



**FOUNDATION INVESTIGATION
REPORT
PETERSON CREEK
CULVERT REPLACEMENT
HIGHWAY 636
TOWNSHIP OF CLUTE
AGREEMENT No.: 5010-E-0006
GWP: 5481-09-00
WP: 5481-09-01
GEOCRES NO.: 42H-44**

March 2012

DST Reference No. GS-TB-012144

Prepared for:

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DST CONSULTING ENGINEERS INC.

Table of Contents

1. INTRODUCTION	1
2. SITE DESCRIPTION	2
3. INVESTIGATION PROCEDURES AND LABORATORY TESTING.....	7
4. DESCRIPTION OF SUBSURFACE CONDITIONS	9
4.1 Surface Treatment.....	9
4.2 Embankment Fill.....	9
4.3 Organics	10
4.4 Topsoil	10
4.5 Clay.....	11
4.6 Groundwater	11
5. REFERENCES	12
6. LIMITATIONS OF REPORT	13

APPENDICES

LIMITATIONS OF REPORT	'A'
DESCRIPTIVE TERMS FOR SOIL CLASSIFICATION	B'

DRAWINGS

BOREHOLE LOCATION PLAN AND CROSS SECTIONS	1 - 3
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ENCLOSURES

LOG OF BOREHOLES	1 - 4
GRAINSIZE ANALYSIS	5 - 6
ATTERBERG LIMITS TEST RESULTS	7 - 9

List of Tables

Table 3.1	Detail of borehole locations	7
Table 4.1	Depths and elevations of auger refusals	9
Table 4.2	Depth of water table at boreholes	11

List of Figures

Figure 2.1	Culvert inlet (facing east).....	3
Figure 2.2	Culvert outlet (facing northwest)	3
Figure 2.3	Culvert supports	4
Figure 2.4	Failure at culvert connections	4
Figure 2.5	Vegetation at culvert inlet (facing west)	5
Figure 2.6	Vegetation at culvert outlet (facing east).....	5
Figure 2.7	Facing south from culvert.....	6
Figure 2.8	Facing north from culvert.....	6

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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 Peterson Creek culvert on Highway 636. 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 file findings (Part 1) and recommendations for design and construction for the proposed culvert replacement (Part 2).

2. SITE DESCRIPTION

The site is located on Highway 636, approximately 3.7 km north of the Highway 11 and Highway 636 intersection, Township of Clute, Cochrane Area. The structural site number is 39E-257.

Existing structure at this location is a 2.85 x 32.95 m Structural Plate Corrugated Steel Pipe (SPCSP) culvert built in 1983 with a depth of soil cover of approximately 4 m. The culvert was identified to be in poor condition with significant sagging and reverse curvature. Supporting column has been installed approximately along the center line but deformation between points of support is evident. It is understood that the existing culvert will be replaced by a 3.0 x 2.4 x 36.0 m pre-cast box structure and replacement will be performed with staged construction method involving installation of roadway protection and temporary widening of the embankment.

The embankment slopes at this location are approximately 2H:1V except the slopes, closer to the existing culvert on the west side, where they were identified to be approximately 1.5H:1V. Both sides of the embankment were sparsely vegetated granular material (Figures 2.5 and 2.6). The photographs shown in Figures 2.1 to 2.4 were taken by MTO and photographs shown in Figures 2.5 to 2.8 were taken by DST during a site visit September 23rd, 2010.

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 that the local area landform is identified as till, clay ground moraine with bedrock plains. The topography in the area is mainly low local relief; plains with mixed wet and dry drainage conditions in the area.



Figure 2.1 Culvert inlet (facing east)



Figure 2.2 Culvert outlet (facing northwest)



Figure 2.3 Culvert supports



Figure 2.4 Failure at culvert connections



Figure 2.5 Vegetation at culvert inlet (facing west)



Figure 2.6 Vegetation at culvert outlet (facing east)



Figure 2.7 Facing south from culvert



Figure 2.8 Facing north from culvert

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out between January 31st, 2011 and February 5th, 2011 utilizing a CME 750 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 diamond drilling techniques and two (2) using hand augers.

Two boreholes were advanced through the road structure at Station 10+004 offset 2.5 m right and at Station 9+997 offset 2.5 m left. Two boreholes were advanced at beyond the toe of slope near the existing culvert inlet and outlet. 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).

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 as shown in drawing 1. The ground surface elevations at the borehole locations were surveyed by DST personnel. At approximately Station 9+960 at 12 m left a benchmark with elevation of 98.5 m was placed in a guard rail post as shown in Drawing 1. Elevations are correlated to surveyed elevations provided by Genivar. 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+004	97.2	20.3	2.5 Rt
BH2	9+997	97.3	15.6	2.5 Lt
BH3	10+015	91.1	1.2	25 Rt
BH4	9+997	92.2	1.0	14 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) and Filed Vane Shear Tests were 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 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 tests included moisture contents, particle size analyses and Atterberg limits including plastic limit and liquid limit. A total of twenty nine (29) moisture contents, six (6) sieve analyses, four (4) 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 9). Fines contents obtained from sieve analysis, completed on base and subbase materials.

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 surface treatment overlying a sand with some crushed gravel and clay fill that is underlain by a sand fill. This fill is then underlain silty clay with lenses of sand found in some locations.

Table 4.1 Depths and elevations of auger refusals

Borehole ID	Depth of auger refusal (m)	Elevation of auger refusal (m)
BH3	1.2	89.9
BH4	1.0	91.2

4.1 Surface Treatment

Surface treatment was encountered in Boreholes 1 and 2 with a thickness of approximately 50 mm.

4.2 Embankment Fill

Thickness of the fill is between approximately 7.4 and 7.5 m at this location. Within the sand fill, cobbles and rock fill were encountered during the drilling process. Within the clay fill wood debris was encountered during the drill process. Grain size distributions of the fill material are reported in borehole logs (Enclosures 1 to 4) and plots (Enclosures 5 through 6).

A pavement structure beneath the surface treatment of sand and some crushed gravel and silt was identified in Boreholes 1 and 2 from 50 mm below surface to depths up to 0.18 m; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 97.3 and 97.0 m respectively. Gradation analyses conducted on a sample from Borehole 1 indicates gravel, sand, and fines contents of approximately 18%, 65% and 17% respectively. This material does not classify as Granular A meeting SSP 110S13 requirements. The moisture content of samples was 8%.

