FOUNDATION INVESTIGATION REPORT
ASINN CREEK CULVERT REPLACEMENT
HIGHWAY 599
TOWNSHIP OF SKEY, THUNDER BAY DISTRICT
AGREEMENT NO.: 4014-E-0023
SITE NO.: 48W-314/C
GEOCRES NO. 52G-12
GWP: 6354-14-00

JANUARY 11, 2019
GS-TB-020407

PREPARED FOR:
Ministry of Transportation
Planning and Design
Eastern Region Office
1355 John Counter Blvd.,
Kingston, ON K7L 5A3

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

DST Consulting Engineers Inc. (DST) was retained by MTO under the direction of the prime consultant, Planmac Engineering Inc. (Planmac), to conduct a foundation investigation and provide a report for the proposed culvert replacement on Highway 599. This work was carried out under Agreement No.: 4014-E-0023.This report addresses the field investigation, laboratory test program, factual report on conditions (Part 1) and conditions for the proposed culvert replacement (Part 1).

This report was initially submitted to Planmac and MTO in March 2017. It has been re-issued, at the request of WSP on behalf of MTO, with revisions to accommodate its updated (90%) design, including revisions to both its Drawings (Borehole Location Plan and Borehole Location Plan Soil Strata).

This revised report supersedes the previous DST March 23, 2017 report.

2. SITE DESCRIPTION

The site is located on Highway 599, approximately 10.7 km North-East of Highway 17 (Latitude 49.4691, Longitude -91.5443), Station 12+464, in the Township of Skey, in the District of Thunder Bay. The Highway runs northeast to southwest across a short drainage channel flowing northwest from Little Sandbar Lake into Sandbar Lake. The drainage channel is broad and flat, being about 100m wide at the culvert location. The existing Asinn Creek occupies a narrow meandering path within the wider drainage channel. The twin culverts are aligned northwest to southeast and perpendicular to the Highway.

The existing 21.2 m long Corrugated Steel Pipe (CSP) twin culvert is approximately 2.40 m in diameter. The year of construction of the existing culvert is not known with certainty (Figure 2-1

and Figure 2-2). An inspection by others indicates medium corrosion above the waterline and severe corrosion below the waterline. It was also reported that both barrels have deformation under the roadway and debris build up in the north barrel.

Based on the Ontario Structure Inspection Manual (OSIM), the fill thickness at the culvert location is approximately 1.0 m and the height of the embankment is approximately 2.3 m with side slopes of approximately 2H: 1V. There is some erosion of the embankment fill between the culvert barrels at the inlet and outlet areas. This is reportedly due to a lack of protective vegetation cover over the fill material. (Figure 2-2). The wider drainage feature is vegetated with reeds and grasses, while the main channel is open water. The surrounding slopes adjacent to the wider drainage feature are forested.

Figure 2-1: Location of existing culvert at Highway 599 (looking west)

Figure 2-2: Embankment slope condition

3. REGIONAL GEOLOGY

Geological information is available from published *Ontario Geological Survey Map #52GSW* by the *Ontario Ministry of Natural Resources* for the Skey area. The local area landform is identified as outwash plain, valley train. Outwash deposits include plains, fans, deltas, and valley trains of varying sizes, all consisting mainly of sand and gravel. Most outwash sediments were drained from the front of a melting glacier and accumulated in flooded lowlands and valley bottoms. Although most outwash deposits formed in proglacial positions, some accumulated over masses of stagnant glacier ice, resulting in pitted or kettled surfaces. Outwash landscapes that show abandoned channel scars, braid bars or deep kettle holes are commonly coarse in texture (i.e. gravelly and cobbly rather than sandy).

As indicated on the Bedrock Geology of Ontario West Central Sheet Map 2542, the soil at the site is underlain by intrusive rocks of Archaen age comprising of massive to foliated granodiorite to granite. Secondary intrusive dyke swarms comprising of Palaeoproterozoic age diabase/dolerite (23b Wabigoon swarm) are indicated to cut across the area trending north west to south east.

4. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out on September 10th to September 11th, 2015 utilizing a CME 750 drill rig equipped for geotechnical drilling and operated by DST. A total of four boreholes were advanced to depths ranging from 12.2 m to 16.3 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 Borehole Location Plan and Drawings 1 and 2 in Appendix C. Borehole 1 was advanced north of the existing culvert at Station 12+471, 3.9 m left of centreline, and advanced to a depth of 14.9 m below existing surface. Borehole 2 was advanced north of the existing culvert at Station 12+474, 12.8 m right of centreline, and advanced to a depth of 12.2 m below existing surface. Borehole 3 was advanced south of the existing culvert at Station 12+456, 6.1 m right of centreline, and advanced to a depth of 16.3 m below existing surface. Borehole 4 was advanced south of the existing culvert at Station 12+458, 5.1 m left of centreline, and advanced to a depth of 14.9 m below surface.

The borehole locations were 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 benchmark 416.142 m N and W in root of 0.30Φ Balsam (N = 5482306.5 m, E = 192860.4 m) as indicated on the drawings provided by the Ministry. Table 4.1 summarizes the details of borehole locations and depths.

All boreholes were abandoned using suitable abandonment barrier as described in Ontario Regulation 903 and its amendments. Augured boreholes were decommissioned by backfilling from the bottom of the hole to the ground surface with bentonite chips.

The fieldwork was supervised on a full-time basis by DST personnel who located the boreholes in the field, arranged for clearance of subsurface utilities, supervised the drilling and in-situ testing operations, retrieved samples, logged the boreholes, and supervised the backfilling of boreholes and reinstatement of drilling locations. Soil samples were obtained from the auger flights and from the split spoon sampler used for the Standard Penetration Test (SPT). The SPT testing was carried out in accordance with the procedures described in ASTM D1586. The number of blows required to drive the sampler 300 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 geotechnical testing laboratory in Thunder Bay for further analyses.

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 testing included chemical tests, natural moisture contents and particle size analyses on selected soil samples. A total of twenty-seven (27) natural moisture contents, nine (9) grain size particle analyses, five (5) hydrometer tests, one (1) Atterberg limits test and two (2) sets of chemical tests have been carried out for this assignment. Laboratory test results are presented in the Boreholes Logs and graphical plots attached in Appendix D (Enclosures).

Table 4-1 Details of Borehole Locations

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)	Completion Details
Borehole 1	12+471	417.2	14.9	3.9 Lt	Borehole backfilled with bentonite chips to ground surface.
Borehole 2	12+474	415.8	12.2	12.8 Rt	Borehole backfilled with bentonite chips to ground surface.
Borehole 3	12+456	417.0	16.3	6.1 Rt	Borehole backfilled with bentonite chips to ground surface.
Borehole 4	12+458	416.9	14.9	5.1 Lt	Borehole backfilled with bentonite chips to ground surface.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

The subsurface conditions presented below are based on the information obtained during power auger drilling and laboratory determination on selected samples.

The generalized stratigraphy of the existing embankment and outside the embankment footprint, based on the conditions encountered in the boreholes consists of the following:

- Embankment fill comprising loose sand and gravel.
- Topsoil encountered at the base of the embankment north of the culverts.
- Underlain by loose to occasionally compact sand (upper layer)
- Which is underlain by a silt layer with trace to some sand, clay and trace gravel.
- Underlying the silt layer is a loose to compact sand (lower layer) is encountered

The soil strata at the culvert location have been summarized in Table 5-1 and detailed descriptions are provided below.

Table 5-1 Summary of soil strata at the culvert location

Layer	Depth (m)	Elevation (m)	Comments
Fill	0.0 to 2.3 0.0 to 2.3 0.0 to 2.3	417.2 to 414.9 417.0 to 414.7 416.9 to 414.6	Borehole 1 Borehole 3 Borehole 4
Topsoil	0.0 to 0.20	415.8 to 415.6	Borehole 2
Sand (Upper Layer)	2.3 to 6.7 0.2 to 3.8 2.3 to 3.8 2.3 to 3.8	414.9 to 410.5 415.6 to 412.0 414.7 to 413.2 414.6 to 413.1	Borehole 1 Borehole 2 Borehole 3 Borehole 4
Silt	6.7 to 12.2 3.8 to 12.2 3.8 to 8.8 3.8 to 12.2	410.5 to 405.0 412.0 to 403.6 413.2 to 408.2 413.1 to 404.7	Borehole 1 Borehole 2 Borehole 3 Borehole 4
Sand (Lower Layer)	12.2 to 14.9 8.8 to 16.3 12.2 to 14.9	405.0 to 402.3 408.2 to 400.7 404.7 to 402.0	Borehole 1 Borehole 3 Borehole 4

5.1 Fill – Sand and Gravel to Sand

Fill – Sand and Gravel to Sand, some to trace Silt was encountered in Boreholes 1, 3 and 4 with thicknesses of up to 2.3 m (Elev. 417.2 to 414.9 m, Elev. 417.0 to 414.7 m and Elev. 416.9 to 416.1 m). The natural moisture contents of samples tested was found to range between 4 and 26 %. The laboratory test results are summarized in Table 5-2.

