	Project Name 407 East Extension Project		Client Name: Her Majesty the Queen	
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			407 East Construction General Partnership			HMQ
Rev.	Issue Date (yyyy-mm-dd)	Description	Prepared by Qualitas.	Verified by Quality Manager	Approved by Project Director	Approved by
FA	2013-06-19	Geotechnical information	JA	WG	RH	
FB	2014-01-10	Geotechnical information	JA	WG	RH	

Hwy 407 East Extension Project No. 610706

Structure M-39 Foundation Design Geotechnical Information

Segment A3

Prepared by:
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Date: 2014-01-10

Geocrest No. 30M15-134

FOUNDATION DESIGN MEMORANDUM FD-M39

Reference: 610706-23-GEO-RPT-CGP-G002_FB.BRIDGE M39-GEO.pdf

Project: Highway 407 East Extension

Title: Structure M-39

**Type: 21 m span, Twin one span bridge
Highway 407 over Lynde Creek Tributary**

1 SITE AND GEOTECHNICAL INFORMATIONS

- 5 boreholes are available for both structures M-39 (WBL and EBL) (see Appendix 1):
 - Boreholes for the WBL structure: WM40-1, BH-M39-103 and BH-M39-104;
 - Boreholes for the EBL structure: BH-M39-101 and 10-04;
 - Location: drawings G12166-A3-01 (see Appendix 4) and G12166-M39-01 (see Appendix 3).
- Borehole logs and lab test results are presented in Appendices 1 and 2;
- Stratigraphy and soil properties: see drawing G12166-M39-01 (see Appendix 3).
 - The general stratigraphy of the site, under the superficial layers, consists of 2 main soil layers. These layers include a clayey till deposit, which in turn lies on a dense to very dense cohesionless till. Also, silt/sand layers were encountered in BH-M39-101, 103 and 104. The presence of a surficial silty and sandy layer was occasionally encountered in some boreholes;
 - Bedrock was not encountered in any boreholes.

1.1 TOPSOIL / SURFICIAL LAYER

Following the 0.6 m to 0.8 m thick topsoil layer, a cohesionless surficial layer was identified in boreholes BH-M39-101, BH-M39-102 and BH-M39-103. The deposit consists in a sand and silt to a sandy silt with trace clay and gravel.

The “ N_{SPT} ” measured in the surficial layer range from 3 to 24. The compactness can be described as very loose to compact.

1.2 COHESIVE TILL

A cohesive till (clayey deposit) has been identified in all 5 boreholes. It varies in composition from a silt and clay with trace sand and gravel to a sandy and clayey silt with trace gravel. Its thickness ranges from 3.4 to 9.3 m. Atterberg’s limits determinations indicate that the deposit is of low to medium plasticity with a liquid limit varying between 26 to 34 % and a plasticity index ranging from 12 to 19 %. Water content of these samples range from 22 to 24 %. A total of 2 undrained shear strength values were measured in the clayey till deposit in BH-M39-103 with a field vane. The values measured were of 88 and 75 kPa at respective depths of 4.0 m and 4.5 m, which classify the consistency as stiff. Moreover, based on the measured “ N_{SPT} ” values, the consistency of the cohesive till deposit could generally be classified as very stiff to firm.

1.3 COHESIONLESS TILL

The cohesionless till is found below the cohesive till deposit, from elevations ranging between 147.3 and 149.6 m. It generally varies in composition from a silty sand with some clay and trace gravel on the finer side to a silty and gravelly sand with trace clay on the coarser side.

The “ N_{SPT} ” measured in the cohesionless till are generally greater than 30 and the compactness can be described as dense to very dense. However, exceptionally in BH-M39-103, “ N_{SPT} ” values of 7 and 21 were measured in the cohesionless till deposit

at elevations of 149.4 m and 143.3 m respectively, which indicates a state of compactness that can be described as loose to compact.

1.4 SILT/SAND LAYER

In all boreholes except borehole 10-04 and WM40-1, silt/sand layers were encountered at depths ranging between 6.1 and 10.1 m. The composition of those layers varies between a sandy silt with trace clay in BH-M39-101 and fine uniform sand with some to trace gravel and trace silt in boreholes BH-M39-103 and BH-M39-104. The thickness of these intermediate layers varies between 1.8 and 3.6 m.

A total of 3 standard penetration tests (SPT) were executed in the intermediate silt/sand layers, with obtained values varying between 10 and 39, which indicates a compact to dense state of compactness.

1.5 GROUNDWATER

For the present investigation, a standpipe was installed temporarily in borehole BH-M39-104. In the standpipe, installed at a depth of 6.1 m (el. 150.7 m) below ground surface, a water level approximately 2.1 m (el. 158.9 m) above ground level was measured on February 26th, 2013. Following this reading, because of the high artesian pressure, the standpipe was removed and the hole was plugged.

In the borehole 10-04, done in a previous study, the groundwater level was measured 0.6 m above ground surface at an elevation of 156.8 m on March 27, 2010.

It is important to mention that all boreholes executed for the present investigation showed a high artesian pressure. During the present study, the artesian pressure was observed when drilling reached elevations ranging generally between 136 and 150 m. In fact, these elevations, generally, coincide with the beginning of the intermediate silt/sand layer under the cohesive till deposit.

The description and the positioning of this artesian pressure are given on the borehole logs and stratigraphic profile drawings (appendices 1 and 3).

2 RECOMMENDATIONS

2.1 DESCRIPTION OF THE STRUCTURES

The general arrangements of the structures are shown on drawing 610706-23-STR-DRW-CGP-A002-FA of Appendix 5. They consist of twin single span bridges approximately 33 m apart. According to the drawing, the underside of the west and east abutments will be located at approximately elevations 156 m, whereas the existing ground varies between 156.1 m and 157.0 m. The bridges are planned to be resting on piles.

The approach fills required to reach the bridge deck would be approximately 5.5 m high.

2.2 GEOTECHNICAL ISSUES

Considering the geotechnical properties of the soils present at the site and the artesian conditions observed during the drilling operations, the implementation of caissons in the cohesionless till deposit, would be hampered by the fact that detrimental and unavoidable soil “cave-ins” and “wash-outs” could be experienced during installation. Also, using piles will present problems such as the puncturing of the clayey layer which could result in upsurges of water along the face of the piles. Therefore, construction approaches will have to be adjusted to the site inherent conditions. The use of spread footings for the foundations of the bridges should be considered.

2.3 FROST PROTECTION

The foundation must be placed at a minimum depth of 1.2 m below the final grade, for adequate frost protection. The equivalent protection could be provided by using polystyrene as suggested by the *Canadian Foundation Engineering Manual* (2006, Article 13.5.2 Page 196). It is usually accepted that 25 mm of polystyrene provide a protection which is equivalent to 600 mm of soil.

2.4 FOUNDATIONS RECOMMENDATIONS

2.4.1 Spread footings

- According to the borehole information, the foundations placed at elevation 155.0 m will be seated in the surficial layer or the cohesive till;
- Bearing capacity at elevation 155 m, on the surficial layer or the cohesive till, is 350 kPa at SLS for foundation with a width (B) of 3 m or less. For foundation with a width (B) between 3 and 4 m, the bearing capacity on the surficial layer or the cohesive till is 300 kPa at SLS. The factored ULS capacity is 500 kPa. The bearing capacity value at SLS considers a maximum settlement of 25 mm and a differential settlement of 20 mm;
- It should be noted that the bearing capacity value at ULS is for vertical loads. For eccentric and inclined loads, the capacity must be adjusted by the structural engineer according to sections 6.7.3 and 6.7.4 of the CHBDC (2006).

2.4.2 Pile foundation

Alternatively, the foundation could consist in piles. It is important to remind that using piles will present problems such as the puncturing of the clayey layer which could result in upsurges of water along the face of the piles. Therefore, construction approaches will have to be adjusted to the site inherent conditions.

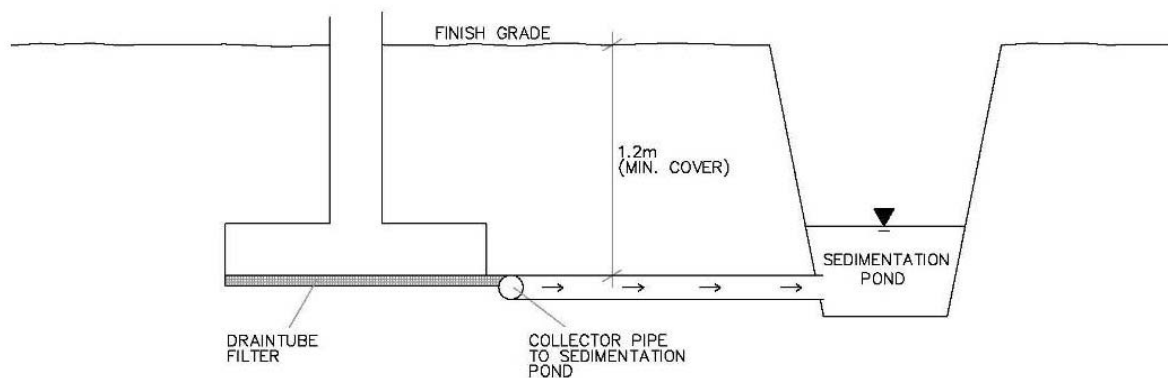
The design and construction of deep foundations (piles or caissons) should meet requirements of OPSS 903.

2.4.2.1 Steel H-Piles

- Foundations (pile caps) of the abutments could also be placed on H-pile HP 310 x 110 at elevation 156 m;
- Piles can be driven to refusal in the very dense till encountered between elevation 142 m and 149 m. So, pile lengths would be around 7 to 14 m;

- Piles driven about 2 m in the very dense cohesionless till would have a factored ULS capacity of 1,600 kN and a SLS capacity of 1,400 kN;
- For piles spaced at more than 1.5 m ($5d$ (dimension of pile = 0.3 m x 5)), no reduction factor or special provision will be needed. If piles are closer than 1.5 m and when the exact location of each pile will be known, we should be consulted to see what has to be done.
- Water could be flowing along the outside of the H-piles when the piles will go through the soil strata under artesian pressure. A filter layer consisting in a clean stone wrapped in a nonwoven geotextile should be installed under the pile cap in order to collect the water that may rise along the piles from the artesian pressure. The filter layer has to retain soils particles that may be present in the rising water. Since construction of this filter layer could be difficult in some instances, an alternate option would be to use drain tube products. Figure 1 shows a proposed installation of drain tube product under the pile cap connected to a collector pipe that would take the collected water to a sedimentation pond. A technical sheet for this product is inserted in Appendix 6.

FIGURE 1
FILTER LAYER UNDER PILE CAP



- The bearing capacities of the piles must be confirmed by dynamic load tests using the Pile Driving Analyser on at least 10% of piles;
- No negative skin friction has to be considered for the piles.

2.4.2.2 Lateral resistance of piles

- Lateral resistance of the piles can be computed using a p - y curve where y represents the lateral deflexion and p represents the resistance from the soils in force per unit length of pile;
- The required geotechnical parameters for the lateral resistance of the piles at the abutments are given below Elevation of 156 m;
- The p - y curves for each soil unit can be computed using the method proposed Reese and al.¹, chapter 14. The required geotechnical parameters are given in Table 1 for pile driven into the till deposit.

¹ Reese, L.C., Isenhower, W.M. and Wang, S.-T. 2006. Analysis and Design of Shallow and Deep Foundations. John Wiley and Sons, Inc. New York.

TABLE 1
GEOTECHNICAL PARAMETERS
FOR LATERAL RESISTANCE OF PILE IN SOIL

Layer		Elevations from-to (m)	Type of soil (rock)	\bar{N}_{SPT}	c_u (kPa)	q_u (MPa)	RQD (%)	γ (total) (kN/m ³)	ϕ (°)	δ (°)	$K_{py}^{(1)}$ (MN/m ³)		$K_p^{(2)}$	ϵ_{50}
No.	Description										Static	Cyclic		
1	Surficial silt/sand layer – very loose to compact	156.0-155.0	Cohesionless	3	-	-	-	15.0	28	11	4.3	4.3	2.8	-
2	Clayey till – firm to very stiff	155.0-150.5	Cohesive		75	-	-	20.0			81	32	1.0	0.006
3	Silt/Sand layer – compact	150.5-147.5	Cohesionless	10	-	-	-	17.0	30	11	11.3	11.3	3.0	-
4	Clayey till – hard	147.5-146	Cohesive		200	-	-	20.0			271	108	1.0	0.004
5	Cohesionless till – very dense	146.0-138	Cohesionless	100	-	-	-	22.0	40	11	43.0	43.0	4.6	-
Abbreviations		\bar{N}_{SPT}	Standard Penetration Test, “N” value											
		c_u	Undrained shear strength of clay (kPa)											
		q_u	Unconfined compression of rock (MPa)											
		RQD	Rock Quality Designation (%)											
		γ (total)	Total unit weight (kN/m ³)											
		ϕ	Angle of internal friction (°)											
		δ	Angle of side friction between soil and deep foundation material (°) (based on BOWLES, J. “ <i>Foundation Analysis and Design</i> ” 5 th Edition, McGraw-Hill, 1996 (see Table 11-6))											
		K_{py}	Coefficient of lateral subgrade reaction (MN/m ³) (as recommended by Reese, L.C. et al. 2006) ¹ (see Tables 14.1 and 14.3)											
		K_p	Coefficient of passive pressure (dimensionless) $K_p=(1+\sin\phi)/(1-\sin\phi)$											
ϵ_{50}	Strain corresponding to one half of the maximum principal stress difference (as recommended by Reese, L. C. et al. (2006) ¹ (see Table 14.2)													
Notes 1: REESE, L. C.; ISENHOWER, W. M. & WANG, S-T: “ <i>Analysis and Design of Shallow and Deep Foundations</i> ” John Wiley & Sons, New York, 2006.														
2: As wall movement must take place to develop the full passive earth pressure, the K_p value must be reduced to keep this movement within reasonable limits. Thus the K_p value must be adjusted according to the graph of figure C6.16 of the commentary of the CHBDC (CAN/CSA-S6-06) which is equivalent to the graph of figure 24.5 of the CFEM (2006).														

