DESKTOP FOUNDATION STUDY
STEELES AVENUE BRIDGE OVER HIGHWAY 404
TORONTO, ONTARIO
G.W.P. 2179-08-00, ASSIGNMENT NO. 2012-E-0042

Geocres Number: 30M14-400

Report to

URS Canada Inc.

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TABLE OF CONTENTS

PART 1 FACTUAL INFORMATION

1 INTRODUCTION 1
2 SOURCES OF INFORMATION 1
2.1 MTO GEOCRES Files 1
2.2 Publications 2
3 SITE DESCRIPTION 2
3.1 General 2
3.2 Geology 2
4 DESCRIPTIONS OF SUBSURFACE CONDITIONS 2
4.1 Topsoil 3
4.2 Pavement 3
4.3 Clayey Silt with Some Sand (Upper Cohesive Stratum) 3
4.4 Silty Sand, Some Gravel, Trace Clay 3
4.5 Clayey Silty, Trace Sand, Trace Gravel (Lower Cohesive Stratum) 4
4.6 Groundwater Level 4
5 MISCELLANEOUS 4

PART 2 DISCUSSION AND RECOMMENDATIONS

6 GENERAL 6
7 EXISTING FOUNDATION ASSESSMENT 6
7.1 West Abutment 6
7.2 Pier 7
7.3 East Abutment 7
7.4 Sliding Resistance 7
8 SUITABILITY OF THE EXISTING FOUNDATIONS 8
9 AUGMENTED FOUNDATIONS 8
10 PREFERRED FOUNDATION 9
11 ABUTMENTS 9
12 EMBANKMENTS 9
13 DRAINAGE AND DEWATERING 10
14 ROADWAY PROTECTION 10

15 SEISMIC ASSESSMENT 10
16 DETAIL DESIGN STAGE 11
17 CLOSURE 11

Appendices

Appendix A GEOCRES Information

Appendix B Site Setting

Appendix C Comparison of Foundation Alternatives

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents a summary of the background information collected in relation to the desktop foundation study at the site of the Highway 404 underpass at Steeles Avenue, Site 37-274.

The purpose of this desktop investigation is to summarize currently available subsurface information pertinent to the foundation aspects of the proposed rehabilitation works. The information includes previous foundation reports, technical memoranda and internal correspondence available from the Ministry of Transportation Ontario (MTO) GEOCRES system, geological reports and maps, and site reconnaissance visits.

Thurber carried out this desktop study as a sub-consultant to URS Canada Inc. under the MTO Consultant Assignment Number 2012-E-0042.

2 SOURCES OF INFORMATION

The following sources of information were used to compile the background information:

2.1 MTO GEOCRES Files

The following GEOCRES files are included in Appendix A and have been used in the preparation of this report:

Reference 1: GEOCRES 30M14-254. In particular, memo date March 17, 1997, Encroachment of proposed Highway 404 Widening on Existing Bridge Footings, Hwy 404 – Steeles Avenue Underpass, Site 37-274, Hwy 404 – Woodbine Avenue Ramp Underpass, Site 37-1017, WP 111-84-01, Preliminary Design Study, Hwy 404 from Hwy 401 to Hwy 407, Central Region.

Reference 2: GEOCRES File 30M14-62. In particular:

November 1976 – Foundation Investigation Report for Steeles Ave, Interchange Underpass, Hwy. 404, District 6, Toronto, W.P. 160-74-13, Site 37-274.

March 14, 1975 – Foundation Investigation Report for Highway 404 Underpass at Steeles Avenue, Borough of North York – Metropolitan Toronto, District No. 6, Toronto, Site 37-274, W.P. 160-74-13.

April 1970 – Foundation Investigation Report for Proposed Crossing at Steeles Avenue East and New King's Hwy. 404, District No. 6 (Toronto), W.J. 70-F-16 – W.J. 293-61

Reference 3: GEOCRES File 30M14-62. In particular:

May 30, 1962 – Foundation Investigation for Proposed Interchange at Metro Limits, Hwy. #404 & Steeles Ave., Line 'A', District #6, W.J.-F-43 – W.P. 293-61

2.2 Publications

Reference 4 - Ontario Department of Mines and Northern Affairs, Map 2226, Physiography of the South Central Portion of Southern Ontario (to accompany "The Physiography of Southern Ontario" by L.J. Chapman and D.F. Putnam.

3 SITE DESCRIPTION

3.1 General

The site lies at the intersection of the Highway 404 corridor and the alignment of Steeles Avenue East just north of where the highway moves to the west and off the original Woodbine Avenue alignment. At this point, Woodbine Avenue lies approximately 325 m to the east and Don Mills Road lies 700 m to the west.

The area surrounding the site is shown in the Google Earth image in Appendix B. The lands to the east of Highway 404 are generally commercial and light industrial. The lands to the west of the highway are generally residential, with a commercial plaza on the north side of Steeles Avenue, a public school a short distance to the southwest and a cemetery a short distance south on the west side of the highway.

The topography is generally flat, with a gradual slope from the north to the south.

3.2 Geology

Reference 4 shows that the site lies on the boundary between a drumlinized till plain and a bevelled till plain, but in an area generally recognized as part of the Peel Plain.

4 DESCRIPTIONS OF SUBSURFACE CONDITIONS

The investigation reported in Reference 2 was conducted for the existing underpass configuration whereas the investigation reported in Reference 3 was conducted for an earlier design for an overpass. Accordingly, while the results in Reference 3 have been reviewed, the description of the subsurface conditions has been based on Reference 2. The descriptions are based on site conditions at the time of the investigation, which may have been modified by subsequent construction activities.

The soil stratigraphy at the site is summarized in the following sections. Reference should be made to Records of Borehole contained in References 2 and 3 for further details. The factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions.

The original information is presented in Imperial Units but has been converted to Metric Units for presentation and discussion in this report.

4.1 Topsoil

The site was originally overlain by approximately 300 mm of topsoil. It is assumed that the topsoil has been completely removed during construction.

4.2 Pavement

While there was no pavement on site at the time of the original investigation, pavement structure now exists on Steeles Avenue and on Highway 404.

4.3 Clayey Silt with Some Sand (Upper Cohesive Stratum)

The original topsoil was underlain by a stratum described as clayey silt, some sand, trace gravel.

The base of this layer lay at Elevation 178.82 to 181.96. The present day thickness will be the difference between these elevation and the elevation to which the site was stripped to construct Highway 404 and the structure. It is estimated that the base of the pavement structure lies at approximate Elevation 178.29. Therefore, it can be assumed that the silty clay has been completely removed below the highway.

It is assumed that the silty clay remains in place under the Steeles Avenue approach fills and in the area adjacent to these embankments.

The SPT values shown on the Record of Borehole sheets range from 9 to 41 blows for 0.3 m of penetration, indicating stiff to hard conditions, but in general very stiff.

Grain size distribution envelops are provided in Reference 2 in Appendix A.

Other physical properties are summarized as follows:

Liquid Limit (W_L)	15 to 42%
Plastic Limit (W_P)	11 to 26%
Moisture Content (W)	10 to 24%

4.4 Silty Sand, Some Gravel, Trace Clay

The upper cohesive stratum was underlain by a stratum that was described as "silty fine sand to fine sand silt with traces of clay and some gravel". The grain size distribution envelop in Reference 2 suggests that this soil can be described as a fine textured glacial till.

All but two of the boreholes terminated in this stratum after penetrating for 3.96 to 15.21 m, corresponding to Elevation 176.96 to 166.50. The sand was fully penetrated in Boreholes 4 and 5, where thicknesses of 9.91 and 14.17 m were established, corresponding to Elevation 168.91 and 165.44.

The SPT values on the Record of Boreholes sheets range from 33 to values well in excess of 100 blows for 0.3 m of penetration. These values indicate dense to very dense conditions, though predominantly very dense. Dynamic cone penetrometer tests conducted adjacent to each borehole indicated very dense conditions as soon as the sand was contacted.

Grain size distribution envelops are provided in Reference 2 in Appendix A.

The natural moisture contents range from 4 to 14%, indicating low natural moisture contents.

4.5 Clayey Silty, Trace Sand, Trace Gravel (Lower Cohesive Stratum)

Borehole 4 and 5 fully penetrated the silty sand layer and encountered a lower cohesive stratum described as "clayey silt with traces of sand and gravel".

Boreholes 4 and 5 both terminated in this stratum after penetrating for 2.28 and 1.37 m, respectively, corresponding to Elevation 166.63 and 164.07.

The SPT values shown on the Record of Borehole sheets range from 72 to in excess of 100 blows for 0.3 m of penetration, indicating hard conditions,

Other physical properties are summarized as follows:

Liquid Limit (W_L)	21 to 39%
Plastic Limit (W_P)	13 to 20%
Moisture Content (W)	15 to 22%

4.6 Groundwater Level

Most of the Record of Borehole sheets carry the note "Water Level not established".

The most recent text, November 1976, states that the water level across the site ranges from 7.62 to 8.84 m below ground surface, corresponding to Elevation 173.12 to 174.64.

5 MISCELLANEOUS

Mr. Alastair Gorman, P.Eng. reviewed the background information and prepared this report. Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundations projects, reviewed the report.

Thurber Engineering Ltd.

Alastair Gorman, P.Eng., M.Sc.
Senior Foundations Engineer
and Project Manager

P.K. Chatterji, P.Eng., Ph.D.
Review Principal

DESKTOP FOUNDATION STUDY
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TORONTO, ONTARIO
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Geocres Number: 30M14-400

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

6 GENERAL

This report presents interpretation of the available geotechnical data presented in Part 1 Factual Information. It also presents an assessment and discussion of the foundation conditions and geotechnical resistance available at each of the existing foundation elements.

Subsurface conditions (especially near-surface conditions), groundwater and surface water conditions and ground surface elevations may have been altered since the time of the original investigations as a result of subsequent construction or land use changes. The discussion and recommendations presented in this report are based on the original site investigation, the original design drawing and subsequent internal MTO correspondence. The design drawing used in preparation of this report is titled "Highway 404 Underpass at Steeles Ave. East General Plan" and was produced as part of WP No. 160-74-13.

The underpass consists of twin, two-span structures approximately 105 m long. The total width of the twin decks is approximately 32 m. The abutments of the two structures are offset approximately 20 m to accommodate the skew between Steeles Avenue and Highway 404. All foundation elements are shown to be spread footings.

Details of the actual rehabilitation works are unavailable to Thurber at the time of preparation of this report and users must make their own interpretation of the adequacy of the foundations to support the rehabilitated structure.

7 EXISTING FOUNDATION ASSESSMENT

Reference 2 recommends that the foundations be designed on the basis of a "safe net bearing pressure of 4.0 tons/ft^2". This can be considered to be equivalent to 400 kPa in SI units and the safe net bearing pressure in working stress is equivalent to the SLS value in Limit States design. The report gave an elevation at each borehole below which this bearing pressure could be applied. All foundations appear to be constructed below these elevations.

7.1 West Abutment

The underside of the west abutment footing is interpreted to lie at approximately Elevation 179.67. The most relevant soil information is provided by Boreholes 1 and 12,

which both show very dense cohesionless soil at the founding elevation, minimum N = 53 blows for 0.3 m of penetration.

Assuming a footing width of at least 2.5 m and applying current standards and analyses, the available geotechnical resistance for the existing west abutment footing is:

- 500 kPa SLS
- 750 kPa ULS_f

7.2 Pier

The pier footing is interpreted to be founded at approximately Elevation 177.84, based on a footing thickness of 1.5 m. The most relevant soil information is provided by Boreholes 2, 3, 7 and 8, which all show that the founding soil is very dense and has SPT values generally in excess of 100 blows for 0.3 m of penetration.

This soil deposit, at this depth, can be considered to provide an unyielding founding stratum. Accordingly, geotechnical resistance that can be used to evaluate this footing is

- 1,000 kPa ULS_f
- SLS condition will not govern

7.3 East Abutment

The underside of the east abutment footing is interpreted to lie at approximately Elevation 178.30. The most relevant soil information is provided by Boreholes 4, 5 and 11, which all show very dense cohesionless soil at the founding elevation, minimum N = 48 blows for 0.3 m of penetration.

Assuming a footing width of at least 2.5 m and applying current standards and analyses, the available geotechnical resistance for the existing west abutment footing is:

- 500 kPa SLS
- 750 kPa ULS_f

7.4 Sliding Resistance

The sliding resistance of the cast-in-place concrete foundation on the very dense soil at this site can be based on a coefficient of sliding friction of 0.40.

8 SUITABILITY OF THE EXISTING FOUNDATIONS

Based on information provided by URS Canada Inc., the load demands and geotechnical resistances under the foundation elements are summarized as follows:

Abutments

Load Condition	Pressure Exerted by Foundation (kPa)		Geotechnical Resistance (kPa)
	Post Rehabilitation	Stage 2[1]	
ULS_f	486	490	750
SLS	379	382	500

Pier

Load Condition	Pressure Exerted by Foundation (kPa)		Geotechnical Resistance (kPa)
	Post Rehabilitation	Stage 2[1]	
ULS_f	722	831	1000
SLS	581	642	Note 2

1) Stage 2 rehabilitation includes eccentric loading.

2) SLS condition does not govern.

Based on this information, the existing foundations are adequate to safely support the temporary and permanent loads from the structure rehabilitation.

9 AUGMENTED FOUNDATIONS

For new construction, a variety of foundation options would normally be considered, including spread footings or deep foundations such as driven H-piles, tube piles or drilled shaft piles (caissons).

In this particular case, if the foundations need to be augmented due to structure widening or to carry increased loads due to rehabilitation, it is recommended that shallow spread footing matching the existing footings be used. Driven piles are considered to be impractical due to the very dense nature of the soil and caissons, while providing high resistance, would require slow and laborious installation.

A comparison of foundation alternatives is presented in the table in Appendix C.

If footing widenings are required, it is recommended that they be designed as follows:

1. The factored bearing pressure applied by the structure must not exceed the factored geotechnical resistances provided in Section 8.
2. The widened footing must be proportioned such that the applied bearing pressure does not exceed the pressure applied by the existing footings.
3. Footing widenings or new footings adjacent to the existing must be founded at the same elevation as the adjacent footing, as far as possible.
4. All footing bases must be provided with a minimum of 1.2 m of soil cover as frost protection.

10 PREFERRED FOUNDATION

From a geotechnical and cost perspective, if new foundation construction is required, the preferred alternative is spread footings bearing on the very dense silty sand at elevations matching those of the existing footings.

11 ABUTMENTS

The existing structure abutments are supported on spread footings. Accordingly, conventional or semi-integral abutments are feasible.

From a geotechnical perspective, integral abutment design is also possible at this site, but this would require complete reconstruction of the abutments.

12 EMBANKMENTS

The existing approach embankments on Steeles Avenue appear to be stable and to be performing well.

If an embankment widening is required, it can be assumed to have satisfactory stability if it is constructed with side slopes not exceeding 2H:1V and using granular or SSM materials.

Widenings must be keyed into the existing embankment slope in accordance with OPSD 208.010.

Based on the available geotechnical information, any embankment widening will potentially be underlain by 1.8 to 3.5 m of very stiff clay which in turn is underlain by an extensive deposit of very dense silty sand. Settlement under an embankment widening will occur mostly as construction takes place and there will not be long term consolidation issues at this site.

All new embankment grading must be provided with erosion protection either by sodding or seeding, depending on the Contract requirements. Sodding or seeding must be in accordance with OPSS 803 or OPSS 804, respectively.

13 DRAINAGE AND DEWATERING

Based on the reported groundwater elevations and the anticipated depth of excavation (matching existing footings), there will be no requirement for site dewatering prior to excavation.

However, some seepage may enter excavations from the near surface soils and from precipitation runoff. The Contractor must, therefore, be prepared to unwater the excavation. Pumping from properly constructed, filtered sumps may be sufficient, but the responsibility to design dewatering and unwatering systems remains with the Contractor.

14 ROADWAY PROTECTION

Depending on the design requirements, if foundation widening or abutment rehabilitation is required, roadway protection may be required to facilitate excavation. The design of the roadway protection must be carried out by the Contractor. Feasible systems include interlocking steel sheet piling or soldier piles and lagging.

The roadway protection must be designed and constructed to meet Performance Level 2 in OPSS 539. Earth pressures may be calculated using the parameters in the Table 14.1.

Table 14.1 – Earth Pressure Design Parameters – Static Conditions

Parameter	Soil Type			
	OPSS Granular A or Granular B Type II	OPSS Granular B Type I	OPSS SSM Fill	Silty Clay / Clay
Effective Friction Angle, ϕ	35°	32°	30°	27°
Unit Weight, γ (kN/m^3)	22.8	21.2	21.0	18.5
Active Earth Pressure Coefficient, Ka (Unrestrained Wall)	0.27	0.31	0.33	0.38
At-rest Earth Pressure Coefficient, Ko (Restrained Wall)	0.43	0.47	0.50	0.55
Passive Earth Pressure Coefficient, Kp (Movement Towards Soil Mass)	3.7	3.3	3.0	2.7

15 SEISMIC ASSESSMENT

If a seismic assessment of the structure is required, the seismic component of the active earth pressure acting on the abutment can be calculated using the Mononobe-Okabe method with k_h= A/2 where A is the zonal acceleration ratio. The dynamic active earth pressure coefficients (K_{AE}) are provided in Table 15.1.

Table 15.1 – Earth Pressure Design Parameters – Dynamic (Seismic) Conditions

Parameter	Soil Type			
	OPSS Granular A or Granular B Type II	OPSS Granular B Type I	OPSS SSM Fill	Silty Clay / Clay
Effective Friction Angle, ϕ	35°	32°	30°	27°
Unit Weight, γ (kN/m^3)	22.8	21.2	21.0	18.5
Dynamic Active Earth Pressure Coefficient, K_{AE}	0.33	0.37	0.40	0.45

The K_{AE} values have been calculated based on Section 4.6.4 of the CHBDC for a yielding wall with a vertical back and horizontal backfill. The angle of friction between the wall and the soil has been set at 0 degrees to generate a conservative estimate. The application of amplification factors to the zonal acceleration ratio has not been included.

