



**FOUNDATION INVESTIGATION REPORT
CEDAR CREEK CULVERT REPLACEMENT
HIGHWAY 595
TOWNSHIP OF O'CONNOR, THUNDER BAY DISTRICT
AGREEMENT NO.: 6013-E-0021
ASSIGNMENT NO.: 4
SITE NO.: 48W-171/C
GEOCRES NO. 52A-193
GWP 6353-14-00**

**JANUARY 9, 2015
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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 595. 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 595, approximately 1.45 km South of Highway 590 (latitude 48.3861, longitude -89.7008), LHRS 62920, offset 10.830, Station 20+860, in the Township of O'Connor, in the District of Thunder Bay.

It is understood that the existing 11.5 m long centreline culvert is a three sided cast-in-place concrete box approximately 6.1 m wide and approximately 2.3 m in height of the existing culvert (Figure 2.3 and 2.4). The original date of construction is unknown and inspection conducted by others indicates there is delamination and spalls, wide cracks in the retaining walls and exposed rebar in the soffit. The fill thickness above the culvert is approximately 0.7 m and the side slope of the embankment is approximately 1.5H:1V. The surrounding area is moderately vegetated and wooded (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 O'Connor area. The map indicates that the local area landform is identified as a till, clay ground moraine. The topography in the area is mainly low local relief; plain with dry drainage conditions.



Figure 2.1 Location of existing culvert at Highway 595 (looking North)



Figure 2.2 Location of existing culvert at Highway 595 (looking South)



Figure 2.3 Culvert outlet (looking West)



Figure 2.4 Culvert inlet (looking East)

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out on August 20th and 21st, 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 0.5 m to 5.0 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 and Drawings 2 to 3. Borehole 1 was advanced South of the existing culvert at station 20+856, 1.5 m right of centreline, and advanced to a depth of 5.0 m below surface. Borehole 2 was advanced North of the existing culvert at station 20+864, 1.7 m left of centreline, and advanced to a depth of 3.5 m below existing surface. Borehole 3 was advanced 2.0 m North of Borehole 2 at station 20+866 to confirm the soil conditions. The remaining two boreholes were advanced with portable hand equipment at the inlet and outlet of the existing culvert. Borehole 4 was advanced at the outlet at station 20+860, 7.5 m right of centreline, where bedrock was encountered on the surface. Borehole 5 was advanced at the inlet at station 20+860, 7.5 m left of centreline, and advanced to a depth of 0.5 m below existing surface.

The borehole locations are referenced to the MTO Station numbering system as indicated on the drawings provided by the Ministry. The ground surface elevations at the borehole locations were surveyed by DST personnel and referenced to the existing culvert at Station 20+860. The nail on telephone/hydro pole # 282 on the north side of the culvert at approximately Station 20+894, 10.0 m right 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 eighteen (18) moisture contents, three (3) sieve analyses, two (2) particle size analyses and five (5) Atterberg limits have been done for this assignment. Laboratory test results are presented in the Boreholes Logs and graphical plots attached Appendix D (Enclosures).

Table 3.1 Detail of borehole locations

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)
BH1	20+856	100.1	5.0	1.5 Rt
BH2	20+864	100.1	3.5	1.7 Lt
BH3	20+866	100.1	4.3	1.7 Lt
BH4 (HA)	20+860	95.4	0.0	7.5 Rt
BH5 (HA)	20+860	95.0	0.5	7.5 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, 2, and 3, consists of surface treatment and cold mix patching overlying a fill consisting of sand, silt and clay underlain by silty clay which is again underlain by a till material overlaying bedrock.

Table 4.1 Summary of soil strata at the culvert location

Layer	Depth (m)	Elevation (m)	Comments
Surface Treatment	0.0 to 0.1 0.0 to 0.2	100.0 to 99.9 100.1 to 99.9	Cold mix patching
Fill- Sand	0.1 to 0.8 0.2 to 0.8	99.9 to 99.3 99.9 to 99.4	
Fill- Silt	0.8 to 1.5	99.3 to 98.5	
Fill- Silty Clay	0.8 to 3.1	99.4 to 97.0	
Silty Clay	1.5 to 4.6	98.5 to 95.4	
Till	4.6 to 5.0 3.1 to 3.5	95.4 to 95.0 97.0 to 96.6	

4.1 Surface Treatment

Surface treatment with cold mix patching was encountered at surface in Boreholes 1, 2, and 3 with thicknesses ranging from 60 to 200 mm.

4.2 Fill – Sand

Sand fill with some gravel, trace to some silt was encountered in Boreholes 1, 2, and 3 below the asphalt at depth of 0.1 m, 0.2 m and 0.2 m with a thickness of 0.7 (Elev. 99.9 to 99.3 m), 0.6 (Elev. 99.9 to 99.4 m), and 0.3 m (Elev. 100.0 to 99.7 m) respectively.

The moisture contents of the sand and gravel material vary from 3 to 5 %. The results of laboratory tests are summarized in Table 4.2.

Table 4.2 Summary of sand and gravel fill sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	30
Sand %	59
Fines %	11

4.3 Fill – Silt

Silt fill with sand, trace gravel, trace clay and cobbles was encountered in Boreholes 1 and 3 at depth of 0.8 m and 0.5 m with a thickness of 0.7 m (Elev. 99.3 to 98.5 m) and 1.0 m (Elev. 99.7 to 98.6 m) respectively.

SPT 'N' value found to be 9, indicating a loose condition. The moisture contents of the silt material vary from 12 to 20 %. The results of laboratory tests are summarized in Table 4.3.

Table 4.3 Summary of silt fill particle size analyses

Laboratory Results – Particle Size Analyses	
Gravel %	2
Sand %	36
Silt %	52
Clay %	10

4.4 Fill-Silty Clay

Silty Clay Fill was encountered in Borehole 2 at depth of 0.8 m with thickness of 2.3 m (Elev. 99.4 to 97.0 m). Atterberg limits tests carried out on samples from Borehole 2 indicate that the clay has low to medium plasticity. The moisture content of the clay ranges from 17 to 29 %. Field vane tests completed in Borehole 2 showing 65 kPa indicating a stiff consistency. The laboratory test results are summarized in following Tables 4.4 and 4.5.

