



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
REPLACEMENT OF STRUCTURAL CULVERT No 30-676/C
HIGHWAY 12, 75 m EAST OF CONCESSION ROAD 10
ORILLIA, ONTARIO
G.W.P. 2183-13-00**

GEOCRES Number: 31D-594

**SUBMITTED TO
McINTOSH PERRY CONSULTING ENGINEERS LTD.**

**August 7, 2015
19-3405-5**

Table of Contents

PART 1 FACTUAL INFORMATION

1	INTRODUCTION.....	1
2	SITE DESCRIPTION.....	1
3	BACKGROUND – PREVIOUS INVESTIGATION	2
4	SITE INVESTIGATION AND FIELD TESTING	2
5	LABORATORY TESTING	3
6	DESCRIPTION OF SUBSURFACE CONDITIONS	3
6.1	Overview / General	3
6.2	Fill: Silty Sand with Gravel	3
6.3	Fill: Silty Clay with Sand	4
6.4	Clay (CH) with Sand / Silty Clay (CI) trace Sand	4
6.5	Silty Sand (SM) to Silt (ML) with Sand	5
6.6	Silty Sand (SM) with Gravel	5
6.7	Bedrock	6
6.8	Groundwater Conditions	6
7	MISCELLANEOUS.....	7

Appendices

Appendix A	Borehole Locations and Soil Strata Drawings
Appendix B	Record of Borehole Sheets
Appendix C	Laboratory Test Results
Appendix D	Selected Photographs of Culvert Location
Appendix E	2009 Foundation Investigation Report

**FOUNDATION INVESTIGATION REPORT
REPLACEMENT OF STRUCTURAL CULVERT No 30-676/C
HIGHWAY 12, 75 m EAST OF CONCESSION ROAD 10
ORILLIA, ONTARIO
G.W.P. 2183-13-00
GEOCRES Number: 31D-594**

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) at Structural Culvert 30-676/C located on Highway 12 approximately 12 km east of Orillia, Ontario. Thurber carried out the investigation as a sub-consultant to McIntosh Perry Consulting Engineers (McIntosh Perry) under Agreement No. 2013-E-0053.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on this data, to provide a borehole location plan, record of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions.

2 SITE DESCRIPTION

The culvert is located on Highway 12, approximately 75 m east of Concession Road 10, near Orillia, Ontario. It is noted that for project orientation purposes Highway 12 within the project limits, will be assumed to run east-west. The location of Culvert 30-676/C is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

Within the project limits Highway 12 is a two-lane, undivided highway with a rural cross-section, 3.75 m wide lanes and 3m wide granular shoulders. The maximum height of the road embankment is approximately 3 m in the area of the culvert and the existing side slopes are graded at approximately 3H:1V.

The existing culvert has been identified as having been constructed in 1953 and consists of an open footing (rigid frame) cast-in-place culvert with a length of approximately 21 m, interior width of 3.66 m, approximate opening height of 1.5 m and cover of 890 mm. The top of the stream bed is at approximately elevation 222.3 m. Flow through the culvert is from north to south.

The lands surrounding the roadway are typically agricultural with some residential and agricultural buildings. Storm water drainage in the area is to ditches and culverts. Typical site photographs are presented in Appendix D.

The site is located within a Physiographic Region known as the Simcoe Lowlands (Chapman and Putnam, 1984). This region was flooded by the glacial Lake Algonquin and is bordered by shorecliffs, beaches and boulder terraces and as such is characterized by a mixture of sand, silt and clay deposits.

3 BACKGROUND – PREVIOUS INVESTIGATION

A Foundation Investigation was carried out for a possible rehabilitation of Culvert 30-676/C by Infrastructure Engineering Group Inc. (IEG). The results of that investigation are presented in a Foundation Investigation Report (GEOCRE Report No. 31D-488, dated November 2009). A copy of this report is provided in Appendix E for reference.

The investigation consisted of two sampled boreholes and two dynamic cone penetration tests (DCPT). The boreholes were advanced through the existing roadway shoulders, and DCPT test holes (not sampled) advanced near the inlet and outlet of the culvert.

For reference, the IEG report indicates that the stratigraphy in the area of the culvert structure is generally characterized by granular fill related to the highway pavement structure, over a silty clay fill over very soft silty clay and/or very loose to loose sand and silt over a compact to very dense silty sand (till-like), underlain by very strong limestone bedrock. One of the boreholes advanced by IEG was extended into the underlying bedrock by coring. The bedrock surface in this borehole was identified at elevation 217.47 m.

The results of the IEG investigation were reviewed and considered when planning the current investigation.

4 SITE INVESTIGATION AND FIELD TESTING

Prior to carrying out the drilling investigation, a site visit was conducted by Thurber personnel and the locations of the proposed boreholes were laid out on site.

As a component of our standard procedures and due diligence, Thurber contacted Ontario One Call to clear the borehole locations of underground utilities.

The field investigation for this site was carried out on October 6th and 7th, 2014, and included drilling three boreholes. The approximate locations of the boreholes are shown on the Borehole Location and Soil Strata drawing in Appendix A and summarized in Table 4-1.

Table 4-1: Borehole Summary

Borehole	Location	Ground Surface Elevation (m)	Depth (m)
14-1	Near south (outlet) end of culvert	223.8	6.0
14-2	Edge of pavement eastbound lane	224.9	7.5
14-3	Near north (inlet) end of culvert	223.5	6.0

The inlet and outlet boreholes were advanced using portable drilling equipment. A CME75 truck mounted drill equipped with hollow stem augers was used for the edge of pavement borehole. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Split spoon samples were collected at regular depth intervals in the boreholes while conducting Standard Penetration Tests (SPTs), following the methods described in ASTM Standard D1586-11. All soil samples recovered from the boreholes were placed in moisture-proof

bags, the bags were labelled, and the samples returned to Thurber's Ottawa geotechnical laboratory for further examination and testing.

Groundwater levels were measured on completion of drilling in the open boreholes prior to backfilling.

The as-drilled locations of the boreholes and ground surface elevations at the borehole locations were surveyed by Thurber on October 7, 2014. The geodetic ground surface elevation at the top of pavement at the culvert location was used as a benchmark.

5 LABORATORY TESTING

Geotechnical laboratory testing was carried out in the Thurber geotechnical laboratory in Ottawa, Ontario, and consisted of natural moisture content determination and visual identification of all soil samples in accordance with the current MTO standards. Grain size distribution analysis and Atterberg limit testing were also carried out on selected samples to MTO and ASTM standards.

The laboratory test results are presented on the Record of Borehole sheets in Appendix B and the Figures in Appendix C.

6 DESCRIPTION OF SUBSURFACE CONDITIONS

6.1 Overview / General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile for the culvert site is presented on the Borehole Locations and Soil Strata Drawing in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions.

For reference, the stratigraphy in the area of the culvert structure is generally characterized by fill material (pavement structure, culvert backfill, embankment fill), over firm to stiff clay/silty clay, over very loose to compact silty sand to silt with sand, over compact to very dense silty sand with gravel. All boreholes were terminated on inferred bedrock.

6.2 Fill: Silty Sand with Gravel

A fill layer consisting predominantly of silty sand with gravel was encountered beneath the 50 mm thick asphalt surface in Borehole 14-2. The top of this layer was at elevation 224.8 m and the layer had a thickness of 1.4 m. The standard penetration test (SPT) 'N' values for this layer range from 2 to 21 blows per 0.3 m of penetration; indicating a very loose to compact state.

The moisture content of a sample tested was 5%. The results of grain size analysis conducted on one sample of the granular fill material are presented on Fig. No. 1 in Appendix C. The results are summarized in Table 6-1.

Table 6-1: Gradation Results for Silty Sand with Gravel Fill

Soil Particles	%
Gravel	20
Sand	55
Silt and Clay	25

6.3 Fill: Silty Clay with Sand

A fill layer consisting predominantly of silty clay with sand with some wood fragments was encountered beneath the granular fill layer in Borehole 14-2. The top of the fill layer was at elevation 223.5 m and the layer had a thickness of 1.6 m. The SPT 'N' value for this layer was 3 blows per 0.3 m of penetration, indicating a soft consistency.

The moisture content of a sample tested was 31%. The results of grain size analysis conducted on a sample of this fill material are presented on Fig. No. 2 in Appendix C. The results are summarized in Table 6-2.

Table 6-2: Gradation Results for Silty Clay with Sand Fill

Soil Particles	%
Gravel	2
Sand	20
Silt and Clay	78

Atterberg Limit testing was completed on one sample. The test results are illustrated on Figure No. 6 in Appendix C and are summarized in Table 6-3. The results indicate that the material exhibits intermediate plasticity.

Table 6-3: Atterberg Limits Test Results

Borehole	Sample	LL	PL	PI	Classification
14-2	SS-3	38	17	21	CI

6.4 Clay (CH) with Sand / Silty Clay (CI) trace Sand

A deposit of clay to silty clay with varying amounts of sand was encountered beneath the surficial vegetation in Boreholes 14-1 and 14-3, located near the outlet and inlet, respectively.

The top of this stratum ranged in elevation from 223.5 to 223.8 m and the thickness of the layer was 1.8 m in both boreholes. The SPT 'N' values for this stratum ranged from 3 to 9 blows per 0.3 m of penetration indicating a soft to stiff consistency.

The moisture content of the samples tested ranged from 18% to 45%. The results of grain size analysis conducted on two samples of the clay/silty clay material are presented on Fig. No. 3 in Appendix C. The results are summarized in Table 6-4.

Table 6-4: Gradation Results for Clay

Soil Particles	%
Gravel	0
Sand	6 to 23
Silt	54 to 55
Clay	23 to 39

Atterberg Limit testing was completed on two samples. The test results are illustrated on Figure No. 6 in Appendix C and are summarized in Table 6-5. The results indicate that the material ranged from high to intermediate plasticity.

Table 6-5: Atterberg Limits Test Results

Borehole	Sample	LL	PL	PI	Classification
14-1	SS-1	52	27	25	CH
14-1	SS-3	37	15	22	CI

6.5 Silty Sand (SM) to Silt (ML) with Sand

A layer of silty sand (SM) to silt (ML) with sand was encountered in all boreholes. The top of this stratum ranged from elevation 221.7 to 222.0 m and the material had a thickness ranging from 2.0 to 4.2 m. The SPT 'N' values for this stratum range from 1 to 20 blows per 0.3 m of penetration indicating a very loose to compact condition.

The moisture content of the samples tested ranged from 11% to 23%. The results of grain size analysis conducted on three samples of this deposit are presented on Fig. No. 4 in Appendix C. The results are summarized in Table 6-6.

Table 6-6: Gradation Results for Silty Sand to Silt

Soil Particles	%
Gravel	0 to 10
Sand	23 to 51
Silt	36 to 73
Clay	4 to 9

The results of the Atterberg Limits testing indicate that fines content of this stratum is comprised of a non-plastic silt.

6.6 Silty Sand (SM) with Gravel

The silty sand to silt with sand material in Boreholes 14-1 and 14-2 was underlain by a deposit of silty sand with gravel. The top of this stratum was encountered at elevations ranging from 219.6 m to 220.0 m and the thickness was 2.2 m. The SPT 'N' values for this stratum ranged from 5 to 88 blows per 0.3 m of penetration indicating a loose to very dense condition but typically a loose to compact condition

The moisture content of the samples tested ranged from 8% to 12%. The results of grain size analysis conducted on two samples of the material are presented on Fig. No. 5 in Appendix C. The results are summarized in Table 6-7.

Table 6-7: Gradation Results for Silty Sand

Soil Particles	%
Gravel	16 to 30
Sand	36 to 42
Silt	26 to 32
Clay	8 to 10

Atterberg Limit testing was completed on one sample. The test results are illustrated on Figure No. 6 in Appendix C and are summarized in Table 6-8. The results indicate that the material has low plasticity (CL-ML).

Table 6-8: Atterberg Limits Test Results

Borehole	Sample	LL	PL	PI	Classification
14-2	SS-10	18	11	7	CL-ML

6.7 Bedrock

All three boreholes were terminated on inferred bedrock based on SPT refusal at elevations ranging from 217.4 m to 217.8 m. Bedrock coring was outside the scope of work for this investigation. Bedrock was proven by coring in Borehole C28-3 during the previous investigation at this site and was identified at elevation 217.47 m.

6.8 Groundwater Conditions

Groundwater levels were measured on completion of drilling in the open boreholes prior to backfilling. Free water was observed at depths below existing grade of 1.4 m to 2.4 m; corresponding to elevations ranging from 222.1 m to 222.5 m.

The values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level will be influenced by the water level in the stream and ditches and may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

McIntosh Perry reported a water level in the creek of approximately 222.1 m on November 5, 2014.

7 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber surveyed the borehole locations, and provided the northing and easting coordinates and ground surface elevations. Ohlmann Geotechnical Services (OGS) Inc. of Almonte, Ontario supplied and operated both the portable and track-mounted CME 75 drill rigs to carry out the drilling, sampling, and in-situ testing. The drilling, and sampling operations in the field were supervised on a full time basis by Ms. Katrina Young of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa.

Overall project management and direction of the field program was provided by Dr. Fred Griffiths, P.Eng. Interpretation of the field data and preparation of this report was completed by Kenton Power, P.Eng. and Paul Carnaffan, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.



