GEOCRES No:
30M15-73

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GEOTECHNICAL INVESTIGATION

GO-ALRT, THICKSON ROAD CROSSING

WHITBY, ONTARIO

PROJECT NO: EGG OOO-24A (REVISED)

INTERIM REPORT

Town of Whitby
Regional Municipality of Durham
District No. 6, Central Region

Ref. No. 83-8-9A
November 1983

Prepared For:
GO-ALRT

Distribution:

10 copies - Ministry of Transportation & Communications
1 copy - Dominion Soil Investigtion Inc.

Ref. No. 83-8-9A

C O N T E N T S

A P P E N D I C E S

E N C L O S U R E S

1. INTRODUCTION

Dominion Soil Investigation Inc., Consulting Geotechnical Engineers, have been authorized by GO-ALRT to conduct a soil investigation at the site where the proposed GO-ALRT line will cross Thickson Road in the Town of Whitby, Ontario. The crossing is situated about 200 m north of the Thickson Road and Highway 401 interchange, in a moderately built-up, light industrial area.

The average grade of Thickson Road at the crossing is about Elevation 94.8 m which is 1.3 m above the existing ground level of 93.5 m. The GO-ALRT tracks will run at Elevation 88.7 m, and the grade separation will be achieved by an underpass structure. The conceptual design information was transmitted to us by Mr. M.S. Devata, P.Eng., Supervising Engineer of the Ministry of Transportation and Communications, technical advisor to GO-ALRT on the project.

The purpose of the geotechnical investigation was to determine the subsoil and groundwater conditions and to define the engineering soil properties pertinent to the design of the foundations of the underpass. The report also deals with the anticipated construction conditions.

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In accordance with an earlier Engineering Agreement (No. EGG 000-24A), dated August 4, 1983, a soil investigation was performed in August 1983, about 50 m north of the site at the intersection of a previous alignment of the proposed GO-ALRT line with Thickson Road. At that location the GO-ALRT tracks were planned to run above Thickson Road, supported by an overpass structure. The findings of that investigation were reported under our Reference No. 83-8-9, dated September, 1983. The test holes belonging to that investigation were numbered 1 through 5.

For the present investigation, consisting of six boreholes (numbered 6 through 11), a revised proposal, dated October 28, 1983, was submitted to the Ministry by Dominion Soil Investigation Inc.

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2. SUMMARY

Below roadfill extending to a maximum depth of 2.9 m below existing ground level, dense to silty sand till was encountered which contains stiff silty clay lenses. At larger depths there are saturated and very dense sand lenses or layers. At the time of the soil investigation the groundwater level was generally at El. 90.7 m.

The proposed structure can be supported by spread footing foundations placed at shallow depths. No construction problems are anticipated and seepage water can be collected in temporary sumps and removed by pumping.

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3. SUBSURFACE CONDITIONS

3.0 General

The soil profile encountered in the boreholes is shown on the Record of Borehole Sheets which are included in this report as Enclosures 1 through 6. They indicate the stratigraphic boundaries between the encountered soil strata, sampling details and the field and laboratory test results. The purpose of this report section is to summarize the findings and define those soil properties which are relevant for the design of the foundations and substructures of the proposed underpass.

The six boreholes indicated that the natural subsoil generally consists of dense to very dense silty sand till deposits containing embedded stiff to very stiff silty clay lenses and very dense and saturated sand lenses or layers.

The terminology and abbreviations used throughout this report are explained on Page 1 of the Appendix.

3.1 Soil Stratigraphy

Fill, extending to a maximum depth of 2.9 m, was encountered in five of the six boreholes. Most of it is believed to have been deposited in connection with the construction of Thickson Road and was found to consist of a mixture of sand,

.../...

gravel, clay and traces of organic matter. Buried remains of the old topsoil and asphalt pavement were found in the fill in Boreholes 11 and 9, respectively. The fill is believed to have received compaction during its deposition.

The surface of the natural substrata was encountered at an average elevation of 92.2 m (range 91.4 to 93.4 m). The principal deposit is a silty sand till which contains traces of gravel. Figure 7 illustrates the grain size distribution of three samples with summarized results below:

Soil Component	Average	Range
Gravel	9%	5 - 12%
Sand	50%	42 - 57%
Silt	32%	31 - 34%
Clay	9%	7 - 12%

As indicated by the liquid limits and plasticity indexes of 12 to 15 per cent and 1 to 3 per cent, respectively, the silty sand till is practically a non-plastic material. Some samples, however, exhibited some cohesion due to negative pore pressure, the clay content or slight cementation.

The average water content of the unweathered silty sand till is about 9% (range: 6.5 to 12%) and two unit weight measurements yielded results of 22.9 and 23.8 kN/m^3.

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The silty sand till is generally dense above Elevation 89 to 90 m and becomes very dense below. Due to its "wide" gradation and high density expressed by the low void ratios (0.2 to 0.3), the angle of friction is estimated to be at least 41 degrees and the deposit can be considered as practically incompressible.

At higher levels silty clay lenses, and at greater depths, fine sand lenses or layers were encountered.

The gradation characteristics of two silty clay samples are shown on Figure 9. It can be seen that the gravel content ranges from 5 to 10%, the sand content from 35 to 68%, the silt content from 21 to 33% and the clay content from 6 to 22%. The liquid limit and plasticity index range from 19 to 33% and 8 to 13%, respectively. The water content of the silty clay samples generally was between 7.6 and 12.3% and the consistency of the silty clay lenses was stiff to very stiff and hard above and below Elevation 90 m, respectively.

Below Elevation 88 m, very dense fine sand with some silt lenses or layers were encountered. One grain size distribution curve on Figure 8 indicates the following composition: 6% gravel, about 28% silt and 5% clay size particles, and 61% sand. In most cases the samples were

.../...

saturated indicating that at least some of the fine sand lenses may be interconnected with an aquifer.

A plasticity chart, where the results of Atterberg tests were plotted which were obtained on the tested samples, is presented on Figure 10.

3.2 Groundwater Conditions

It was mentioned above that some of the deeper lying sand deposits are water bearing. In two boreholes (Nos. 9 and 10) the groundwater was encountered when the saturated fine sand strata were intercepted. Piezometers installed in the saturated sand showed variable heads ranging from Elevation 87.8 to 90.8 m.

The water table in Borehole 8 is not representative because the borehole had to be backfilled immediately upon its completion as Thickson Road was being paved at the time of the field work.

From the water levels recorded in the remaining boreholes it is our opinion that the groundwater level at the time of the investigation was generally at Elevation 90.7m.

