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FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 211-90-01 DIST 13

HWY 534/11 STR SITE 44-363

Hwy. 534/Hwy. 11, Powassan Overpass

CONT 95-214

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GEOCRES 31L-55

DATE DEC 09 1991

FOUNDATION INVESTIGATION REPORT
For
Highway 534/Highway 11, Powassan
Overpass
W.P. 211-90-01, Site No. 44-363
District 13, North Bay

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. It is proposed to construct a two span structure that will carry the existing secondary Highway 534/Clarke Street over Highway 11. This report describes the subsurface conditions at the site and provides recommendations pertaining to the structure foundations and related earthworks.

SITE DESCRIPTION AND GEOLOGY

The site is located at the intersection of Clarke Street (Highway 534) and Highway 11 in the Township of south Himsworth (Town of Powassan) District of Parry Sound. Highway 11 currently consists of 4 lanes and Clarke Street two lanes, both of which are paved roadways surrounded by flat to gently undulating grasslands. A residential home is located to the west with the west approach and abutment located on its driveway. To the northeast an Ontario Provincial Police station and at approximately ½ km east is the Town of Powassan with many residential homes. The groundsurface ranged from east to west 245.4 m to 250.5 m with it rising gently to the west.

Overhead wires ran directly above the proposed overpass beside Clarke Street and Highway 534 running east/west.

The terrain surrounding the site is generally flat and used primarily as agricultural farmland.

Physiographically, the site is located in the geological domain known as the Algonquin Highlands. This region in much of the area is underlain by granite and other hard precambrian rocks. There are frequent outcrops of bare rock but they do not amount to more than 5% of the total area. The soils are generally shallow but thicknesses over the bedrock varies greatly over short distances.

Highway 11 from Gravenhurst to North Bay follows a narrow strip in which sand, silt and clay deposits occupy the hollows. The deep soils developed on the fine sand, silt and clay have been cleared and support farming settlements.

INVESTIGATION PROCEDURES

Soil data and inherent properties were obtained by in situ and laboratory testing. The procedures employed are discussed below.

FIELD INVESTIGATION

The fieldwork for the site investigation was carried out between 91 08 13 and 91 08 31 and consisted of seven boreholes placed at approach, abutment and pier locations. East and west of Highway 11 at Clarke Street/Highway 534.

Five boreholes were sampled, with two approach boreholes advanced 12.7 m and 2 abutment, 1 pier boreholes advanced 26.8 m to 30.9 m below the ground surface. Rock core samples were retrieved upon encountering bedrock or boulders. Cone penetration tests were employed from the invert of the two approach boreholes and from the ground surface at the abutment and pier locations.

Track mounted CME 55 equipment employing hollow stem augering techniques was used to advance all boreholes with wash boring and rock coring techniques being utilized at abutment and pier locations. In general, disturbed subsoil samples were retrieved at 0.75 m intervals for the surficial 4.5 m and 1.5 m thereafter. All samples were identified in the field and then returned to the laboratory for applicable testing. Rock core sampling was performed down 3.5 m into bedrock at one borehole. In situ vane tests were also conducted in cohesive materials to determine the undisturbed and remoulded undrained shear strengths of soil. The test was conducted employing the standard MTO 'N' vane in accordance with ASTM D2573.

Groundwater levels were obtained by monitoring the levels in the open boreholes throughout the duration of the field investigation. Two piezometers were installed, one on each side of Highway 11. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes were provided by MTO Surveys and Plans Section, Northern Region.

Laboratory Analysis

The following laboratory tests were carried out on select soil samples.

1) Atterberg Limit Test
2) Grain Size Analysis
3) Natural Moisture Contents
4) Unit Weights

Laboratory test results are given in the following section of this report and are illustrated on figures and borehole logs included in the Appendix.

SUBSURFACE CONDITIONS

General

The subsoil stratigraphy encountered at this site consisted of a thin 60 cm deep surficial sand, trace clay with organics underlain by clayey silt, trace sand deposit which was encountered more predominantly towards the east ranging in thickness of 3.7 m to 11.6 m. Occasional sandy silt seams were encountered. A 1 m to 17 m (east to west) deposit of sandy silt and a sand and gravel, trace silt deposit was found to underly the above layer. The material contains more gravel at greater depths with numerous boulders encountered. At one location bedrock was established at a depth of 27.9 m.

The plan and location of boring and the stratigraphical profile are shown Drawing No. 2119001-A, in the attached Appendix. The field and laboratory test results are plotted on the record of borehole sheets and in the appendix of this report. A brief description of the different soil types is given below.

Clayey Silt, Trace Sand

The native surficial deposit spread across the site increasing with depth towards the east with a thickness of 3.7 m to 11.6 m consisting of a cohesive clayey silt, trace sand with a thin 60 cm layer of silty sand, with organics at the surface. Occasional sandy silt seams were encountered interbedded in the clayey silt, trace sand.

Results of Grain Size Distribution tests carried out on select samples are shown in Figure 1 in the Appendix, in an envelope form. The results indicate the material contains a large percentage of clay and silt with a trace of sand. The deposit is comprised primarily of 0-3% gravel, 1-3% sand, 53-77% silt and 21-44% clay.

The results from the Atterberg Limit tests performed on the fine fraction of this deposit is summarized as follows:

	Range	No. of Tests
Natural Moisture Content (w)	26-42%	8
Liquid Limit (w_L)	28-40%	8
Plastic Limit (w_P)	16-21%	8
Plastic Index (I_P)	11-19%	8
Unit Weight (kN/m^3)	17.1-20.7	8

From the plasticity chart (Figure 2), the layer can be classified as a clayey silt of low to intermediate plasticity.

In this stratum the standard penetration resistance 'N' values ranged from 1 to 30 blows/0.3 m indicating the material has a very soft to very stiff consistency. The values of undrained shear strength obtained using the field vane range from 30 to 66 kPa with one test >120 kPa possibly due to a presence of gravel. Range of sensitivity was 2.7 to 5.

Sandy Silt

Underlying the above deposits throughout the site was 1 m to 17 m (east to west) thickness of sandy silt. The material contained a greater percentage of sand at greater depths.

