



Golder Associates

CONSULTING GEOTECHNICAL AND MINING ENGINEERS

GEOCRES No

30M15-91

PICKERING-OSHAWA SECTION

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WO EGG-000-25 DIST 6

HWY GO-ALRT STR SITE

ADDITIONAL FOUNDATION INVESTIGATION
GO-ALRT UNDERPASS AT CHAMPLAIN AVE.
WHITBY, ONTARIO

DISTRIBUTION

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1.0 INTRODUCTION

On behalf of GO-ALRT, the Ministry of Transportation and Communications has retained Golder Associates to carry out a foundation investigation for the proposed GO-ALRT rapid transit route at Champlain Avenue in Whitby, Ontario.

In September, 1983 a previous investigation was conducted by Golder Associates at a location immediately north of the present site. That investigation was for the previously proposed crossing of the GO-ALRT track over Champlain Avenue. The findings and results of the September, 1983 investigation are given in Golder Associates report 831-1206. The investigation reported herein was carried out in November, 1983 and concerns the proposed structure which will carry Champlain Avenue over the realigned GO-ALRT track (refer to Drawing EGG-000-25-A).

Authorization for the investigations was received in a letter dated August 4, 1983 from I. C. Campbell, Program Executive Director of GO-ALRT. The recent investigation was carried out in accordance with the terms of reference set out in Golder Associates' letter of November 4, 1983 to Mr. M. Devata, P. Eng., of the Pavement and Foundation Design Section of the Ministry of Transportation and Communications.

The purpose of the investigation was to determine the subsurface conditions at the site and, based on these, to provide recommendations pertinent to the geotechnical design of the proposed works.

2.0 SITE DESCRIPTION

The site is located on Champlain Avenue, about 200 m east of Thickson Road in Whitby, Ontario. At this location, Champlain Avenue runs in a north-south direction just north of Highway 401. The ground surface in the area slopes to the south-west toward Corbett Creek which is located about 1 kilometre to the west.

At the present time, two existing watermains are located along the east side of Champlain Avenue at about elevation 90 m. A 250 mm diameter storm sewer with an invert elevation of about 89.9 m is located along the west side of Champlain Avenue.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

The site is located in the physiographic region known as the Iroquois Plain. The overburden soils in the area consist of glacial till with discontinuous deposits of glacio-lacustrine clays and silts. These latter soils were deposited in glacial Lake Iroquois which occupied the Lake Ontario basin at the end of the last ice age. The shoreline of this glacial lake is located about four kilometres north of the site. Water well records indicate that shale bedrock of the Whitby Formation is to be found at depths of 30 to 50 m in the area.

3.2 Soil Stratigraphy

3.2.1 General

Details of the subsurface conditions encountered in the boreholes are given on the Record of Borehole sheets and figures following the text of this report. In general, the subsurface conditions consist of surficial deposits of topsoil and fill underlain by a discontinuous clay deposit. These soils are underlain at all boreholes by silty sand till to depths of 5.5 to 8.5 m. Below the till, silty clay was found at some borehole locations and this in turn is underlain by highly dilatant silt. At a depth of 14.6 m, silty clay till was found in Borehole 11.

3.2.2 Topsoil and Fill

At most boreholes, up to 0.1 m of topsoil was encountered at the ground surface. This is underlain at Borehole 11 by fill consisting of silty sand with a trace of sand and gravel and organic material. Given the close proximity of this borehole to the storm sewer, it is considered likely that this fill is part of the sewer trench backfill.

The fill is in a loose condition as N^* values of 4 to 8 were measured in the deposit. The water content of three samples of the fill was measured to be 12 and 19 per cent.

3.2.3. Upper Clay

Between 0.9 and 2.8 m of brown silty clay was encountered in Boreholes 13, 14 and 16, i.e. on the east side of Champlain Avenue. The clay has a stiff to very stiff consistency based on 'N' values which range from 9 to 29. Traces of sand and gravel were found in the clay from Borehole 14 and the clay from Borehole 16 is fissured. A grain size distribution curve of the clay is given in Figure 1. The water content of this soil was found to vary from 17 to 36 per cent.

3.2.4 Silty Sand Till

At all borehole locations, silty sand till was encountered below the topsoil, fill or upper clay. The till which was found to depths of 5.5 to 8.5 m is a well-graded mixture of sand and silt containing 10 to 20 per cent gravel and clay sized particles. The presence of occasional cobbles within the till was inferred from grinding of the augers during drilling. Typical grain size distributions of the till are shown on Figure 2.

The till is weathered brown to about elevation 90 m below which it is grey. 'N' values in the till are variable and range from 21 to more than 100. While the till generally has a very dense relative density, in places its relative density is "compact". The fines content of the till has a very low plasticity (plasticity index of 3 per cent or less) and the water content of samples of the till varied from 5 to 13 per cent.

*'N' Values - Refer to Explanation of Terms.

3.2.5 Silty Clay

In Boreholes 12, 13 and 17 up to 1.2 m of silty clay was encountered at the base of the silty sand till. Grain size distribution curves of this material are shown on Figure 3. The silty clay has a very hard consistency (N values generally in excess of 100) and correspondingly low water contents of 12 per cent. The plasticity index of one sample of the material from Borehole 12 was measured to be 5 per cent. In the previous investigation, Golder Associates Report 831-1206, plasticity indices and liquid limits of as much as 14 and 28 per cent, respectively, were measured in this stratum, indicative of a clay of low plasticity.

3.2.6 Silt

Below the silty sand till and the silty clay, uniformly graded silt containing traces of fine sand and clay was found to the end of all boreholes except Borehole 11. The silt is highly dilatant and non-plastic. Typical grain size distribution curves of the material are shown on Figure 4. In some of the samples, the silt was found to be layered and occasional lenses or seams of sand were also noted.

The silt is generally in a very dense state as the N values measured within the material were mainly in excess of 100. Between elevations 83 and 84 m, pockets of less dense material were found having N values as low as 29. The water content of the silt was measured to be between 13 and 25 per cent.

3.2.7 Silty Clay Till

At a depth of 14.6 m in Borehole 11, hard silty clay with some sand and trace gravel (till) was encountered. The till has a low plasticity (plasticity index of 5 per cent)

and the water content was measured to be 14 per cent or just below the plastic limit. A grain size distribution of this material is shown on Figure 5.

3.3 Groundwater Conditions

Standpipes were sealed into different strata at various depths across the site to permit monitoring of groundwater pressures. During drilling operations, free groundwater was generally not encountered until the borehole was advanced below depths of about 6 to 7 m, corresponding to the top of the silt. While augering through the silt, considerable groundwater entered the boreholes, causing the sides of the holes to cave in.