2.5 LATERAL EARTH PRESSURE ON RIGID WALLS

As planned, the abutment walls will eventually be supporting selected backfill materials. These materials will induce lateral pressures on the wall. Four factors can contribute to lateral pressures:

- The types of backfill material;
- The structural rigidity of the frame;

- The lateral pressure induced from the compaction equipment;
- The seismic loading.

This section treats only with the first 3 above factors. The seismic load is related to the intensity of acceleration predicted for the area. This is further discussed for the Highway 407 area in the *Canadian Highway Bridge Design Code* (CAN/CSA-S6-06).

The lateral earth pressures should be calculated in conformity to section 6.9 of CHBDC.

2.5.1 Type of backfill material and wall structural rigidity

The backfill materials should consist of Granular “A” or Granular “B” type II. The material must be placed by 300 mm thick lifts. Each layer must be compacted to 95% standard Proctor density.

The backfill materials must consist of either Granular “A” or Granular “B” type II. It is recommended to use a triangular lateral pressure distribution and the following parameters in Table 2 in the design.

TABLE 2
SOIL PARAMETERS FOR BACKFILL

PARAMETERS	SYMBOL	BACKFILL	
		Granular “A”	Granular “B” type II
Total unit weight	γ	22	21
Submerged unit weight	γ'	12	11
Effective angle of internal friction	ϕ'	35°	35°
Coefficient of passive earth pressure	K_p	3.7 ⁽¹⁾	3.7 ⁽¹⁾
Coefficient of active earth pressure	K_a	0.27	0.27
Coefficient of earth pressure at rest	K_o	0.43	0.43
<p>Notes 1: As wall movement must take place to develop the full passive earth pressure, the K_p value must be reduced to keep this movement within reasonable limits. Thus the K_p value must be adjusted according to the graph of figure C6.16 of the commentary of the CHBDC (CAN/CSA-S6-06) which is equivalent to the graph of figure 24.5 of the CFEM (2006). The coefficient of passive earth pressure must be reduced to take into account the wall movement required to fully mobilize the passive earth pressure according to Figure 24.5 of the CFEM (2006)</p> <p>2: Values of the coefficients in the table are unfactored.</p>			

2.5.2 Horizontal pressure due to compaction effect

The compaction of the backfill material behind the rigid wall will induce further pressure on the wall in excess of the lateral pressure determined above. Thus the compaction effort should be reduced behind the wall. From a practical point of view, it is usually recommended to avoid compacting the backfill soil with heavy equipment from a distance equivalent to 1.5 m from the wall. This non densified zone could be compacted using small compaction equipments such as hand operated plates or small rollers.

2.6 HORIZONTAL RESISTANCE OF FOUNDATIONS TO SLIDING

If spread footings are used, the foundation must generate enough resistance against sliding caused by the lateral soil pressure. The lateral resistance can be obtained by one or a combination of the following means:

- Sliding friction at the underside of the footing;
- Passive earth pressure at the foundation level.

The friction between the foundation and the native soil should comply with article 6.7.5 of the CHBDC (CAN/CSA-S06-06). In this case, the angle of friction between the concrete of the foundation and the native soil could be taken as 35° which yields a friction coefficient ($\tan \delta$) of 0.7 (unfactored). As stated in CHBDC, a geotechnical resistance reduction factor of 0.8 should be used.

As for the contribution of the passive pressure at the foundation level, the designer should comply with article 24.12.4.2 of the CFEM (2006) which states that:

“Sliding stability must be adequate without using the passive resistance above the frost depth as frost action can degrade the strength of the natural of backfill materials”

2.7 SEISMIC CONSIDERATION

For seismic design, the site is classified as Soil Profile Type I (Table 4.4, CAN/CSA-S6-06).

2.8 APPROACH FILLS

- The approach fills will reach maximum height of about 5.5 m. Considering the soil properties, an approach embankment up to 6 m high with side slopes no steeper than 2H : 1V as per MTO requirements will be safe against deep seated slope instability. Surface of the slope must be protected against erosion.
- The fills will be constructed with proper compactable soils which will mainly consist of excavated materials from the cut sections. The fills will be built by 300 mm thick lifts each compacted to 95% standard Proctor density;
- The approach fill, will induce a pressure of about 110 kPa on the native soils. This pressure is expected to produce a settlement less than 25 mm based on the correlation of the clay properties. The settlement will consist mainly in recompression settlement and is expected to take place mostly during fill construction.

3 CONSTRUCTION RECOMMENDATIONS AND PRECAUTIONS

- Excavation at the abutments could reach the groundwater level which is to be expected near the existing ground level. It is important to note that due to the relative high permeability of the silty sand/silt and sand superficial deposit, important water infiltrations are to be expected. Therefore, depending on the construction season, important quantities of water may infiltrate, thus an adequate pumping must be provided;
- Due to the presence of artesian pressures, excavation could be difficult because of water infiltration and possible bottom heave, since safety factor (SF) against bottom heave is 1.2 instead of 1.4 as generally required. Considering this issue, an adequate dewatering system must be installed prior to excavation in order to lower the groundwater level at least 0.3 m below the bottom of the excavation;

- Temporary excavations in the native soil which can be considered as Type 3 soils (OSHA) will likely be stable at 1H : 1V after proper dewatering.

GROUPE QUALITAS INC.

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Louis D'Amours, P. Eng., M.A.Sc.

Reviewed by: Jean Authier, P. Eng., M.A.Sc.

Date: January 10, 2014

Appendix 1 - Borehole Logs
Appendix 2 - Results of Laboratory Tests
Appendix 3 - Soil Stratigraphy
Appendix 4 - Borehole Location Plan
Appendix 5 - Drawing of Structure
Appendix 6 - Drain Tube Technical Sheet

A P P E N D I X 1

BOREHOLE LOGS

EXPLANATORY NOTES BOREHOLE AND TEST PIT LOG (page 1 of 2)

The object of the borehole and test pit log is to present field and laboratory data concerning soil, bedrock and groundwater conditions. The purpose of this note is to explain the terminology, symbols and abbreviations used on the log.

STRATIGRAPHY

1. DEPTH - ELEVATION

The depth and elevation of contacts between the various geological strata are given in relation to the ground surface at the borehole or test pit location. Elevations refer to a datum as specified in the general heading of the log.

2. SOIL DESCRIPTION

Soils are described according to their physical and geotechnical properties.

Soil particle size classification is given below:

<u>IDENTIFICATION</u>	<u>PARTICLE SIZE (mm)</u>
Clay	< 0.002
Silt	0.002 - 0.08
Sand	0.08 - 5
Gravel	5 - 80
Cobble	80 - 300
Boulder	> 300

The proportion of each soil constituent, as identified by the particle size range, is defined by the following descriptive terms:

<u>DESCRIPTION</u>	<u>PARTICLE SIZE FRACTION (%)</u>
Trace	1 - 10
Some	10 - 20
Adjective (ex.: sandy silt, silty)	20 - 35
And (ex.: sand and gravel)	> 35

2.1 STATE OF COMPACTNESS OF COHESIONLESS SOILS

The state of compactness of cohesionless soils is evaluated using the "N-value" obtained during the Standard Penetration Test (SPT).

<u>COMPACTNESS</u>	<u>N-VALUE (blows / 300 mm)</u>
Very loose	< 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very dense	> 50

2.2 CONSISTENCY AND PLASTICITY OF COHESIVE SOIL

The consistency of cohesive soils is defined by the undrained shear strength. The undrained shear strength of the intact clay (c_u) and remoulded clay (c_r) is measured in situ or in the laboratory.

<u>CONSISTENCY</u>	<u>UNDRAINED SHEAR STRENGTH, c_u (kPa)</u>
Very soft	< 12
Soft	12 - 25
Firm	25 - 50
Stiff	50 - 100
Very stiff	100 - 200
Hard	> 200

<u>DEGREE OF PLASTICITY</u>	<u>LIQUID LIMIT, w_L (%)</u>
Low	< 30
Medium	30 - 50
High	> 50

3. ROCK DESCRIPTION

Rock is described according to its geological origin, composition, structural characteristics and mechanical properties.

The Rock Quality Designation (RQD) is determined according to the ASTM D 6032 Standard.

<u>CLASSIFICATION</u>	<u>RQD VALUE (%)</u>
Very poor quality	< 25
Poor quality	25 - 50
Fair quality	50 - 75
Good quality	75 - 90
Excellent quality	90 - 100

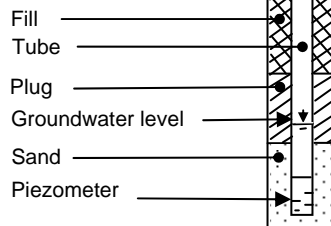
<u>JOINT SPACING CLASSIFICATION</u>	<u>SPACING WIDTH (mm)</u>
Extremely close	0 - 60
Close	60 - 200
Moderately close	200 - 600
Wide	600 - 2000
Very wide	> 2000

<u>STRENGTH</u>	<u>UNCONFINED COMPRESSIVE STRENGTH, q_u (MPa)</u>
Extremely weak	< 1
Very weak	1 - 5
Weak	5 - 25
Medium strong	25 - 50
Strong	50 - 100
Very strong	100 - 250
Extremely strong	> 250

EXPLANATORY NOTES BOREHOLE AND TEST PIT LOG (page 2 of 2)

GROUNDWATER LEVEL

The column "Groundwater Level" gives the groundwater level measured in a stand pipe, piezometer, monitoring well or directly in the borehole or test pit. The survey date is also indicated in this column. The sketch opposite illustrates the different symbols used.



SAMPLES

1. TYPE AND NUMBER

The column "Type and Number" corresponds to the sample number. It includes 2 letters indicating the sample type followed by a sequence number. The sample types are as follows:

SS : Split spoon	RC : Rock core
LS : Large diameter sampler	GS : Grab sample
TW : Thin wall tube	AS : Auger sample
TU : Geoprobe™ sampling tube	

2. CONDITION

The depth, strength and condition of each sample is given in this column. The following symbols indicate the condition of the sample:



3. RECOVERY

Sample recovery corresponds to the recovered length of the sample in relation to the length of penetration of the sampler, expressed in percentage. The sample length is equal to the distance from the top of the sampler to the cutting edge whether or not the lower part of the sample is lost.

IN SITU AND LABORATORY TESTS

In situ and laboratory test results are indicated in the column "In Situ and Laboratory Tests" at the corresponding depth.

The following list of abbreviations identifies these tests.

ABBREVIATIONS

A	Absorption, L/min-m (Packer Test in rock)
CA	Chemical analysis
C	Consolidation test
C _c	Curvature coefficient
C _u	Uniformity coefficient
c _u	Intact undrained shear strength, measured with the field vane, kPa
c _r	Remoulded undrained shear strength, measured with the field vane, kPa
c _{us}	Intact undrained shear strength, measured with the Swedish fall-cone, kPa
c _{rs}	Remoulded undrained shear strength, measured with the Swedish fall-cone, kPa
c _{up}	Intact undrained shear strength, measured with the portable vane apparatus, kPa
c _{rp}	Remoulded undrained shear strength, measured with the portable vane apparatus, kPa
D _r	Relative density
E _M	Pressuremeter modulus, kPa or MPa
G	Particle size distribution by sieve and washing
I _L	Liquidity index
I _p	Plasticity index, %
k _c	Coefficient of permeability (hydraulic conductivity), measured in situ, m/s
k _L	Coefficient of permeability (hydraulic conductivity), measured in the laboratory, m/s
N _{dc}	Dynamic cone penetrometer blow count (DCPT)
N	Standard penetration test (SPT) index
P ₈₀	Sieve analysis by washing on the 80 µm sieve
P _L	Pressuremeter limit pressure, kPa
P _r	Proctor Test
γ	Unit weight, kN/m ³
γ'	Effective unit weight, kN/m ³
q _u	Unconfined compressive strength of rock, MPa
R	Split spoon penetration refusal
S	Particle size distribution by hydrometer testing
S _t	Sensitivity (c _u /c _r)
CPV	Corrosivity point value
w	Water content, %
w _L	Liquid limit, %
w _p	Plastic limit, %

CLIENT : 407 East Construction General Partnership
PROJECT : Highway 407 East Extension
LOCATION : Segment A-3, Whitby, Ontario
FILE : G12166

BOREHOLE : BH-M39-101
DATE : 2013-03-07
COORDINATES : MTM NAD 83
E: 346 680,3 **N**: 4 867 914,7

DEPTH (m)	ELEVATION (m) GEODETIC	DESCRIPTION	WATER LEVEL	SAMPLES			IN SITU AND LABORATORY TESTS			
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%)	OTHER TESTS	
	156,4							$\frac{W_p}{W} \frac{W_L}{W}$		$\blacktriangle C_u$ (kPa) $\blacktriangledown C_{us}$ (kPa) $\triangle C_r$ (kPa) ∇C_{rs} (kPa) $\bullet N_{dc}$ (blows/300 mm)
								10 20 30 40		20 40 60 80
		Topsoil.		SS-1	X	42	3			
0,6	155,8	Silt and sand, trace gravel and clay.		SS-2	X	79	10	9	G	
1,4	155,0	compact.		SS-3	X	100	32	13	G S	
2,1	154,3	Till: sandy and clayey silt, trace gravel. Hard.		SS-4	X	96	20	17	G S	
3,7	152,7	Till: silt and clay, some sand, trace gravel. Very stiff.		SS-5	X	79	16			
4,4		Till: clayey silt, trace sand and gravel. Low to medium plasticity (CL). Firm.		SS-6	X	100	5	16 24 33		
5,5				SS-7	X	100	5	24		
6,1	150,3	Sandy silt, trace clay. Compact.		SS-8	X	100	7	14 22 26	G S	
7,7		Presence of water and sand upsurges under artesian pressure between depths of approximately 7 m (el. 149.4 m) and 9 m (el. 147.4 m).		SS-9	X	100	10		G S	
8,8				SS-10	X	0	*			
9,1	147,3	Till: clayey and sandy silt, trace gravel. Hard.		SS-11	X	75	39		G S	

REMARKS : - R: refusal to the penetration of the split spoon sampler.
- Sample SS-10 was impossible to recover due to artesian pressure causing water and sand upsurges.

