

**FOUNDATION REPORT FOR DESKTOP STUDY
HIGHWAY 403 AND QEW WIDENING
QEW FROM TRAFALGAR ROAD EASTERLY TO
EAST OF WINSTON CHURCHILL BLVD.
AND
HIGHWAY 403 FROM QEW NORTHERLY TO
HIGHWAY 407 AND WINSTON CHURCHILL BLVD.
OAKVILLE AND MISSISSAUGA, ONTARIO
W.P. 09-20007**

Geocres Number: 30M5-285

Report to

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Appendix A	Record of Borehole Sheets (GEOCRES Information)
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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents a summary of the factual findings obtained from various foundation/geotechnical investigations conducted in the late 1970s and early 1980s at the bridge sites included within the project area of the QEW/Highway 403 Widening from Trafalgar Road to Winston Churchill Blvd.

Table 1 below lists the structures that are addressed in this report.

Sequential Number	MTO Site I.D.	Structure	Photo Ref.
QEW			
1	10-140C	Hwy. 403/QEW Joshua Creek Arch Culvert Rehabilitation	1
2	10-161	Hwy. 403/QEW Trafalgar Road Underpass	2
3	10-162	QEW Royal Windsor Drive Underpass	3
4	24-375	QEW Underpass at Winston Churchill Blvd.	4
QEW / Hwy. 403 Interchange			
5	10-282-1	Hwy. 403 W-N Ramp Under E-N,S Ramp Rehabilitation	5
6	10-282-2	Hwy. 403 W-N Ramp Under Upper Middle Road Rehabilitation	5
7	10-283	Hwy. 403 N-W Ramp Over E-N,S Ramp & Upper Middle Road Rehabilitation	6
8	10-284	QEW W – Hwy 403 N Ramp Under QEW	7
9	Not available	QEW E-Hwy 403 N Ramp (proposed)	8, 9
10	Not available	Hwy. 403 N-QEW E Ramp (proposed)	8, 9

Sequential Number	MTO Site I.D.	Structure	Photo Ref.
Ford Drive Interchange			
11	10-285	Hwy. 403 N-W Ramp Over Ford Drive Rehabilitation	10
12	10-286	QEW Overpass at Ford Drive	11
13	10-287	Hwy. 403 W-N Ramp Over Ford Drive Rehabilitation	11
14	Not available	Ford Drive N-QEW E Ramp & Hwy 403 N Ramp Over Ford Drive (proposed)	11
15	Not available	Ford Drive S-QEW W Ramp Over Ford Drive (proposed)	9
Hwy. 403 / Hwy. 407			
16	10-325	Hwy. 403 E-S Ramp Over 2 Hwy. 403/407 Connections	12
17	10-326	Hwy. 407 to 403 Over Hwy. 403 to 407	13
18	10-327	Ninth Line Over Hwy. 403 to 407	14
19	10-328	Ninth Line Over Hwy. 407 W-S Ramp	15
20	24-384	Hwy. 403 Underpass at Winston Churchill Blvd.	16
21	Not available	Dundas Street – Service Road Over Dundas Street (proposed)	17
22	10-280	Hwy. 403 Burnhamthorpe Road Underpass Rehabilitation	18
23	10-281	Hwy. 403 Underpass at Dundas Street Rehabilitation	19

The purpose of this desktop report is to summarize currently available subsurface information pertinent to the preliminary foundation design of the above referenced structures. The information includes that obtained from previous foundation/geotechnical reports available from the Ministry of Transportation Ontario (MTO) GEOCRESS system, geological reports and maps, preliminary general arrangement drawings, and site reconnaissance visits.

Thurber carried out this desktop study as a sub-consultant to McCormick Rankin, a member of MMM Group Limited (MRC), under the MTO Consultant Assignment Number 2009-E-0024.

2 SITE DESCRIPTION

2.1 General

The project area covered in this report extends along Queen Elizabeth Way (QEW) from Trafalgar Road easterly to east of Winston Churchill Blvd (7.0 km) and along Highway 403 from the QEW northerly to Highway 407 and beyond to Winston Churchill Blvd. (7.5 km). Within the project area, there are nineteen existing bridge structures located at eight interchanges. The structure locations are shown on the drawings attached at the end of this text.

2.2 Geology

The project area is located within three different physiographic regions; known as the South Slope, the Lake Iroquois Plain and the Peel Plain. A brief description of these physiographic regions is presented in the following paragraphs.

The South Slope is a strip of land bound by the Iroquois Plain to the south and the Peel Plain to the north. It extends from the Niagara escarpment to Trent River. The South Slope is characterized by glacial till deposits overlying shale bedrock of the Queenston and Dundas Formation.

The Lake Iroquois Plain is a nearly level terrace approximately 3.5 km wide (on average) bordering Lake Ontario from the Niagara River to the Trent River. The Lake Iroquois Plain is characterized by old delta deposits, off-shore deposits and soft red shale shorecliffs. Local to the project area, a thin layer of reddish clayey silt (residual soil) resulting from erosion of the shale overlies the red shale bedrock.

The Peel Plain is located north of the South Slope and is characterized by cohesive glacial till and granular deposits underlain by shale bedrock.

2.3 Topography and Land Use

Between Trafalgar Road and Winston Churchill Blvd., the QEW corridor runs typically parallel to the lake shore along relatively flat terrain, though the highway rises gradually towards the east. The land adjacent to the QEW is largely devoted to commercial/light industrial land use, except for the Ford Drive area where the Ford Motor Company plant occupies the land bound by Hwy. 403/QEW to the north and west, Royal Windsor Drive to the south and Ford Drive to the east.

From the QEW/Hwy. 403 interchange northerly to the Hwy. 403/Hwy. 407 interchange and then easterly to Winston Churchill Boulevard, the terrain gently slopes upwards away from the lake. The adjacent land on the east and south sides of Highway 403 is also predominantly occupied by commercial/light industrial buildings, whereas open fields lie on the west side of the highway. There is some residential development at the northwest quadrant of Highway 403 and Winston Churchill Boulevard.

3 STUDY PRODECURES

The information gathering for this report has been based on a desktop study of available sources, with no borehole drilling and sampling in this phase of the work.

Existing surface and subsurface conditions relevant to the rehabilitation or replacement of the existing structures and embankments, and pertinent to the proposed new structures referenced above, have been investigated by the following methods:

- Review of existing Foundation Investigation and Design Reports available from the MTO GEOCRES system.
- Review of the general arrangement drawings for the existing structures
- Review of available preliminary general arrangement drawings for the proposed new structures and rehabilitation work on the existing structures.
- Review of published geological information for the study area.
- Site reconnaissance visits by Thurber staff to observe and document, including taking photographs of the existing structures, embankments and any visible geological/geotechnical features.

A search for information into Thurber's in-house database revealed some information at the Hwy. 403 and 407 interchange area for the purpose of high mast lighting pole design and construction. There is, however, no information available for structure locations addressed in this report.

3.1 MTO GEOCRES Files

Existing foundation/geotechnical information relevant to the subject sites has been obtained from the MTO GEOCRES library. The reports used in the course of the desktop study are included in Appendix A and are listed below:

Reference 1

Foundation Investigation Report for W-N and W-S Ramp Over Joshua Creek, W.P. 125-66-23, Site 10-140C, QEW, District 4, Hamilton, GEOCRES No. 30M5-115, dated January 18, 1978, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 2

Foundation Investigation Report for Trafalgar Road Interchange, W.P. 1-79-07, QEW, District 4, Hamilton, GEOCRES No. 30M5-120, dated February 1979, prepared by Associated Technical Services Limited

Reference 3

Foundation Investigation and Design Report for Royal Windsor Drive Underpass, Queen Elizabeth Way, Highway 403, W.P. 67-98-00, District 4/6, Toronto, GEOCRES No. 30M5-204, dated November 1998, prepared by Golder Associates Ltd.

Reference 4

Foundation Investigation Report for Winston Churchill Boulevard Interchange Underpass, QEW, W.P. 125-66-12, Site 24-375, District 4, Hamilton, GEOCRES No. 30M12-121,

prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 5

Foundation Investigation Report for W-N Ramp Highway 403 Structure under Ramp E-NS, QEW/Ford Drive/Highway 403 Interchange, W.P. 159-75-07, Site 10-282A, District 4, Hamilton, GEOCREs No. 30M5-110, dated June 16, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 6

Foundation Investigation Report for W-N Ramp Highway 403 under North Service Road, QEW/Ford Drive/403 Interchange, W.P. 159-75-08, Site 10-282B, District 4, Hamilton, GEOCREs No. 30M5-111, dated June 1, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 7

Foundation Investigation Report for QEW/Ford Drive/403 Link Interchange, N-W Ramp Highway 403 over Ramp E-N.S. and North Service Road, W.P. 159-75-09, Site 10-283, District 4, Hamilton, GEOCREs No. 30M5-114, dated January 12, 1978, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 8

Foundation Investigation Report for W-N Ramp Highway 403 Under QEW, W.P. 159-75-06, Site 10-284, QEW, District 4, Hamilton, GEOCREs No. 30M5-117, dated February 20, 1978, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 9

Foundation Investigation for N/W Ramp Structure over Ford Drive, QEW/403/Ford Drive Interchange, W.P. 125-66-18, Site 10-285, District 4, Hamilton, GEOCREs No. 30M5-107, dated May 20, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 10

Foundation Investigation Report for QEW Over Ford Drive, W.P. 125-66-17, Site 10-286, QEW, District 4, Hamilton, GEOCREs No. 30M5-116, dated January 25, 1978, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 11

Foundation Investigation Report for W-N Ramp Highway 403 Structure over Ford Drive, QEW/Ford Drive/403 Interchange, W.P. 125-66-16, Site 10-287, District 4, Hamilton, GEOCREs No. 30M5-106, dated May 17, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 12

Foundation Investigation Report for E-S Ramp Underpass, Highway 403 & 407 Interchange Complex, W.P. 197-77-03, Site 10-82-325, District #4 (Hamilton), GEOCREs No. 30M12-169, prepared by Pavement & Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 13

Foundation Investigation Report for Highway 407 Underpass Structures, Highway 403 & 407 Interchange Complex, W.P. 197-77-02, Site 10-82-326, District #4 (Hamilton), GEOCREs No. 30M12-170, prepared by Pavement & Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 14

Foundation Investigation Report for Ninth Line Underpass, Highway 403 & 407 Interchange Complex, W.P. 197-77-05, Site 10-82-327, District 4, Hamilton, GEOCREs No. 30M12-173, dated December 24, 1982, prepared by Pavement & Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 15

Foundation Investigation Report for W-S Ramp and Ninth Line, Highway 403 & 407 Interchange Complex, W.P. 197-77-04, Site 10-82-328, District #4 (Hamilton), GEOCREs No. 30M12-174, dated January 11, 1983, prepared by Pavement & Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 16

Foundation Investigation Report for Winston Churchill Boulevard Underpass, W.P. 158-75-03, Site No. 24-384, District 4, Hamilton, GEOCREs No. 30M12-129, dated October 20, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 17

Foundation Investigation Report for Burnhamthorpe Road Underpass, W.P. 158-75-04, Site 10-280, Highway 403, District 4, Hamilton, GEOCREs No. 30M12-128, prepared by

Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 18

Foundation Investigation Report for Highway 403 Link, Hwy 5 Underpass, W.P. 159-75-03, Site 10-281, Highway 403, District 4, Hamilton, GEOCREs No. 30M12-127, dated August 31, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

3.2 Geological Information

During the preparation of this report, reference was made to Chapman and Putnam, “The Physiography of Southern Ontario”, Third Edition, Ontario Geological Survey, Special Volume 2, Ministry of Natural Resources, 1984.

3.3 Site Reconnaissance Visit

Site reconnaissance visits were carried out by Thurber engineering staff during the preparation of this report. Each of the sites was visited and documented for visible geological/geotechnical features and for assessing structure/embankment performance. The documentation includes photographs of the subject bridges and culverts. Selected photographs showing the existing structures are included in Appendix B.

Based on the site observations, it is considered that the structures and immediate approach embankments (i.e. within 20 m of the abutments) under consideration did not show visible signs of distress and appeared to be functioning for their intended purposes.

4 DESCRIPTIONS OF SUBSURFACE CONDITIONS

Based on the subsurface information documented in References 1 to 18, the following sections present the scope of investigation and summarize the available subsurface information for various site locations. The descriptions are based on site conditions at the time of the investigation, which may have been modified by subsequent construction activities.

Some of the information in References 1 to 18 is presented in Imperial Units and has been converted to Metric Units for presentation and discussion in this report.

The soil stratigraphy at or near the site locations is summarized in the following sections. Reference should be made to Records of Borehole contained in References 1 to 18 for further details. The factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions.

It is noted that the following site I.D.'s and section headings correspond to those for the proposed structures shown in Table 1 in Part 1.

4.1 Site 10-140C - Hwy. 403/QEW Joshua Creek Arch Culvert Extension

This culvert is located approximately 160 m south of the QEW/Hwy. 403 overpass structure at Ford Drive. It allows Joshua Creek to flow under the highway. The existing structure is a reinforced concrete arch culvert of approximately 100 m in length and a span of about 10.4 m with an invert slab approximately 230 mm thick.

GEOCRES File 30M5-115 (Reference 1) contains the findings of four boreholes, that were previously drilled for the Joshua Creek crossing under the QEW W – Ford Drive N/S Ramp located east of the subject arch culvert, to depths of between 2.7 and 3.4 m. Dynamic Cone Penetration Tests (DCPTs) were also performed in two of the boreholes.

The subsurface conditions encountered in these boreholes consisted of topsoil and clayey silt overlying shale bedrock. The clayey silt layer of 0.9 to 1.8 m in thickness, containing some sand and occasional gravel, was encountered below approximately 300 mm of topsoil. SPT N-values recorded in the clayey silt ranged from 15 to 51 blows for 0.3 m of penetration, indicating a very stiff to hard consistency. Atterberg Limits tests results indicate that the clayey silt is of low plasticity. Measured moisture contents in the clayey silt samples ranged from 10 to 12%.

Shale bedrock was encountered below the clayey silt at Elevations 116.7 and 117.2 m. The shale is described as grey, soft and fissile with 50 to 300 mm thick limestone interbeds. Rock Quality Designation (RQD) values for the bedrock cores ranged from 15 to 30 %, indicating a poor rock quality.

Groundwater levels measured in the open boreholes were found to vary between Elevation 117.7 and 117.8 m.

4.2 Site 10-161: Hwy. 403/QEW Trafalgar Road Underpass

This bridge carries Trafalgar Road over the Highway 403 / QEW lanes in Oakville. This is a double span, post tensioned concrete bridge, and each span measures about 42.7 m (140.0') in length. The width of the deck varies with a maximum width of greater than 25 m.

GEOCRES File 30M5-120 (Reference 2) documents the findings of nine boreholes that were drilled at the location of the existing structure. Four of the boreholes were drilled through the Trafalgar Road approach fills, three were drilled close to the QEW centreline and the remaining two were drilled at the toes of the approach fills. These along with other boreholes in the vicinity of the interchange were drilled subsequent to the construction of the structure. The depths of these boreholes vary from 2.6 to 9.4 m.

At the approach embankments, the subsurface conditions encountered in the boreholes consisted of asphalt and road base material (granular or concrete) overlying 5.9 to 7.5 m of silty clay embankment fill. SPT N-values recorded in the silty clay fill ranged from 7 to 43 blows per 0.3 m penetration, indicating a firm to hard consistency. Below the fill or topsoil, a layer of silty clay containing some sand and trace gravel was encountered except at the south abutment where a layer of gravelly sand ranging from 0.5 to 0.6 m thick overlay the silty clay. The gravelly sand was in a compact to very dense state as indicated by SPT 'N' values of 12 to 58 blows per 0.3 m penetration. The silty clay layer ranged from 0.6 to 1.6 m in thickness. SPT N-values recorded in the silty clay layer ranged from 8 to 42 blows per 0.3 m penetration indicating a stiff to hard consistency. Atterberg Limits tests results indicate that the silty clay is of low plasticity. The silty clay has a natural moisture content ranging from approximately 16 to 26%. At the pier location below the QEW, a composite pavement (asphalt on concrete) was found overlying a layer of limestone screenings to about 0.9 m depth, below which a 1.2 to 1.4 m thick layer of silty clay mixed with weathered shale was encountered. SPT 'N' values of 12 to 74 blows per 0.3 m penetration recorded in this layer indicated that it had a stiff to hard consistency.

Shale bedrock was encountered below the silty clay layer between Elevations 103.9 m and 107.3 m. The upper 2 m of the shale was weathered with frequent clay layers. The boreholes were generally dry upon completion.

4.3 Site 10-162: QEW Royal Windsor Drive Underpass

This bridge carries Royal Windsor Drive over QEW. This is a double span, post tensioned concrete bridge, and each span measures about 42.7 m (140.0') in length. The width of the deck varies with a maximum width of greater than 25 m.

GEOCRES File 30M5-204 (Reference 3) documents the findings of twelve boreholes that were drilled at the location of the existing structure. Bedrock was cored and proven in three of these boreholes.

The subsurface conditions encountered in the boreholes consisted of topsoil and/or 0.15 to 0.75 m of silty clay fill overlying 0.2 to 1.2 m of silty clay till which is in turn underlain by shale bedrock. SPT N-values recorded in the silty clay till ranged from 19 to greater than 100 blows per 0.3 m penetration indicating a very stiff to hard consistency. Atterberg Limits tests results indicate that the silty clay is of medium to high plasticity.

Shale bedrock was encountered below the silty clay layer between Elevations 102.3 and 104.1 m. The shale is described as highly to moderately weathered, grey, fine grained, thinly bedded, with limestone interbeds. Rock Quality Designation (RQD) values ranged from approximately 0 to 60%, indicating a very poor to fair rock quality. The boreholes were generally dry upon completion.

Groundwater levels in piezometers installed in selected boreholes ranged from Elevation 101.3 to 102.1 m.

4.4 Site 24-375: QEW Underpass at Winston Churchill Blvd.

This is a four span concrete bridge carrying Winston Churchill Blvd. over the QEW. The bridge is about 100 m (325') in length and over 30 m (100') in width. The approach fills are up to 7.5 m high.

GEOCRE File 30M12-121 (Reference 4) documents the findings of ten boreholes that were drilled in the vicinity of the existing structure. The depths of these boreholes vary from 4.1 to 8.0 m. Dynamic Cone Penetration Tests (DCPTs) were also completed in six of the boreholes.

The subsurface conditions encountered in these boreholes consisted of topsoil or 0.6 to 1.1 m of sand to sand and gravel fill overlying 0.5 to 2.3 m of clayey silt. The soils are underlain by shale bedrock. SPT N-values recorded in the fill ranged from 5 to 20 blows for 0.3 m penetration indicating a loose to compact relative density. SPT N-values recorded in the clayey silt layer ranged from 14 to 82 blows for 0.3 m penetration indicating a stiff to hard consistency. Atterberg Limits tests results indicate that the clayey silt is of low plasticity.

Shale bedrock was encountered below the clayey silt at Elevations 142.9 to 141.0 m. The shale is described as soft, fissile, red in colour with greyish green shale and limestone interbeds of up to 300 mm thick. The upper 1 m of bedrock is highly weathered.

Groundwater levels at the time of the investigation were found to range from Elevation 141.7 to 143.8 m which correspond to approximately 0.6 to 1.5 m below the original ground surface.

4.5 Site 10-282/1: Hwy 403 W-N Ramp Under E-N/S Ramp

This bridge carries the QEW E-N/S ramp over the Highway 403 W-N Ramp. This is a three-span, post tensioned concrete bridge. The centre span measures about 23.5 m in length and the approach spans are each 14.0 m in length. The width of the deck is approximately 11.8 m.

GEOCRE File 30M5-110 (Reference 5) documents the findings of five boreholes that were drilled at the location of the existing structure. The depths of these boreholes vary from 9.1 to 12.1 m. Dynamic Cone Penetration Tests (DCPTs) were also completed in three of the boreholes.

The subsurface conditions encountered in these boreholes consisted of 1.8 to 2.7 m of clayey silt overlying shale bedrock. SPT N-values recorded in the clayey silt layer ranged from 27 to 44 blows for 0.3 m penetration indicating a very stiff to hard consistency.

Atterberg Limits tests results indicate that the clayey silt is of low plasticity. Measured moisture contents in the clayey silt samples ranged from 8 to 14%.

Shale bedrock was encountered below the clayey silt at Elevations 145.0 to 147.0 m. The shale is described as soft, fine textured, red in colour, and fissile having thin horizontal bedding planes with limestone interbeds ranging between 50 and 150 mm thick. The upper 0.9 to 1.8 m of bedrock is soft and weathered. Rock Quality Designation (RQD) values recorded for the core samples below the weathered zone ranged from 40% to 85% indicating improving rock quality with depth, ranging from poor to good.

The groundwater level at the time of the investigation was found to range from Elevation 147.2 to 148.4 m which corresponded to approximately 0.8 m below the original ground surface.

4.6 Site 10-282/2: Hwy 403 W-N Ramp Under Upper Middle Road

This bridge carries Upper Middle Road (North Service Road) over the Highway 403 W-N Ramp. This is a three-span, post tensioned concrete bridge. The centre span measures about 24.4 m in length and the approach spans are each about 15.2 m in length. The width of the deck is approximately 20.7 m.

GEOCRE File 30M5-111 (Reference 6) documents the findings of four boreholes that were drilled near the location of the existing structure. The depths of these boreholes vary from 9.1 to 12.1 m. Dynamic Cone Penetration Tests (DCPTs) were also completed in two of the boreholes. In addition, four test pits were excavated to supplement the borehole information.

The subsurface conditions encountered in these boreholes and test pits consisted of 1.5 to 2.1 m of clayey silt overlying shale bedrock. SPT N-values recorded in the clayey silt layer ranged from 27 to 82 blows for 0.3 m penetration indicating a very stiff to hard consistency. Atterberg Limits tests results indicate that the clayey silt is of low plasticity. Measured moisture contents in the clayey silt samples ranged from 8 to 14%.

Shale bedrock was encountered below the clayey silt at Elevations 146.0 to 147.9 m. The shale is described as soft, fine textured, red in colour, and fissile having thin horizontal bedding planes with limestone interbeds up to 150 mm in thickness. The upper 0.9 to 1.8 m of bedrock is soft and weathered. Rock Quality Designation (RQD) values recorded for the core samples below the weathered zone ranged from 0% to 85% indicating variable rock quality ranging from very poor to good.

The groundwater level at the time of the investigation was found to range from Elevation 147.6 to 148.9 m which corresponded to approximately 0.3 to 0.5 m below the original ground surface.

4.7 Site 10-283: Hwy 403 N-W Ramp Over E-N/S Ramp & Upper Middle Road

This bridge carries the Highway 403 / QEW N-W Ramp over the QEW E-N/S Ramp and Upper Middle Road. This is a four-span, post tensioned concrete bridge. The two main spans each measure about 51.8 m in length and the approach spans are each about 25.9 m in length. The width of the deck is approximately 16.1 m.

GEOCRES File 30M5-114 (Reference 7) documents the findings of twelve boreholes that were drilled within or adjacent to the footprint of the existing structure. The depths of these boreholes vary from 3 to 6.25 m. Dynamic Cone Penetration Tests (DCPTs) were completed in seven of the boreholes.

The subsurface conditions encountered in these boreholes consisted of 0.5 to 2.6 m of clayey silt fill overlying clayey silt which is in turn underlain by shale bedrock. SPT N-values recorded in the clayey silt fill typically ranged from 7 to 19 blows per 0.3 m penetration, indicating a firm to very stiff consistency.

A layer of clayey silt containing trace to some sand and gravel was encountered below the fill. The clayey silt was found to be 0.8 to 3.2 m thick overlying bedrock and has a natural moisture content of 10 to 16%. SPT N-values recorded in the clayey silt at this site ranged from 21 to 100 blows for 0.3 m penetration, indicating a very stiff to very hard consistency. Atterberg Limits tests results indicate that the clayey silt is of low plasticity. Measured moisture contents in the clayey silt samples ranged from 10 to 16%.

Shale bedrock was encountered below the clayey silt at Elevations 141.1 to 145.9 m or about 1.5 to 3.5 m depth, and generally sloping from north to south. The bedrock is described as shale, fine grained, soft and fissile, red in colour with stronger limestone interbeds up to 200 mm thick. Rock Quality Designation (RQD) values recorded for the core samples within the weathered zone of the shale were 0%, and up to 50% in the limestone indicating typically very poor to fair quality.

The groundwater level at the time of the investigation was found to range from Elevation 142.7 to 146.5 m which corresponded to depths of approximately 0.6 to 1.1 m below the original ground surface.

4.8 Site 10-284: QEW W-Hwy 403 N Ramp Under QEW

The existing twin structures carry the QEW Westbound and Eastbound lanes over the Highway 403 W-N Ramp. These are three-span, post tensioned concrete bridges. The main span measures about 42.7 m (140') in length and the approach spans are each about 21.9 m (72') in length. The width of the deck is approximately 17.7 m.

GEOCRES File 30M5-117 (Reference 8) documents the findings of eight boreholes that were drilled near the foundations of the existing structures. The depths of these boreholes vary from 4.6 to 13.5 m.

The subsurface conditions encountered in these boreholes consisted of 2.1 to 2.4 m of silty clay overlying shale bedrock. SPT N-values recorded in the silty clay typically ranged from 14 to 87 blows per 0.3 m penetration indicating a stiff to hard consistency. Atterberg Limits tests results indicate that the silty clay is of low to medium plasticity. Measured moisture contents in the clayey silt samples ranged from 14 to 24%.

Shale bedrock was encountered below the silty clay at Elevations 142.0 to 1145.4m or about 2.1 to 2.4 m depth. The bedrock is described as shale, fine texture, soft and fissile, red in colour with stronger limestone interbeds up to 175 mm thick. The upper 3.1 to 4.6 m of bedrock was found to be generally soft and weathered. Rock Quality Designation (RQD) values recorded for the core samples within the weathered zone ranged from 13% to 75% indicating improving rock quality with depth, ranging from very poor to fair.

The groundwater level at the time of the investigation was found to be at about 2.1 m below ground surface, or between Elevations 142.0 and 144.8 m.

4.9 QEW E - Hwy 403 N Ramp (proposed)

Based on a preliminary highway design plan, this bridge will carry the new QEW E - Hwy 403 N Ramp over the QEW E - Ford Drive N/S Ramp and over Upper Middle Road. It is anticipated that this will be a multi-span concrete bridge with an overall length in the order of 170 m. The bridge will be sufficiently wide to carry two lanes of traffic.

GEOCRE Files 30M5-110 and -111 (References 5 and 6) document the findings of nine boreholes and four test pits that were located in the vicinity of the Highway 403 W-N Ramp under E-N/S Ramp and Upper Middle Road, about 230 m west of this site. Dynamic Cone Penetration Tests (DCPTs) were also completed in several of these boreholes. These boreholes were between 9.1 and 12.1 m deep and the test pits were sufficiently deep to expose bedrock.

The subsurface conditions encountered in these boreholes consisted of localized clayey silt fill overlying clayey silt which is in turn underlain by shale bedrock. The clayey silt containing trace to some sand and gravel was found to be in the order of 2 to 3 m thick. SPT N-values recorded in the clayey silt ranged from 27 to 82 blows for 0.3 m penetration, indicating a very stiff to hard consistency. Atterberg Limits tests results indicate that the clayey silt is of low plasticity.

Shale bedrock was encountered below the clayey silt at Elevations 145.0 to 147.9 m at the time of the investigation. It is expected, however, that the bedrock elevations have been altered during past construction at this interchange. The upper 2 m below bedrock surface has been weathered and softened. The sound bedrock below is described as shale, fine grained, soft and fissile, red in colour with stronger limestone interbeds up to 200 mm

thick. Rock Quality Designation (RQD) values recorded for the core samples typically indicate very poor rock quality near the surface improving to fair rock quality with depth.

The groundwater level at the time of the investigation was found to be within 1 m depth below the original ground surface. It is expected that the groundwater has since been altered as a result of past construction.

4.10 Hwy 403 N - QEW E Ramp (proposed)

Based on a preliminary highway design plan, this bridge will carry the new Hwy 403 N - QEW E Ramp. This bridge will pass over the QEW westbound and eastbound lanes, the realigned QEW E- Ford Drive N/S Ramp, Upper Middle Road and the Highway 403 eastbound lands. It is anticipated that this will be a multi-span concrete bridge with an overall length of over 400 m. The bridge will be sufficiently wide to carry two lanes of traffic.

The previous section 4.9 presents subsurface information from GEOCREs that is also relevant to this bridge.

4.11 Site 10-285 Hwy 403 N-W Ramp over Ford Drive

The existing Hwy 403 N-QEW W Ramp structure over Ford Drive has a single span of 39.6 m length. The archive General Arrangement drawing (WP 159-75-01) indicates that the abutments are supported on spread footings with a design top-of-footing elevation of 125.6 m. Ford Drive is constructed in a cut of approximately 3.0 m depth and approach embankments of approximately 3.0 m in height are present above the top of the cut.

Two boreholes were drilled at each foundation unit during the Foundation Investigation carried out for the structure in 1977 (GEOCREs No. 30M5-107, Reference 9). The subsurface stratigraphy encountered in these boreholes consisted of a 2.1 to 2.9 m thick layer of native clayey silt underlain by shale bedrock. SPT N-values recorded in the clayey silt ranged from 16 to 133 blows/0.3 m of penetration, indicating a very stiff to hard consistency.

The bedrock surface was encountered at Elev. 126.3 to Elev. 128.5. The bedrock consisted of grey shale with limestone layers.

Groundwater levels measured in the open boreholes ranged from 0.9 to 1.2 m below the ground surface at the time of drilling (Elevation 127.5 to 129.1 m).

4.12 Site 10-286: QEW Overpass at Ford Drive

The existing QEW structure over Ford Drive has a single span of 39.6 m length. The archive General Arrangement drawing (WP 125-66-17) indicates that the abutments are

supported on spread footings with a design top-of-footing elevation of 125.0 m. Ford Drive is constructed in a cut of approximately 6.5 to 7.5 m depth.

Two boreholes were drilled near each foundation unit during the Foundation Investigation carried out for the structure in 1977 (GEOCRETS No. 30M5-116, Reference 10). The subsurface stratigraphy encountered in these boreholes consisted of a 2.1 to 2.4 m thick layer of native clayey silt underlain by shale bedrock. SPT N-values recorded in the clayey silt ranged from 16 to 46 blows/0.3 m of penetration, indicating a very stiff to hard consistency.

The bedrock surface was encountered at Elev. 126.3 to Elev. 128.5. The bedrock consisted of grey shale with limestone layers.

Groundwater levels measured in the open boreholes ranged from 1.2 to 1.8 m below the ground surface at the time of drilling (Elev. 127.2 to 129.0 m).

4.13 Site 10-287 – Highway 403 W-N Ramp over Ford Drive

The existing Highway 403 W-N Ramp structure over Ford Drive has a single span of 39.6 m length. The archive General Arrangement drawing (WP 159-75-01) indicates that the abutments are supported on spread footings with a design top-of-footing elevation of 125.3 m. Ford Drive is constructed in a cut of approximately 4.6 to 8.0 m depth.

Two boreholes were drilled at each foundation unit during the Foundation Investigation carried out for the structure in 1977 (GEOCRETS No. 30M5-106, Reference 11). The subsurface stratigraphy encountered in these boreholes consisted of a 2.2 to 2.4 m thick layer of native clayey silt underlain by shale bedrock. SPT N-values recorded in the clayey silt ranged from 7 to 46 blows/0.3 m of penetration, indicating a firm to hard (typically very stiff to hard) consistency.

The bedrock surface was encountered at Elev. 126.3 to Elev. 128.6. The bedrock consisted of grey shale with limestone layers.

Groundwater levels measured in the open boreholes ranged from 1.2 to 2.0 m below the ground surface at the time of drilling (Elev. 127.4 to 128.9 m).

4.14 Ford Drive N - QEW E & Hwy 403 N Ramp over Ford Drive

A new structure is planned for this location. This structure will be situated immediately south of the existing QEW W – Hwy 403 N Ramp structure over Ford Drive (Site 10-287), and the subsurface conditions at the new structure location are expected to be similar to those at the existing structure location, as described above. Reference should therefore be made to the subsurface conditions summarized for the Highway 403 W-N Ramp structure over Ford Drive in the preceding section.

4.15 Ford Drive S – QEW W Ramp over Ford Drive

A new structure is planned for this location. This structure will be situated immediately north of the existing Hwy 403 N – QEW W Ramp structure over Ford Drive (Site 10-285), and the subsurface conditions at the new structure location are expected to be similar to those at the existing structure location, as described above. Reference should therefore be made to the subsurface conditions summarized for the Highway 403 N-W Ramp structure over Ford Drive in a preceding section and the corresponding foundation design recommendations.

4.16 Site 10-325 – Highway 403 E-S Ramp over Highway 403/407 Connections

The existing Highway 403 E-S Ramp structure over the Highway 403/407 Connections has eight spans ranging from 40.0 to 57.0 m in length. The archive General Arrangement drawing (WP 197-77-03) indicates that the piers and abutments are supported on spread footings with design top-of-footing elevations of 178.75 m (north abutment), 176.5 m (three north piers), 180.0 m (centre pier), 180.8 m (three south piers), and 185.0 m (south abutment). The approach embankments are in the order of 6 to 10 m in height.

Seven boreholes were drilled along the ramp alignment during the Foundation Investigation carried out for the structure in 1982 (GEOCRE No. 30M12-169, Reference 12). The subsurface stratigraphy encountered in these boreholes consisted of native silty clay till underlain by a stratum of silty sand to sandy silt, overlying shale bedrock. A silty clay layer was encountered between the sand/silt and shale in two boreholes drilled at the south end of the structure.

The silty clay till deposit ranged in thickness from 7.0 to 10.5 m with a lower boundary at Elev. 170.0 to 174.3. SPT N-values recorded in the glacial till deposit ranged from 21 blows/0.3 m to 110 blows/0.18 m, indicating a very stiff to hard (typically hard) consistency.

The underlying silty sand to sandy silt layer was 5.1 to 14.4 m thick with a lower boundary at depths of 15.2 to 21.4 m (Elev. 165.6 to 157.6). One borehole was terminated in the sand/silt at 21.4 m depth (Elev. 159.9). SPT N-values recorded in the sand/silt generally ranged from 60 blows/0.15 m to 90 blows/0.03 m penetration, indicating a very dense relative density. One value of 19 blows/0.3 m was recorded in one borehole at the north abutment, indicating a compact zone.

The silty clay layer encountered in two boreholes towards the south end of the structure was 4.7 to 6.0 m thick with a lower boundary at 19.9 and 22.9 m depth (Elev. 160.9 and 157.6). The silty clay was hard with N-values of 30 blows/0.08 m to 100 blows/0.15 m.

Shale bedrock with limestone layers was encountered below the sand/silt and silty clay in four boreholes at depths of 18.4 to 22.9 m (Elev. 157.6 to 162.5). The boreholes were terminated in the bedrock at depths of 19.9 to 24.4 m.

During drilling, groundwater was measured in three of the boreholes at depths of 0.8 to 1.0 m below the ground surface, at Elev. 179.9 to 180.5.

4.17 Site 10-326 – Highway 407 to 403 over Highway 403 to 407

The existing Highway 407 to 403 structures over Highway 403 to 407 has two spans of 35.0 m length. The archive General Arrangement drawing for the SS-W Ramp (W.P. 197-77-17) forming the east side of the structure (the GA for the main structure was not available) indicates that the pier and abutments are supported on spread footings with design top-of-footing elevations at 179.0 m (north abutment), 176.0 m (pier), and 180.0 m (south abutment). Highway 403 to 407 was constructed in a cut of approximately 2.5 to 3.5 m, and approach embankments in the order of 3.0 to 4.0 m in height were constructed above the cut.

Five boreholes were drilled at the structure location during the Foundation Investigation carried out in 1982/83 (GEOCREC No. 30M12-170, Reference 13). The subsurface stratigraphy encountered in these boreholes consisted of native silty clay till underlain by a stratum of sandy silt to silty sand, overlying shale bedrock. A silty clay layer was encountered within the silt/sand in one borehole.

The silty clay till deposit ranged in thickness from 5.9 to 11.0 m with a lower boundary at Elev. 169.1 to 175.3. One borehole was terminated in the till at 8.0 m depth (Elev. 172.8). SPT N-values recorded in the glacial till deposit ranged from 16 to 97 blows/0.3 m, indicating a very stiff to hard consistency.

The underlying sandy silt to silty sand layer was 8.8 to 13.6 m thick with a lower boundary at depths of 19.5 to 19.8 m (Elev. 160.3 to 161.8). In one borehole, this deposit was interrupted by a hard silty clay layer between 10.3 and 13.7 m depth. SPT N-values recorded in the silt/sand generally ranged from 43 blows/0.3 m to 100 blows/0.08 m penetration, indicating a dense to very dense (typically very dense) relative density. A value of 27 blows/0.3 m was recorded in one borehole, indicating a compact zone.

Shale bedrock with limestone layers was encountered below the silt/sand in four boreholes at depths of 19.5 to 19.8 m (Elev. 160.3 to 161.8). The boreholes were terminated in the bedrock at depths of 21.4 to 22.9 m.

During drilling, groundwater was measured at the ground surface in three boreholes, at Elev. 180.1 to 181.6. In one other borehole, groundwater was observed at about 0.6 m depth, Elev. 180.2.

4.18 Site 10-327 – Ninth Line over Highway 403 to 407

The existing Ninth Line underpass structure over Highway 403 to 407 has two spans of 30.2 and 33.2 m in length. The archive General Arrangement drawing for the structure (WP 197-77-05) indicates that the pier and abutments are supported on spread footings with design top-of-footing elevations at 179.2 m (north abutment), 175.0 m (pier), and 179.1 m (south abutment). Highway 403 to 407 was constructed in a cut of approximately 5.0 m, and approach embankments in the order of 2.0 to 3.0 m in height were constructed above the cut.

One borehole was drilled at each foundation unit during the Foundation Investigation carried out for the structure in 1982/83 (GEOCRETS No. 30M12-173, Reference 14). The subsurface stratigraphy encountered in these boreholes consisted of native silty clay till underlain by a stratum of sandy silt to silty sand, overlying shale bedrock.

The silty clay till deposit was 13.7 and 14.5 m thick in two of the boreholes, with a lower boundary at Elev. 168.5 and 168.2. One borehole was terminated in the till at 9.2 m depth (Elev. 172.9). SPT N-values recorded in the glacial till ranged from 18 blows/0.3 m to 120 blows/0.1 m penetration, indicating a very stiff to hard consistency.

The underlying sandy silt to silty sand layer was 6.1 and 5.3 m thick with a lower boundary at 19.8 m depth (Elev. 162.4 and 162.9). SPT N-values recorded in the silt/sand generally ranged from 60 blows/0.3 m to 50 blows/0.03 m penetration, indicating a very dense relative density. A value of 13 blows/0.3 m was recorded in one borehole, indicating a compact zone.

Shale bedrock with limestone layers was encountered below the silt/sand in two boreholes at 19.8 depths (Elev. 162.4 and 162.9). The boreholes were terminated in the bedrock at depths of 24.5 and 21.4 m.

During drilling, groundwater was measured at the ground surface in two boreholes, at Elev. 182.2 and 182.7. In one other borehole, groundwater was observed at about 3.3 m depth, Elev. 178.8.

4.19 Site 10-328 – Ninth Line over Highway 407 W-S Ramp

The existing Ninth Line structure over the Highway 407 W-S Ramp has three spans of 30.8 m, 32.1 m, and 30.8 m in length. The archive General Arrangement drawing for the structure (WP 197-77-04) indicates that the piers and abutments are supported on spread footings with design top-of-footing elevations at 185.3 m (west abutment), 179.1 m (piers), and 185.35 m (east abutment). Approach embankments are in the order of 8.0 m in height.

Two boreholes were drilled at the location of this structure during the Foundation Investigation carried out in 1982 (GEOCRETS No. 30M12-174, Reference 13). The

subsurface stratigraphy encountered in these boreholes consisted of native silty clay till underlain by a stratum of sandy silt to silty sand, overlying shale bedrock.

The silty clay till deposit was 14.6 m thick in both boreholes, with a lower boundary at Elev. 165.7 and 165.5. SPT N-values recorded in the glacial till ranged from 24 blows/0.3 m to 100 blows/0.075 m penetration, indicating a very stiff to hard (typically hard) consistency.

The underlying sandy silt to silty sand layer was 6.8 m thick with a lower boundary at 21.4 m depth (Elev. 158.9 and 158.7). SPT N-values recorded in the silt/sand ranged from 112 blows/0.3 m to 100 blows/0.075 m penetration, indicating a very dense relative density.

Shale bedrock with limestone layers was encountered below the silt/sand at 21.4 m depth (Elev. 158.9 and 158.7). The boreholes were terminated at the bedrock surface.

During drilling, groundwater was measured at the ground surface, at Elev. 180.3 and 180.1.

4.20 Site 24-384 – Highway 403 Underpass at Winston Churchill Boulevard

The existing Winston Churchill Boulevard structure over Highway 403 has two spans of 33.5 m in length. The archive General Arrangement drawing for the structure (WP 158-75-03) indicates that the pier and abutments are supported on spread footings with design top-of-footing elevations at 173.0 m (abutments), and 171.6 m (pier). The approach embankments are in the order of 5.5 to 6.5 m in height.

Two boreholes were drilled at each abutment location and three boreholes were drilled at the pier during the Foundation Investigation carried out for the structure in 1976/77 (GEOCREs No. 30M12-129, Reference 16). The subsurface stratigraphy encountered in these boreholes consisted of native clayey silt till underlain by clayey silt with seams of silt.

The clayey silt till deposit was 7.0 to 9.4 m thick with a lower boundary at Elev. 162.8 to 166.0. One borehole was terminated in the till at 6.2 m depth (Elev. 166.6). SPT N-values recorded in the glacial till ranged from 20 blows/0.3 m to 100 blows/0.15 m penetration, indicating a very stiff to hard consistency.

Five of the boreholes were terminated in the underlying clayey silt at depths of 11.1 to 18.3 m (Elev. 162.2 to 153.9). SPT N-values recorded in the clayey silt ranged from 90 blows/0.3 m to 135 blows/0.15 m penetration, indicating a hard consistency.

During drilling, groundwater was measured at depths varying from 0.9 to 7.9 m below the ground surface, at Elev. 164.9 to 172.8. The variable groundwater levels were attributed to irregular layers of silt in the lower clayey silt deposit.

4.21 Service Road over Dundas Street

A new structure is planned to carry a new service road over Dundas Street approximately 250 m west of the existing Highway 403 – Dundas Street Underpass. The subsurface conditions at the new structure location are expected to be similar to those at the existing underpass location (Site 10-281). Reference should therefore be made to the subsurface conditions summarized for the Highway 403 – Dundas Street Underpass structure presented in the following section 4.23.

4.22 Site 10-280: Hwy 403 Burnhamthorpe Road Underpass

The existing Burnhamthorpe Road structure over Highway 403 has two spans of 25.9 m length each. The archive General Arrangement drawing (WP 158-75-04) indicates that the pier and abutments are supported on spread footings with design top-of-footing elevations of 179.8 m (west abutment), 179.1 m (pier), and 180.0 m (east abutment). The approach embankments range in height from about 3.5 to 6.4 m.

Two boreholes were drilled at each foundation unit during the Foundation Investigation carried out for the structure in 1977 (GEOCRETS No. 30M12-128, Reference 17). The subsurface stratigraphy encountered in these boreholes consisted of a thin topsoil layer overlying native clayey silt till, which in turn was underlain by silt to silty sand in two boreholes. In the two boreholes encountering silt/sand, the lower boundary of the till was encountered at 10.4 m depth (Elev. 171.0 and 171.2), and the boreholes were terminated in the silt/sand at depths of 18.6 and 11.1 m. One borehole was terminated on boulders in the till at 5.2 m depth, and the remaining boreholes were terminated in the till at 11.1 m depth.

SPT N-values recorded in the glacial till deposit ranged from 26 blows/0.3 m to 100 blows/0.1 m of penetration, indicating a very stiff to hard (typically hard) consistency. SPT N-values recorded in the underlying silt and sand deposits ranged from 53 blows/0.3 m to 100 blows/0.23 m penetration, indicating a very dense condition.

Groundwater levels measured in the open boreholes ranged from 0.9 to 3.9 m below the ground surface, at Elevation 180.7 to 177.4 m.

4.23 Site 10-281: Hwy.403 Dundas Street Underpass Rehabilitation

The existing Dundas Street structure over Highway 403 has two spans of 30.5 m length each. The archive General Arrangement drawing (WP 159-75-03) indicates that the pier and abutments are supported on spread footings with design top-of-footing elevations of 170.7 m (abutments) and 167.3 m (pier). The approach embankments are approximately 4.9 m in height.

Two boreholes were drilled at each foundation unit during the Foundation Investigation carried out for the structure in 1977 (GEOCRETS No. 30M12-127 Reference 12). The

subsurface stratigraphy encountered in these boreholes generally consisted of a native silt layer underlain by a sand layer and a second discontinuous silt layer, overlying clayey silt till, in turn underlain by shale bedrock.

The upper silt layer was 1.5 to 2.7 m thick and the underlying sand layer was 1.2 to 2.0 m thick. The silt layer underlying the sand was encountered in four of the six boreholes and ranged from 0.8 to 1.2 m in thickness. In one borehole at the west abutment, a second sand layer with a thickness of 1.5 m was encountered below the silt. In all, the total thickness of the silt and sand deposits ranged from 4.1 to 4.7 m, locally 7.5 m where the second sand layer was encountered.

SPT N-values recorded in the silt and sand layers ranged from 31 blows/0.3 m to 106 blows/0.15 m penetration, indicating a dense to very dense relative density. A value of 17 blows/0.3 m was recorded in one borehole at the west abutment, indicating a compact condition.

The clayey silt till deposit was encountered at depths of 4.1 to 4.7 m (Elev. 165.8 to 166.6) in all boreholes except the borehole with the second sand layer. The till was 2.7 to 3.8 m thick with a lower boundary at depths of 7.0 to 8.2 m (Elev. 162.5 to 163.7). SPT N-values recorded in the glacial till deposit ranged from 38 to 187 blows/0.3 m (typically greater than 100), indicating a hard consistency.

Shale bedrock with limestone layers was encountered below the clayey silt till in five boreholes and below the sand in one borehole at depths of 7.0 to 8.2 m (Elev. 162.5 to 163.7). The boreholes were terminated in the bedrock at depths of 7.5 to 9.3 m.

During drilling, groundwater was measured in four of the boreholes at approximately 1.4 m below the ground surface, at Elev. 169.6.

5 MISCELLANEOUS

Ms. Lindsey Blaine, E.I.T. and Mr. Alastair E. Gorman, P.Eng prepared the Foundation Investigation Report.

Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundations projects, reviewed the report.

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Review Principal



**FOUNDATION REPORT FOR DESKTOP STUDY
HIGHWAY 403 AND QEW WIDENING
QEW FROM TRAFALGAR ROAD EASTERLY TO
EAST OF WINSTON CHURCHILL BLVD.
AND
HIGHWAY 403 FROM QEW NORTHERLY TO
HIGHWAY 407 AND WINSTON CHURCHILL BLVD.
OAKVILLE AND MISSISSAUGA, ONTARIO**

W.P. 09-20007

Geocres Number: 30M5-285

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

6 GENERAL

This report presents interpretation of the available geotechnical data described in Part 1 Factual Information, and assessment of the feasibility of new foundation works at each of the subject sites. The report discusses various foundation alternatives and presents preliminary foundation design recommendations for each site.

Subsurface ground conditions (especially near-surface conditions), groundwater and surface water conditions and ground surface elevations may have been altered since the time of the investigations as a result of subsequent construction or land use changes. Therefore, the recommended geotechnical resistances and founding elevations, which are largely based on pre-construction investigations, must be considered preliminary. These recommendations must be confirmed by additional investigation and assessment during detailed design.

7 PRELIMINARY FOUNDATION RECOMMENDATIONS

The following site specific foundation recommendations are based on information from the boreholes closest to the site. In some cases, boreholes are located at the specific foundation elements while in other cases data has been extrapolated from boreholes in the general vicinity.

7.1 Site 10-140C - Highway 403/QEW Joshua Creek Arch Culvert Extension

Foundation Alternatives

If the arch culvert is extended, it is assumed that the extension will be similar in type and configuration to the existing culvert. It is anticipated that new wingwalls will be required at any new inlet or outlet location. Preliminary drawings indicate that the culvert will be extended westward to accommodate a new ramp.

In order to match the existing culvert, open footings will have to be used to provide foundation support to the extension and the new wingwalls. Information from the investigation for the W-N Ramp over the creek show that shale bedrock at that site lies at approximate Elevation 117.

Since shale is frost susceptible, the underside of the footings must have a minimum of 1.2m of earth cover for frost protection purposes.

Foundation Design

Based on a previous General Arrangement drawing, the projected underside of footing for the extension would likely vary between approximate Elevations 119.0 and 119.5 m to maintain continuity of the invert grade. The archive drawings show that the culvert was designed to be founded on bedrock. The spread footings for the culvert extension and headwalls must also be founded on the shallow shale bedrock at this site to provide adequate bearing support and to control differential settlement between the new construction and the existing culvert. For preliminary design of footings for the extension and the headwalls, it is recommended that a factored geotechnical resistance at ULS of 1,000 kPa be used and the SLS condition may be assumed not to govern. To prevent further weathering and softening of the shale at the base of the excavation, a concrete mud slab must be placed immediately following excavation.

Based on the information at the W-N Ramp, other near-by boreholes and site observations, it is anticipated that bedrock will be encountered at this site at an elevation that makes spread footings feasible. However, site specific investigation is required to confirm the stratigraphy. If the acceptable founding elevation on shale is found to be below the desirable underside of footing, possible alternatives include:

- Extending the culvert foundation to bedrock
- Placing mass concrete fill up to the founding elevation
- Extending the extent of the excavation and placing engineered granular fill, in which case bearing resistances of 900 kPa at factored ULS and 350 kPa at SLS must be assumed though it may be possible to increase the SLS value based on the findings of a site investigation.

Assuming that an invert slab is designed to match the existing, it may be necessary to excavate across the width of the creek to remove loose or soft soils and replace with compacted granular fill. Excavation and replacement might favour using spread footings on engineered fill.

Given the anticipated extent of construction work, it is considered that creek diversion will be required during construction. This may be accomplished by means of a flume pipe or a

pumping system. In either case, for preliminary design, it must be assumed that a cofferdam will be required around the work area, together with a dewatering scheme.

Detail design must address the risk of undermining the existing footings and invert slab.

It is recommended that any new embankment be designed with a sideslope inclination of 2H : 1V or flatter for maintaining long term stability.

7.2 Site 10-161 – Highway 403/QEW Trafalgar Road Underpass

Foundation Alternatives

If the existing bridge is to be widened or reconstructed, it is recommended that the new foundation types be similar to those currently used for the existing bridge. Any new approach fill should have a sideslope inclination of 2H : 1V or flatter for maintaining long term stability.

Based on a previous General Arrangement drawing, the two existing abutments are supported on steel HP 12x74 piles driven to bedrock and the pier is supported on footings that are likely founded on bedrock.

Given the shallow depth to bedrock rock at the highway grade and founding conditions of the existing bridge discussed above, spread footings founded on bedrock are suitable for new piers at this site. The footings can be founded either in the upper weathered bedrock or the underlying, more competent bedrock. New abutments may be supported on HP 310x110 piles founded on bedrock. Alternatively, augered piles or caissons socketed into bedrock may also be considered, especially for pier extension where this scheme may reduce traffic disruption.

Foundation Design

For preliminary design of pier footings on the upper weathered shale, it is recommended that a factored geotechnical resistance at ULS of 800 kPa and a geotechnical resistance at SLS of 600 kPa be used. For the more competent bedrock typically at 2 m below the top of bedrock, a factored geotechnical resistance at ULS of 1,000 kPa may be used and the SLS condition may be regarded as not governing. To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed as soon as the bedrock surface has been properly prepared and is free of loose debris. A minimum of 1.2 m of earth cover must be provided above the base of the footings for frost protection purposes.

The HP 310x110 piles may be driven to refusal on bedrock and designed for a factored axial geotechnical resistance at ULS of 2,000 kN and a geotechnical resistance at SLS of 1,800 kN. Should vibration amongst other reasons prevent driving piles, the piles may be installed within a 600 mm diameter augered hole to socket into bedrock. Similar design capacities may be used for augered piles. For preliminary design, a 1.2 m diameter

augered caisson socketed 3 m below the top of shale may be assumed to have a factored geotechnical resistance at ULS of 4,500 kN and a geotechnical resistance at SLS of 3,600kN.

It is anticipated that there will not be any excavation below the groundwater level that will induce significant inflow. Accordingly, it can be assumed at this stage that dewatering will be limited to sump pumping.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.3 Site 10-162: QEW Royal Windsor Drive Underpass

Given the shallow depth to bedrock, spread footings founded on bedrock are suitable for this site. The footings can be founded either in the upper weathered bedrock or the more competent bedrock.

It is considered likely that no work will be planned for this bridge as it was only recently reconstructed. As such, foundation recommendations have not been further developed.

7.4 Site 24-375: QEW Underpass at Winston Churchill Blvd.

Foundation Alternatives

If the existing bridge is to be widened or reconstructed, it is recommended that the new foundation types be similar to those currently used for the existing bridge. Any new approach fill should have a sideslope inclination of 2H : 1V or flatter for maintaining long term stability.

Based on a previous General Arrangement drawing, the existing bridge piers are supported by spread footings founded on the shale bedrock. Any new footings may be founded at about the same elevations as the existing footings on bedrock. At the abutments, conventional steel H-pile foundations have been used. New abutments may be supported on either steel H-piles or spread footings founded on bedrock.

Foundation Design

For preliminary design of footings on weathered shale, a factored geotechnical resistance at ULS of 800 kPa and a geotechnical resistance at SLS of 600 kPa may be used. For footings on sound shale typically at 1.5 to 2 m below the top of bedrock, a factored geotechnical resistance at ULS of 1,000 kPa and the SLS condition can be assumed not to govern. To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. A minimum of 1.2 m of earth cover must be provided above the base of the footings for frost protection purposes. For piled foundations, steel HP 310x110 installed within an augered hole into shale of 600 mm nominal diameter may be used. The remaining space should be grouted with 30 MPa

concrete. These piles may be assumed to have a factored geotechnical resistance at ULS of 2,000 kN and an SLS resistance of 1,800 kN.

No dewatering problems are anticipated during excavation and construction of the foundation. Any seepage and/or runoff into the excavations can be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.5 Site 10-282/1: Highway 403 W-N Ramp Under E-N,S Ramp

Foundation Alternatives

The foundation elevations shown on the archive General Arrangement drawing indicate that the structure is founded on shale bedrock. If the existing bridge is to be widened or reconstructed, it is recommended that the new foundation types be similar to those currently used for the existing bridge. Alternatively, if a new structure is planned on the same or an adjacent alignment, an integral abutment design is possible. In this case, special consideration must be given to the details of pile installation in order to provide the required flexibility in the upper 3.0 m length.

Any new approach fill should have a sideslope inclination of 2H : 1V or flatter for maintaining stability long term stability.

Foundation Design

For preliminary design of footings on the very stiff to hard clayey silt, it is recommended that a factored geotechnical resistance at ULS of 500 kPa and a geotechnical resistance at SLS of 300 kPa be used. For footings on weathered shale, a factored geotechnical resistance at ULS of 800 kPa and a geotechnical resistance at SLS of 600 kPa may be used. For footings on sound shale typically at 1.5 to 2 m below the top of bedrock, a factored geotechnical resistance at ULS of 1,000 kPa may be used and the SLS condition may be assumed not to govern. To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. A minimum of 1.2 m of earth cover must be provided above the base of the footings for frost protection purposes.

If an integral abutment design is developed, HP 310 X 110 piles can be designed on the basis of a factored geotechnical resistance at ULS of 2,000 kN and an SLS resistance of 1,800 kN

No dewatering problems are anticipated during excavation and construction of the foundation. Any seepage and/or runoff into the excavations can be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.6 Site 10-282/2: Highway 403 W-N Ramp Under Upper Middle Road

Foundation Alternatives

The foundation elevations shown on the preliminary rehabilitation drawing indicate that the structure is founded on shale bedrock. If the existing bridge is to be widened or reconstructed, it is recommended that the new foundation types be similar to those currently used for the existing bridge. Alternatively, if a new structure is planned on the same or an adjacent alignment, an integral abutment design is possible. In this case, special consideration must be given to the details of pile installation in order to provide the required flexibility in the upper 3.0 m length.

Foundation Design

For preliminary design of footings on the very stiff to hard clayey silt, it is recommended that a factored geotechnical resistance at ULS of 500 kPa and a geotechnical resistance at SLS of 300 kPa be used. For footings on weathered shale, a factored geotechnical resistance at ULS of 800 kPa and a geotechnical resistance at SLS of 600 kPa may be used. For footings on sound shale typically at 1.5 to 2 m below the top of bedrock, a factored geotechnical resistance at ULS of 1,000 kPa may be used and the SLS condition may be assumed not to govern. To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. A minimum of 1.2 m of earth cover must be provided above the base of the footings for frost protection purposes.

If an integral abutment design is developed, HP 310 X 110 piles can be designed on the basis of a factored geotechnical resistance at ULS of 2,000 kN and an SLS resistance of 1,800 kN

No dewatering problems are anticipated during excavation and construction of the foundation. Any seepage and/or runoff into the excavations can be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.7 Site 10-283: Highway 403 N-W Ramp Over E-N,S Ramp & Upper Middle Road

Foundation Alternatives

The archive General Arrangement drawing indicates that the existing structure is supported on spread footings bearing on shale bedrock. If the existing bridge is to be widened or

reconstructed, it is recommended that the new foundation types be similar to those currently used for the existing bridge.

Given the presence of shallow bedrock, deep foundations are not considered feasible at this site.

Foundation Design

For preliminary design of footings on weathered shale, a factored geotechnical resistance at ULS of 800 kPa and a geotechnical resistance at SLS of 600 kPa may be used. For footings on sound shale typically at 1.5 to 2 m below the top of bedrock, a factored geotechnical resistance at ULS of 1,000 kPa may be used and the SLS condition can be assumed not to govern. To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. A minimum of 1.2 m of earth cover must be provided above the base of the footings for frost protection purposes.

No dewatering problems are anticipated during excavation and construction of the foundation. Any seepage and/or runoff into the excavations can be handled with the use of sumps and pumps.

Any modification to the approach fill should have a sideslope inclination of 2H : 1V or flatter for maintaining long term stability.

7.8 Site 10-284: Highway 403 W-N Ramp Under QEW

Foundation Alternatives

The archive General Arrangement drawing indicates that the existing structure is supported on spread footings bearing on shale bedrock. If the existing twin bridges are to be widened or reconstructed, it is recommended that the new foundation types be similar to those currently used for the existing bridge. Alternatively, it would be possible to reconstruct integral abutments on this site. In this case, some excavation of bedrock will be required around the abutment and special consideration must be given to the details of pile installation in order to provide the required flexibility in the upper 3.0 m length.

The existing bridges are supported on spread footings founded on the shale bedrock. Any new footings may be founded at about the same elevations as the existing footings on bedrock. Footings may be founded on the overlying very stiff to hard silty clay.

Foundation Design

For preliminary design of footings on weathered shale, a factored geotechnical resistance at ULS of 800 kPa and a geotechnical resistance at SLS of 600 kPa may be used. Sound shale is typically at 3 to 6 m below the top of bedrock at this site and sub-excavation may be required in order to achieve founding on this material. Footings on the sound shale may be designed using a factored geotechnical resistance at ULS of 1,000 kPa and the SLS condition will not govern. To prevent deterioration of the exposed shale at the base of the

foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. A minimum of 1.2 m of earth cover must be provided above the base of the footings for frost protection purposes.

No dewatering problems are anticipated during excavation and construction of the foundation. Any seepage and/or runoff into the excavations can be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.9 QEW E - Highway 403 N Ramp

Foundation Alternatives

No existing borehole data has been found on the alignment of this structure. Review of the results of borehole investigations for near-by structure sites, coupled with site observations, indicates that this structure site is underlain by shallow shale bedrock. On this basis, it is recommended that the piers of the new structure be supported on spread footings bearing on sound shale bedrock, which is anticipated to lie within 3 m of the ground surface. Drilled piles (caissons) would be a viable alternative.

Based upon the preliminary General Arrangement, the abutments could be supported on spread footing bearing on engineered granular fill pads founded on the bedrock. Drilled piles (caissons) would be a viable alternative to support the abutments.

The use of driven piles might be possible at the north abutment, if this type of foundation offered advantages. At the south abutment, the underside of the abutment may be too close to the bedrock for driven piles to be the preferred alternative. However, if socketed H-piles could be used if this system offers advantages.

Foundation Design

For footings on sound shale typically at about 3 m below the top of bedrock, a factored geotechnical resistance at ULS of 1,000 kPa may be used and the SLS condition will not govern. To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. A minimum of 1.2 m of earth cover must be provided above the base of the footings for frost protection purposes.

No dewatering problems are anticipated during excavation and construction of the foundation. Any seepage and/or runoff into the excavations can be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for the approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.10 Highway 403 N - QEW E Ramp

This structure closely parallels that for the QEW E-Hwy 403 N Ramp and similar recommendations apply.

No existing borehole data has been found on the alignment of this structure. Review of the results of borehole investigations for near-by structure sites, coupled with site observations, indicates that this structure site is underlain by shallow shale bedrock. On this basis, it is recommended that the piers of the new structure be supported on spread footings bearing on sound shale bedrock, which is anticipated to lie within 3 m of the ground surface. Drilled piles (caissons) would be a viable alternative.

Based upon the preliminary General Arrangement, the abutments could be supported on spread footing bearing on engineered granular fill pads founded on the bedrock. Drilled piles (caissons) would be a viable alternative to support the abutments.

The use of driven piles might be possible at the north abutment, if this type of foundation offered advantages. At the south abutment, the underside of the abutment may be too close to the bedrock for driven piles to be the preferred alternative. However, socketed H-piles or augered caissons could be used if this system offers advantages.

Foundation Design

For footings on sound shale typically at about 3 m below the top of bedrock, a factored geotechnical resistance at ULS of 1,000 kPa may be used and the SLS condition will not govern. To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. A minimum of 1.2 m of earth cover must be provided above the base of the footings for frost protection purposes.

For preliminary design, HP 310 X 110 piles socketed in shale may be assumed to have a factored geotechnical resistance at ULS of 2,000 kN per pile and an SLS resistance of 1,800 kN. A 1.2 m diameter augered caisson socketed 3 m below the top of shale may be assumed to have a factored geotechnical resistance at ULS of 4,500 kN and a geotechnical resistance at SLS of 3,600 kN.

No dewatering problems are anticipated during excavation and construction of the foundation. Any seepage and/or runoff into the excavations can be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for the approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.11 Site 10-285 – Highway 403 N-W Ramp over Ford Drive

The archive General Arrangement drawing for the existing Highway 403 N-W Ramp structure over Ford Drive indicates that the structure is supported on spread footings with a design top-of-footing elevation at 125.6. Based on the GEOCRE data, shale bedrock is present at the founding level.

If widening or reconstruction of the structure is planned, the preferred foundation option consists of spread footings founded on shale bedrock at the same level as the existing footings. Preliminary design of spread footings founded on the sound shale should be carried out using a factored geotechnical resistance at ULS of 1,000 kPa and the SLS condition will not govern.

To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. Footings constructed on shale bedrock must have a minimum 1.2 m thickness of earth cover as protection against frost action.

As bedrock is shallow at this site, deep foundations including augered caissons (drilled shafts) and driven steel H-piles are not considered to be a cost-effective alternative and are not recommended.

However, if reconstruction of integral abutments is an option, it could be accommodated at this site. In this case, some excavation of bedrock will be required around the abutment, the piles must be socketed into bedrock and special consideration must be given to the details of pile installation in order to provide the required flexibility in the upper 3.0 m length. For preliminary design, HP 310 X 110 piles socketed in shale may be assumed to have a factored geotechnical resistance at ULS of 2,000 kN per pile and an SLS resistance of 1,800 kN.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.12 Site 10-286 - QEW Overpass at Ford Drive

The archive General Arrangement drawing for the existing QEW structure over Ford Drive indicates that the structure is supported on spread footings with a design top-of-footing elevation at 125.0. Based on the GEOCRE data, shale bedrock is present at the founding level.

The preferred foundation option for structure widening consists of spread footings founded on shale bedrock at the same level as the existing footings. Preliminary design of spread footings founded on the sound shale should be carried out using a factored geotechnical resistance at ULS of 1,000 kPa and the SLS condition will not apply.

To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. Footings constructed on shale bedrock must have a minimum 1.2 m thickness of earth cover as protection against frost action.

As bedrock is shallow at this site, deep foundations including augered caissons (drilled shafts) and driven steel H-piles would typically not be considered to be a cost-effective alternative from a foundation viewpoint. However, if reconstruction of integral abutments is an option, it could be accommodated at this site. In this case, some excavation of bedrock will be required around the abutment, the piles must be socketed into bedrock and special consideration must be given to the details of pile installation in order to provide the required flexibility in the upper 3.0 m length.

For HP 310 x 110 H-piles socketed into bedrock as outlined above, a factored axial resistance of 2,000 kN at ULS is recommended for preliminary design and an SLS resistance of 1,800 kN.

To provide the required flexibility in the piles for integral abutment design, the upper 3 m of the piles should be surrounded by concentric 800 and 600 mm diameter CSPs as specified by the integral abutment design procedures. After the pile is installed, the space between the pile and the 600 mm CSP should be filled with sand.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.13 Site 10-287 – Highway 403 W-N Ramp over Ford Drive

The archive General Arrangement drawing for the existing Highway 403 W-N Ramp structure over Ford Drive indicates that the structure is supported on spread footings with a design top-of-footing elevation at 125.3. Based on the GEOCRE data, shale bedrock is present at the founding level.

The preferred foundation option for structure widening consists of spread footings founded on shale bedrock at the same level as the existing footings. Preliminary design of spread footings founded on the sound shale should be carried out using a factored geotechnical resistance at ULS of 1,000 kPa and the SLS condition will not apply.

To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. Footings constructed on shale bedrock must have a minimum 1.2 m thickness of earth cover as protection against frost action.

As bedrock is shallow at this site, deep foundations including augered caissons (drilled shafts) and driven steel H-piles would typically not be considered to be a cost-effective alternative from a foundation viewpoint. However, if reconstruction of integral abutments is an option, it could be accommodated at this site. In this case, some excavation of bedrock will be required around the abutment, the piles must be socketed into bedrock and special consideration must be given to the details of pile installation in order to provide the required flexibility in the upper 3.0 m length.

For HP 310 x 110 H-piles socketed into bedrock as outlined above, a factored axial resistance of 2,000 kN at ULS is recommended for preliminary design and an SLS resistance of 1,800 kN.

To provide the required flexibility in the piles for integral abutment design, the upper 3 m of the piles should be surrounded by concentric 800 and 600 mm diameter CSPs as specified by the integral abutment design procedures. After the pile is installed, the space between the pile and the 600 mm CSP should be filled with sand.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.14 Ford Drive N-QEW E Ramp over Ford Drive

A new structure is planned for the Ford Drive N-QEW E Ramp over Ford Drive. This structure will be situated immediately south of the existing Highway 403 W-N Ramp structure over Ford Drive (Site 10-287), and therefore the GEOCRE data available for the existing structure has been used to develop preliminary foundation recommendations for the new structure.

Ford Drive is constructed in a cut at the proposed structure location. Based on the GEOCRE data, shale bedrock is expected to be present at the base of the cut.

From a foundations viewpoint, the preferred foundation option consists of spread footings founded on shale bedrock. The footings must be founded below the weathered bedrock surface on sound shale, which was encountered at Elev. 125.7 to Elev. 127.7 at the Highway 403 W-N Ramp immediately to the north. Preliminary design of spread footings

founded on the sound shale should be carried out using a factored geotechnical resistance at ULS of 1,000 kPa and the SLS condition will not govern.

To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. Footings constructed on shale bedrock must have a minimum 1.2 m thickness of earth cover as protection against frost action. As bedrock is shallow at this site, deep foundations including augered caissons (drilled shafts) and driven steel H-piles would typically not be considered to be a cost-effective alternative from a foundation viewpoint. However, if construction of integral abutments is an option, it could be accommodated at this site. In this case, some excavation of bedrock will be required around the abutment, the piles must be socketed into bedrock and special consideration must be given to the details of pile installation in order to provide the required flexibility in the upper 3.0 m length.

For HP 310 x 110 H-piles socketed into bedrock as outlined above, a factored axial resistance of 2,000 kN at ULS is recommended for preliminary design. The SLS reaction will not govern design.

To provide the required flexibility in the piles for integral abutment design, the upper 3 m of the piles should be surrounded by concentric 800 and 600 mm diameter CSPs as specified by the integral abutment design procedures. After the pile is installed, the space between the pile and the 600 mm CSP should be filled with sand.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.15 Ford Drive S – QEW W Ramp Over Ford Drive

A new structure is planned for the Ford Drive S - QEW W Ramp over Ford Drive. This structure will be situated immediately north of the existing QEW over Ford Drive structure (Site 10-286), and therefore the GEOCREC data available for the existing structure has been used to develop preliminary foundation recommendations for the new structure.

Ford Drive is constructed in a cut at the proposed structure location. Based on the GEOCREC data, shale bedrock is expected to be present in the base and sides of the cut.

Typically, from a foundations viewpoint, spread footings founded on shale bedrock would be recommended. The footings must be founded below the weathered bedrock surface on sound shale, which was encountered at Elev. 125.5 to Elev. 127.1 at the QEW overpass immediately to the south. Preliminary design of spread footings founded on the sound

shale should be carried out using a factored geotechnical resistance at ULS of 1,000 kPa and the SLS condition will not govern.

To prevent deterioration of the exposed shale at the base of the foundation excavations, a concrete mud slab must be placed once the bedrock surface has been properly prepared and is free of loose debris. Footings constructed on shale bedrock must have a minimum 1.2 m thickness of earth cover as protection against frost action. As bedrock is shallow at this site, deep foundations including augered caissons (drilled shafts) and driven steel H-piles would typically not be considered to be a cost-effective alternative from a foundation viewpoint. However, if reconstruction of integral abutments is an option, it could be accommodated at this site. In this case, some excavation of bedrock will be required around the abutment, the piles must be socketed into bedrock and special consideration must be given to the details of pile installation in order to provide the required flexibility in the upper 3.0 m length.

For HP 310 x 110 H-piles socketed into bedrock as outlined above, a factored axial resistance of 2,000 kN at ULS is recommended for preliminary design and an SLS resistance of 1,800 kN.

To provide the required flexibility in the piles for integral abutment design, the upper 3 m of the piles should be surrounded by concentric 800 and 600 mm diameter CSPs as specified by the integral abutment design procedures. After the pile is installed, the space between the pile and the 600 mm CSP should be filled with sand.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.16 Site 10-325 – Highway 403 E-S Ramp over Highway 403/407 Connections

The archive General Arrangement drawing for the existing Highway 403 E-S Ramp structure over the Highway 403/407 Connections indicates that the structure is supported on spread footings with design top-of-footing elevations at 178.75 (north abutment), 176.5 (three north piers), 180.0 (centre pier), 180.8 (three south piers), and 185.0 (south abutment).

Based on the GEOCRE data, the soil at the design founding levels generally consists of very stiff to hard native silty clay till. The design founding level of the south piers is near the preconstruction ground surface and subexcavation to penetrate surficial topsoil and softened material was likely necessary. The GA drawing indicates that the south abutment was perched on a pad of Granular A material placed over the native silty clay subgrade.

If widening or modification of the structure is planned, the preferred foundation option consists of spread footings founded on the very stiff to hard silty clay till or a granular engineered fill at the same levels as the existing footings. Preliminary design of spread footings founded on the very stiff to hard silty clay till or Granular A engineered fill pad should be carried out using a factored geotechnical resistance at ULS of 525 kPa and a geotechnical reaction at SLS of 350 kPa.

The footings must have a minimum 1.2 m thickness of earth cover as protection against frost action.

Deep foundations including augered caissons (drilled shafts) and driven steel H-piles are considered feasible as an alternative to spread footings. However, deep foundations are unlikely to be cost-effective for the subsurface conditions this site, and will not match the existing foundation type. It is anticipated that pre-augering may be required at many of the foundation units to enable driving of steel piles to an adequate depth to achieve lateral fixity.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.17 Site 10-326 – Highway 407 to 403 over Highway 403 to 407

The archive General Arrangement drawing for the existing Highway 407 to 403 structure over the Highway 403 to 407 (SS-W Ramp available only) indicates that the pier and abutments are supported on spread footings with design top-of-footing elevations at 179.0 (north abutment), 176.0 (pier), and 180.0 (south abutment). Based on the GEOCRESS data, the soil at the design founding levels generally consists of very stiff to hard native silty clay till.

If widening or modification of the structure is planned, the preferred foundation option consists of spread footings founded on the very stiff to hard silty clay till at the same levels as the existing footings. Preliminary design of spread footings founded on the very stiff to hard silty clay till should be carried out using a factored geotechnical resistance at ULS of 450 kPa and a geotechnical reaction at SLS of 300 kPa.

The footings must have a minimum 1.2 m thickness of earth cover as protection against frost action.

Deep foundations including augered caissons (drilled shafts) and driven steel H-piles are considered feasible as an alternative to spread footings. However, deep foundations are unlikely to be cost-effective for the subsurface conditions this site, and will not match the

existing foundation type. Pre-augering may be required to enable driving of steel piles to an adequate depth to achieve lateral fixity.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.18 Site 10-327 – Ninth Line over Highway 403 to 407

The archive General Arrangement drawing for the existing Ninth Line underpass structure over Highway 403 to 407 indicates that the pier and abutments are supported on spread footings with design top-of-footing elevations at 179.2 (north abutment), 175.0 (pier), and 179.1 (south abutment). Based on the GEOCRES data, the soil at the design founding levels generally consists of very stiff to hard native silty clay till.

If widening or modification of the structure is planned, the preferred foundation option consists of spread footings founded on the very stiff to hard silty clay till at the same levels as the existing footings. Preliminary design of spread footings founded on the very stiff to hard silty clay till should be carried out using a factored geotechnical resistance at ULS of 450 kPa and a geotechnical reaction at SLS of 300 kPa.

The footings must have a minimum 1.2 m thickness of earth cover as protection against frost action.

Deep foundations including augered caissons (drilled shafts) and driven steel H-piles are considered feasible as an alternative to spread footings. However, deep foundations are unlikely to be cost-effective for the subsurface conditions this site, and will not match the existing foundation type.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.19 Site 10-328 – Ninth Line over Highway 407 W-S Ramp

The archive General Arrangement drawing for the existing Ninth Line structure over the Highway 407 W-S Ramp indicates that the piers and abutments are supported on spread footings with design top-of-footing elevations at 185.3 (west abutment), 179.1 (piers), and 183.4 (east abutment). Based on the GEOCRES data, the soil at the design founding level

for the piers consists of hard native silty clay till. The GA drawing indicates that the abutments are perched on Granular A pads placed over the native silty clay subgrade.

If widening or modification of the structure is planned, the preferred foundation option consists of spread footings founded on the hard silty clay till or granular engineered fill pads at the same levels as the existing footings. Preliminary design of spread footings founded on the hard silty clay till should be carried out using a factored geotechnical resistance at ULS of 600 kPa and a geotechnical reaction at SLS of 400 kPa. The SLS reaction for abutment footings constructed on an engineered fill pad should be reduced to 350 kPa.

The footings must have a minimum 1.2 m thickness of earth cover as protection against frost action.

Deep foundations including augered caissons (drilled shafts) and driven steel H-piles are considered feasible as an alternative to spread footings. However, deep foundations are unlikely to be cost-effective for the subsurface conditions this site, and will not match the existing foundation type. Pre-augering may be required to enable driving of steel piles to an adequate depth to achieve lateral fixity.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.20 Site 24-384 – Highway 403 Underpass at Winston Churchill Boulevard

The archive General Arrangement drawing for the existing Winston Churchill Boulevard structure over Highway 403 indicates that the pier and abutments are supported on spread footings with design top-of-footing elevations at 173.0 (abutments) and 171.6 (pier). Based on the GEOCREST data, the soil at the design founding levels generally consists of very stiff to hard native clayey silt till.

If widening or modification of the structure is planned, the preferred foundation option consists of spread footings founded on the very stiff to hard clayey silt till at the same levels as the existing footings. Preliminary design of spread footings founded on the very stiff to hard silty clay till should be carried out using a factored geotechnical resistance at ULS of 525 kPa and a geotechnical reaction at SLS of 350 kPa.

The footings must have a minimum 1.2 m thickness of earth cover as protection against frost action.

Deep foundations including augered caissons (drilled shafts) and driven steel H-piles are considered feasible as an alternative to spread footings. However, deep foundations are unlikely to be cost-effective for the subsurface conditions this site, and will not match the existing foundation type. It is anticipated that pre-augering may be required to enable driving of steel piles to an adequate depth to achieve lateral fixity.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.21 Service Road over Dundas Street

A new structure is planned to carry a new service road over Dundas Street approximately 250 m west of the existing Highway 403-Dundas Street Underpass. GEOCREs information is not available for the new structure location. GEOCREs data available for the existing Highway 403 – Dundas Street underpass (Site 10-281) has therefore been used to develop preliminary foundation recommendations for the new Service Road structure.

The subsurface stratigraphy encountered in the boreholes drilled at the existing underpass location generally consisted of dense to very dense silt and sand layers overlying hard clayey silt till, underlain by shale bedrock at depths of 7.0 to 8.2 m (Elev. 162.5 to 163.7). Subsurface conditions including the depth and elevation of bedrock may differ at the new structure location and must be determined by field investigation.

Based on the available data, spread footings could be founded on the dense to very dense silt and sand or hard clayey silt till, though this might lead to very high abutment stems. Preliminary design of spread footings founded on the dense to very dense/hard native soils should be carried out using a factored geotechnical resistance at ULS of 600 kPa and a geotechnical reaction at SLS of 400 kPa.

The footings must have a minimum 1.2 m thickness of earth cover as protection against frost action.

Steel H-piles are considered a feasible alternative to spread footings if integral abutment design is planned. It is anticipated that pre-augering may be required to enable driving of steel piles to an adequate depth to achieve lateral fixity. If shale bedrock is present at shallower depth than at the Highway 403 underpass, it may be necessary to socket the piles into shale by drilling/coring a socket into the bedrock, inserting the pile, then backfilling around the pile with concrete. A minimum socket length of 3 m in shale is recommended.

For HP 310 x 110 H-piles driven into very dense/hard native soils or socketed into bedrock as outlined above, a factored axial resistance of 2,000 kN at ULS is recommended for preliminary design and an SLS resistance of 1,800 kN.

To provide the required flexibility in the piles for integral abutment design, the upper 3 m of the piles should be surrounded by concentric 800 and 600 mm diameter CSPs as specified by the integral abutment design procedures. After the pile is installed, the space between the pile and the 600 mm CSP should be filled with sand.

Augered caissons (drilled shafts) may also be considered but are unlikely to be the most cost-effective alternative for the subsurface conditions this site. For preliminary design, a 1.2 m diameter augered caisson socketed 3 m below the top of shale may be assumed to have a factored geotechnical resistance at ULS of 4,500 kN and a geotechnical resistance at SLS of 3,600kN. The caisson capacities must be re-evaluated based on the results of field investigation during detailed design.

Caisson installation must be carried out using such means as steel liners or drilling mud to support the sidewalls in cohesionless soils below the groundwater level.

Any excavations in the cohesionless silts and sands below the groundwater table will require a temporary dewatering scheme to lower the groundwater table at least 0.3 m below the base of the excavation for foundation construction. Any seepage or run-off into excavations maintained above the groundwater level should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for construction of approach embankments or cut slopes provided the sideslope inclination is 2H : 1V or flatter. Gravel sheeting and a toe subdrain may be required if any sections of cut slope extend below the groundwater level within the cohesionless silts/sands.

7.22 Site 10-280 – Highway 403 Burnhamthorpe Road Underpass

The archive General Arrangement drawing for the existing Burnhamthorpe Road underpass indicates that the structure is supported on spread footings with design top-of-footing elevations at 179.8 (west abutment), 179.1 (pier), and 180.0 (east abutment). Based on the GEOCRE data, the founding soils at this level consist of hard native clayey silt till.

If widening or reconstruction of the structure is planned, the preferred foundation option consists of spread footings founded on the hard native clayey silt till at the same level as the existing footings. Preliminary design of spread footings founded on the hard till should be carried out using a factored geotechnical resistance at ULS of 600 kPa and a geotechnical reaction at SLS of 400 kPa.

The footings must have a minimum 1.2 m thickness of earth cover as protection against frost action.

Deep foundations including augered caissons (drilled shafts) and driven steel H-piles are considered feasible as an alternative to spread footings. However, deep foundations are unlikely to be cost-effective for the subsurface conditions this site. It is anticipated that pre-augering may be required to enable driving of steel piles to an adequate depth to achieve lateral fixity.

No dewatering problems are anticipated during excavation and construction of foundations. Any seepage and/or runoff into the excavations should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments provided the sideslope inclination is 2H : 1V or flatter.

7.23 Site 10-281 – Highway 403 Underpass at Dundas Street

The archive General Arrangement drawing for the existing Dundas Street underpass indicates that the structure is supported on spread footings with design top-of-footing elevations at 170.7 (abutments) and 167.3 (pier). Based on the GEOCRE data, the founding soils at these levels consist of dense to very dense silts and sands, with shale bedrock encountered at Elevation 162.5 to 163.7. Locally at the north end of the west abutment, a compact zone was encountered below the founding level, at approximate Elev. 167.5.

If widening or reconstruction of the structure is planned, the preferred foundation option consists of spread footings founded on the dense to very dense silt and sand at the same level as the existing footings. Preliminary design of spread footings founded on the dense to very dense native silt/sand should be carried out using a factored geotechnical resistance at ULS of 600 kPa and a geotechnical reaction at SLS of 400 kPa.

At the north end of the west abutment where a compact zone was identified, lower resistance values 400 kPa at factored ULS and 200 kPa at SLS should be employed, or the footing must be stepped down to Elev. 166.0 to found on the clayey silt till. Alternatively, an additional borehole should be advanced at this location during detailed design to confirm the localized condition.

The footings must have a minimum 1.2 m thickness of earth cover as protection against frost action.

Deep foundations including augered caissons (drilled shafts) and driven steel H-piles are considered feasible as an alternative to spread footings. However, deep foundations are unlikely to be cost-effective for the subsurface conditions this site, and will not match the existing foundation type. It is anticipated that pre-augering may be required to enable driving of steel piles to an adequate depth to achieve lateral fixity.

Groundwater was measured at approximate Elev. 169.6 in boreholes drilled prior to construction of Highway 403 and the existing underpass structure. The current groundwater level may be lower as a result of highway construction. Any excavations in the cohesionless silts and sands below the groundwater table will require a temporary dewatering scheme to lower the groundwater table at least 0.3 m below the base of the excavation for foundation construction. Any seepage or run-off into excavations maintained above the groundwater level should be handled with the use of sumps and pumps.

No stability problems are anticipated at this site for modifications/additions to the existing approach embankments or cut slopes provided the sideslope inclination is 2H : 1V or flatter. Gravel sheeting and a toe subdrain should be provided along any sections of cut slope within the cohesionless silts/sands extending below the groundwater level.

8 CLOSURE

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

Thurber Engineering Ltd.

Murray R. Anderson, P.Eng., M.Eng.
Senior Foundations Engineer



Sydney Pang, P.Eng., Ph.D.
Senior Foundations Engineer

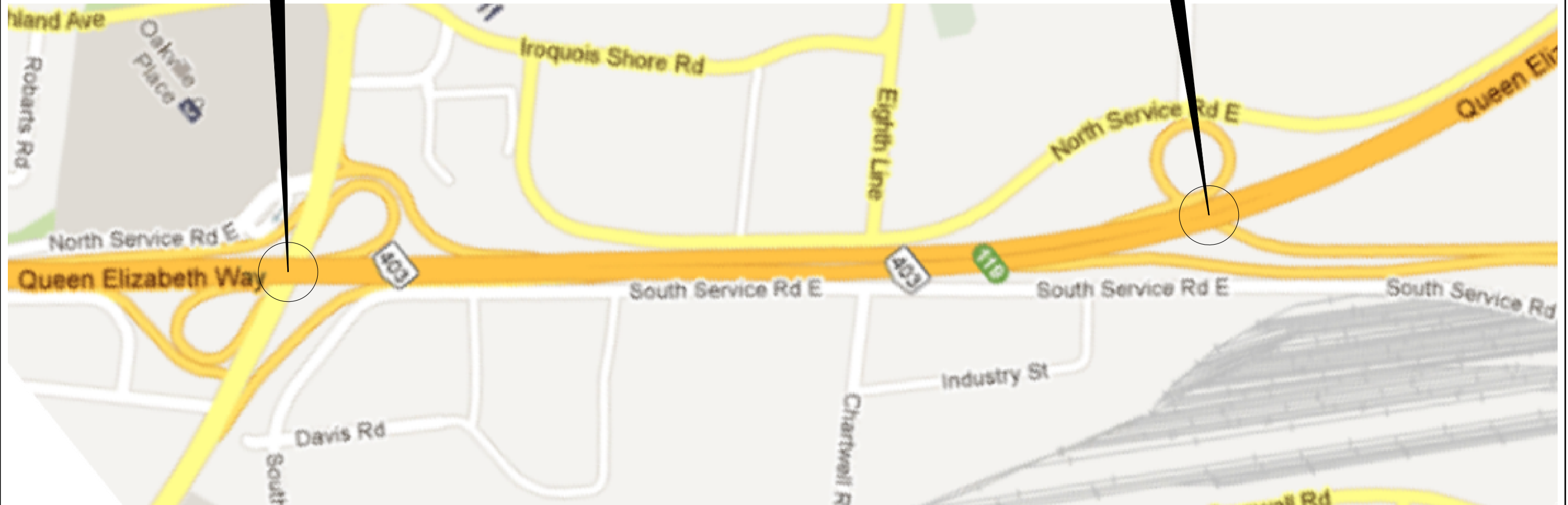


Alastair Gorman, P.Eng., M.Sc.
Senior Foundations Engineer



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





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LIST OF FOUNDATION / GEOTECHNICAL REFERENCES

Reference 2

Foundation Investigation Report for Trafalgar Road Interchange, W.P. 1-79-07, QEW, District 4, Hamilton, GEOCREs No. 30M5-120, dated February 1979, prepared by Associated Technical Services Limited

Reference 3

Foundation Investigation and Design Report for Royal Windsor Drive Overpass, Queen Elizabeth Way, Highway 403, W.P. 67-98-00, District 4/6, Toronto, GEOCREs No. 30M5-204, dated November 1998, prepared by Golder Associates Ltd.

[illegible]

Q.E.W. S-W RAMP OVER FORD DRIVE
(PROPOSED STRUCTURE)

SITE 10-285
HIGHWAY 403 N-W
RAMP OVER FORD DR.
REFERENCE 9

SITE 10-286
Q.E.W. OVER FORD
DRIVE
REFERENCE 10

SITE 10-287
HIGHWAY 403 W-N
RAMP OVER FORD DR.
REFERENCE 11

Q.E.W. N-E RAMP OVER FORD DRIVE
(PROPOSED STRUCTURE)

CONT No
WP No

Q.E.W. & HWY. 403 IMPROVEMENTS
STRUCTURE LOCATIONS AND
SOURCES OF FOUNDATION REFERENCE



SHEET



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SITE 10-140C
Q.E.W./HWY.403 EXIT
RAMP TO FORD DRIVE
OVER JOSHUA CREEK
REFERENCE 1

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LIST OF FOUNDATION / GEOTECHNICAL REFERENCES

Reference 1
Foundation Investigation Report for W-N and W-S Ramp Over Joshua Creek, W.P. 125-66-23, Site 10-140C, QEW, District 4, Hamilton, GEOCREs No. 30M5-115, dated January 18, 1978, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 9
Foundation Investigation for N/W Ramp Structure over Ford Drive, QEW/403/Ford Drive Interchange, W.P. 125-66-18, Site 10-285, District 4, Hamilton, GEOCREs No. 30M5-107, dated May 20, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 10
Foundation Investigation Report for QEW Over Ford Drive, W.P. 125-66-17, Site 10-286, QEW, District 4, Hamilton, GEOCREs No. 30M5-116, dated January 25, 1978, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 11
Foundation Investigation Report for W-N Ramp Highway 403 Structure over Ford Drive, QEW/Ford Drive/403 Interchange, W.P. 125-66-16, Site 10-287, District 4, Hamilton, GEOCREs No. 30M5-106, dated May 17, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

REVISIONS		DATE	BY	DESCRIPTION
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		LOAD	DATE	MAR. 2013
		STRUCT	DWG	2

SITE 10-283
N-W RAMP HWY. 403 OVER
E-N/S RAMP Q.E.W. AND
UPPER MIDDLE ROAD
REFERENCE 7

SITE 10-282B
UPPER MIDDLE ROAD
OVER W-N RAMP
HIGHWAY 403
REFERENCE 6

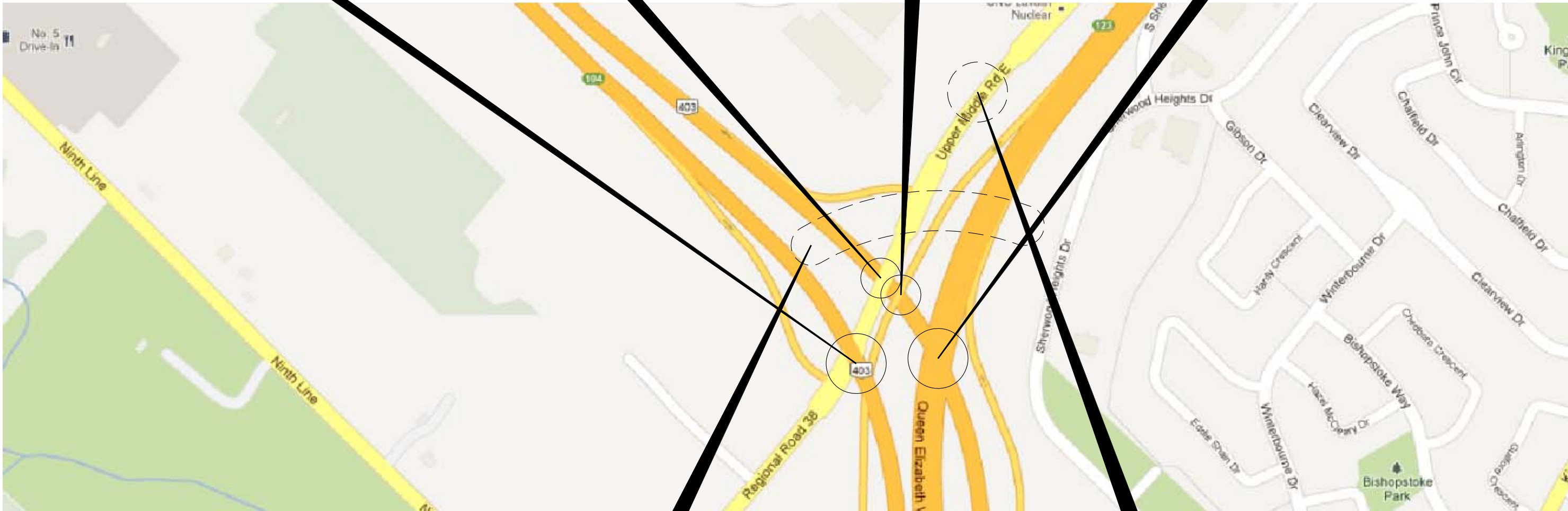
SITE 10-282A
E-N/S RAMP Q.E.W.
OVER W-N RAMP
HIGHWAY 403
REFERENCE 5

SITE 10-284
Q.E.W. OVER W-N RAMP
HIGHWAY 403
REFERENCE 8

CONT No
WP No
Q.E.W. & HWY. 403 IMPROVEMENTS
STRUCTURE LOCATIONS AND
SOURCES OF FOUNDATION REFERENCE



SHEET



HIGHWAY 403 / Q.E.W.
N-E RAMP
(PROPOSED STRUCTURE)

HIGHWAY 403 / Q.E.W.
E-N RAMP
(PROPOSED STRUCTURE)

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LIST OF FOUNDATION / GEOTECHNICAL REFERENCES

- Reference 5**
Foundation Investigation Report for W-N Ramp Highway 403 Structure under Ramp E-NS, QEW/Ford Drive/Highway 403 Interchange, W.P. 159-75-07, Site 10-282A, District 4, Hamilton, GEOCRE No. 30M5-110, dated July 16, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.
- Reference 6**
Foundation Investigation Report for W-N Ramp Highway 403 under North Service Road, QEW/Ford Drive/403 Interchange, W.P. 159-75-08, Site 10-282B, District 4, Hamilton, GEOCRE No. 30M5-111, dated June 1, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

- Reference 7**
Foundation Investigation Report for QEW/Ford Drive/403 Link Interchange, N-W Ramp Highway 403 over Ramp E-N.S. and North Service Road, W.P. 159-75-09, Site 10-283, District 4, Hamilton, GEOCRE No. 30M5-114, dated January 12, 1978, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.
- Reference 8**
Foundation Investigation Report for W-N Ramp Highway 403 Under QEW, W.P. 159-75-06, Site 10-284, QEW, District 4, Hamilton, GEOCRE No. 30M5-117, dated February 20, 1978, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

REVISIONS		DATE		BY		DESCRIPTION		DATE		MAR. 2013	
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SITE 24-375
Q.E.W. UNDER WINSTON
CHURCHILL BLVD.
REFERENCE 4

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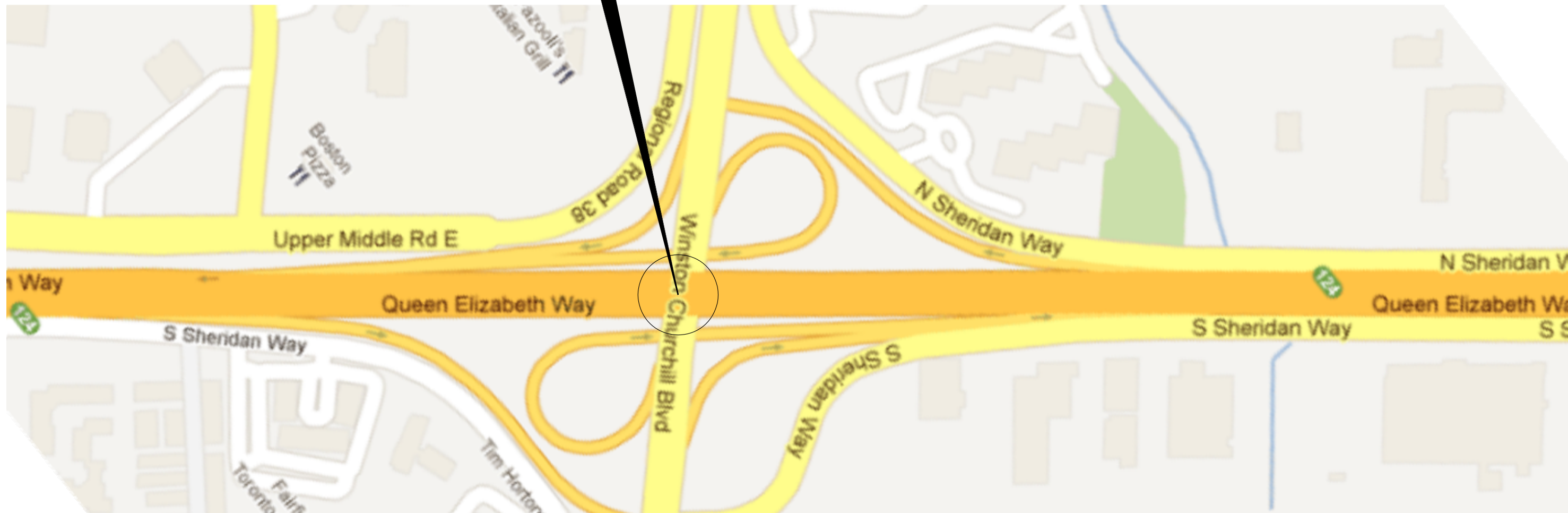
Q.E.W. & HWY. 403 IMPROVEMENTS
STRUCTURE LOCATIONS AND
SOURCES OF FOUNDATION REFERENCE



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LIST OF FOUNDATION / GEOTECHNICAL REFERENCES

Reference 4

Foundation Investigation Report for Winston Churchill Boulevard Interchange Underpass, QEW, W.P. 125-66-12, Site 24-375, District 4, Hamilton, GEOCREs No. 30M12-121, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

REVISIONS		DATE		BY		DESCRIPTION		DATE	
		DESIGN	LRB	CHK	SKP	CODE	LOAD	DATE	MAR. 2013
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SITE 10-280
HIGHWAY 403 UNDER
BURNHAMTHORPE ROAD
REFERENCE 17

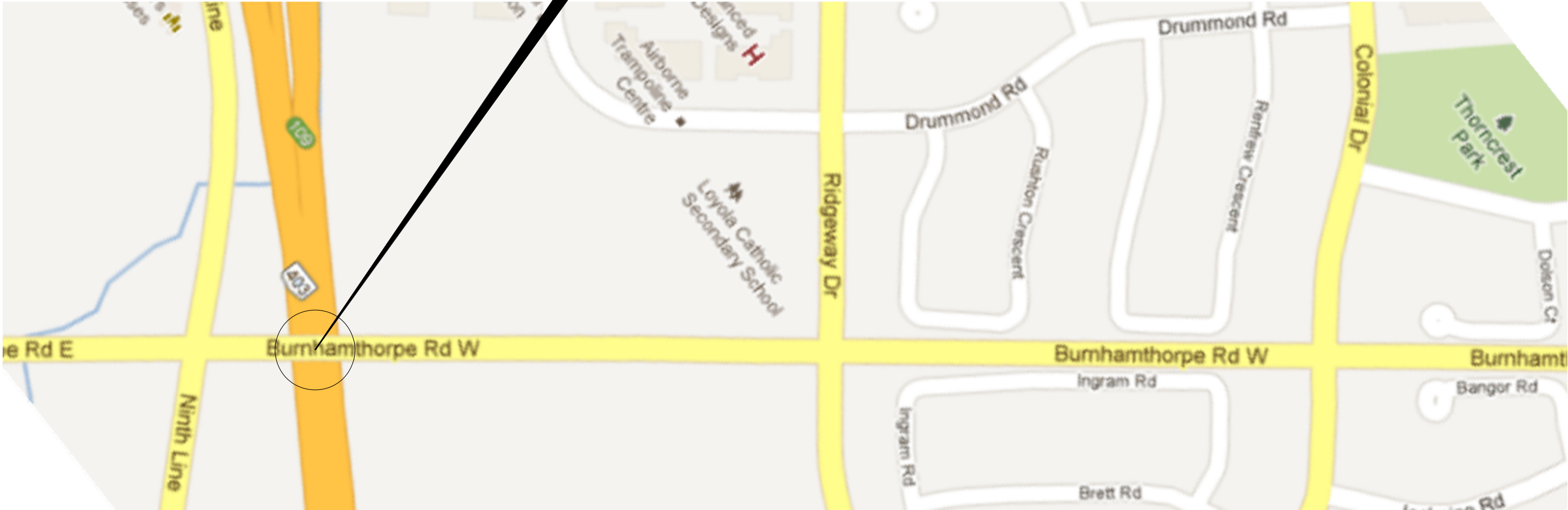
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WP No
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STRUCTURE LOCATIONS AND
SOURCES OF FOUNDATION REFERENCE



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LIST OF FOUNDATION / GEOTECHNICAL REFERENCES

Reference 17
Foundation Investigation Report for Burnhamthorpe Road Underpass, W.P. 158-75-04, Site 10-280, Highway 403, District 4, Hamilton, GEOCREs No. 30M12-128, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications.

REVISIONS		DATE		BY		DESCRIPTION	
DESIGN	LRB	CHK	SKP	CODE	LOAD	DATE	MAR. 2013
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SITE 10-327
NINTH LINE OVER
HIGHWAY 403 TO
HIGHWAY 407
REFERENCE 14

SITE 10-328
NINTH LINE OVER
HIGHWAY 407 W-S
RAMP
REFERENCE 15

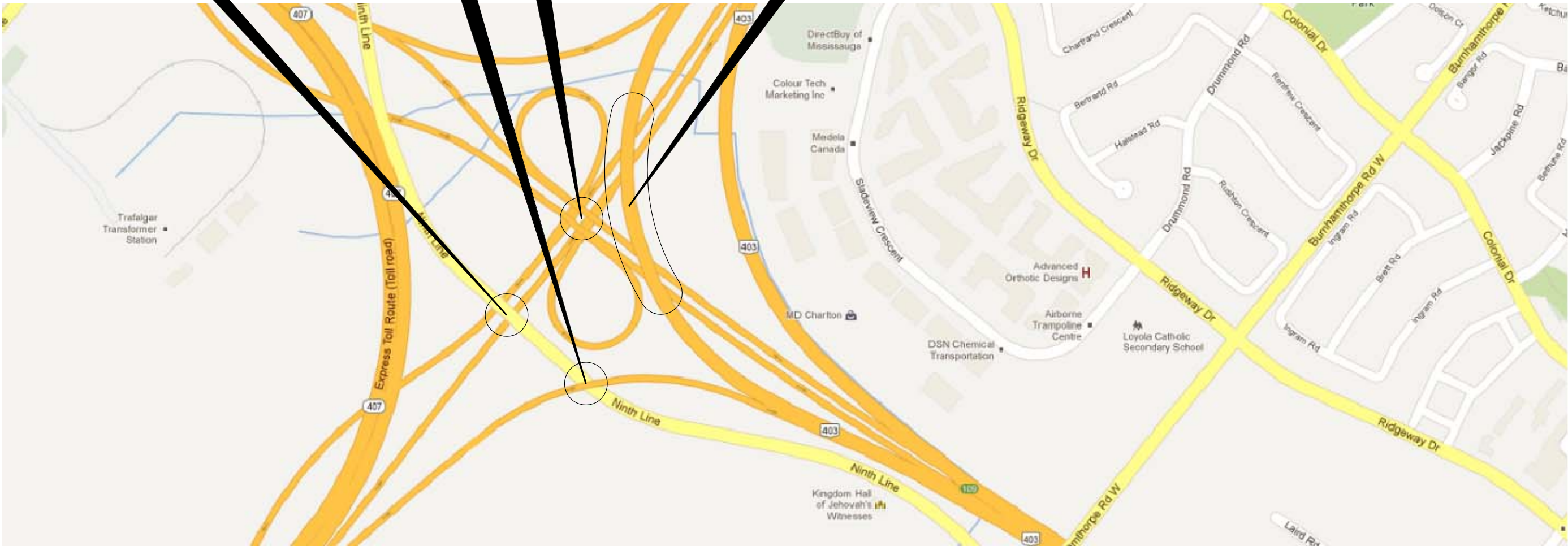
SITE 10-326
HWY. 407 TO HWY. 403
OVER HWY. 403 TO
HWY. 407
REFERENCE 13

SITE 10-325
E-S RAMP HWY. 403
OVER 2 HWY. 403/407
CONNECTIONS
REFERENCE 12

CONT No
WP No
Q.E.W. & HWY. 403 IMPROVEMENTS
STRUCTURE LOCATIONS AND
SOURCES OF FOUNDATION REFERENCE



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LIST OF FOUNDATION / GEOTECHNICAL REFERENCES

- Reference 12
Foundation Investigation Report for E-S Ramp Underpass, Highway 403 & 407 Interchange Complex, W.P. 197-77-03, Site 10-82-325, District #4 (Hamilton), GEOCREs No. 30M12-169, prepared by Pavement & Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.
- Reference 13
Foundation Investigation Report for Highway 407 Underpass Structures, Highway 403 & 407 Interchange Complex, W.P. 197-77-02, Site 10-82-326, District #4 (Hamilton), GEOCREs No. 30M12-170, prepared by Pavement & Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.

- Reference 14
Foundation Investigation Report for Ninth Line Underpass, Highway 403 & 407 Interchange Complex, W.P. 197-77-05, Site 10-82-327, District 4, Hamilton, GEOCREs No. 30M12-173, dated December 24, 1982, prepared by Pavement & Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.
- Reference 15
Foundation Investigation Report for W-S Ramp and Ninth Line, Highway 403 & 407 Interchange Complex, W.P. 197-77-04, Site 10-82-328, District #4 (Hamilton), GEOCREs No. 30M12-174, dated January 11, 1983, prepared by Pavement & Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.

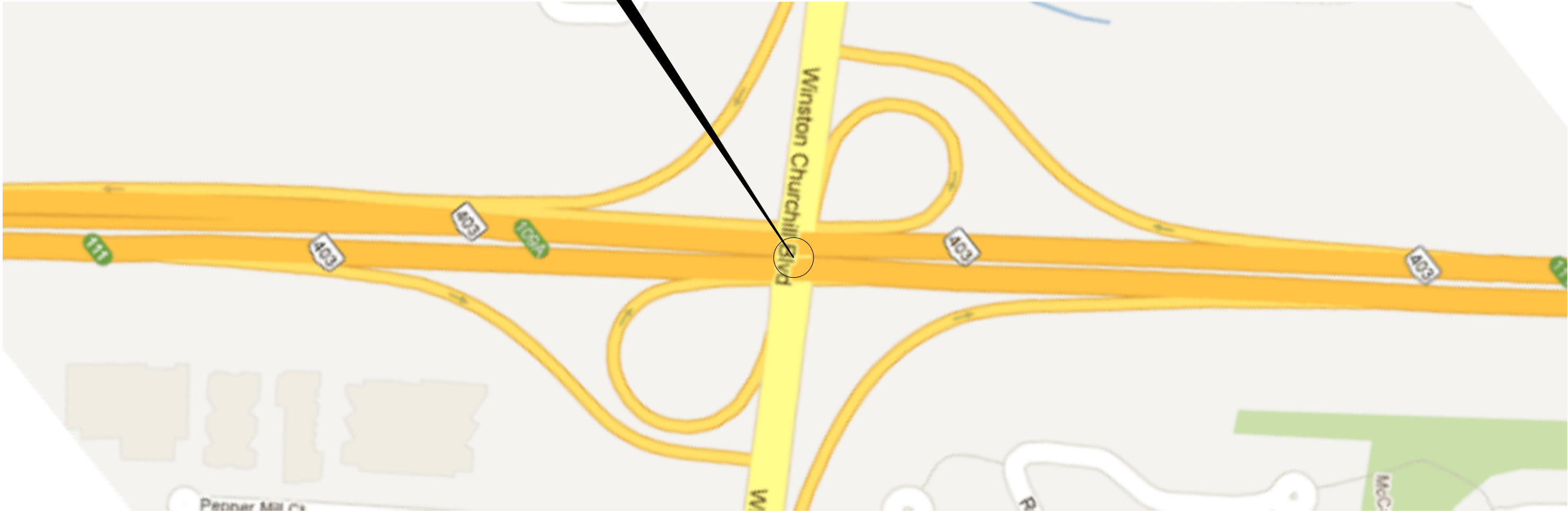
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DATE	BY	CHK	SKP	CODE	LOAD	DATE	MAR.	2013	
DESIGN	LRB	CHK	LRB	SITE	STRUCT	DWG	7		

SITE 24-384
HIGHWAY 403 UNDER
WINSTON CHURCHILL
BLVD.
REFERENCE 16

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WP No
Q.E.W. & HWY. 403 IMPROVEMENTS
STRUCTURE LOCATIONS AND
SOURCES OF FOUNDATION REFERENCE



SHEET



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LIST OF FOUNDATION / GEOTECHNICAL REFERENCES

Reference 16
Foundation Investigation Report for Winston Churchill Boulevard Underpass, W.P. 158-75-03, Site No. 24-384, District 4, Hamilton, GEOCRE No. 30M12-129, dated October 20, 1977, prepared by Soil Mechanics Section, Engineering Materials Office, Ministry of Transportation and Communications

REVISIONS		DATE		BY		DESCRIPTION	
DESIGN	LRB	CHK	SKP	CODE	LOAD	DATE	MAR. 2013
DRAWN	MFA	CHK	LRB	SITE	STRUCT	DWG	8

G.I.-30 SEPT. 1976

GEOCRES No. 30M5-115DIST. 4 REGION W.P. No. 125-66-23CONT. No. 79-80W. O. No. STR. SITE No. 10-140CHWY. No. Q.E.W.LOCATION W-N Ramp over
Joshua CreekNo of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



Ontario

Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 125-66-23

DIST 4

HWY QEW

STR SITE 10-140C

W-N and W-S Ramp Over Joshua Creek

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SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	78 01 18	M.L.
TUBES	—	—
ROCK CORES	After 75' depth	M.L.

FOUNDATION INVESTIGATION REPORT

For

W-N and W-S Ramp Over Joshua Creek
W.P. 125-66-23, Site 10-140C
Hwy. QEW, District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project during the period of November 14 and 15, 1977. The fieldwork consisted of four sampled boreholes advanced by means of a continuous flight auger machine equipped with 3¼" I.D. hollow stem augers. In addition, diamond drilling techniques were employed to obtain BXL size core samples of the bedrock. The boreholes ranged in depth from 6 to 11 feet below the ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately half a mile east of Q.E.W. and Joshua Creek crossing in the Town of Oakville, Regional Municipality of Halton. The land immediately adjacent to the site has a gentle rolling topography sloping down to the south. The creek bed has exposed the underlying red Queenston shale.

The land forms part of the green park area surrounding the Ford Motor Co. of Oakville office building.

Physiographically the site lies on the southern edge of the region referred to as the "South Slope". This region is a strip of land bounded by the Iroquois Plain on the south and Peel Plain on the north. The region is characterized by glacial till overburden underlain by shale bedrock of Queenston and Dundas Formation of the Upper Ordovician Age.

SUBSURFACE CONDITIONS

The subsurface conditions at the site were found to be quite uniform. A 3 to 5 foot layer of clayey silt is underlain by shale bedrock. Detailed descriptions of the various soil and rock types encountered in each borehole are given in the Record of Borehole Sheets. The estimated stratigraphical profile and sections shown on Drawing No. 1256623-A are based upon this information. From ground level downwards the various types encountered are as follows.

Clayey Silt With Some Sand and Occasional Gravel

Under a one foot layer of topsoil a cohesive stratum 3 to 6 feet thick consisting of clayey silt with some sand and occasional gravel was encountered. The Standard Penetration Tests gave an 'N' value range of 15 to 51 blows per foot indicating that the consistency of the layer is very stiff to hard.

The physical properties of the clayey silt as determined from laboratory testing are summarized below:

		<u>Range</u>
Liquid Limit	(W _L) %	30-32
Plastic Limit	(W _p) %	20-22
Moisture Content	(W) %	10-12

The results of the Atterberg Limit Tests indicate that the cohesive layer is inorganic and of low plasticity.

Bedrock

Underlying the cohesive clayey silt layer is the bedrock which was proven to a maximum depth of 5 feet. The bedrock consists of interbedded layers of shale and limestone. The shale is soft, red in colour and fissile, having thin horizontal bedding planes with seams of limestone up to one foot thick. In B.H. #2 the upper one foot of the bedrock is weathered and below this the bedrock is moderately fractured. A detailed description of the bedrock is given on the Record of Borehole Sheets. The Rock Quality Designation (RQD) for the cored samples of the bedrock is about 15% to 30% indicating that the rock quality is generally poor.

Groundwater

The groundwater level conditions were observed by measuring in the open boreholes during and after the completion of the foundation investigation. The groundwater level was found to vary between elevation 386.0 and elevation 386.5 which corresponds to 2 to 3.5 feet below the existing ground surface. The water level in the creek during the time of investigation was at elevation 385.0. The groundwater levels are shown on the Record of Borehole Sheets, as well as on Drawing No. 1256623-A.

DISCUSSION AND RECOMMENDATIONS

As part of the proposed new complex interchange connecting Q.E.W. to Hwy. 403 a structure will be required to carry W-N and W-S Ramp over Joshua Creek.

In the vicinity of the proposed structure the existing ground elevation varies from elevation 388 to elevation 389.5. The proposed grade of the W-N and W-S Ramp elevation is at elevation 406.0. This will necessitate embankment fills of maximum 16.5 feet.

A single span structure is presently being considered.

Structure Foundations

In case a single span closed type structure is considered, the abutment footings can be founded on spread footings. The footings can be placed at or below elevation 383.0 and designed for an allowable load up to 10 t.s.f. Since the shale is frost susceptible the underside of the footings should be provided with a minimum of 4 feet of earth cover for frost protection purposes.

Other Considerations

To prevent softening of the shale bedrock due to weathering, the excavated base should be covered with a minimum of 3 inches of mass concrete immediately after the excavation.

No dewatering problems are anticipated for the construction of the foundations. Any minor seepage or surface runoff into the excavations can be handled by pumping from sumps.

Approaches

The approach fills will have a maximum height of 16.5 feet. No stability problems are anticipated for the proposed approach fills constructed with standard 2:1 slopes.

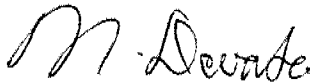
MISCELLANEOUS

The fieldwork was carried out during November 14 and 15, 1977 under the supervision of Mr. V. Korlu, Project Engineer, who also prepared this report.

The drilling equipment was owned and operated by D.S.I.L. Drilling Inc. of Toronto.

This report was reviewed by Mr. M. Devata, Supervising Engineer.


