FOUNDATION INVESTIGATION REPORT
DECEPTION CREEK TRIBUTARY CULVERT REPLACEMENT
HIGHWAY 11
TOWNSHIP OF CALDER
AGREEMENT No.: 5010-E-0006
GWP: 5149-11-00
WP: 5113-09-01
GEOCRES NO.: 42H-50

March 2012

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Prepared for:

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DST CONSULTING ENGINEERS INC.

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

DST Consulting Engineers Inc. has been subcontracted by Genivar who was retained by the Ministry of Transportation (MTO), Northeastern Region, to conduct a geotechnical investigation for the replacement of the Deception Creek Tributary culvert on Highway 11. This work was carried out under Agreement No.: 5010-E-0006, Detailed Design for the Replacement / Rehabilitation of Various Culverts.

This report addresses the field investigation, laboratory test program, factual report on conditions (Part 1) and recommendations for design and construction for the proposed culvert replacement (Part 2).

2. SITE DESCRIPTION

The site is located on Highway 11, approximately 19.6 km west of the Highway 11 and Highway 579 intersection, Township of Calder, Cochrane Area. The structural site number is 39E-255.

Existing structure at this location is a three cell timber box 2.13 m x 1.75 m x 26.0 m culvert built in 1983 with a depth of cover of approximately 1.5 m. The culvert was to be in fair to poor condition and the timber elements appear to be rotting and checking, with some elements missing completely. Significant loss of fill on the embankment and major asphalt patching on the roadway directly above the culvert were also noted.

The embankment slopes at this location are approximately 1.5H:1V. Both sides of the embankment were sparsely vegetated granular material with muskeg at the toe of the embankment. The photographs shown in Figures 2.1 to 2.6 were taken by MTO.

Geological information is available from published *Ontario Geological Survey Map # 5036* by the *Ontario Ministry of Natural Resources* for the Smooth Rock area, District of Cochrane. The map indicates a ground moraine formation with till and clay materials, subordinate landforms of organic terrain with peat and muck are also present. The topography in the area landform is mainly moderate local relief, the dominant land surface is undulating to rolling, and the subordinate organic terrain is plain like. The surface drainage conditions are mixed wet and dry within the ground moraine terrain, and wet in the organic terrain.

Figure 2.1 Culvert inlet (facing northeast)

Figure 2.2 Culvert outlet (facing south)

Figure 2.3 Culvert deterioration

Figure 2.4 Missing culvert sections

Figure 2.5 Vegetation at culvert intlet (facing southwest)

Figure 2.6 Vegetation at culvert inlet (facing northeast)

Figure 2.7 Facing east from culvert

Figure 2.8 Asphalt deterioration facing northeast

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out between March 24th, 2011 and March 28th, 2011 utilizing a CME 55 drill rig that was operated by DST personnel. A total of four (4) boreholes were advanced for the purpose of foundation design at this site, two (2) using hollow stem augers and other two (2) using hand augers. Boreholes were advanced to depths ranging from 3.1 to 17.4 m.

Two boreholes were advanced through the road structure at Station 9+996 offset 5.0 m left and at Station 10+004 offset 5.0 m right. Two auger boreholes were advanced at beyond the toe of slope near the existing culvert inlet and outlet at Station 9+996 offset 16.6 m left and Station 10+005 offset 17.3 m right respectively. The minimum number of boreholes, and depths and locations of boreholes were chosen according to the given specification in Request for Quotation (RFQ) by MTO.

The borehole locations are referenced to the MTO Station numbering system as indicated in the RFQ. The centreline of the existing culvert was assumed as Station 10+000. The ground surface elevations at the borehole locations were surveyed by DST personnel. At approximately Station 10+030 offset 20 m left a benchmark with an elevation of 97.9 m was placed in the telephone pole and flagged. Borehole locations, stationing and benchmark location are shown on the Borehole Location Plan, Drawings 1. Table 3.1 summarizes the detail of borehole locations and depths.

Table 3.1 Detail of borehole locations

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)
BH1	9+996	99.2	17.4	5.0 Lt
BH2	10+004	99.4	15.8	5.0 Rt
HA1	10+005	96.8	3.1	17.3 Rt
HA2	9+996	96.7	3.1	16.6 Lt

The fieldwork was supervised on a full-time basis by DST personnel who located the boreholes in the field, performed sampling and in-situ testing and logged the boreholes. Standard Penetration Testing (SPT) was performed in the boreholes advanced with hollow stem augers. Field vane test (FVT) was performed to estimate undrained shear strength of the cohesive soils. 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 three (43) moisture contents, five (5) sieve analyses, six (6) particle size analyses and seven (7) Atterberg limit tests have been carried out for this assignment. Laboratory test results are presented in the Boreholes Logs (Enclosures 1 to 4), and Plots (Enclosures 5 to 10).

4. DESCRIPTION OF SUBSURFACE CONDITIONS

The subsurface conditions are presented based on the information obtained during field and laboratory testing.

The generalized stratigraphy of the existing embankment, based on the conditions encountered in boreholes, consists of surfacing (hot mix asphalt) overlying sand with crushed gravel fill that is underlain by a mixed backfill including sand and clay surrounding the existing culvert. This fill is then underlain by clay over a deeper silty sand to sand and silt layer.

4.1 Topsoil and Organics

A topsoil layer of up to 150 mm was encountered in hand auger holes 1 and 2. Organic material was also encountered in Hand Auger Holes 1 and 2 at depths from 0.7 to 1.5 m and 0.2 to 0.9 m; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 96.1 and 95.3 m in auger hole 1 and 96.5 and 95.8 in auger hole 2 respectively. The thickness of this stratum in auger hole 1 and 2 was approximately 0.8 m and 0.7 m respectively.

4.2 Asphalt

Asphalt was encountered in boreholes 1 and 2 with a thickness of approximately 115 mm.

4.3 Embankment Fill

Embankment fill layer was encountered in Borehole 1 and 2 below the asphalt layer and at Hand Auger Hole 1. It was encountered at depths between 0.11 and 3.8 m below surface in Boreholes 1 and 2; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 99.3 and 95.5 m respectively. This material was also identified between surface and depths of 0.7 m below surface in Auger hole 1; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 96.8 and 96.1 m respectively. Within the sand fill cobbles were noted during the drilling process. Grain size distributions of the fill material are reported in borehole logs (Enclosures 1 to 4) and plots (Enclosures 5 and 7).

A pavement structure of two materials over the native soil was identified. Directly below the asphalt a fill of predominantly sand and crushed gravel materials was encountered at boreholes 1 and 2 from 115 mm below surface to depths up to 0.2 m; this corresponds to maximum and

minimum upper and lower boundary elevations of approximately 99.3 and 99.0 m respectively. The thickness of this stratum in both Borehole 1 and 2 was approximately 0.1 m. This layer is roadbed granular layer. Gradation analyses conducted on a sample from Borehole 2 indicates gravel, sand, and fines content of approximately 42%, 55% and 3% respectively. This material does not classify as Granular A material but does meet OPSS specifications for Granular B, Type I meeting SSP 110S13 requirements. Material percentages passing the 13.2, 9.5 and 4.75 mm sieves were too high for strict adherence to Granular A and Granular B, Type II specifications. The moisture content of samples was between 4 and 7%.

Directly below this sand and crushed gravel, a fill of predominantly compact to very dense sand materials was encountered at Boreholes 1 between depths of 0.2 and 3.8 m below surface; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 99.0 and 95.5 m respectively. In Borehole 1 the thickness of this stratum was approximately 3.6 m. This material was also encountered in Borehole 2 between depths of 0.2 and 2.2 m below surface as well as between 3.4 and 3.8 m below surface; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 99.2 and 97.2 m as well as 96.0 and 95.6 m respectively. In Borehole 2 the thickness of the upper and lower stratums was approximately 2.0 m and 0.4 m respectively. Gradation analyses conducted on samples from Borehole 1 and 2 indicate gravel, sand, and fines contents of from 2 to 20%, 69 to 80% and 8 to 20% respectively. This material does not classify as Granular B, Type I meeting SSP 110S13 requirements, as higher fine content was resulted from the gradation tests. Material percentages passing the 0.075 mm sieve was too high for strict adherence to Granular B, Type I specifications. The moisture content of samples was between 4 and 11%.

