



C. MIRZA ENGINEERING INC.  
GEOTECHNICAL SPECIALISTS & CONSULTING ENGINEERS

Suite 31, 1262 Don Mills Road, North York, Ontario, Canada M3B 2W7 • Telephone (416) 441-2560 • Telex 06-966637

FOUNDATION INVESTIGATION REPORT  
GO-ALRT Project EGG-000-26  
CP/Cadbury Spur Line Crossing  
and Earth Cuts

Our File: 83-028  
Consultant Agreement No: EGG-000-26

Preliminary	1984 01 03
Final	1984 01 21

Distribution:

MTC - 12 copies  
Files - 1 copy



## TABLE OF CONTENTS

INTRODUCTION	1
SITE AND GEOLOGY	2
FIELD AND LABORATORY WORK	2
SUBSURFACE CONDITIONS	4
General	4
Surficial Soils	4
Glacial Till - Silty Fine Sand to Sandy Silt	4
GROUNDWATER CONDITIONS	5
DISCUSSION AND RECOMMENDATIONS	7
General	7
Cut Stability	7
Basal Stability	8
Construction Considerations	9
 APPENDIX	
Explanation of Terms Used in Report	
Office Record of Borehole Logs 1 - 12	
Figures 1 - 2	
Plan	
Profile	



FOUNDATION INVESTIGATION REPORT  
GO-ALRT Project EGG-000-26  
CP/Cadbury Spur Line Crossing  
and Earth Cuts

---

INTRODUCTION

In August 1983, C. Mirza Engineering Inc. were invited by the Ministry of Transportation and Communications, on behalf of GO-ALRT, to carry out a detailed subsurface investigation at the site of a proposed structure to carry the GO-ALRT alignment trackage across and over an existing CP spur running northwards from the Cadbury Plant in Whitby, Ontario. In October, 1983, the grades for the GO-ALRT alignment were altered, resulting in the trackage going below the CP Spur. Our Company was invited to proceed with a supplementary investigation to take into account a new structure configuration resulting from the changed grade. In conjunction with the supplementary investigation, we were also requested to conduct an investigation into the stability of deep cuts west of the proposed structure site.

The field work was completed for the original investigation in August 1983 and an interim report was presented to the MTC on 1983 09 09. The supplementary field investigation was completed in November 1983. However, prior to the completion of the supplementary field work, a tentative report speculating on the cut stability necessitated by the revised grade was submitted on 1983 10 26. After completion of the supplemental field work in November, another interim report was in the process of being prepared pending the provision of suitable G plans for the railway crossing and a B Plan for the deep cuts. However, in December 1983, we were advised that the proposed structure crossing of the CP Spur Line had been eliminated from the plans for GO-ALRT. For this reason, it was requested that this report confine itself only to factual data insofar as the proposed, now deleted structure was concerned, but elaborate on the stability of the proposed deep cuts west of the structure location. This report is submitted in compliance with the above requests and changes.



## SITE AND GEOLOGY

The site is located in the Town of Whitby, Ontario. Specifically, the Cadbury Plant is located in the northeast quadrant of the Thickson Road-Highway 401 interchange complex. A spur line runs north from the back of the Cadbury Plant to join up with CP trackage. The CP tracks are located about midway between Dundas Street in Whitby and Highway 401 to the south.

The topography at this site is gently undulating, reflecting the drum-linized till plain in this part of the physiographic region known as the South Slope. Cigar shaped flutings running more or less northwest by southeast are very prominent in this area. These represent buried drumlins which have been covered over by a mantle of more recent basal tills.

The soil conditions in this area are quite variable within distances of 500 to 1000 metres. West of Thickson Road, deep soft clay deposits are present. East of Thickson Road, the stratigraphy is quite complex and involves preconsolidated clays under tills of glacio-fluvial and glacio-lacustrine origins. The presence of random pure sand and silt seams indicates the influence of post glacial Lake Ontario on the sedimentology of the area.

In the area of the investigation, the land slopes generally in a southerly direction. However, it also undulates in the east and west directions as a result of the buried drumlins. The deep cut west of the proposed structure site is located in one of these drumlins.

## FIELD AND LABORATORY WORK

As mentioned in the Introduction, the field work was carried out in two stages. In the initial investigation, a total of seven boreholes was carried out, one of which was accompanied by a dynamic cone penetration resistance test. A supplementary cone test was also carried out to delineate a loose or soft condition encountered in one of the boreholes. In the subsequent November investigation, four additional boreholes were drilled. Also, two of the previously drilled boreholes were relocated and two new boreholes drilled adjacent to them for installation of



## FIELD AND LABORATORY WORK - continued:

piezometers. Piezometers were also installed in each of the four additional boreholes.

