

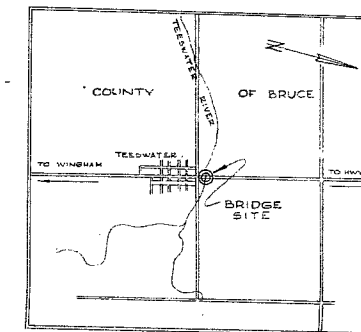
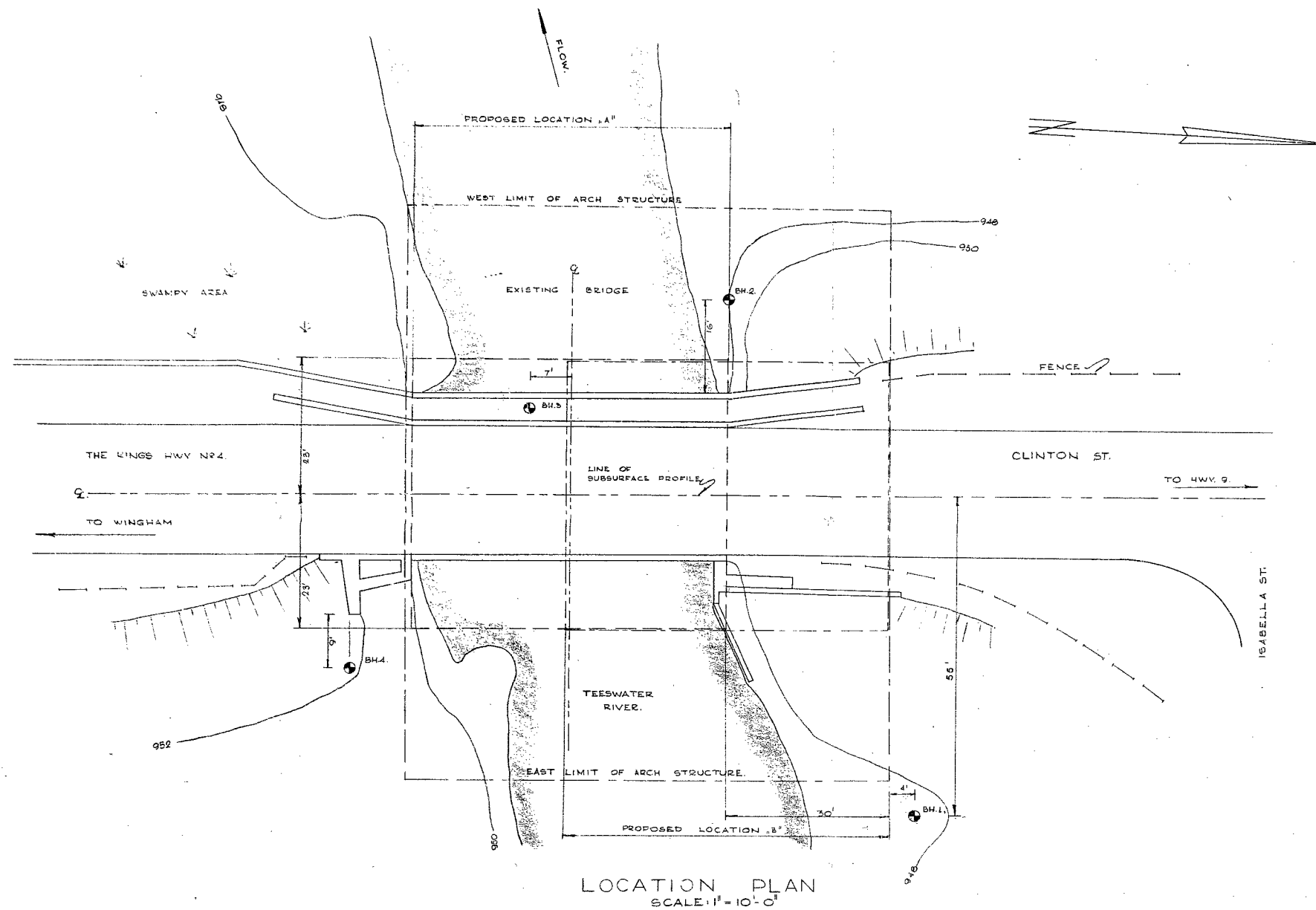
#61-F-204-C