Silty clay was encountered in Borehole 2 between depths of 2.2 and 3.4 m below surface; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 97.2 and 96.0 m respectively. The thickness of this stratum was approximately 1.2 m. This material was also encountered in Auger hole 1 between depths of 0.3 and 0.7 m below surface; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 96.5 and 96.1 m respectively. Atterberg limits tests carried out on samples from Boreholes 2 and Auger hole 1 indicate this clay has an intermediate plasticity with liquid limits and plasticity indices ranging from approximately 36 to 37% and 15 to 19% respectively. Moisture content of the samples was between 23 and 37%.

4.4 Clay

Clay was encountered in Boreholes 1 and 2 as well as Hand Auger Holes 1 and 2. It was encountered at depths between 3.8 and 13.0 m below surface in Boreholes 1 and 2; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 95.5 and 98.2 m respectively. This material was also identified at depths between 0.9 and of 3.1 m below surface in Auger holes 1 and 2; this corresponds to maximum upper boundary elevations of approximately 95.3 and 95.8 m respectively. The thickness of this stratum was found to be approximately 9.2 m as determined in Borehole 1 and 2. For Auger Holes 1 and 2 the thickness of this stratum is not determined as borehole terminus was reached within this stratum. Atterberg limit test carried out on samples from Boreholes 1 and 2 as well as Hand Auger Hole 1 indicates this clay has a low to high plasticity with liquid limits and plasticity indices ranging from of 25 to 66% and 11 to 41% respectively. In-situ field vane tests taken in Boreholes 1 and 2 indicate undrained shear strengths between 29 and 91 kPa with sensitivities ranging from 2 to 6 which indicates consistencies of firm to stiff. Gradation analyses conducted on samples from Boreholes 1 and 2 as well as Hand Auger Holes1 and 2 indicate gravel, sand, silt and clay contents of approximately 0 to 1%, 1 to 12%, 11 to 61% and 31 to 88% respectively. Moisture contents of samples ranged from 17% to 62%.

4.5 Silty Sand to Sand and Silt

Loose to dense silty sand to sand and silt was encountered in the Boreholes 1 and 2 at depths below approximately 13.0 m below surface; this corresponds to maximum upper boundary elevations of approximately 86.2 and 86.4 m in Borehole 1 and 2 respectively. The thickness of this stratum is not defined in Boreholes 1 and 2 as borehole terminus was reached within the stratum. Gradation analyses conducted on samples from boreholes 1 and 2 indicate gravel, sand, and fines contents of approximately 3 to 7%, 47 to 60% and 37 to 46% respectively. Moisture contents of samples ranged from 9% to 16%.

4.6 Groundwater

The groundwater table was identified below the ground surface during the field investigation and visual identification of soil samples. The estimated depth of groundwater level below the ground surface elevation is given in Table 4.1. The water level in the creek at the culvert was at an elevation of approximately 96.6 m during the field investigation. The groundwater levels and water level at the culvert can be expected to vary with season and precipitation events.

Table 4.1 Depth of water table at boreholes

Borehole ID	Borehole elevation (m)	Water table elevation (m)	Depth of water table below the ground surface (m)
BH1	99.2	96.5	2.7
BH2	99.4	96.5	2.9
HA1	96.8	96.7	0.2
HA2	96.7	96.5	0.2

5. REFERENCES

Canadian Highway Bridge Design Code (2006), CAN/CSA-S6-06, A National Standard of Canada, Canadian standards Association.

Municipal and Provincial Common, Volume 1 - General & Construction Specifications, "*Ontario Provincial Standard for Roads & Public Works*" Spec No. *OPSS* 422, 501, 510, 511, 517, 518, 539, 805, 902.

Municipal and Provincial Common, Volume 3 - Drawings for Roads, Barriers, Drainage, Sanitary Sewers, Watermains and Structures, "*Ontario Provincial Standard for Roads & Public Works*" Spec No. *OPSD* 203.040, 803.010, 810.010, 810.020, 3090.100.

Municipal and Provincial Common, Volume 2 - Material Specifications, "*Ontario Provincial Standard for Roads & Public Works*" Spec No. *OPSS* 1860.

Special Provisions, Ontario Provincial Standards, SP110S13.

The Surveys and Design Office, Highway Engineering Division, Ministry of Transportation, 1990, Pavement Design and Rehabilitation Manual.

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.

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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 a Quality Verification Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes. The 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'

DESCRIPTIVE TERMS

FOR SOIL CLASSIFICATION

Descriptive Terms for soil classification:

As per the soil classification manual by MTO, the descriptive terms based on percent by mass of the whole sample, are described as per following table

Descriptive Term	Example	Percent by Mass of Sample
And (with two major soil types)	Sand and gravel	40-60
Adjective (silty)	Silty	30-40
With	Silt with fine sand	20-30
Some	Silt, some fine sand	10-20
Trace	Sand, trace of gravel	0-10

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

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

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

D R A W I N G S

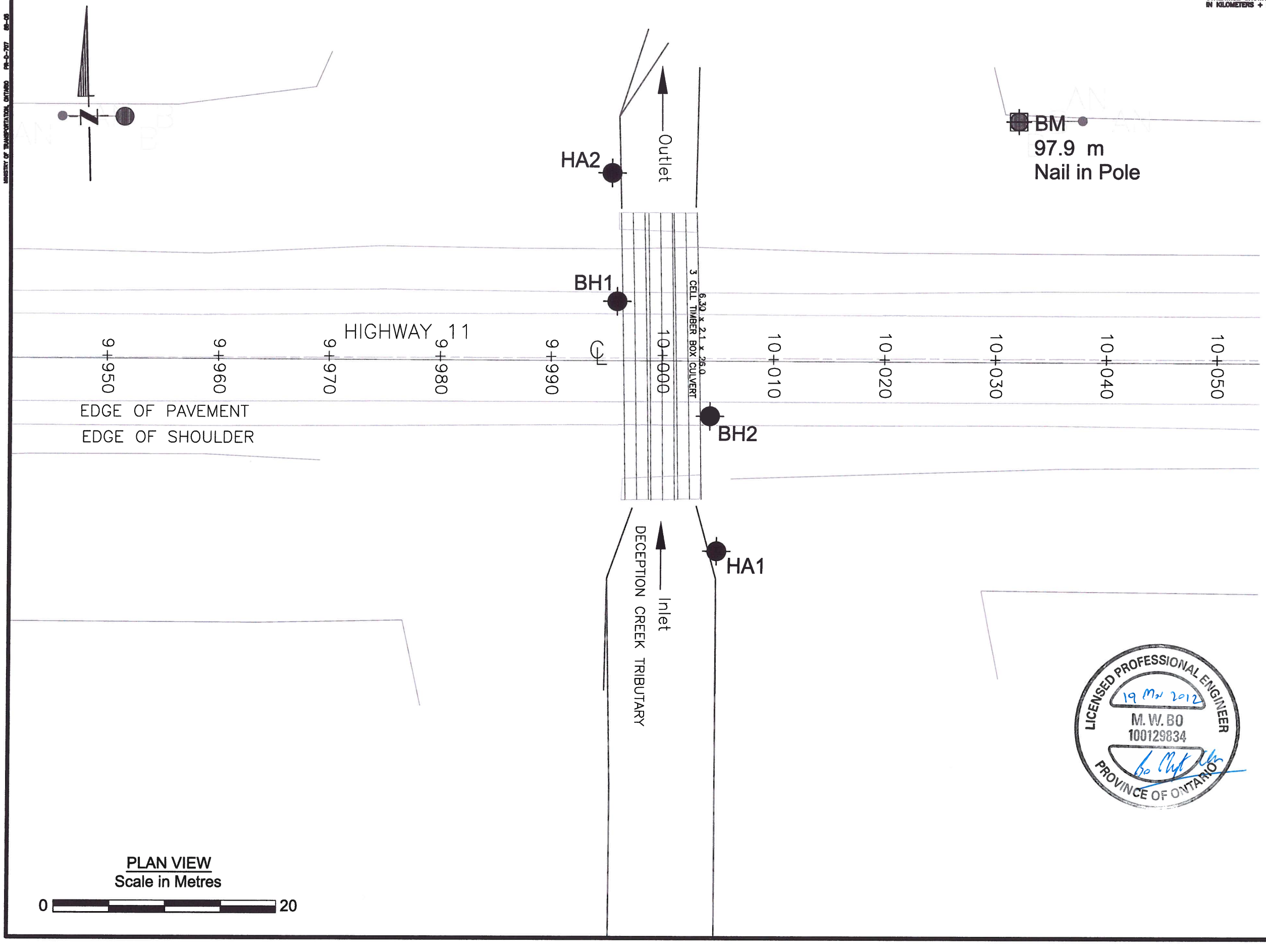
METRIC

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

CONT	No 2012-5119
GWP	No 5149-11-00
WP	No 5113-09-01
Site	No 39E-255
Geocres	No 42H-50

