FOUNDATION INVESTIGATION REPORT
SLATE RIVER TRIBUTARY CULVERT REPLACEMENT
HIGHWAY 61
TOWNSHIP OF BLAKE, THUNDER BAY DISTRICT
AGREEMENT NO.: 6013-E-0021
ASSIGNMENT NO.: 4
SITE NO.: 48W-195/C
GEOCRES NO. 52A-194
GWP 6305-14-00

JANUARY 9, 2015
GS-TB-019500

PREPARED FOR:
Ministry of Transportation
Geotechnical Section
Northwestern Region Office
615 South James Street
Thunder Bay, ON P7E 6P6

3 Copies - Ministry of Transportation, Thunder Bay, ON
1 Copy - DST Consulting Engineers

DST CONSULTING ENGINEERS INC.
605 Hewitson Street, Thunder Bay, Ontario P7B 5V5
Phone: 1-807-623-2929 Fax: 1-807-623-1792

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

DST Consulting Engineers Inc. (DST) has been retained by the Ministry of Transportation (MTO), Geotechnical Section, Northwestern Region to conduct a foundation investigation for the proposed culvert replacement on Highway 61. This work was carried out under Agreement No.: 6013-E-0021, Geotechnical Retainer, Assignment No. 4.

This report addresses the field investigation, laboratory test program, factual report on soils conditions at the culvert location.

2. SITE DESCRIPTION

The site is located on Highway 61, approximately 0.17 km North of Boy Scout Road (latitude 48.2746, longitude -89.4843), LHRS 33540, offset 1.617, Station 23+375, in the Township of Blake, in the District of Thunder Bay.

It is understood that the existing 25.9 m long centerline culvert is a Cast-in-place concrete box culvert approximately 6.1 m wide and approximately 1.5 m in height. The existing culvert (Figure 2.3 and 2.4) was originally built in 1899 and inspection by others indicates the culvert is undersized, and is always submerged. The fill thickness above the culvert is approximately 1.0 m and the side slope of the embankment is approximately 2H:1V. The surrounding area is moderately vegetated (Figure 2.1 and 2.2). Photographs were taken by others (Figures 2.1 to 2.4).

Geological information is available from published *Ontario Geological Survey Map #52ASW* by the *Ontario Ministry of Natural Resources* for the Blake Township area. The map indicates that the local area landform is identified as clayey glaciolacustrine plain. The topography in the area is mainly low local relief; plain with dry drainage conditions.

Figure 2.1 Location of existing culvert at Highway 61 (looking North)

Figure 2.2 Location of existing culvert at Highway 61 (looking South)

Figure 2.3 Culvert inlet (looking West)

Figure 2.4 Culvert outlet (looking East)

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out between August 28th and September 5th, 2014 utilizing a CME 750 drill rig equipped for geotechnical drilling and operated by DST. A total of five boreholes were advanced to depths ranging from 3.6 m to 10.8 m. The minimum number and depth of the boreholes was specified by the Ministry of Transportation (MTO).

The borehole locations and stratigraphic sections are shown on the Borehole Location Plan Drawing 1 to 3. Borehole 1 was advanced south of the existing culvert at Station 23+370, 5.1 m right of centreline, and advanced to a depth of 10.8 m below surface. Borehole 2 was advanced North of the existing culvert at Station 23+380, 5.0 m left of centreline, and advanced to a depth of 10.8 m below existing surface. Borehole 3 was advanced North of the existing culvert at Station 23+385, 14.0 m right of centreline, and advanced to a depth of 6.0 m below existing surface. Borehole 4 was advanced at the inlet at Station 23+379, 16.5 m left of centreline, and advanced to a depth of 4.0 m below existing surface. Borehole 5 was advanced at the Inlet at Station 23+372, 16.5 m left of centreline, and advanced to a depth of 3.6 m below existing surface.

The borehole locations are referenced to the MTO Station numbering system as indicated on the drawings provided by MTO. The ground surface elevations at the borehole locations were surveyed by DST personnel and referenced to the existing culvert at Station 23+375. A nail in wooden pole on the south side of the culvert at Station 23+345, 11.0 m Lt was assigned as temporary benchmark with elevation of 100.0 m Table 3.1 summarizes the detail of borehole locations and depths.

All boreholes were abandoned using suitable abandonment barrier as described in Ontario Regulation 903 and its amendments. Boreholes were decommissioned by backfilling to the bottom of the road base with cuttings and bentonite chips. From the bottom of the road base, granular materials were replaced to the bottom of the asphalt and the asphalt was sealed with a cold patch.

The fieldwork was supervised on a full-time basis by DST personnel who located the boreholes in the field, performed sampling, in-situ testing and logged the boreholes. Soil samples were obtained from the auger flights and from the split spoon sampler used for the standard penetration test (SPT). The SPT involves driving a 51 mm diameter thick-walled sampler into the soil under the energy of a 63.5 kg weight falling through 760 mm. The number of blows required to drive the sampler 305 mm is known as the standard penetration blow count (N) which provides an

indication of the condition or consistency of the soil. The soil samples collected during drilling were identified in the field, placed in labelled containers and transported to DST's laboratory in Thunder Bay for further analysis.

Classification and index tests were subsequently performed in the laboratory on samples collected from the boreholes to aid in the selection of engineering properties. Laboratory tests included moisture contents, particle size analyses and Atterberg limits including plastic limit and liquid limit. A total of twenty seven (27) moisture contents, two (2) sieve analyses, one (1) particle size analyses and seven (7) Atterberg limits have been done for this assignment. Laboratory test results are presented in the Boreholes Logs and attached graphical plots in Appendix D (Enclosures).

Table 3.1 Detail of borehole locations

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)
BH1	23 + 370	101.4	10.8	5.1 Rt
BH2	23+380	101.2	10.8	5.0 Lt
BH3	23+385	98.6	6.0	14.0 Rt
BH4	23+379	98.7	4.0	16.5.0 Lt
BH 5	23+372	98.7	3.6	16.5 Lt

4. DESCRIPTION OF SUBSURFACE CONDITIONS

The subsurface conditions are presented based on the information obtained during power auger drilling and hand auger drilling.

The generalized stratigraphy of the existing embankment, based on the conditions encountered in Boreholes 1 and 2, consists of asphalt overlying a granular sand layer that is underlain by silty clay.

