

OFFICE LOCATION -
DOWNSVIEW AVE.
KEELE ST. - HIGHWAY 401
TORONTO, ONTARIO.



ONTARIO
DEPARTMENT OF HIGHWAYS

22-62 784
POSTAL ADDRESS -
DEPARTMENT OF HIGHWAYS
PARLIAMENT BUILDINGS,
TORONTO 5, ONTARIO.

Bridge Division,
December 1, 1961.

MEMO AND/OR TO:

Mr. A. G. Stermac,
Principal Foundation Eng.,
Department of Highways,
Room 107, Lab. Bldg.,
Downsview, Ontario,

RE: W.P. 177-60
W.P. 116-59
Lancaster Twp. Br. #10
Lancaster Twp. Br. #11
Hwy. 401 and Hwy. 2 at
Sutherland Ck., 2.3 Mi.
West of Quebec Bdry.

Enclosed find one preliminary plan for the
subject structures (D4958-P).

The designer appears to have conformed to the
recommendations and comments as set out in the
foundation report which you forwarded November 8,
1961 but we would appreciate any comments which
you would like to make.

JBC/ea
cc. D. Smith

J. B. Curtis,
Bridge Location Engineer.

10-15-61

WILLIAM A. TROW AND ASSOCIATES LTD.

SITE INVESTIGATIONS
LABORATORY TESTING
SOIL MECHANICS CONSULTATION

W. A. TROW, M.A.S.C., M.E.I.C., P.ENG.

1850 JANE ST.,
WESTON, ONT.
CH. 1-4644

Project: J542

Nov. 16, 1960

Mr. A. Rutka,
Acting Materials & Research Engineer,
Department of Highways of Ontario,
Parliament Buildings,
Toronto, Ontario

Attention: Mr. L.G. Soderman, P.Eng.

Re: Test Results, Sutherland Creek

Dear Sirs:

Enclosed herewith are two copies of the borehole logs,
borehole location plan and the results of tests performed on the
marine clay at this site.

Yours very truly,

WAT/gc
Encls.

WAT
William A. Trow, P.Eng.

SUMMARY OF LABORATORY TEST RESULTS - SUTHERLAND CREEK CROSSING

Elevation		SHEAR STRENGTH PSF				NATURAL MOISTURE CONTENT % Dry Weight			LIQUID LIMIT % Dry Weight			PLASTIC LIMIT % Dry Weight		
		Hole No.				Hole No.			Hole No.			Hole No.		
1	3	4	7	11	12	4	11	12	4	11	12	4	11	12
153.0	V >2100													
152.0				U 1950	U 1830		38	43		79	80		24	24
151.0					V >2100									
150.0	V 3150													
149.0	V >2100			U 1425	U 1550		56	52		85	75		27	24
148.0		U 1650				51			88			30		
147.0			1150	V 1400	V >2100									
146.0		V 1680		U 1450	U 1300		56	60		67	82		22	27
145.0		U 900		V 850		51.4(failure zone) 59.1			73			24		
144.0					V 950									
143.0		V 1050		U 275		37	(probably more clay in this test)			24			18	
142.0				V 650										
141.0		U 350			V 1250	48.9 Clay Composite								
		U 500				34.2	28							
						Silt 27.2								
140.0						20.4			18.5			14		

Legend: U = Undrained triaxial test results - cell pressure equal to or just above overburden.

V = Field vane test.

LEGEND

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—

2" I.D. SHELBY TUBE —x—x—x—x—

2" DIA. CONE ————

SHEAR STRENGTH

UNDRAINED TRIAXIAL
AT OVERBURDEN PRESSURE ⊕

UNCONFINED COMPRESSION ⊗

VANE TEST AND SENSITIVITY (S) +^sNATURAL MOISTURE CONTENT
AND LIQUIDITY INDEXX^{LI}

ATTERBERG LIMITS

LIQUID LIMIT —○—

PLASTIC LIMIT ———

SAMPLE TYPE

2" O.D. SPLIT TUBE

2" I.D. SHELBY TUBE

3" O.D. SHELBY TUBE

BOREHOLE No. 1

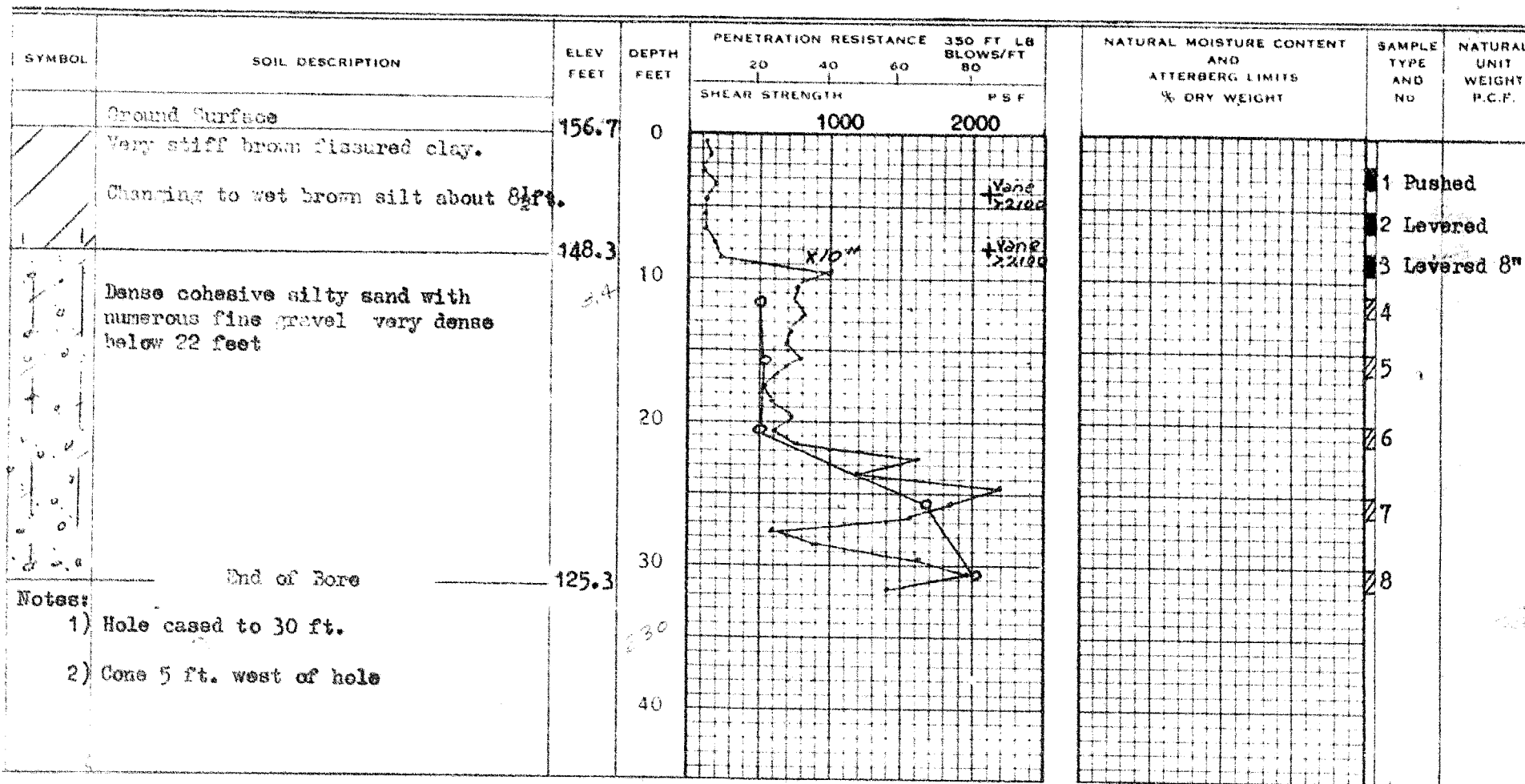
PROJECT Sutherland Creek and Hwy. No. 2 Crossing-Hwy. 401

LOCATION East of Lancaster, Ont.

HOLE LOCATION See Dwg. No. 1

HOLE ELEVATION 156.7 ft.

DATUM Top North Guard Rail Existing Bridge = 163.3



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SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

LEGEND

DRAWING No. 3

PROJECT No. J542

BOREHOLE NO. 2
 PROJECT Sutherland Creek and Hwy. No. 2 Crossing-Hwy. 401
 LOCATION East of Lancaster, Ont.
 HOLE LOCATION See Dwg. No. 1
 HOLE ELEVATION 157.2 ft.
 DATUM Top North Guard Rail Existing Bridge = 163.3

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—
 2" I.D. SHELBY TUBE —x—x—x—x—
 2" DIA. CONE ————

SHEAR STRENGTH

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊙
 UNCONFINED COMPRESSION ⊗
 VANE TEST AND SENSITIVITY (S) +^s

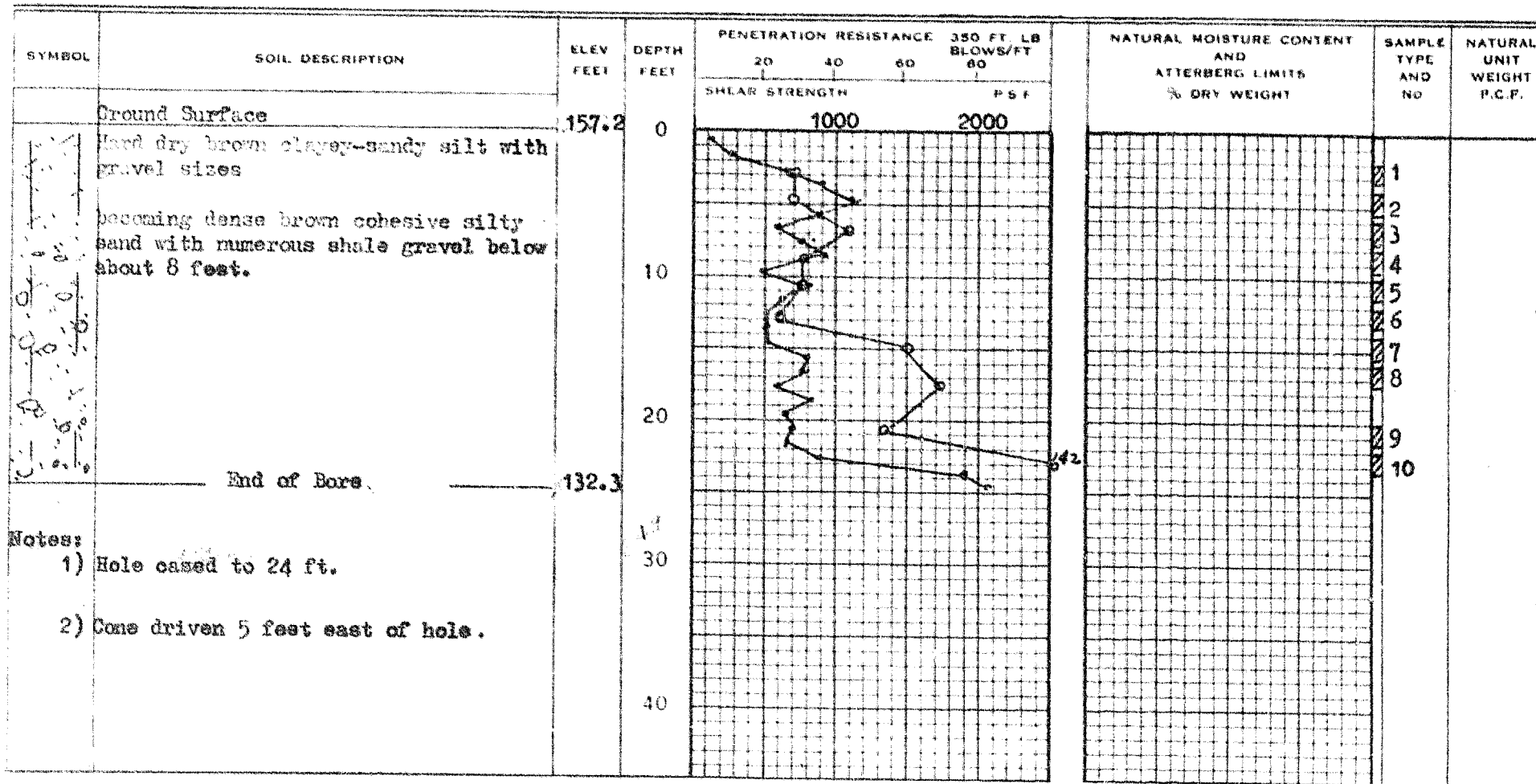
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

ATTERBERG LIMITS

LIQUID LIMIT —○—
 PLASTIC LIMIT ———

SAMPLE TYPE

2" O.D. SPLIT TUBE —■—
 2" I.D. SHELBY TUBE —■—
 3" O.D. SHELBY TUBE —■—



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SITE INVESTIGATIONS SOIL MECHANICS CONSULTATION

DRAWING No. 4
PROJECT No. J542

LEGEND

BOREHOLE No. 3
PROJECT Sutherland Creek and Hwy. No. 2 Crossing-Hwy. 401
LOCATION East of Lancaster, Ont.
HOLE LOCATION See Dwg. No. 1
HOLE ELEVATION 154.4 ft.
DATUM Top North Guard Rail Existing Bridge = 163.3