Beneath this sand with some crushed gravel and silt a fill of predominantly loose to compact

sand materials was encountered at Boreholes 1 and 2 from 0.16 m below surface to depths up to 6.0 m; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 97.1 and 91.3 m respectively. In Boreholes 1 and 2 rock fill and cobbles were encountered within the sand fill from approximately 0.6 to 2.3 m and 4.6 and 6.0 m below surface; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 96.7 and 91.3 m respectively. Gradation analyses conducted on samples from Boreholes 1 and 2 indicate gravel, sand, and fines contents of approximately 1 to 17%, 70 to 98% and 2 to 21% respectively. Some of this material classifies as Granular B, Type I meeting SSP 110S13 requirements. The moisture content of samples was between 3 and 22%.

Beneath this loose to compact sand a silty clay fill was encountered in Boreholes 1 and 2 between 5.3 and 7.5 m below surface; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 92.0 and 89.8 m respectively. The moisture content of samples was between 16 and 39%.

Beneath this silty clay fill a compact sand material was encountered between depths of 6.8 and 7.5 m below surface in Boreholes 1; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 90.5 and 89.7 m respectively. The thickness of the stratum was determined to be approximately 0.7 m in thickness. Gradation analyses conducted on a sample from Borehole 1 indicates gravel, sand, and fines contents of approximately 25%, 69% and 6% respectively. The moisture content of a sample was 11%.

4.3 Organics

Organic material, decomposed wood, was encountered mixed with the embankment fill materials in Boreholes 1 and 2 between depths of approximately 4.9 and 6.8 m; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 92.3 and 90.5 m respectively. The moisture content of a sample was 167%.

4.4 Topsoil

Topsoil with variable gradations and organics was encountered at surface in Boreholes 3 and 4 at depths between surface and 60 mm; this corresponds to maximum and minimum upper and lower boundary elevations of approximately 91.05 and 90.9 m in Borehole 3 and 92.15 and 91.9 m in Borehole 4 respectively.

4.5 Clay

Silty clay was encountered in Boreholes 1 through 4. It was encountered at depths from 5.3 to 20.3 m; this corresponds to maximum upper boundary elevations of approximately 89.8 m and 92.1 m in Boreholes 1 and 2 and Boreholes 3 and 4 respectively. The thickness of this stratum is not defined in Boreholes 1 through 4 as borehole terminus was reached within the stratum. Atterberg limit tests carried out on samples from Boreholes 1, 2 and 3 indicate this clay varies from low to high plasticity with liquid limits and plasticity indexes from 29 to 65 and 14 to 40 respectively. In-situ field vane tests taken in Boreholes 1 and 2 indicate undrained shear strengths between 55 and 220 kPa with sensitivities ranging from 3 to 4. The moisture contents of samples range from 16% to 55%.

4.6 Groundwater

The groundwater table was identified below the ground surface during the field investigation and through visual identification of soil samples. The estimated depth of groundwater level below the ground surface elevation is given in Table 4.2. The water levels at the culvert inlet and outlet were at elevations of approximately 92.0 m and 91.1 m respectively 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 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	97.2	92.1	5.1
BH2	97.3	91.5	5.8
BH3	91.1	90.1	1.0
BH4	92.2	92.1	0.1

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, SP105S10.

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:



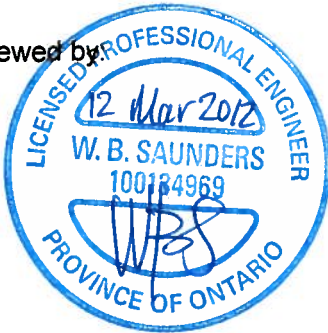
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APPENDIX 'A'

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 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 (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	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

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 = $\frac{c_u}{\tau_r}$

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	KN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	KN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	KN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	KN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	KN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	KN/m^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

D R A W I N G S

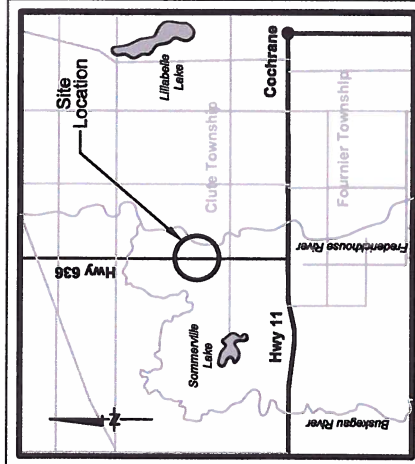


METRIC
DIMENSIONS ARE IN METRES
UNLESS
OTHERWISE SHOWN
IN KILOMETRES + METERS

CONT No 2012-5121
GWP No 5481-09-00
WP No 5481-09-01
Site No 39E-257
Geocres No 42H-44

CULVERT REPLACEMENT
3.7 Km North of Hwy 11
Highway 636 – Clute Twp.
Borehole Location Plan

SHEET



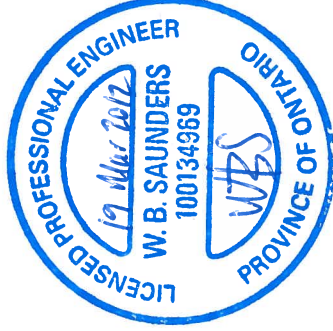
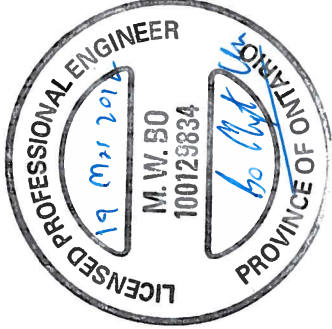
KEY PLAN
SCALE IN KILOMETRES
0 12

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	97.22	5437894	488437	10+004	2.5 m RT
BH2	97.34	5437973	488431	9+997	2.5 m LT
BH3	94.05	5437894	488454	10+015	23.0 m RT
BH4	92.15	5437975	488430	9+997	14.0 m LT