Table 4.1 Summary of soil strata at the culvert location

Layer	Depth (m)	Elevation (m)	Comments
Asphalt	0.05	101.4 to 101.3 101.1 to 101.0	
Fill- Sand and Crushed Gravel	0.05 to 0.3	101.3 to 101.2 101.0 to 100.8	
Sand	0.3 to 4.6 0.3 to 5.3	101.2 to 96.8 100.8 to 95.8	
Clay	4.6 to 10.8 5.3 to 10.8	96.8 to 90.6 95.8 to 90.3	

4.1 Asphalt

Asphaltic concrete was encountered at surface in Boreholes 1 and 2 with thickness of 50 mm.

4.2 Topsoil and organics

Topsoil was encountered in Boreholes 3, 4 and 5 at surface with a thickness of approximately 0.1 m (Elev. 98.6 to 98.5 m), 1.5 m (Elev. 98.7 to 97.2 m) and 1.1 m (Elev. 98.7 to 97.6 m) respectively. Standing water was observed in Boreholes 4 and 5.

4.3 Fill – Sand and Crushed Gravel

Sand fill and crushed gravel, trace to some silt was encountered in Boreholes 1 and 2 below the asphalt with a thickness of 0.2 m at depths between 0.1 to 0.3 m (Elev. 101.4 to 101.2m) and depths between 0.1 to 0.3 m (Elev. 101.0 to 100.8 m) respectively. The moisture contents of samples tested range from 4 to 6 %.

4.4 Fill - Sand

Fill Sand with to some gravel and some silt was encountered in the Boreholes 1 and 2 with a thickness of approximately 4.4 m and 5.1 m at depths 0.2 to 4.6 m (Elev. 101.2 to 96.8 m) and 0.2 to 5.3 m (Elev. 100.9 to 95.8 m) respectively.

SPT 'N' values vary from 2 to 21, indicating a very loose to compact condition. The moisture contents of the sand material vary from 4 to 17 %. The laboratory test results are summarized in following Tables 4.2

Table 4.2 Summary of particle size analysis

Laboratory Results	
Gravel %	18 to 30
Sand %	55 to 68
Silt %	14 to 15

4.5 Sand

Sand with some gravel was encountered in the Boreholes 3, 4 and 5 with a thickness of approximately 0.5 m, 0.3 m and 0.3 at depths 0.1 to 0.6 m (Elev. 98.5 to 98.0 m), 1.5 to 1.8 m (Elev. 97.2 to 96.9 m) and 1.1 to 1.4 m (Elev. 97.6 to 97.3 m) respectively. Black organics mixed with the sand layer was observed in Borehole 3.

SPT 'N' values was found to be 1 in Borehole 3, indicating a very loose condition. The moisture contents of the sand material for borehole 1 was found to be 44.

4.6 Silt-sandy

Sandy silt with some clay was encountered in Borehole 3 at depth of 0.6 m (Elev. 98.0 m) with thickness of 1.7 m. SPT 'N' values were found to vary between 1 and 3, indicating a very loose condition. The moisture contents of the tested sample was found to be between 19 to 43. The laboratory test results are summarized in following Tables 4.3

Table 4.3 Summary of particle size analysis-silt

Laboratory Results	
Gravel %	0
Sand %	51
Silt %	31
Clay %	18

4.7 Clay-silty

Silty clay material was encountered in Boreholes 1, 2, 3, 4 and 5 at a depths of 4.6 m (Elev. 96.8 m), 5.3 m (Elev. 95.8 m), 2.3 m (Elev. 96.3 m), 1.8 m (Elev. 96.9 m) and 1.4 m (Elev. 97.3 m) respectively. The thickness of this stratum is not defined as borehole terminus was reached within this stratum. Organics was encountered in Borehole 3 within this stratum.

Atterberg limits tests carried out on samples from Boreholes 1, 2, and 3 indicate that the clay has intermediate to high plasticity with liquid limits ranging from 41 to 70 % and plasticity indexes ranging from 15 to 39 %. The moisture content of the clay ranges from 25 to 72 %. Field vane tests completed in Boreholes 1, 2 and 3 vary between 35 kPa to 90 kPa indicating firm to stiff consistency. The laboratory test results are summarized in following Tables 4.4.

Table 4.4 Summary of Atterberg limits- clay

Laboratory Results – Atterberg Limits	
Liquid Limit %	41 to 70
Plastic Limit %	20 to 44
Plastic Index %	15 to 39

4.8 Groundwater

At the time of the field investigation groundwater was observed in Borehole 1 and Borehole 2 at depth of 2.3 m (Elev. 99.1 m) and 2.2 m (Elev. 98.9 m) respectively. The groundwater levels can be expected to vary with the season and precipitation events.

Table 4.5 Groundwater

Borehole Number	Ground water Depth (m)	Elevation (m)
Borehole 1	2.3	99.1
Borehole 2	2.2	98.9

5. MISCELLANEOUS

Site work was carried out between August 27 and September 5, 2014 utilizing a CME 750 all-terrain drill rig operated by DST personnel. Fieldwork was supervised on a full time basis by Peter Raynak who located the boreholes in the field, performed sampling, in-situ testing and logged the boreholes. Soil samples collected during drilling were identified in the field, placed in labelled containers and transported to DST's laboratory in Thunder Bay for further analysis. Interpretation of the data and preparation of the report was completed by Deep Bansal, P.Eng and reviewed by Prof. Myint Win Bo, P.Eng a designated principal contact for MTO projects.

6. LIMITATIONS OF REPORT

A description of limitations which are inherent in carrying out site investigation studies is given in Appendix 'A', and this forms an integral part of this report.

For DST CONSULTING ENGINEERS INC.

Prepared by:

Deep Bansal, P. Eng
Geotechnical Engineer

Reviewed by:

Bernardo Villegas, M.Sc
Manager

Reviewed By:

Dr. M W Bo, PhD., P. Eng, P.Geo, Int PE,
C.Geol, C. Eng, Eur Geol, Eur Eng
Senior Vice President / Senior Principal

APPENDIX 'A'

LIMITATIONS OF REPORT

L I M I T A T I O N S O F R E P O R T

GEOTECHNICAL STUDIES

The data, conclusions and recommendations which are presented in this report, and the quality thereof, are based on a scope of work authorized by the Client. Note that no scope of work, no matter how exhaustive, can identify all conditions below ground. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the specific locations tested, and conditions may become apparent during construction which were not detected and could not be anticipated at the time of the site investigation. Conditions can also change with time. It is recommended practice that DST Consulting Engineers be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavation, planning, development, etc.

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 details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

Unless otherwise noted, the information contained herein in no way reflects on environmental aspects of either the site or the subsurface conditions.

The comments given 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, e.g. 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.

Any results from an analytical laboratory or other subcontractor reported herein have been carried out by others, and DST Consulting Engineers Inc. cannot warranty their accuracy. Similarly, DST cannot warranty the accuracy of information supplied by the client.

