

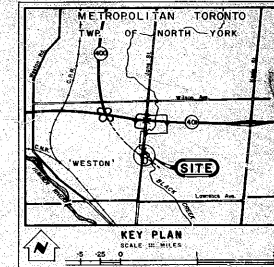
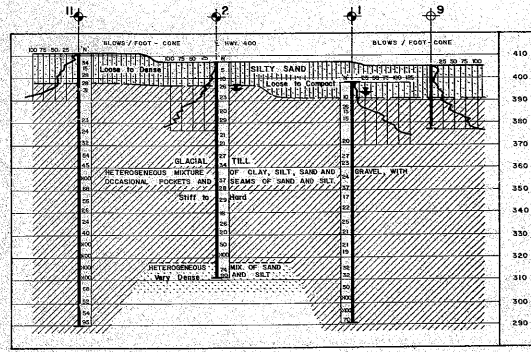
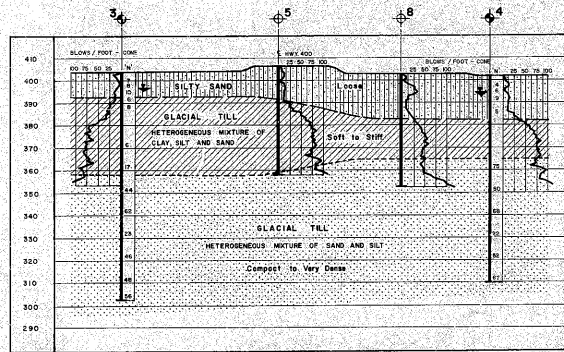
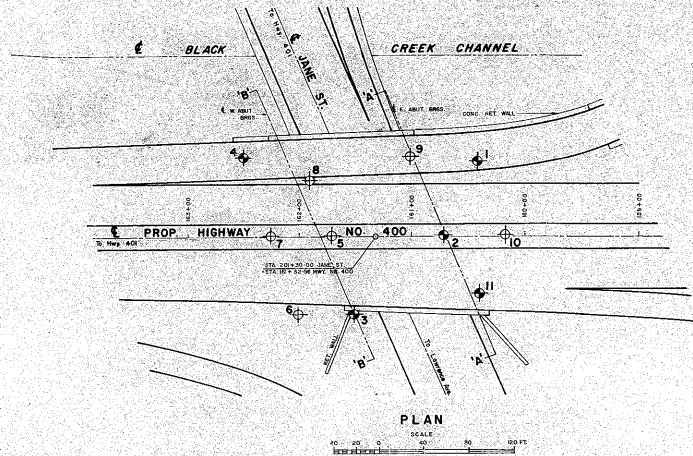
63-F-146

W.P. # 113-63

W.P. # 114-63

Hwy. # 400 E'

JANE ST.



LEGEND			
●	Bore Hole		
⊙	Cone Penetration Hole		
⊙	Bore & Cone Penetration Hole		
⊙	Water Level established at time of field investigation, Sept. 1963		

NO.	ELEVATION	STATION	OFFSET
1	398.0	180+40	30' RT.
2	402.2	180+70	0
3	403.8	181+50	70' LT.
4	401.7	182+50	70' RT.
5	405.5	181+70	0
6	401.1	182+00	70' LT.
7	401.0	182+25	0
8	402.7	181+80	30' RT.
9	405.0	181+50	70' RT.
10	398.2	180+15	0
11	411.2	180+40	50' LT.

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes, the boundaries are assumed from geological evidence and may be subject to considerable error.

DATE	BY	REVISION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

JANE STREET

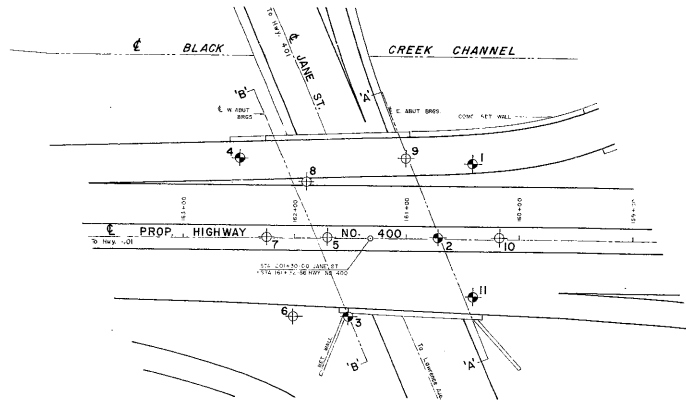
KING'S HIGHWAY NO. 400 (PROP. EXTENSION) DIST. NO. 6
CO. YORK, METROPOLITAN TORONTO
TWP. NORTH YORK LOT COR.

BORE HOLE LOCATIONS & SOIL STRATA

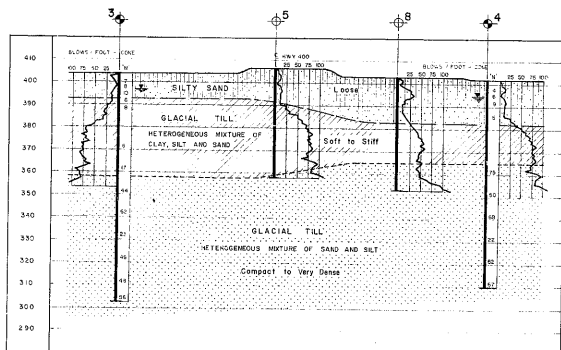
DESIGNED BY	CHECKED BY	DATE	NO. 63-F-109A
DATE	NO. 63-F-109A	DATE	NO. 63-F-109A

APPROVED BY: [Signature] DATE: [Date]

Geotechnical 30/11/142

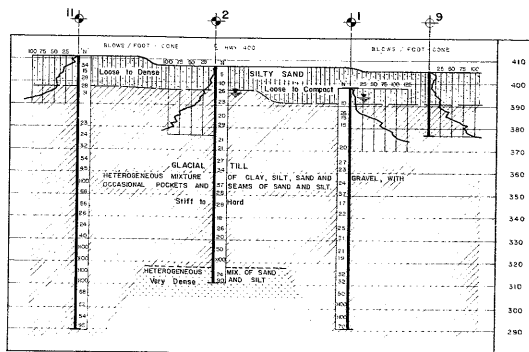


PLAN
SCALE
1" = 40' 0"

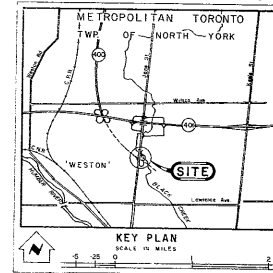


B - B

SECTIONS



A - A



LEGEND

- Bore Hole
- ⊕ Case Penetration Hole
- ⊕ Bore & Case Penetration Hole
- ⊕ Water Levels established at time of field investigation, Sept. 1963

NO.	ELEVATION	STATION	OFFSET
1	398.0	160+40	70' RT.
2	407.2	160+70	E
3	403.8	161+50	70' LT.
4	401.7	162+50	70' RT.
5	404.5	161+70	E
6	401.1	162+00	70' LT.
7	401.0	162+25	E
8	402.7	161+90	50' RT.
9	402.0	161+00	70' RT.
10	398.2	160+15	E
11	411.2	160+40	50' LT.

30911-1A
REVISED

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

JANE STREET

KING'S HIGHWAY NO. 400 (PROP. EXTENSION) DIST. NO. 6
CO. YORK METROPOLITAN, TORONTO
TWP. NORTH YORK LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

DESIGNED BY M. H. [checked] P. H. [checked] DIST. NO. 63-F-109A
DRAWN BY J. C. [checked] P. H. [checked] DIST. NO. 63-F-109A
DATE MAR. 10, 1964 SITE NO. [checked]
APPROVED BY [signature] DIST. NO. [checked] BRIDGE DRAWING NO.

MEMORANDUM

To: Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

FROM: Foundation Section,
Materials & Research Div.,
Room 107, Lab. Bldg.

Attention. Mr. S. McCombie

DATE: March 11, 1964

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

Proposed Retaining Walls at the
Intersection of Highway 400 and
Jane Street, District 6, Toronto.

W.J. 63-F-146 -- W.P. 113-63

W.P. 114-63

Attached, we are forwarding to you, our detailed
foundation investigation report on the subsoil condition
existing at the above structure location.

We believe that you will find the factual data and
recommendations contained therein, adequate for your design
requirements. Should further information be required, please
do not hesitate to contact our Office.

KYL/MdeF

Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
C. K. Hunter (2)
C. Fraser
T. J. Kovich
A. Watt

Foundations Office
Gen. Files

K. Y. Lo.
K. Y. Lo,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

TABLE OF CONTENTS

1. INTRODUCTION.
 2. DISCUSSION AND RECOMMENDATIONS:
 - 2.1) General.
 - 2.2) North-west Retaining Wall.
 - 2.3) North-east Retaining Wall.
 - 2.4) East Retaining Wall.
 - 2.5) South Retaining Walls.
 3. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION REPORT

For

Proposed Retaining Walls at the
Intersection of Highway 400 and
Jane Street, District 6, Toronto

W.J. 63-F-146 -- W.P. 113-63

W.P. 114-63

1. INTRODUCTION:

A request for a foundation investigation for the proposed retaining walls at the intersection of Hwy. 400 and Jane Street was received from Mr. J. Curtis of the Bridge Division.

A field investigation was subsequently carried out by this Section to determine the subsoil conditions at this site. Presented in this report are the results of the investigation, together with the recommendations pertaining to the design of retaining structure foundations.

2. DISCUSSION AND RECOMMENDATIONS:

2.1) General:

As part of the Hwy. 400 and Jane St. interchange, it is proposed to construct several retaining walls. These are as follows:

i) North-west Retaining Wall - to be located between Stations 162+60 and 165+90, approximately 80 ft. Rt.

ii) North-east Retaining Wall - to connect the two proposed bridges on the north side of the north-east ramp.

iii) East Retaining Wall - to be located between Stations 156+50 and 159+00, approximately 60 ft. Rt.

cont'd. /2 ...

2. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

2.1) General: (cont'd.) ...

iv) South Retaining Walls - two retaining structures to be located at south end of the east and west abutments of the main structure.

It is understood that the walls will be approximately 30 ft. in height.

2.2) North-west Retaining Wall (Refer to Section A-A on
Dwg. 63-F-146A)

The subsoil at this site was found to consist of approximately 12 ft. of loose to compact silty sand, followed by a deposit of glacial till. The upper portion of this deposit extending to about 37 ft. below ground level, was a cohesive heterogeneous mixture of clay, silt, sand and occasional gravel. The lower portion of the glacial till deposit is a heterogeneous mixture of sand and silt. The stratum was investigated to a maximum depth of 62 ft. below ground level. The consistency of the cohesive portion was found to be firm to stiff, whereas the relative density of the non-cohesive portion was very dense. The ground water level in the boreholes was quite uniform at approximate elevation 394 (8.5' below ground level).

The subsoil conditions at the site are not favourable for a spread footing type foundation. Therefore, the structure should be supported on large displacement end-bearing piles, driven to approximate elevation \pm 365. Either steel tube or timber piles may be used, with the load per pile limited mainly by structural considerations of the type of pile selected.

cont'd. /3 ...

2. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

2.3) North-east Retaining Wall (Refer to Section B-B on
Dwg. 63-F-146A)

At this location, subsoil consisted of about 9 ft. of very loose to compact silty sand, below which a deposit of glacial till was encountered. The glacial till generally consists of a cohesive mixture of clay, silt, sand and gravel, with occasional pockets and seams of sand and silt. The stratum was investigated to a maximum depth of 62 ft. below ground level. Its consistency was found to range from stiff to hard. The ground water level was found to be at approximate elevation 394.

The subsoil conditions in this area are not favourable for shallow spread footing type foundations. The structure should be supported on large displacement piles. Because of the variable nature of the consistency of the subsoil, it is very difficult to predict the exact lengths or the probable bearing loads for the piles. However, a pile loading test is to be carried out in this general area, with the subsoil conditions similar to this site. The results of the proposed pile loading test should enable the determination of the probable bearing loads as well as tip elevations.

Since this retaining wall connects the two proposed structures at this site, the preliminary recommendations are the same as given for the east abutment of the Jane Street overpass (63-F-109) and the south abutment of the Black Creek structure (63-F-95). Thus, a safe load of 50 tons/pile may be used for piles driven to an estimated tip elevation ± 330 .

cont'd. /4 ...

2. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

2.4) East Retaining Wall (Refer to Section C-C on
Dwg. 63-F-146A)

Extending from the ground level is a 7-ft. thick layer of loose silty sand. Immediately beneath the sand is a stratum of glacial till. Except at the west end of the retaining wall the glacial till is a cohesive heterogeneous mixture of clay, silt, sand and some gravel, with the consistency ranging from stiff to hard. At the west end of the proposed structure, the glacial till was a granular heterogeneous mixture of sand, silt and some fine gravel, with a relative density of compact. Ground water in the boreholes was found at average elevation 395.

The structure may be supported either on a spread footing type of foundation, or on large displacement piles.

For spread footings, placed at approximate elevation 390, a safe design load of 2 T.S.F. may be used.

Because of the variable consistency, as well as composition of the subsoil here, it is difficult to predict the exact pile lengths or the probable load per pile. A pile loading test, to be conducted at the adjoining Black Creek structure (63-F-95) in subsoil conditions similar to those at this retaining wall, may yield more accurate information in this matter. For preliminary design purposes, a safe load of 50 tons/pile may be used for 12 $\frac{3}{4}$ " O.D. x 1/4" steel tube piles driven to an estimated tip elevation \pm 335.

cont'd. /5 ...

2. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

2.5) South Retaining Walls (Refer to Section D-D on
Dwg. 63-F-146A)

The walls are to be located at the south-west and south-east corners of the Jane Street underpass. Because of this, the recommendations submitted in our Report W.J. 63-F-109 for the underpass structure foundations, apply to the retaining walls as well.

3. MISCELLANEOUS:

The field work, performed in January 1964, together with the preparation of this report, was undertaken by Mr. R. Magi, Project Foundation Engineer. The investigation was carried out under the general supervision of Mr. M. Devata, Senior Foundation Engineer, who also reviewed this report.

Equipment was owned and operated by Dominion Soil Investigation Ltd. of Toronto.

March

APPENDIX I.

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
Q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_i	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

JOB 63-F-146

LOCATION 80' Rt. Sta. 165+80

ORIGINATED BY R.M.

W.P.

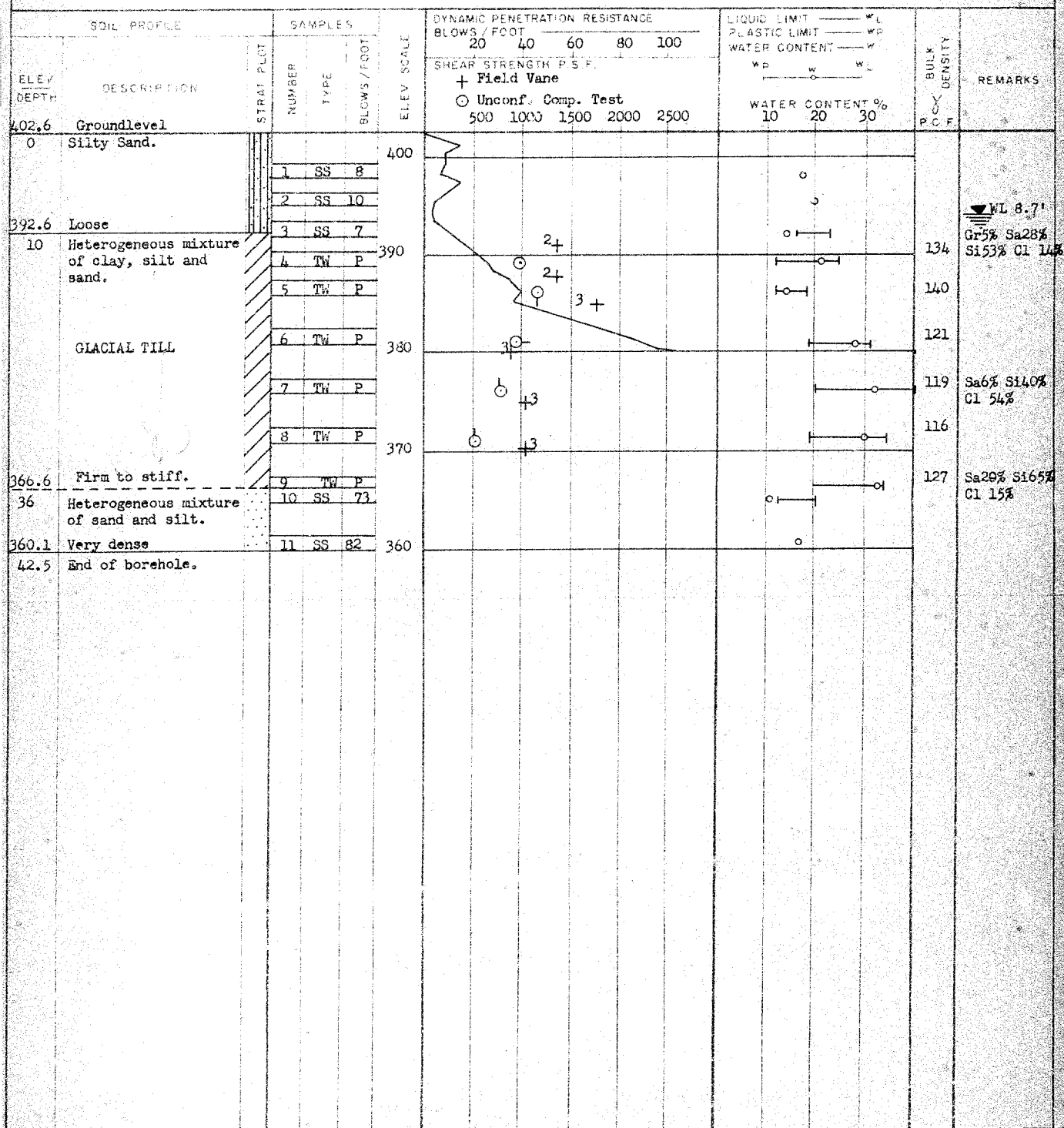
BORING DATE Jan. 25, 1964.

