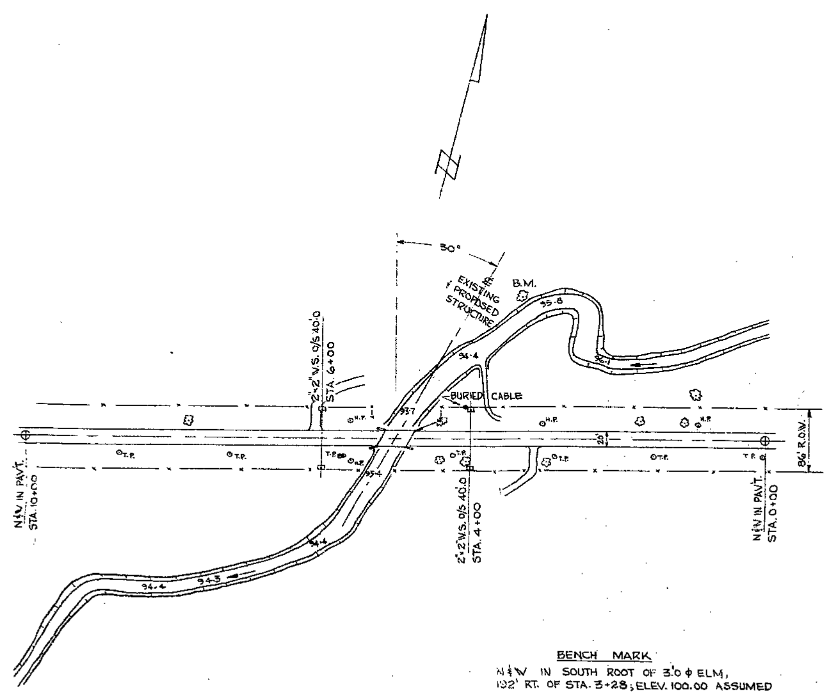
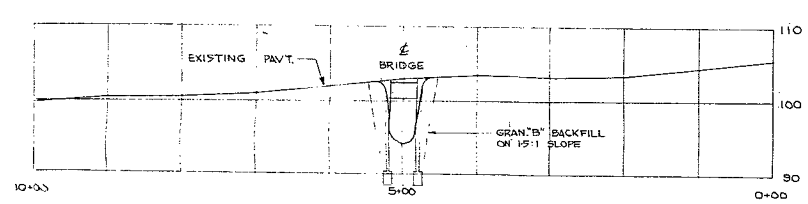
64-F-277m
BRIDGE #137
LOT 31, CON X & XI
LONDON
TWP.



BENCH MARK
N/W IN SOUTH ROOT OF 3'0" φ ELM, 132' RT. OF STA. 3+28; ELEV. 100.00 ASSUMED

PLAN

SCALE: 1" = 100'

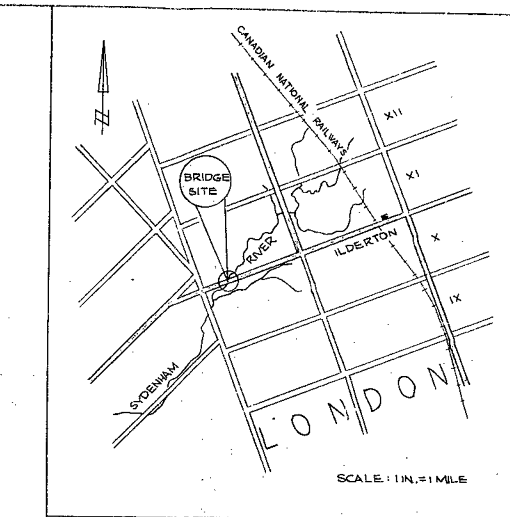


PROFILE

SCALE: HORIZ. 1" = 100'
VERT. 1" = 10'

NOTE:

SOIL REPORT IS AVAILABLE FOR INSPECTION AT COUNTY ENGINEER'S OFFICE.



KEY PLAN

DATA

1. SPECIAL FEATURES:-

SURROUNDING TERRAIN IS QUITE FLAT.

2. UPSTREAM STRUCTURES:-

DISTANCE UPSTREAM = 1.3 MI.; 22'×6' CONC. CULVERT.
NO FLOODING OVER ROAD.
NET X-SECT. AREA AT H.W. = 132 SQ.FT.

DOWNSTREAM STRUCTURES:-

DISTANCE DOWNSTREAM = 0.5 MI.; 31' SIMPLE SPAN.
H.W.L. IS APPROX. 1 FT. OVER ROAD.
WATERWAY OPENING OF BRIDGE = 155 SQ.FT.

EXISTING STRUCTURES:-

30' RT. SPAN (SKEW = 30°) BUILT IN 1938.
HT. ABOVE NORMAL H.W.L. = 3 FT.
NET X-SECT. AREA AT H.W. = 171 SQ. FT.

3. Reasons why these bridges are fair indications of size of proposed bridge:-

PROP. BRIDGE = 30 × 6 = 180 SQ. FT.

4. Is the stream gradient liable to be lowered? NO
5. Navigation clearance required, if any:- NO
6. Railway clearance required, if any:- NO
7. Temporary detour required? YES