Appendix B

DESCRIPTION OF TERMS

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS

TEXTURAL CLASSIFICATION OF SOILS

BOULDERS	COBBLES	GRAVEL	SAND	SILT	CLAY
GREATER THAN 200 mm	75 TO 200 mm	4.75 TO 75 mm	0.075 TO 4.75 mm	0.002 TO 0.075 mm	LESS THAN 0.002 mm

COARSE GRAIN SOIL DESCRIPTION (50% GREATER THAN 0.075 mm)

TERMINOLOGY	TRACE OR OCCASIONAL	SOME	WITH	ADJECTIVE (e.g. SILTY OR SANDY)	AND (e.g. SAND AND SILT)
	LESS THAN 10%	10 TO 20%	20 TO 30%	30 TO 40%	40 TO 60%

CONSISTENCY*: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (C_U) AND SPT 'N' VALUES AS FOLLOWS

C_U (kPa)	0 – 12	12 – 25	25 – 50	50 - 100	100 - 200	> 200
N (BLOWS / 0.3 m)	<2	2 - 4	4 - 8	8 - 15	15 - 30	>30
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

N (BLOWS / 0.3 m)	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, 100 mm+ IN LENGTH EXPRESSED AS A PERCENTAGE OF THE LENGTH OF THE CORING RUN.

THE ***ROCK QUALITY DESIGNATION*** *(R.Q.D)* FOR MODIFIED RECOVERY IS:

R.Q.D (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

LEGEND OF RECORDS FOR BOREHOLES: SYMBOLS AND ABBREVATIONS FOR SAMPLE TYPE

SS	SPLIT SPOON SAMPLE	WS	WASH SAMPLE
TW	THIN WALL SHELBY TUBE SAMPLE	AS	AUGER (GRAB) SAMPLE
PH	SAMPLER ADVANCED BY HYDRAULIC PRESSURE	TP	THIN WALL PISTON SAMPLE
WH	SAMPLER ADVANCED BY SELF STATIC WEIGHT	PM	SAMPLER ADVANCED BY MANUAL PRESSURE
SC	SOIL CORE	RC	ROCK CORE
▼	WATER LEVEL	$SENSITIVITY = \frac{UNDISTURBED\ SHEAR\ STRENGTH}{REMOLDED\ SHEAR\ STRENGTH}$	

*HIERARCHY OF SOIL STRENGTH PREDICTION: **1)** LABORATORY TRIAXIAL TESTING. **2)** FIELD INSITU VANE TESTING. **3)** LABORATORY VANE TESTING. **4)** SPT VALUES. **5)** POCKET PENETROMETER.

Appendix C

DRAWINGS

C:\Users\ndennis\SharePoint\CAD, GIS and gINT - Documents 1\CAD_GIS_gINT\CAD Working Folder\JH PROGRESS - GS-TB-016499 - 6013-E-0021 Assignment4 489-183C Jarvis River Culvert

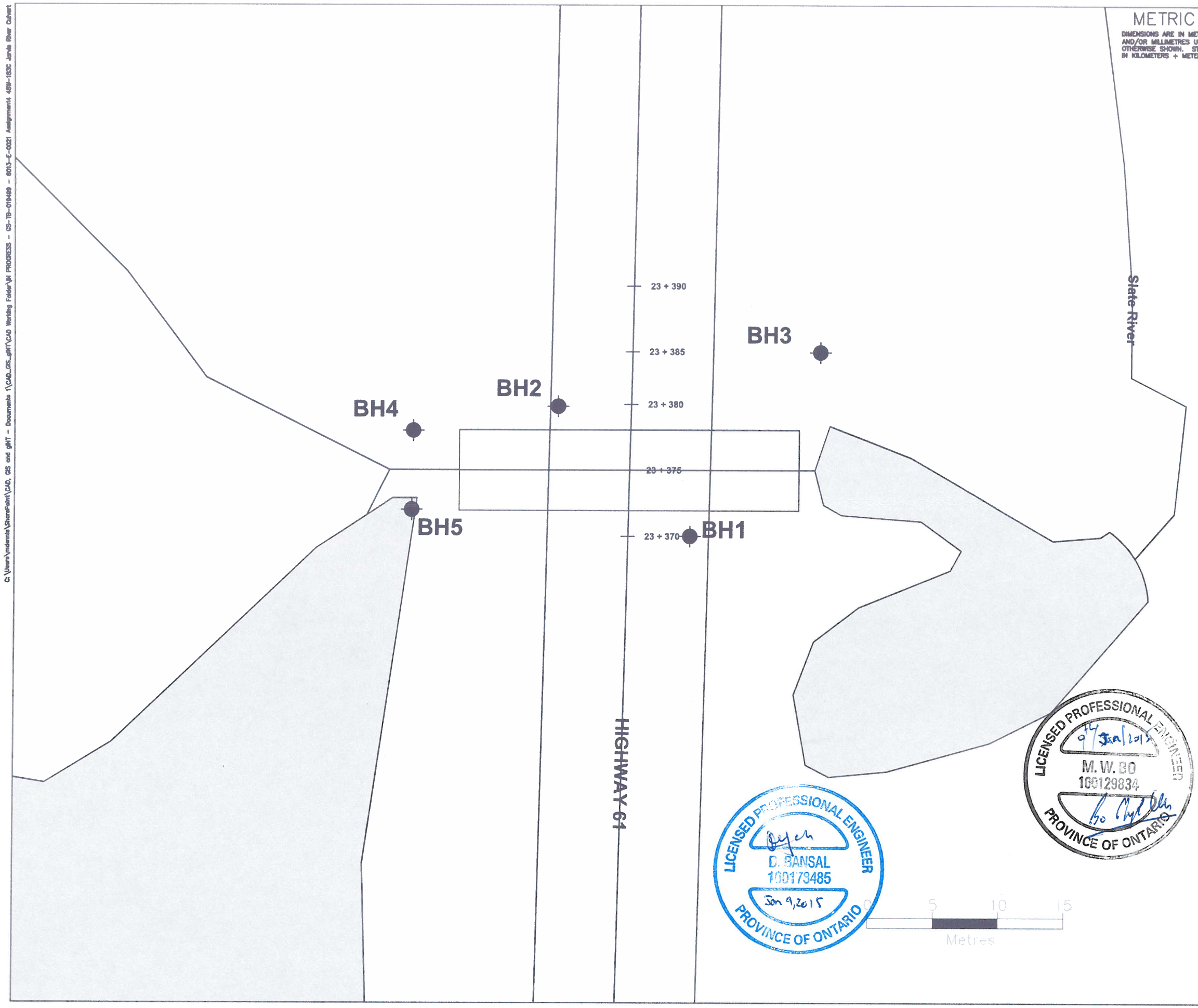
METRIC

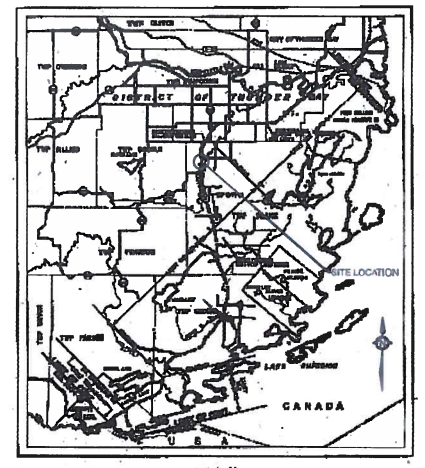
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLES OTHERWISE SHOWN. STATIONS IN KILOMETERS + METERS