Table 4.4 Summary of Atterberg limits- clay

Laboratory Results – Atterberg Limits	
Liquid Limit %	26 to 37
Plastic Limit %	16 to 23
Plastic Index %	9 to 14

Table 4.5 Summary of clay particle size analyses

Laboratory Results – Particle Size Analyses	
Gravel %	0
Sand %	30
Silt %	36
Clay %	34

4.5 Silty Clay

A silty clay material was encountered in Boreholes 1 and 3 at depths of 1.5 m (Elev. 98.5 m) and 1.5 m (Elev. 98.6 m) with thickness of 3.1 m (Elev. 98.5 to 95.4 m), and 1.6 m (Elev. 98.6 to 97.0 m) respectively. In Boreholes 3 silty clay was again encountered at depths of 3.7 m (Elev. 96.4 m) with thickness of 0.3 m (Elev. 96.4 to 96.1 m).

Atterberg limits tests carried out on samples from Boreholes 1 and 3 indicate that the clay has low to high plasticity. The moisture content of the clay ranges from 18 to 35 %. Field vane test completed in Boreholes 1 showing 100 kPa indicating a stiff consistency. The laboratory test results are summarized in following Tables 4.6

Table 4.6 Summary of Atterberg limits- clay

Laboratory Results – Atterberg Limits	
Liquid Limit %	33 to 51
Plastic Limit %	22 to 27
Plastic Index %	9 to 23

4.6 Gravel

Gravel with some sand, trace silt was encountered in Borehole 3 at depth of 3.1 m with thickness of 0.7 m (Elev. 97.0 to 96.3 m). The moisture content of the tested sample was found to be 10%. The

results of laboratory tests are summarized in Table 4.7.

Table 4.7 Summary of gravel sieve analyses

Laboratory Results – Sieve Analyses	
Gravel %	79
Sand %	15
Fines %	6

4.7 Sand

Sand with some gravel, cobbles and boulders was encountered in Borehole 5 at the surface. The thickness of this stratum is not defined as borehole terminus was reached within this stratum due to auger refusal on possible bedrock at depth of 0.5 m (94.8 m).

4.8 Till

Till material with sand and gravel, with silt and trace clay was encountered in Borehole 1 and 3 at depth of 4.6 m (Elev. 95.4 m) and 4.0 m (Elev. 96.1 m). The thickness of this stratum is not defined as borehole terminus was reached within this stratum due to auger refusal on possible bedrock.

The moisture content of the tested sample was found to be 20%. The results of laboratory tests are summarized in Table 4.8.

Table 4.8 Summary of till sieve analyses

Laboratory Results – Sieve Analyses	
Gravel %	44
Sand %	36
Fines %	20

4.9 Auger Refusal

Auger Refusal on possible bedrock was encountered in Borehole 1, 3, 4 and 5 at depth of 5.0 m (Elev. 95.0 m), 4.3 m (Elev. 95.8 m), 0.0 m (Elev. 95.0 m) and 0.5 m (Elev. 94.8 m) respectively. For Borehole 2 auger refusal on possible concrete abutment was encountered at depth of 3.5 m (Elev. 96.6 m).

4.10 Groundwater

At the time of the field investigation groundwater was observed in Boreholes 1 and 2 and groundwater depths are summarized in Table 4.9. The groundwater levels can be expected to vary with the season and precipitation events.

Table 4.9 Summary of Groundwater

Borehole	Groundwater Depth (m)	Groundwater Elevation (m)
Borehole 1	3.0	97.0
Borehole 2	3.0	97.1

5. MISCELLANEOUS

Site work was carried out during the week of August 20th, 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:

Reviewed by:



Deep Bansal, P. Eng
Geotechnical Engineer

A handwritten signature in blue ink, appearing to read "Bernardo Villegas".

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

LIMITATIONS OF REPORT

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 \bar{N} .

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 ABBREVIATIONS 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

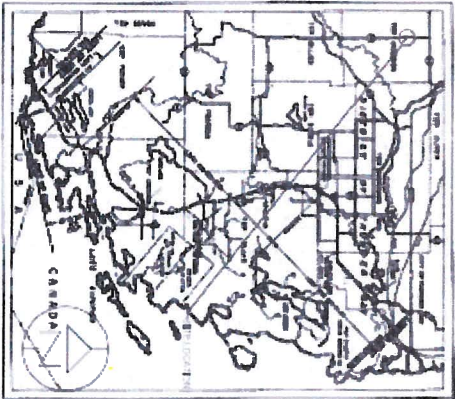
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METERS

CONT No 6353-14-00
GWP No 52A-193
GEOCRES No 52A-193



CULVERT REPLACEMENT
CEDAR CREEK CULVERT
STA 9+995 TO STA 10+006
Survey 13-06 Revised

SHEET



LEGEND

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

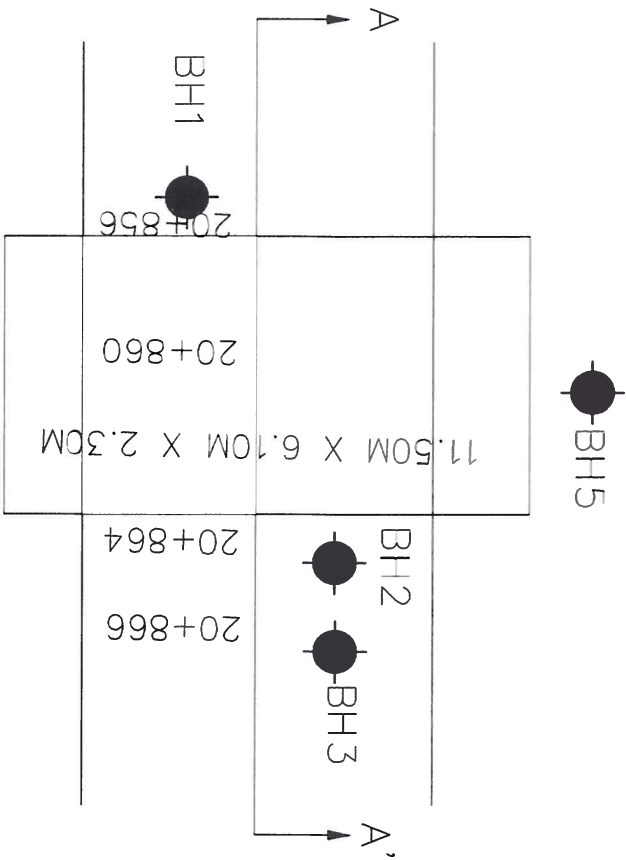
- Fill
- Organics
- Topsoil
- Silt
- Sand
- Clay
- Sand & Gravel
- Boulders
- Bedrock