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

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DRAWING 1

PLAN VIEW
Scale in Metres

0 10

BM 98.5 m
Nail in Guard Rail Post

EDGE OF SHOULDER
EDGE OF PAVEMENT

TOE OF SLOPE

Existing
2.85 m x 32.95 m
SPCSP Culvert

Outlet

Inlet

HIGHWAY 636


Peterson Creek

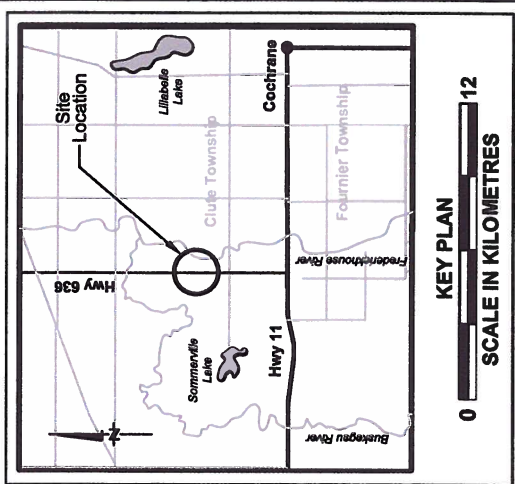
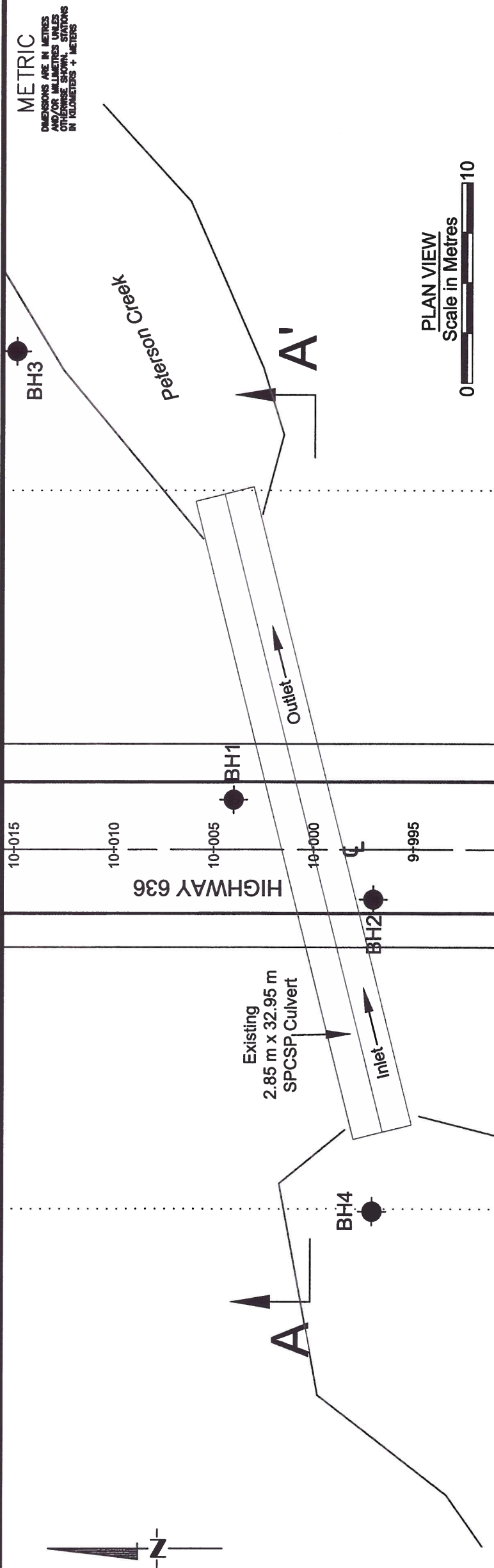
BH3


















BH1

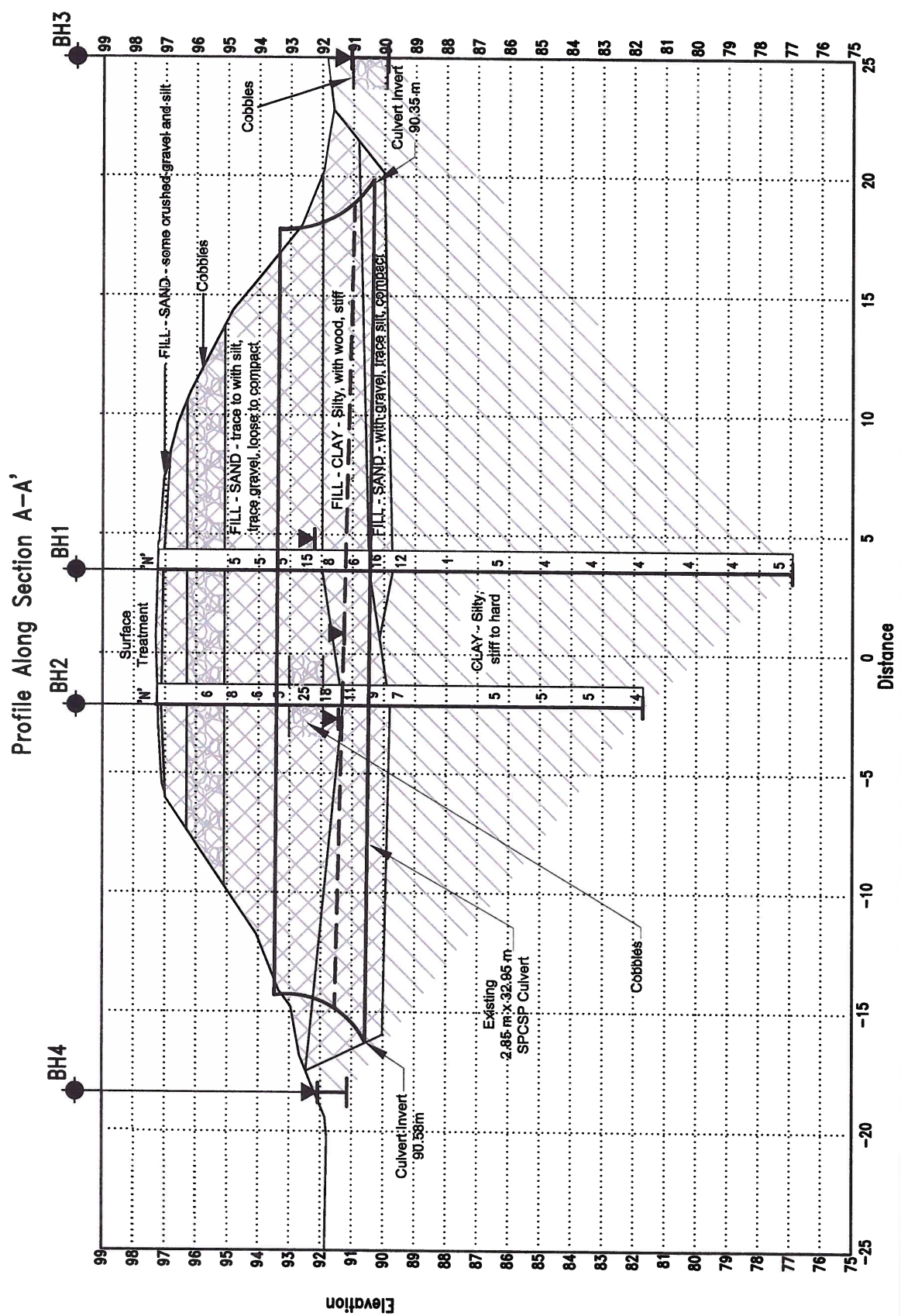
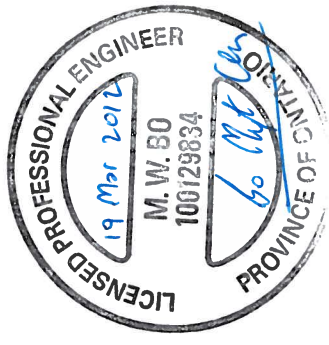
BH2