The boreholes were initially located by reference to a staked GO-ALRT centreline. Elevations were surveyed by our staff from an MTC benchmark near Highway 401. During the survey, a temporary benchmark was established on one of the CP Spur Tracks. In the subsequent November investigation, we were advised that the centreline had been changed to a revised alignment. Hence, the formerly drilled boreholes were re-assigned new location Station values based on the revised chainages and alignment, by scaling from available plans. With the exception of Borehole 12, all the other field logs submitted with this report have been tied into the revised chainage. No plan was available in the vicinity of Borehole 12. Hence, the chainage shown on the log sheet for this borehole is related to the former chainage and alignment of the GO-ALRT centreline (pre-revision chainage and alignment).

The boreholes were drilled with a muskeg-vehicle mounted auger drilling machine. Soil samples were obtained at 1.5 metre or lesser intervals in the Standard Penetration resistance Test (ASTM D-1586-67), the corresponding N values being noted. Since cohesive soft to firm soils were not encountered in any of the boreholes, no field vanes or tube samples were obtained.

Piezometers sealed so as to prevent infiltration of surface waters, were installed at the locations of Boreholes 1, 5, 9, 10, 11 and 12. In Boreholes 11 and 12 two piezometers were installed at different depths to measure the groundwater hydraulic gradients. The depths of piezometers and seals are shown on the individual borelog sheets.

During an elevation survey for the November investigation, it was discovered that an error of +1.0 metres had been made in the elevations reported in the interim report dated 1983 09 09. Proper corrections have now been made, and the elevations shown on the appended log sheets are the correct values.



## FIELD AND LABORATORY WORK - continued:

All of the samples obtained at the site were transported to our Toronto Laboratory for further visual examination and testing. Laboratory tests included the following:

Moisture Contents  
Atterberg Limits  
Grain Size Distribution

## SUBSURFACE CONDITIONS

General:

The site is overlain by a thin veneer of clayey topsoil some 100 to 300 mm in thickness. In the depressions, a silty clay of low to medium plasticity is present as a surface veneer below the topsoil. Elsewhere, the predominant soil type is a glacial till of variable composition, but essentially consisting of sandy silts to silty fine sands with enough clay binder to give a cohesive appearance to some samples. Some cohesive zones are present in the glacial till. These are not continuous and occur randomly.

Surficial Soils:

The surficial soils consist of a clayey dark brown to brown topsoil some 100 to 300 mm in thickness followed by a silty clay of low to medium plasticity in some locations. At Borehole 7 and Cone Test 8, the silty clay was found to be of medium plasticity (Figure 1).

At Boreholes 9 and 10, the topsoil was found to be underlain by a thin veneer of fill material consisting of a silty clay of low plasticity mixed with sand, some gravel and organics.

Glacial Till - Silty Fine Sand to Sandy Silt:

The predominant stratum across the site is a dense to very dense glacial till deposit consisting of fine grained non-cohesive soils with some to trace of clay and gravel. The till is weathered, desiccated



## SUBSURFACE CONDITIONS - continued:

Glacial Till - continued:

and fissured in the upper 2 to 5 metres. The open fissures have become rust stained.

The moisture content of the glacial till in the desiccated zone runs about 10 per cent. In composition, sands predominate in some samples and silts in others. For this reason, the till has been classified as a sandy silt to silty sand. Typical grain size distribution curves are shown in Figure 2. From these grain size curves, a general conclusion reached is that the till becomes finer grained moving westwards from the structure location ( compare curves for Boreholes 1 to 7 with those for Boreholes 9 to 12).

Below the desiccated zone, the till assumes a characteristic grey to dark grey colour. The moisture content does not change appreciably, except in silty and sandy lenses found at random at depth in some boreholes (for example Boreholes 11 and 12). In Boreholes 11 and 12, fine sand and silt was encountered below elevations 85 and 83 respectively.

The N values in the till deposit were generally very high with some exceptions. At Borehole 7, a weak zone was encountered between elevations 89 and 86. In Borehole 9, a compact zone was encountered between elevations 90.5 and 89. With these two exceptions, the till was found to be in a dense to very dense state. The cohesive portions of the till in Boreholes 4, 6 and 9 were found to be hard to very hard based on N values in excess of 30 blows per 0.3 metres.