Paul Carnaffan, M.Eng., P.Eng.
Associate, Senior Geotechnical Engineer

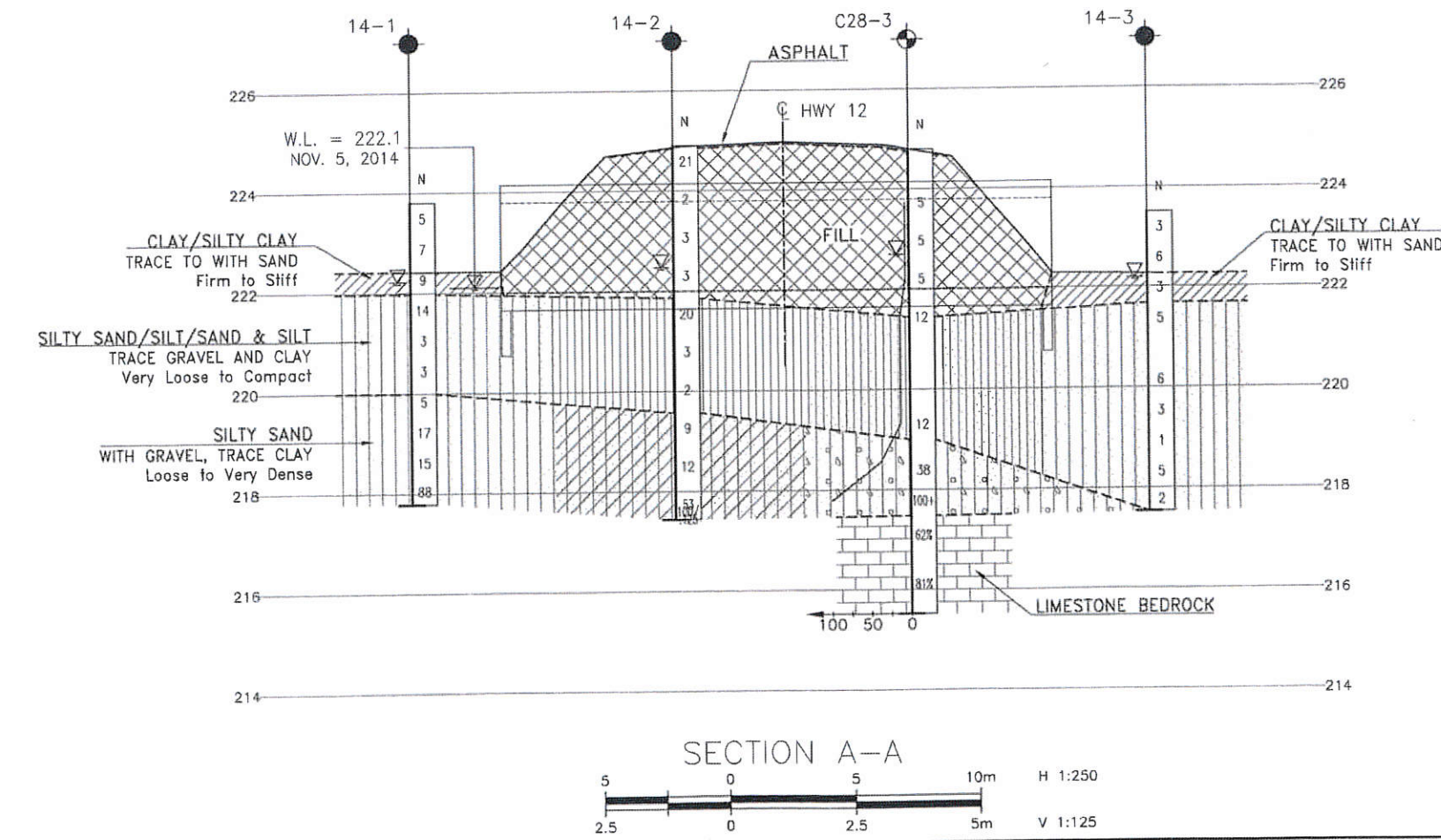
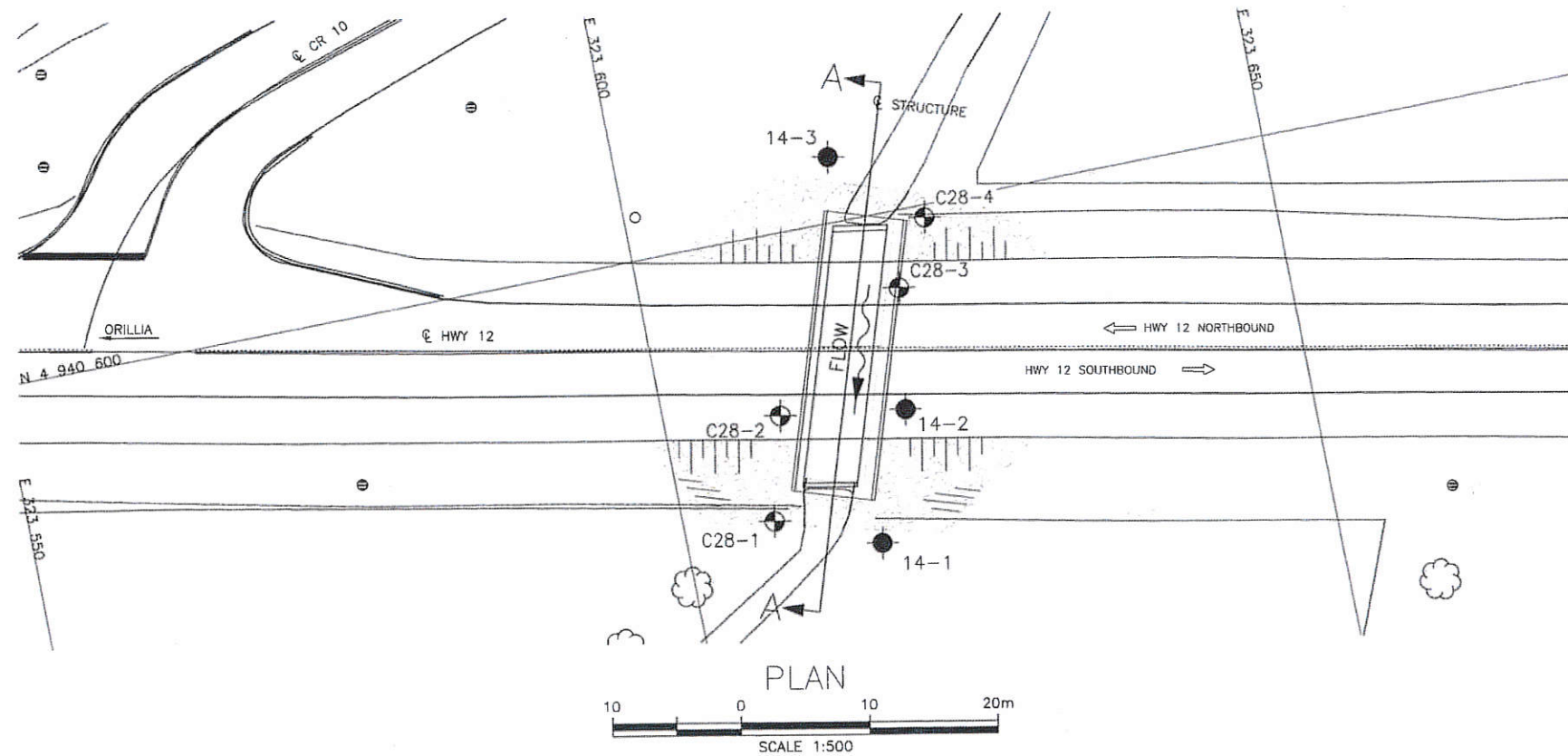


Fred Griffiths, P.Eng.
Associate, Senior Geotechnical Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

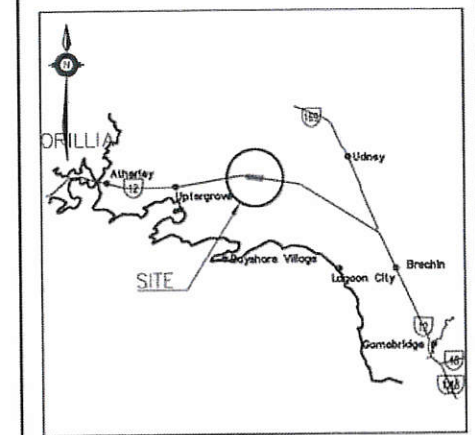
Appendix A
Borehole Locations and Soil Strata Drawings



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

CONT No
WP No 2183-13-00

HIGHWAY 12
CULVERT 30-676/C
BOREHOLE LOCATIONS AND SOIL STRATA



LEGEND

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

NO	ELEVATION	NORTHING	EASTING
14-1	223.8	4 940 574.7	323 614.9
14-2	224.9	4 940 584.6	323 618.7
14-3	223.5	4 940 605.1	323 616.5
C28-1	222.9	4 940 578.0	323 607.0
C28-2	224.7	4 940 586.0	323 609.0
C28-3	224.8	4 940 594.0	323 620.0
C28-4	224.0	4 940 599.0	323 623.0

-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. 31D-594



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CM	CHK	PC
DRAWN	MFA	CHK	PC
CODE	LOAD	DATE	JUL 2015
SITE	STRUCT	DWG	1

Appendix B
Record of Borehole Sheets



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

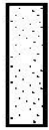


STRATA PLOT:

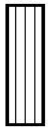
Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel



Sand



Silt



Clay



Organics



Asphalt



Concrete



Fill



Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT “N” Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved.

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 to 2 m
Medium bedded	0.2 to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 to 60 mm
Laminated	6 to 20 mm
Thinly laminated	Less than 6 mm

STRENGTH CLASSIFICATION

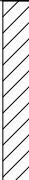












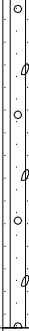



Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

RECORD OF BOREHOLE No 14-1

1 OF 1

METRIC

GWP# 2183-13-00 LOCATION Highway 12 & Mara Concession Road 10 N 4 940 574.7 E 323 614.9 ORIGINATED BY KMY
 HWY 12 BOREHOLE TYPE Portable COMPILED BY KMY
 DATUM Geodetic DATE 2014.10.06 - 2014.10.06 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)								
								20 40 60 80 100					w _P w w _L								
223.8																					
0.0	CLAY (CH) with sand firm to stiff brown dry		1	SS	5		223											0 23 54 23			
222.6			2	SS	7																
1.2	SILTY CLAY (CI) trace sand stiff brown wet		3	SS	9			222										0 6 55 39			
222.0			4	SS	14													2 51 40 7			
1.8	Silty SAND (SM) trace gravel trace clay very loose to compact grey saturated		5	SS	3				221												
			6	SS	3																
			7	SS	5																
220.0	Silty SAND (SM) with gravel trace clay loose to very dense grey saturated		8	SS	17					220											
			9	SS	15														16 42 32 10		
			10	SS	88																
217.8																					
6.0	END OF BOREHOLE At 6.0 m on inferred bedrock																				

ONTMT4S 19-3405-5 HWY 12 12112014.GPJ 2012TEMPLATE(MTO).GDT 16/11/15

RECORD OF BOREHOLE No 14-2

1 OF 1

METRIC

GWP# 2183-13-00 LOCATION Highway 12 & Mara Concession Road 10 N 4 940 584.6 E 323 618.7 ORIGINATED BY KMY
 HWY 12 BOREHOLE TYPE Truck-Mount COMPILED BY KMY
 DATUM Geodetic DATE 2014.10.07 - 2014.10.07 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
224.9														
0.0	50 mm ASPHALT		1	SS	21		224							20 55 25 (SI+CL)
	Silty sand with gravel brown dry FILL		2	SS	2									
223.5														
1.4	Silty clay with sand brown moist some wood fragments FILL		3	SS	3		223							2 20 54 24
			4	SS	3									
221.9							222							
3.0	SILT (ML) with sand trace clay very loose to compact grey saturated		5	SS	20									
			6	SS	3		221							0 23 73 4
			7	SS	2		220							
219.6														
5.3	Silty SAND with gravel compact to very dense grey wet		8	SS	9		219							
			9	SS	12									
			10	SS	53		218							30 36 26 8
217.4			11	SS	100/									
7.5	END OF BOREHOLE At 7.5 m on inferred bedrock				125mm									

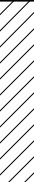



+³, ×³: Numbers refer to Sensitivity
 20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-3

1 OF 1

METRIC

GWP# 2183-13-00 LOCATION Highway 12 & Mara Concession Road 10 N 4 940 605.1 E 323 616.5 ORIGINATED BY KMY
 HWY 12 BOREHOLE TYPE Portable COMPILED BY KMY
 DATUM Geodetic DATE 2014.10.06 - 2014.10.06 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE													
								● QUICK TRIAXIAL × LAB VANE													
223.5							20	40	60	80	100										
0.0	CLAY (CH) with sand firm to stiff brown dry		1	SS	3																
			2	SS	6																
222.3																					
1.2	SILTY CLAY (CI) trace sand soft brown wet		3	SS	3																
221.7																					
1.8	Silty SAND (SM) trace gravel trace clay very loose to compact grey saturated		4	SS	5																
					5	SS	6														
					6	SS	3														
					7	SS	1														
					8	SS	5														
			9	SS	2																
217.5	SPT blows for SS9 were 1, 1, 1 and 100 for 25 mm																				
6.0	END OF BOREHOLE At 6.0 m on inferred bedrock																				

ONTMT4S 19-3405-5 HWY 12 12112014.GPJ 2012TEMPLATE(MTO).GDT 16/11/15

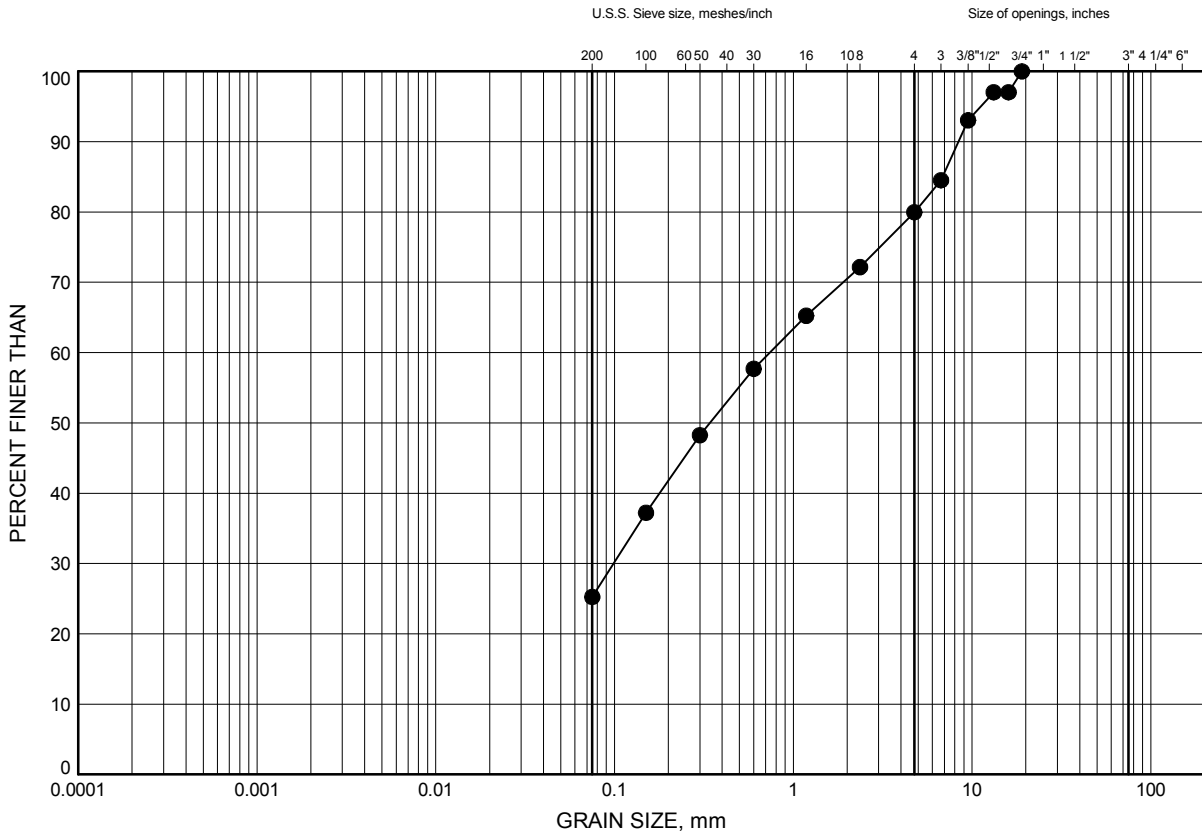
Appendix C

Laboratory Test Results

Highway 12 & Mara Concession Road 10 GRAIN SIZE DISTRIBUTION

FIGURE 1

FILL: Silty Sand with Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-2	0.30	224.59

