

G.I.-30 SEPT. 1976

GEOCRES No. 40J16-36DIST. 1 REGION W.P. No. 122-65-01CONT. No. 75-027W. O. No. STR. SITE No. HWY. No. 402LOCATION Modeland Road,
InterchangeNo. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

40J 16-8 WP 29-62 (F)

-27 WP 122-65-01 (F)

-36 WP 122-65-01 FILE

-40 WP 122-65-03 & 04
CONT 75-27

MEMORANDUM

40 J 101

GEOCRE No.

To: Mr. P. R. Davis,
Bridge Engineer,
Bridge Office,
Admin. Bldg.

FROM: Foundation Section,
Materials & Testing Office,
Room 107, Lab. Bldg

ATTENTION: Mr. S. McCombie

DATE: April 21, 1970

OUR FILE REF.

IN REPLY TO

MAY 4 1970

40J16-36

GEOCRE No.

SUBJECT:

Sheets

FOUNDATION INVESTIGATION REPORT

For

The Proposed Approaches
In the Vicinity of Modeland Road
Interchange -- C.A.H. #402
Twp. of Sarnia, Co. of Lambton
District No. 1 (Chatham, Ont.)
W.J. 69-F-119 -- W.P. 122-65-01

20, 21, 27, 29, 30

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

We believe that the factual data and recommendations contained therein, will prove adequate for your design requirements. Should additional information be required, please feel free to contact our Office.

AGS/WdeF
Attach.

A. G. Stermac
A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

cc: Messrs. B. R. Davis
H. A. Tregaskes
D. W. Farren
W. Zonnenberg
F. C. Brown
A. P. Watt (2)
J. Roy
B. A. Singh

Foundations Files
Gen. Files

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FOUNDATION INVESTIGATION REPORT
For
The Proposed Approaches
In the Vicinity of Modeland Road
Interchange -- C.A.H. #402
Twp. of Sarnia, Co. of Lambton
District No. 1 (Chatham, Ont.)
W.J. 69-F-119 -- W.P. 122-65-01

1. INTRODUCTION:

During the routine soils investigation in the vicinity of the proposed Modeland Road and C.A.H. #402 Interchange, deep deposits of organic material were discovered at locations where embankments were to be constructed. Following this discovery, a discussion was held between the Foundation Section and the Regional Materials Engineer, and it was decided that additional deep borings were needed to determine accurately the lateral and vertical extent of the organic deposit, and also the soil properties.

The additional borings were carried out jointly by the Foundation Section and the Regional Soil Section. Presented in this report, are the results of the field investigation, together with recommendations pertaining to the design of the proposed approach embankments.

2. DESCRIPTION OF THE SITE:

The site of the proposed approach embankments is situated in the Eastern outskirts of the City of Sarnia, approx. 0.4 miles North of the existing Hwy. #402.

The area investigated is flat and cultivated farmland.

Physiographically, the site is located in the region referred to as the Huron Fringe.

3. FIELD AND LABORATORY INVESTIGATION PROCEDURES:

A total of 21 sampled boreholes and 18 dynamic cone penetration tests were carried out by the Foundation Section during the course of the field work. Boring was achieved by means of continuous flight auger machines adapted for soil sampling purposes.

During the field work, 'disturbed' samples were obtained by means of a standard split-spoon sampler; the energy used in driving it, conformed to the requirements of the Standard Penetration Test.

'Undisturbed' samples were recovered using 2-inch I.D. Shelby tubes, which were pushed into the soil hydraulically, or by hand. Where possible, field vane tests were carried out at elevations 12 inches below sample depths.

Dynamic cone penetration tests were carried out adjacent to some boreholes and, also, at six other locations. Driving energy to advance the cone was 350 ft.-lbs. per blow. The boreholes were surveyed in the field by personnel from London Region Engineering Surveys Section. The locations and elevations of the borings (including those carried out by the Soils Section, where depth of organics exceeded 5 ft.), are shown on Drawing No. 69-F-119A, which accompanies this report.

All samples were visually examined and classified at the site as well as in the laboratory. Following this inspection, laboratory tests were carried out on selected samples to determine the following physical properties:

- Atterberg Limits (oven and air-dried)
- Moisture Content
- Grain-size Distribution
- Organic Content
- Undrained Shear Strength
- Bulk Density

The test results are summarized on the Record of Borehole sheets contained in the Appendix of this report.

4. SOIL TYPES AND SOIL CONDITIONS:

4.1) General:

An extensive deposit of organic soil was found to overlie the terrain traversed by the proposed Hwy. #402 between approximate Sta. 60+00 and Sta. 85+00 . A similar deposit was found to extend between Sta. 411+00 and Sta. 437+00 on Modeland Road.

The depth of organics varies greatly from a minimum of 5 ft. to a maximum of about 30 ft. At some locations the organic soil is overlain by up to 10 ft. of sand, and at other locations, sand layers of varying thickness are contained within the organic deposits.

Reference should be made to Drawing No. 69-F-119A, where the horizontal and vertical extent of the organic deposit is plotted. Borelogs for the 21 holes carried out by the Foundation Section are included in the Report Appendix.

4.2) Silty Sand to Sand:

This stratum was encountered in the following borcholes immediately below the topsoil: #100, #102, #105, #108, #110, #111 and #208. The depth was found to vary between 4 and 23 ft. The material in the deposit consists mainly of sand and silt with traces of clay. The natural moisture content ranges from 12% to 30%. Based on the Standard Penetration Test, the relative density may be described as very loose to compact.

4.3) Organic Silt and Clay:

This material was found to cover a large area in the vicinity of proposed Modeland Road Interchange. The lateral and vertical extent of the deposit is shown on the above mentioned drawing. In general, the thickness was found to vary between 5 and 30 ft.

The overall deposit is made up of layers of organic silt, organic clay, silty fine sand with decayed and undecayed

4. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

4.3) Organic Silt and Clay: (cont'd.) ...

organic substances and occasionally black-coloured, very soft peat. The thickness of the individual layers ranged from a few inches to 30 ft.

Although the consistency of the organic silts and clays is in general soft, a fairly wide scatter of results of undrained shear strength measurements was obtained, ranging from a low of about 200 p.s.f. to a high of about 900 p.s.f. For design purposes, however, it may be assumed that the upper 18 ft. of the deposit has an average shear strength of 400 p.s.f., whilst below this level, the average is about 700 p.s.f.

The natural moisture content is in general, in excess of 60%.

The physical properties of the overall deposit are plotted on the Record of Borehole sheets contained in the Appendix. It is pointed out, however, that the major portion of the organic material exhibits very low shear strength upon remoulding.

4.4) Groundwater Conditions:

The groundwater level was found to be at or slightly below the ground surface, during the field investigation.

5. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct approach embankments at the intersection of the proposed new Hwy. #402 and Modeland Road. The maximum height of the fill will be in the order of 26 ft. above the existing ground level.

The subsoil at the site was found to consist of irregular deposits of organic material and sand, up to 30 ft. in thickness. Groundwater level was at or slightly below the ground surface.

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

There are two main problems to be overcome on this project due to the presence of the organic soil. The first is stability of the embankments, and the second is the settlement which will occur under the embankments. The problem of embankment stability can be solved by excavating all or part of the organic soil and replacing this material with suitable granular fill. The problem of settlements can be minimized, if not completely solved, by surcharging those portions of the fill where the organic soil has not been completely excavated. Following, therefore, are our recommendations relating to the construction of the proposed Hwy. #402 and Modeland Rd.

(1) Excavate all organic soil and replace with suitable granular up to about 3 ft. above water level, and suitable earth fill above that level. If this treatment is carried out, there should be no stability or settlement problems.

(2) Excavate all organic soil where it occurs down to a depth of about 13 ft. and replace with fill material as in (1). At those areas where organic soil still remains in place, the fill should be surcharged with a minimum of 3 ft. of soil, and a maximum of about 6 ft. over the deepest remaining deposits. It will be necessary to observe, by means of settlement plates, the performance of the fill so that the appropriate duration of time of surcharging can be determined. It is believed that a period of time not less than 1 year will be required. If the foregoing treatment is carried out, it is believed that stability problems will be solved, and that settlement problems will be reduced to an acceptable level.

Figure No. 1, on the following page, shows the details of excavation and backfilling for Cases (1) and (2).

