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DIST. 6 REGION \_\_\_\_\_

W.P. No. 89-78-00

CONT. No. \_\_\_\_\_

W. O. No. \_\_\_\_\_

STR. SITE No. \_\_\_\_\_

HWY. No. 407

LOCATION Hwy 407 FROM JANE ST  
To WOODBINE AVE

No of PAGES - \_\_\_\_\_



OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. \_\_\_\_\_

REMARKS: \_\_\_\_\_

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Ontario

Ministry of  
Transportation and  
Communications

# foundation investigation and design report

ENGINEERING MATERIALS OFFICE  
SOIL MECHANICS SECTION

WP 89-78-00

DIST. 6

HWY 407

STR SITE

Feasibility Study of Hwy. 407  
From East of Jane Street  
to East of Woodbine Avenue

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# FOUNDATION INVESTIGATION REPORT

For

Feasibility Study  
of Hwy. 407 From East of  
Jane Street to East of Woodbine Avenue  
W.P. 89-78-00, District 6, Toronto

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## INTRODUCTION

This report contains the results of a feasibility foundation investigation performed at structural project sites along the above mentioned route study. The field investigation was carried out during the period from November 6 to November 23, 1978 and consisted of a total of 23 boreholes. The borings were advanced to depths ranging from 26 to 132 feet by means of continuous flight hollow stem augers. In addition, a thorough literature search of subsoil information within the study area resulted in the use of data from 5 additional borings, B.H. 24 to B.H. 28, advanced previously by this Section at nearby site locations.

## ROUTE DESCRIPTION AND GEOLOGY

The study route extends east-west immediately north of the Metropolitan Toronto boundary through the Towns of Vaughan, Richmond Hill and Markham, within the Regional Municipality of York. The area for this portion of the Hwy. 407 study roughly parallels the existing Hwy. 7 between the C.N.R. Concord Marshalling Yard and Woodbine Avenue.

Topography in general can be described as gently undulating, except where the creeks and rivers have cut steep valleys into the surficial deposits. Predominant land use along the proposed right of way consists of cultivated open fields except for localized residential and light industrial uses along the major arterial roads.

Physiographically, the study area is wholly located within the region known as the "Peel Plain". The plain is characterized by drumlinized till plains or boulder clay modified by basins of

lacustrine sedimentation and dissected by branches of the Don River. Lake deposits consist of stratified to varved sands, silts and clay that are widespread in the area and overlie the till. Where the drainageways have cut deep valleys, modern stream alluvium generally consisting of stratified sand and some gravel can be found. Slope-wash deposits of sand and silt occur along the bottom of many of the rivers and streams.

#### SUBSURFACE CONDITIONS

Generally, two prominent subsurface soils were encountered throughout the study area

- i) clayey silt till
- ii) silty sand to sandy silt

The predominant subsurface stratum over most of the study area consists of a glacial till composed of a heterogeneous mixture of clayey silt, some sand and traces of gravel. Results from testing indicate the clayey silt to be inorganic, generally of low plasticity. This ground moraine till deposit was explored to a maximum depth of 78 feet with consistency ranging from stiff to hard but generally very stiff throughout. This competent till is usually unsorted and well graded, but zones of sand and/or silt inclusions were found throughout.

The lacustrine deposits of silty sand to sandy silt were found to be more dominant in the eastern portion of the study area. Occasional silt and gravel layers or silt lenses were found in various locations. The denseness of these materials based on Standard Penetration Test results was found to vary from loose to very dense, but generally dense throughout. Often this stratum was interrupted by beds of clay silt generally firm to stiff in consistency. The granular deposit was explored to a maximum depth of 42 feet.

The glacial till overlies bedrock in the area, however, bedrock was not encountered in any of the borings. Generally, bedrock has a southward slope in the study area and can be found at depths in excess of 200+ feet.

Groundwater was encountered at depths ranging from 7 to 35 feet below ground surface, except adjacent to waterways where the groundwater level would approximate the river water level.

The boundaries between various soil types, the groundwater conditions, and the results of physical testing on representative samples are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, as well as site locations, are shown on the attached Drawings 897800-A and B.

## DISCUSSION AND RECOMMENDATIONS

At present the regional planning and design staff is involved in the preliminary design phase for Hwy. 407, a provincial freeway link to serve both as a northern east-west traffic corridor and a Metropolitan Toronto bypass. This report concerns itself with the Hwy. 407 study section from west of Keele Street to east of Woodbine Avenue. This section also addresses itself to a major relocation of Hwy. 7 north from west of Dufferin Street to east of Bayview Avenue. Twenty-eight structure sites including five river crossings were investigated for this program. Presently proposed grades for Hwy. 407 in the area will involve roadway cuts to 25 feet in depth and fills up to 40 feet in height.

In general, subsurface conditions over the site are uniform and competent for structure foundation and embankment loadings.

Our comments for the feasibility, design and construction of the various structures are given on the Foundation Data Sheets included in the Appendix. A data sheet is supplied for each of 28 areas; the area location is described on these sheets and is also shown on Drawing No. 897800-A and B. An explanation of information supplied on the data sheet is outlined below.

1. The site number given (i.e. B-1, B-2, etc.) is a numbering system developed for the purposes of the feasibility study only. The actual location is shown on Drawing No. 897800-A and B.
2. The original ground elevation range given is based on a small scale  $\varnothing$  profile and as such the accuracy is not great.
3. The proposed roadway-railway grades are based on a small scale  $\varnothing$  profile at the intersection of centrelines. The grade given is understood to be preferred by Planning and Design.
4. Subsurface conditions are described here very briefly and are based on generally not more than one boring per area.

Consistencies and relative densities, where applicable, are given.

#### 5. Recommendations - Structure

The recommendations are discussed separately for abutments and piers. The options for structure foundations are given in preferential order based on geotechnical/economical considerations. Further elaboration of structure recommendations made on the data sheets are given below.

Compacted Granular Pad - This option is for abutments only where subsurface conditions are competent. This option is not recommended for water crossings. The minimum requirements of a compacted granular pad are shown on Figure 1 in the Appendix. Furthermore, the footing for this scheme could be designed to a maximum allowable pressure of 3.0 t.s.f.

