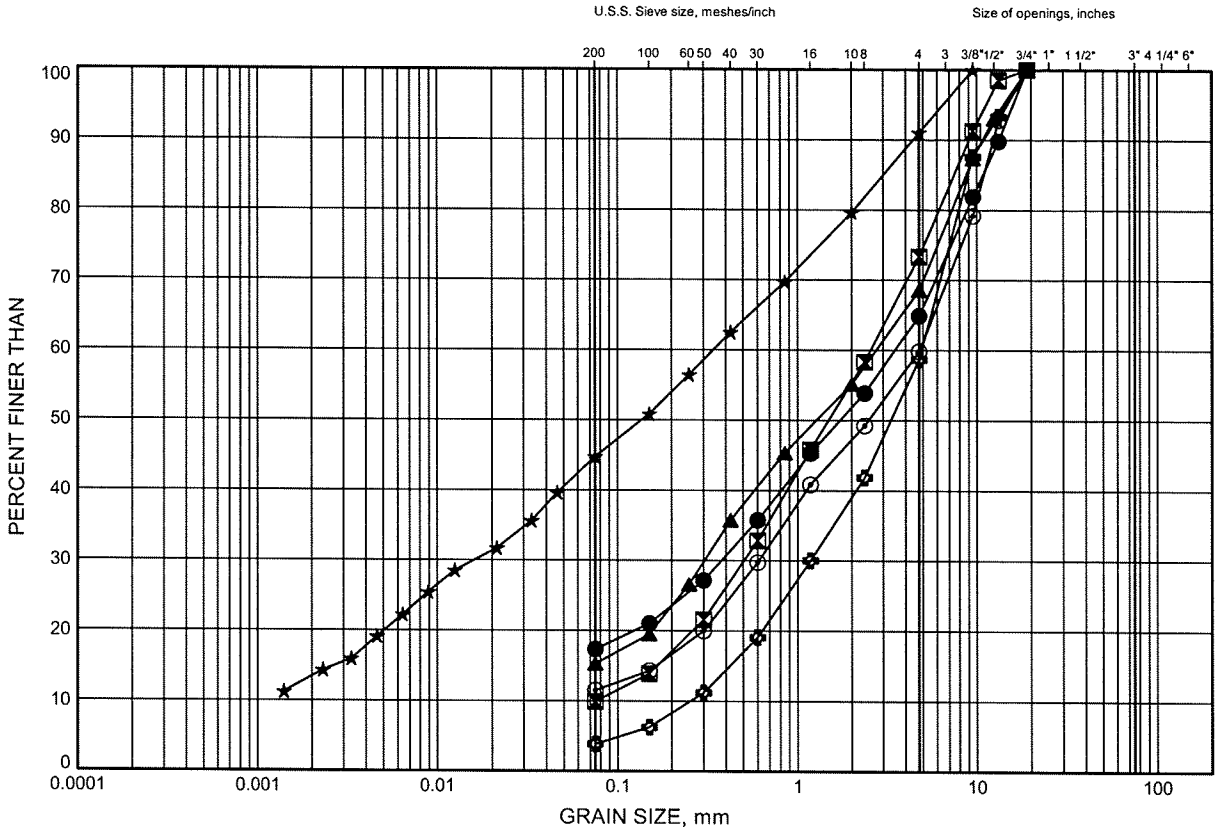
Laboratory Test Results

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B1

GRANULAR FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-01	0.46	166.57
⊠	PC-02	0.46	166.89
▲	PC-03	0.30	167.02
★	PC-04	0.30	166.80
⊙	PC-05	0.46	165.06
✿	PC-06	0.46	165.37

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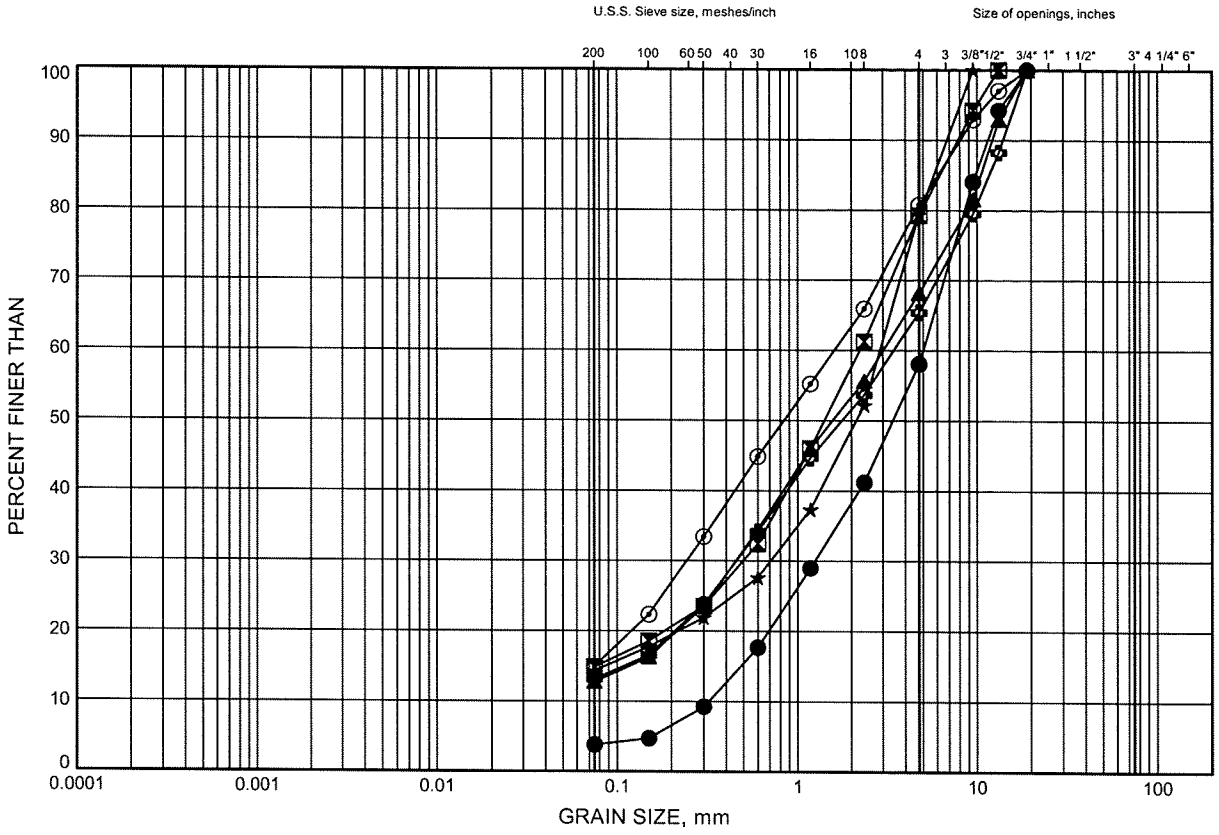
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B2

GRANULAR FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-09	0.30	170.75
⊠	PC-10	0.20	170.72
▲	PC-12	0.46	172.91
★	PC-13	1.83	170.73
⊙	PC-14	1.07	171.78
✿	PC-16	0.46	169.01

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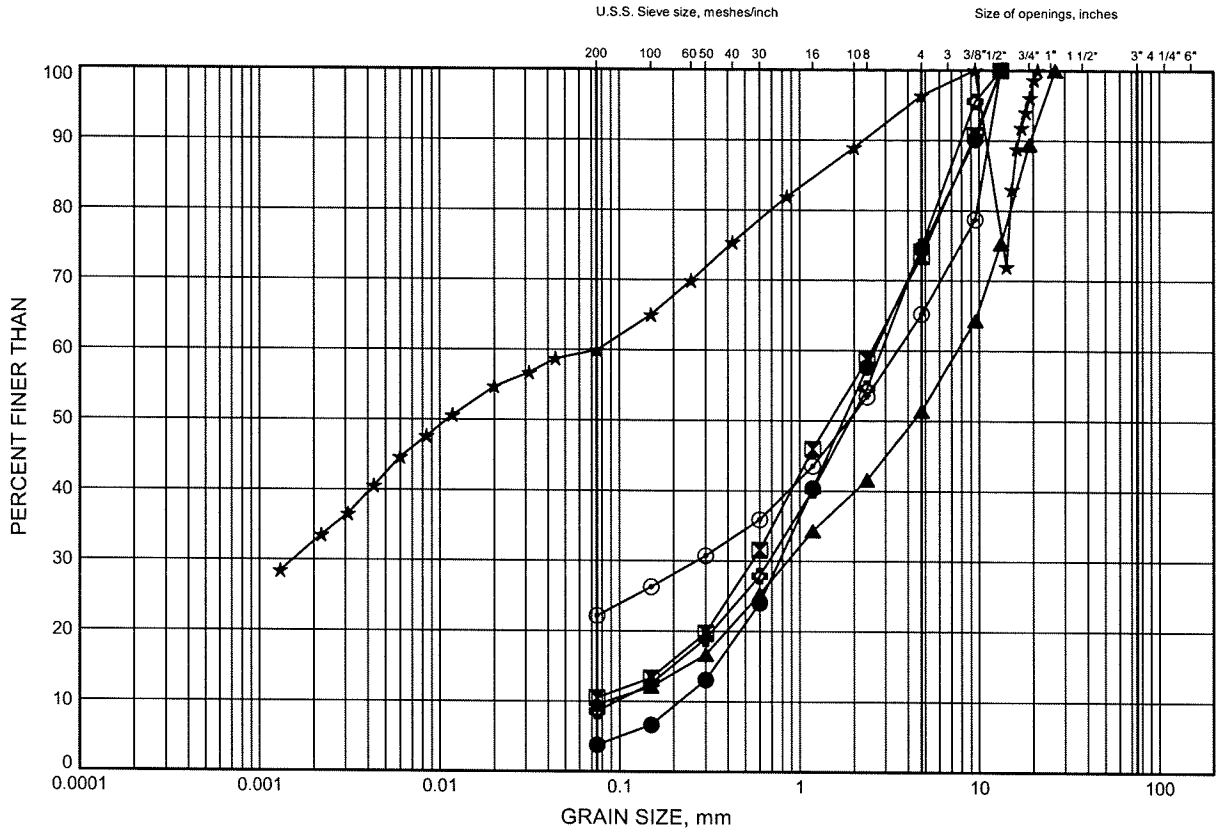
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B3

GRANULAR FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-17	0.27	167.08
⊠	PC-18	0.46	167.12
▲	PC-19	0.30	165.29
★	PC-20	0.30	165.10
⊙	PC-22	0.38	167.54
✿	PC-25	0.30	180.85

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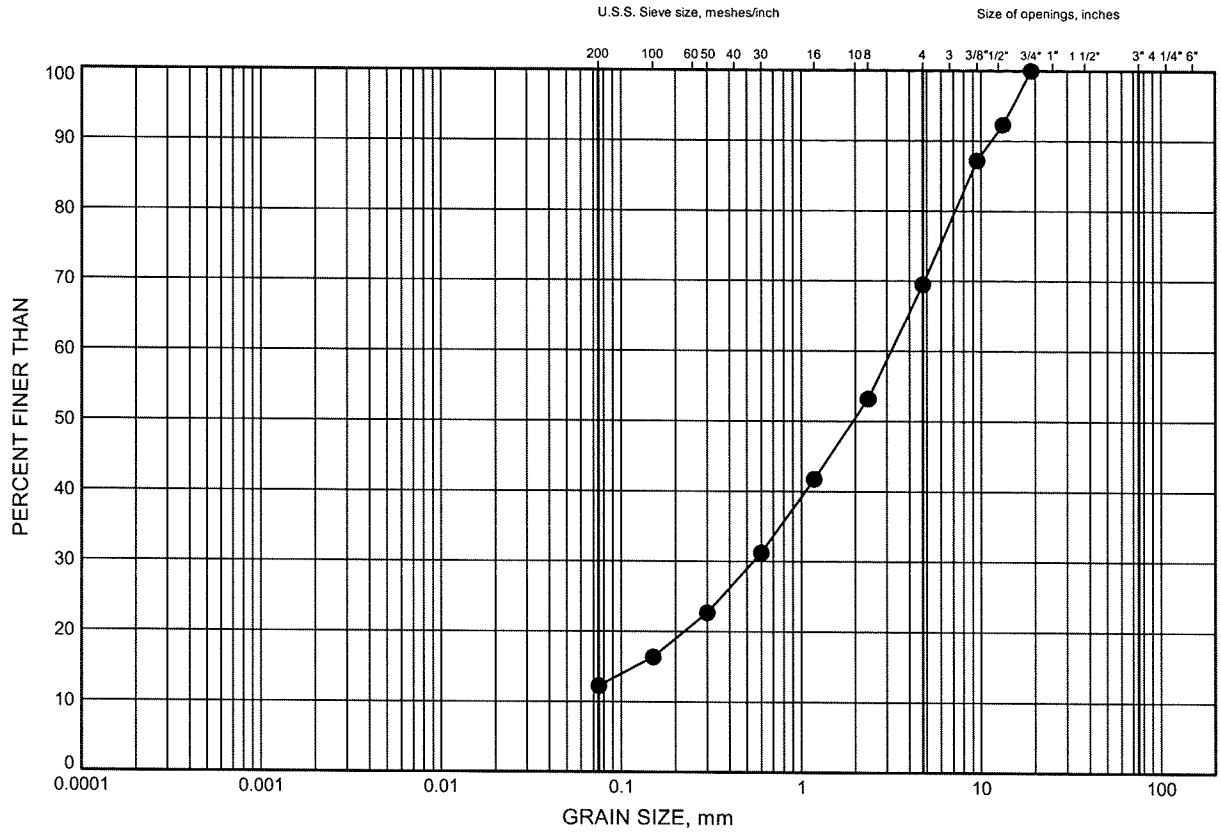
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B4

GRANULAR FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-28	0.30	180.67

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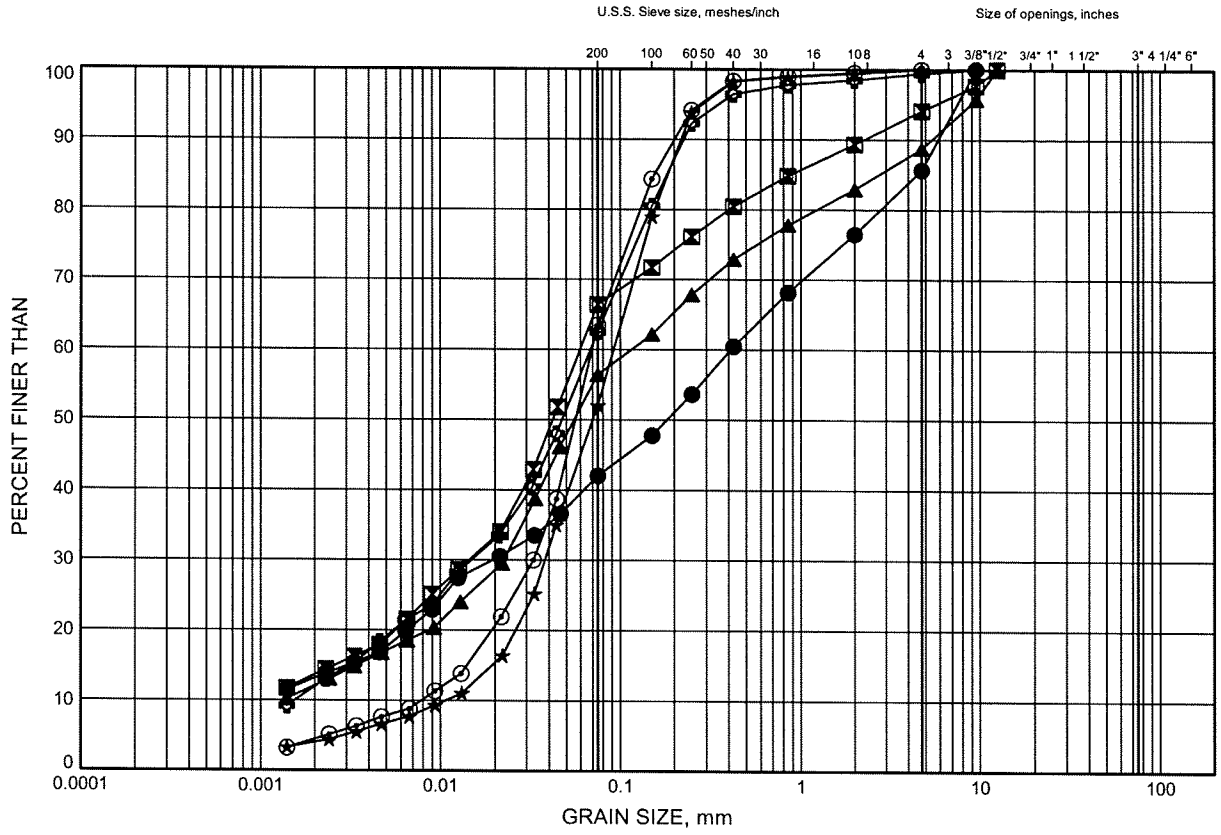
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND TO SANDY SILT FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-02	3.35	163.99
⊠	PC-03	3.35	163.97
▲	PC-04	2.59	164.52
★	PC-25	3.35	177.80
⊙	PC-26	1.83	179.45
✪	PC-26	4.11	177.16

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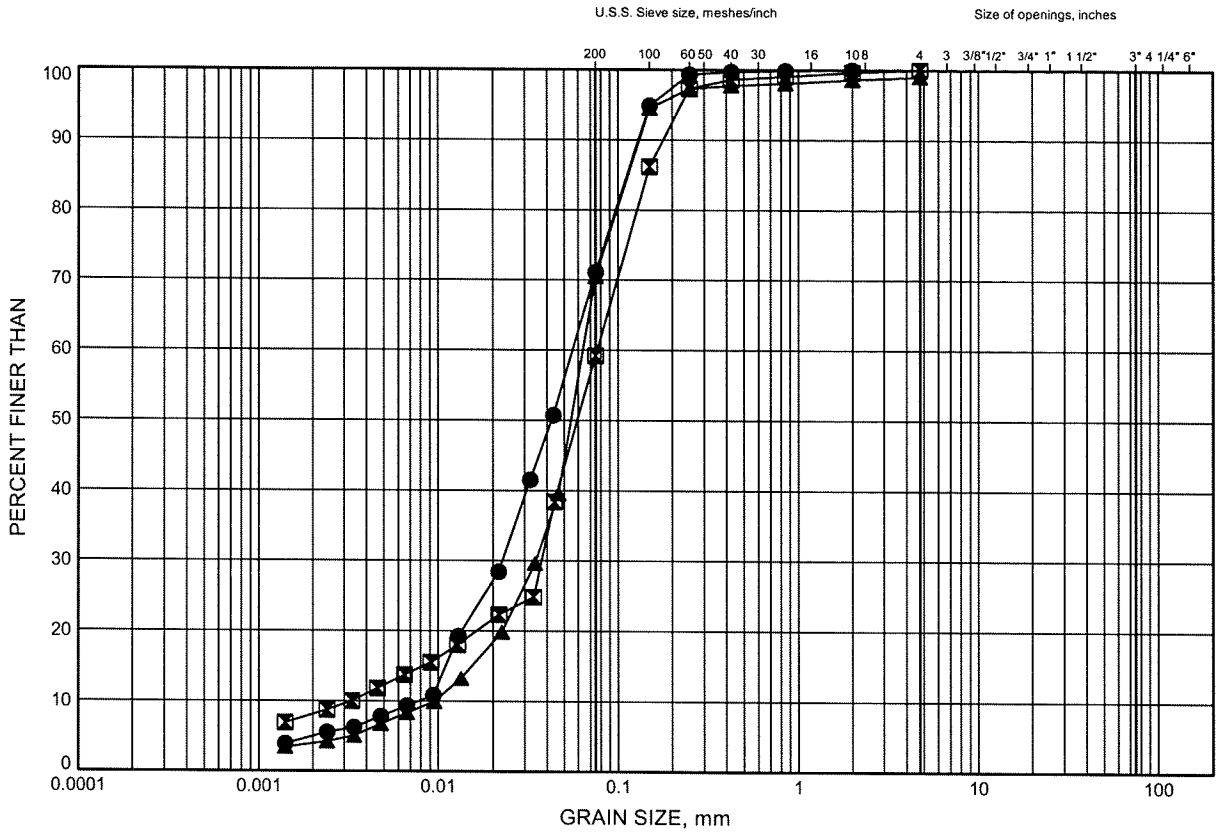
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND TO SANDY SILT FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-27	3.35	177.25
⊠	PC-28	3.35	177.62
▲	PC-30	4.88	175.12

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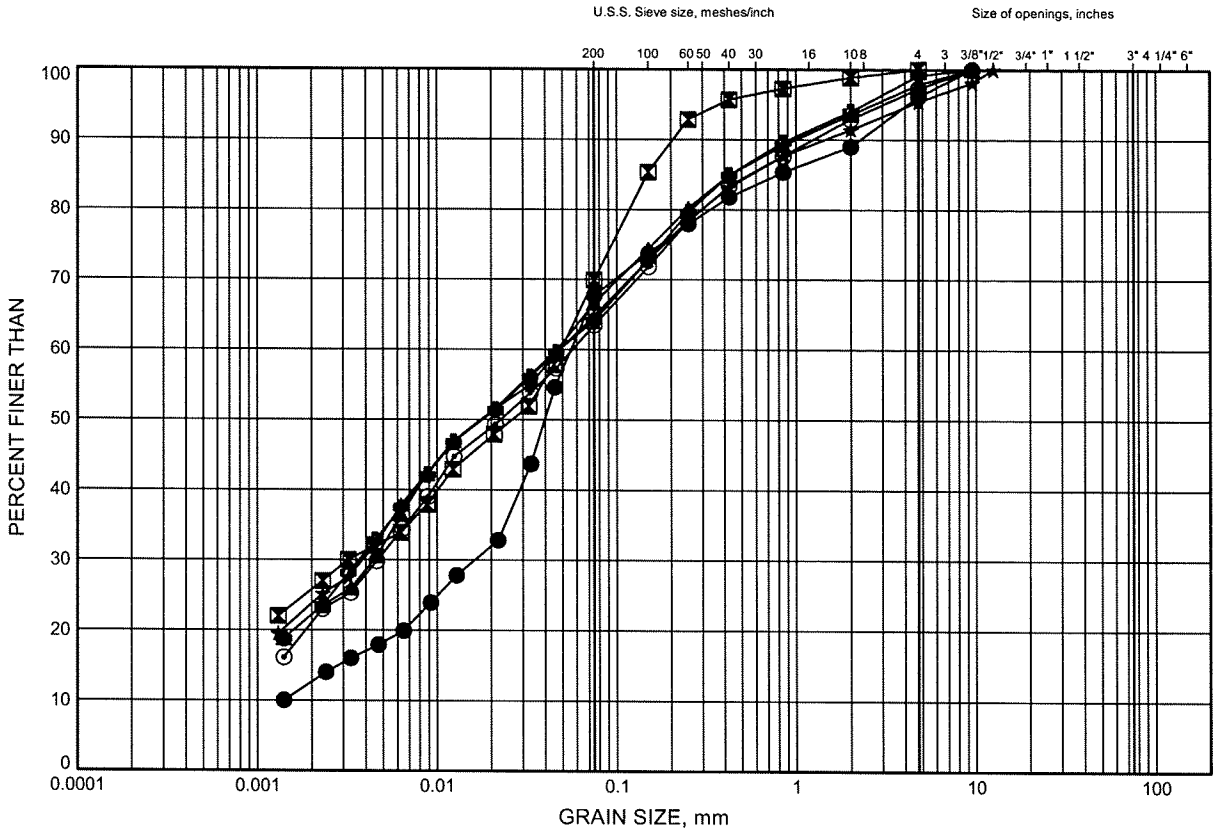
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B7

CLAYEY SILT TO SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-05	4.11	161.40
⊠	PC-06	1.83	163.99
▲	PC-07	2.59	165.05
★	PC-08	1.07	166.31
⊙	PC-09	1.83	169.22
✿	PC-10	2.59	168.33

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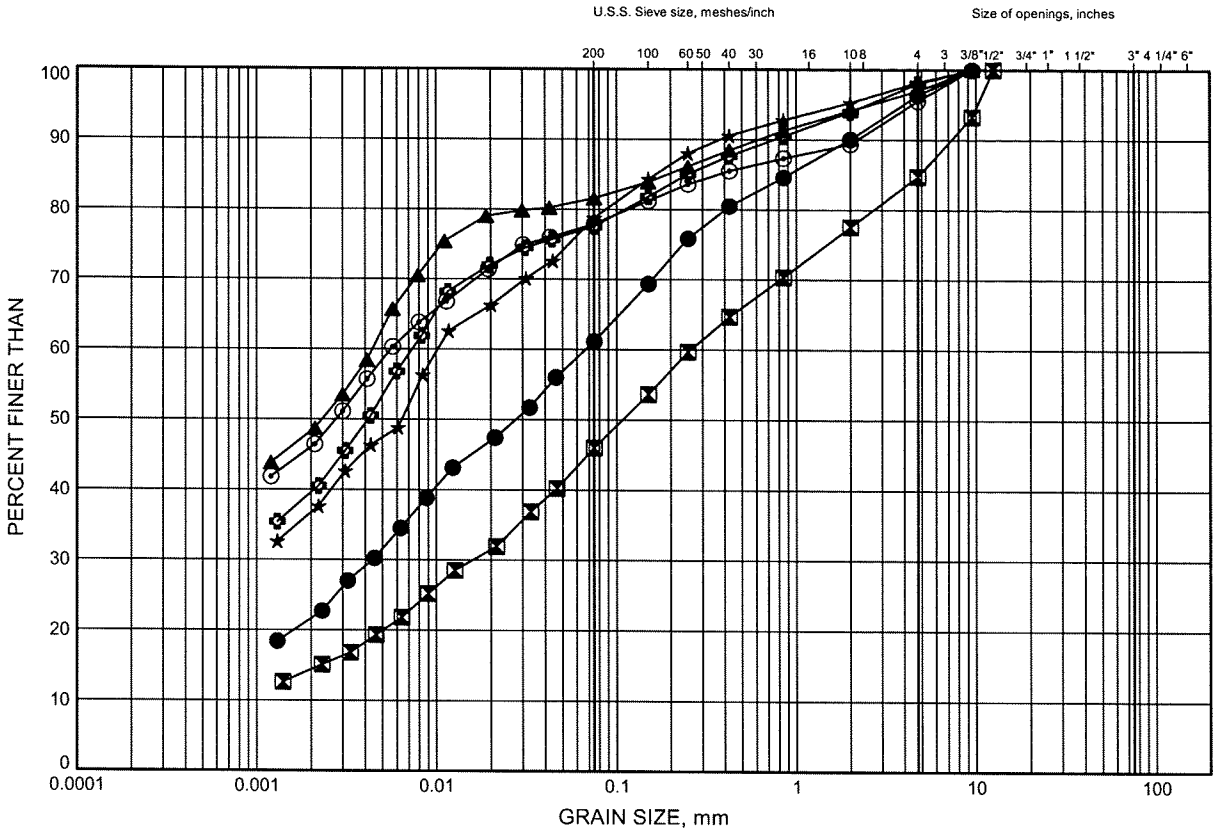
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B8

CLAYEY SILT TO SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-10	6.40	164.52
⊠	PC-11	1.83	171.15
▲	PC-12	2.59	170.78
★	PC-12	6.40	166.97
⊙	PC-13	4.88	167.68
✿	PC-14	3.35	169.49

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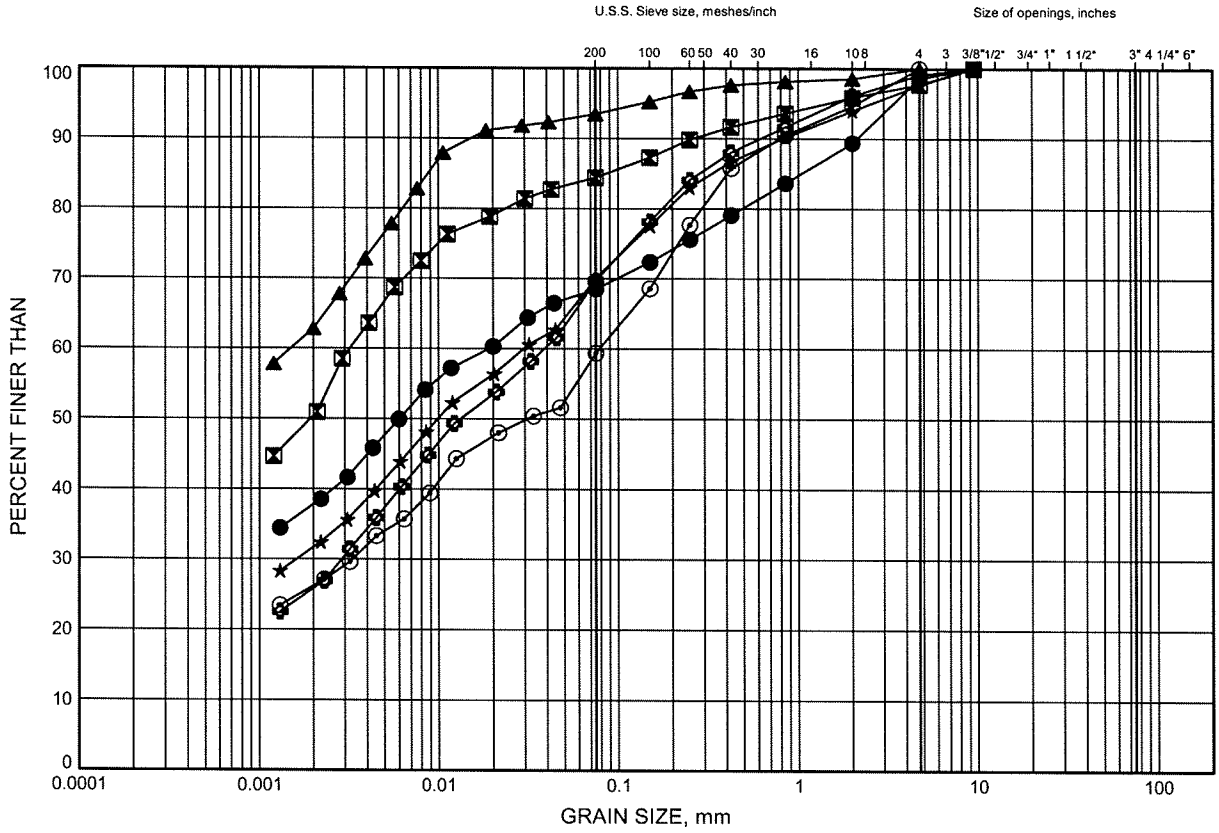
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B9

