Mr. A. Toye

Bridge Engineer

Mr. A. Rutka

December 9th, 1955

Re: Foundation Investigation
Q.E.W. at Geneva Street, St.
Catharines, W.P. 30-55, Project F55-16

Attached herewith is the foundation report for the above mentioned structure and work project which was requested recently. We will be glad to discuss this report with you should any queries arise.

F.A. Brownridge
Materials & Research Eng.

Per.

(A.Rutka)

AR:W
att.

c.c. Mr. A Toye,
Mr. J. Walter,
Mr. H.Tregaskes,
Mr. R.E. Richardson,
Mr. G. Ferentzy.

REPORT ON FOUNDATION INVESTIGATION

FOR

The Geneva Street Overpass Bridge

on

Q. E. W. Highway in St.Catharines

Site Plan No. D-3496-1

Copies to:

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Bridge Office (2)

Mr. J. Walter
Design Engineer (1)

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Project F-55-16

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INTRODUCTION

A bridge has been proposed for the intersection of Q.E.W. and Geneva Street in St. Catherines. This bridge will be an overpassing structure over the street.

Subsoil investigation was therefore required on the proposed site to determine the most suitable method of foundation for the bridge footings.

Investigation was also extended to the approach sections on both sides of the bridge to determine the soil condition there for the retaining wall foundation and to check the stability of the earth fill.

PROCEDURE

The exploration on the above site was done with the aid of a coredrill machine mounted on truck. Undisturbed soil samples were secured by shelby tubes on clayey soils except where standard penetration tests were necessary, as determined by the field engineer.

Altogether eighteen test holes were made. Nine are bore holes, the rest being penetration holes only. The time occupied for the whole operation in the field was from September 8 to October 15, 1959.

The location of all the test holes together with appropriate sectional profiles of the subsoil are shown in Drawing F-59-164. The logs of the boreholes together with the different test results are found under Appendix I.

SOIL CONDITIONS

The general soil profile of the foundation site is a thin layer of hard clay overlying medium to soft clay.

The topmost layer of hard clay is desiccated soil as a result of oxidation and loss of moisture. The composition of the soil is quite uniform throughout the area, except in the vicinities of B.H. 4 and B.H. 12 where this clay is slightly sandy in texture.

Laboratory unconfined compressive tests indicated that the clay has shearing strength averaging about 2.0 tons/sq.ft.

The underlying layer of softer clay varies from about 50 ft. to 60 ft. in thickness. It has shearing strength which averages about 1,500 lbs./sq.ft. varying but very slightly with depth to about 800 lbs./sq.ft.

WATER CONDITION

The clay has water content about 10% to 15% in the top stratum varying to about 20% in the lower stratum. The soil material in both clay regions has a low void ratio of about 0.50, pores being saturated.

No water table was actually observed in the clay layers, except for the water which was left there from boring operations.

ANALYSIS OF TEST RESULTS AND DISCUSSIONS

Bridge Foundation

Four bore holes were made at the location of the footings; two on each side. These borings showed that the topmost layer of soil is hard clay with medium to soft clay underlying it.

The shearing strength of the hard clay varies from about 1.5 tons/sq.ft. to as high as 2.5 tons/sq.ft. signifying that the soil in the topmost layer can provide a bearing capacity of atleast 3 tons/sq.ft.

However, since this relatively thin layer of hard clay just overlies softer clay, the pressures applying at the footing level would spread out with depth, and thus the induced pressures reaching the poorer material must not be larger than the safe bearing capacity there. These have been investigated according to the boring datas as obtained from the four bore holes. In each case the lower layer of softer clay controls in the determination of the permissible magnitude of loading. The most unfavourable stresses in the buried stratum of softer clay are at its surface.

The bottom of the footings have been proposed to place at El. 321.5. Assuming long footings with width 7 ft., it has been estimated by Dr. Meyerhof's formula for bearing capacity of cohesive soil that the allowable bearing capacity for the west footing is 2.5 tons/sq.ft. whilst for the east footing is only 1.6 tons/sq.ft. and no more. These estimations are based on cohesion of 1,000 lbs/sq.ft. for the buried stratum of softer clay. The safety factor provided is 3.

According to the geological condition of the foundation site, it has been observed that the clay material is highly impermeable, also there is no apparent draining stratums in either clay layers through which the pore water can escape once load is applied. It is therefore very doubtful if any settlement at all would occur under the footings. However, taking into consideration the soft clay only, the degree of ultimate settlement from both footings will be more or less the same, being between 2.5 inches and 3.5 inches approximately. If single-drainage is assumed the time required to reach 90% consolidation is as long as 15 to 20 years. The largest settlement will be on the East footing, but the greatest differential settlement is not expected to be larger than 1.0 inch. With these factors in view, if a uniform load of 1.6 tons/sq.ft. is used for design for all the footings the differential settlement is expected to be even much less than 1.0 inch. Under such condition a rigid framed structure can be built on the site.

If higher load should be used the width of the east footing must be increased accordingly.

Retaining Wall Foundation

The founding elevation of the retaining wall footing has been proposed at 322.0. If the width of the footing is 11 ft. the bearing pressure allowed on the soil at this elevation should not exceed 1.2 tons/sq.ft.

Due to eccentric loading of these footing it is difficult to evaluate the settlement. If uniform load of 1.2 tons/sq.ft. is assumed the footings are expected to settle about 4.0 inches ultimately. With increasing distance away from the bridge abutments, both the height of the fill and retaining wall diminishes. Consequently settlement becomes less as the pressure on the footings decreases. Due to such varying loads on the footings, construction joints should be provided for the retaining walls to take care of any possible differential settlement.

Stability of the Back-Fill

The stability of the fill on the approaches has been examined with respect to failure by sliding. It has been found that the most dangerous zone of failure lies within the layer of softer clay. Different cases of failure have been tried out, according to the datas from B.H. 4 from which the strength of the clay has been found to be weakest. Figures 1, 2 and 3 are presented here under Appendix II. It appears that the most critical slip surface would extend to the soft clay and cut the top of the fill at the furthest edge of the roadway. Assuming that the soft clay has only cohesion of 600 lbs/sq.ft. the factor of safety is about 1.26. There should, however, be no danger of sliding.

The settlement due to the soft clay under a fill of 21 ft. is expected to be about 10.0 inches ultimately. Also assuming single-drainage, the time required to reach 60% consolidation is about 25 years and a much longer time to get to 90%. This settlement is much greater than that under the footings of the bridge. For this reason, it is advisable that the fills be brought up to the required height before the construction of the bridge structure itself. It is equally important that the fills be brought up simultaneously on the two approaches. This procedure will counter-balance the fills onto each other, thus eliminating the possibility of sliding under the abutments in a lateral direction.

CONCLUSIONS

Bridge Foundation

The El. 321.5 for founding the footings of the bridge is suitable. If the width of both the footings is to be maintained at 7 ft. the permissible bearing capacity of the soil at the founding elevation is 1.6 tons/sq. ft.

Both the footings are expected to settle between 2.5 inches to 3.5 inches ultimately. The largest differential settlement will not be greater than 1.0 inches. It will therefore be safe to adopt a rigid framed structure on the site.

Retaining Wall Foundation

The allowable bearing capacity of the soil at elevation 322.0 for the retaining wall footings should not exceed 1.2 tons/sq. ft.

Retaining Wall Foundation (continued)

For uniform loading of 1.2 tons/sq. ft. the footings are expected to settle about 4.0 inches ultimately, becoming less as both the height of the fill and the retaining walls decreases. Construction joints should be provided for the retaining walls to take care of any possible differential settlements.

The retaining walls should be first built to hold the fill to the required height before the construction of the bridge structures.

Stability of the Back-Fill

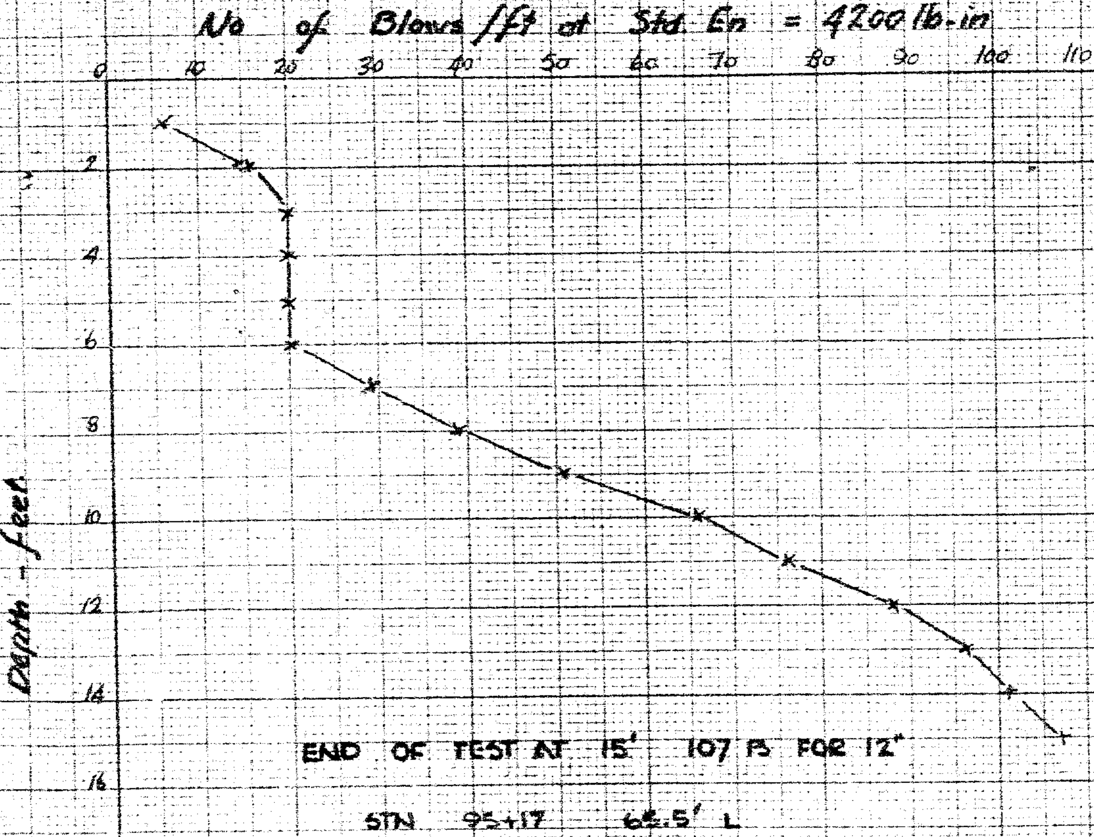
There should be no danger of sliding under a fill of 21 ft. held by the retaining wall. Ultimate settlement under the fill is expected to be about 10.0 inches.

It is advisable to bring the fills up simultaneously on both the approaches to eliminate the possibility of sliding under the abutments in the direction of the highway.

