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Mr. A. Toys

December 14, 1955

Bridge Engineer

Re: Foundation Investigation:

Highways Laboratory, Sheppard Ave.

Highway 401: C.N.R. Overpass East of
Cornwall. Site Plan E3891-1. Project F55-10

We are forwarding herewith the foundation investigation report for the above noted structure. This structure does not appear on any immediate preparation list but was investigated because our core drill equipment was working this past summer in the Cornwall area.

As you will notice from the included plan No. F 55-10A, the bore holes were placed in the immediate vicinity of the proposed footing locations. It became apparent upon analyzing the results of the samples that the foundation conditions are much worse than anticipated in the field and as a result additional borings may be required depending upon the final design chosen. However, from the preliminary borings, three alternatives are proposed for the approach fills as follows:

1. Construction of the approach fills in stages to a 3:1 slope over a 2-year period.
2. Construction of bents.
3. Trestle construction in lieu of fill over an area where the proposed height of fill is more than the subsoil can support safely.

For this latter alternative, additional field work will be required to determine the type of foundation that will be required for the trestle footings beyond the area of our preliminary bore holes.

After you have studied the various proposals put forth we would be pleased to hear from you as to the final acceptable design so that we may perform additional investigations if required.

F. C. Brownridge
Materials and Research Engineer
Per:

A. Rutka

(A. Rutka)

Encls in:

Mr. A. Toys (2)
Mr. J. Walter
Mr. F. Prosser
Mr. J. B. Miles
Mr. C. Parvatisen
File

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REPORT OF FOUNDATION INVESTIGATION

FOR PROPOSED NEW BRIDGE

ON HIGHWAY NO. 401 OVERPASSING CNR.

at Cornwall

Bridge Site Plan No. E-2891-1

Copies to:

Mr. A. Toye, Bridge Engineer,	(2)
Mr. J. Walter, Design Engineer,	(1)
Mr. H. Tregaskes, Const. Engineer,	(1)
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Mr. G. Farantatos	(1)
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Project No. F-55-18

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INTRODUCTION

A new bridge is to be built for Highway No. 401 for the crossing of the Canadian National Railway, located about 3 miles North-East of Cornwall.

Subsoil investigation was conducted on the above site to find out the best type of foundation for the overpassing structure.

PROCEDURE

The field exploration on the foundation site was performed with the aid of a coredrill machine mounted on track.

Altogether four cone penetration holes and two bore holes were made.

The locations and elevation of the bore holes are shown in Drawing S-55-12a. Their logs are found under Appendix I.

SOIL CONDITIONS

One borehole was made on each side of the railway track where the proposed footings of the new bridge are to be located. According to findings from these two boreholes, the sub soil of the area can be generally described as clay overlying dense sandy till.

The consistency of the clay was in probability affected by the position of the ground water. That above the water level was hard clay; below it the clay was found to be soft, and fully saturated.

The layer of till has a larger proportion of sand than clay, but throughout its depth to the end of the boreholes its composition is very sticky and gravelly making deeper boring difficult.

Both boreholes were brought down to about 30 ft.

WATER CONTENT

The water table level in B.S. # 3 was observed to exist at about 4.5 ft. below ground surface. This was observed 24 hours after casing was withdrawn and hole bailed dry. Apparently the water table in B.S. # 1 must have existed at the level where the soft wet clay was located.

ANALYSIS OF TEST RESULTS AND DISCUSSION

Bridge Foundation

The hard clay samples gave unconfined compressive strength about 3,400 lbs/sq.ft. but the soft clay has an average value of only 600 lbs/sq.ft.

The unconfined compressive strength of the hard clay found above the water table level indicates that the safe bearing capacity of this material to be around 3,400 lbs/sq.ft. However, because of the small depth of this hard clay layer, any pressure greater than 1,000 lbs/sq.ft. exerting on it would overstress the immediately underlying soft clay. Due to this danger the use of spread footing foundation for the new bridge is not recommended.

