



**FOUNDATION INVESTIGATION
REPORT
HIGHWAY 101
TOWNSHIP OF IVANHOE
AGREEMENT No.: 5010-E-0006
WP No.: 5464-08-01
GWP: 5464-08-00
GEOCRES NO.: 42B-7**

April 2011

Prepared for:

Genivar
221 – 39 Robertson Road
Ottawa, Ontario
K2H 8R2

1 copy – To: Genivar, Ottawa
1 copy - Ministry of Transportation, Foundations Group, Downsview, ON
2 copies – Ministry of Transportation, North Bay, ON
1 copy – DST Consulting Engineers Inc., Thunder Bay

DST CONSULTING ENGINEERS INC.
605 Hewitson Street, Thunder Bay, Ontario P7B 5V5
Phone: 1-807-623-2929 Fax: 1-807-623-1793

DST CONSULTING ENGINEERS INC.

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**FOUNDATION INVESTIGATION REPORT
SLOAN CREEK CULVERT REPLACEMENT
HIGHWAY 101
TOWNSHIP OF IVANHOE
AGREEMENT NO.: 5010-E-0006
WP: 5464-08-01
GWP: 5464-08-00
GEOCRES NO. 42B-7**

PART 1: FACTUAL INFORMATION

1. INTRODUCTION

DST Consulting Engineers Inc. has been subcontracted by Genivar which was retained by the Ministry of Transportation (MTO), Northeastern Region, to conduct a geotechnical investigation for the replacement of a culvert on Highway 101. 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 and provides a factual report on conditions encountered (Part 1) at the location of the proposed culvert replacement.

2. SITE DESCRIPTION

The site is located on Highway 101, approximately 8.5 km west of Highway 7072, Township of Ivanhoe, New Liskeard Area. The structural site number is 46-542.

Existing culvert at this location is a two-span timber box culvert with the dimensions of 4.5 m width, 1.7 m height and 27 m length (Figure 2.1) and consists of about 4 m thick cover. The culvert was identified to be in poor condition and the timber element of this structure appeared to be with significant rotting, with extensive wood shoring in place, especially at the west end (Figures 2.2 and 2.3). In addition, east head wall was identified to be completely separated. The entrance and exit extremities of the culvert have rotated upward inhibiting flow. It is understood that the existing culvert will be replaced by a pre-cast box structure.

The embankment slopes at this location are approximately 2H:1V except the slopes, closer to the existing culvert, where they were identified to be approximately 1H:1V. Both sides of the embankment are heavily vegetated (Figures 2.4 and 2.5). The photographs shown in Figures 2.1 to 2.4 were taken by MTO and photograph shown in Figure 2.3 was captured during DST's drilling activities.



Figure 2.1 Culvert outlet (looking south)



Figure 2.2 Culvert outlet (looking west)



Figure 2.3 Culvert in poor condition (looking north)



Figure 2.4 Vegetation (looking north)



Figure 2.5 Vegetation (looking southwest)

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out in a period between September 19, 2010 and September 28, 2010 utilizing a CME 750 drill rig that was operated by DST personnel. A total of three (3) hydraulically drilled boreholes using hollow stem augers were put down for the purpose of foundation design at this site.

Two boreholes were advanced at either end of the existing culvert (inlet and outlet). The remaining one that was close to the existing culvert was advanced at right side of the roadway centreline at a distance of 1.3 m. 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. Borehole locations and stratigraphic sections are shown on the Borehole Location Plans, (Drawings 1 to 4). All boreholes were abandoned using suitable abandonment barrier as described in O. Reg. 903 and its amendments.

The borehole locations are referenced to the MTO Station numbering system as indicated in the RFQ. The ground surface elevations at the borehole locations were surveyed by DST personnel. A station selected on top of a rock knob was assigned as temporary benchmark with elevation of 352.2 m (Drawing 1). Station 10+000 was assigned to the center of the culvert as shown in Drawing 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	10+000	343.6	10.0	15.0 Rt
BH2	10+000	343.2	4.3	12.0 Lt
BH3	9+995	347.8	11.5	1.3 Rt

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 each borehole. 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 thirty one (31) moisture contents, two (2) sieve analyses, fifteen (15) particle size analyses and one (1) Atterberg limit test has been carried out for this assignment. Laboratory test results are presented in the Boreholes Logs (Enclosures 1 to 3), and Plots (Enclosures 4 to 9).

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 a fill that is underlain by a silt material. The fill consists of sand overlying silt that is underlain by sand. Auger refusals were encountered at different elevations in each borehole (Table 4.1).

Table 4.1 Depths and elevations of auger refusals

Borehole ID	Depth of auger refusal (m)	Elevation of auger refusal (m)
BH1	10.0	333.6
BH2	4.3	338.9
BH3	11.5	336.3

4.1 Asphalt

Asphalt was encountered in Borehole 3 that was drilled on the embankment. The thickness of the asphalt is approximately 150 mm.

4.2 Embankment Fill

Thickness of the fill is about 5.0 m at this location. Within the fill, boulders and cobbles were noted during the drilling process. Grain size distributions of the fill material are reported in borehole logs (Enclosures 1 to 3) and plots (Enclosures 6 and 7).

The upper fill material was identified below the asphalt as “Sand and Gravel”, based on the main fractions of the material. The thickness of the sand and gravel layer is about 1.1 m and this material consists of occasional cobbles and boulders. The sand material consists of gravel varying from 37 to 41%, sand varying from 51 to 53% and fines varying from 5 to 12%. According to the granular gradations, the material identified in the embankment fill can be classified as “Granular B Type 1” (SP110S13, Table 2). SPT value is about 21 and indicates the compactness condition as compact. The moisture contents vary from 2 to 12%.

A silt fill material was identified below the “Sand and Gravel” and has a thickness of about 0.8 m. The silt material, having a trace of rootlets, consists of about 22% sand, 72% silt and 6% clay. The SPT value is about 17 and indicates the compactness condition as compact. The moisture content of the silt material is about 21%.

A sand fill material was identified below the silt material and has a thickness of about 3.1 m. Occasional cobbles were identified within the sand layer that consists of gravel varying from 2 to 19%, sand varying from 40 to 46%, silt varying from 32 to 53% and clay varying from 2 to 6%. SPT values vary from 4 to 23 and indicate a compactness varying from very loose to compact. The moisture contents of the sand material vary from 9 to 16%.

4.3 Silt

A silt material was identified below the fill material in Borehole 3 and below topsoil in Boreholes 1 and 2 (Enclosures 1 to 3). The silt material extends down to the auger refusal in Boreholes 1 and 3, and to sand material in Borehole 2. Thickness of the silt material varies from 3.5 to 9.9 m. Within the silt material, occasional cobbles and boulders were identified.

One Atterberg limit test (Enclosure 9) indicates that the silt has a liquid limit of about 23% and plasticity index of about 5%, indicating clay with low plasticity to silt with low plasticity. The moisture contents of the silt vary from 8 to 28%. SPT values vary from 23 to 100+ and indicate the consistency from very stiff to hard.

4.4 Sand

A sand material was identified below 3.7 m depth in Borehole 2 (Enclosure 2). The thickness of the sand layer is about 0.6 m. Within the sand material, occasional cobbles and boulders were identified.

According to the particle analysis results, the sand material consists of 7% gravel, 62% sand, 22% silt and 9% clay. The moisture content of the sand is about 10%. SPT value is more than 100 and indicates the compactness condition of very dense.

4.5 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 4.2. The water level at the culvert was at an elevation of 342.5 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 4.2 Probable 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	343.6	342.6	1.0
BH2	343.2	342.9	0.3
BH3	347.8	342.4	5.3

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 510, 511, 518, 577, 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 1010, 1860.

Special Provisions, Ontario Provincial Standards, SP110S13, SP105S10, SP511S01.

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:



for

Loges Paramaguru, PhD
Geotechnical Specialist

Reviewed by:



Dr. M W Bo, PhD., P. Eng, P.Geo, Int PE,
C.Geol, C. Eng, Eur Geol, Eur Eng
Senior Principal / Director (GeoServices)

Reviewed by:



Mike Fabius, P. Eng.
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'

NONSTANDARD PROVISIONS

DEWATERING STRUCTURE EXCAVATION - Item No.

