

Mr. A. M. Towe,

May 31, 1962.

Bridge Engineer.

REVIEW OF SOILS REPORT BY
DOMINION SOIL INVESTIGATION, LTD.
(Bridge Office Ref. BA 1419)

Materials & Research Division,

(Foundation Section)

Attention: Mr. K. L. Kleinsteiber,
Municipal Bridge Liaison Engr.

Re: Township of Malahide,
Brown Bridge over Catfish Drain,
County of Elgin,
Lot 29, Con. VIII/IX. . Dist. #2

We have reviewed the above-mentioned report and herewith submit our comments for your consideration:

The consultant's recommendation pertaining to the foundations of the proposed structure is a possible and safe solution. To carry out the proposed solution, steel sheet piling will have to be used during construction. Since it is believed that if the footings are placed within the clay layer - i.e., at elevation 48.0, they will be adequately protected against scour, and therefore the steel sheet piling can be pulled out and salvaged.

However, if the sheet piling is left in place, the footings can be placed within the sand layer at an elevation that would not be governed by the scour, but by the frost criterion. A safe net load of 2.5 T/sq.ft. is suggested for the design. The sheet piling should be tied in with the footing, thus becoming part of it.

It is a matter of economical consideration which should decide between the above-mentioned solutions.

AGS/MdeF

cc: Foundations Office
Gen. Files.

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER



ONTARIO

DEPARTMENT OF HIGHWAYS

Bridge Division


Memo to Mr. A. Stermac Date May 31, 1962
Municipal Foundation Eng.
Room 107, Lab. Bldg Subject Township of Malahide
From G.C.E. Burkhardt Brown Bridge over Catfish Drain
County of Elgin
Lot 29, Con. VIII/IX
Our File # BA 1419

D/S.T. 2

We are enclosing herewith a copy of the Foundation Report, by Dominion Soil Investigation Limited, and one copy of the Preliminary Plan for your comments.

We intend to approve the preliminary design not later than June 15, 1962. We would appreciate it very much if we could have your comments within the next two weeks.

GCEB/m


G.C.E. Burkhardt,
for K. L. Kleinsteinber
Municipal Bridge Liaison Eng.

BA 1419

STRUCTURE SITE No. 5-105

MESSRS. FRED A. BELL AND ASSOCIATES
CONSULTING ENGINEERS
17 Hincks Street
ST. THOMAS ONTARIO

62-F-265M

Report on
SOIL INVESTIGATION
for

ROAD BRIDGE, CONCESSIONS 8-9, LOTS 28-29,
TOWNSHIP OF MALAHIDE, COUNTY OF ELGIN

by
DOMINION SOIL INVESTIGATION LIMITED
363 Queens Avenue
LONDON ONTARIO

Reference no. 2-4-L3

April 1962

CONTENTS

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

ENCLOSURES

	<u>No.</u>
LOCATION OF BOREHOLES AND SUBSURFACE PROFILE	1
ENGINEERING DATA SHEETS	2 & 3

INTRODUCTION

In accordance with verbal authorization from Mr. R. Lemon a soil investigation has been carried out at a site in Malahide Township where it is proposed to replace an existing bridge with a new structure.

In defining the terms of reference for this project, the proposed new structure was described as a 44-foot span bridge 28 feet wide. The deck would consist of freely-supported prestressed beams, and the estimated total load on each abutment was 156 tons. The new road elevation was given as 70.0 feet or approximately 2 feet below the existing deck level.

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

I DESCRIPTION OF SITE AND GEOLOGY

The site lies in undulating rural country 4 miles east and 3 miles north of Aylmer, where a concession road crosses a tributary of the Catfish Creek (Catfish Drain). The existing bridge has a span of 35 feet. The abutments, which rest on a sand stratum at a shallow depth, are being undermined by the creek and have moved appreciably from their original position.

The overlying sand stratum is part of the extensive Norfolk Sand Plain which covers most of Norfolk and parts of Elgin, Brant and Oxford counties. This is a large delta formed by meltwater from the Grand River area during the time of the glacial lakes Whittlesey and Warren which occupied the present Erie basin.

