

FOUNDATION INVESTIGATION REPORT

PROPOSED EXTENSION OF STRUCTURAL CULVERT 8-467C HIGHWAY 26 FROM FORMER ST. VINCENT/SYDENHAM TOWNLINE TO MEAFORD

G.W.P. 167-91-00
Agreement # 3006-E-0002



I.E.
Group



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Prepared for:

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May 17, 2010
07-6-IEG1-8-467C

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PART A – FOUNDATION INVESTIGATION

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out in August 2007 by Infrastructure Engineering Group Inc. (IEG) on behalf of Stantec Consulting Ltd. (Stantec).

This assignment involves the rehabilitation of the pavement structure on Highway 26 from 0.3 km west of the former St. Vincent/Sydenham to 0.8 m west of the Town of Meaford west limit.

It includes the replacement/extension of a single existing structural culvert, as well as many non-structural culvert extensions and replacements. The project also includes intersection realignments, intersection improvements, construction of a new truck climbing lane, minor horizontal and vertical alignment improvements and electrical work.

Foundation investigation and recommendations are required for the design and construction of culvert replacements and extension as part of the improvement of Highway 26. A single structural culvert, nineteen (19) non-structural culverts, a swamp area, two high fill areas and a deep cut area are to be investigated. This report covers the structural culvert at Site 8-467C.

The purpose of the investigation was to obtain information about the subsurface conditions at the site by means of boreholes and, based on the findings, to provide geotechnical recommendations for the foundation elements. Armour Stone wing walls will be required at the inlet of Structure 8-467C in accordance with the RFP terms of reference. Extension of the culvert may be required pending on the results of the culvert inspection specified under Section 6.3.1 of the RFP document.

Authorization to complete this assignment was given by Mr. Dan Green, P. Eng., of Stantec Consulting Ltd., the TPM Consultant who is completing this assignment for MTO under Agreement # 3006-E-0002.

2.0 SITE DESCRIPTION

2.1 Site Location

Structure 8-467C is located at Station 11+393 on Highway 26, approximately 1.1 km east of the west limit of this Contract (Station 10+300). The east limit of this Contract is located 0.3 km east of the former St. Vincent/Sydenham Township Boundary (Station 10+000). Photographs of this culvert site are presented in Appendix “D”. The existing structure is a reinforced concrete, rigid frame open footing culvert with a span of 3.40 meters, a height of 1.80 meters and a length of 28.00 m, with an overfill height of approximately 3.0 m. The culvert opening dimensions were provided in the RFP documents.

The culvert site is located within a drainage valley in which the stream flows northerly. The approach embankments were built on both the east and west sides of the culvert, with a maximum height of approximately 4.8 m. The embankment slopes are typically 2.5H to 3H:1V and are grass covered. Signs of embankment erosion were observed at the time of this foundation investigation.

The headwalls that exist at both ends of the culvert are constructed of gabion baskets. Brown silt to silty clay deposit was noted at the streambed.

The groundwater condition was monitored during and upon completion of sampling. There was approximately 0.8 m of water running in the creek at the time of our field work between August 20 and 27, 2007 (Summer). This recorded water level is considered to be of a low flow condition.

2.2 Physiography and Topography

Physiography for the areas includes from west to east, part of a limestone plain, a till plain and a clay plain. Drumlins occur throughout the region, but were not observed in the project corridor. Underlying bedrock geology is dominated by Silurian sandstone, shale, dolostone and siltstone for one-third of the project area. The remainder of the project area has Ordovician shale, limestone, dolostone and siltstone.

Overall, physiographic regions include, from west to east, the Bruce Peninsula (i.e., part of the Niagara Escarpment with shallower soils, more irregular rock types, and more water bodies as compared to further south) and the northern tip of the Bighead Valley (i.e., an indentation in the Niagara Escarpment that only touches the east end of the project corridor).

For most of this region, soils are brunisols and podzols (i.e. brown forest soils and grey-brown podzols) that have formed on calcareous till. The pH is neutral to alkaline. Slopes tend to be moderate.

Only two of the Niagara Escarpment Plan zoning designations, Escarpment Natural and Escarpment Rural Area, are located within the project limits within a relatively short section adjacent to the highway ROW. This section of the ROW includes the area where the westbound truck climbing lane is proposed.

The project limit also encroaches onto the plains forest of the Bayview Escarpment Area of Natural and Scientific Interest (ANSI) which was expanded in 1998 to include sections of land adjacent to the north side of Highway 26 (i.e. approximately 1 km of ROW in total), located 1 km east of the Sydenham/St. Vincent Township Line, and falls within the area of the westbound truck Climbing Lane. Much of this area has been disturbed and it is possible that the ANSI boundary extends to the highway simply to act as a buffer to the more sensitive ANSI features that are located further north.

The asphalt pavement surface over the existing culvert is near elevation 331.7 m while the ground surface at the base of the embankment and in the flood plain is near elevation 328.8 m.

3.0 INVESTIGATION PROCEDURES

3.1 Field Investigation

Between August 20 and 27, 2007, a CME 55 drill rig was supplied by London Soil Test Ltd. and used on site for drilling and Standard Penetration Testing (SPT, following the procedures of ASTM D 1586). Three (3) boreholes were drilled and sampled to obtain data for foundation design of the proposed rehabilitation work and potential culvert extension. The locations of the boreholes are shown on Drawing 1.

The culvert borehole numbering system was established from the catchment area numbering system used in the Drainage Report of this project, as agreed with Stantec. The boreholes were numbered 8-467C-1 to 8-467C-3 for the subject culvert and the depths of sampling were as follows:

Borehole No.	Depth of Sampling (m)
8-467C-1	4.11
8-467C-2	7.62
8-467C-3	3.66

The boreholes were drilled using continuous flight solid stem augers. Soil samples were retrieved at selected intervals throughout the depths of the boreholes in conjunction with Standard Penetration Tests (SPT). Samples were generally taken at intervals of depth of 0.75 m to the maximum depth of exploration.

Field pocket penetrometer was used on the retrieved SPT samples, where applicable, to determine the undrained shear strength of the cohesive soil deposits. It is noted that the measured shear strength value would be slightly lower than the actual value due to sampling disturbance.

Seepage and water levels were noted in each borehole during and at the completion of drilling and sampling. All boreholes were grouted with a bentonite/cement mix at completion of sampling in accordance with Ontario Regulation 903.

