

G.I.-30 SEPT. 1976

GEOCRES No. 40P1-50 & 40P1-61DIST. 4 REGION W.P. No. 40-74-05 / 40-74-08CONT. No. W. O. No. STR. SITE No. 1-138
1-179HWY. No. B. S. A. R.LOCATION EASTWARD CREEKCULVERTSNo OF PAGES - =====
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

Ontario
Department of Transportation and Communications

XXXXXXXXXXXXXXXXXXXX

MEMORANDUM

TO: Mr. B. R. Davis,
Bridge Engineer,
Bridge Office,
Admin. Bldg.

ATTENTION: Mr. S. McCombie

FROM: Foundation Section,
Room 107, Lab. Bldg.

DATE: June 18, 1971

IN REPLY TO

June 23, 1971

OUR FILE REF.

SUBJECT:

40PI-50
GEOCRES No.

FOUNDATION INVESTIGATION REPORT
For
The Proposed Eastward Creek Culvert
Along the
Future Brantford Expressway No. 2
City of Brantford
District No. 4 (Hamilton)
W.O. 71-11022 -- ~~W.P. 70-68-04~~
~~(06,09,07)~~
NEW WP: 40-74-05 AND 08

Attached, we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above structure site.

We believe that the factual data and recommendations contained therein, will prove adequate for your design requirements. Should additional information be required, please feel free to contact our Office.

AGS/MdeF
Attach.

cc: Messrs. B. R. Davis
F. G. Allen
D. W. Farren
W. Zonnenberg
C. R. Robertson

A. P. Watt (2)

J. Roy
B. J. Giroux
B. A. Singh
M. M. Dillon (Galt) - A. Kobelak

Foundations Files
Gend Files

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

TABLE OF CONTENTS

1. INTRODUCTION.
2. DESCRIPTION OF THE SITE.
3. FIELD AND LABORATORY INVESTIGATIONS.
4. SOIL CONDITIONS:
 - 4.1) General.
 - 4.2) Mixed Fills.
 - 4.3) Silty Sands, Sandy Silts, Gravelly Sands, etc.
 - 4.4) Irregular Seams of Silts, Clayey Silts and Silty Clays.
 - 4.5) Silts and Clayey Silts.
 - 4.6) Bedrock.
5. GROUNDWATER CONDITIONS.
6. DISCUSSION AND RECOMMENDATIONS:
 - 6.1) General.
 - 6.2) General Comments and Recommendations:
 - 6.2.1) Earth Pressures.
 - 6.2.2) Dewatering of Excavations.
 - 6.2.3) Foundations in the Vicinity of Utilities.
 - 6.3) Eastward Canal:
 - 6.3.1) Open Channel Sections.
 - 6.3.2) Culvert Sections.
 - 6.4) T.H. & B.R. Overhead at the Expressway Crossing - (Structure #8).
 - 6.5) T.H. & B.R. Overhead at Ramp E - (N/S/W) - (Murray St. Exit) (Structure #6).
 - 6.6) Retaining Walls.
7. MISCELLANEOUS.

FOUNDATION INVESTIGATION REPORT
For
The Proposed Eastward Creek Culvert
Along the
Future Brantford Expressway No. 2
City of Brantford
District No. 4 (Hamilton)
W.O. 71-11022 -- W.P. 70-68-04
(06;09;07)

1. INTRODUCTION:

The Foundation Section was requested by Mr. A. P. Watt, Regional Bridge Planning Engineer, Southwestern Region, to carry out foundation investigations at the sites of several crossings, retaining walls and the Eastward Creek culvert, in conjunction with the proposed Brantford Expressway #2. The request was submitted in a memo, dated March 17, 1971.

In this report the foundation investigation along the proposed Eastward Creek culvert (W.P. 70-68-04) is discussed. As was agreed subsequently by Mr. Watt, this report includes the proposed T.H. & B.R. overhead structure at the Murray-Mohawk Ramp (W.P. 70-68--6), the T.H. & B.R. overhead at the Expressway crossing (W.P. 70-68-09) and two retaining walls, proposed to be built integral with the culvert (W.P. 70-68-07).

In the following sections the field and laboratory investigations are outlined and recommendations are given for the foundations of the individual structures.

2. DESCRIPTION OF THE SITE:

The easterly, approx. 900-ft. length of the proposed creek diversion runs near the existing Mohawk Canal, which is to be abandoned and filled. The vicinity along this section of the canal is wasteland, having been used as a dumping site for waste products of the Massey-Ferguson plant. The middle, roughly 1,800 ft.

2. DESCRIPTION OF THE SITE: (cont'd.) ...

long section of the culvert will be situated immediately north of the proposed expressway. This portion of the area is a residential zone of the City of Brantford, occupied mainly by single family units.

The westerly 700-800 ft. or so, follows the abandoned railway line, crossing Alfred Street, just north of the existing bridge.

The inlet and outlet portions of the Eastward Creek are designed to be open channels, as indicated on the attached drawings.

3. FIELD AND LABORATORY INVESTIGATIONS:

The field investigation consisted of some 26 sampled boreholes and 22 dynamic cone penetration tests. Boreholes were implemented by using one continuous hollow stem auger and one conventional diamond drill rig adapted for soil sampling purposes. Soil specimens were secured at frequent intervals by means of split-spoon and thin-walled 2" dia. Shelby tube samplers. Split-spoon samplers were advanced by the Standard Penetration technique, penetration 'N' values having been recorded on the borelogs. Shelby tubes were pushed into the soil, either manually or hydraulically. Field vane tests were performed at those depths where the consistency of the cohesive deposits permitted.

All the samples were shipped to the Department of Transportation and Communications laboratories, where they were again identified and recorded. The subsequent laboratory testing program consisted of natural moisture contents, Atterberg limits and grain-size analyses. Representative samples were further tested in order to determine unconsolidated, undrained shear strength parameters and consolidation characteristics. On undisturbed samples, taken from the proposed open cut locations, consolidated, undrained triaxial tests were carried out with pore pressure measurements using the stage loading method.

3. FIELD AND LABORATORY INVESTIGATIONS: (cont'd.) ...

Laboratory and field test results are compiled on the accompanying borelog sheets, while the locations and elevations of the borings are shown on Drawing #71-11022A, B, C & D in the Appendix.

4. SOIL CONDITIONS:

4.1) General:

The various soil strata encountered in the boreholes along the proposed Eastward Canal were identified to be as follows: mixed fills, sands, silty sands and gravelly sands, irregularly stratified silts, clayey silts and silty clays, and the bottom layer of the overburden, consisting of silts and clayey silts with occasional gravel. Since the soils were described at length in our Preliminary Foundation Report (W.J. 68-F-64), a brief summary only, is given under the forthcoming paragraphs.

4.2) Mixed Fills:

The easterly, approx. 500-ft. length of the proposed canal crosses the area adjacent to the Mohawk Canal, where the surficial deposit was found to be a mixed fill, consisting essentially of the waste products of the Massey-Ferguson plant. The material is black in colour, largely fine-grained, containing, however, chunks of slag and cinders and other debris. The depth of this layer varies between 6 ft. and 14 ft. Penetration 'N' values were measured to be between 4 blows per ft. and 17 blows per ft.

4.3) Silty Sands, Sandy Silts, Gravelly Sands, etc.

Underlying the fill along the east end, and right below ground level along the largest portion of the line, a granular deposit, consisting predominantly of fine sand was noted. East of Murray St. at the high ground, however, the sands are covered with a 10 - 20 ft. thick clayey silt deposit. The grain-size distributions of the granular soils are quite varied, but all the

4. SOIL CONDITIONS: (cont'd.) ...

4.3) Silty Sands, Sandy Silts, Gravelly Sands, etc.: (cont'd.) ...

samples exhibited quick dilatancy, thus they are highly susceptible to conditions of unbalanced hydrostatic heads. The silty fine sand and the sandy silt portion of this deposit is considered to be the most treacherous material from the engineering point of view, when situated under water. The lower boundary of the purely granular material lies around the bottom of the proposed culvert footing, or a few feet above this elevation.

Typical grain-size curves of the granular soils are presented on Fig. #1 in the Appendix.

4.4) Irregular Seams of Silts, Clayey Silts and Silty Clays:

Underlying the granular deposit, a stratified stratum of silts, clayey silts and silty clays with occasional seams and pockets of sand, forms the main body of the overburden. This 40 - 70 ft. thick deposit is generally cohesive; however, it is to be emphasized that 'boilings' and 'blow-outs' occurred in the boreholes within some sand layers and pockets. The stratification of the materials is usually horizontal. In some locations the laminae are fairly regular, but in most cases, seams were found to be in a random order, varying in thickness and frequency of occurrence. The undrained shear strengths of the deposit were determined by field vane, laboratory unconfined and quick triaxial tests. In evaluating the tests, it was noted that the field vane test results were somewhat too high, likely on account of the high silt content of the layers. Average values were calculated for each individual structure, and along sections of the proposed culvert. Mean values used varied between 1,250 PSF and 1,500 PSF.

Grain-size curves of the clayey silt and silty clay portions of the stratified stratum are shown on Figs. #2 and #3, whereas all the undrained shear strength results are combined for the various sections and structures on Figs. #4, 5, 6, 7 and 8.

4. SOIL CONDITIONS: (cont'd.) ...

4.4) Irregular Seams of Silts, Clayey Silts and Silty Clays:
(cont'd.) ...

Consolidated undrained triaxial tests were performed on two representative samples, taken from the locations of the proposed East and West end open channel sections. Tests were performed in order to obtain shear strength parameters in terms of effective stresses, by using stage loading techniques. Tests resulted in $C' = 0$ and $\phi' = 29.9^\circ$ at the East end open channel and $C' = 185$ PSF and $\phi' = 27.8^\circ$ at the West.

4.5) Silts and Clayey Silts:

In some of the boreholes around el. 610 - 620 ft., a silt to clayey silt layer was encountered, having very stiff to hard consistency, with penetration 'N' values ranging from 20 blows per ft. to as high as 90 - 100 blows per ft. Lower penetration resistances obtained in this stratum were considered to be caused by the loosening effect of the hydrostatic uplift pressures. Very little stratification was observed in the silt, and it contained occasional grains of gravel and pebbles, hence this layer is likely a glacial deposit.

Fig. #9 shows typical grain-size curves of this material.

4.6) Bedrock:

Some of the boreholes were advanced down to reach the bedrock surface, which was assumed to be at those elevations where definite bouncing of the drill rod was noted. The bedrock surface was observed to have a slight dip eastward, being established around el. 593 - 600 ft. at the West end of the investigated line, and roughly at 577 - 582 ft. at the East. Since the bedrock had been proved during previous investigations, no diamond drilling was carried out at this time. The underlying bedrock is known to be almost pure dolomite of the Lockport formation.

5. GROUNDWATER CONDITIONS:

Groundwater levels were measured in each borehole during the field investigation. Observations were made for several days and the equilibrium water levels recorded. These levels are plotted on the respective borclogs. The water level generally lies some 4 - 8 ft. below ground level, corresponding to elevations between 652 ft. and 662 ft. In boreholes placed east of Murray St. on the high ground (B.H.'s #13, 14, 28 and 29), however, water levels were found to be some 20 - 23 ft. below ground level, around el. 667 ft. - 673 ft., indicating a hydrostatic gradient towards the lower ground.

The water level of the Mohawk Canal was at el. 652.2 ft. at the West end, and at el. 652.03 ft. at the East.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

As was mentioned earlier, this report deals with the foundation problems concerning (a) the proposed Eastward Canal and culvert, (b) the T.H. & B.R. overhead at the expressway crossing, (c) the T.H. & B.R. overhead at the Murray-Mohawk ramp and (d & e) two retaining walls, proposed to be monolithic with the culvert.

Subsoils along the investigated line may be summarized to consist of sandy silts to silty sands, underlain by stratified silts, clayey silts and silty clays. Under the East portion of the line, considerable fill of cinders and slag was encountered.

General comments and recommendations - applicable to all structures in question, are given under the next subsection, followed by recommendations for the individual structures.

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) General Comments and Recommendations:

6.2.1) Earth Pressures:
- - - - -

Culverts should be designed to resist vertical pressures developed on the top of the culvert, due to the weight of soil and possible live load. Adjacent to the culvert, a downward force (drag) will develop in cases where settlement will be less under the culvert than under the soil adjacent to it. For computation of this force, a friction resistance coefficient of $\mu = \tan 30^\circ$ should be used for the drag of soil (granular type backfill) against concrete, and $\mu = \tan 35^\circ$ for the drag of soil against soil above the culvert. The coefficient of earth pressures at rest is assumed to be $K_0 = (1 - \sin \phi) = 0.5$ (Jaky, 1938). The same values may be used for designing the retaining walls integral with the culvert. For the wall stability, a coefficient of active earth pressures $K_a = \tan^2 \left(45^\circ - \frac{\phi}{2} \right) = 0.35$ is suggested. For calculating critical bending moments in the culvert walls and slab, values of $K_0 \text{ max.} = 1.0$ and $K_0 \text{ min.} = 0.4$ may be used. In calculating the factor of safety against sliding along the base for retaining walls integral with culverts lying within the sands and sandy silts, a coefficient of friction $\tan \phi = 0.40$ may be assumed; within the cohesive strata (clayey silt, layers of silt, clayey silt and silty clay), an adhesion value of $C_{adh} = 1,250 \text{ PSF}$ may be employed. The surface of the cohesive material should be roughened before the concrete base is placed.

6.2.2) Dewatering of Excavations:
- - - - -

The prevailing groundwater levels during the field investigation, are marked on the soil profiles. Seasonal fluctuation of the water surface is anticipated within one calendar year.

Excavations above the water level will involve no problems, and all the soils encountered will be stable for a limited time with 1 horizontal to 1 vertical slopes.

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) General Comments and Recommendations: (cont'd.) ...

6.2.2) Dewatering of Excavations: (cont'd.) ...
- - - - -

Excavations below the water level, within the clayey silts and silty clays, are expected to cause no special problems on account of the low permeability of these soils. Conventional open pumping will suffice for the removal of the accumulated seepage water. Excavations within the sands and silts, however, will require some dewatering scheme, since these soils will become unstable and will 'boil' under the uplift pressure of the unbalanced hydrostatic head. In order to prevent 'quick' conditions of the soils, oversize excavations may be constructed as shown on Fig. #10. This method would involve an initial gradual pumping, with final pumping confined to the shallow ditches around the bottom of the excavation. The side slopes should be cut as steep as possible, and the rate of pumping should be such, that the sides of the excavations do not slough in.

Excavations within the above mentioned cohesionless deposits may also be carried out with vertical walls within the protection of interlocking sheet piles. Sheet piling should be driven to a distance below the bottom of the excavation equal to, or greater than the distance of the water level above it, to prevent 'boiling'.

It appears, however, that along its entire length, the bottom of the culvert excavation will be either in the cohesive soils or just a short distance above the cohesive layers. In the latter event, due to the relatively impervious nature of these materials, sheet pile penetrations can be reduced, according to the formula given on Fig. #11. The formula may be used only in those cases where the length of the sheeted excavation is at least 4 times larger than the excavation width.

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) General Comments and Recommendations: (cont'd.) ...

6.2.3) Foundations in the Vicinity of Utilities:

Several existing utilities cross the sites of the proposed culvert and structures.

The locations of these sewers and utilities must be taken into consideration when decisions are made regarding the type of foundation to be employed - i.e., spread footings or piles. Our recommendations pertaining to spread footings are, of course, valid only for footings placed in undisturbed original ground. Where piles are to be driven adjacent to existing utilities, special precautions must be taken to ensure that no damage results. We suggest that the following procedure be adopted:

(1) Where piles will be 12 feet or more from the edge of a utility, no special precautions need be taken.

(2) All piles closer than 12 feet from a utility should be prebored to a depth of 6 ft. below the pipe bottom. The size of the augered hole need only be slightly larger than the pile section.

(3) Where holes are augered in non-cohesive subsoil, casing may be required to prevent the holes from caving in.

6.3) Eastward Canal:

6.3.1) Open Channel Sections:

The inlet and outlet portions of the Eastward Canal are proposed to be built as open channels. Subsoils at the upstream open channel were found to consist of a 10 - 15 ft. thick silty sand and sandy silt deposit, followed by clayey silt to silt with occasional seams of silty clay. At this location the bottom of the proposed channel will lie within the clayey silts. At the location of the downstream open channel, slag and cinder fill covers the area,

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.3) Eastward Canal: (cont'd.) ...

6.3.1) Open Channel Sections: (cont'd.) ...

- - - - -

the thickness of which varies between 2 ft. and 15 ft. Below the fill a fairly thick layer of sand, silt and gravel was found. At this end of the line the channel bottom will likely be in the granular deposits. No overall stability problems are anticipated for the proposed 1-1/2 horizontal to 1 vertical slopes; however, constant maintenance will be required, to eliminate surface erosion, especially within the fills. It is suggested that a protective filter blanket, consisting of a min. 12-inch thick layer of G.B.C. type 'A' material be provided on the slopes, at least up to the flood level, to prevent piping caused by seepage, and consequent sloughing, and to minimize the necessity for maintenance. On the streambed, and at certain locations on the banks, some rip-rap might be required to prevent erosion; the Hydrology Section should be consulted concerning this.

6.3.2) Culvert Sections:

- - - - -

A double box culvert is proposed for the stream diversion at the East end, between the open channel and the proposed railway tunnel, for a length of approx. 250 ft. The same solution will apply between the two proposed railway overheads, roughly for a distance of 560 ft. At the West end, adjacent to the open channel, the box culvert will be around 580 ft. long.

The bottom of the culvert will be placed between el. 642 ft. and 644 ft. Spread footings at the above elevations may be designed with allowable net bearing pressures of 1.3 TSF. No settlements are foreseen under the culvert, provided they are constructed on undisturbed soils.

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.4) T.H. & B.R. Overhead at the Expressway Crossing -
(Structure #8):

Around Station 170+00, the proposed expressway will cross the T.H. & B. railway with an overhead structure. The crossing is designed to be a combined structure, the railway tunnel being constructed at the top of the culvert as a monolithic unit. The base of the structure will be around el. 642 ft. It is anticipated that the bottom of the excavation will be partially in the sands and partially in the clayey silts as shown on the profile of Drawing #71-11022D.

In contemplating a spread footing type of foundation, the net safe bearing capacity of the subsoils, right below the footing elevations may be assumed to be 1.25 TSF. If the structure can economically be designed to keep the pressures within this limit, then spread footings may be constructed.

Alternatively, the structure may also be supported on end-bearing steel H-piles, driven to refusal either on bedrock or on the hard glacial till, right above the rock. Refusal of pile penetration is expected to be reached around el. 575 - 580 ft. Safe design loads equal to the full structural strength of the pile section used may be employed on such piles.

Consideration may also be given to a friction pile type foundation, employing timber piles embedded within the stratified stratum. Calculations indicated that - e.g., a 12-inch diameter timber pile with an embedded length of 45 ft., will support safe loads of 20 tons per pile. A full-scale pile loading test should be carried out prior to adopting such friction pile foundations.

The expressway embankment at the railway crossing will be as high as 30 - 32 ft. Settlement computations, based on laboratory consolidation tests, and using a reduction factor due to overconsolidation (Skempton & Bjerrum, 1957), resulted in consolidation settlements of approx. 10 inches. Since the fill will be supported laterally by retaining walls and not by slopes,

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.4) T.H. & B.R. Overhead at the Expressway Crossing -
(Structure #8): (cont'd.) ...

it is anticipated that, almost the full amount of settlement will be differential at the entrance location. If the structure is designed to be supported on spread footings, the culvert will have to be so constructed, that it withstands this approx. 10-inch differential settlement at the tunnel entrances. By employing end-bearing steel H-piles, settlements of the structure itself can entirely be eliminated.