DRILLING METHOD : Drilling of a NW casing and a tricone.

CLIENT : 407 East Construction General Partnership
PROJECT : Highway 407 East Extension
LOCATION : Segment A-3, Whitby, Ontario
FILE : G12166

BOREHOLE : BH-M39-101
DATE : 2013-03-07
COORDINATES : MTM NAD 83
E: 346 680,3 **N**: 4 867 914,7

DEPTH (m)	ELEVATION (m) GEODETIC	DESCRIPTION	WATER LEVEL	SAMPLES			IN SITU AND LABORATORY TESTS												
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%) <div><div>W_P</div><div><div>W</div><div>W_L</div></div></div>	OTHER TESTS	▲ C _u (kPa) ▼ C _{us} (kPa) △ C _r (kPa) ▽ C _{rs} (kPa)									
	● N _{dc} (blows/300 mm)																		
	10							20		30	40	20	40	60	80				
10,7	145,7	Till : clayey and sandy silt, trace gravel. Hard. Till : silt and sand, trace gravel and clay to silty sand, some gravel, trace clay. Very dense.		SS-12	⊗	100	R												
11																			
12				SS-13	⊗	100	R												
13																			
14				SS-14	⊗	100	R												
15																			
16				SS-15	⊗	100	R												
17				SS-16	⊗	100	R												
18																			
18,6	137,8	End of borehole		SS-17	⊗	100	R												
19																			
20																			

REMARKS : - R: refusal to the penetration of the split spoon sampler.
 - Sample SS-10 was impossible to recover due to artesian pressure causing water and sand upsurges.

DRILLING METHOD : Drilling of a NW casing and a tricone.

CLIENT : 407 East Construction General Partnership
PROJECT : Highway 407 East Extension
LOCATION : Segment A-3, Whitby, Ontario
FILE : G12166

BOREHOLE : BH-M39-103

DATE : 2013-02-23 to 2013-02-25

COORDINATES : MTM NAD 83

E: 346 661,9 **N**: 4 867 967,8

DEPTH (m)	ELEVATION (m) GEODETTIC	DESCRIPTION	WATER LEVEL	SAMPLES			IN SITU AND LABORATORY TESTS			
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%)	OTHER TESTS	ΔC_u (kPa) ∇C_{us} (kPa) ΔC_r (kPa) ∇C_{rs} (kPa) $\bullet N_{dc}$ (blows/300 mm)
	157,0							W_p W_L W		
								10 20 30 40		20 40 60 80
		Topsoil.		SS-1	X	92	9			
0,8	156,2	Sand and silt, trace gravel and clay. Loose to compact.		SS-2	X	100	6	17	G	
2,0	155,0	Till : clay and silt, some sand, trace gravel. Medium plasticity (CL). Very stiff to the depth of 3.8 m; stiff thereafter.		SS-3	X	67	11			
				SS-4	X	100	17	19	G S	
				SS-5	X	100	23			
				SS-6	X	100	7	16 26 34		88 75
				SS-7	X	100	5	24	G S	
5,3	151,7	Till: clayey and sandy silt, trace gravel. Firm.		SS-8	X	100	8	17	G S	
6,0	151,0	Till: silt and clay, some sand, trace gravel. Firm.		SS-9	X	100	8		G	
7,6	149,4	Till : silty and gravelly sand, trace clay. Loose. Presence of water and sand upsurges under artesian pressure between depths of approximately 7.6 m (el. 149.4 m) and 13.7 m (el. 143.3 m).		SS-10	X	50	7		G S	

REMARKS : - R: refusal to the penetration of the split spoon sampler.
- Vane tests were carried out in an adjacent borehole.

DRILLING METHOD : Drilling of a NW casing and a tricone: Nilcon vane apparatus.

CLIENT : 407 East Construction General Partnership

PROJECT : Highway 407 East Extension

LOCATION : Segment A-3, Whitby, Ontario

FILE : G12166

BOREHOLE : BH-M39-103

DATE : 2013-02-23 to 2013-02-25

COORDINATES : MTM NAD 83

E: 346 661,9 **N:** 4 867 967,8



[illegible]

REMARKS : - R: refusal to the penetration of the split spoon sampler.
- Vane tests were carried out in an adjacent borehole.

DRILLING METHOD : Drilling of a NW casing and a tricone: Nilcon vane apparatus.

CLIENT : 407 East Construction General Partnership
PROJECT : Highway 407 East Extension
LOCATION : Segment A-3, Whitby, Ontario
FILE : G12166

BOREHOLE : BH-M39-103
DATE : 2013-02-23 to 2013-02-25
COORDINATES : MTM NAD 83
E: 346 661,9 **N**: 4 867 967,8

DEPTH (m)	ELEVATION (m) GEODETIC	DESCRIPTION	WATER LEVEL	SAMPLES			IN SITU AND LABORATORY TESTS													
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%) <div><div>W_P</div><div><div>W</div><div>W_L</div></div></div>	OTHER TESTS	▲ C _u (kPa) ▼ C _{us} (kPa) △ C _r (kPa) ▽ C _{rs} (kPa) ● N _{dc} (blows/300 mm)										
	10									20	30	40	20	40	60	80				
21	137,0	Till : sand and silt, some gravel, trace clay. Very dense. Presence of water and sand upsurges under artesian pressure starting at an approximate depth of 21.3 m (el. 135.7 m).		SS-16		100	R													
22	21,8 135,2	End of borehole		SS-17		100	R													
23																				
24																				
25																				
26																				
27																				
28																				
29																				
30																				

REMARKS : - R: refusal to the penetration of the split spoon sampler.
- Vane tests were carried out in an adjacent borehole.

DRILLING METHOD : Drilling of a NW casing and a tricone: Nilcon vane apparatus.

CLIENT : 407 East Construction General Partnership
PROJECT : Highway 407 East Extension
LOCATION : Segment A-3, Whitby, Ontario
FILE : G12166

BOREHOLE : BH-M39-103B

DATE : 2013-02-23

COORDINATES : MTM NAD 83

E: 346 661,9 **N**: 4 867 967,8

DEPTH (m)	ELEVATION (m) GEODETIC	DESCRIPTION	WATER LEVEL	SAMPLES			IN SITU AND LABORATORY TESTS						
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%) <div><div>W_P</div><div><div></div><div>W</div></div><div>W_L</div></div>	OTHER TESTS	▲ C _u (kPa) ▼ C _{us} (kPa) △ C _r (kPa) ▽ C _{rs} (kPa)			
	● N _{dc} (blows/300 mm)												
	157,0								10203040			20406080	
1		No sampling to a depth of 4.6 m, See borehole BH-M39-103A for soil description.											
2													
3													
4													
5													
5.2	151,8	End of borehole		TW-1	<div></div>	100	-	<div><div>15</div><div>21</div><div>26</div><div>18</div></div>		C _{us} = 850 kPa			
6													
7													
8													
9													
10													

297

REMARKS : Borehole was put down adjacent to borehole BH-M39-103.

DRILLING METHOD : Rotation of hollow stem auger to the depth of 3.7 m; drilling of a NW casing.

CLIENT : 407 East Construction General Partnership
PROJECT : Highway 407 East Extension
LOCATION : Segment A-3, Whitby, Ontario
FILE : G12166

BOREHOLE : BH-M39-104

DATE : 2013-02-25 to 2013-02-26

COORDINATES : MTM NAD 83

E: 346 691,8 **N**: 4 867 962,0

DEPTH (m)	ELEVATION (m) GEODETTIC	DESCRIPTION	WATER LEVEL	SAMPLES			IN SITU AND LABORATORY TESTS			
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%)	OTHER TESTS	▲ C _u (kPa) ▼ C _{us} (kPa) △ C _r (kPa) ▽ C _{rs} (kPa) ● N _{dc} (blows/300 mm)
	156,8							W _p — W — W _L 10 20 30 40		20 40 60 80
		Topsoil.		SS-1		88	6			
0,6	156,2	Silty sand , trace gravel and clay.		SS-2		75	3	18	G S	
1		Very loose to depth of 1.4 m; compact thereafter.		SS-3		83	18			
2				SS-4		100	24			
2,9	153,9	Till : clay and silt, trace sand and gravel.		SS-5		100	17		G S	
3		Very stiff.		SS-6		100	15			
4				SS-7		79	8		G S	
4,6	152,2	Till : clayey and sandy silt, trace gravel.		CF-8		0	15			
5		Firm to stiff.		SS-9		100	4			
6				SS-10		100	31		G	
6,5	150,3	Fine uniform sand , trace silt and gravel.		SS-11		100	R		G	
7		Loose to compact.								
8		Presence of water and sand upsurges under artesian pressure between depths of 6.5 m (el. 150.3 m) and 8.3 m (el. 148.5 m).								
8,3	148,5	Till : silt and sand, trace to some gravel, trace clay.								
9		Very dense.								
10										

REMARKS : - R: refusal to the penetration of the split spoon sampler.
 - Water level approximately 2.1m (el.158.9m) above ground level on 2013-02-26.

DRILLING METHOD : Drilling of a NW casing and a tricone.

CLIENT : 407 East Construction General Partnership
PROJECT : Highway 407 East Extension
LOCATION : Segment A-3, Whitby, Ontario
FILE : G12166

BOREHOLE : BH-M39-104
DATE : 2013-02-25 to 2013-02-26
COORDINATES : MTM NAD 83
E: 346 691,8 **N**: 4 867 962,0

DEPTH (m)	ELEVATION (m) GEODETIC	DESCRIPTION	WATER LEVEL	SAMPLES			IN SITU AND LABORATORY TESTS												
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%) <div><div><div>W_P</div><div>W</div><div>W_L</div></div></div>	OTHER TESTS	▲ C _u (kPa) ▼ C _{us} (kPa) △ C _r (kPa) ▽ C _{rs} (kPa)									
										● N _{dc} (blows/300 mm)									
	10									20	30	40	20	40	60	80			
11	146,8	Till : silt and sand, trace to some gravel, trace clay. Very dense.		SS-12	<div></div>	100	R												
12																			
13																			
14																			
15																			
16																			
17	17,0	139,8	End of borehole	SS-16	<div></div>	100	R												
18																			
19																			
20																			

REMARKS : - R: refusal to the penetration of the split spoon sampler.
 - Water level approximately 2.1m (el.158.9m) above ground level on 2013-02-26.

DRILLING METHOD : Drilling of a NW casing and a tricone.

RECORD OF BOREHOLE No 10-04

1 OF 2

METRIC

G.W.P. 2110-05-00 LOCATION N 4 867 900.3 E 346 706.2 ORIGINATED BY ES
 HWY 7 and 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2010.02.02 - 2010.02.02 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						x LAB VANE	20	40
156.1							20	40	60	80	100	20	40	60	GR SA SI CL			
0.0	ORGANICS, trace clay, trace roots and rootlets Loose Dark Brown		1	SS	7													
155.3																		
0.8	Silty CLAY, some sand Stiff to Very Stiff Grey (TILL)(CL)		2	SS	12													
			3	SS	22										0 16 44 40			
			4	SS	26													
			5	SS	15										0 8 41 51			
	Firm		6	SS	7													
149.6			7	SS	6													
6.5	Silty SAND, some clay, trace gravel, occasional cobble Very Dense Grey Damp (TILL)																	
			8	SS	73										5 49 33 13			
			9	SS	100/ 0.175													

Continued Next Page

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

RECORD OF BOREHOLE No 10-04

2 OF 2

METRIC

G.W.P. 2110-05-00

LOCATION N 4 867 900.3 E 346 706.2

ORIGINATED BY ES

HWY 7 and 407

BOREHOLE TYPE Hollow Stem Augers

COMPILED BY AN

DATUM Geodetic

DATE 2010.02.02 - 2010.02.02

CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL															
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L	WATER CONTENT (%)																		
Continued From Previous Page																													
	Silty SAND, some clay, trace gravel, occasional cobble Very Dense Grey Damp (TILL)		10	SS	100/ 0.163		146																						
							145																						
			11	SS	100/ 0.125		144																						
							143																						
142.2			12	SS	114/ 0.200																								
13.9	<p>END OF BOREHOLE AT 14.0m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.</p> <p>WATER LEVEL READINGS:</p> <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH (m)</th> <th>ELEV. (m)</th> </tr> </thead> <tbody> <tr> <td>2010.02.17</td> <td>0.68*</td> <td>156.88</td> </tr> <tr> <td>2010.02.19</td> <td>0.68*</td> <td>156.88</td> </tr> <tr> <td>2010.03.16</td> <td>0.50*</td> <td>156.70</td> </tr> <tr> <td>2010.03.27</td> <td>0.58*</td> <td>156.78</td> </tr> </tbody> </table> <p>* Above Ground Surface</p>														DATE	DEPTH (m)	ELEV. (m)	2010.02.17	0.68*	156.88	2010.02.19	0.68*	156.88	2010.03.16	0.50*	156.70	2010.03.27	0.58*	156.78
DATE	DEPTH (m)	ELEV. (m)																											
2010.02.17	0.68*	156.88																											
2010.02.19	0.68*	156.88																											
2010.03.16	0.50*	156.70																											
2010.03.27	0.58*	156.78																											

+³ ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE



PROJECT 07-1111-0053

W.O. 07-20015

DIST Central

DATUM Geodetic

LOCATION N 4867951.9 ; E 346735.8

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash boring from 7.3 m to 13.8 m depth

DATE February 27 and 29, 2008

1 OF 2

METRIC

ORIGINATED BY PKS

COMPILED BY DD

CHECKED BY TZ/BLT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES									
159.4 0.0	GROUND SURFACE													
	TOPSOIL Loose Brown Moist		1	SS	4		159							
158.6 0.8	CLAYEY SILT with SAND, trace to some gravel (TILL) Stiff to very stiff Brown to grey Moist		2	SS	9		158							
			3	SS	11									
			4	SS	29									
			5	SS	23									
			6	SS	18									
153.9 5.5	SILTY CLAY Stiff Grey Wet		7	SS	12		153							
151.8 7.6		SILT Very loose Grey Wet	8	SS	3		151							
150.3 9.1	SAND and SILT, some clay and gravel, containing clayey silt seams (TILL) Compact to very dense Grey Wet		9	SS	17		150							
		10	SS	108		149								
		11	SS	100/0.23		147								
145.6 13.8		END OF BOREHOLE	12	SS	100/0.17		146							



PROJECT 07-1111-0053

W.O. 07-20015

DIST Central

DATUM Geodetic

LOCATION N 4867951.9 ; E 346735.8

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; Wash boring from 7.3 m to 13.8 m depth

DATE February 27 and 29, 2008

2 OF 2

METRIC

ORIGINATED BY PKS

COMPILED BY DD

CHECKED BY TZ/BLT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES									
	--- CONTINUED FROM PREVIOUS PAGE ---													
	NOTE: 1. Water level measured in open borehole upon completion of drilling at a depth of 3.0 m below ground surface (Elevation 156.4 m).													