## GROUNDWATER CONDITIONS

The groundwater conditions were assessed in open boreholes at locations 1 to 7 initially. Subsequently water level measurements were taken in Boreholes 1, 5, 9, 10 11, and 12 in the piezometers at weekly intervals. The last set of readings was taken on 1983 11 16, and is shown plotted on the individual borelog sheets for these boreholes.



## GROUNDWATER CONDITIONS - continued:

The depth to the groundwater ranges from 1.3 metres at Borehole 9 to 5.0 metres at Borehole 10. The water tables are shown plotted on the Profile. From west to east, there is a general tendency for the water table to parallel the ground surface. The high water table encountered at Borehole 5 is presumed to be a perched condition. Such a condition was also found at Borehole 9 immediately below the fill.

In the nested piezometers at Boreholes 11 and 12, a downward drainage gradient was observed. At Borehole 11, the gradient is small. At Borehole 12, the lower piezometer was placed in a wet fine sand deposit which occurs immediately below the glacial till at elevations 83 to 85 in this area. This lower piezometer shows an excess head within the fine sand deposit. Given the present ground elevation, this head is sub-artesian in nature. Hence, it may have an influence on cut stability and bottom behaviour after excavation of the cut to final grade. This is discussed in detail in the next section of the report.

During the drilling of the boreholes in the November investigation, wet zones were observed in all of the four new boreholes. These zones are listed below:

Borehole 9	Elevation 87.1
10	89.6 to 88.1
11	88.8
12	90.2 and 88.1 to 86.6

These wet zones likely represent trapped downward draining water blocked by slightly cohesive till matrices, as in the case of Borehole 9.

Note should be made of the wet conditions encountered also in the basal silt and fine sand at Boreholes 11 and 12.





## DISCUSSION AND RECOMMENDATIONS

### General:

Due to the decision to abandon the structure at the GO-ALRT and CP Spurline crossing, the discussion and recommendations to follow address only the cut excavation and stability problems within the length of GO-ALRT investigated in this study (Stations 17+062 to 16+800 approx.).

Final profile grades and plans showing the full alignment in the study area are not available. This discussion is therefore based on the preliminary information supplied. The proposed final grade of the cut will be at elevation 88±. For this grade, the depths of cut will range from 4 to 10 metres, being smallest at the east end of the project and deepest at the west end.

The subsurface investigation has revealed the presence of a fine grained, often slightly cohesive, glacial till of glacio-lacustrine origin. The till deposit is generally in a dense to very dense condition, or hard where cohesive. It is overlain, at the east end of the project by a surficial deposit of silty clay of low to medium plasticity, some 1.5 metres in thickness in a depression for an intermittent creek which crosses the site in a more or less north-south direction. Bordering the existing spur line, the surficial deposits consist of fill materials, possibly derived from the excavation for the spurline into the Cadbury plant.

### Cut Stability:

The glacial till and the surficial silty clay deposits are competent to support final cut slopes of 2 horizontal to 1 vertical. However, due to the presence of localized wet zones and perched water tables, some surficial sloughing can be expected during excavation of these cuts. It is felt that no special dewatering measures are necessary to make the required excavations, as the prevailing water table will be drawn down in conjunction with the excavation process. The till is very tightly knit and may not drain rapidly. Hence, the rate of excavation should be slow enough to permit drawdown of the water table concomittant with the



## DISCUSSION AND RECOMMENDATIONS - continued:

Cut Stability - continued:

excavation.

As an alternative to slow excavation, consideration may be given to the advance cutting of a full depth excavation along the proposed centreline of GO-ALRT. This pilot trench will induce downward drainage in the side slopes. From this pilot drainage trench, the final excavation slopes can be shaped to the desired geometry.

In order to protect the final cut slopes from surficial erosion, it is recommended that a bench be provided at mid-height of the slope. However, this bench will increase the right-of-way property takings. As an alternative, it is recommended that a subdrain be installed in the slope at a depth of 3.0 metres below existing grade. The drainage pipe should be surrounded with a 19 mm clear stone backfill. Since seepage velocities into the drain are likely to be quite low, no geotextile application is felt necessary to prevent contamination of the stone backfill from the glacial till matrix. The depth of the subdrain should be 1.2 metres below finished surface.