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4. DISCUSSION AND RECOMMENDATIONS

4.0 Conceptual Design

According to preliminary information available at the time of preparing this report, the proposed underpass will consist of two retaining wall type abutments approximately 10 metres apart from one another. The central and highest portion of the retaining walls will carry the girders or beams supporting the roadway. The "abutment" sections will be flanked by wing walls gradually diminishing in height as the embankment height decreases and the overall length of the underpass will be about 70 metres. The top of the GO-ALRT rails are proposed to be at El. 88.7 m and the clear height of the structure will be about 5 metres. The maximum height of the "abutments" is therefore expected to be about 1 m higher (i.e. about 6 m). The highest foundation base level, dictated by the requirements of finished grade, is El. 87.20 m, as shown on a preliminary profile obtained from the Ministry.

Our recommendations are based on these premises.

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4.1 Foundation Design

The soil borings indicate that the subsoils at the site below El. 87.20 m are very dense or hard and therefore the proposed structures can be suppported by spread footing foundations proportioned by using high bearing capacities. For the sake of completeness the bearing capacities will also be specified for higher elevations in the following table:

Foundation Elevation	Factored Bearing Capacity at Ultimate Limit State	Bearing Capacity at Serviceability Limit States Type II
m	kPa	kPa
91.0	270	180
90.0	380	250
89.0	450	300
88.0	1200*	800*
87.0 or lower	1500*	1000*

* The recommended high bearing capacities at or below El. 88.0 m are based on the very high 'N'-values and on the favorable properties of the substrata such as high unit weight, wide gradation, low water content and void ratio. It is our opinion, however, that for practical reasons and conservatively the maximum value of the factored bearing capacity at the ultimate limit state should not exceed 900 kPa and the maximum value of the bearing capacity at serviceability limit states, Type II, should not exceed 600 kPa.

.../...

The serviceability condition is based on the assumption that the encountered foundation subgrade is the same as indentified at the same elevation in the nearest borehole and that the subgrade disturbance is minimal during construction.

Settlement of footings placed at or above El. 89.0 m are not expected to exceed 25 mm while that of footings placed at or below El. 88.0 m should not settle more than about 12 mm. Differential settlements, in our opinion, should not be more than about one-half of the total.

Under inclined loading conditions the bearing capacity at the ultimate limit state should be reduced in accordance with Clause 6.7.3.3.5 of the Ontario Highway Bridge Design Code, 1979 edition (OHBDC).

For horizontal forces the sliding resistance of the footing should be calculated by assuming that the friction angle is 26 degrees between the concrete footing and natural subgrade.

The earth cover for frost protection should be minimum 1.2 m thick above the base level of the footings.

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4.2 Lateral Earth Pressure

It is recommended that properly compacted and free-draining granular material should be used as backfill behind the retaining walls. Perforated pipes and/or drainage holes should be incorporated in the design to minimize the buildup of hydrostatic pressures. The perforated pipes should be surrounded with a suitable geofabric such as Terrafix 270R or approved equal to prevent clogging.

Assuming that free draining granular material and adequate drainage is provided behind retaining structures (Figure 6.9.6.1 OHBDC), the lateral earth pressure can be calculated by using the following equivalent fluid pressures:

i) On the major portion of the retaining wall where active earth pressure conditions could develop:

At Ultimate Limit State	8 kPa/m
At Serviceability Limit State Type II	6.5 kPa/m

.../...

ii) Rigid walls of bridge abutments should be designed to withstand the at-rest earth pressures which can be approximated using the following equivalent fluid pressures:

At Ultimate Limit State	10	kPa/m
At Serviceability Limit State Type II	8.5	kPa/m

When using the above values, it is assumed that the slope of the backfill behind the retaining structure is approximately level.

Construction joints should be provided between yielding and rigidly restrained portions of retaining walls.

Care should be given to avoid the development of large horizontal pressures by the compaction of the backfill behind the retaining walls and abutments. Vibratory compaction equipment, for use behind the retaining structures, must be restricted in size as per current M.T.C. specifications.

4.3 Construction

The construction of the foundations and substructures should not encounter unusual difficulties. The excavations can be made with sloping sides - 1 to 1 slopes, generally, should be

.../...

stable - or supported with skeleton sheeting and bracing if the space is restricted. In accordance with the Ontario Safety Laws, excavations deeper than 1.2 m must have sloping sides or braced walls.

Minor seepage can occur from surface water percolating through fissures in the upper and weathered zones of the fill and natural soil strata. This water can be collected in temporary sumps dug outside the footing areas and removed by pumping. The presence of water bearing sand lenses or layers, however, must not be ruled out; these were encountered in the borings with increasing frequency at greater depths.

If the wet sands are isolated with limited water supply, filtered sumps would perform satisfactorily for the collection of water. Should, however, an aquifer be intercepted with the excavation, larger volumes of water can enter the excavation and in this case, wellpoints may be required to unwater the subgrade. By keeping the foundation base level as high as possible, such occurrences can be minimized.

The excavated footing grade should be protected with a 100 mm thick mud-mat (i.e. concrete base) to seal off the bottom of

.../...

excavation, minimize subgrade disturbance and create a tidy working area, e.g. for laying reinforcing bars.

5. CLOSURE

The Statement of Limitation, as quoted in the Appendix, is an integral part of this report.

DOMINION SOIL INVESTIGATION INC.

L.S. Rolko, P.Eng.

LSR:bh

A P P E N D I X

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

PROCEDURES

Field Work

The boreholes were set out in the field by the personnel of Dominion Soil Investigation Inc., using a preliminary Site Plan received on October 21, 1983, from Mr. M. MacLean, P.Eng., of the Ministry of Transportation and Communications. Existing buildings were used as reference points for the survey.

The ground elevations at the boreholes were determined with reference to a benchmark which was shown to us by the Surveyors of the Ministry. The benchmark is defined as the "Top of northwest bolt in foundation of a light stand, at the southeast corner of property at 336 Thickson Road, geodetic elevation: 91.55 m".

The field work was carried out between November 2 and 5, 1983, and consisted of drilling six boreholes ranging in depth from 9.3 and 14.0 m. The following schedule summarizes the dates of borings:

.../...

Borehole No.	Depth m	Boring Date (1983)	Remarks
6	9.4	Nov. 5	-
7	9.3	Nov. 3-4	5.9 m piezometer Borehole relocated once. Redrilled 7 m.
8	10.4	Nov. 2	-
9	14.0	Nov. 2-3	10.7 m piezometer
10	9.3	Nov. 5	7.6 m piezometer
11	9.3	Nov. 5	-

Total drilling:	61.7 m
Redrill:	7 m
Total length of piezometers:	24.2 m

The borehole locations are shown on the drawing included with this report, while the logs of boreholes are contained on Figures 1 through 6. The borehole locations are also defined with coordinates.

The boreholes were advanced by a power auger equipped with hollow-stem augers. Samples were taken with a standard 51 mm o.d. split spoon sampler which was advanced in accordance with Standard Penetration Test method.