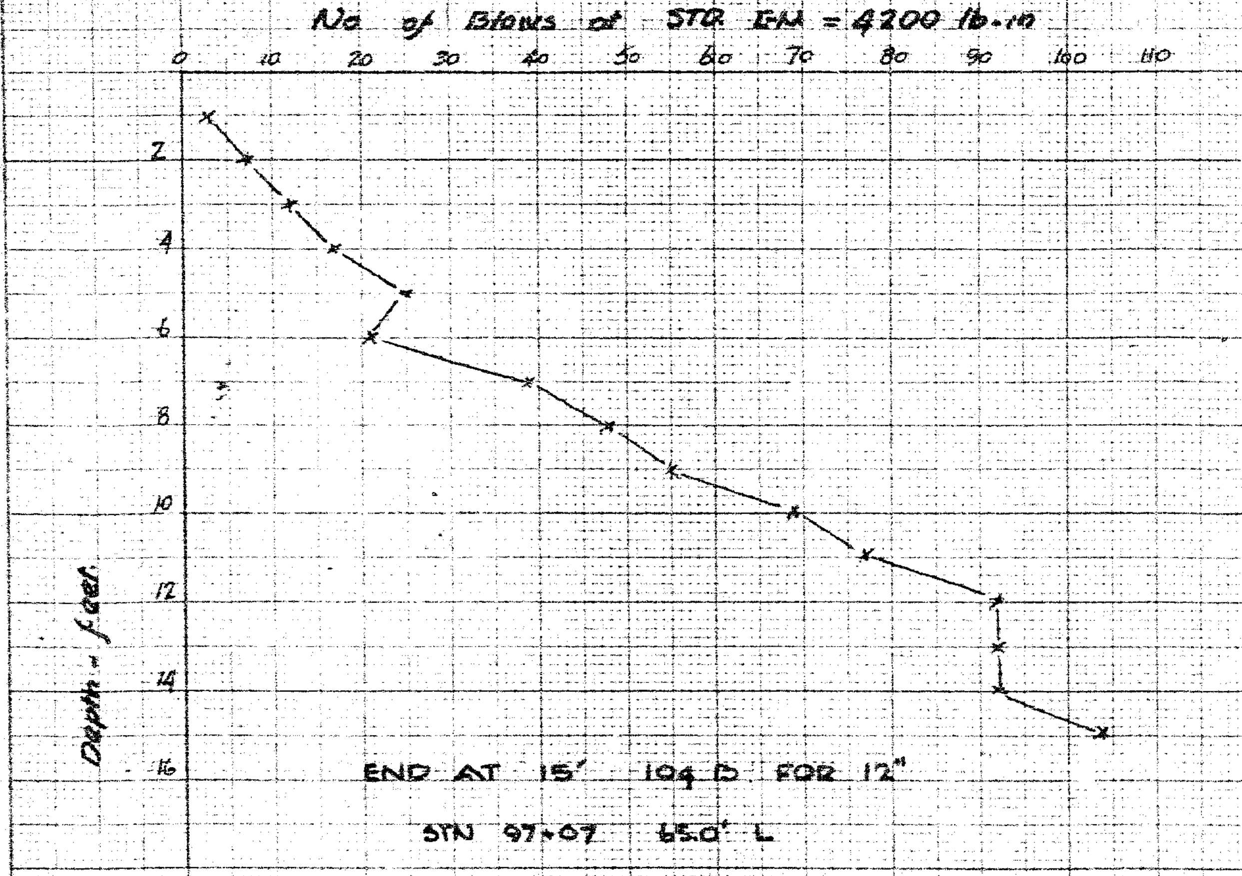
G. N. Farantatos
Foundation Engineer.

APPENDIX I

CONE PENETRATION TEST

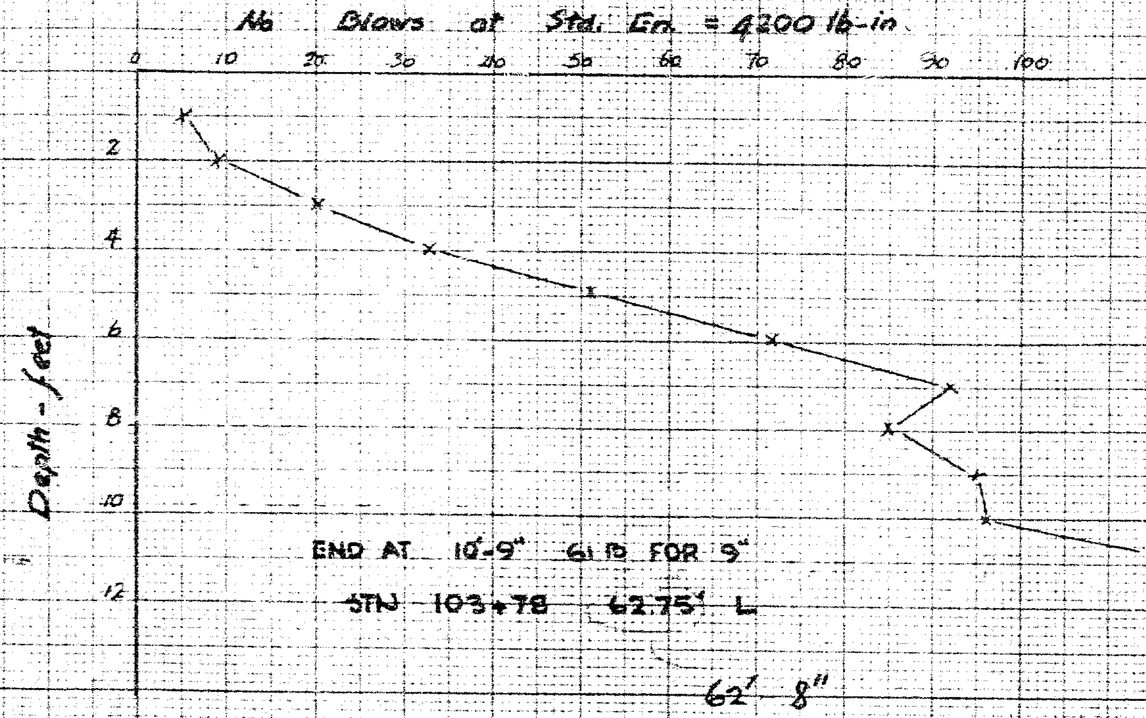


CONE PENETRATION TEST



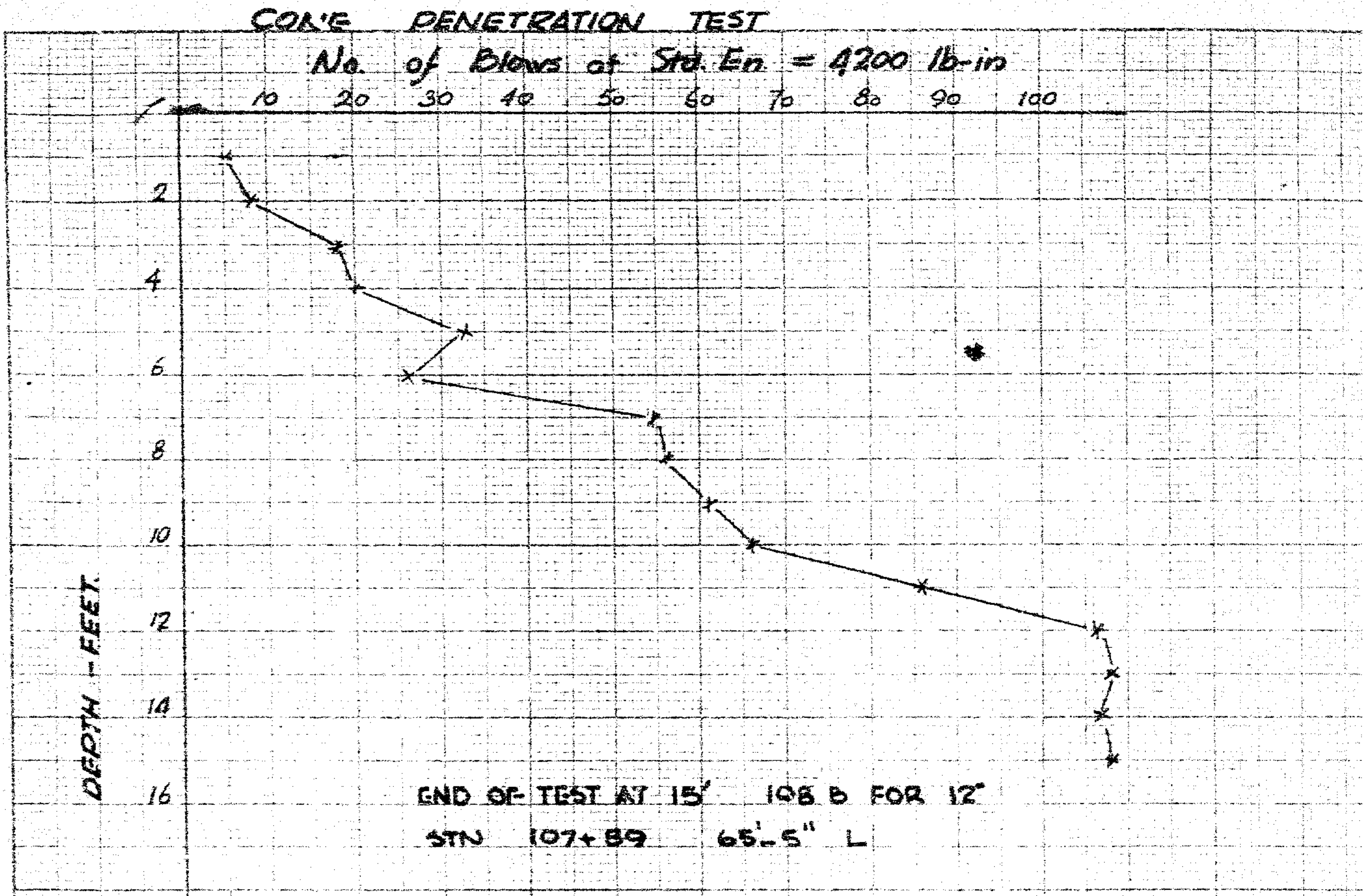
55 · F · 16 ST. CATHARINES B.H. #6

CONE PENETRATION TEST



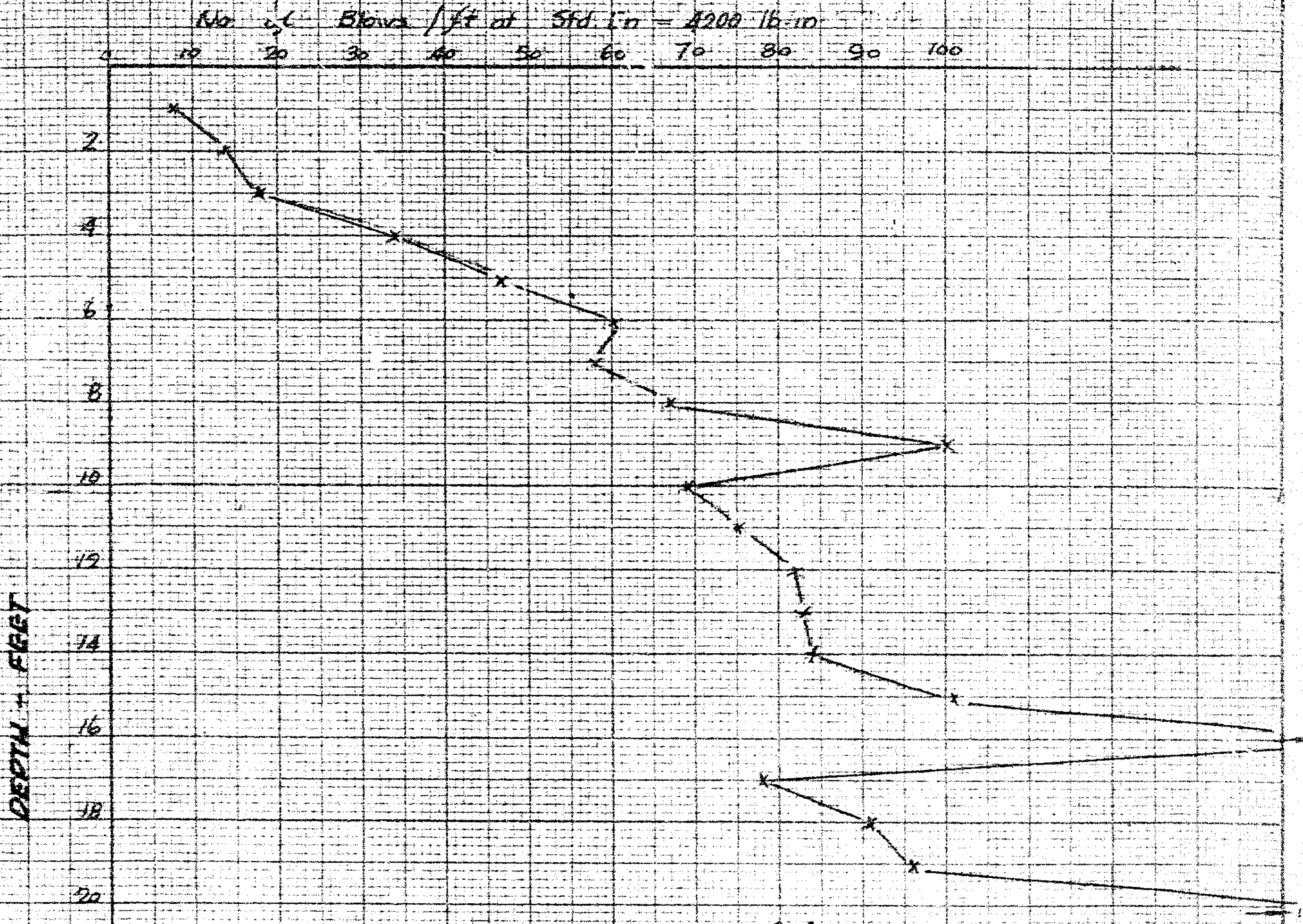
B.H.