Who will build it? CONTRACTOR

Who will maintain it? CONTRACTOR

8. Information on water level according to local residents:-

H.W.L. = 100.0±
L.W.L. = 95.0±

9. Road Design Information:-

ROAD TO BE CONSTRUCTED IN 1964

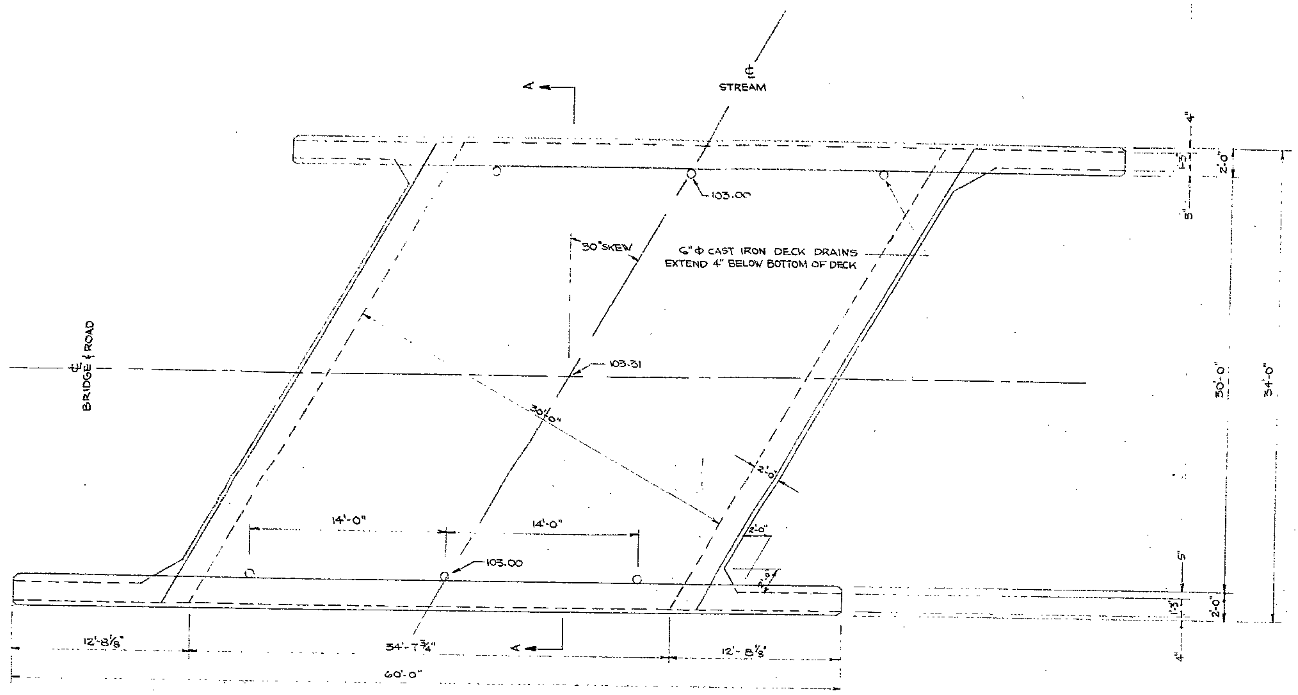
STRUCTURAL DATA

1. Net span and type of bridge:- 30' RIGID FRAME
2. Roadway width on bridge:- 30'
3. Number and width of sidewalks:- NONE
4. Skew Angle:- 30°
5. Approximate Volume of Concrete:-
6. Approximate Weight of Reinforcing Steel:-
7. Drainage Area:- 8 SQ.MI.

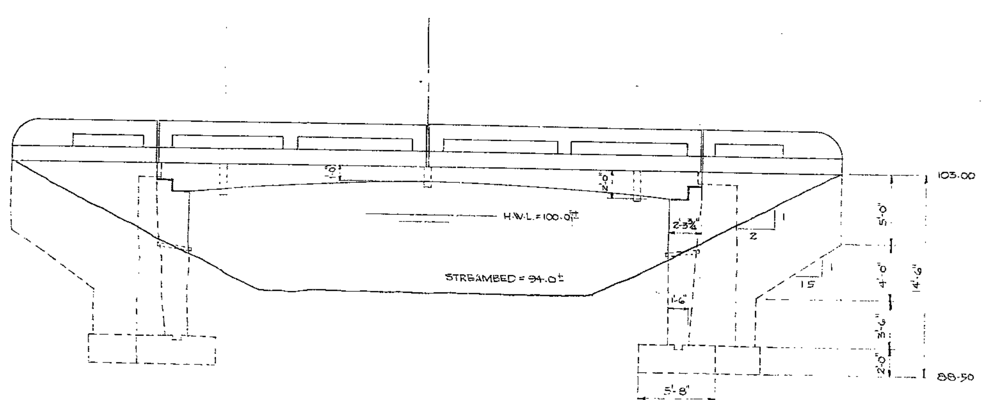
Field Investigation Made By
J. F. McIntyre

REGISTERED PROFESSIONAL ENGINEER
J. P. McINTYRE
PROVINCE OF ONTARIO

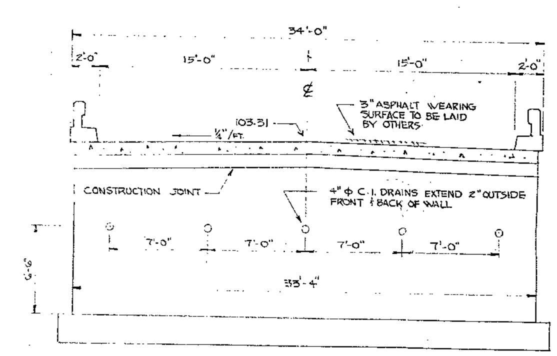
SHEET 1	OF
COUNTY OF MIDDLESEX	
BRIDGE NO. 137	
LOT 31, CON. X & XI, LONDON TOWNSHIP C.R. NO. 16	
SCALE AS SHOWN DRAWN BY J.P.M. DRWG NO. 8/16/31/8	ENGINEER DATE MAR. 17, 1964



PLAN



SOUTH ELEVATION



SECTION A-A

GENERAL NOTES

1. Structure to be built in accordance with D.H.O. Specs. Form 9, revised August, 1963, and County of Middlesex supplemental specifications.
2. Excavation for footings to be finished by hand to the neat dimensions and the concrete shall be placed on undisturbed material on front, back, and bottom faces.
3. Excavation for footings shall be made as neat as possible but in any case, shall be filled completely with footing concrete.
4. Footing depth is subject to revision by the Engineer.
5. Footings are designed for an allowable soil pressure of 4.5 K/sq. ft.
6. Reinforced Concrete shall have a minimum compressive strength of 3,000 p.s.i. in 28 days and maximum slump of 3". County to design a mix on receiving samples of sand and aggregate from the successful bidder.
7. Note the added addendum in County specifications regarding the addition of an admixture containing an air entraining agent. For estimating purposes, assume that ¼ lb. of <u>Highway Pozzolith</u> shall be added per bag of cement.
8. Maximum Size Aggregate:

   ¾" in deck slabs, Curb, and guard rails
   1½" in footing
   1" elsewhere

9. Concrete Cover (main reinforcing)

   3" in contact with earth and water
   2" in top of deck
   1½" in bottom of deck
   2" elsewhere