CULVERT REPLACEMENT
AT DECEPTION CREEK TRIBUTARY
Highway 11 – Calder Twp.
Geotechnical Investigation

SHEET



PLAN VIEW
Scale in Metres
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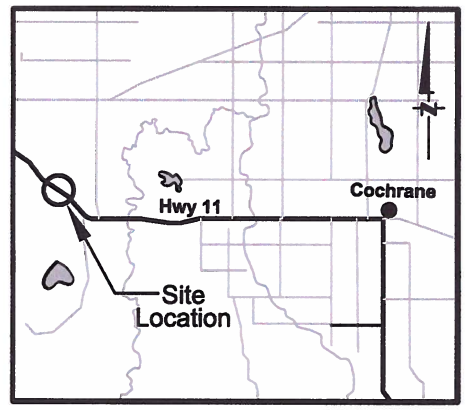

KEY PLAN
0 20
SCALE IN KILOMETRES

LEGEND

- Borehole/Hand Auger
- Borehole with DCPT
- Dynamic Cone Penetration Test (DCPT)
- Rock Probe
- 'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)
- Water level at time of investigation.
- Benchmark
- Fill
- Organics
- Topsoil
- Till
- Bedrock
- Sand
- Silt
- Clay
- Sand & Gravel
- Boulders

No.	Elevation	Northing	Easting	Station	Offset
BH1	99.23	5435780	477833	9+996	5.0 RT
BH2	99.38	5435777	477827	10+004	5.0 LT
HA1	98.84	5435772	477828	10+005	17.3 RT
HA2	98.65	5435794	477835	9+996	16.6 LT

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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

METRIC

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

CONT	No 2012-5119
GWP	No 5149-11-00
WP	No 5113-09-01
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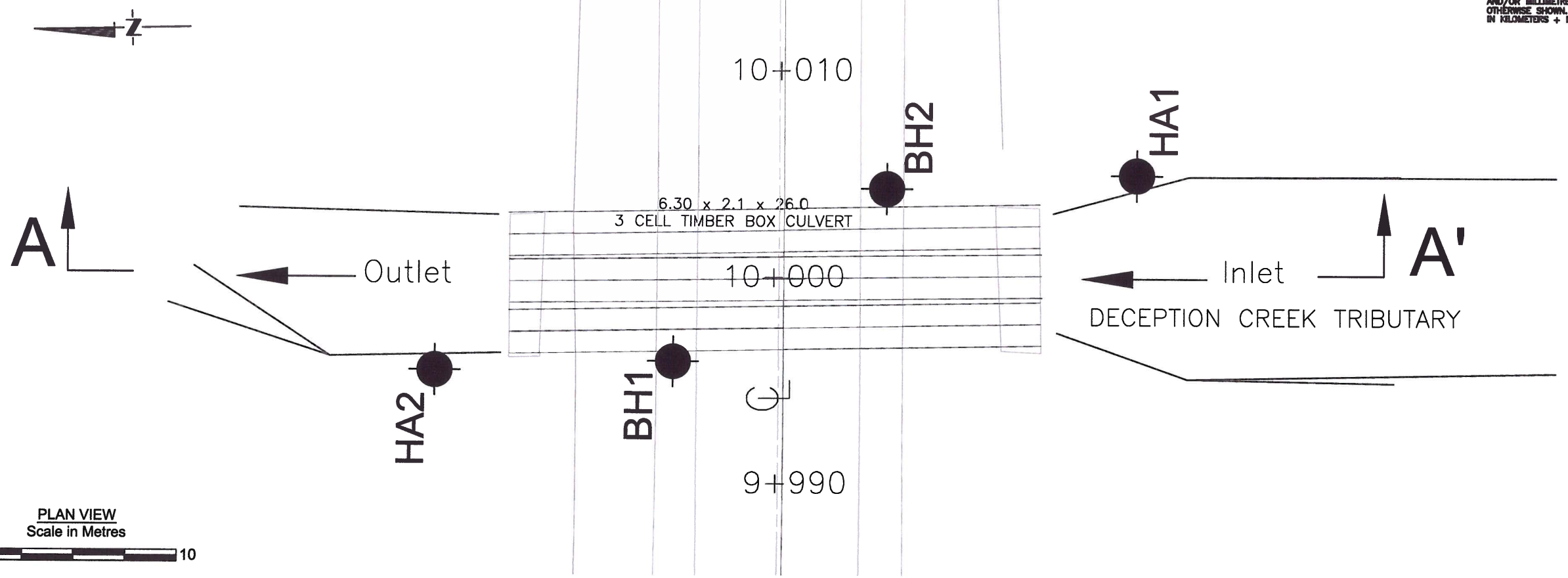
CULVERT REPLACEMENT
AT DECEPTION CREEK TRIBUTARY
Highway 11 – Calder Twp.
Geotechnical Investigation

SHEET 25



PLAN VIEW
Scale in Metres
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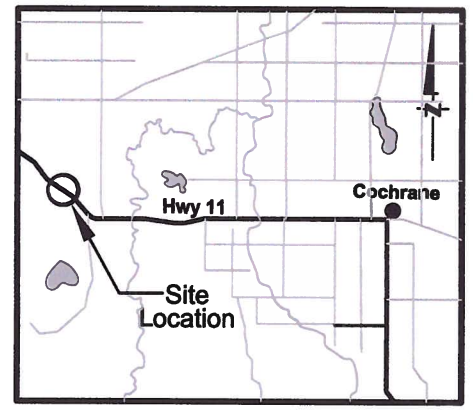