No.	Elevation	Northing	Eastings	Station	Offset
BH1	100.0	5382627 m N	300041 m E	20+888	1.5 m RT
BH2	100.1	5382642 m N	300035 m E	20+864	1.7 m LT
BH3	100.1	5382638 m N	300037 m E	20+866	1.7 m LT
BH4	95.0	5382624 m N	300032 m E	20+860	7.5 m RT
BH5	95.3	5382632 m N	300023 m E	20+860	7.5 m LT

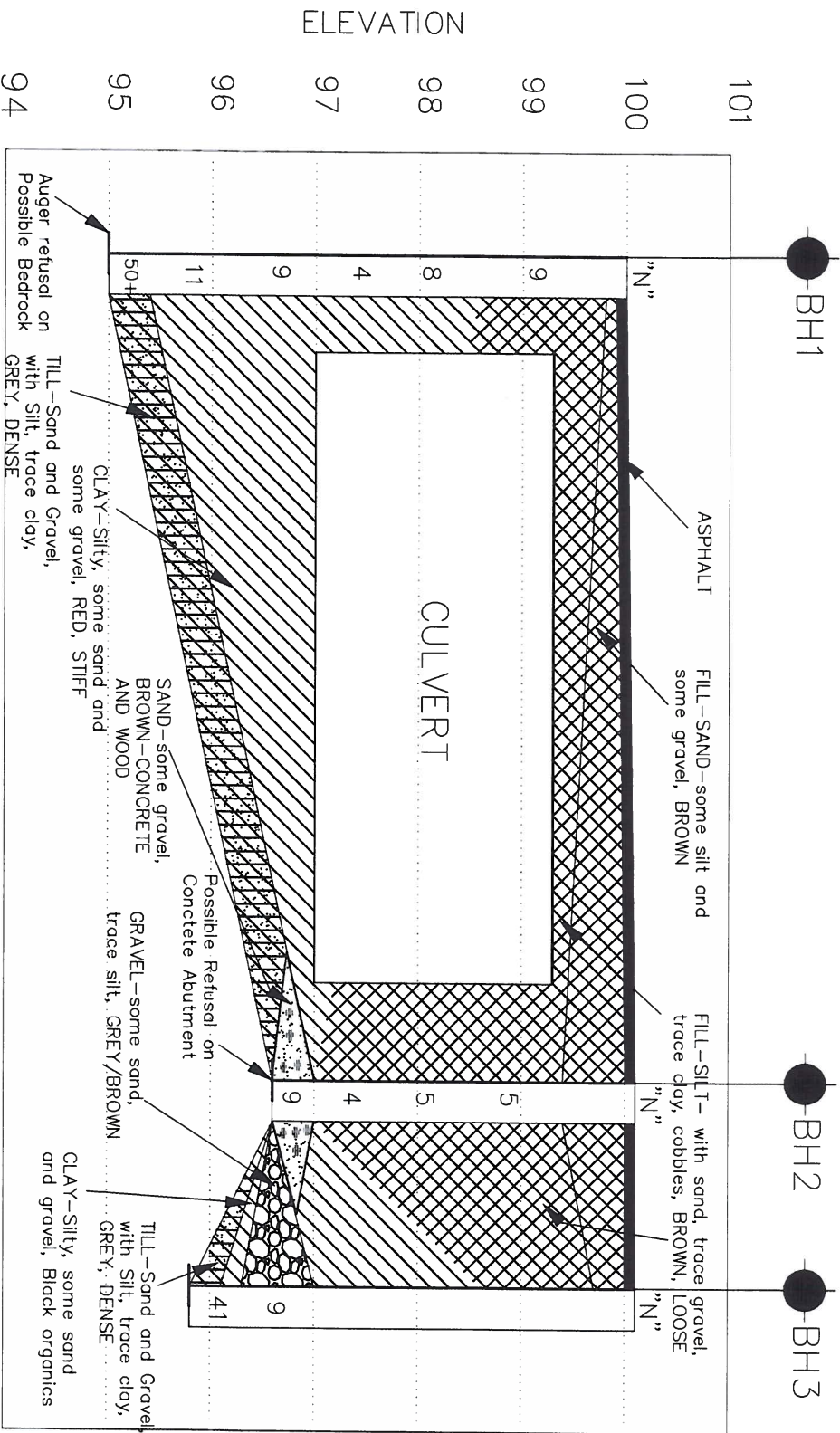
NOTE:
The boundaries between soil strata have been established only at borehole
locations. Between borehole locations they are assumed by interpolation
and may not represent actual conditions.

DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 823-2929
Fx: (807) 823-1792
Email: thunderbay@dstgroup.com

DRAWING 1



PROFILE ALONG SECTION A-A'



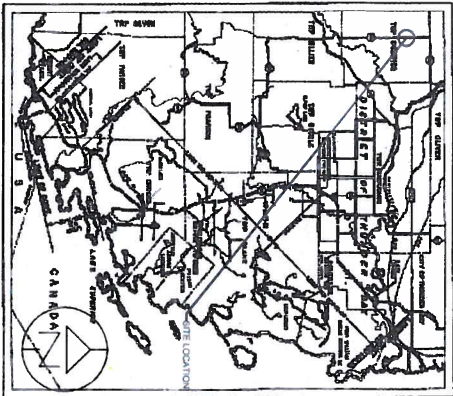
METRIC
DIMENSIONS ARE IN METRES
AND DIMENSIONS IN FEET
AND INCHES ARE SHOWN
WHERE APPROPRIATE
OTHERWISE SHOWN
IN KILOMETERS + METERS

CONT No 6353-14-00
GWP No 52A-193
GEOCRES No 52A-193



CULVERT REPLACEMENT
CEDAR CREEK CULVERT
STA 20+856 TO STA 20+866
Survey 13-06 Revised

SHEET



LEGEND

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

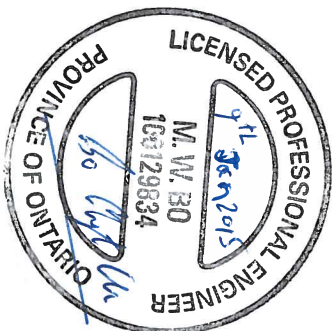
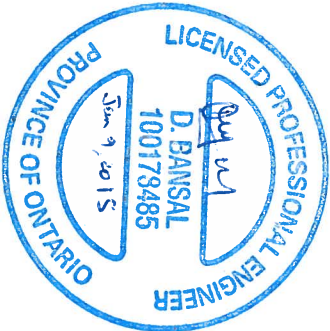
- Fill
- Organics
- Topsoil
- Sand
- Clay
- Silt
- Sand & Gravel
- Boulders
- Bedrock

No.	Elevation	Northing	Eastng	Station	Offset
BH1	106.0	5382827 m N	300641 m E	20+856	1.5 m RT
BH2	106.1	5382842 m N	300635 m E	20+864	1.7 m LT
BH3	106.1	5382838 m N	300637 m E	20+866	1.7 m LT
BH4	95.0	5382824 m N	300652 m E	20+860	7.5 m RT
BH5	95.3	5382832 m N	300623 m E	20+860	7.5 m LT

NOTE:
The engineering drawings have been established only at borehole
locations. Between boreholes the boundaries are assumed by interpolation
and may not represent actual conditions.

DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 623-8929
Fax: (807) 623-1792
Email: thunderbay@dstgroup.com

DRAWING 2



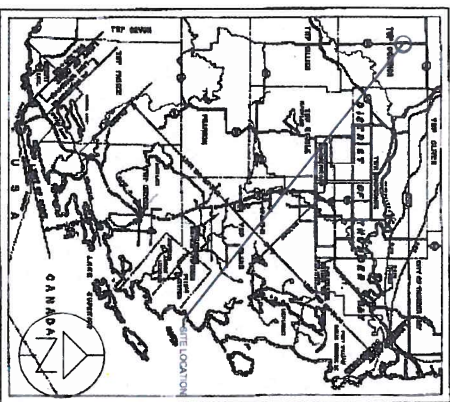
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DIMENSIONS ARE IN METERS
AND/OR MILLIMETERS UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETERS + METERS

CONT No
GMP No 6353-14-00
GEOCRE No 52-193



CULVERT REPLACEMENT
CEDAR CREEK CULVERT
STA 20+856 TO STA 20+866
Survey 13-06 Revised

SHEET



LEGEND

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

- Fill
- Organics
- Sand
- Silt
- Clay
- Sand & Gravel
- Boulders

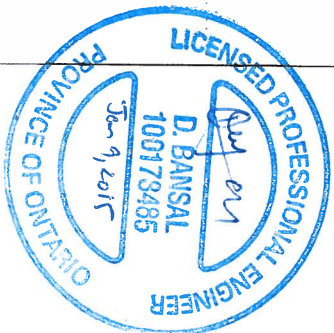
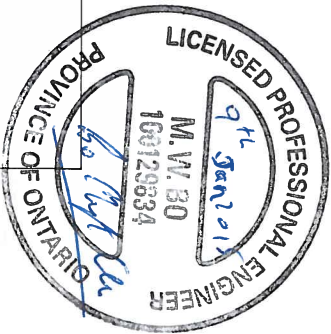
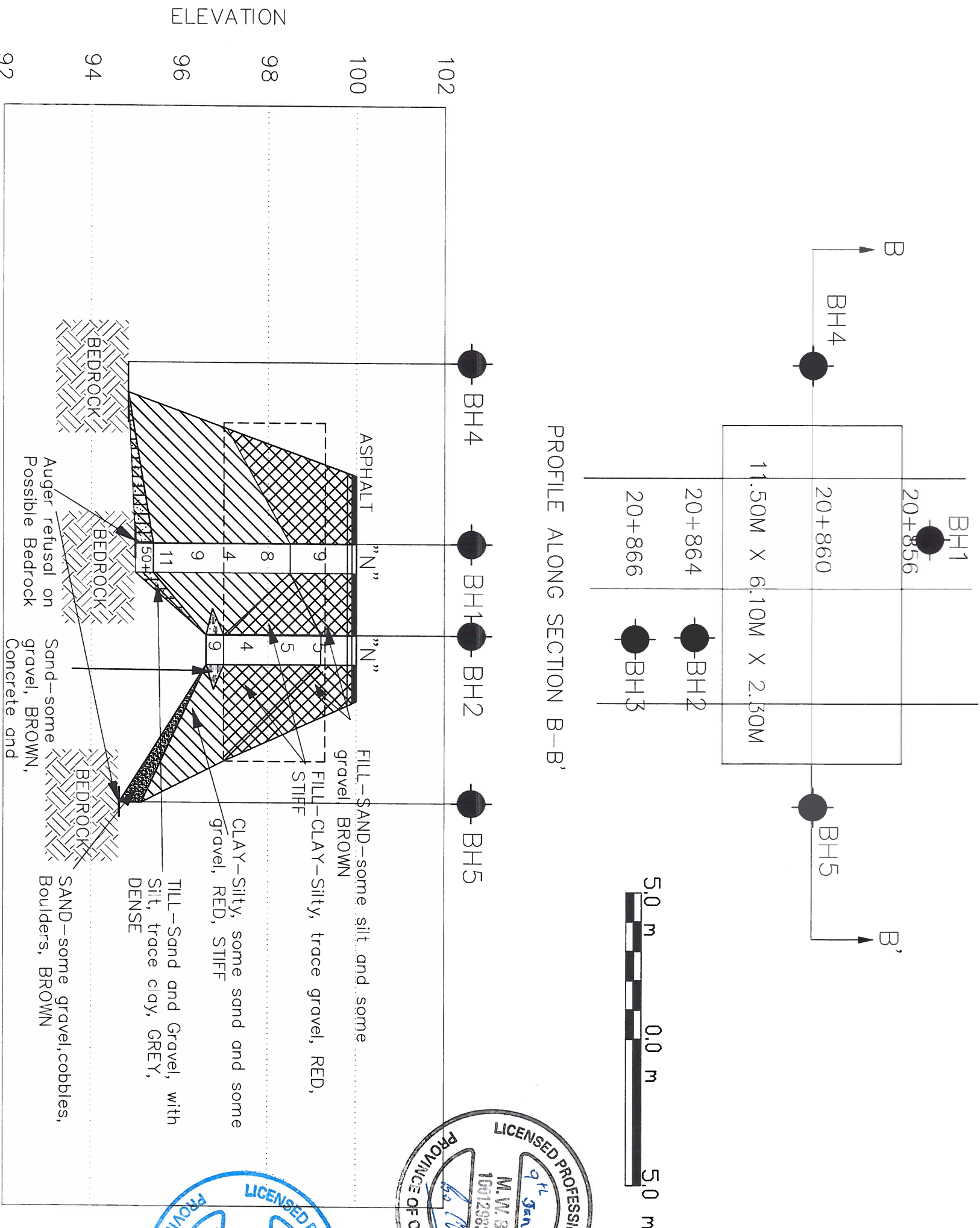
No.	Elevation	Northing	Easting	Station	Offset
BH1	100.0	5382827 m N	300041 m E	20+856	1.5 m LT
BH2	100.1	5382842 m N	300033 m E	20+864	1.7 m LT
BH3	100.1	5382838 m N	300037 m E	20+868	1.7 m LT
BH4	95.0	5382824 m N	300052 m E	20+860	7.5 m RT
BH5	95.3	5382832 m N	300023 m E	20+860	7.5 m LT

NOTE:
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed by interpolation and may not represent actual conditions.