16 DETAIL DESIGN STAGE

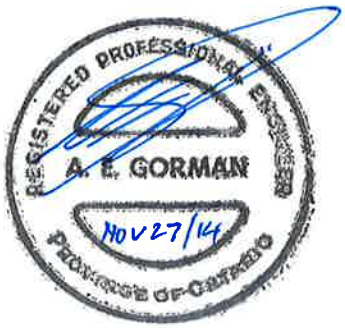
At the detail design stage, the design requirements must be assessed to determine if addition site investigation, field testing and geotechnical design recommendations are required. Any such work must be completed in accordance with current MTO standards.

17 CLOSURE

Engineering analysis and preparation of the foundation design report were carried out by Mr. Alastair Gorman, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Alastair Gorman, P.Eng., M.Sc.
Senior Foundations Engineer
and Project Manager



P.K. Chatterji, P.Eng., Ph.D.
Review Principal

Appendix A

GEOCRES Information

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M14-254

DIST. CR REGION

W.P. No. 111-84-01

CONT. No.

W. O. No.

STR. SITE No. 37-274
37-1017

HWY. No. 404

LOCATION STEELES AVE. U'PASS
WOODBINE AVE. RAMP U'PASS

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

memorandum

Ontario

To: V. Boehnke
Head, Structural Engineering Section
Central Region

August 19, 1997

Attn: N. Garland
Sr. Structural Engineer

From: Pavements and Foundations Section
Room 315, Central Building

Phone: 235-4333

Re: Feasibility of Proposed RSS Retaining Wall
Hwy 404 - Woodbine Avenue Ramp Underpass, Site 37-1017
WP 111-84-00, Central Region

The Highway 404 widening at the Woodbine Avenue Ramp underpass requires the construction of a retaining wall on the north side of the east abutment. An RSS wall or slope would appear as the most practical installation at this location.

Based on the subsurface investigation conducted for the existing structure (June 1974), the surficial deposit is for the most part a firm to very stiff clayey silt underlain by dense to very dense sandy silt to silty sand. It is felt that sufficient subsurface information exists for design and construction of an RSS wall or slope. It should be noted that the water table is high and disturbance of the non-cohesive deposit should be avoided.

Given the difficulty with placing the reinforcing elements in a 90° bend, it is preferred that the proposed corner be eliminated for ease of construction.

If there are any questions regarding the above, please advise.

Betty Bennett, P.Eng.
Foundation Engineer

memorandum

Ontario

To: V. Boehnke
Head, Structural Engineering Section
Central Region

August 18, 1997

Attn: N. Garland
Sr. Structural Engineer

From: Pavements and Foundations Section
Room 315, Central Building

Phone: 235-4333

Re: Encroachment of Proposed Sewer on Existing Bridge Footings
Highway 404 Widening on Existing Bridge Footings
Hwy 404 - Woodbine Avenue Ramp Underpass, Site 37-1017
WP 111-84-00, Central Region

In conjunction with the Highway 404 widening at the Woodbine Avenue Ramp underpass, it is proposed to install a 825 mm diameter storm sewer adjacent the east abutment footing. It appears that it is intended to place the sewer pipe by trench excavation. Foundation recommendations regarding this installation are requested.

The Woodbine Avenue ramp structure is founded on steel tube piles driven into very dense sandy silt to silty sand material. Groundwater levels, at the time of the foundation investigation (May 1974), were measured at approximate El. 178.6. From pile driving records retrieved for the existing underpass structure, the tube piles advanced at the east abutment were driven to El. 174.2.

The proposed trench excavation will extend to 174.7 with the the invert of the storm sewer at El. 174.9. The excavation would take place from 5 to 20 m away from the abutment. Because of the shallow depth of the piles and the presence of a high water table in non-cohesive material, excavation of a trench in the vicinity of the abutment is cause for concern. The trench excavation is in the order of 5 m in depth and will require extensive shoring to ensure the safety of the abutment as well as the roadway. Any loss of ground due to hydrostatic pressures could result in the movement of the abutment foundations. Specific details regarding the proposed installation of the storm sewer by trench excacation should be provided in order that this construction method be further assessed.

Consideration should be given to jacking the pipe into place, if only in the vicinity of the abutment, to reduce the excavation and shoring requirements. If there are any questions regarding the above, please advise.

Betty Bennett, P.Eng.
Foundation Engineer

memorandum

Ontario

March 17, 1997

To: V. Boehnke
Head, Structural Engineering Section
Central Region

Attn: N. Garland
Sr. Structural Engineer

From: Pavements and Foundations Section
Room 315, Central Building

Phone: 235-4333

Re: Encroachment of Proposed Highway 404 Widening on Existing Bridge Footings
Hwy 404 - Steeles Avenue Underpass, Site 37-274
Hwy 404 - Woodbine Avenue Ramp Underpass, Site 37-1017
WP 111-84-01, Preliminary Design Study
Hwy. 404 from Hwy 401 to Hwy 407
Central Region

It is proposed to widen Highway 404 from 401 to Highway 407. Because of the skew angle of the above-mentioned structures across Highway 404, the proposed widening of Highway 404 will encroach on sections of the existing abutment footings. In order to accommodate the pavement structures at these locations, excavation adjacent the footings is required. In addition, the removal of slope paving results in the removal of earth cover required for frost protection.

A request for foundation recommendations was issued to determine the constraints for excavation adjacent to the footings, as well as the measures necessary to protect the footings from frost and other elements.

Hwy 404 - Steeles Avenue Underpass

The Steeles Avenue Underpass is founded on spread footing foundations. The subsurface material is composed of dense to very dense silty sand and the water table is present some 5 m below the base of footing elevations. The footings currently have frost protection from slope paving that extends from the abutment wall.

The areas of concern are the northeast corners of the NW and SW abutments and the southwest corners of the NE and SE abutments. It is estimated that, given the skew of the structure, the widenings will encroach on the footings for a distance of 3 m along the length of the footings and a distance of 2 m along the width of the footings. In the worst case scenario, the pavement structure would extend for a depth of 300 mm below the footing elevation. Because the widenings will expose the footings at these locations, it is recommended that some means of protecting the footings be provided.

At the affected footing locations, it is recommended that excavation be limited to a maximum of 300mm below the base of footing elevation. The footings should be protected with a minimum thickness of 100 mm of polystyrene insulation (e.g. Dow HI -100) placed directly against the concrete of the footing. The insulation should extend over top of the footing, vertically down the side of footing to the desired depth (300 mm max below base of footing), then extend horizontally outward from the footing for a distance of 2m. Refer to attached Figure 1 for a conceptual sketch. The insulation should be adhered to the concrete footing.

Polystyrene is susceptible to disintegration when exposed to ultraviolet radiation, hence a minimum 300 mm of earth cover is required, preferably Granular A. The 300mm thickness of cover may also includes paving materials. To keep water from ponding around the footing area, drainage should be directed away from the footing and tied into the pavement drainage scheme. This may require that the shoulder be sloped away from the abutment. The insulation extending beyond the footing should also be placed on a grade sloping away from the footing. A polyethylene liner is recommended between the insulation and earth cover for waterproofing purposes.

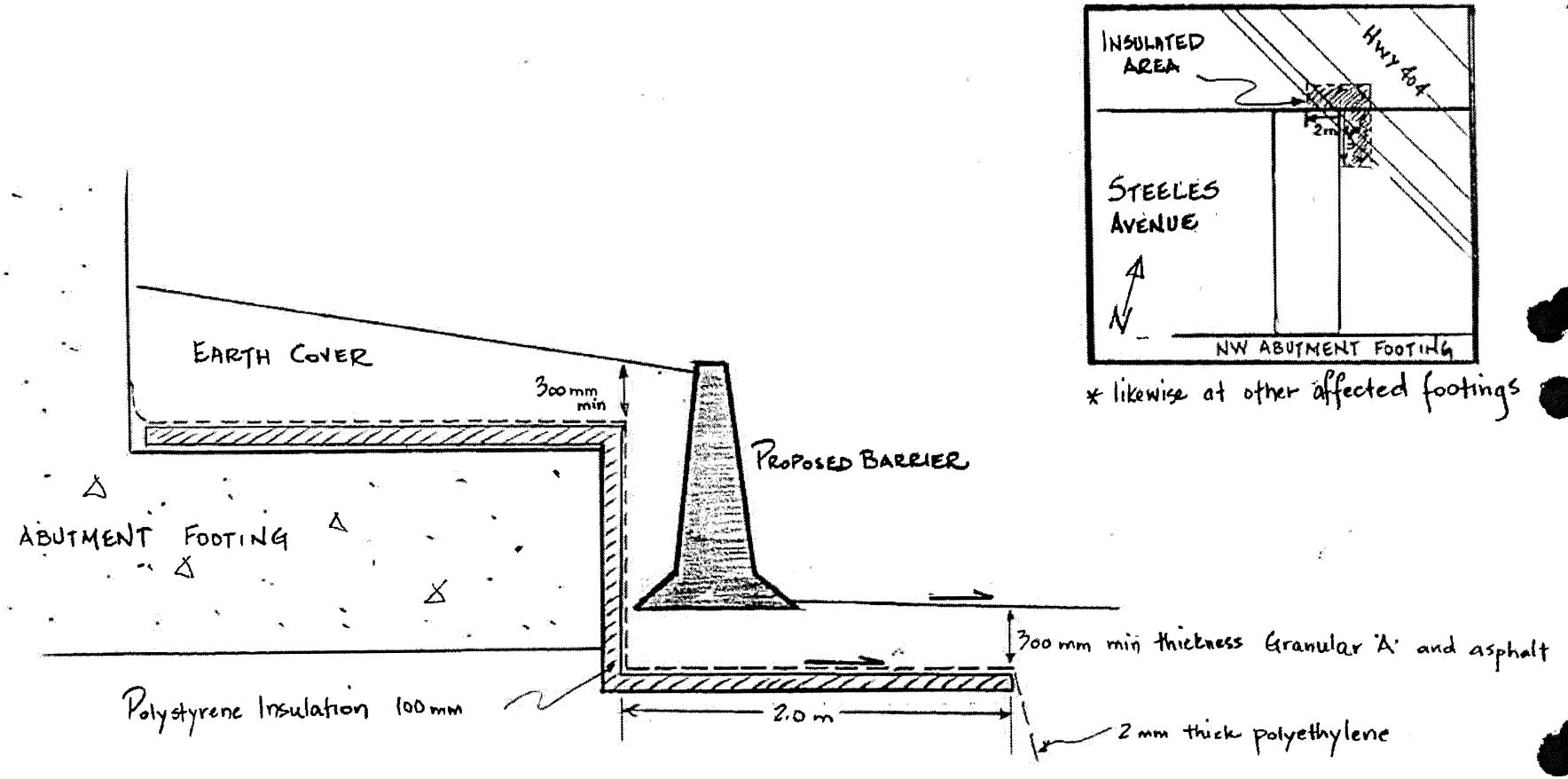
Hwy 404 - Woodbine Avenue Ramp Underpass

The Woodbine Avenue ramp structure is founded on steel tube piles driven into very dense sandy silt to silty sand material. Frost cover is not generally a concern with pile caps. Because excavation for the proposed pavement structure may be carried out adjacent and below the pile cap, it is preferable that drainage be encouraged away from the footing.

If there are any questions regarding the above, please advise.

B Bennett

Betty Bennett, P.Eng.
Foundation Engineer



Hwy 404 and Steeles Ave. Underpass

WP 111-84-01

Figure 1

nts

CONTRACT No. 30M14-62

DIST. 6 REGION Central

W.P. No. 160-74-13

CONT. No. 76-107

W. O. No.

STR. SITE No. 37-274

HWY. No. 404

LOCATION Steeles Ave. Interchange Underpass

OVERSIZE PLANS TO BE FILMED IN WITH THIS REPORT 4

REMARKS: documents to be unfolded before microfilming

FOUNDATION INVESTIGATION REPORT

For

Steeles Ave. Interchange Underpass
Hwy. 404, District 6, Toronto
W.P. 160-74-13, Site No. 37-274

INTRODUCTION

This report contains results of a foundation investigation carried out at the site of the above mentioned project. The fieldwork was carried out during the periods of April 26, 1962 to May 8, 1362; February 23, 1970 to March 5, 1970; and February 27, 1975 to March 3, 1975. It consisted of a total of 10 boreholes advanced by either augering or by diamond drilling techniques to depths ranging from 19 to 59 ft. below the ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located on Steeles Avenue approximately 1000 feet west of Woodbine Avenue in Metropolitan Toronto. Gently rolling terrain is prevalent throughout this area and the immediate vicinity of the site consists mostly of open fields.

The site lies on what is known physiographically as the "Peel Plain". This Plain is largely composed of a till resulting from the most recent glaciation of the area. The till overlies interglacial and interstadial sands and is itself overlain in places by postglacial clays and sands.

SUBSURFACE CONDITIONS

General

Generally uniform conditions were found to prevail over the site area. Subsoil consists of 6 to 11.5 feet of stiff to very stiff clayey silt with some sand and a trace of gravel followed by 33 to at least 50 feet of dense to very dense silty sand with traces of clay and some gravel. Detailed descriptions of various soil types encountered in each borehole are given on the Record of Borehole Sheets. The estimated stratigraphical profile of Drawing No. 37-242-A is based upon this information.

From ground level downwards, the various soil types encountered are as follows:

Clayey Silt With Some Sand (Upper Cohesive Deposit)

Underlying 1.0 ft. of clayey topsoil, a stratum of clayey silt some sand and a trace of gravel was encountered. The clayey silt stratum, ranging in thickness from 6 to 11.5 feet, extends over the entire area investigated.

Physical properties of the material in the deposit as determined from field and laboratory tests, are summarized as follows:

Liquid Limit (W_L)	15% to 42%
Plastic Limit (W_p)	11% to 26%
Moisture Content (W)	10% to 24%
'N' Values	9 to 35 blows per ft.

Typical grain size distribution curves, in an envelope form, for the samples from this stratum are given in the Appendix of this report on Figure 1. Based on the 'N' values as obtained from the Standard Penetration Tests, it is estimated that the consistency of the cohesive deposit ranges from stiff to very stiff and is generally very stiff.

Silty Sand With Traces of Clay and Some Gravel

Below the clayey silt stratum a very dense deposit of silty fine sand to fine sandy silt with traces of clay and some gravel was found. The thickness of the stratum varies from 33 to at least 50 feet, which was the maximum depth investigated.

Typical grain size distribution curves are given in an envelope form in the Appendix of this report on Figure 2. The relative density of the deposit, based on results of the Standard Penetration Tests, is estimated to be dense to very dense, with the 'N' values varying from 33 to more than 100 blows/ft.

Clayey Silt With Traces of Sand and Gravel (Lower Cohesive Deposit)

This deposit was encountered below the granular stratum in two of the deep boreholes carried out at the eastern portion of the structure. The thickness was not established but it extends at least 5.0 feet below the silty sand stratum. The 'N' values ranged from 72 to over 100 blows/ft. indicating a hard consistency.

Physical properties as determined from laboratory tests, are:

Liquid Limit	(W_L)	21% to 39%
Plastic Limit	(W_p)	13% to 20%
Moisture Content	(W)	15% to 22%

GROUNDWATER CONDITIONS

Water level observations were carried out in some of the open boreholes during the periods of both the 1970 and the 1975 investigations. Results of the investigations show that the water level across the site is approximately 25 to 29 feet below ground level, i.e. between elevations 568 and 573.