Groundwater levels in the standpipes have continued to rise in the period since the investigation. The groundwater levels in the silty sand till were between elevation 91 and 92.6 m. The water level in the underlying silt stratum in Borehole 11 was about 1 m higher than that in the overlying silty sand till. This implies slight upward seepage at the site. It is probable that the water levels will vary seasonally.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 Project Description

The proposed GO-ALRT rapid transit track will approach Champlain Avenue in a cut about 5 m deep. Champlain Avenue will be raised to about 2.5 m above its present grade. The elevation of the top of rail at Champlain Avenue will be 88.70 m. Preliminary plans of the proposed structure were provided on a topographic plan of the site and a profile along the GO-ALRT track. These drawings indicate that a single 10 m span structure is planned to carry Champlain Avenue over the GO-ALRT track. Retaining walls will be constructed parallel to the track for a distance of 10 m beyond the edge of the abutments. Wing walls will extend back from the abutments for a distance of about 8 m. The preliminary footing elevation for the abutment as indicated on the drawings is approximately elevation 87.2 m.

4.2 Foundations

The silty sand till and underlying clay and silt are suitable for the support of spread footings provided steps are taken to ensure that excess water pressure does not build up in the silt. The silty sand till is variable in consistency above elevation 88 m. Wing wall footings may be founded on the silty sand till above this elevation. Assuming they are at 1.2 m depth and at least 2 m wide, they can be designed for factored bearing capacities of 400 kPa and 200 kPa at ultimate and serviceability limit states, respectively. For footings on the very dense sandy silt till or underlying soils at or below elevation 88 m, having a width of at least 4 m and having a minimum depth of soil cover of 1.2 m, the bearing capacity at ultimate limit state can be taken as 600 kPa. A bearing capacity at serviceability limit state of 300 kPa will result in settlements of less

than 25 mm. It should be noted that the bearing capacities should be checked once the foundation geometry is finalized.

For all footings supporting an inclined load as in the case of retaining walls, the factored bearing capacity at ultimate limit state should be reduced in accordance with Section 6.7.3.3.5 of the Ontario Highway Bridge Code. The reduction factors for granular soil should be used.

The silty sand till is very well graded and consequently it is less permeable than the underlying silt. Where the silt is capped by the till or silty clay, there is a potential for loss of bearing capacity in the silt due to water pressure build up. This water pressure must be bled off by a line of permanent relief wells extending along the back of the bridge abutment and retaining wall footings to 5 m beyond either end. The wells should be 300 mm in diameter, spaced at 4 m centres and extend 2 m into the silt. They must be backfilled with a filter sand of gradation within the limits shown in Figure 8. The top of the wells can be hydraulically connected to the free draining fill to be placed behind the abutment and retaining wall (refer to Section 4.3).

The location of the existing storm sewer and any associated structure should be taken into account in the design of footings. All footings must be placed outside a line extending up to 45° from any excavation for this installation.

Footings should be placed a minimum of 1.2 m below finished grade for frost protection.

Footing excavations should be inspected by a qualified geotechnical engineer prior to placement of concrete.

4.3 Earth Pressures

For the retaining walls and bridge abutments, the lateral earth loads will depend on the type and method of placement of the backfill materials and on the subsequent lateral movement of the structure. The following recommendations are made concerning the design of the abutment and retaining walls.

- o Selected "free draining" granular fill, in accordance with MTC specifications should be used as backfill immediately behind the structures. The granular fill should be placed in the wedge-shaped zone defined by a 60 degree line extending up and back from the bottom of the rear face of the structures' footings.
- o All granular fill should be compacted in 200 mm thick lifts to 95 per cent of the Standard Proctor density of the material. However, heavy compaction equipment should not be used behind any structure within a lateral distance equal to the current height of the fill above the base of the structure.
- o Longitudinal drains located immediately below the base of the walls should be installed to provide positive drainage of the granular backfill.
- o If the abutment support and retaining walls will permit lateral yielding at the top of the walls equal to not less than 1/2 per cent of the retained height then 'active' earth pressure conditions should be used in the design. If, however, the structures are not permitted to yield by 1/2 per cent of their height then 'at rest' pressure conditions should be used. It is anticipated that retained heights of soil behind retaining walls and/or abutments will not exceed 10 m. Accordingly, the following equivalent fluid pressure may be used in the design:

At ultimate limit states:

'active' condition	8.0 kPa/m
'at rest' condition	10.0 kPa/m

At serviceability limit states:

'active' condition	6.5 kPa/m
'at rest' condition	8.5 kPa/m

These pressures assume level backfill and vertical walls. Retaining walls may be required to support sloping backfill and the design earth pressure for these should be determined once the geometry has been decided.

It is recommended that, if the retaining walls are designed for active conditions, they should be kept structurally separate from the abutments to allow differential movement to take place.

4.4 Excavations

The silty sand till, the silty clay and the silt which will be exposed in the permanent cut slopes and will provide support for the bridge, are below the water table. It is therefore essential that groundwater levels at the site be controlled during excavation and in the long term. Permanent drainage works will be required to relieve the pressure in the silt deposit.


The silt deposit at or along the base of proposed footing excavations is highly susceptible to disturbance and upward seepage of groundwater must not take place during construction. Prior to excavation, the piezometric head in the soil must be lowered to 1 m below any excavation by means of a vacuum well point system. This temporary dewatering system must be kept in operation until a system of permanent pressure relief wells is installed (refer to Section 4.2 of this report). The consequences of not

providing proper groundwater control measures include possible instability of cut slopes, uplift or heave of the excavation base causing a loosening of the foundation subsoils and subsequent settlement when footing loads are applied.

Temporary excavations will remain stable at slopes of 1.5 horizontal to 1 vertical provided that an adequate system of groundwater control is employed.

4.5 Permanent Cut Slopes

The permanent cut slopes will extend through the surficial clay, the silty sand till and may expose the underlying silty clay and silt. Permanent cut slopes within the existing fill and silty sand till can be designed at 2 to 1 if adequate drainage is provided to lower the piezometric pressure to below the face of the slope. Such a drainage system could consist of a longitudinal drain installed at a depth of 1.5 m below slope surface at a maximum distance of 3 m below the top of the slope. An additional 1.5 m deep longitudinal drain should be provided within the fill at the top of the cut to intercept the groundwater flow. In addition, collector drains should be installed along the toe of the slope at a depth of 1.5 m. Where cut slopes are less than 3 m, the longitudinal drain should be incorporated into the toe drain.



The high water pressures within the clay deposit encountered east of Champlain Avenue are unlikely to be reduced by the drains although the clay will be subject to some degree of underdrainage. The clay is fissured and the effective cohesion value (c') will be low in the long term due to softening. Stability analyses, carried out using Hoek and Bray (1977) stability charts, indicate that, for an angle of friction of 27° which is considered to be a reasonable

value for a clay of low plasticity, the slope is stable at an angle of 2 horizontal to 1 vertical if an effective cohesion (c') of 3 kPa can be relied upon in the long term. If c' reduces to 1 kPa, a 3:1 slope is required for stability. It is considered that a 3:1 slope in the clay will be stable in the long term and this should only be steepened if observations on slopes in the area in a similar material under the same groundwater conditions have proved their stability.