BH4

CONT	No 2012-5121		SHEET
GWP	No 5481-09-00		10
WP	No 5481-09-01		
Site	No 39E-257		
Geocres	No 42H-44		
CULVERT REPLACEMENT 3.7 Km North of Hwy 11 Highway 636 - Clute Twp. Borehole Location Plan			



LEGEND					
	Borehole/Hand Auger	 Sand  Silt  Clay  Sand & Gravel  Boulders			
	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		Organics		
	Topsoil		Till		
	Bedrock				
No.	Elevation	Northing	Easting	Station	Offset
BH1	97.22	5457884	488437	10+004	2.5 m RT
BH2	97.34	5457873	488431	9+497	2.5 m LT
BH3	91.05	5457894	488454	10+915	23.0 m RT
BH4	92.15	5457875	488420	9+497	14.0 m LT



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

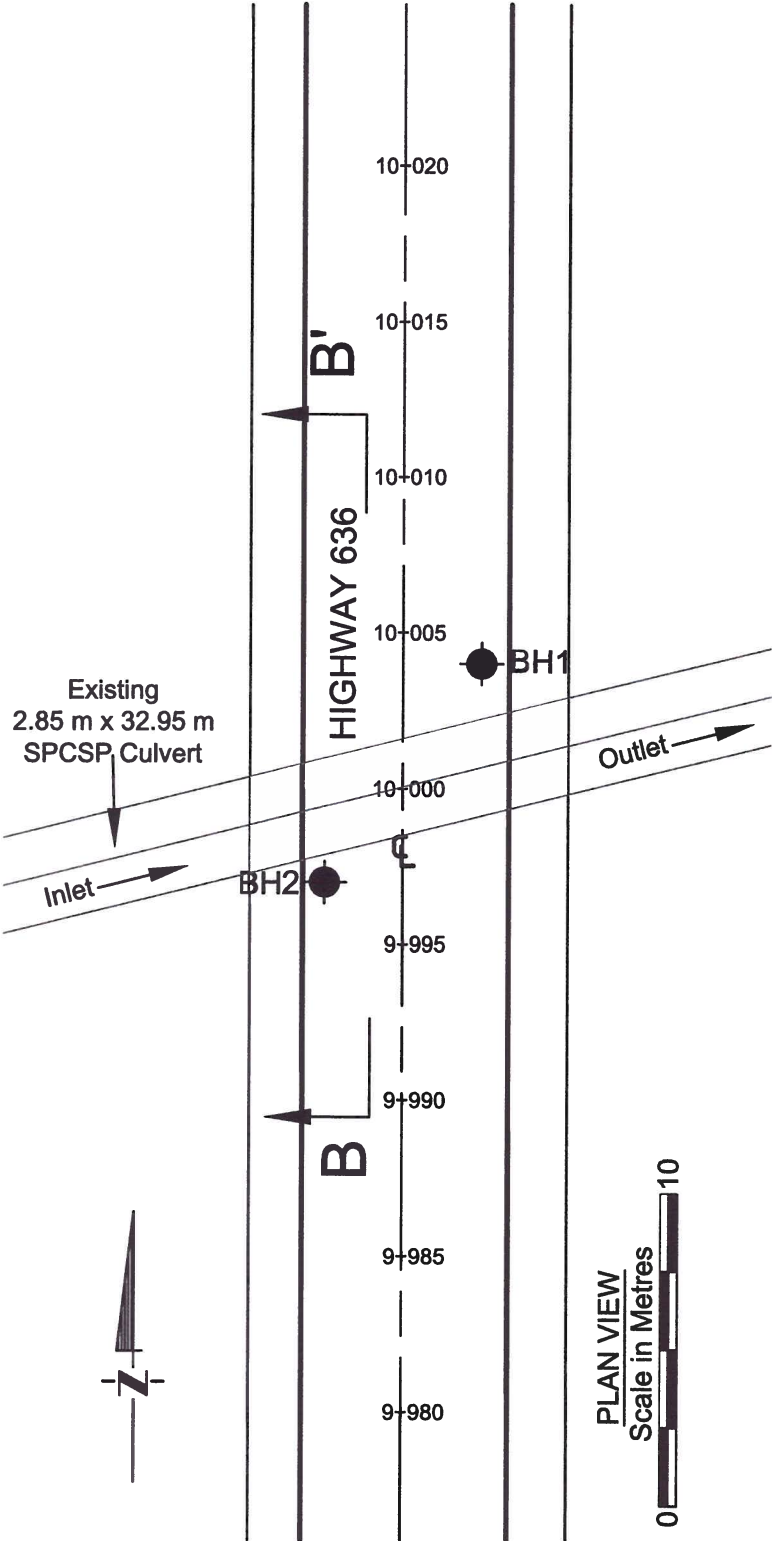
DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 623-2929
Fx: (807) 623-1792
Email: thunderbay@dstgroup.com