The underlying clay apparently belongs to the Ekfrid Clay Plain immediately to the west.

II FIELD WORK

Field work was carried out on the 25th and 26th of April 1962 and consisted of 2 boreholes at the locations shown on enclosure 1. Dynamic cone penetration tests were made adjacent to each borehole using a 2-inch diameter 60° cone. Standard Penetration tests were made at frequent intervals with a 2-inch O.D. split spoon. A constant driving energy was employed in the Standard Penetration and dynamic cone penetration tests using a 140-pound hammer dropping 30 inches. The former test provided disturbed samples of the strata and the latter a continuous record of soil density.

One undisturbed sample was recovered from the clay stratum in borehole 2 using a 2-inch diameter thin-walled Shelby tube. A vane shear test was performed a short distance below this sample, using a 4-bladed vane 2 inches in diameter and 4 inches long. Both the insitu and remoulded shear strengths were measured, and the ratio of these results is defined here as the sensitivity of the clay.

The results of the field tests are recorded on data sheets comprising enclosures 2 and 3. Elevations have been referred to a benchmark on the north-west bridge seat (El. 70.27 feet).

III LABORATORY WORK

A short testing program has been carried out to determine the shear strength and other physical properties of the clay stratum. The following is a summary of results:

Borehole No.	1	1	2	2	2
Sample No.	4	5	4	5	6
Natural moisture content (%)	20.9	21.6	21.0	21.7	22.3
Liquid limit (%)	-	34.2	32.5	-	-
Plastic limit (%)	-	14.5	14.8	-	-
Plasticity index	-	19.7	17.7	-	-
Liquidity index	-	0.31	0.33	-	-
Void ratio	-	-	0.57	-	-
Bulk density (p.c.f.)	-	-	129.5	-	-
Shear strength (p.s.f.) (from unconfined compression test)	-	-	2140	-	-
Degree of saturation (%)	-	-	100	-	-
Group symbol	-	CL	CL	-	-

The foregoing results show that the material is a fully saturated clay of low plasticity with a natural moisture content well below the liquid limit. The shear strength value of 2140 p.s.f. is in excellent agreement with the field vane shear test result of 2100 p.s.f.

IV SUBSURFACE CONDITIONS

A subsurface profile is shown on enclosure 1 and illustrates two principal strata:

- (i) Below the organic topsoil a sand stratum extends for a depth of 15 to 16 feet. At borehole 1 the sand is loose

and at borehole 2 it is compact. Above El. 60 the grain size is medium to coarse and fine gravel particles are also present. Below this elevation the grain size decreases. This stratum is well graded throughout its depth and contains little or no silt. It is highly pervious. Between the sand and the underlying clay a thin seam of cohesionless silt was encountered in both boreholes.

- (ii) A stratum of grey silty clay extends throughout the remainder of the depth explored. The top of this layer is stiff and becomes hard between Els. 42 and 43. This material has been the subject of a laboratory testing programme and its physical properties are described in detail in Section III.

V BEARING CAPACITY AND SETTLEMENT

The lowest elevation of the creek bed is 57.0 feet. Allowing 6 feet for erosion the maximum footing elevation would be 51.0 feet. This level is in the sand layer almost on top of the grey silt stratum and it would be difficult to obtain a firm dry footing grade in either of these materials. The underlying stiff clay will provide a much better foundation and it is proposed that footings should be located at El. 48.0 feet.

The ultimate bearing capacity of a footing 5 feet wide and 28 feet long has been calculated according to Meyerhof. Assuming a shear strength (cohesion) of 2100 p.s.f. the ultimate bearing capacity is 14,000 p.s.f. Applying a factor of safety of 3, the maximum allowable soil pressure is 4666 p.s.f.

The total live and dead load per abutment has been given as 156 tons, or 2200 p.s.f. on a footing 5 feet x 28 feet. The overburden pressure will amount to 1320 p.s.f. (assumed 22 feet of sand at 60 p.c.f.) giving a gross soil pressure of 3520 p.s.f. compared to an allowable 4666 p.s.f. There is thus adequate bearing capacity.

