



**FOUNDATION INVESTIGATION REPORT
SHAMROCK LAKE CULVERT WEST
HIGHWAY 11
UNSURVEYED TERRITORY, THUNDER BAY DISTRICT
AGREEMENT NO.: 6013-E-0021
ASSIGNMENT NO.: 5
SITE NO.: 48C-186/C
MTO GEOCRES NO. 52H-26
WORK ORDER NO. GWP 6911-12-00**

**MARCH 17, 2015
GS-TB-019794**

PREPARED FOR:
Ministry of Transportation
Geotechnical Section
Northwestern Region Office
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Table of Contents

1. INTRODUCTION	1
2. SITE DESCRIPTION	2
3. INVESTIGATION PROCEDURES AND LABORATORY TESTING.....	5
4. DESCRIPTION OF SUBSURFACE CONDITIONS	7
4.1 Asphalt.....	7
4.2 Fill – Granular	7
4.3 Sand	8
4.4 Groundwater	8
5. MISCELLANEOUS	10
6. LIMITATIONS OF REPORT	11

Appendices

LIMITATIONS OF REPORT ‘A’
DESCRIPTION OF TERMS..... ‘B’
DRAWINGS ‘C’
ENCLOSURES ‘D’

List of Tables

Table 3.1	Detail of borehole locations	6
Table 4.1	Summary of soil strata at the culvert location	7
Table 4.2	Summary of sand fill sieve analyses	8
Table 4.3	Summary of sand particle size analyses	8

List of Figures

Figure 2.1	Location of existing culvert at Highway 11 (Looking South)	3
Figure 2.2	Location of existing culvert at Highway 11 (Looking North)	3
Figure 2.3	Culvert inlet (Looking West)	4
Figure 2.4	Culvert outlet (Looking Northeast)	4

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HIGHWAY 11
THUNDER BAY DISTRICT
AGREEMENT NO.: 6013-E-0021
ASSIGNMENT #5
SITE NO.: 48C-186/C**

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 11. This work was carried out under Agreement No.: 6013-E-0021, Geotechnical Retainer, Assignment No. 5.

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 11, approximately 30.8 km North of Highway 17 (latitude 49.2595, longitude -88.137), Station 13+078, in unsurveyed territory, in the District of Thunder Bay.

It is understood that the existing 33.3 m long centerline culvert is a cast-in-place concrete box culvert approximately 4.0 m wide and 2.44 m in height. The existing culvert (Figure 2.3 and 2.4) was originally built in 1899 and inspection by others indicates there is an extensive deterioration of concrete, cracks on walls and soffit and severely corroded rebar in soffit. The fill thickness above the culvert is approximately 5.0 m and the side slope of the embankment is approximately 2H: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). The flow direction of water in the creek is from east to west.

Geological information is available from published *Ontario Geological Survey Map #52HSE* by the *Ontario Ministry of Natural Resources* for the area. The map indicates that the local area landform is identified as outwash plain consisting of gravel and sand. The topography in the area is mainly low local relief; kettled or pitted with dry drainage conditions.



Figure 2.1 Location of existing culvert at Highway 11 (Looking South)



Figure 2.2 Location of existing culvert at Highway 11 (Looking North)



Figure 2.3 Culvert inlet (Looking West)



Figure 2.4 Culvert outlet (Looking Northeast)

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out between October 14, 2014 and October 20, 2014 utilizing a CME 750 drill rig equipped for geotechnical drilling and operated by DST. A total of four boreholes were advanced up to depths of 14.3 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 Drawings 1 to 3. Borehole 1 was advanced North of the existing culvert at station 13+081, 4.5 m right of centreline, and advanced to a depth of 14.3 m below existing surface. Borehole 2 was advanced South of the existing culvert at station 13+071, 4.5 m right of centreline, and advanced to a depth of 14.3 m below existing surface. Borehole 3 was advanced south of existing culvert at station 13+074, 4.6 m left of centreline, and advanced to a depth of 14.3 m below existing surface. Borehole 4 was advanced North of existing culvert at station 13+087, 4.6 m left of centreline, and advanced to a depth of 14.3 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 13+078. The centreline of the road at station 13+078 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 forty eight (48) moisture contents, and Twenty Two (22) sieve analyses have been carried out for this assignment. Laboratory test results are presented in the Boreholes Logs and in graphical plots in Appendix D (Enclosures).

Table 3.1 Detail of borehole locations

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)
BH1	13+081	99.9	14.3	4.5 Rt
BH2	13+071	99.6	14.3	4.5 Rt
BH3	13+074	99.6	14.3	4.6 Lt
BH4	13+087	100.1	14.3	4.6 Lt

4. DESCRIPTION OF SUBSURFACE CONDITIONS

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

The generalized stratigraphy of the existing embankment, based on the conditions encountered in Boreholes 1 to 4, consists of asphalt overlying granular sand or sand and crushed gravel fill underlain by sand with trace to with silt.