55-F-16 ST. CATHARINES B.H #8



55-F-16 ST. CATHARINES BH #9

GRAPH OF CONE PENETRATION TEST

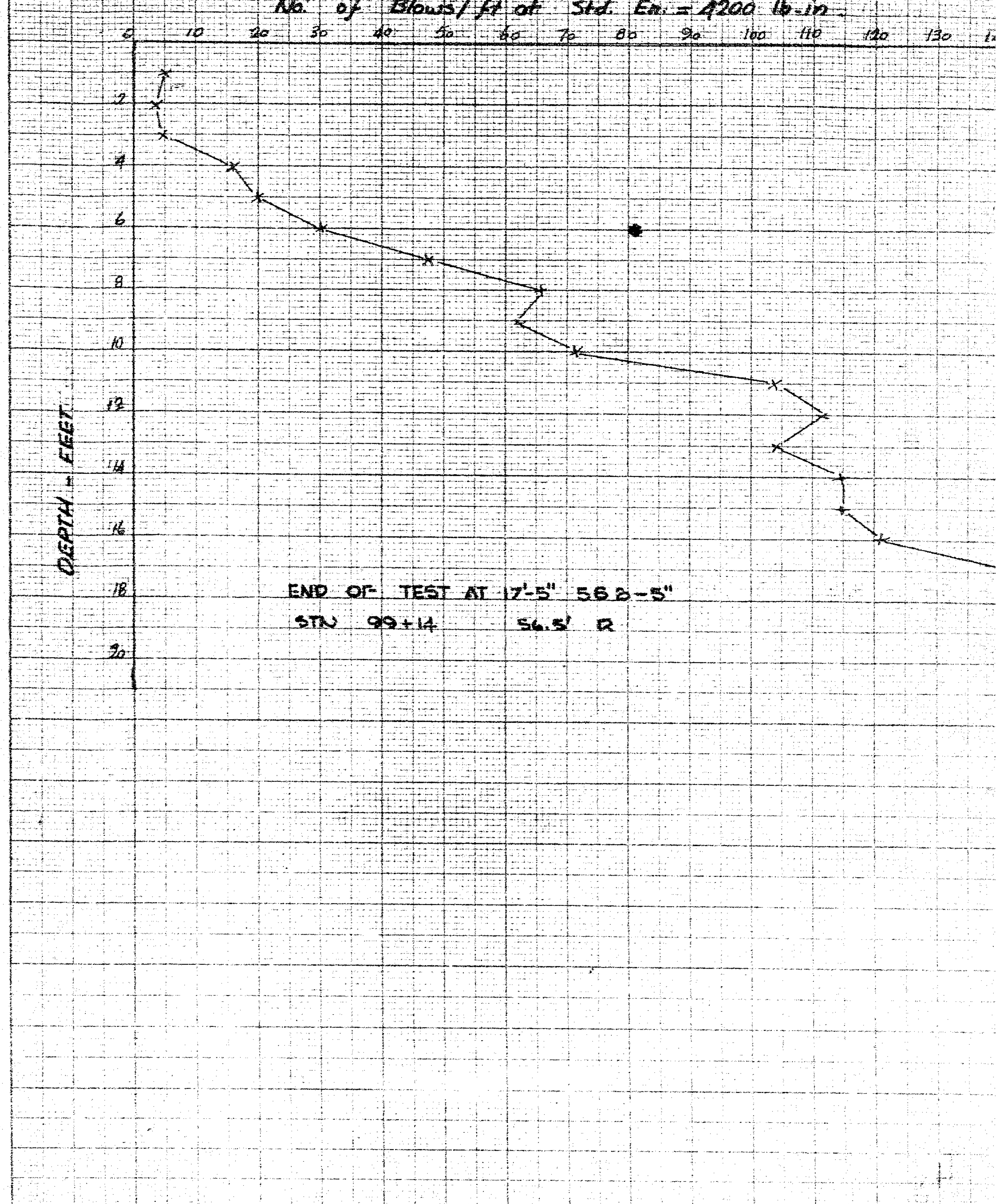


END OF TEST AT 20' 167B FOR 12"

STN 95+06 64.0' R.