Stability analyses, in terms of total stresses, were carried out for the embankment, by an electronic computer. The geometry of the fill was input with 2 horizontal to 1 vertical slopes, and also with retaining walls at both sides. In the latter case, failure was assumed to take place below the footing of the walls along a circular arc. Both computations resulted in acceptable factors of safety, thus no berms will be required for embankments up to 32 ft. heights.

6.5) T.H. & B.R. Overhead at Ramp E - (N/S/W) (Murray St. Exit) -
(Structure #6):

Under Ramp E-(N/S/W) the railway line is proposed to cross in a tunnel independently designed, but adjacent to the culvert crossing. The centre-line of the railway tunnel will run parallel to the centre-line of the culvert, at a distance of some 35 ft. The approximate footing base of the culvert will be around el. 644 ft., while that of the railway, at el. 653 ft.

The values of the undrained shear strengths of the underlying materials at this location were found to be somewhat higher than those at the expressway overhead, so that either spread footings or piled foundations may be constructed. On spread footings, allowable net bearing pressures up to 1.7 TSF may be designed. Because of the close proximity of the culvert to the proposed tunnel, great care should be taken not to disturb

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.5) T.H. & B.R. Overhead at Ramp E - (N/S/W) (Murray St. Exit) - (Structure #6): (cont'd.) ...

the soils at or near the location of the tunnel, by the culvert excavation. If this cannot be avoided, spread footings for the tunnel should be ruled out.

In the case of designing piled foundations, either end-bearing steel H-piles, or shorter timber, frictional piles may be used as described under Subsection (6.4). Steel H-piles should be driven to practical refusal, the depth of which is expected to be reached around el. 585 - 595 ft., within the hard glacial till or on bedrock. Again, design loads equal to the structural strength of the section may be employed on steel H-piles. The use of shorter timber piles ought to be confirmed by a pile loading test, as mentioned earlier.

A dewatering scheme for the excavations will be necessary due to the sandy silt to silty sand subsoils. Details of such schemes were discussed under Subsection (6.2.2).

No appreciable settlements are foreseen under the railway tunnel, since the grade of the ramp at the crossing will be near the existing ground level.

6.6) Retaining Walls:

The proposed sites of the two retaining walls, designed to be built integral with the culvert were included in the field investigations. The wall, located north of the proposed railway tracks between Railway Station 142+30 and Station 151+80 was numbered Wall #1. The length of this wall will be around 950 ft., the height from the footing of the culvert to the top of the retained soils varying between 18 ft. and 42 ft. A short wall is proposed at the south entrance of the railway tunnel at Structure #7, providing lateral support to the partial slope of the expressway embankment. This approx. 110-ft. long wall is identified on the drawing as Wall #2.

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.6) Retaining Walls: (cont'd.) ...

According to the soil stratigraphy, it appears that the base of the culvert along Wall #1 will be below the surficial sand and sandy silt stratum, within the stratified clayey silts. The footing of Wall #2, however, will lie within the sands or immediately beneath the granular layer.

It is estimated that the soils under Wall #1 will support net safe loads of 1.5 TSF, whereas the net safe bearing capacity under Wall #2 may be taken to be 1.25 TSF. If the above bearing values are not sufficient for the economical design of spread footings, piled foundations ought to be adopted as discussed under the preceding sections. Probable bedrock elevations along these walls may be read from the stratigraphical profiles on the drawings.

For the suggested factors to be used for earth pressure calculations and resistance against sliding, together with recommended dewatering schemes, reference is made to Section (6.2).

Backfill of the retaining walls - where applicable - should comply with D.H.O. Standard SD-4-58.

7. MISCELLANEOUS:

The field work, carried out during the period April 19 - May 11, 1971, was supervised by Messrs. H. Stankaitis, Field Technician, M. Logan and K. Williams, engineering students, under the general supervision of Mr. A. K. Barsvary, Senior Foundation Engineer, who also wrote this report.

Equipment used was owned and operated by P.V.K. Drilling Co., Burford, Ontario.

Mr. K. G. Selby, Supervising Foundation Engineer, reviewed the report.

June, 1971

APPENDIX I

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2 (2; 71-11021) FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,821 N.; 799,264 E.

ORIGINATED BY H.S.

W.P. 70-68-04

BORING DATE April 7-13, 1971

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Auger & Washboring

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.				WATER CONTENT %				
							UNCONFINED ● QUICK TRIAXIAL		+ FIELD VANE x LAB. VANE		w_p ——— w ——— w_L 10 20 30				
668.5	Ground Level														
0.0	Clayey Silt to Silt, layers of Sand. Fill? Brown. Very stiff & compact.		1	SS	15	660									
653.0			2	SS	18										
			3	SS	13										
15.5	Clayey silt to silt. Irregular seams & layers of silty clay & sandy silt. Firm to hard. Brownish grey.		4	SS	7	650									
			5	TW	PM										
			6	SS	12										
			7	TW	PM	640									
			8	SS	10										
			9	SS	PM	630									
			10	SS	10										
			11	TW	PM	620									
			12	SS	35										
			13	SS	49	610									
			14	SS	39										
			15	SS	32	600									
			16	SS	19										
			17	SS	40	590									
586.5			18	SS	22										
82.0	Clayey silt to silt with traces of sand & gravel. (Glacial Till) Hard.		19	SS	37	580									
			20	SS	76										
568.8	Probable Bedrock.		21	SS	46	570									
99.7	End of Borehole														

RECORD OF BOREHOLE No. 3 (3; 71-11021) FOUNDATION SECTION

ORIGINATED BY H.S.

COMPILED BY A.K.B.

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 10

FOUNDATION SECTION

JOB 71-11022

LOCATION

Co-ords. 672,825 N; 800,132 E.

ORIGINATED BY HS

W.P. 70-68-06

BORING DATE

April 19 - 20, 1971

COMPILED BY

AKB

DATUM Geodetic

BOREHOLE TYPE

Washboring, NX Casing

CHECKED BY

AKB

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_p	w	w_L		
668.0	Ground Level															
0.0	Silty sand with some gravel. Dense		1	SS	38	660										32 43 (25)
656.0	Brown		2	SS	30											0 12 (88)
12.0	Clayey silt to silt. Stiff		3	SS	9	650										
	Grey		4	TW	PM											
640.0			5	SS	9	640										
28.0	Irregular seams of silt, clayey silt and silty clay. Stiff to Hard		6	TW	PM											121
	Grey & Brown		7	SS	8											
			8	TW	PM	630										
			9	SS	10											
			10	TW	PM											122
			11	SS	8	620										
			12	TW	PM											128
606.5			13	SS	32	610										
61.5	End of Borehole		14	SS	26											

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 11

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-ords. 672,817 N; 800,027 E.

ORIGINATED BY HS

W.P. 70-68-06

BORING DATE Apr. 20-21, 1971

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.				WATER CONTENT %					
							UNCONFINED		FIELD VANE		w_p ——— w ——— w_L					
						1000	2000				10	20	30		GR. SA. SI. CL.	
675.2	Ground Level															
0.0	Clayey silt to silt Very Stiff to Firm Brown and Grey		1	SS	16	670									0 1 83 16	
			2	SS	20											
			3	SS	15	660										
			4	SS	7											
652.2	Irregular Seams of silt, clayey silt, silty clay. Stiff to Very Stiff Grey and Brown		5	TW	PM	650								127	0 7 82 11	
23.0			6	SS	9											
			7	TW	PM	640										121 122
			8	SS	8											
			9	TW	PM											
			10	SS	12	630										
			11	TW	PM											
618.7			12	SS	21	620								0 1 79 20		
56.5	End of Borehole															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 12

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-ords. 672,794 N; 799,917 E.

ORIGINATED BY HS

W.P. 70-68-06

BORING DATE April 19-20, 1971

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_p ——— w ——— w_L				
							SHEAR STRENGTH P.S.F.					WATER CONTENT %				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					10 20 30				
684.0	Ground Level						1000		2000							
0.0	Clayey silt to silt.					680										
	Very Stiff		1	SS	15											
672.0	Brown		2	SS	18											
12.0	Sandy silt to silt, random deams of clayey silt.		3	SS	33	670									0 20 73 7	
			4	SS	35											
			5	SS	39	660										
			6	SS	8											
		Dense to Loose	7	TW	PM	650				+ > 2000			NP		0 5 87 8	
642.0	Grey		8	SS	15											
42.0	Irregular seams of silt, clayey silt and silty clay.		9	TW	PM	640								126 122		
			10	SS	15											
			11	TW	PM									129		
			12	SS	12	630										
			13	TW	PM									122 123		
			14	SS	17											
		Stiff to Very Stiff	15	TW	PM	620								126		
			16	SS	10											
		Grey & Brown	17	TW	PM	610								131		
			18	SS	14											
596.0			19	SS	14	600								0 2 83 15		
88.0	Sandy silt with gravel															
592.5	(Till)		20	SS	90									8 41 41 10		
91.5	End of Borehole															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No.13

FOUNDATION SECTION

JOB 71-11022

LOCATION

Co-ords. 672,778 N; 799,814 E.

ORIGINATED BY HS

W.P. 70-68-06

BORING DATE

April 21, 1971

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE

Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %				
							1000	2000	10	20	30		
682.8	Ground Level												
0.0	Clayey silt					680							
	Stiff		1	SS	14								
	Brown												
670.8			2	SS	14								
12.0	Sandy silt to silt		3	SS	33	670							
	Random seams of clayey silt.		4	SS	42								
			5	SS	25	660							
			6	SS	21								
	Compact to Dense		7	SS	30	650							
			8	SS	20								
640.8			9	SS	15	640							
42.0	Irregular seams of		10	TW	PM							122	
	silt, clayey silt and		11	SS	13							127	
			12	TW	PM	630						123	
	silty clay		13	SS	14								
			14	SS	PM							130	
	Stiff to Hard		15	SS	39	620							
			16	SS	25								
	Grey and Brown		17	SS	17	610							
			18	SS	18	600							
593.8	Silt, traces of sand												
591.3	and gravel. (Fill)		19	SS	120								
91.5	End of Borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 14

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,875 N.; 801,054.5 E.

ORIGINATED BY M.L.

W.P. 70-68-09

BORING DATE April 28-29, 1971

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %
							20	40	60	80	100	P.S.F.					
657.2	Ground Level																
0.0	Gravelly sand. Compact to dense.		1	SS	13	650											
			2	SS	26												
			3	SS	41												
642.7			4A	SS	14												
			4B	SS	11												
14.5	Irregular seams of silt, clayey silt & silty clay Stiff to very stiff. Grey.		5	SS	11	640											
			6	TW	PM												
			7	SS	9	630											
			8	TW	PM												
621.2			9	SS	20	620											
36.0	Clayey silt with gra. Glacial Till																
615.7			10	SS	62												
41.5	End of Borehole																

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 15

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,911 N.; 800,918 E.

ORIGINATED BY M.L.

W.P. 70-68-09

BORING DATE April 29-30, 1971

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Washboring. NX. Casing

CHECKED BY

M.L.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.				w_p — w — w_L WATER CONTENT % 10 20 30				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE 1000 2000								
658.0	Ground Level														
0.0	Sandy gravel, some silt. Compact.		1	SS	32	650									45 36 (19)
646.5			2	SS	21										
11.5	Irregular seams of silt, clayey silt and silty clay.		3	SS	17	640									0 1 89 10
		4	SS	15											
			5	SS	9	630									119
		6	TW	PM											
	Traces of sand.		7	SS	10	620									117
	Stiff to hard.		8	TW	PM										
	Grey and brown.		9	SS	18	610									123
			10	SS	26										
			11	SS	36	600									0 1 74 25
			12	SS	29										
			13	SS	28	590									0 1 78 21
			14	SS	45										
			15	SS	51	580									
			16	SS	20										
			17	SS	19										
577.5	Probable Bedrock.		18	SS	100										
80.5	End of Borehole.														

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 16

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,926 N; 800,815.5 E.

ORIGINATED BY M.L.

W.P. 70-68-09

BORING DATE April 30 - May 3, 1971

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY *AK*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %		
							20	40	60	80	100	UNCONFINED + FIELD VANE QUICK TRIAXIAL x LAB. VANE					w_p	w	w_L
							1000	2000				10 20 30							
671.0	Ground Level					670													
0.0	(Fill)																		
	Silt, traces of clay and sand.		1	SS	14														
	Very stiff.		2	SS	16	660													
	Brown.		3	SS	18														
653.0																			
18.0	Sandy gravel, some silt.		4	SS	143	650													
644.5	Very dense.		5	SS	80														
26.5																			
	Irregular seams of silt, clayey silt and silty clay.		6	SS	33	640													
			7	SS	13														
			8	TW	PM														
			9	SS	14	630													
			10	TW	PM														
	Stiff to hard.		11	SS	24														
	Grey and brown.		12	SS	33	620													
			13	SS	31														
			14	SS	30	610													
			15	SS	54														
599.5			16	SS	61	600													
71.5	End of Borehole.																		

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 17

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,922 N.; 800,724 E.

ORIGINATED BY M.L.

W.P. 70-68-09

BORING DATE May 4-5, 1971

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					WATER CONTENT % w_p — w — w_L 10 20 30				
							UNCONFINED		FIELD VANE							
						QUICK TRIAXIAL		LAB. VANE								
						1000		2000								
658.6	Ground Level															
0.0	Gravelly sand. Compact		1	SS	17										0 74 (26)	
649.1			2	SS	38											
9.5	Silt. Very stiff.		3	SS	32										0 5 92 3	
639.6			4	SS	24											
19.0			5	SS	25											
	Irregular seams of silt, clayey silt and silty clay.		6	SS	11											
			7	TM	PM									111 126		
			8	SS	16											
			9	TM	PM									129		
	Stiff to hard.		10	SS	21											
	Grey and brown.		11	SS	17										0 1 49 50	
			12	SS	23											
			13	SS	41										0 1 74 25	
			14	SS	29											
			15	SS	29											
588.6			16	SS	62										0 3 76 21	
70.0	Clayey si. with some sand. Glacial Till.															
582.1	Probable Bedrock.		17	SS	111											
76.5	End of Borehole.															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 18

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-ords. 672,917 N; 800,597 E.

ORIGINATED BY HS

W.P. 70-68-09

BORING DATE April 23 - 26, 1971

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_p	w	w_L		
656.8	Ground Level															
0.0	Gravelly sand.		1	SS	5											
	Compact		2	SS	24											
648.3			3	SS	14											
8.5			4	SS	13											
	Irregular seams of		5	SS	9											
	silt, clayey silt		6	SS	10											
	and silty clay.		7	TW	PM											
			8	SS	9											
			9	TW	PM											
	Stiff to Hard		10	SS	14											
			11	TW	P/6"											
	Grey and Brown		12	SS	20											
603.8			13	SS	33											
53.0	Silt, some seams of		14	SS	39											
	clayey silt.		15	SS	30											
			16	SS	21											
	Very Stiff to Hard		17	SS	17											
580.3			18	SS	92											
76.5	End of Borehole															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 25

FOUNDATION SECTION

JOB 71-11022 LOCATION Co-Ord's: 672,895 N; 798,840 ORIGINATED BY H.S.
 W.P. 70-68-04 BORING DATE April 30, 1971 COMPILED BY A.K.B.
 DATUM Geodetic BOREHOLE TYPE Auger CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.				WATER CONTENT %					
							1000		2000		10 20 30					
660.6	Ground Level					660										
0.0	Silty fine sand		1	SS	12	650									0 76 (24)	
	Compact.		2	SS	27											
650.6	Brown		3	SS	17										0 3 84 13	
10.0	Irregular seams of silt. clayey silt & silty clay. Firm to Hard. Grey & brown.		4	SS	14	640										
			5	SS	8											
			6	SS	9	630										
			7	TW	PH											
			8	SS	14	620										
			9	TW	PH											
			10	SS	27											
614.1				11	SS	43										
46.5		End of Borehole.														

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 26

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,932 N. 798,838 E.

ORIGINATED BY H.S.

W.P. 70-68-04

BORING DATE May 3, 1971

COMPILED BY K.W.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %		
							20	40	60	80	100	UNCONFINED + FIELD VANE QUICK TRIAXIAL x LAB. VANE					w_p — w — w_L		
							1000	2000				10 20 30							
661.8	Ground Level																		
0.0	Very fine sand to silty sand. Compact. Brown		1	SS	15	660										0 94 (6)			
			2	SS	22														
649.8			3	SS	25	650										7 56 (37)			
12.0			4	SS	32														
	Clayey silt to silt, occasional seams of silty clay.		5	SS	13														
			6	SS	12	640													
	Firm to hard.		7	TW	PM/9"														
			8	SS	13	630													
			9	SS	17														
			10	SS	33	620													
			11	SS	40														
			12	SS	40	610													
			13	SS	52														
			14	SS	14	600													
			15	SS	13														
			16	SS	13	590													
584.8	Probable Bedrock																		
77.0	End of Borehole.																		

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 27

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,939 N: 798,715 E.

ORIGINATED BY H.S.

W.P. 70-68-04

BORING DATE April 28, 1971

COMPILED BY K.W.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_p	w	w_L		
662.3	Ground Level															
0.0	Silty sand to gravelly sand. Loose to very dense.		1	SS	6	660							○			0 71 15 14
			2	SS	22							○				
			3	SS	57							○				46 44 (10)
649.3			4	SS	12	650							○			
13.0			5	SS	16								○			0 4 89 7
	Clayey silt to silt Random seams of silty clay. Stiff to very stiff. Grey & brown.		6	SS	10	640								○		
			7	TW	PM									○	126	
			8	SS	16	630								○		
			9	TW	PH									—○—	129	
			10	SS	23	620								—○—		
			11	SS	29									○		0 5 75 20
			12	SS	24	610								○		
			13	SS	30											
602.3																
			14	SS	31	600								○		
60.0	Silt, traces of clay. Brown. Hard.		15	SS	36									○		0 1 94 5
			16	SS	40	590								○		
587.3	Probable Bedrock															
75.0	End of Borehole.															

DEPARTMENT OF HIGHWAYS- ONTARIO

RECORD OF BOREHOLE No. 28

FOUNDATION SECTION

MATERIALS & TESTING OFFICE

JOB 71-11022

LOCATION Co-ords. 672,766 N; 799,720 E.

ORIGINATED BY HS

W.P. 70-68-04

BORING DATE April 22, 1971

COMPILED BY MW

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.					
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %				
							20	40	60	80	100	1000 2000					w_p — w — w_L				
												○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					10 20 30				
689.5	Ground Level																				
0.0	Clayey silt, seams of sand. Stiff to Very Stiff		1	SS	24	680															
2			SS	18																	
3			SS	10																	
671.0	18.5	Fine Sandy Silt Dense	4	TW	PM	670															
5			SS	48																	
659.5	30.0	Irregular seams of silt, clayey silt and silty clay Stiff to Very Stiff Grey and Brown	6	SS	21	660															
			7	TW	PM	650															
			8	SS	14																
			9	TW	PM																
			10	SS	15	640															
			11	SS	28																
			12	SS	21																
			13	SS	25																
			14	SS	18	630															
			15	SS	16																
			16	TW	PM																
			17	SS	15	620															
18	SS	14																			
19	TW	PM	610																		
20	SS	16																			
21	SS	17	600																		
595.5	Silty Sand (Till)		22	SS	27																
96.5	End of Borehole																				

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 29

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,757 N; 799,570 E

ORIGINATED BY H.S.