Results of Grain Size Distribution tests carried out on select samples are shown on Figure 3 in the Appendix. The results summarize Grain Size Distribution tests carried out on this material throughout the site. The above figure confirmed a greater percentage of sand. The deposit comprised primarily of 0-1% gravel, 18-98% sand, 3-63% silt and 1-8% clay.

Due to the non-cohesive nature of this deposit no Atterberg Limit tests were performed.

Standard Penetration tests carried out in this deposit revealed 'N' values just slightly higher than those of the previous deposit ranging from 3 to 46 blows/0.3 m. This indicates a very loose to very dense state of denseness.

Sand and Gravel, trace Silt, Cobbles and Boulders (Glacial Till)

Underlying all the above deposits throughout the site and extending down past the termination depths of the boreholes is a non-cohesive heterogeneous mixture of silt, sand and gravel with random boulders encountered. This deposit contained a greater percentage of gravel at greater depths. Augering through this material was a slow process with recovery in split spoons being low and rock coring techniques being implemented to bore through boulders. In one borehole (BH 7) bedrock was confirmed.

Results of Grain Size Distribution tests carried on select samples are shown on Figure 4 in the Appendix. This figure indicates a high percentage of gravel was encountered. The deposit comprised primarily of 10-100% gravel, 0-90% sand, 1-9% of silt and clay.

Due to the non-cohesive nature of this deposit no Atterberg Limit tests were performed.

Standard Penetration tests carried out in this deposit revealed 'N' values >120 blows/0.15 m with a great increase over the overlying deposits. Thus this material has a very dense state of denseness. Cone penetration tests conducted at various locations generally hit refusal (blows >120/0.3 m) within or near this deposit.

Bedrock

Bedrock was encountered at the west abutment location (BH 7) at a depth of 27.4 m. 3.35 m of rock core was retrieved to confirm that it was bedrock as a presence of boulders were encountered.

A petrographer described the bedrock as granite of the Prenville Province, medium to coarse grained, strong, unweathered to slightly weathered; undulating rough to smooth. This confirms the general type of bedrock encountered in this area.

GROUNDWATER CONDITIONS

Observations of the groundwater level were carried out by measuring the water level in open boreholes and in two piezometers placed at each end of the site.

Groundwater levels determined at the time of this investigation varied throughout the site with elevations of 245 m (6 m depth) to 240 (7 m depth) from west to east. Groundwater levels, however, are subject to seasonal fluctuations and hence can vary throughout the season.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a two span structure having an aproximate width of 11.3 m and having spans of 42 m which will carry the east and west bound lanes of Highway 534 over Highway 11 just south of Clarke Street. Currently Highway 534 terminates at Highway 11 (west side) and Clarke Street continues to the east. This site is located in the district of Parry Sound, Township of South Himsworth just west of the Town of Powassan. Original E-plans indicated fills in the order of magnitude of 8 m to the east and 5 m to the west. However, recent revisions have lowered the profile grade of the bridge by 2 m which would decrease the height of fill embankments to approximately 6 m to the east and 3 m to the west, but would also now require some cut underneath the bridge to accommodate minimum clearance. This report is based on the assumption that the grade of the overpass will be lowered by the 2 m.

The natural ground surface varied throughout the site. Rising gently towards the west with elevations of 246 m to 251 m respectively.

To facilitate the design and construction of this proposed structure foundations and related earthworks for the approach ramps over Highway 11, the following foundation and geotechnical recommendations are provided in the scope of this report.

1) Structural Foundation
2) Lateral Earth Pressure
3) Slope Stability
4) Construction Consideration

1) Structural Foundations

The surficial soils at the site are unsuitable for the support of conventional shallow spread footings. Consequently, it is recommended that abutment and pier foundations be founded on end-bearing steel H-piles driven to refusal or bedrock. Fill material employed should not exceed grain size of 75 mm to prevent pile driving impediment. For purposes of the O.H.B.D.C., the steel H-piles can be designed using the axial capacities tabulated below:

Axial Capacity - Driven Steel H-Piles

Pile Type	Structure	Factored Capacity at U.L.S. (kN)	Bearing Capacity at S.L.S. Type II	Estimated Pile Tip El. (m)
HP310x110	E. Abutment	1600	1150	220±
	Pier	1600	1150	217±
	W. Abutment	1600	1150	220±
HP310x79	E. Abutment	1150	890	220±
	Pier	1150	890	217±
	W. Abutment	1150	890	220±

The capacities pertain to vertical piles only and reductions to account for inclined loading shall conform to factors provided in Section 6.8.3.4.3 of the O.H.B.D.C.

Depending on when the piles are driven, a reduction in the pile capacities may have to be applied to compensate for the effects of the anticipated downdrag.

In view of the presence of boulders it is recommended that pile installation be carefully controlled and monitored employing the Hiley Dynamic Driving Formula in accordance with MTO standards SS103-10 or SS 103-11 and assuming an ultimate capacity as tabulated below:

Ultimate Capacity Employing Hiley Dynamic Formula

Pile Type	Ultimate Capacity (kN)
HP310x110	3450
HP310x79	2670

To facilitate pile penetration through the heterogeneous mixture of silt, sand and gravel with occasional boulders deposit, it is recommended that the steel H-piles be equipped with reinforced tips.

Pile caps should be placed as high as possible within the approach embankments or within the clayey silt to avoid any dewatering problems.

Pile spacing shall comform with Section 6.8.3.10 of the O.H.B.D.C. For centrally loaded piles, equal load sharing of the deep foundations units can be assumed. The design of eccentric loaded deep foundation units shall comply with Section 6.8.3.4.2 of the O.H.B.D.C.

All pile caps shall be protected against frost penetration by providing a minimum 2.0 m earth cover or equivalent frost protection.