DST Consulting Engineers Inc.
605 Hewittson Street
Thunder Bay, ON M7B 5V5
Tel: (807) 623-5839
Fax: (807) 623-1792
Email: thunderbay@dstgroup.com

DRAWING 3

PROFILE ALONG SECTION B-B'







Appendix D
ENCLOSURES

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Cedar Creek Culvert STA 20+856, 1.5 RT ORIGINATED BY PR
DIST HWY 595 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY MD
DATUM LOCAL DATE 2014 08 20 CHECKED BY DM

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			PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w
100.0	GROUND SURFACE															
99.9	ASPHALT		AS1	AS			99							2 36 52 10		
99.3	FILL-SAND & CRUSHED GRAVEL- Trace silt															
0.8	FILL-SILT- with sand, trace gravel, trace clay, cobbles, BROWN, LOOSE		SS2	SS	9			98								
98.5																
1.5	CLAY-Silty , some sand and some gravel, RED, STIFF		SS3	SS	8				97							
			SS4	SS	4											
			SS5	SS	9											
		SS6	SS	11												
95.4	TILL- Sand and gravel, with silt, trace clay, GREY, DENSE		SS7	SS	50+	96							44 36 (20)			
5.0	END OF BOREHOLE Auger Refusal on Possible Bedrock															
							95									

NR = NO RECOVERY

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ENCLOSURE 1

ONL MOT GS-TB-019503_BH_LOGS_CEDAR_CREEK.GPJ DST_MIN.GDT 1/9/15

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Cedar Creek Culvert 595 STA 20+864, 1.7 LT ORIGINATED BY PR
 DIST HWY 595 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY MD
 DATUM LOCAL DATE 2014 08 20 CHECKED BY DM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
100.1	GROUND SURFACE					▽	100										0 30 36 34
99.9	ASPHALT		AS1	AS													
0.2	FILL-SAND-some silt and some gravel, BROWN																
99.4																	
0.8	FILL-CLAY-silty, trace gravel, RED, STIFF		SS2	SS	5		99										
			SS3	SS	5		98										
			SS4	SS	4												
97.0							97										
3.1	SAND- some gravel, BROWN																
96.6	-CONCRETE AND WOOD		SS5	SS	9												
3.5	END OF BOREHOLE Possible Refusal on Concrete Abutment																

NR = NO RECOVERY

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ENCLOSURE 2

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Cedar Creek Culvert 595 STA 20+866, 1.7 LT ORIGINATED BY PR
DIST HWY 595 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY MD
DATUM LOCAL DATE 2014 08 20 CHECKED BY DM

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								○ UNCONFINED □ QUICK TRIAXIAL	+ FIELD VANE × LAB VANE							
100.1	GROUND SURFACE						20	40	60	80	100					
100.0	ASPHALT		AS1	AS												
99.7	FILL-SAND-some gravel, some silt, BROWN															
0.5	FILL-SILT- with sand, some gravel,trace clay, BROWN/REDDISH		AS2	AS												
98.6	CLAY-Silty-trace gravel, RED, STIFF		AS3	AS												
1.5			AS4	AS												
97.0	GRAVEL-some sand, trace silt, GREY/BROWN		SS5	SS	9											
96.3	CLAY-Silty, some sand and gravel, Black organics		SS6	SS	41											
4.0	TILL- Sand and gravel, with silt, trace clay															
95.8	END OF BOREHOLE Auger Refusal on Possible Bedrock															
4.3																

NR = NO RECOVERY

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ENCLOSURE 3

ONL MOT GS-TB-019503_BH_LOGS_CEDAR_CREEK.GPJ DST_MIN.GDT 1/9/15

RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Cedar Creek Culvert 595 STA 20+860, 7.5 RT ORIGINATED BY PR
 DIST HWY 595 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY MD
 DATUM LOCAL DATE 2014 08 21 CHECKED BY DM

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 (%)			
95.0	GROUND SURFACE						20	40	60	80	100	20	40	60		
	BEDROCK ON SURFACE END OF BOREHOLE															

ONL MOT GS-TB-019503_BH_LOGS_CEDAR_CREEK.GPJ DST_MIN.GDT 1/9/15

NR = NO RECOVERY +³, X³: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

ENCLOSURE 4

RECORD OF BOREHOLE No BH5

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Cedar Creek Culvert 595 STA 20+860, 7.0 LT ORIGINATED BY PR
 DIST HWY 595 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY MD
 DATUM LOCAL DATE 2014 08 21 CHECKED BY DM

