



## Memorandum

To: G.C.E. Burkhardt (3)  
Reg. Structural Planning Engineer  
Central Region  
3501 Dufferin St., Downsview

From: Soil Mechanics Section  
Geotechnical Office  
West Building, Downsview

Attention:

Date: July 17, 1975

Our File Ref.

In Reply to

JUL 21 1975

Subject:

|             |
|-------------|
| 40P1-72     |
| GEOCRES No. |

### FOUNDATION INVESTIGATION REPORT

For

Proposed Retaining Walls 'A' and 'B'  
on Ramps W-NS and NS-E Between  
Market St. and Erie Ave.  
on the B.S.A.R.  
City of Brantford, Dist.#4, (Hamilton)  
W.P. 40-74-06; Site 1-R

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.

*K.G. Selby*

K.G. SELBY  
Supervising Engineer

c.c. E.J. Orr  
B.R. Davis  
B.J. Giroux  
G.A. Wrong  
R.S. Pillar  
D. Gunter  
C.R. Robertson  
R. Hore  
J. Anderson )  
R. Fitzgibbon) memo only  
G. Sloan  
Files  
Record Services

*also  
Note: Refer to previous  
report number  
W.P. 40-74-06  
(formerly W.P. 70-68-18)  
which is for walls in  
this area as well.*

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## 1. INTRODUCTION

The Soil Mechanics Section was requested by Mr. G.C.E. Burkhardt, Regional Structural Planning Engineer, Central Region, to carry out an investigation at the site of proposed retaining walls 'A' and 'B' in the vicinity of Erie Ave. and B.S.A.R. The request was submitted in a memorandum dated May 26, 1975.

Presented in this report are the results of the investigation, together with recommendations concerning foundations.

## 2. DESCRIPTION OF THE SITE

The site of proposed retaining wall 'A' is situated between the existing ramp W-N, S and the future ramp N-S, E., for an approximate length of 33 ft.

Wall 'B' will be located just east of the future ramp N, S-E. The length is approx. 90 ft.

The adjacent area with the exception of the already completed portion of B.S.A.R. is flat and mainly used as parking lot.

Physiographically, the site is located somewhere around the boundary of the regions known as the 'Norfolk Sand Plain' and the 'Horseshoe Moraines'. The site is a deltaic deposition of varved silts and clayey silts deposited by Lake Warren, during the recession of the Wisconsin Glacier.

### 3. FIELD AND LABORATORY INVESTIGATION

A total of three sampled boreholes and three dynamic cone penetration tests was carried out during the course of the field work along the toe of the existing ramp W-NS. Boring was achieved by means of a continuous flight hollow stem auger mounted on a musked vehicle. During the field work, disturbed samples were obtained by means of a split-spoon sampler; the energy used in driving it, conformed to the requirements of the Standard Penetration Test. 'Undisturbed' samples were recovered using 2-inch I.D. Shelby Tubes which were pushed into the soil hydraulically. Field vane tests were performed in cohesive soils where possible at elevations 12 inches below the various sample depths. Dynamic cone penetration tests were carried out adjacent to each borehole. Driving energy to advance the cone was 350 ft.-lbs. per blow.

The boreholes were surveyed in the field by personnel from the Central Region Engineering Surveys Office. The locations and elevations of the borings are shown on Drawing No. 407406-B which accompanies this report.

All samples were visually examined and classified at the site as well as in the laboratory. Following this inspection, laboratory tests were carried out on selected samples to determine the following physical properties:

- Natural Moisture Content
- Atterberg Limits
- Grain-Size Distribution
- Undrained Shear Strength
- Bulk Density

The test results are summarized on the Record of Borehole Sheets in the Appendix of this report.

### 4. SOIL TYPES AND SOIL CONDITIONS

#### 4.1 General

Generally uniform subsoil conditions were found to prevail over the site area. The subsoil consists of a surficial deposit of

fill material, followed sand and gravel with some silt and clay, followed by irregular layers of clayey silt and silt with occasional sand layers, followed by clayey silt to silt. Dolomite type bedrock was found to underlie the overburden. The estimated stratigraphical profile is shown on Drawing No. 407406-B.

A more detailed description of the subsoil with regard to soil types and soil properties follows:

#### 4.2 Fill Material

This material was intersected from ground level to a maximum depth of 5.5 ft. The material is basically sand but contains organic matters.

#### 4.3 Silty Sand, Traces of Clay

Under the fill material, silty sand with traces of clay deposit was encountered. The lower boundary was found to vary between elev. 651 and elev. 653. The material consists mainly of silts and sands with traces of clay. Standard Penetration Testing gave 'N' values ranging from 3 to 8 blows per foot. The relative density may be described as very loose to loose.

#### 4.4 Sand and Gravel, Traces of Silt and Clay

The silty sand stratum is underlain by an approx. 10 - 12 ft. thick sand and gravel with traces of silt and clay zone. Throughout the entire depth, the deposit contains some 7 - 11% (silt and clay) fines, 33 - 40% sand and 49 - 58% gravel.

The relative density of the overall stratum ranges from dense to very dense, corresponding to Standard Penetration Test 'N' values of 31 to 177 blows per foot.

#### 4.5 Irregular Layers of Clayey Silt and Silt

Under the granular deposits, a cohesive stratum, containing irregular layers of clayey silt and silt was intersected at all boring locations. The layers are generally horizontal with

thickness ranging anywhere from 1/8" to 3/4" or more. Occasional sand layers were also discovered. The thickness of the stratum is some 30 - 34 ft., extending to elev. 608 - 612. The average liquid and plastic limit of the clayey silt layers are 28% and 16%, while for the silt layers the corresponding figures are 21% and 15%. The average natural moisture of the overall deposit is about 20%. The bulk density ranges from 126 to 138 p.c.f. Limited number of in-situ vane test and laboratory unconfined compression test indicate a stiff to very stiff consistency, averaging about 1900 p.s.f.

#### 4.6 Clayey Silt to Silt

This deposit was encountered below the irregularly layered cohesive deposit and extends to the bedrock. (elev. 598 - 601) Standard Penetration Test 'N' values ranged from 64 to over 100 blows per foot. The consistency is estimated to be hard.

#### 4.7 Bedrock

Dolomite type bedrock of the Lockport Formation was proved in Boreholes #245 and 247. The bedrock surface varies between elev. 598 and elev. 601. Core recoveries were in excess of 95%. Examination of the recovered rock cores indicates that the bedrock is basically sound throughout.

### 5. GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

|           |             |
|-----------|-------------|
| B.H. #245 | Elev. 639.1 |
| B.H. #246 | Elev. 644.3 |
| B.H. #247 | Elev. 647.2 |

No artesian conditions were encountered.

## 6. DISCUSSION AND RECOMMENDATIONS

### 6.1 General

It is proposed to construct retaining walls 'A' and 'B' east and west of the future ramp N, S-E. The location of these walls are shown on Drawing No. 407406-B.

### 6.2 Retaining Wall 'A'

This wall is located between the existing ramp W-N, S and future ramp N, S-E. The finished grade of ramp W-N, S varies from elev. 661 at Sta. 7+45 to elev. 675 at Sta. 4+25. The finished grade of ramp N, S-E will be about 2 - 3 ft. below the grade of ramp W-N, S. The entire length of wall 'A' foundation will be located within the existing embankment.

The following construction procedures are recommended for the wall foundation:

- a) Excavate trench for the footing, approx. 3 ft. wider on each side than the actual footing width.
- b) The depth of the trench should extend at least 2 ft. below the frost protection requirements (which is 4 ft. in this area).
- c) Backfill trench with well compacted Granular 'A' material up to 4 ft. below the finished ground surface.
- d) Place footing on Granular 'A' material and construct wall.
- e) The backfill to the wall should be in accordance with Standard SD-4-58.

Some form of roadway protection will be required for the existing ramp during construction.

For footings placed on compacted Granular 'A' overlying existing fill material a safe design load of 2.0 t.s.f. may be assumed for design purposes.

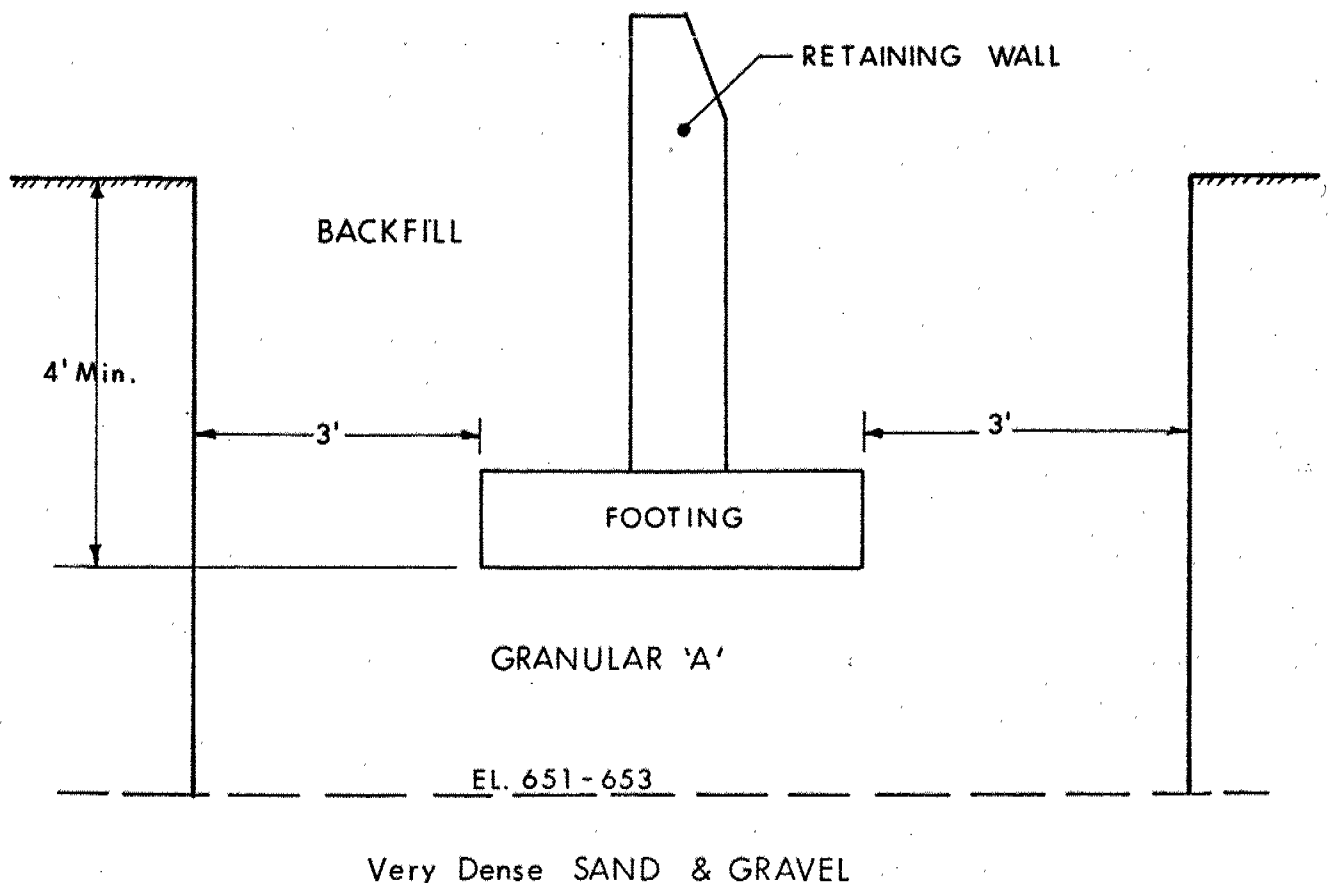
For computation of sliding resistance for the retaining wall founded on spread footings a friction coefficient of 0.55 may be assumed to apply between bases of footings and the underlying compacted granular fill.