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

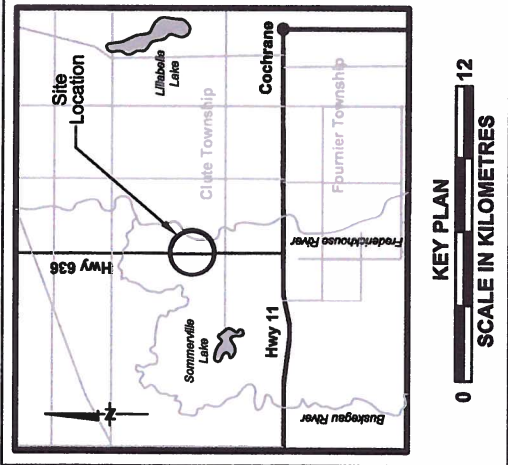
CONT No 2012-5121
GWP No 5481-09-00
WP No 5481-09-01
Site No 39E-257
Geocres No 42H-44

CULVERT REPLACEMENT
3.7 Km North of Hwy 11
Highway 636 - Clute Twp.
Borehole Location Plan

SHEET
11

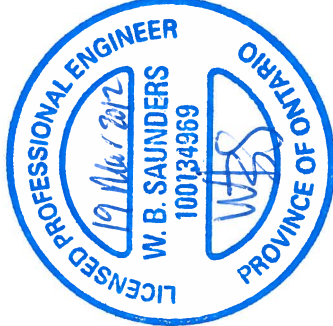
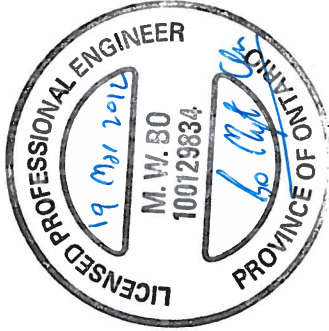


PLAN VIEW
Scale in Metres



KEY PLAN
SCALE IN KILOMETRES

LEGEND					
	Borehole/Hand Auger		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.
	Bench mark		Fill		Organics
	Topsoil		Till		Bedrock
	Sand		Silt		Clay
	Sand & Gravel		Boulders		
No.	Elevation	Northing	Easting	Station	Offset
BH1	97.22	5437684	488437	10+004	2.5 m RT
BH2	97.34	5437673	488431	9+997	2.5 m LT
BH3	91.05	5437684	488454	10+015	25.0 m RT
BH4	92.15	5437675	488420	9+997	14.0 m LT



NOTE:
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locations. Between boreholes the boundaries are assumed by interpolation
and may not represent actual conditions.

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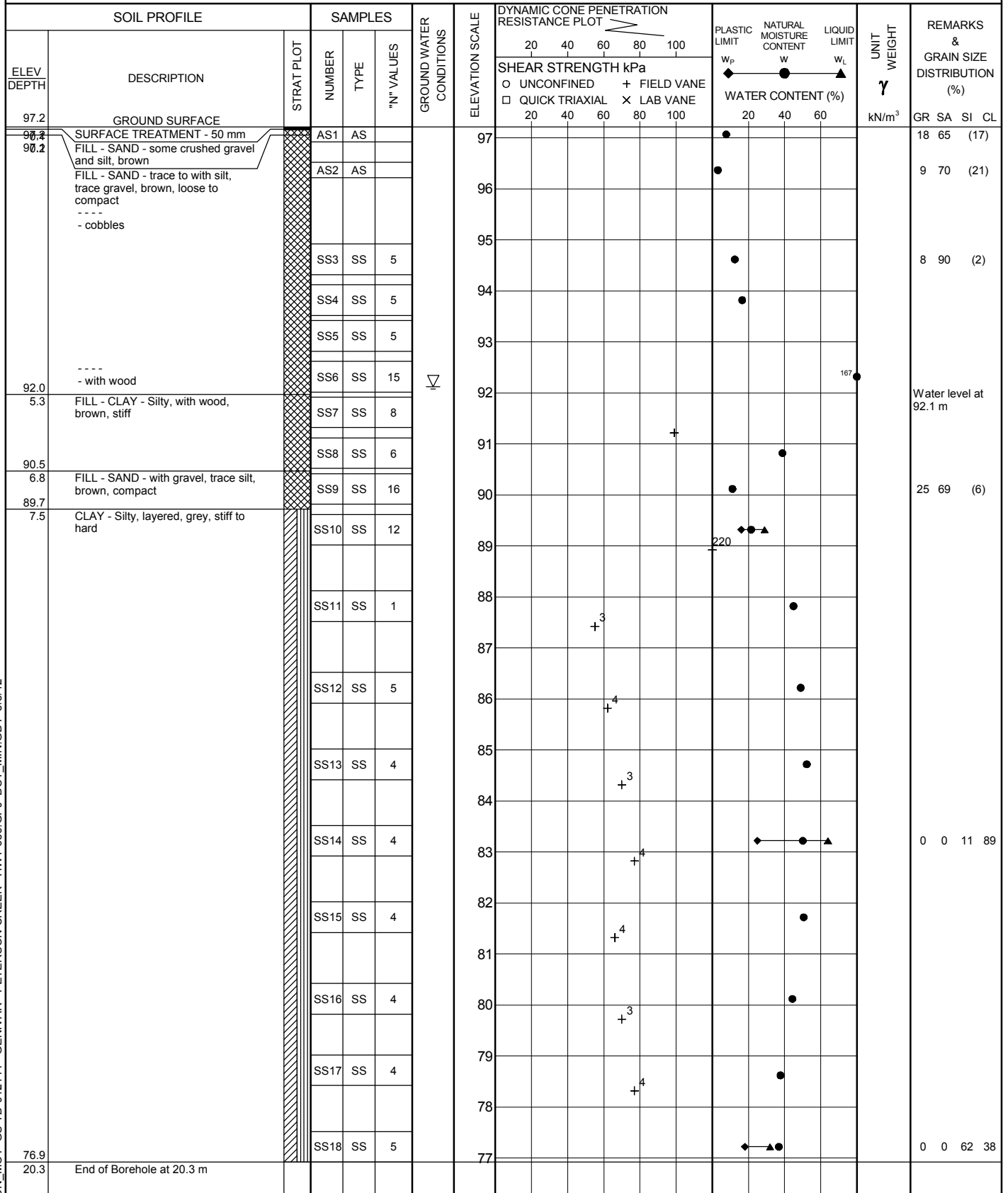
E N C L O S U R E S