10. Deck falsework shall not be struck until all backfill has been placed and compacted behind the abutments to the satisfaction of the Engineer.
11. All exposed concrete edges to have ¾" chamfer unless otherwise noted.
12. Drain pipes and joint materials shall be supplied by the Contractor.
13. Construction year to appear on two diagonally opposite corners. Templates to be supplied by the County.
14. Design Loading: H 20 - S 16
15. Estimated Concrete:________________
16. Estimated Reinforcing Steel:____________

REGISTERED PROFESSIONAL ENGINEER
J. P. McINTYRE
PROVINCE OF ONTARIO

SHEET 2	OF
COUNTY OF MIDDLESEX	
BRIDGE NO. 137 LOT 31, CON. X & XI, LONDON TOWNSHIP; C.R. NO. 16	
SCALE 3/16" = 1' DRAWN BY: J.P.M. DRWG NO. 8/16/31/B	[signature] ENGINEER DATE MAR. 17, 1964

BA 1786

MR. F. B. D. ARNOLD
COUNTY ENGINEER
COUNTY OF MIDDLESEX
COUNTY OFFICES
LONDON ONTARIO

Report on SOIL INVESTIGATION for BRIDGE #137

LOT 31, CONCESSIONS X & XI

TOWNSHIP OF LONDON

by

DOMINION SOIL INVESTIGATION LIMITED
363 Queens Avenue
LONDON ONTARIO

Reference No. 4-2-L7
12th March, 1964

CONTENTS

ENCLOSURES

SUMMARY

The stratification is a rather complex layered system of granular and cohesive glacial and glacio-fluvial deposits.

It is recommended that the structure should be supported on spread footings at El.88.5 feet, designed for a gross soil pressure not exceeding 4500 p.s.f.

There is a slight possibility that an unstable condition might develop in the footing grade when the water level is lowered within the excavation. Procedures for dealing with this are discussed, and alternative methods of construction described briefly.

I INTRODUCTION

In accordance with a letter of authorization dated 28th January 1964 from Mr. J. P. McIntyre, Assistant County Engineer, a soil investigation has been carried out at a site in the Township of London where it is proposed to replace an existing road bridge with a new structure.

It is understood that the new bridge will be of approximately the same span and in the same position as the existing one. The latter carries a county road across the Sydenham River approximately 2 miles to the west of Ilderton.

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

II FIELD WORK

Field work was carried out during the period 10th to 12th February 1964, and consisted of 2 boreholes at the locations shown on enclosure 2. The holes were carried to a depth of 30 feet below the river bed because at the time of the field work the use of a piled foundation appeared to be a possible solution.

The results of the field tests are shown on geotechnical data sheets comprising enclosures 3 and 4. Elevations have been referred to the client's local datum (nail and washer in south root of 3-foot Ø elm, 192 feet right of Sta.3+28; elevation 100.0 assumed).

III SUBSURFACE CONDITIONS

Details of the stratification at each borehole are shown on the data sheets and a general picture of the subsurface conditions is given by the profile on enclosure 2. The following notes are intended only to augment these data.

The stratification is fairly complex, and a somewhat simplified version of it is given below:

Approximate depth (feet)	
0 to 10	Firm clayey silt fill. The dark brown colour is given by the presence of finely divided organic matter. The deposit is firm and cohesive.
10 to 12	Greyish-brown silt. This is a firm to very stiff natural stratum, lying immediately below the stream bed. It is saturated and contains a variable proportion of clay.

Approximate depth (feet)	
12 to 15.5	Gravelly silty sand. This is a dense pervious well graded material containing all sizes of particles from about 1" down to silt size. It consists mainly of fine to coarse sand. At borehole 1 in particular a laminated structure was observed, consisting of 1/2" to 1" layers of sand and sandy silt.
15.5 to 20	Sandy clayey silt till. The material is very stiff to hard, cohesive and impervious. It contains 5 to 10% of angular granular particles generally less than 1/2 inch in diameter.
20 to 26	Fine, compact to dense, uniform sand. At borehole 1 there is a trace of fine gravel and the deposit is very silty.

Below 26 feet the stratification in the two boreholes is quite different. Reference is made again to the respective data sheets and subsurface profile.

It would be difficult to trace the geological history of all of these deposits. They are all apparently of glacial or glacio-fluvial origin, perhaps deriving from more than one cycle of glaciation. The site is located in an area of bevelled ground moraine between the Seaforth Moraine to the west and the Lucan Moraine to the east. Generally similar conditions have been found within this area at structures located 2 to 3 miles downstream.* Conceivably the entire area of land between these two moraines is a glacial spillway.

IV FOUNDATIONS

The level of the stream bed is 93.7 feet. Allowing 5 feet for scour protection, a footing elevation of 88.5 feet is indicated. This lies within the graded upper sand stratum, 2 feet above the till at borehole 1, and almost on the surface of the till at borehole 2. 'N' values of 20 in the sand layer and 23 (minimum) in the till layer were recorded, corresponding to safe soil pressures of 8000 p.s.f. and 5500 p.s.f. respectively (for homogeneous materials). In the prevailing conditions, which will be discussed at greater length, it is recommended that the structure should be supported at El.88.5 on spread footings designed for a gross soil pressure not exceeding *4500 p.s.f.* The corresponding total

* see reference 1.

settlement is not expected to exceed *one inch*, nor the differential settlement between the abutments to exceed *3/4 inch*.

Particular attention has been given to the dewatering of the excavation because of a condition which is illustrated on enclosure 5. The stratification shown is that found in borehole 1, and is the least favourable of the two boreholes. If the water table is lowered to the level of the till (El.86.6) there will be an unbalanced hydrostatic pressure of 350 p.s.f. on the underside of the till layer, tending to bend it and 'blow' through the bottom of the excavation. However, if the width of the footing does not exceed 5 feet, the 4-foot deep till stratum (5.5 feet at borehole 1) will act more as a plug than a beam, i.e. it will not bend over so short a length, and the shear resistance on the sides of the 'plug' will counteract the excess water pressure. The average shearing force will be 350 x 5/8 = 220 p.s.f. Assuming that the maximum shearing force is twice the average, and taking the shear strength of the till conservatively as 2500 p.s.f., the factor of safety against a bottom blow is 2500/2 x 220 = 5.7. This should be adequate to compensate for any variations in water level, or in the thickness or elevation of the till stratum.

In the unlikely event that a weak spot in the till layer does lead to a blow-out, the water table should be allowed to rise immediately, disturbed material should be removed by sub-aqueous excavation, and a concrete bottom lining poured with the aid of a tremie-pipe. However, this possibility is quite remote, and it is suggested that the proposed procedure is justifiable in view of the relatively small size of the structure, and the cost of alternatives.