### 6.3 Retaining Wall 'B' #2

An approx. 90 ft. long and 8 - 9 ft. high (above existing ground) retaining wall is proposed east of the future ramp N, S-E.

The subsoil at this location consists of up to 5.5 ft. thick fill material, followed by loose, silty sand at the south side of the proposed wall. A very dense, approx. 12 ft. thick sand and gravel zone was encountered between elev. 651 and elev. 653.

In view of the subsoil conditions, it is recommended that the fill material and the loose silty sand be replaced with Granular 'A' material as indicated below;





A safe design load of 2.5 t.s.f. may be assumed for design purposes.

A value of 0.55 (coefficient of friction) may be used in computation of the sliding resistance.

The backfilling of the retaining wall should comply with MTC Standard No. SD-4-58. No dewatering problems are anticipated.

#### 6.4 Embankment

The proposed embankment should consist of well compacted acceptable material. Outside the retaining wall area 2:1 slopes are recommended.

The new fill should be keyed into the existing embankment.

Any soft or organic surficial material should be removed according to current MTC Standards.

#### 7. MISCELLANEOUS

The field work was carried out during the period of June 2 - 6, 1975, under the supervision of Mr. G.R. Bardell, Project Engineer,

Equipment used was owned and operated by Atcost Soil Drilling Inc.

This report was written by Mr. P. Payer, Senior Engineer and reviewed by Mr. K.G. Selby, Supervising Engineer.

*P. Payer*  
P. PAYER  
Senior Engineer

*K. G. Selby*  
K.G. SELBY  
Supervising Engineer



July 1975

## APPENDIX

## RECORD OF BOREHOLE NO 245

W.P. 40-74-06 LOCATION Co-ords. 15,672,639 N; 796,920 E. ORIGINATED BY GB  
 DIST. 4 HWY. B.S.A.R. BORING DATE June 2, 1975 COMPILED BY GB  
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Hollow Stem Auger CHECKED BY *CP*

| SOIL PROFILE   |  |             | SAMPLES |      |            | GROUND WATER<br>ELEV. | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | LIQUID LIMIT — $w_L$<br>PLASTIC LIMIT — $w_p$<br>WATER CONTENT — $w$ |     |       | UNIT<br>WEIGHT<br>$\gamma$<br>P.C.F. | REMARKS<br>%<br>GR. SA. SI. CL. |
|----------------|--|-------------|---------|------|------------|-----------------------|---|----|----|----|-----|--|-----|-------|--------------------------------------|---------------------------------|
| ELEV.<br>DEPTH | DESCRIPTION  | STRAT. PLOT | NUMBER  | TYPE | 'N' VALUES |                       | 20  | 40 | 60 | 80 | 100 | $w_p$  | $w$ | $w_L$ |                                      |                                 |
| 658.8          | Ground Level   |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 0.0            | Fill material with organics.                                     |             | 1       | SS   | 5          |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 653.3          |  |             | 2       | SS   | 31         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 5.5            | Sand and gravel, trace of silt & clay.                           |             | 3       | SS   | 63         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
|                | Dense to Very Dense  |             | 4       | SS   | 128        |                       |   |    |    |    |     |  |     |       |                                      |                                 |
|                |  |             | 5       | SS   | 54         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 640.9          |  |             | 6       | SS   | 8          |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 17.9           | Irregular layers of clayey silt and silt, occasional sand layers |             | 7       | TW   | PH         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
|                |  |             | 8       | SS   | 13         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
|                |  |             | 9       | SS   | 23         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
|                | Stiff to Very Stiff  |             | 10      | SS   | 25         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
|                |  |             | 11      | SS   | 11         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
|                |  |             | 12      | TW   | PH         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 610.3          |  |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 48.5           | Clayey silt to silt  |             | 13      | SS   | 64         |                       |   |    |    |    |     |  |     |       |                                      |                                 |
|                | Hard   |             | 14      | SS   | 101        |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 601.0          |  |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 57.8           | Dolomite Bedrock   |             | 15      | RC   |            |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 596.0          | Sound  |             |         | BX   | 100%       |                       |   |    |    |    |     |  |     |       |                                      |                                 |
| 62.8           | End of Borehole  |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |                                 |

## ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 246

W.P. 40-74-06

LOCATION Co-ords. 15,672,551 N; 796,991 E.

ORIGINATED BY GB

DIST. 4 HWY. B.S.A.R.

BORING DATE June 6, 1975

COMPILED BY GB

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Hollow Stem Auger

CHECKED BY *GB*

| SOIL PROFILE   |  |             | SAMPLES |      |                       | GROUND WATER<br>ELEV. | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | LIQUID LIMIT $w_L$<br>PLASTIC LIMIT $w_p$<br>WATER CONTENT $w$ |     |       | UNIT<br>WEIGHT<br>$\gamma$<br>P.C.F. | REMARKS    |
|----------------|--|-------------|---------|------|-----------------------|-----------------------|---|----|----|----|-----|--|-----|-------|--------------------------------------|------------|
| ELEV.<br>DEPTH | DESCRIPTION  | STRAT. PLOT | NUMBER  | TYPE | N <sup>o</sup> VALUES |                       | 20  | 40 | 60 | 80 | 100 | $w_p$  | $w$ | $w_L$ |                                      |            |
| 659.5          | Ground Level   |             |         |      |                       |                       |   |    |    |    |     |  |     |       |                                      |            |
| 0.0            | Fill material with organics                                |             |         |      |                       |                       |   |    |    |    |     |  |     |       |                                      |            |
| 656.9          |  |             | 1       | SS   | 5                     |                       |   |    |    |    |     |  |     |       |                                      |            |
| 2.6            | Silty sand, traces of clay.                                |             | 2       | SS   | 8                     |                       |   |    |    |    |     |  |     |       |                                      |            |
| 651.0          | Loose  |             | 3       | SS   | 44                    |                       |   |    |    |    |     |  |     |       |                                      |            |
| 8.5            | Sand and gravel, traces of silt & clay                     |             | 4       | SS   | 177                   | 650                   |   |    |    |    |     |  |     |       |                                      | 0 84 (16)  |
|                | Very Dense   |             |         |      |                       |                       |   |    |    |    |     |  |     |       |                                      | 49 40 (11) |
| 641.6          |  |             | 5       | SS   | 8                     |                       |   |    |    |    |     |  |     |       |                                      |            |
| 17.9           | Irregular layers of clayey silt and silt occ. sand layers. |             | 6       | SS   | 17                    |                       |   |    |    |    |     |  |     |       |                                      |            |
|                | Stiff to Very Stiff  |             | 7       | TW   | PH                    |                       |   |    |    |    |     |  |     |       |                                      |            |
|                |  |             | 8       | SS   | 42                    | 620                   |   |    |    |    |     |  |     |       |                                      |            |
| 612.0          |  |             |         |      |                       |                       |   |    |    |    |     |  |     |       |                                      |            |
| 47.5           | Clayey silt to silt.                                       |             | 9       | SS   | 166                   | 610                   |   |    |    |    |     |  |     |       |                                      |            |
|                | Hard   |             |         |      |                       |                       |   |    |    |    |     |  |     |       |                                      |            |
| 599.7          |  |             |         |      |                       | 600                   |   |    |    |    |     |  |     |       |                                      |            |
| 59.8           | Probable Bedrock<br>End of Borehole                        |             |         |      |                       |                       |   |    |    |    |     |  |     |       |                                      |            |

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 247

W.P. 40-74-06 LOCATION Co-ords. 15,672,432 N; 797,029 E. ORIGINATED BY GB  
 DIST. 4 HWY. B.S.A.R. BORING DATE June 4, 1975 COMPILED BY GB  
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Hollow Stem Auger CHECKED BY CP

| SOIL PROFILE   |  |             | SAMPLES |      |            | GROUND WATER<br>ELEV. | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | LIQUID LIMIT — $w_L$<br>PLASTIC LIMIT — $w_p$<br>WATER CONTENT — $w$ |     |       | UNIT<br>WEIGHT<br>$\gamma$<br>P.C.F. | REMARKS    |
|----------------|--|-------------|---------|------|------------|-----------------------|---|----|----|----|-----|--|-----|-------|--------------------------------------|------------|
| ELEV.<br>DEPTH | DESCRIPTION                            | STRAT. PLOT | NUMBER  | TYPE | 'N' VALUES |                       | 20  | 40 | 60 | 80 | 100 | $w_p$  | $w$ | $w_L$ |                                      |            |
| 659.4          | Ground Level                           |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |            |
| 0.0            | Fill material with organics            |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |            |
| 656.4          |  |             | 1       | SS   | 7          |                       |   |    |    |    |     |  |     |       |                                      | 1 44 (55)  |
| 3.0            | Silty sand                             |             | 2       | SS   | 3          |                       |   |    |    |    |     |  |     |       |                                      |            |
| 652.4          | Very Loose                             |             | 3       | SS   | 64         |                       |   |    |    |    |     |  |     |       |                                      | 57 33 (10) |
| 7.0            | Sand and gravel, trace of silt & clay. |             | 4       | SS   | 128        |                       |   |    |    |    |     |  |     |       |                                      |            |
|                | Very Dense                             |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |            |
| 641.4          |  |             | 5       | SS   | 13         |                       |   |    |    |    |     |  |     |       |                                      |            |
| 18.0           | Irregular layers of clayey silt & silt |             | 6       | TW   | PH         |                       |   |    |    |    |     |  |     |       |                                      |            |
|                | occ. layers of sand.                   |             | 7       | SS   | 16         |                       |   |    |    |    |     |  |     |       |                                      |            |
|                | Stiff to Very Stiff                    |             | 8       | TW   | PH         |                       |   |    |    |    |     |  |     |       |                                      |            |
| 607.6          |  |             | 9       | SS   | 218        |                       |   |    |    |    |     |  |     |       |                                      |            |
| 51.8           | Clayey silt to silt                    |             | 10      | RC   | 98%        |                       |   |    |    |    |     |  |     |       |                                      |            |
|                | Hard                                   |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |            |
| 598.6          |  |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |            |
| 60.8           | Dolomite Bedrock                       |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |            |
| 594.6          | Sound                                  |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |            |
| 64.8           | End of Borehole                        |             |         |      |            |                       |   |    |    |    |     |  |     |       |                                      |            |

OFFICE REPORT OF SOIL EXPLORATION

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTPENETRATION RESISTANCE

'N' STANDARD PENETRATION RESISTANCE : - 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>c LB./SQ. FT.</u> | <u>DENSENESS</u> | <u>'N' BLOWS / FT.</u> |
|--------------------|----------------------|------------------|------------------------|
| VERY SOFT          | 0 - 250              | VERY LOOSE       | 0 - 4                  |
| SOFT               | 250 - 500            | LOOSE            | 4 - 10                 |
| FIRM               | 500 - 1000           | COMPACT          | 10 - 30                |
| STIFF              | 1000 - 2000          | DENSE            | 30 - 50                |
| VERY STIFF         | 2000 - 4000          | VERY DENSE       | > 50                   |
| HARD               | > 4000               |                  |                        |