Table 4.1 Summary of soil strata at the culvert location

Layer	Depth (m)	Elevation (m)	Comments
Asphalt	0 to 0.04	99.9 to 99.8	BH1
	0 to 0.05	99.6 to 99.5	BH2
	0 to 0.08	99.6 to 99.5	BH3
	0 to 0.20	100.1 to 99.9	BH4
Fill- Granular	0.04 to 7.6	99.8 to 92.3	BH1
	0.05 to 6.1	99.5 to 93.5	BH2
	0.08 to 6.1	99.5 to 93.5	BH3
	0.20 to 7.6	99.9 to 92.5	BH4
Sand	0.23 to 14.3	92.3 to 85.6	BH1
	0.24 to 14.3	93.5 to 85.3	BH2
	0.23 to 14.3	93.5 to 85.3	BH3
	0.32 to 14.3	92.5 to 85.8	BH4

4.1 Asphalt

Asphaltic concrete was encountered at surface in Boreholes 1, 2, 3 and 4 with thickness between 40 mm to 200 mm.

4.2 Fill – Granular

Granular sand or sand and crushed gravel fill with trace to with gravel, trace to with silt was encountered in Boreholes 1 to 4 below the asphalt with a thickness from 6.0 m to 7.6 m at depths between 0.04 and 7.6 m (Elev. 99.8 to 92.3 m), 0.05 and 6.1 m (Elev. 99.5 to 93.5 m), 0.08 and 6.1 m (Elev. 99.5 to 93.5 m) and 0.20 and 7.6 m (Elev. 99.9 to 92.5 m) respectively. Black organics within this stratum were encountered in Borehole 1 at depth of 7.0 m.

SPT 'N' values for the samples range between 2 to 30 indicating very loose to dense conditions. The moisture contents of samples tested range from 4 to 17% except for one sample in Borehole 1 at 7.0 m depth has high moisture content of 48% due to organic content. The results of laboratory tests are summarized in Table 4.2.

Table 4.2 Summary of sand fill sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	0 to 29
Sand %	61 to 88
Fines %	8 to 28

4.3 Sand

Sand with trace to some gravel, trace to with silt, cobbles, was encountered in Boreholes 1 to 4 at depths from 6.1 m to 7.6 m (Top Elev. 92.3 m to 93.5 m). The thickness of this stratum is not defined as borehole terminus was reached within this stratum.

SPT 'N' values for this samples range between 5 and 54 indicating loose to very dense conditions. The moisture contents of samples tested range from 13 to 23%. The laboratory test results are summarized in following Tables 4.3.

Table 4.3 Summary of sand particle size analyses

Laboratory Results – Particle Size Analysis	
Gravel %	1 to 15
Sand %	72 to 87
fines %	6 to 25

4.4 Groundwater

The groundwater table was identified below the ground surface based on the field observation and visual identification of the soil samples. The estimated groundwater level below the ground surface elevation is given in Table 4.4. The groundwater levels can be expected to vary with the season and precipitation events.

Table 4.4 Groundwater Depths

Borehole Number	Groundwater Depth (m)	Elevation (m)
BH1	6.1	93.8
BH2	6.1	93.5
BH3	6.1	93.5
BH4	6.1	94.0

5. MISCELLANEOUS

Site work was carried out between October 14, 2014 and October 20, 2014 utilizing a CME 750 drill rig equipped for geotechnical drilling and operated by DST. 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:

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

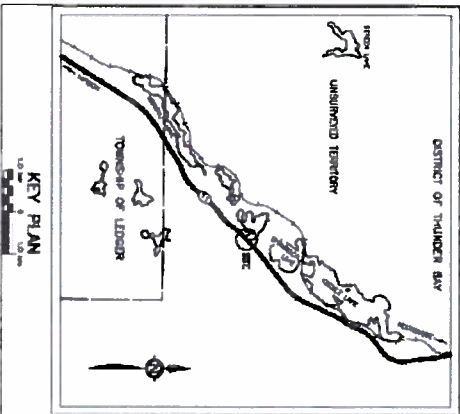
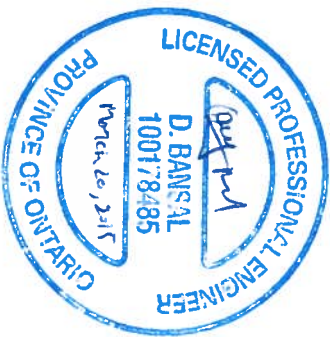
DRAWINGS

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

CONT No
GWP No 6911-12-00
SITE No 48C-186/C
GEOCRETS No 52H-26

CULVERT REPLACEMENT
SHAMROCK WEST CULVERT
STA 13+068 TO STA 13+088
Survey _____ 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
- Till
- Bedrock
- Sand
- Silt
- Clay
- Sand & Gravel
- Boulders

No.	Elevation	Numbering	Existing	Station	Offset
BH1	99.9	•	•	13+081	4.5 m RT
BH2	99.6	•	•	13+071	4.5 m RT
BH3	99.6	•	•	13+074	4.6 m LT
BH4	100.1	•	•	13+087	4.6 m LT

