#58-F-216-C

HWY. #401

NAPANEE RIVER,

NAPANEE

Telephone 2-6815
2-1214

J. D. LEE & COMPANY
LIMITED
Consulting Engineers
10 Chapman Street
Kingston, Ontario

DATE Dec. 4/58.

TO: F. L. HEWSON
O.H.O. Bridge Office
Toronto

FILE 170

RE: MINKS BRIDGE
NAPANEE RIVER

Enclosed herewith are:

COPIES	DRAWING NO.	DATE	DESCRIPTION
1			Soils Report BA 755

☐ for your approval and/or comments

☐ approved except as noted, please revise and re-submit

☐ approved for use in connection with your work on the project

☐ please return _____ copies of _____

REMARKS:

Returned with Thanks

Yours very truly,
per: J.D.L.
J.D.LEE & COMPANY LIMITED

PRELIMINARY SITE INVESTIGATION

for the

PROPOSED CROSSING OF HIGHWAY NO. 401

at the

NAPANEE RIVER near NAPANEE, ONTARIO

for the

DEPARTMENT OF HIGHWAYS-ONTARIO

by the

Engineering Division

HUNTING TECHNICAL AND EXPLORATION SERVICES LIMITED

Toronto, Ontario

ORDER OF CONTENTS

SECTION 1.1

1.11 General

The purpose of this report is to present the results of a subsurface soil investigation for the foundation of the bridge and approach fills at the proposed crossing of Highway No. 401 and the Napanee River near Napanee, Ontario.

SECTION 1.2

DISCUSSION OF PROCEDURES

1.21 Location of Boreholes

The borehole locations for this investigation were established by Department of Highways' surveyors. At the completion of the work, each borehole was marked with a large stake denoting the hole number for future reference. The borehole locations are shown on the plan in Appendix 1.51.

1.22 Subsurface Drilling and Sampling

A preliminary programme, specified by the client, of 6 soil borings was initiated in the vicinity of the proposed site of the Napanee River bridge. The programme was later enlarged to include three additional holes to investigate the approach fill foundations.

A skid mounted, hydraulic head Junior Longyear diamond drilling rig was used on this project. All boring and sampling operations were completed by an experienced soil sampling crew under the supervision of a geologist experienced in soil sampling procedures.

All soil borings were performed by the standard wash boring procedure. By this method, drill casing was driven into the soil by a 350 lb. hammer to a depth of 5 feet or change in strata. All containing soil was thoroughly washed out to the bottom of the casing. Sampling tools were then lowered on the end of the rods to the bottom of the hole. The sample was then taken and the sampling tools removed from the hole. An additional 5' length of casing was added and the procedure repeated.

In the cohesionless soils, an attempt was made to obtain samples by means of a 2 inch O.D. standard split spoon sampler. The standard penetration test using a 140 lb. hammer falling 30 inches was recorded for each foot of penetration with a split spoon sampler. When necessary, samples for identification and correlation were obtained with a side slit sampler.

"Undisturbed" samples were taken in 2 inch Shelby Tubes which were dunamically driven into the soil and extracted. All Shelby Tube samples were classified, tagged and sealed immediately upon recovery from the hole. In order that samples with a minimum of disturbance might be obtained for laboratory consolidation tests, a hydraulically operated 3 inch Osterberg piston sampler was used. All disturbed representative samples, i.e. split spoon samples and side slit samples, were visually examined and classified on the site, then placed in jars and forwarded to the engineering office.

Undisturbed and remolded in situ vane shear tests were conducted in the cohesive soils using a 2 inch diameter vane. The results of these tests are shown on the borehole logs.

1.23 Soil Testing

Selective disturbed and undisturbed samples from each strata were forwarded to the laboratory as a check on the visual field classification, and for unconfined compression and consolidation tests.

The results of all tests are given in the Appendices. The laboratory tests on the samples were performed by:

Donald Inspection Ltd.,
340 Richmond Street West,
Toronto, Ontario.

and

Prof. W. L. Sagar,
University of Toronto.

1.34 Soil Conditions

Soil conditions encountered at the site consisted generally of five structural types which overlaid bedrock in the following order.

1. Very dense grey till
2. Medium dense grey fine sand and silt
3. Grey interbedded silt and clay
4. Loose brown silty sand with organic matter.

The physical properties of the major soil types at the site are summarized below in order of their occurrence above bedrock.

1. Very Dense Grey Till

The till consists of a hetrogeneous mixture of silt and sand with a trace of fine gravel and clay. This soil was encountered under the west side of the river and in the north and central part of the east side. The boring for the east approach fill was terminated in the overlying strata, thus the till layer may be present in this area. Borehole 6, at the south end of the east abutment shows a very thin strata of silt and clay which may possibly be a reworked till overlying limestone. The limestone was not cored for a sufficient depth in borehole 6 to prove it to be bedrock.

The "till" stratum has an average penetration resistance of 96 blows/foot with a wide variation (25 to 178) probably due to the presence of gravel fragments.

2. Medium Dense Grey Fine Sand and Silt

This stratum overlies the till in all borings along centerline. It is entirely absent in borehole 1, (north end of west abutment) and has been replaced by two strata (sand and sand with fine gravel, see below) in borehole 6 (south end of east abutment).

The stratum is not entirely continuous in texture or density,

but is similar and is basically comparable throughout in engineering properties. The apparent density varies from loose to medium dense, but this material was noted to rise in the casing in several places prior to sampling, thus the densities recorded may be lower than the true in situ density.

Some gravel fragments were noted in this stratum. The stratum varies from a silty fine and medium sand to a fine sand and silt.

3. Grey Interbedded Silt and Clay

This stratum is encountered in all boreholes and is the predominant soil under the area.

This stratum varies from stiff to soft. The upper part of the stratum, say to elev. 25', is desiccated to a stiff material with a maximum recorded unconfined compressive strength (undisturbed) of 2.45 tons/ft.^{2}. The strength decreases with depth to a minimum recorded unconfined strength of 0.4 ton/ft.^{2}. The close relationship between unconfined compressive strength and depth is shown in the test results listed in Appendix 1.55

The physical content of this stratum consists of silt, silty clay and plastic clay in thin layers (one to two inches or less). There are also some very thin sand seams (one fifth of an inch or less in thickness). The overall characteristic of the material is that of a clay or silty clay. The wide variation in Atterberg limits reflects the interbedded nature of the material.

The strength of this soil is reduced greatly by remolding (see recorded unconfined compressive strength). The percentage loss of strength increases as the undisturbed strength decreases.

4. Loose Brown Silty Sand with Organic Matter

This stratum is encountered in all boreholes. It occurs above the interbedded silt and clay for a depth of about 6 feet deep on the east bank and about 10 feet on the west bank. The material is believed to represent recent alluvium and thus can be expected to be somewhat variable in content.

The top few feet of this stratum generally consists of a light brown silt and fine sand with a little organic matter. The lower part of the stratum is generally coarser and contains more organic matter. The coarsest material noted was a medium sand with some fine gravel. The organic material in the lower part of the stratum consists almost entirely of wood fragments. The three gradation tests presented in the Appendices represent typical samples from the lower part of this formation.

The average penetration resistance of this stratum is 2.8 blows/foot, from a range of 1 to 6 blows/foot.

SECTION 1.3

DISCUSSION OF SITE

1.31 Geographic Location

The proposed site is located on the Napanee River at the proposed crossing of King's Highway No. 401. The site is in the Kingston District of the Department of Highways - Ontario approximately 1-1/4 miles N.N.E. of the town of Napanee.

1.32 Bedrock Geology

The bedrock in the general area is a flat and undulating Black River limestone plain from which the glaciers stripped most of the overburden. The overburden is only 6 to 12 inches deep over much of the region with deeper soils developed in depressions and in stream valleys.

1.33 Overburden Geology

The proposed bridge site is located in the Napanee River valley which is approximately 1/2 mile wide and is bordered at both sides by limestone under shallow overburden.

The valley is of pre-glacial origin and has since filled up with deposits of the following:

a) Glacial origin (till overlying bedrock)

b) Glacio-fluvial origin (various sand formations overlying the till)

c) Lacustrine origin (clay and silt beds overlying the sand)

d) Recent alluvial origin (silt, sand and organic material at the surface to depth of approximately 10 feet).

Apparently erosion took place at various times during the history of the valley. For instance, erosion of the till deposits and of the newly formed sand formations occurred during the glacio-fluvial stage. At a late stage of deglaciation the present waterfall at Napanee was formed. During this period the silt, sand and organic

alluvial deposit was formed. At this time further erosion apparently took place removing large amounts of drift from the valley.

1.35 Comments

Our understanding of the initial bridge design is that abutments are contemplated at approximately chainages 358+70 and 359+80. The approaches to the bridge are to be made on fill, contained and protected by wingwalls.

With reference to this proposal, we would like to make the following comments for your consideration.