Date January 2015
GWP# 2183-13-00

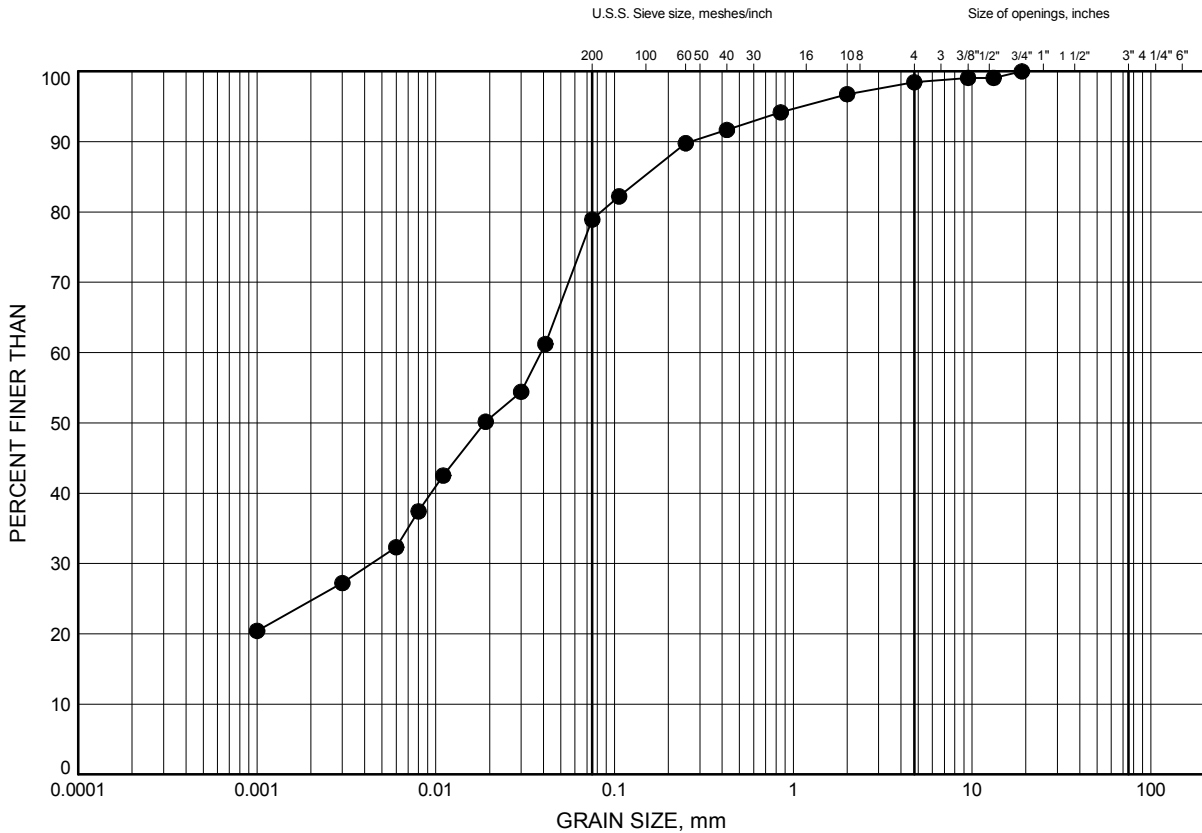


Prep'd CM
Chkd. PC

Highway 12 & Mara Concession Road 10 GRAIN SIZE DISTRIBUTION

FIGURE 2

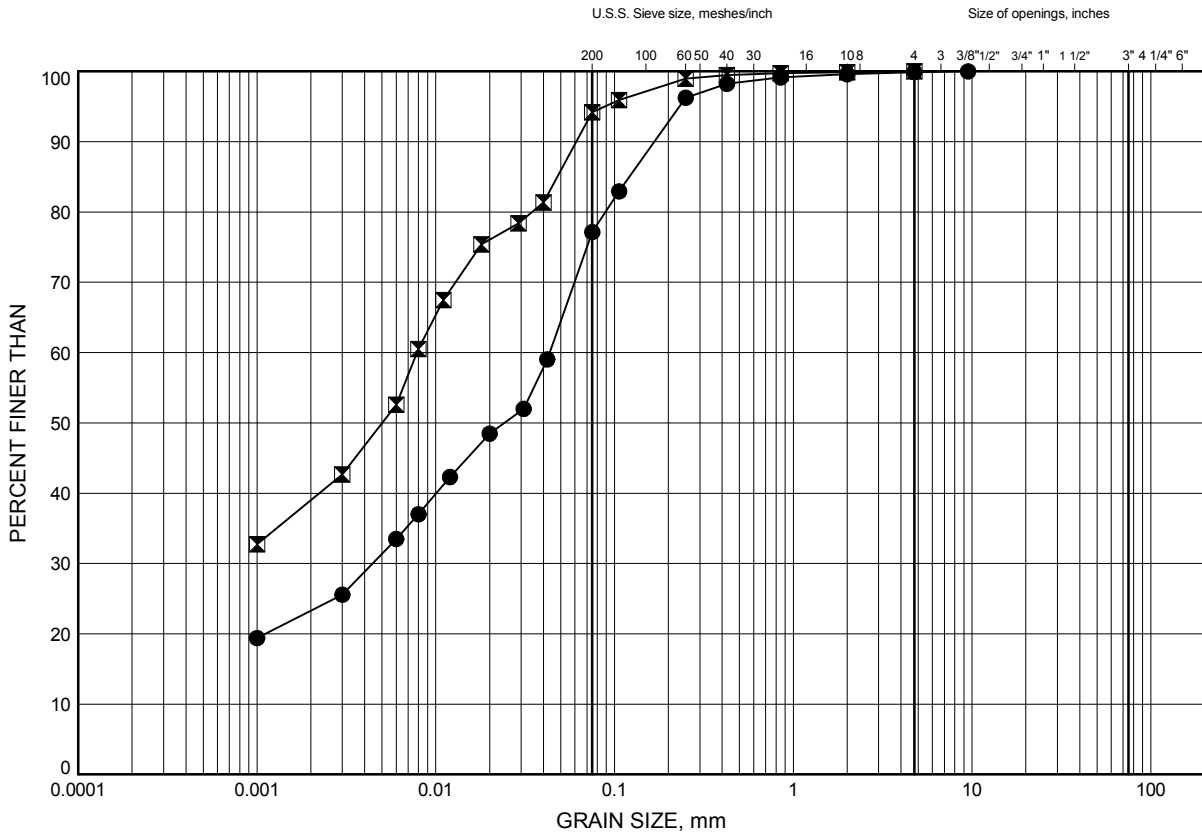
FILL: Silty Clay with Sand



Highway 12 & Mara Concession Road 10 GRAIN SIZE DISTRIBUTION

FIGURE 3

Clay / Silty Clay



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-1	0.30	223.49
⊠	14-1	1.52	222.28

Date January 2015

GWP# 2183-13-00



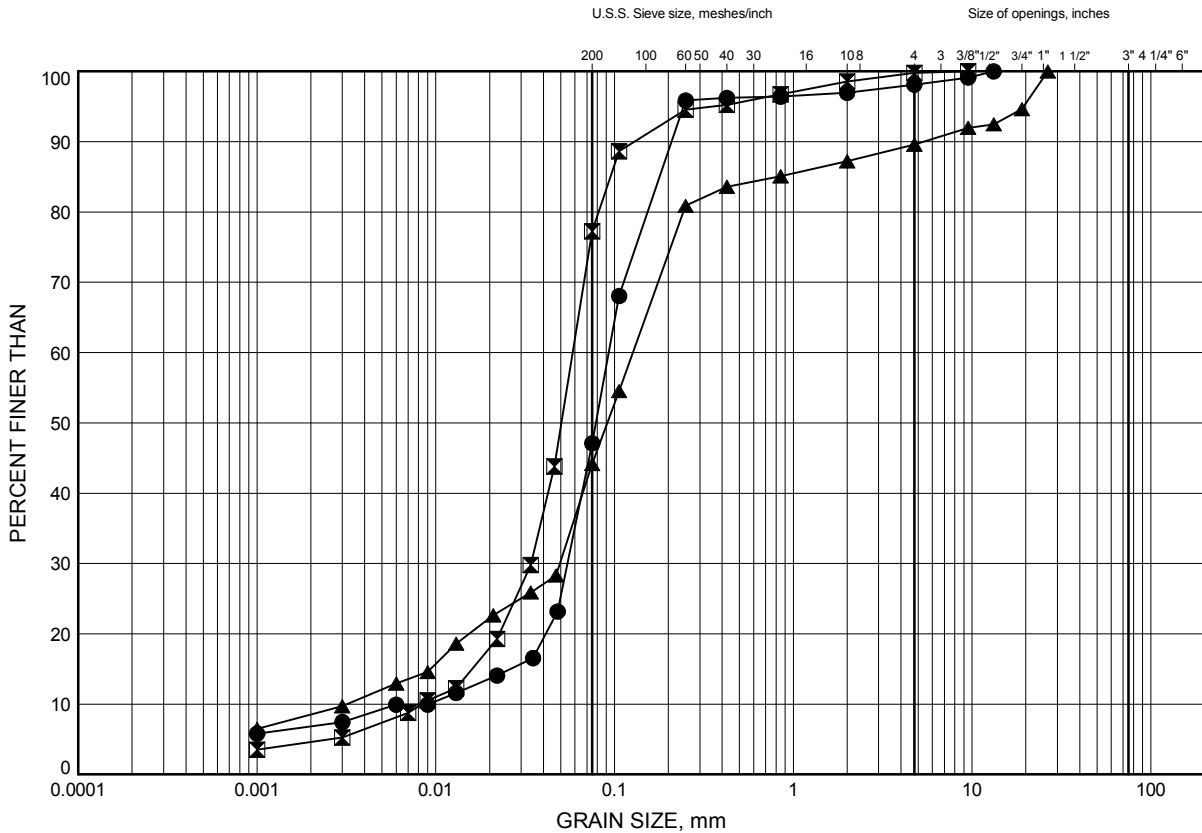
Prep'd CM

Chkd. PC

Highway 12 & Mara Concession Road 10 GRAIN SIZE DISTRIBUTION

FIGURE 4

Silty Sand / Silt with Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-1	2.13	221.67
⊠	14-2	4.11	220.78
▲	14-3	3.35	220.15

Date January 2015

GWP# 2183-13-00



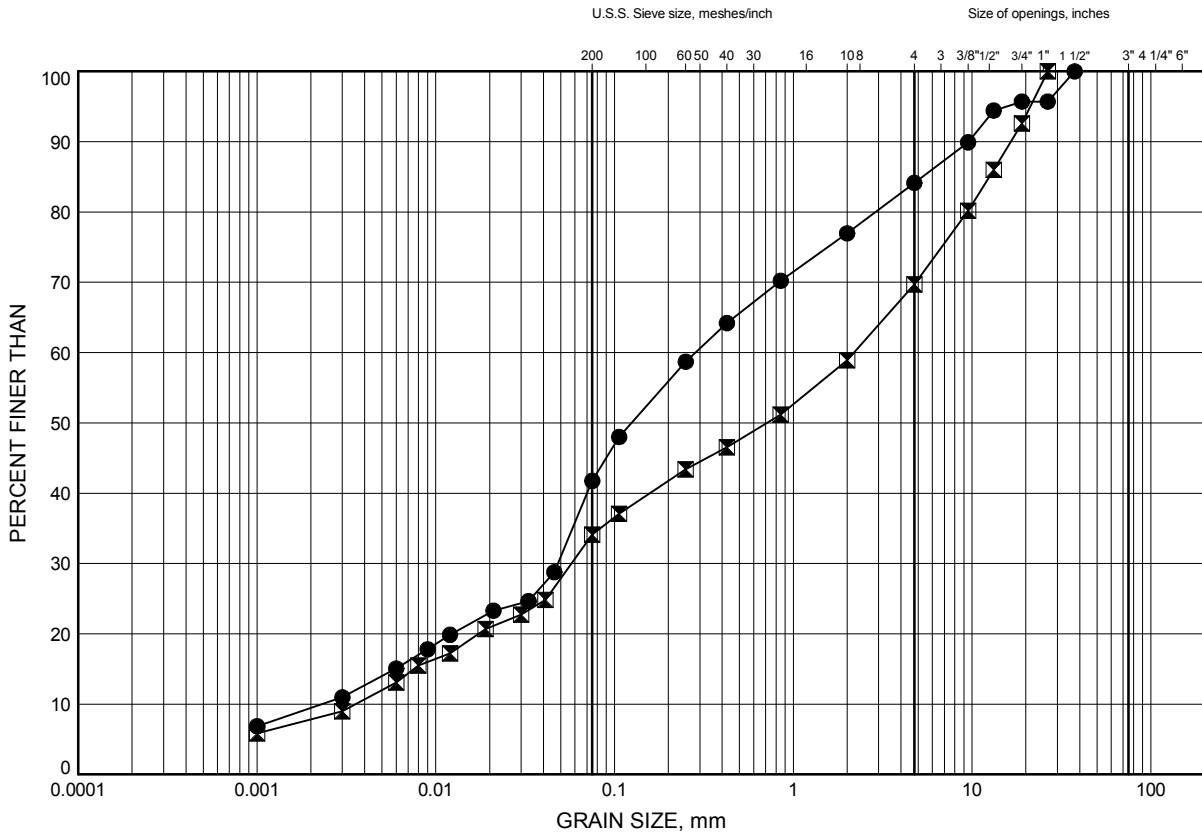
Prep'd CM

Chkd. PC

Highway 12 & Mara Concession Road 10 GRAIN SIZE DISTRIBUTION

FIGURE 5

Silty Sand with Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-1	5.18	218.62
⊠	14-2	7.16	217.74