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

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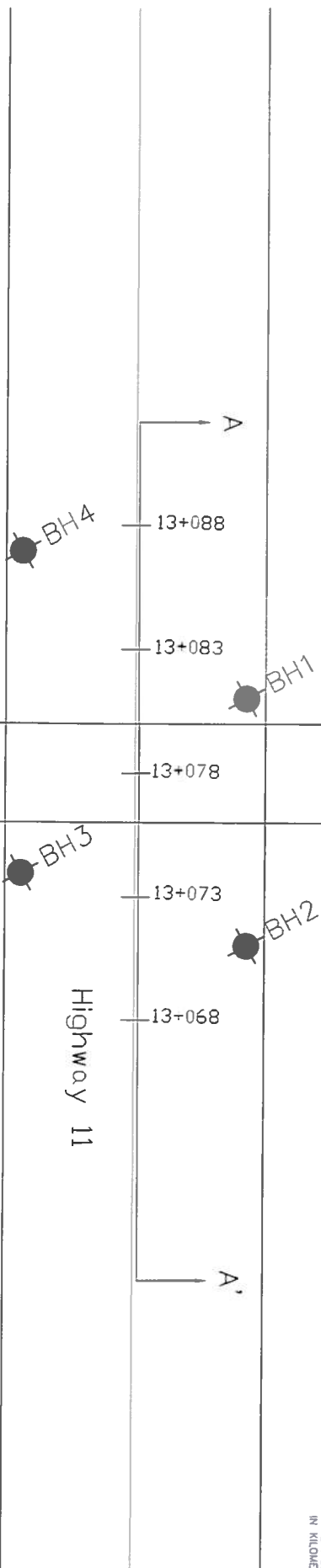
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METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNITS
OTHERWISE SHOWN. STATIONS
IN KILOMETERS + METERS

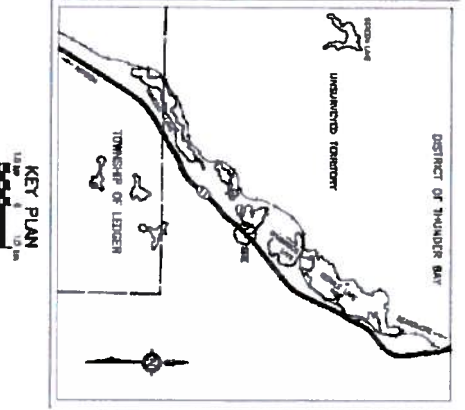
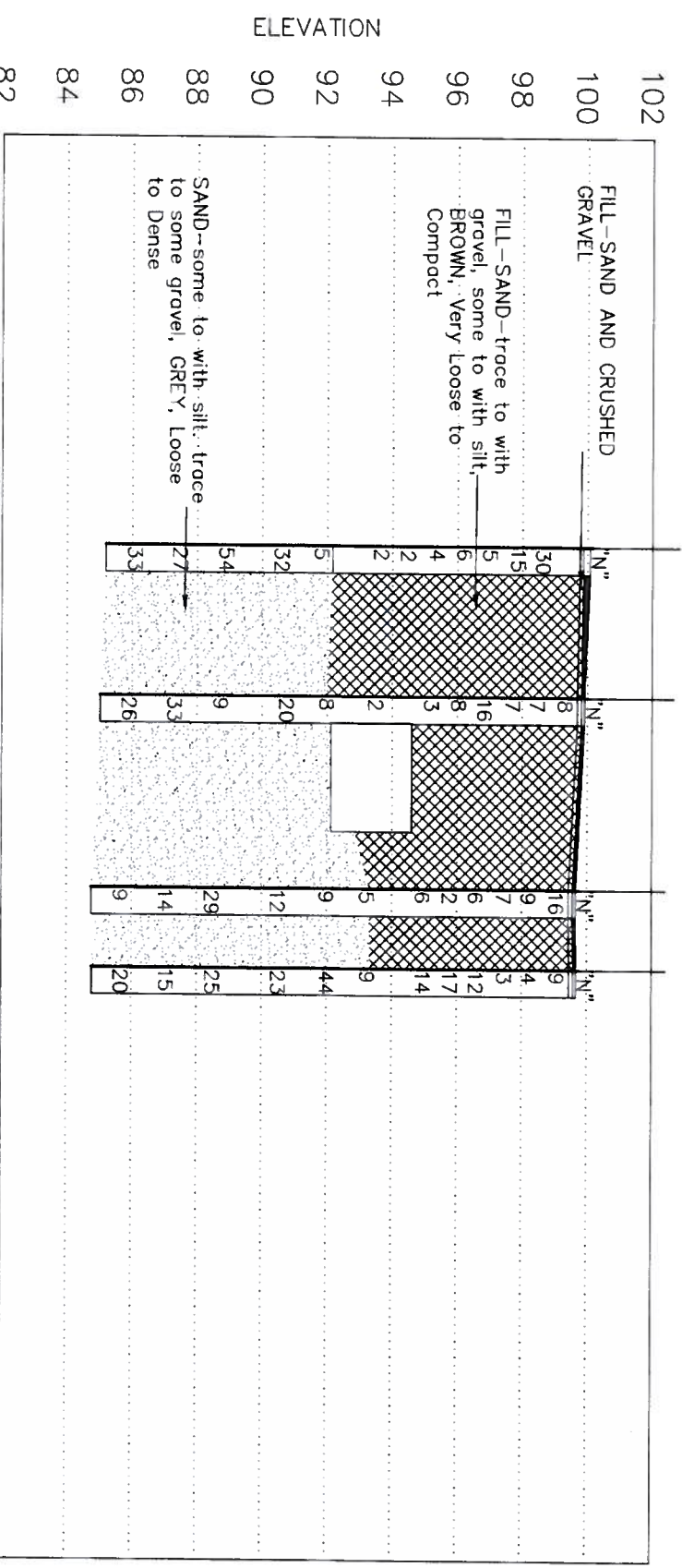
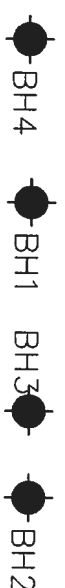
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SITE No 48C-186/C
GEOCRES No 52H-26