V. Korlu, P. Eng.
Project Engineer



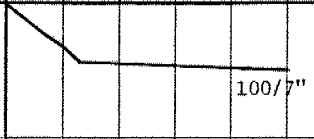

M. Devata, P. Eng.
Supervising Engineer

MD/VK/gs
January, 1978

APPENDIX

RECORD OF BOREHOLE No 1

W P 125-66-23 LOCATION Co-ords N 15,803,181; E 954,335 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" Hollow Stem Auger; BXL Core and Cone Test COMPILED BY V.K.
 DATUM Geodetic DATE November 14, 1977 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	W _p	W		
389.6	Ground Level											
0.0	Topsoil											
384.6	Clayey Silt, Sand & Gravel Hard		1	SS	51							
5.0	Shale Bedrock*						100/7"					
379.6						380						
10.0	End of Borehole * <u>Bedrock</u> : Shale, grey, soft, fissile, 2" limestone seams R.Q.D. 15%											

RECORD OF BOREHOLE No 2

W P 125-66-23 LOCATION Co-ords N 15,803,193; E 954,297 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" Hollow Stem Auger; BXL Core and Cone Test COMPILED BY V.K.
 DATUM Geodetic DATE November 14, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L		
								SHEAR STRENGTH			WATER CONTENT (%)		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
389.6	Ground Level												
0.0	Topsoil												
383.6	Clayey Silt, Sand and Gravel Very Stiff		1	SS	15								50 22 14 5
6.0	Weathered							100/6"					
378.6	Shale Bedrock*						380						
11.0	End of Borehole * <u>Bedrock</u> : Shale, grey, soft, fissile. 4" limestone seams R.Q.D. 20%												

RECORD OF BOREHOLE No 3

W P 125-66-23 LOCATION Co-ords N 15,803,229; E 954,333 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3½" Hollow Stem Auger; BXL Core COMPILED BY V.K.
 DATUM Geodetic DATE November 14, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
388.1	Ground Level																
0.0	Topsoil																
384.1	Clayey Silt, sand and Gravel																
4.0																	
379.1	A Bedrock*																
9.0	End of Borehole																
	* Bedrock:																
	A. Shale, grey, soft fissile with 1" seams of limestone																
	B. Limestone, light grey, fine to med. grained, hard. Fossiliferous																
	R.Q.D. 30%																

RECORD OF BOREHOLE No 4

W P 125-66-23 LOCATION Co-ords: N 15,803,217; E 954,368 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3½" Hollow Stem Auger; BXL Core COMPILED BY V.K.
 DATUM Geodetic DATE November 15, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
388.0	Ground Level																
0.0	Topsoil																
383.0	Clayey Silt, Sand and Gravel, Very Stiff		1	SS	18												56 21 18 5
5.0																	
378.0	A Bedrock*																
10.0	End of Borehole																
	* Bedrock:																
	A. Shale, grey, soft fissile, thin seams of limestone.																
	B. Limestone, light grey, med. grained, hard, fossiliferous																
	R.Q.D. 30%																

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS




LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}U$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
E S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE 
 w SLOPE ANGLE-BACKFACE OF WALL 
 β ANGLE OF SLOPE 
 N_q, N_c, N_{γ} BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w_L - w_p$
 I_L LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
 A_c ACTIVITY = $\frac{I_p \text{ of soil}}{I_p \text{ of } 2\mu m \text{ Soil Fraction}}$
 O_m ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 σ_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

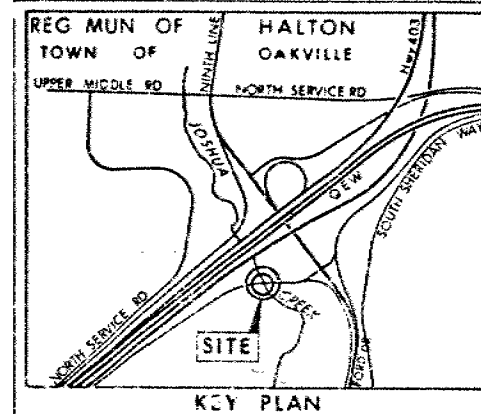
NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

CONT No
WP No 125-66-23



W-N & W-S RAMP OVER JOSHUA CR
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- W' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60" Cone, 350 ft lbs energy)
- W.L. at time of investigation Nov 1977

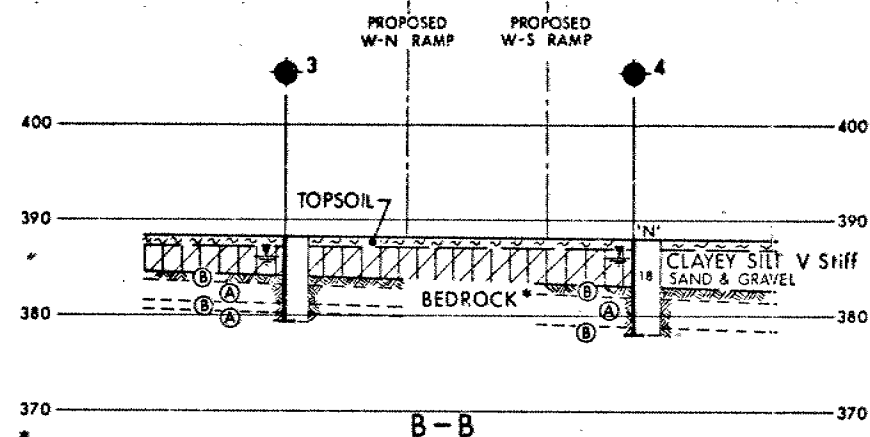
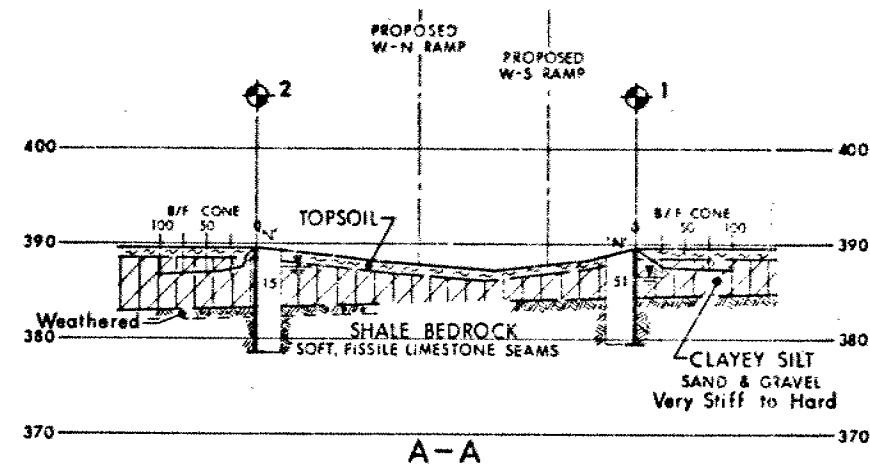
No	ELEVATION	CO ORDINATES	
		NORTH	EAST
1	389.6	15 803 181	954 335
2	389.6	15 803 193	954 297
3	388.1	15 803 229	954 333
4	388.0	15 803 217	954 368

-NOTE-

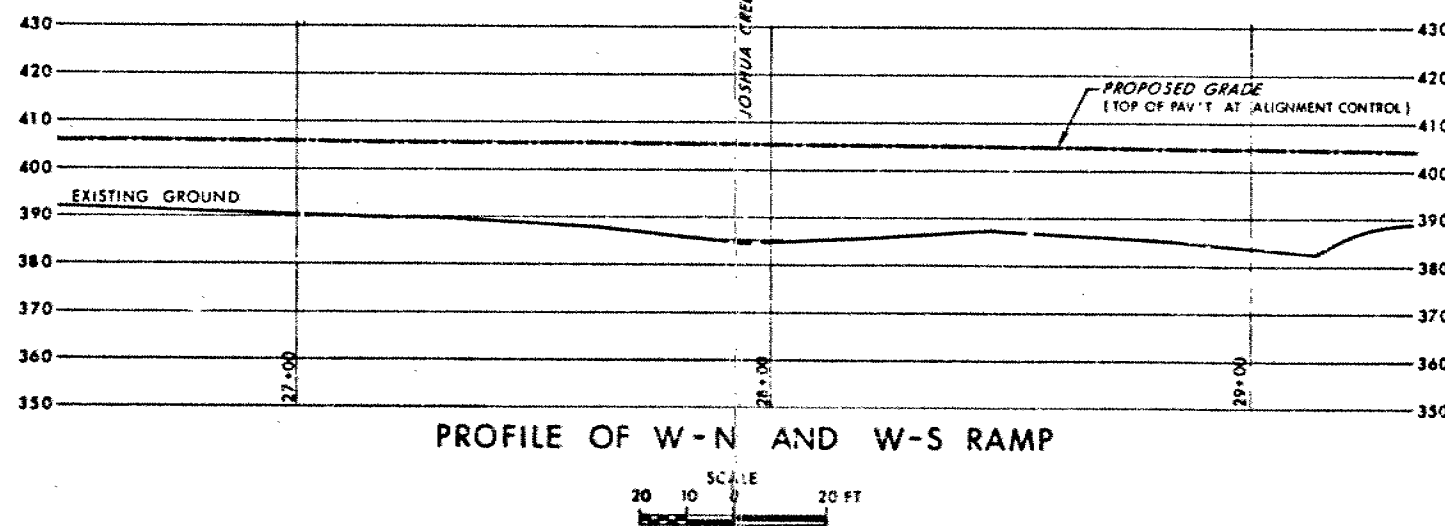
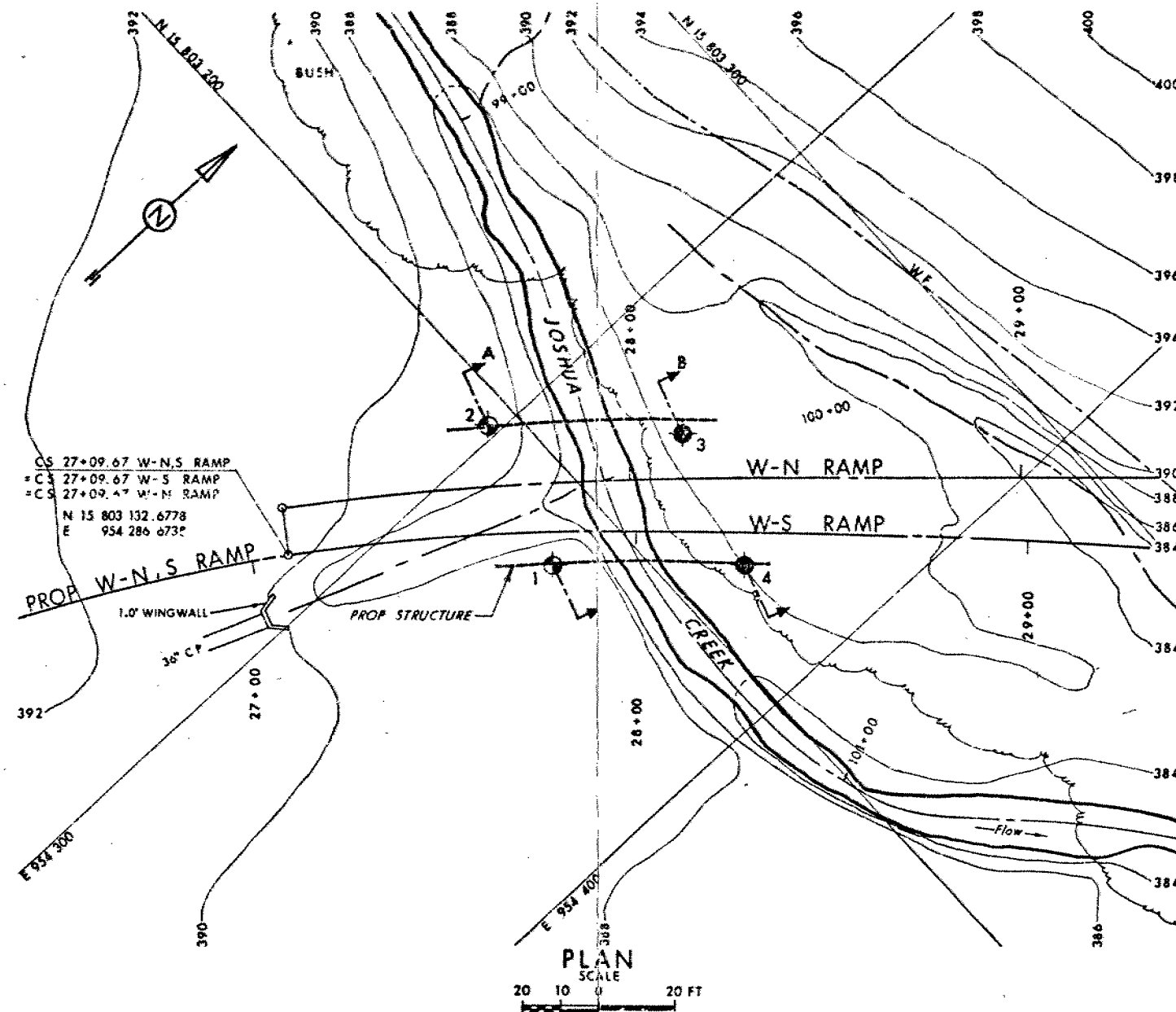
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

HWY No. QEW
DRAWN BY: [Signature] CHECKED BY: [Signature] DATE: Jan 5, 1978
SITE 10-140 C
NO 1256623-A



- * BEDROCK
 (A) SHALE, SOFT FISSILE, THIN SEAMS OF LIMESTONE.
 (B) LIMESTONE, FINE TO MEDIUM GRAINED, HARD, FOSSILIFEROUS.



REF: Giffels, Davis & Jorgensen
Consulting Engineers, Date: 7/7/10/78



NOTES

CLASS OF CONCRETE
DECK, ABUTMENTS, STUB WALLS AND BARRIER WALLS 4000 psi
REMAINDER 3000 psi

GRADE OF REINFORCING STEEL
REINFORCING STEEL SHALL BE C.S.A. G30.12-M SERIES, GRADE 400
REINFORCING BARS WITH THE DESIGNATION C AT THE END OF BAR MARKS SHALL BE COATED BARS

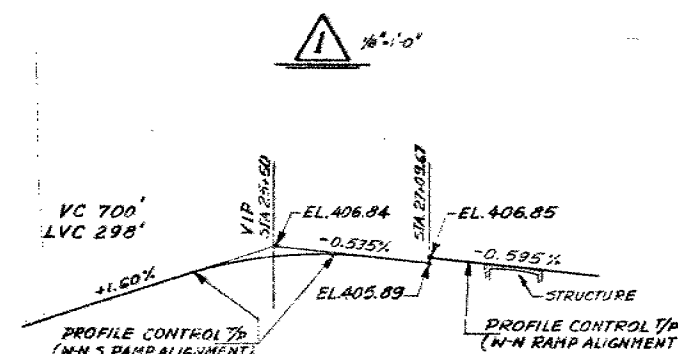
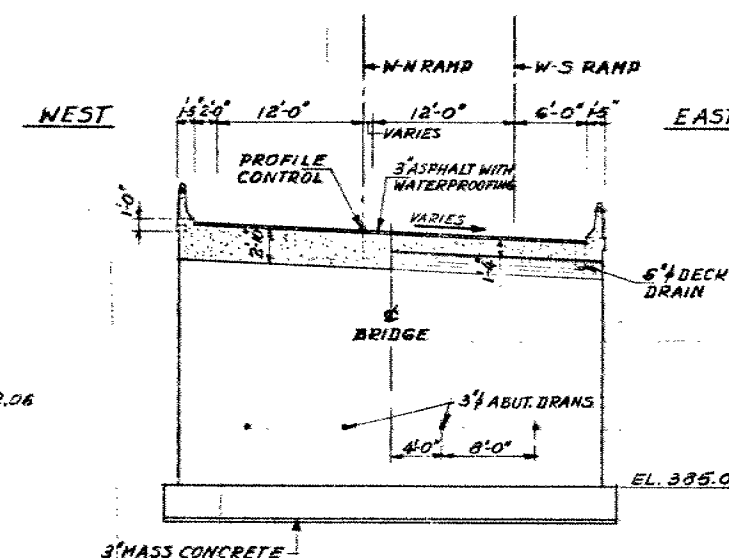
CLEAR COVER TO REINFORCING STEEL
FOOTINGS 3", ABUTMENTS 3", STUB WALLS 3", DECK TOP 2", DECK BOT 1 1/2", BARRIER WALLS 1 1/2", RETAINING WALLS 3", APPROACH SLABS 2", UNLESS NOTED OTHERWISE ON DRAWINGS

CONSTRUCTION NOTES
FOOTINGS TO BE CAST ON AND AGAINST UNDISTURBED GROUND
BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS AND FOR BOTH SIDES OF RETAINING WALLS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME.
AT NO TIME SHALL THE DIFFERENCE IN ELEVATIONS BE GREATER THAN 2 FEET
CONCRETE BARRIER WALL ABOVE RETAINING WALLS SHALL BE CAST AFTER THE BACKFILL FOR THE RETAINING WALLS HAS BEEN PLACED

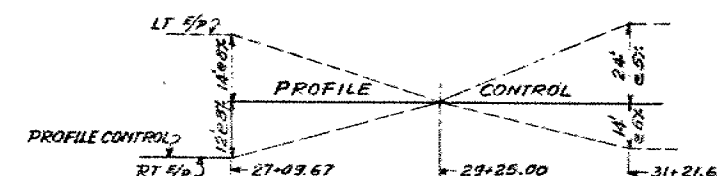
Mass concrete to be placed immediately after excavation

LIST OF DRAWINGS

- 10-140C-1 GENERAL LAYOUT
- 2 BORE HOLE LOCATIONS & SOILS STRATA
- 3 FOOTINGS
- 4 FRAME AND STUB WALLS
- 5 RETAINING WALLS
- 6 BARRIER WALL
- 7 20 FT. APPROACH SLAB
- 8 STEEL RAILING (SINGLE TUBE)
- 9 STANDARD DETAILS I
- 10 STANDARD DETAILS II
- 11 AS CONSTRUCTED ELEV. & DIM.



PROFILE OF W-N, S AND W-N RAMP
N.T.S.



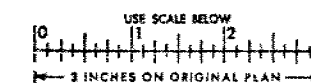
SUPERELEVATION TRANSITION OF W-N & W-S RAMP
N.T.S.

CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS

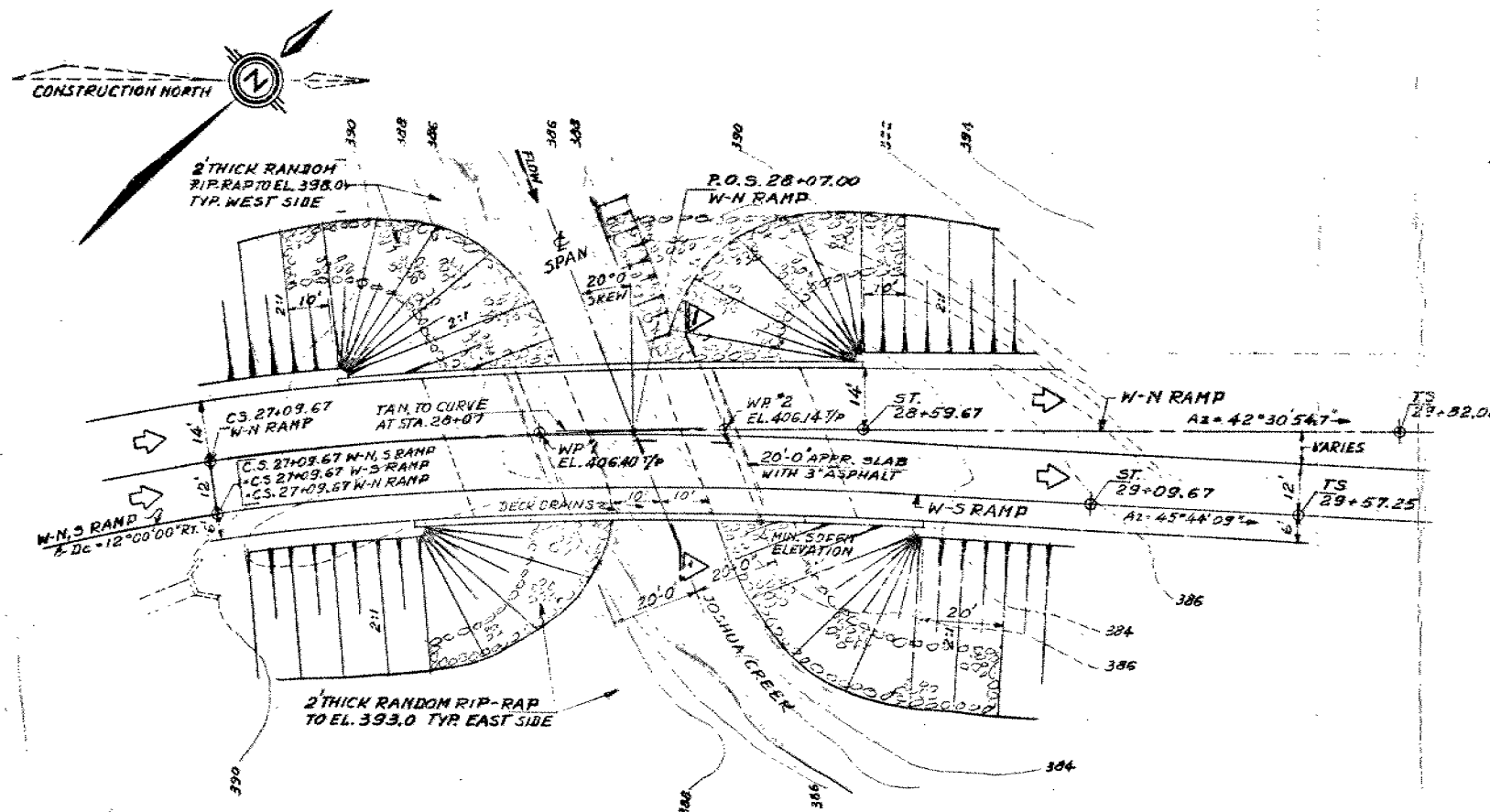
1. CONCRETE IN BRIDGE	271 cu yd
2. CONCRETE IN RETAINING WALLS	116 cu yd
3. CONCRETE IN BARRIER WALLS	16 cu yd
4. CONCRETE IN APPROACH SLABS	41 cu yd

FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION

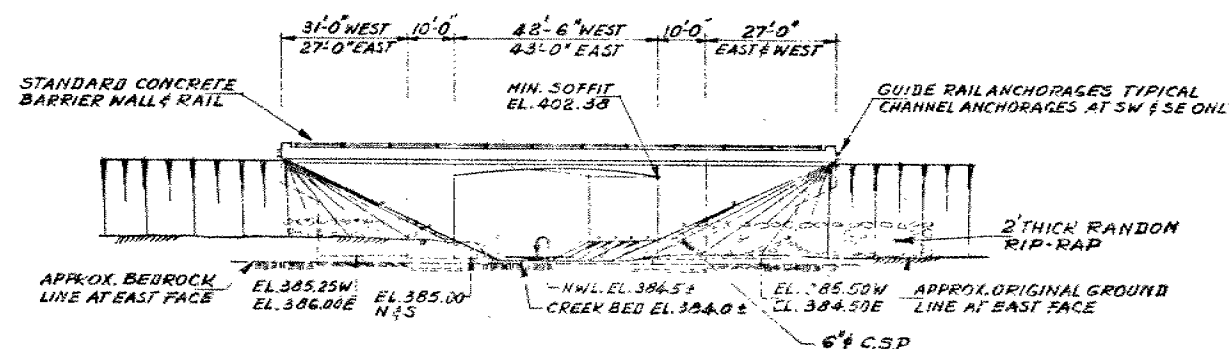
DESIGN: J. J. CHECK: C. C. LOADING: S. S. DATE: 10-140C DWG-1



PLAN
SCALE: 1" = 20'-0"

NOTES
M.P. DENOTES WORKING POINT
T.P. DENOTES TOP OF FINISHED PAVEMENT

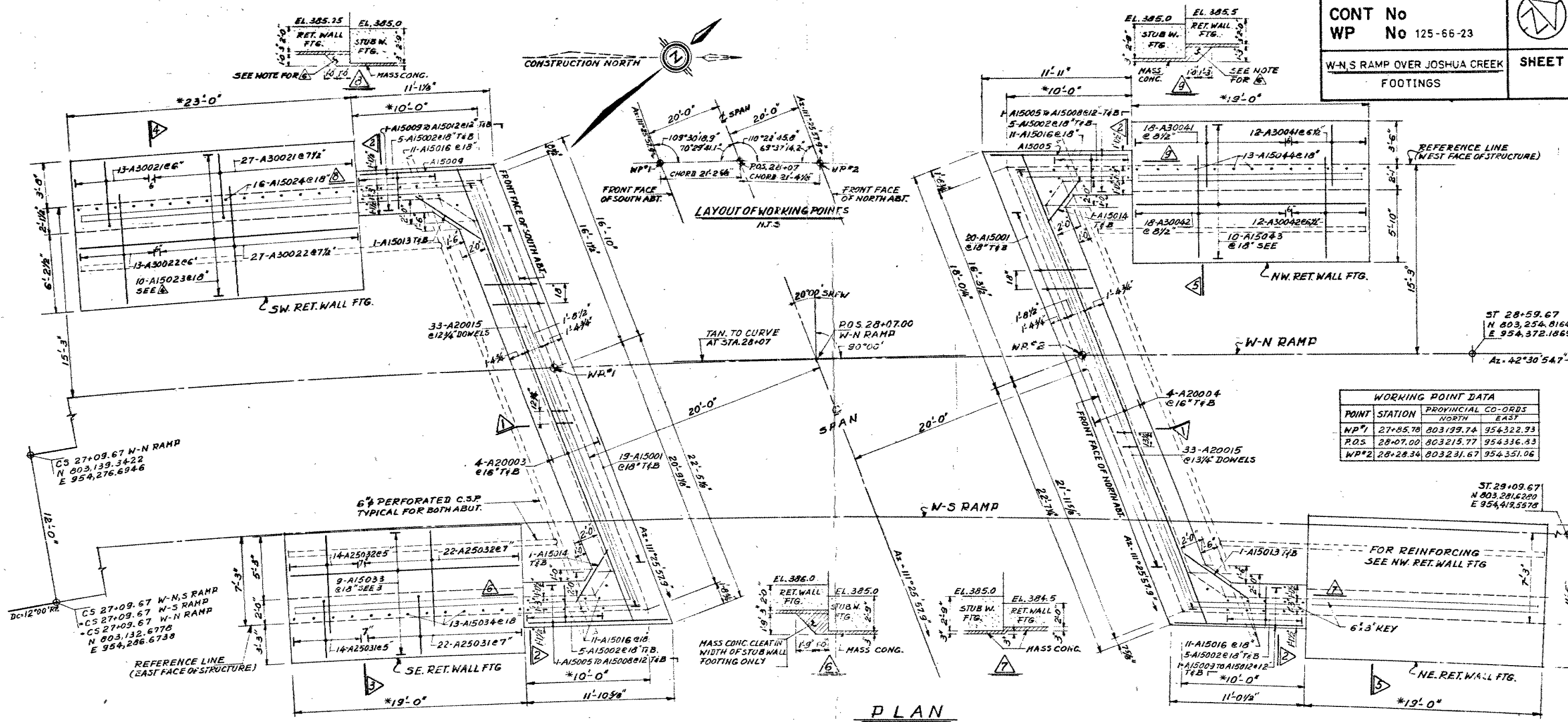
B.M. ELEV. 440.81
TOP OF NW CORNER OF CONC. PORCH
OF BHB W. OF FORD DR. & E. OF QEW
100 FT. RT. STA. 109+37 EXISTING FORD DR.



ELEVATION
SCALE: 1" = 20'-0"

CONT No
WP No 125-66-23

W-N S RAMP OVER JOSHUA CREEK
FOOTINGS



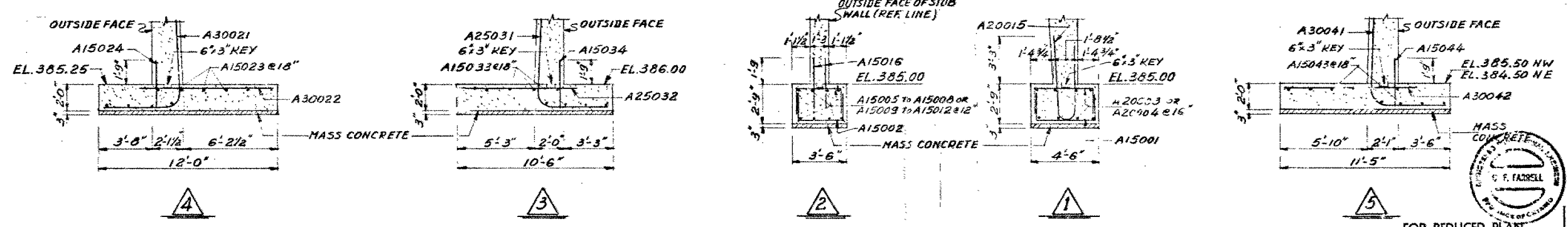
WORKING POINT DATA			
POINT	STATION	PROVINCIAL CO-ORDS NORTH	EAST
WP1	27+85.78	803199.74	954322.93
P.O.S.	28+07.00	803215.77	954336.83
WP2	28+28.34	803231.67	954351.06

PLAN

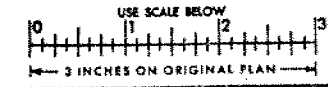
* DIMENSIONS MEASURED ALONG
REFERENCE LINE (EAST OR WEST
FACES OF STRUCTURE)

NOTES

- 3" THICK MASS CONCRETE TO BE PLACED IMMEDIATELY AFTER COMPLETION OF FOOTING EXCAVATIONS
- WP DENOTES WORKING POINT
- T&B DENOTES TOP AND BOTTOM



SCALE: 1/4" = 1'-0"



REVISIONS	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

78 09 21

Re: W-NS Ramp Over Joshua Creek
W.P. 125-66-23, Site 10-140C
District 4, Hamilton

It was recently brought to our attention that the design of the above mentioned structure has been modified. In the revised scheme as shown on Drawing No. 10-140-1 and 10-140-3, the long wingwalls previously contemplated have been replaced by retaining walls which are isolated from the main structure. Also, the founding elevations of the various footing elements have been raised somewhat. Since the footings of the main structure and the retaining walls are still founded in the bedrock in compliance with our recommendations contained in the foundation report, the modified design is acceptable.

B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs

cc: G.C.E. Burkhardt
Files ✓

ASSOCIATED GEOTECHNICAL SERVICES LTD.



CAMBRIDGE LEASEHOLDS LIMITED

FOUNDATION INVESTIGATION REPORT
TRAFALGAR ROAD INTERCHANGE
WP 1-79-~~07~~07
HWY Q.E.W. DISTRICT 4, HAMILTON

CONTRACT 79-113

Ministry of Transportation and Communications

Damas and Smith Limited
Consulting Engineers

submitted by

ASSOCIATED TECHNICAL SERVICES LIMITED
756 Gordon Baker Road
WILLOWDALE, Ontario M2H 3B4
Telephone #416-499-5355

February 1979

GEO. 30 M 5-120

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

W.P. 1-79-01 07

Dist. 4

Hwy. Q.E.W.

Str. Site

Trafalgar Road Interchange

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GEOCRES

DATE

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3.4 Bedrock	3
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APPENDIX

Plan and Profiles

Borehole Logs

Figure 1

FOUNDATION INVESTIGATION REPORT
for
Trafalgar Road Interchange
W.P. 1-79-01 ~~107~~ Site
Hwy. Q.E.W., District 4, Hamilton

1. INTRODUCTION

This report contains the results of a foundation investigation carried out in January, 1979 to provide information for the design and construction of an underpass structure and approach fills, a subway, several retaining walls and a culvert for the above listed site. The field work consisted of 17 sampled boreholes advanced by means of a continuous flight auger machine equipped with solid stem augers. In addition, diamond drilling techniques were employed to obtain BXL size core of bedrock. The boreholes ranged in depth from 3 to 31 feet below ground surface.

2. SITE DESCRIPTION AND GEOLOGY

The site is located in the Town of Oakville about 1 mile east of Oakville Creek.

The site lies within a physiographic region known as the Lake Iroquois plain which is a nearly level terrace about 2 miles wide bordering Lake Ontario. The terrace was formed by wave erosion during the life of glacial Lake Iroquois and at the subject site erosion into red Queenston shale bedrock took place. Subsequent weathering of exposed bedrock resulted in a thin mantle of red silty clay or weathered shale over bedrock at the site area.

3. SUBSURFACE CONDITIONS

3.1 General

Surficial soils at the site were found to be relatively shallow and consisted of a red silty clay or weathered shale ranging in thickness from 3.0 to 8.5 feet. Underlying the surficial red silty clay, bedrock consisting of red shale in the northern part of the site and grey shale in the southern part was encountered.

Man-made fill was found in part of the area of the proposed north Service Road. The approach fills to the present Trafalgar Road underpass were also investigated and found to consist of red silty clay with chunks of shale bedrock.

The boundaries between the various soil types are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with an estimated stratigraphic profile based on borehole data, is shown on Drawing No. 17901.

The various subsoil types encountered are briefly described in the following paragraphs.

3.2 Silty Clay (Surficial)

The primary surficial soil overlying the majority of the site consisted of a silty clay ranging in depth from 3.0 to 8.0 feet. In most boreholes, the stratum was overlain by a thin veneer of topsoil. The red silty clay is the product of insitu weathering of the underlying shale bedrock thus the stratum can be expected to be more soil-like near ground surface and more rock-like with depth. The composition of the cohesive red silty clay soil is shown on the grain size distribution chart in Figure 1. Typical moisture content and unit weight values obtained on selected representative samples are shown on the borehole logs and are summarized in the following table.

	<u>Range</u>	<u>Average</u>
Moisture Content(%)	15-26	20.6
Unit Weight (p.c.f.)	119-137	127.6

Standard Penetration Test 'N' values ranged from 6 to 82 blows per foot with an average value of 30 blows per foot. The highest values of penetration resistance were generally found close to the bedrock surface or in areas with a higher percentage of shale rock fragments.

Attempts to measure the undrained shear strength of the silt clay soil were usually frustrated by the presence of shale rock fragments. However, a few values were obtained ranging from 0.6 to 3.7 T.S.F. with an average value of 1.8 T.S.F. In consideration of the high field moisture conditions, we estimate the average value of undrained shear strength to be in the order of 1.0 T.S.F.

3.3 Existing Approach Fills

The existing approach fill embankments are approximately 20 to 22 feet high and consist of red silty clay with frequent fragments of shale rock. Standard Penetration Test 'N' values ranged from 7 to 43 blows per foot with an average of 17 blows per foot. Typical moisture content and unit weight values obtained on samples of approach fill are summarized as follows.

	<u>Range</u>	<u>Average</u>
Moisture Content (%)	7-19	11.5
Unit Weight (p.c.f.)	130-146	138.5

3.4 Bedrock

Bedrock consisted of a red shale in the northern part of the site and a grey shale in the southern part. Bedrock elevations varied from 358 in the northern most part of the site to 327 in the southern portion. These elevations indicate that the upper surface of the bedrock slopes towards the south at a gentle angle. The upper several feet of bedrock were found to be weathered along horizontal joints to form thin layers of clay. The frequency and thickness of clay layering diminished with depth.

The site lies along the boundary of two geological formations; the upper red shale of the Queenston formation and the lower grey shale of the Georgian Bay formation. The Queenston formation is a red, thinly bedded rock with occasional light grey or green bands. It is horizontally bedded and both horizontally and vertically jointed. The Georgian Bay formation consists of a grey to bluish fissile shale with interstratified hard layers of sandstone or limestone. The boundary between the formations is not abrupt but rather gradual through a thickness of about 15 feet.

Geologically, shales are formed from clays and silts through consolidation. Compaction of the clays and silts takes place due to the weight of overlying sediments and initially consists of expulsion of water from the soil voids. As the consolidation process proceeds, more and more grain to grain contact is achieved and cementation of the solid particles begins. It may continue until the mass becomes comparatively strong and durable.

Depending upon the consolidation history, rocks of the shale type respond in various ways to exposure to the elements. Those shales formed by compaction alone will revert to their original mud after a few cycles of wetting and drying. These are known as compaction shales. Those shales which reduce to chips and mud are called semi-cemented shales, while those that are unaffected by wetting and drying cycles are known as cemented shales. The shales encountered at the site may be classified as semi-cemented shales, that is, they will be reduced from an apparently solid rock to mud and chips after a few cycles of wetting and drying. Thus when these shales are exposed to the air, the disintegration process begins immediately and within a short period of time, the once solid rock becomes mud and chips.

Disintegration of fresh shale exposures can be prevented by immediately sealing exposed rock faces with liquid asphalt, grout, concrete, gunite or other similar material

in order to prevent the occurrence of wetting and drying cycles.

3.5 Groundwater

Most of the boreholes on this project were dry on completion. Where water was encountered, it was found in granular materials overlying the silty clay soil.

4. DISCUSSION AND RECOMMENDATIONS

4.1 Discussion

The proposed construction of the new Trafalgar Road Interchange presently contemplates the following elements:

- 1) Underpass and approach fills
- 2) Subway on Trafalgar Road North
- 3) Retaining Wall in the south-east quadrant of the interchange.
- 4) Retaining Walls and culvert in the north-west quadrant.

4.2 Underpass

A twin two span post-tensioned concrete underpass structure is proposed to carry Trafalgar Road over the Q.E.W. The planned structure will have a combined span length of 280 feet and a deck width in excess of 100 feet. Approach embankments will be approximately 22 to 25 feet high.

4.2.1 Spread Footings

The structure may be founded on spread footings taken down to sound bedrock with an allowable loading of 10 tons per square foot. Founding levels are expected to be suitable at the following elevations

North Abutment	- 342.0
Centre Pier	- 339.0
South Abutment	- 339.0

In order to resist lateral forces acting on the abutment foundations, frictional forces between the footing bases and the shale bedrock can be calculated using a coefficient of friction of 0.45. Backfill behind the abutments should be composed of well compacted free-draining granular material with provisions made for adequate drainage.

The lateral earth pressure exerted on the abutment walls by the granular backfill can be computed using a unit weight of 130 pcf for the backfill and a coefficient of earth pressure of:

$K_a = 0.35$ for the "active" case where
rotation about the base is allowed

$K_o = 0.5$ for the "at rest" case where
no rotation or translation about the
base is permitted.

4.2.2 Perched Pier and Abutments

Alternatively, the structure may be built on perched foundations supported on end bearing steel H-piles driven to sound bedrock at the following elevations:

North Abutment - 340 ±

Centre Pier - 337 ±

South Abutment - 337 ±

Piles driven to sound bedrock can be designed for the allowable structural capacity of the pile (i.e. 12,000 p.s.i. for steel 'H' section pile). In order to minimize damage during driving to bedrock and to facilitate penetration of weathered bedrock, all pile tips should be reinforced with welded steel flange plates as per current M.T.C. standards.

4.3 Approach Fill Embankments

It is intended to raise the existing embankments by about 3 feet and to widen the existing embankment to accommodate new traffic lanes. No stability problems are anticipated with the embankment fills if 2:1 slopes are employed. It should be realized, however, that some post construction settlement of the new embankment will take place. The amount of settlement will vary between 0.2 and 1.0 percent (or more) of the embankment height depending upon the placement moisture content and degree of compaction of the new fill.

4.4 Subway

It is proposed to construct a subway beneath Trafalgar Road to provide access to a proposed shopping centre. According to the available information, the subway will provide 9 feet of vertical clearance below the Trafalgar Road structure with an access road profile grade at elevation 355 beneath the centreline of Trafalgar Road.

Excavation for the subway will be through 5 feet of silty clay above elevation 358 and through weathered shale to about elevation 351.

The abutments for the Trafalgar Road bridge may rest on spread footings placed at elevation 350 with an allowable bearing capacity of 10 tons per square foot. For computation of sliding resistance, a coefficient of friction of 0.45 may be assumed between the base of the footing and the shale bedrock. Granular backfill should be used with the same assumptions given in section 4.2.1.

Cut slopes in soil and weathered shale may be constructed safely with standard 2:1 side slopes.

4.5 Retaining Walls

Several retaining walls are proposed in connection with the new interchange which vary in height from 3 feet to 13 feet above present ground surface. At most retaining wall locations, the upper surface of shale bedrock is located within 5 feet of ground surface. However, the upper portion of shale bedrock is weathered along horizontal joints into thin clay layers. These layers decrease in thickness and frequency with depth and disappear at a depth of about 6 feet below the upper rock surface. Considering the retaining walls founded on spread footings at the upper rock surface, we recommend a maximum allowable bearing capacity of 5 tons per square foot at this level in order to limit settlement in the clay layers. For computation of sliding resistance, a coefficient of friction of .30 along a clay seam beneath the base of the footing may be used. If greater

sliding resistance is required, it may be obtained by the use of dowels or a key.

Alternatively bin type walls may be designed using a foundation clay shear strength of 1 ton per square foot. Where the bins are placed on shale or weathered shale, the factor of safety against sliding should be computed using an angle of friction of 24 degrees between the bottom of the bin and shale bedrock. Sliding along a potential bedrock clay layer should also be considered using a shearing resistance of 1500 p.s.f. along the clay layer.

4.6 General

The shale bedrock weathers rapidly on exposure to air and water thus a concrete working slab should be poured as soon as possible after rock is exposed in order to protect it in the footing excavation.

Concentrated water flow can cause severe erosion of the shale in the bottom and sides of a water course, therefore, it is important that the water channel be lined in areas where this type of erosion will be detrimental.

Spread footings and pile caps should be protected against frost heaving by a minimum depth of cover of 4 feet.

Prior to the placement of earth fills, topsoil should be excavated for a minimum distance of 50 feet behind the abutments.

No major dewatering problems are envisaged for footings excavations at this site. Any seepage into the excavations can be handled by pumping from open sumps.

Respectfully submitted



J. Kilgour, P. Eng.

Designated Consulting Engineer



APPENDIX

SOIL CLASSIFICATION SYSTEM

The following system was used to describe the various soils encountered at the site as determined by visual field examination and test. It was also used to classify those soils upon which a laboratory grain size determination had been made.

<u>Soil Components</u>	<u>Particle Size</u>
Clay	less than .002 mm.
Silt	from .002 mm. to .06 mm.
Sand	from .06 mm. to 2.0 mm.
Gravel	from 2.0 mm. to 2 in.
Cobbles	from 2 in. to 6 in.
Boulders	greater than 6 in.

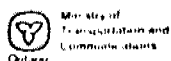
<u>Descriptive Terms</u>	<u>Range of Proportions</u>
and	greater than 40%
with	25% to 40%
some	10% to 25%
trace	less than 10%

Example: Silt (predominant type) with (25%-40%) sand, some (10%-25%) gravel, trace (less than 10%) clay.

STANDARD PENETRATION CLASSIFICATION

Relative Density of Sands as determined by Standard Penetration Tests		
No. of Blows/foot N	Relative Density D_r	Designation on Borehole Log
0 - 4	0% - 20%	Very Loose
4 - 10	20% - 40%	Loose
10 - 30	40% - 60%	Medium Dense
30 - 50	60% - 80%	Dense
Over 50	80% - 100%	Very Dense

Shear Strengths of Clays as determined by Standard Penetration Tests		
No. of Blows/foot N	Shear Strength s psf	Designation on Borehole Log
2	250	Very soft
2 - 4	250 - 500	Soft
4 - 8	500 - 1000	Medium
8 - 15	1000 - 2000	Stiff
15 - 30	2000 - 4000	Very Stiff
Over 30	Over 4000	Hard



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RECORD OF BOREHOLE No 25

W P 1-79-07 LOCATION Co-ords 15,792,381 N; 950,605 E. ORIGINATED BY T.L.
 DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 22, 1979 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
361.6	Ground Level																
0.1	Topsoil.																
	Silty clay.																
	Stiff to hard Red		1	SS	10											130.1	
					38/12"												
356.6			2	SS	51/6"												
5.0	Red Shale Bedrock																
354.8			3	SS	100/8"												
6.8	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



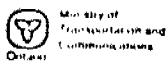
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RECORD OF BOREHOLE No 26

W P 1-79-07 LOCATION Co-ords. 15,792,494 N; 950,652 E. ORIGINATED BY T.L.
 DIST Hamilton HWY O.E.W. BOREHOLE TYPE Solid Stem Auger, BXL Rock Core COMPILED BY T.L.
 DATUM Geodetic DATE January 16, 1979 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH					WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE						
363.8	Ground Level							20	40	60	80	100					
0.0	Silty clay with shale fragments. Stiff Red		1	AS													
			2	SS	18												
358.3			3	SS	11/6"												
5.5	Shale Bedrock with several thin horizontal layers of silty clay. Decreasing in frequency with depth. Red		4	AS	100/5"												
			5	RC BXL	87%												
			6	RC BXL	91%												
350.8	Shale Bedrock		7	RC BXL	100%												
13.0	Sound Red																
			8	RC BXL	100%												
344.3	End of Borehole																
19.5																	



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RECORD OF BOREHOLE No 29

W P 1-79-07 LOCATION Co-ords. 15,792,244 N; 950,662 E. ORIGINATED BY T.L.
 DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 10, 1979 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
358.8	Ground Level																GR SA SI CL
0.0	Topsoil.																
0.5	Fill - silty clay, occasional pocket of sand. Red		1	SS	6		357										
			2	SS	13												
355.8	Shale Bedrock, weathered horizontal layers. Red		3	SS	138		355										
3.0			4	SS	150		353										
352.4			5	SS	100/5"												
6.4	End of Borehole Refusal to augers																

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RECORD OF BOREHOLE No 33

W P 1-79-07 LOCATION Co-ords. 15,791,722 N; 951,081 E. ORIGINATED BY T.L.
 DIST Hamilton HWY O.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 19, 1979 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
352.6	Ground Level																
0.0	Topsoil																
0.3	Silty clay, occasional shale fragments.		1	AS			350									126.7	
			2	SS	12											128.4	
	Stiff Red		3	SS	8											130.0	
			4	SS	12											136.9	
147.1					50/4"												
5.5	Shale Bedrock, weathered horizontal layers.		5	SS	50/4"		345										
	Red		6	SS	100/5"												
343.0			7	AS													
9.6	End of Borehole																



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RECORD OF BOREHOLE No 34

W P 1-79-07 LOCATION Co-ords 15,791,785 N; 951,136 E. ORIGINATED BY T.L.
 DIST Hamilton Hwy Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 15, 1979 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
374.8	Ground Level																
0.0 373.8 1.0	Asphalt.																
371.8	Gravelly silty sand.		1	AS													
2.0	Fill - silty clay with occasional shale fragments.		2	SS	10		370									143.9	
	Red		3	AS												138.0	
			4	SS	8											141.1	
							360										
			5	SS	11											143.1	
																145.8	
352.3 21.5	Red silty clay.		6	SS	32												
			7	SS	77												
	Apparent shale bedrock Red		8	SS	160												
348.0 25.9	End of Borehole		9	SS	70/6		350										



RECORD OF BOREHOLE No 35

W P 1-79-07 LOCATION Co-ords. 15,791,825 N; 951,163 E. ORIGINATED BY TL
DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY TL
DATUM Geodetic DATE January 12, 1979 CHECKED BY _____

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RECORD OF BOREHOLE No 36

W P 1-79-07 LOCATION Co-ords 15,791,578 N; 951,141 E. ORIGINATED BY T.L.
DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
DATUM Geodetic DATE January 18, 1979 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
352.9	Ground Level																
0.0	Asphalt.		1	AS													
0.5	Concrete.		2	AS													
1.5	Limestone screenings		3	SS	42												
349.9	Silty clay to weathered shale.		4	SS	85/12"												
3.0	Stiff Red		5	SS	50/4"												
345.9	Shale Bedrock with occasional thin horizontal layer of weathered shale decreasing in frequency with depth.		6	SS	160/11"												
7.0	Red and Grey Sound		7	AS													
			8	SS	100/5"												
			9	RC BXL	93%												
			10	RC BXL	100%												
331.9	End of Borehole																
21.0																	

*3, *5. Numbers refer to
Sensitivity

13-25 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 36A

W P 1-79-07 LOCATION Co-ords. 15,791.471 N; 951,173 E. ORIGINATED BY T.L.
 DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 23, 1979 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
353.6	Ground Level																GR SA SI CL
0.0	Asphalt.																
0.5	Concrete.																
352.1							352										
1.5	Limestone screenings		1	AS													
350.6							350										
3.0	Silty clay to weathered shale.		2	SS	12											131.8	
			3	SS	35		348									123.6	
	Stiff Red		4	SS	45/12"		346									132.6	
346.1					80/6"												
7.5	Apparent Shale Bedrock		5	SS	100/6.5"												
345.1	Red																
8.5	End of Borehole																

*3, *5: Numbers refer to
Sensitivity

20
15-20% STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 37

W P 1-79-07 LOCATION Co-ords. 15,791,693 N; 951,228 E. ORIGINATED BY T.L.
DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
DATUM Geodetic DATE January 23, 1979 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
354.5	Ground Level																
0.0	Asphalt.						354										
0.5	Concrete.																
353.0																	
1.5	Limestone screenings.		1	AS			352										
351.5																	
3.0	Gravelly silty clay to weathered shale.		2	SS	46		350										
	Red		3	SS	14												
			4	SS	74		348										
347.0																	
7.5	Apparent Shale Bedrock		5	SS	155/10"		346										
345.7	Red & Grey		6	SS	100/4"												
8.8	End of Borehole																



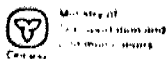
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RECORD OF BOREHOLE No 38

W P 1-79-07 LOCATION Co-ords 15,791,439 N: 951,192 E. ORIGINATED BY T.L.
 DIST Hamilton Hwy Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 23, 1979 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
349.3	Ground Level																
0.0	Topsoil.		1	AS													
0.4	Asphalt.																
0.6	Wet gravelly sand.		2	AS													
	Brown																
346.8							348										
2.5	Silty clay.		3	SS	8		346										
	Red																
344.8			4	SS	28/12 40/6		344										
4.5	Severely Weathered shale with horizontal clay seams.		5	SS	40												
	Red and Green		6	SS	61		342										
340.8			7	SS	41/61 100/7		340										
8.7	Apparent Shale Bedrock																
	End of Borehole																



HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 39

W P 1-79-07 LOCATION Co-ords. 15,791,498 N; 951,245 E. ORIGINATED BY T L
 DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T L
 DATUM Geodetic DATE January 11, 1979 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
372.8	Ground Level																
0.0 0.8	Gravelly clayey sand. Fill - gravelly silty clay with occasional shale fragments. Red.		1	AS			370									137.2	
			2	AS													
			3	SS	43		365										
			4	SS	10		360										
			5	SS	14		355										
			6	SS	14		350										
			7	SS	20												
347.8 25.0 321.1 26.7 34.0	Gravelly sand. Silty clay. Red		8	SS	12		345										
28.0	Apparent Shale Bedrock Red		9														
30.9	End of Borehole																



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 40

W P 1-79-07 LOCATION Co-ords. 15,791,557 N; 951,280 E. ORIGINATED BY T.L.
 DIST Hamilton Hwy Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 12, 1979 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
373.8	Ground Level																
372.8	Asphalt		1	AS													
1.0	Gravelly sand.																
	Fill - silty clay with shale fragments.		2	AS			370										
	Red		3	SS			365										
			4	SS	40		360										
			5	AS													
			6	SS	12												
			7	SS	10		355										
			8	SS	15												
			9	AS			350										
348.3			10	SS	58												
25.5	Gravelly sand. Brown																
346.7			11	SS	40/61												
27.1	Apparent Shale Bedrock				100/50												
345.9																	
27.9	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 45

W P 1-79-07 LOCATION Co-ords 15,790,577 N; 951,724 E. ORIGINATED BY TL
DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Stem Auger COMPILED BY TL
DATUM Geodetic DATE January 15, 1979 CHECKED BY _____

[illegible]

OFFICE REPORT ON SOIL EXPLORATION



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 46

W P 1-79-07 LOCATION Co-ords. 15,790,806 N; 951,650 E. ORIGINATED BY T.L.
 DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 15, 1979 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					W _p	W	W _L		
								SHEAR STRENGTH									
337.9	Ground Level																
0.0	Silty clay topsoil.		1	AS													
0.5	Silty clay. Red																
1.0	Crushed stone and Red silty clay.		2	SS	76		336										
2.0	Silty clay with frequent shale fragments		3	SS	28										126.6		
															120.6		
	Stiff Red		4	SS	13		334								126.1		
															119.9		
			5	SS	13		332										
			6	SS	9/6" 56/5"		330								130.7		
330.0																	
7.9	Apparent Shale Bedrock		7	SS	100/6"												
329.4	Grey																
8.5	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION


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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 70

W P 1-79-07 LOCATION Co-ords. 15,792,052 N; 950,816 E. ORIGINATED BY T.L.
 DIST Hamilton, HWY 0.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 10, 1979 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION [%] GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
361.8	Ground Level													
0.0	Fill - mixture of gravelly silty sand, silty clay and shale fragment. Brown		1	SS	112									
350.8														
1.0			2	SS	83		360							
			3	SS	102		358							
			4	SS	92									
	Fill - grey angular shale fragments and silty sand matrix.		5	SS	120		356							
355.1	Shale Bedrock Grey				100/2"									
6.7	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION





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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 71

W P 1-79-07 LOCATION Co-ords. 15,791,857, N; 950,803 E. ORIGINATED BY T.L.
DIST Hamilton Hwy Q.E.W. BOREHOLE TYPE Solid Stem Auger COMPILED BY T.L.
DATUM Geodetic DATE January 11, 1979 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) OR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
358.9	Ground Level																
0.0	Silty clay topsoil.		1	SS	26												
357.9	Fill - silty clay with grey shale fragments		2	SS	79												
1.0																	
355.4			3	AS													
3.5	End of borehole Refusal to augers Apparent Bedrock																

OFFICE REPORT ON SOIL EXPLORATION

*3, *5: Numbers refer to
Sensitivity

20
15
10
5
0
*5: (% STRAIN AT FAILURE



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 71A

W P 1-79-07 LOCATION Co-ords 15,791,863 N; 950,800 E. ORIGINATED BY T.L.
 DIST Hamilton HWY Q.E.W. BOREHOLE TYPE Stem Auger COMPILED BY T.L.
 DATUM Geodetic DATE January 10, 1979 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
358.9	Ground Level																GR SA SI CL
0.0	Silty clay topsoil.																
357.9							358										
1.0	Fill - red silty clay with grey shale fragments.		1	SS	49/10"		357										
355.9																	
3.0	End of Borehole Refusal to augers Apparent Bedrock																

OFFICE REPORT ON SOIL EXPLORATION

TYPICAL RED SILTY CLAY

FIG No 1

W P 1-79-07

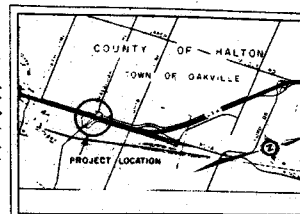
CONT No 79-III
WP No 1-79-07

RETAINING WALLS
BORE HOLE LOCATIONS & SOIL STRATA

SHEET
5

SCALE IN FEET
0 100 200 300 400

ASSOCIATED TECHNICAL SERVICES LTD.



KEY PLAN

Scale 1:50,000

LEGEND

- Bore Hole
- ▲ Dynamic Cone Penetration Test (Cone)
- ◆ Bore Hole & Cone
- BT Blows/ft (Std Pen Test 350 ft lbs energy)
- CGPE Blows/ft (60° Cone, 350 ft lbs energy)
- ⬇ Wt at time of investigation
- R No further penetration with power auger

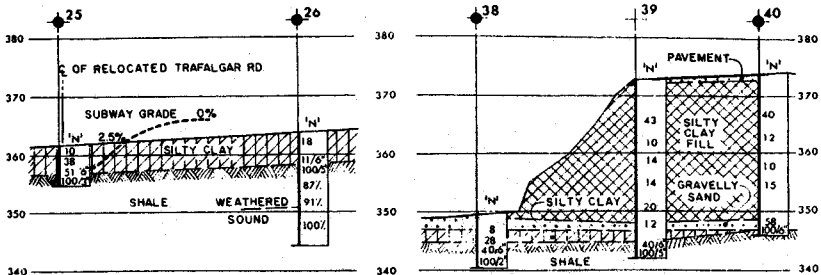
No	ELEVATION	COORDINATES	
		NORTH	EAST
25	361.6	15792.281	950.005
26	363.8	15792.494	950.052
29	358.8	15792.244	950.002
33	352.6	15791.722	951.081
34	374.8	15791.785	951.136
35	374.4	15791.825	951.103
36	352.9	15791.578	951.141
36A	353.0	15791.621	951.173
37	354.5	15791.693	951.228
38	349.3	15791.439	951.192
39	372.8	15791.489	951.245
40	373.8	15791.557	951.280
45	333.6	15790.577	951.724
46	337.9	15790.800	951.650
70	361.8	15792.052	950.816
71	358.9	15791.857	950.803
71A	358.9	15791.803	950.800

-NOTE-

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

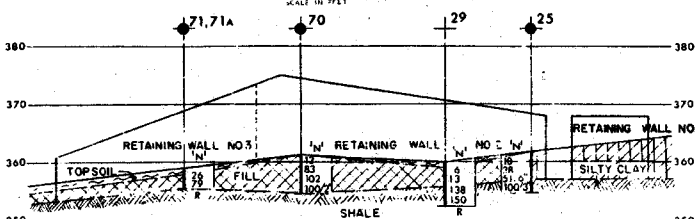
DATE	BY	DESCRIPTION

DESIGNED BY	Q.E.W.	DATE	FEB 22 1979	SITE	10-MIN
CHECKED BY		CHECKED BY		CHECKED BY	



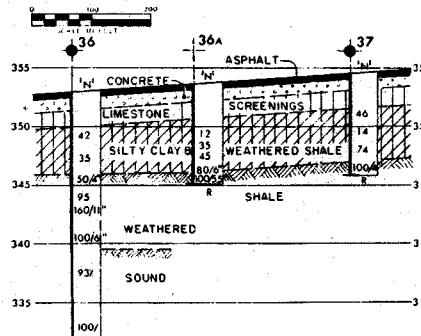
SECTION AA

SECTION E-E



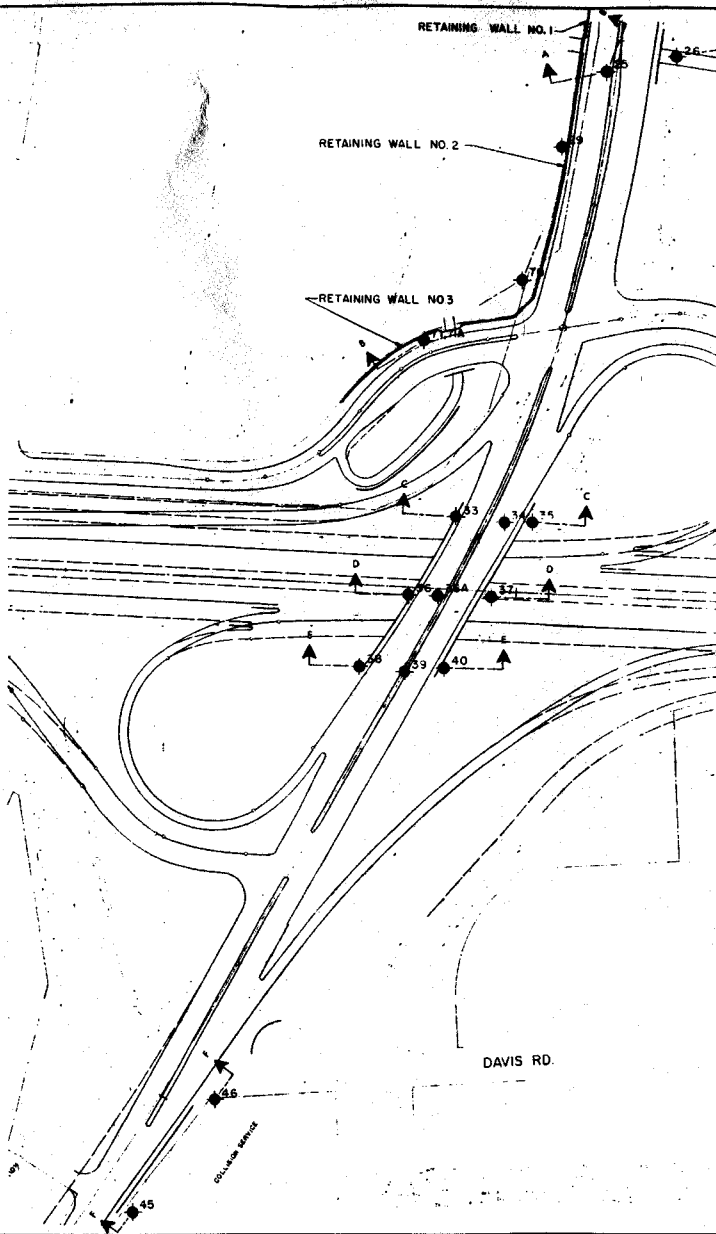
SECTION B-B

SECTION C-C



SECTION D-D

SECTION F-F



GEOCRES No. 30M5-204DIST. 4#6 REGION _____W.P. No. 67-98-00

CONT. No. _____

W. O. No. _____

STR. SITE No. _____

HWY. No. QEWLOCATION ROYAL WINDSOR ~~ST~~ UNDERPASSNo of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS: _____

Golder Associates Ltd.

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Mississauga, Ontario, Canada L5N 5S3
Telephone (905) 567-4444
Fax (905) 567-6561



**FOUNDATION INVESTIGATION AND DESIGN
ROYAL WINDSOR DRIVE UNDERPASS
QUEEN ELIZABETH WAY
HIGHWAY 403 W.P. 67-98-00
DISTRICT 4/6, TORONTO**

Submitted to:

McCormick Rankin Corporation
2655 North Sheridan Way
Mississauga, Ontario
L5K 2P8

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Mississauga, Ontario

November 1998

981-1122

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In Order
Following
Page No. 15

List of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Record of Borehole Sheets

Drawing N1122001 "QEW Underpass at Royal Windsor Drive, Borehole Locations and
Soil Strata"

Figure 1

November 1998

981-1122

PART A – FIELD INVESTIGATION

**ROYAL WINDSOR DRIVE UNDERPASS
QUEEN ELIZABETH WAY
HIGHWAY 403 W.P. 67-98-00
DISTRICT 4/6, TORONTO**

1.0 INTRODUCTION

Golder Associates Ltd. has been retained by McCormick Rankin Corporation (McCormick Rankin) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a geotechnical investigation at the site of the proposed underpass structure at Royal Windsor Drive in the Town of Oakville, Ontario. The underpass structure is part of the project which consists of an extension of a 2 km long westbound auxiliary lane on Queen Elizabeth Way (QEW) between Highway 403 (Oakville Link) and Trafalgar Road in MTO District 4/6. Incorporated into the project are highway widening, pavement rehabilitation and modifications to affected interchanges. This report addresses the proposed bridge structure over QEW and its approaches within 20 m of the structure.

The purpose of the geotechnical investigation is to determine the subsurface conditions at the site of the proposed bridge structure by drilling boreholes, and carrying out in situ tests and laboratory tests on selected samples. Based on our interpretation of the data obtained, recommendations on the geotechnical aspects of design of the proposed works are provided. Comments are also provided on anticipated construction problems where they may affect design of the proposed bridge and approach embankments.

The configuration of the proposed underpass structure at Royal Windsor Drive was shown on the drawing provided to us which was a 1:1000 preliminary plan. Bennett Young Limited, professional land surveyors staked the locations of the bridge abutments in the field.

The terms of reference for the scope of work are outlined in our proposal letter P81-1021, dated January 13, 1998. The work was carried out in accordance with our Quality Control Plan for Foundation Design Services, dated March 10, 1998. During the course of the field work, the number of boreholes was increased to accommodate the site conditions as encountered.

2.0 SITE DESCRIPTION

The site is located approximately 150 m to the south of the existing Royal Windsor Drive in the Town of Oakville, Ontario, within MTO District 4/6.

The topography of the site is relatively flat. The ground surface generally slopes down to the east towards Lake Ontario. The ground surface to the west of QEW generally varies between Elevations 105.2 m and 105.6 m; there is a drainage ditch approximately 2 m in depth along the west side of QEW. The ground surface to the east of QEW varies between Elevation 103.6 m and Elevation 103.9 m. The grade of the existing QEW in the area of the proposed bridge site is at about Elevation 105.5 m. Vegetation cover on both sides of the existing highway consists of grass and shrubs.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on August 10 and 11, 1998. At this time twelve boreholes were put down at the site. Five boreholes, numbered 2, 3 and PH1 to PH3, were put down at the proposed east bridge abutment and five boreholes numbered 1, 4 and PH5 to PH7, were drilled at the location of the proposed west abutment. In addition, Boreholes PH4 and PH8 were put down within the east and west approach embankments, respectively. It is understood that during discussion with MTO, it was agreed that it would be acceptable to delete the drilling of the two boreholes in the median of the QEW and still comply with the MTO guidelines for foundation design.

The investigation was carried out using a bombardier mounted CME 55 drill rig supplied and operated by Master Soil Investigation of North York. In the boreholes, samples of the overburden and bedrock were obtained at regular intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedures. Three of the boreholes, namely Boreholes 2 to 4, were extended by coring into the bedrock and were terminated between 4.9 m and 5.2 m depth. NQ size rock core samples were obtained from these boreholes. The remaining boreholes were terminated between 1.5 m and 2.0 m depth below existing ground surface. Groundwater conditions in the open boreholes were observed throughout the drilling operations. Piezometers were installed in two boreholes to permit monitoring of the groundwater levels at the site.

The field work was supervised on a full-time basis by a member of our technical staff who located the boreholes in the field, directed the drilling, sampling and in situ testing operations, and logged the boreholes. The soil and rock samples were identified in the field, placed in labeled containers and transported back to our laboratory in Mississauga for further examination. Index and classification tests were carried out on selected samples. The results of the testing are shown on the Record of Borehole sheets and on Figure 1.

The boreholes located at each limit of the proposed abutments were staked in the field by Bennett Young Limited prior to our mobilization to site. We understand that the borehole elevations are referenced to Geodetic Datum. The ground surface elevations and locations of the remaining boreholes were established in the field by our personnel with reference to the staked out locations surveyed by Bennett Young Limited. The northing and easting co-ordinates of the borehole locations are indicated on the Record of Borehole sheets; the locations of the boreholes and probeholes are shown on a Drawing N1122001, "QEW Underpass at Royal Windsor Drive, Borehole Locations and Soil Strata", attached.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

From published geologic information, the site is located in the physiographic region known as the Peel Plain. The Peel Plain is generally composed of clayey soils covering the central portions of York, Peel and Halton Regions (Chapman and Putnam, "The Physiography of Southern Ontario", 3rd Edition, 1984). The surface topography of the Peel Plain slopes gradually and fairly uniformly towards Lake Ontario. The local physiography is characterized by shallow overburden consisting mainly of silty clay till with frequent shale fragments. The overburden is underlain by shale bedrock of the Georgian Bay Formation. The depth to bedrock at this site is shallow, varying typically between 1.5 m and 2 m below existing ground surface.

4.2 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets, following the text of this report. The stratigraphic boundaries shown on the borehole sheets are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

Relevant information on subsurface conditions was obtained from Boreholes 1 to 4 and PH1 to PH8. The subsurface information obtained from the current investigation was supplemented by the borehole information obtained for geotechnical / pavement component of the project (new auxiliary lane and ramp at Royal Windsor Drive) and provided to us by John Emery Geotechnical Engineering Limited.

In summary, the subsoils at the site consist of surficial topsoil and / or fill overlying a stratum of silty clay till. The overburden is underlain by grey shale bedrock that contains limestone interlayers. A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Topsoil and Fill Materials

Topsoil was encountered in all of the boreholes put down on site; the topsoil thickness varied between 150 mm and 180 mm. Underlying the topsoil is fill material extending to depths between 0.3 m to 0.9 m. The fill material typically consists of silty clay with trace sand, gravel and trace organic matter (rootlets and topsoil lenses). This fill is likely native silty clay till reworked during QEW construction.

The silty clay fill is stiff to very stiff. Standard Penetration Test (SPT) 'N' values ranging from 8 blows for 0.3 m of penetration to 21 blows per 0.3 m penetration were measured in the fill material.

4.2.2 Silty Clay Till

The fill is underlain by a till deposit consisting of brown and grey, mottled, silty clay with trace sand, trace gravel and shale fragments. The silty clay till is very stiff to hard and extends to depths between 1.1 m and 1.5 m.

N values measured during the Standard Penetration testing carried out within the till deposit range from 19 to in excess of 100 blows per 0.3 m of penetration, indicating a very stiff to hard consistency. Grain size distribution test results for samples of the silty clay till are shown on Figure 1. Atterberg Limit tests indicate liquid limit ranging from 45 per cent to 51 per cent and plasticity index ranging from 23 per cent to 26 per cent.

4.2.3 Bedrock

Bedrock of the Georgian Bay Formation consisting of grey shale with interbeds of limestone was encountered in all of the boreholes. The bedrock surface was inferred from penetration resistance during drilling and visual examination of samples retrieved. The surface of the bedrock varies from about Elevation 103.7 m to about Elevation 104.1 m in the boreholes located on the west side of QEW (west abutment) and from Elevation 102.3 m to Elevation 102.7 m in the boreholes located on the east side of QEW (east abutment). The bedrock surface steps down to the east; there is approximately 1.5 m difference in the bedrock surface elevation as encountered in the boreholes put

down on the west and east side of the highway. The bedrock surface appears to be relatively flat in the north to south direction on both sides of QEW.

The bedrock surface depths and elevations at the borehole locations put down during the investigation are summarized below:

<i>Borehole</i>		<i>Ground Surface Elevation (m)</i>	<i>Bedrock Surface</i>	
<i>Number</i>	<i>Location</i>		<i>Depth (m)</i>	<i>Elevation (m)</i>
3	East Abutment	103.90	1.52	102.38
PH1		103.87	1.52	102.35
PH2		103.86	1.52	102.34
PH3		103.89	1.22	102.67
2		103.88	1.52	102.36
PH4	East Approach	103.63	1.07	102.56
4	West Abutment	105.24	1.50	103.74
PH5		105.26	1.52	103.74
PH6		105.27	1.52	103.75
PH7		105.25	1.20	104.05
1		105.18	1.22	103.96
PH8	West Approach	105.57	1.52	104.05

Bedrock coring was carried out in Boreholes 2 to 4 for a length of about 3.0 m in each borehole. The bedrock samples obtained consist of grey, fine grained, thinly bedded shale with interlayers of fresh crystalline and fossiliferous limestone. Limestone bands comprise between 24 per cent and 30 per cent of the total core length.

In the two boreholes at the east abutment, measured Rock Quality Designation (RQD) values of 7 per cent and 22 per cent were obtained in the upper portion of the core samples (above about Elevation 101.2 m). Below Elevation 101.2 m, RQD values of greater than 45 per cent were measured on the core samples. Based on inspection of the rock core samples, there are numerous limestone layers below Elevation 101.5 m in Borehole 2 and below Elevation 101.2 m in Borehole 3 and the rock is generally in a moderately weathered state. In Borehole 4 located in the area of the west abutment, an RQD value measured on the upper portion of core sample (above Elevation 102.0 m) was 0 per cent and below Elevation 102.0 m, the measured RQD value was 56 per cent.

Point load tests were carried out on the core samples retrieved from the boreholes. The diametral Point Load Indices $Is_{(50)}$ measured on the shale samples ranged from about 0.27 MPa to 0.69 MPa; values ranging from about 1.54 MPa to 5.07 MPa were obtained for samples of the fresh limestone. The results of point load tests carried out on the core samples obtained are summarized below:

SUMMARY OF POINT LOAD TESTING

<i>Borehole Number</i>	<i>Sample Depth (m)</i>	<i>Point Load Index $Is_{(50)}$</i>	<i>Rock Type</i>
2	3.0	2.485	Limestone
	3.2	2.219	Limestone
	3.4	4.753	Limestone
	4.3	1.535	Limestone
	4.6	0.519	Shale
3	3.5	4.374	Limestone
	3.7	4.508	Limestone
	3.9	3.078	Limestone
	4.3	4.578	Limestone
	4.4	2.720	Limestone
4	3.0	0.682	Shale
	3.5	3.391	Limestone
	4.0	0.685	Shale
	4.2	5.070	Limestone
	4.4	0.270	Shale

Based on an empirical relationship between point load index and uniaxial compressive strength, these results correspond to an average unconfined compressive strength of 12 MPa for the moderately weathered to fresh shale and 28 MPa for the fresh limestone.

4.3 Groundwater Conditions

On completion of drilling, all of the boreholes, except Boreholes 2 to 4, were dry. Boreholes 2 to 4, where rock coring was carried out, were dry during drilling in the overburden, however, on completion of drilling the water level in open boreholes was influenced by water used during rock coring.

Piezometers were installed in Boreholes 2 and 4 to monitor the groundwater conditions. Details of the piezometer installations and water level measurements are shown on the attached Record of Borehole sheets. The water levels measured in the piezometers were at Elevation 101.3 m in Borehole 2 located on the east side of QEW and at Elevation 102.1 m in Borehole 4 located on the west side of QEW. The measurements indicate that the groundwater level slopes downward toward the east. Groundwater levels are expected to fluctuate seasonally and are expected to be higher during wet periods of the year.

PART B – FOUNDATION DESIGN

**ROYAL WINDSOR DRIVE UNDERPASS
QUEEN ELIZABETH WAY
HIGHWAY 403 W.P. 67-98-00
DISTRICT 4/6, TORONTO**

5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the geotechnical aspects of design of the underpass structure at Royal Windsor Drive based on our interpretation of the factual information obtained during the investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

The works described in this report are associated with the proposed bridge and its approaches within 20 m of the structure. It is understood that the proposed underpass structure to carry the realigned Royal Windsor Drive over the QEW will be a two span structure about 64 m in length. The final road grade at the structure will be at about Elevation 114.3 m and will require approximately 9 m to 10.5 m high embankments.

The proposed horizontal and vertical alignment for the underpass structure was shown on the preliminary drawings provided to us as part of the preliminary design report and on the General Arrangement Plan.

5.2 Bridge Foundations

The surface of the bedrock varies from about Elevation 103.7 m to about Elevation 104.1 m at the location of the west abutment and from about Elevation 102.3 m to Elevation 102.7 m at the location of the east abutment, some 1.2 m to 1.5 m below the existing ground surface. At the location of the proposed pier, the bedrock surface was interpolated to be at about Elevation 103.0 m based on the borehole information at the west and east abutments. The upper 1.0 m to 1.7 m of the bedrock is typically highly fractured. The water levels in the piezometers installed within the bedrock were at Elevation 102.1 m in the area of the west abutment and at Elevation 101.3 m in the area of the east abutment, or about 3.1 m and 2.5 m depths below existing ground surface, respectively.

Considering the shallow depth of the bedrock, it is recommended that the bridge structure be supported by spread footings founded on bedrock. A founding level at the surface of the shale bedrock (on the fractured portion) or extended deeper to the less fractured bedrock may be assumed for design of the abutment and pier footings, as indicated below.

5.2.1 Factored Geotechnical Resistance

Spread footings for the abutments placed on properly prepared shale bedrock at the surface of the shale bedrock may be designed for a factored geotechnical resistance at Ultimate Limit States (FCULS) of 850 kPa. Spread footings taken deeper to found on the less fractured shale interbedded with crystalline and fossiliferous limestone at Elevation 102.0 m at the location of the west abutment and at Elevation 101.2 m at the location of the east abutment and at Elevation 101.5 m at the pier may be designed for a FCULS of 2,000 kPa. These values are for vertical concentric loads only. Effects of load inclination and eccentricity need to be taken into account as appropriate. Serviceability Limit States (SLS) conditions do not apply to footings placed on bedrock.

The following table summarizes the highest recommended design founding elevations and the factored geotechnical resistances at Ultimate Limit States (FCULS):

<i>Abutment Location</i>	<i>Reference Boreholes</i>	<i>Higher Design Founding Elevation (m)</i>	<i>FCULS (kPa)</i>	<i>Alternate Design Founding Elevation (m)</i>	<i>FCULS (kPa)</i>
West Abutment	1, 4 and PH5 to PH7	103.7	850	102.0	2,000
Central Pier	Subsurface conditions interpolated from the borehole information put down at the west and east abutments	103.0		101.5	
East Abutment	2, 3 and PH1 to PH3	102.3		101.2	

All footing excavations should be inspected prior to placing concrete to ensure that the base has been adequately cleaned and that the bedrock conditions as exposed at the founding level are consistent with the design assumptions. All loose or shattered rock within the footprint of the footings and at the founding level should be removed and replaced with concrete. To prevent

deterioration of the shale, a mud mat of lean concrete should be placed immediately after excavation.

If space restrictions within the median do not allow the use of spread footings for the pier, consideration could be given to supporting the pier on caissons socketted into the lower portion of the shale. For typical caisson diameters of 0.9 m to 1.5 m, the caissons should be designed based on shaft friction developed on the portion of the caisson formed within the bedrock. For initial sizing of the caissons, the following design values may be assumed:

Within the upper 1.5 m of weathered, fractured bedrock, a geotechnical resistance at Ultimate Limit States of 550 kPa may be assumed for unit shaft friction for loading in compression. Below Elevation 101.5 m, a FCULS value of 850 kPa may be assumed.

5.2.2 Horizontal Resistance

Resistance to lateral forces / sliding resistance between the concrete spread footings and bedrock should be calculated in accordance with Section 6-8.4.3 of the OHBDC. For the spread footings placed on the moderately weathered shale at the lower founding level, horizontal shear resistance can be supplemented by passive resistance from the weathered / fractured rock in front of the footing. For design, an unfactored effective angle of friction of 30 degrees ($K_p = 3.0$) and effective cohesion, c' , of 80 kPa can be assumed for design. A unit weight of 23 kN/m³ can be used in design.

If necessary, sliding resistance can be supplemented by doweling into bedrock. The dowels will be formed within the relatively unfractured, unweathered bedrock below Elevation 101.5 m. For loading in tension, a unit bond stress of 450 kPa at Ultimate Limit States may be assumed for the grout-to-rock interface for the dowels. The dowels should be a minimum of 1.0 m long within the rock and the structural strength of the dowel and the compressive strength of the grout should not be exceeded.

5.2.3 Frost Protection

All footings should be provided with a minimum of 1.2 m of earth cover for frost protection purposes.

5.3 Lateral Earth Pressures

The lateral pressures acting on the bridge abutments will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill and on the subsequent lateral movement of the structure. The following recommendations are made concerning the design of the abutments and the retaining walls in accordance with OHBDC:

- Select free-draining granular fill meeting the specifications of OPSS Granular A or Granular B but with less than 5 per cent passing the 200 sieve should be used as backfill behind the walls. All granular fill should be compacted in lifts of loose thickness not greater than 200 mm to 95 per cent of the material's Standard Proctor maximum dry density.
- Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill.
- The granular fill may be placed either in a zone with width equal to at least 1.2 m behind the back of the stem (Case I) or within the wedge-shaped zone defined by a 60 degree line extending up and back from the bottom of the rear face of the footing (Case II).
- If the wall support allows lateral yielding of the stem (unrestrained structure), active earth pressures may be used in the geotechnical design of the structure. If the abutment support does not allow lateral yielding (restrained structure), at-rest pressures should be assumed for geotechnical design.
- A compaction surcharge equal to 16 kPa should be included in the lateral earth pressures for the structural design of the abutment wall in accordance with OHBDC Figure 6-7.4.3.
- For Case I, the pressures are based on the embankment fill materials and the following parameters (unfactored) may be assumed:

Soil unit weight 21 kN/m³
(assuming clean earth fill)

Coefficients of lateral earth pressure:

'active'	0.31
'at rest'	0.47

- For Case II, the pressures are based on the granular fill as placed and the following parameters (unfactored) may be assumed:

	Granular A	Granular B
Soil Unit Weight	22 kN/m ³	21 kN/m ³
Coefficients of Lateral Earth Pressure		
'active'	0.27	0.31
'at rest'	0.43	0.47

Soil Unit Weight	Granular A 22 kN/m ³	Granular B 21 kN/m ³
Coefficients of Lateral Earth Pressure		
'active'	0.27	0.31
'at rest'	0.43	0.47

It should be noted that the above design parameters assume level backfill and ground surface behind the wall. Other aspects of the abutment granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD-3501.00.

5.4 Excavations

At the abutments, the excavations for footing construction at the higher level will be about 1.5 m deep below existing ground surface and will extend through the fill and silty clay till deposit into the highly weathered bedrock consisting of shale with limestone interbeds. As shown on the Preliminary Design Study drawings, the existing road grade of QEW is at about Elevation 105.5 m at the location of the pier and the excavation for footing construction at the pier will extend through as much as 2.5 m of the existing road fill.

Conventional excavation equipment would be suitable for excavating the overburden. Temporary cuts in the overburden may be made with side slopes not steeper than 1 horizontal to 1 vertical (1H:1V). For the footing placed at the lower elevation within the less fractured bedrock, excavation into the shale bedrock may be carried out with conventional hydraulic equipment equipped with rock teeth. Rock splitting equipment (hoe ram) may be required to break up fresh limestone layers encountered within the bedrock. Temporary shallow excavations into the shale may be made in vertical cut. Some ravelling of the fractured bedrock present in the upper 1.0 m to 1.7 m zone should be expected. Where space is restricted, such as likely will be the case at the pier, consideration should be given to the use of soldier pile and lagging for temporary support to the sides.

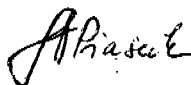
The water levels measured in the piezometers were at Elevation 102.1 m at the west abutment and at Elevation 101.3 m at the east abutment (about 3.1 m and 2.5 m depths below existing ground surface). The base of the footing excavations will likely be at or below the groundwater level; some water inflow into the excavations should be expected. This inflow can be handled by

5.5 Approach Embankments

The proposed underpass structure will require 9 m to 10.5 m in height embankments. Topsoil and fill materials should be stripped from below the footprint area of the fill embankment and all subgrade soils should be proof-rolled prior to fill placement. The subgrade consists of silty clay till.

Construction of the embankment above the prepared subgrade may be carried out using clean earth fill (in accordance with OPSS 212) or Select Subgrade Material (in accordance with OPSS 1010), depending on material available. All embankment fill should be placed in regular lifts with loose thickness not exceeding 300 mm, and be compacted to at least 95 per cent of the material's Standard Proctor maximum dry density. The final lift prior to placement of the granular subbase or base course should be compacted to 100 per cent of the Standard Proctor maximum dry density. Inspection and field density testing should be carried out by qualified geotechnical personnel during all fill placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved. The permanent slopes of the embankment should be maintained not steeper than 2 horizontal to 1 vertical. Vegetation cover should be established on all slopes to protect embankment fill against surficial erosion.

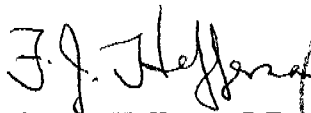
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AMP/ASP/FJH/amp/clg
WORD S/FINAL/AT/1100/981-1122/81122KR1



LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.).

Dynamic Penetration Resistance; N_6 :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60° conical tip and a projected end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	c_u, s_u kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w _p	plastic limit
w _l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane test (LV-laboratory vane test)
γ	unit weight

Note:

- Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I GENERAL

π	= 3.1416
$\ln x$	natural logarithm of x
$\log_{10} x$ or $\log x$	logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stresses (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation
*	Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

(a) Index Properties (con't.)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity Index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(c) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(d) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_α	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	Overconsolidation ratio = σ'_p / σ'_{vo}

(e) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1. $\tau = c' + \sigma' \tan \phi'$

2. Shear strength = (Compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	> 2 m
Thickly bedded	0.6 m to 2m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	< 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	> 3 m
Wide	1 - 3 m
Moderately close	0.3 - 1 m
Close	50 - 300 mm
Very close	< 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 - 60 mm
Medium Grained	60 microns - 2 mm
Fine Grained	2 - 60 microns
Very Fine Grained	< 2 microns

Note: * Grains > 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

B - Bedding	P - Polished
FO - Foliation/Schistosity	S - Slickensided
CL - Cleavage	SM - Smooth
SH - Shear Plane/Zone	R - Ridged/Rough
VN - Vein	ST - Stepped
F - Fault	PL - Planar
CO - Contact	FL - Flexured
J - Joint	UE - Uneven
FR - Fracture	W - Wavy
MF - Mechanical Fracture	C - Curved
- Parallel To	
⊥ - Perpendicular To	

N1122001.BHS

W.P. 67-98-00
 DIST. QEW / ROYAL WINDSOR DRIVE
 LOCATION 4814606.408N; 290680.528E

RECORD OF BOREHOLE 1

BORING DATE: AUG.11/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + Q - ● rem V - ⊕ U - ○	WATER CONTENT, PERCENT Wp ----- W ----- Wl 10 20 30 40		
				DEPTH (m)								
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		105.18								
		Topsoil		0.00								
		Silty Clay, trace sand, trace gravel, trace organics Very stiff Brown (FILL)		0.15 0.30	1	50 DO	16					
1		Silty Clay, trace sand, trace gravel, trace shale fragments Very stiff to hard Grey and brown, mottled (TILL)		103.96 1.22	2	50 DO	60/ .10					
		Shale Bedrock Weathered Grey (Georgian Bay Formation)		103.68 1.52								
2												
			END OF BOREHOLE									
3												
4												
5												
6												
7												
8												
9												
10												

Note:
Open borehole dry
on completion of
drilling.

Note:
Open borehole dry
on completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

DATA INPUT: PS AUG.26/98

SOIL/6

NY120202.BHS

DATA INPUT: PS AUG 28/98

SOLM6

W.P. 67-98-00
 DIST. QEW / ROYAL WINDSOR DRIVE
 LOCATION 4814635.240N; 290756.997E

RECORD OF BOREHOLE 2

BORING DATE: AUG.10/98

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp W Wl		
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		103.88							
		Topsoil		0.00							
		Silty Clay, some sand, trace gravel, occ. topsoil lenses Very stiff Dark brown and grey (FILL)		0.15	1	50 DO	21				
				103.03							
1		Silty Clay, trace sand, trace gravel, trace shale fragments Very stiff Grey and brown, mottled (TILL)		0.85	2	50 DO	19				
				102.36							
		Shale Bedrock Weathered Grey (Georgian Bay Formation)		1.52							
2				101.75							
				2.13							
		BOREHOLE CONTINUED FOR BEDROCK CORING DETAILS, REFER TO SHEET 2.									
3											
4											
5											
6											
7											
8											
9											
10											
		CONTINUED ON NEXT PAGE									

BENTONITE
SEAL

SAND
FILTER

Note.
Open borehole dry
during drilling
in overburden.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

N1122002 BHR

DATA INPUT: PS AUG 26/98

ROCKMVS


W.P. 67-98-00
DIST. QEW / ROYAL WINDSOR DRIVE
LOCATION: 4814635.240N290756.997E

RECORD OF BOREHOLE: 2

DRILLING DATE: AUG 10/98
DRILL RIG: CME 55 BOMBARDIER
DRILLING CONTRACTOR: MASTER SOILS

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-1122



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH % RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION							
															RECOVERY TOTAL CORE %	SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec
0		CONTINUED FROM PREVIOUS PAGE																			
1																					
2		CONTINUED FROM SHEET 1.		101.75																	
3	NQ CORING	Highly weathered becoming moderately weathered below 2.4m depth, grey, fine grained, thinly bedded Shale (70%) and fresh crystalline and fossiliferous Limestone (30%) typically in 25mm to 100mm thick layers. (Georgian Bay Formation)		1	0.25	100															
4				2	0.42	100															
5																					
6																					
7		END OF BOREHOLE		98.70																	
8		Note: Limestone layers greater than 100mm in thickness were encountered at the following depths: 3.22m - 140mm 3.41m - 180mm 4.33m - 270mm 4.90m - 110mm		5.18																	
9																					
10																					

Note:
Water level in piezometer at 101.4m depth on Aug. 18, 1998 and at Elev. 101.3m on Oct. 3, 1998.

DEPTH SCALE:
1 to 50

Golder Associates

LOGGED: SB
DATE:
CHECKED: AMP

N1122003 BHS

DATA INPUT: PS AUG 26/98

SOILM6

W.P. 67-98-00
 DIST. GEW / ROYAL WINDSOR DRIVE
 LOCATION: 4814612.253N; 290747.229E

RECORD OF BOREHOLE 3

BORING DATE: AUG.10/98

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp — W — Wi			
									nat V - + Q - ● rem V - ⊕ U - ○		
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		103.90							
		Topsoil		0.00							
		Silty Clay, some sand, trace gravel, trace shale fragments, occ. topsoil lenses Very stiff Dark brown and grey (FILL)		0.18	1	50 DO	20				
				103.14							
				0.76							
1		Silty Clay, trace sand, trace gravel, trace shale fragments Very stiff Grey and brown, mottled (TILL)		102.38	2	50 DO	27				
		Shale Bedrock Weathered Grey		1.52	3	50 DO	80/ 15				
				102.07							
				1.83							
2	BOREHOLE CONTINUED FOR BEDROCK CORING DETAILS, REFER TO SHEET 2.										
3											
4											
5											
6											
7											
8											
9											
10	CONTINUED ON NEXT PAGE										

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

N1122003.BHR

DATA INPUT: PS AUG 26/98

ROCKMVS







W.P. 67-98-00
 DIST. QEW / ROYAL WINDSOR DRIVE
 LOCATION: 4814612.253N,290747.229E

RECORD OF BOREHOLE: 3

DRILLING DATE: AUG.10/98
 DRILL RIG: CME 55 BOMBARDIER
 DRILLING CONTRACTOR: MASTER SOILS

SHEET 2 OF 2
 DATUM: GEODETIC
 PROJECT: 981-1122



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	CORING LOG												DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
				ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH % RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY k, cm/sec			
								TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION	DIP w.r.t. CORE AXIS				
															FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN		
0		CONTINUED FROM PREVIOUS PAGE															
1																	
2		CONTINUED FROM SHEET 1.		102.07													
2	NQ CORING AUG. 20/98	Highly weathered becoming moderately weathered below 2.7m depth, grey, fine grained, thinly bedded Shale (72%) and fresh crystalline and fossiliferous Limestone interlayers (28%). (Georgian Bay Formation)		1.83	1	0.55	100						50mm Clay Seam				
80mm BC																	
70mm BC																	
50mm BC																	
90mm BC																	
10mm Clay Seam																	
150mm BC																	
70mm BC																	
50mm BC																	
20mm Clay Seam																	
110mm BC																	
30mm BC																	
50mm BC																	
5		END OF BOREHOLE		99.02													
5				4.88													
6		Note: Limestone layers greater than 100mm in thickness were encountered at the following depths: 2.69m - 100mm 3.49m - 140mm 3.67m - 127mm 3.91m - 178mm 4.20m - 292mm															
7																	
8																	
9																	
10																	

DEPTH SCALE:

1 to 50

Golder Associates

LOGGED: SB

DATE:

CHECKED: AMP

W.P.

67-98-00

RECORD OF BOREHOLE 4

SHEET 1 OF 2

DIST.

QEW / ROYAL WINDSOR DRIVE

BORING DATE: AUG.11/98

DATUM: GEODETIC

LOCATION:

4814586.730N; 290672.187E

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp — W — Wi			
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE	105.24								
		Topsoil	109.89								
		Silty Clay, some sand, trace gravel, trace organics Very stiff Brown (FILL)	104.48	1	50 DO	18					
1		Silty Clay, trace sand, trace gravel, occ. shale fragments Hard Brown and grey, mottled (TILL)	0.76	2	50 DO	60/ 15					
		Shale Bedrock Weathered Grey (Georgian Bay Formation)	103.74	3	50 DO	75/ 12					
2		BOREHOLE CONTINUED FOR BEDROCK CORING DETAILS, REFER TO SHEET 2.	1.67								
3											
4											
5											
6											
7											
8											
9											
10											

CONTINUED ON NEXT PAGE

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1122

Note:
Water level in
piezometer at
Elev. 102.14m on
Aug.19, 1998 and
on Oct.3, 1998.

LOGGED: SB

DATE:

CHECKED: AMP

Golder Associates

N1122PH1 BHS

W.P. 67-98-00
 DIST. QEW/ROYAL WIN.
 LOCATION: N 4814606.408; E 290680.528

RECORD OF BOREHOLE PH1

BORING DATE: AUG.10/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH				WATER CONTENT, PERCENT					
				DEPTH (m)				Cu, kPa	nat V - + rem V - ⊗	Q - ● U - ○	Wp	W	Wl				

0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		103.87												
		Topsoil		0.00												
		Silty Clay, some sand, trace gravel, trace organics		0.15	1	50 DO	11									
		Stiff Brown (FILL)		103.11												
1		Silty Clay, trace sand, trace gravel, trace shale fragments		0.76	2	50 DO	26									
		Very stiff Grey and brown, mottled (TILL)		102.35												
		Shale Bedrock		1.52	3	50 DO	60/ .15									
		Weathered Grey (Georgian Bay Formation)		101.89												
2		END OF BOREHOLE		1.98												
3																
4																
5																
6																
7																
8																
9																
10																

Note:
Open hole dry on
completion of
drilling.

Note:
Open hole dry on
completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

DATA INPUT: PS NOV 19/98

SOILM6

W.P. 67-98-00
DIST. QEW/ROYAL WIN.
LOCATION: N 4814606.408; E 290680.528

RECORD OF BOREHOLE PH2

BORING DATE: AUG.10/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m										
				DEPTH (m)				SHEAR STRENGTH				WATER CONTENT, PERCENT					
								Cu, kPa	nat V - rem V -	+ ⊕	q - ● u - ○	Wp --- W --- Wl					
0	ONE 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		103.86													
		Topsoil		0.00													
		Silty Clay, some sand, trace gravel, trace shale fragments		0.15													
		Very stiff		103.36	1	50 DO	17										
		Brown and grey, mottled (FILL)		0.50													
1		Silty Clay, trace sand, trace gravel, occ. shale fragments															
		Very stiff			2	50 DO	19										
		Brown and grey, mottled (TILL)															
				102.34		50 DO	50/ 03										
		Shale Bedrock Weathered		1.52													
2		Grey (Georgian Bay Formation)		102.03													
		END OF BOREHOLE		1.83													
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Note:
Open hole dry on
completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

N1122PH3 BHS
DATA INPUT: PS NOV 19/98
SOILM6

W.P. 67-98-00
DIST. QEW/ROYAL WIN.
LOCATION: N 4814606.408; E 290680.528

RECORD OF BOREHOLE PH3

BORING DATE: AUG.10/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT:



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa				WATER CONTENT, PERCENT					
								nat V - + rem V - ⊕	Q - ● U - ○	Wp ----- W ----- Wl		10 20 30 40					
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		103.89													
		Topsoil		0.00													
		Silty Clay, some sand, trace gravel, trace organics		0.15	1	50 DO	13										
		Stiff Brown and grey (FILL)		103.29													
				0.60													
1		Silty Clay, trace sand, trace gravel, trace shale fragments			2	50 DO	60/ .15										
		Hard Brown and grey, mottled (TILL)		102.67													
				1.22													
				102.37													
				1.52													
2		Shale Bedrock Weathered Grey (Georgian Bay Formation)															
		END OF BOREHOLE															
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Note:
Open hole dry on
completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

N1122PH4 BHS

W.P. 67-98-00
 DIST. QEW/ROYAL WIN.
 LOCATION: N 4814606.408; E 290680.528

RECORD OF BOREHOLE PH4

BORING DATE: AUG.10/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp — W — Wi		
				DEPTH (m)							
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		103.83							
		Topsoil		0.00							
		Silty Clay, some sand, trace gravel, trace shale fragments, occ. topsoil lenses		0.15	1	50 DO	8				
		Stiff Brown and grey (FILL)		102.73							
1		Silty Clay, trace sand, trace gravel, trace shale fragments		0.90	2	50 DO	60/ 15				
		Hard Grey and brown, mottled (TILL)		1.07							
		Shale Bedrock Weathered Grey (Georgian Bay Formation)		102.11							
2		END OF BOREHOLE		1.52							
3											
4											
5											
6											
7											
8											
9											
10											

Note:
Open borehole dry
on completion of
drilling.

Note:
Open borehole dry
on completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

DATA INPUT: PS NOV 19/98

SOILS 6

W.P. 67-98-00
DIST. QEW/ROYAL WIN.
LOCATION: N 4814606.408; E 290680.528

RECORD OF BOREHOLE PH5

BORING DATE: AUG.11/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp W Wt				
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE	105.28								
		Topsoil	0.00								
		Silty Clay, some sand, trace organics (FILL)	0.17 0.30	1	50 DO	29					
1		Silty Clay, trace sand, trace gravel, trace shale fragments, occ. cobble, occ. silt partings Very stiff to hard Brown and grey, mottled (TILL)	103.74	2	50 DO	35					
		Shale Bedrock Weathered Grey (Georgian Bay Formation)	1.52 1.88	3	50 DO	60/ .15					
2		END OF BOREHOLE									
3											
4											
5											
6											
7											
8											
9											
10											

Note:
Open hole dry on
completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

W.P. 67-98-00
DIST. QEW/ROYAL WIN.
LOCATION: N 4814606.408; E 290880.528

RECORD OF BOREHOLE PH6

BORING DATE: AUG.11/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER TYPE	BLOWS/0.3m	SHEAR STRENGTH		WATER CONTENT, PERCENT			
							Cu, kPa	nat V - + Q - ● rem V - ⊗ U - ○	Wp			W
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		105.27								
		Topsoil		0.00								
		Silty Sand, trace gravel, occ. silty clay lenses		0.15	1	50 DO	18					
		Compact Brown (FILL)		104.68								
				0.61								
1		Silty Clay, trace sand, trace gravel, occ. shale fragments			2	50 DO	64					
		Hard (TILL)		103.75								
		Shale Bedrock		1.52	3	50 DO	75/ .15					
		Weathered Grey (Georgian Bay Formation)		1.68								
2		END OF BOREHOLE REFUSAL TO AUGER PENETRATION PROBABLY ON LIMESTONE LAYER.										
3												
4												
5												
6												
7												
8												
9												
10												

Note:
Open hole dry on
completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

W.P. 67-98-00
DIST. QEW/ROYAL WIN.
LOCATION: N 4814606.408; E 290680.528

RECORD OF BOREHOLE PH7

BORING DATE: AUG.11/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, K, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH				WATER CONTENT, PERCENT					
				DEPTH (m)				Cu, kPa	nat V - + Q - ● rem V - ⊕ U - ○	Wp — W — Wl 10 20 30 40							
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		105.25													
		Topsoil		0.00													
		Silty Clay, some sand, trace gravel, occ. topsoil lenses		0.15	1	50 DO	14										
		Stiff Brown (FILL)		104.64													
				0.61													
1		Silty Clay, trace sand, trace gravel, occ. shale fragments		104.18	2	50 DO	50/ .08										
		Hard Brown and grey, mottled (TILL)		1.07													
		Shale Bedrock Weathered Grey (Georgian Bay Formation)		103.73													
				1.52													
2		END OF BOREHOLE															
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Note:
Open hole dry on
completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AMP

N1122PH8 BHS

W.P. 67-98-00
 DIST. QEW/ROYAL WIN.
 LOCATION: N 4814606.408; E 290680.528

RECORD OF BOREHOLE PH8

BORING DATE: AUG.11/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1122



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH				WATER CONTENT, PERCENT	
								nat V - + Cu, kPa	Q - ● rem V - ⊗ U - ○			Wp	W
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		105.57									
		Topsoil		0.00									
		Silty Clay, some sand, trace gravel, trace shale fragments		0.15	1	50 DO	15						
		Stiff Brown (FILL)		104.97 0.60									
1		Silty Clay, trace sand, trace gravel, trace shale fragments			2	50 DO	59						
		Hard Grey and brown, mottled (TILL)		104.05									
		Shale Bedrock		1.52	3	50 DO	58/ 15						
		Weathered Grey (Georgian Bay Formation)		1.68									
2		END OF BOREHOLE											
3													
4													
5													
6													
7													
8													
9													
10													

Note:
Open hole dry on
completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB
 CHECKED: AMP

DATA INPUT: PS NOV 19/98

SOILM6

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT. No.
WP No. 67-98-00

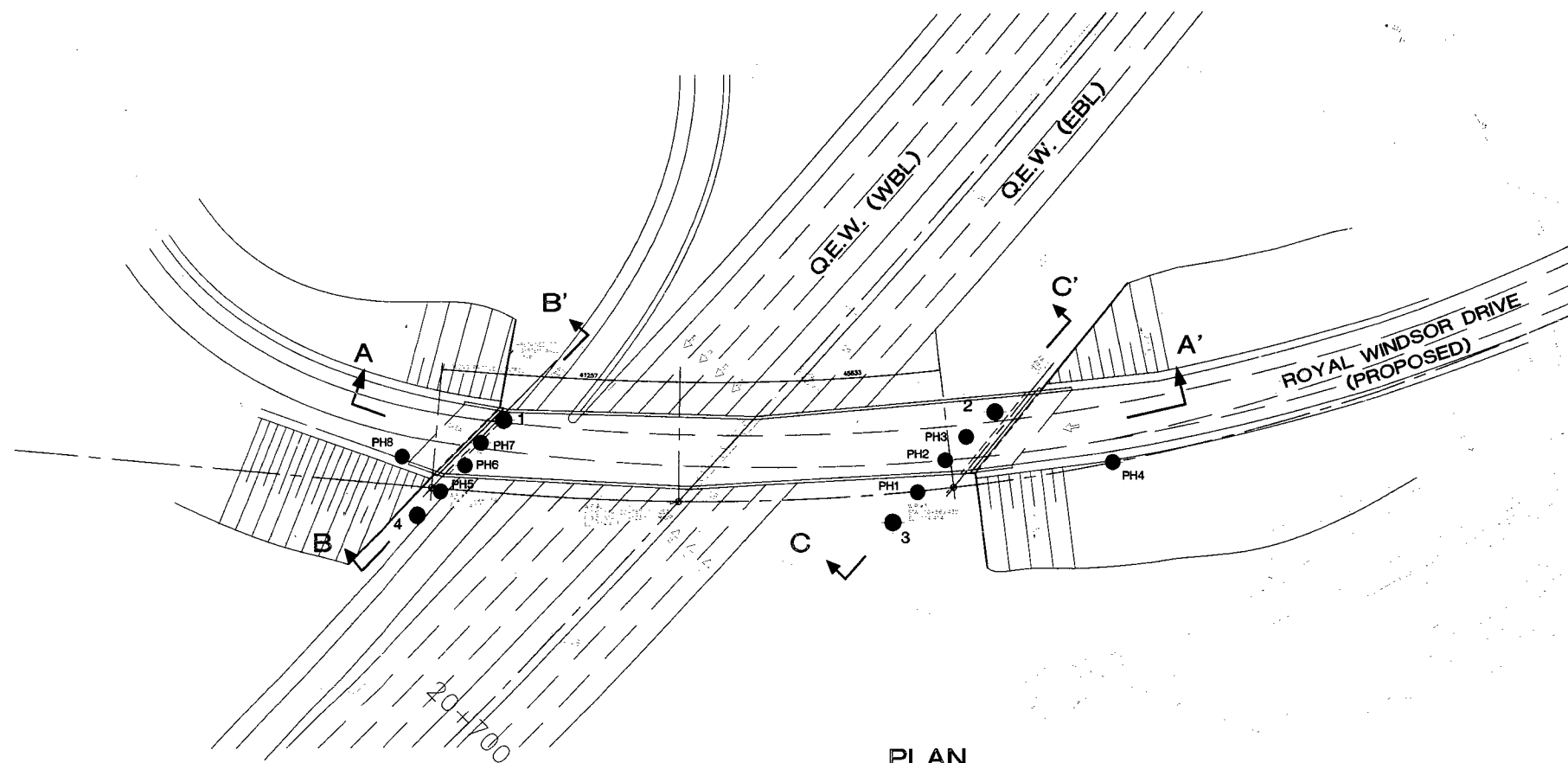
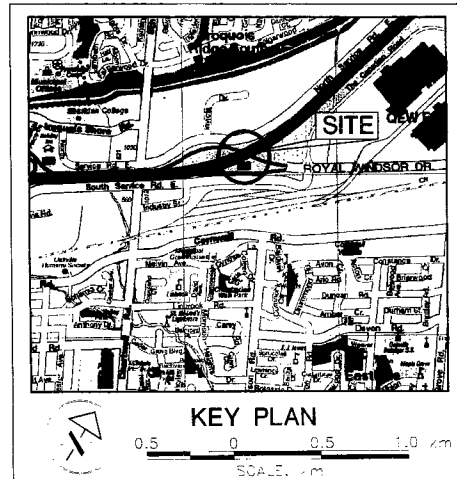
Q.E.W. UNDERPASS AT
ROYAL WINDSOR DRIVE
BORE HOLE LOCATIONS & SOIL STRATA



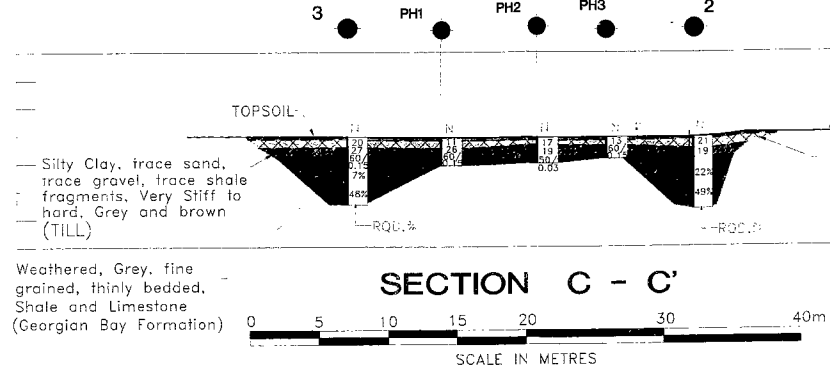
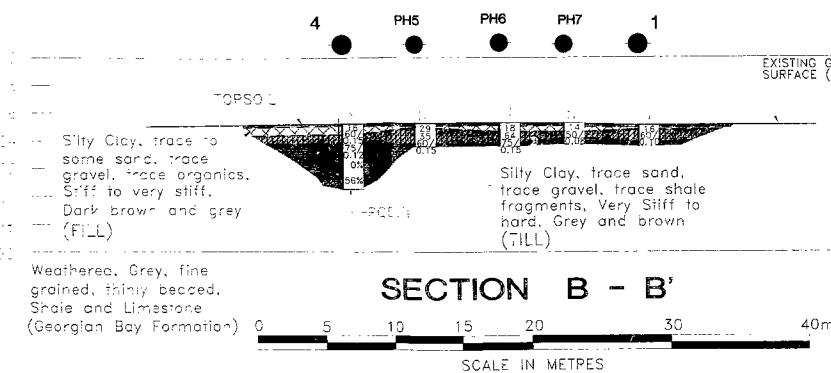
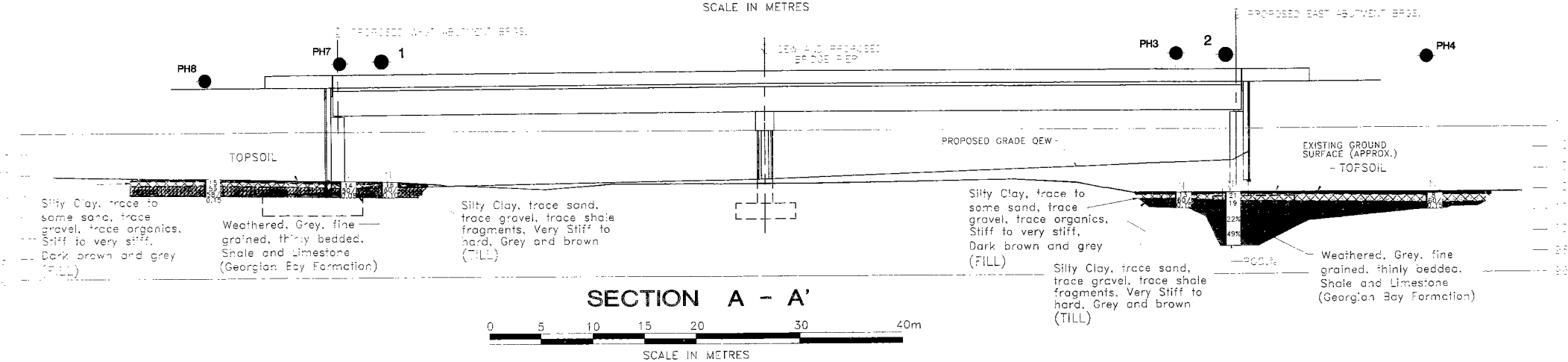
SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



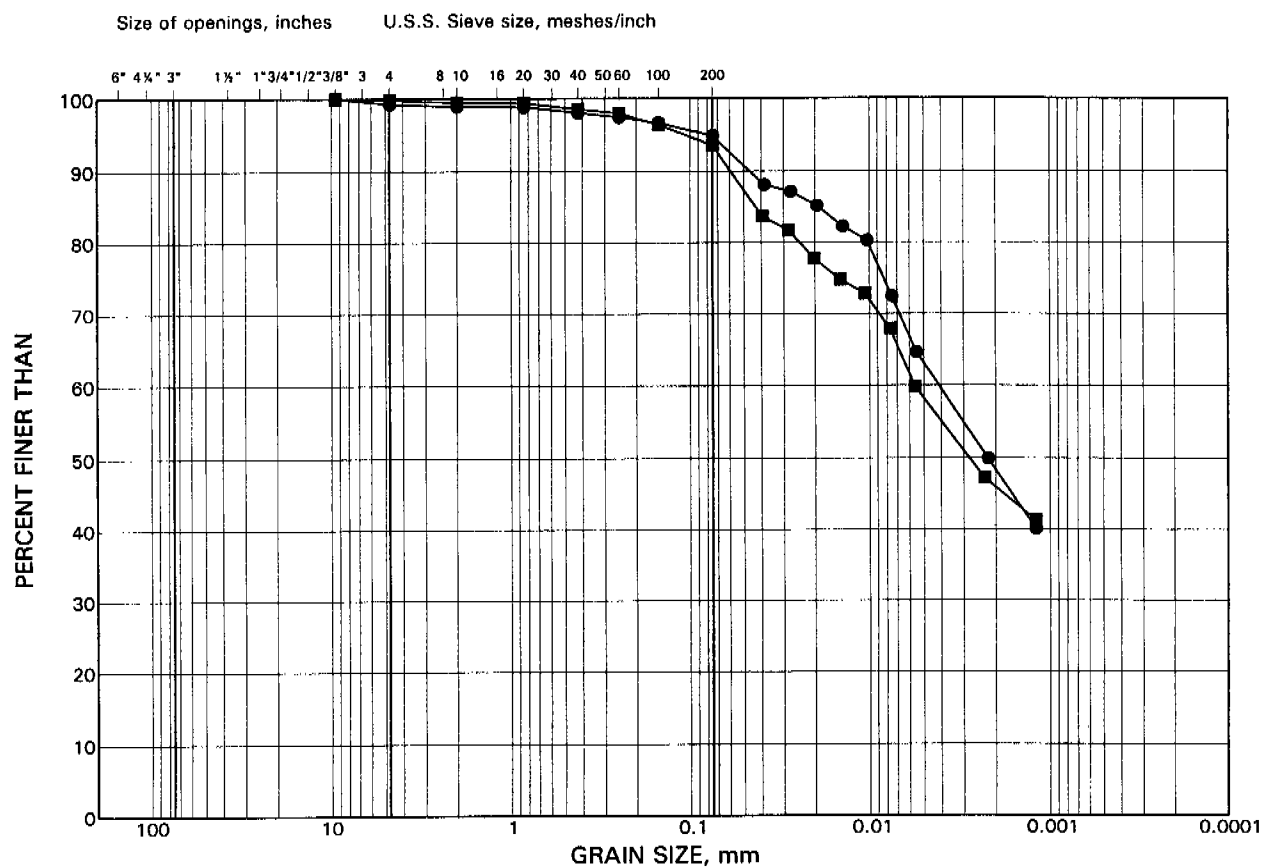
LEGEND			
●	Bore Hole		
⊖	Dynamic Cone Penetration Test (Cone)		
⊕	Bore Hole & Core		
	Blows/0.3m (Std. Pen. Test, 475 lbf/ft)		
	Core Blows/0.3m (60" Cone, 475 lbf/ft)		
▽	WL at time of investigation		
LOCATION			
No.	ELEVATION	NORTHING	EASTING
1	105.18	4,814,606.408	290,680.528
2	103.88	4,814,635.240	290,756.997
3	103.90	4,814,612.253	290,747.229
4	105.24	4,814,586.730	290,672.167
PH1	103.87	4,814,606.408	290,680.528
PH2	103.86	4,814,606.405	290,680.526
PH3	103.89	4,814,606.405	290,680.528
PH4	103.63	4,814,606.408	290,680.525
PH5	105.26	4,814,606.408	290,680.525
PH6	105.27	4,814,606.403	290,680.528
PH7	105.25	4,814,606.408	290,680.528
PH8	105.57	4,814,606.408	290,680.528



NO.	DATE	BY	REVISION
Geocres No.			
HWY. No. QEW	PROJECT NO.: 981-1122	DIST. 4/6	
SUBM'D. AMP	CHKD: AMP	DATE: 1998.11.06	SITE 10-162
DRAWN: KHW	CHKD: AMP	APPD.	DWG. N1122001

GRAIN SIZE DISTRIBUTION

FIGURE 1



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE ELEVATION(m)
●	2	102.6
■	3	102.8

DOCUMENT MICROFILMING IDENTIFICATION

G.I-30 SEPT 1976

GEOCRES No. 30M12-121

DIST. 4 REGION Central

W.P. No. 125-66-12

CONT. No. 78-09

W. O. No. _____

STR. SITE No. 24-375

HWY. No. QEW

LOCATION Winston Churchill

Boulevard Interchange Underpass

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 3

REMARKS: documents to be unfolded
before microfilming

INTRODUCTION

The Soil Mechanics Section was requested to carry out a foundation investigation for a new proposed interchange underpass at the intersection of the Queen Elizabeth Way and Winston Churchill Boulevard.

Following this request a total of six dynamic penetration tests and ten boreholes were carried out at or adjacent to the proposed abutment and pier locations to determine the subsoil conditions which are of significance to the planning and design of the proposed structure.

This report contains the results obtained from our investigations, along with our recommendations pertaining to the approaches and proposed structure.

SITE DESCRIPTION

The site is located within the physiographic region known as the Iroquois Plain. This region is a strip of land bordering Lake Ontario from the Niagara River to the Trent River varying in width from a few hundred yards to eight miles. Inundated in the late Pleistocene time by a body of water known as Lake Iroquois, it is characterized by old deltas, off-shore deposits and soft red shale shorecliffs. This shale is of the Queenston Formation of the Upper Ordovician age.

The land immediately adjacent to the site has a relatively flat topography sloping only slightly to the south. Drainage ditches excavated within the area have exposed the underlying red shale bedrock characteristic of the Queenston shale area.

This area has for many years been a leading early truck crop area but recently has undergone considerable industrial, commercial and residential development.

SUBSURFACE CONDITIONS

General

Subsoil within the vicinity of the site generally consists of topsoil overlying a random mixture of sand and gravel, silt, clayey silt and clean rubble. This layer overlies red shale bedrock.

Borings performed through or immediately adjacent to the shoulders of the existing service roads indicated that this random mixture of sand and gravel, silt and clean rubble extends from ground level to the underlying layer of red clayey silt, a depth varying between 0.5 and 4.0 feet.

Borings performed outside these areas indicated a surficial layer of topsoil approximately 6 inches thick followed by a layer of red clayey silt. As shown on the Record of Borehole Sheets, this cohesive clayey silt layer varies in thickness from 1.5 to 7.5 feet.

A more complete description of the various soil types is as follows.

Medium to Coarse Sand, Trace of Fine Gravel and Silt

This homogeneous granular material was intersected only in Borehole 3. Based upon a Standard Penetration Test 'N' value of 5 blows/foot, the material within this zone has a 'loose' denseness. It is believed that this material is a granular fill covering the 18 inch concrete storm water drain pipe running parallel to the ditch line on the north side of the Q.E.W.

