

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 259-66-05

DIST 1

HWY E.C.Row Expy STR SITE 6-295

Jefferson Boulevard Overpass
2.3 Miles East of Walker Road

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JARS	79-07-12	1288
TUBES	79-07-12	1288
ROCK CORES	79-07-12	1288

FOUNDATION INVESTIGATION REPORT

For

Jefferson Boulevard Overpass
2.3 Miles East of Walker Road
W.P. 259-66-05, Site 6-295
E.C. Row Expressway, District 1, Chatham

INTRODUCTION

This report contains the results of a foundation investigation carried out for the above project. Fieldwork consisted of four sampled boreholes advanced during the period May 15 to 18, 1979 employing an auger machine mounted on a tracked vehicle. Bedrock was proven in one borehole by obtaining a BXL size rock core.

SITE DESCRIPTION

The site is located on the southeastern boundary of the City of Windsor approximately 200 feet south of the intersection of Jefferson Boulevard and the existing E.C. Row Avenue. The surrounding area is flat reflecting its physiographic designation as part of the St. Clair Clay Plain. Land use in the area is gradually changing from agricultural to industrial as development of the area proceeds. At the crossing Jefferson Boulevard is a two lane paved road flanked by gravel shoulders and shallow ditches.

SUBSURFACE CONDITIONS

General

Subsoil consists of about 125 feet of clayey silt followed by 10 to 15 feet of very dense granular till. These deposits overly weathered grey shale bedrock.

Reference should be made to the Record of Borehole Sheets which are contained in the report Appendix. They show the boundaries between soil types, as well as a summary of all field and laboratory tests performed. Reference should also be made to Drawing No. 2596605A which shows the location and elevations of all borings, as well as inferred subsoil stratigraphy.

Clayey Silt

The upper 125 feet of overburden consists of clayey silt with sand and a trace of gravel. A plot of liquid limit versus plastic index for samples from this deposit are shown as Figure 1 of the Appendix. The deposit has developed a 10 to 15 foot thick desiccated crust which is brown in colour and has an undrained shear strength ranging from 10,000 to 2500 psf. Below the crust the undrained shear strength ranges from 2500 to 1500 psf with the exception of the lower 25 feet where somewhat higher values are found. Moisture contents are generally between 12 and 20 percent with the lower values found in the crust.

Granular Till

A 10 to 15 foot thick deposit of very dense granular till was encountered overlying the bedrock. It consists of a mixture of boulders, cobbles, gravel, sand, silt and clay. Standard Penetration tests resulted in 'N' values ranging from 40 to in excess of 100 blows per foot. Other tests resulted in no penetration due to the sampler bouncing on cobbles or boulders. When refusal to a tricone bit occurred a five foot run with a BXL core barrel was taken. Several pieces of sedimentary and metamorphic rock were recovered with the largest being about 10 inches in length. The moisture content of samples tested from this deposit varied from 6 to 10 percent.

Bedrock

Bedrock was encountered at elevation 464 some 138 feet below the surface. It consisted of weathered grey shale containing seams of clay up to 1/2 inch in thickness.

Groundwater

Groundwater entered the boreholes slowly until the granular till was encountered. It then rose slowly to about four feet below the surface.

DESIGN CONSIDERATIONS

It is proposed that the E.C. Row Expressway pass over Jefferson Boulevard on a single span structure approximately 75 feet in length and 115 feet in width. Full height abutments would be employed to retain the approximately 23 foot high embankments.

RECOMMENDATIONS

Closed Abutments

It is recommended that the abutments be supported on spread footings in original ground at elevation 497 with a design load of 3 tons per square foot. Resistance to horizontal forces may be found employing a design adhesion value of 2000 lb. per square foot. It is predicted that maximum settlement will not exceed 6 inches.

Perched Abutments

If perched abutments are required they may be supported on compacted granular 'A' cores within the approach fills. A design loading of 3 tons per square foot should be employed. For calculations of sliding resistance a friction coefficient of 0.5 may be assumed to apply between the footing and the granular 'A'. A suggested construction scheme is shown as Figure 2 in the Appendix.