CULVERT REPLACEMENT
SHAMROCK WEST CULVERT
STA 13+068 TO STA 13+088
Survey _____ Revised _____

SHEET



PROFILE ALONG SECTION A-A'



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
	Till
	Bedrock
	Sand
	Silt
	Clay
	Sand & Gravel
	Boulders

No.	Elevation	Northing	Easting	Station	Offset
BH1	99.9	-	-	13+081	4.5 m RT
BH2	99.8	-	-	13+071	4.5 m RT
BH3	99.8	-	-	13+074	4.5 m LT
BH4	100.1	-	-	13+087	4.6 m LT

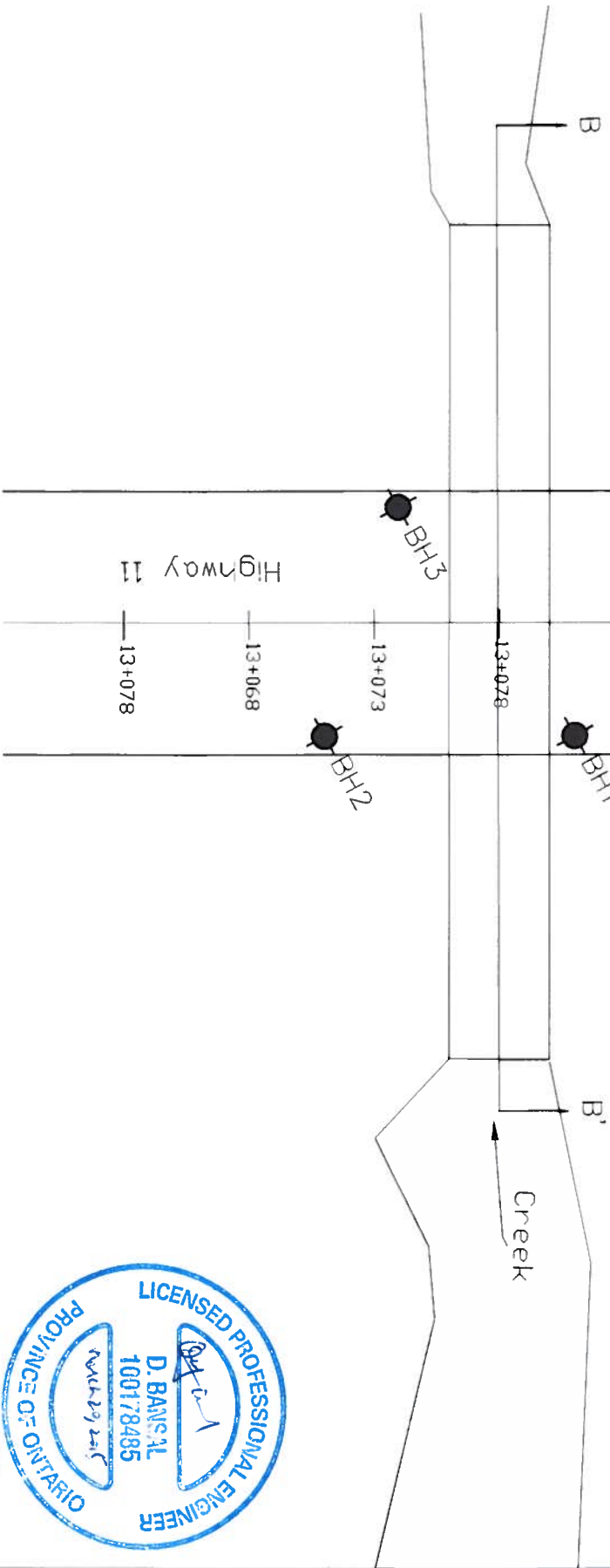
NOTE:
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed by interpolation and may not represent actual conditions.