M. Devata, P. Eng.
Supervising Engineer

November, 1976
MD/gs

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

$\overline{\blacktriangledown}$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

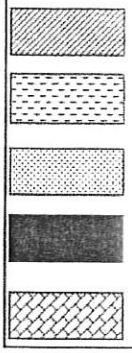
(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION	
Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

DISCONTINUITY SPACING	
Bedding	**Bedding Plane Spacing**
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

BEDROCK

STRENGTH CLASSIFICATION			
Rock Strength	**Approximate Uniaxial Compressive Strength**		**Field Estimation of Hardness***
	(MPa)	**(psi)**	
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length
Solid Core Recovery:(SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run
Rock Quality Designation;(RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a % of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index:(FI)	Frequency of natural fractures per 0.3m of core run.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS–ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

W.P. 160-74-13 LOCATION Co-ords. 919,835 N; 1,038,815 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE February 24, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill & Cone Test CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	REMARKS GR SA SI CL
602.0	Ground Level						
	Topsoil						
1.0	Clayey silt with traces of sand & grav. Very Stiff		1	SS	20		
596.0			2	SS	84		
6.0	Silty fine sand with traces of clay and some gravel.		3	SS	90		19 36 36 9
			4	SS	144/8"		6 50 37 7
			5	SS	105/6"		
			6	SS	83/4"		
			7	SS	130/8"		
			8	SS	50/3"		6 50 34 10
	Very Dense		9	SS	153		
			10	SS	111/9"		
			11	SS	100/4"		21 68 (11)
			12	SS	106		
			13	SS	134/8"		3 62 (35)
546.3			14	SS	100/3"		
55.7	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE

LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w (w_P — w — w_L)

WATER CONTENT % (20 40 60)

UNIT WEIGHT γ

600 590 580 570 560 550 540

20 15 5 10 % STRAIN AT FAILURE

MINISTRY OF TRANSPORTA' ON AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

W.P. 160-74-13 LOCATION Co-ords. 919,854 N; 1,038,881 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE March 5, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill & Cone Test CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w (w_P w w_L) / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR SA SI CL
601.8	Ground Level									
	Topsoil	~~				600				
1.0	Clayey silt with some sand		1	SS	16			H–I		0 15 45 40
593.8	Stiff		2	SS	35			H–I		
8.0			3	SS	63			OH		8 39 45 8
	Silty fine sand to fine sandy silt with traces of clay and gravel.		4	SS	160/9"	590		OH		
			5	SS	50/2"			o		4 49 45 2
			6	SS	75/4"			o		
			7	SS	150/ 6"	580		o		
	Very dense		8	SS	140/6"			o		
571.3			9	SS	150/ 6"					
30.5	End of Borehole					570		o		36 48 9
	Water Level not established									

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE Nº 3

W.P. 160-74-13 LOCATION Co-ords. 919,876 N; 1,038,946 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE March 3, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill & Cone Test CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w (w_P — w — w_L) / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS / % GR SA SI CL
600.2	Ground Level					600				
	Topsoil									
1.0	Clayey silt with some sand & traces gravel.		1	SS	9					
591.2	Stiff to very stiff		2	SS	21					3 32 43 22
9.0			3	SS	74	590				
	Silty fine sand with traces of clay & some gravel.		4	SS	125					1 49 35 5
			5	SS	180/3"					
			6	SS	50/2"	580				5 49 33 3
	Dense to very dense.		7	SS	90/6"					
			8	SS	115					
568.7			9	SS	43	570				3 71 (26)
31.5	End of Borehole									
	Water Level not established					560				

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 4

W.P. 160-74-13 LOCATION Co-ords. 919,895 N; 1,039,012 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE February 23, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill & Cone Test CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	REMARKS GR SA SI CL
598.2	Ground Level						
	Topsoil						
1.0	Clayey silt with traces of sand and gravel.		1	SS	14		
			2	TW	FM		
586.7	Stiff		3	SS	41		
11.5			4	SS	61		
	Silty fine sand with traces of clay & some gravel.		5	SS	76/6"		2 52 36 10
			6	SS	100/6"	590	
			7	SS	70/3"		
	Dense to very dense		8	SS	77		
						580	
			9	SS	110		26 35 33 6
			10	SS	66		
						570	
			11	SS	110/6"		20 41 33 6
554.2							
44.0	Clayey silt with traces of sand & gravel		12	SS	108/6"		
	Hard					560	
546.7			13	SS	142		
51.5	End of Borehole						
						550	
						540	

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE

LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w (w_P — w — w_L)

WATER CONTENT % (20 40 60)

UNIT WEIGHT γ

% STRAIN AT FAILURE (15 20 10 5)

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS–ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5

W.P. 160-74-13 LOCATION Co-ords. 919,821 N: 1,039,147 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE February 26, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill & Cone Test CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.
596.8	Ground Level					
	Topsoil					
1.0	Clayey silt with traces of sand and gravel. Stiff		1	SS	14	
589.3			2	SS	25	
7.5			3	SS	106	
			4	SS	70	
	Silty fine sand with traces of clay and some gravel		5	SS	100/7"	
			6	SS	145/9"	
			7	SS	100/5"	
	Very dense		8	SS	131/10"	
			9	SS	125/9"	
			10	SS	148/8"	
			11	SS	114	
			12	SS	64	
			13	SS	54	
542.8			14	SS	150/0"	
54.0	Clayey silt with traces of gravel					
538.3	Hard		15	SS	72	
58.5	End of Borehole					

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE

LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w (w_P — w — w_L)

WATER CONTENT % (20 40 60)

UNIT WEIGHT γ

REMARKS	% GR	SA	SI	CL
	8	49	37	6
	9	47	42	2
	13	45	37	5
	22	47	27	4

20 ◇ 5 % STRAIN AT FAILURE 10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 6

W.P. 160-74-13 LOCATION Co-ords. 919,811 N; 1,039,117 E ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE March 3, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill & Cone Test CHECKED BY [illegible]

ELEV. / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w (w_P — w — w_L) / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS: % GR SA SI CL
597.7	Ground Level									
	Topsoil									
1.0	Clayey silt with some sand		1	SS	14					0 15 29 46
591.2	Stiff		2	SS	28					6 40 43 10
6.5	Silty fine sand to fine sandy silt with traces of clay & gravel.		3	SS	78	590				
			4	SS	57					7 43 40 10
			5	SS	89	580				
578.2			6	SS	159					
19.5	End of Borehole Water Level not established					570				

15 20 10 5 % STRAIN AT FAILURE

MINISTRY OF TRANSPORTA N AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 7

W.P. 160-74-13 LOCATION Co-ords. 919,781 N; 1,039,017 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE March 2, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill & Cone Test CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	LIQUID LIMIT w_l / PLASTIC LIMIT w_p / WATER CONTENT w — WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR SA SI CL
599.6	Ground Level									
1.0	Clayey silt with some sand.		1	SS	17			○		0 15 58 27
593.6	Very stiff		2	SS	52			○		
6.0	Silty fine sand with traces of clay and some gravel.		3	SS	347/9"	590		○		
			4	SS	112/6"			○		11 46 37 6
			5	SS	100/5"					
580.6	Dense to very dense		6	SS	270/5"			○		16 54 24 6
19.0	End of Borehole					580				
	Water Level not established									

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 8

W.P. 160-74-13 LOCATION Co-ords. 919,784 N; 1,038,954 E. ORIGINATED BY CH

DIST. 6 HWY 404 BORING DATE May 2, 1962 COMPILED BY BK

DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing & Cone Test CHECKED BY CH

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w (w_P — w — w_L) WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % R SA SI CL
599.0	Ground Level									
598.0	Topsoil									
1.0	Clayey silt with sand and occasional gravel		1	SS	20					
591.0	Med. dense-Brown.		2	SS	21					
			3	SS	48					
8.0	Silty-fine sand with occasional gravel. Very dense-Brown		4	SS	>100	590				
578.0			5	SS	>100	580				
21.0	End of Borehole Water Level not established					570				

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 8

W.P. 160-74-13 LOCATION Co-ords. 919,784 N; 1,038,954 E. ORIGINATED BY CH

DIST. 6 HWY 404 BORING DATE May 2, 1962 COMPILED BY BK

DATUM Geodetic BOREHOLE TYPE Washboring – BX Casing & Cone Test CHECKED BY GH

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ⊙ QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % 20 40 60	UNIT WEIGHT γ	REMARKS GR % SA % SI. % CL %
599.0	Ground Level									
598.0	Topsoil									
1.0	Clayey silt with sand and occasional gravel		1	SS	20					
591.0	Med. dense–Brown.		2	SS	21					
			3	SS	48					
8.0	Silty-fine sand with occasional gravel. Very dense–Brown		4	SS	> 100	590				
578.0			5	SS	> 100	580				
21.0	End of Borehole. Water Level not established					570				

20
15 ⊙ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 11

W.P. 160-74-13 LOCATION Co-ords. 919,910 N; 1,039,127 E. ORIGINATED BY C.McK

DIST. 6 HWY. 404 BORING DATE February 27, 1975 COMPILED BY C.McK

DATUM Geodetic BOREHOLE TYPE Auger with CME 750 & Cone Test CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER ELEV.
595.0	Ground Level					
0.0	Topsoil					
1.0	Clayey silt with some sand & traces of organics		1	SS	12	
589.0	Stiff to v. stiff		2	SS	26	
6.0	Silty sand with traces of clay and some gravel.		3	SS	48	
			4	SS	63	
			5	SS	102	
			6	SS	111	
			7	SS	171	
	Dense to v. dense		8	SS	100/3"	
			9	SS	154	
558.5			10	SS	133	
36.5	End of Borehole Hole caved in at 26.5' probeble water level 568.5					

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

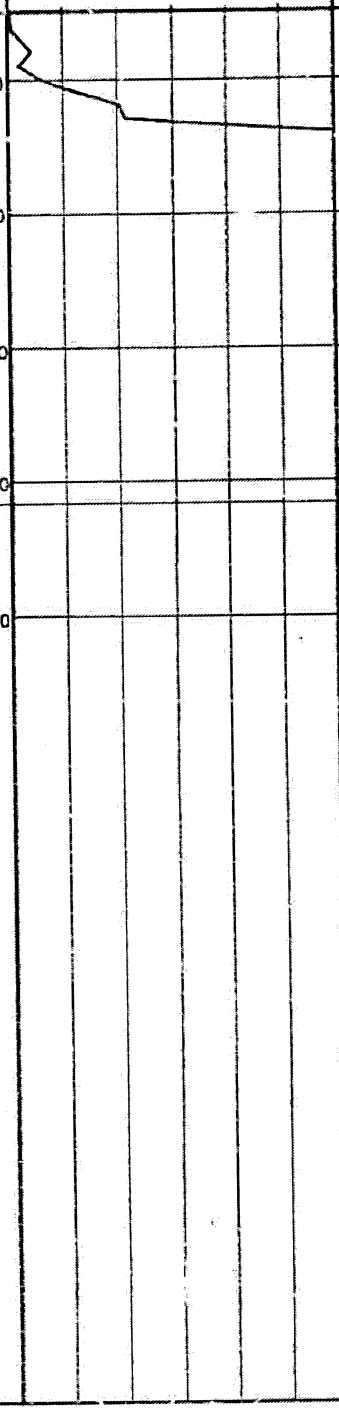
SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_p
WATER CONTENT —— w
w_p w w_L
WATER CONTENT %

UNIT WEIGHT γ

REMARKS

% GR SA SI CL



20
15 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 12

W.P. 160-74-13 LOCATION Co-ords. 919,731 N; 1,038,769 E. ORIGINATED BY C.McK

DIST. 6 HWY. 404 BORING DATE March 3, 1975 COMPILED BY C. McK

DATUM Geodetic BOREHOLE TYPE Auger and Sample with CME 750 & Cone Test CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUE	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT %	UNIT WEIGHT γ	REMARKS % GR SA SI CL
603.0	Ground Level									
0.0	Topsoil									
1.0	Clayey silt with some sand & traces of organics. Stiff		1	SS	12	600				
597.0			2	SS	13					
6.0	Silty sand with traces of clay and some gravel.		3	SS	53					
			4	SS	53		100/6"			
			5	SS	54	590				
			6	SS	48					
			7	SS	150/10"					
						580				
	Dense to very dense.		8	SS	106					
			9	SS	33					
						570				
			10	SS	110					
						560				
			11	SS	155/11"					
						550				
547.1			12	SS	100/3"					
55.9	End of Borehole Water Level not established					540				

20
15 ◇ 5 % STRAIN AT FAILURE
10

GRAIN SIZE DISTRIBUTION

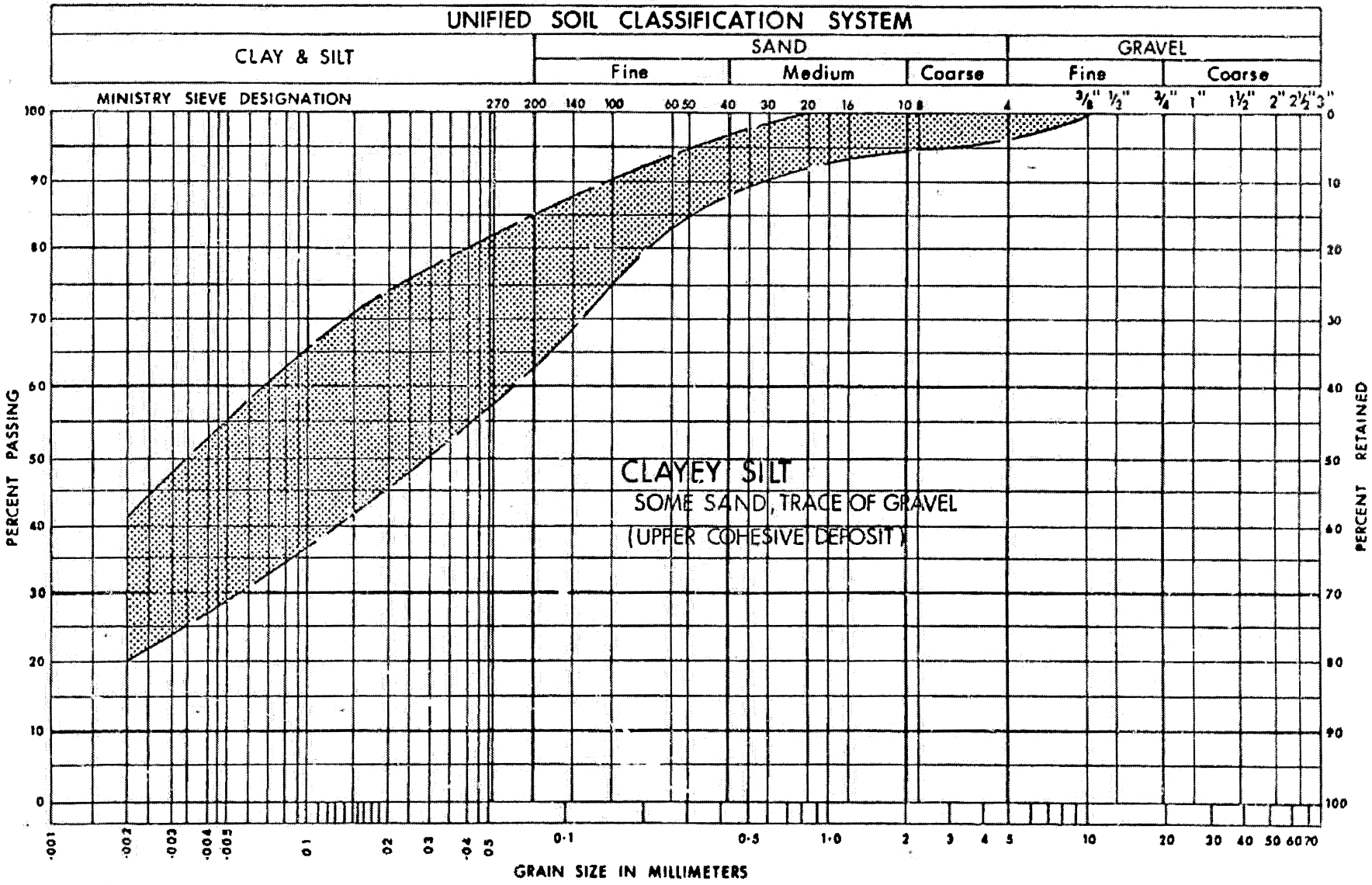


FIG. 1

W.P. 160-74-13

GRAIN SIZE DISTRIBUTION

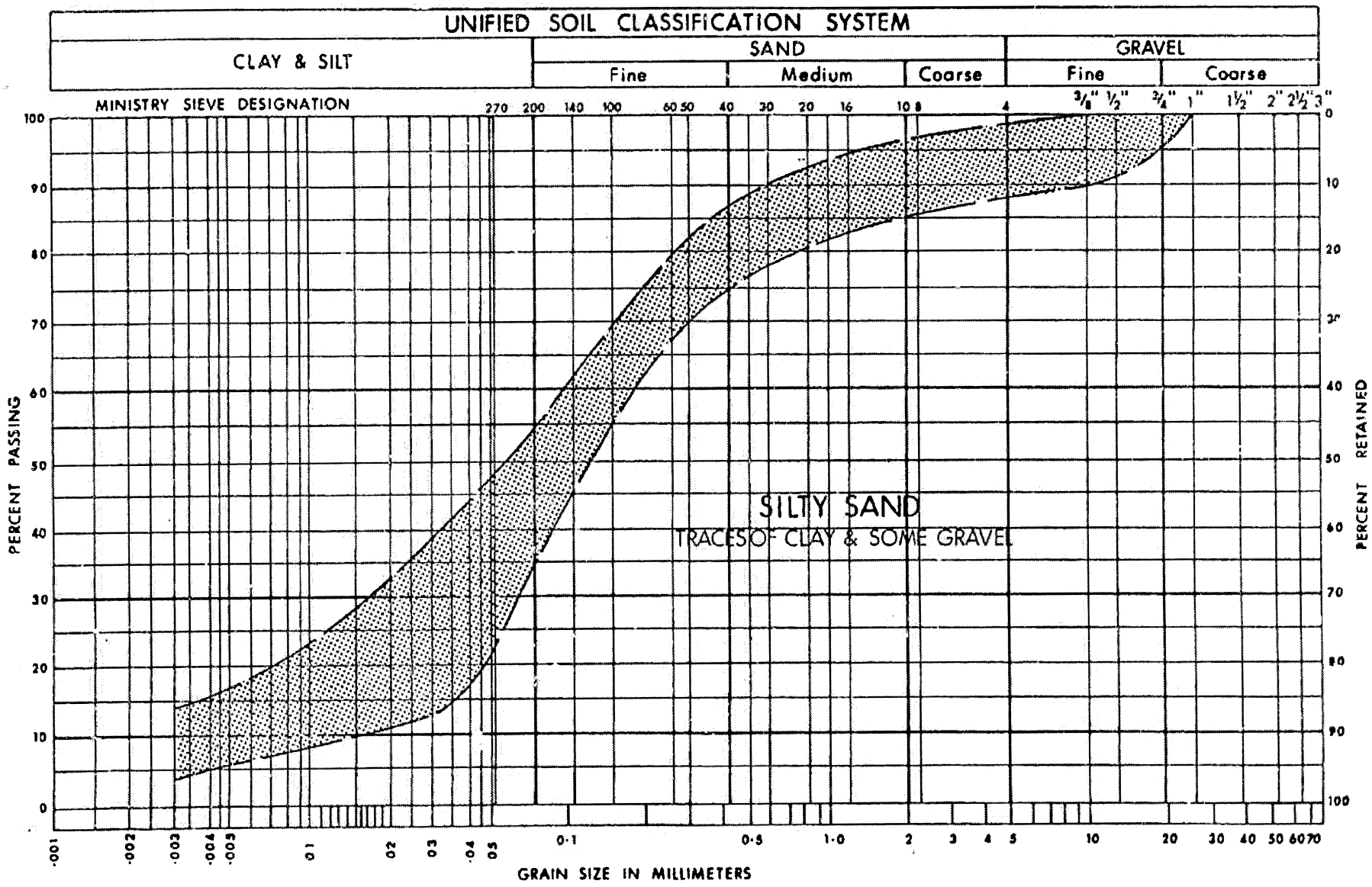


FIG. 2

W.P. 160-74-13

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. C. Mirza,
Head, Soils Mechanics Section,
West Building.