Alternately, perched abutments may be supported on closed end tube piles driven into the crust. A design load of 25 tons per pile may be employed for 12 3/4" x 1/4 piles driven to elevation 592.

It is predicted that total settlement will not exceed 6 inches. The settlement occurring after construction of the structure may be reduced through the use of stage construction.

Piers

If a multi-span structure is constructed the piers may be supported on spread footings. A design load of 3 tons per square foot may be supported at elevation 597. Resistance to sliding may be calculated employing a design adhesion value of 2000 pounds per square foot. It is predicted that settlement will not exceed 2 inches.

Steel H Piles

Alternately, the structure may be supported on steel H piles with driving controlled by SS3-11. Piles with a 74 lb. section will achieve a design load of 120 tons per pile at approximate elevation 464. The pile tips should be reinforced by standard flange plates to prevent damage due to boulders in the till layer overlying the bedrock. In this case settlement will be less than one inch.

Dewatering

No dewatering problems are anticipated due to the relatively impervious nature of the subsoil.

Frost Protection

The base of all footings should be protected from frost action by a minimum of four feet of cover.

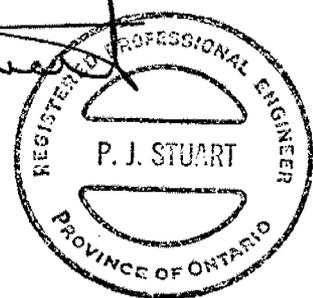
Approach Fills

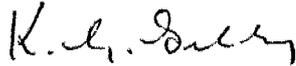
No stability problems are anticipated with 25 foot approach fills if 2 horizontal to 1 vertical slopes are employed.

Earth Pressure

It is anticipated that backfill to abutments will consist of quarried rock meeting granular 'A' specifications. It is estimated it will have a unit weight of 150 pcf. Earth pressure for abutments which are not fixed at the top may be calculated employing this value and a coefficient of earth pressure of 0.3 when supported on spread footings and 0.4 if supported on long piles.


P.J. Stuart, P. Eng.
Project Engineer




K.G. Selby, P. Eng.
Supervising Engineer

July, 1979

APPENDIX



RECORD OF BOREHOLE No 1

W P 259-66-05 LOCATION Coords. N 15 365 212; E 881 157 ORIGINATED BY PRK
 DIST 1 HWY E.C. Row BOREHOLE TYPE Hollow Stem Auger and B Casing COMPILED BY PRK
 DATUM Geodetic DATE May 15, 1979 CHECKED BY [Signature]

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						
601.9	Ground Level																	
0.0	Brown Grey Clayey Silt With Sand Trace of Gravel Hard to Stiff		1	SS	16													
			2	SS	40													
			3	SS	34													
			4	SS	26													
			5	SS	17													
			6	SS	12													
			7	SS	9													
			8	SS	11													
			9	SS	9													
			10	SS	8													
			11	SS	9													
			12	SS	11													
			13	SS	13													
			14	SS	26													
			15	SS	19													
482.9																		

OFFICE REPORT ON SOIL EXPLORATION

119.0

Continued

+³, x⁵: Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 1 Continued

W P 259-66-05 LOCATION Coords. N 15 365 212; E 881 157 ORIGINATED BY PRK
 DIST 1 HWY E.C.Row Expy BOREHOLE TYPE Tri-Cone With Casing, BXL Core COMPILED BY PRK
 DATUM Geodetic DATE May 15, 1979 CHECKED BY [Signature]

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			SHEAR STRENGTH 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
482.9	continued															
119.0	Clayey Silt						480									
476.9																
125.0	Mixture of Boulders Cobbles, Gravel, Sand, Silt and Clay Very Dense (Glacial Till)		16	SS	40											
			17	BXL RC	31% Rec		270									
			18	SS	100											
464.2			19	SS												
137.7	Grey Shale Bedrock (Weathered)		20	BXL RC	50% Rec											
458.5			21	SS	100											
143.4	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