It will be necessary to brace the excavation, either with light-gauge metal sheeting or sheet piling, or timber planks. It may not be possible to drive timber through the dense sand stratum prior to excavation. In this case it can be driven in stages as the excavation proceeds. The sheeting or timber planks should be driven to approximately the top of the till layer. It will then be possible to dewater the excavation by pumping. The water table inside the excavation should not be lowered any further than is necessary to give dry working conditions, because the unbalanced hydrostatic pressure will vary directly with the water level inside the excavation.

An alternative method of dewatering would be to form a steel sheet pile enclosure around the footing and pump it dry. In such a case both footings could bear in the till using a soil pressure of 5500 p.s.f. The length of the sheet piles should be such that the distance from the tips of the piles to the footing grade is equal to or more than the distance from the footing grade to the water table.

A further alternative will be considered briefly for the purpose of comparison, and that is the use of end bearing piles. Timber piles of nominal 12-inch diameter, designed for a 20-ton working load, may be expected to set between Els. 80 and 85. It may not be possible to drive the piles through the bottom of the till layer without damage, especially in the conditions encountered at borehole 2. Steel pipe piles of 12-inch diameter have a theoretical safe working load of 30 tons at El.80, increasing by about 0.6 of a ton per foot of penetration below that level. Franki-type piles of higher bearing capacity could probably be formed in the lower granular layer, encountered between Els. 65 and 70. This last possibility would require further study.

V REFERENCES

1. Dominion Soil Investigation Limited reports 1-8-L6, October 1961, and 3-8-L4, August 1963 for Messrs. A. M. Spriet and Associates Limited.

2. The Physiography of Southern Ontario by L. J. Chapman and D. F. Putnam of the Ontario Research Foundation - University of Toronto Press 1951.

3. Procedures for Testing Soils, ASTM, April 1958. pp. 186 to 198. (Unified Soil Classification System - by A. A. Wagner).

4. Proceedings of the 4th International Conference on Soil Mechanics and Foundation Engineering (Research on Determining the Density of Sands by Spoon Penetration Testing - by H. J. Gibbs and W. G. Holtz of the United States Bureau of Reclamation.) London, 1957.

5. Terzaghi and Peck: Soil Mechanics in Engineering Practice. John Wiley and Sons, New York 1948.

6. Standard Penetration Tests and Bearing Capacity of Cohesionless Soils, by G. G. Meyerhof, ASCE Paper 866, January 1956.

DOMINION SOIL INVESTIGATION LIMITED

James Park, M.Sc., P.Eng.

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
		COARSE	FINE	COARSE	MEDIUM	FINE						
Ø > 8"	3"	3/4"	4.76mm	2.0	0.42	0.074	0.002 >		NO SIZE LIMIT			

U.S. Standard Sieve Size: No.4, No.10, No.40, No.200

SAMPLE TYPES.

AS	Auger sample	RC	Rock core	TP	Piston, thin walled tube sample
CS	Sample from casing	%	Recovery	TW	Open, thin walled tube sample
ChS	Chunk sample	SS	Split spoon sample	WS	Wash sample

SAMPLER ADVANCED BY static weight : w
" pressure : p
" tapping : t

OBSERVATIONS MADE WHILE CORING: Steady pressure; No pressure; Intermittent pressure; Washwater returns; Washwater lost

PENETRATION RESISTANCES.

SYMBOL:

DYNAMIC PENETRATION RESISTANCE : to drive a 2"ϕ, 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

STANDARD PENETRATION RESISTANCE, -N- : to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot.

EXTRAPOLATED -N- VALUE — 322

The energy for the penetration resistances is supplied by a 140 lb. hammer falling 30 inches

SOIL PROPERTIES.

W %	Water content	γ	Natural bulk density (unit weight)	k	Coeff. of permeability
LL %	Liquid limit	e	Void ratio	C	Shear strength — in terms of total stress
PL %	Plastic limit	RD	Relative density	ϕ	Angle of int. friction — in terms of total stress
PI %	Plasticity index	C_v	Coeff. of consolidation	C'	Cohesion — in terms of effective stress
LI	Liquidity index	m_v	Coeff. of volume compressibility	ϕ'	Angle of int. friction — in terms of effective stress

UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —

TRIAXIAL / UNCONFINED COMPRESSION TEST: ◉ ● St

LABORATORY / FIELD VANE TEST: X St, + St

POCKET PENETROMETER TEST: St

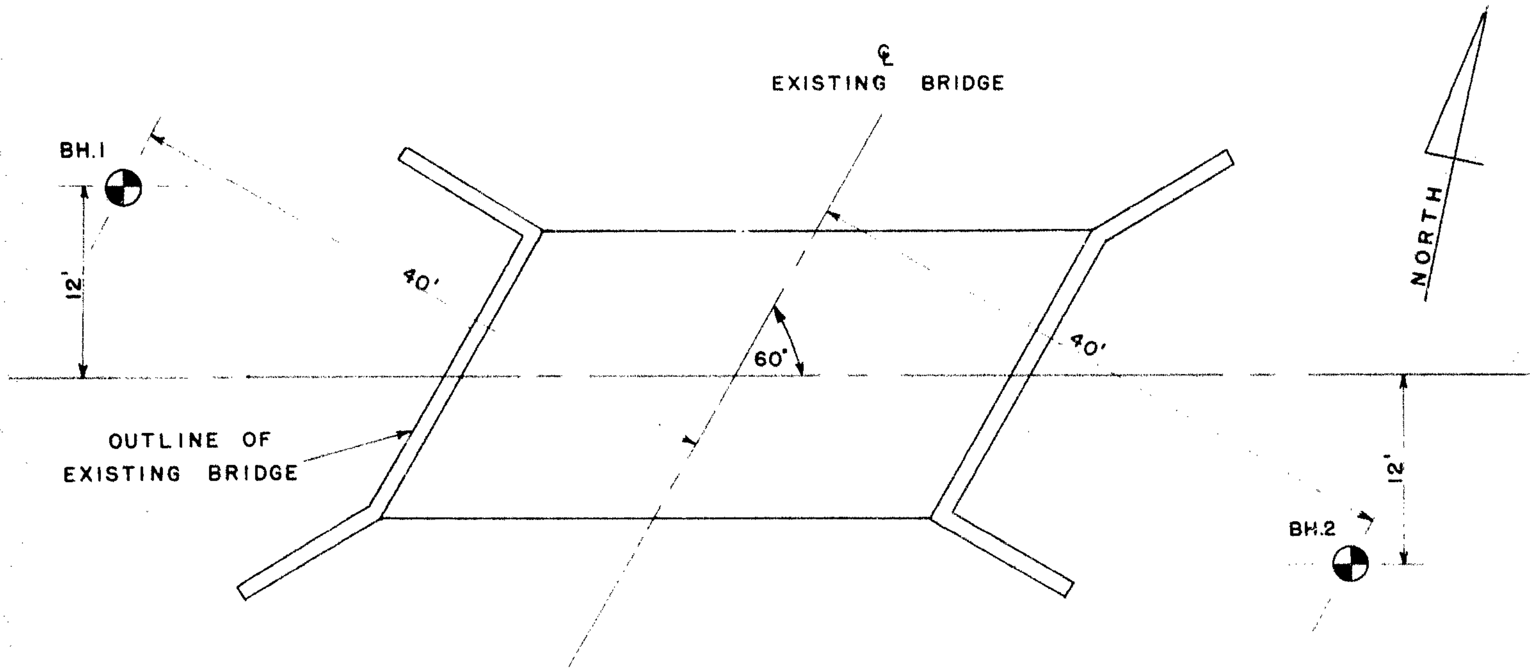
Strain at failure is represented by direction of stem: 20%, 15%, 5%, 10%