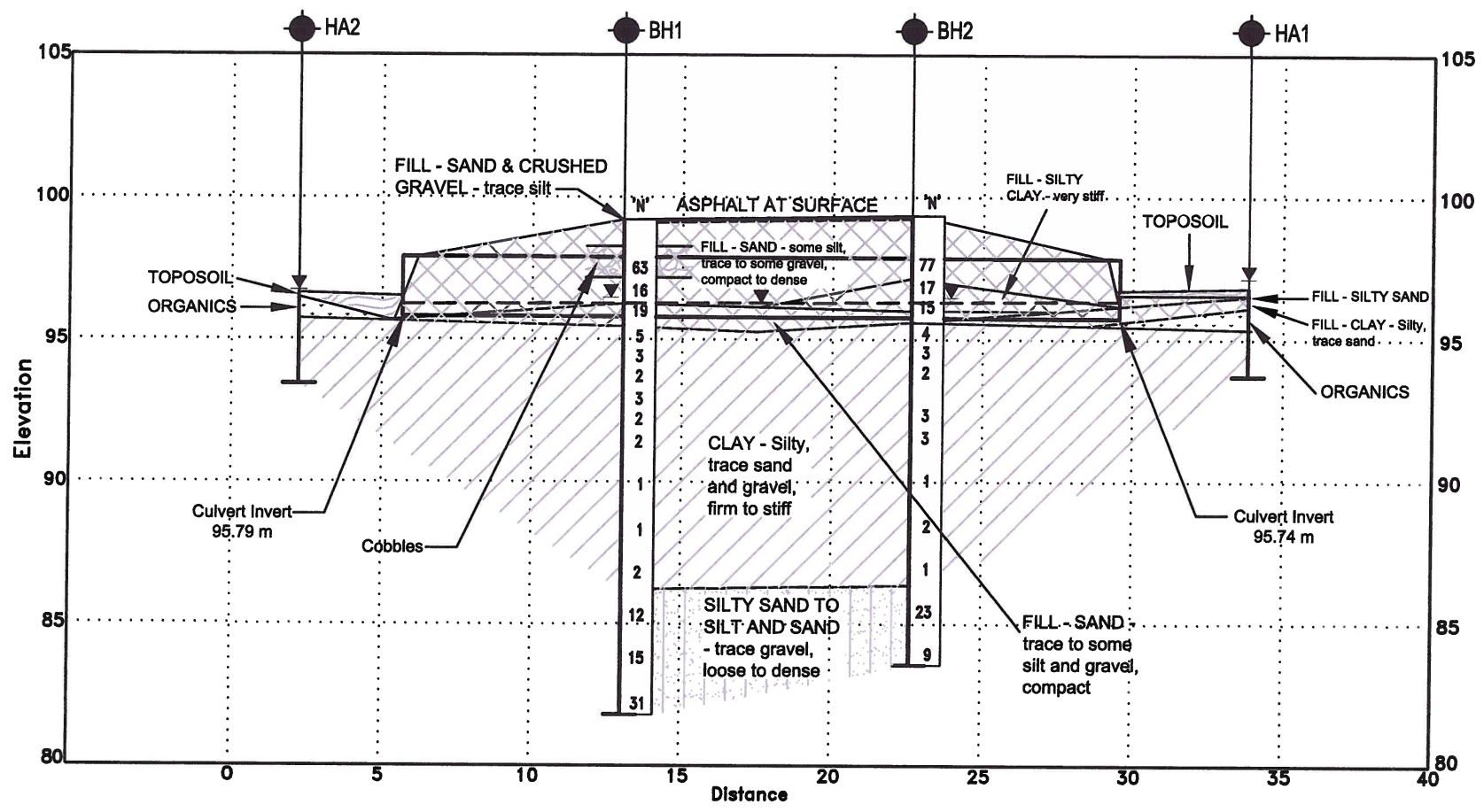
KEY PLAN
0 20
SCALE IN KILOMETRES

LEGEND

- Borehole/Hand Auger
- Borehole with DCPT
- Dynamic Cone Penetration Test (DCPT)
- Rock Probe
- 'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)
- Water level at time of investigation.
- Benchmark

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

PROFILE ALONG SECTION A-A'



No.	Elevation	Northing	Easting	Station	Offset
BH1	99.23	5435780	477833	9+996	5.0 RT
BH2	99.38	5435777	477827	10+004	5.0 LT
HA1	98.84	5435772	477828	10+005	17.3 RT
HA2	98.65	5435794	477835	9+996	16.6 LT

LICENSED PROFESSIONAL ENGINEER
19 Mar 2012
M. W. BO
100129834
PROVINCE OF ONTARIO

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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 2

MINISTRY OF TRANSPORTATION, ONTARIO RR-D-707 05-05

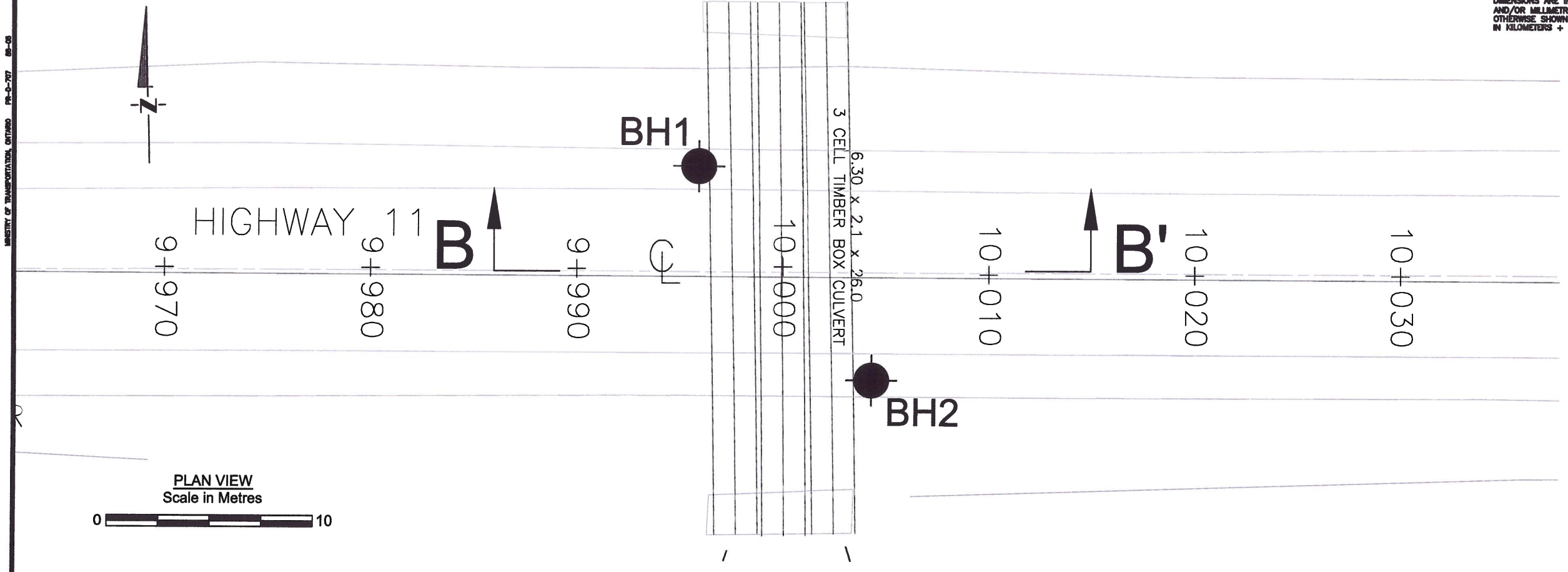
METRIC

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

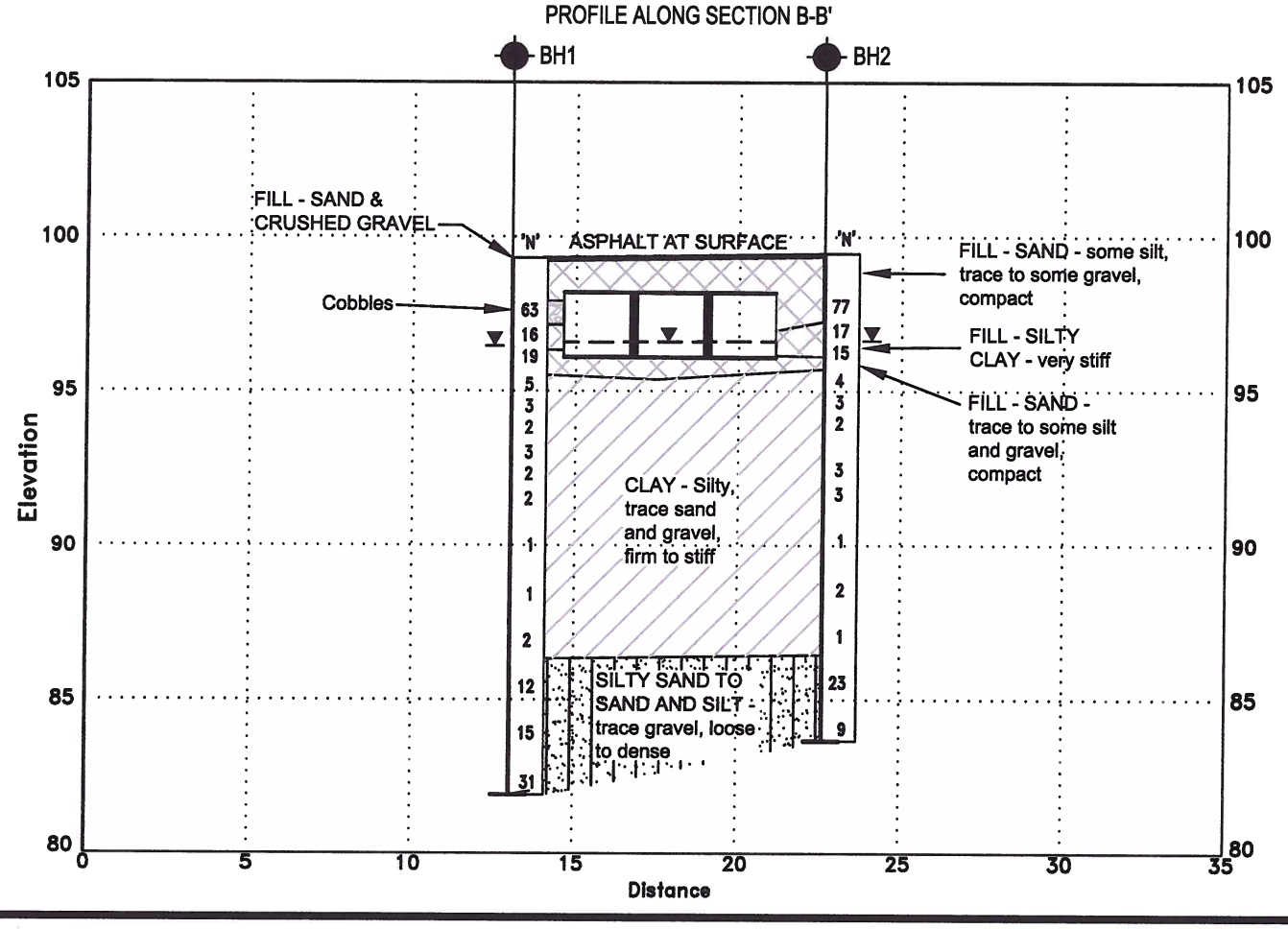
CONT	No 2012-5119
GWP	No 5149-11-00
WP	No 5113-09-01
Site	No 39E-255
Geocres	No 42H-50