Sand and Gravel (Rubble)

This fill material consists of a mixture primarily of sand and gravel, with pockets of silty clay and crushed brick. Standard Penetration Test 'N' values ranging between 14 and 20 blows/foot are indicative of a compact relative density. This granular material was intersected in boreholes 1, 2 and 7 through the shoulders of the north and south service roads and extends from ground surface to a depth ranging between 0.5 and 2.0 feet.

Clayey Silt

This soil is the predominating overburden material throughout the site. In some areas, however, it is overlain by the previously described granular material. The consistency differs between the south side and north side of the Q.E.W. Standard Penetration Test 'N' values taken on the north side ranging from 42 to 82 blows/foot indicate a hard consistency.

Similarly, 'N' values obtained from tests on the south side ranging from 14 to 61 blows/foot indicate a stiff to hard consistency.

Atterberg Limit tests performed on the samples obtained indicated the following limits.

	<u>Range</u>	<u>Average</u>
Plastic Limit	17-19%	18%
Liquid Limit	28-33%	30%
Moisture Content	13-17%	14%

These results are plotted on the Plasticity Chart on Figure 1 within the Appendix of this report. Organic content tests performed on the samples indicate it to range between 0.4% and 4.7% within the top 2.5 to 6.5 feet.

Bedrock

Bedrock consists primarily of a red shale which predominates throughout this region. Core samples indicate this shale to be fine textured, soft, fissile and readily broken down into a reddish clay soil if exposed to weathering agents. Frequent bands of greyish-green shale approximately 1 to 4 inches thick were also encountered. Several layers of medium hard, fine textured limestone were also intercepted in all boreholes. These bands varied in thickness from .1 to 1.0 feet. A more detailed description may be found on the Diamond Drill Record sheets contained within the Appendix.

It is estimated that approximately the upper 3 feet of the bedrock is considerably weathered. For this reason, the bedrock surface was extremely difficult to determine. However, based upon Dynamic Cone Penetration tests and Standard Penetration tests, it is estimated that the bedrock surface elevation varies between 462.6 and 468.7 with the average being 465.7. Bedrock elevations so determined in each borehole are shown on the Record of Borehole sheets.

Groundwater

Groundwater levels in B.H.'s 1, 2, 3, 3A, 7A and 8 were not observed because, due to their close proximity to the travelled highway, they had to be filled in immediately after completion and before the groundwater could stabilize. In B.H.'s 4, 5, and 6 no groundwater was observed during augering down to the bedrock surface. However, rock cores were taken in these holes and this involved the use of water. After completion

of drilling operations in these holes water levels stabilized within one or two days at the following elevations: 465.0, 468.5 and 471.8, respectively.

In borehole 7 augering was continued into the bedrock to a depth of about 12 feet below the bedrock surface (i.e. to elev. 451.7). The hole remained dry until augering reached elevation 457+ at which time it filled with water eventually rising to elevation 463.5 within about 2 hours after completion of the borehole. No further water levels were measured in this hole.

From the foregoing it is concluded that

- (1) The bedrock contains fissures in the upper 10 feet which act as aquifers.
- (2) Excavations within the overburden are not likely to encounter groundwater.
- (3) Excavations which penetrate the bedrock may possibly encounter aquifers which produce water under static heads to elevations 465-471.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct a six lane three span underpass structure at this site with span lengths of 86.0' - 152.0' - 86.0'. The proposed grade elevations will be about 496 feet at the abutments and about 498 feet at the centre of the midspan.

Structure

The proposed structure abutments may be constructed within the approach fills and founded on end bearing piles driven to bedrock. In this case steel H piles are recommended using the maximum allowable design load for the particular section used. For estimating purposes, it should be assumed that the piles will penetrate about 1 foot below the bedrock surface as shown on Drawing 1256612-A. Alternatively, the proposed abutments may be founded on spread footings constructed within the hard clayey silt stratum which overlies the bedrock or within the sound bedrock at or about the following elevations using the design loads as noted:

North Abutment

Within overburden at elev. 466.0 - 5 t.s.f.

Within bedrock at elev. 462.0 - 10 t.s.f.

South Abutment

Within overburden at elev. 466.0 - 5 t.s.f.

Within bedrock at elev. 462.0 - 10 t.s.f.

The proposed piers may be founded at elevation 462 within the sound bedrock in which case design loads up to 10 t.s.f. may be assumed.

In computing resistance to lateral pressures a coefficient of friction equal to 0.4 may be assumed to apply between the bedrock or clayey silt subsoil and the underside of spread footings. A minimum of 4 feet of cover should be provided for frost protection for footings or pile caps. No dewatering problems are anticipated for footings constructed with the overburden. In the case of footings constructed in the bedrock it is possible that water bearing fissures may be encountered. In this event dewatering can be achieved by pumping from suitably constructed sumps.

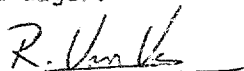
Concrete working slabs will be necessary to protect the foundation surfaces immediately on exposure since the shale bedrock and also the clayey silt subsoil softens rapidly on exposure to moisture. Differential settlements between piers and abutments will be negligible.

Approaches

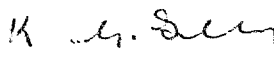
Approach fills approximately 25 feet in height will be required. No stability problems are anticipated. At locations where piles are to be driven grain size of fill should not exceed 3 inches.

MISCELLANEOUS

All field work was performed under the direct supervision of Mr. R. Van Veen during the period of October 21st to October 26th, 1976 using a tracked vehicle mounted C.M.E. 45 solid auger.



R. Van Veen
Project Engineer



K.G. Selby, P. Eng.
Supervising Engineer

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 125-66-12

LOCATION Co-ords. N.15,809,379 E.956,428

ORIGINATED BY RVV


DIST 4 HWY Q.E.W.










BORING DATE October 22, 1976

COMPILED BY RVV

DATUM Geodetic

BOREHOLE TYPE Solid Auger, BXL Core & Cone Test

CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w		UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p w w_L		
469.5	Ground Level													
468.0	Gravelly (100%) FILL - Compact		1	SS	14									0 29 38 33
1.5	Clayey silt. Red		2	SS	42									
464.0	Hard		3	SS	100/24"									
5.5	Bedrock - Red Shale		4	SS	125/75"									
	Soft Fissile with bands of greyish- green shale and limestone		5	SS	218/79"	460								
			6	SS	125/74"									
			7	SS	130/75"									
			8	SS	100/73"									
446.0			9	RC BXL	rec. 100%	450								
23.5	End of Borehole Note: Water Level not established.													

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

WP 125-66-12 LOCATION Co-ords. N.15,809,290 E.956,359 ORIGINATED BY RVV
 DIST 4 HWY Q.E.W. BORING DATE October 22, 1976 COMPILED BY RVV
 DATUM Geodetic BOREHOLE TYPE Solid Auger & BXL Core CHECKED BY EF

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100	W_P	W	W_L		
470.6	Ground Level															
0.0	Sand & gravel, silt, clayey Clayey Silt. Red Hard	Traces of organics	1	SS	18	470									0.7%	
465.1			2	SS	82											
5.5	Bedrock - Red Shale Soft, Fissile with bands of greyish- green shale and limestone.		3	SS	81/3"											
			4	RC BXL	Rec. 93%											
455.6			5	RC BXL	Rec. 98%	460										
			6	RC	100%											
15.0	End of Borehole															
	Note: Water Level not established.															

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

WP 125-66-12

LOCATION Co-ords. N.15,809,308 E.956,470

ORIGINATED BY RVV

DIST 4 HWY Q.E.W.




BORING DATE October 21, 1976

COMPILED BY RVV

DATUM Geodetic

BOREHOLE TYPE Solid Auger, BXL Core & Cone Test

CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w		UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w_L		
468.1	Ground Level														
0.0	Sand, medium to coarse trace of fine gravel & silt. Fill. Loose		1	SS	5										
464.1	Clayey silt. Red trace of gravel. Hard		2	SS	65										
462.6			3	RC BXL	Rec. 91%										
5.5	Bedrock - Red Shale, Soft, Fissile with bands of greyish- green shale and limestone.		4	RC BXL	Rec. 98%										
450.1			5	RC BXL	Rec. 100%										
18.0	End of Borehole Note: Water Level not established.														

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3A

WP 125-66-12

LOCATION Co-ords. N.15,809,307 E.956,465

ORIGINATED BY RVV


DIST 4 HWY Q.E.W.

BORING DATE October 21, 1976

COMPILED BY RVV

DATUM Geodetic

BOREHOLE TYPE Solid Auger

CHECKED BY 

SOIL PROFILE			SAMPLES		GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W		UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		VALUES	20	40	60	80	100	WATER CONTENT %		
468.1	Ground Level													
0.0	Topsoil													
464.1	Sand, medium to coarse trace of fine gravel & silt. Fill. Loose													
462.6	Clayey silt, Red, Hard													
5.5	Bedrock - Red Shale, Soft, fissile with bands of greyish- green shale & limestone.													
454.8			1	SS	100/4"									
			2	SS	100/4"									
13.3	End of Borehole Note: Water Level not established.													

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 125-66-12

LOCATION Co-ords. N.15,809,260 E.956,426

ORIGINATED BY RVV


DIST 4 HWY Q.E.W.



BORING DATE October 21, 1976

COMPILED BY RVV

DATUM Geodetic

BOREHOLE TYPE Solid Auger & BXL Core

CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W_P	W	W_L		
469.5	Ground Level															
0.0	Topsoil															
464.5	Clayey Silt Red Hard		1	SS	61											
5.0	Bedrock - Red Shale, Soft, fissile with bands of greyish- green shale and limestone		2	SS	100/0											
			3	RC BXL	Rec. 65%	460										
			4	RC BXL	Rec. 95%											
452.0			5	RC BXL	Rec. 100%											
17.5	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 5

WP 125-66-12 LOCATION Co-ords. N.15,809,198 E.956,578 ORIGINATED BY RVV
 DIST 4 HWY Q.E.W. BORING DATE October 25, 1976 COMPILED BY RVV
 DATUM Geodetic BOREHOLE TYPE Solid Auger & BXL Core & Cone Test CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	W_P	W	W_L		
470.5	Ground Level															
0.0	Topsoil															
	Clayey silt, trace of organics		1	SS	20											
464.5	Red Hard		2	SS	115											
6.0	Bedrock - Red Shale, Soft, fissile with bands of greyish-green shale and limestone.		3	RC BXL	Rec. 90%											
453.8			4	RC BXL	Rec. 100%											
16.7	End of Borehole															

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 6

WP 125-66-12

LOCATION Co-ords. N.15,809,150 E.956,535

ORIGINATED BY RVV

DIST 4 HWY Q.E.W.

BORING DATE October 25 & 26, 1976

COMPILED BY RVV

DATUM Geodetic

BOREHOLE TYPE Solid Auger & BXL Core & Cone Test

CHECKED BY *RP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT W_L		UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	PLASTIC LIMIT W_p		
473.0	Ground Level													
0.0	Topsoil													
	Clayey silt		1	SS	14	470								
	Red		2	SS	61									
465.0	Stiff to Hard	trace of organics	3	SS	100%									
8.0	Bedrock - Red Shale		4	BXL	100%									
	Soft, fissile with bands of greyish-green shale and limestone.		5	RC	Rec. 80%	460								
			6	BXL	Rec. 78%									
			7	BXL	100%									
			8	RC	Rec. 98%	450								
446.7														
26.3	End of Borehole													

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 7

WP 125-66-12 LOCATION Co-ords. N.15,809,166 E.956,638 ORIGINATED BY RVV
 DIST 4 HWY Q.E.W. BORING DATE October 26, 1976 COMPILED BY RVV
 DATUM Geodetic BOREHOLE TYPE Solid Auger and Cone Test CHECKED BY 4.

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x 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
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
471.9	Ground Level									
469.9	Sand & gravel (Rubble) Fill Compact		1	SS	20	470				
2.0	Clayey silt, trace of organics		2	SS	16					
	layers of fine sand		3	SS	25					
463.4	Hard		4	SS	130/10"					
8.5	Bedrock - Red Shale		5	SS	180/8"	460				
	Soft, fissile with bands of greyish-green shale and limestone		6	SS	100/4"					
451.7			7	SS	100/3"					
20.2	End of Borehole									

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 7A

WP 125-66-12

LOCATION Co-ords. N.15,809,168 E.956,641

ORIGINATED BY RVV

DIST 4 HWY Q.E.W.

BORING DATE October 26, 1976

COMPILED BY RVV

DATUM Geodetic

BOREHOLE TYPE Solid Auger & BXL Core

CHECKED BY *ef.*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
471.9	Ground Level															
469.9	Sand & gravel (Rubble) Fill Compact					470										
2.0	Clayey silt, trace of layers of fine sand organics															
463.4	Hard															
8.5	Bedrock - Red Shale		1	RC	33%	460										
	Soft, fissile with bands of greyish- green shale and limestone.		2	RC BXL	Rec. 68%											
451.2			3	RC BXL	Rec. 100%											
20.7	End of Borehole															
	Note: Water Level not established.															

OFFICE-REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 8

WP 125-66-12

LOCATION Co-ords. N.15,809,085 E.956,570

ORIGINATED BY RVV


DIST 4 HWY Q.E.W.

BORING DATE October 26, 1976

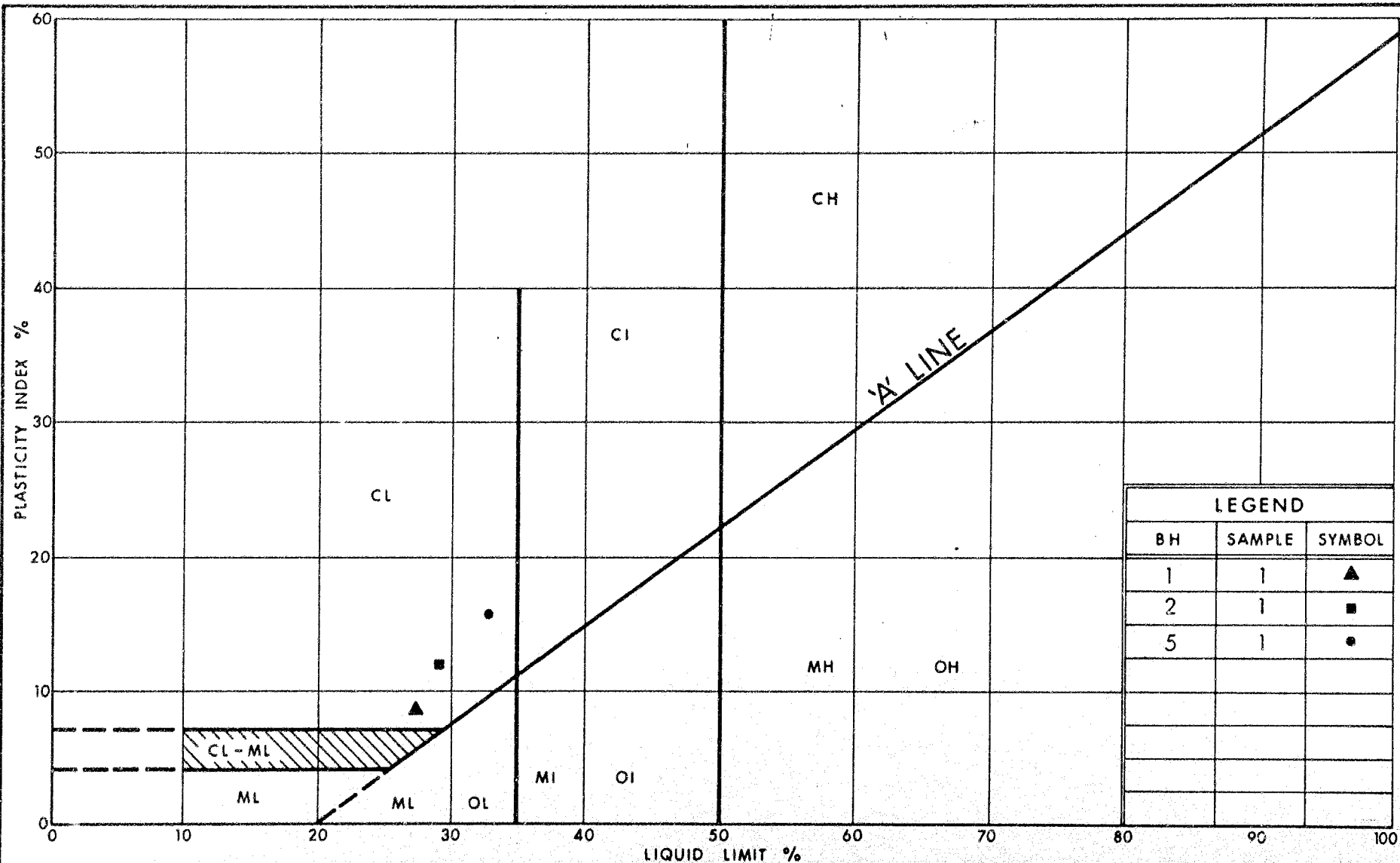
COMPILED BY RVV

DATUM Geodetic

BOREHOLE TYPE Solid Auger & EXL Core & Cone Test

CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w		UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	WATER CONTENT % w_p w w_L			
473.7	Ground Level														
0.0	trace of organics & gray Clayey silt		1	SS	51										
468.7	Red Hard		2	SS	50										
4.0	Bedrock - Red Shale		3	SS	100										
	Soft, fissile with bands of greyish-green shale and Limestone.		4	RC	64										
			5	RC EXL	Rec. 94%										
455.6			6	RC EXL	Rec. 77%										
18.1	End of Borehole Note: Water Level not established.														



LEGEND

BH	SAMPLE	SYMBOL
1	1	▲
2	1	■
5	1	●



Ontario

 Ministry of
Transportation and
Communications

ENGINEERING SERVICES BRANCH

PLASTICITY CHART

CLAYEY SILT

FIG No 1

W P 125-66-12



Ministry of
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Communications

DIAMOND DRILL RECORD

HOLE NO. 1 & 2 SHEET NO. _____

PROPERTY LOCATION W.P. 125-66-12
QEW & Winston Churchill Blvd.
LATITUDE _____
DEPARTURE _____
BEARING _____

DIP
90°

TOTAL FOOTAGE _____

ELEV. COLLAR _____
DATUM _____
DATE STARTED _____
DATE COMPLETED _____
DRILLED BY _____
LOGGED BY _____

FOOTAGE		FORMATION	SAMPLE NUMBER			REMARKS
FROM	TO					
		HOLE #1				
18.5'	18.7'	Shale, red colour, fine texture, soft fissile, absorptive.				
18.7'	19.3'	Limestone, shaly, light grey colour, fine texture, med. hard				
19.3'	21.3'	Shale (Same description as above for shale)				
21.3'	21.6'	Limestone (Same description as above for limestone)				
		HOLE #2				
6.0'	6.6'	Limestone, (Same description as above for Limestone)				
6.6'	8.3'	Shale (Same description as above for Shale)				
8.3	8.5'	Limestone (Same description as above for Limestone)				
8.5	15.0'	Shale (Same description as above for Shale)				

DATE OF EXAMINATION November 23, 1976

B. K. Glassford



Ministry of
Transportation and
Communications

DIAMOND DRILL RECORD

HOLE NO. 3 SHEET NO. _____

DIP

PROPERTY LOCATION W.P. 125-66-12
QEW & Winston Churchill Blvd.
LATITUDE _____
DEPARTURE _____
BEARING _____

90°

TOTAL FOOTAGE _____

ELEV. COLLAR _____
DATUM _____
DATE STARTED _____
DATE COMPLETED _____
DRILLED BY _____
LOGGED BY _____

FOOTAGE		FORMATION	SAMPLE NUMBER			REMARKS
FROM	TO					
		HOLE #3				
6.5'	10.8'	Shale, red colour, fine texture, soft fissile, absorptive.				
10.8'	11.1'	Limestone, shaly, light grey colour, fine texture, med. hard				
11.1'	14.0'	Shale (Same description as above for Shale)				
14.0'	14.2'	Limestone (Same description as above for Limestone)				
14.2'	14.5'	Shale (Same description as above for Shale)				
14.5'	15.5'	Limestone (Same description as above for Limestone)				
15.5'	17.5'	Shale (Same description as above for Shale)				
17.5'	18.0'	Limestone (Same description as above for Limestone)				

DATE OF EXAMINATION November 23, 1976

B. K. Glassford



Ministry of
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Communications

Ontario

DIAMOND DRILL RECORD

HOLE NO. 4 SHEET NO. _____

PROPERTY W.P. 125-66-12
LOCATION QEW & Winston Churchill Blvd.
LATITUDE _____
DEPARTURE _____
BEARING _____

DIP
90°

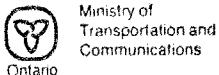
TOTAL FOOTAGE _____

ELEV. COLLAR _____
DATUM _____
DATE STARTED _____
DATE COMPLETED _____
DRILLED BY _____
LOGGED BY _____

FOOTAGE		FORMATION	SAMPLE NUMBER			REMARKS
FROM	TO					
		Hole #4				
6.1'	6.4'	Limestone, shaly, light grey colour, fine texture, med. hard				
6.4'	7.9'	Shale, red colour, fine texture, soft fissile, absorptive.				
7.9'	8.1'	Limestone, (Same description as above for Limestone)				
8.1'	10.1'	Shale, (Same description as above for Shale)				
10.1'	10.8'	Limestone, (Same description as above for Limestone)				
10.8'	13.7'	Shale, (Same description as above for Shale)				
13.7'	13.9'	Limestone, (Same description as above for Limestone)				
13.9'	17.3'	Shale, (Same description as above for Shale)				

DATE OF EXAMINATION November 23, 1976

B. K. Glassford



DIAMOND DRILL RECORD

HOLE NO. 5 SHEET NO.

DIP

90°

PROPERTY LOCATION W.P. 125-66-12
QEW & Winston Churchill Blvd.
LATITUDE
DEPARTURE
BEARING

TOTAL FOOTAGE _____

ELEV. COLLAR _____

DATUM _____

DATE STARTED _____

DATE COMPLETED _____

DRILLED BY _____

LOGGED BY _____

[illegible]

DATE OF EXAMINATION November 23, 1976

B. K. Glassford



Ministry of
Transportation and
Communications

DIAMOND DRILL RECORD

HOLE NO. 6 SHEET NO. _____

DIP

90°

PROPERTY W.P. 125-66-12
LOCATION QEW & Winston Churchill Blvd.
LATITUDE _____
DEPARTURE _____
BEARING _____

TOTAL FOOTAGE _____

ELEV. COLLAR _____
DATUM _____
DATE STARTED _____
DATE COMPLETED _____
DRILLED BY _____
LOGGED BY _____

FOOTAGE		FORMATION	SAMPLE NUMBER			REMARKS
FROM	TO					
		HOLE #6				
8.3'	20.4'	Shale, red colour, fine texture, soft fissile, absorptive.				
20.4'	20.9'	Limestone, shaly, light grey colour, fine texture, med. hard				
20.9'	22.0'	Shale (Same description as above for Shale)				
22.0'	22.5'	Limestone (Same description as above for Limestone)				
22.5'	24.2'	Shale (Same description as above for Shale)				
24.2'	24.3'	Limestone (Same description as above for Limestone)				
24.3'	24.6'	Shale (Same description as above for Shale)				
24.6'	24.7'	Limestone (Same description as above for Limestone)				
24.7'	25.0'	Shale (Same description as above for Shale)				
25.0'	25.2'	Limestone (Same description as above for Limestone)				
25.2'	25.7'	Shale (Same description as above for Shale)				
25.7'	25.8'	Limestone (Same description as above for Limestone)				
25.8'	26.3'	Shale (Same description as above for Shale)				

DATE OF EXAMINATION November 23/76

B.K. Glassford



DIAMOND DRILL RECORD

HOLE NO. 7 SHEET NO.

DIP

90°

PROPERTY _____ W.P. 125-66-12 _____
LOCATION _____ QEW & Winston Churchill Blvd. _____
LATITUDE _____
DEPARTURE _____
BEARING _____

TOTAL FOOTAGE _____

ELEV. COLLAR _____
 DATUM _____
 DATE STARTED _____
 DATE COMPLETED _____
 DRILLED BY _____
 LOGGED BY _____

[illegible]

DATE OF EXAMINATION November 23, 1976

B. K. Glassford



HOLE NO. 8 SHEET NO. _____

DIE

90°

ELEV. COLLAR

DATUM

DATE STARTED

DATE COMPLETED

DRILLED BY

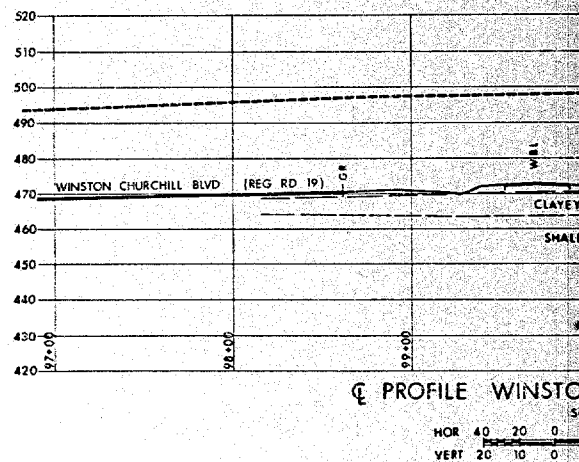
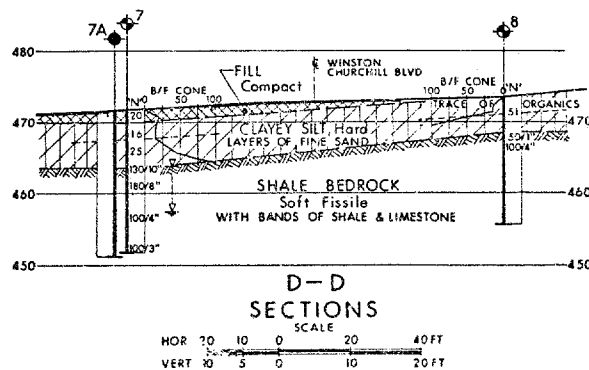
LOGGED BY

PROPERTY LOCATION W.P. 125-66-12
LATITUDE
DEPARTURE
BEARING

TOTAL FOOTAGE _____

DATE OF EXAMINATION November 23, 1976

B. K. Glassford



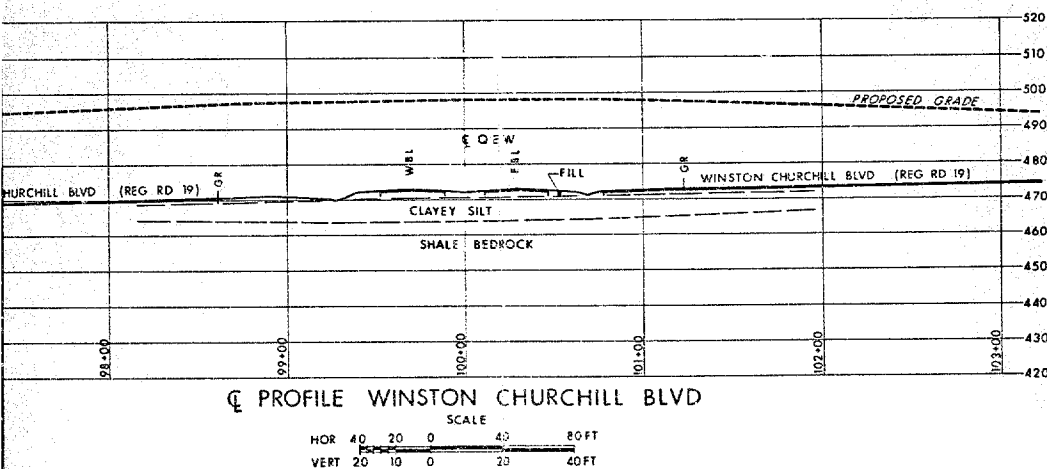
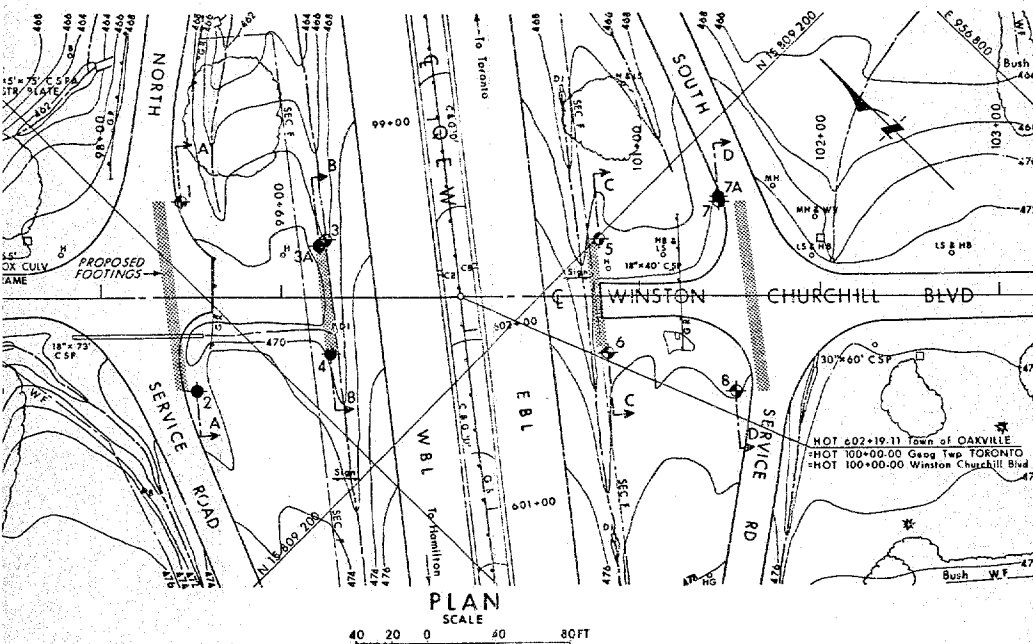
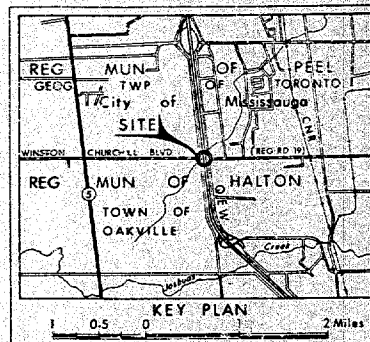
CONT No
WP No 125-66-12



WINSTON CHURCHILL BLVD

SHEET

BORE HOLE LOCATIONS & SOIL STRATA



- LEGEND**
- Bore Hole
 - ⊕ Dynamic Cone Penetration Test (Cone)
 - ⊕ Bore Hole & Cone
 - W Blows/ft (Std Pen Test 350 ft lbs energy)
 - CONE Blows/ft (60° Cone, 350 ft lbs energy)
 - W L at time of investigation Oct 1976
 - W L NOT ESTABLISHED IN BORE HOLE # 1, 2, 3, 3A, 7A & 8
 - Head
 - Hydrostatic Pressure
 - Encountered

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	469.5	15 809 379	956 428
2	470.6	15 809 298	956 359
3	468.1	15 809 308	956 470
3A	468.1	15 809 307	956 465
4	469.5	15 809 260	956 426
5	470.5	15 809 198	956 578
6	473.0	15 809 150	956 535
7	471.9	15 809 166	956 638
7A	471.9	15 809 168	956 641
8	473.7	15 809 085	956 570

NOTE

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

REVISIONS	DATE	BY	DESCRIPTION

HWY No QEW ST. 4
SURVEY CHECKED DATE Dec 8, 1976 SITE 24-375
DRAWN CHECKED APPROVED TWC1256612-A

REF No B-81-QEW-1

DOCUMENT NO. 125-66-12

GEOCRES No. 36 H 12 - 121

DIST 4 REGION GENERAL

W.P. No. 125-66-12

CONT. No. 78-09

W.C. No.

STR. SITE No. 24-315

HWY. No. QEW

LOCATION WINSTON CHURCHILL BVD

INTERCHANGE UNDERPASS

DATE OF INSPECTION 12/1/67

REMARKS

30H12-121

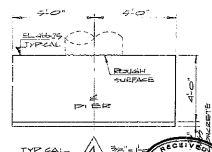
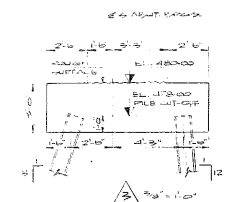
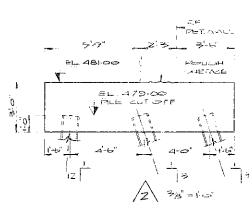
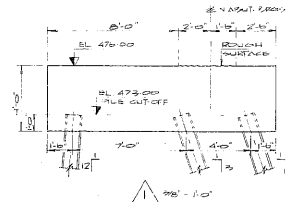
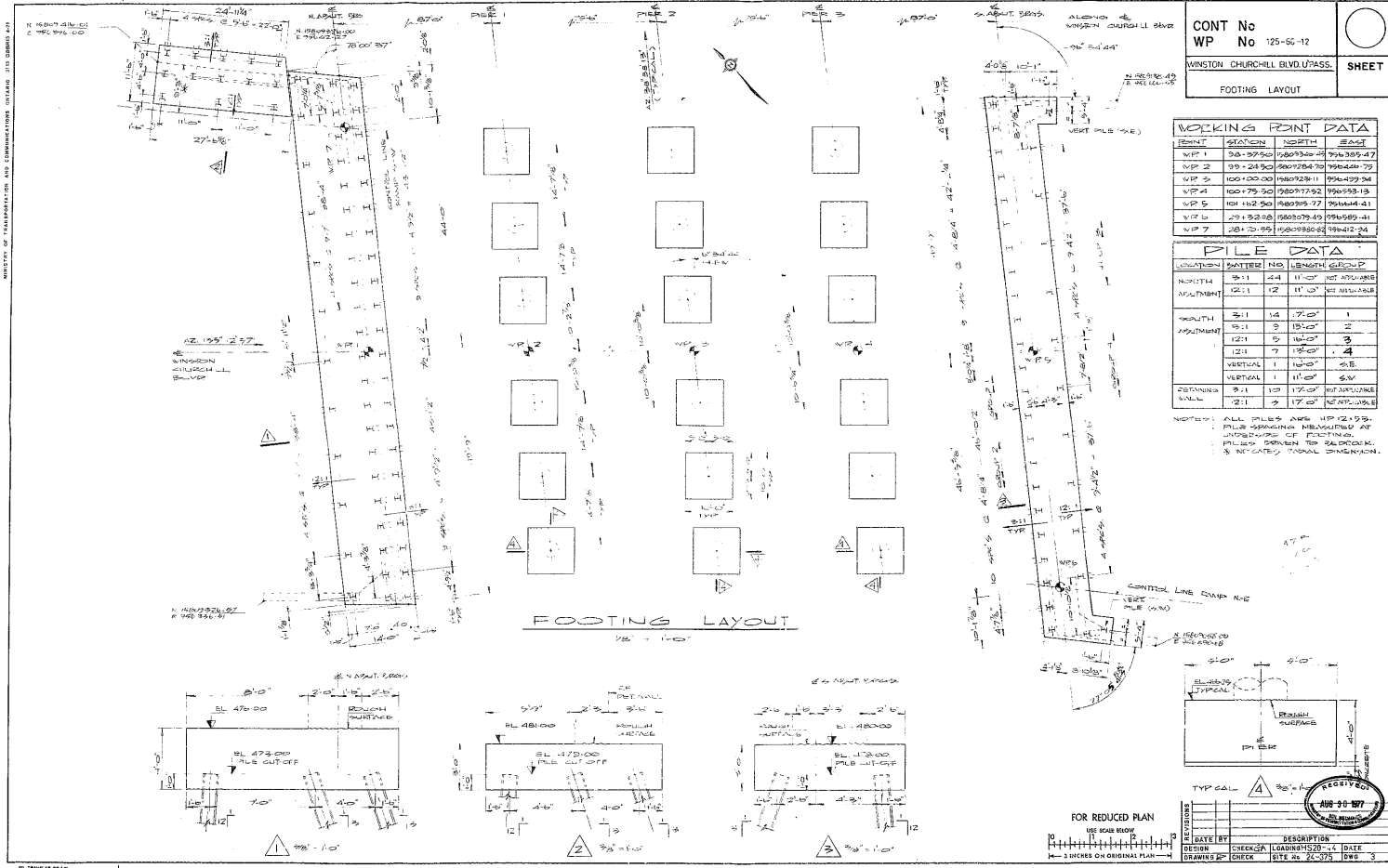
CONT No
WP No 125-56-12
WINSTON CHURCHILL BLVD U/PASS
FOOTING LAYOUT

SHEET

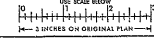
POINT	STATION	NORTH	EAST
WP 1	30+22.50	5807339.43	796389.47
WP 2	30+24.50	5807284.70	796444.72
WP 3	100+00.00	5807239.11	796499.34
WP 4	100+75.50	5807177.92	796553.13
WP 5	101+12.50	580715.77	796604.41
WP 6	20+52.50	580579.49	796585.41
WP 7	20+50.50	580580.83	796412.24

LOCATION	WATER	NO	LENGTH	GROUP
NORTH	11	44	11'-0"	NOT APPLICABLE
NORTH	12	12	11'-0"	NOT APPLICABLE
SOUTH	11	14	17'-0"	1
SOUTH	11	9	15'-0"	2
SOUTH	12	5	14'-0"	3
SOUTH	12	7	15'-0"	4
VERTICAL	1	13'-0"	45.75	
VERTICAL	1	11'-0"	5.75	
STATIONING	11	12	17'-0"	NOT APPLICABLE
STATIONING	12	3	17'-0"	NOT APPLICABLE

NOTES: ALL PILES ARE UP 12.125.
PILE SPACING MEASURED AT INTERSECTION OF FOOTING.
PILES DRIVEN TO BEDROCK.
5 INDICATES TYPICAL SPACING.



FOR REDUCED PLAN
USE SCALE BELOW



REVISION	DATE	BY	DESCRIPTION
1	08/30/87	ALB	ALB
2			
3			
4			
5			
6			
7			
8			
9			
10			



DOCUMENT MICROFILMING IDENTIFICATION

9-20 SEP 1978

GEOCRES No. 30M5-110

DIST. 4 REGION Central

W.P. No. 159-75-07

CONT. No. 78-104

W. O. No. _____

STR. SITE No. 10-282A

HWY. No. _____

LOCATION QEW/Ford Drive /
Hwy 403

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 1

REMARKS: documents to be unfolded
before microfilming

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 159-75-07

DIST 4

HWY QEW/Ford Drive/ STR SITE 10-282A
Hwy. 403

W-N Ramp Hwy. 403 Structure
under Ramp E-NS

DISTRIBUTION

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SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	77 of 23	MD
TUBES	—	—
ROCK CORES	The remainder of the Core	MD

FOUNDATION INVESTIGATION REPORT

For

W-N Ramp Hwy. 403 Structure under Ramp E-NS
QEW/Ford Drive/Hwy. 403 Interchange
W.P. 159-75-07 Site 10-282A
District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project during the period of March 24, 1977 to March 29, 1977. The field work consisted of 5 sampled boreholes advanced by employing solid stem augers and BXL coring techniques. The boreholes ranged in depth from 30 to 40 feet below the ground level.

SITE DESCRIPTION AND GEOLOGY

The site is located adjacent to Upper Middle Road approximately 1,100 feet north of the existing Queen Elizabeth Way Underpass at Ford Drive in the Town of Oakville, Regional Municipality of Halton. The land immediately adjacent to the site has a gentle rolling topography sloping down to the south. Drainage ditches excavated within the area have exposed the underlying red shale characteristic of the Queenston shale area. The land is developed for farming purposes.

Physiographically the site lies on the southern fringe of the region referred to as the South Slope. This region is a strip of land bounded by the Iroquois Plain on the south and the Peel Plain on the north and extends from the Niagara escarpment to the Trent River. The region is characterized by a shallow till overlying shale of the Queenston and Dundas Formations of the Upper Ordovician age.

SUBSURFACE CONDITIONS

Generally uniform subsurface conditions were found to exist across the site. A 6 to 9 foot layer of clayey silt was found to overly shale bedrock of the Queenston Formation. Detail descriptions of the various soil and rock types encountered in each borehole are given on the Record of Borehole Sheets. The

estimated stratigraphical profile and sections shown on Drawing No. 1597507-A are based upon this information. From ground level downwards, the various soil types encountered are as follows:

Clayey Silt, Trace of Sand

Immediately below the natural ground level a cohesive stratum 6 to 9 feet thick consisting of clayey silt with traces of sand was encountered. The Standard Penetration Test gave 'N' values ranging from 27 to 44 blows/ft., indicating that the consistency of this stratum varies from very stiff to hard.

The physical properties of the clayey silt as determined from laboratory testing are summarized below:

	<u>Range</u>	<u>Average</u>
Liquid Limit (W_L) %	29-35	31
Plastic Limit (W_p) %	18-20	18
Moisture Content (W) %	10-14	12
Plasticity Index (I_p)	11-17	13

The results of the Atterberg Limit tests are shown on the Plasticity Chart Fig. 1. The Atterberg Limits indicate that the cohesive stratum is generally inorganic and of low plasticity.

Two typical grain size distribution curves from this stratum are shown on the grain size distribution curve Fig. 2.

Bedrock

Underlying the cohesive deposit is shale bedrock which was proven to a maximum depth of 34 feet. The bedrock can be described as soft, fine textured, red in colour, fissile and having thin horizontal bedding planes with seams of limestone up to 6" thick. The upper 3 to 6 feet of the shale bedrock is moderately weathered. A detailed description of the bedrock is given on the Record of Borehole Sheets.

The rock quality designation (RQD) classification gives an indication of the quality of the bedrock with respect to the number of fractures and amount of softening or alteration of the rock mass. The RQD is the total length of rock core pieces of 4 or more inches in length expressed as a percentage of the total length of core drilled. The RQD for the rock core varies from 0 to 85%, generally increasing with depth. These values indicate a rock quality of very poor to good. The low RQD is due to the thin horizontal bedding of the fissile shale.

GROUNDWATER

The groundwater level conditions were observed by measuring in the open boreholes during and after the completion of the foundation investigation. The groundwater levels were found to vary between elevation 483 and 487 which corresponds to 2.5 feet below the existing ground surface. The groundwater levels are shown on the Record of Borehole Sheets as well as on Drawing No. 1597507-A.

DISCUSSION AND RECOMMENDATIONS

As part of the proposed new complex interchange connecting QEW to Hwy. 403 several structures will be necessary. This report deals with a structure which will be required in this complex to carry Hwy. 403 W-N Ramp under the E-NS Ramp.

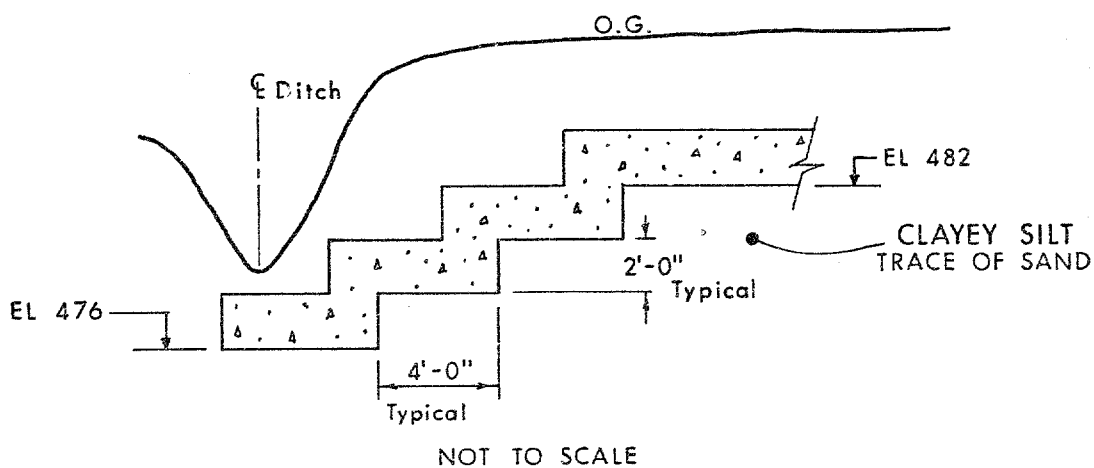
In the vicinity of this proposed structure, the existing ground is at about elevation 487. The proposed grade of the E-NS Ramp will be at elevation 491 and the grade of the W-N Ramp is to be at elevation 468. In order to attain the proposed grade of E-NS Ramp, fills up to 4 feet will be required. The proposed grade of W-N Ramp is such that cuts up to 19 feet will be necessary.

In the vicinity of the southern portion of the proposed west abutment a four to six foot deep drainage ditch paralleling Upper Middle Road is present. Therefore, special measures will be required in the design of this abutment.

Present proposals call for a three span bridge (38'-69'-38') with perched abutments and two centre piers to carry E-NS Ramp over the W-N Ramp Hwy. 403.

Abutment Foundation

The abutments for the proposed structure can be supported on spread footings situated within the clayey silt stratum. To minimize the abutment height the east abutment footing should be located at elevation 485. The footing for the west abutment should be situated at elevation 482 except in the region of the drainage ditch which parallels Upper Middle Road. The footing elevation at the ditch location should be at elevation 476. The difference in footing elevations could be obtained by means of a step footing as shown in the figure below:



Both abutment footings may be designed for a bearing pressure of up to 3 tsf. In any case, the underside of the footing should be provided with at least 4 feet of earth cover for frost protection.

Alternatively, both abutment footings can be founded on the weathered or sound bedrock designed for a bearing pressure of up to 5 tsf and 10 tsf respectively.

For frost protection requirements, the underside of the abutment footings should be provided with 4 feet of earth cover.

For estimating the earth pressure of granular backfill on the abutment walls a coefficient of active earth pressure of $K_a = 0.33$ may be used if some movement at the top of the wall is permitted. If no movement at the top of the wall is anticipated, a coefficient of earth pressure at rest $K_0 = 0.5$ may be used for design purposes.

To estimate the horizontal resistance to sliding between rough concrete and the clayey silt deposit, an adhesion value of up to 2000 psf may be used for design purposes. If the footings are founded on the shale bedrock a coefficient of friction of 0.60 should be used in the design to estimate the resistance to sliding.

In order to relieve the build up of hydrostatic pressures behind the abutment walls the structure should be backfilled with free draining granular material and provided with weepholes or other types of drainage conduit.

Pier Foundation

The proposed grade of the W-N Ramp will be such that the pier footings will be situated within the sound shale bedrock. Therefore, it is recommended that the piers be supported on spread footings designed for a bearing pressure of up to 10 tsf. Since the shale is frost susceptible, the underside of the footing should be provided with 4 feet of earth cores.

Other Considerations

To prevent softening of the shale bedrock at the footing grade due to surface runoff, the shale bedrock should be covered with 3 inches of mass concrete

immediately after the completion of the excavation.

No dewatering problems are anticipated for the construction of the abutment and pier footings. Any minor seepage or surface runoff into the excavations can be handled by pumping from sumps.

Approach Fill - E-NS Ramp

In the vicinity of the proposed structure approach fills of up to 4 feet in height will be required for the E-NS Ramp. No slope stability problems are anticipated provided the slopes are constructed at 2:1 (horizontal:vertical).

Cut W-N Ramp

As mentioned previously, a cut of up to 19 feet will be necessary at the structure site in order to reach the profile grade of the proposed W-N Ramp Hwy. 403. This cut will be made through the cohesive clayey silt and into the shale bedrock. The shale is susceptible to weathering and erosion, therefore, the cut should be treated as an earth cut and constructed with 2:1 slopes. It is further recommended that the cut slopes be covered with topsoil and sodded according to current MTC standards.

MISCELLANEOUS

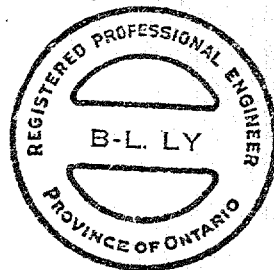
The field work for this investigation was carried out under the supervision of Mr. V. Korlu, Project Engineer and Mr. C.T. Johnson, Project Engineer. The equipment used was owned and operated by Geocon Ltd., Toronto and Atcost Ltd., Toronto.

This report was written by Mr. C.T. Johnson and reviewed by Mr. M. Devata, Supervising Engineer.

for B. Ly

C.T. Johnson, P. Eng.
Project Engineer

M. Devata
M. Devata, P. Eng.
Supervising Engineer



FOUNDATION REQUEST

In a memorandum dated February 16, 1977, Mr. G.C.E. Burkhardt, Head, Structural Section requested the Soil Mechanics Section to prepare a Foundation Investigation Report for the W-N Ramp Hwy. 403 structure under Ramp E-NS.

FIELD AND LABORATORY INVESTIGATION PROCEDURES

A total of five boreholes of which three were accompanied with a dynamic penetration test were put down using a muskeg mounted auger machine equipped with solid stem augers and rock coring equipment.

The locations and elevations of the boreholes were surveyed by personnel from the Central Regional Surveys and Plans Section.

Disturbed soil samples were received by means of a 2 inch O.D. split spoon sampler driven in accordance with the specifications of the Standard Penetration Test. Rock core of the bedrock was obtained by coring with BXL diamond bits.

The samples were visually examined and identified in the field and again in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples of the cohesive stratum to determine the natural moisture content, Atterberg Limits and grain size distribution.

The rock core was examined and logged in detail in the laboratory by Mr. B.K. Glassford, Geologist.

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 11

WP 159-75-07

LOCATION Co-ords. N 15,805,900; E 953,757

ORIGINATED BY CTJ

DIST 4 HWY 403

BORING DATE March 28, 1977

COMPILED BY CTJ

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger; BXL core & Cone Test

CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
488.2	Ground Level															
0.0	Clayey silt, trace of sand		1	SS	31											
482.2	Very stiff Red		2	SS	145	11"										
6.0	(Weathered)															
479.2	(Sound)															
9.0	Shale Bedrock		3	RC BXL	100% Rec										RQD 40%	
	Shale Bedrock, red colour, fine texture soft, fissile, with interbedded thin seams of limestone up to 6" thick, thin horizontal bedding.		4	RC BXL	100% Rec										RQD 50%	
			5	RC BXL	100% Rec										RQD 85%	
448.4																
39.8	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 12

WP 159-75-07 LOCATION Co-ords. N 15,805,758; E 953,686 ORIGINATED BY CTJ
 DIST 4 HWY 403 BORING DATE March 24, 1977 COMPILED BY CTJ
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger; BXL core CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			UNIT WEIGHT γ	REMARKS	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		'N' VALUES	20 40 60 80 100					w_p w w_L				
							SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ○ QUICK TRIAXIAL x LAB VANE					WATER CONTENT % 10 20 30				
485.4	Ground Level														GR SA SI CL	
0.0	Clayey silt, trace of sand		1	SS	31											
479.4	Very stiff Red		2	SS	55											
6.0			3	SS	100/4 1/2"											
473.4	(weathered)		4	SS	100/4"											
12.0	(sound)		5	SS	100/1"											
	Shale Bedrock					470										
	Shale Bedrock, red colour, fine texture soft, fissile with thin seams of limestone present, thin horizontal bedding		6	RC BXL	100% Rec	460									RQD 50%	
			7	RC BXL	100% Rec										RQD 75%	
452.7																
32.7	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 13

WP 159-75-07

LOCATION Co-ords. N 15,805,861; E 953,791

ORIGINATED BY VK

DIST 4 HWY 403

BORING DATE March 28, 1977

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger; BXL Core

CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
487.8	Ground Level					ELEV										GR SA Si CL
0.0	Clayey silt Trace of sand Hard. Red		1	SS	38											0 6 74 20
480.8			2	SS	129	480										
477.8	(weathered)		3	SS	100	477.8										
10.0	(sound)															
	Shale Bedrock		4	RC BXL	100% Rec	470										RQD 30%
	Shale Bedrock, red, fine texture, soft, fissile with lime- stone interbedded seams up to 2" thick thin horizontal bedding.		5	RC BXL	100% Rec	460										RQD 50%
457.9																
29.9	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 14

W.P. 159-75-07

LOCATION Co-ords. N 15,805,727; E 953, 710

ORIGINATED BY VK

DIST 4 HWY 403

BORING DATE March 29, 1977

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger; EXL Core & Cone Test

CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w w_p — w — w_L			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
484.7	Ground Level															
0.0	Clayey silt, Trace of sand Red Very Stiff to Hard		1	SS	27	480										
475.7			2	SS	40											
9.0			3	SS	100/6"											
469.7	(weathered)		4	SS	105/5"											
15.0	(sound) Shale Bedrock		5	SS	100/6"	470										
	e below		6	RC EXL	50% Rec	460										
454.7			7	RC EXL	100% Rec											
30.0	End of Borehole															
	* Shale Bedrock, red, fine texture, soft, fissile with interbedded thin seams of limestone up to 2" thick, thin horizontal bedding.															

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 17

WP 159-75-07

LOCATION Co-ords. N 15,805,835; E 953,725

ORIGINATED BY CTJ

DIST 4 HWY 403

BORING DATE March 25, 1977

COMPILED BY CTJ

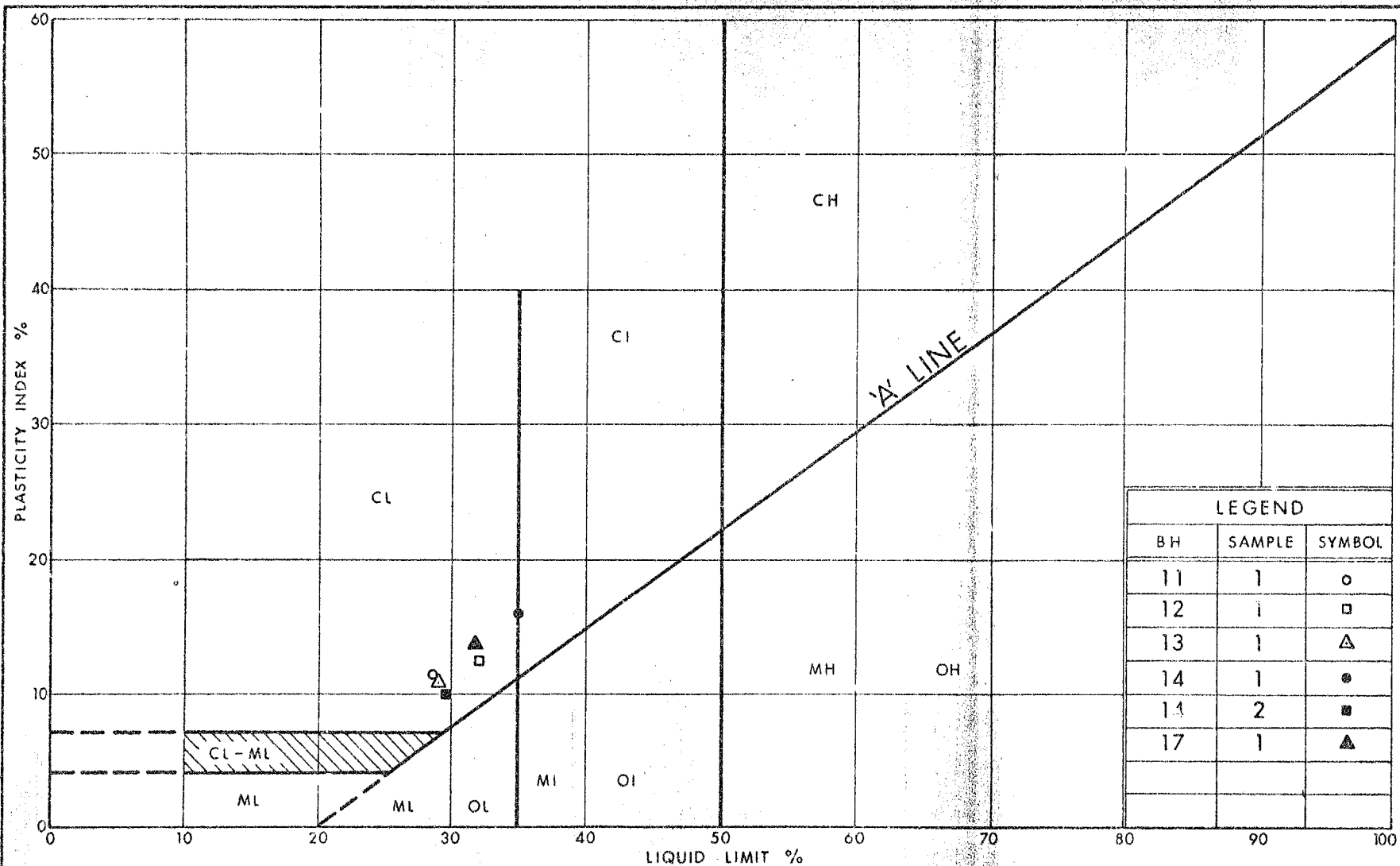
DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger; EXL Core & Cone Test

CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P W W_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
487.2	Ground Level									
0.0	Clayey silt, trace of sand, occ. cobbles. Hard Red		1	SS	44					
481.2			2	SS	137	100/8"				
6.0	Shale Bedrock (weathered)		3	SS	100	6"				
475.2	(sound)		4	SS	100	6"				
12.0			5	SS	100	4"				
	Shale bedrock, red colour, fine texture soft fissile, bedding close to very close, interbedded with limestone seams up to 6" thick, thin horizontal bedding.		6	SS	100	3"				
			7	SS	100	1"				
			8	RC BXL	100%	Rec	460			RQD 40%
457.5										
29.7	End of borehole									

OFFICE REPORT ON SOIL EXPLORATION



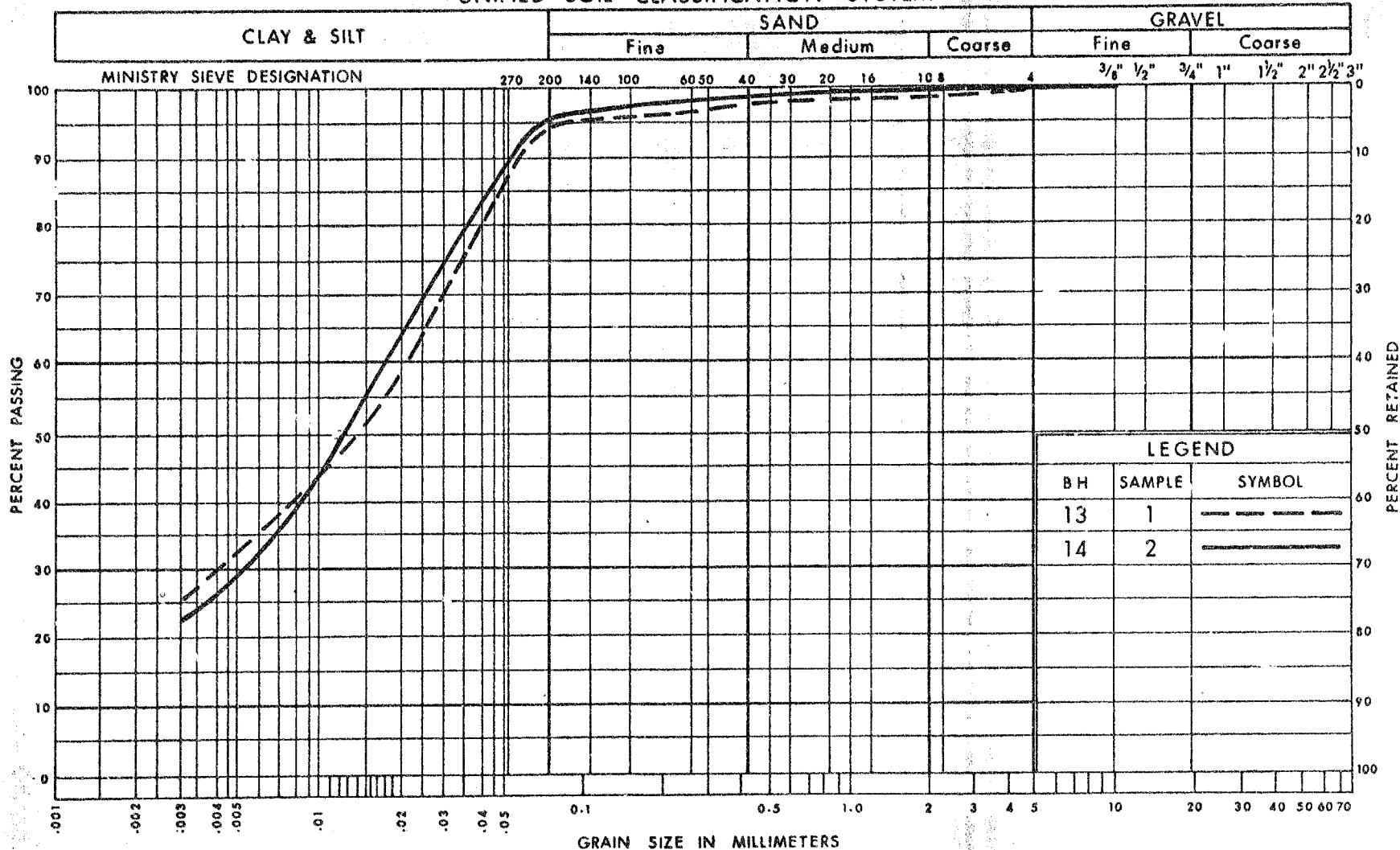
Ministry of
Transportation and
Communications

PLASTICITY CHART CLAYEY SILT TRACE OF SAND

FIG No 1

W P 159 - 75 - 07

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications
Ontario
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
TRACE OF SAND

FIG No 2

W P 159 - 75 - 07

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

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

TERMS TO BE USED IN DESCRIBING SOILS:-

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

TYPE OF SAMPLE

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

P.H SAMPLE ADVANCED HYDRAULICALLY

P.M SAMPLE ADVANCED MANUALLY

SOIL TESTS

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

ABBREVIATIONS & SYMBOLS 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
w_s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

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

STRESS AND STRAIN

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

EARTH PRESSURE

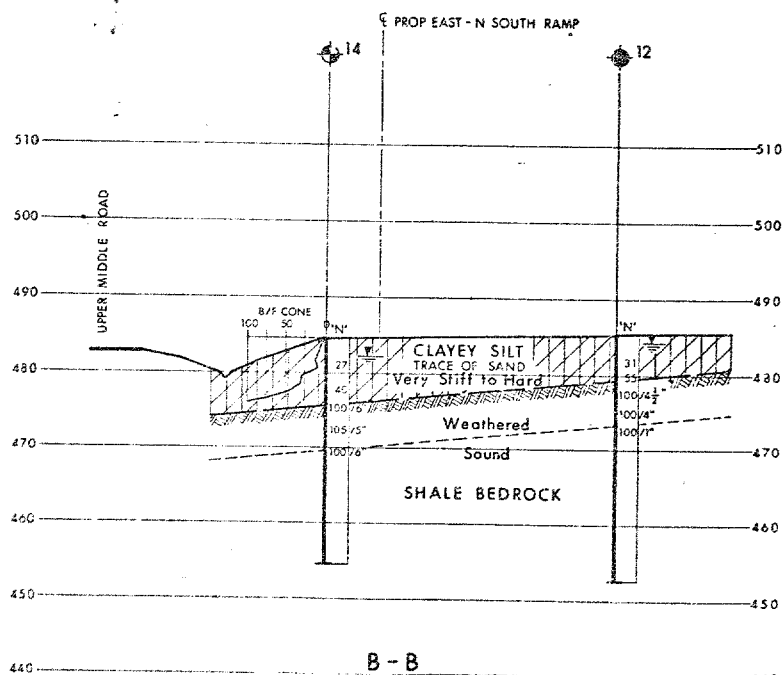
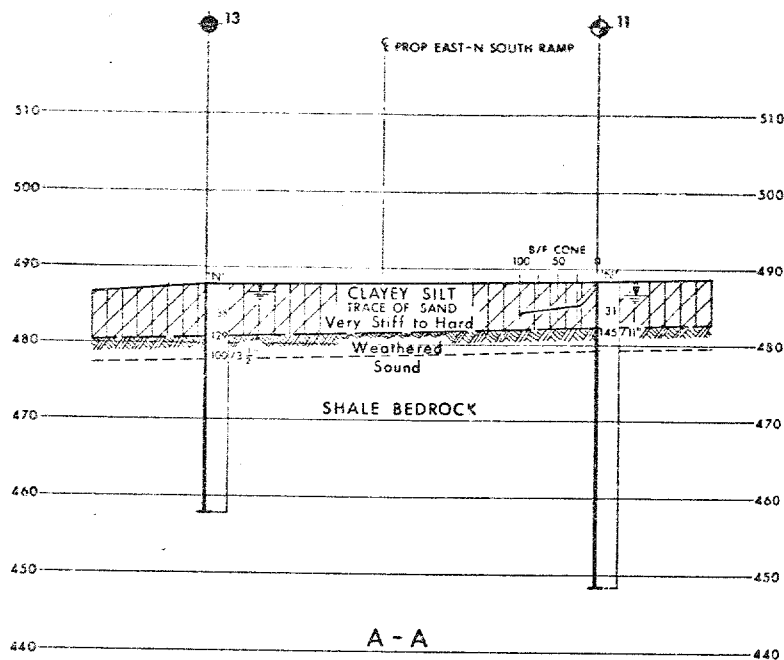
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

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

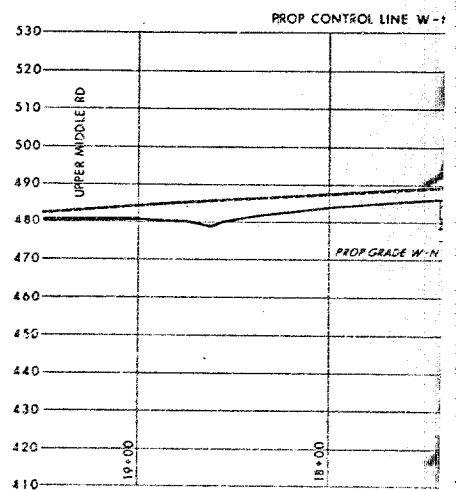
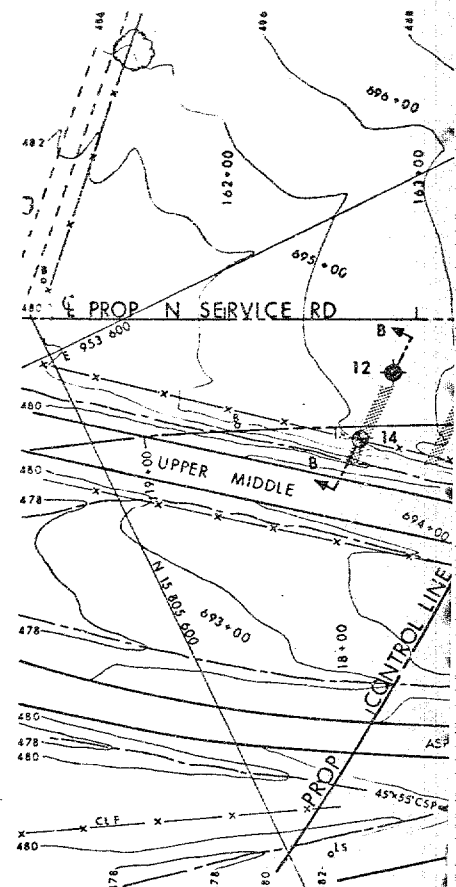
SLOPES

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



SECTIONS

10 0 SCALE 10 20 FT



PROFILE - PR
HOR 41
VERT 2

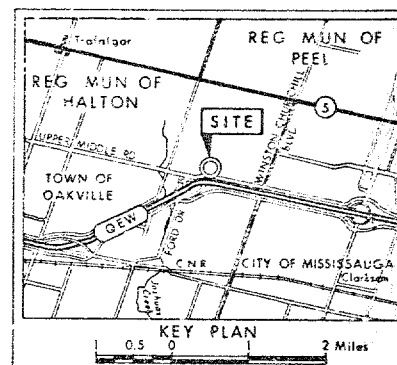
CONT No
WP No 159-75-07



PROPOSED EAST-N SOUTH RAMP

SHEET

BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊗ Bore Hole & Cone
- N Blows/ft (Std Pen Test, 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W L at time of investigation Mar 1977

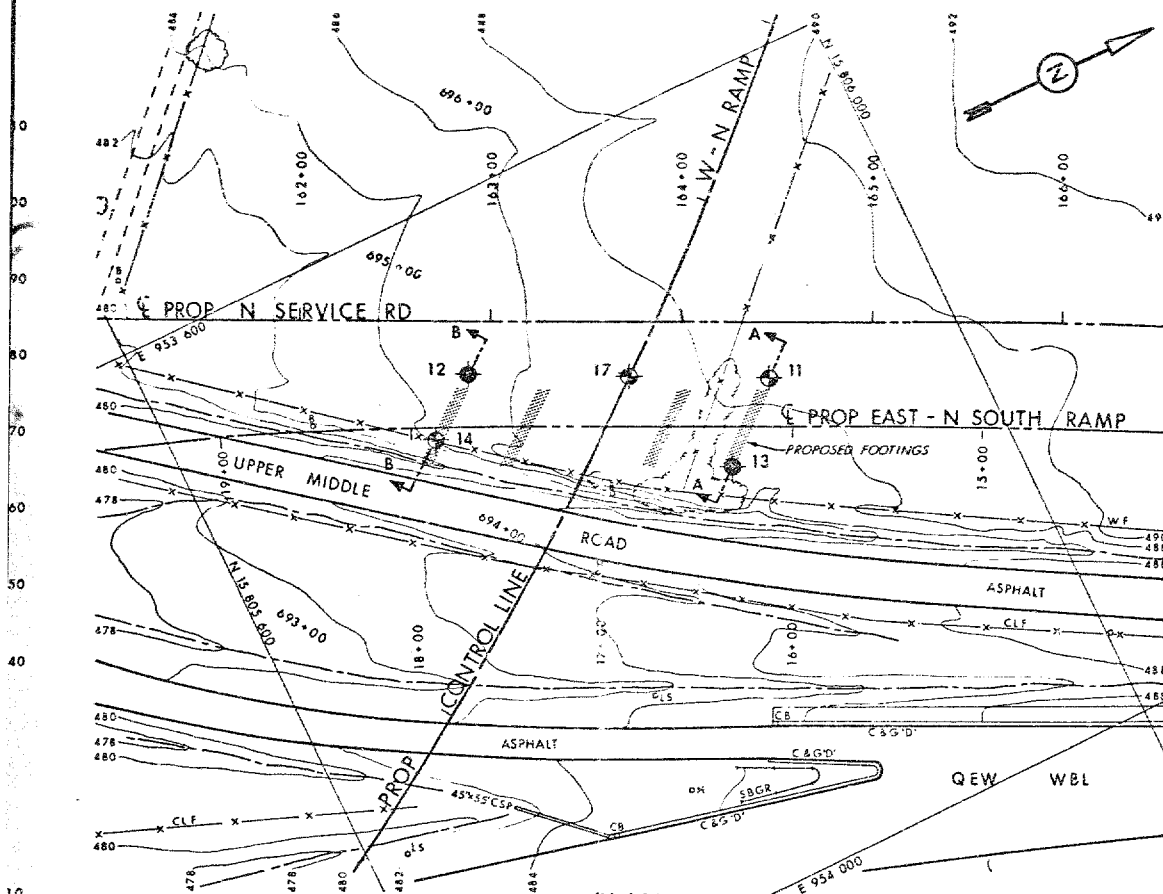
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
11	488.2	15 805 900	953 757
12	485.4	15 805 738	953 686
13	487.8	15 805 861	953 791
14	484.7	15 805 727	953 710
17	487.2	15 805 835	953 725

NOTE

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

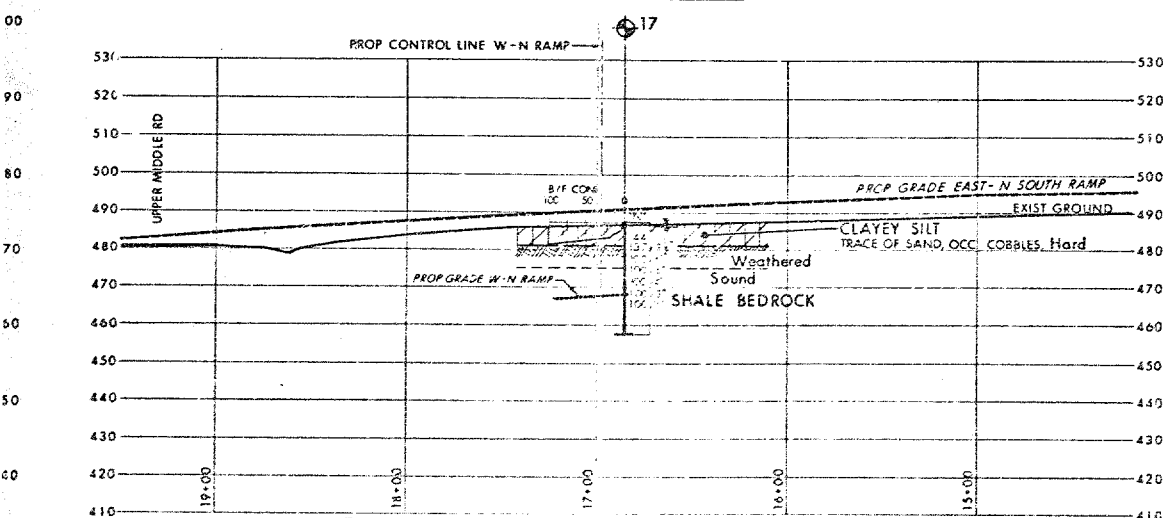
REVISION	DATE	BY	DESCRIPTION

AT NO 403 W-N RAMP
REV CT1 CHANGED TO 10/27/1977
DRAWN RS CHECKED
REF No B-82-QEW-2, Sept 1976



PLAN

0 SCALE 40 80



PROFILE - PROPOSED EAST-N SOUTH RAMP

HOR 40 0 SCALE 40 80 FT

VERT 20 0 20 40 FT



Memorandum

To: Mr. C. Mirza
Head, Soil Mechanics Section
West Building

From: R.A. Jeffries
Structural Section
3501 Dufferin Street

Attention:

Date: February 16, 1977

Our File Ref.

In Reply to

Subject: Re: Q.E.W./403/Ford Drive Interchange
Site 24 W.P. 159-75-05.
District 4

A new complex interchange connecting Q.E.W. to Highway 403 Link and to a re-aligned Ford Drive is presently scheduled for 1978. Due to the intricate staging that is required for this above-mentioned interchange and the adjacent and interconnected, Q.E.W./Winston Churchill Blvd. Interchange, the detour scheme necessary for the Q.E.W. traffic will require four structures to be constructed as an advance structure contract.

Also as part of this contract, additional structures (possibly twin cell box culverts) will be required to carry the Q.E.W. and associated ramps over Joshua Ck., possibly on a new alignment slightly north of the existing creekbed, this data will be submitted to your office when available.

Two structures will be required to carry Q.E.W. detour traffic, and ultimately Highway 403 W-N Ramp and N-W Ramp, over Ford Drive. Ford Drive will be relocated to the south and will be in cut, crossing under Q.E.W. At present single span structures, 3 lanes wide are proposed to carry Q.E.W. over Ford Dr.

A Third structure will be necessary to carry Highway 403 W-N Ramp over the North Service Rd.

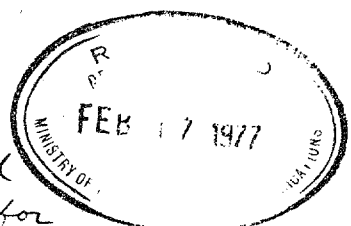
The fourth structure required to complete the detour staging will be Highway 403W-N Ramp over the E-N S Ramp.

Preliminary details of the proposed structure and roadway alignments are indicated on the enclosed plans.

These plans include:

Q.E.W./403/Ford Dr. Interchange sketch plan -- 1 copy
Ford Dr. Underpass at N-W Ramp --- 2 copies
Ford Dr. Underpass at W-N Ramp --- 2 copies
North Service Rd. Underpass at W-N Ramp and E-NS Ramp Underpass at W-N Ramp - 2 copies
Photographs

murty Please advise me when individual W.P.'s and site numbers are received for recording purposes. Also, please tell me if this should be recorded as 'one request or four and whether you consider this to be adequate to justify field work.



To complete the interchange to the extent shown on the sketch plan (ultimately two addition ramps may be constructed) at least 6 more structures are to be constructed. The Foundation request for these bridges will be submitted at a later date as part of the main Q.E.W./403/Ford Dr. contract.

Could you please prepare a Foundation Investigate Report of sufficient scope to facilitate the design of the proposed structure for each of the four structures.

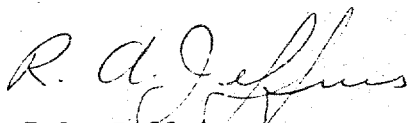
The current schedule calls for a complete Foundation Investigation for the first 4 structures, as follows:

first structure on April 20
second structure on May 4
third structure on May 18
fourth structure on June 1

Individual W.P.'s and Bridge Site No.s will be forwarded to your office as soon as they are assigned.

Should additional clarification and/or details be required, please do not hesitate to call this office.

RAJ:sg
attch:


R.A. Jeffries /
Structural Supervisor
for:
G.C.E. Burkhardt
Head, Structural Section

c,c, W.Roters
J. Anderson
R. Fitzgibbon

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 159-75-08

DIST 4

HWY QEW/Ford Drive/ STR SITE 10-282B
403

W-N Ramp Hwy. #403 under North Service Road

DISTRIBUTION

G.C.E. Burkhardt (3)

R.D. Gunter

M.R. Ernesaks

D.E. Thrasher (2)

C. Grebski

G.A. Wrong

B.J. Giroux

R.S. Pillar

R. Hore

R. Fitzgibbon }

J. Anderson }

G. Sloan }

Files }

cover only

SAMPLE DISPOSITION NOTICE

TYPE	DISCARD AFTER	RECOMM. BY
JARS	77 of 01	M.D.
TUBES	-	-
ROCK CORES	The remainder of contract	M.D.

FOUNDATION INVESTIGATION REPORT

For

W-N Ramp Hwy. #403 under North Service Road
QEW/Ford Drive/403 Interchange
W.P. 159-75-08, Site 10-282B
District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project during the period of March 24, 1977 to March 29, 1977. The fieldwork consisted of 5 sampled boreholes advanced by means of a continuous flight auger machine equipped with solid stem augers. In addition, diamond drilling techniques were employed to obtain BXL size core of the bedrock. The boreholes ranged in depth from 30 to 40 feet below the ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 1100 feet north of the existing Queen Elizabeth Way underpass at Ford Drive in the Town of Oakville, Regional Municipality of Halton. The land immediately adjacent to the site has a gentle rolling topography sloping down to the south. Drainage ditches excavated within the area have exposed the underlying red shale characteristic of the Queenston shale area. The land is developed for farming purposes.

Physiographically the site lies on the southern edge of the region referred to as the 'South Slope'. This region is a strip of land bounded by the Iroquois Plain on the south and the Peel Plain on the north extending from the Niagara escarpment to the Trent River. The region is characterized by a shallow till overlying shale of the Queenston and Dundas Formations of the Upper Ordovician age.

SUBSURFACE CONDITIONS

Generally uniform subsurface conditions were found to exist across the site. A 5 to 7 foot layer of clayey silt was found to overly shale

bedrock of the Queenston Formation. Detailed description of the various soil and rock types encountered in each borehole are given in the Record of Borehole Sheets. The estimated stratigraphical profile and sections shown on Drawing No. 1597508-A are based upon this information. From ground level downwards, the various soil types encountered are as follows:

Clayey Silt, Trace of Sand

Immediately below the natural ground level a cohesive stratum 5 to 7 feet thick consisting of clayey silt with traces of sand was encountered. The Standard Penetration Tests gave a 'N' value range of 22 to 82 blows/ft. Based on these 'N' values the consistency of this stratum is estimated to range from very stiff to hard.

The physical properties of the clayey silt as determined from laboratory testing are summarized below:

		<u>Range</u>	<u>Average</u>
Liquid Limit	(W_L) %	26-32	29
Plastic Limit	(W_p) %	14-20	17
Moisture Content	(W) %	8-14	12
Plasticity Index	I_p	10-14	12

The results of the Atterberg Limit tests are shown on the Plasticity Chart on Fig. 1. The Atterberg Limits indicate that the cohesive stratum is generally inorganic and of low plasticity.

Bedrock - Shale

Underlying the cohesive deposit is shale bedrock which was proven to a maximum depth of 34 feet. The bedrock can be described as soft, fine textured, red in colour, fissile having thin horizontal bedding planes with seams of limestone up to 6" thick. Generally, the upper 3 to 6 ft. of the shale bedrock is moderately weathered. However, in B.H. #9 in addition to the upper weathered zone two distinct bands of weathered shale were also encountered. These weathered zones extend from 14' to 16' 5" and 18' 2" to 21' 8" below the ground surface. A detailed description of the bedrock is given on the Record of Borehole Sheets.

The rock quality designation (RQD) classification gives an indication of the quality of the bedrock with respect to the number of fractures and amount of softening or alternation of the rock mass. The RQD is the total length of rock core pieces of 4 or more inches in length expressed as a percentage of the total length of core drilled. The RQD for the cored shale bedrock varies from 0 to 85%, indicating a rock quality ranging from very poor to good. Generally, the higher RQD values being measured at greater depths in the boreholes.

GROUNDWATER

The groundwater level conditions were observed by measuring in the open boreholes during and after the completion of the foundation investigation. The groundwater levels were found to vary between elevation 484.4 and 488.4 which corresponds to 1.0 to 1.5 feet below the existing ground surface. The groundwater levels are shown on the Record of Borehole Sheets as well as on Drawing No. 1597508-A.

DISCUSSION AND RECOMMENDATIONS

As part of the proposed new complex interchange connecting QEW to Hwy. 403 a structure will be required to carry Hwy. 403 W-N Ramp under the North Service Road.

In the vicinity of the proposed structure, the existing ground level is at about elevation 487. The proposed grade of the North Service Road will be at elevation 493 and the grade of the W-N Ramp is to be at elevation 470. This will necessitate fills of 6 ft. and cuts of about 17 ft.

A three span structure (38'-69'-38') with perched abutments and two centre piers are presently being considered for the structure carrying the North Service Road over the W-N Ramp.

Abutments Foundation

The abutments for the proposed structure can be supported on spread footings situated within the clayey silt stratum at or below elevation 482 for the west abutment and at or below elevation 485 for the east abutment. Footings so founded may be designed for a bearing pressure of up to 3.0 tons per square foot. In any case, the underside of the footing should be provided with at least 4 feet earth cover for frost protection requirements.

For estimating the earth pressure of granular backfill on the abutment walls a coefficient of active earth pressure of $K_a = 0.33$ may be used if some movement at the top of the wall is permitted. If no movement at the top of the wall is anticipated, a coefficient of earth pressure at rest $K_0 = 0.5$ may be used for design purposes.

To estimate the horizontal resistance to sliding between rough concrete and the clayey silt stratum, an adhesion value of up to 2000 psf may be used for design purposes.

In order to relieve the build up of hydrostatic pressures behind the abutment walls the structure should be backfilled with free draining granular material and provided with weepholes or other type of drainage conduit.

Pier Foundation

The proposed grades of the W-N Ramp will be such that the pier footings will be situated within the sound shale bedrock. Therefore, it is recommended that the piers be supported on spread footings designed for an allowable bearing pressure of up to 10 tons per square foot. Since the shale is frost susceptible, the underside of the footings should be provided with 4 feet of earth cover.

Other Considerations

To prevent softening of the shale bedrock due to weathering at the footing elevation, it should be covered with 3 inches of mass concrete immediately after the completion of the excavation.

No dewatering problems are anticipated for the construction of the abutment and pier footings. Any minor seepage or surface runoff into the excavations can be handled by pumping from sumps.

Approach Fill - North Service Road

For the North Service Road, approach fills of up to 6 feet in height will be required at the proposed structure. No slope stability problems are expected provided the slopes are constructed at 2:1 (horizontal:vertical).

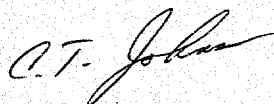
Cut - W-N Ramp

As mentioned previously, a cut of up to 17 feet will be necessary at the structure site in order to reach the profile grade of the proposed W-N Ramp of Hwy. 403. This cut will be made through the cohesive clayey silt and into the shale bedrock. The shale is susceptible to weathering and erosion, therefore, the cut should be treated as an earth cut and constructed with 2:1 slopes. It is further recommended that the cut slopes be covered with topsoil and sodded according to current MTC standards.

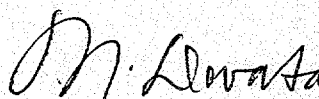
MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Mr. C.T. Johnson. The equipment used was owned and operated by Geocon Ltd., Toronto and Atcost, Ltd., Toronto.

This report was written by Mr. C.T. Johnson, Project Engineer and reviewed by Mt. M. Devata, Supervising Engineer.



C.T. Johnson
Project Engineer



M. Devata, P. Eng.
Supervising Engineer



MD/CTJ/bp
May, 1977

FOUNDATION REQUEST

In a memorandum dated February 16, 1977, Mr. G.C.E. Burkhardt, Head, Structural Section requested the Soil Mechanics Section to prepare a Foundation Investigation Report for the North Service Road Structure over W-N Ramp Hwy. #403.

FIELD AND LABORATORY INVESTIGATION PROCEDURES

A total of five boreholes four of which were accompanied with a dynamic penetration test were put down using a muskeg mounted auger machine equipped with solid stem augers and rock coring equipment.

The locations and elevations of the boreholes were surveyed by personnel from the Central Regional Surveys and Plans Section.

Disturbed soil samples were received by means of a 2 inch O.D. split spoon sampler driven in accordance with the specifications of the Standard Penetration Test. Rock core of the bedrock was obtained by coring with BXL diamond bits.

The samples were visually examined and identified in the field and again in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples of the cohesive stratum to determine the natural moisture content, Atterberg Limits and grain size distribution.

The rock core was examined and logged in detail in the laboratory by Mr. B.K. Glassford, Geologist.

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 9

WP 159-75-08

LOCATION Co-ords. N 15,805,939; E 953,723

ORIGINATED BY CTJ

DIST 4 HWY 403

BORING DATE March 29, 1977

COMPILED BY CTJ

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger; BXL core & Cone Test

CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
489.4	Ground Level															
0.0	Clayey silt, trace of sand		1	SS	82											
484.4	Hard, Red		2	SS	700	6"										
5.0																
479.4	(Weathered)					480										
10.0	(Sound)															
	Shale Bedrock		3	RC	100%											
	(Weathered)			BXL	Rec											
	(Weathered)		4	RC	100%	470										
	(Weathered)			BXL	Rec											
	* See below															
458.5			5	RC	100%	460										
				BXL	Rec											
30.9	End of Borehole															
	* Shale Bedrock, red colour, soft, fine texture, fissile with thin seams of limestone up to 6" thick, thin hori- zontal bedding															

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 10

WP 159-75-08

LOCATION Co-ords. N 15,805,795; E 953,656

ORIGINATED BY CTJ

DIST 4 HWY 403

BORING DATE March 24, 1977

COMPILED BY CTJ

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger; BXL Core & Cone Test

CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P W W_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
486.0	Ground Level									
0.0	Clayey silt, trace of sand. Very stiff to hard. Red		1	SS	22					0 5 67 28
479.0			2	SS	99					
7.0	Shale bedrock (weathered)		3	SS	140/10"					
474.0	(sound)		4	SS	100/4"					
12.0			5	SS	100/5"	470				
	Shale Bedrock, red colour, fine texture soft, fissile with thin seams of limestone up to 5" thick thin horizontal bedding.		6	SS	100/8"					
			7	BXL	60% Rec					RQD 0%
			8	RC	100% Rec	460				
			9	BXL	100% Rec					
456.0										
30.0	End of Borehole									

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 11

WP 159-75-08

LOCATION Co-ords. N 15,805,900; E 953,757

ORIGINATED BY CTJ

DIST 4 HWY 403

BORING DATE March 28, 1977

COMPILED BY CTJ

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger; BXL core & Cone Test

CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS % GR SA SI C
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100				w_p — w — w_L				
							SHEAR STRENGTH				WATER CONTENT %				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				10 20 30				
488.2	Ground Level					ELEV									
0.0	Clayey silt, trace of sand		1	FS	31	480									
482.2	Very stiff Red		2	SS	145/11"										
6.0	(Weathered)														
479.2	(Sound)														
9.0	Shale Bedrock		3	RC BXL	100% Rec										
	Shale Bedrock, red colour, fine texture soft, fissile, with interbedded thin seams of limestone up to 6" thick, thin horizontal bedding.	4	RC BXL	100% Rec											
		5	RC BXL	100% Rec											
448.4						450									
39.8	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 12

WP 159-75-08

LOCATION Co-ords. N 15,805,758; E 953,686

ORIGINATED BY CTJ

DIST 4 HWY 403

BORING DATE March 24, 1977

COMPILED BY CTJ

DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger; BXL core

CHECKED BY RS

SOIL PROFILE		STRAT. PLOT	SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	N' VALUES		20	40	60	80	100	W_P	W	W_L		
485.4	Ground Level															
0.0	Clayey silt, trace of sand															
479.4	Very stiff Red		1	SS	31											
6.0			2	SS	55	480										
			3	SS	100	481"										
473.4	(weathered)		4	SS	100	482"										
12.0	(sound)		5	SS	100	483"										
	Shale Bedrock					470										
	Shale Bedrock, red colour, fine texture soft, fissile with thin seams of limestone present, thin horizontal bedding		6	RC BXL	100% Rec	460										RQD 50%
			7	RC BXL	100% Rec											RQD 75%
452.7																
32.7	End of Borehole															

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 17

WP 159-75-08

LOCATION Co-ords. N 15,805,835; E 953,725

ORIGINATED BY CTJ

DIST 4 HWY 403

BORING DATE March 25, 1977

COMPILED BY CTJ

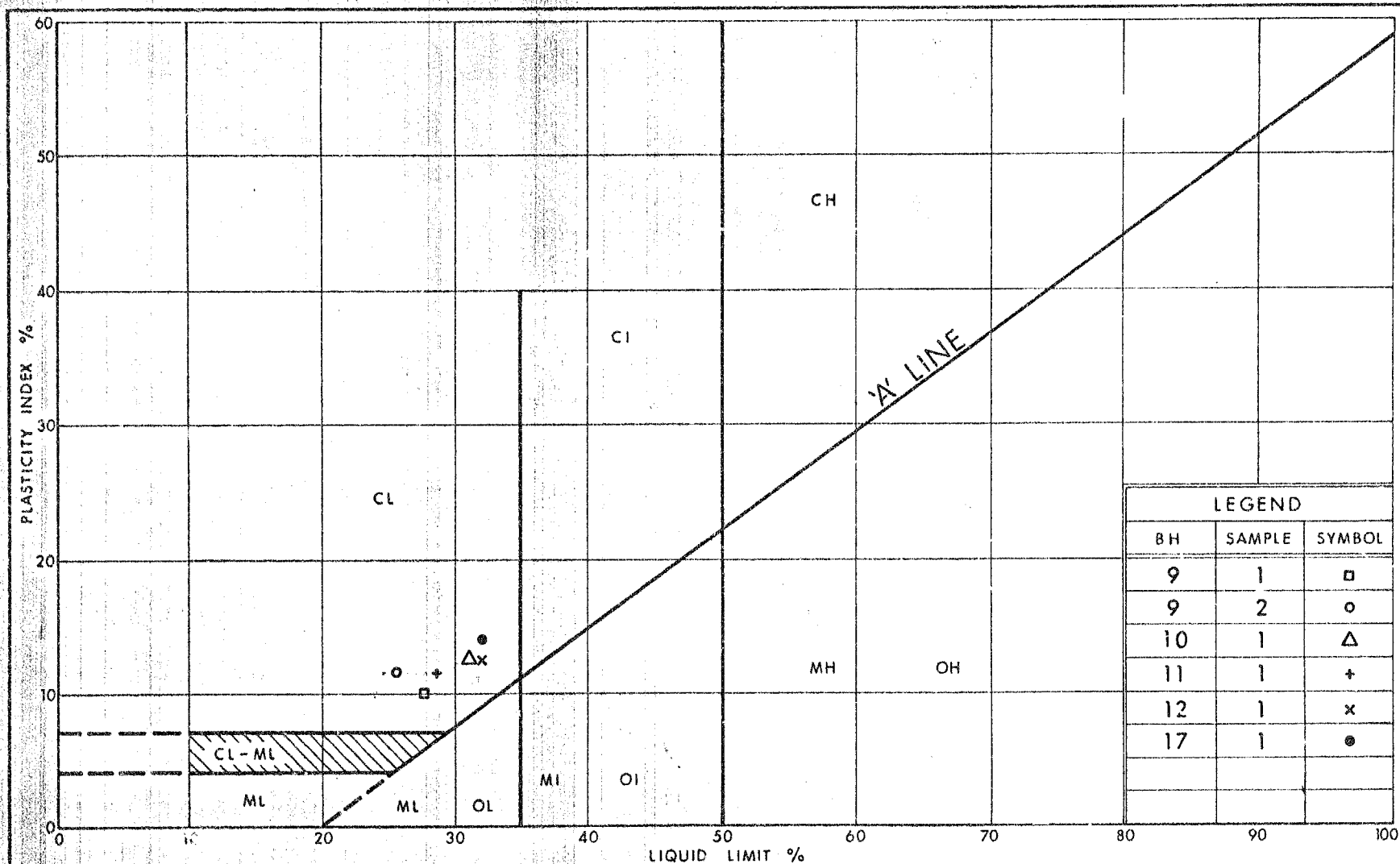
DATUM Geodetic

BOREHOLE TYPE Solid Stem Auger; BXL Core & Cone Test

CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100				w_p — w — w_L				
							SHEAR STRENGTH				WATER CONTENT %				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				10 20 30				
487.2	Ground Level					FLEV									
0.0	Clayey silt, trace of sand, occ. cobbles		1	SS	44	9 1/2"									
481.2	Hard Red		2	SS	137	6"	480								
6.0	Shale Bedrock		3	SS	100	6"									
475.2	(weathered)		4	SS	100	6"									
12.0	(sound)		5	SS	100	4"	470								
	Shale Bedrock, red colour, fine texture, soft fissile, bedding close to very close, interbedded with lime stone seams up to 6" thick, thin horizontal bedding.		6	SS	100	3"									
			7	SS	100	1"									
			8	RC BXL	100% Rec		460								RQD 40%
457.5		End of Borehole													
29.7															

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transportation and
Communications

PLASTICITY CHART
CLAYEY SILT
TRACE OF SAND

FIG No 1

W P 159 - 75 - 08

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

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

TERMS TO BE USED IN DESCRIBING SOILS:-

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

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W	THINWALL OPEN
W.S	WASHED SAMPLE	T.P	THINWALL PISTON
S.T	SLOTTED TUBE SAMPLE	OS	OESTERBERG SAMPLE
A.S	AUGER SAMPLE	FS	FOIL SAMPLE
CS	CHUNK SAMPLE	RC	ROCK CORE

P.H SAMPLE ADVANCED HYDRAULICALLY

P.M SAMPLE ADVANCED MANUALLY

SOIL TESTS

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

ABBREVIATIONS & SYMBOLS USED IN THIS 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
w_S	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
C_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

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

STRESS AND STRAIN

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

EARTH PRESSURE

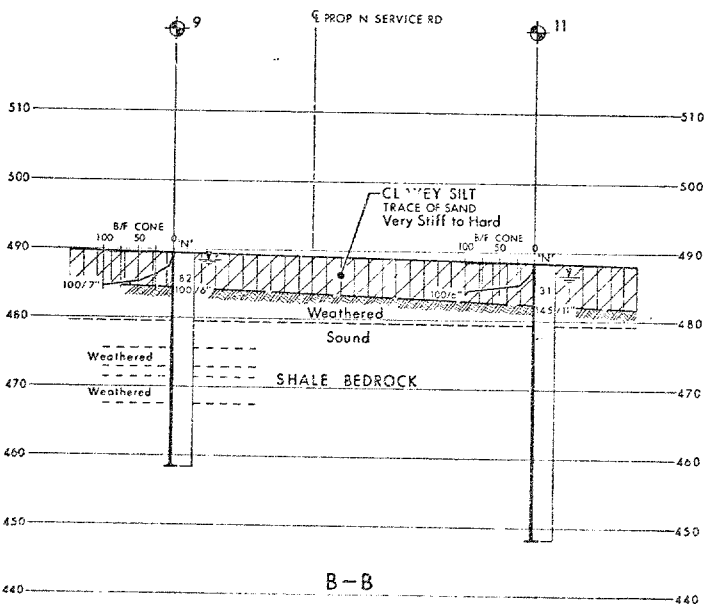
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

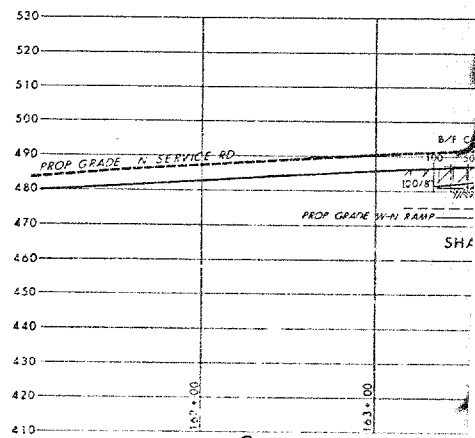
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

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



10 0 SCALE 10 20 FT



HOR 40
VERT 20

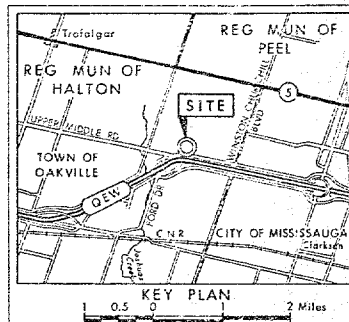
CONT No
WP No 159-75-08

PROPOSED NORTH SERVICE RD

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blow/ft (Std Pen Test 350 ft lbs energy)
- Cone Blow/ft (60° Cone, 250 ft lbs energy)
- WL at time of investigation Mar 1977

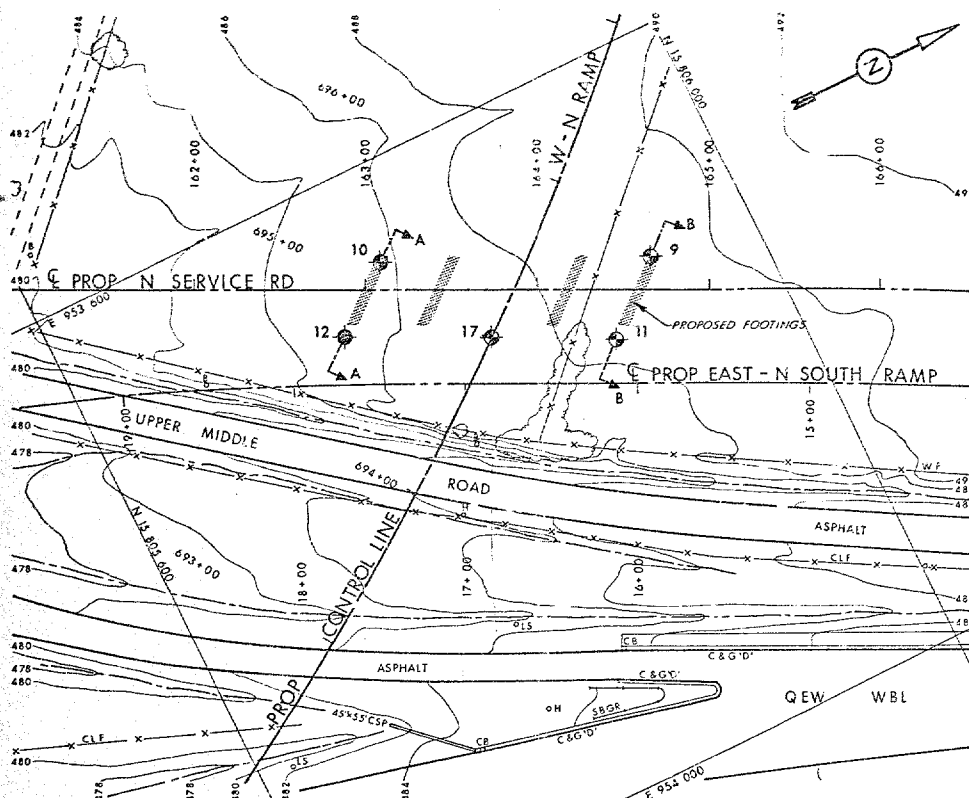
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
9	489.4	15 805 939	953 723
10	486.0	15 805 795	953 656
11	488.2	15 805 900	953 757
12	485.4	15 805 758	953 686
17	487.2	15 805 835	953 725

-NOTE-

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

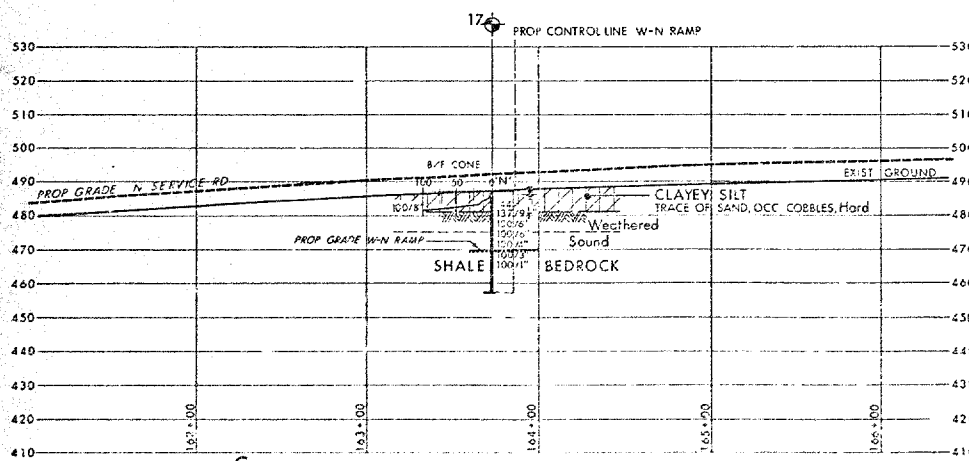
REVISIONS	DATE	BY	DESCRIPTION

REVISED: 403 W-N RAMP
CHECKED: C.J. WICKERT, DATE: May 25, 1977, SITE NO: 2828
DRAWN: R.S. (initials), SCALE: 1597508-A



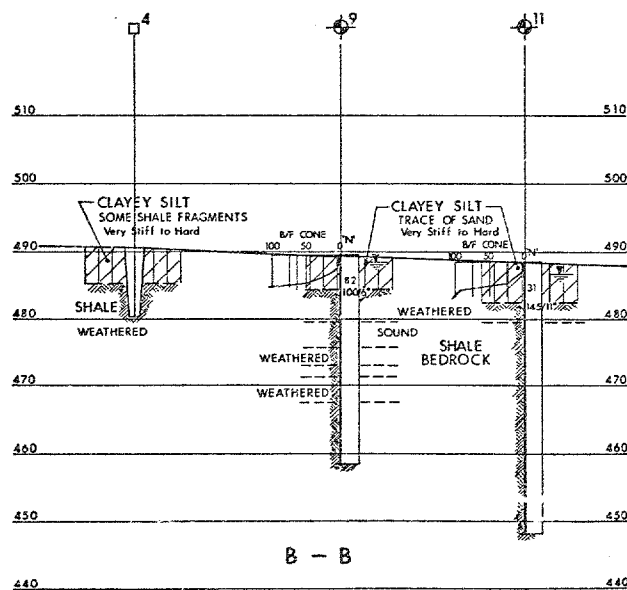
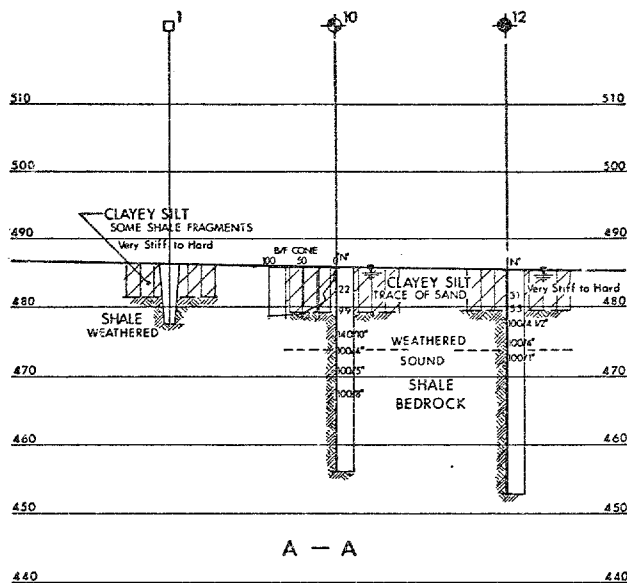
PLAN

0 SCALE 40 80



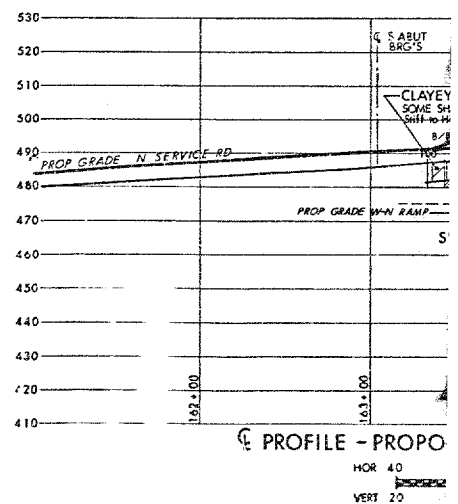
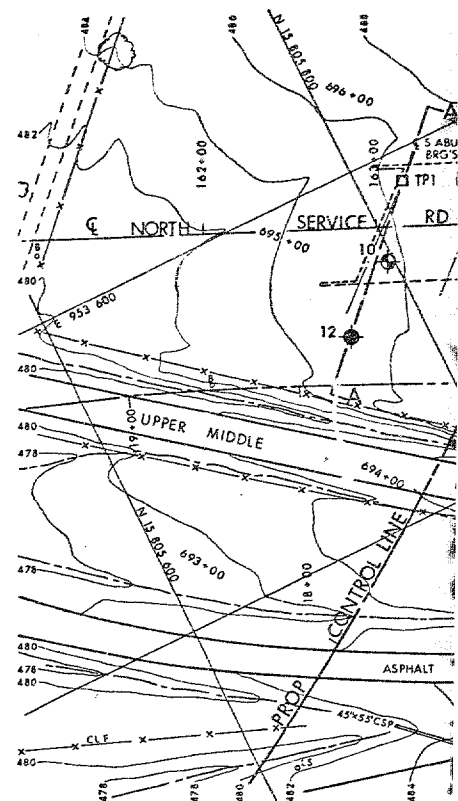
PROFILE - PROPOSED NORTH SERVICE ROAD

HOR 40 0 SCALE 40 80 FT
VERT 20 0 20 AC FT



SECTIONS

SCALE
 HOR 20 10 0 10 20 FT
 VERT 10 5 0 5 10

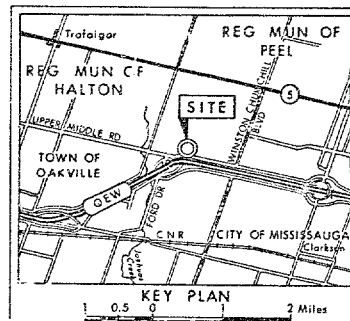


CONT No
WP No 159-75-08



W-N RAMP HWY 403 UNDER
NORTH SERVICE ROAD
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- Blows/ft (Std Pen Test 350 ft lbs energy)
- Cone Blows/ft (60" Cone, 350 ft lbs energy)
- WL at time of investigation Mar 1977
- TEST PITS

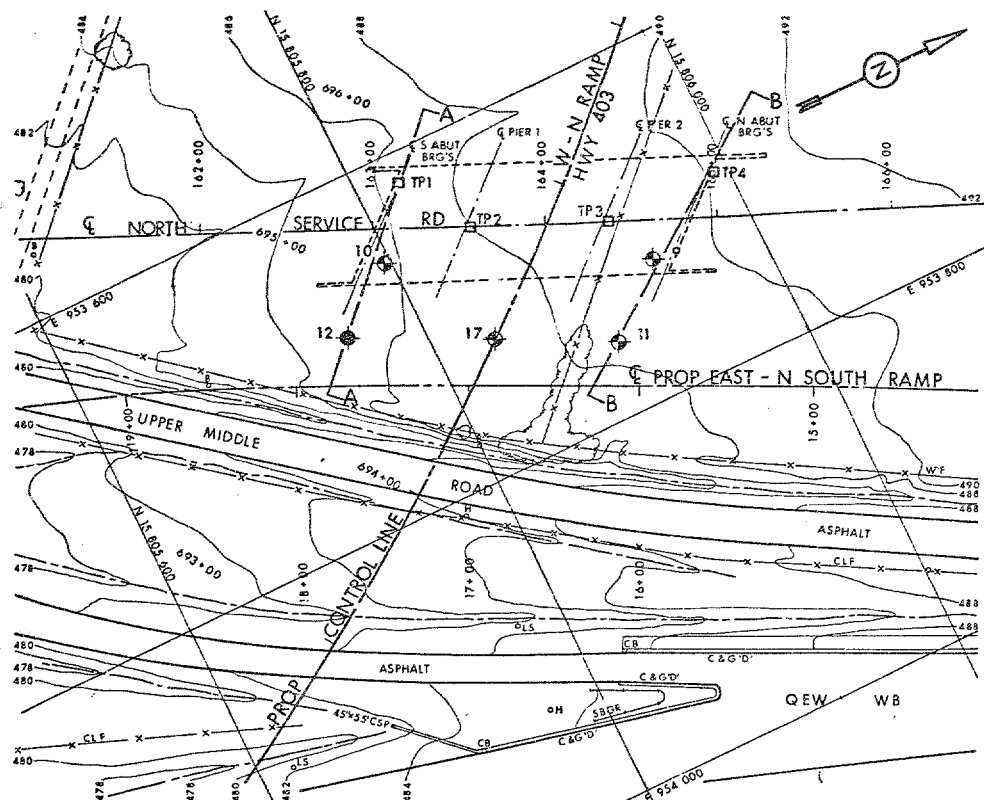
No	ELEVATION	CO-ORDINATES NORTH	EAST
9	489.4	15 805 939	953 723
10	486.0	15 805 795	953 656
11	488.2	15 805 900	953 751
12	485.4	15 805 758	953 686
17	487.2	15 805 635	953 725
TEST PITS			
1	486.6	15 805 823	953 618
2	487.9	15 805 848	953 659
3	489.2	15 805 923	953 694
4	490.3	15 805 992	953 693

-NOTE-

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

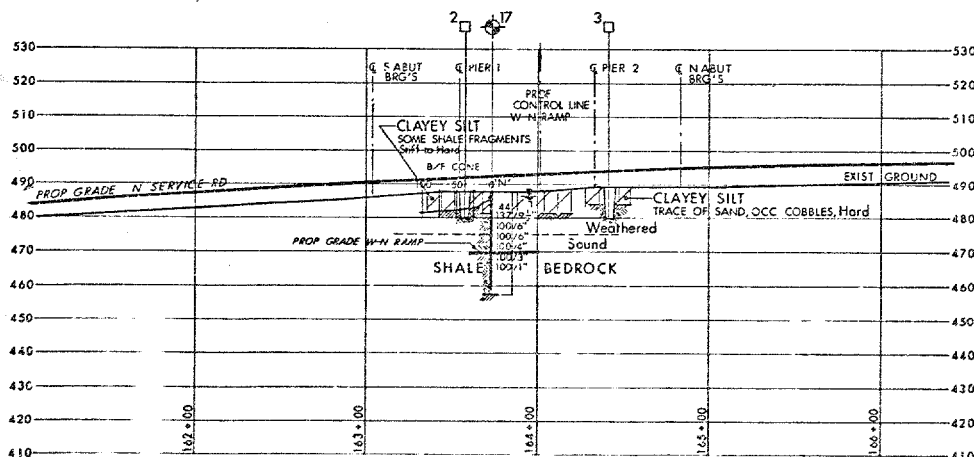
REVISIONS	DATE	DESCRIPTION
1	78 06 00	TEST PITS 1 TO 4 ADDED. SECTIONS REVISED

HWY No 403 W-N RAMP DIST 4
S.W.D. C.F. CHENIERE, DATE May 25, 1977, SITE 10-2828
DRAWN R.S. CHECKED M.A. APPROVED J.W. LONG 10-2828-2



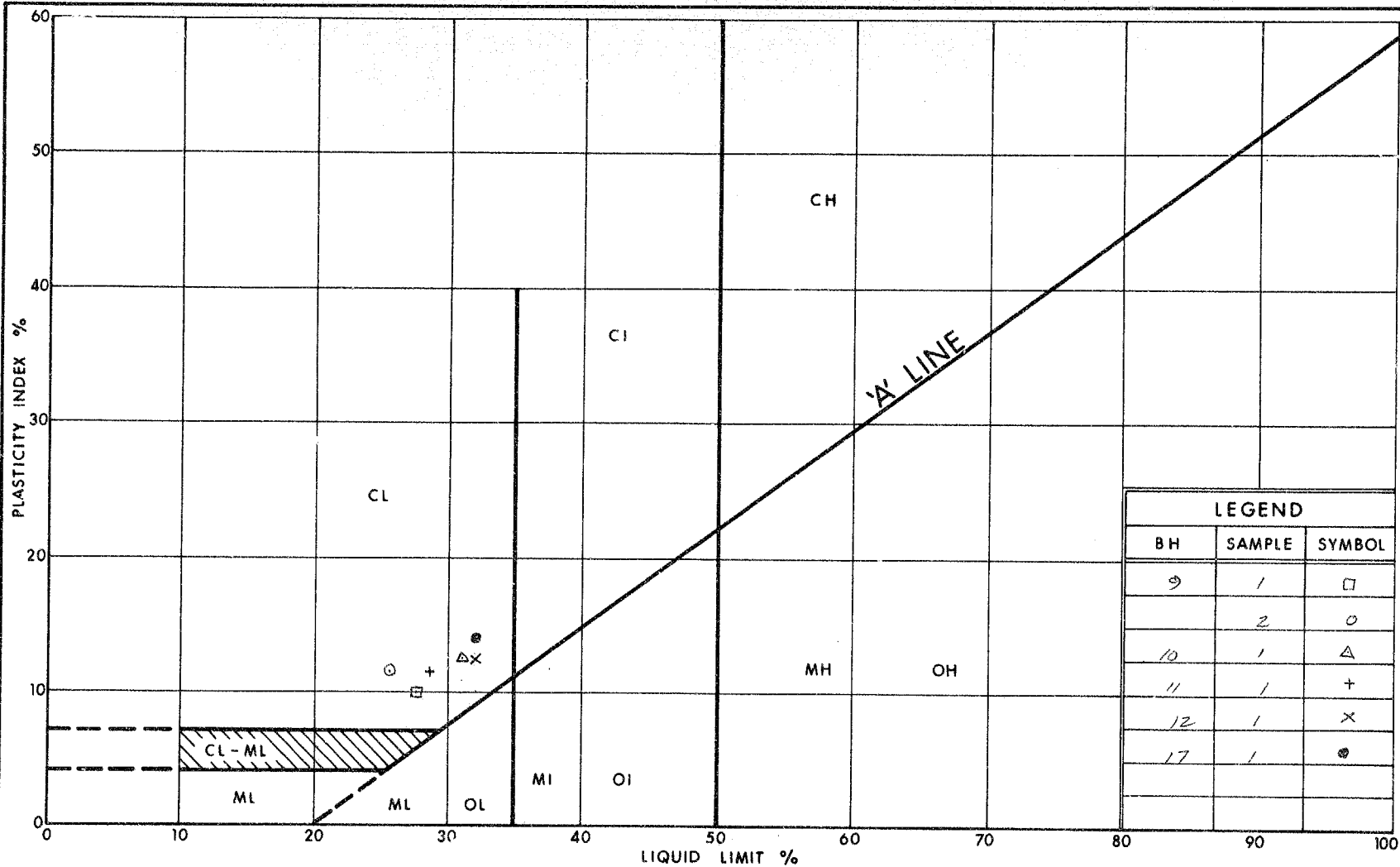
PLAN

0 SCALE 40 FT



PROFILE - PROPOSED NORTH SERVICE ROAD

HOR 0 SCALE 40 FT
VERT 20 0 20



Ontario

 Ministry of
Transportation and
Communications

ENGINEERING SERVICES BRANCH

PLASTICITY CHART

 CLAYEY SILT
TRACE OF SAND.