The settlement of the structure due to consolidation of the clay cannot be calculated without consolidation test results. However, in view of the magnitude of the loading in relation to the stiffness of the clay and the fact that the structure will be freely supported, such tests have not been considered justified. It is estimated that a settlement of one inch would occur under a net pressure of 2200 p.s.f. if the coefficient of volume compressibility of this material were 60 t.s.f. Experience in clays of

similar consistency has shown that this coefficient is generally of greater magnitude indicating in this case even smaller settlements. It is concluded that the settlement of this structure under the proposed loading will be one inch or less, and is therefore not significant.

VI CONSTRUCTION

The main construction problem will be to secure a dry excavation through the pervious sand stratum. It is recommended that surface water should be diverted away from the site, and the area of excavation should be sealed by driving steel sheet piles a short distance (1 to 2 feet) into the clay. Seepage into the excavation can be removed by pumping from sumps which should be dug below the footing grade.

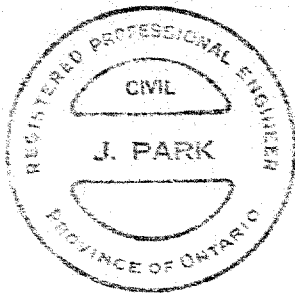
Once the grade level has been reached it should be examined to ensure that the conditions encountered in the boreholes are representative of the entire site. Any unsound material should be removed from the grade and backfilled with lean concrete. A thin layer of lean concrete spread over the bottom of the excavation will prevent disturbance during construction.

VII SUMMARY

1. The principal strata are a layer of loose to compact sand extending to El. 50 and thereafter a stiff grey silty clay which becomes hard after 5 to 7 feet.
2. Footings should be located in the clay stratum at El. 48.0. The maximum allowable soil pressure at this level on a footing 5 feet wide is 4666 p.s.f.
3. Under the proposed loading the net pressure below the footings will be 2200 p.s.f. It is estimated that the total consolidation settlement under this pressure will be less than one inch and therefore not significant for a freely supported structure.
4. To obtain a dry excavation it is proposed that the construction area should be isolated using steel sheet piles driven a short distance into the clay to effect a water seal.

VIII REFERENCES

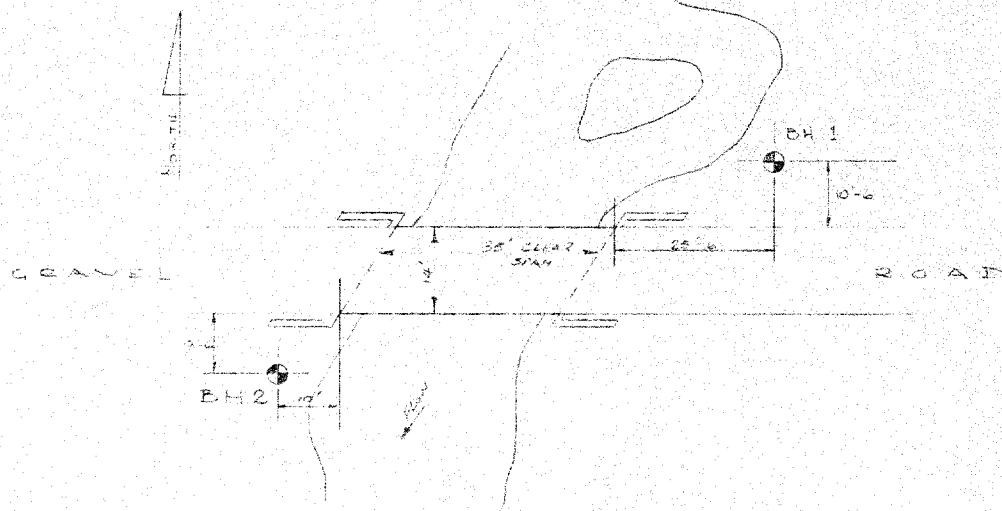
1. The Physiography of Southern Ontario by L.J. Chapman and D.F. Putman of the Ontario Research Foundation - University of Toronto Press 1951.
2. Procedures for Testing Soils, ASTM, April 1958. pp. 186 to 198. (Unified Soil Classification System - by A.A. Wagner)
3. The Ultimate Bearing Capacity of Foundations by G.G. Meyerhof Geotechnique, Vol. II, 1950 & 1951.