The drain trenches should be backfilled with free-draining granular 'B' having not less than 50 per cent passing the #20 sieve and the perforated drains should be wrapped in a geotextile such as Terrafix 270R to prevent migration of fines into the pipe.

The pressure relief wells recommended for behind the abutments and retaining walls (Section 4.2) will ensure that there is no uplift of the tracks in the area of the structure. The approach cut is being investigated by others and the possibility of uplift in relation to proposed grade and groundwater pressures must be taken into account in the design.

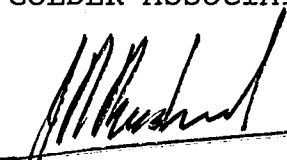
A 0.3 m thick granular drainage blanket should be placed in the base of the excavation and incorporated into the track base design. MTC Granular 'B' having not less than 50 per cent passing the #20 sieve should be used for the drainage blanket. The subgrade below the drainage blanket should be sloped at 2 per cent to promote drainage to the perforated collector drains at the toe of the cut slopes. P

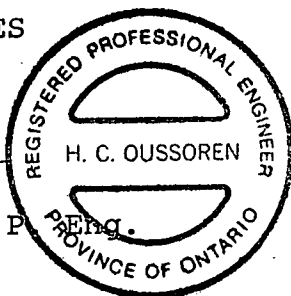
The slopes should be hydro-seeded to minimize surficial erosion. Pervious zones within the till may cause localized concentration of seepage out of the slope and these areas may require dressing with a granular filter blanket.

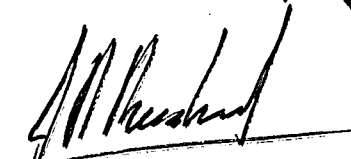
4.6 Approach Embankments

The topsoil and any loose surficial soil should be removed from the area of the approach embankments. The embankment fill should consist of clean, non-organic earth fill and should be compacted at or near the optimum moisture content to at least 95 per cent of Standard Proctor density in lifts not thicker than 200 mm. Provided the foregoing is carried out, no slope instability or settlement problems are anticipated. The embankment slopes should be seeded as a protection against erosion caused by run-off.

GOLDER ASSOCIATES


For H. C. Oussoren, P. Eng.




J. R. Busbridge, P. Eng.

HCO/JRB/cg

REFERENCES

HOOK, E., BRAY, J.W. (1977). "Rock Slope Engineering",
Institute of Mining and Metallurgy, London.

APPENDIX A
INVESTIGATION PROCEDURE

March, 1984

831-1206-1

INVESTIGATION PROCEDURE

The field work for this investigation was carried out between November 14 and 18, 1983. At that time a series of seven boreholes (Boreholes 11 to 17) were put down at the locations shown on Figure EGG-000-25-A using a Bombardier-mounted CME 55 power auger supplied and operated by Master Soil Investigations Ltd. The field work was supervised throughout by a member of Golder Associates' staff who located the boreholes, cleared the locations for buried services, directed the drilling and logged the borings.

The boreholes were advanced using solid stem augers. Some caving of the borehole walls was experienced within the lower silt stratum. At regular intervals of depth, samples of the soil were obtained with a split-barrel sampler as part of the Standard Penetration Test. Following completion, standpipes were installed in selected boreholes in different strata to permit monitoring of groundwater levels.

The borehole elevations were surveyed by Golder Associates and are referenced to the benchmark on the concrete monument located south of Highway 401 and about 200 m east of Thickson Road. The geodetic elevation of this point is 98.029 m and was provided by MTC staff.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

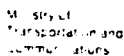
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	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^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						



METRIC

W P EGG-000-25 LOCATION N4,859,116 E352,670 ORIGINATED BY KES
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFV
DATUM Geodetic DATE November 14, 1983 CHECKED BY HCO

[illegible]

* 3, x 5 Numbers refer to 20
15 \pm 5 10% STRENGTH AT FAILURE

METRIC

W P EGG-000-25 LOCATION N4,859,123 E352,662 ORIGINATED BY KES
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE November 14, 1983 CHECKED BY HCO

[illegible]

RECORD OF BOREHOLE No 13

METRIC

W P EGG-000-25 LOCATION N4,859,134 E352,682 ORIGINATED BY KES
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
 DATUM Geodetic DATE November 17, 1983 CHECKED BY HCO

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			20	40	60	80	100					
93.2	GROUND SURFACE																
0.1	Topsoil																
92.2	Silty clay Very stiff Brown		1	SS	25												
1.0	Silty sand trace to some gravel trace clay (TILL)		2	SS	21												
			3	SS	50												
			4	SS	55												
	Compact to Very Dense Brown becoming grey below elev. 91.2		5	SS	42												
87.4			6	SS	110/150mm												
5.8	Silty clay some sand		7	SS	100/150mm												1 26 45 28
86.5	Hard Grey		8	SS	138/150mm												0 13 73 14
6.7	Silt some clay trace fine sand, occasional sand seams.		9	SS	173												
	Very Dense Grey		10	SS	87												
			11	SS	120/150mm												
			12	SS	158/250mm												
77.8			13	SS	140/150mm												
15.4	END OF BOREHOLE																

RECORD OF BOREHOLE No 14

METRIC

W P EGG-000-25 LOCATION N4, 859,143 E352,675 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE November 18, 1983 CHECKED BY HCO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
93.0	GROUND SURFACE													
0.0	Silty clay trace sand and gravel		1	SS	9		92							
91.3	Stiff to Very stiff Brown		2	SS	14									
1.7	Silty sand trace to some gravel, trace clay (TILL)		3	SS	37									
			4	SS	21									
			5	SS	29									
	Compact to Very Dense Brown becoming Grey be- low elev. 89.7		6	SS	707/ 150mm									
86.7			7	SS	1007/ 125mm									
6.3	Silt trace fine sand and clay		8	SS	130/ 225mm									
	Dense to Very Dense Grey		9	SS	42									
			10	SS	128									
			11	SS	118/ 225mm									
			12	SS	110/ 225mm									
77.7			13	SS	150/ 100mm									
15.3	END OF BOREHOLE													

RECORD OF BOREHOLE No 15

METRIC

W P EGG-000-25 LOCATION N4,859,107 E352,675 ORIGINATED BY KES
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
 DATUM Geodetic DATE November 15, 1983 CHECKED BY HCO

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
92.8	GROUND SURFACE																
0.1	Topsoil																
	Silty sand trace to some gravel trace clay (TILL)		1	SS	27		92										
			2	SS	33												
			3	SS	125												
	Compact to Very Dense		4	SS	1047 150mm		90										
	Brown becoming grey below elev. 89.8		5	SS	122												
			6	SS	1077 150mm		88										
87.3																	
5.5	Silt trace sand																
86.7	Very Dense Grey		7	SS	1007 50mm												
6.1	END OF BOREHOLE																
							86										
							Borehole dry during drilling										