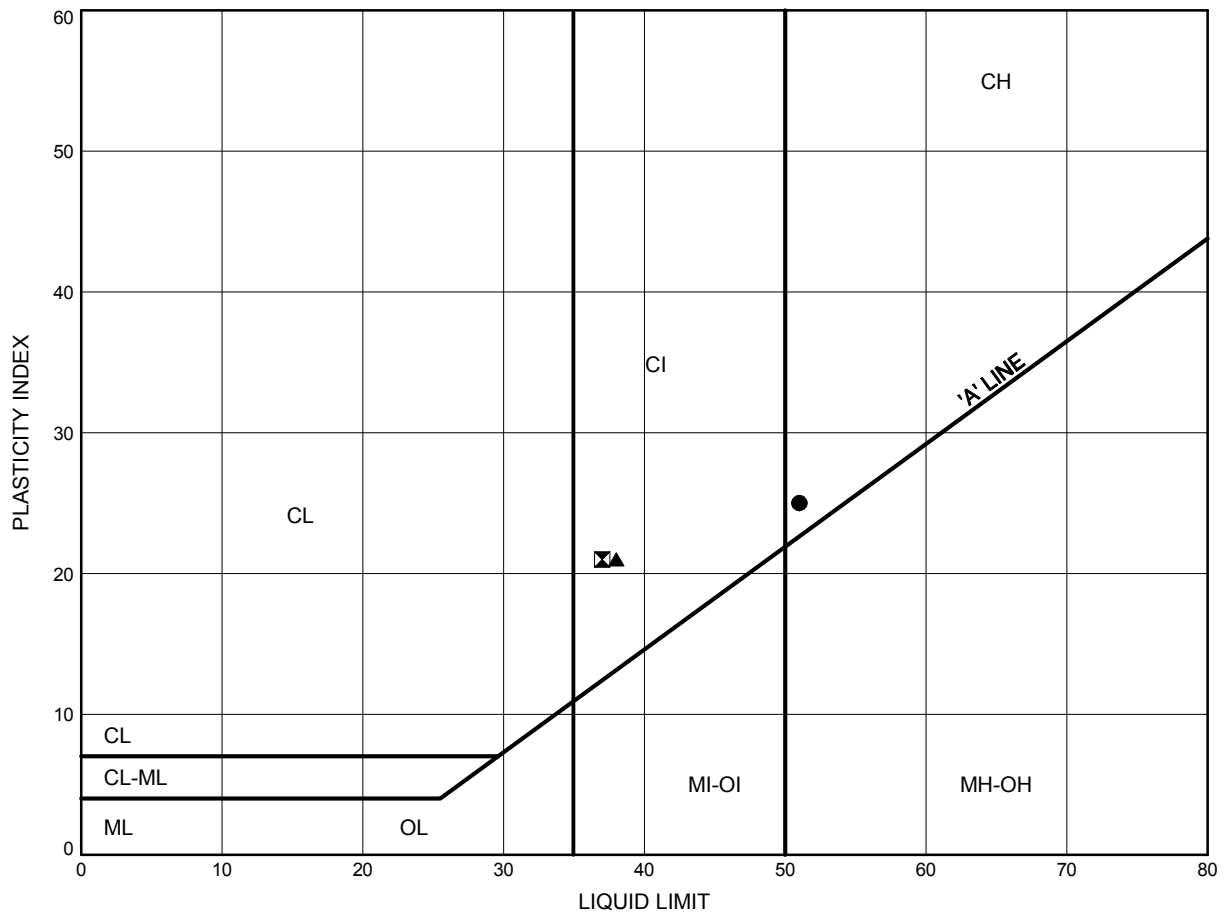
Date January 2015
GWP# 2183-13-00



Prep'd CM
Chkd. PC

Highway 12 & Mara Concession Road 10 ATTERBERG LIMITS TEST RESULTS

FIGURE 6



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-1	0.30	223.49
⊠	14-1	1.52	222.28
▲	14-2	1.83	223.07

Date January 2015

GWP# 2183-13-00



Prep'd CM

Chkd. PC

Appendix D
Selected Photographs of Culvert Location



Photo 1: Looking west at culvert alignment and intersection with Concession Rd 10.



Photo 2: North end – existing culvert outlet.

Appendix E
Existing GEOCRETS Report

FOUNDATION INVESTIGATION REPORT

PROPOSED REHABILITATION OF
STRUCTURAL CULVERT SITE NO. 30-676/C
TOWNSHIP OF RAMA
HIGHWAY 12 FROM GAMEBRIDGE TO RAMA ROAD 25

W.P. 365-98-00
Agreement # 2004-E-0070



I.E.
Group

FOUNDATION INVESTIGATION REPORT

PROPOSED REHABILITATION OF
STRUCTURAL CULVERT SITE NO. 30-676/C
TOWNSHIP OF RAMA
HIGHWAY 12 FROM GAMEBRIDGE TO RAMA ROAD 25

W.P. 365-98-00
Agreement # 2004-E-0070

Prepared for:
Morrison Hershfield Limited
Suite 600
255 Yorkland Blvd.
Toronto, Ontario M2J 1T1

Mr. Stanley Ma, Project Manager

Prepared by:
Infrastructure Engineering Group Inc.
39-69 Bessemer Road
London, Ontario
N6E 2V6

November 6, 2009

08-1-IEG6-30-676/C

Distribution:

5	Copies -	Morrison Hershfield Limited
	Digital Copies -	Morrison Hershfield Limited
3	Copies -	Infrastructure Engineering Group Inc.

Geocres No.: 31D-488

TABLE OF CONTENTS

PART A – FOUNDATION INVESTIGATION	1
1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION	2
2.1 Site Location.....	2
2.2 Physiography and Topography.....	2
3.0 INVESTIGATION PROCEDURES.....	3
3.1 Field Investigation	3
3.2 Laboratory Analysis	5
4.0 SUBSURFACE CONDITIONS	5
4.1 General Subsurface Conditions	5
4.1.1 Pavement, Fill	5
4.1.2 Silty Clay	6
4.1.3 Sand and Silt	6
4.1.4 Silty Sand (Till-like)	7
4.1.5 Limestone Bedrock.....	7
4.2 Groundwater Conditions.....	7
5.0 STATEMENT OF LIMITATION	9

Drawings & Appendices

Drawing 1	Borehole Locations and Soil Strata
Appendix “A”	Explanation of Terms Used in Report
	Record of Borehole Sheets Boreholes C28-1 to C28-4
Appendix “B”	Laboratory Test Results
	Grain Size Distribution Figures 1, 3, 5 and 7
	Plasticity Chart Figures 2, 4 and 6
	Rock Core Compressive Strength Figure 8
Appendix “C”	Limitations of Report
Appendix “D”	Site Photographs

PART A – FOUNDATION INVESTIGATION

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out in December 2008 and February 2009 by Infrastructure Engineering Group Inc. (IEG) on behalf of Morrison Hershfield Limited (Morrison Hershfield).

This assignment involves the rehabilitation of approximately 24 km of Highway 12, from Rama Road to Gamebridge. The original scope of the rehabilitation is based on addressing the immediate and short term deficiencies identified in the Ministry's Highway Assessment Report for W.O. #03-20019 (February 2005). The scope of work may include extension or replacement of seven (7) non-structural culverts and four (4) structural culverts.

Foundation investigation and recommendations are required for the design and construction of culvert replacements and/or extension as part of the improvement of Highway 12. Seven (7) non-structural culverts and four (4) structural culverts are to be investigated. The scope of work was subsequently changed to include rehabilitation/replacement of non-structural Culvert C03, and rehabilitation of structural Culvert C28, and no work to be done on structural Culverts C14, C15 and C25.

This report covers the site of Structural Culvert No. 30-676/C, also described as C28 in this report, and in the culvert summary as Culv 28.

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.

Based on the information presented in the Preliminary Drawings provided by Morrison Hershfield, and verbal discussion with the project team, it is understood this culvert will be rehabilitated and will not be replaced. The rehabilitation will consist of concrete repairs and installation of tie-back anchors near the toe of the culvert walls.

Authorization to complete this assignment was given by Mr. Stanley Ma, P. Eng., of Morrison Hershfield, the TPM Consultant who is completing this assignment for MTO under Agreement # 2004-E-0070.

2.0 SITE DESCRIPTION

2.1 Site Location

The project alignment starts in Gamebridge, at Station 10+000 and extends northerly to approximately Station 19+200 just south of County Road 169, then extends north westerly to approximately Station 24+800 just before Side Road 15, then extends westerly to Station 34+000 just east of Rama Road 25. For the purpose of description, standard MTO conventional description will be used, i.e. a site north pointing in the direction of increasing chainage. When facing the direction of increasing chainage, the right hand side is referred to as east, and the left hand side is referred to as west. Any directions with clarifications in brackets (e.g., north-west) are given with reference to the true north direction.

Structure 30-676/C is located on Highway 12, approximately 16.5 km north of the south limit of this Contract at Gamebridge (Station 10+000), located at Station 26+514. Photographs of this culvert site are presented in Appendix "D". The Culvert Summary provided by Morrison Hershfield indicates that the existing structure is a reinforced concrete, rigid frame open footing culvert with a span of 3.66 m, a height of 1.8 m, a length of 20.6 m (3.66 m span by 1.53 m height in accordance with ETR Plate No. 205-12/55-0), with an overfill height of approximately 0.9 m. The culvert opening dimensions were obtained from the Culvert Summary provided by Morrison Hershfield and compared with the ETR drawings provided in the RFP.

This culvert is located within a drainage valley in which the stream easterly (northerly). The approach embankments were built on both the east and west sides of the culvert, with a maximum height of approximately 2.9 m. The embankment slopes are typically 3H:1V or flatter and are grass covered. No signs of embankment slope instability were observed at the time of this foundation investigation.

There are no headwalls for this culvert and the ends of the culvert protrude beyond the road embankment. The water levels were observed above the bottom of the creek, at an approximate Elevation of 222.6 m on December 17, 2008, likely reflecting a normal flow condition.

Photographs taken on March 1, 2002, as shown in Appendix B of the Highway Assessment Study Report indicate that water level was slightly lower than those observed during the field work.

2.2 Physiography and Topography

The project alignment except for the extreme western portion is located within the Simcoe Lowlands physiographic region (Chapman and Putnam, 1984). This area was previously flooded by glacial Lake Algonquin. The portion of the alignment located east of the Atherley Narrows (narrows between Lakes Couchiching and Simcoe) is comprised of an elevated, drumlinized till plain comprised primarily of undifferentiated sand to sandy silt (Chapman and Putnam, 1984). The character of local topography and soils in proximity to the highway corridor elsewhere are predominantly comprised of clay plain with interspersed elongated drumlins comprised of

calcareous till (kame moraine) (Chapman and Putnam, 1984). There is a large patch of peat/muck located on the east shore of Lake Simcoe associated with several of the wetland features located along the lakeshore. There is also a section of Carden limestone plain located north of the Talbot River at the south end of the study area. This area is characterized as limestone overlaid with a very shallow overburden (Chapman and Putnam, 1984).

The topography of the study area is primarily flat with scattered drumlin features. The area slopes gently down towards Lake Simcoe. There are numerous headwater areas of small size that traverse the ROW of Highway 12. Movement of shallow ground water is confined by the tight till and clay soils and would follow surficial topography towards Lake Simcoe.

There are six provincially significant wetlands (PSW) located in part within the project alignment. From west to east, they include the Orillia Filtration Swamp, Victoria Point Wetland, Atherley Wetlands, Mud Lake Wetland, Barnstable Bay Wetland, and the Lagoon City Wetland.

The asphalt pavement surface over the existing culvert is near Elevation 224.9 m while the ground surface at the base of the embankment at the stream bed is at approximate Elevation 221.9 m.

3.0 INVESTIGATION PROCEDURES

3.1 Field Investigation

Between December 3, 2008 and February 18, 2009, a CME 55 truck-mounted 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). Two (2) boreholes (Boreholes C28-2 and C28-3) were drilled and sampled to obtain data for foundation design of the proposed rehabilitation work and potential culvert replacement. Rock coring was carried out on February 18, 2009 in Borehole C28-3 to provide geotechnical data as per the requirements of our proposal for this work. Hand-drilled boreholes cannot be completed at the location of Borehole C28-1 and C28-4 due to inundation of the area, and a series of dynamic cone penetration tests were carried out instead. The locations of the boreholes are shown on Drawing 1.

The culvert borehole numbering system was established from the Culvert Summary spreadsheet provided by Morrison Hershfield. The subject Culvert was identified as Culv 28, with a Structure Number 30-676/C as presented in the Culvert Summary. The boreholes for this culvert are numbered C28-1 to C28-4 accordingly.

The boreholes were numbered C28-1 to 28-4 for the subject culvert and the depths of sampling were as follows:

Borehole No.	Depth of Sampling (m)
C28-1 (DCP only)	3.76
C28-2	7.32
C28-3 (with rock coring)	9.27
C28-4 (DCP only)	4.39

The sampled boreholes were drilled using continuous flight solid stem or hollow 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.

The undrained shear strength was obtained by shear vane test, with the sensitivity measured. Field pocket penetrometer was used on the retrieved SPT samples, where applicable, to determine the undrained shear strength of the cohesive soil deposits. These undrained shear strengths are used to supplement the properties of the cohesive soils. It is noted that the measured shear strength value on the retrieved SPT samples would be slightly lower than the actual value due to sampling disturbance.

Rock cores were retrieved using NQ core assembly (47.6 mm ID). The rock core samples were identified in the field and physical index properties were determined by visual examination and also by measurement of rock quality designations (RQD's) and rock core recovery. All rock cores were placed in wooden core boxes and transported to our laboratory for further examination, to confirm the field logging, and laboratory testing.

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 provided by Morrison Hershfield 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, Atterberg Limit tests and unit weight tests were performed on selected samples.

A section of the rock core (at 8.47 m depth from Borehole C28-3) was selected for unconfined compressive strength testing in accordance with ASTM 2938. The testing was performed by Trow Associates Inc. of Brampton and the results are presented as Figure 8 in Appendix B.

The results of the laboratory testing are presented on the Record of Borehole sheets (Appendix "A"), and Laboratory Test Results (Figures 1 to 8, 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 Drawings 1 and 2 will vary between and beyond the borehole locations.

In general, the subsurface deposits at the site consist of loose embankment fill, placed on very soft silty clay or loose to compact sand and silt to sandy silt deposits to depths of 5.03 m (Elevation 219.71 m at Borehole C28-2) and 5.79 m (Elevation 219.00 m at Borehole C28-3). These very soft/loose to compact deposits were underlain by a compact to very dense silty sand stratum to depths of 7.32 m (Elevation 217.42 m at Borehole C28-2) and 7.32 m (Elevation 217.47 m at Borehole C28-3). The silty sand was further underlain by limestone bedrock.

4.1.1 Pavement, Fill

Boreholes C28-2 and C28-3, located at the edge of existing pavement in the shoulder areas, encountered 360 mm shoulder gravel. Underlying the shoulder gravel is the embankment fill material that extended to depths of 3.05 to 3.35 m, respective Elevations of 221.69 m and 221.44 m at Boreholes C28-2 and C28-3. The fill beneath the shoulder gravel consists of a mixture of silt, sand and gravel with cobbles and silty clay lumps.