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The drilling equipment is owned and operated by D.S.I.L. Drilling Inc. The field work was carried out under the supervision of the engineering staff of Dominion Soil Investigation Inc., who directed the drilling and sampling operations, described the recovered samples and logged the borings.

Laboratory Work

All samples were shipped to our laboratory where they were examined, described and classified by visual and manual methods. Selected representative samples were subjected to detailed laboratory tests which were carried out in accordance with standardized methods. The following types of tests were performed:

1. Water content and unit weight
2. Grain size analysis (by sieving and hydrometration)
3. Atterberg limits (liquid and plastic limits)

The water content and unit weight of the soil indicate the denseness of the soil and its suitability for engineering purposes, while the grain size analyses and Atterberg limits tests are needed for classification purposes.

.../...

The grain size distribution curves are shown on Figures 7 through 9 and a plasticity chart is shown on Figure 10. All laboratory test results are shown on the logs of boreholes and are summarized in Table I which follows.

BH	SA	DEPTH	w	w_L	w_p	I_p	I_L	GRADATION GR	SA	SI	CL	γ	γ_d	e	c	σ_3	ε_f		GROUP SYMB.
No.		m	per cent					per cent									%		
6	2	1.1	12.0	15	12	3	0	12	42	34	12								SM-ML
	3	2.4	10.5	33	20	13	-0.7	5	68	21	6								SC-CL
	4	3.4	9.1																
	5	4.7	9.3																
	6	6.2	12.0																
	7	7.7	10.3																
7	1	1.1	16.4																
	2	1.7	10.1																
	3	2.4	8.1																
	4	3.4	8.6																
	5	4.7	7.6																
	6	6.3	20.4																
8	4	3.4	16.9	19	11	8	0.7	10	35	33	22								CL-SC
	5	4.9	9.0	12	11	1	-2.0	11	52	29	8								SM-ML
	6	6.2	7.5																
9	4	3.4	12.3																
	5	4.9	8.7									23.1	21.3	0.2					
	6	6.3	7.6																
	7	7.7	6.5																

SUMMARY OF LABORATORY TESTS

TABLE I SHEET 1 OF 2

BH No.	SA No.	DEPTH m	w per cent	w_L per cent	w_P per cent	I_P per cent	I_L	GRADATION GR per cent	GRADATION SA per cent	GRADATION SI per cent	GRADATION CL per cent	γ	γ_d	e	c	σ_3	ε_f %		GROUP SYMB.
10	3	2.4	10.7																
	4	3.4	11.1									22.9	20.6	0.3					
	5	4.9	7.1	13	12	1	-4.9	5	57	31	7	23.8	22.2	0.2					SM-ML
	6	6.3	9.6																
	7	7.8						6	61	28	5								SM

S U M M A R Y O F L A B O R A T O R Y T E S T S

T A B L E I SHEET 2 OF 2

DOMINION SOIL INVESTIGATION INC.

A P P E N D I X

STATEMENT OF LIMITATION

The conclusions and recommendations in this report are based on information determined at the testhole locations. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the site investigations.

We recommend that we be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

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 of alignment and elevations stated in the report. Since all details of the design may not be known, in our analysis certain assumptions had to be made. The actual conditions may, however, vary from those assumed, in which case changes and modifications may be required to our recommendations.

We recommend, therefore, that we be retained during the final design stage to review the design drawings and to verify that they are consistent with our recommendations or the assumptions made in our analysis.

In cases where these recommendations are not followed, the company's responsibility is limited to report accurately the information encountered in the testholes.

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 boreholes may not be sufficient to determine all the factors that may affect construction methods and costs. 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.

E N C L O S U R E S

Ministry of Transportation and Communications Ontario

DOMINION SOIL INVESTIGATION INC.

REF. NO. 83-8-9A

FIGURE 1

RECORD OF BOREHOLE No 6

METRIC

W P EGG 000-24A LOCATION CO-ORDS. 4,858,930N; 352,513E ORIGINATED BY S.D.

DIST 6 HWY GO-ALRT BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.

DATUM GEODETIC DATE 1983.11.05 CHECKED BY

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.2	Ground Level						
0.0	Fill, (sand and gravel)					93	
92.4	0.15 m Topsoil						
0.8	Silty sand, slightly cohesive, trace gravel. Compact / Dense. Light brown mottled. Damp to moist. (Glacial Till)	1	SS	20		92	
		2	SS	38			12 42 34 12
91.1						91	
2.1	Silty clay with sand, trace gravel. Hard. Light greyish brown, with white and brown specks. Moist / Damp. (Glacial Till) occasional sand lenses	3	SS	21	▼		5 68 21 6
		4	SS	33		90	
						89	
		5	SS	50/0.13m			
87.8						88	
5.4	Fine sand, some silt. Very dense. Light Brown and black. Damp	6	SS	60/0.15m		87	
86.2						86	
7.0	Silty sand, trace of gravel. Very dense. Light grey. Moist (Glacial Till)	7	SS	100/0.15m		85	
84.8							
8.4	Fine sand, some silt. Very dense. Light grey. Wet					84	
83.8		8	SS	50/0.13m			
9.4	End of Borehole						

Dynamic cone penetration resistance plot (20 40 60 80 100); Shear strength: ○ Unconfined, ● Quick triaxial, + Field vane, × Lab vane; Plastic limit W_p, Natural moisture content W, Liquid limit W_L; Water content (%) 10 20 30; Unit weight γ

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

DOMINION SOIL INVESTIGATION INC.
REF. NO. 83-8-9A

FIGURE 2

RECORD OF BOREHOLE No 7

METRIC

W P EGG 000-24A — LOCATION CO-ORDS. 4,858,908N; 352,512E — ORIGINATED BY S.D.
DIST 6 HWY GO-ALRT — BOREHOLE TYPE HOLLOW STEM AUGER — COMPILED BY F.L.
DATUM GEODETIC — DATE 1983.11.03 & 04 — CHECKED BY

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%)
92.9	Ground Level						
0.0	0.2 m Topsoil Silty sand, slightly cemented light brown, slightly weathered, loamy compact, moist very dense, occasionally slightly cemented (Glacial Till)	1	SS	29	PIEZOMETER	92 / 91	Refusal on boulder at El. 85.3 m. Borehole moved 2 m N.E.
		2	SS	36			
		3	SS	71	SEAL	90	
		4	SS	53		89	
88.9 / 4.0	Silty clay with sand trace gravel, Damp, light grey (Glacial Till) Hard occ. wet sand lenses	5	SS	50/0.10m	▽	88	
87.4 / 5.5	Fine sand, some silt Very dense, Grey, Wet					87	
86.6 / 6.3	Silty sand, trace of gravel Boulder Grey Very dense, Damp, gravelly lense occasionally slightly cemented, Wet sand lenses (Glacial Till)	6	SS	60/0.15m		86	
		See note				85	
		7	SS	50/0.08m		84	
83.6 / 9.3		8	SS	70/0.15m			
	End of Borehole						