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

|      |                     |      |                   |
|------|---------------------|------|-------------------|
| S.S. | SPLIT SPOON         | T.W. | THINWALL OPEN     |
| W.S. | WASHED SAMPLE       | T.P. | THINWALL PISTON   |
| S.T. | SLOTTED TUBE SAMPLE | O.S. | OESTERBERG SAMPLE |
| A.S. | AUGER SAMPLE        | F.S. | FOIL SAMPLE       |
| C.S. | CHUNK SAMPLE        | R.C. | ROCK CORE         |

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

|     |   |      |                 |
|-----|---|------|-----------------|
| U   | UNCONFINED COMPRESSION                    | L.V. | LABORATORY VANE |
| UU  | UNCONSOLIDATED UNDRAINED TRIAXIAL         | F.V. | FIELD VANE      |
| CIU | CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL | C    | CONSOLIDATION   |
| CID | " " DRAINED "                             | S    | SENSITIVITY     |
| CAU | " " ANISOTROPIC UNDRAINED "               |      |                 |
| CAD | " " DRAINED "                             |      |                 |

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTSOIL PROPERTIES

|            |  |
|------------|--|
| $\gamma$   | UNIT WEIGHT OF SOIL (BULK DENSITY)                                   |
| $\gamma_s$ | UNIT WEIGHT OF SOLID PARTICLES                                       |
| $\gamma_w$ | UNIT WEIGHT OF WATER   |
| $\gamma_d$ | UNIT DRY WEIGHT OF SOIL (DRY DENSITY)                                |
| $\gamma'$  | 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   |
| $w_s$      | 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  |
| $\tau_f$   | SHEAR STRENGTH   |
| $c'$       | EFFECTIVE COHESION INTERCEPT   |
| $\phi'$    | EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION                  |
| $c_u$      | APPARENT COHESION  |
| $\phi_u$   | APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION                   |
| $\mu$      | COEFFICIENT OF FRICTION  |
| $S_t$      | SENSITIVITY  |

GENERAL

|                                     |                                   |
|-------------------------------------|-----------------------------------|
| $\pi$                               | = 3.1416                          |
| e                                   | BASE OF NATURAL LOGARITHMS 2.7183 |
| $\log_e \sigma$ OR $\ln \sigma$     | NATURAL LOGARITHM OF $\sigma$     |
| $\log_{10} \sigma$ OR $\log \sigma$ | LOGARITHM OF $\sigma$ 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  |
| $\sigma$   | NORMAL STRESS  |
| $\sigma'$  | NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED) |
| $\tau$     | SHEAR STRESS   |
| $\epsilon$ | LINEAR STRAIN  |
| $\gamma$   | SHEAR STRAIN   |
| $\nu$      | POISSON'S RATIO ( $\mu$ IS ALSO USED)                  |
| E          | MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)        |
| G          | MODULUS OF SHEAR DEFORMATION                           |
| K          | MODULUS OF COMPRESSIBILITY                             |
| $\eta$     | COEFFICIENT OF VISCOSITY                               |

EARTH PRESSURE

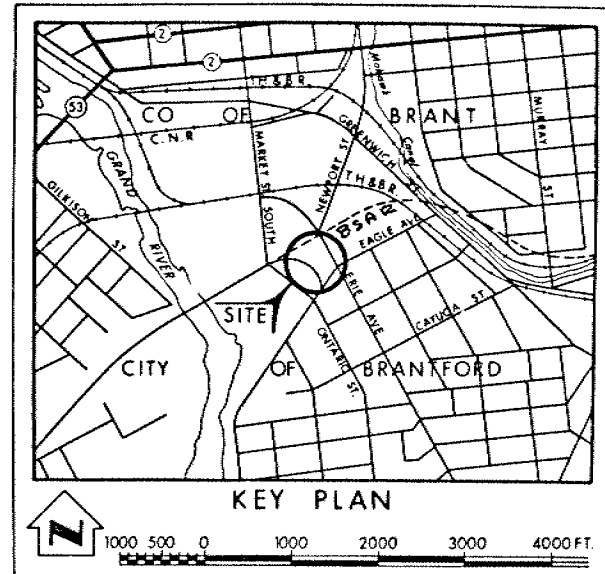
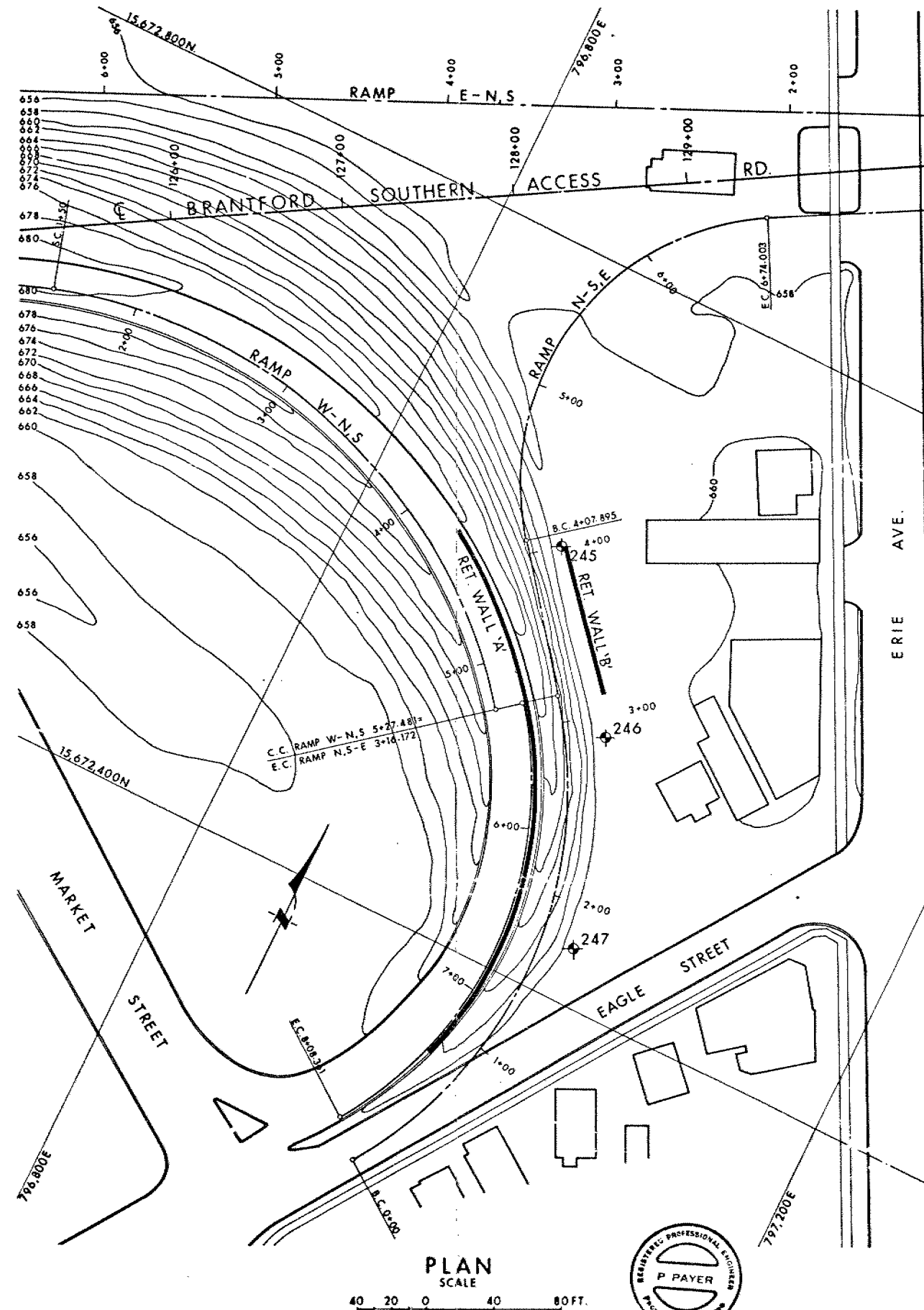
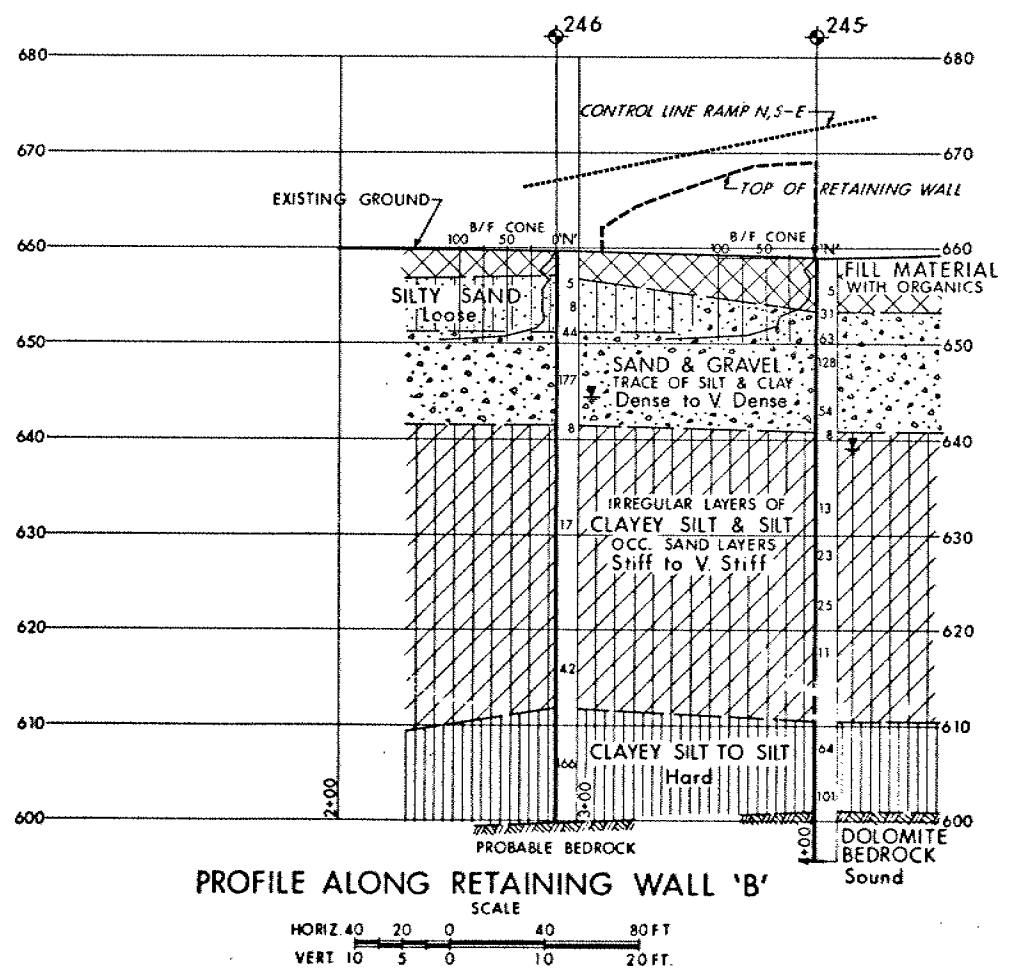
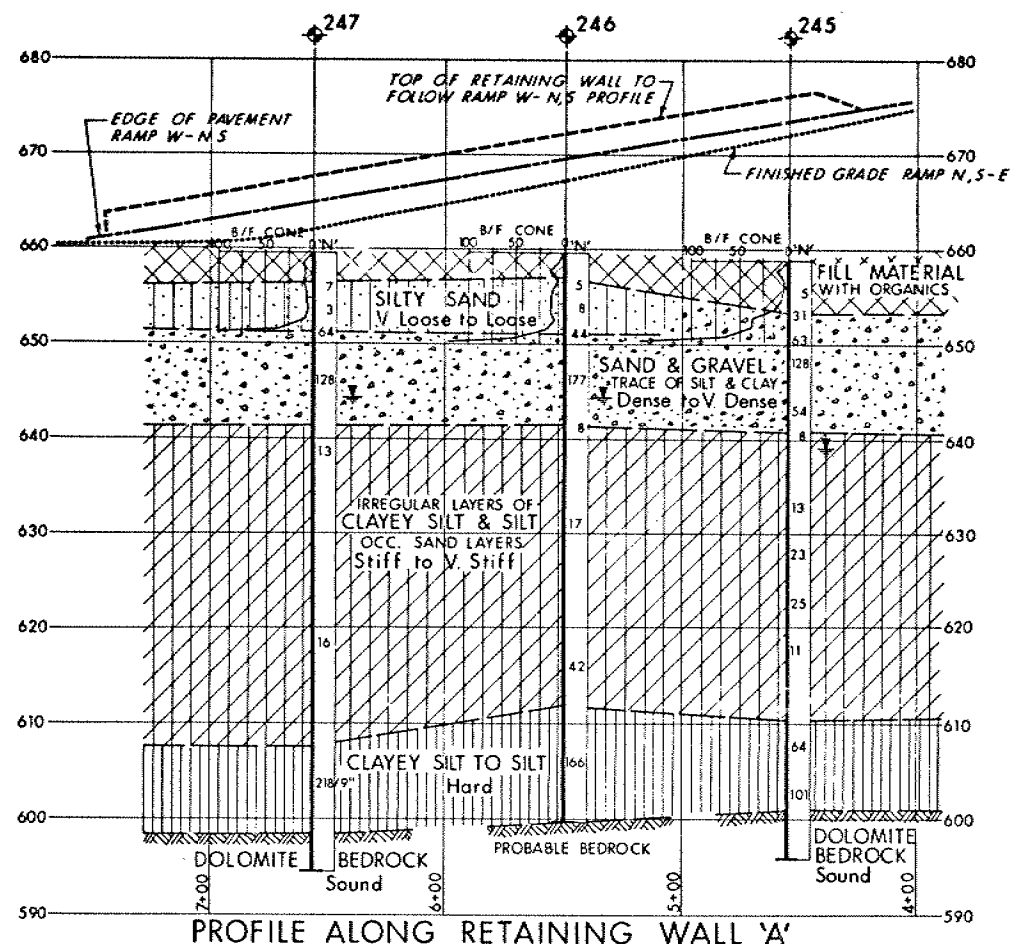
|          |   |
|----------|---|
| d        | DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE   |
| $\delta$ | ANGLE OF WALL FRICTION  |
| K        | DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS |
| $K_0$    | COEFFICIENT 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 |
| $\beta$ | ANGLE OF SLOPE TO HORIZONTAL             |



### LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Resistance Test  
B/F CONE - Blows/Ft. Cone Test (350 ft. lbs. energy/blow)
- ⊕ Bore Hole & Cone Test
- ⊕ Water Levels established at time of field investigation, June 1975

| NO. | ELEVATION | CO-ORDINATES<br>NORTH | EAST    |
|-----|-----------|-----------------------|---------|
| 245 | 658.8     | 15,672,639            | 796,920 |
| 246 | 659.5     | 15,672,551            | 796,991 |
| 247 | 659.4     | 15,672,432            | 797,029 |

NOTE: FOR CONTRACT DOCUMENT  
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the HAMILTON District Office.

### 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  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

### PROPOSED RETAINING WALLS 'A' & 'B'

HIGHWAY NO. Brantford Southern Access Road DIST NO. 4  
CO. BRANT City of BRANTFORD  
TWP. LOT. CON.

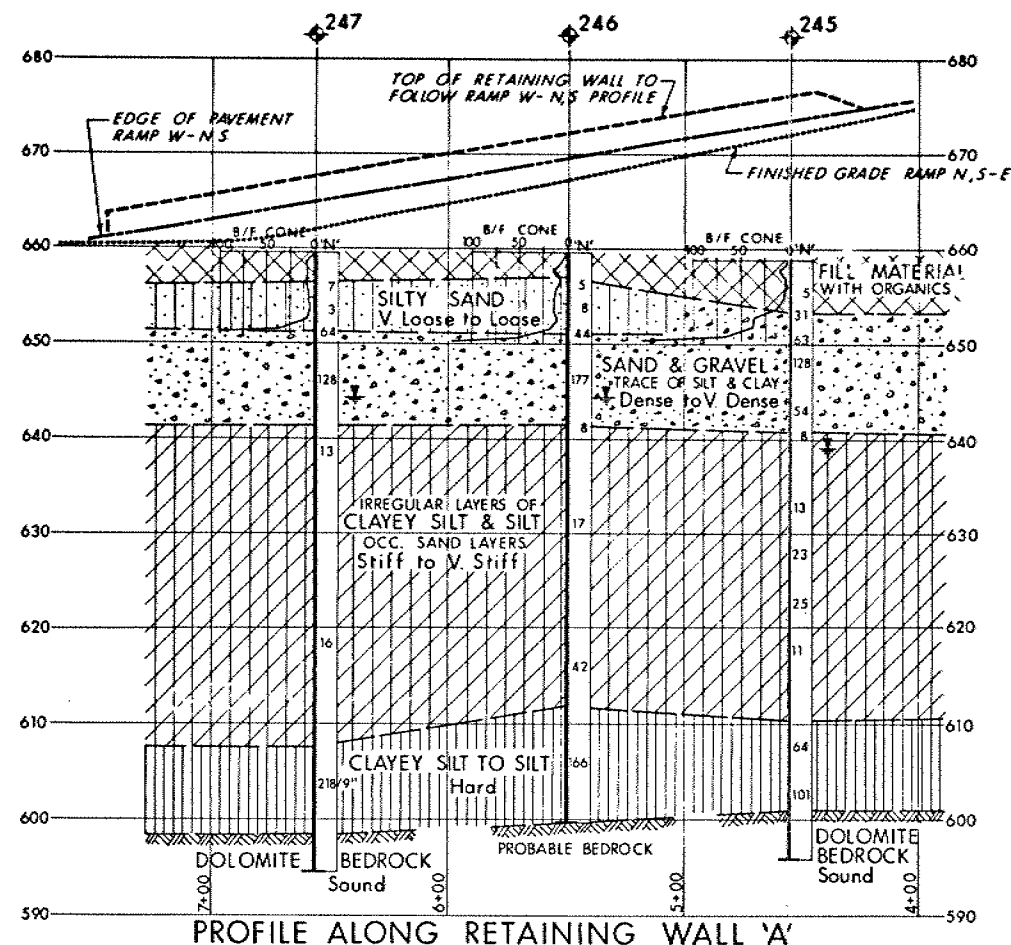
### BORE HOLE LOCATIONS & SOIL STRATA

|                    |                 |                    |             |
|--------------------|-----------------|--------------------|-------------|
| SUBMIT P.P.        | CHECKED         | WP NO. 40-74-06    | DRAWING NO. |
| DRAWN              | CHECKED         | W.O. NO.           | 407406-B    |
| DATE July 16, 1975 | SITE NO. 1-R.W. | BRIDGE DRAWING NO. |             |
| APPROVED           | CONT NO.        |                    |             |

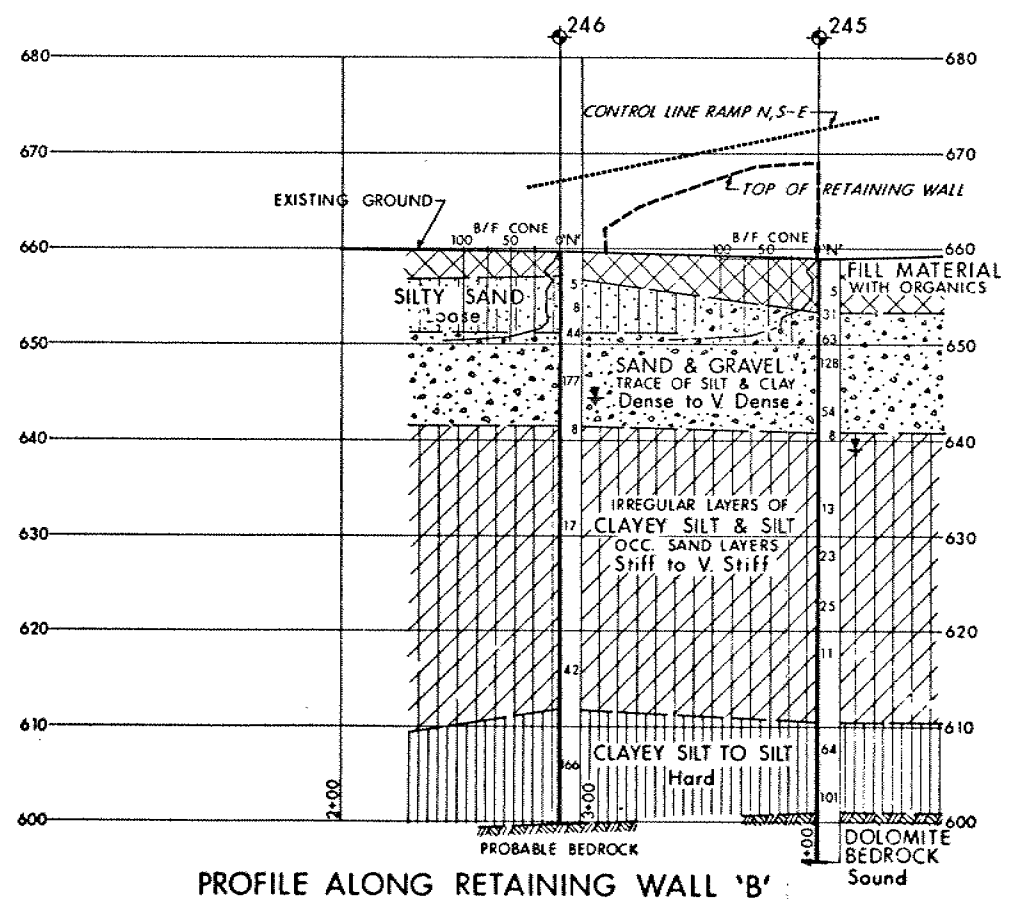
REF. NO. DILLON CONS. ENG.'S  
7301-16-1 BSAR GEOM 75-2, May 6, 1975