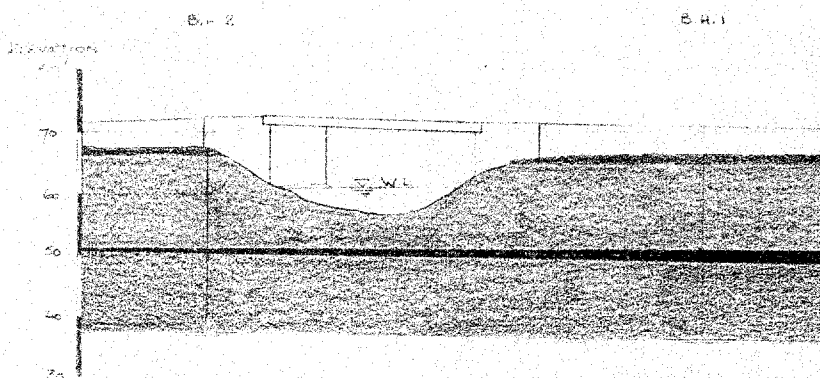
DOMINION SOIL INVESTIGATION LIMITED

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

SCALE:
1" TO 20'







LOCATION OF BOREHOLES



SUBSURFACE PROFILE

LEGEND

-  ORGANIC SANDY TOPSOIL
-  SAND (LOOSE TO COMPACT)
-  SILT
-  SILTY CLAY (STIFF TO HARD)