Non-Standard Special Provision

902.01 SCOPE

Section OPSS 902.01 of OPSS 902 is amended by the addition of the following:

As part of the work under this item, the Contractor shall:

- Carry out any additional field investigation the Contractor deems necessary in order to engineer the unwatering systems;
- Design and install dewatering systems to construct the work in the dry;
- Carry out works necessary for the dewatering system that may include sheet piling, tremie concrete seal, sand bagging, etc.;

The Contractor is advised that the use of a suitable sump and pump system is required for working under dry conditions and to prevent disturbance of the excavation base through hydraulic heave. It should be noted that depending on the season, depth of excavation and amount of water flow through the creek may vary.

The Contractor shall provide a continuous dewatering operation to keep the excavation stable and free of water. The excavation must be monitored daily throughout the duration of excavation until the completion of backfilling to confirm this. The dewatering system must be maintained and the surrounding area monitored for impacts to items such as, but not limited to, settlement and groundwater usage.

Section OPSS 902.01 of OPSS 902 is amended by the following subsection:

902.01.01 Flow Rates

The Contractor must satisfy himself with the local conditions and anticipated water flows, levels and flow velocity to be met with during construction. He shall make his own estimate of the facilities required and difficulties to be encountered including the nature of subsurface materials and conditions. For the protection scheme water flows, the water elevation is shown on the Contract Documents.

902.03 DEFINITIONS

Section OPSS 902.03 of OPSS 902 is amended by the addition of the following:

Stamped:	Refers to drawings or details that have been reviewed and stamped "Conforms With Contract Documents". The stamp shall
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include the date and signature of the Quality Verification Engineer (QVE).

Quality Verification Engineer (QVE): An Engineer licensed to practice in the Province of Ontario who has a minimum of five (5) years of experience in the field of design and/or construction of dewatering systems. The Contractor shall retain the QVE to ensure conformance with the contract document.

Dewatering System Design Engineer: An Engineer licensed to practice in the Province of Ontario who has a minimum of five (5) years of experience in the field of design and/or construction of bridges. In addition, the Dewatering System Design Engineer shall have had responsible experience in the design of at least 5 other dewatering systems. The Contractor shall retain the Dewatering System Design Engineer to ensure conformance with the contract documents and issue certificate(s) of conformance for the design.

902.04 SUBMISSION AND DESIGN REQUIREMENTS

Section OPSS 902.04 of OPSS 902 is amended by the addition of the following:

Design of components of the dewatering systems shall be in accordance with CAN/CSA-S6-00 and standard referenced therein.

Submission of Shop Drawings

All shop drawings submissions shall bear the seal and signature of the Dewatering System Design Engineer.

The Contractor shall submit to the Quality Verification Engineer shop drawings for review and stamping.

At least two weeks prior to the commencement of dewatering system construction, the Contractor shall submit to the Contract Administrator, for information purposes only, four (4) sets of stamped drawings/calculations of the dewatering system.

The Contractor shall, at least three (3) weeks prior to the commencement of the dewatering system installation, submit to the QVE for review, four sets of drawings and calculations indicating:

- the dewatering system design, including design criteria and loading;
- the location, type and dimensions of each dewatering system to be used;
- a schematic showing the configuration of all dewatering systems;
- the material and dimensions of dewatering system components to ensure stability of the design excavation and the dewatering system, and the construction sequence and schedule of each

component for which the dewatering system is designed.

The QVE shall review all calculations, construction details, shop drawings and procedures.

All submissions shall bear the seal and signature of the Dewatering System Design Engineer and QVE.

Certificates of Conformance

The Dewatering System Design Engineer shall inspect the installation of each component prior to the executing of the next stage in that dewatering system. After the installation/construction of each component, the Contractor shall submit a Certificate of Conformance to the Contract Administrator, sealed and signed by the Dewatering System Design Engineer. The Certificates of Conformance shall state that the dewatering system is in place, and has been installed in conformance with the stamped shop drawings and the Contract Drawings.

The Contractor will note that several Certificates of Conformance may be required, each to coincide with each dewatering system installation.

902.07 CONSTRUCTION

Section OPSS 902.07 of OPSS 902 is amended by the addition of the following:

All concrete work must be carried out in the dry.

Minimum dimensions for the inside face of the dewatering system shall be sufficient for installation of the new culvert.

902.10 BASIS OF PAYMENT

Section OPSS 902.10 of OPSS 902 is amended by the addition of the following:

Payment at the contract price for the dewatering systems shall be full compensation for all labour, equipment and materials to carry out the work.

EARTH EXCAVATION FOR STRUCTURE - Item No.

Special Provision

OPSS 902 shall apply except as amended and extended herein:

902.01 SCOPE

OPSS 902.01 shall be amended by the addition of the following:

Work under this tender item includes the excavation to construct the new culvert including its footings, retaining wall and bedding below the roadway subgrade.

902.07 CONSTRUCTION

902.07.05 Excavation

902.07.05.02 Excavation for Foundation

Subsection OPSS 902.07.05.02 shall be amended by the addition of the following:

If organic materials are encountered during excavation, the sub-excavations to remove any organics and wood shall be completed in accordance with OPSD 203.040.

Any disturbed and unsuitable soils shall be replaced by compacted “Granular A” material.

NOTICE TO CONTRACTOR

Special Provision

FOUNDATION CONDITIONS

The Contractor is advised of the following foundation conditions:

Occasional cobbles and boulders were identified within the fill and native materials within the advanced borehole locations.

The foundation soils, sensitive soil in particular, will be very susceptible to disturbance and weakening as a result of traffic, standing water and frost. Any foundation soils that could be disturbed should be protected. The bottom of the excavation on which the culvert or granular pad is to rest shall not be disturbed. The bedding placement shall commence immediately after the final removal of material to the foundation level has been completed.

RIVER STONE - Item No.

Special Provision

The river stone to be provided under this Tender Item shall meet the following specifications:

- Round washed river stone with a diameter between 10 – 25mm.
- Thickness of river stone to be 300mm.

River stone shall be placed in all areas of disturbed streambed, both at the inlet and the outlet.

MEASUREMENT FOR PAYMENT

Measurement is by the area in metres squared of the stream bottom.

BASIS OF PAYMENT

Payment at the contract price for the tender items shall be full compensation for all labour, Equipment and Materials to do the work.

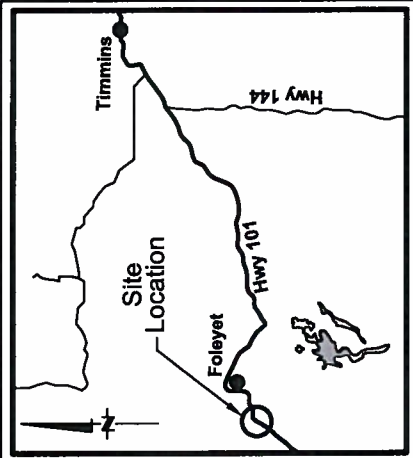
DRAWINGS

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

AGREEMENT No 5010-E-0006
CONT No 2011-5116
GWP No 5464-08-00
WP No 5464-08-01
Site No 46-542
Geocres No 42B-7

CULVERT REPLACEMENT
AT SLOAN CREEK
Highway 101 - Foleyet Twp.
Geotechnical Investigation