FROM: G. C. E. Burkhardt,
Structural Planning Office,
3501 Dufferin Street.

ATTENTION: Mr. K. Selby,
Supervising Engineer.

DATE: December 16,1974.

OUR FILE REF.

IN REPLY TO

SUBJECT: Hwy. 404 Underpass at Steeles Ave.,
W.P. 160-74; Site 37-274,
District 6, Toronto.

GIVING WP ONLY,

It has been recently announced that a freeway system will be implemented along the Hwy. 404 corridor, instead of the previously considered arterial road concept. To comply with such planning an interchange at above site needs to be included in the Hwy. 404 first stage of construction which stretches from north of Sheppard Ave. to north of Steeles Ave.

It should be pointed out that, at above location, a structure has been designed back in 1971 whereby Hwy. 404 was assumed to overpass Steeles Ave. Your office issued on May 8, 1970 the pertinent Foundation Report W.J. 70-F-16. However, due to economic reasons and other factors, the interchange layout has been revised to consider an underpass condition i.e., Hwy. 404 will be now underpassing Steeles Ave. Very likely, an expansion joint to be located along the raised median of Steeles Ave. will allow for two independant "square" structures.

Could you kindly review subject Foundation Report and give us the necessary recommendations for the proposed work. If you feel that additional field work becomes required, please advise accordingly.

To enable your office to carry out the required studies attached please find:

1) Two prints of a drawing covering the site under consideration; depicted in red are probable footing locations, proposed spans and width of the bridge deck.

   Also shown are existing and future ground lines of both Steeles Ave. and Hwy. 404

2) One copy of the "initial geometrics" for Steeles Ave. and Hwy. 404, as prepared by Cole, Sherman and Associates.

..... 2

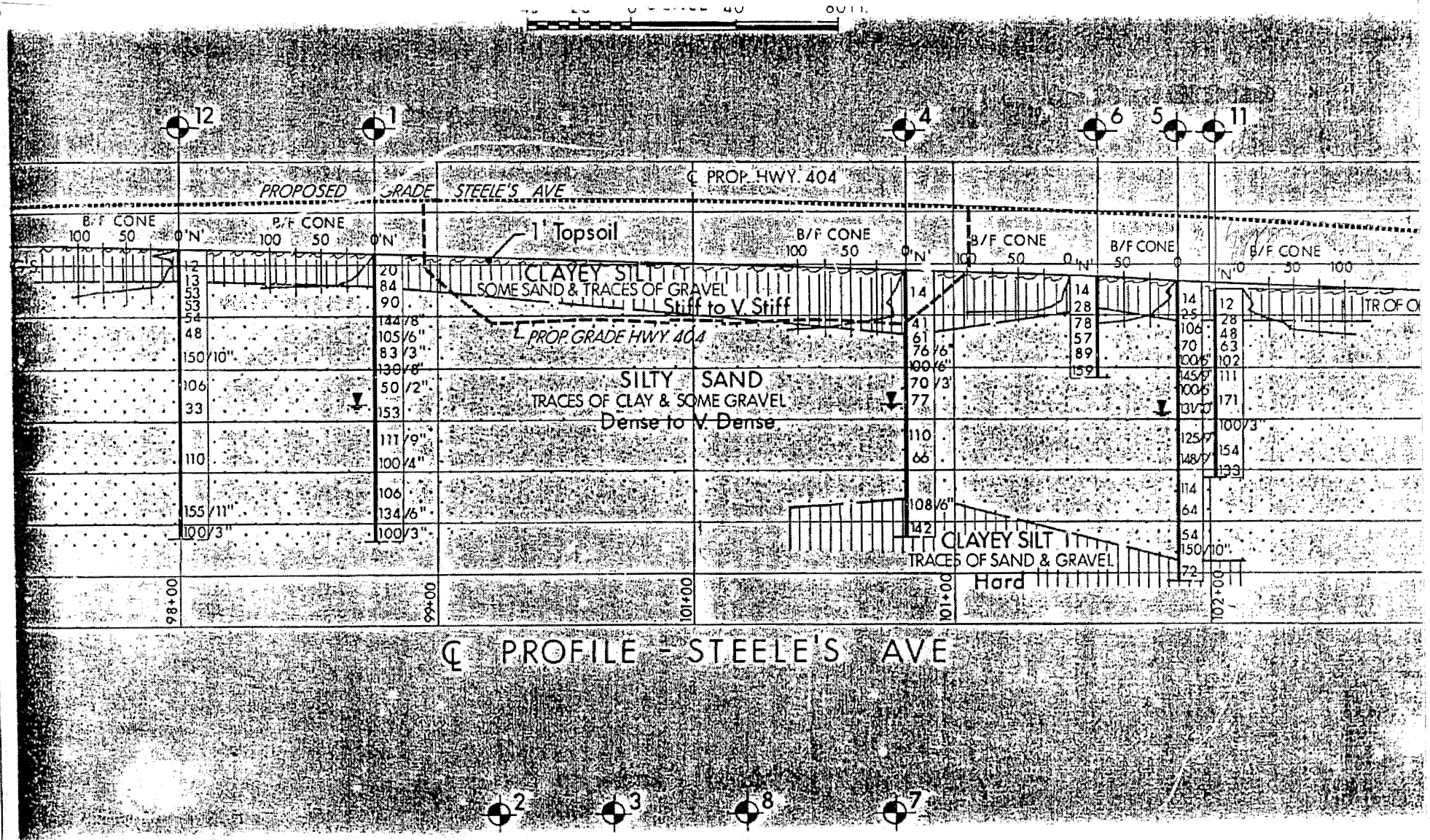
As previously discussed and agreed upon, your recommendations should be available on or before January 29, 1975 so as to allow this contract to be completed as scheduled.

If additional information on the above is required please do not hesitate to call us.

MDB:lm
Attach.

M. D. Bendayan,
STRUCTURAL PLANNING ENGINEER,
for:
G. C. E. Burkhardt,
REG. STRUCTURAL PLANNING ENG.

c.c. D. Smith
R. Fitzgibbon
R. D. Gunter
J. Anderson
J. D. Barclay


12
1
4
6
5
11
PROPOSED GRADE STEELE'S AVE
℄ PROP. HWY. 404
B/F CONE
100 50 0 'N'
1' Topsoil
CLAYEY SILT
SOME SAND & TRACES OF GRAVEL
Stiff to V. Stiff
℄ PROP. GRADE HWY. 404
SILTY SAND
TRACES OF CLAY & SOME GRAVEL
Dense to V. Dense
CLAYEY SILT
TRACES OF SAND & GRAVEL
Hard
98+00
99+00
101+00
102+00
℄ PROFILE - STEELE'S AVE
2
3
8
7

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. G. C. E. Burkhardt (3)
Regional Structural Planning Engr.
Central Region
3501 Dufferin Street

From: Soil Mechanics Section
Geotechnical Office
West Building, Downsview

Attention:

Date: March 14, 1975

MAR 21 1975

Our File Ref. W.P. 160-74-13

In Reply to

Subject:

FOUNDATION INVESTIGATION REPORT

for

Highway 404 Underpass at Steeles Avenue
Borough of North York - Metropolitan Toronto
District No. 6, Toronto
Site 37-274 W.P. 160-74-13
Cont 76-107

30 M 14-62
GEOCRES No.

Attached we are forwarding to you a revised Foundation Investigation Report for the above mentioned structure site. The previous Foundation Reports submitted by this Section, dated May 30, 1962 and May 8, 1970, with respective project numbers W.J. 62-F-43 and W.J. 70-F-16, under W.P. 293-61, have been superseded due to change in the overall design concept of Hwy. 404 in this area.

We believe that the factural 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.

M. DEVATA
Supervising Engineer.

c.c. E. J. Orr
B. R. Davis
R. S. Pillar
H. Greenland
B. J. Giroux
D. Gunter
G. A. Wrong
P. Lewycky
✓ Files
Record Services
J. Anderson) memo only
R. Fitzgibbon)

TABLE OF CONTENTS

1. INTRODUCTION

2. DESCRIPTION OF THE SITE & GEOLOGY

3. FIELD AND LABORATORY INVESTIGATION

4. SUBSOIL CONDITIONS

(4.1) General
(4.2) Clayey Silt with Some Sand
(4.3) Silty Sand with Traces of Clay and Some Gravel
(4.4) Clayey Silt with Traces of Gravel

5. GROUNDWATER CONDITIONS

6. DISCUSSION AND RECOMMENDATIONS

7. MISCELLANEOUS

FOUNDATION INVESTIGATION REPORT

for

Highway 404 Underpass at Steeles Avenue
Borough of North York - Metropolitan Toronto
District No. 6, Toronto
Site 37-274 W.P. 160-74-13

1. INTRODUCTION

The design of proposed Hwy. 404 shows that a grade separation will be required where Hwy. 404 crosses Steeles Avenue in the Borough of North York, Metropolitan Toronto.

There are two previous foundation reports for this site under W.P. 293-61. They are W.J. 62-F-43 and W.J. 70-F-16, dated May 30, 1962 and May 8, 1970 respectively.

It has been recently decided to revert the Hwy. 404 arterial scheme to the original freeway concept. According to such planning, several modifications are now required to the structure lately designed within the Section of Hwy. 404 comprised between Sheppard Avenue and Steeles Avenue. In addition, two new grade separations will be introduced at Finch Avenue and Steeles Avenue.

Additional borings have been carried out recently by this Section for the revised concept and this report contains all the pertinent data obtained from the above mentioned investigations together with our recommendations for the foundations of the proposed structure and immediate approaches.

2. DESCRIPTION OF THE SITE & GEOLOGY

The site is located on Steeles Avenue approximately 1000 ft. west of Woodbine Avenue in Metropolitan Toronto. Gently rolling terrain is prevalent throughout this area and the immediate vicinity of the site consists mostly of open fields.

The site lies on what is known physiographically as the "Peel Plain". This Plain is largely composed of a till resulting from the most recent glaciation of the area. The till overlies interglacial and interstadial sands and is itself overlain in places by postglacial clays and sands.

3. FIELD AND LABORATORY INVESTIGATION

Field work at the site (initial investigations by the Soil Mechanics Section dated May 30, 1962 and May 8, 1970, and recent investigations, also by the soil Mechanics Section) consisted of ten sampled boreholes with accompanying Dynamic Cone Penetration tests driven adjacent to the boreholes.

The boreholes were advanced using conventional auger drilling machines adapted for soil sampling purposes. Disturbed samples were obtained using a 2-inch O.D. split spoon sampler driven to the specifications for the Standard Penetration Test. Samples were visually examined in the field and subsequently in the laboratory. Tests were carried out on selected samples to determine the following physical properties:

Atterberg Limits
Moisture Content
Grain-size Distribution

The results of field and laboratory tests are summarized in the Record of Borehole sheets, which are contained in the Appendix to this report.

All boreholes were surveyed in the field by personnel from Central Region Engineering Surveys Office at the time of each respective field investigation. The locations and elevations of the borings are shown on Drawing No. 1607013-A which accompanies this report.

4. SUBSOIL CONDITIONS

(4.1) General

Generally uniform conditions were found to prevail over the site area. Subsoil consists of 6 to 11.5 ft. of stiff to very

stiff clayey silt with traces of sand and gravel followed by at least 30 ft. of dense to very dense silty sand with traces of clay and some gravel. Detailed descriptions of various soil types encountered in each borehole are given on the Record of Borehole sheets. The estimated stratigraphical profile of Drawing No. 1607413-A is based upon this information.

From ground level downwards, the various soil types encountered are as follows:

(4.2) Clayey Silt with Some Sand (Upper Cohesive Deposit)

Underlying 1.0 ft. of clayey topsoil, a stratum of clayey silt with traces of sand and gravel was encountered. The clayey silt stratum, ranging in thickness from 6 to 11.5 ft., extends over the entire area investigated.

Physical properties of the material in the deposit, as determined from field and laboratory tests, are summarized as follows:

Liquid Limit : (WL)	15 % to 42 %
Plastic Limit : (WP)	11 % to 26 %
Moisture Content : (W)	10 % to 24 %
"N" Values :	12 to 2[illegible] Blows per Ft.

Typical grain size distrubution curves, in an envelope form, for the samples from this stratum is given in the Appendix of this report on Figure 1. Based on the foregoing it is estimated that the consistency of the cohesive deposit ranges from stiff to very stiff and is generally very stiff.

(4.3) Silty Sand with Traces of Clay and Some Gravel

Below the clayey silt stratum a very dense deposit of silty fine sand to fine sandy silt with traces of clay and some gravel was found. The thickness of the stratum varies from 34 to at least 49 ft., which was the maximum depth investigated.

Typical grain size distribution curves are given in envelope form in the Appendix of this report on Figure 2. The relative density of the deposit, based on results of the Standard Penetration tests, is estimated to be dense to very dense, with the "N" values

varying from 33 to more than 100 blows/ft. and generally increasing with depth.

(4.4) Clayey Silt with Traces of Gravel (Lower Cohesive Deposit)

This deposit was encountered below the granular stratum in boreholes 4 & 5. The thickness was not established, but it extends at least 5.0 ft. below the silty sand stratum. The 'N' values ranged from 72 to over 100 blows/ft. indicating a hard consistency.

Physical properties, as determined from laboratory tests, are:

Liquid Limit : (WL)	21 % to	39 %
Plastic Limit : (WP)	13 % to	20 %
Moisture Content : (W)	15 % to	22 %

5. GROUNDWATER CONDITIONS

Water level observations were carried out in the open boreholes during the periods of both the 1970 and the 1975 investigation. Results of the 1970 investigation show the water level across the site is approximately 25 to 29 ft. below ground level, i.e. between elevations 571.0 and 573.0. The 1975 investigation shows a substantial drop in the water table as the water level was measured to be 45 ft. below the ground level, i.e. an elevation of 558. This drop in the water table is probably due to the fact that adequate time was not given for the water to stabilize during the most recent investigations.

6. DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a new over pass structure at this site. The most recent proposals call for a two span structure consisting of two 175 ft. span lengths and a total width of 108 ft. The center line of Steeles Avenue will remain as is, and will be carried over Hwy. 404.

The proposed grade of Hwy. 404 is such that cuts up to 12 ft. will be necessary in order to achieve the proposed grade of Hwy. 404 (elevation 589). In addition, approach fills up to a maximum height of 12 ft. above original ground surface will be necessary to meet the design grades of proposed Steeles Avenue.

As mentioned earlier in this report, the subsoil at the site consists of clayey topsoil, followed by stiff to hard clayey silt with some sand for a maximum depth of 11.5 ft., followed by approximately 34 to 49 ft. of dense to very dense silty sand with traces of clay and some gravel, followed by hard clayey silt with traces of gravel.

The subsoil conditions are such that spread footing type foundations may be utilized for the bridge piers and abutments.

A net safe bearing pressure of 4.0 tons/ft^2 may be assumed for design purposes. Based on this assumption, suitable footing elevations may be determined by interpolating between the following elevations given for each borehole location.

Borehole	1	- at or below	Elev. 597.0
	2	- "	Elev. 593.0
	3	- "	Elev. 590.0
	4	- "	Elev. 586.0
	5	- "	Elev. 588.0
	6	- "	Elev. 588.0
	7	- "	Elev. 592.0
	8	- "	Elev. 590.0
	11	- "	Elev. 586.0
	12	- "	Elev. 593.0

In all cases, a minimum earth cover of 4 ft. to the underside of the footing should be provided for frost protection requirements.

Backfill for the abutments consisting of free-draining granular material as per current M.T.C. Standards should be carried out and provision for drainage from this material should be made to ensure that no excess hydrostatic or ice pressures build up behind the walls. In the design of the abutments it is recommended that an earth pressure coefficient, Ka, of 0.3 be used, provided that some minor movement of the top of the abutments can be accommodated.

For a spread footing foundation, imposing the loads, and placed at the elevations discussed above, it is estimated that the differential settlement between adjacent piers or between a pier and an adjacent

abutment will be of the order of ½-inch, provided that the cohesive stratum or silty sand strata are not softened or loosened at and below foundation grade during construction.

To prevent softening of the subsoil in foundation excavations due to water seepage and construction operations, it is recommended that a thin working mat of lean concrete be laid down as soon as possible after foundation grade is reached and the excavations kept dry. No dewatering problems are anticipated since excavations will be well above the ground-water level.

No stability problems are anticipated for the proposed approach embankments on Steeles or the proposed cuts on Hwy. 404, provided the slopes are not steeper than 2 horizontal to 1 vertical. To prevent surface water erosion and gullying of the slopes, provision should be made for sodding them as soon as possible following construction.

7. MISCELLANEOUS

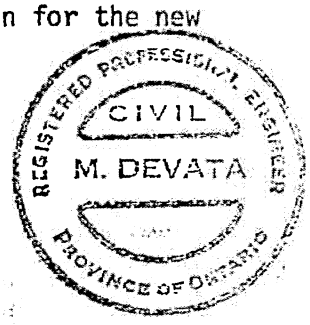
The field work for borehole 8 of this report was preformed within the period of April 26, 1962 to May 8, 1962, under the supervision of Mr. G. Mierzynski. The equipment was owned and operated by the Johnston Drilling Co. of Ottawa.