COMPILED BY R.M.

DATUM 402.6

BOREHOLE TYPE Washboring and Cone Penetration.

CHECKED BY M.D.



JOB 63-F-146

LOCATION 83' Rt. Sta. 164+60

ORIGINATED BY R.M.

V. P.

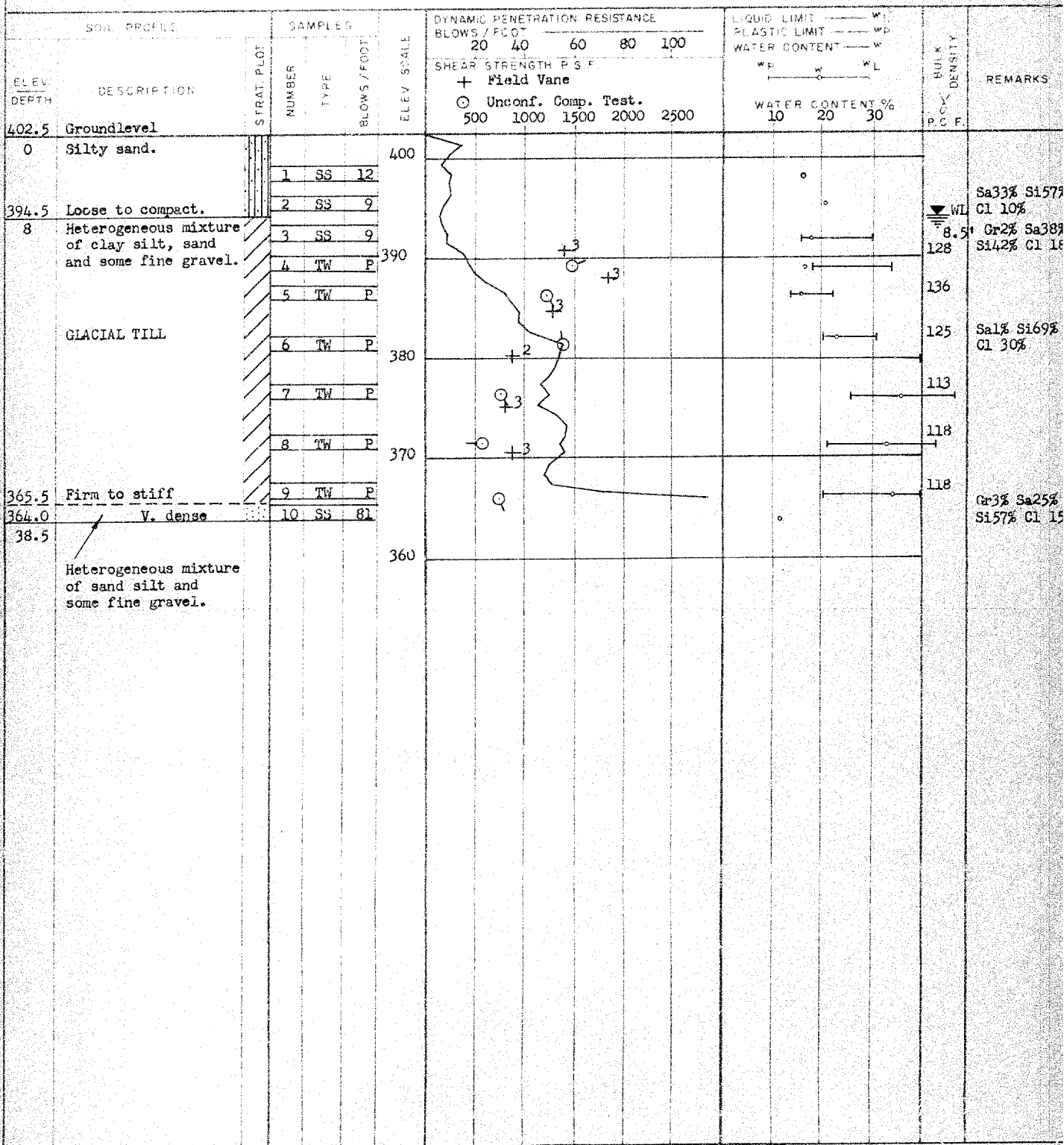
BORING DATE Jan. 16, 1964.

COMPILED BY R.M.

DATUM 402.5

BOREHOLE TYPE Washboring & Cone Penetration

CHECKED BY M.D.



HOB 63-F-146

LOCATION 80' Rt. Sta. 163+80

ORIGINATED BY R.M.

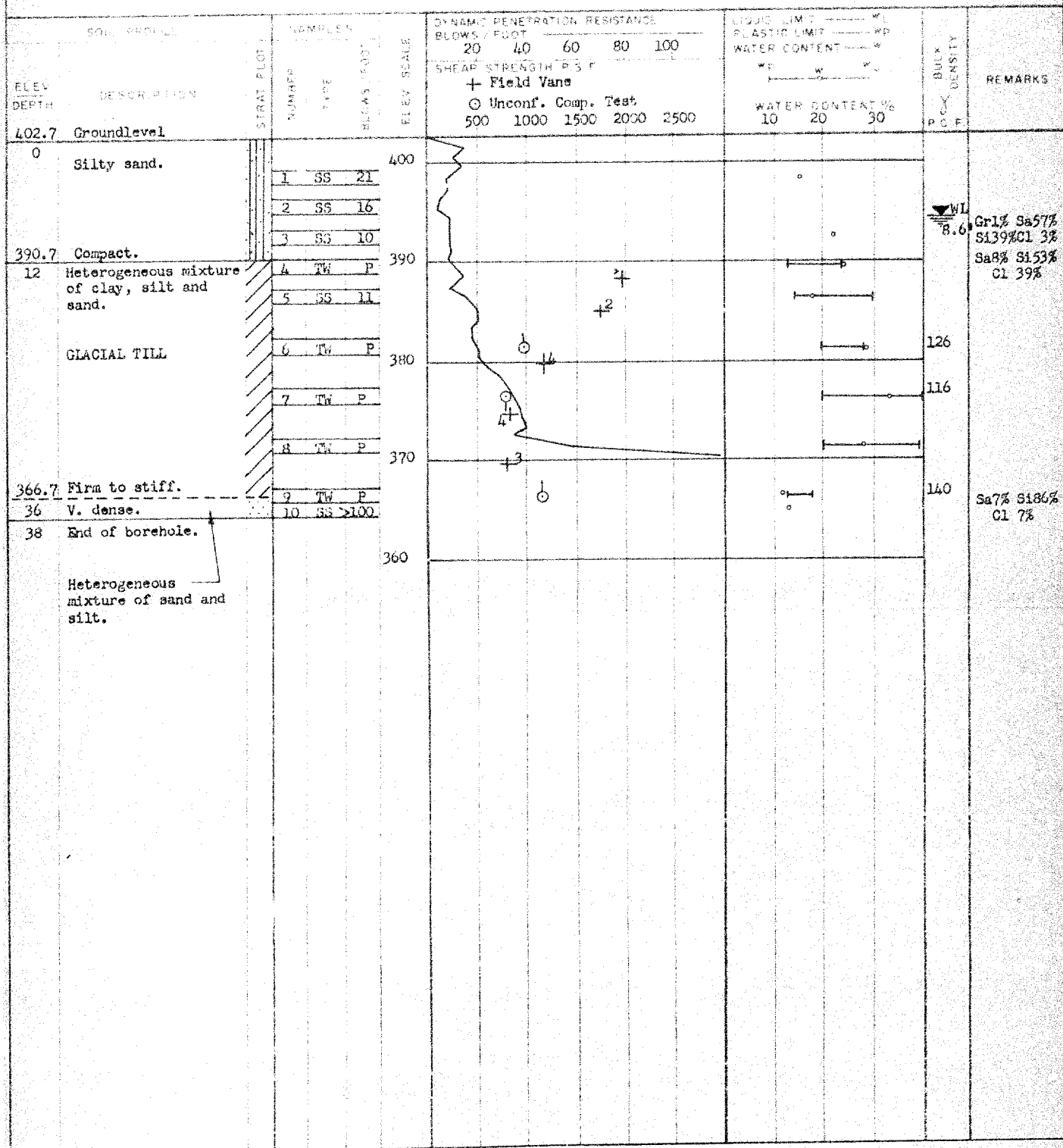
BORING DATE Jan. 21, 1964.

COMPILED BY R.M.

DEPTH 402.7

BOREHOLE TYPE Washboring & Cone Penetration

CHECKED BY M.D.



CHECKED 5⁴ M.D.

JOB 63-F-146

LOCATION 70' Rt. Sta. 162450

ORIGINATED BY R.M.

W.P.

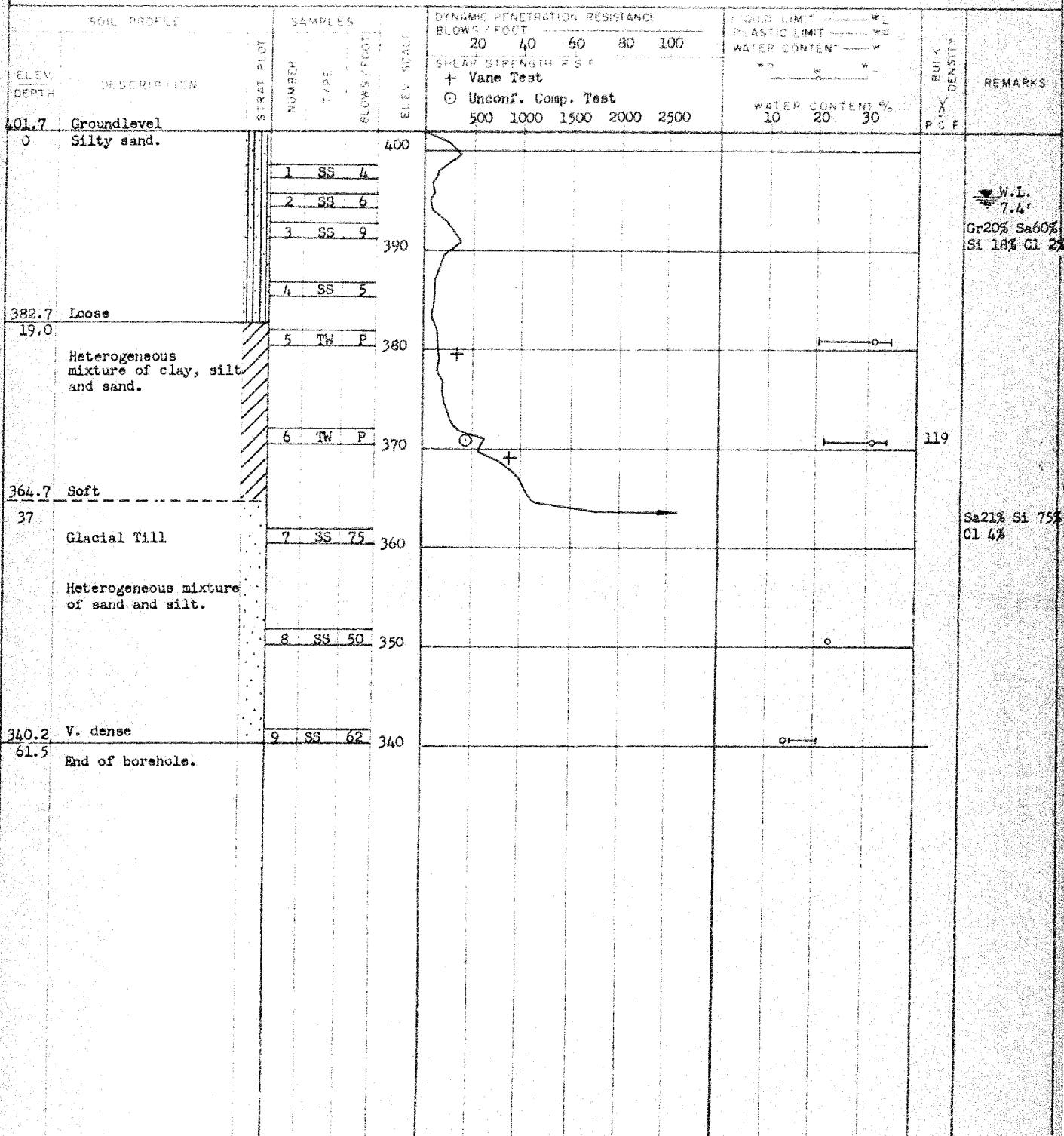
BORING DATE Sept. 18, 1963.

COMPILED BY R.M.

DATUM 401.7

BOREHOLE TYPE Cone Penetration and Washboring.

CHECKED BY M.D.



JOB 63-F-146

LOCATION 70' Lt. Sta. 161+50

ORIGINATED BY R.M.

W P

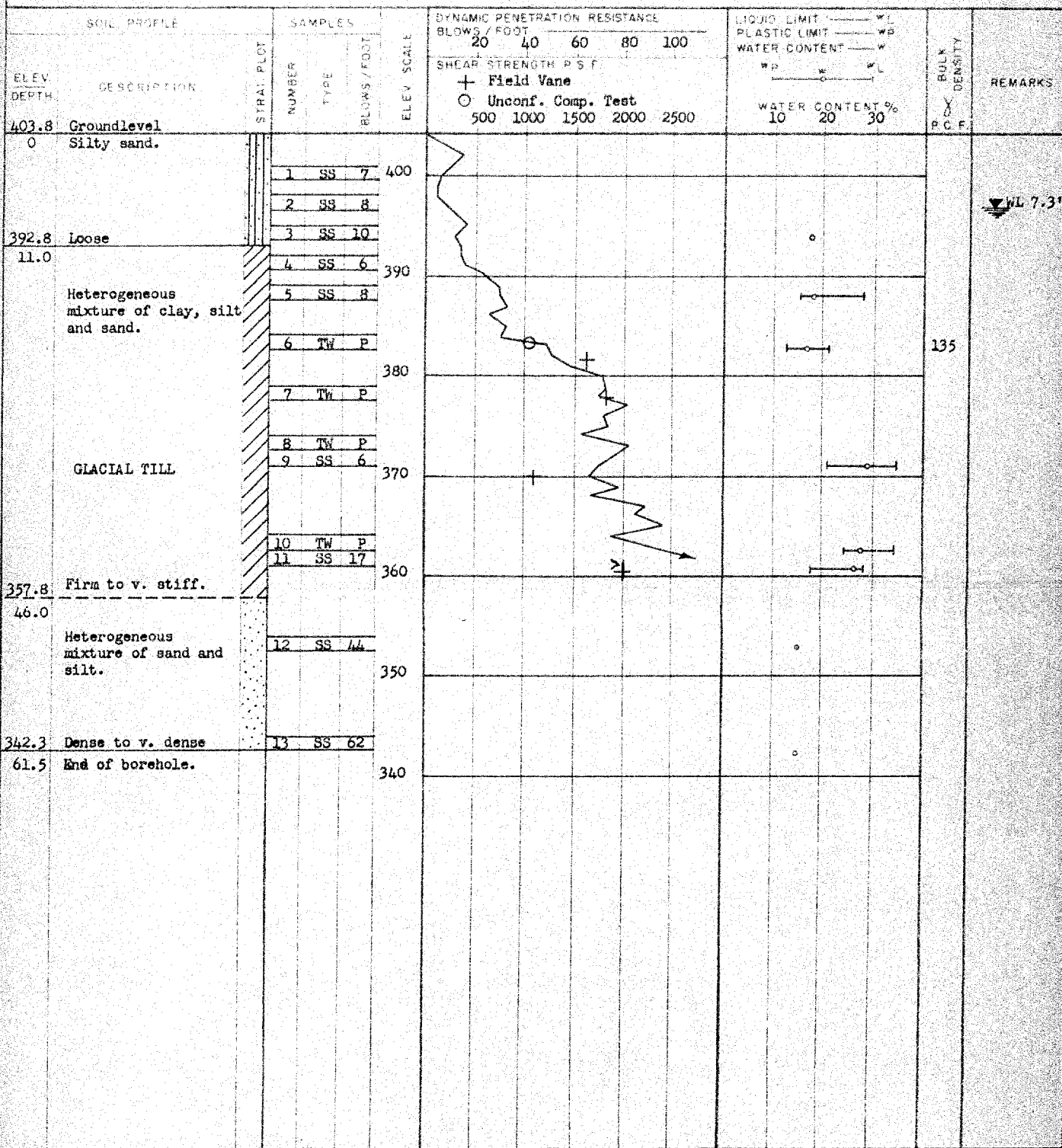
BORING DATE Sept. 16, 1963.