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

CONT	No	
GWP	No 6911-12-00	
SITE	No 48C-186/C	
GEOCRES	No 52H-26	

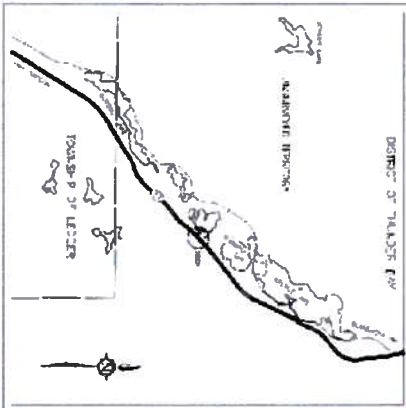
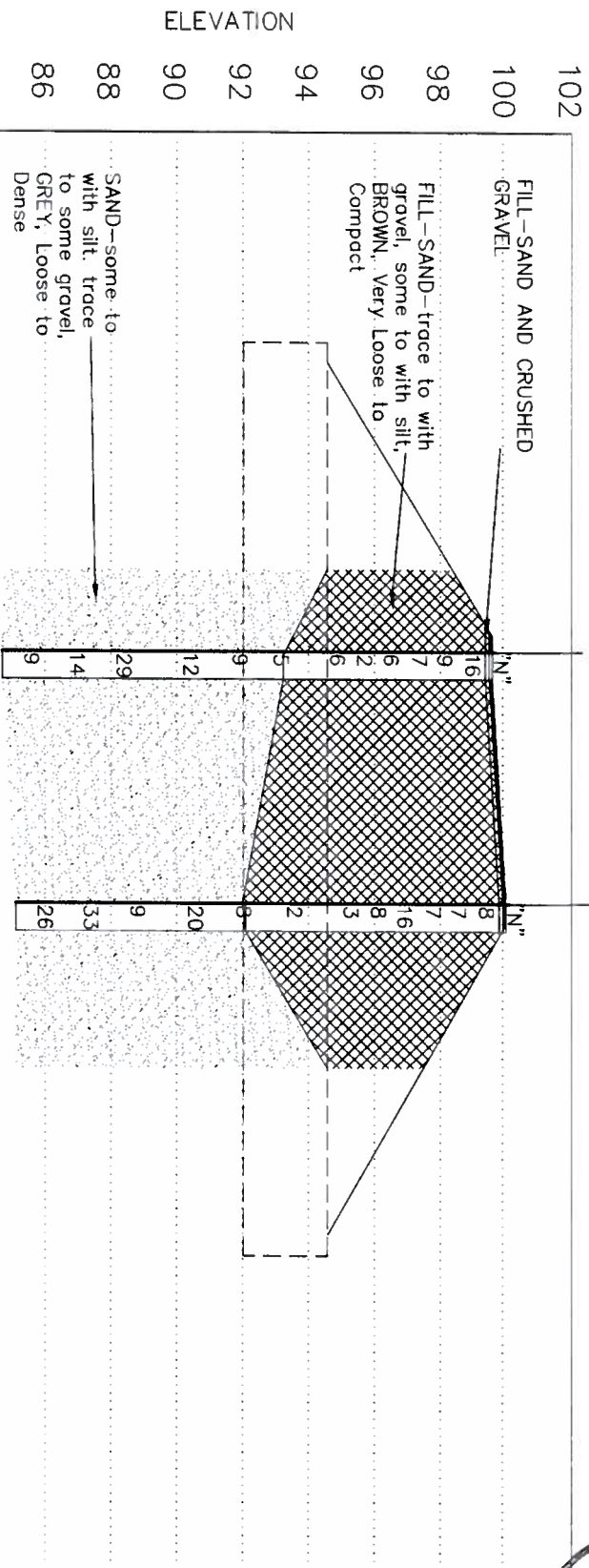
CULVERT REPLACEMENT SHAMROCK WEST CULVERT	SHEET
STA 13+068 TO STA 13+088	
Survey _____ Revised _____	



PROFILE ALONG SECTION B-B'

BH3 BH1

25 M 0.0 M 25 M



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
- Till
- Bedrock
- Sand
- Silt
- Clay
- Sand & Gravel
- Boulders

No.	Elevation	Nothing	Easting	Station	Offset
BH1	99.9	-	-	13+081	4.5 m RT
BH2	98.8	-	-	13+071	4.5 m RT
BH3	98.8	-	-	13+076	4.5 m LT
BH4	100.1	-	-	13+087	4.8 m LT

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

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Appendix D

ENCLOSURES

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Shamrock Lake West STA 13+081, 4.5 RT ORIGINATED BY PR
DIST Thunder Bay HWY 11 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB
DATUM Local DATE 2014 10 14 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								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	□ QUICK TRIAXIAL						× LAB VANE		
99.9	GROUND SURFACE																	
98.8	ASPHALT		AS1	AS														
98.7	FILL-SAND AND CRUSHED GRAVEL																	
98.2	FILL-SAND-trace gravel, trace to with silt, BROWN, Very Loose to Compact		SS2	SS	8										17 68 (15)			
			SS3	SS	7													
			SS4	SS	7													
			SS5	SS	16										0 79 (21)			
			SS6	SS	8													
			SS7	SS	3										1 75 (24)			
			SS8	SS	2													
92.3	-black organics																	
7.6	SAND-trace to with silt, trace gravel, GREY, Loose to Dense		SS9	SS	8										4 86 (10)			
			SS10	SS	20													
			SS11	SS	9													
			SS12	SS	33													
			SS13	SS	26										7 73 (20)			
85.6	END OF BOREHOLE																	
14.3																		