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



RECORD OF BOREHOLE No 2

W P 259-66-05 LOCATION Coords. N 15 365 116; E 881 211 ORIGINATED BY PRK
 DIST 1 HWY E.C.Row Expy BOREHOLE TYPE Hollow Stem Auger COMPILED BY PRK
 DATUM Geodetic DATE May 17, 1979 CHECKED BY [Signature]

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					
601.6	Ground Level															
0.0	Brown Grey Clayey Silt With Sand Trace of Gravel Hard to Stiff		1	SS	30											
			2	SS	50											
			3	SS	32											
			4	SS	17											
			5	TW	PH										137	
			6	TW	PH										137	
			7	TW	PH										137	
			8	TW	PH										139	
			9	SS	12											
560.1					10	SS	11									
41.5	End of Borehole Note: Water Level Not Established															

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 3

W P 259-66-05 LOCATION Coords. N 15 365 192; E 881 046 ORIGINATED BY PRK
 DIST 1 HWY E.C.Row Expy BOREHOLE TYPE Hollow Stem Auger COMPILED BY PRK
 DATUM Geodetic DATE May 17, 1979 CHECKED BY CP

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 PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
602.1	Ground Level																
0.0	Brown Grey Clayey Silt With Sand Trace of Gravel Hard to Stiff		1	SS	11												
			2	SS	40												
			3	SS	35												
			4	SS	13												
			5	TW	PH											140	
			6	TW	PH												
			7	TW	PH												
			8	TW	PH												
			9	SS	8												
			10	SS	12												
560.6																	
41.5	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to 20
Sensitivity 15-5 (% STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

W P 259-66-05 LOCATION Coords. N 15 365 072; E 881 083 ORIGINATED BY PRK
 DIST 1 HWY E.C.Row Expy BOREHOLE TYPE Hollow Stem Augers, Tri-cone Washboring COMPILED BY PRK
 DATUM Geodetic DATE May 17, 1979 CHECKED BY *ep.*

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
601.6	Ground Level															
0.0	Brown Grey Clayey Silt With Sand Trace of Gravel Hard to Stiff		1	SS	12											
				2	SS	39										
				3	SS	34										
				4	SS	20										
				5	SS	14										
				6	SS	15										
				7	SS	12										
				8	SS	14										
				9	SS	11										
				10	SS	11										
				11	SS	13										
				12	SS	7										
				13	SS	6										
				14	SS	15										
				15	SS	31										
				16	SS	30										
482.6																
119.0																