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—

2" I.D. SHELBY TUBE —*—*—*—*

2" DIA CONE ————

SHEAR STRENGTH

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊕

UNCONFINED COMPRESSION ⊗

VANE TEST AND SENSITIVITY (S) ⊕^s

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

X^{LI}

ATTERBERG LIMITS

LIQUID LIMIT —○—

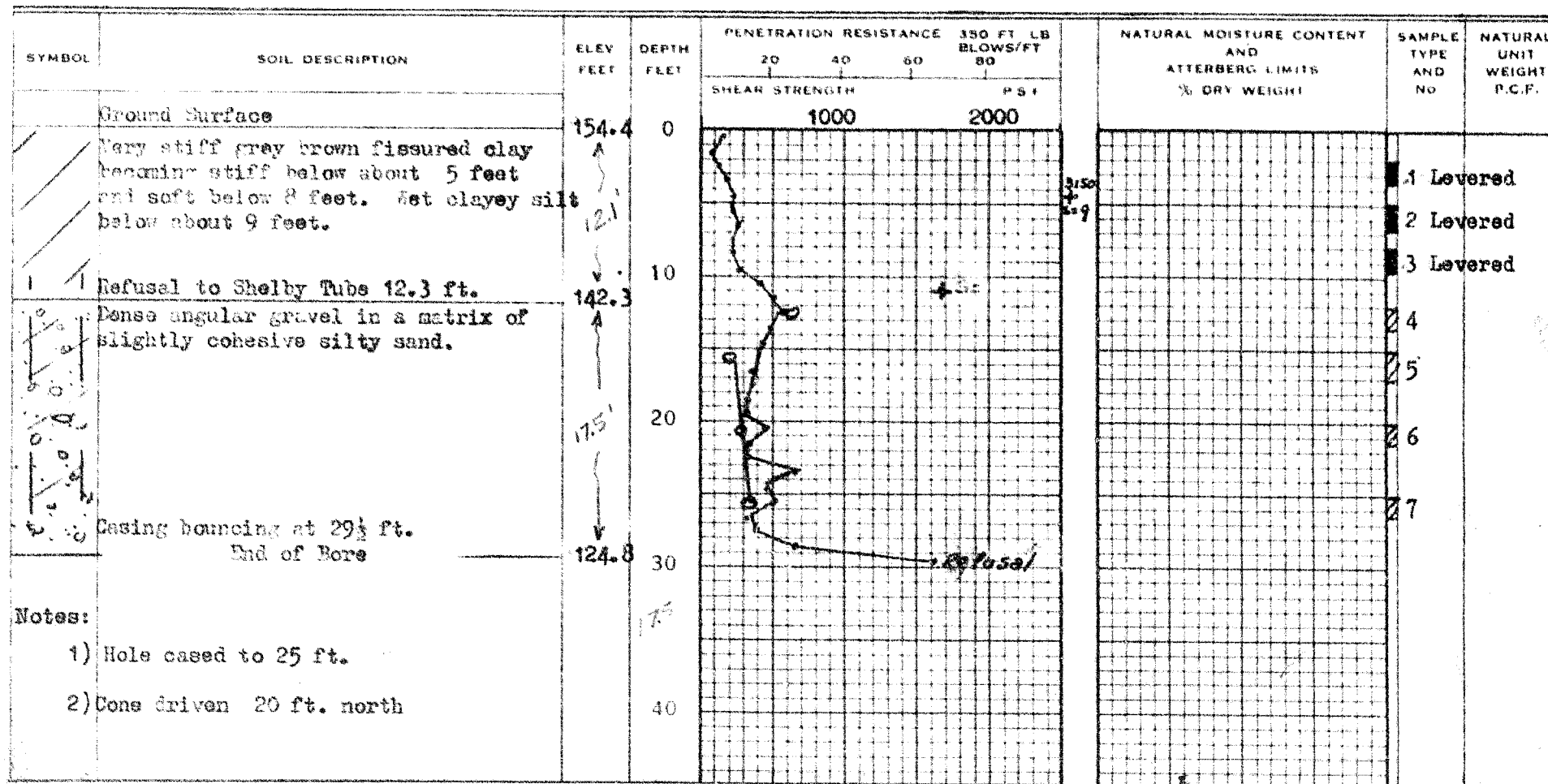
PLASTIC LIMIT —|—

SAMPLE TYPE

2" O.D. SPLIT TUBE ⊠

2" I.D. SHELBY TUBE ⊡

3" O.D. SHELBY TUBE ⊢



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SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

LEGEND

DRAWING No. 5
PROJECT No. J542

BOREHOLE No. 4
PROJECT Sutherland Creek and Hwy. No. 2 Crossing-Hwy. 401
LOCATION East of Lancaster, Ont.
HOLE LOCATION See Dwg. No. 1
HOLE ELEVATION 154.4 ft.
DATE Top North Guard Rail Existing Bridge = 163.3

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—
2" I.D. SHELBY TUBE *—*—*—*—
2" DIA. CONE ————

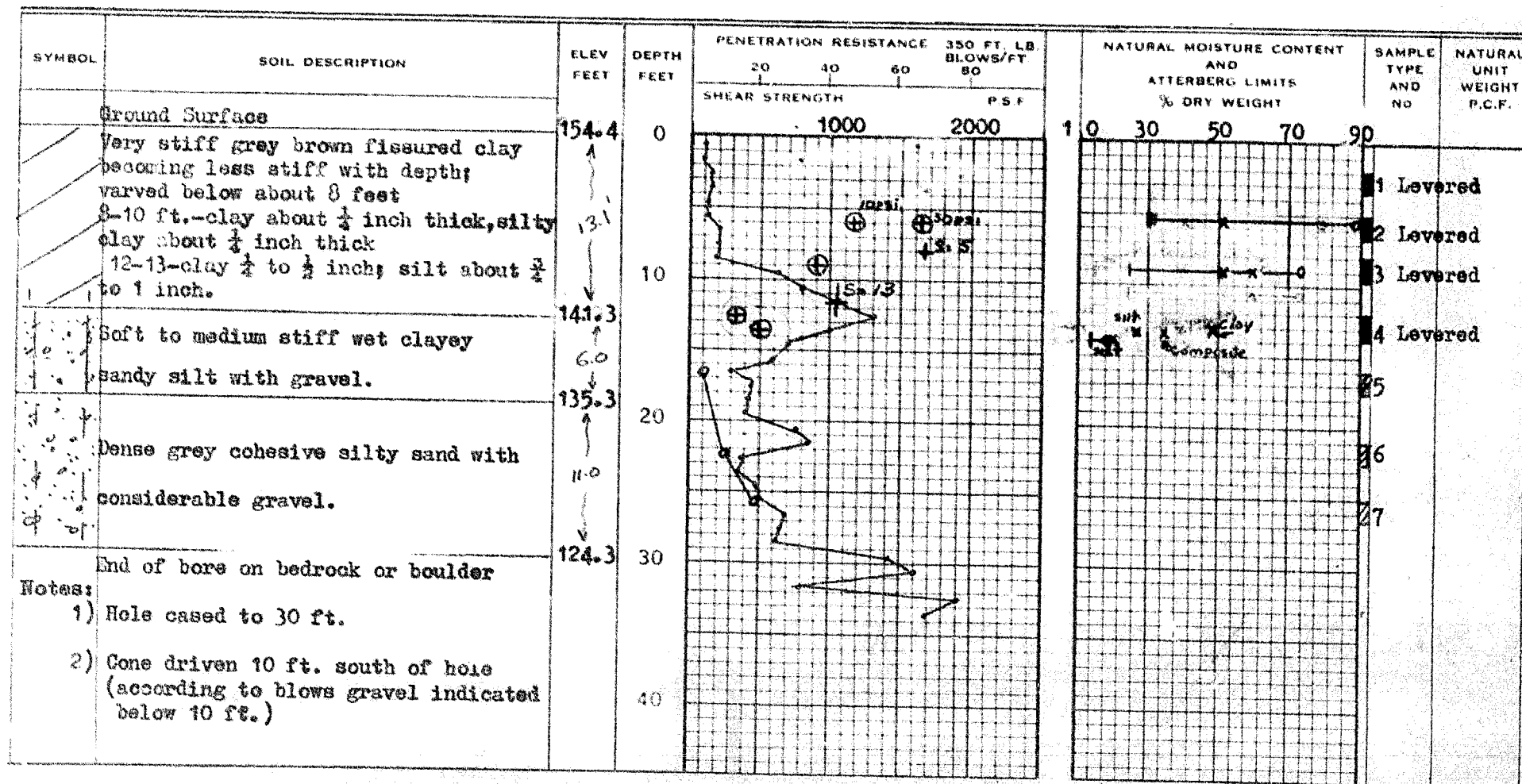
SHEAR STRENGTH

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊕
UNCONFINED COMPRESSION ⊗
VANE TEST AND SENSITIVITY (S) +^s

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

ATTERBERG LIMITS

LIQUID LIMIT —○—
PLASTIC LIMIT ———
SAMPLE TYPE
2" O.D. SPLIT TUBE ⊠
2" I.D. SHELBY TUBE ⊡
3" O.D. SHELBY TUBE ⊢



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SITE INVESTIGATIONS SOIL MECHANICS CONSULTATION

LEGEND




DRAWING No. 6
PROJECT No. J-42


BOREHOLE No. 5
PROJECT Sutherland Creek & Hwy. No. 2 Crossing Hwy. 401
LOCATION East of Lancaster
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 154.6 ft.
DATUM Top north Guard Rail existing bridge 163.3

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE 
2" I.D. SHELBY TUBE 
2" DIA. CONE 

SHEAR STRENGTH




UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 
UNCONFINED COMPRESSION 
VANE TEST AND SENSITIVITY (S) 

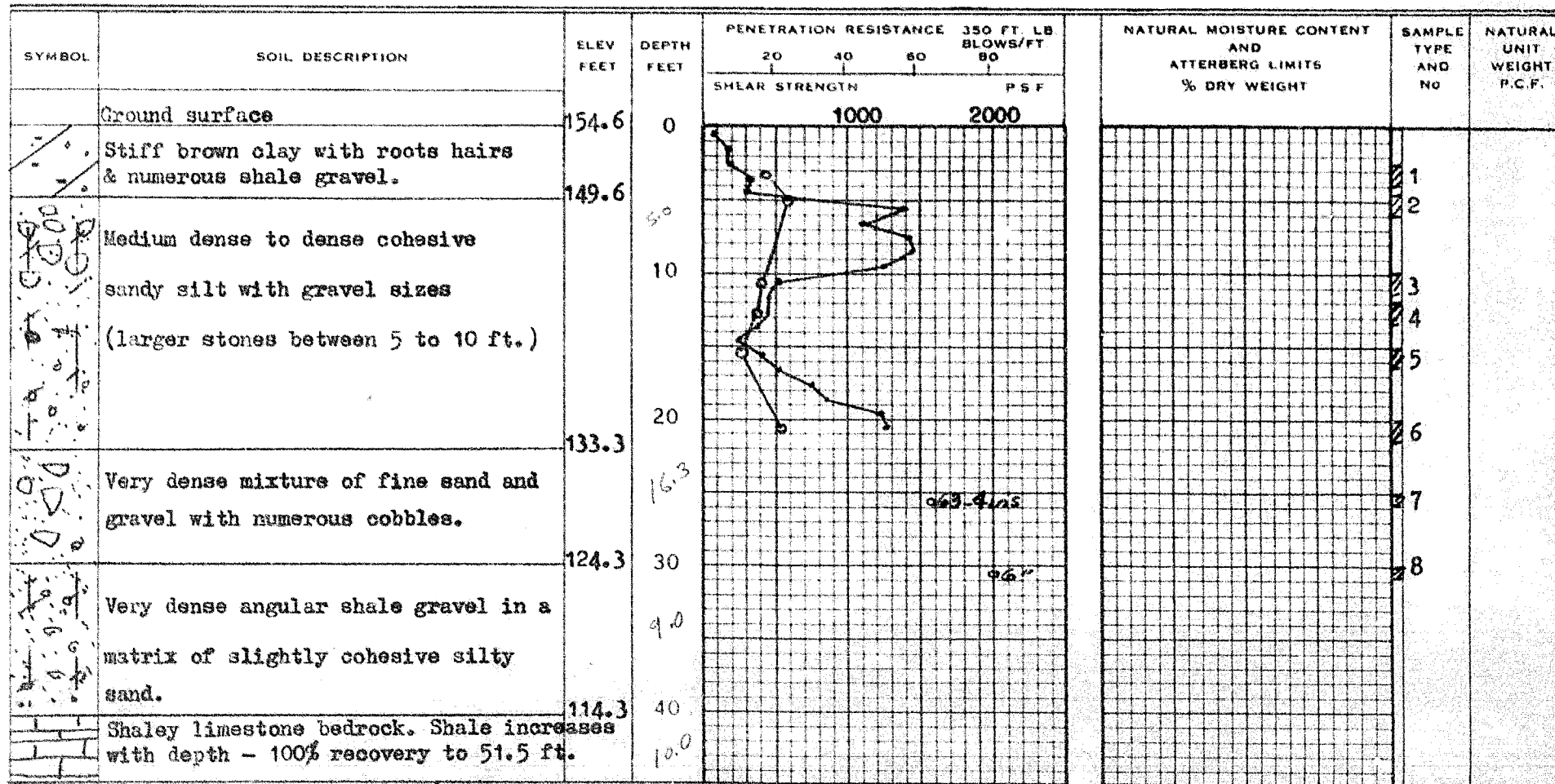
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX 

ATTERBERG LIMITS

LIQUID LIMIT 
PLASTIC LIMIT 

SAMPLE TYPE

2" O.D. SPLIT TUBE 
2" I.D. SHELBY TUBE 
3" O.D. SHELBY TUBE 



Notes: 1) Hole cased to 35 ft. 2) Cone 5 ft. north.