W.P. 115-61

HWY. #4

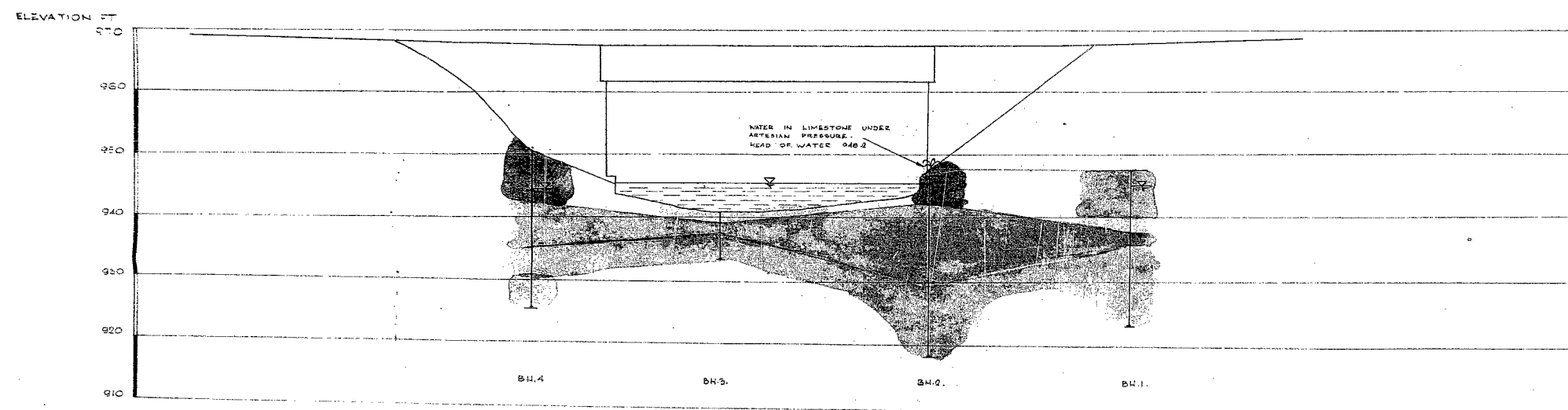
TEESWATER

RIVER BRIDGE



LEGEND:

- GRAVEL SAND FILL.
- BROWN SILTY FINE TO MEDIUM SAND
- BROWNISH CLAYEY SILT AND FINE SAND
- POROUS LIMESTONE WITH CAVITIES AND WEATHERED SURFACE
- BUFF COLORED GRAVELLY SAND WITH SILT.
- NON POROUS LIMESTONE.



OUR REF. No. 1-10-3	DEPARTMENT OF HIGHWAYS - ONTARIO
ENCL. No. 1	SOIL INVESTIGATION FOR
DATE OCT. 1961	TEESWATER RIVER BRIDGE AT TEESWATER.
DRAWN BY EL	DOMINION SOIL INVESTIGATION LIMITED 88 EGLINTON AVENUE EAST
Checked BY	TORONTO 12 ONTARIO

Mr. A. N. Lave, Bridge Engineer,
Bridge Division,
Materials & Research Division,
(Foundation Section).

October 25, 1961.

FOUNDATION INVESTIGATION REPORT
By: Dominion Soil Investigation,
Limited.

Attention: Mr. A. N. Lave

Re: Longwater River Bridge,
Hwy. No. 4 - District No. 3,
S.D. 115-61.

Attached, we are sending you the above-
mentioned report prepared and submitted by the Consultant,
Dominion Soil Investigation, Ltd. of Toronto.

The recommendations contained in the report
are self-explanatory and we believe, sufficient for your
future design work. Should there be any additional information
or clarification that you require, please feel free to call on
our Office.

AG /P/24F
P/24F.

cc: Messrs. A. N. Lave (2)
M. A. Trepanier
M. D. McMillan
A. Gater
G. C. Barrett
J. Roy
J. J. Novich
J. A. Gruppier
A. L. Paine
R. Norman
A. Watt
Foundation Office
Mr. Paine.

A. G. Sterner
A. G. Sterner,
PRINCIPAL FOUNDATION ENGINEER

Mr. A. Stermac
Principal Engineer
Room 107 Lab Bldg.