Our field engineer, Mr. Ralph Billings, P. Eng., supervised the fieldwork and worked under the direction of the project engineer, Mr. Eric Chung, P. Eng. Our field staff cleared the location of buried utilities and logged the boreholes. The soil samples obtained were placed in labeled

containers and transported to IEG's London laboratory for further examination and laboratory testing.

The stations, offsets and ground surface elevations at the as drilled borehole locations were surveyed by AGM London and provided to IEG for the purpose of this report.

The results of the drilling, sampling, in-situ testing and groundwater observations are summarized on the Record of Borehole sheets and enclosed in Appendix "A".

3.2 Laboratory Analysis

Geotechnical laboratory testing consisted of natural moisture content determinations and visual classifications of all retrieved soil samples. In addition, grain size analyses and Atterberg Limit tests were performed on selected samples.

The results of the laboratory testing are presented on the Record of Borehole sheets (Appendix "A"), and Laboratory Test Results (Figures 1 to 5, Appendix "B").

4.0 SUBSURFACE CONDITIONS

4.1 General Subsurface Conditions

Reference is made to the Record of Borehole sheets (Appendix "A") and Laboratory Test Results (Appendix "B") for detailed subsurface soil and groundwater conditions encountered in the boreholes. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and, consequently, represent transitions between soil types rather than exact planes of geological change. The soil profiles depicting the subsurface conditions on Drawing 1 will vary between and beyond the borehole locations.

In general, the subsurface deposits at the site consist of loose to compact embankment fill placed on compact to very dense sand and gravel over compact to very dense sand and silt till.

4.1.1 Pavement, Fill, Topsoil

Borehole 8-467C-2, which was located at the north edge of existing pavement in the shoulder area, encountered 1050 mm shoulder gravel. Underlying the shoulder gravel is the embankment fill material that extended to a depth of 3.96 m (Elevation 327.66 m). The fill consists of mainly mixed gravel, sand silt and clay, and with a 1 m thick layer of sandy topsoil at the bottom of the layer. Occasional cobbles are present within the fill layer.

A single grain size distribution of the embankment fill is shown on Figure 1 of Appendix "B".

Standard penetration tests yielded “N”-values generally from 8 to 21 blows per 0.3 m. This fill is brown to grey in colour and the measured natural moisture contents range from 8 to 13%. Based on the above field and laboratory test results, together and tactile examination, the fill materials exhibited loose to compact compactness condition. A single high “N”-value of over 100 blows per 0.3 m was encountered at a depth of 2.3 m, indicative of the presence of gravel or cobbles.

One (1) sample was tested and exhibited the following Atterberg Limit. These results are shown in Figure 2 of Appendix “B” and summarized below:

Liquid Limit (W_L)	21%
Plastic Limit (W_P)	14%
Plasticity Index (I_p)	7%

Unit weight of the fill was not determined due to the disturbance of the soil samples during sampling and sample retrieval.

At Boreholes 8-467C-1 and 8-467C-3, topsoil was contacted to depths of 0.15 m.

4.1.2 Sand to Sand and Gravel

The topsoil at Borehole 8-467C-3 and the embankment fill at Borehole 8-467C-2 are underlain by a silty sand to sand and gravel deposit which extends to a depth of 5.94 m (Elevation 325.68 m) at Borehole 8-467C-2, and 2.13 m (Elevation 326.70 m) at Borehole 8-467C-3. Three (3) grain size analyses were performed and the results are plotted on Figure 3 of Appendix “B”.

Standard penetration testing yielded “N”-values of 10 to 63 blows per 0.3 m. It is noted that the upper 1.5 m stratum of the deposit consists of silty sand in Borehole 8-467C-3, with “N”-value of 10, and therefore was compact. Generally, the sand to sand and gravel is in dense to very dense compactness condition. The natural moisture content was measured between 6 and 12%.

4.1.3 Sand and Silt Till

A stratum of brown sand and silt till is present below the topsoil or sand to sand and gravel layers, and extends beyond the maximum depth of exploration at 4.11 m, 7.62 m and 3.66 m below the existing ground surface of Boreholes 8-467C-1, 2 and 3, respectively. Clayey silt layers are present within the sand and silt till in Borehole 8-467C-2 at depths of between 5.94 m and 6.40 m below the present ground surface. Silty clay layers are also present in Borehole 8-467C-1 at depths of between 3.05 m and 4.11 m below the existing ground surface.

Three (3) grain size analyses were performed on the sand and silt till deposit and the results are presented on Figure 4 of Appendix “B”. The deposit contained predominantly sand and silt particles, with trace to some clay and some gravel to gravelly.

Two (2) samples of the clayey silt and silty clay layers were tested and exhibited the following Atterberg Limits. These results are shown in Figure 5 of Appendix "B" and summarized below:

Liquid Limit (W_L)	17 and 22%, average at 19.5%
Plastic Limit (W_P)	12 and 15%, average at 13.5%
Plasticity Index (I_p)	5 and 7 %, average 6.0%

The natural moisture contents were in the range of 6 to 14%. These results are characteristic of silt soils (CL-ML) with clayey low plasticity (CL) layers.

Standard penetration tests yielded "N"-values from 13 to over 100 blows per 0.3 m. It is noted that the upper 2.1 m stratum at Borehole 8-467C-1 had the "N"-values of 13 and 20, and therefore was compact. Generally, the sand and till deposit was in dense to very dense compactness condition.

4.2 Groundwater Conditions

The groundwater condition was monitored during and upon completion of sampling. There was approximately 0.8 m of water running in the creek at the time of our field work between August 20 and 27, 2007 (Summer). This recorded water level is considered to be of a low flow condition.

On completion of drilling, free groundwater was observed in the boreholes and summarized below:

Borehole	Water Level in Borehole, m (Elevation, m)	Remarks
8-467C-1	2.1 (327.41)	Measured at completion
8-467C-2	5.3 m (326.32)	Dry cave-in to 4.6 m, Elevation 327.02 m. Spoon wet at 5.3 m, Elevation 326.32 m (assumed water level based on moisture content).
8-467C-3	1.5 (327.33)	Measured at completion

The water level in Borehole 8-467C-3 was observed in a sand and gravel deposit and would infer the groundwater level, as well as the water level in the creek at the time of field work.

It should be noted that the groundwater level will fluctuate seasonally and in response to weather events. Under adverse conditions, water could be perched within the embankment fill. It is reasonable to assume that groundwater could be similar to the water level in the creek during high flow conditions.