Dynamic cone penetration resistance plot: 20 40 60 80 100
Shear strength: ○ Unconfined, ● Quick Triaxial, + Field Vane, × Lab Vane

Water content (%) (plastic limit Wp, natural moisture content W, liquid limit WL): scale 10 20 30

Sample	Water content (approx. %)
1	~16
2	~10
3	~8
4	~9
5	~8
6	~20

UNIT WEIGHT γ — GR SA SI CL

+³, ×⁵ : Numbers refer to Sensitivity — 20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

DOMINION SOIL INVESTIGATION INC.
REF. NO. 83-8-9A

FIGURE 3

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8

METRIC

W P EGG 000-24A LOCATION CO-ORDS. 4,858,958N; 352,537E ORIGINATED BY S.D.
DIST 6 HWY GO-ALRT BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.11.02 CHECKED BY

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.3	Ground Level							
0.0	0.15 m Gran. A Fill; 0.30 m Gran. B Fill; Fill (mixed: clay, sand, gravel) Stiff to firm, Brown rusty and black specks, Damp to Wet	1	SS	15		94, 93		Groundwater level immediately upon completion of boring.
		2	SS	20		92		
91.4		3	SS	4				
2.9	Silty clay, sandy, trace gravel. Stiff, Light brown, Moist to Wet (Glacial Till)	4	SS	15		91		10 35 33 22
90.3 / 4.0	Silty sand, trace gravel. Brown with rusty, black and grey specks. Dense / Very dense. Moist / Damp	5	SS	34		90		11 52 29 8
	Cobbles and Gravel	6	SS	50/0.13m		89, 88		
	occasionally slightly cemented (Glacial Till); Cobbles and Boulders	7	SS	50/0.0m		87, 86		
85.8 / 8.5	Fine sand, traces of gravel and silt. Very dense, Grey, Moist	8	SS	75/0.15m	▼	85		
83.9 / 10.4	End of Borehole (Refusal to auger and sampling tool)					84		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE
PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ

+3, ×5 : Numbers refer to Sensitivity   15 ◇ 5 (%) STRAIN AT FAILURE (20 / 10)

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC

W P EGG 000-24A LOCATION CO-ORDS. 4,858,930N; 352,538E ORIGINATED BY S.D.
DIST 6 HWY GO-ALRT BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.11.02 & 03 CHECKED BY

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
95.5	Ground Level								
0.0	Fill - (sand with silt and gravel) Dense Moist Brown	1	SS	33		95			
	old asphalt pavement	2	SS	50/0.08m		94			
93.4 2.1	Silty clay, sandy, trace of gravel; Very stiff, Moist (Glacial Till)	3	SS	21	PIEZOMETER	93			
		4	SS	22		92	~12		
91.5 4.0	Silty sand, trace of gravel (Glacial Till) Dense Moist	5	SS	30	▼	91	~10	23.1	
	Very dense, Damp; Light brown, rusty and black specks	6	SS	50/0.13m	SEAL	90 / 89	~9		
	Grey with black specks; occasionally slightly cemented	7	SS	65/0.15m		88	~9		
87.1 8.4	Fine sand, trace of gravel and some silt, Wet					87			← Water encountered during drilling.
	Very dense, Grey	8	SS	55/0.15m		86			
	Dense, brown silt lense	9	SS	45		85			
84.5 11.0	Silty sand, trace of gravel, slightly cemented; Moist, Very dense, Grey (Glacial Till)	10	SS	60		84 / 83			
82.4 13.1	Fine sand, trace silt; Very dense, Grey, Wet; Gravel layer	11	SS	50/0.10m		82			
81.5 14.0	End of Borehole								

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30

+3, ×5 : Numbers refer to Sensitivity   15 ◇ 5 (20, 10) (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10

METRIC

W P EGG 000-24A LOCATION CO-ORDS. 4,858,974N; 352,552E ORIGINATED BY S.D.

DIST 6 HWY GO-ALRT BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.

DATUM GEODETIC DATE 1983.11.05 CHECKED BY

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.5	Ground Level								
0.0	Fill (clay mixed with topsoil) 0.3 m Topsoil				PIEZOMETER	92			
91.6 / 0.9	rootlets Silty clay, sandy, trace gravel. Very stiff, Light brown, Moist (Gl. Till)	1	SS	18		91			
		2	SS	21	▼				
90.4 / 2.1	Silty sand, trace gravel (Glacial Till)	3	SS	22		90	o		
		4	SS	26		89	o	22.9	
	Compact, Brown, Moist / Very dense, Grey, Damp				SEAL	88			
	occasionally slightly cemented	5	SS	78			o H	23.8	5 57 31 7
	Moist, occasional wet sand lenses					87		←	Water encountered during drilling.
86.0		6	SS	50/0.10m		86	o		
6.5	Fine sand, some silt, trace gravel. Saturated, Very dense, Grey					85			
		7	SS	50/0.10m					6 61 28 5
83.8 / 8.7	Silty sand, tr. gravel. Very dense, Grey, Damp (Glacial Till)					84			
83.2		8	SS	70/0.15m					
9.3	End of Borehole								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100. SHEAR STRENGTH: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, x LAB VANE. PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30.

+3, x5 : Numbers refer to Sensitivity — 20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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REF. NO. 83-8-9A

FIGURE 6

RECORD OF BOREHOLE No 11

METRIC

W P EGG 000-24A — LOCATION CO-ORDS. 4,858,957N; 352,558E — ORIGINATED BY S.D.

DIST 6 HWY GO-ALRT — BOREHOLE TYPE HOLLOW STEM AUGER — COMPILED BY F.L.