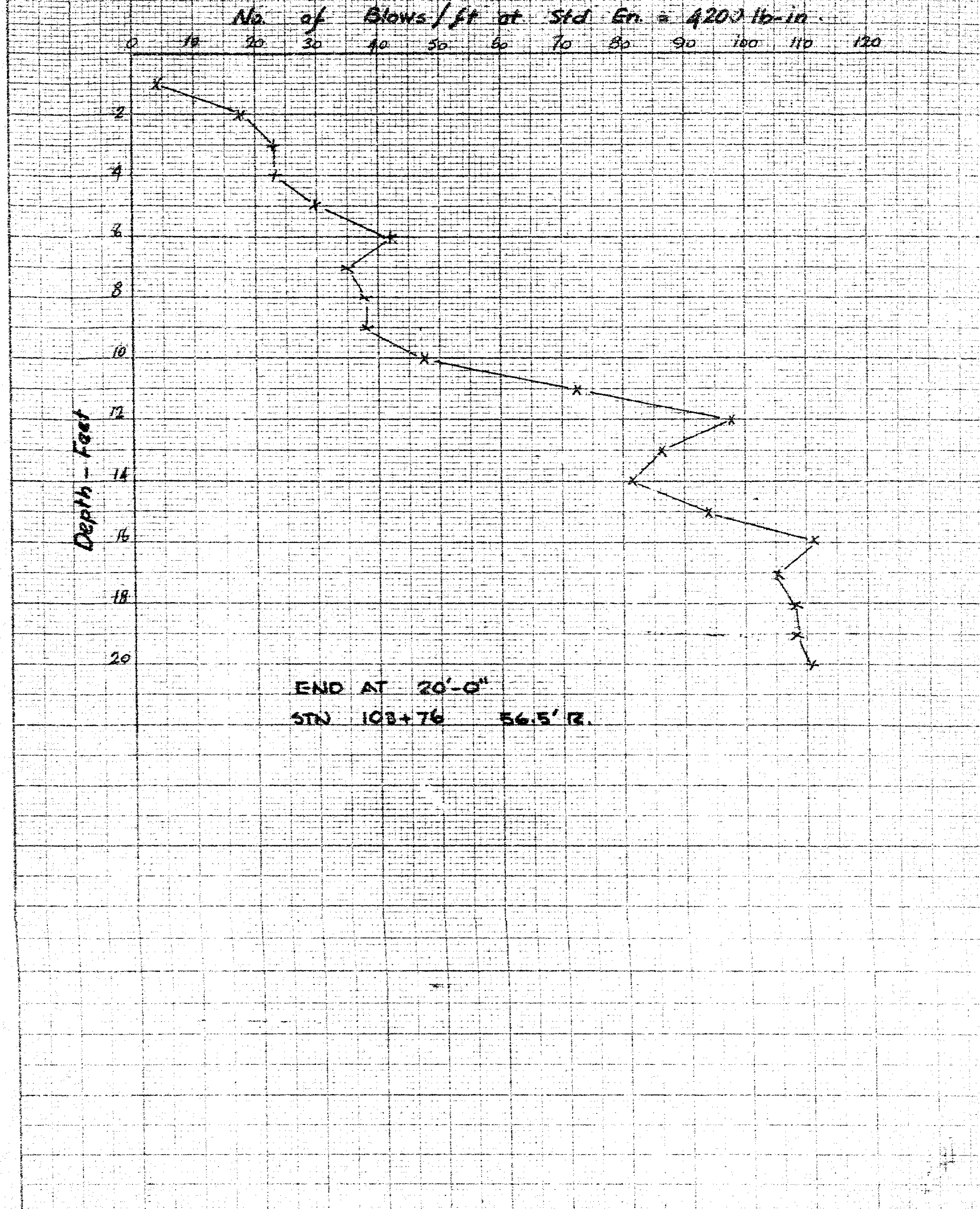
55-F-16 ST. CATHARINES B.H #11

CONE PENETRATION TEST



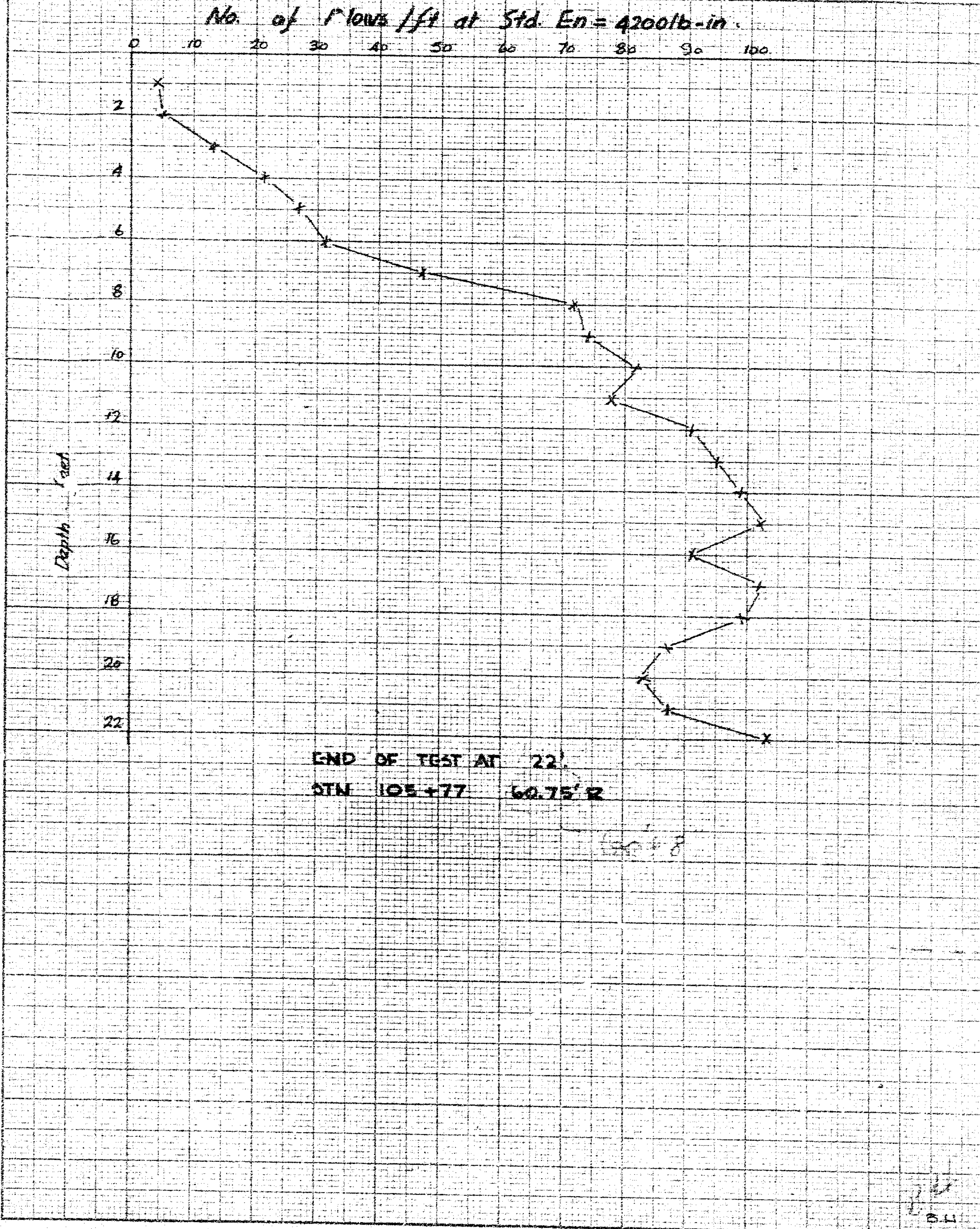
55-F-16 ST. CATHARINES BH# 14

CONE PENETRATION TEST

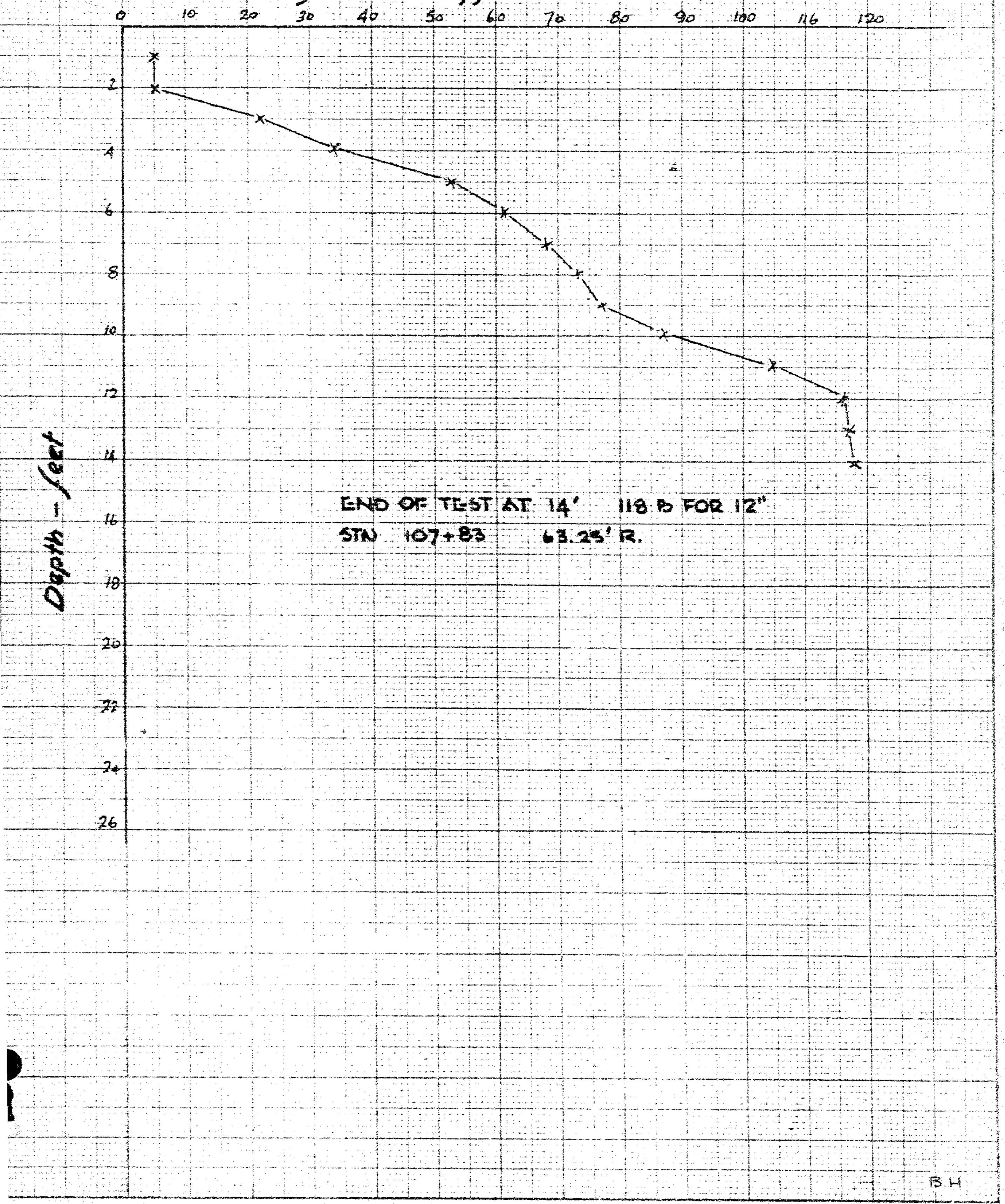


55-F.16 ST. CATHDRINES B.H # 15

CONE PENETRATION TEST



CONE PENETRATION TEST



APPENDIX II

SLOPE STABILITY ANALYSIS (ASSUME $\phi = 0$ FOR ALL SOILS.) BASED ON B.H. #4 DATAS.

CASE I THE SLIP SURFACE EXTENDS TO SOFT CLAY AND CUTS THE TOP OF FILL AT THE FARTHEST EDGE

CALCULATIONS – LENGTH OF ARC $= \frac{\pi R}{180}\theta = 2.164\theta$

$L_1 = 22.7 \therefore L_1C_1 = 13600$

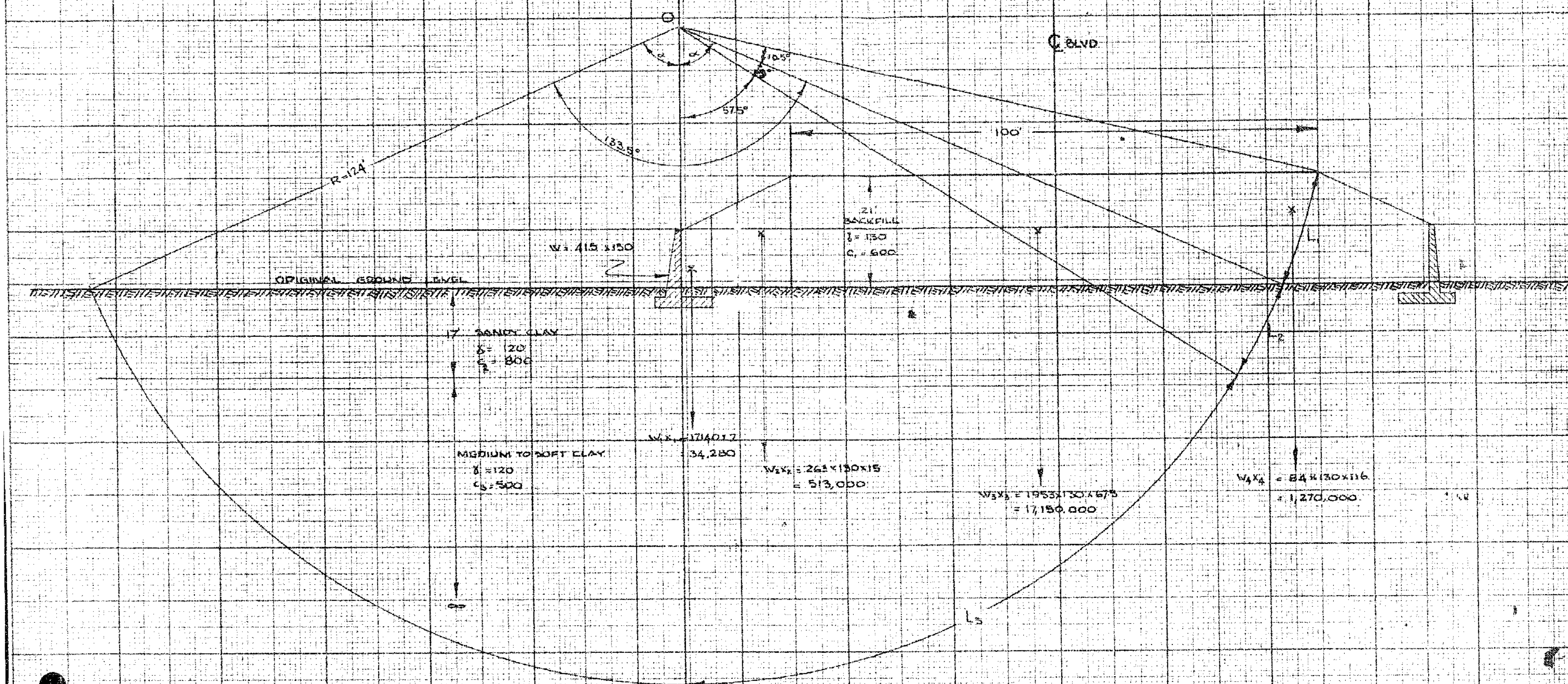
$L_2 = 19.5 \therefore 2L_2C_2 = 31,200$

$L_3 = 124.5 \therefore 2L_3C_3 = 124,500$

$\Sigma LC = 169300$

$F_{S\,(c_3=500)} = \frac{R\Sigma LC}{\Sigma Wx} = \frac{124 \times 169300}{18,967,280} = 1.10$

$F_{S\,(c_3=600)} = 1.26$



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SLOPE STABILITY ANALYSIS (ASSUME $\phi = 0$ FOR ALL SOILS)

BASED ON B.H.#4 DATAS

CASE II THE SLIP SURFACE EXTENDS TO SOFT CLAY AND CUTS THE TOP OF FILL AT ℄ OF BLVD.