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

ENCLOSURE 1

ONL MOT GS-TB-019794 SHAMROCK 30.8.GPJ DST_MIN_GDT 2/23/15

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Shamrock Lake West STA 13+071, 4.5 RT ORIGINATED BY PR
DIST Thunder Bay HWY 11 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB
DATUM Local DATE 2014 10 14 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							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
99.6	GROUND SURFACE							20 40 60 80 100							
98.5	ASPHALT		AS1	AS			99							25 63 (12)	
98.2	FILL-SAND AND CRUSHED GRAVEL		SS2	SS	9										
	FILL-SAND-trace gravel, trace to with silt, BROWN, Very Loose to Compact		SS3	SS	4		98								
			SS4	SS	3		97							1 77 (22)	
			SS5	SS	12		96								
			SS6	SS	17										
			SS7	SS	14		95								
							94								
93.5															
6.1	SAND-trace to some gravel, trace to some silt, GREY, Loose to Dense		SS8	SS	9		93							4 88 (8)	
							92								
			SS9	SS	44		91								
							90								
							89							7 81 (12)	
			SS10	SS	23		88								
							87								
			SS11	SS	25		86							15 79 (6)	
			SS12	SS	15										
			SS13	SS	20										
85.3															
14.3	END OF BOREHOLE														

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

ENCLOSURE 2

ONL MOT GS-TB-019794 SHAMROCK 30.8.GPJ DST_MIN.GDT 2/23/15

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Shamrock Lake West STA 13+074, 4.6 LT ORIGINATED BY PR
DIST Thunder Bay HWY 11 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB
DATUM Local DATE 2014 10 14 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 (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE						□ QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)
99.6	GROUND SURFACE						20	40	60	80	100						
98.5	ASPHALT		AS1	AS													
98.2	FILL-SAND AND CRUSHED GRAVEL		SS2	SS	16												
	FILL-SAND-trace gravel, trace to some silt, BROWN, Very Loose to Compact		SS3	SS	9												
			SS4	SS	7												
			SS5	SS	6												
			SS6	SS	2												
			SS7	SS	6												
93.5	SAND-trace to some gravel, trace to some silt, GREY, Loose to Compact		SS8	SS	5												
6.1			SS9	SS	9												
			SS10	SS	12												
			SS11	SS	29												
			SS12	SS	14												
			SS13	SS	9												
85.3	END OF BOREHOLE																
14.3																	