Bridge Division,
September 27, 1961.

MEMORANDUM TO:

Mr. C. R. Hopkins,
Regional Planning Engineer,
Department of Highways,
335 Saskatoon Street,
LONDON, Ontario.

RE: W.F. 115-61
Teeswater River Bridge
Highway #4, District #1

Subject to suitable foundation soil conditions your proposed location of the above structure with centre line coincident with the present Highway #4 centre line is approved by this office.

Considering hydrological problems only, a profile grade crossing the stream at elevation 964 would be sufficient.

However the proximity of the entrance at Sta. 214+96.5 together with the existing approach grades which closely match the adjacent highway grade in the town would preclude the use of that elevation and your proposed profile grade crossing the stream at an elevation 970. and dipping 0.5% towards the north would seem the most logical for a bridge structure.

Should soil conditions permit we will consider a culvert type arch at this site and request that you show also an alternative profile grade representing the best sag curve possible at this site.

GS/m
c.c.

S. McCoakie
L. B. Barrett
A. Gater
A. Stermac
R. Fitzgibbon

G. Scott,
Bridge Location Engineer

Ontario
Department of Highways
Materials and Research Section

REPORT ON
FOUNDATION INVESTIGATION
FOR
TEESWATER RIVER BRIDGE
HWY. #4 - DISTRICT #3
W.P. 115-61

Submitted by:
DOMINION SOIL INVESTIGATION LIMITED
88 Eglinton Avenue East
Toronto 12 Ontario

Our Ref. No. 1-10-3

October 1961

C O N T E N T S

	<u>Page</u>
INTRODUCTION	1
I. DESCRIPTION OF SITE AND GEOLOGY	2
II. FIELD WORK	2
III. LABORATORY WORK	3
IV. SUBSURFACE CONDITIONS	4
V. WATER CONDITIONS	5
VI. DISCUSSION AND RECOMMENDATIONS	5
VII. SUMMARY	6
VIII. REFERENCES	7

E N C L O S U R E S

KEY PLAN, LOCATION OF BOREHOLES AND SUBSURFACE PROFILE	Encl. #1
GEOTECHNICAL DATA SHEETS	Encls. #2-5 incl.
LABORATORY TEST RESULTS:	
GRAIN SIZE DISTRIBUTION CURVE	Encl. #6

DOMINION SOIL INVESTIGATION LIMITED

Foundation Engineering - Soil Mechanics

Soil Boring & Rock Diamond Drilling

Field & Laboratory Testing

HEAD OFFICE
88 EGLINTON AVENUE EAST
TORONTO 12, CANADA
Tel. HUdson 7-3633

BRANCH OFFICE
363 QUEENS AVENUE
LONDON, ONTARIO
Tel. GEneral 3-3851

Authorization was received from the Department of Highways, Materials and Research Section, to conduct a foundation investigation at the site of a proposed bridge in Teeswater, Ontario.

A bridge site plan (E 3974-1) was provided to us showing two proposed locations of a single span structure and one proposed location of an arch type culvert.

The purpose of the investigation was to reveal the subsurface conditions and determine the necessary soil properties for the design and construction of foundations.

I. DESCRIPTION OF SITE AND GEOLOGY

The proposed structure will carry Highway No. 4 above the Teeswater River, close to the northern limits of the Town of Teeswater (pop. around 950) in the County of Bruce, in Culross Township. Now there is a narrow bridge at this location which needs to be modernized.

The Teeswater River at the site runs in a broad valley, the morphology of which suggests an ancient glacial spillway. The water from the melting ice shield cut its way into the till deposit covering the entire surrounding area. Later, with the retreat of the ice cover, the river became smaller also, finally a secondary route was carved into the bottom of the wide valley. During the course of its history the river changed its bed as proven by the subsoil stratification. (See IV Subsurface Conditions)

This area is one of the good general farming districts in Southern Ontario. A dairy plant is located near the bridge site.

The underlying rock is of the devonian, sedimentary type - predominantly limestone.

II. FIELD WORK

Field work was carried out during the period October 5th to October 12th, 1961, and comprised four boreholes and three dynamic cone penetration tests at the locations shown on enclosure one. The positions of the test holes were set out on the site with the assistance of the drawing provided to us. Elevations were measured relative to the pavement on the bridge.