CLAYEY SILT TO SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-15	2.46	166.73
⊠	PC-16	2.59	166.88
▲	PC-18	1.83	165.75
★	PC-21	1.07	167.18
⊙	PC-22	3.35	164.57
✿	PC-23	1.83	167.53

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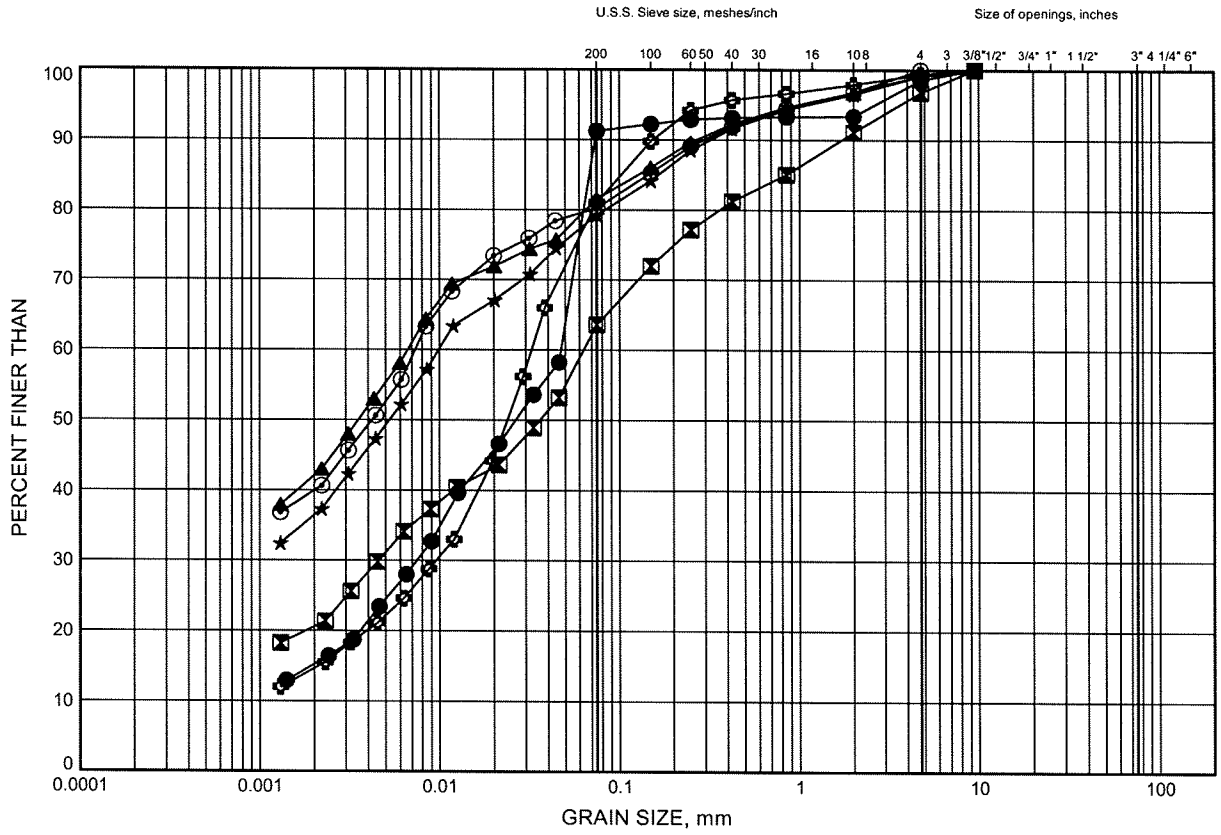
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B10

CLAYEY SILT TO SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-23	3.35	166.01
⊠	PC-24	1.07	167.95
▲	PC-25	6.40	174.75
★	PC-26	6.40	174.88
⊙	PC-29	2.59	177.29
✿	PC-29	4.88	175.00

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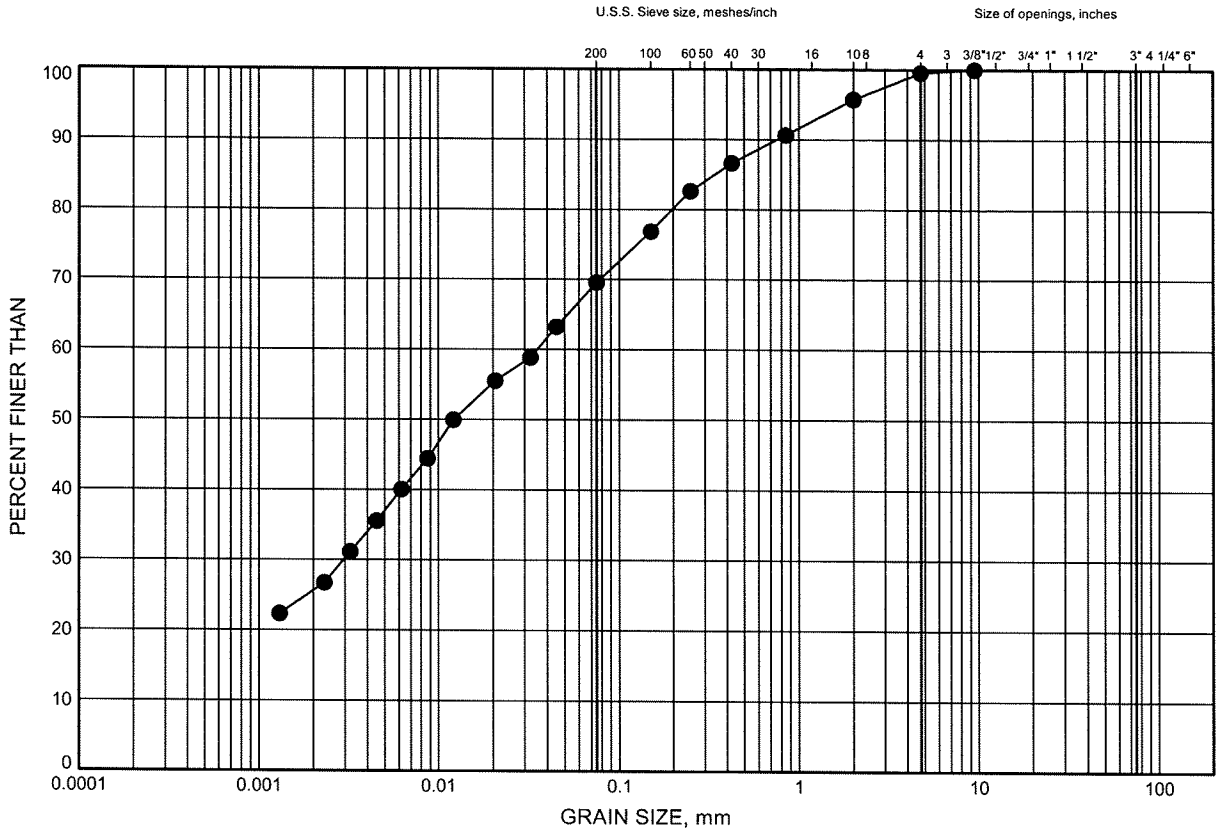
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B11

CLAYEY SILT TO SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-30	3.35	176.65

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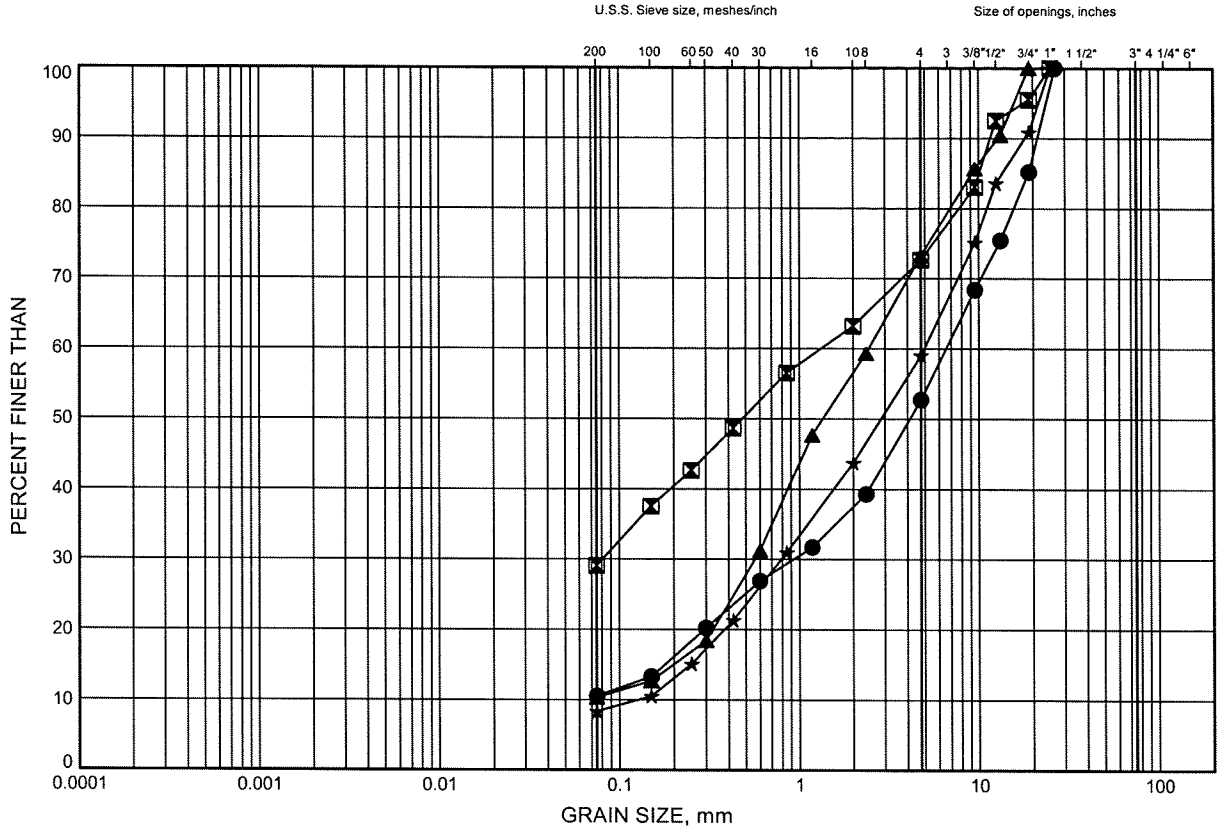
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B12

SAND TO SAND & GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-21	7.92	160.32
⊠	PC-22	6.40	161.52
▲	PC-23	7.92	161.43
★	PC-24	7.92	161.09

W.P.# 202-95-00

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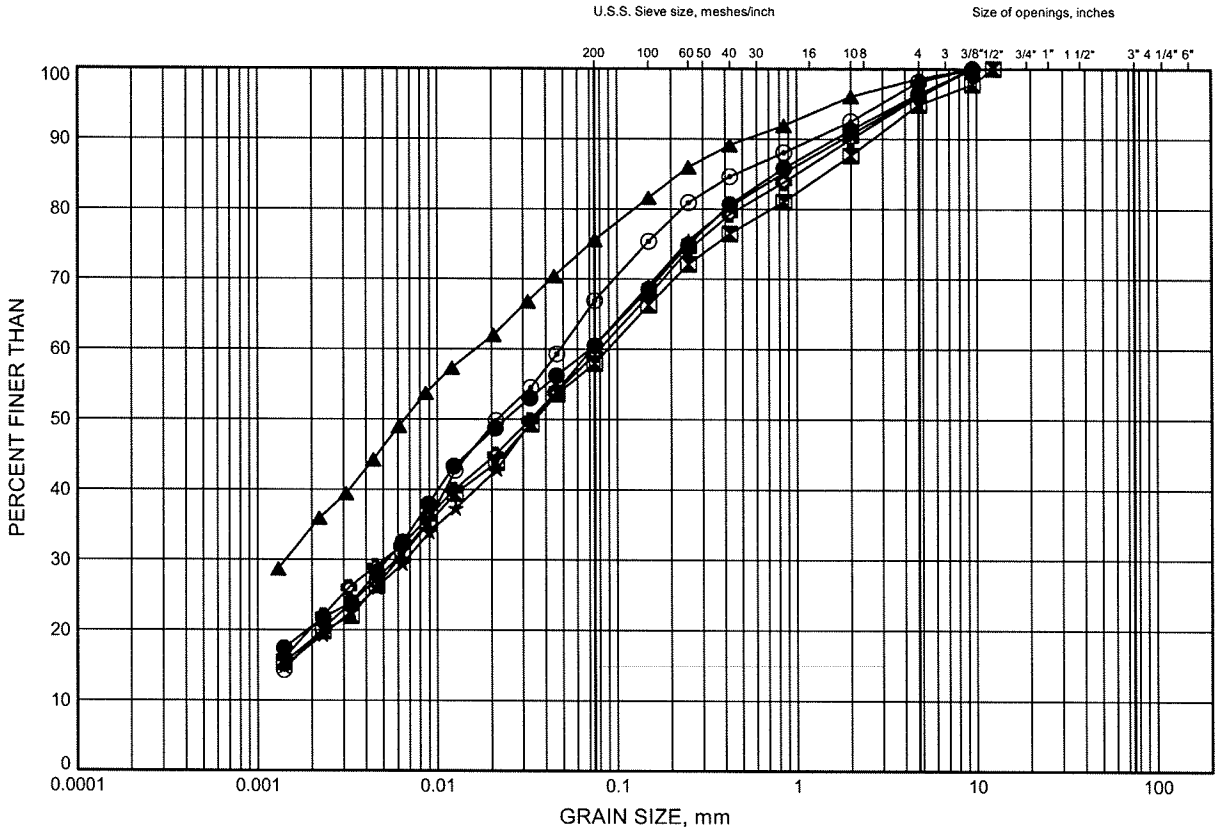
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B13

SILTY CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-01	2.59	164.43
⊠	PC-01	7.92	159.10
▲	PC-02	6.40	160.95
★	PC-03	7.92	159.40
⊙	PC-04	7.92	159.18
✿	PC-05	9.45	156.07

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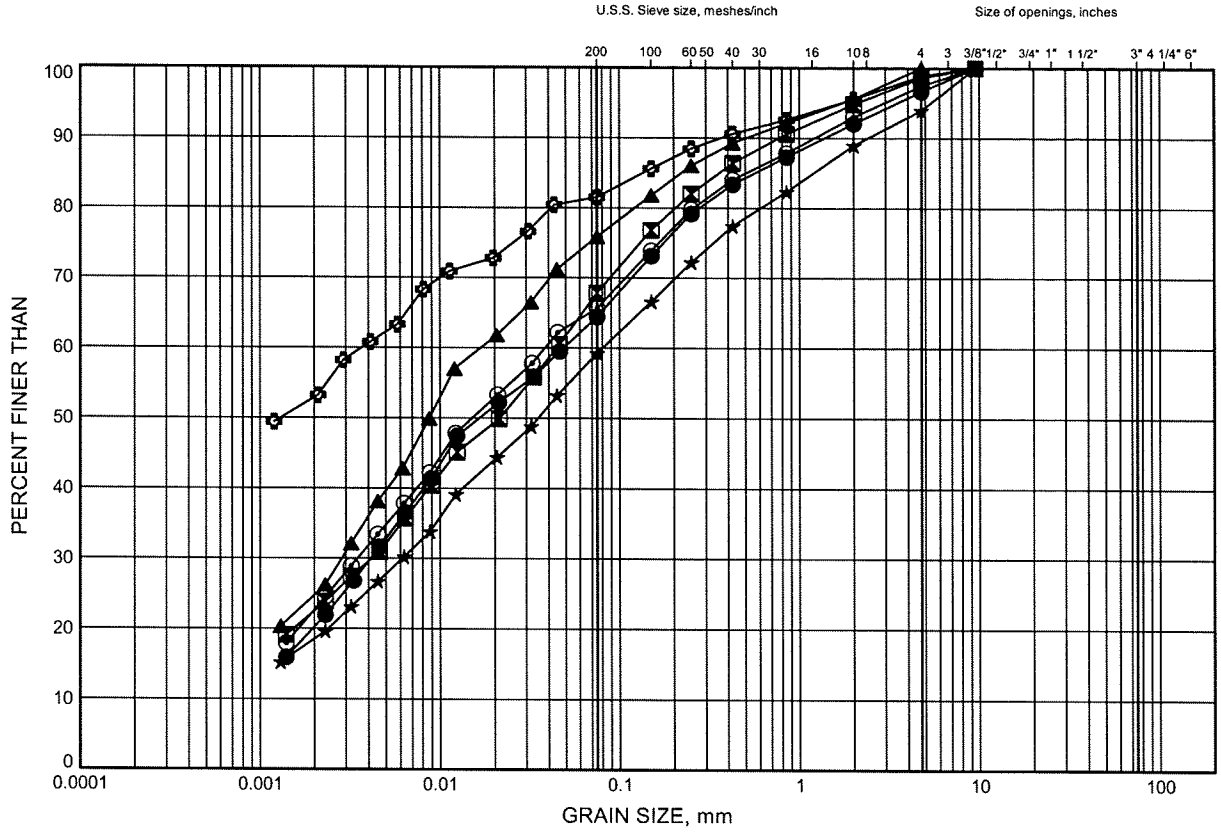
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B14

SILTY CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-06	6.40	159.42
⊠	PC-07	4.88	162.76
▲	PC-07	7.92	159.72
★	PC-08	6.40	160.98
⊙	PC-09	7.92	163.13
✿	PC-11	4.88	168.10

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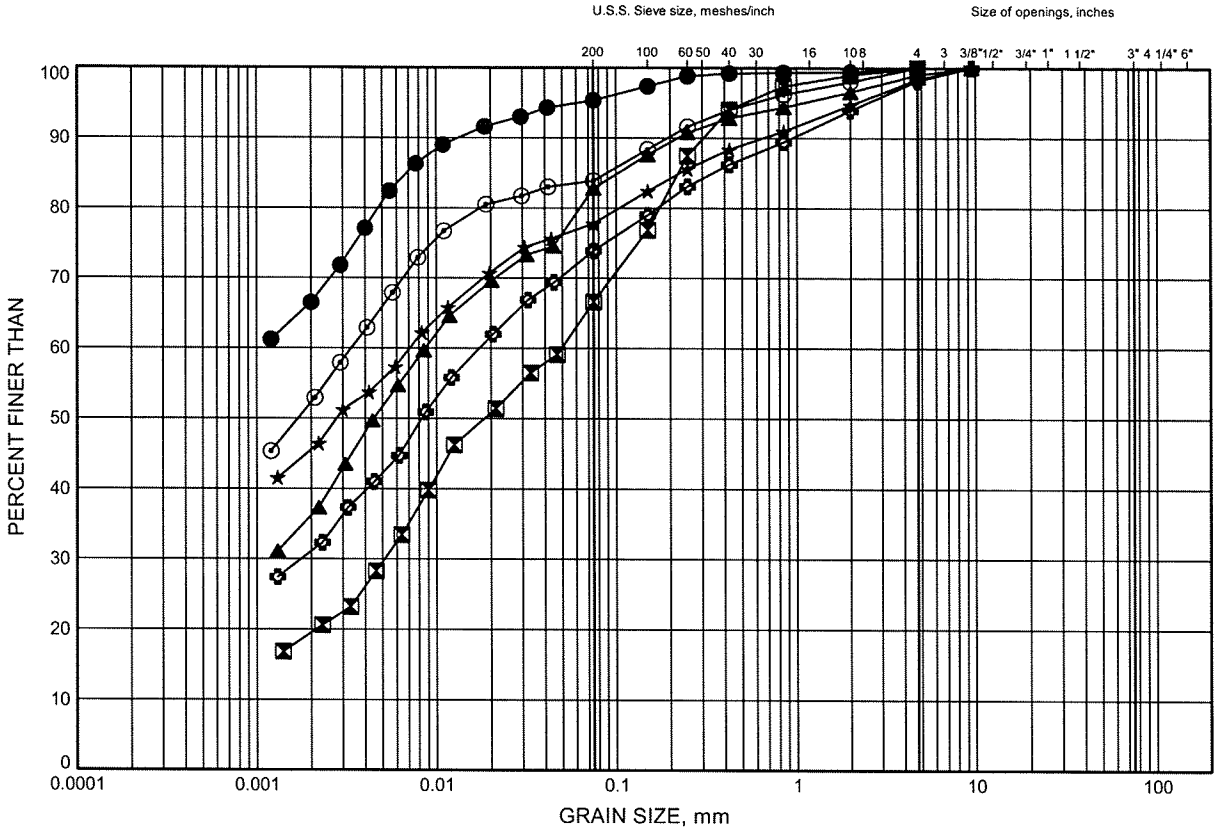
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B15

SILTY CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-11	9.45	163.53
⊠	PC-13	9.45	163.11
▲	PC-14	7.92	164.92
★	PC-15	7.92	161.27
⊙	PC-16	7.92	161.55
✿	PC-17	3.35	163.99

W.P.# 202-95-00.....
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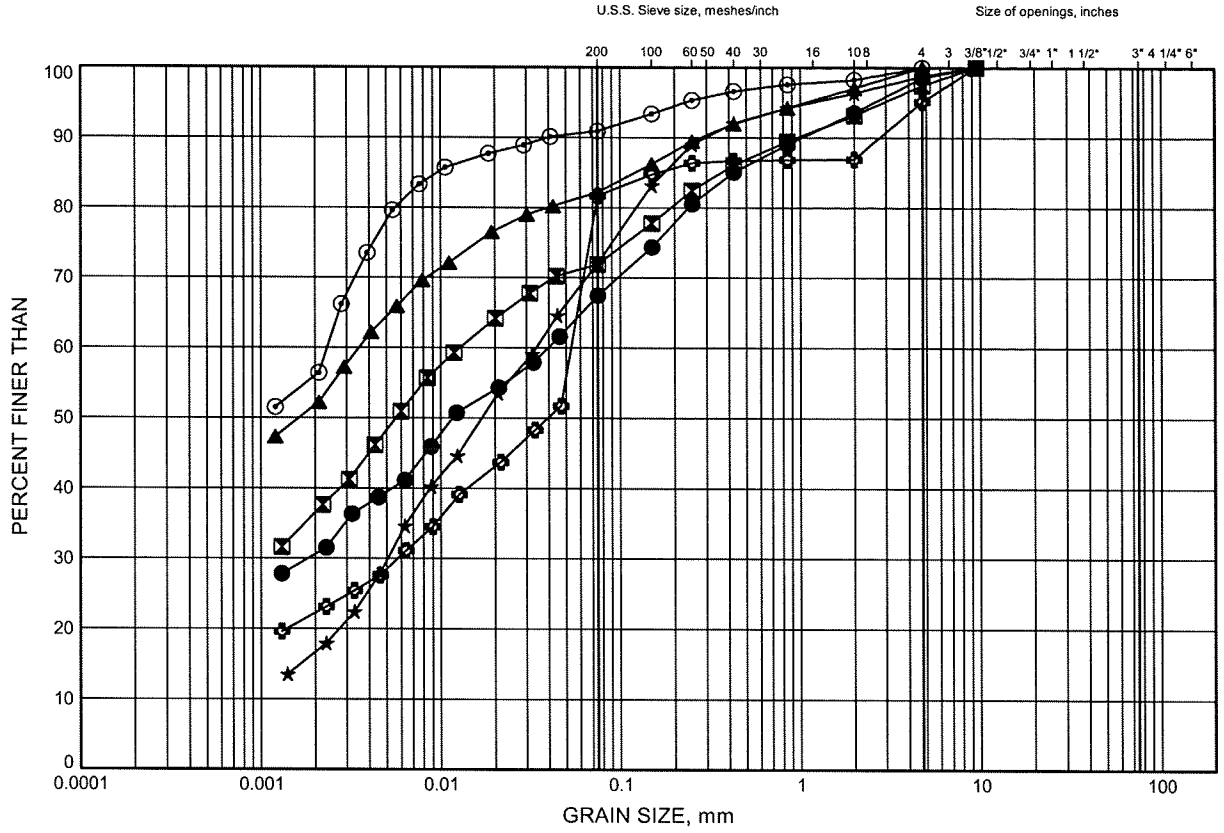
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B16

SILTY CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-17	6.40	160.94
⊠	PC-18	6.40	161.18
▲	PC-19	2.59	163.00
★	PC-20	6.40	159.01
⊙	PC-20	9.45	155.96
✿	PC-24	4.11	164.90

W.P.# 202-95-00
Prepared By MFA
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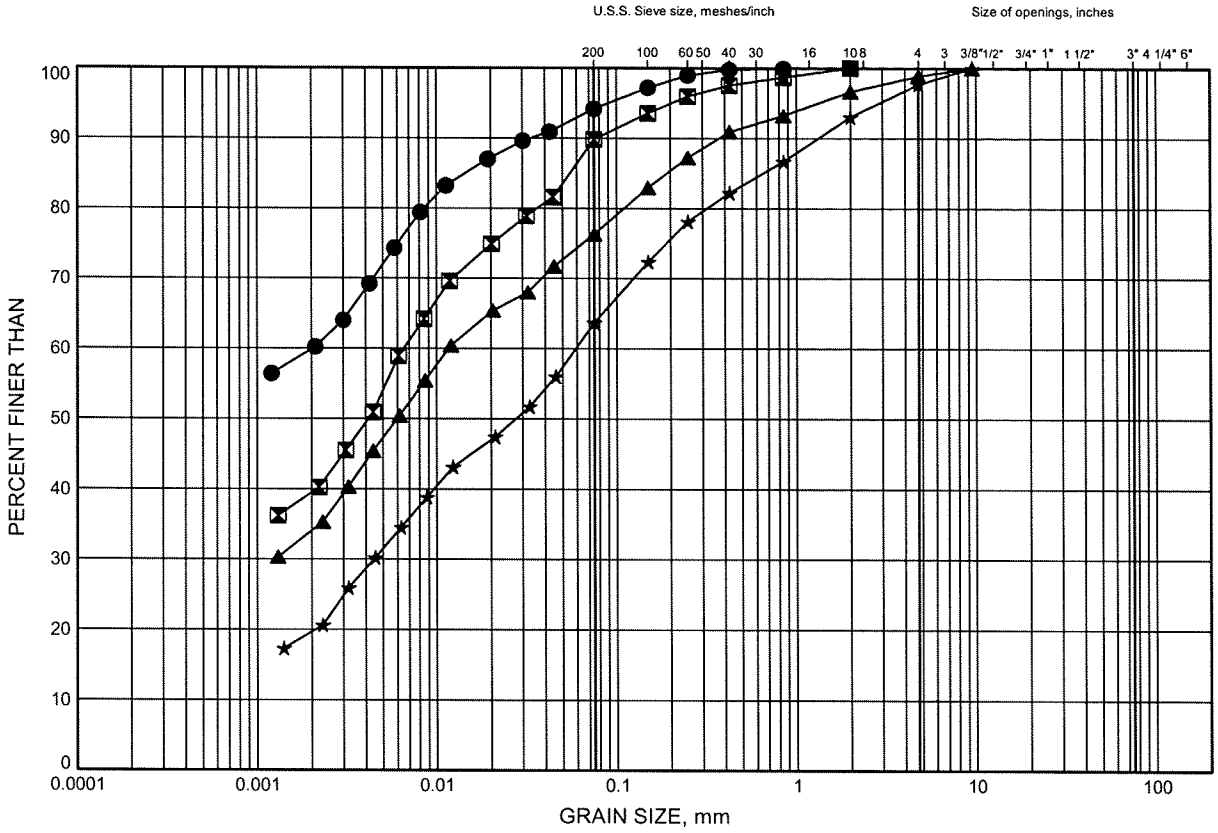
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B17

SILTY CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-27	9.45	171.16
⊠	PC-28	9.45	171.52
▲	PC-29	9.45	170.43
★	PC-30	9.45	170.55

W.P.# 202-95-00

Prepared By MFA

Checked By MEF

THURBER

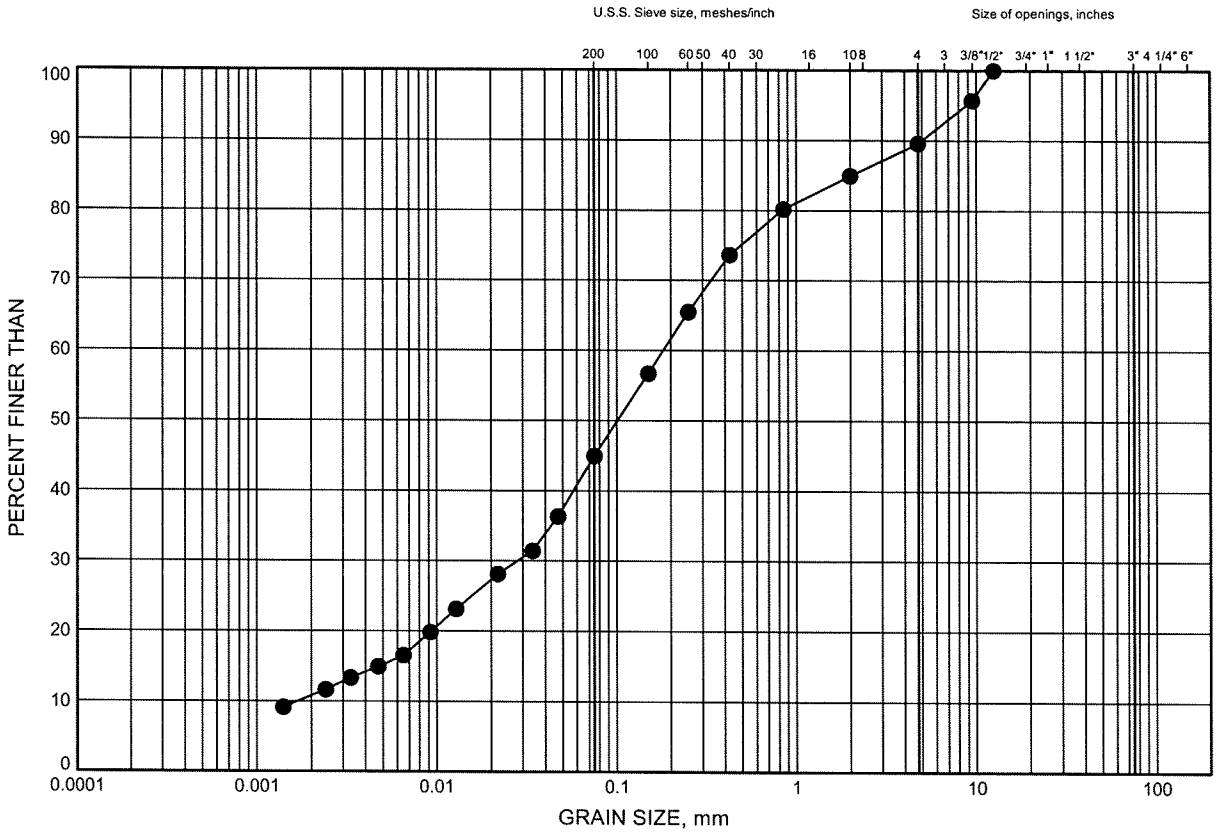
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