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

ENCLOSURE 3

ONL MOT GS-TB-019794 SHAMROCK 30.8.GPJ DST_MIN.GDT 2/23/15

RECORD OF BOREHOLE No BH4

1 OF 1

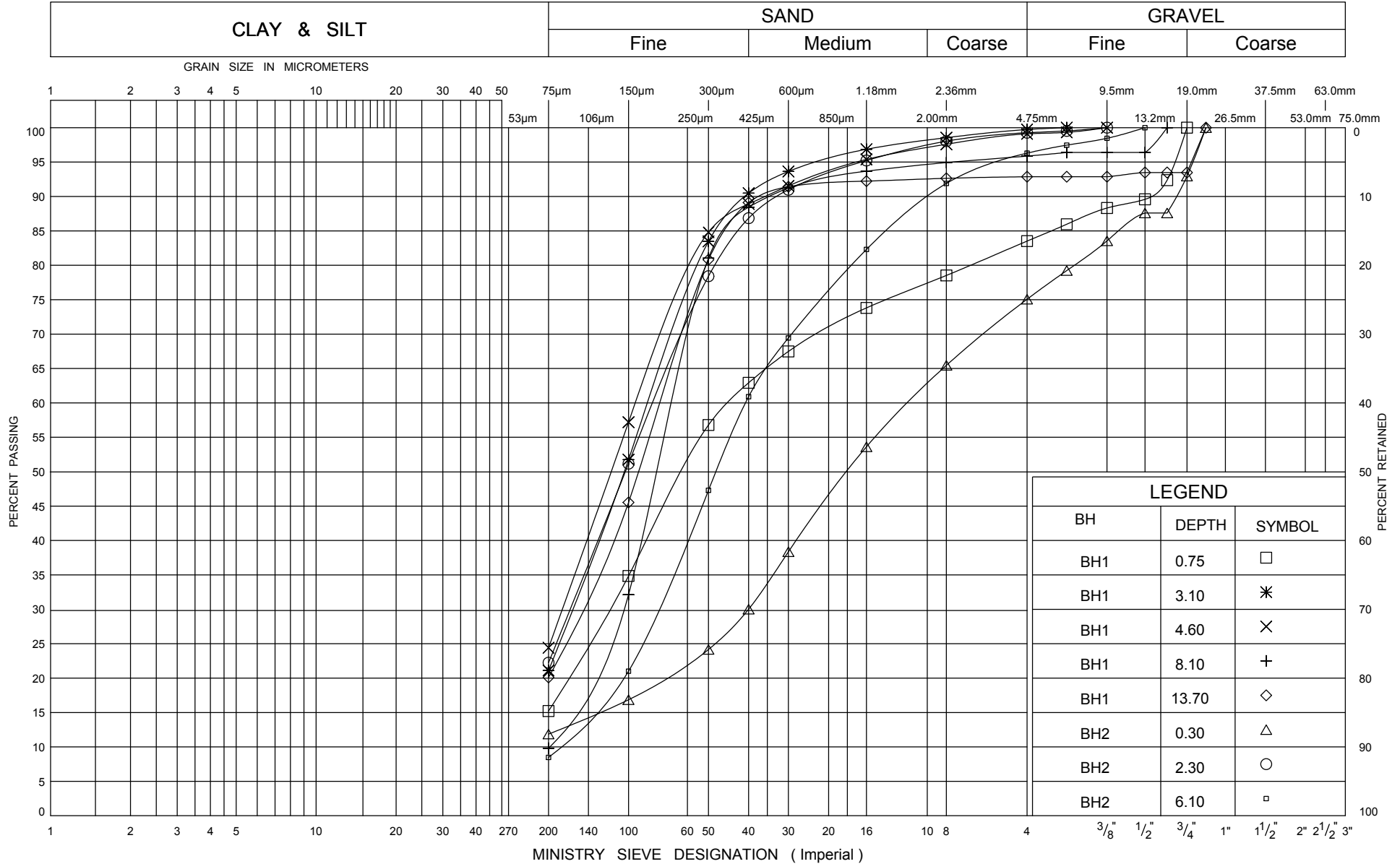
METRIC

W.P. 6013-E-0021 LOCATION Shamrock Lake West STA 13+087, 4.6 LT ORIGINATED BY PR
DIST Thunder Bay HWY 11 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB
DATUM Local DATE 2014 10 14 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 (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED □ QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
100.1	GROUND SURFACE							20 40 60 80 100										
99.9	ASPHALT																	
99.8	FILL-SAND AND CRUSHED GRAVEL		AS1	AS											16 68 (16)			
0.3	FILL-SAND-trace to with gravel, some to with silt, BROWN, Very Loose to Compact		SS2	SS	30													
			SS3	SS	15										23 64 (12)			
			SS4	SS	5													
			SS5	SS	6													
			SS6	SS	4													
			SS7	SS	2										1 72 (28)			
			SS8	SS	2													
92.5																		
7.6	SAND-some to with silt, trace to some gravel, GREY, Loose to Dense		SS9	SS	5										1 74 (25)			
			SS10	SS	32													
			SS11	SS	54										12 72 (16)			
			SS12	SS	27										1 78 (21)			
			SS13	SS	33													
85.8																		
14.3	END OF BOREHOLE																	