RECORD OF BOREHOLE No 16

METRIC

W P EGG-000-25 LOCATION N4,859,154 E352,686 ORIGINATED BY KES
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE November 17, 1983 CHECKED BY HCO

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			20	40	60	80	100					
93.5	GROUND SURFACE															GR SA SI CL
0.1	Topsoil															
	Silty clay, fissured		1	SS	21											2 12 46 40
	Very stiff Brown		2	SS	29											
			3	SS	29											
90.6			4	SS	26											
2.9	Silty sand trace to some gravel trace clay (TILL)		5	SS	22											
	Compact to Brown Very Dense becoming grey below elev. 90.4		6	SS	30											
			7	SS	107/100mm											
85.6			8	SS	100/150mm											
7.9	Silt trace fine sand and clay occasional sand seams															
84.2	Very Dense Grey		9	SS	103/150mm											
9.3	END OF BOREHOLE															



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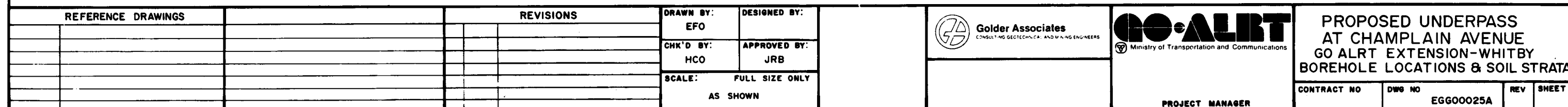
RECORD OF BOREHOLE No 17

METRIC

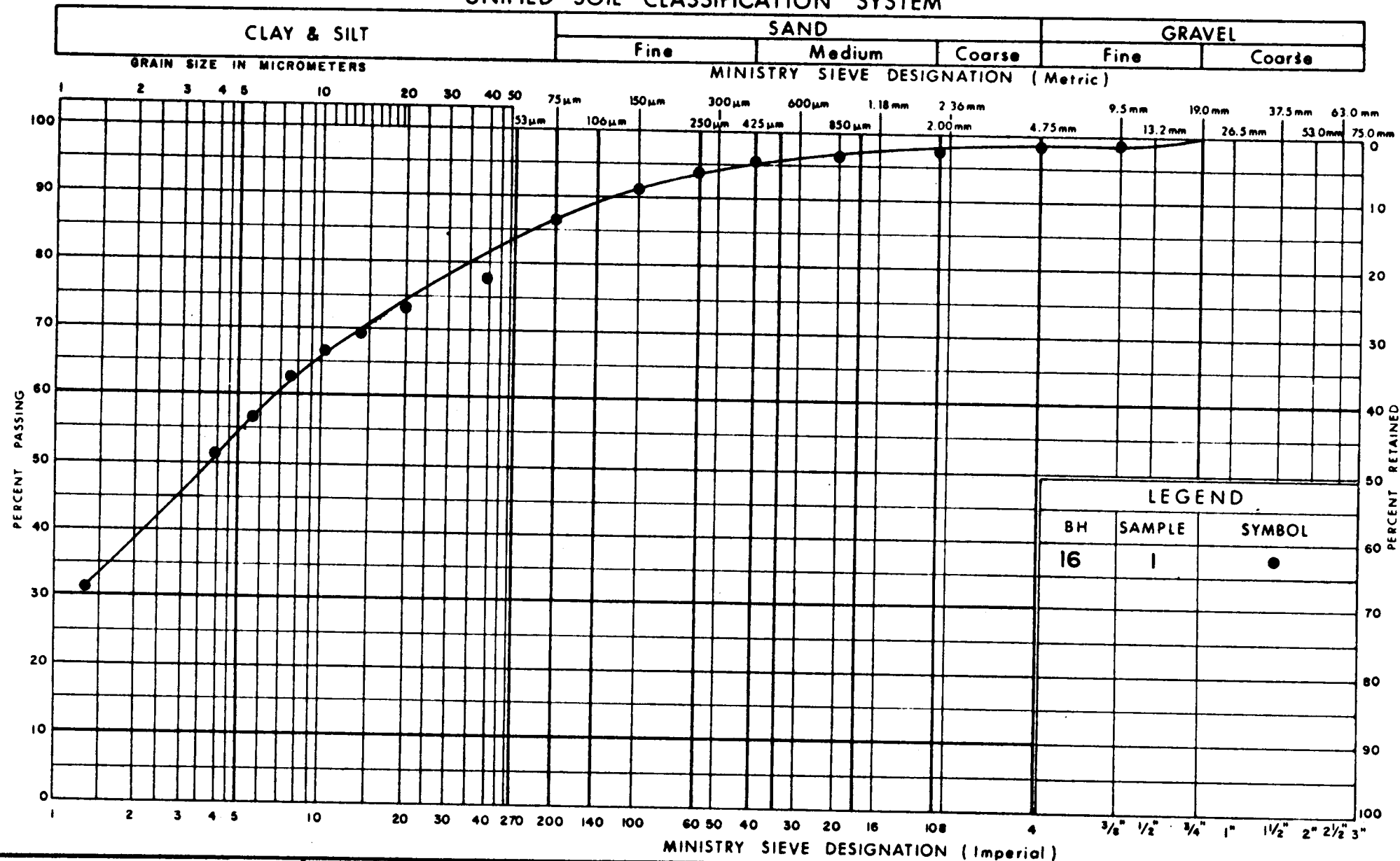
W P EGG-000-25 LOCATION N4.859.103 E352.653 ORIGINATED BY KES
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE November 15, 1983 CHECKED BY HCO

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			20	40	60	80	100					
92.4	GROUND SURFACE																
0.1	Topsoil						92										
	Silty sand trace to some gravel trace clay (TILL)		1	SS	23												
			2	SS	39												
			3	SS	151		90										
			4	SS	137												
	Compact to Very Dense Brown becoming grey below elev. 88.6		5	SS	105/150mm												
			6	SS	112/150mm		88										
			7	SS	110/150mm												
85.1							86										
7.3	Silty Clay trace to some sand		8	SS	34												
84.0	Hard Grey																
8.4	Silt trace fine sand and clay						84										
82.8	Dense Grey		9	SS	55												
9.6	END OF BOREHOLE						82										

ALL DIMENSIONS SHOWN ARE
IN METRES AND/OR MILLI-
METRES UNLESS OTHERWISE
NOTED.