Field work for boreholes 1 to 7 inclusive was carried out under the supervision of Mr. H. Szymanski during the period February 23 to March 5, 1970. The equipment was owned and operated by Canadian Longyear Limited.

The most recent field investigation, boreholes 11 & 12, was carried out under the supervision of Mr. C. McKercher during the period February 27, 1975 to March 3, 1975. Student Technician, Mr. C. McKercher also prepared this revised report incorporating all the pertinent information for the new concept of Hwy. 404.

M. Devata

M. DEVATA
Supervising Engineer.



March 14, 1975

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1 (B.H.1-70-11016)

W.P. 160-74-13 LOCATION Co-ords. 919,835 N; 1,038,815 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE February 24, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR SA SI CL
602.0	Ground Level									
	Topsoil									
1.0	Clayey silt with traces of sand & gravel		1	SS	20					
596.0	Very Stiff									
6.0			2	SS	84					
	Silty fine sand with		3	SS	90					19 36 36 9
	traces of clay and		4	SS	144/8"					6 50 37 7
	some gravel.		5	SS	105/6"					
			6	SS	83/3"					
			7	SS	130/8"					
			8	SS	50/3"					6 50 34 10
	Very Dense									
			9	SS	153					
			10	SS	111/9"					
			11	SS	100/4"					21 68 (11)
			12	SS	106					
			13	SS	134/3"					3 62 (35)
546.3			14	SS	100/3"					
55.7	End of Borehole									

GROUND WATER ELEV. scale: 600, 590, 580, 570, 560, 550, 540

20 / 15 ◇ 5 / 10 % STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2 (B.H. 10 - 70-11016)

W.P. 160-74-13 LOCATION Co-ords. 919,854 N; 1,038,881 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE March 5, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE	LIQUID LIMIT W_L, PLASTIC LIMIT W_P, WATER CONTENT W (W_P — W — W_L) / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR. SA SI. CL
601.8	Ground Level									
	topsoil					600				
1.0	Clayey silt with some sand		1	SS	16					
593.8	Stiff		2	SS	35			OH		0 15 45 40
8.0	Silty fine sand to fine sandy silt with traces of clay and gravel.		3	SS	63					8 39 45 8
			4	SS	160/9"	590		OH		
			5	SS	50/2"			o		4 49 45 2
			6	SS	75/4"			o		
			7	SS	150/	6" 580		o		
	Very dense		8	SS	140/5"					
571.3			9	SS	150/	6"		o		36 48 9
30.5	End of Borehole					570				

15 20 5 10 % STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3 (B.H. 9-70-11016)

W.P. 160-74-13 LOCATION Co-ords. 919,876 N; 1,038,946 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE March 3, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	LIQUID LIMIT W_L, PLASTIC LIMIT W_P, WATER CONTENT W (W_P — W — W_L) WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR. SA. SI. CL.
600.2	Ground Level					600				
	Topsoil									
1.0	Clayey silt with some sand & traces gravel.		1	SS	9					
591.2	Stiff to very stiff		2	SS	21					3 32 43 22
9.0			3	SS	74	590				
	Silty fine sand with traces of clay & some gravel.		4	SS	125					1 49 35 5
			5	SS	180/3"					
			6	SS	50/2"					15 49 33 3
	Dense to very dense.		7	SS	90/6"	580				
			8	SS	115					
568.7			9	SS	43	570				3 71 (26)
31.5	End of Borehole									
						560				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 4 (B.H. 2-70-11016)

W.P. 160-74-13 LOCATION Co-ords. 919,895 N; 1,039,012 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE February 23, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w (w_P w w_L) WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR. SA. SI. CL
598.2	Ground Level									
	Topsoil									
1.0	Clayey silt with traces of sand and gravel.		1	SS	14					
			2	TW	PH					
586.7	Stiff		3	SS	41	590				
11.5			4	SS	61					
	Silty fine sand with traces of clay & some gravel.		5	SS	76/6"					2 52 36 10
			6	SS	100/6"	580				
			7	SS	70/3"					
	Dense to very dense		8	SS	77					
						570				
			9	SS	110					26 35 33 6
			10	SS	66					
			11	SS	110/5"	560				20 41 33 6
554.2										
44.0	Clayey silt with traces of sand & gravel		12	SS	108/5"					
	Hard					550				
546.7			13	SS	142					
51.5	End of Borehole					540				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5 (B.H. 3-70-11016)

W.P. 160-74-13 LOCATION Co-ords. 919,821 N; 1,039,147 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE February 26, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	LIQUID LIMIT W_L, PLASTIC LIMIT W_P, WATER CONTENT W (W_P — W — W_L) / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR SA SI CL
596.8	Ground Level									
	Topsoil									
1.0	Clayey silt with traces of sand and gravel. Stiff		1	SS	14					
589.3			2	SS	25	590				
7.5	Silty fine sand with traces of clay and some gravel. Very dense		3	SS	106					8 49 37 6
			4	SS	70					
			5	SS	100/6"	580				9 47 42 2
			6	SS	145/9"					
			7	SS	100/6"					
			8	SS	131/10"	570				
			9	SS	125/9"					
			10	SS	148/9"	560				13 45 37 5
			11	SS	114					
			12	SS	64	550				22 47 27 4
			13	SS	54					
542.8			14	SS	150/0"					
54.0	Clayey silt with traces of gravel Hard		15	SS	72	540				
538.3										
58.5	End of Borehole					530				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 6 (B.H. 8-70-11016)

W.P. 160-74-13 LOCATION Co-ords. 919,811 N; 1,039,117 E ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE March 3, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill CHECKED BY

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w, WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR. SA. SI. CL
597.7	Ground Level									
	Topsoil									
1.0	Clayey silt with some sand		1	SS	14					0 15 39 46
591.2	Stiff		2	SS	28					6 40 43 10
6.5	Silty fine sand to fine sandy silt with traces of clay & gravel.		3	SS	78	590				
			4	SS	57					7 43 40 10
			5	SS	89					
578.2			6	SS	159	580				
19.5	End of Borehole					570				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 7 (B H 5 - 70 - 11016)

W.P. 160-74-13 LOCATION Co-ords. 919,781 N; 1,039,017 E. ORIGINATED BY HS

DIST. 6 HWY. 404 BORING DATE March 2, 1970 COMPILED BY HS

DATUM Geodetic BOREHOLE TYPE Pen Drill CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w (w_P — w — w_L) / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR SA SI CL
599.6	Ground Level									
1.0	Clayey silt with some sand.		1	SS	17					0 15 58 27
593.6	Very stiff		2	SS	52					
6.0	Silty fine sand with traces of clay and some gravel.		3	SS	134/7"	590				
			4	SS	112/6"					11 46 37 6
			5	SS	100/5"					
580.6	Dense to very dense		6	SS	170/5"					16 54 24 6
19.0	End of Borehole					580				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 8 (B.H 4-62-F-43)

W.P. 160-74-13 LOCATION Co-ords. 919,764 N; 1,038,954 E. ORIGINATED BY GH

DIST. 6 HWY. 404 BORING DATE May 2, 1962 COMPILED BY BK

DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing & Cone Penetration CHECKED BY GR

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER ELEV.
599.0	Ground Level					
598.0	Topsoil					
1.0	Clayey silt with sand and occasional gravel		1	SS	20	
			2	SS	21	
591.0	Med. dense-Brown.		3	SS	48	
8.0	Silty-fine sand with occasional gravel.					590
	Very dense-Brown		4	SS	> 100	
578.6			5	SS	> 100	580
21.0	End of Borehole					570

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100)

SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE

LIQUID LIMIT w_L — PLASTIC LIMIT w_P — WATER CONTENT w — WATER CONTENT % (20, 40, 60)

UNIT WEIGHT γ

REMARKS: % GR SA SI CL

20 15 ◇ 5 10 % STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 11

W/P 160-74-13 LOCATION Co-ords. 919,910 N; 1,039,127 E. ORIGINATED BY C.McK

DIST 5 HWY. 404 BORING DATE February 27, 1975 COMPILED BY C.McK

DATUM Geodetic BOREHOLE TYPE Auger with CME 750 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w (w_P — w — w_L) WATER CONTENT %	UNIT WEIGHT γ	REMARKS % GR SA SI C
595.0	Ground Level									
0.0	Topsoil									
1.0	Clayey silt with some sand & traces of organics		1	SS	12					
589.0	Stiff to v. stiff		2	SS	28	590				
6.0	Silty sand with traces of clay and some gravel.		3	SS	48					
			4	SS	63					
			5	SS	102					
			6	SS	111	580				
	Dense to v. dense		7	SS	171					
			8	SS	100/3"	570				
			9	SS	154					
558.5			10	SS	133	560				
36.5	End of Borehole					550				

15 20 5 % STRAIN AT FAILURE 10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 12

W.P. 160-74-13 LOCATION Co-ords. 919,731 N; 1,038,769 E. ORIGINATED BY C.McK

DIST. 6 HWY. 404 BORING DATE March 3, 1975 COMPILED BY C. McK

DATUM Geodetic BOREHOLE TYPE Auger and Sample with CME 750 CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w (w_P — w — w_L) / WATER CONTENT %	UNIT WEIGHT γ	REMARKS % GR SA SI CL
603.0	Ground Level									
0.0	Topsoil									
1.0	Clayey silt with some sand & traces of organics. Stiff		1	SS	12	600				
597.0			2	SS	13					
6.0	Silty sand with traces of clay and some gravel.		3	SS	53					
			4	SS	53					
			5	SS	54	590				
			6	SS	48					
			7	SS	150/10"		100/6"			
						580				
	Dense to very dense.		8	SS	106					
			9	SS	33					
						570				
			10	SS	110					
						560				
			11	SS	155/11"					
						550				
547.1			12	SS	100/3"					
55.9	End of Borehole									
						540				

20
15 ⊹ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

GRAIN SIZE DISTRIBUTION

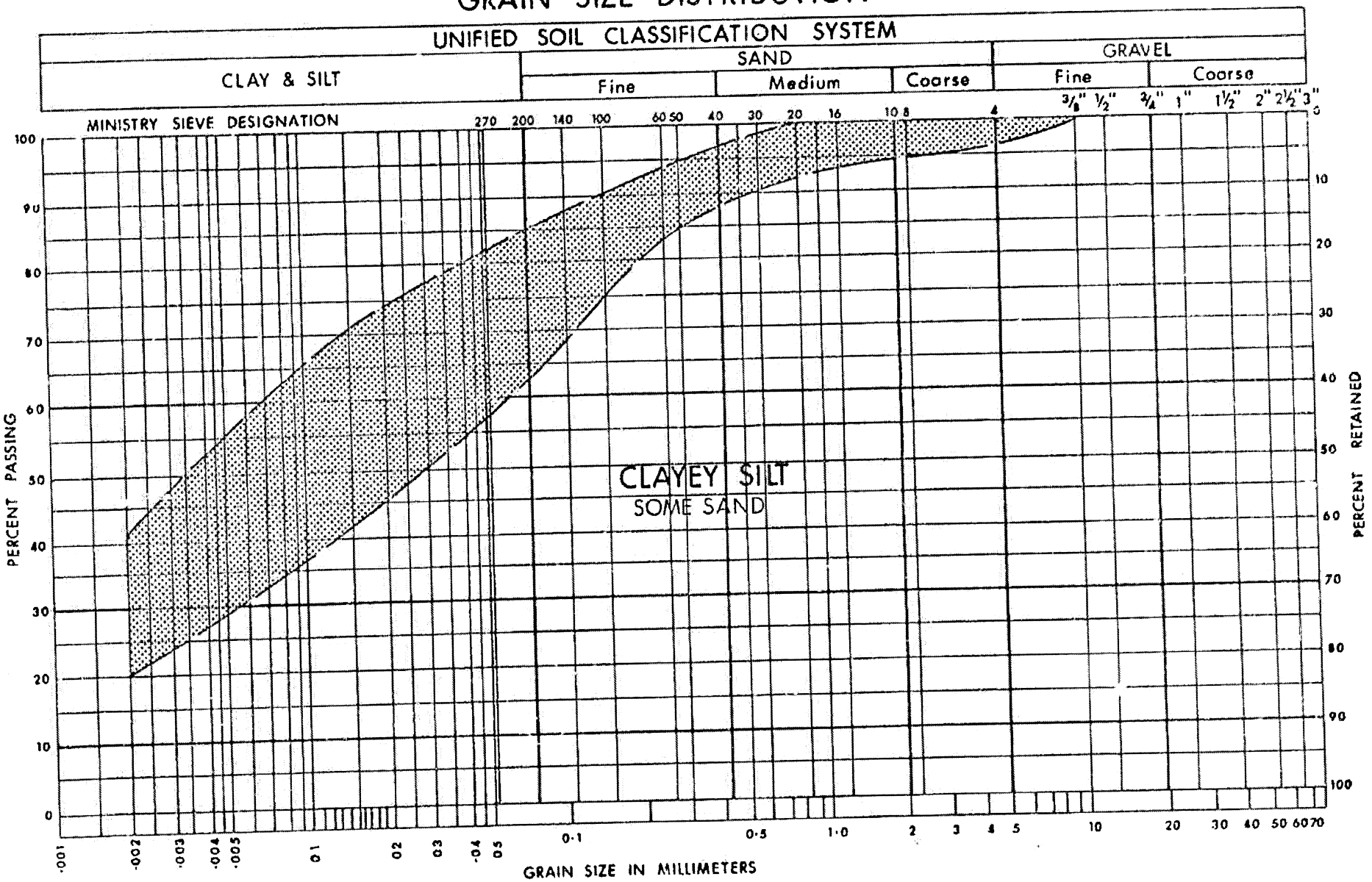


FIG. 1

GRAIN SIZE DISTRIBUTION

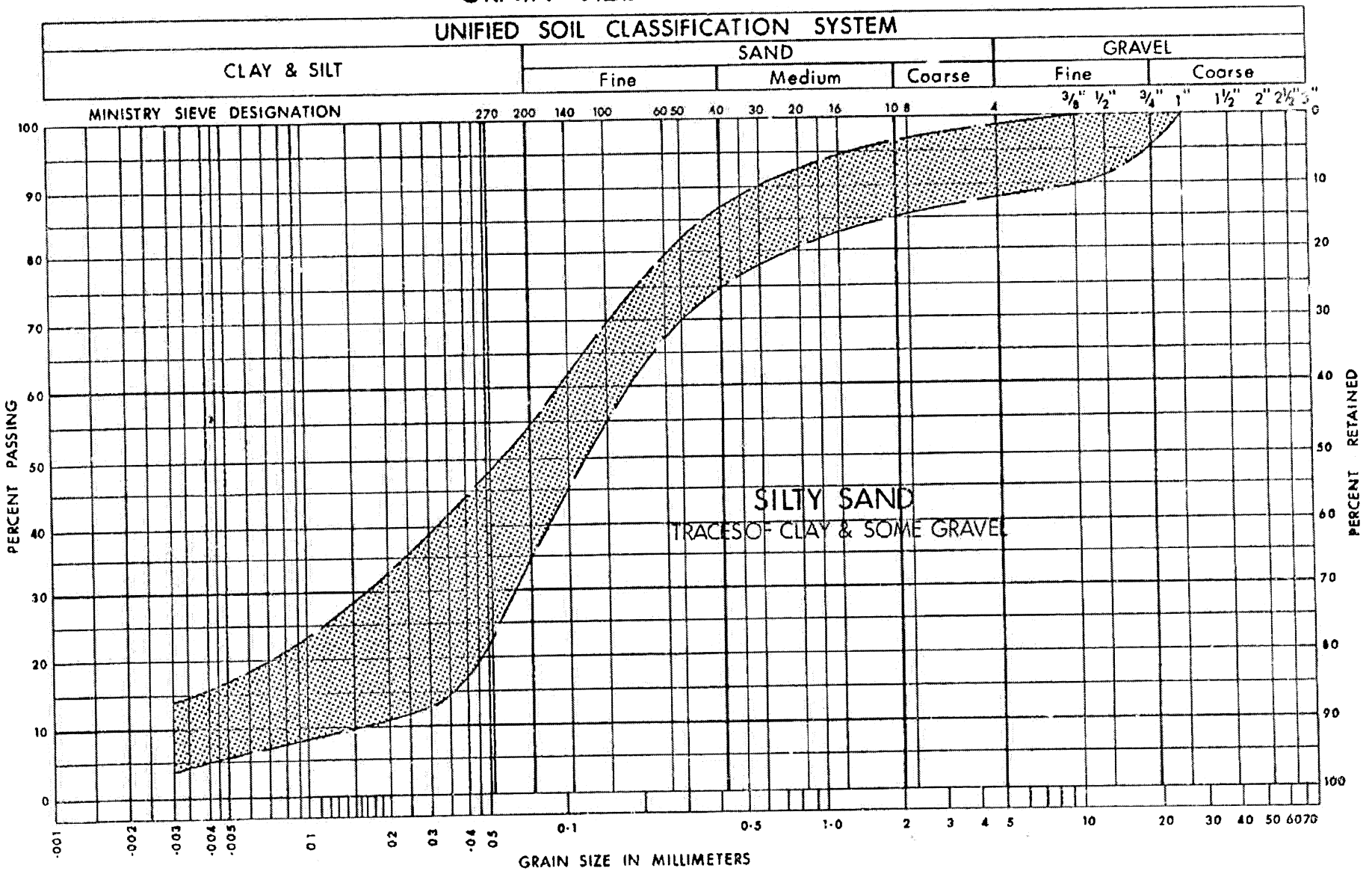
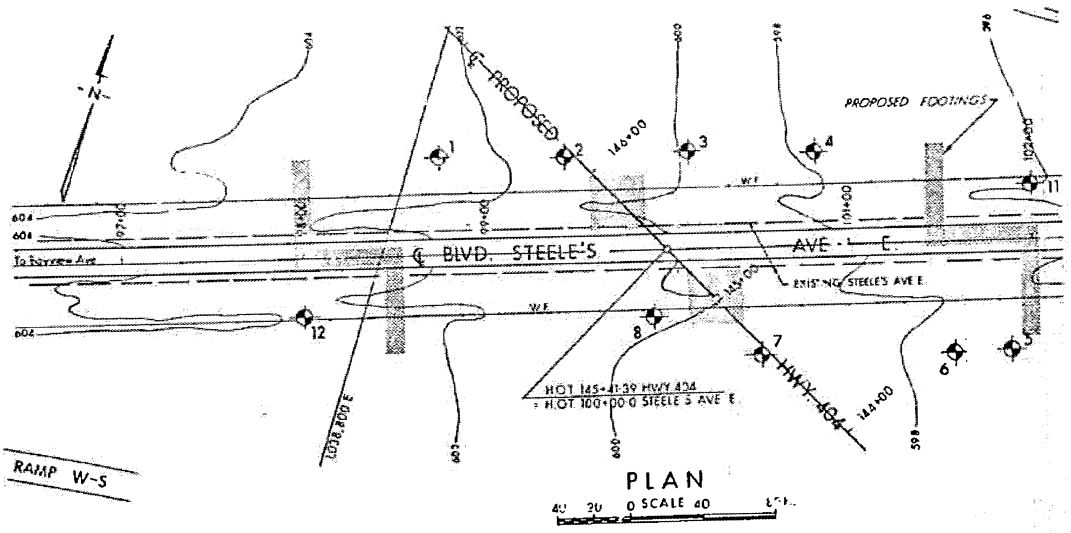
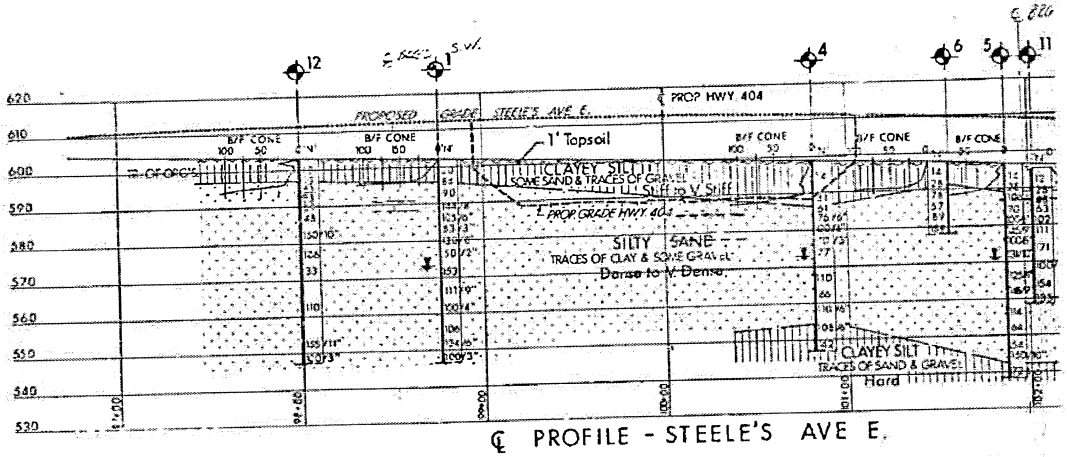