2) Lateral Earth Pressure on Structure

Free draining material such as Granular 'A' or 'B' shall be used within a wedge behind the abutments and retaining walls bounded by a plane rising at 60° to the horizontal as shown in Figure 6-9.6.1 of the O.H.B.D.C. The application of granular material combined with weep holes in the abutment walls to drain any accumulation of water in the backfill will prevent hydrostatic pressure build-up. Design parameters of the soil are given in the table below:

Backfill Properties

	Granular 'A'	Granular 'B'
Angle of Internal Friction (ϕ unfact)	35°	30°
Unit Weight (kN/m^3)	22.8	21.2
*Coefficient of Active Earth Pressure (Ka)		
- S.L.S.	0.27	0.33
- U.L.S.	0.33	0.4
*Coefficient of Earth Pressure at Rest (Ko)		
- S.L.S.	0.43	0.5
- U.L.S.	0.5	0.58

3) Slope Stability

No stability problems are anticipated for the proposed 6 m and 3 m fill embankment at the abutment structures constructed with 2H:1V front and side slopes.

All exposed slopes should be protected from erosional forces by providing an effective erosional control protection scheme.

To the east, with fills approximately 6 m proposed, settlements in the order of magnitude of 40-80 mm are anticipated. Half would be due to the recompression of the native subsoil and settlements within the fills under its own weight. The remaining settlements will be due to consolidation of the clayey silt deposit encountered in the top 10 m of overburden. The majority of settlement will occur within 3 months after construction. If necessary, the settlements could be accelerated by surcharging the fills. Otherwise the fill would have to remain in place for at least three months prior to paving. To the west, with fills of approximately 3 m proposed, settlements of 40 mm are expected immediately after completion of construction.

4) Construction Considerations

In the construction of the embankment fills, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

Embankment fills should be placed and compacted as specified in OPSS 206.07.07 and OPSS 501 series.

No dewatering should be necessary for excavation within the surficial clayey silt, trace sand. But should the excavation cuts or the pile caps intersect the non-cohesive silt, trace sand layer with a high water table a dewatering scheme may be necessary due to quick conditions (weakening condition of founding material).

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of M. Michalek, Junior Foundation Engineering and P. Thase, Student Engineer, utilizing equipment owned and operated by Master Soil Investigations Ltd.

The project was carried out under the general supervision of B. Iyer, Senior Foundation Engineer. The report was written by M. Michalek, reviewed by B. Iyer and approved by M. Devata, Chief Foundation Engineer.

M. Michalek
Junior Foundation Engineer

M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

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:

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

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

ROCK CORE DESCRIPTION
WP 211-90-01

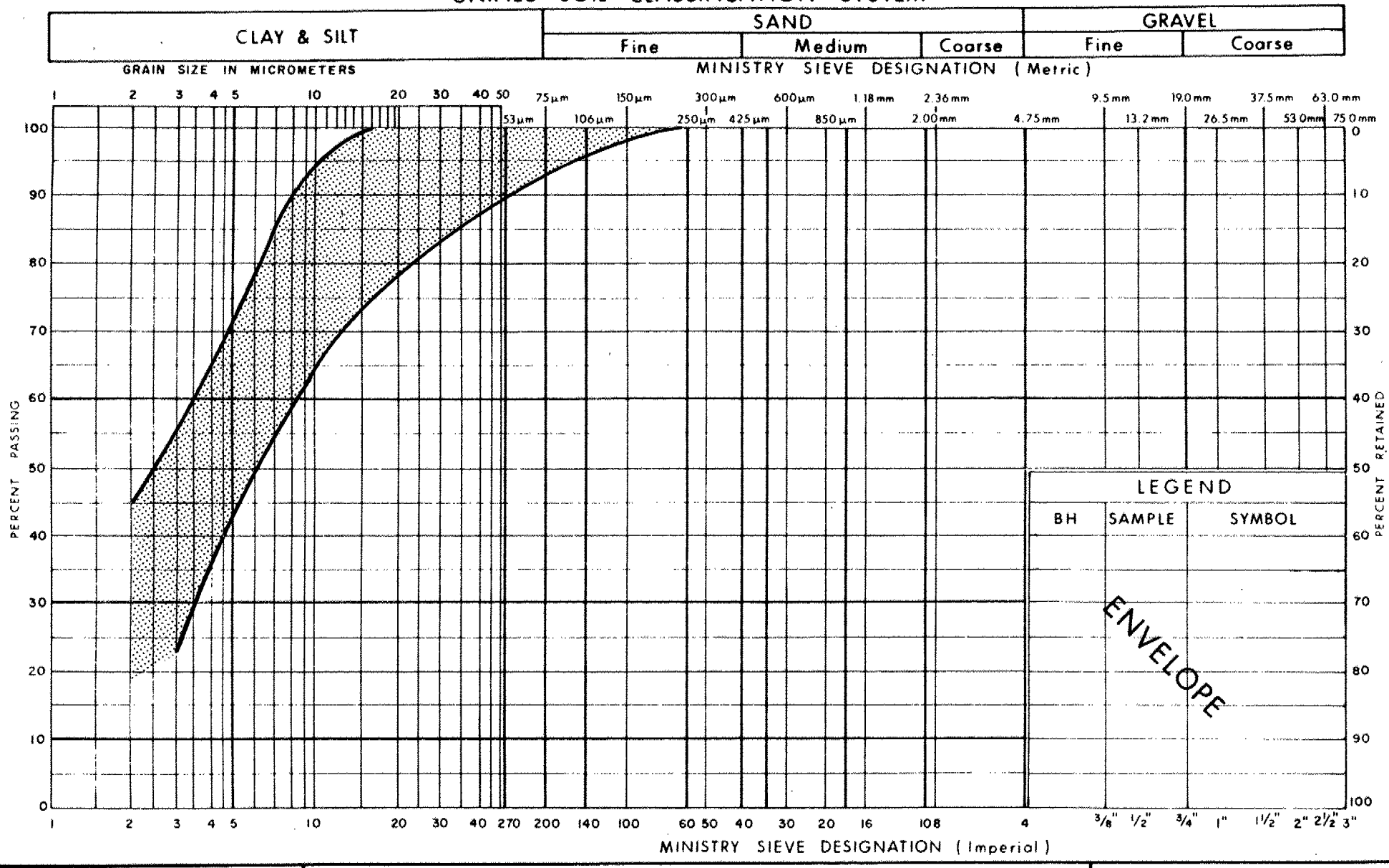
CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
7	22	27.43-29.26	92	60	27.43-30.78	**GRANITE** (biotite-bearing and gneissic), greyish red to moderate reddish orange; medium to coarse grained; strong; unweathered to slightly weathered; fractures moderately close to very close spaced, near vertical to flat, undulating, rough to smooth.
	23	29.26-30.78	100	83		