CALCULATIONS: LENGTH OF ARC $= \frac{\pi R}{180}\theta = 1.258\theta$

$L_1 = 22'$ $L_1C_1 = 13,200$

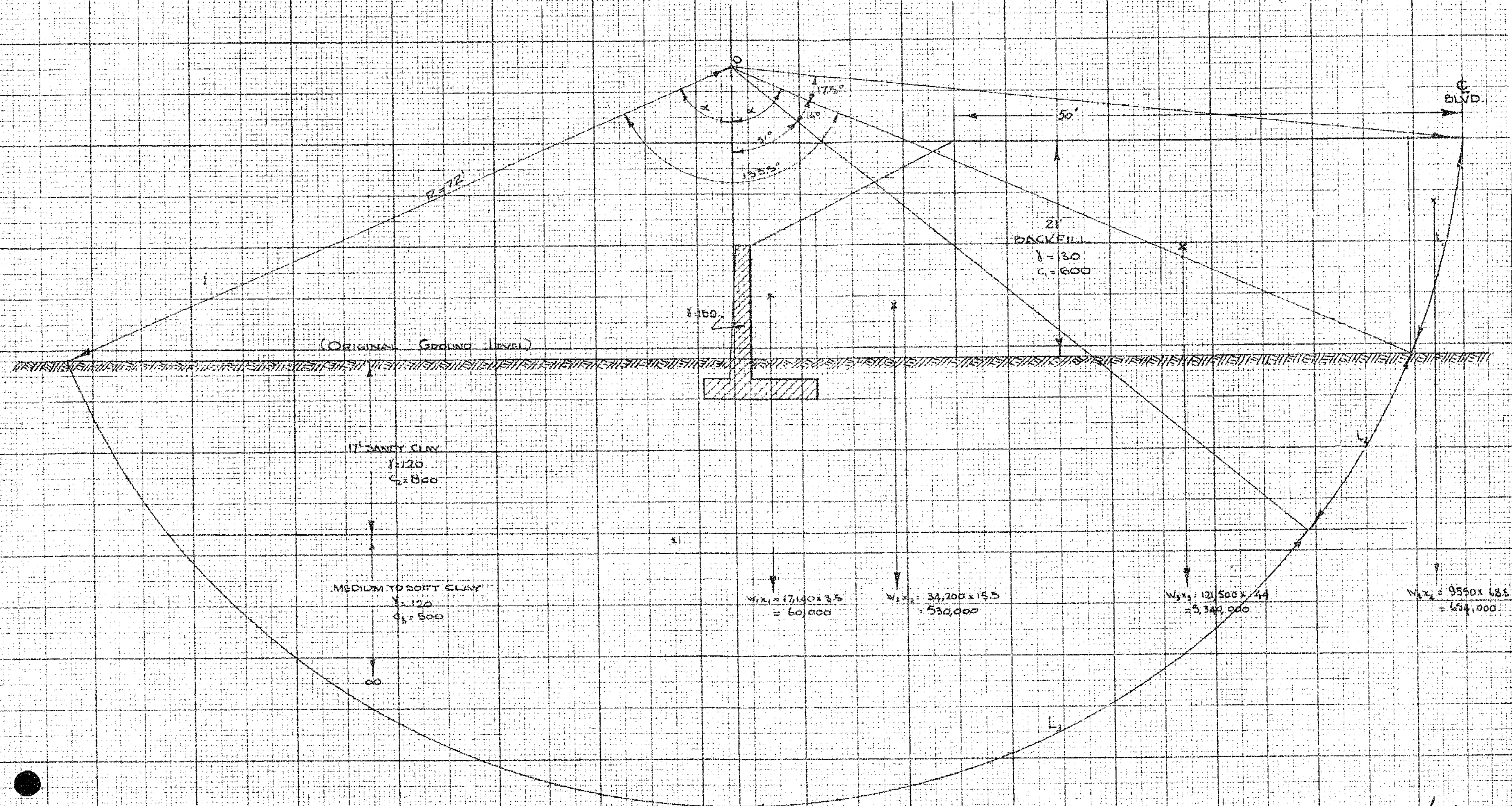
$L_2 = 20.1'$ $2L_2C_2 = 32,100$

$L_3 = 64'$ $2L_3C_3 = 64,000$

$\Sigma LC = 109300$

$F_{s}\ (c_3 = 500) = \frac{R\Sigma LC}{\Sigma Wx} = \frac{72 \times 109,300}{6,584,000} = 1.20$

$F_{s}\ (c_3 = 600) = 1.33$



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SLOPE STABILITY ANALYSIS

CASE III THE SLIP SURFACE ONLY CUTS THROUGH THE SANDY CLAY LAYER RESULTING AS A TOE FAILURE

CALCULATIONS:- LENGTH OF ARC = $\frac{\pi 2}{180}\theta = 0.728\,\theta$

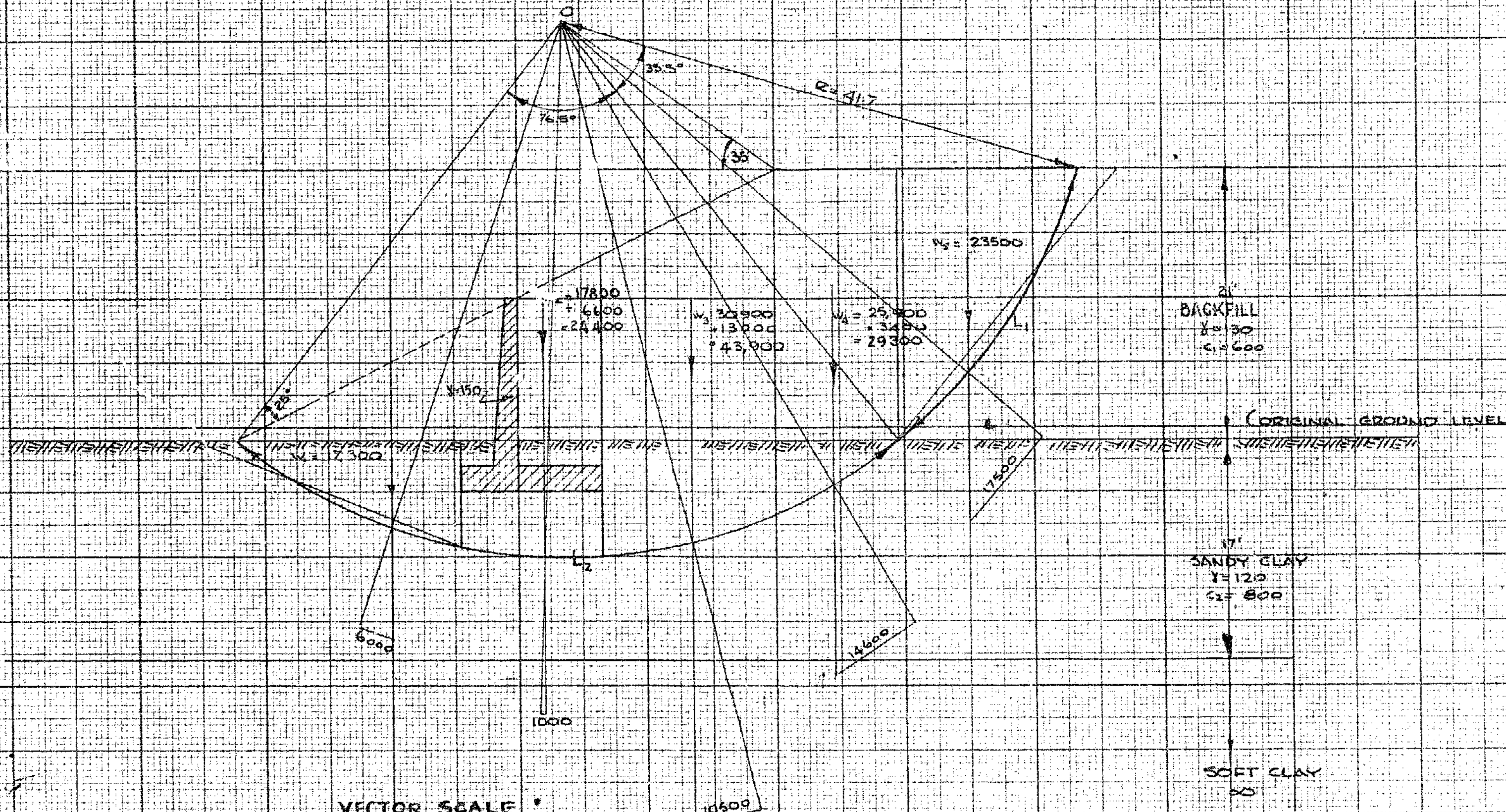
$L_1 = 25.8 \quad \therefore L_1C_1 = 15{,}500$

$L_2 = 55.6 \quad \therefore L_2C_2 = 44{,}500$

$\Sigma LC = 60{,}000$

$F_s = \frac{R \Sigma LC}{R \Sigma T} = \frac{60000}{35{,}100}$

$= 1.70$



VECTOR SCALE :
1" = 20,000 lbs

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#55-F-16

Q.E.W. HWY.

IN ST. CATHERINES

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG: CORE DRILL #4
CASING: 4" PIPE & BX (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT. 250 # DROP ____ INCHES

JOB: 55-F-16
DATUM: STN 99+34 60.5' L
COMPILED BY: BH CHECKED BY: W. WONG

BORING Nº: 3
DATE REPORT: SEPT. 16, 1955.
BORING DATE: SEPT 14-16, 1955

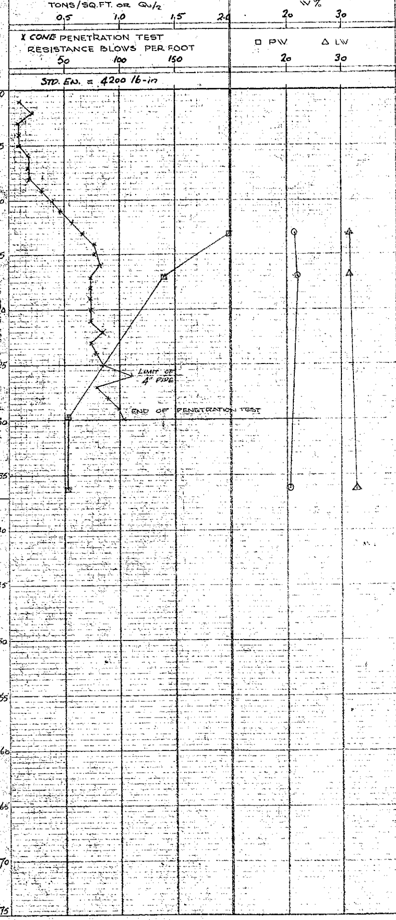
SAMPLE CONDITION
- DISTURBED
- GOOD
- LOST

SAMPLE TYPES
- C.S - CHUNK
- D.O. - DRIVE OPEN
- D.F. - DRIVE FOOT VALVE
- T.O. - THIN WALLED OPEN
- W.S. - WASHED SAMPLE
- R.C - ROCK CORE

ABBREVIATIONS
- V - INSITU VANE SHEAR TEST
- M - MECHANICAL ANALYSIS
- U - UNCONFINED COMPRESSION
- Q_c - TRIAXIAL CONSOLIDATED QUICK
- Q - TRIAXIAL QUICK
- S - TRIAXIAL SLOW
- γ - UNIT WEIGHT
- K - PERMEABILITY
- C - CONSOLIDATION
- CA. - CASING
- W.L. - WATER LEVEL IN CASING
- W.T. - WATER TABLE IN SOIL

SOIL PROFILE

ELEVN. DEPTH	WATER CONDITIONS	DESCRIPTION
326.2	N.B. NO WATER WAS OBSERVED TO ENTER THIS HOLE	BROWN SANDY CLAY (GRAVELLY IN SOME LAYERS)
306.2 / 20.0		GREY CLAY
289.2 / 37.0		END OF BOREHOLE - 37'-0"



SAMPLES

PENETRATION RESISTANCE: No. OF BLOWS/FT AT STANDARD ENERGY 4700 lb-in

OTHER TESTS	CONDITION	TYPE	Nº	PENETRATION RESISTANCE	ELEV. RECOV. %
	DISTURBED	W.S	1A	-	-
	LOST	T.O 3"	1B	39	LOST
γ = 127	GOOD	T.O 3"	2	46	75
γ = 121	GOOD	T.O 2"	3	-	100
	LOST	T.O 3"	4	16	LOST
	LOST	T.O 3"	5	23	LOST
	LOST	T.O 3"	6	27	LOST
γ = 125	GOOD	T.O 2"	7	12	75
γ = 125	GOOD	T.O 2"	8	13	83

TL 129

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLO ATIO

DRILL RIG Core Drill #4
CASING BX (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT 250 # DROP — INCHES