UNIFIED SOIL CLASSIFICATION SYSTEM



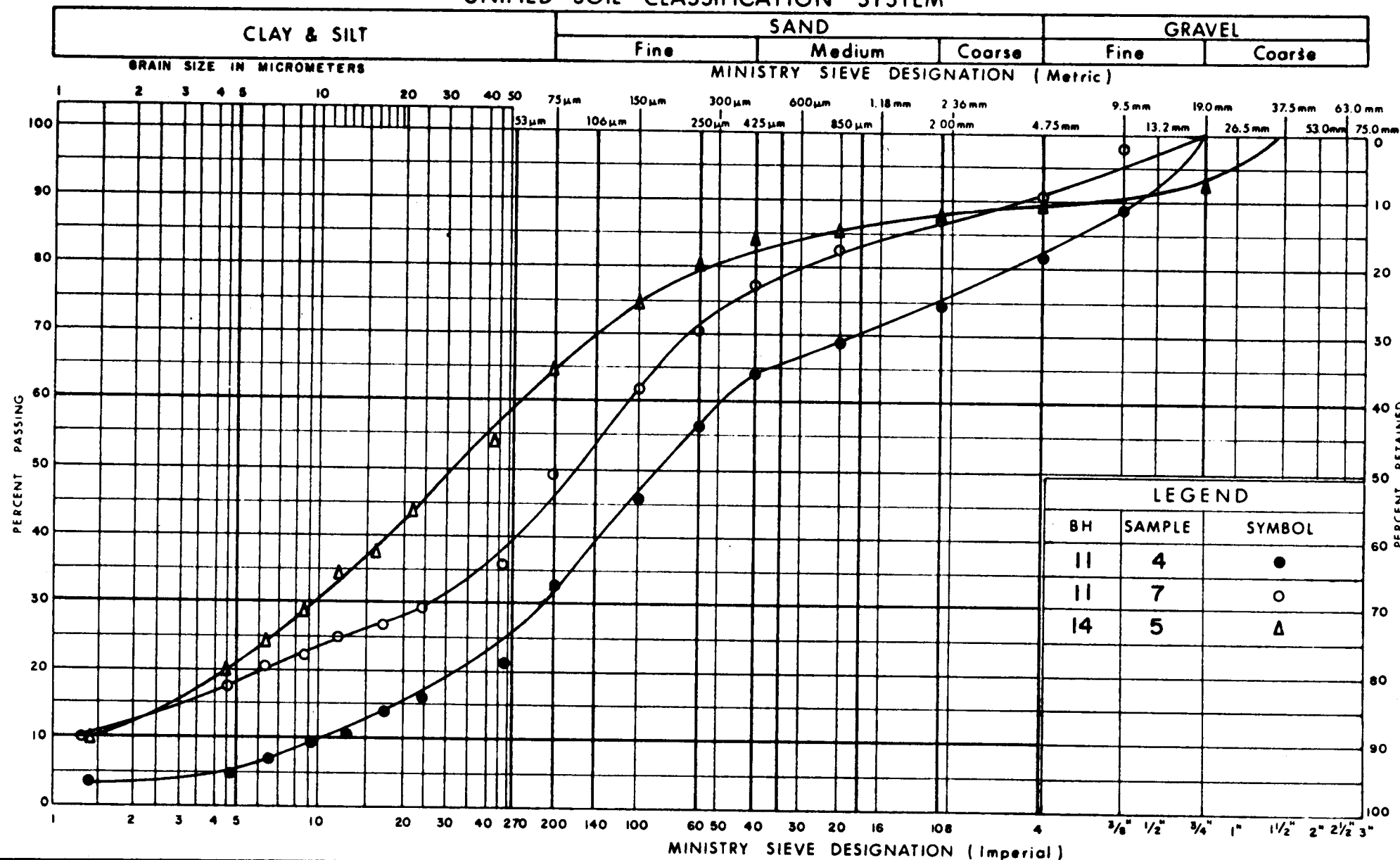
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GRAIN SIZE DISTRIBUTION
UPPER SILTY CLAY

FIG No I

W P EGG-000-25

UNIFIED SOIL CLASSIFICATION SYSTEM



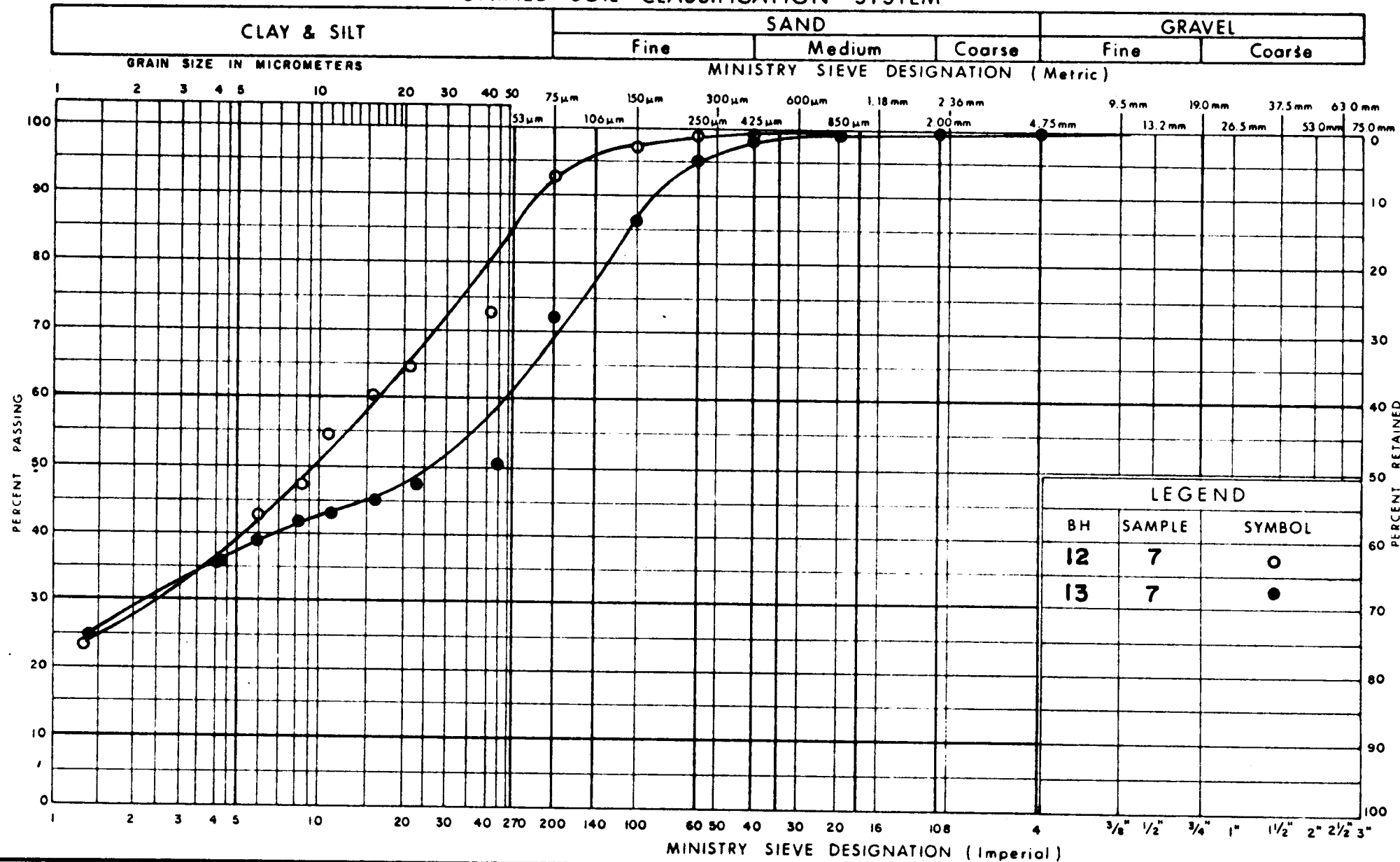
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND TILL