Pile foundation brought down to bear on the till is the most appropriate method. In this respect, either the steel H-pile or the concrete cast-in-place pile could be used.

The concrete cast-in-place pile has the advantage of utilizing its highly compressed layer in the dense till layer. Such type of piles could usually provide about 100 tons per pile, having the advantage of very small or negligible settlement. The lengths required of such piles may lie between 17 ft. to 25 ft. depending on the irregularity of the till strata and the elevation of the footings. They should be penetrated at least 5 ft. into the till layer.

Stability of Approach Fills

The following analyses assume soil conditions as existed in BH # 1 and B.A. # 1.

As indicated in the Bridge Site Plan No. B-2391-1, it requires about 34 ft. of fill on both the approaches to bring the roadway up to the proposed grade.

Because of the very low shearing strength of the soft clay existing below the water table level, there is a danger of sliding from within this weak layer once it is overstressed.

The height of fill that can be safely brought up on the approaches is estimated to be 25 ft. on 1:3 slope. It is therefore not safe to install the fill up at one time to any height greater than 25 ft.

The procedure of making the fill in stages may be employed. This requires that the safe fill of 25 ft. be first installed from original ground level on 1:3 slope. A time of about 20 to 24 months is then allowed for the underlying soft clay to consolidate thereby increasing its shearing strength. By this process it is estimated that the shearing strength of the clay will be increased by about 10% to 40% after about 24 months. At the end of that time the fill can then be brought up to the required height.

For less-time consuming, stabilization by loading berms may be used to bring the fills up to the required height in one stage. For this operation berms are necessary where fills exceed the safe height of 25 ft. according to Road Profile No. -V-3468-6, berms are required between Sta. 645+00 and Sta. 646+70, up to the limits of the abutments. For maximum fill of 34 ft. the length of berms required should be 40 ft. and may be reduced in accordance with the overall height of the fills.

Stability of Approach Fills (continued)

Each berm will be 20 ft. in height throughout the loading distance.

From knowledge of liquid limits of the clay the ultimate settlement due to the effect of 34 ft. of fill is expected to be as much as 20.0 inches. This will take a period of from 5 to 6 years to reach 90% consolidation.

Summarizing from the above analyses it now leads to the fact that the methods already discussed are either time consuming or expensive. If fills are made up to the limits of the abutments as shown in Drawing No. F-55-131, there is still no apparent guarantee as to the stability of the fill because of the soft clay. This statement may be verified with respect to the safety of the existing railway track. The back fill near the abutment as proposed is maximum i.e. 34 ft. On account of this large increased weight there is a possibility that soft clay under the fill may squeeze out and move into zones of lesser stress. This may result in the heaving up of the ground under the railway track. For this reason it is advisable that the bridge on such location should be a trestled structure extending across the railway track, from Sta. 645+00 to Sta. 645+70. At these limits the abutments may be located as the fills will be 20 ft. which the ground can safely carry. Where piers are required in the immediate positions the foundation can be provided by piles as mentioned previously.

Conclusion

Bridge Foundation

Pile foundation for the new bridge is recommended because of the poor shearing strength of the soft clay.

Concrete cast-in-place piles or steel H-piles could be used. Such piles should be driven to bear in the hard sandy-fill layer, located between elevations 16.0 and 16.4, as observed in the two borings.

Bridge Foundation (Continued)

The length of piles will be between 17 ft. to 25 ft. or more, depending on the elevation and irregularity of the till layer.

Concrete cast-in-place piles with compressed barge in the till are expected to provide 100 tons per pile.

Steel H-piles can also be used but the load bearing capacity should be checked by driving formula or by actual pile loading tests.

Stability of Approach Fills

The fills required on both approaches vary to a maximum height of 34 ft. at the abutments according to Bridge Site Plan No. E-3891-1. The safe fill that can be put up should not exceed 25 ft. on 1:3 slope.

It is not advisable to place the abutments of the bridge at the locations as proposed. The load from the large fills at the abutments may cause heaving of the ground under the railway track because of the possible movement of the underlying soft clay. Giving due consideration to the safety of the railway track it is recommended that the bridge for this site should be a structure trestled across the railway line, with the abutments to be located at approximately Sta. 645+00 and Sta. 642+70.