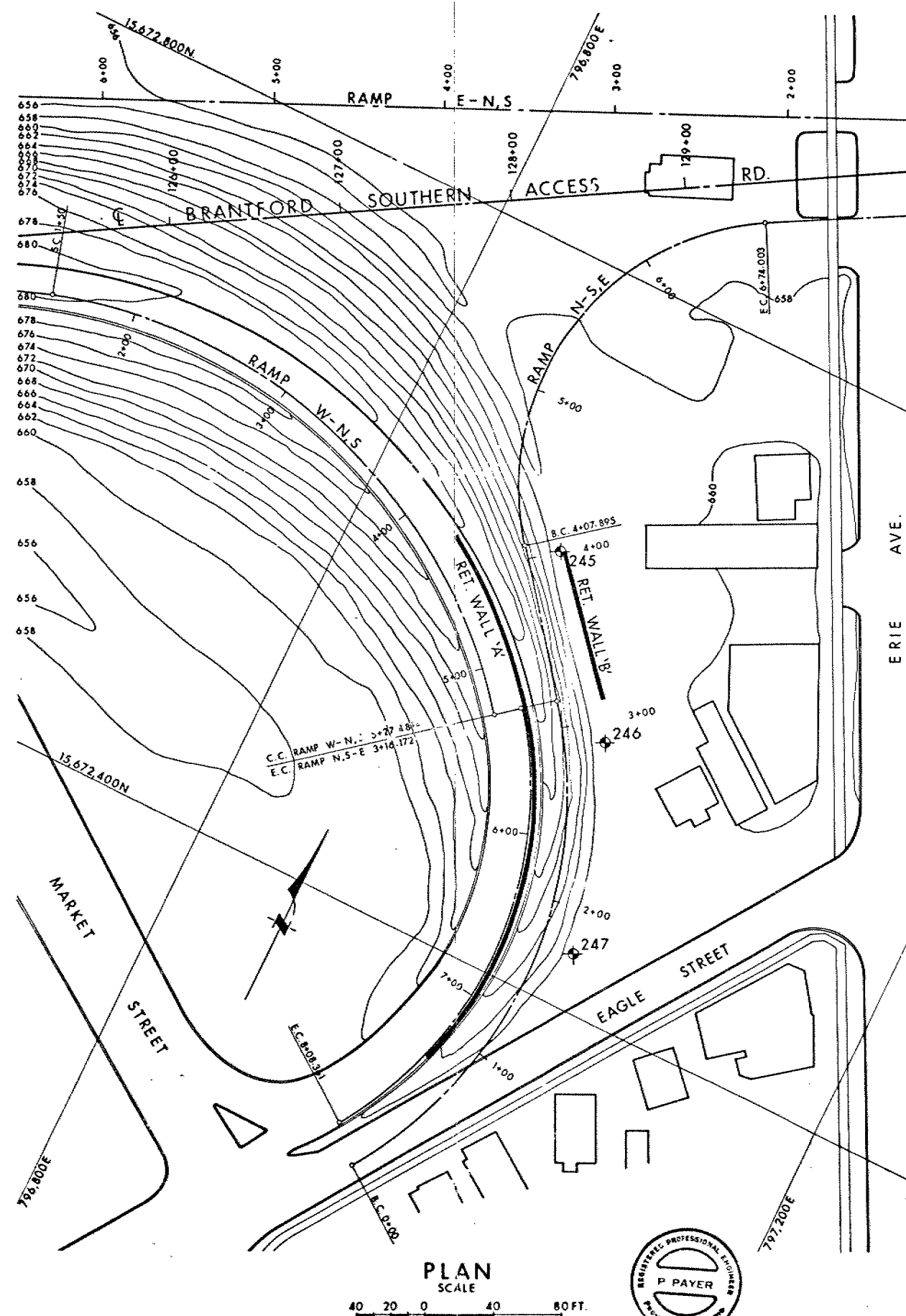


PROFILE ALONG RETAINING WALL 'A'



PROFILE ALONG RETAINING WALL 'B'

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

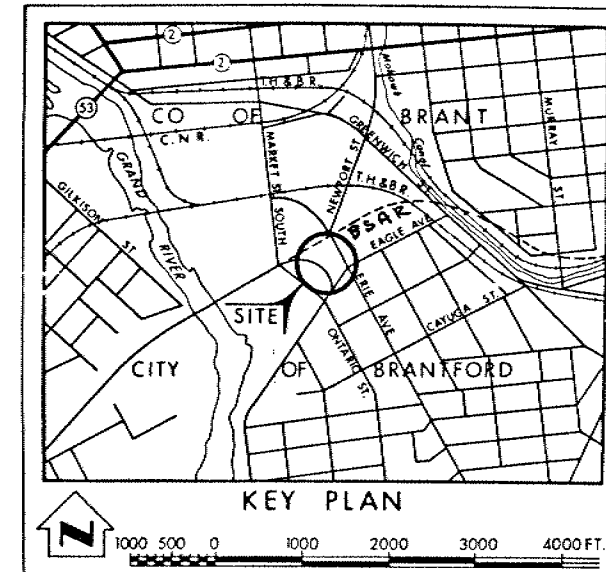


PLAN

SCALE 40 20 0 40 80 FT.



REF. NO. DILLON CONS. ENG'S  
7301-16-1 BSAR GEOM. 75-2, May 6, 1975



LEGEND

- Bore Hole
- Dynamic Cone Penetration Resistance Test  
B/F CONE - Blows/Ft. Cone Test (350 ft. lbs. energy/blow)
- Bore Hole & Cone Test
- Water Levels established at time of field investigation, June 1975

| NO. | ELEVATION | CO-ORDINATES<br>NORTH | EAST    |
|-----|-----------|-----------------------|---------|
| 245 | 658.8     | 15,672,639            | 796,920 |
| 246 | 659.5     | 15,672,551            | 796,991 |
| 247 | 659.4     | 15,672,432            | 797,029 |

NOTE: FOR CONTRACT DOCUMENT  
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the HAMILTON District Office.

NOTE

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

| REVISION | DATE | BY | DESCRIPTION |
|----------|------|----|-------------|
|          |      |    |             |

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

### PROPOSED RETAINING WALLS 'A' & 'B'

HIGHWAY NO. Brantford Southern Access Road DIST. NO. 4  
CO. BRANT City of BRANTFORD  
TWP. LOT CON.

### BORE HOLE LOCATIONS & SOIL STRATA

|                    |                |                    |             |
|--------------------|----------------|--------------------|-------------|
| SUBMIT P.P.        | CHECKED        | W.P. NO. 40-74-06  | DRAWING NO. |
| DRAWN              | CHECKED        | A.C. NO.           | 407406-B    |
| DATE July 16, 1975 | SITE NO. 1-R-W | BRIDGE DRAWING NO. |             |
| APPROVED           | CONF. NO.      |                    |             |

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: Mr. A. P. Watt, (2)  
Regional Structural Planning Eng.,  
Southwestern Region,  
London, Ontario.

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

ATTENTION: DATE: August 16, 1972.

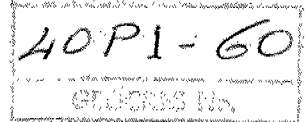
OUR FILE REF.

IN REPLY TO

AUG 18 1972

SUBJECT:

FOUNDATION INVESTIGATION REPORT  
For  
Proposed Retaining Walls #4 and #5  
At the Erie St. Overpass of Brantford  
Expressway #2, District #4, Hamilton  
W.O. 72-11081 --- ~~W.P. 70-68-18~~



NEW WP: 40-74-06 (PP)  
MAR 10/75

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.

AGS/ao  
Attch.

*A. G. Stermac*  
A. G. Stermac,  
PRINCIPAL FOUNDATIONS ENGINEER.

cc: Messrs. D. W. Farren  
B. R. Davis  
A. Rutka  
A. McConnell  
C. R. Robertson  
B. J. Giroux  
G. A. Wrong  
B. A. Singh  
J. R. Roy  
Foundations Files ✓  
Documents

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FOUNDATION INVESTIGATION REPORT  
For  
Proposed Retaining Walls #4 and #5  
At the Erie St. Overpass of Brantford  
Expressway #2, District #4, Hamilton  
W.O. 72-11081      --      W.P. 70-68-18

---

1. INTRODUCTION:

The Foundations Office was requested by Mr. A. P. Watt, Regional Structural Planning Engineer, Southwestern Region, to carry out an investigation at the site of proposed retaining Walls #4 and 5, north of the proposed Erie St. overpass of Brantford Expressway #2. The request was submitted in a memo dated June 28, 1972.

The subsequent field and laboratory investigations were implemented under the supervision of this Office. The boreholes were located in the field and surveyed by personnel of the Engineering Survey Office, Southwestern Region.

Presented in this report are the results of the investigations, together with recommendations concerning foundations.

2. DESCRIPTION OF THE SITE:

The site of proposed retaining Wall #4 is situated near the north property line of a drive-in restaurant (Kentucky Fried Chicken). The area is asphalt paved, and at the present time, it is used as a parking lot. Wall #5 will be located just north of the Brewers Retail Store, where the site is occupied by a sunken alley, used for loading and unloading. The ground level of the alley is about 8 ft. lower than the pavement of Erie St.

Geologically the area lies somewhere around the boundary of the physiographic regions known as the "Norfolk Sand Plain" and the "Horseshoe Moraines." The beds of silt and sand are considered to be deltaic in glacial lakes Whittlesey and Warren. The varved silts and clayey silts were also deposited by Lake Warren, during a recession of the Wisconsin glacier.

### 3. FIELD AND LABORATORY INVESTIGATIONS:

Some six boreholes and six dynamic cone penetration tests were implemented during the field work. Boreholes #1, 2 and 3 were placed at the location of proposed Wall #4 and Holes #4, 5 and 6 at Wall #5. A continuous hollow stem flight auger was used for the drilling, taking samples at regular intervals. Granular deposits were tested by means of split spoon samplers, which were advanced by a 140 lbs. hammer falling 30 inches. The number of hammer blows necessary to advance the split spoons 1 ft. into the soils, were marked as Standard Penetration N values. In the cohesive deposits thin walled Shelby tube samples were taken. The sampler was pushed into the undisturbed soil by means of the hydraulic head of the auger. Undrained shear strengths of the cohesive materials were measured by field vane tests, according to conventional methods. All the samples were subjected to visual examinations and classifications. Laboratory tests were performed on representative samples in order to determine natural moisture contents, Atterberg limits and grain size distributions. Further tests of unconfined compressions were carried out on "undisturbed" samples and the undrained shear strengths calculated.

Field and laboratory test results are compiled on the accompanying office borelogs. The locations and elevations of the boreholes as well as the estimated soil stratigraphy are shown on Drawing #72-11081 A in the Appendix.

#### 4. SOIL CONDITIONS:

##### 4.1) General:

The surficial deposit was found to be cinder and sand fill along both retaining walls, containing some organic matters, wood, etc. Underlying the fill a granular layer of sand and sandy gravel was noted, which in turn was followed by irregular seams and layers of clayey silt and silt. Bedrock was proven in two locations.

A brief description of the various deposits is given below.

##### 4.2) Cinder and Sand Mixture (Fill):

Under the asphalt pavement along proposed Wall #4 the fill was found to be some 10 - 11 ft. deep, extending to elevation 646 ft. - 647 ft. Under Wall #5 the bottom of the fill was around elevation 641.8 ft. - 642.7 ft. The engineering quality of the fill is varied, portions of it containing a fair amount of acceptable sands; portions, however, being almost entirely cinder and other organic substances. Standard penetration tests, carried out within this material confirmed the non-uniform nature of the fill. 'N' values were measured to be between 3 blows/ft. and 47 blows/ft. indicating relative densities of very loose to dense. Occasionally the fill contains seams of fine grained material, mainly silts. A typical grain size analysis of the silts resulted in 0% gravel, 21% sand, 74% silt and 5% clay particles.