SHEET
13



- 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

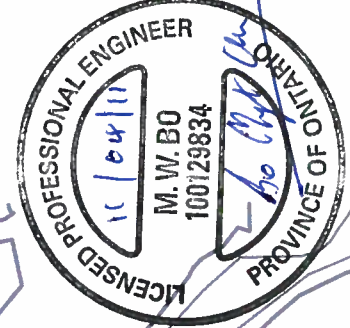
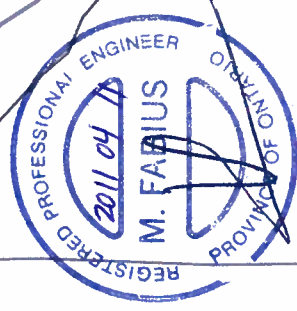
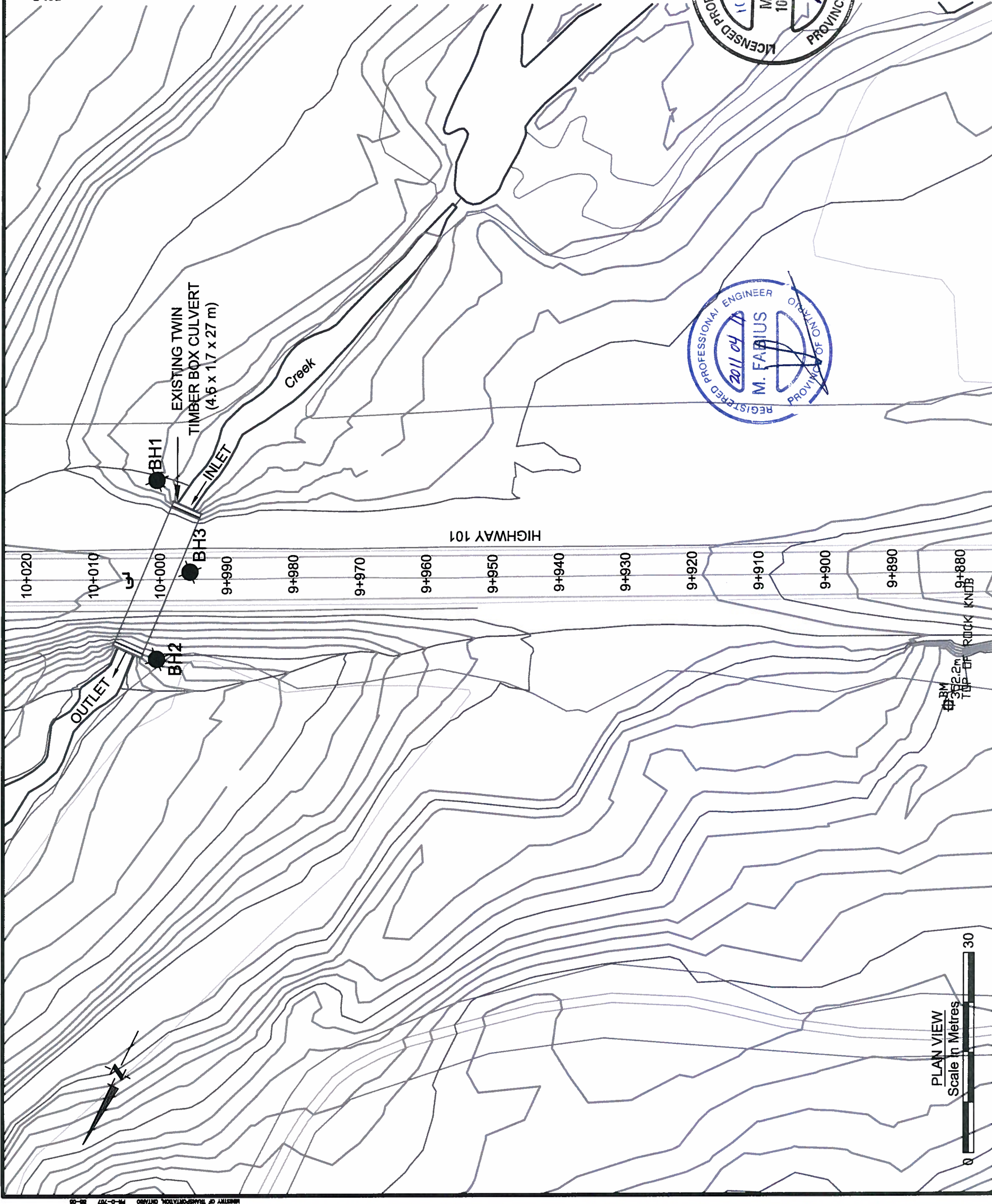
No.	Elevation	Nothing	Station	Offset
BH1	343.392	5341489	413584	10+000 15.0 m RT
BH2	343.222	5341484	413572	10+000 12.0 m LT
BH3	347.762	5341489	413573	9+895 1.3 m RT

NOTE: Coordinates based on MTM Zone 13

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

DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 623-2923
Fx: (807) 623-1792
Email: thunderbay@dstgroup.com

DRAWING 1

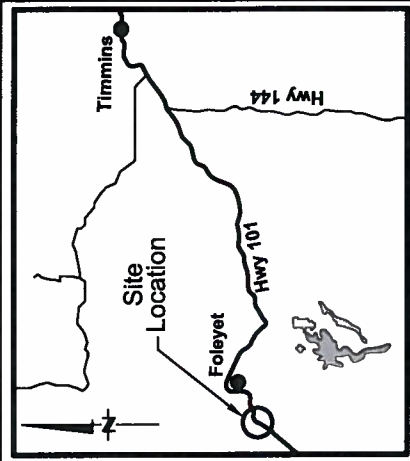


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METERS

AGREEMENT No 5010-E-0006
CONT
No 2011-5116
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WP No 5464-08-01
Site No 46-542
Geocres No 428-7

CULVERT REPLACEMENT
AT SLOAN CREEK
Highway 101 - Foleyet Twp.
Borehole Locations and Stratigraphy

SHEET
14



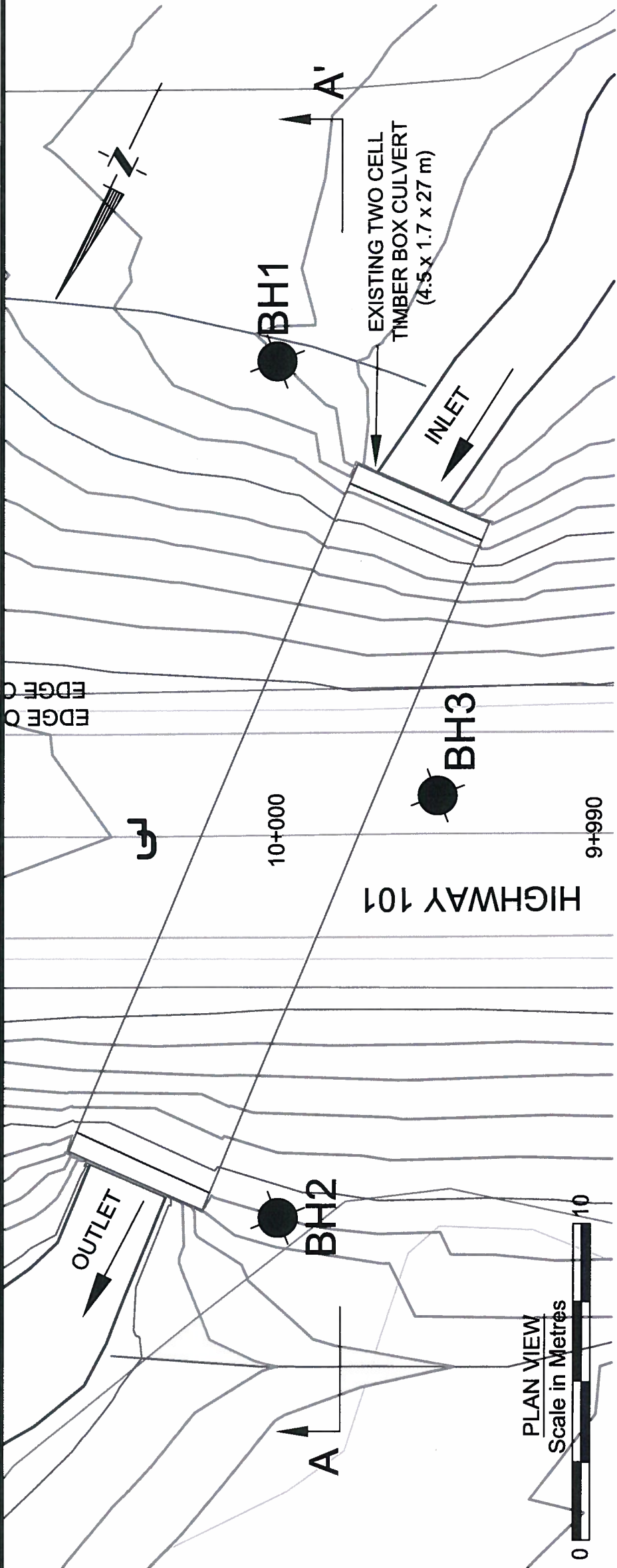
LEGEND				
●	Borehole			
⊕	Borehole with DCPT			
⊕	Dynamic Cone Penetration Test (DCPT)			
⊕	Rock Probe			
●	Blows/0.3m (Std. Pen Test, 475 J/Blow)			
⊕	Water level at time of investigation.			
⊕	Benchmark			
⊕	Fill	⊕	Sand	
⊕	Organics	⊕	Silt	
⊕	Topsoil	⊕	Clay	
⊕	Till	⊕	Sand & Gravel	
⊕	Bedrock	⊕	Boulders	
No.	Elevation	Northing	Easting	Station
BH1	342.592	5341469	413584	10+000
BH2	343.222	5341484	413572	10+000
BH3	347.762	5341469	413573	9+985
				1.3 m RT