W.P. 70-68-04

BORING DATE April 26, 1971

COMPILED BY K.W.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %
							20	40	60	80	100	UNCONFINED	FIELD VANE	QUICK TRIAXIAL			
							1000		2000				10	20	30		
692.4	Ground Level															GR. SA. SI. CL.	
0.0	Clayey silt, occasional seams of sand. Hard to stiff.					690											
			1	SS	62												
			2	SS	23	680										0 0 63 37	
			3	SS	15												
669.4			4	SS	10	670										0 0 65 35	
23.0	Irregular seams of silt, clayey silt and silty clay. Stiff to very stiff. Grey and brown.		5	TW	PM6" PH12"											127 0 54 (46)	
			6	SS	22	660											
			7	SS	9												
			8	TW	PM	650										125	
			9	SS	9											0 5 92 3	
			10	SS	13	640										121	
			11	TW	PM											127	
			12	SS	13											125	
			13	TW	PM	630											
			14	SS	14												
			15	TW	PM9" PH6"											123	
			16	SS	20	620											
			17	SS	24												
			18	SS	12	610										0 0 70 30	
			19	SS	11												
			20	TW	PM	600										130	
595.9			21	SS	19											128	
96.5	End of Borehole																

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 31

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,812 N; 799,147 E.

ORIGINATED BY H.S.

W.P. 70-68-04

BORING DATE May 5, 1971

COMPILED BY K.W.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_p	w	w_L		
664.0	Ground Level															
0.0	Very fine sand with some silt, traces of gravel. Loose to compact.		1	SS	6	660										0 82 (18)
			2	SS	21											5 85 (10)
648.0			3	SS	25	650										
16.0	Irregular seams of silt, clayey silt and silty clay. Traces of sand. Stiff to very stiff. Grey and brown.		4	SS	20											
			5	SS	11	640										
			6	TW	PH											124
			7	SS	14											
			8	TW	PH	630										124
			9	SS	19											
			10	SS	13											0 0 66 34
			11	SS	14	620										
			12	SS	25											
			13	TW	PH											0 2 76 22
			14	SS	23	610										
			15	SS	18											
			16	SS	14	600										129 0 2 69 29
			17	SS	11											
			18	TW	PH	590										129
583.7	Probable Bedrock		19	SS	30/4"											
80.3	End of Borehole.															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 32

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,853 N; 798,957 E.

ORIGINATED BY H.S.

W.P. 70-68-04

BORING DATE May 4, 1971

COMPILED BY K.W.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WATER CONTENT % w_p ——— w ——— w_L				
663.0	Ground Level															
0.0	Very fine sand with some silt, traces of gravel. Loose to compact.		1	SS	7	660									0 85 (15)	
649.0			2	SS	18	650										
14.0	Irregular seams of silt, clayey silt and silty clay.		3	SS	12											
			4	SS	10	640									0 0 74 26	
			5	SS	9											
			6	TW	PH										124	
			7	SS	11											
			8	TW	PH	630									127	
	Stiff to very stiff.		9	SS	20											
			10	SS	22											
	Grey and brown.		11	SS	23	620										
			12	SS	19											
			13	SS	22	610										
			14	SS	22	600										
			15	SS	10											
			16	SS	10											
			17	SS	11	590										
582.0	Probable Bedrock															
81.0	End of Borehole.															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 44

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,863 N.: 801,151 E.

ORIGINATED BY M.L.

W.P. 70-68-04

BORING DATE April 26-28, 1971

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.				WATER CONTENT %				
							1000 2000				w_p ——— w ——— w_L 10 20 30				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE								
660.7	Ground Level					660									
0.0	Slag, cinder & mixed fill. Very loose.		1	SS	4										
654.2	Black.		2	SS	18										
6.5	Sandy silt with some gravel & gravelly sand with some si. Compact to dense.		3	SS	26	650									
			4	SS	30										
			5	SS	20										
642.2			6	SS	11										
18.5	Silt to clayey silt, a few occasional seams of silty clay.		7	TW	PM	640								123	
			8	SS	6										
			9	TW	PM	630								120	
			10	SS	13										
			11	TW	PM	620								118	
			12	SS	12										
			13	TW	PM	610								130	
606.7	Clayey silt.														
604.2	Glacial Till.		14	SS	61										
56.5	End of Borehole.														

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 45

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's : 673,483N., 798,079 E.

ORIGINATED BY K.W.

W.P. 70-68-04

BORING DATE May 10, 1971

COMPILED BY W.A.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Hollow Stem Auger & Cone

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS/FOOT	20	40	60	80	100	PLASTIC LIMIT — w_p	WATER CONTENT — w		
659.8	Ground Level															
0.0	Uniform fine sand & silty sand, traces of gravel. Loose to compact.		1	SS	7											
			2	SS	12											0 72 (28)
			3	SS	16	650										
644.8			4	SS	13											8 87 (5)
15.0	Clayey silt to silt, occasional seams of silty clay.		5	SS	7											
			6	TW	PH	640										124
			7	SS	21											
	Firm to very stiff.		8	TW	PH	630										125
			9	SS	23											
	Seam of Sand		10	TW	PH	620										130
			11	SS	10											122
	Probable Bedrock		12	TW	PH	610										
			13	SS	39											
601.8																
58.0	End of Borehole.					600										
						590										

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 46

FOUNDATION SECTION

JOB 71-1022 LOCATION Co-Ord's 673,282 N.; 798,234 E. ORIGINATED BY K.W.
 W.P. 70-68-04 BORING DATE May 11, 1971 COMPILED BY W.A.
 DATUM Geodetic BOREHOLE TYPE C.M.F. Hollow Stem Auger & Cone CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %
							20	40	60	80	100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL			
662.9	Ground Level						1000	2000				10	20	30	GR. SA. SI. CL.		
0.0	Sandy gravel, some silt. Fill. Loose to compact.		1	SS	4	660									45 36 (19)		
			2	SS	18												
			3	SS	14												
650.4			4	SS	9	650											
12.5	Clayey silt to silt, occasional seams of silty clay. Stiff to very stiff.		5	TW	PH										119.5		
			6	SS	10										121.0		
			7	TW	PH	640									122		
			8	SS	25												
			9	TW	PH	630									126		
622.9			10	SS	23												
40.0	Silt to clayey silt. Hard. Grey. Probable Bedrock.		11	SS	78	620											
			12	SS	46												
			13	SS	70/6"	610											
			14	SS	81												
595.4			15	SS	66	600											
67.5	End of Borehole.					590											

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 47

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 673,270 N; 798,314 E.

ORIGINATED BY K.W.

W.P. 70-68-04

BORING DATE May 7, 1971

COMPILED BY W.A.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Hollow Stem Auger & Cone

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WATER CONTENT % w_p — w — w_L				
662.3	Ground Level															
0.0	Fine to coarse sand to silty sand, traces of gravel.		1	SS	14	660									0 70 (30)	
			2	SS	15											
			3	SS	23											
648.8	Compact.		4	SS	16	650										
13.5	Clayey silt to silt, occasional seams of clayey silt, traces of sand.		5	SS	10										0 1 59 40	
			6	TW	PH											
			7	SS	12	640										
			8	TW	PH											
			9	SS	24	630									0 3 81 16	
			10	SS	26	620										
			11	SS	13											
612.3			12	SS	60	610										
50.0	Silt.		13	SS	50/4"											
	Hard.		14	SS	55/6"	600										
	Grey.		15	SS	50/6"											
595.3	Probable Bedrock.															
67.0	End of Borehole.					590										

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 48

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 673,126 N; 798,453 E.

ORIGINATED BY H.S.

W.P. 70-68-04

BORING DATE May 30, 1971

COMPILED BY W.A.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Hollow Stem Auger & Cone.

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %		
							20	40	60	80	100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					10 20 30		
662.3	Ground Level																		
0.0	Silty sand to gravelly sand becoming Silt.		1	SS	28	660													
			2	SS	42	650													
	Dense to very dense.		3	SS	60														
639.8			4	SS	65	640													
22.5	Clayey silt, random pockets of silty clay, seams of sand.		5	SS	27														
			6	SS	26														
			7	SS	17														
	Stiff to very stiff.		8	TW	PH	630													
			9	SS	16														
			10	TW	PH														
618.8	Sand		11	SS	23	620													
43.5	End of Borehole.					610													

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 49

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 673,006 N; 798,605 E.

ORIGINATED BY H.S.

W.P. 70-68-04

BORING DATE April 29, 1971

COMPILED BY W.A.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Hollow Stem Auger & Cone

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %
							20	40	60	80	100	1000n 2000					
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					w_p — w — w_L					
662.6	Ground Level																
0.0	Silty sand with some gravel.					660											
	Dense to very dense.		1	SS	25												
649.6						650											
13.0	Clayey silt to silt, irregular seams of silty clay, pockets of sand. Stiff to very stiff.																
		2	SS	60													
		3	SS	18													
		4	SS	8													
		5	TW	PH			640									119	
		6	SS	10													
		7	TW	PH												120	
		8	SS	19			630										
		9	TW	PH												126	
		10	SS	15													
							620										
			11	SS	21												
			12	SS	19		610										
			13	SS	12												
			14	SS	18		600										
			15	SS	14												
589.6			16	SS	25	590											
73.0	End of Borehole.					580											

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 52

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-ords. 672,922 N; 800,415 E.

ORIGINATED BY HS

W.P. 70-68-04

BORING DATE May 6, 1971

COMPILED BY WA

DATUM Geodetic

BOREHOLE TYPE CME hollow stem auger & cone

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %
							20	40	60	80	100	P.S.F.					
658.1	Ground Level																
0.0	Silty fine sand, traces of gravel.																
651.6	Compact		1	SS	18												
6.5	Irregular seams of silt, clayey silt and silty clay		2	SS	12												
			3	SS	8												
			4	SS	7												
			5	TW	PH												
			6	SS	9												
			7	TW	PH												
			8	SS	11												
			9	TW	PH												
			10	SS	13												
			11	TW	PH												
			12	SS	18												
611.6	End of Borehole																
46.5																	

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 53

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,784 N.; 801,294.5 E.

ORIGINATED BY M.L.

W.P. 70-68-04

BORING DATE April 23, 1971

COMPILED BY W.A.

DATUM Geodetic

BOREHOLE TYPE Washboring, NX. Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WATER CONTENT % w_p ——— w ——— w_L				
658.4	Ground Level															
0.0	Silty sand with some gravel. Compact.		1	SS	15											
			2	SS	17											
			3	SS	14											
639.9			4	SS	14											
18.5	Irregular seams of silt, clayey silt and silty clay. Stiff.		5	TW	PM										127	
			6	SS	11											
			7	TW	PM										122	
			8	SS	17											
			9	TW	PM										126.5	
			10	SS	14											
			11	SS	21											
605.4			12	SS	12											
13.0	Silt with traces of clay. Stiff.		13	TW	PM										135 0 0 90 10	
596.9			14	SS	12											
61.5	End of Borehole.															

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 54

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,701 N.; 801,392 E.

ORIGINATED BY M.L.

W.P. 70-68-04

BORING DATE April 22, 1971

COMPILED BY W.A.

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT 20 40 60 80 100					SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE				
660.3	Ground Level															
0.0	Slag & cinder Fill.															
653.3	Loose, black.		1	SS	9											
7.0	Gravelly sand, traces of silt.		2	SS	15	650										21 70 (9)
	Compact		3	SS	23											
640.8			4	SS	7	640										
19.5	Irregular seams of silt, clayey silt and silty clay.		5	TW	PM											127
	Traces of sand. Stiff to very stiff.		6	SS	8											
			7	SS	18	630										
			8	SS	13											
			9	TW	PM											131
			10	SS	11	620										
612.8			11	SS	54											
47.5	Silt, traces of clay.		12	SS	17	610										
	Stiff to hard.		13	SS	9											
598.8			14	SS	49	600										0 3 86 11
61.5	End of Borehole.					590										

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 55

FOUNDATION SECTION

JOB 71-11022

LOCATION Co-Ord's: 672,670 N.; 801,502.5 E.

ORIGINATED BY M.L.

W.P. 70-68-04

BORING DATE April 21, 1971

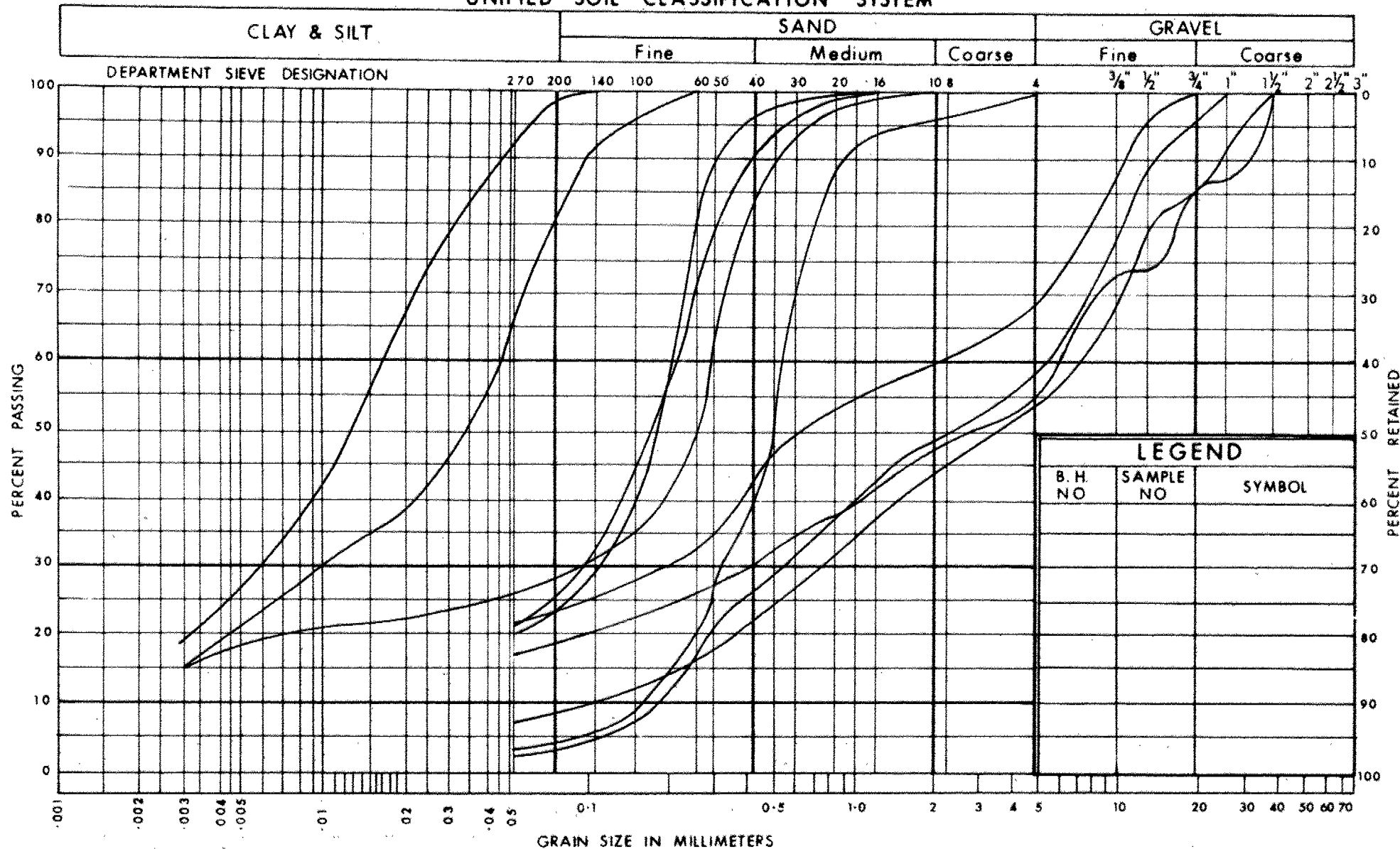
COMPILED BY W.A.

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing & Cone

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT 20 40 60 80 100					SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					WATER CONTENT % w_p ——— w ——— w_L 10 20 30
662.6	Ground Level																
0.0	Slag and cinder fill.	X	1	SS	17	660											
	Compact.		2	SS	11	650											
648.6	Black.																
646.1	Gravelly sand.	•••	3	SS	9	640											
16.5	Irregular seams of silt, clayey silt and silty clay.		4	SS	8	630											
			5	TV	PM												
			6	SS	9												
			7	TV	PM												
			8	SS	21												
			9	SS	31												
621.1	Stiff.		10	SS	27	620											
41.5	End of Borehole.																