MIS-MTO 001 07-1111-0053.GPJ GAL-MISS.GDT 5/19/10 DD/SAC

MIS-MTO 001 07-1111-0053.GPJ GAL-MISS.GDT 5/19/10 DD/SAC

Continued Next Page

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

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

A P P E N D I X 2

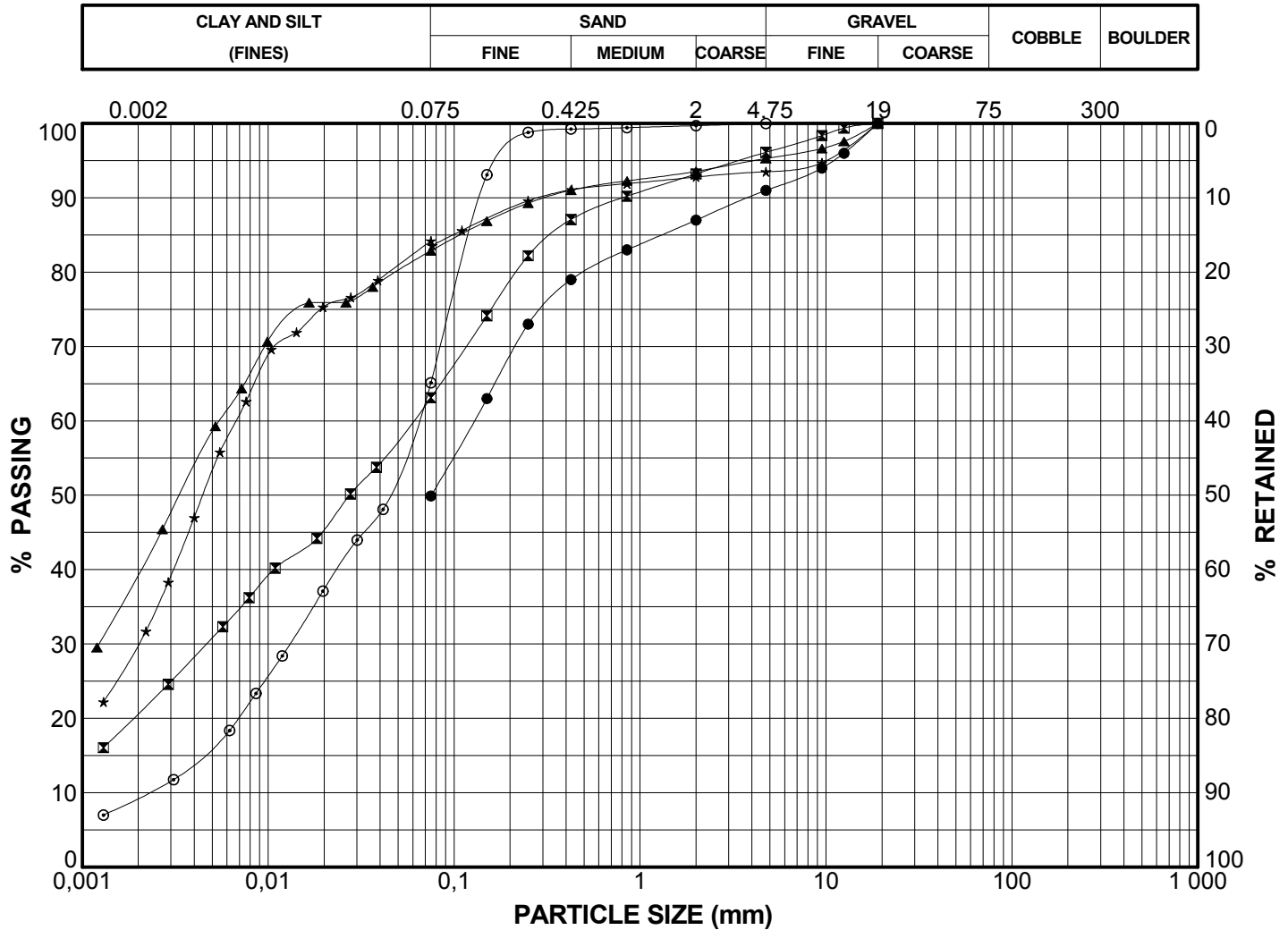
RESULTS OF LABORATORY TESTS

CLIENT : 407 East Construction General Partnership

PROJECT : Highway 407 East Extension

LOCATION : Segment A-3, Whitby, Ontario

FILE : G12166



	Sounding	Sample	Depth (m)		Gravel (%)	Sand (%)	Silt and Clay (%)		Description
			from	to					
●	BH-M39-101	SS-2B	0,8	1,4	9	41	50		Silt and sand , trace gravel and clay.
▣	BH-M39-101	SS-3	1,5	2,1	4	33	42	21	Till : sandy and clayey silt, traces gravel.
▲	BH-M39-101	SS-4	2,3	2,9	5	12	43	40	Till : silt and clay, some sand, traces gravel.
★	BH-M39-101	SS-8	5,3	5,9	7	9	54	30	Till : clayey silt, traces sand and gravel.
⊙	BH-M39-101	SS-9	6,1	6,7	0	35	56	9	Sandy silt , traces clay.

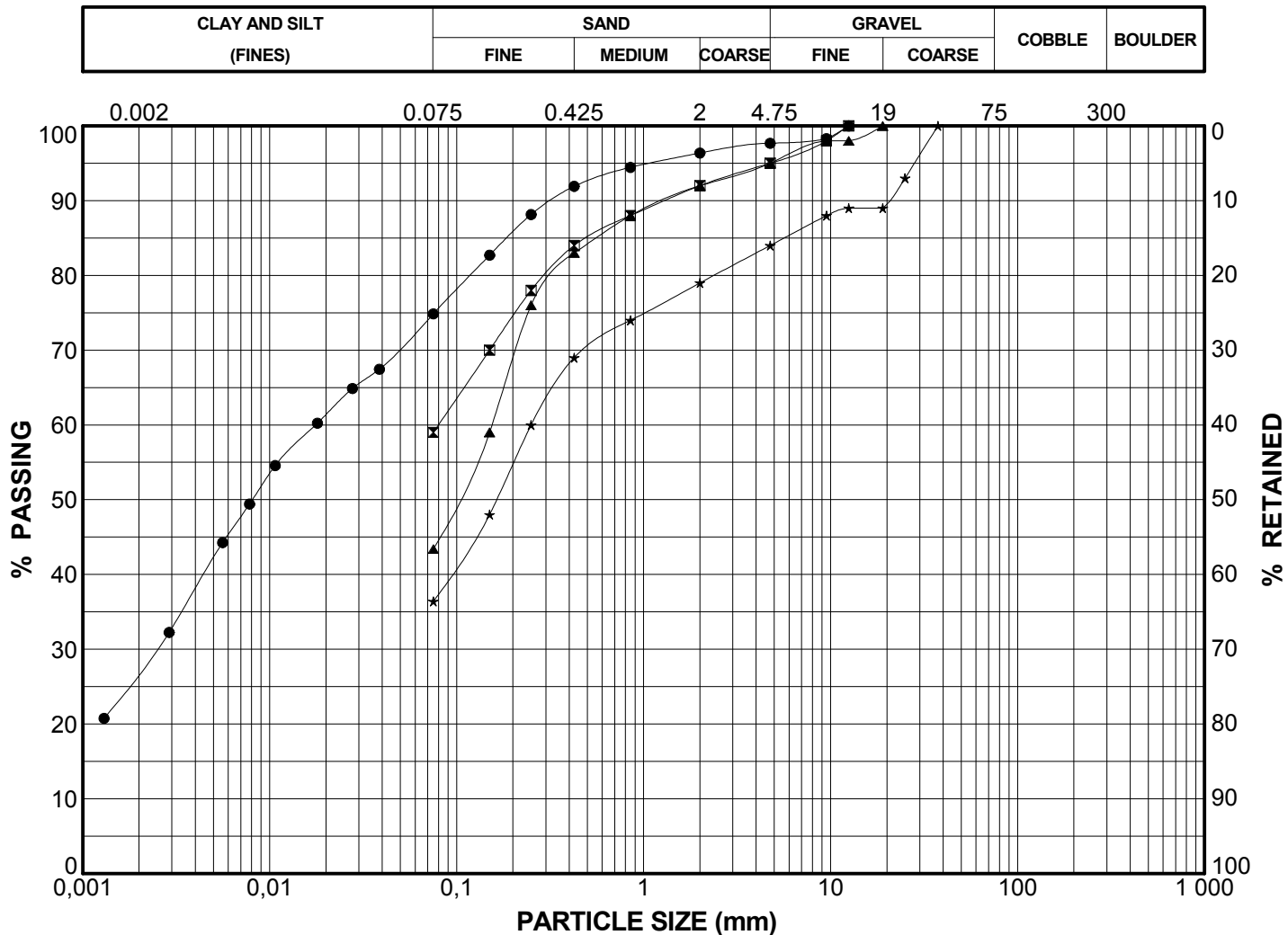
REMARKS :

CLIENT : 407 East Construction General Partnership

PROJECT : Highway 407 East Extension

LOCATION : Segment A-3, Whitby, Ontario

FILE : G12166



	Sounding	Sample	Depth (m)		Gravel (%)	Sand (%)	Silt and Clay (%)		Description
			from	to					
●	BH-M39-101	SS-11	9,1	9,8	2	23	48	27	Till: clayey and sandy silt, traces gravel.
▣	BH-M39-101	SS-12	10,7	11,0	5	36	59		Till : silt and sand, trace gravel and clay.
▲	BH-M39-101	SS-13	12,2	12,5	5	52	43		Till : sand and silt, trace gravel and clay.
★	BH-M39-101	SS-16B	16,8	17,0	16	48	36		Till : silty sand, some gravel, trace clay.

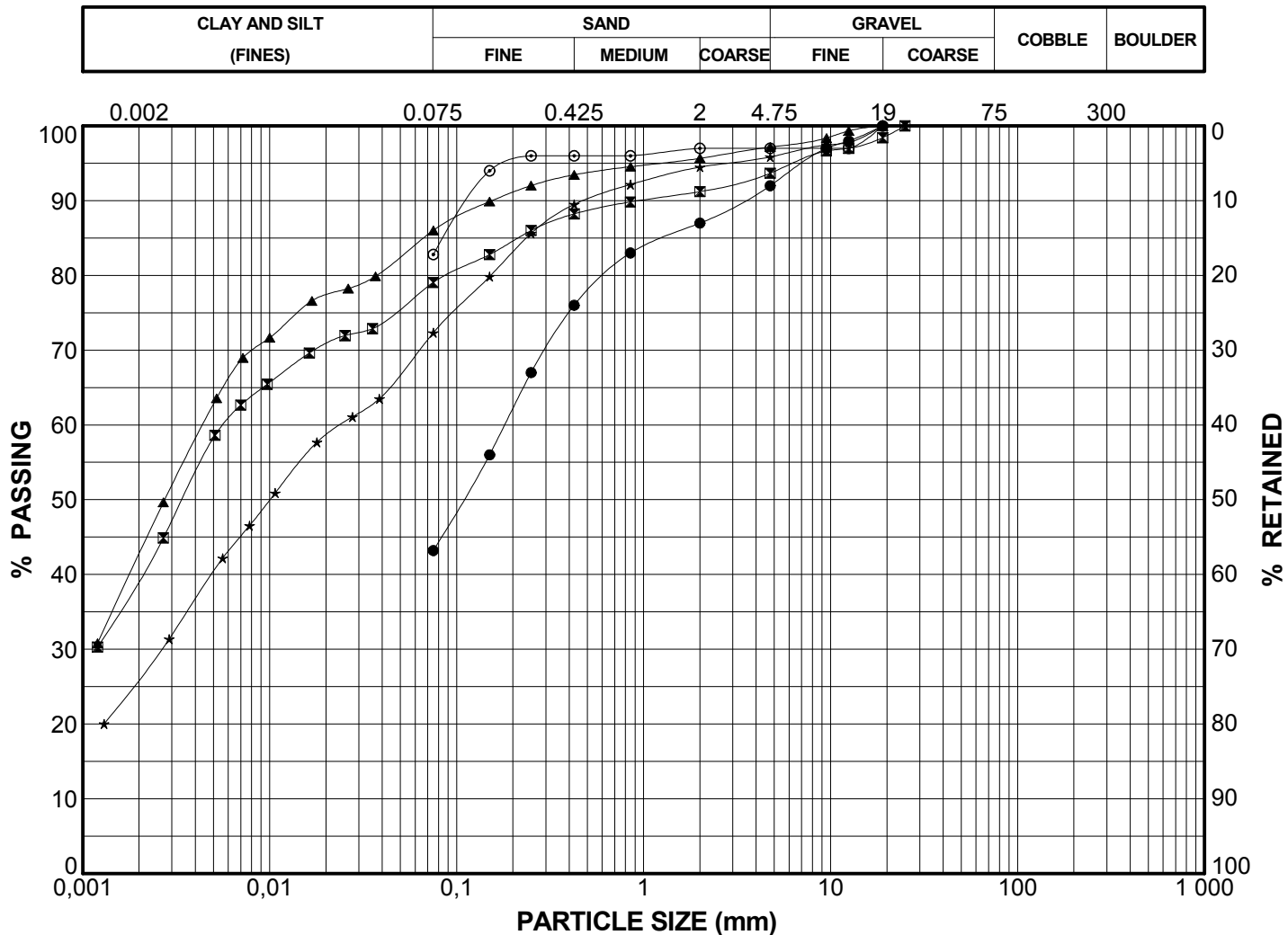
REMARKS :