A. Structures

1) Considering the possibility of using spread footings for the base of the abutments and wing walls, we have determined that the footings can be founded on top of the clay layer with a safe soil pressure in the order of 3000 lbs. per square foot. With this loading, a settlement in the order of two inches should be expected to occur. (See graph overleaf for estimated settlement time.) This recommended safe soil pressure is made with the stipulation that the clay subsoil is not unduly disturbed during excavation procedures.

We recommend that excavation for the footings be made within a sheet steel pile wall driven a short distance into the clay. Unless thus protected the sand alluvium during excavation below the water table is likely to become in a quick condition. When designing the sheet pile wall and calculating the lateral earth pressures against the sheeting, we recommend that an equivalent fluid pressure coefficient of 0.75 be used for the sand alluvium.

Due to the erratic silt and organic content of the sand alluvium overlying the clay, we do not feel that the effectiveness of a well point system can be determined before installation, there-

fore we hesitate to recommend its use at this site.

2) Alternatively the abutment foundations may be placed on piles. Considering that part of the pile load that may be carried by skin friction in the clay, we recommend that the remolded value of shear strength taken from the vane shear tests be the maximum shear strength value considered.

B. Approach Fills

Slope stability computations for base failure of a 15 foot high approach fill were carried out. Our investigations indicate that no stability problems are to be expected with the approach fills.

With reference to preparation of the foundations for the approach fills, we recommend that the clayey topsoil be entirely removed prior to fill placing.

SECTION 1.4

PERSONNEL

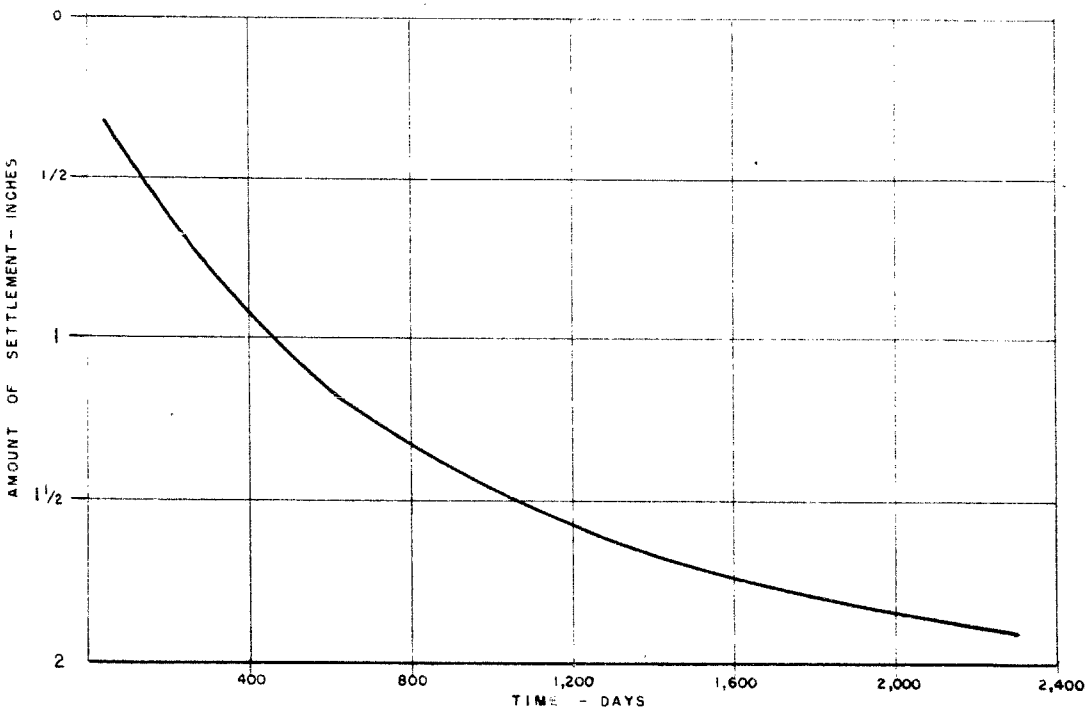
The field work was performed under the supervision of I. E. Thurber, B.Sc.

This report was written by J. Kilgour, P.Eng., P. Arkema, P.Eng., and N.W.E. Lee, P.Eng.

SECTION 1.5

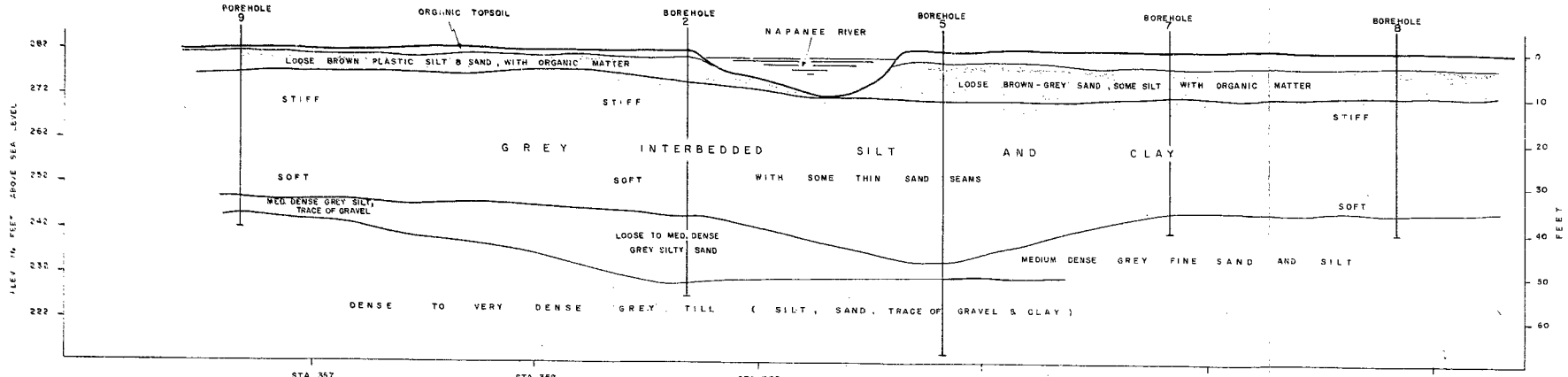
APPENDICES

1.51 GENERAL PLAN OF SITE



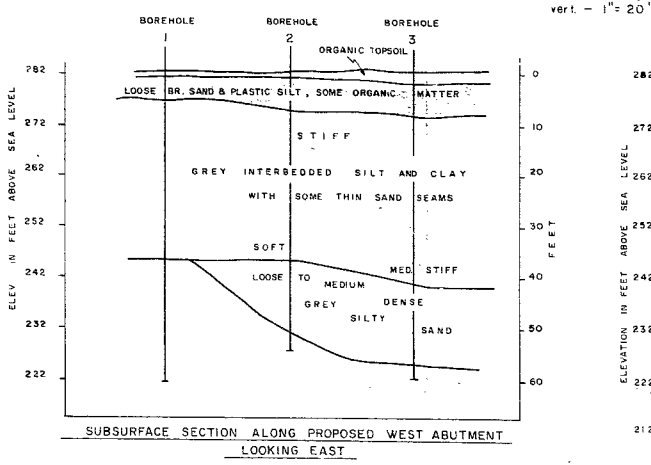
TIME - SETTLEMENT CURVE FOR A 10 FT. WIDE FOOTING WITH A LOADING OF 3,000 lbs / ft^2

1.52 SUBSURFACE SECTIONS

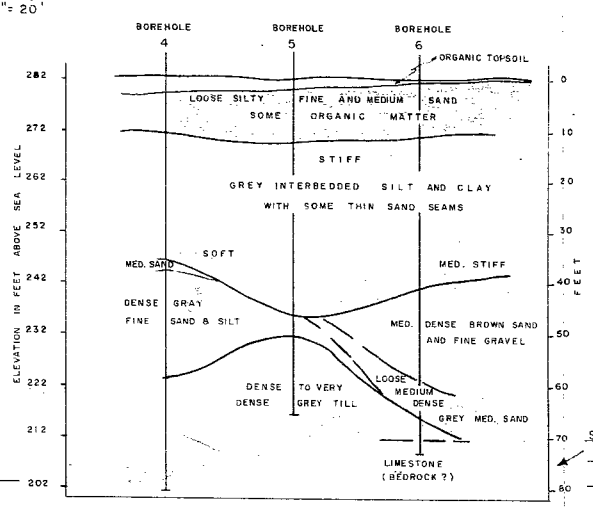


SUBSURFACE SECTION ALONG PROPOSED CENTERLINE

Scale -
hor. - 1" = 40'
vert. - 1" = 20'



SUBSURFACE SECTION ALONG PROPOSED WEST ABUTMENT LOOKING EAST



SUBSURFACE SECTION ALONG PROPOSED EAST ABUTMENT LOOKING EAST

PROPOSED CROSSING OF NAPANEE RIVER
AND KING'S HIGHWAY No. 401

1.53 OFFICE LOGS OF BOREHOLES

JOB No. H415/58 LOCATION HWY. 401 NAIANEE RIVER

CLIENT DEPARTMENT OF HIGHWAYS ONTARIO

COORDINATES STA. 258 + 70 W 50' L. OF CL.