St : sensitivity = $\frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$

SOIL DESCRIPTION.

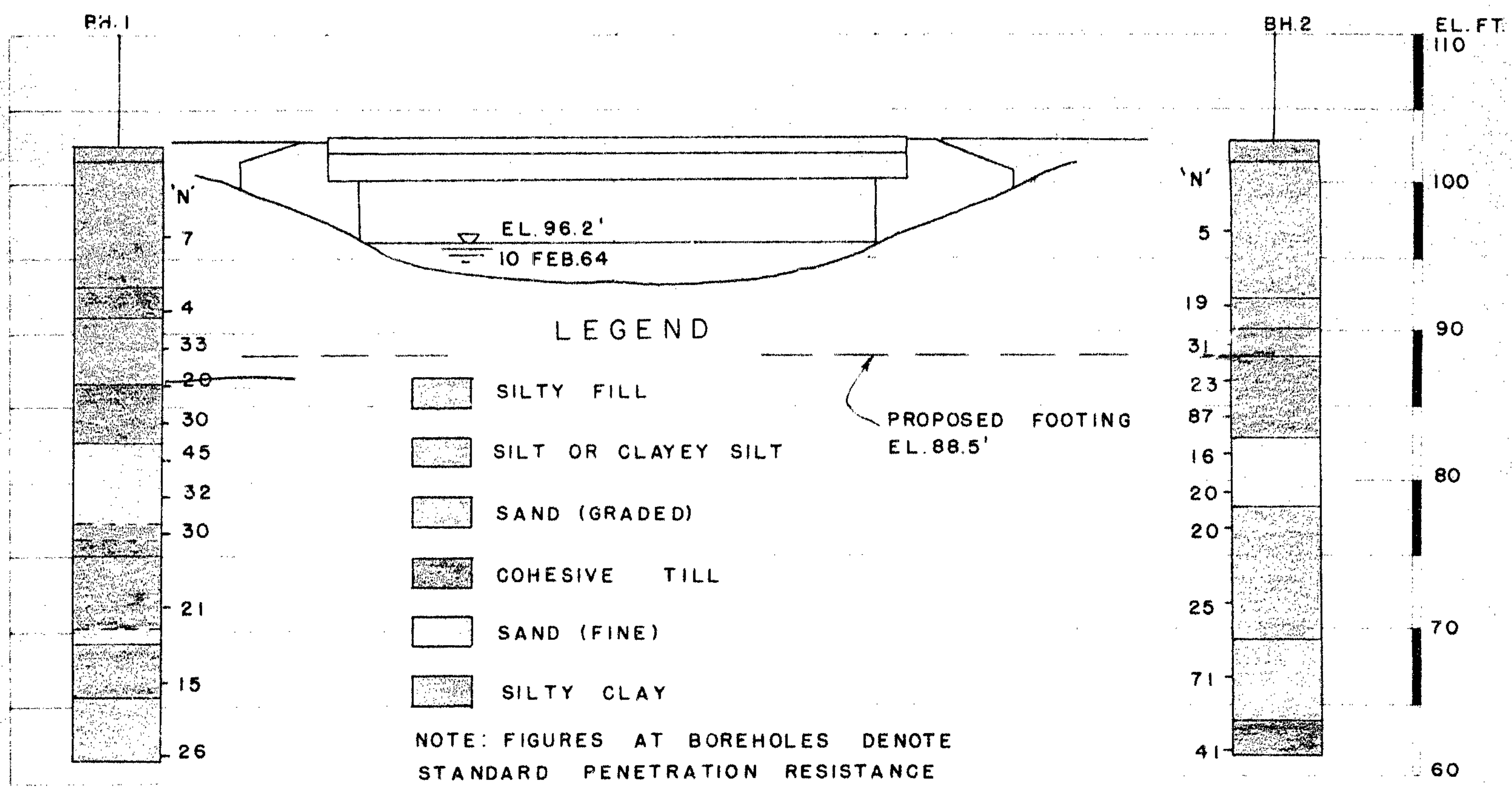
COHESIONLESS SOILS:	RD:
Very loose	0 – 15 %
Loose	15 – 35 %
Compact	35 – 65 %
Dense	65 – 85 %
Very dense	85 – 100 %

COHESIVE SOILS:	C lbs/sq.
Very soft	less than 250
Soft	250 – 500
Firm	500 – 1000
Stiff	1000 – 2000
Very stiff	2000 – 4000
Hard	over 4000