CLIENT : 407 East Construction General Partnership

PROJECT : Highway 407 East Extension

LOCATION : Segment A-3, Whitby, Ontario

FILE : G12166



	Sounding	Sample	Depth (m)		Gravel (%)	Sand (%)	Silt and Clay (%)		Description
			from	to					
●	BH-M39-103	SS-2	0,8	1,4	8	49	43		Sand and silt, trace gravel and clay.
▣	BH-M39-103	SS-4	2,3	2,9	6	15	40	39	Till: clay and silt, some sand, trace gravel.
▲	BH-M39-103	SS-7	4,6	5,2	3	11	43	43	Till: clay and silt, some sand, trace gravel.
★	BH-M39-103	SS-8	5,3	5,9	4	24	46	26	Till: clayey and sandy silt, trace gravel.
⊙	BH-M39-103	SS-9	6,1	6,7	3	14	83		Till: silt and clay, some sand, trace gravel.

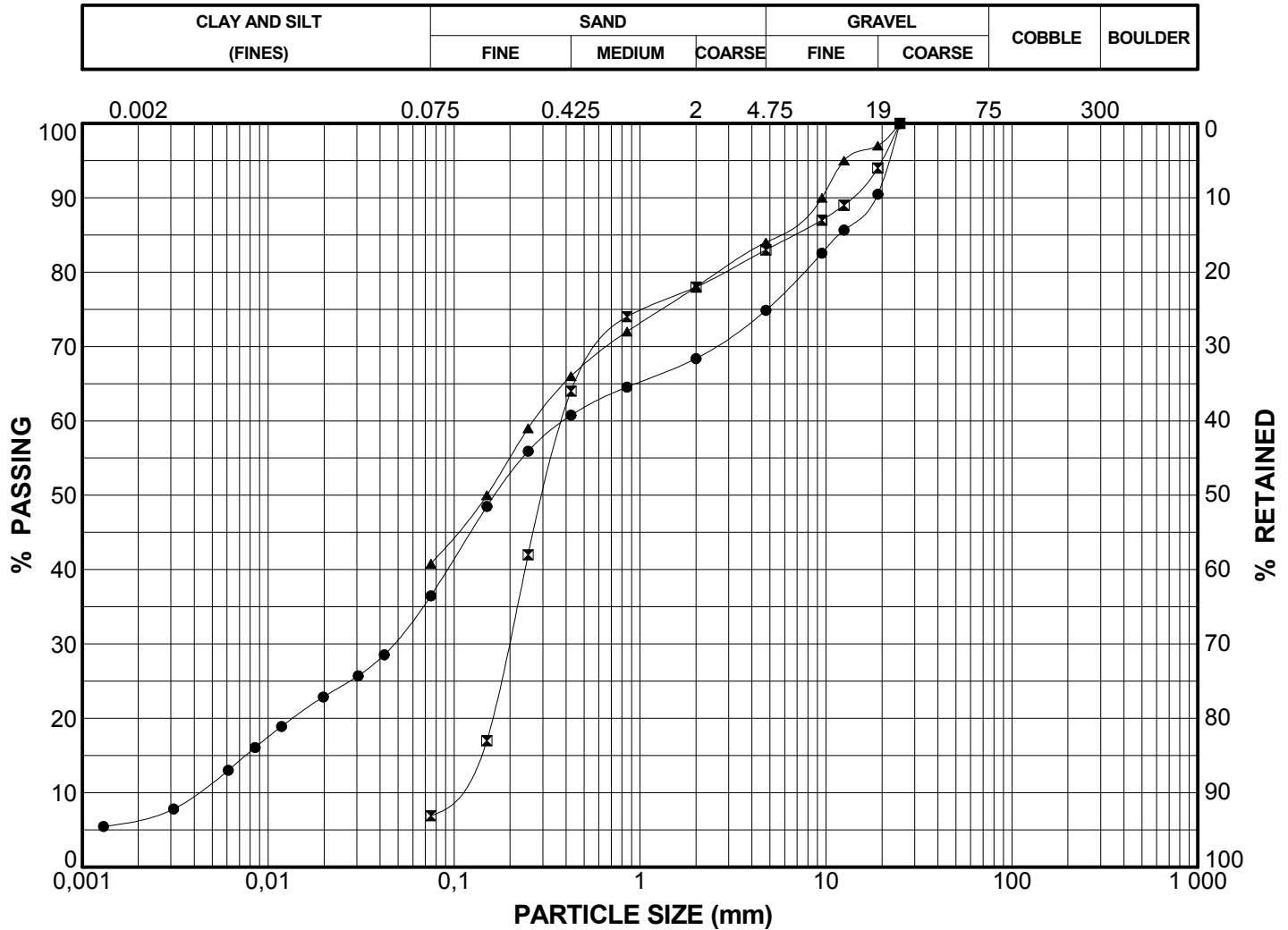
REMARKS :

CLIENT : 407 East Construction General Partnership

PROJECT : Highway 407 East Extension

LOCATION : Segment A-3, Whitby, Ontario

FILE : G12166



	Sounding	Sample	Depth (m)		Gravel (%)	Sand (%)	Silt and Clay (%)		Description
			from	to					
●	BH-M39-103	SS-10	7,6	8,2	25	38	30	7	Till: silty and gravelly sand, trace clay.
×	BH-M39-103	SS-11	10,7	11,1	17	76		7	Fine uniform sand, some gravel, trace silt.
▲	BH-M39-103	SS-15	18,3	18,5	16	43		41	Till: sand and silt, some gravel, trace clay.

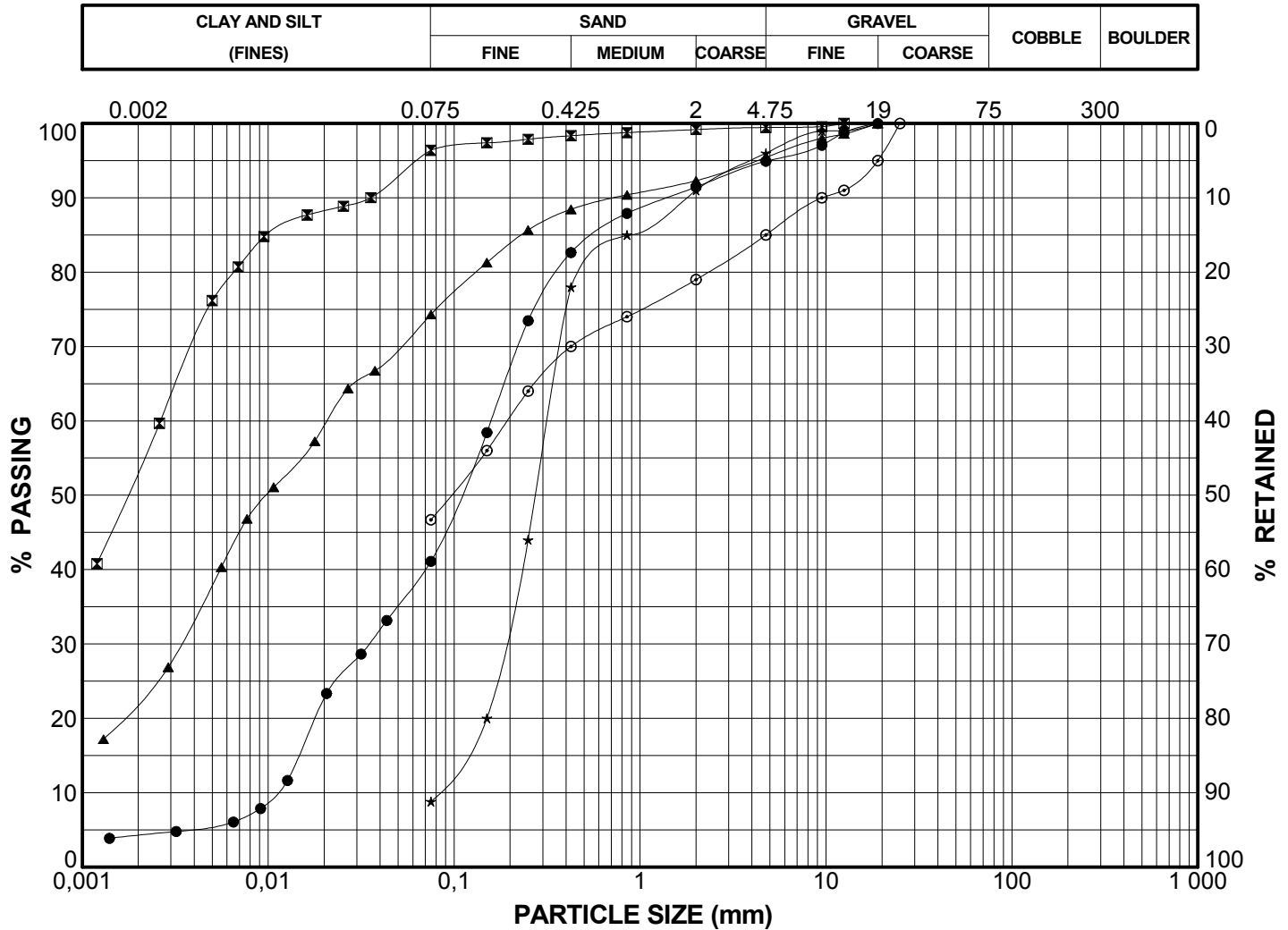
REMARKS :

CLIENT : 407 East Construction General Partnership

PROJECT : Highway 407 East Extension

LOCATION : Segment A-3, Whitby, Ontario

FILE : G12166

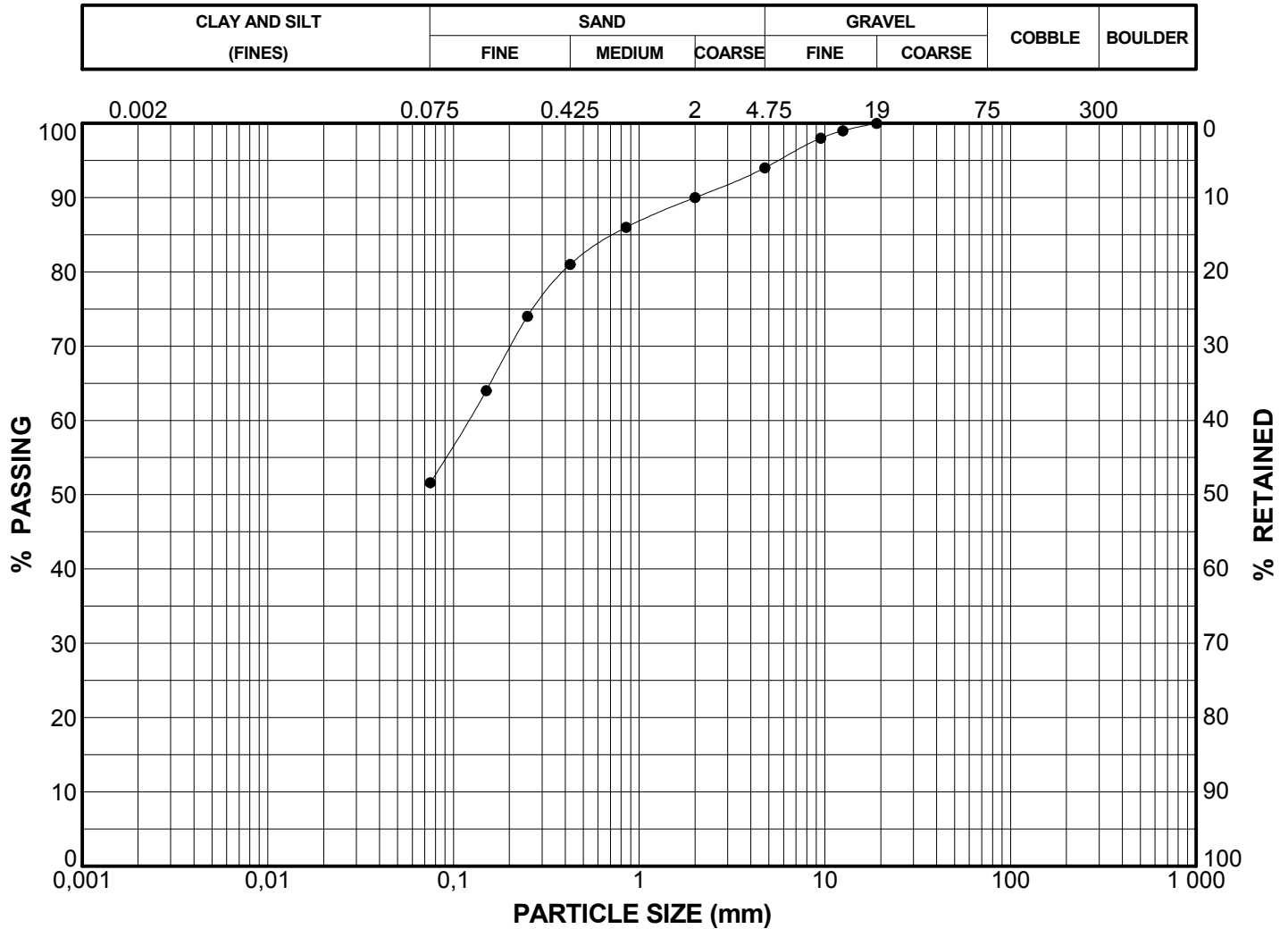


	Sounding	Sample	Depth (m)		Gravel (%)	Sand (%)	Silt and Clay (%)		Description
			from	to					
●	BH-M39-104	SS-2	0,8	1,4	5	54	37	4	Silty sand , trace gravel and clay.
⊠	BH-M39-104	SS-5	3,1	3,7	1	3	43	53	Till : clay and silt, trace sand and gravel.
▲	BH-M39-104	SS-7	4,6	5,2	5	21	52	22	Till : clayey and sandy silt, trace gravel.
★	BH-M39-104	SS-10	7,6	8,2	4	87		9	Fine uniform sand , trace silt and gravel.
⊙	BH-M39-104	SS-11	9,1	9,5	15	38		47	Till : silt and sand, some gravel, trace clay.