The boreholes were of 3 in. diameter. They were lined (or partly lined) with Bx casing advanced to the required sampling depths by the repetitious procedure of alternately driving and washing.

Standard penetration tests were made at frequent intervals using a 2 in. outside diameter split spoon driven into the bottom of the clean borehole by a constant driving energy (140 pound hammer dropping 30 inches). The dynamic cone penetration test is one type of deep sounding in which the Bx rods with a 2 in. diameter 60 degree apex cone driving point are driven into the subsoil without casing and applying the same driving energy as above. The former test provided disturbed samples of the substrata indicating their relative density and consistency and the latter a continuous record of soil density.

Where bedrock or boulder was encountered the holes were advanced by diamond drilling. AXT size (1-1/8 in. diameter) core was recovered.

The samples were shipped to our laboratory where they were thoroughly examined and classified by visual and hand (by touching) methods again.

The stratification of the subsoil, sampling depths, and the results of the penetration tests together with percentages of core recovery are recorded on data sheets comprising enclosures two to five inclusive.

Attention is called to the very difficult setup and moving conditions at the site. Besides this, the removal of earth, cutting of the slopes was required to provide a flat place for safe and efficient drilling.

III. LABORATORY WORK

The properties of the buff coloured gravelly sand with silt (crushed limestone) were checked in the laboratory because an accurate assessment of the properties of this material is important from the point of view of dewatering.

The grain size distribution of the deposit was determined and recorded on enclosure six. To find out its plastic properties the liquid and plastic limit tests were performed. The conclusion is that the soil has no plasticity. (See also enclosure six.)

The moisture content of a few samples taken from this crushed limestone material was also checked. They expose a rather wide variation (from 9 to 18 per cent, roughly) depending on the predominant grain size in the particular test sample.

The ground water obtained in borehole four was subjected to chemical analysis. Herewith the results:

pH = 7.61 (slightly alkaline)

SO₄ = 47 parts per million (allowable)

Organic content = negligible.

Regarding the above normal results, no further analysis was undertaken.

It may be concluded that the ground water is not aggressive to concrete.

IV. SUBSURFACE CONDITIONS

Soils of mainly glacial origin were encountered, the type of the uppermost layers depending on the location of the particular borehole. A detailed description is presented below:

- (i) Those holes - i.e. number two and four - which were drilled into the slope of the approach to the bridge, penetrated through several feet of gravel-sand fill. The fill contained traces of organics: probably the remains of the original topsoil.
- (ii) The first borehole was drilled in the riverbank with vegetation all around, hence the first few inches comprised the organic topsoil; whereas the location of borehole number three was almost in the centre of the river, thus a shallow alluvial silty sand layer covers the substrata. Numerous boulders were observable lying on the bottom of the river.

In borehole No. 1, brown clayey silt with fine sand - probably also of glacial origin - was found below the topsoil and overlying a narrow band of silty sand.

- (iii) The layer which may serve as a foundation material is a buff coloured gravelly sand with silt - a decomposed limestone. It is well graded (see encl. 6), very densely packed, has no plasticity. The shape of the grains is sharp, angular indicating that the place of origin was not far from the site.

This is a glacial drift the top of which was at around 943 feet before erosion cut riverbeds into it. (See BH #3 and probably also BH #1.) The bottom of the stratum is around 936 feet, except around borehole #2 where it is deeper (see below).

- (iv) The bedrock at the area is a light coloured porous limestone, the surface of which is weathered and contains cavities. This was the cause of the generally poor percentages of rock core recovered. A non-porous limestone was encountered in borehole four between elevations 930 and 925 feet.

The surface of the limestone bedrock suggests a different course of the ancient glacial river. The centreline of the "old" Teeswater River has probably passed at the location of borehole two. Later, this

riverbed was filled up with glacial drift (see above) and the river cut a new course south of the old one.

V. WATER CONDITIONS

The ground water level corresponds to the water level in the river. An exception was borehole two, where water under artesian pressure in the cavities of the limestone was relieved by the boring. The water came up to elevation 948.1 (8" above ground, 2'-6" above river water level) within four minutes. (It was impossible to bail out this hole below a depth of six feet.)