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

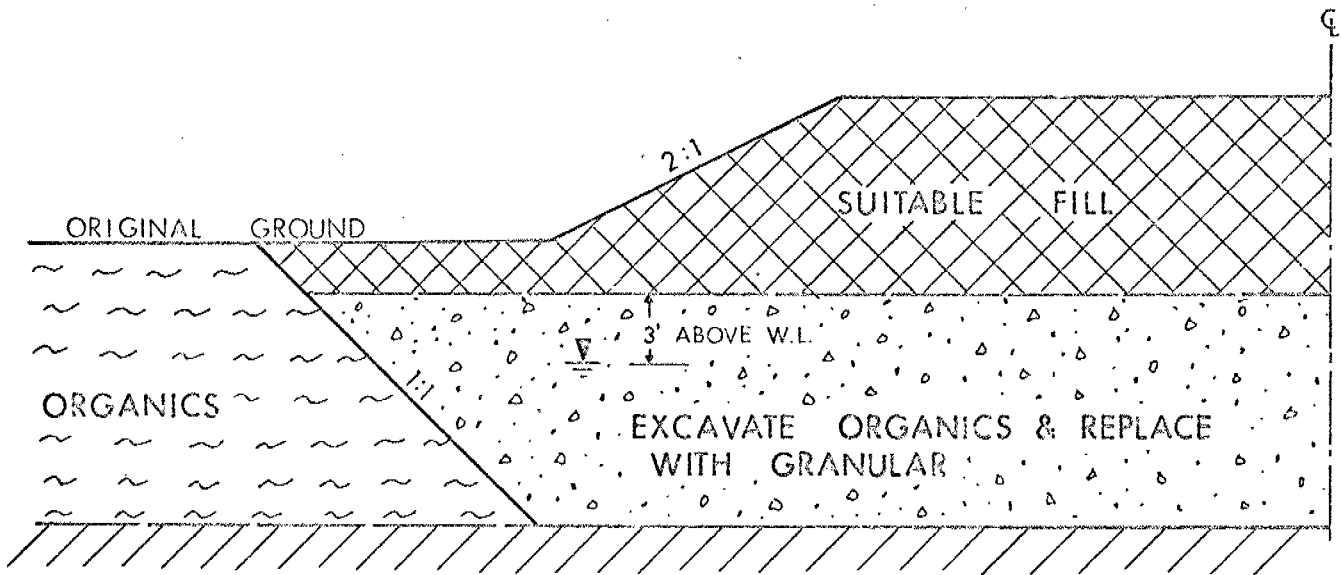


Fig. No. 1

Stability analyses carried out in terms of total stresses, indicate that the proposed highway embankments will be stable if the above described recommendations are carried out.

It may be advantageous to adjust the present line of Hwy. #402 to avoid the deeper organic deposits on the North side.

6. MISCELLANEOUS:

The field investigation was carried out during the period December 11 - 19, 1969, under the supervision of Messrs. P. Payer and A. Prakash, Project Foundation Engineers.

Equipment was owned and operated by Dominion Soil Investigation Limited, and G. Wimpey (Canada) Limited.

This report was written by Mr. P. Payer, and reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

April, 1970

APPENDIX I

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 100

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 66 + 00 150' Lt. Hwy. 402 ORIGINATED BY AP

W.P. 122-65-01 BORING DATE December 11, 1969 COMPILED BY PP

DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— W _L PLASTIC LIMIT ——— W _p WATER CONTENT ——— W			BULK DENSITY γ	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		W _p ——— W ——— W _L WATER CONTENT %						
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE	1000	2000	25			50	75
588.4	Ground Level												P.C.F.	GR. SA. CL.	
0.0	Silty sand to sand, some clay & organics.		1	SS	6										
			2	TW	PM										
578.4	Loose		3	SS	4	580									0 41 49 10
10.0	Organic silt, clay		4	TW	PM		q							98	
	Layers of peat and sand		5	SS	9			+ 2.1							
			6	TW	PM	570	q	+ 1.7							
	Soft to stiff		7	SS	5			+ 1.9						96	
			8	TW	PM			+ 1.9							
560.9			9	SS	3			+ 3.0							
27.5	End of Borehole				560										

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 101

FOUNDATION SECTION

JOB 69-F-119

W.P. 122-65-01

DATUM Geodetic

LOCATION Sta. 67 + 00 @ Hwy. 402

BORING DATE December 12, 1969

BOREHOLE TYPE Cont. Flight Auger

ORIGINATED BY AP

COMPILED BY PP

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — W _L PLASTIC LIMIT — W _P WATER CONTENT — W			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.			WATER CONTENT %				
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE		W _P — W — W _L				
588.6	Ground Level						1000	2000		25	50	75	P.C.F.	GR. SA. SI. CL.
0.0	Topsoil	~												
	Silty sand, traces of clay & organics	~	1	SS	5					○				
580.6	Loose	~	2	SS	4					○				0 82 16 2
8.0	Organic silt, clay	~	3	SS	3	580	+2.1							
	Layers of sand	~	4	TW	PM		+2.1				—	○		
		~	5	SS	4		+1.9							
		~				570								
	Soft to stiff	~	6	TW	PM		○	+1.9				— ○ —	93	
		~	7	SS	7						—	○		
560.1		~												
28.5	Clayey silt	~				560		+1.8						
557.1	Stiff	~	8	SS	12									
31.5	End of Borehole	~												
						550								

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 102

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 68 + 00 @ Hwy. 402

ORIGINATED BY PP

W.P. 122-65-01

BORING DATE December 15, 1969

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY *SL*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT _____ w_L PLASTIC LIMIT _____ w_P WATER CONTENT _____ w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %				
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE	w_p	w	w_L		
						1000	2000	25	50	75			
589.0	Ground Level												
0.0	Silty fine sand with some clay		1	SS	4	580	+ 2.7					0 48 42 10	
580.5	Loose		2	SS	4								
8.5	Organic silt, clay		3	SS	4								
	Layers of peat and sand		4	TW	PH	570							
			5	SS	5								
			6	TW	PM								
	Soft to firm					560							
564.5	Clayey silt - hard		7	SS	39								
24.5	End of Borehole					560							

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 103

FOUNDATION SECTION

JOB	69-F-119	LOCATION	Sta. 68 + 00 150' Lt. Hwy. 402	ORIGINATED BY	AP
W.P.	122-65-01	BORING DATE	December 12, 1969	COMPILED BY	PP
DATUM	Geodetic	BOREHOLE TYPE	Cont. Flight Auger	CHECKED BY	

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P S F.		WATER CONTENT %				
							ϕ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE	25	50	75		
						1000	2000						
588.4	Ground Level												
0.0	Organic silt, clay,		1	SS	5								
			2	SS	4								
	Layers of peat and sand		3	TW	PM	580	ϕ + 6.0						90
			4	SS	4								
			5	TW	PM	570	ϕ + 5.0						114
	Soft to firm		6	SS	5								
			7	TW	PM	560	+ 5.0						
556.9	Sand & gravel. V. dense		8	SS	61								
31.5	End of Borehole												
						550							

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 104

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 69 + 00 150' Lt. Hwy. 402 ORIGINATED BY PP
 W.P. 122-65-01 BORING DATE December 15, 1969 COMPILED BY PP
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger CHECKED BY /

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH PS F.		WATER CONTENT %					
							\circ UNCONFINED \bullet QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE	w_p ——— w ——— w_L	25	50			75
588.4	Ground Level						1000	2000						
0.0	Organic silt		1	SS	2	580								
	Layers of silty sand		2	SS	2									
			3	SS	2									
			4	SS	2									
			5	SS	2									
	Very soft to firm					570								
			6	TW	PH									
						560								
			7	TW	PH									
556.9	clayey silt hard		8	SS	31	550								
31.5	End of Borehole													

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 105

FOUNDATION SECTION

JOB	69-F-119	LOCATION	Sta. 70 + 00 150' Lt. Hwy. 402	ORIGINATED BY	PP
W.P.	122-65-01	BORING DATE	December 15, 1969	COMPILED BY	PP
DATUM	Geodetic	BOREHOLE TYPE	Cont. Flight Auger	CHECKED BY	