NOTE: Coordinates based on MTM Zone 13

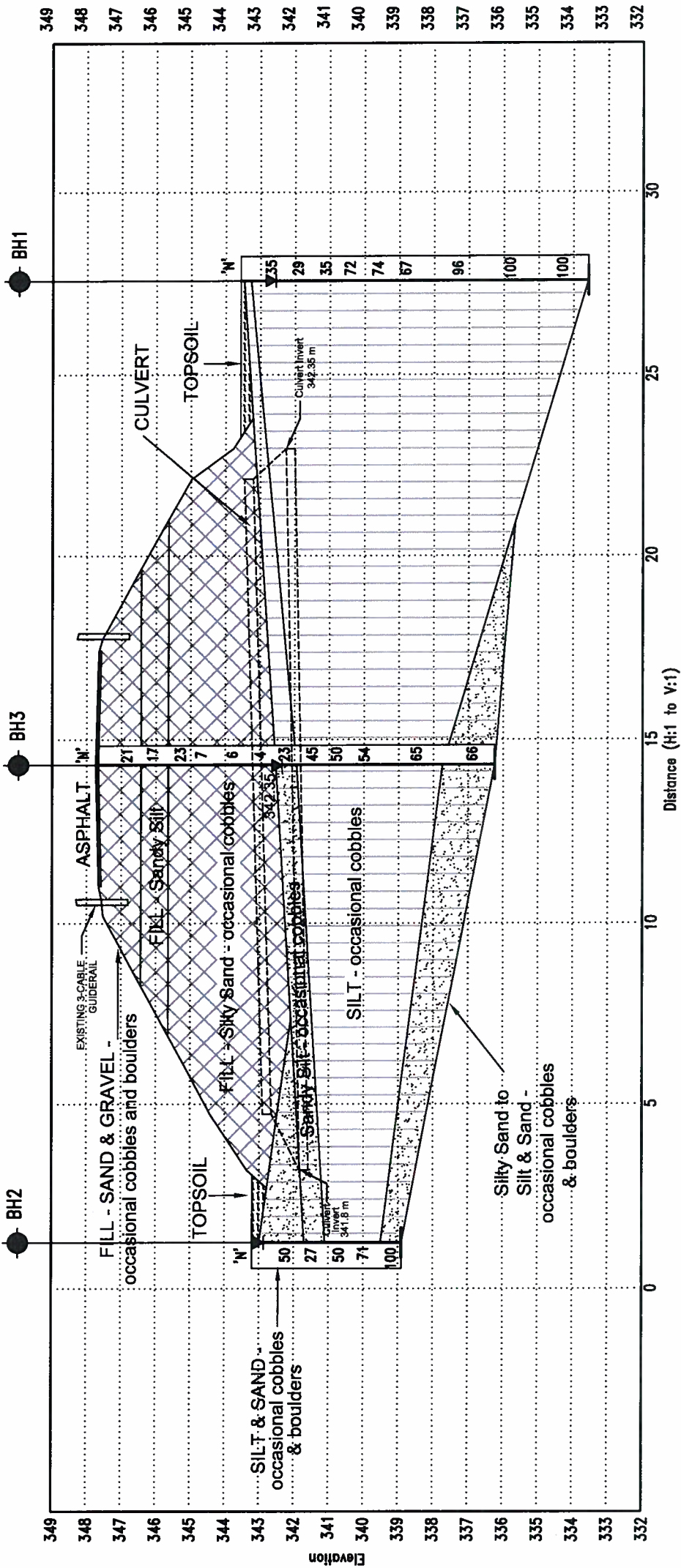
NOTE:
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed by interpolation and may not represent actual conditions.

DST
DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 9V5
Ph: (807) 623-2329
Fx: (807) 623-1792
Email: thunderbay@dstgroup.com

DRAWING 2



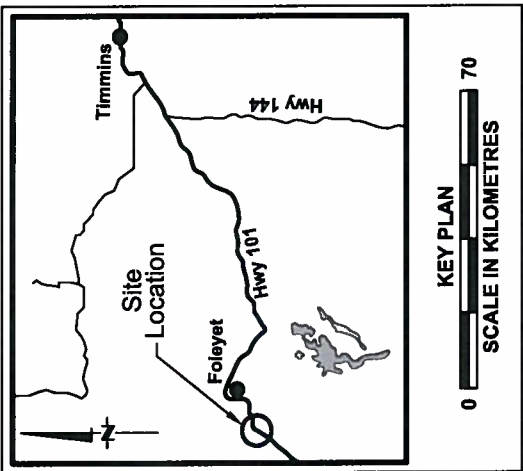
PROFILE ALONG SECTION A-A'



AGREEMENT No 5010-E-0006
CONT No 2011-5116
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WP No 5464-08-01
Site No 46-542
Geocres No 428-7

CULVERT REPLACEMENT
AT SLOAN CREEK
Highway 101 – Foleyet Twp.
Borehole Locations and Stratigraphy

SHEET
15



◆ 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	Nothing	Easting	Station	Offset
BH1	343.592	5341459	413504	10+000	15.0 m RT
BH2	343.222	5341484	413572	10+000	12.0 m LT
BH3	347.782	5341469	413573	9+995	1.3 m RT

NOTE: Coordinates based on MTM Zone 13

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

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

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

DRAWING 3

EDGE
EDGE

BH1

EXISTING TWO CELL
TIMBER BOX CULVERT
(4.5 x 1.7 x 27 m)

INLET

B'

BH3

10+000

HIGHWAY 101

9+990

BH2

OUTLET

B

PLAN VIEW
Scale in Metres
0 10

BH2

PROFILE ALONG SECTION B-B'

BH3

ASPHALT 'N'

EXISTING 3-CABLE GUIDERAIL

FILL - SAND & GRAVEL - occasional cobbles and boulders

TOPSOIL

SILT & SAND - occasional cobbles and boulders

FILL - Silty Sand - occasional cobbles

FILL - Silty Sand - occasional cobbles

SANDY SILT - occasional cobbles

SILT - occasional cobbles

Silty Sand to Silt & Sand - occasional cobbles and boulders

Elevation

Distance (H:1 to V:1)

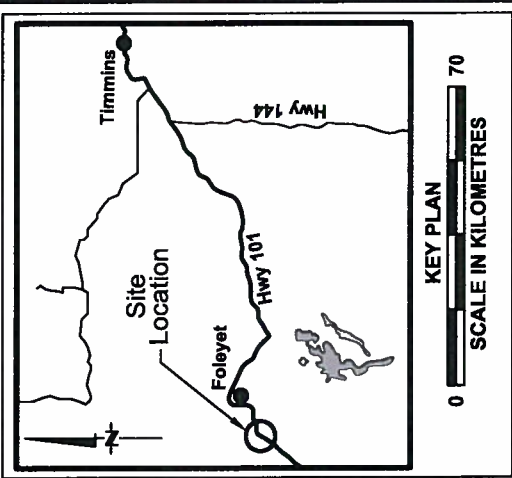
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METERS

AGREEMENT No 5010-E-0008
CONT No 2011-5116
GWP No 5464-08-00
WP No 5464-08-01
Site No 46-542
Geocres No 42B-7