##### 4.3) Sandy Gravel to Sand with Traces of Silt:

The fill is underlain by sands and sandy gravels with traces of silt. This granular deposit was found to be some 8 - 15 ft. thick under proposed Wall #4 and only 5 ft. thick under Wall #5. The relative density of the sands and gravels is considered to be dense to very dense. Since this layer lies partially under the ground water level, some loosening and boiling of the soils were noted on account of the unbalanced hydrostatic head. Throughout the entire depth, the stratum contains

some 5 - 11% fines, mainly belonging to the silt range. The rest of the particles were identified to be sands and gravels.

4.4) Irregular Seams of Clayey Silt and Silt:

Under the granular soils, cohesive deposits, identified to be irregular seams of clayey silts and silts were recorded in every borehole. The thickness of the stratum is some 27 - 36 ft. extending to geodetic elevation 600 - 605 ft. This cohesive deposit has stiff to very stiff consistency, corresponding to penetration 'N' values of 9 blows/ft. up to 25 blows/ft. Laboratory unconfined compression tests resulted in undrained shear strengths averaging 1500 p.s.f. The stratification of the stratum is near horizontal with irregular brown and grey colour seams of 1/8" - 1" thickness. The average plastic limit of the silt and clayey silt seams is estimated to be 20%, the liquid limits of the silt seams being 22% - 23% and the clayey silts approximately 30%. The natural moisture contents of the samples are near, or in some occasions above the liquid limits. The bulk density of the deposit is 123 - 125 p.c.f.

4.5) Bedrock:

Bedrock was proven by diamond drilling in B.H.'s #2 and 6. The surface of the rock was established at elevation 604.6 ft. in the location of B.H. #2 and at elevation 600.5 ft. in B.H. #6. The rock surface is believed to have a very slight dip towards east. Some 4 - 5 ft. thickness of the rock was drilled, resulting in good recoveries of 95 - 100%. The cores were identified to be dolomites of the Lockport formations.

4.6) Groundwater Conditions:

Groundwater levels were registered in the boreholes to lie within the granular aquifer, between elevation 642 ft. and 646 ft. There is a hydrostatic gradient towards east. No water level observations were carried out in B.H.'s #1 and 3, since these holes caved in upon withdrawal of the auger.

## 5. DISCUSSION AND RECOMMENDATIONS:

### 5.1) General:

Proposed Brantford Expressway #2 will cross Erie St. with an overpass structure. The north slopes of the approach embankments are designed to be laterally supported by two bin type retaining walls of various heights. Wall #4 at the west approach will be some 195 ft. long; Wall #5, retaining the east approach fill being some 295 ft.

Under the cinder and sand fill, some sand and gravel deposit, followed by seams of silt and clayey silt form the overburden. Dolomite bedrock was encountered around elevation 600 ft. - 604 ft.

### 5.2) Foundations:

Since the mixed surficial fill has very dubious engineering values, it should be replaced by well compacted GBC-A material, under the proposed crib walls.

For estimating purposes it may be assumed that the excavation should extend down to approximate elevation 646 ft. - 647 ft. under proposed Wall #4 and to elevation 642 ft. - 643 ft. under Wall #5. It is believed that excavations extending below the above elevations will encounter groundwater, which in turn will induce quick conditions at the excavation basis. Deeper excavations than the suggested ones, therefore, should not be carried out. The bottom of the excavations should be some 6 ft. wider than the width of the wall. Side slopes should be formed with 1 horizontal to 1 vertical. The GBC-A should be compacted to 100% Proctor density. The excavations should be refilled up to some 2 ft. below original ground surface, and then re-excavated for the walls. The bottom of the cribs should be placed directly on the GBC-A fill, some 4 ft. below finished ground level.

The recommended step by step construction of the wall foundations is shown on Figure #1 at the end of this report.

If above procedure is adhered to, then no stability problems or excess settlements are envisaged.



6. MISCELLANEOUS:

The field work was carried out during July 7 - 16, 1972, under the supervision of Mr. P. Martin, Engineering Student.

The equipment used was owned and operated by P.V.K. Drilling Company, Burford, Ontario.

This report was written by Mr. A. K. Barsvary, Senior Foundations Engineer.

*A. K. Barsvary*

AKB/ao

A. K. Barsvary, P. Eng.

August 14, 1972.



APPENDIX I

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 1

JOB 72-11081

LOCATION Co-ord's 15,672,847 N. 796,748 E.

ORIGINATED BY P.M.

W.P. 70-68-18

BORING DATE July 7, 1972

COMPILED BY P.M.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger.

CHECKED BY

| SOIL PROFILE |   |             | SAMPLES |      |            | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE  |  |  |  |  | LIQUID LIMIT — $w_L$<br>PLASTIC LIMIT — $w_p$<br>WATER CONTENT — $w$              |  |     | BULK DENSITY<br>$\gamma$<br>P.C.F.                                      | REMARKS |  |  |  |
|--------------|---|-------------|---------|------|------------|-------------|---------------------------------|--|--|--|--|---|--|-----|---|---------|--|--|--|
| ELEV. DEPTH  | DESCRIPTION                                 | STRAT. PLOT | NUMBER  | TYPE | BLOWS/FOOT |             | BLOWS / FOOT<br>20 40 60 80 100 |  |  |  |  | SHEAR STRENGTH P.S.F.<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × LAB VANE |  |     |   |         | WATER CONTENT %<br>$w_p$ — $w$ — $w_L$ |  |  |
|              |   |             |         |      |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
|              |   |             |         |      |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
| 656.8        | Ground level.                               |             |         |      |            |             |                                 |  |  |  |  |   |  |     | GR.SA.SI.CL.  |         |  |  |  |
| 0.0          | Black cinder, sand and silt mixture. Fill.  |             | 1       | SS   | 8          |             |                                 |  |  |  |  |   |  |     | W.L. hole caved in July 10/72<br><br>0 21 74 5<br>0 95 (5)<br>53 38 (9) |         |  |  |  |
|              | Loose.                                      |             | 2       | SS   | 5          |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
| 646.8        |   |             | 3       | SS   | 9          |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
| 10.0         | Poorly graded sandy gravel, traces of silt. | 4           | SS      | 12   |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
|              | Loose to dense.                             | 5           | SS      | 51   |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
|              |   | 6           | SS      | 22   |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
|              |   | 7           | SS      | 7    |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
| 631.3        |   | 8           | SS      | 24   |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
| 25.5         | Irregular seams of clayey silt & silt.      | 9           | SS      | 20   |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
|              | Stiff to very stiff.                        | 10          | SS      | 20   |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
|              | Grey and brown.                             | 11          | SS      | 16   |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
|              |   | 12          | TW      | PM   |            |             |                                 |  |  |  |  |   |  | 128 |   |         |  |  |  |
|              |   | 13          | TW      | PH   |            |             |                                 |  |  |  |  |   |  | 127 |   |         |  |  |  |
|              |   | 14          | SS      | 18   |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
| 604.3        | End of borehole.                            |             |         |      |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |
| 52.5         | Probable bedrock.                           |             |         |      |            |             |                                 |  |  |  |  |   |  |     |   |         |  |  |  |

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 2

JOB 72-11081

LOCATION Co-ord's 15,672,893 N. 796,838 E.

ORIGINATED BY P.M.

W.P. 70-68-18

BORING DATE July 10, 1972

COMPILED BY P.M.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger &amp; AXT Rock Core.

CHECKED BY

| SOIL PROFILE |  |             | SAMPLES |        |            | ELEV. SCALE  | DYNAMIC PENETRATION RESISTANCE<br>BLOWS / FOOT |  | LIQUID LIMIT $W_L$<br>PLASTIC LIMIT $W_p$<br>WATER CONTENT $W$ |  | BULK DENSITY<br>$\gamma$<br>P.C.F. | REMARKS   |                 |  |
|--------------|--|-------------|---------|--------|------------|--|--|--|--|--|------------------------------------|-----------|-----------------|--|
| ELEV. DEPTH  | DESCRIPTION  | STRAT. PLOT | NUMBER  | TYPE   | BLOWS/FOOT |  | SHEAR STRENGTH P.S.F.                          |  |  |  |                                    |           | WATER CONTENT % |  |
|              |  |             |         |        |            |  | 20 40 60 80 100                                |  |  |  |                                    |           |                 |  |
|              |  |             |         |        |            | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE |  |  |  |  | $W_p$ — $W$ — $W_L$                |           |                 |  |
|              |  |             |         |        |            | 1000 2000  |  |  |  |  | 10 20 30                           |           |                 |  |
| 657.6        | Ground level.  |             |         |        |            |  |  |  |  |  |                                    |           |                 |  |
| 0.0          | Black cinder, sand & silt fill.<br>Compact to dense.                           |             | 1       | SS     | 13         |  |  |  |  |  |                                    |           |                 |  |
|              |  |             | 2       | SS     | 47         |  |  |  |  |  |                                    |           |                 |  |
|              |  |             | 3       | SS     | 16         |  |  |  |  |  |                                    |           |                 |  |
| 646.4        |  |             | 4       | SS     | 10         |  |  |  |  |  |                                    |           |                 |  |
| 11.2         | Sand to sandy gravel<br>Traces of silt.<br>Compact to very dense               |             | 5       | SS     | 15         |  |  |  |  |  |                                    | 3 88 (9)  |                 |  |
|              |  |             | 6       | SS     | 20         |  |  |  |  |  |                                    | 57 37 (6) |                 |  |
|              |  |             | 7       | SS     | 62         |  |  |  |  |  |                                    |           |                 |  |
| 635.6        |  |             | 8       | SS     | 9          |  |  |  |  |  |                                    |           |                 |  |
| 22.0         | Irregular seams of<br>clayey silt & silt.<br><br>Stiff.<br><br>Grey and brown. |             | 9       | TW     | PM         |  |  |  |  |  |                                    | 123       |                 |  |
|              |  |             | 10      | SS     | 13         |  |  |  |  |  |                                    | 1 4 66 29 |                 |  |
|              |  |             | 11      | TW     | PM         |  |  |  |  |  |                                    | 125       |                 |  |
|              |  |             | 12      | SS     | 12         |  |  |  |  |  |                                    |           |                 |  |
|              |  |             | 13      | TW     | PM         |  |  |  |  |  |                                    | 124.5     |                 |  |
| 604.6        |  |             |         |        |            |  |  |  |  |  |                                    |           |                 |  |
| 53.0         | Dolomite bedrock.  |             | 14      | AXT RC | Rec. 95%   |  |  |  |  |  |                                    |           |                 |  |
| 599.0        |  |             |         |        |            |  |  |  |  |  |                                    |           |                 |  |
| 58.6         | End of borehole.   |             |         |        |            |  |  |  |  |  |                                    |           |                 |  |

FOUNDATIONS OFFICE

JOB 72-11081

LOCATION Co-ord's 15,672,933 N. 796,918 E.

ORIGINATED BY P.M.

W.P. 70-68-18

BORING DATE July 11, 1972

COMPILED BY P.M.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger.

CHECKED BY                     

15  $\phi$  5 % STRAIN AT FAILURE

## RECORD OF BOREHOLE № 4

JOB 72-11081

LOCATION Co-ord's 15,672,973 N. 797,030 E.