***CR** = CORE RECOVERY
***RQD** = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

UNIFIED SOIL CLASSIFICATION SYSTEM



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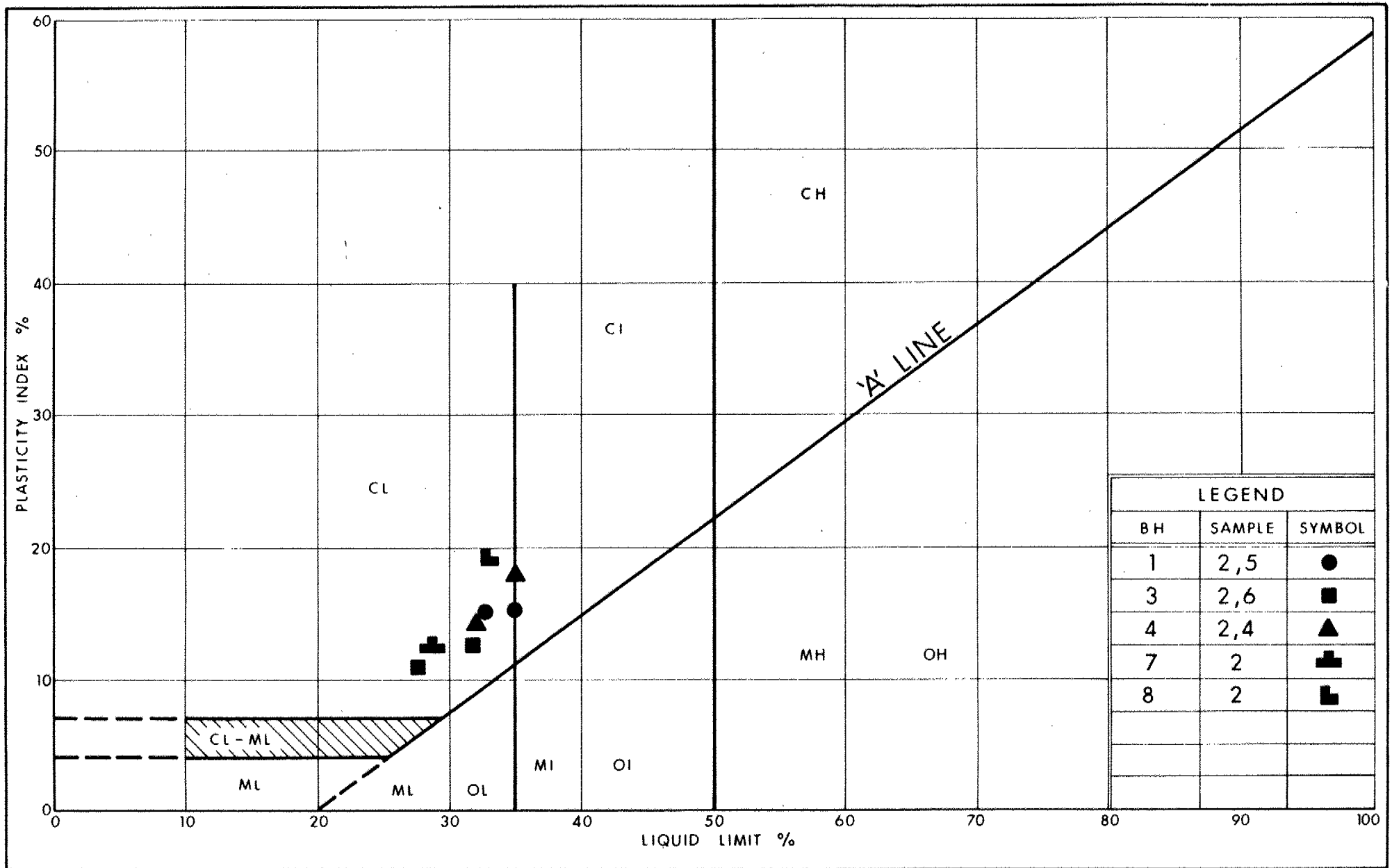
GRAIN SIZE DISTRIBUTION
CLAYEY SILT, TRACE SAND