REMARKS :

PARTICLE SIZE DISTRIBUTION

CLIENT : 407 East Construction General Partnership
PROJECT : Highway 407 East Extension
LOCATION : Segment A-3, Whitby, Ontario
FILE : G12166



	Sounding	Sample	Depth (m)		Gravel (%)	Sand (%)	Silt and Clay (%)	Description
			from	to				
●	BH-M39-104	SS-14	13,7	14,0	6	42	52	Till: silt and sand, trace gravel and clay.

REMARKS :

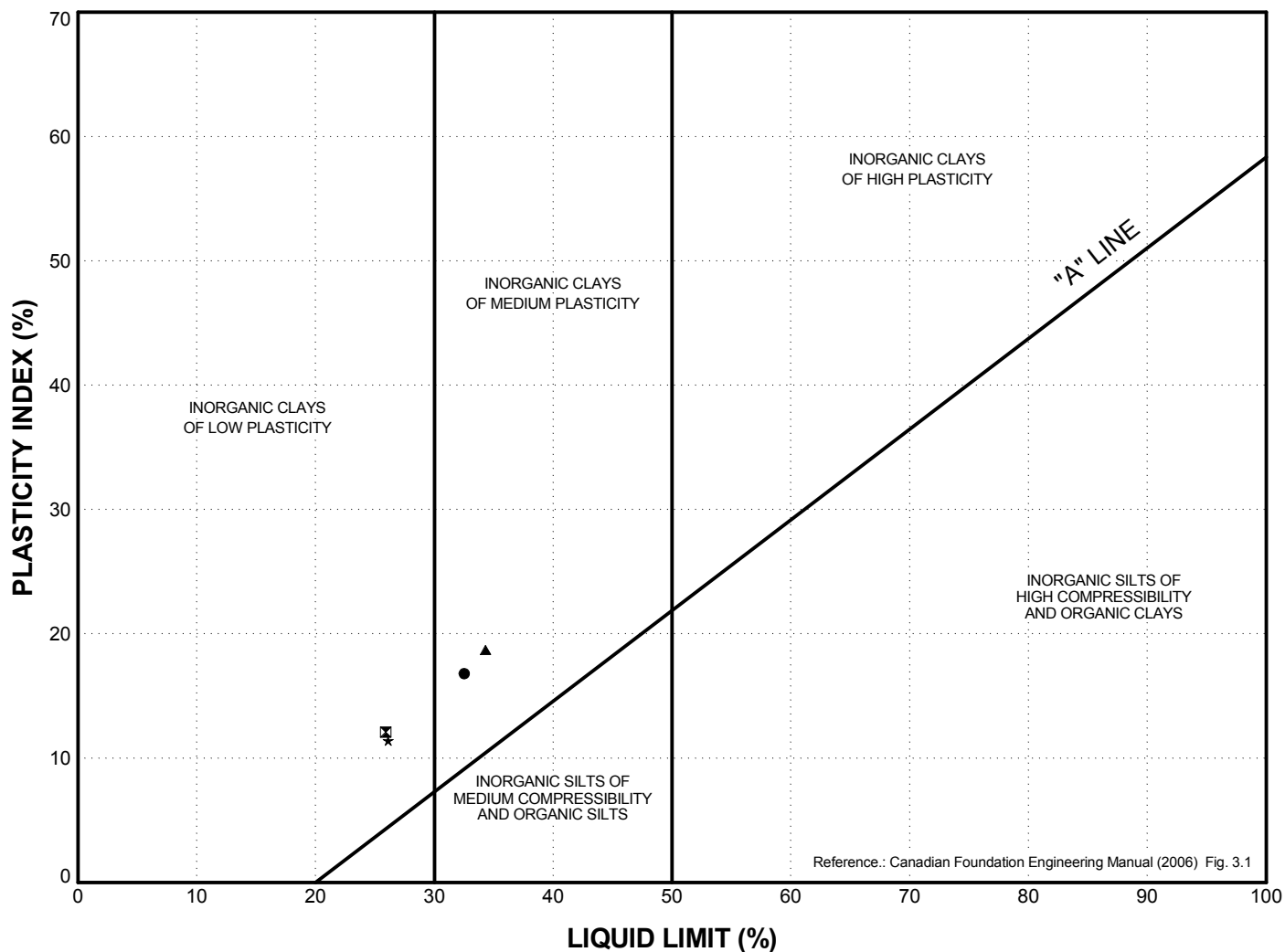
PLASTICITY CHART

CLIENT : 407 East Construction General Partnership

PROJECT : Highway 407 East Extension

LOCATION : Segment A-3, Whitby, Ontario

FILE : G12166



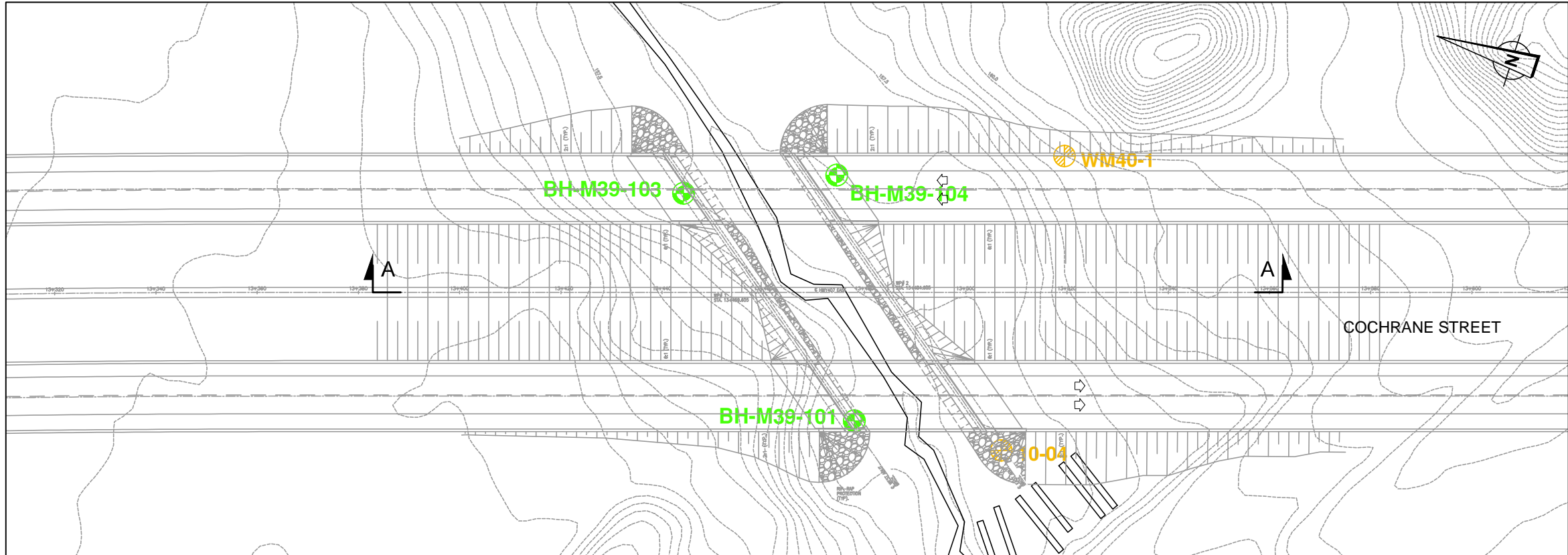
	Sounding	Sample	Depth (m)		w (%)	w _L (%)	w _P (%)	I _P (%)	I _L	DESCRIPTION
			from	to						
●	BH-M39-101	SS-6	3,8	4,4	24	33	16	17	0,5	Till: clayey silt, traces sand and gravel, medium plasticity (CL).
⊠	BH-M39-101	SS-8	5,3	5,9	22	26	14	12	0,7	Till: clayey silt, traces sand and gravel, low plasticity (CL).
▲	BH-M39-103	SS-6	3,8	4,4	26	34	16	19	0,6	Till: clay and silt, some sand, trace gravel, medium plasticity (CL).
★	BH-M39-103B	TW-1	4,6	5,2	21	26	15	11	0,5	Till: clayey silt, trace sand and gravel, low plasticity (CL).

REMARKS:

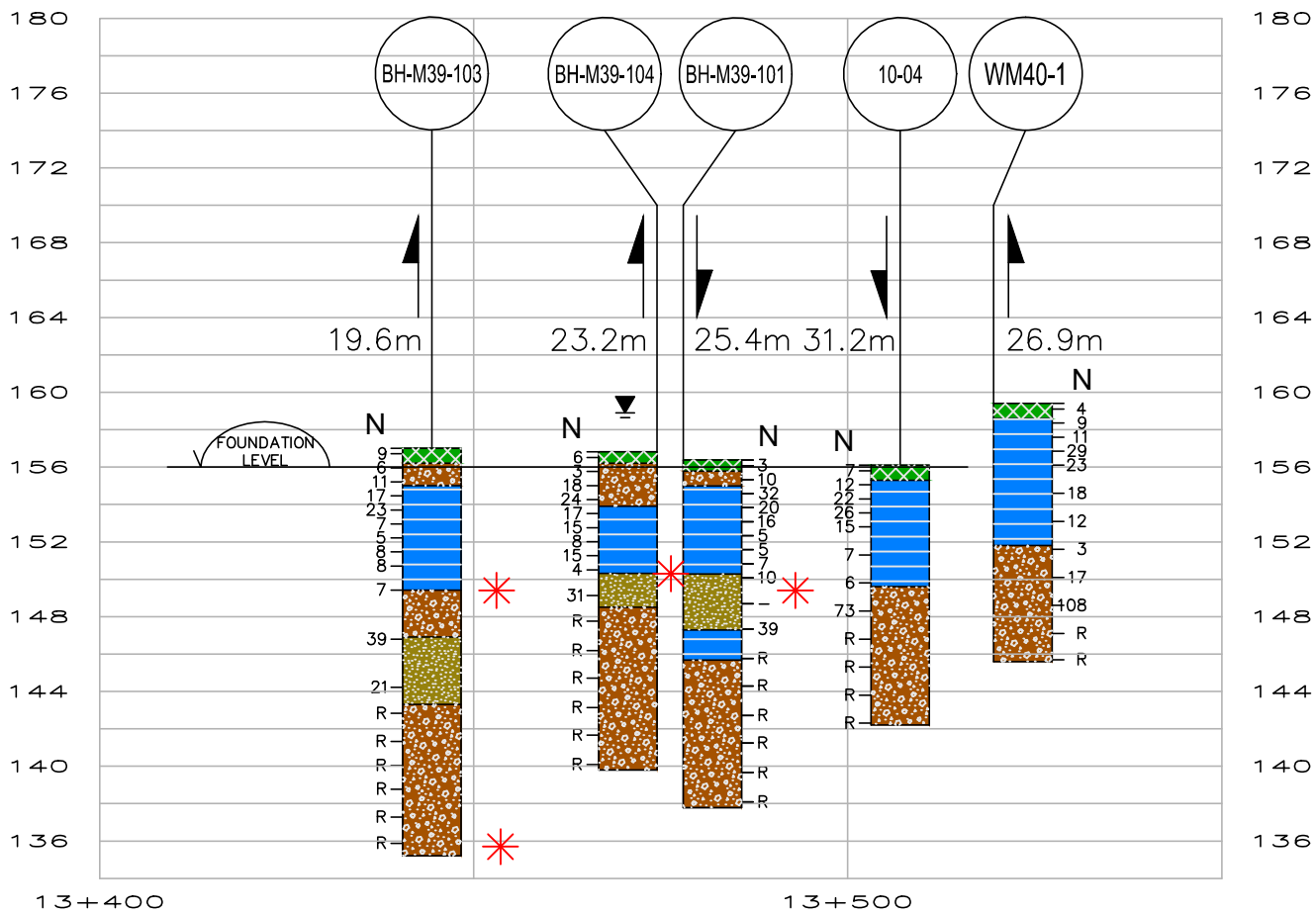
A P P E N D I X 3

SOIL STRATIGRAPHY

T:\Proj\QUALITAS - ST-LAURENT\Geotech\Projets\Dossiers G12\G12101 - 499\G12166\DAO\ Dessins\G12166-SEG-A3\structure M-39.dwg