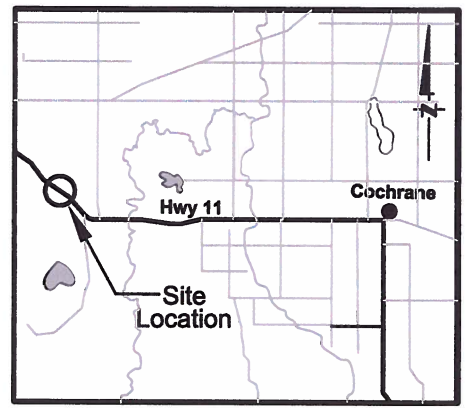
CULVERT REPLACEMENT
AT DECEPTION CREEK TRIBUTARY
Highway 11 – Calder Twp.
Geotechnical Investigation

SHEET 26



PLAN VIEW
Scale in Metres
0 10





KEY PLAN
0 20
SCALE IN KILOMETRES

LEGEND

- Borehole/Hand Auger
- Borehole with DCPT
- Dynamic Cone Penetration Test (DCPT)
- Rock Probe
- 'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)
- Water level at time of investigation.
- Benchmark

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

No.	Elevation	Northing	Easting	Station	Offset
BH1	99.23	5435780	477833	9+998	5.0 RT
BH2	99.38	5435777	477827	10+004	5.0 LT
HA1	96.84	5435772	477826	10+005	17.3 RT
HA2	96.65	5435794	477835	9+996	16.6 LT

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DRAWING 3

E N C L O S U R E S

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 5113-09-01 LOCATION STA. 9+996, 5.0 m LT (5435780 m N, 477833 m E) ORIGINATED BY KS/JF

DIST HWY 11 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY ML

DATUM Assumed DATE 2011 03 25 CHECKED BY WS/BV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.2	GROUND SURFACE						
99.1	ASPHALT - 115 mm		AS1	AS			Water level at 2.75 m on completion. Cave at 2.2 m. Frozen to 2.0 m
99.0 / 0.2	FILL - SAND & CRUSHED GRAVEL - trace silt, brown						
	FILL - SAND - some silt, trace gravel, brown, compact		AS2	AS			
	- - - - - cobbles - - - -		SS3	SS	63		8 79 (13)
96.3			SS4	SS	16	▽	
3.0	FILL - SAND - some silt, trace gravel, brown, compact		SS5	SS	19		2 78 (20)
95.5							
3.8	CLAY - Silty, brown, trace sand, firm to stiff		SS6	SS	5		
			SS7	SS	3		
			SS8	SS	2		
			SS9	SS	3		
			SS10	SS	2		0 8 58 34
			SS11	SS	2		
			SS12	SS	1		
			SS13	SS	1		0 1 24 75
			SS14	SS	2		
86.2							
13.0	SAND - Silty, trace gravel, grey, compact to dense		SS15	SS	12		
			SS16	SS	15		3 60 (37)
			SS17	SS	31		
81.8							
17.4	End of Borehole at 17.4 m						

ELEVATION SCALE: 99, 98, 97, 96, 95, 94, 93, 92, 91, 90, 89, 88, 87, 86, 85, 84, 83, 82

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

×³, ★³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

ON_MOT GS-TB-012144 - DECEPTION CREEK TRIBUTARY - HWY 11.GPJ DST_MIN.GDT 13/3/12

ENCLOSURE 1

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 5113-09-01 LOCATION STA. 10+004, 5.0 m RT (5435777 m N, 477827 m E) ORIGINATED BY KS/JF

DIST HWY 11 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY ML

DATUM Assumed DATE 2011 03 28 CHECKED BY WS/BV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.4	GROUND SURFACE						99				
99.3 / 0.1	ASPHALT - 115 mm										
99.2 / 0.2	FILL - SAND & CRUSHED GRAVEL - trace silt, brown		AS1	AS							
			AS2	AS							
	FILL - SAND - some gravel & silt, brown, compact		AS3	AS							
97.2			SS4	SS	77		98				42 55 (3) Water level at 2.9 m on completion. Cave at 4.3 m. Frozen to 2.3 m
2.2	FILL - CLAY - Silty, brown, very stiff		SS5	SS	17	▽	97				20 69 (11)
96.0			SS6	SS	15		96				
3.4 / 95.6	FILL - SAND - some gravel, trace silt, grey, compact										12 80 (8)
3.8	CLAY - Silty, trace sand and gravel - grey, firm to stiff		SS7	SS	4		95				
			SS8	SS	3			3			
			SS9	SS	2		94	3			
			TW10	TW			93				1 9 59 31
			SS11	SS	3						
			SS12	SS	3		92	2			
							91	2			
			SS13	SS	1		90	6			0 1 11 88
			SS14	SS	2		89	4			
			SS15	SS	1		88				
86.4							87	5			
13.0	SAND & SILT - trace gravel, grey, loose to compact		SS16	SS	23		86				
							85				
83.6			SS17	SS	9		84				7 47 (46)
15.8	End of Borehole at 15.8 m										

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

ON_MOT GS-TB-012144 - DECEPTION CREEK TRIBUTARY - HWY 11.GPJ DST_MIN.GDT 13/3/12

ENCLOSURE 2

RECORD OF BOREHOLE No HA1

1 OF 1

METRIC

W.P. 5113-09-01 LOCATION STA. 10+005, 17.3 m RT (5435772 m N, 477826 m E) ORIGINATED BY KS/JF

DIST HWY 11 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY ML

DATUM Assumed DATE 2011 03 24 CHECKED BY WS/BV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
96.8	GROUND SURFACE										
96.8 / 0.0	TOPSOIL - 50 mm		SA21	AS							450 mm Standing Water.
96.5 / 0.3	SAND - Silty, trace gravel, brown		SA22	AS							
96.1 / 0.7	CLAY - Silty, trace sand, brown/grey		SA23	AS			96				
	ORGANICS - fibrous, dark brown										
95.3 / 1.5	CLAY - Silty, trace sand, grey		SA24	AS			95				0 8 61 31
93.7			SA25	AS			94				
3.1	End of Borehole at 3.1 m										