FIG No 1
W P 211-90-01



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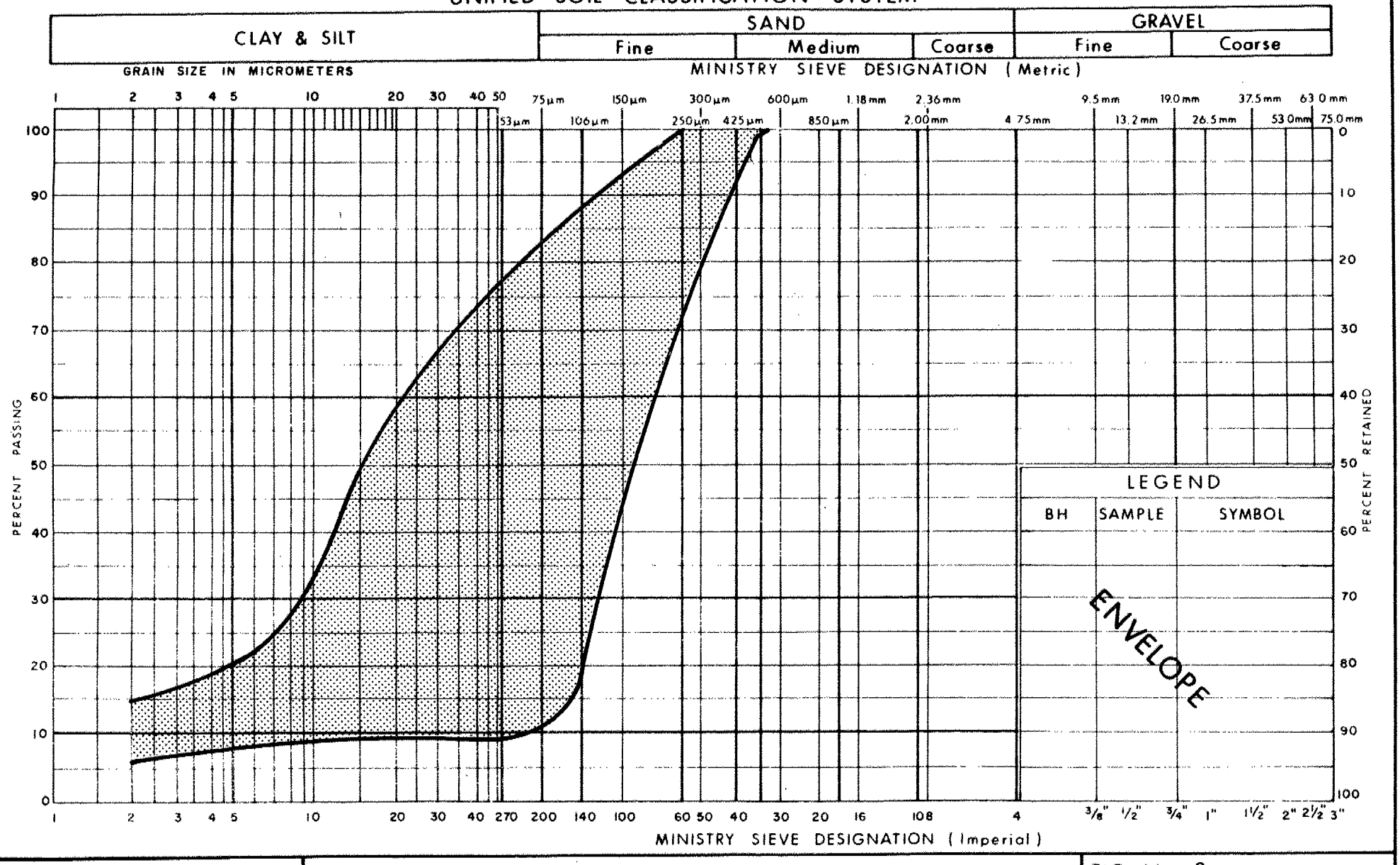
PLASTICITY CHART
CLAYEY SILT, TRACE SAND

FIG No 2
WP 211-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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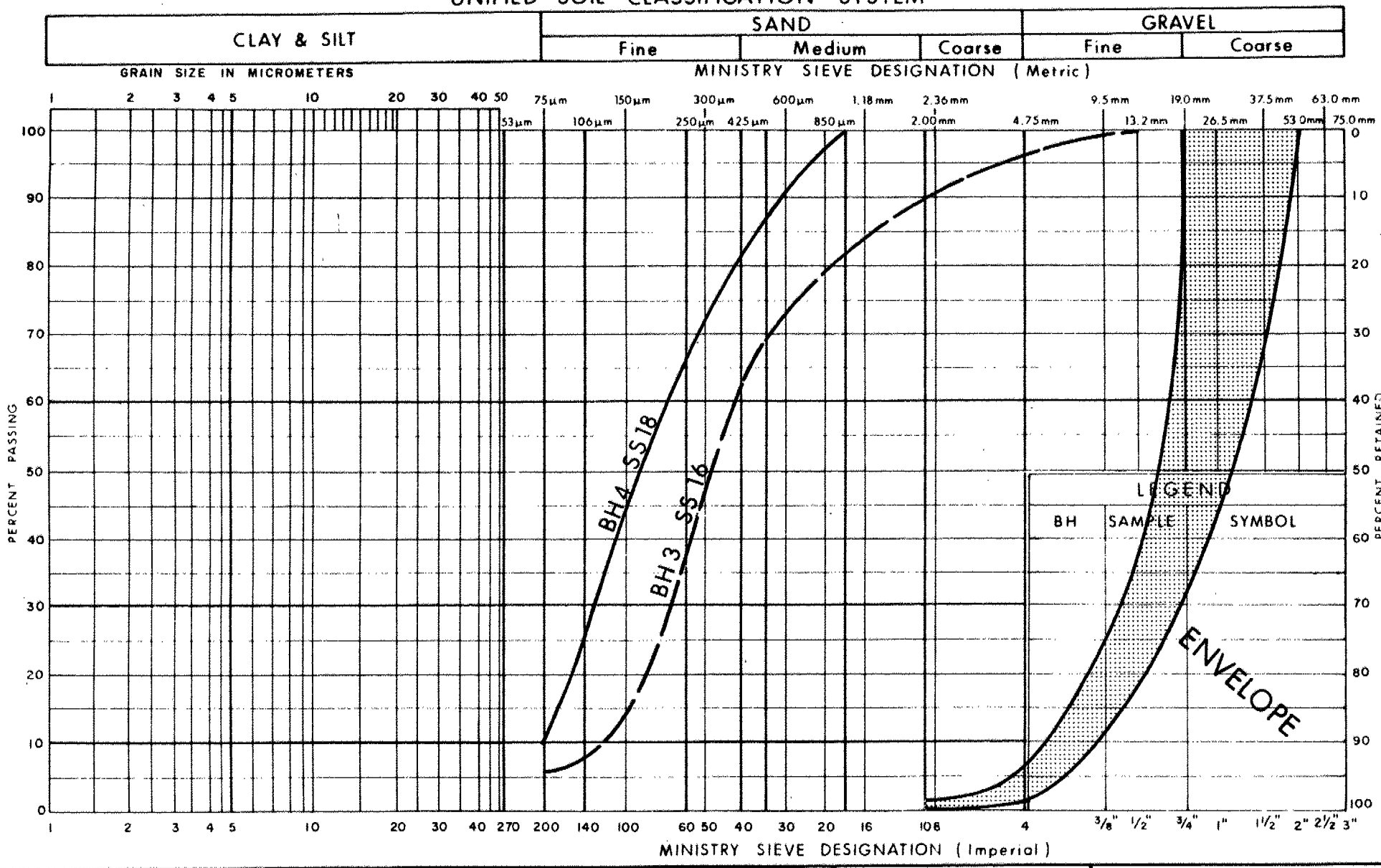
GRAIN SIZE DISTRIBUTION
SANDY SILT

FIG No 3

W P 211-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SAND & GRAVEL
TRACE SILT

FIG No 4

W P 211-90-01

RECORD OF BOREHOLE No 1 — 1 OF 1 — METRIC

W.P. 211-90-01 LOCATION COORDS. N 5 104 352.2; E 315 011.8 ORIGINATED BY M.M.