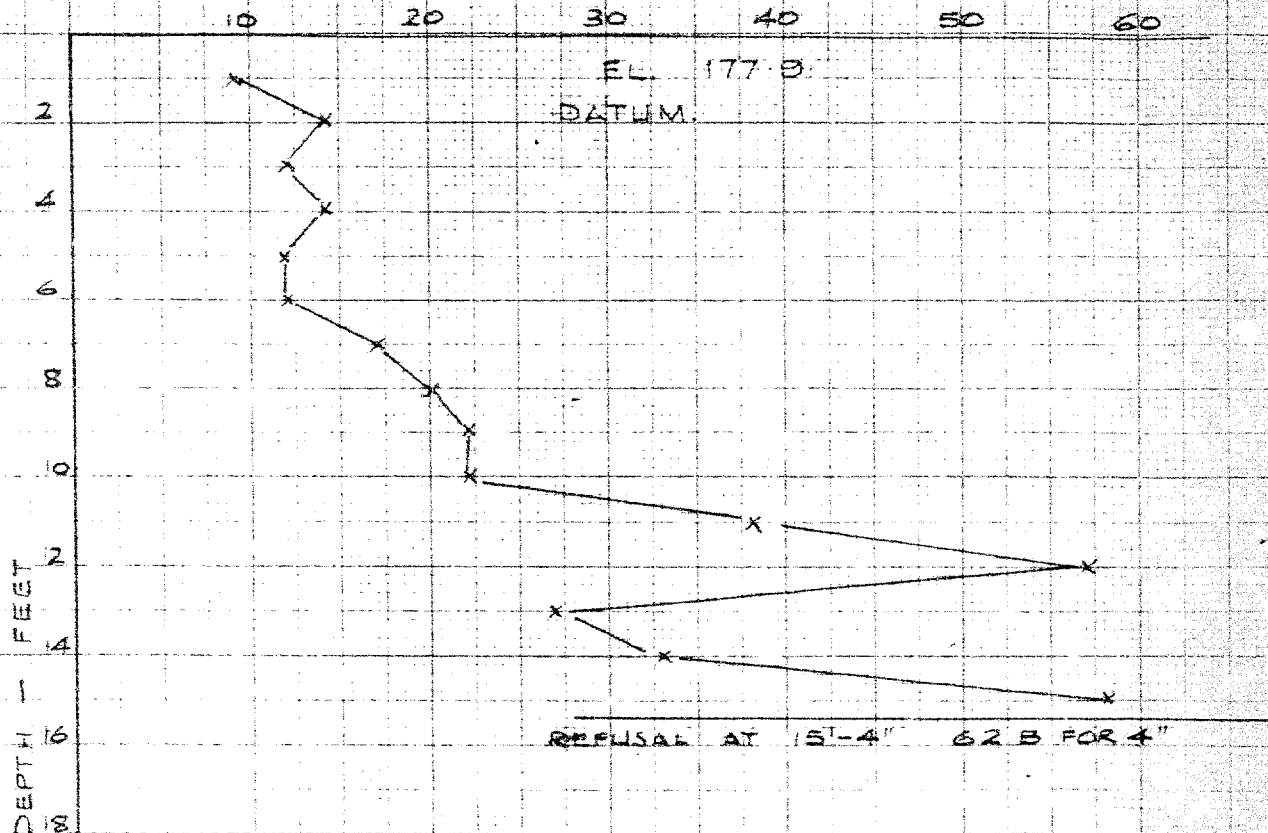
The fills at these limits are 25 ft. which the ground can safely carry.

Any piers in the intermediate positions may be likewise supported on piles.