Spread Footings - This option is given for abutments and piers where subsurface conditions are competent. The maximum elevation and corresponding maximum design load is given. It is to be noted the spread footings should be provided with a minimum of 4 feet of earth cover for frost protection purposes. In addition, where the spread footing is to be founded on a cohesive deposit, subject to softening upon exposure to construction or weather conditions, it would be necessary to protect the base of the footing excavation from softening by placing a working slab of lean concrete immediately upon completion of the footing excavation. Also, where the footing is located in a granular deposit and the water table is at or above the footing founding level, it will be necessary to prevent the base of the footing from boiling due to an unbalanced excess hydrostatic head. In this case a dewatering scheme would be required. Two alternative dewatering schemes are shown on Figure 2 and Figure 3.

End-Bearing Piles - This founding scheme is recommended for abutments and piers where appropriate. The recommendation gives the estimated pile tip elevation. Generally, the end bearing piles can be designed for the maximum allowable

structural capacity which is dependent on the pile section chosen. For example, the maximum allowable load for a 12BP74 steel 'H' pile would be 110 tons per pile. It is generally assumed steel 'H' piles will be used, however, if a certain pile section is not suitable at the specific area, this fact is mentioned in the data sheet. Pile driving would be field controlled by the Hiley Formula unless it is being driven to the bedrock surface or in clayey subsoil.

Friction Piles - This foundation is recommended for abutments and piers where it is considered to be suitable and economically competitive with an end bearing pile. The loading recommendations are given for a #14 timber pile of specified length. If a different type of friction pile is contemplated the maximum allowable load could be prorated by comparing the surface area of the pile in question and the timber pile.

#### 6. Recommendation - Approaches

The recommendations for fill slopes, cut slopes and berm requirements, are based on the proposed preliminary grades assuming fills are constructed of acceptable earth borrow according to current M.T.C. Specifications. Any changes in profile grade would require a reassessment of these recommendations. Also discussed under this heading is special treatment, i.e. benching, slope protection, etc., that is anticipated at this location. No excessive settlements of embankments at the proposed fill heights are anticipated at this stage.

#### 7. Remarks

In this column assumptions made and geotechnical preference of schemes if appropriate, are discussed, as well as other options or considerations to be evaluated during this stage of design.

#### MISCELLANEOUS

The various comments outlined in this report are for feasibility study purposes based on limited field data. It will be necessary

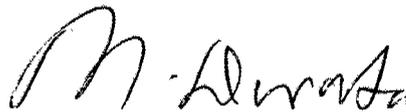
to carry out a detailed subsurface investigation at each of the structure sites when the design details and geometries are finalized and approved. In some areas, groundwater studies and special in-situ field testing may be warranted.

The fieldwork for this investigation was carried out under the supervision of Mr. T.J. Kazmierowski, Project Engineer, using equipment rented from Dominion Soil Investigation Limited.

This report was written by Mr. T.J. Kazmierowski and reviewed by Mr. M. Devata, Supervising Engineer



T.J. Kazmierowski, P.  
Project Engineer



M. Devata, P. Eng.  
Supervising Engineer

February, 1979

APPENDIX

# FOUNDATION DATA SHEET

W.P. 89-78-00 SITE B-1 LOCATION Hwy. 407 Crossing C.N.R. Concord Marshalling Yard  
 ORIGINAL GROUND ELEV. 688-691 PROPOSED HWY. 407 GRADE ELEV. 714-720+

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<p><u>Reference Boreholes 22 &amp; 23</u></p> <p>BH 22 (eastern portion) 0-80' + clayey silt stiff to hard</p> <p>BH 23 (western portion) 0-50' + clayey silt stiff to hard</p> <p><u>Groundwater</u></p> <p>Overnight water level at 35' below ground surface.</p>	<p><u>Abutments and Piers</u></p> <p>1) Footings founded on end-bearing steel 'H' section piles driven to tip elevations of 610+ on east side, 635+ on west side. Designed for the maximum allowable load per pile section.</p>	<p>Fill heights up to 35 ft. will be stable with forward and side slopes of 2:1. However, a 10 foot wide mid-height bench incorporating an intercepting ditch should be considered in order to minimize future slope maintenance problems.</p>	<p>A suggested subway scheme beneath the marshalling yard is feasible considering the competent nature of the subsoils at this site. However, an in depth study of the groundwater regime of the area and permeability and deformation characteristics of the soils will be necessary for any large scale cut and tunnelling operations.</p>



# FOUNDATION DATA SHEET

W.P. 89-78-00      SITE B-3      LOCATION Hwy. 407 Crossing C.N.R. Newmarket Subdivision  
 ORIGINAL GROUND ELEV. 646      PROPOSED HWY. 407      GRADE ELEV. 622  
 Proposed C.N.R. 'Newmarket' Subdivision Grade Elevation 645

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<p><u>Reference Boreholes 20</u></p> <p>0-13' clayey silt very stiff to hard</p> <p>13'-40.5' silty sand to sandy silt Loose to dense</p> <p>40.5'-50' + clayey silt hard</p>  <p><u>Groundwater</u></p> <p>Water level encountered at 15' below ground surface.</p>	<p><u>Abutments and Piers</u></p> <p>1) End-bearing steel 'H' piles driven to a minimum tip elevation 595+ designed for the maximum allowable structural capacity of the given pile section.</p> <p>2) Abutments may be perched on spread footings located in the cut slopes at elevation 636 for an allowable loading of 3.0 t.s.f.</p>	<p>Fill heights up to N/A ft. will be stable with forward and side slopes of 2:1.</p> <p>Cuts up to a depth of 25 feet will prove stable with 2:1 slopes and berm geometry. However, due to the granular nature of the subsoil and groundwater level an extensive temporary and permanent dewatering system and slope treatment will be required. Further, if cuts are contemplated, a detailed hydrogeological study should be carried out to evaluate the effects of such cuts on the groundwater regime.</p>	<p>In view of the recommendations, a structure to carry Hwy. 407 over the C.N.R. Newmarket Subdivision is preferred from a geotechnical cost viewpoint.</p>



# FOUNDATION DATA SHEET

W.P. 89-78-00      SITE B-5      LOCATION Hwy. 7N Crossing West Don River  
 ORIGINAL GROUND ELEV. 613.5      PROPOSED HWY. 7N      GRADE ELEV. \_\_\_\_\_