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SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

DRAWING No. 7
PROJECT No. J542

LEGEND

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—
2" I.D. SHELBY TUBE *—*—*—*—
2" DIA. CONE ————

SHEAR STRENGTH

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊕
UNCONFINED COMPRESSION ⊗
VANE TEST AND SENSITIVITY (S) +^s

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX X^{LI}

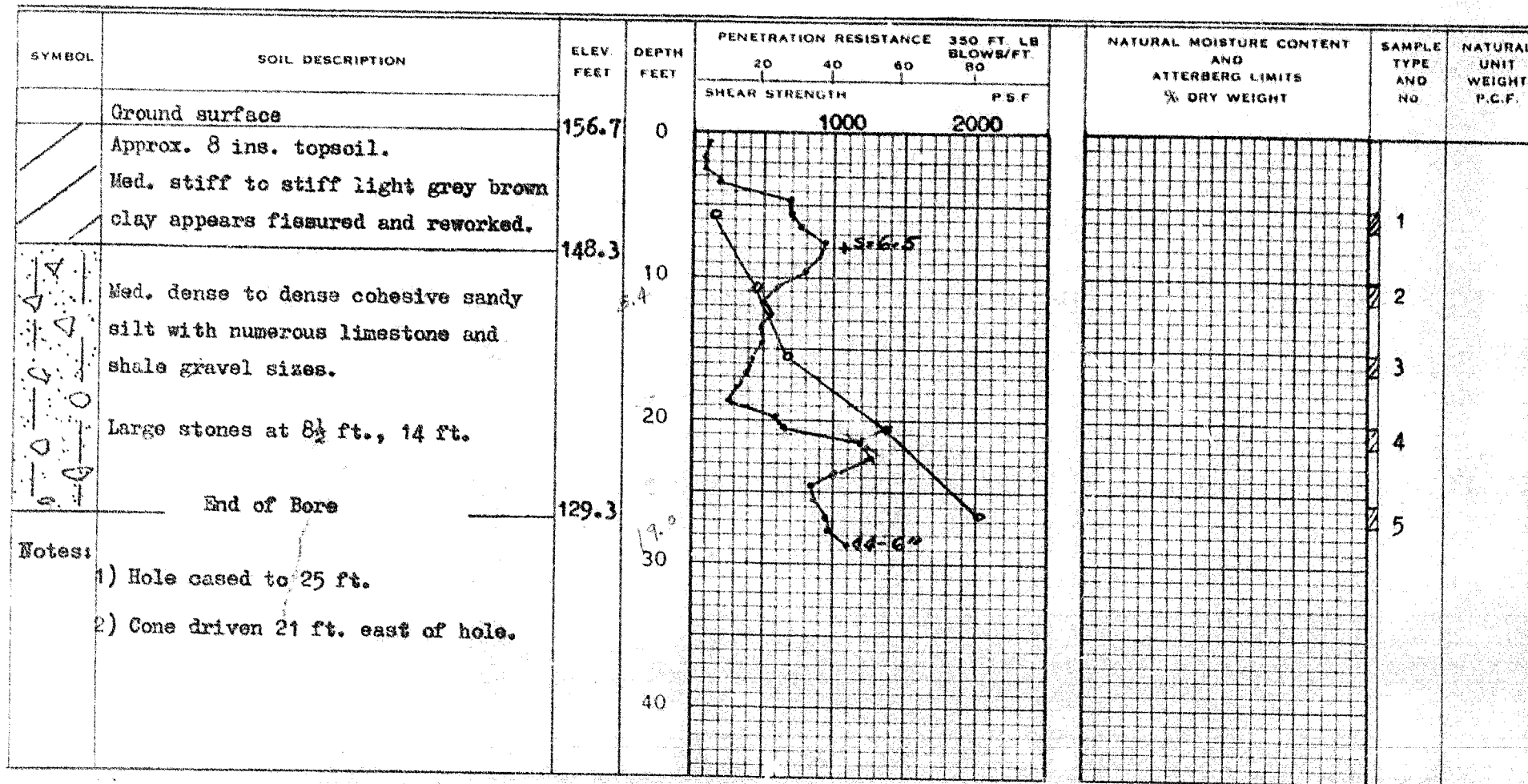
ATTERBERG LIMITS

LIQUID LIMIT —○—
PLASTIC LIMIT ———

SAMPLE TYPE




2" O.D. SPLIT TUBE —■—
2" I.D. SHELBY TUBE —■—
3" O.D. SHELBY TUBE —■—

BOREHOLE No. 6
PROJECT Sutherland Creek & Hwy. No. 2 Crossing Hwy. 401
LOCATION East of Lancaster, Ont.
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 156.7 ft.
DATUM Top north Guard Rail existing Bridge 163.3






BOREHOLE NO. 7
PROJECT Sutherland Creek & Hwy. No. 2 Crossing Hwy. 401
LOCATION East of Lancaster, Ont.
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 155.4 ft.
DATUM Top north Guard Rail existing bridge = 163.3

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE 
2" I.D. SHELBY TUBE 
2" DIA. CONE 

SHEAR STRENGTH

UNDRAINED TRIAXIAL
AT OVERBURDEN PRESSURE 
UNCONFINED COMPRESSION 
VANE TEST AND SENSITIVITY (S)  L^S




NATURAL MOISTURE CONTENT
AND LIQUIDITY INDEXLI
X

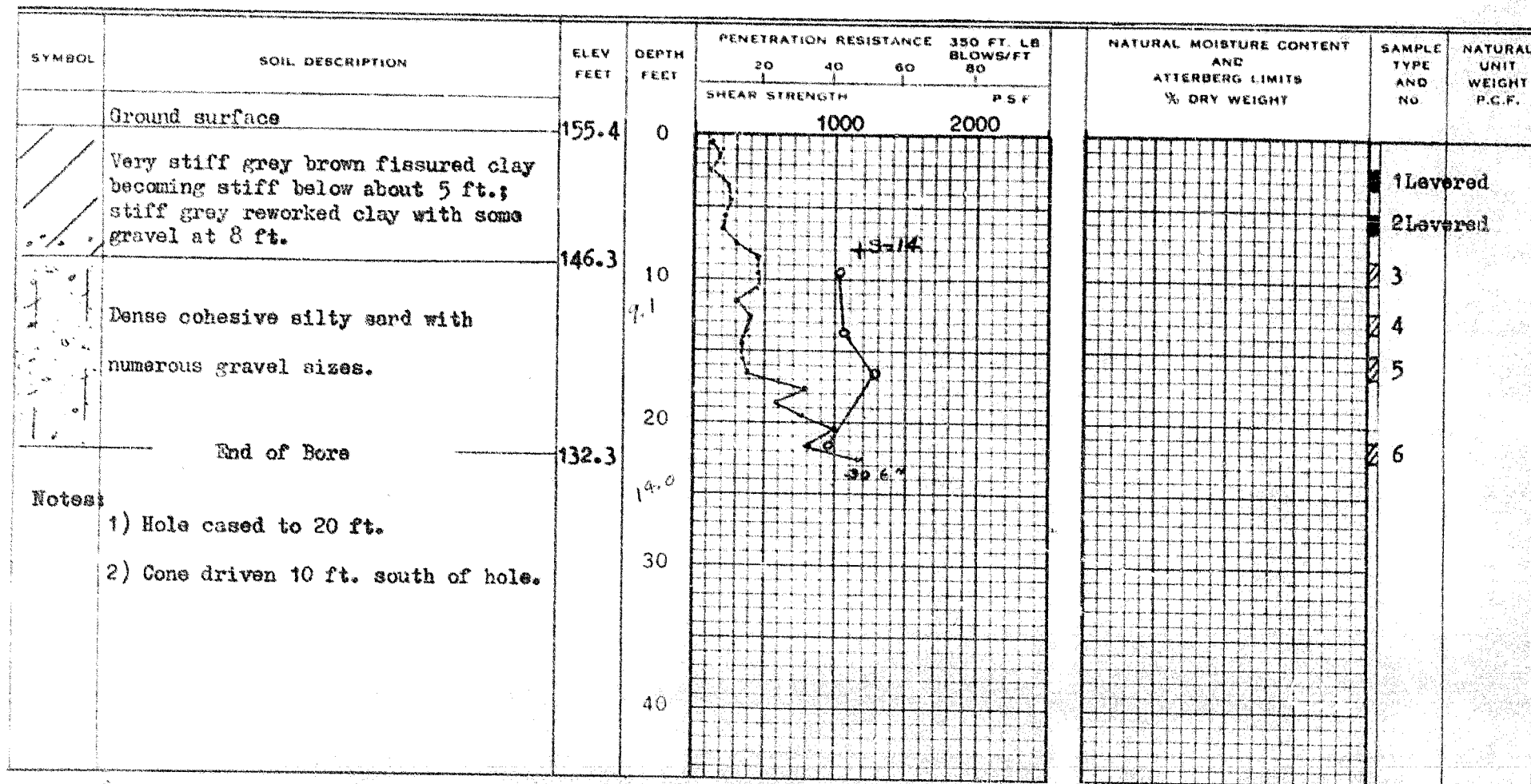
ATTERBERG LIMITS

LIQUID LIMIT

PLASTIC LIMIT

SAMPLE TYPE

2" O.D. SPLIT TUBE 
2" I.D. SHELBY TUBE 
3" O.D. SHELBY TUBE 



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SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

LEGEND

DRAWING NO. 9
PROJECT NO. J542

BOREHOLE NO. 8
PROJECT Sutherland Creek & Hwy. No. 2 Crossing Hwy. 401
LOCATION East of Lancaster
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 157.20 ft.
DATUM Top north Guard Rail existing bridge 163.3

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—
2" I.D. SHELBY TUBE —+—+—+—+—
2" DIA. CONE —————
SHEAR STRENGTH
UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊙
UNCONFINED COMPRESSION ⊙
VANE TEST AND SENSITIVITY (S) +^s

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

ATTERBERG LIMITS

LIQUID LIMIT —○—

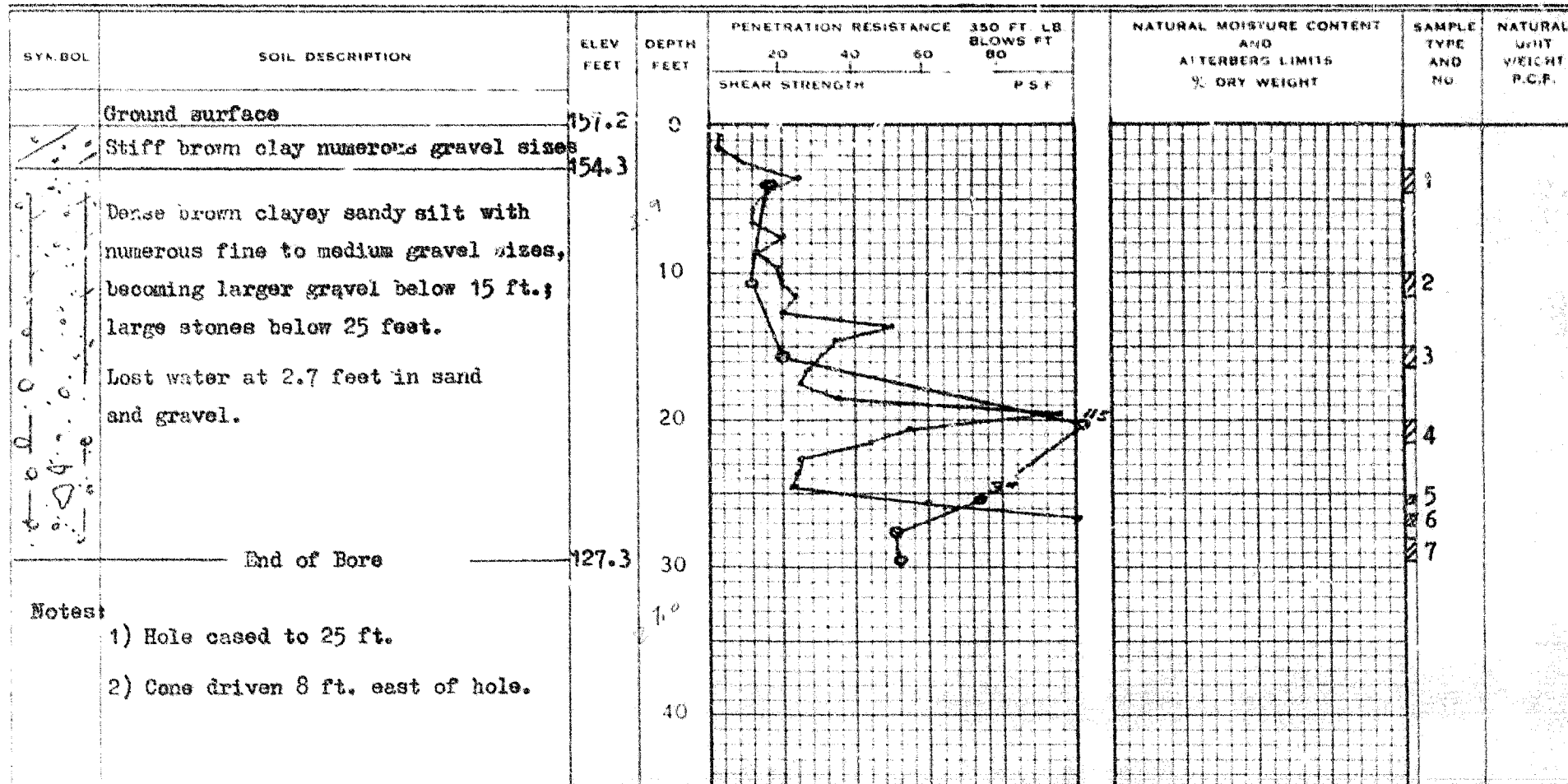
PLASTIC LIMIT ———

SAMPLE TYPE

2" O.D. SPLIT TUBE —○—

2" I.D. SHELBY TUBE —+—

3" O.D. SHELBY TUBE —■—



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SITE INVESTIGATION'S · SOIL MECHANICS CONSULTATION

LEGEND

DRAWING No. 10
PROJECT No. J542

BOREHOLE No. 9
PROJECT Sutherland Creek & Hwy. No. 2 Crossing Hwy. 401
LOCATION East of Lancaster, Ont.
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 157.0 ft.
DATUM Top north Guard Rail existing bridge 163.3

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—
2" I.D. SHELBY TUBE *—*—*—*—
2" DIA. CONE ————