Table 5-2 Summary of Particle Size Distribution - Fill - Sand and Gravel to Sand

Laboratory Results – Particle Size Distribution	
Gravel %	1 to 43
Sand %	50 to 88
Fines %	7 to 12

5.2 Topsoil

Topsoil was encountered at surface in Borehole 2 with thicknesses of 0.2 m. It is likely that top soil or other organic soil may also extend outside the area of the embankment fill.

5.3 Sand- Upper Layer

Sand, trace to some Silt, trace Gravel was encountered in all four boreholes, Borehole 1, 2, 3 and 4, at the depth of 2.3 m, 0.2 m, 2.3 m and 2.3 m, with a thickness of 4.4 m (Elev. 414.9 to 410.5 m), 3.6 m (Elev. 415.6 to 412.0 m), 1.5 m (Elev. 414.7 to 413.2 m) and 3.0 m (Elev. 416.1 to 413.1 m) respectively. Organic matter was encountered within this material in Borehole 1, 2, and 3 at depths between 2.3 m to 4.6 m, 0.2 m to 3.8 m and 2.3 m to 3.8 m respectively.

SPT 'N' values vary from 1 to 16, indicating a very loose to compact condition. The natural moisture contents of the sand material vary from 10 to 55 %. The high natural moisture content in the sand layer is an indication of the organic matter encountered within this layer. The laboratory test results are summarized in Table 5-3.

Table 5-3 Summary of Particle Size Distribution - Sand

Laboratory Results – Particle Size Distribution	
Gravel %	0 to 2
Sand %	84 to 93
Fines %	7 to 14

5.4 Silt

Silt, some Sand to Sandy, trace to some Clay was encountered in all four boreholes, Borehole 1, 2, 3 and 4, at the depth of 6.7 m, 3.8 m, 3.8 m and 3.8 m, with a thickness of 5.5 m (Elev. 410.5 to 405.0 m), 8.4 m (Elev. 412.0 to 403.6 m), 5.0 m (Elev. 413.2 to 408.2 m) and 8.4 m (Elev. 413.1 to 404.7 m) respectively. However, the thickness of the silt layer was not proven at Borehole 2 as the borehole was terminated within this layer.

SPT 'N' values vary from 7 to 18, indicating a loose to compact condition or firm to stiff consistency. The natural moisture contents of the silt material vary from 19 to 40 %. Atterberg Limits test and hydrometer tests were carried out on samples from Boreholes 2, 3 and 4. The results of the Atterberg Limits test indicate that the silt is of low plasticity. Therefore, the silt layer can behave either as cohesionless or cohesive depending on the clay content as shown in the borehole logs. Plasticity charts are presented in Appendix D. The laboratory test results are summarized in Table 5-4 and Table 5-5 below.

Table 5-4 Summary of Particle Size Distribution - Silt

Laboratory Results – Particle Size Distribution	
Gravel %	0 to 2
Sand %	2 to 31
Silt %	69 to 85
Clay %	5 to 29

Table 5-5: Summary of Atterberg Limits - Silt

Laboratory Results – Atterberg Limits	
Liquid Limit %	25
Plastic Limit %	19
Plasticity Index %	6

5.5 Sand- Lower Layer

Sand and silt to some silt, with some Gravel, was encountered in Boreholes 1, 3 and 4, at depths of 12.2 m (Elev. 405.0 m), 8.8 m (Elev. 408.2 m) and 12.2 m (Elev. 404.7 m) respectively. The thickness of the sand layer was not proven as Boreholes 1, 2 and 3 were terminated within this layer.

SPT 'N' values vary from 5 to 33, indicating a loose to compact condition, with one value in the dense category. The natural moisture contents of the sand material vary from 11 to 22 %. The laboratory test results are summarized in Table 5-6.

Table 5-6 Summary of Particle Size Distribution - Sand

Laboratory Results – Particle Size Distribution	
Gravel %	12 to 24
Sand %	46 to 59
Fines %	17 to 42

5.6 Groundwater

Groundwater levels in the boreholes where seepage was noted were measured upon completion of borehole drilling and prior to backfilling of the borehole. This information is included on the Borehole Logs in Appendix D.

At the time of the field investigation groundwater was observed in all four boreholes on completion of drilling (See Table 5-7). The water level of the creek was recorded at an elevation 414.0 m during the field investigation. Therefore, it is assumed that the groundwater table at all borehole locations would be close to or slightly above this level. The interpreted groundwater table at the time of investigation is indicated on the borehole logs.

Given the permeable nature of the stratigraphy at this site, groundwater levels can be expected to vary as the river level varies both seasonally and with local precipitation events.

Table 5-7 Groundwater depth at completion of drilling

Borehole	Groundwater Depth (m)	Groundwater Elev. (m)
Borehole 1	2.1	415.1
Borehole 2	0.7	415.1
Borehole 3	1.9	415.1
Borehole 4	1.8	415.1

5.7 Chemical Test Results

Selected soil samples were submitted to ALS Laboratories Thunder Bay for chemical analyses (pH, sulphate, conductivity, resistivity and Chloride) to assess the potential for corrosion and sulphate attack on buried structures.

The results are presented below in Table 5-8 and 5-9 and discussed in Section 7.15. Copies of the Laboratory Certificate of Analyses are provided in Appendix ‘F’.

Table 5-8: Chemical Test Results – Soil Sample

Sample ID	Moisture (%)	Sulphate (mg/kg)	Chloride (mg/kg)	pH	Conductivity (umhos/cm)	Resistivity (ohm - cm)
BH1 at 2.7 m depth	48	131	507	5.43	408	2450

Table 5-9: Chemical Test Results – Water sample

Sample ID	Sulphate (mg/L)	Chloride (mg/L)	pH	Conductivity (umhos/cm)	Resistivity (ohm - cm)
Creek sample	1.43	2.76	7.22	65.6	15244

6. MISCELLANEOUS

Site work was carried out from September 10th to September 11th, 2015 utilizing a CME 750 all-terrain drill rig operated by DST personnel. Fieldwork was supervised on a full-time basis by Mark Menei who located the boreholes in the field, performed sampling, in-situ testing and logged the boreholes. Soil samples retrieved 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 Selorm Danku, Geotechnical Engineer P.Eng., and approved by Mike Fabius, Senior Geotechnical Engineer, P. Eng.