JOB 55-F-16
DATUM STN 100+70 61.4' L
COMPILED BY B.H. CHECKED BY W. WONG

BORING No 4
DATE REPORT SEPT 10, 1955
BORING DATE SEPT 8 & 9, 1955

SAMPLE CONDITION

- DISTURBED
- GOOD
- LOST

SAMPLE TYPES

- C.S - CHUNK
- D.O - DRIVE OPEN
- D.F - DRIVE FOOT VALVE
- T.O - THIN WALLED OPEN
- W.S - WASHED SAMPLE
- R.C - ROCK CORE

ABBREVIATIONS

- V - INSITU VANE SHEAR TEST
- M - MECHANICAL ANALYSIS
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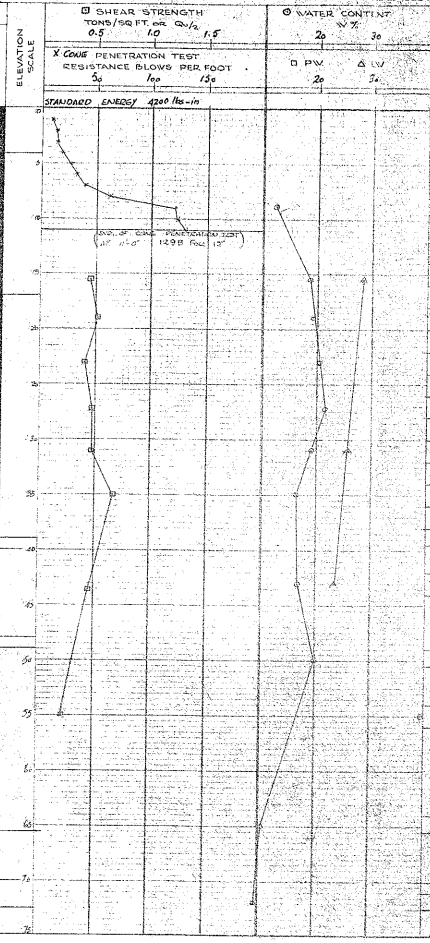
- γ - UNIT WEIGHT
- K - PERMEABILITY
- C - CONSOLIDATION
- CA - CASING
- W.L - WATER LEVEL IN CASING
- W.T - WATER TABLE IN SOIL

SOIL PROFILE

ELEVN / DEPTH	WATER CONDITIONS	DESCRIPTION
325.8 / 0		
321.5		(ELEV. OF BOTTOM OF FOOTINGS)
		LIGHT BROWN SANDY CLAY. Very dense in top layers and gradually getting softer with depth
308.8 / 17.0	N.B. Hole inside Water at 35'	SOFT GREY CLAY.
286.8 / 39.0		WATER BEARING SAND
285.8 / 40.0		SOFT GRAY CLAY
277.8 / 48.0		SAND
276.8 / 49.0	N.B. At 54' water rose to height of 5' above ground level	SOFT GRAY CLAY.
260.3 / 65.5		BROWN CLAY. Slightly stony and dense.
255.8 / 70.0		HARD RED SANDY CLAY.
253.3 / 72.5		(END OF BOREHOLE)



SAMPLES

OTHER TESTS	CONDITION	TYPE	No	PENETRATION RESISTANCE (No. Blows/ft of Std. Energy 4200 lb-in)	ELEV RECOV %
	Disturbed	D.O	1	57	45
	Good	T.O 2"	2	55	83
	Lost	T.O 2"	3	—	LOST
γ = 120	Good	T.O 2"	4	16	67
γ = 125	Good	T.O 2"	5	14	71
γ = 126	Good	T.O 2"	6	16	79
γ = 128	Good	T.O 2"	7	20	88
γ = 126	Good	T.O 2"	8	18	75
γ = 134	Good	T.O 2"	9	22	71
	Disturbed	D.O	10	10	100
γ = 133	Good	T.O 2"	11	21	96
	Disturbed	D.O	12	7	108
γ = 130	Good	T.O 2"	13	18/24"	100
	Disturbed	T.O 2"	14	—	15
	Disturbed	W.S	15	—	—
	Disturbed	D.O	16	78	38

TL-129

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG: Core Drill #4
CASING: ____ (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT: 250 #   DROP: 24 INCHES
JOB: F-55-16 ST. CATHERINES
DATUM: STN 102 + 02 62.6' L
COMPILED BY: JB CHECKED BY: W. Wong
BORING Nº: 5
DATE REPORT: 17-X-55
BORING DATE: 15-X-55

SAMPLE CONDITION: DISTURBED; GOOD; LOST

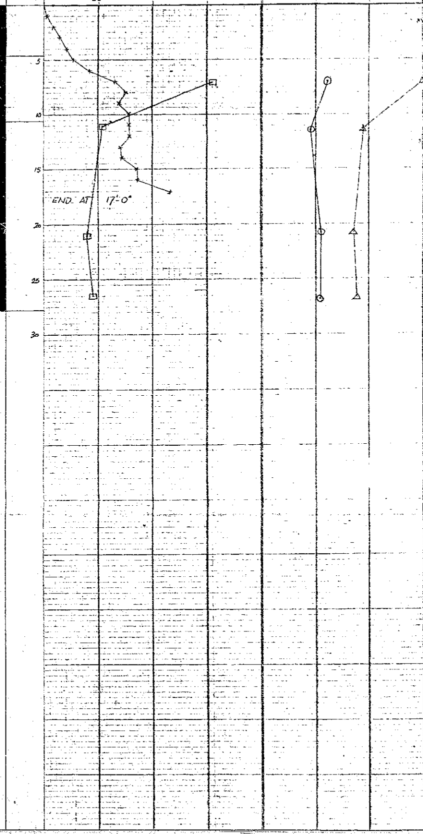
SAMPLE TYPES: C.S - CHUNK; D.O. - DRIVE OPEN; D.F. - DRIVE FOOT VALVE; W.S. - WASHED SAMPLE; T.O. - THIN WALLED OPEN; R.C. - ROCK CORE

ABBREVIATIONS: V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Qc - TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; γ - UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; CA - CASING; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

SOIL PROFILE

ELEVn DEPTH	WATER CONDITIONS	DESCRIPTION
326.2' / 0		HARD BROWN CLAY
321.5' (ELEV. OF BOTTOM OF FOOTING) / 4.7		
315.7 / 10.5'		MEDIUM GREY CLAY
298.45		End of Borehole 27'-9"

□ SHEAR STRENGTH TONS/SQ.FT. or Qu/2 (0.5, 1.0, 1.5, 2.0) — ⊙ WATER CONTENT W% (20, 30, 40)
X CONE PENETRATION TEST RESISTANCE BLOWS PER FOOT, STANDARD ENERGY 4200 IN LB (50, 100, 150, 200) — □ PW. △ LW



SAMPLES

No. of Blows/ft at std Energy = 4200 lb in

OTHER TESTS	CONDITION	TYPE	Nº	PENETRATION RESISTANCE	ELEV. RECOV. %
γ = 120	Good	T.O. 2"	1	38	70
γ = 138	Good	T.O. 2"	2	20	70
	Good	T.O. 2"	3	25	70
γ = 133	Good	T.O. 2"	4	24	85
γ = 130	Good	T.O. 2"	5	24	80

TL-129

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG: CORE DRILL #4
CASING: BX (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT: 250 #   DROP: 24 INCHES
JOB: F-55-16 ST. CATHERINES
DATUM: STN. 105 + 88 64.8' L
COMPILED BY: J.B. CHECKED BY: W. Wong
BORING Nº: 7
DATE REPORT: 13-X-55
BORING DATE: 12-13-X-55

SAMPLE CONDITION: DISTURBED; GOOD; LOST

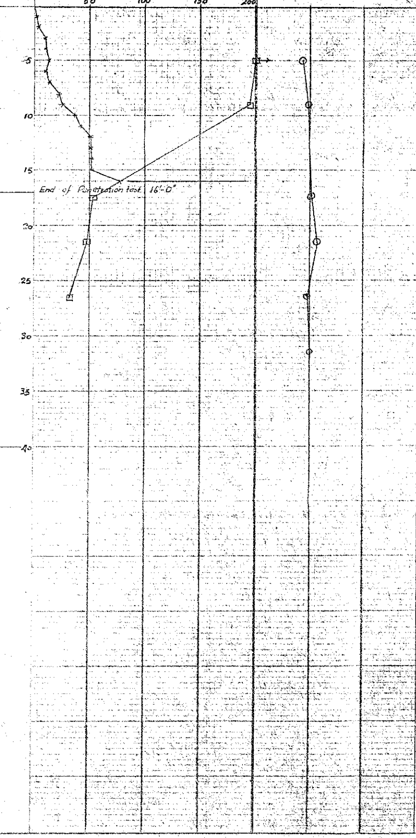
SAMPLE TYPES: C.S - CHUNK; D.O. - DRIVE OPEN; D.F. - DRIVE FOOT VALVE; W.S. - WASHED SAMPLE; T.O. - THIN WALLED OPEN; R.C. - ROCK CORE

ABBREVIATIONS: V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Qc - TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; γ - UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; CA - CASING; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

SOIL PROFILE

ELEVn DEPTH	WATER CONDITIONS	DESCRIPTION
326.2' / 0		HARD BROWN CLAY
309.2' / 17.0'		MEDIUM GREY CLAY.
286.2		End of Borehole 40'-0".

□ SHEAR STRENGTH TONS/SQ.FT. or Qu/2 (0.5, 1.0, 1.5, 2.0) — ⊙ WATER CONTENT W% (20, 30)
X CONE PENETRATION TEST RESISTANCE BLOWS PER FOOT, STANDARD ENERGY 4200 IN-LB (50, 100, 150, 200) — □ PW. △ LW



SAMPLES

OTHER TESTS	CONDITION	TYPE	Nº	PENETRATION RESISTANCE	ELEV. RECOV. %
γ = 133	Good	T.O. 2"	1	71	100
γ = 130	Good	T.O. 2"	2	41	70
	Good	S.S.	3	38	80
γ = 128	Good	T.O. 2"	4	23	80
γ = 130	Good	T.O. 2"	5	18	90
γ = 129	Good	T.O. 2"	6	13	100
	Good	T.O. 2"	7	27	100
	Good	T.O. 2"	8	13	100

TL 125

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATIO

DRILL RIG: CORE DRILL #4
CASING: B.X. (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT.: 250 # DROP 24 INCHES
JOB: F-55-16 ST. CATHERINES
DATUM: STN 97+19.5 64'-9" R
COMPILED BY: J.B. CHECKED BY: W. WONG
BORING Nº: 10
DATE REPORT: 22-IX-55
BORING DATE: 20, 21-IX-55.

