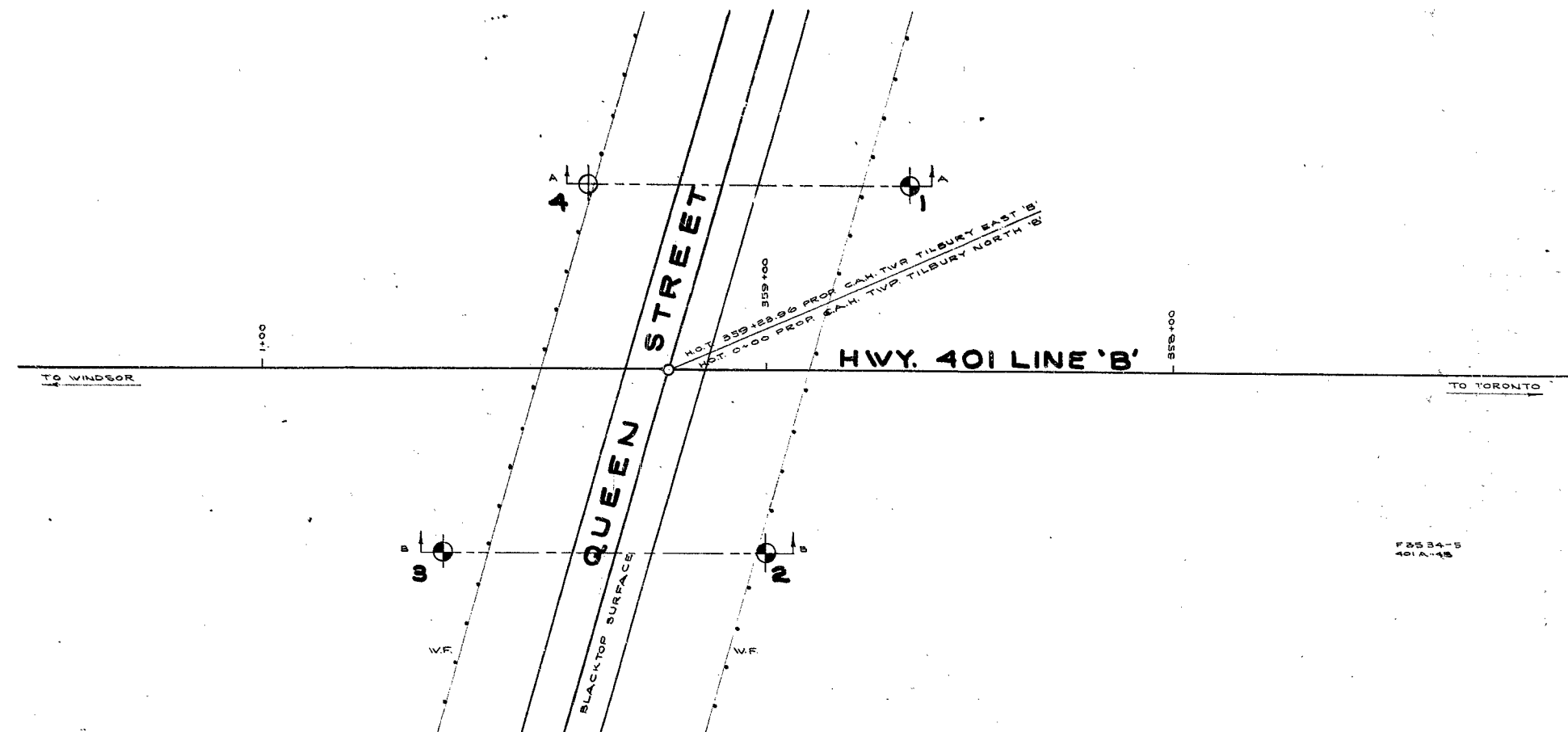
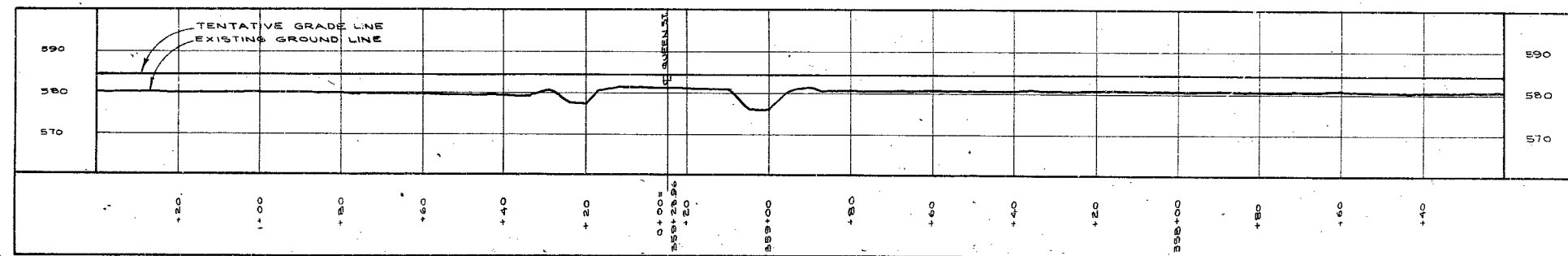