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %				
							1000	2000	25	50	75		
589.0	Ground Level												
0.0	Sandy silt with traces of clay.												
585.0			1	SS	5								
4.0	Organic silt, clay		2	SS	4								
	Layers of sand		3	SS	2	580							
			4	SS	2								
			5	SS	2								
	Soft		6	TW	PH	570	+ s3.0						
			7	TW	PH		+ s3.3						
560.5			8	SS	16	560	p s2.7						
28.5	Sand & gravel												
557.5	Dense												
31.5	End of Borehole					550							

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 107

FOUNDATION SECTION

JOB 69-F-119

LOCATION Sta. 81+00 100' Lt. Hwy. 402

ORIGINATED BY PP

W.P. 122-65-01



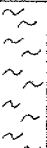






BORING DATE December 16, 1969

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

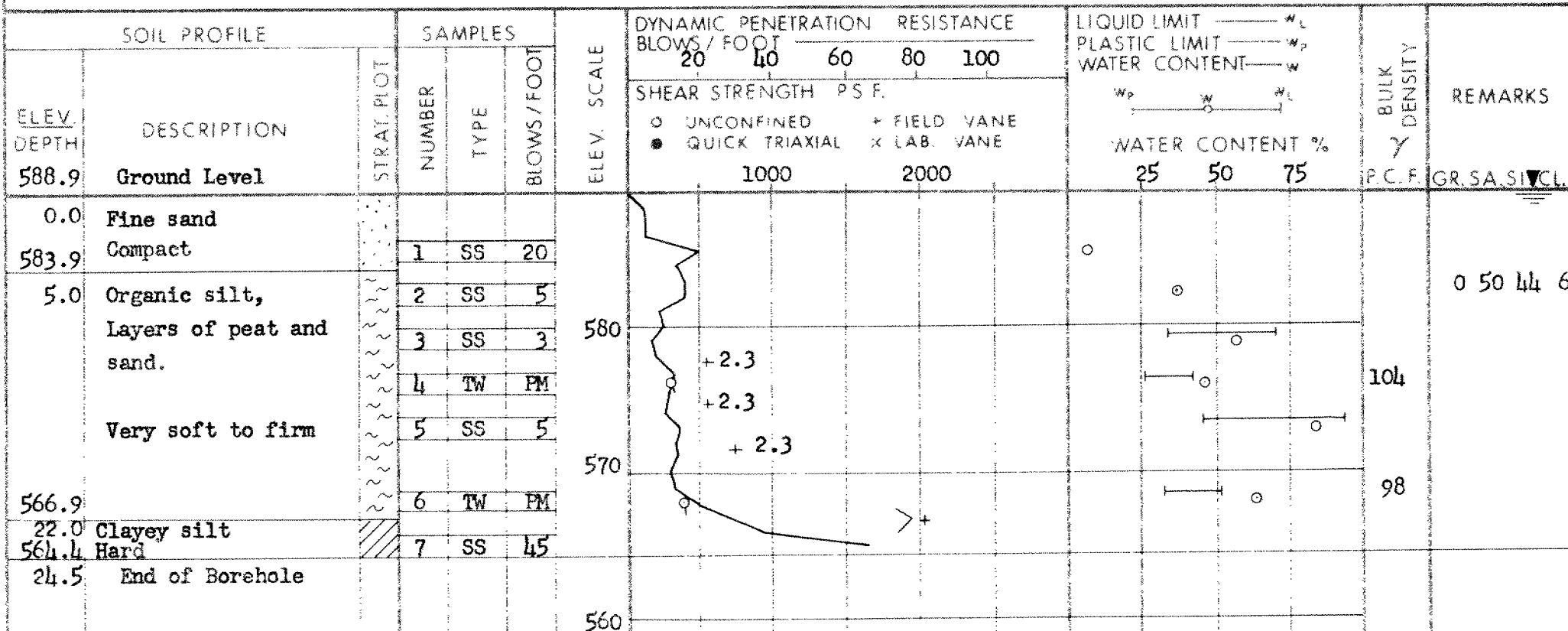
SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L WATER CONTENT % 25 50 75			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE							
588.4	Ground Level													
0.0	Clayey silt with some sand.					580								587.0 ▼
583.4	Stiff		1	SS	15									
5.0	Silty sand with some clay.		2	SS	20									
579.9	Compact													
8.5	Organic silt, clay		3	SS	2									
	Layers of sand		4	SS	3	570								
			5	SS	4									
														
	Soft		6	TW	PH	560								
			7	SS	3									
560.4	Clayey silt with some sand & trace of gravel													
28.0	Very stiff		8	SS	28									
556.9														
31.5	End of Borehole					550								

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 108

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 81 + 00 100' Rt. Hwy. 402 ORIGINATED BY PP
W.P. 122-65-01 BORING DATE December 16, 1969 COMPILED BY PP
DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger CHECKED BY



DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 109

FOUNDATION SECTION

JOB	69-F-119	LOCATION	Sta. 82 + 00 100' Lt. Hwy. 402	ORIGINATED BY	PP
W.P.	122-65-01	BORING DATE	December 16, 1969	COMPILED BY	PP
DATUM	Geodetic	BOREHOLE TYPE	Cont. Flight Auger	CHECKED BY	

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH PS F. 1000 2000	WATER CONTENT % 25 50 75					
588.4 0.0	Ground Level												
	Organic silt		1	SS	10	580							
	Layers of peat and sand		2	SS	2								0 45 50 5
	Traces of clay		3	SS	2								
	Soft to stiff		4	SS	2								
			5	SS	2								
			6	TW	PM	570							
565.4 23.0	Sand with layers												
561.9	of clayey silt		7	SS	20							130 0 46 44 10	
26.5	End of Borehole					560							

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 110

FOUNDATION SECTION

JOB 69-F-119

LOCATION Sta. 82 + 00 100' Rt. Hwy. 402

ORIGINATED BY PP

W.P. 122-65-01

BORING DATE December 16, 1969

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT % 25 50 75
							20	40	60	80	100	○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB. VANE				
588.9	Ground Level						1000		2000								
0.0	Silty sand to sand		1	SS	16												
			2	SS	9												
			3	SS	6												
	Loose to compact		4	TW	PM												
			5	SS	6												
			6	TW	PM												
565.9																	
23.0	Organic silt, clay, Layers of sand		7	SS	5												
558.9	Firm																
557.4	Clayey silt		8	SS	26												
31.5	End of Borehole																

0 84 (16)

FOUNDATION SECTION

ORIGINATED BY PP

COMPILED BY PP

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION		RESISTANCE		LIQUID LIMIT		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	BLOWS / FOOT	PS.F.	PS.F.	W _p	W _L			
588.1	Ground Level					20	40	60	80	100	W _p	W	
						SHEAR STRENGTH				WATER CONTENT %			
						1000		2000		25 50 75			
						○ UNCONFINED		+ FIELD VANE					
						● QUICK TRIAXIAL		x LAB. VANE					
0.0	Fine Sand												
583.1	Loose		1	SS	7								
5.0	Organic silt, clay		2	SS	2								
	Layers of peat and sand		3	SS	3								
	Very soft to soft		4	SS	2								
			5	SS	3								
568.6	Clayey silt with some sand		6	TW	PM								
565.1	End of Borehole												
23.0													