CONT	No
WP	No 6305-14-00
SITE	No 48W-195/C
GEOCRES	No 52A-194

CULVERT REPLACEMENT
SLATE RIVER CULVERT
STA 23+370 TO STA 23+385
Survey_____ Revised_____

SHEET





KEY PLAN

LEGEND

- Borehole
- Borehole with CPT
- Asphalt Core
- Rock Probe
- 'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)
- Water level at time of investigation.

Fill, Organics, Topsoil, Till, Bedrock
Sand, Silt, Clay, Sand & Gravel, Boulders

No.	Elevation	Northing	Easting	Station	Offset
BH1	101.4	5349847 m N	315764 m E	23+370	5.1 m RT
BH2	101.2	5349860 m N	315694 m E	23+380	5.0 m LT
BH3	98.6	5349862 m N	315714 m E	23+385	14.0 m RT
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BH5	-	-	-	23+372	16.5 m LT

LICENSED PROFESSIONAL ENGINEER
D. BANSAL
100173485
Jan 9, 2015
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
09 Jan 2015
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100129834
PROVINCE OF ONTARIO

NOTE:
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DST consulting engineers
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Thunder Bay, ON P7B 5V5
Ph: (807) 623-2929
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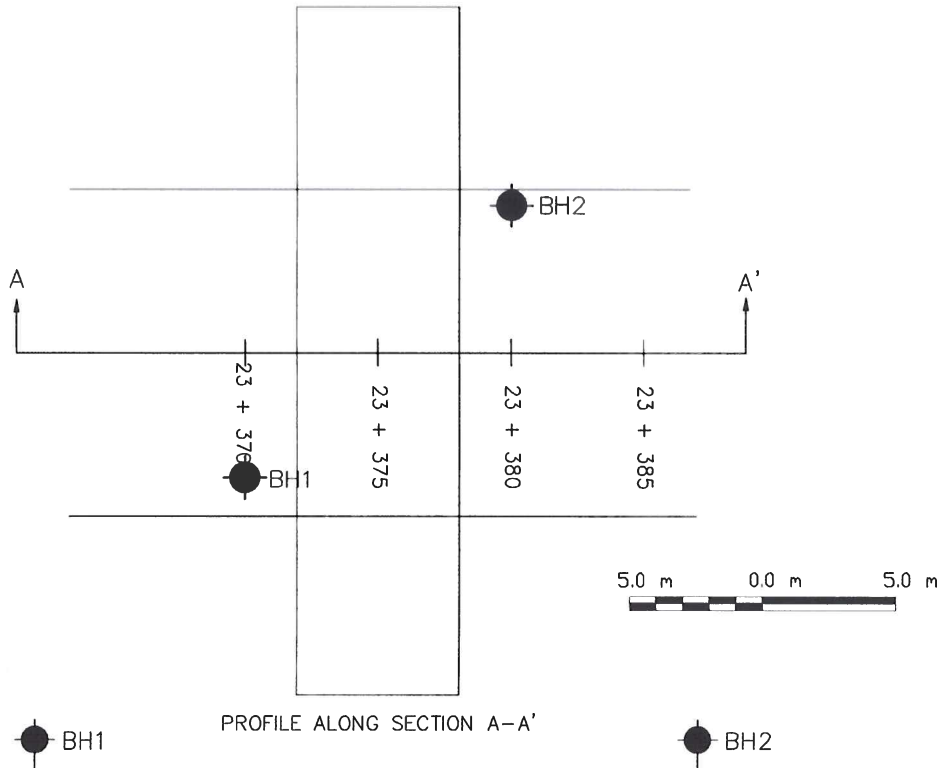
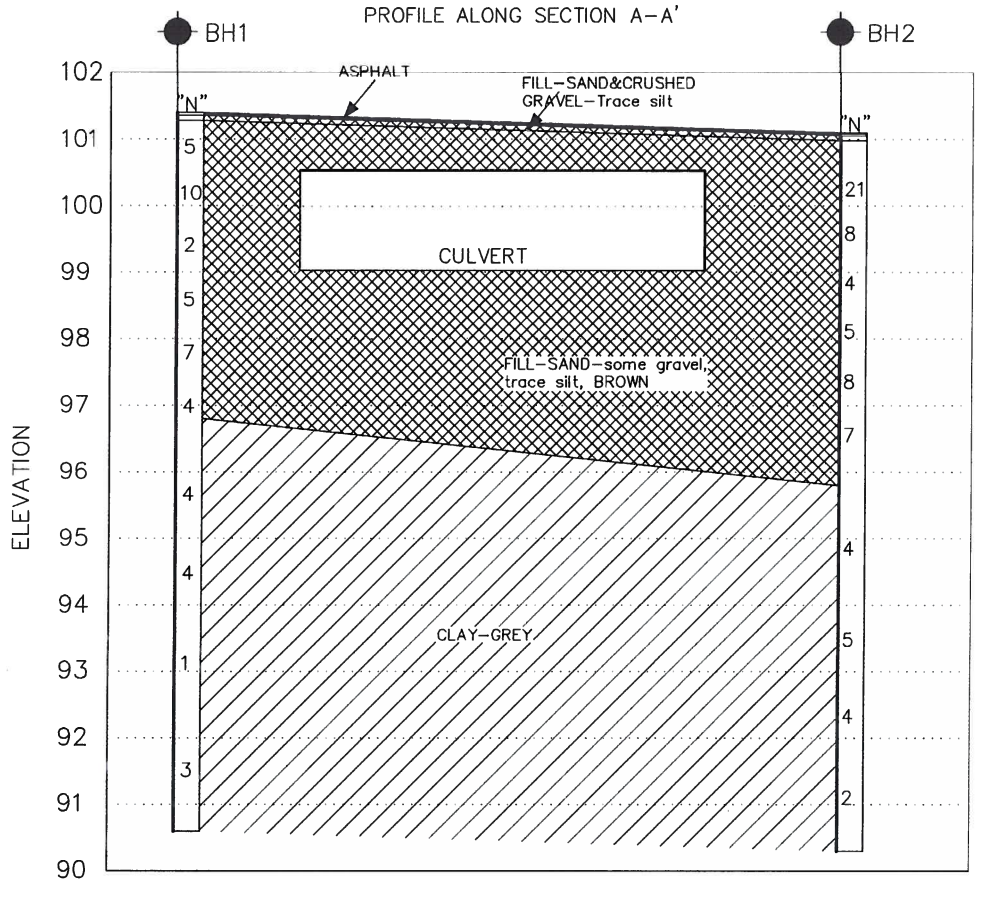
DRAWING 1