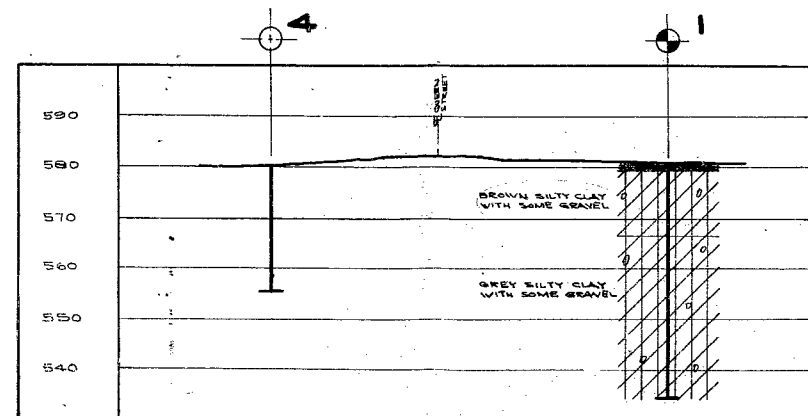
59-F-2
W.P.# 161-58
Hwy. # 401 E
QUEEN ST.
CROSSING AT
TILBURY



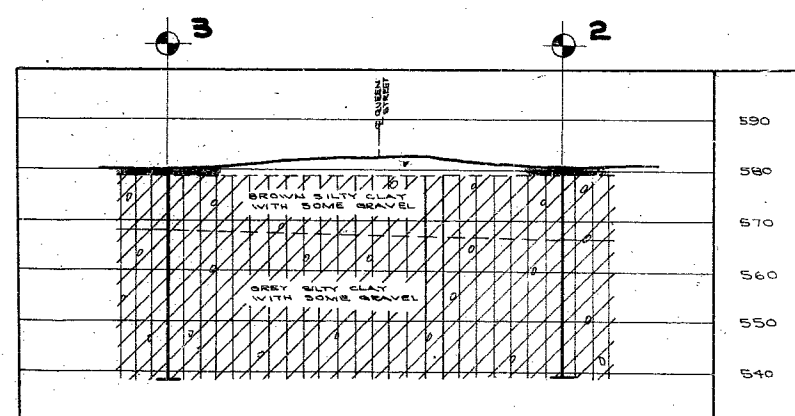
PLAN



PROFILE



A-A



B-B

LEGEND

- BORE HOLE
- PENETRATION HOLE
- BORE & PENETRATION HOLE

HOLE NO.	ELEVATION	STATION	DISTANCE FROM E.
1	580.5'	358+65	45' RT.
2	580.5'	359+00	45' LT.
3	580.0'	00+55	45' LT.
4	580.0'	00+20	45' RT.

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.

DEPARTMENT OF HIGHWAYS-ONTARIO
MATERIALS & RESEARCH SECTION

QUEEN STREET PROPOSED CROSSING

SHOWING POSITIONS & ELEVATIONS OF HOLES

HWY 401 DISTRICT 1 COUNTY ESSEX & KENT
TOWNSHIP TILBURY EAST & NORTH LOT 22 CON. 4
LOCATION AT TILBURY
DRAWN BY: T. MELLORES CHECKED BY: W.P. 161-59
DATE: MARCH 12/59 APPROVED BY: DRAWING NO.
SCALE: 1"=20' F 59-2A



ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, Date June 22, 1959.
Bridge Engineer. Subject Re: FOUNDATION REPORT -
 From Materials & Research Section. W.P. 161-58 - W.J. F-59-2.
 Attention: Mr. S. McCombie.

Hwy. 401 Line 'B' & Queen Street Crossing,
 at Tilbury,
 Lot 22, Con. IV, Twp. of Tilbury E. & N.

Enclosed herewith is our report on the subsoil conditions existing at the above noted site. The field work consisted of three sampled borings carried out to a maximum depth of 77 feet. The subsoil stratigraphy consists of a deep deposit of lacustrine, silty clay containing a minor percentage of fine to medium gravel. The upper 25 feet of this deposit was found to be in a stiff, preconsolidated state. The lower zone of the deposit was found to be normally consolidated. The stiff consistency of the upper layer is the result of desiccation and oxidation.

For your convenience, the principal recommendations outlined in this report, are summarized as follows:-

- (1) Spread footing support can be obtained at a shallow depth at this site. A safe permissible bearing capacity of 2 1/2 tons/sq. ft. can be applied at or below elevation 574' (i.e., six feet below ground surface).
- (2) Settlement resulting from the consolidation of the subsoil due to footing and embankment loads at the abutment location, has been estimated as six inches. Movement of the order of three inches can be expected within the first fifty years. If a single-span structure is to be used, differential movement should not exceed one inch.

cont'd. /2 ...

Recommendations: (cont'd.) ...

- (3) If a multi-span structure is decided upon, the general layout should be reviewed by the Foundation Section to determine the magnitude of differential settlement expected between abutment and adjacent piers.
- (4) The subsoil has sufficient strength to safely support the proposed embankment loadings.
- (5) Ground water conditions are such that no problems need be anticipated with respect to excavations for footings. No artesian conditions were noted in any of the borings.

If any questions arise with respect to the contents of this report, please contact our office.

LGS/MdeF
Encl.

L. G. Soderman,
PRINCIPAL FOUNDATIONS & SOILS ENGINEER.

cc: Messrs. A. M. Towe
H. A. Tregaskes
D. G. Ramsay
H. Orlando
G. U. Howell
J. Roy
Dr. P. Karrow
Foundation Section.
Gen. Files.

FOUNDATION REPORT

on

Hwy. 401 Line 'B' & Queen Street Crossing,
at Tilbury,

Lot 22, Con. IV, Twp. of Tilbury E. & N.

Plan No: F-3534-5

Profile No: F-3534-9

Chainage: Sta. 359+23.96

Distribution:

Mr. A. M. Teye,
Bridge Engineer. (2)

Mr. H. A. Tregaskes,
Construction Engineer. (1)

Mr. D. G. Ramsay,
Design Engineer. (1)

Mr. H. Orlando,
Regional Proj. Design Engr. (1)

Mr. G. U. Howell,
District Engineer,
Chatham, Ontario. (1)

Mr. J. Roy,
Regional Soils Engineer,
London, Ont. (1)

Dr. P. Karrow,
Department of Mines. (1)

Foundation Section. (1)

Gen. Files. (1)

W.J. F-59-2

W.P. 161-58.

INTRODUCTION:

Presented in this report are the results of a subsoil investigation carried out at a structure location where proposed Hwy. 401 Line 'B' underpasses Queen Street in Tilbury, Lot 22, Con. IV, Township of Tilbury East & North (Station 359+23.96, Profile No. F-3534-9). This report contains the field and laboratory findings and recommendations for the foundation of the proposed structure.

The field work commenced on Jan. 5, 1959 and was completed on Jan. 16, 1959.

DESCRIPTION OF THE SITE & GEOLOGY:

The site and its surrounding areas are generally flat farmlands presently under cultivation. At the time of the investigation, the area was covered by ice and snow.

Physiographically, the site under consideration is located on the Essex Clay Plain of the St. Clair Clay Plains, inundated by Glacial Lakes Whittlesey and Warren. According to available geological information, these extensive plains covering a large area of South-Western Ontario, are covered by deep deposits of clay, underlain by limestone or shale bedrock. At this site, the upper zone of the clay stratum was found to be desiccated and exists in a stiff condition for a depth of approximately 25 feet.

cont'd. /2 ...

DESCRIPTION OF FIELD & LABORATORY WORK:

Field work consisted of 3 sampled boreholes carried out by a standard diamond drill adapted for soil sampling. Conventional wash boring procedures were followed and samples were recovered at depth intervals of 5 feet. Samples were obtained by means of 2" I.D. thin-walled shelly tube samplers or a 2" O.D. split barrelled spoon sampler. The dimensions of this spoon sampler and the energy used in driving it conform to requirements of the Standard Penetration Test. In addition, dynamic cone penetration tests adjacent to each sampled borehole, one separate dynamic cone penetration test and in-situ vane shear tests were carried out. Immediately after the investigation, an additional boring was made adjacent to B.H. No. 3 to confirm the similar subsoil conditions that were encountered in other sites recently investigated in this area. Borehole log for this additional boring is not presented in this report and has been kept for reference.

Upon receipt in the laboratory, samples were visually examined and identified. Routine index tests were performed on selected representative samples. Laboratory test results have been presented in the borehole logs and detailed in tabular form.

The location plan and subsoil profile are presented in Drawing No. F-59-2A.

SUBSOIL CONDITIONS:

Subsoil conditions at this site are similar to other sites recently investigated in this area. Reference to the borehole logs shows that the site is underlain by a stiff silty clay crust followed by the thick stratum of soft to medium silty clay.

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

In each of the sampled boreholes, the frozen topsoil was found to be underlain by a 25-foot stiff crust of silty clay extending from Elevations 580' to 555'. Underneath the stiff crust the stratum of soft to medium silty clay was encountered. This stratum was explored to a depth of 77 feet below the ground surface (i.e. Elev. 503') in the additional boring adjacent to B.H. No. 3. In general, the soil types encountered are as follows:-

1. Stiff Silty Clay -

The stiff condition of this upper crust is believed to be the result of desiccation. The upper 12' to 14' has been subjected to oxidation resulting in its present brownish colour. Below the oxidized zone the colour is predominantly grey. The material contains approximately 23% silt, 17% sand and 6% fine to medium gravel throughout. The average unit weight and moisture content were found to be 130 p.c.f. and 20%, respectively. Liquid and plastic limits averaged 30% and 18%. Laboratory shear strength tests show an average of 2000 p.s.f. to be representative for the 25-ft. layer. Judging from its moisture content and Atterberg limits, the stiff silty clay appears to be saturated and preconsolidated. This is borne out by the consolidation test results.

2. Soft to Medium Silty Clay -

Underneath the stiff clay crust the thick stratum of soft to medium silty clay was encountered. The colour is predominantly grey. It contains approximately 22% silt, 17% sand and 6% fine to medium gravel throughout. The average unit weight

cont'd. /4 ...

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

2. Soft to Medium Silty Clay - (cont'd.) ...

and moisture content were found to be 125 p.c.f. and 25%, respectively. Liquid and plastic limits averaged 30 and 18%. Laboratory tests show that the shear strength of the silty clay decreases with depth and reaches a constant value of 800 p.s.f. below approximately Elev. 543'. A plot of shear strength versus depth has been presented and is included in this report under Appendix I. The silty clay is fully saturated and laboratory consolidation test results indicate that it is normally consolidated.

Laboratory and field test results have been summarized in Table No. I. and are included in this report under Appendix I.

WATER CONDITIONS:

No ground water was encountered throughout the depths of boring during the investigation. The water level of Lake St. Clair is presently at approximately Elev. 574'.

Due to the impermeable nature of the subsoil strata, it was not possible to accurately establish the elevation of the ground water table during the boring programme. The samples obtained were fully saturated, and the ground water table has been assumed at or slightly below the existing ground surface. In view of the fact that no water-bearing sand seams or artesian water conditions were encountered during the time of boring, the amount of seepage inflow during footing excavations will be of minor quantities, only.

cont'd. /5 ...

FOUNDATION CONSIDERATIONS:

The upper stiff clay crust is competent to provide adequate foundation support for the proposed structure. Laboratory and field test results are such that spread footing support can be obtained in the stiff silty clay at Elev. 574' or below. At this elevation or below, for footings of 7' to 10' in width, an allowable bearing pressure of 2 1/2 t.s.f. incorporating a safety factor of 3, can be used for spread footing design. Footings founded at Elev. 574' are believed to have sufficient protection from frost action. To avoid overstressing and excessive settlement in the thick stratum of soft clay, footings should not be founded below Elev. 565'.

Long-term settlements under the footings, as a result of the application of 2 1/2 t.s.f. abutment footing pressure and 1.8 t.s.f. embankment load due to approximately 28 feet of fill, have been estimated as of the order of 6 inches. This is due to the fact that the stresses caused by the applied loads will influence the thick stratum of soft to medium silty clay for a considerable depth. In view of the slow rate of consolidation expected of clay, settlement will continue over several decades. For a period of 50 years a total settlement of the order of 3 inches may be anticipated. Differential settlements may be taken as of the order of 1" to 1 1/2". In view of the relatively uniform subsoil conditions at the site, little differential settlements of any consequence need be anticipated of a single-span structure since each abutment will virtually settle the same amount. This

cont'd. /6 ...

FOUNDATION CONSIDERATIONS: (CONT'D) ...

amount of settlement is significant, however, for a multi-span structure where centre piers are incorporated, since long-term differential movement between the abutment and the piers would result due to the fact that consolidation of the footings under the piers would be unaffected by the fill adjacent to the abutments. It appears that if a multi-span design is contemplated, consideration should be given to the amount of differential settlement the structure can tolerate.

Under the proposed grade line of Queen Street, the maximum height of fill is approximately 28 ft. The subsoil can safely support this embankment loading. The proposed grade line of Hwy. 401 does not present any approach fill stability problem.

No excessive seepage problems with respect to shallow footing excavations are anticipated.

CONCLUSIONS & RECOMMENDATIONS:

- (1) The site is underlain by a stiff clay crust followed by deep deposits of soft to medium silty clay.
- (2) Subsoil conditions are such that spread footing support can be obtained in the upper stiff clay crust at Elev. 574' or below. At this elevation, or below, for footings of 7' to 10' in width, an allowable bearing pressure of 2 1/2 t.s.f. can be used for spread footing design. Footings founded at Elev. 574' are believed to have sufficient protection from frost action. To avoid overstressing and excessive settlement in the thick stratum of soft clay, it is recommended that footings should not be founded below Elev. 565'.

cont'd. /7 ...

CONCLUSIONS & RECOMMENDATIONS: (cont'd.) ...

- (3) Long-term settlements under the footings resulting from the application of 2 1/2 t.s.f. footing pressure and 1.8 t.s.f. embankment load, over a period of 50 years have been estimated as of the order of 3 inches. Differential settlement may be taken as of the order of 1" to 1 1/2". In view of the relatively uniform subsoil conditions at the site, little differential settlements need be anticipated of a single-span structure since each abutment will virtually settle the same amount. If a multi-span design is contemplated, consideration should be given to the amount of differential settlement the structure can tolerate.
- (4) The proposed grade line of either Queen Street or Hwy. 401 presents no approach fill stability problems.
- (5) No ground water problems with respect to shallow footing excavations are anticipated.

AKL
A. K. Loh,
FOUNDATIONS ENGINEER.

APPENDIX I.

JOB F-59-2
W.P. 161-58

Table No. 1 (cont'd)

SUMMARY OF FIELD & LABORATORY TESTS

JOB F-59-2W.P. 161-58

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
	S13	75'-77'	Soft to med. grey silty clay with sand layers	18	-	-	-	-	-	
		28'	Stiff grey silty clay	-	-	-	-	1760	-)
		38'	" " " "	-	-	-	-	1840	-)
		43'	" " " "	-	-	-	-	1280	-) In-situ vane test. ¹
		53'	Soft to med. grey silty clay	-	-	-	-	560	-)
		58'6"	" " " " " "	-	-	-	-	720	-)
Note: Laboratory test results of B.H. No. 3 presented were taken from an additional boring adjacent to B.H. No. 3.										
Tl denotes thin-walled shelby samples. Sl denotes split spoon sample.										
Consolidation characteristics:-										
Depth	0'-25' :-	Coefficient of volume compressibility			0.007 sq.ft./ton.					
		Coefficient of consolidation			0.14 sq.ft./day.					
Depth	25' & below :-	Compression index			0.16					
		Coefficient of consolidation			0.0875 sq.ft./day					
		Preconsolidation pressure			submerged unit weight x depth					
					(normally consolidated)					

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATIONDRILL RIG 54-6 OPERATION BORE & PENETRATION JOB F-59-2 WP. 161-59 BORING 1 STA. 358+65.45' RT.
CASING B X (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT FEB. 1959
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY V.K. DATE BORING 7 JAN. 1959

ABBREVIATIONS

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q_c - TRIAXIAL CONSOLIDATED QUICKQ - TRIAXIAL QUICK
S - TRIAXIAL SLOW
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOILK - PERMIABILITY
C - CONSOLIDATION
CA - CASING
γ - UNIT WEIGHTC.S. - CHUNK
D.O. - DRIVE OPEN
D.F. - DRIVE FOOT VALVE
T.O. - THIN WALLED OPEN

SAMPLE TYPES

SS - SLEEVE SAMPLE
PS - PISTON SAMPLE
WS - WASHED SAMPLE
RC - ROCK CORE

SAMPLE CONDITION

- DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE

SHEAR STRENGTH IN LBS./SQ. FOOT

2000 4000 6000 8000

WATER CONTENT W% 10 20 30 40 50 60 70 80

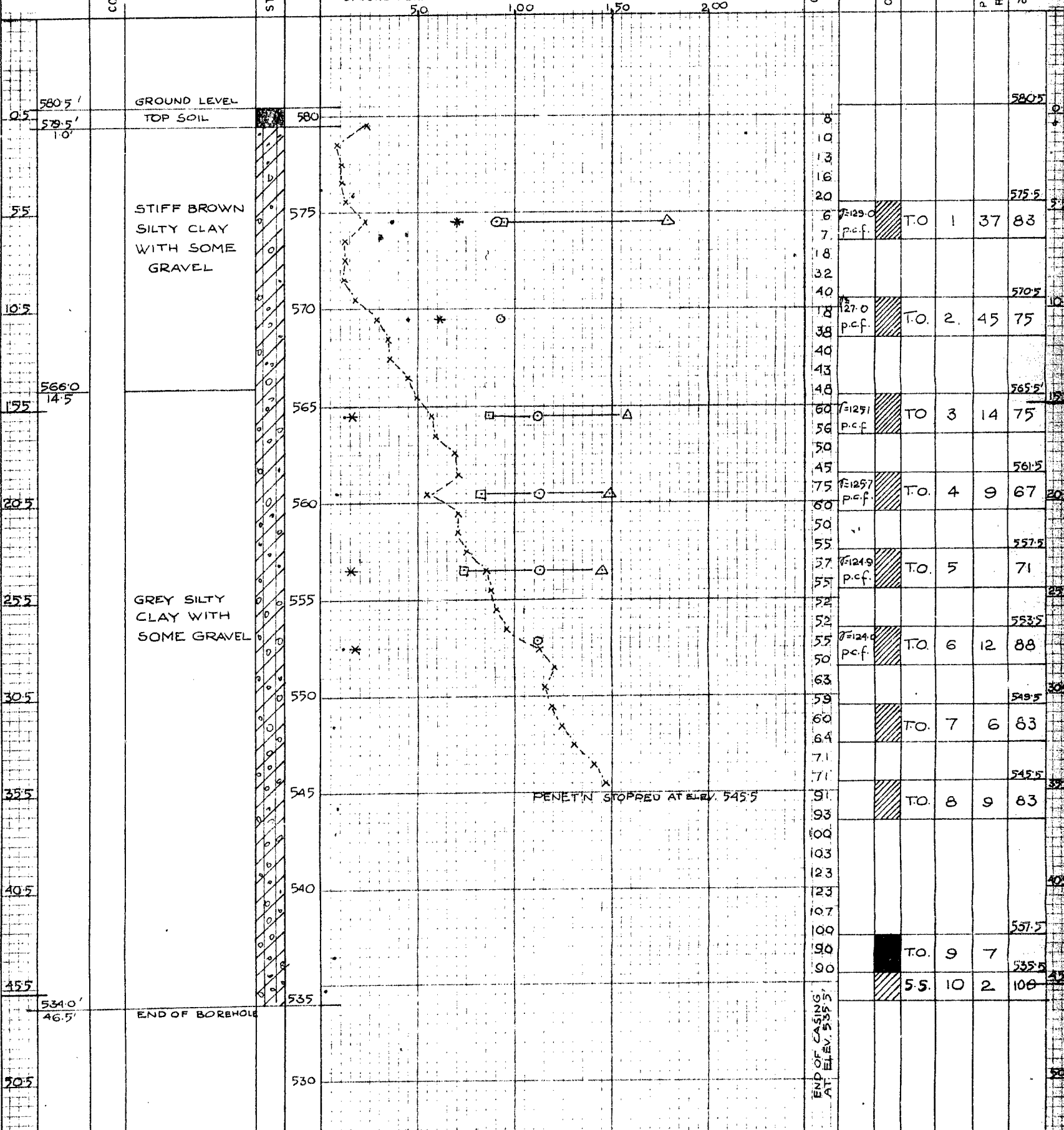
PENETRATION TEST RESISTANCE BLOWS PER FOOT

AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X-----X STAND. PEN. •-----•

50 100 150 200

SAMPLES

OTHER TESTS
CONDITION
TYPE
NO.
PENETRATION RESISTANCE
ELEV. RECOV.
%

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-6 OPERATION BORE & PENETRATION JOB F-59-2 WP 161-58 BORING 2 STA 359+00 45' LT
CASING B X (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT FEB 1959
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY V.K. DATE BORING 9 JAN 1959

ABBREVIATIONS

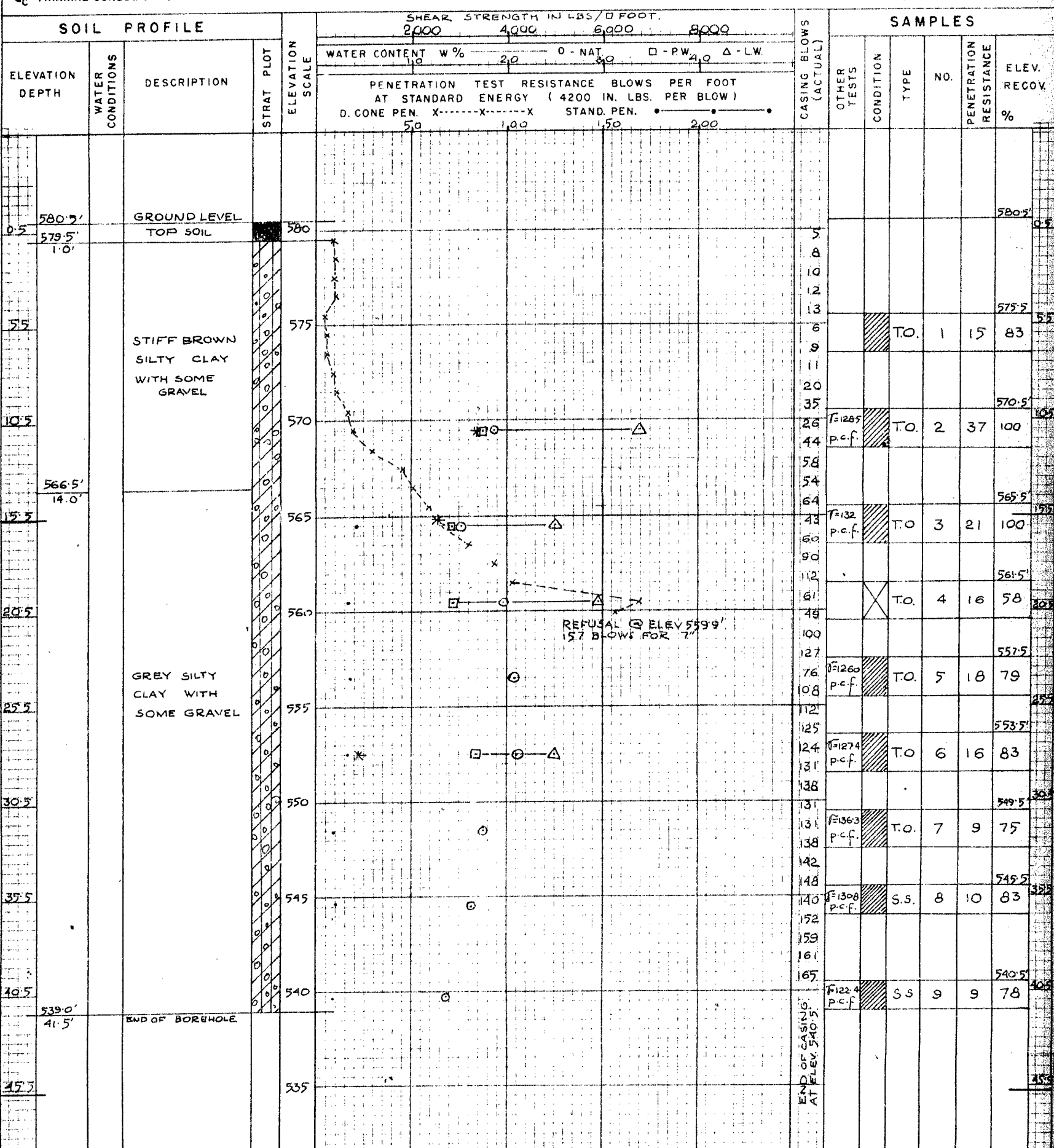
V - INSITU VANE SHEAR TEST Q - TRIAXIAL QUICK K - PERMIABILITY
M - MECHANICAL ANALYSIS S - TRIAXIAL SLOW C - CONSOLIDATION
U - UNCONFINED COMPRESSION WL - WATER LEVEL IN CASING CA - CASING
Qc - TRIAXIAL CONSOLIDATED QUICK WT - WATER TABLE IN SOIL γ - UNIT WEIGHT

SAMPLE TYPES

C.S. - CHUNK SS - SLEEVE SAMPLE
D.O. - DRIVE OPEN PS - PISTON SAMPLE
D.F. - DRIVE FOOT VALVE WS - WASHED SAMPLE
T.O. - THIN WALLED OPEN R.C. - ROCK CORE

SAMPLE CONDITION

 - DISTURBED
 - FAIR
 - GOOD
 - LOST



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATIONDRILL RIG 54-6 OPERATION BORE & PENETRATION JOB F-59-2 WP 161-50 BORING 3 STA. 00+55.47 LT
CASING B-X (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT FEB 1955
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY V.K. DATE BORING 13 JAN. 1959

ABBREVIATIONS

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

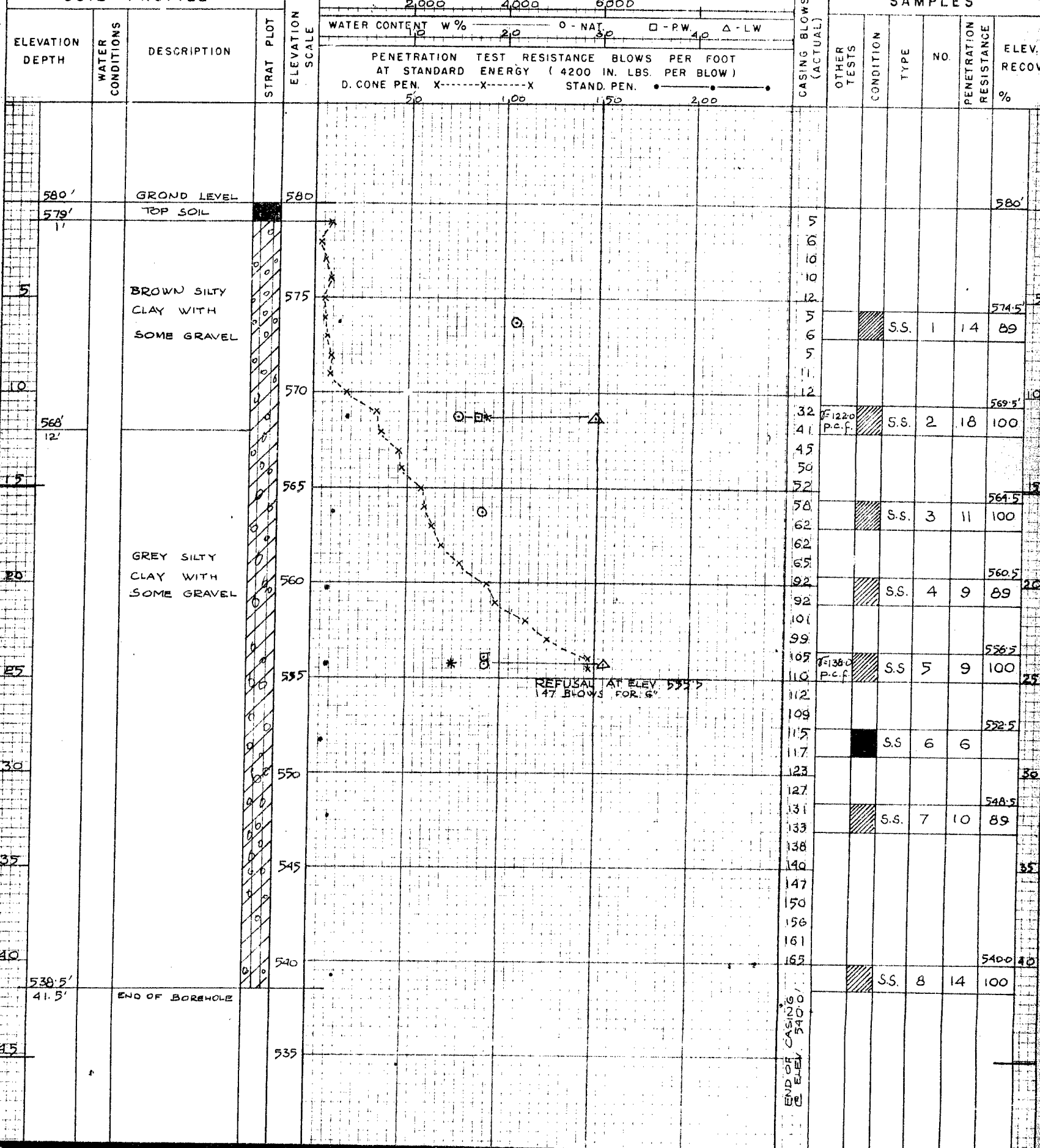
SAMPLE TYPES

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

SAMPLE CONDITION

 - DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE



DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-6 OPERATION PENETRATION JOB F-59-2 W.P. 161-5B BORING 4 STA. 00+20 45' RT.
 CASING B X (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT FEB. 1959
 SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY V.K. DATE BORING 20 JAN. 1959

ABBREVIATIONS

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

SAMPLE TYPES

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

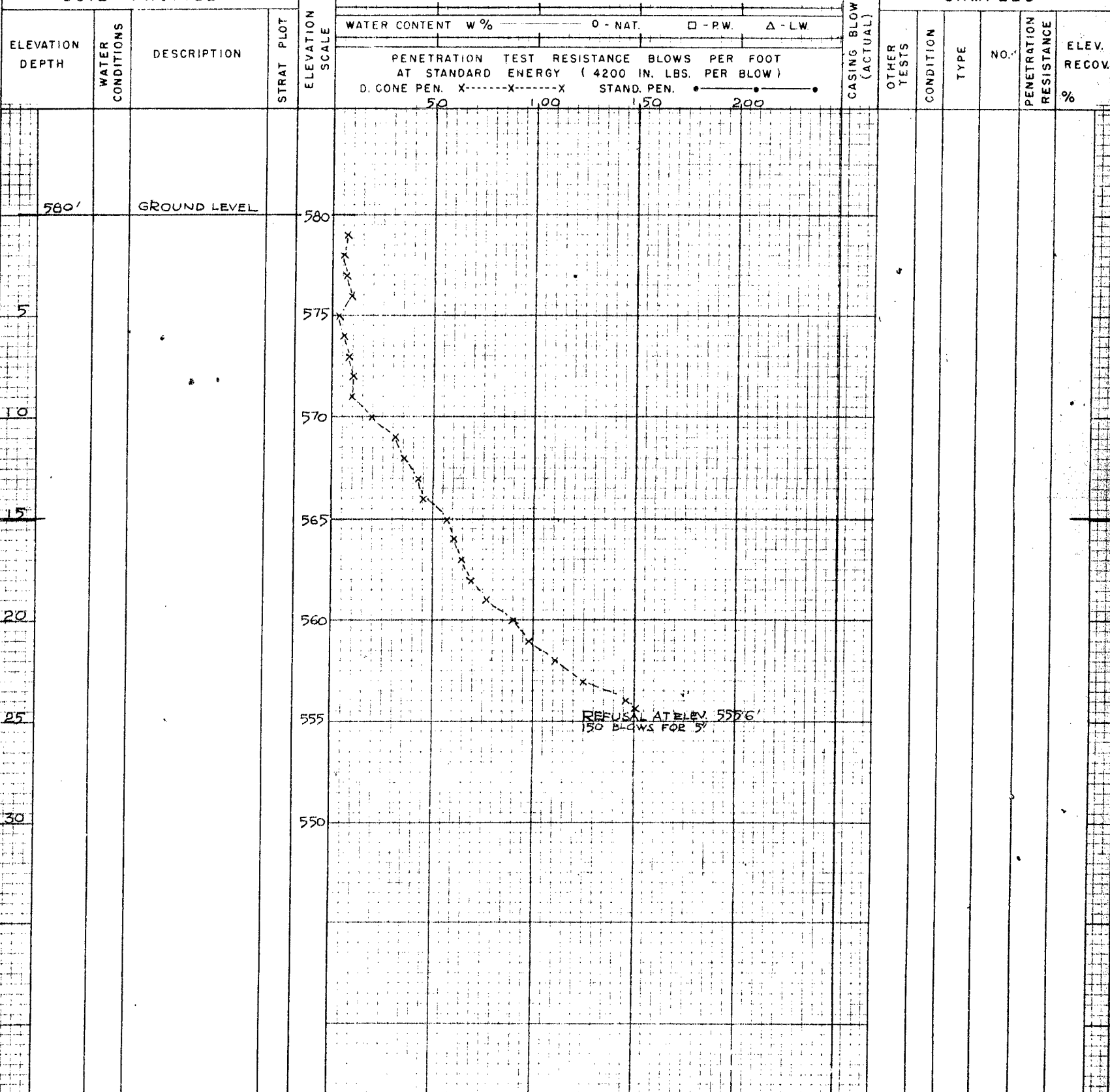
SAMPLE CONDITION



- DISTURBED
 - FAIR
 - GOOD
 - LOST

SOIL PROFILE

SAMPLES



SHEAR STRENGTH IN P.S.F.