OUR REFERENCE NO. 2-4-L3

GEOTECHNICAL DATA SHEET FOR BOREHOLE 1

CLIENT: Messrs. Fred A. Bell & Associates

METHOD OF BORING: washboring

ENCLOSURE NO. 2

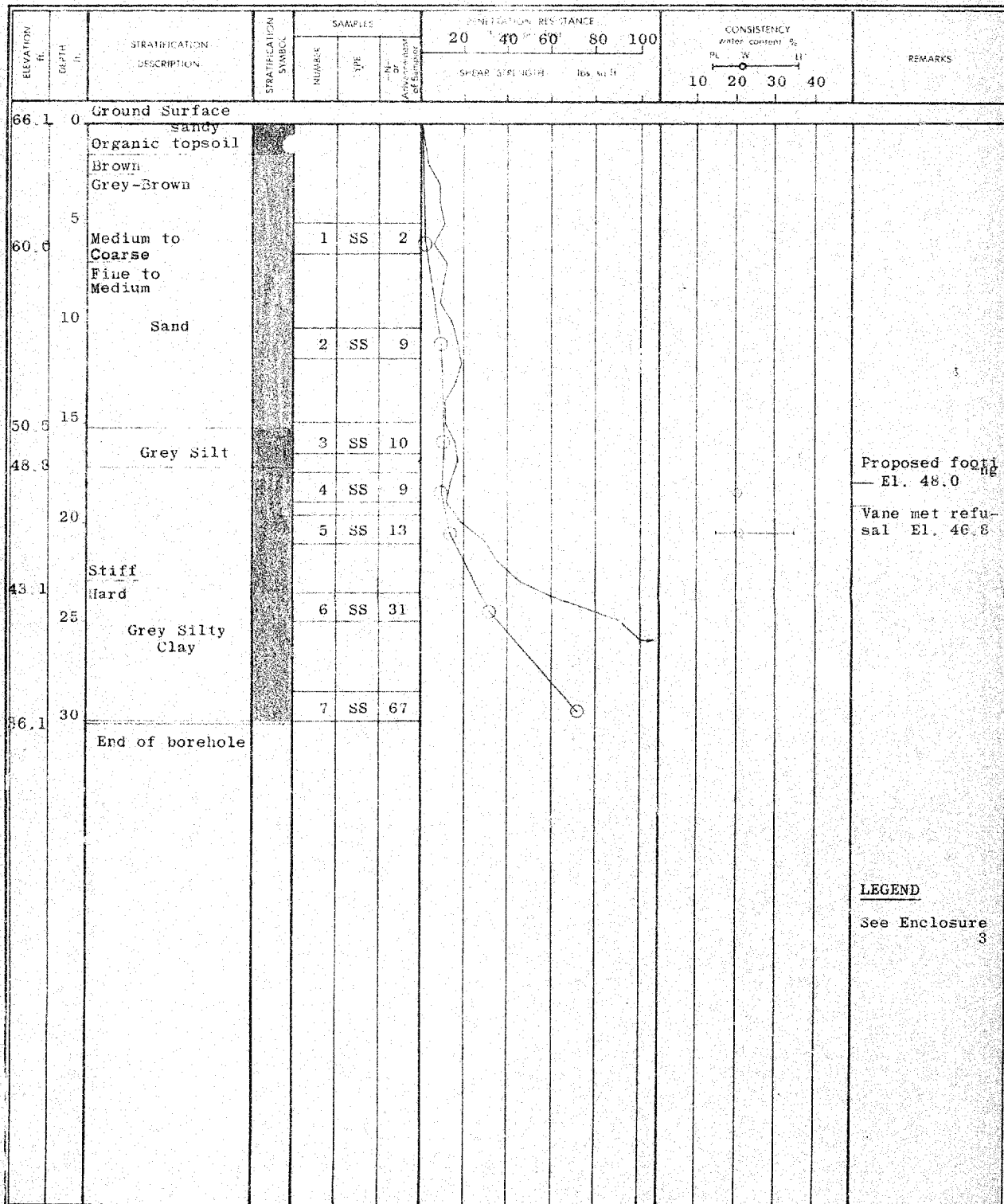
PROJECT: Road Bridge

DIAMETER OF BOREHOLE: 2-7/8"

LOCATION: Malahide Township

DATE: 25 April 1962

DATUM ELEVATION: 70.27 feet northwest bridge seat



VERTICAL SCALE: 1 IN. TO

5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: MC

CHD: JP

GEOTECHNICAL DATA SHEET FOR BOREHOLE...2...

OUR REFERENCE NO. 2-4-L3

CLIENT: Messrs. Fred A. Bell & Associates

PROJECT: Road Bridge

LOCATION: Malahide Township

DATUM ELEVATION: 70.27 feet northwest bridge seat

METHOD OF BORING: washboring

DIAMETER OF BOREHOLE: 2-7/8"

DATE: 26 April 1962

ENCLOSURE NO. 3

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE		CONSISTENCY		REMARKS
				NUMBER	TYPE	NO. - S Adjustment to Sample	blows per foot	lb/in ²	water content %	PL W LI	
							20 40 60 80 100				
							SHEAR STRENGTH				
							1000 2000				
									10 20 30 40		
67.2	0	Ground Surface									
		Organic sandy topsoil									
	5	Medium to Coarse Brown Sand and Fine Gravel		1	SS	18					
59.2	10	Fine to Medium Grey-Brown Sand		2	SS	13					
	15			3	SS	14					
50.9	18	Grey Silt		4	TW						
	20			5	SS	14					
		Grey Silty Clay			Vane						
42.2	25	Stiff Hard		6	SS	15					
	30			7	SS	28					
37.2		End of borehole									