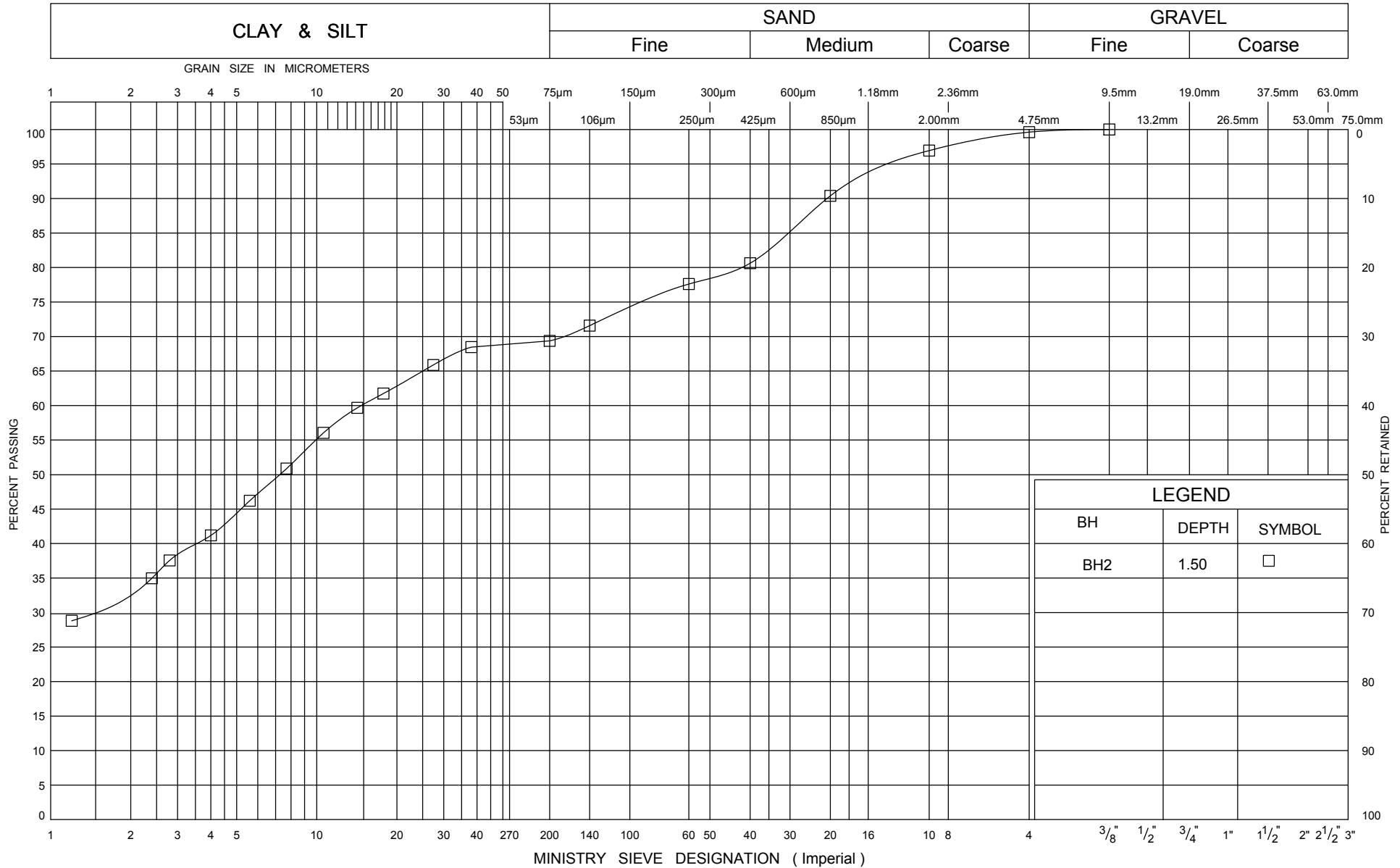
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	20	40	60			
95.3	GROUND SURFACE																
94.8	SAND- some gravel, cobbles, boulders, BROWN																
0.5	END OF BOREHOLE Auger Refusal on Possible Bedrock																

ONL MOT GS-TB-019503_BH_LOGS_CEDAR_CREEK.GPJ DST_MIN.GDT 1/9/15

NR = NO RECOVERY + ³, X ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT GRAIN SIZE GS-TB-019503_BH_LOGS_CEDAR_CREEK.GPJ DST_MIN.GDT 11/25/14

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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GRAIN SIZE DISTRIBUTION
FILL-CLAY

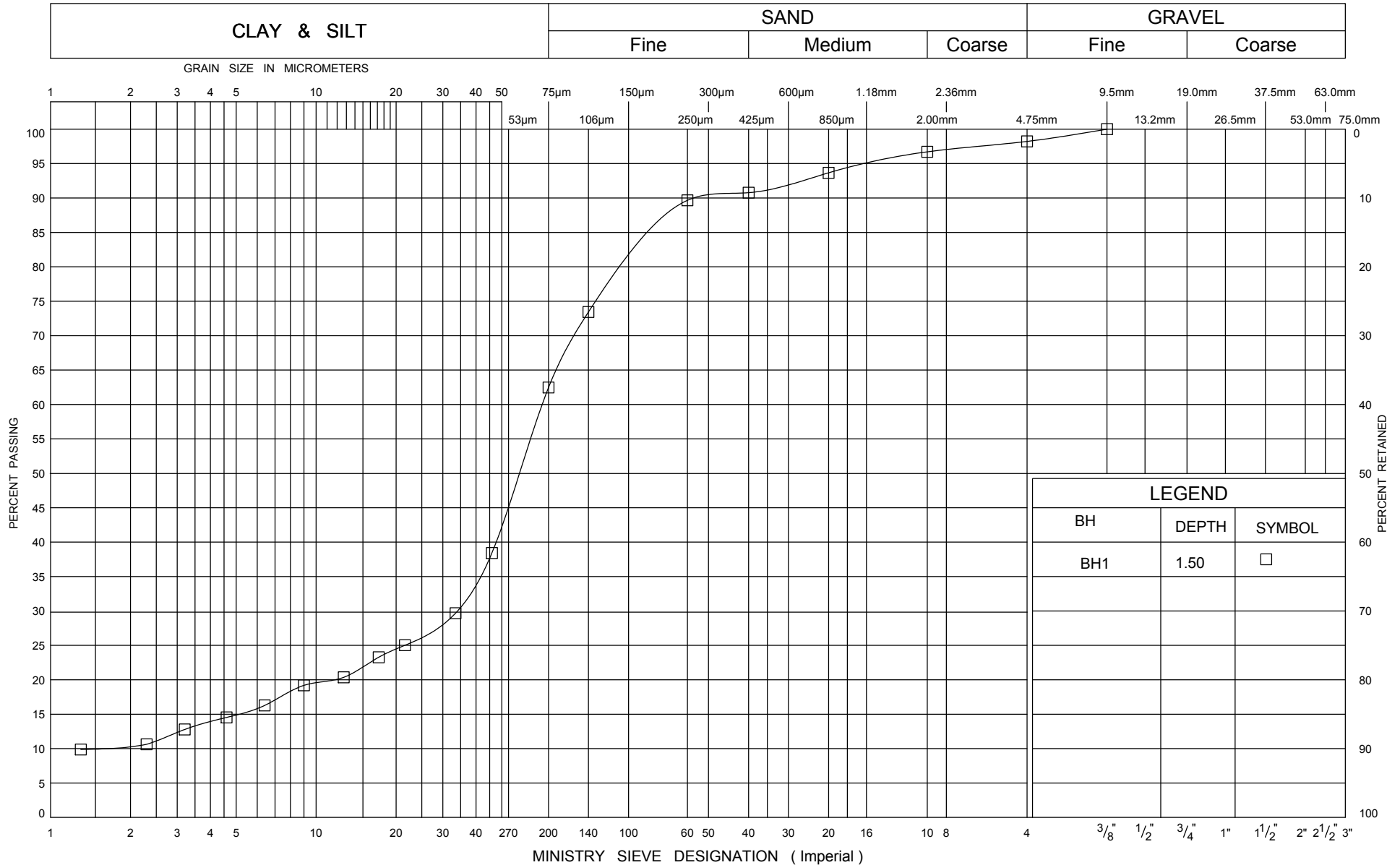
ENCLOSURE 6

W P 6013-E-0021

HWY 595

ONTARIO MOT GRAIN SIZE GS-TB-019503_BH_LOGS_CEDAR_CREEK.GPJ DST_MIN.GDT 11/25/14

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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Ontario