PROFILE ALONG SECTION A–A'



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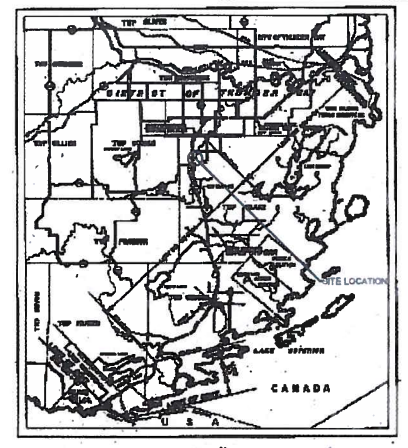

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Fx: (807) 623-1792
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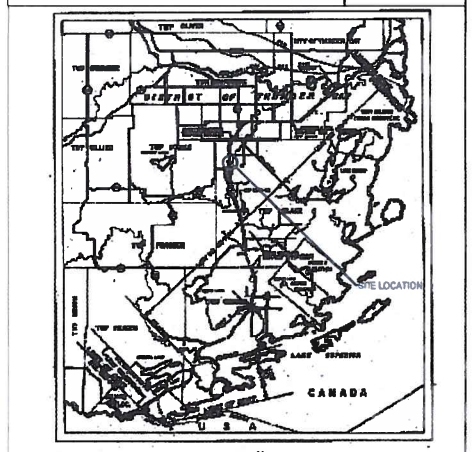

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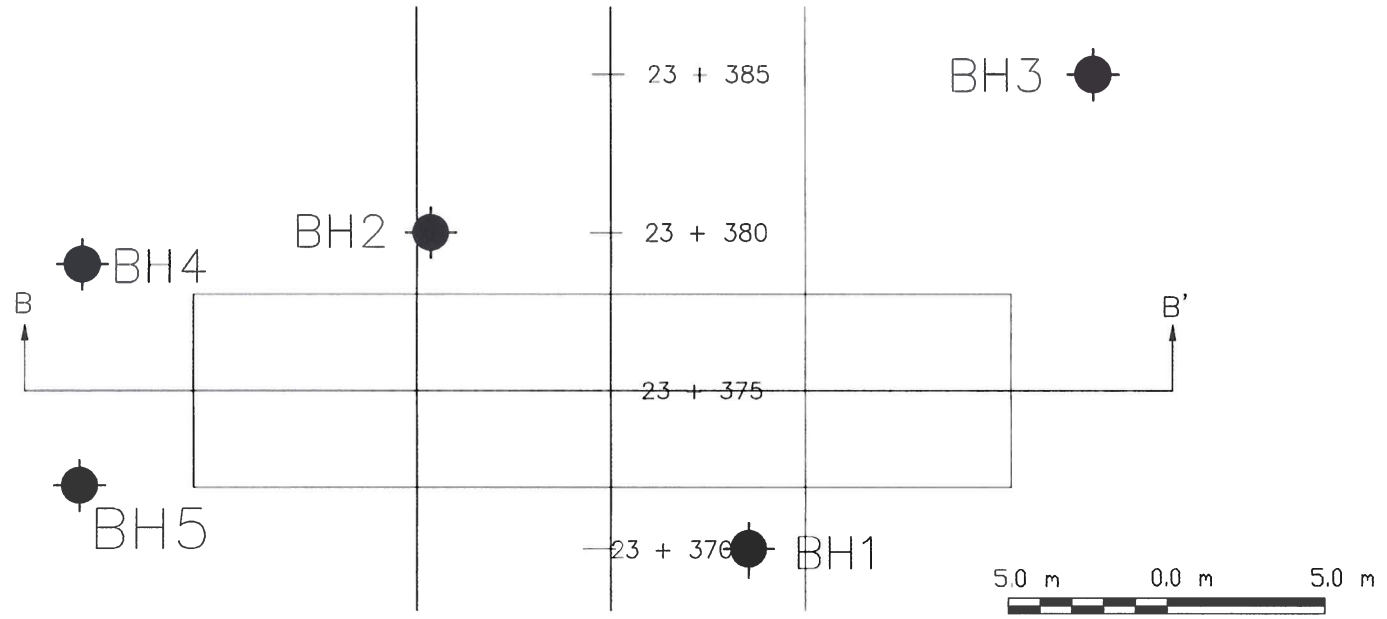
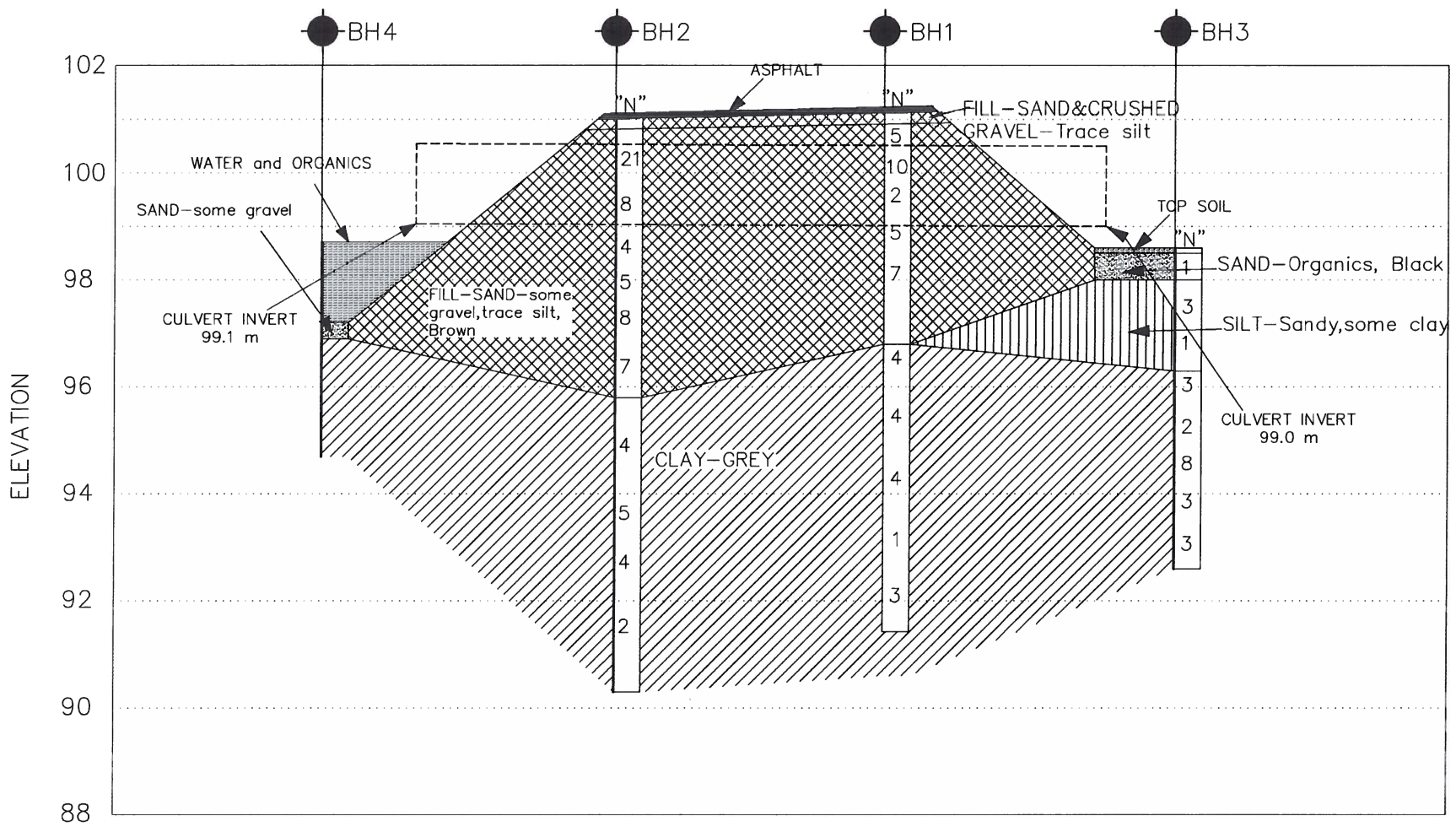