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CULVERT REPLACEMENT
AT SLOAN CREEK
Highway 101 – Foleyet Twp.
Borehole Locations and Stratigraphy



◆

Borehole

⊕

Borehole with DCPT

⊗

Dynamic Cone Penetration Test (DCPT)

●

Hand Auger

⌵

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	Eastng	Station	Offset
BH1	343.592	5341459	413584	10+000	15.0 m RT
BH2	343.232	5341484	413572	10+000	12.0 m LT
BH3	347.762	5341468	413573	9+995	1.3 m RT

NOTE: Coordinates based on NAD 83 Zone 18

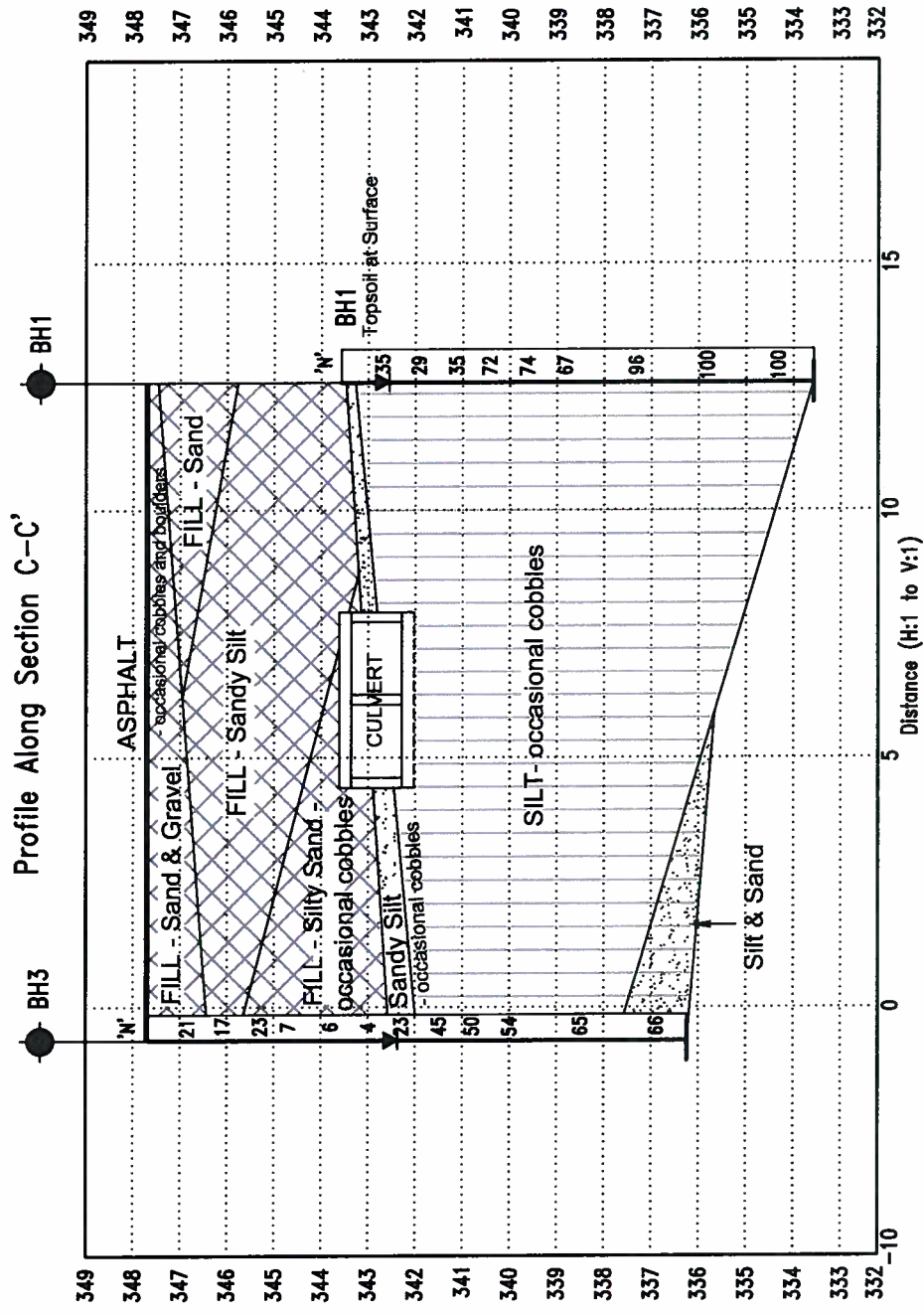
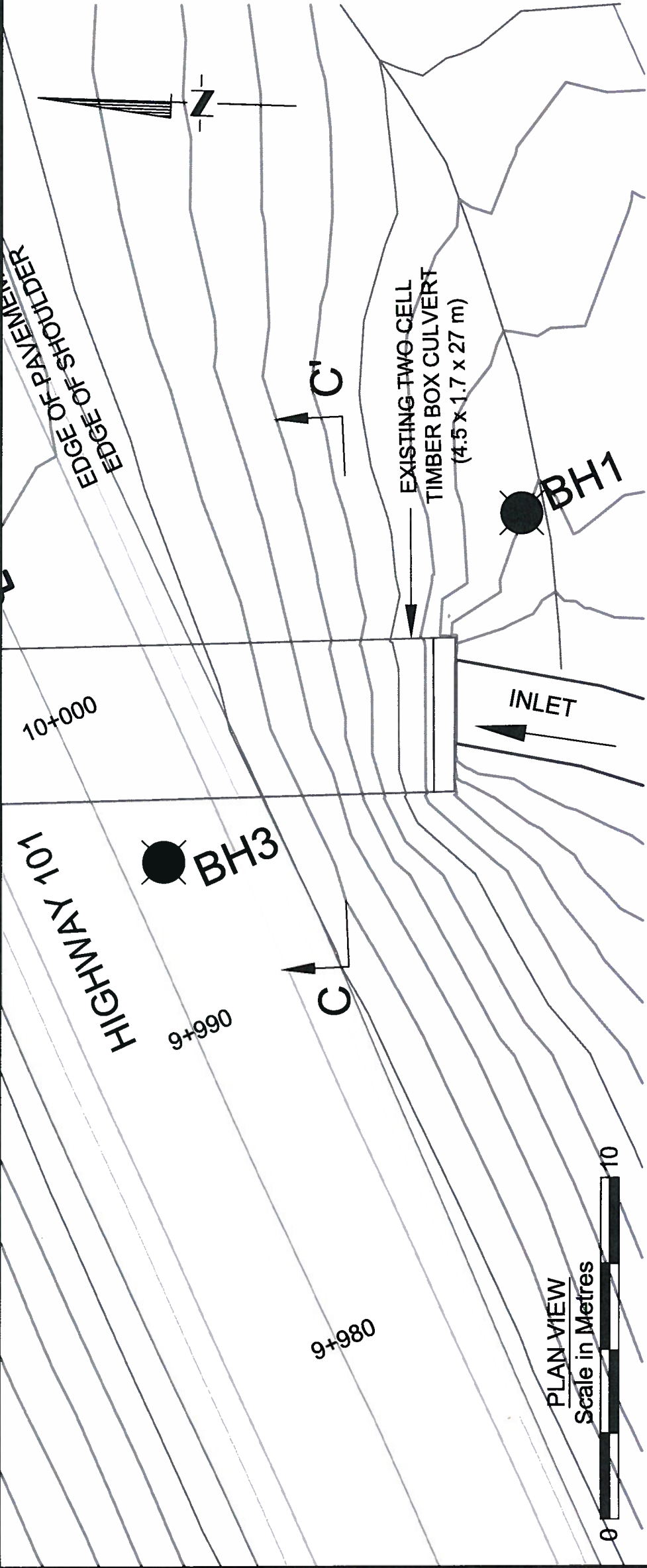
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DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 623-2929
Fx: (807) 623-1792
Email: thunderbay@dstgroup.com



2011 04 11

REGISTERED PROFESSIONAL ENGINEER

M. TABIUS

PROVINCE OF ONTARIO

11 04 11

LICENSED PROFESSIONAL ENGINEER

M. W. BO

100129834

PROVINCE OF ONTARIO

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

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 5464-08-01 (Geocres No. 42B-7) LOCATION STA. 10+000 15.0 m RT (MTM Zone 13 5341459 m N, 413584 m E) ORIGINATED BY PR
DIST HWY 101 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY ML
DATUM Local DATE 2010 09 25 CHECKED BY MWB