LEGEND

SS denotes 2" O.D. split spoon (disturbed) sample

TW denotes 2" dia. thin-walled Shelby tube (undisturbed) sample

• denotes shear strength in unconfined compression test

○ denotes natural moisture content

⊕ denotes insitu vane shear test and sensitivity

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE MC

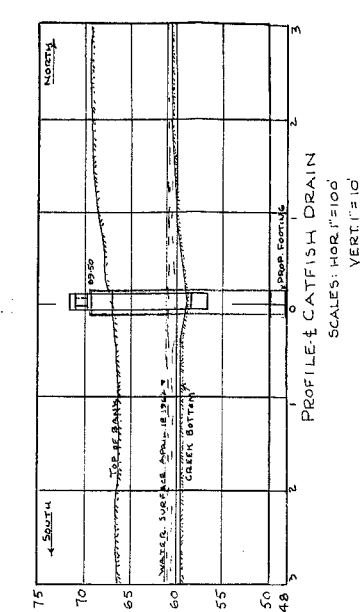
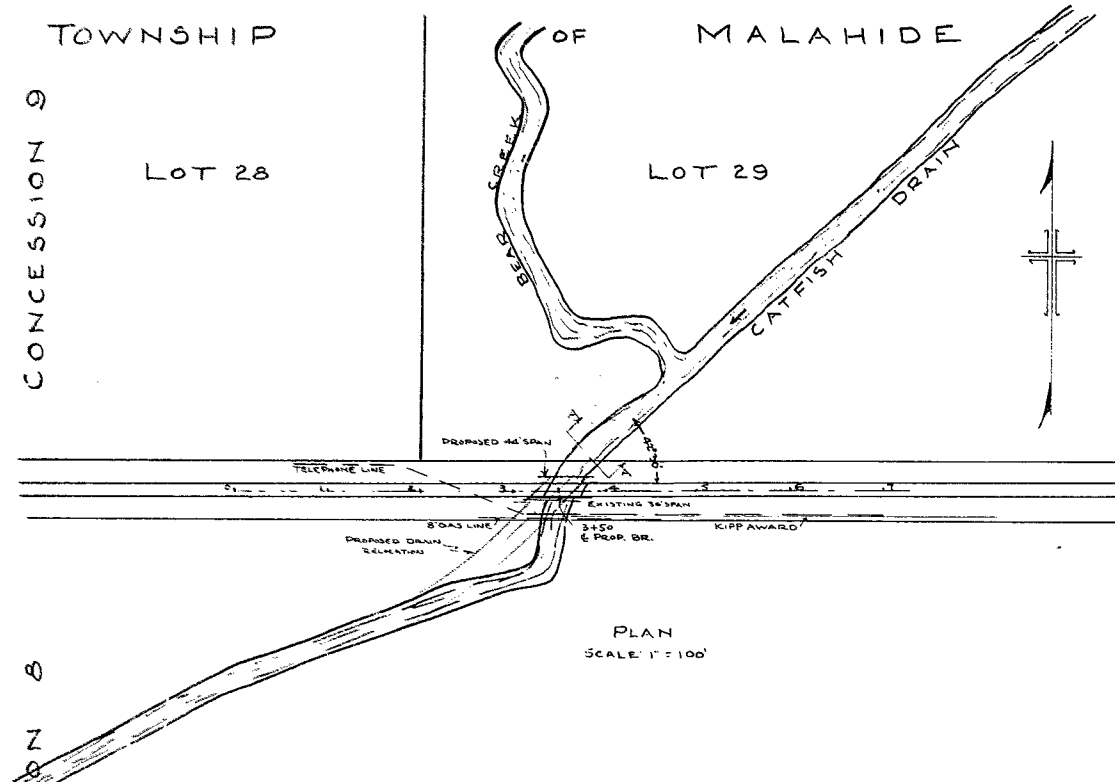
CHD: JP