SHEAR STRENGTH

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊕
UNCONFINED COMPRESSION ⊗
VANE TEST AND SENSITIVITY (S) †

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

LI
X

ATTERBERG LIMITS

LIQUID LIMIT —○—

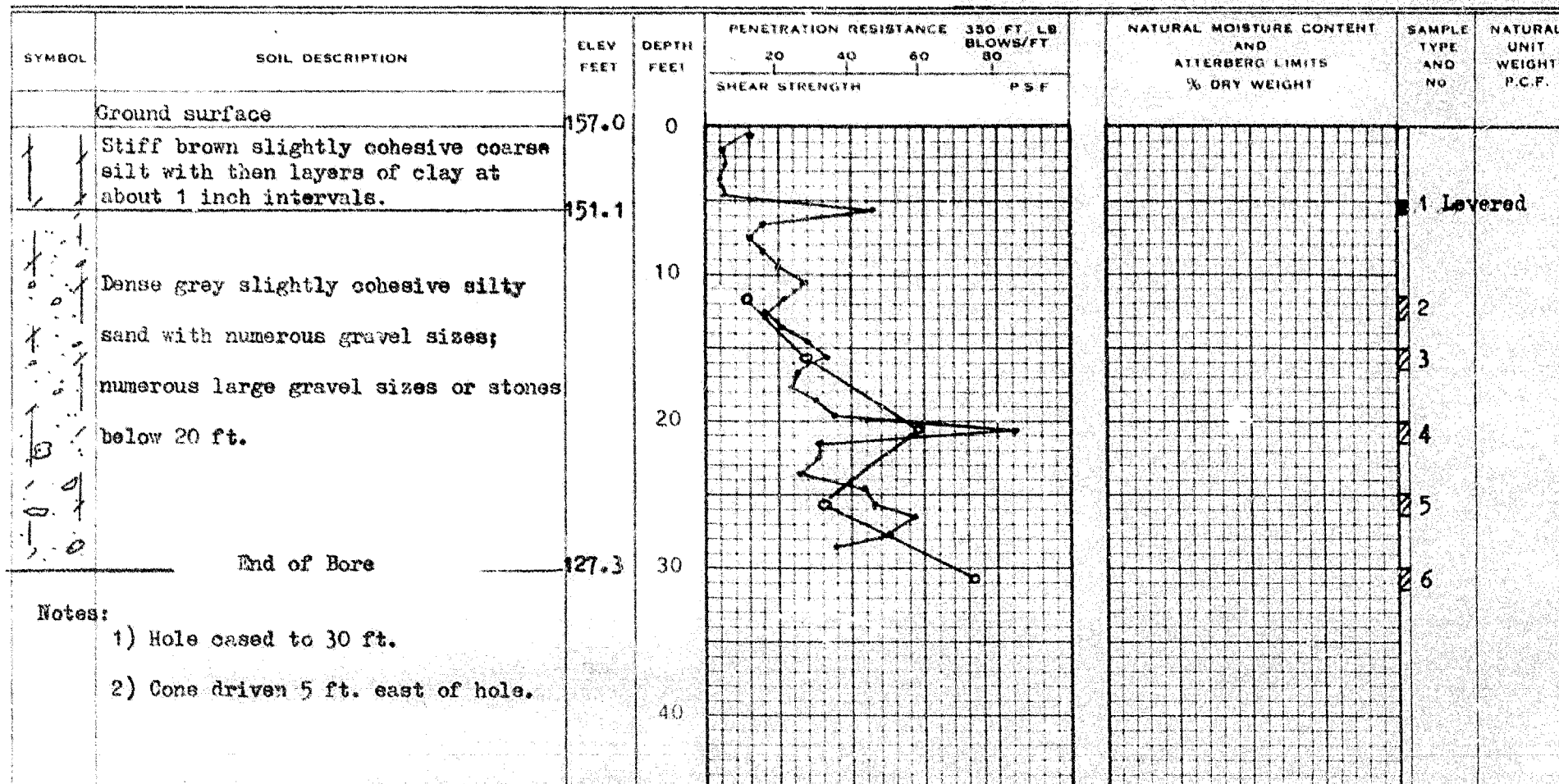
PLASTIC LIMIT ———

SAMPLE TYPE

2" O.D. SPLIT TUBE ⊡

2" I.D. SHELBY TUBE ⊢

3" O.D. SHELBY TUBE ⊣



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SITE INVESTIGATIONS SOIL MECHANICS CONSULTATION

DRAWING No. 11
PROJECT No. J542

LEGEND

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—
2" I.D. SHELBY TUBE —x—x—x—x—
2" DIA. CONE ————

SHEAR STRENGTH

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊕
UNCONFINED COMPRESSION ⊗
VANE TEST AND SENSITIVITY (S) ⊕³

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

X^{LI}

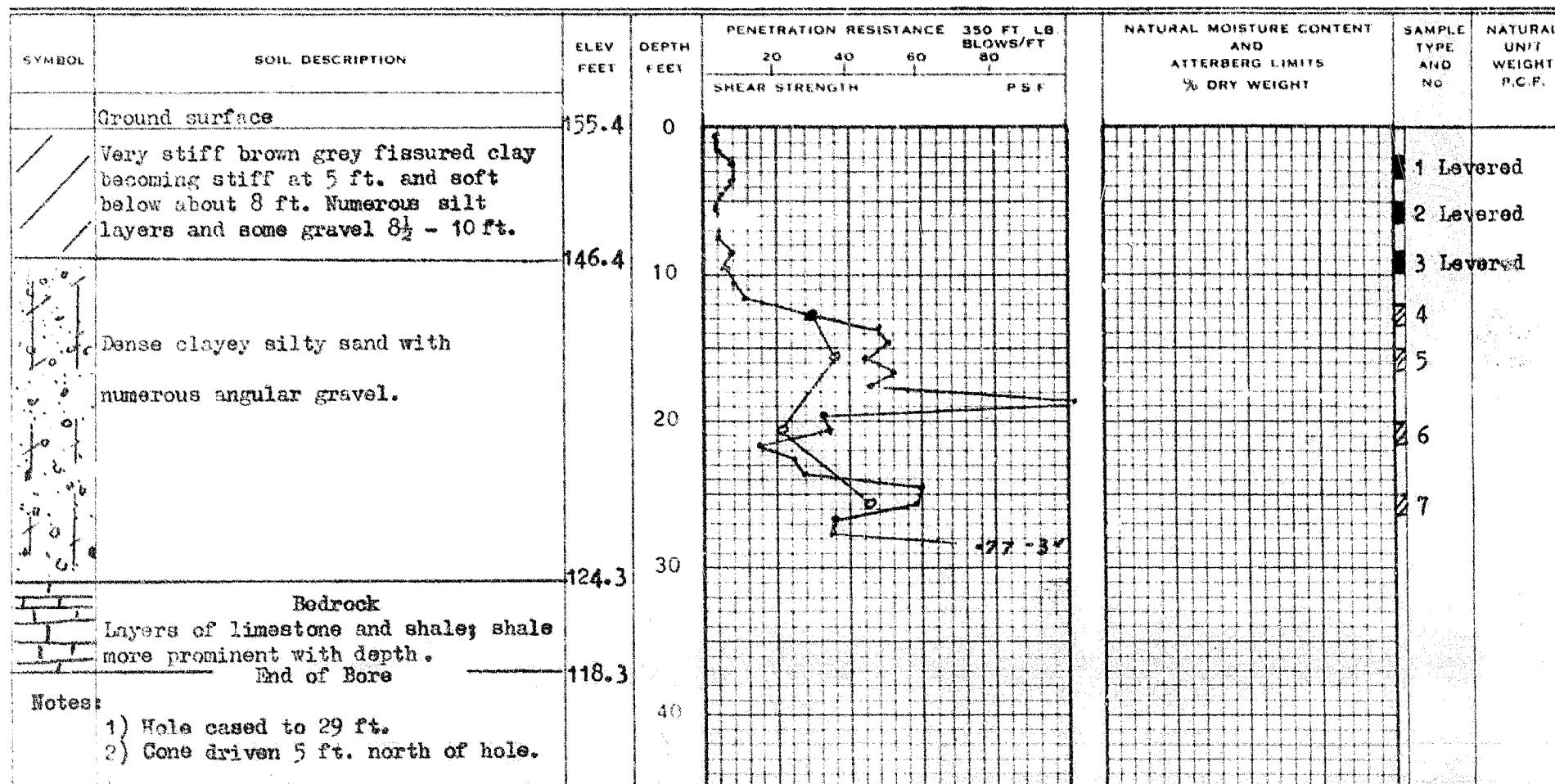
ATTERBERG LIMITS

LIQUID LIMIT —○—
PLASTIC LIMIT ———

SAMPLE TYPE

2" O.D. SPLIT TUBE ⊗
2" I.D. SHELBY TUBE ⊗
3" O.D. SHELBY TUBE ⊗

BOREHOLE No. 10
PROJECT Sutherland Creek & Hwy. No. 2 Crossing Hwy. 401
LOCATION East of Lancaster, Ont.
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 155.4 ft.
DATUM Top north Guard Rail existing bridge 163.3



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SITE INVESTIGATIONS SOIL MECHANICS CONSULTATION

DRAWING NO. 12
PROJECT NO. J542

LEGEND

BOREHOLE NO. 11
PROJECT Sutherland Creek & Hwy. No. 2 Crossing Hwy. 401
LOCATION East of Lancaster, Ont.
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 156.0 ft.
DATUM Water level Sutherland Creek = 152.13
On August 8, 1960

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—
2" I.D. SHELBY TUBE —x—x—x—x—
2" DIA. CONE ————

SHEAR STRENGTH

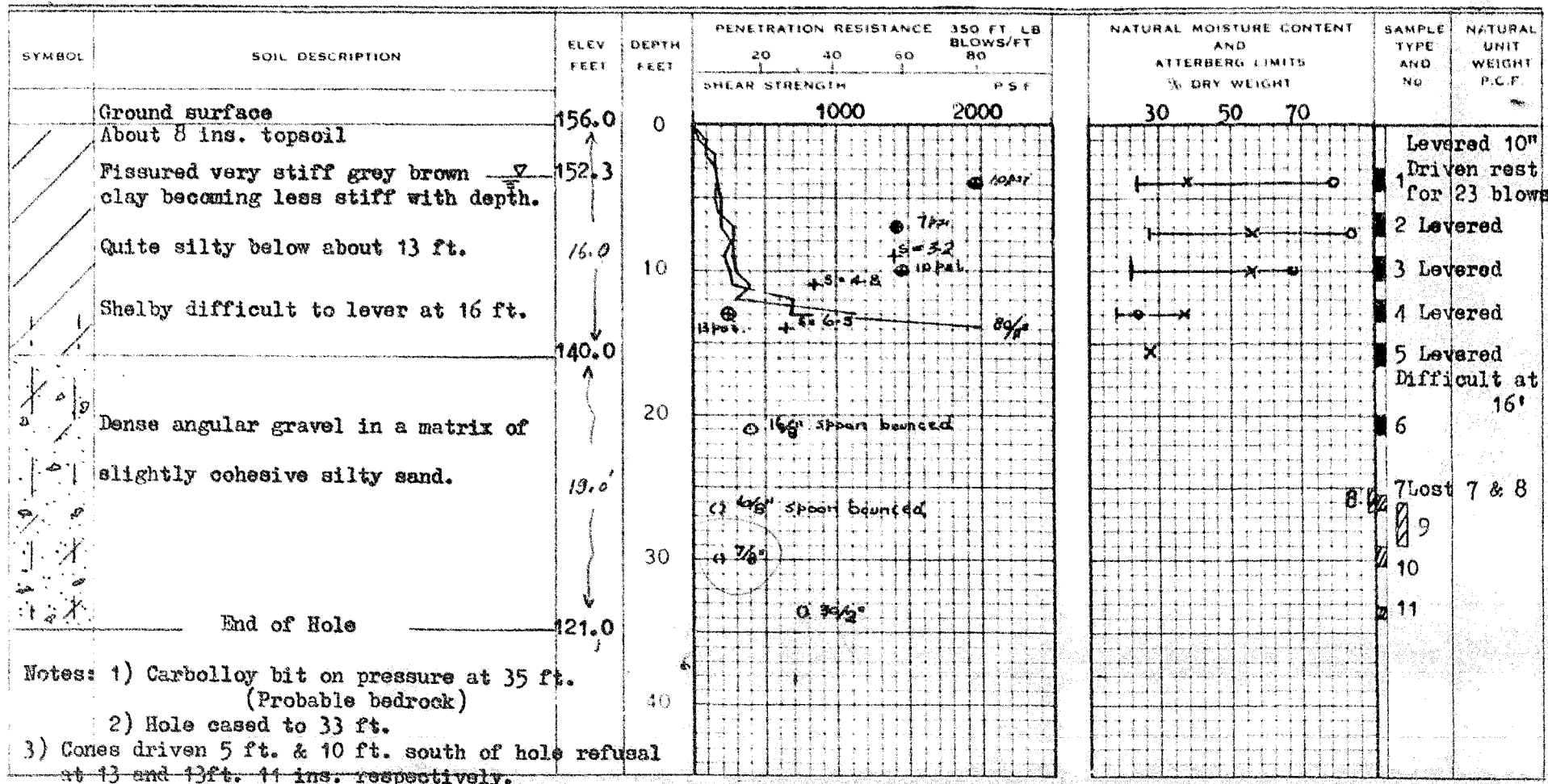
UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊕
UNCONFINED COMPRESSION ⊙
VANE TEST AND SENSITIVITY (S) +^s

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

ATTERBERG LIMITS

LIQUID LIMIT —○—
PLASTIC LIMIT ———
SAMPLE TYPE

2" O.D. SPLIT TUBE —○—
2" I.D. SHELBY TUBE —x—
3" O.D. SHELBY TUBE —■—



BOREHOLE No. 12PROJECT Sutherland Creek & Hwy. No. 2 Crossing Hwy. 401LOCATION East of Lancaster, Ont.HOLE LOCATION See Dwg. 1.HOLE ELEVATION 156.4 ft.DATUM Water level Sutherland Creek = 152.13
On August 8, 1960