Continued

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

OFFICE REPORT ON SOIL EXPLORATION



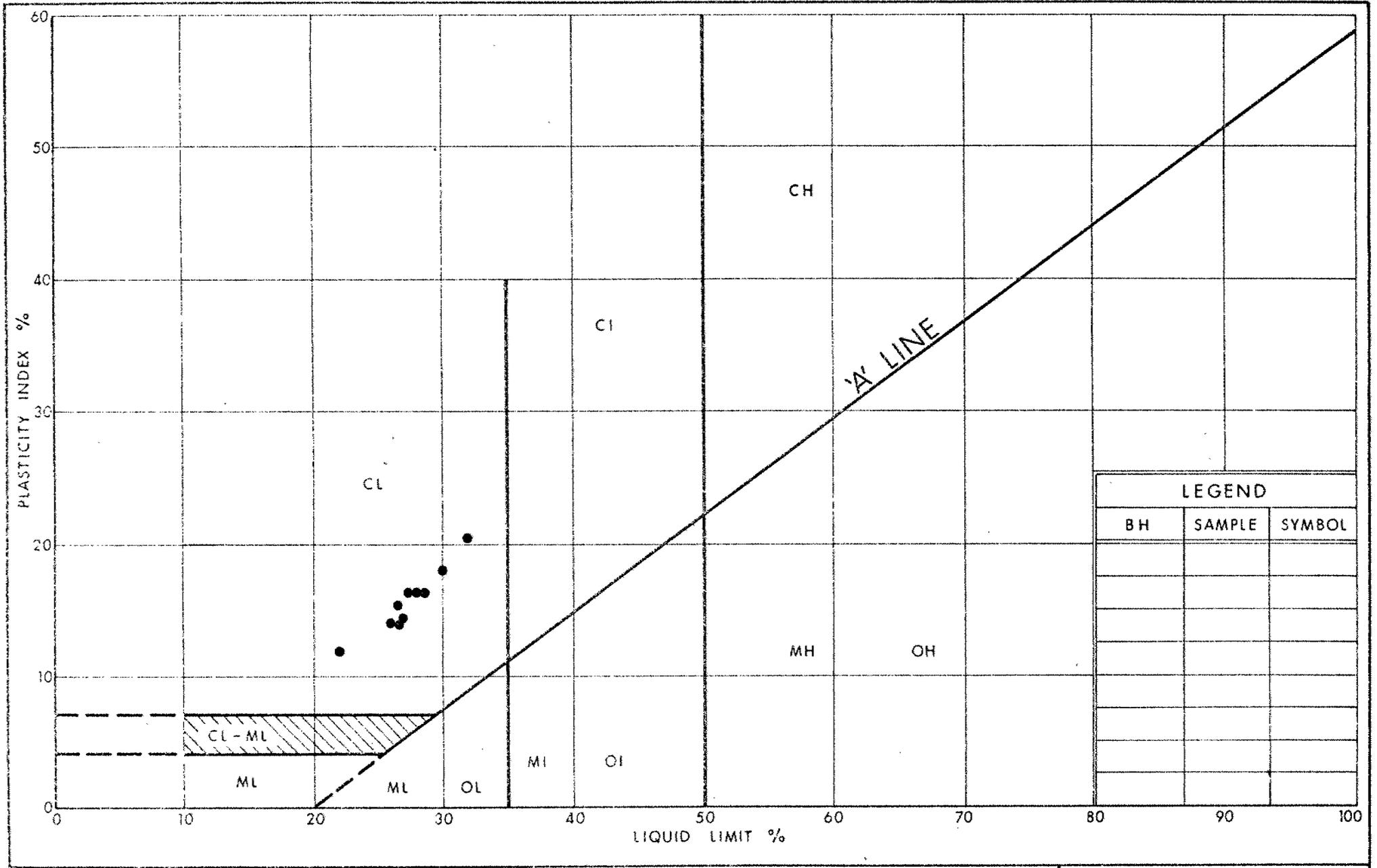
RECORD OF BOREHOLE No 4 Continued

W P 259-66-05 LOCATION Coords. N 15 365 072; E 881 083 ORIGINATED BY PRK
 DIST 1 HWY E.C.Row Expy BOREHOLE TYPE Tri-Cone Washboring COMPILED BY PRK
 DATUM Geodetic DATE May 17, 1979 CHECKED BY EP

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					
482.6	Continued																
119.0	Clayey Silt						480										
476.6																	
125.0	Boulders, Cobbles Gravel, Sand, Silt and Clay, Very Dense																
470.1	(Glacial Till)		17	SS	120/6"											38 45 12 5	
131.5	End of Borehole																