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<p><u>Reference Boreholes</u> 24</p> <p>0-8' sand and gravel loose to dense</p> <p>8'-17.5' clayey silt very dense</p> <p>17.5-25' silty sand dense</p> <p>25-41' + clayey silt dense</p>  <p><u>Groundwater</u></p> <p>Water level at 4' below ground surface.</p>	<p>A soil-steel structure i.e. C.S.P. or S.P.P.A. with minor stream realignment is recommended for this site.</p> <p>Alternatively, a single span concrete rigid frame structure can be founded on spread footings at or below elevation 605 for an allowable bearing pressure of 3.0 t.s.f.</p>	<p>Fill heights up to 25 ft. will be stable with forward and side slopes of 2:1.</p>	<p>Due to the lack of vertical alignment data, it is assumed that fills in the order of 25 feet are required at this site.</p> <p>A temporary dewatering system for footing excavation or pipe placement may be required.</p>



































# FOUNDATION DATA SHEET

W.P. 89-78-00      SITE B-25      LOCATION Hwy. 407 E-N Ramp to Hwy. 404 at Hwy. 7  
Hwy. 404 S-W Ramp to Hwy. 407 at Hwy. 7  
 ORIGINAL GROUND ELEV. 624 to 629      PROPOSED HWY. 407 GRADE ELEV. \_\_\_\_\_

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<p> <u>Reference Boreholes 27 &amp; 28</u>            Borehole 27 (west)            0-8.5' clayey silt, hard            8.5-19' sandy silt                compact to hard            19-61' + clayey silt, stiff                to hard            Borehole 28 (east)            0-11.5' sandy silt, dense                to very dense            11.5-20' silty clay to                clayey silt, hard            20-36' + clayey silt                very dense    <u>Groundwater</u>            Water level at 1' below            ground surface.         </p>	<p> <u>East Structure: Abutments</u>            1) On compacted granular pad within                fills.            2) End-bearing piles driven to tip                elevation 600+ for maximum structural                capacity of pile section.    <u>West Structure: Abutments</u>            1) On compacted granular pad within fills.            2) End-bearing piles driven to tip                elevation 570+ for maximum structural                capacity of pile section.         </p>	<p>           Fill heights up to 20 ft.            will be stable with forward            and side slopes of 2:1.         </p>	







### RECORD OF BOREHOLE No 1 (Site B-28)

W P 89-78-00 LOCATION Coords. N 15 929 960; E 1 037 920 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 6, 1978 CHECKED BY [Signature]

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						WATER CONTENT (%)		
592.9	Ground Level																			
0.0	Trace of Organics  Clayey Silt Some Sand Trace of Gravel Soft to Hard  Silty Clay  Sand and Silt Seams Throughout		1	SS	5															
			2	SS	5															
			3	SS	17															
			4	SS	16															
			5	SS	8															
			6	SS	9															
			7	SS	4															
			8	SS	2															
			9	SS	29															
			10	SS	30															
			11	SS	4															
539.9					12	SS	53													
53.0	Silty Sand																			
533.4			13	SS	69															
59.5	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 (Site B-23)

W P 89-78-00 LOCATION Coords. N 15 929 100; E 1 034 550 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 6, 1978 CHECKED BY *CP*

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	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						SHEAR STRENGTH
607.8	Ground Level																
0.0	Clayey Silt Trace Sand and Organics Very Stiff Brown  Sandy Silt to Silty Sand Trace Gravel and Clay  Brown  Dense to Very Dense	1	SS	17													
		2	SS	22													
599.3		3	SS	7													
8.5		4	SS	36													0 9 89 2
		5	SS	84													5 62 28 5
		6	SS	67													
		7	SS	115/	9"												
		8	SS	100/	3"												
		9	SS	109													0 74 25 1
567.3	End of Borehole																
41.5	Water Level Not Encountered																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3 (Site B-24)

W P 89-78-00 LOCATION Coords. N 15 930 860; E 1 034 030 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 7, 1978 CHECKED BY CP

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						SHEAR STRENGTH
											○ UNCONFINED	+	FIELD VANE	WATER CONTENT (%)				
											● QUICK TRIAXIAL	x	LAB VANE	10	20	30		
608.8	Ground Level																	
608.8	Topsoil																	
2.0	Clayey Silt, Trace Sand and Gravel Soft to Firm		1	SS	4													
			2	SS	7													
600.8	Sandy Silt		3	SS	10												0 18 81 1	
8.0			4	SS	8													
595.3	Loose		5	SS	11													
13.5	Clayey Silt Some Sand Trace Gravel  Sand and Silt Seams Throughout  Very Stiff to Hard		6	SS	60												16 29 37 18	
			7	SS	81													
			8	SS	21													
			9	SS	107												0 1 58 41	
562.3	End of Borehole		10	SS	102													
46.5																		

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 4 (Sites B-26 & B-27)

W P 89-78-00 LOCATION Coords. N 15 929 250; E 1 035 930 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 7, 1978 CHECKED BY *TK*

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
600.4	Ground Level															
0.0	Topsoil															
597.4																
3.0	Clayey Silt, Some Sand, Trace of Gravel		1	SS	21											
592.4	Very Stiff		2	SS	22											
8.0	Silt to Sandy Silt		3	SS	19									0 3 94 3		
	Trace Clay and Gravel		4	SS	14									0 7 92 1		
			5	SS	22											
			6	SS	12									7 42 42 9		
577.4	Compact		7	SS	16											
23.0	Clayey Silt Some Sand Trace of Gravel		8	SS	51											
	Sand and Silt Seams Very Stiff to Hard		9	SS	35											
			10	SS	19											
551.9			11	SS	707	6"										
48.5	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 5 (Site B-22)

W P 89-78-00 LOCATION Coords. N 15 928 610; E 1 031 470 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 8, 1978 CHECKED BY [Signature]

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	PLASTIC LIMIT $W_p$	NATURAL MOISTURE CONTENT $W$	LIQUID LIMIT $W_L$				
608.9	Ground Level																				
606.9	Topsoil																				
2.0	Clayey Silt Some Sand Trace Gravel  Occasional Silt and Sand Seams Throughout  Stiff to Hard	[Strat Plot]	1	SS	14													0 14 61 25			
			2	SS	14																
			3	SS	24																
			4	SS	40																
			5	SS	38																
			6	SS	46																10 33 43 14
			7	SS	81																
582.9			8	SS	60																
26.0	End of Borehole  Note: Water Level Not Established																				