C. S. Farantatos
Foundation Engineer.

GRAPH OF CONE PENETRATION TEST

NO BLOWS/FT AT STD EN. = 4200 lb.in

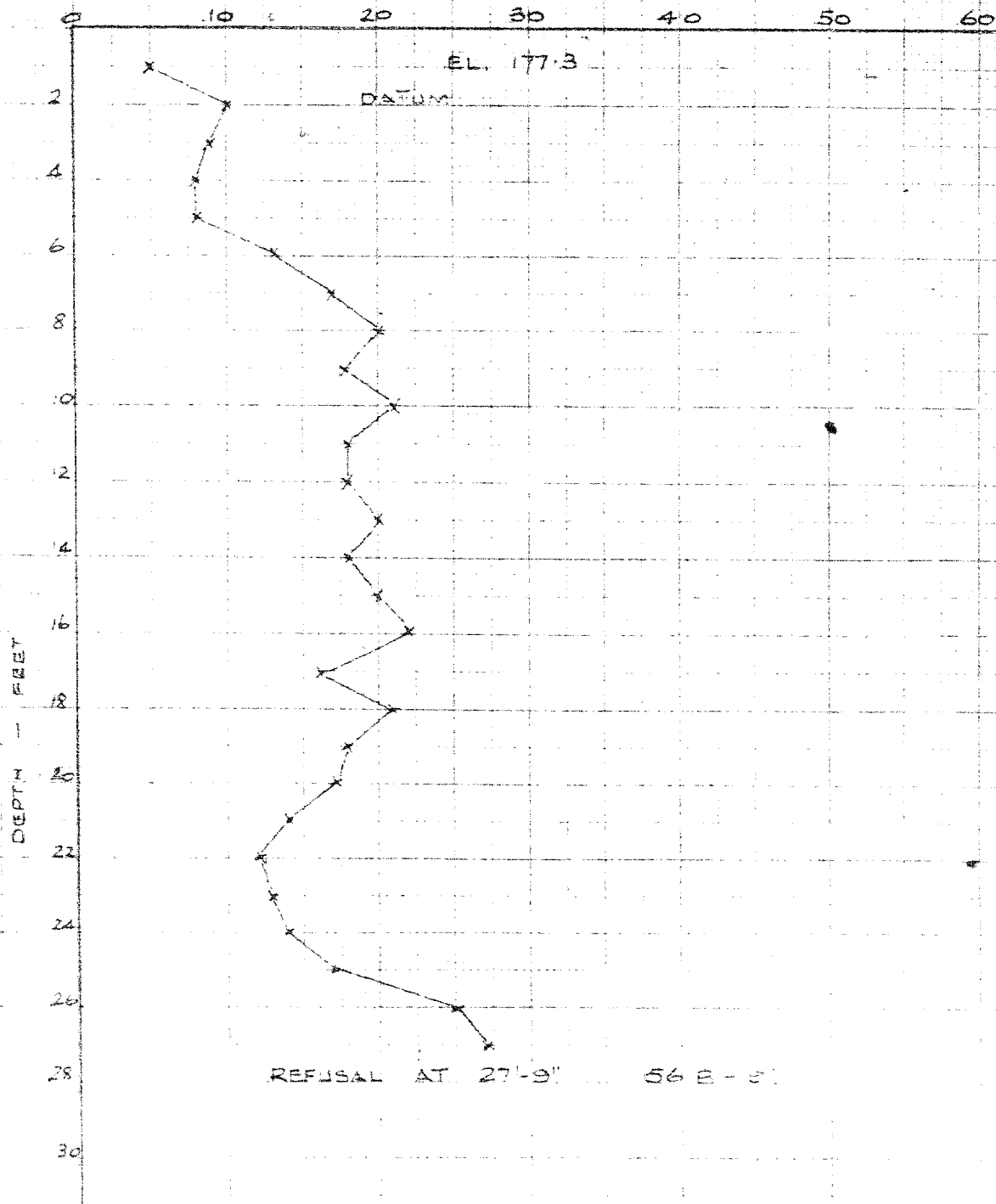


JOB # 55 F-18

BH #4.

GRAPH OF CONE PENETRATION TEST

NO. BLOWS/FT. AT STD. EN = 4200 lb. in.