Two (2) grain size distribution analyses of the embankment fill is shown on Figure 1 of Appendix "B". The results of an Atterberg Limit test are provided in Figure 2.

Standard penetration tests yielded "N"-values from 4 to 12 blows per 0.3 m. This fill is brown to dark brown in colour and the measured natural moisture contents range from 10 to 42%. The

higher moisture contents reflect the presence of organic matters and clay lumps. Based on one sample, the unit weight of the fill was measured to be 22.1 kN/m^3 .

Based on the above field and laboratory test results, together with visual and tactile examination, the fill beneath the shoulder gravel consists of a mixture of silt, sand and gravel with cobbles and silty clay lumps and has a loose to compact compactness condition.

4.1.2 Silty Clay

A 0.76 m thick layer of brown to grey silty clay was contacted below the embankment fill at Borehole C28-2 and extended to a depths of 3.81 m below the existing ground surface (at Elevations 220.93 m). The silty clay also contains organic inclusions.

A single grain size analysis was performed and the results are presented on Figure 3 of Appendix "B". The same sample was tested for Atterberg Limits and the results in Figure 4 of Appendix "B" and summarized below:

Liquid Limit (W_L)	25%
Plastic Limit (W_P)	14%
Plasticity Index (I_p)	11%
Natural Moisture Content (W)	49%

A standard penetration test yielded an "N"-value of 1 blow per 0.3 m. The low N-value could also be attributed by disturbance from the drilling operations. Based on the above field and laboratory test results, together with visual and tactile examination, the silty clay deposit is considered to have a very soft consistency and can be classified as a clay of low plasticity (CL).

4.1.3 Sand and Silt

The silty clay at Borehole C28-2 and the embankment fill at C28-3 were underlain by a sand and silt deposit that extended to depths of 5.03 to 5.79 m, at Elevations of 219.71 m and 219.00 m in Boreholes C28-2 and C28-3, respectively.

Three (3) grain size analyses were performed and the results are presented on Figure 5 of Appendix "B". One (1) sample was tested and exhibited the following Atterberg Limits. These results are shown in Figure 6 and summarized below:

CL-ML, Sample at 5.33 m from Borehole C28-3

Liquid Limit (W_L)	16%
Plastic Limit (W_P)	10%
Plasticity Index (I_p)	6%
Natural Moisture Content (W)	9%

The natural moisture contents were in the range of 9 to 24%, indicative of wet to saturated moisture condition. The results of the grain size and Atterberg Limit tests indicate that the sand and silt is generally non-plastic to slightly plastic and can be classified as a SM-ML material with occasional clayey pockets (CL-ML).

Standard penetration tests yielded “N”-values between 2 and 12 blows per 0.3 m, indicative of very loose to compact compactness condition.

4.1.4 Silty Sand (Till-like)

The sand and silt to sandy silt were underlain by a silty sand deposit which has a till-like structure.

A single grain size analysis was performed and the results are presented on Figure 7 of Appendix “B”.

The natural moisture contents of the silty sand were in the range of 8 to 16%, indicative of damp to moist moisture condition. Standard penetration tests yielded “N”-values 20 and over 100 blows per 0.3 m. Based on the above field and laboratory test results, together with visual and tactile examination, the silty sand till-like deposit exhibited a compact to very dense compactness condition.

4.1.5 Limestone Bedrock

The silty sand till-like stratum was further underlain by a grey to tan limestone bedrock at depths of 7.32 m (Elevation 217.42 m at Borehole C28-2) and 7.32 m (Elevation 217.47 m at Borehole C28-3). The appearance of the rock core sample is fossiliferous with sections that are coralliferous, with close to wide bedding planes.

Recovery of the rock core sample was at 100%. Rock Quality Designation (RQD) varied from 62 to 81%, indicative of a fair to good quality.

A single uniaxial compressive strength determination carried out on a section of rock core samples yielded a result of 128 MPa. The uniaxial compressive strength test report is presented in Figure 8.

4.2 Groundwater Conditions

The groundwater condition was monitored during and upon completion of sampling. On completion of drilling, groundwater was observed in Boreholes C28-2 and C28-3 at depths of 2.3 and 2.1 m, corresponding to Elevations 222.44 and 222.69 m.

The water levels were observed above the bottom of the creek, at an approximate Elevation of 222.6 m on December 17, 2008, likely reflecting a normal flow condition.

Photographs taken on March 1, 2002, as shown in Appendix B of the Highway Assessment Study Report indicate that water level was slightly lower than those observed during the 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

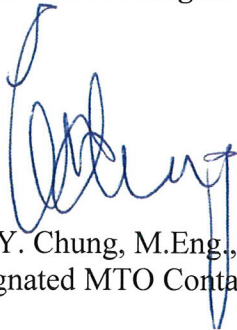
We recommend that once the details of the proposed structure are finalized, our recommendations should be reviewed for their specific applicability.

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



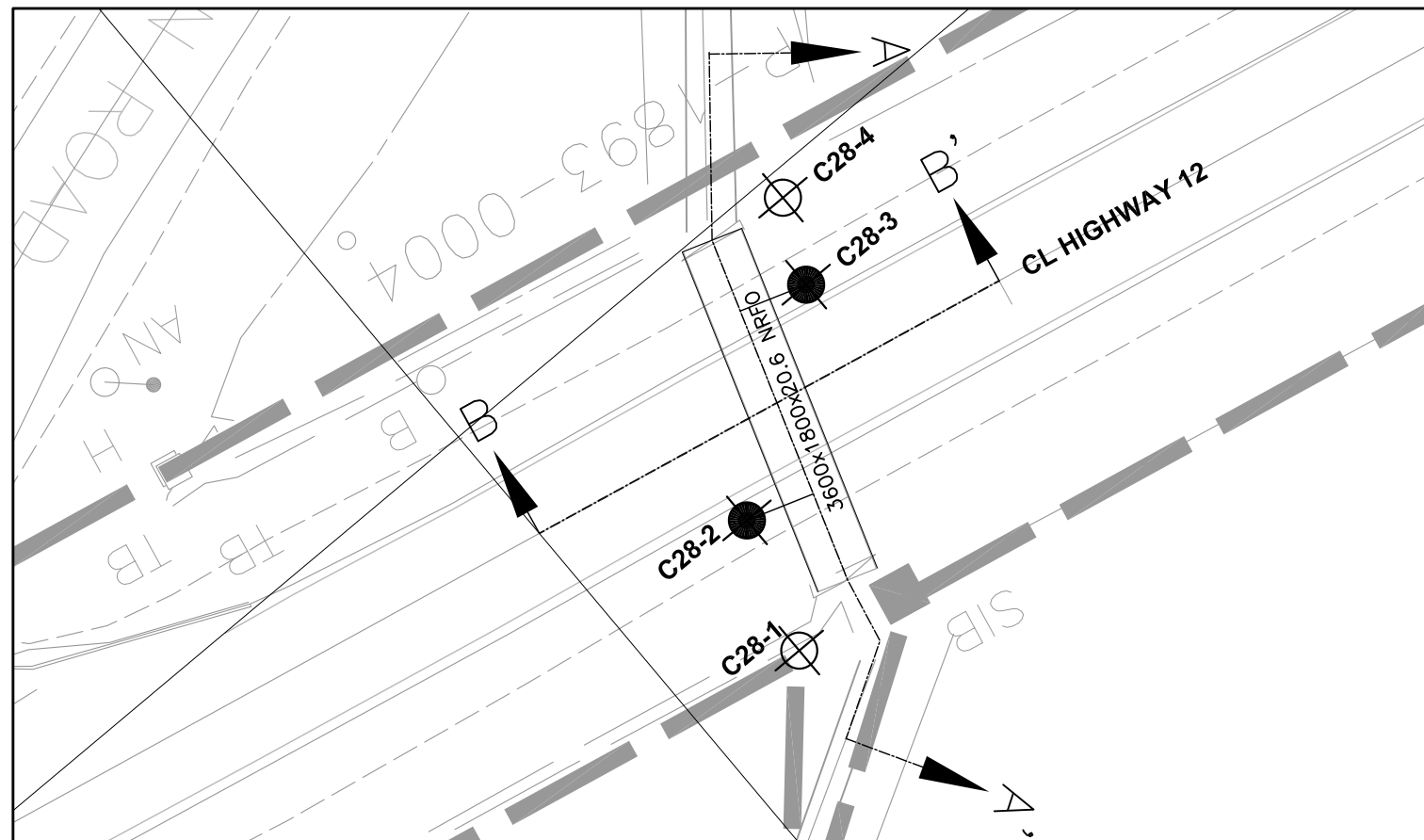
Tom O'Dwyer, P. Eng.
Quality Review Engineer



Ministry of Transportation/Morrison Hershfield Limited
W.P. 365-98-00
Rehabilitation of Highway 12 from Rama Road to Gamebridge
Agreement # 2004-E-0070

08-1-IEG6-30-676/C
Final Report
Drawing 1
November 6, 2009

Drawings 1 & 2
Borehole Locations
And
Soil Strata



BOREHOLE LOCATION PLAN

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No xxxx-xxxx
WP No GWP 365-98-00

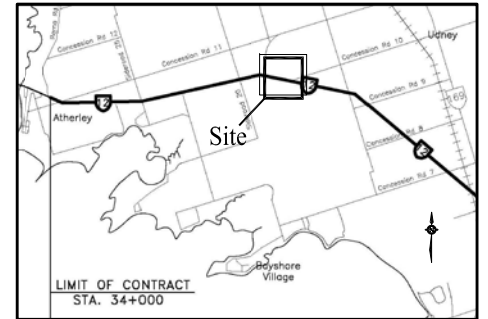
Structural Culvert 30-676/C
Highway 12
BOREHOLE LOCATION PLAN & PROFILE



SHEET
1

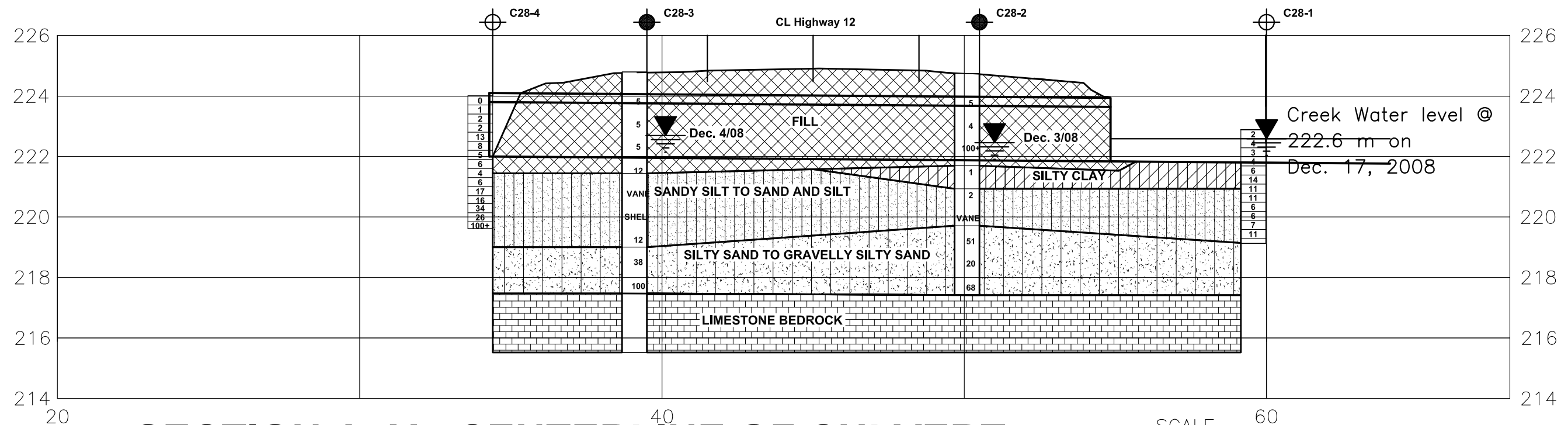
I.E. Group Infrastructure Engineering Group Inc.
Pavement & Construction Materials Consulting Engineers
GTA • Kitchener • London • Windsor

KEYPLAN NTS



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Standpipe



SECTION A-A' - CENTERLINE OF CULVERT

SCALE 60

5m 0 2m
Horizontal and Vertical

NOTES

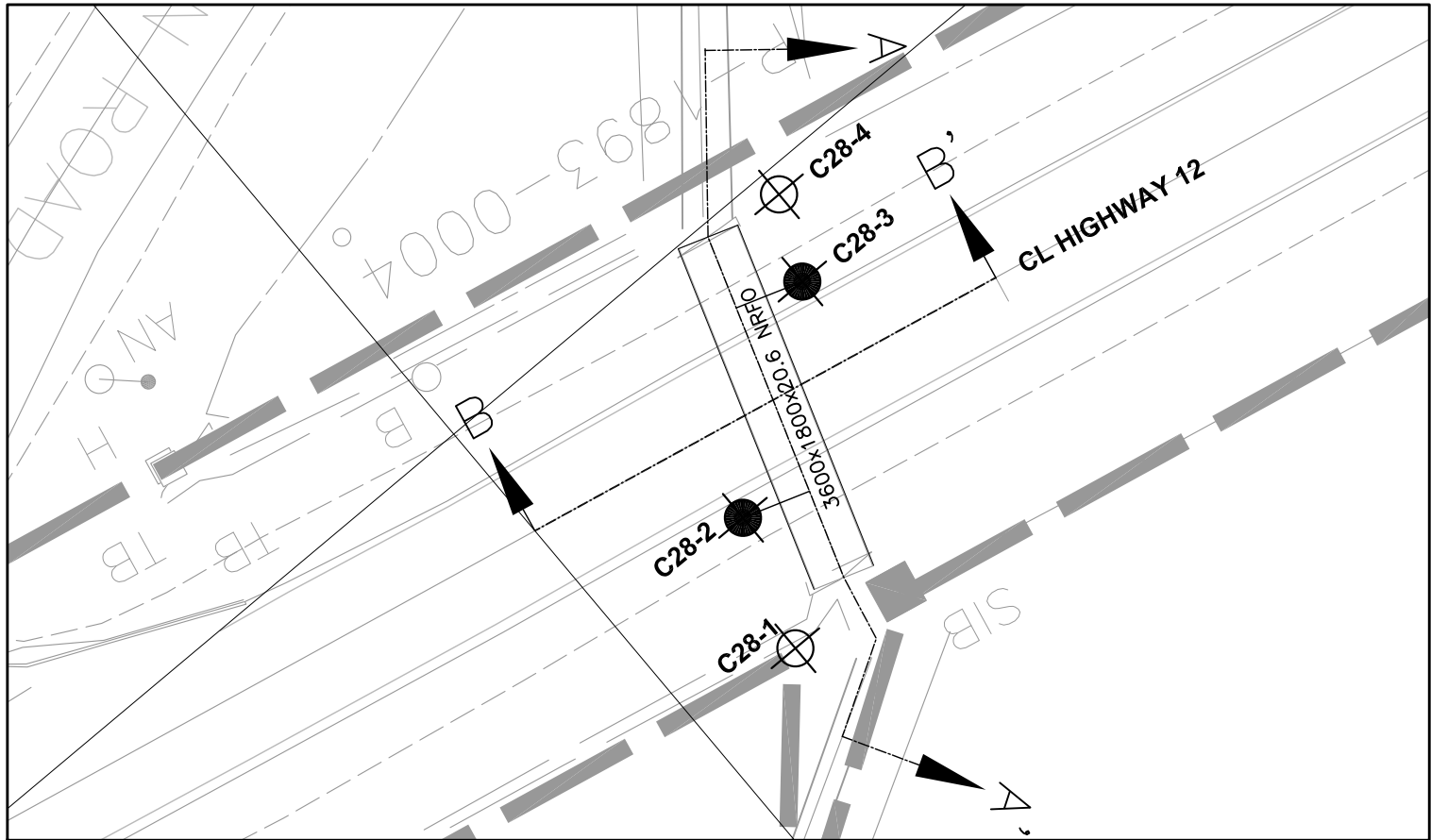
- THE COMPLETE FOUNDATION INVESTIGATION AND DESIGN REPORT FOR THIS PROJECT AND OTHER RELATED DOCUMENTS MAY BE EXAMINED AT THE ENGINEERING MATERIALS OFFICE, DOWNSVIEW. INFORMATION CONTAINED IN THIS REPORT AND RELATED DOCUMENTS ARE SPECIFICALLY EXCLUDED IN ACCORDANCE WITH THE CONDITIONS OF SECTION GC2.01 of OPS GEN. COND.
- THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES AND BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.
- SUBGRADE ELEVATION OF THE EXISTING FOOTING NOT KNOWN AND IS ESTIMATED TO BE AT 1.6m BELOW THE CREEK BED.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