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 113

FOUNDATION SECTION

JOB 69-F-119

LOCATION Sta. 84 + 00 100' Rt. Hwy. 402

ORIGINATED BY PP

W.P. 122-65-01

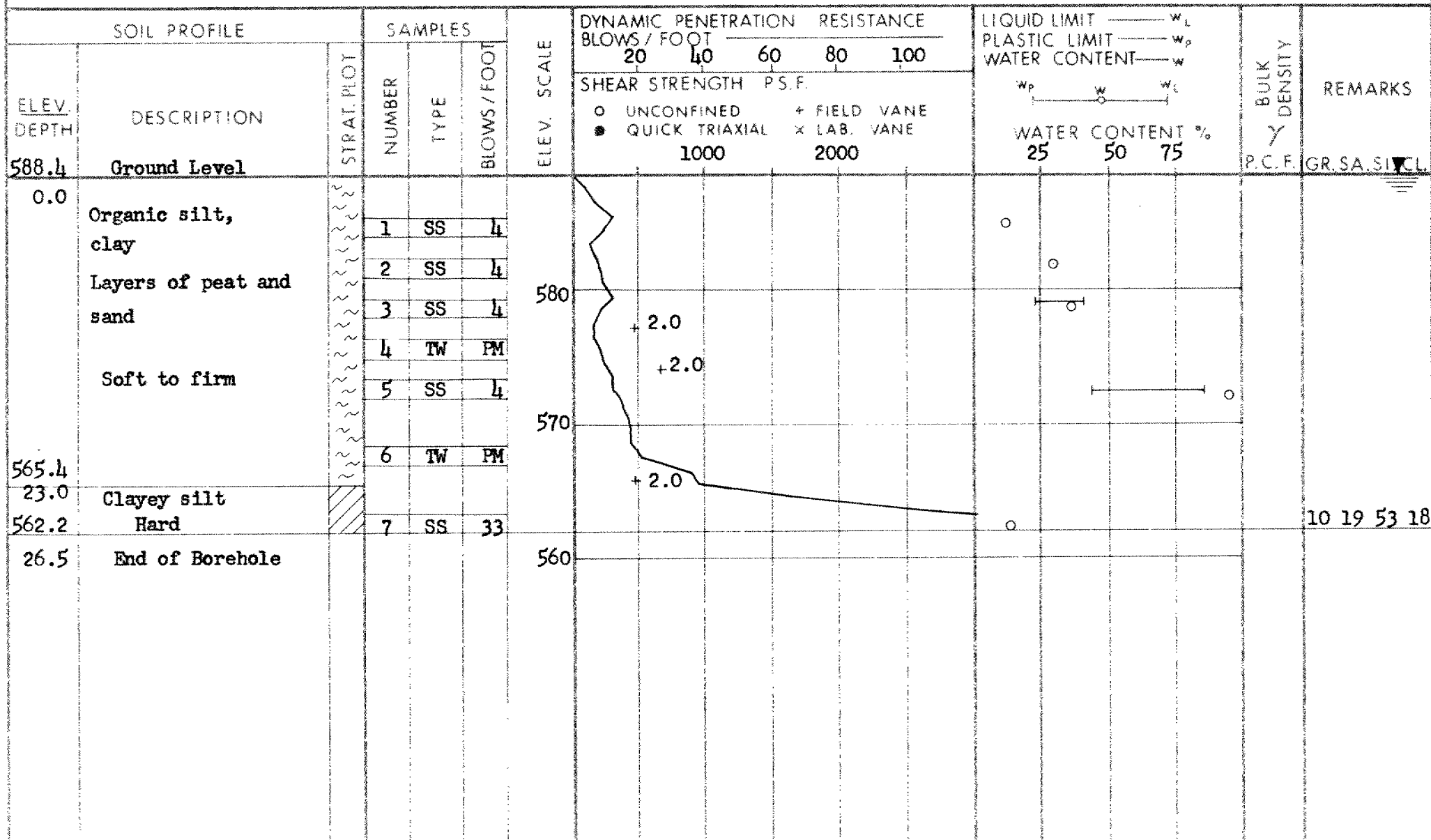
BORING DATE December 17, 1969

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY




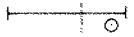
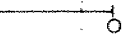
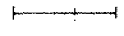
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FOUNDATION SECTION

ORIGINATED BY AP

COMPILED BY PP

CHECKED BY

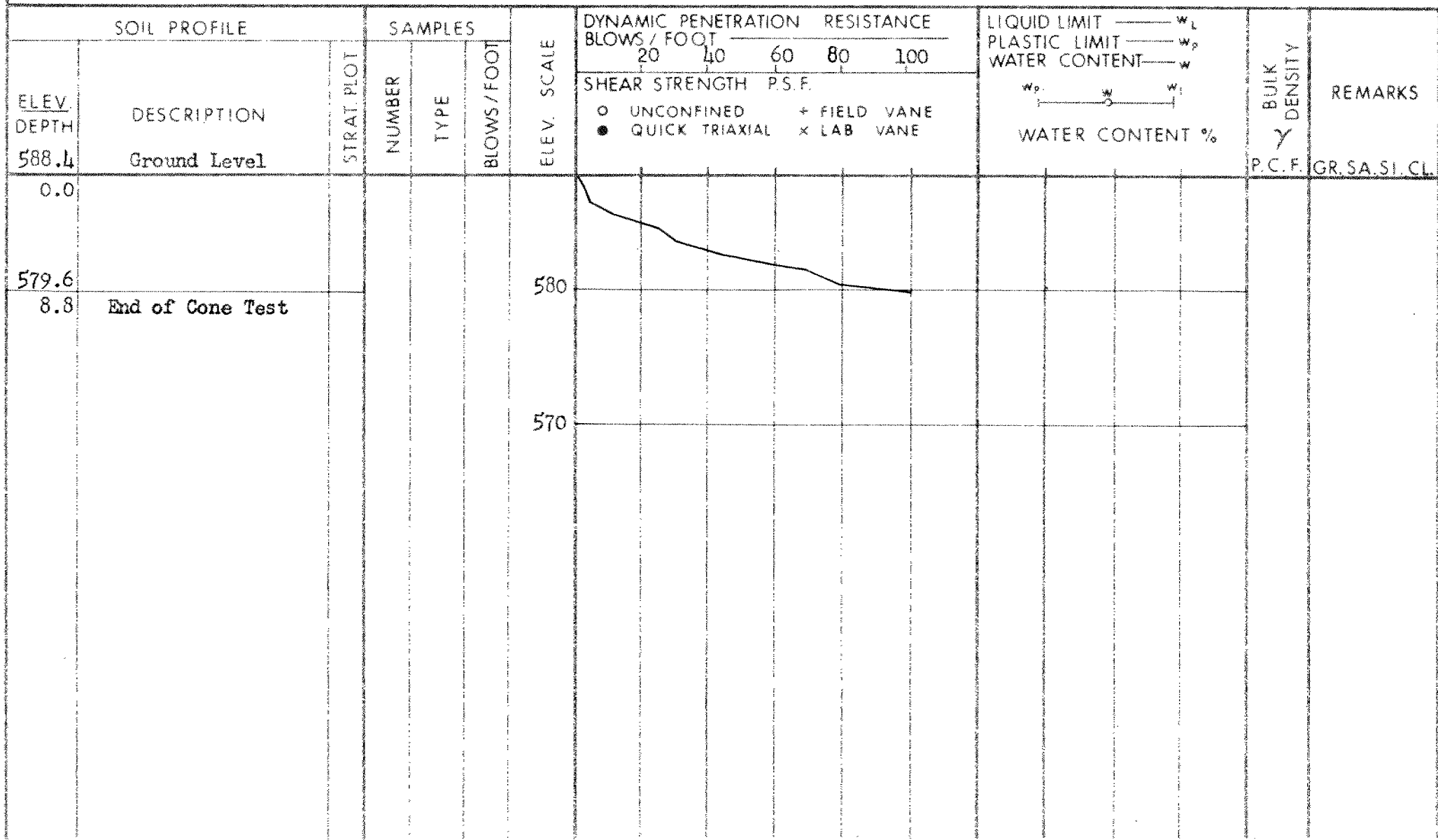
SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. MOT.	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.		WATER CONTENT %					
								\circ UNCONFINED \bullet QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE					
								1000	2000	25	50	75		
588.4 0.0	Ground Level													
	Organic silt, clay		1	TW	PM			\circ + 4.7					99	584.4 ∇
	Layers of peat and sand.		2	SS	8			+ 4.0						
			3	TW	PM	580		\circ + 6.0			\circ		122	
			4	SS	4			+			\circ			0 23 67 10
			5	TW	PM			\circ +			\circ		118	
			6	SS	2	570		+		+ 2.8				
			7	TW	PM			\circ + 5.0					99	
			8	SS	9			+ 2.3					\circ	
560.4 28.0	Very soft to stiff End of Borehole			9	TW	PM	560	\circ			\circ		132	0 60 29 11
						550								

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 115

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 79 + 00 @ Hwy. 402 ORIGINATED BY PP
 W.P. 122-65-01 BORING DATE December 17, 1969 COMPILED BY PP
 DATUM Geodetic BOREHOLE TYPE Cone Test Only CHECKED BY PP