GRAIN SIZE DISTRIBUTION FILL-SILT

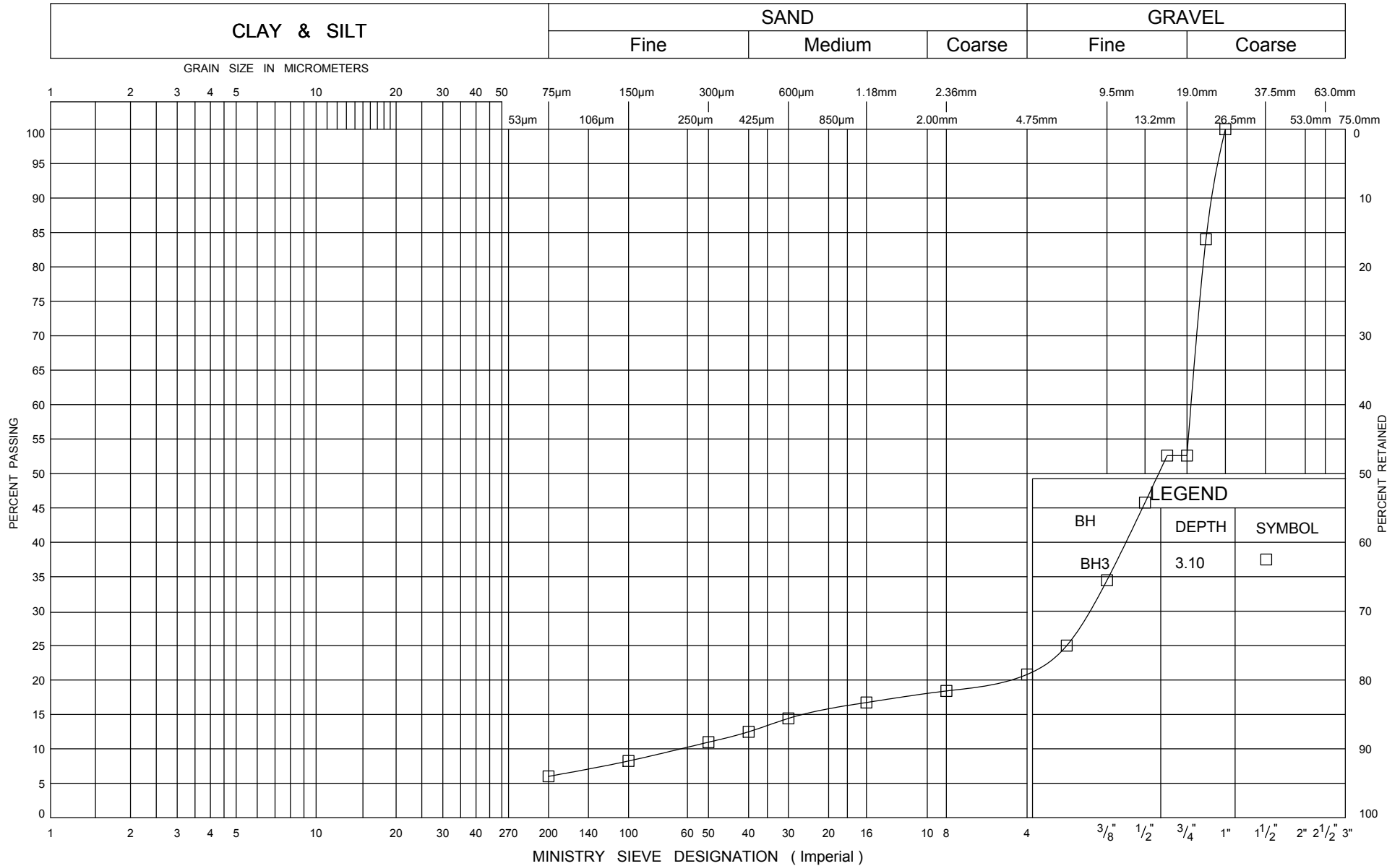
ENCLOSURE 8

W P 6013-E-0021

HWY 595

ONTARIO MOT GRAIN SIZE GS-TB-019503_BH_LOGS_CEDAR_CREEK.GPJ DST_MIN.GDT 11/25/14

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION GRAVEL

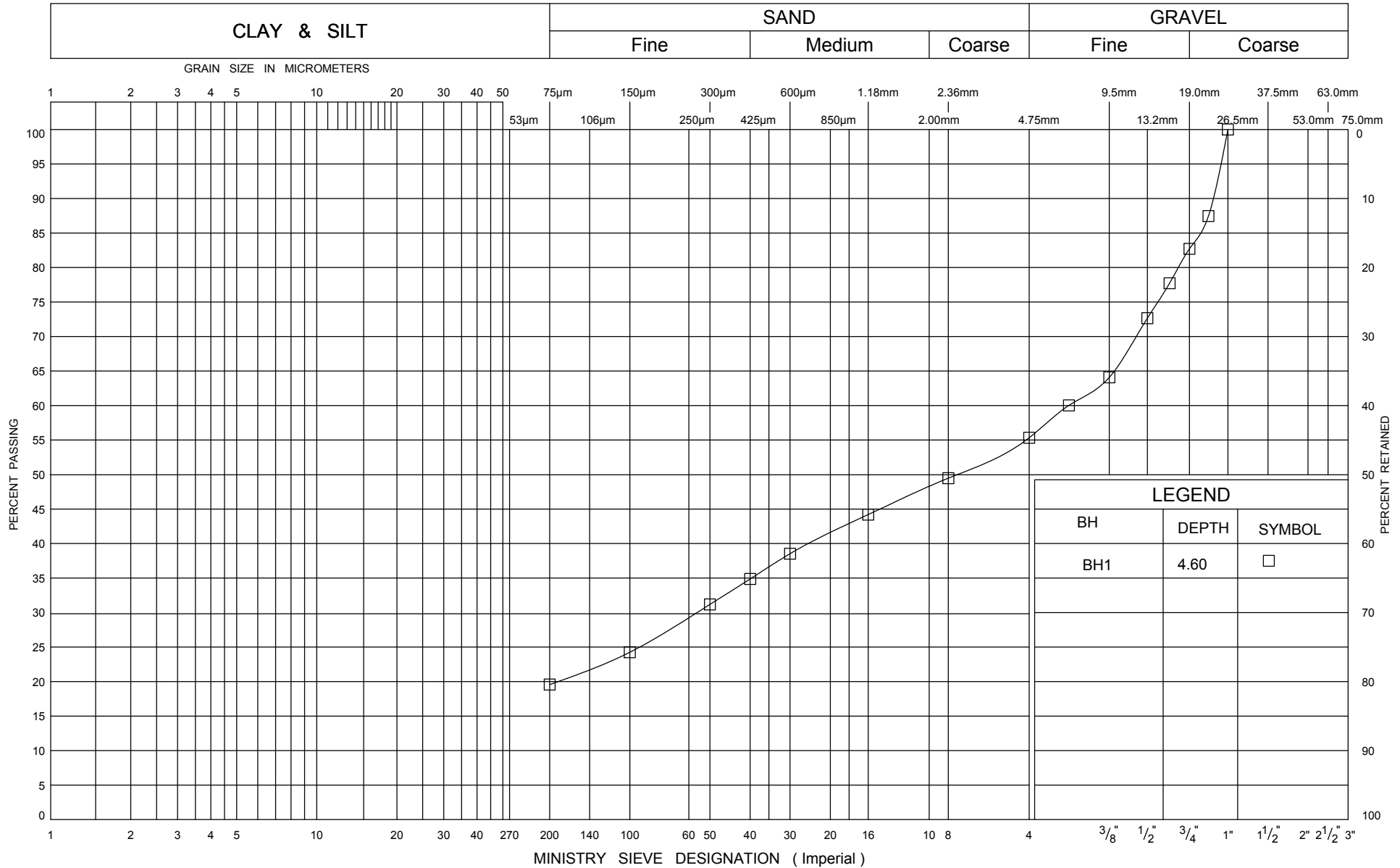
ENCLOSURE 9

W P 6013-E-0021

HWY 595

ONTARIO MOT GRAIN SIZE GS-TB-019503_BH_LOGS_CEDAR_CREEK.GPJ DST_MIN.GDT 11/25/14