Basal Stability:

The final finished grade will be at elevation 88±. The water bearing, presently sub-artesian fine sand deposit occurs at elevations 83+ to 85±. The static water head in the fine sand deposit is at elevation 92±. Hence, the unbalanced hydrostatic head after excavation will be some 4 metres. However, the soil cover above the top of the fine sand deposit will be some 3 to 4.5 metres. Since soil weighs about twice as much as water, the factor of safety against bottom heave will be greater than 1. Therefore, no special dewatering measures are necessary to prevent bottom heave. If the final excavation is taken down to below elevation 88, bottom heave or bottom blow-out are distinct possibilities!

In order to relieve upward hydrostatic pressures beneath the base of the cut, it is recommended that a toe drain be provided adjacent to



## DISCUSSION AND RECOMMENDATIONS - continued:

Basal Stability - continued:

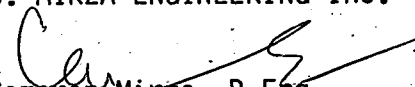
the railbed structure. This drain may be of the same type as used in the cut slope. However, filter cloth surround of the backfill is recommended due to the likely higher seepage velocities into the subdrain from the surrounding soil.

Excavation of the toe drain along the sides of the rail bed will reduce the overburden thickness locally along the drain alignment. This will increase the upward component of the unbalanced hydrostatic head. In order to ensure basal stability of the toe drain, it is recommended that the drain excavations be no longer than 15 metres in the open. The drain pipe and backfill should be placed immediately after excavation and that section completed prior to the opening up of the next section. This installation in steps will ensure that bottom failure is either prevented or at least kept localized. Localized conditions, where the sand layer occurs above elevation 85 are possible. The contractor may be given the option of advanced dewatering of the underlying sand deposit by well points or any other means, if he chooses to install the toe drain in one long continuous step. It is felt that the installation in 15 metre sections will be more economical.

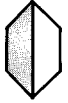
Construction Considerations:

The glacial till weighs about  $21 \text{ kN/m}^3$  in its in-situ state. After excavation and placement in fills, it may shrink by 3 to 5 per cent. Its present moisture content is close to optimum. However, there are localized wet zones which are obviously higher than the optimum. Hence selective fill control may be necessary by site inspection. The silty clay material in the vicinity of Borehole 7 is not acceptable as fill. The glacial till material is fine grained and frost susceptible. It should not be used within 1.2 metres of the railbed structure.

Respectfully submitted:  
C. MIRZA ENGINEERING INC.

  
Cameron Mirza, P.Eng.  
1984 01 21





## APPENDIX

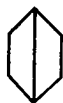
Explanation of Terms Used in Report

Office Record of Boreholes 1 to 12

Figures 1 and 2

Plan

Profile



## 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

## MECHANICAL PROPERTIES OF SOIL

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

## STRESS AND STRAIN

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

f: failure

## PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{\min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
$\rho_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{\text{sat}}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{\text{sat}}$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{\max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{kN}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						



Ministry of  
Transportation and  
Communications  
Ontario

# RECORD OF BOREHOLE No 1

METRIC

W P EGG - 000-26 LOCATION Sta 16+962 o/s 8.5 m Rt. Q GO-ALRT. ORIGINATED BY RB  
DIST 6 HWY GO - ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY SOA  
DATUM Geodetic DATE 1983-08-23, and 1983-11-03 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)				
94.0	Ground Surface															
0.0	Topsoil 25cm		1	CS	-											
	Brown Some Mottling		2	SS	47											
	Dense to very Dense		3	SS	58											
92.0	GLACIAL TILL															
2.0	Sandy Silt to Silty Sand with some Clay and Gravel		4	SS	53											
	Occ. Cobbles and Boulders															
	Very Dense		5	SS	84											
	Grey		6	SS	60/8cm											
			7	SS	60/5cm											
84.8			8	SS	60/10cm											
9.2	End of Borehole															

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



Ministry of  
Transportation and  
Communications

# RECORD OF BOREHOLE No 2

METRIC

W P EGG - 000 - 26 LOCATION Sta 16+948 o/s 20 m Lt. Q GO-ALRT ORIGINATED BY RB  
DIST 5 HWY GO - ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY SCA  
DATUM Geodetic DATE 1983-08-23 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80						100
											○ UNCONFINED	+ FIELD VANE	WATER CONTENT (%)				
											● QUICK TRIAXIAL	x LAB VANE	10	20	30		
96.7	Ground Surface																
0.0	Topsoil 30 cm		1	CS	-								○				
			2	SS	52												
	Brown to Mottled Grey Very Dense		3	SS	90												
			4	SS	105/23cm								○				
92.9	GLACIAL TILL																
3.8	Sandy Silt to Silty Sand with Clay and some gravel		5	SS	60/8cm												
			6	SS	60/8cm								○				
	Occ. Boulders and Cobbles																
89.0	Grey V. Dense		7	SS	60/8cm												
7.7	End of Borehole																
	Borehole dry upon completion.																