FIG No 2

W P EGG-000-25

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

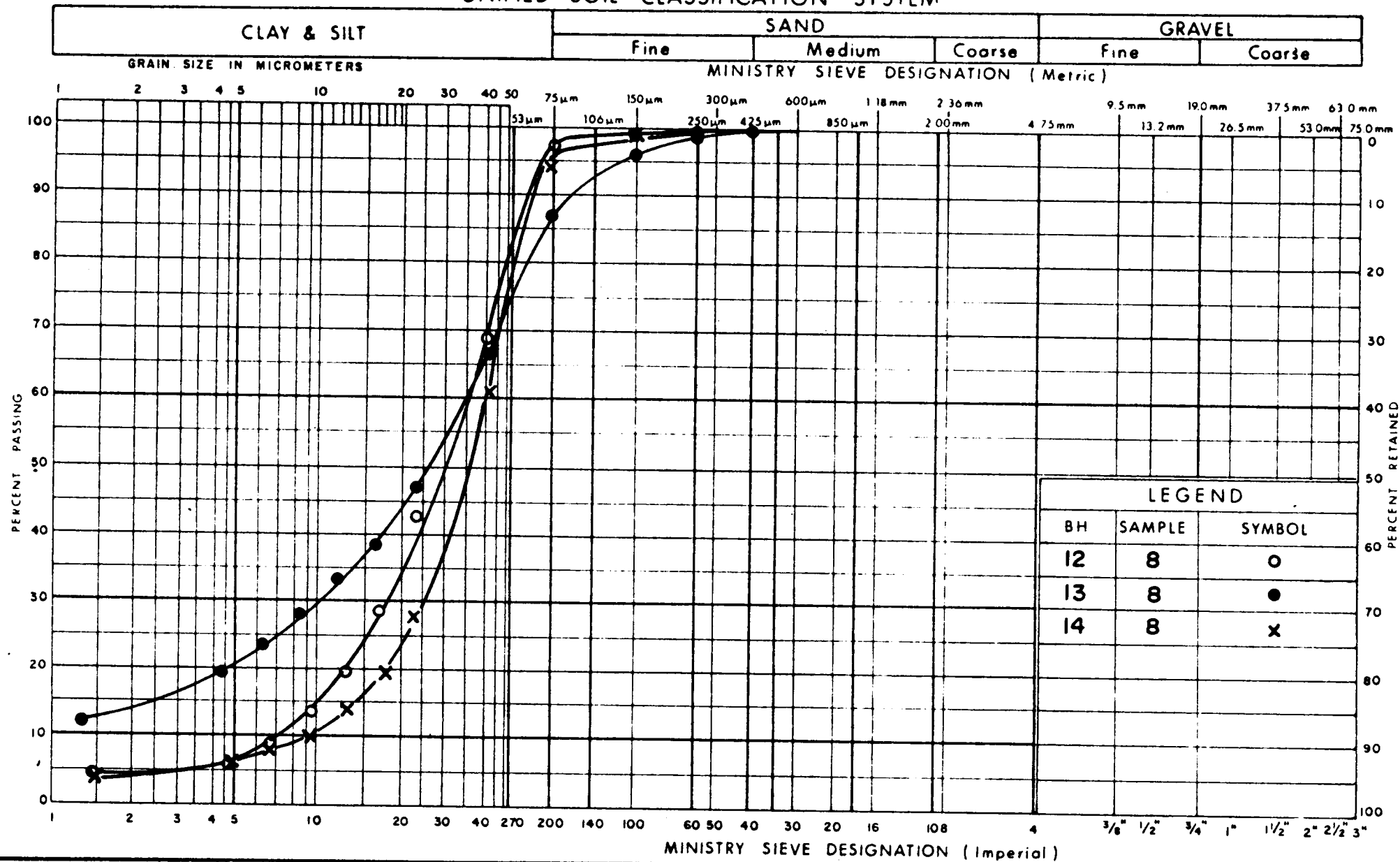
 Ministry of
Transportation and
Communications

 GRAIN SIZE DISTRIBUTION
SILTY CLAY

FIG No 3

W P EGG - 000 - 25

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

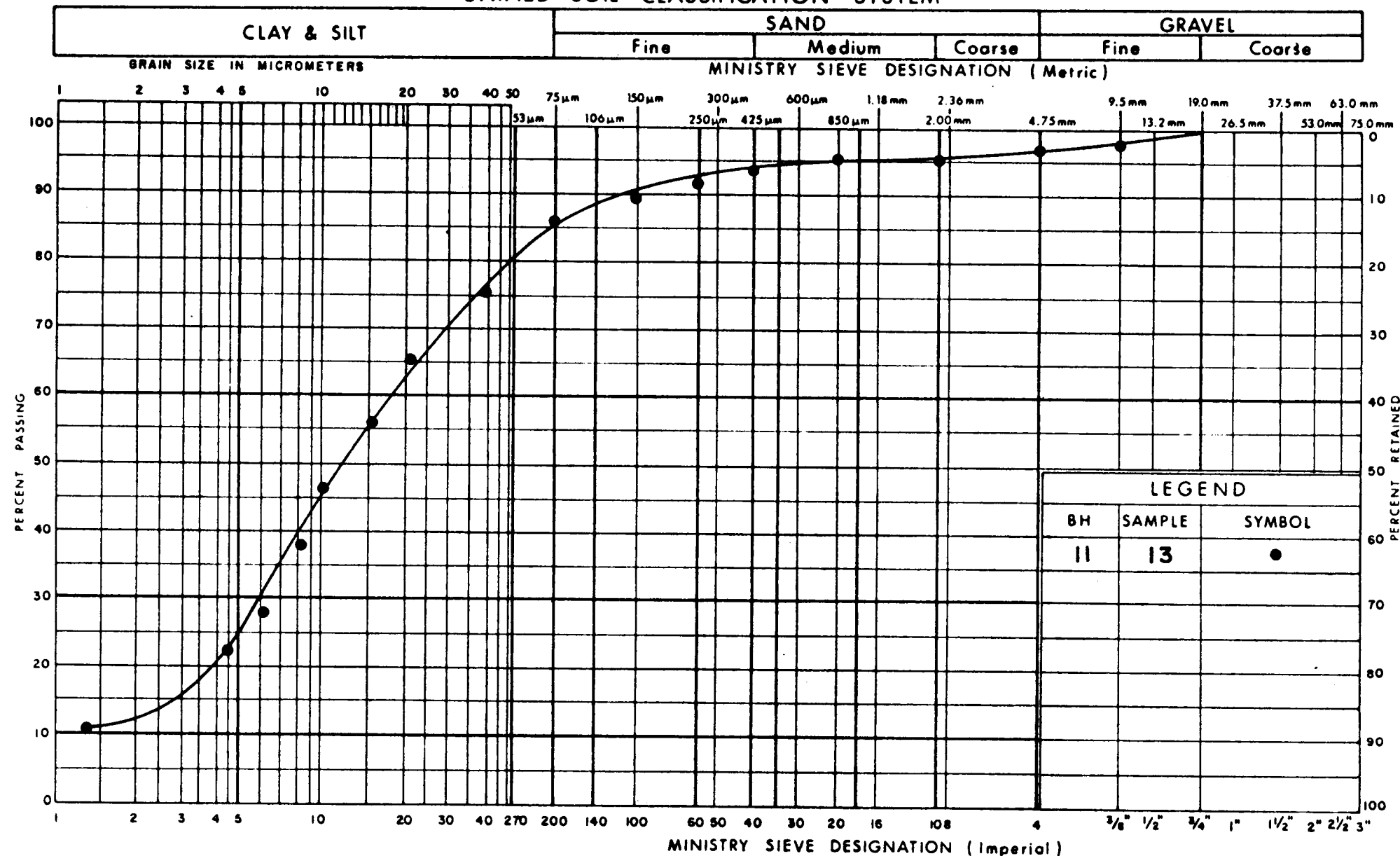
 Ministry of
Transportation and
Communications