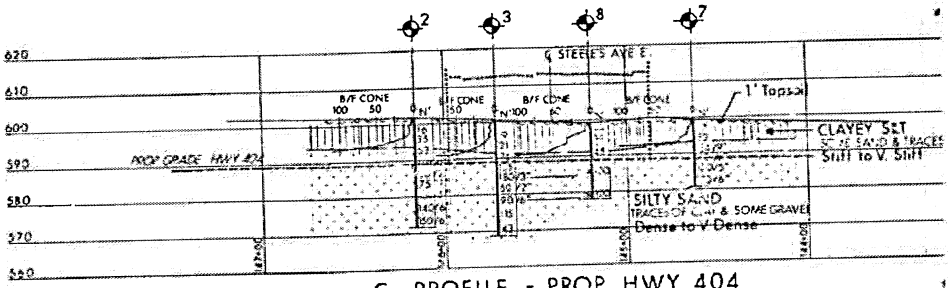
FIG. 2

W.P. 160-74-13





℄ PROFILE - STEELE'S AVE E.

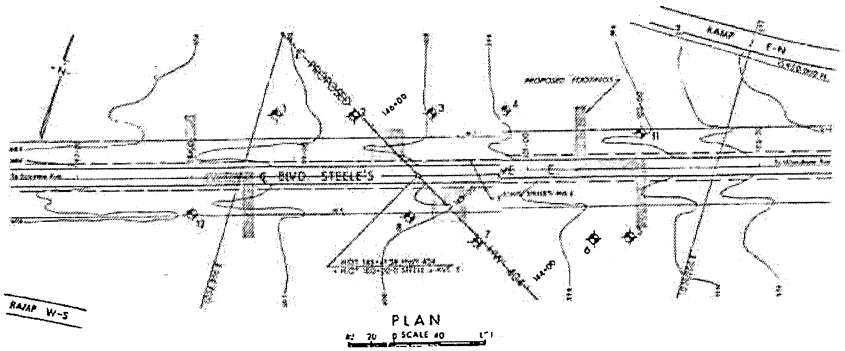


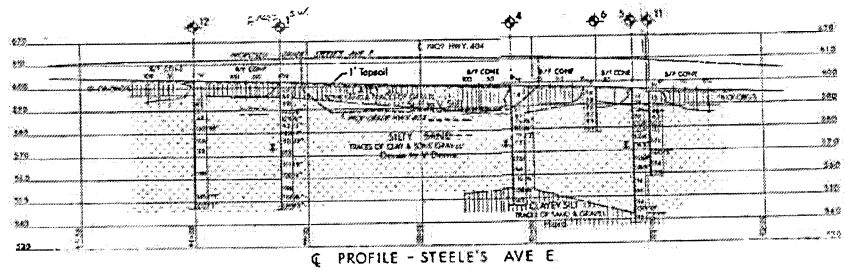
℄ PROFILE - PROP. HWY. 404

SCALE FOR PROFILES

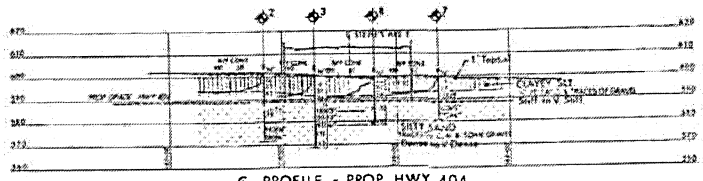
VERT 20 10 0 20 40 FT

HORIZ 40 20 0 40 80

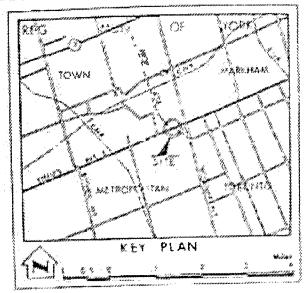




℄ PROFILE - STEELE'S AVE E.



℄ PROFILE - PROP. HWY. 404



LEGEND

- Bore Hole
- Dynamic Cone Penetration Resistance Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation FEB 1970

Water level in bore holes 2,3,6,7,8, 11 & 12 not established at time of field investigation

NO.	ELEVATION	CO-ORDINATES NORTH	EAST
1	602.0	919,835	1,038,815
2	601.8	919,854	1,038,881
3	600.2	919,876	1,038,845
4	597.	9	1,038,282
5	596.8	9	1,038,147
6	597.7	919,811	1,038,113
7	599.6	919,781	1,038,017
8	599.0	919,762	1,038,914
11	595.0	919,810	1,039,137
12	603.0	919,731	1,038,769

— NOTE —

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

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 [illegible] Office.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS — ONTARIO

STEELE'S AVE E.

HIGHWAY NO. PROP. 404 — DIST. NO. 6

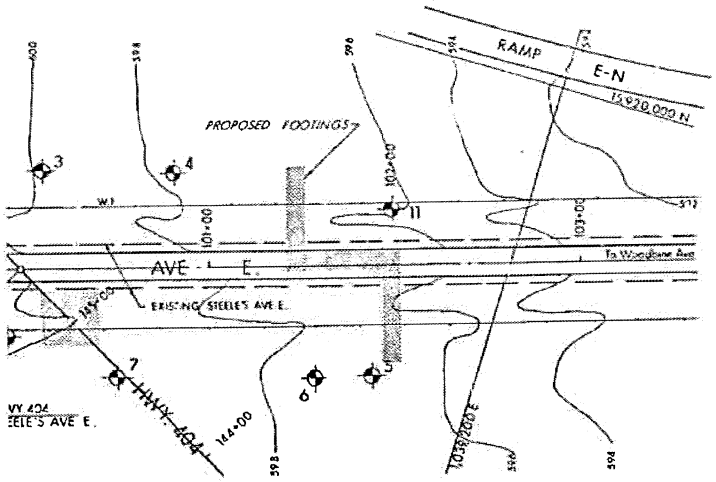
REG. MUN. OF YORK — METRO. TORONTO

TOWN OF MARKHAM — CON.

BORE HOLE LOCATIONS & SOIL STRATA

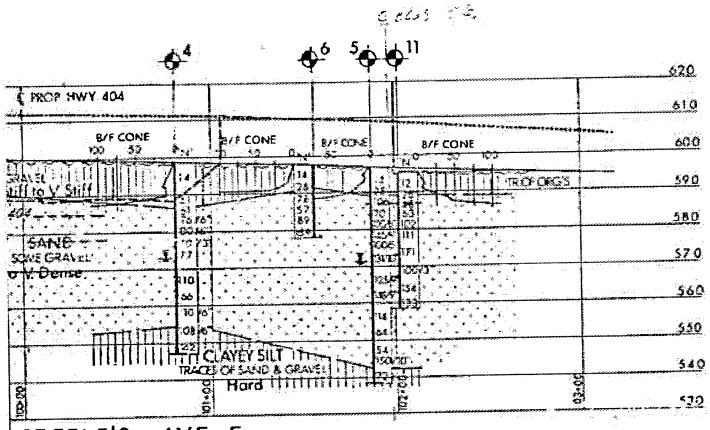
160741 3-A

DES. COLE SHERMAN & ASSOCIATES LTD.

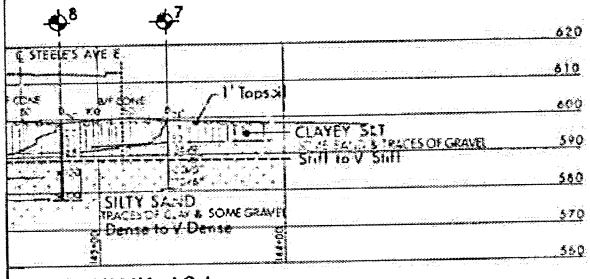


AN

ALE 40 FT.



STEELE'S AVE E.

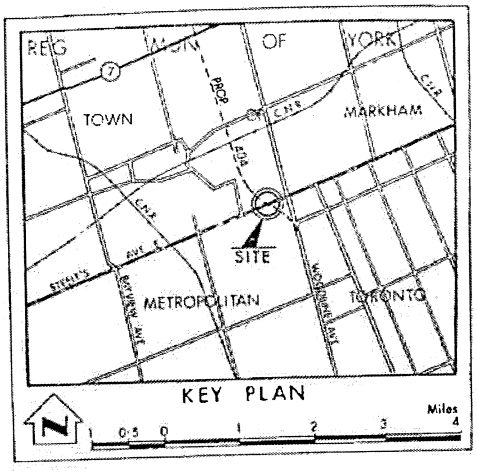


PROP. HWY. 404

FOR PROFILES

20 40 FT

40 80



LEGEND

- Bore Hole
- Dynamic Cone Penetration Resistance Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation FEB. 1970

Water Level in boreholes 2,3,6,7,8, 11 & 12 not established at time of field investigation

NO.	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	602·0	919,835	1,038,815
2	601·8	919,854	1,038,881
3	600·2	919,876	1,038,946
4	598·?	919,895	1,039,012
5	596·8	919,821	1,039,147
6	597·7	919,811	1,039,117
7	599·6	919,781	1,039,017
8	599·0	919,784	1,038,958
11	595·0	919,910	1,039,127
12	603·0	919,731	1,038,769

B.H.'S 1 to 7 DONE IN 1970 (70-1101A)
B.H. 8 " " 1962 (62-F-43)
B.H.S. 11&12 " " 1975

— NOTE —

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

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 TORONTO District Office.

REVISIONS	DATE	BY	DESCRIPTION

REF. COLE, SHERMAN & ASSOCIATES LTD.

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

STEELE'S AVE E.

HIGHWAY NO PROP. 404 DIST NO 6

REG. MUN. OF YORK METRO. TORONTO

TOWN OF MARKHAM LOT CON

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD V.K.	CHECKED	MAP NO 160-74-13	DRAWING NO 1607413-A
DRAWN S.D.	CHECKED	T.A.C. NO	
DATE 7 MAR 1975	SITE NO 37-27A		MICROFILM DRAWING NO
APPROVED	CONT NO		

FOUNDATION INVESTIGATION REPORT
For
Proposed Crossing at
Steeles Avenue East
And
New King's Hwy. No. 404
District No. 6 (Toronto)
W.J. 70-F-16 -- W.J. 293-61

1. INTRODUCTION:

A memo requesting a foundation investigation at the site of the above mentioned structure site, was received from Mr. W. S. Melinyshyn, Regional Bridge Planning Engineer, on February 11, 1970.

A field investigation was subsequently carried out by this Section in order to determine the subsoil and groundwater conditions at the site.

This report contains the results of our field and laboratory investigations, together with our recommendations pertaining to the design of foundations for the proposed structure and the stability of the approach embankments.

2. DESCRIPTION OF THE SITE:

The proposed structure is located on Steeles Ave. East approximately 1,000 ft. west of Woodbine Ave. in Metropolitan Toronto, and will carry Highway #404 over Steeles Ave.

Physiographically, this area is referred to as the "Peel Plain".

Gently rolling terrain is prevalent throughout this area, and the immediate vicinity of the site consists mostly of cultivated farmland.

3. FIELD AND LABORATORY WORK:

A total of 9 sampled boreholes and 10 dynamic cone penetration tests was carried out during the course of the field investigation, using a continuous flight auger machine adapted for soil sampling purposes. During the field work, disturbed samples were obtained by means of a standard split-spoon sampler; the energy used in driving it, conformed to the requirements of the Standard Penetration Test. The same method was used to advance the dynamic cones.

The samples were visually examined in the field and subsequently in the laboratory. Following this examination, laboratory tests were carried out on selected samples to determine the various physical properties of the subsoil, namely:

Atterberg Limits
Moisture Contents
Grain-size Distributions

The laboratory test results are plotted on the individual Record of Borelog sheets. The results of typical mechanical analyses tests are shown in Figs. 1 and 2 of the report Appendix.

The locations and elevations of all boreholes were surveyed by personnel from the Toronto Regional Engineering Surveys Section and are shown on Dwg. 70-F-16A, which accompanies this report.

4. SUBSOIL CONDITIONS:

4.1) General:

Generally uniform conditions were found to prevail over the site area. Subsoil consists from 6 to 13.5 ft. of stiff to hard clayey silt with traces of sand and gravel followed by at least 30 ft. of very dense silty sand to sandy silt. Detailed descriptions of various soil types encountered in each borehole

..... 3

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

4.1) General: (cont'd.) ...

are given on the Record of Borehole sheets. The estimated stratigraphical profile of Drawing No. 70-F-16A is based upon this information.

From ground level downwards, the various soil types encountered are as follows:

4.2) Clayey Silt with Traces of Sand and Gravel:

Underlying 1.0 ft. of clayey topsoil, a stratum of clayey silt with traces of sand and gravel was encountered. The clayey silt stratum, ranging in thickness from 6 - 11.5 ft., extends over the entire area investigated.

Physical properties of the material in the deposit, as determined from field and laboratory tests, are summarized as follows:

Liquid Limit	:	23.1% to 42.1%
Plastic Limit	:	15.3% to 25.7%
Moisture Content	:	14.6% to 24.0%
Grain-size Distribution:-		
Gravel	:	5.0% (Avg.)
Sand	:	15.0% to 32.0%
Silt	:	39.0% to 53.0%
Clay	:	22.0% to 46.0%
'N' Values	:	9 to 71 blows/ft.

Typical grain-size distribution curves are given in the Appendix of this report in Fig. 2. Based on the foregoing, it is estimated that the undrained shear strength of this material is in the range 1500 p.s.f. to more than 10,000 p.s.f. The average strength, however, is estimated to be approximately 2000 - 3000 p.s.f.

..... 4

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

4.3) Silty Fine Sand to Fine Sandy Silt with Traces of Clay and Some Gravel:

Below the clayey silt stratum a very dense deposit of silty fine sand to fine sandy silt with traces of clay and some gravel was found. The thickness of the stratum varies from 34 to at least 49 ft. which was the maximum depth tested. Physical properties of the deposit, as determined from laboratory tests, are as follows:

Moisture Content	:	4.1% to 14.4%
Grain-size Distribution:-		
Gravel	:	2.0% to 26.0%
Sand	:	33.0% to 68.0%
Silt	:	11.0% to 48.0%
Clay	:	2.0% to 10.0%

Typical grain-size distribution curves are given in the Appendix of this report in Fig. 2. The relative density of the deposit, based on results of the Standard Penetration tests, is estimated to be very dense, with the 'N' values varying from 52 to more than 100 blows/ft. and generally increasing with depth.