FIG No 1

W P 159-75-08



Memorandum

To: Mr. C.S. Grebski
Head, Central Section
Structural Office
West Building, Downsview

From: Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

Attention: Mr. W. Lin

Date: 78 06 09

Our File Ref.

In Reply to

Subject: Re: 'N Ramp, Hwy. 403 Underpass
North Service Road
W.P. 159-75-08, Site 10-282-B
District 4, Hamilton

Further to our memorandum of 78 04 10, we have now completed an additional investigation to determine the subsurface conditions at the new footing locations. In this additional investigation, four testpits were excavated by means of a backhoe. The locations and elevations of the testpits, together with our findings, are tabulated below:

<u>Testpit No.</u>	<u>Location</u>	<u>Elevation</u>	<u>Subsurface Conditions</u>
1	N 15805823 E 953618 (South Abutment)	486.6	0-5' very stiff reddish clayey silt with shale fragments 5-9' reddish weathered soft shale
2	N 15805848 E 953659 (South Pier)	487.9	0-5' very stiff reddish clayey silt with shale fragments 5-8.5' reddish weathered soft shale
3	N 15805923 E 953691 (North Pier)	489.2	0-5' very stiff reddish clayey silt with shale fragments 5-9.5' reddish weathered soft shale
4	N 15805992 E 953691 (North Abutment)	490.3	0-5.1' very stiff reddish clayey silt with shale fragments 5.1-10' reddish weathered soft shale

Based on this recent information, together with our previous subsurface data, we are satisfied with designs of the foundations as shown in Drawing No. 10-282B-1 and 3.

cont'd.....

The additional subsurface information will be included in our foundation report and subsoil strata drawing for contract purposes. This memorandum should be attached to our foundation report.

B. Ly
B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs

cc: G.C.E. Burkhardt (3)
R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

Files]

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 159-75-09

DIST 4

HWY 403

STR SITE 10-283

Q.E.W./Ford Drive/403 Link Interchange
N - W Ramp Highway 403 Over Ramp
E - N.S. and North Service Road

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

C. Grebski
G.A. Wrang
B.J. Giroux
R.S. Pillar

R. Hore

R. Fitzgibbon
J. Anderson
G. Sloan

Files ✓

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	78 01 15	MA
TUBES	—	—
ROCK CORES	Save full amount of core	MA

FOUNDATION INVESTIGATION REPORT

For

Q.E.W./Ford Drive/403 Link Interchange

N - W Ramp Highway 403 Over Ramp

E - N.S. and North Service Road

W.P. 159-75-09, Site 10-283

District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project during the period of Nov.9 and 10, 1977. The fieldwork consisted of 7 sampled boreholes advanced by means of a continuous flight auger machine equipped with 3¼" hollow stem augers. In addition, diamond drilling techniques were employed to obtain BXL size core of the bedrock. The boreholes ranged in depth from 10 to 20 ft. below the ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 500 feet north of the existing Queen Elizabeth Way underpass at Ford Drive in the Town of Oakville, Regional Municipality of Halton. The land immediately adjacent to the site has a gentle rolling topography sloping down to the south. Drainage ditches excavated within the area have exposed the underlying red Queenston shale. The land is developed for farming purposes.

Physiographically the site lies on the southern edge of the region referred to as the "South Slope". This region is a strip of land bounded by the Iroquois Plains on the south and the Peel Plains on the north. The region is characterized by glacial till overburden underlain by shale bedrock of Queenston and Dundas Formation of the Upper Ordovician age.

SUBSURFACE CONDITIONS

Subsurface conditions were found to be uniform across the site. A 5 to 10 foot thick layer of clayey silt is underlain by shale bedrock of the Queenston Formation. A detailed description of the various

soil and rock types encountered in each borehole is given in the Record of Borehole Sheets. The estimated stratigraphical profile and sections shown on Drawing No. 1597509-A are based upon this information. From ground level downwards, the various types encountered are as follows:

Clayey Silt With Some Sand and Occasional Gravel

Under a 12" thick layer of topsoil is a cohesive stratum of 5 to 10 feet thick deposit of clayey silt with some sand and occasional gravel. The Standard Penetration Tests gave "N" values in the range of 21 to over 100 blows per foot. Based on these "N" values the consistency of this cohesive stratum is estimated to be very stiff to hard.

The physical properties of the clayey silt as determined from laboratory testing are summarized below:

	<u>Range</u>
Liquid Limit (W_L) %	27 - 33
Plastic Limit (W_p) %	17 - 19
Moisture Content (W) %	9.5 - 15.5

The results of the Atterberg Limit tests are shown on the Plasticity Chart on Fig.1. The Atterberg Limits indicate that the cohesive stratum is generally inorganic and of low plasticity.

Bedrock - Shale

Underlying the cohesive deposit is shale bedrock which was proven to a maximum depth of 10 feet. The bedrock may be described as soft, red in colour and fissile, having thin horizontal bedding planes with seams of limestone up to 8" thick. Generally, the upper 6" to 12" of the shale bedrock is weathered. A detailed description of the bedrock is given on the Record of Borehole Sheets. The rock quality designation (RQD) for the cored shale bedrock varies from 0% to 50%, indicating a rock quality ranging poor to good.

Groundwater

The groundwater level conditions were observed by measuring in the open

boreholes during and after the completion of the foundation investigation. This groundwater level was found to vary between elevation 468.3 and 480.7 which corresponds to 2.0 to 3.5 feet below the existing ground surface. The groundwater levels are shown on the Record of Borehole Sheets, as well as on Drawing No. 1597509-A.

DISCUSSION AND RECOMMENDATIONS

As part of the proposed new complex interchange connecting Q.E.W. to Hwy.403,a new structure will be required to carry Hwy.403 N-W Ramp over E-N-S Ramp and North Service Road.

In the vicinity of the proposed structure, the existing ground elevation varies from 472.0 to 483.0. The proposed grade of the N-W Ramp elevation varies from 492.0 to 509.0 feet. This will require embankments 20 feet at the south side and 26 feet at the north side of the structure.

A four span structure (90'-150'-150'-90') with perched abutments and three center piers are presently being considered.

Piers

The shale bedrock at this site is 5 to 10 feet below the existing ground elevation. The three center piers designated as Piers 1,2 and 3 can be founded on shale bedrock at the following elevations:

	<u>Elevations</u>
Pier 1	464.0
Pier 2	470.0
Pier 3	476.0

Piers founded on spread footings at the above indicated elevations can be designed for 10 t.s.f. Since the shale is frost susceptible, the underside of the footings should be provided with 4 feet of earth cover for frost protection.

Other Considerations

To prevent softening of the shale bedrock due to weathering, the excavated base should be covered with a minimum of 3" of mass concrete immediately after the excavation.

No dewatering problems are anticipated for the construction of the foundations. Any minor seepage or surface runoff into the excavations can be handled by pumping from sumps.

Abutments

According to present proposals "perched" type abutments are contemplated. The abutments can be supported on a core of well compacted granular "A" fill material above the natural subsoil as per M.T.C. current practices. An allowable load of $2\frac{1}{2}$ t.s.f may be used for design purposes. All the topsoil should be removed to the full base width of the granular core. Alternatively, these perched abutments can be supported on end bearing piles driven to the shale bedrock. For example, a 12BP74 steel H pile driven to bedrock can be designed for a safe load of 95 tons per pile.

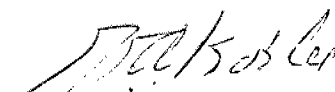
Approaches


The approach fills will be in the order of maximum 26 feet. No stability problems are anticipated for the proposed approach fills constructed with standard 2:1 slopes.

MISCELLANEOUS

The fieldwork was carried out during Nov.9 and 10, 1977 and supervised by Mr. V. Korlu, Project Engineer, who also prepared this report. The drilling equipment was owned and operated by Dominion Soils Limited of Toronto.

The report was reviewed by Mr. M. Devata, Supervising Engineer.


V. Korlu, P. Eng.
Project Engineer


M. Devata, P. Eng.
Supervising Engineer

MD/VK/eh

January 1978

APPENDIX

RECORD OF BOREHOLE No 1

W P 159-75-09 LOCATION Co-ords N 15 805 666; E 953 420 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" Hollow Stem Auger BXL Core COMPILED BY P.J.
 DATUM Geodetic DATE November 9th, 1977 CHECKED BY P.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
483.7	Ground Level													
0.0	Topsoil													
478.7	Clayey silt with traces of sand Hard		1	SS	46		480							0 6 76 18
5.0	Shale		2	BXL	100% Rec.									
473.7	Bedrock													
10.0	End of Borehole						470							
	Bedrock: Shale, Brown red colour, fine texture, soft, fissile - R.Q.D. 0%													

RECORD OF BOREHOLE No 2

W P 159-75-09 LOCATION Co-ords N 15 805 696; E 953 468 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3½" Hollow Stem Auger BXL Core COMPILED BY C.J.
 DATUM Geodetic DATE November 10th, 1977 CHECKED BY C.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
483.1	Ground Level													
0.0	Topsoil													
478.1	Clayey silt with trace of sand Hard		1	SS	50		480							0 2 74 24
5.0	Shale		2	BXL	100% Rec.									
473.1	Bedrock													
10.0	End of Borehole						470							
	Bedrock: Shale, brown red colour, fine texture, soft and fissile R.Q.D. 0%													

RECORD OF BOREHOLE No 3

W P 159-75-09 LOCATION Co-ords N 15 805 604; E 953 491 ORIGINATED BY V.K.
DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" Hollow Stem Auger BXL Core COMPILED BY *el.f.*
DATUM Geodetic DATE November 9th, 1977 CHECKED BY *el.f.*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
481.1	Ground Level																
0.0	Topsoil																
476.1	Clayey Silt with traces of sand Hard		1	SS	44		480										0 9 71 20
5.0	Shale		2	BXL	100% Rec.												
	Bedrock						470										
466.1																	
15.0	End of Borehole																
	Bedrock: Shale, brown red colour, with few thin beds of grey shale, fine texture, soft and fissile -R.Q.D. 0%																

RECORD OF BOREHOLE No 4

W P 159-75-09 LOCATION Co-ords N 15 805 464; E 953 561 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3 1/4" Hollow Stem Auger BXL Core COMPILED BY *el. J.*
 DATUM Geodetic DATE November 10th, 1977 CHECKED BY *el. J.*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
476.9	Ground Level																
0.0	Topsoil																
	Clayey silt with traces of sand		1	SS	32												0 3 72 25
469.9	Hard		2		95		470										
7.0	Shale with seams of shaly limestone		3	BXL	100% Rec.												
459.9	Bedrock						460										
17.0	End of Borehole																
	Bedrock: Shale, brown red colour, fine texture, soft and fissile. Shaly Limestone, light grey colour, fine texture medium hard to soft. R.Q.D. 0%																

RECORD OF BOREHOLE No 5

W P 159-75-09 LOCATION Co-ords N 15 805 333; E 953 616 ORIGINATED BY V.K.
DIST 4 HWY 403 BOREHOLE TYPE 3 1/4" Hollow Stem Auger BXL Core COMPILED BY *g.f.*
DATUM Geodetic DATE November 10th, 1977 CHECKED BY *g.f.*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
474.8	Ground Level																
0.0	Topsoil																
	Clayey Silt With Traces of Sand Very Stiff		1	SS	21		470										0 8 52 40
			2	SS	29												
464.3			3	SS	100												0 2 67 31
10.5	Shale With Seams of Shaly Limestone		4	BXL	100% Rec.		460										
	Bedrock																
454.3	End of Borehole																
20.5	Bedrock: Shale, brown red colour, fine texture, soft and fissile. Shaly limestone, light grey colour, medium hard to soft, medium texture R.Q.D.0%																



RECORD OF BOREHOLE No 6

W P 159-75-09 LOCATION Co-ords N 15 805 241; E 953 615 ORIGINATED BY V.K.
DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" Hollow Stem Auger BXL Core COMPILED BY V.J.
DATUM Geodetic DATE November 10th, 1977 CHECKED BY V.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
472.5	Ground Level													
0.0	Topsoil	~												
463.0	Clayey Silt With Some Sand and Gravel Very Stiff to Hard		1	SS	24		470							14 17 39 30
			2		58									
			3	SS	66/									
4	BXL	100% Rec.												
9.5	Weathered					9"								
457.5	Shale With Seams of Shaly Limestone Bedrock						460							
15.0	End of Borehole													
	Bedrock:													
	Shale, brown red colour, fine texture, soft and fissile. Shaly limestone, light grey colour, medium hard to soft, medium texture													
	R.Q.D.0%													

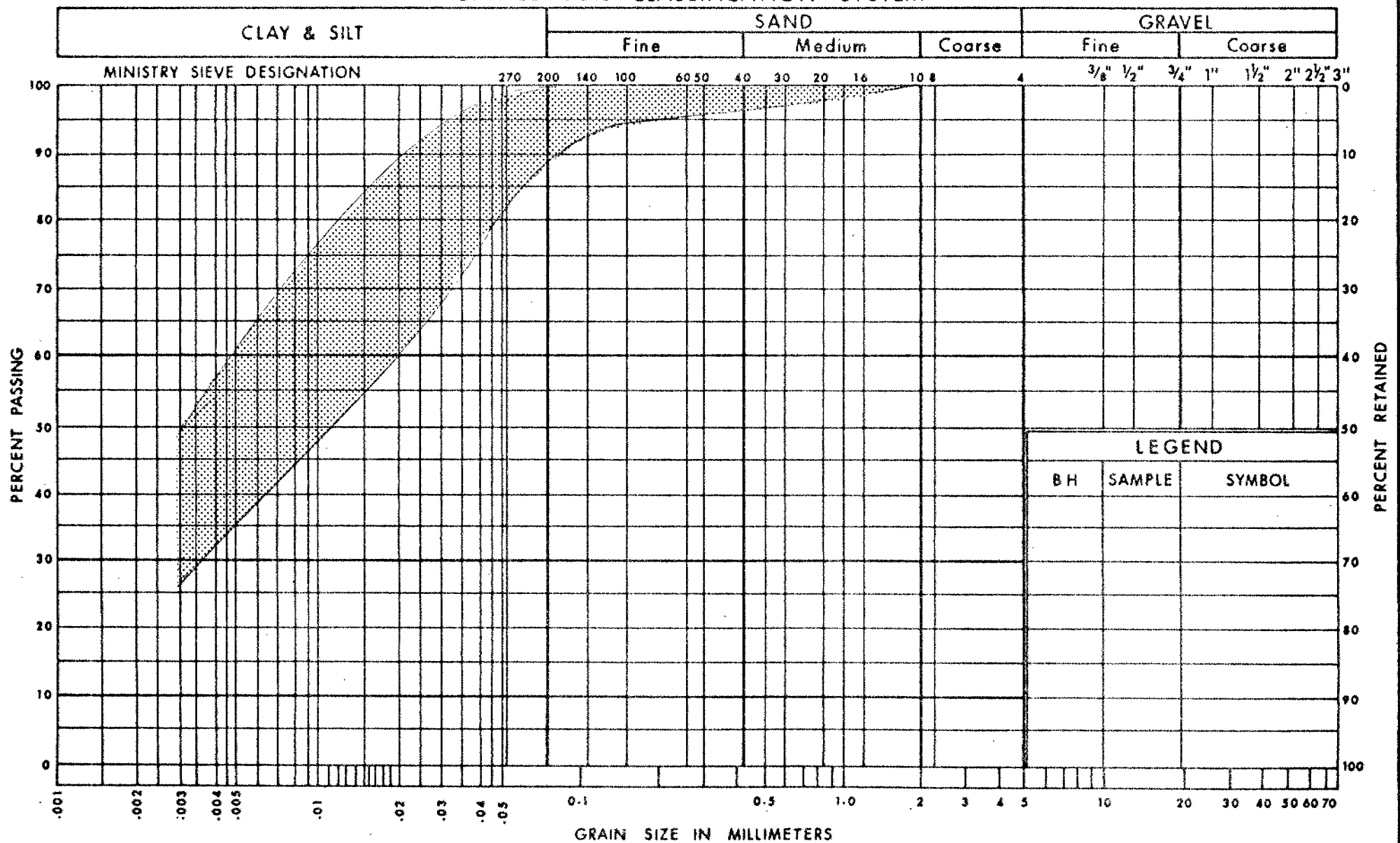


RECORD OF BOREHOLE No 7

W P 159-75-09 LOCATION Co-ords N 15 805 259; E 953 669 ORIGINATED BY V.K.
DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" Hollow Stem Auger BXL Core COMPILED BY S.I.
DATUM Geodetic DATE November 9th, 1977 CHECKED BY W.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		W _p	W	W _L		
471.8	Ground Level													
0.0	Topsoil						470							
	Clayey Silt With Traces of Sand		1	SS	32									
	Hard		2	SS	40									
462.8	Weathered		3	SS	50/	5"								
9.0	Shale With Seams of Shaly Limestone		4	BXL	100% Rec.		460							
457.3	Bedrock													
14.5	End of Borehole													
	Bedrock:													
	Shale, brown red colour, fine texture, soft and fissile. Shaly limestone, light grey colour, fine texture, medium hard to soft, shale R.Q.D.0% limestone R.Q.D.50%													

UNIFIED SOIL CLASSIFICATION SYSTEM

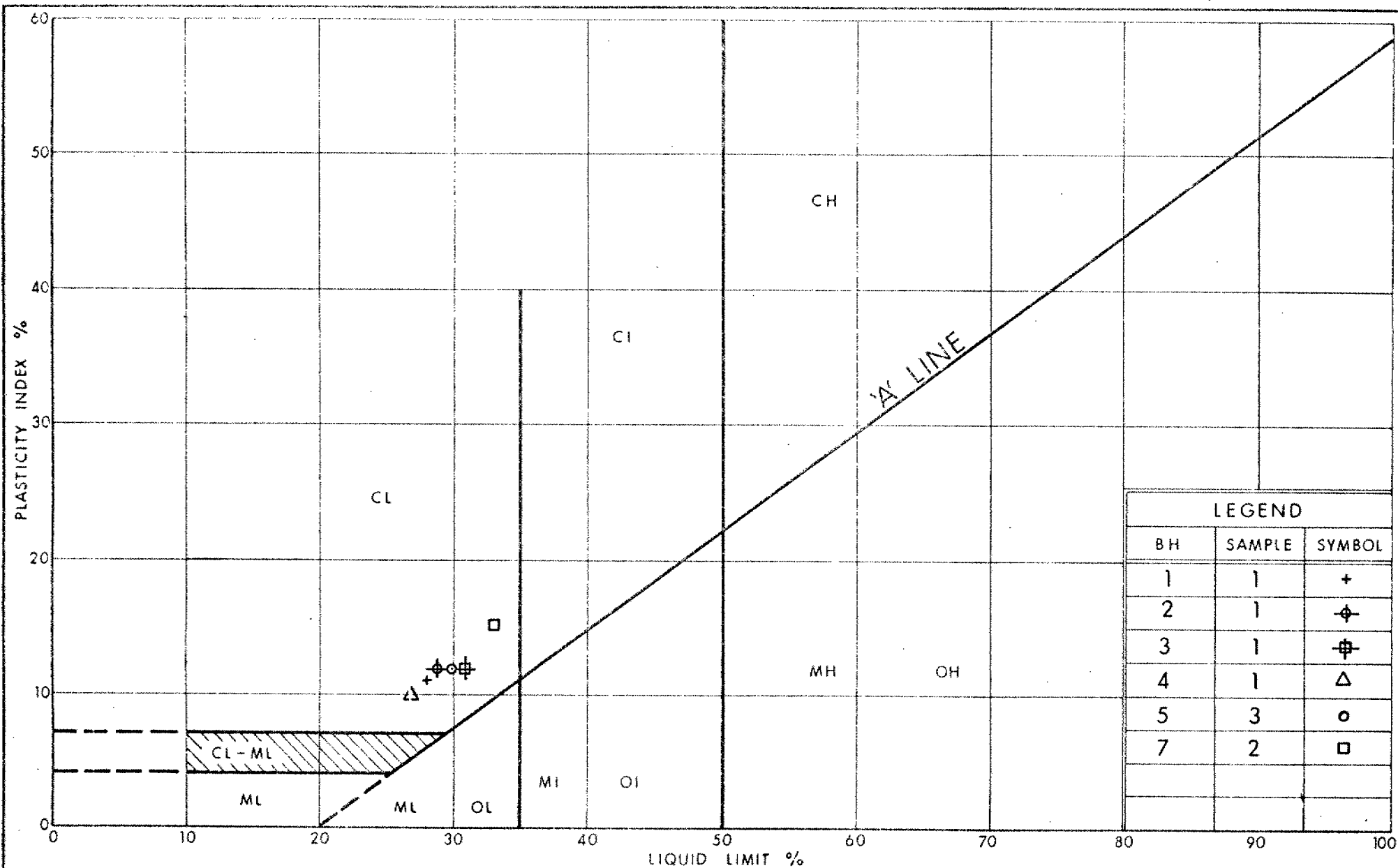


Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
WITH TRACES OF SAND

FIG No 1

W P 159-75-09



Ontario

Ministry of
Transportation and
Communications

PLASTICITY CHART CLAYEY SILT WITH TRACES OF SAND

FIG No 2

W P 159-75-09

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $C\bar{U}$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c, N_{γ} BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w_L - w_p$
 I_L LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
 A_c ACTIVITY = $\frac{I_p \text{ of soil}}{I_p \text{ of } 2\mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

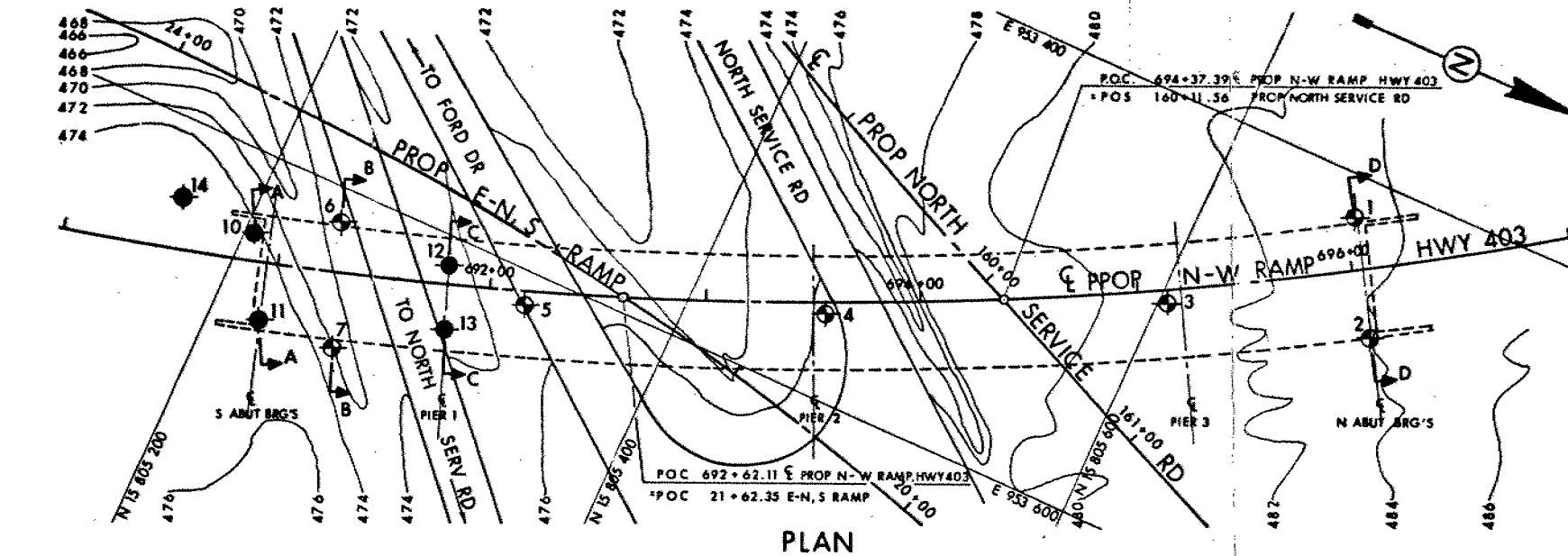
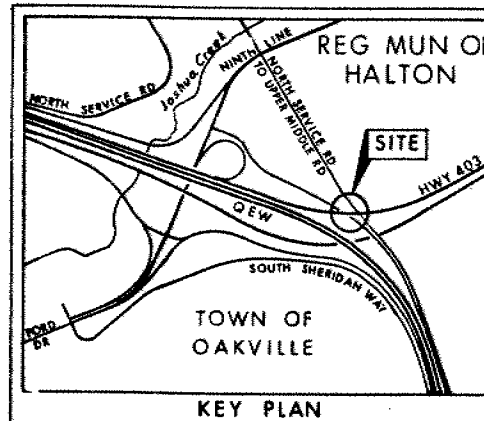
NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

CONT No
WP No 159-75-09



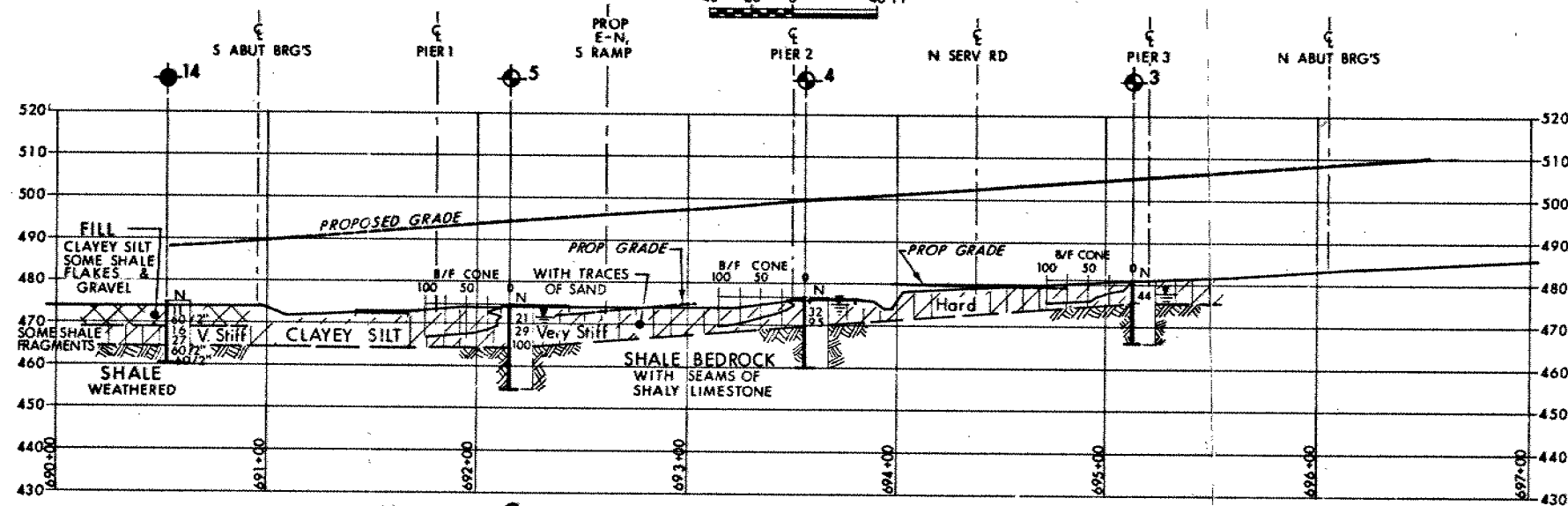
N-W RAMP HWY 403 OVER
E-N, S RAMP & NORTH SERVICE RD
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



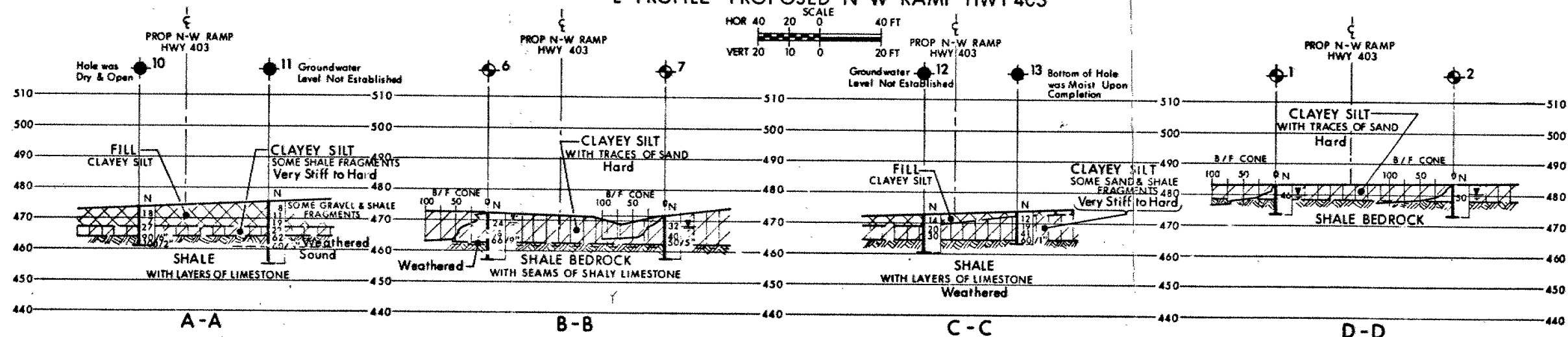
PLAN

SCALE
40 20 0 20 40 FT



PROFILE - PROPOSED N-W RAMP HWY 403

SCALE
HOR 40 20 0 20 40 FT
VERT 20 10 0 10 20 FT



SECTIONS

SCALE
20 10 0 10 20 FT

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- "N" Blows/ft (Std Pen Test 350ft lbs energy)
- CONE Blows/ft (60° Cone, 350ft lbs energy)
- W.L. at time of investigation Nov 1977, W.L. for B.H. 14 see RECORD OF BOREHOLE

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	483.7	15 805 666	953 420
2	483.1	15 805 696	953 468
3	481.1	15 805 604	953 491
4	476.9	15 805 464	953 561
5	474.8	15 805 333	953 616
6	472.5	15 805 241	953 615
7	471.8	15 805 259	953 669
10	474.0	15 805 302	953 640
11	475.7	15 805 221	953 671
12	472.9	15 805 291	953 612
13	473.9	15 805 302	953 640
14	476.0	15 805 165	953 634

NOV 1977

OCT 1978

NOTE

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

REVISIONS	DATE	BY	DESCRIPTION

GEORES No 30 MS - 114

HWY No 403	CHECKED	DATE APR 25, 1979	SITE 10-283
SUBM'D & L	CHECKED	APPROVED	DWG 10-283-2

REF No DWG 10-283-1, May 1978



Memorandum

To: Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

From: Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

Attention:

Date: 78 11 07

Our File Ref.

In Reply to

Subject: Re: Addendum to Foundation Investigation and
Design Report for N-W Ramp, Hwy. 403 Over E-N,S Ramp
and Upper Middle Road, QEW/Ford Drive/Hwy. 403 Link
Interchange, Site 10-283, W.P. 159-75-09
District #4, Hamilton

A foundation investigation and design report for the above mentioned structure was submitted by the Soil Mechanics Section on 78 01 12. The Preliminary Bridge Plan Drawing (10-283-P1) submitted to us indicates that the south abutment and Pier #1 have been relocated approximately 35 feet southerly from the original proposal. Further, it was recently proposed by the Regional Structural Section that a 60 foot long retaining wall would be constructed on the west side of the south abutment in order to retain the approach fills from encroaching on the future E-N,S Ramp. In view of this, it was decided that an additional investigation would be carried out to obtain subsurface data for the design and construction of the relocated footings and the retaining wall.

The additional investigation was carried out during the period of October 16 to October 17, 1978 consisting of five sampled boreholes (B.H. 10 to B.H. 14 inclusive). A sketch showing the location and elevation of the borings, together with Record of Borehole Sheets, are attached to this memorandum. A revised drawing incorporating the additional subsurface data will be submitted at a later date. This recent investigation revealed that in the vicinity of the retaining wall and the new footing locations, the site is underlain by a layer of cohesive earth fill, followed by a deposit of clayey silt and then by shale bedrock. The fill has a thickness ranging from 1.5 feet to 8.5 feet and is composed of local clayey silt subsoil. Based on the 'N' values which vary from 7 blows/foot to 19 blows/foot, it is inferred that the fill was relatively uniformly compacted. The clayey silt stratum is between 2.5 feet to 7.5 feet thick. The cohesive subsoil is reddish in color and has a very stiff to hard consistency. Reference should be made to the foundation report for a detailed description of the clayey silt. Bedrock is a soft, fissile, fine textured red shale with occasional limestone bands. The upper 4 feet of the bedrock was found to be weathered.

cont'd.....

Based on the subsurface conditions our recommendations are as follows.

Pier #1

The footings should be founded in shale bedrock at or below elevation 464.0. In such a case the footings can be designed for an allowable bearing pressure of 5 tsf. The shale is frost susceptible, therefore, the underside of the footings should have a minimum of 4 feet of earth cover for frost protection purposes. To prevent softening of the shale after it is exposed by excavation, a 3" mass concrete slab should be cast immediately after the footing formation surface is reached. No major de-watering problems are anticipated for the construction of the foundations.

South Abutment

The south abutment footing should also be founded within the shale bedrock at or below elevation 464.0 and designed for a bearing capacity of 5 tsf. If it is desirable to reduce the height of the abutment the footing founding level can be raised by supporting the spread footings on a well compacted Granular 'A' pad placed on the clayey silt stratum at elevation 466. In such a case a bearing capacity of 2.5 tsf can be assumed for design purposes. The underside of the abutment footings should also have a minimum of 4 feet of earth cover for frost protection purposes regardless of which foundation scheme is adopted.

Retaining Wall

The type of retaining wall has not been finalized at this stage. If a concrete cantilever retaining wall is adopted, it can be supported on spread footings founded either within the clayey silt at or below elevation 468.0 or on a well compacted granular 'A' pad placed on the natural undisturbed ground. For either foundation scheme, a bearing capacity of 2.5 tsf can be assumed. Alternatively, the retaining structure can be constructed of reinforced earth or interlocking bins. If such a scheme is adopted this Section will provide pertinent recommendations.

It should be noted that this memorandum, together with the enclosed borehole logsheets, should be attached to and read in conjunction with our foundation report for this project. If we can be of any further help to you, please contact us.

B. Ly
B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs
Attach.

cc: G.C.E. Burkhardt	D.E. Thrasher	R.S. Pillar
R.D. Gunter	G.A. Wrong	R. Hore
M.R. Ernesaks	B.J. Giroux	Files✓



Memorandum

To: Mr. C. Mirza,
Head,
Soils Mechanics Section,
Central Building, Downsview.

From: G.C.E. Burkhardt,
Structural Section,
Central Region.

Attention:

Date: 1978-10-11

Our File Ref.

In Reply to

Subject: RE: N-W Ramp Hwy. 403 Over E-N,S Ramp
& Upper Middle Road,
Q.E.W./Ford Drive/Highway 403 Link Interchange,
Site 10-283, W.P. 159-75-09,
District 4

Please note the following revisions to the site plan (new site plan attached) and the addition of a 60' retaining wall required at the end of the southwest wingwall of the above mentioned structure.

Revisions of the site plan contains the following points:

1. Change in name from North Service Road to Upper Middle Road. The name of the road changes just to east of the structure, this section will be called the Upper Middle Road and should be revised on drawings and correspondence.
2. Complete new horizontal and vertical alignments of Upper Middle Road.
3. Typical cross-sections.
4. Superelevation attaining at Upper Middle Road.

These changes are associated with the Upper Middle Road revised design.

Additional Retaining Wall:

On the south approach of this structure the high fill of the N-W Ramp Highway 403 interferes with E-N,S Ramp cut grading, and therefore it is desirable to design a retaining wall on the left side of the south abutment. The length of retaining wall would be approximately 60' starting at Sta. 690+15⁺. A sketch showing the location is attached.

Could you please provide the Structural Office with sufficient data to enable them to design this additional retaining wall.

RAJ:gj
Attach.

c.c. W. Roters
R. Fitzgibbon

R. A. Jeffries
R.A. Jeffries,
Structural Supervisor,
for:
G.C.E. Burkhardt,
Head, Structural Section.

Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

Mr. W.L. Lin

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

78 07 24

Re: N-W Ramp Hwy. 403 Over
E-N, S Ramp and North Service Road
W.P. 159-75-09, Site 10-283
District 4, Hamilton

We have reviewed the Preliminary Bridge Plan Drawing (10-283-P1).
Our comments are as follows:

It appears from your preliminary structure drawing that there is a considerable revision with regard to the location of the south abutment and Pier #1. The revised location is approximately 35 feet southerly from the original proposal. A shift of this nature should have been notified to this Section so that additional investigation or revised recommendations could have been provided.

It should be noted that the bedrock at the site is sloping and furthermore, the upper portion of the overburden contains organic material and softened zones. In order to provide necessary comments with regard to structure foundations and related earthworks, additional borings will have to be carried out. A structure with an estimated cost of \$1,067,000 should be designed with appropriate factual data. Therefore, this Section will carry out the necessary additional field investigation in order to provide relevant comments pertaining to foundation requirements. This investigation will be undertaken in the near future.

The granular 'A' core used to support the north abutment footing should have a horizontal clearance of 10 feet around the perimeter of the footing.

B. Ly
B. Ly
Senior Engineer

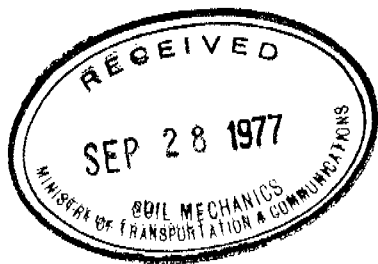
For: M. Devata
Supervising Engineer

BL/MD/gs

cc: G.C.E. Burkhardt
Files ✓

G.I.-30 SEPT. 1976

GEOCRES No. 30M5-114DIST. 4 REGION W.P. No. 159-75-01CONT. No. 79-80W. O. No. STR. SITE No. 10-283HWY. No. 403LOCATION N-W. RampNo of PAGES -=====OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



North Service Road looking west
towards N-W Ramp Hwy. 403 alignment

SITE 10-283



Looking west along Joshua Creek towards
W-N Ramp alignment

SITE 10-283

G.I.-30 SEPT. 1976

GEOCRES No. 30M5-114DIST. 4 REGION W.P. No. 159-75-09CONT. No. 79-80W. O. No. STR. SITE No. 10-283HWY. No. 403LOCATION Q.E. W./Ford Drive/403
Link InterchangeNo of PAGES - =====OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

GENERAL NOTES

CLASS OF CONCRETE
 DECK & PIER COLUMNS - 5000 PSI
 BARRIER WALLS - 4000 PSI
 REMAINDER - 3000 PSI

CLEAR COVER TO REINFORCING STEEL
 DECK: TOP - 2" BOTTOM - 1 1/2"
 COLUMNS: - 2 1/2"
 FOOTINGS AND ABUTMENTS - 3"
 REMAINDER - AS NOTED

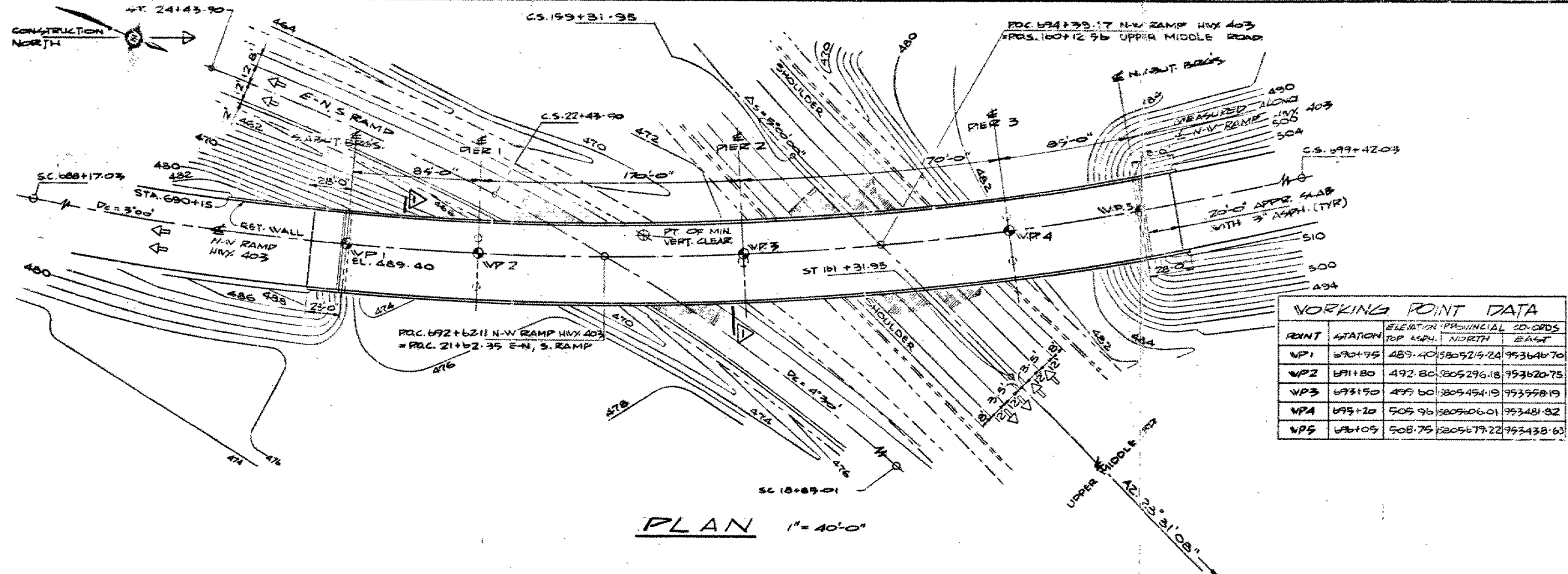
GRADE OF REINFORCING STEEL
 400
 REINF. BARS WITH THE DESIGNATION 'C' AT THE END OF BAR MARKS SHALL BE COATED BARS.

CONSTRUCTION NOTES
 THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF $\pm 1/8"$
 NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED, SET-LED AND CURED.

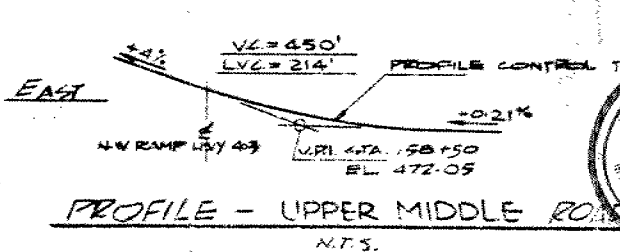
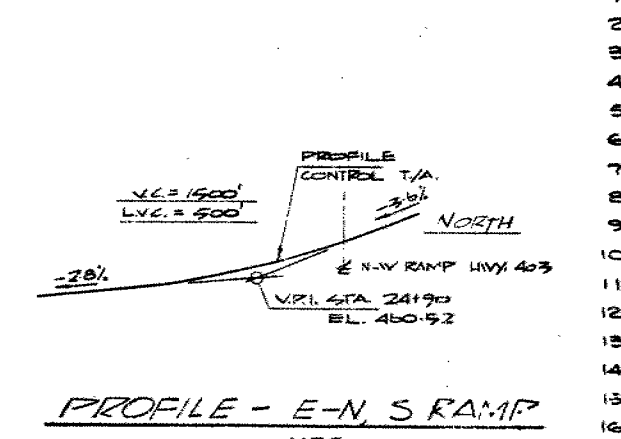
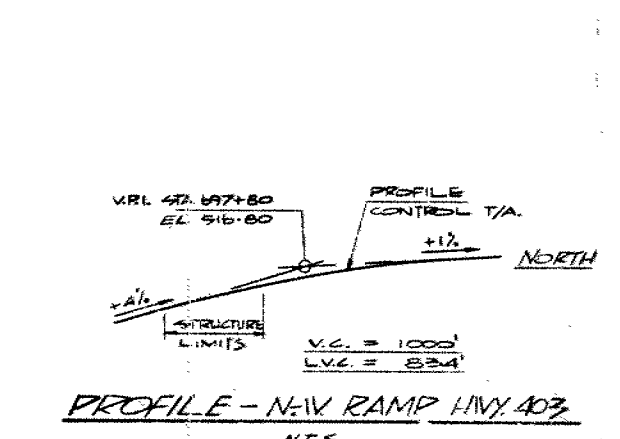
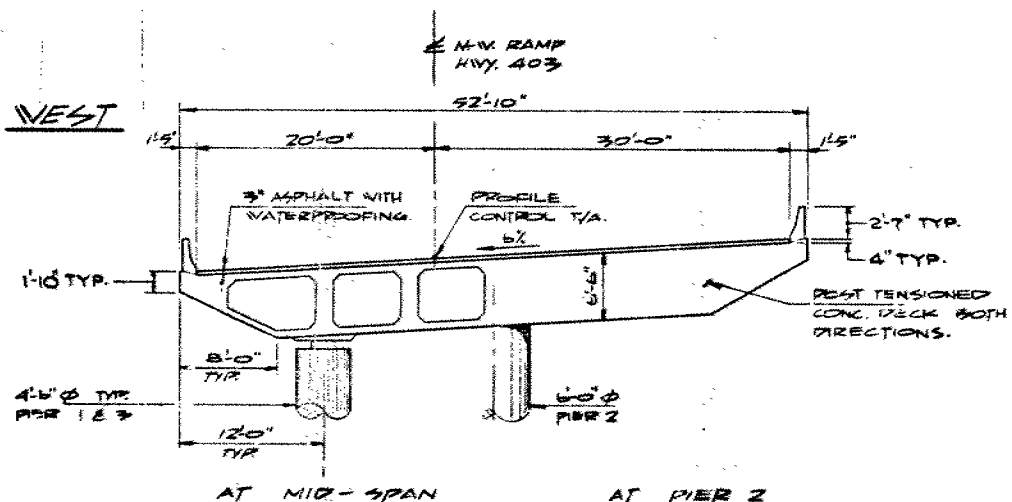
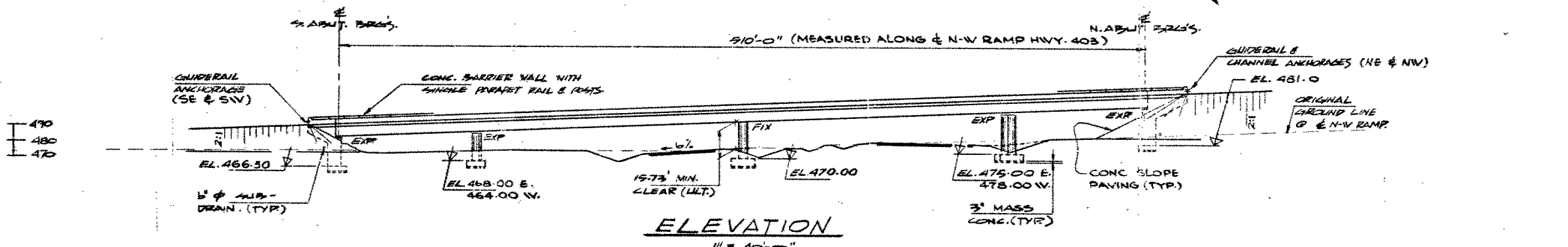
TO ACHIEVE THE MIN. CLEAR COVER OF 2" SPECIFIED, THE TOP LAYER OF DECK STEEL SHALL BE PLACED PRIOR TO CONCRETING WITH A CLEAR COVER OF $2 1/2" \pm 1/2"$ TOLERANCE.

LIST OF DRAWINGS

- GENERAL DRAWING
- BORE HOLE LOCATIONS & SOIL STRATA
- FOOTING DETAILS
- SOUTH ABUTMENT AND WINGWALLS
- NORTH ABUTMENT AND WINGWALLS
- RETAINING WALL
- PIER DETAILS
- DECK DETAILS
- TRANSV. CABLE DETAILS
- LONGIT. CABLE DETAILS
- DECK REINFORCING
- BARRIER WALL I
- BARRIER WALL II
- STEEL RAILINGS (SINGLE TUBE)
- 20 FT APPROACH SLAB
- DETAILS OF CONC SLOPE PAVING
- AS CONSTRUCTED ELEV & DIM
- STANDARD DETAILS - I
- STANDARD DETAILS - II

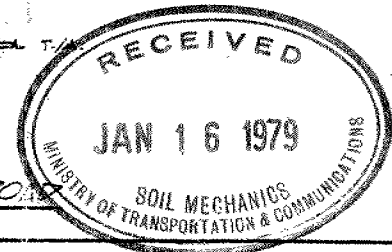


WORKING POINT DATA				
POINT	STATION	ELEVATION	PROVINCIAL CO-ORDS	
			NORTH	EAST
VP1	690+75	489.40	5305219.24	95364070
VP2	691+80	492.80	5305296.18	95362075
VP3	693+50	499.60	5305494.19	95359819
VP4	695+20	505.96	5305606.01	95348182
VP5	696+05	508.75	5305679.22	95343863



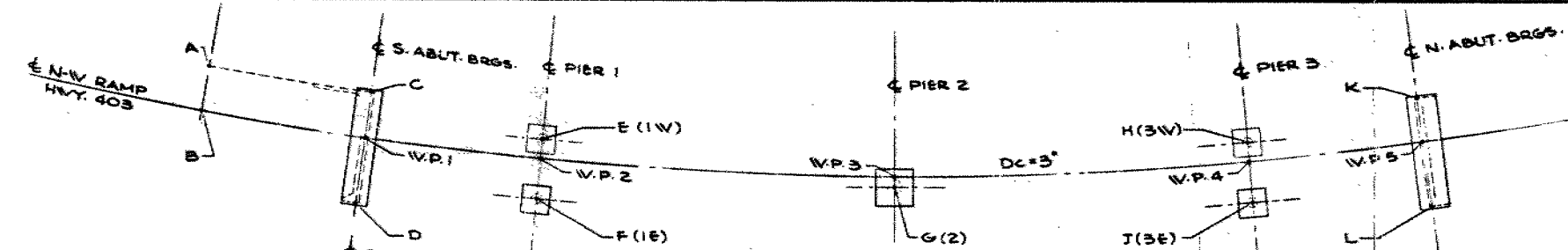
B.M. ELEV. 472.83
 TOP OF N.E. CORNER OF CONCRETE PORCH ON N. FACE OF HOUSE
 520' LT., STA. 551+90 Q.E.W.

NOTE
 PIER COLUMN IS INTEGRAL WITH DECK AT PIER 2.



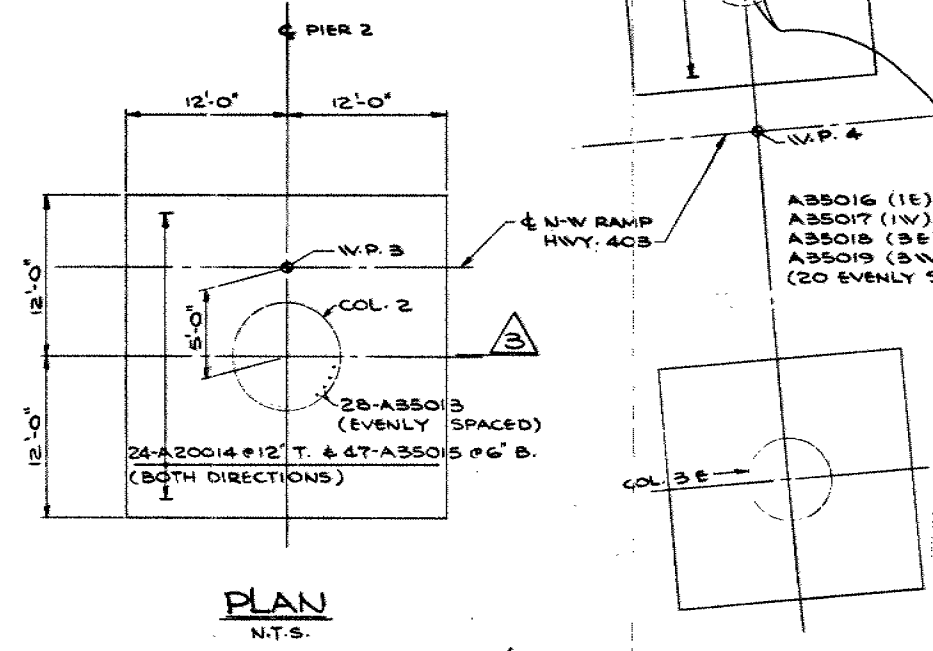
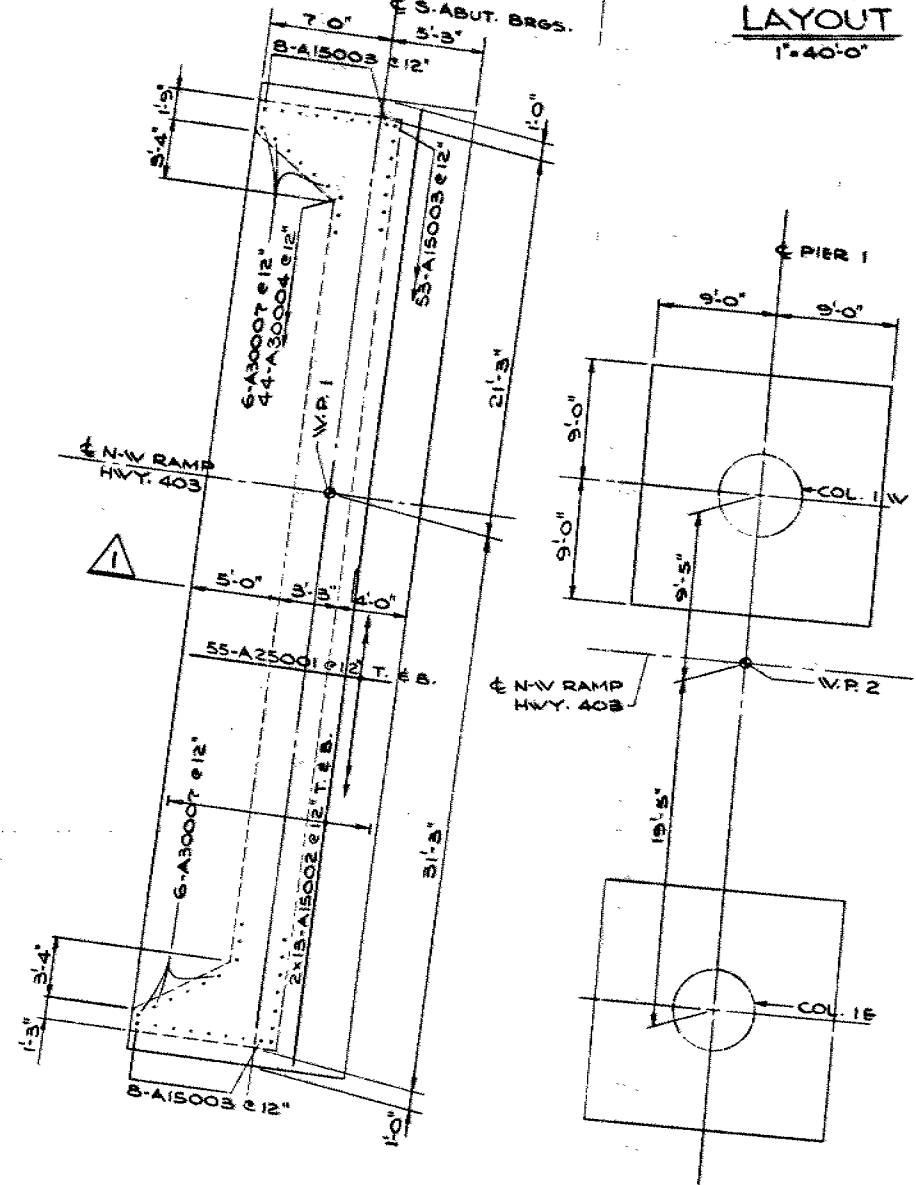
FOR REDUCED PLAN
 USE SCALE BELOW
 3 INCHES ON ORIGINAL PLAN

REVISIONS	DATE	BY	CHECK	DESCRIPTION	DATE	BY	CHECK	DESCRIPTION
1				DESIGN				
2				DRAWING				

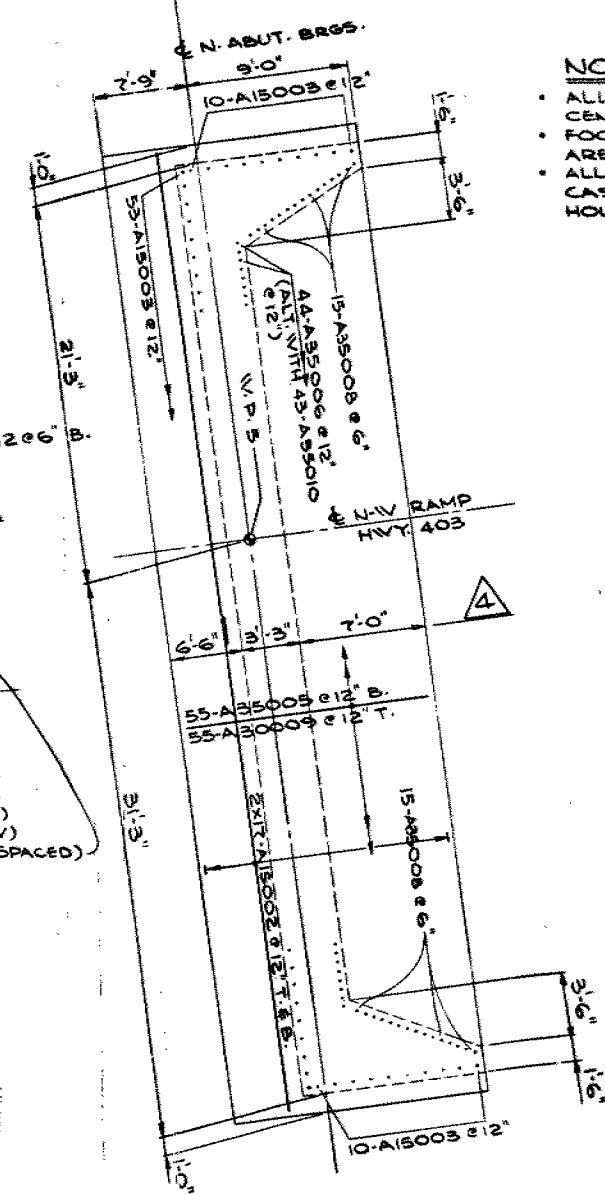


LAYOUT
1"=40'-0"

POINT	STATION	COORDINATES	
		N	E
A		15805132.91	953647.20
B	693+15	15805138.08	953667.81
C		15805209.21	953626.33
V.P. 1	690+95	15805215.24	953646.70
D		15805224.12	953676.67
E		15805293.10	953611.85
V.P. 2	691+80	15805296.18	953620.75
F		15805302.52	953639.11
V.P. 3	693+50	15805454.19	953558.19
G		15805456.23	953562.75
H		15805601.40	953473.61
V.P. 4	695+20	15805606.01	953481.82
J		15805615.50	953498.77
K		15805668.02	953420.59
V.P. 5	696+05	15805679.22	953438.65
L		15805695.69	953465.21

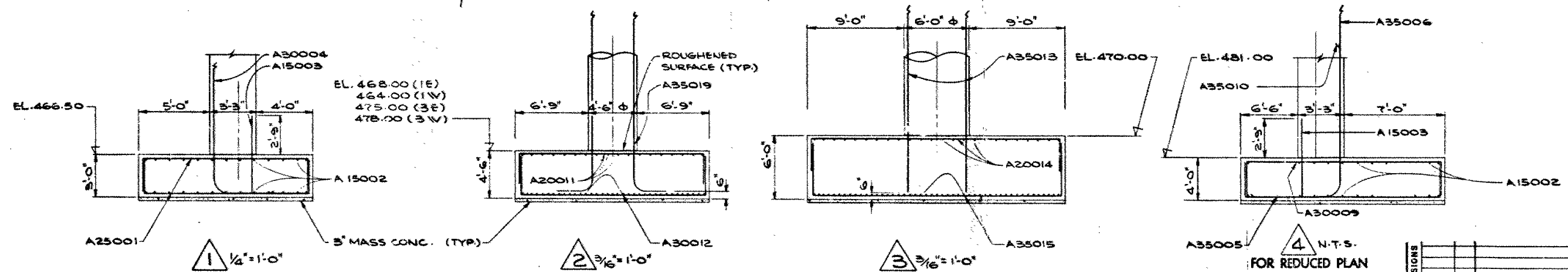


PLAN
N.T.S.



NOTES:

- ALL DIMENSIONS ALONG CENTRE LINES ARE RADIAL.
- FOOTINGS OF PIER 1 & PIER 3 ARE SIMILAR EXCEPT NOTED.
- ALL MASS CONCRETE TO BE CAST ON BEDROCK WITHIN 3 HOURS AFTER EXCAVATION.



FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION
DESIGN		CHECK	LOADING HS 20-44
DRAWING		CHECK	SITE No 10-25 DWG 5

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 159-75-06

DIST 4

HWY QEW

STR SITE 10-284

W-N Ramp Hwy. 403 Under QEW

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SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	78-02-20	1248
TUBES	—	—
ROCK CORES	(Contract Award)	1248

FOUNDATION INVESTIGATION REPORT

For

W-N Ramp Hwy. 403 Under QEW
W.P. 159-75-06, Site 10-284
QEW, District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out for the above project. It is based on 8 sampled boreholes advanced with a truck mounted CME55 auger during the period December 14 to 22, 1977. Solid stem augers were employed to auger through the overburden and into the shale bedrock. In the 4 boreholes adjacent to the planned pier locations casing was set in the rock and BXL or NXL size rock core samples were obtained.

SITE DESCRIPTION

The site is located on the QEW some 900 feet north of the existing Ford Drive underpass structure. At this location the QEW has 2 degrees of curvature and consists of 6 traffic lanes plus paved median and shoulders. This general area has a gentle slope to the south and west toward Joshua Creek. Land use is in transition from being predominantly agricultural to being residential and industrial.

SUBSURFACE CONDITIONS

Overburden consists of a 7 to 8 foot layer of silty clay. It has a very stiff to hard consistency with Standard Penetration 'N' values ranging from 14 to in excess of 40 blows per foot. Moisture content decreases from about 24 percent near the surface to less than 15 percent at the contact with the shale.

The silty clay overburden is underlain by shale bedrock of the Queenston formation. It is generally red to greyish red in colour but does contain grey green bands of shaley limestone which are usually less than a foot in thickness. The upper 10 to 15 feet of shale is soft and weathered with occasional hard bands consisting chiefly of the green shaley limestone. In particular the upper 5 to 7 feet has an altered texture which is less fissile than the lower layers. The shale below this upper weathered zone (shale more than 22 feet from the ground surface) is generally hard and fissile but does contain soft and weathered zones. More detailed descriptions, as well as recovery percentages and RQD values are included on the log sheets.

Groundwater levels were recorded in several of the open boreholes during the period of the fieldwork. They indicate a groundwater level about 7 feet below the ground surface.

DESIGN CONSIDERATIONS

Proposal

The proposed scheme calls for the QEW to remain at approximately its existing grade and to pass over a depressed W-N Ramp of Hwy. 403. The twin structures carrying the QEW will have spans of 80, 135 and 80 feet.

Recommendations

Spread footings: The proposed structures should be supported on spread footings in the shale bedrock. The pier footings will be founded approximately 30 feet below the ground surface in the relatively sound shale bedrock. They may be designed with loads of up to 10 tons per square foot. The abutment footings will be located approximately 15 to 20 feet below the ground surface in shale bedrock exhibiting considerable softening and weathering. The design load for the abutment footings should, therefore, not exceed 5 tons per square foot. To prevent deterioration of the shale bedrock on exposure to air and water the footing bases should be covered by 6 inches of mass concrete within 3 hours of the excavation reaching grade. Any soft shale encountered at the footing grade should be excavated and replaced by mass concrete.

Frost protection: The underside of the footings should be provided with 4 feet of cover to prevent deterioration of the shale due to frost action.

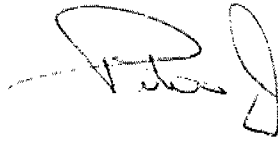
Dewatering: No serious dewatering problems are anticipated. Any seepage water should be removed by pumping from sumps.

MISCELLANEOUS

Resistance of the footing to sliding on the shale bedrock should be calculated using a coefficient of friction of 0.4. Further resistance to sliding should be achieved by placing dowels in the bedrock.

The abutment walls should be backfilled with free draining granular material with weep holes provided to prevent buildup of hydrostatic pressure.

All cut slopes in the shale bedrock should be made at 2 horizontal to 1 vertical and treated in the same manner as cut slopes in earth.



P. Stuart, P. Eng.
Project Engineer



K.G. Selby, P. Eng.
Supervising Engineer

February, 1978

APPENDIX

RECORD OF BOREHOLE No 1

W P 159-75-06 LOCATION N 15 805 696 E 953 919 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger COMPILED BY P.J.S.
 DATUM Geodetic DATE December 22, 1977 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
484.1	Ground Level													
0.0	SILTY CLAY													
	Very Stiff To Hard		1	SS	15		480							
477.1			2	SS	60									
7.0	QUEENSTON SHALE BEDROCK		3	SS	100/12"									
			4	SS	100/9"									
	Red To Grey Red		5	SS	100/5"		470							
468.9			6	SS	50/3"									
15.2	End Of Borehole													
	Note: W.L. Not Established													

RECORD OF BOREHOLE No 2


W P 159-75-06 LOCATION N 15 805 618 E 953 900 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Augers, NX Casing and NXL Core COMPILED BY P.J.S.
 DATUM Geodetic DATE December 15, 1977 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
482.2	Ground Level													
0.0	SILTY CLAY						480							
	Very Stiff To Hard		1	SS	14									
475.2			2	SS	47									
7.0	QUEENSTON SHALE BEDROCK		3	SS	100/14"									
	Red To Grey Red		4	NXL	80% Rec		470							RQD = 33
	Fine Texture		5	NXL	41% Rec									RQD = 13
	Soft And Fissile		6	NXL	81% Rec									RQD = 29
	With Thin Bedding		7	NXL	81% Rec		460							RQD = 38
	Including A Few Thin Shaly Limestone Beds		8	NXL	85% Rec									RQD = 30
			9	NXL	97% Rec									RQD = 73
			10	NXL	87% Rec		450							RQD = 73
			11	NXL	100% Rec									RQD = 75
440.3														
41.9	End Of Borehole													
	Note: W.L. Not Established													

+3, x5: Numbers refer to Sensitivity
 20
 15 ϕ 5 (%) STRAIN AT FAILURE
 10

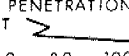
RECORD OF BOREHOLE No 3

W P 159-75-06 LOCATION N 15 805 486 E 953 872 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger, B Casing and BXL Core COMPILED BY P.J.S.
 DATUM Geodetic DATE December 14, 1977 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
478.8	Ground Level													
0.0	SILTY CLAY													
	Very Stiff		1	SS	15									
471.8	To Hard		2	SS	38									
7.0	QUEENSTON SHALE BEDROCK		3	SS	100/10"									
	Red To Grey Red													
	Fine Texture		4	BXL Core	97% Rec									RQD = 30
	Soft And Fissile													
	With Thin Bedding		5	BXL Core	70% Rec									RQD = 46
	Including A Few													
	Thin Shaly Limestone													
	Beds		6	BXL Core	100% Rec									
	Limestone Bed 21'-21'7"													
	Shaly Limestone 33'-34'													
			7	BXL Core	100% Rec									RQD = 65
436.5	End Of Borehole													
42.3	Note: W.L. Not Established													

RECORD OF BOREHOLE No 4

W P 159-75-06 LOCATION N 15 805 407 E 953 858 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger COMPILED BY P.J.S.
 DATUM Geodetic DATE December 22, 1977 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
477.7	Ground Level													
0.0	SILTY CLAY													
	Very Stiff To Hard		1	SS	15									0 8 65 27
469.7			2	SS	58									
8.0	QUEENSTON SHALE BEDROCK		3	SS	100/9"									0 2 68 30
	Red To Grey Red		4	SS	100/6"									
			5	SS	75/4"									
457.5														
			6	SS	75/13"									
20.2	End Of Borehole													
	Note: W.L. Not Established													

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

W P 159-75-06 LOCATION N 15 805 318 E 953 954 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger COMPILED BY P.J.S.
 DATUM Geodetic DATE December 22, 1977 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
474.0	Ground Level																
0.0	SILTY CLAY						470										
	Very Stiff		1	SS	30												
466.0	To Hard		2	SS	87												
8.0	QUEENSTON SHALE BEDROCK		3	SS	100/13"		460										
	Red To Grey Red		4	SS	50/1"												
			5	SS	100/11"												
453.8			6	SS	75/3"												
20.2	End Of Borehole																

RECORD OF BOREHOLE No 6

W P 159-75-06 LOCATION N 15 805 395 E 953 965 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger, BX Casing, BXL Core COMPILED BY P.J.S.
 DATUM Geodetic DATE December 20, 1977 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
476.2	Ground Level																
0.0	SILTY CLAY						470										
	Very Stiff		1	SS	21												
468.2	To Hard		2	SS	53												
8.0	QUEENSTON SHALE BEDROCK		3	SS	100/6"		460										
	Red To Grey Red																
	Fine Texture		4	BXL	95% Core Rec		450										RQD = 38
	Soft And Fissile																
	With Thin Bedding																
	Including A Few Thin																
	Beds Of Shaly Limestone		5	BXL	100% Core Rec		440										RQD = 75
	Limestone Bed 31'9"-32'2"																
	Limestone Bed 40'6"-41'4"		6	BXL	95% Core Rec												RQD = 33
431.9																	
44.3	End Of Borehole																
	Note: W.L. Not Established																

+3, x5: Numbers refer to 20
 15 5 (%) STRAIN AT FAILURE
 Sensitivity 10

RECORD OF BOREHOLE No 7

W P 159-75-06 LOCATION N 15 805 525 E 953 990 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger, BX Casing, BXL Core COMPILED BY P.J.S.
 DATUM Geodetic DATE December 20, 1977 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
479.4	Ground Level																GR SA SI CL
0.0	SILTY CLAY																
	Very Stiff		1	SS	21												0 4 45 51
	To Hard																
471.4			2	SS	116/15"												0 7 63 30
8.0	QUEENSTON SHALE BEDROCK		3	SS	100/12"		470										0 3 71 26
	Red To Grey Red																
	Fine Texture		4	BXL Core	98% Rec		460										RQD = 50
	Soft And Fissile																
	With Thin Bedding																
	Including A Few																
	Shaly Limestone Beds		5	BXL Core	100% Rec		450										RQD = 67
	Shaly Limestone 15'8"-16'0"																
	Shaly Limestone 40'8"-41'0"																
	Shaly Limestone 43'5"-44'5"		6	BXL Core	100% Rec		440										RQD = 54
434.4																	
45.0	End Of Borehole																
	Note: W.L. Not Established																

RECORD OF BOREHOLE No 8

W P 159-75-06 LOCATION N 15 805 601 E 954 015 Co-ords. ORIGINATED BY P.J.S.
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Auger COMPILED BY P.J.S.
 DATUM Geodetic DATE December 21, 1977 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
481.3	Ground Level																GR SA SI CL
0.0	SILTY CLAY						480										
	Very Stiff		1	SS	16												
	To Hard																
473.3			2	SS	56												
8.0	QUEENSTON SHALE BEDROCK		3	SS	100/7"		470										
	Red To Grey Red		4	SS	100/5"												
			5	SS	75/3"												
463.6			6	SS	75/3"												
17.7	End Of Borehole																

+3, x5: Numbers refer to 20
 Sensitivity 15-20 (%) STRAIN AT FAILURE
 10

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON "A" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}\bar{U}$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S POIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_c, N_q, N_γ BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
 I_C CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{2.45 \text{ of } \mu m \text{ Soil Fraction}}$
 O_m ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

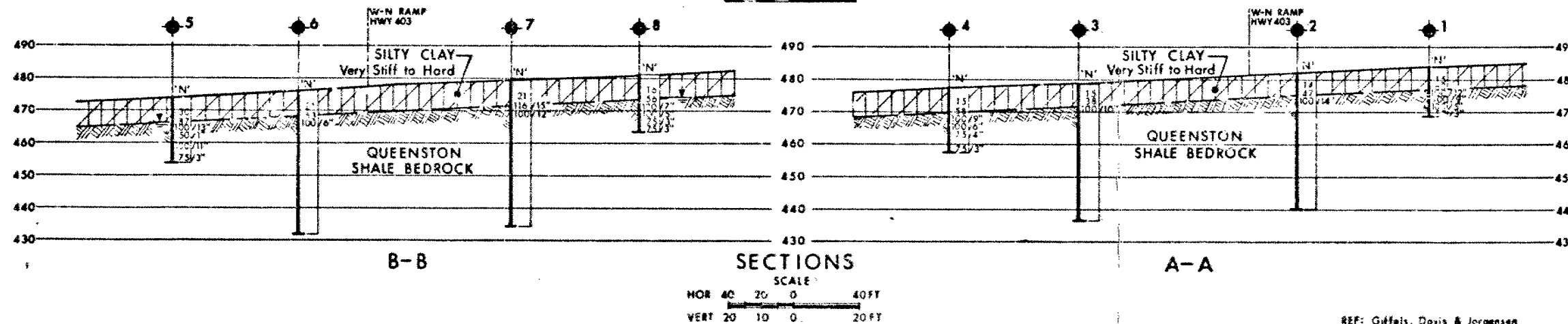
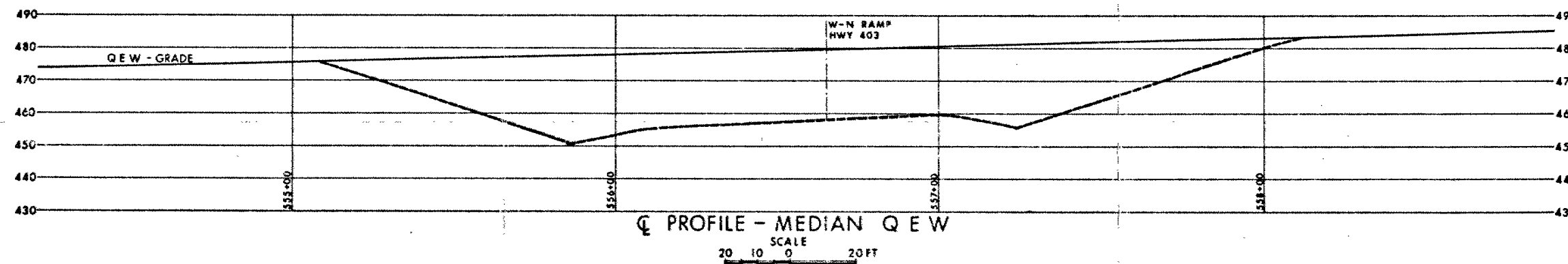
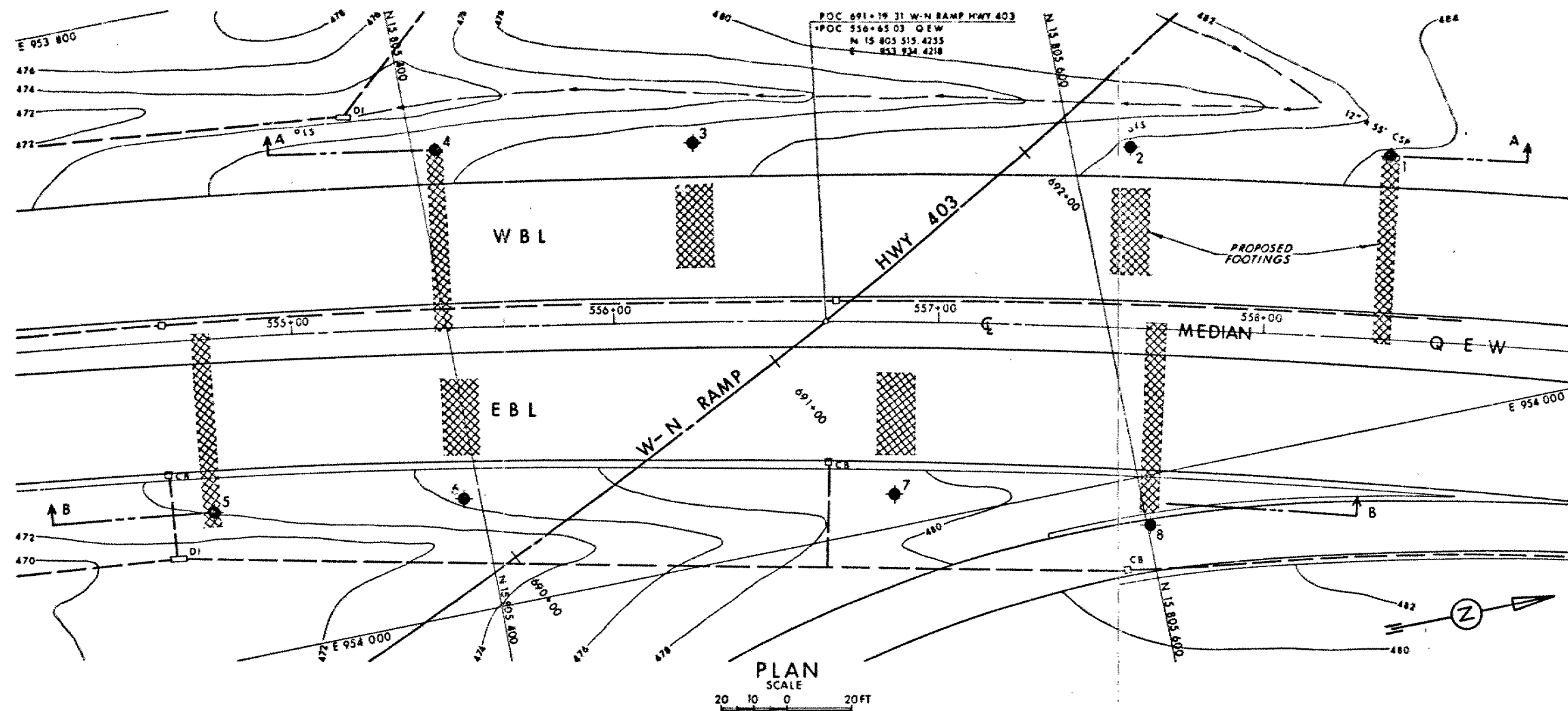
STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 α_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_c OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 σ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE
 σ'_1 = EFFECTIVE NORMAL STRESS

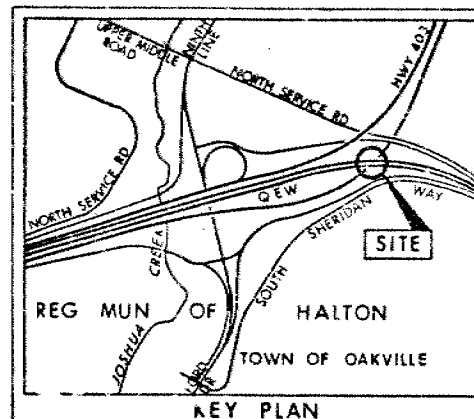


CONT No
WP No 159-75-06

W-N RAMP HWY 403
UNDER QEW
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- WL at time of investigation Dec 1977
- WL NOT Established for Bore Holes 1, 2, 3, 4, 6 & 7.

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	484.1	15 805 696	953 919
2	482.2	15 805 618	953 900
3	478.8	15 805 475	953 872
4	477.7	15 805 407	953 858
5	474.0	15 805 318	953 954
6	476.2	15 805 395	953 965
7	479.4	15 805 525	953 990
8	481.3	15 805 601	954 015

NOTE

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

DATE	BY	DESCRIPTION

REF: Giffels, Davis & Jorgensen
Consulting Engineers 20/6/77

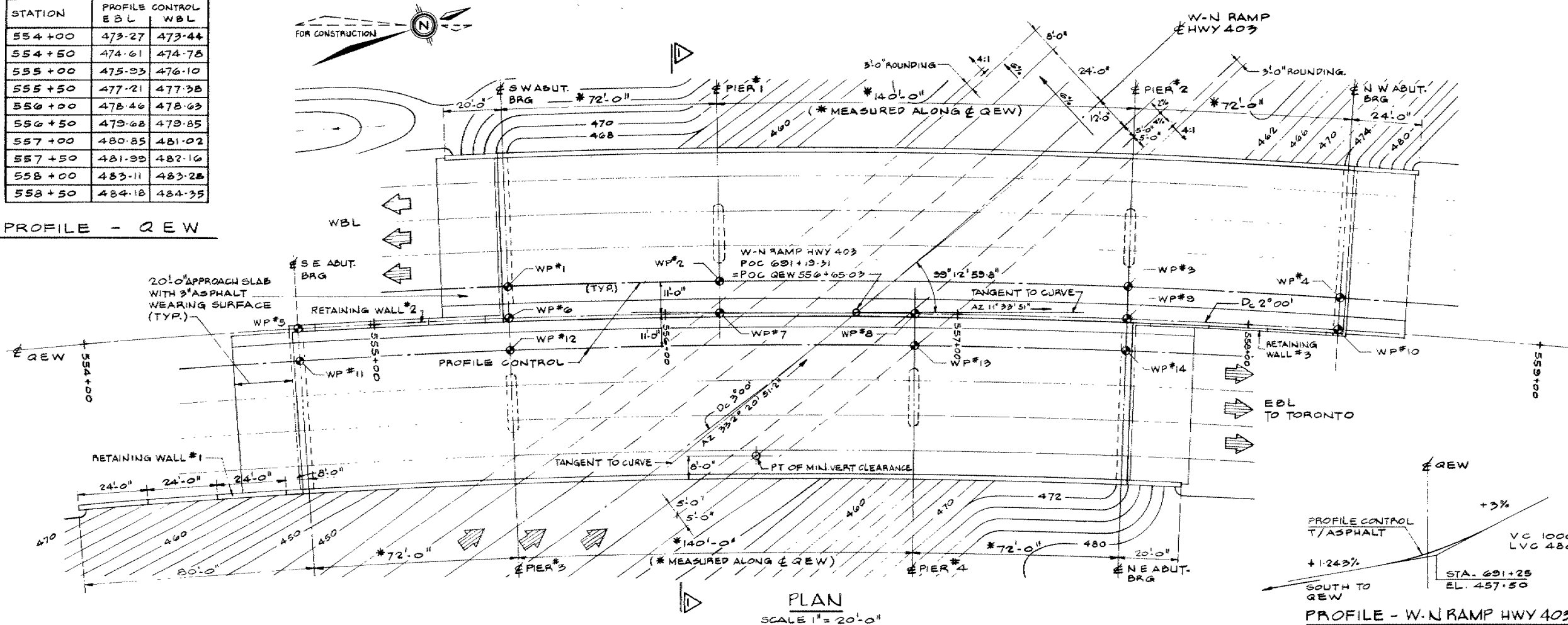
HWY No QEW
DRAWN BY J.S. CHECKED BY J.S. DATE Feb 15, 1978
DRAWN BY J.S. CHECKED BY J.S. DATE Feb 15, 1978

G.I.-30 SEPT. 1976

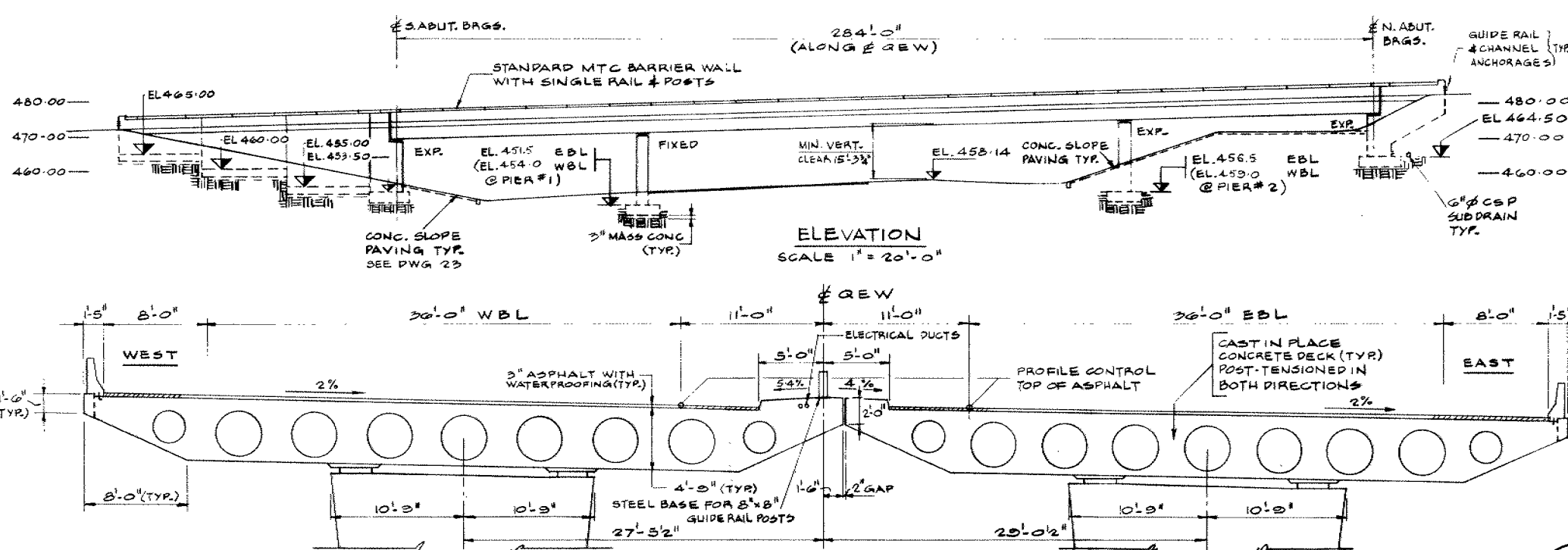
GEOCRES No. 30M5-117DIST. 4 REGION W.P. No. 159-75-06CONT. No. 79-80W. O. No. STR. SITE No. 10-284HWY. No. 403LOCATION W-N Ramp, Hwy 403
Under Q.E.W.No of PAGES - =====OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

STATION	PROFILE CONTROL EBL	WBL
554+00	473.27	473.44
554+50	474.61	474.78
555+00	475.93	476.10
555+50	477.21	477.38
556+00	478.46	478.63
556+50	479.68	479.85
557+00	480.85	481.02
557+50	481.99	482.16
558+00	483.11	483.28
558+50	484.18	484.35

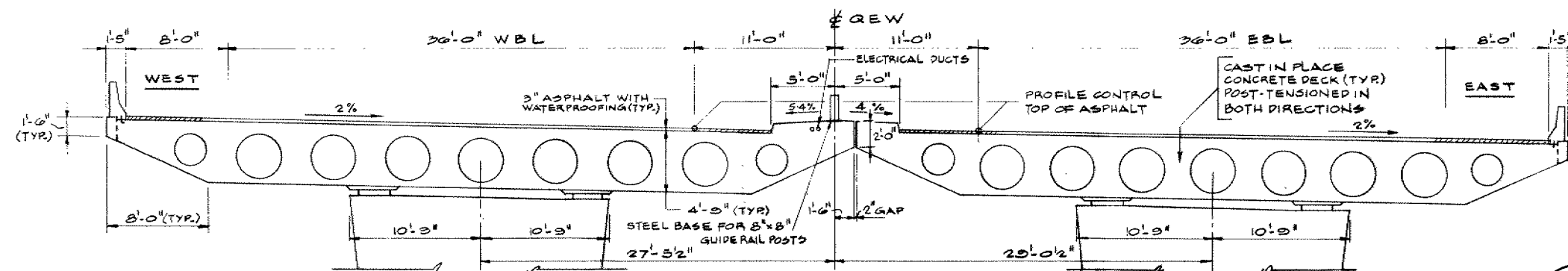
PROFILE - QEW



PLAN
SCALE 1" = 20'-0"



ELEVATION
SCALE 1" = 20'-0"



TYPICAL SECTION
SCALE 3/16" = 1'-0"

DIST 4		
CONT No		
WP No 159-75-06		
W-N RAMP HWY 403		SHEET
UNDER Q E W		
GENERAL PLAN		
Giffels Consulting Engineers		

GENERAL NOTES

- CLASS OF CONCRETE**
- DECK 5000 PSI
BARRIER WALLS, PIER COLUMNS 4000 PSI
REMAINDER 3000 PSI
- REINF. STEEL GRADE**
- ALL REINF. STEEL TO BE GRADE 400
- REINF. BARS WITH THE DESIGNATION "C" AT THE END OF BAR MARKS SHALL BE COATED BARS.
- CLEAR COVER TO REINF. STEEL**
- FTGS, ABUTMENTS, WINGWALLS, RETAIN. WALLS, 3"
PIER COLUMNS 2"
DECK TOP 2", BOT. 1 1/2"
CURBS & APPROACH SLABS 2"
BARRIER WALLS 1 1/2"
AND/OR AS NOTED ON DRAWINGS.
- CONSTRUCTION NOTES**

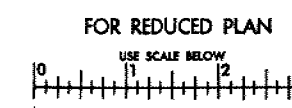
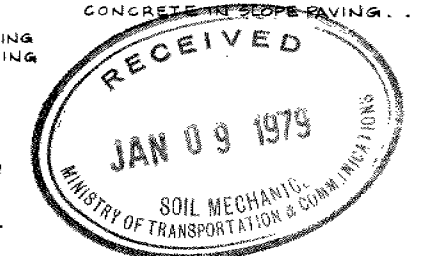
- THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF $\pm 1/8"$
- NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE DECK CONCRETE HAS BEEN PLACED, STRESSED, & GROUTED.
- THREE MONTHS AFTER STRESSING OPERATIONS HAVE BEEN COMPLETED OR EARLIER, DEFORMATION OF THE ELASTOMERIC BEARINGS REACHES THE ALLOWABLE VALUE SPECIFIED BY THE MANUFACTURER, THE DECK SHALL BE JACKED UP AT THE ABUTMENTS TO PERMIT BEARINGS TO RETURN TO THE VERTICAL POSITION.
- JACKING PROCEDURE SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL BEFORE EXECUTION.
- TO ACHIEVE THE MINIMUM CLEAR COVER OF 2" SPECIFIED, THE TOP LAYER OF DECK REINF. SHALL BE PLACED PRIOR TO CONCRETING WITH A CLEAR COVER OF $2 1/2" \pm 1/2"$ TOLERANCE.

- CONCRETE QUANTITIES**
- CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.
- CONCRETE IN PIERS, ABUTMENTS & WING WALLS
- | | |
|--------------------|--------|
| 4000 PSI | 204 cy |
| 3000 PSI | 516 cy |
- PRESTRESSED CONG. BRIDGE DECK 388 cy
CONCRETE IN RETAINING WALLS 200 cy
CONCRETE IN BARRIER WALLS 59 cy
CONCRETE IN APPROACH SLABS 137 cy
CONCRETE IN SLOPE PAVING 232 cy

B.M. ELEV. 472.83
TOP OF NE CORNER OF CONG. PORCH ON N. FACE OF HOUSE.
520 FT. LT. STA. 551+90 QEW

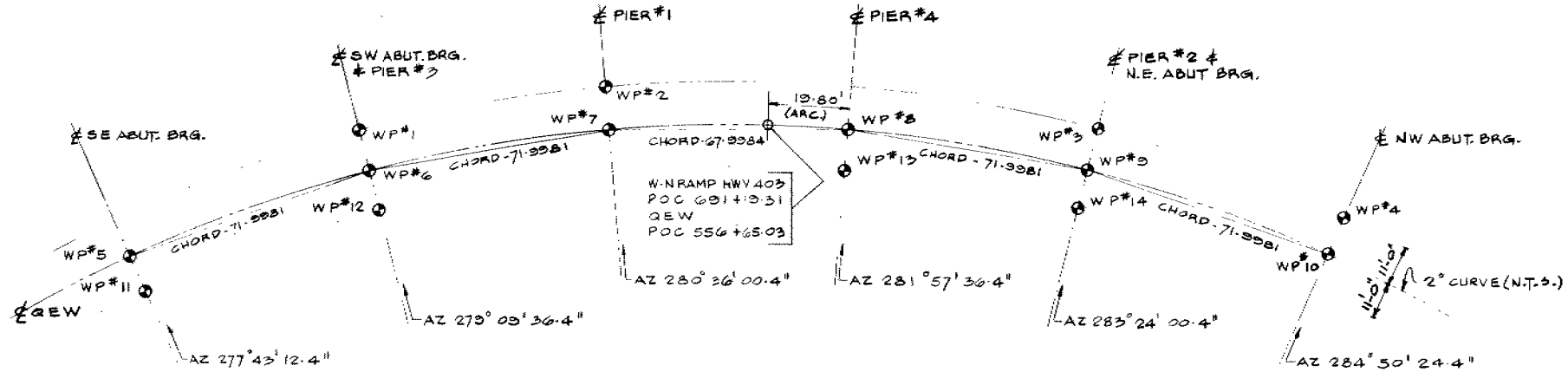
LIST OF DRAWINGS

1. GENERAL PLAN
2. BOREHOLE LOCATIONS & SOIL STRATA
3. FOUNDATION LAYOUT
4. FOOTING REINFORCEMENT
5. S.W. ABUTMENT & BRGS.
6. N.W. ABUTMENT & BRGS.
7. S.E. ABUTMENT & BRGS.
8. N.E. ABUTMENT & BRGS.
9. ABUTMENT DETAILS
10. RETAINING WALL #1
11. RETAINING WALLS #2 & #3
12. PIERS & PIER BRGS.
13. DECK LAYOUT & DETAILS
14. LONGITUDINAL POST-TENSIONING
15. TRANSVERSE POST-TENSIONING
16. DECK REINFORCING I
17. DECK REINFORCING II
18. DECK REINFORCING III
19. BARRIER WALL (WEST)
20. BARRIER WALL (EAST)
21. STEEL RAILING (SINGLE TUBE)
22. 20 FT. APPROACH SLABS
23. SLOPE PAVING DETAILS
24. AS CONSTRUCTED ELEV. & DIM.
25. STANDARD DETAILS I
26. STANDARD DETAILS II
27. STANDARD DETAILS III



REVISIONS	DATE	BY	DESCRIPTION
DESIGN E.P.B.	CHECK	LOADING HS20-44	DATE DEC.78
DRAWING B.W.	CHECK	SITE No 10-284	DWG 1

WORKING POINT DATA				
POINT	STATION ON Q.E.W.	OFFSET FROM Q.E.W.	PROVINCIAL CO-ORDINATES NORTH	EAST
WP 1	555+44.83	11'-0" LT	15,805,238.9426	953,901.9429
WP 2	556+16.83	11'-0" LT	15,805,470.1453	953,914.3442
WP 3	557+56.83	11'-0" LT	15,805,607.5380	953,943.5610
WP 4	558+28.83	11'-0" LT	15,805,677.6889	953,961.1827
WP 5	554+72.83	-	15,805,325.9731	953,902.2350
WP 6	555+44.83	-	15,805,297.1915	953,912.8026
WP 7	556+16.83	-	15,805,468.1218	953,925.1565
WP 8	556+84.83	-	15,805,534.8066	953,938.4574
WP 9	557+56.83	-	15,805,605.0487	953,954.2615
WP 10	558+28.83	-	15,805,674.8715	953,971.8258
WP 11	554+72.83	11'-0" RT	15,805,324.4954	953,913.1353
WP 12	555+44.83	11'-0" RT	15,805,395.4403	953,922.6623
WP 13	556+84.83	11'-0" RT	15,805,522.5271	953,949.2186
WP 14	557+56.83	11'-0" RT	15,805,602.4993	953,964.9620



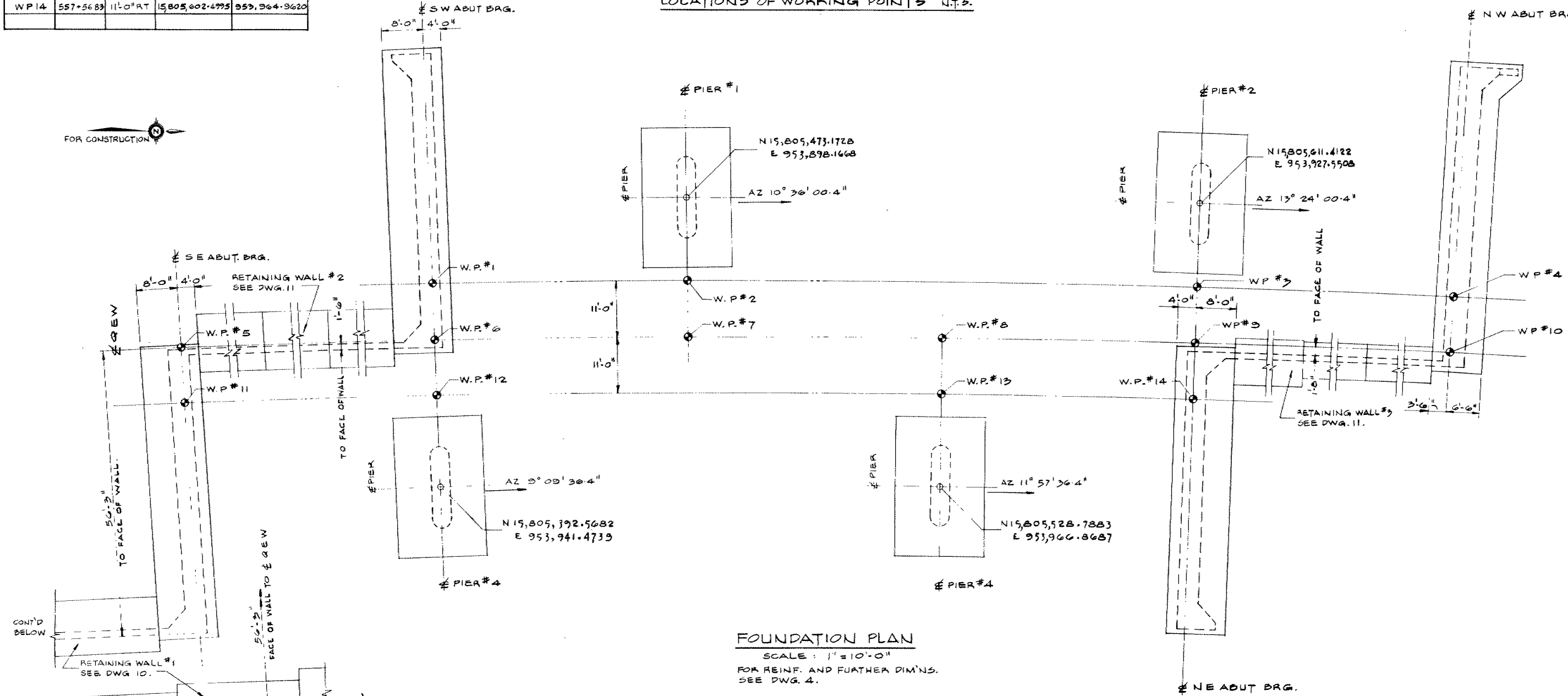
CONT No
WP No 159-75-06

W-N RAMP HWY 403
UNDER Q.E.W.
FOUNDATION LAYOUT

Giffels
Giffels, Davis & Jorgensen
Consulting Engineers

SHEET

LOCATIONS OF WORKING POINTS N.T.S.

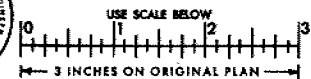


FOUNDATION PLAN

SCALE: 1" = 10'-0"
FOR REINF. AND FURTHER DIM'S.
SEE DWG. 4.



FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION
DESIGN E.P.D.	CHECK W.K.	LOADING HS20-44	DATE JAN 79
DRAWING B.G.W.	CHECK E.P.D.	SITE No 10-284	DWG 3

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M5-107

DIST. 4 REGION Central

W.P. No. 125-66-18

CONT. No. 78-104

W. O. No. _____

STR. SITE No. 10-285

HWY. No. 403

LOCATION N/W Ramp Structure
over Ford Drive, QEW/403/
Ford Drive Interchange

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 3

REMARKS: documents to be unfolded
before microfilming

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 125-66-18

DIST 4

HWY 403

STR SITE 10-285

N/W Ramp Structure over Ford Drive
QEW/403/Ford Drive Interchange

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

R. Fitzgibbon)
J. Anderson) cover only
G. Sloan

Files ✓

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	72 05 20	DDA
TUBES	—	—
ROCK CORES	Around 17 Cent.	DDA

FOUNDATION INVESTIGATION REPORT

For

N/W Ramp Structure over Ford Drive
QEW/403/Ford Drive Interchange
W.P. 125-66-18, Site 10-285
District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project during the period of March 21, 1977 to March 23, 1977. The fieldwork consisted of 4 sampled boreholes advanced using solid stem augers and diamond drilling techniques. The boreholes ranged in depth from 30 to 31 feet below the ground surface. Bedrock was proven by obtaining up to 23 feet of BXL core in each borehole.

SITE DESCRIPTION AND GEOLOGY

The site is located just east of the QEW approximately 900 feet south of the existing QEW Underpass at Ford Drive in the Regional Municipality of Halton, Town of Oakville. The land immediately adjacent to the site slopes gently south to Joshuas Creek located some 500 feet to the south. The land is used for farming and light industry with some unproductive, tree covered land along Joshuas Creek.

Physiographically the site lies on the southern fringe in the region referred to as the South Slope. This region is a strip of land bounded by the Iroquois Plain on the south and the Peel Plain on the north and extends from the Niagara Escarpment to the Trent River. This region is characterized by a shallow till overlying shale of the Queenston and Dundas Formation of the Upper Ordovician age.

SUBSURFACE CONDITIONS

General

Generally, a 5 to 10 foot overburden consisting of clayey silt to silty clay was found immediately above the grey shale bedrock of the Dundas Formation. Detailed descriptions of the various soil and rock types encountered in each borehole are given in the Record of Borehole Sheets. The estimated stratigraphical profile and sections shown on Drawing # 1256618-A are based upon this information.

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

Clayey Silt to Silty Clay, Trace of Sand

Immediately below the ground level or a thin 2 foot cover of topsoil, a 5 to 10 foot cohesive stratum consisting of clayey silt to silty clay with traces of sand was encountered. The cohesive stratum is brown in colour except in B.H.'s 5 and 7 where the lower 3 feet of the stratum is grey.

The physical properties of the cohesive deposit as determined by laboratory testing are as follows:

		<u>Range</u>	<u>Average</u>
Natural Moisture Content	(W) $\%$	9 - 21	15
Liquid Limit	(W _L) $\%$	28 - 38	34
Plastic Limit	(W _p) $\%$	16 - 22	19
Plasticity Index	(I _p) $\%$	12 - 18	15

The Atterberg Limits (see Plasticity Chart, Fig. #1) indicate that the cohesive stratum is inorganic and of low to intermediate plasticity.

Two typical grain size distribution curves from this stratum are shown on Fig. #2.

The Standard Penetration Test results generally ranged from 32 to 71 blows/ft. indicating a hard consistency. However, at isolated depths near the surface the 'N' values ranged from 16 to 22 blows/ft. indicating a very stiff consistency at these locations.

Bedrock - Shale

Underlying the cohesive deposit is bedrock which was explored to a maximum depth of 23 feet below the cohesive deposit. The bedrock is grey shale with intermittent layers of shaly limestone and limestone up to 18" thick. The upper 2 to 8 feet of the shale bedrock being moderately weathered. A detailed description of the bedrock is listed on the Record of Borehole Sheets.

The rock quality designation (RQD) classification gives an indication of the quality of the bedrock with respect to the number of fractures and amount of core pieces of 4 or more inches in length expressed as a percentage of the total length of core drilled. The RQD for the rock core varies from 0% to 70%, indicating a rock quality of very poor to fair. The low RQD values are due to the thin horizontal bedding of the fissile shale.

Groundwater

The groundwater level conditions were observed by measuring in the open boreholes after the completion of the investigation. The groundwater levels were found to vary between elevation 418.4 and 423.6 or 3 to 4 feet below the existing ground level. The groundwater levels are shown on the Record of Borehole Sheets as well as on Drawing #1256618-A.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a new complex interchange connecting QEW to Hwy 403 Link and to a re-aligned Ford Drive. Two structures will be required to carry QEW detour traffic and ultimately Hwy. 403 W-N Ramp and N-W Ramp, over Ford Drive.

The proposed profile grade of the N-W Ramp at the structure location is about elevation 433 and on a 4% grade increasing to the north. The proposed profile grade of Ford Drive is to be at approximately elevation 407, therefore, requiring a 17 to 24 foot cut at the structure location. Present proposals for the N-W Ramp Structure over Ford Drive, call for a 99 foot single span, three lane bridge with closed type abutments.

Structure Foundations

The closed abutments for the proposed structure can be supported on spread footings located within the sound shale and may be designed for a maximum bearing pressure up to 10 tsf. A minimum earth cover of 4 feet should be provided to the underside of the footings, since the shale is considered susceptible to frost action. To prevent softening of the shale due to weathering at the footing grade, it should be covered with 3 inches of mass concrete immediately after the completion of the excavation.

No dewatering problems are anticipated for the construction of the abutment footings. Any minor seepage or surface runoff into the excavations can be handled by pumping from sumps.

Other Considerations

For estimating the earth pressure on the abutment walls a coefficient of active earth pressure of $K_a = 0.33$ may be used if some movement at the top of the wall is permitted. If no movement at the top of the wall is anticipated, a coefficient of earth pressure at rest $K_o = 0.5$ may be used for design purposes.

To estimate the horizontal resistance to sliding between rough concrete and the shale, a coefficient of friction of 0.55 may be used.

In order to relieve the build up of hydrostatic pressure behind the abutment walls the structure should be backfilled with free draining granular material and provided with weepholes or other types of drainage conduit.

Ford Drive

As mentioned previously, a cut of up to 24 feet deep will be required in the vicinity of the structure in order to reach the new grade of the proposed Ford Drive. This cut will be made through the cohesive stratum and into the shale bedrock. The shale is susceptible to weathering and erosion, therefore, the cuts should be treated as earth cuts and constructed with 2:1 slopes. It is further recommended that the cut slopes be covered with topsoil and sodded according to current MTC standards.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. V. Korlu, Project Engineer and Mr. M. MacLean, Project Engineer. The equipment used was owned and operated by Atcost Ltd., Toronto, Ontario.

This report was written by Mr. C.T. Johnson, Project Engineer and reviewed by Mr. M. Devata, Supervising Engineer.



C.T. Johnson
Project Engineer



M. Devata, P. Eng.
Supervising Engineer

CTJ/MD/1f
May, 1977

FOUNDATION REQUEST

In a memorandum dated February 16, 1977, Mr. G.C.E. Burkhardt, Head, Structural Section requested the Soil Mechanics Section to prepare a Foundation Investigation Report for the N-W Ramp structure over Ford Drive.

FIELD AND LABORATORY INVESTIGATION PROCEDURES

A total of four boreholes each accompanied with a dynamic penetration test were put down using a muskeg mounted auger machine equipped with solid stem augers and rock coring equipment.

The locations and elevations of the boreholes were surveyed by personnel from the Central Regional Surveys and Plans Section.

Disturbed soil samples were received by means of a 2 inch O.D. split spoon sampler driven in accordance with the specifications of the Standard Penetration Test. Rock core of the bedrock was obtained by coring with BXL diamond bits.

The samples were visually examined and identified in the field and again in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples of the cohesive stratum to determine the natural moisture content, Atterberg Limits and grain size distribution.

The rock core was examined and logged in detail in the laboratory by Mr. B.K. Glassford, Geologist.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 5

WP 125-66-18 LOCATION Co-ords N 15 803 726; E 953 841 ORIGINATED BY VK
DIST 4 HWY 403 BORING DATE March 22, 1977 COMPILED BY VK
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, BXL Core & Cone Test CHECKED BY PS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES					
422.7	Ground Level									
0.0	Clayey Silt to Silty Clay, Trace of Sand		1	SS	16	420				
414.7	Very Stiff Brown to Hard Grey		2	SS	37					
8.0	(Weathered)		3	SS	100/4"					
411.7	(Sound)		4	BXL	100% REC	410				RQD 0%
11.0	Shale Bedrock * (See Below)		5	BXL	100% REC					RQD 0%
			6	BXL	100% REC	400				RQD 70%
			7	BXL	90% REC					RQD 20%
391.7	End of Borehole									
31.0	*Intermittent thin beds of shale, shaly limestone & limestone (dark grey colour, fine texture, soft to hard, shale is fissile, thin horizontal bedding) with Limestone seams (light grey, fine texture, hard)									
from	14'4" to 15'4"									
	17'3" to 18'6"									
	21'0" to 21'9"									
	26'0" to 27'6"									

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 6

WP 125-66-18 LOCATION Co-ords N 15 803 824; E 953 833 ORIGINATED BY VK
DIST 4 HWY 403 BORING DATE March 21, 1977 COMPILED BY VK
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, BXL Core & Cone Test CHECKED BY AS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100	w_p	w	w_L	
428.5	Ground Level						SHEAR STRENGTH					WATER CONTENT %			
							○ UNCONFINED + FIELD VANE					10 20 30			GR SA SI C
							● QUICK TRIAXIAL x LAB VANE								
0.0	Clayey Silt to Silty Clay, Trace of Sand Occ. cobbles		1	SS	37										
421.3	Hard, Brown		2	SS	113										
7.0	Shale Bedrock * (See below)		3	SS	100.5"	420									
414.0	(Weathered)		4	SS	136.7/11"										
14.5	(Sound)		5	BXL	100% REC	410									
			6	BXL	75% REC										
			7	BXL	100% REC										
			8	BXL	100% REC	400									
398.5	End of Borehole														RQD 15%
30.0	from														
	*Intermittent shale, shaly limestone and shale beds (soft to med. hard, fine texture, shale is fissile, thin horizontal bedding with Limestone seams (med. hard, fine texture, light grey colour, fossiliferous, shale seams present) 21'3" to 24'2" 26'3" to 27'5"														
	Note: Waterlevel not established														

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 7

WP 125-66-18 LOCATION Co-ords N 15 803 726; E 953 787 ORIGINATED BY VK
 DIST 4 HWY 403 BORING DATE March 23, 1977 COMPILED BY VK
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, BXL Core & Cone Test CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
421.4	Ground Level					ELEV										
419.8	Topsoil					420										
1.8	Clayey Silt to Brown Silty Clay, Grey		1	SS	32											0 2 54 44
414.4	Trace of Sand		2	SS	133											
7.0	(Weathered)					410										
8.7	(Sound)		3	BXL	100% REC											
	Shale Bedrock * (See Below)		4	BXL	100% REC											RQD 10%
			5	BXL	100% REC	400										RQD 25%
			6	BXL	100% REC											RQD 35%
			7	BXL	100% REC											RQD 0%
			8	BXL	50% REC											RQD 0%
391.4			9	BXL	100% REC											RQD 0%
30.0	End of Borehole															
	* Intermittent shale, shaly limestone & shale beds (Soft to hard, fine texture, shale is fissile & grey to red grey colour, thin horizontal bedding) with Limestone seams (light grey, soft to hard, fine texture with shale seams present)															
	from 9'3" to 9'8"															
	13'4" to 13'10"															
	18'4" to 18'8"															
	19'4" to 20'4"															
	23'4" to 24'7"															

OFFICE REPORT ON SOIL EXPLORATION

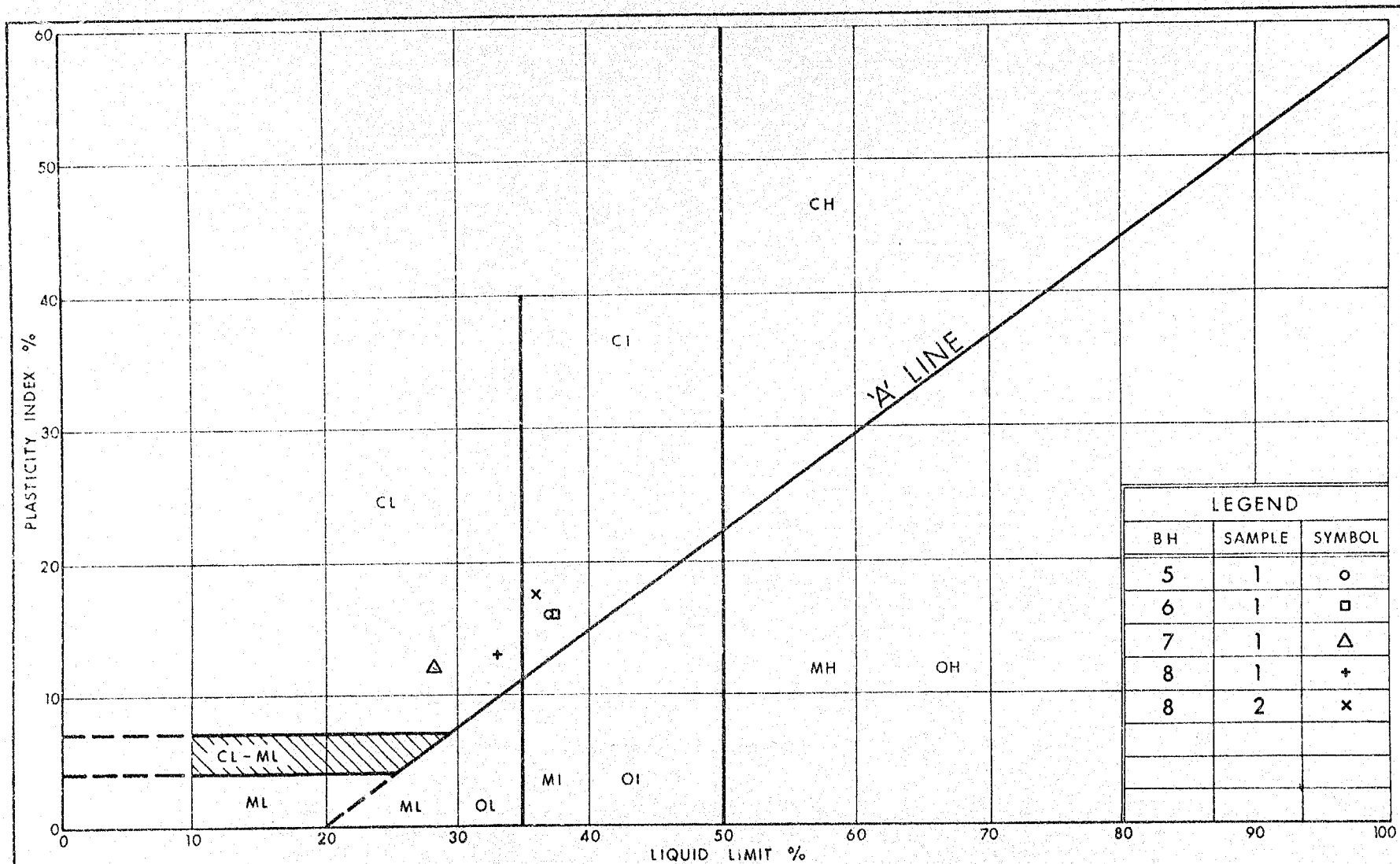
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 8

WP 125-66-3 LOCATION Co-ords N 15 803 824, E 953 779 ORIGINATED BY VK
DIST 4 HWY 403 BORING DATE March 23, 1977 COMPILED BY VK
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, BXL Core & Cone Test CHECKED BY R.