55-F-18
Hwy. #401
OVERPASSING
C.N.R. AT
CORNWALL

EDITED
FOR MICROFILMING
BY *H.P.* DATE *2/10*

TL 159
S4.90

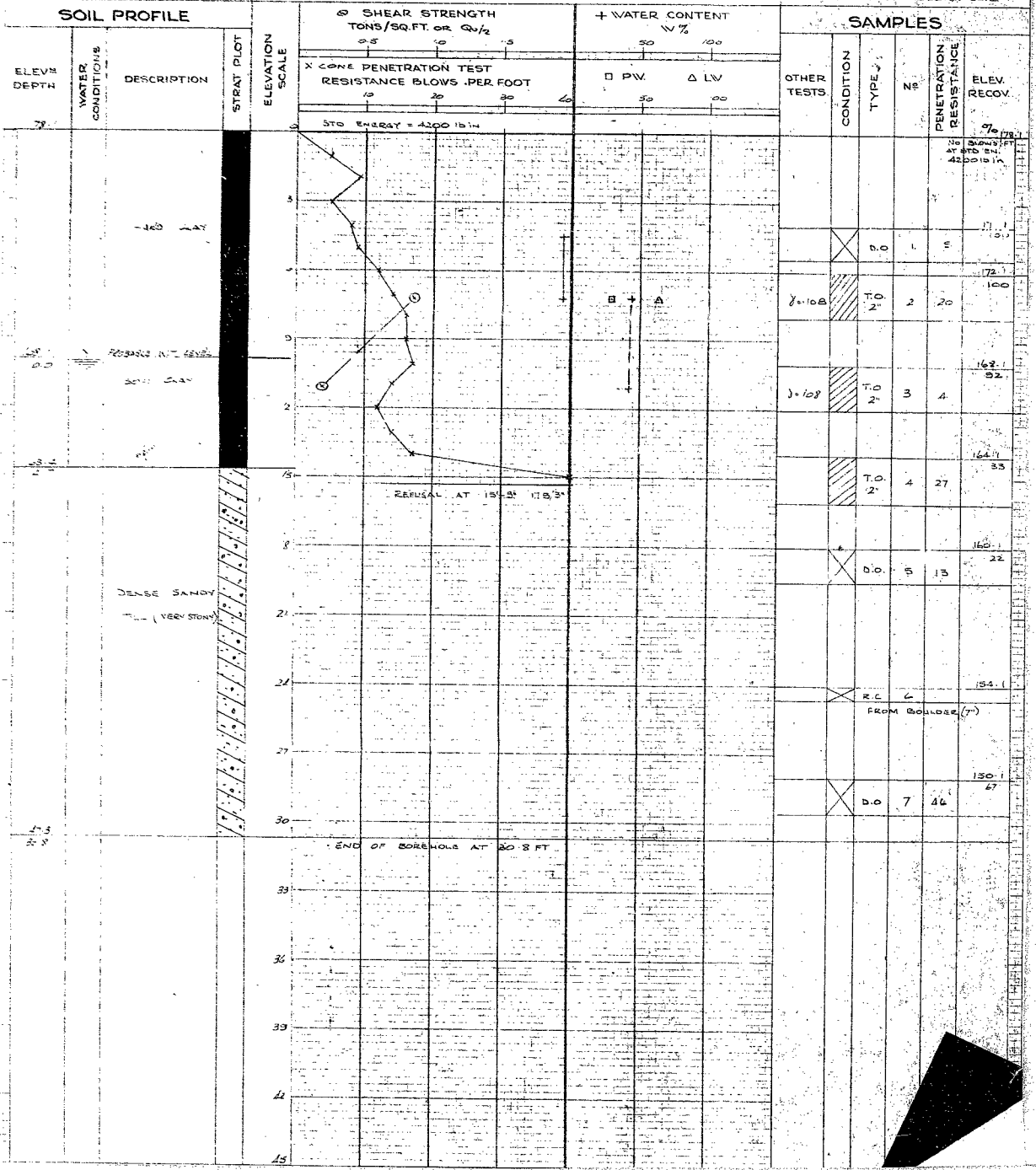
MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG: CASE DRILL #1
CASING: (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT: # DROP: INCHES
JOB: 55-E-12 AT CHARLOTTENBURG
DATE: JULY 23, 1964
BORING NO: 3
DATE REPORT: JULY 27, 1964
BORING DATE: JULY 23, 1964
COMPILED BY: B.H. CHECKED BY: HONG M.