COMPILED BY R.M.

DATUM 403.8

BOREHOLE TYPE Washboring & Cone Penetration.

CHECKED BY M.D.



JOB 63-F-146

LOCATION 50' Lt. Sta. 160440

ORIGINATED BY R.H.

W.P.

BORING DATE Jan. 24, 1964.

COMPILED BY R.H.

DATUM 411.2

BOREHOLE TYPE Washboring & Cone Penetration.

CHECKED BY M.D.

SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — W _L PLASTIC LIMIT — W _P WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS		
ELEV DEPTH	DESCRIPTION	STRAT. PROF.	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	20	40	60	80	100			W _P	W
							SHEAR STRENGTH P.S.F.					WATER CONTENT %			
							+ Field Vane								
							○ Unconf. Comp. Test								
							500 1000 1500 2000 2500					10 20 30			
411.2	Groundlevel														
0						410									
			1	SS	34										
			2	SS	15										
			3	SS	28										
398.2	Compact to dense		4	SS	28										
13	GLACIAL TILL		5	SS	31										
	Heterogeneous mixture of clay silt, sand and gravel with occasional seams and pockets of sand and silt.		6	TM	P										
			7	TM	P										
			8	SS	23										
			9	SS	24										
			10	SS	32										
			11	SS	54										
			12	SS	45										
			13	SS	>100										
349.7	Stiff to hard.		14	SS	68										
61.5	End of borehole.					350									
</															

Gr9% Sa49%
Si27% Cl 15%Gr2% Sa26%
Si55% Cl 17%Sa9% Si 67%
Cl 24%Gr1% Sa29%
Si55% Cl 15%

JOB 63-F-146

LOCATION 95' Rt. Sta. 160465

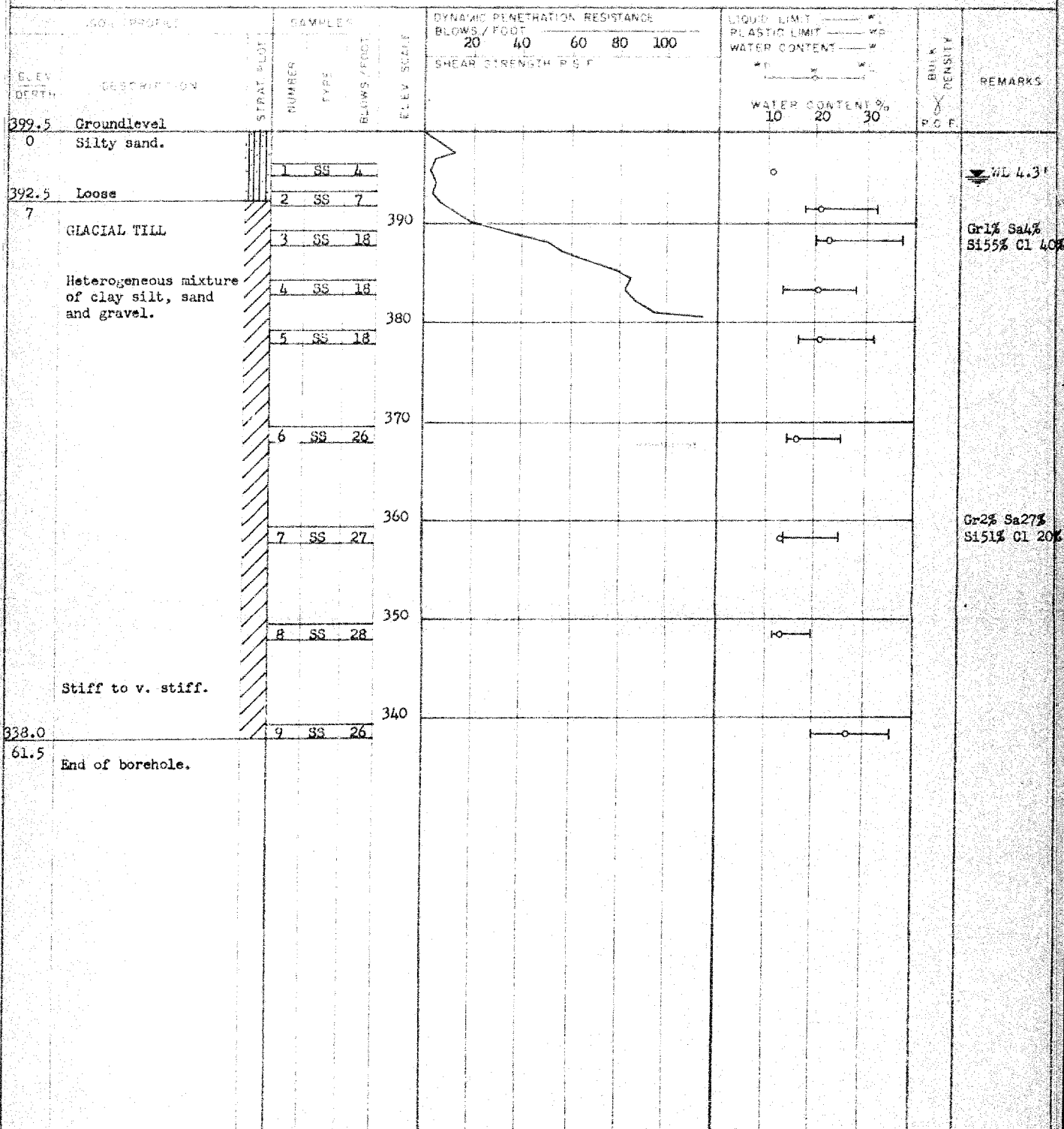
ORIGINATED BY R.M.

W.F. 21 BORING DATE Dec. 10, 1963.

COMPILED BY R.M.

DATUM 399.5 BOREHOLE TYPE Washboring and Cone Penetration.

CHECKED BY M.D.



JOB 63-F-146

LOCATION 115' Rt. Sta. 159/30

ORIGINATED BY R.M.

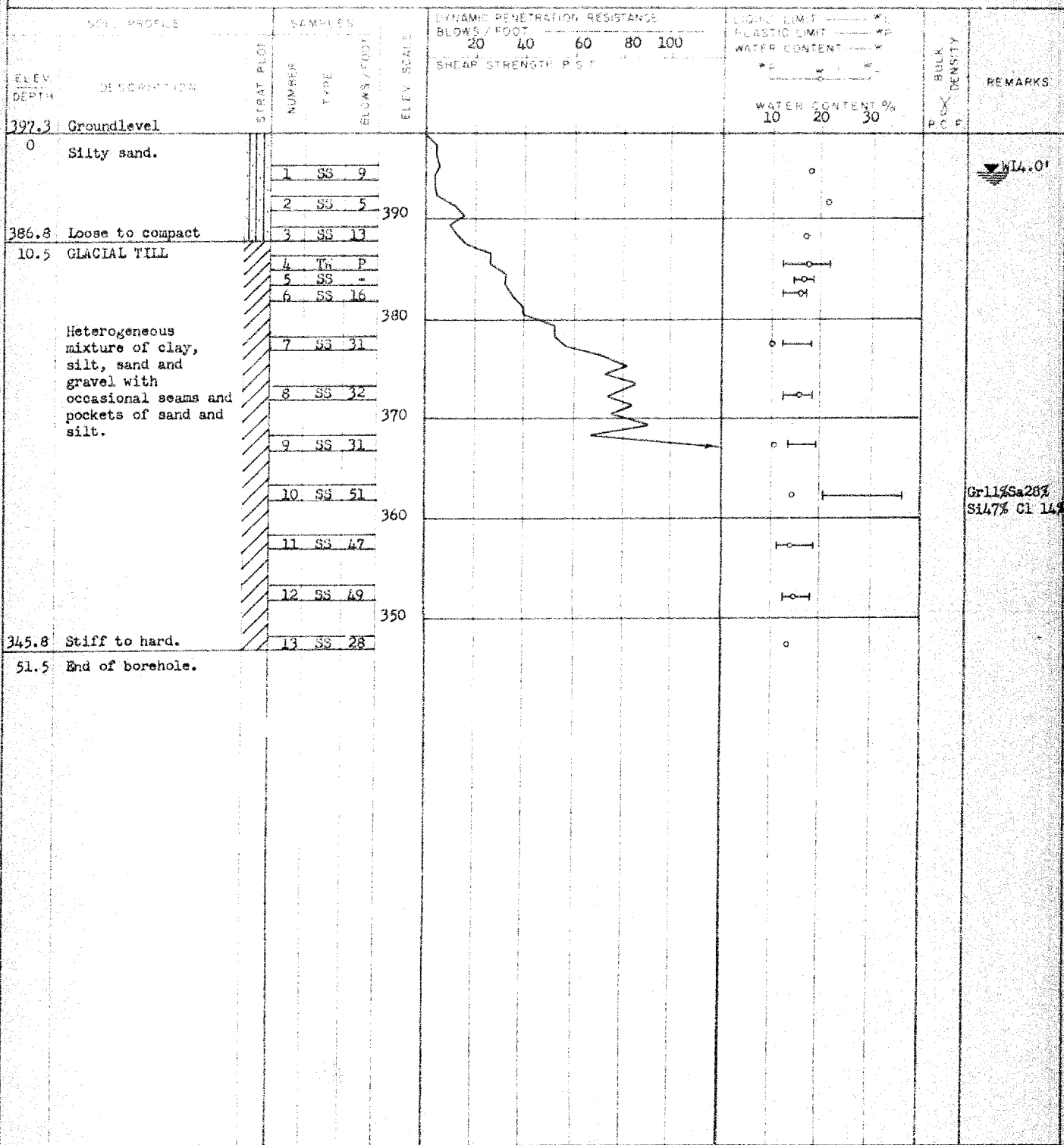
W. R. BORING DATE Sept. 3, 1963.

COMPILED BY R.M.

DATUM 397.3

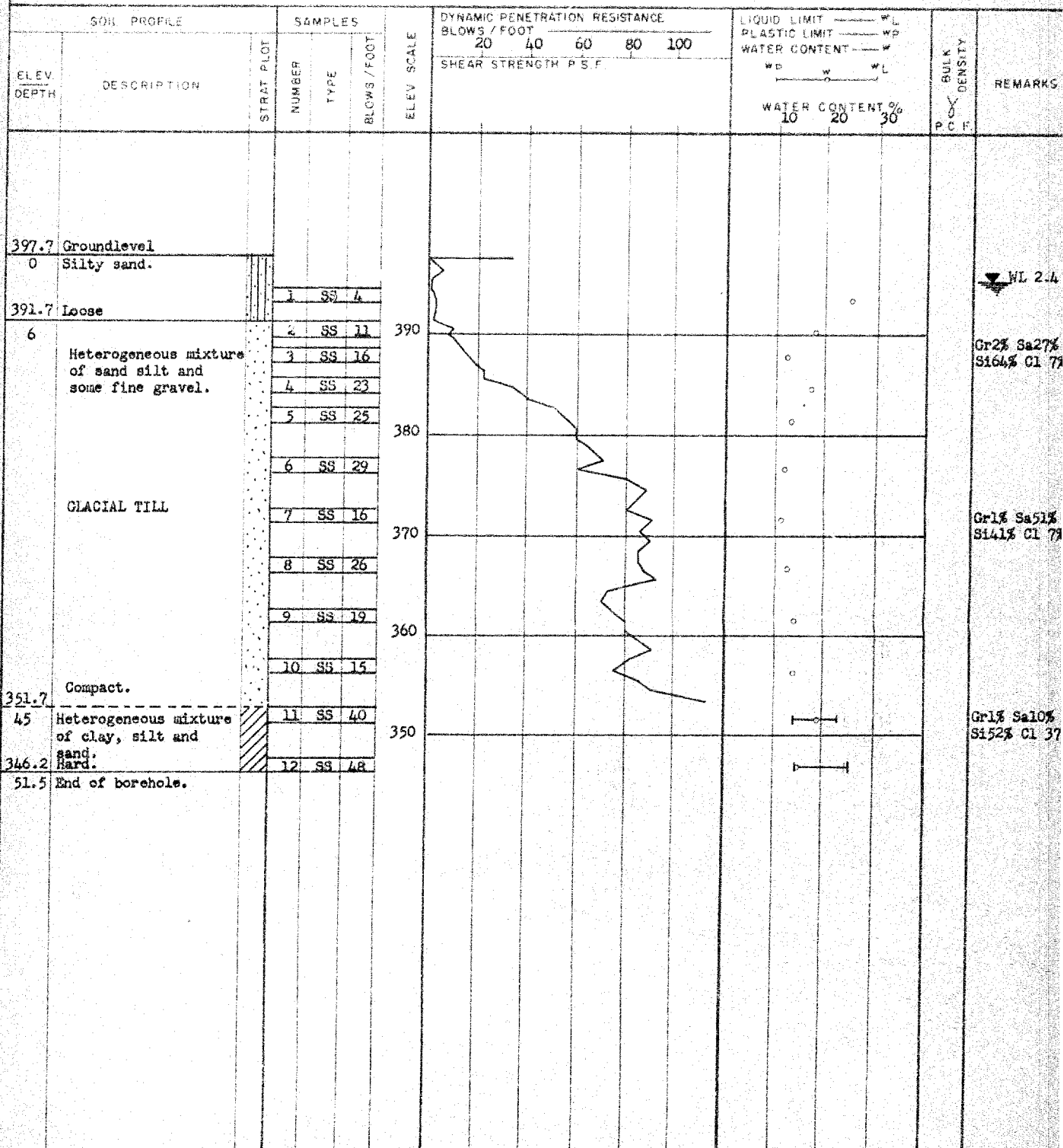
BOREHOLE TYPE Washboring & Cone Penetration

CHECKED BY M.D.



JOB 63-F-146LOCATION 60' Rt. Sta. 158+90ORIGINATED BY R.M.

W.P.

BORING DATE Jan. 28, 1964.COMPILED BY R.M.DATUM 397.7BOREHOLE TYPE Washboring and Cone Penetration.CHECKED BY M.D.

SOIL PROFILE		SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	Liquid Limit — WL Plastic Limit — WP	BULK DENSITY P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.			WATER CONTENT % WP W WL
397.6	Groundlevel									
0	Silty sand.		1	SS	4				WL 2.5'	
390.6	Loose		2	SS	9					
7	GLACIAL TILL Heterogeneous mixture of clay, silt, sand and fine gravel.		3	SS	16				Gr 9% Sa 13% Si 60% Cl 18%	
			4	SS	16					
			5	TW	P					
			6	SS	20				Si 86% Cl 14%	
			7	SS	21					
			8	SS	22				Sa 7% Si 56% Cl 37%	
			9	SS	23					
361.1		Stiff to v. stiff		10	SS	25				
36.5	End of borehole.									

JOB 63-F-146

LOCATION 60' Rt. Sta. 157+40

ORIGINATED BY R.M.

W.P.

BORING DATE Jan. 30, 1964.

COMPILED BY P.M.

DATUM 397.5

BOREHOLE TYPE Washboring & Cone Penetration.

CHECKED BY M.D.