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT			LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20 40 60 80 100			W_P W W_L				
427.4	Ground Level													
0.0	Clayey Silt to Silty Clay, Trace of Sand		1	SS	21									
417.9	Very Stiff to Hard Brown occ. layers of grey		2	SS	71									0 1 70 29
9.5	Shale Bedrock *		3	SS	156	9"								
412.4	(See Below) (Weathered)		4	SS	150	7"								
15.0	(Sound)		5	BXL	100%									RQD 0%
			6	BXL	100% REC									RQD 12%
			7	BXL	100% REC									RQD 5%
396.4			8	BXL	100% REC									RQD 41%
31.0	End of Borehole													
	*Intermittent shale, shaly limestone & shale beds (soft to hard, fine texture, light grey to black colour, shale is fissile, thin horizontal bedding, limestone seams up to 3" thick) with Limestone seams (hard light grey colour, fine texture)													
from	24'8" to 25'6" 29'6" to 31'0"													



Ontario

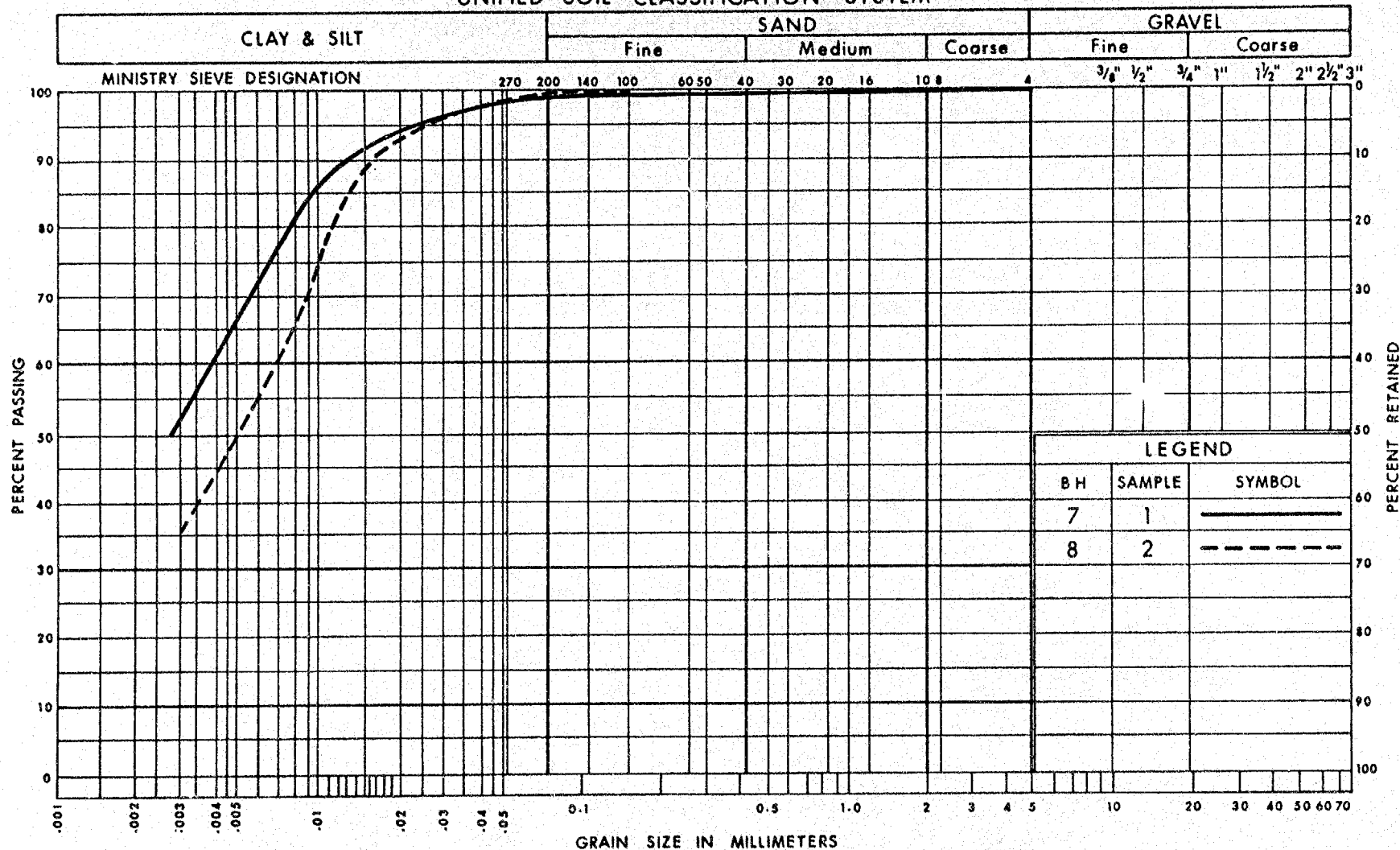
Ministry of
Transportation and
Communications

PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
TRACE OF SAND

FIG No 1

W P 125-66-18

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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Communications
Ontario
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
TRACE OF SAND

FIG No 2

W P 125-66-18

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

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

TERMS TO BE USED IN DESCRIBING SOILS :-

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

TYPE OF SAMPLE

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

P.H SAMPLE ADVANCED HYDRAULICALLY

P.M SAMPLE ADVANCED MANUALLY

SOIL TESTS

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

ABBREVIATIONS & SYMBOLS USED IN THIS 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
w_s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

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

STRESS AND STRAIN

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

EARTH PRESSURE

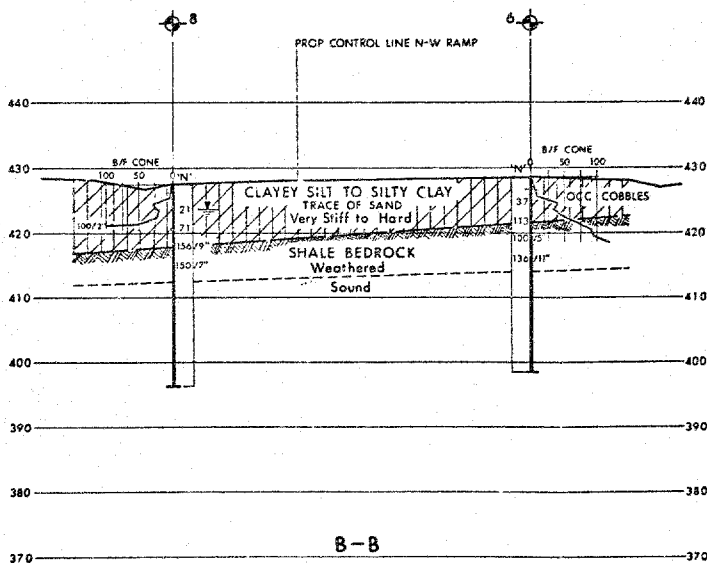
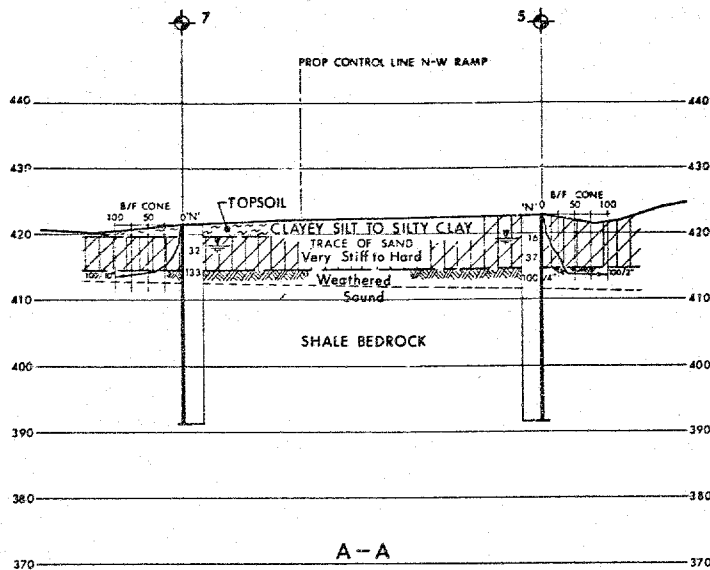
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

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

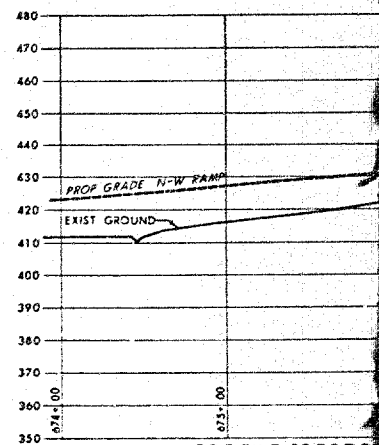
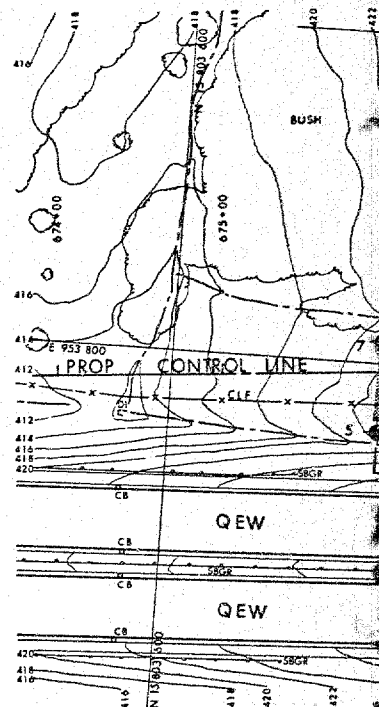
SLOPES

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



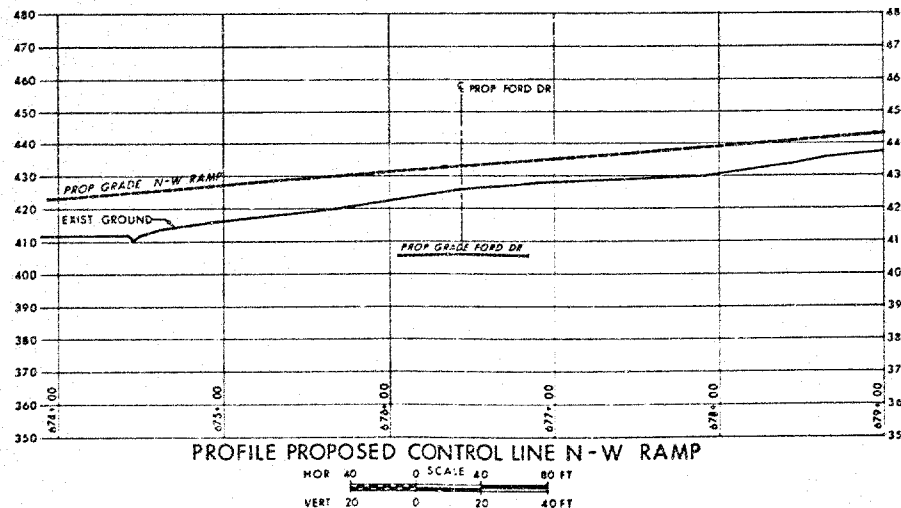
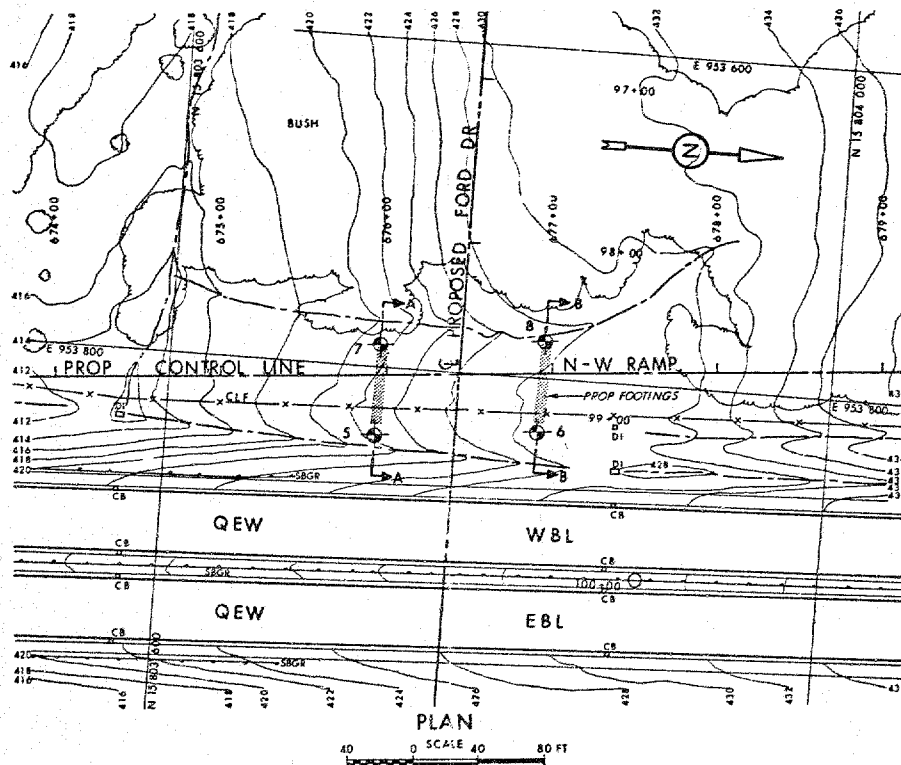
SECTIONS

10 0 5 SCALE 10 20 FT



PROFILE PROPOSE

HOR 40
VERT 20



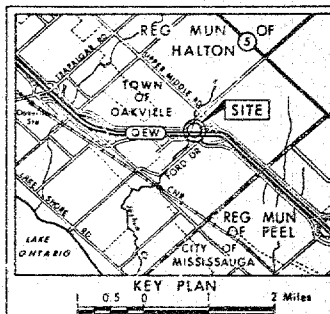
CONT No
WP No 125-66-18



PROPOSED FORD DRIVE

SHEET

BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- "N" Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (50" Cone, 350 ft lbs energy)
- WL at time of investigation March 1977
WL for B.H. No 6 not established

No	ELEVATION	CG-ORDINATES	
		NORTH	EAST
5	422.7	15 803 726	953 841
6	428.5	15 803 824	953 833
7	421.4	15 803 726	953 747
8	427.6	15 803 824	953 779

-NOTE-

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

REVISIONS	DATE	BY	DESCRIPTION

May No 403 N-W RAMP DIST 4
S.M.C.T.J. CHECKED DATE May 11, 1977 SITE 10-285
DRAWN B.S. CHECKED DATE May 11, 1977 DWG 1256618-A

REF No B-82-QEW-2, Sept. 1976

DOCUMENT IDENTIFICATION

GEOCRES No. 30 H 5 - 107

DIST. 4 REGION CENTRAL

W.P. No. 125-66-78

CONT. No. 78-104

W. O. No. _____

STR. SITE No. 10-285

HWY. No. 403

LOCATION N/W Ramps STRUCTURE

OVER FORD DR. , NEW / 403 / FORD DRIVE

INTERCHANGE

CHECKED BY _____ DATE OF INSPECTION _____ THIS REPORT 3

REMARKS: _____

3045-107

DIST. 4	
CONT No	
WP No	125-56-18
N-W RAMP HWY. 403 OVER FORD DRIVE GENERAL PLAN	
	SHEET

GENERAL NOTES

CLASS OF CONCRETE

DECK, BARRIER WALLS,
ABUTMENTS & WINDWALLS: 4000 P.S.I.
REMAINDER: 3000 P.S.I.

CONCRETE QUANTITIES

ABUTMENTS & WINDWALLS: +
DECK: +
BARRIER WALLS: +
APPROACH SLABS: +
SLOPE PAVING: +
RETAINING WALLS: +

CLEAR COVER TO REIN. STEEL

FOOTINGS & ABUTMENTS: 5"
DECK: 2" TOP, 1" BOTTOM
BARRIER WALLS: 1 1/2" EXCEPT AS NOTED
APPROACH SLABS: 2"

TO ACHIEVE THE MIN. CLEAR COVER OF 2",
SPECIFIED, THE TOP LAYER OF DECK STEEL
SHALL BE PLACED PRIOR TO CONCRETE
WITH A CLEAR COVER OF 2 1/2" ± 1/2"

REINFORCING STEEL GRADE 60

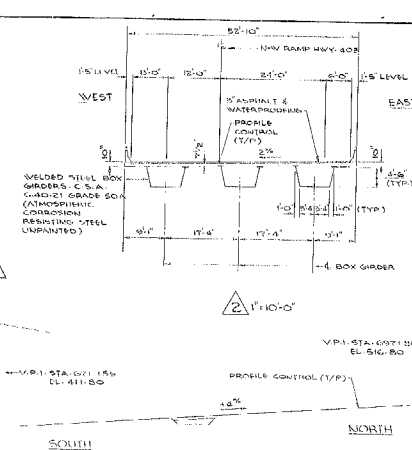
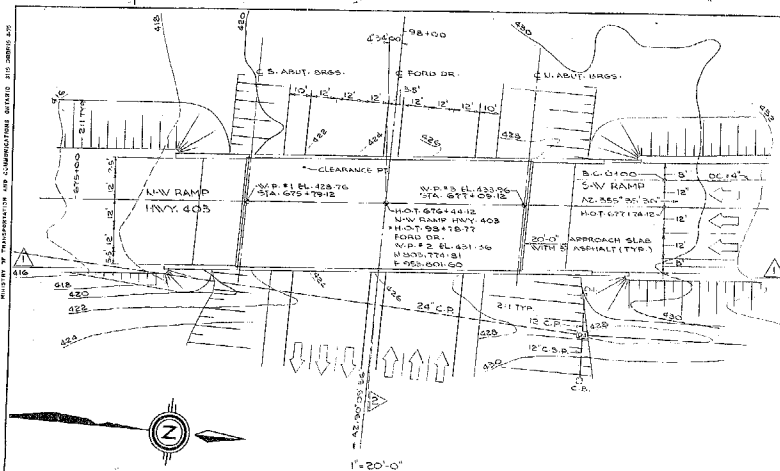
STRUCTURAL STEEL: 100 TON

CONSTRUCTION NOTES

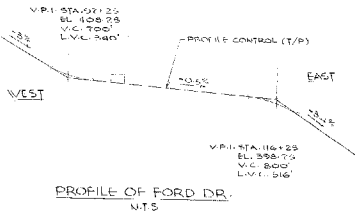
THE CONTRACTOR IS RESPONSIBLE FOR
FINISHING THE BEARING SLATS DEAD
LEVEL TO THE SPECIFIED ELEVATIONS WITH
A TOLERANCE OF ± 1/4".
NO CONCRETE SHALL BE PLACED ABOVE
THE ABUTMENT BEARING SLATS UNTIL
THE CONCRETE IN THE DECK HAS BEEN
PLACED.

LIST OF DRAWINGS

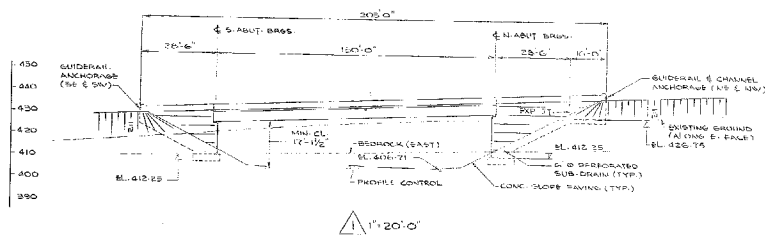
1. GENERAL PLAN
2. BORE HOLE LOCATIONS & SOIL STRATA
3. FOOTING DETAILS
4. SOUTH ABUTMENT
5. N. ABUTMENT & KIT. WALLS
6. STRUCTURAL STEEL
7. DECK REINFORCING
8. DECK LAYOUT & SKEED ELEVATIONS
9. BARRIER WALL
10. STEEL RAILINGS (SINGLE TUBE)
11. 20 FT. APPROACH SLAB
12. DETAILS OF CONC. SLOPE PAVING
13. STANDARD DETAILS I
14. STANDARD DETAILS II
15. STANDARD DETAILS III
16. AS CONSTRUCTED ELEV. & DIM.



PROFILE OF N-W RAMP HWY. 403
N.T.S.



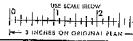
PROFILE OF FORD DR.
N.T.S.



B.M. ELEV. 662.91
BENCHMARK IS LOCATED ON
TOP OF SW BOLT ON 66 L&G
OF HYDRO TOWER 250 FT. 17.1
STA. 547+51 GEN.



FOR REDUCED PLAN



DATE	DESCRIPTION
11/11/1988	DESIGNED BY: TRANSPORTATION AND COMMUNICATIONS DIVISION, DATE: 11/11/1988
11/11/1988	DRAWN BY: TRANSPORTATION AND COMMUNICATIONS DIVISION, DATE: 11/11/1988

REMARKS: _____

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 125-66-17

DIST 4

HWY QEW

STR SITE 10-286

QEW Over Ford Drive

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

R. Fitzgibbon)
J. Anderson) cover only
G. Sloan

Files

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	78-01-25	124/8
TUBES	—	—
ROCK CORES	CONTRACT HAWARD	124/2

FOUNDATION INVESTIGATION REPORT

For

QEW Over Ford Drive
W.P. 125-66-17, Site 10-286
QEW, District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out for the above project. It is based on 4 boreholes which were advanced during the period March 21 to 23, 1977 for adjacent structures under Work Projects 125-66-16/18. These boreholes were advanced into the shale bedrock employing solid stem augers, and then BXL core samples were obtained from each borehole.

SITE DESCRIPTION

This site is located on the QEW approximately 900 feet south of the existing Ford Drive underpass structure. At this location the QEW consists of 6 traffic lanes plus paved shoulders and median. The ground surface in this area slopes gently towards Joshua Creek which is located some 500 feet to the south. Land use in the area is in transition from being predominantly agricultural to being industrial and residential.

SUBSURFACE CONDITIONS

The overburden in the area consists of a 7 to 8 foot layer of clayey silt to silty clay. It has a very stiff to hard consistency with Standard Penetration 'N' values ranging from 16 to 50 blows per foot. Moisture content varies between 10 and 20 percent with an average of about 15 percent.

The clayey silt to silty clay overburden is underlain by shale bedrock of the Meaford Dundas Formation. It is interbedded with layers of shaley limestone and limestone up to 1.5 feet in thickness. The shale is grey and fissile exhibiting thin horizontal bedding. An upper zone up to 7 feet in thickness shows considerable deterioration and is shown on the sections and logsheets as weathered. Detailed descriptions of the cores recovered are given on the Record of Borehole Sheets located in the Appendix of this report.

Groundwater levels in the open boreholes were recorded during the period of the fieldwork. They indicate the groundwater level was from 4 to 6 feet below the ground surface.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed that in the new interchange the QEW will pass over a depressed Ford Drive on a single span structure 130 feet in length. This structure will be flanked on either side by similar structures carrying ramps between the QEW and Hwy. 403. The construction of the ramp structures will precede that of the QEW structure.

Spread Footings

The structure should be supported on spread footings. Where the footings bear on sound shale an allowable load up to 10 tons per square foot may be used. In cases where footings are founded on shale described as weathered the allowable load should be reduced to 5 tons per square foot. Any footings founded in the clayey silt to silty clay overburden may be loaded to a maximum of 2 tons per square foot. To prevent deterioration of the shale due to exposure to air and water the footing base should be covered by 6 inches of mass concrete within 3 hours of it being excavated to grade.

Frost Protection

Since the shale is susceptible to frost action the underside of the footings should be provided with 4 feet of cover.


Dewatering

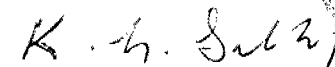
No unwatering problems are anticipated in excavations for footings. Any seepage water should be pumped from summs.

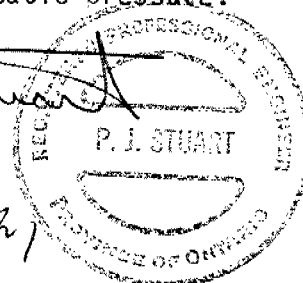
MISCELLANEOUS

Resistance to sliding of the footing on the shale bedrock may be calculated using a coefficient of friction of .50.

The abutment walls should be backfilled with free draining granular material and weep holes should be provided to prevent a buildup of hydrostatic pressure.


P.J. Stuart, P. Eng.
Project Engineer


K.G. Selby, P. Eng.
Supervising Engineer



APPENDIX

RECORD OF BOREHOLE No 3

W P L25-06-17 LOCATION Co-ords N 15 803 724; E 954 012 ORIGINATED BY CTJ
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY CTJ
 DATUM Geodetic DATE March 23, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
422.0	Ground Level							20 40 60 80 100								
0.0	Clayey Silt To Silty Clay, Some Sand, Trace Of Gravel		1	SS	46		420									
414.5	Hard		2	SS	32											
412.3	(Weathered)		3	SS	112											
9.5	(Sound)		4	BXL	91% REC		410								RQD 30%	
	Shale Bedrock (See Below)*		5	BXL	100% REC		400								RQD 63%	
392.3																
29.7	End Of Borehole															
	*Intermittent shale, shaly limestone & limestone, fine tex- ture, soft to med.hard light grey, shale is fissile, thin bedding with Limestone (med. hard, fine texture, light grey, fossil- iferous) seams from 12'8" to 13'6" 19'6" to 20'2" 25'3" to 26'2"															

RECORD OF BOREHOLE No 4

W P 125-66-17 LOCATION Co-ords N 15 803 823; E 954 023 ORIGINATED BY CTJ
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger, BXL Core COMPILED BY CTJ
DATUM Geodetic DATE March 22, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH							WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							W _p	W	W _L
427.1	Ground Level																
0.0	Clayey Silt To Silty Clay, Some Sand Traces Of Gravel (Reworked) Very Stiff		1	SS	16		420								5 31 39 25		
420.0			2	SS	111/8"												
7.1	(Weathered)		3	SS	131/9"												
417.1	(Sound)		4	BXL	84% REC										RQD 25%		
10.0	Shale Bedrock (See Below)*		5	BXL	100% REC		410								RQD 15%		
			6	BXL	97% REC										RQD 60%		
397.9							400										
29.2	End Of Borehole																
	*Intermittent Shale, Shaly Limestone & Limestone Beds, Soft To Hard, Fine Texture, Shale ls Fissile, Light Grey Colour, Thin hori- zontal Bedding With Limestone (Hard, Fine Texture fossiliferous) seams from 11'10" to 12'4" 13' 6" to 14'2" 22' 2" to 22'6" 23' 0" to 23'10" 28'10" to 29'2"																



RECORD OF BOREHOLE No 5

W P 125-66-17 LOCATION Co-ords N 15 803 726; E 953 841 ORIGINATED BY VK
DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger, BXL Core & Cone Test COMPILED BY VK
DATUM Geodetic DATE March 22, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
422.7	Ground Level																
0.0	Clayey Silt To Silty Clay, Trace Of Sand Very Stiff Brown To Hard Grey		1	SS	16		420										
414.7			2	SS	37												
8.0			3	SS	100												
411.7	(Weathered)																
11.0	(Sound)		4	BXL	100% REC		410										RQD 0%
	Shale Bedrock* (See Below)		5	BXL	100% REC												RQD 0%
			6	BXL	100% REC		400										RQD 70%
			7	BXL	90% REC												RQD 20%
391.7	End Of Borehole																
31.0	*Intermittent Thin Beds Of Shale, Shaly Limestone & Limestone (Dark Grey Colour, Fine Texture, Soft To Hard, Shale Is Fissile, Thin Horizontal Bed- ding) With Limestone Seams (Light Grey, Fine Texture, Hard) From 14'4" to 15'4" 17'3" to 18'6" 21'0" to 21'9" 26'0" to 27'6"																

RECORD OF BOREHOLE No 6

W P 125-66-17 LOCATION Co-ords N 15 803 824; E 953 833 ORIGINATED BY VK
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Solid Stem Auger, BXL Core & Cone Test COMPILED BY VK
 DATUM Geodetic DATE March 21, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH						
428.5	Ground Level													
0.0	Clayey Silt To Silty Clay, Trace Of Sand Occ. Cobbles Hard, Brown		1	SS	37									
421.5			2	SS	113									
7.0	Shale Bedrock * (See Below)		3	SS	100	5"	420							
414.0	(Weathered)		4	SS	136	11"								
14.5	(Sound)		5	BXL	100% REC		410							
			6	BXL	75% REC									
			7	BXL	100% REC									
			8	BXL	100% REC		400							
398.5														RQD 15%
30.0	End Of Borehole													
	*Intermittent Shale, Shaly Limestone And Shale Beds (Soft To Med. Hard, Fine Texture Shale is Fissile, Thin Horizontal Bedding With Limestone Seams (Med. Hard, Fine Texture, Light Grey Colour, Fossiliferous, Shale Seams Present) 21'3" to 24'2" 26'3" to 27'5" Note: Waterlevel not established													

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON "A" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4"+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}\bar{U}$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{w_L - w_P}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{w_L - w_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{I_P \text{ of } 2 \mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

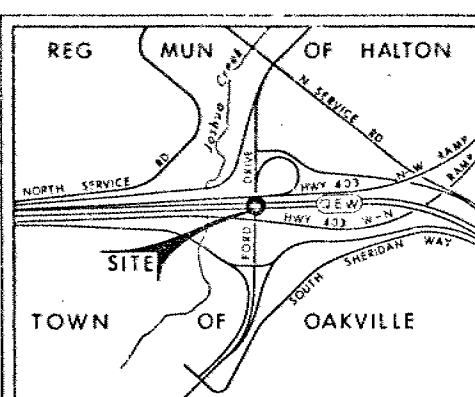
STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W/L at time of investigation March/77
- W/L NOT Established in B H #6

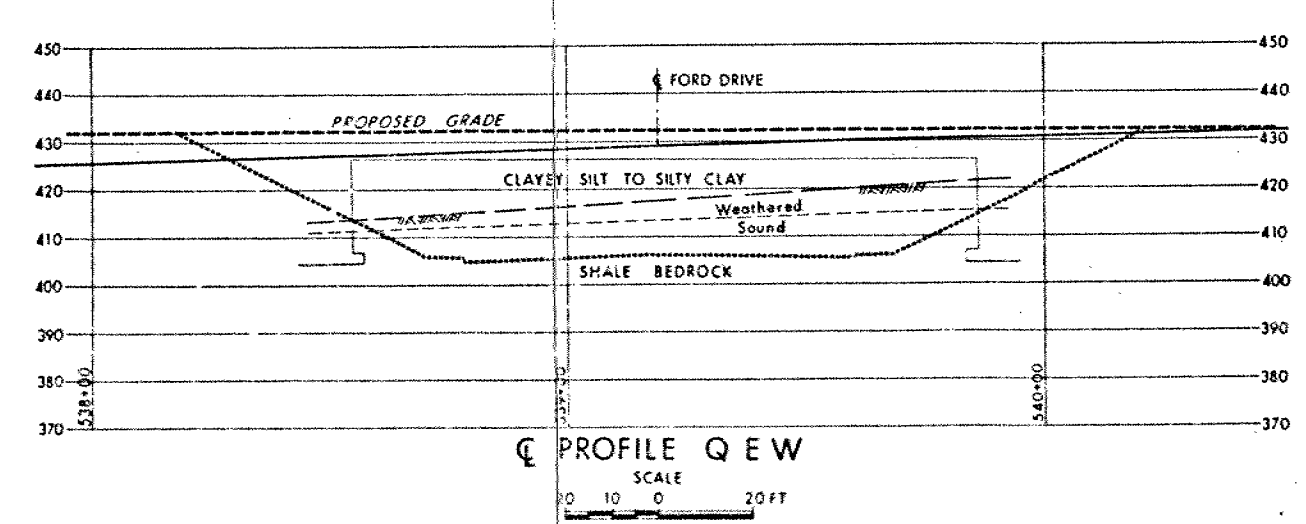
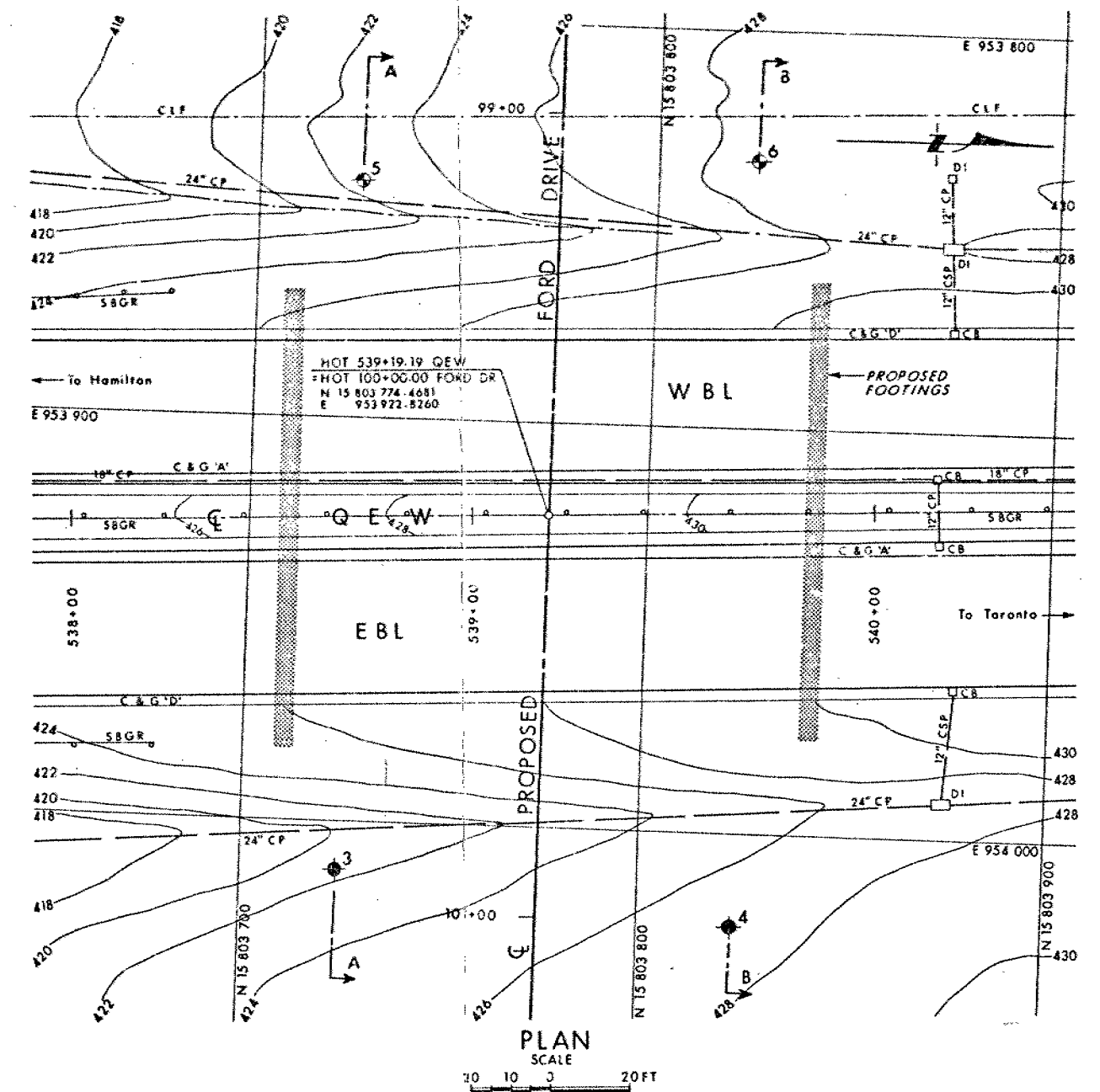
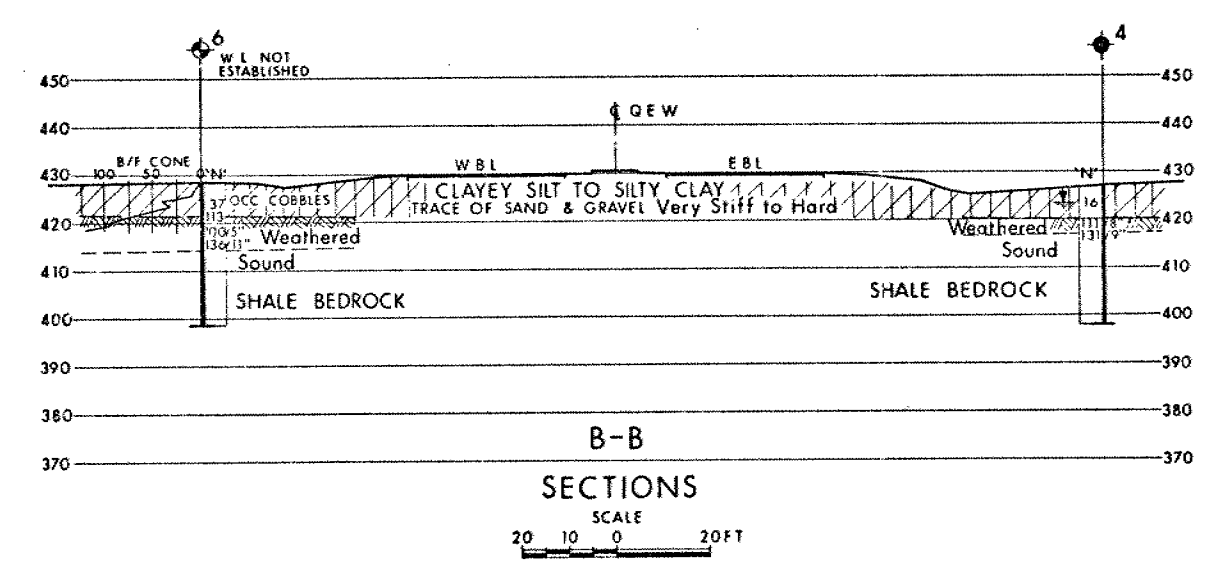
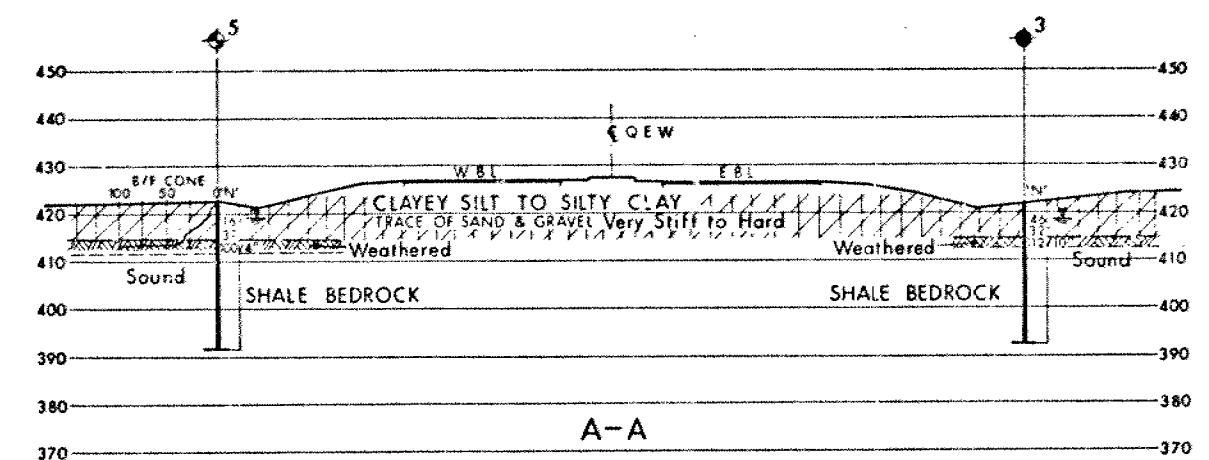
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
3	422.0	15 803 724	954 012
4	427.1	15 803 823	954 023
5	422.7	15 803 726	953 841
6	428.5	15 803 824	953 833

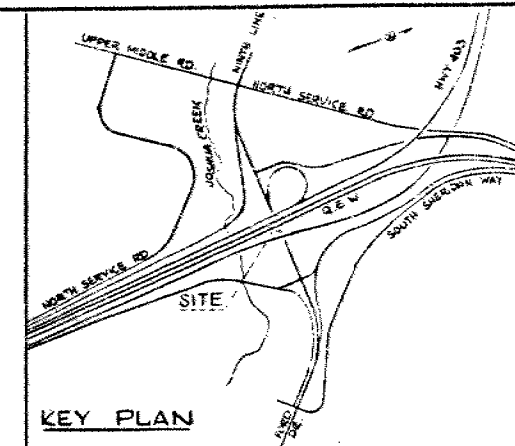
-NOTE-
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS

DATE	BY	DESCRIPTION

Geocres No 30M5-116
MAY No Q E W
SLASH P15 CHECKED DATE Jan 20, 1978 SITE 10-286
DRAWN BY CHECKED BY APPROVED BY
DWG 1256617-A





GENERAL NOTES

CLASS OF CONCRETE

DECK & BARRIER WALLS : 4000 R.S.I.
REMAINDER : 3000 R.S.I.

CONCRETE QUANTITIES

ABUTMENTS & WINGWALLS	= 525	CU. YDS
DECK	= 411	" "
BARRIER WALLS	= 29	" "
APPROACH SLABS	= 147	" "
SLOPE SAVINGS	= 74	

STRUCTURAL STEEL QUANTITIES -202 TONNES

CLEAR COVER TO REINF STEEL

FOOTINGS & ABUTMENTS 3"
DECK 2" TOP; 1" BOT.
BARRIER WALLS 1 1/2" (EXCEPT AS
APPROACH SLABS 2" NOTED)
COATED BARS HAVE A SUFFIX "C"
TO ACHIEVE THE MIN CLEAR COVER OF 2"
SPECIFIED, THE TOP LAYER OF DECK STEEL
SHALL BE PLACED PRIOR TO CONCRETING
WITH A CLEAR COVER OF 2 1/2" ± 1/2"
TOLERANCE

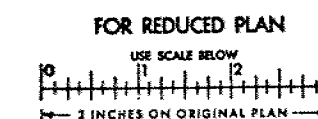
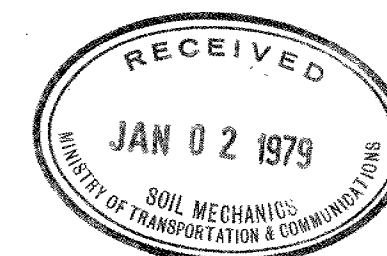
REINFORCING STEEL : GRADE 400

CONSTRUCTION NOTES

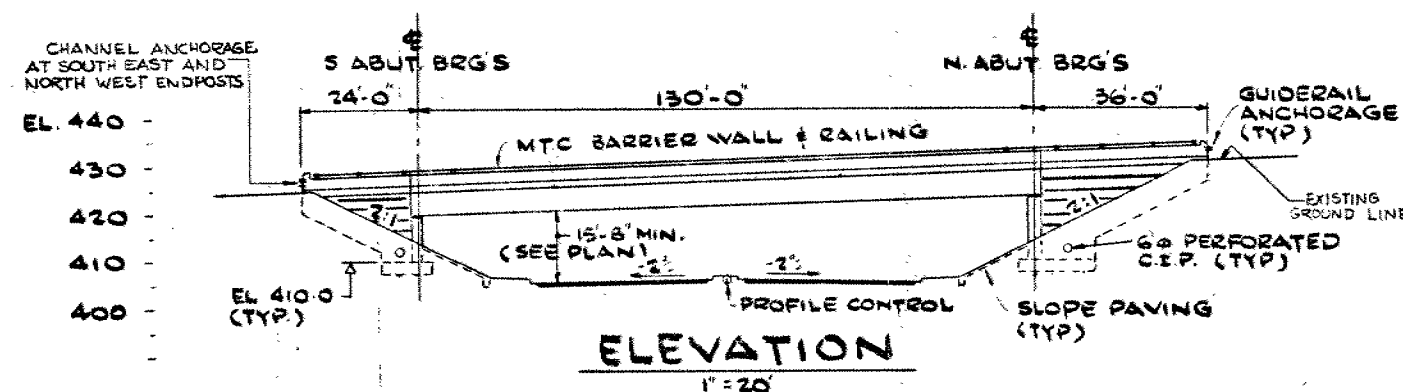
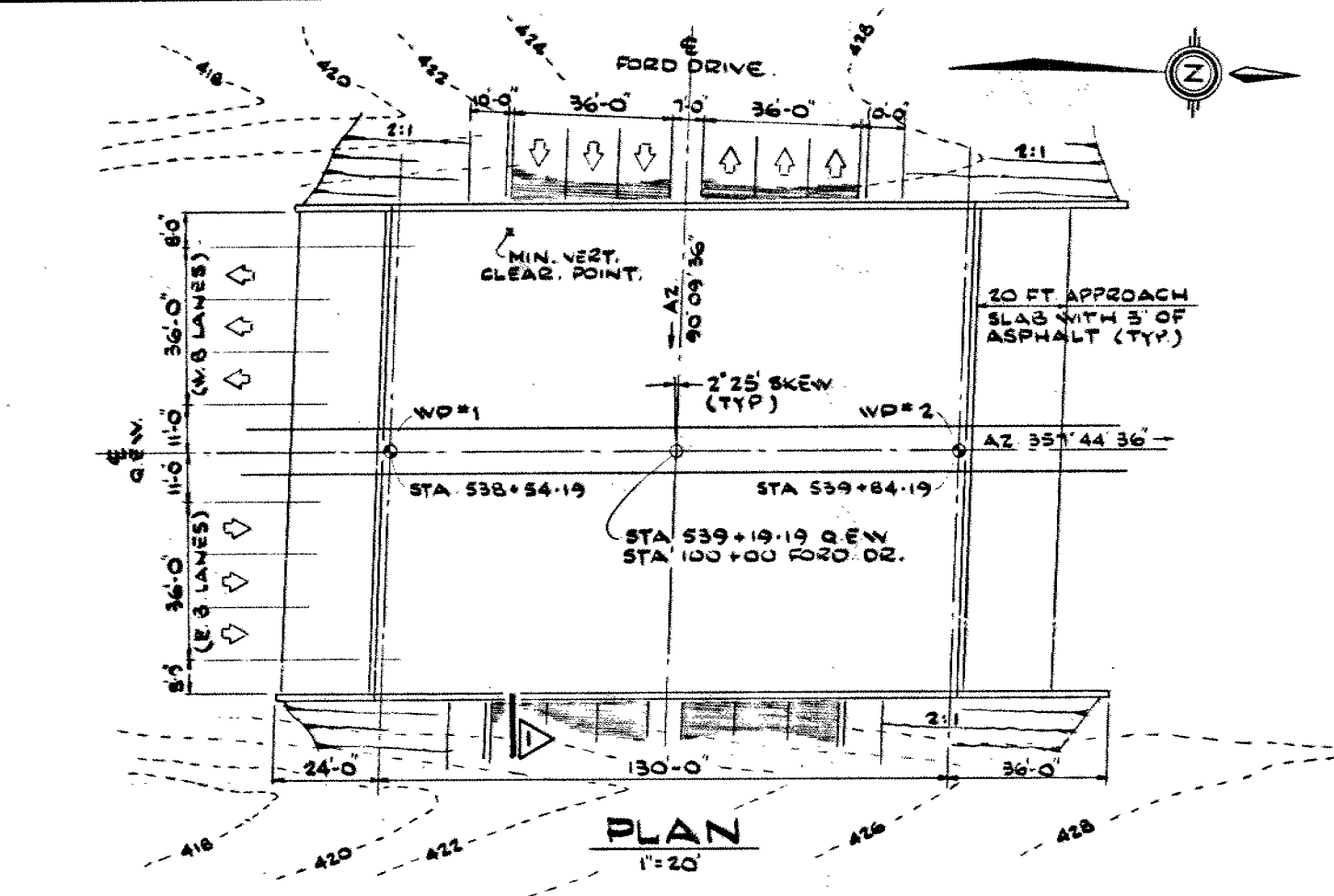
THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF $\pm 1/8"$.

NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.

FORMWORK BETWEEN THE DECK AND
BALLAST WALL SHALL BE REMOVED.

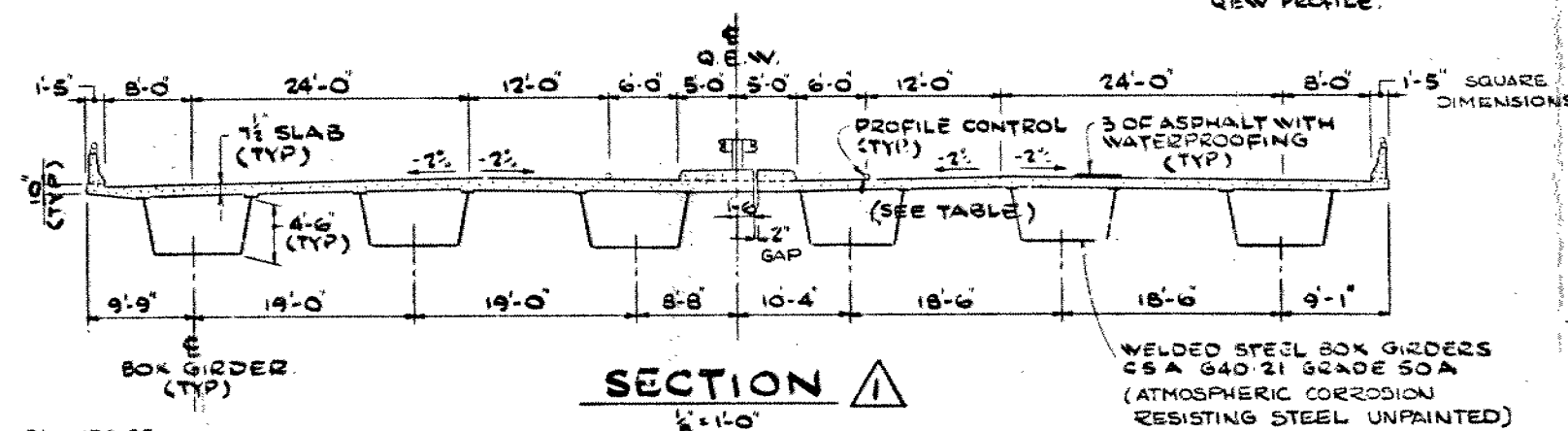


REVISIONS				
	DATE BY:	DESCRIPTION		
DESIGN	CHECK	LOADING	DATE	
DRAWING	CHECK	SITE No.	DWG. No.	



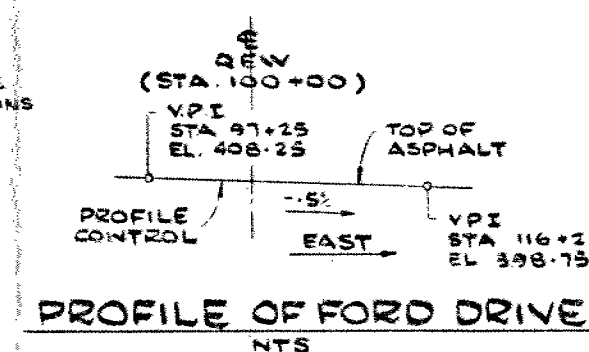
* PROFILE OF QEW (T/A)		
STATION	PROFILE CONTROL	
	E.B.L.	W.B.L.
538 +25	425.62	426.00
+50	426.38	426.76
+75	427.12	427.50
539 +00	427.89	428.27
+25	428.62	429.00
+50	429.39	429.77
+75	430.16	430.50
540 +00	430.92	431.30
+25	431.67	432.08

* PROFILE OF QEW. IS EXISTING
QEW PROFILE.



B. M. EL. 472.83

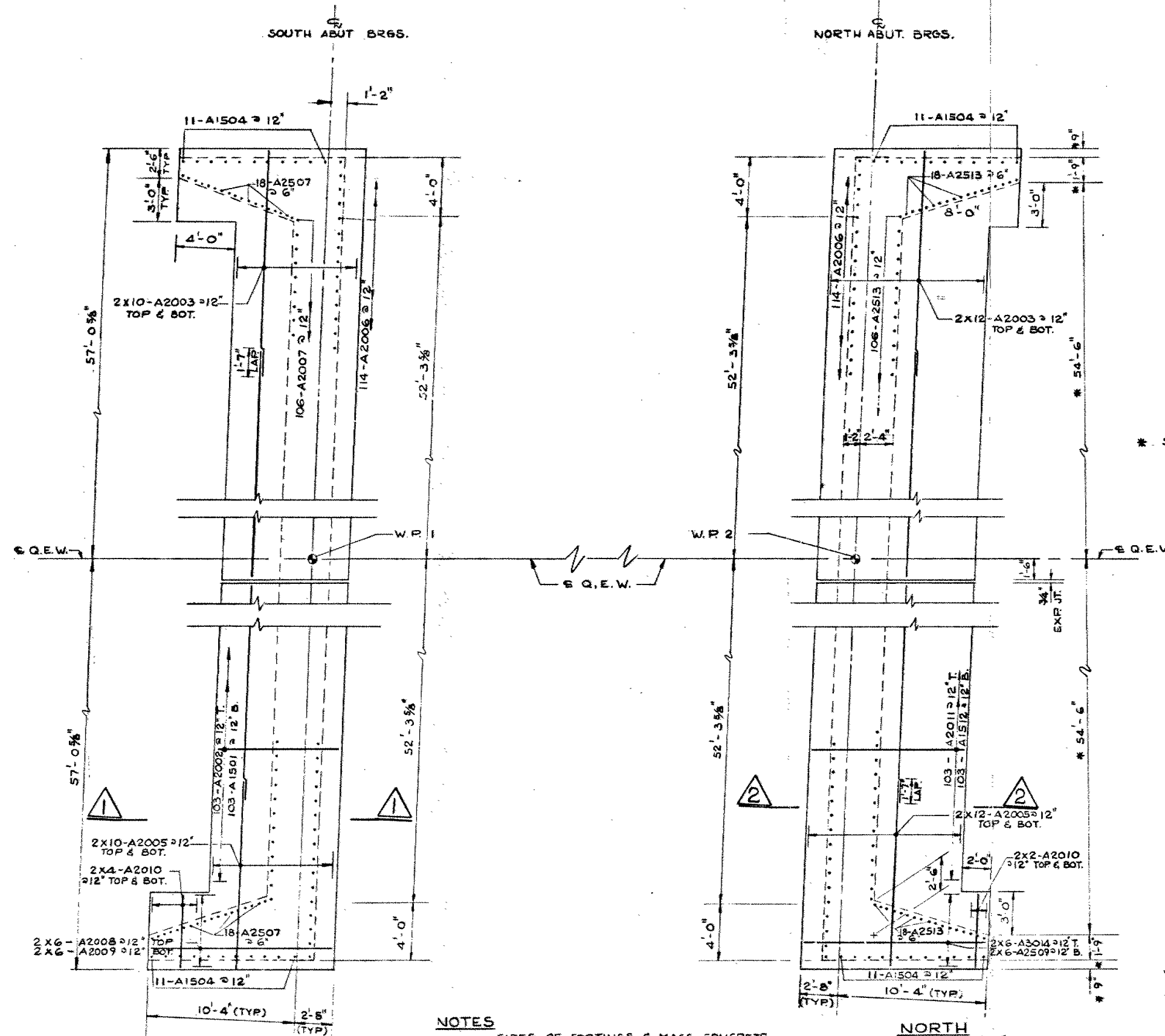
BENCH MARK IS LOCATED ON TOP OF
NE CORNER OF CONCRETE PORCH ON N. FACE
OF HOUSE 520 FT. LT., STA. 551+90 Q.E.W.



CONT No
WP No 125-66-17

O.E.W.
OVER FORD DRIVE
FOOTING DETAILS

SHEET

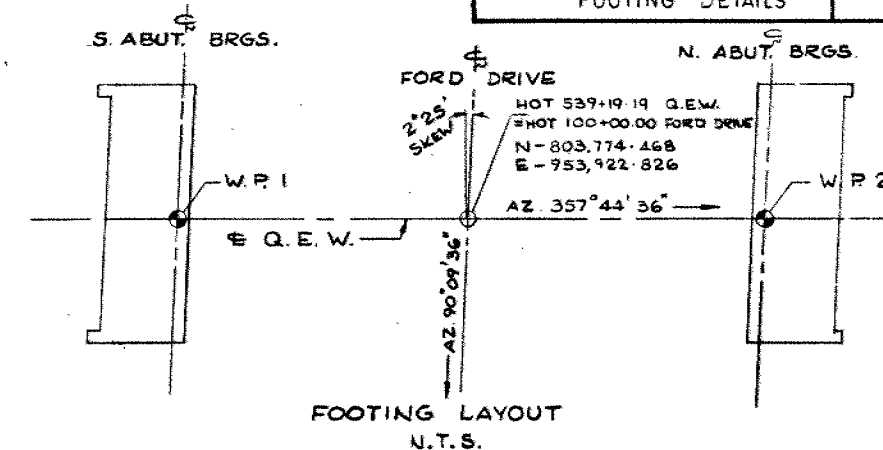


NOTES

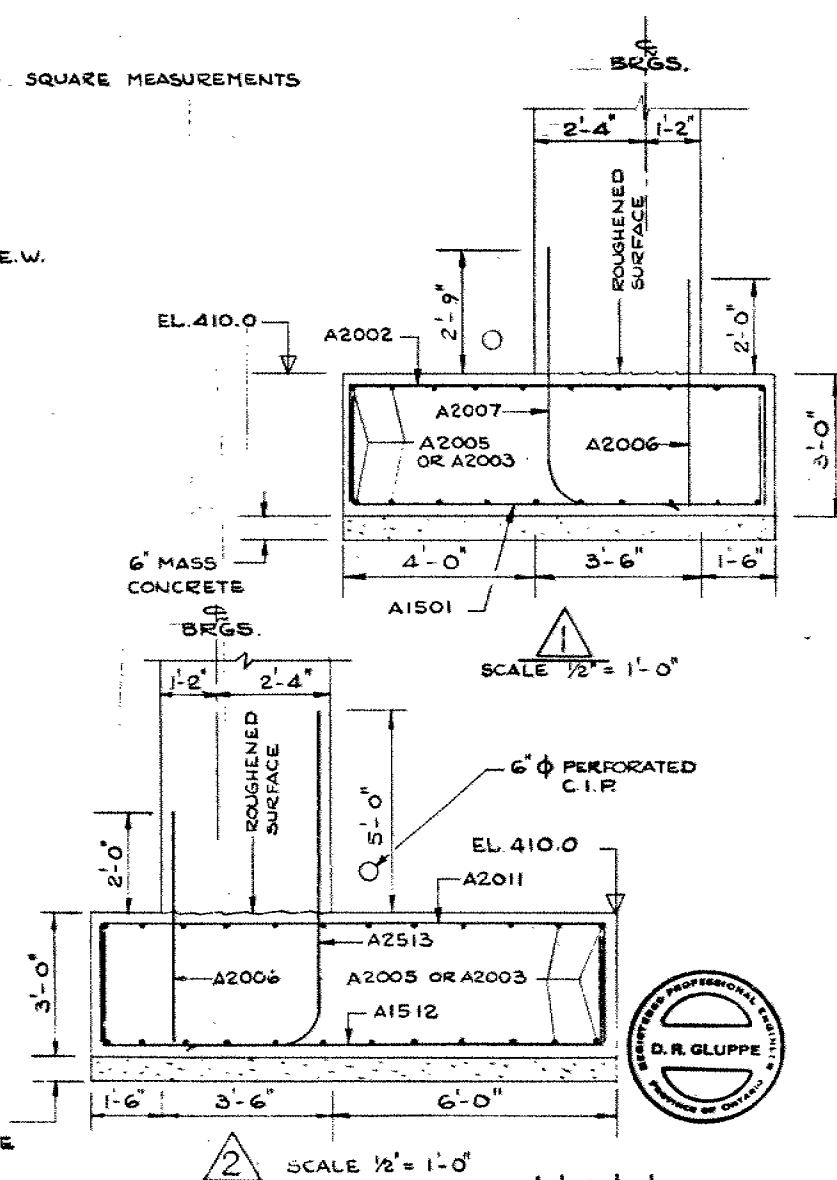
- * SIDES OF FOOTINGS & MASS CONCRETE TO BE CAST AGAINST UNDISTURBED MATERIAL.
- * MASS CONCRETE TO BE CAST WITHIN 3 HOURS AFTER FTG. EXCAVATION IS COMPLETED.

SOUTH
SCALE 1/2" = 1'-0"

NORTH
SCALE 1/2" = 1'-0"

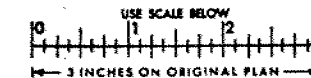


* SQUARE MEASUREMENTS



W.P. PROVINCIAL CO-ORDINATES			
W.P. STATIONS	CO-ORDINATES		
1	538+54.19	803,709.509	953,925.130
2	539+84.19	803,839.427	953,920.522

FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			



DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30MS-106

DIST. 4 REGION Central

W.P. No. 125-66-16

CONT. No. 78-104

W. O. No. _____

STR. SITE No. 10-287

HWY. No. _____

LOCATION W-N Ramp Hwy. 403

Structure over Ford Drive, QEW/
Ford Drive /403 Interchange

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 3

REMARKS: documents to be unfolded
before microfilming

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 125-66-16

DIST 4

HWY 403

STR SITE 10-287

W-N Ramp Hwy. 403 Structure over Ford Drive
QEW/Ford Drive/ 403 Interchange

DISTRIBUTION

C.G.E. Burkhardt (3)
R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

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G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

R. Fitzgibbon)
J. Anderson } cover only
G. Sloan }

Files ↓

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	7705 17	MD
TUBES		
ROCK CORES	to be removed of contract	MD

FOUNDATION INVESTIGATION REPORT
For

W-N Ramp Hwy. 403 Structure over Ford Drive
QEW/Ford Drive/ 403 Interchange
W.P. 125-66-16 Site 10-287
District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project during the period of March 21, 1977 to March 23, 1977. The fieldwork consisted of 4 sampled boreholes advanced by employing solid stem augers and BXL coring techniques. The boreholes ranged in depth from 29 to 31 feet below the ground level.

SITE DESCRIPTION AND GEOLOGY

The site is located just east of the QEW approximately 900 feet south of the existing QEW Underpass at Ford Drive in the Regional Municipality of Halton, Town of Oakville. The land immediately adjacent to the site slopes gently south to Joshuas Creek located some 500 feet to the south.

The land is used for farming and light industry with some unproductive, tree covered land along Joshuas Creek.

Physiographically the site lies on the southern fringe of the region referred to as the South Slope. This region is a strip of land bounded by the Iroquois Plain on the south and the Peel Plain on the north and extends from the Niagara escarpment to the Trent River. The region is characterized by a shallow till overlying shale of the Queenston and Dundas Formation of the Upper Ordovician age.

SUBSURFACE CONDITIONS

Generally, a 7 to 8 foot layer of clayey silt was found to overly 2 to 3 feet of moderately weathered grey shale underlain by sound shale of the Dundas Foundation. Detailed descriptions of the various soil and rock types encountered in each borehole are given in the Record of Borehole Sheets. The estimated stratigraphical profile and section shown on Drawing #1256616-A are based upon this information. From ground level downwards, the various soil types encountered are as follows:

Clayey Silt, Some Sand, Trace of Gravel

Immediately below a thin cover of topsoil, a 7 to 8 foot thick stratum of cohesive soil consisting of clayey silt with some sand and traces of gravel was encountered. In boreholes 2, 3 and 4, the upper 4 to 6 feet of this cohesive stratum is in a reworked condition due to previous highway construction activities.

The results of the Atterberg Limit tests as determined by laboratory testing are shown on the Plasticity Chart, Figure 1 and are listed below:

	<u>Range</u>	<u>Average</u>
Natural Moisture Content (W) %	14 - 18	16
Liquid Limit (W _L) %	27 - 34	30
Plastic Limit (W _p) %	17 - 20	18
Plasticity Index (I _p) %	9 - 15	11

The Atterberg Limits indicate that the cohesive stratum is generally inorganic and of low plasticity.

Two typical grain size distribution curves from this stratum are shown on Figure 2.

The Standard Penetration Test results ranged from 7 to 30 blows/ft. in the reworked zone, elsewhere, they varied from 32 to 44 blows/ft. indicating that the consistency of the reworked zone varies from firm to very stiff, whereas the consistency of the cohesive deposit elsewhere is hard.

Bedrock

Underlying the cohesive stratum is shale bedrock which was proven to a maximum depth of 23 feet. The bedrock is a grey shale with intermittent layers of limestone and shaly limestone. The upper 2 to 3 feet of the bedrock is moderately weathered.

The rock quality designation (RQD) classification gives an indication of the quality of the bedrock with respect to the number of fractures and amount of softening or alteration of the rock mass. The RQD is the total length of rock core pieces of 4 or more inches in length expressed as a percentage of the total length of core drilled. The RQD for the rock core varies from 0 to 75%, generally increasing with depth. These values indicate a rock quality of very poor to fair due to the presence of thin horizontal bedding planes.

A detailed description of the bedrock is given on the individual Report of Borehole Sheets.

GROUNDWATER

The groundwater level conditions across the site were observed by taking readings in the open boreholes during and after the completion of the field investigation. The results of the readings are shown on the Record of Borehole Sheets, as well as on Drawing #1256616-A.

The observations indicate that the groundwater levels vary between elevations 418 and 423, which corresponds to levels 4 to 6.5 feet below the existing ground surface.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a new complex interchange connecting QEW to Hwy. 403 Link and to a re-aligned Ford Drive. Two structures will be required to carry QEW detour traffic and ultimately Hwy. 403 W-N Ramp and N-W Ramp, over Ford Drive.

The proposed profile grade of the W-N Ramp at station 673+37 is about elevation 428 and on a 3% grade increasing to the north. The profile grade of the proposed Ford Drive is to be at approximately elevation 405, therefore requiring a 17 to 24 foot cut at the structure location.

Present proposals call for a 99 foot single span, three lane bridge with closed type abutments for the Ford Drive Underpass at W-N Ramp.

Structure Foundations

The closed abutment for the proposed Ford Drive Underpass at W-N Ramp can be supported on spread footings located within the sound shale and may be designed for a maximum bearing pressure of upto 10 tsf. A minimum earth cover of 4 feet should be provided to the underside of the footings, since the shale is considered susceptible to frost action. To prevent softening of the shale due to weathering at the footing elevation, it should be covered with 3 inches of mass concrete immediately after the completion of the excavation.

No dewatering problems are anticipated for the construction of the abutment footings. Any minor seepage or surface runoff into the excavations can be handled by pumping from sumps.

Other Considerations

For estimating the earth pressure of granular backfill on the abutment walls, a coefficient of active earth pressure of $K_a = 0.33$ may be used if some movement at the top of the wall is permitted. If no movement at the top of the wall is anticipated a coefficient of earth pressure at rest $K_o = 0.5$ may be used for design purposes.

To estimate the horizontal resistance to sliding between rough concrete and the shale, a coefficient of friction of 0.55 may be used.

In order to relieve the build up of hydrostatic pressure behind the abutment wall the structure should be backfilled with free draining granular material and provided with weepholes or other types of drainage conduit.

Ford Drive


As mentioned previously, a cut of up to 24 feet deep will be required in the vicinity of the structure in order to reach the new grade of proposed Ford Drive. This cut will be made through the cohesive clayey silt and into the shale bedrock.

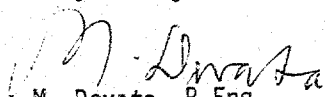
The shale is susceptible to weathering and erosion, therefore, the cuts should be treated as earth cuts and constructed with 2:1 slopes. It is further recommended that the cut slopes be covered with topsoil and sodded according to current MTC standards.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. C.T. Johnson, Project Engineer. The equipment used was owned and operated by Geocon Ltd., Toronto, Ontario.

This report was written by Mr. C.T. Johnson and reviewed by Mr. M. Devata, Supervising Engineer.


C.T. Johnson
Project Engineer


M. Devata, P.Eng.
Supervising Engineer

CTJ/MD/1f
May, 1977

FOUNDATION REQUEST

In a memorandum dated February 16, 1977, Mr. G.C.E. Burkhardt of the Structural Planning Office requested the Soil Mechanics Section to prepare a Foundation Investigation Report for the Ford Drive Underpass at W-N Ramp.

FIELD AND LABORATORY INVESTIGATION PROCEDURES

A total of 4 boreholes were put down using a muskeg mounted auger machine equipped with solid stem augers and rock coring equipment.

The locations and elevations of the boreholes were surveyed by personnel from the Central Regional Surveys and Plans Section.

Disturbed soil samples were recovered by means of a 2 inch O.D split spoon sampler driven in accordance with the specifications of the Standard Penetration Test. Rock core of the bedrock was obtained by coring with BXL diamond bits.

The samples were visually examined and identified in the field and again in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples of the cohesive stratum to determine the natural moisture content, Atterberg Limits and grain size distribution.

The rock core was examined and logged in detail in the laboratory by Mr. B.K. Glassford, Geologist.

APPENDIX

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 125-66-16 LOCATION Co-ords N 15 803 724; E 954 067 ORIGINATED BY CTJ
DIST 4 HWY 403 BORING DATE March 23, 1977 COMPILED BY CTJ
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, BXL Core CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N° VALUES		20	40	60	80	100			
425.1	Ground Level													
0.0	Clayey silt, some sand, trace of gravel		1	SS	30									
417.2	Very Stiff Reworked		2	SS	16									
415.7	(Weathered)		3	SS	31									
10.0	(Sound)		4	BXL	80% REC									
	Shale Bedrock (See Below)*		5	BXL	90% REC									
			6	BXL	100% REC									
393.8	End of Borehole													
31.3	*Intermittent shale, shaley limestone & limestone, fine texture, soft to hard bedding is thin and horizontal, light grey color, shale is fissile with Limestone (hard, fine texture, light grey, fossiliferous, horizontal bedding) seams from 22'0" to 22'8" 27'0" to 28'0"													

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

WP 125-66-16 LOCATION Co-ords. N 15 803 823; E 954 078 ORIGINATED BY CTJ
DIST 4 HWY 403 BORING DATE March 21, 1977 COMPILED BY CTJ
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, BXL Core CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100	w_p	w	w_L		
429.4	Ground Level															
0.0	Clayey silt, some sand, trace of gravel, occ. organic inc. Firm Reworked		1	SS	7											
421.9	Hard		2	SS	44											
7.5	(Weathered)		3	SS	79											
418.9	(Sound)		4	SS	153	420										
10.5	Shale Bedrock (See Below)*		5	BXL	63% REC											RQD 0%
			6	BXL	98% REC	410										RQD 16%
			7	BXL	92% REC	400										RQD 57%
399.4	End of Borehole															
30.0	*Intermittent shale, shaley limestone & limestone, soft to hard, fine texture, light grey colour, shale is fissile, thin bedding - horizontal with limestone, (med. hard to hard, fine texture light grey colour, fossiliferous) seams from 13'8" to 14'4" 20'10" to 21'7" 22' 8" to 24'5" 25' 1" to 26'4"					390										

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

WP 125-66-16 LOCATION Co-ords N 15:803 724; E 954 012 ORIGINATED BY CTJ
 DIST 4 HWY 403 BORING DATE March 23, 1977 COMPILED BY CTJ
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, EXL Core CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w w_p — w — w_L WATER CONTENT % 10 20 30	UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
422.0	Ground Level													
0.0	Clayey Silt, some Sand, Trace of Gravel	Red Grey	1	SS	46	420								
414.5	Hard		2	SS	32									
412.5	(Weathered)		3	SS	112	110"								
9.5	(Sound)													
	Shale Bedrock (See Below)*		4	BXL	91% REC	410								RQD 30%
			5	BXL	100% REC	400								RQD 63%
392.3														
29.7	End of Borehole					390								
	*Intermittent shale, shaly limestone & limestone, fine texture, soft to med. hard, light grey, shale is fissile, thin bedding with Limestone (med. hard, fine texture, light grey, fossiliferous) seams from 12'8" to 13'6" 19'6" to 20'2" 25'3" to 26'2"													

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

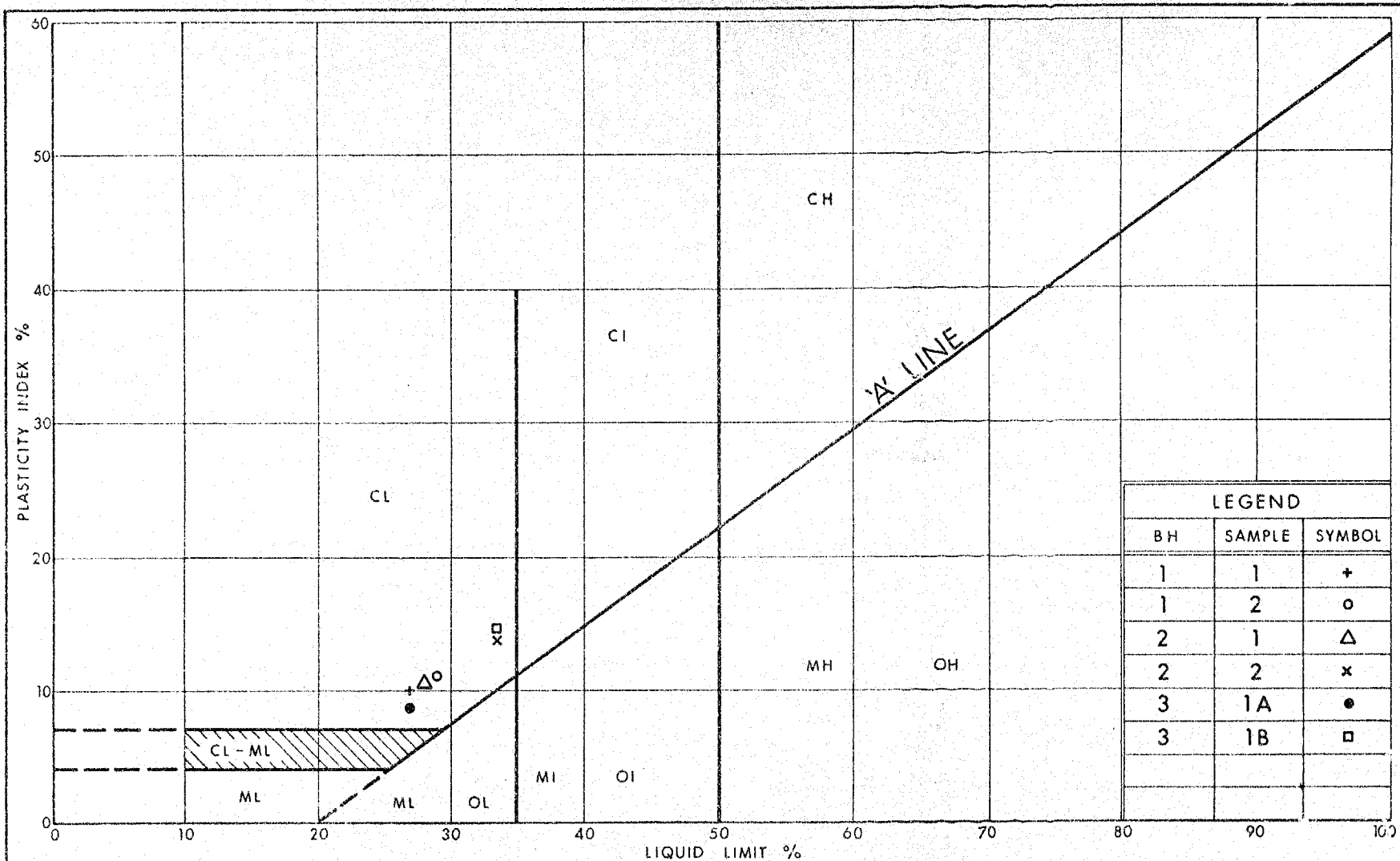
HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 125-66-16 LOCATION Co-ords N 15 803 823; E 954 023 ORIGINATED BY CTJ
 DIST 4 HWY 403 BORING DATE March 22, 1977 COMPILED BY CTJ
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger, BXL Core CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p — w — w_L					WATER CONTENT %
427.1	Ground Level													10	20	30	GR SA SI C
0.0	Clayey Silt, some Sand, trace of gravel (Reworked) Very Stiff		1	SS	16												5 31 39 25
420.0			2	SS	111	8"											
7.1	(Weathered)		3	SS	131	9"											
417.1	(Sound)		4	BXL	84% REC												RQD 25%
10.0	Shale Bedrock (See Below)*		5	BXL	100% REC												RQD 15%
			6	BXL	97% REC												RQD 60%
397.9																	
29.2	End of Borehole																
	*Intermittent shale, shaly limestone & limestone beds, soft to hard, fine texture, shale is fissile, light grey colour, thin horizontal bedding with Limestone (Hard, fine texture fossiliferous) seams from 11'10" to 12'4" 13'6" to 14'2" 22'2" to 22'6" 23'0" to 23'10" 28'10" to 29'2"					390											

OFFICE REPORT ON SOIL EXPLORATION



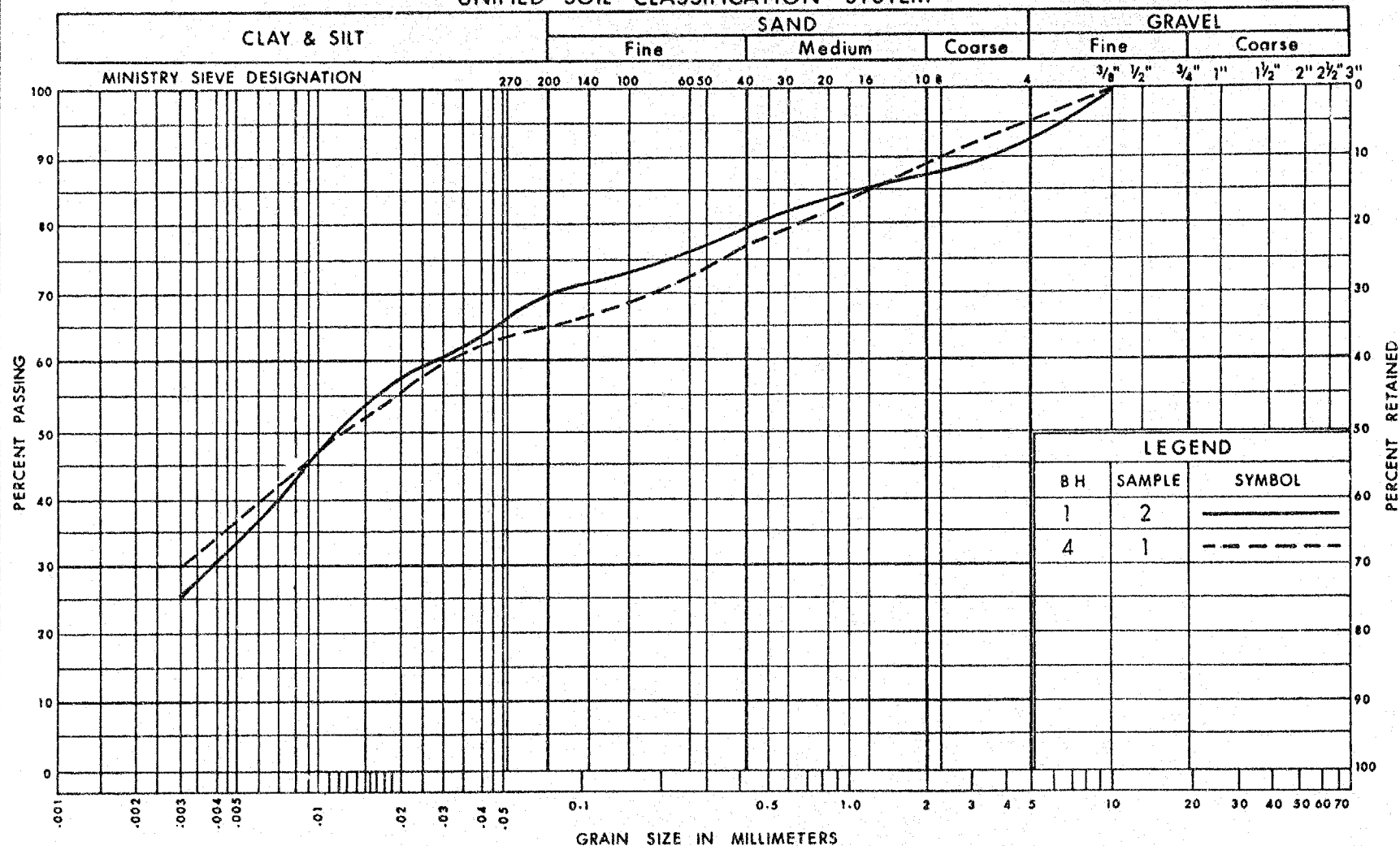
Ministry of
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Communications
Ontario

PLASTICITY CHART
CLAYEY SILT
SOME SAND, TRACE OF GRAVEL

FIG No 1

W P 125-66-16

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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Communications
Ontario
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
SOME SAND, TRACE OF GRAVEL

FIG No 2

W P 125 - 66 - 16

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

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

TERMS TO BE USED IN DESCRIBING SOILS:-

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

TYPE OF SAMPLE

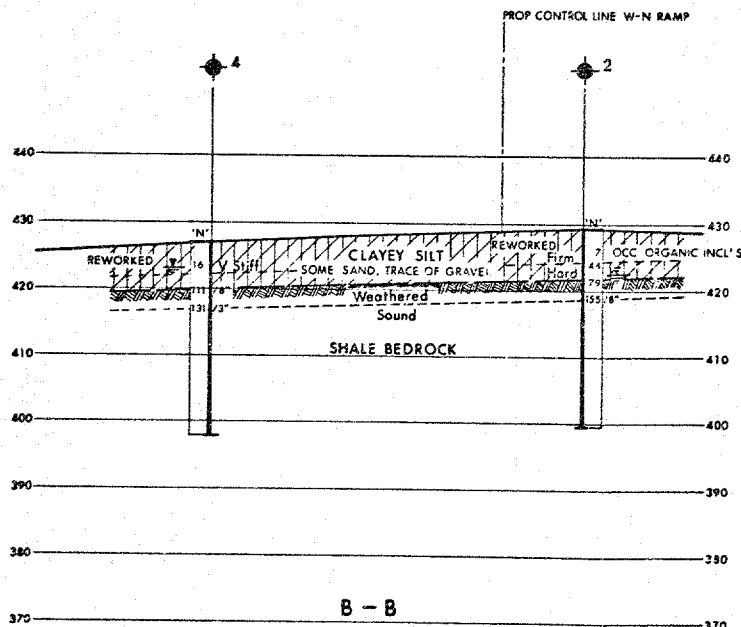
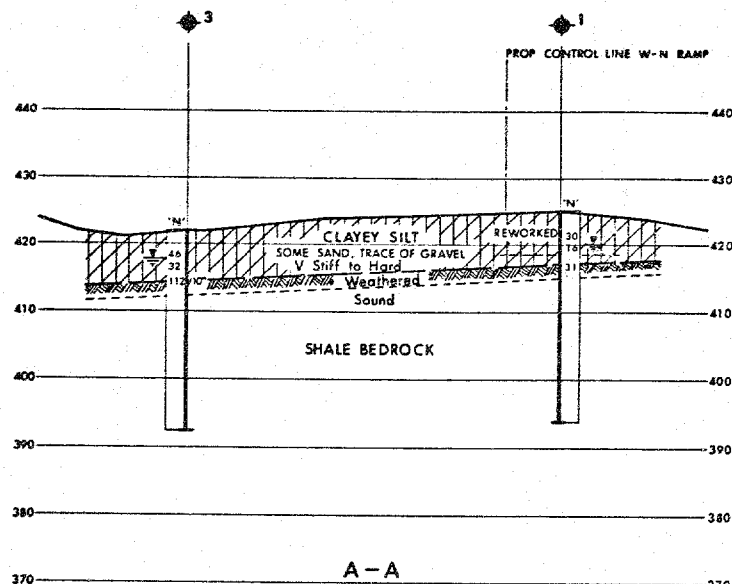
S.S	SPLIT SPOON	T.W	THINWALL OPEN
W.S	WASHED SAMPLE	T.P	THINWALL PISTON
S.T	SLOTTED TUBE SAMPLE	O.S	OESTERBERG SAMPLE
A.S	AUGER SAMPLE	F.S	FOIL SAMPLE
C.S	CHUNK SAMPLE	R.C	ROCK CORE

P.H SAMPLE ADVANCED HYDRAULICALLY

P.M SAMPLE ADVANCED MANUALLY

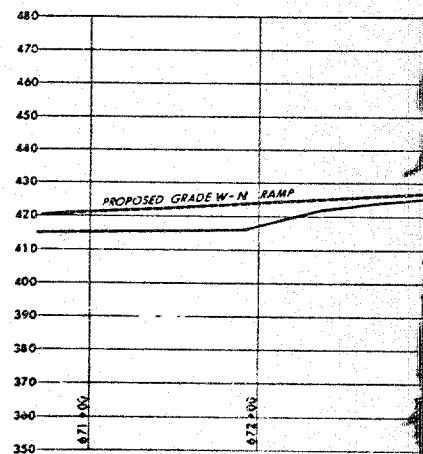
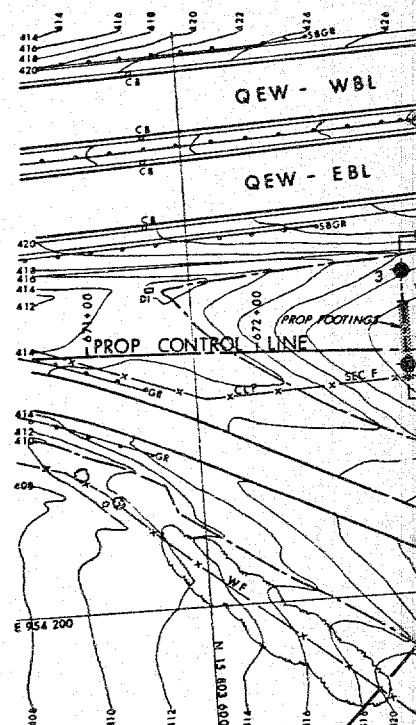
SOIL TESTS

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



SECTIONS

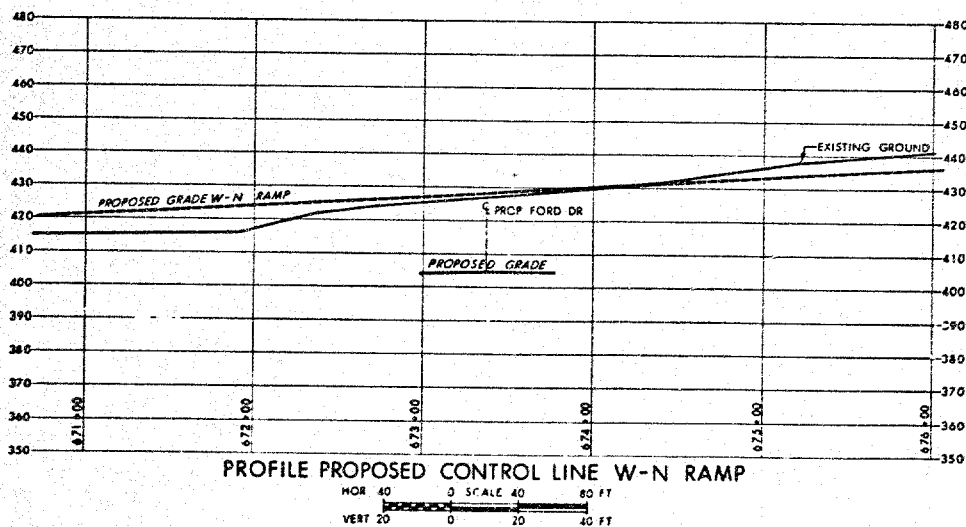
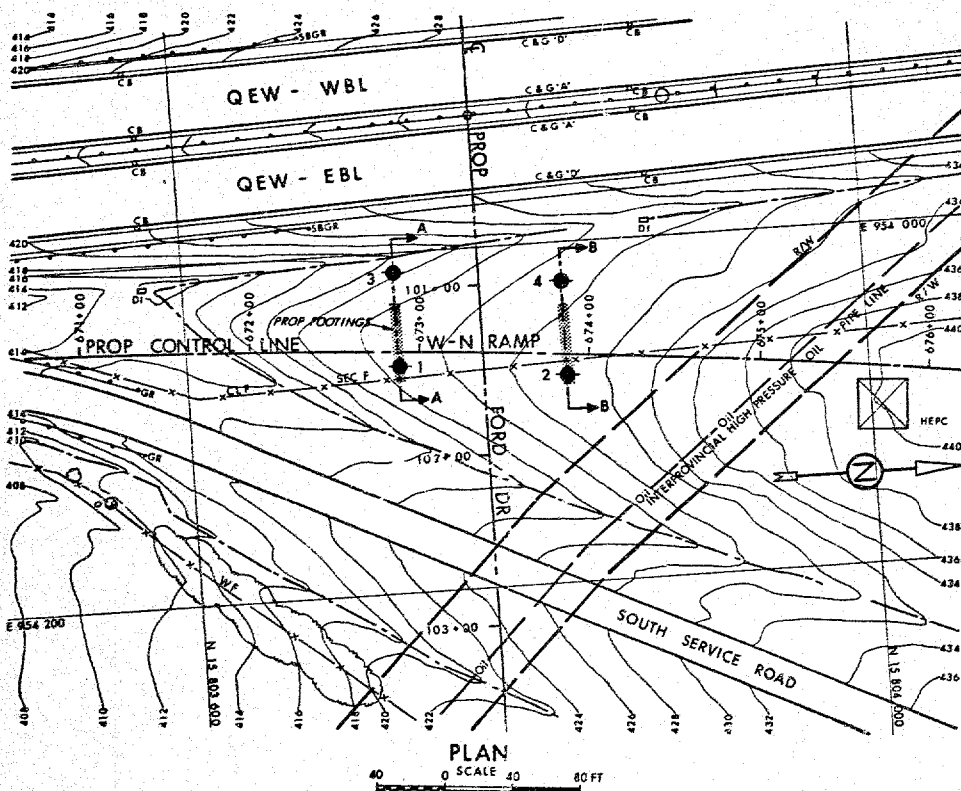
10 0 SCALE 10 20 FT



PROFILE PROPOSED

HOR 40

VERT 20



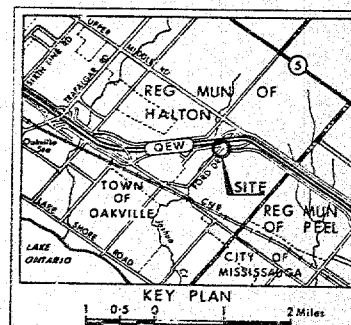
CONT No
WP No 125-66-16

PROPOSED FORD DRIVE

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- ✶ Blows/ft (Std Pan Test 350 ft lbs energy)
- CON Blows/ft (60° Cone, 350 ft lbs energy)
- ↓ WL at time of investigation on March 1977

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	425.1	15 803 724	954 067
2	429.4	15 803 823	954 078
3	422.0	15 803 724	954 012
4	427.1	15 803 823	954 023

NOTE

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

DATE	BY	DESCRIPTION

PLAN No 403 W-N RAMP
S. SMD CTJ CHECKED DATE May 4, 1977
ORGAN 85 CHECKED DATE
REF No 8-82-QEW-2 Sept 1976
SITE 10-287
No 1256616-A

ABBREVIATIONS & SYMBOLS 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
w_S	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN densest STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_r	SENSITIVITY

GENERAL

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

STRESS AND STRAIN

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

EARTH PRESSURE

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

FOUNDATIONS

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

SLOPES

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

DOCUMENT MICROFILMS IDENTIFICATION

GEOCRES No. 364 S - 706

DIST 4 REGION CENTRAL

W.P. No. 125-66-16

CONT. No. 78-104

W. O. No. _____

STR. SITE No. 10 - 287

HWY. No. _____

LOCATION V-N RmPs HWY 403

STRUCTURE OVER FORD DRIVE, GEN/FORD DR/403

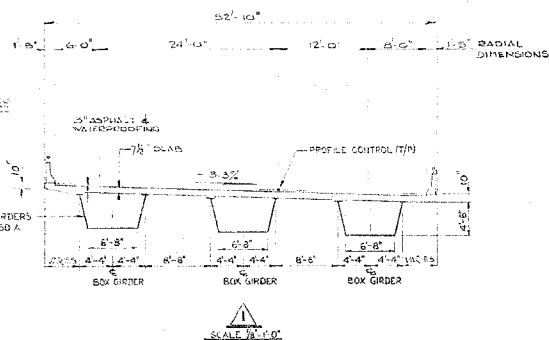
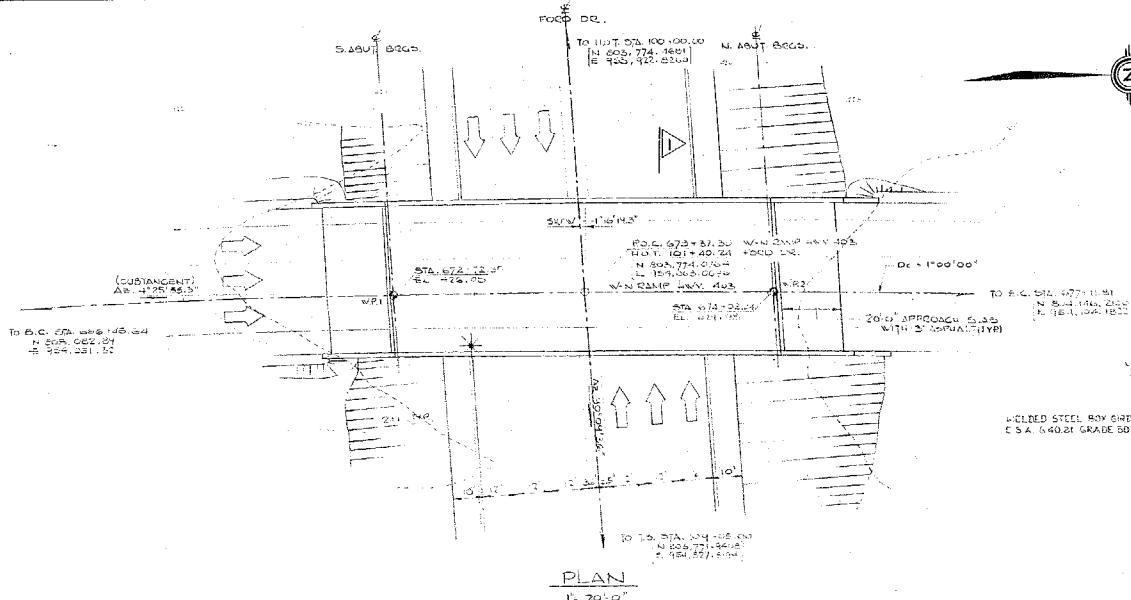
INTERCHANGE

OVER-SIGHT PHOTOGRAPH MADE FROM AERIAL PHOTOGRAPH REPORT 3

REMARKS: _____

3045-106

DIST. NO. 4	SHEET
CONT. No WP No 125-66-16	
W-N RAMP HWY. 403 OVER FORD DRIVE GENERAL PLAN	



- LIST OF DRAWINGS
1. GENERAL PLAN
 2. BORE HOLE LOCATIONS & SOIL STRATA
 3. FOOTING DETAILS
 4. SOUTH ABUTMENT
 5. NORTH ABUTMENT & RETAINING WALLS
 6. STRUCTURAL STEEL
 7. DECK REINFORCING
 8. DECK LAYOUT & SCREED ELEVATIONS
 9. BARRIER WALL
 10. STEEL RAILING (SINGLE TUBE)
 11. 20 FT APPROACH SLAB
 12. DETAILS OF CONC SLOPE PAVING
 13. STANDARD DETAILS I
 14. STANDARD DETAILS II
 15. STANDARD DETAILS III
 16. AS CONSTRUCTED ELEV. & DIM.

GENERAL NOTES

CLASS OF CONCRETE

ABUT. DECK & BARRIER WALLS 4000 P.S.I.
REMAINDER 3000 P.S.I.

CONCRETE QUANTITIES

RETAINING WALL 10 CU YDS
ABUTMENTS & WINGWALLS 236 CU YDS
DECK 182 " "
BARRIER WALLS 29 " "
APPROACH SLABS 62 " "
SLOPE PAVING 36 " "

STRUCTURAL STEEL QUANTITIES-106 TONS

CLEAR COVER TO REINF. STEEL

FOOTINGS & ABUTMENTS 3"
DECK 2" TOP; 1" BOTTOM
BARRIER WALLS 1/2" (EXCEPT AS NOTED)
APPROACH SLABS 2"

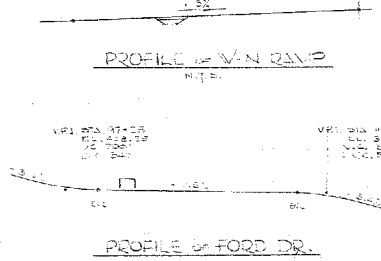
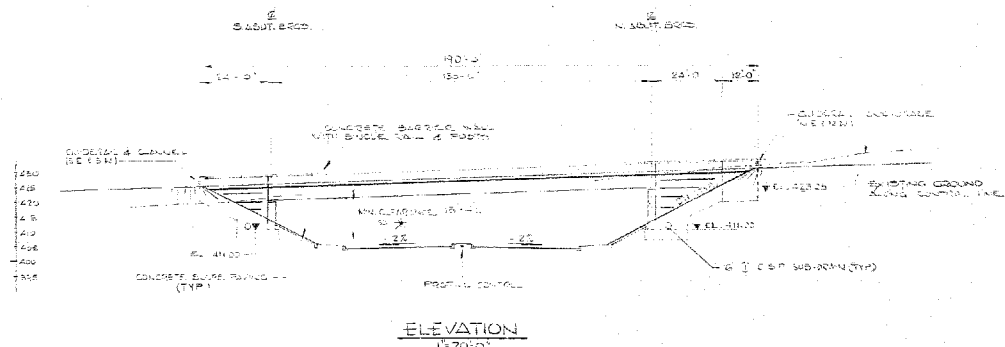
TO ACHIEVE THE MIN. CLEAR COVER OF 2" SPECIFIED, THE TOP LAYER OF DECK STEEL SHALL BE PLACED PRIOR TO CONCRETING WITH A CLEAR COVER OF 2 1/2" ± 1/2" TOLERANCE

REINFORCING STEEL: GRADE 60

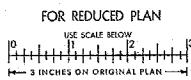
CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± 1/8".

NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.



B.M. ELEV. 440.81
BENCH MARK IS LOCATED ON TOP OF NW CORNER OF CONC. PAVEMENT OF SH-1 WEST OF FORD DR. 6 EAST OF G.E.W. 150 FT. RT. STA. 109+27 EXISTING FORD DR.



REVISION	DATE	BY	DESCRIPTION
1	NOV 24 1977	E.C. LANE	DESIGN
2			CHECK
3			LOADING
4			NOV 24 1977
5			NOV 24 1977
6			NOV 24 1977
7			NOV 24 1977
8			NOV 24 1977
9			NOV 24 1977
10			NOV 24 1977

SHEET



- SIDES OF FIG. & MASS CONCRETE TO BE CAST AGAINST UNDISTURBED MATERIAL
- MASS CONCRETE TO BE CAST IMMEDIATELY AFTER FIG. EXCAVATION IS COMPLETED.
- WALL LENGTHS MEASURED ALONG FRONT FACE.

SOUTH
 $\frac{1}{2}h = 1' - 0"$

NORTH
1/4" = 1'-0"

W.F. PROVINCIAL CO-ORDINATES			
W.F.	STATIONS	CO-ORDINATES	
		N	E
1	672+72.85	805704.25	954058.41
2	674+02.85	805558.86	954068.46



FOR REDUCED PLAN

DISC SCARC INTCH

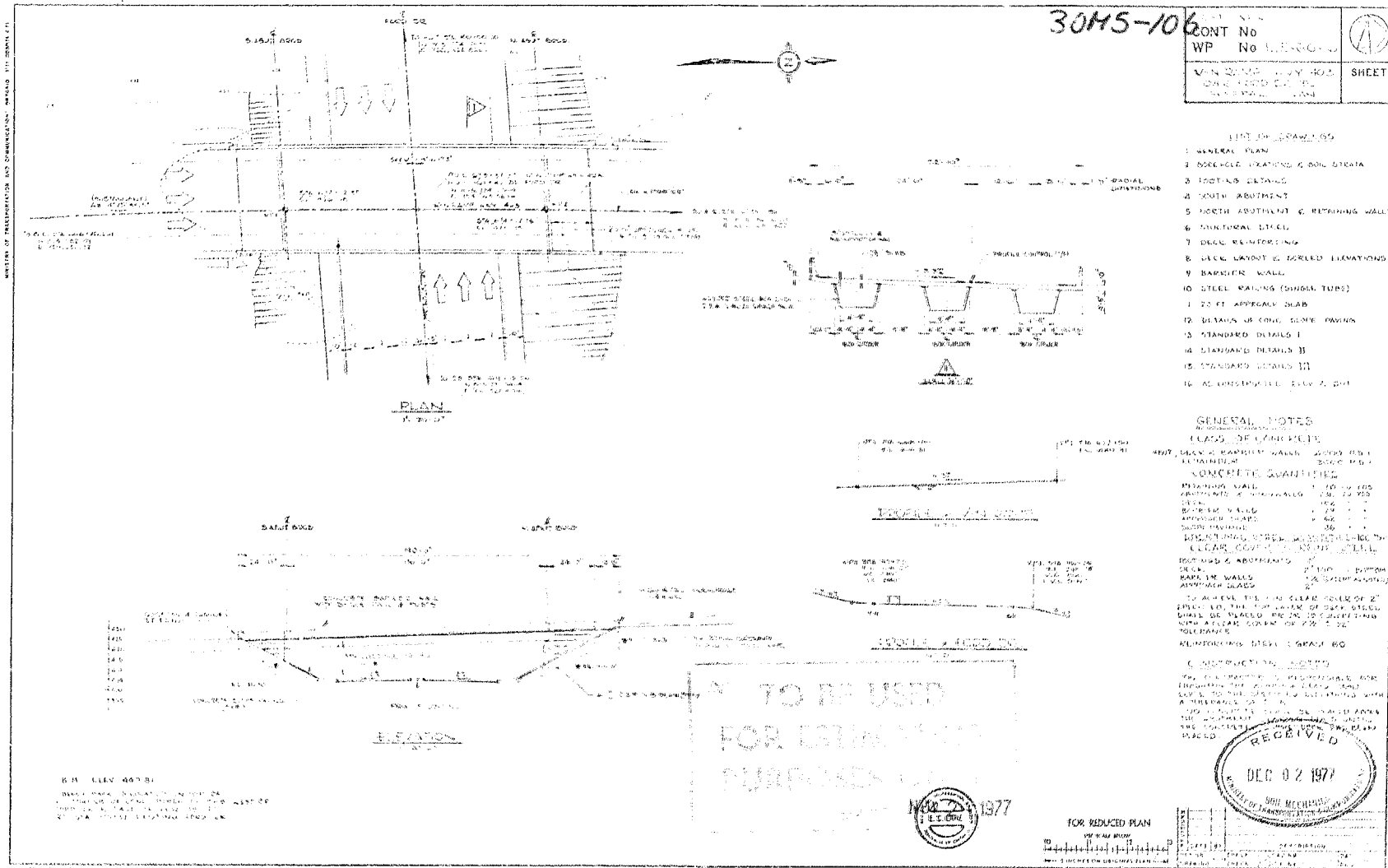
0 1 2

3 INCHES ON ORIGINAL PLAN

Systems

DATE	BY	DESCRIPTION
DESIGN-CL	CHECKING	LOADING IS 20.44
DRAWING DATE	CHECKED	SITE No. 10-282

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN FEET AND INCHES





Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 197-77-03

DIST 4

HWY 403 & 407

STR SITE 10-82-325

E-S Ramp Underpass Hwy. #403 & 407 Interchange
Complex

CONT. 84-78

DISTRIBUTION

G.C.E. Burkhardt (3)
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B.J. Giroux
R. Hore

R. Fitzgibbon (Cover Only)
T.J. Kovich (Cover Only)

Files

FOUNDATION INVESTIGATION REPORT

For

E-S Ramp Underpass
Hwy. #403 & 407 Interchange Complex
W.P. 197-77-03; Site 10-82-325
District #4 (Hamilton)

INTRODUCTION

This report contains the results of the foundation investigations carried out at the aforementioned site on 81 12 23 - 82 01 05, 82 10 28 - 82 11 01 and 82 11 22. The fieldwork consisted of seven sampled boreholes and seven dynamic cone penetration tests adjacent to each borings. The borings were advanced by continuous flight auger machines mounted on muskeg vehicles and equipped either with 83 mm (I.D.) hollow stem or solid stem augers.

SITE DESCRIPTION

The site is located in the vicinity of the existing Ninth Line Road, some 1.0 km north of Burnhamthorpe Rd. in the town of Milton, town of Oakville and the city of Mississauga. The surrounding terrain is relatively flat. Physiographically the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of cohesive type glacial till, followed by sandy silt to silty sand deposit, followed by shale bedrock. In some of the borings, a silty clay stratum was encountered over the bedrock. The boundaries of the different strata, together with

the obtained field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 1977703-A. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below a thin layer of topsoil a till-like zone was encountered at every boring location. The thickness varies from 7.0 m to 10.5 m. In B.H.'s #14 & 15 this zone was not fully penetrated. The material in the deposit was found to consist of a heterogeneous mixture of silty clay, sand and gravel. The matrix of this till is basically cohesive in nature - i.e., silty clay binding coarser particles. There are random localized zones where the matrix is only slightly cohesive. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 21 to over 100 blows per 30 cm.

In the vicinity of Boreholes #14 & 15 the extreme upper portion (1.0 - 1.5 m) of the material is in a soft to very soft condition due to the stagnant surface water.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>
Natural Moisture Content (%)	6-16
Liquid Limit (%)	12-29
Plastic Limit (%)	11-18

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

The consistency of the overall deposit varies from very stiff to hard. The very stiff zones are mainly confined to the upper portion of the deposit.

Sandy Silt to Silty Sand, Traces of Gravel & Clay

This stratum was encountered in those borings which were advanced below the above described glacial till. The thickness varied from 5.1 m to 14.4 m at the boring locations. The material in the deposit consists of sands and silts with varying proportions, with traces of gravel and clay. Occasional layers of silty clay were also intercepted in the lower part of the deposit.

Standard Penetration Tests, carried out within the deposit, gave 'N' values over 100 blows per 30 cm. Based on this value, the overall deposit may be classified as being very dense. The natural moisture content ranges from 9 to 14%. The results of the grain-size analyses performed on selected samples are plotted in an envelope form on Figure #2 of the Appendix.

Silty Clay, Some Sand

An approximate 4.7 to 6.0 m thick silty clay, some (trace) of sand zone was found to underlie the silty sand to sandy silt stratum in B.H.'s #4 and #5.

This deposit has a hard consistency. The natural moisture content is in the order of 15%.

Shale Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand and/or below the silty clay deposits in Boreholes #1, 4, 5 and 102. The shale is badly weathered. No core samples were obtained.

GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation: B.H. #1 El. 179.9

B.H. #2 El. 180.5

B.H. #4 El. 180.0

No groundwater level measurements were carried out in B.H.'s #5 and #102.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct two new highways (Hwy. #403 and Hwy. #407) in the vicinity of the existing Ninth Line, about 1.0 km north of Burnhamthorpe Rd. An interchange complex, consisting of several structures will be required to allow traffic transfer from one multi-lane highway to the other. One of these structures, designated as E-S Ramp, is the subject of this report.

This E-S Ramp structure will be built on a horizontal curve, having a radius of 450 m. A total of nine footings will be required. The following span lengths (beginning at the south abutment) are proposed at the time of this report preparation: 44.5 m - 55.5 m - 41.0 m - 55.5 m - 55.5 m - 55.5 m - 53.0 m - 42.5 m. The chainage of the south abutment bearings is at Sta. 1 + 298.142. In this report the piers are numbered from 1 to 7, progressing from the south abutment to the north. The height of the approach embankments are as follows:

South Approach: 10 m

North Approach: 6 m

The vertical clearance is 4.65 m at the crossing of Hwy. #407 N.B.L. and E-S Ramp underpass structure.

STRUCTURE FOUNDATIONS

The following foundation alternatives are recommended:

1) Spread Footings Within Original Ground

The entire structure (abutments and piers) may be supported on spread footing type foundations at or below the following elevations:

<u>Footing Location</u>	<u>Recommended Footing Level (At or Below)</u>
South Abutment	E1. 178.8
Pier #1 7	E1. 178.8 ✓ (178.5)
#2 6	E1. 178.8
#3 5	E1. 178.8
#4 4	E1. 178.2 (179.0)
#5 3	E1. 178.2 ✓ (175.5)
#6 2	E1. 178.2 ✓ (173.5)
#7 1	E1. 177.6 ✓ (175.0)
North Abutment	E1. 177.6

It should be noted, however, that 1.4 m of earth cover should be provided, to the underside of the footings, for frost protection purposes. For footings founded at or below the above quoted elevations, an allowable bearing value of up to 385 kPa can be used in design.

For purposes of the O.H.B.D.C. the following design values are recommended:

Factored Bearing Capacity at U.L.S. = 580 kPa

Bearing Capacity at S.L.S. Type II = 385 kPa

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the code. For the granular backfill a non-yielding foundation condition should be assumed, in which case a value of $K_o=0.43$ is recommended. The base of the footing excavations should be protected by 15 cm of mass concrete within 8 hours of exposure.

Settlements of the foundation subsoil, due to the surcharge loading of the footings will be negligible (approx. 25 mm) in magnitude.

No dewatering problems are anticipated due to the relatively impervious nature of the subsoil.

2) Spread Footings on Compacted Granular Fill

As an alternative, the abutments may be supported on spread footings placed on well compacted, suitable granular material within the approach fills. A safe design load of 355 kPa may be assumed. A detailed construction scheme is outlined on Fig. 3 of the Appendix. In computing the shearing resistance between the base of the footing and the compacted Granular 'A' core, the coefficient of friction may be taken as 0.55. For purposes of the O.H.B.D.C. the following design values are recommended:

Bearing Capacity at S.L.S. Type II = 335 kPa

Factored Bearing Capacity at U.L.S. = 500 kPa

Handwritten note: Increase to 900 kPa
12/8
84-01-04

3) Perched Abutments on Short Piles

As a second alternative, the abutments may be constructed within the approach fills and supported on short piles driven through the fill some 10 m into the original subsoil. In the case of steel 'H' piles (310 HP 110 or 310 HP 79) design loads up to 890 kN may be assumed.

Handwritten note: 10m

The piles should be driven in accordance with M.T.C. Standards SS103-10 or SS103-11. For the purpose of the O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S. = 1160 kN

Capacity at S.L.S. Type II = 890 kN

The pile caps should have a minimum of 1.4 m earth cover for frost protection requirements.

APPROACH EMBANKMENTS

Fills up to 10 m will be required at this location adjacent to the proposed structure. No stability problems are anticipated for the approaches of this height constructed with 2:1 slopes. The fill should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches through which piles may have to be driven, and it is recommended that this portion of the fill contain no larger grain sizes than 75 mm. It is estimated that the total settlement caused by the embankment loading will be in the order of 50 mm.

In the vicinity of Borehole No. 14 (Sta. 1 + 360+) a very soft, about 1.5 m thick surficial material was encountered. It is recommended that this very soft zone of the glacial till be removed to its full vertical and horizontal extent within the construction area. The exact dimensions (vertical & horizontal) of the soft material at this location and at other locations along the proposed embankment will be determined by the Regional Geotechnical Section.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. D. Collom, Construction Technician (1981) and Mr. J. Hayward, Student Field Technician (1982). The equipment used was owned and operated by Master Soil Investigation Ltd. This report was written by Mr. P. Payer, and reviewed by Mr. K.G. Selby.

P. Payer
P. Payer, P. Eng.
Foundations Engineer



K.G. Selby
K.G. Selby, P. Eng.
Senior Foundations Engineer

APPENDIX



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RECORD OF BOREHOLE No 1

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 898.5; E 286 663.8 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY GP
DATUM Geodetic DATE 82 10 28 CHECKED BY SP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40	60	80	100	SHEAR STRENGTH
180.9	Ground Level																	
0-0	Heterogeneous Mixture of Silty Clay		1	SS	27		180											
	Sand & Gravel		2	SS	33		178											
	V. Stiff to Hard		3	SS	35													
	Glacial Till		4	SS	21													
			5	SS	39													
			6	SS	69													
173.9							174											
7.0	Compact		7	SS	19		172										8 40 42 10	
	Silty Sand to Sandy Silt		8	SS	75/ 15 cm		170											
	Trace of Gravel & Clay		9	SS	90/ 8 cm		168										10 37 51 2	
	Very Dense		10	SS	90/ 8 cm		166											
			11	SS	70/ 8 cm		164											
			12	SS	64/ 23 cm		162											
162.5																		
18.4	Reddish Brown Weathered Shale																15 39 34 12	
161.0			13	SS	100/ 5 cm													
19.9	End of Borehole																	

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



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RECORD OF BOREHOLE No 2

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 805.5; E 286 649.5 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PP
DATUM Geodetic DATE 82 10 29 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH					
181.3	Ground Level						20 40 60 80 100	10 20 30					
0.0	Heterogeneous Mixture of Silty Clay (CL)												
	Sand & Gravel		1	SS	38/23	cm							
	Hard		2	SS	76/23	cm							
	Glacial Till		3	SS	32								
			4	SS	60/15	cm							
			5	SS	60/15	cm							
			6	SS	60/15	cm							
174.3													
7.0	Sandy Silt to Silty Sand		7	SS	60/15	cm							
	Some Gravel		8	SS	80/	8 cm							
	Traces of Clay		9	SS	75/	8 cm							
			10	SS	75/	8 cm							
	Very Dense												
			11	SS	90/	8 cm							
			12	SS	60/	10 cm							
										</			

+3, x5 : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



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RECORD OF BOREHOLE No 4

METRIC

W P 197-77-03

LOCATION Co-ords. N 4 820 604.7;

E 286 684.4

ORIGINATED BY JH

DIST 4 HWY 403

BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test

COMPILED BY PP

DATUM Geodetic

DATE 82 10 29 and 82 11 01

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						WATER CONTENT (%) 10 20 30
180.8	Ground Level													
0.0	Heterogeneous Mixture of Silty Clay		1	SS	30									
	Sand & Gravel		2	SS	42									
	Hard		3	SS	61									
	Glacial Till		4	SS	92									
			5	SS	40/8 cm									
			6	SS	43									
			7	SS	60/15 cm									
			8	SS	30/8 cm									
170.7														
10.1	Silty Sand to Sandy Silt		9	SS	30/8 cm									
	Traces of Gravel & Clay													
	V. Dense		10	SS	90/3 cm									
165.6														
15.2	Silty Clay		11	SS	30/8 cm									
	Some Sand													
	Hard													
160.9			12	SS	60/8 cm									
19.9	End of Borehole													
	Reddish Brown Weathered Shale													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



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Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 516.5; E 286 734.0 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY GP
DATUM Geodetic DATE 82 11 01 and 02 CHECKED BY EP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
180.5	Ground Level									10	20	30		
0.0	Heterogeneous Mixture of Silty Clay		1	SS	35		180							
			2	SS	76		178							
	Sand & Gravel		3	SS	65		176							
	Hard		4	SS	38		174							
	Glacial Till		5	SS	42		172							
			6	SS	66/	23 cm	170							
			7	SS	101		168							
170.0														
10.5	Silty Sand to Sandy Silt		8	SS	86/	23 cm	170							
	Traces of Gravel & Clay		9	SS	80/	15 cm	168							
	V. Dense		10	SS	70/	15 cm	166							
163.6														
16.9	Silty Clay		11	SS	65/	15 cm	162							
	Traces of Sand						160							
	Hard		12	SS	100/	15 cm	158							
157.6														
22.9	Reddish Brown Weathered Shale													
156.1														
24.4	End of Borehole													
	Note: No Groundwater Level Measurements Were Carried Out.													