ELEV. (surface) 282·9 (collar) — Datum GEOD.

BOREHOLE NUMBER — 1 — — —

DATE (started) MAY 8, 1958 (finished) MAY 12, 1958

RIG No. 1 TYPE JUN. LONGYEAR

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 1

silt | clay | sand | gravel | peat | fill

x — standard penetr. 2 s.s.
Δ — vane shear
o — pocket penetrometer

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

S.S. — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit

SAMPLE CONDITION
— undisturbed
— disturbed but represent.
— fair
— lost

BORING LOG

SCALE FT	DEPTH FT.	ELEV. FT	WATER OBSERVATION	LOG	DESCRIPTION
		282·9			
	1·0	281·9			BROWN TOPSOIL
5			G.W.L. MAY 15		LOOSE BROWN PLASTIC SILT AND SAND SOME ORGANIC MATTER
	6·0	276·9			STIFF GREY BROWN SILT AND CLAY
	8·5	274·4			
10					STIFF GREY INTERBEDDED SILT AND CLAY WITH THIN SAND SEAMS
15					
20					
25					
30					
35					SOFT GREY INTERBEDDED SILT AND CLAY WITH THIN SAND SEAMS
	38·5	244·4			
40					VERY DENSE GREY TILL CONSISTING OF SILT AND FINE SAND WITH TRACE OF COARSE SAND, GRAVEL AND CLAY
45					
50					
55					
60					
	61·3	221·6			END OF BOREHOLE

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 | 1 1/2

STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 40 60

SAMPLES

No.	COND.	DEPTH FROM	DEPTH TO	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)
1		2·0	3·5	S S	9/18	6
2		5·0	6·5	S S	15/18	5
3		8·0	9·5	S S	14/18	12
4		10·0	11·5	S T	18/18	–
5		15·0	16·5	S T	15/18	5
6		20·0	21·5	S T	18/18	2
7		25·0	26·5	S T	18/18	–
8		30·0	31·5	S T	18/18	1
9		35·0	36·5	S T	18/18	–
10		40·0	41·5	S S	12/18	55
11		44·0	44·5	S S	5/6	74/6"
		55·0	60·0	D B		
12		60·0	61·3	S S	12/16	130

LABORATORY TESTS

ATTERBERG LIMITS WP X—O WI

● — NATURAL WATER CONTENT

REMARKS

3" OSTERBERG

3" OSTERBERG

35' END OF H CASING
3" OSTERBERG
STONES INFLUENCING VANE READING

JOB No. H415/58 LOCATION HWY 401 NAPANEE RIVER
CLIENT DEPARTMENT OF HIGHWAYS - ONTARIO
COORDINATES STA. 358 + 67 1' L. OF CL.
ELEV. (surface) 282·7 (collar) — Datum GEOD.
BOREHOLE NUMBER 2
DATE (started) MAY 3, 1958 (finished) MAY 6, 1958
RIG No. 1 TYPE JUN. LONGYEAR

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 2

silt | clay | sand | gravel | peat | fill

x — standard penetr. 2 S.S.
a — vane shear
o — pocket penetrometer

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

S.S. — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit

SAMPLE CONDITION
— undisturbed
— disturbed but represent.
— fair
— lost

BORING LOG

SCALE FT.	DEPTH FT.	ELEV FT.	WATER OBSERVATION	LOG	DESCRIPTION
		282·7			
	1·2	281·5			BROWN ORGANIC TOPSOIL
5	7·0	275·7	G.W.L MAY 7		LOOSE BROWN SAND AND PLASTIC SILT, SOME ORGANIC MATTER
10					STIFF GREY INTERBEDDED SILT AND CLAY WITH THIN SAND SEAMS
15					
20					
25					
30					SOFT GREY INTERBEDDED SILT AND CLAY WITH THIN SAND SEAMS
35	37·0	245·7			
40					LOOSE TO MEDIUM DENSE GREY SILTY SAND
45					
50	52·0	230·7			
55	54·7	228·0			VERY DENSE GREY TILL (SEE REMARKS)
					END OF BOREHOLE
60					

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 | 1 | 1 1/2

STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 | 40 | 60

SAMPLES

No.	COND.	DEPTH FROM	DEPTH TO	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)
1		0	1·5	SS	9/18	1
2		3·0	4·5	SS	18/18	3
3		6·0	7·5	SS	18/18	5
4		7·5	8·0	ST	6/6	–
5		8·0	9·0	ST	12/12	–
6		14·0	15·0	ST	17/18	8
7		19·0	20·5	ST	18/18	3
8		24·0	25·5	ST	18/18	–
9		29·0	31·0	ST	0/24	1
10		34·0	35·5	ST	14/18	–
11		39·0	40·5	ST	18/18	1
12		44·0	45·5	SS	8/18	11
13		49·0	50·5	SS	18/18	–
14		54·0	54·7	SS	8/8	108/8"

LABORATORY TESTS

ATTERBERG LIMITS wp X—O wl
● — NATURAL WATER CONTENT

C

	REMARKS
	3" OSTERBERG
	" "
	3" OSTERBERG
	3" OSTERBERG
	SAND ROSE APPROX. 4" IN CASING BEFORE SAMPLE COULD BE TAKEN
	57 BLOWS FOR FINAL 3" PENETRATION

TILL CONSISTS OF SILT AND FINE SAND WITH TRACE OF CLAY AND COARSE SAND

H CASING 0 - 35'
B X CASING 35' - 54'

JOB No. H 415/58 LOCATION HWY 401 NAPANEE RIVER
CLIENT DEPARTMENT OF HIG. WAYS - ONTARIO
COORDINATES STA. 358+66 48' R. OF CL
ELEV. (surface) 282·7 (coll.) — Datum GEOD.
BOREHOLE NUMBER 3
DATE (started) APR. 30, 1958 (finished) MAY 2, 1958
RIG No. 1 TYPE JUN. A LONGYEAR

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 3

silt | clay | sand | gravel | peat | fill

x — standard penetr. 2 S.S.
Δ — vane shear
o — pocket penetrometer

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

S.S — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit

SAMPLE CONDITION
— undisturbed
— disturbed, but represent.
— fair
— lost

BORING LOG

SCALE FT	DEPTH FT	ELEV FT	WATER OBSERVATION	LOG	DESCRIPTION
		282·7			
	2·0	280·7			BROWN TOPSOIL
5					LOOSE BROWN SAND AND SILT SOME ORGANIC MATTER
	6·3	276·4	G.W.L.		
	8·0	274·7			LOOSE GREY GRAVEL
10					STIFF GREY INTERBEDDED SILT AND CLAY WITH THIN SAND SEAMS
15					
20					
25					
30					MEDIUM STIFF GREY INTERBEDDED SILT AND CLAY WITH THIN SAND SEAMS
35					
	37·8	244·9			
	38·5	244·2			GRAVEL LAYER
40					MEDIUM STIFF GREY VARVED SILT AND CLAY
	42·0	240·7			
45					
50					LOOSE TO MEDIUM DENSE GREY SILTY FINE SAND (SOME GRAVEL FRAGMENTS)
55					
	57·5	225·2			
60	60·0	222·7			VERY DENSE GREY TILL
					END OF BOREHOLE

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 | 1 1/2

STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 40 60

SAMPLES

No.	COND	DEPTH FROM	DEPTH TO	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)
1		0	1·5	S S	18 / 18	1
2		3·0	4·5	S S	12 / 18	5
3		6·0	7·5	S S	15 / 18	1
4		9·0	10·5	S T	10 / 18	9
5		14·0	15·5	S T	18 / 18	5
6		19·0	20·5	S T	15 / 18	4
7		24·0	25·5	S T	18 / 18	1
8		29·0	30·5	S T	18 / 18	1
9		34·0	35·5	S T		0
10		39·0	40·5	S T	[illegible]	1
11		44·0	45·5	S T	0 / 18	4
12		49·0	50·5	S S	16 / 18	65 *
13		54·0	55·5	S S	16 / 18	24
14		59·0	60·0	S S	5 / 12	150

LABORATORY TESTS

ATTERBERG LIMITS WD X — O WI
● — NATURAL WATER CONTENT

REMARKS

END N X CASING 25'

PENETRATION BY ROD WEIGHT

4 BLOWS ON S S 18" RECOVERY

RECOVERED 16" WITH S S

* SAMPLER STUCK IN CASING

END B X CASING 59' - PROBABLE BOULDER AT 60'

TILL CONSISTS OF SILT AND SAND WITH SOME FINE GRAVEL AND TRACE OF CLAY

JOB No. H 415/58 LOCATION HWY. 401 - NAPANEE RIVER
CLIENT DEPARTMENT OF HIGHWAYS - ONTARIO
COORDINATES STA. 359 + 82 50' L. OF CL.
ELEV. (surface) 282·0 (collar) — Datum: GEOD.
BOREHOLE NUMBER 4
DATE (started) APR. 10, 1958 (finished) APR. 15, 1958
RIG No. 1 TYPE JUN. LONGYEAR