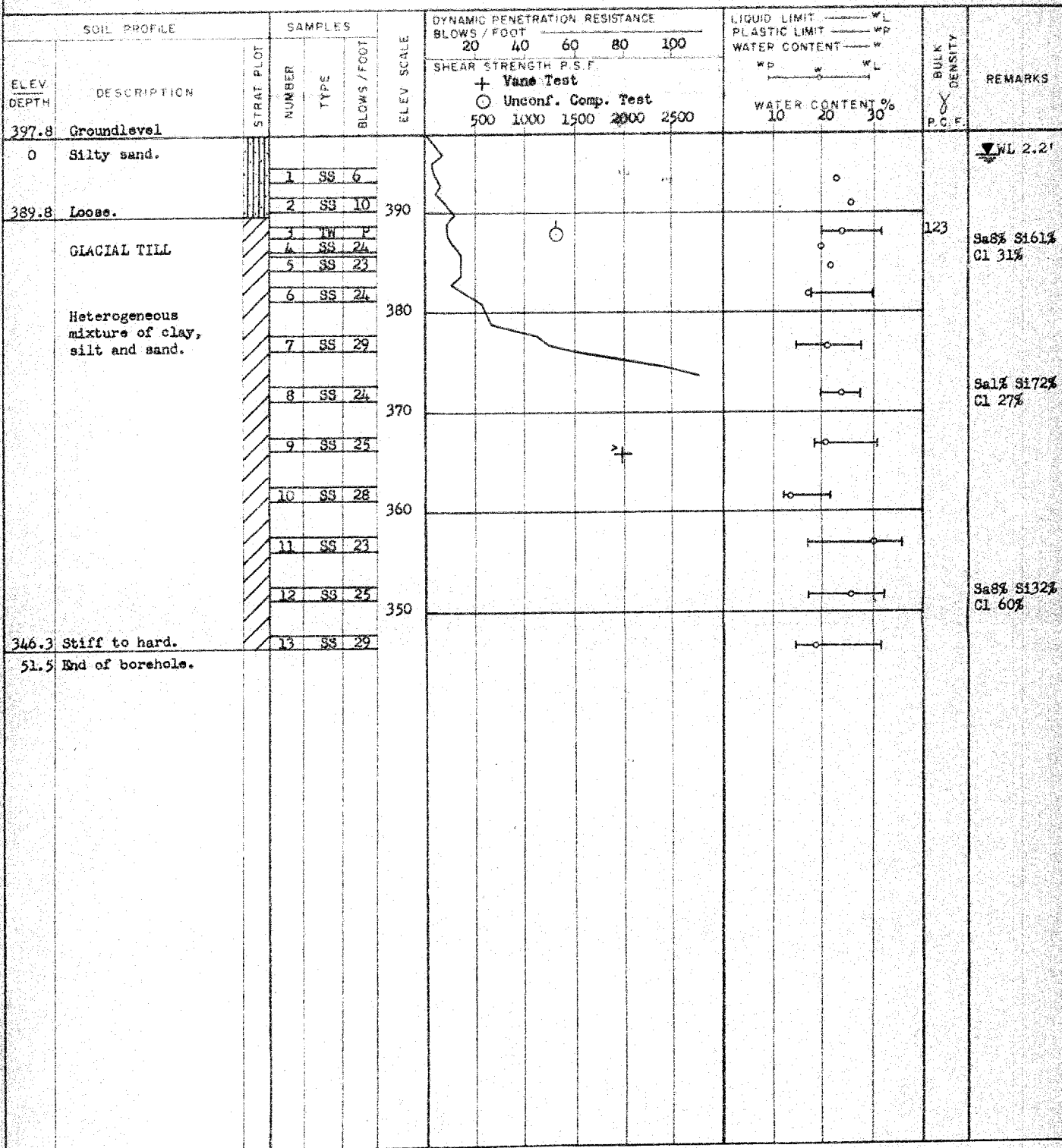
SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— W			BULK DENSITY P.C.F.	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WP	W	WL		
397.5	Groundlevel															
0	Silty sand.															
391.5	Loose		1	SS	4											
6	GLACIAL TILL		2	SS	16	390										
	Heterogeneous mixture of clay silt, sand and gravel.		3	SS	29											
			4	SS	40											
			5	SS	26	380										
			6	SS	29											
			7	SS	31	370										
			8	SS	32											
361.0	Stiff to hard.		9	SS	37	360										
36.5	End of borehole.															

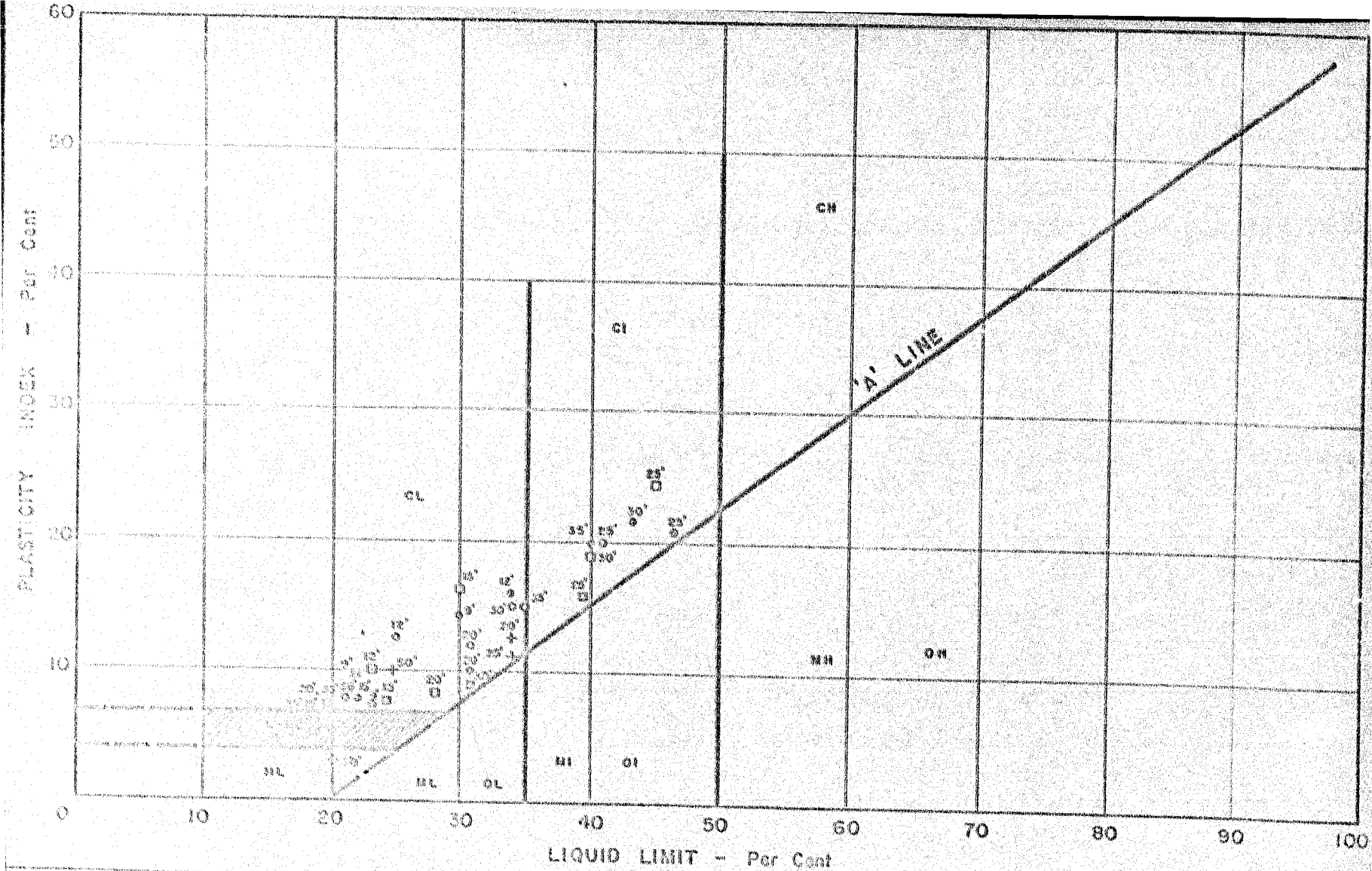
Gr 5% Ss 5%
S140% Cl 50%

W.L. 2.3'

JOB 63-F-146LOCATION 60' Rt. Sta. 156/60ORIGINATED BY R.M.

W.P.

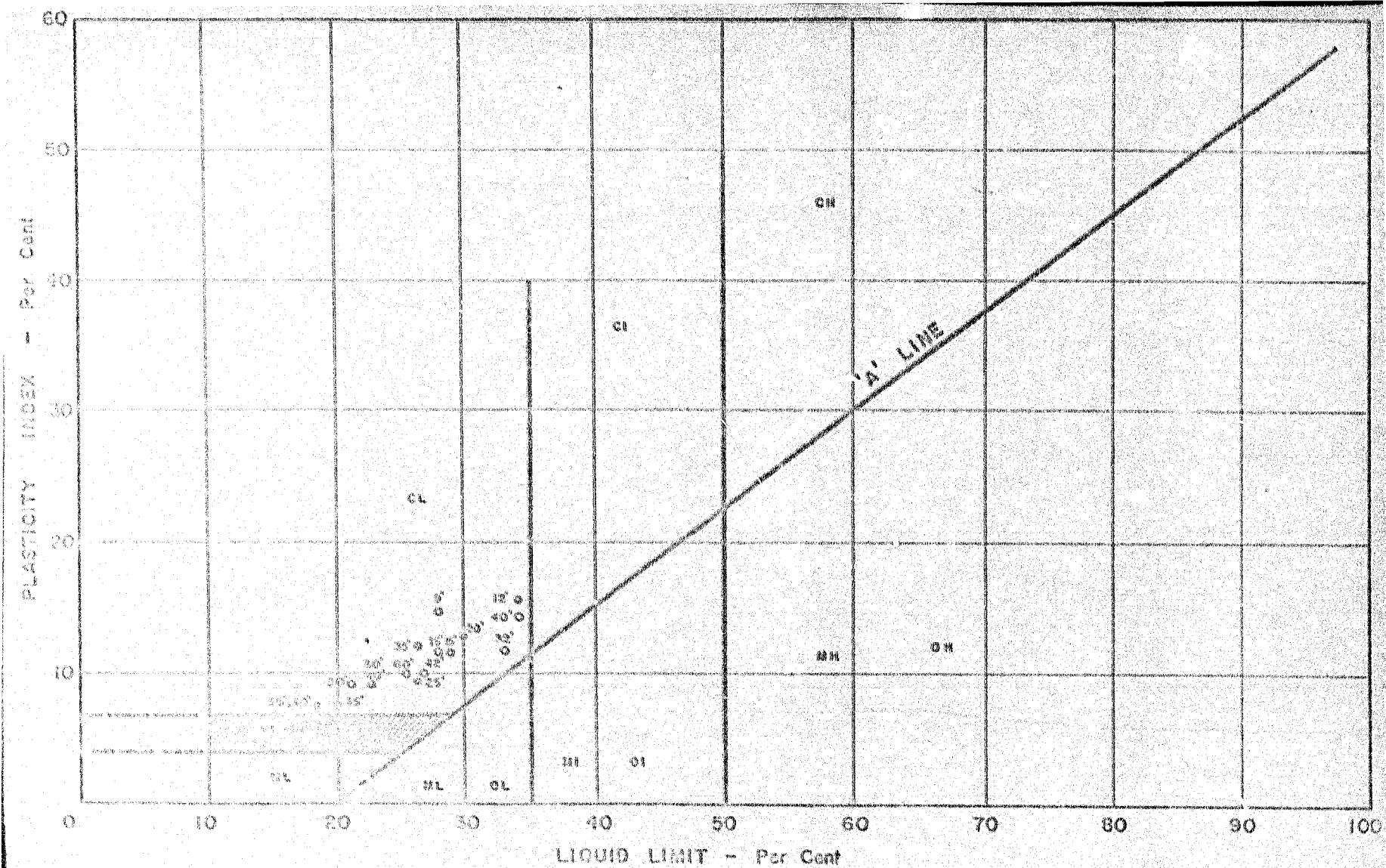
BORING DATE Feb. 3, 1964.COMPILED BY R.M.DATUM 397.8BOREHOLE TYPE Washboring and Cone Penetration.CHECKED BY M.D.



NOTES

B.H. 1	o
B.H. 2	a
B.H. 3	o
B.H. 4	o
B.H. 5	+

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH DIVISION
 PLASTICITY CHART
 Job No. 63-E-146 W.P. No. _____
 Location N.W. RET. WALL AT JANE ST. & HWY. 400