VI. DISCUSSION AND RECOMMENDATIONS

It is understood that two types of structure are considered: a single span bridge (at two alternative locations: A and B) and a culvert type arch. This will be discussed separately:

- (i) Single span structure, location A.

Footings can be placed in the decomposed limestone layer.

Base level: Allowable bearing pressure:

el. 942 ft. 6000 p.s.f.

937 ft. or lower 8000 p.s.f.

Settlements will be negligibly small.

- (ii) Single span structure, location B.

Footings can be placed in the decomposed limestone or on the bedrock itself.

Base level: Allowable bearing pressure:

937 ft. or lower 8000 p.s.f.

The bearing capacity is not increased on the surface of the limestone bedrock owing to its porous nature and the presence of cavities therein.

Settlements will not be of appreciable magnitude.

- (iii) A culvert type arch:

The unit bearing pressure under these types of structures are generally very light. It is recommended that the base slab be placed at around elevation 937 feet with the allowable bearing pressure of 8000 p.s.f.

Settlements will be negligibly small.

Construction

Construction of the footings should present no particular problem in any one of the three possible solutions. Excavation should be done when the water level is low, then dewatering costs will be kept to a minimum. Footings can be constructed in open-cut pits, seepage water collected in temporary ditches along the sides and pumped out of a deep well dug in a corner of the excavation.

The danger of piping (hydraulic failure of the bottom of excavation) depends on two factors: (1) the head of water above base level, (2) the length of the period while the excavation stays open. The first factor should not present difficulties if the water level is low. The critical value of the hydraulic gradient is quite high, because the material is well graded and densely packed. The time factor, however, plays an important role. The upward water pressure tends to wash out the fine silt particles of the subsoil, and gradually loosens its structure. Therefore, the lean concrete should be poured as soon as possible against the bottom of excavation, thus sealing off the groundwater.

Attention is called to the importance of close supervision when the proposed footing grade is being reached by the excavation. The "no settlement" prediction refers to undisturbed footing grade only. Hence loosening of the subgrade must be prevented, or if it ever occurred, loose spots should be removed and recompacted with vibrating equipment to a satisfactory density.

VII. SUMMARY

1. The subsoil at the site is mainly of glacial origin. A very dense gravelly sand with silt (decomposed limestone) or the bedrock itself may serve as foundation material.
2. The proposed structure can be supported by spread footings placed at shallow depths.
3. Allowable bearing pressures vary with depth and they are specified in paragraph VI.
4. Construction of footings should present no problems. Water can be removed by pumping from open pits.



DOMINION SOIL INVESTIGATION LIMITED

L. R. Szalatkay
L. R. Szalatkay, P.Eng.
Senior Soils Engineer

VIII. REFERENCES

1. Procedures for Testing Soils, ASTM, April 1958, pp. 186 to 198. (Unified Soil Classification System - by A. A. Wagner)
2. Terzaghi and Peck: Soil Mechanics in Engineering Practice. John Wiley & Sons, New York, 1948
3. The Physiography of Southern Ontario by L. J. Chapman and D. F. Putnam of the Ontario Research Foundation - University of Toronto Press, 1951
4. Grundbau-Taschenbuch (Foundation Engineering Handbook, in German). W. Ernst & Son, Berlin, 1955

E n c l o s u r e s

GEOTECHNICAL DATA SHEET FOR BOREHOLE 1. . . .

FORM REFERENCE NO 1-10-3

CLIENT DEPARTMENT OF HIGHWAYS.
PROJECT TEESWATER RIVER BRIDGE
LOCATION TEESWATER, ONT.
DATUM ELEVATION 947.5

METHOD OF BORING WASH BORING
DIAMETER OF BOREHOLE 3"
DATE OCT. 7 & 10, 1961

ENCLOSURE NO 2.

ELEVATION +	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot		CONSISTENCY water content %		REMARKS
				NUMBER	TYPE	N or Advancement of Sampler	SHEAR STRESS lbs. sq. ft.	PL	W	LI	
947.5	0	ORGANIC TOPSOIL	WM								
	3	BROWNISH CLAYEY SILT AND FINE SAND.		1.	SS	10					
				2.	SS	22					
940		BROWN SILTY FINE TO MEDIUM SAND		3.	SS	12					
	10	BUFF COLORED GRAVELLY SAND WITH SILT. (decomposed limestone)		4.	SS	7100					
	15	LIGHT, POROUS LIMESTONE		5.	AXT core	Rec.: 48%					
930		WITH CAVITIES		6.	AXT core	Rec.: 60%					
	20	AND WEATHERED SURFACE.		7.	AXT core	Rec.: 50%					
923.5		END OF BOREHOLE.									