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

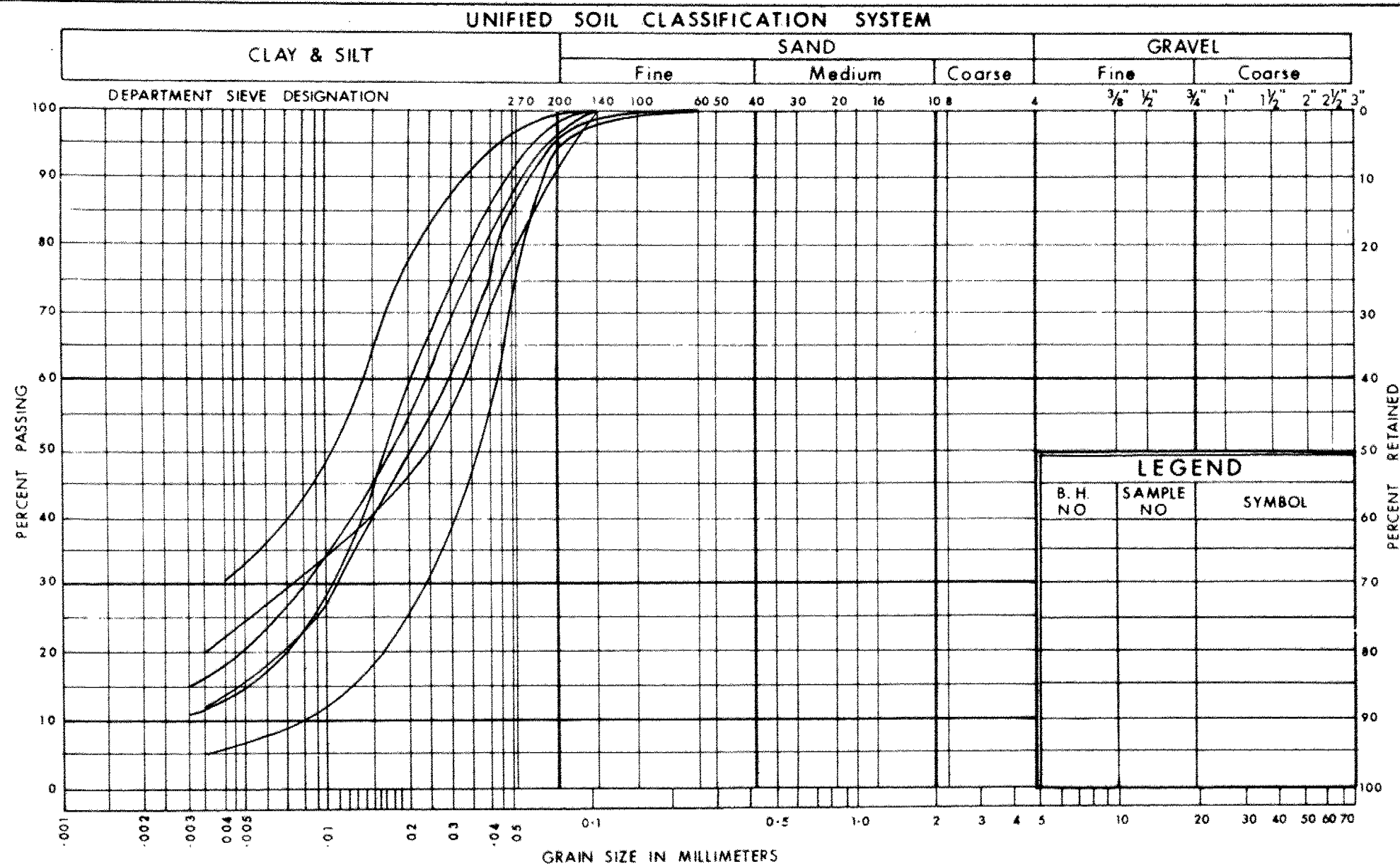
GRAIN SIZE DISTRIBUTION

SURFICIAL SAND AND SILT STRATA

W.P. No. 70-68-04

JOB No: 71-11022

FIG. 1



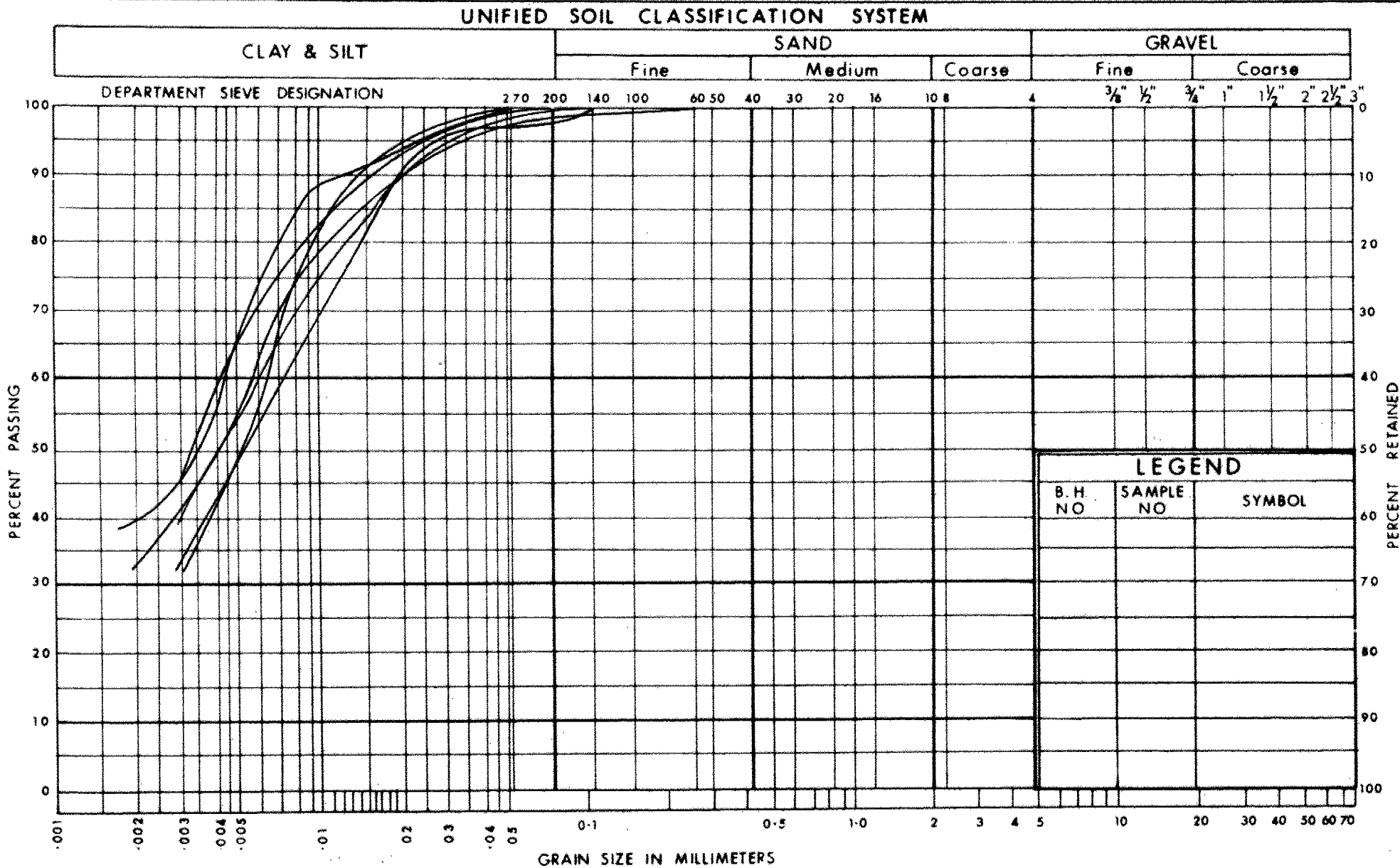
DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION SILT TO CLAYEY SILT PORTION OF THE STRATIFIED STRATUM

W.P. No. 70-68-04

JOB No: 71-11022

FIG. 2



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION

SILTY CLAY PORTION OF THE STRATIFIED STRATUM

W.P. No. 70-68-04

JOB No: 71-11022

FIG. 3

UNDRAINED SHEAR STRENGTH vs. ELEVATION

EAST END

Boreholes No. 44, 53, 54, 55

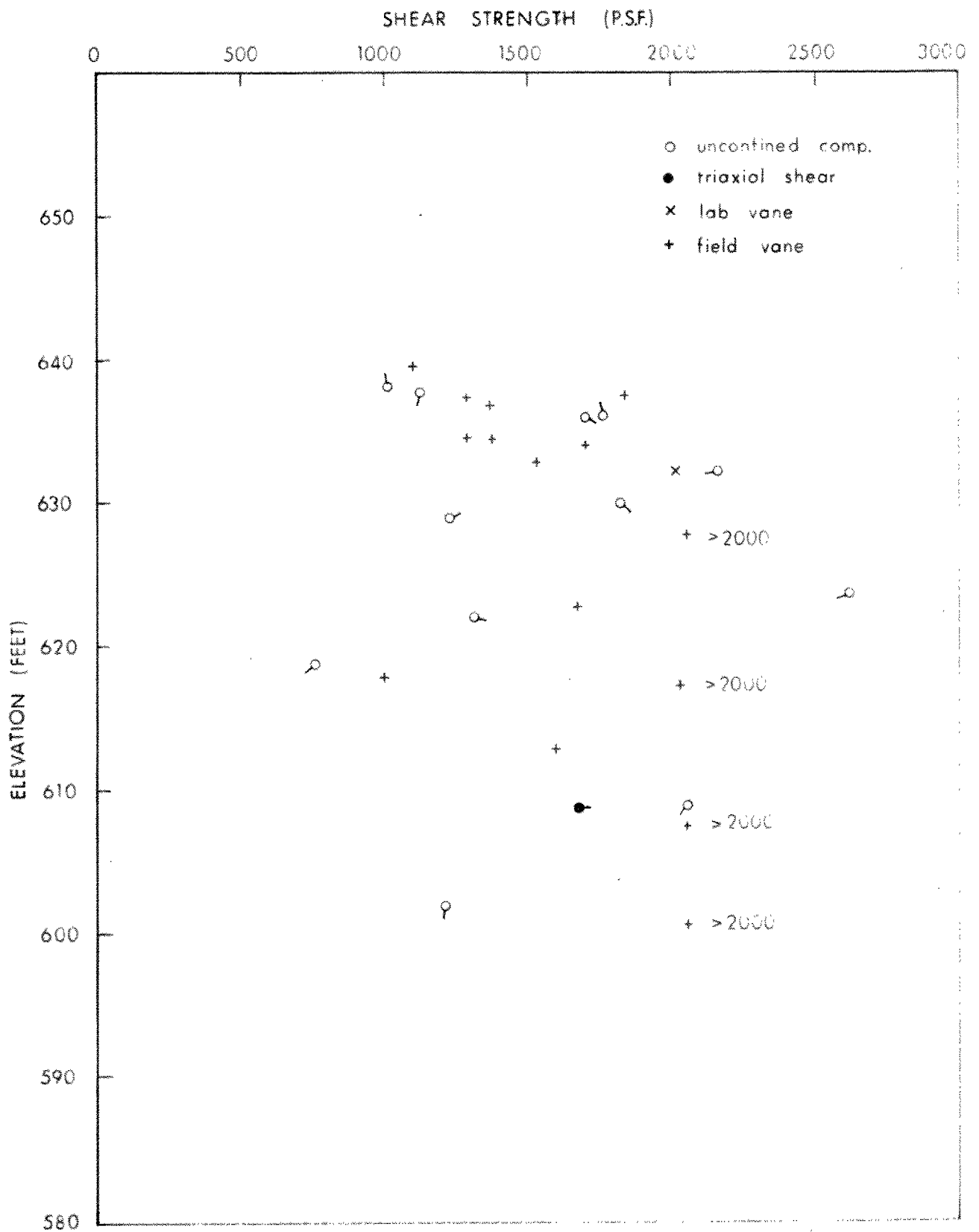


FIG. 4

71-11022

Boreholes No. 14, 15, 16, 17, 18



UNDRAINED SHEAR STRENGTH vs. ELEVATION

E-(NSW) RAMP - OVERHEAD

Boreholes No. 10, 11, 12, 13

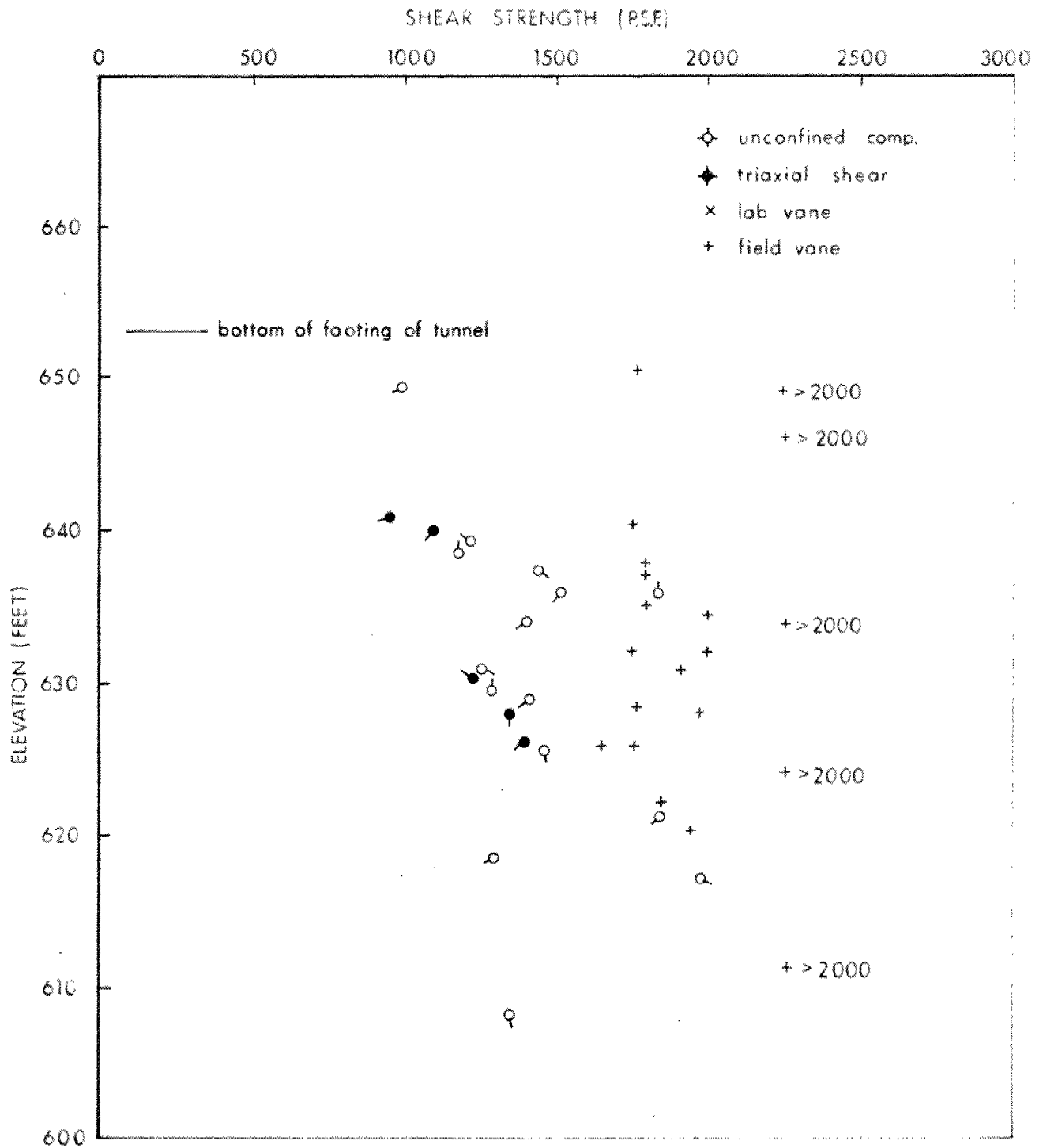


FIG. 6

71-11022

UNDRAINED SHEAR STRENGTH vs. ELEVATION WEST OF RAMP - RETAINING WALL

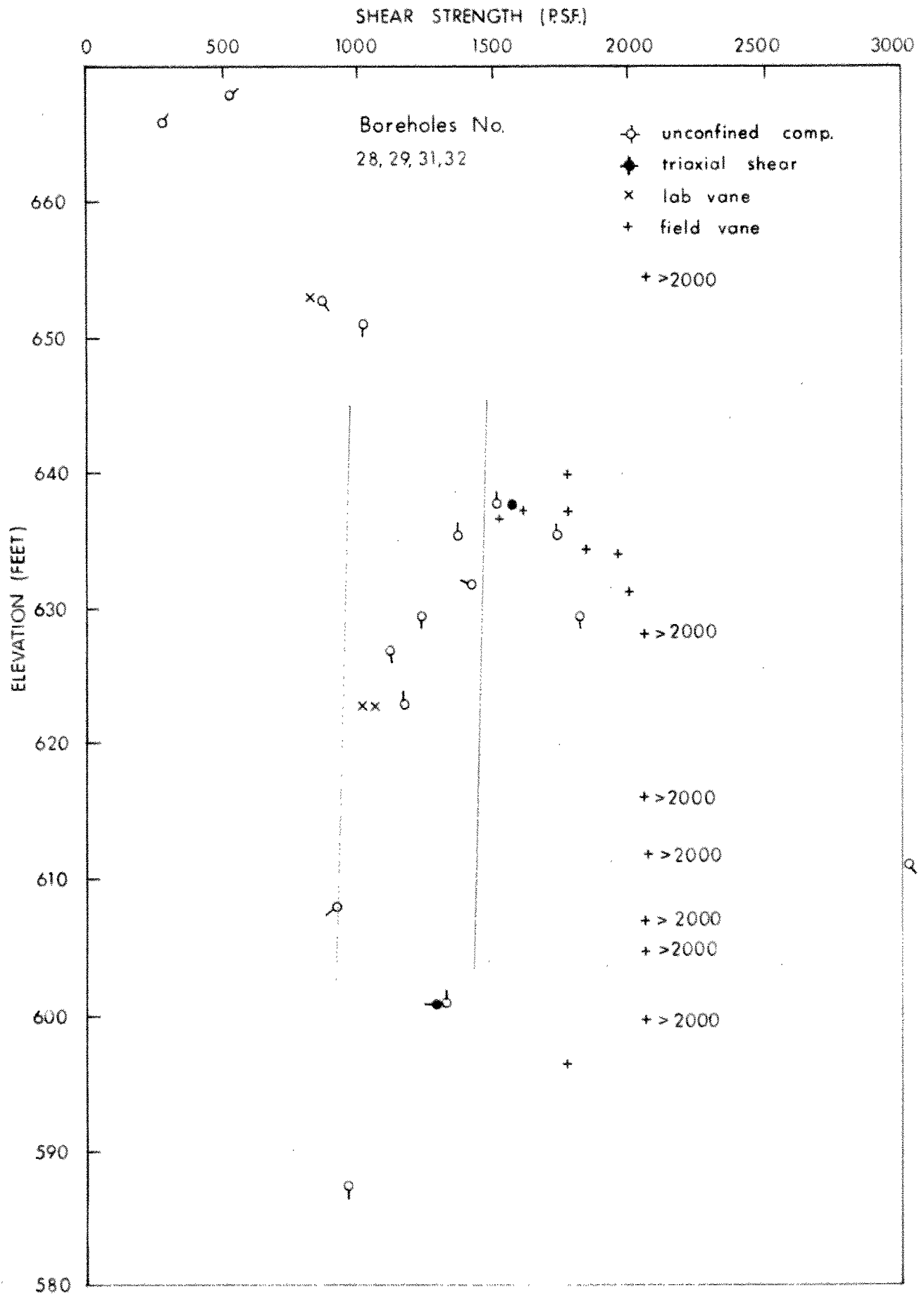
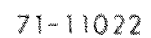
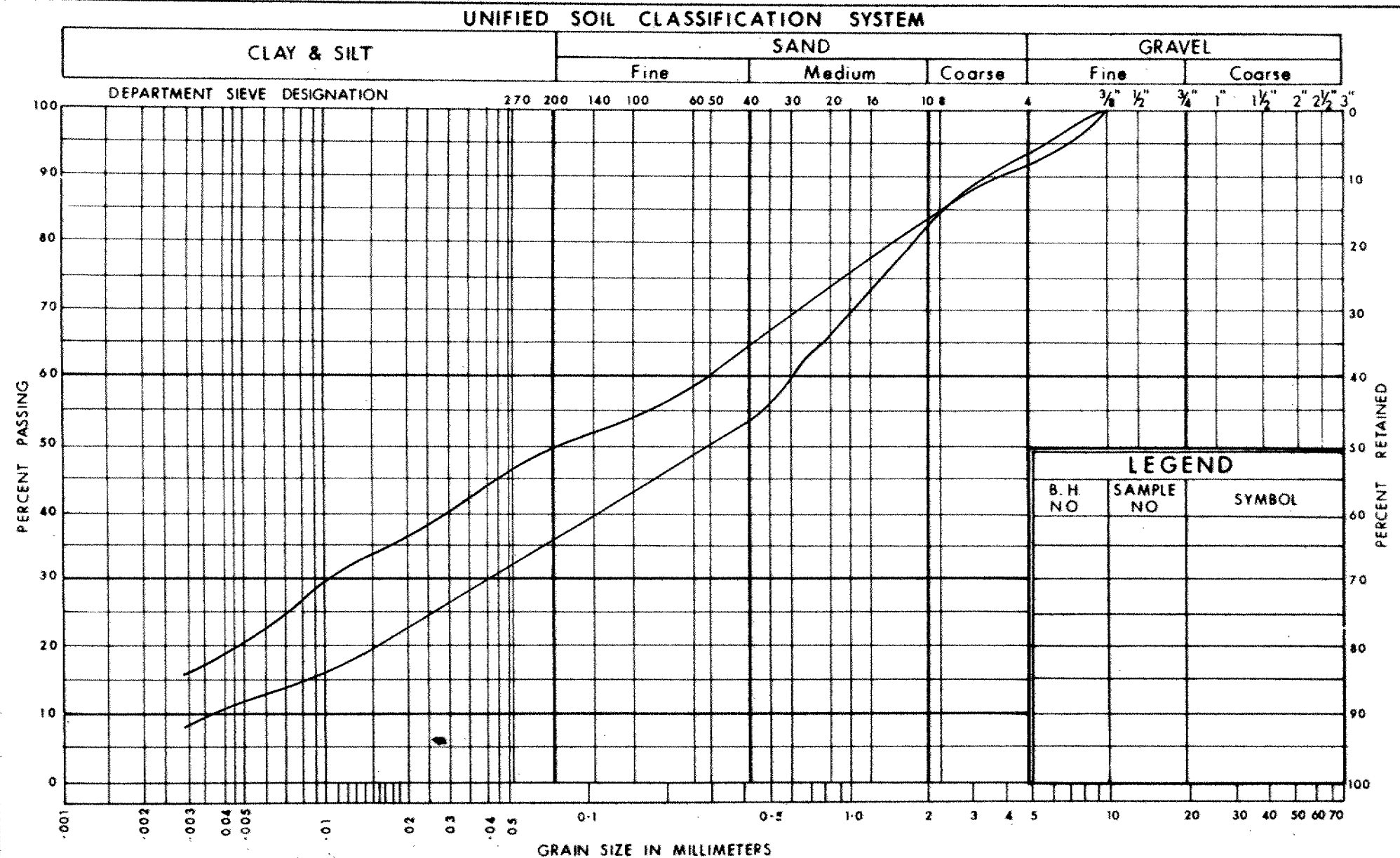