NOTES

B.H. 6

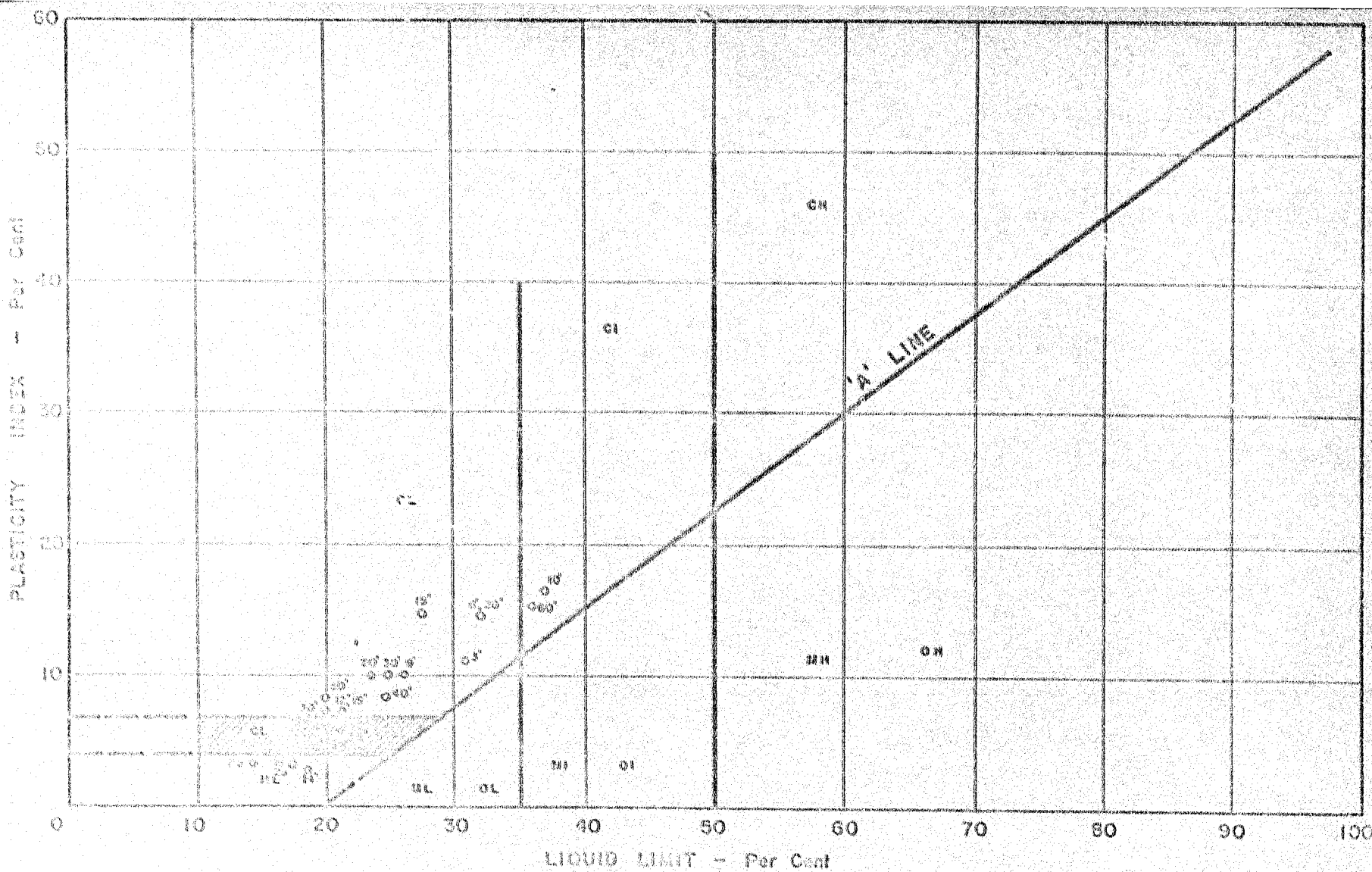
o

B.H. 7

o

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION
PLASTICITY CHART

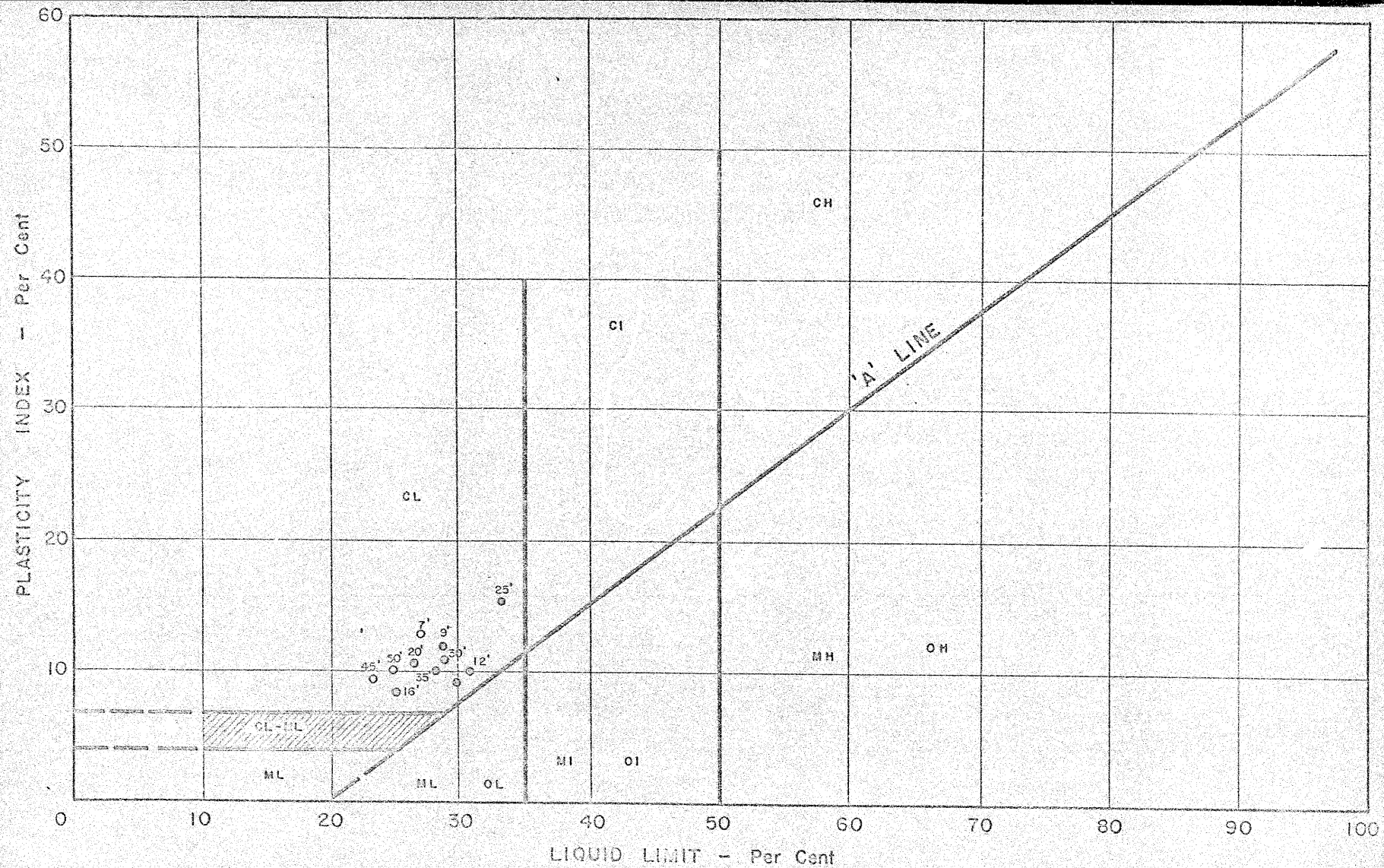
Job No. 63-E-146 W.P. No.
Location SOUTH RET. WALLS AT JANE ST. & HWY. 400



NOTES S.H. 8 0
 S.H. 9 4
 S.H. 10 6

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH DIVISION
 PLASTICITY CHART

Job No. 63-F-146 W.P. No. _____
 Location N.E. RET. WALL AT JANE ST. & HWY 400



NOTES

B.H. 11 ○

B.H. 12 ○

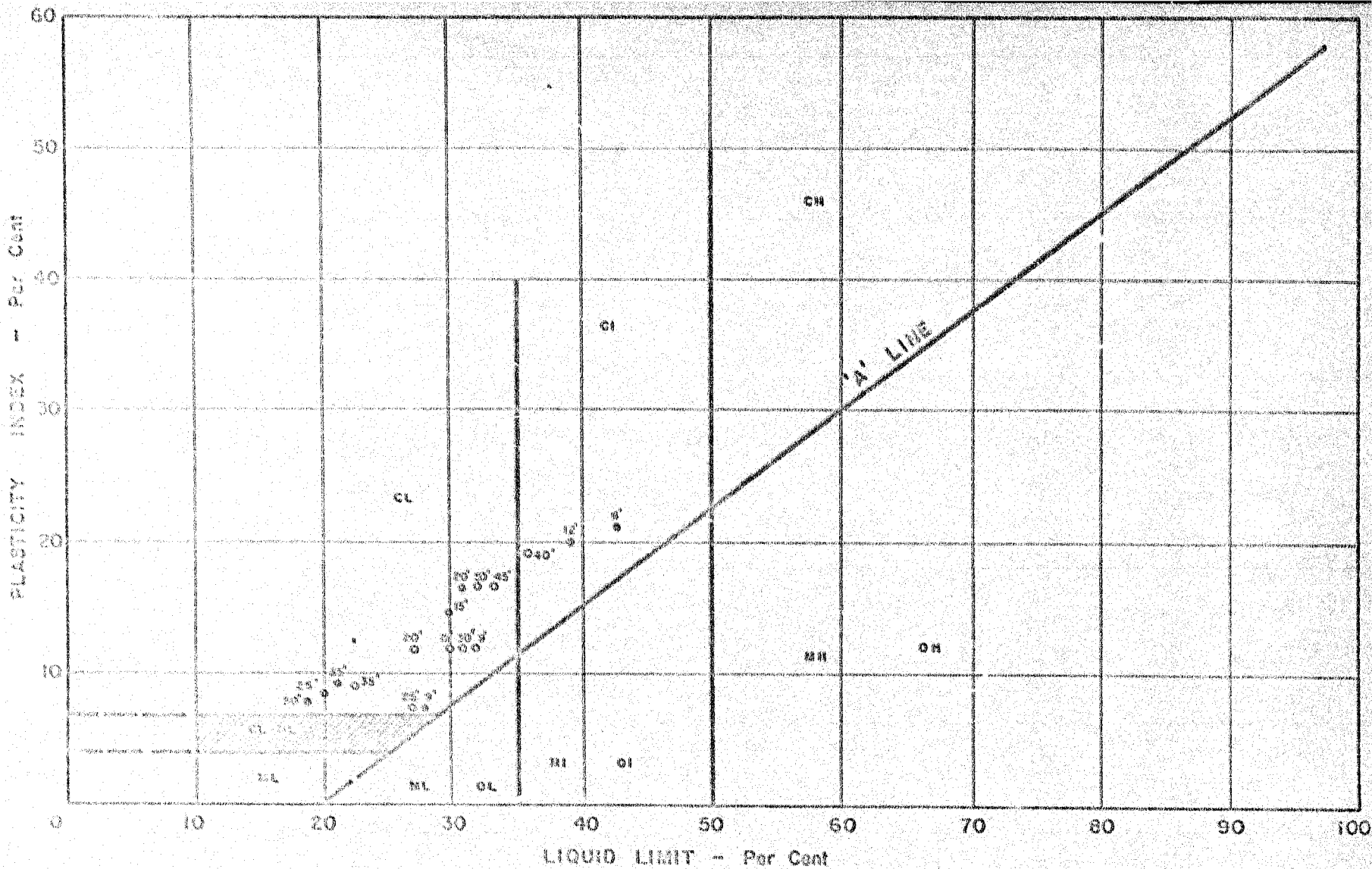
DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION

PLASTICITY CHART

Job No. 63-F-146 W.P. No. _____

Location EAST RET. WALLS AT JANE ST. & HWY 400



NOTES B.N. 13 ○
B.N. 14 ○

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION
PLASTICITY CHART

Job No. 63-F-146 W.P. No.

Location EAST RET. WALL AT JANE ST & HWY 400

Plot on 30M11
same as #142 (maybe this report should be included)
DEPARTMENT OF HIGHWAYS ONTARIO
MEMORANDUM
BA 1789 with 142

To: Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

FROM: Foundation Section,
Materials & Research Div.,
Room 107, Lab. Bldg.

Attention: Mr. S. McCombie

DATE: March 4, 1964

OUR FILE REF.

IN REPLY TO

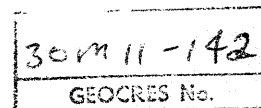
SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

Proposed Structure at the Crossing
of Hwy. 400 and Jane Street
District No. 6, Toronto

W.J. 63-F-109 -- W.P. 113-63



Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above-noted structure site.

We believe that you will find the factual data and recommendations contained therein, adequate for your future design work. Should further information be required with respect to this project, please feel free to contact our Office.

KYL/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
C. K. Hunter (2)
C. Fraser
T. J. Kovich
A. Watt

Foundations Office
Gen. Files

KYL
K. Y. Lo,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

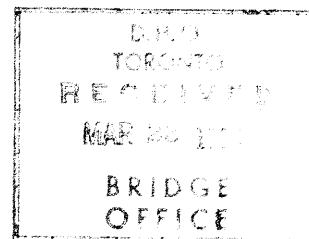


TABLE OF CONTENTS

1. INTRODUCTION.
2. DESCRIPTION OF THE SITE.
3. FIELD INVESTIGATION PROCEDURE.
4. LABORATORY TESTS.
5. SUBSOIL CONDITIONS:
 - 5.1) General.
 - 5.2) Silty Sand.
 - 5.3) Glacial Till -
 - 5.3.1) Heterogeneous Mixture of Clayey Silt with Sand and occasional Gravel (Glacial Till).
 - 5.3.2) Sand and Silt with occasional Gravel (Glacial Till)
6. GROUND WATER.
7. DISCUSSION AND RECOMMENDATIONS:
 - 7.1) Structure Foundations -
 - 7.1.1) West Abutment.
 - 7.1.2) East Abutment.
8. SUMMARY.
9. MISCELLANEOUS.

FOUNDATION INVESTIGATION REPORT

For

Proposed Structure at the Crossing
of Hwy. 400 and Jane Street
District No. 6, Toronto
W.J. 63-F-109 -- W.P. 113-63

1. INTRODUCTION:

A request for a foundation investigation at the site of the proposed crossing of Hwy. 400 and Jane St., was received from Mr. J. Curtis of the Bridge Office.

A field investigation was subsequently carried out by this Section to determine the subsoil conditions at the site of the proposed structure. Presented in this report are the results of this investigation, together with recommendations pertaining to the design of structure foundations and approach embankments.

2. DESCRIPTION OF THE SITE:

The proposed structure is located about one-half mile south of Hwy. 401, where the future Hwy. 400 crosses Jane St. It is part of the proposed Hwy. 400 extension.

The topography of the site is generally flat, covered with weeds and small bush. The Black Creek meanders through this area in a west-east^x direction and is spanned by a new structure at Jane St. This structure is located adjacent to the proposed overpass. There are also some small dwellings in the area.

Physiographically, the site lies in the South Slope Region, which is the south slope of an interlobate moraine. This moraine consists of a clayey-silty till deposited during the Pleistocene Ice Epoch.

cont'd. /2 ...

3. FIELD INVESTIGATION PROCEDURE:

A total of 5 boreholes and 11 dynamic cone penetration tests were carried out during the course of the field investigation. Boring was achieved by means of conventional diamond drilling equipment adapted for soil sampling purposes. Undisturbed soil samples were obtained by means of 2-inch I.D. Shelby tubes, some of which were pushed manually and some of which had to be gently hammered into the soil. Disturbed samples were recovered by means of a standard 2-inch O.D. split-spoon sampler. In-situ vane tests were carried out wherever possible, in cohesive deposits.

The locations and elevations of all boreholes are shown on Dwg. 63-F-109A which accompanies this report. The borehole elevations were provided by D.H.O. survey crew working from a Bench Mark located on the existing Jane St. and Black Creek bridge.

4. LABORATORY TESTS:

Samples were visually examined and identified in the laboratory as well as in the field. Tests were carried out in the laboratory for the determination of Atterberg limits, moisture contents, grain size distributions, shear strength measurements and bulk densities.

The laboratory test results have been summarized on borehole logs and are included in this report in Appendix I.

5. SUBSOIL CONDITIONS:

5.1) General:

The subsoil conditions at the site were found to be quite variable. Detailed descriptions of various soil types encountered

cont'd. /3 ...

5. SUBSOIL CONDITIONS: (cont'd.) ...

5.1) General: (cont'd.) ...

in each boring are given in Appendix I of this report. The estimated stratigraphical profile of Dwg. 63-F-109A is based upon this information.

From ground level downwards, the various soil types encountered are as follows:

5.2) Silty Sand:

This stratum was encountered in all boreholes. The depth of the layer varied from 7 ft. in B.H. #1 to 19 ft. in B.H. #4. Standard Penetration Test or 'N' values ranged from 4 to 34 blows/ft., indicating a relative density of loose to dense.

5.3) Glacial Till:

A stratum of glacial till extends immediately below the deposit of silty sand in all the boreholes. The lower boundary of the till deposit was not determined, but extends at least 122 ft. below ground level. This deposit is essentially cohesive in the upper portion and mainly consists of a heterogeneous mixture of clayey silt, with sand and occasional gravel. The lower portion of this deposit except in boreholes #1 and #11, generally consists of a granular deposit of sand and silt with occasional gravel.

5.3.1) Heterogeneous Mixture of Clayey Silt with Sand and occasional Gravel (Glacial Till):

This cohesive deposit varies in thickness from 18 ft. in B.H. #4 to 79 ft. in B.H. #2. In B.H.'s #1 and #11 the lower boundary was not determined, but extended at least 103 ft. below the silty sand stratum.

cont'd. /4 ...

5. SUBSOIL CONDITIONS: (cont'd.) ...

5.3.1) Heterogeneous Mixture of Clayey Silt with Sand and occasional Gravel (Glacial Till): (Cont'd.) ...

The results of field and laboratory tests are given in the borehole logs appended to this report. A study of the liquid and plastic limits shows that the soil is heterogeneous. The liquid limit varies from 18% to 34%, while the plastic limit varies from 12% to 24%. The moisture contents varied from 12% to 31%.

The shear strength and Standard Penetration (N) values as determined in the field and in the laboratory, were as follows:

In-situ Vane Test	850 p.s.f. - > 2000 p.s.f.
Undrained Lab. Shear Strength	480 p.s.f. - 3070 p.s.f.
'N' Values	15 blows/ft.- > 100 blows/ft.

Based on these values, the consistency of the stratum may be described as firm to hard.

5.3.2) Sand and Silt with occasional Gravel (Glacial Till):

The granular deposit consisting of a mixture of sand and silt with occasional gravel was observed in B.H.'s #2, #3 and #4 immediately below the cohesive portion of the glacial till stratum.

The upper boundaries of the granular portion on the west side vary between approximate elevations 358 and 365 (B.H.'s #3 and #4). On the east side it was found to be below elevation 320 in B.H. #2 only. This above deposit was proved to a maximum depth of 56 ft. in B.H. #3.

Standard Penetration (N) values in the stratum varied from 22 to > 100 blows/ft., indicating a relative density of compact to very dense.

cont'd. /5 ...

6. GROUND WATER:

During the foundation investigation, ground water observations were carried out. No ground water was observed in B.H. #11. In the other boreholes the water was found at approximate elevation 395.

7. DISCUSSION AND RECOMMENDATIONS:

It is proposed to extend Hwy. #400 to Jane St. approximately one-half mile south of Hwy. #401. An interchange is planned at the crossing of future Hwy. #400 and Jane St. This requires the construction of several ramps as well as structures. A single-span 100-ft. rigid frame structure is proposed, where the new highway #400 crosses Jane St.

Subsoil at the site consists of a stratum of loose to dense silty sand, followed by glacial till. The upper portion of this stratum is cohesive with consistency ranging from soft to hard and the lower portion is non-cohesive with a relative density of compact to very dense.

7.1) Structure Foundations:

The subsoil conditions at the site are not favourable for a spread footing type foundation. Therefore, the structure should be supported on large displacement steel tube piles (say, $12\frac{3}{4}$ " O.D. x $\frac{1}{4}$ "). However, subsoil conditions vary considerably from the east to the west side. In view of this, the foundations for the east and west abutments should be considered separately.

cont'd. /6 ...

7. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

7.1.1) West Abutment:

At this location the granular portion of the glacial till deposit was observed some 37 to 46 ft. below the ground surface (average elevation 360). The steel tube piles ($12\frac{3}{4}$ " O.D. x $\frac{1}{4}$ ") driven to an estimated tip elevation 350, may provide a safe design load of 70 tons/pile. However, the piling in the field should be controlled by the use of the Hiley Formula as per current D.H.O. Standards DD-1218 and 1219.

7.1.2) East Abutment:

East of Jane St. the granular glacial till deposit was encountered in B.H. #2 only, approximately 90 ft. below ground level. The consistency of the cohesive portion of the glacial till deposit varies considerably. In view of this, it is very difficult to predict the precise lengths nor the probable bearing loads for the proposed piles. A pile loading test is already proposed at the crossing of the N.E. ramp of Hwy. 400 and Black Creek. The subsoil conditions at the east abutment location are comparable to those at the proposed pile loading test site. Therefore, the results of the pile loading test will enable the determination of the probable bearing loads as well as tip elevations.

For preliminary design purposes, a safe load of 50 tons/pile may be used for tubular piles driven to an estimated tip elevation \pm 335.

No stability problems are anticipated for the approach fills with standard 2:1 side slopes.

cont'd. /7 ...

8. SUMMARY:

Subsoil at the site is quite variable, consisting of silty sand, followed by a deep deposit of glacial till origin.

The structure should be supported on large displacement tubular piles ($12\frac{3}{4}$ " O.D. x $\frac{1}{4}$ ") driven into the till stratum.

The west abutment may be supported on large displacement end-bearing piles driven to an estimated tip elevation \pm 360.

A safe design load of 70 tons/pile may be used.

However, for the east abutment the probable bearing loads and the tip elevations of the piles will be determined after completion of the pile load test proposed at the crossing of Black Creek and the N.E. ramp of future Hwy. 400. For preliminary design purposes, a safe design load of 50 tons/pile may be used for tubular piles driven to an estimated tip elevation \pm 335.

No approach fill stability problems are anticipated.

9. MISCELLANEOUS:

The field work, performed in September and December 1963 and January 1964, together with the preparation of this report, was undertaken by Mr. R. Magi, Project Foundation Engineer. The investigation was carried out under the general supervision of Mr. M. Devata, Senior Foundation Engineer, who also reviewed this report.

Equipment was owned and operated by Dominion Soil Investigation, Ltd. of Toronto.

March 1964

APPENDIX I.

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 63-F-109

LOCATION 70' Rt. Sta. 160/40

ORIGINATED BY R.M.

W P 113-63

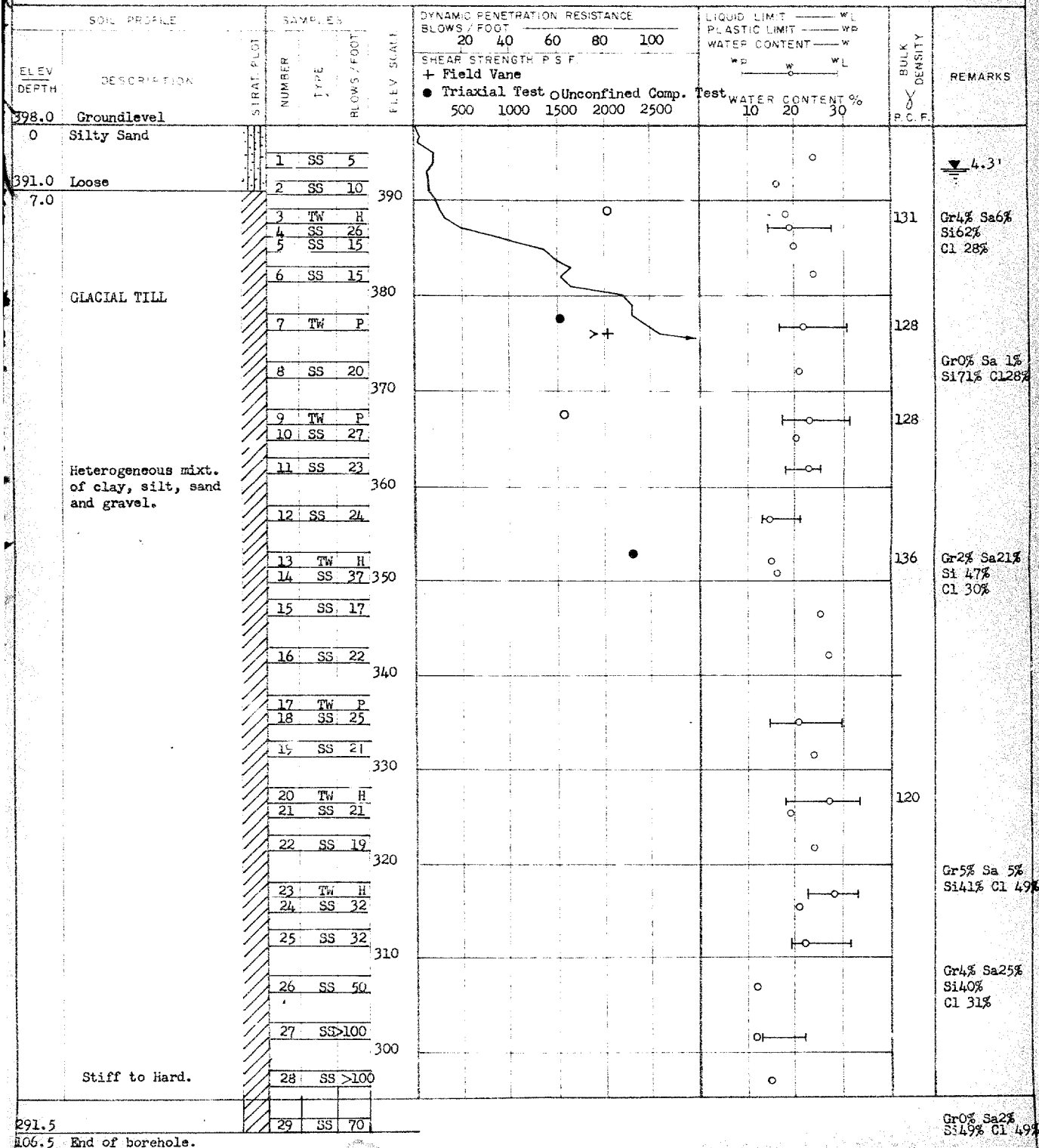
BURNING DATE Sept. 9-11, 1963.

COMPILED BY R.M.

DATUM 397.9

BOREHOLE TYPE Cone Penetration & Washboring.

CHECKED BY M.D.



RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 63-F-109

LOCATION E. Sta. 160+70

ORIGINATED BY R.M.

W.D. 113-63

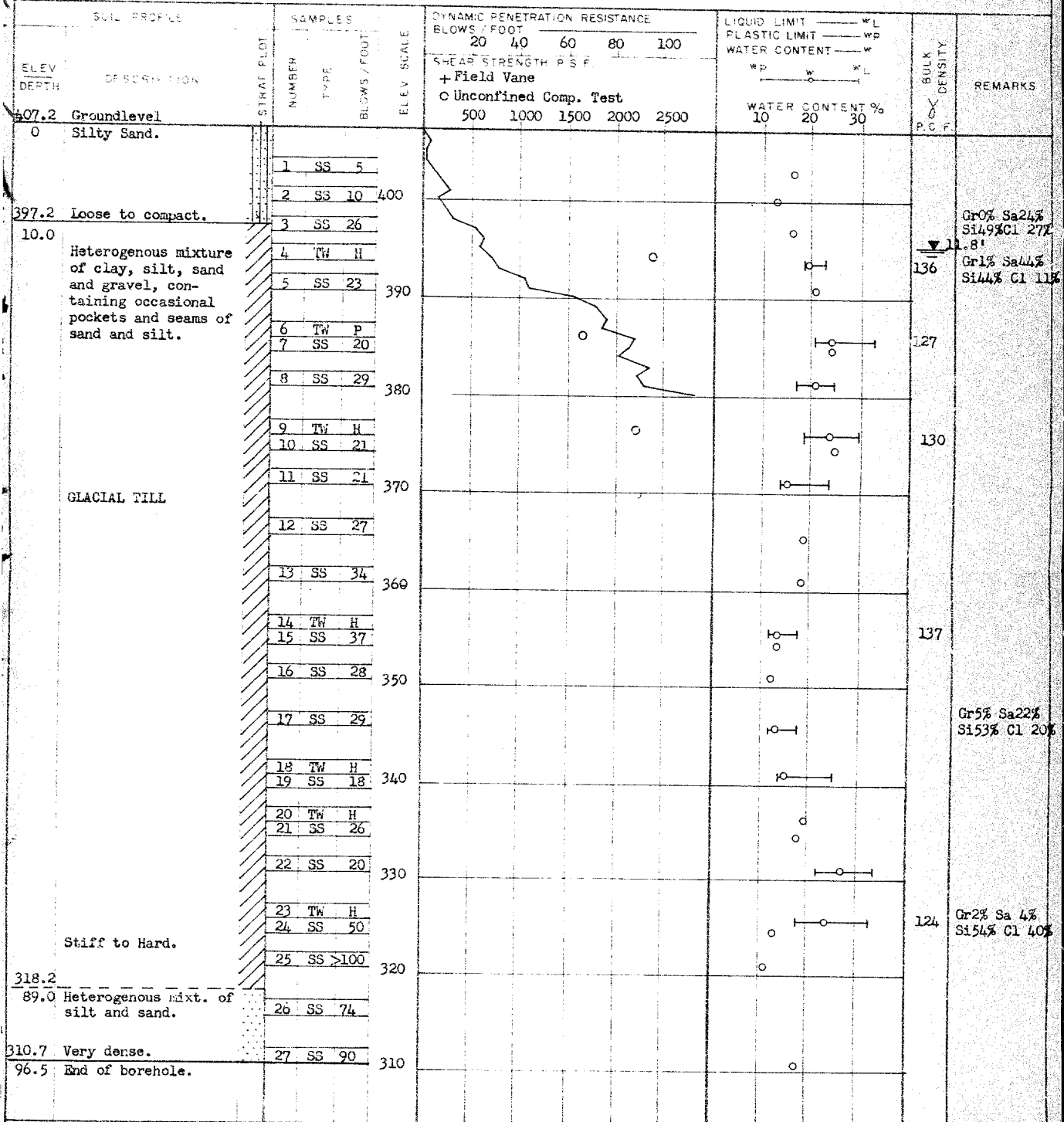
BORING DATE Sept. 12 & 13, 1963.

COMPILED BY R.M.

DATUM 407.2

BOREHOLE TYPE Washboring

CHECKED BY M.D.



RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 63-F-109

LOCATION 70' Lt. Sta. 161450

ORIGINATED BY R.M.

W P 113-63

BORING DATE Sept. 16 & 17, 1963.

COMPILED BY R.M.

DATUM 403.3

BOREHOLE TYPE Washboring & Cone Penetration.

CHECKED BY M.D.

SOIL PROFILE

SAMPLES

DYNAMIC PENETRATION RESISTANCE

BLOWS / FOOT
20 40 60 80 100

LIQUID LIMIT ——— WL

PLASTIC LIMIT ——— WP

WATER CONTENT ——— W

WD ——— WL

SHEAR STRENGTH P.S.F.

+ - Field Vane

O - Unconfined Comp. Test

500 1000 1500 2000 2500

WATER CONTENT %

10 20 30

BULK
DENSITY
X
P.C.F.

REMARKS

ELEV
DEPTH

DESCRIPTION

STRAT. PLOT

NUMBER

TYPE

BLOWS / FOOT

ELEV SCALE

403.8 Groundlevel

0 Silty Sand

392.8 Loose

11.0

Heterogenous mixture
of clay, silt and
sand.

GLACIAL TILL

357.8 Firm to v. stiff.

46.0

Heterogenous mixture
of sand and silt.

302.3

101.5

End of borehole.

1 SS 7 400

2 SS 8

3 SS 10

4 SS 6 390

5 SS 8

6 TW P 380

7 TW P

8 TW P

9 SS 6 370

10 TW P

11 SS 17 360

12 SS 44 350

13 SS 62 340

14 SS 23 330

15 SS 46 320

16 SS 48 310

17 SS 56

7.3

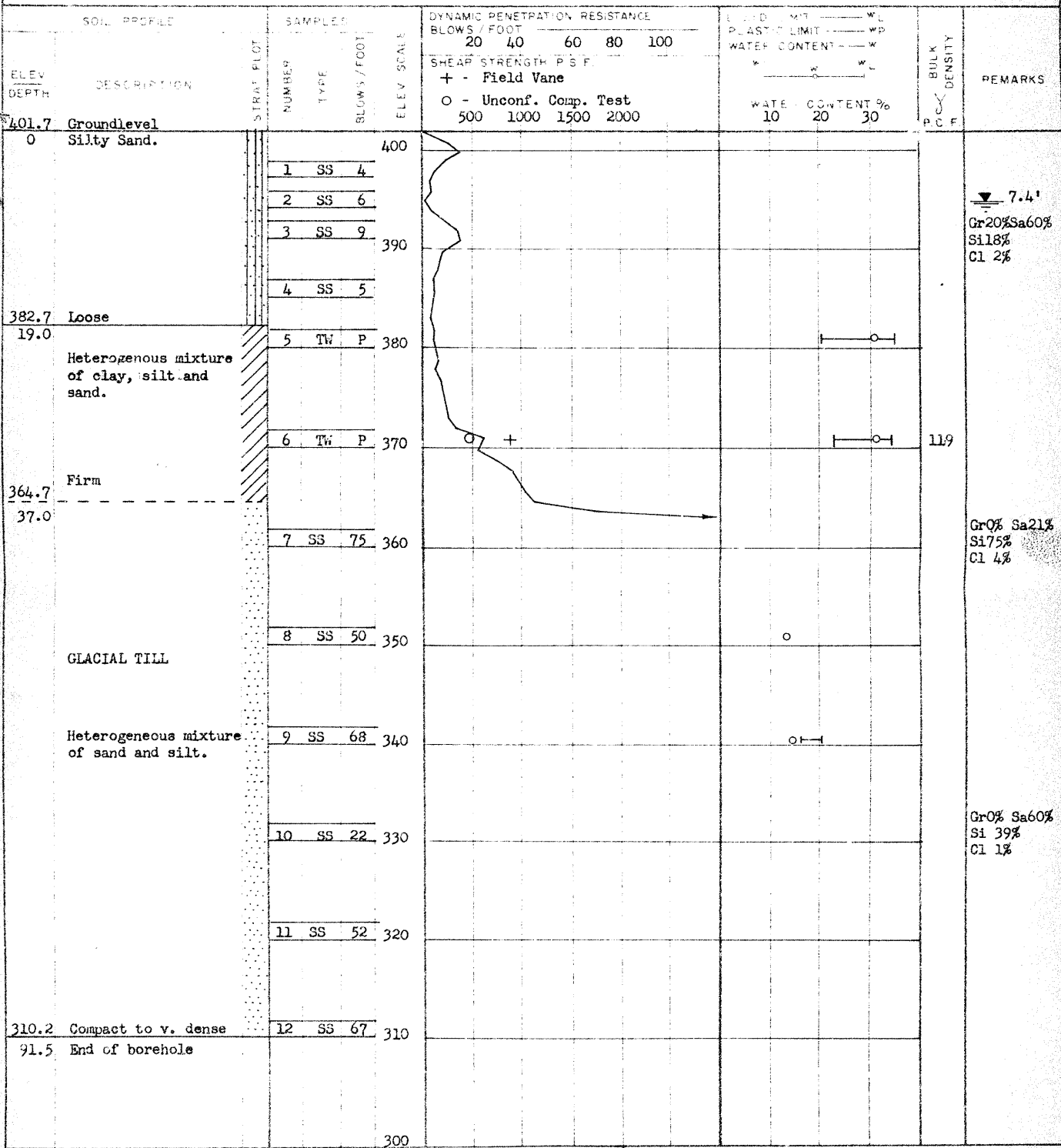
135

GrO% Sa37
SI61%
Cl 2%GrO% Sa34
SI59%
Cl 7%

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 63-F-109 LOCATION 70' Rt. Sta. 162+50 ORIGINATED BY R.M.
W.P. 113-63 BORING DATE Sept. 18 & 23, 1963. COMPILED BY R.M.
DATUM 401.7 BOREHOLE TYPE Cone Penetration and Washboring. CHECKED BY M.D.



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 63-F-109

LOCATION E, Sta. 161+70

ORIGINATED BY R.M.

W.P. 113-63

BORING DATE Oct. 4, 1963.

COMPILED BY R.M.

DATUM 406.5

BOREHOLE TYPE Cone Penetration.