ORIGINATED BY P.M.

W.P. 70-68-18

BORING DATE                      July 12, 1972

COMPILED BY P.M.

DATUM Geodetic

BOREHOLE TYPE   Hollow Stem Auger

CHECKED BY ES

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE No 5

JOB 72-11081

LOCATION Co-ord's 15,673,016 N. 797,159 E.

ORIGINATED BY PM.

W.P. 70-68-18

BORING DATE July 14, 1972

COMPILED BY P.M.DATUM GeodeticBOREHOLE TYPE Hollow Stem Auger.CHECKED BY [Signature]

| SOIL PROFILE   |  |             | SAMPLES |      |            | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE<br>BLOWS / FOOT |    |    |    |     | LIQUID LIMIT <u>W<sub>L</sub></u><br>PLASTIC LIMIT <u>W<sub>p</sub></u><br>WATER CONTENT <u>W</u> |   |                | BULK DENSITY<br><u>γ</u><br>P.C.F. | REMARKS |
|----------------|--|-------------|---------|------|------------|-------------|--|----|----|----|-----|---|---|----------------|------------------------------------|---------|
| ELEV.<br>DEPTH | DESCRIPTION  | STRAT. PLOT | NUMBER  | TYPE | BLOWS/FOOT |             | 20   | 40 | 60 | 80 | 100 | W <sub>p</sub>  | W | W <sub>L</sub> |                                    |         |
| 650.0          | Ground level.  |             |         |      |            |             |  |    |    |    |     |   |   |                |                                    |         |
| 0.0            | Black cinder & sand<br>mixture. Fill.<br>Loose to very loose.                        |             | 1       | SS   | 8          |             |  |    |    |    |     |   |   |                |                                    |         |
| 642.5          |  |             | 2       | SS   | 3          |             |  |    |    |    |     |   |   |                |                                    |         |
| 7.5            | Sandy gravel traces<br>of silt. Very dense.<br>to compact.                           |             | 3       | SS   | 54         |             |  |    |    |    |     |   |   |                |                                    |         |
| 636.5          |  |             | 4       | SS   | 41         |             |  |    |    |    |     |   |   |                |                                    |         |
| 13.5           |  |             | 5       | SS   | 15         |             |  |    |    |    |     |   |   |                |                                    |         |
|                | Clayey silt, seams<br>and small pockets of<br>sand.<br>Very stiff.<br>Greyish brown. |             | 6       | SS   | 15         |             |  |    |    |    |     |   |   |                |                                    |         |
|                |  |             | 7       | TW   | PM         |             |  |    |    |    |     |   |   |                |                                    |         |
|                |  |             | 8       | SS   | 19         |             |  |    |    |    |     |   |   |                |                                    |         |
|                |  |             | 9       | TW   | PH         |             |  |    |    |    |     |   |   |                |                                    |         |
|                |  |             | 10      | SS   | 16         |             |  |    |    |    |     |   |   |                |                                    |         |
|                |  |             | 11      | TW   | PM         |             |  |    |    |    |     |   |   |                |                                    |         |
|                |  |             | 12      | SS   | 16         |             |  |    |    |    |     |   |   |                |                                    |         |
| 603.0          |  |             |         |      |            |             |  |    |    |    |     |   |   |                |                                    |         |
| 47.0           | End of borehole.<br>Probable bedrock.  |             |         |      |            |             |  |    |    |    |     |   |   |                |                                    |         |

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 6

JOB 72-11081

LOCATION Co-ord's 15,673,063 N. 797,287 E.

ORIGINATED BY P.M.


W.P. 70-68-18

BORING DATE July 13, 1972

COMPILED BY P.M.

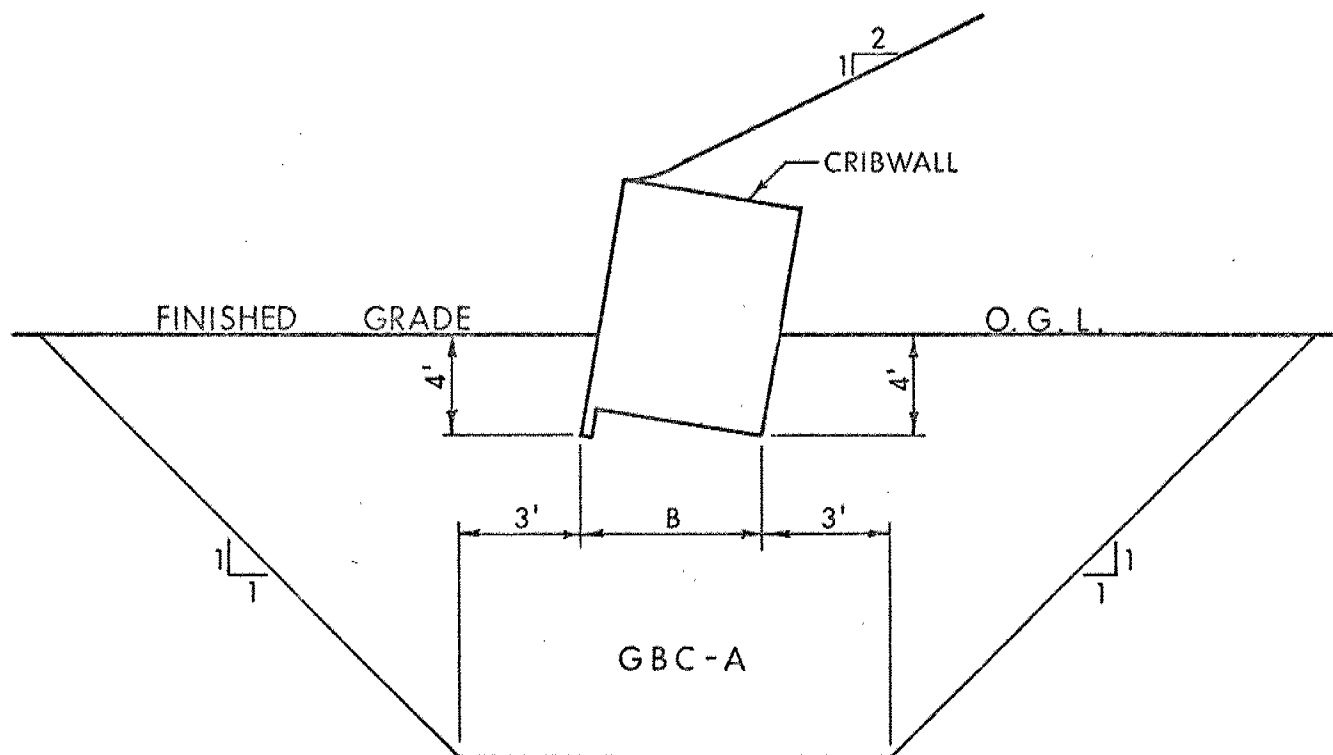
DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger &amp; AXT Rock Core.

CHECKED BY 

| SOIL PROFILE |  |             | SAMPLES |      |              | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE<br>BLOWS / FOOT           |  | LIQUID LIMIT ——— $w_L$<br>PLASTIC LIMIT ——— $w_p$<br>WATER CONTENT ——— $w$ |  | BULK DENSITY<br>$\gamma$<br>P.C.F. | REMARKS |                 |  |
|--------------|--|-------------|---------|------|--------------|-------------|--|--|--|--|------------------------------------|---------|-----------------|--|
| ELEV. DEPTH  | DESCRIPTION  | STRAT. PLOT | NUMBER  | TYPE | BLOWS/FOOT   |             | SHEAR STRENGTH P.S.F.                                    |  |  |  |                                    |         | WATER CONTENT % |  |
|              |  |             |         |      |              |             | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE |  |  |  |                                    |         |                 |  |
|              |  |             |         |      |              |             | 1000 2000  |  |  |  |                                    |         |                 |  |
|              |  |             |         |      |              |             | $w_p$ ——— $w$ ——— $w_L$                                  |  | 10 20 30   |  |                                    |         |                 |  |
| 649.9        | Ground level.                                      |             |         |      |              |             |  |  |  |  |                                    |         |                 |  |
| 0.0          | Slightly org. sand<br>some cinder. Fill.<br>Loose. |             | 1       | SS   | 10           |             |  |  |  |  |                                    |         |                 |  |
|              |  |             | 2       | SS   | 7            |             |  |  |  |  |                                    |         |                 |  |
| 641.8        |  |             | 3       | SS   | 31           |             |  |  |  |  |                                    |         |                 |  |
| 8.1          | Gravelly sand.                                     |             | 4       | SS   | 58           |             |  |  |  |  |                                    |         |                 |  |
| 636.6        | Dense to very dense.                               |             | 5       | SS   | 7            |             |  |  |  |  |                                    |         |                 |  |
| 13.3         | Irregular seams of<br>clayey silt & silt.          |             | 6       | SS   | 10           |             |  |  |  |  |                                    |         |                 |  |
|              | Stiff.   |             | 7       | TW   | PM           |             |  |  |  |  |                                    |         |                 |  |
|              | Grey and brown.                                    |             | 8       | SS   | 9            |             |  |  |  |  |                                    |         |                 |  |
|              |  |             | 9       | TW   | PM           |             |  |  |  |  |                                    |         |                 |  |
|              |  |             | 10      | SS   | 9            |             |  |  |  |  |                                    |         |                 |  |
|              |  |             | 11      | TW   | PM           |             |  |  |  |  |                                    |         |                 |  |
|              |  |             | 12      | SS   | 14           |             |  |  |  |  |                                    |         |                 |  |
| 600.5        | Boulders   |             | 13      | SS   | --           |             |  |  |  |  |                                    |         |                 |  |
| 49.4         | Dolomite bedrock.                                  |             | 14      | RC   |              |             |  |  |  |  |                                    |         |                 |  |
| 596.4        |  |             | 15      | RC   | Rec.<br>100% |             |  |  |  |  |                                    |         |                 |  |
| 53.5         | End of borehole.                                   |             |         |      |              |             |  |  |  |  |                                    |         |                 |  |





NOTES:

1. Excavate fill to approximate el. 646-647 under wall N<sup>o</sup> 4 and el. 642-643 under wall N<sup>o</sup> 5 as shown.
2. Refill hole up to 2' below original ground surface with well compacted GBC-A material.
3. Re-excavate for cribwall footings.