GRAIN SIZE DISTRIBUTION

FIGURE B18

SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PC-19	7.76	157.83

W.P.# 202-95-00

Prepared By MFA

Checked By MEF

THURBER

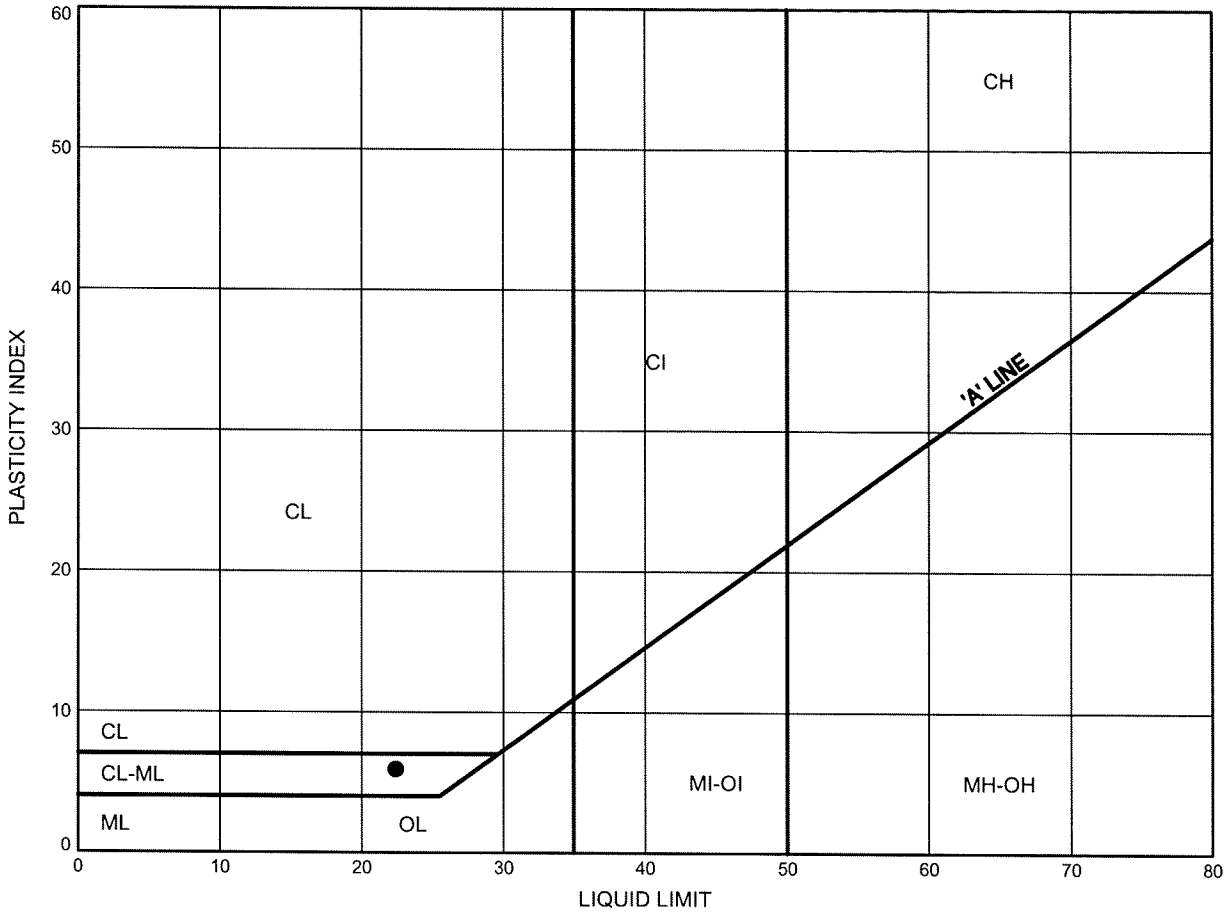
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

ATTERBERG LIMITS TEST RESULTS

FIGURE B19

SANDY SILT FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-03	3.35	163.97

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Project 202-95-00

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Chkd. MEF

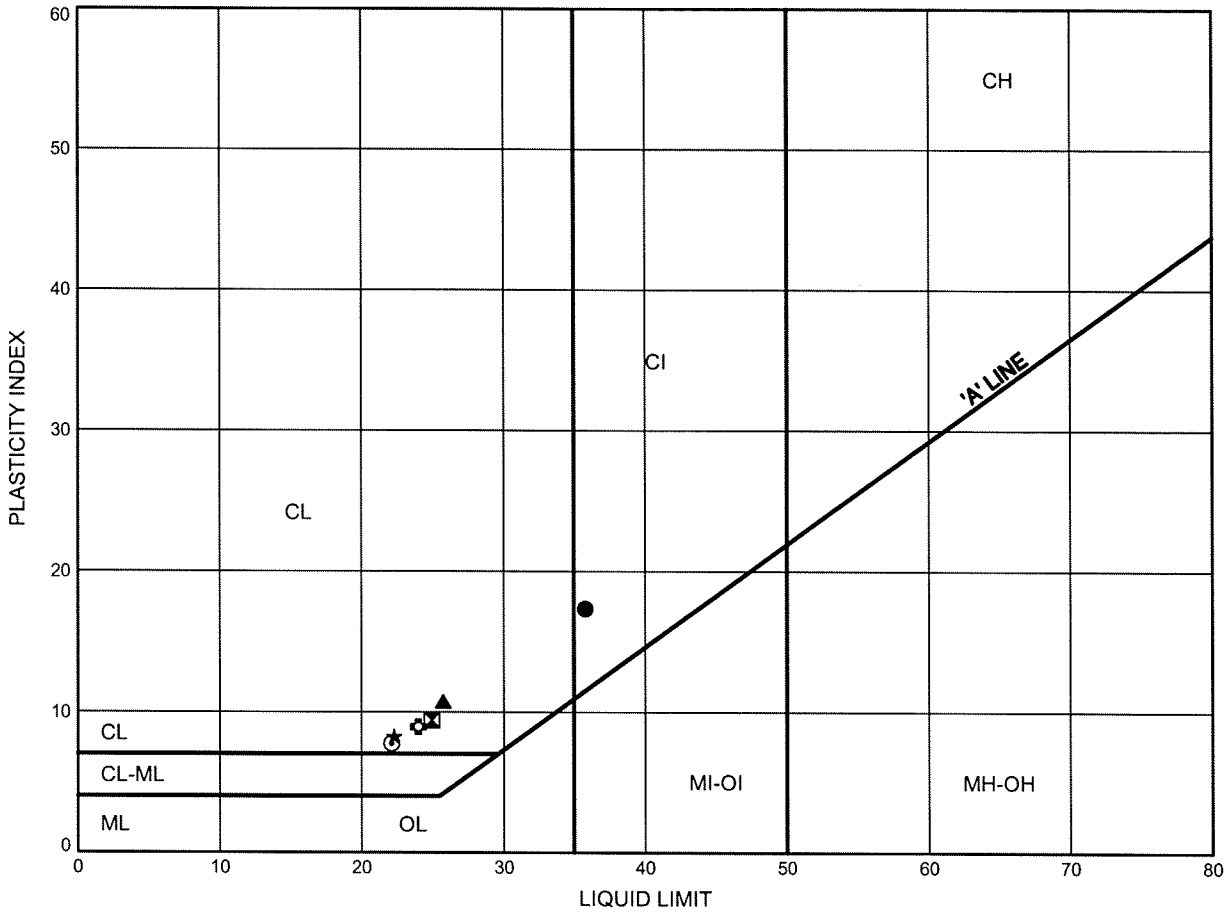
THURBALT 9270.GPJ 1/22/10

Hwy 427 Northbound and Southbound

ATTERBERG LIMITS TEST RESULTS

FIGURE B20

SILTY CLAY FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-06	1.83	163.99
⊠	PC-07	2.59	165.05
▲	PC-08	1.07	166.31
★	PC-09	1.83	169.22
⊙	PC-10	2.59	168.33
✿	PC-10	6.40	164.52

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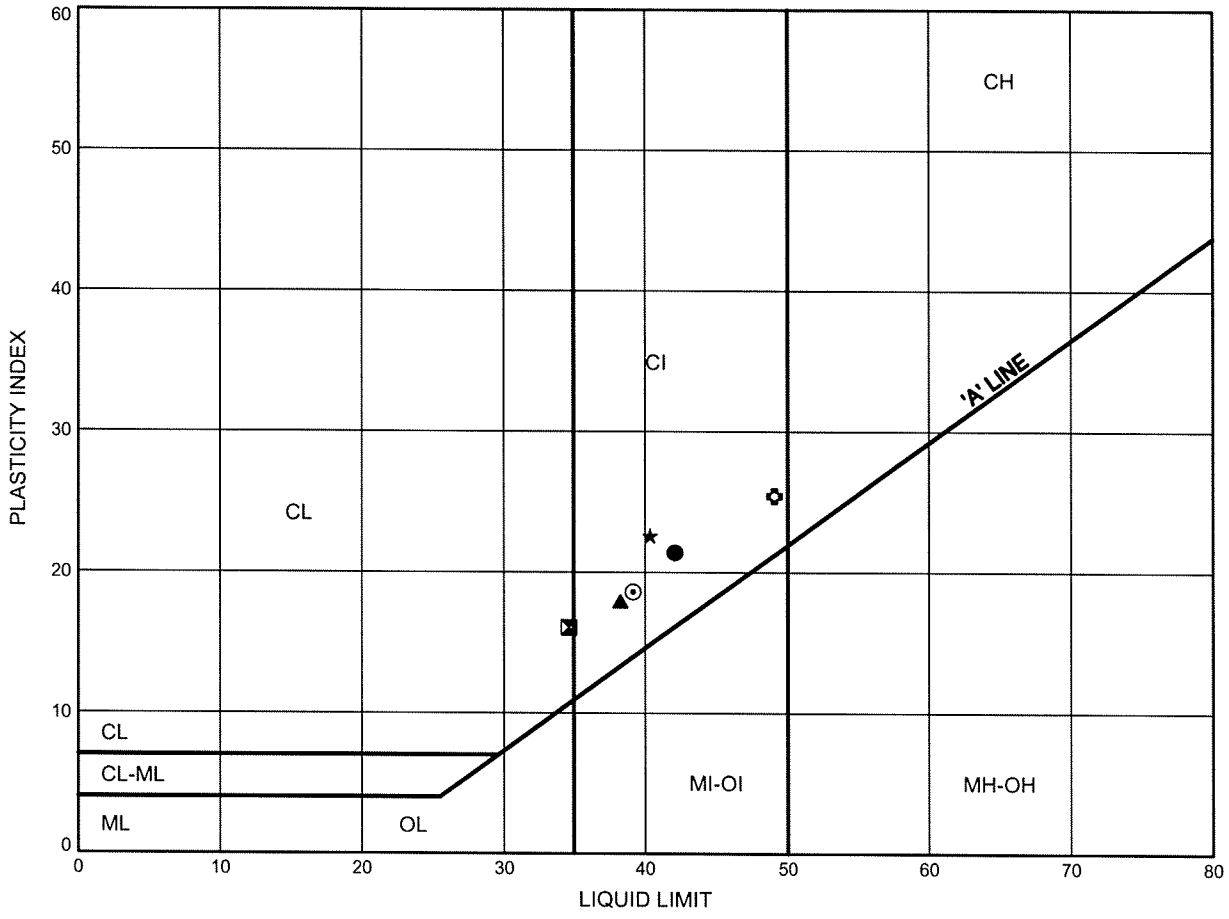
Hwy 427 Northbound and Southbound

ATTERBERG LIMITS TEST RESULTS

FIGURE B21

SILTY CLAY FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-12	2.59	170.78
⊠	PC-12	6.40	166.97
▲	PC-14	3.35	169.49
★	PC-15	2.46	166.73
⊙	PC-16	2.59	166.88
✿	PC-18	1.83	165.75

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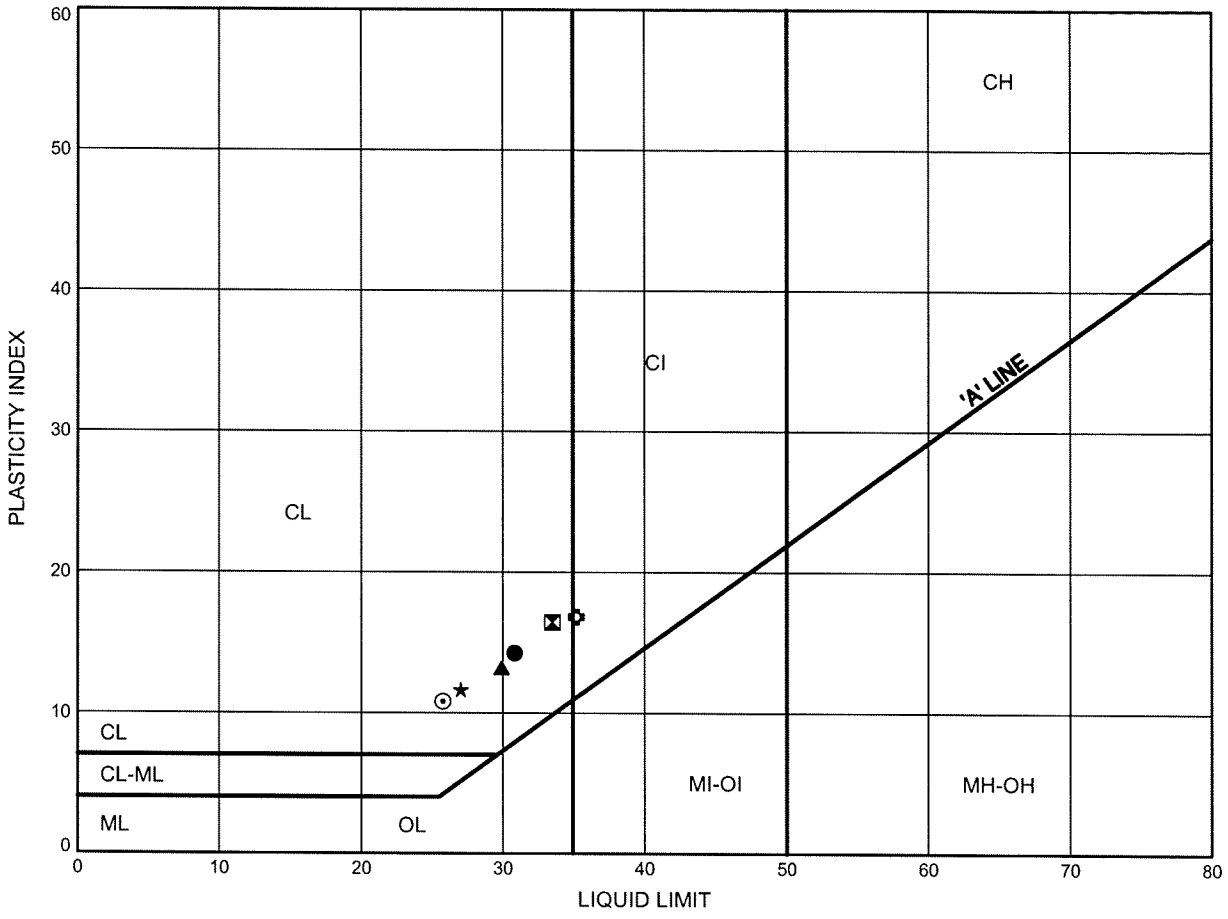
ATTERBERG LIMITS TEST RESULTS

FIGURE B22

SILTY CLAY FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-20	0.30	165.10
⊠	PC-21	1.07	167.18
▲	PC-22	3.35	164.57
★	PC-23	1.83	167.53
⊙	PC-24	1.07	167.95
✿	PC-25	6.40	174.75

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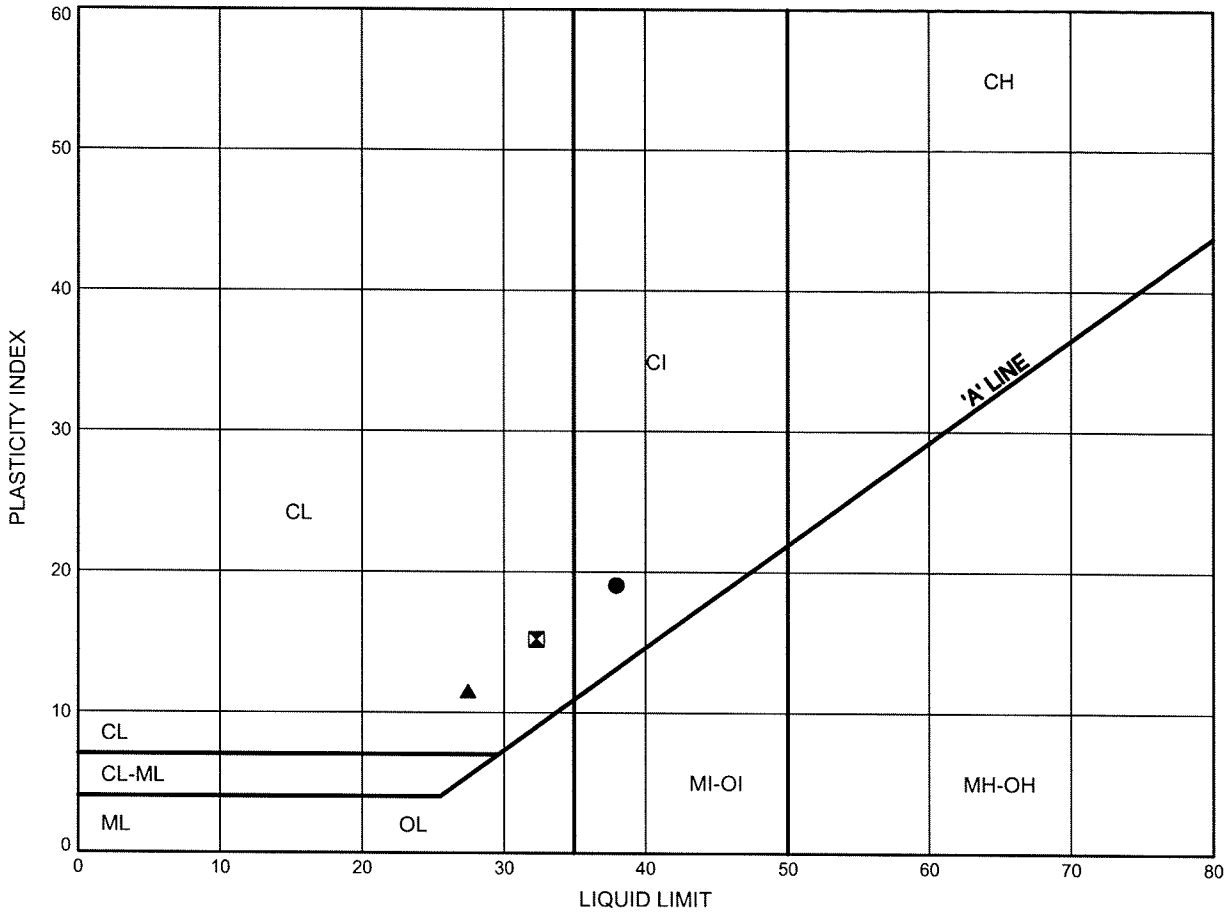
ATTERBERG LIMITS TEST RESULTS

FIGURE B23

SILTY CLAY FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-26	6.40	174.88
⊠	PC-29	2.59	177.29
▲	PC-30	3.35	176.65

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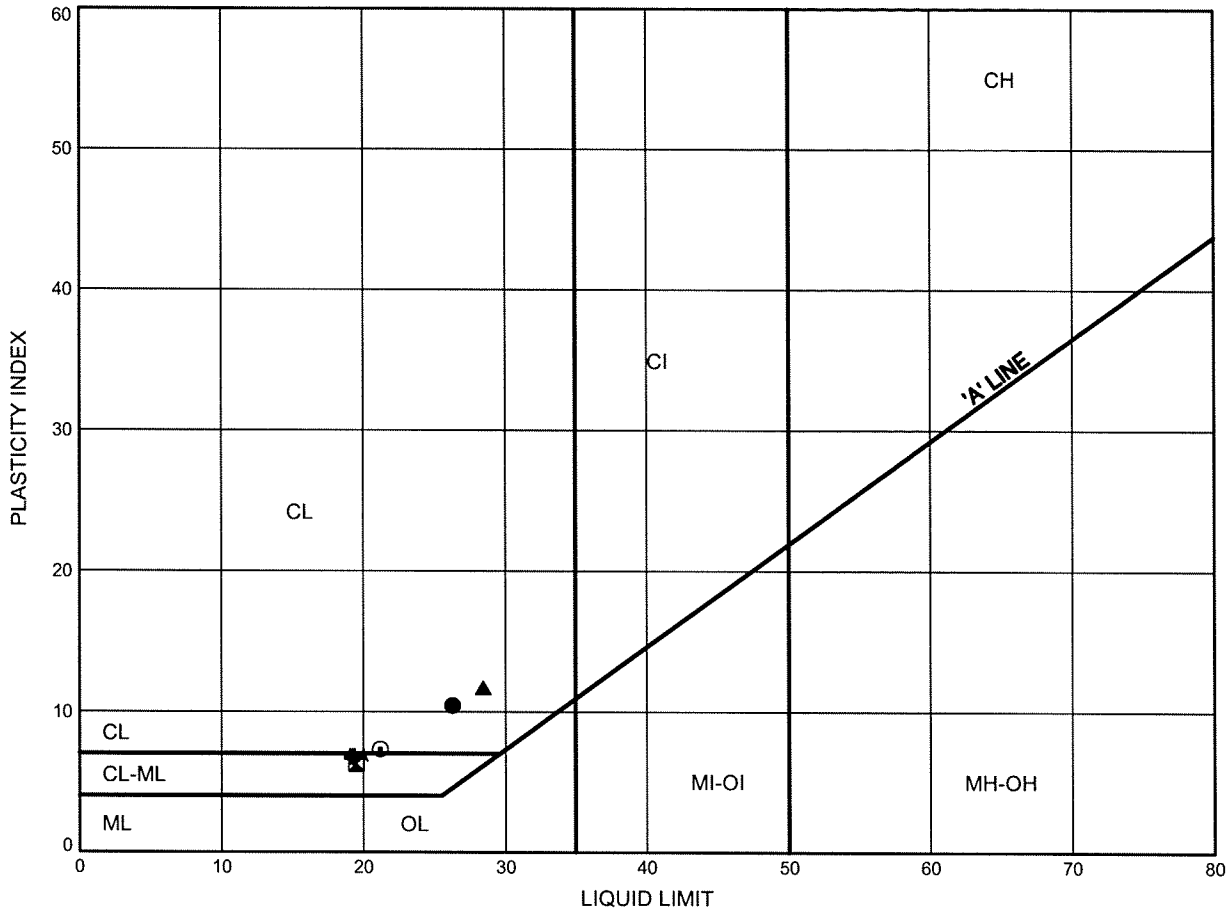
Hwy 427 Northbound and Southbound

ATTERBERG LIMITS TEST RESULTS

FIGURE B24

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-01	2.59	164.43
⊠	PC-01	7.92	159.10
▲	PC-02	6.40	160.95
★	PC-03	7.92	159.40
⊙	PC-04	7.92	159.18
✿	PC-05	9.45	156.07

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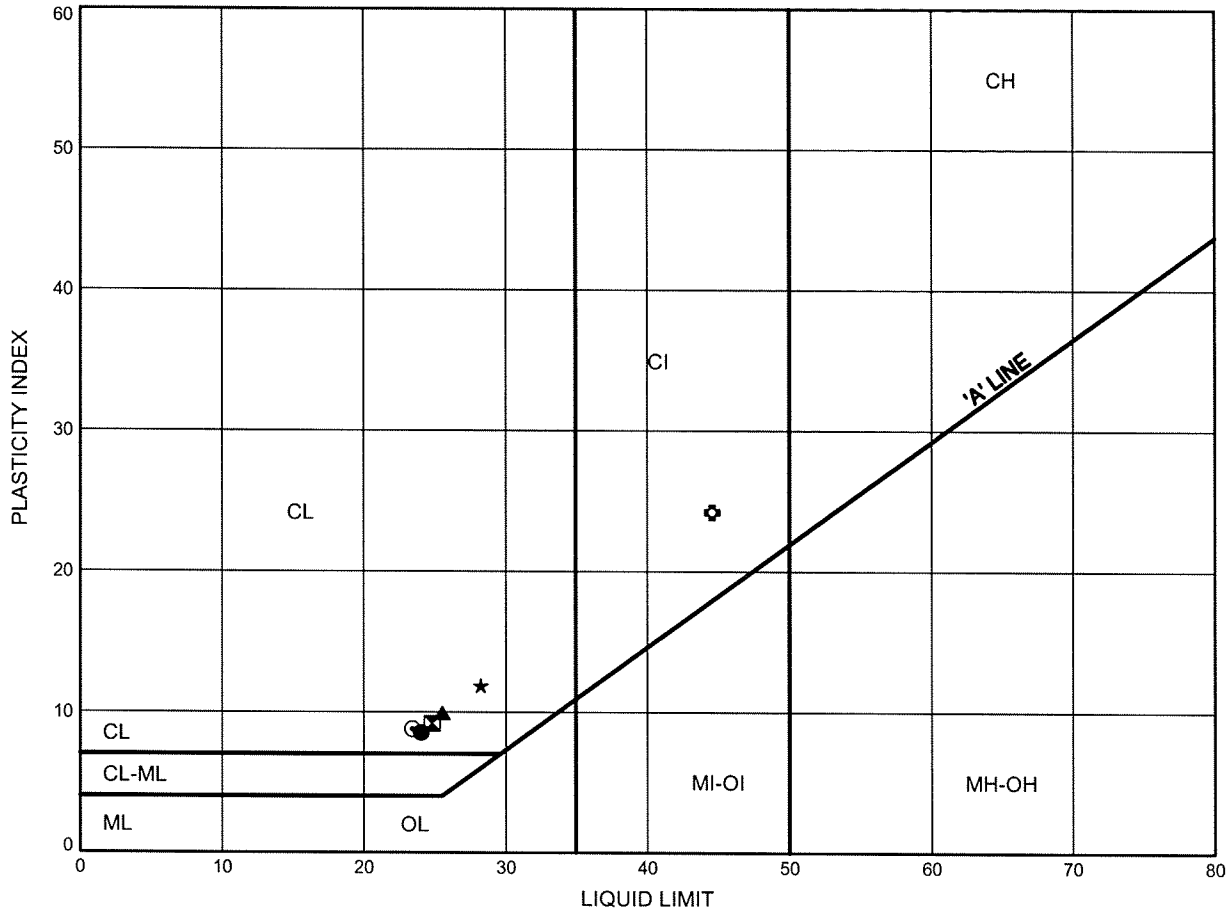
Hwy 427 Northbound and Southbound

ATTERBERG LIMITS TEST RESULTS

FIGURE B25

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-06	6.40	159.42
⊠	PC-07	4.88	162.76
▲	PC-07	7.92	159.72
★	PC-08	6.40	160.98
⊙	PC-09	7.92	163.13
✿	PC-11	4.88	168.10

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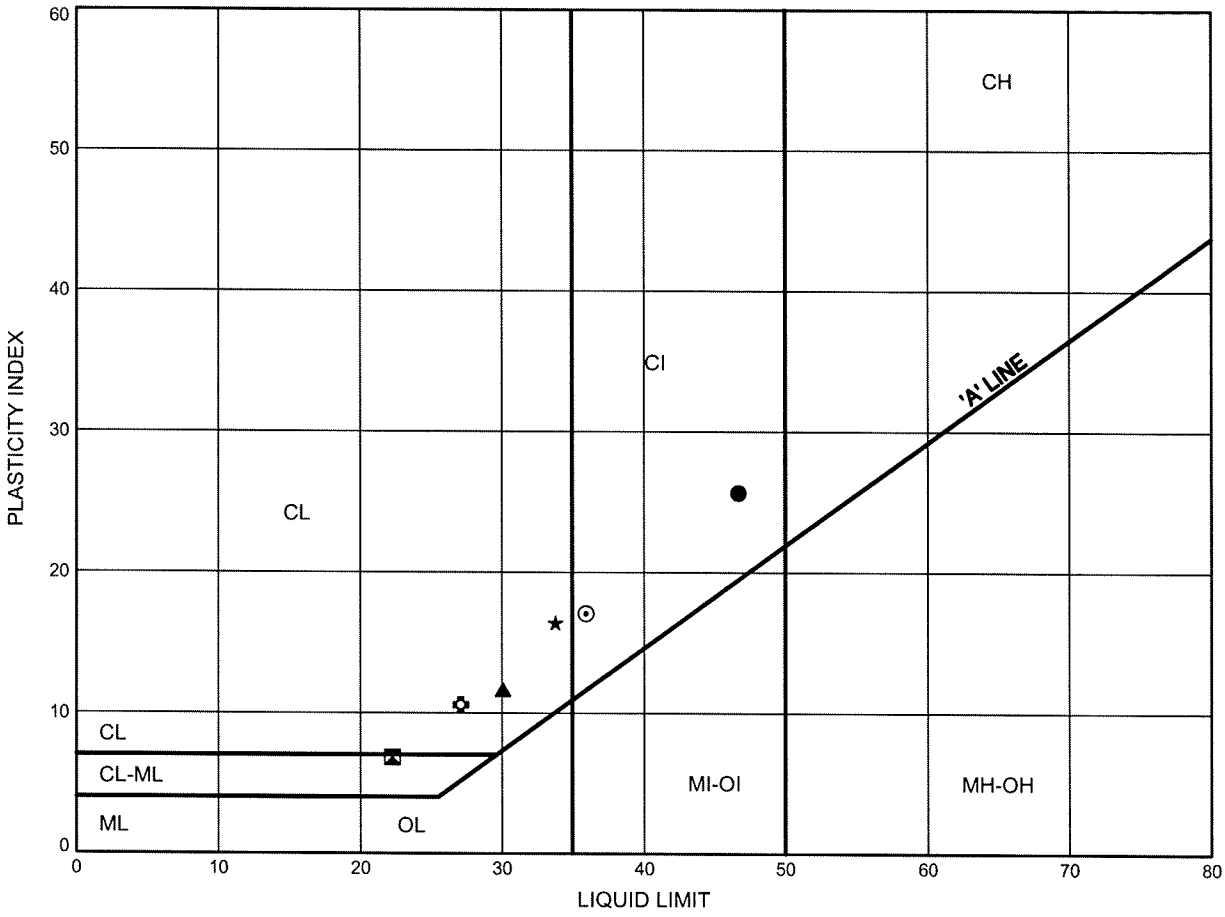
Hwy 427 Northbound and Southbound