CHECKED BY M.D.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 63-F-109 LOCATION 70' Lt. Sta. 162400 ORIGINATED BY R.M.
W.P. 113-63 BORING DATE Oct. 4, 1963. COMPILED BY R.M.
DATUM 401.1 BOREHOLE TYPE Cone Penetration. CHECKED BY H.D.

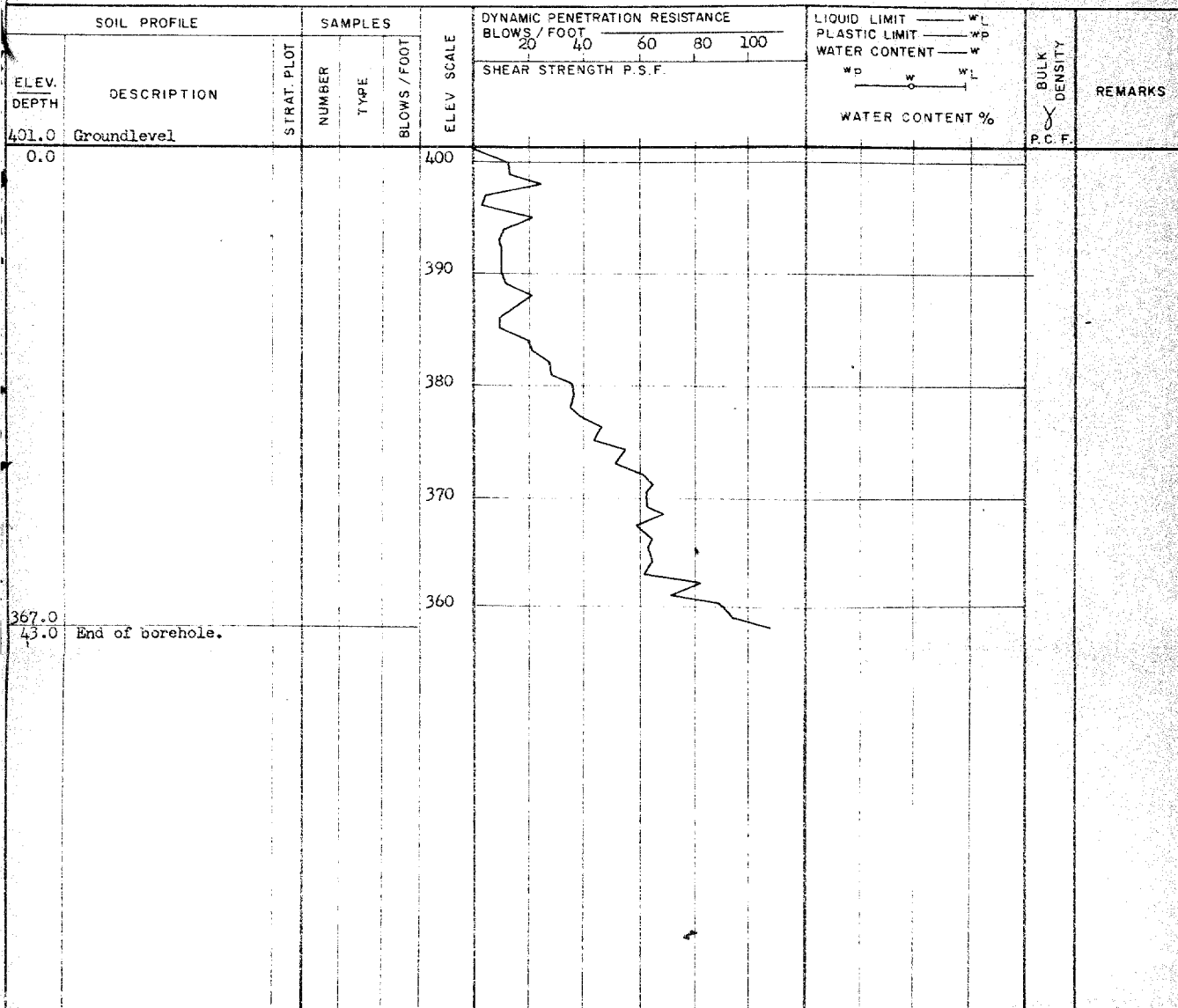
SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT <u>W_L</u> PLASTIC LIMIT <u>W_P</u> WATER CONTENT <u>W</u>		BULK DENSITY <u>Y</u> P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.		
401.1	Groundlevel								
0.0						400			
						390			
						380			
374.1									
27.0	End of borehole.					370			

61-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 63-F-109LOCATION C, Sta. 162+25ORIGINATED BY R.M.W.P. 113-63BORING DATE Oct. 4, 1963.COMPILED BY R.M.DATUM 401.0BOREHOLE TYPE Cone Penetration.CHECKED BY M.D.

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

JOE 63-F-109

LOCATION 50' Rt. Sta. 161+90

ORIGINATED BY H.M.

W.P. 113-63

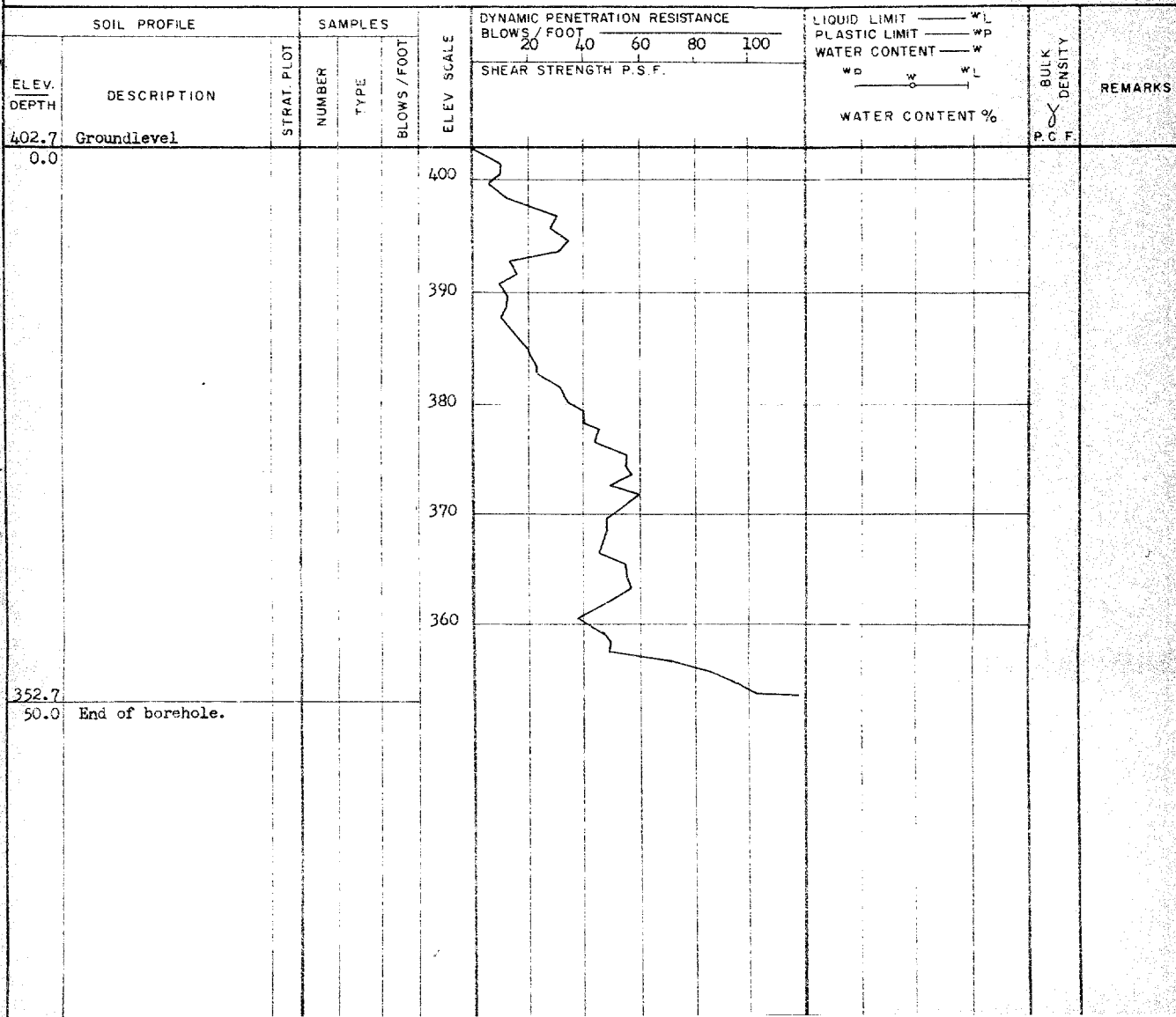
BORING DATE Oct. 1963.

COMPILED BY R.M.

DATUM 402.7

BOREHOLE TYPE Cone Penetration.

CHECKED BY M.D.



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 9

FOUNDATION SECTION

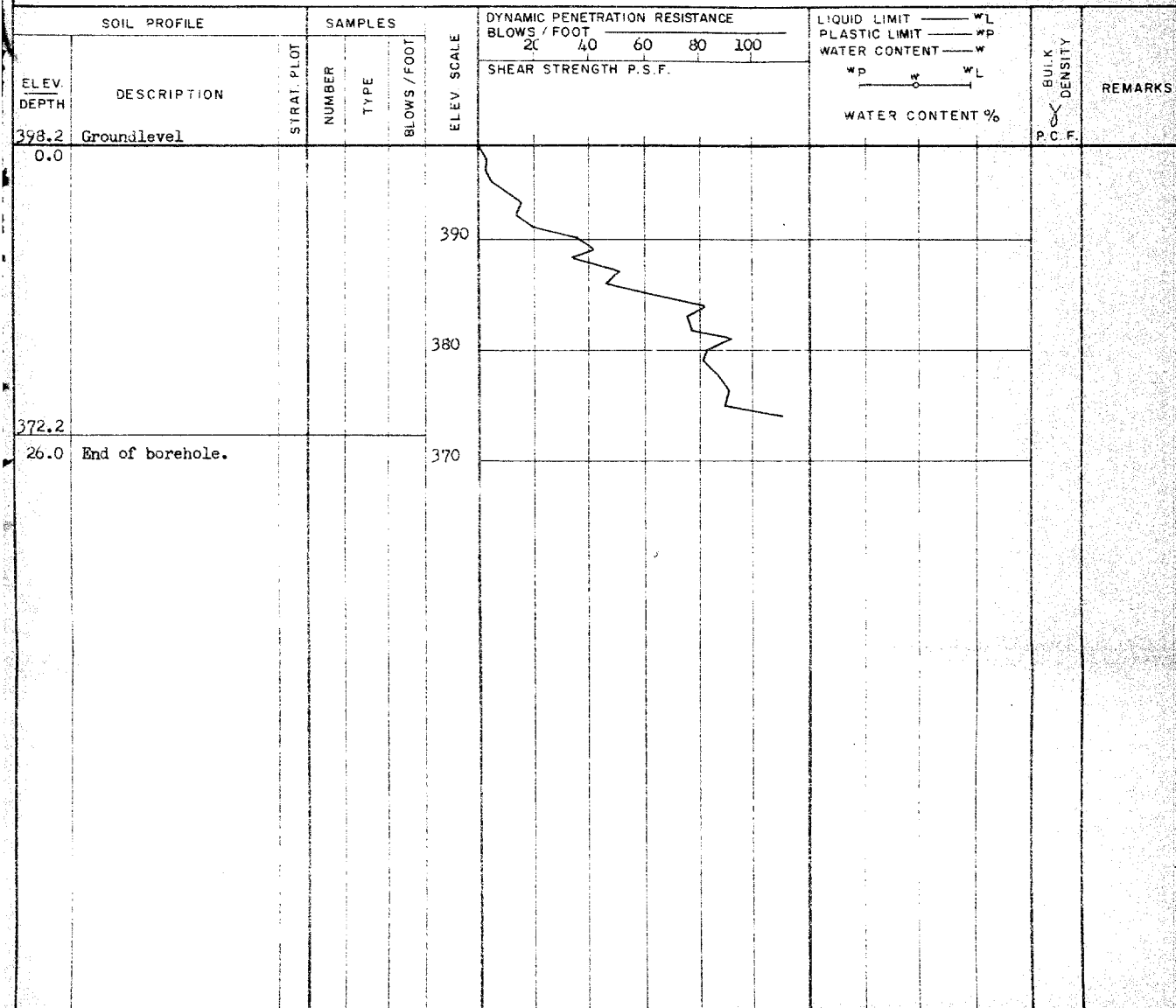
JOB 63-F-109LOCATION 70' Rt. Sta. 161400ORIGINATED BY R.M.W.P. 113-63BORING DATE Oct. 6, 1963.COMPILED BY R.M.DATUM 405.0BOREHOLE TYPE Cone Penetration.CHECKED BY M.D.

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WP — WL WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER TYPE					
405.0	Groundlevel							
0.0								
				400				
				390				
				380				
377.0								
28.0	End of borehole.							
				370				

RECORD OF BOREHOLE NO. 10

FOUNDATION SECTION

JOB 63-F-109 LOCATION E. Sta. 160+15 ORIGINATED BY R.M.
W.P. 113-63 BORING DATE Oct. 8, 1963. COMPILED BY R.M.
DATUM 398.2 BOREHOLE TYPE Cone Penetration. CHECKED BY M.D.



RECORD OF BOREHOLE NO. 11

FOUNDATION SECTION

JOB 63-F-109

LOCATION 50' Lt. Sta. 160#40

ORIGINATED BY R.M.

W P 113-63

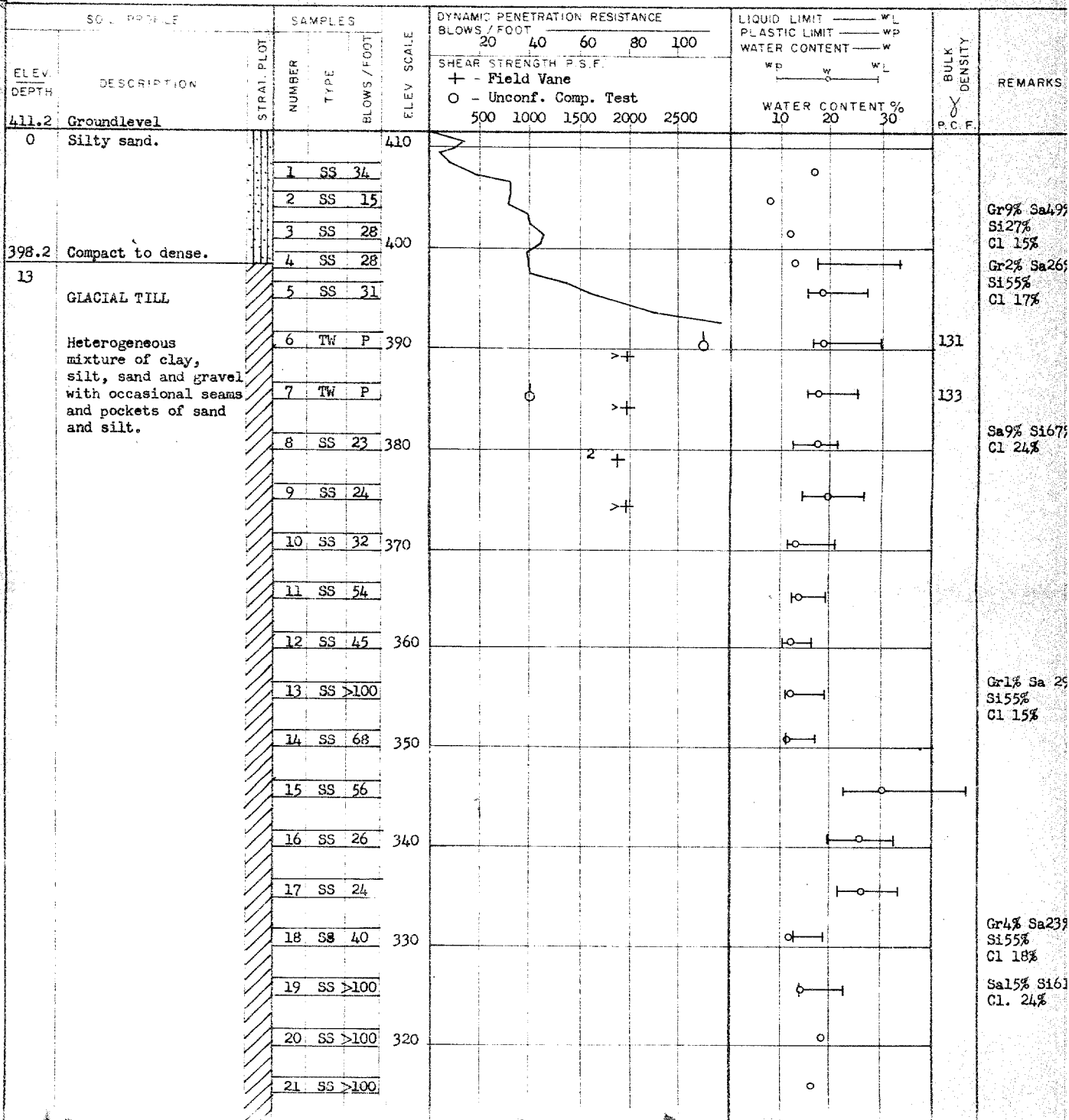
BORING DATE Jan. 24, 1964.