PROFILE ALONG SECTION B-B'



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DRAWING 3

Appendix D

ENCLOSURES

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Slate River Tributary Culvert STA 23+370 RT 5.1 m ORIGINATED BY PR

DIST Thunder Bay HWY 61 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB

DATUM Local DATE 2014 08 27 CHECKED BY DM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, □ QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
101.4	GROUND SURFACE										
101.4 / 0.0	ASPHALT										
101.3 / 0.1	FILL-SAND & CRUSHED GRAVEL-Trace silt		AS1	AS							
0.3	FILL-SAND-some gravel, trace silt, BROWN		SS2	SS	5						
			SS3	SS	10						
			SS4	SS	2	▽					
			SS5	SS	5						18 68 (14)
96.8			SS6	SS	7						
4.6	CLAY-Silty, GREY		SS7	SS	4			+6			
			SS8	SS	4						
			SS9	SS	1			+6			
			SS10	SS	3						
90.6								+6			
10.8	END OF BOREHOLE										

ELEVATION SCALE: 101, 100, 99, 98, 97, 96, 95, 94, 93, 92, 91

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: 50 100 150 200 250

WATER CONTENT (%): 20 40 60

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES GS-TB-019500 SLATE RIVER.GPJ DST_MIN.GDT 11/24/14

ENCLOSURE 1

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Slate River Tributary Culvert STA 23+380 LT 5.0 m ORIGINATED BY PR

DIST Thunder Bay HWY 61 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB

DATUM Local DATE 2014 08 27 CHECKED BY DM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
101.1	GROUND SURFACE										
100.1	ASPHALT										
100.8	FILL-SAND & CRUSHED GRAVEL-Trace silt		AS1	AS							
0.3	FILL-SAND-some gravel, trace silt, BROWN		SS2	SS	21						30 55 (15)
			SS3	SS	8	▽					
			SS4	SS	4						
			SS5	SS	5						
			SS6	SS	8						
			SS7	SS	7						
95.8											
5.3	CLAY-Silty, GREY		SS8	SS	4						
			SS9	SS	5						
			SS10	SS	4						
			SS11	SS	2						
90.3											
10.8	END OF BOREHOLE										

ELEVATION SCALE: 101, 100, 99, 98, 97, 96, 95, 94, 93, 92, 91

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE — 50 100 150 200 250

+5 +10 +6.5 +7.2

WATER CONTENT (%): 20 40 60

$+^3$, $\times^3$: Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

ON_MOT-HIGH VANES GS-TB-019500 SLATE RIVER.GPJ DST_MIN.GDT 11/24/14

ENCLOSURE 2

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Slate River Tributary Culvert STA 23+385 RT 14.0 m ORIGINATED BY PR

DIST Thunder Bay HWY 61 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB

DATUM Local DATE 2014 09 05 CHECKED BY DM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
98.6	GROUND SURFACE										
98.5 / 0.1	TOPSOIL										
98.0	SAND-organics, BLACK		SS1	SS	1						
0.6	SILT-sandy, some clay, Very Loose		SS2	SS	3		98	2			0 51 31 18
			SS3	SS	1		97				
96.3											
2.3	CLAY-Silty, GREY/REDISH		SS4	SS	3		96				
	-Trace Organics		SS5	SS	2						
			SS6	SS	8		95	8, 6			
			SS7	SS	3		94	4			
92.6			SS8	SS	3		93				
6.0	END OF BOREHOLE										

NR = NO RECOVERY $+^{3}$, $\times^{3}$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT GS-TB-019500 SLATE RIVER.GPJ DST_MIN.GDT 1/9/15

ENCLOSURE 3

RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Slate River Tributary Culvert STA 23+379 LT 16.5 m ORIGINATED BY PR

DIST Thunder Bay HWY 61 BOREHOLE TYPE Hand Auger Hole COMPILED BY DB

DATUM Local DATE 2014 09 05 CHECKED BY DM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
98.7	GROUND SURFACE										
	WATER and ORGANICS						98				
97.2											
1.5 / 96.9	SAND-some gravel						97				
1.8	CLAY-silty						96				
94.7							95				
4.0	END OF BOREHOLE										