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 6 (Site B-21)

W P 89-78-00 LOCATION Coords. N 15 928 820; E 1 025 940 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 8, 1978 CHECKED BY [Signature]

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					
											○ UNCONFINED	+ FIELD VANE	WATER CONTENT (%)				
											● QUICK TRIAXIAL	x LAB VANE	10	20	30		
620.3	Ground Level																
0.0	Clayey Silt Trace of Sand		1	SS	32												
			2	SS	37											0 3 83 14	
			3	SS	32												
			4	SS	16											0 4 79 17	
	Sand Seams		5	SS	16												
			6	SS	29												
	Cobbles																
599.3	Very Stiff to Hard		7	SS	60											0 13 66 21	
21.0	Sandy Silt Trace of Clay Dense to Very Dense		8	SS	46												
			9	SS	33											0 37 62 1	
578.8			10	SS	73												
41.5	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 7 (Site B-17)

W P 89-78-00 LOCATION Coords. N 15 929 020; E 1 024 770 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 8, 1978 CHECKED BY [Signature]

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							
666.6	Ground Level							20 40 60 80 100							
0.0	Clayey Silt With Sand Trace of Gravel  Occasional Sand Seams  Very Stiff to Hard		1	SS	15		660							4	28 52 16
			2	SS	22										
			3	SS	53										
			4	SS	79										
			5	SS	110	9"								9	45 40 6
			6	SS	56		650							5	32 45 18
			7	SS	86										
			8	SS	125										
640.6	Cobbles														
26.0	End of Borehole													0	6 (94)

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity 20  
 15  $\phi$  5 (%) STRAIN AT FAILURE  
 10



RECORD OF BOREHOLE No 8 (Site B-18)

W P 89-78-00 LOCATION Coords. N 15 929 580; E 1 024 760 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 9, 1978 CHECKED BY CP

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						SHEAR STRENGTH
674.5	Ground Level																	
0.0	Silty Sand Trace of Gravel and Clay Brown Loose to Compact		1	SS	15												8 46 41 5	
			2	SS	11													
665.0			3	SS	7													
9.5	Clayey Silt With Sand Trace of Gravel  Stiff to Hard		4	SS	10												6 32 46 16	
			5	SS	25													
			6	SS	120													
			7	SS	71/6"													
643.0			8	SS	97													
31.5	End of Borehole																	

OFFICE REPORT ON SOIL EXPLORATION

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



HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 9 (Sites B-19 & B-20)

W P 89-78-00 LOCATION Coords. N 15 931 070; E 1 024 820 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 9, 1978 CHECKED BY [Signature]

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					
648.7	Ground Level																
0.0	Sandy Silt to Silty Sand Some Gravel Trace of Clay Compact to Very Dense	[Strat Plot]	1	SS	18								○			20 36 40 4	
			2	SS	58								○			14 44 33 9	
			3	SS	27											63 27 (10)	
			4	SS	69												
			5	SS	42												
633.2			6	SS	25												
15.5	Clayey Silt Trace of Sand and Gravel  Very Stiff to Hard	[Strat Plot]	7	SS	24								○			1 0 53 46	
			8	SS	56												
618.2			9	SS	25											0 12 82 6	
30.5	Silt Some Sand Trace of Clay Compact to Very Dense	[Strat Plot]															
607.2			10	SS	62												
41.5	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity  
 20  
 15 - 5 (%) STRAIN AT FAILURE  
 10

RECORD OF BOREHOLE No 10 (Site B-15)

W P 89-78-00 LOCATION Coords. N 15 929 470; E 1 019 970 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 9, 1978 CHECKED BY [Signature]

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					
655.0	Ground Level														
0.0	Clayey Silt With Sand Trace of Gravel Stiff to Very Stiff		1	SS	13										
646.5			2	SS	17										0 27 52 21
			3	SS	49										
8.5	Layered Sandy Silt to Silty Sand		4	SS	81										0 19 79 2
			5	SS	55										
	Some Gravel Trace of Clay		6	SS	37										0 84 15 1
	Dense to Very Dense		7	SS	86/	11" <sup>11</sup>									
628.9			8	SS	68/	6"									22 36 38 4
26.1	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

+3, x<sup>5</sup>: Numbers refer to Sensitivity 20 15-0.5 (%) STRAIN AT FAILURE 10



RECORD OF BOREHOLE No 11 (Site B-14)

W P 89-78-00 LOCATION Coords. N 15 928 630; E 1 018 500 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 14, 1978 CHECKED BY [Signature]

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	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						WATER CONTENT (%)
636.4	Ground Level																
0.0	Clayey Silt Some Sand Trace of Gravel  Stiff to Very Stiff	1	SS	12													2 18 50 30
		2	SS	19													
		3	SS	35													
		4	SS	30													
		5	SS	29													0 7 68 25
		6	SS	22													
617.9																	
18.5	Silt Trace of Sand and Clay  Loose to Very Dense	7	SS	23													0 6 92 2
		8	SS	7													
		9	SS	44													
600.2																	
		10	SS	76/9"													
36.2	End of Borehole  Note: Water Level Not Established																

OFFICE REPORT ON SOIL EXPLORATION

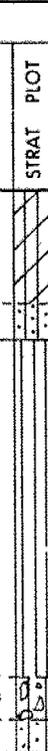
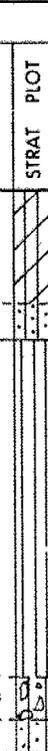
RECORD OF BOREHOLE No 12 (Site B-13)

W P 89-78-00 LOCATION Coords. N 15 927 550; E. 1 018 670 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 14, 1978 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60					
630.0	Ground Level														
0.0	Clayey Silt Some Sand Trace of Gravel		1	SS	21										
			2	SS	23										3 29 31 37
			3	SS	17										
			4	SS	18										
			5	SS	25										
	Occasional Sand Seams		6	SS	31										3 14 62 21
			7	SS	30										
	Very Stiff to Hard		8	SS	22										
600.0															
30.0	Silty Clay Trace of Sand Hard		9	SS	40										0 5 43 52
588.5															
41.5	End of Borehole Note: Water Level Not Established		10	SS	90										