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —○—○—○—

2" I.D. SHELBY TUBE *—*—*—*—

2" DIA. CONE ————

SHEAR STRENGTH

UNDRAINED TRIAXIAL
AT OVERBURDEN PRESSURE ⊕

UNCONFINED COMPRESSION ⊗

VANE TEST AND SENSITIVITY (S) +^sNATURAL MOISTURE CONTENT
AND LIQUIDITY INDEXLI
X

ATTERBERG LIMITS

LIQUID LIMIT —○—

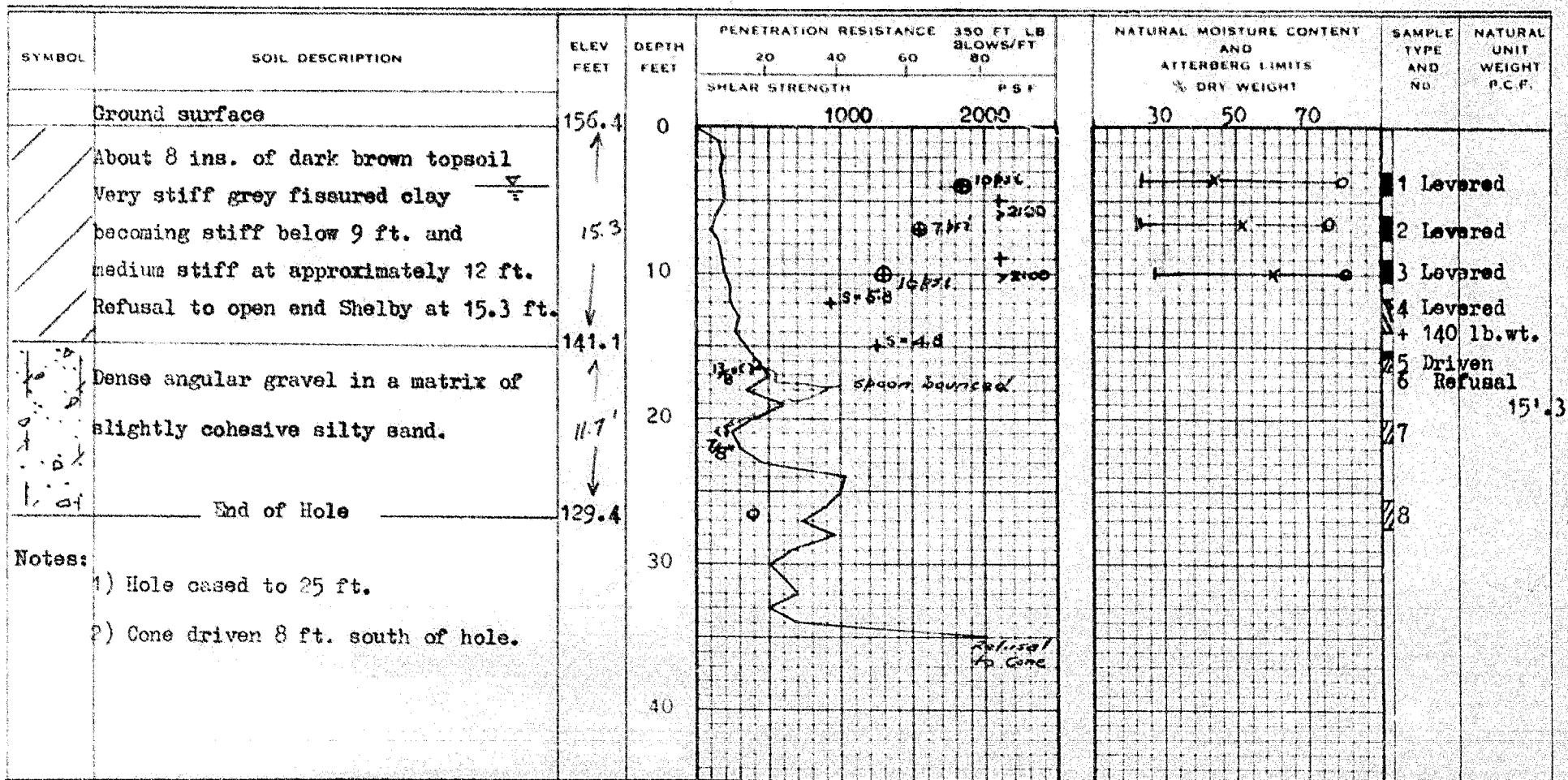
PLASTIC LIMIT ———

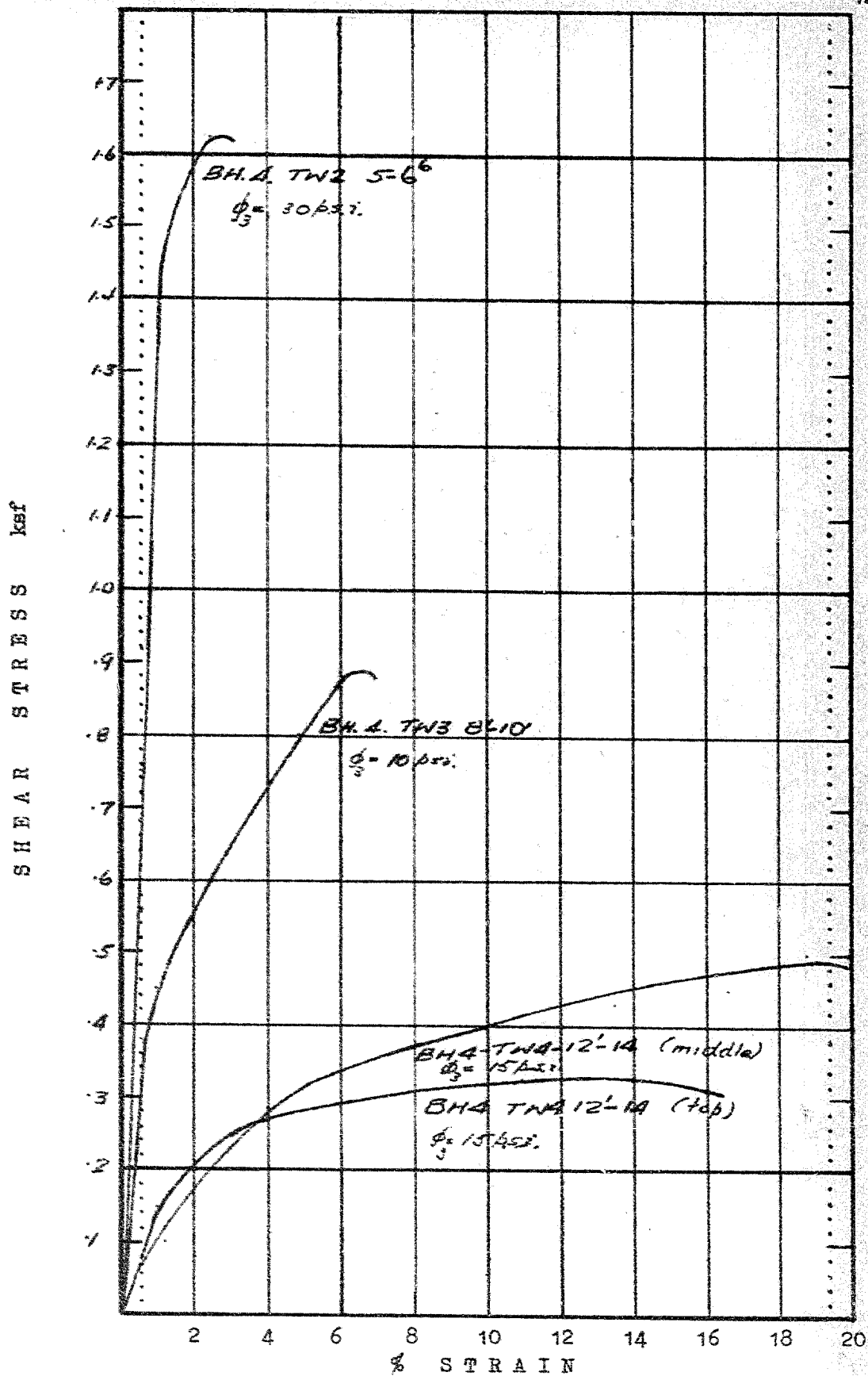
SAMPLE TYPE

2" O.D. SPLIT TUBE ⊠

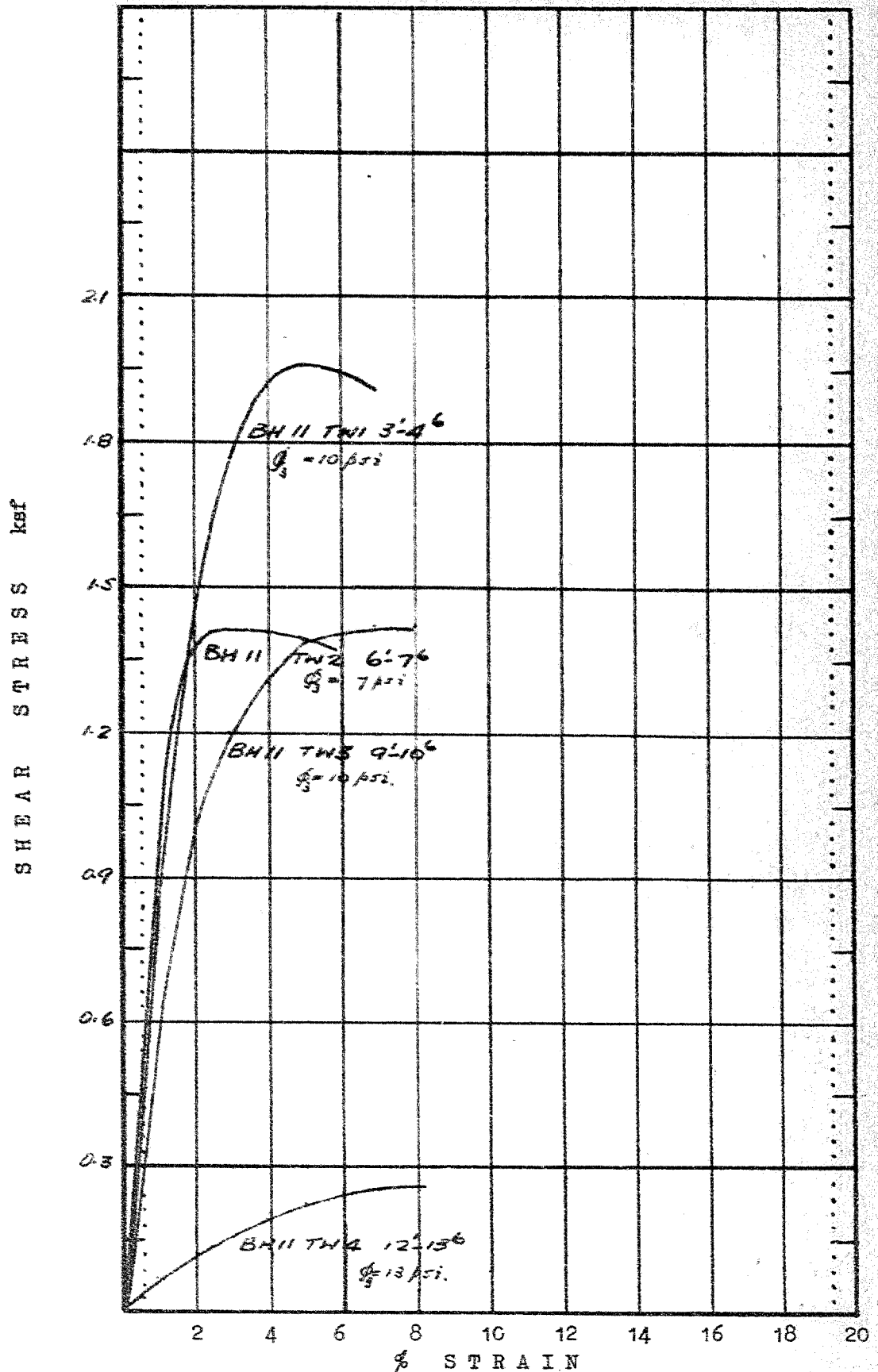
2" I.D. SHELBY TUBE ⊡

3" O.D. SHELBY TUBE ⊢

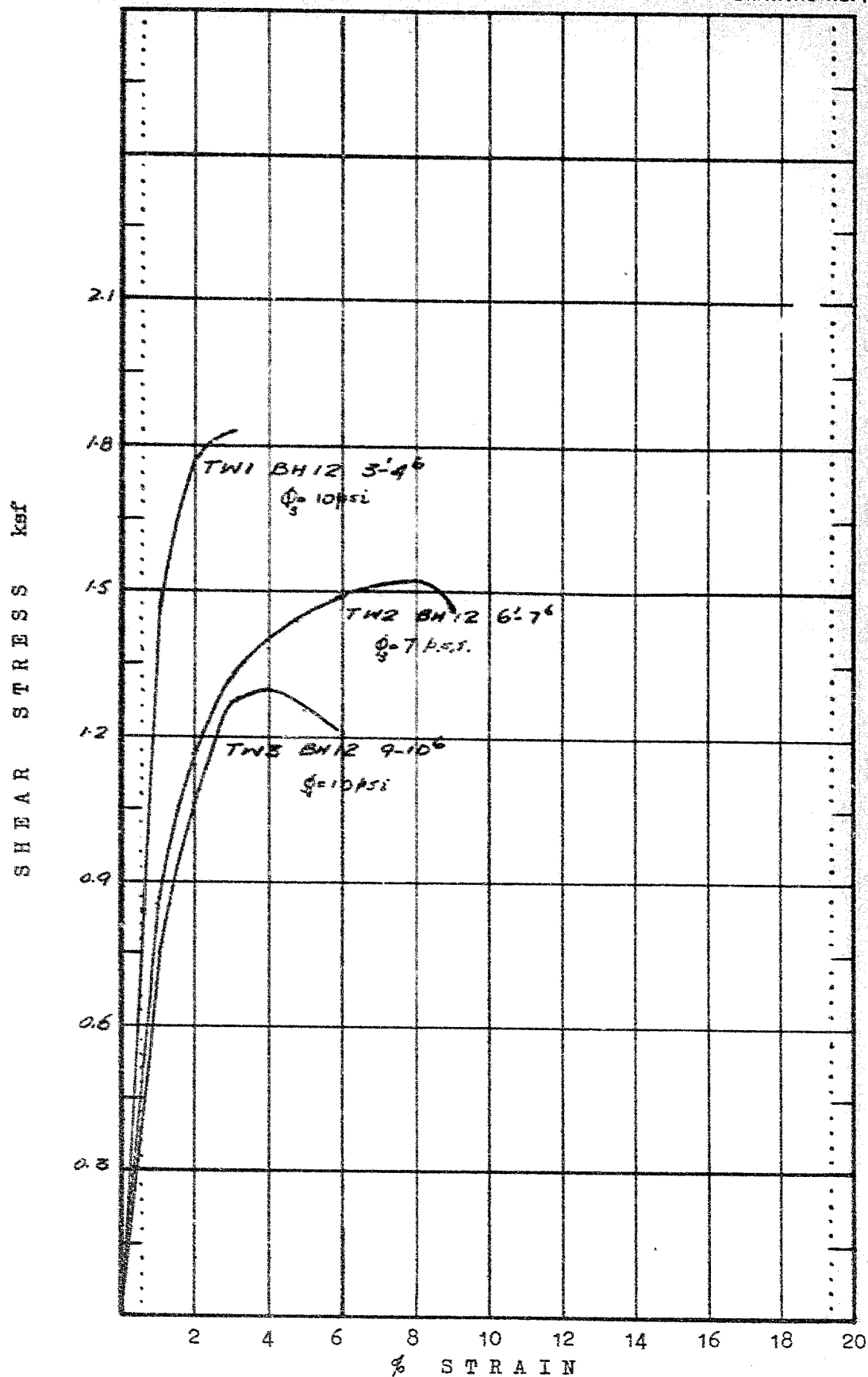




STRESS STRAIN CURVES - UNDRAINED TRIAXIAL TEST RESULTS



STRESS STRAIN CURVES - UNDRAINED TRIAXIAL TEST RESULTS



STRESS STRAIN CURVES - UNDRAINED TRIAXIAL TEST RESULTS

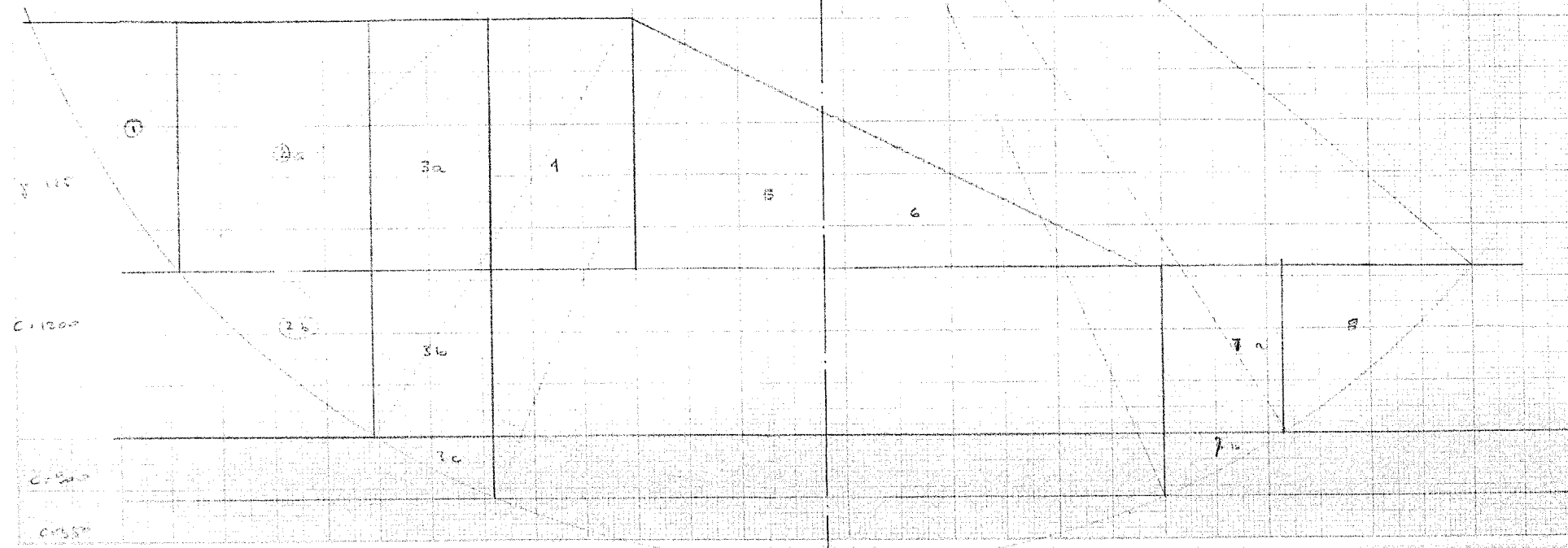
Disturbing Moment				N _y	
①	$\frac{24 \times 14.5}{8} \times 12.5 =$	21800	66.8	1450000	✓
②	$\frac{12.5 \times 15.5 \times 24}{2} =$	55500	52.8	2930000	✓
③	$11.5 \times 24 \times 12.5 =$	34400	37.8	1300000	✓
④	$14 \times 24 \times 12.5 =$	42000	25.0	1050000	✓