FIG. 7

Boreholes No. 25, 26, 27, 45, 46, 47, 48





DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

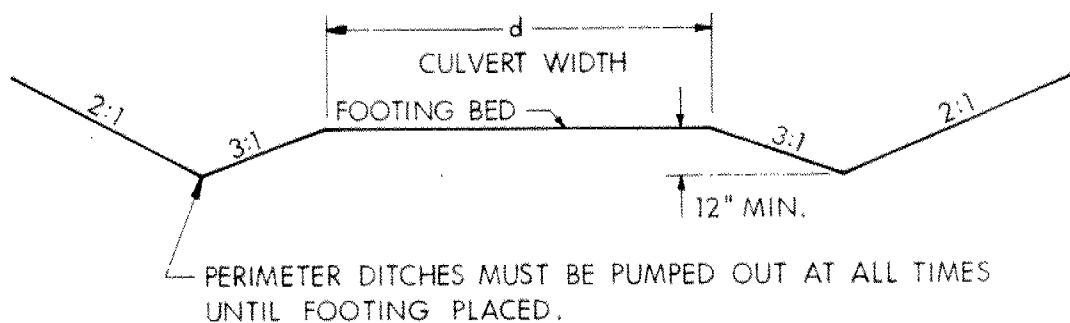
GRAIN SIZE DISTRIBUTION

GLACIAL TILLS

W.P. No. 70-68-04

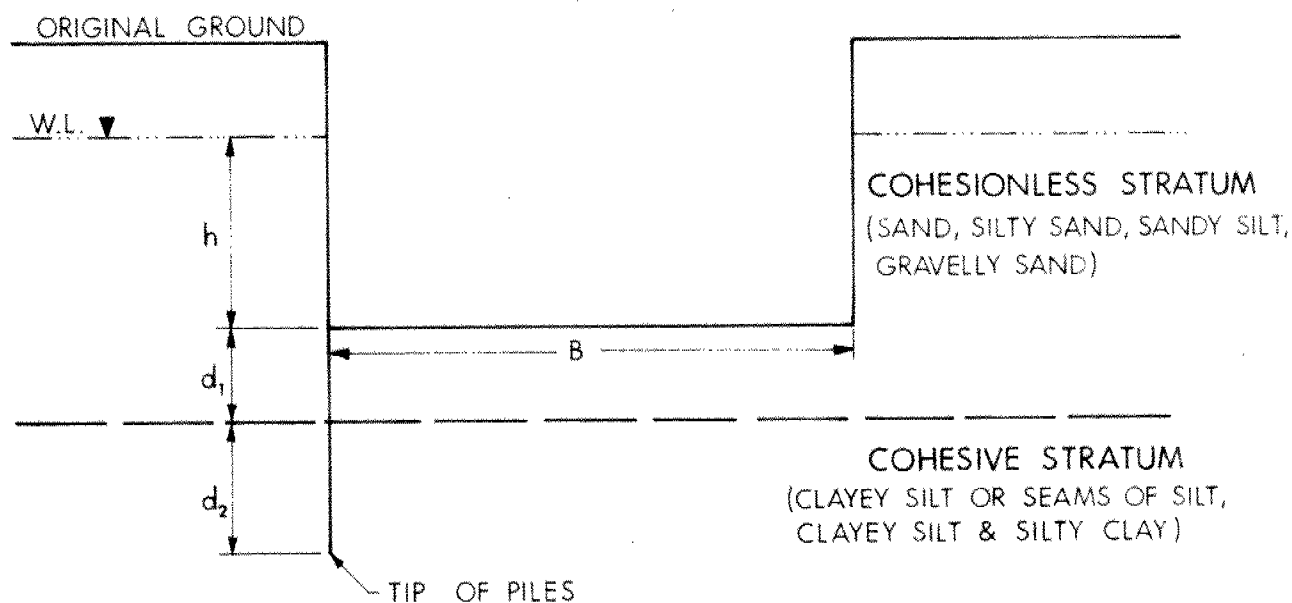
JOB No: 71-11022

FIG. 9



PROPOSED OVERSIZE EXCAVATION

FIG. 10



$$FS = \frac{[(d_1 + d_2) \times B \times \gamma] + (d_2 \times 2 \times C_{ADH})}{(h + d_1 + d_2) \times \gamma_w} \geq 1$$

WHERE

FS = FACTOR OF SAFETY. SHOULD BE EQUAL TO OR GREATER THAN 1.

γ = BULK DENSITY OF SOIL. USE 125 PCF.

C_{ADH} = ADHESION BETWEEN PILE AND SOIL. USE 800 PSF.

γ_w = DENSITY OF WATER (62.4 PCF)

FORMULA SUGGESTED FOR THE RESTRICTION OF SHEET PILE LENGTHS

FIG. 11

71-11022

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

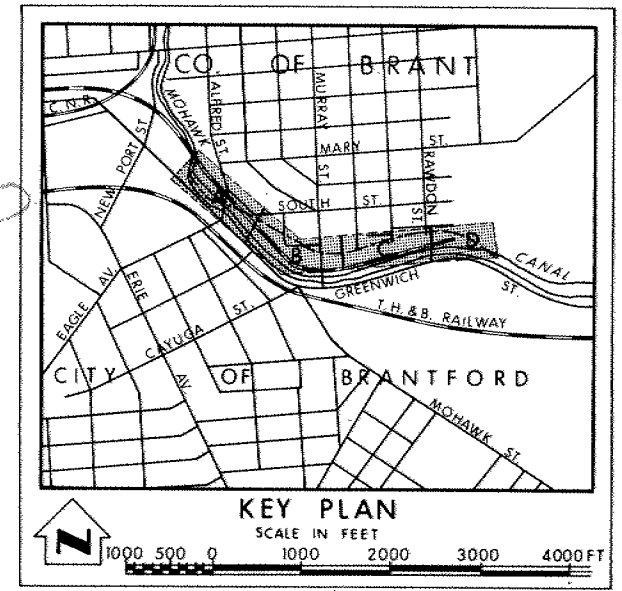
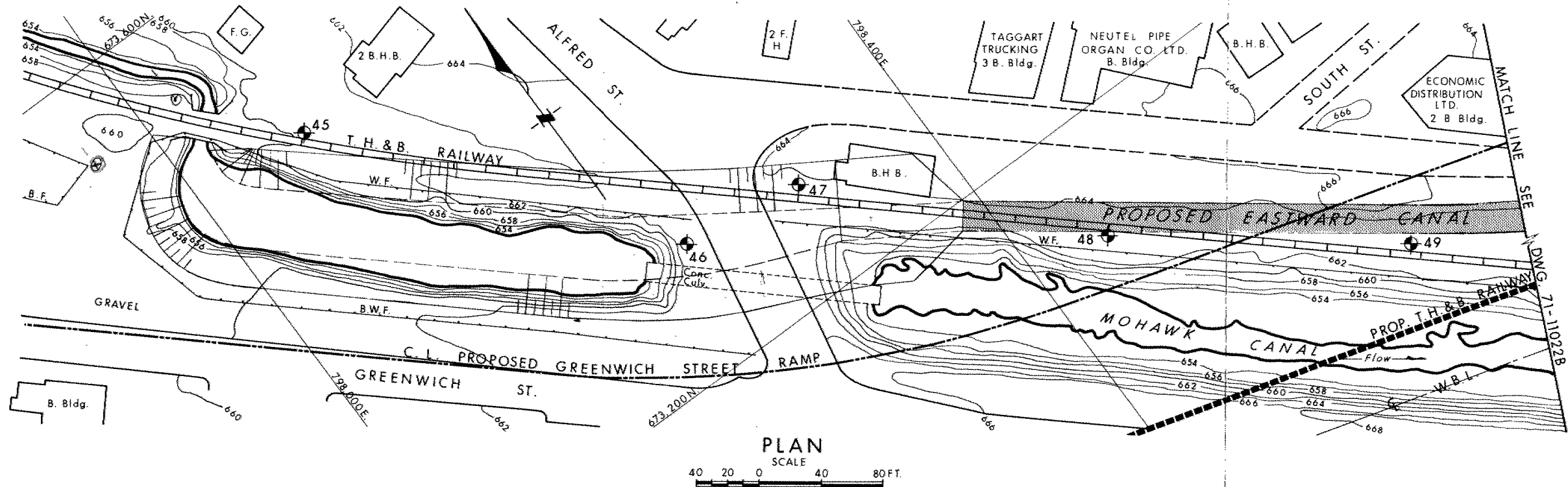
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

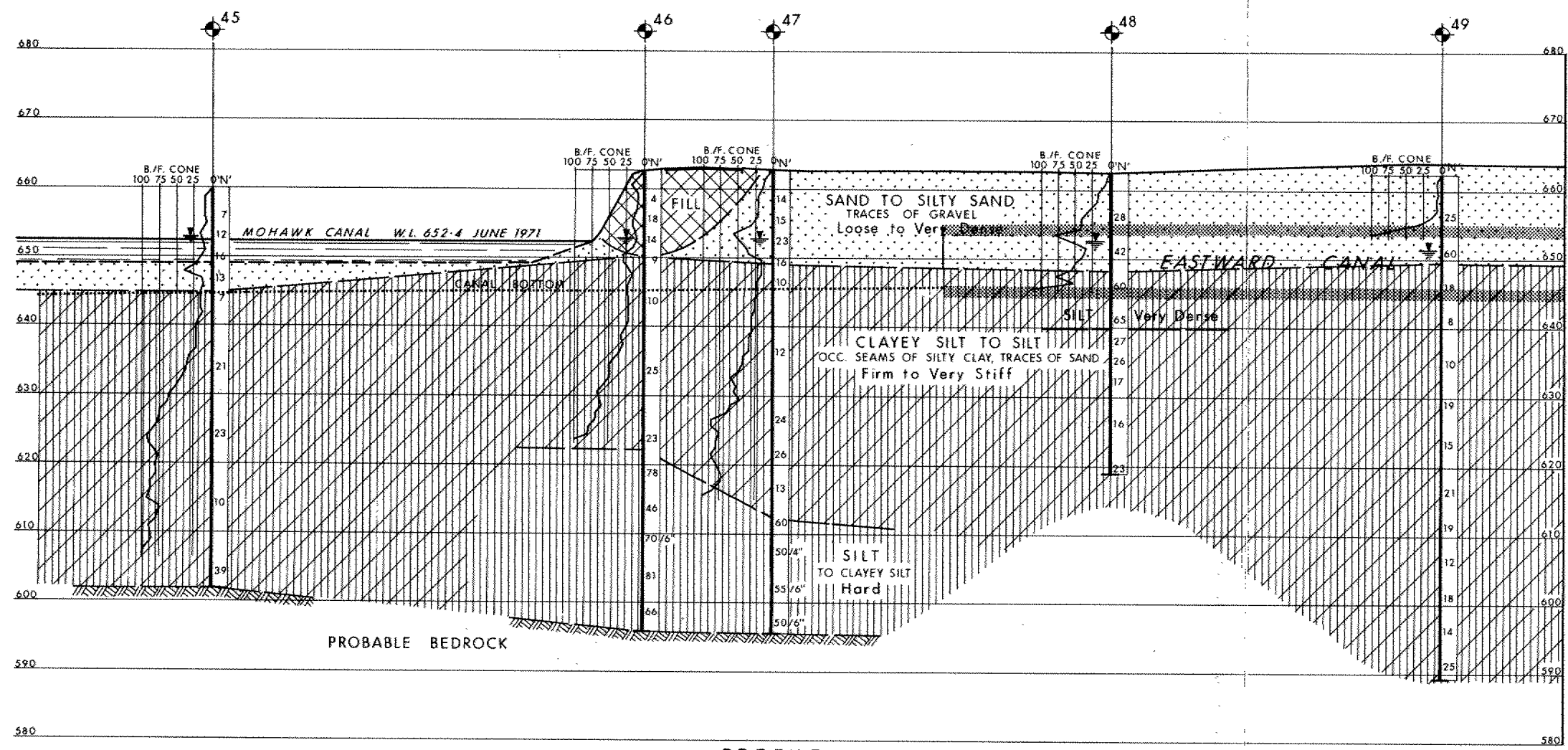
H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



- LEGEND**
- Bore Hole
 - ⊕ Cone Penetration Test
 - ⊕ Bore Hole & Cone Test
 - W.L. Water Levels established at time of field investigation, APRIL & MAY 1971

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
45	659.8	673,483	798,079
46	662.9	673,282	798,234
47	662.3	673,270	798,314
48	662.3	673,126	798,453
49	662.6	673,006	798,605

— NOTE —
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.



PROFILE
SCALE
HORIZ. 40 20 0 40 80 FT.
VERT. 10 5 0 10 20 FT.

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATION SECTION

EASTWARD CANAL

HIGHWAY NO. BRANTFORD EXPRESSWAY DIST. NO. 4
CO. BRANT CITY OF BRANTFORD
TWP. LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBWD. A. B.	CHECKED <u> </u>	W.P. NO. 70-68-04	DRAWING NO.
DRAWN <u> </u>	CHECKED <u> </u>	JOB NO. 71-11022	71-11022A
DATE <u>June 15, 1971</u>	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <u> </u>	CONF. NO.		

OVERSIZE DRAWING

Foundation Section
Tel 248-3282
(Area Code 416)

Room 107, Lab. Bldg.,
Hwy. 401 & Keele St.,
Downsview 464, Ontario.

July 21, 1971

M.M. Dillon Ltd.,
120 Main St.,
GALT, Ontario.

Attention: Mr. A. Kobelak, P. Eng.,
Project Manager

Re: Brantford Expy. #2,
W.P. 70-68-0-4 W.O. 71-11022
Dist. #4 (Hamilton)

Dear Sirs:

As requested in your letter, dated July 14, 1971, we have reviewed the soil information in the vicinity of B.H.'s 28, 29, and 13 on the abovementioned project. We would not advise increasing the net-bearing pressure on the soil beyond the value of 1.3 t.s.f., recommended in the report and suggest that piles be used to support the structure where necessary.

Yours very truly,

K. G. Selby

K. G. Selby,
Supervising Foundation Engineer
For:
A. G. Stermac,
Principal Foundation Engineer

KGS/ht

c.c.: Messrs. A.P. Watt
J.L. Keen

Foundation Files
Gen. Files

(3.2) Open Channel

To reshape the connecting open channel section between the two culvert segments, cuts and fills will be required. All slopes should be constructed with 2:1 slopes.

(a) The fill sections should be constructed according to current MTC Standards. Granular 'B' is recommended as fill material. The top 12" (on slope) should consist of Granular 'A' to act as a filter. This zone should extend to the observed high water level. To protect the slopes against erosion, rip-rap should be provided.

(b) An approximate 12" thick Granular 'A' filter blanket should be placed on the cut slopes. Rip-rap should be provided as a means of protection against erosion.

4. GENERAL COMMENTS

This memorandum supersedes the 'Discussion and Recommendations' part of Foundation Investigation Report W.O. 72-11085 issued on November 1, 1972.

The memorandum should be attached to the above quoted Foundation Report.

Should additional information be required, please contact our Office.


P. PAYER
Senior Engineer

for: K. G. SELBY
Supervising Engineer.

c.c. E. J. Orr
B. R. Davis
R. S. Pillar
C. R. Robertson
B. J. Giroux
D. Gunter
G. A. Wrong
P. Lewycky
M. M. Dillon Ltd., Mr. A. Kobelak

Files
Record Services

J. Anderson)
R. Fitzgibbon) memo only

3. RECOMMENDATIONS

Our modified recommendations in connection with the newly proposed culverts and open channel construction are discussed below.

(3.1) Culverts

- (a) Excavate muck in creek bed to its full vertical extent. Horizontally, the subexcavation should extend for a minimum distance of 5 ft. beyond the culvert sides, and replaced with suitable Granular material.
- (b) A minimum 18" thick pad, consisting of Granular 'A' is required at the underside of the proposed box culverts.
- (c) Net safe bearing capacity of 1.25 t.s.f. is suggested for the new box culverts.
- (d) Since the compaction of the Granular 'A' pad and formation of the culvert floor requires dry conditions, a dewatering scheme will be necessary. This dewatering scheme may consist either of interlocking sheet piling driven to an approximate distance of 3 ft. into the cohesive stratum (i.e. Elev. 642±) or, an oversize excavation with perimeter ditches. These ditches should have a depth of 2 ft. below the bottom of the Granular 'A' pad.
- (e) Long term settlements will take place within the cohesive deposit due to the culvert and embankment loading. It is estimated that the magnitude of settlement will be in the order of 1 - 2" under a 10 ft. high earth cover and 6 - 7" below a 20 ft. high embankment.
A joint system should be designed to accommodate the differential settlement under various fill heights.
- (f) The backfill to the culvert should be according to current MTC Specifications. However, it would be advantageous for the backfill to consist of similar material as the existing creek banks (i.e. silty sand).



Memorandum

W.P. 40-74-08

To: Mr. G. C. E. Burkhardt
Regional Structural Planning Engr.
Central Region
3501 Dufferin St., Downsview

From: Soil Mechanics Section
Geotechnical Office
West Building, Downsview

Attention: Mr. W. M. Killin

Date: April 7, 1975

Our File Ref. W.P. 40-74-05, -08

In Reply to

Subject: ADDENDUM TO FOUNDATION INVESTIGATION REPORT
FOR THE PROPOSED EAST WARD CREEK CULVERT(S)
W.P. 40-74-05 under B.S.A.R.
W.P. 40-74-08 under Murray St.
Brantford Southern Access Road
City of Brantford, District #4

1. INTRODUCTION

Since the issue of our original Foundation Report W.O. 72-11085 (formerly W.P. 70-68-04) dated November 1, 1972, new proposals have been submitted for the construction of the future East Ward Creek culverts by the B.S.A.R. Design Committee.

The new proposals call for construction of a single celled box culvert (9' X 12') under B.S.A.R. and a similar type culvert under Murray St. A reshaped open channel will connect the culverts. The invert of both culverts will be at Elev. 648±. A continuous, 9' X 12' S.P.P.A. culvert with invert level at Elev. 642-643 was proposed previously at this site. The ϵ of the future culvert will remain almost the same as formerly proposed.

In view of the current proposals, we have reviewed the validity of Foundation Investigation Report W.O. 72-11085 and our comments are as follows:

2. SUBSOIL CONDITIONS

For subsoil information, reference should be made to Foundation Investigation Reports W.O. 72-11085 and W.O. 71-11022 (formerly W.P. 70-68-04). We believe that the factual data contained in these Reports pertaining to the subsoil conditions will prove to be adequate for design and construction purposes.

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: Mr. J. G. Forster, (2)
Senior Soils Engineer,
Southwestern Region,
London, Ontario.

FROM: Foundations Office,
Design Services Branch,
West Bldg., Downsview.