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 467.5; E 286 767.0 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 82 11 22 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
179.8	Ground Level		1	SS		4/45								
0.0	V. Soft to Soft		2	SS	13									
	Heterogeneous Mixture of Silty Clay		3	SS	38									
	Sand & Gravel		4	SS	84									
	Stiff to Hard		5	SS	91									
			6	SS	60									
174.8			7	SS	59									
5.0	End of Borehole													
	Surface Water Level 15 cm above Ground Level (82 11 22)													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 15

METRIC

W P 197-77-03 LOCATION Co-ords. N 4 820 415.0; E 286 838.5 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY PP
DATUM Geodetic DATE 82 11 22 CHECKED BY *GP*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100		W _p	W	W _L		
180.0	Ground Level												
0.0	Soft		1	SS	37								
	Heterogeneous Mixture of Silty Clay		2	SS	98	28 cm							
	Sand & Gravel		3	SS	89								
	Hard		4	SS	71								
	Glacial Till		5	SS	34								
173.4			6	SS	40								
6.6	End of Borehole												

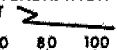

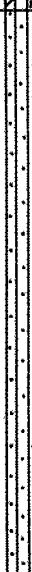

+3, x5: Numbers refer to
Sensitivity

20
15 \pm 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 102

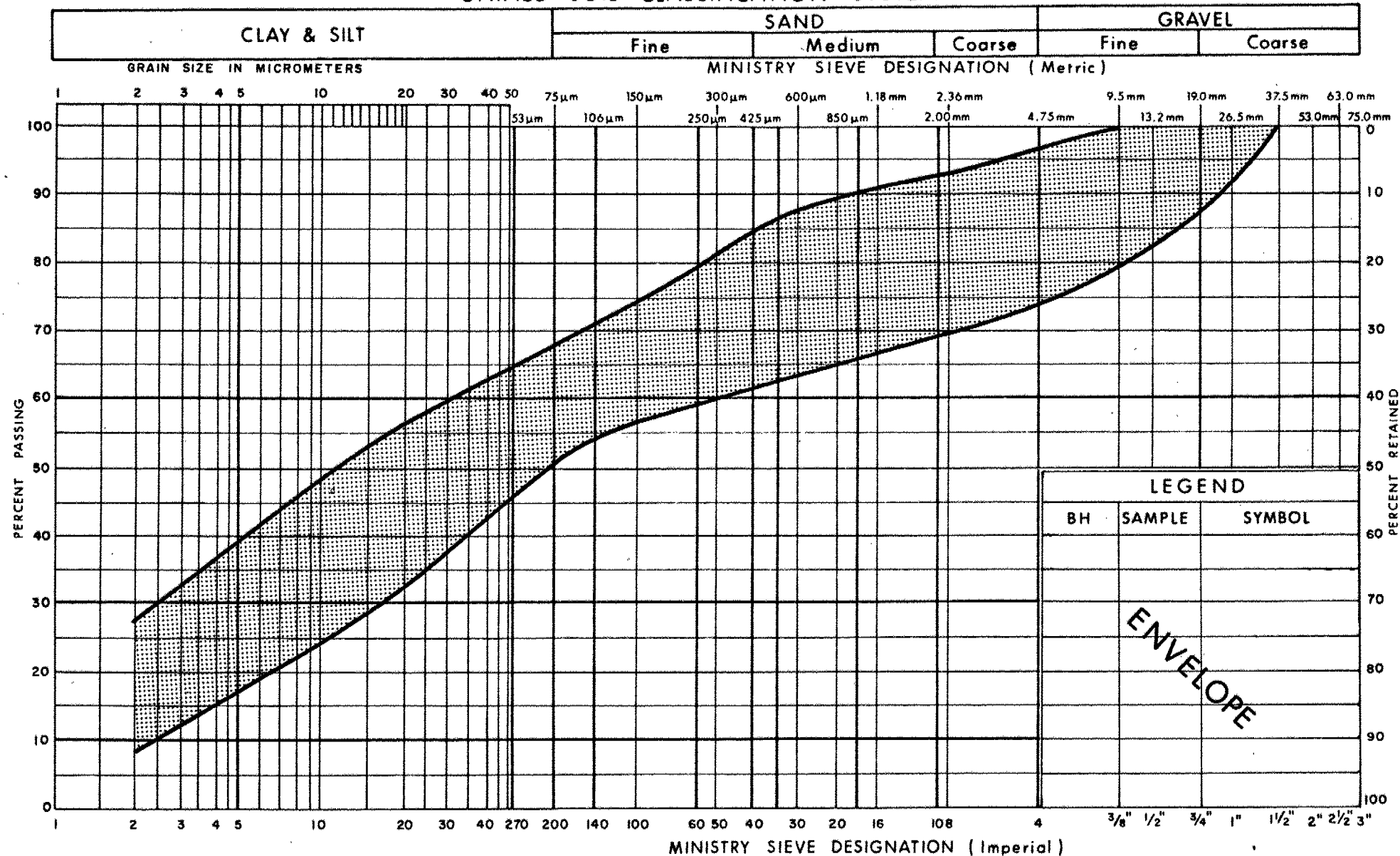
METRIC

W P 197-77-03 LOCATION Co-ords N 4 820 741.1; E 286 632.4 ORIGINATED BY DBC
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (H.S.) & Cone Test COMPILED BY PP
DATUM Geodetic DATE 81 12 23 - 82 01 05 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%) 10 20 30	GR SA SI CL
181.0	Ground Level															
0.0	Heterogeneous Mixture of Silty Clay		1	SS	22		180		○	—			16 23 43 18			
	Sand & Gravel		2	SS	29											
	V. Stiff to Hard		3	SS	27					○	—		3 31 42 24			
	Glacial Till		4	SS	72			178								
			5	SS	38											
			6	SS	33			176								
			7	SS	39					○	—		26 23 32 20			
			8	SS	111					○			6 31 55 8			
			9	SS	83			174		○			15 34 38 13			
			10	SS	110	18 cm				○	—		10 30 45 15			
172.5																
8.5	Sandy Silt to Silty Sand		11	SS	125	23 cm	172									
	Traces of Gravel & Clay		12	SS	186	15 cm	170			○		6 24 61 9				
	Occ. Silty Clay Layers		13	SS	100	10 cm	168									
	V. Dense		14	SS	115	13 cm	166			○		11 43 40 6				
			15	SS	49		164									
			16	SS	100	10 cm	162			○	—	4 38 48 10				
			17	SS	100	15 cm	160									
			18	SS	67	15 cm				○			1 12 82 5			
160.3																
20.7	Reddish Brown		19	SS	100	15 cm	160		○	W _p = 14%		0 26 57 17				
159.5	Weathered Shale									W _L = 52%						
21.5	End of Borehole															
	Note: No Groundwater Level Measurements Were Carried Out.															

+3, x5 : Numbers refer to 20
Sensitivity 15 ± 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



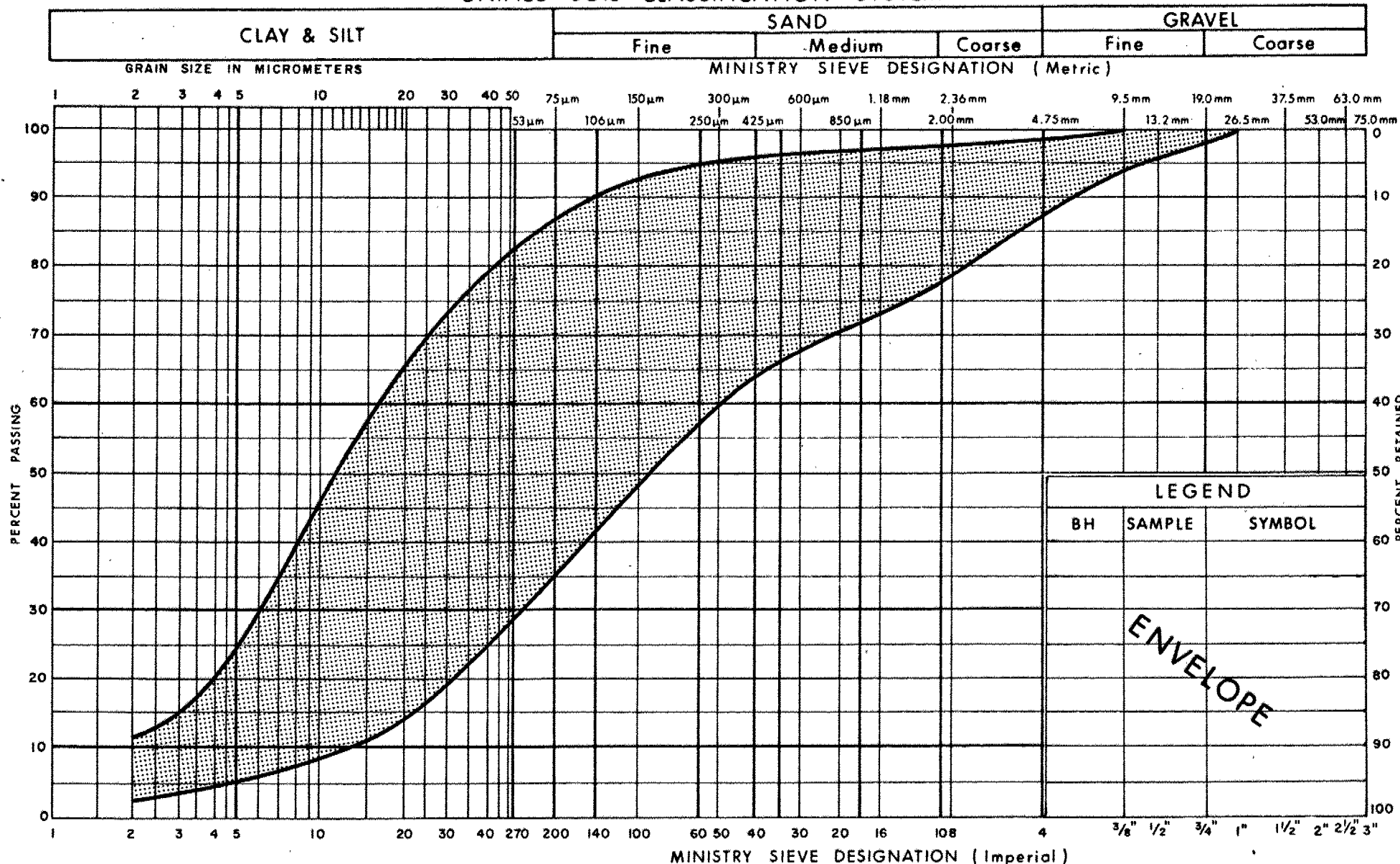
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GRAIN SIZE DISTRIBUTION
HET MIXTURE OF
SILTY CLAY SAND & GRAVEL (Glacial Till)

FIG No 1

W P 197-77-03

UNIFIED SOIL CLASSIFICATION SYSTEM



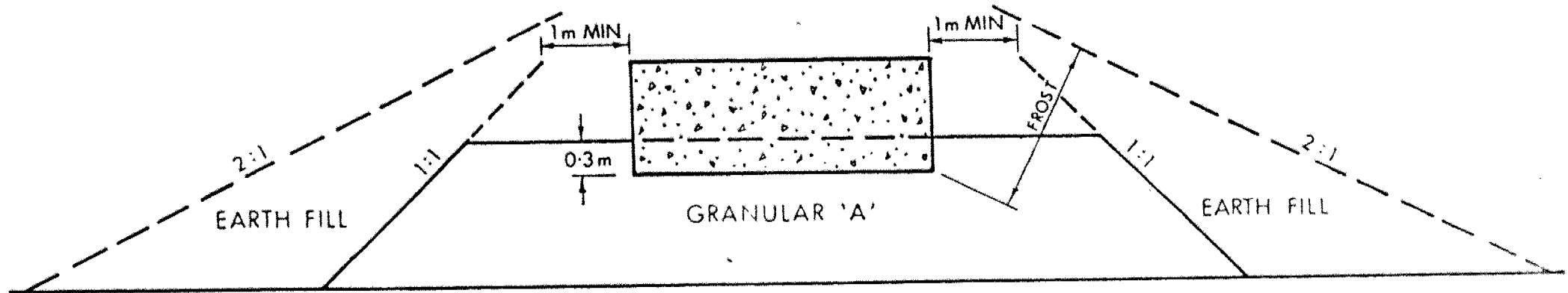
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Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT
TRACES OF GRAVEL & CLAY

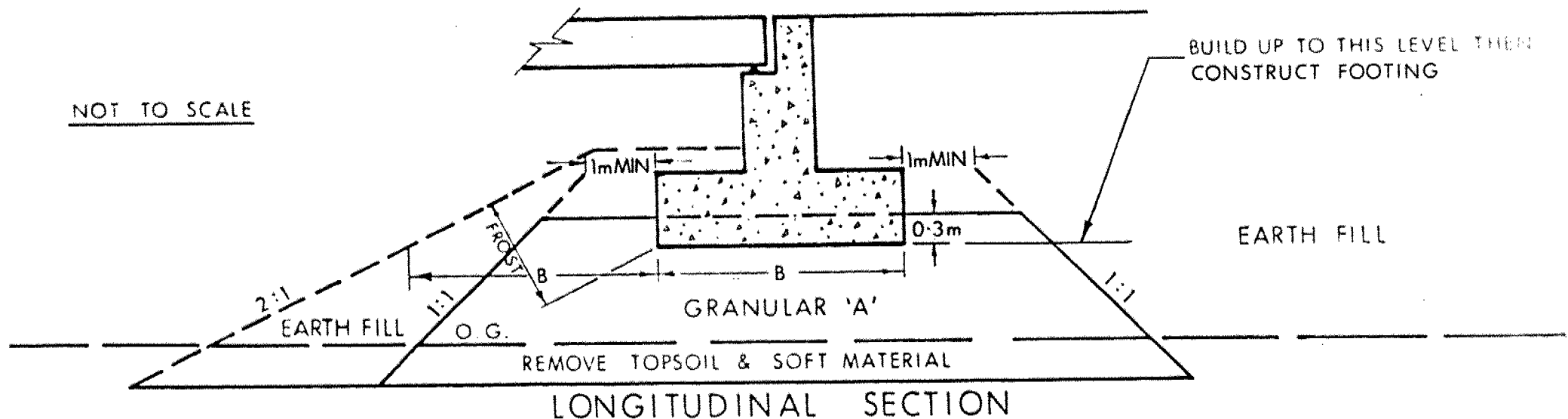
FIG No 2

W P 197-77-03

ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



X SECTION



LONGITUDINAL SECTION

NOTES:

- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.C. STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

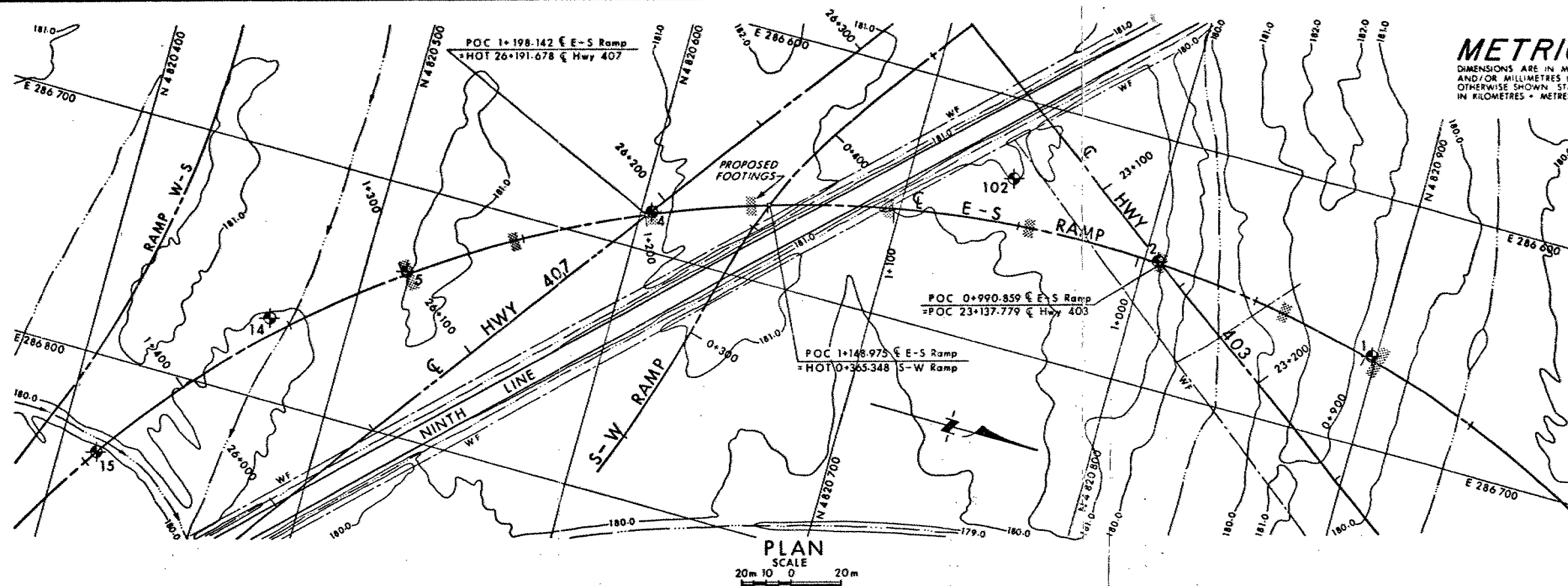
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

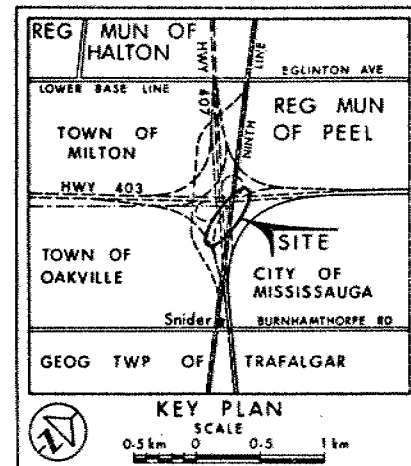
PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $\frac{w_L - w_p}{w - w_p}$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						



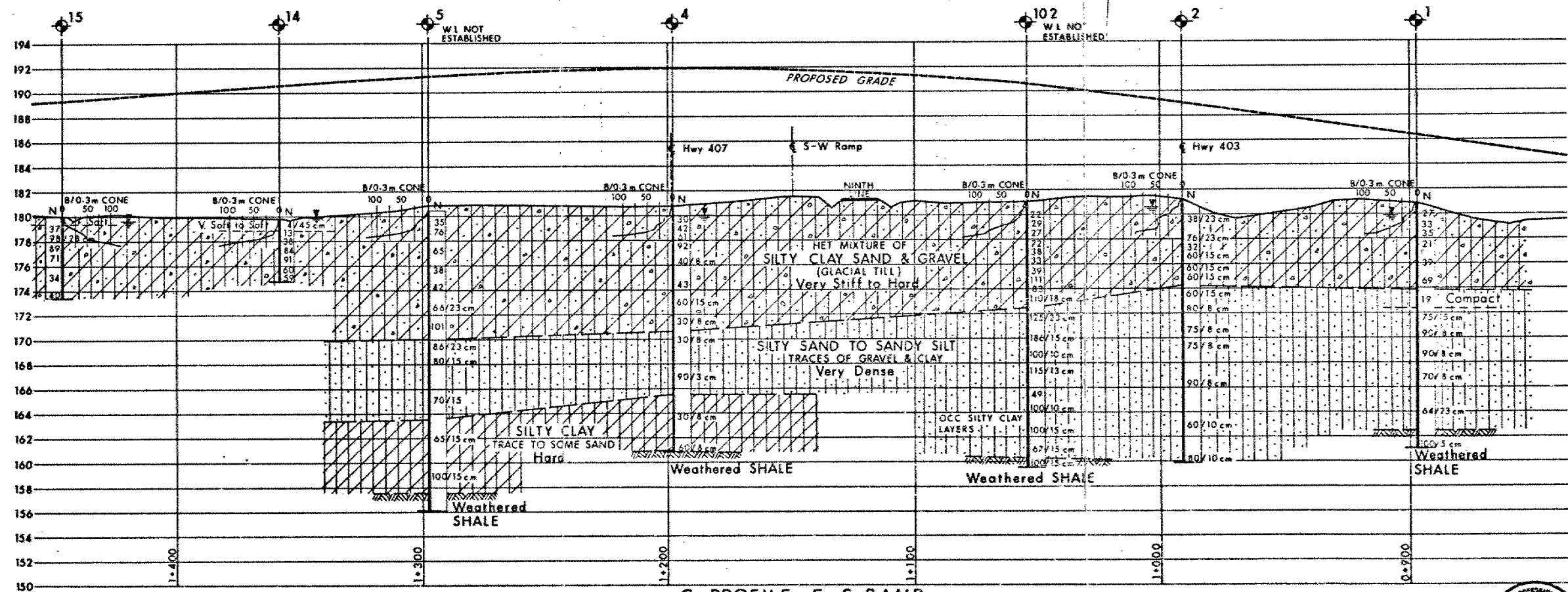
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 197-77-03
E-S RAMP UNDERPASS
(HWY 403 & 407)
BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation
1982 10 and 1982 11
- W.L. Not Established in BH 5 & 102



PROFILE E-S RAMP

SCALE
HOR 20m 10 0 20m
VERT 4m 2 0 4m

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	180.9	4820898.5	286663.8
2	181.3	4820805.5	286649.5
4	180.8	4820604.7	286684.4
5	180.5	4820516.5	286734.0
14	179.8	4820467.5	286767.0
15	180.0	4820415.0	286838.5
102	181.0	4820741.1	286632.4

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: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION
1	1982 11 30		

Geocres No 30M12-169

HWY No 403	SITE 10-82-325
SUBMITED PP CHECKED	DATE 1982 11 30
DRAWN BY CHECKED	DATE 1977 03 04



memorandum



To: W.L. Lin
Design Engineer
Structural Office
4th Floor
3501 Dufferin Street

Date: 1984 02 03

From: Foundation Design Section
Room 315, Central Building

RE: Ramp E-S Underpass
Hwy. 403/407 Interchange
W.P. 197-77-03, Site 10-82-325
District #4, Hamilton

Further to our recent discussions regarding Pier #4 at the above-mentioned structure, the factored bearing capacity at U.L.S. for the footing founded at el. 177.00 may be increased to 1050 kPa for your design purposes.

A handwritten signature in dark ink, appearing to read "K.G. Selby".

K.G. Selby, P. Eng.
Senior Foundations Engineer

KGS/mmj

memorandum



To: W.L. Lin
Design Engineer
Structural Office
3501 Dufferin Street

Date: 1984 01 05

From: Foundation Design Section
Room 315, Central Building

Re: Ramp E-S Underpass
Hwy. #403/407 Interchange
W.P. 197-77-03, Site: 10-82-325
District #4 (Hamilton)

As per our discussion of 84 01 04, the factored bearing capacity at U.L.S. for spread footings on compacted granular fill may be increased up to 900 kPa. This applies to the abutments only.

A handwritten signature in dark ink, appearing to read "K.G. Selby".

K.G. Selby, P. Eng.
Senior Foundations Engineer

KGS/mmj

memorandum



To: W.L. Lin
Design Engineer
Structural Office
4th Floor
3501 Dufferin Street

Date: October 26, 1983

From: Foundation Design Section
Room 315, Central Building

Re: Ramp E-S Underpass
Highway 403/407 Interchange
W.P. 197-77-03, Site 10-82-325
District #4 (Hamilton)

We have reviewed the final bridge drawings (#1, #4 and #5) for the above project and are submitting the following comments.

The base of the footing excavations should be protected with a 15 cm thick mass concrete within 12 hours of exposure. A note should appear on the drawings concerning this requirement.

K.G. Selby

KGS/mmj

K.G. Selby, P. Eng.
Senior Foundations Engineer

memorandum



To: Mr. K. Selby,
Senior Foundation Engineer,
Pavement and Foundation
Design Section,
Central Building, Downsview.

Date: 1983-01-27

Central Region

RE: Foundation Investigation and Design Reports,
Highway 403/407 Interchange Structures,
W.P. 197-77-02, -03, -04 and -05,
District 4, Hamilton

The above four (4) Foundation Investigation Reports, and your memorandum dated 83-01-25, indicate that 1.4 metres of earth cover is required for frost protection purposes. Our practice, however, is to allow for 1.2 metres depth only for the structures located in District 4, Hamilton.

Would you please, therefore, advise us whether the excessive depth for the frost protection to the footings of the structures is necessary.

HKJ:rb

A handwritten signature in cursive script that reads "H. Jagasia".

H.K. Jagasia,
Senior Structural Engineer,
for:
G.C.E. Burkhardt,
Head, Structural Section.

c.c. K.G. Bassi
N. Sen
C.P. Korzeniowski
(McCormick, Rankin & Assoc.)

EARTH COVER: 1.2m. O.K.
PHONED BY K.G. SELBY
83-01-26



DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 3012-169

DIST. 4 REGION

W.P. No. 197-77-03

CONT. No. 84-78

W. O. No.

STR. SITE No. 10-82-325

HWY. No. 403/407

LOCATION Ramp E-S Underpass (Structure #4)
403 E-407 S Ramp over 403 & 407

No. of PAGES -

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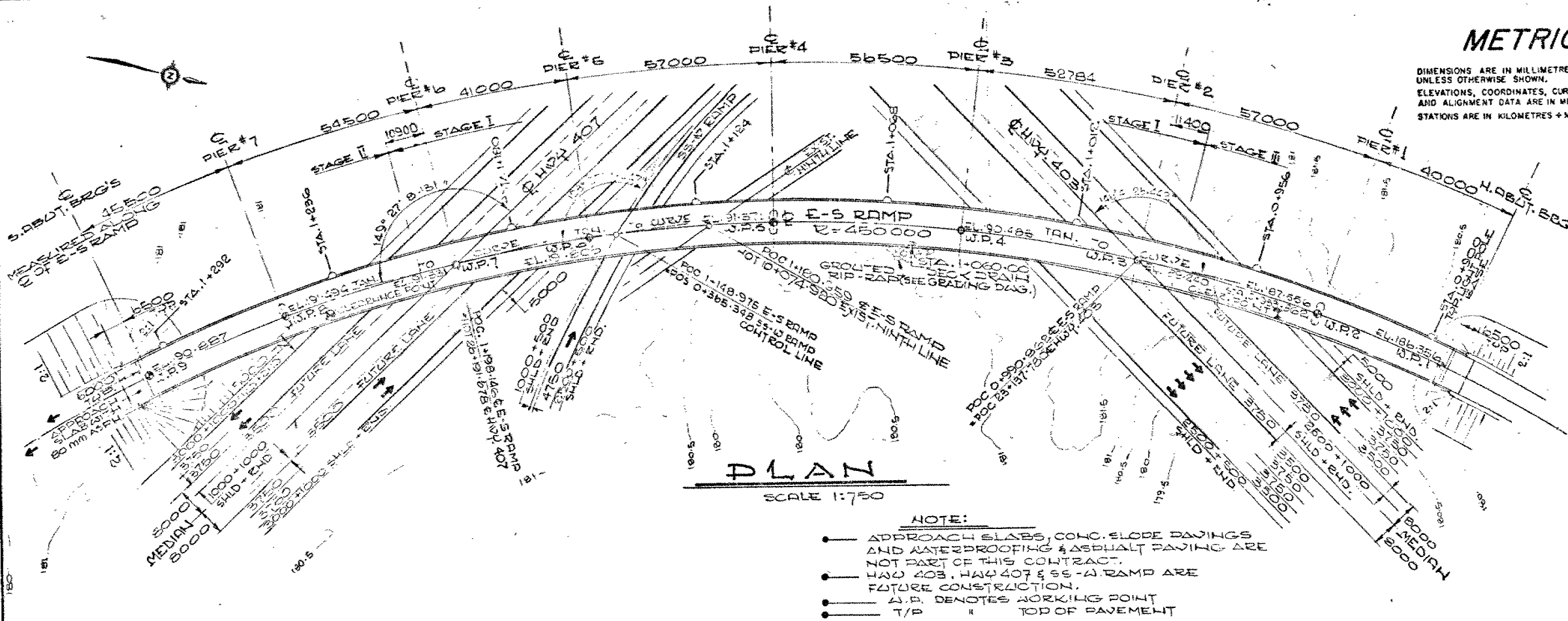
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

RAMP E-S UNDERPASS
HIGHWAY 403/407 INTERCHANGE
GENERAL ARRANGEMENT



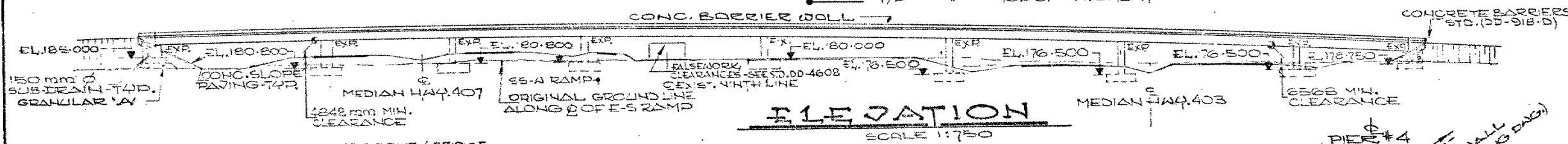
GENERAL NOTES

CLASS OF CONCRETE

DECK & PIER COLUMNS	35 MPa
BARRIER WALLS, ABUTMENTS	30 MPa
WINGWALLS	30 MPa
REMAINDER	20 MPa
CLEAR COVER TO REINFC. STEEL	
FOOTINGS	100 ± 25 mm
TOP SLAB - TOP	70 ± 20 mm
TOP SLAB - BOTT.	40 ± 10 mm
BOTTOM SLAB - TOP	40 ± 10 mm
BOTTOM SLAB - BOTT.	40 ± 10 mm
ABUT. SIDES	40 ± 10 mm
PIERS, ABUTMENTS & WINGWALLS	80 ± 20 mm
FRONT FACES	70 ± 20 mm
REMAINDER	40 ± 10 mm
UNLESS OTHERWISE NOTED	
REINFORCING STEEL	
REINFORCING STEEL SHALL BE GRADE 400	
REINFORCING BARS WITH DESIGNATION 'C' AT END OF BAR MARKS SHALL BE EPOXY COATED BARS.	

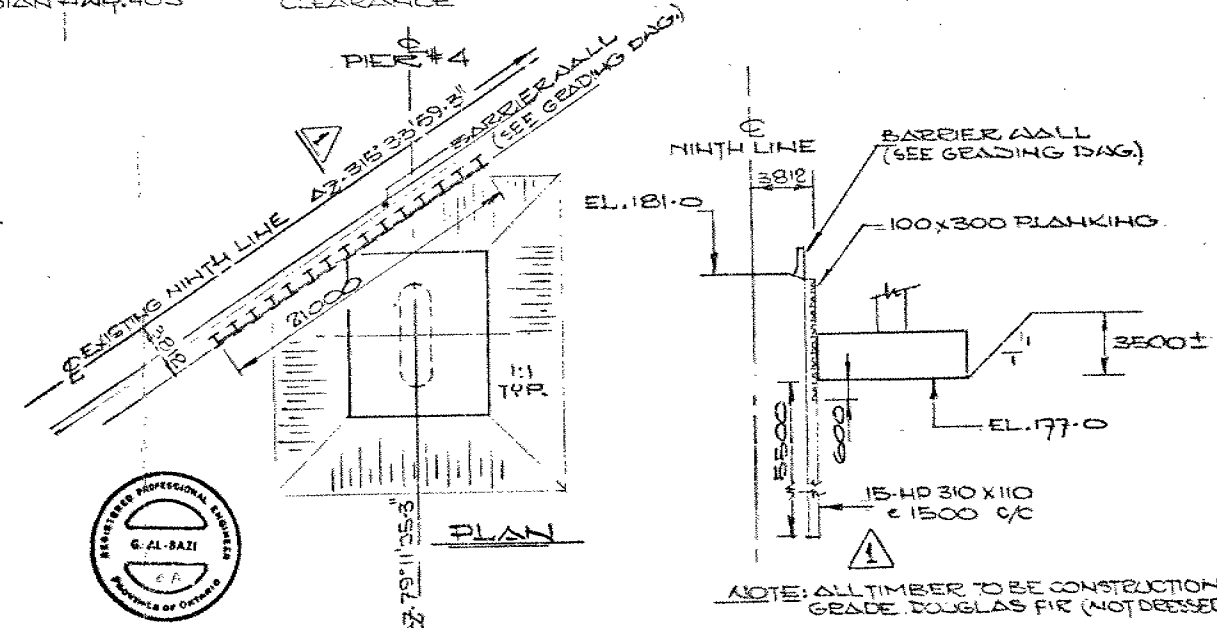
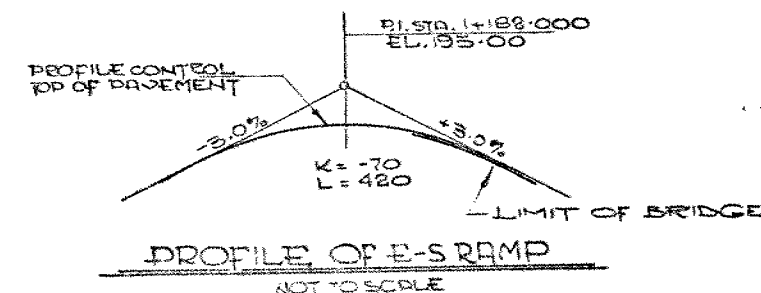
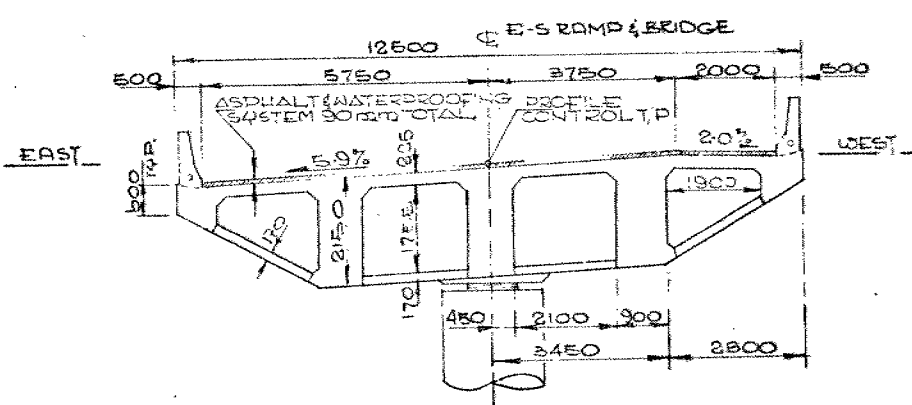
CONSTRUCTION NOTES

- THE CONTRACTOR SHALL FINISH THE BEARING SEAT/STEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± 3 mm
- THE SUPERSTRUCTURE SHALL BE BUILT IN THREE CONSTRUCTION STAGES AS SHOWN.



LIST OF DRAWINGS

- GENERAL ARRANGEMENT
- BOREHOLE LOCATIONS & SOIL STRATA
- LOCATION OF WORKING POINTS
- ABUTMENT FOOTINGS
- PIER FOOTINGS
- NORTH ABUTMENT
- SOUTH ABUTMENT
- PIER DETAILS
- BEARINGS
- DECK DETAILS I
- " II
- TRANSVERSE TENDONS
- LONGITUDINAL CABLE DETAILS I
- " II
- DECK REINFORCING DETAILS I
- " II
- " III
- " IV
- EXPANSION JOINTS
- BARRIER WALL
- 6000 mm APPROACH SLABS
- DETAILS OF CONC. SLOPE DRAINING
- AS CONSTRUCTED ELEV. & DIM.
- BRIDGE DATA & SITE NUMBER DATA
- STANDARD DETAILS
- QUANTITIES (P.Q.D.)
-



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN		CHECK	LOADING
DRAWING		CHECK	SITE

METRIC

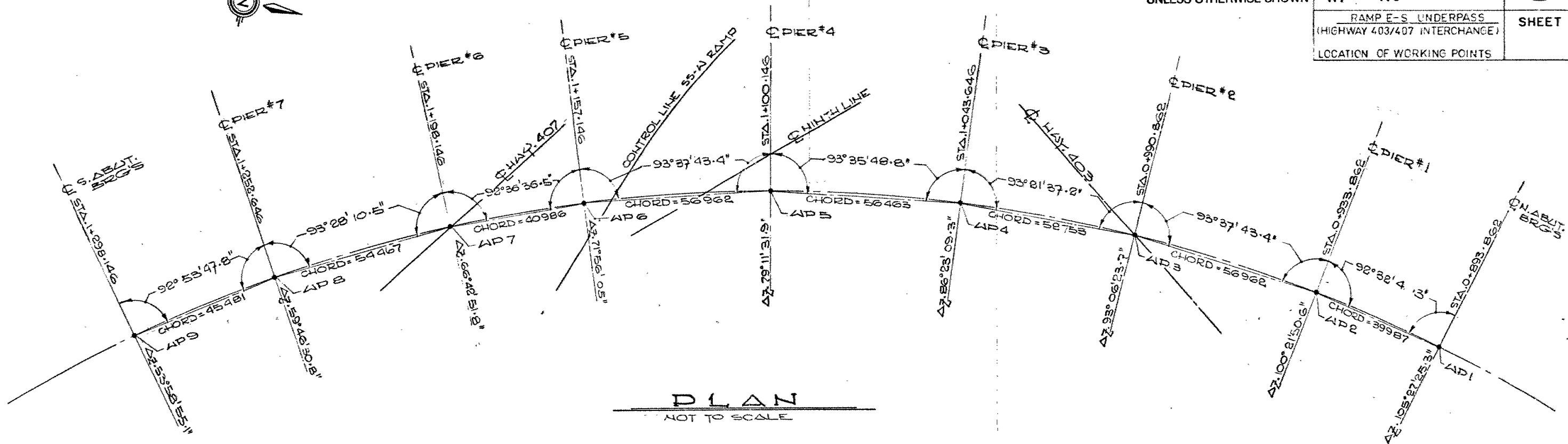
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 197-77-03

RAMP E-S UNDERPASS
(HIGHWAY 403/407 INTERCHANGE)

LOCATION OF WORKING POINTS

SHEET



PLAN

NOT TO SCALE

PROVINCIAL CO-ORDINATES OF WORKING POINTS

AP9		AP8		AP7		AP6		AP5		AP4		AP3		AP2		AP1	
N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E
4820516.970	286735.275	4820555.061	286710.422	4820603.697	286685.902	4820642.042	286671.431	4820697.206	286657.230	4820753.222	286650.142	4820805.975	286649.939	4820862.544	286656.590	4820901.520	286665.524



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN		CHECK	LOADING
DRAWING		CHECK	SITE No



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of
Transportation

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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 197-77-02 DIST 4
HWY 407 STR SITE 10-82-326
Hwy. #403 & 407 Interchange Complex

DISTRIBUTION

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F. Norman
J. Smrcka (2)
K. Bassi
B.J. Giroux
R. Hore

R. Fitzgibbon (Cover Only)
T.J. Kovich (Cover Only)

Files ✓

FOUNDATION INVESTIGATION REPORT

For

Hwy. 407 Underpass Structures
Hwy. #403 & 407 Interchange Complex
W.P. 197-77-02; Site 10-82-326
District #4 (Hamilton)

INTRODUCTION

This report contains the results of the foundation investigations carried out at the aforementioned site on 82 11 02 - 82 11 08. The fieldwork consisted of four sampled boreholes and one dynamic cone penetration test adjacent to each boring. The borings were advanced by continuous flight auger machines mounted on muskeg vehicles and equipped with solid stem augers.

SITE DESCRIPTION

The site is located in the vicinity of the existing Ninth Line Road, approximately 1.0 km north of Burnhamthorpe Rd. in the towns of Milton and Oakville. The surrounding terrain is relatively flat. Physiographically, the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of cohesive type glacial till, followed by a sandy silt to silty sand deposit, followed by shale bedrock. In one of the borings a silty clay stratum was encountered within the sandy silt to silty sand deposit. The boundaries of the different strata, together with the obtained field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 1977702-A. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below the ground surface, a till-like zone was encountered at every boring location. The thickness varies from 6 m to 11 m. This material is basically cohesive in nature - i.e., silty clay binding coarser particles. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 16 to over 95 blows per 30 cm. In all four boreholes the material has a very stiff to hard consistency.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>	<u>Avg.</u>
Natural Moisture Content (%)	8.0 - 12.5	10.5
Liquid Limit (%)	18.5 - 23.0	21.7
Plastic Limit (%)	13.0 - 16.0	14.3

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

Sandy Silt to Silty Sand, Some Gravel, Trace of Clay

This stratum was encountered in all four borings below the above described glacial till. The thickness varies from 9 m to 13 m. The material in the deposit consists mainly of sands and silts with traces of clay and varying amounts of gravel. A layer of silty clay was found within the deposit at the location of B.H. #7.

Standard Penetration Tests, carried out within the deposit, gave 'N' values from 27 to over 120 blows per 30 cm. These values indicate that the deposit is in a dense to very dense condition. The natural moisture content ranges from 7.5% to 10%. The results of the grain-size analyses performed on selected samples are plotted in envelope form on Figure #2 of the Appendix.

Silty Clay, With Sand, Trace of Gravel

A layer of silty clay approximately 7 m thick was found within the silty sand to sandy silt layer at B.H. #7.

The deposit has a hard consistency, as indicated by 'N' values of 60 blows per 15 cm. The natural moisture content is in the order of 9%.

Shale Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand deposits at all four boreholes. The shale is badly weathered and was penetrated by approximately 3 m, using augers.

GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

B.H. #	6	7	9
El.	181.6	180.9	180.1

No groundwater level measurements were carried out at Borehole #8.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct two new highways (Hwy. #403 and Hwy. #407) in the vicinity of the existing Ninth Line, about 1.0 km north of Burnhamthorpe Rd., in the towns of Milton and Oakville. In the above-mentioned area, an interchange complex consisting of several bridge structures will be required. Two of these structures, designated as the Hwy. 407 Southbound and Northbound Underpasses, are the subjects of this report.

The Hwy. 407 Underpass structures are identical in geometry and are centred approximately 23.5 m apart. They are two-span structures of 36.50 m per span, and are symmetrically located about the intersections of the centrelines of Hwy. #403 and Hwy. #407.

The profile grade of the Hwy. 403 W.B.L. and E.B.L. is approximately El. 177.5 m at the centreline of the Hwy. 407 underpass structures. The profile grade of the underpass at the corresponding point is approximately El. 185.0 m. To accomplish the proposed grades as described above, the following earthworks will be performed.

<u>Location</u> (Hwy. 407 Chainage)	<u>Cut</u>	<u>Fill</u>
South Abutment, Sta. 26 + 306 \pm	5.0 m \pm	3.6 m \pm
North Abutment, Sta. 26 + 376 \pm	4.0 m \pm	4.6 m \pm

The vertical clearance is 5.00 m at the crossing of the Hwy. #403 E.B.L. and the Hwy. #407 N.B. underpass structure.

STRUCTURE FOUNDATIONS

The following foundation design alternatives are recommended:

1) Spread Footings Within Original Ground

The entire structure (abutments and piers) may be supported on spread footing type foundations at or below the following elevations:

<u>Footing Location</u>	<u>Recommended Footing Level</u> <u>(At or Below)</u>
S.B.L. Underpass, South Abutment	El. 179.0 m
S.B.L. Underpass, Pier	El. 175.0 m
S.B.L. Underpass, North Abutment	El. 179.0 m
N.B.L. Underpass, South Abutment	El. 179.0 m
N.B.L. Underpass, Pier	El. 175.0 m
N.B.L. Underpass, North Abutment	El. 178.0 m

It should be noted, however, that 1.4 m of earth cover should be provided to the underside of the footings for frost protection purposes.

For footings founded at or below the above quoted elevations, an allowable bearing value of 300 kPa may be used in design.

For purposes of the O.H.B.D.C. the following design values are recommended:

Factored Bearing Capacity at U.L.S.: 460 kPa

Bearing Capacity at S.L.S. Type II: 300 kPa

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the code. For the granular backfill, a non-yielding foundation condition should be assumed, in which case a value of $K_o=0.43$ is recommended. The base of the footing excavations should be protected by 15 cm of mass concrete within 8 hours of exposure.

Settlements of the foundation subsoil, due to the surcharge loading of the footings will be negligible (approx. 25 mm) in magnitude.

No dewatering problems are anticipated during excavation and construction of the abutment footings, founded in the relatively impervious glacial till layer. *Although it is reasonable to assume that excavation for the pier footings will lead to a hydrostatic imbalance within the soil, "boiling" of the exposed, non-cohesive sandy silt layer is not expected to occur to a significant extent.

2) Pile Foundations

As a second alternative, any one or all of the abutments and piers may be supported on piles driven to refusal. In the case of steel 'H' piles (310 HP 110 or 310 HP 79) two approaches may be used.

- 1) Drive piles to bedrock at El. 159 m \pm , assuming design loads of up to 1160 kN. For the purpose of O.H.B.D.C., the following design values are recommended:

Factored Capacity at U.L.S.: 1500 kN

Capacity at S.L.S. Type II: 1160 kN

- 2) Drive piles to El. 168.0 m \pm , assuming design loads of up to 890 kN. For the purpose of O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S.: 1160 kN

Capacity at S.L.S. Type II: 890 kN

Piles should be driven in accordance with M.T.C. Standards SS103-10 or SS103-11.

The pile caps should have a minimum of 1.4 earth cover for frost protection requirements. The driving energy should not be less than 50 kJ.

APPROACH EMBANKMENTS

Fills up to 5 m in height above the existing ground surface will be required at this location. No stability problems are anticipated for the approaches of this height constructed with 2:1 slopes. The fill should consist of well compacted acceptable material. It is estimated that the total settlement will be in the order of 25 mm.

In the vicinity of Sta. 26 + 450, Hwy. 407, a low wet area exists, at the proposed north approach embankment location. Any soft material in this area must be removed. The exact dimensions and location of this area will be carried out by the Regional Geotechnical Section.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. J. Hayward, Student Field Technician. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was written by Mr. Hayward and reviewed by Mr. P. Payer and Mr. K.G. Selby.



J. Hayward

J. Hayward
Student Field Technician

P. Payer

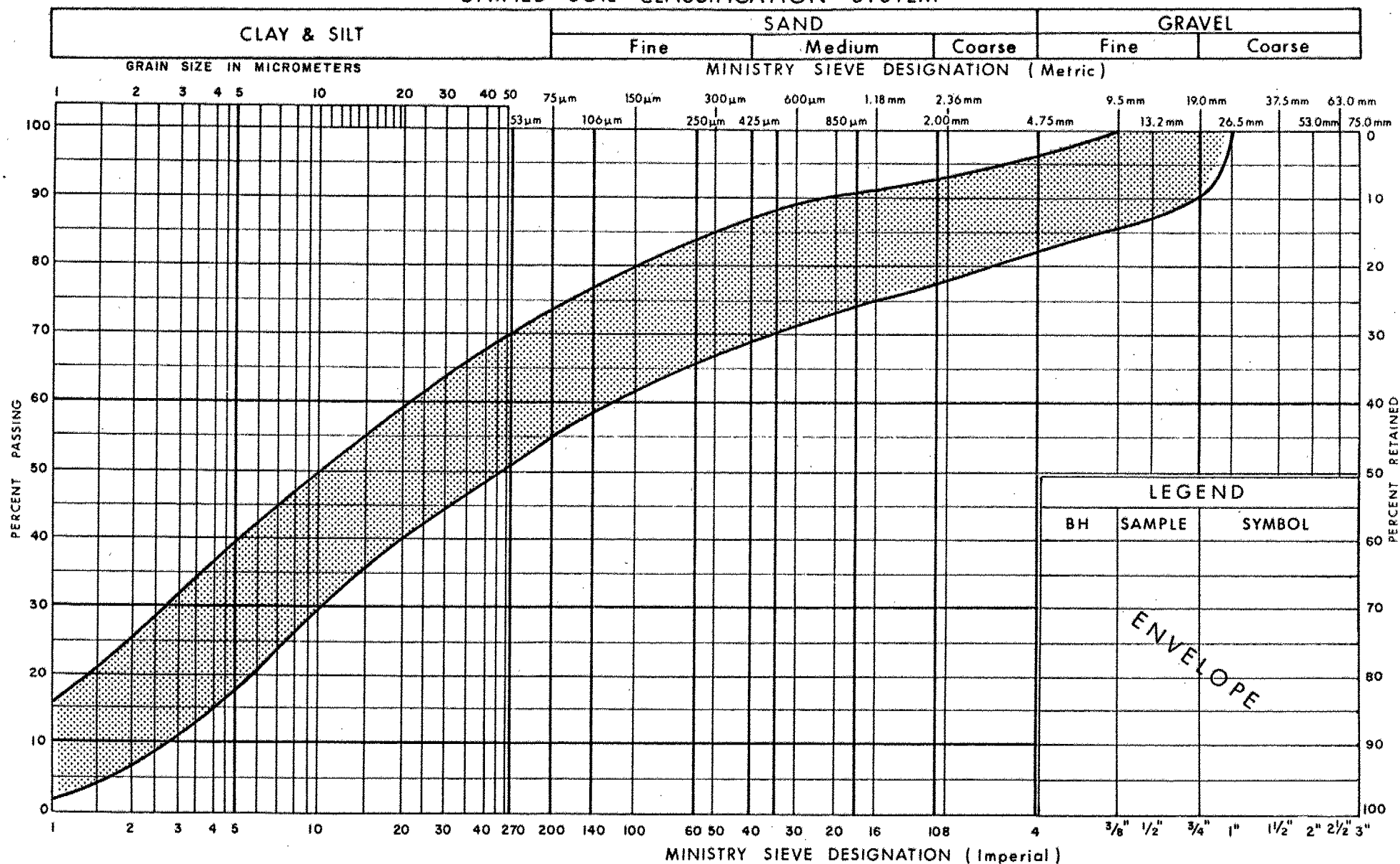
P. Payer, P. Eng.
Foundations Engineer

K. G. Selby

K.G. Selby, P. Eng.
Senior Foundations Engineer

A P P E N D I X

UNIFIED SOIL CLASSIFICATION SYSTEM



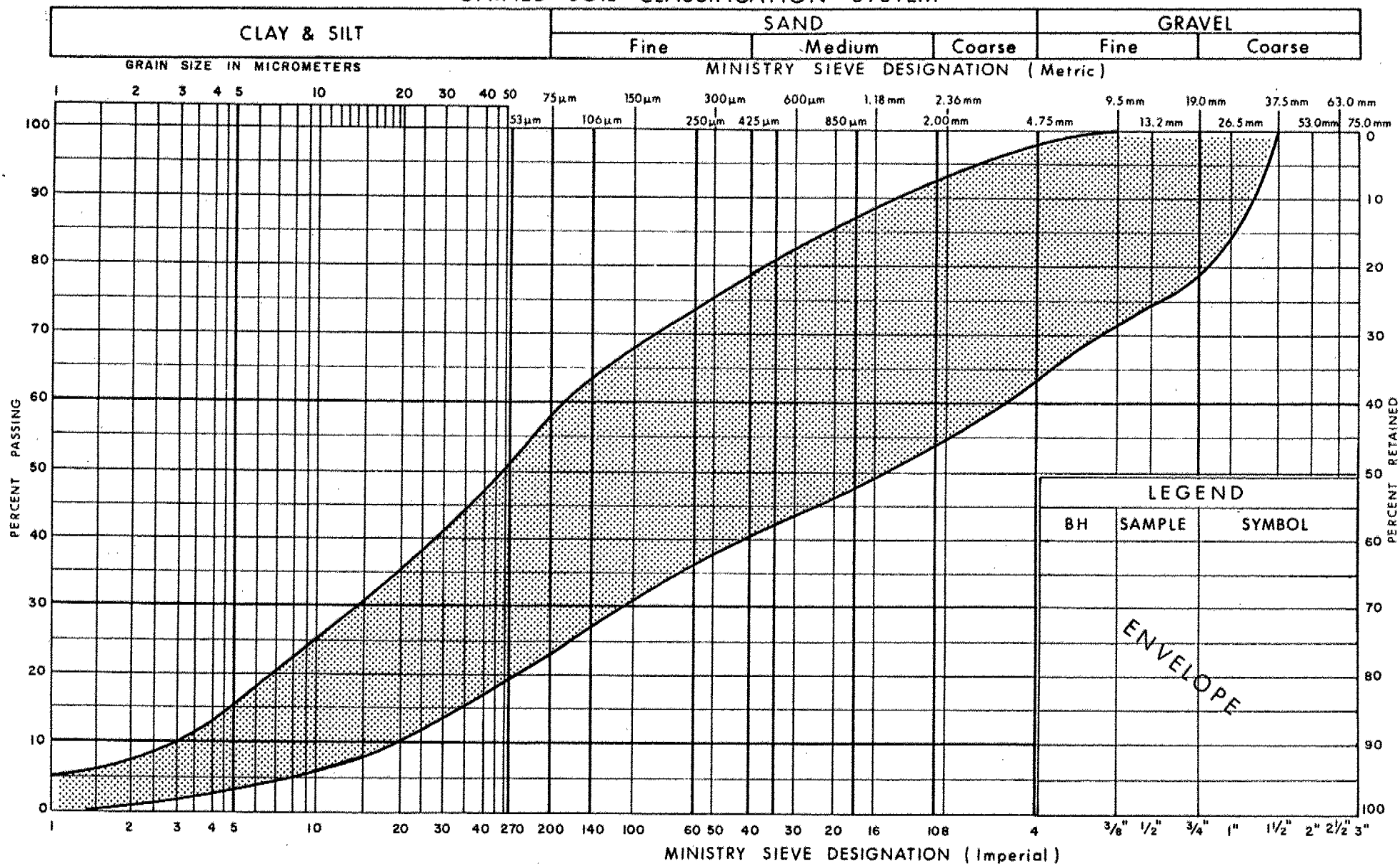
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF
SILTY CLAY SAND & GRAVEL
(GLACIAL TILL)

FIG No 1

W P 197-77-17

UNIFIED SOIL CLASSIFICATION SYSTEM



**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILTY SAND
SOME GRAVEL TRACE CLAY

FIG No 2

W P 197 - 77 - 17

RECORD OF BOREHOLE No 6

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 651.8; E 286 577.9 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
DATUM Geodetic DATE 1982 11 02 and 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH		W _p	W			W _L
									○ UNCONFINED	+ FIELD VANE					
181.6	Ground Level													GR SA SI CL	
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	22	23 cm	180							8 23 49 20	
			2	SS	42		178								
			3	SS	67		176								5 21 52 22
			4	SS	86		174								13 23 44 20
175.3	Some Gravel Sandy Silt to Silty Sand Trace Clay Very Dense with Gravel Trace Gravel		5	SS	75	15 cm	172							10 40 43 7	
6.3			6	SS	82		170								
			7	SS	40		168								
			8	SS	78		166								37 37 24 2
			9	SS	72		164								
			10	SS	100		162								7 43 44 6
161.8	Weathered Red Shale						160								
19.8															
158.7	End of Borehole														
22.9															

+3, x5: Numbers refer to 20
Sensitivity 15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 695.2; E 286 518.5 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
 DATUM Geodetic DATE 1982 11 05 and 08 CHECKED BY LB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
180.9	Ground Level															GR SA SI CL
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	19		180									
			2	SS	35											
			3	SS	51											6 25 50 19
			4	SS	43											
			5	SS	20											10 26 48 16
			6	SS	16											5 26 44 25
175.0			7	SS	24											9 25 42 24
5.9	Sandy Silt to Silty Sand, Some Gravel, Trace Clay Dense to Very Dense		8	SS	27											
			9	SS	43											
			10	SS	62											25 44 26 5
			11	SS	60/	15 cm										
170.6	Silty Clay with Sand Trace Gravel Hard		12	SS	60/	15 cm										
10.3			13	SS	80/	10 cm										9 30 42 19
																5 31 42 22
167.2	Sandy Silt to Silty Sand, Trace Gravel, Clay Very Dense		14	SS	60/	15 cm										
13.7			15	SS	60/	8 cm										6 36 54 4
161.4	Weathered Red Shale															
19.5																
159.5			16	SS	80/	8 cm										
21.4	End of Borehole															

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 8

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 692.5; E 286 607.3
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test
DATUM Geodetic DATE 1982 11 03

ORIGINATED BY JH
COMPILED BY JH
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH						WATER CONTENT (%)
180.6	Ground Level							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	10 20 30						
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	23		180								
			2	SS	36			178							3 27 50 20
			3	SS	66			176							
			4	SS	64			174							8 25 44 23
173.4			5	SS	42			172							2 74 20 4
7.2	Sandy Silt to Silty Sand, Some Gravel Trace Clay Very Dense		6	SS	70		170								
			7	SS	94		168								
			8	SS	60/	8 cm	166								18 48 28 5
			9	SS	70/	15 cm	164								
			10	SS	90/	10 cm	162								12 46 37 5
			11	SS	100/	15 cm	160								
160.8	Weathered Red Shale														
19.8															
159.2			12	SS	100/	8 cm								10 15 52 23	
21.4	End of Borehole														
	Note: No Groundwater Level Measurements Were Carried Out.														

+³, ×⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 735.6; E 286 548.0 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
DATUM Geodetic DATE 1982 11 04 and 05 CHECKED BY *so*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
180.1	Ground Level															GR SA SI CL
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	26		180									
			2	SS	70		178									5 27 46 22
			3	SS	36		176									8 30 43 19
			4	SS	41		174									17 22 45 16
			5	SS	46		172									
			6	SS	97		170									17 26 43 14
169.1	Sandy Silt to Silty Sand, Trace Gravel, Clay Very Dense		7	SS	60/	15 cm	168									3 27 64 6
11.0			8	SS	71/	15 cm	166									10 48 37 5
			9	SS	62/	15 cm	162									
160.3							160									
19.8	Weathered Red Shale															
158.7			10	SS	60/	3 cm										
21.4	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 10

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 692 E 286 564 ORIGINATED BY SO
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger COMPILED BY SO
DATUM Geodetic DATE 83 02 16 CHECKED BY SO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100					
180.8	Ground Level															
0.0																
	Heterogeneous Mixture of Silty Clay, Sand and Gravel (glacial till)		1	SS	31											
			2	SS	36											
			3	SS	56											
			4	SS	94											
			5	SS	64											
			6	SS	54											
			7	SS	62											
			8	SS	120/	25 cm										
			9	SS	130/	25 cm										
172.8			10	SS	63											
8.0	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

METRIC

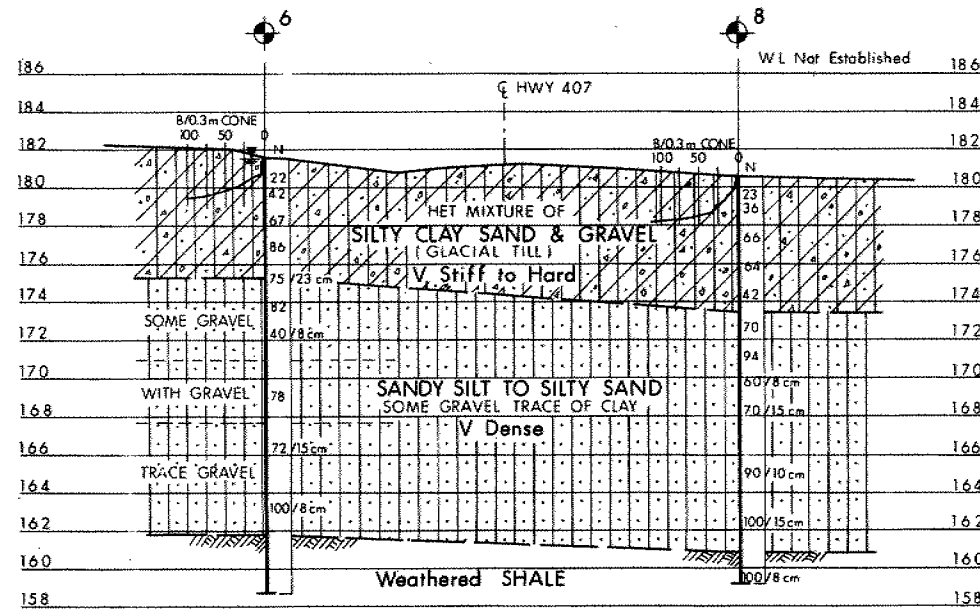
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 197-77-17

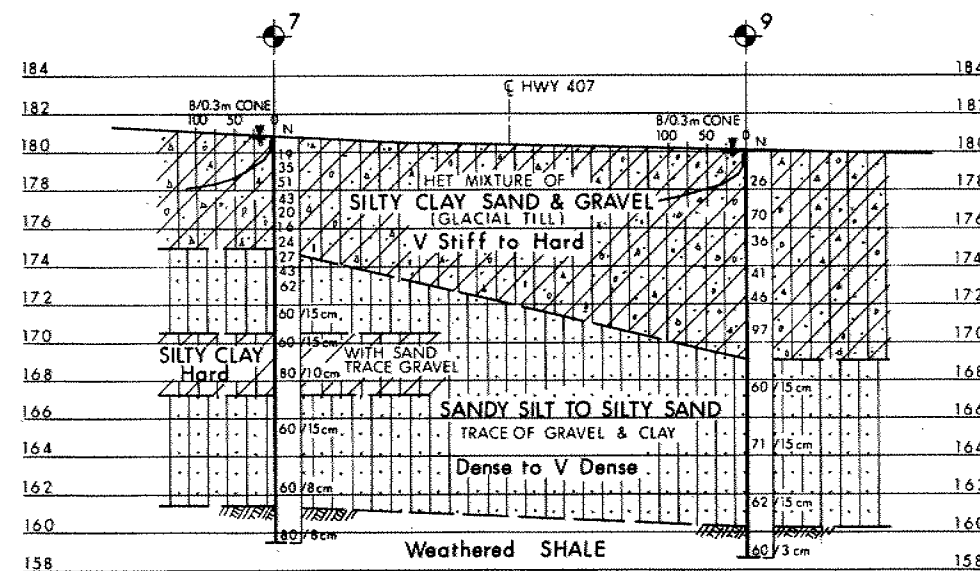


SHEET

BORE HOLE LOCATIONS & SOIL STRATA



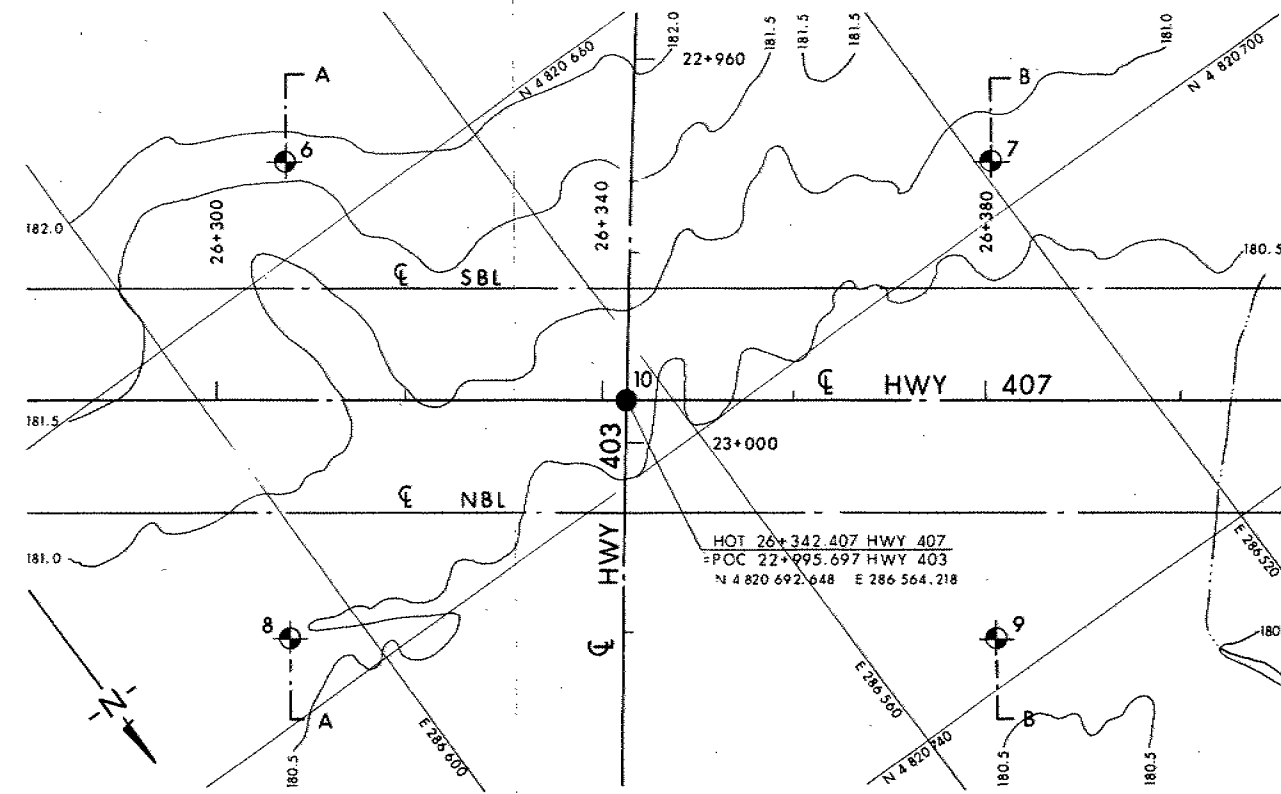
A-A



B-B

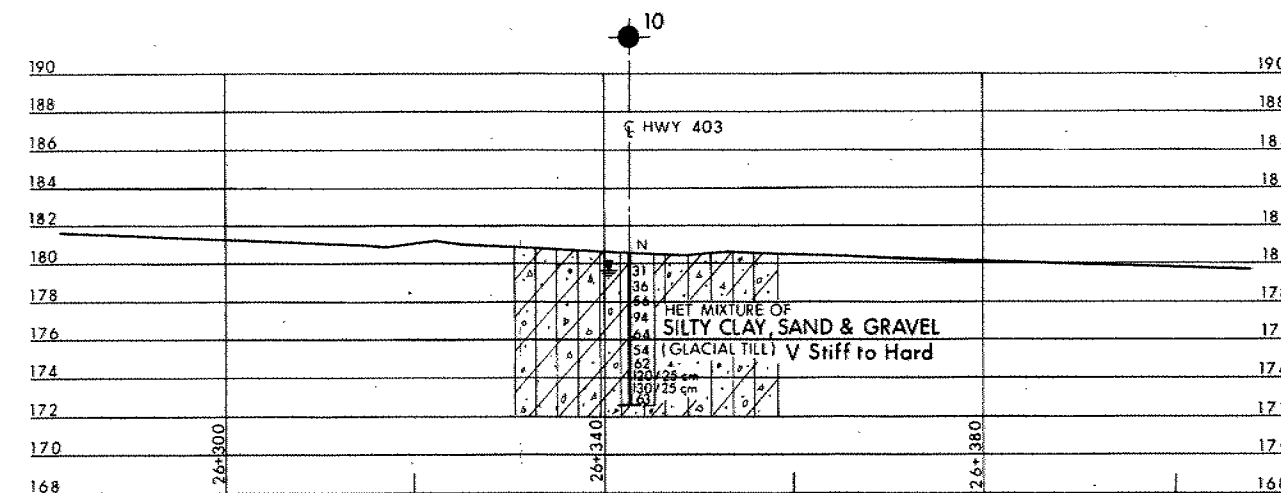
SECTIONS

SCALE
HORIZ: 8m 4 0 8m
VERT: 4m 2 0 4m



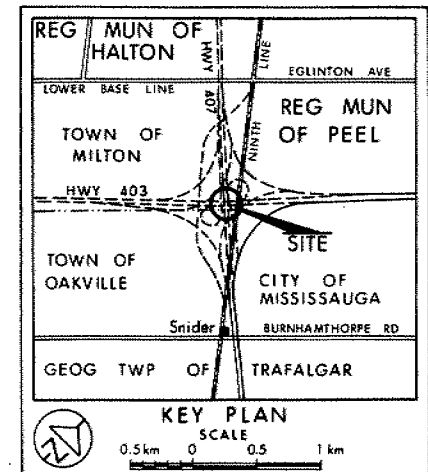
PLAN

SCALE
8m 4 0 8m



CL PROFILE HWY 407

SCALE
HORIZ: 8m 4 0 8m
VERT: 4m 2 0 4m



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 8211 & 8302
- W.L. Not Established in BH 8

No	ELEVATION	CO-ORDINATES NORTH	EAST
6	181.6	4 820 651.8	286 577.9
7	180.9	4 820 695.2	286 518.5
8	180.6	4 820 692.5	286 607.3
9	180.1	4 820 735.6	286 548.0
10	180.8	4 820 692.0	286 564.0

NOTE

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

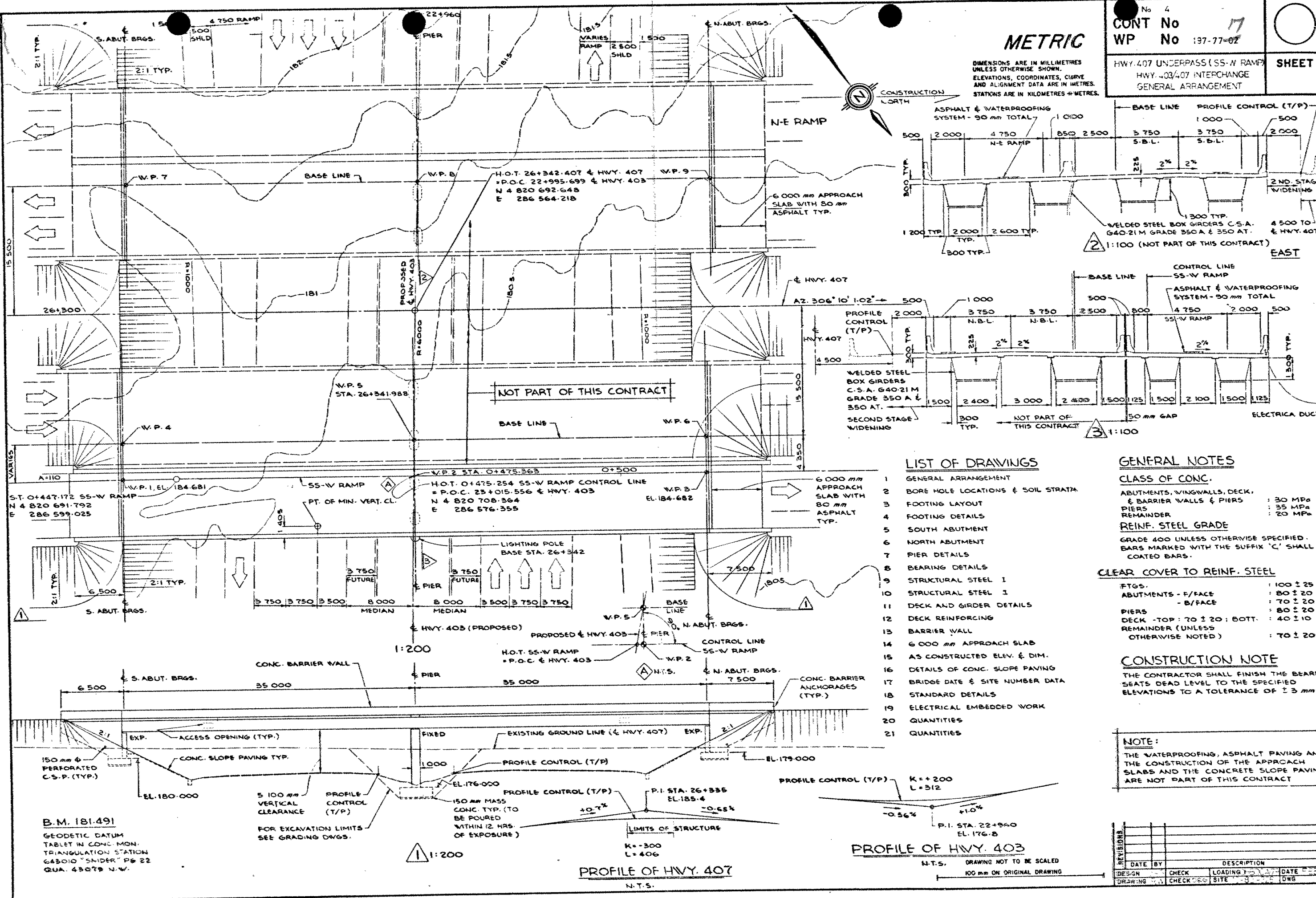
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION
1	83 10	SO	BORE HOLE TO BE ADDED

Geocres No 30M12-170	HWY No 407 & 403	DIST 4
SUBM'D PP CHECKED	DATE 82 12 14	SITE 10-82-326
DRAWN SO CHECKED	APPROVED	DWG

METRIC

DIMENSIONS ARE IN MILLIMETRES
 UNLESS OTHERWISE SHOWN.
 ELEVATIONS, COORDINATES, CURVE
 AND ALIGNMENT DATA ARE IN METRES.
 STATIONS ARE IN KILOMETRES + METRES.



LIST OF DRAWINGS

- 1 GENERAL ARRANGEMENT
- 2 BORE HOLE LOCATIONS & SOIL STRATA
- 3 FOOTING LAYOUT
- 4 FOOTING DETAILS
- 5 SOUTH ABUTMENT
- 6 NORTH ABUTMENT
- 7 PIER DETAILS
- 8 BEARING DETAILS
- 9 STRUCTURAL STEEL 1
- 10 STRUCTURAL STEEL 3
- 11 DECK AND GIRDER DETAILS
- 12 DECK REINFORCING
- 13 BARRIER WALL
- 14 6 000 mm APPROACH SLAB
- 15 AS CONSTRUCTED ELEV. & DIM.
- 16 DETAILS OF CONC. SLOPE PAVING
- 17 BRIDGE DATE & SITE NUMBER DATA
- 18 STANDARD DETAILS
- 19 ELECTRICAL EMBEDDED WORK
- 20 QUANTITIES
- 21 QUANTITIES

GENERAL NOTES

CLASS OF CONC.

ABUTMENTS, VINGWALLS, DECK,
 & BARRIER WALLS & PIERS : 30 MPa
 PIERS : 35 MPa
 REMAINDER : 20 MPa

REINF. STEEL GRADE

GRADE 400 UNLESS OTHERWISE SPECIFIED.
 BARS MARKED WITH THE SUFFIX 'C' SHALL BE
 COATED BARS.

CLEAR COVER TO REINF. STEEL

FTGS. : 100 ± 25
 ABUTMENTS - F/FACE : 80 ± 20
 - B/FACE : 70 ± 20
 PIERS : 80 ± 20
 DECK - TOP : 70 ± 20; BOTT. : 40 ± 10
 REMAINDER (UNLESS OTHERWISE NOTED) : 70 ± 20

CONSTRUCTION NOTE

THE CONTRACTOR SHALL FINISH THE BEARING
 SEATS DEAD LEVEL TO THE SPECIFIED
 ELEVATIONS TO A TOLERANCE OF ± 3 mm

NOTE:

THE WATERPROOFING, ASPHALT PAVING AND
 THE CONSTRUCTION OF THE APPROACH
 SLABS AND THE CONCRETE SLOPE PAVINGS
 ARE NOT PART OF THIS CONTRACT

PROFILE OF HWY. 403

N.T.S. DRAWING NOT TO BE SCALED
 100 mm ON ORIGINAL DRAWING

PROFILE OF HWY. 407

N.T.S.

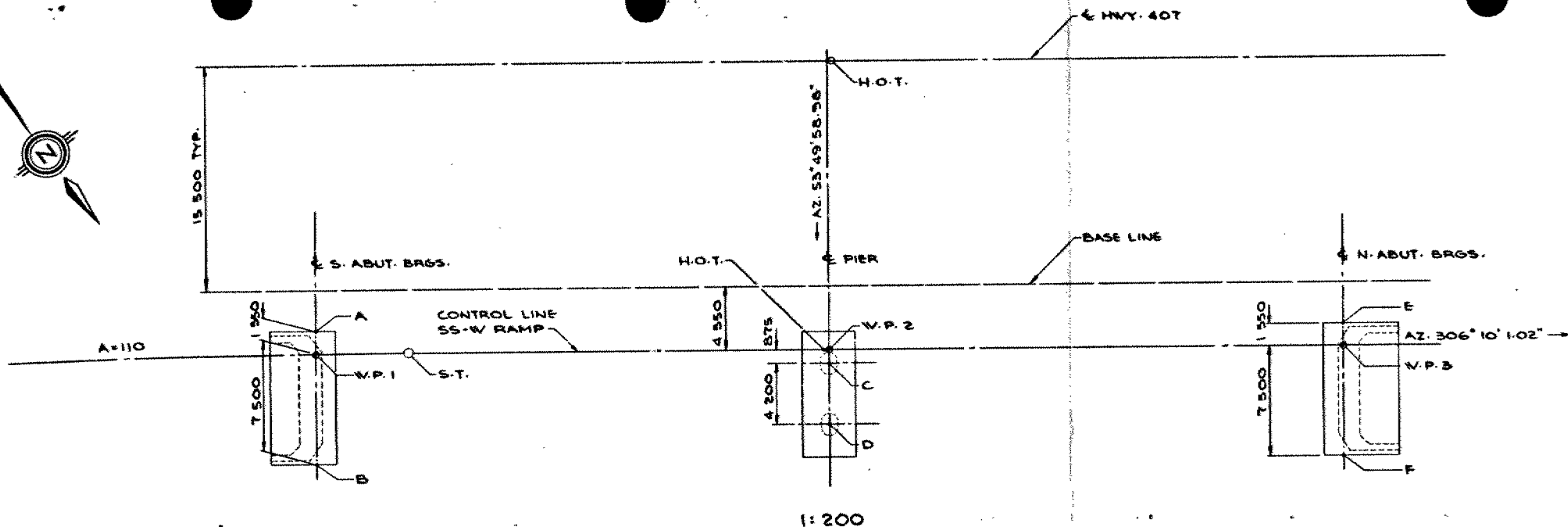
B.M. 181.491
 GEODETIC DATUM
 TABLET IN CONC. MON.
 TRIANGULATION STATION
 643010 "SNIDER" PG 22
 QUA. 43079 N.W.

5 100 mm
 VERTICAL
 CLEARANCE
 PROFILE
 CONTROL
 (T/P)
 FOR EXCAVATION LIMITS
 SEE GRADING DWGS.

1:200

K=+300
L=406

K=+200
L=312



NOTE: ALL ϵ ARE PARALLEL

POINT	STATION	CO-ORDINATES	
		N	E
A	0+440.366	4 820 686.524	286 603.615
V.P. 1	0+440.363	4 820 687.775	286 604.530
B	0+440.347	4 820 693.830	286 608.956
S.T.	0+447.172	4 820 691.792	286 599.025
H.O.T.	0+475.254	4 820 708.364	286 576.355
V.P. 2	0+475.363	4 820 708.425	286 576.271
C	0+475.363	4 820 703.134	286 576.789
D	0+475.363	4 820 712.525	286 579.267
H.O.T.	26+342.407	4 820 692.648	286 564.218
E	0+510.363	4 820 727.827	286 547.099
V.P. 3	0+510.363	4 820 729.079	286 548.014
F	0+510.363	4 820 735.133	286 552.440

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

CONT No
WP No 197-77-02

HWY 407 UNDERPASS (SS-W RAMP)
HWY 403/407 INTERCHANGE
FOOTING LAYOUT

SHEET

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

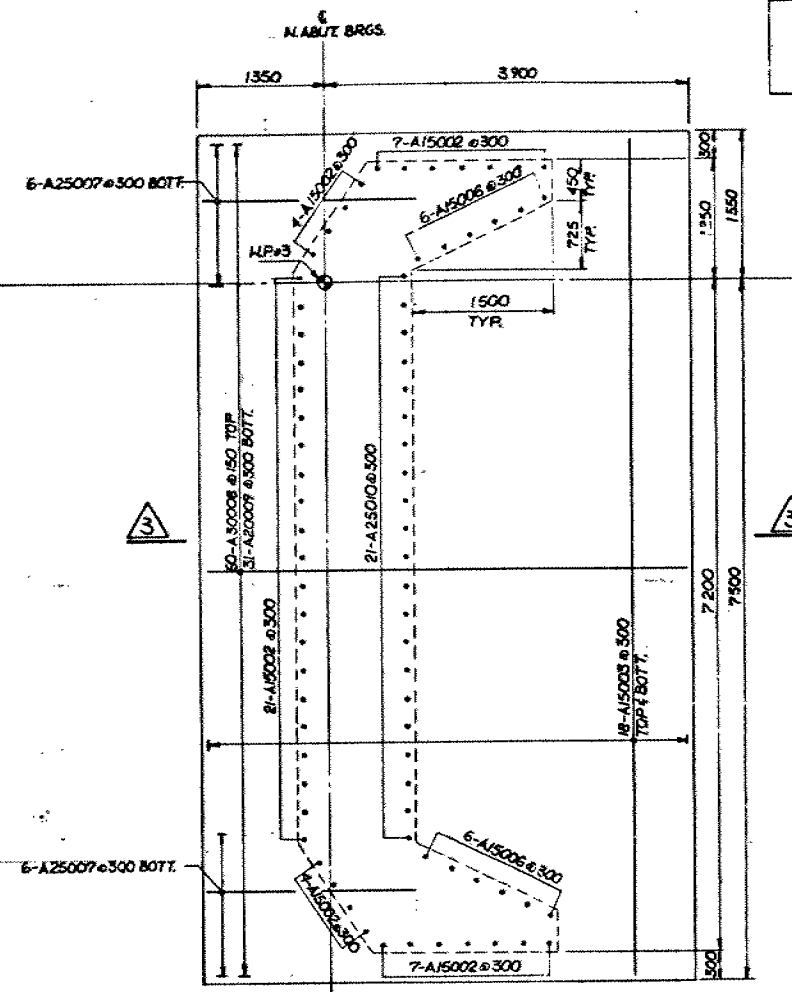
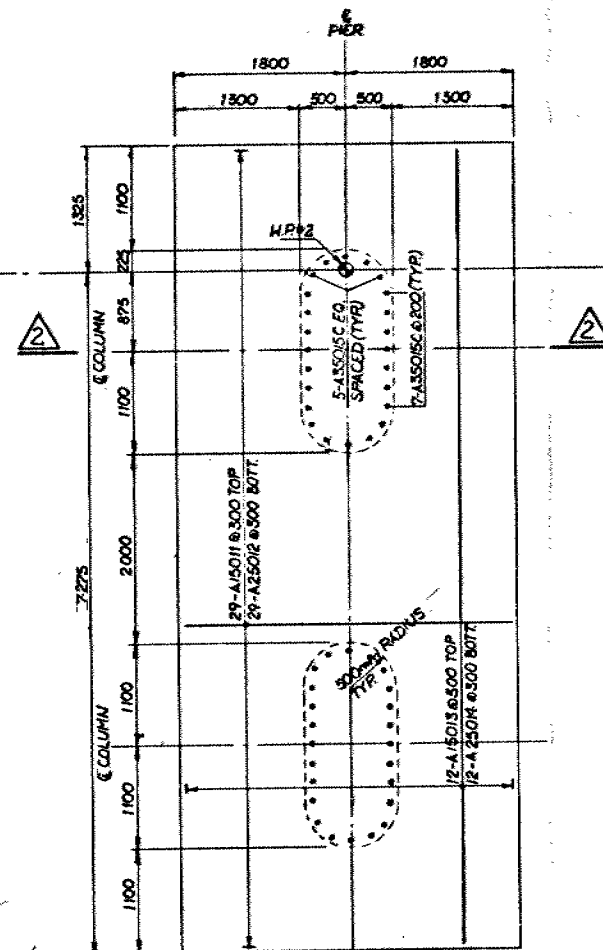
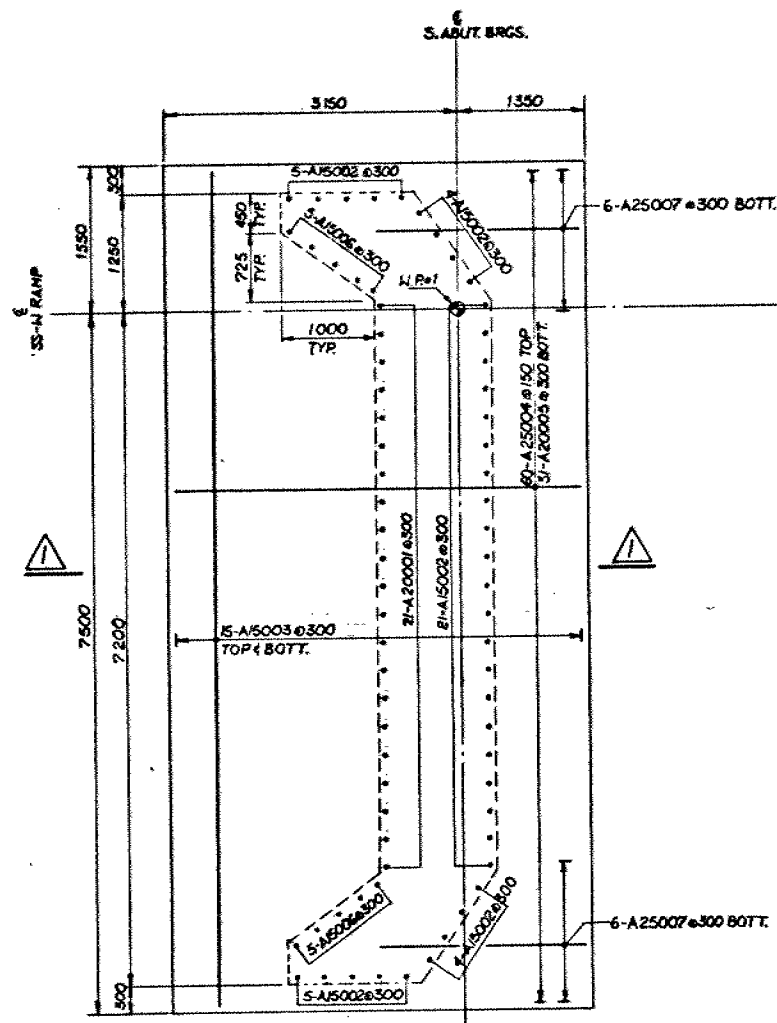
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DRAWING	08/08	RW	CHECK	08/08	RW
LOADING	08/08	RG	CHECK	08/08	RG
SITE No	08/08	RG	CHECK	08/08	RG
DWG	08/08	RG	CHECK	08/08	RG

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

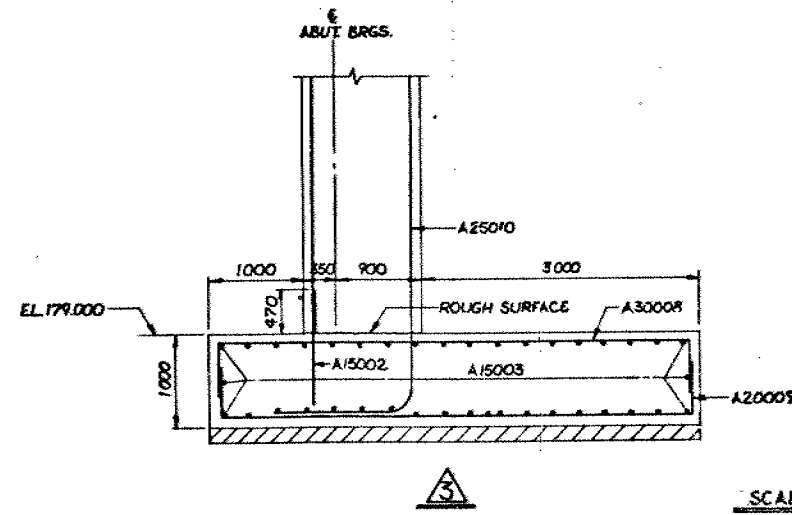
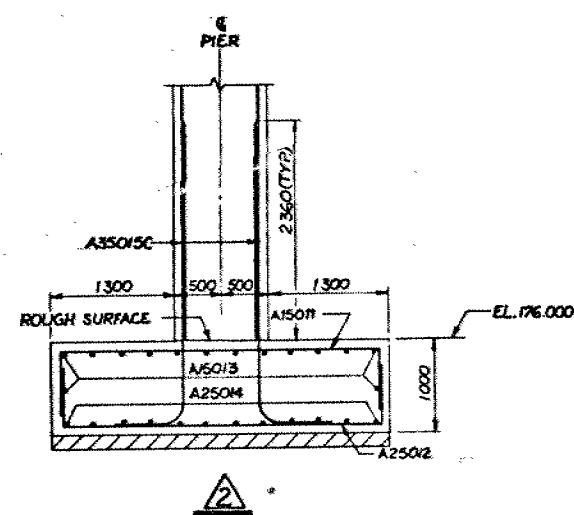
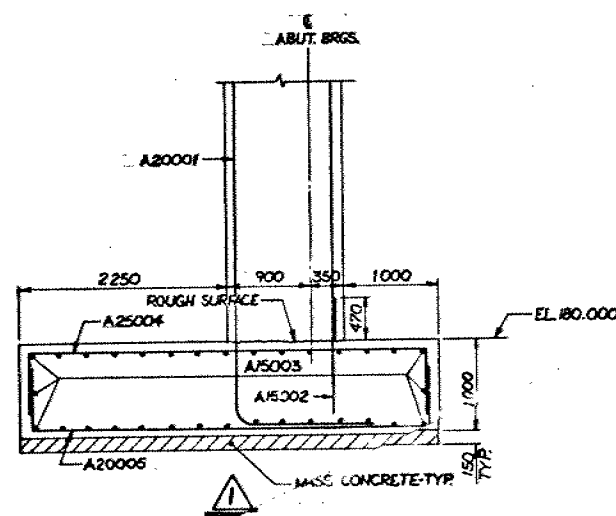
CONT No 17
WP No 197-77-07

HWY 407 UNDERPASS (SS-W RAMP)
HWY 403 INTERCHANGE
FOOTING DETAILS

SHEET



PLAN



NOTES:
• DRWG. TO BE READ IN CONJUNCTION WITH DRWG. NO. 3
• 150 mm OF MASS CONCRETE TO BE CAST AT BASE OF ALL FOOTINGS EXCAVATION WITHIN 12 HOURS OF EXPOSURE.

SCALE 1:40

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN			
CHECK			
DRAWING			



Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

CONT 84-78

WP 197-77-05

DIST 4

HWY 403 & 407 STR SITE 10-82-327

Ninth Line Underpass, Hwy. #403 & 407
Interchange Complex

DISTRIBUTION

G.C.E. Burkhardt (3)

R.D. Gunter

F. Norman

J. Smrcka (2)

K. Bassi

B.J. Giroux

R. Hore

R. Fitzgibbon (Cover Only)

T.J. Kovich (Cover Only)

Files

FOUNDATION INVESTIGATION REPORT

For

Ninth Line Underpass

Hwy. #403 & 407 Interchange Complex

W.P. 197-77-05; Site 10-82-327

District 4, Hamilton

BH No 12

ADDED 83/006

INTRODUCTION:

This report contains the results of the foundation investigation carried out at the aforementioned site on 82 11 08. The fieldwork consisted of two sampled boreholes and one dynamic cone penetration tests adjacent to each boring. The borings were advanced by continuous flight auger machines mounted on muskeg vehicles and equipped with solid stem augers.

SITE DESCRIPTION

The site is located in the vicinity of the existing Ninth Line Road, some 1.0 km north of Burnhamthorpe Rd. in the town of Milton, and town of Oakville. The surrounding terrain is relatively flat. Physiographically the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consists of cohesive type glacial till, followed by sandy silt to silty sand deposit, followed by shale bedrock. The boundaries of the different strata, together with the obtained field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 1977705-A. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below a thin layer of topsoil a till-like zone was encountered at every boring location. The thickness varies from 13.7 m. to 14.5 m. The material in the deposit was found to consist of a heterogeneous mixture of silty clay, sand and gravel. The matrix of this till is basically cohesive in nature - i.e., silty clay binding coarser particles. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 18 to over 100 blows per 30 cm.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>
Natural Moisture Content (%)	7-14
Liquid Limit (%)	20-27
Plastic Limit (%)	12-17

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

The consistency of the overall deposit varies from very stiff to hard.

Sandy Silt to Silty Sand, Traces of Gravel & Clay

This stratum was encountered in each boring below the above described glacial till. The thickness varied from 5.3 m to 6.1 m at the boring locations. The material in the deposit consists of sands and silts with varying proportions, with traces of gravel and clay. Occasional layers of silty clay were also intercepted in the lower part of the deposit.

Standard Penetration Tests, carried out within the deposit, gave 'N' values to range from 13 to over 100 blows per 30 cm. Based on this value, the overall deposit may be classified as being compact to very dense. The natural moisture content ranges from 12 to 13%. The results of the grain-size analyses performed on two samples are as follows: Gravel: 3-13%, Sand: 41-48%, Silt: 34-48% and Clay: 5-8%.

Shale Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand deposits, at EL. 162.9 and at EL. 162.4. The shale is badly weathered. No core samples were obtained.

Groundwater Conditions

The groundwater levels were observed to be at ground surface during the field investigation.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct a single span (68 m in length) over the future Hwy. #403. The profile grade of Ninth Line is set at EL. 185.8 (north end) and EL. 184.4 (south end). The bottom of Hwy. #403 median ditch will be at EL 176±. The level of the natural ground surface varies between EL. 182± and EL. 182.6±. In order to realize the proposed grades, up to 6 m deep cuts and up to 3 m high fills will be required.

Structure Foundations

The following foundation alternatives are recommended:

1.) Spread Footings within Original Ground

The abutments may be supported on spread footing type foundations at or below EL. 180. The frost protection criteria is 1.4 m of earth cover in this area. An allowable bearing value of up to 300 kPa can be used in design.

For purposes of the O.H.B.D.C. the following design values are recommended:

Factored Bearing Capacity at U.L.S. = 450 kPa

Bearing Capacity at S.L.S. Type II = 300 kPa

Earth pressures should be computed as per subsection 6.6.1.2.2 of the code. For the granular backfill a non-yielding foundation condition should be assumed, in which case a value of $K_0 = 0.43$ is recommended. The base of the footing excavations should be protected by 15 cm of mass concrete within 8 hours of exposure. Settlements of the foundation subsoil, due to the surcharge loading of the footings will be negligible (Approx. 25 mm) in magnitude.

No dewatering problems are anticipated due to the relatively impervious nature of the subsoil.

2.) Perched Abutments on Short Piles

As an alternative, footings may be constructed within the original subsoil or within the approach fills and supported on short piles driven to a minimum elevation 172±. In the case of steel 'H' piles (310 HP 79), design loads up to 890 KN may be assumed. The piles should be driven in accordance with SS103-10 or SS103-11. The driving energy should not be less than 50 kJ.

For purposes of the O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S. = 1160 KN

Capacity at S.L.S. Type II = 890 KN

The pile caps should have a minimum of 1.4 m earth cover for frost protection purposes.

Approach Embankments

Fills up to 3 m will be required at this location adjacent to the proposed structure. No stability problems are anticipated for the approaches of this height constructed with 2:1 slopes. The fill should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches through which piles may have to be driven, and it is recommended that this portion of the fill contain no larger grain sizes than 75 mm. It is estimated that the total settlement caused by the embankment loading will be in the order of 25 mm or less.

Cut Sections

Cuts up to 6 m in depth will also be required. The groundwater level was found to be at the ground surface. It is assumed that the slopes will drain in time as the excavation is carried downward. Possible softening of the bottom of the slope, due to seepage, should be prevented by providing adequate drainage and/or filter blankets. The final slopes should not be steeper than 2:1.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. J. Hayward, Student Field Technician. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was written by Mr. P. Payer, and reviewed by Mr. K. G. Selby.



P. Payer
P. Payer, P. Eng.
Foundations Engineer

K. G. Selby
K. G. Selby, P. Eng.
Senior Foundations Engineer

APPENDIX

RECORD OF BOREHOLE No 10

METRIC

W P 197-77-05 LOCATION Co-ords. N 4 820 518.2; E 286 466.6 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone COMPILED BY JB
DATUM Geodetic DATE 82 11 08 CHECKED BY JB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						WATER CONTENT (%) 10 20 30
182.2	Ground Surface						182								
0.0	Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till) Very Stiff to Hard		1	SS	40		180							8 22 51 19	
			2	SS	78		178							6 31 44 19	
			3	SS	45		178								
			4	SS	18		176								7 31 42 20
			5	SS	42		176								
			6	SS	41		174								3 31 45 21
			7	SS	33		174								
			8	SS	23		172								
			9	SS	67	23 cm	172								
			10	SS	60	5 cm	170								6 38 43 13
			11	SS	68		170								
			12	SS	90	25 cm	168								
168.5	Sandy Silt to Silty Sand, Traces of Gravel & Clay Compact to Very Dense		13	SS	13		168								
14			SS	60	8 cm	164								3 41 48 8	
15			SS	110	5 cm	162									
162.4	Weathered Red Shale		16	SS	100	10 cm	158								
157.7			17	SS	100	10 cm	158								
24.5	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 11

METRIC

W P 197-77-05 LOCATION Co-ords. N 4 820 560.3; E 286 415.4 ORIGINATED BY JR
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone COMPILED BY JR
DATUM Geodetic DATE 82 11 08 CHECKED BY JR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
182.7	Ground Surface															
0.0	Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till) Very Stiff to Hard	1	SS	37		182										
		2	SS	88		180										
		3	SS	79		178										
		4	SS	47		176										
		5	SS	29		174										
		6	SS	24		172										
		7	SS	28		170										
		8	SS	28		168										
		9	SS	40	23 cm	166										
		10	SS	60	10 cm	164										
		11	SS	50	8 cm	162										
		12	SS	70	15 cm											
168.2	Sandy Silt to Silty Sand, Some Gravel, Trace Clay Very Dense	13	SS	60												
14.5		14	SS	30	3 cm											
162.9	Weathered Red Shale	15	SS	100	8 cm											
19.8																
161.3	End of Borehole															
21.4																

OFFICE REPORT ON SOIL EXPLORATION



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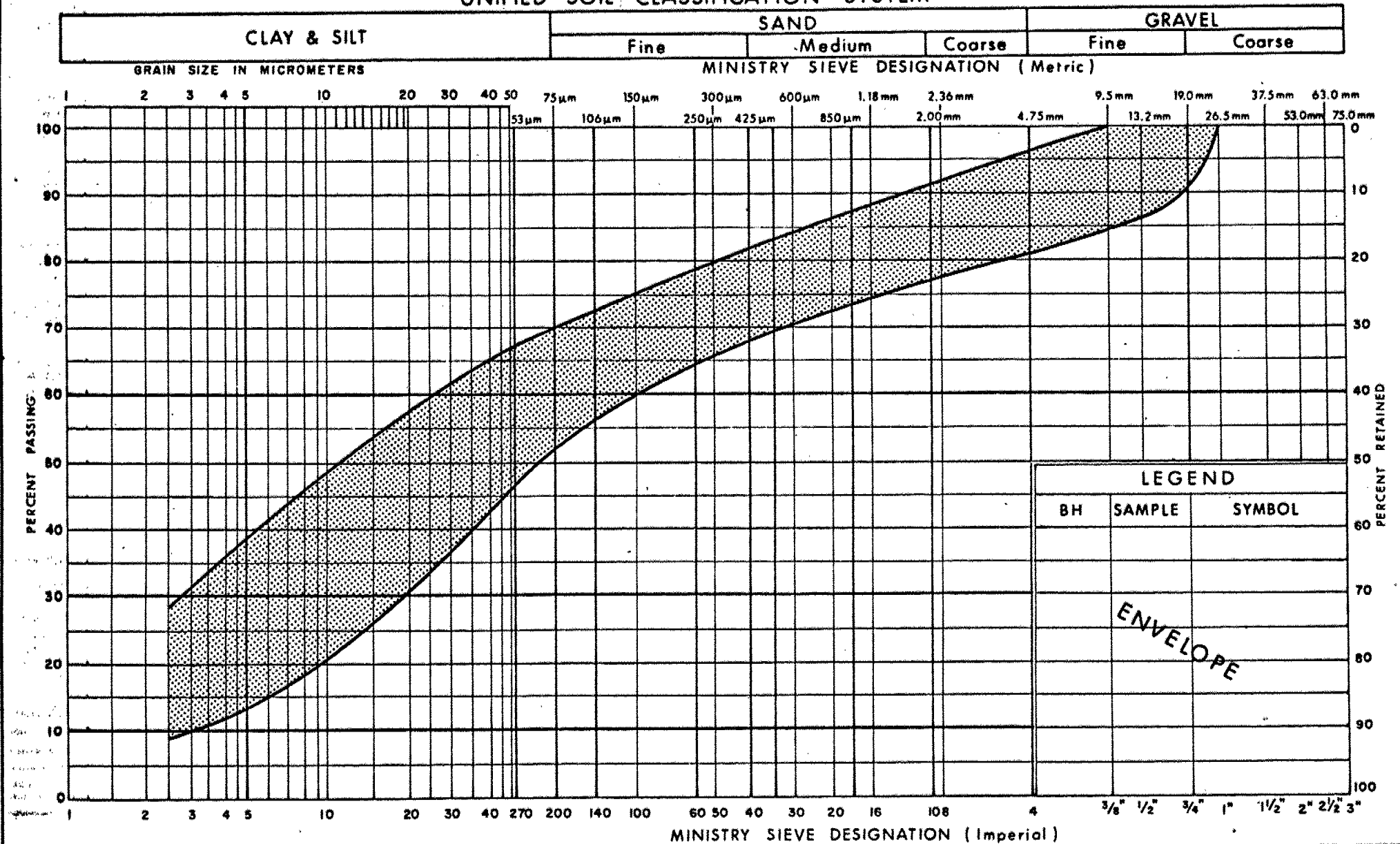
RECORD OF BOREHOLE No 12

METRIC

W P 197-77-05 LOCATION Co-ords. N 4 820 539.2; E 286 441.2 ORIGINATED BY SO
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger COMPILED BY SO
DATUM Geodetic DATE 83 02 16 CHECKED BY SO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
182.1	Ground Level						182		○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
0.0			1	SS	55									
			2	SS	68									
			3	SS	98									
			4	SS	106									
			5	SS	93									
			6	SS	74									
			7	SS	77									
			8	SS	44									
			9	SS	32									
			10	SS	46									
			11	SS	81									
172.9			12	SS	120	10 cm	174							
9.2														

T ON SOIL EXPLORATION

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GRAIN SIZE DISTRIBUTION HET MIXTURE OF SILTY CLAY SAND & GRAVEL (GLACIAL TILL)

FIG No 1

W P 197-77-05

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
σ_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_f	kPa	REMOULDED SHEAR STRENGTH
S_f	1	SENSITIVITY = $\frac{c_u}{\tau_f}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

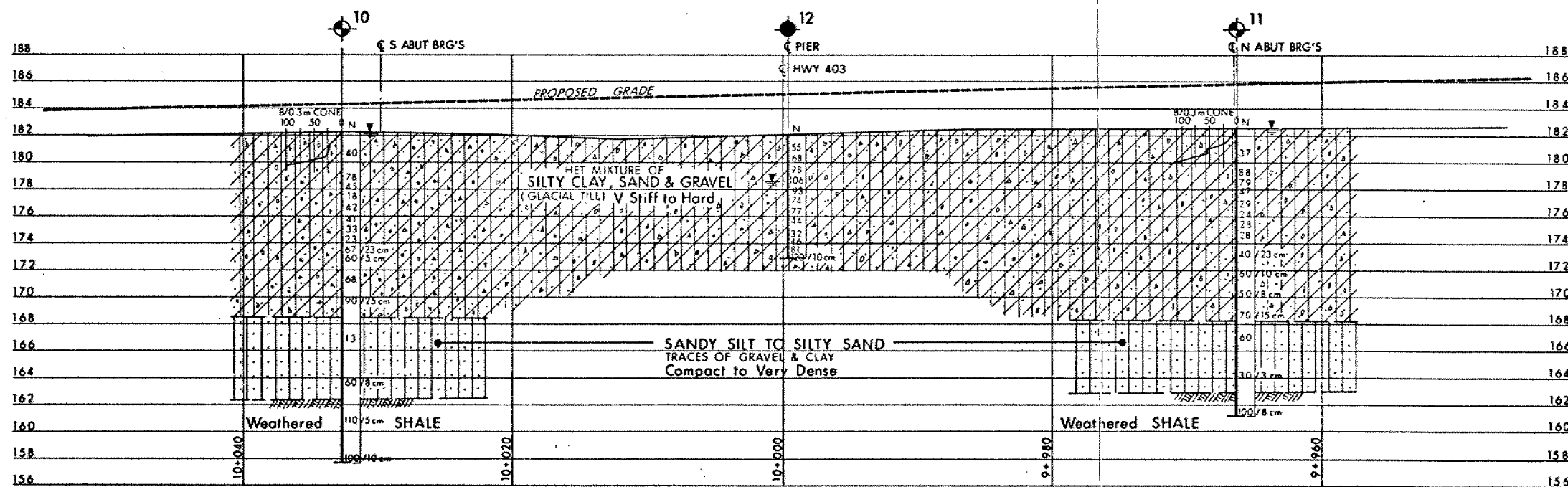
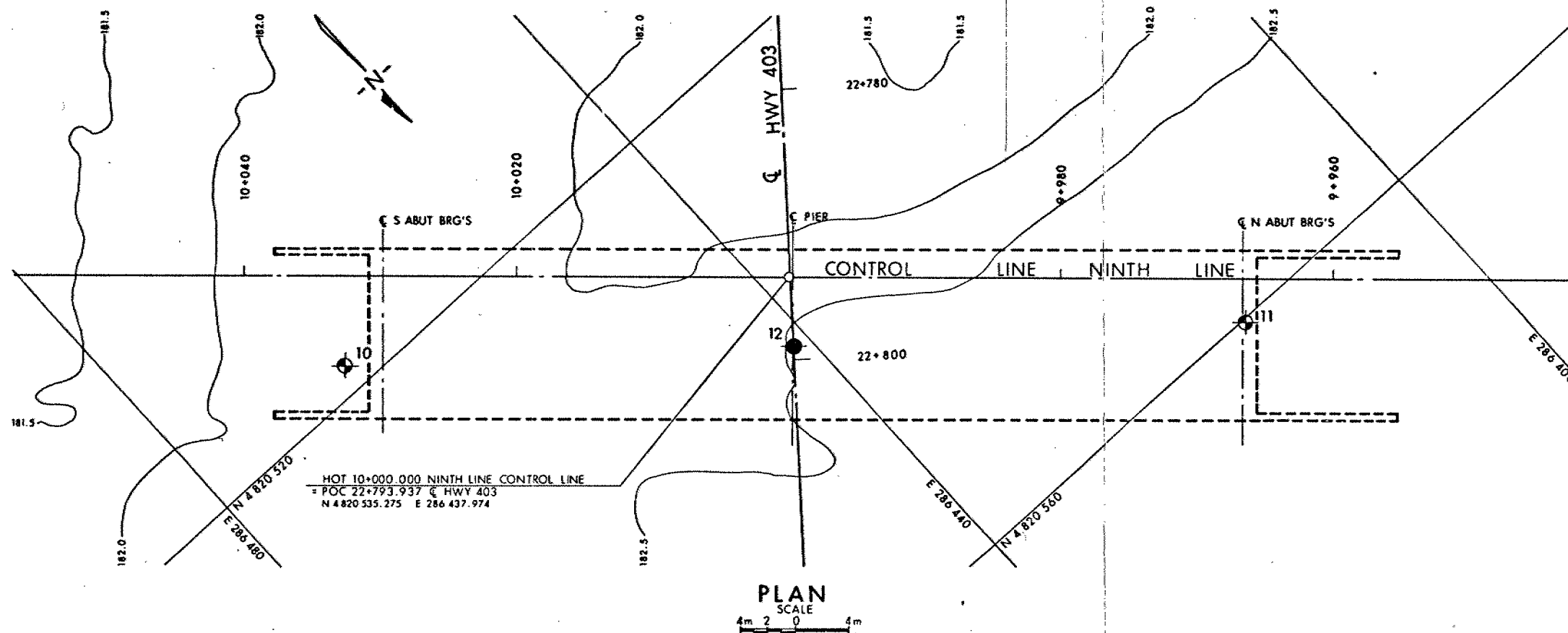
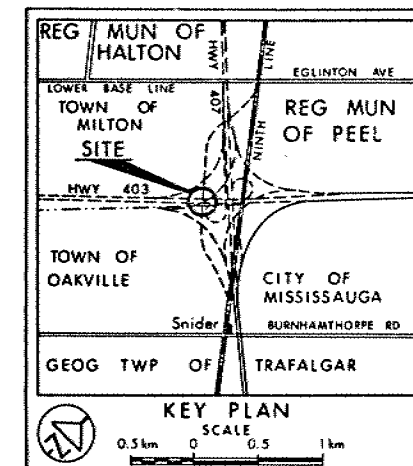
CONT No
WP No 197-77-05

NINTH LINE

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W/L at time of investigation 82 11 & 83 02

No	ELEVATION	CO ORDINATES	
		NORTH	EAST
10	182.2	4820518.2	286466.6
11	182.7	4820560.3	286415.4
12	182.1	4820539.2	286441.2

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: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102.2 of Form 100.

83 10	SO	BORE HOLE 12 ADDED	
DATE	BY	DESCRIPTION	
Geocres No 30M12-173			
HWY No 403			DIST 4
SLURRY PP	CHECKED	DATE 82 12 21	SITE 10-82-327
DRAWN SO	CHECKED	DATE	DWG 2

memorandum



To: W.L. Lin
Design Engineer
Structural Office
3501 Dufferin Street

Date: 1983 10 12

From: Foundation Design Section
Room 315, Central Building

Re: Ninth Line Overpass
Highway 403/407 Interchange
W.P. 197-77-05; Site 10-82-327
District #4 (Hamilton)

We have reviewed the final bridge drawings (Dwg. #1, and #3)
for the above mentioned project, and have no comments.

A handwritten signature in cursive script, appearing to read "K.G. Selby".

K.G. Selby, P. Eng.
Sr. Foundations Engineer

KGS/mmj

memorandum



To: Mr. G.C.E. Burkhardt
Head, Structural Section
Central (5000 Yonge St.) Region

Date: 83 01 25

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Pier Foundation
Ninth Line Underpass
Hwy. #403/407
W.P. 197-77-05, Site 10-82-327
District #4 (Hamilton)

On 83 01 17 we were advised by your Mr. Jagasia that a 2 span structure is proposed at this location. Our original Foundation Investigation Report gave recommendations for the abutments only, since the latest bridge site plan (labelled as 'Final Bridge Site Plan' in Mr. Jagasia's letter of 82 12 13) indicated a single span structure.

Our recommendations for the pier footing foundation are as follows:


- a.) Support the pier on spread footing type foundations at or below El. 174. An allowable bearing value of up to 300 kPa can be used in design.
- b.) O.H.B.D.C. Requirements:
 - Factored Bearing Capacity at U.L.S. = 450 kPa
 - Bearing Capacity at S.L.S. Type II = 300 kPa
- c.) The excavation for the pier footing should be carried out after the roadway cut is completed.
- d.) The base of the footing excavation should be protected by 15 cm of mass concrete within 8 hours of exposure.
- e.) The frost protection requirements in this area is 1.4 m of earth cover.

.../2

- 2 -

Please attach this memorandum to the original Foundation Investigation Report.

We have no further comments on this subject.