FOUNDATION SECTION

CHECKED BY *[Signature]*

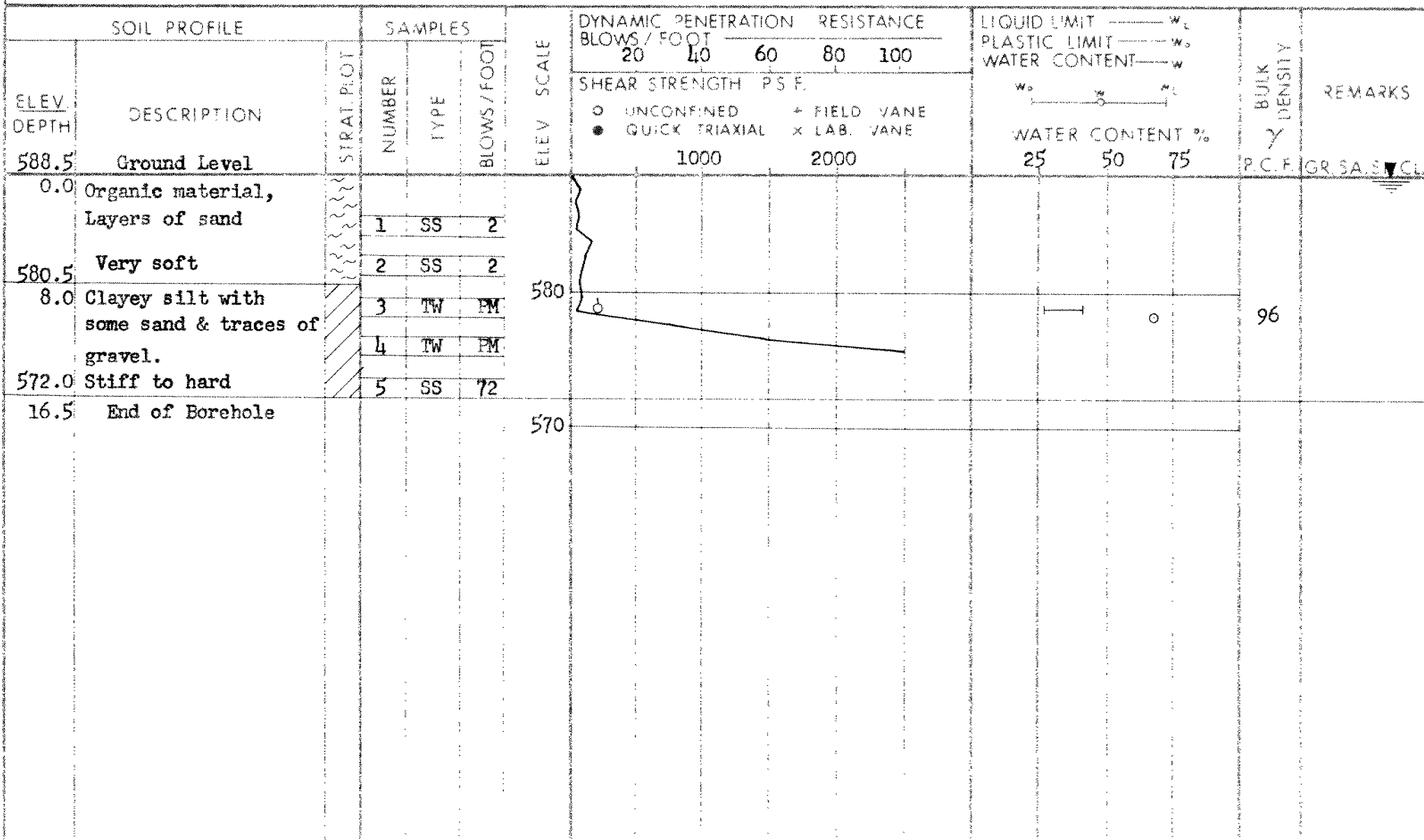
[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 200

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 416 + 60 125' Lt. Modeland Rd. ORIGINATED BY PP
 W.P. 122-65-01 BORING DATE December 17, 1969 COMPILED BY PP
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger CHECKED BY PP



DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 201

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 418 + 55 125' Lt. Modeland Rd.