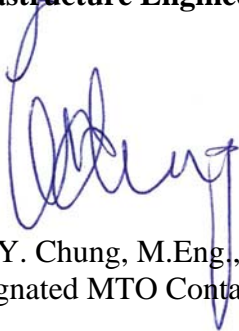
5.0 STATEMENT OF LIMITATION

We recommend that once the details of the proposed structure are finalized, our recommendations should be reviewed for their specific applicability.

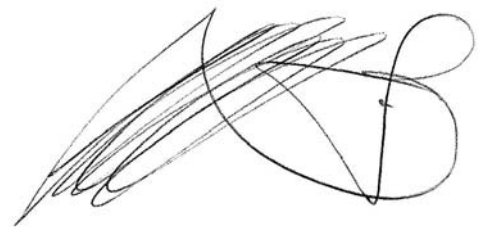
The Limitations of Report, as Quoted in Appendix "C", is an integral part of this report.

We trust that we have completed the assignment within the Terms of Reference for this project. If there are any questions concerning this report, please do not hesitate to contact our office.

Yours truly,
Infrastructure Engineering Group Inc.



Eric Y. Chung, M.Eng., P.Eng.
Designated MTO Contact



Joseph Law, P.Eng.
Project Manager



Tom O'Dwyer, P. Eng.
Quality Review Engineer



Ministry of Transportation/Stantec Consulting Ltd.
G.W.P. 167-91-00 - Rehabilitation of Highway 26
From Former St. Vincent/Sydenham Townline to Meaford
Agreement # 3006-E-0002

07-6-IEG1-8-467C
Final Report
Drawing 1
May 17, 2010

Drawing 1
Borehole Locations
And
Soil Strata

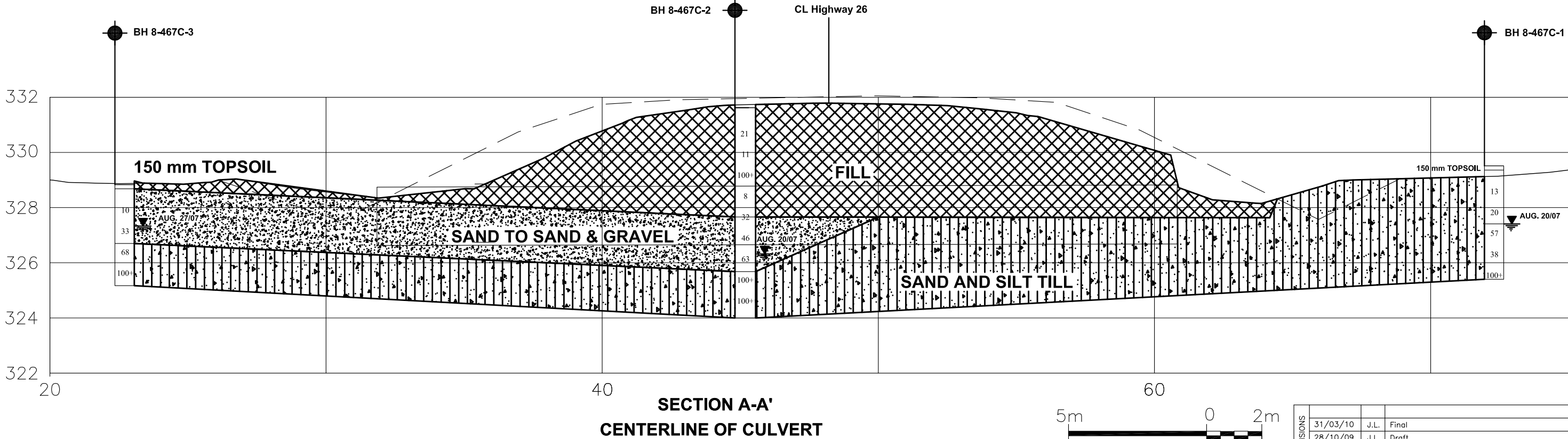
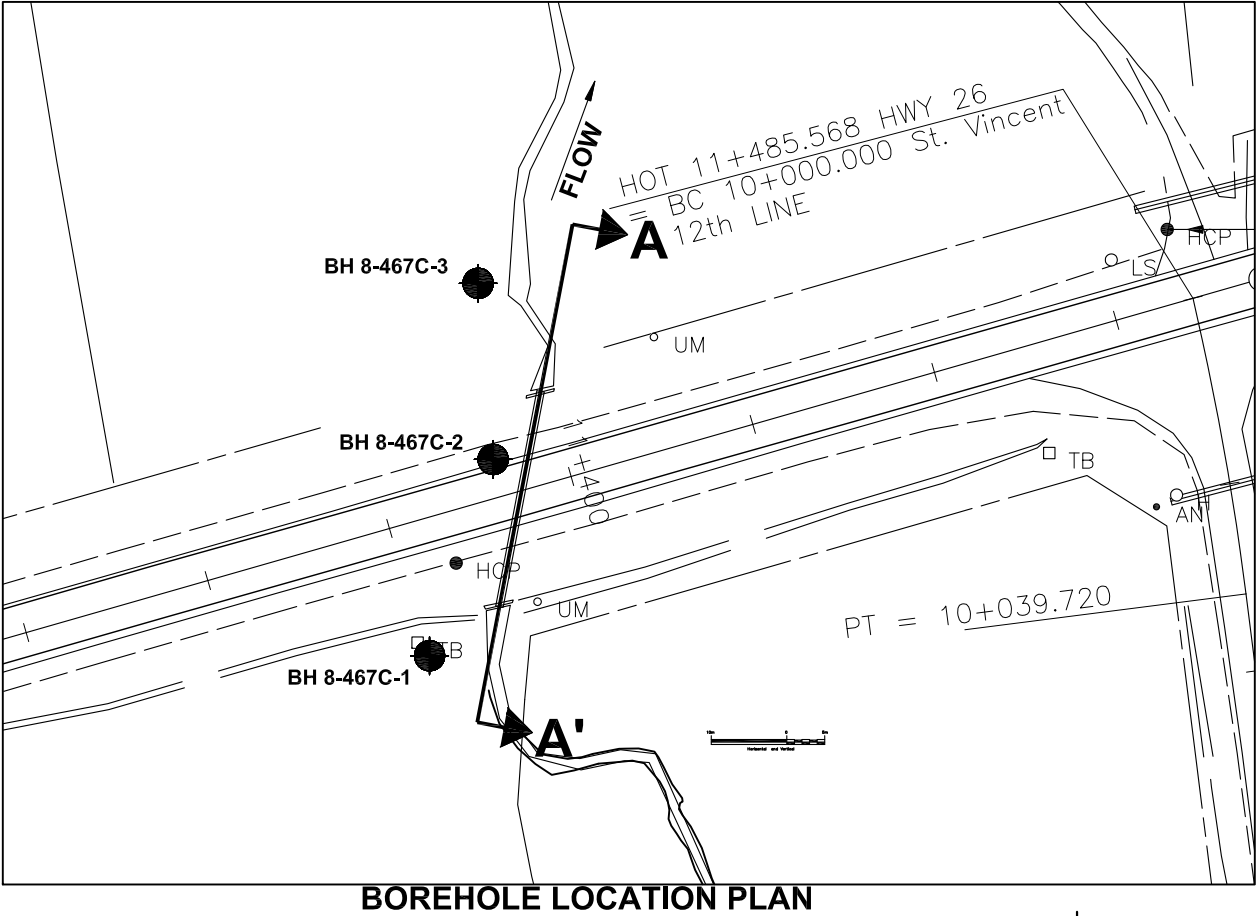
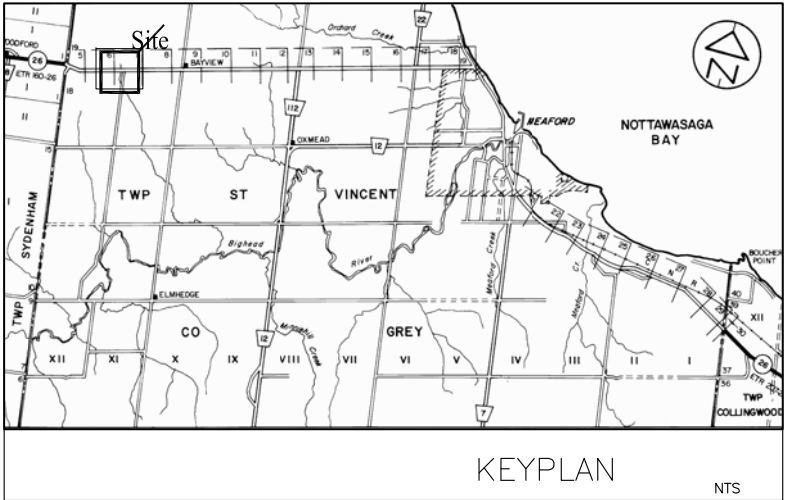
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No xxxx-xxxx
WP No GWP 167-91-00