7. 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:

Selorm Danku, P.Eng.
Geotechnical Engineer

Approved by:

Mike Fabius, P.Eng.
Senior Geotechnical Engineer

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

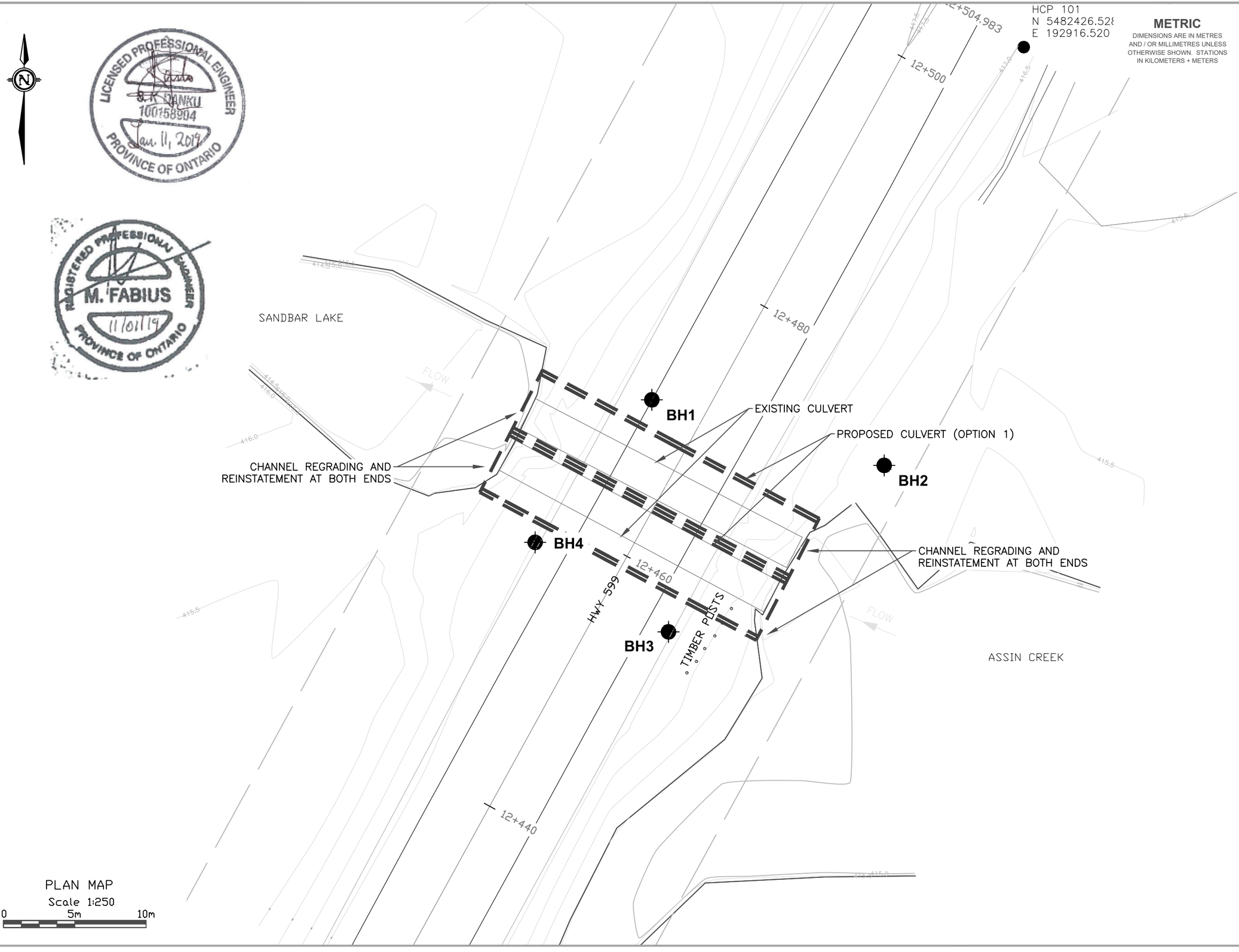
LEGEND OF RECORDS FOR BOREHOLES: SYMBOLS AND ABBREVATIONS FOR SAMPLE TYPE

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



PLAN MAP
Scale 1:250
0 5m 10m

LICENSED PROFESSIONAL ENGINEER
S.K. DANKU
100158904
Jan 11, 2019
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
M. FABIUS
11/01/19
PROVINCE OF ONTARIO

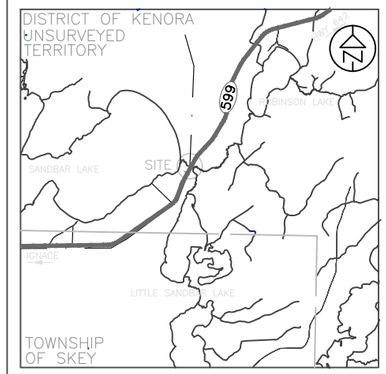
METRIC
DIMENSIONS ARE IN METRES AND / OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETERS + METERS

AG No 4014-E-0023
WP No 6354-14-00
SITE No 48C-0314/C0
GEOCRES No 52G-12

CULVERT REPLACEMENT ASSIN CREEK CULVERT
STA 12+422 TO STA 12+500
Survey 13-06 Revised

SHEET 1

BOREHOLE LOCATIONS



KEY PLAN
1.0 km 0 1.0 km

LEGEND

Borehole

No.	Elev. (m)	MTM Zone 16 North (m)	MTM Zone 16 East (m)	Survey Station	Survey Offset
BH1	417.2	5482275	410311	12+471	3.9 m LT
BH2	415.8	5482272	410325	12+474	12.8 m RT
BH3	417.0	5482258	410312	12+456	6.1 m LT
BH4	416.9	5482262	410304	12+458	5.1 m RT

REV	DATE	ISSUE	DRAWN BY	CHECKED	APPROVAL
1	21-Sep-15	DRAFT	MD	BV	MWB
2	2-Feb-16	DRAFT	EM	SD	MK
3	16-May-16	DRAFT	EM	PDS	MK
4	01-Mar-17	DRAFT	LA	BV	MF
5	25-Oct-18	DRAFT	CS	SD	BV

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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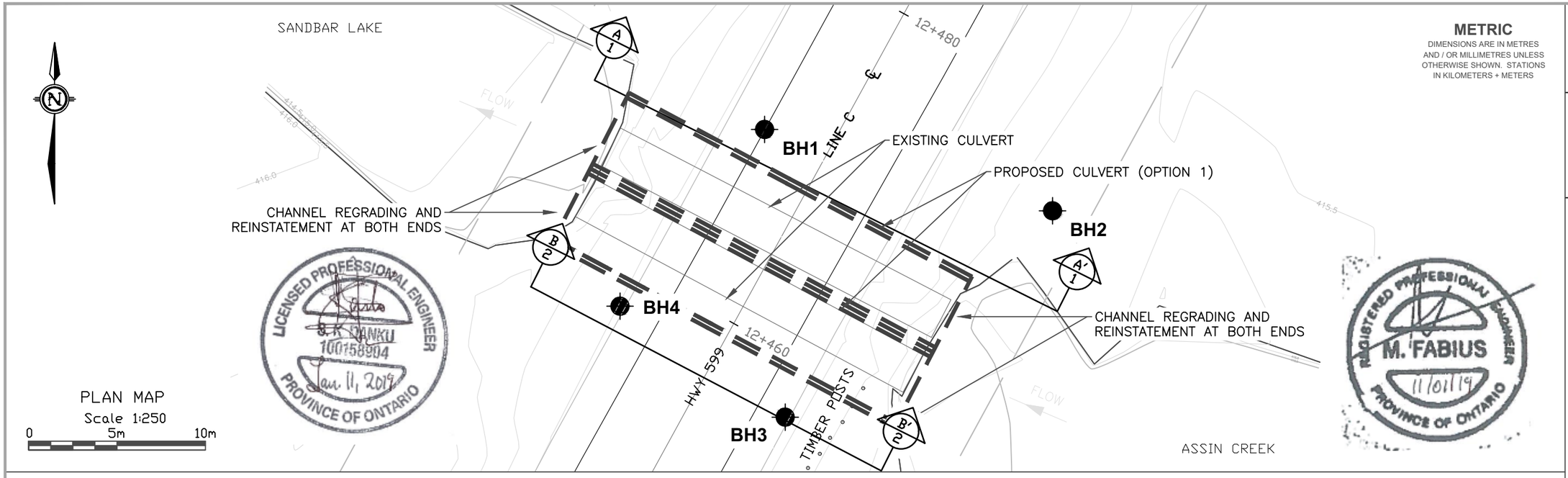
DRAWING 1



PLAN MAP
Scale 1:250
0 5m 10m

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

AG	No	4014–E–0023
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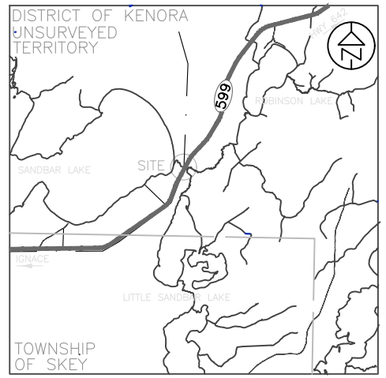
CULVERT REPLACEMENT ASSIN CREEK CULVERT
STA 12+422 TO STA 12+500
Survey 13–06 Revised
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 2