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

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION SOIL DESCRIPTION

ENCLOSURE 1

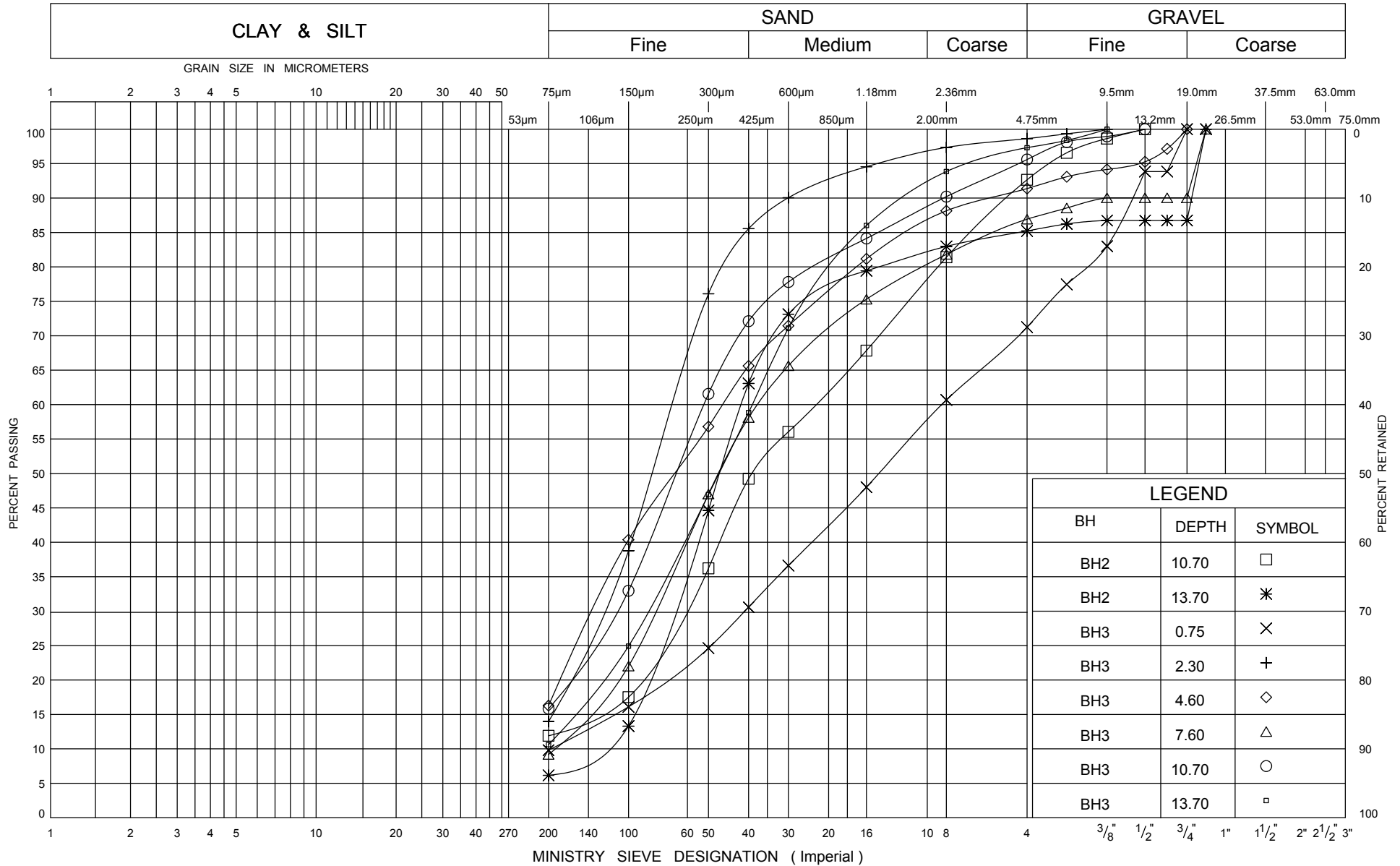
W P 6013-E-0021

17



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Transportation
Ontario

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation
Ontario

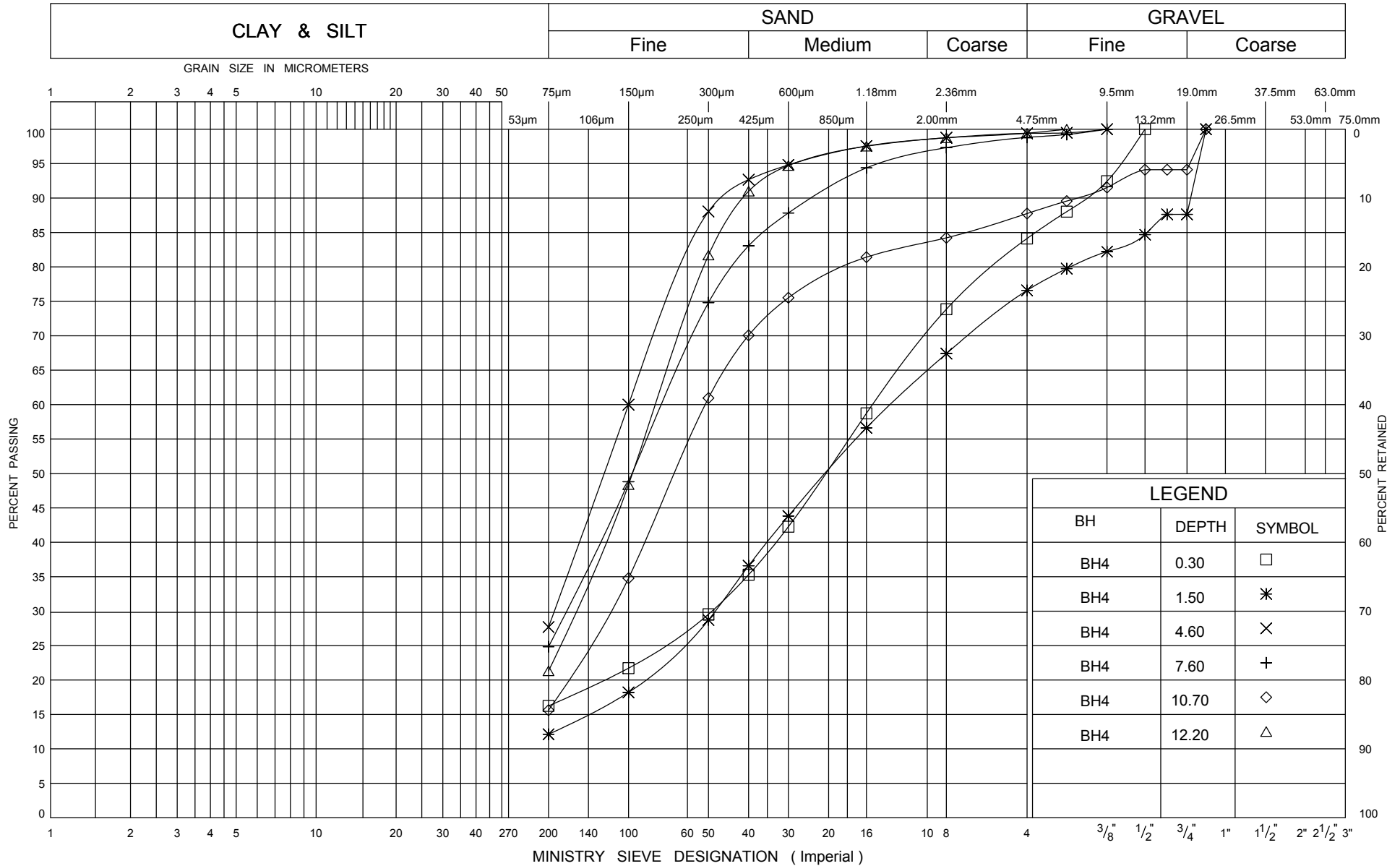
GRAIN SIZE DISTRIBUTION SOIL DESCRIPTION

ENCLOSURE 2

W P 6013-E-0021

17

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation
Ontario

GRAIN SIZE DISTRIBUTION SOIL DESCRIPTION

ENCLOSURE 3

W P 6013-E-0021

17