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 5481-09-01 LOCATION STA. 10+004, 2.5 m RT (5437684 m N, 488437 m E) ORIGINATED BY PR
DIST HWY 636 BOREHOLE TYPE Hollow Stem Auger COMPILED BY ML
DATUM Local DATE 2011 01 31 CHECKED BY WS/BV



ON MOT CS-TB-012144 - GENIVAR - PETERSON CREEK - HWY 636.GPJ DST_MIN.GDT 5/3/12

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

ENCLOSURE 1

METRIC

ON MOT GS-TB-012144 - GENIVAR - PETERSON CREEK - HWY 636.GPJ DST MIN.GDT 5/3/12

[illegible]

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

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 5481-09-01 LOCATION STA. 10+015, 25.0 m RT (5437694 m N, 488459 m E) ORIGINATED BY PR
 DIST HWY 636 BOREHOLE TYPE Hand Auger COMPILED BY ML
 DATUM Local DATE 2011 02 05 CHECKED BY WS/BV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	20	40	60			
91.1	GROUND SURFACE																
90.0	TOPSOIL - 50 mm CLAY - Silty, trace gravel, brown - cobbles		AS1	AS												Water level at 90.1 m	
89.9			AS2	AS													
1.2	End of Borehole at 1.2 m																

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

RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

W.P. 5481-09-01 LOCATION STA. 9+997, 14.0 m LT (5437675 m N, 488420 m E) ORIGINATED BY PR
 DIST HWY 636 BOREHOLE TYPE Hand Auger COMPILED BY ML
 DATUM Local DATE 2011 02 05 CHECKED BY WS/BV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	20	40	60			
92.2	GROUND SURFACE																
90.1	TOPSOIL - 60 mm																
91.2	CLAY - Silty, some sand and gravel, brown		AS1	AS												Water level at 92.1 m	
1.0	End of Borehole at 1.0 m																

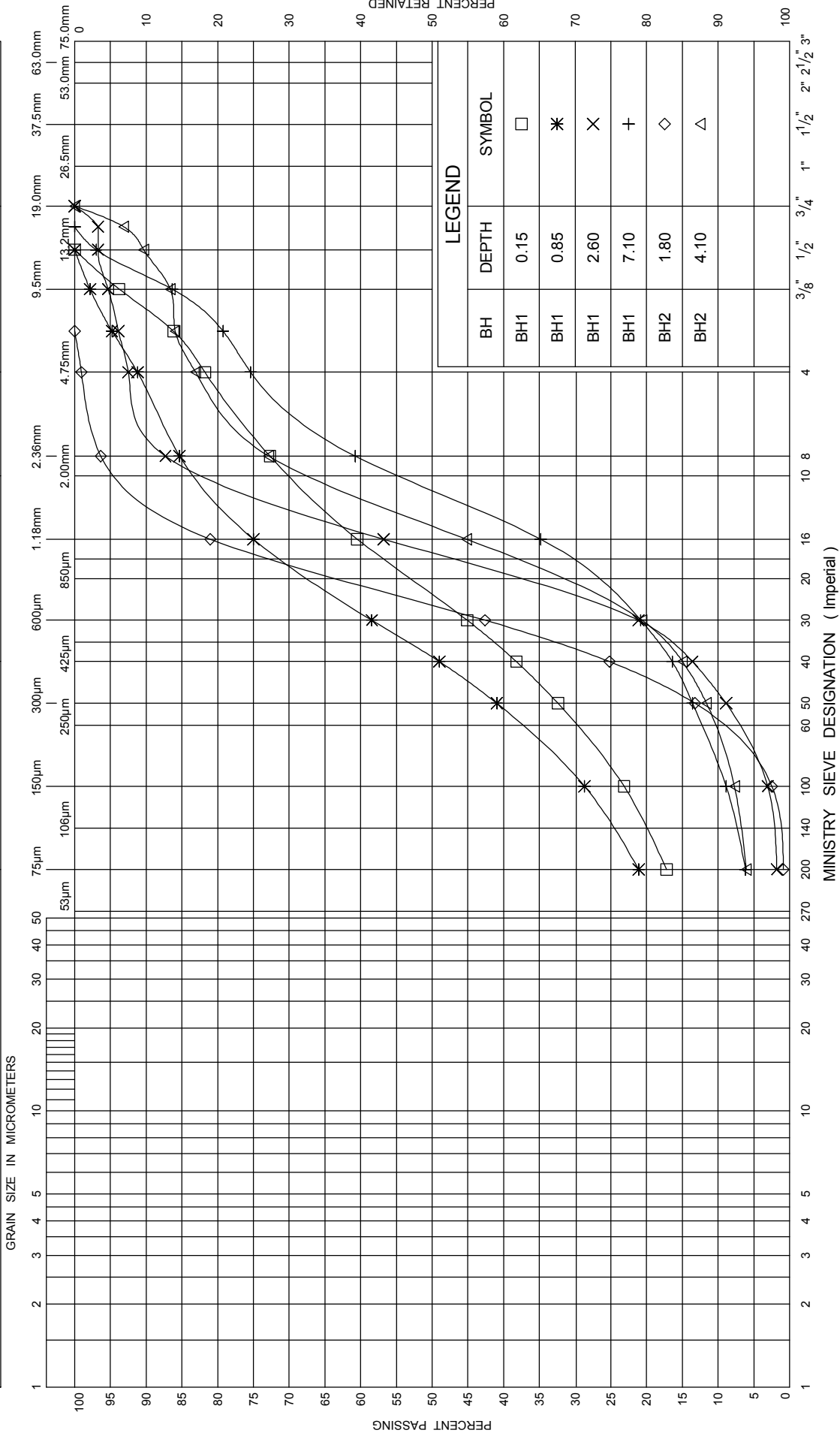
✕³, ★³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 4