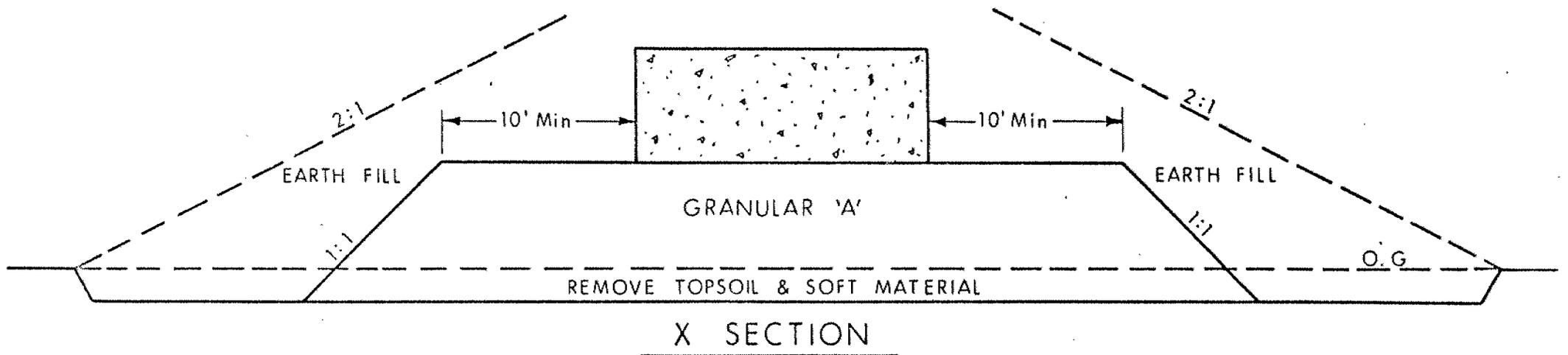
OFFICE REPORT ON-SOIL EXPLORATION

*³, x⁵: Numbers refer to Sensitivity 20
 15 5 (%) STRAIN AT FAILURE
 10

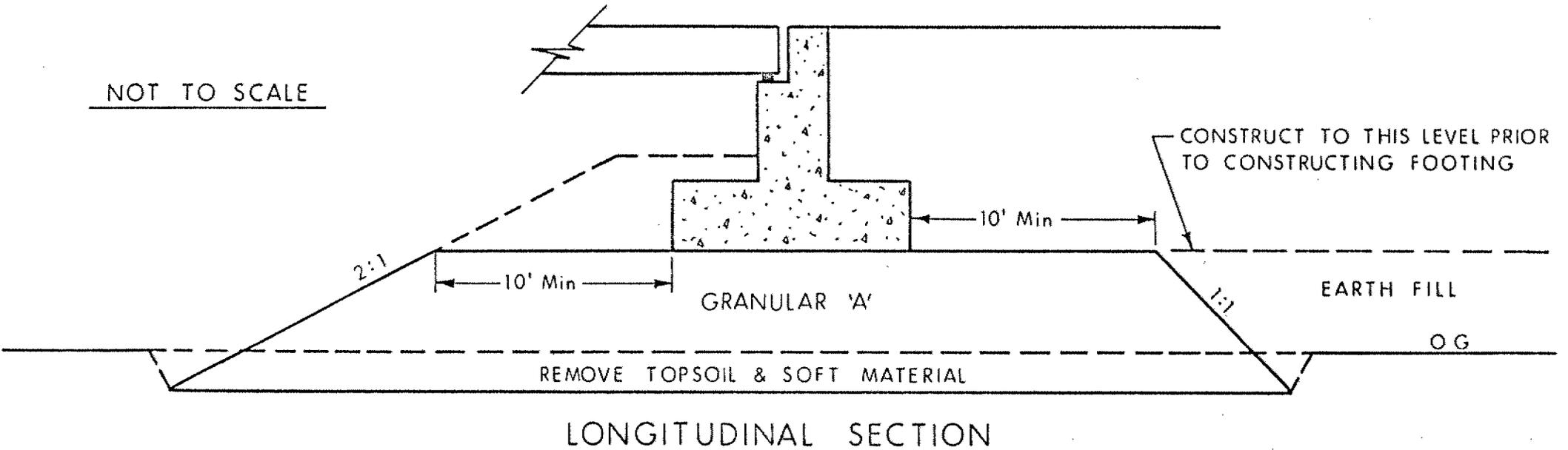


LEGEND		
BH	SAMPLE	SYMBOL

ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



NOT TO SCALE



NOTE:

REMOVE TOPSOIL & OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH FILL.

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N.