ATTENTION:

DATE: October 5, 1972.

OUR FILE REF.

IN REPLY TO

NOV 1 1972

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For

The Modified Proposal of the
Eastward Creek Culvert
Brantford Expressway #2
District #4

W.O. 72-11085 -- ~~W.P. 70-68-04~~ 00

NEW WP: 40-74-05 AND 08

40 P1-61

Attached we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above-mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

A. G. Stermac

A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

AGS/ao
Attach.

cc: E. J. Orr
B. R. Davis
A. Rutka
A. McConnell
C. R. Robertson
B. J. Giroux
A. P. Watt
J. R. Roy
G. A. Wrong
B. A. Singh
M. M. Dillon (Galt) - A. Kobelak

Foundations Files
Documents

TABLE OF CONTENTS

1. INTRODUCTION.
 2. FIELD AND LABORATORY INVESTIGATIONS.
 3. SUBSOIL CONDITIONS.
 4. DISCUSSION AND RECOMMENDATIONS.
 - 4.1) General.
 - 4.2) Soil Stratigraphy.
 - 4.3) Dewatering of the Excavations.
 - 4.4) Settlements.
 - 4.5) Bearing Capacity of the Subsoil.
 5. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION REPORT
For
The Modified Proposal of the
Eastward Creek Culvert
Brantford Expressway #2
W.O. 72-11085 - W.P. 70-68-04

1. INTRODUCTION:

During the Brantford Expressway design subcommittee meeting on August 9, 1972, it was decided that a soil investigation should be carried out along the proposed eastward creek culvert. Subsequent to the meeting Mr. J. G. Forster, Senior Soils Engineer, Southwestern Region, confirmed the request for the investigation in a memo dated August 14, 1972. The present proposal of the eastward creek culvert utilizes the existing creek bed along the larger portion of its length, thus the alignment differs considerably from the one previously proposed.

The purpose of the recent investigation has been (a) to establish subsoil conditions at and below the proposed culvert excavations, (b) to determine dewatering problems in the excavations on account of the presence of susceptible soil strata, (c) to predict consolidation settlements along the section where a fill will be constructed above the culvert, (d) to recommend safe design loads at the bottom of the proposed arch culvert.

Presented in this report are the results of the investigation together with comments concerning above problems.

2. FIELD AND LABORATORY INVESTIGATIONS:

The recent investigation consisted of six sampled boreholes, placed in the creek, by employing a portable raft.

Shallow holes, drilled previously and located on the banks of the creek were also used to estimate soil stratigraphy. A conventional diamond drill adapted for soil sampling purposes was used to advance the holes. Samples were recovered by means of split-spoon and Shelby tube samplers. In situ undrained shear strengths were determined in the borings by field vane tests.

Laboratory unconfined and quick triaxial tests were performed on undisturbed samples and the bulk densities calculated. Several Atterberg limit tests and grain size analyses were carried out in order to define physical characteristics and predict soil behaviour under unbalanced hydrostatic pressures. On the attached borelog sheets there are the results of all the field and laboratory tests.

The locations of the borings are marked on Drawings #72-11085A, B & C. The estimated stratigraphical profile shown on the drawings are based on the borelog sheets.

3. SUBSOIL CONDITIONS:

Boreholes located on the banks of the creek revealed a surficial deposit of fine sands, silty sands and gravelly sands. The lower boundary of this stratum lies around elevation 644-650 ft. This material was described at some length in our original report, numbered 71-11022 under section (4.3). To avoid redundancy it will not be repeated here. This sand and silty sand layer was entirely missing along the creek bed. The surficial layer in the creek was identified to be black organic muck of some 5-6 feet thickness, extending to approximate elevation 645-646 ft. The organic layer contains mainly silts and it is very soft with natural moisture contents in excess of 55-60%. This material has no engineering values.

Underlying the black muck a deep deposit of clayey silt with irregular layers of silt and thin seams of silty clay was found extending to elevation 583-597 ft. This is the

predominant deposit in Brantford and as such was discussed in all of our previous reports dealing with the proposed expressway (See Reports #71-11021, 71-11022, 71-11024, etc.). This stratified stratum under the creek bed was found to exhibit somewhat higher plasticities than elsewhere, pure silts being present mainly in the deeper elevations. The undrained shear strengths of the clayey silts under the proposed culvert invert is estimated to be 1000 - 1200 p.s.f. ✓

Following the laminated deposits, glacial tills were observed, consisting of clayey silts with traces of sand and gravel, and silty sands with clay and gravel. The glacial deposit lies more than 50 ft. below the creek bed, thus will have no effect on the construction of the culvert.

The water level of the eastward creek during the field work was measured to be at elevation 652.2 - 652.3 ft. The depth of water of the creek varies between 1.0 ft. and 2.5 ft.

4. DISCUSSION AND RECOMMENDATIONS:

Superseded in following memo - apr. 7/75

4.1) General:

The present proposal calls for the construction of a 19' 14" x 12' 2" multi-plate arch culvert to replace the existing eastward canal. The upstream end of the culvert will be immediately east of the Eagle Ave.-Alfred St. bridge, running easterly for a distance of some 3,400 ft. A short section of the creek, west of the Murray-Mohawk structure will be built as open channel. The invert of the arch culvert will be around elevation 642 - 643 ft., some 7 - 8 ft. below existing creek bed. The culvert will be crossed by several fills, proposed to be built to carry the expressway, Greenwich St. and certain ramps. The depth of cover over the culvert at these locations will range from 6.5 ft. up to 26 ft.

4.2) Soil Stratigraphy:

Soil stratigraphy along the proposed culvert is shown on Drawing #72-11085A, B and C. The uppermost stratum was

identified to be sand, gravelly sand, silt and sandy silt, extending to elevation 644-650 ft. The existing creek bed is covered by a 5-6 ft. thick black organic muck. Under the sands and the muck, clayey silt with irregular seams of silt and silty clay were found within a considerable depth. The consistency of this layer varies between firm and very stiff.

4.3) Dewatering of the Excavations:

Excavations for the culvert will extend to elevation 640 - 642 ft. depending on the thickness of bedding. The average water level is at elevation 652 ft., some 10 - 12 ft. higher than the excavation bottom. The fine sands, sandy silts and silts are highly susceptible to conditions of unbalanced hydrostatic heads. The base of the excavations will, however, likely be within the irregularly stratified clayey silts. To evaluate the behaviour of this material when subjected to hydrostatic pressures is very difficult, on account of the presence of random seams. It is assumed that the silty clay and clayey silt seams have sufficient cohesion to resist uplift pressures. The silt seams and pockets, having no internal strength, will become 'quick' and will boil in the excavations under unbalanced water head. Boreholes placed in the creek bed indicated that soils within the zone effected by the future excavations contain mainly clayey silts, thus no blow out of the bottom may occur. Notwithstanding it is anticipated that some silt and sand intrusions will be encountered along the length of the culvert, causing unstable conditions. In view of the above, provisions should be provided for a dewatering scheme. Such scheme may consist of driving interlocking sheet piles down to a distance below the bottom of the excavation equal to or greater than the height of prevailing water head above it. In adopting this scheme water from the excavation may be pumped out without inducing quick conditions.

Other dewatering schemes such as construction of an oversize excavation and pumping from shallow perimeter sumps, or

a well point system could most probably be equally effective. Their effectiveness, though, cannot be established without the benefit of a full scale field test.

Whether the feasibility of these alternatives should be established in the design stage or whether it should be left to the Contractor to choose his own method is a matter that should be discussed and decided upon. It should be borne in mind that the effectiveness of one of the dewatering schemes is already established.

We feel that the choice of the dewatering scheme should remain the prerogative of the Contractor. The design should only specify that the integrity of the bottom of the foundation excavation shall be preserved under any and all circumstances and conditions. A method to achieve this could but not necessarily should be shown on the design drawings. The Contractor's attention should, though, be drawn to the fact that unless an appropriate dewatering scheme is applied the deterioration of the excavation bottom may occur and it will be his responsibility to rectify it and it will be at his expense.

4.4) Settlements:

- a) Long term settlements will take place under the arch culvert along those lengths, where additional fills will be constructed over the culvert, due to the consolidation of cohesive strata. Consolidation settlements were calculated, using laboratory compression curves. Two such curves (void ratio versus log. pressure) are shown on Fig. #1 & 2. Stresses caused by the embankment loads were computed by the elastic theory according to Boussinesq. It appears that critical conditions may arise around culvert Sta. 22+00 near the west abutment of the eastbound structure, where differential settlements could cause culvert deformations. As a consequence settlements were calculated under this location (finite end condition).

Assuming the height of the approach fill to be 20 ft, settlements beneath the culvert will be around 6-7 inches. In the case of a 26 ft. approach fill the predicted settlements will be 11 - 12 inches.

The rate of settlements will likely be relatively fast, since pore pressures will dissipate along the more pervious seams and layers. As a rough estimate some 10 years may be assumed for 90% consolidation.

- b) Small additional settlements are anticipated to take place immediately upon placing the fills due to the elastic deformations of the subsoil. Elastic settlements are not expected to exceed 1 - 2 inches.
- c) Further settlements will also take place along the entire length of the construction because of the lowering of the water table. It is assumed that the creek water will be lowered some 10 ft., which in turn will permanently depress the groundwater in the adjacent areas. This increase of effective overburden pressure will produce settlements, that will be roughly proportional to the descent of the piezometric level. The magnitude of this settlement might be in the order of 1-3 inches.

4.5) Bearing Capacity of the Subsoil:

Below the proposed invert elevation the clayey silts will support safe design loads of 1.2 t.s.f. No bearing capacity problems will be encountered below the arch culvert, due to the imposed vertical loads. Corner bearing pressures will, however, exceed the allowable bearing capacity, under high fills and railway crossings. At these locations beddings should be so designed as to be able to distribute the applied stresses to such an extent, that the remaining stresses at the interface of the bedding and the in situ soil be not more than 1.2 t.s.f.

It is estimated that along the length of the culvert, where stresses at the haunches will be between 4 t.s.f. and 5 t.s.f. the bedding should horizontally extend to a distance of 6 ft., measured at the top of the corner radius of the pipe arch. The depth of the bedding below the culvert invert should be at least 30 inches as shown on Fig. #3.

At those locations where the applied stresses on the haunches of the arch culvert will be between 5 t.s.f. and 6 t.s.f., the

depth of bedding should be increased from 2.5 ft. to 3 ft. The horizontal extent of the backfill, may remain 6 ft.

Along the length of the culvert where stresses at the haunches will be 4 t.s.f. or less, bedding dimensions used in the preliminary design - submitted by Mr. A. Kobelak of M. M. Dillon & Company during the August 30, 1972, Subcommittee meeting - are acceptable.

Bedding at the haunches should be constructed with granular "A" material, compacted to at least 95% Proctor density. It is to be pointed out, that the bottom of the excavation must be entirely dry and undisturbed in order to achieve proper compaction.

It is felt that the removal of sheet piles after completion of the bedding might cause some loosening of the in situ soil and the granular "A", resulting in a small lateral displacement of the bedding. In our estimate this lateral yield would not be more than 1 inch, at both sides. Removal of the sheet piles should, therefore, depend on whether or not the culvert could tolerate such a movement.

Regardless of above comments it is recommended that in the event of using sheet piles at those locations where stresses at the haunches exceeds 5 t.s.f., piles be left in place to facilitate proper compaction of the backfill.

5. MISCELLANEOUS:

The field work carried out during the period of August 21 - September 7, 1972, was supervised by Mr. P. Korgemagi, Project Foundations Engineer.

Equipment used was owned and operated by P.V.K. & Sons Drilling Company, Burford, Ontario.

This report was written by Mr. A. K. Barsvary, Senior Foundations Engineer and reviewed by Mr. K. G. Selby, Supervising Foundations Engineer.

A. K. Barsvary

A. K. Barsvary, P. Eng.



K. G. Selby

K. G. Selby, P. Eng.

AKB/ao

October 4, 1972.



Memorandum

111.
~~W.P. 70-68-04~~
40-74-05, -08

To: Mr. G. C. E. Burkhardt
Regional Structural Planning Engr.
Central Region
3501 Dufferin St., Downsview

From: Soil Mechanics Section
Geotechnical Office
West Building, Downsview

Attention: Mr. W. M. Killin

Date: April 7, 1975

Our File Ref. W.P. 40-74-05, -08

In Reply to

Subject:

ADDENDUM TO FOUNDATION INVESTIGATION REPORT
FOR THE PROPOSED EAST WARD CREEK CULVERT(S)
W.P. 40-74-05 under B.S.A.R.
W.P. 40-74-08 under Murray St.
Brantford Southern Access Road
City of Brantford, District #4

1. INTRODUCTION

Since the issue of our original Foundation Report W.O. 72-11085 (formerly W.P. 70-68-04) dated November 1, 1972, new proposals have been submitted for the construction of the future East Ward Creek culverts by the B.S.A.R. Design Committee.

The new proposals call for construction of a single celled box culvert (9' X 12') under B.S.A.R. and a similar type culvert under Murray St. A reshaped open channel will connect the culverts. The invert of both culverts will be at Elev. 648±. A continuous, 9' X 12' S.P.P.A. culvert with invert level at Elev. 642-643 was proposed previously at this site. The ϵ of the future culvert will remain almost the same as formerly proposed.

In view of the current proposals, we have reviewed the validity of Foundation Investigation Report W.O. 72-11085 and our comments are as follows:

2. SUBSOIL CONDITIONS

For subsoil information, reference should be made to Foundation Investigation Reports W.O. 72-11085 and W.O. 71-11022 (formerly W.P. 70-68-04). We believe that the factual data contained in these Reports pertaining to the subsoil conditions will prove to be adequate for design and construction purposes.

3. RECOMMENDATIONS

Our modified recommendations in connection with the newly proposed culverts and open channel construction are discussed below.

(3.1) Culverts

- (a) Excavate muck in creek bed to its full vertical extent. Horizontally, the subexcavation should extend for a minimum distance of 5 ft. beyond the culvert sides, and replaced with suitable Granular material.
- (b) A minimum 18" thick pad, consisting of Granular 'A' is required at the underside of the proposed box culverts.
- (c) Net safe bearing capacity of 1.25 t.s.f. is suggested for the new box culverts.
- (d) Since the compaction of the Granular 'A' pad and formation of the culvert floor requires dry conditions, a dewatering scheme will be necessary. This dewatering scheme may consist either of interlocking sheet piling driven to an approximate distance of 3 ft. into the cohesive stratum (i.e. Elev. 642±) or, an oversize excavation with perimeter ditches. These ditches should have a depth of 2 ft. below the bottom of the Granular 'A' pad.
- (e) Long term settlements will take place within the cohesive deposit due to the culvert and embankment loading. It is estimated that the magnitude of settlement will be in the order of 1 - 2" under a 10 ft. high earth cover and 6 - 7" below a 20 ft. high embankment.
A joint system should be designed to accommodate the differential settlement under various fill heights.
- (f) The backfill to the culvert should be according to current MTC Specifications. However, it would be advantageous for the backfill to consist of similar material as the existing creek banks (i.e. silty sand).

(3.2) Open Channel

To reshape the connecting open channel section between the two culvert segments, cuts and fills will be required. All slopes should be constructed with 2:1 slopes.

(a) The fill sections should be constructed according to current MTC Standards. Granular 'B' is recommended as fill material. The top 12" (on slope) should consist of Granular 'A' to act as a filter. This zone should extend to the observed high water level. To protect the slopes against erosion, rip-rap should be provided.

(b) An approximate 12" thick Granular 'A' filter blanket should be placed on the cut slopes. Rip-rap should be provided as a means of protection against erosion.

4. GENERAL COMMENTS

This memorandum supersedes the 'Discussion and Recommendations' part of Foundation Investigation Report W.O. 72-11085 issued on November 1, 1972.

The memorandum should be attached to the above quoted Foundation Report.

Should additional information be required, please contact our Office.


P. PAYER
Senior Engineer

for: K. G. SELBY
Supervising Engineer.

c.c. E. J. Orr
B. R. Davis
R. S. Pillar
C. R. Robertson
B. J. Giroux
D. Gunter
G. A. Wrong
P. Lewycky
M. M. Dillon Ltd., Mr. A. Kobelak

Files
Record Services

J. Anderson)
R. Fitzgibbon) memo only

APPENDIX I

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 101

JOB 72-11085

LOCATION Co-ords. 15,673,075 N; 798,503 E.

ORIGINATED BY PM

W.P. 70-68-00

BORING DATE July 17, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.			WATER CONTENT %					
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE		w_p w w_L	10 20 30				
662.3	Ground Level													GR.SA.SI.CL.	
0.0	Fine sand becoming gravelly sand. Compact to Dense		1	SS	22									0 94 (6)	
			2	SS	26										18 75 (7)
			3	SS	62										0 1 76 23
			4	SS	37										
648.9	Brown		5	SS	47	650									
13.4	Clayey silt with irregular seams of silt and silty clay.		6	SS	28										
			7	SS	25										
			8	SS	22										
			9	SS	20										
			10	SS	28	640								0 0 72 28	
			11	SS	22										
	Stiff to Very Stiff		12	SS	19										
			13	SS	11										
	Grey and Brown		14	TW	PM	630							123		
			15	SS	28										
		16	SS	21											
		17	SS	18											
		18	SS	16											
620.3			19	SS	16										
42.0	End of Borehole														

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 102

JOB 72-11085

LOCATION Co-ords. 15,672,732N; 798,827 E.

ORIGINATED BY PM

W.P. 70-68-00

BORING DATE July 19, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Washboring BX Casing

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			w_p w w_L WATER CONTENT % 10 20 30				
655.0	Ground Level													
0.0	Fine sand to gravelly sand.		1	SS	13	650								
			2	SS	23									
			3	SS	28									
644.0	Compact		4	SS	17	640								
			5	SS	12									
			6	SS	12									
11.0	Seams of silt and clayey silt.													
638.5	Stiff		7	SS	10									
16.5	End of Borehole													
	</													

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 103

JOB 72-11085

LOCATION Co-ords. 15,672,405 N; 799,169 E.

ORIGINATED BY PM

W.P. 70-68-00

BORING DATE July 20, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Washboring, BX Casing

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT W_L PLASTIC LIMIT W_p WATER CONTENT W				BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.				W_p — W — W_L WATER CONTENT % 10 20 30					
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
652.8	Ground Level															
0.0	Gravelly sand, some silt.		1	SS	2	650									18 67 (15)	
			2	SS	10											
	Very loose to Compact		3	SS	16											
644.3			4	SS	18											
8.5	Clayey silt to silt.															
638.3	Stiff		5	SS	9	640									0 1 76 23	
14.5	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 104

JOB , 72-11085

LOCATION Co-ords. 15,672,531 N; 799,660 E.

ORIGINATED BY PM

W.P. 70-68-00

BORING DATE July 20, 1972

COMPILED BY A.K.P.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY J.K.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w w_p ——— w ——— w_L			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.			WATER CONTENT % 10 20 30					
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
665.3	Ground Level														
0.0	Slightly organic silt		1	SS	11	660									
	Fill		2	SS	9										
	Stiff		3	SS	12										
654.9			4	SS	14										
10.4	Silty sand.		5	SS	24	650								0 68 27 5	
652.1			6	SS	29										
13.2	Clayey silt to silt.		7	SS	12										
	Stiff		8	SS	12										
			9	SS	16	640								0 6 73 21	
			10	SS	15										
			11	SS	12										
639.8	Grey		12	SS	9										
25.5	End of Borehole													0 0 86 11	

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 105

JOB 72-11085

LOCATION Co-ords. 15,672,658 N; 800,207 E.