SAMPLE CONDITION
DISTURBED
GOOD
LOST

SAMPLE TYPES
CS - CHUNK
DO - DRIVE OPEN
DF - DRIVE FOOT VALVE
TO - THIN WALLED OPEN
VS - WASHED SAMPLE
RC - ROCK CORE

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



TL 159
S4.90

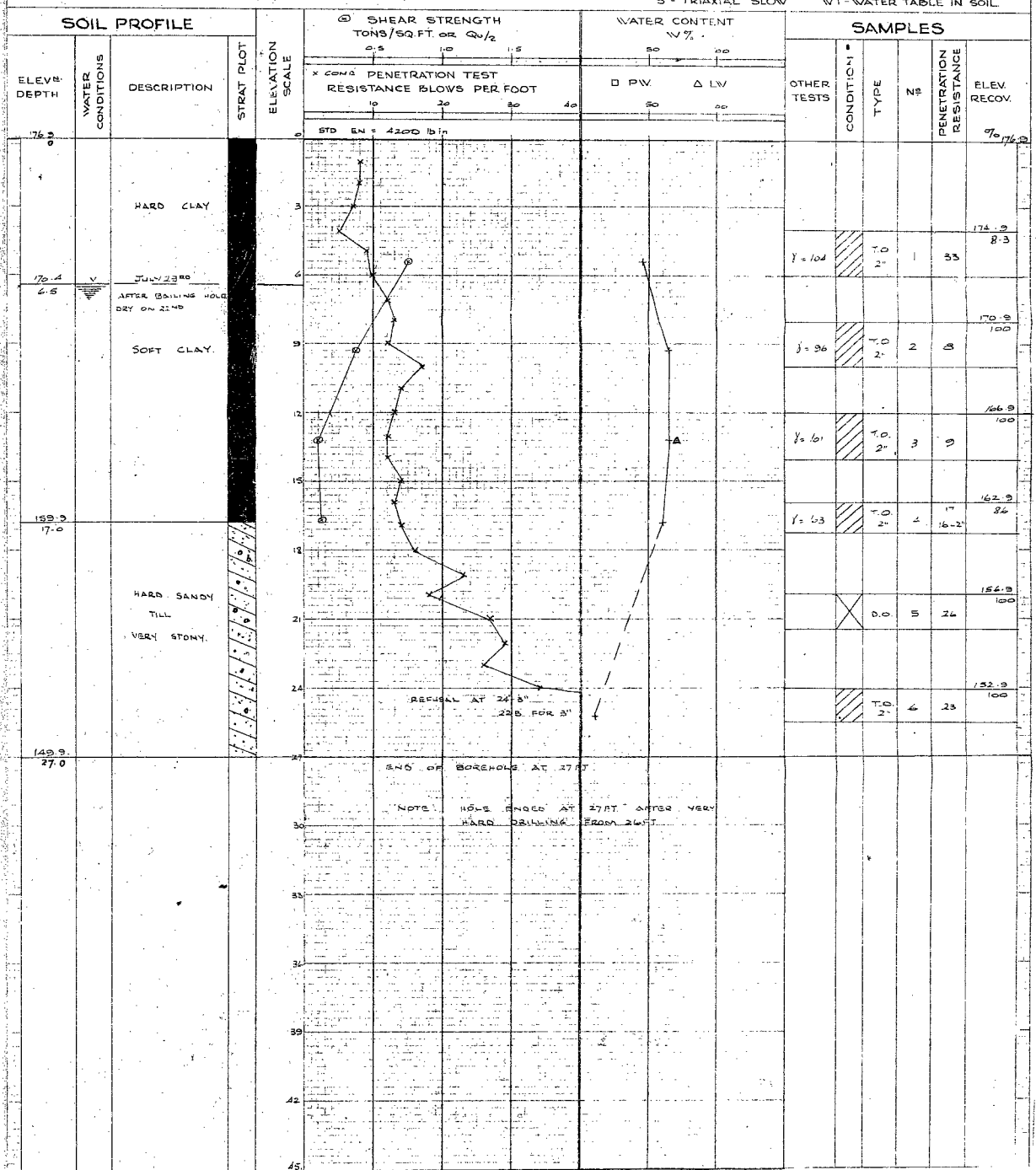
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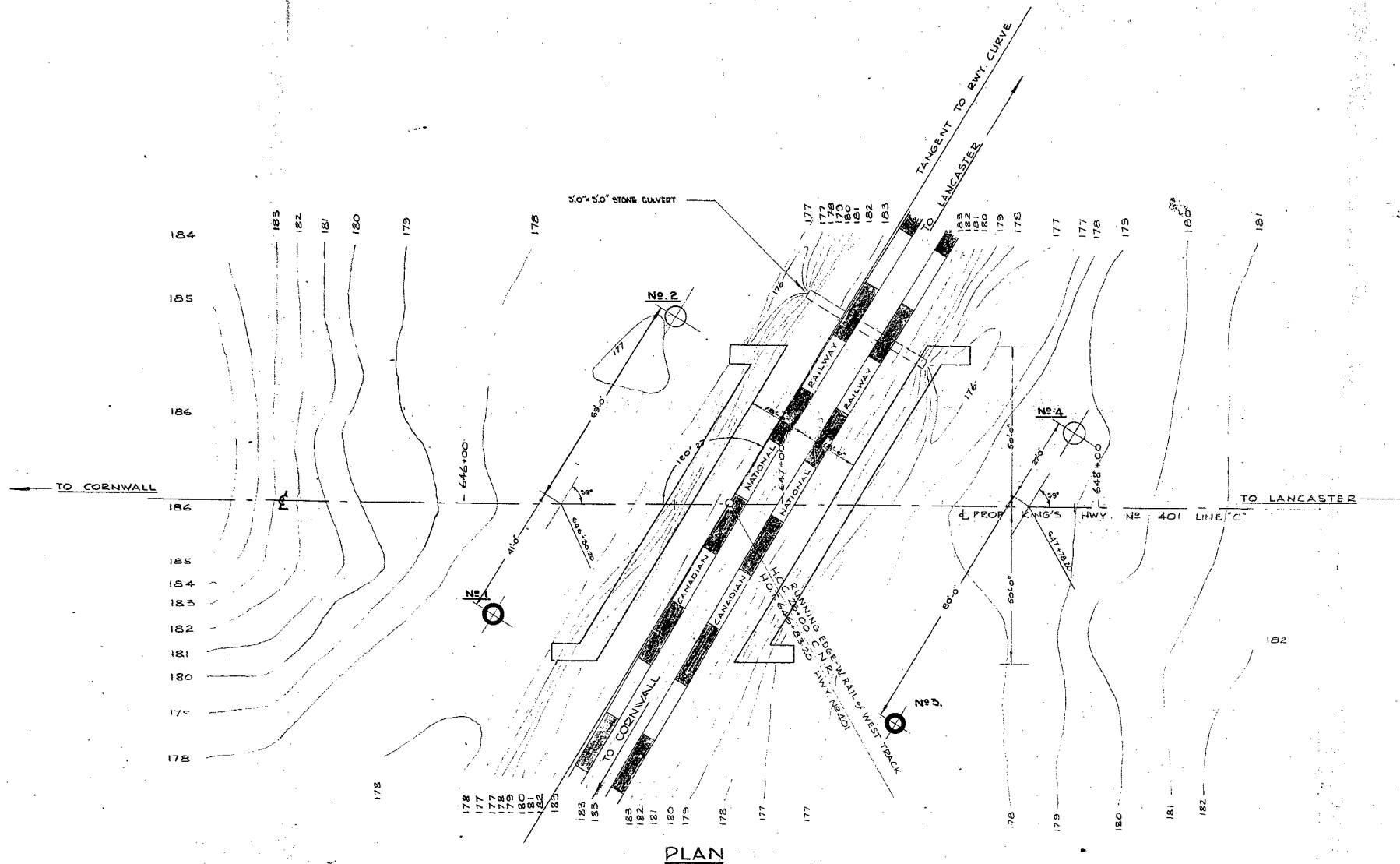