ATTERBERG LIMITS TEST RESULTS

FIGURE B26

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-11	9.45	163.53
⊠	PC-13	9.45	163.11
▲	PC-14	7.92	164.92
★	PC-15	7.92	161.27
⊙	PC-16	7.92	161.55
✿	PC-17	3.35	163.99

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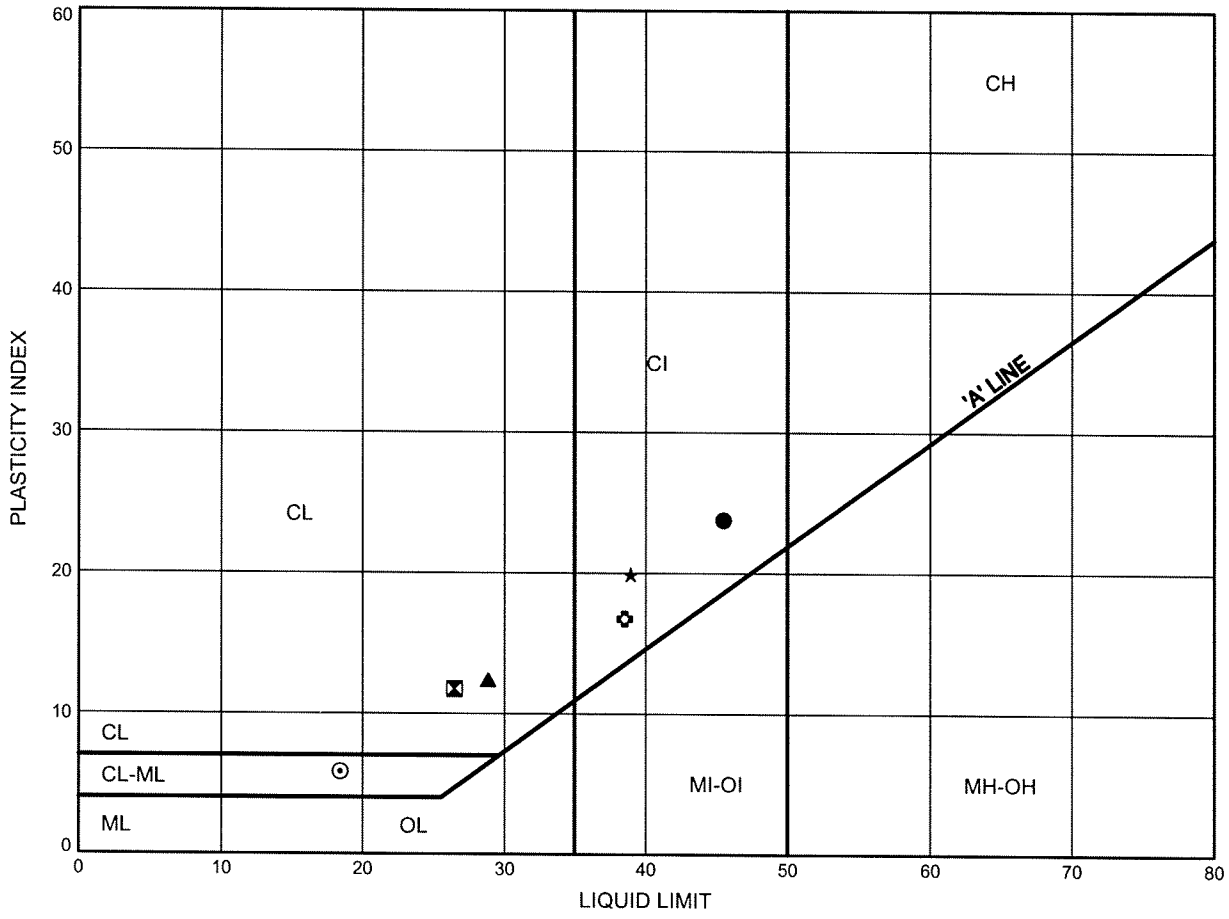
Hwy 427 Northbound and Southbound

ATTERBERG LIMITS TEST RESULTS

FIGURE B27

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-17	4.88	162.47
⊠	PC-17	6.40	160.94
▲	PC-18	6.40	161.18
★	PC-19	2.59	163.00
⊙	PC-20	6.40	159.01
✿	PC-20	9.45	155.96

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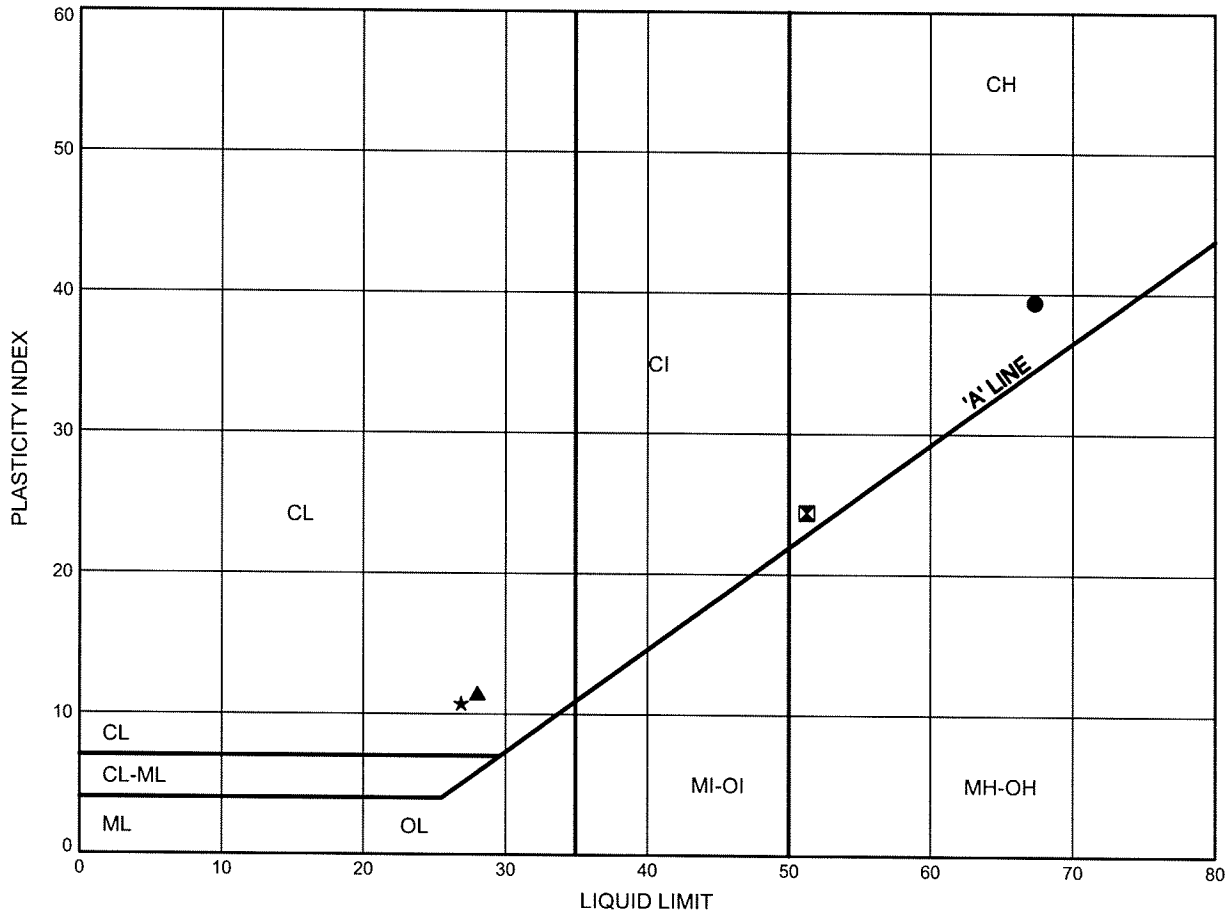
Hwy 427 Northbound and Southbound

ATTERBERG LIMITS TEST RESULTS

FIGURE B28

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	PC-27	9.45	171.16
⊠	PC-28	9.45	171.52
▲	PC-29	9.45	170.43
★	PC-30	9.45	170.55

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Appendix C

List of Special Provisions

and

Suggested Text for NSSP

1. List of Special Provisions Referenced in this Report

- SP539SO1

2. Suggested Text for NSSP on Trenchless Installation.

The Contractor's attention is drawn to the following:

- The fill material and glacial till deposit may contain cobbles and boulders.
- The pipe installations will be done partially through cohesive fill and glacial till. The Contractor shall select equipment capable of drilling through these cohesive deposits without choking up the augers.
- A maximum distance of 600 mm should be maintained between the boring face and the pipe liner during installation to prevent sloughing or cave of cohesionless soils. Pipe installation should be continuous and no gaps should be left between the boring face and the outer casing during work stoppages, i.e. overnight and weekends.
- At locations where the pipe crossings are to be installed in cohesionless soil (Station 20+635, 22+582, 22+945, 27+232, and 27+375), loss of ground (sloughing or cave) may occur in the borings. In these areas, methods which preclude caving and loss of ground, such as jack and bore with the pipe advancing closely behind the boring face, shall be employed at these locations.

PIPE INSTALLATION BY TRENCHLESS METHOD – Item No.

Non Standard Special Provision February 2009

1. SCOPE

This specification covers the general requirements for the installation of pipes by trenchless methods.

The Contractor shall determine the most appropriate method of installation. Specifications for Jack & Bore, Pipe Ramming, Directional Drilling, and Tunnelling are provided herein, and shall be applied to the installation method considered feasible by the Contractor.

OPSS 415 (Construction Specification for Pipeline and Utility Installation by Tunnelling), OPSS 416 (Construction Specification for Pipeline and Utility Installation by Jacking and Boring) and OPSS 450 (Construction Specification for Pipeline and Utility Installation in Soil by Horizontal Directional Drilling) shall not be used to do the work for the above tender item.

2. REFERENCES

This specification refers to the following standards, specifications, or publications:

Foundation Investigation Report, Proposed Sewer Pipe Crossings, Highway 427 Inside Widening From Fasken Drive to Steeles Avenue, Toronto, Ontario, G.W.P. 202-95-00, by Thurber Engineering Ltd. Reference No. 19-92-70.

Ontario Provincial Standard Specifications, General

OPSS 180	Management and Disposal of Excess Material

Ontario Provincial Standard Specifications, Construction

OPSS 504	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 507	Site Restoration Following Installation of Pipelines, Utilities and Associated Structures in Open Cut
OPSS 514	Trenching, Backfilling, and Compaction
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 538	Support Systems
OPSS 539	Protection Schemes

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1802	Smooth Walled Steel Pipe

MTO Specifications

OPSS 1820	Material Specification for Circular Concrete Pipe
OPSS 1840	Material Specification for Non-Pressure Polyethylene Plastic Pipe Products

American Society for Testing and Materials (ASTM) International Standards

ASTM A252-93	Welding and Seamless Steel Pipe Piles
ASTM D2657-03	Standard Practice for Heat Fusion Joining of Polyelofin Pipe and Fittings
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM F894	Polyethylene Large Diameter Profile Wall Sewer and Drain Pipe

Canadian Standards Association Standards:

CSA B182.6	Profile Polyethylene Sewer Pipe and Fittings.
CAN/CSA A5-93	Portland Cement
CSA W59	Welded Steel Construction (Metal Arc Welding)

3. DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backreamer: a cutting head suitably designed for the subsurface conditions that is attached to the end of a drill string to enlarge the pilot bore during a pullback operation.

Bore Path: a drilled path according to the grade and alignment tolerances specified in the Contract Documents.

Design Engineer: means the Engineer retained by the Contractor who produces the original design and working drawings. The design engineer shall be licensed to practice in the Province of Ontario.

Design Checking Engineer: means the Engineer retained by the Contractor who checks the original design and working drawings. The design checking engineer shall be licensed to practice in the Province of Ontario.

Digger Shield/Hand Mining: a method of forming a horizontal bore in the subsurface by essentially simultaneously jacking ahead while tunnelling advances using hand–mining (man-entry operation or "Jack and Mine) or a "digger" type shield with a hydraulic excavator arm to remove materials from inside the liner pipe.

Drilling Fluids: a mixture of water and additives, such as bentonite, polymers, surfactants, and soda ash, designed to block the pore space on a bore wall, reduce friction in the bore, and to suspend and carry cuttings to the surface.

Drilling Fluid Fracture or Frac Out: a condition where the drilling fluid's pressure in the bore is sufficient to overcome the in situ confining stress, thereby fracturing the soil and/or rock materials and allowing the drilling fluids to migrate to the surface at an unplanned location.

Engineer: a Professional Engineer licensed by the Professional Engineers of Ontario to practice in the Province of Ontario.

Excavation: includes all materials encountered regardless of type and extent. Excavation shall include removal of natural soil, large boulders, cobbles, wood and fill regardless of means necessary to break consolidated materials for removal.

Environmentally Sensitive Area (ESA): areas adjacent to construction that are off limits to the Contractor as specified elsewhere in the Contract.

Fill: man-made mixture of previously placed/handled materials such as sand, clay, silt, gravel, broken rock, sometimes containing organic and/or deleterious materials, placed in an excavation or other area to raise the surface elevation.

Grouting: injection of grout into voids.

Guidance System: an electronic system capable of locating the position, depth and orientation of the drill head during the directional drilling process.

Directional Drilling (DD): directional boring or guided boring.

HDPE: high density polyethylene.

Inadvertent Returns: the flow of unexpected fluids, saturated materials (or running soil) towards the drilling rig that typically originated from an artesian aquifer encountered during the drilling process.

Jack & Bore: a method of forming a horizontal bore in the subsurface by essentially simultaneously jacking ahead and rotating a cutter head, followed by removal of material from inside the bore.

Loss of Circulation: the discontinuation of the flow of drilling fluid in the bore back to the entry or exit point or other planned recovery points.

Pilot Bore: the initial bore to set directional controlled horizontal and vertical alignment between the connecting points.

Pipe Jacking: a method for installing steel casing or concrete pipe in the subsurface utilizing hydraulically operated jacks of adequate number and capacity to ensure smooth and uniform advancement without overstressing the liner/pipe.

Pipe Ramming: a method for installing steel casings utilizing the energy from a percussion hammer to advance a steel casing with a cutting shoe attached at the front end of the casing.

Primary Liner (Support): system installed prior to or concurrent with excavation, to maintain stability of an excavation and to support earth or rock and any structure utilities or other facilities in or on the supported earth or rock mass, until the excavation is completed.

Product: pipe culverts, pipe sewers, watermain pipe and sanitary pipe.

Pullback: that part of the DD method in which the drill string is pulled back through the bore path to the entry point.

Quality Verification Engineer (QVE): an Engineer who has a minimum of five (5) years experience in the field of pipe installation using trenchless methods or alternatively has demonstrated expertise by providing satisfactory quality verification services for the work at a minimum of two (2) projects of similar scope to the contract. The Quality Verification Engineer shall be retained by the Contractor to certify that the work is in general conformance with the contract documents and to issue Certificate(s) of Conformance.

Reaming: a process for pulling a tool attached to the end of the drill string through the bore path to enlarge the bore and mix the cuttings with the drilling fluid. This typically includes multiple passes.

Rock: natural beds or massive fragments, or the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or sedimentary in origin, which may or may not be weathered and includes boulders having a size equivalent to 0.3 m in diameter or greater.

Secondary Liner: concrete pipe, HDPE pipe or un-reinforced cast-in-place concrete, installed subsequent to tunnel excavation.

Shaft: vertically sided excavation used as entry and/or exit points from which the trenchless method is initiated or directed for the installation of product.

Strike Alert: a system that is intended to alert and protect the operator in the case of inadvertent drilling into an electrical utility cable. The strike alert system consists of a sensor and an alarm connected to the drill rig and a grounding stake. The alarm may be audio or visual or both.

Slurry: a mixture of soil and/or rock cuttings, and drilling fluid.

Soil: all materials except those defined as rock, and excludes stone masonry, concrete, and other manufactured materials; includes rock fragments having an equivalent size less than 0.3 m in diameter.

Tunnelling: an underground method of constructing a passage open at both ends that involves installing a pipe.

4. DESIGN AND SUBMISSION REQUIREMENTS

4.01 General

The Contractor's documentation, submission requirements and installation methods shall specifically consider and address the subsurface conditions at each pipe crossing as identified in the Foundation Investigation Report.

4.02 Working Drawings

Three copies of stamped working drawings for portal or shaft construction, primary liner, excavation, secondary lining, dewatering and groundwater control and grouting shall be submitted to the Contract Administrator (CA) at least one (1) week prior to the commencement of the work for information purposes. All submissions shall bear the seal and signature of the Design Engineer and Design

Checking Engineer. The Contractor shall have a copy of the stamped working drawings at the site during construction.

As a minimum, working drawings/details pertaining to the tunnel design and construction shall include the following (as appropriate):

a) Plans, Elevations and Details:

- A work plan outlining the materials, procedures, methods and schedule to be used to execute the work;
- A list of personnel, including backup personnel, and their qualifications and experience;
- A safety plan including the company safety manual and emergency procedures;
- The work area layout;
- An erosion and sediment control plan that includes a contingency plan in the event the erosion and sediment control measures fail;
- A drilling fluid management plan, if applicable, that addresses control of frac-out pressures, any potential environmental impacts and includes a contingency plan detailing emergency procedures in the event that the fluid management plan fails;
- Lighting, ventilation and fire safety details as may be required by applicable occupational health and safety regulations; and
- Excavated materials disposal plan.

b) Design Criteria:

- Primary liner design details, if applicable; and
- Design assumption and material data when materials other than those specified are proposed for use.
- Drill path design, details of alignment and alignment control, maximum curvature and reaming stages;

c) Materials:

- Certification from the manufacturer that the product furnished on the contract meets the specifications cited in the manufacturer's product specification and that the materials supplied are suitable for the application; and
- Material mixture for filling voids and installation procedures.

d) Upstream/Downstream Portal Installation Procedure:

- The access shaft or entry/exit pit details designed and stamped/signed by the Design Engineer, as applicable; and
- Face support and other temporary support details, if applicable.

e) Primary Liner/Secondary Liner Installation and Grouting Procedure:

- Excavation and pipe jacking procedures, including methodology to handle obstructions and preventing soil cave-in; and
- Details of tunnelling equipment/methods to be used for the works.

f) Excavation and Dewatering:

- Ground control/dewatering details, as applicable, describing the proposed method for control, handling, treatment, and disposal of water.

g) Monitoring Method

- The methods to be employed to monitor and maintain the alignment of the installation;

4.03 Site Survey

Prior to commencing the work, the Contractor shall, at each pipe location, layout the alignment and install settlement monitoring points.

4.04 Certificate of Conformance

The Contractor shall submit details of the sequence and method of construction to the Quality Verification Engineer for review, prepared and stamped by the Design Engineer. The Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer a minimum of one week prior to commencement of work under this item. The Certificate shall state that the construction procedures are in conformance with the requirements and specifications of the contract documents.

The Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer upon completion of each of the following operations and prior to commencement of each subsequent operation for each pipe installation:

Site Surveying (as noted in Section 4.02)
Excavation for pits including dewatering of excavation
Jacking/Ramming/Directional Drilling of Casing/Liner
Excavation and Dewatering
Installation of the Product
Grouting Operations

Each Certificate of Conformance shall state that the work has been carried out in general conformance with the contract documents, specifications and/or stamped working drawings.

In addition, upon completion of the installation of the pipe at each location, the Contractor shall submit to the Contract Administrator a **final** Certificate of Conformance sealed and signed by the Quality Verification Engineer. The Certificate shall state that the pipe has been installed in general conformance with the Contractor's Submission and Design Requirements, stamped working drawings and contract documents.

The Design Engineer will not be permitted to carry out the work of the Quality Verification Engineer.

5. MATERIALS

5.01 Product

The product shall be concrete pipe or high density polyethylene pipe as specified.

5.02 Concrete

Concrete shall be according to OPSS 1350. The concrete strength shall be as specified in the Contractor's design submission.

5.03 Concrete Reinforcement

Steel reinforcing for concrete work shall be according to OPSS 1440.

5.04 Timber

Timber shall be sound, straight, and free from cracks, shakes and large or loose knots.

5.05 Grout

The Contractor shall submit the proposed grout mix design for grouts to be used for lubricating jacking pipe and for filling of voids and annular spaces. Purging grout shall consist of a mixture of one part Portland cement conforming to the requirements of CAN/CSA A5-93 and two parts mortar sand conforming to OPSS 1004 wetted with only sufficient water to make the mixture plastic.

5.06 Jack & Bore Materials

5.06.01 Pipe Materials

Steel pipe shall conform with ASTM A252-95 welded joints suitable for jacking operations. The Contractor shall select pipe class for pipe jacking.

Concrete pipe as per OPSS 1820.

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

5.07 Pipe Ramming Materials

5.07.01 Pipe Materials

Steel pipe shall conform with ASTM A 252-93 welded joints.

New steel casing when specified shall be smooth wall carbon steel pipe according to ASTM A252-93 Grade 2.

Used steel casing can be used provided that the steel casing can resist the applicable static and dynamic loadings.

Pipe wall thickness shall be determined by the Contractor based on static and dynamic loads from traffic loading and anticipated ramming forces for selected pipe and driven pipe lengths. The wall thickness shall be increased as required to ensure the casing is not damaged during handling and installation. A minimum wall thickness of 50 mm and minimum yield strength of 240 MPa is required.

Pipe segments shall be determined by the Contractor.

Steel pipe joints shall be pressure fit type or welded.

All steel casing pipe shall be square cut.

Steel casing pipe shall have roundness such that the difference between the major and minor outside diameters shall not exceed 1% of the specified nominal outside diameter or 6 mm, whichever is less.

Steel casing pipe shall have a minimum allowable straightness of 1.5 mm maximum per metre of length.

5.07.02 Mill Certificates

For permanent casing, the Contractor shall submit to the Contract Administrator at the time of delivery one copy of the mill certificate, indicating that the steel meets the requirements for the appropriate standards for casings.

Where mill test certificates originate from a mill outside Canada or the United States of America the Contractor shall have the information on the mill certificate verified by testing by a Canadian laboratory. The laboratory shall be accredited by a Canadian National Accreditation Body to comply with the requirements of ISO/IEC Guide 25 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements. The stamp shall include the appropriate material specification number, the date and the signature of an authorized officer of the Canadian testing laboratory.

5.08 Directional Drilling Materials

5.08.01 Drilling Fluids

The drilling fluids shall be mixed according to the manufacturer's recommendations and be appropriate for the anticipated subsurface conditions.

5.08.02 Pipe Materials

High Density Polyethylene (HDPE) pipe as per OPSS 1840 shall be used in accordance with ASTM D3350.

The requirements for fittings shall be suitable for and compatible with the class and type of pipe with which they will be used and in according to CAN/CSA-B182.6 or ASTM F894.

The Contractor shall determine the required dimensional ratio (DR) of the HDPE pipe to support all subsurface conditions and hydrostatic pressures, and to withstand the grouting pressure and installation forces. The Contractor shall identify these forces in his submission requirements.

The Contractor's submission shall demonstrate, in conjunction with the manufacturer's specifications, that the heat resistance of the pipe material is sufficient to tolerate without damage the heat of hydration generated by grout curing.

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

Jointing of HDPE piping shall be completed by thermal butt fusion in accordance with manufacturer's recommended procedures and as outlined in the latest revision of ASTM D2657. All manufacturer's recommendations and procedures shall be followed during the jointing process.

Jointing of HDPE piping to other piping materials or appurtenances shall be completed using flanged connections.

5.09 Tunnelling Materials

5.09.01 Primary Liner

Tunnelling methods will require installation of a primary liner to provide support and stability to the excavation.

5.09.02 Secondary Liner

Concrete or High Density Polyethylene Pipe shall be used according to the following requirements.

5.09.02.01 Concrete Pipe

Concrete pipe as per OPSS 1820 shall be used. The Contractor shall select the pipe class to withstand grouting pressure and installation forces. The Contractor shall identify these forces in his submission requirements.

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

5.09.02.02 High Density Polyethylene (HDPE)

High Density Polyethylene (HDPE) pipe as per OPSS 1840 shall be used in accordance with ASTM D3350.

The requirements for fittings shall be according to CAN/CSA-B182.6 or ASTM F894.

The Contractor shall determine the required dimensional ratio (DR) to withstand the grouting pressure and installation forces. The Contractor shall identify these forces in his submission requirements.

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

Jointing of HDPE piping shall be completed by thermal butt fusion in accordance with manufacturer's recommended procedures and as outlined in the latest revision of ASTM D2657. All manufacturer's recommendations and procedures shall be followed during the jointing process.

Jointing of HDPE piping to other piping materials shall be completed using flanged connections.

6. EQUIPMENT

6.01 Jack & Bore Equipment

Jack & bore equipment shall be determined by the Contractor and shall be identified in the submission requirements specified herein.

Specific details of the manner in which rock or boulders will be broken and removed from the face and the face will be protected to prevent soil loss into the liner shall be submitted to the Contract Administrator for information purposes prior to proceeding with the works.

6.02 Pipe Ramming Equipment

Pipe ramming equipment shall be determined by the Contractor and shall be identified in the submission requirements specified herein.

The pipe ramming hammer(s) shall be capable of driving the pipe casing from the drive pit through the existing subsurface conditions at the site.

Specific details of the manner in which rock or boulders will be broken and removed from the face and the face will be protected to prevent soil loss into the pipe shall be submitted to the Contract Administrator for information purposes prior to proceeding with the works.

6.03 Directional Drilling Equipment

6.03.01 General

The directional drilling equipment shall consist of a directional drilling rig and a drilling fluid mixing and delivery system of sufficient capacity to successfully complete the product installation without exceeding the maximum tensile strength of the product being installed.

6.03.02 Drilling Rig

The directional drilling rig shall:

- consist of a leak free hydraulically powered boring system to rotate, push, and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill head;
- contain a guidance system to accurately guide boring operations;
- be anchored to the ground to withstand the rotating, pushing, and pulling forces required to complete the product installation; and
- be grounded during all operations unless otherwise specified by the drilling rig manufacturer.

6.03.03 Drill Head

The drill head shall be steerable by changing its rotation, be equipped with the necessary cutting surfaces and drilling fluid jets, and be of the type for the anticipated subsurface conditions,

6.03.04 Guidance System

The guidance system shall be setup, installed, and operated by trained and experienced personnel. The operator shall be aware of any magnetic or electromagnetic anomalies and shall consider such influences in the operation of the guidance system when a magnetic or electromagnetic system is used.

6.03.05 Drilling Fluid Mixing System

The drilling fluid mixing system shall be of sufficient size to thoroughly and uniformly mix the required drilling fluid.

6.03.06 Drilling Fluid Delivery System

The delivery system shall have a means of measuring and controlling fluid pressures and be of sufficient flow capacity to ensure that all slurry volumes are adequate for the length and diameter of the final bore and the anticipated subsurface conditions. Connections between the delivery pump and drill pipe shall be leak-free.

6.04 Tunnelling Equipment

Tunnelling equipment shall be determined by the Contractor and shall be identified in the submission requirements specified herein.

Specific details of the manner in which rock or boulders will be broken and removed from the tunnel face shall be submitted to the Contract Administrator information purposes. Use of explosives or rock fracturing chemicals shall only be considered subject to a field demonstration satisfactory to the Ministry prior to its use.

7. CONSTRUCTION

7.01 General

The Contractor shall notify the Contract Administrator at least 48 hours in advance of starting work. The proposed method of pipe installation shall be subject to the limitations presented in the following subsections.

7.01.01 Layout, Alignment and Depth Control

The location of the installation shall be established from the lines, elevations and tolerances specified in the Contract Documents. The pipe installation shall be to the horizontal and vertical alignments specified in the Contract Drawings. Deviations from location, alignment, grades and/or invert levels shall be corrected by the Contractor at no cost to the Ministry.

All reference points necessary to construct the pipe installation and appurtenances shall be laid out.

The Contractor shall calibrate tracking and locating equipment at the beginning of each work day, and shall monitor and record the alignment and depth readings provided by the tracking system at every 5 m in normal conditions and every 2 m where precise alignment control is necessary;

The Contract Administrator shall be provided with the assistance and access necessary to check the layout of the pipe installation and associated appurtenances.

All excavations shall be carried out in accordance with the Occupational Health and Safety Act (OHSA) of Ontario.

For directional drilling, the contractor shall ensure that during pilot hole drilling the maximum degree of deviation or "dog-leg" shall be 2.5 degrees per 9m drill pipe length. Any deviation exceeding 2.5 degrees will necessitate a pull-back and straightening of the alignment at the Contractor's sole expense. The pilot hole exit location shall be within 0.5m of the target location.

7.01.02 Shafts

Shafts shall be specified in the Contractor's submission. The boundaries and protection of these shall be as required to contain all disturbances to areas outside of the ESA limits.

Shafts shall be maintained in a drained condition.

A minimum 2.4 m high secure fence shall be installed around the perimeter of the construction shaft area with gates and truck entrances. The fence shall be removed on completion of the work.

7.01.03 Protection Systems

The construction of all protection systems shall be according to OPSS 539. Where the stability, safety, or function of an existing roadway, watercourse, other works, proposed works or ESA's may be impaired due to the method of operation, protection shall be provided. Protection systems include primary liner and portal excavation support systems. Protection may include sheathing, shoring, and piles where necessary to prevent damage to such works or proposed works

7.01.04 Settlement or Heave

Any disturbance to the ground surface (settlement or heave) as a result of the pipe installation shall be immediately corrected by the Contract, at no additional cost to the Ministry.

7.01.05 Stability of Excavation

The construction methods, plant, procedures, and precautions employed shall ensure that excavations are stable, free from disturbance, and maintained in a drained condition.

The construction methods, plant, and materials employed shall prevent the migration of soil and/or rock material into the excavation from adjacent ground.

7.01.06 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 504.

Existing underground facilities shall be exposed to verify its horizontal and vertical locations when the outlet pipe path comes within 1.0 m horizontally or vertically of the existing facility. Existing facilities shall be exposed by non-destructive methods.

7.01.07 Transporting, Unloading, Storing and Handling Materials

Manufacturer's handling and storage recommendations shall be followed.

7.01.08 Trenching, Backfilling and Compacting

Trenching, backfilling, and compacting for entry and exit points or other locations along the pipe path shall be according to OPSS 514.

7.01.09 Dewatering

The work of this Section includes control, handling, treatment, and disposal of groundwater. The Contractor shall review the foundation investigation report for reference to soil and groundwater conditions on the project site and plan a dewatering scheme accordingly.