62-F-265M

LOT 28-29, Con. 8^h

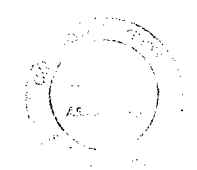
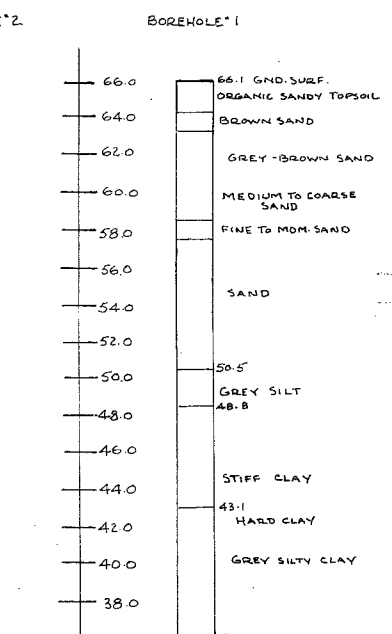
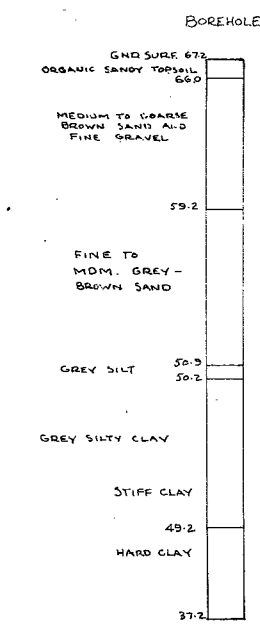
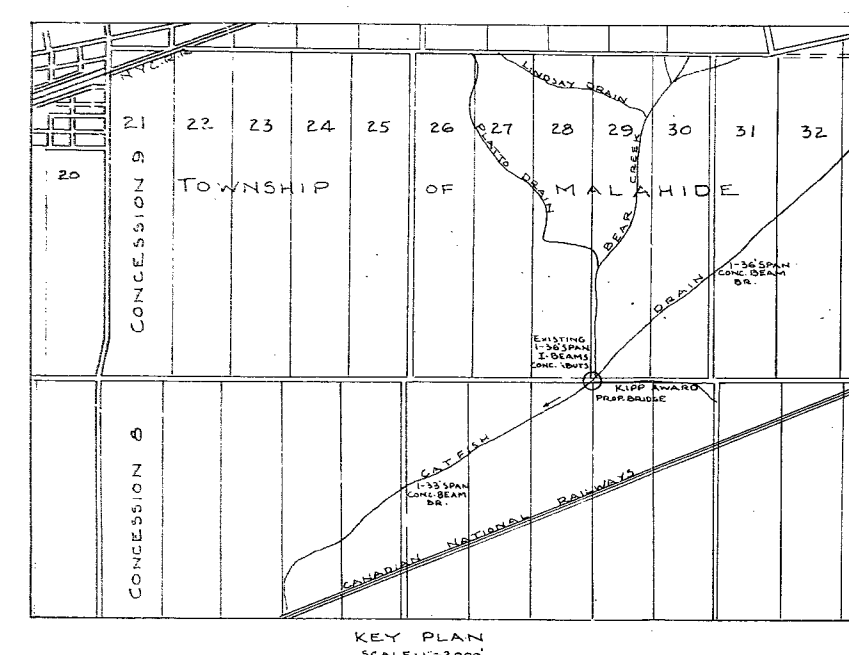
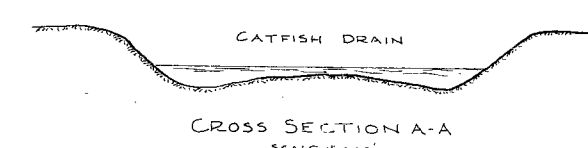
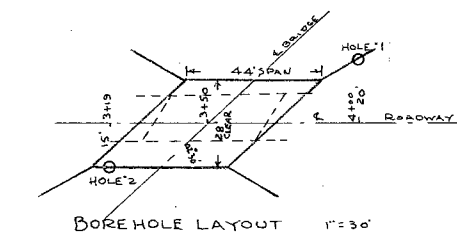
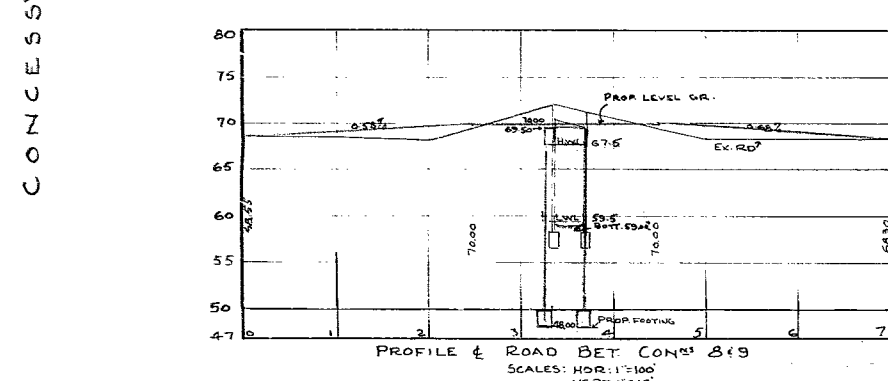
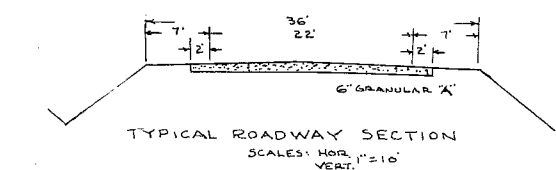
CATFISH DRAIN