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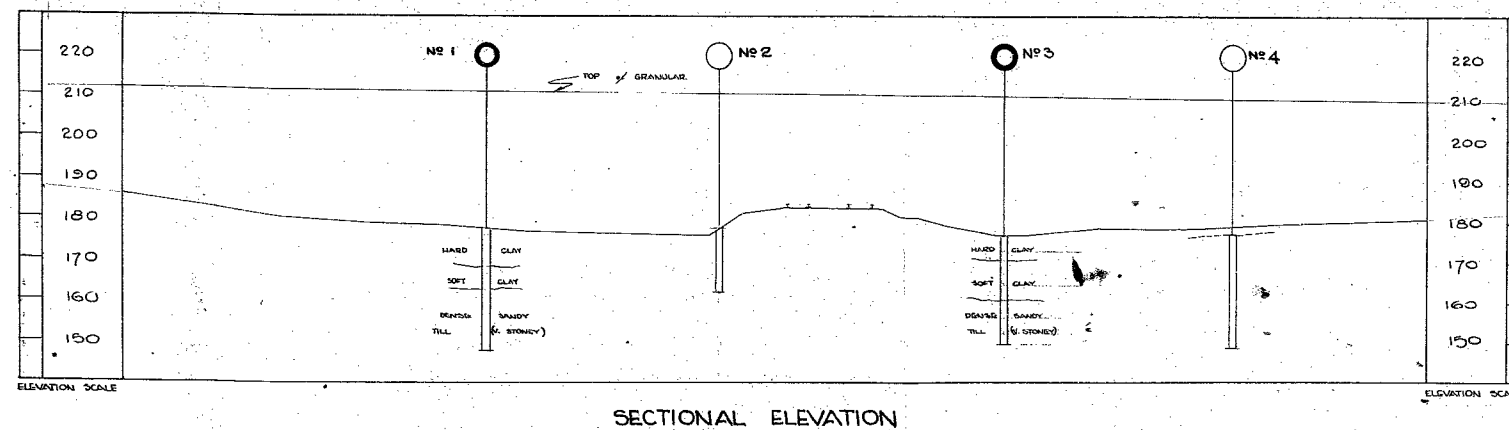
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LEGEND
 ○ BOREHOLE
 ○ PENETRATION HOLE

SCALES
 HORIZONTAL 1 inch = 20 feet
 VERTICAL 1 inch = 20 feet



PRINT RECORD		
NO.	FOR	DATE

DEPARTMENT OF HIGHWAYS-ONTARIO			
MATERIALS		LABORATORY - TORONTO	
PROPOSED CROSSING of CANADIAN NATIONAL RAILWAY AND KING'S HIGHWAY No. 401 PROPOSED REVISION LINE "C"			
THE KING'S HIGHWAY No. 401		DIV. No. 9	
CO. GLENGARRY			
TWP. CHARLOTTENBURG		LOT 6	CON. II
LOCATION of BOREHOLES & SOIL PROFILE			
APPROVED			
CHIEF BRIDGE ENGINEER		CHIEF ENGINEER	
DESIGN	CHECK	CONTRACT	NUMBER
DRAWING	NDM	CHECK	LOADING
TRACING	CHECK	DATE	NOV 8 1955
DRAWING NUMBER		F-55-18-A	

REVISIONS	DATE	BY	DESCRIPTION