The Contractor shall control groundwater inflows to excavations to maintain stability of surrounding ground, to prevent erosion of soil, to prevent softening of ground exposed in the excavation, and to avoid interfering with execution of the work.

The Contractor shall maintain excavations free of standing water at all times during excavation, including while concrete is curing.

Should water enter the excavation in amounts that could adversely affect the performance of the work or could cause loss of ground, the Contractor shall take immediate steps to control the inflow.

The Contractor is alerted that seepage zones of perched water within the fill materials should be expected, particularly where granular materials are excavated.

Dewatering shall be according to OPSS 517.

7.01.10 Removal of Boulders

The Contractor is alerted that cobbles and boulders should be anticipated in the soil deposits at the site. Accordingly, the Contractor shall address the removal of cobbles and boulders in the proposed method of construction. The Contractor shall immediately inform the Contract Administrator of any obstruction encountered.

7.01.11 Record Keeping

Verification record requirements of the alignment and depth of the installation shall be as specified in the Contract Documents. A copy of the verification records shall be given to the Contract Administrator at the completion of the installation.

7.01.12 Testing

Testing of the product installation shall consist of verifying the specified grade between the two ends of the pipe and passing of water from the median end of the pipe to the outlet end to confirm gravity flow conditions.

7.01.13 Management and Disposal of Excess Material

Management and disposal of excess material shall be according to OPSS 180. Satisfactory re-usable excavated material required for backfill shall be separated from unsuitable excavated material.

7.01.14 Site Restoration

Site restoration shall be according to OPSS 507.

7.01.15 Supervision

A qualified individual, who is experienced in the pipe installation by trenchless methods shall supervise the work at all times.

7.02 Jack & Bore Installation

7.02.01 Method of Installation Procedure

The installation procedure to be used shall be subject to the following limitations:

- Hydraulically operated jacks of adequate number and capacity shall be provided to ensure smooth and uniform advancement without over-stressing of the pipe.
- A suitably padded jacking head or collar shall be provided to transfer and distribute jacking pressure uniformly over the entire end bearing area of the pipe.
- The jacking pipe shall be fully supported in the jacking pit at the specified line and grade.
- Selection of the excavation method and jacking equipment shall take into consideration the conditions at each pipe crossing.

7.02.02 Pipe Installation

Concrete pipe joints shall be water tight and according to OPSS 1820 and must withstand jacking forces, determined by the Contractor.

During the jacking of the liner the space between the liner and the wall of the excavation shall be kept filled with bentonite slurry. Upon completion of jacking, the space between the liner and the wall of the excavation shall be filled with grout.

The annular space between the liner and the product shall be fully grouted with a water tight, expandable and stable grout.

7.03 Pipe Ramming Installation

For pipe ramming installation the following requirements apply:

Only smooth walled steel pipe shall be used. But welding of pipe joints shall conform to CAS W59.

Ramming equipment of adequate capacity shall be provided to ensure smooth and uniform advancement without overstressing of the pipe. Delays shall be avoided between ramming operations.

A ramming head shall be provided to transfer and distribute jacking pressure uniformly over the entire end bearing area of the pipe.

Two or more lubricated guide rails or sills shall be provided of sufficient length to fully support the pipe at the specified line and grade in the ramming pit. Pipe shall be installed to the line and grade specified.

Following installation of the liner pipe, all material shall be removed from the pipe to the satisfaction of the Contract Administrator. Any voids remaining between the pipe and the excavation wall shall be grouted as soon as the pipe is rammed. The annular space between the liner pipe and the product shall be fully grouted with a water tight, expandable and stable grout.

7.04 Directional Drilling Installation

7.04.01 General

When strike alerts are provided on a drilling rig, they shall be activated during drilling and maintained at all times.

7.04.02 Site Preparation

The work site shall be graded or filled to provide a level working area for the drilling rig. No alterations beyond what is required for DD operations are to be made. All activities shall be confined to designated work areas.

7.04.03 Pilot Bore

The pilot bore shall be drilled along the bore path in accordance with the grade, alignment, and tolerances as indicated on the Contractor's submitted drilling plan to ensure that the product is installed to the line and grade shown on the Contract Drawings. The Contractor's methods shall take into consideration the conditions at each crossing within the pipe alignment and shall be suitable to advance through such obstructions such as cobbles and boulders and address the potential for deflection off these obstruction and/or soil conditions.

In the event the pilot bore deviates from the submitted path, the Contract Administrator shall be notified. The Contract Administrator may require the Contractor to pullback and re-drill from the location along the bore path before the deviation.

In the event that a drilling fluid fracture, inadvertent returns, or loss of circulation occurs during pilot bore drilling operations, the Contract Administrator shall be advised of the event and action shall be taken in accordance with the Contractor's submitted contingency plan.

At the entry and exit points, there is potential for ravelling of the existing soil, fill and or weathered rock areas along the alignment. This is conventionally addressed by the use of drilling fluid. However, casing may be required. The Contractor's methods shall take into consideration the potential need to install sections of casing to manage ravelling at or near ground surface.

If a drill hole beneath the highway must be abandoned, the hole shall be backfilled with grout or bentonite to prevent future subsidence.

The Contractor shall maintain drilling fluid pressure and circulation throughout the DD process, including during the initial pilot bore and during the reaming process.

The Contractor shall at all times and for the entire length of the installation alignment be able to demonstrate the horizontal and vertical position of the alignment, the fluid volume used, return rates and pressures.

7.04.04 Drilling Fluid Fracture (Frac-Out)

In order to reduce the potential for hydraulic fracturing of the hole during directional drilling, a minimum depth of cover of 5m is normally maintained between the pipe and the ground surface. Sections of the pipe close to the exit pit with less than 5m cover shall be cased. The Contractor shall ensure that drilling fluid pressures are properly set and controlled to prevent frac-out, for the depth of cover available between the bottom of the pavement structure (bottom of the subbase material) and the top of the bore.

Since fluid loss normally occurs in fault zones, fracture zones, or seams of coarse material, fluid migration does not always gravitate to the surface, thus making detection difficult. Once a fluid loss is detected, the Contractor shall halt operations immediately and conduct a detailed examination of the drill path and implement measures to mitigate fluid loss. If no surface migration is evident, resume operation while paying particular attention to fluid monitoring.

In the event of a fluid migration to the surface occurring, the Contractor shall halt all operations immediately, isolate the migration site, and recover fluids. Once the fracture is controlled, continue drilling operations with the operator paying particular attention to the fracture points

7.04.05 Reaming

The bore shall be reamed using the appropriate tools to a diameter at least 50% greater than the outside diameter of the product.

7.04.06 Product Installation

7.04.06.01 General

The product shall be jointed according to manufacturer's recommendations. The length of the product to be pulled shall be jointed as one length before commencement of the continuous pulling operation.

The product shall be protected from damage during the pullback operation.

The minimum allowable bending radius for the product shall not be exceeded.

Product shall be allowed to recover before connections to new or existing facility are made. Product recovery time shall be according to manufacturers recommendations.

7.04.06.02 Pullback and Grouting

After successfully reaming the bore to the required diameter, the product shall be pulled through the bore path. Once the pullback operation has commenced, it shall continue without interruption until the product is completely pulled into bore unless otherwise approved by the Contract Administrator.

A swivel shall be used between the reamer and the product being installed to prevent rotational forces from being transferred to the product. When specified in the Contract Documents, a weak link or breakaway connector shall be used to prevent excess pulling force from damaging the product.

The product shall be inspected for damage where visible at excavation pits and where it exits the bore. Any damage noted shall be rectified to the satisfaction of the Contract Administrator,

The pull back and reaming operations shall not exceed the fluid circulation rate capabilities. Reaming and back pulling operations shall be planned to insure that, once started, all reaming and back pulling operations are completed without stopping and within the permitted work hours.

The space between the pipe and the excavation walls shall be filled with grout.

7. 05 Tunnelling Installation

7.05.01 General

The method of tunnelling shall be selected by the Contractor and shall be submitted to the Contract Administrator prior to commencement of the work for information purposes.

Excavation of native soil and fill shall be done in a manner to control groundwater inflow to the excavation and to prevent loss of ground into the excavation.

Methods of excavating the tunnel shall be capable of fully supporting the face and shall accommodate the removal of boulders and other oversize objects from the face. Continuous ground support shall be maintained during excavation.

As the excavation progresses, the Contractor shall continuously monitor (every 2m) indications of support distress, such as cracking, deflection or failure of support system and subsidence of ground near the excavation.

The Contractor shall advance the ventilation system as a regular part of the normal excavation cycle.

The Contractor shall provide lighting in accordance with OHSA requirements for the entire length of the tunnel.

The tunnel is to be kept sufficiently dry at all times to permit work to be performed in a safe and satisfactory manner.

The Contractor shall maintain clean working conditions at all times in tunnels.

In the event that excavation threatens to endanger personnel, the Work, or adjacent property, the Contractor shall cease excavation. The Contractor shall then evaluate methods of construction and revise as necessary to ensure the safe continuation of the work.

The Contractor shall maintain tunnel excavation line and grade to provide for construction of final lining within specified tolerances.

7.05.01 Tunnelling Method

The tunnelling method shall be suitable to provide face support in changing ground conditions that may be encountered during the progress of the work. The selection of the tunnelling method should consider the soil conditions at each pipe crossing and the presence of obstructions, such as cobbles and boulders, with respect to the tunnel alignment.

7.05.02 Primary Liner (Support System)

Primary support systems shall prevent deterioration, loosening, or unravelling of ground surfaces exposed by excavation.

The primary liner support system shall be designed and installed to achieve the intended performance requirements.

Primary liner support system shall maintain the safety of personnel, minimize ground movement into the excavation, ensure stability and maintain strength of ground surrounding the excavation.

The primary liner shall be designed to support all subsurface conditions and hydrostatic pressures and to withstand any additional loads caused by installation and grouting, and shall ensure that no ground loading or other loading will be placed on the new work until after design strength has been reached.

The primary liner shall be installed so that the exterior is as tight as possible to the excavated surface of the tunnel and allows the placement of the full design thickness of the secondary lining.

Primary support systems shall be compatible with the encountered ground conditions, with the method of excavation, with methods for control of water, and with placement of the permanent lining.

All voids between the primary lining and the surface of the excavation shall be filled with cement grout. If an unexpanded liner is used, the space outside the liner plates shall be grouted at least daily.

7.05.03 Secondary Liner

13 7.05.03.01 PLACING OF GROUT

The void outside the finished secondary liner shall be filled with cement grout according to the Contractor's submission.

Grout shall not be placed until the lining has achieved 85% of its specified strength or 30 MPa. Grouting shall be limited to such sequences and programs as are necessary to avoid damaging any part of the works or any other structure or property.

7.06 Instrumentation Monitoring

The work specified in this Section includes furnishing and installing instruments for monitoring of settlement and ground stability.

Surface settlement markers for monitoring ground stability shall be installed at the pavement/ground surface level on the shoulder, side slope and pavement at not greater than 5 m intervals along the tunnel alignment and as an array of three in ground (1.5 m depth) measurement points on the shoulder of the highway perpendicular to the alignment. The equipment and procedures used for settlement monitoring during construction must be capable of surveying the settlement point elevations to within ± 1 mm of the actual elevation.

Surface settlement markers shall be hardened steel markers treated or coated to resist corrosion, with an exposed convex head having a minimum diameter of 12 mm and similar to surveyor's PK nails. Markers shall be rigidly affixed so as not to move relative to the surface to which it is attached. Traffic shall be managed by the contractor using short term lane closures in accordance with the Ontario Traffic Manual (OTM).

In general, settlement monitoring points shall be 12-18 mm rebar encased in a 50-70 mm, SCH40 PVC pipe, set to a depth of 1.5 m below ground surface. The assembly shall be placed in a drill hole and backfilled with uniform sand as shown on the Contract Drawings.

The Contractor shall install all surface settlement instruments a minimum of one week prior to the start of works.

The surface settlement instruments shall be clearly labelled for easy identification.

The Contractor shall submit to the Contract Administrator a site plan showing the locations of the monitoring points, a geodetic survey of the settlement monitoring points including station, offset and elevation recorded at the following time intervals:

- Three consecutive readings at least one week prior to commencement of the work (Baseline Reading);
- Once per shift during tunnelling operations period; and
- Weekly after completion of the work for one month, or until such time at which all parties agree that further movement has stopped.

All readings shall be submitted to the Contract Administrative for information purposes on a weekly basis. Each report shall include all survey data collected in tabular and graphical format as plots of time versus settlement in comparison to survey data collected prior to commencement of the work.

7.07 Criteria for Assessment of Roadway Subsidence/Heave

Based on the monitoring of ground movement as specified in Subsection 4.02, the following represents trigger levels that define magnitude of movement and corresponding action:

- Review Level: If a maximum value of 10 mm relative to the baseline readings is reached, the Contractor shall review or modify the method, rate of sequence of construction or ground stabilization measures to mitigate further ground displacement.

  If the Review Level is exceeded, the Contractor shall immediately notify the CA and review and discuss response actions. The Contractor shall submit a plan of action to prevent Alert Levels from being reached. All construction work shall be continued such that the Alert Level is not reached.

- Alert Level: If a maximum value of 15 mm relative to the baseline readings is reached, the Contractor shall cease construction operations, inform the Contract Administrator and execute pre-planned measures to secure the site, to mitigate further movements and to assure safety of public and maintain traffic.

  No construction shall take place until all the following conditions are satisfied:

  - The cause of the settlement has been identified.
  - The Contractor submits a corrective/preventive plan.
  - Any corrective and/or preventive measure deemed necessary by the Contractor is implemented.
  - The CA deems it is safe to proceed.

The Contractor shall avoid damaging instrumentation during construction. Instrumentation that is damaged as a result of the Contractor's operation shall be repaired or replaced by the Contractor within one business day. The costs for replacement/repair shall be borne by the Contractor.

At the completion of the job, the Contractor shall abandon all instrumentations installed during the course of the Work.

9. MEASUREMENT FOR PAYMENT

Measurement shall be by Plan Quantity Payment as may be revised by Adjusted Plan Quantity Payment in metres, following along the centre line of the pipes from centre to centre of maintenance holes or chambers (catch basins) or from/to the end of the pipe where no maintenance hole or chamber is installed, of the actual length of pipe installed by trenchless methods.

10. BASIS OF PAYMENT

Payment at the contract price shall be full compensation for providing all labour, equipment and materials required for excavation (regardless of material encountered), dewatering, sheathing and shoring, supply and installation of pipe liners, settlement monitoring and instrumentations site restoration and for all other work necessary to complete the installation as specified.

Payment for the rigid or flexible pipe conduits installed inside the pipe liners shall be paid separately under the appropriate tender items.

Where a protection system is made necessary because of the Contractor's operations (e.g. choice of trenchless installation method), the cost shall be included in this item and shall be full compensation for all labour, equipment and materials required to carry out the work including subsequently removing the temporary protection system and performing any necessary restoration work.

Payment for connecting intercepted drains and service connections shall be made on the following basis:

(a) Where such drains and service connections are shown on the contract drawings the cost of connections shall be included in the contract price for pipe installation.

(b) Where such drains and service connections are not shown on the contract drawings, the cost of connections will be considered an allowable extra to the contract.

Payment for removal of boulders/obstructions greater than an equivalent 0.3 m in diameter shall be on a time and materials basis. The Contractor shall inform the Contract Administrator when boulders/obstructions are encountered and prior to removal to allow for proper and accurate tracking of time and material charges.

Notes to Designer:

- *Under Section 7.01.06, minimum horizontal and vertical clearances to existing facilities shall be identified in the Contract Documents. Clearances shall be measured from the nearest edge of the largest cut diameter required to the nearest edge of the facility being paralleled or crossed. The number of exposures required to monitor work progress shall be specified in the Contract Documents.*

Appendix D

Instrumentation and Monitoring Program

INSTRUMENTATION AND MONITORING PROGRAM **- Item No.**
PROPOSED SEWER CROSSINGS OF HIGHWAY 427
FASKEN DRIVE TO STEELES AVENUE - HIGHWAY 427 WIDENING

Special Provision

1 GENERAL

1.1 Scope

This special provision contains the requirements for the supply, installation and monitoring of the following instruments:

- Surface Monitoring Point (SMP)
- Settlement Pin (SP)

The instruments shall be installed along the centreline of the sewer alignments and in arrays. Each array consists of a group of instruments installed approximately perpendicular to the sewer alignments.

1.2 Purpose

The purpose of these instruments is to monitor settlements during installation of fifteen (15) proposed storm water sewers with diameters ranging from 300 mm to 750 mm.

The methodologies and rate of installation may need to be adjusted as a result of the instrumentation readings.

1.3 Contractor's Scope of Work

The Contractor shall be fully responsible to procure, install, protect, monitor, reduce and transmit data for all monitoring instruments and to decommission the instruments as described herein.

The required survey of all the instruments shall be carried out by the Contractor's qualified surveyors.

1.4 Or equal

The term, >or equal= shall be understood to indicate that the equal product is the same or better than the specified product in function, performance, reliability, quality and general configuration.

1.5 Notification

The Owner, the Ontario Ministry of Transportation (MTO), the Contract Administrator (CA), and CA's Geotechnical Consultant, shall be notified five days in advance of commencing the installation of instruments. All instruments shall be installed and their baseline readings (see Section 6.3) established to the satisfaction of all parties listed above not less than five days in advance of the installation operations.

1.6 Instrument Installation and Monitoring Requirements

The Contractor shall be prepared to install and monitor all instruments.

1.7 Drawings

Reference shall be made to Drawings 19-92-70-1 to 19-92-70-11 for instrument locations.

1.8 Subsurface Conditions

The subsurface conditions at the site are described in Thurber's Report titled "Foundation Investigation Report, Proposed Sewer Pipe Crossings, Highway 427 Inside Widening From Fasken Drive to Steeles Avenue, Toronto, Ontario, GWP 202-95-00". Prepared for SNC-Lavalin, dated January 22, 2010.

2 INSTALLATION

2.1 General

There are two hundred and nineteen (**219**) surface monitoring points (SMP) and thirty (**30**) settlement pins (SP) to be installed at this site as shown on Drawings 19-92-70-1 to 19-92-70-11. SMPs will be installed along the centreline of traffic lanes and / or paved shoulders in arrays of either three (3) instruments or one (1) single instrument. SPs will be installed on the side slopes or at the toes of highway embankments along the proposed sewer centrelines. The numbers of monitoring points that will be installed at each location of sewer crossings are shown in the table below:

Str. No to Str. No (Hwy 427 Station to Station)	Diameter (mm)	Length (m)	Depth of Crown Below Grade (m)	Number of Monitoring Points	
				SMP	SP
136A (20+557) – 137 (20+549)	300	29	2.2	17	2
165 (20+635) – 166 (20+635)	375	23	1.7	14	1
173 (20+819) – 174A (20+819)	300	32	1.6 - 2.0	16	1
210A (21+387) – 209 (21+387)	675	25	1.2 – 1.4	18	–
347 (21+873) – 348A (21+873)	525	33	1.9 – 2.4	14	2
13 (22+516) – Outlet (22+516)	375	44	2.4 – 2.8	17	1
24 (22+582) – 22 (22+582)	300	32	1.7 – 1.8	16	3
31 (22+945) – 30A (22+945)	375	32	3.2 – 3.4	14	2
34 (23+155) – 33A (23+155)	450	31	1.5 – 1.7	14	2
77C (23+641) – 77D (23+641)	750	25	2.0	12	2
E (26+071) – Outlet (26+071)	300	45	2.1 – 2.6	14	3
E1 (26+150) – Outlet (26+150)	450	33	2.1 – 2.3	14	2
99 (27+232) – Outlet (27+232)	300	47	2.2 – 3.6	13	4
100A (27+375) – Outlet (27+375)	300	47	3.4 – 4.0	16	3
105A (27+575) – Outlet (27+575)	450	17	2.2	10	2

Each of the arrays with three instruments will consist of the following:

- One (1) instrument installed at the proposed sewer centreline
- One (1) instrument installed at 1.5m north of the proposed sewer centreline
- One (1) instrument installed at 1.5m south of the proposed sewer centreline

2.2 Instrument Location

The Contractor's surveyors shall accurately survey the location of each instrument to obtain coordinates and elevations.

2.3 Survey Benchmarks

The Contractor's surveyors shall identify or establish non-yielding survey benchmarks (BM) at the site in order to carry out elevation surveying and achieve the accuracy specified below.

2.4 Accuracy of Surveying for Elevations

Elevations shall be surveyed to an accuracy of ± 2 millimetres or better.

2.5 Materials and Equipment

The Contractor shall supply all materials and equipment required for installation of the instrumentation.

2.6 Protection of Instruments

All instruments shall be adequately protected by the Contractor such that they are not damaged during construction. Any instrument damaged directly or indirectly by the Contractor's work shall be immediately replaced by the Contractor at the Contractor's expense.

Instruments installed in the travelled portion of the roadway (lanes and shoulders) shall be protected to avoid puncturing of vehicle tires.

2.7 Installation Program

Instrument installation and baseline readings shall be completed before any trenchless installation operations.

3 SURFACE MONITORING POINT (SMP) - SUPPLY & INSTALLATION

3.1 General

3.1.1 Scope

This Section contains the requirements for the supply and installation of SMPs.

The purpose of SMP is to monitor settlement of asphalt paved surface. The ground movement readings shall assist in assessing the sewer performance and any need to modify the installation methodology as required. Settlement is measured by level surveying the SMPs with reference to stable, non-settling benchmarks.

3.1.2 General Procedure

SMPs shall be rigidly affixed so as not to move relative to the asphalt pavement surface to which they are attached.

3.1.3 Location

The locations of SMPs are shown on Drawings 19-92-70-1 to 19-92-70-11.

3.2 Materials

3.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the SMPs.

3.2.2 Steel Markers

The Contractor shall supply hardened steel markers with an exposed convex head, similar to surveyor's PK nails, treated or coated to resist corrosion. The steel markers shall have a minimum diameter of 12mm and have sufficient length for anchoring in the pavement and to withstand the weather conditions and effects of traffic.

The exposed nail head shall be equipped with reflective paint or reflective tape to allow for measurements with total-station equipment.

3.3 Installation

3.3.1 General

Traffic shall be managed by the Contractor using short term lane closures in accordance with the Ontario Traffic Manual (OTM), Book 7.

3.4 Documentation

Relevant installation details shall be recorded and documented. These include, but are not limited to:

- SMP easting, northing and elevation;
- Dates of installation;
- Installation notes / sketches.

4 SETTLEMENT PIN (SP) - SUPPLY & INSTALLATION

4.1 General

4.1.1 Scope

This Section contains the requirements for the supply and installation of SPs.

The purpose of SP is to monitor the settlement of the ground and highway embankments along the proposed sewer alignments. The settlement readings shall assist in assessing the sewer performance and any need to modify the installation methodology as required. Settlement is measured by level surveying the SPs with reference to stable, non-settling benchmarks.

4.1.2 General Procedure

The SP shall be a steel pin cast into concrete on the side slopes or at the toes of embankments as per attached Figure 1.

The concrete will be cast in-situ in a 0.5 m deep hole dug at the above locations.

4.1.3 Location

The locations of SPs are shown on Drawings 19-92-70-1 to 19-92-70-11.

4.2 Materials

4.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the SPs.

4.2.2 Sonotube Concrete Form

The Contractor shall supply Sonotube concrete forms or equal. Sonotubes shall be sized as per the attached installation details with a minimum wall thickness of 5 mm. Sonotubes shall be protected from rain and moisture on site until used.

4.2.3 Concrete

The Contractor shall supply concrete (OPSS 1350) with strength and set time sufficient to secure the settlement pin within two days of pouring.

4.2.4 Pin

The Contractor shall supply a 25.4 mm minimum diameter reinforcing steel bar (OPSS 905) cut 0.4 m long.

The top of the reinforcing steel bar shall be angled or rounded such that a single survey point can be clearly identified and repeated. For safety purpose, the top of pin shall be protected with a plastic cap when it is not being surveyed.

4.3 Installation

4.3.1 General

The Contractor shall install the settlement pins as per the drawings provided in Figure 1.

4.4 Documentation

Relevant installation details shall be recorded and documented. These include, but are not limited to:

- SP location, easting and northing;
- Elevation of top of pin;
- Dates of installation;
- Installation notes / sketches.

5 DECOMMISSIONING OF INSTRUMENTS

5.1 General

The Contractor shall decommission all SMPs and SPs after the completion of the monitoring program as directed by CA and CA's Geotechnical Consultant.

6 MONITORING PROGRAM

6.1 General

The instrumentation monitoring services specified herein apply to all the SMPs and SPs for this site. The requirements include data collection, reporting, data reduction and data transmission.

The Contractor shall carry out the monitoring program for this project. The required tasks include the following:

- Supply materials and equipment required for monitoring;
- Level survey the instruments with no interference with the traffic on Hwy 427 and its ramps;
- Compile and reduce the survey data as described in Section 6.4.2;
- Transmit the settlement data and associated pipe installation /construction activities to CA, CA's Geotechnical Consultant and MTO;
- Notify CA, CA's Geotechnical Consultant and MTO of any required modifications to the construction procedures;
- Notify CA, CA's Geotechnical Consultant and MTO of any modifications of the

original site conditions related to pipe installation or otherwise, including appearance of cracks on the pavement and shoulder, concrete barriers etc;

- Notify immediately CA, CA's Geotechnical Consultant and MTO if Review or Alert Levels have been reached or exceeded and follow the procedures outlined in Section 6.5.

6.2 Purpose

The purpose of this program is to monitor settlement of the paved surfaces and embankments at selected locations during the trenchless installation of the storm water sewers.

The rate and / or methodology of trenchless installation may need to be adjusted based on the instrumentation readings.

6.3 Reading Schedule and Frequency

The Contractor shall keep a complete record in electronic and hard copy formats of all instrumentation survey and associated data, including the location of the advancing face at the time of each survey.

Monitoring shall commence after the installation of an instrument. Monitoring is to continue as specified in this document and as required by CA and CA's Geotechnical Consultant.

The minimum monitoring frequencies along with the anticipated number of readings are given in Table 5.1 below. The monitoring frequency is the same for each individual instrument. Instruments shall be read more frequently as required by CA and CA's Geotechnical Consultant.

Table 5.1 - Minimum Monitoring Frequency

STAGE	FREQUENCY	ANTICIPATED NO. OF READINGS PER INSTRUMENT (**)
Baseline Readings (*)	3 readings on 2 consecutive days	3
Just prior to start of sewer installation	Once	1
During sewer installation	A minimum of three (3) sets of readings be taken daily for all instruments located above a sewer being installed, provided that movements are within anticipated limits. Monitoring of movements is also required during work stoppages, such as during non-operation periods (off-shifts) or weekends.	Variable
After completion of sewer installation	After the end of installation of each sewer, all instruments located above the sewer shall be read weekly for the first month.	4

(*) Baseline Readings: Instrument elevation readings taken prior to sewer installation to provide a baseline against which all subsequent readings are compared to assess settlements of the ground.
(**) Number of readings may vary.

6.4 Specific Requirements

6.4.1 Surveying

The elevations of the instruments shall be surveyed to an accuracy of plus/minus two (±2) millimetres or better, and shall be reported to the nearest millimetre. Shoulder and lane closures for instrument readings are not permitted.

6.4.2 Data Recording and Data Reduction

For every instrument elevation reading the following information shall be recorded electronically in an Excel spreadsheet containing the following information:

- Date and time of the day
- Location of the advancing face (i.e. distance from launching point) at the time of data recording
- Construction activities (e.g. sewer installation underway; weekend – no construction; boulder encountered at the advancing face of installation, etc)
- Pavement visual survey (e.g.: No visual pavement distress; 1 mm wide, 3 m long pavement crack parallel to west shoulder and close to instruments No. A, B and C, sketches and photos, etc)

- Instrument Number
- Settlement Array Number
- Horizontal distance measured along the sewer alignment between the advancing face of installation and the instrument or array of instruments that contains the instrument being monitored
- Instrument elevation
- Instrument settlement

The settlement data shall be presented in X-Y charts as follows:

- Settlement versus Time for each instrument
- Settlement versus Distance from the advancing face of installation for each instrument
- Settlement profile for different dates along each of the sewer alignments
- Settlement profile for different dates along each of the settlement arrays

Reported information should be supplemented by sketches, diagrams and plots as necessary.

6.4.3 Data Transmission

All settlement data obtained on a particular day shall be reported in electronic format to CA, CA's Geotechnical Consultant and MTO not later than mid-day on the next calendar day. Any unusual movements deduced from the field data must be reported immediately before leaving the site.

6.5 Criteria for Assessment

The following settlement levels are to be observed:

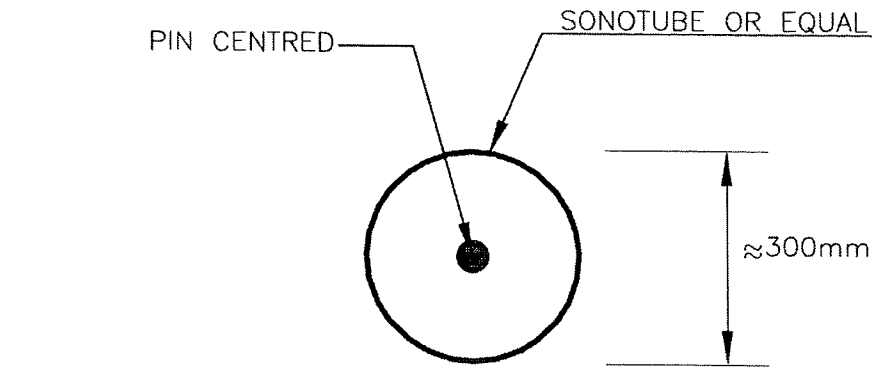
Review Level – A maximum value of 10 mm relative to the baseline or zero readings. If the Review Level is exceeded, the Contractor shall immediately notify CA, CA's Geotechnical Consultant and MTO, and review and discuss response actions. The Contractor shall submit a plan of action to prevent Alert Level from being reached. All construction work shall be continued such that Alert Level is not reached.