KEY PLAN
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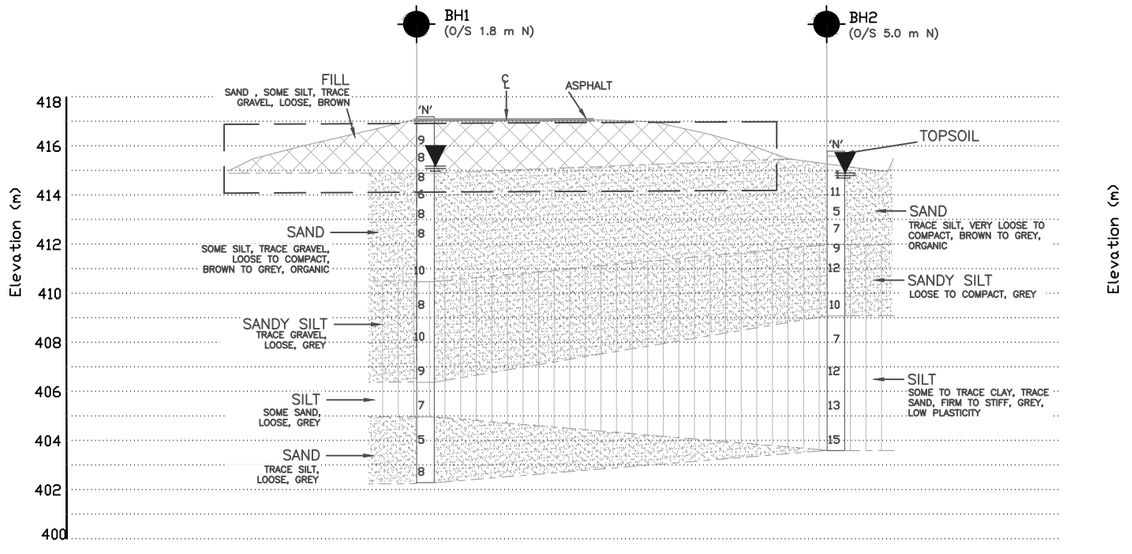

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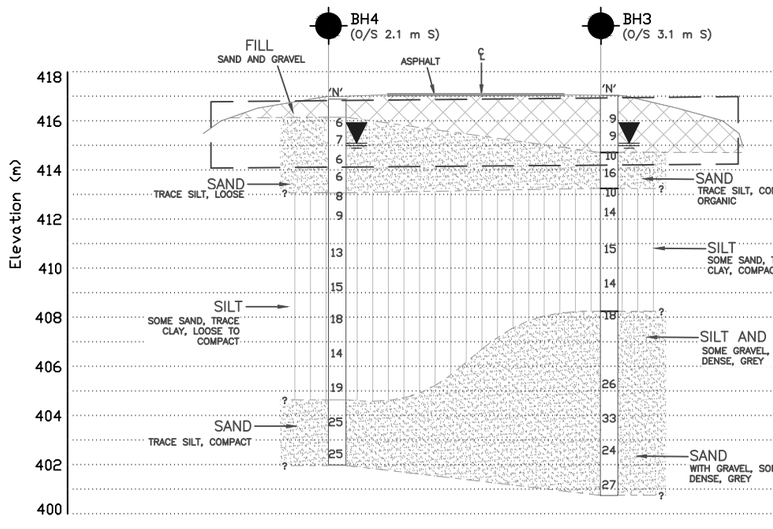

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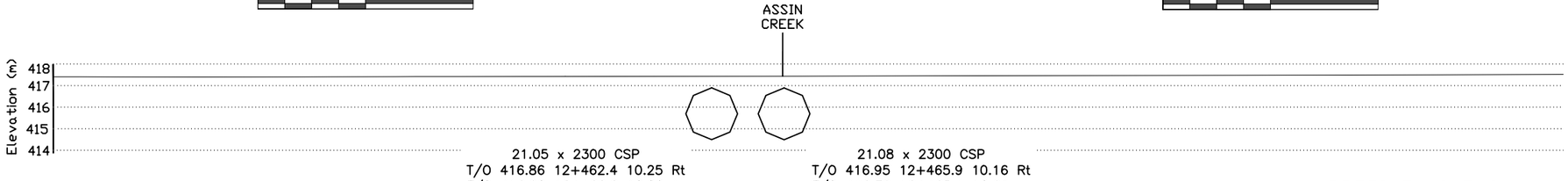
0 5m 10m



PROFILE LINE C
Scale 1:250
0 5m 10m

LEGEND

- Borehole
- 'N' SPT (BLOWS/300 mm)
- Water level at completion of drilling

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

No.	Elev. (m)	MTM Zone 16 North (m)	MTM Zone 16 East (m)	Survey Station	Survey Offset
BH1	417.2	5482275	410311	12+471	3.9 m LT
BH2	415.8	5482272	410325	12+474	12.8 m RT
BH3	417.0	5482258	410312	12+456	6.1 m LT
BH4	416.9	5482262	410304	12+458	5.1 m RT

REV	DATE	ISSUE	DRAWN BY	CHECKED	APPROVAL
1	21-Sep-15	DRAFT	MD	BV	MWB
2	2-Feb-16	DRAFT	EM	SD	MK
3	8-May-16	DRAFT	EM	PDS	MK
4	13-Oct-16	DRAFT	EM	SD	MK
5	8-Dec-16	DRAFT	RW	PDS	MK
6	1-Mar-17	DRAFT	RW	BV	MF
7	25-Oct-18	DRAFT	CS	SD	BV

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
DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 623-2929
Fx: (807) 623-1792
Email: thunderbay@dstgroup.com

DRAWING 2

Appendix D

ENCLOSURES

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. GWP 6354-14-00 LOCATION ASINN CREEK ORIGINATED BY MM

DIST MTO HWY 599 BOREHOLE TYPE HOLLOW STEM AUGER - 80 mm ID / SOLID STEM AUGER COMPILED BY SA

DATUM Geodetic DATE 2015 09 11 CHECKED BY SD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
417.2	GROUND SURFACE								
	FILL - SAND, SOME SILT, TRACE GRAVEL LOOSE BROWN		AS1	AS			417		
			SS2	SS	9		416		
			SS3	SS	8	▽			1 87 (12)
414.9							415		Water level taken at 2.1 m at end of drilling
2.3	SAND, SOME SILT, TRACE GRAVEL LOOSE TO COMPACT BROWN TO GREY ORGANIC MATTER AT 2.3 m to 4.6 m		SS4	SS	8				
			SS5	SS	6		414		
			SS6	SS	8		413		2 84 (14)
			SS7	SS	8		412		
410.5			SS8	SS	10		411		
6.7	SANDY SILT, TRACE GRAVEL LOOSE GREY						410		
			SS9	SS	8		409		
			SS10	SS	10		408		
407.0									
10.2	SILT, SOME SAND LOOSE GREY		SS11	SS	9		407		
			SS12	SS	7		406		0 15 (85)
405.0							405		
12.2	SAND, TRACE SILT LOOSE GREY								
			SS13	SS	5		404		
			SS14	SS	8		403		
402.3									
14.9	END OF BOREHOLE AT 14.9 m								

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

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

ON_MOT-HIGH VANES AC - BH LOGS.GPJ DATA TEMPLATE.GDT 13/5/16

ENCLOSURE 1

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. GWP 6354-14-00 LOCATION ASINN CREEK ORIGINATED BY MM

DIST MTO HWY 599 BOREHOLE TYPE HOLLOW STEM AUGER - 80 mm ID / SOLID STEM AUGER COMPILED BY SA

DATUM Geodetic DATE 2015 09 10 CHECKED BY SD

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) (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
415.8	GROUND SURFACE										
415.6	TOPSOIL										
0.2	SAND, TRACE SILT VERY LOOSE TO COMPACT BROWN TO GREY		AS1	AS		▽	415				Water level taken at 0.7 m at end of drilling
			SS2	SS	1						
			SS3	SS	11		414				
	ORGANIC		SS4	SS	5		413				
			SS5	SS	7						
412.0							412				
3.8	SANDY SILT LOOSE TO COMPACT GREY		SS6	SS	9						0 31 (69)
			SS7	SS	12		411				
			SS8	SS	10		410				
409.1							409				
6.7	SILT, SOME CLAY, TRACE SAND FIRM TO STIFF GREY										
	LOW PLASTICITY		SS9	SS	7		408				0 5 76 19
			SS10	SS	12		407				
			SS11	SS	13		406				
	TRACE CLAY		SS12	SS	15		405				
403.6							404				2 20 73 5
12.2	END OF BOREHOLE AT 12.2 m										