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES GS-TB-019500 SLATE RIVER.GPJ DST_MIN.GDT 11/24/14

RECORD OF BOREHOLE No BH5

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Slate River Tributary Culvert STA 23+372 LT 16.5 m ORIGINATED BY PR

DIST Thunder Bay HWY 61 BOREHOLE TYPE Hand Auger Hole COMPILED BY DB

DATUM Local DATE 2014 09 05 CHECKED BY DM

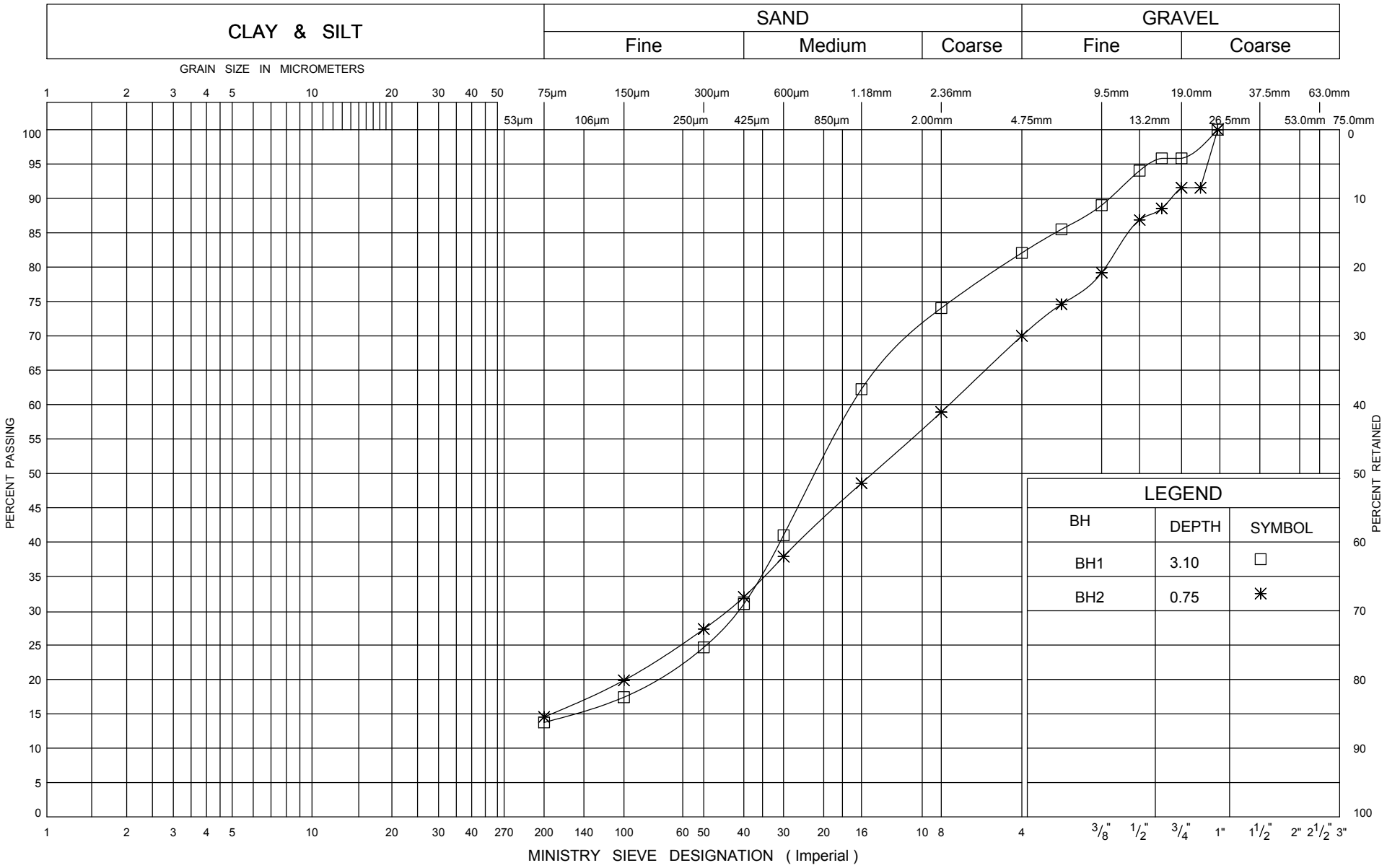
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
98.7	GROUND SURFACE										
	WATER and ORGANICS						98				
97.6 1.1											
97.3	SAND-some gravel						97				
1.4	CLAY-silty										
							96				
95.1											
3.6	END OF BOREHOLE										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES GS-TB-019500 SLATE RIVER.GPJ DST_MIN.GDT 11/24/14