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 4

silt | clay | sand | gravel | peat | fill

x — standard penetr. 2 S.S.
Δ — vane shear
o — pocket penetrometer

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

S.S. — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit

SAMPLE CONDITION: undisturbed | disturbed but represent. | fair | lost

BORING LOG

SCALE DEPTH FT	ELEV FT	WATER OBSERVATION	LOG	DESCRIPTION
	282·0			
3·0	279·0	G.W.L. APR. 18		SOFT BROWN ORGANIC SILT & SAND
11·3	270·7			LOOSE GREY SAND, SOME SILT, SOME ORGANIC MATTER
				STIFF GREY CLAY WITH INTERBEDDED SILT SEAMS, AND THIN SAND SEAMS
35·5	246·5			SOFT
38·0	244·0			MEDIUM DENSE GREY MEDIUM SAND
				VERY DENSE GREY FINE SAND & SILT (WITH GRAVELLY LAYERS)
59·0	223·0			
				VERY DENSE GREY TILL
81·0	201·0			END OF BOREHOLE

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 | 1 | 1 1/2

STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 | 40 | 60

SAMPLES

No.	COND.	DEPTH FROM	DEPTH TO	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)
1		0	2·0	ST	17 / 24	
2		5·0	7·0	ST	16 / 24	
3		10·0	11·9	ST	14 / 18	
4		15·3	16·8	ST	15 / 18	
5		20·5	22·0	ST	10 / 18	
6		25·5	27·5	ST	22 / 24	
7		30·5	32·2	SS	19 / 20	12
8		35·5	37·0	ST & SS	→	19
9		40·3	41·8	SS	15 / 18	65
10		45·0	46·5	SS	8 / 18	178
11		50·3	51·8	SS	18 / 18	148
12		55·0	56·5	SS	16 / 18	58
13		59·0	66·0	DB	12 / 84	
14		70·0	73·0	DB	36 / 36	
15		74·3	77·3	DB	24 / 36	
16		77·3	81·2	DB	42 / 47	

LABORATORY TESTS

ATTERBERG LIMITS wp x — o wl
● — NATURAL WATER CONTENT
25 | 50 | 75

U undist. t / ft²

No.	U undist. t / ft²	REMARKS
4	2·45	RATE 8 SEC. FOR 12"
5		NX CASING HARD TO DRIVE DUE TO FRICTION
8		SAMPLE RECOVERED WITH SIDE SLIT SAMPLER
12		REFUSAL ON SS WITH 350 LBS. HAMMER
14		COARSE TILL & BOULDER CORE

JOB No. H 415/58 LOCATION HWY 401 NAPANEE RIVER

CLIENT DEPARTMENT OF HIGHWAYS - ONTARIO

COORDINATES STA. 359 + 74 CL.

ELEV. (surface) 282·0 (collar) — Datum GEOD.

BOREHOLE NUMBER 5

DATE (started) APR. 16, 1958 (finished) APR. 18, 1958

RIG No. 1 TYPE JUN. LONGYEAR

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 5

silt | clay | sand | gravel | peat | fill

x — standard penetr. 2 S.S.
Δ — vane shear
o — pocket penetrometer

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

S.S — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit

SAMPLE CONDITION: undisturbed | disturbed but represent | fair | lost

BORING LOG

FIELD TESTS

LABORATORY TESTS

SCALE DEPTH FT	DEPTH FT	ELEV. FT	WATER OBSERVATION	LOG	DESCRIPTION
		282·0			
	2·5	279·5			SOFT BROWN ORGANIC SILT & SAND
5			G.W.L. APRIL 18		(SOME SILT) LOOSE GREY SAND SOME ORGANIC MATTER
10	11·5	270·5			
15					STIFF GREY INTERBEDDED SILT & CLAY WITH THIN SAND SEAMS
20					
25					
30					SOFT GREY INTERBEDDED SILT & CLAY WITH THIN SAND SEAMS
35					
40					
45	47·0	235·0			
50	51·0	231·0			LOOSE GREY FINE SAND & SILT
55					DENSE TO VERY DENSE GREY TILL CONSISTING OF SAND, SILT SOME GRAVEL, TRACE OF SILT
60					
65	67·0	215·0			
70					END OF BOREHOLE

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 | 1 | 1 1/2

STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 | 40 | 60

No.	COND	DEPTH FROM	DEPTH TO	TYPE	RECOVERY LENGTH REC. / DIST DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)	ATTERBERG LIMITS W_P X—O W_L ● — NATURAL WATER CONTENT (25	50	75)	U undist t/ft²	U remolded t/ft²	M	REMARKS
1		2·0	3·5	S T	10 / 18	1							
2		7·0	8·5	S T	14 / 18	1						✓	
3		12·0	13·5	S T	13 / 18	12				2·4	1·7		
4		17·0	18·5	S T	11 / 18	10				1·7	–		
5		22·0	23·5	S T	16 / 18	6				1·15	0·65		
6		27·0	28·5	S T	18 / 18	1				0·7	–		
7		32·0	34·0	S T	24 / 24	1				0·45	–		
8		37·5	39·5	S T	18 / 18	1				0·6	–		
9		42·0	43·5	S T	11 / 18	4				0·65	–		
10		47·0	48·5	S T	13 / 18	4							SAMPLE IN JAR
11		52·0	53·5	S S	15 / 18	25							
12		54·0	55·5	S S	15 / 18	69							
13		57·0	58·5	S S	5 / 18	91							
14		62·0	63·5	S S	14 / 18	47							
15		65·5	67·0	S S	15 / 18	100							

JOB No. H 415/58 LOCATION HWY 401 NAPANEE RIVER
CLIENT DEPARTMENT OF HIGHWAYS – ONTARIO
COORDINATES STA 359 + 82 50' RT. OF CL.
ELEV (Surface) 282·0 (Datum) — Datum GEOD.
BOREHOLE NUMBER 6
DATE (Started) APR. 19, 1958 (Finished) APR. 22, 1958
RIG No. 1 TYPE JUN. LONGYEAR

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 6

silt, clay, sand, gravel, peat, fill

x — standard penetr. 2 s.s.
△ — vane shear
○ — pocket penetrometer

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

S.S — split spoon
S.T. — shelby tube
T.W.P — thin walled piston
D.B. — diamond bit

SAMPLE CONDITION
— undisturbed
— disturbed but represent.
— foil
— lost

BORING LOG

FIELD TESTS

LABORATORY TESTS

SCALE DEPTH FT	ELEV FT	WATER OBSERVATION	LOG	DESCRIPTION	SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 | 1/2 — STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 40 60	No.	COND.	DEPTH FROM	DEPTH TO	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)	ATTERBERG LIMITS wp X — o wl ● — NATURAL WATER CONTENT 25 50 75	U undist. t/ft²	U remolded	REMARKS
	282·0															
	1·0	281·0		ORGANIC TOPSOIL		1		0	1·5	SS	13/18	2				
5			GWL	VERY LOOSE SILTY FINE AND MEDIUM SAND WITH ORGANIC MATTER		2		5·0	6·5	SS	13/18	2				
10	11·3	270·7				3		10·0	11·5	SS	18/18	3				
15				STIFF GREY INTERBEDDED SILT AND CLAY WITH SOME THIN SAND SEAMS		4		15·0	16·5	ST	13/18	14		2·25	1·50	
20						5		20·0	21·5	ST	18/18	10				
25						6		25·5	27·0	ST	13/18	4				
30						7		30·0	31·5	ST	18/18	4				
35				MEDIUM STIFF GREY INTERBEDDED SILT AND CLAY WITH SOME THIN SAND SEAMS		8		35·0	36·5	ST	14/18	1		0·70	0·21	
40	40·5	241·5				9		40·0	41·5	ST	18/18	1				
45				MEDIUM DENSE BROWN SAND AND FINE GRAVEL		10		45·0	46·5	SS	18/18	10				
50						11		50·0	51·5	SS	0/18	20				RECOVERED WITH SIDE SLIT SAMPLER
55						12		55·0	56·5	SS	0/18	16				" " " " "
60	60·0	222·0				13		60·5	62·0	SS	18/18	8				
65				LOOSE TO MEDIUM DENSE GREY MEDIUM SAND TRACE OF SILT		14		65·0	66·5	SS	16/18	22				
	68·0	214·0														
70	71·0	211·0		MEDIUM DENSE GREY CLAY AND SILT		15		70·0	70·4	ST	5/5	3/5"				
						16		70·4	71·0	SS	6/7	10/7"				REFUSAL WITH 25 BLOWS
	73·0	209·0		LIMESTONE (?BEDROCK)		17		71·0	73·0	DB	24/24	—				
75				END OF BOREHOLE												