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

RECORD OF BOREHOLE No HA2

1 OF 1

METRIC

W.P. 5113-09-01 LOCATION STA. 9+996, 16.6 m LT (5435794 m N, 477835 m E) ORIGINATED BY KS/JF

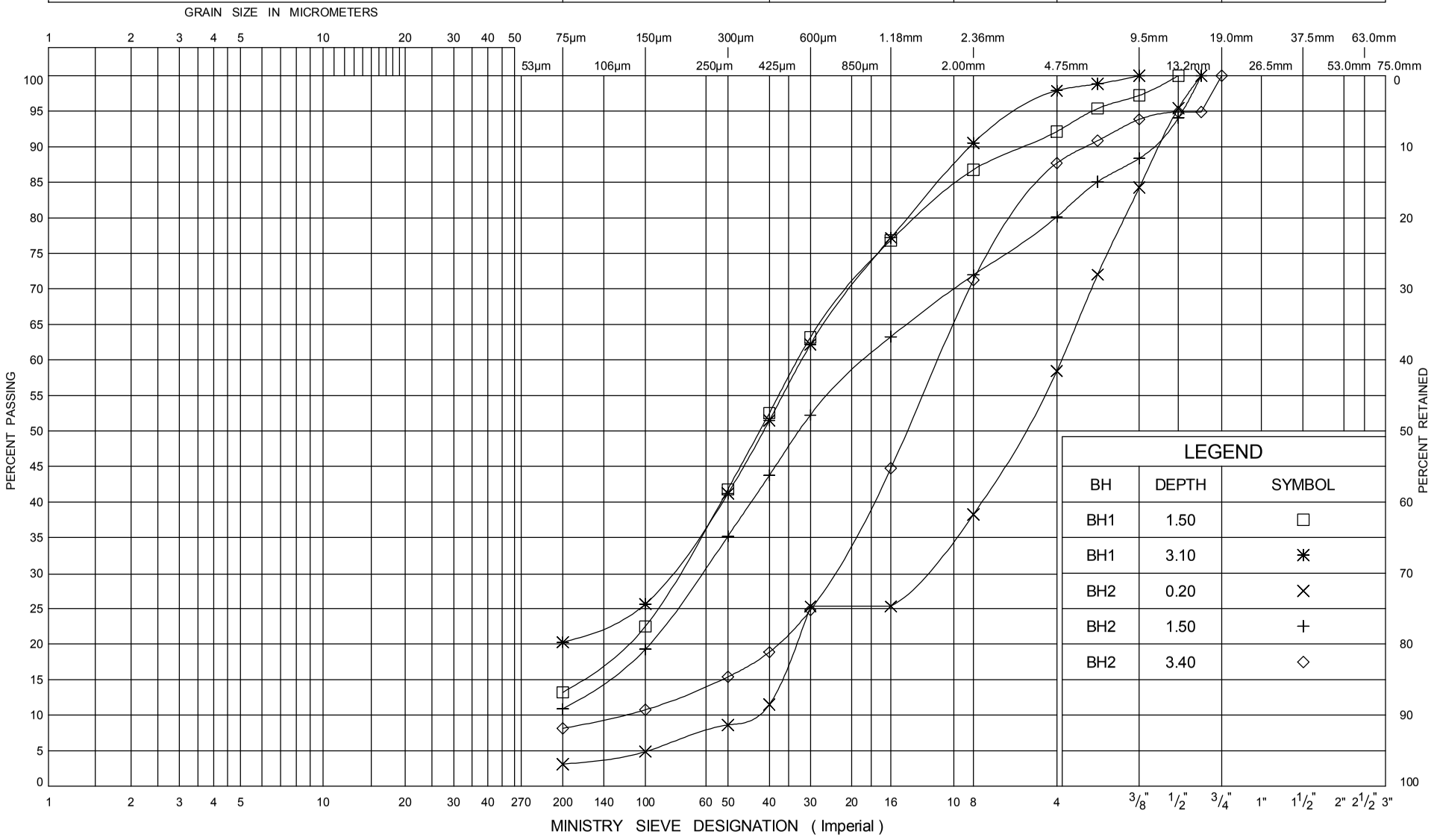
DIST _____ HWY 11 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY ML

DATUM Assumed DATE 2011 03 24 CHECKED BY WS/BV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
96.7	GROUND SURFACE										
96.5	TOPSOIL - 150 mm										100 mm Standing Water.
0.2	ORGANICS - fibrous, dark brown										
95.8							96		113		
0.9	CLAY - Silty, trace sand, grey		SA26	AS							
			SA27	AS			95				0 12 57 31
			SA28	AS			94				
93.5											
3.2	End of Borehole at 3.1 m										

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

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE GS-TB-012144 - DECEPTION CREEK TRIBUTARY - HWY 11.GPJ DST_MIN.GDT 5/3/12

Ministry of Transportation Ontario

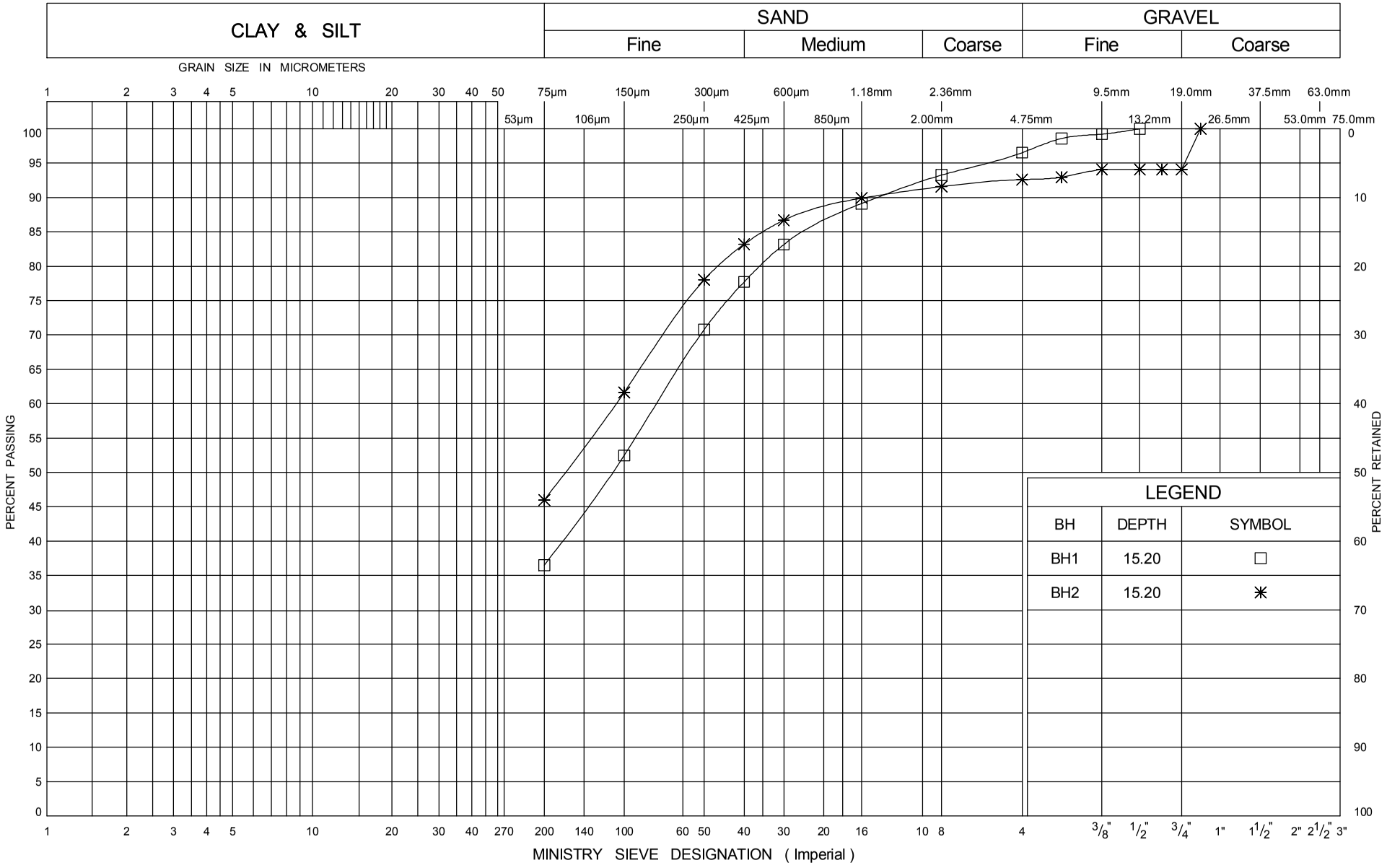
GRAIN SIZE DISTRIBUTION
SAND

ENCLOSURE 5

W P 5113-09-01

HIGHWAY 11

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE GS-TB-012144 - DECEPTION CREEK TRIBUTARY - HWY 11.GPJ DST_MIN.GDT 5/3/12