Culvert # 8-467C
Highway 26
BORE HOLE LOCATIONS & SOIL STRATA

I.E. Infrastructure Engineering Group Inc.
Pavement & Construction Materials Consulting Engineers
GTA • Kitchener • London • Windsor


SHEET
1



NOTES
1. THE COMPLETE FOUNDATION INVESTIGATION AND DESIGN REPORT FOR THIS PROJECT AND OTHER RELATED DOCUMENTS MAY BE EXAMINED AT THE ENGINEERING MATERIALS OFFICE, DOWNSVIEW.
INFORMATION CONTAINED IN THIS REPORT AND RELATED DOCUMENTS ARE SPECIFICALLY EXCLUDED IN ACCORDANCE WITH THE CONDITIONS OF SECTION GC2.01 of OPS GEN. COND.
2. THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES AND BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.
3. SUBGRADE ELEVATION OF THE EXISTING FOOTING NOT KNOWN AND IS ESTIMATED TO BE AT 1.4m BELOW THE CREEK BED.
4. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

BOREHOLE NO.	ELEVATION	UTM CO-ORDINATES NORTH	EAST
8-467C-1	329.51	4940391	208872
8-467C-2	331.62	4940417	208880
8-467C-3	328.83	4940440	208878

REVISIONS	DATE	BY	DISCRIPTION
1	31/03/10	J.L.	Final
2	28/10/09	J.L.	Draft

HWY No.	HWY 26	DIST	Owen Sound
SUBM'D	J.L.	CHECKED E.C.	DATE 25/01/08
DRAWN	J.L.	CHECKED J.L.	APPROVED E.C.

Geocres : 41A-210

Ministry of Transportation/Stantec Consulting Ltd.
G.W.P. 167-91-00 - Rehabilitation of Highway 26
From Former St. Vincent/Sydenham Townline to Meaford
Agreement # 3006-E-0002

07-6-IEG1-8-467C
Final Report
Appendix A
May 17, 2010

Appendix A

Explanation of Terms Used in Report

Record of Borehole Sheet

Boreholes 8-467C-1 TO 3

EXPLANATION OF TERMS USED IN REPORT

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

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 1" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T.W. ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T.W. ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 8-467C-1

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4940391, Easting - 208872 ORIGINATED BY RB
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN
 DATUM Geodetic DATE 20.8.07 - 20.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
						20	40	60	80	100	10	20	30		
329.51	Ground														
0.00	150 mm TOPSOIL.														
			1	SPT	13		329							0 42 44 14 (58)	
			2	SPT	20		328								
			3	SPT	57		327							Water level measured @ 2.1 m @ completion.	
326.46			4	SPT	38		326							13 25 38 24 (61)	
3.05															
			5	SPT	100+										
325.40															
4.11	End of borehole.													Sampler and auger refusal @ 4.11 m.	