JOB No. H 415/58 LOCATION HWY 401 NAPANEE RIVER
CLIENT DEPARTMENT OF HIGHWAYS - ONTARIO
COORDINATES STA. 360 + 84 CL
ELEV. (surface) 282·0 (collar) — Datum GEOD.
BOREHOLE NUMBER 7
DATE (started) APR. 24, 1958 (finished) APR. 25, 1958
RIG No. 1 TYPE JUN. LONGYEAR

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 7

silt, clay, sand, gravel, peat, fill

x — standard penetr. 2 S.S.
Δ — vane shear
o — pocket penetrometer

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

S.S. — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit

SAMPLE CONDITION: undisturbed; disturbed but represent.; fair; lost

BORING LOG

SCALE DEPTH FT	ELEV FT	WATER OBSERVATION	LOG	DESCRIPTION
	282·0			
4·0	278·0			SOFT BROWN ORGANIC SILT
9·8	272·2			VERY LOOSE DARK GREY SAND WITH ORGANIC MATTER & SOME FINE GRAVEL
				STIFF GREY INTERBEDDED SILT AND CLAY WITH SOME THIN SAND SEAMS
36·0	246·0			SOFT GREY INTERBEDDED SILT AND CLAY WITH SOME THIN SAND SEAMS
40·5	241·5			MEDIUM DENSE GREY FINE SAND AND SILT
				END OF BOREHOLE

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 | 1 1/2

STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 | 40 | 60

SAMPLES

No	COND.	DEPTH FROM	DEPTH TO	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)
1		0	1·6	S S	9 / 18	3
2		3·0	4·5	S S	15 / 18	1
3		6·0	7·5	S S	/ 18	1
4		9·0	10·5	S S	13 / 18	3
5		14·0	15·5	S T	13 / 18	9
6		19·0	20·5	S T	17 / 18	3
7		24·0	25·5	S T	18 / 18	3
8		29·0	30·5	S T	15 / 18	3
9		34·0	35·5	S T	0 / 18	0
10		39·0	40·5	S S	16 / 18	4

LABORATORY TESTS

ATTERBERG LIMITS wp x — o wl
● — NATURAL WATER CONTENT

U undist. t/ft²
U remolded

	U undist. t/ft²	U remolded	M	REMARKS
1				
2				
3			✓	
4				
5				
6				
7				
8	0·75	0·25		
9				PUSHED BY WEIGHT OF HAMMER
10				SAND ROSE IN CASING

JOB No. H 415/58 LOCATION HWY 401 NAPANEE RIVER

CLIENT DEPARTMENT OF HIGHWAYS - ONTARIO

COORDINATES STA 361 + 84 CL.

ELEV. (surface) 281·0 (collar) — Datum GEOD.

BOREHOLE NUMBER — 8

DATE (started) APR. 26, 1958 (finished) APR. 26, 1958

R·G No. 1 TYPE JUN. LONGYEAR

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 8

silt | clay | sand | gravel | peat | fill

x — standard penetr. 2 S.S.
Δ — vane shear
o — pocket penetrometer

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

S.S — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit

SAMPLE CONDITION
— undisturbed
— disturbed, but represent.
— fair
— lost

BORING LOG

SCALE DEPTH FT	DEPTH FT	ELEV FT	WATER OBSERVATION	LOG	DESCRIPTION
		281·0			
	3·5	277·5			SOFT BROWN ORGANIC SILT
5			G.W.L. MAY 15		VERY LOOSE GREY BROWN SAND, SOME SILT WITH ORGANIC MATTER
10	10·0	271·0			
					STIFF GREY INTERBEDDED SILT AND CLAY WITH SOME THIN SAND SEAMS
15					
20					
25					
30					
					MEDIUM STIFF GREY INTERBEDDED SILT AND CLAY WITH SOME THIN SAND SEAMS
35					
	37·0	244·0			
					MEDIUM DENSE GREY BROWN FINE SAND AND SILT
40	40·5	240·5			
					END OF BOREHOLE
45					
50					
55					
60					

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 | 1 1/2

STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 | 40 | 60

No.	COND.	DEPTH FROM	DEPTH TO	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)
1		0	1·5	S S	13 / 18	1
2		3·0	4·5	S S	18 / 18	1
3		6·0	7·5	S S	14 / 18	1
4		9·0	10·5	S S	14 / 18	5
5		14·0	15·5	S T	16 / 18	9
6		19·0	20·5	S T	17 / 18	8
7		24·0	25·5	S T	15 / 18	7
8		29·0	30·5	S T	15 / 18	4
9		34·0	35·5	S T	16 / 18	8
10		39·0	40·5	S S	16 / 18	8

LABORATORY TESTS

ATTERBERG LIMITS wp X—O wl
● — NATURAL WATER CONTENT

U undist. t/ft²

M

0·99

REMARKS

SAND ROSE IN CASING

JOB No. H415/58 LOCATION HWY 401 - NAPANEE RIVER
CLIENT DEPARTMENT OF HIGHWAYS - ONTARIO
COORDINATES STA. 356 + 68 2·5 L. OF CL.
ELEV. (surface) 282·0 (collar) — Datum GEOD.
BOREHOLE NUMBER 9
DATE (started) MAY 15, 1958 (finished) MAY 16, 1958
RIG No. 1 TYPE JUN. LONGYEAR

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 9

silt | clay | sand | gravel | peat | fill

x — standard penetr. 2 s.s.
Δ — vane shear
o — pocket penetrometer

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

S.S — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit

SAMPLE CONDITION
— undisturbed
— disturbed but represent.
— fair
— lost

BORING LOG

SCALE FT	DEPTH FT	ELEV FT	WATER OBSERVATION	LOG	DESCRIPTION
		282·0			
	0·8	281·2			ORGANIC TOPSOIL
					LOOSE DARK BROWN PLASTIC SILT
5	5·5	276·5	G.W.L MAY 16		AND SAND WITH ORGANIC MATTER
	7·0	275·0			STIFF GREY BROWN SANDY CLAY
10					STIFF — VERY STIFF GREY INTERBEDDED SILT AND CLAY WITH SOME THIN SAND SEAMS
15					
20					
25					
30					MEDIUM STIFF
	33·0	249·0			
35					MEDIUM DENSE GREY SILT TRACE GRAVEL FRAGMENTS
	37·0	245·0			DENSE GREY TILL
40	40·0	242·0			(SAND, SILT WITH FINE GRAVEL)
					END OF BOREHOLE
45					

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 | 1 1/2

STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 | 40 | 60

SAMPLES

No.	COND	DEPTH FROM	DEPTH TO	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)
1		2·0	3·5	S S	9/18	5
2		5·0	6·5	S S	11/18	12
3		8·0	9·5	S T	8/18	15
4		14·0	15·5	S T	10/18	20
5		19·0	20·5	S T	15/18	9
6		24·0	25·5	S T	15/18	10
7		29·0	30·5	S T	LOST	7
8		34·0	35·5	S S	18/18	11
9		39·0	40·0	S S	12/12	53

LABORATORY TESTS

ATTERBERG LIMITS wp x — o wl
● — NATURAL WATER CONTENT

REMARKS

B X CASING 0 - 39'

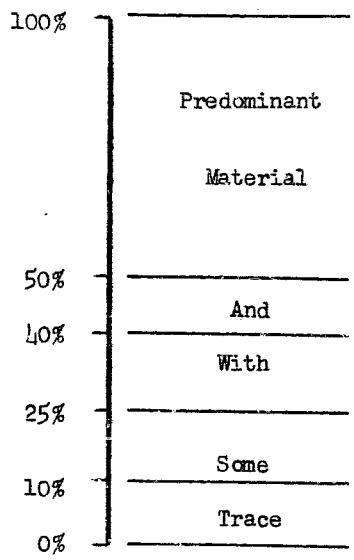
1.54 SOIL CLASSIFICATION CHARTS

HUNTING TECHNICAL & EXPLORATION SERVICES

1450 O'Connor Drive Toronto, Ontario

SOIL TYPES

The following system was used in classifying the various soils by name:



Example:

Medium dense	grey	silt	with	fine sand
(Penet. resist.) or relative density	(colour)	(pred. type)	(25%-40%)	(other type)

Unless believed to have a significant effect on the soil characteristics the minor soil types (i.e. traces) present are disregarded in the name used on the boring log and cross-sections. The complete classification is given with the gradation analysis.

In all cases the strength characteristics (e.g. penetration resistance) is quoted first, followed by the colour and finally the descriptive name based on the mechanical analysis.

HUNTING TECHNICAL & EXPLORATION SERVICES

1450 O'Connor Drive Toronto, Ontario

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

Soils encountered in sub surface exploration for engineering purposes are composed of organic or inorganic materials, water, air and dissolved salts. The water and air are generally considered to be uniform so that identification is primarily in the nature of organic or inorganic (mineral grains) and dissolved salts.

In the field a soil is general y identified in terms of grain size characteristics, color and mineral content — properties of the mineral grains. Occasionally, the origin of a soil is included in the identification.

The systems used to describe soils in terms of engineering properties are called classification systems. In the system described below, the soils are first identified and then classified in terms of strength characteristics which are of prime importance in utilizing the soil boring data in designing a safe and economical foundation.