⑤	$\frac{24 \times 15}{2} \times 18 \times 12.5 =$	43300	9.0	395000	✓
⑥	$\frac{15 \times 30}{2} \times 12.5 =$	28200	-10.0	-252000	✓
				6,843000	✓

Restoring Moment

R = 82'
L = 412'

$$\begin{aligned}
 & \checkmark 2.5 \times 120' \times 82' = 2430000 \\
 & \checkmark 12 \times 50' \times 82' = 960000 \\
 & \checkmark 33 \times 35' \times 82' = 348000 \\
 & \hline
 & 438000 \times 2 = 8776000
 \end{aligned}$$

S.F. = $\frac{8776000}{6843000} = 1.28$



DISTURBING MOMENT

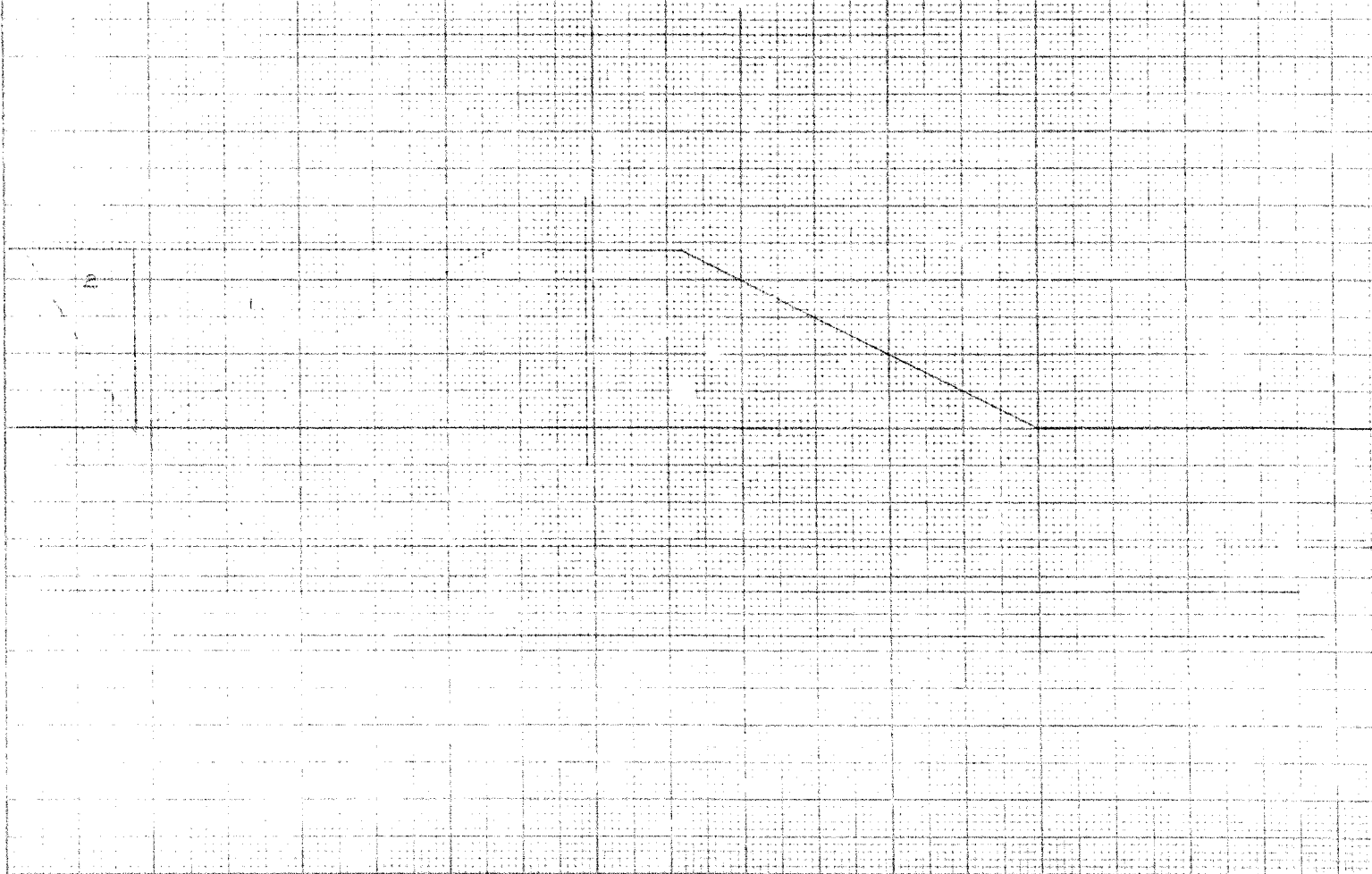
$$① 48(24)(0.5)(45) = 25,920$$

$$② 15(24)(0.5)(36) = 11,880$$

$$\underline{37,800}$$

$$S.F. = \frac{3,500,000}{37,800(125)}$$

$$= 1.80$$



$$\begin{aligned}
 \textcircled{1} \quad 48(24)(0.5)(3) &= 1,730 \\
 \textcircled{2} \quad 50(24)(1)(35) &= 42,000 \\
 \textcircled{3} \quad 16(24)(0.5)(10) &= 12,700 \\
 &\hline
 &57,630
 \end{aligned}$$

LESS

$$\begin{aligned}
 37(15)(0.5)(12) &= -4,000 \\
 &\hline
 &53,630
 \end{aligned}$$

$$\begin{aligned}
 S.F. &= \frac{8,500,000}{53,630(125)} \\
 &= 1.27
 \end{aligned}$$