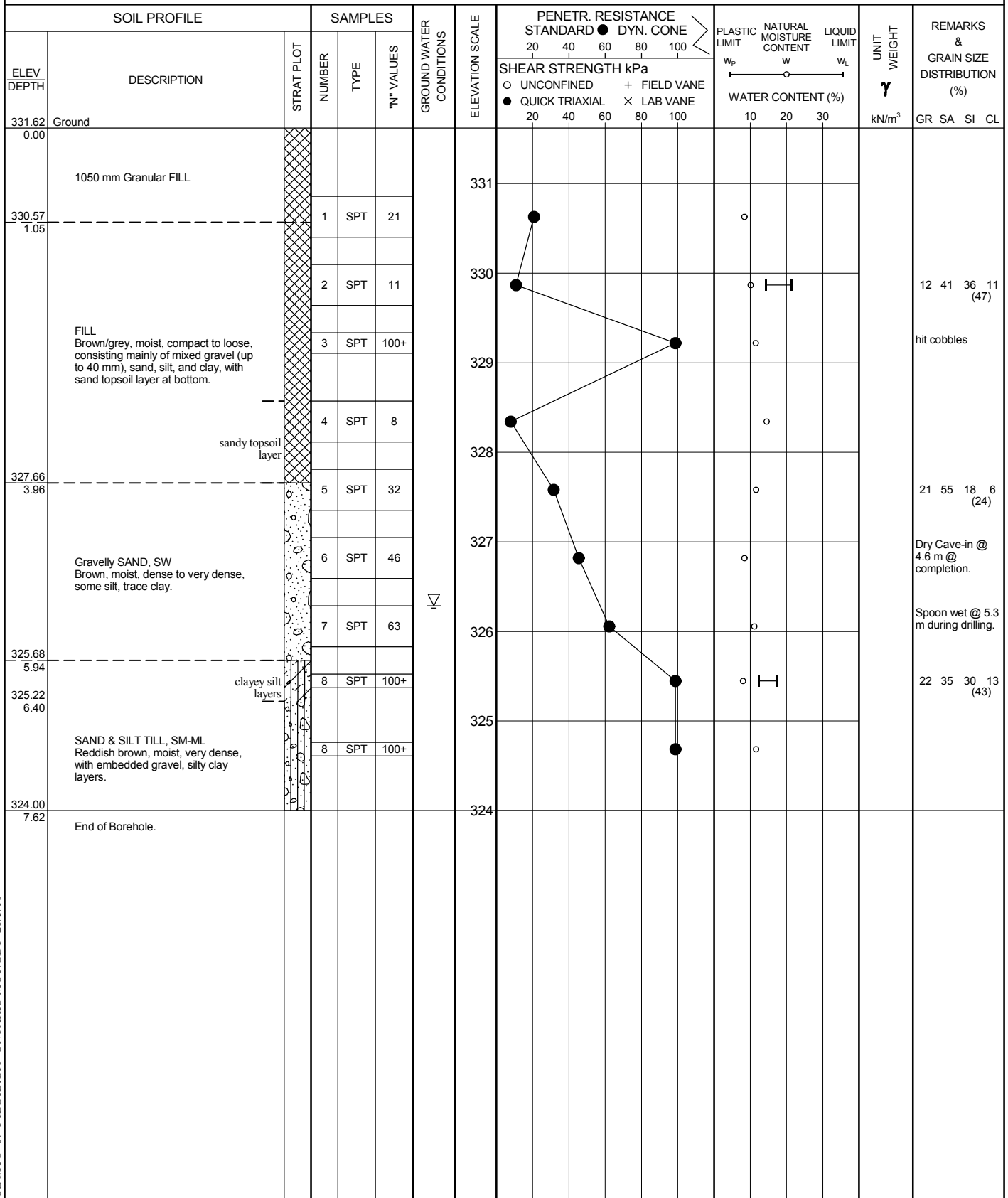
JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 20/3/10

RECORD OF BOREHOLE No 8-467C-2

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4940417, Easting - 208880 ORIGINATED BY RB
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN
 DATUM Geodetic DATE 20.8.07 - 20.8.07 CHECKED BY JL



JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 20/3/10

+ 3, X 3: Numbers refer to
Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No 8-467C-3

1 OF 1

METRIC

W.P. GWP 167-91-00 LOCATION Northing - 4940440, Easting - 208878 ORIGINATED BY RB
 DIST Owen Sound HWY 26 BOREHOLE TYPE S/S Augering, 110 mm dia. COMPILED BY NN
 DATUM Geodetic DATE 27.8.07 - 27.8.07 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE STANDARD ● DYN. CONE		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× LAB VANE							
328.83 0.00	Ground 150 mm TOPSOIL.															
	Silty SAND to SAND & GRAVEL, SW-GW to SM Brown to reddish brown, moist to wet, compact to dense, some silt and trace clay.		1	SPT	10		328								19 54 18 9 (27)	
			2	SPT	33		327								48 36 11 5 (16)	
326.70 2.13			3	SPT	68										Water level measured @ 1.5 m @ completion. 10 45 39 6 (46)	
	SAND & SILT TILL, SM-ML Reddish brown, moist, very dense, with embedded gravel.		4	SPT	100+		326									
325.17 3.66	End of borehole.													Auger refusal @ 3.66 m. Possible boulder or bedrock.		