DIST 13 HWY 11/534 BOREHOLE TYPE H.S. AUGER, DYNAMIC CONE COMPILED BY A.H.

DATUM GEODETIC DATE 91/08/13 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
245.4	GROUND SURFACE							
0.0	SAND WITH GRAVEL, TRACE ORGANICS		1	SS	15			
			2	SS	5		17.1	0 1 66 33
	CLAYEY SILT TRACE SAND VERY SOFT TO STIFF		3	SS	4			
			4	SS	2			
			5	SS	2		19.2	0 3 71 26
			6	SS	3			
	BROWN GREY		7	SS	1	▼		
			8	SS	1			
			9	SS	2			0 1 77 22
233.8			10	SS	2			
11.6 232.7	SANDY SILT TRACE CLAY COMPACT		11	SS	12			0 17 80 3
12.7 222.8	End of Borehole							
22.6	End of Cone Test PROBABLE BOULDER							

ELEVATION SCALE: 244, 242, 240, 238, 236, 234

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
o 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 (%) 10 20 30

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3 1 OF 1 METRIC

W.P. 211-90-01 LOCATION COORDS. N 5 104 336.7; E 314 991.6 ORIGINATED BY M.M.

DIST 13 HWY 11/534 BOREHOLE TYPE H.S. AUGER, WASH BORING, DYNAMIC CONE COMPILED BY A.H.

DATUM GEODETIC DATE 91/08/13 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.0	GROUND SURFACE										
0.0	ORGANICS										
	CLAYEY SILT TRACE SAND VERY SOFT TO VERY STIFF		1	SS	29						
			2	SS	15					20.7	0 1 74 25
			3	SS	10						
			4	SS	10						
			5	SS	4						
			6	SS	3					18.5	0 2 77 21
	BROWN GREY										
			7	SS	1	▼					
237.5			8	SS	24						
8.5	SANDY SILT TRACE CLAY LOOSE TO COMPACT		9	SS	8						
			10	SS	6						0 52 42 6
			11	SS	19						
			12	SS	11						0 50 47 3
			13	SS	16						
228.5			14	SS	6						
17.5	SAND AND GRAVEL TRACE SILT VERY DENSE		15	RC	REC	0%					RQD 0%
			16	SS	72	/8cm					1 98 1 0
	VERY LOOSE		17	SS	1						
			18	SS	98	/15cm					
			19	SS	53	/8cm					
	OCCASIONAL COBBLES AND BOULDERS										
219.2			20	SS	64	/13cm					98 0 2 0
26.8	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

15 (20/10) 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4 1 OF 2 METRIC

W.P. 211-90-01 LOCATION COORDS. N 5 104 331.4; E 314 948.0 ORIGINATED BY M.M.

DIST 13 HWY 11/534 BOREHOLE TYPE HOLLOW STEM AUGER, WASH BORING COMPILED BY A.H.

DATUM GEODETIC DATE 91/08/18 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
245.9	GROUND SURFACE						
0.0	TRACE ORGANICS						
	CLAYEY SILT TRACE SAND FIRM TO STIFF	1	SS	13			
		2	SS	11		21.0	0 1 69 30
		3	SS	7			
		4	SS	5		18.7	0 3 53 44
	BROWN	5	TW	PH			
	GREY	6	SS	7			
240.4							
5.5	SANDY SILT TRACE CLAY VERY LOOSE TO COMPACT	7	SS	5	▼		
		8	SS	1			
		9	SS	7			
		10	SS	6			
		11	SS	7			0 46 51 3
		12	SS	5			
		13	SS	12			
	DENSE	14	SS	46			
228.2							
17.7	SAND AND GRAVEL TRACE SILT VERY DENSE	15	SS	46			0 93 3 4
		16	SS	120			
	VERY LOOSE	17	SS	2			
		18	SS	2			0 91 9 0
		19	SS	60	/8cm		
	OCCASIONAL COBBLES AND BOULDERS	20	SS	80	/15cm		

ELEVATION SCALE: 244, 242, 240, 238, 236, 234, 232, 230, 228, 226, 224, 222, 220, 218, 216

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o 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 (%) 10 20 30

+5 +3 +3 w=42 o

Continued

+3, x5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No 4 2 OF 2 METRIC

W.P. 211-90-01 LOCATION COORDS. N 5 104 331.4; E 314 948.0 ORIGINATED BY M.M.

DIST 13 HWY 11/534 BOREHOLE TYPE HOLLOW STEM AUGER, WASH BORING COMPILED BY A.H.

DATUM GEODETIC DATE 91/08/18 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
215.0	Continued		21	SS	120	/5cm					99 0 1 0
30.9	End of Borehole										

+^{3}, x^5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5 1 OF 1 METRIC

W.P. 211-90-01 LOCATION COORDS. N 5 104 321.2; E 314 952.2 ORIGINATED BY M.M.

DIST 13 HWY 11/534 BOREHOLE TYPE DYNAMIC CONE COMPILED BY A.H.

DATUM GEODETIC DATE 91/08/28 CHECKED BY B.I.

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	WATER CONTENT (%)		GR SA SI CL
246.2	GROUND SURFACE						246	20 40 60 80 100	10 20 30		
0.0	PROBABLE CLAYEY SILT TRACE SAND FIRM TO STIFF						244				
240.4							242				
5.8	PROBABLE SANDY SILT TRACE CLAY VERY LOOSE TO DENSE						240				
227.9							238				
							236				
							234				
							232				
							230				
18.3	End of Cone Test PROBABLE BOULDER										

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6 1 OF 1 METRIC

W.P. 211-90-01 LOCATION COORDS. N 5 104 314.8; E 314 909.0 ORIGINATED BY M.M.

DIST 13 HWY 11/534 BOREHOLE TYPE DYNAMIC CONE COMPILED BY A.H.

DATUM GEODETIC DATE 91/08/28 CHECKED BY B.I.