JOB NO. 72-11081

FIG. NO. 1

## 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

|            |  |
|------------|--|
| $\gamma$   | UNIT WEIGHT OF SOIL (BULK DENSITY)                                   |
| $\gamma_s$ | UNIT WEIGHT OF SOLID PARTICLES                                       |
| $\gamma_w$ | UNIT WEIGHT OF WATER   |
| $\gamma_d$ | UNIT DRY WEIGHT OF SOIL (DRY DENSITY)                                |
| $\gamma'$  | 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  |
| $\tau_f$   | SHEAR STRENGTH   |
| $c'$       | EFFECTIVE COHESION   |
| $\phi'$    | EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION                  |
| $c_u$      | APPARENT COHESION  |
| $\phi_u$   | APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION                   |
| $\mu$      | COEFFICIENT OF FRICTION  |
| $S_t$      | SENSITIVITY  |

## GENERAL

|                           |                                   |
|---------------------------|-----------------------------------|
| $\pi$                     | = 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  |
| $\sigma$   | NORMAL STRESS  |
| $\sigma'$  | NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED) |
| $\tau$     | SHEAR STRESS   |
| $\epsilon$ | LINEAR STRAIN  |
| $\gamma$   | SHEAR STRAIN   |
| $\nu$      | POISSON'S RATIO ( $\mu$ IS ALSO USED)                  |
| E          | MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)        |
| G          | MODULUS OF SHEAR DEFORMATION                           |
| K          | MODULUS OF COMPRESSIBILITY                             |
| $\eta$     | COEFFICIENT OF VISCOSITY                               |

## EARTH PRESSURE

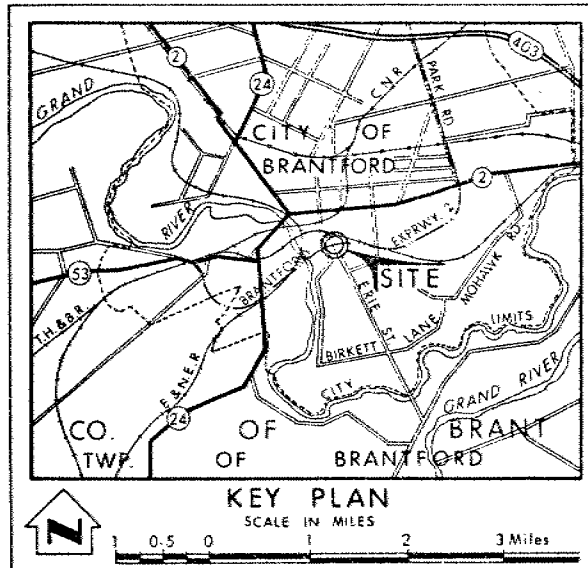
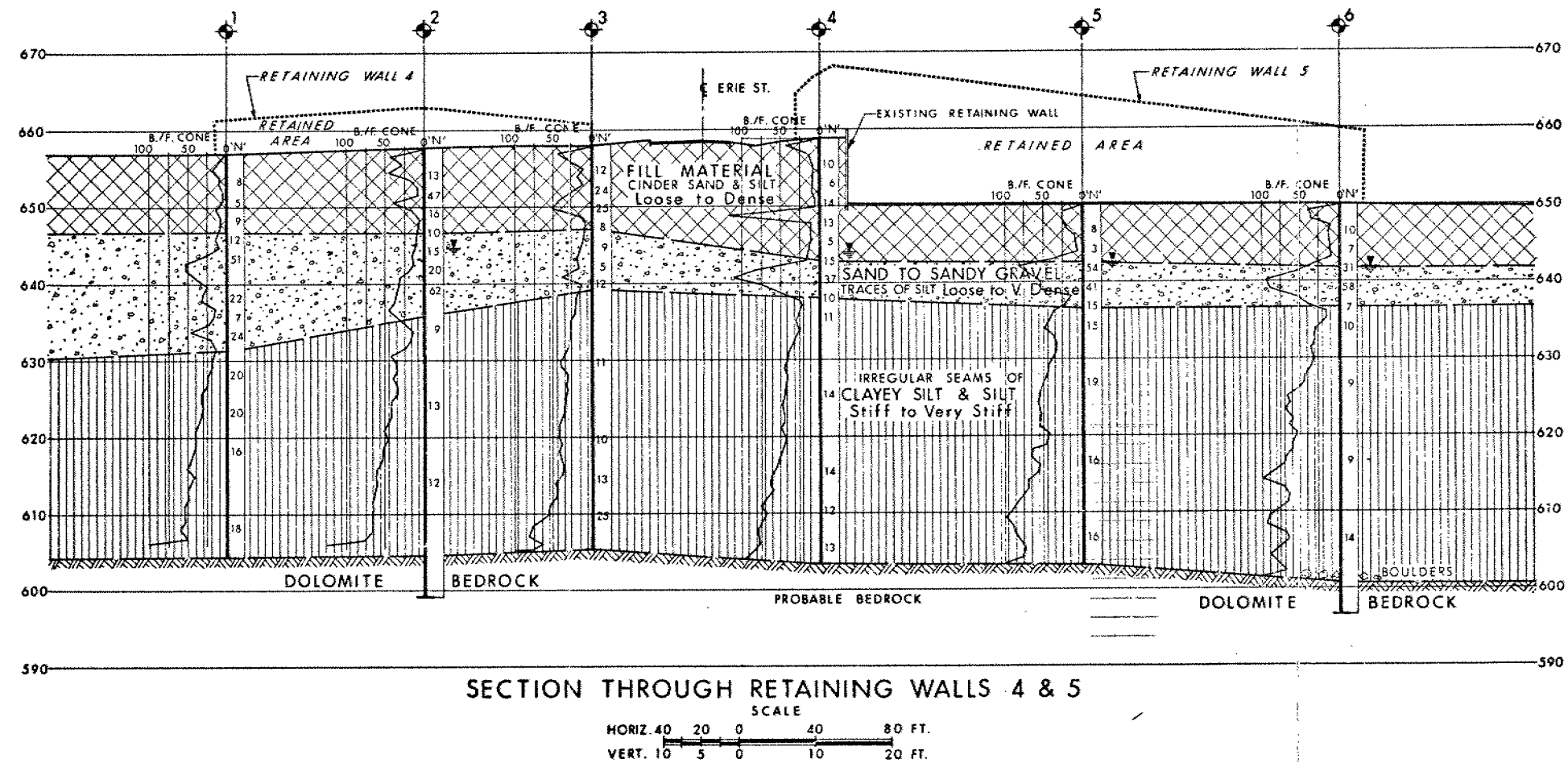
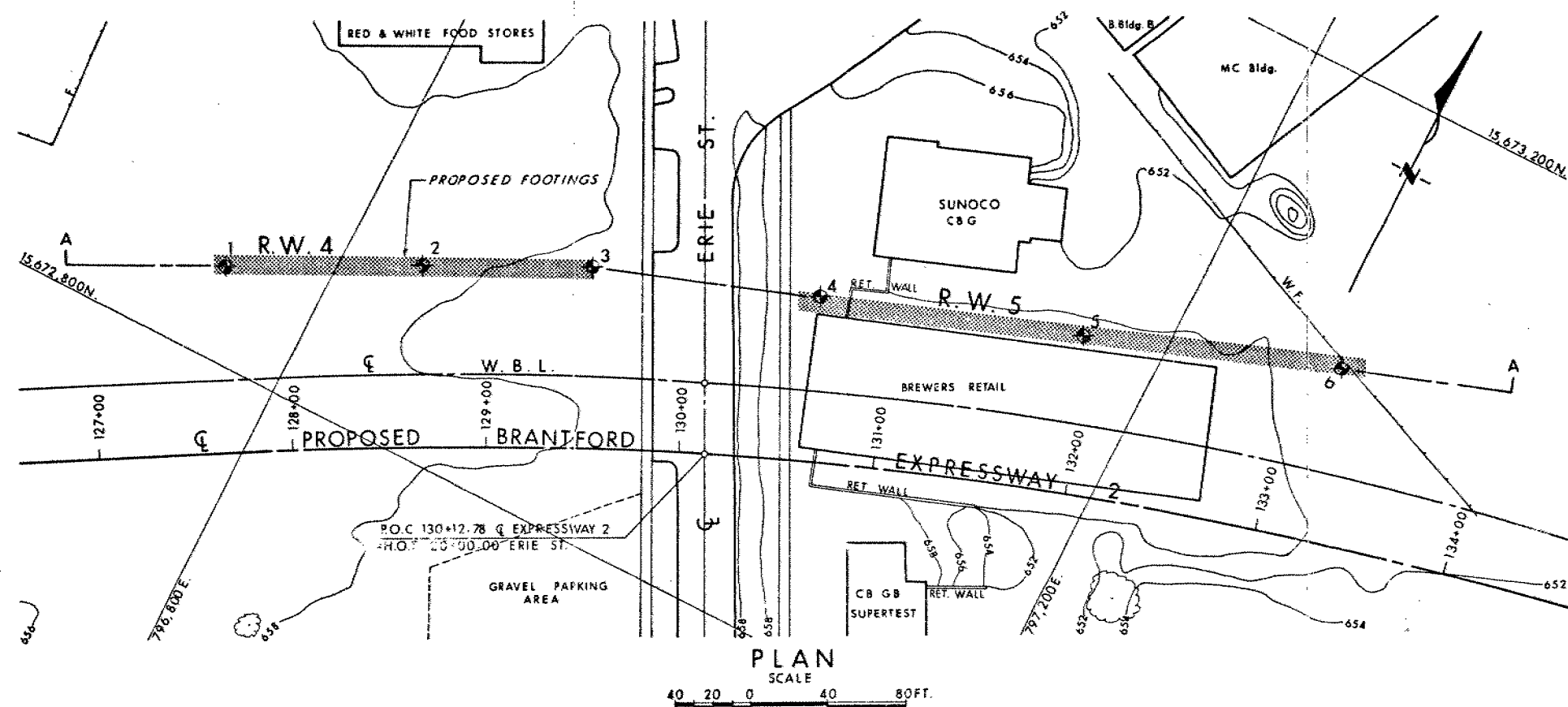
|          |   |
|----------|---|
| d        | DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE   |
| $\delta$ | ANGLE OF WALL FRICTION  |
| K        | DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS |
| $K_0$    | COEFFICIENT 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 |
| $\beta$ | ANGLE OF SLOPE TO HORIZONTAL             |



| LEGEND |  |              |         |
|--------|--|--------------|---------|
|        | Bore Hole  |              |         |
|        | Cone Penetration Test  |              |         |
|        | Bore Hole & Cone Test  |              |         |
|        | Water Levels established at time of field investigation July 1972                |              |         |
|        | Water Levels in Bore Holes 1 & 3 not established at time of field investigation. |              |         |
| NO.    | ELEVATION  | CO-ORDINATES |         |
|        |  | NORTH        | EAST    |
| 1      | 656.8  | 15,672,847   | 796,748 |
| 2      | 657.6  | 15,672,893   | 796,838 |
| 3      | 657.9  | 15,672,933   | 796,918 |
| 4      | 658.7  | 15,672,973   | 797,030 |
| 5      | 650.0  | 15,673,016   | 797,159 |
| 6      | 649.9  | 15,673,063   | 797,287 |

**— 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 & COMMUNICATIONS<br>DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE |   |                      |                  |
| <b>RETAINING WALLS 4 &amp; 5</b><br>(ERIE STREET)  |   |                      |                  |
| HIGHWAY NO. EXPRESSWAY 2   |   | DIST. NO. 4          |                  |
| CO. BRANT  |   | CITY OF BRANTFORD    |                  |
| TWP. BRANTFORD   |   | LOT _____ CON. _____ |                  |
| <b>BORE HOLE LOCATIONS &amp; SOIL STRATA</b>   |   |                      |                  |
| SUBWD. A. B.   | CHECKED <input checked="" type="checkbox"/> | W.P. NO. 70-68-18    | DRAWING NO.      |
| DRAWN <input checked="" type="checkbox"/>  | CHECKED <input checked="" type="checkbox"/> | JOB NO. 72-11081     | <b>72-11081A</b> |
| DATE Aug. 8, 1972  | SITE NO.                                    | BRIDGE DRAWING NO.   |                  |
| APPROVED <i>[Signature]</i>  | CONF. NO.                                   |                      |                  |