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									
								20	40	60	80	100					
343.6	GROUND SURFACE																
343.5	TOPSOIL - 100 mm		AS1	AS													
343.3	SILT - Sandy, some gravel, occasional cobbles and boulders, brown																
343.3	SILT - trace clay, occasional cobbles and boulders, brown, very stiff to hard		SS1	SS	35												
	----- - some sand																
			SS2	SS	29												
			SS3	SS	35												
			SS4	SS	72												
			SS5	SS	74												
			SS6	SS	67												
338.3																	
5.3	SILT - trace clay, grey, hard																
			SS7	SS	96												
			SS8	SS	100+												
	----- - Clayey, occasional cobbles		SS9	SS	100+												
333.6																	
10.0	End of Borehole at 10.0 m Auger Refusal																

ON MOT CS-TB-012144 - GENIVAR - IVANHOE CREEK (SLOAN) - HWY 101.GPJ DST_MIN.GDT 10/2/11

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

ENCLOSURE 1

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 5464-08-01 (Geocres No. 42B-7) LOCATION STA. 10+000 12.0 m LT (MTM Zone 13 5341484 m N, 413572 m E) ORIGINATED BY PR
DIST HWY 101 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY ML
DATUM Local DATE 2010 09 26 CHECKED BY MWB

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 (%)		
								20 40 60 80 100										20 40 60		
343.2	GROUND SURFACE																			
343.0	TOPSOIL - 200 mm		AS1	AS																
0.2	SILT & SAND - trace clay and gravel, occasional cobbles and boulders, brown, hard		SS1	SS	50															
341.7																				
1.5	SILT - Sandy, some gravel, trace clay, occasional cobbles, grey, very stiff		SS2	SS	27															
341.1																				
2.1	SILT - trace clay, occasional cobbles, grey, hard		SS3	SS	50															
			SS4	SS	71															
339.5																				
3.7	SAND - Silty, trace clay and gravel, occasional cobbles & boulders, grey, very dense		SS5	SS	100+															
338.9																				
4.3	End of Borehole at 4.3 m Auger Refusal																			

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

ENCLOSURE 2

ON MOT CS-TB-012144 - GENIVAR - IVANHOE CREEK (SLOAN) - HWY 101.GPJ DST_MIN.GDT 10/2/11

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 5464-08-01 (Geocres No. 42B-7) LOCATION STA. 9+995, 1.3 m RT (MTM Zone 13 5341469 m N, 413573 m E) ORIGINATED BY PR
DIST HWY 101 BOREHOLE TYPE Hollow Stem Auger (80 mm ID) COMPILED BY ML
DATUM Local DATE 2010 09 27 CHECKED BY MWB

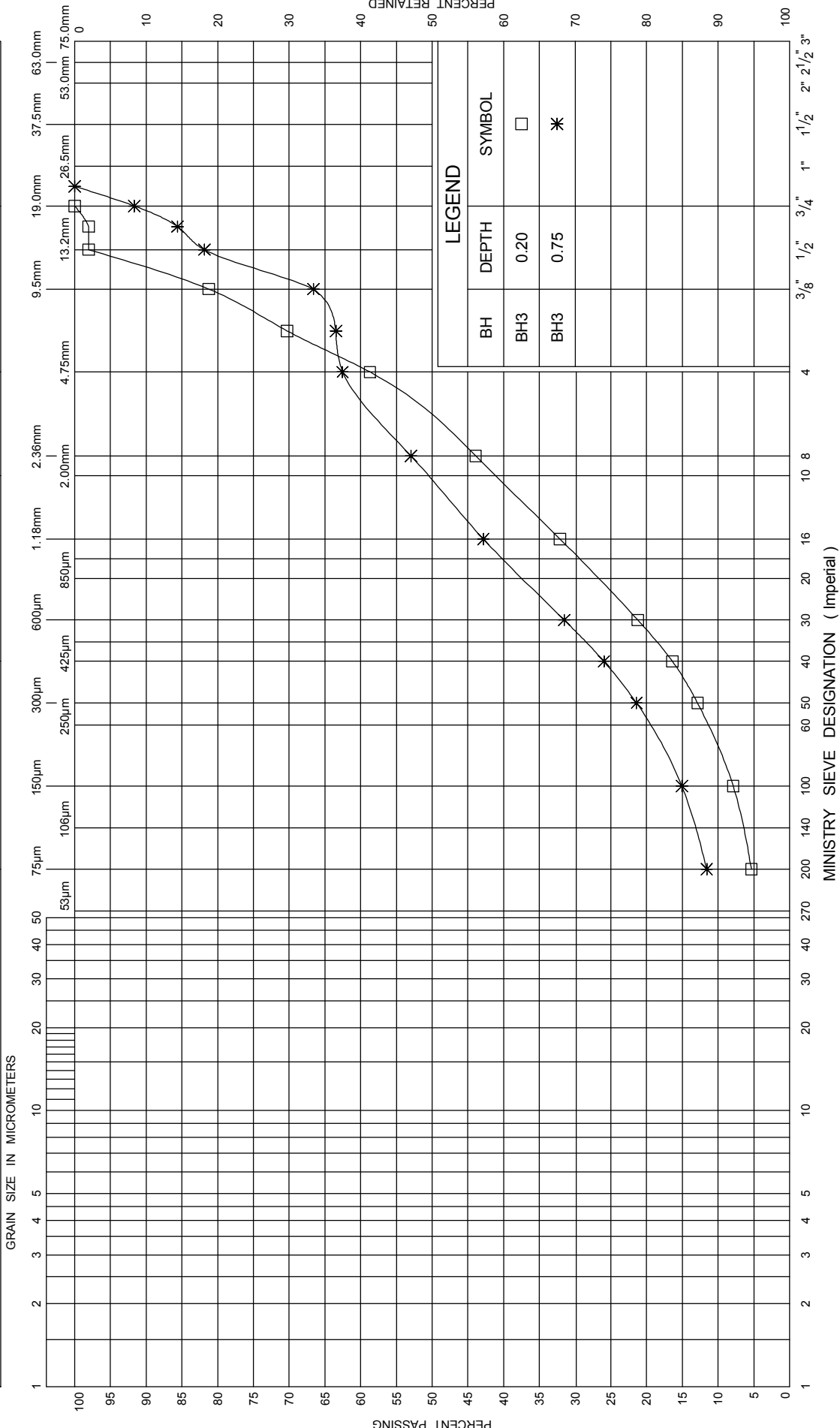
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20	40	60			80	100
347.8	GROUND SURFACE													
347.6	ASPHALT - 150 mm		AS1	AS									41 53 (6)	
0.2	FILL - SAND & GRAVEL - trace silt, occasional cobbles and boulders, brown, compact		SS1	SS	21								37 51 (12)	
346.5	FILL - SILT - Sandy, trace clay, trace rootlets, brown, compact		SS2	SS	17								0 22 72 6	
345.7	FILL - SAND - Silty, trace to some gravel, trace clay, occasional cobbles, brown, very loose to compact		SS3	SS	23									
2.1			SS4	SS	7								19 46 32 3	
			SS5	SS	6									
	----- - SILT		SS6	SS	4								2 40 53 5	
342.6	SILT - Sandy, grey, very stiff		SS7	SS	23								Water level at 5.3 m on completion. Cave at 6.1 m.	
342.0	SILT - trace to some clay, trace sand, grey, hard		SS8	SS	45									
5.8			SS9	SS	50								0 0 92 8	
			SS10	SS	54									
			SS11	SS	65								0 1 83 16	
337.8	SILT & SAND - some clay, trace gravel, grey, hard		SS12	SS	66								3 40 44 13	
10.0														
336.3	End of Borehole at 11.5 m Auger Refusal													
11.5														

Numbers refer to
Sensitivity

3% STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine		Medium	Coarse	Fine	Coarse