ORIGINATED BY PM

W.P. 70-68-00

BORING DATE July 18, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				W_P	W	W_L		
658.5	Ground Level														
0.0	Fine sand and gravelly sand.		1	SS	8	650									
			2	SS	27										
650.5	Loose to Dense		3	SS	32										
8.0	Silt, traces of clay and sand.		4	SS	16	640									0 3 92 5
			5	SS	14										0 9 86 5
			6	SS	8										
			7	SS	14										
	Loose to Compact		8	SS	13	640									
639.0			9	SS	8										
19.5	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 106

JOB 72-11085

LOCATION Co-ords. 15,672,775 N; 800,580 E.

ORIGINATED BY PM

W.P. 70-68-00

BORING DATE July 21, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Washboring, BX Casing

CHECKED BY *AKB*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			WATER CONTENT % 10 20 30				
660.1	Ground Level													
0.0	Silty sand to gravelly sand.		1	SS	14	660								
			2	SS	12									
			3	SS	9									
	Loose to Dense.		4	SS	10									2 54 (14)
			5	SS	28									43 46 (11)
646.5	Brown		6	SS	41	650								
13.6	Silt, traces of clay.		7	SS	35									
644.1			8	SS	30									
16.0	Sandy silt, some		9	SS	21									20 25 51 4
640.1	gravel. Compact		10	SS	14	640								
20.0	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 107

JOB 72-11085

LOCATION Co-ords. 15,672,825 N; 801,001 E.

ORIGINATED BY PM

W.P. 70-68-00

BORING DATE July 18, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY *AKB*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
657.5	Ground Level					650								43 56 (1) 0 11 80 9
0.0	Gravelly sand, slightly organic.		1	SS	10									
			2	SS	22									
			3	SS	63									
	Compact to Dense		4	SS	29									
647.3			5	SS	9									
10.2	Silt, traces of sand and clay. Loose		6	SS	9									
642.0			7	SS	12									
15.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 108

JOB 72-11085

LOCATION Co-ords. 15,672,978 N; 798,523 E.

ORIGINATED BY ECB

W.P. 70-68-00

BORING DATE August 21, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w w_p ——— w ——— w_L WATER CONTENT % 10 20 30			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 1000 2000							
652.3	Water Level													
650.0	Canal Water					650								
2.3	Black Muck													
646.3			1	SS	2							60		
6.0	Irregular seams of reddish-brown and grey clayey silts and grey silts with traces of clay. Stiff to Very Stiff		2	SS	7									
			3	TW	PM		640	9					126	0 0 74 26
			4	SS	11									
			5	TW	PH			9					122	
			6	SS	16		630							
			7	TW	PM			9					121	
			8	SS	14									
			9	TW	PM		620						127	
			10	SS	15									0 2 73 25
			11	SS	13									
			12	SS	23		600							
596.8				13	SS	22								2 5 82 11
55.5	Glacial Till													
591.8	Clayey silt, traces of sand & gravel. V. Hard		14	SS	100	2"								
60.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 108A

JOB 72-11085

LOCATION Co-ords. 15,672,618 N; 798,940 E.

ORIGINATED BY ECB

W.P. 70-68-00

BORING DATE Aug. 22, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.			WATER CONTENT %				
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
652.2	Water Level						1000	2000		10	20	30		GR.SA.SI.CL.
650.4	Canal Water					650								
647.7	Black Muck		1	SS	11									
4.5	Irregular seams of clayey silt and silt with traces of clay.		2	TW	PM								121	
	Firm to Very Stiff		3	SS	6	640								0 0 62 38
			4	TW	PM				+ > 2000				125	
			5	TW	PM				+ > 2000				123	
	Grey & reddish-brown		6	SS	19	630								
623.2			7	TW	PM								123	
29.0	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 109

JOB 72-11085

LOCATION Co-ords. 15,672,418 N; 799,541 E.

ORIGINATED BY ECB

W.P. 70-68-00

BORING DATE August 23, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT					
652.1	Water Level									
650.6	Canal Water					650				
1.5	Black Muck									
645.7			1	SS	10					
6.4			2	SS	6					0 0 79 21
			3	TW	PM	640				125
			4	SS	6					1 0 58 41
			5	TW	PM					128
	Irregular seams of grey and brown clayey silt and grey silt with traces of clay.		6	SS	13	630				
			7	SS	17					
			8	SS	31	620				
			9	SS	26					
	Firm to Very Stiff		10	SS	17	610				
			11	TW	PM					
			12	SS	18	600				0 0 73 27
			13	SS	15					
			14	SS	13	590				
585.2	Glacial Till		15	SS	111					17 37 32 14
583.2	Silty sand with cl. & gr. s.									
68.9	End of Borehole									

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 109A

JOB 72-11085 LOCATION Co-ords. 15,672,525 N; 799,887 E.
W.P. 70-68-00 BORING DATE August 24, 1972
DATUM Geodetic BOREHOLE TYPE Washboring, NX Casing

ORIGINATED BY ECB
 COMPILED BY AKB
 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT w_L	PLASTIC LIMIT w_p	WATER CONTENT w	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.	w_p w w_L				
							<div><div>○ UNCONFINED</div><div>● QUICK TRIAXIAL</div></div>	<div><div>+ FIELD VANE</div><div>x LAB VANE</div></div>	WATER CONTENT % 10 20 30			
652.1	Water Level						1000	2000	10	20	30	GR. SA. SI. CL.
	Canal Water											
1.0	Black Muck					650						
645.6			1	SS	9						57	
6.5			2	TW	PM						127	
	Irregular seams of clayey silt and silt with some clay.		3	SS	14	640						
			4	TW	PM						119	
			5	SS	19							
			6	TW	PM						121	
		Stiff to Very Stiff		7	SS	22						
622.6												
29.5	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 110

JOB 72-11085

LOCATION Co-ords. 15,672,628 N; 800,240 E.

ORIGINATED BY PK

W.P. 70-68-00

BORING DATE Sept. 6-7, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

CHECKED BY *AKB*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.			WATER CONTENT %					
							UNCONFINED ○	FIELD VANE +	QUICK TRIAXIAL ●	LAB VANE ×	w_p	w			w_L
652.2	Water Level														
650.6	Canal Water														
1.6	Black Muck					650									
645.2			1	SS	10										
7.0			2	SS	11										
			3	TW	PM	640							126		
			4	TW	PM								124		
			5	TW	PM								125		
			6	SS	12	630									
	Irregular seams of brown and grey clayey silt and grey silt.		7	TW	PM								123		
			8	SS	13	620									
	Stiff to Very Stiff		9	TW	PM								126		
			10	SS	10	610									
			11	TW	PM								125		
			12	SS	13	600									
			13	TW	PM								131		
583.7						590									
68.5	Silty sand with traces of clay and gravel. (Glacial Till)		14	SS	46	580								5 56 31 8 0 96 (4)	
574.0	Dense to Very Dense													9 47 33 11	
78.2	End of Borehole Probable Bedrock														

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 111

JOB 72-11085

LOCATION Co-ords. 15,672,746 N; 800,576 E.

ORIGINATED BY PK

W.P. 70-68-00

BORING DATE Sept. 11-12, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Washboring NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w		BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %			
							\circ UNCONFINED \bullet QUICK TRIAXIAL	+ FIELD VANE x LAB VANE	w_p — w — w_L	10 20 30		
652.1	Water Level						1000 2000		10 20 30		GR. SA. SI. CL.	
649.9	Creek Water					650						
2.2	Black Muck		1	SS	13							
645.8			2	SS	4							
6.3			3	TW	PM							
			4	TW	PM							
	Irregular seams of brown & grey clayey silt & grey silt.		5	SS	9							
			6	TW	PM							
			7	SS	15							
	Stiff to Very Stiff		8	SS	13							
			9	TW	PM							
			10	SS	46							
592.0			11	SS	25							
60.1			12	SS	50							
	Silty sand with											
	boulder		13	RC	5%							
	traces of clay and gravel. (Glacial Till)		14	SS	59							
568.5	Very Dense											
83.6	Bedrock Dolomite		15	RC	93%							
563.6	Sound											
88.5	End of Borehole											

VOID RATIO - PRESSURE CURVES

JOB NO. 72 - 11085

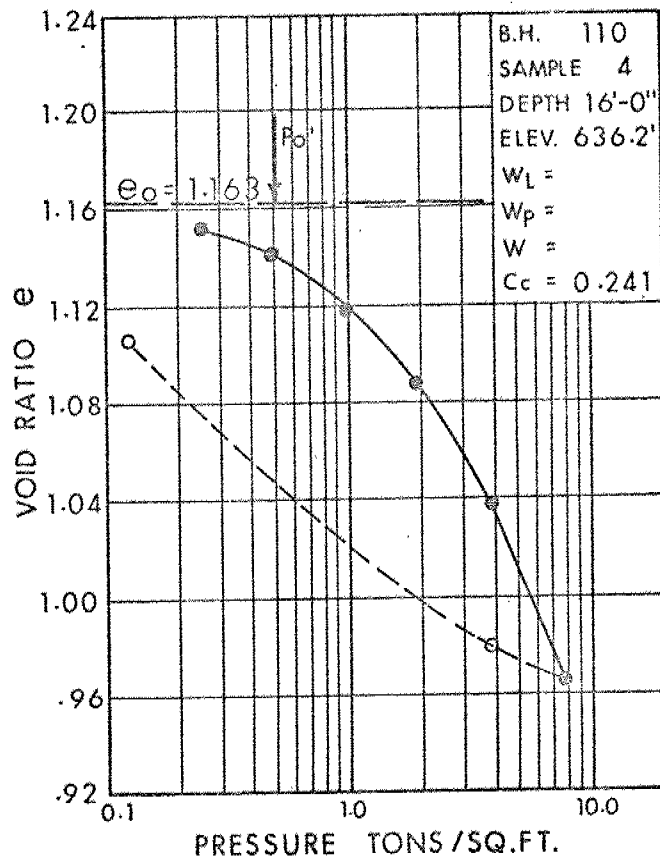


FIG. NO. 1

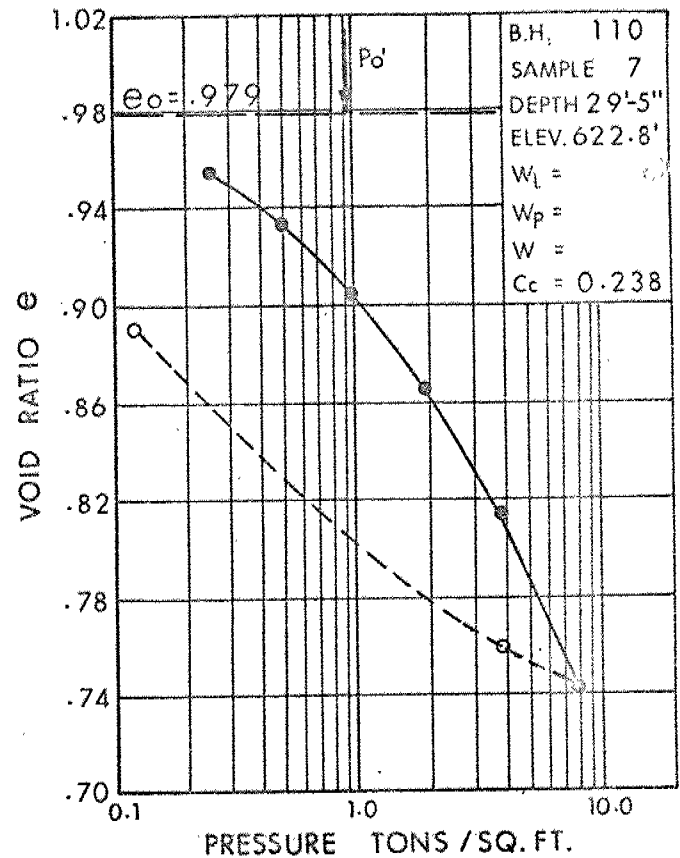
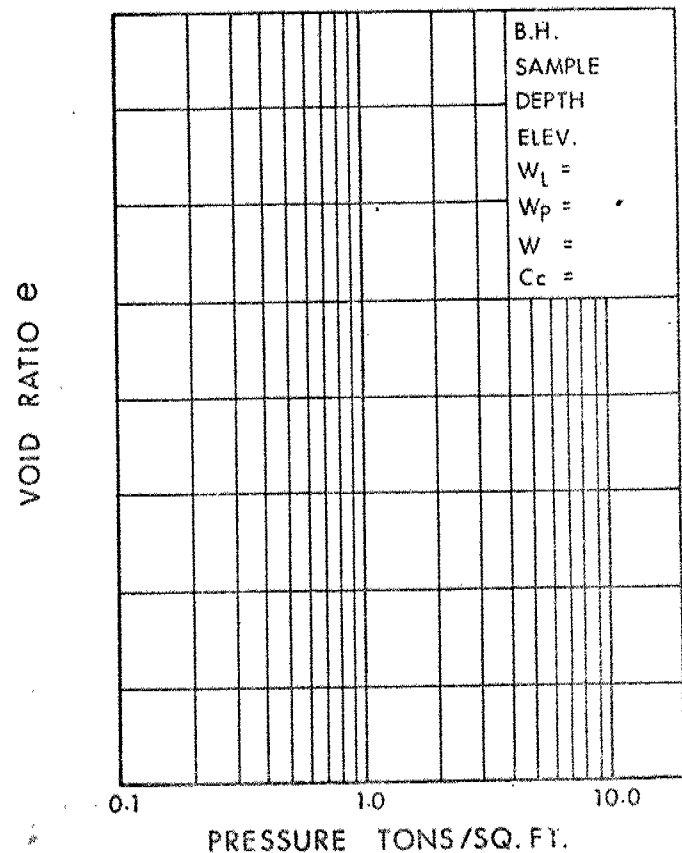
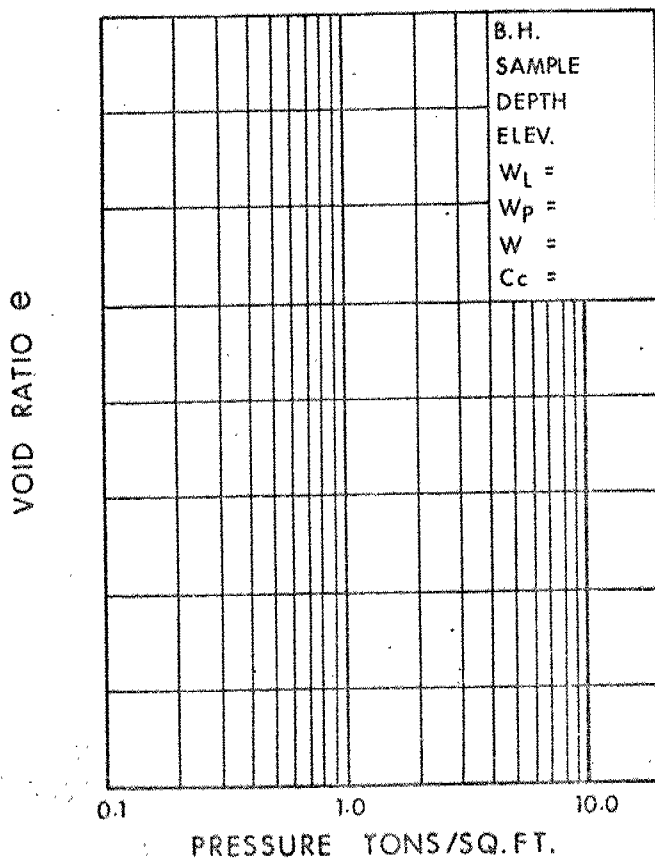
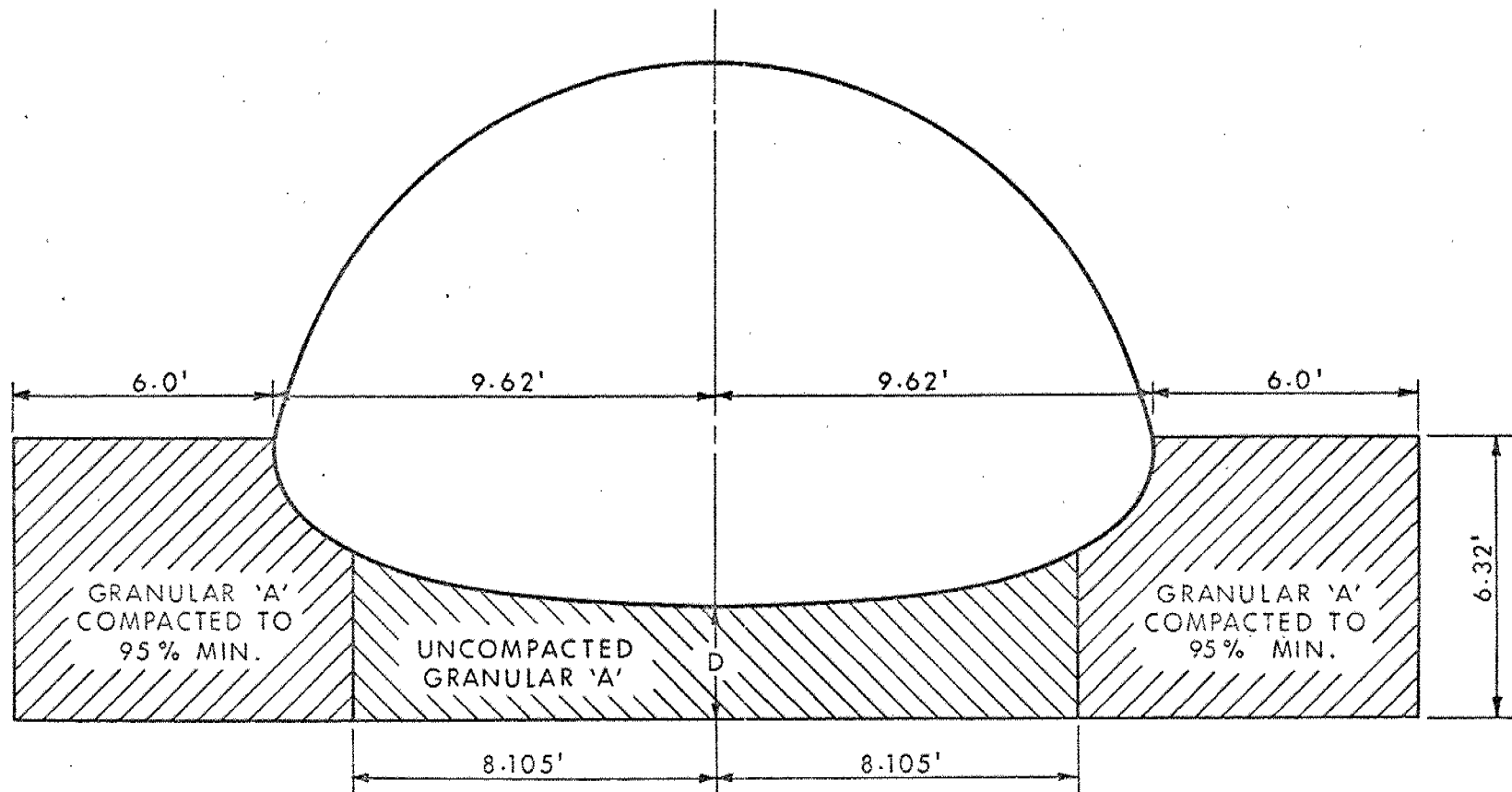


FIG. NO. 2



PROPOSED BEDDING



NOTE :

IF STRESSES ON THE HAUNCHES ARE BETWEEN 4 t.s.f. & 5 t.s.f. THEN D=2.5 FT.
IF STRESSES ON THE HAUNCHES ARE BETWEEN 5 t.s.f. & 6 t.s.f. THEN D=3.0 FT.