LOCATION OF BOREHOLES

SCALE: 1 INCH TO 10 FEET



SUBSURFACE PROFILE

SCALE: 1 INCH TO 10 FEET

OUR REFERENCE NO. 4-2-L7

GEOTECHNICAL DATA SHEET FOR BOREHOLE 1

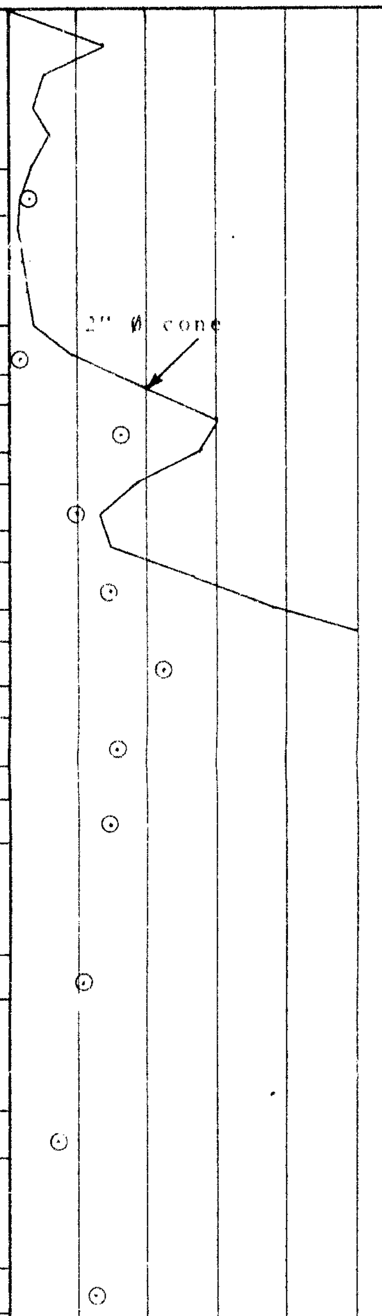
CLIENT: County of Middlesex
PROJECT: Road Bridge
LOCATION: Township of London near Ilderton
DATUM ELEVATION: 100.0' (nail in root of 3' elm 192' right of Sta.3+28)

METHOD OF BORING: Washboring
DIAMETER OF BOREHOLE: Bx (3-inch)
DATE: Feb.10-11, 1964.

ENCLOSURE NO. 3

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" or Advancement of Sampler	REMARKS
102.6	0	Ground Surface				
		Brown sandy road fill.				
100		Dark brown, firm, sandy clayey silt fill. damp, gravelly / moist				
	5		1	SS	7	W.L. on completion of borehole El. 96.1' 12 Feb. 64. W.L. in creek El. 96.2' 10 Feb. 1964
95						
	10	Greyish-brown firm, wet, silt (some cohesion).	2	SS	4	
90		Grey, wet, dense layers of sandy silt, fine sand and coarse sand.	3	SS	33	Proposed footing El. 88.5'.
	15		4	SS	20	
85		Grey, damp to moist, very stiff sandy clayey silt till (embedded grits and gravel)	5	SS	50	
	20	Grey, dense, very silty fine sand (trace of gravel).	6	SS	45	
80			7	SS	32	
	25	hard clayey silt seam	8	SS	30	
75		Grey, moist, very stiff silty sandy clay till (embedded grits and gravel)				
	30		9	SS	21	
70		fine sand seam				
	35	Grey, moist, stiff silty clay.	10	SS	15	
65		Grey, compact, fine to coarse silty sand (trace of gravel)				
	40		11	SS	26	
60		End of borehole				

PENETRATION RESISTANCE blows per foot 20 40 60 80 100 — SHEAR STRENGTH lbs/sq.ft



CONSISTENCY water content % PL W LL

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: SB CH'D: JP

GEOTECHNICAL DATA SHEET FOR BOREHOLE 2

OUR REFERENCE NO. 4-2-L7

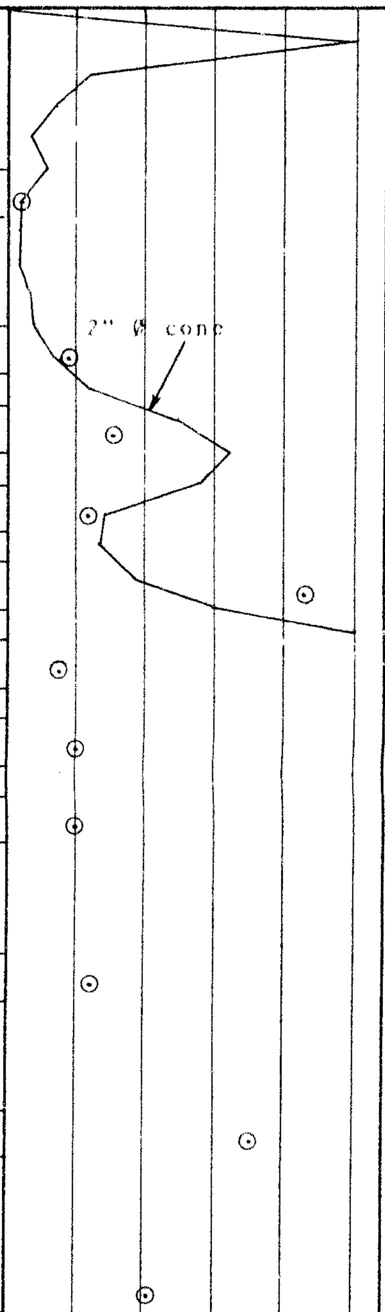
CLIENT County of Middlesex
PROJECT Road Bridge
LOCATION Township of London near Ilderton
DATUM ELEVATION 100.0' (nail in root of 3' elm 192' right of Sta.3+28)

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE Bx(3-inch)
DATE Feb.11-12, 1964.

ENCLOSURE NO 4

Elevation ft	Depth ft	Stratification Description	Sample Number	Type	N° of Advancement of Sampler	Remarks
102.		Ground Surface				
	0	Brown gravelly sandy road fill.				
100		Dark brown, firm, damp / moist clayey sandy silt fill, (trace of organics).	1	SS	5	WL in creek El.96.2' 10 Feb.64.
95	10					
		Greyish-brown, saturated, very stiff clayey silt.	2	SS	19	
90		Grey, dense, silty gravelly, fine to coarse sand (well graded)	3	SS	31	Proposed footing El.88.5'.
	15	Grey, moist, very stiff / hard sandy clayey silt till (embedded grits and gravel).	4	SS	23	
85			5	SS	87	
	20	Grey, compact, fine sand.	6	SS	16	
80			7	SS	20	
	25	Grey, very stiff, slightly cohesive silt.	8	SS	20	
75	30	clayey	9	SS	25	
70	35	Grey, very dense, silty gravel-sand mixture (well graded).	10	SS	71	
65	40	Grey, moist, hard sandy silty clay till (embedded grits and gravel)	11	SS	41	
60		End of borehole				