ON_MOT_CS-TB-012144 - GENIVAR - PETERSON CREEK - HWY 636.GPJ DST_MIN.GDT 5/3/12

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine		Medium	Coarse	Fine	Coarse

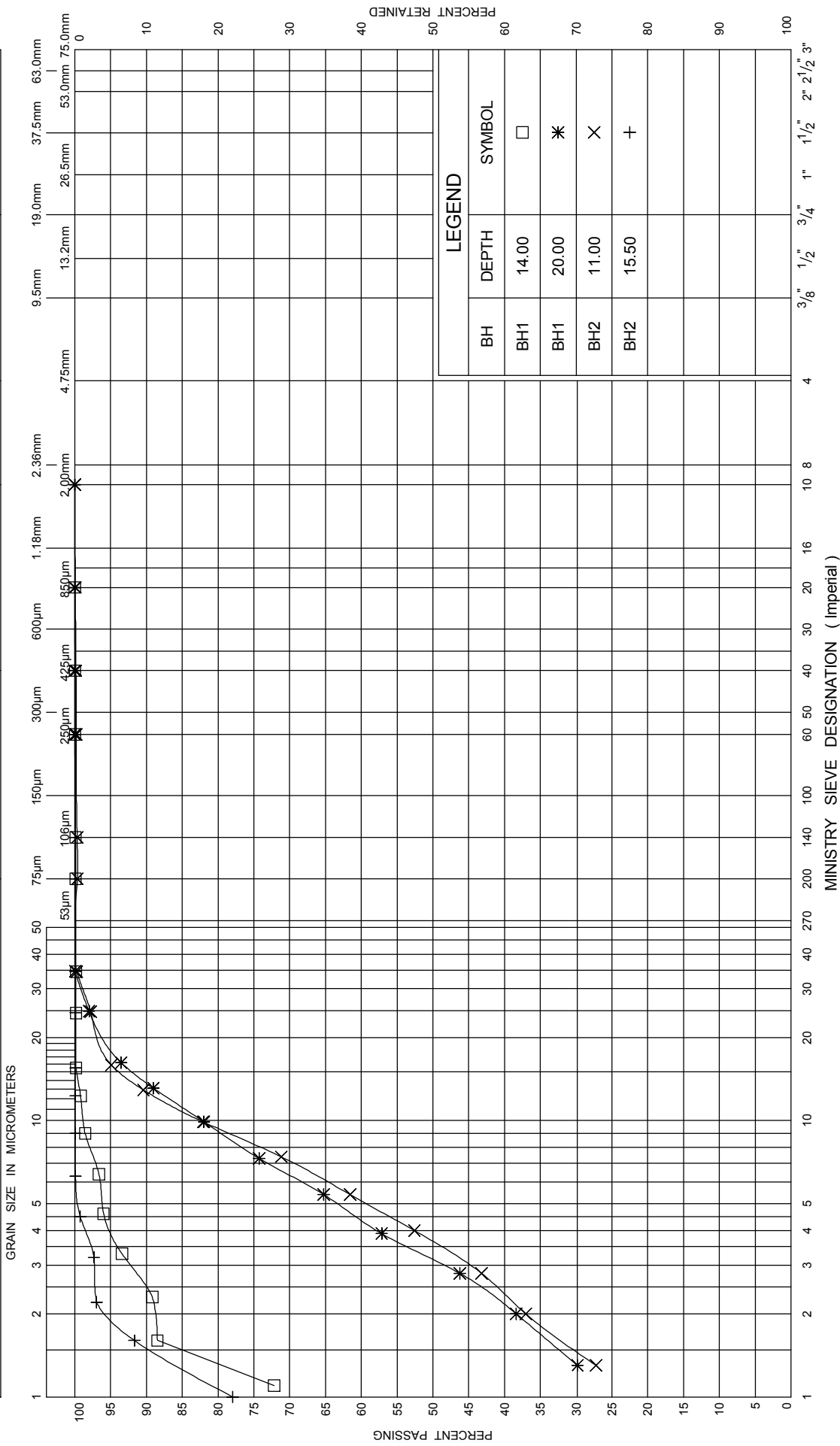


GRAIN SIZE DISTRIBUTION
SAND

ENCLOSURE 5
W P 5481-09-01
HIGHWAY 636

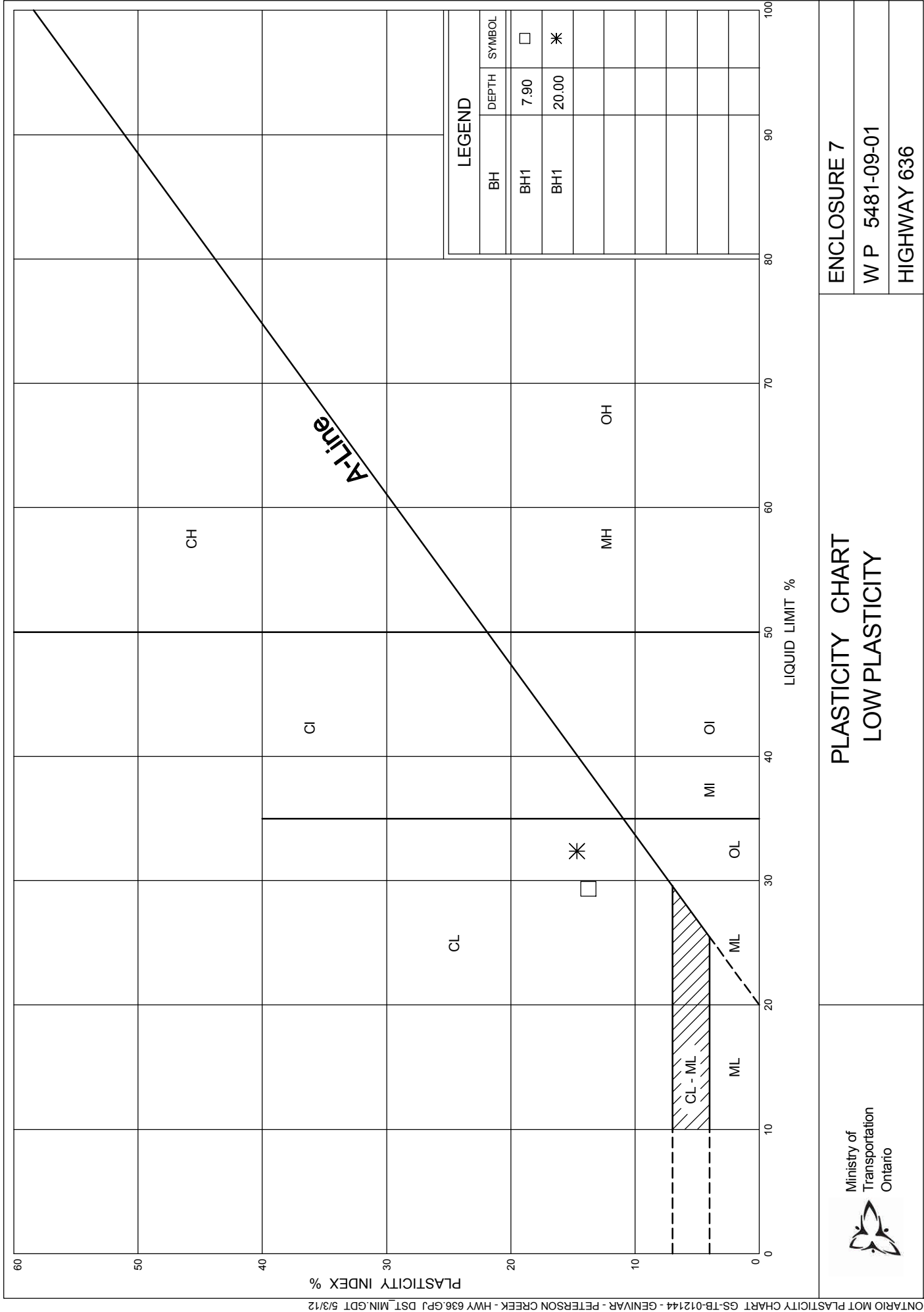