P. Payer, P. Eng.
Foundations Engineer

For: K.G. Selby, P. Eng.
Senior Foundations Engineer

PP:KGS:syc

cc: N. Sen
C.P. Korzeniowski (McCormick, Rankin & Assoc. Ltd.)
R. Fitzgibbon
K.G. Bassi

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30MR-173

DIST. 4 REGION

W.P. No. 197-77-05

CONT. No. 84-78

W. O. No.

STR. SITE No. 10-82-327

HWY. No. 403/407

LOCATION Ninth Line Underpass
(Structure #3)

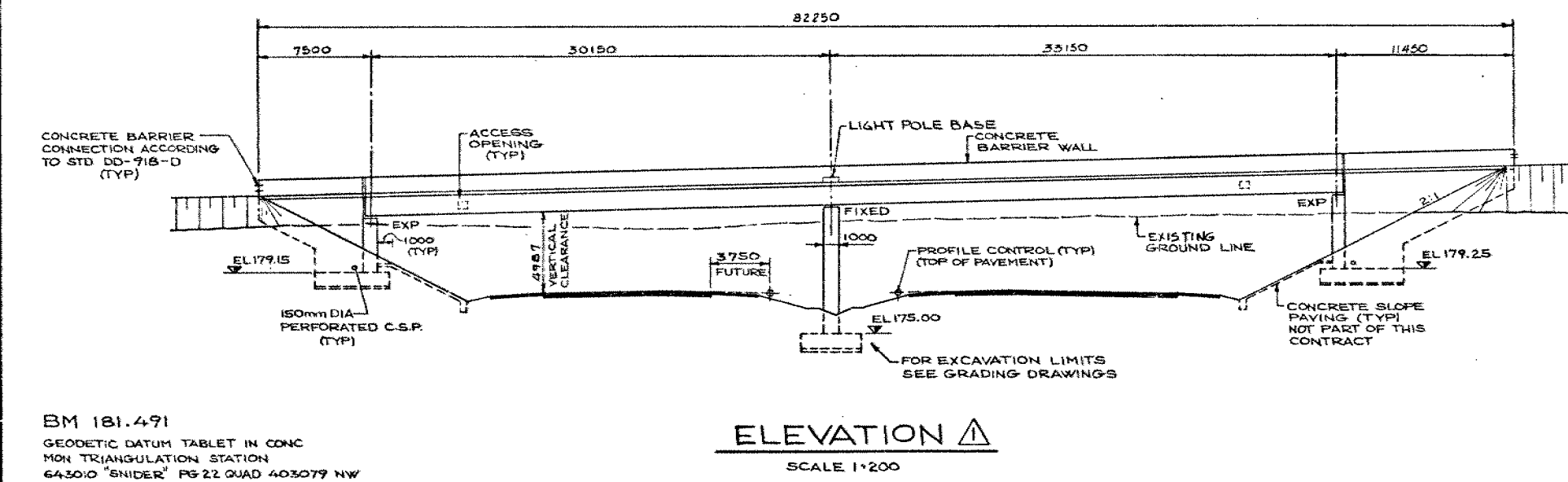
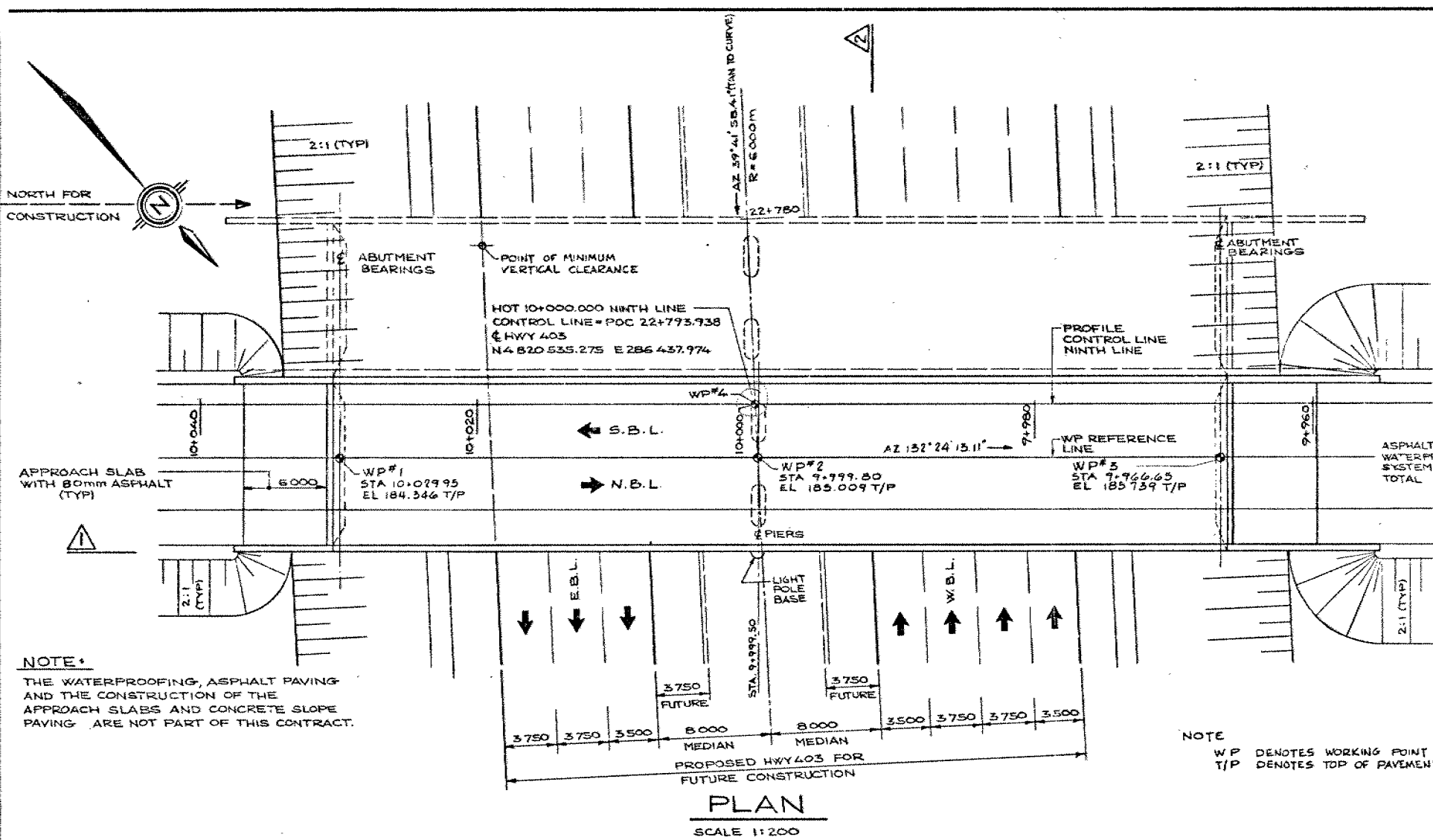
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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DP-8R 11-83



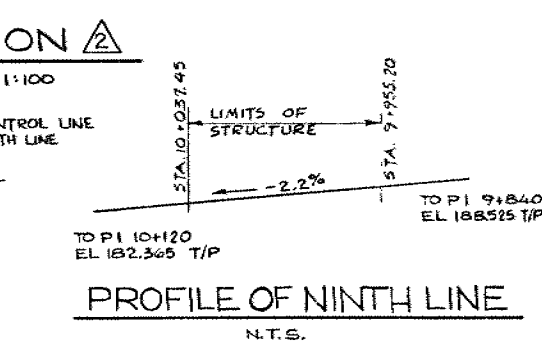
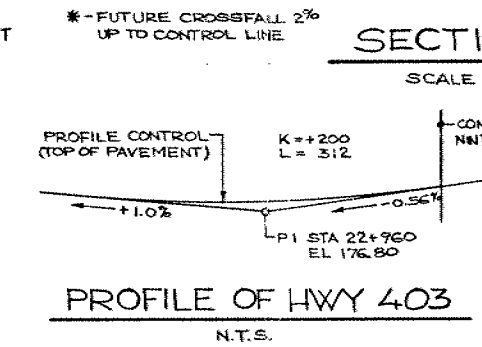
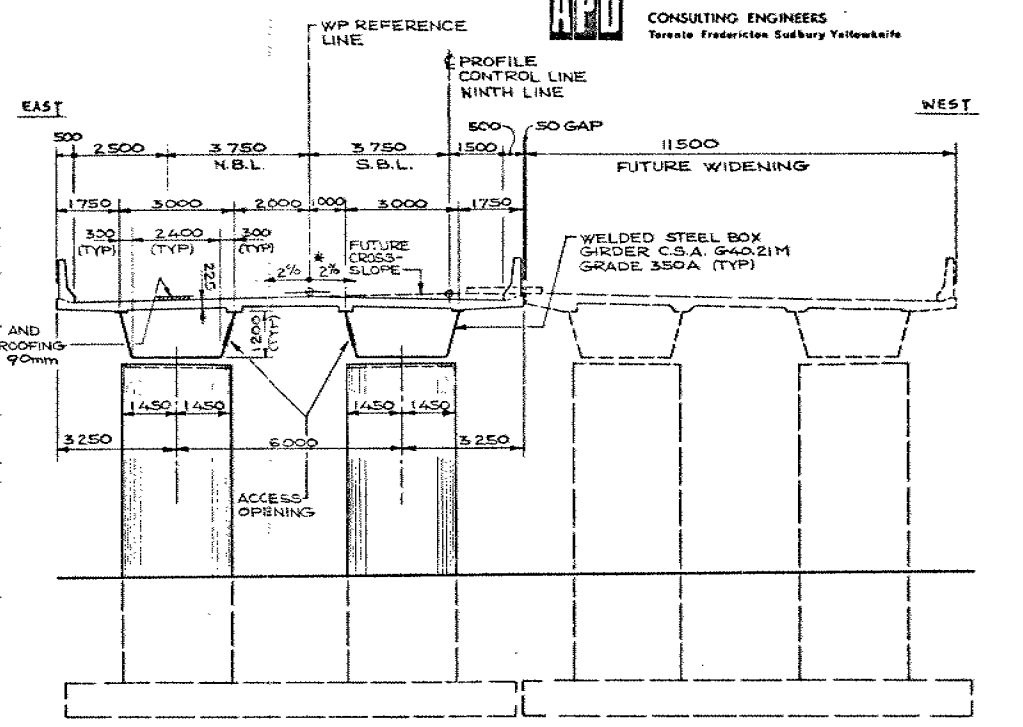
METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DIST. No 4
CONT No
WP No 197-77-05

NINTH LINE UNDERPASS
HWY 403/407 INTERCHANGE
GENERAL ARRANGEMENT

ALBERRY, PULLERITS, DICKSON & ASSOCIATES
CONSULTING ENGINEERS
Toronto Fredericton Sudbury Yellowknife



LIST OF DRAWINGS

- 1) GENERAL ARRANGEMENT
- 2) BOREHOLE LOCATIONS & SOIL STRATA
- 3) FOUNDATION LAYOUT AND DETAILS
- 4) SOUTH ABUTMENT
- 5) NORTH ABUTMENT
- 6) PIER DETAILS
- 7) BOX GIRDERS - PLAN & ELEVATION
- 8) BOX GIRDERS - SECTIONS & DETAILS
- 9) BOX GIRDERS - SECTIONS & DETAILS
- 10) BOX GIRDERS - SECTIONS & DETAILS
- 11) DECK REINFORCING
- 12) DECK DETAILS & SCREED ELEVATIONS
- 13) BARRIER WALLS
- 14) 6000mm APPROACH SLABS
- 15) DETAILS OF CONC SLOPE PAVING
- 16) STANDARD DETAILS
- 17) BRIDGE DATA & SITE NUMBER DATA
- 18) AS CONSTRUCTED ELEVATIONS & DIMENSIONS
- 19) QUANTITIES - STRUCTURE

GENERAL NOTES:

- CLASS OF CONCRETE**
ABUTMENTS, WINGWALLS, DECKS, PIERS AND BARRIER WALLS 30MPa
REMAINDER 20MPa
- REINFORCING STEEL GRADE**
GRADE 400 UNLESS OTHERWISE SPECIFIED.
BARS MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS
- CLEAR COVER TO REINF STEEL**
- | FOOTINGS | 100±25 |
|------------------------------------|--------|
| ABUTMENTS - F-FACE | 80±20 |
| ABUTMENTS - B-FACE | 70±20 |
| PIERS | 80±20 |
| DECKS - TOP | 70±20 |
| DECKS - BOT | 40±10 |
| REMAINDER (UNLESS OTHERWISE NOTED) | 70±20 |

CONSTRUCTION NOTE

THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ±3mm

NOTES FOR STRUCTURAL STEEL SEE DWG NO. 10.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISION	DATE	BY	CHECK	DESCRIPTION
DESIGN	7/2	7/2	7/2	LOADING OHBDC 479
DRAWING	7/2	7/2	7/2	SITE 10-82-327 DWG 1

CONT No
WP No 197-77-05



NINTH LINE UNDERPASS
HWY 403/407 INTERCHANGE
FOUNDATION LAYOUT & DETAILS

SHEET



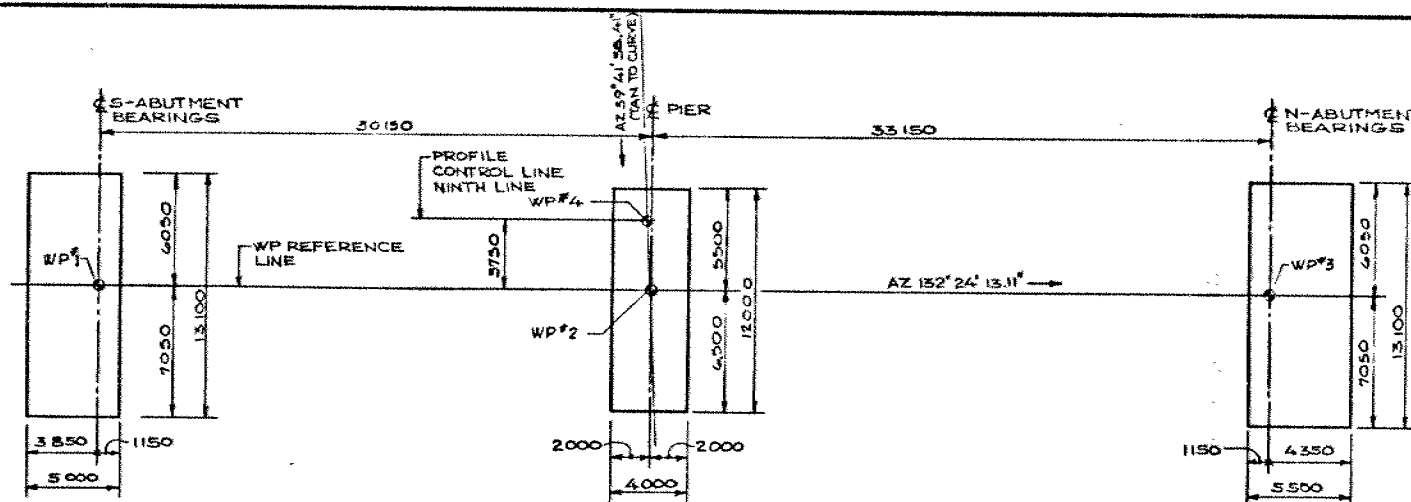
ALBERLY, PULLERITS, DICKSON
& ASSOCIATES
CONSULTING ENGINEERS
Toronto Fredericton Sudbury Yellowknife

METRIC

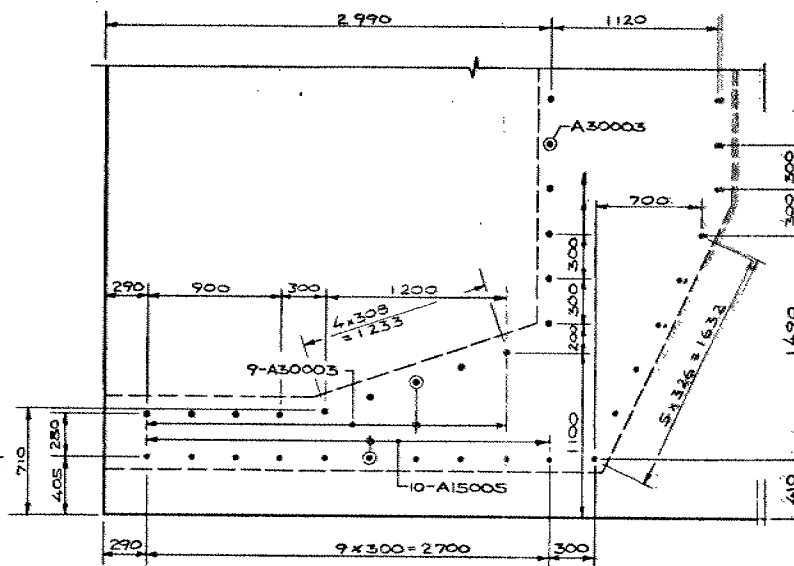
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UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

LOCATION OF WORKING POINTS

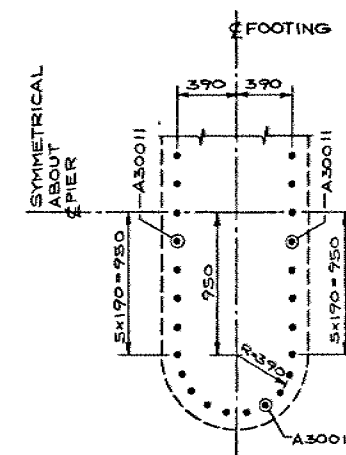
STA	NORTH	EAST	EL T/P
WP#1 10+029.75	4 820 517.847	286 462.6-8	84.346
WP#2 9+777.80	4 820 535.179	286 440.355	85.009
WP#3 9+966.65	4 820 560.534	286 415.877	85.739
WP#4 10+000.00	4 820 535.275	286 437.974	



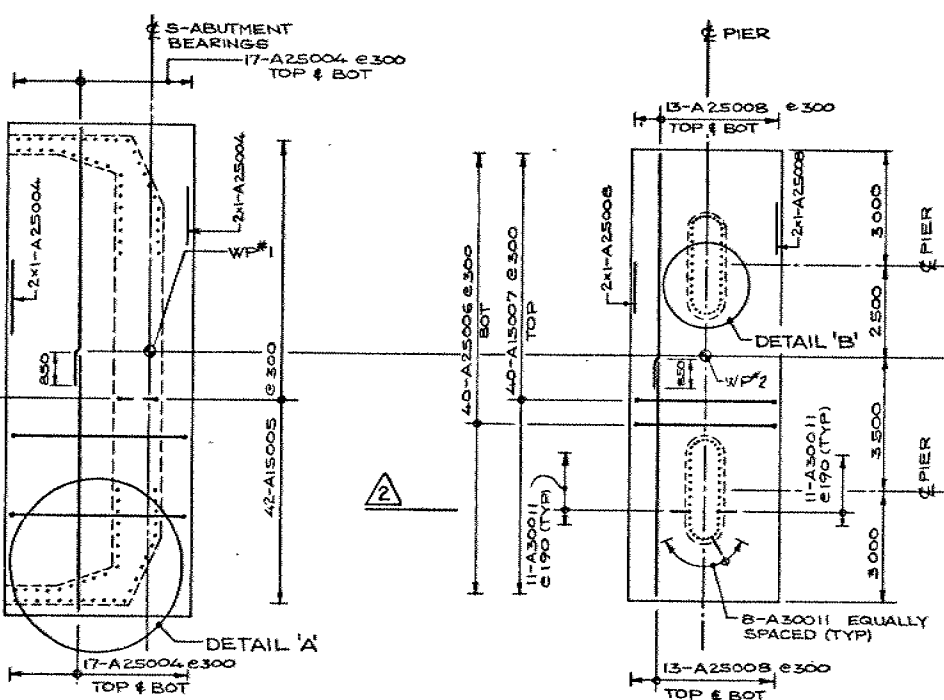
FOOTING LAYOUT
SCALE 1:200



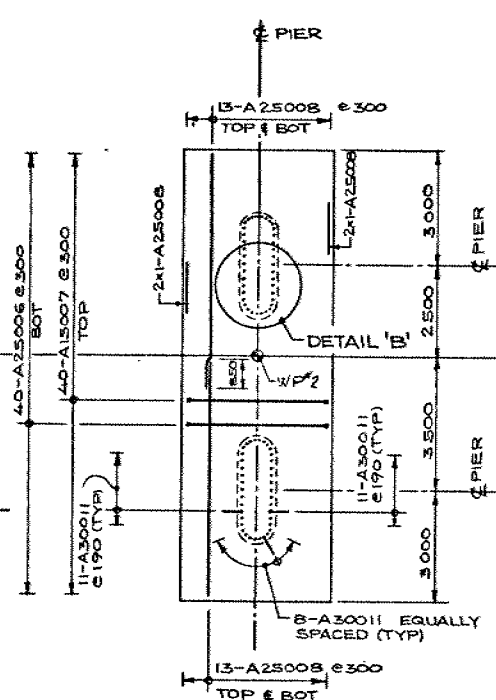
DETAIL A
SCALE 1:25



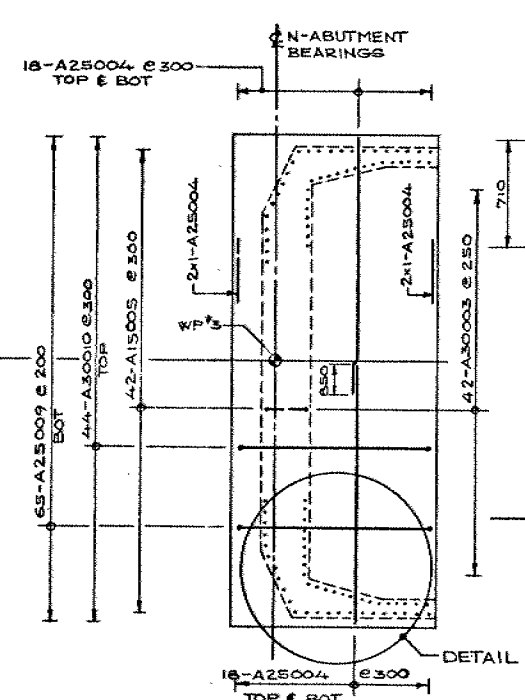
DETAIL B
SCALE 1:25



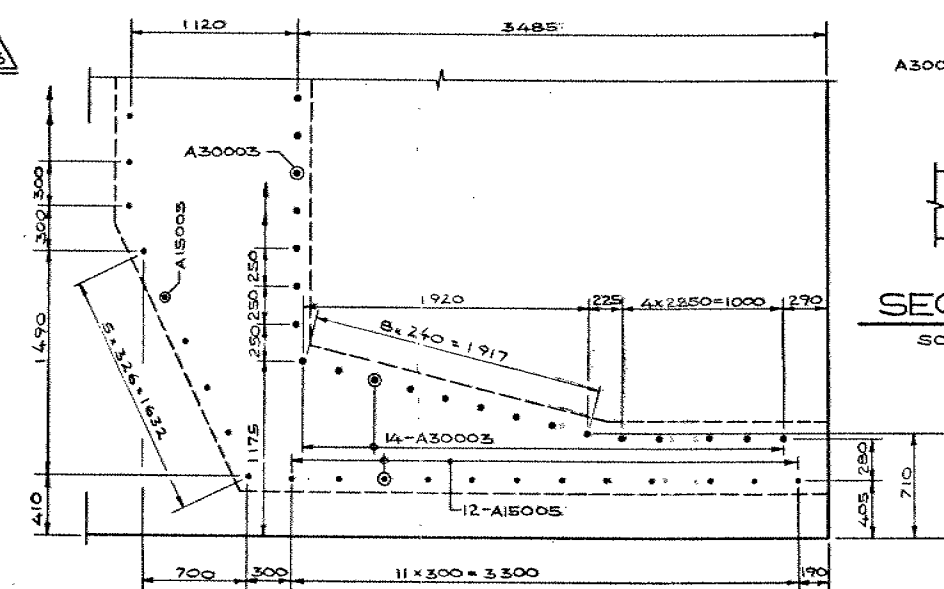
FOOTING SOUTH ABUTMENT
SCALE 1:100



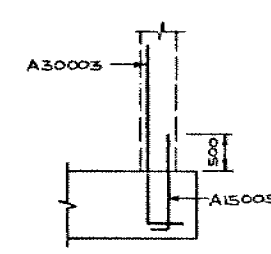
FOOTING PIER
SCALE 1:100



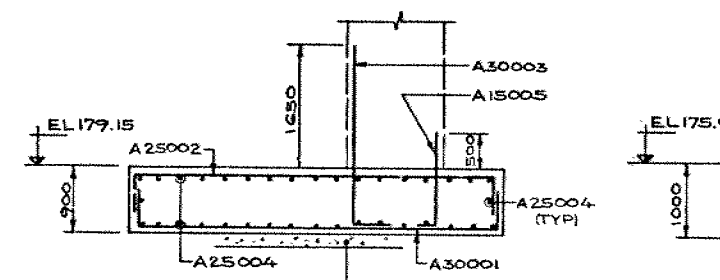
FOOTING NORTH ABUTMENT
SCALE 1:100



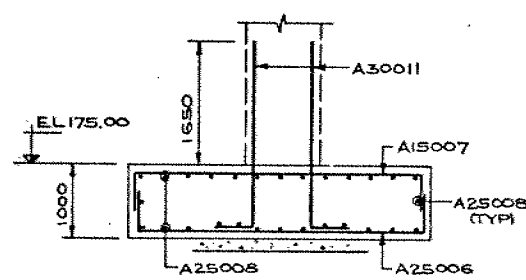
DETAIL C
SCALE 1:25



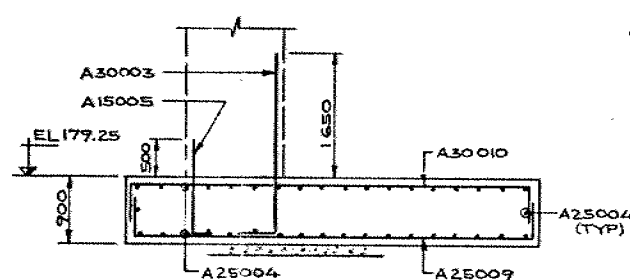
SECTION A
SCALE 1:50



SECTION 1
SCALE 1:50



SECTION 2
SCALE 1:50



SECTION 3
SCALE 1:50

150mm MASS CONCRETE
TO BE POURED WITHIN 12 HRS
OF EXPOSURE
TYP FOR ABUTMENTS & PIER

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN			LOADING ON BOX-CULVERT
DRAWING			SITE 10-82-327 DWG 3



ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

CONT 84-78

WP 197-77-04

DIST 4

HWY 403 & 407

STR SITE 10-82-328

W-S Ramp and Ninth Line, Hwy. #403 & #407
Interchange Complex

DISTRIBUTION

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R. Hore

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Files

FOUNDATION INVESTIGATION REPORT

For

W-S Ramp and Ninth Line
Hwy. #403 & #407 Interchange Complex
W.P. 197-77-04; Site: 10-82-328
District #4 (Hamilton)

INTRODUCTION

This report contains the results of the foundation investigation carried out at the aforementioned site on 82 11 09. The fieldwork consisted of two sampled boreholes and one dynamic cone penetration test adjacent to each boring. The borings were advanced by a continuous flight auger machine mounted on a muskeg vehicle and equipped with solid stem augers.

SITE DESCRIPTION

The site is located west of the existing Ninth Line Road, some 1.0 km north of Burnhamthorpe Rd. in the town of Oakville. The surrounding terrain is relatively flat. Physiographically the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of cohesive type glacial till, followed by sandy silt to silty sand deposit, followed by shale bedrock. The boundaries of the different strata, together with the obtained field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 1977704-A. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below a thin layer of topsoil a till-like zone was encountered at every boring location. The thickness is about 14.6 m. The material in the deposit was found to consist of a heterogeneous mixture of silty clay, sand and gravel. The matrix of this till is basically cohesive in nature - i.e., silty clay binding coarser particles. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 24 to over 100 blows per 30 cm.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>
Natural Moisture Content (%)	7-14
Liquid Limit (%)	18-27
Plastic Limit (%)	11-17

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

The consistency of the overall deposit varies from very stiff to hard.

Sandy Silt to Silty Sand, Some Gravel, Trace of Clay

This stratum was encountered in each boring below the above described glacial till. The thickness was found to be 6.8 m at the boring locations. The material in the deposit consists of sands and silts with varying proportions, with some gravel and trace of clay. Occasional layers of silty clay were also intercepted in the lower part of the deposit.

Standard Penetration Tests, carried out within the deposit, gave 'N' values over 100 blows per 30 cm. Based on this value, the overall deposit may be classified as being very dense. The natural moisture content ranges from 12 to 13%. The results of the grain-size analyses performed on four samples are as follows: Gravel: 2-16%, Sand: 18-44%, Silt: 39-67% and Clay: 5-10%.

Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand deposits at approximate El. 159⁺. The shale is badly weathered. No core samples were obtained.

GROUNDWATER CONDITIONS

The groundwater levels were observed to be at ground surface during the field investigation.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct a three-span (23 m - 32 m - 23 m) structure, designated as W-S Ramp over the realigned Ninth Line Road. The profile of W-S Ramp is set at El. 189+, some 8.5 m over the original ground. The top of pavement of the relocated Ninth Line Road will be at El. 182+. It is assumed that the structure will be built prior to the construction of the new Ninth Line Road at this location.

Structure Foundation

The following foundation alternatives are recommended:

1.) Spread Footings within Original Ground

The entire structure (abutments and piers) may be supported on spread footing type foundations at or below El. 178. It should be noted, however, that 1.4 m of earth cover should be provided, to the underside of the footings, for frost protection purposes. For footings founded at or below the above quoted elevations, an allowable bearing value of up to 385 kPa can be used in design.

For purposes of the O.H.B.D.C. the following design values are recommended:

Factored Bearing Capacity at U.L.S. = 580 kPa

Bearing Capacity at S.L.S. Type II = 385 kPa

The base of the footing excavations should be protected by 15 cm of mass concrete within 8 hours of exposure.

No dewatering problems are anticipated due to the relatively impervious nature of the subsoil.

2.) Spread Footings on Compacted Granular Fill

As an alternative, the abutments may be supported on spread footings placed on well compacted, suitable granular material within the approach fills. A safe design load of 355 kPa may be assumed. A detailed construction scheme is outlined on Fig. 2 of the Appendix. In computing the shearing resistance between the base of the footing and the compacted Granular 'A' core, the coefficient of friction may be taken as 0.55. For purposes of the O.H.B.D.C. the following design values are recommended:

Bearing Capacity at S.L.S. Type II = 335 kPa

Factored Bearing Capacity at U.L.S. = 500 kPa

3.) Perched Abutments on Piles

As a second alternative, the abutments may be constructed within the approach fills and supported on piles driven to El. 171. In the case of steel 'H' piles (310 HP 79) design loads up to 890 kN may be assumed.

The piles should be driven in accordance with M.T.C. Standards SS103-10 or SS103-11. For the purpose of the O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S. = 1160 kN

Capacity at S.L.S. Type II = 890 kN

The pile caps should have a minimum of 1.4 m earth cover for frost protection requirements.

Approach Embankments

Fills up to 8.5 m will be required at this location adjacent to the proposed structure. No stability problems are anticipated for the approaches

of this height constructed with 2:1 slopes. The fill should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches through which piles may have to be driven, and it is recommended that this portion of the fill contain no larger grain sizes than 75 mm. It is estimated that the total settlement caused by the embankment loading will be in the order of 50 mm.

Earth Pressures

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the code. For the granular backfill a non-yielding foundation condition should be assumed, in which case a value of $K_0=0.43$ is recommended.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. J. Hayward, Student Technician. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was written by Mr. P. Payer, and reviewed by Mr. K.G. Selby.



P. Payer, P. Eng.
Foundations Engineer

K.G. Selby, P. Eng.
Senior Foundations Engineer

APPENDIX

RECORD OF BOREHOLE No 12

METRIC

W P 197-77-04 LOCATION Co-ords. 4 820 405.0 N; 286 539.0 E ORIGINATED BY JH
DIST 4 HWY 403/407 BOREHOLE TYPE Cont'. Flight Auger (S.A.) & Cone Test COMPILED BY JH
DATUM Geodetic DATE 82 11 09 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
180.3	Ground Surface												
0.0	Heterogeneous Mixture of Silty Clay (CL) Sand & Gravel V. Stiff to Hard Glacial Till	1	SS	25		180							4 22 53 21
		2	SS	24		178							
		3	SS	45									
		4	SS	91									
		5	SS	91									
		6	SS	106									
		7	SS	79									7 29 46 18
		8	SS	60/	15 cm								15 30 40 15
	Sandy Silt to Silty Sand, Some Gravel Trace of Clay V. Dense	9	SS	86/	15 cm								
165.7		10	SS	112									4 38 53 5
14.6		11	SS	83/	15 cm								10 18 67 5
158.9	End of Borehole	12	SS	80/	10 cm								
21.4	Weathered Red Shale												

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 13

METRIC

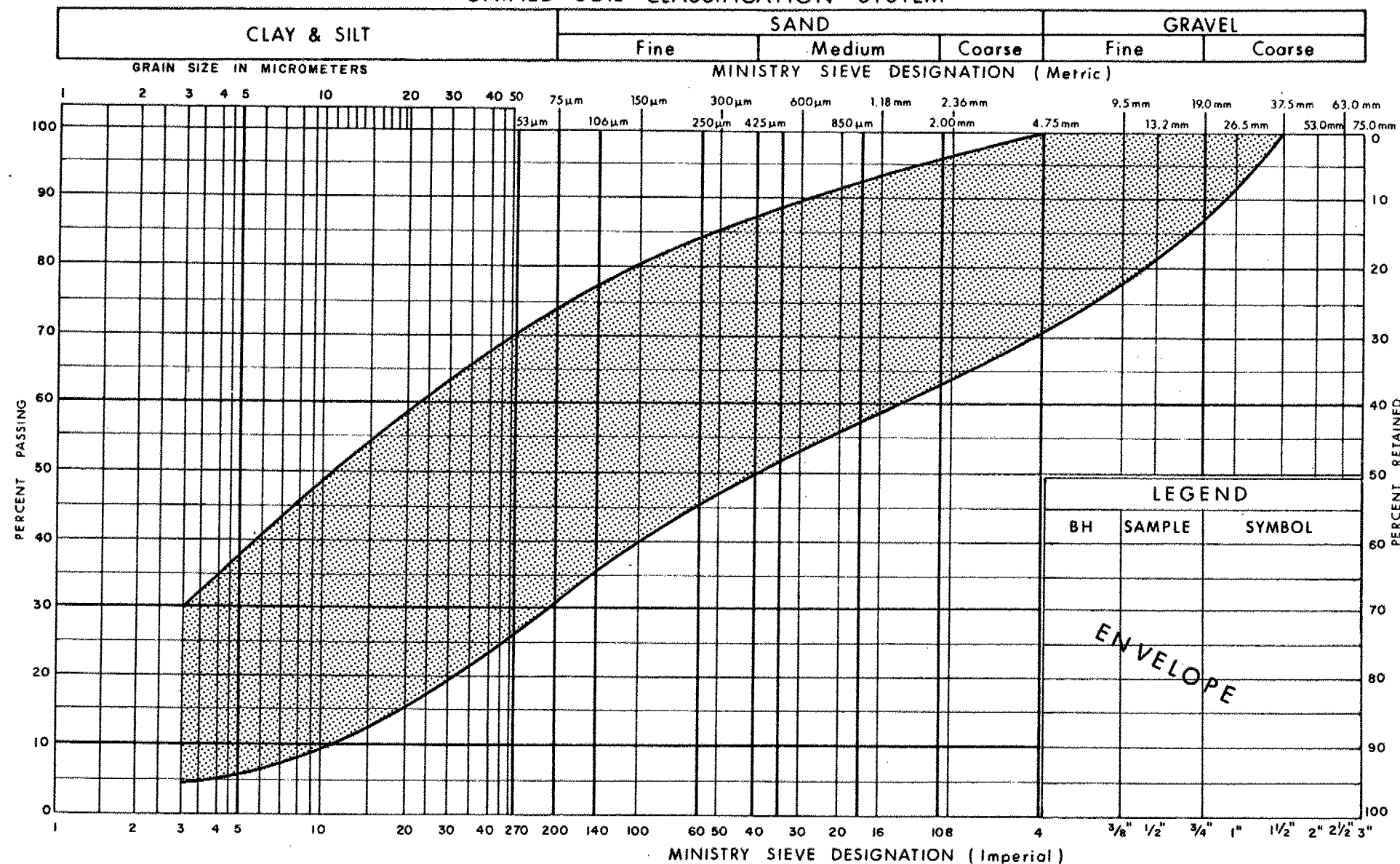
W P 197-77-04 LOCATION Co-ords. 4 820 420.6 N; 286 606.8 E ORIGINATED BY JH
DIST 4 HWY 403/407 BOREHOLE TYPE Cont'. Flight Auger (S.A.) & Cone Test COMPILED BY JH
DATUM Geodetic DATE 82 11 09 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						WATER CONTENT (%)
								20 40 60 80 100						
								SHEAR STRENGTH						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
180.3	Ground Surface												GR SA SI CL	
0.0	Heterogeneous Mixture of Silty Clay (CL) Sand & Gravel Hard Glacial Till		1	SS	40		180						0 27 49 24	
			2	SS	52		178							
			3	SS	67									
			4	SS	42		176							
			5	SS	49									
			6	SS	110		174							
			7	SS	100/	7.5 cm	172							
			8	SS	100/	12.5 cm	170							
			9	SS	68/	15 cm	168							
			10	SS	70/	15 cm	166							
			11	SS	100/	12.5 cm	164							
165.5	Sandy Silt to Silty Sand, Some Gravel Trace of Clay V. Dense		12	SS	80/	7.5 cm	162							
14.6			13	SS	100/	7.5 cm	160							
			14	SS	100/	5 cm								
158.7	End of Borehole													
21.4	Weathered Red Shale													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

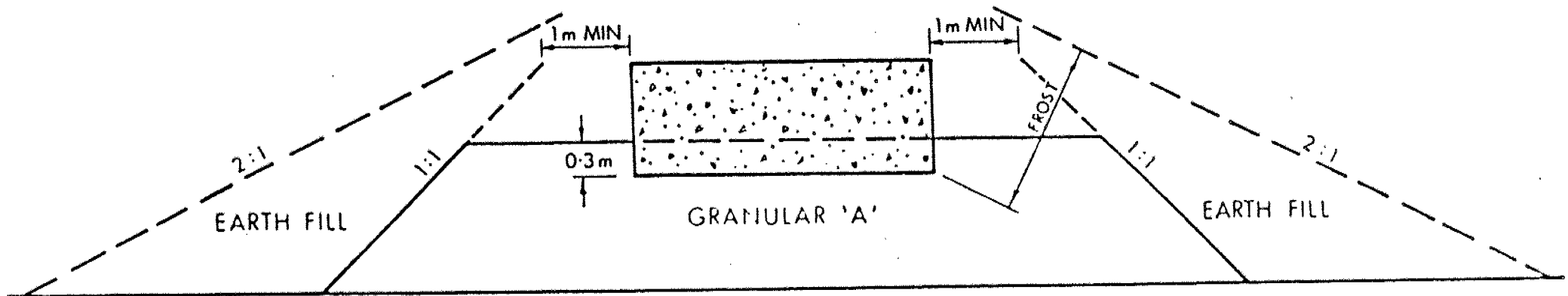
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF SILTY CLAY, SAND
& GRAVEL (Glacial Till)

FIG No 1

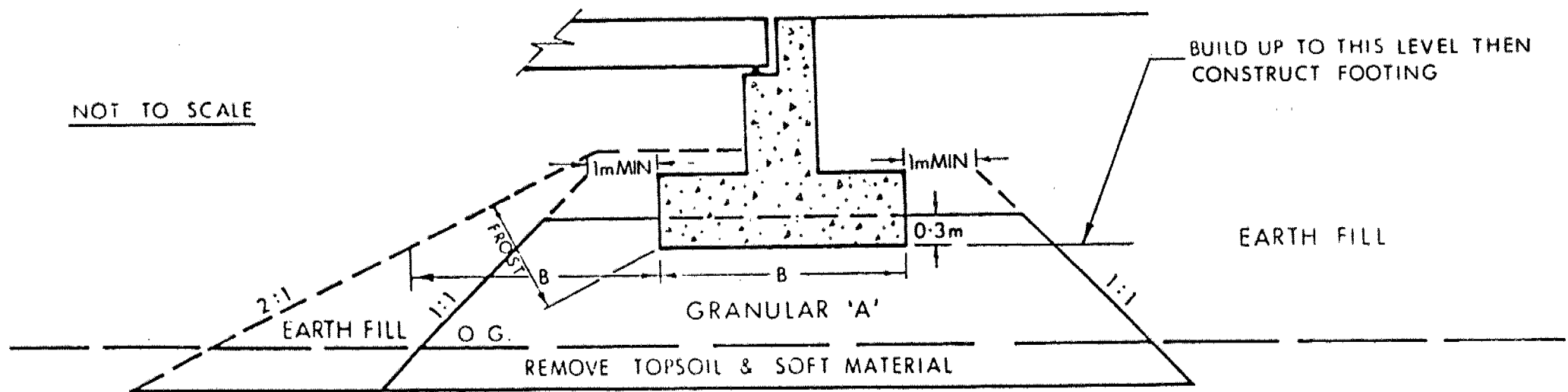
W P 197-77-04

ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



X SECTION

NOT TO SCALE



LONGITUDINAL SECTION

NOTES:

- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.C. STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

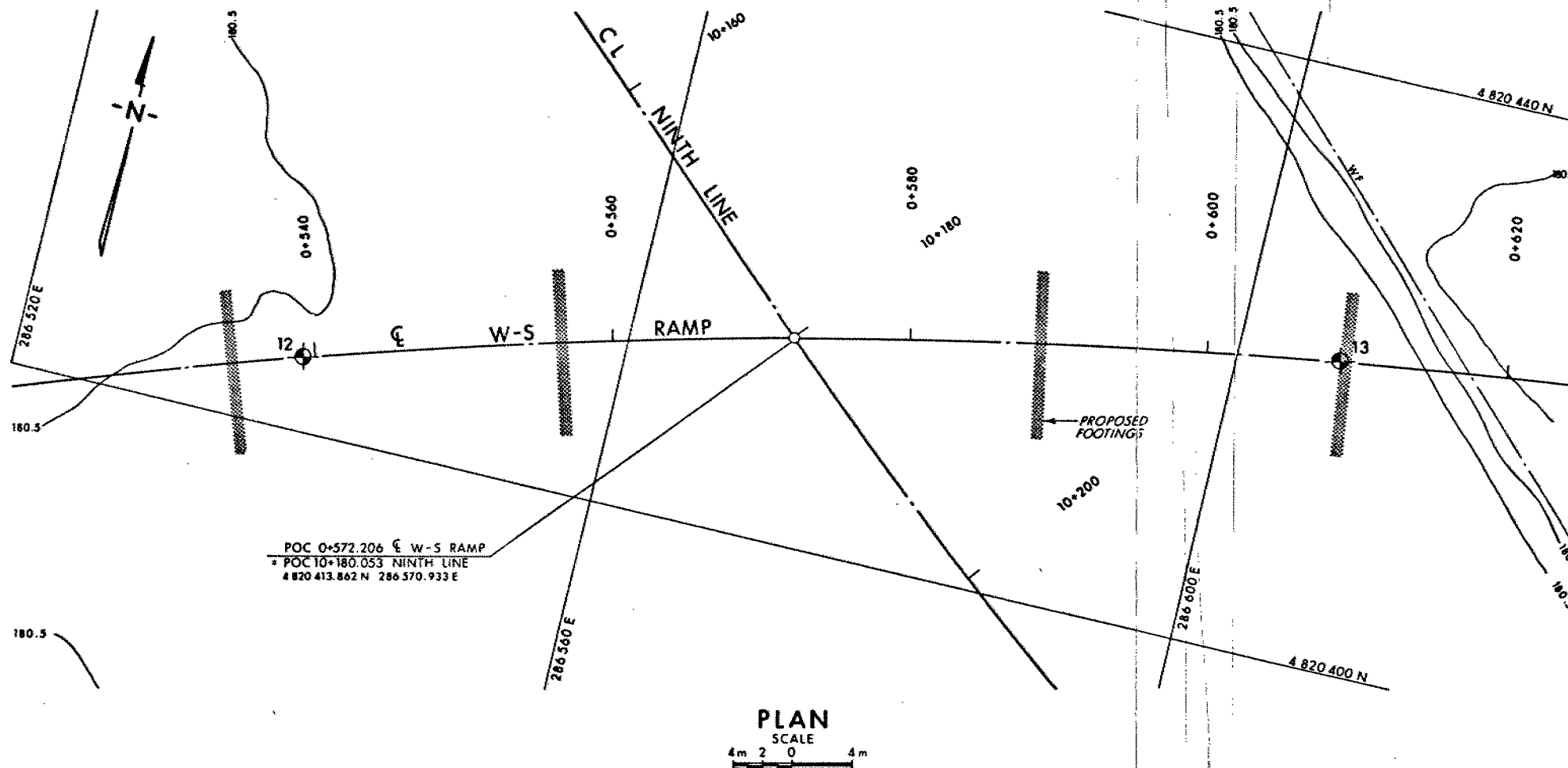
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kn/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kn/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kn/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kn/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kn/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m ³	SEEPAGE FORCE
γ'	kn/m ³	UNIT WEIGHT OF SUBMERGED SOIL						



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

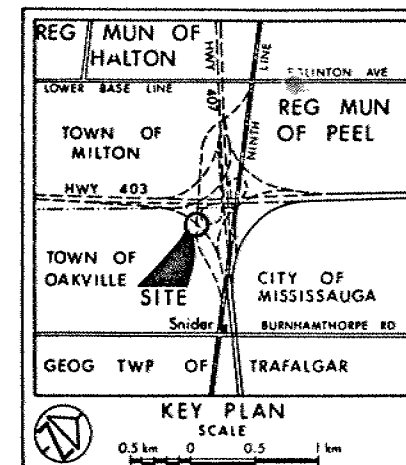
CONT No
WP No 197-77-04

W-S RAMP OVER NINTH LINE

BORE HOLE LOCATIONS & SOIL STRATA

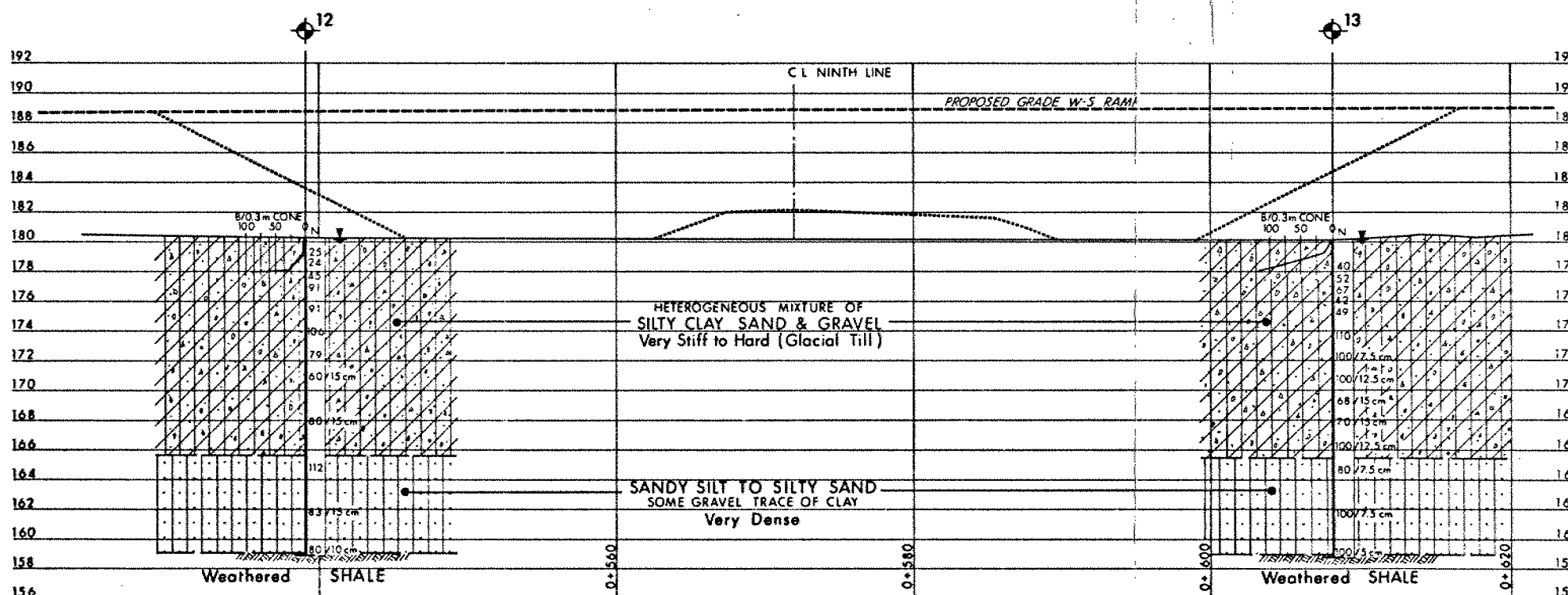


SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 82 11



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: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 30M12-174

HWY No 403/407	CHECKED	DATE 83 01 10	DIST 4
SUBMD PP	CHECKED	DATE 83 01 10	SITE 10-82-328
DRAWN SO	CHECKED	DATE 83 01 10	DWG 1977704-A

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M12-174

DIST. 4 REGION

W.P. No. 197-77-04

CONT. No. 84-78

W. O. No.

STR. SITE No. 10-82-328

HWY. No. 403/407

LOCATION Ramp W-S over 9th line
(Structure #6) 403 W-407 S Ramp over
No. of PAGES - 9th line

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

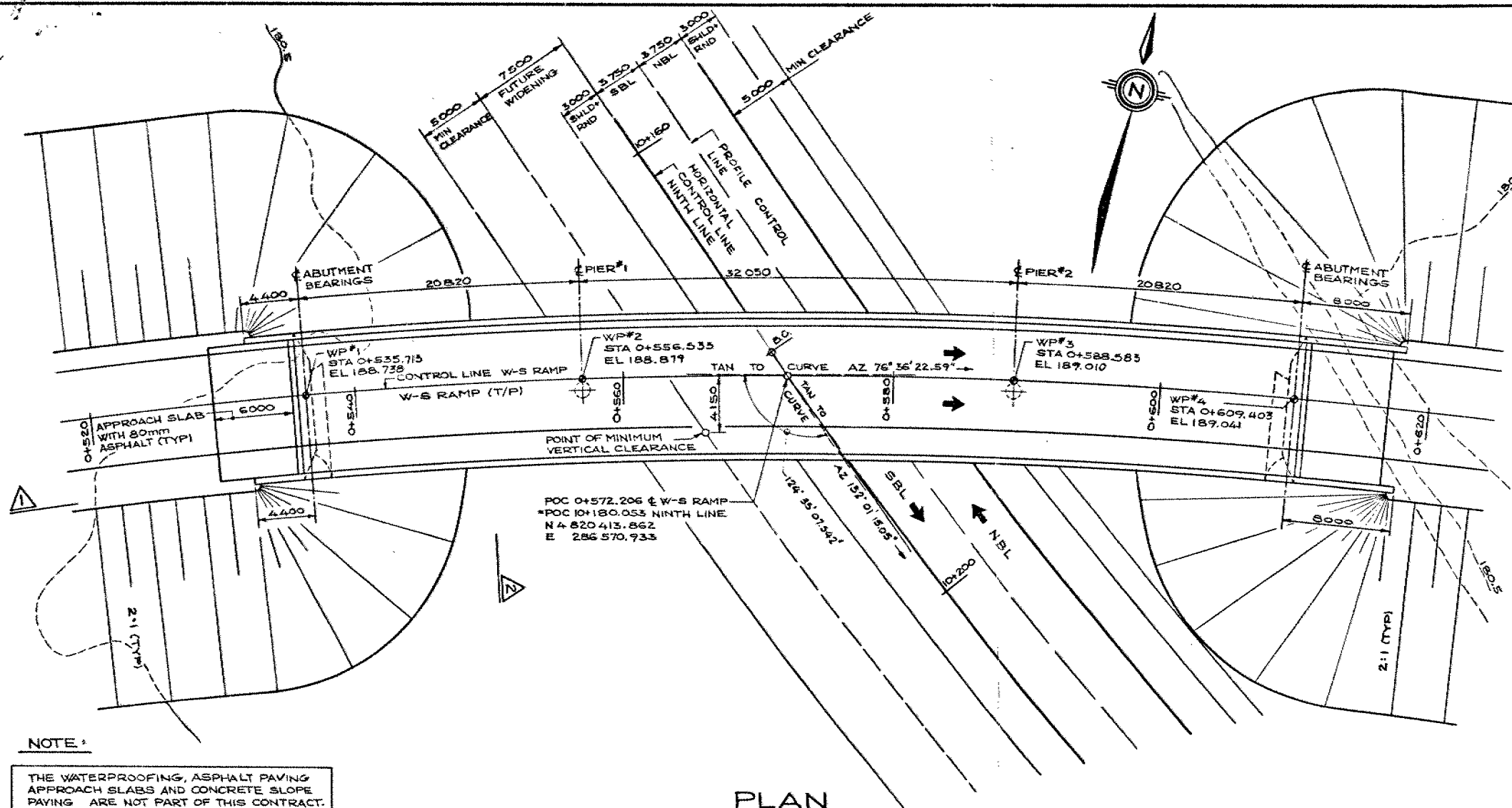
REMARKS:



ALBERRY, PULLERTS, DICKSON
& ASSOCIATES
CONSULTING ENGINEERS
Toronto Fredericton Sudbury Yellowknife

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

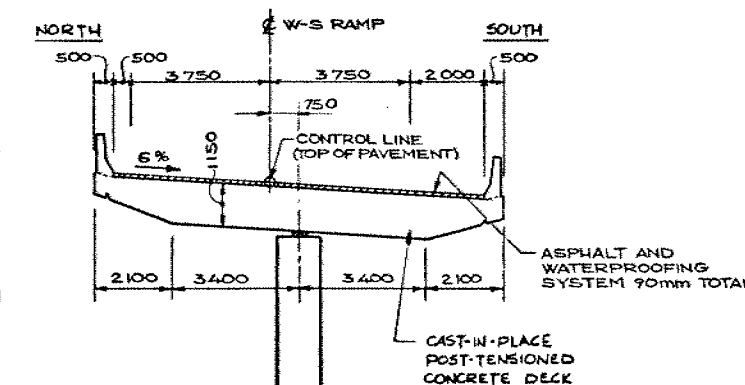


NOTE:

THE WATERPROOFING, ASPHALT PAVING
APPROACH SLABS AND CONCRETE SLOPE
PAVING ARE NOT PART OF THIS CONTRACT.

PLAN

SCALE 1:200



SECTION A-A

SCALE 1:100

LIST OF DRAWINGS

- 1) GENERAL ARRANGEMENT
- 2) BOREHOLE LOCATIONS & SOIL STRATA
- 3) GRANULAR PAD FOUNDATIONS
- 4) FOUNDATION LAYOUT & DETAILS
- 5) WEST ABUTMENT
- 6) EAST ABUTMENT
- 7) PIER DETAILS
- 8) DECK DETAILS
- 9) LONGITUDINAL CABLES
- 10) TRANSVERSE CABLES
- 11) DECK REINFORCING-DETAILS
- 12) BARRIER WALLS
- 13) 6000mm APPROACH SLABS
- 14) DETAILS OF CONC SLOPE PAVING
- 15) STANDARD DETAILS
- 16) BRIDGE DATA & SITE NUMBER DATA
- 17) AS CONSTRUCTED ELEVATIONS & DIMENSIONS
- 18) QUANTITIES - STRUCTURE

GENERAL NOTES:

CLASS OF CONCRETE

ABUTMENTS, WINGWALLS
AND BARRIER WALLS 30MPa
DECK AND COLUMNS 35MPa
REMAINDER 20MPa

REINFORCING STEEL GRADE

GRADE 400 UNLESS OTHERWISE SPECIFIED.
BARS MARKED WITH THE SUFFIX 'C' SHALL
BE COATED BARS.

CLEAR COVER TO REINF STEEL

FOOTINGS 100±25
ABUTMENTS: F-FACE 80±20
B-FACE 70±20
PIERS 80±20
DECK: TOP 70±20
BOT 50±10
REMAINDER (UNLESS OTHERWISE NOTED) 70±20

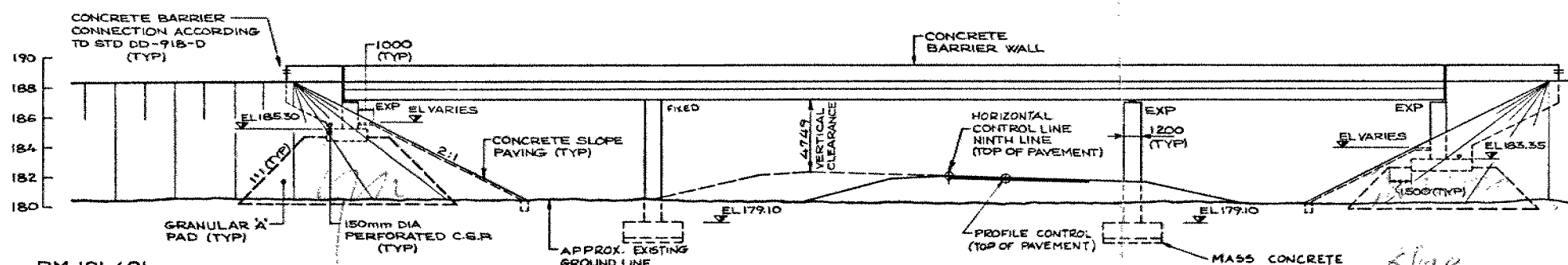
CONSTRUCTION NOTE

THE CONTRACTOR SHALL FINISH
THE BEARING SEATS DEAD LEVEL
TO THE SPECIFIED ELEVATIONS TO
A TOLERANCE OF ±3mm.

THREE MONTHS AFTER THE STRESSING
OPERATIONS HAVE BEEN COMPLETED, THE
DECK SHALL BE JACKED UP AT THE
ABUTMENTS TO PERMIT THE BEARINGS
TO RETURN TO THE VERTICAL POSITION.
THE JACKING PROCEDURE SHALL BE
SUBMITTED TO THE ENGINEER FOR
APPROVAL PRIOR TO EXECUTION.

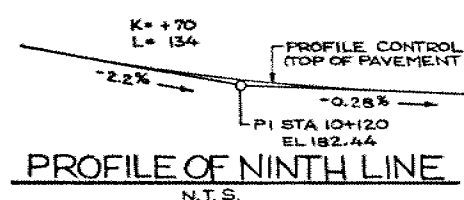
NOTES:

WP DENOTES WORKING POINT
T/P DENOTES TOP OF PAVEMENT



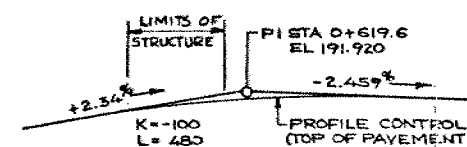
ELEVATION A-A

SCALE 1:200



PROFILE OF NINTH LINE

N.T.S.



PROFILE OF W-S RAMP

N.T.S.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

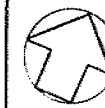
DATE	BY	DESCRIPTION
DESIGN	2/	LOADING CHOC-A-79 DATE JUN 83
DRAWING	2/	CHECK 2/ SITE No 10-82-328 DWG 1

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 197-77-04

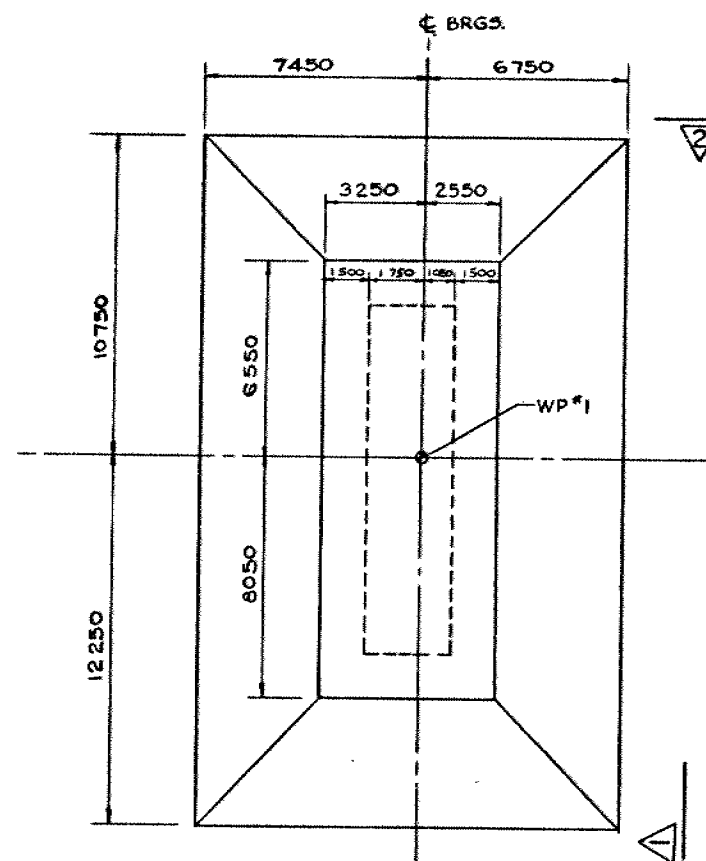
RAMP W-S UNDERPASS AT NINTH LINE
HWY 403/407 INTERCHANGE
GRANULAR PAD FOUNDATION



SHEET

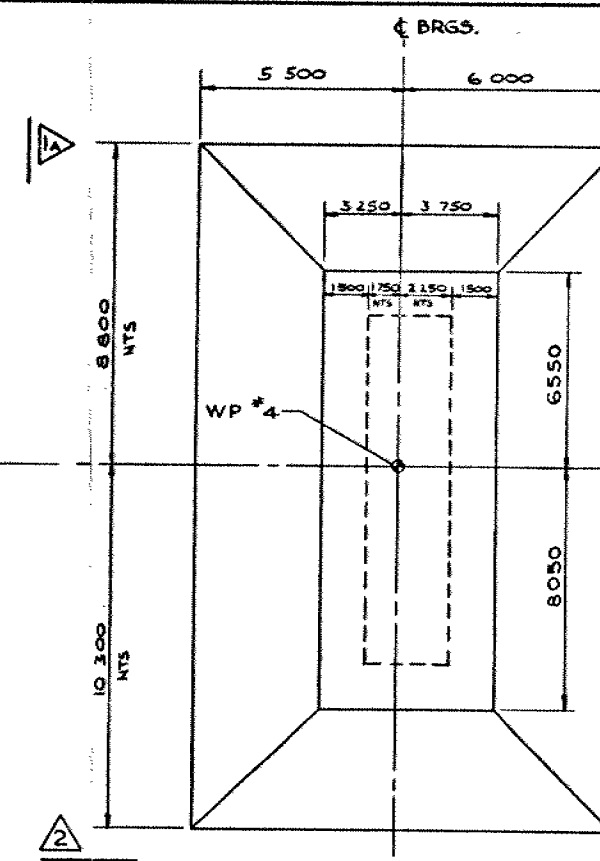


ALBERY, PULLERITS, DICKSON
& ASSOCIATES
CONSULTING ENGINEERS
Toronto Fredericton Sudbury Yellowknife



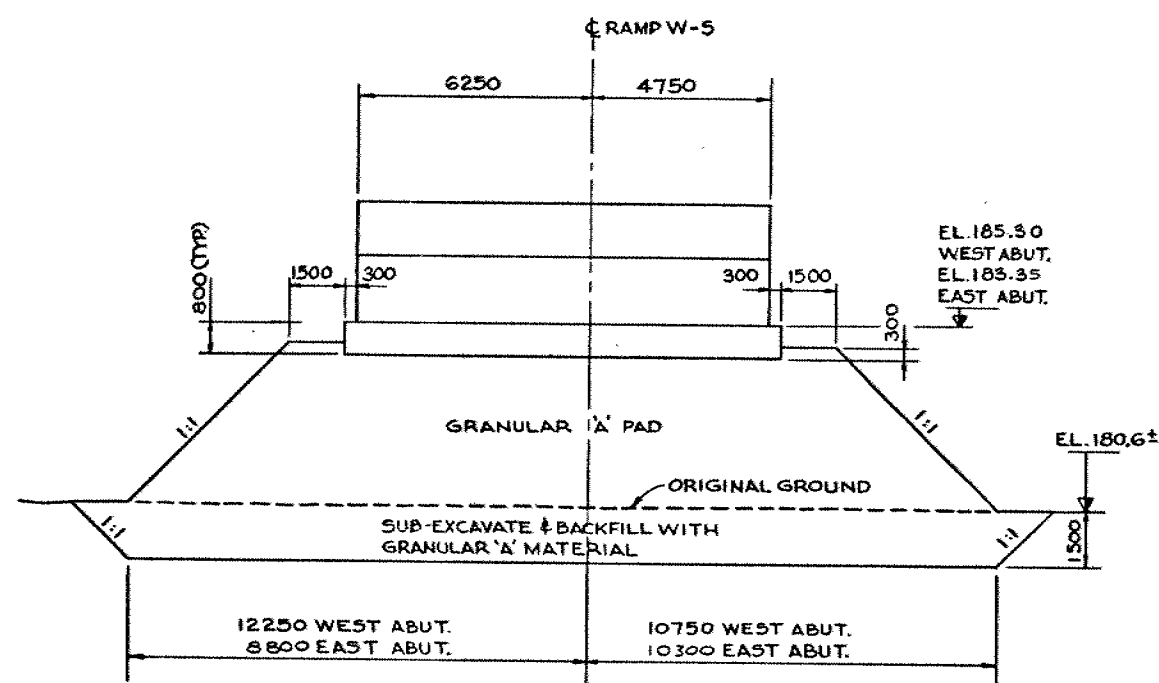
PLAN-WEST ABUTMENT

SCALE 1:125



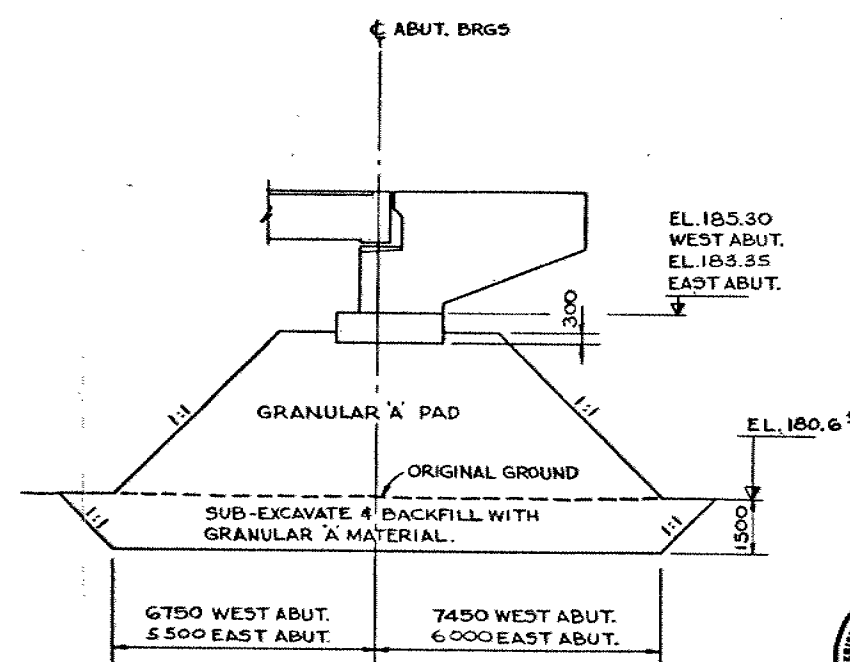
PLAN-EAST ABUTMENT

SCALE 1:125



(1) (2) (OPPOSITE HAND)

SCALE 1:100



(1) (2) (OPPOSITE HAND)

SCALE 1:100



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	CHECK	DESCRIPTION	DATE
DESIGN	8/83	BY	CHECK	LOADING OHBDC-A-79	DATE JUN/83
DRAWING	8/83	BY	CHECK	SITE No 10-62-328	DWG 3



To: Anne Cataford
Executive Support Engineer
Construction Office
Central Region

Date: May 2/94

From: Foundation Design Section
Room 315, Central Bldg.

Tel: (416) 235-3731
Fax: (416) 235-5240

Re: Remedial Measures
Leachate from Blast Furnace Slag
W-S Ramp @ 9th Line
WP 197-77-04, Site 10-82-328
Construction Contract 84-78
Highway 403, District 6, Toronto

As requested in your memo dated April 20/94, we have reviewed the proposal submitted by Proctor and Redfern to eliminate odour problems associated with the leachate originating within the air-cooled blast furnace slag fill beneath the abutments of this bridge. Our comments are restricted to a conceptual review of the slope stability aspects of the proposal since we have not been involved with the design of the slag pad or any aspects of the remedial design.

It is proposed to construct a trench around the base of the approach embankments. It will be 1m wide and extend to elevation 179m. As surface elevation is 181.5m, the depth of trench will not exceed 2.5m. The consultant has limited the length of exposed trench to $\frac{1}{3}$ the length of the toe wall and we are assuming that this acceptable exposed length is less than 5m.

As a minimum constraint, the trench should be outside a 1H:1V slope projected down from the edge of the abutment. This proposal appears to meet this minimum acceptable geometry. However, the consultant should be advised that the remedial measures for the leachate problem should not destabilize the abutment foundations, and that this review does not release him from liability for the design.

As requested, the Proctor and Redfern report is enclosed.

A handwritten signature in cursive script that reads "D. Dundas".

D. Dundas, P.Eng.
Acting Chief Foundation Engineer

encl.

Background Documentation for Halton Sewer Compliance Application

403/9th Line Leachate Investigation and Remediation for the Ministry of Transportation March 1994

Introduction

Leachate is being generated within the bridge abutments located at the 403 and 9th Line overpass. The leachate originates within the blast furnace slag which was used as a granular material in the construction of the abutments. The Ministry of Environment and Energy (MOEE) have instructed the Ministry of Transportation (MTO) to remove the leachate which is existing at the site and to implement a long-term solution to the problem of leachate generation. The following sections describe the details of the problem and the proposed solution.

Background

In 1991, a complaint was received by MOEE regarding the leachate which was seeping from the base of the bridge abutments at the 403/9th Line interchange. In response MOEE instructed MTO to resolve this problem of leachate generation at this site.

To remediate the leachate problem in the short-term, a temporary containment and disposal system was implemented. Ponds were constructed at the base of each abutment to facilitate containment and collection of the leachate. In April 1992, MTO decided that the preferred interim solution was to pump the leachate from the collection ponds and transport it to Halton Region's sanitary sewer system for treatment and disposal at the Skyway WPCP. Permission was granted by Halton to implement this practice on a temporary basis while a more permanent solution to leachate management was being formulated. Leachate was first transported off-site for treatment/disposal in this manner on April 22, 1992. The pooled leachate was pumped six times in 1992 and has been pumped when necessary in 1993.

Proctor & Redfern Limited in association with Jagger Hims Ltd. were retained in the spring of 1993 to investigate the leachate situation and propose a solution to the leachate problem which is acceptable to the MTO and MOEE. The solution which is being proposed consists of two components; a strategy to treat/dispose of any existing leachate, and a strategy to prevent the generation of leachate in the long term. These strategies are described in detail in the following sections.

Slag/Leachate Testing

On June 29, 1993 the site was visited by representatives from Proctor & Redfern and Jagger Hims. Samples of the slag and the leachate were collected and tested in the Proctor & Redfern laboratory. The leachate was tested for compliance with applicable sewer use criteria.

Table 1 provides the information obtained from the chemical analyses of the leachate pooled in the existing containment ponds and of the leachate extracted from within the slag. The values for the leachate in the two ponds were averaged to present a representative value for the pooled leachate. Any parameter which is shaded exceeds Halton's Sanitary Sewer Use By-Law (By-Law No. 182-89). As shown on the Table, sulphate is the only parameter which exceeds the concentration required by Halton's Sewer Use By-Law for the pooled leachate, and Chloride and BOD are the only parameters in excess for the in-slag leachate.

Results from the chemical analysis of the slag revealed that the concentrations of the parameters were lower than the applicable Regulation 347 leachate quality criteria. This finding is in concurrence with the previous leachate extraction test conducted by MTO in January of 1992.

Proposed Leachate Management Approach

Interim Leachate Treatment/Disposal Strategy

The strategy to dispose of the existing leachate involves the drainage of the leachate from the slag pads within the abutments on each side of 9th Line and the drainage of the pooled leachate in the containment ponds. The volume of the recoverable leachate beneath each of the abutments is estimated to be about 55,000 Liters (approx. 12,000 Imp. gal.). Because the slag is considered to be relatively permeable (free draining), it is expected that most of the leachate can be removed as quickly as trucking can be arranged. It is anticipated that a Region of Halton representative will be on-hand during leachate pumping and transport. The specific location of the sewer discharge will be provided by Halton.

As the slag is dewatered, and the water level in the slag is lowered, groundwater in saturated soils which abut the slag will flow into the slag. This flow is expected to be relatively slow because the abutting soils are fine textured and have low hydraulic conductivities. The contribution of the flow from adjacent deposits over the period of leachate removal is expected to be relatively slow and is conservatively estimated to be about 25% of the resident leachate (approx. 25,000 Liters). The initial seepage from the adjacent deposits is expected to be similar in quality to the leachate.

The total amount of leachate to be removed is expected to be about 150,000 Liters (approx. 30,000 Imp. gal.) including the leachate stored in each abutment, the leachate currently pooled in the ponds (approx. 15,000 Liters or less), and the groundwater. The draining of the slag would be expected to be completed within a two week period after the hydraulic connection is made between the slag and the sump.

The characteristics of the leachate transported off-site are expected to be a combination of the characteristics of the in-slag leachate and the pooled leachate (leachate characteristics are shown on Table 1). As the leachate is diluted by groundwater the concentrations shown may decrease by up to 25%.

Drainage will be accomplished by creating a sump at the toe of each slag deposit and pumping the leachate out of the sump. The sump will be made sufficiently deep so that the leachate levels can be lowered at least to the base of the slag. The sump would be backfilled with crushed stone and covered to contain odours. The leachate will be pumped directly from a culvert which is penetrating the stone. The slag will then be maintained in a drained condition for the duration of the construction of the groundwater diversion trench which is described in the following section.

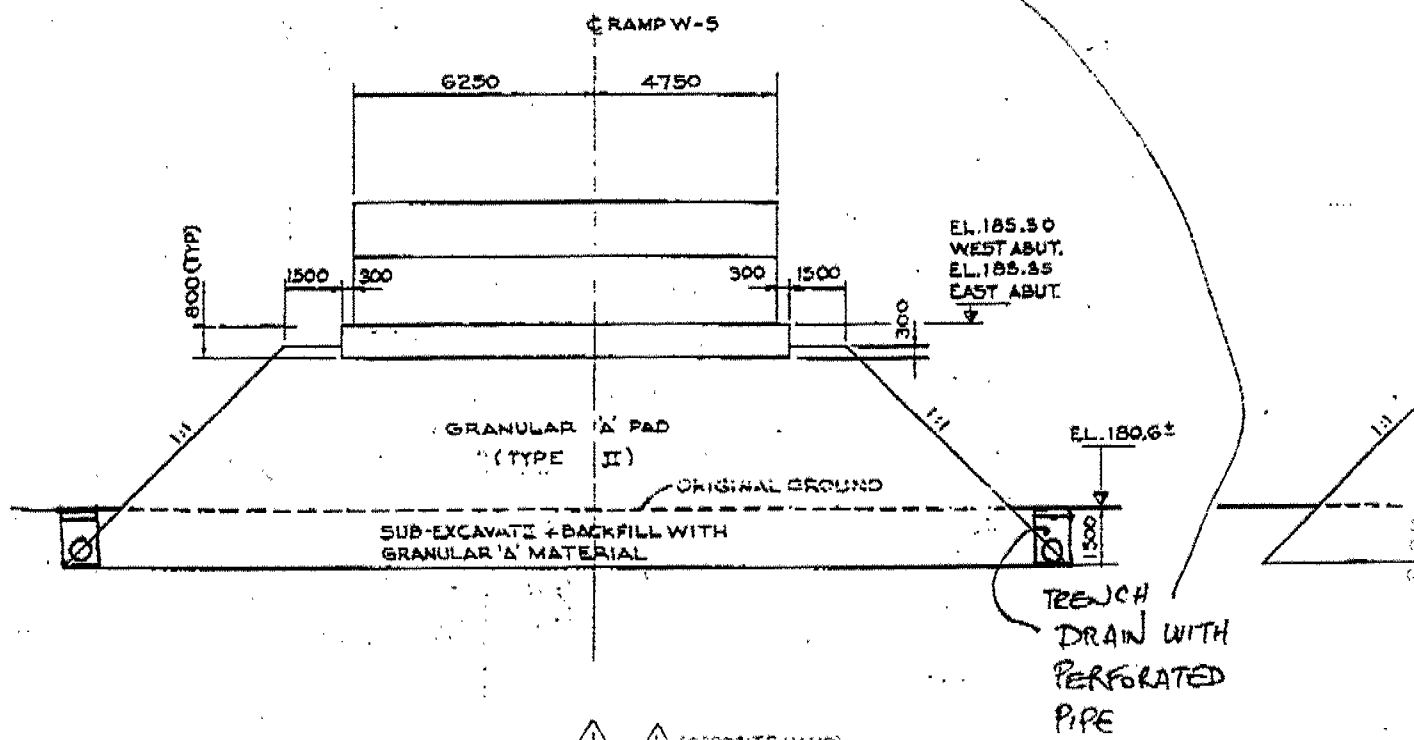
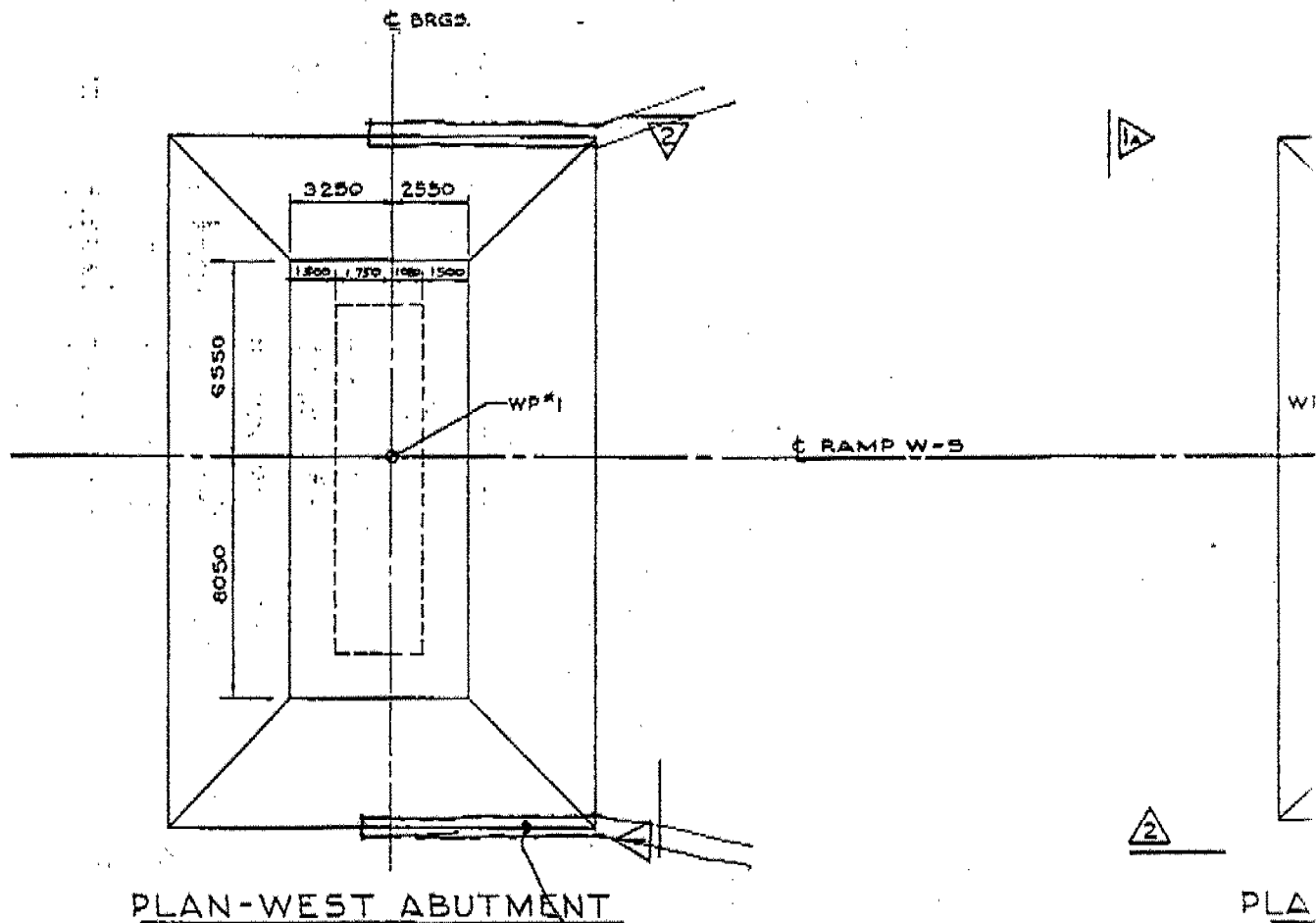
Ongoing Leachate Prevention Strategy

When volume, visual and olfactory observations indicate that the majority of the leachate has been drained from the slag, a shallow groundwater trench will be constructed along the base of three sides of each abutment and beyond the slag. A perforated PVC pipe will run along the length of the trench and the trench will be backfilled with crushed stone. This pipe will intercept groundwater and divert it away from the slag contained within the abutments. This will prevent the generation of leachate by reducing the contact between groundwater and the slag. The trench and pipe will drain by gravity to a 13,500 liter, two chamber septic tank. The contents of the septic tank will be trucked away for treatment for the first week or two until it sampling can demonstrate that the effluent from the septic tank meets storm water discharge criteria. the diverted groundwater will be discharged directly to the adjacent ditch. The ditch connects via a catchbasin to the Region of Peel storm sewer system.

A one year, quarterly, monitoring program is proposed as part of the on-going leachate prevention strategy. If monitoring indicates that the liquid which collects in the leachate collection tank is of unsatisfactory quality for surface discharge, the option of trucking the material to a local sewage treatment plant or accessible sanitary sewer discharge point on an ongoing basis will be discussed with the Region of Halton. If this is not deemed viable, appropriate chemical treatment would be designed and applied to the tank with respect to the offending parameter(s) to meet storm water discharge criteria.

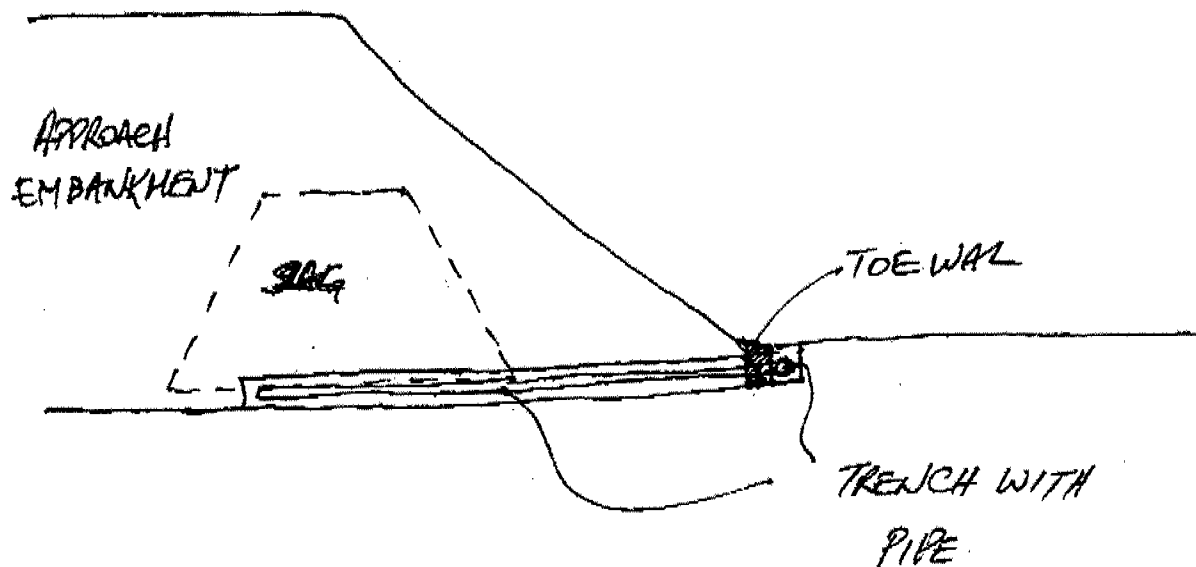
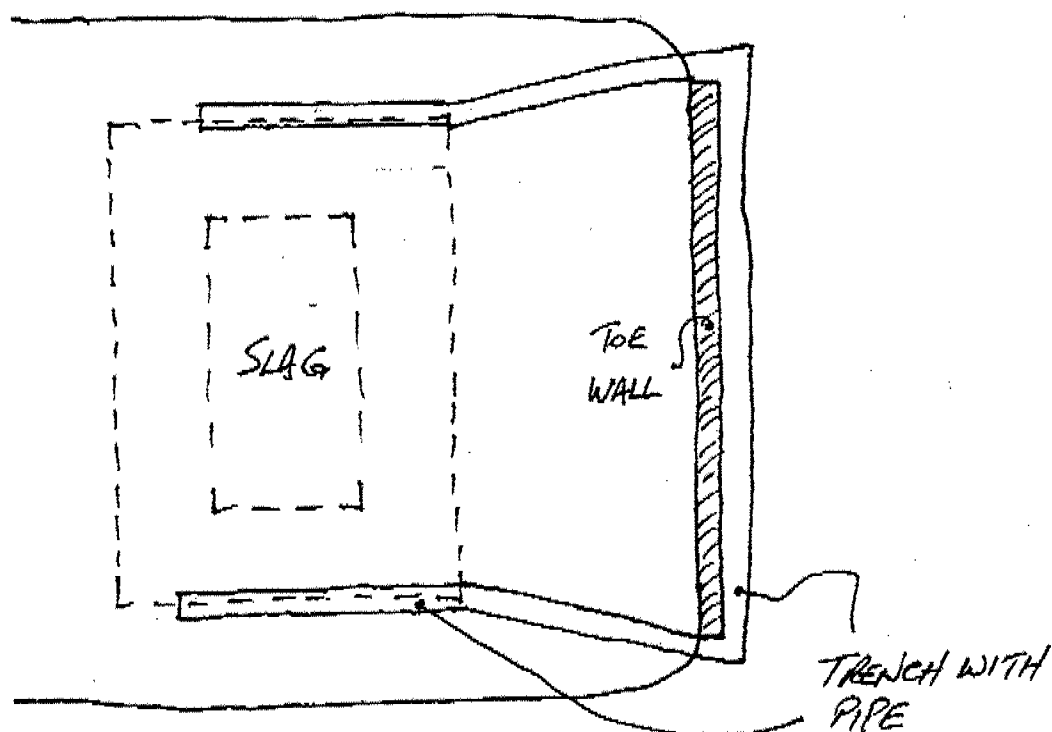
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35-5240



9th Line / Trafalgar Road Structure

Sept 14/92



memorandum



To: R. Kohlberger
Soils Unit Supervisor
Geotechnical Section
Central Region
2nd Floor Atrium Tower

Date: 92 07 09 *July 9*

From: Foundation Design Section
Room 315, Central Building

Re: Proposed Drainage System
Blast Furnace Slag Granular Pad
Hwy. #403 and 9th Line Overpass
District #4 (Burlington)

We have reviewed the proposed drainage system's impact on the stability of the granular pad and the following comments are offered:

1. The size of the proposed trench (located directly adjacent to bottom of the slope paving) should not be larger than 300 mm wide and 600 mm deep as indicated in your memorandum issued on June 9, 1992.
2. Excavation into the granular pad is not permitted.

A handwritten signature in cursive script, appearing to read "P. Payer".

P. Payer, P. Eng
Senior Foundation Engineer

PP/nd

cc: P. Korgemagi ✓
D. Ivanauska
V. Maw

memorandum



To: S.A. Senior
Sr. Soils and Aggregates Engineer
Soils and Aggregates Section
Room 311, Central Building

Date: 1992 01 27

From: Foundation Design Section
Room 315, Central Building

Re: Hwy. 409/9th Line Overpass
Blast Furnace Slag
W.P. 197-77-04, Site 10-82-328
District 4, Burlington

Further to the site visit on December 19, 1991 and your memo dated January 9, 1992, this letter summarizes our concerns for using Blast Furnace Slag as a granular pad for the bridge abutments.

As discussed in your memo, the excavation was made in the east embankment, north side, above the drainage ditch adjacent to the 9th line. During the excavation, the granular slag material was found at the base of the pit and was saturated with yellowish green water. It is understood that samples of the slag were taken for mechanical, chemical, and biological testings. Results should be provided to us upon completion of tests.

Through visual observation, the slag was coloured greenish grey and smelt sulfide odour. It appears that the gradation of slag material is similar to the Granular "A" material. However, the test result should be compared to the gradation of MTO Granular "A" material which was recommended by this office for the Granular "A" pad at each abutment.

It should be noted that during the construction stage, this office was not consulted with replacement of Granular "A" material by blast furnace slag which created environmental problems. It is therefore suggested that this office should be consulted in advance for the future use of such slag material in order to provide proper measures to use the slag as a granular pad for bridge abutments.

We have no further comments on your memo. If you have any further questions, please contact this office.

Tae C. Kim
Tae C. Kim, P. Eng.
Sr. Foundation Engineer

P. Payer
P. Payer, P. Eng.
Sr. Foundation Engineer

PP/TCK/jb
cc: D. Ivanauskas
C.A. Rogers
P. Korgemagi
M. Weaver
G. Cautillo

memorandum

L. Iwanowski
(416) 235-3743
(416) 235-4101 (fax)



To: Ms. D. Ivanauskas
Environmental Unit
Planning and Design Section
Central Region
Atrium Tower, 5th Floor

Date: 92 01 09

From: Soils and Aggregates Section
Engineering Materials Office
Central Building, Room 311
Downsview, Ontario

File No.: 3162-2-4-2



Re: **Hwy. 403/ 9th Line Overpass - Blast Furnace Slag**

On 91 12 19, the embankment at this location was excavated in order to sample air-cooled blast furnace slag used as a granular pad for the bridge overpass footings. In attendance were T. Kim (Foundation Design Section, EMO), B. Foltars, along with backhoe operator and two assistants (Construction, Central Region), and V. Maw and S. Senior (Soils and Aggregates Section, EMO).

Photographs were taken during the excavation. A complete set has been forwarded to T. Kim, and a selected set has been included with this memo (photocopies attached).

The excavation was made in the east embankment, north side, above the drainage ditch adjacent to the 9th line roadway. The resulting pit was measured at 2.0m wide and had a backwall depth of 2.0m.

The slag was located at the base of the pit about 1 metre in from the toe. During the excavation, the granular material was saturated and drained rapidly into the opening. The drain water was yellowish-green in colour and exuded a disagreeable sulphide odour. The slag was coloured greenish-grey. Samples of the slag were taken for material, chemical, and biological identification. Water samples were not taken.

Samples for material identification have been retained by the Soils and Aggregates Section. Tests for gradation and quality will be completed. Results will be forwarded to you as they become available.

Samples for chemical analyses were obtained by the Construction Office staff who indicated they would be forwarding them to the Central Region Environmental Unit for further processing. Five separate samples were obtained using 1/2 pint tin containers (paint cans). It is understood that these samples will be evaluated for chemical content.

Biological samples were also collected to determine the presence and type of bacteria and/or algae within the slag material. These samples have been forwarded to the University of Western Ontario Department of Earth Sciences for evaluation.

Bacteria are known to be quite active in biogeochemical processes, and are used in mine tailings to control heavy metals by direct absorption, or by indirect absorption of the heavy metals into iron oxide precipitates. Sulfate reducing bacteria are also


known to produce hydrogen sulphide (H_2S) biogenically during these processes. Detailed information on this subject may be obtained from the following reference: "*Biosorption of Heavy Metals by Bacterial Biomass*" by H. Mann, in *Biosorption of Heavy Metals*, B. Volesky (Ed.), CRC Press Inc., 1990, pp.93-129. This office has a photocopy of the article if you are interested.

In a current investigation of bacterial growth and iron oxide precipitation in an aggregate source from northern Ontario, bacteria has been found to flourish within an open framework granular deposit just above the water table level. Requirements for the growth of bacteria include space to grow (provided by interparticle pore space) and a source of metal (iron from minerals within the aggregate, i.e. FeS_2). Within blast furnace slag, it is considered unlikely that these conditions could be met since it should be well compacted and most, if not all, of the iron should have been extracted from the blast furnace operations. However, one possibility is that the slag materials used in this embankment were not completely free of iron and that some bacteria (along with symbiotic algae) may be growing within the pores of the slag material. Also, a small piece of stranded cable was found buried in the embankment. This material could have been a source of metal for the bacteria to grow. Samples for biological testing were extracted from a sludge surrounding the cable.

The saturated condition and rapid drainage of the bridge footing indicated that poor drainage conditions exist within the embankment. It is most likely that the frozen ground along the face and toe of the embankment may have contributed to preventing water from draining. Air temperatures during the excavation were approximately $-18^{\circ}C$, while the slag material remained unfrozen with about 0.5m from the surface. Conditions for bacterial growth may be caused within the embankment due to these poor drainage conditions. It is also likely that, as frozen ground conditions improve in the spring, the retained water will be released after the ground thaws out. This could explain why the problem is more evident during this time of the year. During the remainder of the year, water may drain out slowly, thus reducing any noticeable impact of the effluent.

The construction drawings for this contract did not indicate any provisions for drainage of the granular pad within the embankment. A minimum recommendation would be to provide adequate drainage of the granular material. This matter should be discussed with the Regional Geotechnical Office and the Foundation Design Section.

If you require any further information, please do not hesitate to contact me.



S.A. Senior,
Sr. Soils and Aggregates Engineer.

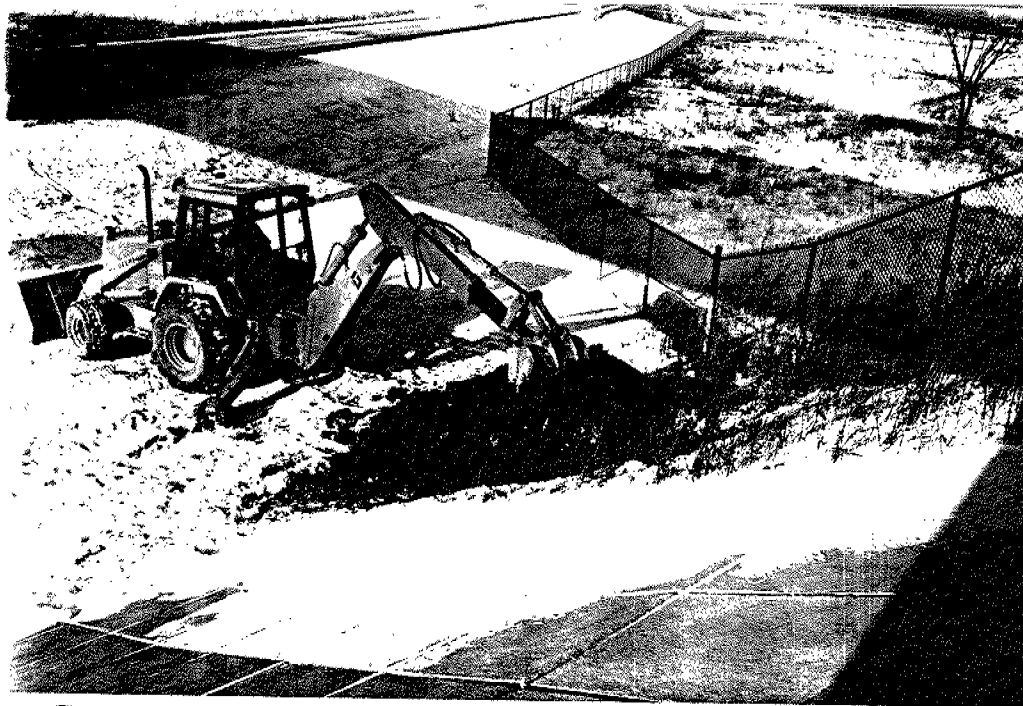
pc: C.A. Rogers
M.S. Devata ✓
P. Korgemagi
G. Cautillo
M. Weaver

SAS/jlp
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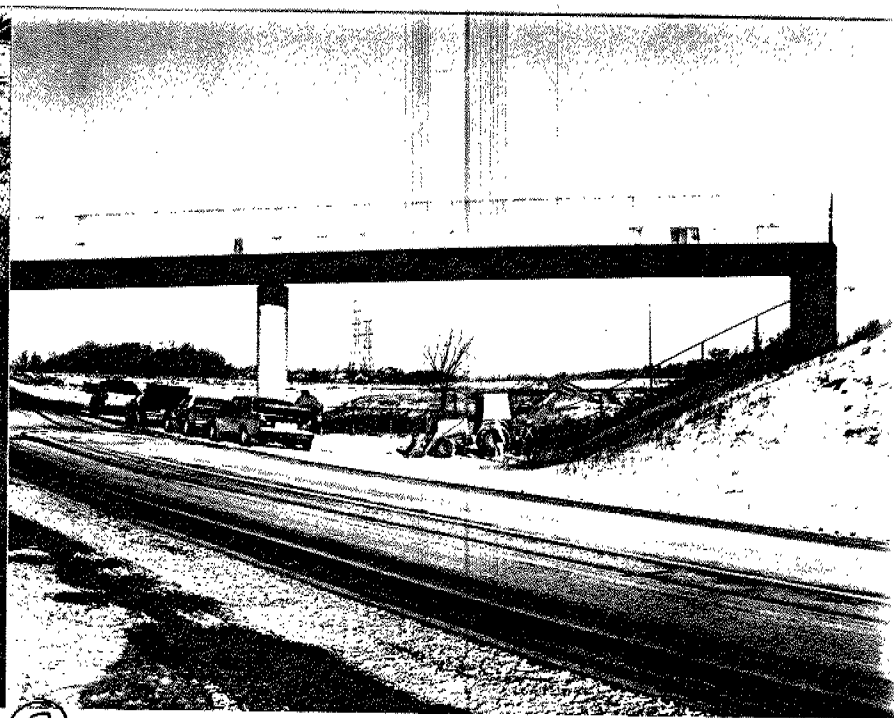
**Photographs - Hwy. 403/ 9th Line Overpass - Blast Furnace Slag
December 12, 1991**

(Contact S. A. Senior for originals)

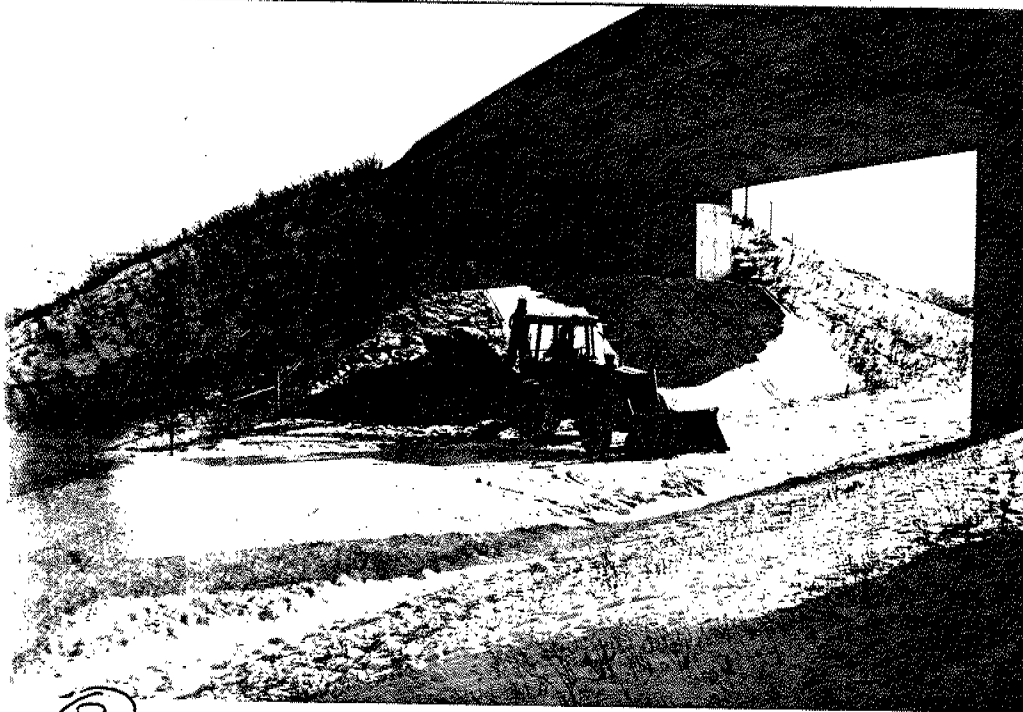
1. excavation site
2. " looking north
3. " east view
4. beginning excavation - steam rising from within
5. excavation site slag material piled in front of opening
6. "
7. close up of slag
8. limit of excavation
9. water draining into excavation
10. " "
11. closeup of steel cable and sludge - biological sample #3 taken
12. closeup of sludge found within slag - biological sample #1 taken
13. " " - biological sample #2 taken
14. water drained into excavation



①



②



③



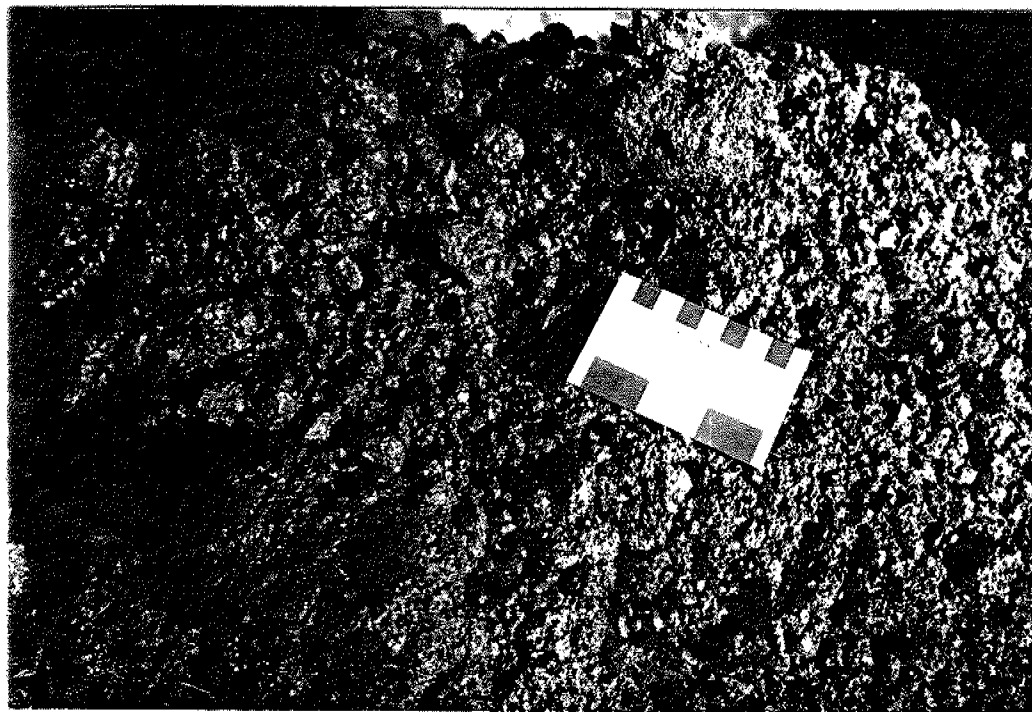
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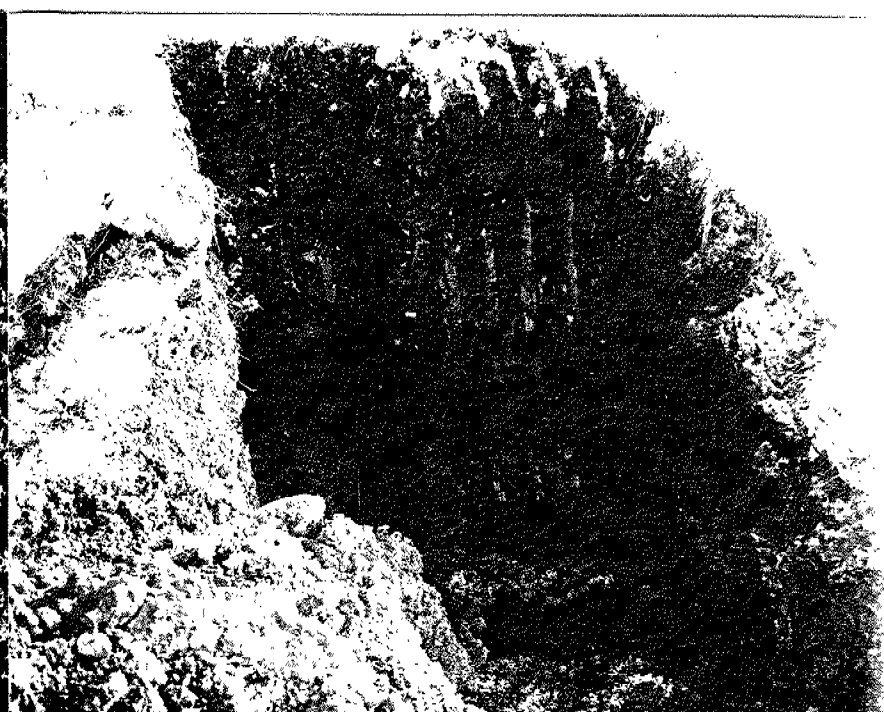
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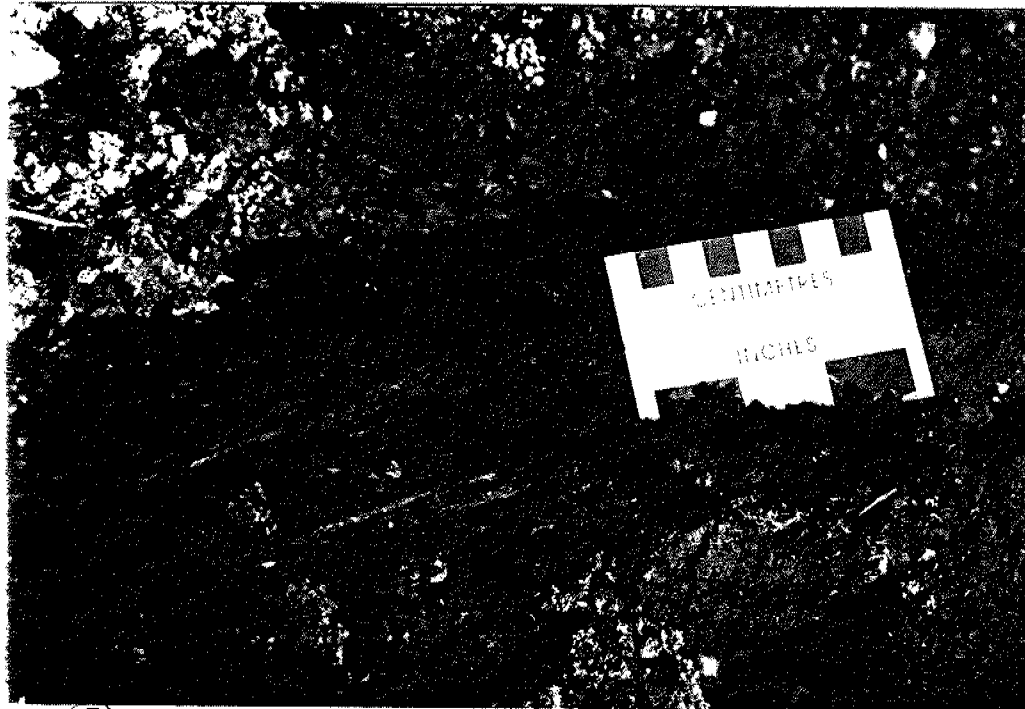
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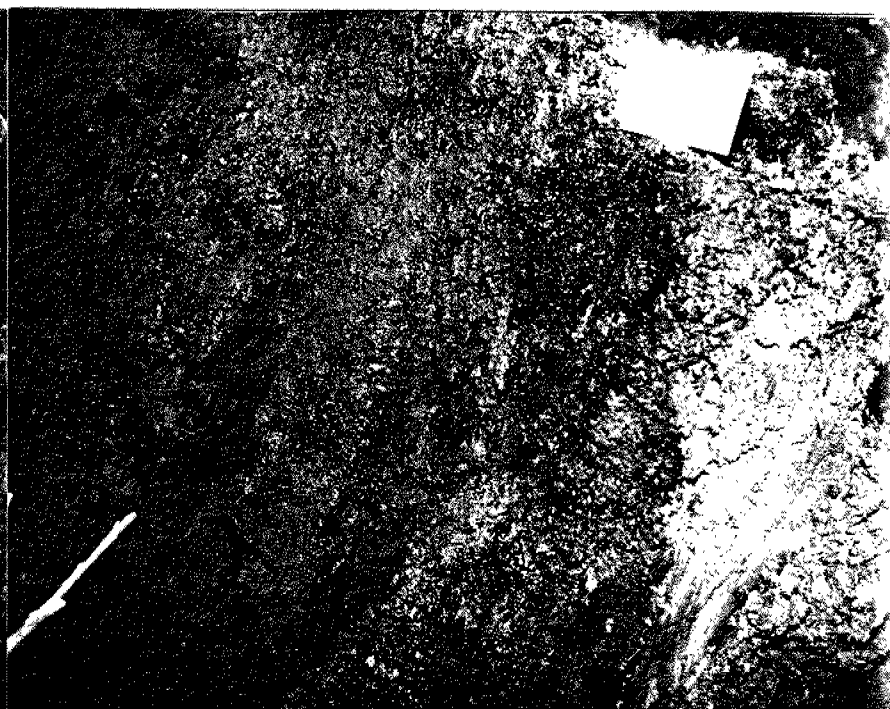
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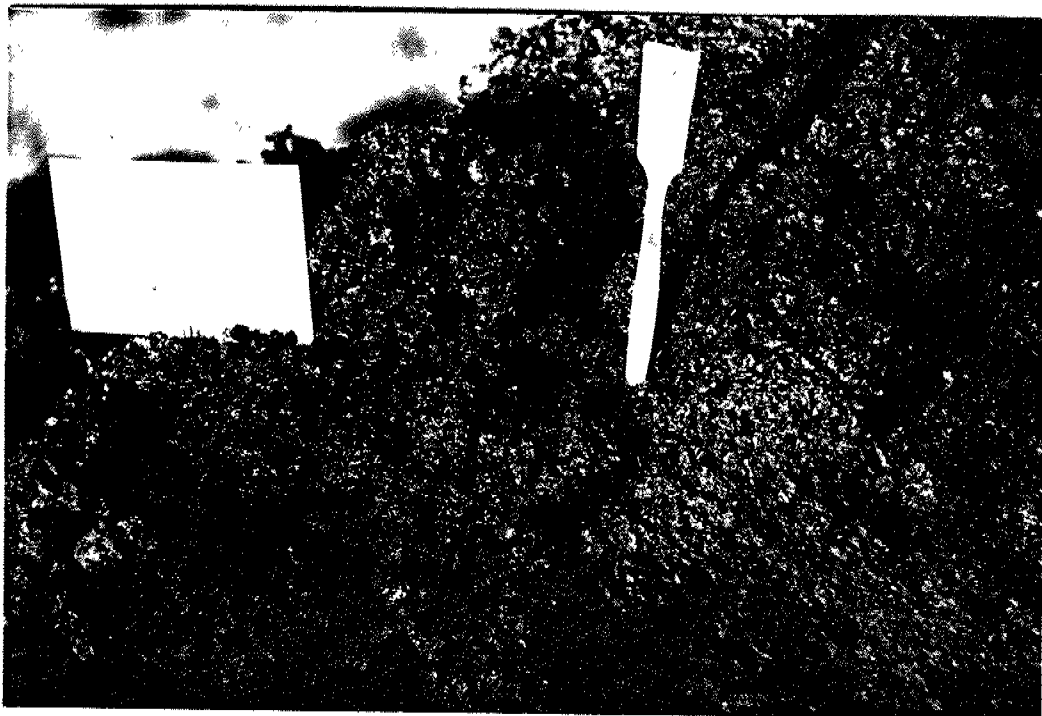
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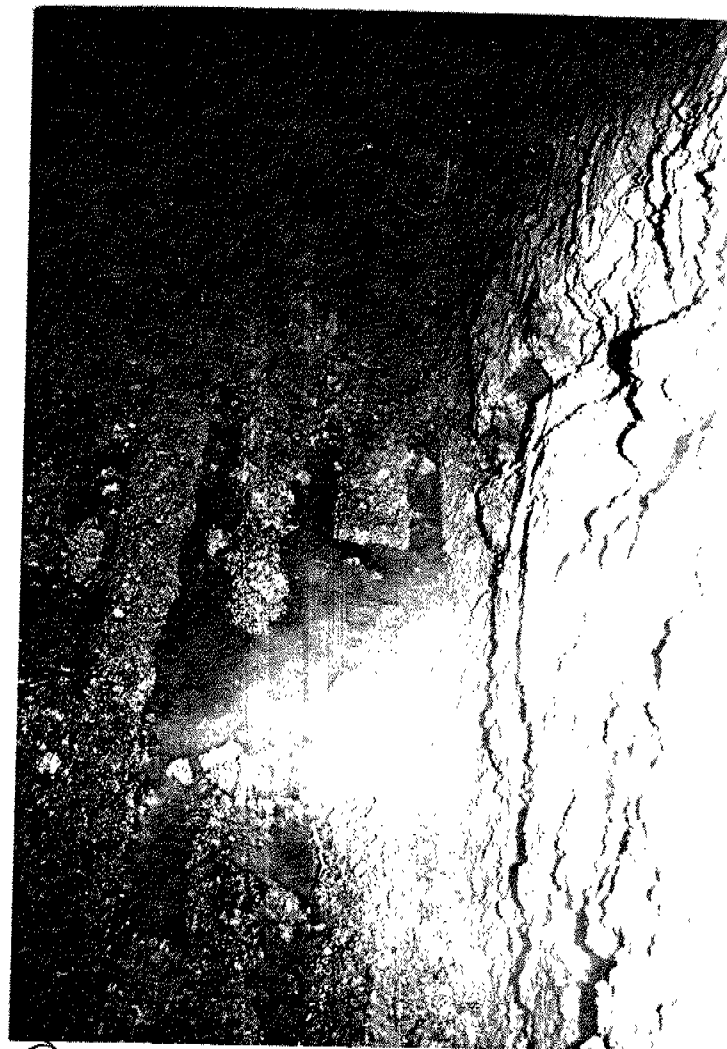
11



12



(12)



(14)

memorandum



To: W.L. Lin
Design Engineer
Structural Office
4th Floor
3501 Dufferin Street

Date: 1983 09 12

From: Pavement and Foundation
Design Section
Room 315, Central Building

Re: Ramp W-S Underpass at Ninth Line
Hwy. 403/407 Interchange
W.P. 197-77-04, Site 10-82-328
District 4, Hamilton

The submitted final drawings and special provisions have been reviewed by the Section.

There are no comments.

A handwritten signature in dark ink, appearing to read "K.G. Selby".

K.G. Selby, P. Eng.
Senior Foundations Engineer

KCS/mmj

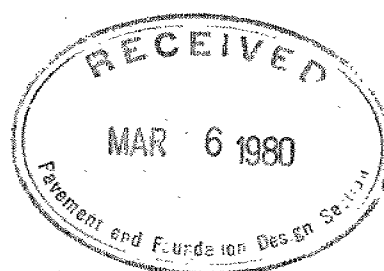
FOUNDATION INVESTIGATION REPORT

CONTRACT NO 80-20



Ontario

Ministry of
Transportation and
Communications



INDEX

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1	Index
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3-17	Foundation Investigation Report W.P. 158-75-03 Winston Churchill Blvd. Underpass

Note: For purposes of the contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above mentioned project.

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}IU$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

SS SPLIT SPOON
WS WASH SAMPLE
ST SLOTTED TUBE SAMPLER
LS BLOCK SAMPLE
CS CHTR SAMPLE
TW THINWALL OPEN
TP THINWALL PISTON
OS OSTEOMYX SAMPLE
FS FOIL SAMPLE
RC ROCK CORE
PH T.W. ADVANCED HYDRAULICALLY
PM T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_p COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 ω SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 L, I FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$
 O_m ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION

STRENGTH PARAMETERS

c ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_r RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS: σ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 J SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

FOUNDATION INVESTIGATION REPORT

For

Winston Churchill Blvd. Underpass
W.P. 158-75-03, Site No. 24-384
District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project during the period of August 15 to August 17, 1977. The field-work consisted of seven sampled boreholes advanced by means of a continuous flight auger machine equipped with hollow stem (3¼" I.D.) augers.