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

S _u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. CUU = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

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

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
δ ANGLE OF WALL FRICTION
k_o COEFFICIENT OF EARTH PRESSURE AT REST
k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
i ANGLE OF INCLINATION OF SURCHARGE
ω SLOPE ANGLE-BACKFACE OF WALL
β ANGLE OF SLOPE
N_γ, N_q, N_c BEARING CAPACITY FACTORS
D_f DEPTH OF FOOTING
B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_w UNIT WEIGHT OF WATER
γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ' UNIT WEIGHT OF SUBMERGED SOIL
G_s SPECIFIC GRAVITY OF SOLIDS
e VOIDS RATIO
e_o INITIAL VOIDS RATIO
e_{max} e IN LOOSEST STATE
e_{min} e IN DENSEST STATE
D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
n POROSITY
w WATER CONTENT
w_L LIQUID LIMIT
w_P PLASTIC LIMIT
w_S SHRINKAGE LIMIT
I_P PLASTICITY INDEX = w_L - w_P
I_L LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
A_c ACTIVITY = $\frac{I_p \text{ of soil}}{I_p \text{ of } 2\mu\text{m Soil Fraction}}$
O_m ORGANIC MATTER CONTENT
S_r DEGREE OF SATURATION
S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

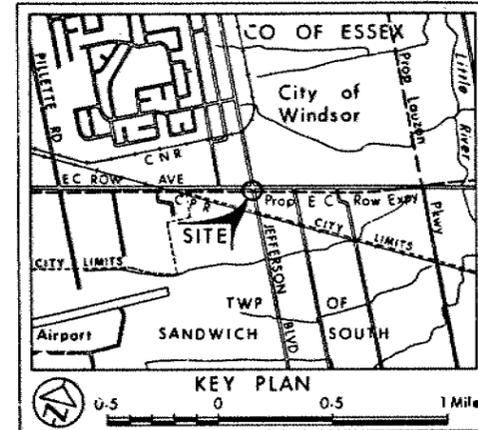
STRENGTH PARAMETERS

φ ANGLE OF SHEARING RESISTANCE
τ_f PEAK SHEAR STRENGTH
τ_R RESIDUAL SHEAR STRENGTH
c COHESION INTERCEPT
σ₁, σ₂, σ₃ NORMAL PRINCIPAL STRESSES
u PORE WATER PRESSURE
u_e EXCESS u
r_u PORE PRESSURE RATIO
q_u UNCONFINED COMPRESSIVE STRENGTH
s_u UNDRAINED SHEAR STRENGTH
ε LINEAR STRAIN
γ SHEAR STRAIN
ν POISSON'S RATIO
E MODULUS OF ELASTICITY
G MODULUS OF SHEAR DEFORMATION
k_s MODULUS OF SUBGRADE REACTION
m, n STABILITY COEFFICIENTS
A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
q RATE OF DISCHARGE
v VELOCITY OF FLOW
i HYDRAULIC GRADIENT
j SEEPAGE FORCE PER UNIT VOLUME
η COEFFICIENT OF VISCOSITY
k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
k_h k IN HORIZONTAL DIRECTION
k_v k IN VERTICAL DIRECTION
m_v COEFFICIENT OF VOLUME CHANGE
c_v COEFFICIENT OF CONSOLIDATION
C_c COMPRESSION INDEX
C_r RECOMPRESSION INDEX
d DRAINAGE PATH DISTANCE
T TIME FACTOR
U DEGREE OF CONSOLIDATION
O_r OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS: σ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE; σ' = EFFECTIVE NORMAL STRESS



- LEGEND**
- Bore Hole
 - ⊕ Dynamic Cone Penetration Test (Cone)
 - ⊙ Bore Hole & Cone
 - 'N' Blows/ft (Std Pen Test 350ft lbs energy)
 - CONE Blows/ft (60° Cone, 350ft lbs energy)
 - ↓ WL at time of investigation May 1979
 - ⊔ WL Not Established in BH 2

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	601.9	15 365 212	881 157
2	601.6	15 365 116	881 211
3	602.1	15 365 .92	881 046
4	601.6	15 365 072	881 083

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

REVISIONS	DATE	BY	DESCRIPTION