Ministry of Transportation Ontario

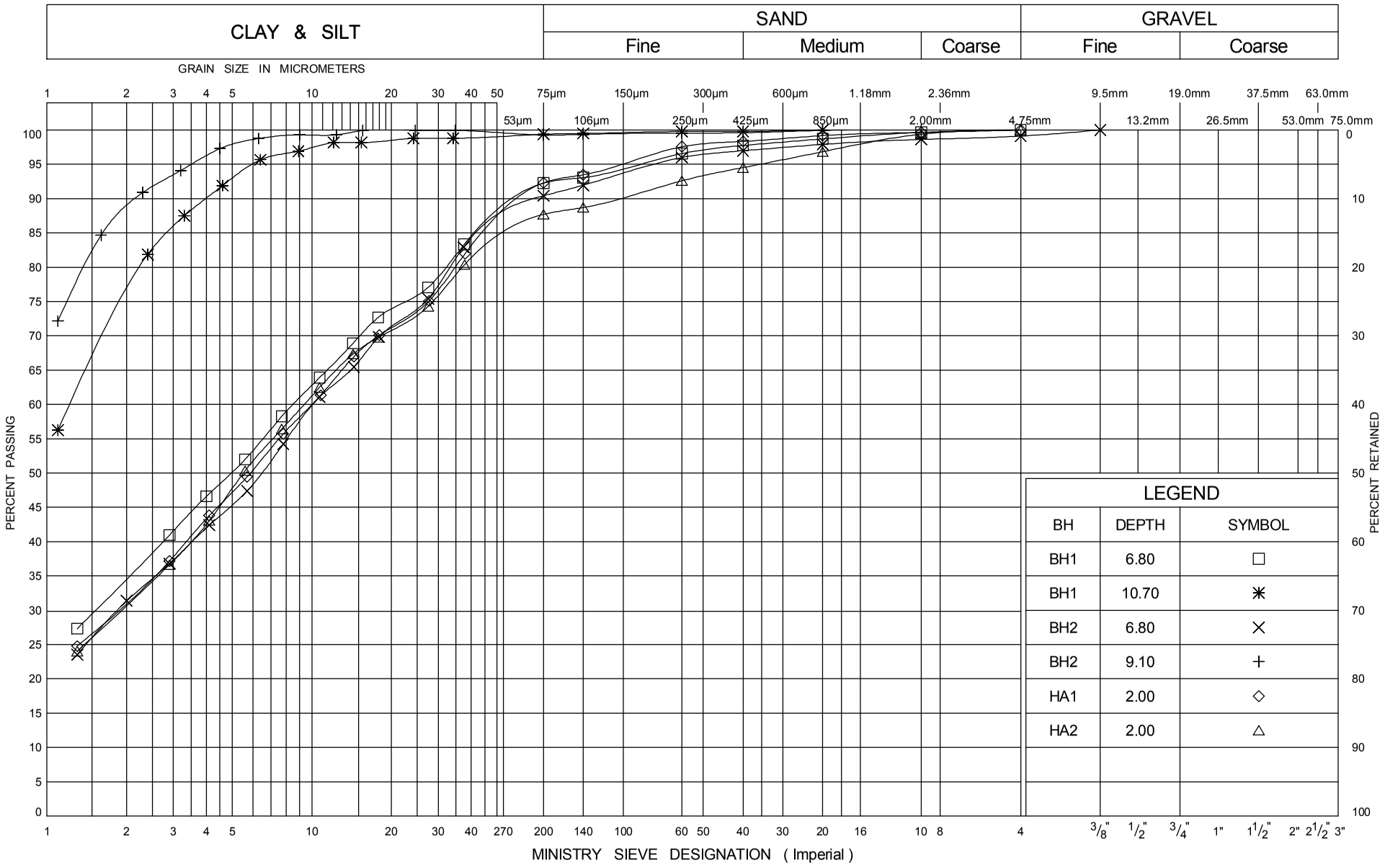
GRAIN SIZE DISTRIBUTION
SAND & SILT TO SILTY SAND

ENCLOSURE 6

W P 5113-09-01

HIGHWAY 11

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE GS-TB-012144 - DECEPTION CREEK TRIBUTARY - HWY 11.GPJ DST_MIN.GDT 5/3/12

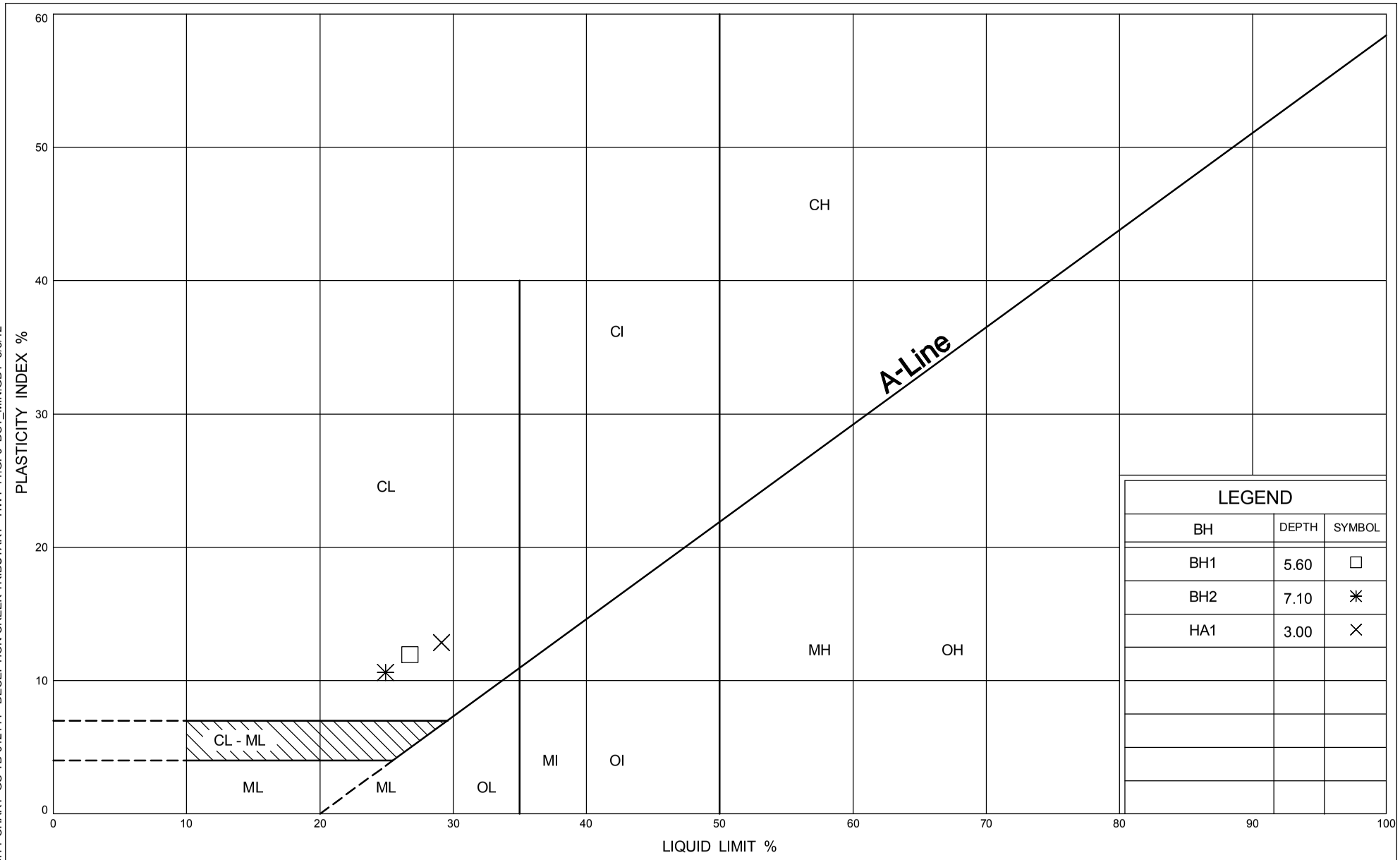
Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION
CLAY