STANDARD
PENETRATION
RESISTANCE

DYNAMIC
CONE TEST.

NOTE:
SS = SPLIT
SPOON SAMPLE.

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: EL.

CHD: \$

GEOTECHNICAL DATA SHEET FOR BOREHOLE . 2 . . .

OUR REFERENCE NO. 1-10-3

CLIENT: DEPARTMENT OF HIGHWAYS.
PROJECT: TEESWATER RIVER BRIDGE.
LOCATION: TEESWATER, ONT.
DATUM ELEVATION: 947.6

WE HOLE OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 3"
DATE: OCT. 6-7, 1961.

ENCLOSURE NO. 3.

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE					CONSISTENCY				REMARKS
				NUMBER	TYPE	No. or Advancement of Sampler	20	40	60	80	100	water content % PL W LI				
							SHEAR STRENGTH lbs. sq. ft.									
947.6	0	GRAVEL SAND FILL		1	SS	4										WATER IN LIMES- TONE UNDER ARTESIAN PRES- SURE HEAD OF WATER: 948.2.
	5	BUFF COLORED GRAVELLY SAND WITH SILT. (decomposed limestone.)		2	SS	33										
940				3	SS	7100										
	10			4	SS	7100										
	15	(COBBLES EMBEDDED IN THE MAIN MATERIAL.)		5	AXT core	Rec'd 5%										
930																
	20	LIGHT, POROUS LIMESTONE WITH CAVITIES AND WEATHERED SURFACE.		6	AXT core	42%										
	25			7	AXT core	68%										
918.6		END OF BOREHOLE														

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: EL.

CH'D: *Handwritten signature*

GEOTECHNICAL DATA SHEET FOR BOREHOLE . 3. . . .

OUR REFERENCE NO. 1-10-3

CLIENT: DEPARTMENT OF HIGHWAYS.
PROJECT: TEESWATER RIVER BRIDGE
LOCATION: TEESWATER, ONT.
DATUM ELEVATION: 967.0

METHOD OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 3"
DATE: OCT. 10-11, 1961.

ENCLOSURE NO. 4.

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE		CONSISTENCY		REMARKS
				NUMBER	TYPE	N ₆₀ or Advancement of Sampler	blows per ft.	SHEAR STRENGTH lbs/sq ft	PI	W	
967.0	0										
	5										
960	10										
	15										
950	20										
	25	WATER									
940	30	BROWN SILTY FINE TO MEDIUM SAND		1	SS	39					
		BUFF COLORED GRAVELLY SAND WITH SILT. (decomposed limestone)		2	SS	7100					
		LIGHT POROUS LIMESTONE WITH CAVITIES & WEATHERED SURFACE.		3	AXT core	Rec. 42%					
933		END OF BOREHOLE.									

GEOTECHNICAL DATA SHEET FOR BOREHOLE .4 . . .

OUR REFERENCE NO. 1-10-3

CLIENT: DEPARTMENT OF HIGHWAYS.
PROJECT: TEESWATER RIVER BRIDGE
LOCATION: TEESWATER, ONT.
DATUM ELEVATION: 950.7

METHOD OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 3"
DATE: OCT. 11-12, 1961.

ENCLOSURE NO. 5

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot		CONSISTENCY water content %		REMARKS
				NUMBER	TYPE	N- or Advancement of Sampler	SHEAR STRENGTH lbs. sq. ft.		PL	W	
950.7	0	GRAVEL SAND FILL									
	5										
	7										
	10	BUFF COLORED GRAVELLY SAND WITH SILT. (decomposed limestone)		1	SS	29					
940											
	15			2	SS	7100					
	20	LIGHT POROUS LIMESTONE		3	AXT core	Rec: 28%					
930											
	25	NON POROUS LIMESTONE.		4	AXT core	93%					
925.7		END OF BOREHOLE									