MALAHIDE



- ### DATA
1. GRADIENT OF CATFISH DRAIN IS 3.7 FT. PER MILE, APPROXIMATELY, FOR A DISTANCE OF 2.2 MILES UPSTREAM FROM PRESENT BRIDGE. SMALL DEBRIS, BRUSH AND ICE IN MODERATE QUANTITIES CARRIED DURING FLOODS.
 2. UPSTREAM BRIDGE ON CATFISH DRAIN 0.87 MI. - BUILT 1907 - 36' SPAN - CONCRETE BEAM - 24' SKEW - APPROX. HEADROOM AT CENTRE 9' DOWNSTREAM BRIDGE 0.9 MI. - 33' SPAN - SKEWED - APPROX. 55' YRS. OLD - CONCRETE BEAMS. BOTH BRIDGES ADEQUATE FOR WATERWAY OPENING.
 3. BRIDGE SHOULD BE LOWERED TO REDUCE HUMP IN ROAD AND SPAN INCREASED ACCORDINGLY.
 4. CATFISH DRAIN CLEANED OUT UNDER MUNICIPAL DRAINAGE ACT, NORTH AND SOUTH OF BRIDGE IN 1936
 5. G.T.B. - NOT REQUIRED
 6. TEMPORARY DETOUR - NOT REQUIRED.
 7. INFORMATION AND EVIDENCE OF EXTREME FLOODING WAS OBTAINED FROM MR. CLAYTON NEWELL, AREA RESIDENT SINCE YEAR 1907. HE ESTIMATES THE HIGHEST WATER ELEVATION IN THE AREA OF THIS CONSTRUCTION TO BE 67.5' AND THE LOWEST WATER ELEVATION TO BE 59.5'. THE ABOVE FIGURES ARE FOR INFORMATIONAL PURPOSES ONLY AND NO WARRANTY IS MADE THAT THESE FIGURES ARE IN ANY WAY INDICATIVE OF THE HIGH AND LOW ELEVATION TO BE EXPECTED OR ENCOUNTERED DURING THIS CONSTRUCTION.

- ### STRUCTURE DATA
1. NET SPAN LENGTH AND TYPE OF BRIDGE - 44' SPAN - PRE-STRESSED CONCRETE BEAMS
 2. ROADWAY WIDTH ON BRIDGE - 28'
 3. NO SIDEWALKS
 4. SKEW ANGLE - 47°30'
 5. PILING
 6. APPROXIMATE VOLUME OF CONCRETE - 350 C.Y.
 7. APPROXIMATE WEIGHT OF STRUCTURAL STEEL - N.A.
 8. APPROXIMATE WEIGHT OF REINFORCEMENT - 39000#
 9. APPROXIMATE VOLUME OF APPROACH FILL 100' EACH SIDE OF STRUCTURE - NIL.
 10. DRAINAGE AREA - 21.33 MILES.



STRUCTURE SITE No. _____

FRED A. BELL & ASSOCIATES
CONSULTING ENGINEERS - ST. THOMAS, ONT.

SITE PLAN
PROPOSED 1 - 44' PRESTRESSED CONC SPAN
BROWN BRIDGE
OVER CATFISH DRAIN

OWNER: TWR OF MALAHIDE
COUNTY: ELGIN
TWR OF MALAHIDE - ROAD BETWEEN CONCS 8 & 9 - LOT 29

LOADING: H 20-S16
ST. THOMAS, ONT. MAY 15 1962

Robert L. Lemmon
CIVIL ENGINEER

SCALE: 1"=5'