 GRAIN SIZE DISTRIBUTION
SILT

FIG No 4

W P EGG - 000 - 25

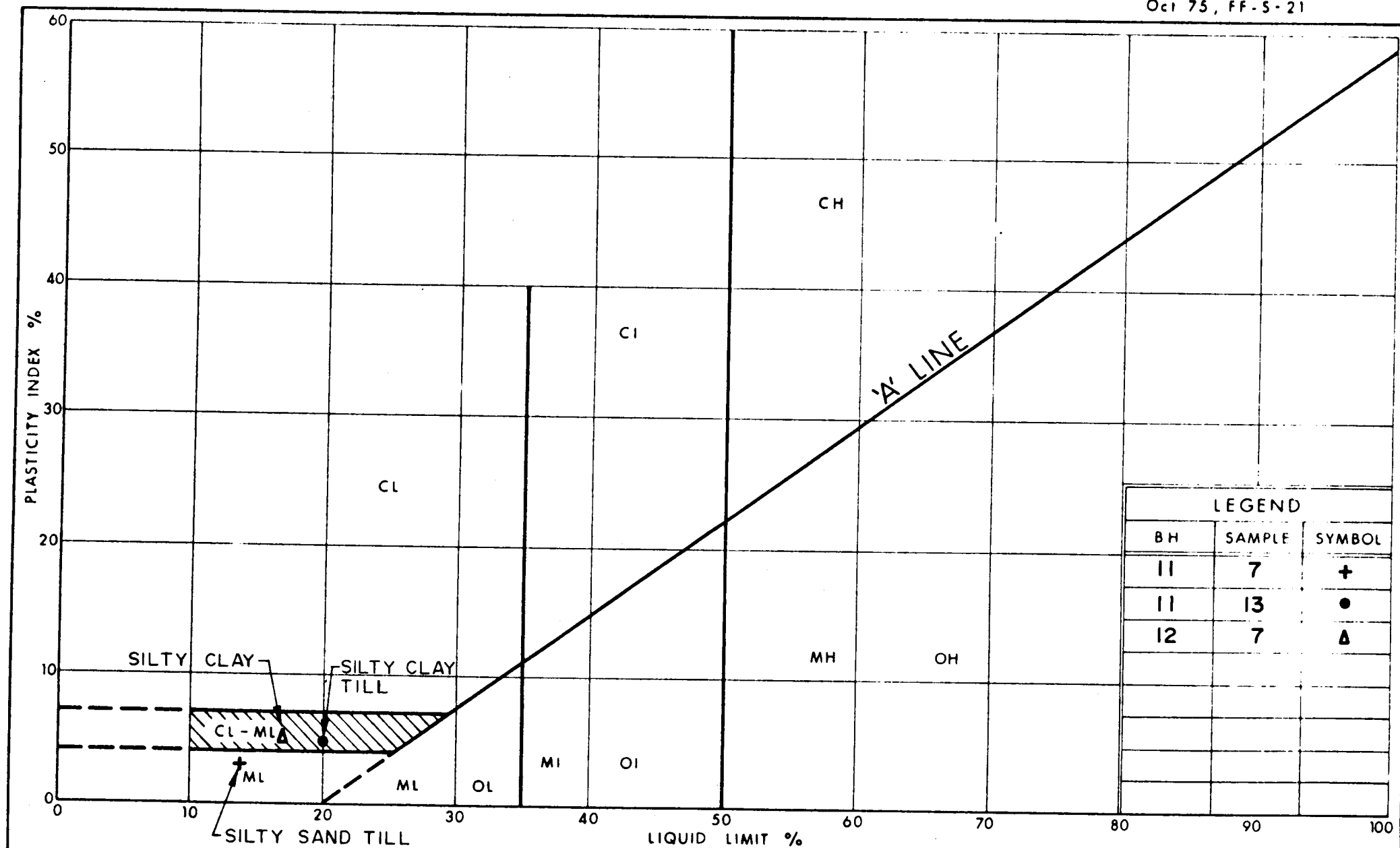
UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SILTY CLAY TILL