STRUCTURE M-39



Scale : 1 : 1000 Hor. / 1 : 400 Vert.
SECTION A-A

LEGEND

- BH-W59-101** Borehole - Structure
- CM21b-3** Borehole - Done previously
- Topsoil / Fill / Organic / Asphalt
- Sand
- Predominantly granular soil (sand and silt, sandy silt, silty sand)
- Clay till
- Rock
- Elevation at which artesian pressure or sand uplifts where noted during drilling

CLIENT:

PROJECT: HIGHWAY 407 EAST EXTENSION

LOCATION: SEGMENT A-3
STRUCTURE M-39

TITLE: BOREHOLE LOCATION AND STRATIGRAPHIC PROFILE

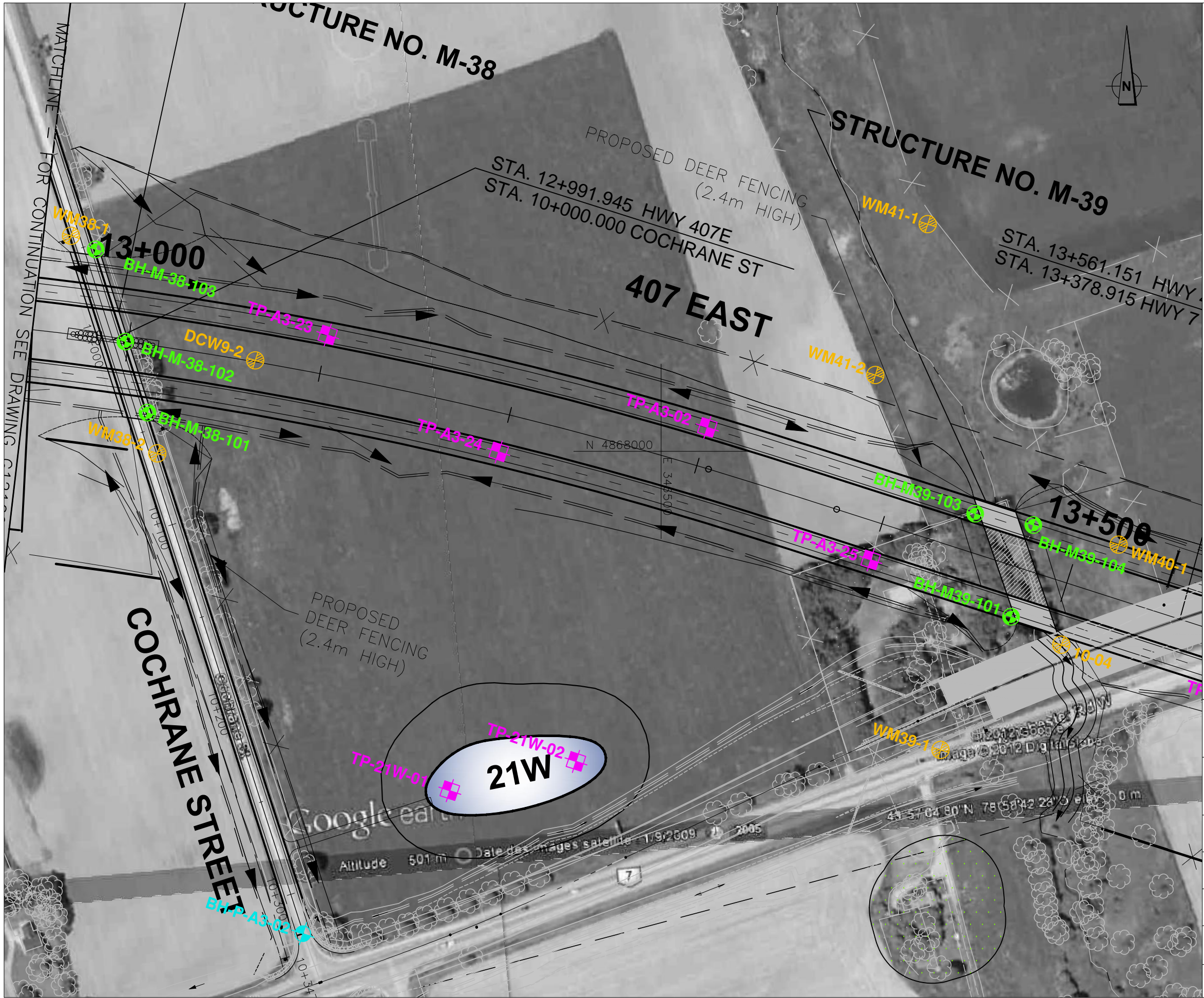
SCALE: 1 : 1000

DATE: 2013-06-19	FILE: G12166	DIV. M39	DRAWING: 01
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A P P E N D I X 4

BOREHOLE LOCATION PLAN

T:\Projet\QUALITAS - ST-LAURENT\Geotech\Projets\Dossiers G12\G12101 à 499\G12166-SEG-A3\G12166-SEG-A3-02 PHOTO.dwg



LEGEND

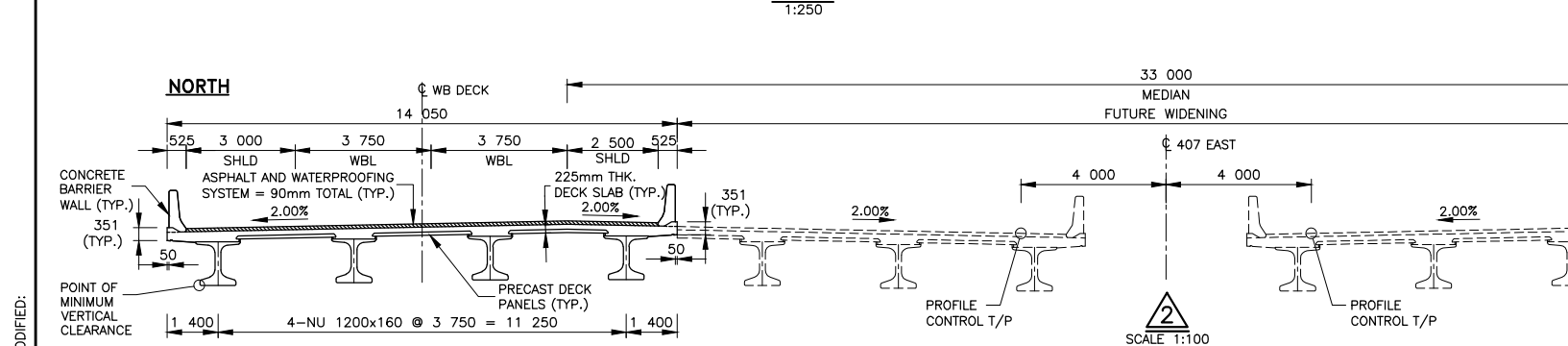
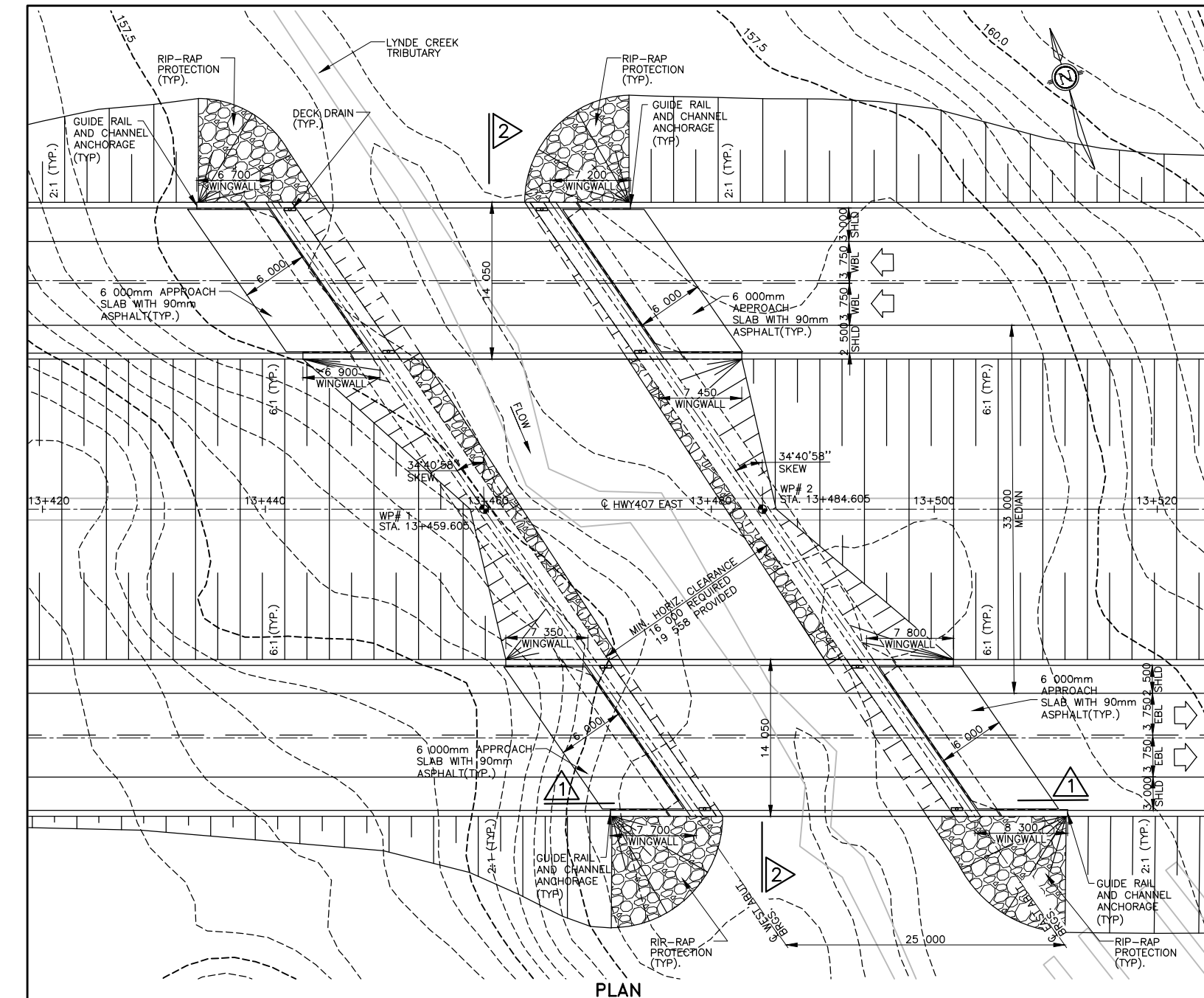
- TP-A3-23 Test Pit
- BH-M38-101 Borehole - Structure
- WM38-2 Borehole - Done previously



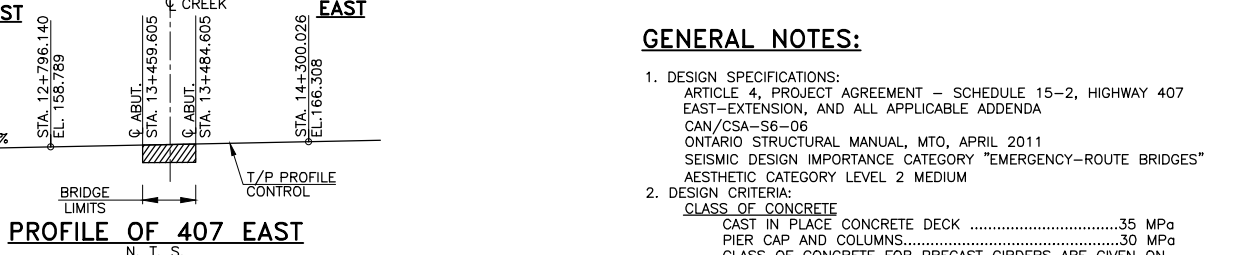
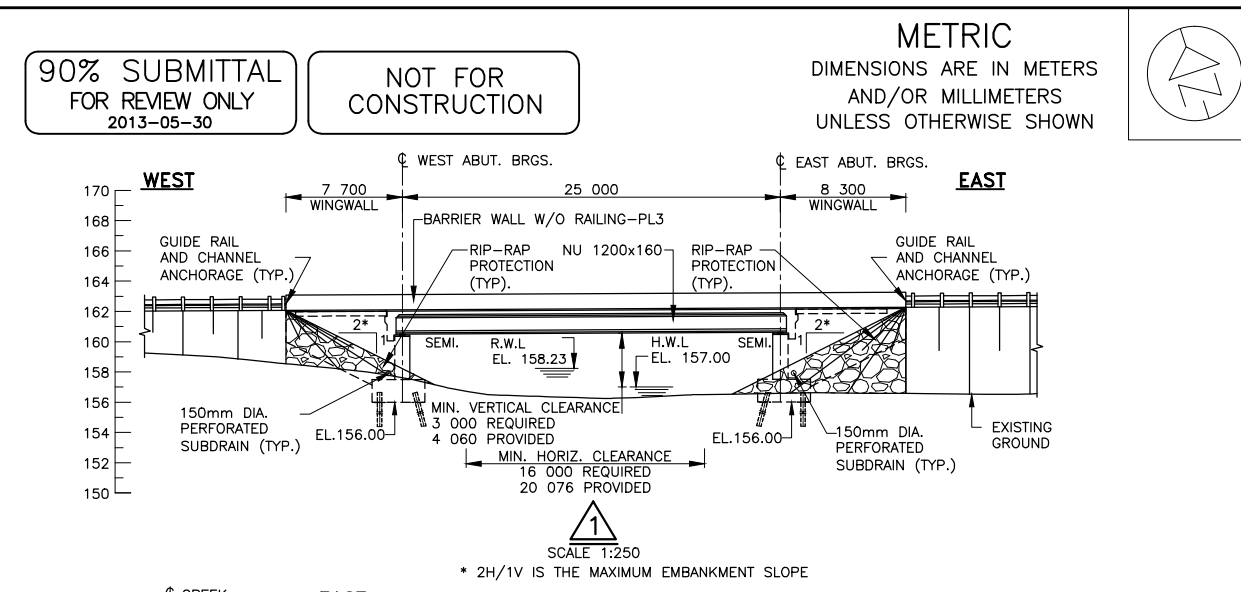
CLIENT:			
PROJECT:	HIGHWAY 407 EAST EXTENSION		
LOCATION:	SEGMENT A-3 STRUCTURES M-38 et M-39		
TITLE:	BOREHOLE LOCATION		
SCALE:	 1 : 2000		
DATE:	FILE:	DIV.	DRAWING:
2013-16-13	G12166	A3	01