+3, x5: Numbers refer to  
Sensitivity

20  
15  $\div$  5 (%) STRAIN AT FAILURE  
10



MINNESOTA  
DEPARTMENT OF  
TRANSPORTATION

# RECORD OF BOREHOLE No 3

METRIC

W P EGG - 000 - 26 LOCATION Sta 16+994 o/s 25 m Lt G 60-ALRT ORIGINATED BY RB  
DIST 6 HWY 60 - ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY SQA  
DATUM Geodetic DATE 1983-08-23 CHECKED BY CM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)							
94.6	Ground Surface															
0.0	Topsoil 25cm	1	CS	-												
	Brown to Grey, mottled	2	SS	35												
	Desiccated Rust Stains on fissures	3	SS	64												
	Dense to V. Dense															
91.4		4	SS	93												
3.2	GLACIAL TILL															
	Sandy Silt to Silty Sand with clay and occ. gravel.	5	SS	50/5cm												
	Random boulders throughout	6	SS	50/5cm												
	Grey															
	Very Dense	7	SS	60/5cm												
85.4		8	SS	65/8cm												
9.2	End of Borehole															
	Note. Water was added during deilling to advance augers.															

+3, x5: Numbers refer to Sensitivity

20  
15  $\div$  5 (%) STRAIN AT FAILURE  
10



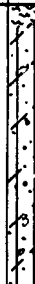




Ministry of  
Transportation and  
Communications

# RECORD OF BOREHOLE No 4

METRIC

W P EGG - 000 - 6 LOCATION Sta 17+009 o/s 25 m Lt G GO-ALRT ORIGINATED BY RB  
DIST 6 HWY GO - ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY SQA  
DATUM Geodetic DATE 1983-08-23 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
93.5	Ground Surface														
0.0	Topsoil 260 mm		1	CS	-		93								
	Mottled Brown		2	SS	44		92								
	Dense to very Dense		3	SS	79		91								
	Random sand seams						90								
90.2			4	SS	102										
3.3	Glacial Till							89							
	Silty Sand with clay and some Gravel.		5	SS	90										
	Occ. Boulders							88							
	Compact zone		6	SS	30										
	Very Dense						87								
							86								
84.3	Grey		7	SS	98										
							85								
84.3			8	SS	60/50mm										
9.2	End of Borehole														

+3, x5: Numbers refer to  
Sensitivity

20  
15  $\div$  5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 5

METRIC

W P EGG - 000 - 26 LOCATION Sta 17+012 G GO-ALRT ORIGINATED BY RB  
DIST 6 HWY GO - ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY SQA  
DATUM Geodetic DATE 1983-08-24 CHECKED BY CM

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	'N' VALUES			20 40 60 80 100					W <sub>p</sub>	W	W <sub>L</sub>		
								SHEAR STRENGTH									
93.6	Ground Surface															GR SA SI CL	
0.0	Topsoil 250 mm		1	CS	-											6 79 ( 15 )	
	Brown		2	SS	24												
			3	SS	18												
	Compact to very Dense																
			4	SS	71												
89.7																	
3.9																	
	Glacial Till		5	SS	32												
	Silty Sand with some clay and gravel, occ. Boulders.		6	SS	41												
	Dense to very Dense		7	SS	79												
84.0	Grey		8	SS	63												
9.6	End of Borehole																

+3, x5: Numbers refer to Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



Ministry of  
Transportation and  
Communications

# RECORD OF BOREHOLE No 6

METRIC

W P EGG - 000 - 26 LOCATION Sta 16+968 o/s 10 m Rt. G GO-ALRT ORIGINATED BY RB  
DIST 6 HWY GO - ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY SQA  
DATUM Geodetic DATE 1983-08-24 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
93.6	Ground Surface																
0.0	Topsoil 250 mm		1	CS	-												
	Glacial Till		2	SS	50												
	V. Dense																
	Brown		3	SS	43												
91.4																	
2.2	Grey																
	Silty Sand with Clay and Gravel		4	SS	24												
	Occ. Boulders																
	Random thin seams and pockets of sand		5	SS	31												
	Compact, becoming very dense with depth		6	SS	107												
			7	SS	70/102mm												
84.4																	
			8	SS	50/50mm												
9.2	End of Borehole																