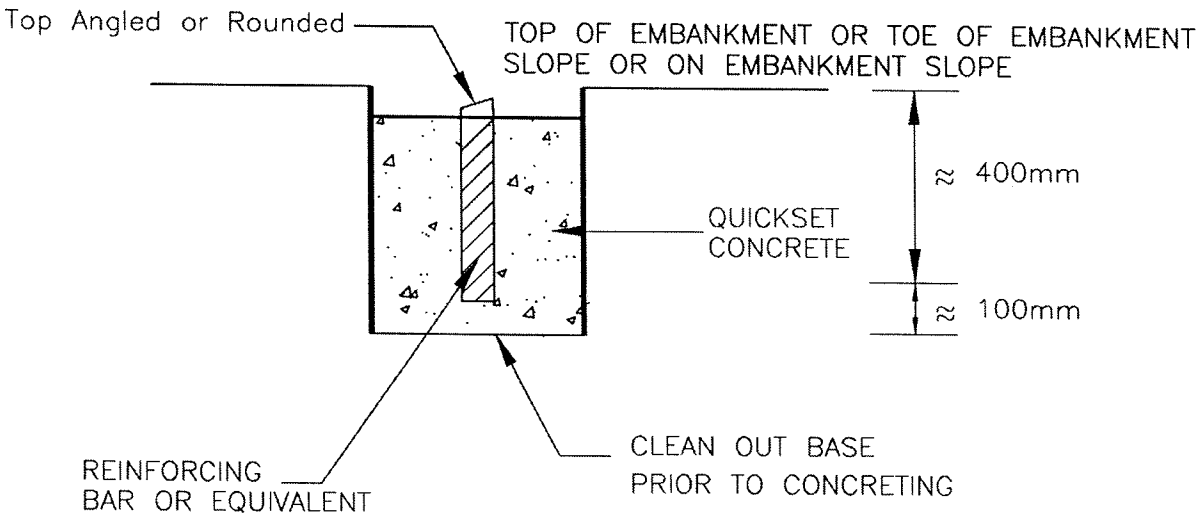
Alert Level – A maximum value of 15 mm relative to the baseline or zero readings. If the Alert Level is reached or exceeded, or lesser ground settlements cause or threaten to cause damage to utilities or the highway pavement, as indicated by monitoring instruments or direct observation, the Contractor shall cease installation operation immediately and inform CA, CA's Geotechnical Consultant and MTO. No construction shall take place until all the following conditions are satisfied:

- The cause of the settlement has been identified;
- The Contractor submits a corrective / preventive plan;
- Any corrective and / or preventive measure deemed necessary by the Contractor is implemented;
- CA, CA's Geotechnical Consultant and MTO deem it is safe to proceed.

7 CONTRACTOR'S RESPONSIBILITY FOR RESTORATION

Notwithstanding the monitoring program to assess the adequacy of the sewer installation method to control potential ground movements and groundwater, the Contractor is responsible for reinstatement (such as surface paving and fill placement) should movements or other surface distress occurs.





SETTLEMENT PIN (SP)

THURBER	**SETTLEMENT PIN (SP) DETAILS**	**FIGURE 1**

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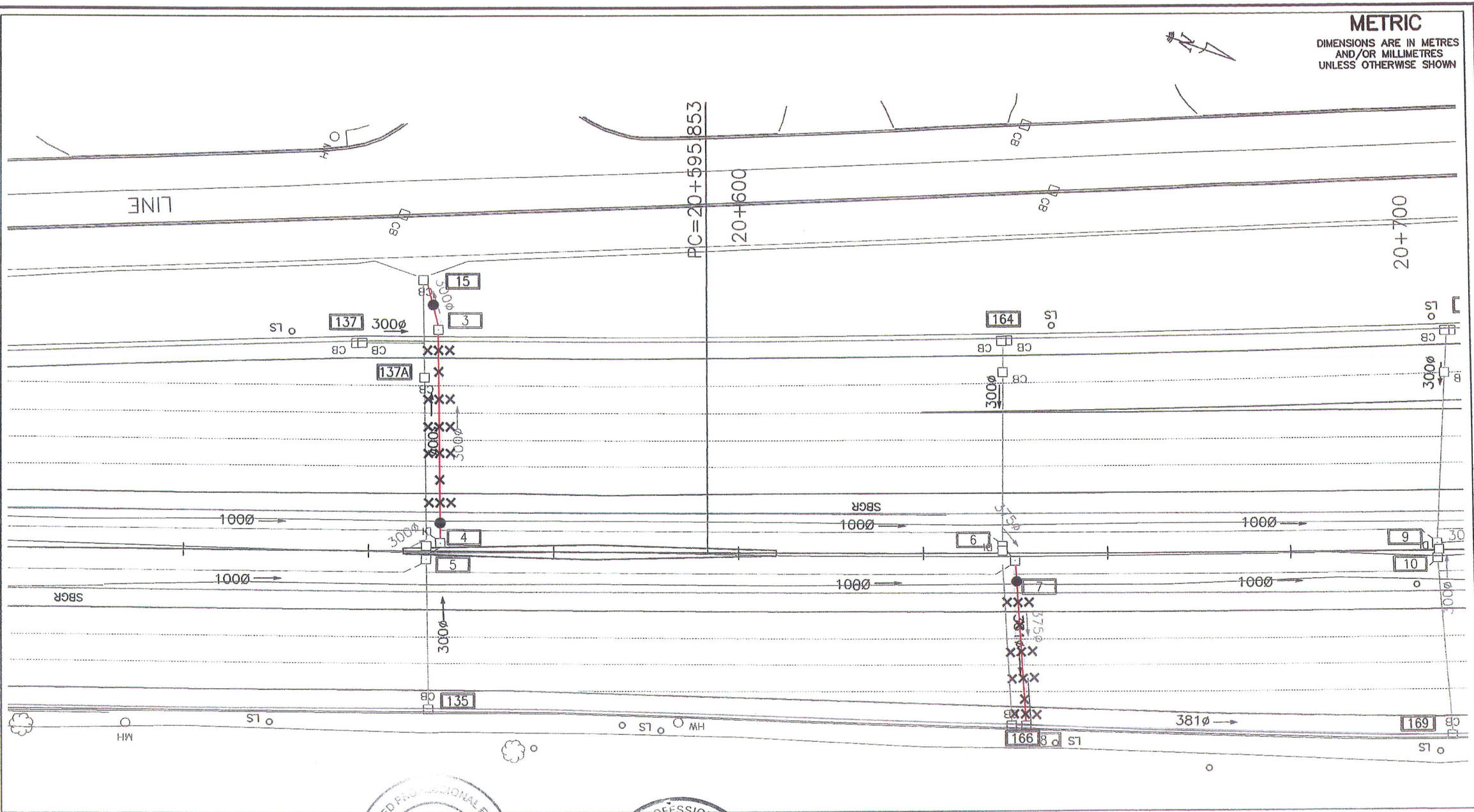
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PROPOSED SEWER CROSSINGS

× SURFACE MONITORING POINT (SMP)

● SETTLEMENT PIN (SP)

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
March 16, 2010
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Mar 16/2010
PROVINCE OF ONTARIO

BASE PLAN PROVIDED BY: SNC-LAVALIN

SNC-LAVALIN

HIGHWAY 427 WIDENING
FROM FASKEN DR. TO STEELES AVE.
G.W.P. 202-95-00
PROPOSED SEWER CROSSINGS
INSTRUMENTATION & MONITORING PROGRAM
STA. 20+500 TO STA. 20+700

19-92-70

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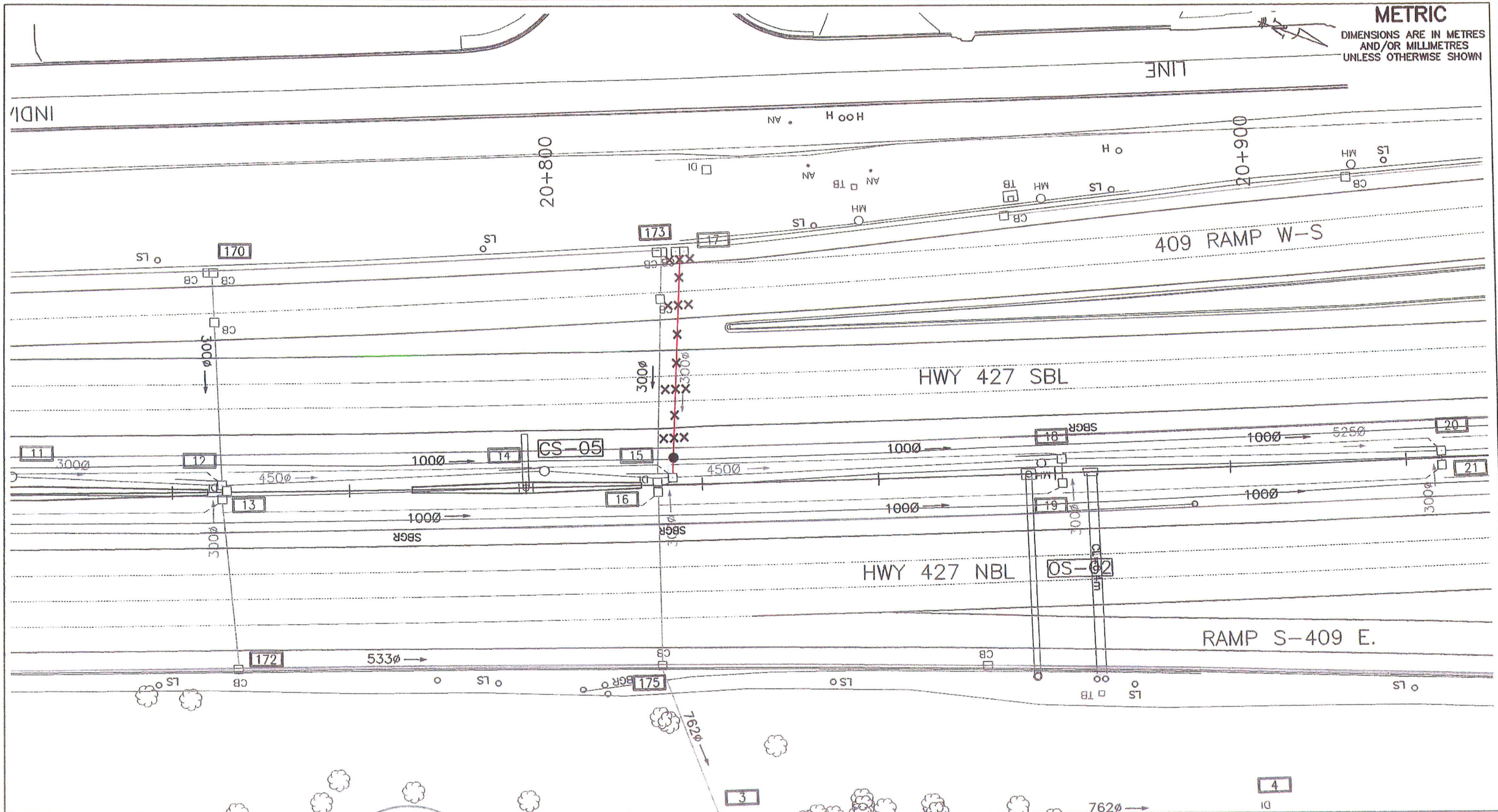

PROPOSED SEWER CROSSINGS
SURFACE MONITORING POINT (SMP)
SETTLEMENT PIN (SP)

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BASE PLAN PROVIDED BY: SNC-LAVALIN

SNC-LAVALIN

HIGHWAY 427 WIDENING
FROM FASKEN DR. TO STEELES AVE.
G.W.P. 202-95-00
PROPOSED SEWER CROSSINGS
INSTRUMENTATION & MONITORING PROGRAM
STA. 20+700 TO STA. 20+930

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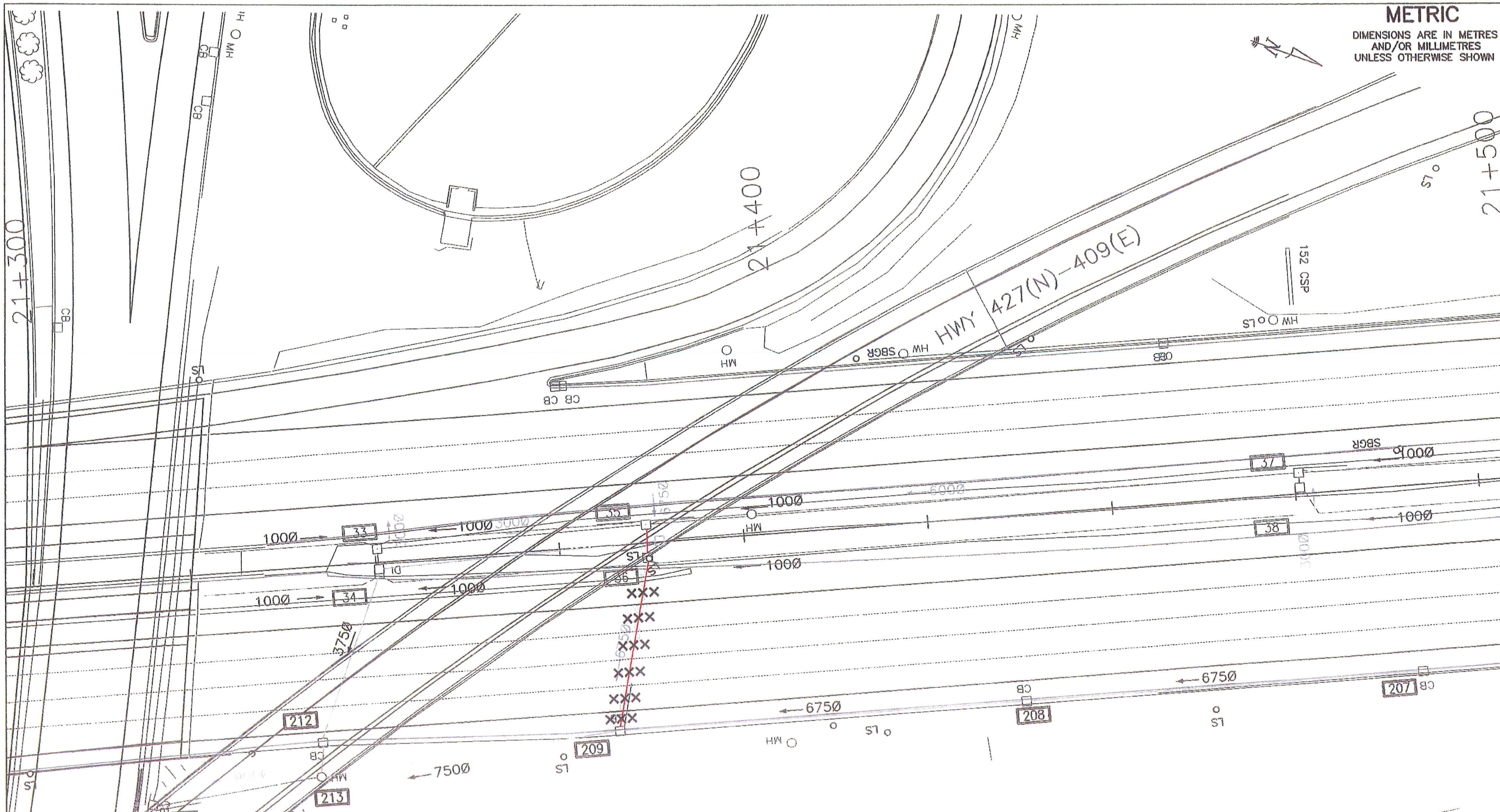

—— PROPOSED SEWER CROSSINGS

✕ SURFACE MONITORING POINT (SMP)

● SETTLEMENT PIN (SP)

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HIGHWAY 427 WIDENING
FROM FASKEN DR. TO STEELES AVE.
G.W.P. 202-95-00
PROPOSED SEWER CROSSINGS
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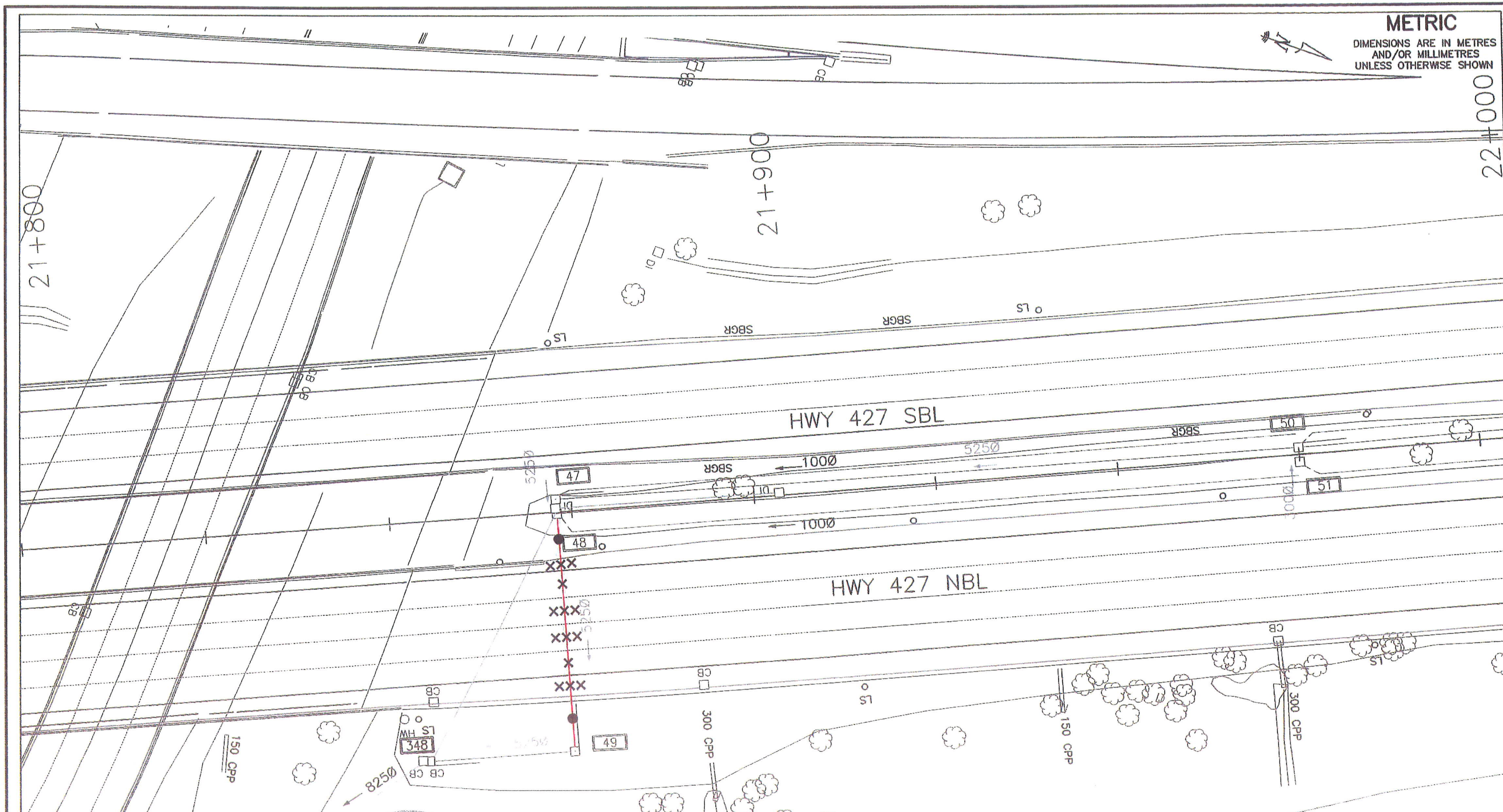

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— PROPOSED SEWER CROSSINGS

× SURFACE MONITORING POINT (SMP)

● SETTLEMENT PIN (SP)

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PROPOSED SEWER CROSSINGS
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METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

RIPRAP
OPSD 810.010
15.0X2.0m

CLUB HOUSE RD.

22+500

22+600

HWY 427 SBL

HWY 427 NBL

OS-08

PROPOSED SEWER CROSSINGS

SURFACE MONITORING POINT (SMP)

SETTLEMENT PIN (SP)

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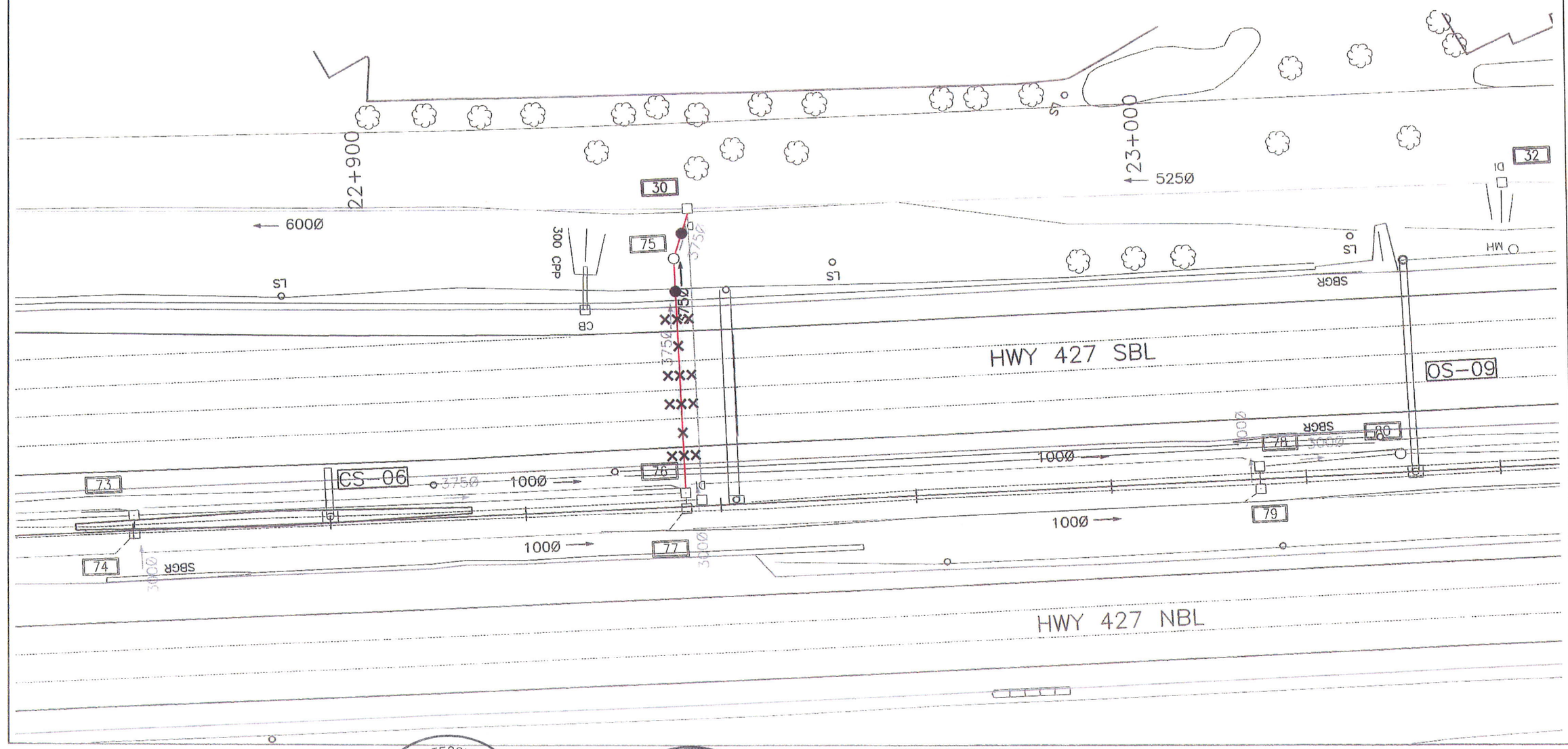

PROPOSED SEWER CROSSINGS

× SURFACE MONITORING POINT (SMP)

● SETTLEMENT PIN (SP)

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INSTRUMENTATION & MONITORING PROGRAM
STA. 22+900 TO STA. 23+000

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METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

23+100

23+200

MH

525Ø

83

33

450Ø

84

85

86

87

81

82

CS-02

100Ø

375Ø

300Ø

-03

HW

+140

PROPOSED SEWER CROSSINGS

SURFACE MONITORING POINT (SMP)

SETTLEMENT PIN (SP)

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BASE PLAN PROVIDED BY: SNC-LAVALIN

SNC-LAVALIN

HIGHWAY 427 WIDENING
FROM FASKEN DR. TO STEELES AVE.
G.W.P. 202-95-00
PROPOSED SEWER CROSSINGS
INSTRUMENTATION & MONITORING PROGRAM
STA. 23+100 TO STA. 23+200

19-92-70

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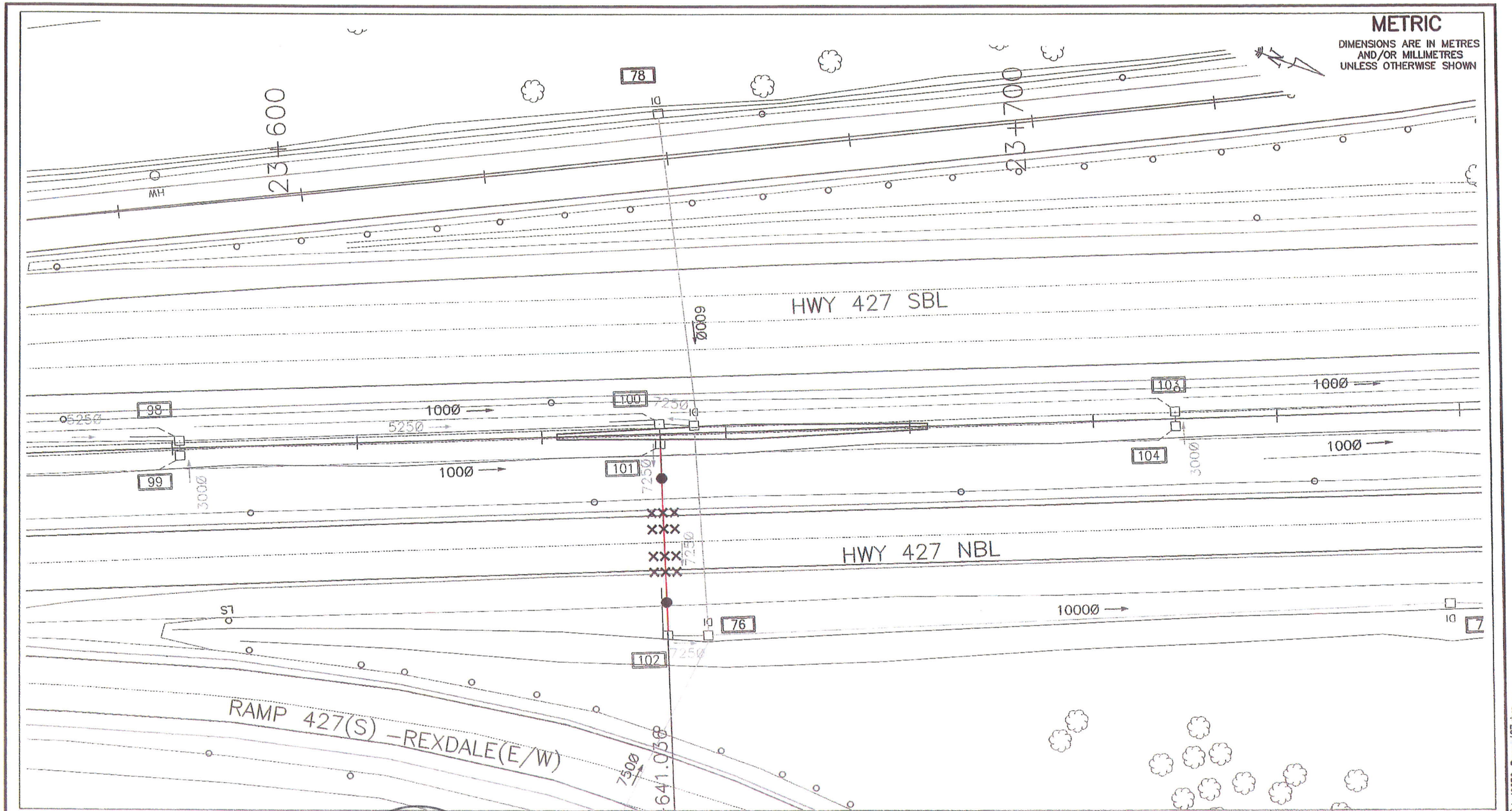

PROPOSED SEWER CROSSINGS

× SURFACE MONITORING POINT (SMP)

● SETTLEMENT PIN (SP)

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HIGHWAY 427 WIDENING
FROM FASKEN DR. TO STEELES AVE.
G.W.P. 202-95-00
PROPOSED SEWER CROSSINGS
INSTRUMENTATION & MONITORING PROGRAM
STA. 23+600 TO STA. 23+700

19-92-70

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METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

26+000

26+100

26+200

300 Plastic Pipe

CB

UM

5°

HWY 427 SBL

610 CSP

1000Ø

180

181

182

183

300Ø

450Ø

HWY 427 NBL

SBGR

RIPRAP
OPSD 810.010
6.0X2.0m

PROPOSED SEWER CROSSINGS

SURFACE MONITORING POINT (SMP)

SETTLEMENT PIN (SP)

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March 16, 2010
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HIGHWAY 427 WIDENING
FROM FASKEN DR. TO STEELES AVE.
G.W.P. 202-95-00
PROPOSED SEWER CROSSINGS
INSTRUMENTATION & MONITORING PROGRAM
STA. 26+000 TO STA. 26+200

19-92-70

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METRIC

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RIPRAP
OPSD 810.010
6.0X2.0m

RIPRAP
OPSD 810.010
6.0X2.0m

27+200

27+300

27+400

HWY 427 SBL

CS-10

HWY 427 NBL

207 208 209 210

100Ø

762 x 99.03 CSP

762 CSP

PROPOSED SEWER CROSSINGS

SURFACE MONITORING POINT (SMP)

SETTLEMENT PIN (SP)

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
March 16, 2010
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
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Mar 16/10
PROVINCE OF ONTARIO

BASE PLAN PROVIDED BY: SNC-LAVALIN

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HIGHWAY 427 WIDENING
FROM FASKEN DR. TO STEELES AVE.
G.W.P. 202-95-00
PROPOSED SEWER CROSSINGS
INSTRUMENTATION & MONITORING PROGRAM
STA. 27+200 TO STA. 27+400