1.27

3

2

1

DISTURBING MOMENT

① $73(2)(1)(38) = 5,550$

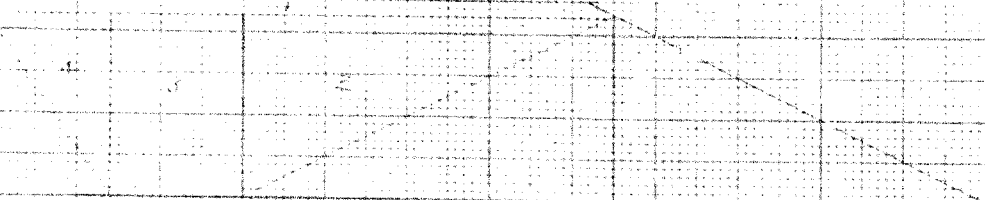
② $45(25)(0.5)(30) = 17,800$

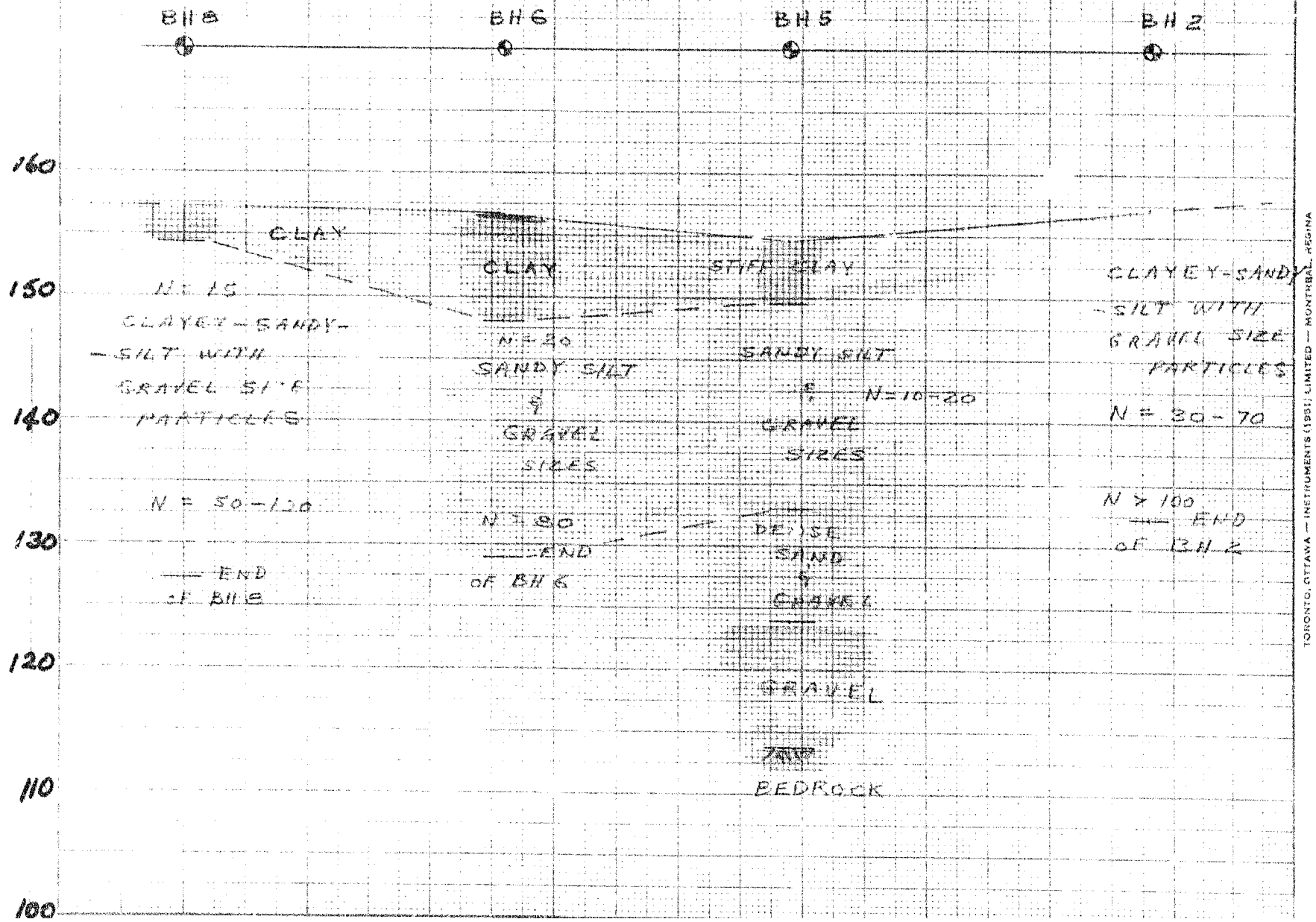
③ $15(20)(0.5)(1) = 10,000$

④ $10(25)(1)(13) = 18,600$
 $43,850$

S.F. $\frac{5,550,000}{43,850(125)}$

1.36





ELEVATION

160

150

140

130

120

110

100

BH 12

BH 11

BH 3 & 4

BH 2

CLAY

CLAY

CLAYEY-SANDY-SILT

C = 1300 - 72100

C = 300 - 1300

WITH

GRAVEL

SIZE

PARTICLES

GRAVEL

GRAVEL

GRAVEL

SILTY SAND

SILTY SAND

SILTY SAND

— END
OF BH 12— END
OF BH 11

ELEVATION

160

150

140

130

120

110

100

BH 7

BH 4

BH 3

BH 1

CLAY

C = 1200 psf

CLAY

C = 1200-1700

V. CLAY

C = 700-1700

CLAY

C = 3150

C = 1700

CLAY

C > 2100 psf

SILTY

SAND

N = 40

CLAYAY

SANDY SILT

N = 80

N = 10

GRAVEL

SILTY SAND

SILTY

SAND

N = 20

— END
OF BH 7

N = 10-20

SILTY

SAND

GRAVEL

N = 15

— END
OF BH 3— END
OF BH 1

$$① 40(20)(0.8)(27) = 10,800$$

$$② 24(20)(1)(52) = 25,000$$

$$③ 12(20)(4.5)(18) = 8,100$$

$$④ 4(4)(0.5)(62) = 500$$

$$⑤ 53(4)(1)(34.5) = 7,300$$

$$⑥ 8(4)(0.5)(5) = 100$$

$$\underline{51,850}$$

$$M_b = 51,850 \text{ Y}$$

$$M_r = \frac{\pi R^3}{180} (C_1 \theta_1 + \Sigma C_2 \theta_2 + \Sigma C_3 \theta_3)$$

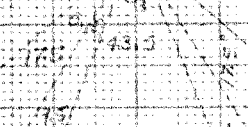
$$= \frac{\pi (81)^3}{180} [350(43.5) + 900(18) + 1200(35)]$$

$$= 8,500,000 \text{ ft-lbs}$$

$$S.F. = \frac{M_r}{M_b}$$

$$S.F. = \frac{8,500,000}{51,850(125)}$$

$$= 1.31$$



$\sigma_1 = 125$
 $\sigma_2 = 0$

$\sigma_1 = 1200$

$\sigma_2 = 900$

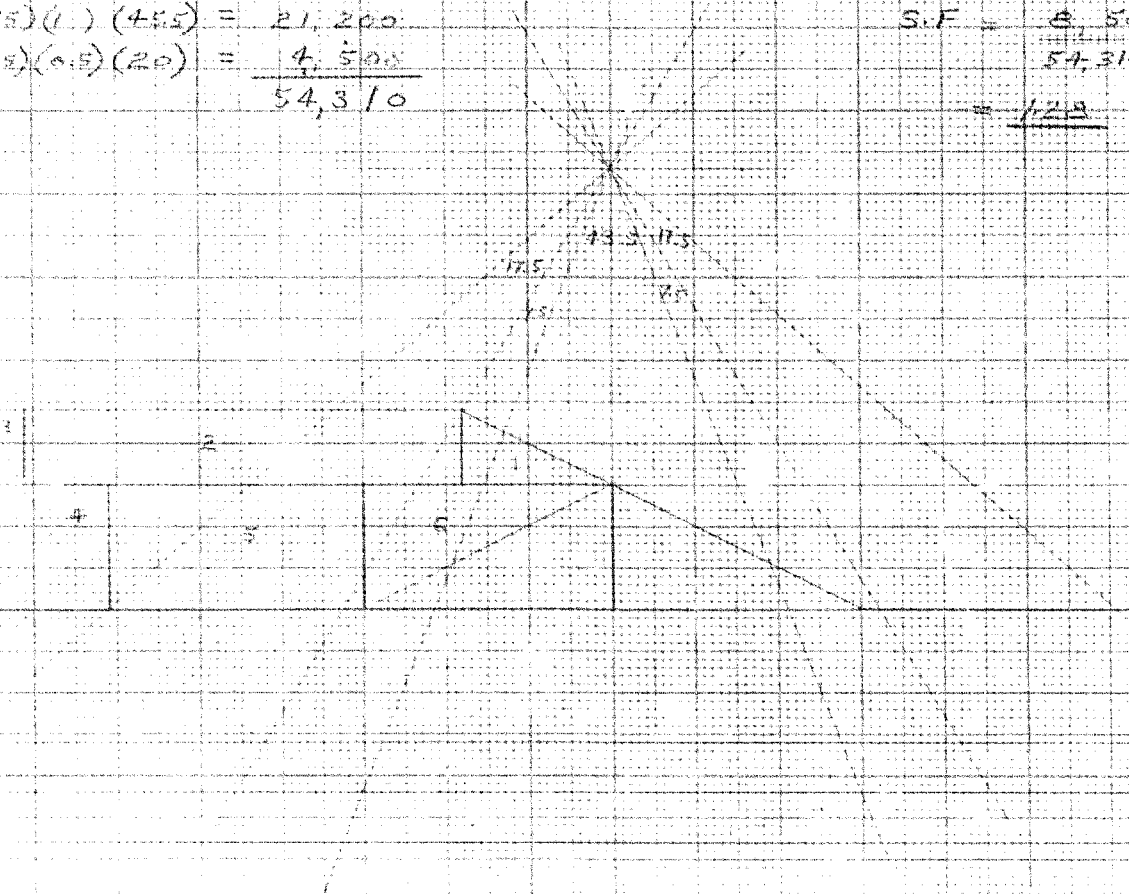
$\sigma_3 = 850$

NO SHEAR STRENGTH IN FILL

DISTURBING MOMENT

- ① $12(3)(0.5)(12) = 970$
 - ② $52(3)(1)(41.5) = 21,240$
 - ③ $5(3)(0.5)(73) = 1,640$
 - ④ $10(15)(0.5)(44) = 4,800$
 - ⑤ $31(15)(1)(45.5) = 21,200$
 - ⑥ $30(15)(0.5)(20) = 4,500$
- 54,310

$S.F. = \frac{8,500,000}{54,310(125)}$
 $= 1.28$



DISTURBING MOMENT

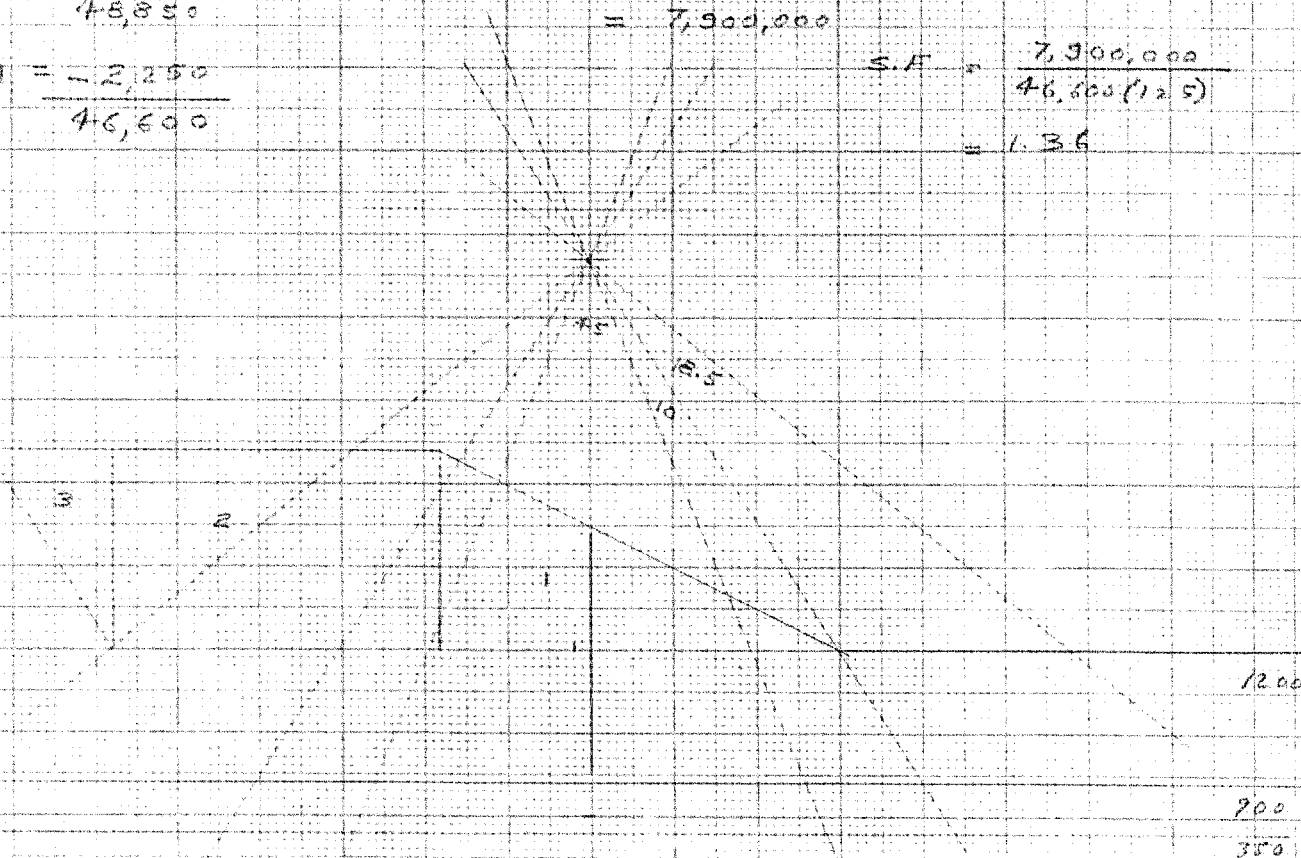
$$\begin{aligned} \textcircled{1} \quad 48(24)(0.5)(2) &= 1,150 \\ \textcircled{2} \quad 40(24)(1)(38) &= 36,400 \\ \textcircled{3} \quad 15(24)(0.5)(63) &= 11,300 \\ &\hline &48,850 \end{aligned}$$

LESS

$$\begin{aligned} 30(18)(0.5)(10) &= -2,250 \\ &\hline &46,600 \end{aligned}$$

$$\begin{aligned} M_r &= \frac{\pi}{180} (75)^2 \left[(33)(1200) + 20(900) + 4.5(350) \right] \\ &= \frac{\pi}{180} (75)^2 (80,700) \\ &= 7,900,000 \end{aligned}$$

$$\begin{aligned} S.F. &= \frac{7,900,000}{46,600(12.5)} \\ &= 1.36 \end{aligned}$$



$$① 42(1)(0.5)(27) = 10,800$$

$$② 25(20)(1)(525) = 26,200$$

$$③ 16(24)(0.5)(70) = 13,400$$

$$④ 57(4)(1)(365) = 84,200$$

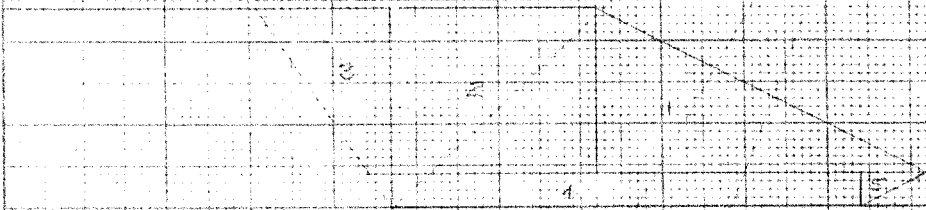
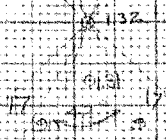
$$⑤ 2(4)(0.5)(5) = 100$$