## RECORD OF BOREHOLE No 13 (Site B-11)

W P 89-78-00 LOCATION Coords. N 15 925 770; E 1 012 000 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 15, 1978 CHECKED BY [Signature]

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60						80
635.2	Ground Level															
0.0	Clayey Silt With Sand Very Stiff		1	SS	25										3 45 37 15	
			2	SS	17											
			3	SS	48											
624.2	Sand Layers		4	SS	40										0 1 (99)	
11.0	Silt Trace of Sand and Clay  Compact to Dense		5	SS	34											
			6	SS	18											
			7	SS	30											
			8	SS	35											
			9	SS	35											
593.7	Silty Sand		10	SS	58										0 70 29 1	
41.5	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 14 (Site B-10)

W P 89-78-00 LOCATION Coords. N 15 925 080; E 1 012 130 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 15, 1978 CHECKED BY [Signature]

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	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE
630.8	Ground Level																	
0.0	Clayey Silt With Sand		1	SS	8	↓												
625.3	Stiff		2	SS	10													
5.5	Sandy Silt Trace of Clay		3	SS	19													
			4	SS	45													
			5	SS	44													
			6	SS	39													
	Occasional Sand Seams Throughout		7	SS	-													
			8	SS	2													
			9	SS	4													
			10	SS	22													
			11	SS	133													
			Loose to Very Dense															
585.1			12	SS	50/3"													
45.7	End of Borehole																	

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 15 (Site B-9)

W P 89-78-00 LOCATION Coords. N 15 923 000; E 1 005 750 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 15, 1978 CHECKED BY CP

SOIL PROFILE		STRAT PLOT	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		NUMBER	TYPE			'N' VALUES	20					
673.7	Ground Level												
0.0	Topsoil												
671.7													
2.0	Clayey Silt Trace to Some Sand Trace of Gravel		1	SS	7								4 20 46 30
			2	SS	19								
			3	SS	16								
			4	SS	11								
	Sand and Silt Inclusions Throughout		5	SS	21								10 42 38 10
			6	SS	8								
			7	SS	16								
	Firm to Hard		8	SS	33								12 26 48 14
			9	SS	38								
632.2			10	SS	37								0 61 37 2
41.5	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity  
 20  
 15  $\phi$  5 (%) STRAIN AT FAILURE  
 10

RECORD OF BOREHOLE No 16 (Site B-8)

W P 89-78-00 LOCATION Coords. N 15 921 650; E 1 005 890 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 16, 17 & 20, 1978 CHECKED BY [Signature]

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
660.5	Ground Level														
0.0	Brown Grey Clayey Silt With Sand Trace of Gravel  Sand and Silt Seams and Layers  Firm to Hard		1	SS	10										
				2	SS	16									4 28 45 23
				3	SS	21									
				4	SS	28									
				5	SS	14									
				6	SS	12									
				7	SS	7									0 36 49 15
				8	SS	18									
				9	SS	24									
				10	SS	28									1 30 42 27
				11	SS	62									
				12	SS	9									
				13	SS	48									
593.5															
67.0	Alternating Layers of Clayey Silt		14	SS	30									18 42 32 8	
	Silty Sand Some Gravel Trace of Clay														
	Compact		15	SS	23									12 60 23 5	
			16	SS	15										
563.5															
97.0	Clayey Silt Trace of Sand and Gravel		17	SS	41									0 6 58 36	
	Hard														
542.0															
118.5															

Continued

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity

20  
15 - 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 16 Continued (Site B-8)

W P 89-78-00 LOCATION Coords. N 15 921 650; E 1 005 890 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger COMPILED BY TK  
 DATUM Geodetic DATE November 16, 17 and 20, 1978 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH									
542.0	cont'd																
118.5	Clayey Silt Trace of Sand and Gravel Hard		18	SS	102/6"		540										
529.0			19	SS	180		530										1 2 (97)
131.5	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 17 (Site B-7)

W P 89-78-00 LOCATION Coords. N 15 916 580; E 1 006 730 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TK  
 DATUM Geodetic DATE November 20, 1978 CHECKED BY [Signature]

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									
628.5	Ground Level																
0.0	Clayey Silt to Silty Clay Trace of Sand and Gravel Sand Seams Stiff to Very Stiff		1	SS	10	↓	620								0 7 37 56		
			2	SS	12												
			3	SS	14												
616.5			4	SS	28												
12.0	Silt, Some Sand		5	SS	104			610								0 14 85 1	
613.5			6	SS	35												
15.0	Clayey Silt Trace of Sand and Gravel		7	SS	46												1 5 43 51
			8	SS	50												
602.0	Hard																
26.5	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



## RECORD OF BOREHOLE No 18 (Site B-6)

W P 89-78-00 LOCATION Coords. N 15 916 740; E 1 005 000 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TK  
 DATUM Geodetic DATE November 20, 1978 CHECKED BY [Signature]

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 (%)		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						WATER CONTENT (%)	
627.3	Ground Level																	
0.0	Brown Grey  Clayey Silt Some Sand Trace of Gravel  Firm to Hard	1	SS	8	↓											1 31 43 25		
		2	SS	16														
		3	SS	11														
		4	SS	7														
		5	SS	11														1 18 41 40
		6	SS	52														
		7	SS	26														
		8	SS	29														
598.3	Sandy Silt Trace of Clay  Dense	9	SS	3														0 38 57 5
29.0		10	SS	30														
		11	SS	26														0 29 61 10
578.3	Clayey Silt With Silt and Sand Seams  Hard	12	SS	50														
49.0		13	SS	63														0 1 72 27
565.8	End of Borehole																	
61.5																		

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 19 (Site B-4)

W P 89-78-00 LOCATION Coords. N 15 915 000; E 1 004 180 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TK  
 DATUM Geodetic DATE November 21, 1978 CHECKED BY [Signature]