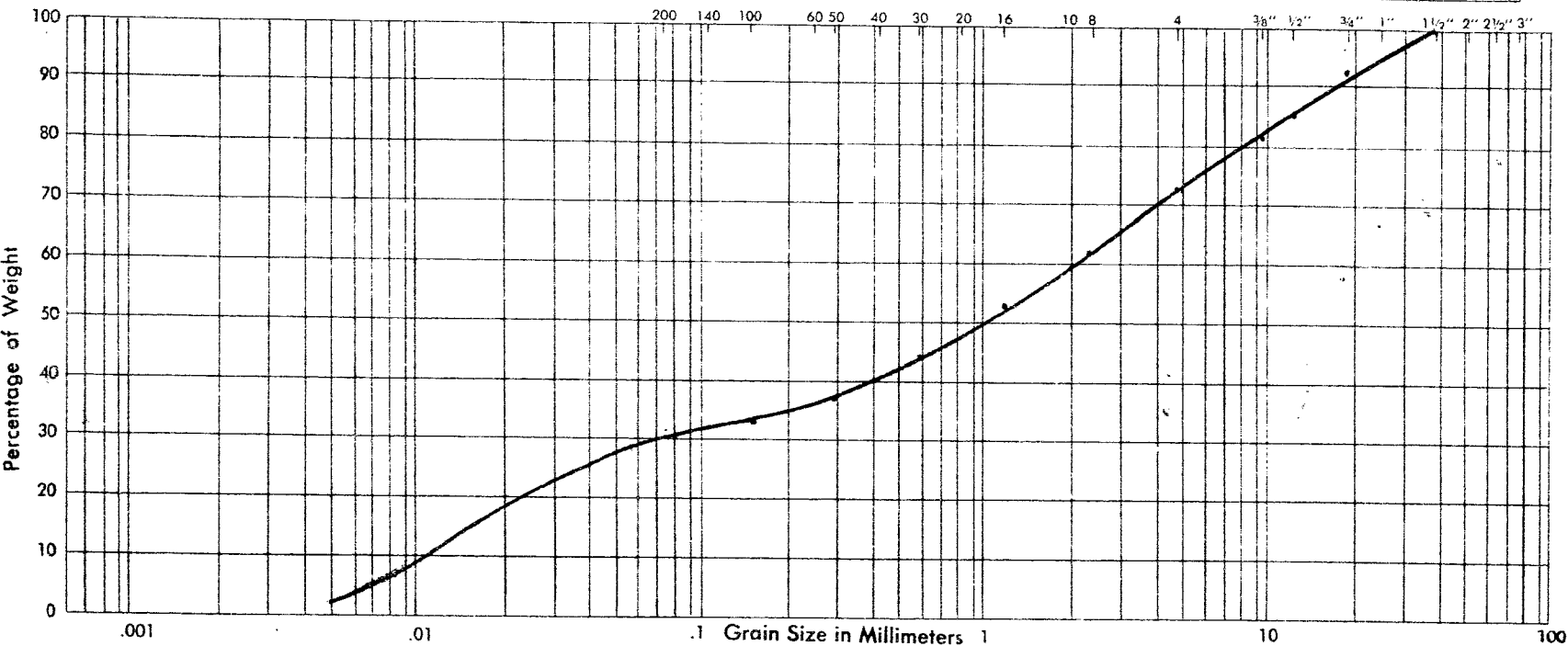
DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 1-10-3

UNIFIED SOIL CLASSIFICATION
SYSTEM

SILT AND CLAY	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE



PROJECT: TEEBWAIVER RIVER BRIDGE
 LOCATION: TEEBWAIVER, ONT.
 BOREHOLE NO.: 1A - 1B COMBINED
 SAMPLE NO.: 1 - 2
 DEPTH OF SAMPLE: 1
 ELEVATION OF SAMPLE: ~ 942 ft

COEFFICIENT OF UNIFORMITY —
 COEFFICIENT OF CURVATURE —

Classification of Sample and Group Symbol:
 GRAVELLY SAND WITH SILT
 (CRUSHED LIMESTONE) GM-SM

PLASTIC PROPERTIES:

LIQUID LIMIT	% = 18.4
PLASTIC LIMIT	% = 17.8
PLASTICITY INDEX	% = .6
MOISTURE CONTENT	% = 9 to 27%
ACTIVITY	= — (VARYING)

Enclosure No. 6.