$$M_p = 58,700 \text{ Y}$$

$$M_p = \frac{\pi (58)^2}{100} \left[42(350) + 16(300) + 57(200) \right]$$

$$= 3,700,000$$

$$S.F. = \frac{3,700,000}{58,700(125)} = 1.32$$



DISTURBING MOMENT

$$① 40(20)(0.5)(27) = 10,800$$

$$② 22(20)(1)(51) = 22,400$$

$$③ 9(20)(0.5)(65) = 5,850$$

$$④ 55(4)(1)(28) = 6,250$$

$$\hline 45,300$$

$$M_d = 45,300(125)$$

$$M_r = \frac{\pi}{180} (74)^2 \left[45.5(350) + 20(300) + 35(120) \right]$$

$$= \frac{\pi}{180} (74)^2 (79,500)$$

$$= 7,600,000$$

$$S.F. = \frac{7,600,000}{45,300(125)}$$

$$= 1.34$$

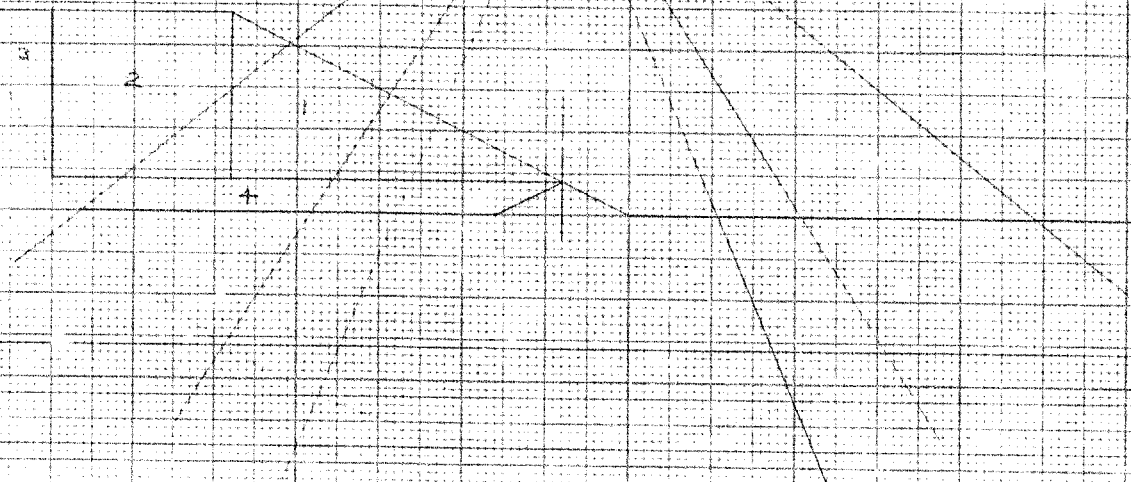
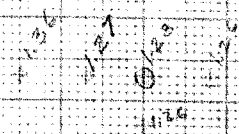
$$\gamma = 125$$

$$C = 48$$

$$C = 1200$$

$$C = 900$$

$$C = 350$$



DISTURBING MOMENT

$$\begin{aligned}
 ① & 34(17)(0.5)(23) = 6550 \\
 ② & 32(17)(1)(50) = 27200 \\
 ③ & 10(12)(0.5)(63) = 5870 \\
 ④ & 6(7)(0.5)(63) = 1320 \\
 ⑤ & 47(7)(1)(375) = 121300 \\
 ⑥ & 14(7)(0.5)(9.3) = 460
 \end{aligned}$$

53,800

RESISTING MOMENT

$$\begin{aligned}
 M_r &= \frac{\pi}{180} (51) \left[35(1200) + 19(900) + 43.5(350) \right] \\
 &= \frac{\pi}{180} (51) (74,300) \\
 &= 5,500,000
 \end{aligned}$$

$$\begin{aligned}
 S.F. &= \frac{5,500,000}{53,800(125)} \\
 &= 1.26
 \end{aligned}$$

C = 1200

C = 900

C = 350

DISTURBING MOMENT

$$① 48(24)(0.5)(10) = 5,750$$

$$② 35(24)(1)(43.7) = 36,500$$

$$③ 16(24)(0.5)(46) = 18,700$$

$$54,950$$

LESS:

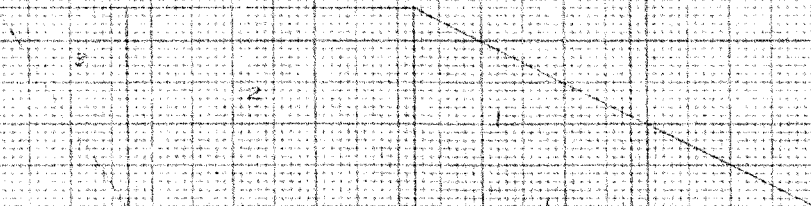
$$20(11)(0.5)(1) = 1,100$$

$$54,100$$

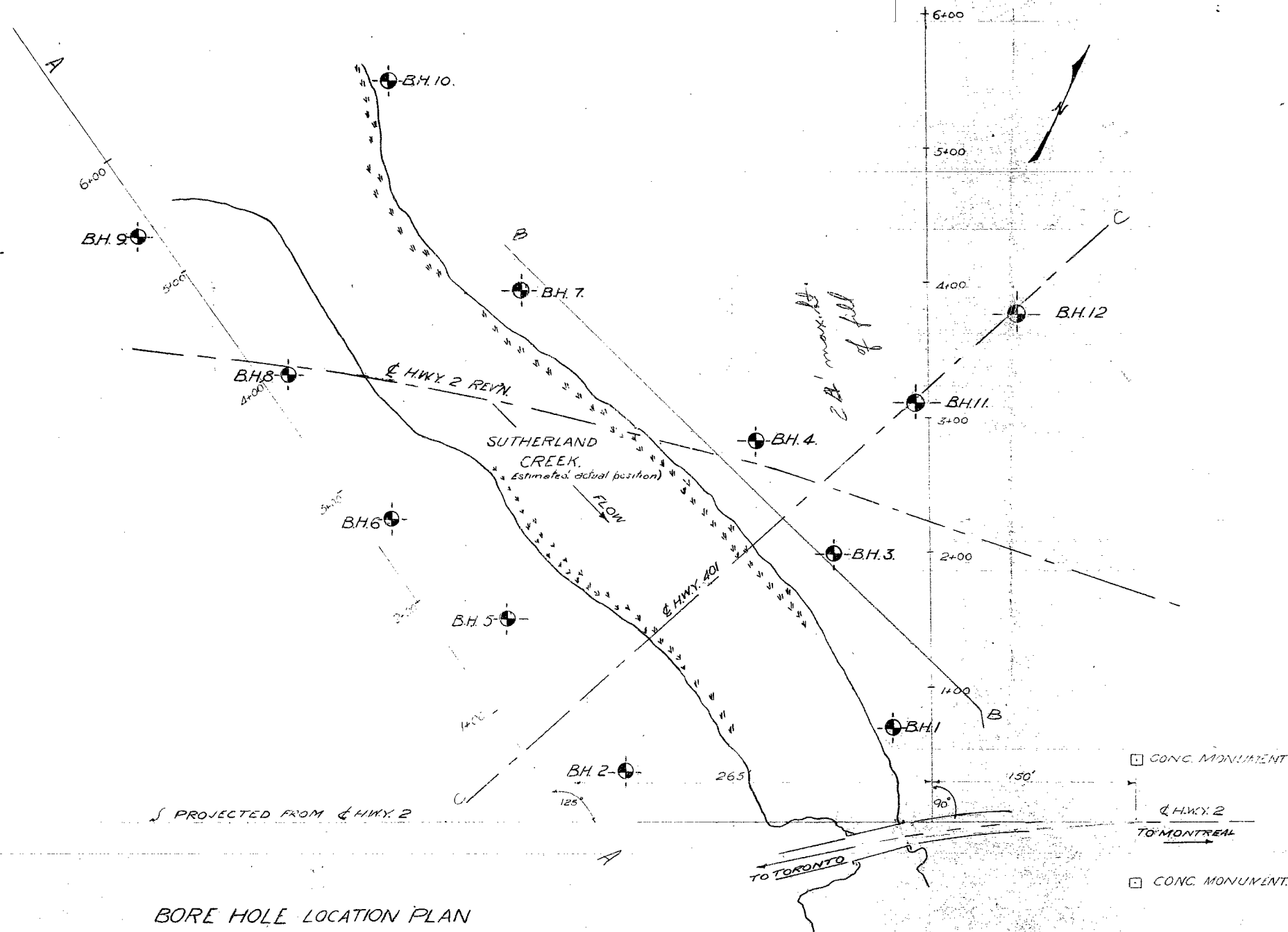
S.F.

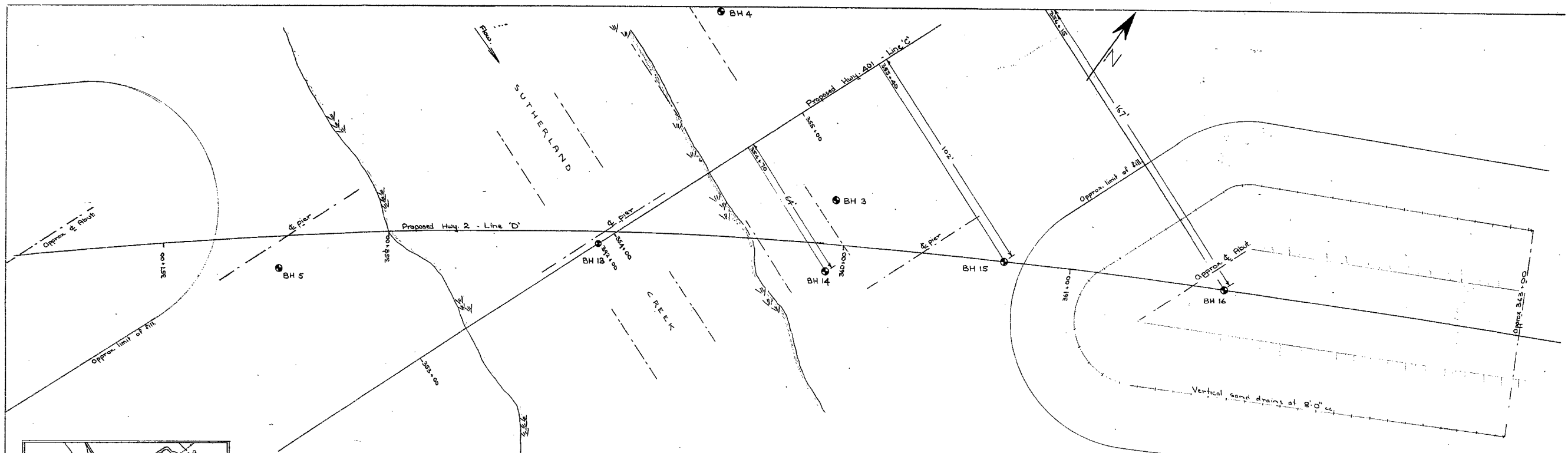
54,950

$$54,100(24.9)$$



60-F-240-C
W.P. # 177-60 ε'
W.P. # 116-59
Hwy. # 401 ε'
Hwy. # 2
BRIDGES # 10 ε' # 11
SUTHERLAND CR.
LANCASTER TWP.

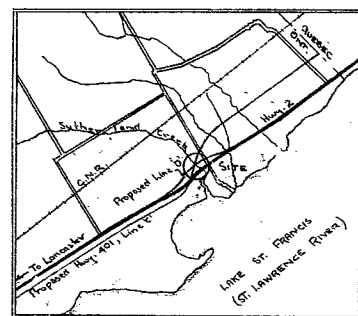




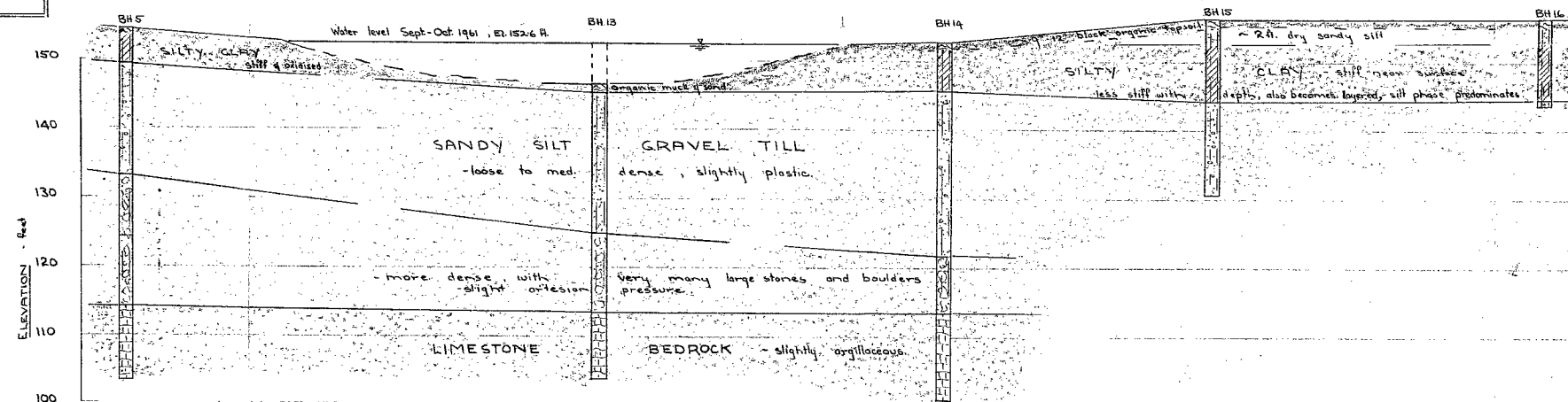
- NOTES:
- 1) Boreholes 3, 4 and 5 put down August 1960. Positions approximate only.
 - 2) Boreholes 13, 14, 15 and 16 made September 1961. Positions related to Line 'C' only; Line 'D' was not pegged out.
 - 3) Additional spans proposed for bridges, as shown above after field work complete.

B.M. - EL. 159.03
Geodetic Datum
N.W. in N.W. root of
15' Map, 220' Rt. of Sh.
354+55, Line 'C'.

PLAN OF SITE - SHOWING BORING LOCATIONS.
(Overlay of plan E4003.1)
Scale: 1" = 20'

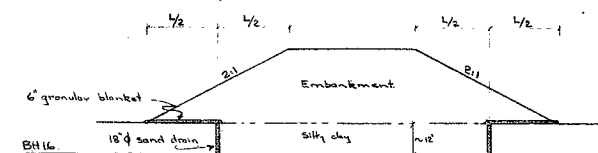


KEY PLAN
1" = 1 mile.



ESTIMATED SUBSOIL STRATIGRAPHICAL PROFILE

Scale: Vert. 1" = 10'
HORIZ. 1" = 20'



CROSS-SECTION THROUGH EMBANKMENT
SHOWING PROPOSED SAND DRAINS

FOUNDATION INVESTIGATION
PROPOSED CROSSING, SUTHERLAND CREEK
HWY. 401 AND HWY. 2

WILLIAM A. TROW & ASSOCIATES LTD.

JS42A

OCT. 1961

DWG. 1