FIG. NO. 3

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_t	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

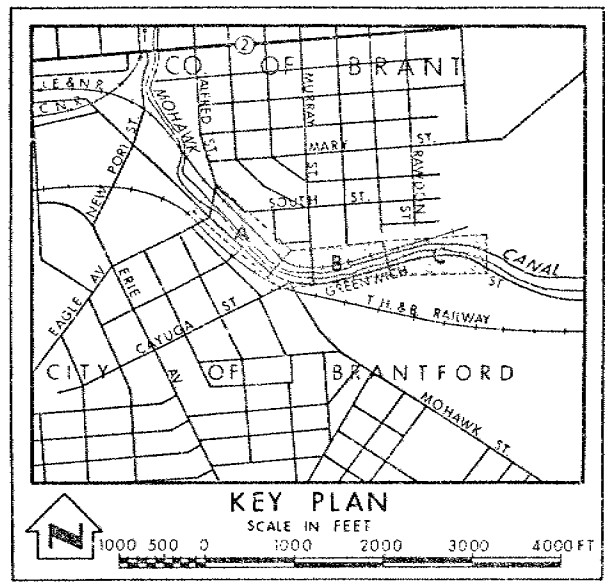
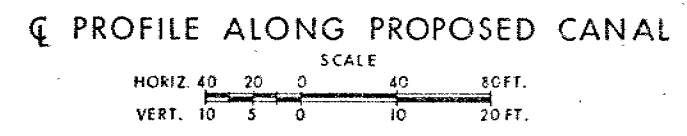
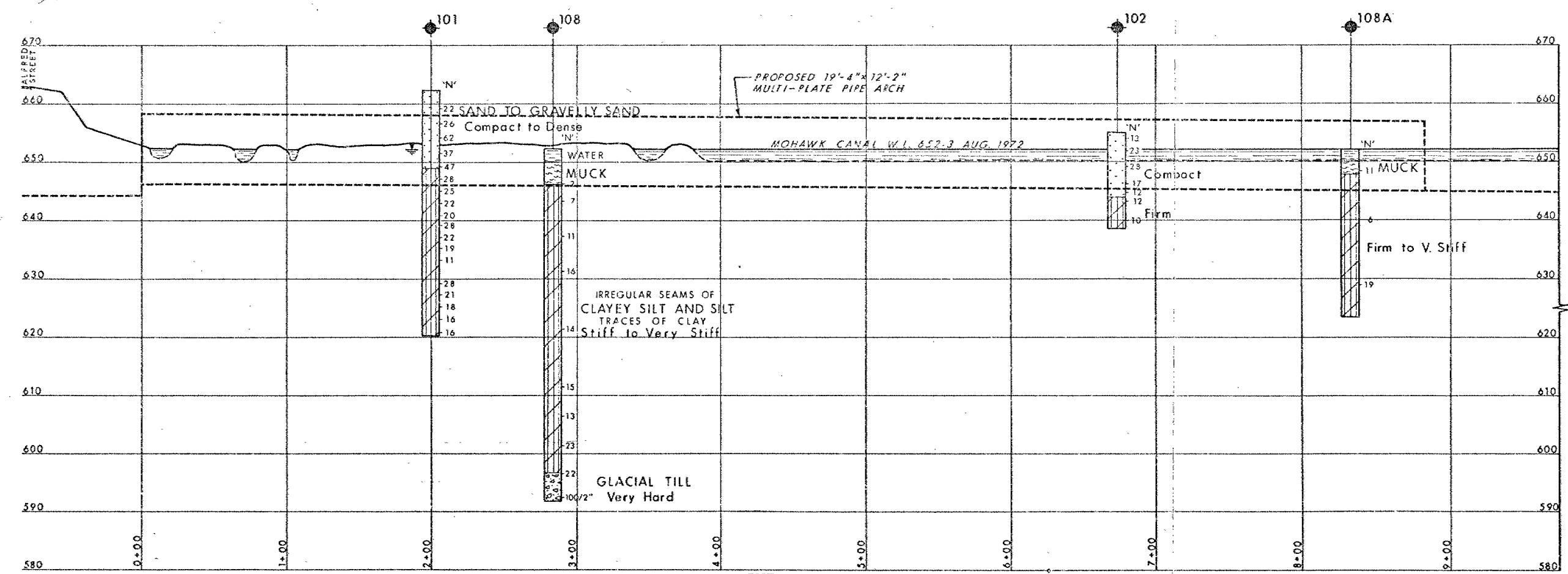
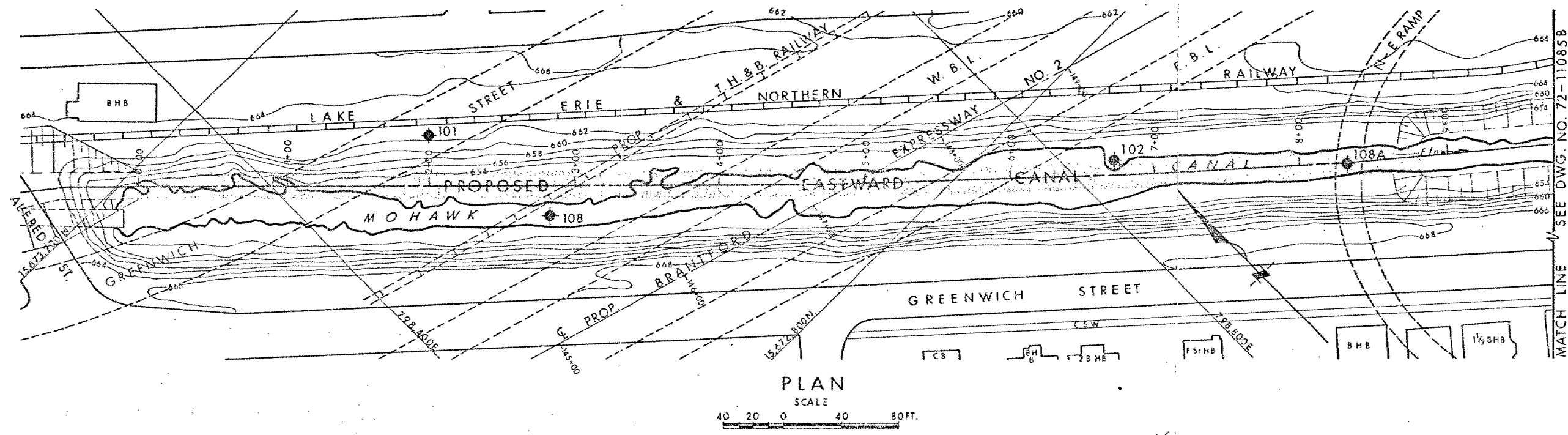
<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H.		SAMPLE ADVANCED HYDRAULICALLY
	P.M.		SAMPLE ADVANCED MANUALLY

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY



- LEGEND**
- Bore Hole
 - Cone Penetration Test
 - Bore Hole & Cone Test
 - Water Levels established at time of field investigation. JULY & AUG. 1972

NO.	ELEVATION	CO-ORD. NATES	
		NORTH	EAST
101	662.3	15,673,075	798,503
102	655.0	15,672,732	798,827
103	652.8	15,672,405	799,169
104	665.3	15,672,531	799,660
105	658.5	15,672,658	800,207
106	660.1	15,672,775	800,580
107	657.5	15,672,825	801,001
108	652.3	15,672,978	798,523
108A	652.2	15,672,613	798,940
109	652.1	15,672,418	799,541
109A	652.1	15,672,525	799,887
110	652.2	15,672,628	800,240
111	652.1	15,672,746	800,576

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
DESIGN SERVICES BRANCH—FOUNDATIONS OFFICE

EASTWARD CANAL

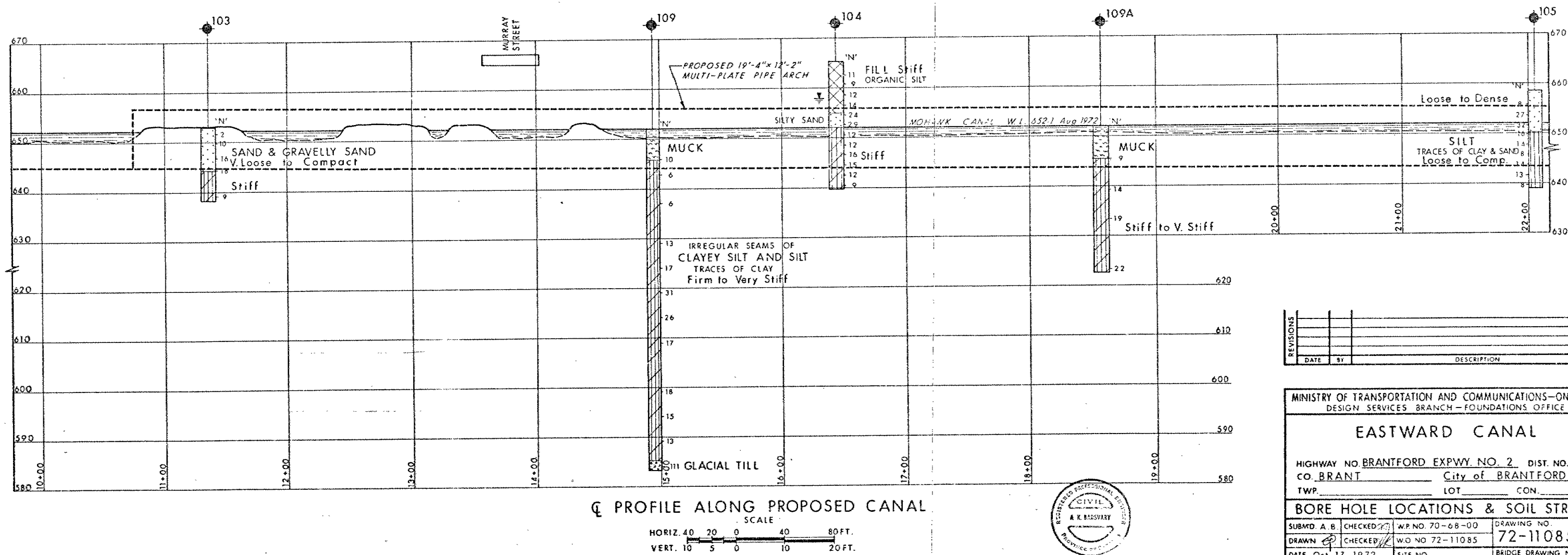
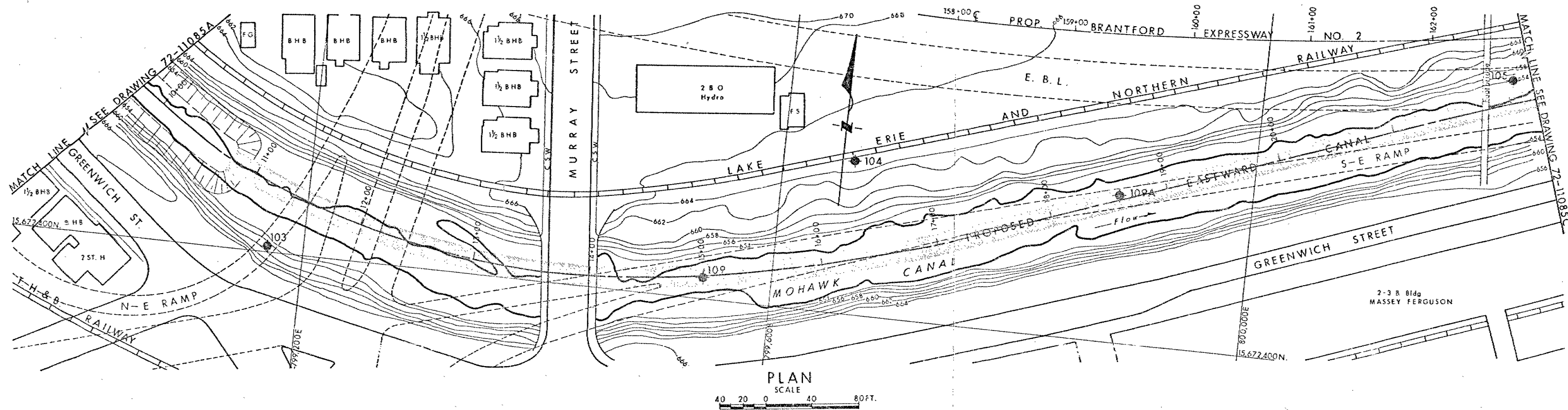
HIGHWAY NO. BRANTFORD EXPWY. NO. 2 DIST. NO. 4
CO. BRANT City of BRANTFORD
TWP. LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD. A. B.	CHECKED <input checked="" type="checkbox"/>	WP NO. 70-68-00	DRAWING NO.
DRAWN <input checked="" type="checkbox"/>	CHECKED <input checked="" type="checkbox"/>	WO. NO. 72-11085	72-11085A
DATE Oct. 16, 1972	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <i>[Signature]</i>	CONT. NO.		



REF. NO. - M.M. DILLON LTD. MC-3

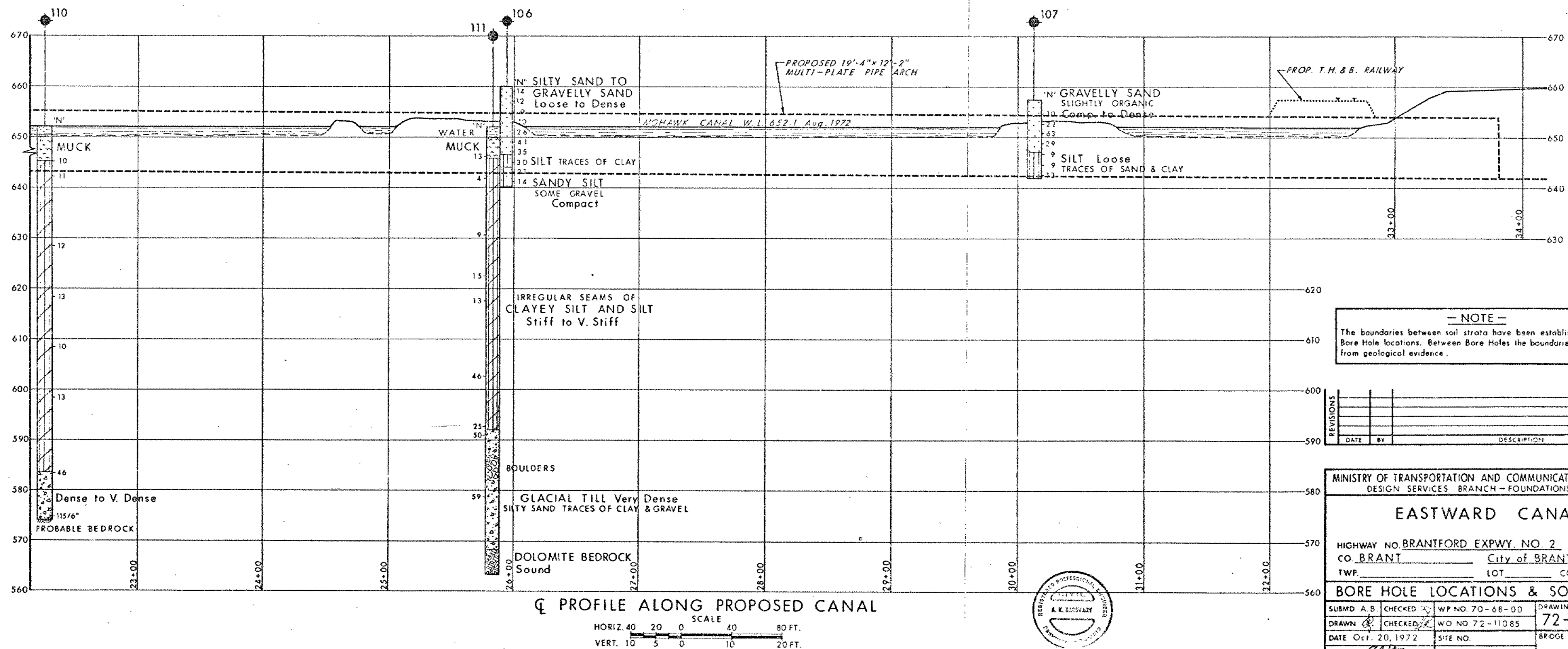
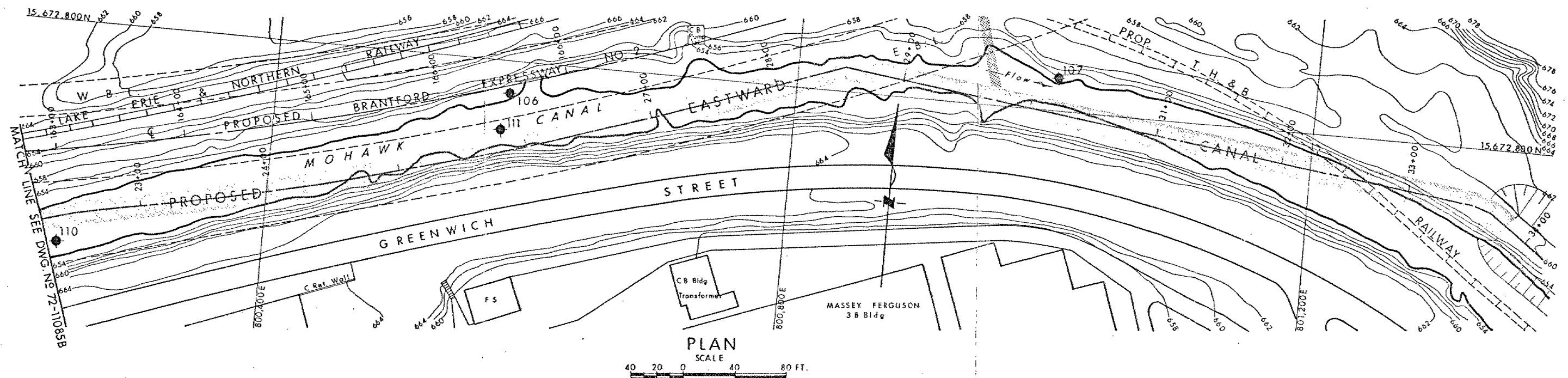


REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO DESIGN SERVICES BRANCH—FOUNDATIONS OFFICE			
EASTWARD CANAL			
HIGHWAY NO. BRANTFORD EXPWY. NO. 2 DIST. NO. 4 CO. BRANT City of BRANTFORD TWP. LOT CON.			
BORE HOLE LOCATIONS & SOIL STRATA			
SUBMD. A. B.	CHECKED	W.P. NO. 70-68-00	DRAWING NO.
DRAWN	CHECKED	W.O. NO. 72-11085	72-11085B
DATE Oct 17, 1972	SITE NO.	BRIDGE DRAWING NO.	
APPROVED	PRINCIPAL FOUNDATION ENGINEER	CONT. NO.	



REF. NO. - M. M. DILLON LTD. MC - 3



REF. NO. - M. M. DILLON LTD MC-3

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO DESIGN SERVICES BRANCH-FOUNDATIONS OFFICE			
EASTWARD CANAL			
HIGHWAY NO. BRANTFORD EXPWY. NO. 2 DIST. NO. 4 CO. BRANT City of BRANTFORD TWP. LOT CON			
BORE HOLE LOCATIONS & SOIL STRATA			
SUBMD. A.B.	CHECKED <input checked="" type="checkbox"/>	WP NO. 70-68-00	DRAWING NO.
DRAWN <input checked="" type="checkbox"/>	CHECKED <input checked="" type="checkbox"/>	WO NO 72-11085	72-11085C
DATE Oct. 20, 1972	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <i>[Signature]</i>	CONT. NO.		