BOREHOLE NO.	ELEVATION	UTM CO-ORDINATES	
		NORTH	EAST
C28-1	222.44	4940578	323607
C28-2	224.74	4940586	323609
C28-3	224.79	4940594	323620
C28-4	223.99	4940599	323623

REVISIONS				
	05/09/09	J.L.	Final Report	
	18/05/09	J.L.	Draft	
	DATE	BY	DISCRIPTION	

Geocres : 31D-488				
HWY No.		HWY 12		DIST CENTRAL
SUBM'D	J.L.	CHECKED E.C.	DATE 25/03/09	SITE 30-676/C
DRAWN	J.L.	CHECKED J.L.	APPROVED E.C.	DWG 1

MINISTRY OF TRANSPORTATION, ONTARIO



BOREHOLE LOCATION PLAN

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No xxxx-xxxx
WP No GWP 365-98-00

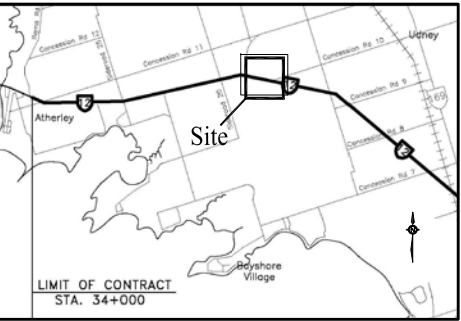


Structural Culvert 30-676/C
Highway 12
BOREHOLE LOCATION PLAN & PROFILE

SHEET
2

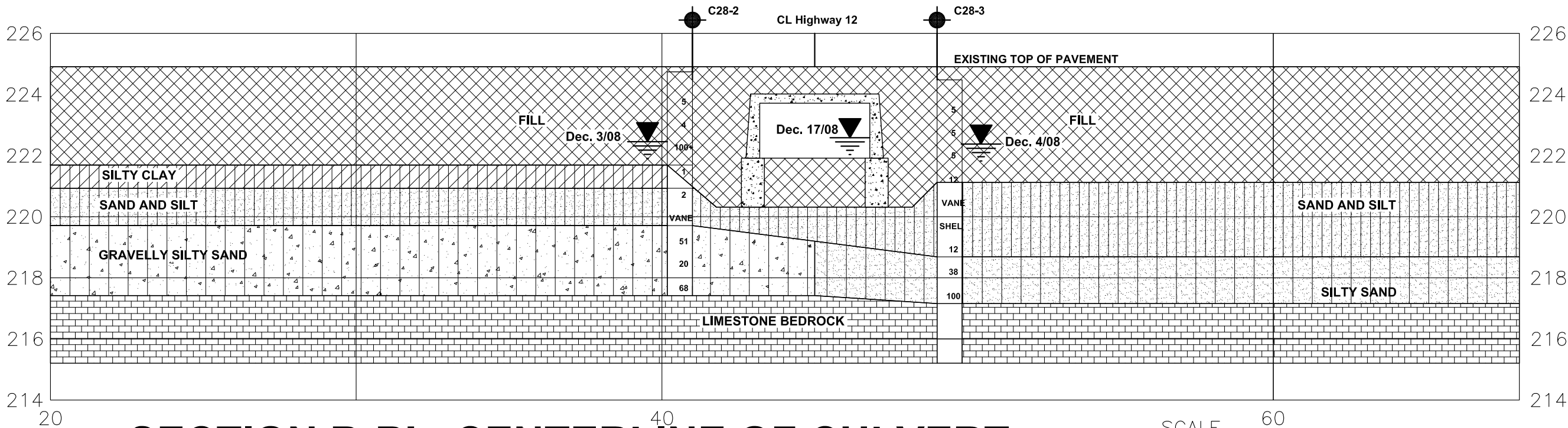
I.E. Infrastructure Engineering Group Inc.
Pavement & Construction Materials Consulting Engineers
GTA • Kitchener • London • Windsor

KEYPLAN NTS



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Standpipe



SECTION B-B' - CENTERLINE OF CULVERT

SCALE 60



- NOTES
- 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.
 - THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES AND BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.
 - SUBGRADE ELEVATION OF THE EXISTING FOOTING NOT KNOWN AND IS ESTIMATED TO BE AT 1.6m BELOW THE CREEK BED.
 - THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

BOREHOLE NO.	ELEVATION	UTM CO-ORDINATES	
		NORTH	EAST
C28-1	222.44	4940578	323607
C28-2	224.74	4940586	323609
C28-3	224.79	4940594	323620
C28-4	223.99	4940599	323623

REVISIONS						
	05/09/09	J.L.	Final Report			
	DATE	BY	DISCRPTION			
Geocres : 31D-488						
HWY No.		HWY 12			DIST	CENTRAL
SUBM'D	J.L.	CHECKED	E.C.	DATE 05/09/09	SITE	30-676/C
DRAWN	J.L.	CHECKED	J.L.	APPROVED E.C.	DWG	2

Appendix A

Explanation of Terms Used in Report

Record of Borehole Sheet

Boreholes C28-1 TO C28-4

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_c	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_c}$

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 C28-1

1 OF 1

METRIC

W.P. WP 365-98-00 LOCATION Northing - 4940578, Easting - 323607 ORIGINATED BY RB
 DIST Central Region HWY Highway 12 BOREHOLE TYPE Dynamic Cone COMPILED BY JL
 DATUM Geodetic DATE 12.17.08 - 12.17.08 CHECKED BY EC

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
						○ UNCONFINED	+ FIELD VANE						
						● QUICK TRIAXIAL	× LAB VANE						
						20 40 60 80 100	20 40 60 80 100						
222.89 0.00	Ground												31.75 Kg (70lbs.) hammer used for driving dynamic cone. Nc values corrected for standard 63 kg (140 lbs.) hammer. W.L. @ 0.3m @ completion.
219.13 3.76	End of Borehole.												Dynamic Cone refusal @ 3.76 m on confirming stratum.

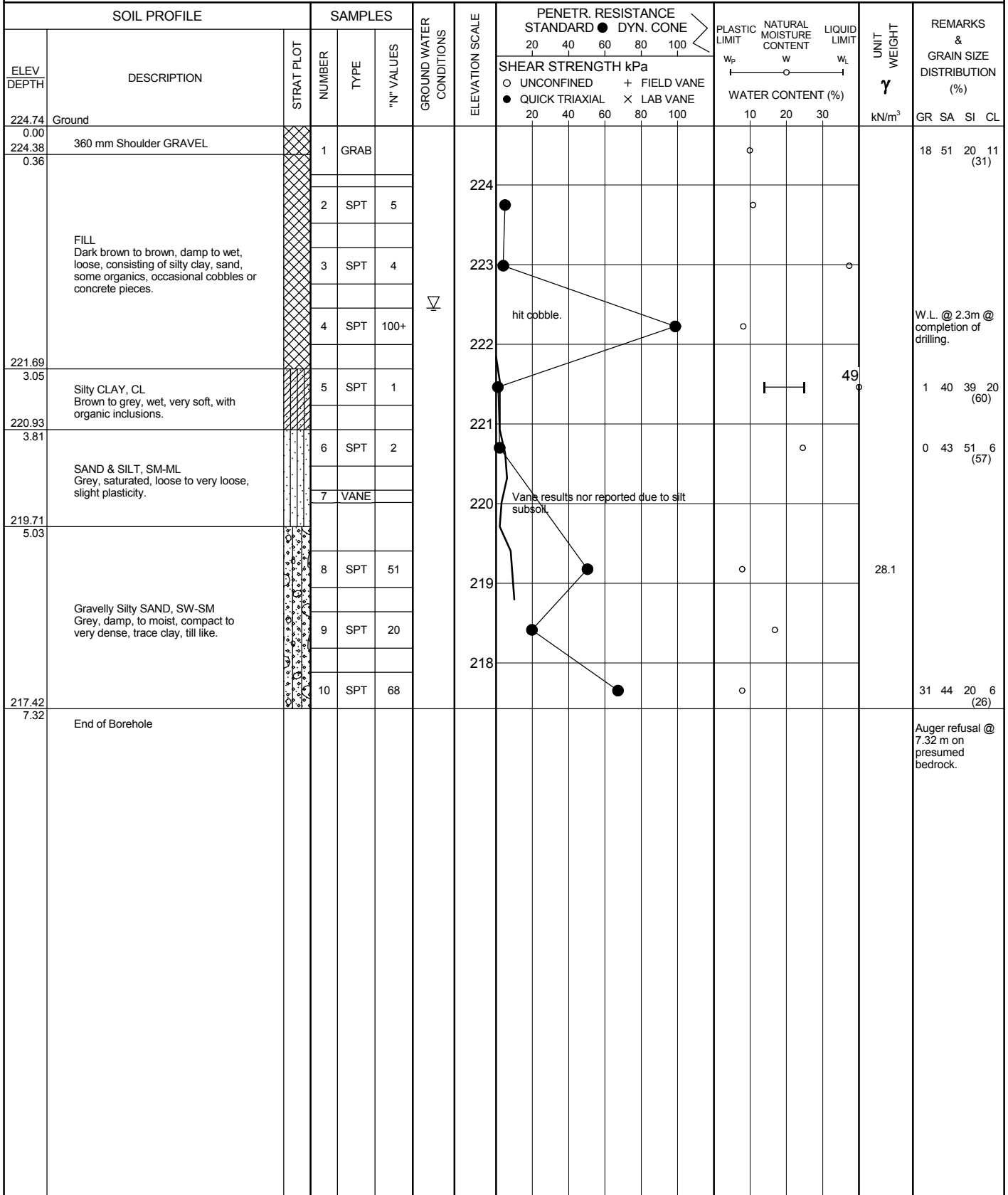
JOE MTO 08-1-IEG6 CULVERTS.GPJ ONTARIO MOT.GDT 05/01/09

RECORD OF BOREHOLE No C28-2

1 OF 1

METRIC

W.P. WP 365-98-00 LOCATION Northring - 4940586, Easting - 323609 ORIGINATED BY RB
 DIST Central Region HWY Highway 12 BOREHOLE TYPE S/S Augering 110 mm Dia. COMPILED BY JL
 DATUM Geodetic DATE 12.03.08 - 12.03.08 CHECKED BY EC



JOE MTO 08-1-IEG6 CULVERTS.GPJ ONTARIO MOT.GDT 05/01/09

+ 3, X 3: Numbers refer to Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No C28-3

1 OF 1

METRIC

W.P. WP 365-98-00 LOCATION Northring - 4940594, Easting - 323620 ORIGINATED BY RB
 DIST Central Region HWY Highway 12 BOREHOLE TYPE H/S Augering 110 mm Dia. COMPILED BY JL
 DATUM Geodetic DATE 12.04.08 - 12.18.08 CHECKED BY EC

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE									
224.79	Ground						20	40	60	80	100							
0.00																		
224.43	360 mm Shoulder GRAVEL		1	GRAB														
0.36	FILL Dark brown to brown, wet, loose to compact, consisting of mixed silty clay, sand and gravel, some organics.		2	SPT	5		224								31 33 26 9 (36)			
			3	SPT	5		223								W.L. @ 2.1m @ completion of drilling.			
			4	SPT	5		222							42				
			5	SPT	12		221											
			6	VANE			220											
221.44	SAND & SILT, SM-ML Grey, wet to saturated, loose to compact, slight plasticity, occasional clayey silt pocket with trace gravel.		7	SH			220								0 30 67 3 (70)			
			8	SPT	12		219								14 42 31 14 (45)			
			9	SPT	38		218											
219.00	Silty SAND, SM Grey, wet, dense to very dense, some gravel, slight plasticity, till like.		10	SPT	100+		218											
5.79							217											
217.47	LIMESTONE BEDROCK Tan to grey, fossiliferous, very strong, fair to good quality, close to wide bedding plane.		11	CORE	NQWL		217								Rock core with NQ wireline. Recovery - 100%, RQD - 62% Recovery - 100%, RQD - 81% Uniaxial Compressive Strength = 128.6 MPa			
7.32			12	CORE	NQWL		216											
215.52																		
9.27	End of Borehole																	

JOE MTO 08-I-IEG6 CULVERTS.GPJ ONTARIO MOT.GDT 05/01/09

+ 3, X 3: Numbers refer to
Sensitivity

○ 150 UNCONFINED SHEAR STRENGTH INFERRED FROM POCKET PENETROMETER READINGS

RECORD OF BOREHOLE No C28-4

1 OF 1

METRIC

W.P. WP 365-98-00 LOCATION Northing - 4940599, Easting - 323623 ORIGINATED BY RB
 DIST Central Region HWY Highway 12 BOREHOLE TYPE Dynamic Cone COMPILED BY JL
 DATUM Geodetic DATE 02.18.09 - 02.18.09 CHECKED BY EC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	PENETR. RESISTANCE		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	STANDARD ● DYN. CONE					
223.99 0.00	Ground						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60 80 100 20 40 60 80 100	10 20 30				31.75 Kg (70lbs.) hammer used for driving dynamic cone. Nc values corrected for standard 63 kg (140 lbs.) hammer.
219.60 4.39	End of borehole.												Dynamic cone refusal @ 4.39 m on presumed bedrock.