ORIGINATED BY PP

W.P. 122-65-01

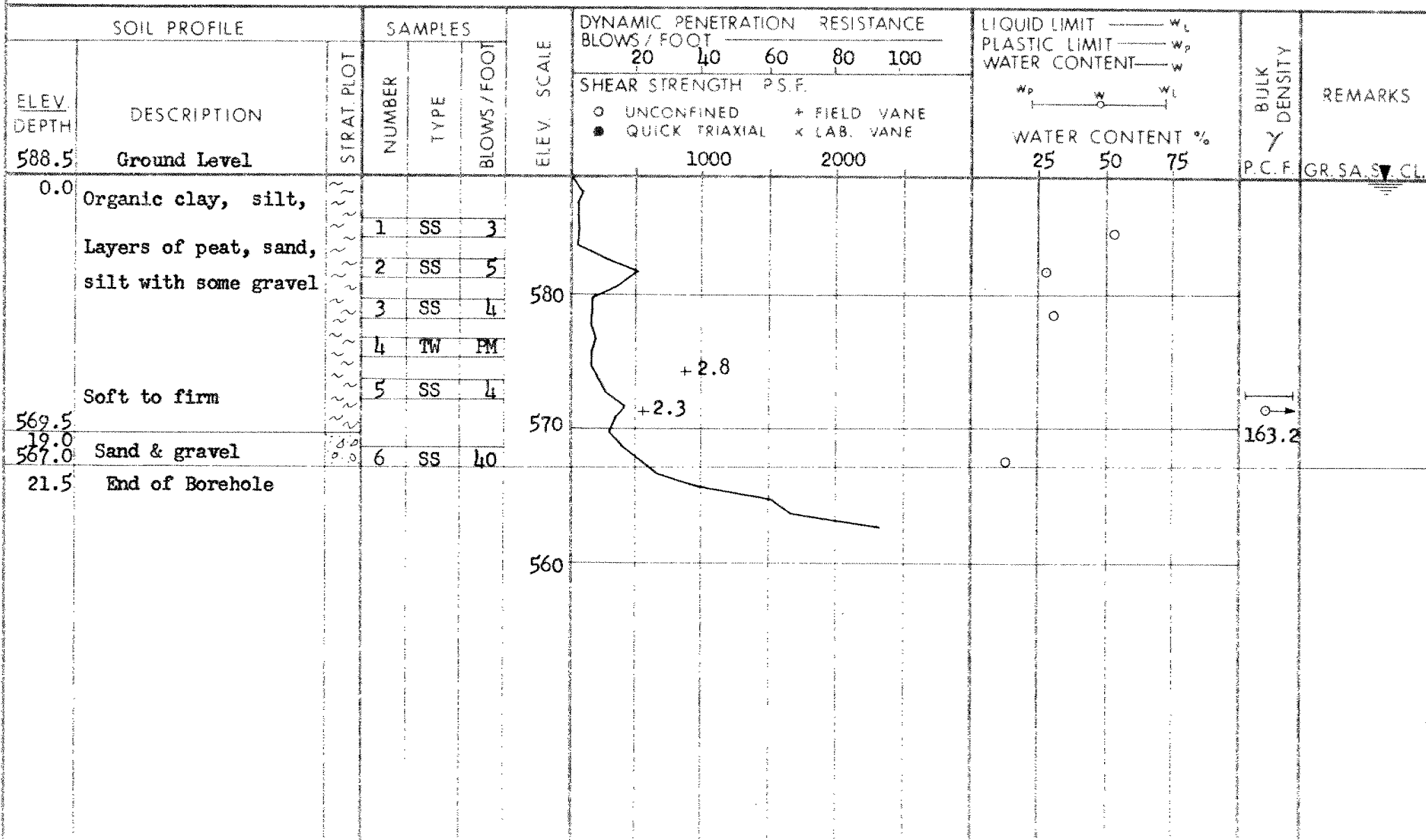
BORING DATE December 17, 1969

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

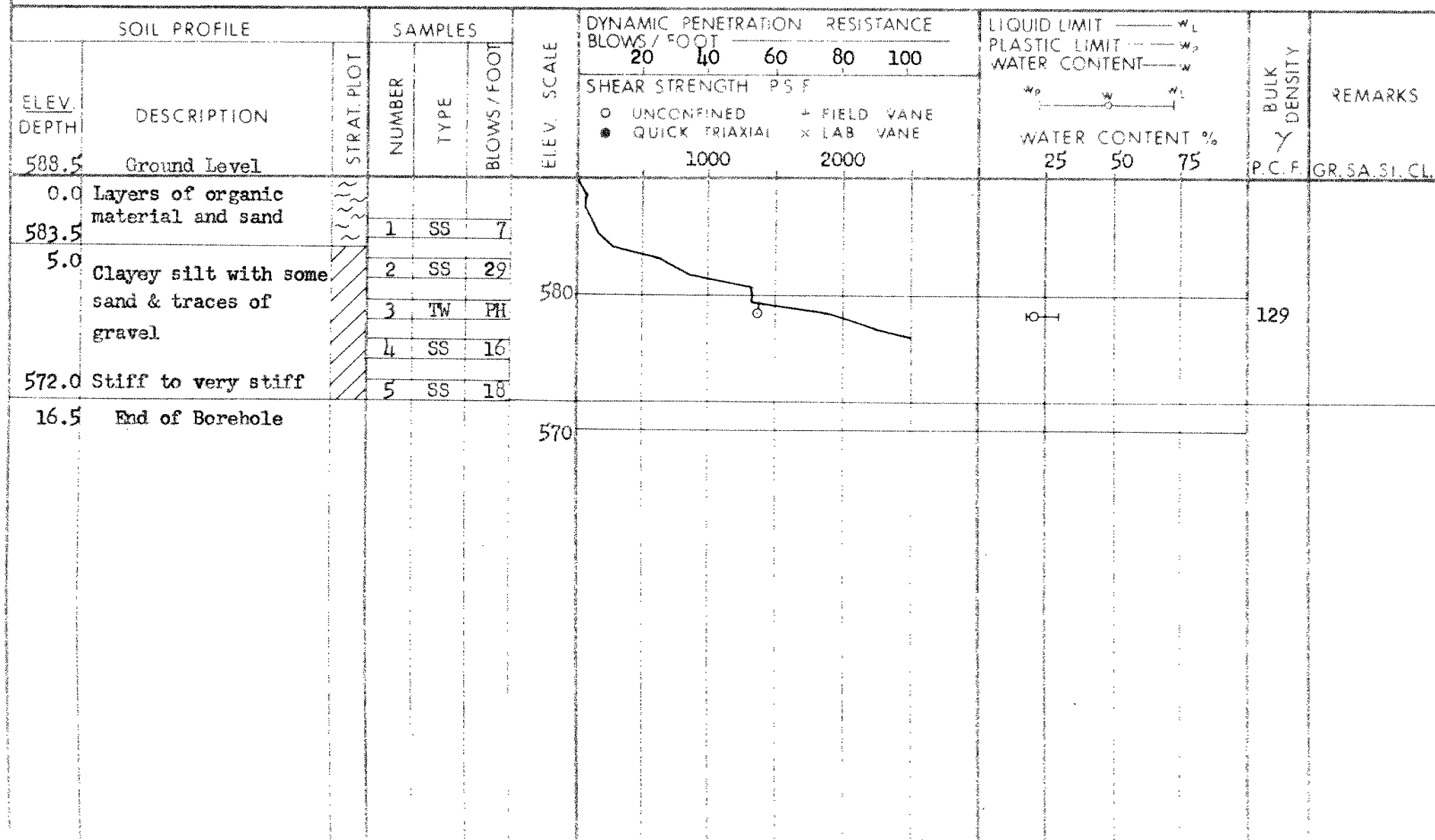


DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 202

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 59 + 00 200' Lt. Hwy. 402 ORIGINATED BY PP
 W.P. 122-65-C1 BORING DATE Dec. 18, 1969 COMPILED BY PP
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger CHECKED BY PP



DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 203

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 418 + 55 310' Lt. Modeland Rd.

ORIGINATED BY PP

W.P. 122-65-01 BORING DATE December 18, 1969

COMPILED BY PP

DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE		STRAT. PLOT	SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — W_L PLASTIC LIMIT — W_p WATER CONTENT — W			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE		20	40	60	80	100	WATER CONTENT % W_p — W — W_L				
588.5	Ground Level					SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE 1000 2000									
0.0	Layers of organics & sand														
584.5															
4.0	Clayey silt with some sand & traces of gravel.		1	SS	9										
			2	SS	30										
578.0	Hard		3	SS	31										
10.5	End of Borehole														

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No.204

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 57 + 00 200' Lt. Hwy. 402 ORIGINATED BY PP
 W.P. 122-65-01 BORING DATE December 18, 1969 COMPILED BY PP
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger CHECKED BY PP

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W	BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	RESISTANCE			
588.5	Ground Level									
0.0	Probably organics									
584.5	Probably clayey silt									
4.0										
579.0		1	SS	35	580					
9.5	End of Borehole									
					570					

SHEAR STRENGTH P.S.F.
 ○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL X LAB VANE

WATER CONTENT %
 W_P — W — W_L

P.C.F. GR. SA. SI. CL.

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 205

FOUNDATION SECTION

JOB 69-F-119

LOCATION Sta. 418 + 55 520' Lt. Modeland Rd.

ORIGINATED BY PP

W.P. 122-65-01

BORING DATE December 18, 1969

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cone Test Only

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w		BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_p — w — w_L WATER CONTENT %		
588.5	Ground Level													
0.0	Probably organic material and clayey silt													
578.5						580								
10.0	End of Cone Test					570								

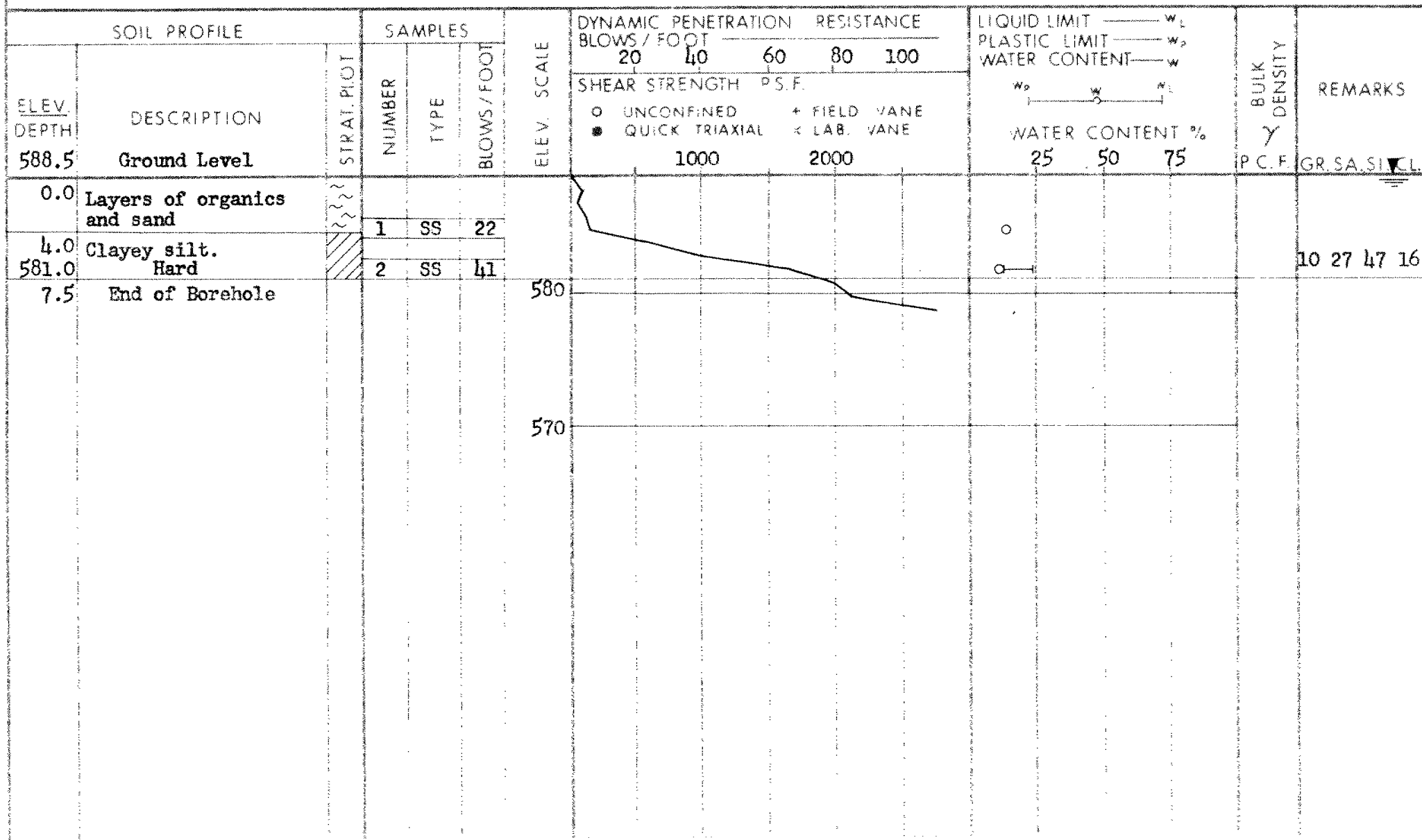
SHEAR STRENGTH P.S.F.
 ○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL x LAB. VANE

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 206

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 423 + 00 115' Lt. Modeland Rd. ORIGINATED BY PP
 W.P. 122-65-01 BORING DATE December 18, 1969 COMPILED BY PP
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger CHECKED BY _____



DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 207

FOUNDATION SECTION

JOB 69-F-119

LOCATION Sta. 425 + 80 75' Lt. Modeland Rd.