19-92-70

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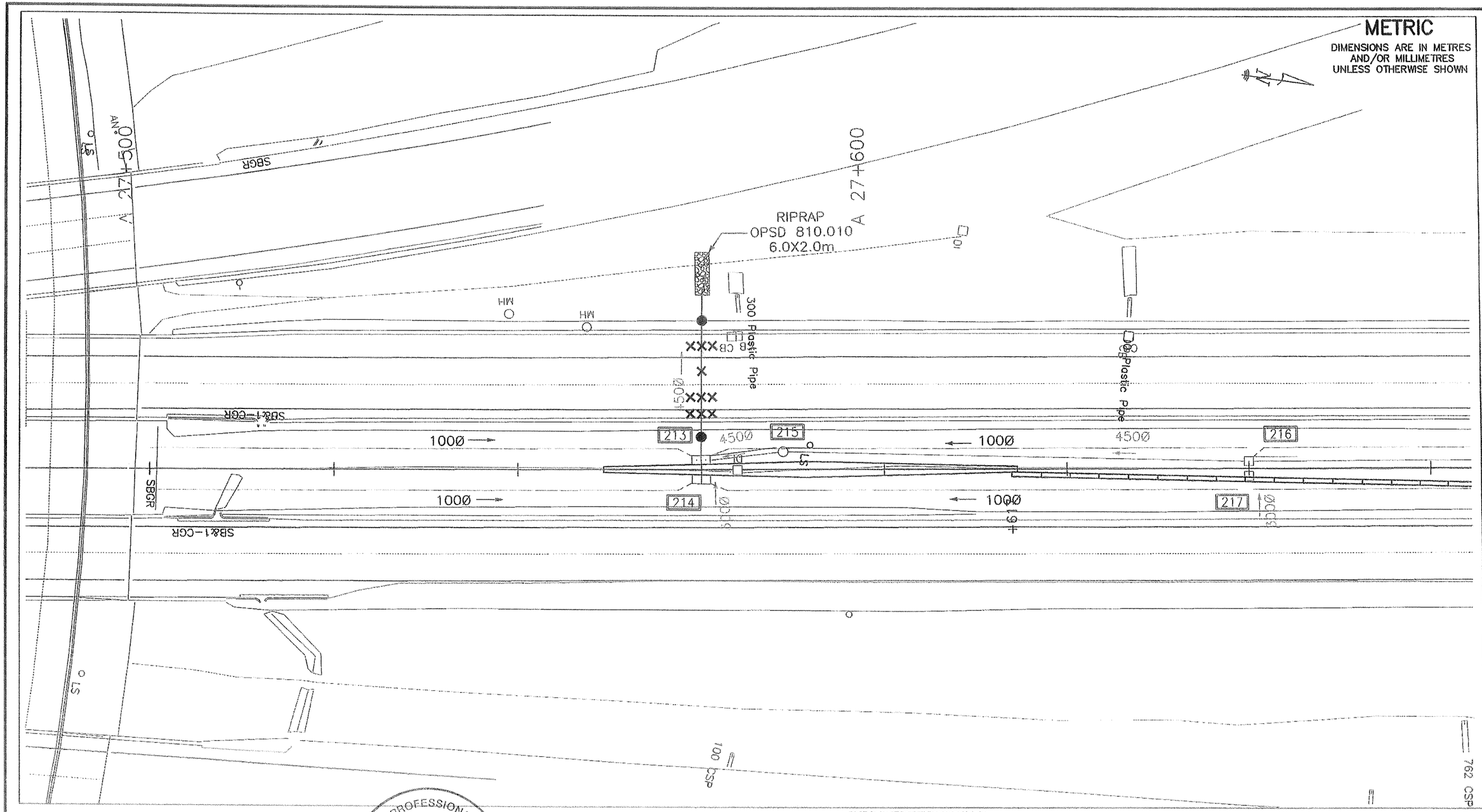

PROPOSED SEWER CROSSINGS

× SURFACE MONITORING POINT (SMP)

● SETTLEMENT PIN (SP)

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
March 16, 2010
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Mar 16/10
PROVINCE OF ONTARIO

BASE PLAN PROVIDED BY: SNC-LAVALIN

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HIGHWAY 427 WIDENING
FROM FASKEN DR. TO STEELES AVE.
G.W.P. 202-95-00
PROPOSED SEWER CROSSINGS
INSTRUMENTATION & MONITORING PROGRAM
STA. 27+500 TO STA. 27+600

19-92-70

THURBER ENGINEERING LTD.
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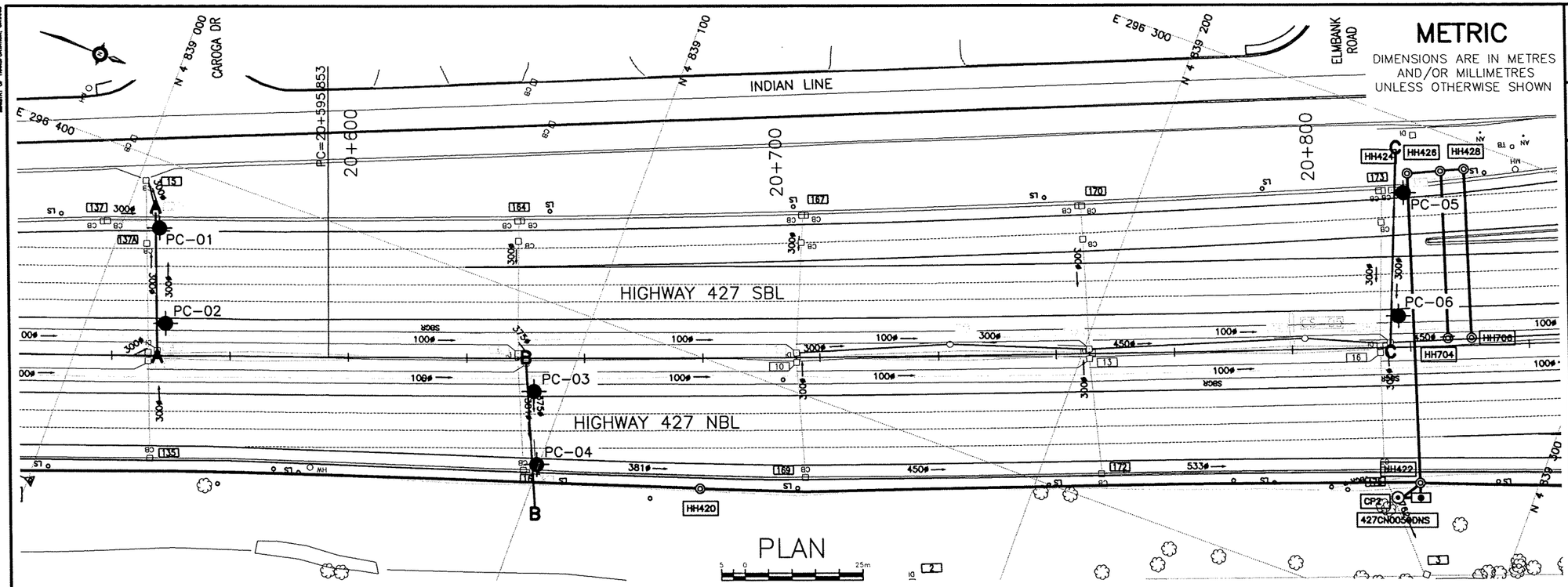
Appendix E

Borehole Locations and Soil Strata Drawings



METRIC

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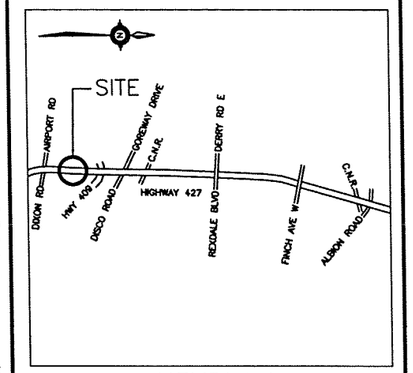
CONT No
GWP No 202-95-00

HIGHWAY 427
INSIDE WIDENING
PROPOSED SEWER PIPE CROSSINGS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

SNC·LAVALIN

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

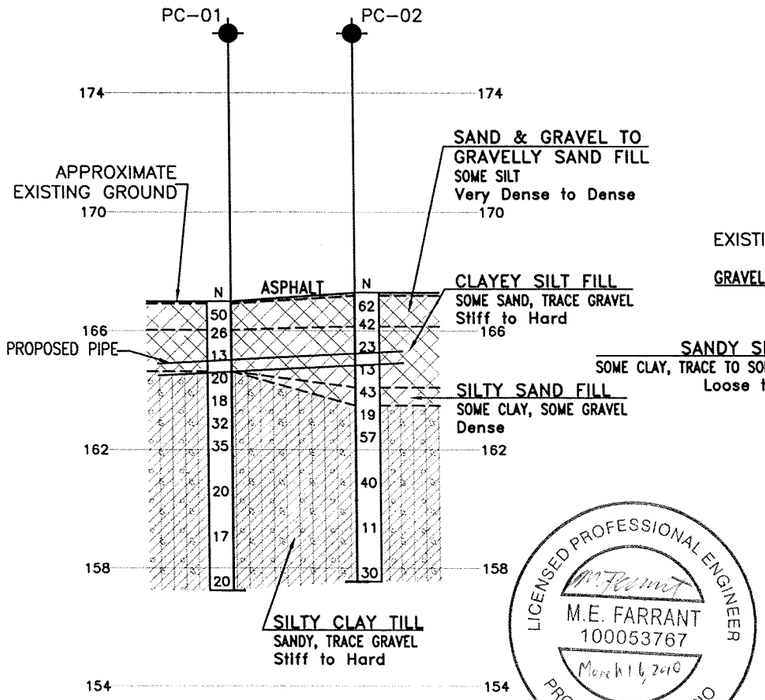
✦	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▽	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
PC-01	167.0	4 839 007.7	296 413.9
PC-02	167.3	4 839 015.8	296 432.7
PC-03	167.3	4 839 093.7	296 419.2
PC-04	167.1	4 839 099.6	296 433.7
PC-05	165.5	4 839 252.0	296 315.0
PC-06	165.8	4 839 260.0	296 340.3

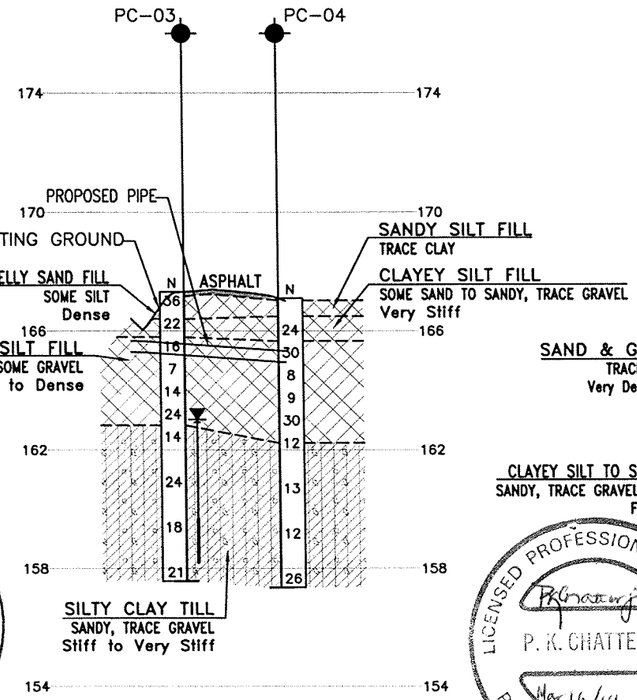
-NOTES-

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

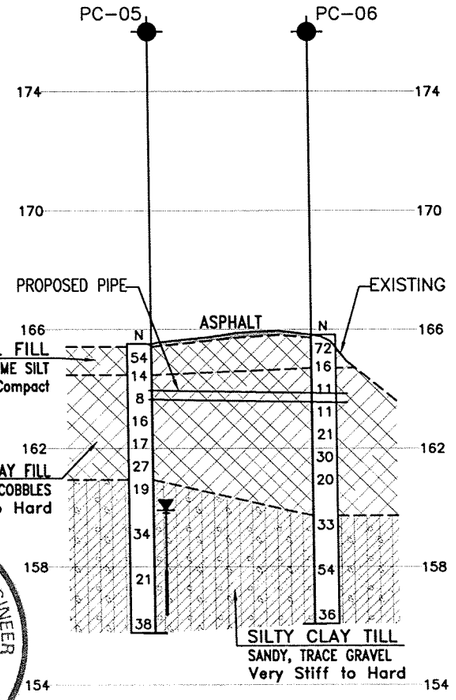
GEOCRES No. 30M12-292



SECTION A–A



SECTION B–B



SECTION C–C

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
March 16, 2010
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Mar 16/10
PROVINCE OF ONTARIO

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN MEF	CHK PKC	CODE	LOAD — DATE JAN. 2010
DRAWN MFA	CHK PKC	SITE	STRUCT — DWG 1

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 202-95-00

HIGHWAY 427
INSIDE WIDENING
PROPOSED SEWER PIPE CROSSINGS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

SNC·LAVALIN

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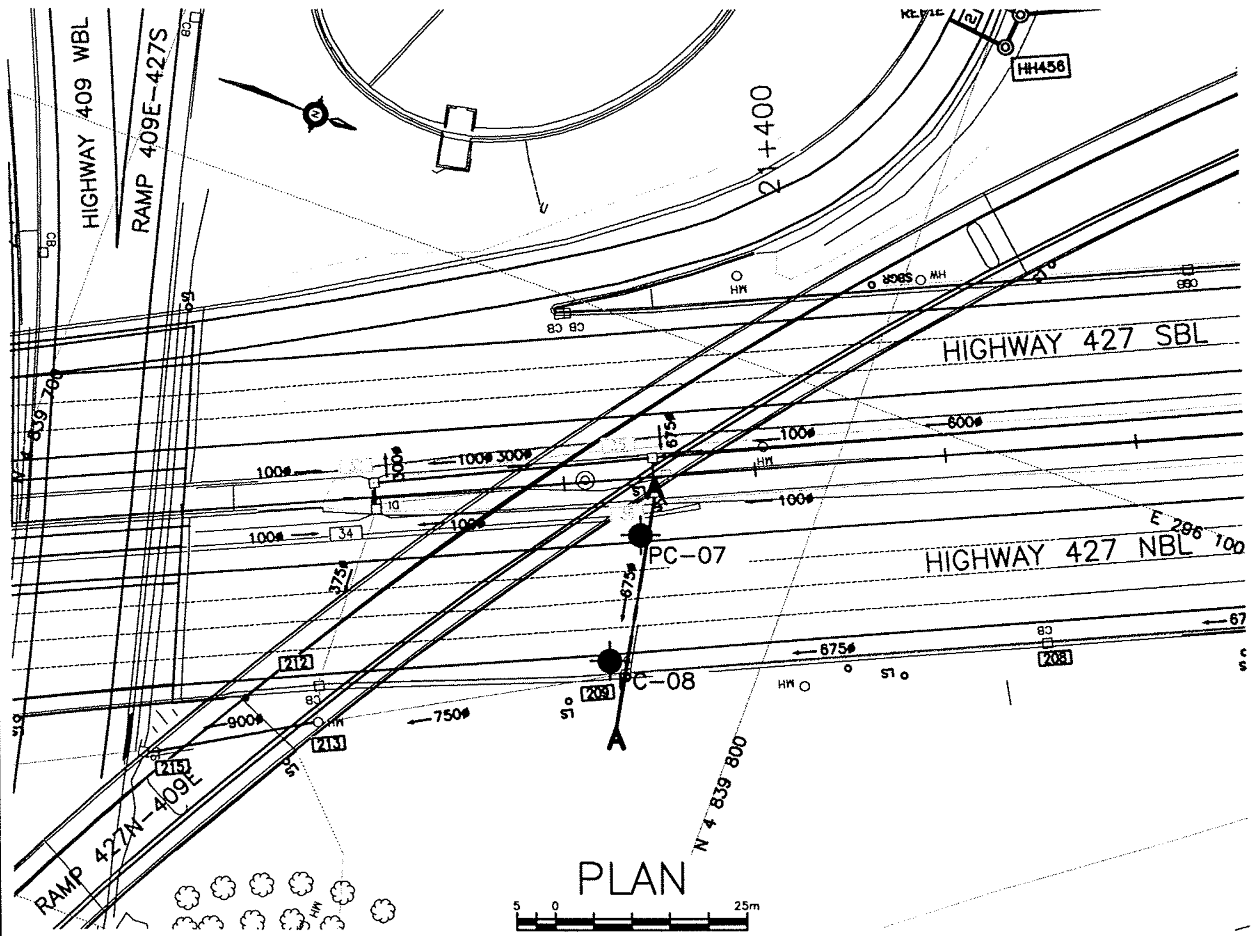
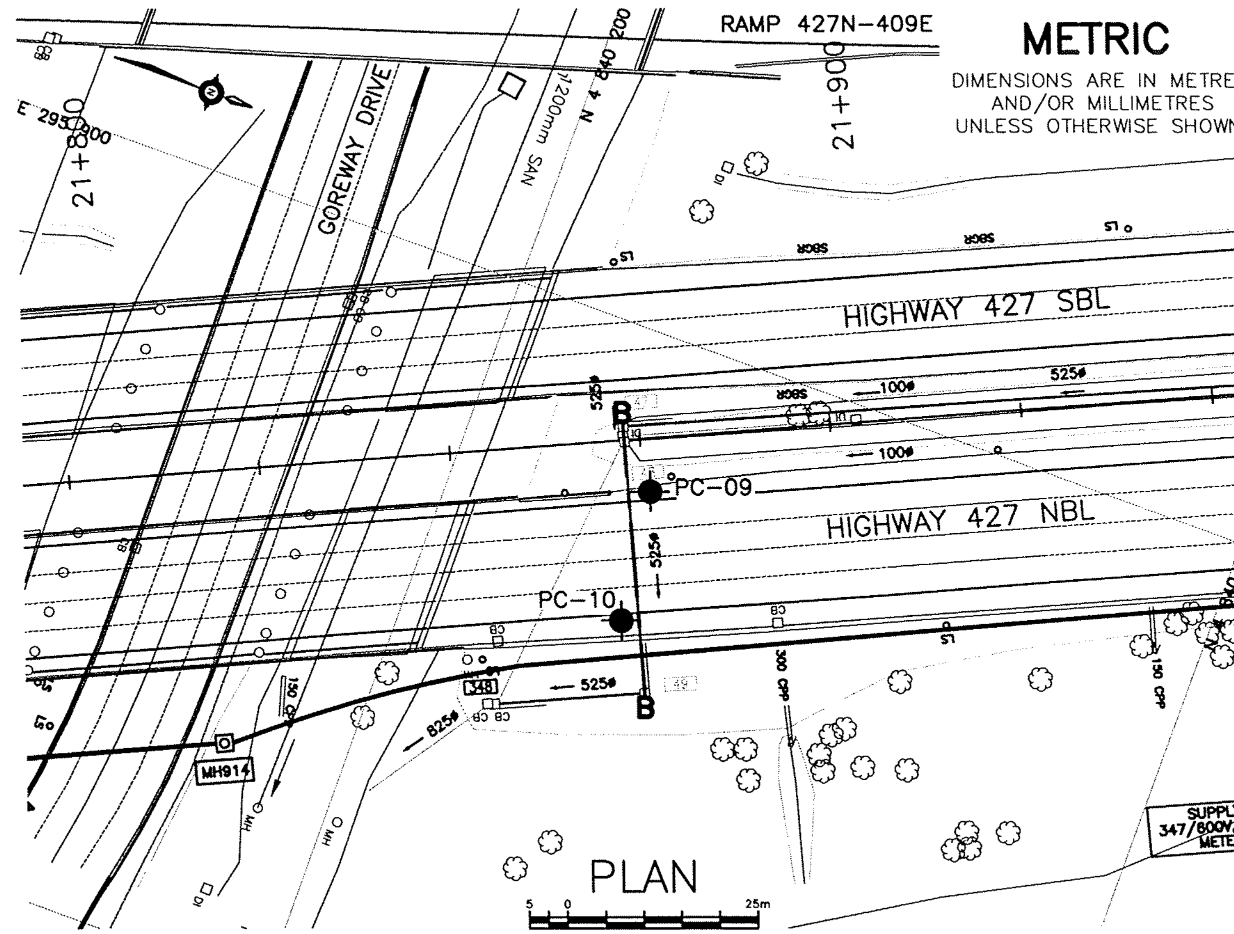
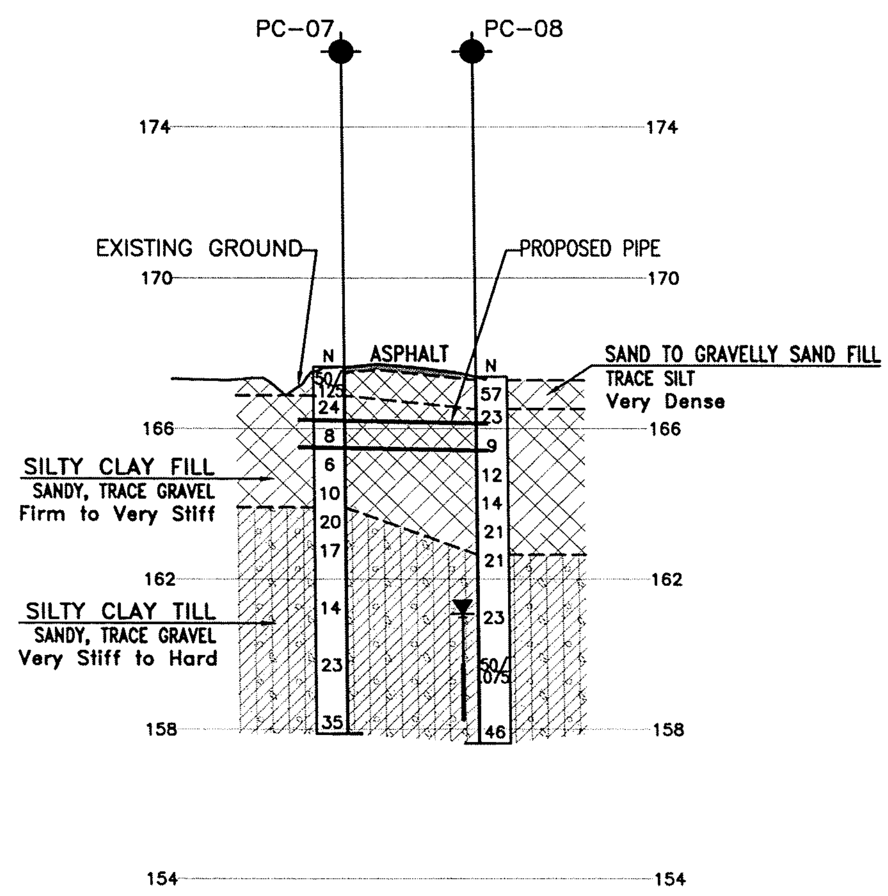
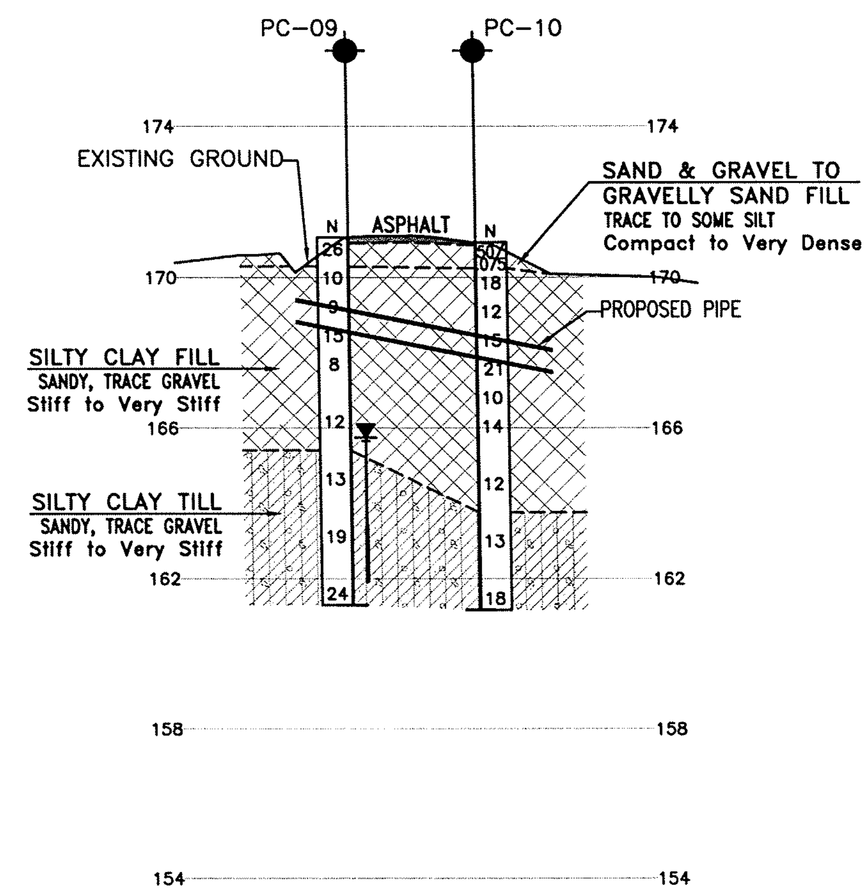
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS







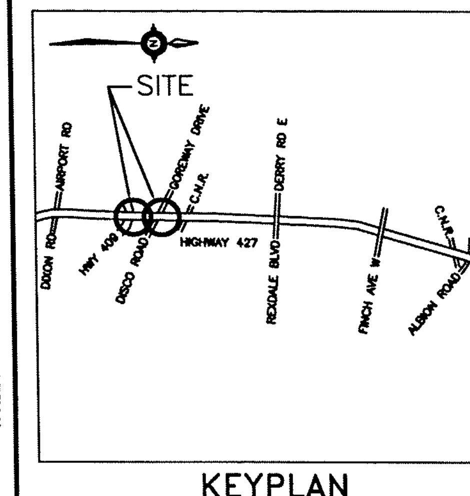
SECTION A–A



SECTION B–B

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
March 16, 2010
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Mar 16/10
PROVINCE OF ONTARIO



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
PC-07	167.6	4 839 779.4	296 126.5
PC-08	167.4	4 839 781.3	296 143.6
PC-09	171.1	4 840 225.4	295 920.3
PC-10	170.9	4 840 227.5	295 937.8

-NOTES-

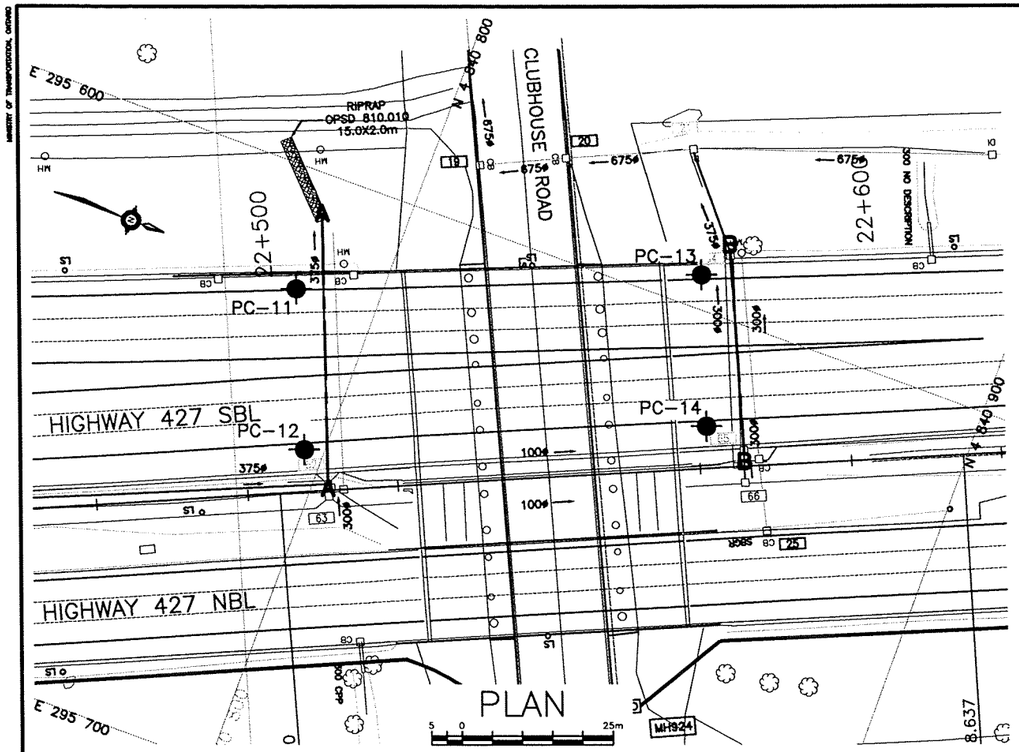
1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

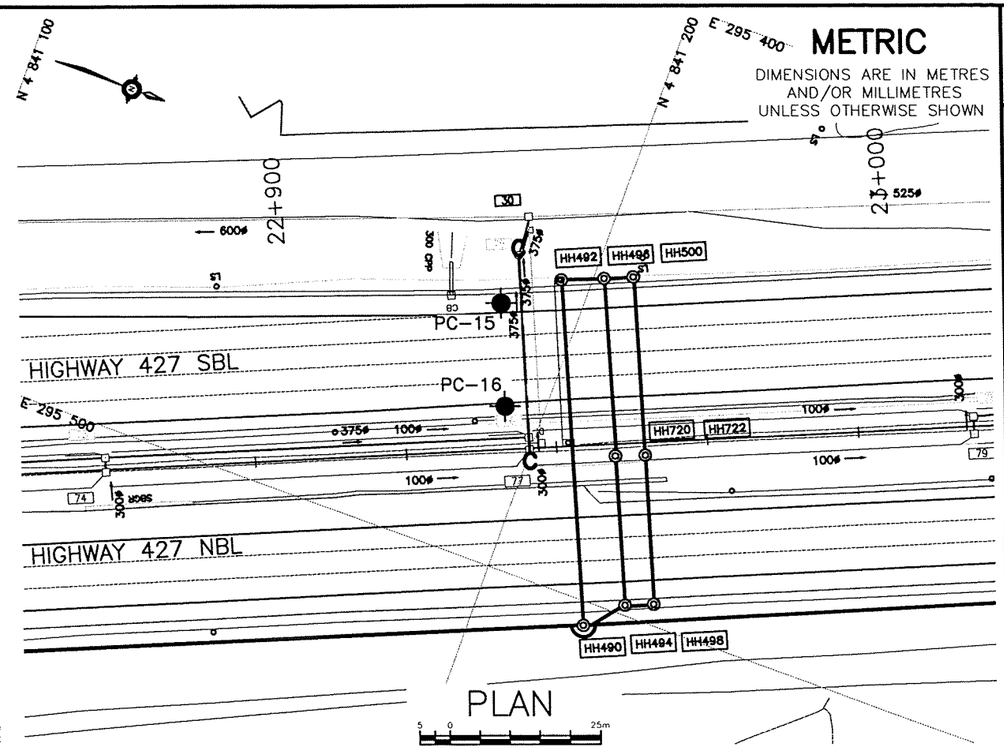
GEOCRES No. 30M12-292

REVISIONS	DATE	BY	DESCRIPTION

DESIGN MEF	CHK PKC	CODE	LOAD	DATE JAN. 2010
DRAWN MFA	CHK PKC	SITE	STRUCT	DWG 2

FILENAME:





METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

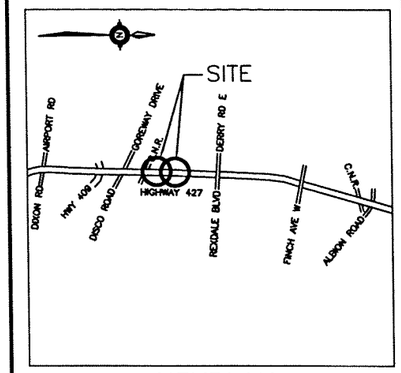
CONT No
GWP No 202-95-00

HIGHWAY 427
INSIDE WIDENING
PROPOSED SEWER PIPE CROSSINGS
BOREHOLE LOCATIONS AND SOIL STRATA

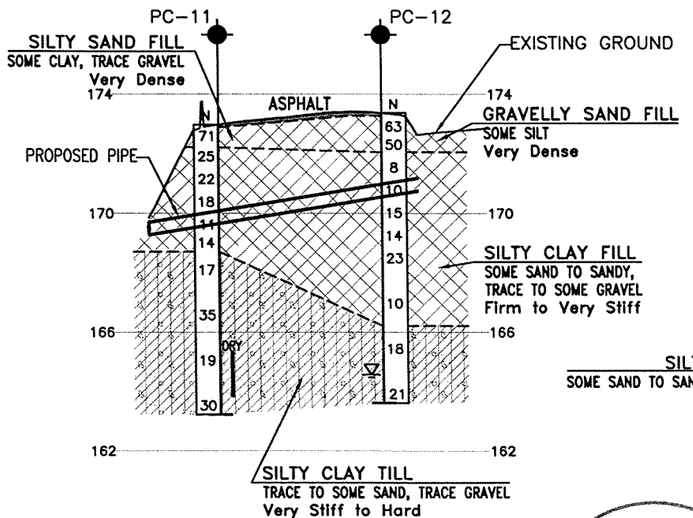
SHEET

SNC·LAVALIN

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

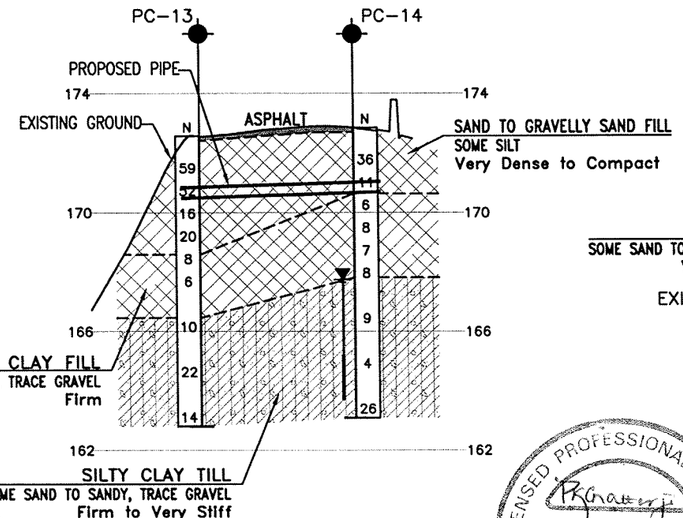


KEYPLAN



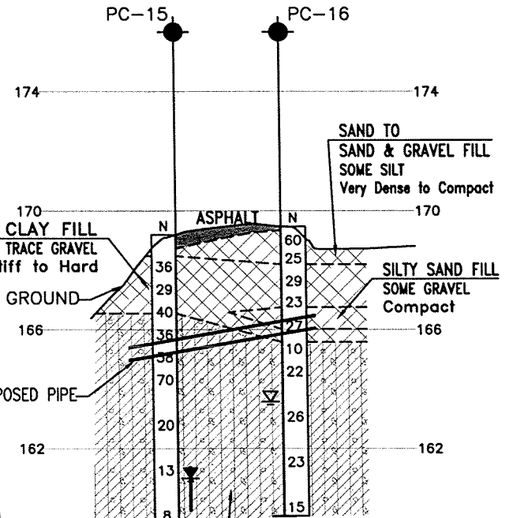
SECTION A-A

5 0 25m
1 0 5m



SECTION B-B

5 0 25m
1 0 5m



SECTION C-C

5 0 25m
1 0 5m

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
PC-11	173.0	4 840 786.3	295 620.1
PC-12	173.4	4 840 796.8	295 645.0
PC-13	172.6	4 840 848.4	295 594.4
PC-14	172.8	4 840 857.8	295 618.1
PC-15	169.2	4 841 187.1	295 457.6
PC-16	169.5	4 841 193.5	295 473.7

-NOTES-

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GEOCRES No. 30M12-292

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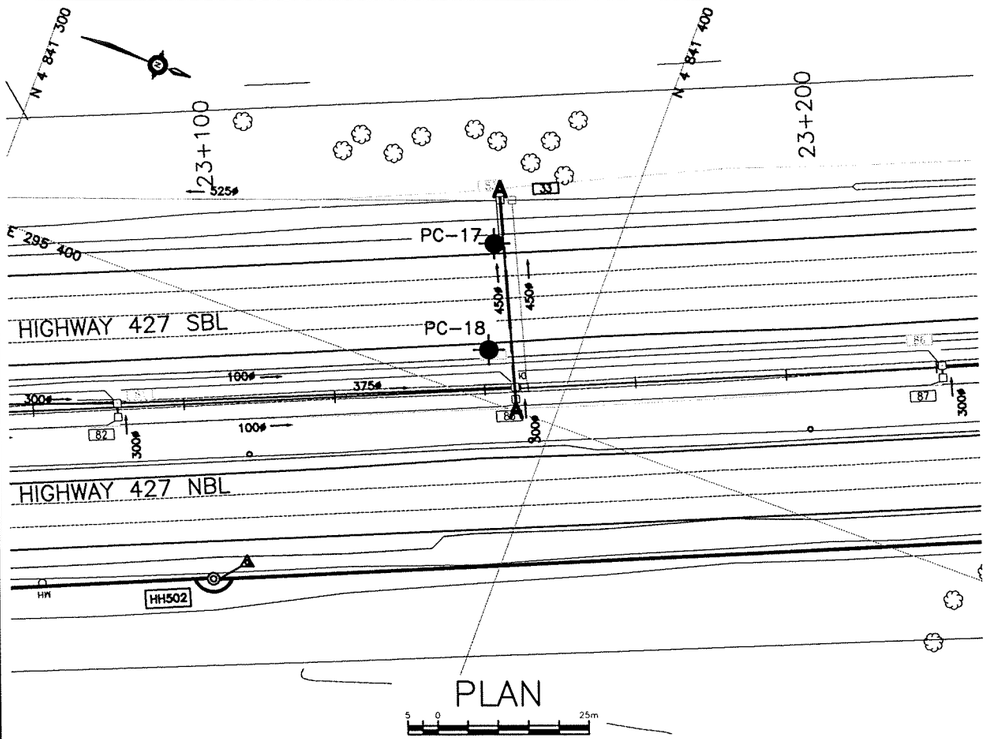
M.E. FARRANT
100053767
March 16, 2010
PROVINCE OF ONTARIO

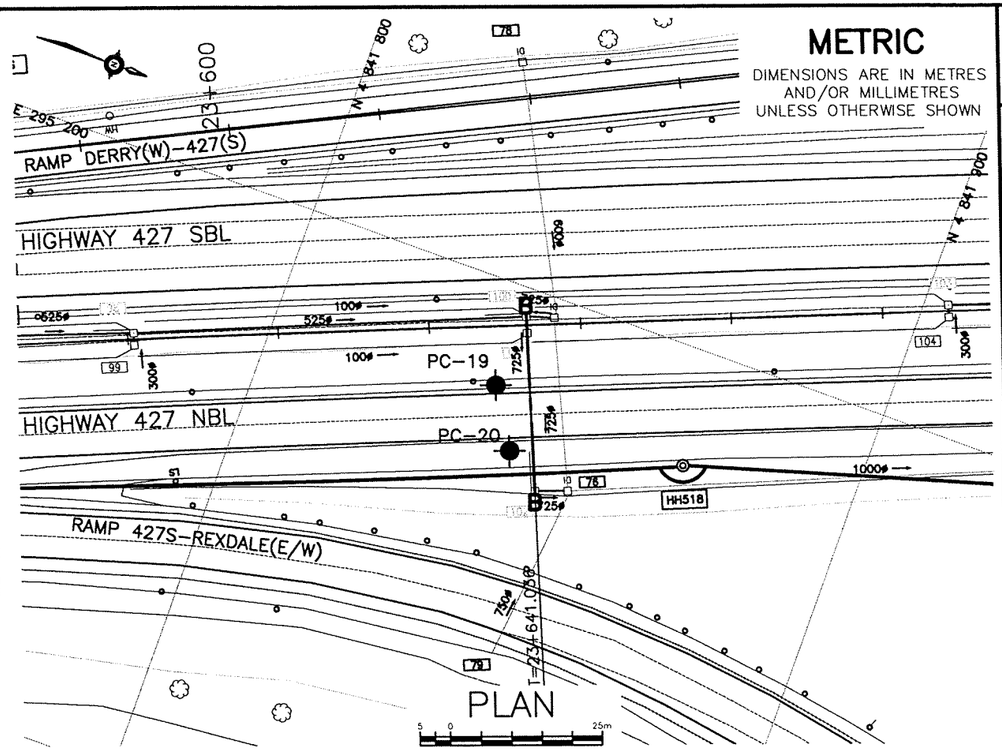
LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Mar 16/10
PROVINCE OF ONTARIO

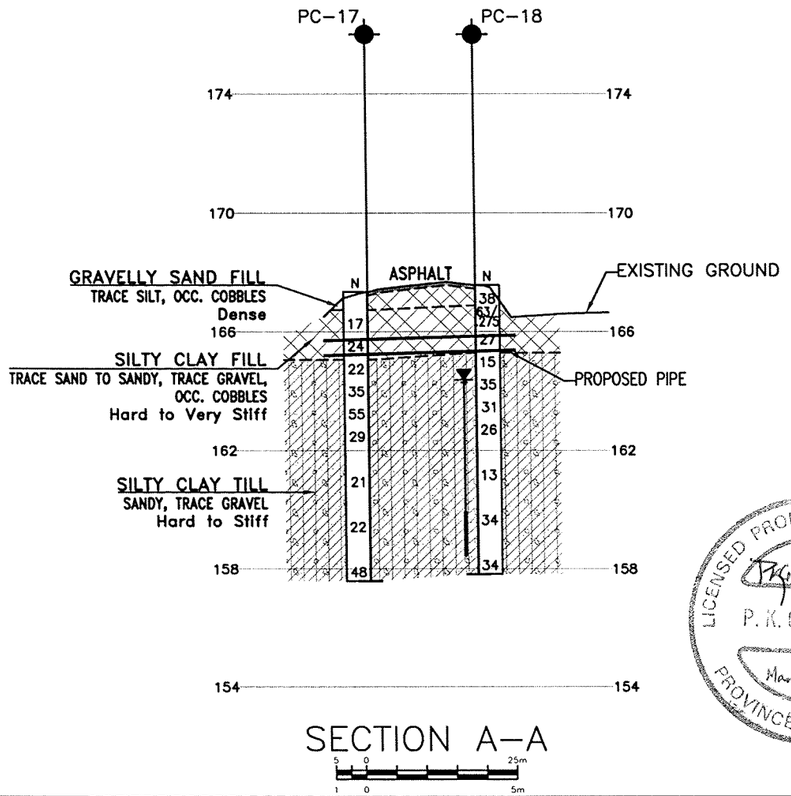
REVISIONS		
DATE	BY	DESCRIPTION

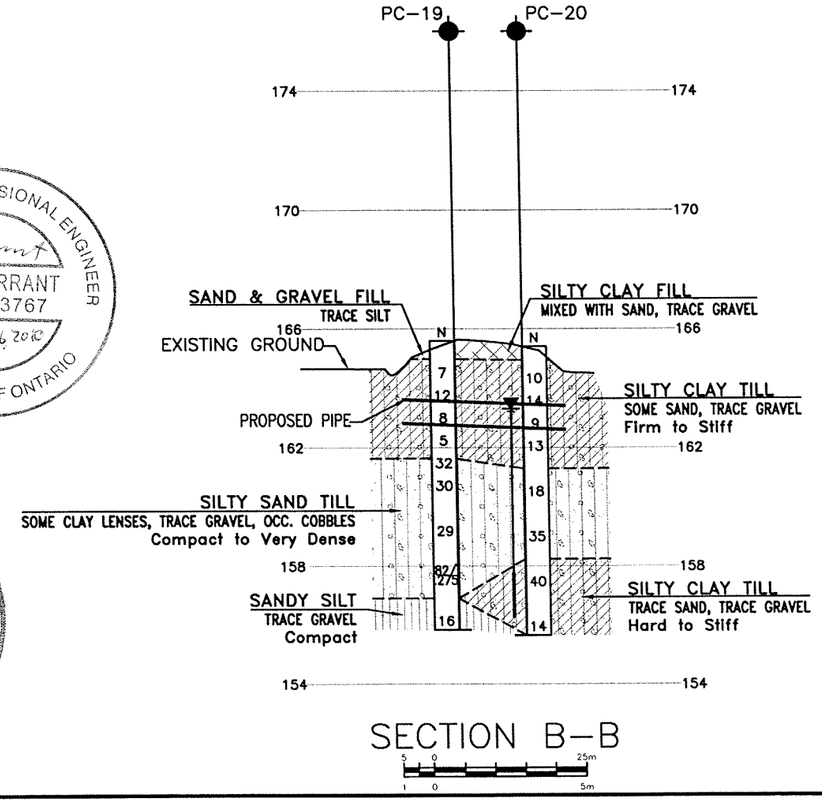
DESIGN	MEF	CHK	PKC	CODE		LOAD	DATE JAN. 2010
DRAWN	MFA	CHK	PKC	SITE		STRUCT	DWG 3

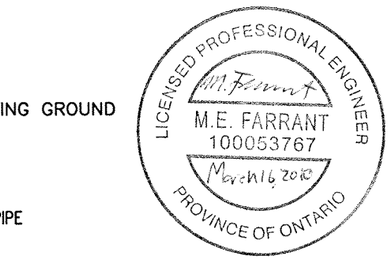
FILENAME











METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 202-95-00

SHEET

HIGHWAY 427
INSIDE WIDENING
PROPOSED SEWER PIPE CROSSINGS
BOREHOLE LOCATIONS AND SOIL STRATA

SNC·LAVALIN

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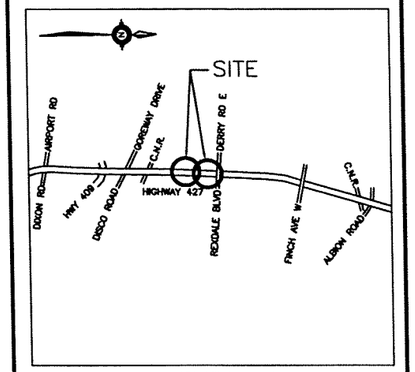

KEYPLAN

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
PC-17	167.3	4 841 380.8	295 374.6
PC-18	167.6	4 841 386.0	295 391.8
PC-19	165.6	4 841 838.0	295 217.3
PC-20	165.4	4 841 843.8	295 226.9

-NOTES-

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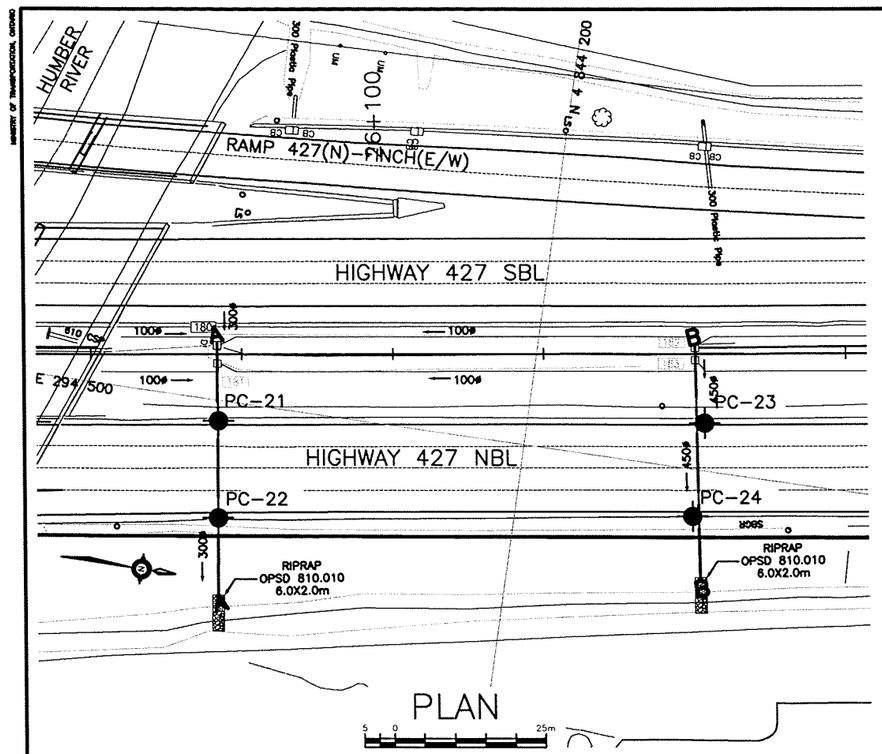
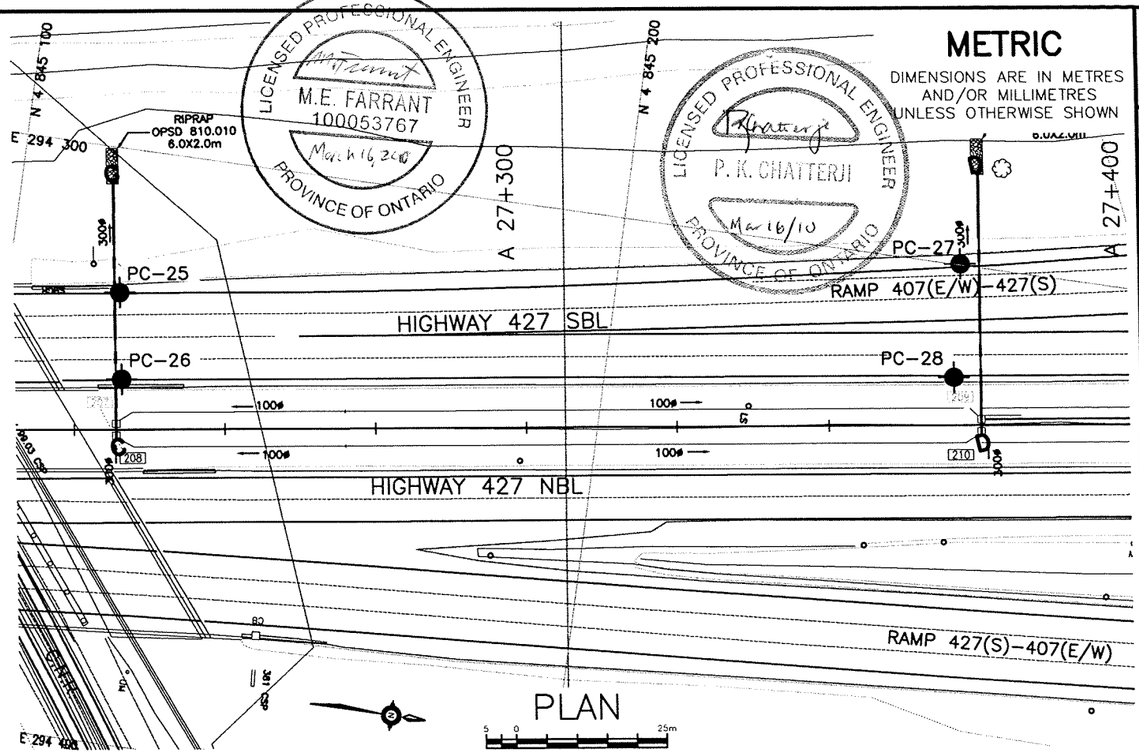
GEOCRES No. 30M12-292

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN MEF	CHK PKC	CODE	LOAD
DRAWN MFA	CHK PKC	SITE	STRUCT

DATE JAN. 2010
DWG 4

FILENAME:





LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
March 16, 2010
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHAITERJI
Mar 16/10
PROVINCE OF ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

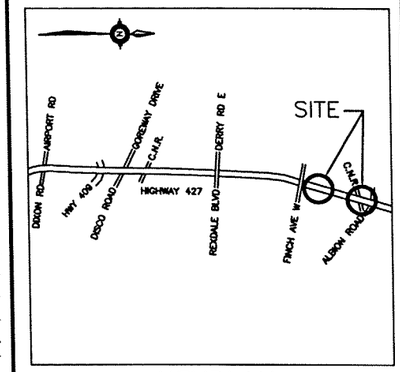
CONT No
GWP No 202–95–00

SHEET

HIGHWAY 427
INSIDE WIDENING
PROPOSED SEWER PIPE CROSSINGS
BOREHOLE LOCATIONS AND SOIL STRATA

SNC·LAVALIN

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
PC–21	168.2	4 844 149.4	294 503.4
PC–22	167.9	4 844 151.6	294 519.6
PC–23	169.4	4 844 228.9	294 492.0
PC–24	169.0	4 844 229.1	294 507.8
PC–25	181.2	4 845 118.7	294 324.3
PC–26	181.3	4 845 120.9	294 338.7
PC–27	180.6	4 845 255.6	294 299.8
PC–28	181.0	4 845 257.0	294 318.8

-NOTES-

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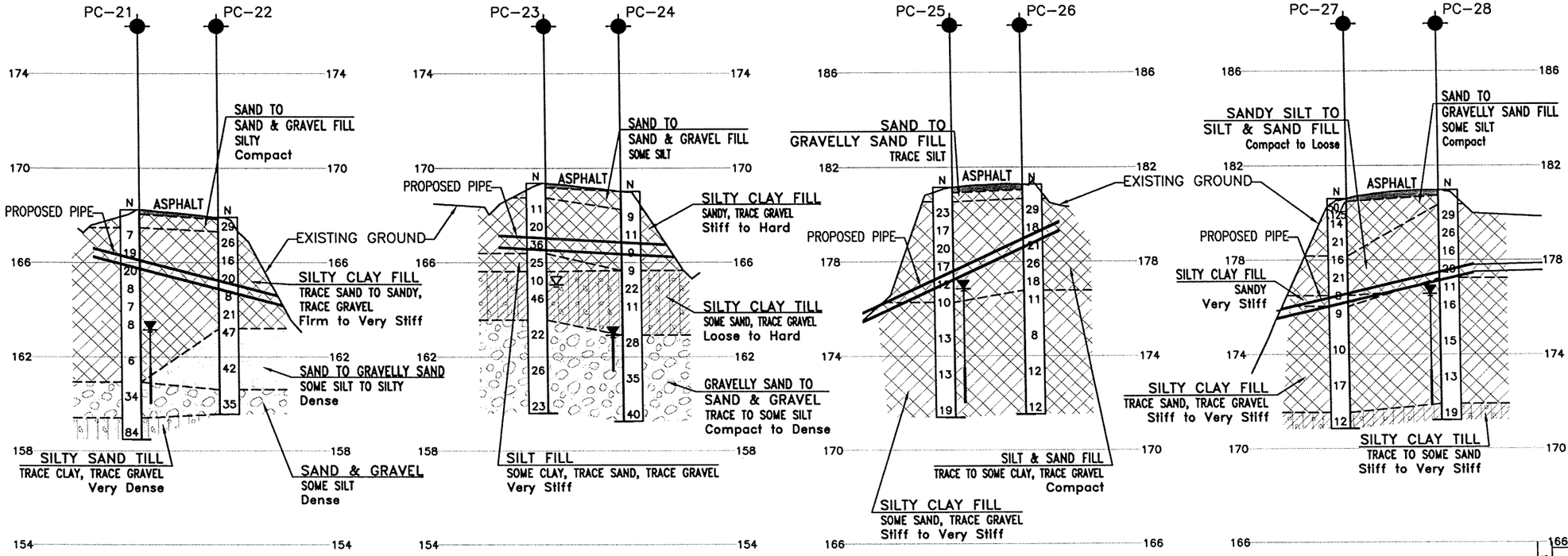
GEOCRES No. 30M12-292



SECTION A–A
SECTION B–B
SECTION C–C
SECTION D–D

REVISIONS	DATE	BY	DESCRIPTION

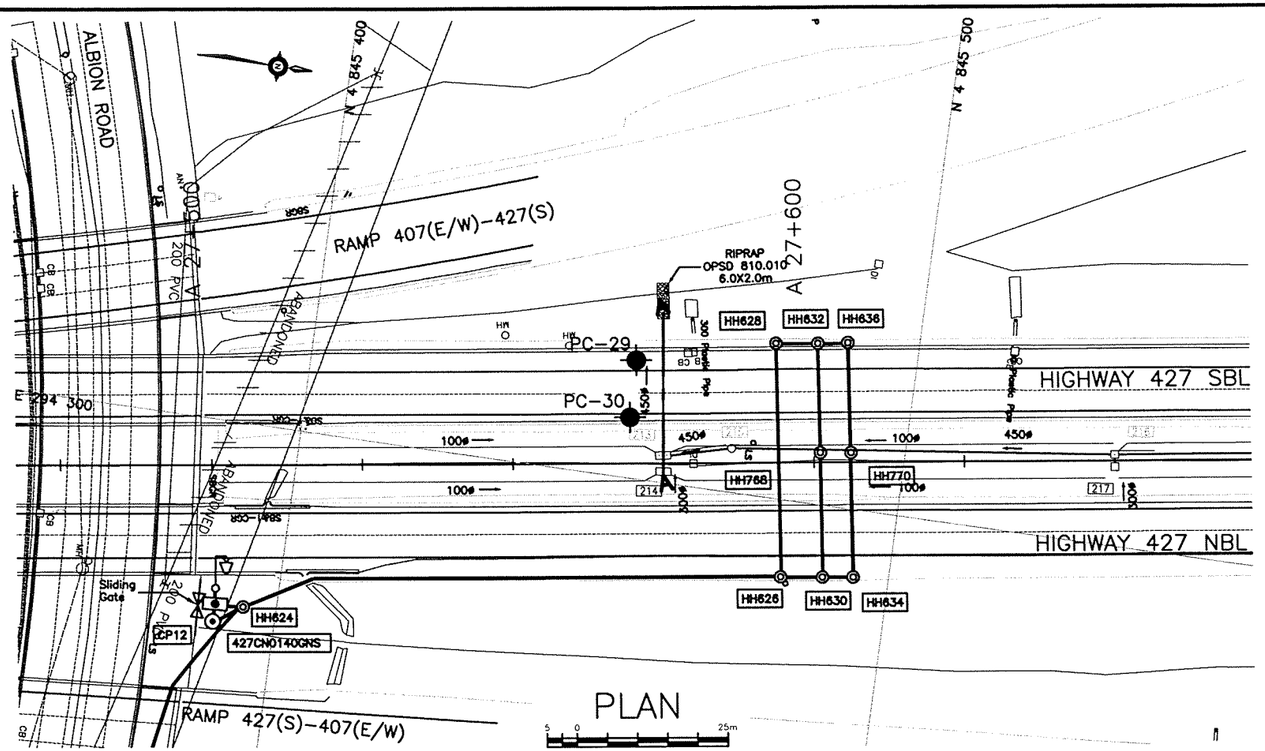
DESIGN	MEF	CHK	PKC	CODE		LOAD	DATE JAN. 2010
DRAWN	MFA	CHK	PKC	SITE		STRUCT	DWG 5

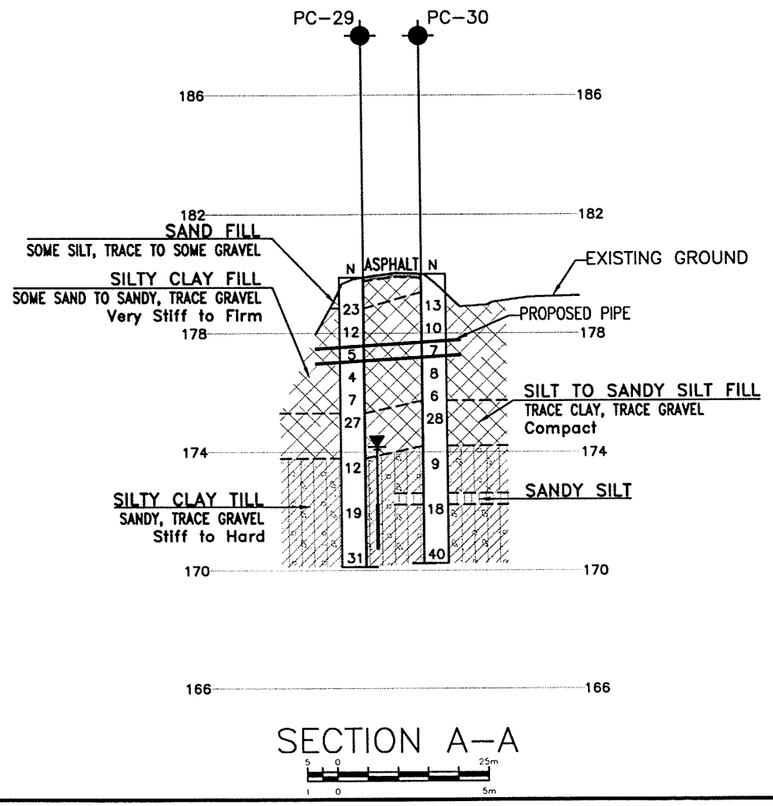
FILENAME:

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN





CONT No
GWP No 202-95-00

SHEET

HIGHWAY 427
INSIDE WIDENING
PROPOSED SEWER PIPE CROSSINGS
BOREHOLE LOCATIONS AND SOIL STRATA

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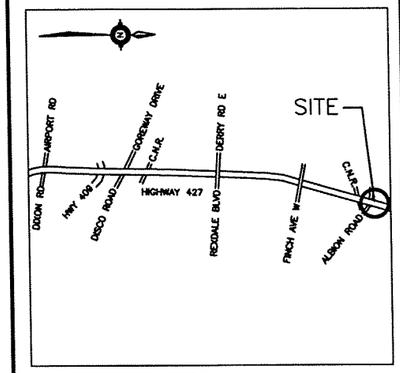

KEYPLAN

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
PC-29	179.9	4 845 453.6	294 280.2
PC-30	180.0	4 845 453.9	294 289.8

-NOTES-

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GEOCRES No. 30M12-292

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M.E. FARRANT
100053767
March 16 2010
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Mar 16/10
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MEF	CHK	PKC	CODE		LOAD	DATE JAN. 2010
DRAWN	MFA	CHK	PKC	SITE		STRUCT	DWG 6

FILENAME