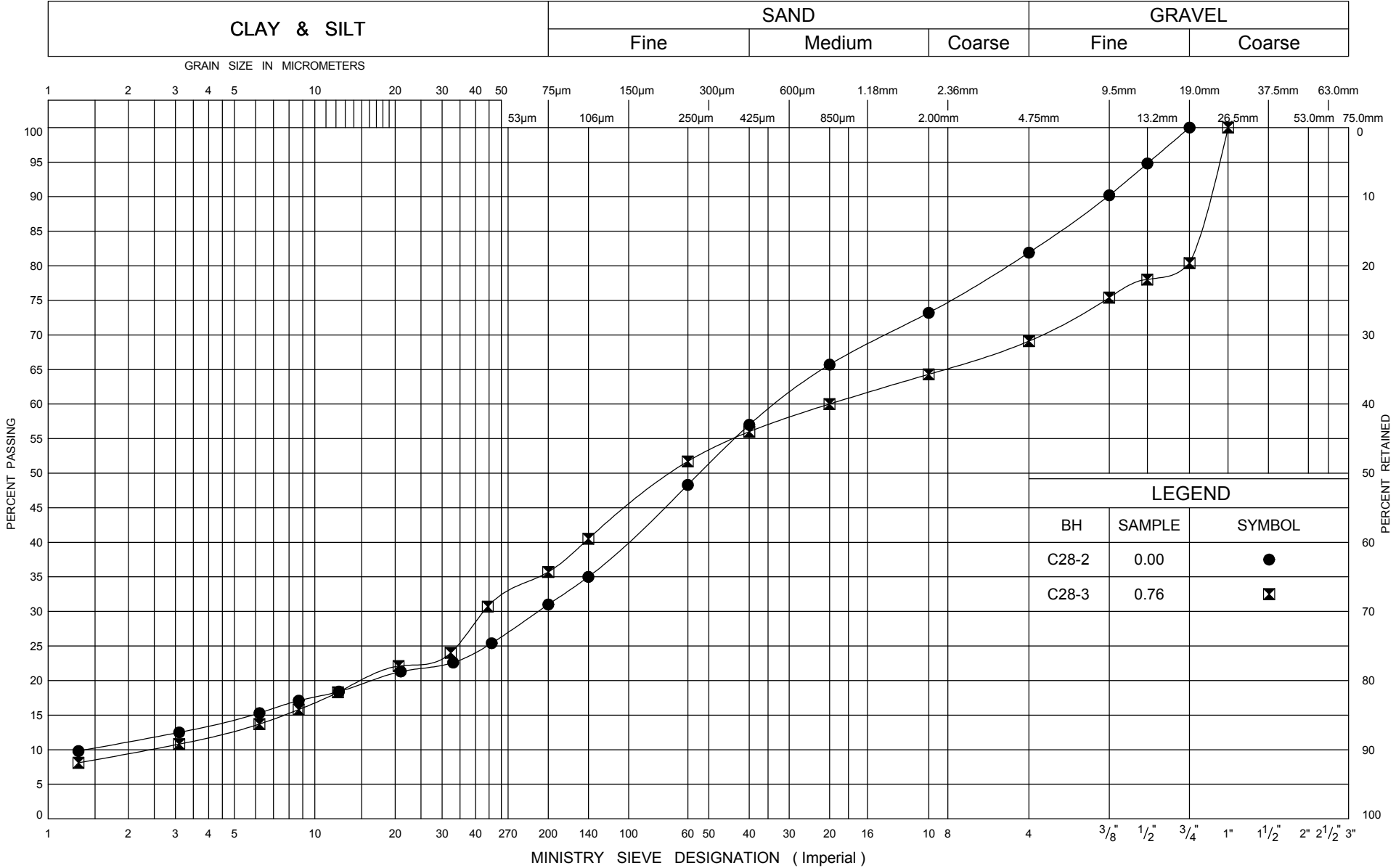
JOE MTO 08-1-IEG6 CULVERTS.GPJ ONTARIO MOT.GDT 05/01/09

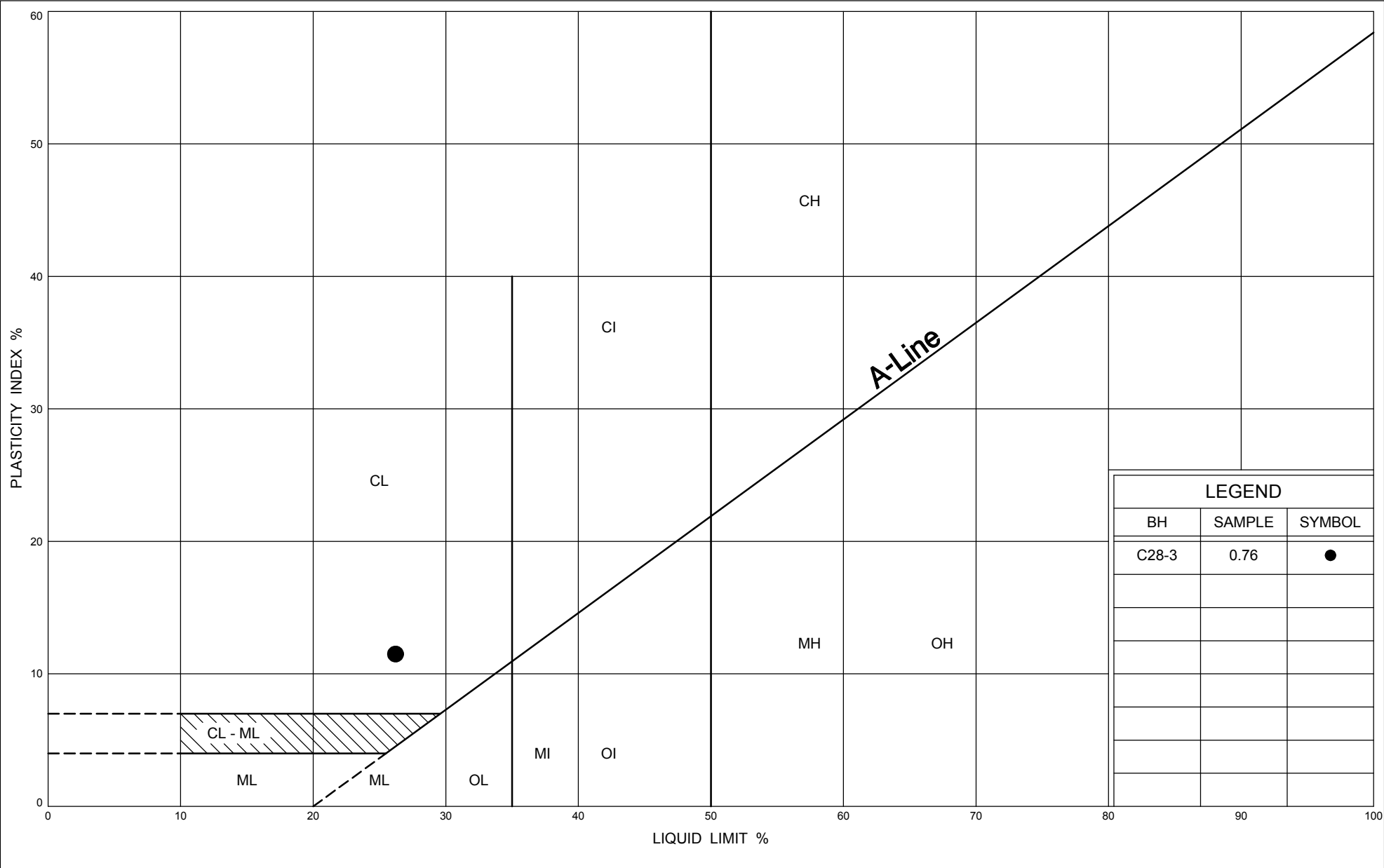
Appendix B

Laboratory Test Results

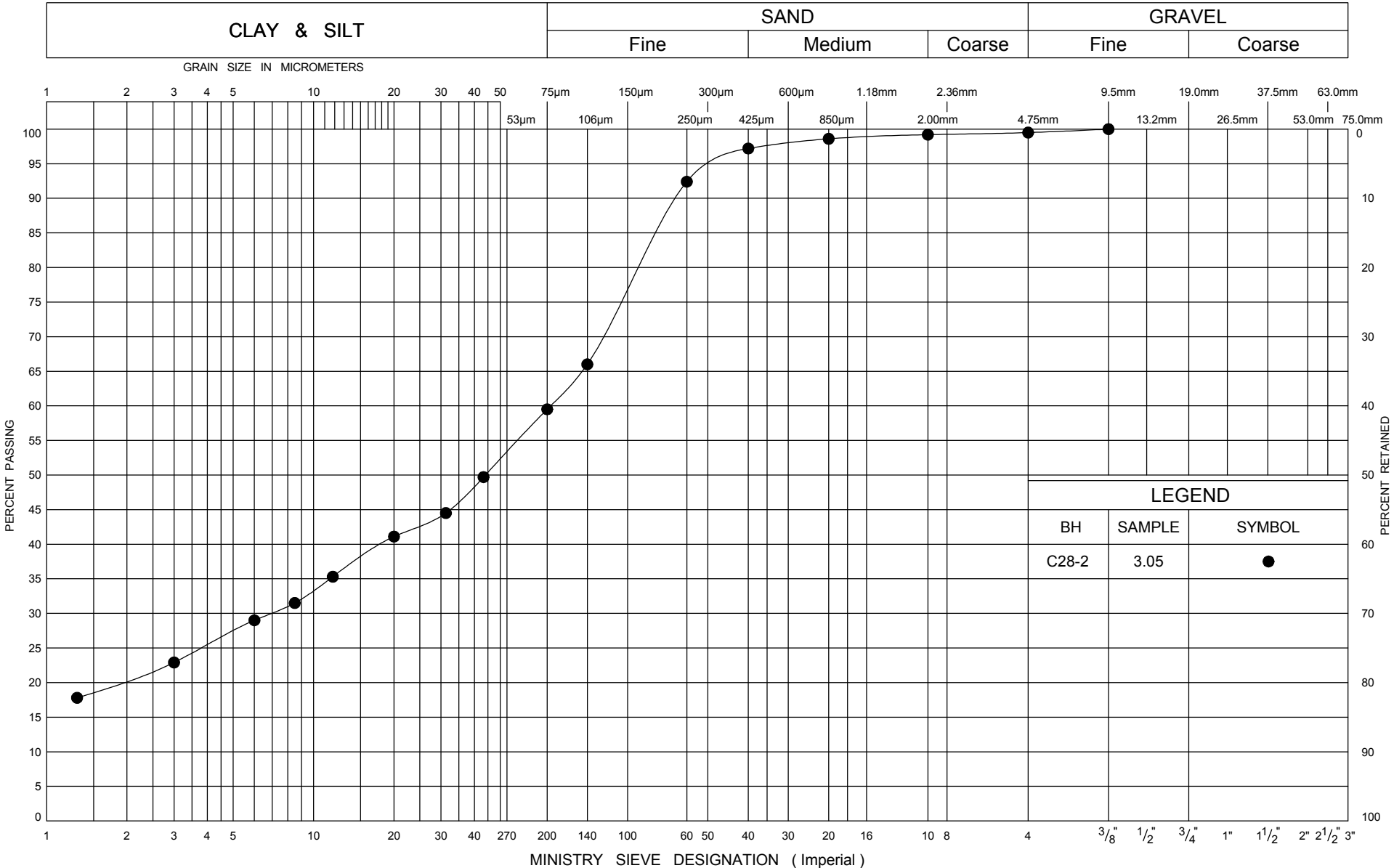
Grain Size Distribution	Figures 1, 3, 5 and 7
Plasticity Chart	Figures 2, 4 and 6
Rock Core Report	Figure 8