FIG No 5
W P EGG-000-25

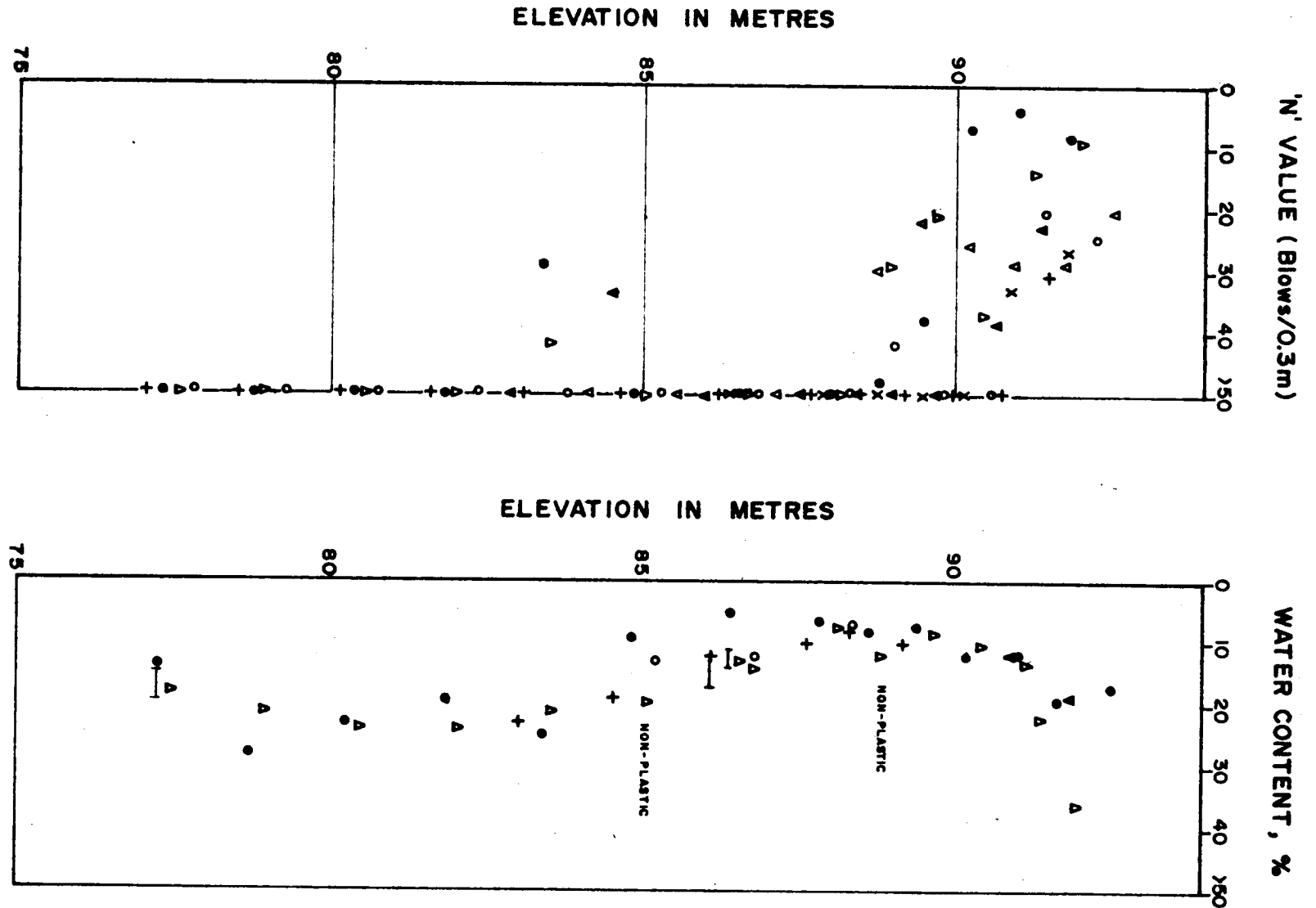


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Ontario

PLASTICITY CHART

FIG No 6

W P EGG - 000 - 25



LEGEND

- BH.11
- + BH.12
- o BH.13
- Δ BH.14
- x BH.15
- ▽ BH.16
- ▽ BH.17

PROFILES OF PENETRATION RESISTANCE AND WATER CONTENT

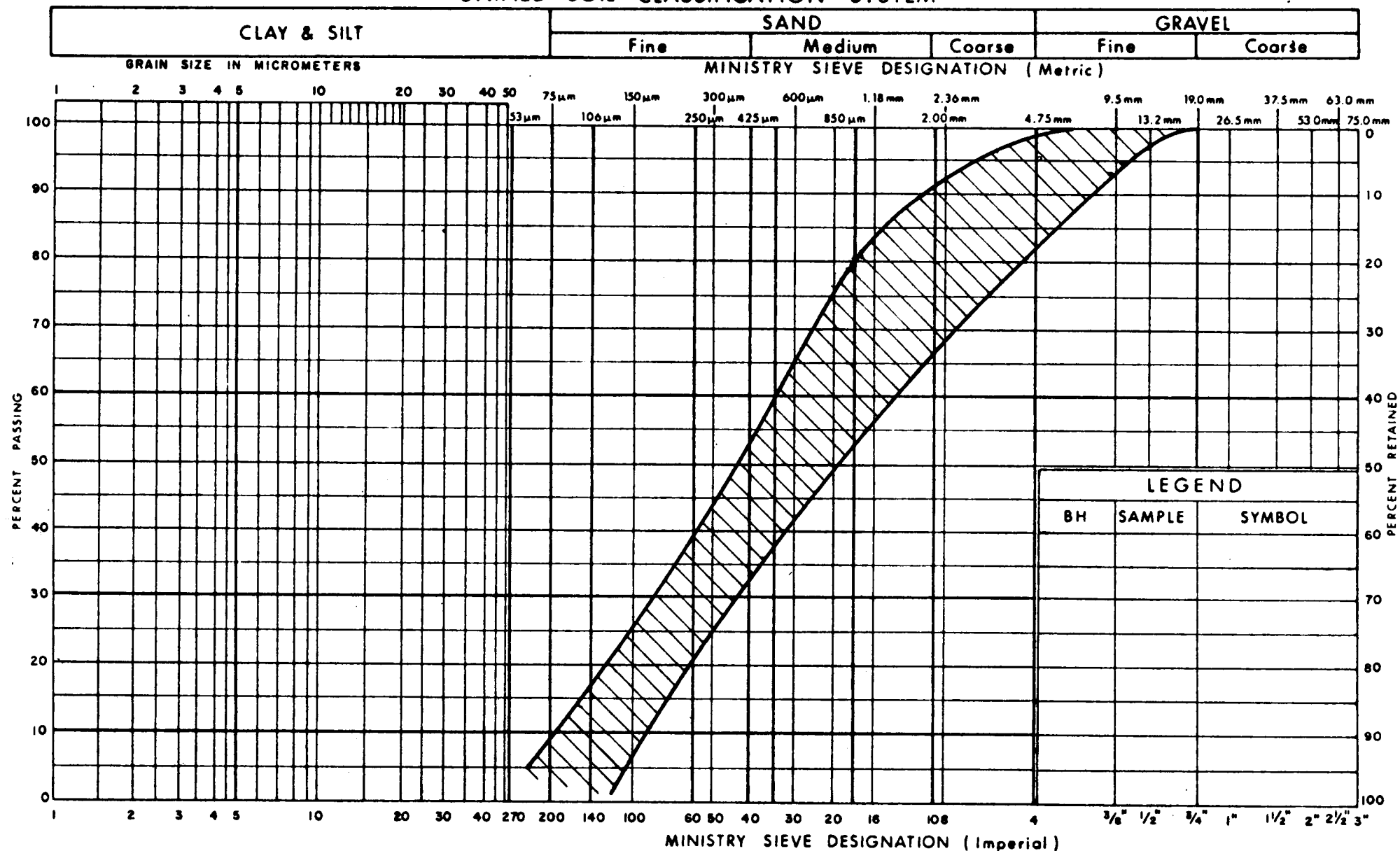
FIG No 7

W P EGG-000-25



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UNIFIED SOIL CLASSIFICATION SYSTEM

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Communications

GRAIN SIZE DISTRIBUTION FILTER MATERIAL FOR RELIEF WELLS

FIG No 8

W P EGG-000-25