PENETRATION RESISTANCE blows per foot 20 40 60 80 100 — SHEAR STRENGTH lbs/sq ft



CONSISTENCY water content % PL W LL

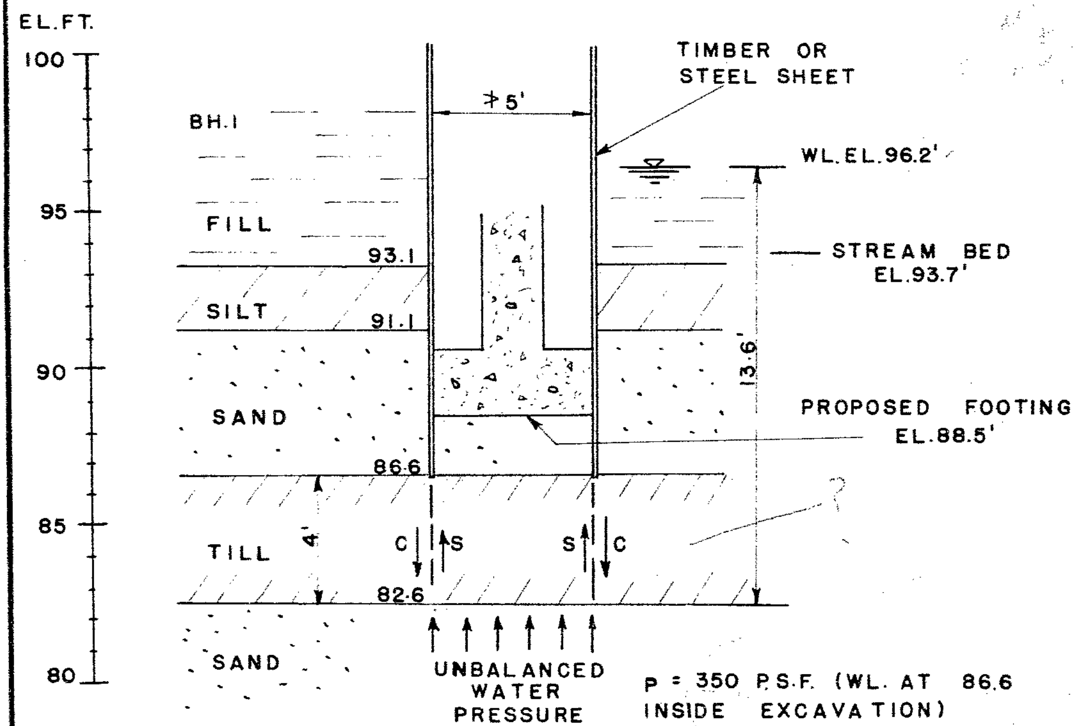
VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE SB CH'D. JP

Our Ref. No. 4-2-L7 Enclosure No. 5

Prep. By JP



S = AVERAGE SHEAR STRESS
= 220 P.S.F.

C = SHEAR STRENGTH
= 2500 P.S.F.

ANALYSIS OF HYDRAULIC STABILITY OF EXCAVATION

SCALE: 1 INCH TO 5 FEET

DOMINION SOIL INVESTIGATION LIMITED

cc: Foundations Office (Rm. 110)

Mr. K. L. Kleinsteiber,
Municipal Bridge Liaison Engr.,
Bridge Division.

Attn: Mr. G.C.E. Burkhardt

Foundation Section,
Materials & Research Div.,
Room 107, Lab. Bldg.

April 17, 1964

County of Middlesex,
Bridge No. 137,
Township of London,
Lot 31, Con. X, XI,
Structure Site No. 20-137,
Your File No. BA 1786.

The above report on foundation investigation submitted by the Consultant, Dominion Soil Investigation Ltd., has been reviewed. A number of problems was raised with the Consultant who replied in a letter dated April 14, 1964, a copy of which is hereby attached.

The greatest uncertainty lies on the exact nature of the soil stratigraphy. The boreholes were put down some 25 ft. away from locations of each abutment and the design by the Consultant was based on the existence of a 4-ft. thick layer of till which may or may not be present at the abutment locations. Due to this uncertainty, the worst case must be provided for in the design of a dewatering scheme.

It is recommended that if the sheet piles can be driven, they should be driven to a depth below the footing elevation equal to the prevailing river level above the footing grade. The sheeting then provides for scour protection.

On the other hand, if the sheeting cannot penetrate a sufficient depth for scour protection purpose, they will be necessary only during construction and some other means for scour protection should be adopted.

We believe that the foregoing information will prove sufficient for your design needs. If there are any queries concerning this project, please feel free to contact our Office.

KYL/MdeF
Attach.
cc: Foundations Office ✓
Gen. Files

K. Y. Lo,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

DOMINION SOIL INVESTIGATION LIMITED
77 CROCKFORD BOULEVARD SCARBOROUGH, ONTARIO TELEPHONE 421-2567

ANCH
QUEENS AVENUE
LONDON, ONTARIO
TELEPHONE GE. 3-3851

FOUNDATION ENGINEERS

P.O. BOX 533
SAULT STE. MARIE
ONTARIO
TELEPHONE AL. 4-2615

London, April 14, 1964.

Department of Highways, Ontario,
Materials and Research Section,
Downsview,
Ontario.

Attention: Mr. K. Y. Lo.

Dominion Soil Investigation Limited Report on Soil Investigation for Middlesex County Bridge #137. Reference No. 4-2-L7.

Gentlemen:

Mr. L. Rolko has passed on to me a number of questions you have raised in connection with this report. I hope the following comments will be helpful.

(i) Location of boreholes. The distance of the holes from the existing bridge was governed by accessibility. To have placed them appreciably closer together would have involved either the construction of working platforms for the drills, or blockage of the road.

(ii) Continuity of till stratum. It is suggested that there may be no till at the borehole locations. While there is no means of proving this one way or the other on the basis of the present evidence, I note that
(a) the top and bottom of the till layer were encountered in both boreholes at closely similar elevations
(b) above elevation 78 the stratification in both boreholes is very similar
(c) the analysis is based on the minimum thickness encountered, and interpolation would indicate a greater thickness over the footing areas and
(d) at another site downstream from this one a similar type of stratification was encountered, i.e. a thin layer of clayey till between cohesionless strata. This latter observation suggests that the condition is common in the area.