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						SHEAR STRENGTH	
											○ UNCONFINED	+	FIELD VANE						
											● QUICK TRIAXIAL	x	LAB VANE						
											WATER CONTENT (%)								
											10	20	30						
608.8	Ground Level																		
0.0	Silty Sand		1	SS	5														
603.3	Loose		2	SS	18												0 7 68 25		
5.5	Clayey Silt Trace of Sand and Gravel		3	SS	31														
			4	SS	29														
			5	SS	61														
			6	SS	21														0 2 93 5
			7	SS	30														
	Very Stiff to Hard		8	SS	41														
		9	SS	39														3 7 45 45	
		10	SS	55															
567.3																			
41.5	End of Borehole																		

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity 20  
15 ◊ 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 20 (Site B-3)

W P 89-78-00 LOCATION Coords. N 15 913 090; E 1 003 420 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TK  
 DATUM Geodetic DATE November 21, 1978 CHECKED BY [Signature]

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					
646.4	Ground Level															
0.0	Clayey Silt With Sand Trace of Gravel		1	SS	19											
			2	SS	26											
			3	SS	48											
633.4	<b>Brown</b> Very Stiff to Grey Hard		4	SS	78/	10"									1 18 45 36	
13.0	Silty Sand to Silt Some Sand Trace of Gravel and Clay  Loose to Dense		5	SS	54											
			6	SS	-											
			7	SS	34										0 69 30 1	
			8	SS	14											
			9	SS	38											
			10	SS	8											
605.9			11	SS	30										2 16 79 3	
40.5	Clayey Silt Some Sand Trace of Gravel Hard															
595.6			12	SS	100/ 3"											
50.8	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to 20  
Sensitivity 15 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 21 (Site B-2)

W P 89-78-00 LOCATION Coords. N 15 912 220; E 1 000 690 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TK  
 DATUM Geodetic DATE November 22, 1978 CHECKED BY [Signature]

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			SHEAR STRENGTH									
666.2	Ground Level																
0.0	Clayey Silt With Sand Trace of Gravel Very Stiff		1	SS	19												
659.2			2	SS	24												
7.0	Clayey Silt  Brown Grey  With Sand Trace of Gravel  Very Stiff to Hard		3	SS	63												
			4	SS	86												
			5	SS	46												
			6	SS	33												
			7	SS	33												
			8	SS	18												
633.2	Clayey Silt Some Sand Trace of Gravel Hard		9	SS	61												
33.0			10	SS	108												
			11	SS	83												
620.4			12	SS	100/9"												
45.8	End of Borehole  Note: Water Level Not Established																

OFFICE REPORT ON SOIL EXPLORATION



### RECORD OF BOREHOLE No 22 (Site B-1)

W P 89-78-00 LOCATION Coords. N 15 911 360; E 998 210 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TK  
 DATUM Geodetic DATE November 22 and 23, 1978 CHECKED BY ep

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								
								20	40	60	80	100				
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    x LAB VANE				————○———— WATER CONTENT (%)				
690.7	Ground Level															
688.7	Topsoil						690									
2.0	Clayey Silt With Sand Trace of Gravel		1	SS	14										2 20 46 32	
			2	SS	17											
			3	SS	25											
			4	SS	27		680									
			5	SS	30											
			6	SS	34											
	Brown Grey		7	SS	22		670								5 39 39 17	
			8	SS	19											
	Stiff to Hard		9	SS	14		660									
			10	SS	19											
			11	SS	14		650								22 31 38 9	
	Some Sand Seams															
642.7																
48.0	Clayey Silt With Silt Inclusions With Sand		12	SS	15		640									
	Trace of Gravel															
	Stiff to Hard		13	SS	11		630									
			14	SS	95		620								8 36 39 17	
609.9			15	SS	100/4"		610									
80.8	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE No 23 (Site B-1)

W P 89-78-00 LOCATION Coords. N 15 911 130; E 997 650 ORIGINATED BY TK  
 DIST 6 HWY 407 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TK  
 DATUM Geodetic DATE November 23, 1978 CHECKED BY EP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				NATURAL MOISTURE CONTENT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	PLASTIC LIMIT W <sub>p</sub>	W			LIQUID LIMIT W <sub>L</sub>	GR	SA
687.9	Ground Level																	
686.2	Topsoil																	
1.5	Brown Grey  Clayey Silt With Sand Trace of Gravel  Stiff to Hard																	
		1	SS	24														
		2	SS	21														
		3	SS	20														
		4	SS	29														
		5	SS	22														
		6	SS	13														
		7	SS	11														
		8	SS	12														
		9	SS	24														
		10	SS	60														
638.0		11	SS	100/5"														
49.9	End of Borehole  Note: Water Level Not Established																	

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity  
 20  
 15  $\phi$  5 (%) STRAIN AT FAILURE  
 10

RECORD OF BOREHOLE No 24 (Site B-5) Formerly BH<sup>F</sup>1  
W.P. 222-60

W P 89-78-00 LOCATION Coords. N 15 916 450; E 1 004 340 ORIGINATED BY BMG  
 DIST 6 HWY 407 BOREHOLE TYPE Washboring and Cone Test COMPILED BY BK  
 DATUM Geodetic DATE August 2, 1960 CHECKED BY *[Signature]*

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60					
613.5	Ground Level														
0.0	Topsail														
	Sand and Gravel Some Organic Material Loose to Dense		1	SS	6		610								
605.5			2	SS	18										
8.0	Clayey Silt With Sand and Gravel		3	SS	32										
	Hard						600								
596.0			4	SS	98										
17.5	Silty Sand Dense		5	AS	35										
588.5							590								
25.0	Clayey Silt With Sand and Gravel		6	SS	45										
	Hard		7	SS	112										
572.0			8	AS	77		580								
41.5	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 5 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No 26 (Site B-16)

Formerly BH #2  
W.P. 148-67-03

W P 89-78-00 LOCATION Coords. N 15 928 520; E 1 020 530 ORIGINATED BY VK  
 DIST 6 HWY 407 BOREHOLE TYPE Washboring, BX Casing and Cone Test COMPILED BY VK  
 DATUM Geodetic DATE January 26, 1970 CHECKED BY [Signature]