Penetration measured by dropping 140 lb. hammer 30" on 2" O.D. split spoon sampler.

Identification (Soil Type)	Classification	Classification Criteria Unconfined Compressive Strength	
Clay	Soft	Less than 0.50 Tons/Sq. Ft.	
	Medium	0.50 to 1.00 Tons/Sq. Ft.	
	Stiff	1.00 to 2.00 Tons/Sq. Ft.	
	Very Stiff	2.00 to 4.00 Tons/Sq. Ft.	
	Hard	Greater than 4.00 Tons/Sq. Ft.	
		Density	
Silt	Loose	Less than 80 lbs./Cu. Ft.	
	Medium Dense	80 to 95 lbs./Cu. Ft.	
	Dense	Greater than 95 lbs./Cu. Ft.	
		Relative Density	Penetration Resist.
Sand	Loose	0 - 30%	0 - 10 Blows/Ft.
	Medium Dense	30 - 60%	10 - 30 Blows/Ft.
	Dense	60 - 90%	30 - 50 Blows/Ft.
	Very Dense	90 -100%	Over 50 Blows/Ft.
			Penetration Resist.
Gravel	Loose		Less than 30 Blows
	Dense		Over 30 Blows/Ft.
Hardpan		Cemented on partially cemented sandy gravels, sands, gravels with or without some clay and silt and having unconfined compression strength greater than 5 tons/Sq. Ft.	
Fill	Organic	Very Loose	0 - 4 Blows/Ft.
		Loose	4 - 10 Blows/Ft.
	Inorganic	Medium	10 - 30 Blows/Ft.
		Dense	30 - 50 Blows/Ft.
		Very Dense	Over 50 Blows/Ft.
		Unconfined Compressive Strength	
Peat	Very Soft	Less than 0.30 Tons/Sq. Ft.	
	Soft	0.30 to 0.60 Tons/Sq. Ft.	
	Stiff	Greater than 0.60 Tons/Sq. Ft.	
		Density	
Organic Silt (Muck)	Loose	Less than 30 lbs./Cu. Ft.	
	Medium Dense	Greater than 80 lbs./Cu. Ft.	

1.55 LABORATORY SOIL TEST RESULTS

APPENDIX 1.55

LABORATORY SOIL TEST RESULTS

Atterberg Limits, Unconfined Compression Tests, Etc.

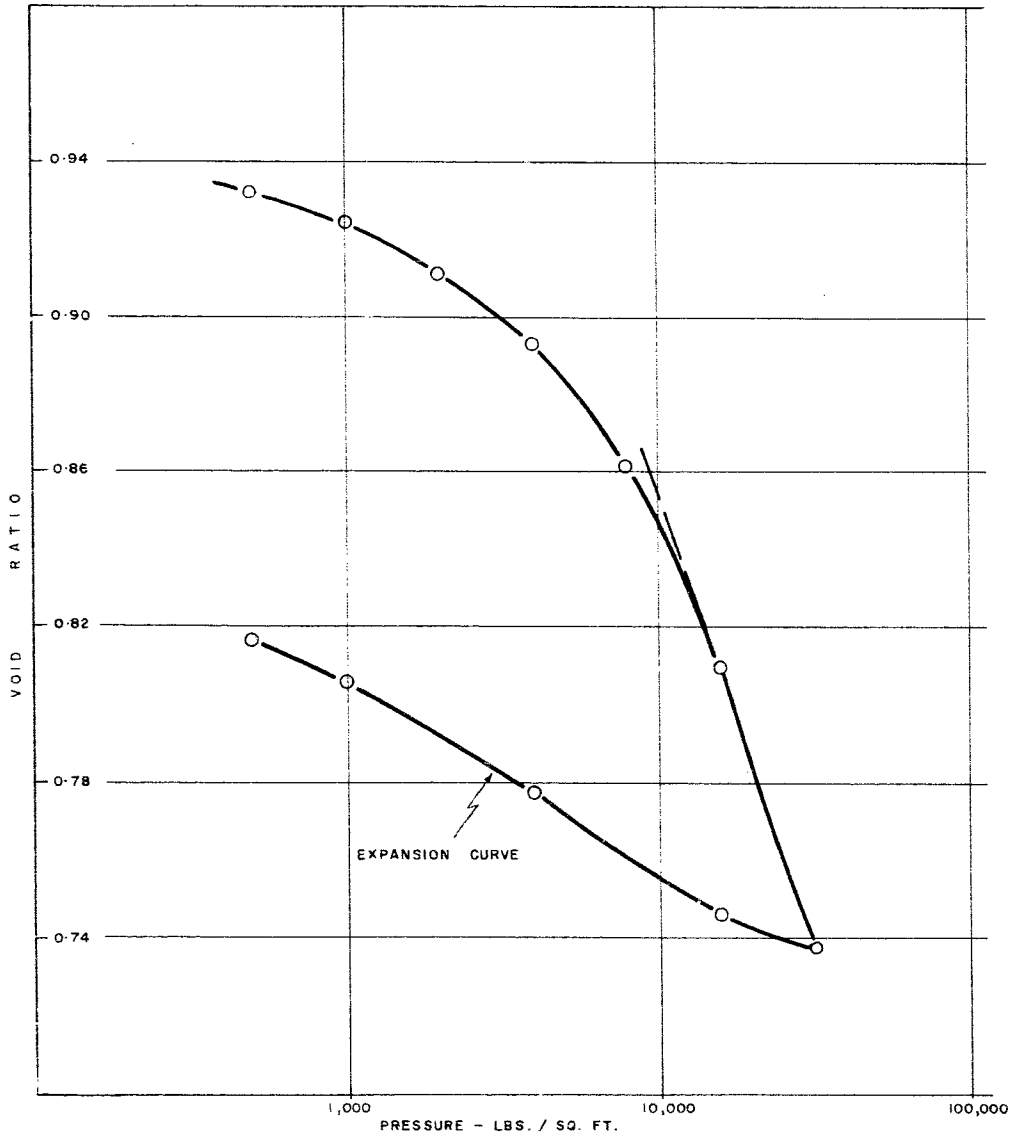
Typical samples of both the sand and clay strata were tested. Results of mechanical analysis and organic content tests on three typical samples of the sand strata have been included in this appendix. Seven sets of Atterberg Limit tests together with fifteen unconfined compression tests were conducted on typical samples of the clay strata. The results of these tests have been listed overleaf. The variation in the Atterberg Limits is believed to be due to the interbedded nature of this strata. A sand seam was noted in Sample 8 (Hole 2). Silt and sand seams were noted in other tube samples that were extruded, but not tested. The variation in compressive strength within the clay layer is closely related to depth and the degree of apparent desiccation extending from the top of this stratum.

CONSOLIDATION TESTS

Two consolidation tests were completed on separate Osterberg samples from the "clayey" strata. The results of these tests are listed below.

Hole	2	2
Sample	5	8
Depth (feet)	8-9	24-25.5
Specific Gravity	2.75	2.74
Compression Index Cc	0.231	0.72
Reconsolidation Pressure*p.s.f.	7000	4800
Load increment of		
500 - 1000 p.s.f., Cv =		0.0187
1000 - 2000 p.s.f.,Cv =		0.0267
2000 - 4000 p.s.f.,Cv =	0.0262	0.0133
4000 - 8000 p.s.f.,Cv =	0.0192	
8000 - 16000 p.s.f.,Cv=	0.0152	