4.4) Clayey Silt with Traces of Gravel:

This deposit was encountered below the silty fine sand to fine sandy silt in boreholes #2 and #3. Its thickness was not determined, but it extends at least 5.0 ft. below the silty-sand stratum. The 'N' values ranged from 72 to over 100 blows/ft. indicating a hard consistency.

Physical properties, as determined from laboratory tests, are:

Liquid Limit	:	21.1% to 38.7%
Plastic Limit	:	12.6% to 19.7%
Moisture Content	:	15.4% to 21.7%

..... 5

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

4.4) Clayey Silt with Traces of Gravel: (cont'd.) ...

The average undrained shear strength is estimated to be in excess of 10,000 p.s.f.

5. GROUNDWATER CONDITIONS:

Water level observations were carried out in the open boreholes during the period of the investigation. Results show that the water level across the site is approximately 25 to 29 ft. below the ground level - i.e., between elevations 571.0 and 573.0.

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a new overpass structure at this site. Present proposals call for a two-span (51.0 ft. - 63.0 ft.) bridge, approximately 240 ft. wide and skewed at an angle of $133^{0}\pm$. The centre-line of Steeles Ave. will remain as is, but the grade will be lowered some 10 ft. The proposed grade of Hwy. #404 is such that approach fills of maximum height of about 22 ft. above the future Steeles Ave. grade will be required.

As mentioned earlier in this report, the subsoil at the site consists of clayey topsoil, followed by stiff to hard clayey silt with traces of sand and gravel for a maximum depth of 11.5 ft., followed by approximately 34 to 49 ft. of very dense silty fine sand to fine sandy silt with traces of clay and some gravel, followed by hard clayey silt with traces of gravel.

The subsoil conditions are such that spread footing type foundations may be utilized for the bridge piers and abutments.

The following recommended footing elevations for the piers and abutments have been obtained, assuming a depth of 4.0 ft. below the proposed final grade level (590.0) to ensure

..... 6

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

adequate frost protection. In this event, therefore, the piers and abutments may be supported on spread footings founded at or below the following elevations:

North Abutment	:	El. 586.0
Centre Pier	:	El. 586.0
South Abutment	:	El. 586.0

A net safe bearing pressure of 4.0 tons/ft.^{2} may be assumed for design purposes.

If changes in grade from that presently proposed occur, suitable footing elevations may be determined by interpolating between the following elevations given for each borehole location, assuming a net safe bearing capacity of 4.0 t.s.f.

Borehole 1	-	At or below	El. 597.0
2	-	" " "	El. 586.0
3	-	" " "	El. 588.0
4	-	" " "	El. 591.0
5	-	" " "	El. 592.0
6	-	" " "	El. 588.0
7	-	" " "	El. 588.0
8	-	" " "	El. 588.0
9	-	" " "	El. 590.0
10	-	" " "	El. 593.0

No dewatering problems are anticipated since excavations will be well above the groundwater level. It is recommended, however, that a suitable working slab be constructed as soon as possible after the excavations are completed, in order to protect the foundation soil from surface water.

No stability problems are anticipated for the proposed approach embankments on Hwy. #404, or the proposed cuts on Steeles Ave.

..... 7

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

If it is decided to construct the abutments perched within the fills, a piled foundation is recommended. It is believed that steel H-piles would be the most suitable type of pile for this purpose. Design loads may be the maximum allowable for the particular steel section adopted. It is estimated that the maximum load will be achieved by driving the piles to approximately el. 580±.

7. MISCELLANEOUS:

The field work, performed during the period from February 23 to March 5, 1970, together with preparation of this report, was undertaken by Mr. H. Szymanski, Foundation Technician.

Equipment used was owned and operated by Canadian Longyear Limited.

The report was reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

April, 1970

GEOCRES No. 30 H14-62

DIST 6 REGION CENTRAL

W.P. No. 160-74-13

CONT. No. 76-107

W.O. No.

STR. SITE No. 37-294

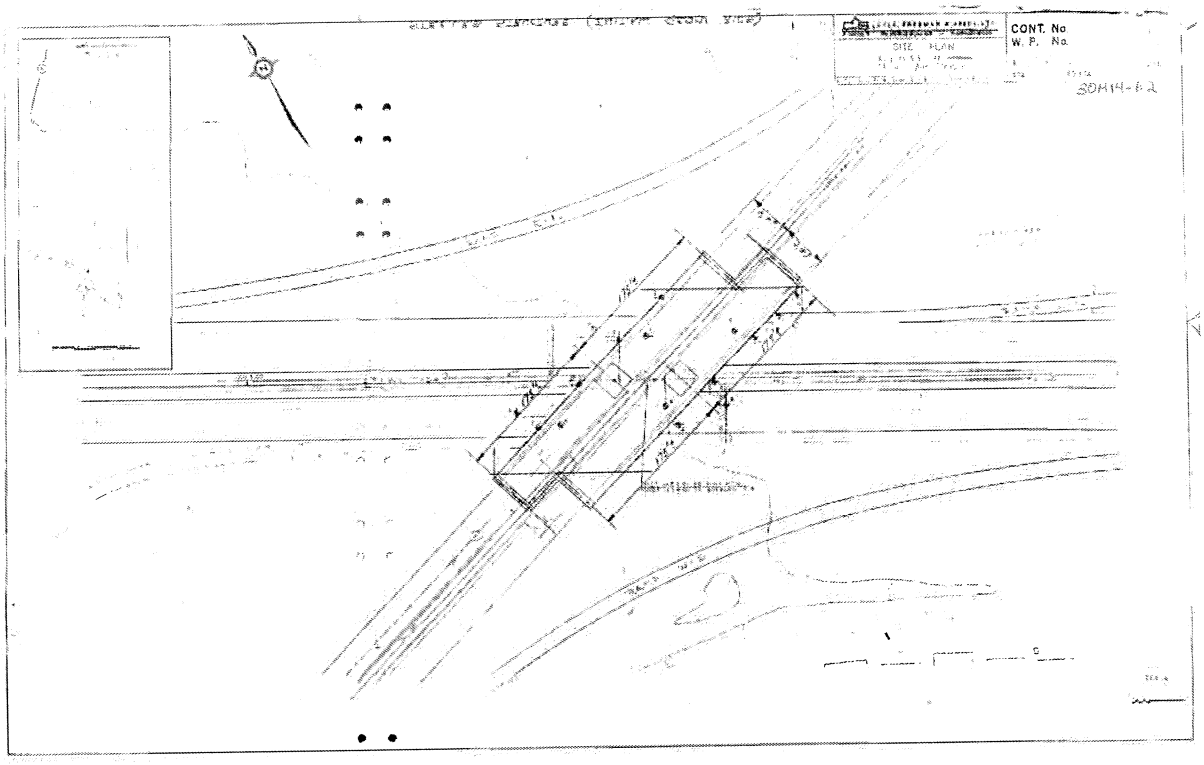
HWY. No. 404

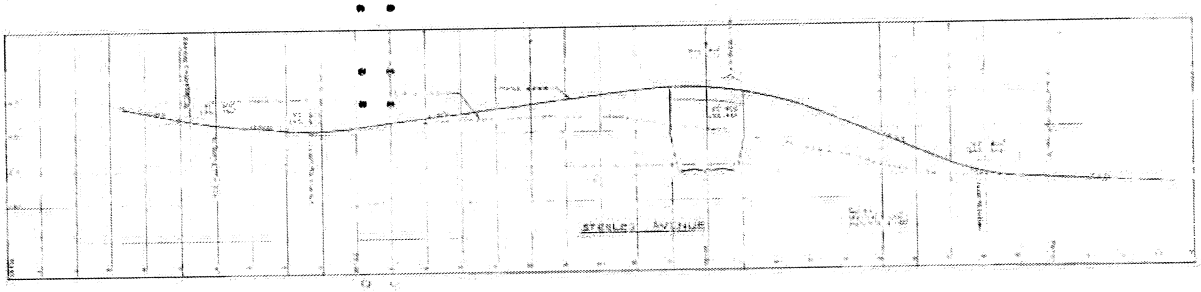
LOCATION STEELES AVE.

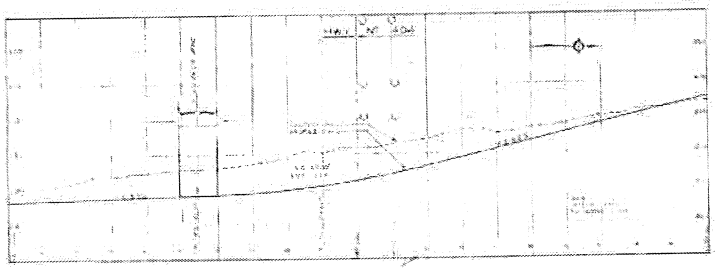
INTERCHANGE UNDERPASS

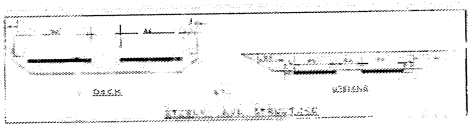
4

REMARKS:

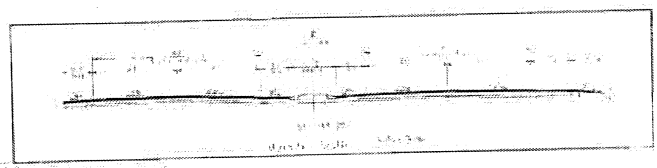


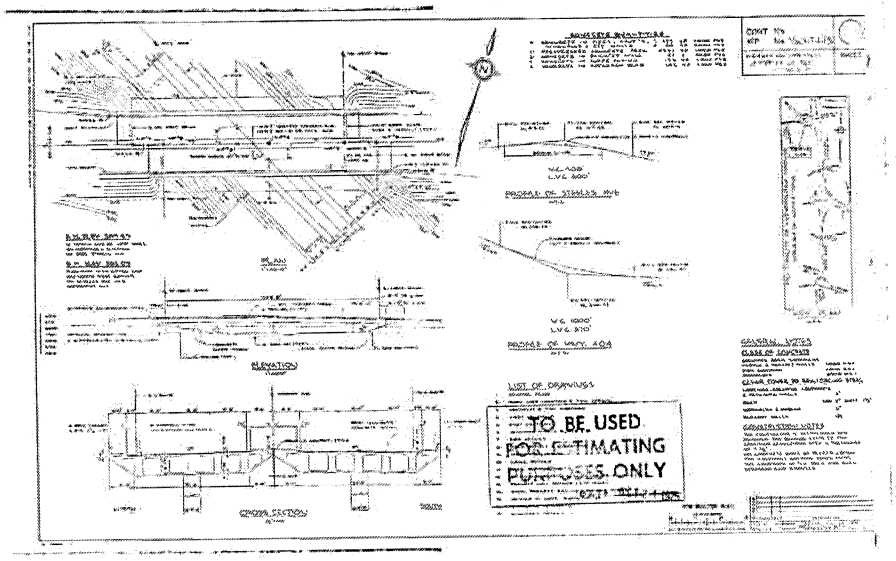


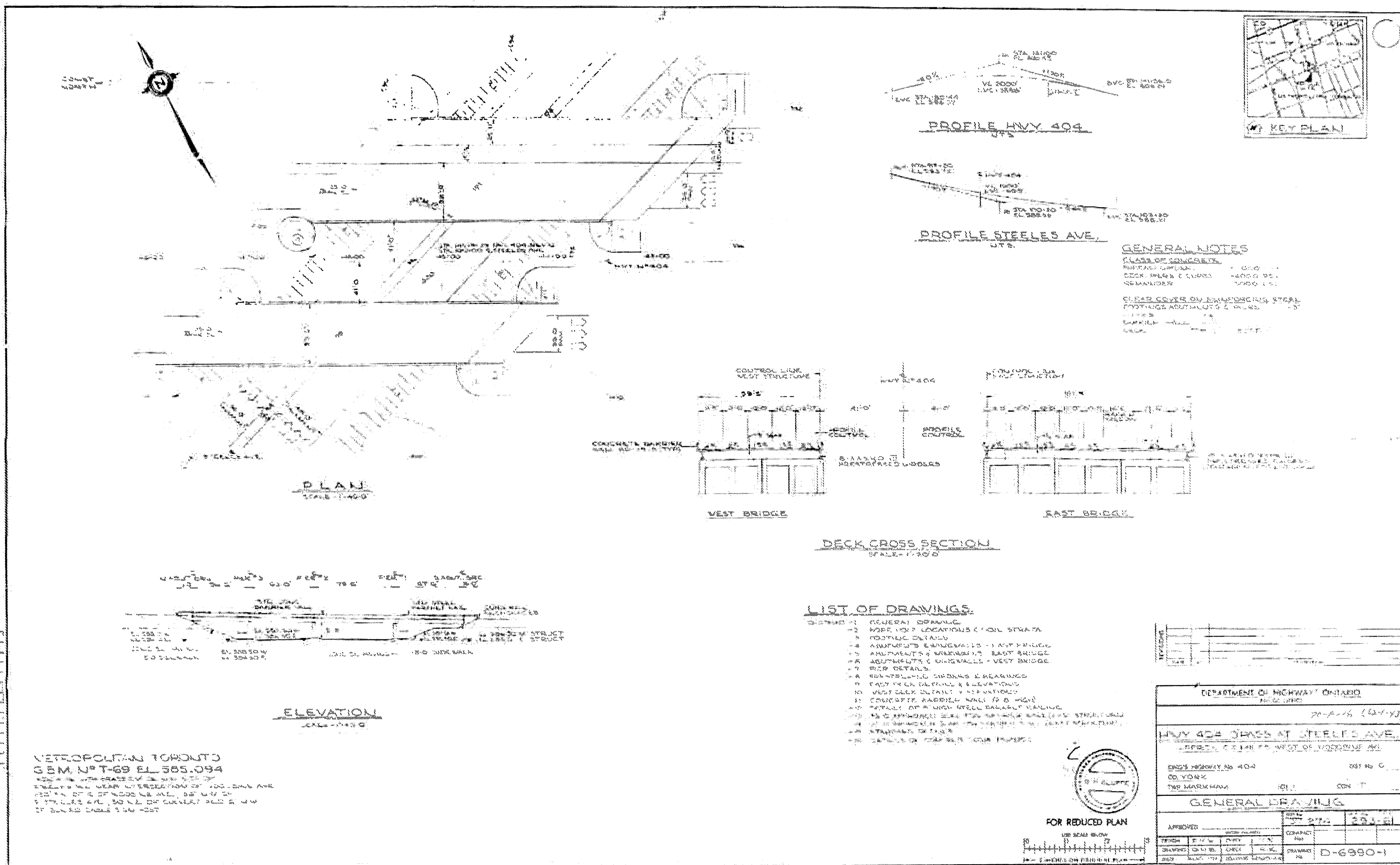


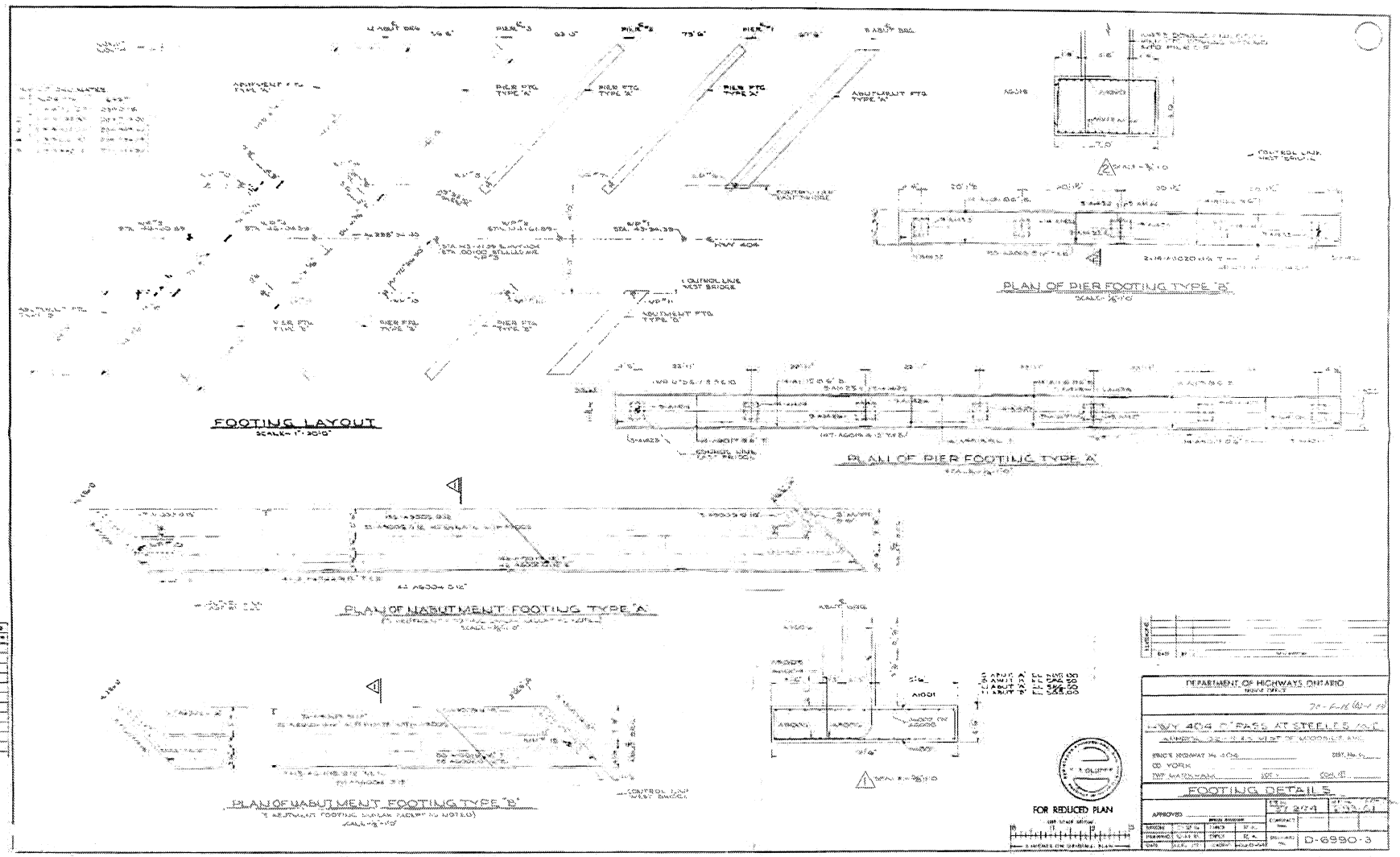


ISSUED




TO BE USED
FOR ESTIMATING
PURPOSES ONLY


KEY PLAN
PROFILE HWY 404
PROFILE STEELES AVE.
GENERAL NOTES
CLASS OF CONCRETE
CLEAR COVER ON REINFORCING STEEL
PLAN
WEST BRIDGE
EAST BRIDGE
DECK CROSS SECTION
ELEVATION
LIST OF DRAWINGS
METROPOLITAN TORONTO
G.B.M. No T-69 EL 585.094
FOR REDUCED PLAN
DEPARTMENT OF HIGHWAYS ONTARIO
HWY 404 O'PASS AT STEELES AVE.
KING'S HIGHWAY No 404
CO. YORK
TWP MARKHAM
GENERAL DRAWING
D-6990-1
30HH-62


FOOTING LAYOUT
SCALE: 1" = 20'-0"
PLAN OF PIER FOOTING TYPE "B"
PLAN OF PIER FOOTING TYPE "A"
PLAN OF ABUTMENT FOOTING TYPE "A"
PLAN OF ABUTMENT FOOTING TYPE "B"
FOR REDUCED PLAN
DEPARTMENT OF HIGHWAYS ONTARIO
HWY 404 O'PASS AT STEELES AVE.
D-6990-3

Mr. A. M. Toye,

Bridge Engineer.