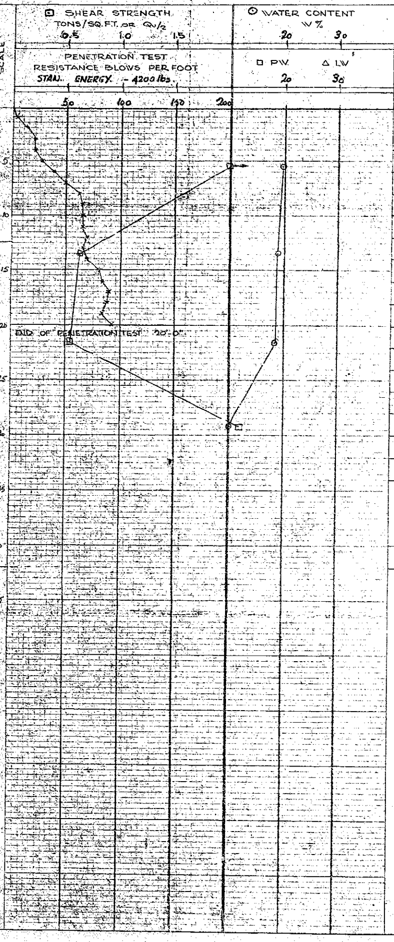
SAMPLE CONDITION: DISTURBED; GOOD; LOST

SAMPLE TYPES: C.S. - CHUNK; D.O. - DRIVE OPEN; D.F. - DRIVE FOOT VALVE; T.O. - THIN WALLED OPEN; W.S. - WASHED SAMPLE; R.C. - ROCK CORE

ABBREVIATIONS: V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Qc - TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; γ - UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; CA. - CASING; W.L. - WATER LEVEL IN CASING; W.T. - WATER TABLE IN SOIL

SOIL PROFILE

ELEV. DEPTH	DESCRIPTION
323.0' / 0	
310.3' / 12.3'	HARD BROWN CLAY
281.0'	MEDIUM GRAY CLAY (STONEY)
(End of Borehole 42'-0")	



SAMPLES

OTHER TESTS	CONDITION	TYPE	Nº	PENETRATION RESISTANCE	ELEV. RECOV. %
γ=128	GOOD	T.O. 2"	1	51	65
	GOOD	T.O. 2"	2	40	75
γ=127	GOOD	T.O. 2"	3	24	95
	GOOD	T.O. 2"	4	25	60
γ=129	GOOD	T.O. 2"	5	20	100
	GOOD	T.O. 2"	6	10	100
γ=144	GOOD	T.O. 2"	7	51	85
	GOOD	T.O. 2"	8	30	85
	GOOD	T.O. 2"	9	60	25

TL 125

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG: CORE DRILL #4
CASING: B.X. (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT.: 250 # DROP 24 INCHES
JOB: F-55-16
DATUM: STN 100+895 58'-0" R
COMPILED BY: V.B. CHECKED BY: W. WONG
BORING Nº: 12
DATE REPORT: 23-IX-55
BORING DATE: 22-IX-55

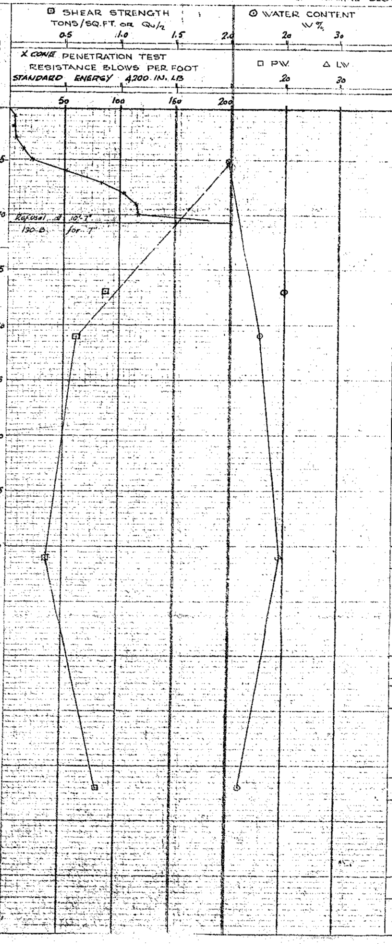
SAMPLE CONDITION: DISTURBED; GOOD; LOST

SAMPLE TYPES: C.S. - CHUNK; D.O. - DRIVE OPEN; D.F. - DRIVE FOOT VALVE; T.O. - THIN WALLED OPEN; W.S. - WASHED SAMPLE; R.C. - ROCK CORE

ABBREVIATIONS: V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Qc - TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; γ - UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; CA. - CASING; W.L. - WATER LEVEL IN CASING; W.T. - WATER TABLE IN SOIL

SOIL PROFILE

ELEV. DEPTH	DESCRIPTION
326.7' / 0	
321.5' / 5.2	STIFF (ELEV. OF BOTTOM OF FOOTING) BROWN SANDY CLAY
313.7' / 13.0'	MEDIUM GREY CLAY STONEY
256.8' / 70.3'	STIFF BROWN CLAY
End of Borehole 72'-0"	



SAMPLES

OTHER TESTS	CONDITION	TYPE	Nº	PENETRATION RESISTANCE (No. of Blows/ft at Std energy = 4200 lb-in)	ELEV. RECOV. %
γ=144	GOOD	T.O. 2"	1	54	100
	GOOD	T.O. 2"	2	110	85
	GOOD	T.O. 2"	3	32	50
γ=119	GOOD	T.O. 2"	4	Pushed	100
γ=126	GOOD	T.O. 2"	5	22	75
	GOOD	T.O. 2"	6	20	100
γ=126	GOOD	T.O. 2"	7	24	100
	LOST	T.O. 2"	8	35	Lost
	GOOD	T.O. 2"	9	8	100
γ=143	GOOD	T.O. 2"	10	47	75
	GOOD	T.O. 2"	11	54	85

TL 179

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG Core Drill #4 — CASING BX (STANDARD SAMPLERS TO FIT UNLESS NOTED) — SAMPLER HAMMER WT 250 # DROP 24 INCHES

JOB F-55-16 — DATUM STN 102+13 - 53.5' R — COMPILED BY V.B. CHECKED BY W. Wong

BORING No 13 — DATE REPORT 29-IX-55 — BORING DATE 23, 24-IX-55

SAMPLE CONDITION: DISTURBED, GOOD, LOST

SAMPLE TYPES: C.S. - CHUNK; D.O. - DRIVE OPEN; D.F. - DRIVE FOOT VALVE; T.O. - THIN WALLED OPEN; W.S. - WASHED SAMPLE; R.C. - ROCK CORE

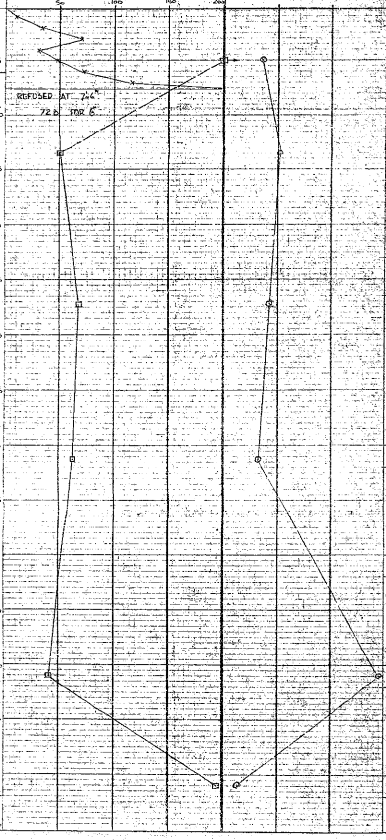
ABBREVIATIONS: V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Q_c - TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; γ - UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; CA - CASING; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

SOIL PROFILE

ELEV'N / DEPTH	DESCRIPTION
327.6' / 0	HARD BROWN CLAY
321.5 / 6.1	(EL. of Bottom of Footing)
317.6' / 10.0'	MEDIUM GRAY CLAY
255.6	End of Borehole 72'-0"

REFUSED AT 7'6" — 72 B for 6"

SHEAR STRENGTH TONS/SQ.FT. or Qu/2 (0.5, 1.0, 1.5) — PENETRATION TEST RESISTANCE BLOWS PER FOOT, STANDARD ENERGY 4200 in-lbs. (50, 100, 150, 200) — WATER CONTENT W% (20, 30) — □ PW, △ LW



SAMPLES

No. of Blows/ft at Std. energy = 4200 lb-in

OTHER TESTS	CONDITION	TYPE	No	PENETRATION RESISTANCE	ELEV. RECOV. %
γ = 136	Good	T.O. 2"	1	68	76
	Good	T.O. 2"	2	51	40
γ = 126	Good	T.O. 2"	3	17	100
	Good	T.O. 2"	4	17	100
CANCELLED SEE FIELD NOTES					
γ = 131	Good	T.O. 3"	5	Pushed	100
γ = 132	Good	T.O. 2"	6	35	100
	Good	T.O. 2"	7	12	100
γ = 119	Good	T.O. 2"	8	11	100
γ = 139	Good	T.O. 2"	9	56	85

TL 179

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG CORE DRILL # 4 — CASING B.X. (STANDARD SAMPLERS TO FIT UNLESS NOTED) — SAMPLER HAMMER WT 250 # DROP 24 INCHES

JOB F-55-16 — DATUM STN 104+76 60'-0" R — COMPILED BY J.B. CHECKED BY W. Wong

BORING No 14A — DATE REPORT 6-X-55 — BORING DATE 4-5-X-55

SAMPLE CONDITION: DISTURBED, GOOD, LOST

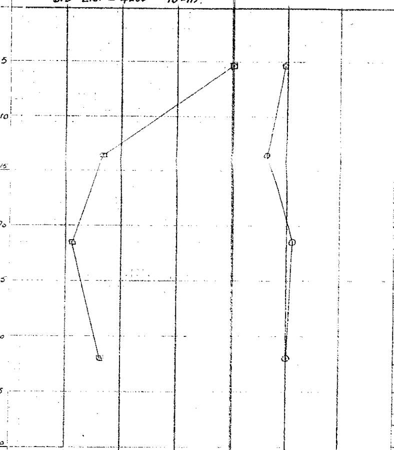
SAMPLE TYPES: C.S. - CHUNK; D.O. - DRIVE OPEN; D.F. - DRIVE FOOT VALVE; T.O. - THIN WALLED OPEN; W.S. - WASHED SAMPLE; R.C. - ROCK CORE

ABBREVIATIONS: V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Q_c - TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; γ - UNIT WEIGHT; K - PERMEABILITY; C - CONSOLIDATION; CA - CASING; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

SOIL PROFILE

ELEV'N / DEPTH	DESCRIPTION
326.9' / 0	HARD BROWN CLAY
311.9' / 15.0'	MEDIUM GREY CLAY
286.9	(End of Borehole 40'-0")

SHEAR STRENGTH TONS/SQ.FT. or Qu/2 (0.5, 1.0, 1.5) — X CONE PENETRATION TEST RESISTANCE BLOWS PER FOOT (50, 100, 150) — STD EN. = 4200 lb-in. — WATER CONTENT W% (20, 30) — □ PW, △ LW



SAMPLES

No. of Blows/ft at Std. energy 4200 lb-in

OTHER TESTS	CONDITION	TYPE	No	PENETRATION RESISTANCE	ELEV. RECOV. %
γ = 132	Good	T.O. 2"	1	83	100
	Good	T.O. 2"	2	27	100
γ = 120	Good	T.O. 2"	-	30	75
	Good	T.O. 2"	4	14	40
γ = 127	Good	T.O. 2"	5	10	100
	Good	T.O. 3"	6	Pushed at field	100
γ = 130	Good	T.O. 2"	7	17	100
	Lost	T.O. 2"	8	17	Lost
	Good	T.O. 2"	9	20	35

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG *CORE DRILL #4*
CASING *BX* (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT *250* # DROP *24* INCHES