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

ON_MOT-HIGH VANES AC - BH LOGS.GPJ DATA TEMPLATE.GDT 13/5/16

ENCLOSURE 2

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. GWP 6354-14-00 LOCATION ASINN CREEK ORIGINATED BY MM

DIST MTO HWY 599 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY SA

DATUM Geodetic DATE 2015 09 10 CHECKED BY SD

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
417.0	GROUND SURFACE										
	FILL - SAND AND GRAVEL, TRACE SILT LOOSE BROWN TO GREY		AS1	AS							43 50 (7)
			SS2	SS	9		416				
			SS3	SS	9	▽	415				0 88 (12) Water level taken at 1.9 m at end of drilling
414.7											
2.3	SAND, TRACE SILT COMPACT GREY ORGANIC MATTER AT 23 m to 3.8 m		SS4	SS	10						
			SS5	SS	16		414				
413.2											
3.8	SILT, SOME SAND, TRACE TO SOME CLAY COMPACT GREY		SS6	SS	10		413				
			SS7	SS	14		412				0 12 80 8
			SS8	SS	15		411				
			SS9	SS	14		410				
408.2							409				
8.8	SILT AND SAND, SOME GRAVEL COMPACT TO DENSE GREY		SS10	SS	18		408				12 46 (42)
			SS11	SS			407				
			SS12	SS	26		406				
			SS13	SS	33		405				
			SS14	SS	24		404				
	SAND WITH GRAVEL, SOME SILT DENSE GREY		SS15	SS	27		403				
400.7							402				
16.3	END OF BOREHOLE AT 16.3 m						401				24 59 (17)

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

ON_MOT-HIGH VANES AC - BH LOGS.GPJ DATA TEMPLATE.GDT 13/5/16

RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

W.P. GWP 6354-14-00 LOCATION ASINN CREEK ORIGINATED BY MM

DIST MTO HWY 599 BOREHOLE TYPE HOLLOW STEM AUGER - 80 mm ID / SOLID STEM AUGER COMPILED BY SA

DATUM Geodetic DATE 2015 09 10 CHECKED BY SD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
416.9	GROUND SURFACE								
416.1	FILL - SAND AND GRAVEL		AS1	AS					
0.8	SAND, TRACE SILT LOOSE BROWN TO GREY		SS2	SS	6		416		
			SS3	SS	7	▽	415		Water level taken at 1.8 m at end of drilling
			SS4	SS	6		414		
413.1	ORGANIC (WOOD FRAGMENTS)		SS5	SS	6				0 93 (7)
3.8	SILT, SOME SAND, TRACE CLAY LOOSE TO COMPACT BROWN TO GREY		SS6	SS	8		413		
			SS7	SS	9		412		0 17 75 8
			SS8	SS	13		411		
			SS9	SS	15		410		
			SS10	SS	18		409		
406.7							408		
10.2	SILT WITH CLAY, TRACE SAND STIFF TO VERY STIFF GREY		SS11	SS	14		407		0 2 69 29
			SS12	SS	19		406		
404.7							405		
12.2	SAND, TRACE SILT COMPACT GREY		SS13	SS	25		404		
			SS14	SS	25		403		
402.0							402		
14.9	END OF BOREHOLE AT 14.9 m								