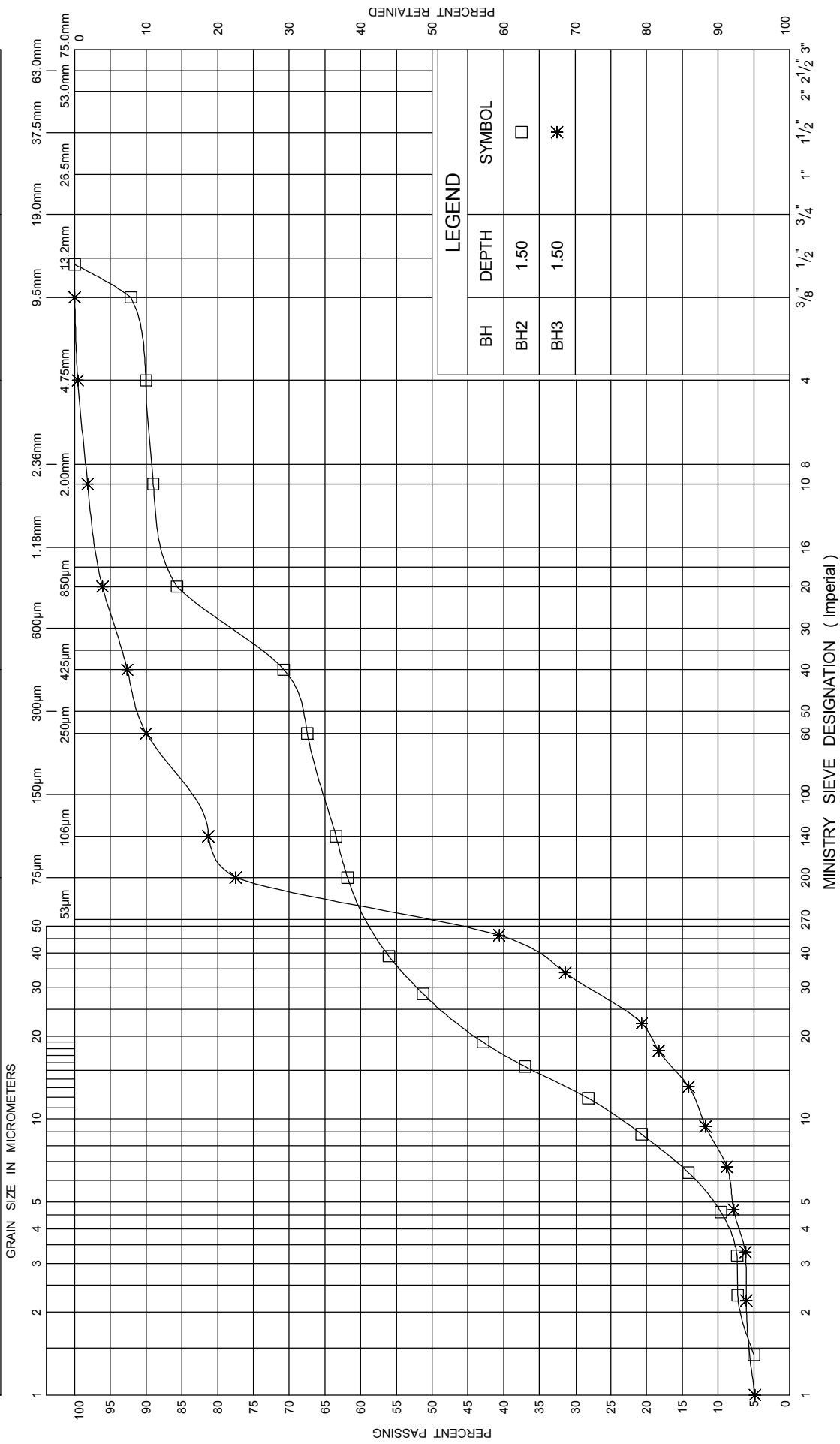
GRAIN SIZE DISTRIBUTION
SAND & GRAVEL

ENCLOSURE 4
W P 5464-08-01
HIGHWAY 101



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine		Medium	Coarse	Fine	Coarse