DATUM GEODETIC — DATE 1983.11.05 — CHECKED BY

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
92.5	Ground Level					
0.0	0.10 m Topsoil. Fill (clay mixed with topsoil) Stiff. 0.3 m Topsoil					92
91.4		1	SS	11		
1.1	Silty clay, sandy, trace gravel. Light brown. Stiff (Gl. Till) Moist	2	SS	15	▼ (water level)	91
90.4						
2.1	Silty sand, trace gravel (Glacial Till). Moist to Damp. Dense ----- Very dense. occ. slightly cemented. Light brown, occ. white and rusty specks ------ occ. sandy and clayey lenses	3	SS	31		90
		4	SS	39		89
		5	SS	50/	0.08m	88
						87
		6	SS	66/	0.15m	86
85.4						
7.1	Sand, well graded, trace of gravel and silt. Grey. Very dense. Saturated	7	SS	100/	0.10m	85
84.0						84
8.5	Silty sand, tr. gravel (Glacial Till). Very dense. Grey. Damp	8	SS	100/	0.15m	
83.2 / 9.3	End of Borehole					

Other columns (no data recorded): STRAT PLOT; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE); PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L — WATER CONTENT (%); UNIT WEIGHT γ; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+3, ×5 : Numbers refer to Sensitivity

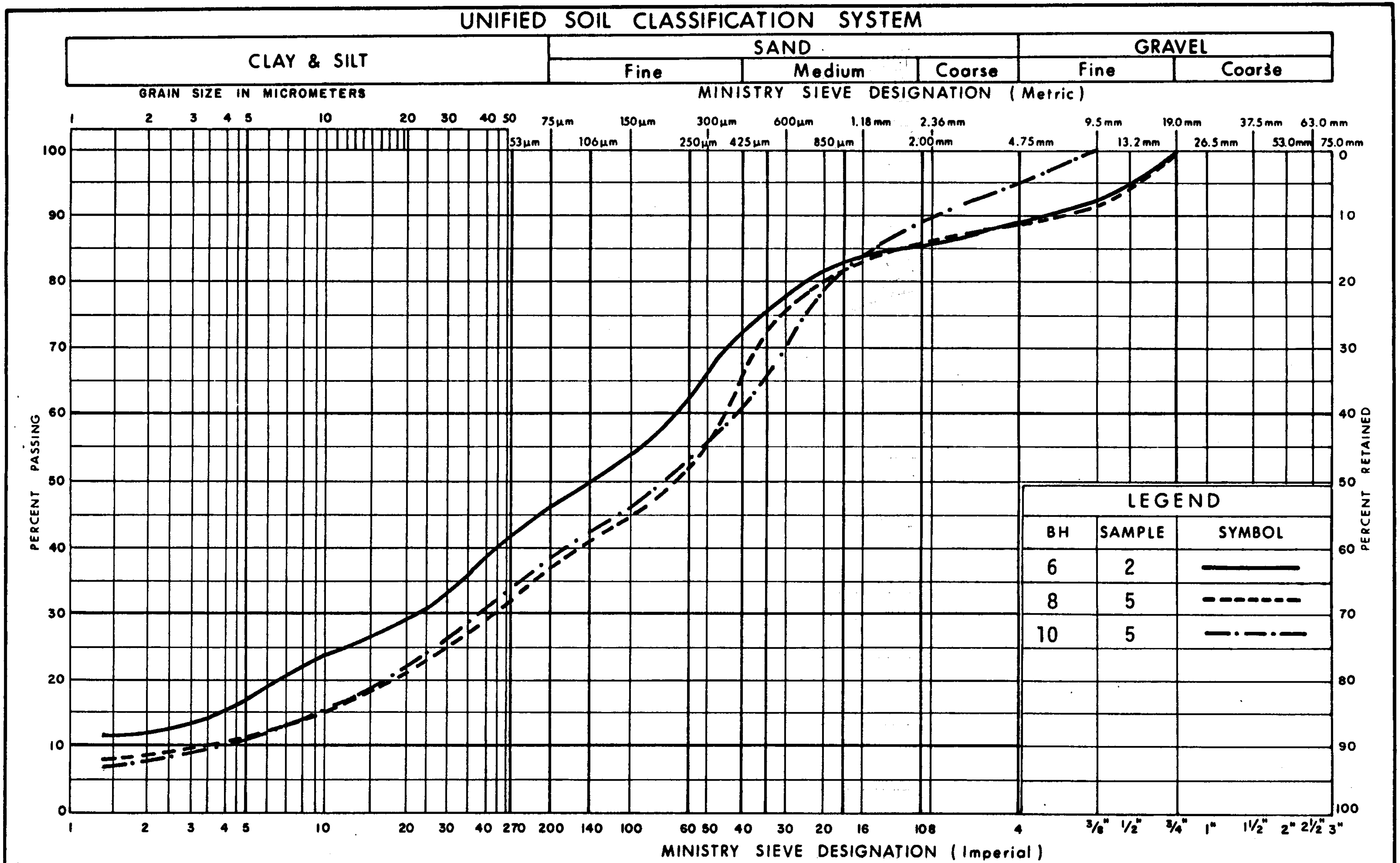
20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

DOMINION SOIL INVESTIGATION INC.