+3, x5 : Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



Ministry of  
Transportation and  
Communications

# RECORD OF BOREHOLE No 7

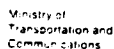
METRIC

W P EGG - 000 - 26 LOCATION Sta 17+050 G GO-ALRT ORIGINATED BY RB  
DIST 6 HWY GO - ALRT BOREHOLE TYPE Solid Stem Auger & Cone Test COMPILED BY SQA  
DATUM Geodetic DATE 1983-08-24 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
91.6	Ground Surface																GR SA SI CL
0.0	Topsoil 250mm		1	CS	-		91										0 92 ( 8 )
90.5	Silty Clay Mottled Brown. Stiff		2	SS	18												
1.1	Compact to V. Dense Glacial Till		3	SS	51												
			4	SS	26												
89.1	Light Grey to Brown						90										12 74 ( 14 )
2.5																	
	Loose Zone		5	SS	6												
	Probably Reworked Till																
	Grey		6	SS	9												
86.2							89										
5.4																	
	Silty Sand with some clay and gravel		7	SS	40/0mm												
	Very Dense																
	Grey		8	SS	60/50mm												
83.9																	
7.7	End of Borehole						84										

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



## METRIC

W P EGG - 000 - 26 LOCATION Sta 17+036 G GO-ALRT ORIGINATED BY RB  
DIST 6 HWY GO - ALRT BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY SQA  
DATUM Geodetic DATE 1983-08-24 CHECKED BY CM

[illegible]

**+3, x5 : Numbers refer to Sensitivity**

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 10

METRIC

W P EGG-000-26 LOCATION Sta 16+968 o/s 4.5 m Lt. Q GO-ALRT ORIGINATED BY RB  
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY SQA  
 DATUM Geodetic DATE 1983-11-03 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							W <sub>p</sub>	W	W <sub>L</sub>			
								SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
95.7	Ground Surface										10	20	30		GR SA SI CL					
0.0	Topsoil 10cm - - - FILL MATERIAL		1	CS	-															
94.8	Si. Clay, Tr. Org.		2	CS	-															
			3	SS	27		95													
0.9	Compact																			
	Mottled Grey - Brown		4	SS	34		94								15 37 (48)					
93.6																				
2.1	V. Dense						93													
	Mottled Grey		5	SS	86		92													
91.4																				
4.3			6	SS	50/3cm		91								W.L. on 1983-11-16					
	GLACIAL TILL		7	SS	81/10cm		90													
	Silty Sand																			
	to						89								Wet Zone					
	Silt																			
	Trace Clay		8	SS	72/10cm		88													
	Some Gravel																			
	V. Dense						87													
	Grey		9	SS	81/10cm										Seal					
85.2							86													
84.9	more Cohesive Zone		10	SS	102/		85								Sealed Perforated Standpipe					
10.8	End of Borehole.																			

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10

5 (%) STRAIN AT FAILURE



Ministry of  
Transportation and  
Communications

# RECORD OF BOREHOLE No 11

METRIC

W P EGG-000-26 LOCATION Sta 16+901 Q GO-ALRT ORIGINATED BY RB  
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger. COMPILED BY SQA  
DATUM Geodetic DATE 1983-11-02 CHECKED BY CM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
97.3	Ground Surface															
0.0	Topsoil 20cm															
	Compact to V. Dense		1	SS	39											
	Mottled Grey - Brown		2	SS	58											3 40 (57)
	Desiccated															
	Rust Staining along fissured planes		3	SS												W.L. on 1983-11-16 Seal Boulder No Sample
			4	SS	46/10cm											Sealed Piezometer
			5	SS	54/10cm											
92.0																
5.3																
	GLACIAL TILL		6	SS	50											Seal
	Silty Fine Sand with Tr. Clay															
	Occ. Gravel		7	SS	50											Sealed Piezometer
	Dense to V. Dense		8	SS	54/8cm											Wet Zone
	Grey		9	SS	74/15cm											
85.1																
84.7	Fine SAND, V. Dense		10	SS	124											
12.6	End of Borehole															

+3, x5: Numbers refer to Sensitivity  
20  
15  $\diamond$  5 (%) STRAIN AT FAILURE  
10