* Not entirely conclusive - see e log P curves



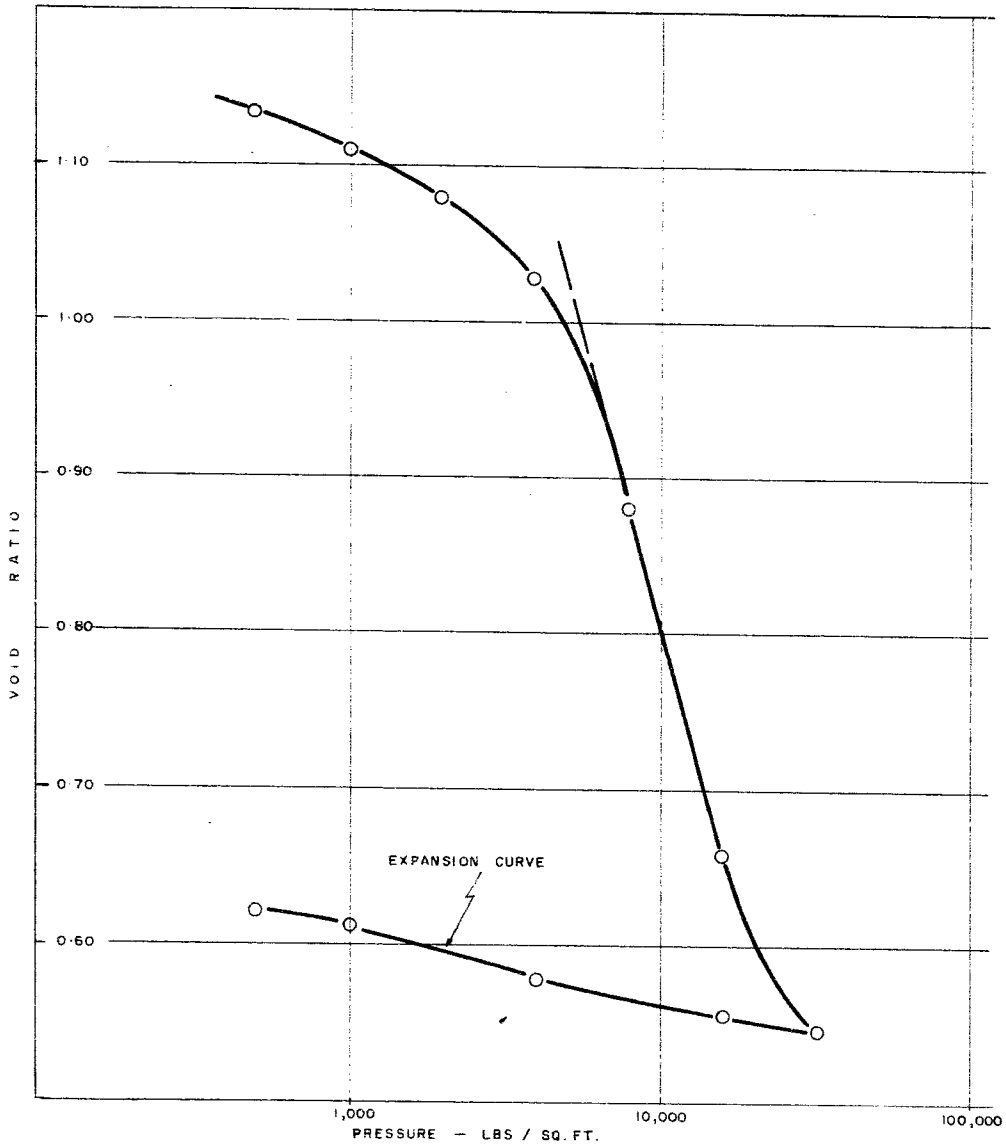
CONSOLIDATION TEST

e log. P CURVE

HOLE No. 2 - SAMPLE No. 5

NAPANEE RIVER SITE

Job H 415/58 - June '58



CONSOLIDATION TEST

e log. P CURVE

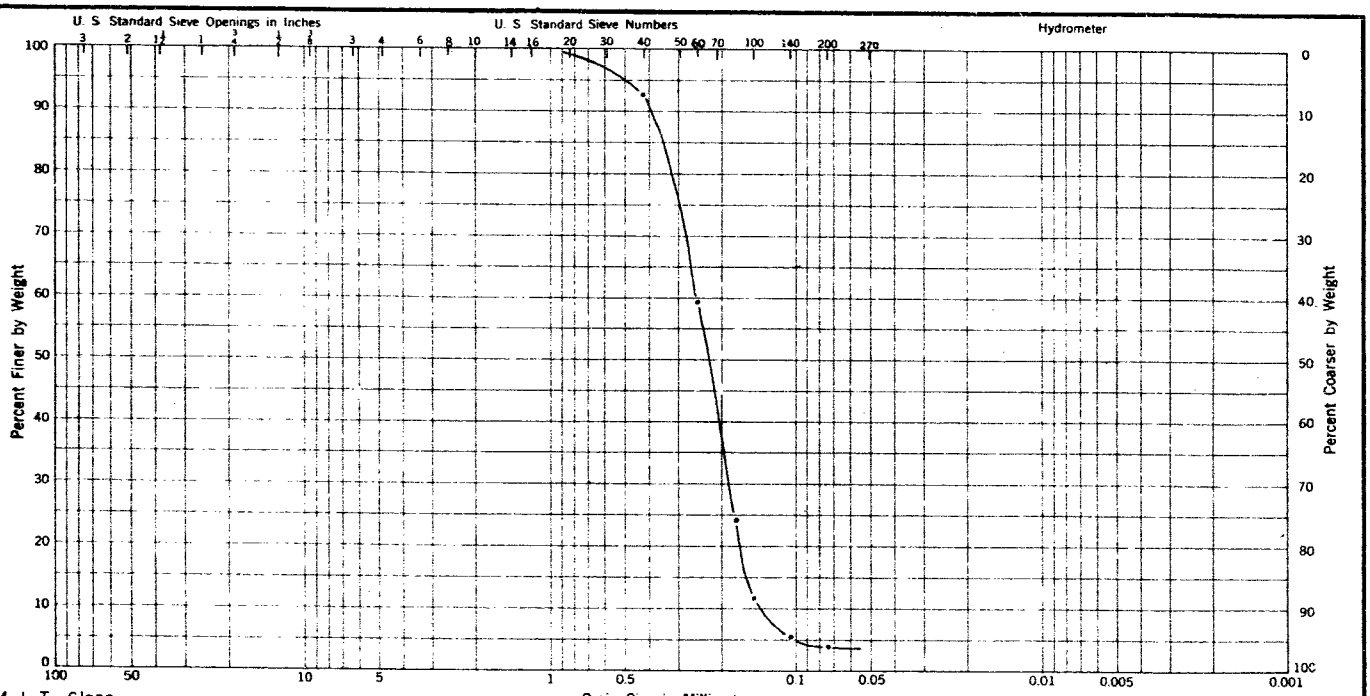
HOLE No. 2 - SAMPLE No. 8

NAPANEE RIVER SITE

Job H 415/58 - June '58

LABORATORY TEST RESULTS - INTERBEDDED SILT AND CLAY STRATUM

HOLE	2	2	4	5	5	5	5	5	5	5	5	5	6	6	7	7	8
Sample	5	8	4	3	4	5	5A	6	6A	7	8	9	4	8	8A	8B	9
Depth (feet) from			15.3	12	17	22	22	27		32			15	35			34
to			16.8	13.5	18.5	23.5	23.5			34			16.5	36			35
Liquid Limit	56.8	26.5	49.5		62.7			18.1			32.3			30.8			
Plastic Limit	24.1	16.6	20.0		27.6			12.4			15.3			15.5			
Plasticity Index	32.7	9.9	29.5		35.1			5.7			17.0			15.3			
Moisture Content (%)			29.4	32.3	36.7	30.0			20.4	18.4	30.0	21.0	37.2	22.2			
Unconfined Compression																	
Undisturbed t/ft.^{2}			2.45	2.43	1.73	1.23	1.10	1.24	0.65	0.45	0.58	0.65	2.25	0.69	0.40	0.75	0.95
Remolded t/ft.^{2}				1.72			0.63						1.47	0.20		0.25	
Sensitivity				1.4			1.7						1.6	3.3		3.0	



3 %	Coarse sand
57 %	Medium "
36 %	Fine "
4 %	Silt

Classification

Medium and fine sand

(14 % organic matter retained on No. 4 sieve)

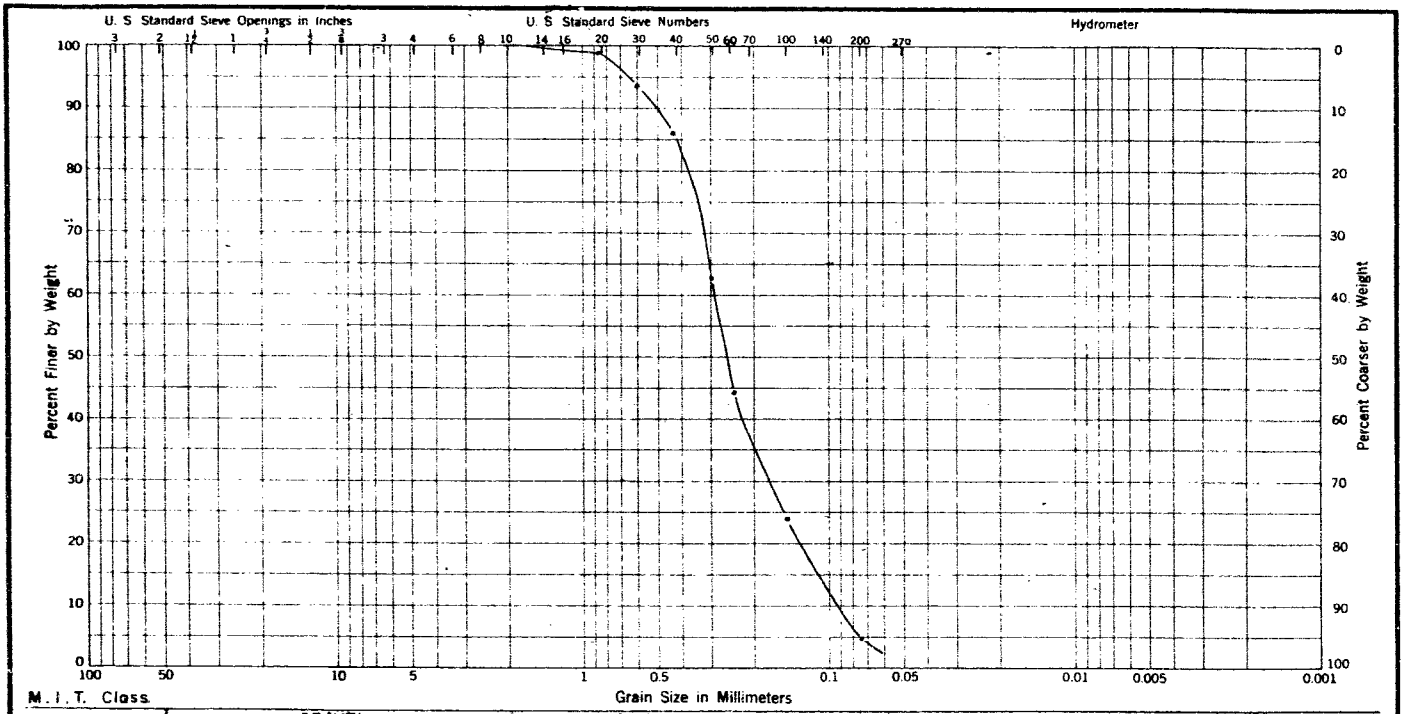
HUNTING TECHNICAL and EXPLORATION SERVICES