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

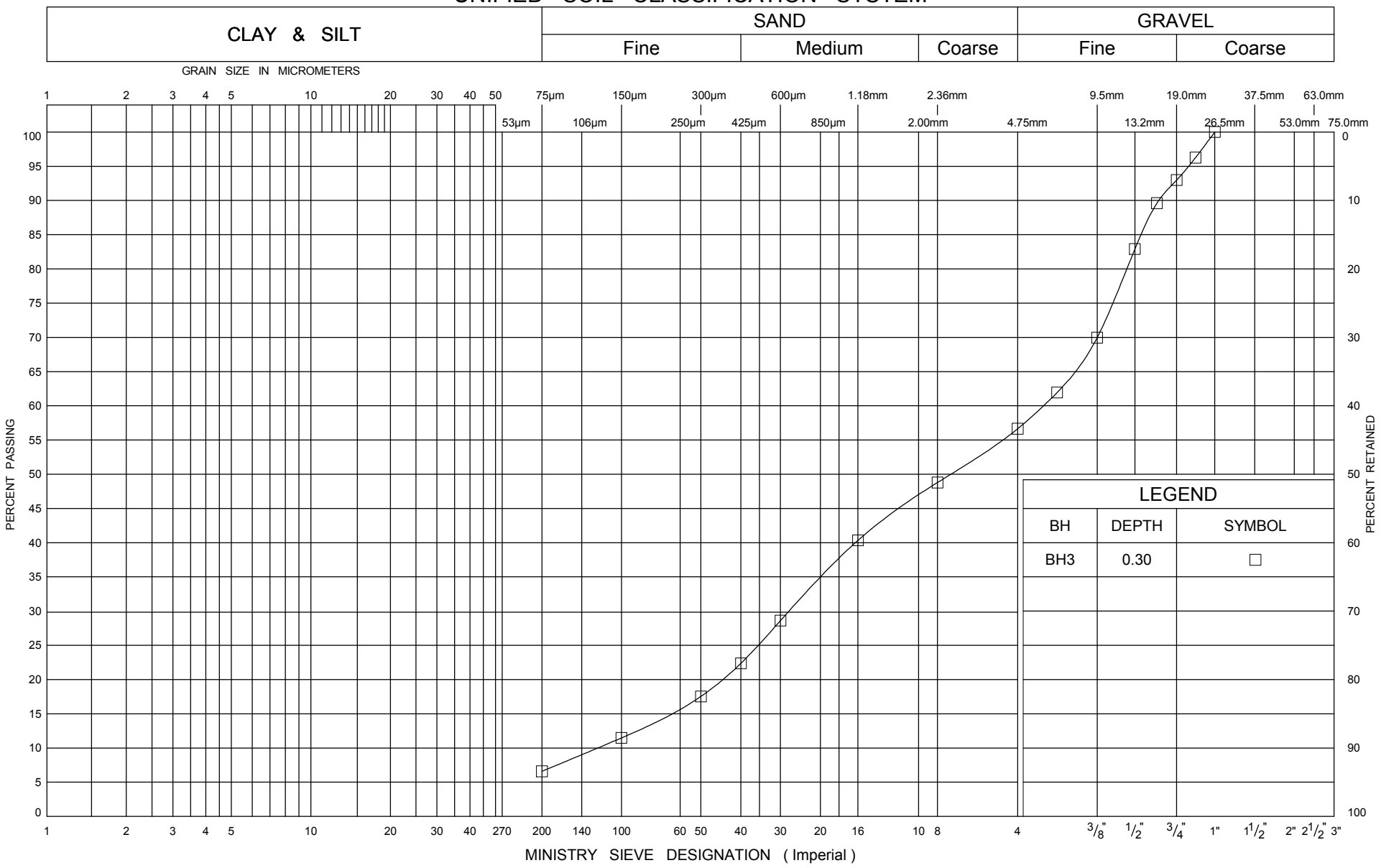
WATER CONTENT (%): 20 40 60

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

ON_MOT-HIGH VANES AC - BH LOGS.GPJ DATA TEMPLATE.GDT 13/5/16

ENCLOSURE 4

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation Ontario

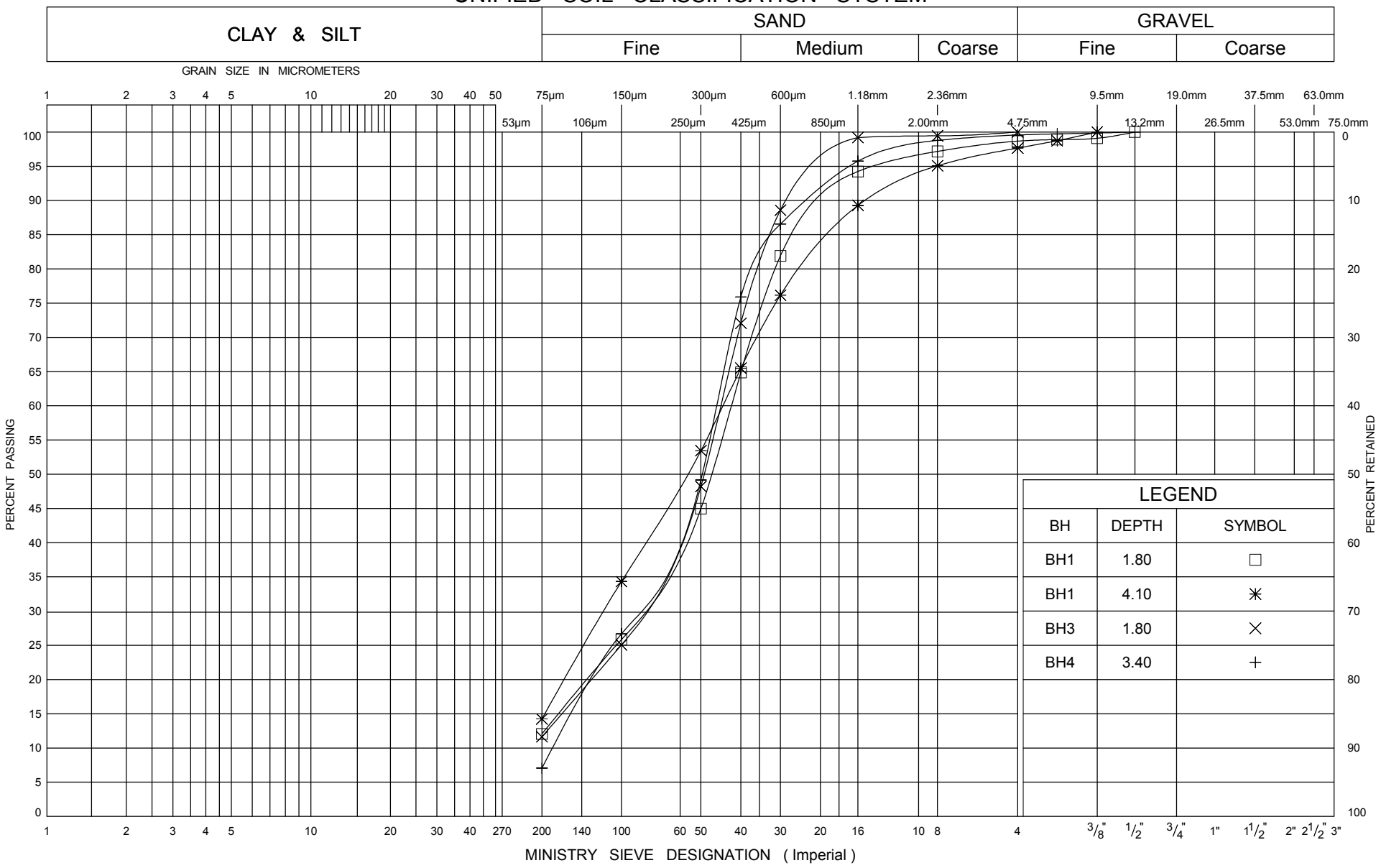
GRAIN SIZE DISTRIBUTION
SOIL DESCRIPTION
FILL - SAND AND GRAVEL

ENCLOSURE 5

DST REF. # GS-TB-020407

ASINN CREEK CULVERT

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation Ontario

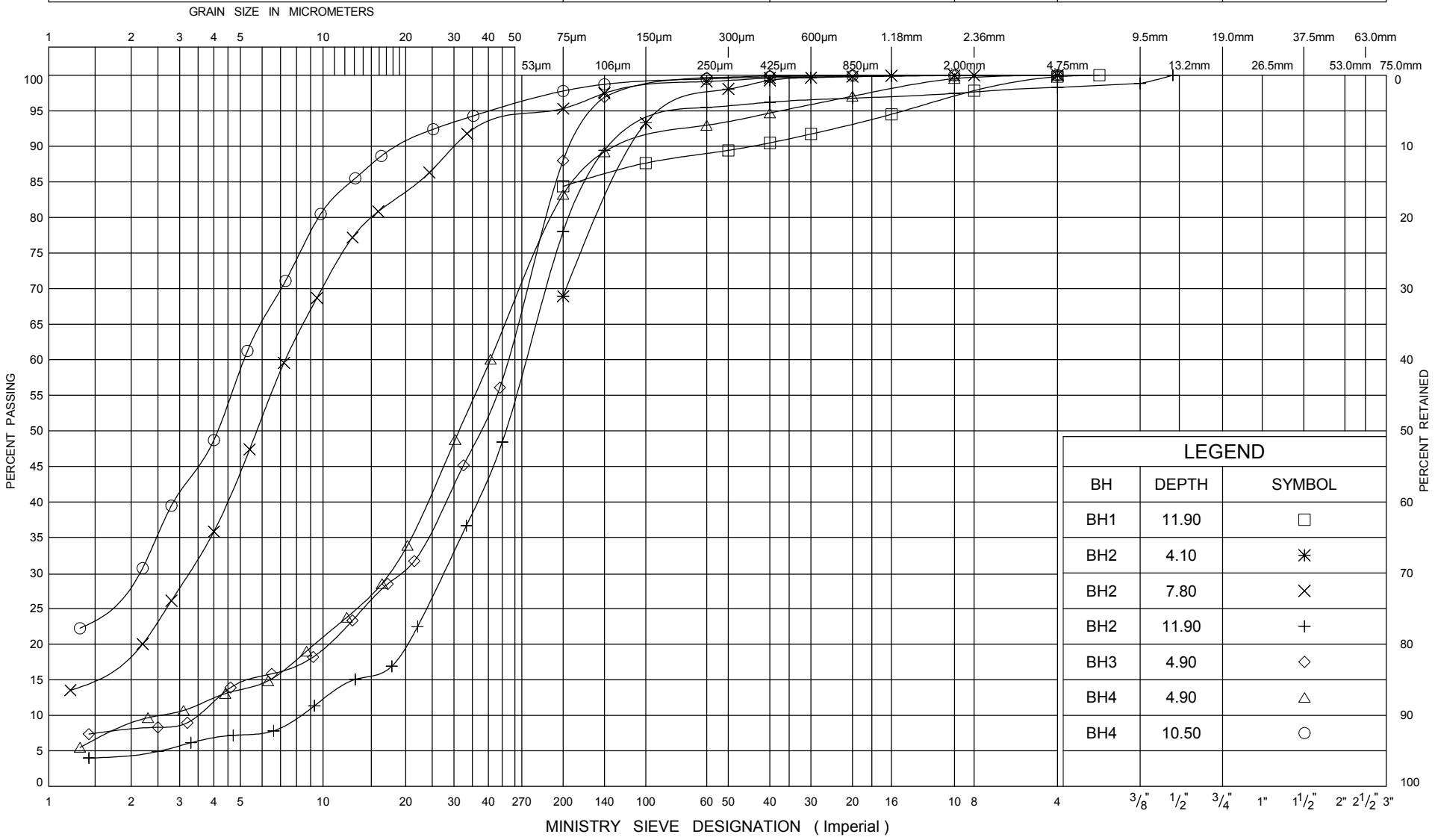
GRAIN SIZE DISTRIBUTION
SOIL DESCRIPTION
SAND - UPPER LAYER

ENCLOSURE 6

DST REF. # GS-TB-020407

ASINN CREEK CULVERT

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	DEPTH	SYMBOL
BH1	11.90	□
BH2	4.10	✳
BH2	7.80	×
BH2	11.90	+
BH3	4.90	◇
BH4	4.90	△
BH4	10.50	○

Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION
SOIL DESCRIPTION
SILT

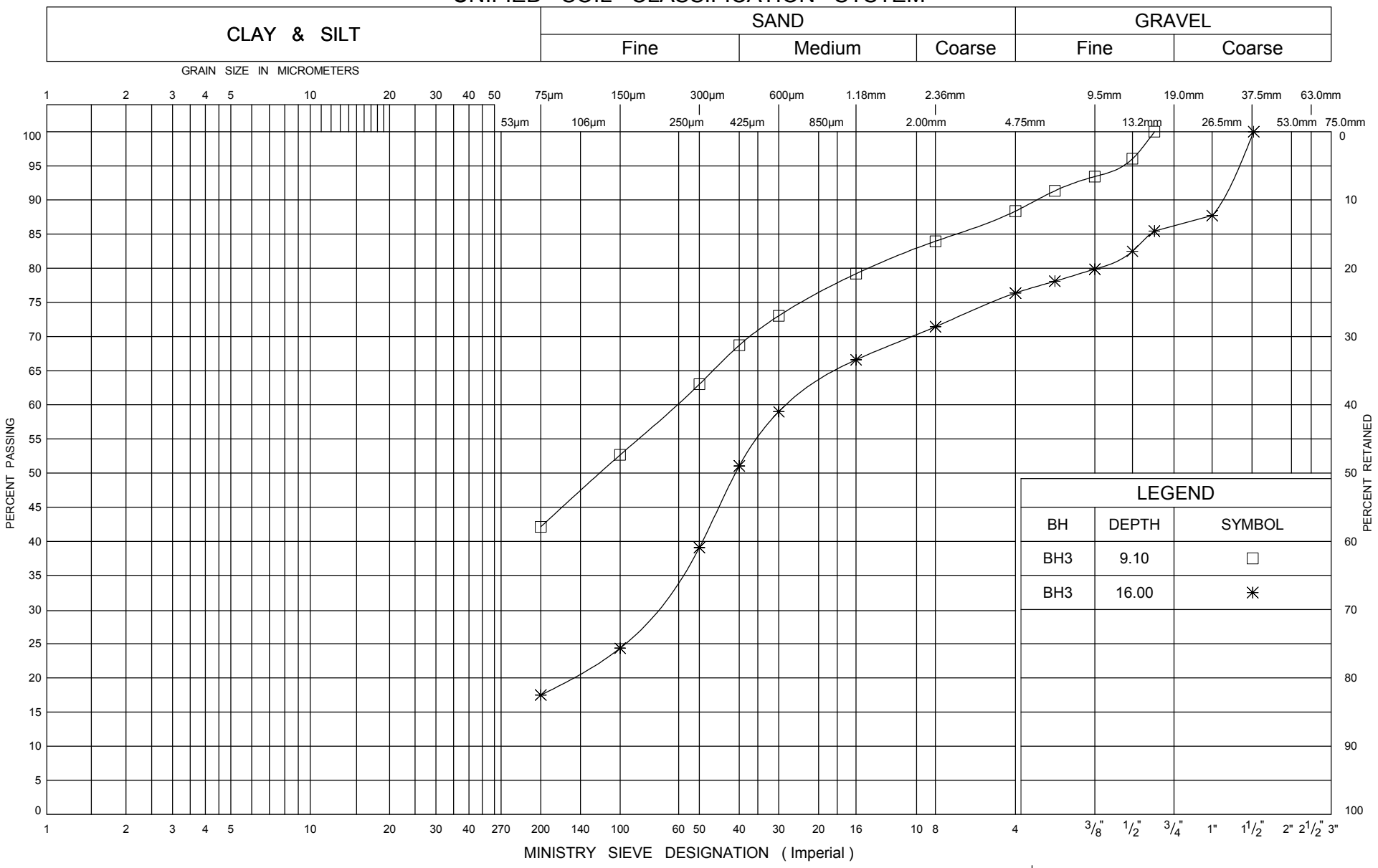
ENCLOSURE 7

DST REF. # GS-TB-020407

ASINN CREEK CULVERT

ONTARIO MOT GRAIN SIZE GS-TB-020407 ASINN CREEK - BH LOGS.GPJ DATA TEMPLATE.GDT 29/1/16

UNIFIED SOIL CLASSIFICATION SYSTEM



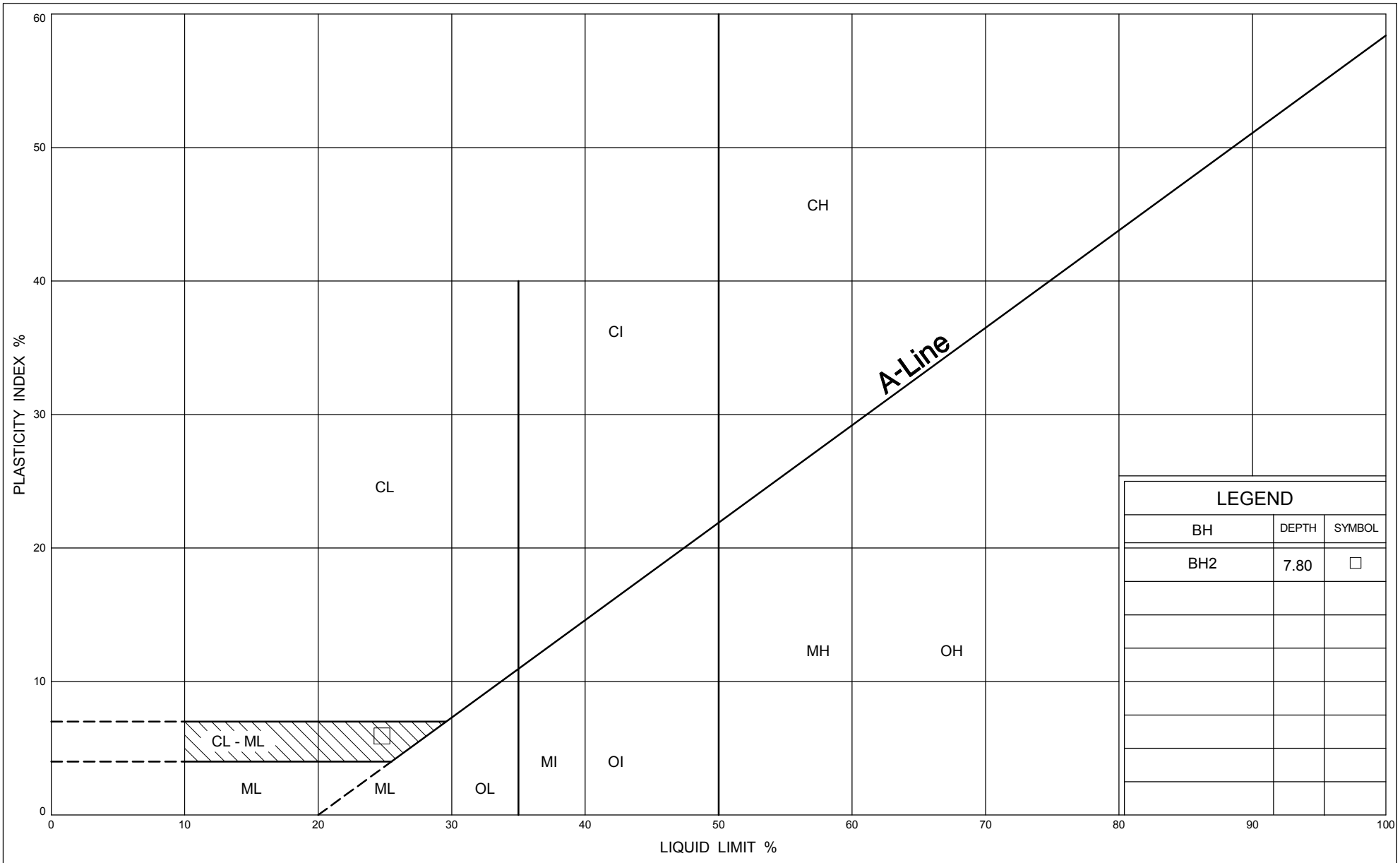
Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION
SOIL DESCRIPTION
SAND - LOWER LAYER

ENCLOSURE 8

DST REF. # GS-TB-020407

ASINN CREEK CULVERT



Ministry of Transportation Ontario

PLASTICITY CHART
SILT

ENCLOSURE 9

DST REF. # GS-TB-020407

ASINN CREEK CULVERT

Appendix E

NON-STANDARD SPECIAL PROVISION

GROUNDWATER - Item No. 1

Non-Standard Special Provision

This special provision covers the groundwater level.