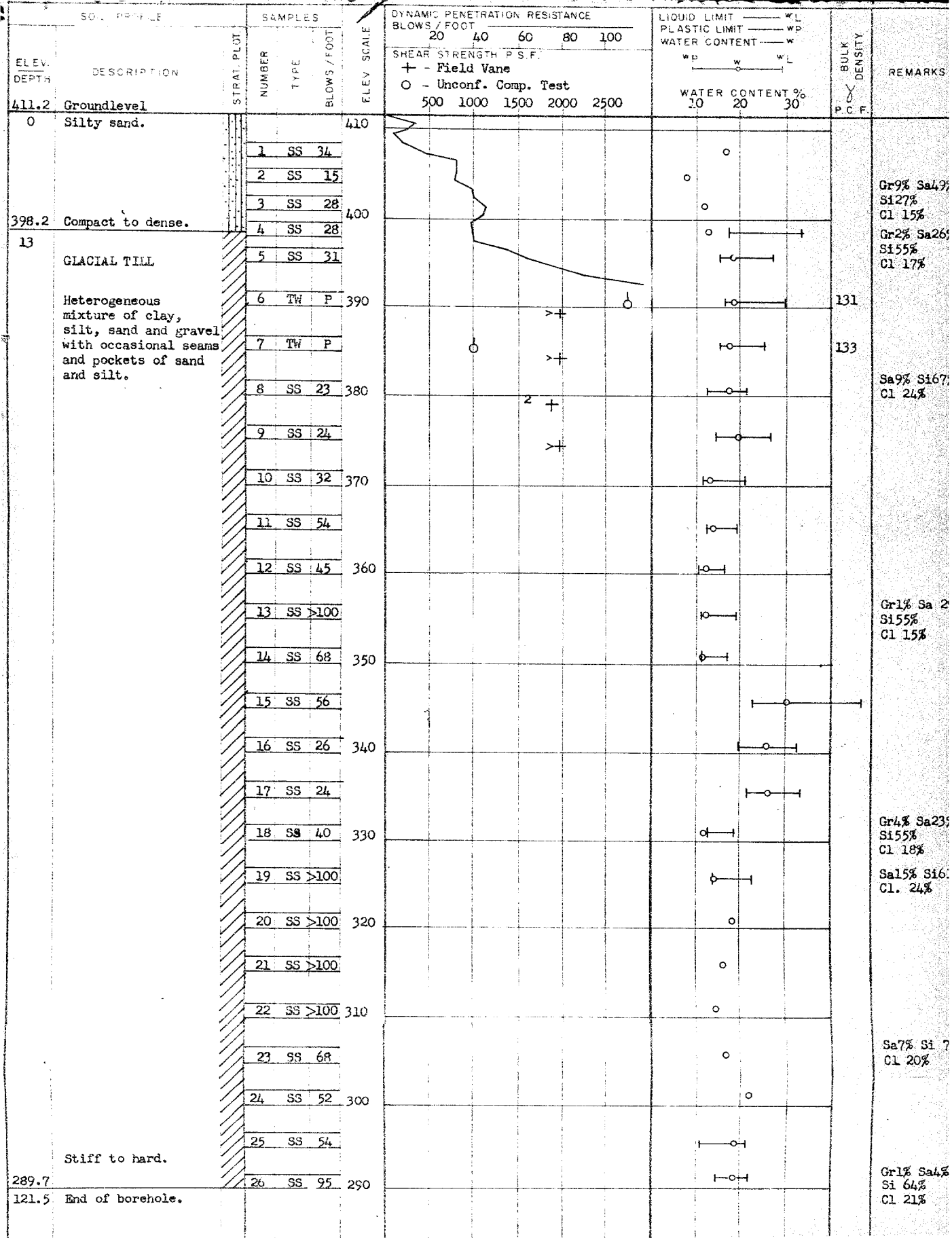
COMPILED BY R.M.

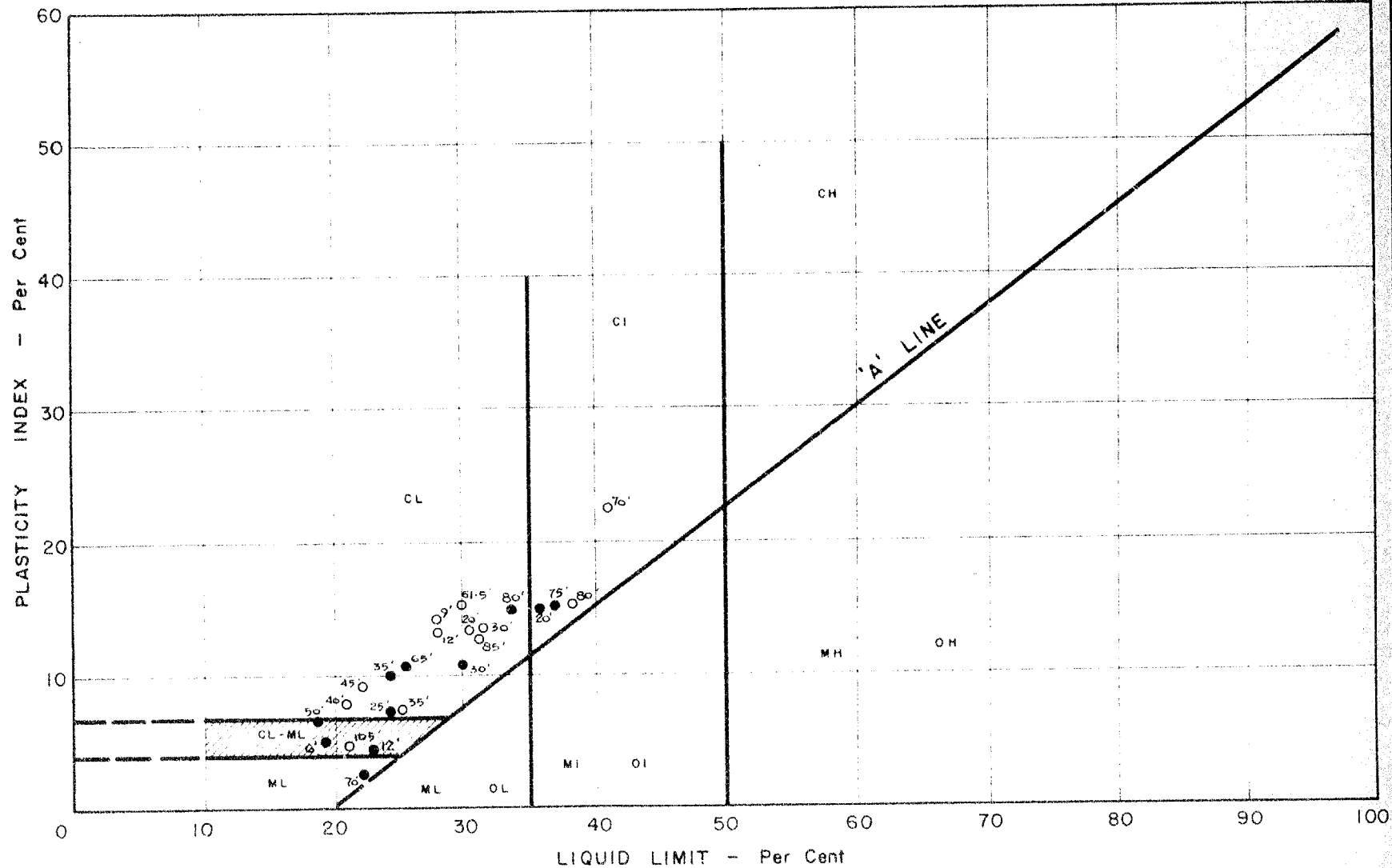
DATUM 411.2

BOREHOLE TYPE Washboring & Cone Penetration.

CHECKED BY M.D.







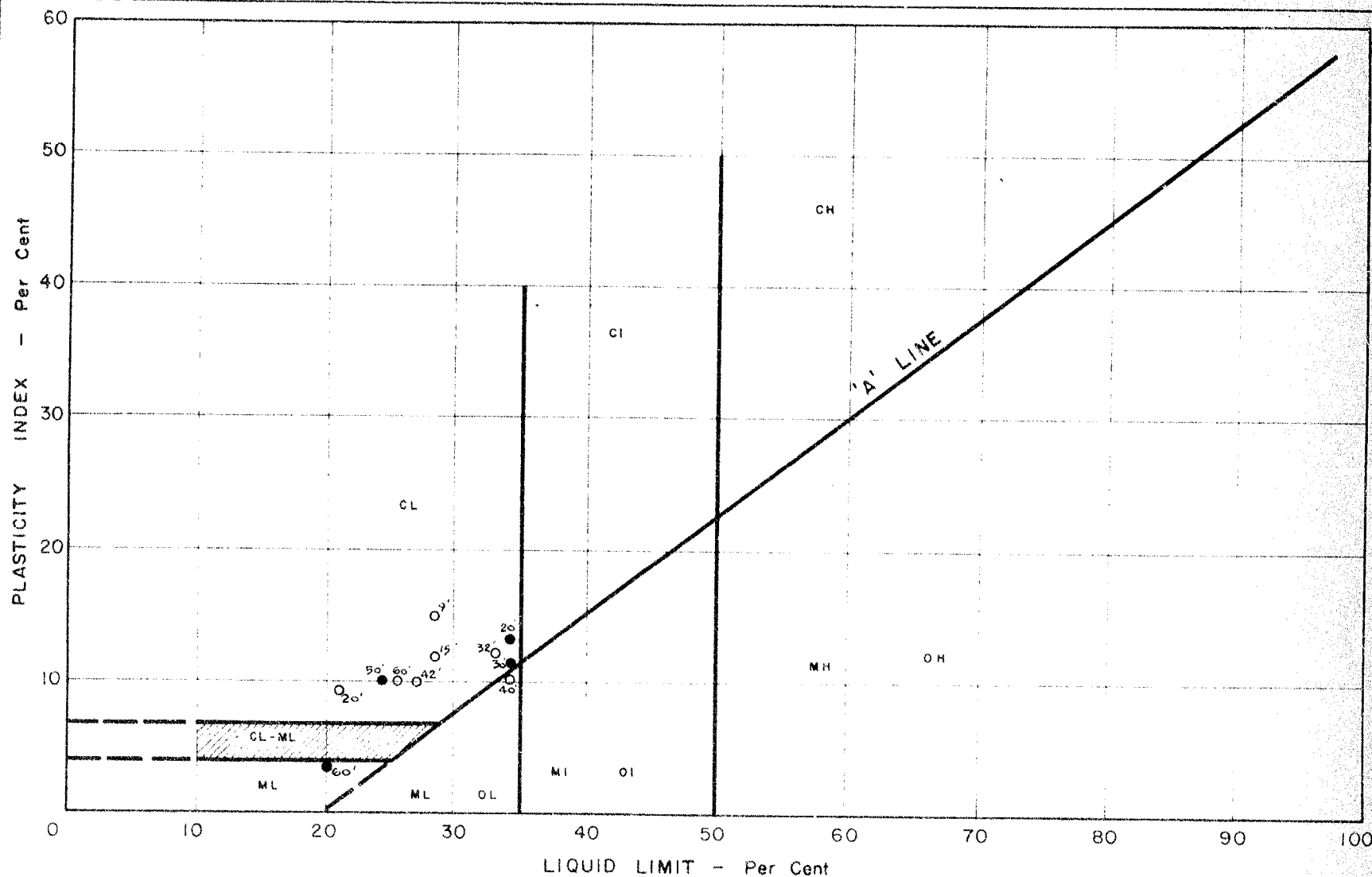
NOTES ○ - BOREHOLE 1
● - BOREHOLE 2

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION
PLASTICITY CHART

Job No. 63-F-109

W.P. No. 113-63

Location HWY. 400 & JANE ST.



NOTES ○ - BOREHOLE 3
● - BOREHOLE 4

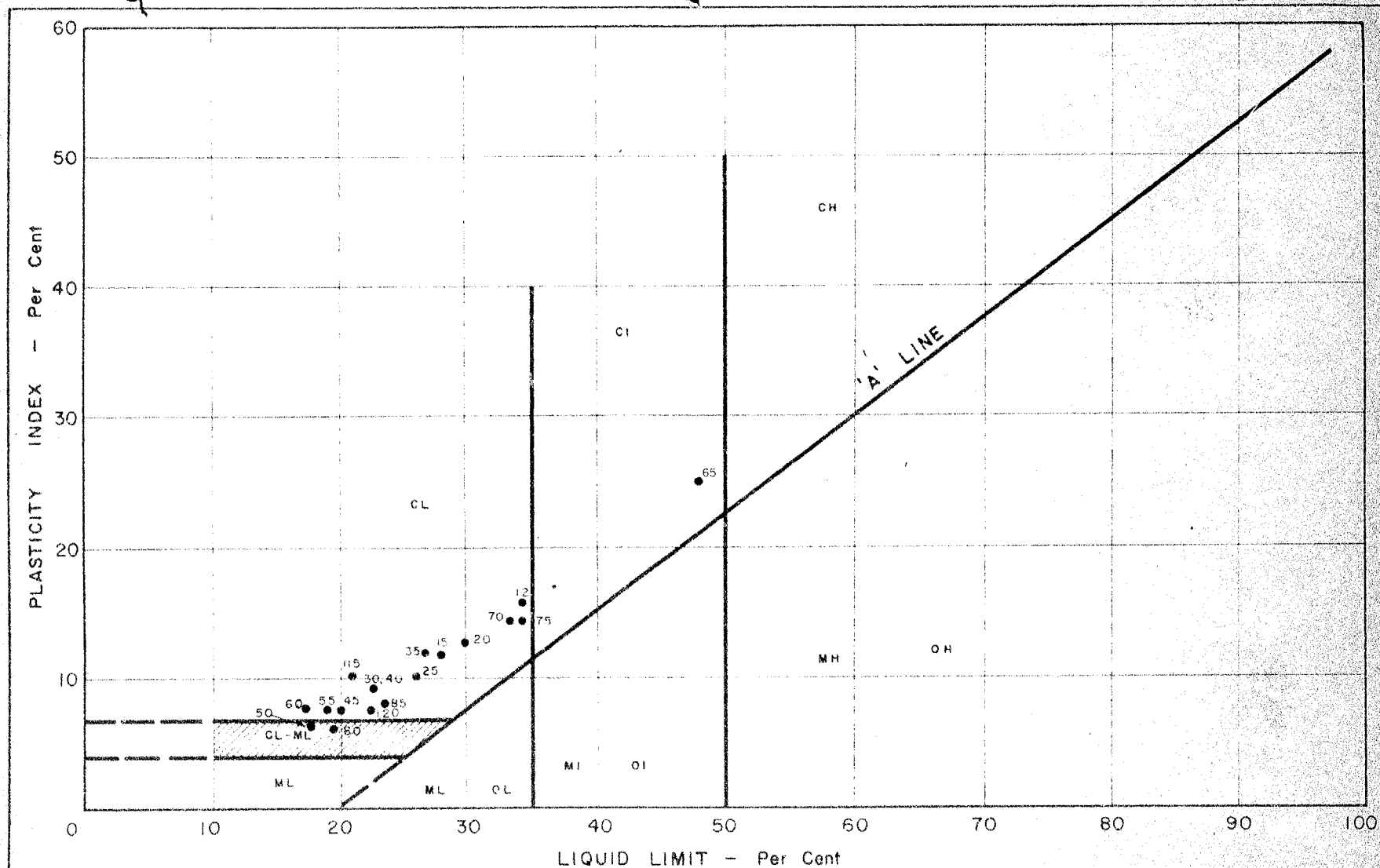
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

PLASTICITY CHART

Job No. 63-F-109

W.P. No. 113-63

Location HWY. 400 & JANE ST.



NOTES BH. N° II

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION
PLASTICITY CHART

Job No. 63-F-109 W.P. No. 113-63

Location HWY. N° 400 & JANE ST.

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Q _u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q _{cu}	CONSOLIDATED UNCDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta \sigma}$
C_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{C_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL