

1957 - Guam -

Feb 17, 1958

Arrival de Fond

W. P. 59-60 River

Fill dirt fill analysis

38 ft roadway and st

new design. #1

Shifting of \pm
17 ft towards the
river

2' higher grade

New standards for
ditch construction

MEMORANDUM

TO: Mr. A. Stermac

FROM: M&R. North Bay

DATE: Sept. 21. 1962

OUR FILE REF.

IN REPLY TO

SUBJECT: WP 69-60 Amable Du-Fond R. Slide.

Enclosed are the cross-section for the failure area along the Amable Du Fond River, as discussed 2 weeks or so ago. This should give you the new $\frac{1}{2}$ profile and the shift in alignment.

Please let me know if any changes are required to Geocons Report Dated Feb 17 1958.

Handwritten: May 17

CR Saint
Reg Sails Eng

GEOCON LTD

HEAD OFFICE

116 J. WALLÉE ST., MONTREAL 18, QUEBEC

TELEPHONE UN. 6-7682

DISTRICT OFFICES

14 MAAS ROAD
REXDALE, TORONTO, ONT.
TEL. 244-8878

1425 WEST PENDER ST.
VANCOUVER 8, B.C.
TEL. WH. 1-2926

Rexdale, Ontario,
September 11th, 1962.

Department of Highways, Ontario,
Materials and Research Section,
Parliament Buildings,
Toronto, Ontario.

Attention: Mr. A. G. Stermac, P. Eng.,
Principal Foundation Engineer.

Dear Sirs:

Please find attached as requested two
copies of our report S-6531 on Soil Investigation and
Stability Analysis, Station 351+60, Highway 17, Mattawa,
Ontario, submitted February 17th, 1958.

Yours very truly,

GEOCON LTD

D. Wagner
D. Wagner

Attach.

W.P. 69-60

GEOCON LTD

HEAD OFFICE

180 VALLEE ST. MONTREAL, P.Q. QUEBEC

TELEPHONE: (514) 233-1000

Rexdale, Ontario,
February 17th, 1969.

14 HAYS ROAD
REXDALE, TORONTO, ONT.

TEL. CN. 488-8111

1155 WEST BROADWAY AVE
VANCOUVER B. C.

TEL. CN. 281-0110

FILE COPY

GEOCON LTD

14 HAYS ROAD

REXDALE — ONTARIO

Department of Highways, Ontario,
Parliament Buildings,
Toronto, Ontario.

Attention: Mr. J. Walter, P.Eng.,
Director of Planning.

Re: Soil Investigation and Stability Analysis,
Station 151 + 60, Highway 17,
Agincourt, Ontario.

58 F 2090

Dear Sir:

This letter accompanies our detailed report on the above soil investigation and stability study.

We find that the existing embankment fill rests on about 3 feet of fine clay, then about 20 feet of loose varved silt followed by dense sand gravel and boulders to a considerable depth.

Computations show that the factor of safety against sliding failure of the existing embankment is about 1.0. The minimum desirable factor of safety is 1.1. This may be achieved by the construction of a toe berm as discussed in the report.

We find also that the roadway may be raised, provided stabilizing berms are provided, to a maximum elevation of 9'4". However considering all requirements it was found the proposed profile shown on your drawing 1546-1 represents for practical purposes the ~~best~~ solution. We recommend that it be adopted. The berms necessary for stability are discussed in detail in the report.

We believe that our report gives all the information in regard to the stability of this section of the roadway. However, should you require any further information, please give us a call.

Yours very truly,

GEOCON LTD

M. A. J. Melich

M. A. J. Melich, P. Eng.,
Chief Engineer.

WJM/cw
5611

BUTLER

ST. JOHN'S

HALIFAX

QUEBEC

MONTREAL

TORONTO

LONDON

VANCOUVER



36531

REPORT

TO

DEPARTMENT OF HIGHWAYS, ONTARIO

ON

SOIL INVESTIGATION AND STABILITY ANALYSIS

HIGHWAY NO. 17 - STATION 351 + 60

MATTAKA

ONTARIO

Distribution:

4 copies - Department of Highways, Ontario,
Toronto, Ontario.

1 copies - Gecon Ltd,
Toronto, Ontario.

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Drawings in Pocket at rear:

56531-1 Boring Plan and Soil Stratigraphy

56531-2 Stability Analyses Showing Remedial Measures

INTRODUCTION

Gecon Ltd has been retained by the Department of Highways, Ontario (proposal dated May 24th, 1957 and accepted June 3rd, 1957) to investigate and report on the soil and stability conditions at the site of observed subsidence and cracking in the roadway of Highway 17 near Mattawa, Ontario.

The purpose of the investigation was to investigate the cause of visible subsidence at the site and to determine remedial measures for the roadway under existing and proposed conditions.

SUMMARIZED SOIL CONDITIONS

The roadway embankment is constructed of rock fill covered by a sand and gravel ballast bed and is up to 17 feet high. The railway embankment south of the highway is constructed of sand and gravel fill. Both the roadway and railway embankment rest on a stratum of firm silty clay, about 5 feet thick, which is underlain by from 6 to 23 feet of loose varved silt. In the river bed the silty clay was not encountered, but here a 12 feet layer of peat was found to overlie the silt. The silt is underlain by an extensive stratum of dense sand and gravel with boulders, resting on gneissic bedrock.

DISCUSSION

History

From available information it is known that the section of Highway 17 under investigation was constructed more than 20 years ago. It is further known that the roadway has since then been brought up to grade a number of times because of local subsidence of the order of several inches at the shoulder of the road adjacent to the river. It has been noticed by the Department of Highways that a continual series of subsidences has been taking place since 1935. An examination of the possible slide area was made on May 17th, 1957 and it was observed that cracks about 6 inches wide ran parallel to and about 5 feet north of the centreline of the road. These cracks extended for a length of about 20 feet and the

History (continued)

area apparently affected by the slide appeared to be about 60 feet long. The maximum subsidence noted at that time was about 2 inches in the centre of this area. According to available information no movement of the Canadian Pacific Railway embankment has ever been reported, and at the time of the site visit no cracking could be seen in the embankment in this area, and the railway lines were perfectly straight.

Stability

Preliminary computations showed that the most important stratum from a stability point of view is the varved silt. To assess the shear strength of the silt stratum, both consolidated-quick and quick type triaxial compression tests were carried out and the results obtained are given by the Mohr's circles on Figures 5 and 6. As can be seen from Figure 5 the results of the consolidated-quick tests are somewhat erratic and this is considered partly due to the presence of irregular clay laminations. Consequently for computation purposes a ϕ_{cq} value of 22 degrees was used, based on experience with similar silt in the area. The quick triaxial compression tests were carried out to determine the effective cohesion due to the clay laminations. As can be seen from the test results plotted on Figure 6, the apparent envelope to the circles is horizontal, corresponding to a shear strength of 0.35 tons per square foot. It is considered that the results of stability computations carried out using alternately $\phi_{cq} = 22$ degrees with cohesion equal to zero, and shear strength = 0.35 tons per square foot with ϕ_{cq} equal to zero would bracket actual conditions.

The observed pattern of cracking and subsidence of the roadway suggests that the movement of the slope is the result of a succession of circular arc type slides. Stability computations based on a ϕ_{cq} value of 22 degrees for the varved silt, and the other data shown on drawing 96531-1, give a range

Stability (continued)

of factors of safety between 0.90 and 0.96, computed as discussed below. Based on a shear strength of 0.35 tons per square foot for the varved silt, the corresponding range obtained was between 1.0 and 1.12. The range in computed critical factors of safety given above was obtained for circular area drawn in turn through each of the observed crack locations, and tangential to the underlying dense sand and gravel stratum. Because the history shows that the various cracks have occurred at different intervals of time and at different locations, it is probable that multiple failure planes have developed, within the zone shown shaded on drawing 36531-1. The factor of safety of the embankment at the time of failure is considered to have been between the computed values of 0.90 and 1.0.

Remedial Measures

It is understood that there is no objection to some widening of the embankment into the river. Based on the results of this investigation, it is considered that the most practical method of increasing the factor of safety of the existing embankment to the minimum desirable value of 1.3, is by the addition of berms at the toe, and it is recommended that this be done. Computations show that a berm with side slopes of 1 vertical to $1\frac{1}{2}$ horizontal at elevation 589 which is 2 feet above maximum observed river level, and about 23 feet wide, would be required at the section investigated where the existing roadway is at about elevation 574. This berm size is required between chainages 351+00 and 352+20 at least, to ensure stability of the critical area.

Computations were also carried out to determine the effect of raising the roadway to the profile proposed by the Department of Highways and shown on drawing C1546-1. Various other profiles were also examined within the range of elevations for which it was practical to construct remedial

Remedial Measures (continued)

measures. It was found that the maximum height to which the roadway could be raised was elevation 584. The necessary size of berm for this maximum elevation is shown on the Typical Section on drawing 50531-2. Computations show that at this elevation the roadway could settle during construction about 6 inches due to compression in the silt stratum. Above elevation 584 berm sizes required become disproportionately large such that the river channel would be seriously constricted. Examination of all the profiles, taking into account not only the soil conditions and the berm sizes required but such requirements as a minimum non-passing sight distance of 350 feet at a design speed of 50 miles per hour, maximum grade of 3 per cent and the apparent economics of cut and fill construction, indicated that the profile shown on the Department of Highways drawing C1546-1 closely represents the most economical solution. A significant advantage of this profile is that only 2 feet of fill are required at the most critical section, namely station 351+60. This means that the final size of berm is only slightly larger than that which will be required in any case to stabilize the existing roadway.

The sizes of berm necessary for this new profile are shown with respect to roadway elevation on drawing 50531-2.

It is essential during construction of the berms that the peat be replaced by fill material as shown on the drawing. The most practical method of doing this is probably to form the berm in such a way that the peat is displaced during construction. Rock fill would be ideal for this purpose, and it is understood that considerable quantities would be available during regrading and widening of the existing highway in this area. It is recommended that the rock fill be placed in anti-dumping in longitudinal strips parallel to the road centreline. Each strip should be advanced on an inclined front to ensure complete displacement of the peat outwards into the river. The slope of the berm

Remedial Measures (continued)

should be constructed of the larger rock sizes to prevent erosion. Sand and gravel could be used for the section of the berm above water level during construction, provided that the slope is protected by rip-rap. It would also be possible to construct the berms by excavating the peat and using sand and gravel throughout as the backfill material, except for rip-rap protection on the slope. If this were done, it is recommended that the peat be excavated in narrow trenches perpendicular to the bank which are back-filled immediately upon completion. In this way the stability of the embankment would be impaired as little as possible during construction. This is important in view of the low margin of safety of the existing embankment. If sand and gravel are used throughout, the berm details shown on the drawings may be used. It is emphasized that whichever construction method is used it is essential for stability, to complete the construction of the required berm before proceeding with elevation of the roadway.

Although this soil investigation only covered the length of roadway affected by subsidence, available evidence suggests that soil conditions similar to those encountered, exist between the rock outcrops to the east and west of the area investigated. Our recommendations for the berm sizes required along this length of roadway are based on this assumption.

It is recommended that the roadway fill be of selected granular material and well compacted in layers about 6 inches in thickness. The upper 4 feet of fill should be of non-frost susceptible material.

To avoid possible saturation of the fill and further softening of the underlying silt in the case of progressive failure it is recommended that the ditch formed between the existing railway embankment and the proposed highway embankment be lined.

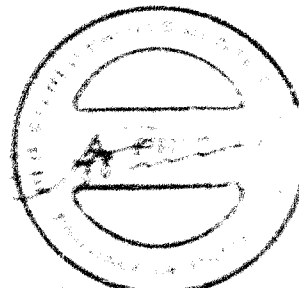
CONCLUSIONS AND RECOMMENDATIONS

6.

1. The existing roadway fill is underlain by a thin layer of clay followed by about 20 feet of varved silt, then sand and gravel to a considerable depth.
2. Computations show that the factor of safety against sliding of the existing embankment is about 1.0.
3. Remedial measures which would improve the factor of safety of the existing embankment to the minimum desirable value of 1.3, are discussed in the report.
4. As discussed in the report, the roadway may be raised provided stabilizing berms are constructed. The profile shown on Department of Highways drawing C1546-1 is considered for practical purposes to be the best solution.
5. Recommendations covering construction of the necessary stabilizing measures are given in the report.

PERSONNEL

The field work was carried out by drillers J. Parreault and H. Gossel under the supervision of Mr. R. Sorenski. The report was written by Messrs. Sorenski and A. Prior, checked by Mr. V. Milligan and reviewed by Mr. M.A.J. Natch.



A. Prior, P. Eng.

AP/cv

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APPENDIX I

Procedure

Site and Geology

Soil Conditions

Water Conditions

Office Reports on Soil Exploration

GEOCON

PROCEDURE

The field work was commenced on June 14th, 1957 and completed on July 8th, 1957. The work was interrupted from June 25th to July 1st due to flooding conditions. Three boreholes, two with adjacent dynamic penetration tests, two hand auger holes and two wash borings were put down. The boreholes were put down with the aid of a skid-mounted machine drillers, the wash borings were put down with floating equipment. The cross section of the river was determined by soundings and a topographical survey of the site was carried out.

Drawing S6531-1 contained in the pocket at the rear of this report shows the topography of the site, the locations of the boreholes and the inferred soil stratigraphy. A detailed log of each boring is given on the Office Reports on Soil Exploration in this Appendix.

Drawing S6531-1 also shows the stability analysis of the present conditions together with the data used in design. Drawing S6531-2 shows the remedial measures for the present conditions and for the conditions after raising of the roadway.

The testing of soil samples was carried out in the Soil Mechanics Laboratory of Geocon Ltd in Toronto. The results of the soil testing are plotted on the Office Reports and on the Figures in Appendix II. The samples remaining after testing will be stored until June 1st, 1958 and then destroyed unless instructions to the contrary are received.

Elevations are referred to Geodetic Datum and the survey was tied in to Bench mark elevation 606.40 at chainage 362+32 as shown on Department of Highways drawing C1546-1.

SITE AND GEOLOGY

The site comprises a section of Highway 17 between chainages 351+00 and 352+50, about 11 miles west of Mattawa, Ontario. The embankment of the Canadian Pacific Railway is directly south of the highway, and the Assiniboine River is directly to the north.

From available geological information the site is known to be covered by post glacial silts and clays of variable thickness, underlain by dense granular deposits, then precambrian granite bedrock.

SOIL CONDITIONS

The principal soil strata encountered in the borings are as follows:

Embankment Fill

The highway embankment fill in the investigated area is from 11 to 17 feet thick in borshaes 3 and 1. The main body of the embankment is composed of rock fill. This rock fill is about 10 feet thick. Boulders of several feet in diameter were encountered. The rock fill is covered by sand and gravel in varying grain sizes to a depth of up to 7 feet. Standard and dynamic penetration tests indicate that the relative density is variable, but generally loose. Design values for the embankment fill are given on Drawing S6331-1.

Topsoil

South of the roadway and railway embankment, the site is covered by about 8 inches of black sandy topsoil.

Gray Brown Silty Clay

Underlying the topsoil in augerholes 4 and 5 and the rock fill in borshaes 1 and 2 is a stratum of gray brown silty clay about 5 feet thick. The upper 1 to 2 feet contain roots. The clay layer throughout contains irregularly spaced horizontal thin seams of brown fine sand. A typical grain-size curve obtained for a sample of the clay is given on Figure 1.

Grey Brown Silty Clay (continued)

Two quick triaxial compression tests were carried out on samples of the clay and an average compressive strength of 0.7 tons per square foot was obtained, indicating that the clay is firm. The obtained stress-strain curves are given on Figure 2. The average wet unit weight is 117 pounds per cubic foot at a natural moisture content of 36 per cent. At this moisture content, two Atterberg limit tests gave liquid limits and plasticity indices of about 36 and 13 per cent respectively.

Grey Fine Sand

Underlying the clay in augerholes 4 and 5 about 1 foot of grey fine sand was encountered. The relative density of this grey sand is estimated to be loose. A typical grain-size curve is given on Figure 1.

Dark Brown Peat

Beneath the river bottom in borehole 3, a 12 foot layer of dark brown peat was encountered. The peat occasionally contains extensive wood accumulations. Standard and dynamic penetration resistances were very low and the peat is therefore considered to be of very soft consistency. Design values for the peat are given on Drawing S6331-1.

Grey Varved Silt

The silty clay and the peat where they occur are underlain by a stratum of grey varved silt. The varves are made up of grey silt and grey brown clay laminae. The clay laminae in the varves are $\frac{1}{2}$ to 1 inch thick. The varves are from 2 to 12 inches apart. Irregular silty fine sand seams between 1/16 to $\frac{1}{2}$ inch in thickness were frequently encountered. Standard penetration resistances or "N" values obtained in the stratum ranged from 1 to 20 blows per foot and were generally 8 blows per foot, indicating that the silt is generally loose in relative density.

Grey Varved Silt (continued)

A number of quick triaxial and consolidated quick triaxial tests were performed on samples of the stratum. An examination of the Mohr circles obtained from the consolidated quick triaxial tests shows no definite envelope. The irregular pattern of the circles is considered partly due to the presence of the irregular clay laminations. For design purposes, a ϕ_{cq} value of 21 degrees was estimated. A plot of Mohr circles obtained for quick triaxial tests shows an apparent cohesion of 0.15 tons per square foot. Computations with both sets of design values were compared and the results are given in the body of the report. Plots of Mohr circles for consolidated quick triaxial tests and for quick triaxial tests are given on Figures 5 and 6 respectively. Typical stress-strain curves for both tests are given on Figures 4 and 3 respectively.

Wet unit weights obtained on samples of the varved silt ranged between 110 and 135 pounds per cubic foot, with corresponding moisture contents ranging between 34 and 19 per cent. The general wet unit weight was 125 pounds per cubic foot at a corresponding natural moisture content of 28 per cent. One Atterberg limit test carried out on a silt layer gave a liquid limit of 26 per cent and plasticity index of 6 per cent with a corresponding moisture content of 21 per cent. Three other Atterberg limit tests, carried out on the clay laminae, gave liquid limits and plasticity indices ranging from 32 to 57 per cent and from 12 to 13 per cent respectively, at corresponding natural moisture contents between 30 and 50 per cent.

Grey and Brown Sand, Gravel and Boulders

Underlying the silt in boreholes 1, 2 and 3 an extensive stratum of sand, gravel and boulders was encountered. Sand and gravel occur in all grain sizes and boulders of up to 6 feet were frequently encountered. Large size boulders especially occur in the lower ranges of the stratum. The

Gray and Brown Sand, Gravel and Pebbles (continued)

different grain sizes generally appear to occur in horizontal alternating layers. "N" values obtained in the stratum ranged from 13 to 63 blows per foot with an average value of 37 blows per foot, indicating that the stratum is generally dense.

From one sand layer, wet unit weights of 148 and 150 pounds per cubic foot were obtained at corresponding moisture contents of 8 and 6 per cent.

Bedrock

Bedrock was core drilled in AIF size for up to 15 feet in boreholes 1 and 2. The bedrock is metamorphic and may be classified as a hard sand coarse grained gneiss, containing feldspar, quartz, hornblende and garnet.

WATER CONDITIONS

During the time of the investigation the river level rose from elevation 548 to 554 and receded again to elevation 551. Highest recorded level in the memory of local residents is at elevation 557. Groundwater level readings were taken in all holes during the time of the investigation and are shown on drawing S&SII-1.

It is considered that, due to caving of the boreholes after installation of the observation pipes to the depth of the varved silt stratum, the water level recorded actually represents the piezometric head in the varved silt stratum. Wash borings 6 and 7 showed a piezometric head in the varved silt approximately 18 inches above existing river level.

EXPLANATION OF THE FORM "OFFICE REPORT ON SOIL EXPLORATION"

The object of this form is to enable a comprehensive study of the soil to be made by combining on one sheet all of the information obtained from the boring. An explanation of the various columns of the report follows.

ELEVATION AND DEPTH

This column gives the elevation and depth of boundaries between the various soil strata. The elevation is referred to the datum shown in the general heading.

WATER CONDITIONS

In this column the water level in the casing at the time of boring or the water table in the ground, determined by a series of observations on a piezometer or standpipe, is indicated to scale by a horizontal line with the symbol W.L. or W.T. above the line. A notation of any complicated groundwater conditions will be made in this column.

DESCRIPTION

A description of the soil, using standard terminology, is contained in this column. The consistency of cohesive soils and the relative density of non-cohesive soils are described by the following terms.

Consistency	U-Strength Tons/sq. ft.	Relative Density	Standard Penetration Resistance Blows/ft.
Very soft	0.00 to 0.25	Very loose	0 to 4
Soft	0.25 to 0.5	Loose	4 to 10
Firm	0.5 to 1.0	Compact	10 to 30
Stiff	1.0 to 2.0	Dense	30 to 50
Very stiff	2.0 to 4.0	Very dense	over 50
Hard	over 4.0		

STRATIGRAPHIC PLOT

The stratigraphic plot follows the standard symbols of the National Research Council, Canada.

ELEVATION SCALE

The information in all columns is plotted to a true elevation scale which is shown in this column.

GRAPHS

The main body of the report forms a graph which is used to plot to correct elevation the important soil properties which are obtained through field and laboratory tests. The scales and symbols for the plotting are shown at the head of the column.

OTHER TESTS

In this column are shown, by symbol, the other field or laboratory tests which have been performed on the soil and for which the results have not been plotted on the above graph.

SAMPLES

The first three columns describe the condition, type and number of each sample obtained from the boring. The location and extent of each sample is plotted to scale.

In the last column is shown the penetration resistance in blows of 4200 inch-pounds required to drive one foot of the sampler into the ground. When a 2 inch Drive Sampler is used the result obtained is termed the "Standard Penetration Resistance".

OFFICE REPORT ON SOIL EXPLORATION

SAMPLE CONDITION

SAMPLE TYPES

ABBREVIATIONS

	DISTURBED
	FAIR
	GOOD
	LOST

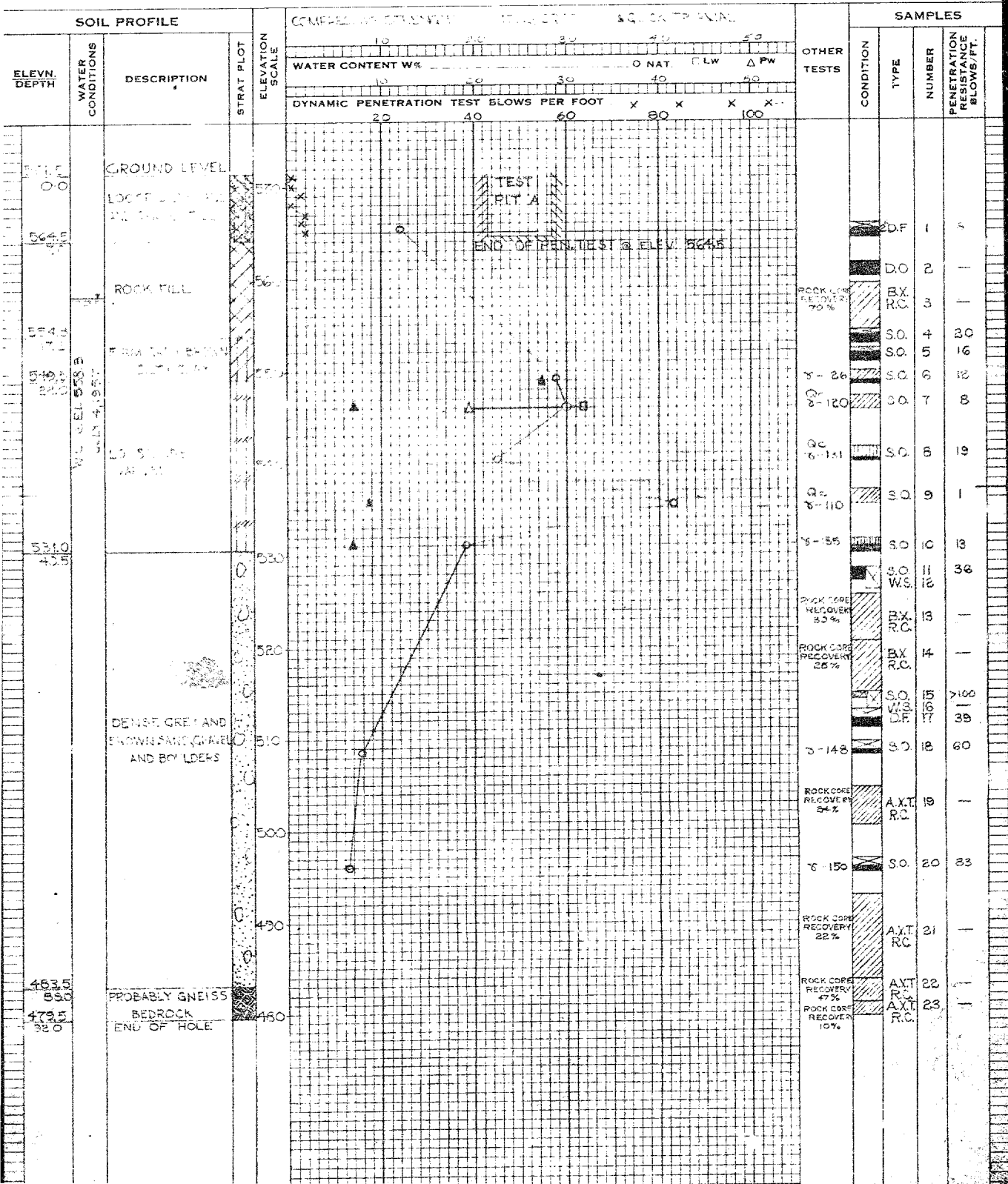
A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE

F.S. - FOIL SAMPLE
S.O. - SLEEVE OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
QC - TRIAXIAL CONSOLIDATED QUICK
Q - TRIAXIAL QUICK
S - TRIAXIAL SLOW

W - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION

WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL



OFFICE REPORT ON SOIL EXPLORATION

SAMPLE CONDITION

 DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES

A.S. - AUGER SAMPLE	F.S. - FOIL SAMPLE
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[illegible]

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT S6531 BORING # 3 DATUM GEOMETRIC CASING Bx
 BORING DATE JULY 3, 1957 REPORT DATE JULY 8, 1957 COMPILED BY R.G. CHECKED BY R.G.
 SAMPLER HAMMER WT 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION

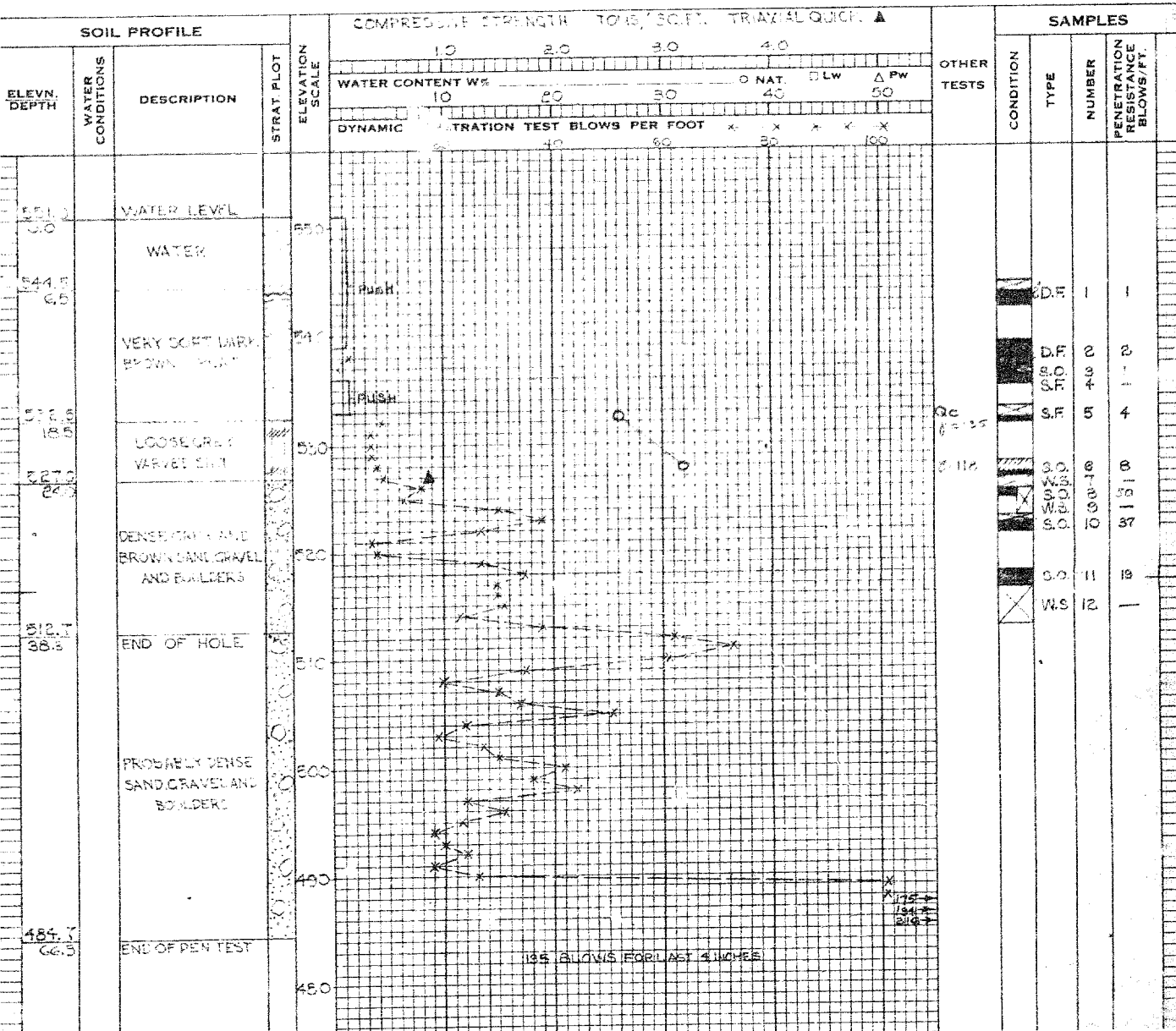
[] DISTURBED
 [] FAIR
 [] GOOD
 [] LOST

SAMPLE TYPES

A.S. - AUGER SAMPLE
 S.T. - SLOTTED TUBE
 W.S. - WASHED SAMPLE
 D.O. - DRIVE-OPEN
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 C.S. - CHUNK SAMPLE
 F.S. - FOIL SAMPLE
 S.O. - SLEEVE-OPEN
 S.F. - SLEEVE-FOOT VALVE
 T.O. - THIN WALLED OPEN
 R.C. - ROCK CORE

ABBREVIATIONS

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



GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT SCF31 LOGGED HOLE 4 DATUM GEODETIC CASING
 BOPING DATE 4-27 REPORT DATE JULY 2, 1957 COMPILED BY R.S. CHECKED BY
 SAMPLER HAMMER WT. 50 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION



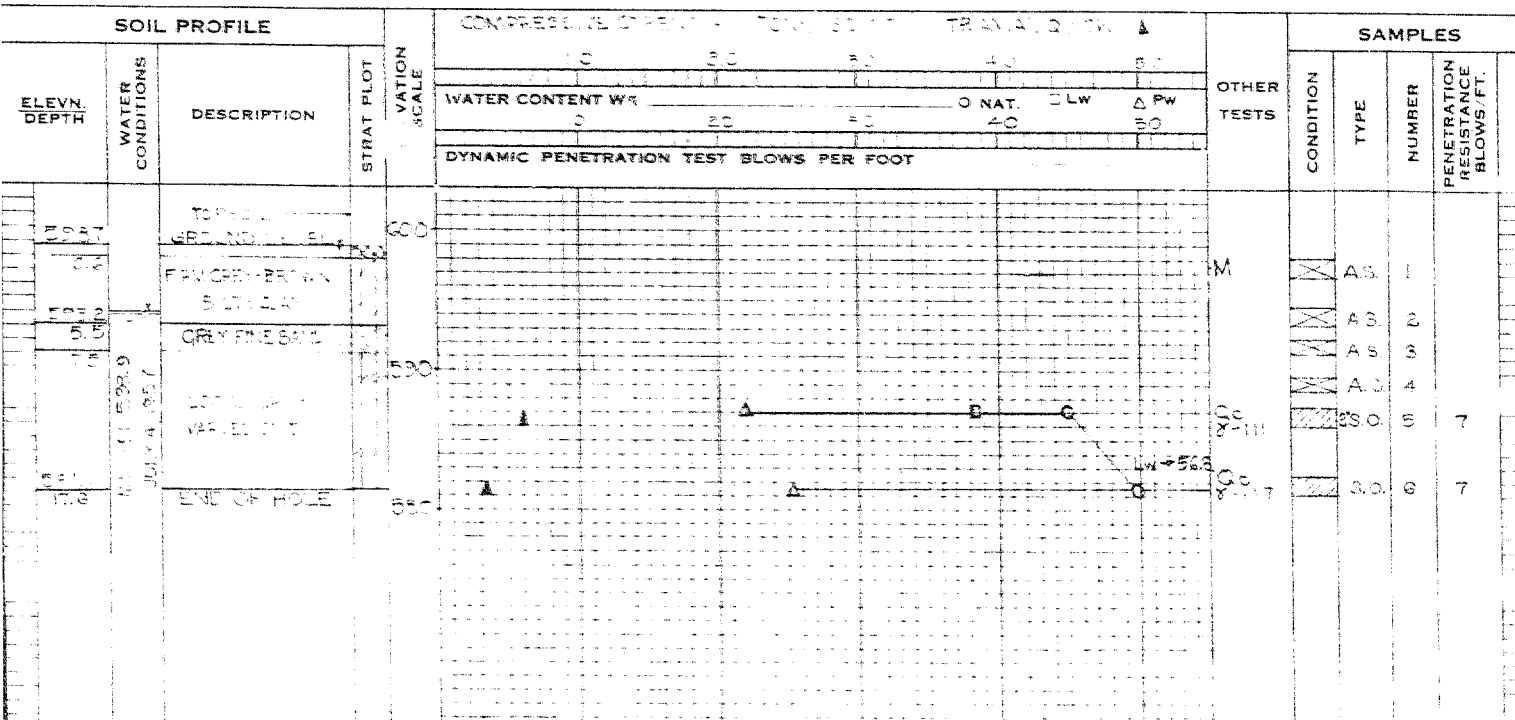
A.S. - AUGER SAMPLE
 S.T. - SLOTTED TUBE
 W.S. - WASHED SAMPLE
 D.O. - DRIVE-OPEN
 D.F. - DRIVE-FOOT VALVE
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 T.O. - THIN WALLED OPEN
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ABBREVIATIONS

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



GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT S9521 AUGER HOLE 5 DATUM GEODETIC CASING
 BORING DATE JULY 4, 1957 REPORT DATE JULY 8, 1957 COMPILED BY R.S. CHECKED BY R.S.
 SAMPLER HAMMER WT. 30 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION



SAMPLE TYPES

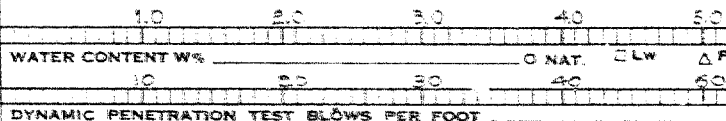
A.S. - AUGER SAMPLE
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 F.S. - FOIL SAMPLE
 S.O. - SLEEVE-OPEN
 S.F. - SLEEVE-FOOT VALVE
 T.O. - THIN WALLED OPEN
 R.C. - ROCK CORE

ABBREVIATIONS

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

SOIL PROFILE

COMPRESSION STRENGTH TONS/SQ FT TRIAXIAL QUICK Δ



DYNAMIC PENETRATION TEST BLOWS PER FOOT

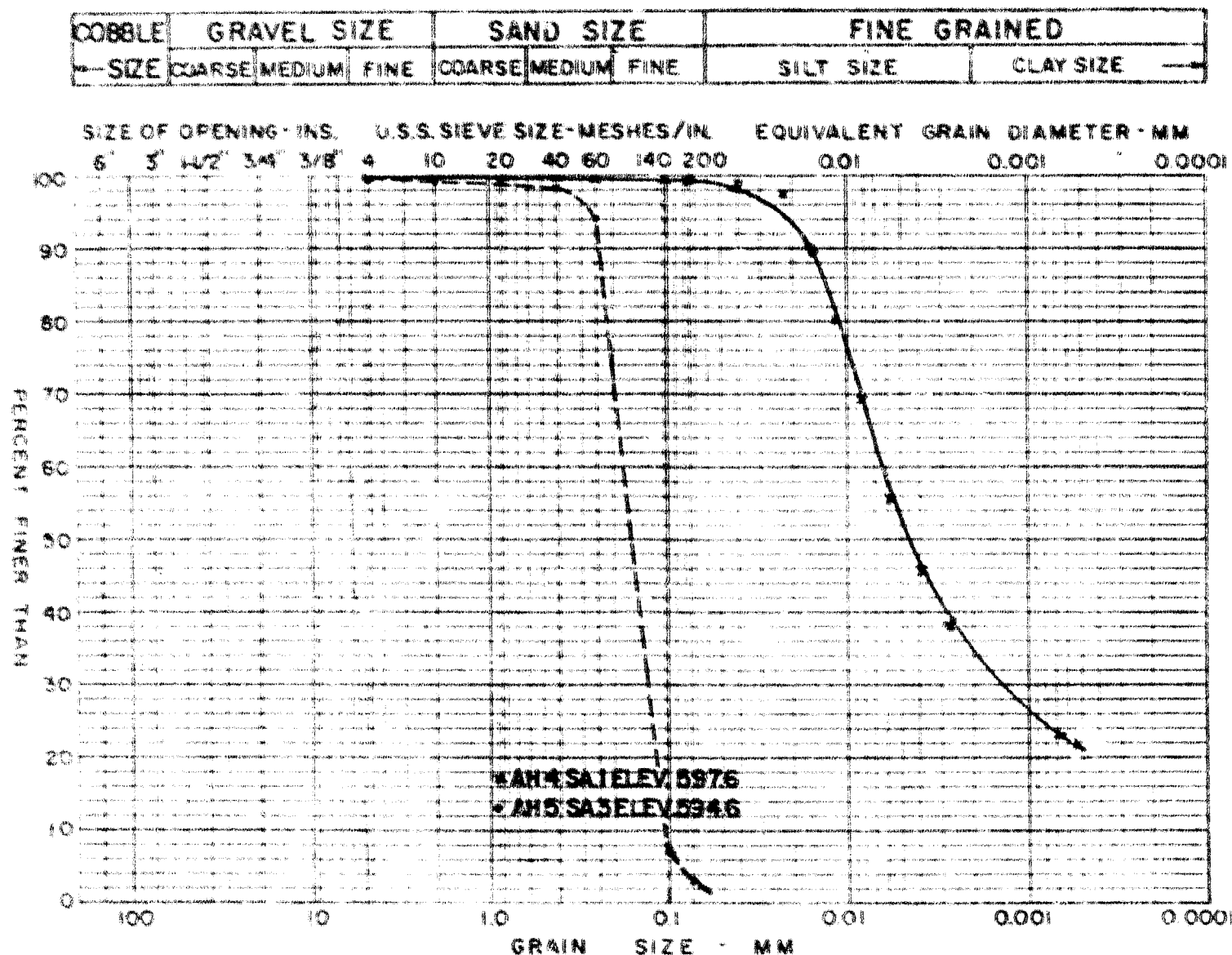
SAMPLES

CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
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FLYEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	OTHER TESTS	CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
0.0		TOP SOIL		0.0					
0.0		GROUND LEVEL		0.0					
0.0		PRIVACY - FLOWN		0.0					
0.0		SILTY CLAY		0.0					
0.0		LOOSE FINE SAND		0.0					
0.0		LOOSE GREY VARIED SILT		0.0					
0.0		END OF HOLE		0.0					

GRAIN SIZE DISTRIBUTION

APPENDIX II
FIGURE 1
PROJECT S6531

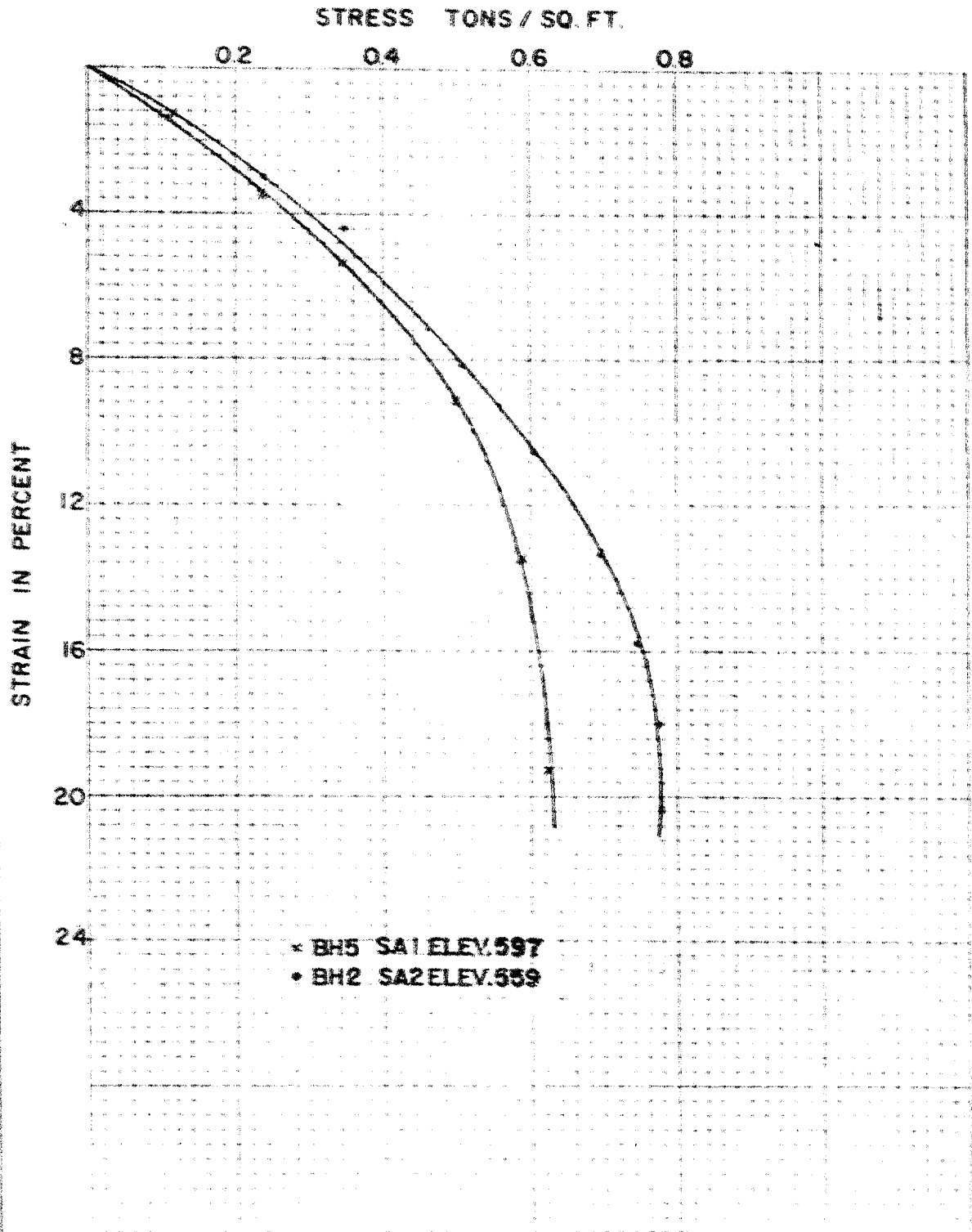


M.I.T. GRAIN SIZE SCALE

GEOCON

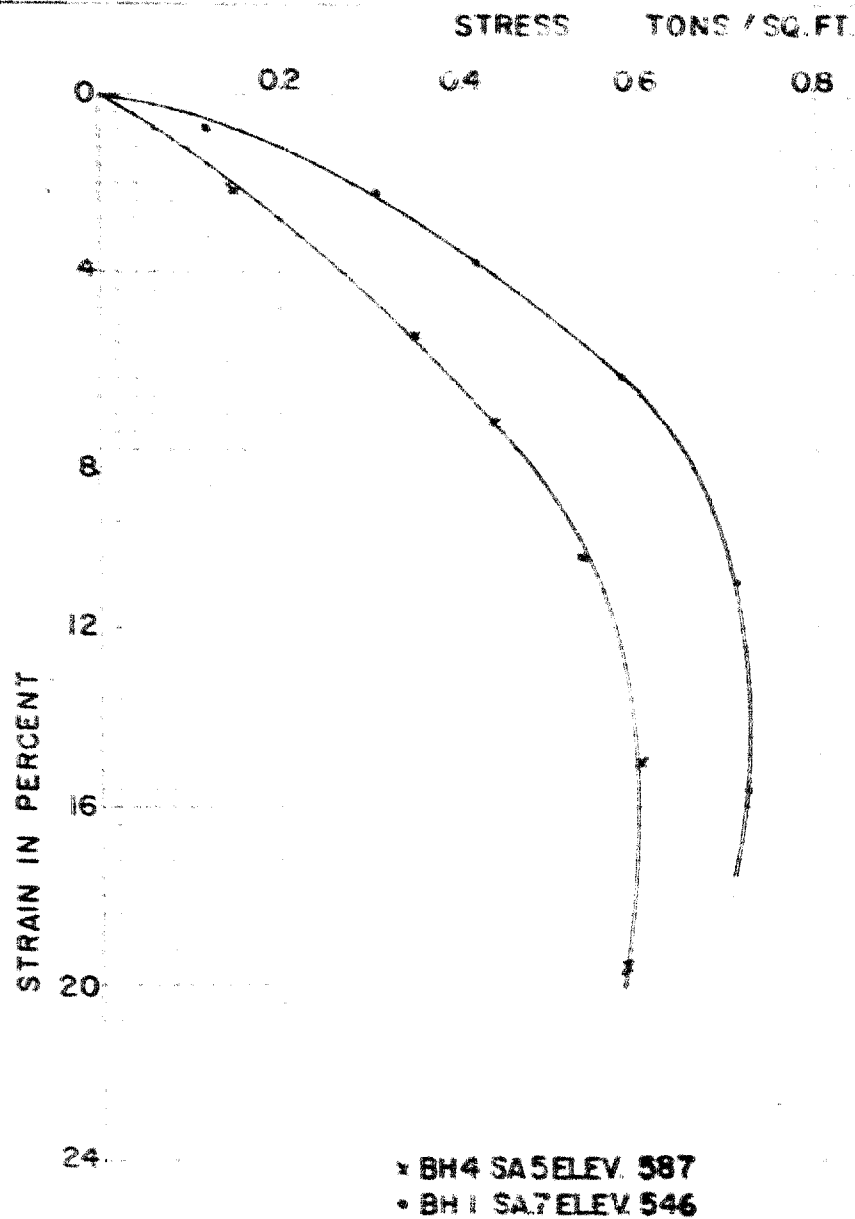
QUICK TRIAXIAL COMPRESSION TESTS SILTY CLAY STRESS STRAIN CURVES

APPENDIX II
FIGURE 2
PROJECT S6531



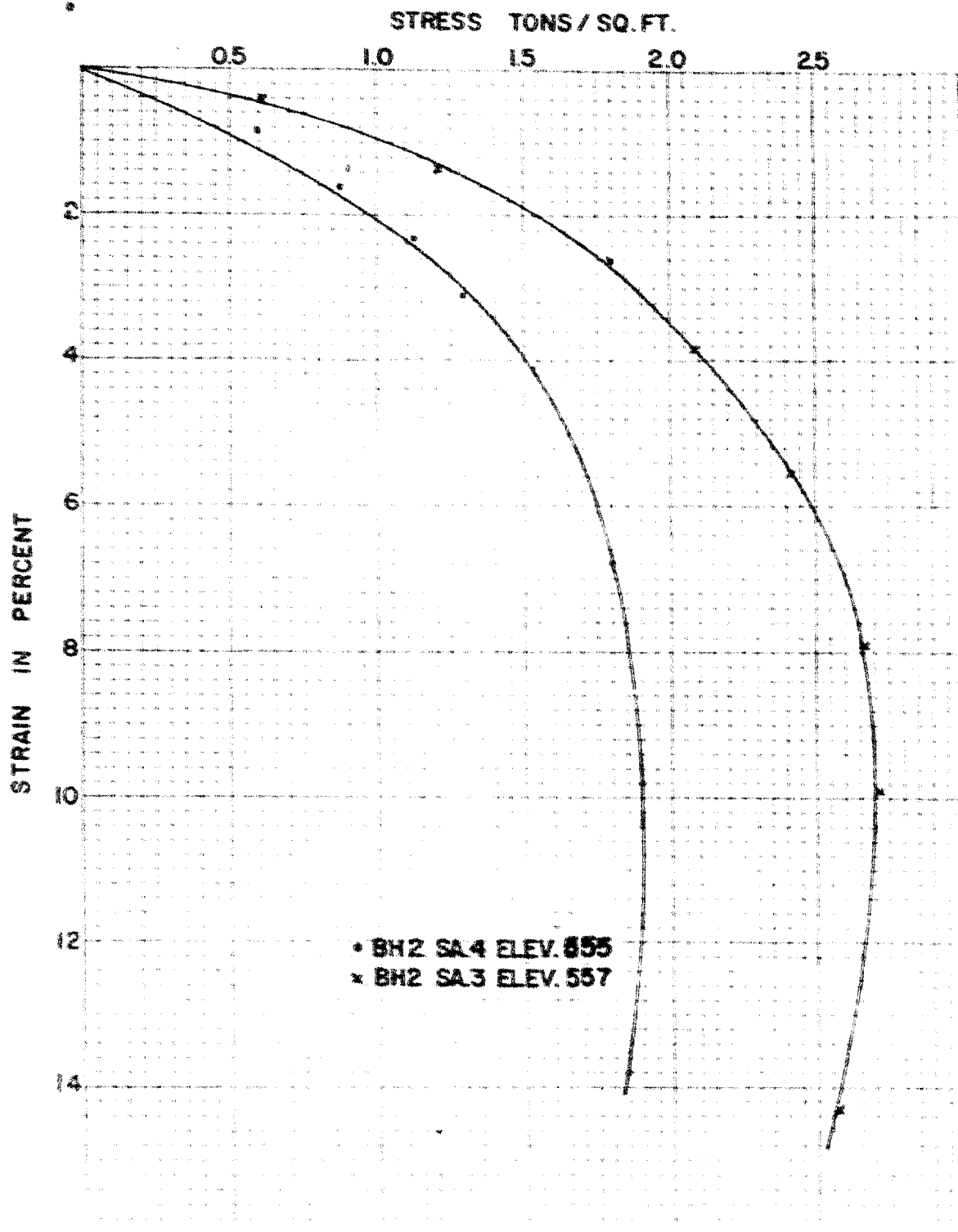
QUICK TRIAXIAL COMPRESSION TESTS VARVED SILT TYPICAL STRESS STRAIN CURVES

APPENDIX II
FIGURE 3
PROJECT S6531



CONSOLIDATED QUICK TRIAXIAL TEST VARVED SILT TYPICAL STRESS STRAIN CURVES

APPENDIX II
FIGURE 4
PROJECT S6531

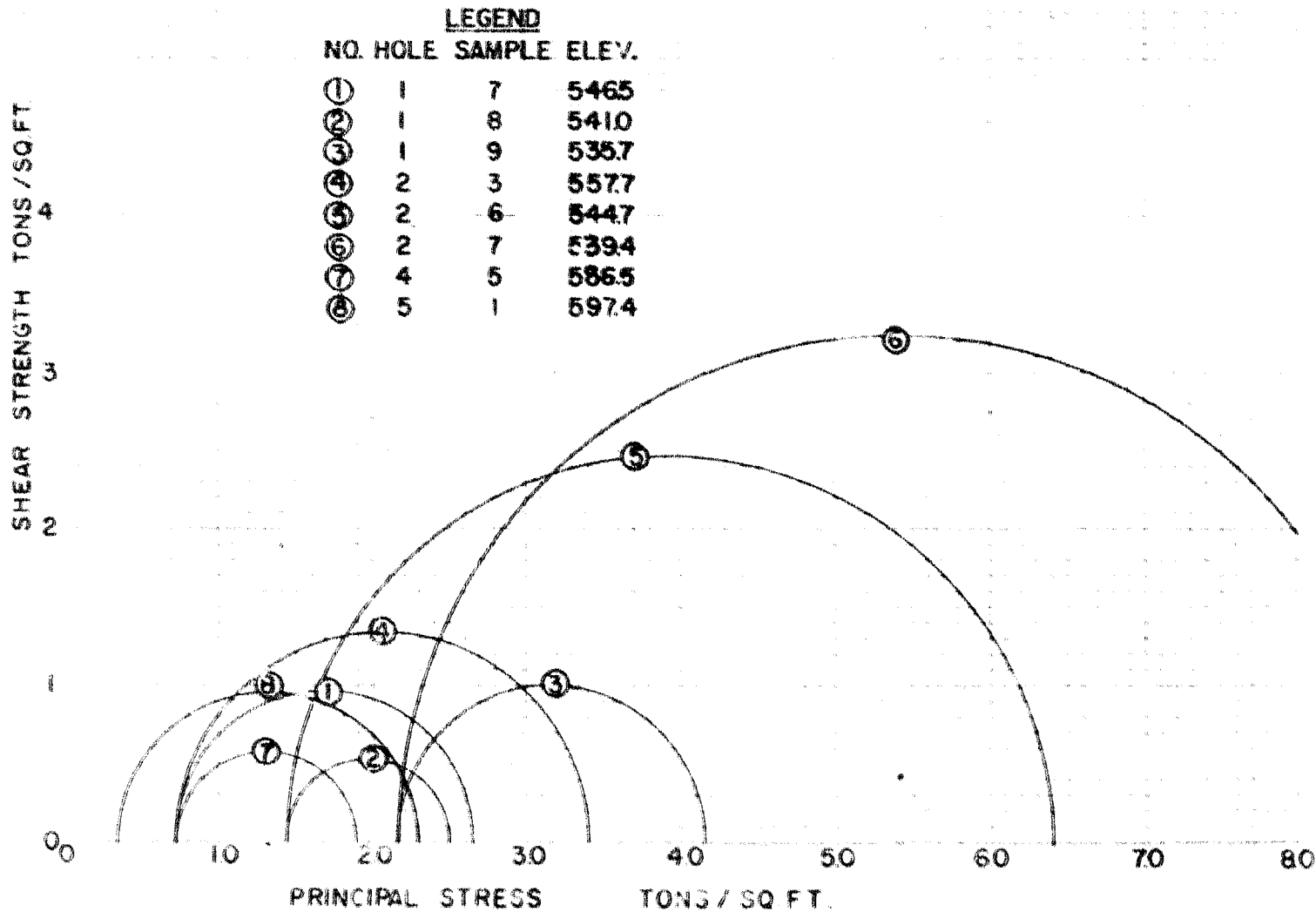


GEOTON

CONSOLIDATED QUICK TRIAXIAL TESTS

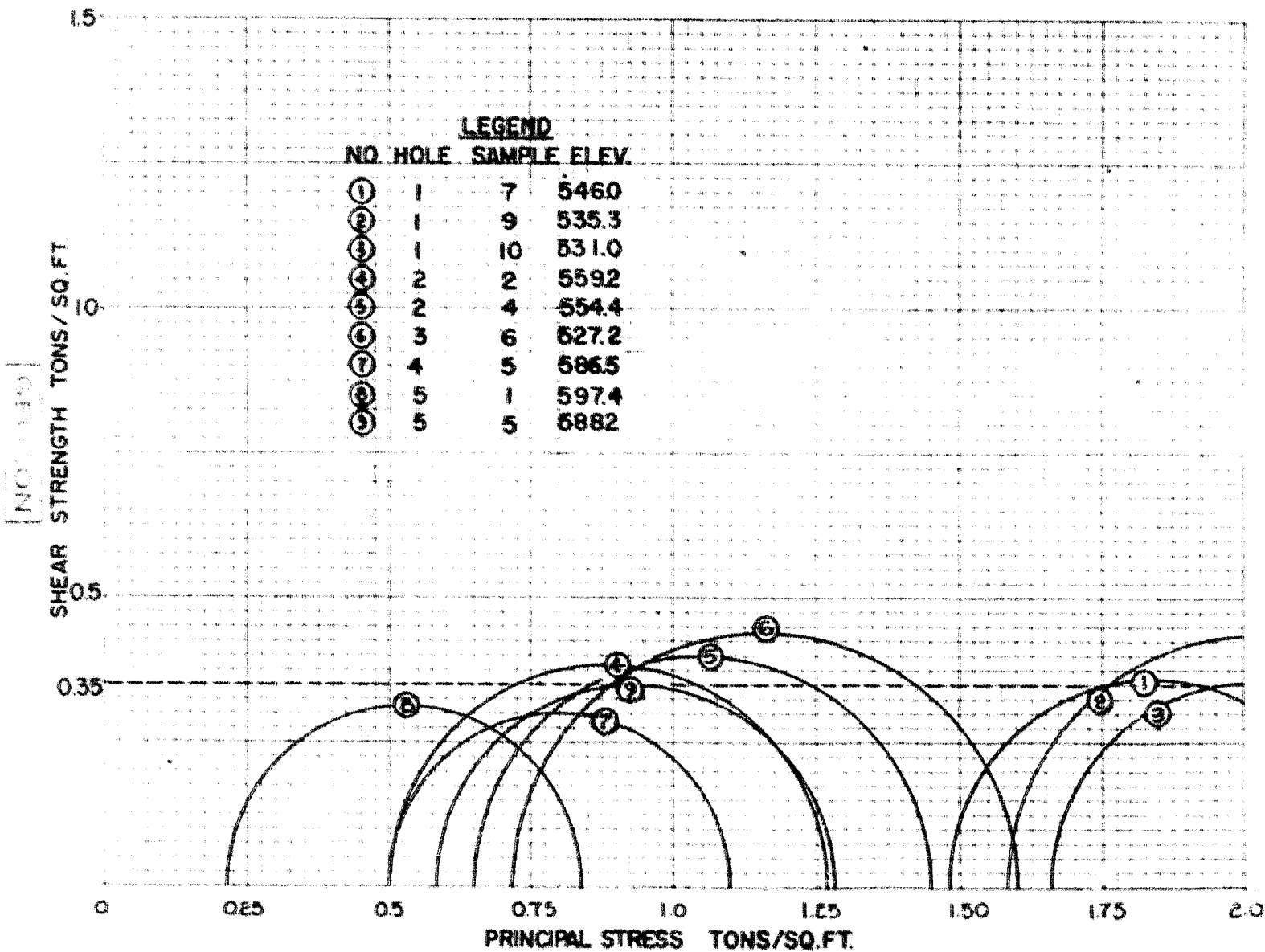
MOHR'S CIRCLES

APPENDIX II
FIGURE 5
PROJECT S6531



QUICK TRIAXIAL COMPRESSION TESTS MOHR'S CIRCLES

APPENDIX II
 FIGURE 6
 PROJECT S6531



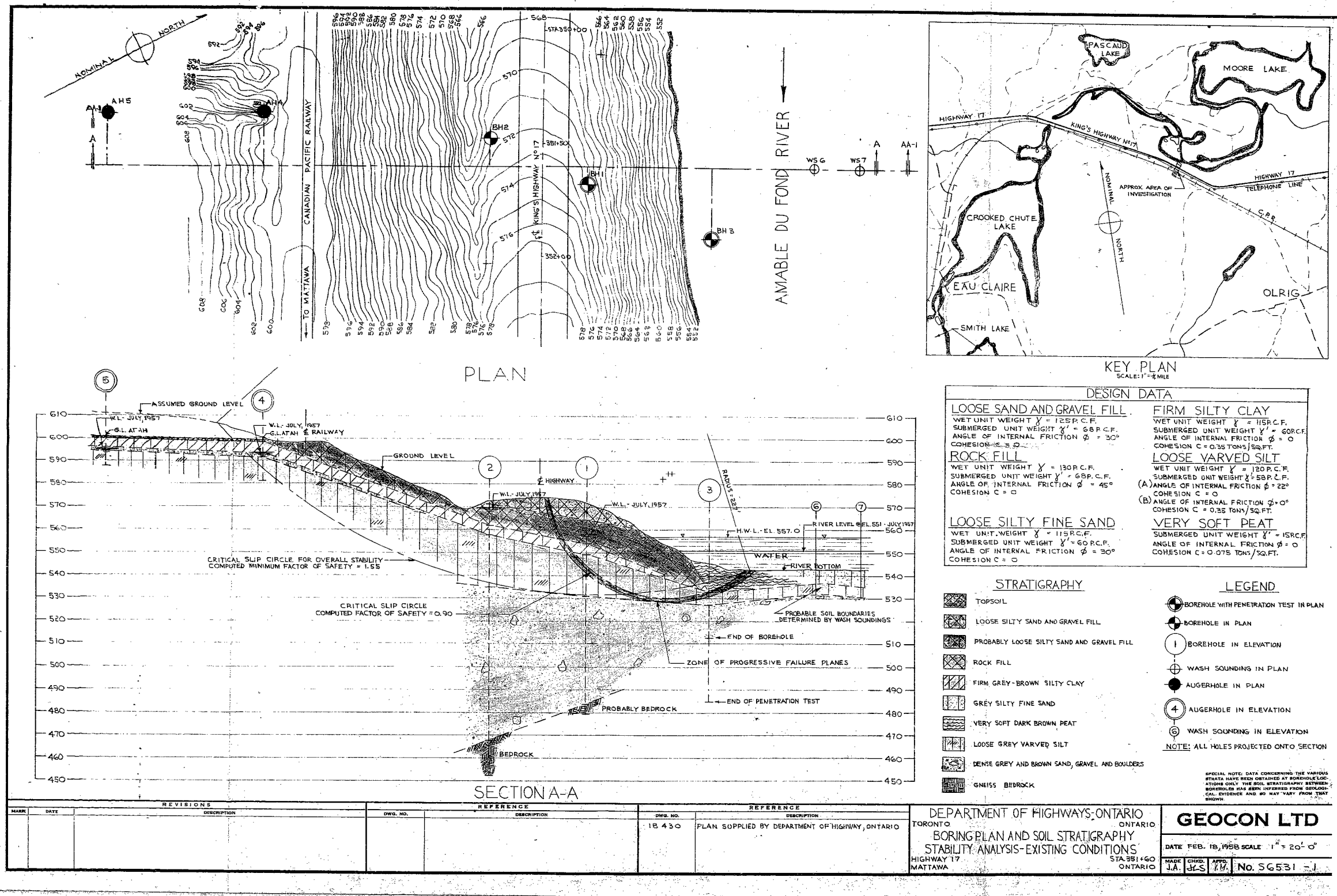
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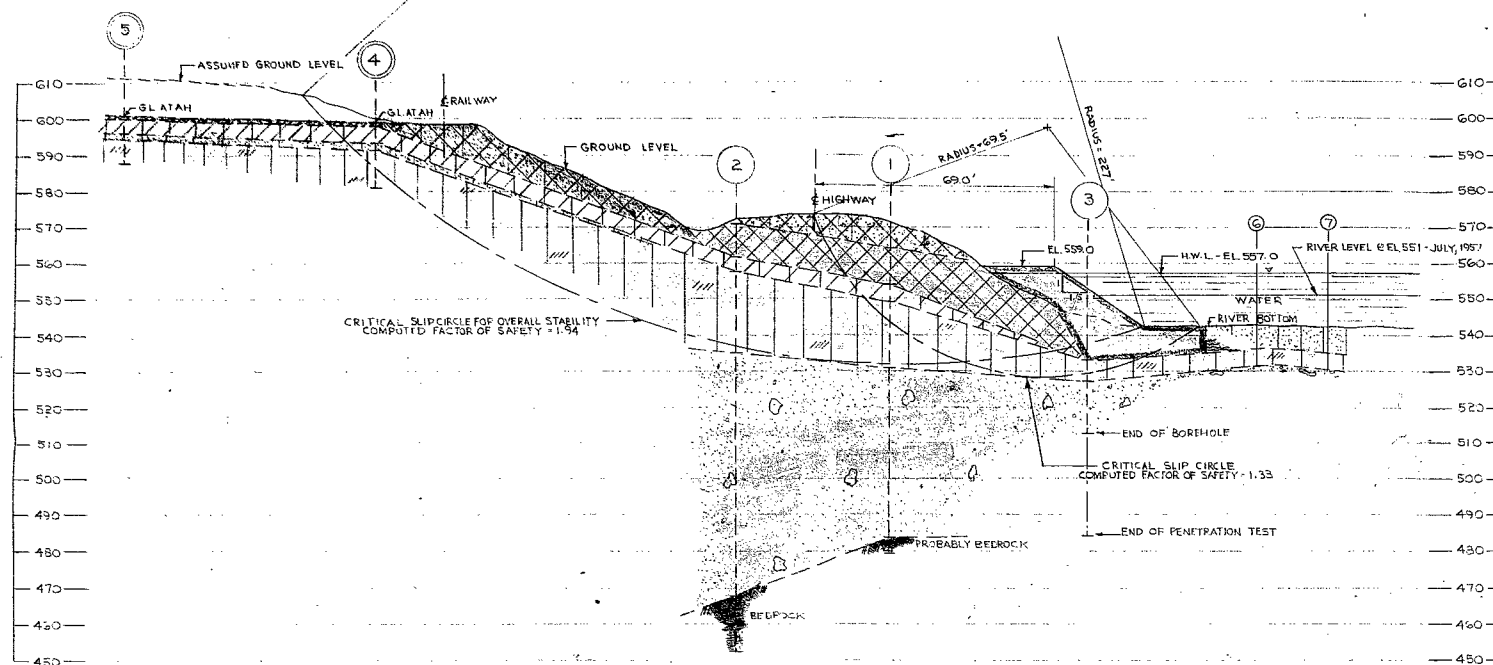
W.P. # 69-60

Hwy # 17

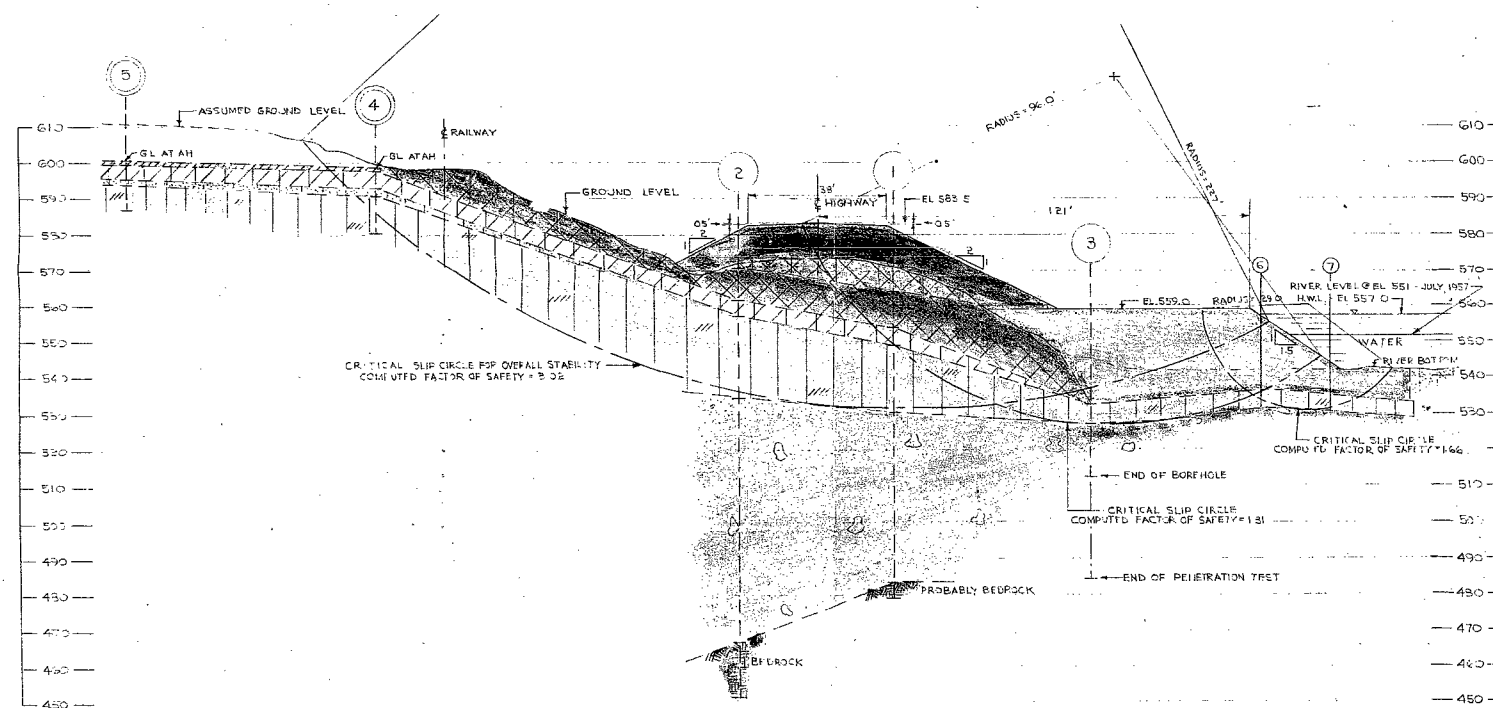
STA. # 351+60

MATTAWA.





SECTION A-A-1
SHOWING REQUIRED REMEDIAL MEASURES FOR EXISTING CONDITIONS

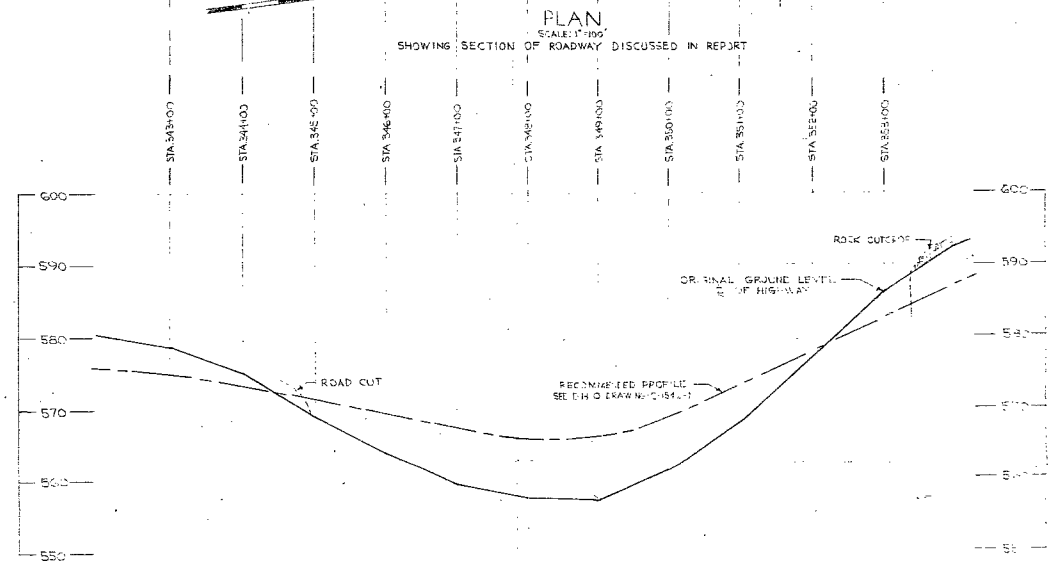
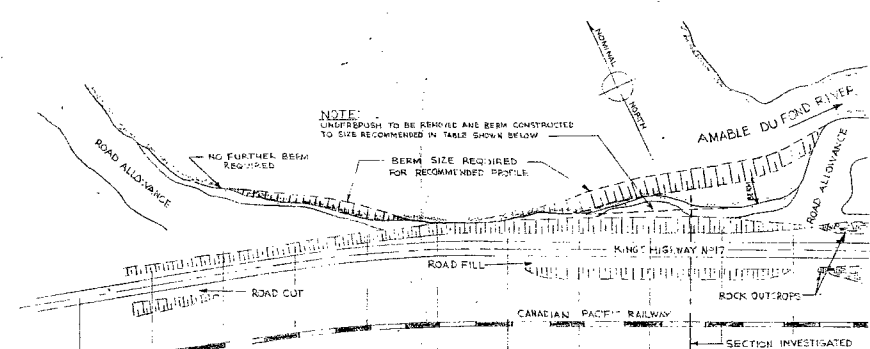


TYPICAL SECTION
SHOWING MAXIMUM HEIGHT TO WHICH EXISTING RAILWAY MAY BE RAISED

STRATIGRAPHY	
[Symbol]	TOPSOIL
[Symbol]	LOOSE SILTY SAND AND GRAVEL FILL
[Symbol]	PROBABLY LOOSE SILTY SAND AND GRAVEL FILL
[Symbol]	ROCK FILL
[Symbol]	REQUIRED SAND AND GRAVEL FILL
[Symbol]	REQUIRED ROCK FILL
[Symbol]	FIRM GREY-BROWN SILTY CLAY
[Symbol]	GREY SILTY FINE SAND
[Symbol]	VERY SOFT DARK BROWN PEAT
[Symbol]	LOOSE GREY VARVED SILT
[Symbol]	DENSE GREY AND BROWN SAND, GRAVEL AND BOULDERS
[Symbol]	GNEISS BEDROCK

DESIGN DATA	
REQUIRED SAND AND GRAVEL FILL	
WET UNIT WEIGHT $\gamma = 125 \text{ PCF}$	
SUBMERGED UNIT WEIGHT $\gamma' = 58 \text{ PCF}$	
ANGLE OF INTERNAL FRICTION $\phi = 30^\circ$	
COHESION $c = 0$	
REQUIRED ROCK FILL	
WET UNIT WEIGHT $\gamma = 115 \text{ PCF}$	
SUBMERGED UNIT WEIGHT $\gamma' = 53 \text{ PCF}$	
ANGLE OF INTERNAL FRICTION $\phi = 45^\circ$	
COHESION $c = 0$	

NOTE: FOR REMAINDER OF DESIGN DATA USED IN STABILITY ANALYSES SEE DRAWING SG531-1.



SECTION ALONG CENTRE LINE OF HIGHWAY
SCALE: HORIZ. 1" = 100' VERT. 1" = 10'

TYPICAL BERM DETAILS ALONG RECOMMENDED PROFILE		
PROPOSED ROADWAY ELEVATION	ELEVATION TOP OF BERM	WIDTH OF BERM AT SIDE SLOPE 1:1.5 (FEET)
566	559	-
568	559	2
570	559	5
572	559	14
574	559	20
576	559	27
578	559	34
580	559	40
582	559	47
584	559	54

- NOTES:
- (1) THE REQUIRED BERM SHOULD BE CONSTRUCTED COMPLETELY BEFORE RAISING THE ROADWAY ELEVATION.
 - (2) THE BERM SHOULD BE CONSTRUCTED OF ROCK FILL.
 - (3) THE ROCK FILL SHOULD BE PLACED BY END DUMPING IN LONGITUDINAL STRIPS PARALLEL TO THE CENTRE LINE. THE STRIPS SHOULD BE ALIGNED IN LINE WITH THE EXISTING COMPLETE DISPLACEMENT OF THE PEAT OUTWARD INTO THE RIVER.
 - (4) THE ROADWAY FILL SHOULD BE OF SELECTED SPANGLAP MATERIAL AND SHOULD BE WELL COMPACTED IN LAYERS NOT EXCEEDING SIX INCHES IN THICKNESS. THE PREPARED FILL SHOULD BE NON-FROST SUSCEPTIBLE.
 - (5) THE SLOPE OF THE BERM SHOULD BE FORMED OF THE LARGER ROCK-FILL SIZES TO PREVENT EROSION.

- LEGEND
- (1) BOREHOLE IN ELEVATION
 - (2) AUGERHOLE IN ELEVATION
 - (3) WASH SOUNDING IN ELEVATION

SPECIAL NOTE: DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

REVISIONS		REVISIONS		REFERENCE		REFERENCE		REFERENCE	
MARK	DATE	DESCRIPTION	MARK	DATE	DESCRIPTION	DWG. NO.	DESCRIPTION	DWG. NO.	DESCRIPTION
						28546	PLAN SUPPLIED BY DEPARTMENT OF HIGHWAYS, ONTARIO	28546	PLAN SUPPLIED BY DEPARTMENT OF HIGHWAYS, ONTARIO
						C1546-1	PROFILE ALONG HIGHWAY 17 - SUPPLIED BY DEPARTMENT OF HIGHWAYS, ONTARIO	C1546-1	PROFILE ALONG HIGHWAY 17 - SUPPLIED BY DEPARTMENT OF HIGHWAYS, ONTARIO
						SG531-1	GEOCON LTD. BORING PLAN & SOIL STRATIGRAPHY	SG531-1	GEOCON LTD. BORING PLAN & SOIL STRATIGRAPHY

DEPARTMENT OF HIGHWAYS, ONTARIO		GEOCON LTD.	
TORONTO	ONTARIO	DATE FEB 20, 1958	SCALE 1" = 20.0'
STABILITY ANALYSES SHOWING REMEDIAL MEASURES EXISTING AND FUTURE CONDITIONS		MADE BY	APP'D BY
HIGHWAY 17 MATTAWA		STA 51+00	STA 51+00
		DATE	NO. SG531-2