(iii) Depth of sheeting. An attempt was made here to allow the use of an inexpensive dewatering method, i.e. the

Department of Highways, Ontario,
Attention: Mr. K. Y. Lo.

April 14, 1964.

use of timber or light steel sheet installed in the same way as in a sewer trench excavation and without the use of pile driving equipment. Such sheeting would be carried down progressively as the excavation proceeded, until the till stratum was encountered and a sufficiently good water barrier formed so that seepage could be controlled by pumping. The bracing members shown in enclosure 5 of the report are not intended to be steel sheet piles.

(iv) Alternative dewatering procedures. An alternative procedure using a steel sheet pile cofferdam is outlined in the last paragraph on page 4.

(v) Unbalanced hydrostatic pressure. With reference to enclosure 5, a copy of which is attached, the head of water outside the enclosure creates a pressure of 62.5 x 13.6 = 850 p.s.f. at the level of section bb. This is resisted by the weight of the till which is taken conservatively as 125 p.c.f. x 4 feet (depth) = 500 p.s.f. (The weight of sand between the footing and the till surface is ignored). The resultant uplift or unbalanced pressure is 350 p.s.f. which must be resisted by the shear strength of the soil along sections ab. The total uplift force per foot length of trench for a 5-foot wide trench is 350 x 5 lbs. Therefore the average shearing force along sections ab is 350 x 5/8 = 220 p.s.f. where 8 feet is the combined length of the two sections ab.

In estimating the factor of safety the maximum shear stress is taken as twice the average and compared with an assumed value of shear strength for the till of 2500 p.s.f. For a material which gives N values of 23 to 87 this figure is probably very conservative and the estimated safety factor of 5.7 could be much higher.

If the water level rises as high as El.100, this adds 240 p.s.f. to the unbalanced pressure and reduces the factor of safety to 3.4, which still allows for some reduction in the thickness of the till.

Department of Highways, Ontario,
Attention: Mr. K. Y. Lo.

April 14, 1964.

(vi) It is recommended that both footings should be located at the same elevation rather than be taken down to the till at borehole 1. This is done to leave as much weight as possible to resist the upthrust in the bottom of the trench.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED,

James Park

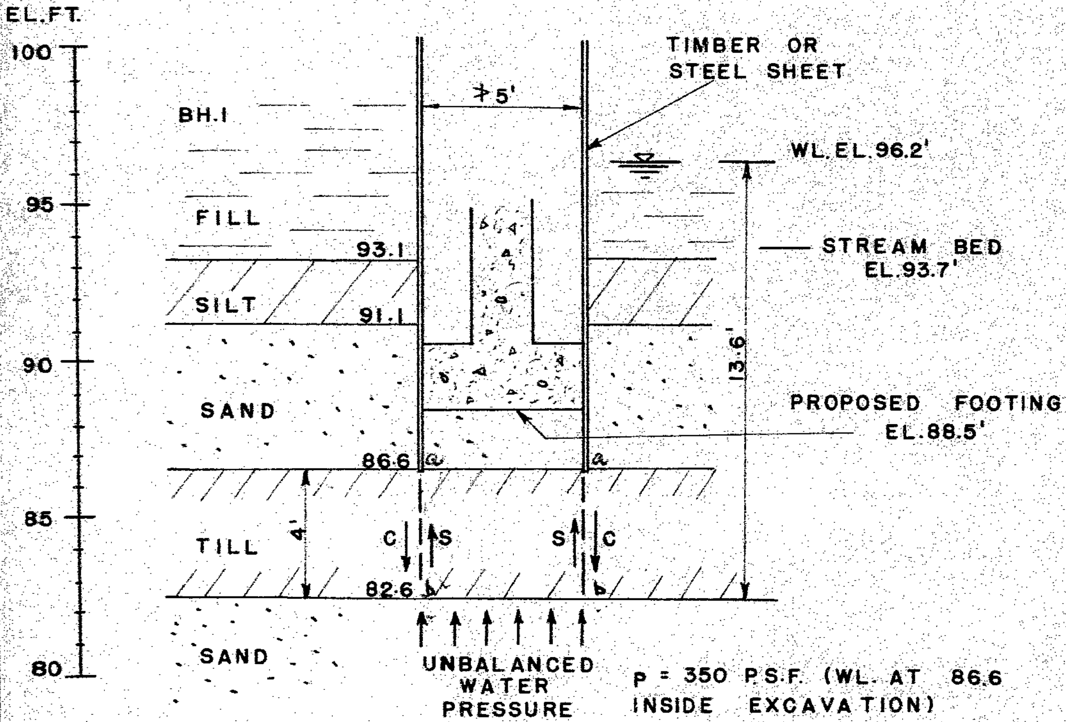
James Park, P.Eng.

Encl.1
JP/sb

Our Ref. No. 4-2-L7

Enclosure No. 5

Prep. By JP



S = AVERAGE SHEAR STRESS
= 220 P.S.F.

C = SHEAR STRENGTH
= 2500 P.S.F.

ANALYSIS OF HYDRAULIC STABILITY OF EXCAVATION

SCALE: 1 INCH TO 5 FEET

BA 1786

1) 10 ft bore [illegible] depths from footing to ensure the existence of the thin clay layer — no art. press recorded

2) should assume H.W.L. = 100.

3) Calc. [illegible] for uplift.

4) Since thickness of clay in doubt, drive long sheets — 25'

5) Alternative : timber piles, raise footing, scour protection

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Making notes

Change of dynamic [illegible]

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. A. Stermac, P. Eng.,
Principal Foundation Engineer,
Materials and Research Section,
DOWNSVIEW, Ontario.

From: Bridge Division,
DOWNSVIEW, Ontario.

Date: April 8, 1964.

Our File Ref.

In reply to

Subject: County of Middlesex,
Bridge No. 137,
Township of London,
Lot 31, Con. X, XI,
Structure Site No. 20-137,
Our File No. BA 1786.

Attached please find one copy of the Foundation Report, by Dominion Soil Investigation Limited, and one copy of the Preliminary Plans, for your comments.

Scour is a problem at this site, therefore additional protection is necessary. Could you give your special attention to the feasibility of sheet piles.

We would appreciate it very much, if we could have your comments at your earliest convenience.

GCEB/lg

for G.C.E. Bauer
K. L. Kleinsteiber,
Municipal Bridge Liaison Engineer.