UNIFIED SOIL CLASSIFICATION SYSTEM

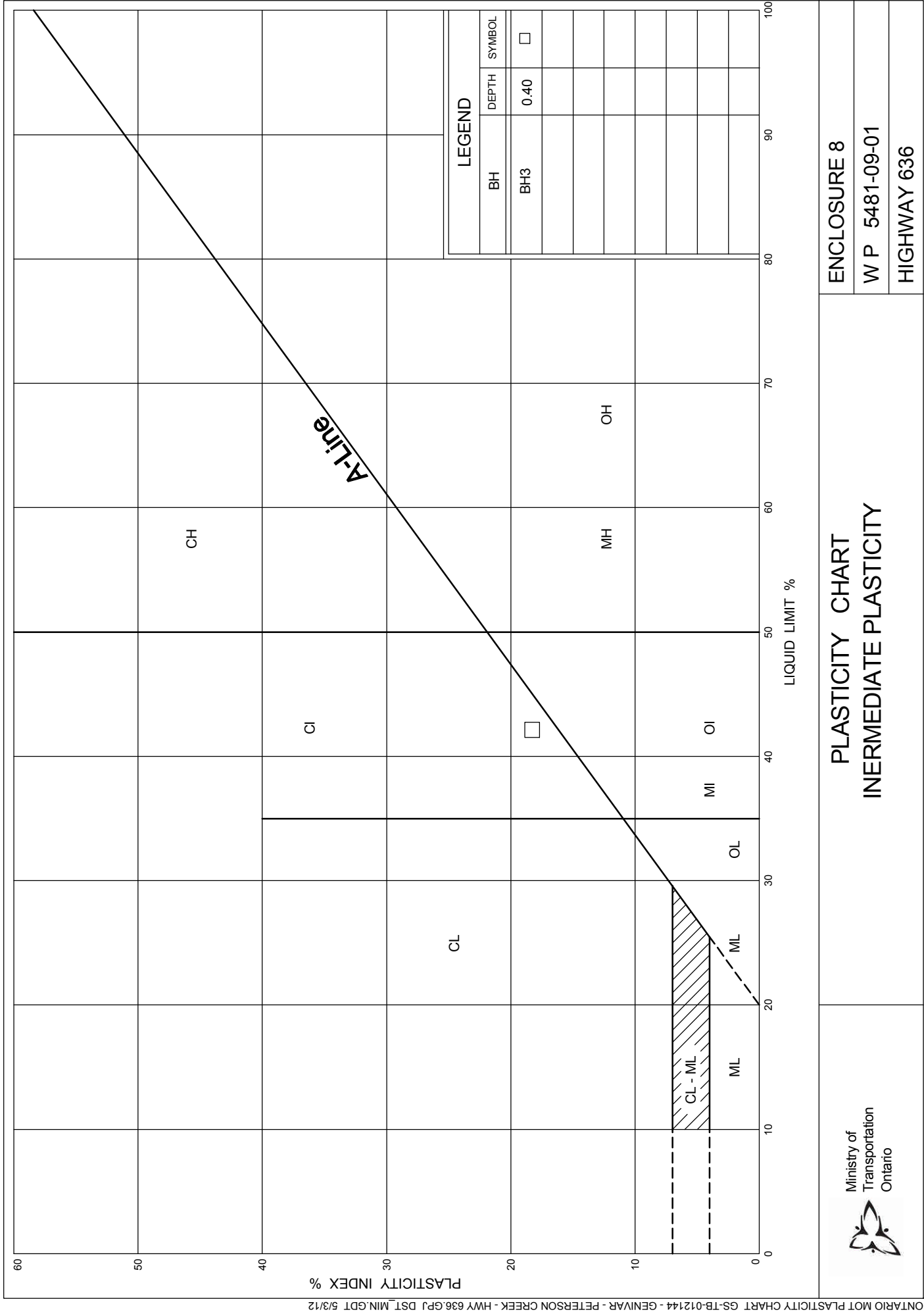
CLAY & SILT		SAND			GRAVEL	
		Fine		Medium	Fine	Coarse



GRAIN SIZE DISTRIBUTION
CLAY

ENCLOSURE 6
W P 5481-09-01
HIGHWAY 636





PLASTICITY CHART
INTERMEDIATE PLASTICITY

ENCLOSURE 8
W P 5481-09-01
HIGHWAY 636