DEPARTMENT OF HIGHWAYS - ONTARIO

PROPOSED BRIDGE SITE
HIGHWAY 401 - NAPANEE RIVER

SOIL MECHANICAL ANALYSIS

BOREHOLE 5 SAMPLE 2 DEPTH 8'



M.I.T. Class.

STONES	GRAVEL	SAND			SILT			CLAY
		Coarse	Medium	Fine	Coarse	Medium	Fine	

7 %	Coarse sand
58%	Medium "
31%	Fine "
4 %	Silt

Classification

Medium and fine sand

(containing wood chips)

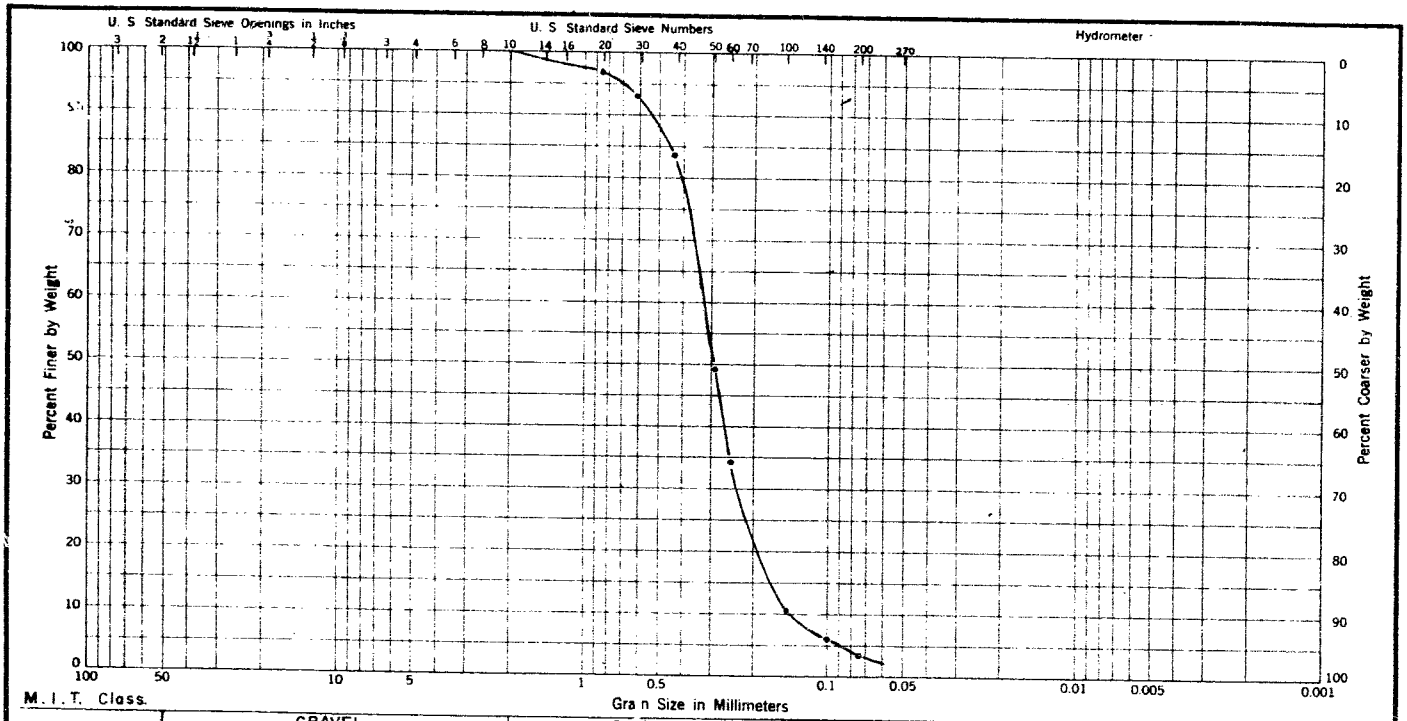
HUNTING TECHNICAL and EXPLORATION SERVICES

DEPARTMENT OF HIGHWAYS - ONTARIO

PROPOSED BRIDGE SITE
HIGHWAY 401 - NAPANEE RIVER

SOIL MECHANICAL ANALYSIS

BOREHOLE 7 SAMPLE 3 DEPTH 7'



7 %	Coarse sand
71 %	Medium "
18 %	Fine "
3 %	Silt

Classification

Medium and fine sand

(containing organic material)

HUNTING TECHNICAL and EXPLORATION SERVICES

DEPARTMENT OF HIGHWAYS - ONTARIO

PROPOSED BRIDGE SITE
HIGHWAY 401 - NAPANEE RIVER

SOIL MECHANICAL ANALYSIS

BOREHOLE 8 SAMPLE 3 DEPTH 7'

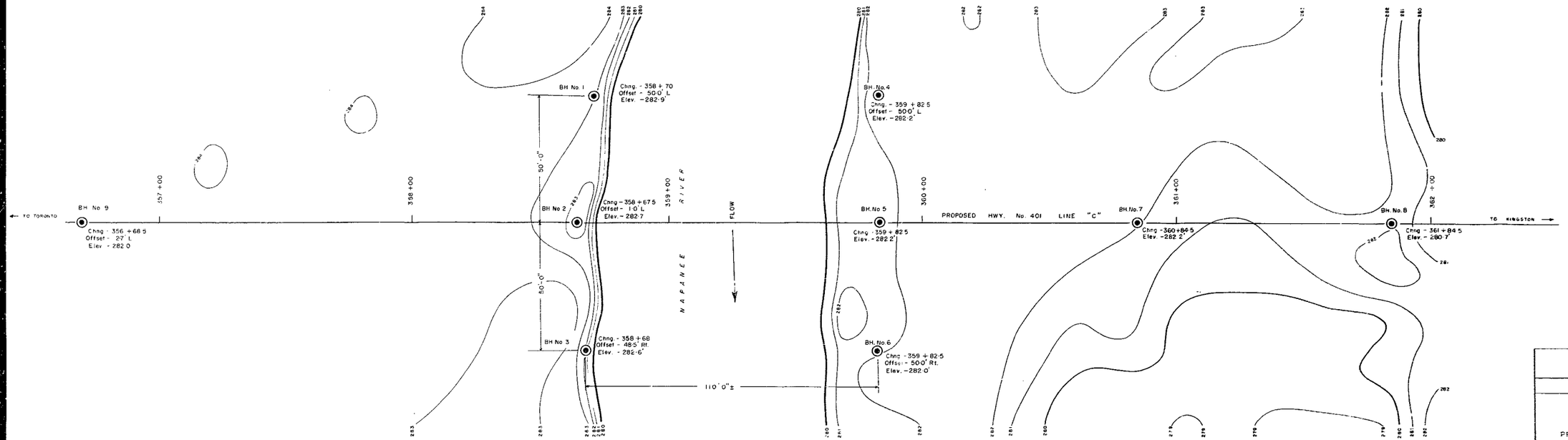
1.56 PHOTOS OF SITE AND RIG

General View of Site Looking West.

Drill Rig Set Up at Hole #5.

General View of Site Looking West.

Drill Rig Set Up at Hole #5.



HUNTING TECHNICAL & EXPLORATION SERVICES LTD
TORONTO

DEPARTMENT OF HIGHWAYS - ONTARIO

PLAN SHOWING
LOCATION OF BOREHOLES FOR
PROPOSED CROSSING AT NAPANEE RIVER
AND
THE KING'S HIGHWAY No. 401
PROPOSED LINE "C"
BRIDGE SITE

SCALE - 1 inch = 20 ft	Drawn by - C.F.B	Date - May 1958

Reference - Plan - E 3374-1