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: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	WATER CONTENT (%)		GR SA SI CL
248.1	GROUND SURFACE							20 40 60 80 100	10 20 30		
0.0	PROBABLE CLAYEY SILT TRACE SAND STIFF TO VERY STIFF						246				
244.0							244				
4.1	PROBABLE SANDY SILT VERY LOOSE TO COMPACT						242				
							240				
							238				
							236				
							234				
							232	122			
230.7											
17.4	End of Cone Test										

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15}\diamond\frac{5}{10}$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 7 1 OF 2 METRIC

W.P. 211-90-01 LOCATION COORDS. N 5 104 304.5; E 314 913.3 ORIGINATED BY M.M.

DIST 13 HWY 11/534 BOREHOLE TYPE H.S. AUGER, WASH BORING, ROCK CORE COMPILED BY A.H.

DATUM GEODETIC DATE 91/08/26 CHECKED BY B.I.

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 (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.0	GROUND SURFACE										
0.0	SAND, TRACE GRAVEL										
	CLAYEY SILT TRACE SAND STIFF TO VERY STIFF		1	SS	30						
			2	SS	14		246			21.0	0 3 60 37
			3	SS	10						
244.3			4	SS	18						
3.7			5	SS	17		244				0 14 79 7
			6	SS	7	▼					
			7	SS	3		242				1 29 63 7
			8	SS	12		240				
	SANDY SILT VERY LOOSE TO COMPACT		9	SS	6						0 52 47 1
			10	SS	6		238				
			11	SS	3		236				
	SAND		12	SS	10		234				0 94 5 1
			13	SS	10		232				
			14	SS	12		230				
			15	SS	15						
227.3			16	SS	16		228				0 54 38 8
20.7	SAND AND GRAVEL TRACE SILT VERY DENSE		17	SS	120	/3cm	226				
	LOOSE		18	SS	5						
			19	SS	120	/3cm	224				
	OCCASIONAL COBBLES AND BOULDERS		20	SS	41		222				
220.1			21	SS	60	/8cm	220				100 0 0 0
27.9	BEDROCK GRANITE SLIGHTLY WEATHERED		22	RC	REC	92%					RQD 60%
			23	RC	REC	100%	218				RQD 83%

Continued

Continued

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7 2 OF 2 METRIC

W.P. 211-90-01 LOCATION COORDS. N 5 104 304.5; E 314 913.3 ORIGINATED BY M.M.

DIST 13 HWY 11/534 BOREHOLE TYPE H.S. AUGER, WASH BORING, ROCK CORE COMPILED BY A.H.

DATUM GEODETIC DATE 91/08/26 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o 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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
	Continued										
217.2			23	RC	REC	100%					RQD 83%
30.8	End of Borehole										

+³, ×⁵: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 8 1 OF 1 METRIC

W.P. 211-90-01 LOCATION COORDS. N 5 104 293.5; E 314 875.0 ORIGINATED BY M.M.

DIST 13 HWY 11/534 BOREHOLE TYPE H.S. AUGER, DYNAMIC CONE COMPILED BY A.H.

DATUM GEODETIC DATE 91/08/28 CHECKED BY B.I.

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
250.5	GROUND SURFACE						
0.0	CLAYEY SILT TRACE SAND STIFF TO VERY STIFF	1	SS	18			
		2	SS	13		18.8	0 1 56 43
		3	SS	10			
		4	SS	12			0 1 83 16
		5	SS	23			
		6	SS	23	▼		
244.2		7	SS	20			0 13 72 15
6.3	SANDY SILT VERY LOOSE TO COMPACT	8	SS	5			
		9	SS	17			
	SAND	10	SS	11			0 96 3 1
237.9		11	SS	13			
12.6	End of Borehole						
231.3							
19.2	End of Cone Test • PROBABLE BOULDERS						

ELEVATION SCALE: 250, 248, 246, 244, 242, 240, 238

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
o 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 (%) 10 20 30

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\diamond^5_{10}$ (%) STRAIN AT FAILURE