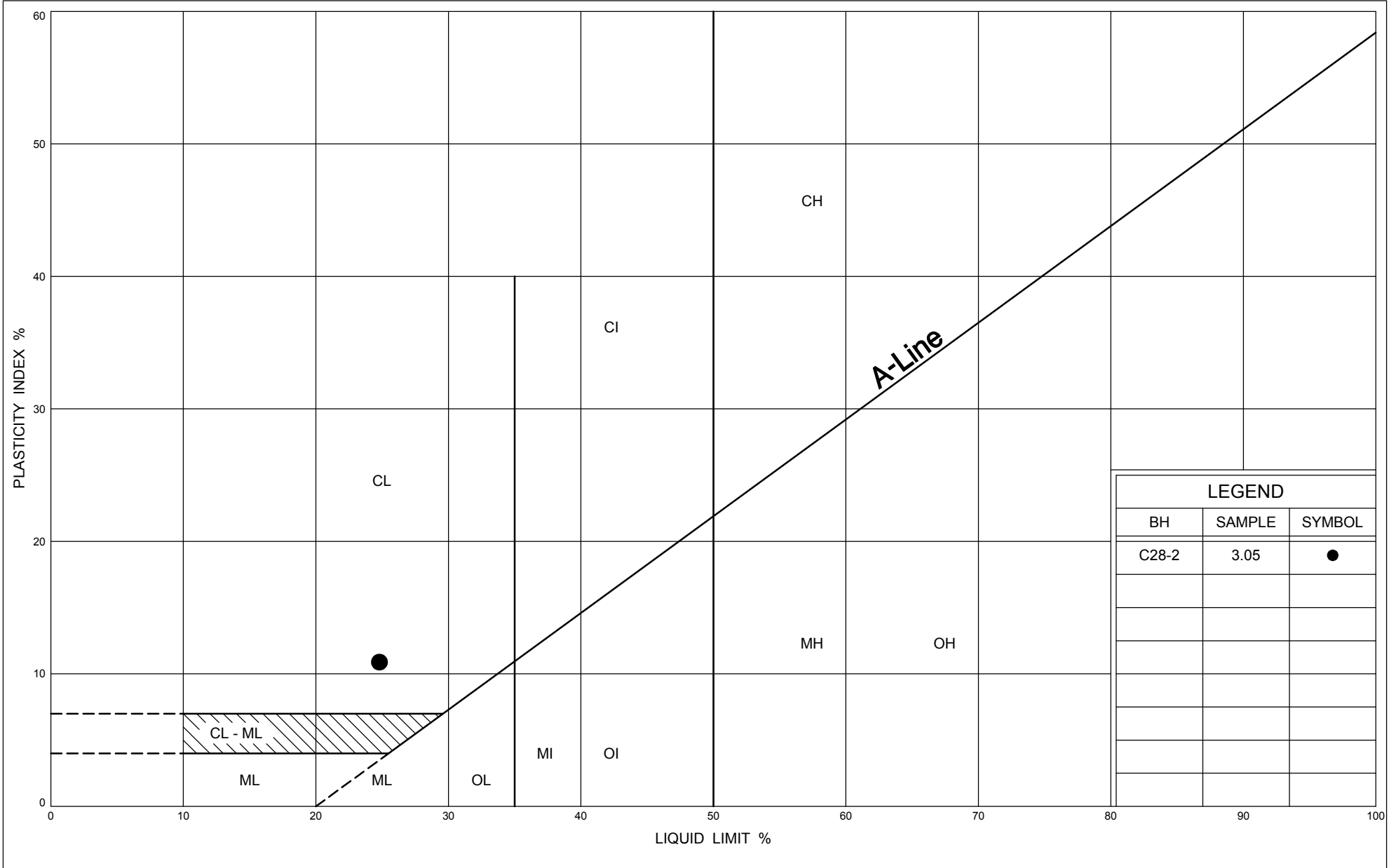
UNIFIED SOIL CLASSIFICATION SYSTEM





UNIFIED SOIL CLASSIFICATION SYSTEM





Ministry of
Transportation

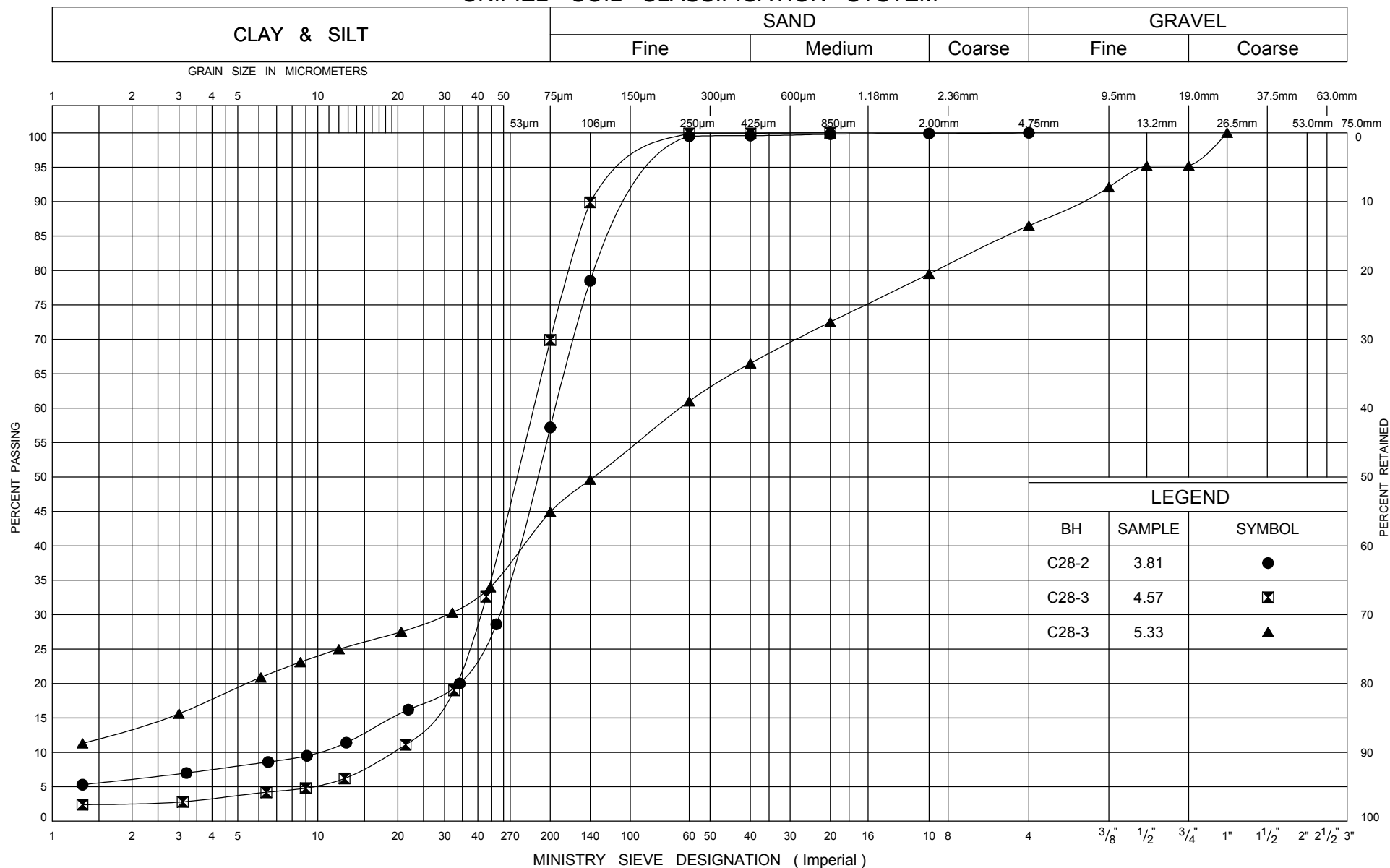
PLASTICITY CHART
SILTY CLAY, CL

FIG No 4

GWP 365-98-00

Highway 12, Rama Road to Gamebridge

UNIFIED SOIL CLASSIFICATION SYSTEM



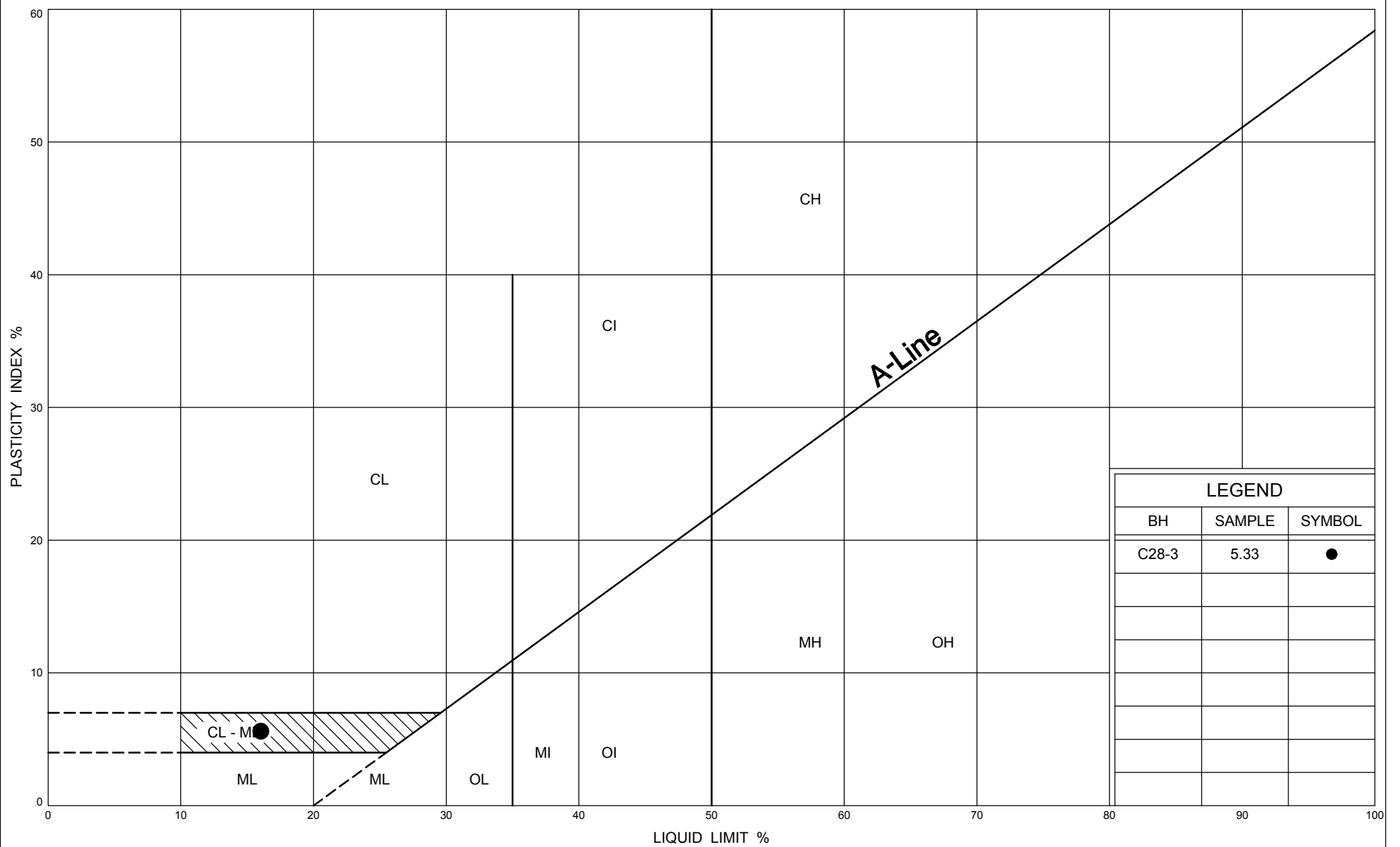
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY SAND, SAND AND SILT, SANDY SILT, SM TO ML

FIG No 5

GWP 365-98-00

Highway 12, Rama Road to Gamebridge



Ministry of
Transportation

PLASTICITY CHART

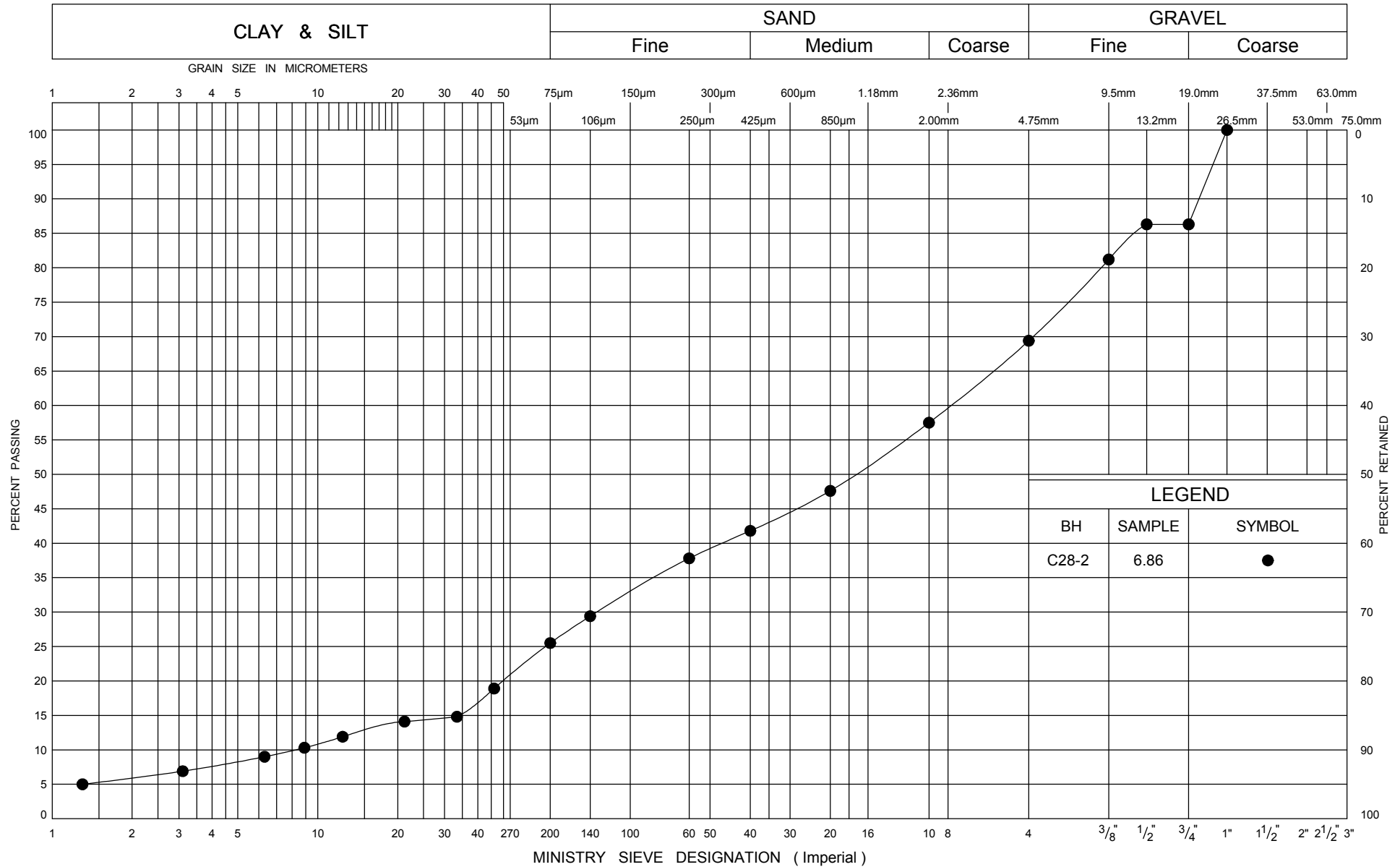
SILTY SAND, SAND AND SILT, SANDY SILT, SM TO ML

FIG No 6

GWP 365-98-00

Highway 12, Rama Road to Gamebridge

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

GRAVELLY SILTY SAND, SW-SM

FIG No 7

GWP 365-98-00

Highway 12, Rama Road to Gamebridge




Rock Core Test Report

Project No.: LAGM00289085C

Project Name: Hwy 12 – 03/20019

Core No.	BH C28-3
Location	27'10"-28'6"
Date Cored	
Date Tested	April 7, 2009
Height - (mm)	126.5
Average Diameter - (mm)	46.2
Corrected Compressive Strength - (MPa)	128.6


Testing Laboratory Representative Signature
Ammanuel Yousif


Date

Ministry of Transportation/Morrison Hershfield Limited
W.P. 365-98-00
Rehabilitation of Highway 12 from Rama Road to Gamebridge
Agreement # 2004-E-0070

08-1-IEG6-30-676/C
Final Report
Appendix C
November 6, 2009

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/Morrison Hershfield Limited
W.P. 365-98-00
Rehabilitation of Highway 12 from Rama Road to Gamebridge
Agreement # 2004-E-0070

08-1-IEG6-30-676/C
Final Report
Appendix D
November 6, 2009

Appendix D

Site Photographs



C28 - Station 26+514 - Looking North



C28 - Station 26+514 - Downstream



C28 - Station 26+514 - Upstream

SITE PHOTOGRAPHS

SITE NO.:30-676/C



C28 Photo 1 Roadway Above Culvert / North Approach Roadway



C28 Photo 3 Culvert Barrel from West



C28 Photo 2 West Elevation



C28 Photo 4 Embankment Erosion at Northwest Corner