ENCLOSURE 7

W P 5113-09-01

HIGHWAY 11



ONTARIO MOT PLASTICITY CHART GS-TB-012144 - DECEPTION CREEK TRIBUTARY - HWY 11.GPJ DST_MIN.GDT 5/3/12

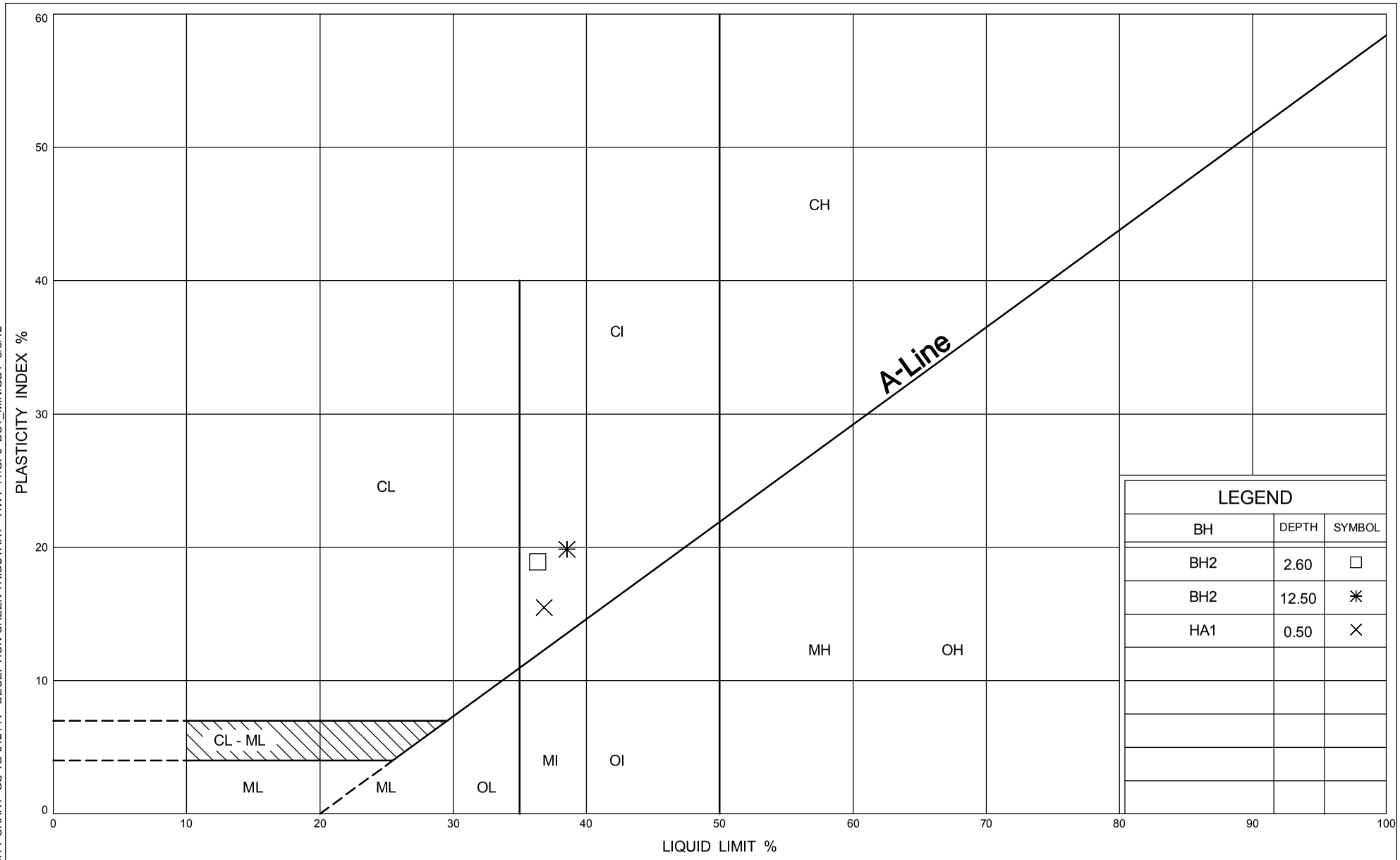
Ministry of Transportation Ontario

PLASTICITY CHART
LOW PLASTICITY

ENCLOSURE 8

W P 5113-09-01

HIGHWAY 11



Ministry of Transportation Ontario

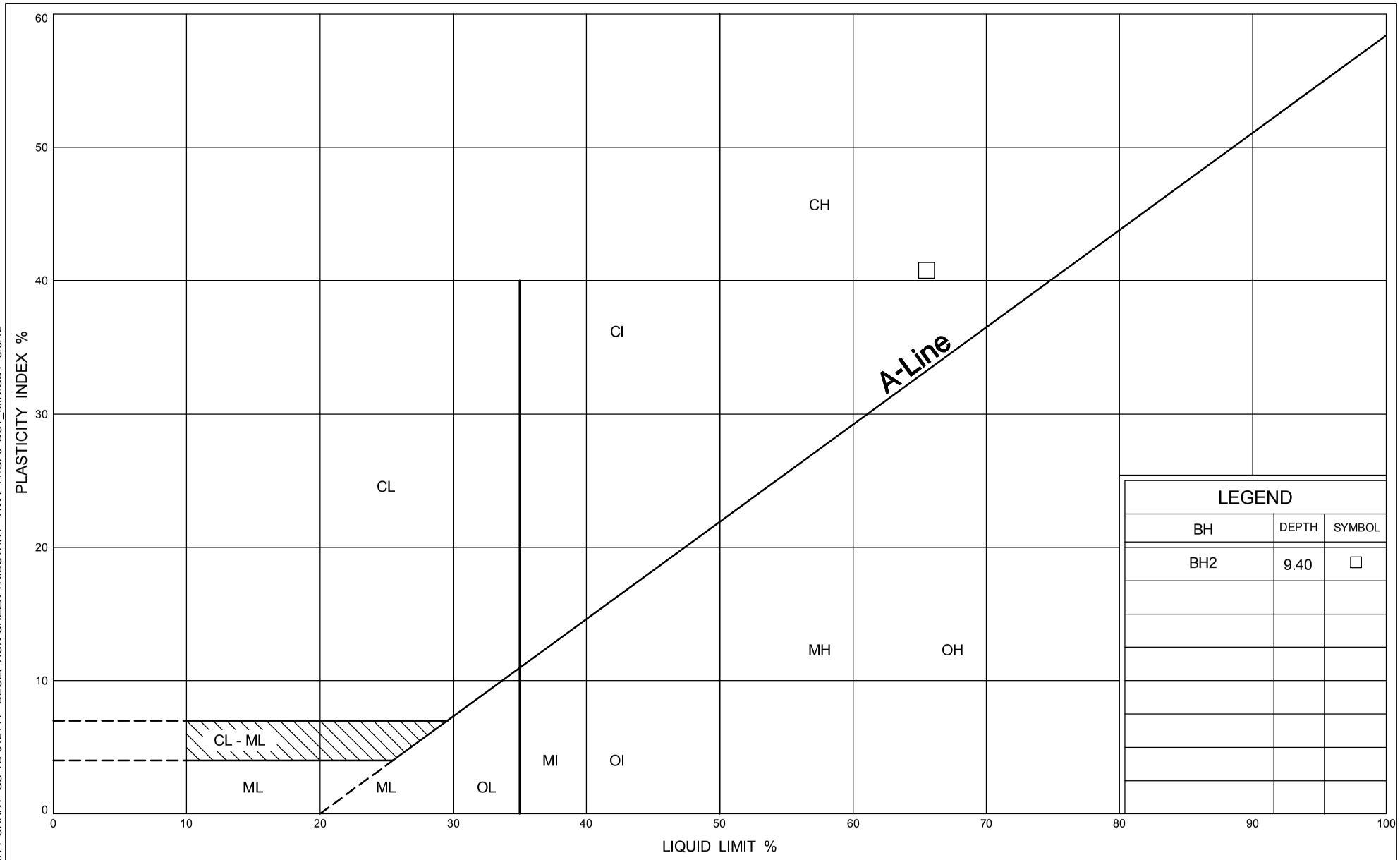
PLASTICITY CHART
INTERMEDIATE PLASTICITY

ENCLOSURE 9

W P 5113-09-01

HIGHWAY 11

ONTARIO MOT PLASTICITY CHART GS-TB-012144 - DECEPTION CREEK TRIBUTARY - HWY 11.GPJ DST_MIN.GDT 5/3/12



Ministry of Transportation Ontario

PLASTICITY CHART
HIGH PLASTICITY

ENCLOSURE 10

W P 5113-09-01

HIGHWAY 11

ONTARIO MOT PLASTICITY CHART GS-TB-012144 - DECEPTION CREEK TRIBUTARY - HWY 11.GPJ DST_MIN.GDT 5/3/12