MINISTRY OF TRANSPORTATION, ONTARIO FH-0-307 88.10

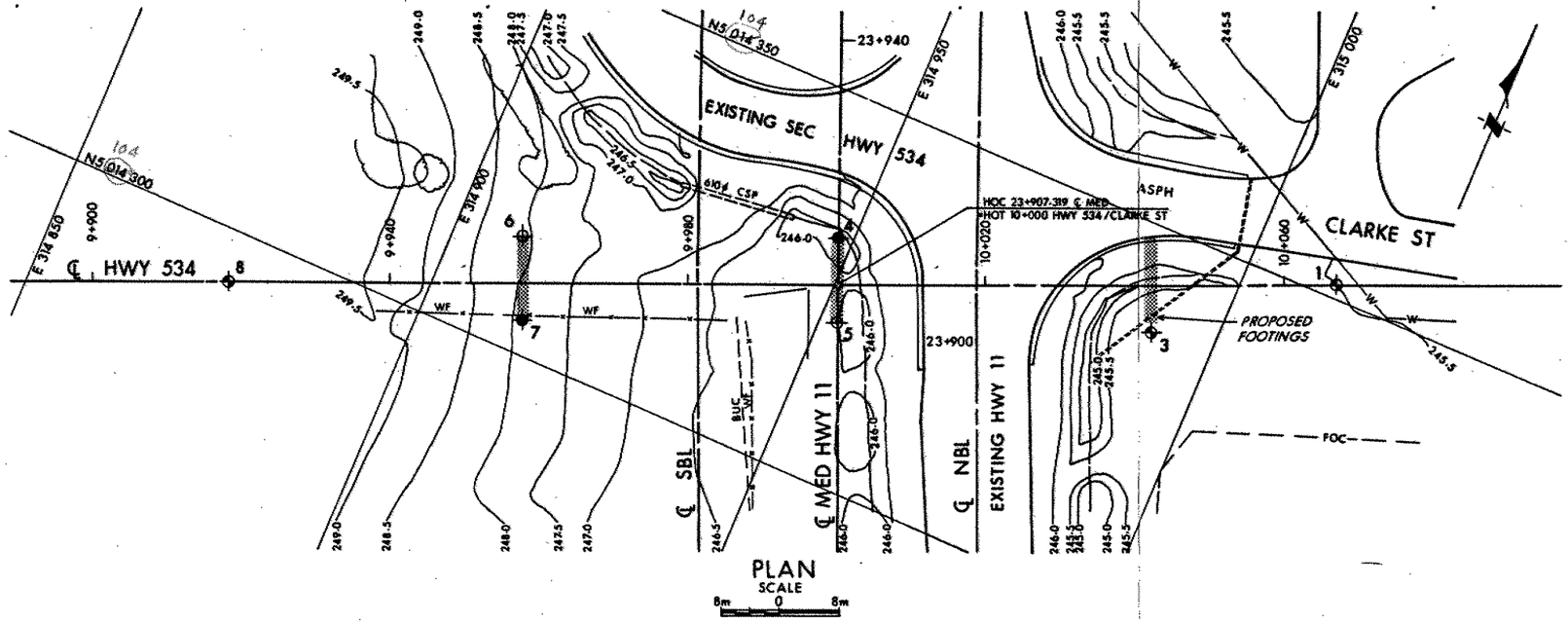
METRIC

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

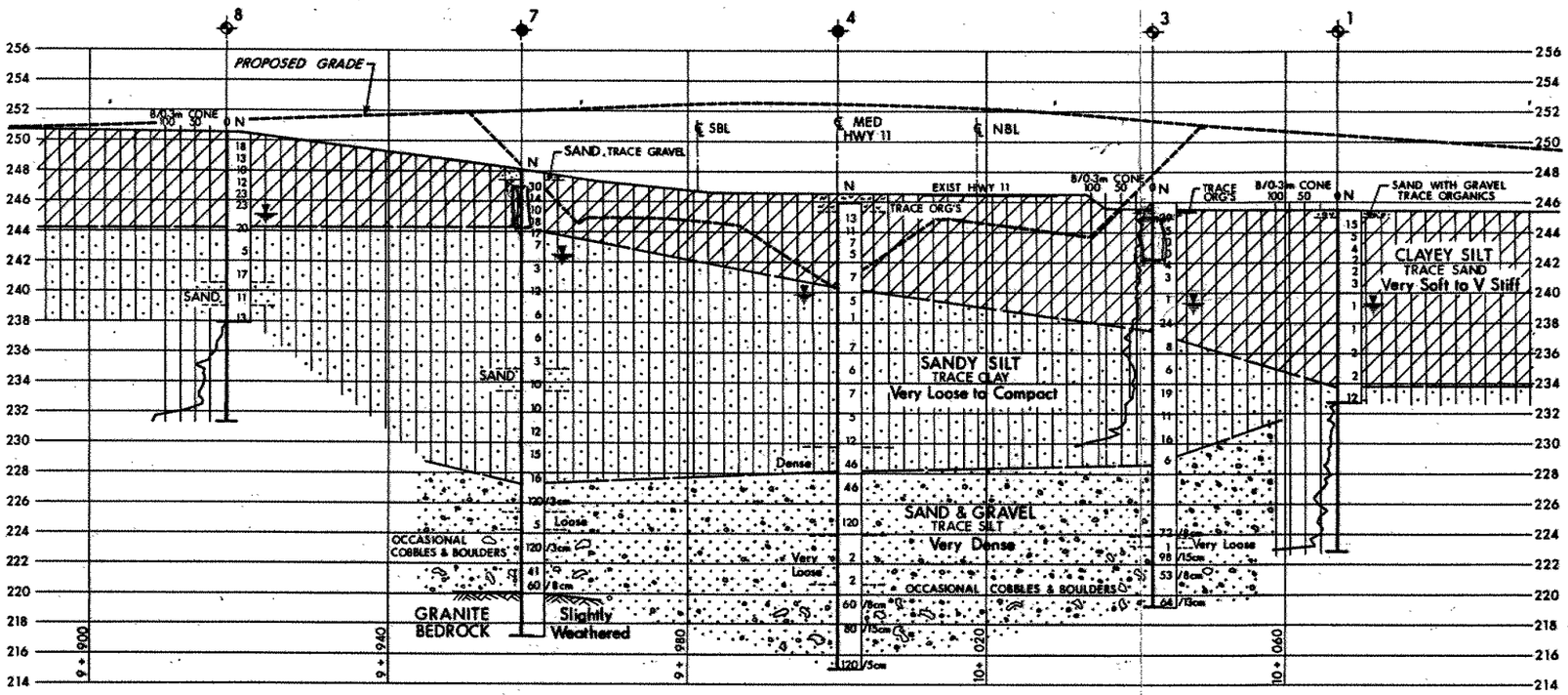
CONT No
WP No. 211-90-01

HWY 11/534 INTERCHANGE
(POWASSAN OVERPASS)
BORE HOLE LOCATIONS & SOIL STRATA

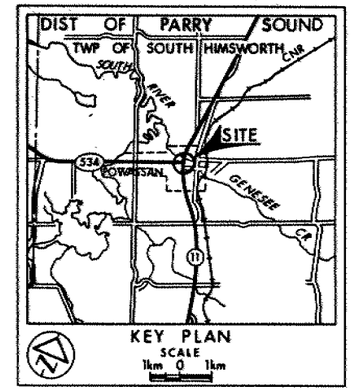
SHEET



PLAN
SCALE
8m 0 8m



℄ PROFILE HWY 534/CLARKE ST
SCALE
8m 0 8m Hor
4m 0 4m Vert



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 91 08

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	245.4	5 104 352.2	315 011.8
3	246.0	5 104 338.7	314 991.6
4	245.9	5 104 331.4	314 948.0
5	246.2	5 104 321.2	314 952.2
6	248.1	5 104 314.8	314 909.0
7	248.0	5 104 304.5	314 913.3
8	250.5	5 104 293.5	314 875.0

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV.	DATE	BY	DESCRIPTION

Geocres No. 31L-55

HWY No 11			DIST 13
SUBM'D MM	CHECKED	DATE 91 11 07	SITE 44-363
DRAWN DT	CHECKED	APPROVED	DWG 2119001-A

REF No E-509-11-2, 90 10