Ministry of  
Transportation and  
Communications

# RECORD OF BOREHOLE No 12

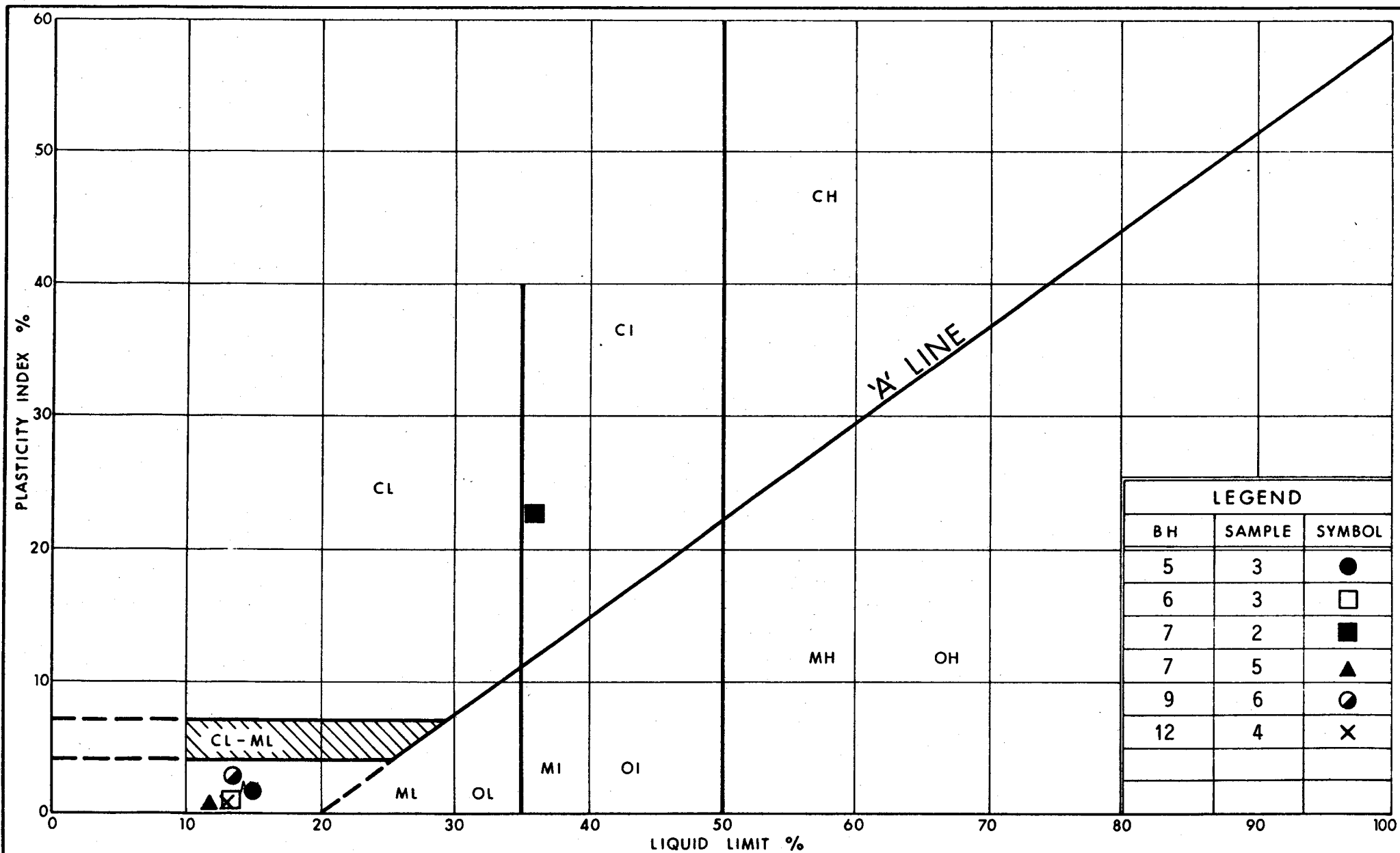
METRIC

W P EGG-000-26 LOCATION Sta 16+800 @ GO-ALRT ORIGINATED BY RB  
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid and Hollow Stem Auger COMPILED BY SQA  
DATUM Geodetic DATE 1983-11-02 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
95.7	Ground Surface													
0.0	Topsoil 15cm		1	CS										
95.0	Clayey SAND													
0.7	V. Dense Desiccated Mottled Brown - Grey  Occ. Cohesive Zones		2	SS	55		95							
			3	SS	60		94							
			4	SS	88		93							
92.0			5	SS	96		92							
3.7	GLACIAL TILL Silty Fine Sand to Sandy Silt with some Clay and Gravel  V. Dense Grey		6	SS	84		91							
			7	SS	90		90							
87.0			8	SS	68		89							
8.7	Fine SAND V. Dense Grey		9	SS	66		88							
85.5			10	SS	80/85		87							
10.2	V. Dense Grey		11	SS	58/100		86							
83.6							85							
12.1	Silty Fine SAND						84							
82.7	Grey, V. Dense.						83							
13.0	End of Borehole													