Materials & Research Division,

(Foundation Section)

Attention: Mr. S. McCombie.

May 30, 1962.

D.H.C. FOUNDATION INVESTIGATION REPORT.

W.J. 62-F-43 -- W.P. 293-61.

Re: Proposed Interchange at Metro Limits, Hwy. #404 & Steeles Ave., Line 'A', District #6.

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

We believe the factual data and recommendations contained therein, should prove adequate for your future design work. Should you require further information, please feel free to contact our office.

K. Y. Lo,
SUPERVISING FOUNDATION ENGR.

For:

A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

AGS/MdeF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
I. C. Campbell
C. Fraser
T. J. Kovich
J. Foy
J. E. Gruspier
S. A. Saint
F. Norman
A. Watt
Foundations Office
Gen. Files.

TABLE OF CONTENTS

1. INTRODUCTION.

2. DESCRIPTION OF SITE.

3. FIELD & LABORATORY INVESTIGATION.

4. SUBSOIL CONDITIONS.

5. GROUND WATER CONDITIONS.

6. DISCUSSION & RECOMMENDATIONS.

7. SUMMARY.

8. MISCELLANEOUS.

FOUNDATION INVESTIGATION

For

Proposed Interchange at Metro Limits,
Hwy. #404 & Steeles Ave., Line 'A',
District #6
W.J. 62-F-43 -- W.P. 293-61.

1. INTRODUCTION:

A memo dated April 19, 1962, requesting a foundation investigation at the site of the proposed new structure, was received from the Bridge Location Engineer on April 25, 1962.

The requested investigation was carried out by this section and presented in this report, are the field and laboratory results, their interpretation and discussion, as well as the necessary recommendations for the foundations of the proposed new overpass.

2. DESCRIPTION OF SITE:

The proposed structure is located approximately 1,000 ft. west of Woodbine Ave., and will carry Highway #404 over Steeles Ave. Gently rolling terrain is prevalent throughout this area, and consists mostly of cultivated farm land.

3. FIELD & LABORATORY INVESTIGATION:

Eight boreholes were drilled at the site, utilizing a conventional diamond drill rig. Disturbed samples were recovered using a 2-inch O.D. split-spoon sampler driven into the soil with an energy of 350 ft.-lbs. per blow. Dynamic Cone Penetration tests were also carried out adjacent to each borehole: the penetration values thus obtained are plotted on the attached borehole logs.

cont'd. /2 ...

2. FIELD & LABORATORY INVESTIGATION: (cont'd.) ...

The locations and elevations of all boreholes, including the estimated stratigraphical profile, are shown on the attached Plan No. 62-F-43A. All elevations are referred to a D.H.O. Bench Mark located in the vicinity and are of geodetic origin.

Each sample of the subsoil was visually classified in the field before transportation to the laboratory where a further visual classification was performed. Liquid limit, plastic limit, moisture content and grain size distribution tests were carried out on representative samples.

The results of these tests are included in the Appendix I of this report.

3. SUBSOIL CONDITIONS:

The subsoil stratification was found to be generally uniform within the area investigated.

Loose clayey topsoil to a depth of 1'-0 was found in all eight boreholes. Underlying this topsoil, a stratum of brown clayey-silt with sand and occasional gravel was discovered.

This clayey-silt deposit, ranging in thickness from - 8 ft. extends over the entire area investigated. Atterberg limits performed on representative samples, gave the following average results:- Liquid limit 35%, plastic limit 20%, moisture content 21%.

cont'd. /3 ...

. SUBSOIL CONDITIONS: (cont'd.) ...

Relative density as determined by both dynamic cone and standard penetration results, in the clayey-silt stratum, ranges from loose to dense, varying from 6 to 28 blows/foot.

Below the clayey-silt with sand and gravel layer, a very dense, brown silty-sand deposit with some gravel, was found. Standard penetration values of not less than 50 blows/ft. were recorded, and in most cases, the blows per foot were in excess of 100 and increasing with depth.

The thickness of the silty-sand deposit was not determined, but it extends at least 31 ft. below the ground level to elevation 567.0.

The highest elevation of the top of this layer is 598.0 (B.H. #5) and the lowest elevation is 589.0 (B.H.'s #1 & #2).

Gradation test on this non-cohesive silty-sand stratum yielded the following average results:- silt 40%, sand 40%, gravel 10%, and clay 10%. Average moisture content was found to be 9%.

. GROUND WATER CONDITIONS:

No evidence of a water table was found within the depth of the borings.

. DISCUSSION & RECOMMENDATIONS:

A three-span overpass is proposed at the site, to carry Hwy. #404 over Steeles Ave. at the Metro Limits.

The subsoil at the site consists of 1'-0 of clayey topsoil, followed by loose to dense, brown clayey-silt with sand

cont'd. /4 ...

. DISCUSSION & RECOMMENDATIONS: (cont'd.) ...

and some gravel to a maximum depth of 9.0 ft. Underlying the clayey-silt layer, a very dense, brown silty-sand deposit, to a depth of 31 ft. was found.

The very dense silty-sand stratum can support spread footings with a safe design pressure of 3 T.S.F.

Both the pier and abutment footings on the south side of Steeles Ave. should be placed at elevation 589.0 or below. On the north side, the pier footings may be placed at elevation 591.0, and the abutment footings at elevation 593.0 or below.

Alternately, the structure may be supported on concrete caissons founded in the very dense silty-sand stratum. For example, a 30" Ø concrete caisson with the lower portion belled, could provide a design load of 120 tons.

Large displacement tube piles driven to practical refusal in the very dense silty-sand stratum, may be used at the abutment locations. Tubular piles 12¾" x 1/4" at 33#/ft. can support a design load of 60 tons each, with pile tip elevation of 588.0.

No dewatering or embankment fill stability problems are anticipated.

7. SUMMARY:

Subsoil at the site consists of 1.0 ft. of clayey topsoil, followed by 4' to 8' of loose to dense clayey-silt with sand and some gravel, underlain by very dense silty-sand with occasional gravel.

cont'd/5 ...

7. SUMMARY: (cont'd.) ...

The very dense silty-sand deposit can provide a safe bearing capacity of 3 T.S.F.

In view of these conditions, three alternatives are suggested for consideration to determine the most economical solution:-

(1) Spread footings with safe bearing pressure of 3 T.S.F. at all locations:-

On the south side of Steeles Ave., the footing elevation for both piers and abutments to be 589.0 or below.

On the north side of Steeles Ave., the footing elevations to be 591.0 and 593.0 or below, for the piers and abutments, respectively.

(2) Footings for the structure supported by bored-in concrete caissons with a design load of 120 Ton per 30" diameter pile.

(3) Footings for the abutments supported on tubular steel piles driven to refusal. For tubular piles, 12¾" x 1/4" at 33#/ft., a design load of 60 T/pile may be used.

No dewatering or embankment fill stability problems are expected.

8. MISCELLANEOUS:

The field work, performed during the period from April 26/62 to May 8/62, together with the preparation of this report, was undertaken by Mr. G. Mierzynski. The investigation was carried out under the general supervision of Mr. M. Devata.

Equipment was owned and operated by the Johnston Drilling Co. of Ottawa.

May 1962.

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 :-

CONSISTENCY	'N' BLOWS/FT	c LB/SQ FT	DENSENESS	'N' BLOWS/FT.
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 INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
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 (YOUNGS 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_o	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

FORM 08 ML-126 REV 1961

81-4381

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO 1

FOUNDATION SECTION

JOB 62-F-43 LOCATION 55' Rt. of Sta. 14+00 ORIGINATED BY G.M.

W.P 291-61 BORING DATE April 26, 27 & 30, 1962. COMPILED BY B.K.

DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing & Cone Penetration. CHECKED BY G.M.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV SCALE
						600
598.0 / 0.0	Groundlevel					
597.0 / 1.0	Topsoil					
	Clayey-silt with sand and occasional fine gravel.		1	SS	15	
	Loose-Brown.		2	SS	9	590
			3	SS	8	
589.0 / 9.0			4	SS	50	
			5	SS	75	
	Silty - fine sand with occasional gravel.		6	SS	>107	
	Very dense					580
	- Brown.		7	SS	93	
			8	SS	130	
						570
567.0 / 31.0	End of borehole.		9	SS	150	

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % 15 30 45

BULK DENSITY γ P.C.F

REMARKS

61-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 62-F-43 LOCATION 60' Rt. of Sta. 13/30 ORIGINATED BY G.M.

W.P 293-61 BORING DATE April 30, 1962. COMPLETED BY B.K.

DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing & Cone Penetration CHECKED BY G.M.

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
597.0	Groundlevel					600				
0.0										
596.0	Topsoil									
1.0	Clayey-silt with sand. Loose to Med. Dense - Brown.		1	SS	28					
589.0						590				
8.0	Silty-fine sand with occasional gravel. Very dense-Brown.		2	SS	98					
			3	SS	138					
576.2			4	SS	>150	580				
20.8	End of borehole.									
						570				

61-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO 3

INVESTIGATION SECTION

JOB 62-F-43 LOCATION 30' Lt. of Sta. 14+10 PREPARED BY G.K.

W P 293-61 BORING DATE May 1, 1962. SAMPLED BY B.K.

DATUM Geodetic BOREHOLE TYPE Washboring - BX casing & Cone Penetration CHECKED BY G.M.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 / SHEAR STRENGTH PSF	LIQUID LIMIT ——— WL; PLASTIC LIMIT ——— WP; WATER CONTENT ——— W; WP — W — WL; WATER CONTENT % 10 20 30	BULK DENSITY PCF	REMARKS
597.5 / 0.0	Groundlevel					600				
596.5 / 1.0	Topsoil									
	Clayey-silt with sand. Med. dense-Brown.		1	SS	22	590				
591.0 / 6.5			2	SS	46					
	Silty-fine sand with occasional gravel. Very dense-Brown.		3	SS	>100	580				
			4	SS	>100					
571.5 / 26.0	End of borehole.		5	SS	>100	570				

61-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 62-F-43 LOCATION 30' Lt. of Sta. 14+80 DESIGNATED BY G.M.
W P 293-61 BORING DATE May 2, 1962. COMPILED BY B.K.
DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing & Cone Penetration. CHECKED BY G.M.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV SCALE
599.0	Groundlevel					600
598.8 / 1.0	Topsoil					
	Clayey-silt with sand and occasional gravel.		1	SS	20	
			2	SS	21	
591.0 / 8.0	Med. dense-Brown.		3	SS	48	590
	Silty-fine sand with occasional gravel.					
	Very dense-Brown.		4	SS	>100	580
578.0 / 21.0	End of borehole.		5	SS	>100	570

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P S F

LIQUID LIMIT —— W_L
PLASTIC LIMIT —— W_P
WATER CONTENT —— W
W_P W W_L
WATER CONTENT % 10 20 30

BULK DENSITY P.C.F.

REMARKS

DEPARTMENT OF HIGHWAYS ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 62-F-43 LOCATION 35' Lt. of Sta. 1+50 ORIGINATED BY G.M.
W.P. 293-61 BORING DATE May 2 & 3, 1962. COMPILED BY B.K.
DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing & Cone Penetration. CHECKED BY G.M.

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE
603.0 / 0.0	Groundlevel					
602.0 / 1.0	Topsoil					
	Clayey-silt with sand.					600
598.0 / 5.0	Dense-Brown.		1	SS	77	
			2	SS	>100	
	Silty-fine sand with occasional gravel.					
			3	SS	>100	590
	Very dense-Brown.					
			4	SS	>100	
			5	SS	>100	580
574.5 / 28.5	End of borehole.		6	SS	>100	
						570

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 10 20 30 40 50
SHEAR STRENGTH P.S.F

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

61-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 62-F-43 LOCATION 60' Rt. of Sta. 0/60 ORIGINATED BY G.M.

W.P 293-61 BORING DATE May 4, 1962. COMPILED BY B.K.

DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing & Cone Penetration CHECKED BY G.M.

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
600.5 0.0	Groundlevel									
599.5 1.0	Topsoil									
	Clayey-silt with sand and occasional gravel.									
	Dense to very dense-Brown.		1	SS	68					
593.0 7.5			2	SS	>100					
	Silty-fine sand with occasional gravel.		3	SS	>100	590				
	Very dense-Brown.		4	SS	>100	580				
578.0 22.5	End of borehole.		5	SS	>100	570				

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 62-F-43 LOCATION 50' Rt. of Sta. 0+00 ORIGINATED BY G.M.
W P 293-61 BORING DATE May 7, 1962. COMPILED BY B.K.
DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing & Cone penetration. CHECKED BY G.M.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV SCALE
599.5	Groundlevel					
0.0						
598.5	Topsoil					
1.0	Clayey-silt with sand and occasional gravel. Loose-Brown.		1	SS	16	
591.5						
8.0	Silty-fine sand with occasional gravel. Very dense-Brown.		2	SS	35	590
			3	SS	72	
			4	SS	>100	580
578.0			5	SS	>100	
21.5	End of borehole.					570

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

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

FORM OB - ML - 126 REV 3/61 — CLERICAL REPORT ON SOIL EXPLORATION

61-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

JOB 62-F-43 — LOCATION 50' Lt. of Sta. 1400 — ORIGINATED BY G.M.

W P 293-61 — BORING DATE May 7, 1962. — COMPILED BY B.K.

DATUM Geodetic — BOREHOLE TYPE Washboring - BX Casing & Cone Penetration. — CHECKED BY G.M.

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 — SHEAR STRENGTH P.S.F	LIQUID LIMIT wL — PLASTIC LIMIT wP — WATER CONTENT w — WATER CONTENT % 10 20 30	BULK DENSITY γ PCF	REMARKS
602.0	Groundlevel									
601.0 / 1.0	Topsoil					600				
	Clayey-silt with sand and occasional fine gravel. Loose to med. dense-Brown.		1	SS	24					
594.0 / 8.0			2	SS	52					
	Silty-fine sand with occasional gravel. Very dense-Brown.		3	SS	>100	590				
585.5 / 16.5	End of borehole.		4	SS	>100	580				

62-F-43

W.P. # 293-61

Hwy # 404

STEELES AVE.

Appendix B

Site Setting

Source: "Ontario." 632823.36 m E 4852401.50 m N. **Google Earth.** August 31, 2009. March 7, 2014.

Appendix C

Comparison of Foundation Alternatives

COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Footings on Native Soil	Caissons	Driven H-Piles	Driven H-Piles
Advantages: i. Generally less costly construction than deep foundation elements. ii. Soil conditions at this site provide high bearing capacities. iii. Match existing foundations and so should provide consistent performance. ***Disadvantages:*** i. Typically lower load bearing capacity than deep foundations. ii. Excavation to base of foundation may require shoring.	***Advantages:*** i. Higher geotechnical resistances than shallow foundations. ii. Possibly smaller excavation and more compact work zone than other alternatives ***Disadvantages:*** i. Higher unit costs than spread footings. ii. Some uncertainty regarding groundwater level in the cohesionless founding stratum. iii. Do not offer significant advantages on this site.	***Advantages:*** i. Higher geotechnical resistances than shallow foundations. ii. Installation of piles could continue in freezing weather iii. Foundation construction may require less volume of excavation than footings. ***Disadvantages:*** i. Higher unit costs than footings. ii. Pile driving would require pre-augering iii. Do not offer significant advantages at this site.	***Advantages:*** i. Higher geotechnical resistances than shallow foundations. ii. Installation of piles could continue in freezing weather iii. Foundation construction may require less volume of excavation than footings. ***Disadvantages:*** i. Higher unit costs than footings. ii. Pile driving would require pre-augering. iii. Do not offer significant advantages at this site.
RECOMMENDED	**FEASIBLE BUT NOT RECOMMENDED**	**NOT RECOMMENDED**	**NOT RECOMMENDED**