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					
											○ UNCONFINED	+ FIELD VANE	WATER CONTENT (%)				
											● QUICK TRIAXIAL	x LAB VANE	10	20	30		
637.9	Ground Level																
0.0	Clayey Silt Some Sand Occasional Gravel		1	SS	9												
			2	SS	39												
			3	SS	49											0 26 60 14	
			4	SS	54												
			5	SS	97											1 20 54 25	
619.4	Stiff to Hard																
18.5	Silty Sand Occasional Gravel		6	SS	100/	5"											
			7	SS	100/	6"										0 65 (35)	
			8	SS	100/	6"											
			9	SS	100/	4"											
599.9	Very Dense																
38.0	Clayey Silt Occasional Gravel Random Seams of Silty Sand		10	SS	100/	5"											
			11	SS	150											0 1 68 31	
			12	SS	140												
			13	SS	100/	6"											
576.4	Hard																
			14	SS	146/	11"											
61.5	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity  
 20  
 15  $\phi$  5 (%) STRAIN AT FAILURE  
 10

RECORD OF BOREHOLE No 27 (Site B-25)

Formerly BH #1  
W.P. 160-74-15  
Cont. 76-107  
ORIGINATED BY DM

W P 89-78-00 LOCATION Coords. N 15 932 198; E 1 033 786  
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger and Washboring and Cone Test  
DATUM Geodetic DATE March 13, April 2, 1970  
COMPILED BY AKB  
CHECKED BY *CP*

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
624.6	Ground Level												
0.0	Clayey Silt Some Sand and Gravel, Hard Brown		1	SS	32								
616.1			2	SS	51								
8.5	Sandy Silt Some Gravel Compact to Dense		3	SS	27								
			4	SS	39								
605.6			5	SS	30								
19.0	Clayey Silt Some Sand and Gravel  Stiff to Hard Grey		6	SS	22								
			7	SS	13								
			8	TW	PM							138	
			9	TW	PM								
			10	SS	15								
			11	SS	134								
			12	SS	243								
563.1			13	SS	140/4"								
61.5	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 28 (Site B-25) (Formerly BH #2  
W.P. 160-74-15  
Cont. 76-107)

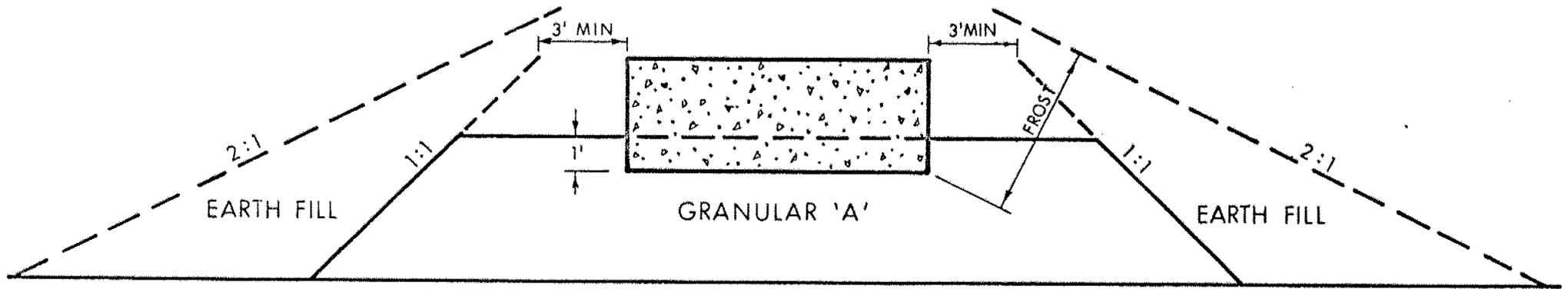
W P 89-78-00 LOCATION Coords. N 15 932 312; E 1 034 150 ORIGINATED BY Dh  
 DIST 6 HWY 407 BOREHOLE TYPE Washboring, NX Casing COMPILED BY AKB  
 DATUM Geodetic DATE April 6, 1970 CHECKED BY [Signature]

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					
629.1	Ground Level													
0.0	Sandy Silt Some Clay Dense to Very Dense		1	SS	35									2 42 (56)
			2	SS	80									5 42 42 11
617.6			3	SS	72									
11.5	Silty Clay to Clayey Silt Some Gravel Hard, Grey		4	SS	57									
			5	SS	110									
609.1			6	SS	132									
20.0	Clayey Silt With Sand and Gravel  Hard Grey		7	SS	142									30 15 31 24
			8	SS	162									
592.6			9	SS	100/4"									
36.5	End of Borehole													

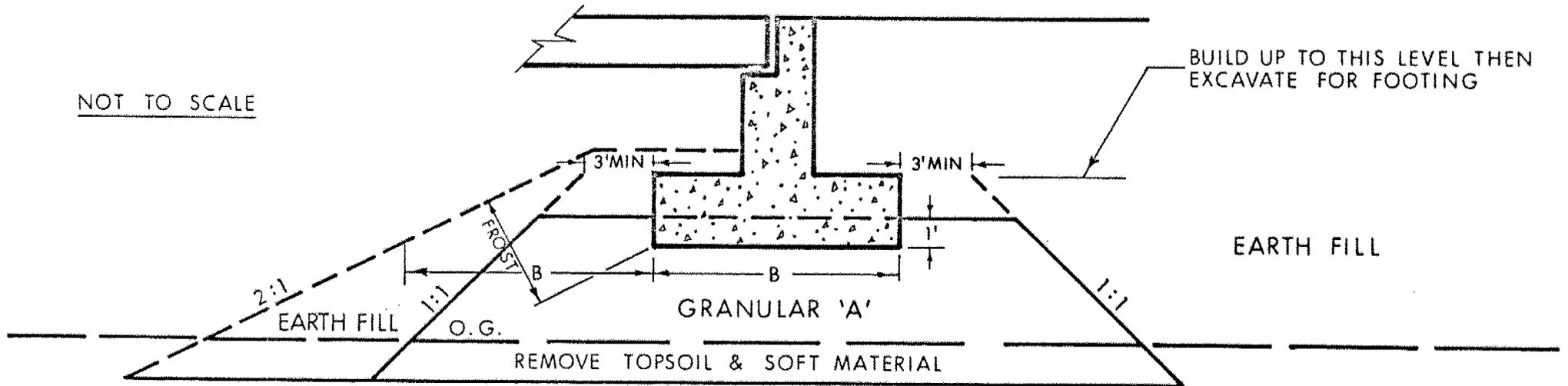
OFFICE REPORT ON SOIL EXPLORATION

+3, x<sup>5</sup>: Numbers refer to Sensitivity  
 20  
 15 5 (%) STRAIN AT FAILURE  
 10

# ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



X SECTION

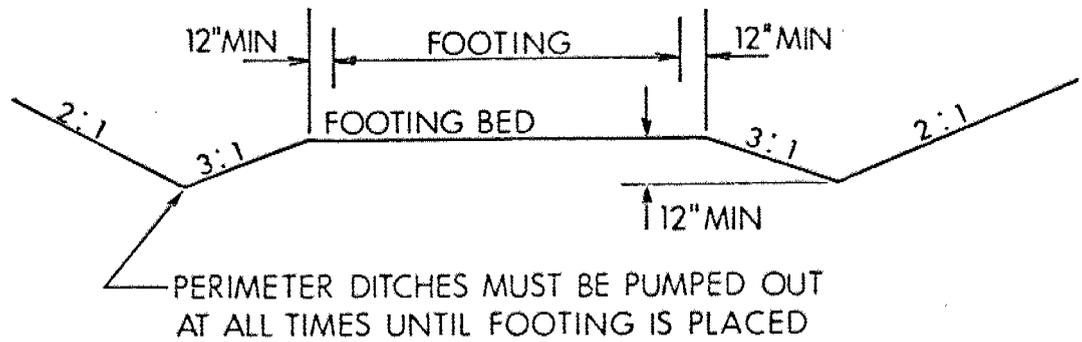


LONGITUDINAL SECTION

NOTES:

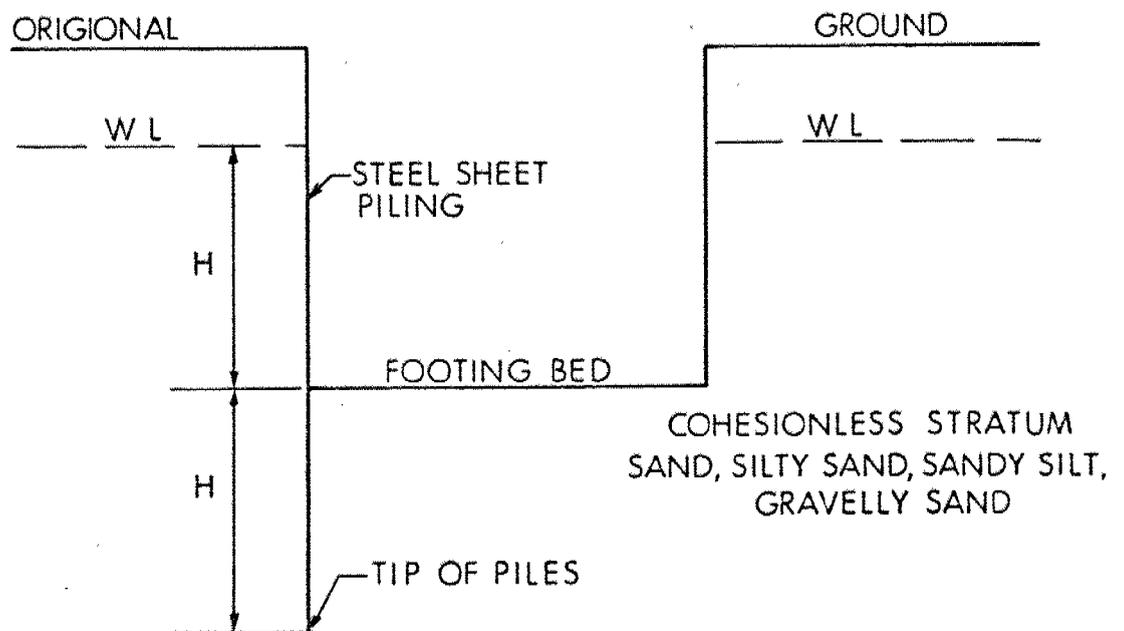
- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO TOP OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.C. STANDARDS.
- 3 - EXCAVATE COMPACTED GRANULAR 'A' & EARTH FILL FOR FOOTING.

FIG. 1



## OVERSIZE EXCAVATION WITH PERIMETER DRAINS

FIG No 2



## STEEL SHEET PILING

FIG No 3

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  $N_c$ .

**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:

$S_u$ (PSP)	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. CIU = 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

$\mu$  COEFFICIENT OF FRICTION  
 $\delta$  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   
 $w$  SLOPE ANGLE-BACKFACE OF WALL   
 $\beta$  ANGLE OF SLOPE   
 $N_\gamma, N_q, N_c$  BEARING CAPACITY FACTORS  
 $D_f$  DEPTH OF FOOTING  
 $B, L$  FOOTING DIMENSIONS

INDEX PROPERTIES

$\gamma$  UNIT WEIGHT OF SOIL (BULK DENSITY)  
 $\gamma_w$  UNIT WEIGHT OF WATER  
 $\gamma_d$  UNIT DRY WEIGHT OF SOIL (DRY DENSITY)  
 $\gamma'$  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 =  $\frac{I_p \text{ of soil}}{I_p \text{ of } 2\mu\text{m Soil Fraction}}$   
 $Om$  ORGANIC MATTER CONTENT  
 $S_r$  DEGREE OF SATURATION  
 $S$  SENSITIVITY =  $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

STRENGTH PARAMETERS

$\phi$  ANGLE OF SHEARING RESISTANCE  
 $\tau_F$  PEAK SHEAR STRENGTH  
 $\tau_R$  RESIDUAL SHEAR STRENGTH  
 $c$  COHESION INTERCEPT  
 $\sigma_1, \sigma_2, \sigma_3$  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  
 $\epsilon$  LINEAR STRAIN  
 $\gamma$  SHEAR STRAIN  
 $\nu$  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  
 $\eta$  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  
 $T_v$  TIME FACTOR  
 $U$  DEGREE OF CONSOLIDATION  
 $O_c$  OVERCONSOLIDATION RATIO (OCR)

**NOTE:** EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:  
 $\phi'$  = EFFECTIVE ANGLE OF SHEARING RESISTANCE;  
 $\sigma'$  = EFFECTIVE NORMAL STRESS

# OVERSIZE DRAWING