ORIGINATED BY PP

W.P. 122-65-01

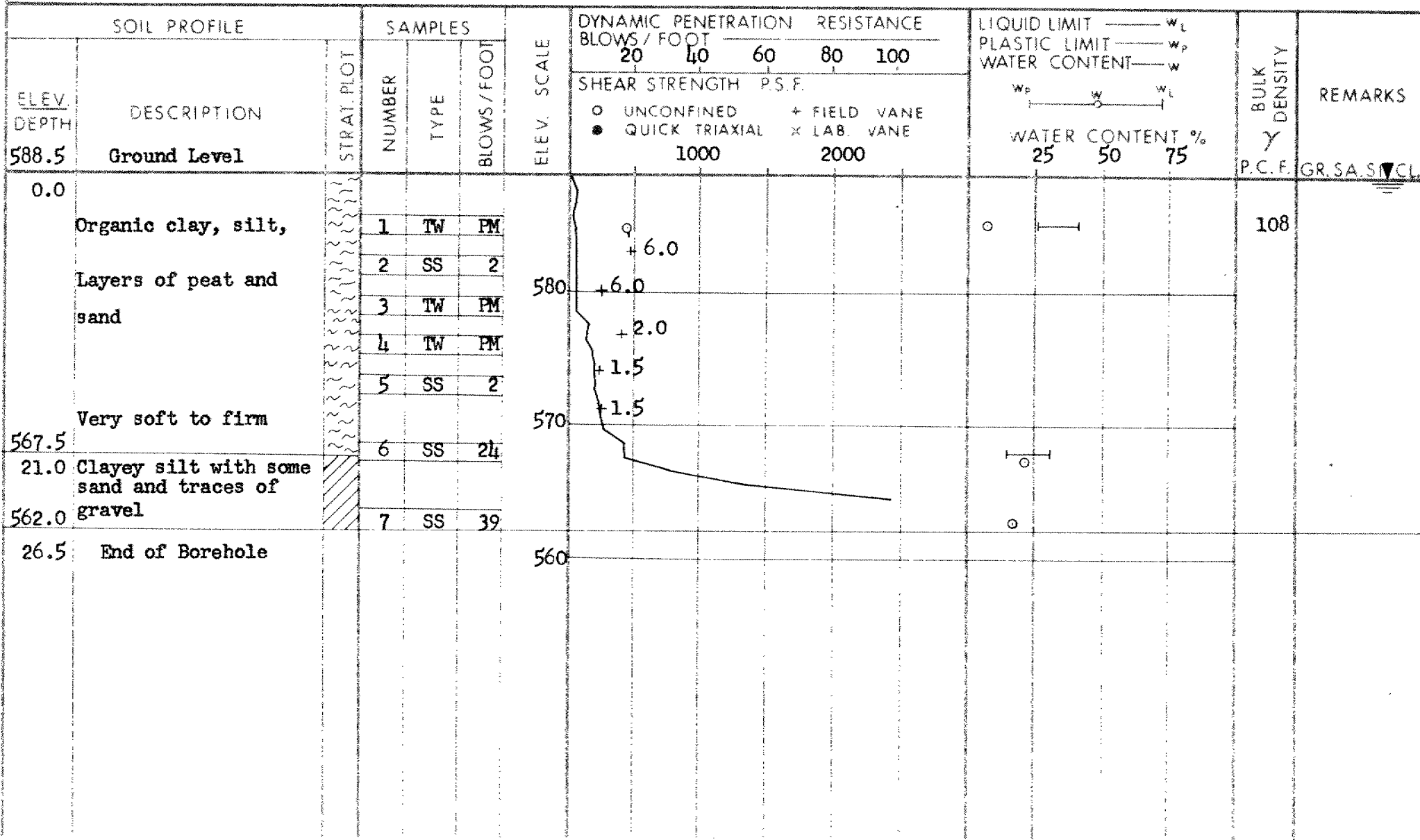
BORING DATE December 18, 1969

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY



DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 208

FOUNDATION SECTION

JOB 69-F-119

LOCATION Sta. 427 + 80 75' Lt. Modeland Rd.

ORIGINATED BY PP

W.P. 122-65-01

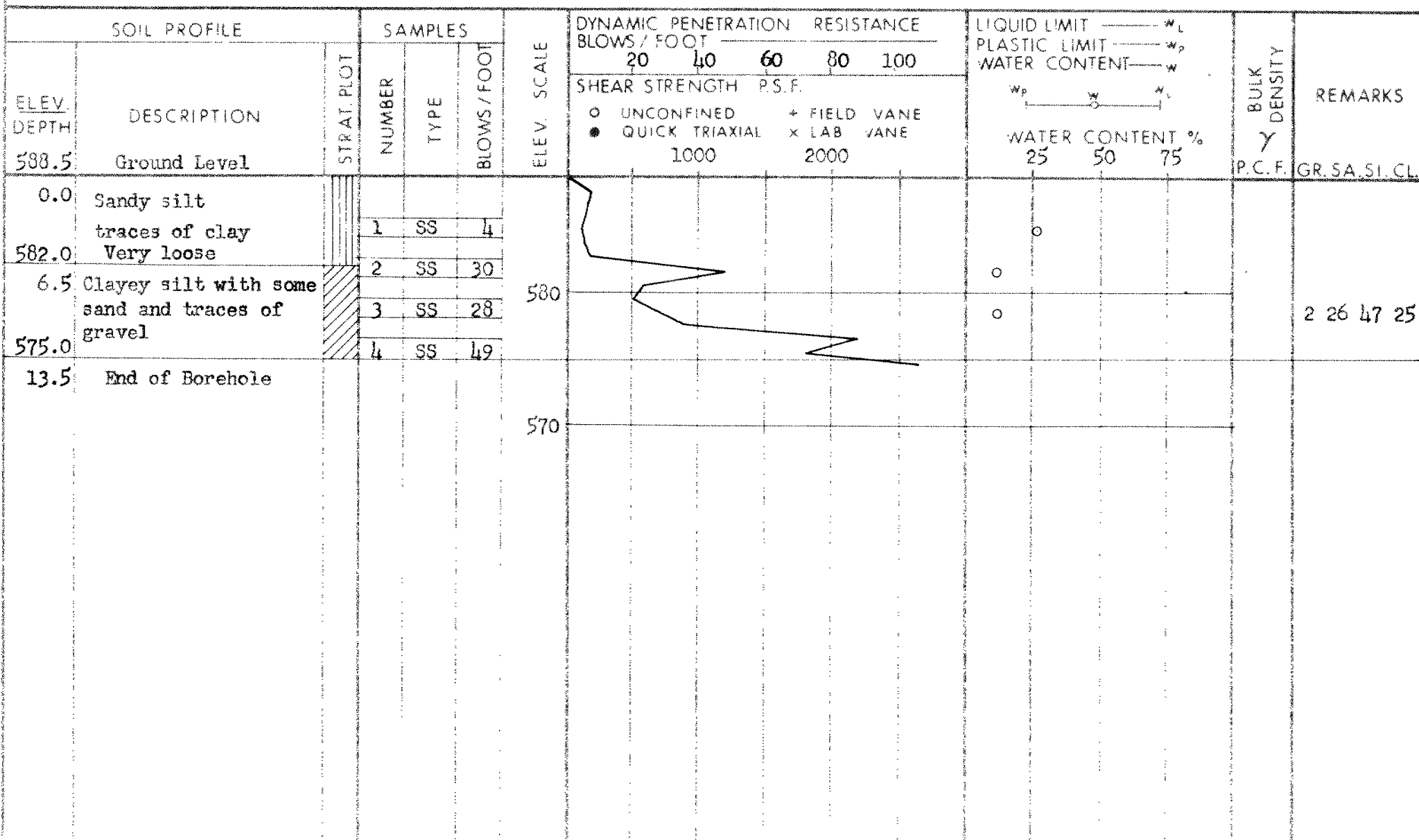
BORING DATE December 13, 1969

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY



FOUNDATION SECTION

ORIGINATED BY PP

COMPILED BY PP

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 210

FOUNDATION SECTION

JOB 69-F-119 LOCATION Sta. 427 + 80 175' Lt. Modeland Rd. ORIGINATED BY PP
 W.P. 122-65-01 BORING DATE December 19, 1969 COMPILED BY PP
 DATUM Geodetic BOREHOLE TYPE Cone Test only CHECKED BY PP