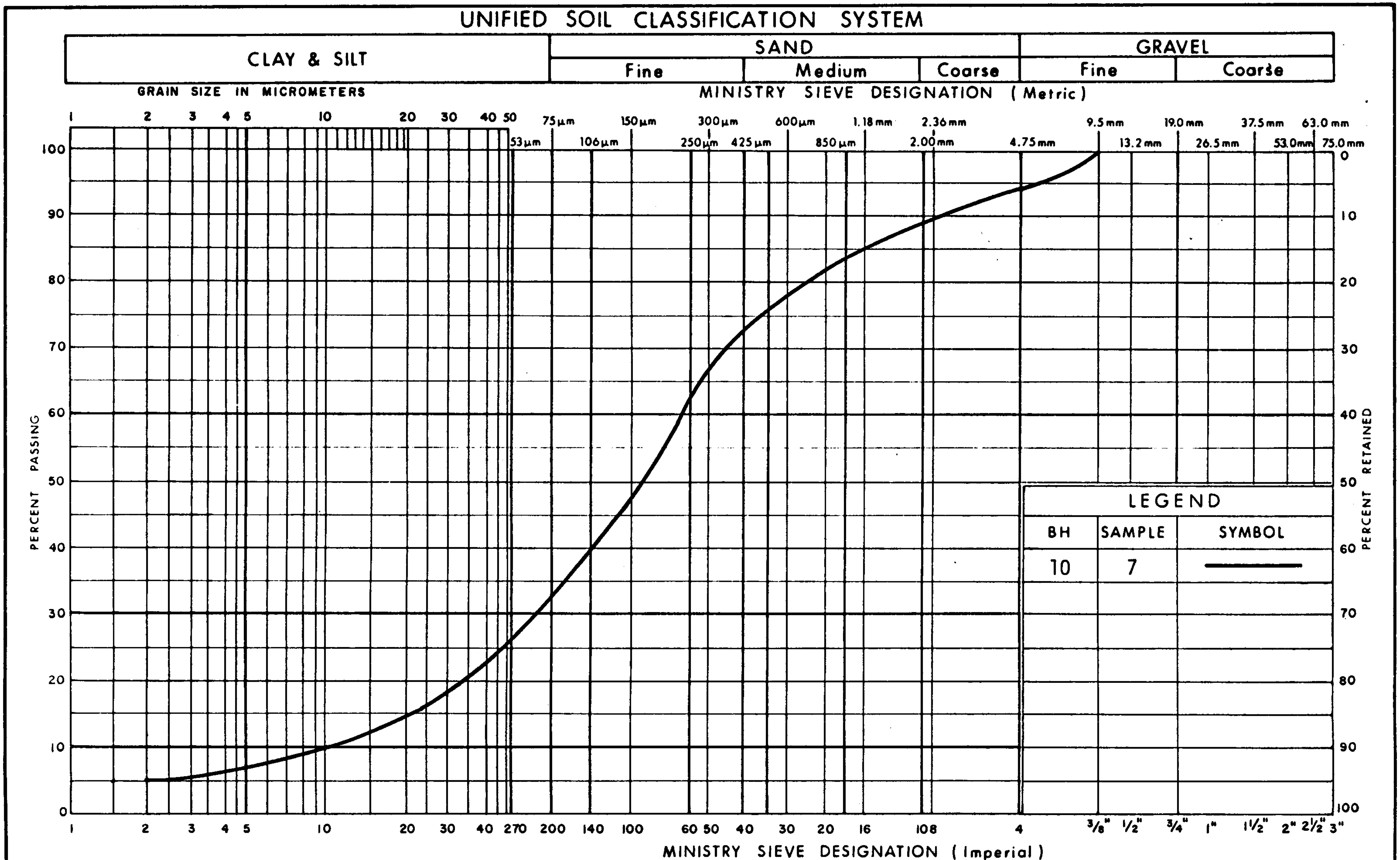
Ref. No. 83-8-9A

78 12 M



Ministry of Transportation and Communications, Ontario	GRAIN SIZE DISTRIBUTION	FIG No 7
	SILTY SAND, TRACE OF GRAVEL (GLACIAL TILL)	W P EGG 000-24A

78 12 M



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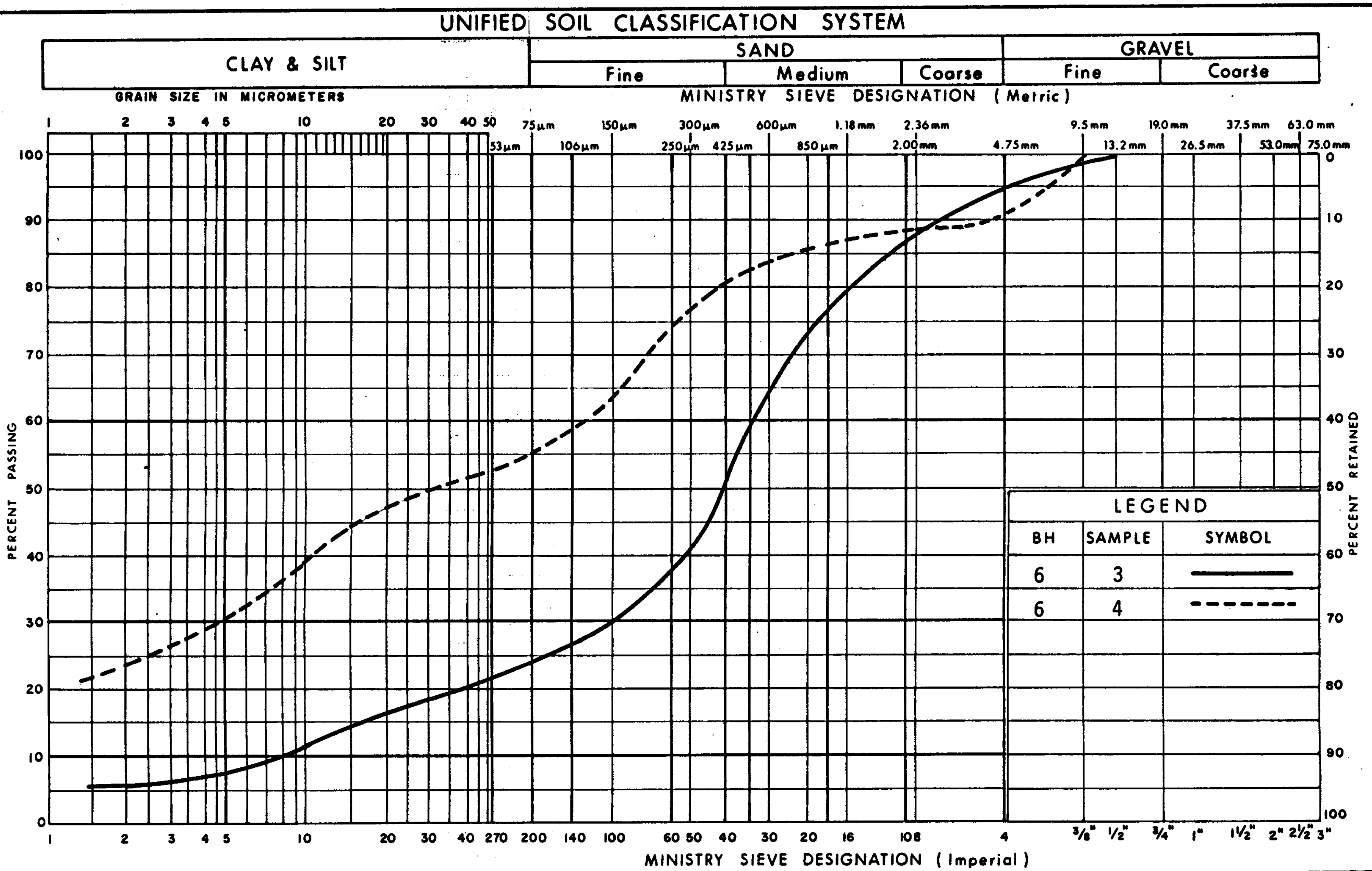
Ontario

GRAIN SIZE DISTRIBUTION

SILTY FINE SAND, TRACE GRAVEL

FIG No 8

W P EGG 000-24A



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Ontario

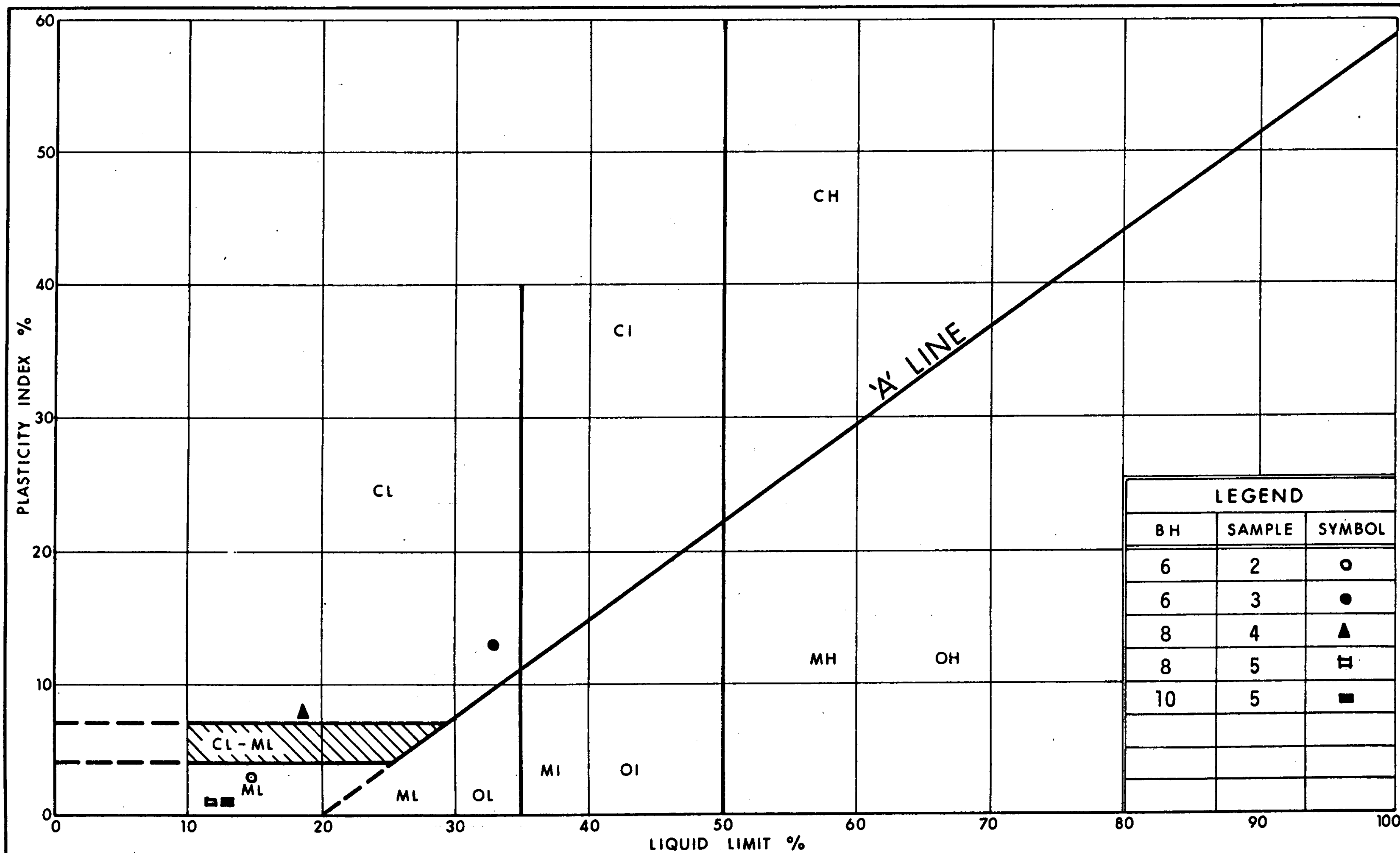
GRAIN SIZE DISTRIBUTION

SILTY CLAY, WITH SAND, TRACE GRAVEL

FIG No	9
W P	EGG 000-24A

DOMINION SOIL INVESTIGATION INC.

REF. NO. 83-8-9A
Oct 75, FF-S-21



LEGEND		
BH	SAMPLE	SYMBOL
6	2	○
6	3	●
8	4	▲
8	5	⌑
10	5	■

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Ontario

PLASTICITY CHART

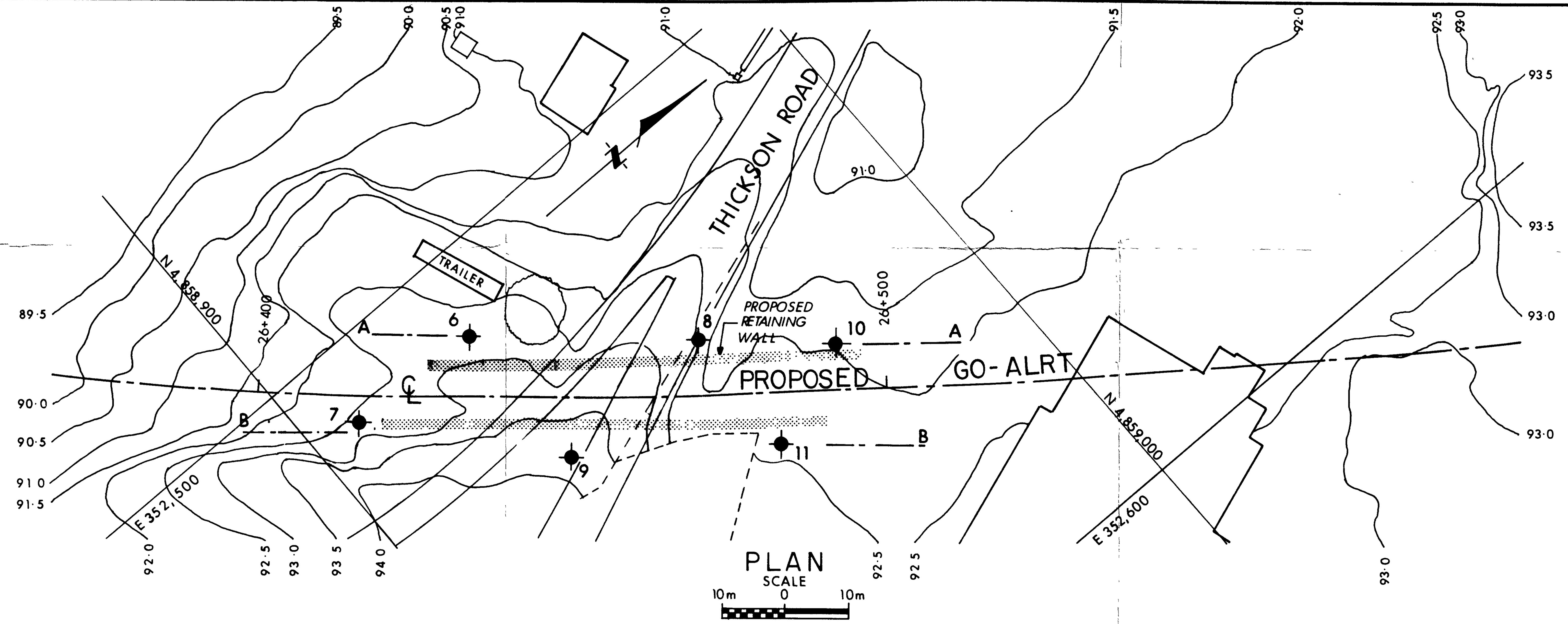
○ ■ ▭ SILTY SAND, TRACE GRAVEL (GLACIAL TILL)

● ▲ SILTY CLAY WITH SAND, TRACE GRAVEL (GLACIAL TILL)

FIG No 10

W P EGG 000-24A

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-D-207 82 04



PLAN
SCALE
10m 0 10m

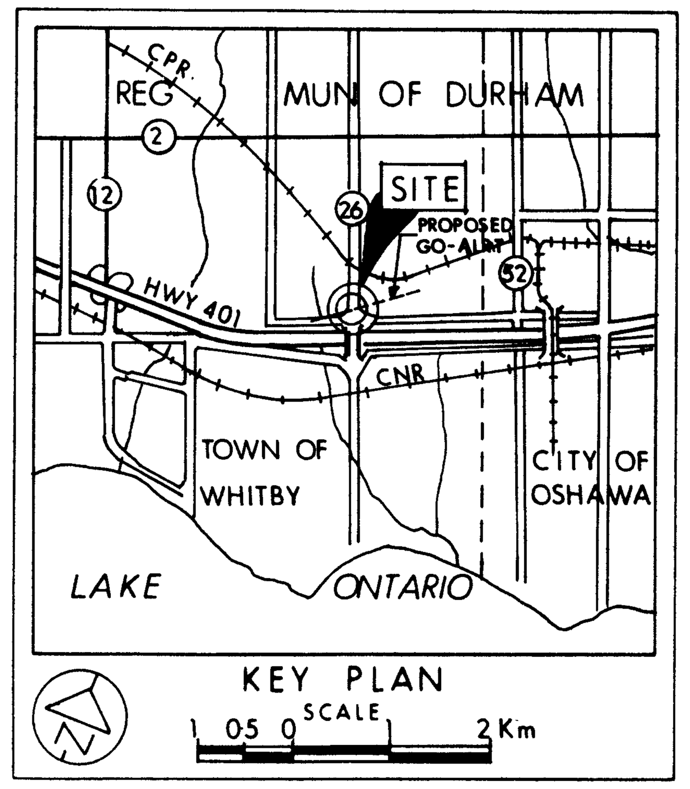
METRIC

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

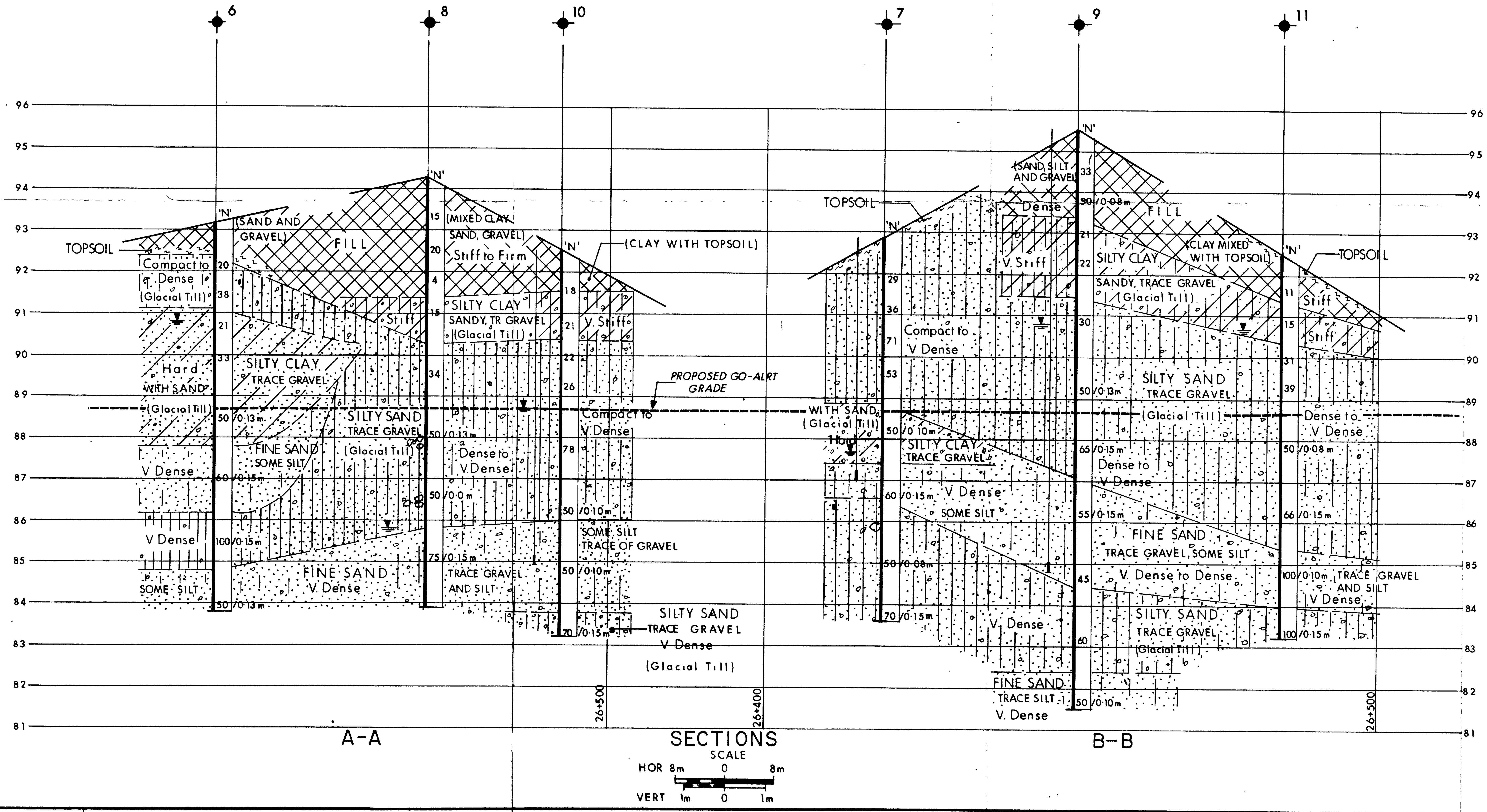
CONT No
WP No EGG000-24A
SHEET

GO-ALRT- THICKSON RD CROSSING
BORE HOLE LOCATIONS & SOIL STRATA

DOMINION SOIL INVESTIGATION INC.



KEY PLAN
SCALE
1 0.5 0 2 Km



SECTIONS
SCALE
HOR 8m 0 8m
VERT 1m 0 1m

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)
- W L at time of investigation 1983 11
- PIEZOMETER

No	ELEVATION	CO-ORDINATES NORTH	EAST
6	93·2	4,858,930	352,513
7	92·9	4,858,908	352,512
8	94·3	4,858,958	352,537
9	95·5	4,858,930	352,538
10	92·5	4,858,974	352,552
11	92·5	4,858,957	352,558

=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

HWY No GO-ALRT			DIST 6
SUBM'D S D	CHECKED LSR	DATE 1983 11 25	SITE
DRAWN FL	CHECKED LSR	APPROVED	DWG EGG000-24A-A