+3, x5: Numbers refer to  
Sensitivity

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



Ministry of  
Transportation and  
Communications

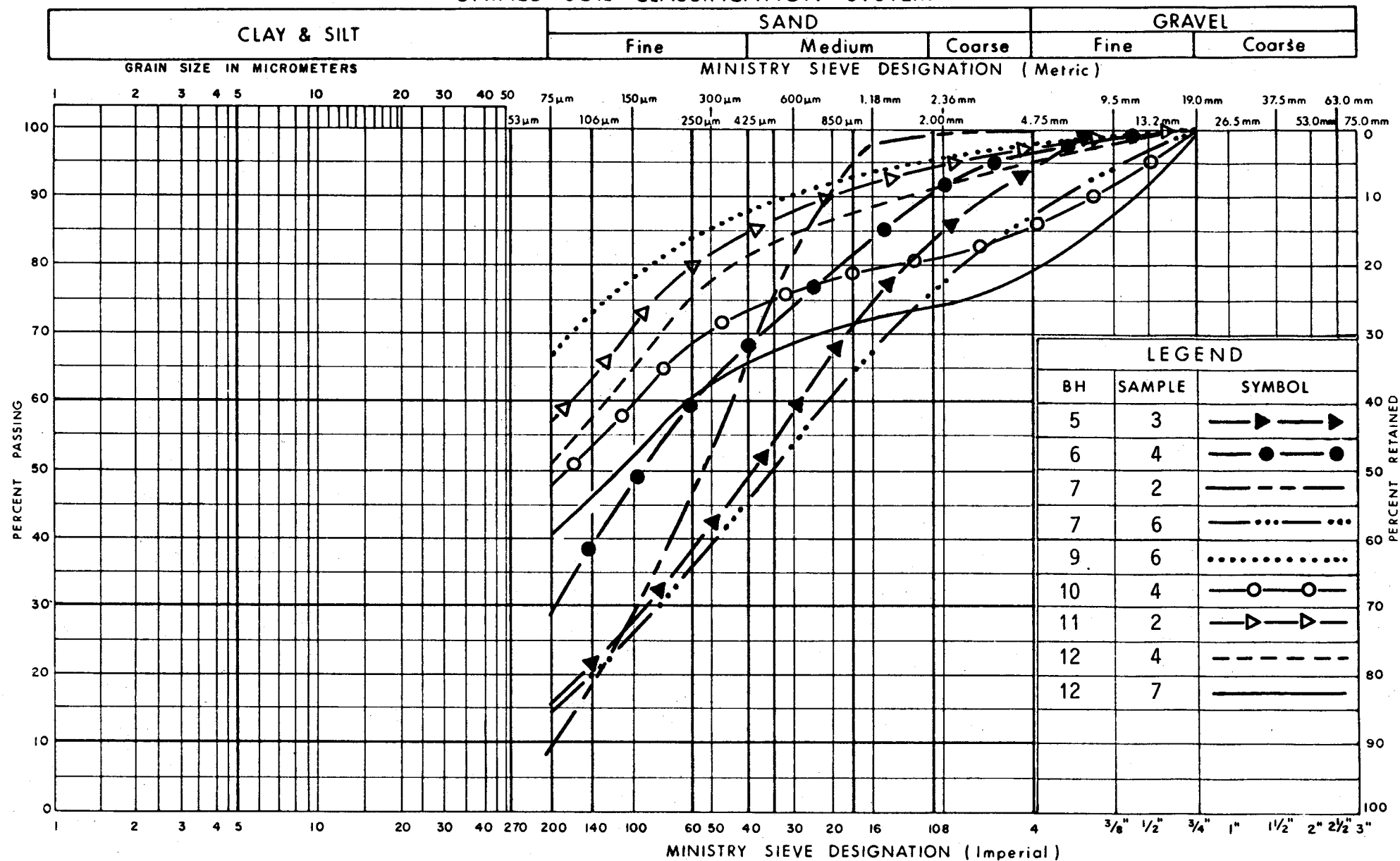
# PLASTICITY CHART Glacial Till and Silty Clay Deposits

FIG No 1

W P EGG - 000 - 26

Whitby

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
GLACIAL TILL - Silty Sand to Sandy Silt with Tr. Clay and  
Gravel

FIG No 2

W P EGG-000-26

Whitby