A P P E N D I X 5

DRAWING OF STRUCTURE



REVISIONS	DATE	DESCRIPTION	DESIGNED BY:	DRAWN BY:	CHECKED BY:	SEAL 1	SEAL 2
PA	2012-12-21	50% DESIGN SUBMITTAL					
FA	2013-05-30	90% DESIGN SUBMITTAL					



- LIST OF DRAWINGS:**

 - GENERAL ARRANGEMENT
 - BOREHOLES LOCATION & SOIL STRATA EBL
 - FOUNDATION LAYOUT (I)
 - WEST ABUT. FOUNDATION LAYOUT
 - WEST ABUT. FOOTING REINFORCEMENT (I)
 - WEST ABUT. FOOTING REINFORCEMENT (II)
 - EAST ABUT. FOUNDATION LAYOUT
 - EAST ABUT. FOOTING REINFORCEMENT (I)
 - EAST ABUT. FOOTING REINFORCEMENT (II)
 - WEST ABUTMENT EBL
 - WEST ABUTMENT REINFORCEMENT EBL
 - WEST ABUTMENT WBL
 - WEST ABUTMENT REINFORCEMENT WBL
 - EAST ABUTMENT EBL
 - EAST ABUTMENT REINFORCEMENT EBL
 - EAST ABUTMENT WBL
 - EAST ABUTMENT REINFORCEMENT WBL
 - DECK 1 EBL
 - DECK 2 EBL
 - DECK REINFORCEMENT EBL
 - DECK 1 WBL
 - DECK 2 WBL
 - DECK REINFORCEMENT WBL
 - PRESTRESSED GIRDERS
- LIST OF ABBREVIATIONS**

ABUT.	ABUTMENT
BRGS.	BEARINGS
CL	CENTERLINE
DIA.	DIAMETER
EB	EASTBOUND
EBL	EASTBOUND LANE
EL	ELEVATION
HORIZ	HORIZONTAL
HWL	HIGH WATER LEVEL
HWY	HIGHWAY
MIN.	MINIMUM
N	NORTH
N.T.S.	NOT TO SCALE
RWL	REGIONAL WATER LEVEL
SHLD	SHOULDER
STA.	STATION
THK	THICKNESS
T/P	TOP OF PAVEMENT
TYP.	TYPICAL
WB	WESTBOUND
WBL	WESTBOUND LANE
W/O	WITHOUT
WP	WORK POINT
- GENERAL NOTES:**

 - DESIGN SPECIFICATIONS:
ARTICLE 4, PROJECT AGREEMENT - SCHEDULE 15-2, HIGHWAY 407 EAST-EXTENSION, AND ALL APPLICABLE ADDENDA
CAN/CSA-S6-06
ONTARIO STRUCTURAL MANUAL, MTO, APRIL 2011
SEISMIC DESIGN IMPORTANCE CATEGORY "EMERGENCY-ROUTE BRIDGES"
AESTHETIC CATEGORY LEVEL 2 MEDIUM
 - DESIGN CRITERIA:
CLASS OF CONCRETE
CAST IN PLACE CONCRETE DECK35 MPa
PIER CAP AND COLUMNS.....30 MPa
CLASS OF CONCRETE FOR PRECAST GIRDERS ARE GIVEN ON PRESTRESSED GIRDER DRAWINGS
PIER DIAPHRAGM35 MPa
REMAINDER30 MPa
CLEAR COVER TO REINFORCING STEEL
FOOTINGS TOP 100±25
DECK TOP 70±20
BOTTOM 40±10
PIER CAPS 70±10
REMAINDER UNLESS OTHERWISE NOTED 70±20
REINFORCING STEEL
CSA G30.18M GRADE 400R, EXCEPT WELDED BARS TO BE GRADE 400W.
PRESTRESSING STEEL
ASTM STANDARD A-416, 7 WIRE STRESS RELIEVED STABILIZED
ULTIMATE TENSILE STRENGTH = 1860 MPa
PROTECTION SYSTEM SHALL CONFORM TO PERFORMANCE LEVEL 3
LOADING
LIVE LOAD: CL 625-ONT
DEAD LOAD: INCLUDES PROVISION FOR INITIAL ASPHALT 90mm OVERLAY
INCLUDES 10 KN/M FOR EACH BARRIER SELF WEIGHT
EARTHQUAKE ACCELERATION: A=0.05
DESIGN TEMPERATURE RANGE: -40°C MIN./+18°C MAX.
WIND LOADS: 1/50 YEAR REFERENCE = 0.52 kPa
 - ROADWAY CLASSIFICATION
HIGHWAY 407E = RFD 120
 - ALL MINIMUM CLEARANCE DIMENSIONS ARE BASED ON THE SUBSTANTIAL COMPLETION DATE OF THE INITIAL WORKS
 - REFER TO ROAD PLANS FOR CLEAR ZONE REQUIREMENTS
 - ALL STATIONS AND ELEVATIONS ARE IN METERS. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.
ALL ELEVATIONS ARE TO GEODETIC DATUM.
 - NO APPARENT UTILITIES ON STRUCTURE.
 - NO HORIZONTAL CURVE ON STRUCTURE.

CONTRACTOR	OWNER
407E CGP	MTO
ENGINEER 1	TITLE
AIA ENGINEERS, LTD.	HIGHWAY 407 EAST EXTENSION
ENGINEER 2	STR M-39: GENERAL ARRANGEMENT
	STRUCTURE
	HWY 407 OVER LYNDE CREEK TRIBUTARY
	SHEET 1 OF 24
	CODE CHBDC-06
	LOAD CL-ONT-625
	SITE 21-713
	PROJECT NO. 610706
	SUBDIVISION 23
	DISC. DOC.
	DRAWING NUMBER 004
	REVISION NUMBER FA

DRAWING NAME:
CREATED:
MODIFIED:

A P P E N D I X 6

DRAIN TUBE TECHNICAL SHEET



DRAINTUBE™ offers:

- ▶ 3 perforated pipes size options (16, 20 and 25 mm)
- ▶ 4 perforated pipe spacing options (2 m, 1 m, 1/2 m, 1/4 m)
- ▶ Multiple geotextile options
- ▶ Available transmissivity between $2.5 \cdot 10^{-4}$ to $4 \cdot 10^{-3}$ m²/s at i=0.1
- ▶ No change in transmissivity between 20 kPa and 2500 kPa
- ▶ Low creep reduction factor
- ▶ No geotextile intrusion
- ▶ Standard roll size – 3.98 m x 75 m
- ▶ Faster and easier to install than other types of geocomposites, no tying required!
- ▶ Consistent QA/QC
- ▶ Competitively priced!

Produced by

AFITEX•Texel
LE DRAINAGE SUR MESURE • THE DRAINAGE YOU WANT

Distributed by

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Fax: 450 650-0104

info@dRAINTUBE.net
WWW.DRAINTUBE.NET

DRAINTUBE™

**In roadworks and
civil engineering**

High-performance and environmentally friendly drainage.

For years stone has been used to provide drainage for roadways.

DRAINTUBE™ offers an effective alternative to stone while at the same time offering a number of advantages, namely:

- Lower costs,
- Faster construction,
- Less excavation and/or backfill
- Better performance,
- Lower greenhouse gas emissions.

Effective road drainage increases durability and performance. DRAINTUBE™ helps to control the harmful effects of freeze-thaw cycles, high water tables, saturated subgrades and heavy loads.

DRAINTUBE™
The drainage you want!

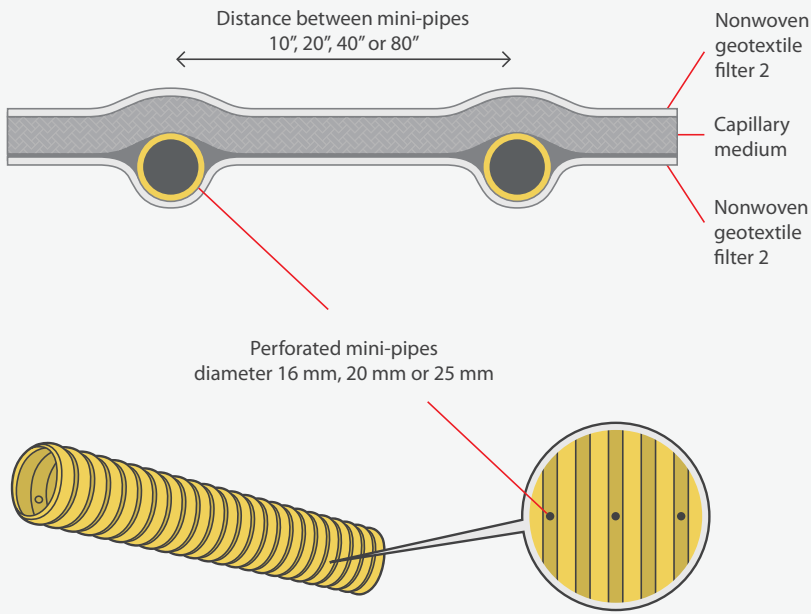
Combining simple and proven geotextile and pipe technology that has been standard for many years, DRAINTUBE™ is manufactured to exacting standards to ensure optimum performance under the most difficult conditions. Each roll performs the functions of separation, filtration and drainage - essential for building better roads.

With its needed structure, DRAINTUBE™ can be customized to meet project specific hydraulic, filtration and separation. That's why we say that DRAINTUBE™ is the drainage you want. Our Lympha software helps the designer choose the appropriate performance properties to solve whatever problems they might encounter.

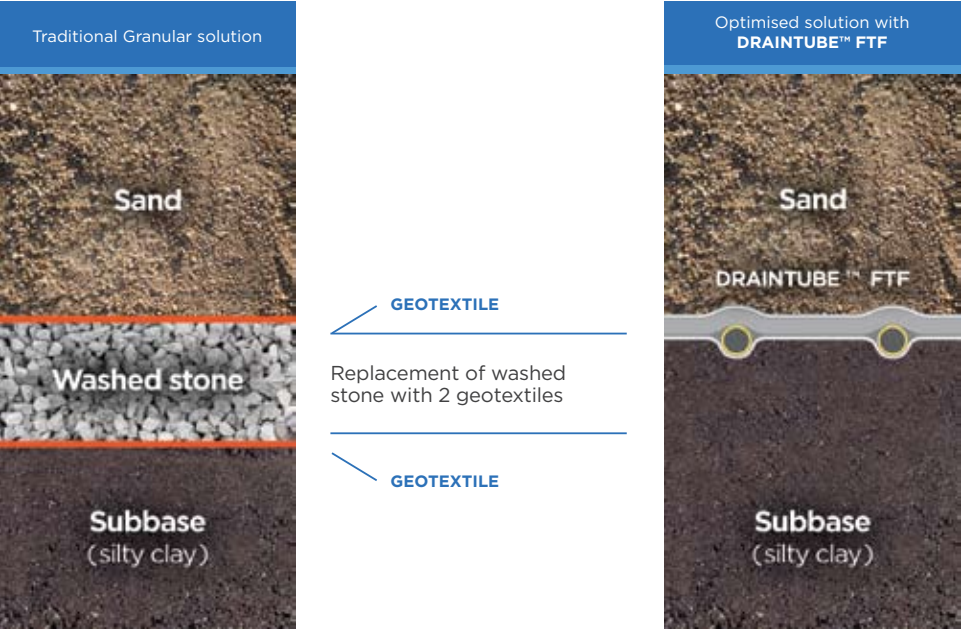
DRAINTUBE™ offers economic, technical and environmental advantages over granular drainage solutions in many civil engineering applications.

DRAINTUBE™ FTF

Extensive laboratory and field testing, plus over 20 years of in-ground experience, proves how soil arching allows DRAINTUBE™ to withstand the heaviest loads.



For roadwork engineering



For backfilled slope or reinforced walls



DRAINTUBE™ advantages:

- DRAINTUBE™ does away with the need for a layer of clean stone and two geotextile separators and it saves excavation time. DRAINTUBE™, specifically sized for the project, provides the same hydraulic capacity as a layer of clean stone.
- Cost savings. The financial advantage over the clean washed stone is evident. There is no need to travel back and forth to a quarry to gather sand.
 - Logistics. Cutting down on the travel time also means the job can be completed sooner.
 - Construction. It is much easier to install DRAINTUBE™ on a low foundation than a layer of clean gravel on a geotextile separator.
 - Helping the planet. Replacing multiple truckloads of stone with DRAINTUBE™ consumes much less carbon, significantly lowering the effects of greenhouse gas.

Stone transport savings
Many advantages

Total distance saved	Fuel quantity	Number of travel saved	GHG emission (CO ₂ equivalent metric tons)
5,400 km	1,660 litres	180 round trips	4.58

(Figures based on a covered area of 10 000 m² using as an example a washed stone deposit situated 15 km from the construction site.)