JOE MTO 07-6-IEGIB.GPJ ONTARIO MOT.GDT 20/3/10

+ 3, X 3: Numbers refer to
Sensitivity

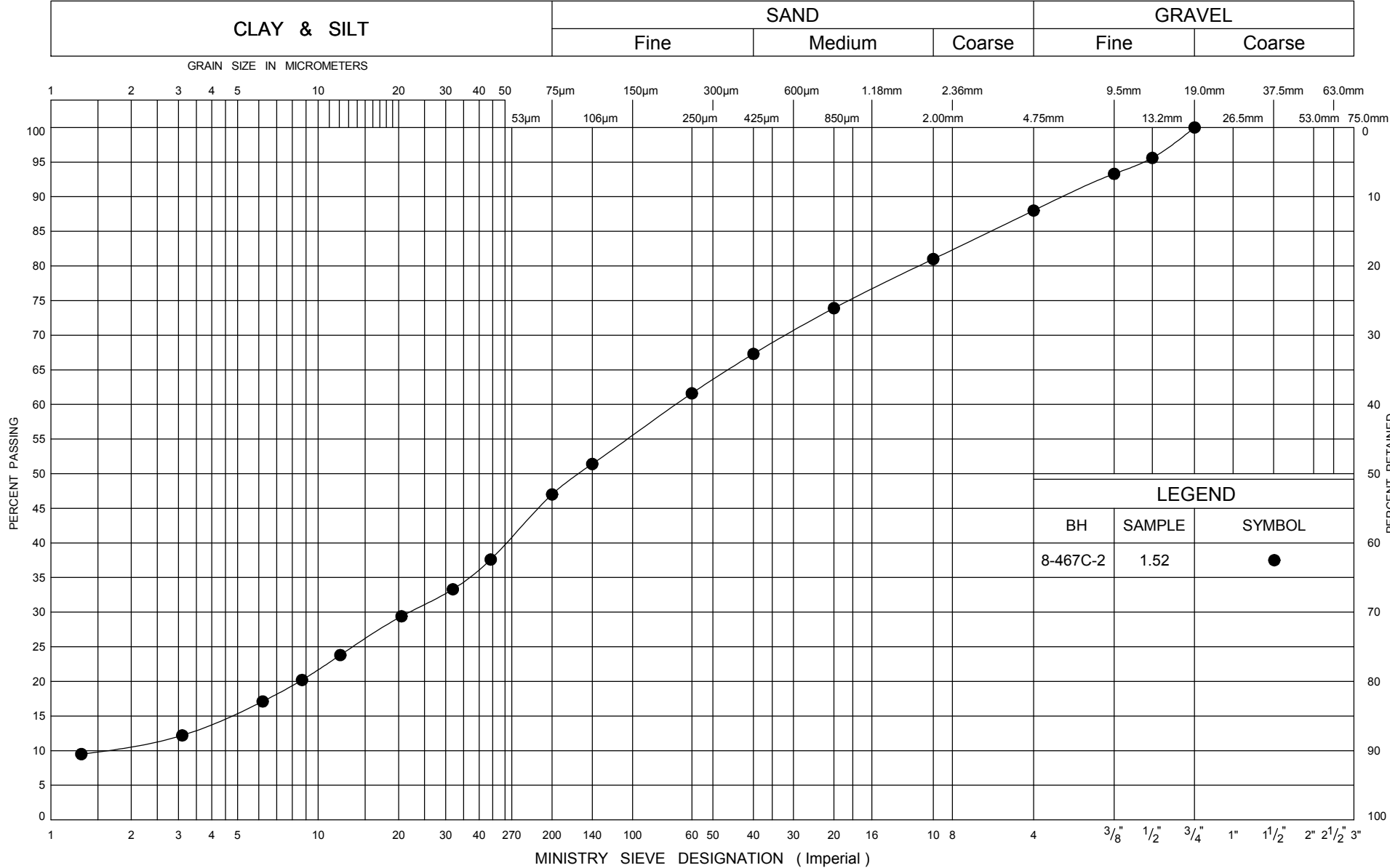
○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

Appendix B

Laboratory Test Results

Grain Size Distribution	Figures 1, 3 and 4
Plasticity Chart	Figures 2 and 5

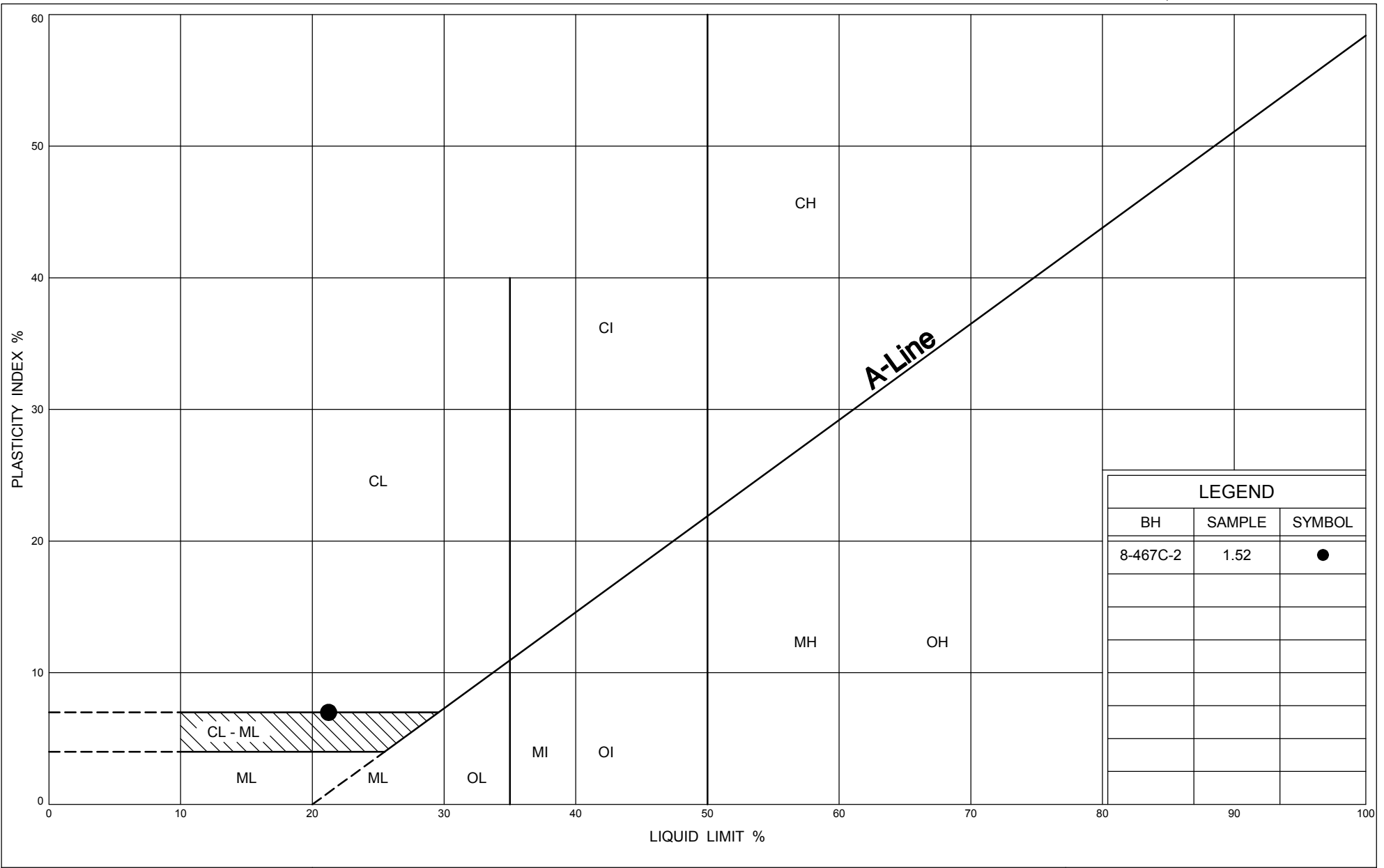
UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
FILL