It should be noted that depending on the season, the amount of water flow through the creek may vary. The groundwater level at the site may also be subject to seasonal variations. The contractor should be prepared for this situation. The contractor should be aware of the high water table, the potential for surface water fluctuations. The contractor should take this into account when selecting an excavation method, and any subsequent dewatering methods.

Appendix F

CHEMICAL TEST RESULTS

DST Thunder Bay
ATTN: Selorm Danku
DST Consulting Engineers Inc.
1120 Premier Way , Suite 200
Thunder Bav ON P7B 0A3

Date Received: 01-DEC-15
Report Date: 10-DEC-15 07:58 (MT)
Version: FINAL

Client Phone: 807-345-3620

Certificate of Analysis

Lab Work Order #: L1708995

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Rikki Thomson
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1708995-1 ASINM CREEK Sampled By: Client on 01-DEC-15 @ 00:01 Matrix: Soil							
Physical Tests							
Conductivity	408		4.0	umhos/cm	07-DEC-15	07-DEC-15	R3325981
% Moisture	48.0		0.10	%	04-DEC-15	05-DEC-15	R3325347
pH	5.43		0.10	pH units		07-DEC-15	R3326423
Resistivity	2450		100	ohm cm	07-DEC-15	07-DEC-15	R3325976
Leachable Anions & Nutrients							
Chloride	507		20	mg/kg	04-DEC-15	08-DEC-15	R3327616
Anions and Nutrients							
Sulphate	131		20	mg/kg	04-DEC-15	08-DEC-15	R3327616

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-WT	Soil	Chloride in Soil	EPA 300.0
EC-WT	Soil	Conductivity (EC)	EPA 9050A
		A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.	
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
PH-WT	Soil	pH	MOEE E3137A
		Soil samples are mixed in the deionized water and the supernatant is analyzed directly by the pH meter.	
RESISTIVITY-WT	Soil	Resistivity	MOECC E3138
		Resistivity on a soil is a 2:1 extraction of DI water to soil. Sample is tumbled for 30 min. Conductivity of the extraction is taken and the inverse is calculated for resistivity.	
SO4-WT	Soil	Sulphate	EPA 300.0

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1708995 Report Date: 10-DEC-15

Client: DST Thunder Bay
DST Consulting Engineers Inc. 1120 Premier Way , Suite 200
Thunder Bay ON P7B 0A3
Contact: Selorm Danku

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-WT	**Soil**							
Batch R3327616								
WG2226771-3 CRM		**AN-CRM-WT**						
Chloride			102.9		%		70-130	08-DEC-15
WG2226771-2 LCS								
Chloride			95.9		%		70-130	08-DEC-15
WG2226771-1 MB								
Chloride			<20		mg/kg		20	08-DEC-15
EC-WT	**Soil**							
Batch R3325981								
WG2227671-1 MB								
Conductivity			<4.0		umhos/cm		4	07-DEC-15
MOISTURE-WT	**Soil**							
Batch R3325347								
WG2226652-2 LCS								
% Moisture			95.5		%		90-110	05-DEC-15
WG2226652-1 MB								
% Moisture			<0.10		%		0.1	05-DEC-15
PH-WT	**Soil**							
Batch R3326423								
WG2228014-1 LCS								
pH			6.99		pH units		6.7-7.3	07-DEC-15
SO4-WT	**Soil**							
Batch R3327616								
WG2226771-3 CRM		**AN-CRM-WT**						
Sulphate			110.5		%		60-140	08-DEC-15
WG2226771-2 LCS								
Sulphate			96.2		%		70-130	08-DEC-15
WG2226771-1 MB								
Sulphate			<20		mg/kg		20	08-DEC-15

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

DST Thunder Bay
ATTN: Bernie Villegas
DST Consulting Engineers Inc.
605 Hewitson street
Thunder Bav ON P7B 5V5

Date Received: 19-OCT-15
Report Date: 21-OCT-15 10:30 (MT)
Version: FINAL

Client Phone: 807-626-1310

Certificate of Analysis

Lab Work Order #: L1689521

Project P.O. #: NOT SUBMITTED
Job Reference: GS-TB-020407
C of C Numbers:
Legal Site Desc:

Rikki Thomson
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1689521-1 LOW RIVER - 48W-6C Sampled By: CLIENT on 15-OCT-15 @ 14:05 Matrix: WATER							
Physical Tests							
Conductivity (EC)	46.6		3.0	uS/cm		19-OCT-15	R3292437
pH	7.37		0.10	pH		19-OCT-15	R3292437
Anions and Nutrients							
Chloride (Cl)	0.47		0.10	mg/L		20-OCT-15	R3293233
Sulfate (SO4)	0.77		0.30	mg/L		20-OCT-15	R3293233
L1689521-2 WIGGLE CREEK -48W-312C Sampled By: CLIENT on 15-OCT-15 @ 15:30 Matrix: WATER							
Physical Tests							
Conductivity (EC)	42.0		3.0	uS/cm		19-OCT-15	R3292437
pH	7.11		0.10	pH		19-OCT-15	R3292437
Anions and Nutrients							
Chloride (Cl)	0.91		0.10	mg/L		20-OCT-15	R3293233
Sulfate (SO4)	1.13		0.30	mg/L		20-OCT-15	R3293233
L1689521-3 SAVANT LAKE - 48W-313C Sampled By: CLIENT on 15-OCT-15 @ 16:10 Matrix: WATER							
Physical Tests							
Conductivity (EC)	52.3		3.0	uS/cm		19-OCT-15	R3292437
pH	6.98		0.10	pH		19-OCT-15	R3292437
Anions and Nutrients							
Chloride (Cl)	2.25		0.10	mg/L		20-OCT-15	R3293233
Sulfate (SO4)	0.51		0.30	mg/L		20-OCT-15	R3293233
L1689521-4 GRAYSTONE LAKE -48W-189C Sampled By: CLIENT on 15-OCT-15 @ 17:13 Matrix: WATER							
Physical Tests							
Conductivity (EC)	31.1		3.0	uS/cm		19-OCT-15	R3292437
pH	7.14		0.10	pH		19-OCT-15	R3292437
Anions and Nutrients							
Chloride (Cl)	0.13		0.10	mg/L		20-OCT-15	R3293233
Sulfate (SO4)	1.21		0.30	mg/L		20-OCT-15	R3293233
L1689521-5 ASINN CREEK-48W-314C Sampled By: CLIENT on 15-OCT-15 @ 10:05 Matrix: WATER							
Physical Tests							
Conductivity (EC)	65.6		3.0	uS/cm		19-OCT-15	R3292437
pH	7.22		0.10	pH		19-OCT-15	R3292437
Anions and Nutrients							
Chloride (Cl)	2.76		0.10	mg/L		20-OCT-15	R3293233
Sulfate (SO4)	1.43		0.30	mg/L		20-OCT-15	R3293233

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Chloride (Cl)	B	L1689521-1, -2, -3, -4, -5
Matrix Spike	Chloride (Cl)	MS-B	L1689521-1, -2, -3, -4, -5

Sample Parameter Qualifier key listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-L-IC-N-TB	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-TITR-TB	Water	Conductivity	APHA 2510 B
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
PH-TITR-TB	Water	pH	APHA 4500-H
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode			
SO4-IC-N-TB	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
TB	ALS ENVIRONMENTAL - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: DST Thunder Bay
DST Consulting Engineers Inc. 605 Hewitson street
Thunder Bay ON P7B 5V5
Contact: Bernie Villegas

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-L-IC-N-TB	**Water**							
Batch R3293233								
WG2196265-6 LCS								
Chloride (Cl)			99.7		%		90-110	20-OCT-15
WG2196265-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	20-OCT-15
EC-TITR-TB	**Water**							
Batch R3292437								
WG2195669-2 LCS								
Conductivity (EC)			97.8		%		90-110	19-OCT-15
WG2195669-1 MB								
Conductivity (EC)			<3.0		uS/cm		3	19-OCT-15
PH-TITR-TB	**Water**							
Batch R3292437								
WG2195669-2 LCS								
pH			6.02		pH		5.9-6.1	19-OCT-15
SO4-IC-N-TB	**Water**							
Batch R3293233								
WG2196265-6 LCS								
Sulfate (SO4)			98.7		%		90-110	20-OCT-15
WG2196265-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	20-OCT-15

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1689521 were received on 19-OCT-15 09:25.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.