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w		BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	20	40	60	80	100		
588.5	Ground Level												
0.0	Probably organic material												
	layers of sand and clayey silt												
576.5													
12.0	End of Cone Test												

SHEAR STRENGTH P.S.F.
 ○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL x LAB VANE

WATER CONTENT %
 w_0 — w — w_L

P.C.F. GR. SA. SI. CL.

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 211

FOUNDATION SECTION

JOB 69-F-119

LOCATION Sta. 423 + 00 175' Lt. Modeland Rd.

ORIGINATED BY PP

W.P. 122-65-01

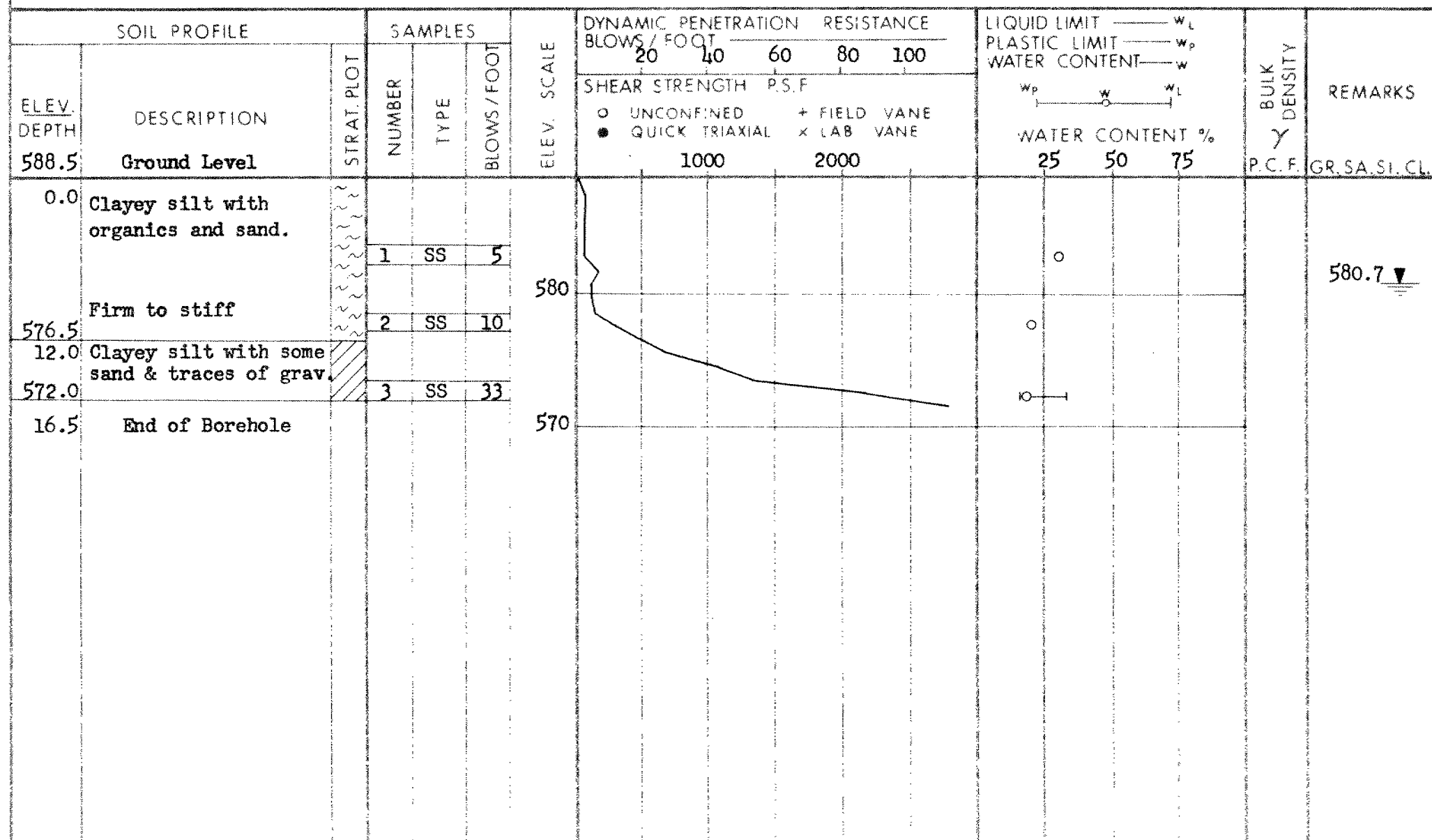
BORING DATE December 19, 1969

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY



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_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ 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

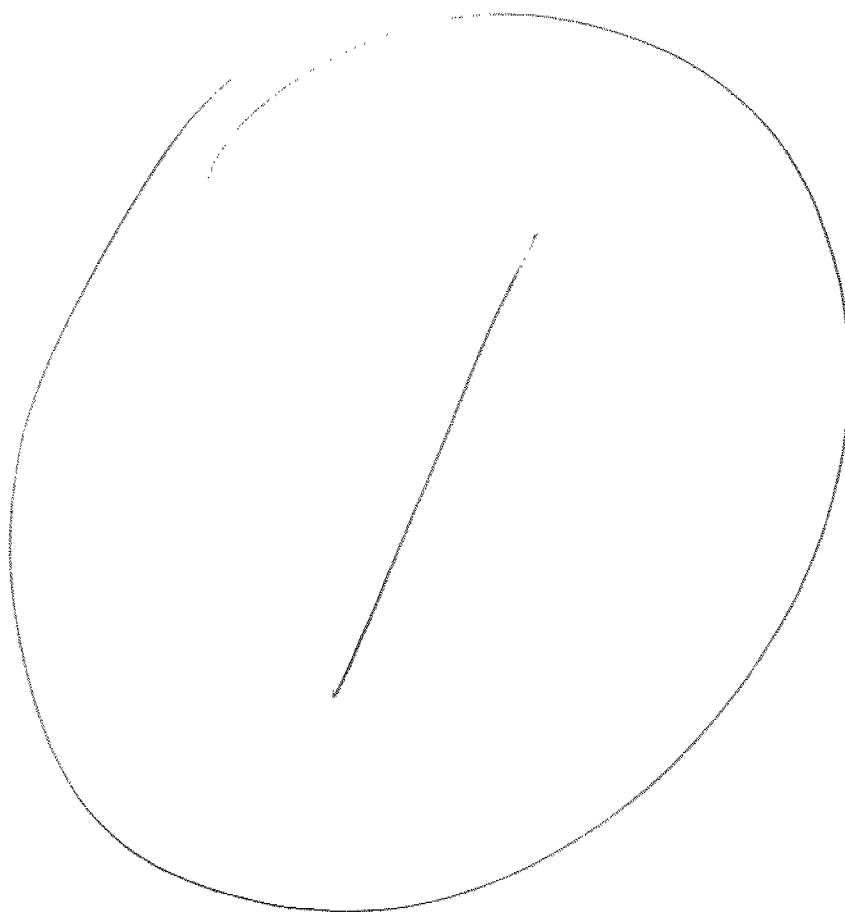
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

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

35MM

DRAWING



35MM

DRAWING