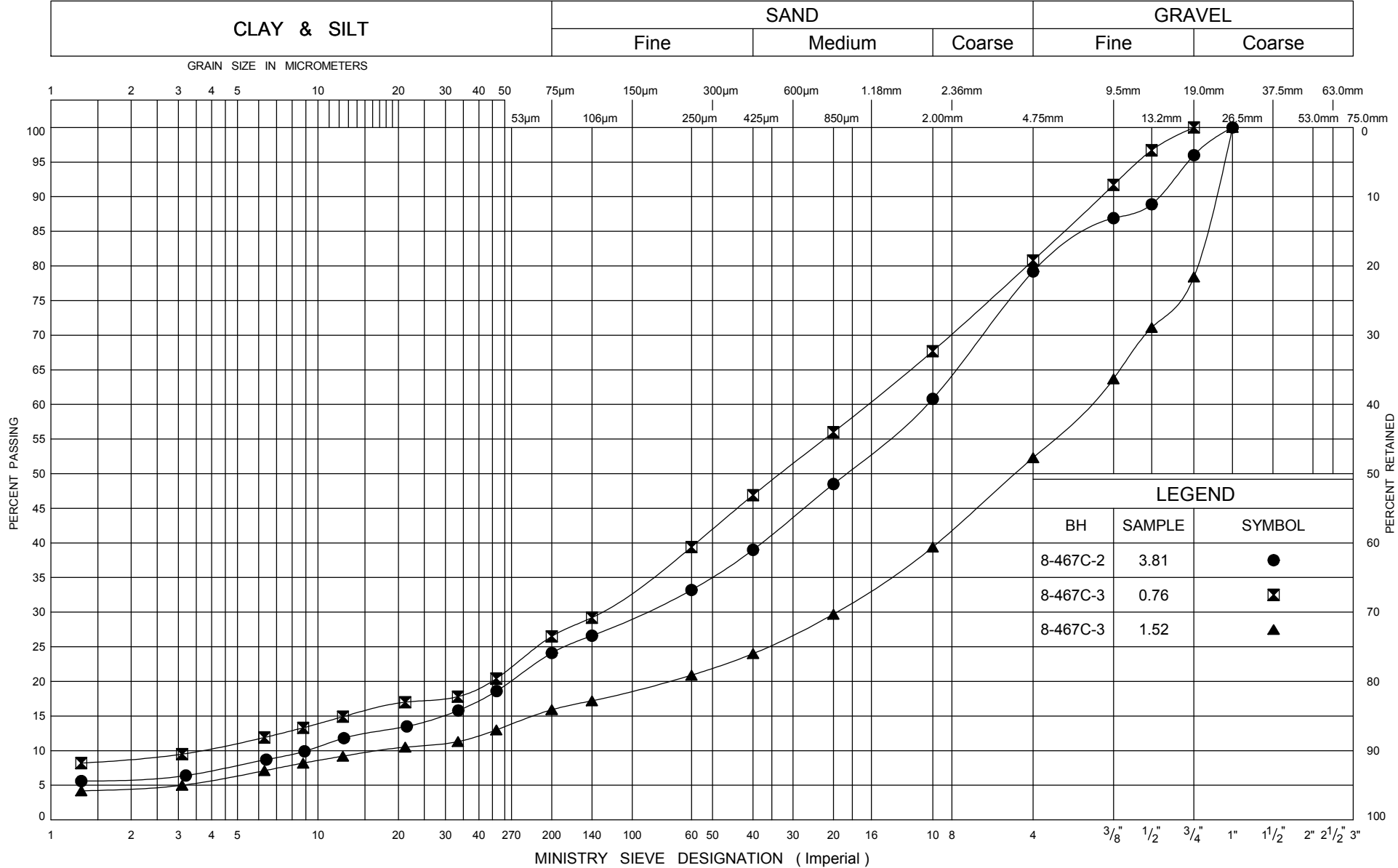
FIG No 1
GWP 167-91-00
Hwy 26 - Sydenham Townline to Meaford



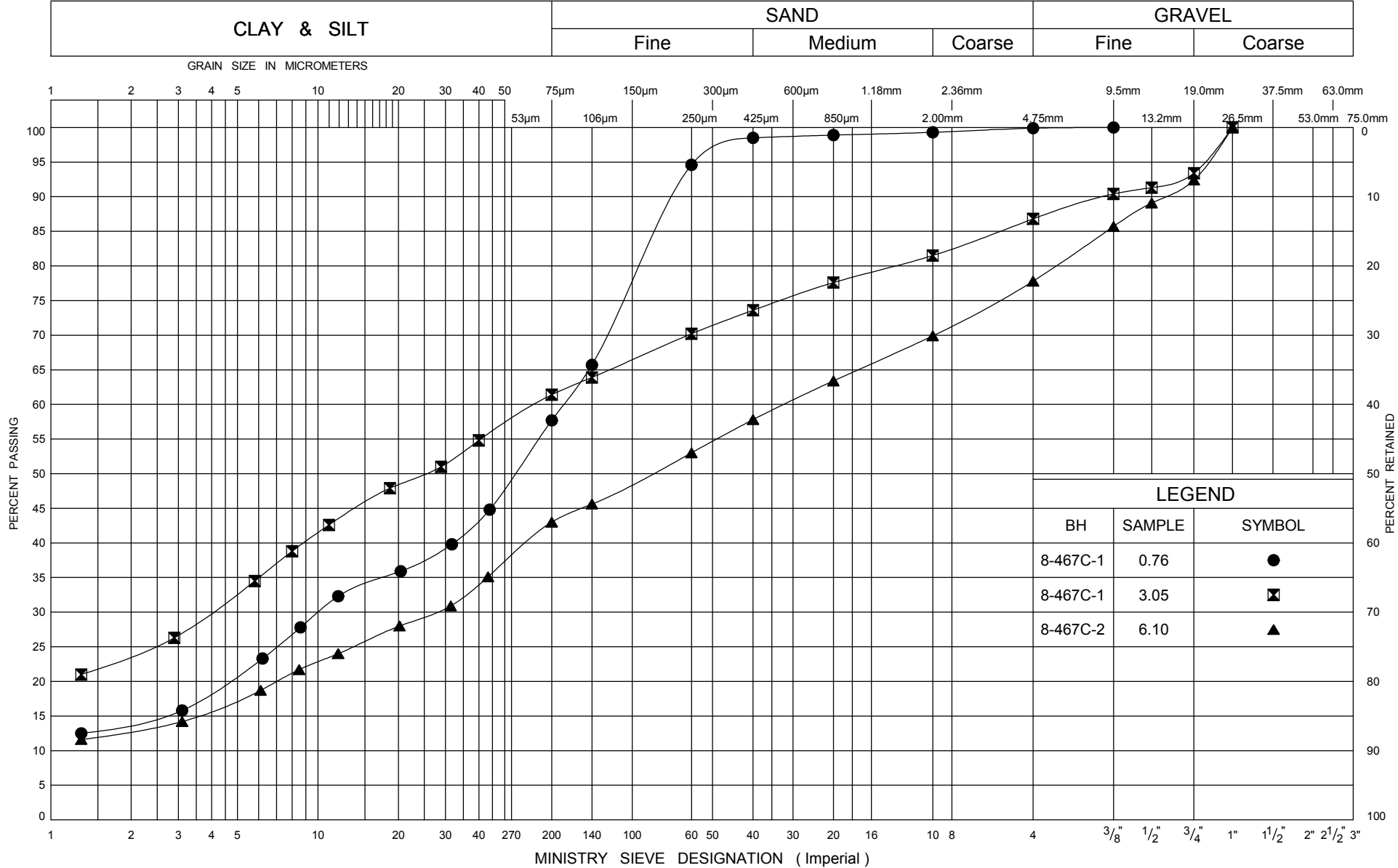


LEGEND		
BH	SAMPLE	SYMBOL
8-467C-2	1.52	●

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE LARGE CULVERTS 07-6-IEG1B.GPJ ONTARIO.MOT.GDT 27/10/09



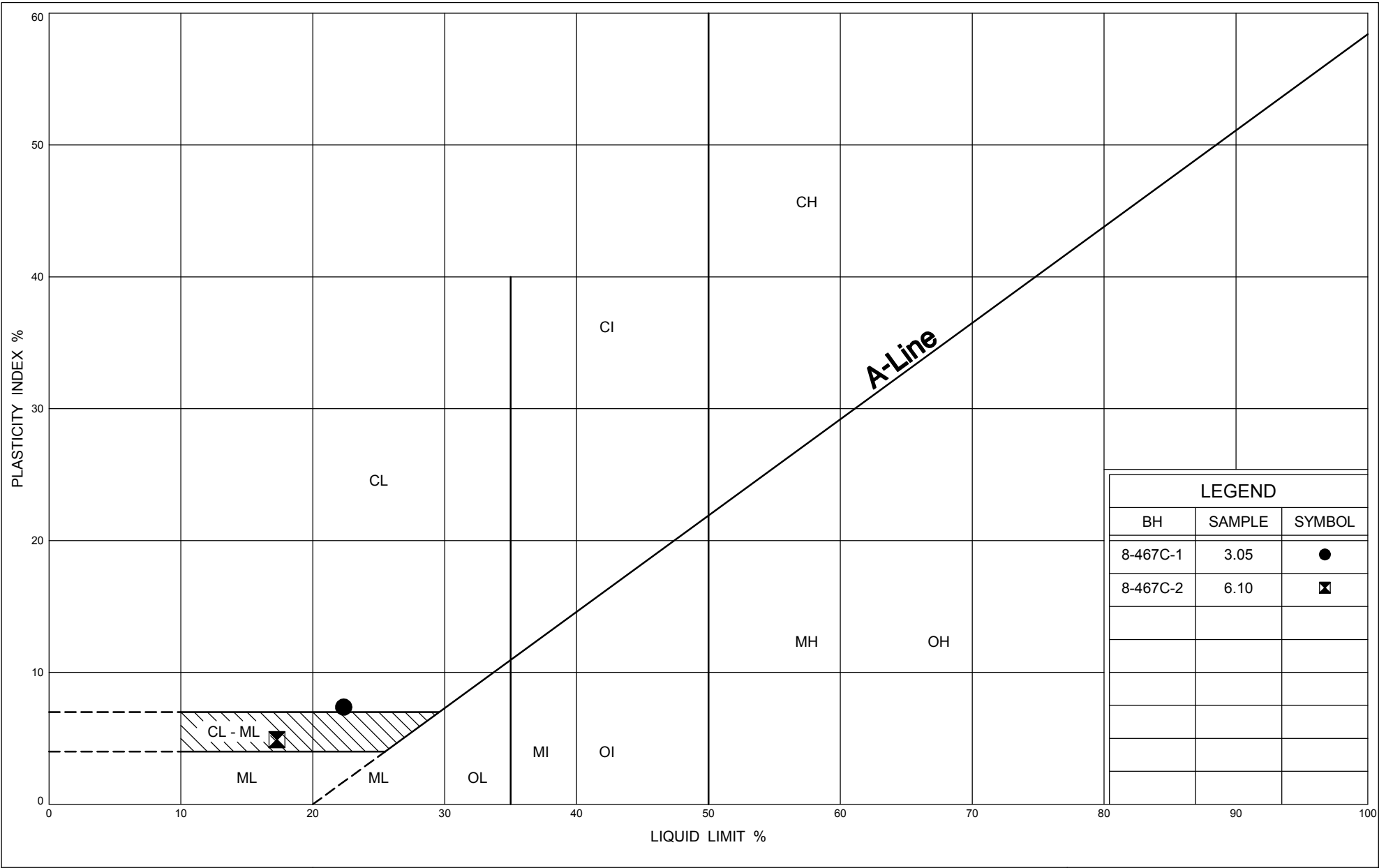
GRAIN SIZE DISTRIBUTION

SAND & SILT TILL WITH SILT AND CLAY LAYERS, SM-ML

FIG No 4

GWP 167-91-00

Hwy 26 - Sydenham Townline to Meaford



Ministry of Transportation/Stantec Consulting Ltd.
G.W.P. 167-91-00 - Rehabilitation of Highway 26
From Former St. Vincent/Sydenham Townline to Meaford
Agreement # 3006-E-0002

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Appendix C

Limitations of Report

APPENDIX C

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusion as to how the subsurface conditions may affect their work.

The benchmark and elevations mentioned in this report were obtained strictly for use in the geotechnical design of the project and by this office only, and should not be used by any other parties for any other purposes.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Infrastructure Engineering Group Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report does not reflect the environmental issues or concerns unless otherwise stated in the report.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, IEG recommends that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

Ministry of Transportation/Stantec Consulting Ltd.
G.W.P. 167-91-00 - Rehabilitation of Highway 26
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Appendix D

Site Photographs



8-467C General View



8-467C Outlet



8-467C Inlet



8-467C Inlet



8-467C Outlet



8-467C Inlet