JOB *F-55-16*
DATUM *STN 106+78 63'-0" R*
COMPILED BY *V.B.* CHECKED BY *W. Wong*

BORING No *15A*
DATE REPORT *13-X-55*
BORING DATE *11-12-X-55*

SAMPLE CONDITION

- DISTURBED
- GOOD
- LOST

SAMPLE TYPES

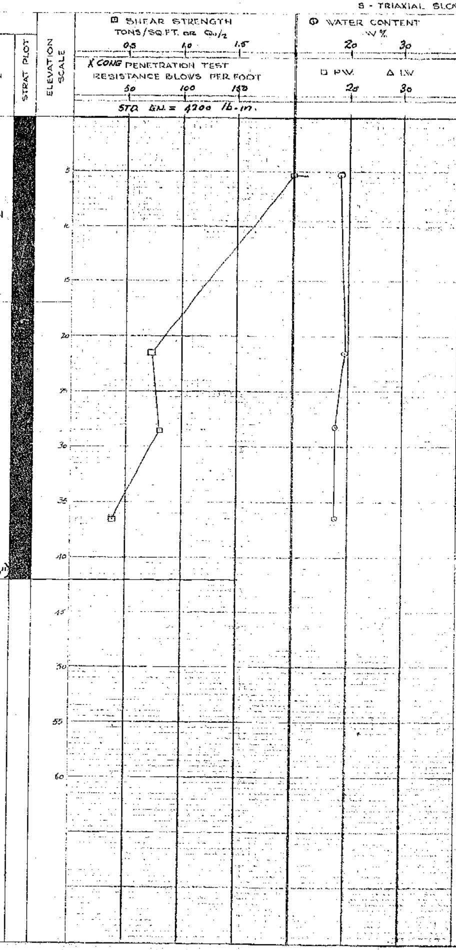
- C.S - CHUNK
- D.O - DRIVE OPEN
- D.F - DRIVE FOOT VALVE
- T.O - THIN WALLED OPEN
- W.S - WASHED SAMPLE
- R.C - ROCK CORE

ABBREVIATIONS

- V - INSITU VANE SHEAR TEST
- M - MECHANICAL ANALYSIS
- U - UNCONFINED COMPRESSION
- Q_c - TRIAXIAL CONSOLIDATED QUICK
- Q - TRIAXIAL QUICK
- S - TRIAXIAL SLOW
- γ - UNIT WEIGHT
- K - PERMEABILITY
- C - CONSOLIDATION
- CA - CASING
- WL - WATER LEVEL IN CASING
- WT - WATER TABLE IN SOIL

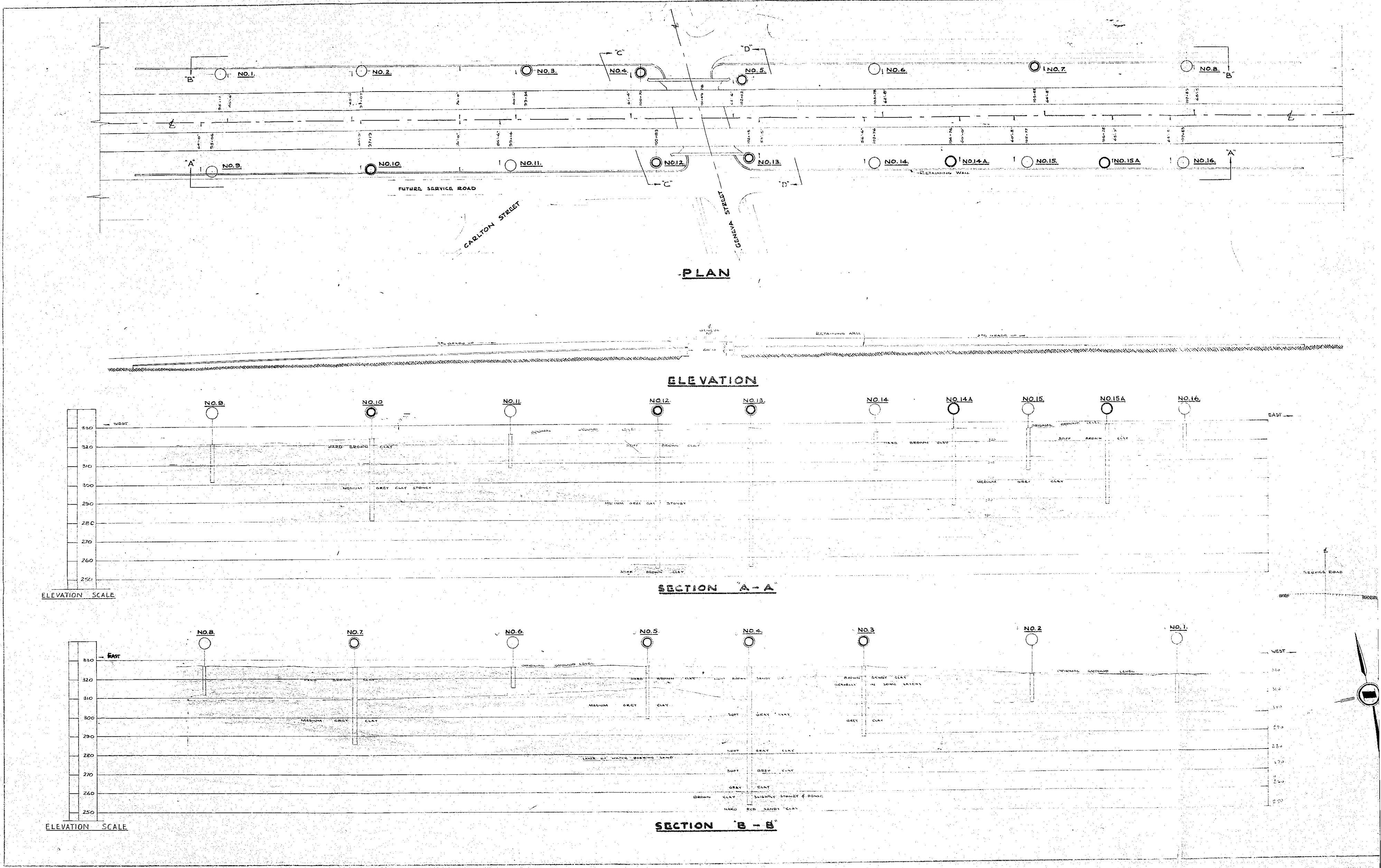
SOIL PROFILE

ELEVn DEPTH	WATER CONDITIONS	DESCRIPTION
328.1 *0*		STIFF BROWN CLAY
311.1 *17.0'*		MEDIUM GREY CLAY
286.1		*(End of Borehole 42'-0")*

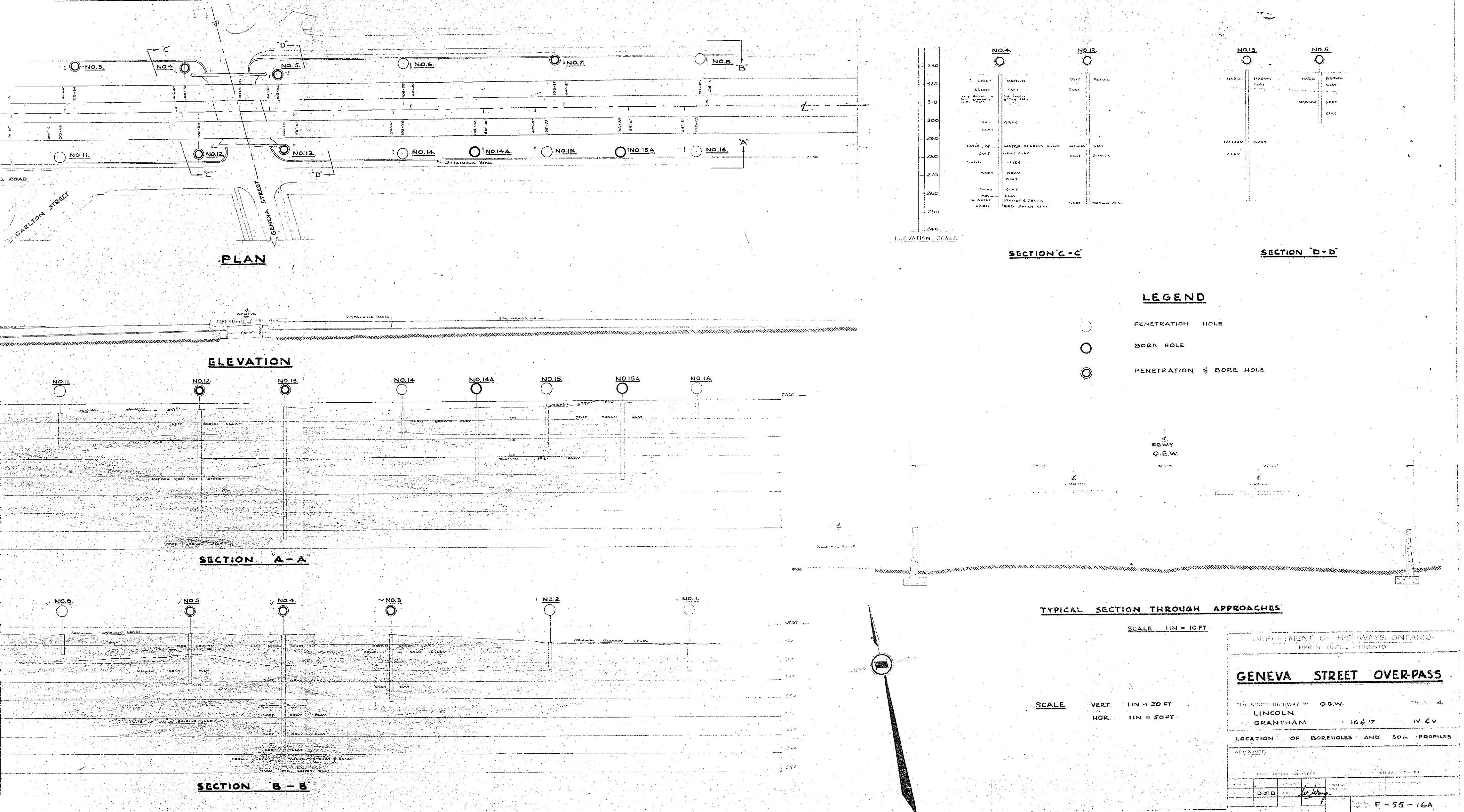


SAMPLES

OTHER TESTS	CONDITION	TYPE	No	PENETRATION RESISTANCE	ELEV. RECOV. %
γ = 131	GOOD	T.O 2"	1	60	50
	GOOD	T.O 2"	2	51	100
	GOOD	T.O 2"	3	31	35
	GOOD	T.O 2"	4	24	100
γ = 131	GOOD	T.O 2"	5	21	100
	GOOD	T.O 2"	6	14	35
γ = 134	GOOD	T.O 2"	7	28	100
γ = 129	GOOD	T.O 2"	8	15	85
	GOOD	T.O 2"	9	15	100



"B"
NO.1.
NO.2.
NO.3.
"C"
NO.4.
"D"
NO.5.
NO.6.
NO.7.
NO.8.
"A"
NO.9.
NO.10.
NO.11.
NO.12.
NO.13.
NO.14.
NO.14A.
NO.15.
NO.15A
NO.16.
FUTURE SERVICE ROAD
CARLTON STREET
GENEVA STREET
RETAINING WALL
PLAN
ELEVATION
WEST
EAST
HARD BROWN CLAY
MEDIUM GREY CLAY STONEY
STIFF BROWN CLAY
MEDIUM GREY CLAY
ORIGINAL GROUND LEVEL
SERVICE ROAD
330
320
310
300
290
280
270
260
250
ELEVATION SCALE
SECTION "A-A"
SOFT GREY CLAY
GREY CLAY
HARD RED SANDY CLAY
SECTION "B-B"



DEPARTMENT OF HIGHWAYS: ONTARIO
BRIDGE OFFICE TORONTO

GENEVA STREET OVER-PASS

THE KING'S HIGHWAY No. Q.E.W. DIV. No. 4
LINCOLN
GRANTHAM 16 & 17 IV & V

LOCATION OF BOREHOLES AND SOIL PROFILES

APPROVED

D.J.D.

F-55-16A