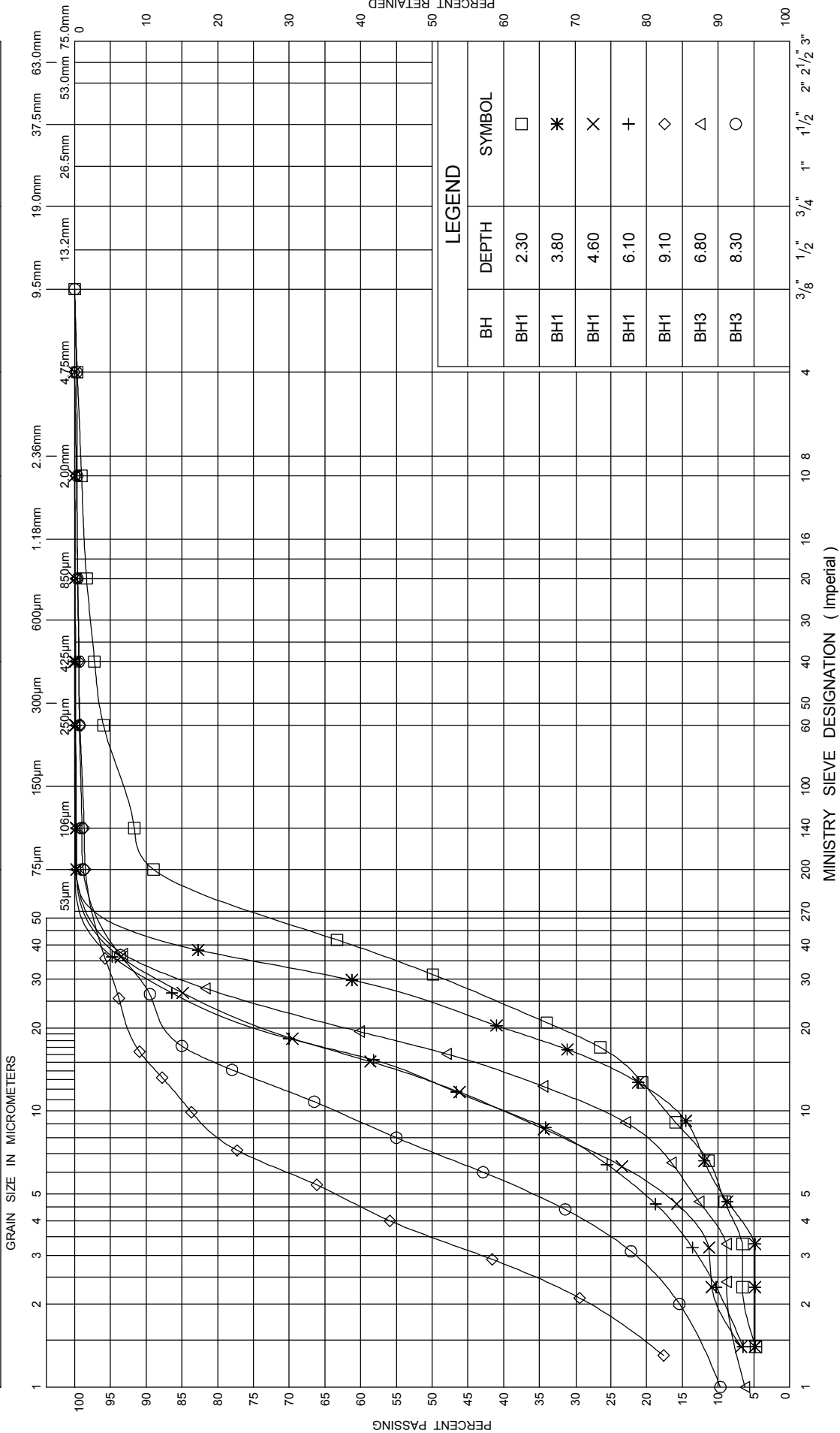
GRAIN SIZE DISTRIBUTION
SANDY SILT

ENCLOSURE 5
W P 5464-08-01
HIGHWAY 101



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse



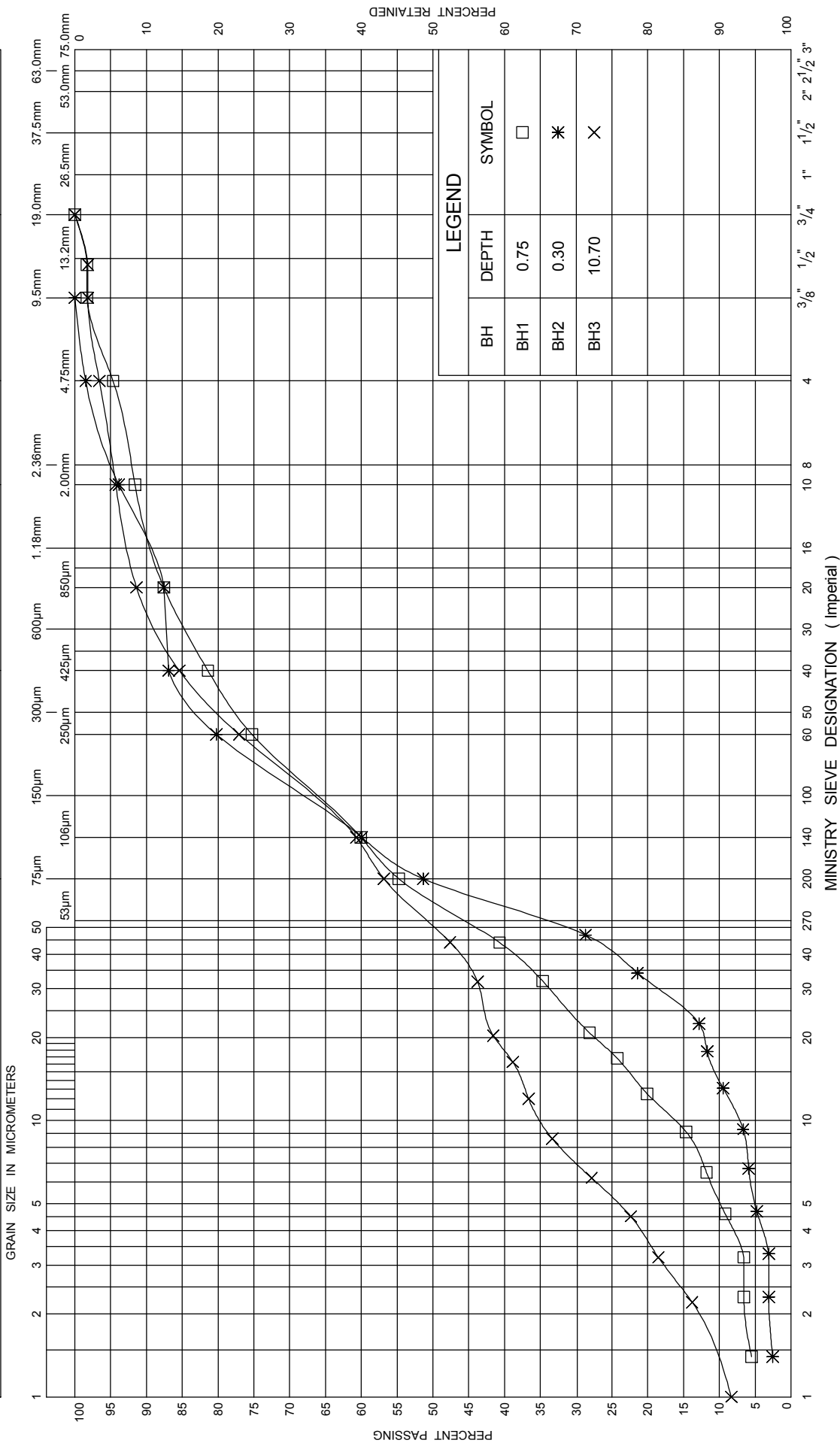
GRAIN SIZE DISTRIBUTION
SILT

ENCLOSURE 6
W P 5464-08-01
HIGHWAY 101



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
		Fine		Medium	Fine	Coarse



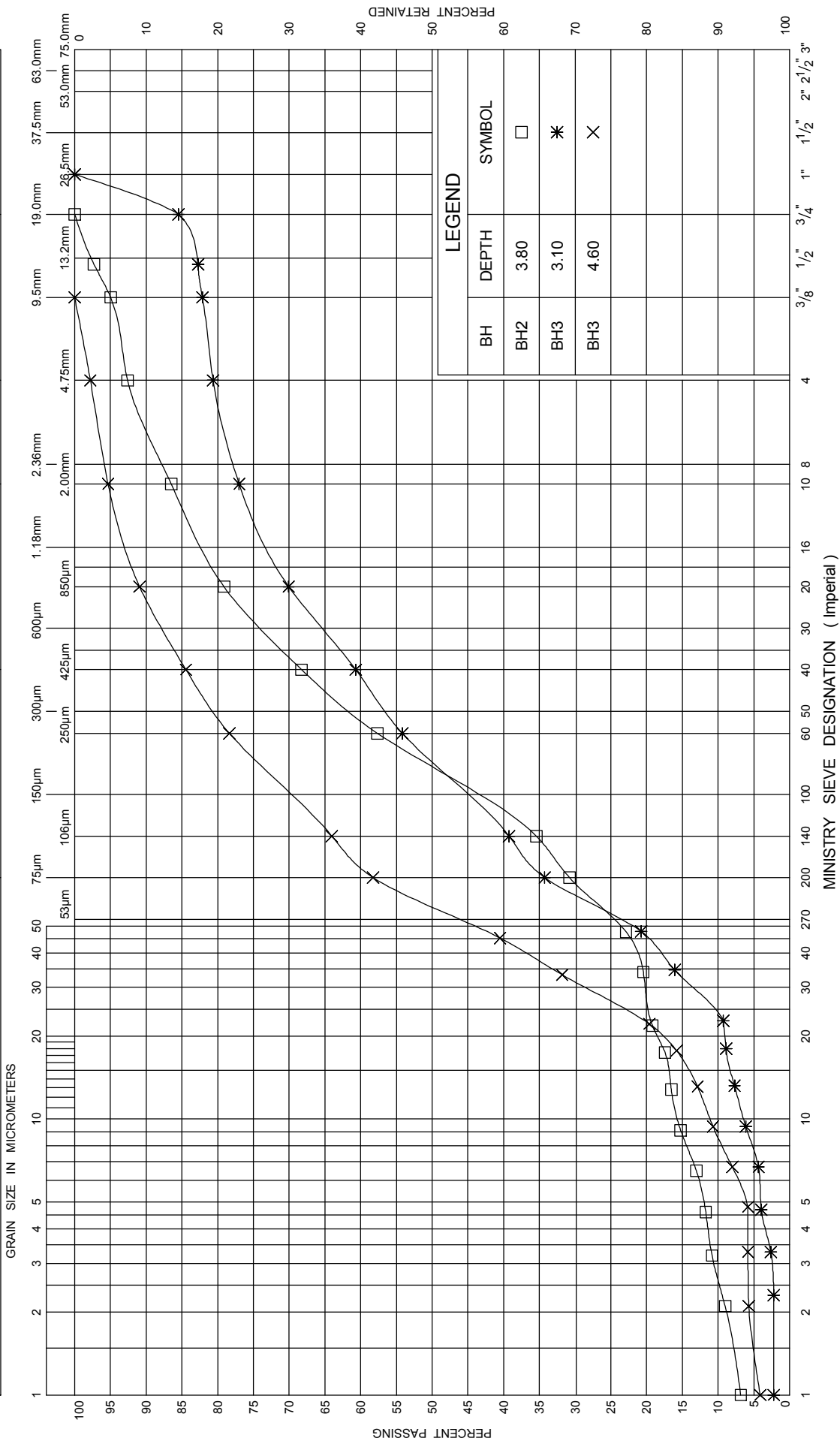
GRAIN SIZE DISTRIBUTION
SILT & SAND

ENCLOSURE 7
W P 5464-08-01
HIGHWAY 101



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
		Fine		Medium	Fine	Coarse



GRAIN SIZE DISTRIBUTION
SILTY SAND

ENCLOSURE 8
W P 5464-08-01
HIGHWAY 101