UNIFIED SOIL CLASSIFICATION SYSTEM



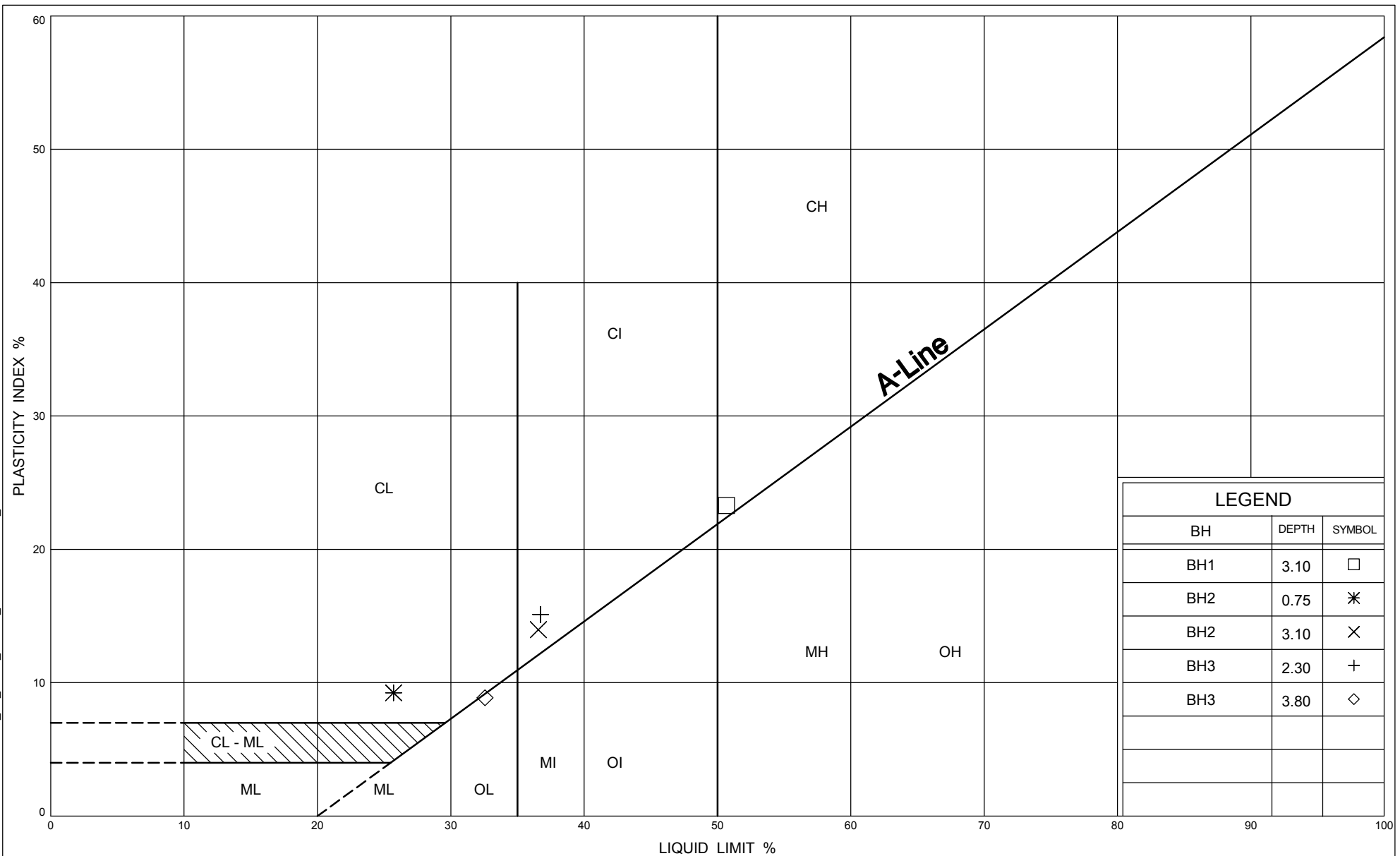
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GRAIN SIZE DISTRIBUTION TILL

ENCLOSURE 10

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HWY 595



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PLASTICITY CHART CLAY-Silty

ENCLOSURE 11

W P 6013-E-0021

HWY 595