ENCLOSURE 5

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION
FILL-SAND

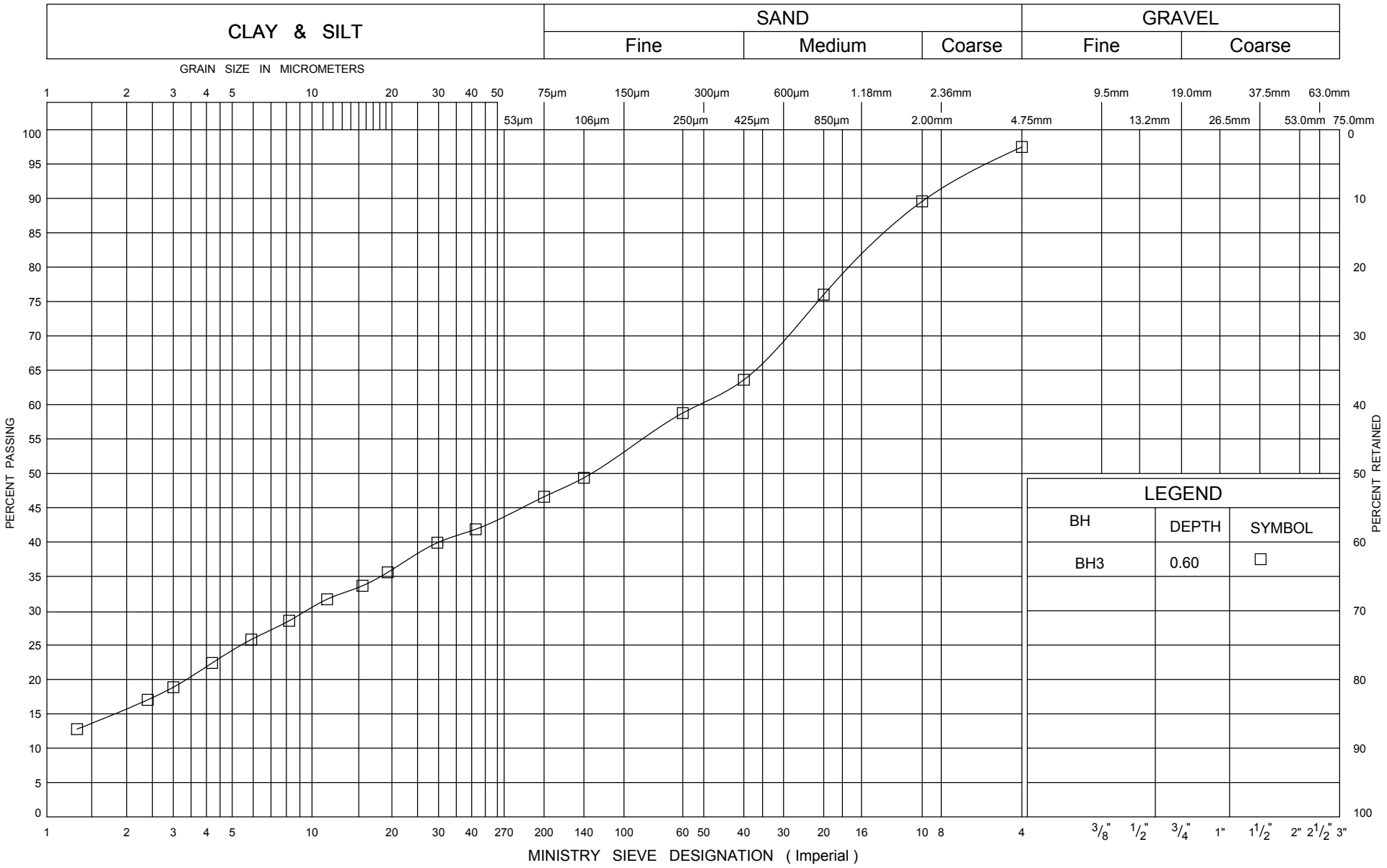
ENCLOSURE 6

W P 6013-E-0021

HWY 61

ONTARIO MOT GRAIN SIZE GS-TB-019500 SLATE RIVER.GPJ DST_MIN.GDT 11/25/14

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation Ontario

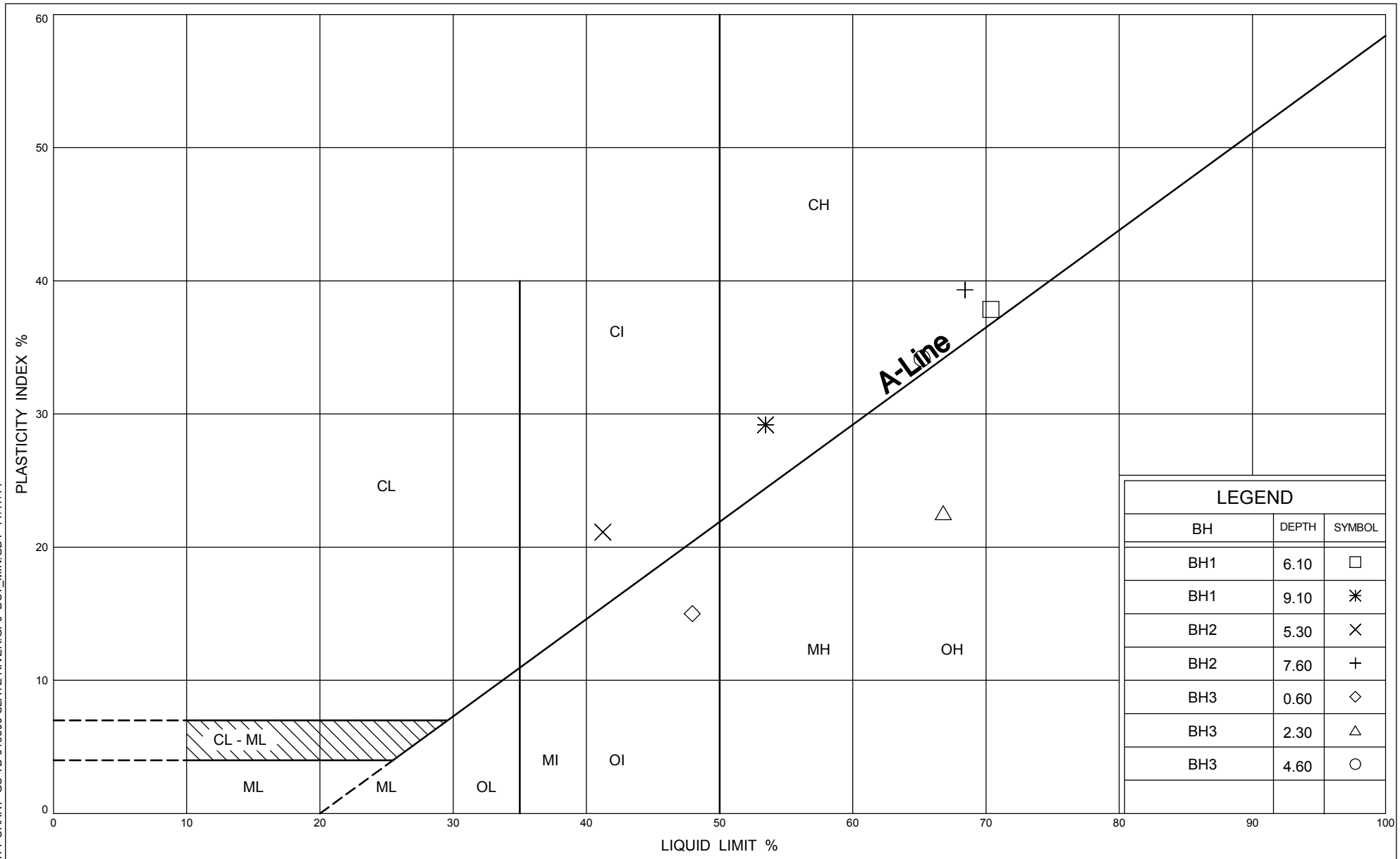
GRAIN SIZE DISTRIBUTION
SILT

ENCLOSURE 7

W P 6013-E-0021

HWY 61

ONTARIO MOT GRAIN SIZE GS-TB-019500 SLATE RIVER.GPJ DST_MIN.GDT 11/25/14



ONTARIO MOT PLASTICITY CHART GS-TB-019500 SLATE RIVER.GPJ DST_MIN.GDT 11/17/14

Ministry of Transportation Ontario

PLASTICITY CHART
CLAY-Silty

ENCLOSURE 8

W P 6013-E-0021

HWY 61