The boreholes ranged in depths from 20.5 to 60.0 feet below the ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located about one mile north of Burnhamthorpe Road in the City of Mississauga, Regional Municipality of Peel.

The topography of the area is flat to gently undulating. The land is developed for farming purposes. Physiographically, the site is situated in the region of "South Slope". The characteristic deposit in the vicinity of the area under investigation is composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock of Meaford-Dundas formation, Ordovician Period.

SUBSURFACE CONDITIONS

General

The subsurface conditions were found to be quite uniform over the site. Under a thin layer of topsoil is a stratum of cohesive glacial till which is underlain by a layered deposit

of clayey silt and silt with trace of sand. Detailed descriptions of the various soil types encountered as well as all field and laboratory test results are given in the Record of Borehole Sheets contained in the report Appendix. The estimated stratigraphical profile and sections shown in Drawing No. 24-384-2 are based upon this information. From ground level downwards the various soil types encountered are as follows:

Glacial Till

Underlying a thin (max. 12") layer of topsoil a deposit of cohesive glacial till was encountered at all locations over the site. The glacial till varies in thickness from 24.0 to 31.0 feet and is comprised of a heterogeneous mixture of clayey silt, sand and gravel. Standard Penetration Tests gave 'N' values ranging from 20 blows to over 100 blows per foot, indicating that the glacial till has a very stiff to hard consistency, but, generally hard.

The physical properties of the glacial till as determined from laboratory testing are summarized below:

	<u>Range</u>
Liquid Limit (W_L) %	21 - 28
Plastic Limit (W_P) %	12 - 15
Moisture Content (W) %	9 - 15

The results of the Atterberg Limit Tests are shown on a Plasticity Chart (Fig. 1) and the typical grain size distribution curves are presented as an envelope in Fig. 2 in the Appendix of this report.

The Atterberg Limits indicate that the cohesive stratum is inorganic and of low plasticity.

At one location a distinct 3 foot thick layer of dense silty sand was sandwiched immediately beneath the glacial till deposit and above the layered clayey silt stratum.

Clayey Silt With a Trace of Sand and Seams of Silt (Layered)

Underlying the cohesive glacial till stratum is a deposit of clayey silt with a trace of sand and seams of silt in a layered condition. The material is made up of irregular layers of clayey silt and silt with traces of sand. Standard Penetration Tests for the overall deposit gave 'N' values well over 100 blows per foot indicating that this layered stratum has a hard consistency in the cohesive portion and very dense relative density in the noncohesive portion of the deposit.

The physical properties of the cohesive portion of the deposit as determined from laboratory testing gave the following results:

	<u>Range</u>
Liquid Limit (W_L) %	22 - 28
Plastic Limit (W_P) %	15 - 18
Moisture Content (W) %	11 - 21

The results of the Atterberg Limit Tests are shown on a Plasticity Chart (Fig. 1) and the typical grain size distribution curves are presented in an envelope form in Fig. 3 in the Appendix of this report.

The Atterberg Limits indicate that the clayey silt layers of the deposit are inorganic and of low plasticity.


Groundwater

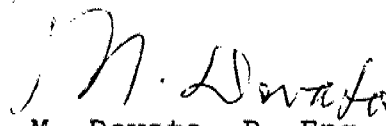
The groundwater levels were observed by measuring in the open borehole during and after the completion of the foundation investigation. The groundwater levels were found to vary between elevations 567 (B.H. 3) and 541 (B.H. 5) which corresponds to depths of 3 feet to 26 feet below the existing ground surface.

The erratic variation of the water levels in the boreholes was attributed primarily due to the presence of irregular

layers of silt in the lower layered deposit of clayey silt.

The groundwater levels are shown on the Record of Borehole Sheets, as well as on Drawing No. 24-384-2.

for 
P.J. Stuart, P. Eng.
Foundations Engineer


M. Devata, P. Eng.
Senior Foundations Engineer

APPENDIX



RECORD OF BOREHOLE No 1

W P 158-75-03 LOCATION Co-ords N 15,821,368; E. 944,431 ORIGINATED BY V.K.
DIST 4 HWY 403 BOREHOLE TYPE 3/4" H.S. Auger and Cone Test COMPILED BY V.K.
DATUM Geodetic DATE August 15, 1977 CHECKED BY JS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100						
568.0	Ground Level												
0.0	Topsoil												
	Het. Mixture of clayey silt, sand and gravel (Glacial Till)		1	SS	50								0 30 52 18
	Very Stiff to Hard		2	SS	38								7 26 47 20
	Brown		3	SS	37								4 28 48 20
	Grey		4	SS	32								
			5	SS	23								
			6	SS	21								
544.0													
24.0	Clayey Silt With Seams of Silt and Trace of Sand		7	SS	163								0 6 74 20
			8	SS	127								
531.5	Hard or Very Dense		9	SS	150								0 0 90 10
36.5	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

W P 158-75-03 LOCATION Co-ords N 15,821,438; E. 944,503 ORIGINATED BY V.K.
DIST 4 HWY 403 BOREHOLE TYPE 3½" H.S. Auger and Cone Test COMPILED BY V.K.
DATUM Geodetic DATE August 15, 1977 CHECKED BY KS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100					
566.2	Ground Level													
0.0	Topsoil													
	Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff to Hard		1	SS	20		560							3 35 50 22
			2	SS	34									12 26 43 19
			3	SS	46									
	Brown		4	SS	41									
	Grey		5	SS	100/	6"	550		100/ 10"					14 25 45 16
			6	SS	143/	10"								
542.2			7	SS	140/	10"	540							0 1 79 20
24.0	Clayey Silt With Seams of Silt and Trace of Sand		8	SS	132/	11"								
529.7	Hard or Very Dense		9	SS	118		530							0 0 59 41
36.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

W P 158-75-03 LOCATION Cor-ords N 15,821,517; E. 944,425 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger and Cone Test COMPILED BY V.K.
 DATUM Geodetic DATE August 16, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH						
568.7	Ground Level							20 40 60 80 100						GR SA SI CL
0.0	Topsoil													
	Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	135	10"								7 25 45 23
			2	SS	45									
			3	SS	75									
	Hard		4	SS	86									15 25 39 21
	Brown		5	SS	66									
	Grey		6	SS	70									25 18 40 17
544.7			7	SS	100	6"								3 6 84 7
24.0	Clayey Silt With Seams of Silt and Trace of Sand		8	SS	160	11"								
			9	SS	175	9"								0 1 80 19
532.2	Hard or Very Dense													
36.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4 (Formerly W.O. 76-11005)

W P 158-75-03 LOCATION Co-ords N. 15,821,474: E. 944,365 ORIGINATED BY V.K.
DIST 4 HWY 403 BOREHOLE TYPE H.S. 3 1/2" Auger (CME 55 M.V.) & Cone Test COMPILED BY V.K.
DATUM Geodetic DATE July 5, 1976 CHECKED BY A.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	10 20 30					
565.0	Ground Level													
0.0	Het. Mix. of Clayey Silt With Sand, Occ. Gravel (Glacial Till) Very Stiff to Hard		1	SS	26		560							0 28 53 19
			2	SS	30									
	Brown		3	SS	72									0 35 49 16
	Grey		4	SS	60									
			5	SS	36		550							
			6	SS	94									0 1 79 20
			7	SS	100	11"	540							
534.0			8	SS	120									
31.0	Clayey Silt With Seams of Silt and Trace of Sand Hard		9	SS	95	9"	530							0 2 86 12
			10	SS	90									
			11	SS	95	9"	520							
505.0							510							
60.0	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

W P 158-75-03 LOCATION Co-ords N. 15,821,525; E. 944,277 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger and Cone Test COMPILED BY V.K.
 DATUM Geodetic DATE August 15, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
567.1	Ground Level													
0.0	Topsoil													
	Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Hard Brown ----- Grey		1	SS	36		560							1 26 52 21
			2	SS	36									
			3	SS	120/	11"								31 21 31 17
			4	SS	170/	11"								
			5	SS	62		550							19 22 44 15
			6	SS	95									
543.1			7	SS	130									
24.0	Clayey Silt With Seams of Silt and Trace of Sand Hard or Very Dense		8	SS	170/	9"	540							0 1 73 26
530.6			9	SS	123									0 1 89 10
36.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

W P 158-75-03 LOCATION Co-ords N. 15,821,447; E. 944,354. ORIGINATED BY V.K.
DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger & Cone Test COMPILED BY V.K.
DATUM Geodetic DATE August 17, 1977 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION [%] GR SA SI CL		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						SHEAR STRENGTH	WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
567.0	Ground Level														
0.0	Topsoil														
	Het. Mixture of Clayey Silt, Sand and Occasional Gravel		1	SS	85		560						0 26 47 27		
	Glacial Till		2	SS	49										
	Hard Brown		3	SS	46										
	Grey		4	SS	90		550						0 29 55 16		
			5	SS	50										
546.5			6	SS	75								0 1 78 21		
20.5	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 7

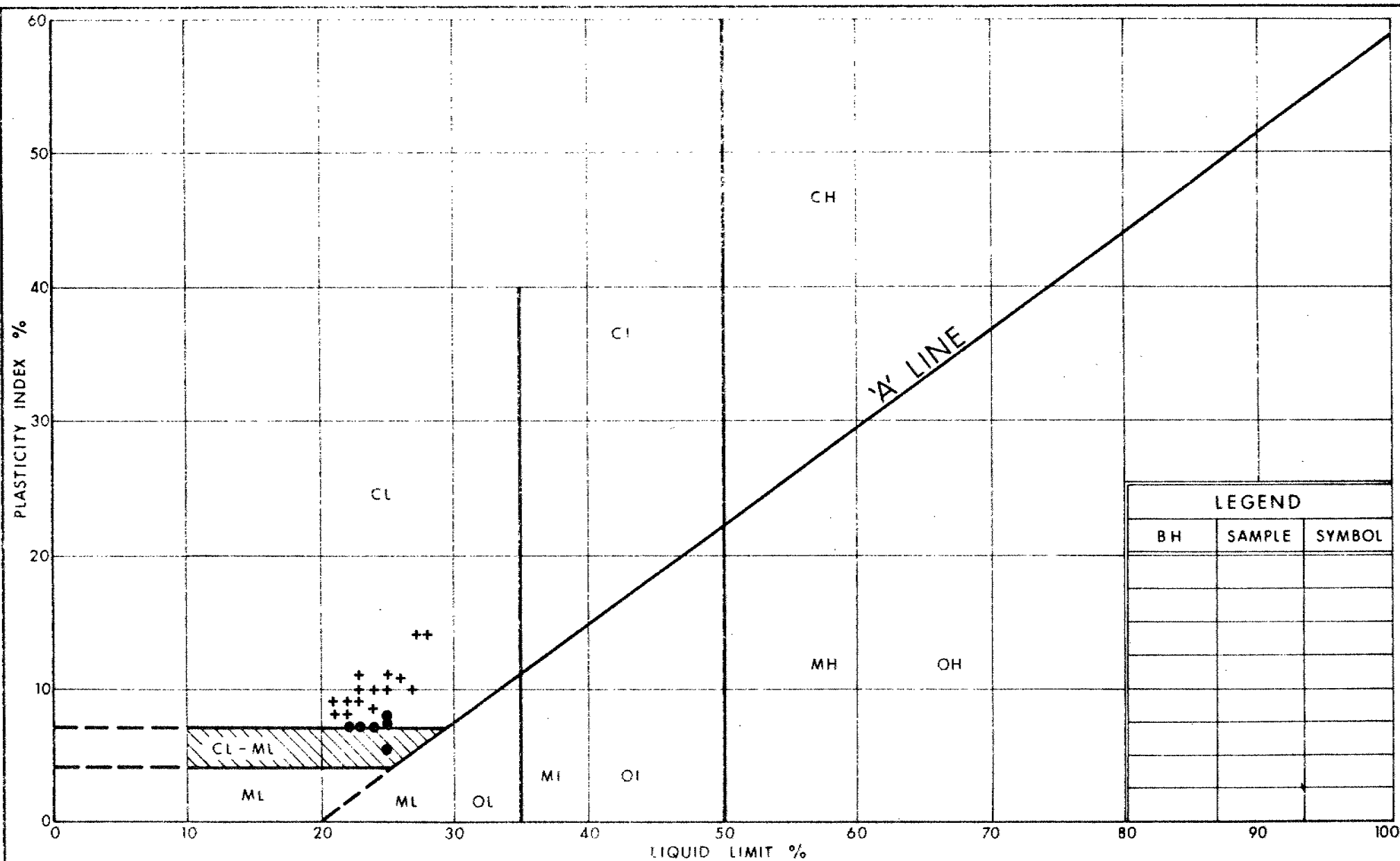
W P 158-75-03 LOCATION Co-ords N. 15,821,595; E. 944,349 ORIGINATED BY V.K.
DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger & Cone Test COMPILED BY V.K.
DATUM Geodetic DATE August 16, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
567.7	Ground Level												
0.0	Topsoil												
	Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	23		560						4 29 46 21
	Very Stiff to Hard Brown		2	SS	68								7 31 45 17
	Grey		3	SS	50								
			4	SS	55								
			5	SS	34		550						1 29 51 19
			6	SS	47								
544.7													
23.0	Silty Sand, fine												
541.7	Dense		7	SS	132								0 34 62 4
26.0	Clayey Silt With Seams of Silt and Trace of Sand		8	SS	155	10"	540						0 1 79 20
531.2	Hard or Very Dense		9	SS	135	6"							
36.5	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

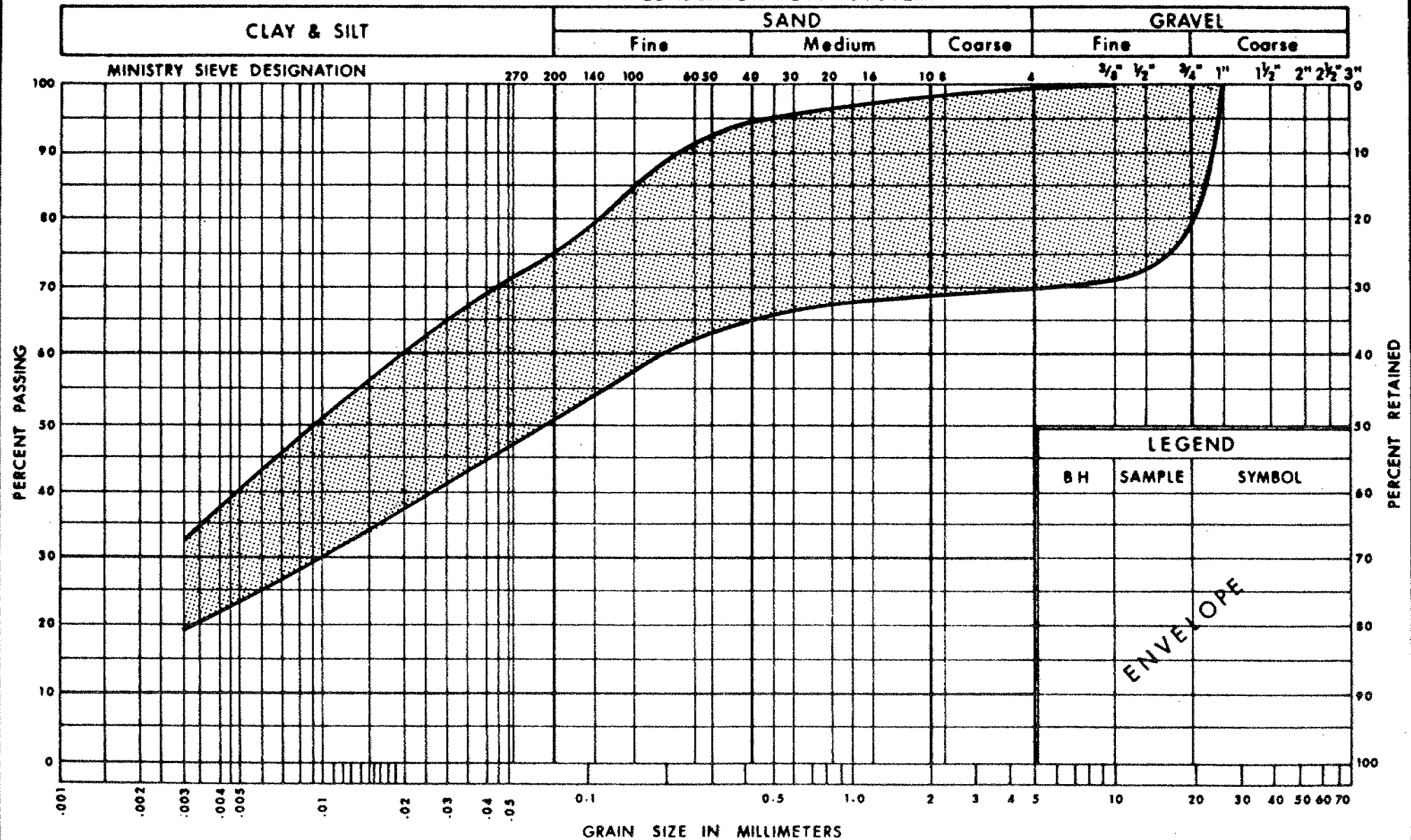
Ministry of
Transportation and
Communications

PLASTICITY CHART
COHESIVE GLACIAL TILL
CLAYEY SILT WITH SEAMS OF SILT

FIG No 1

W P 158 - 75 - 03

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

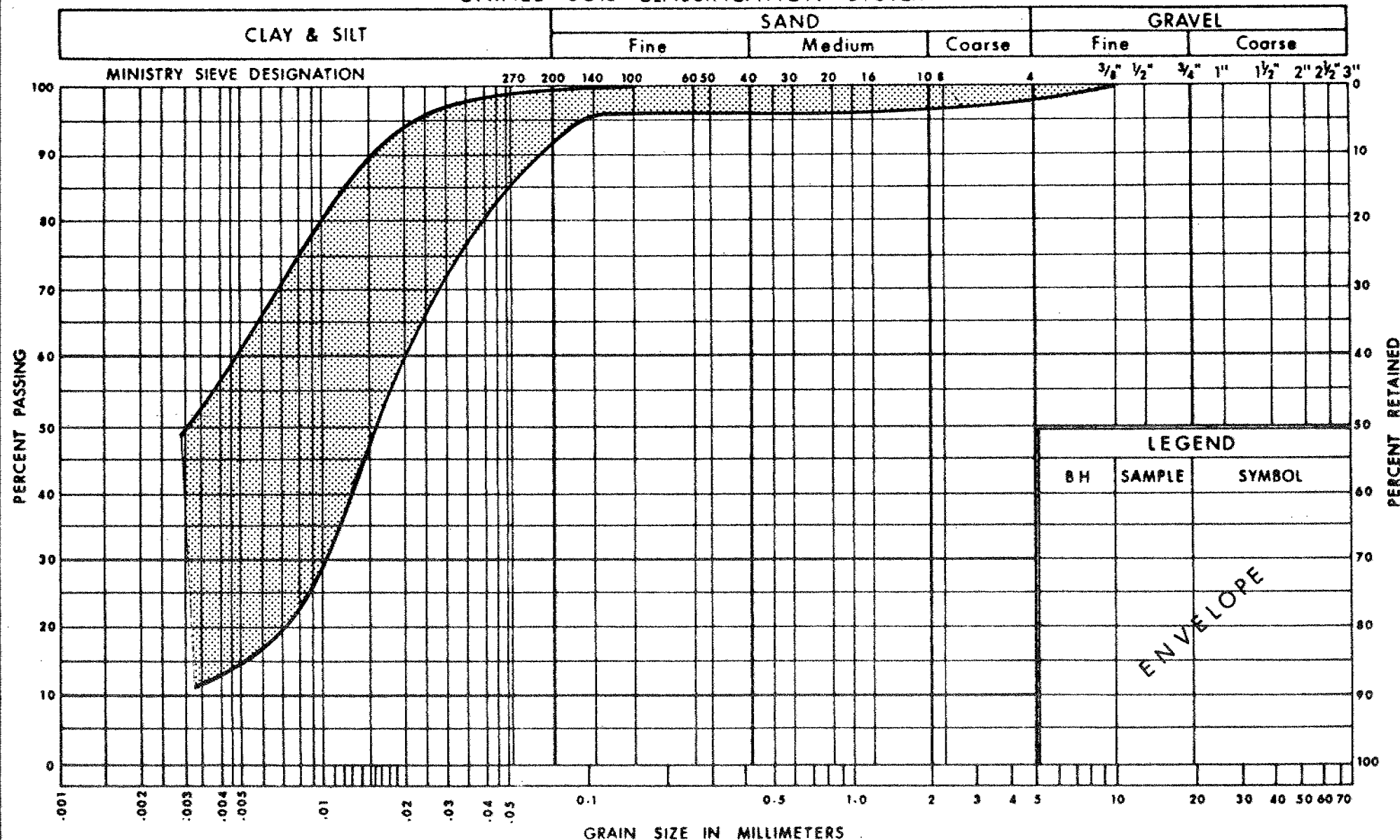
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
GLACIAL TILL
HET MIX OF CLAYEY SILT, SAND & GRAVEL

FIG No 2

W P. 158-75-03

UNIFIED SOIL CLASSIFICATION SYSTEM



**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
WITH SEAMS OF SILT & TRACE OF SAND

FIG No 3

W P 158-75-03

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERTURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 1" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSITY: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	MODERATE	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $C\bar{U}$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_a COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_p COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 ω SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
B.L. FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w_L - w_p$
 I_L LIQUIDITY INDEX = $\frac{w - w_p}{p}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{p}$
 A_c ACTIVITY = $\frac{I_p \text{ of soil}}{I_p \text{ of } 2\mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

STRENGTH PARAMETERS

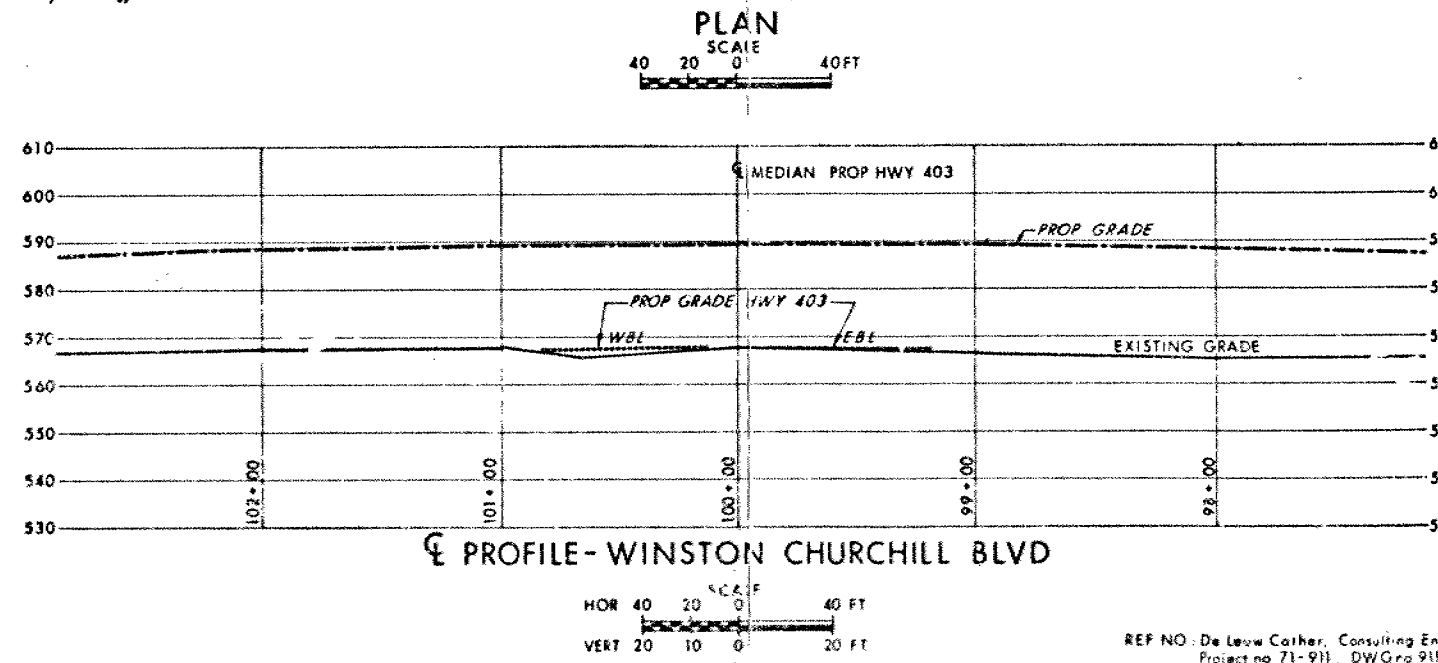
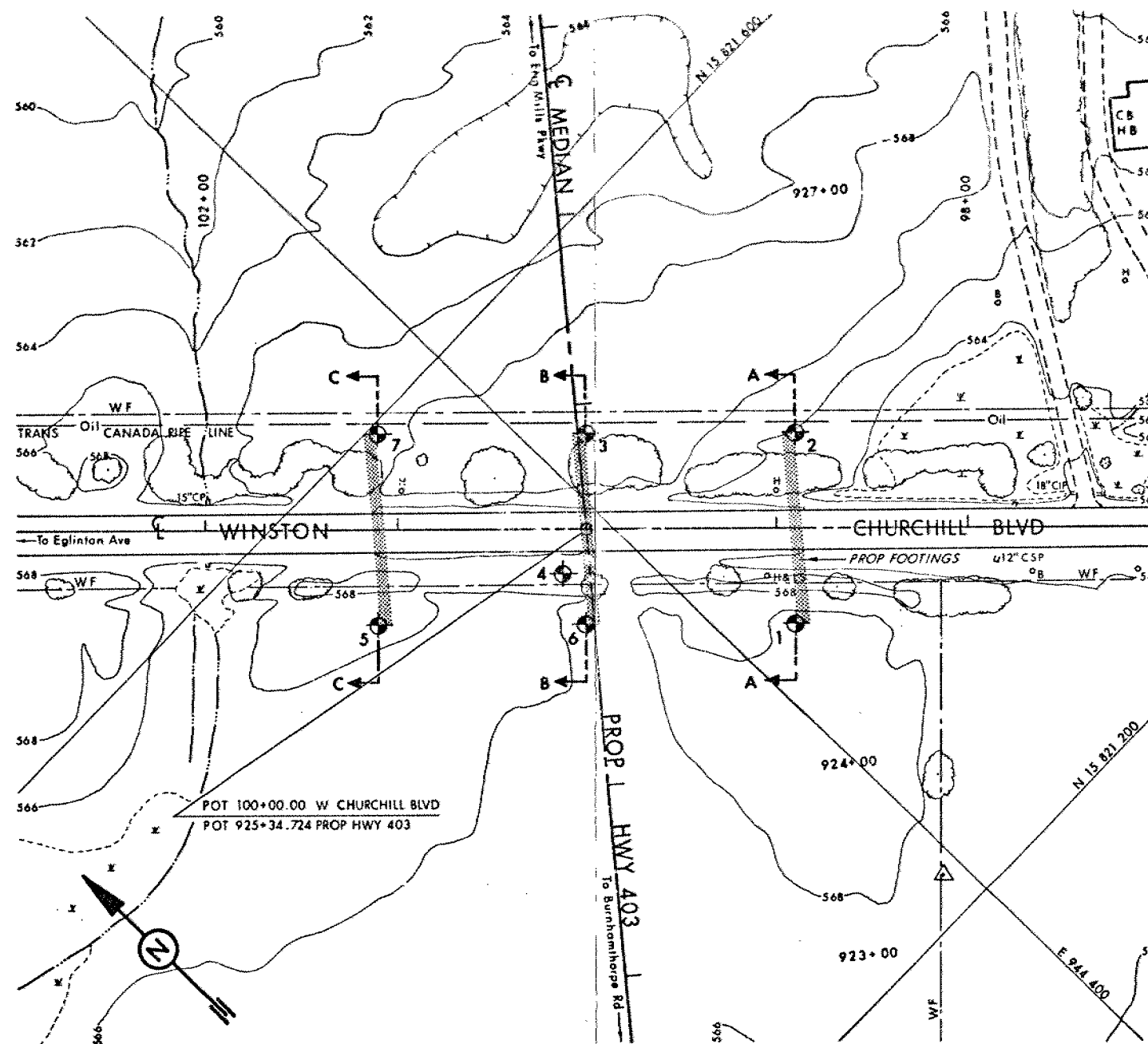
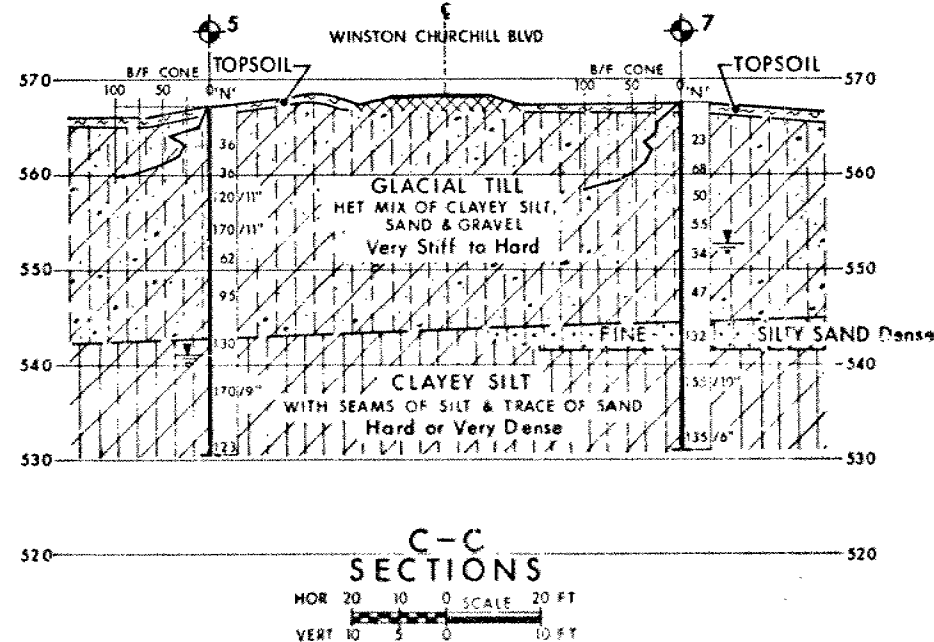
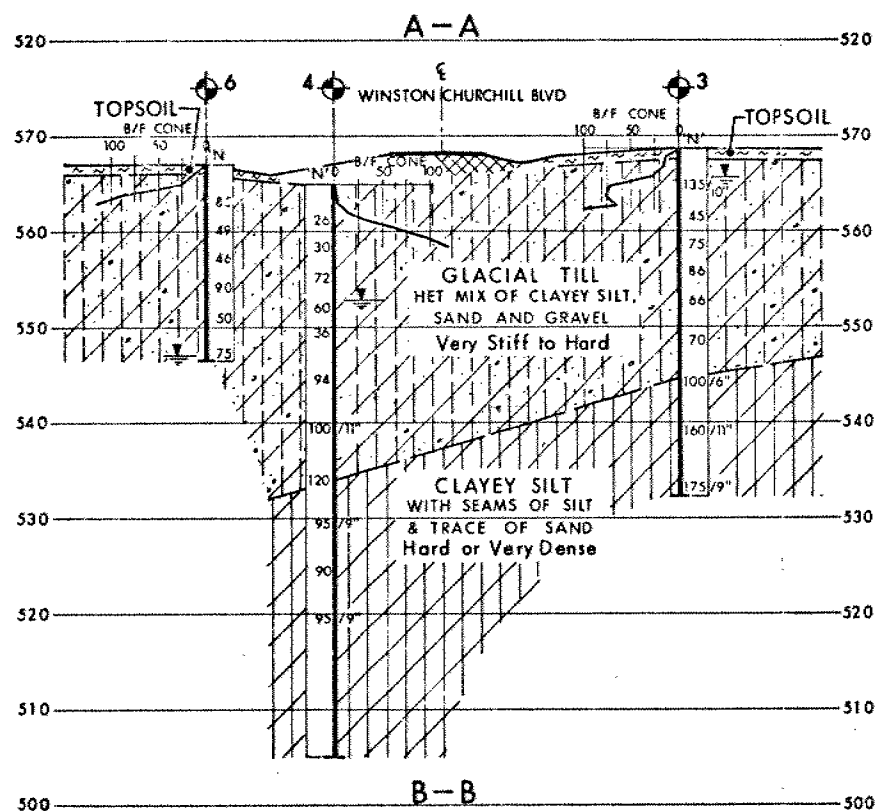
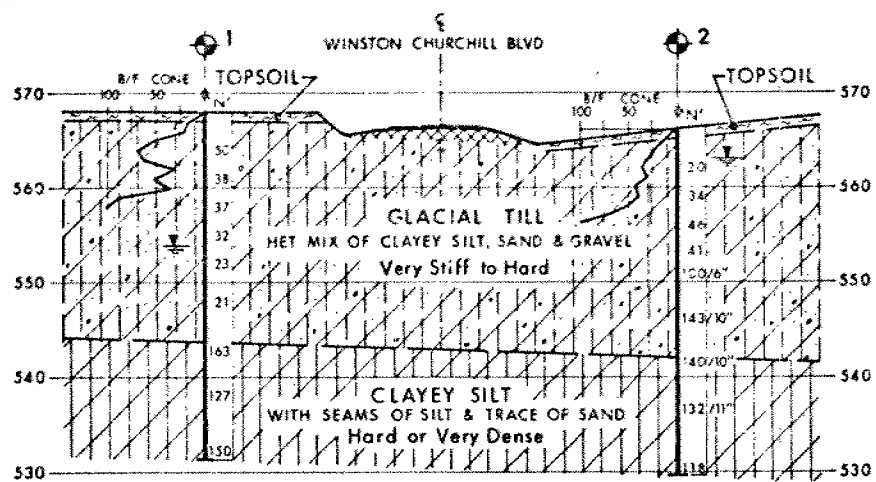
ϕ ANGLE OF SHEARING RESISTANCE
 τ_c PEAK SHEAR STRENGTH
 τ_p RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE-PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 σ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

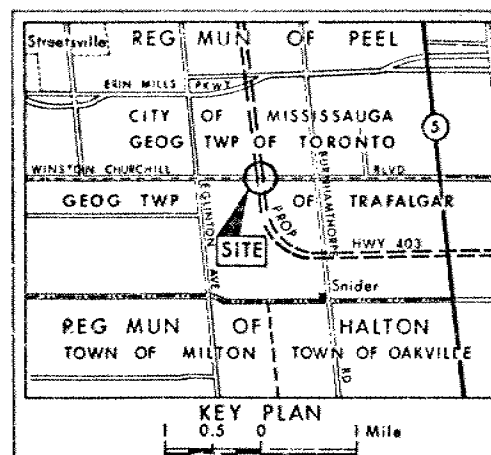
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO



CONT No
WP No 158-75-03

WINSTON CHURCHILL BLVD U'PASS SHEET

BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W.L. at time of investigation Aug 1977
- W.L. for Bore Hole No 4 July 1976

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	568.0	15 821 368	944 431
2	566.2	15 821 438	944 503
3	568.7	15 821 517	944 425
4	565.0	15 821 474	944 365
5	567.1	15 821 525	944 277
6	567.0	15 821 447	944 354
7	567.7	15 821 595	944 349

NOTE-

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

REVISIONS	DATE	BY	DESCRIPTION

REF NO: De Leuw Cather, Consulting Eng's & Plan's
Project no 71-911, DWG no 911-701

HWY No PROPOSED 403
SHEED V.A. 20/7/76 DATE Sept 26, 1977 SITE 24-384
DRAWN BY: J. H. 1587503-A

Mr. C.S. Grebski
Structural Section
2nd Floor, West Building

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

79 05 22

Mr. W. Lin

Re: Hwy. 403 Underpass at Winston Churchill Blvd.
W.P. 158-75-03, Site 24-384
Hwy. 403, District 6, Toronto

As agreed earlier in a structural review meeting, this Section would carry out a supplementary investigation to determine the thickness of the existing granular sub-base on Winston Churchill Blvd. and the condition of the underlying subsoil in order to ensure that the abutment footings of the proposed underpass would be founded in competent natural ground and not on the roadway fill material. We have now completed the field-work. Our findings and comments are as follows.

The existing Winston Churchill Blvd. appears to be constructed on a 15 to 18 inch thick sand and gravel sub-base which is placed on a competent glacial till stratum. The contact between the sandy sub-base and the glacial till is at about elevation 565 at the south abutment location and at about elevation 566 at the north abutment location. Further, the upper one foot or so of the glacial till appears to be somewhat softened.

According to the design drawings for this project, the underside of the north and the south abutment footings will be at elevation 565. In our opinion, this founding elevation would be satisfactory for the north abutment footings. At the south abutment location, this founding elevation could be maintained provided the underlying subsoil is subexcavated to elevation 564 and backfilled with mass concrete. Please ensure that an item for this quantity of mass concrete is included in the contract.

B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs

cc: D. MacDonald
M. Ernesaks
G.C. Burkhardt
Files ✓

Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

88 08 28

Mr. W. Lin

Re: Hwy. 403 Underpass at Winston Churchill Blvd.
W.P. 158-75-03, Site 24-384
Hwy. 403, District 6, Toronto

We have reviewed the final bridge drawings (24-384-1 and 3) for the above mentioned structure. The abutment footings should be placed on undisturbed soil. Therefore, the existing roadway fill material at the abutment locations should be completely removed prior to construction of the abutment footings.

B. Ly
Senior Engineer

BL/gs

cc: Files ✓

Mr. W. L. Lin
Design Engineer, Central Section
Structural Office
West Bldg, Downsview

Soil Mechanics Section
Engineering Materials Office
3rd Floor, Central Building

78 03 21

Re: Hwy #403 Underpass
at Winston Churchill Blvd.,
W.P. 158-75-03, Site 24-384
District 6, Toronto

As per your request, we have reviewed the Preliminary Bridge Plan Drawing 24-384-P1 for the above structure. The designs of the foundations and the approaches are satisfactory to us.

B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/ig

cc: Files ✓

G.I.-30 SEPT. 1976

GEOCRES No. 30M12-129DIST. 4 REGION W.P. No. 158-75-03CONT. No. 80-20W. O. No. STR. SITE No. 24-384HWY. No. 403LOCATION Winston Churchill Blvd.
HudspassNo. of PAGES -

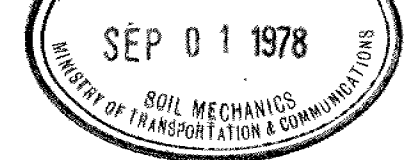
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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

GENERAL NOTES
CLASS OF CONCRETE
DECK & BARRIER WALLS 5000 P.S.I.
PIER COLUMNS 5000 P.S.I.
REMAINDER 3000 P.S.I.
REINFORCING STEEL GRADE
CSA STANDARD G30.12-111977 GRADE 400MP
CLEAR COVER ON REINFORCING STEEL
FOOTINGS & ABUTMENTS 3"
PIER COLUMNS 2"
DECK TOP 1"
DECK BOTTOM 1"
APPROACH SLABS 2"
AND/OR AS NOTED ON DRAWINGS.

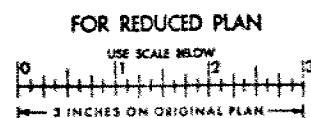
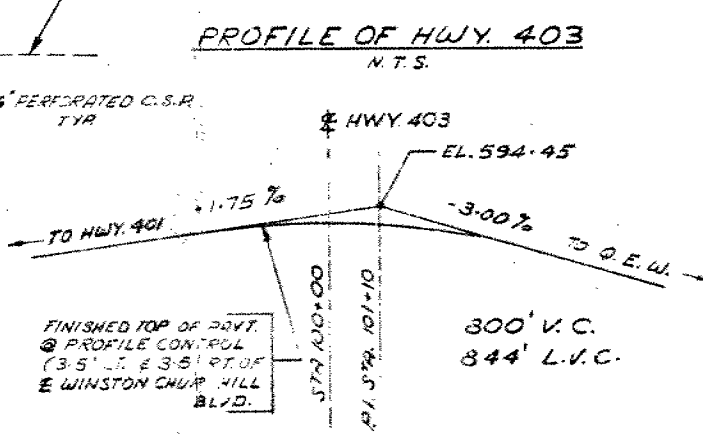
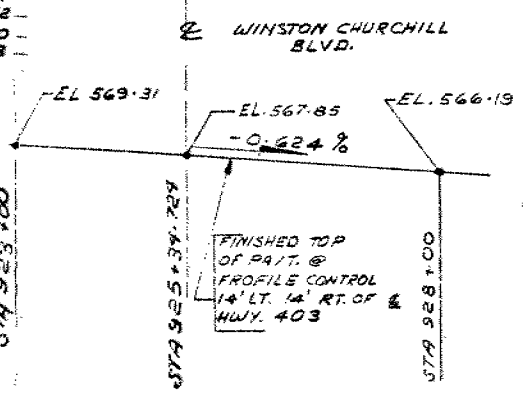
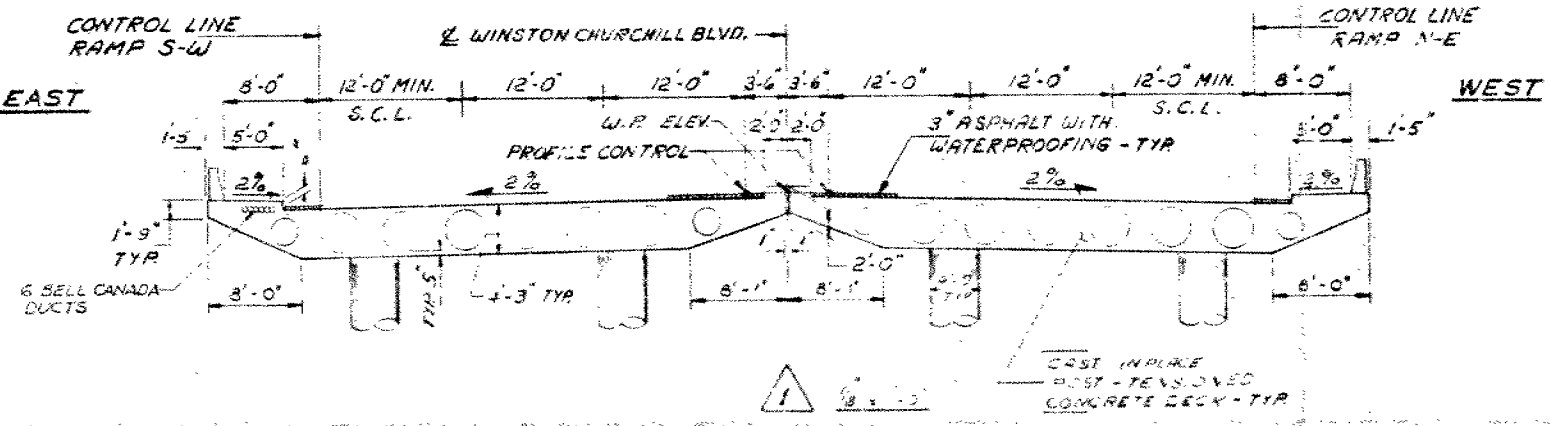
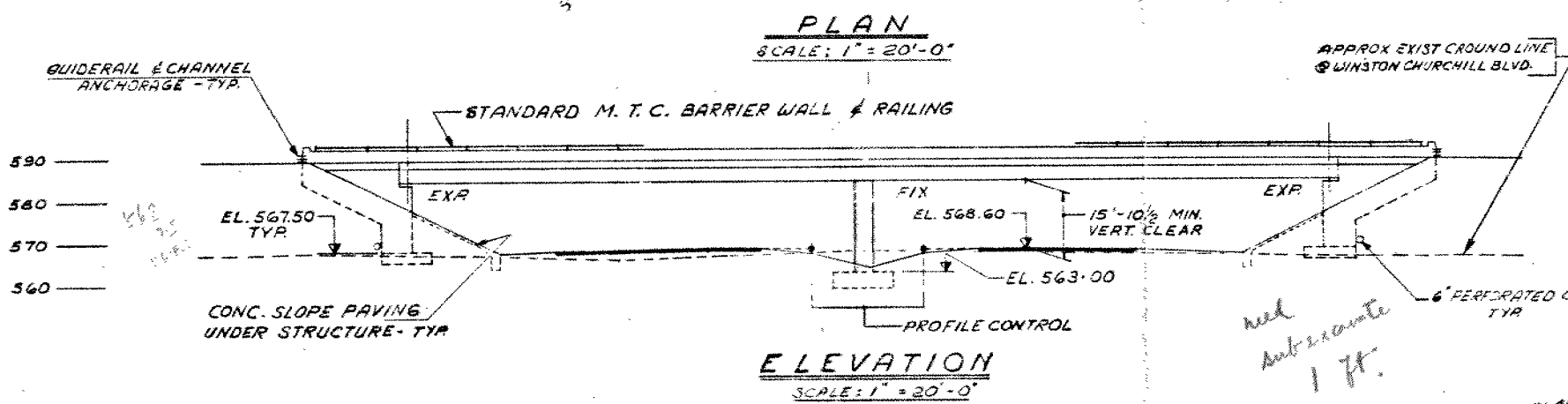
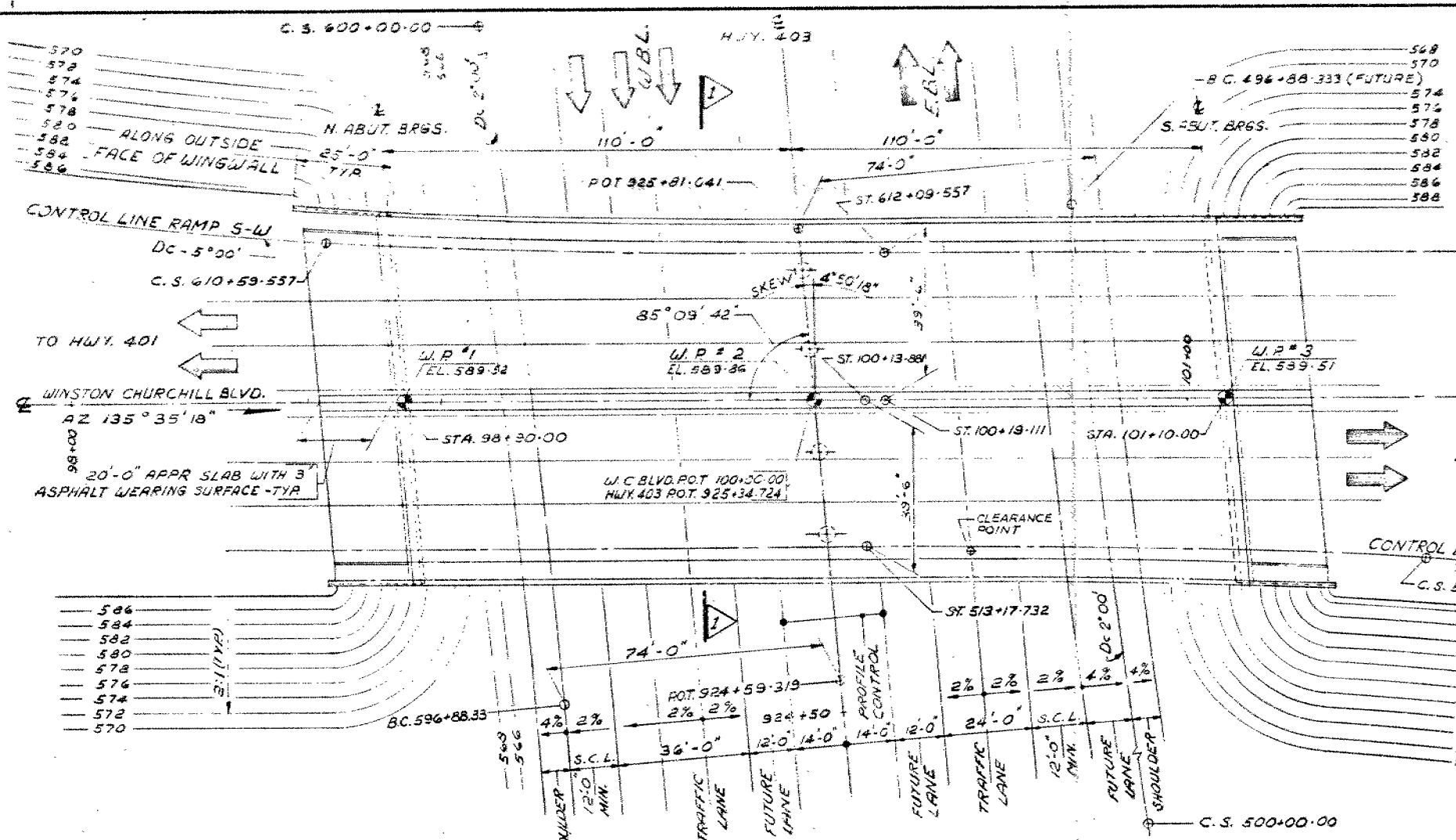
NOTES
1) W.P. DENOTES WORKING POINT
2) REFER TO GRADING DRAWINGS FOR CATCH BASINS OFF STRUCTURE.
CONSTRUCTION NOTES
THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF $\pm \frac{1}{8}$ ".
NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED, STRESSED AND GROUTED.

- LIST OF DRAWINGS**
24-384-1. GENERAL PLAN
-2. BOREHOLE LOCATIONS & SOIL STRATA
-3. FOOTING LAYOUT & DETAILS
-4. FOOTING REINFORCEMENT
-5. WEST & EAST ABUTMENTS
-6. PIER COLUMNS
-7. DECK LAYOUT, SKEW ELEV AND BEARINGS
-8. CABLE DETAILS I
-9. CABLE DETAILS II
-10. DECK REINFORCEMENT I
-11. DECK REINFORCEMENT II
-12. BARRIER WALL WITH SIDEWALK
-13. STEEL RAILING (SINGLE TUBE)
-14. 20 FT. APPROACH SLAB
-15. DETAILS OF CONC SLOPE PAVING
-16. AS CONSTRUCTED ELEV & DIM.
-17. STANDARD DETAILS I
-18. STANDARD DETAILS II
-19. STANDARD DETAILS III



CONCRETE QUANTITIES
CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM ITEMS.

1. CONCRETE IN PIERS, ABUTMENTS AND WINGWALLS	5000 P.S.I.	554 C.Y.
2. PRESTRESSED CONCRETE BRIDGE DECK		2,193 C.Y.
3. CONCRETE IN BARRIER WALLS		41 C.Y.
4. CONCRETE IN APPROACH SLABS		120 C.Y.
5. CONCRETE IN SLOPE PAVING		79 C.Y.



REVISION	DATE	BY	DESCRIPTION

CONT No
WP No 158-75-03

WINSTON CHURCHILL BLVD U'PASS

FOOTING LAYOUT & DETAILS

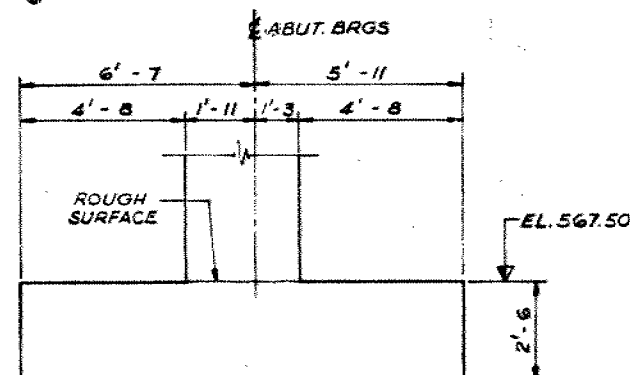
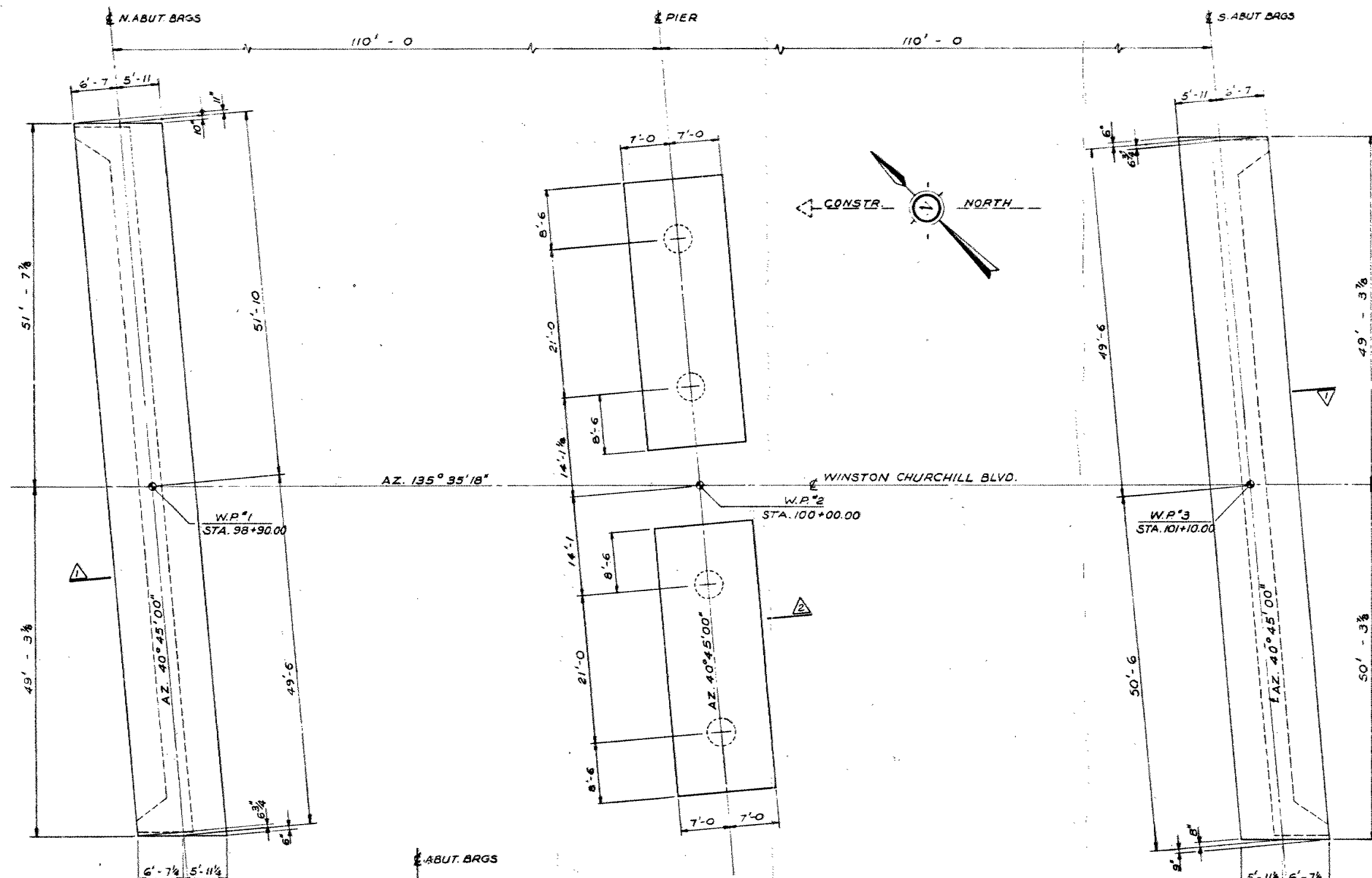
De Leuw Cather CONSULTING ENGINEERS AND PLANNERS

SHEET

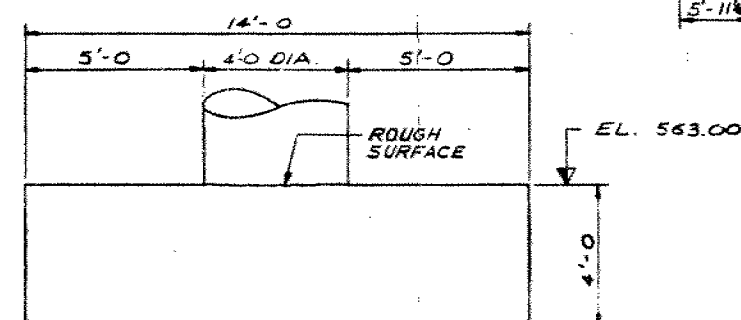
COORDINATES		
W.P.	NORTH	EAST
1	821560.970	944313.789
2	821482.394	944390.768
3	821403.818	944467.747

NOTE
FOOTING TO BE PLACED ON UNDISTURBED SOIL.

$$1100 \times \frac{1}{2} = 550$$

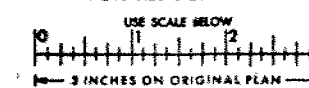


SCALE: 1/8" = 1'-0"



SCALE: 1/8" = 1'-0"

FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION
DESIGN			CHECKED
DRAWING			CHECKED

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M12-128

DIST 4 REGION Central

W.P. No. 158-75-04


CONT. No. 79-31

W. O. No. _____

STR. SITE No. 10-280

HWY. No. 403

LOCATION Burnhamthorpe Rd.
Underpass

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 

REMARKS: documents to be unfolded
before microfilming

FOUNDATION INVESTIGATION REPORT

For

Burnhamthorpe Road Underpass
W.P. 158-75-04, Site 10-280
Hwy. 403, District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project during the period of June, 1976 and August 11 and 12, 1977. The fieldwork consisted of six sampled boreholes advanced by means of a continuous flight auger machine equipped with hollow stem ($3\frac{1}{4}$ " I.D.) augers.

The boreholes ranged in depth from 17.0 feet to 61.0 feet below the ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located about 350 feet east of 9th line and Sneider Corner on existing Burnhamthorpe Road in the City of Mississauga, Regional Municipality of Peel.

The topography of the area is gently sloping in a southerly direction. The land is developed for farming purposes. Physiographically, the site is situated in the region of "South Slope". The characteristic deposit in the vicinity of the area under investigation is composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock of Meaford Dundas formation, Ordovician Period.

This physiographic region is well drained by the Credit, Oakville and Etobicoke Creeks which have cut deep valleys into the overburden. However, in many of the interstream areas drainage is still imperfect.

SUBSURFACE CONDITIONS

General

The subsurface conditions were found to be quite uniform over the site. Under a thin layer of topsoil is a stratum of cohesive glacial till which is underlain by a deposit of silt with traces of sand and occasional clayey silt layers.

Detailed descriptions of the various soil types encountered in each borehole are given in the Record of Borehole Sheets. The estimated stratigraphical profile and sections shown in Drawing No. 1587504-A are based upon this information. From ground level downwards the various soil types encountered are as follows:

Glacial Till

Underlying a thin layer of topsoil a deposit of cohesive glacial till was encountered at all locations over the site. In the explored boreholes the minimum thickness of the glacial till was found to be 34 feet, while the maximum thickness was not explored more than 36 feet in depth. The cohesive glacial till is comprised of a heterogeneous mixture of clayey silt, sand and gravel. The Standard Penetration Tests gave 'N' values ranging from 26 blows to over 100 blows per foot, indicating that the glacial till has a very stiff to hard consistency, but generally hard.

The physical properties of the glacial till as determined from laboratory testing are summarized below:

	<u>Range</u>
Liquid Limit (W_L) %	18-29
Plastic Limit (W_p) %	10-15
Moisture Content (W) %	7-16

The results of the Atterberg Limit tests are shown on the Plasticity Chart (Fig. 1) and the typical grain size distribution curves are presented in an envelope form in Fig. 2 which are included in the Appendix of this report. The Atterberg Limits indicate that the cohesive stratum is inorganic and of low plasticity.

Silt With Trace of Sand, Occasional Clayey Silt Layers

This deposit underlies the cohesive glacial till stratum and was explored only in B.H. 2 to a depth of 27 feet. The material in the stratum is mainly silt with traces of sand and occasional thin layers of clayey silt. The 'N' values obtained from split spoon sampling ranged from 54 to over 100 blows per foot indicating that the relative density of the granular material is very dense.

Groundwater

The groundwater levels were observed by measuring in the open boreholes during and after the completion of the foundation investigation. The groundwater levels were found to vary between elevations 592.9 (B.H. 3) and 582 (B.H. 2) which corresponds to depths of 3 feet to 13 feet below the existing ground surface.

The groundwater levels are shown on the Record of Borehole Sheets, as well as on Drawing No. 1587504 A.

DISCUSSION AND RECOMMENDATIONS

As part of the new Hwy. 403 construction, an underpass structure has been proposed at the crossing of the new Hwy. 403 and the existing Burnhamthorpe Road. It is understood that the Burnhamthorpe Road will be widened to a four lane road in this area.

In the vicinity of the proposed structure the existing grade of the Burnhamthorpe Road varies from 596.0 (south side) to 597.0 (north side). The revised grade of the Burnhamthorpe Road will be at 613.7 (south side) and 609.7 (north side). The proposed grade of Hwy. 403 will be at elevation 590.3. This will necessitate fills up to 18 feet and cuts of 7 feet.

A two span structure (80'-80') consisting of closed type abutments with a centre pier are presently being considered at this site.

Pier Foundation

The pier may be founded on spread footings located within a competent glacial till stratum at or below elevation 586.0 with an allowable load of up to 4 t.s.f. A minimum earth cover of 4 feet from the base of the footings should be provided for frost protection requirements.

No major dewatering problems are anticipated for the construction of foundations since the subsoil is relatively impervious. Any seepage or surface run-off into the excavation could be controlled by pumping from sumps. It should be noted that the foundation excavation base should be kept dry at all times prior to the placing of concrete.

Abutment Foundations

In case closed type abutments are contemplated, the recommendations will be similar to those of pier foundations.

However, if perched abutments are contemplated they should be supported on a core of well compacted granular 'A' material above the natural subsoil as per our current practices. An allowable load of $2\frac{1}{2}$ t.s.f. may be used for design purposes. All the topsoil should be removed to the full base width of the granular core.

Approaches

No stability problems are anticipated for the proposed approach fills and cuts are constructed with 2:1 slopes.

Related Conditions

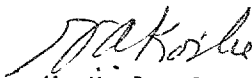
The abutments should be designed to withstand a lateral earth pressure exerted by the backfill and this pressure is dependent on the deformation characteristics of the retaining structure. If some movement of the top of the wall is permitted, then a coefficient of active earth pressure (K_a) of 0.35 can be used. On the other hand, if the structure is designed as rigid frame, then a coefficient of earth pressure at rest (K_0) of 0.5 should be used. To compute the sliding resistance between the rough concrete footing base and cohesive subsoil, an adhesion value of 2000 p.s.f. should be used.

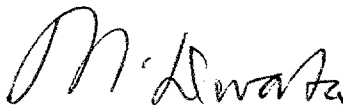
MISCELLANEOUS

The fieldwork was carried out during August 11 and 12, 1977 under the supervision of Mr. V. Korlu, Project Engineer, who also prepared this report.

The drilling equipment was owned and operated by D.S.I.L. Drilling Inc. of Toronto.

This report was reviewed by Mr. M. Devata, Supervising Engineer.


V. Korlu, P. Eng.
Project Engineer


M. Devata, P. Eng.
Supervising Engineer



MD/VK/gs
October, 1977

FIELD AND LABORATORY WORK

Six sampled boreholes, each accompanied by a dynamic cone penetration test, were carried out at this site. The five boreholes (No. 1, 3, 4, 5 & 6) were carried out during recent field investigation, while one borehole (No. 2) was carried out earlier during a preliminary investigation. The borings were advanced by continuous flight auger machines (commercially known as C.M.E.75, H.S.M.V.) adapted for soil sampling purposes.

Samples of the overburden were obtained in a 2" O.D. split spoon sampler at required depths. The sampler was hammered into the soil according to the specifications of Standard Penetration Test. The silt layer was explored (B.H. 2) during a preliminary investigation (W.O. 76-11005) and has been incorporated into this report.

Groundwater level observations were carried out during the time of investigation in the open boreholes. The soil and groundwater conditions encountered at the boring locations are presented in the Record of Borehole Sheets. The locations and elevations of the various boreholes were provided by personnel from Construction Office, Central Region. The elevations in this report are referred to a Geodetic Datum. Boring locations and elevations are shown on Drawing No. 1587504-A.

All samples were subjected to careful visual examination in the field and subsequently in the laboratory. Following this examination laboratory tests were carried out on selected representative samples to determine the physical properties of the various soil types encountered, namely:

- Natural Moisture Content
- Atterberg Limits
- Grain Size Distribution

The results of this testing are plotted on the Record of Borehole Sheets and summarized on Fig. 1 and 2, all contained in Appendix 1 of this report.

RECORD OF BOREHOLE No 1

4820093 287385

W P 158-75-04 LOCATION Co-ords N 15,813,952; E 942,864 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3/4" H.S. Auger & Cone Test COMPILED BY V.K.
 DATUM Geodetic DATE August 11, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100/10"					
597.7	Ground Level													GR SA SI CL
0.0	Topsoil													
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel. (Glacial Till) Hard		1	SS	32									16 18 45 21
			2	SS	48		590							
			3	SS	144/	9"			100/10"					
			4	SS	94									
	Brown		5	SS	179/	11"	580							0 9 79 12
	Grey		6	SS	153									
			7	SS	155/	11"	570							8 25 47 20
			8	SS	138/	11"								
561.2			9	SS	145									
36.5	End of Borehole						560							
1.12														

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2 (Formerly BH 3 W.O. 76-11005)

W P 158-75-04 LOCATION Co-ord's. N 15,811.034; E 942,898 ORIGINATED BY VK
 DIST 4 HWY 403 BOREHOLE TYPE H.S. 3½" Auger (CME#55) & Cone Test COMPILED BY VK
 DATUM Geodetic DATE June 30, 1976 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
595.0	Ground Level																
0.0	Topsoil																
	Het. mix. of clayey silt with sand, occasional gravel (Glacial Till)		1	SS	45		590										0 34 52 14
	Hard		2	SS	100	9"											
	Brown		3	SS	98	9"											
	Grey		4	SS	100	8"											
			5	SS	120	6"	580										
			6	SS	125	6"											
			7	SS	100	9"	570										
			8	SS	97												0 11 47 42
561.0			9	SS	54		560										0 23 68 9
34.0	Silt with trace of sand, occ. clayey silt layers		10	SS	115												22 75 (3)
	Very Dense gravelly sand Dense		11	SS	125	11"	550										
	clayey silt Hard		12	SS	100	9"											0 2 87 11
			13	SS	70	11"	540										0 3 95 2
534.0	Clayey silt Hard		14	SS	100	11"											0 1 89 10
61.0	End of Borehole																

+ 3, x 5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

W P 158-75-04 LOCATION Co-ords N 15,814,085; E. 942,972 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3/4 H.S. Auger & Cone Test COMPILED BY V.K.
 DATUM Geodetic DATE August 11, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
595.6	Ground level																
0.0	Topsoil																
	Het.Mix. of Clayey Silt, Sand and Gravel (Glacial Till) Hard		1	SS	45		590										0 24 50 26
			2	SS	71												
			3	SS	120												
	Brown Grey		4	SS	74												
			5	SS	101		580										
			6	SS	54												0 54 38 8
			7	SS	60		570										4 12 45 39
			8	SS	42												
561.6	Silty sand (fine)																
559.1	V. Dense		9	SS	53		560										0 93 (7)
36.5	End of Borehole																

+3, x5: Numbers refer to Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

W P 158-75-04 LOCATION Co-ords N ^{4,820,147} 15,814,130: E ^{287,401} 942,918 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3½ H.S. Auger & Cone Test COMPILED BY V.K.
 DATUM Geodetic DATE August 12, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
593.9	Ground level																
0.0	Topsoil																
	Het. Mix. of Clayey Silt, Sand and Gravel.		1	SS	84		590										30 22 36 12
	(Glacial Till)		2	SS	62												13 25 44 18
	Hard		3	SS	100/	4"											
	Brown		4	SS	56		580										4 27 48 21
	Grey																
576.9	Boulders		5	SS	100/	4"											
17.0	End of Borehole																

+³, x⁵: Numbers refer to 20
Sensitivity 15 ± 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

W P 158-75-04 LOCATION Cr-ords N 15,814,062; E 942,863 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger & Cone Test COMPILED BY V.K.
 DATUM Geodetic DATE August 12, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
595.2	Ground level													
0.0	Topsoil													
	Het. Mix of Clayey Silt, Sand and Gravel. (Glacial Till)		1	SS	48		590							25 18 41 16
	Hard		2	SS	79									
	Brown		3	SS	105									
	Grey		4	SS	96		580							0 29 56 15
			5	SS	99									
			6	SS	46									0 32 49 19
			7	SS	56		570							
			8	SS	49									1 30 30 39
558.7			9	SS	65		560							3 24 57 16
36.5	End of Borehole													

+³, x⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

W P 158-75-04 LOCATION Co-ords N 15,813,997; E 942,809 ORIGINATED BY V.K.
 DIST 4 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger & Cone Test COMPILED BY V.K.
 DATUM Geodetic DATE August 12, 1977 CHECKED BY RS

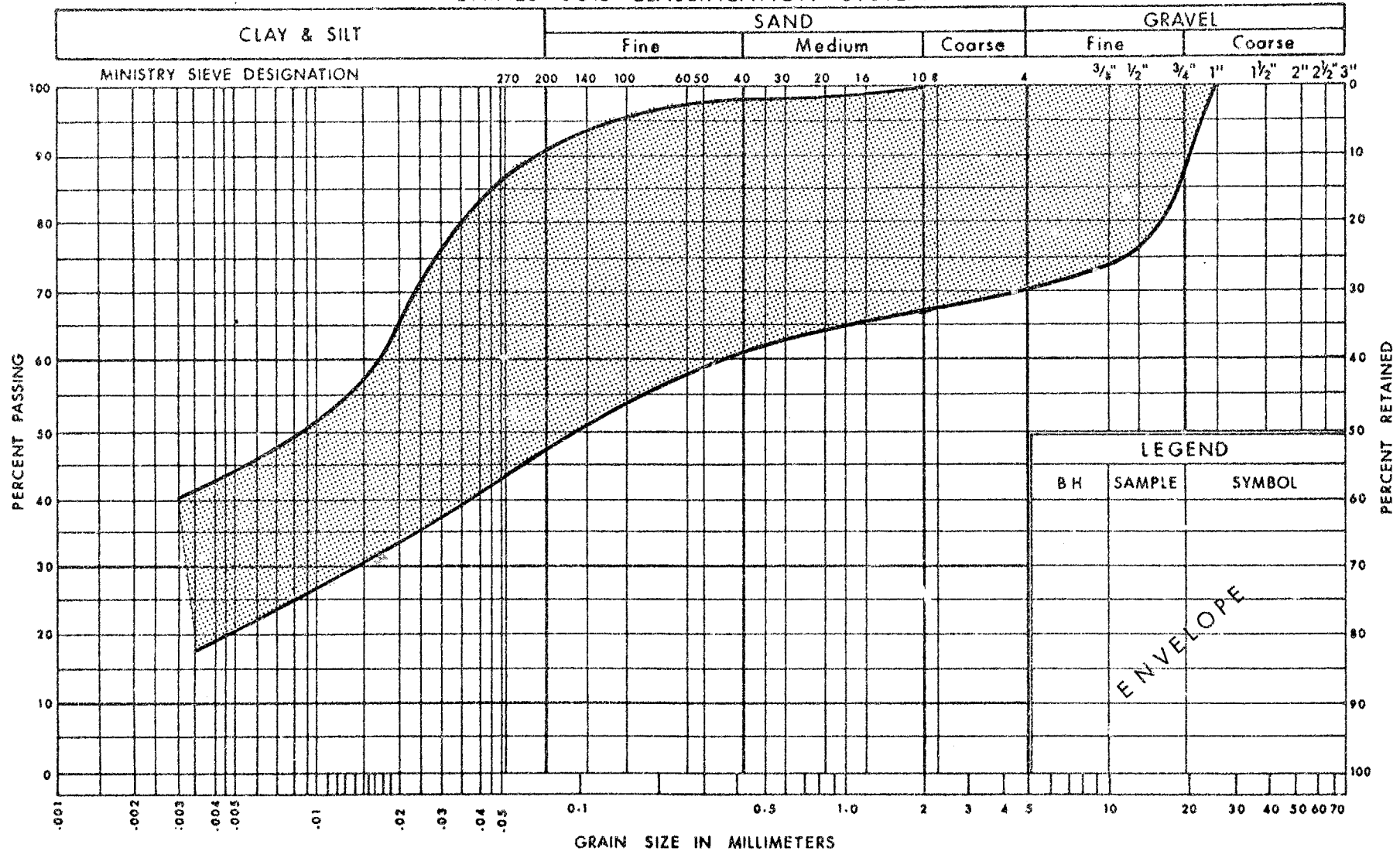
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100			
597.4	Ground Level													GR SA SI CL
0.0	Topsoil													
	Fin. Mix. of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff to Hard		1	SS	38									4 19 52 25
			2	SS	54									
			3	SS	123									
	Brown		4	SS	51									
	Grey		5	SS	101									0 23 62 15
			6	SS	63									
			7	SS	26									
			8	SS	135									
560.9														0 19 60 21
36.5	End of Borehole		9	SS	36									

Ministry of
Transportation and
Communications

PLASTICITY CHART COHESIVE GLACIAL TILL

W P 158 - 75 - 04

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation and
Communications

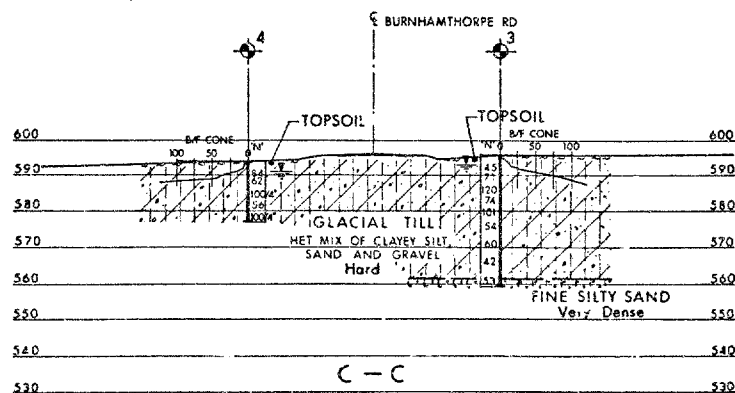
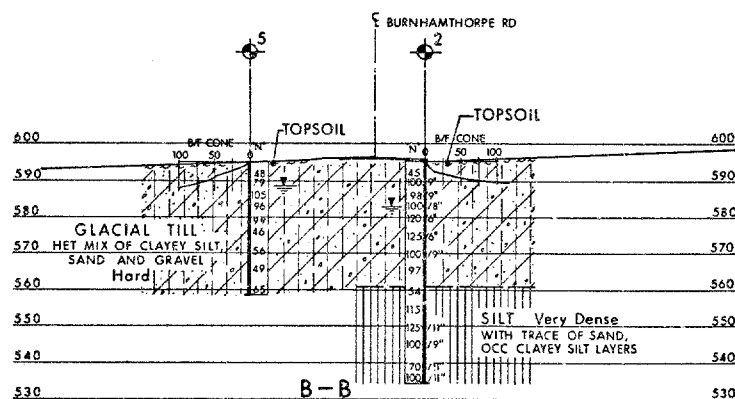
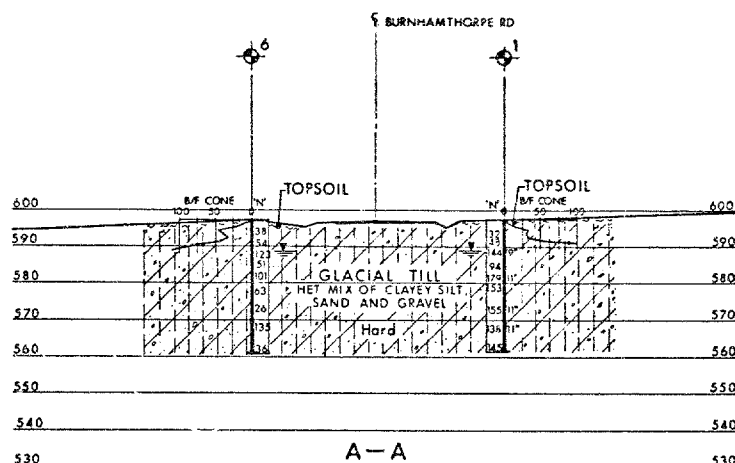
GRAIN SIZE DISTRIBUTION

GLACIAL TILL

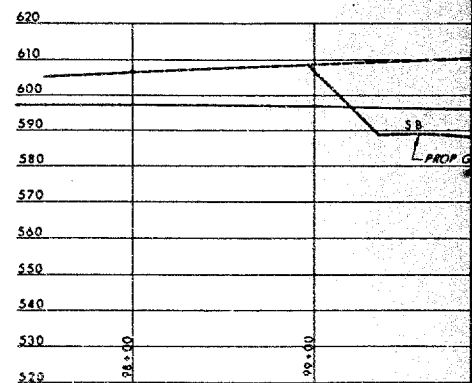
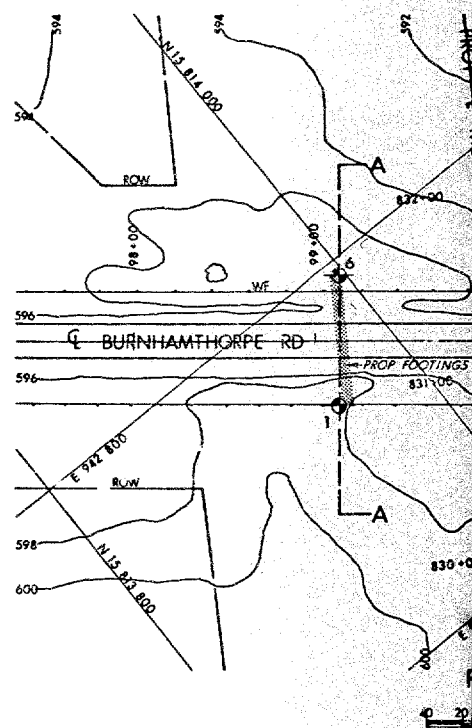
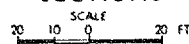
HET MIX OF CLAYEY SILT, SAND & GRAVEL

FIG No 2

WP 158-75-04



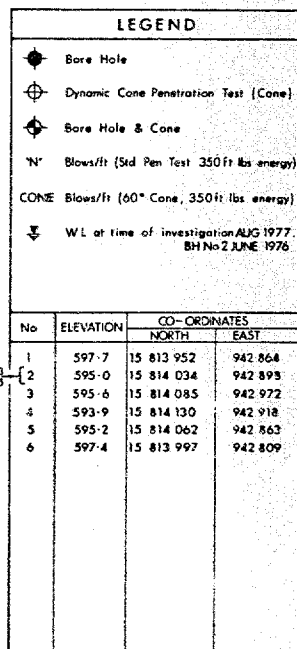
SECTIONS



PROFILE - BURNHAMTHORPE RD



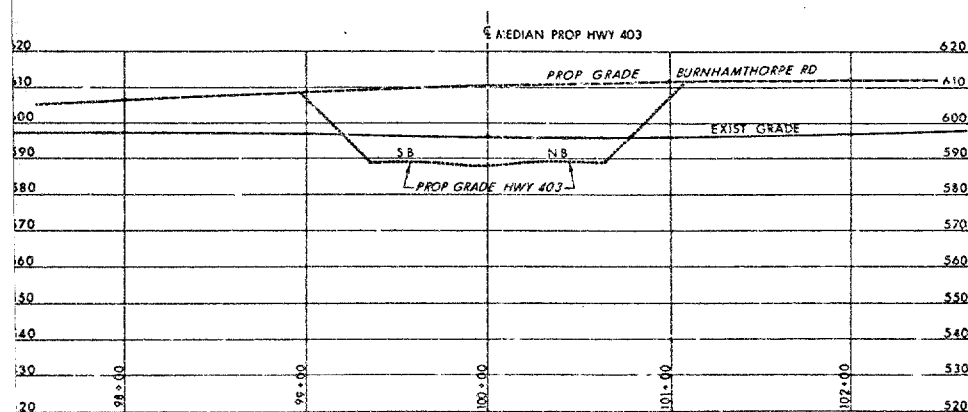
SHEET



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

REVISIONS		DESCRIPTION
DATE	BY	

HWY No. 403 DIST. 4
SLOPE 1/4% SLOPED DATE Oct 13, 1977 SITE 10-280
DRAINAGE 1/4% SLOPED DWG 1587504-A



REF: DE LEUW CATHER CONS ENG
DWG No 911-702



Ontario

Telephone 248-3446

Ministry of
Transportation and
Communications

Planning and Design Section,
Central Region,
3501 Dufferin Street,
Downsview, Ontario.
M3K 1N6.

May 30, 1978

DeLeuw, Cather Engineering Ltd.,
133 Wynford Drive,
Don Mills, Ontario.
M3C 1K1.

Attn: Mr. A. Scott, P.Eng.

Re: W.P. 158-75-06, -01, Highway 403,
W.C. Blvd. to south of Hwy. 5,
District 4, Hamilton.

Gentlemen:

This is to confirm the decision to revise the profile that was reached at our meeting held on May 26, 1978 in our offices attended by yourself, Josselyn, Ernesaks, Burnfield, Roters, Cameron and myself. The revision is required to eliminate 250,000 cubic yards of surplus material and would avoid the high ground-water table at Highway 5 and south of Burnhamthorpe Road, thereby resulting in a saving of about \$700,000 in construction cost.

You are now advised to re-establish the profile for the above section of highway in order to achieve the earth balance within individual contract limits, i.e., I.P. 158-75-06 and W.P. 158-75-01.

As agreed, your latest completion date for the composite contract drawings and documents will be September 13, 1978 which is the late finish date as per Critical Path Schedule. In order to meet this date, the profile should be finalized on or before June 19, 1978, and Bridge Site plans revised and submitted by June 26, 1978. This should provide the Structural Office at least six (6) weeks, which it needs, to revise the structural design. The latest date for receiving structural plan and B-A should be August 25, 1978.



Continued ... /2

May 30, 1978

DeLoux, Gathor Engineering Ltd. - Re: W.P. 158-75-06, -01.

I was recently advised that the contract for W.P. 158-75-06 would be awarded in advance of W.P. 159-75-01. Therefore, I am requesting Mr. Greskow by copy of this memorandum to make available to you the relevant removal and grading drawings for the placement of 60,000 cyds. of materials on or before August 18, 1978. The current Critical Path Schedule should be updated as early as possible to reflect the above changes.

I will now appreciate receiving your request for an addendum for the above revision with appropriate breakdown of work.

Yours very truly,

N. Sen

N. Sen, P.Eng.
Sr. Project Manager

HS/GB

c.c. R. Fitzgibbon
G. Burkhardt
C. Grobski
D. Gunter
W. Kelly
H. Devata
D. Waller
A. Greskow

→ Bin Ly → Please see this and give me your comments.

101.4

78 06 02

Raising the profile grade will be advantageous as it will eliminate the groundwater problems (i.e. wet cuts ^{+ related treatments}) and ^{the} disposal of surplus material. Raising the profile grade will not require a redesign of the footings of the structures.



Memorandum

To: Mr. M.R. Ernesaks
Head, Planning and Design
Central Region
3501 Dufferin Street

From: Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

Attention: Mr. N. Sen

Date: 78 07 04

Our File Ref.

In Reply to

Subject: Re: W.P. 158-75-⁰⁴~~00~~, Hwy. 403
Underpass Structures at
Burnhamthorpe Road, Site 10-280,
Hwy. 5, Site 10-281
District 4, Hamilton

The proposed Hwy. 403 at the above locations will be in cut sections. The subsurface information obtained in these areas indicate that the cuts would be constructed in granular subsoil below the groundwater level. For design and construction purposes, detailed groundwater conditions will be necessary.

At the request of the Regional Geotechnical Office, the Soil Mechanics Section carried out an investigation to determine the groundwater conditions at the above mentioned sites. In this investigation three piezometers were installed at each of the two sites to observe the piezometric head at different elevations in the overburden. In addition, a field pumping test was also performed at the proposed Hwy. 5 Underpass site. The locations and tip elevations of the piezometers, as well as the piezometric water levels, are summarized in the attached tabular forms and also in Figures 1 and 2.

The field pumping test was carried out to observe the recharge conditions and was done in the boring of B1 using NX size casing which was extended below the glacial till stratum into shale bedrock to elevation 530.5. The cased well was pumped out completely and the recharge rate was observed. The results are as follows:

<u>Time Elapsed (Min.)</u>	<u>Water Level in the Cased Well</u>
0	Elev. 530.7
20	Elev. 530.9
65	Elev. 531.8
100	Elev. 532.9

(Original GWL in the cased well prior to pumping was at Elev. 565+)

The piezometer readings and the recharge observations indicate that

1. The groundwater level at these sites exist at a very shallow depth below ground surface.

cont'd.....

2. At the Hwy. 5 Underpass site, recharge of groundwater was found to be in the lower portion of the glacial till stratum at the contact of shale bedrock. However, the shale bedrock was not a confined aquifer as the rate of recharge was observed to be very slow.
3. At the Burnhamthorpe Road Underpass site, the piezometric water levels indicated a hydrostatic condition.

Based on these observations the following conclusions may be drawn:

1. The proposed 2:1 cut slopes for a distance of 100 feet on either side of the structures should be protected with a granular blanket as outlined in our foundation reports. Alternatively, filter fabric can also be used. If such a scheme is adopted, specific recommendations can be provided by Mr. A. Barsvary of the Quality Assurance Section. In addition, a permanent subdrain system should be incorporated under the roadway of Hwy. 403.
2. The proposed 9 foot deep cuts should not have a major effect on deep walls in the surrounding area.
3. These cuts, however, may hinder the supply of groundwater to the adjacent shallow ponds.

The above details were discussed verbally with the Regional Geotechnical Office and Regional Planning and Design Office during various meetings. It is understood that considerations are being given to raise the profile grade of Hwy. 403 an additional 2 to 3 feet in these areas in order to achieve a design with balanced cuts and fills. In our opinion, such a revision would be advantageous since it will minimize the treatments required for the cut sections.

It should be noted that raising of the profile grade of Hwy. 403 as being contemplated will not alter the design of the structure foundations.

Should you require additional information, please contact this Office.

M. Machea
for
B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs

cc: R.D. Gunter
G.C.E. Burkhardt
C.S. Grebski
A. Barsvary
Files

Table 1 Piezometric Data at
Hwy. 403 - Burnhamthorpe Road

<u>Piezometer</u>	<u>Location</u> (Ø Hwy. 403)	<u>GL</u>	<u>Tip Elevation</u>	<u>Piezometric WL</u>	
				(Dec. 77)	(Jan. 78)
A1	821+00; 4.5 Rt	601.6	564.1	597.1	598.5
A2	820+92; 8.2 Rt	601.7	580.2	596.7	597.2
A3	820+83; 11.7 Rt	601.7	591.2	595.7	595.8

- Remarks:
1. All Borings were advanced by means of 3¼ inches I.D. hollow stem augers
 2. The WL inside the augers rose to Elevation 595.7+ as soon as the sand layer was intercepted. This sand layer underlies the surficial clayey silt at a depth of about 6.5 feet below the ground surface.
 3. For subsoil strata, refer to foundation report WP 158-75-04.

Table 2 Piezometric Data at
Hwy. 403 - Hwy. 5

<u>Piezometers</u>	<u>Location (ϕ Hwy. 403)</u>	<u>GL</u>	<u>Tip Elevation</u>	<u>Piezometric W.L.</u>	
				<u>(Dec. 1977)</u>	<u>(Jan. 1977)</u>
B1	759+80; 33.0 Lt.	566.9	531.9	566.9	566.9
B2	759+72; 41.3 Lt.	567.4	546.4	562.4	564.0
B3	759+66; 47.7 Lt.	567.9	557.4	563.9	561.5

- Remarks:
1. B1 was advanced by washboring techniques using NX casing.
B2 and B3 were put down by means of 3 $\frac{1}{4}$ " I.D. hollow stem augers.
 2. B2 was dry before a depth of 15 feet was reached.
 3. The WL inside the augers left in the boring of B3 was observed at elevation 565.4 sixteen hours after the completion of augering.
 4. For subsoil strata, refer to Foundation Report W.P. 159-75-03.

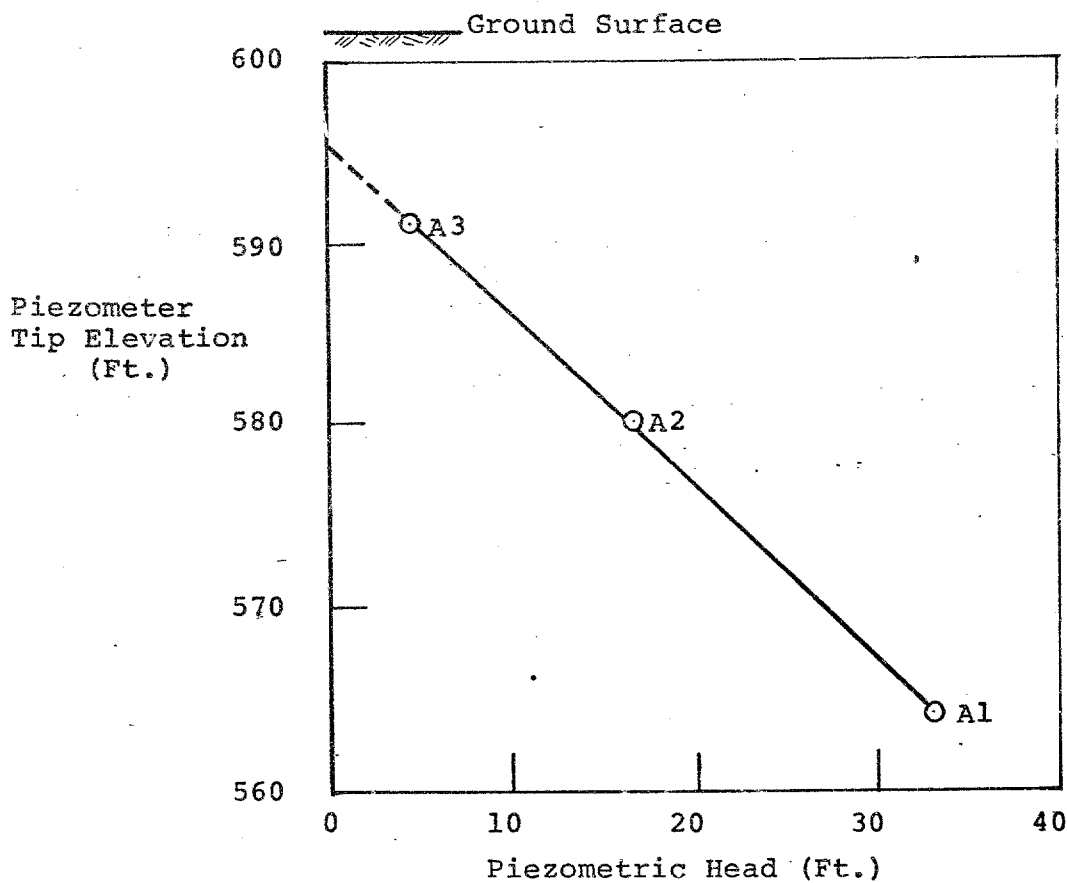


Fig. 1
Piezometric Data
at the
Burnhamthorpe
Underpass Site

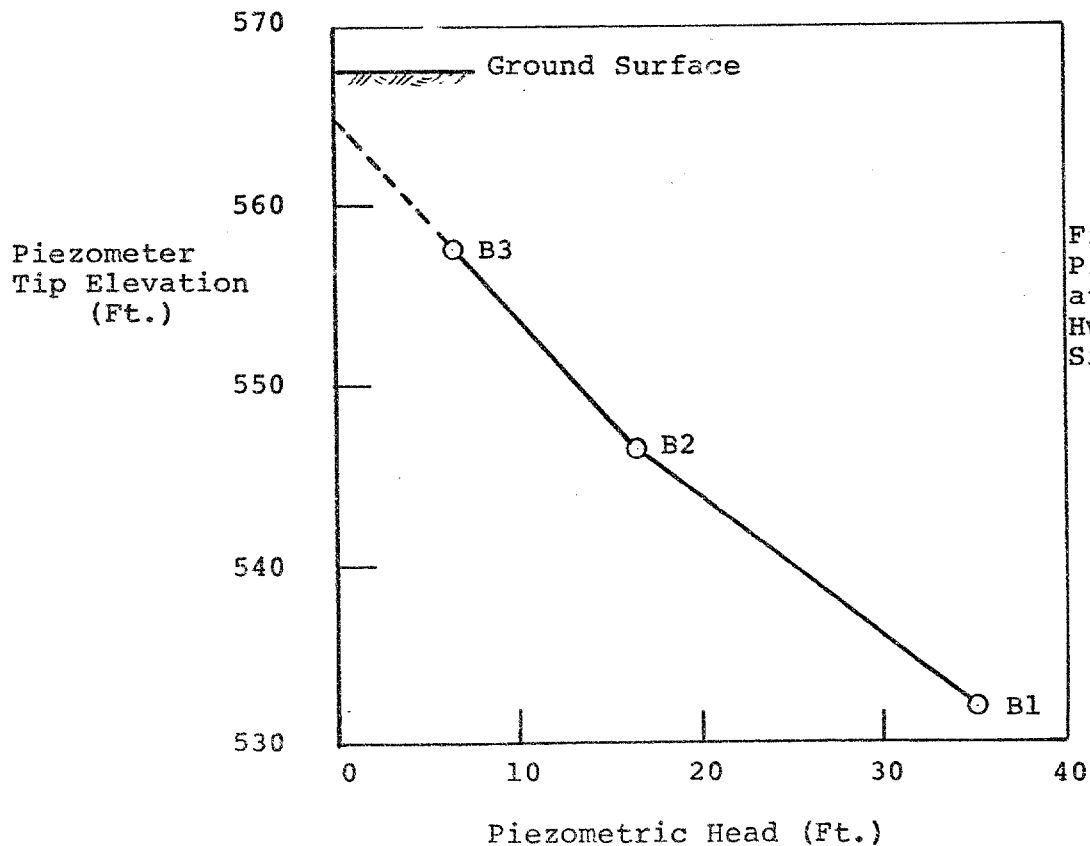


Fig. 2
Piezometric Data
at the
Hwy. 5 Underpass
Site 10-280



Memorandum

To: Mr. C. Mirza,
Head,
Soil Mechanics Section,
West Building, Downsview

From: G.C.E. Burkhardt,
Structural Section,
Central Region

Attention: Mr. M. Devata

Date: June 14, 1977

Our File Ref.

In Reply to

Subject: RE: Burnhamthorpe Road Underpass,
Site 10-280, W.P. 158-75-04
Highway 403 Link, District 4

The above mentioned structure is scheduled for design during 1977-78 as part of the group W.P. 158-75-01.

Could you please prepare a Foundation Investigation Report for the Burnhamthorpe Road Underpass site.

I have enclosed for your information, two copies of the plans which detail the initial geometrics and profile. Indicated on this plan in red pencil are the approximate locations of the proposed footings.

When you reach the stage of preparing the Bore Hole Locations and Soil Strata Drawing, please contact me. At that time a plan should be available at a 1" = 40' scale that should be of assistance to you in preparing the drawing.

To maintain the present design schedule, the Foundation Investigation Report should be completed by October 12, 1977.

If further information is required, please do not hesitate to contact the undersigned.

DB:gj
Encl.

D.H. Bye,
Structural Planning Supervisor,
for:
G.C.E. Burkhardt,
Head, Structural Section

c.c. J. Anderson
Z. Byblow
R. Fitzgibbon
R.D. Gunter
N. Sen



Murty
Please confirm whether this is
Dist 4 or
Dist 6.
Thanks
Car
no need

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 159-75-03

DIST 4

HWY 403

STR SITE 10-281

Hwy. 403 Link, Hwy. 5 Underpass

CONT. 79-31

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

R. Fitzgibbon)
J. Anderson) cover only
G. Sloan)

Files ✓

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	<i>Feb. 28, 1978</i>	<i>BL</i>
TUBES		
ROCK CORES		

FOUNDATION INVESTIGATION REPORT

For

Hwy. 403 Link, Hwy. 5 Underpass
Hwy. 403, District 4, Hamilton
W.P. 159-75-03, Site 10-281

INTRODUCTION

This report contains the results of a foundation investigation performed by the Soil Mechanics Section at the site of the above mentioned project. Fieldwork was carried out during July 18 to July 20, 1977 using 3¼" diameter hollow stem, continuous flight augers and BXL coring techniques to advance 6 boreholes to depths ranging from 25 to 31 feet below the ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located on Hwy. 5, 1 mile west of Winston Churchill Blvd., in the Town of Oakville and the City of Mississauga. The land adjacent to the site has a gently rolling topography, generally sloping down to the southeast toward Lake Ontario.

Hwy. 5 is in a 7 to 10 foot cut at the top of a very gently sloped hill. To the west of the site, the ground slopes down for ½ mile to the valley of Joshuas Creek which meanders within a steep-sided valley with a flood plain about 100 feet wide.

Land in the area is used primarily for wheat and grazing with some residential use.

Numerous ponds dot the area, kept full by the high water table. Water can also be seen lying in depressions in the ground surface, including the ditches beside Hwy. 5, for several days after a rain.

The site lies within the South Slope physiographic region. This region is characterized by glacially deposited overburden overlying shale bedrock of the Queenston and Dundas Formations of the upper Ordovician age.

SUBSURFACE CONDITIONS

General

At this site a mostly noncohesive, fluvial glacial deposit was found immediately below a very thin layer of topsoil. This was underlain by a cohesive glacial till deposit in most locations, followed by shale bedrock.

The upper 6 to 10 feet of the noncohesive deposit is composed of silt with a trace of sand and clay. Below this silt layer fine sand extends to between 11 and 20 feet.

At the south end of the west abutment only, the fine sand layer is underlain by a 5 foot thick deposit of well graded sand extending to bedrock at 25 feet. No cohesive glacial till was found at this location.

Underlying the fine sand layer in all other locations is a glacial till deposit of predominantly clayey silt, with a trace of sand and occasional gravel.

Red shale bedrock was found below the glacial till at depths ranging from 23 to 28 feet.

Detailed descriptions of the various soil and rock types encountered in each borehole are given on the Record of Borehole Sheets. Due to the variable strata sequences encountered, the Record of Borehole Sheets and the profile and cross-sections presented in Drawing No. 1597503-A should be consulted for detailed stratigraphic information.

A detailed description of the subsoil types is given in the following paragraphs.

Silt, Trace of Sand and Clay

This deposit is 6 to 10 feet thick extending from below a very thin topsoil layer (less than 6 inches). The material consists of silt with a trace of sand and a trace to some clay. Typical grain size distribution curves of the material in this deposit are shown in Fig. 1. Standard Penetration Test 'N' values ranging from 31 to 98 indicate a relative density of dense to very dense in this layer. The permeability of this material as estimated from the grain size distribution curves is approximately 10^{-8} to 10^{-7} m/sec.

Sand With Some Silt

This material underlies the silt layer and extends to depths below ground surface between 11 and 20 feet (elevation 549 and 540). Its composition varies

from sand with some silt to sandy silt in some locations. Typical grain size distribution curves of this material are shown in Fig. 2. The relative density of this material is generally dense to very dense but was found to be compact in one location, at the north end of the west abutment at a depth of 10 feet (elev. 550).

Sand (South End of West Abutment)

At the south end of the west abutment a 5 foot thick sand deposit was found to underly the fine sand layer and extend to bedrock at 25 feet. This material is well graded sand with a trace of silt and gravel. It is in a very dense condition. The permeability of this material is estimated as 10^{-7} to 10^{-6} m/sec.

This deposit is thought to have originated as a valley which was cut into glacial till and subsequently filled with fluvial sand.

Glacial Till

In all other locations the fine sand deposit is underlain by glacial till of predominantly clayey silt, with a trace of sand and occasional gravel. This deposit has a thickness of up to 15 feet and is underlain by bedrock at elevation 532 to 537. The consistency of this till is hard and its plasticity is in the low range.

The engineering properties of the cohesive glacial till as determined by laboratory testing are summarized below:

<u>Identity Tests</u>	<u>Range (%)</u>	<u>Average (%)</u>
Liquid Limit (W_L)	27-30	28
Plastic Limit (W_p)	14-16	15
Natural Moisture Content (W)	14-19	17
Plasticity Index (I_L)	12-15	13

Typical grain size distribution curves for this material are shown in Fig. 3.

Shale Bedrock

Red Queenston shale bedrock with occasional thin limestone layers and gray shale pockets was found at depths between 23 and 28 feet (elev. 532 to 537). The surface of the bedrock is relatively flat. Its upper 1 to 3 feet is weathered.

The shale is quite soft and has a low compressive strength as observed during field examinations; therefore, although high RQD values were recorded, the quality of the bedrock is assessed as poor to medium.

Groundwater Conditions

The groundwater table at the time of the fieldwork was found to be at elevation 556.5, about $4\frac{1}{2}$ feet below the Hwy. 5 road surface. Water was also observed lying in ground surface depressions and ponds throughout the area. Since the site was at the top of a gentle hill, these observations indicate relatively poor downward drainage, resulting in perched water conditions at the ground surface.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct an underpass and interchange at this site connecting Hwy. 5 and Hwy. 403. The interchange will include a two span, 200 foot structure carrying Hwy. 5 over Hwy. 403. To achieve the proposed profile grade and required clearance, Hwy. 403 will be in a cut approximately 15 feet deep. Our recommendations pertaining to the design and construction of the structure foundations are given in the following paragraphs.

Pier Foundation

The pier for the proposed structure may be supported on spread footings founded in the fine sand layer at or below elevation 549. A bearing capacity of 2 tsf may be assumed for design of the pier footings.

For frost protection purposes, a minimum 4 feet of earth cover or equivalent insulation must be provided to the underside of the footing.

Due to the high groundwater table and the relatively pervious sand layer, a temporary dewatering scheme will be necessary during excavation and construction of the pier footing. The groundwater table should be lowered to at least 1 foot below founding elevation during this time.

To prevent disturbance of the founding surface, a working slab of lean concrete should be placed immediately after excavation and inspection of the surface.

Abutment Foundations

The abutments may be supported on spread footings or on piles.

Spread footings: Spread footings should be founded in the silt deposit at or below elevation 558. Alternatively, if a perched abutment is desired, the footings can be founded on a compacted granular pad placed on the silt deposit at or below elevation 558 as shown in Fig. 4. At the footing locations, the sub-base of the existing Hwy. 5 and all loose material should be completely removed prior to construction of the footings. It may be necessary to bring the ground surface back up to the founding elevation with mass concrete or compacted granular material.

For either footing scheme a bearing capacity of 2 tsf may be assumed for design and a minimum 4 feet of earth cover or equivalent insulation should be provided to the base of the footings for frost protection purposes.

If the footing is placed directly on the silt deposit, a working slab of lean concrete should be placed immediately after excavation and inspection to prevent disturbance of the founding surface.

The groundwater table should be kept at least 1 foot below founding elevation during excavation and construction of the footings. This should not present a problem as the normal groundwater table is below this elevation. Any seepage or run-off into the excavation can be removed by pumping from sumps.

Piles: Either H piles or tube piles may be used for the abutment foundation. They should be designed as end-bearing piles and for the maximum structural capacity of the sections chosen. Pile driving should be controlled by Hiley formula.

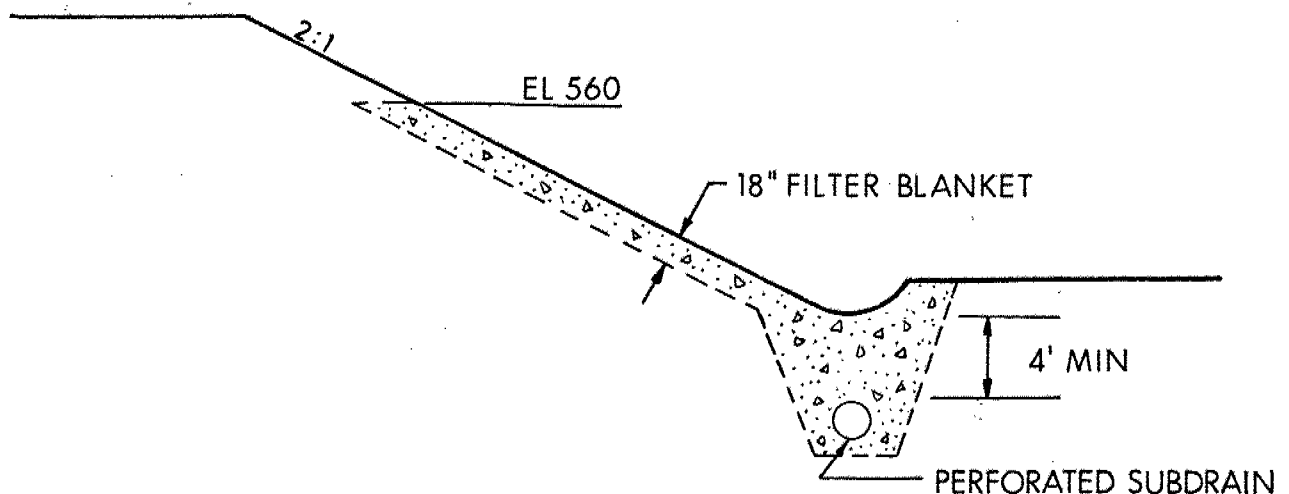
The estimated tip elevations at which the piles would achieve the design capacity are tabulated below:

	<u>H Pile</u>	<u>Tube Pile</u>
West Abutment - North End	535	538
West Abutment - South End	538	548
East Abutment - North End	540	545
East Abutment - South End	542	545

Embankments

No stability problems are anticipated for the proposed cuts for Hwy. 403 if 2:1 slopes are used.

Due to the high groundwater table, seepage will occur through the silt layer and, if not intercepted, will result in erosion and sloughing of the slope surfaces. In order to prevent this damage, a filter blanket at least 18 inches thick should be placed where water bearing material may intersect the slope within 100 feet of the structure. This filter blanket should drain to a perforated subdrain, installed at least 4 feet below ground surface, which in turn should drain to a stream or storm sewer system. A typical section incorporating a filter blanket is shown below.



MISCELLANEOUS

The fieldwork was carried out under the supervision of Mr. J. White. The equipment was owned and operated by Master Drilling Company Ltd.

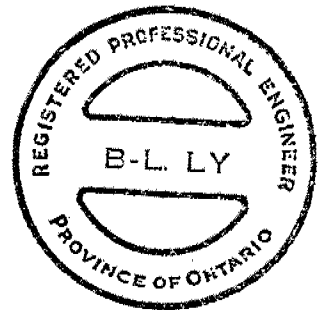
This report was prepared by Mr. J. White and reviewed by Mr. B. Ly.

James R White

J. White
Student Technician (Field)

B. Ly

B. Ly, P. Eng.
Senior Engineer




BL/JW/gs
August, 1977

APPENDIX

RECORD OF BOREHOLE No 11

W P 159-75-03 LOCATION Co-ords N 15,810,069: E 948,600 ORIGINATED BY J.R.W.
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.R.W.
 DATUM Geodetic DATE July 19, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
560.0	Ground Level																
0.0	Silt trace of sand and clay Dense		1	SS	35		550							o			0 5 84 11
554.0																	
6.0	Fine sand with silt Compact		2	SS	17												
549.4																	
10.6	Silt some clay traces of sand		3	SS	72									o			39 28 26 7
546.0																	
14.0	Glacial Till Het. mixture of clayey silt, some sand occasional gravel		4	SS	53		540										0 5 66 29
			5	SS	38												
			6	SS	88												
	Hard		7	SS	110												
533.5			8	SS	131												
531.8	Shale Bedrock																
28.1	End of Borehole																



+³, x⁵: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 12

W P 159-75-03 LOCATION Co-ords N 15,810,147: E 948,662 ORIGINATED BY J.R.W.
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger- BXL Rock Core COMPILED BY J.R.W.
 DATUM Geodetic DATE July 18, 1977 CHECKED BY J.R.W.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
						WATER CONTENT (%)									
						W _p W W _L									
559.1	Ground Level										10 20 30				
0.0	Silt trace of sand and clay Dense		1	SS	31		550								
554.1			2	SS	52										
5.0	Fine sand with silt Very Dense		3	SS	60										0 59 (41)
548.1			4	SS	69										
11.0	Silt with sand Very Dense		5	SS	106/6"										0 35 (65)
544.1			6	SS	70/6"										
15.0	Glacial Till Hard		7	SS	64/6"		540								
	Het. mixture of clayey silt, some sand occasional gravel														
535.1			8	SS	98/6"										
24.0	Bedrock red soft shale some limestone layers		10	RC	-										
529.5	and grey shale pockets		12	RC	95%		530							RQD 87%	
29.6	End of Borehole														

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 13

W P 159-75-03 LOCATION Co-ords N 15,810,217; E 948,715 ORIGINATED BY J.R.W.
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.R.W.
 DATUM Geodetic DATE July 19, 1977 CHECKED BY RC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
560.1	Ground Level						560										GR SA SI CL
0.0																	
552.6	Silt traces of sand and clay Dense		1	SS	89									0			0 4 85 11
7.5	Sand traces of silt Very Dense		2	SS	65		550										
546.6																	
13.5	Glacial Till Hard		3	SS	140												
	Het. mixture of clayey silt, some sand occasional gravel		4	SS	78/6		540										
537.1			5	SS	145												
535.6	Shale Bedrock		6	SS	182												
24.5	End of Borehole																
	Note: Water level not established																

+³, x⁵: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 14

W P 159-75-03 LOCATION Co-ords N 15,810.017: E 948.664 ORIGINATED BY J.R.W.DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger -BXL Rock Core COMPILED BY J.R.W.DATUM Geodetic DATE July 18, 1977 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH									
559.8	Ground Level																GR SA SI CL
0.0	Silt trace of sand Very Dense		1	SS	84												0 12 (88)
550.8			2	SS	98												
9.0	Sand with silt Very Dense		3	SS	92												
544.3																	
15.5	Silt trace of sand Very Dense		4	SS	97												
540.3			5	SS	-												7 76 (17)
19.5	Sand trace of silt and gravel Very Dense		6	SS	99												17 64 (19)
535.3																	
24.5	Weathered Shale with limestone chips		7	SS	98/51												7 27 48 18
26.8	Shale bedrock with limestone layers		8	SS	107/76												
529.2			9	RC	100%												RQD 98%
30.6	End of Borehole																

+³, x⁵: Numbers refer to
Sensitivity20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 15

W P 159-75-03 LOCATION Co-ord N 15,810,097 E 948,726 ORIGINATED BY J.R.W.
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.R.W.
 DATUM Geodetic DATE July 19, 1977 CHECKED BY JRS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL x LAB VANE									
560.1	Ground Level																
0.0	Silt traces of sand and clay Hard																
551.1			1	SS	47												
9.0	Sand some silt occasional gravel and cobbles		2	SS	37		550							5 75 (20)			
544.6	Dense to Very Dense		3	SS	71												
15.5	Glacial Till		4	SS	88									0 8 61 31			
	Het. mixture of clayey silt, some sand occasional gravel		5	SS	186		540										
533.1	Hard		6	SS	187									0 6 74 20			
27.0	Shale Bedrock		7	SS	185/6"												
28.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 16

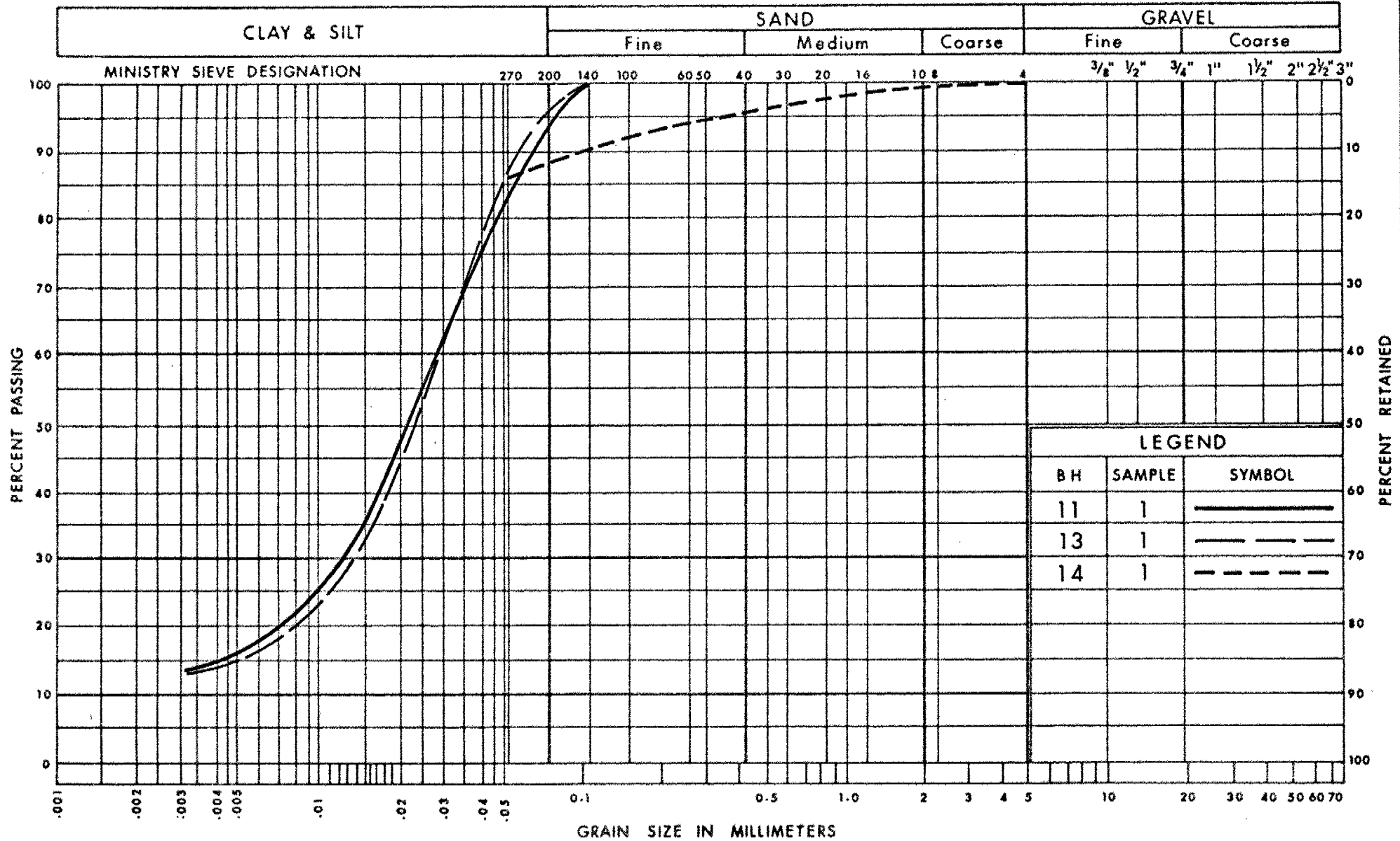
W P 159-75-03 LOCATION Co-ords N 15,810,175: E 948,789 ORIGINATED BY J.R.W.
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.R.W.
 DATUM Geodetic DATE July 20, 1977 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
559.7	Ground Level																GR SA SI CL
0.0	Silt trace of sand occasional cobbles																
550.7							550										0 74 (26)
9.0	Fine Sand some silt Very Dense		1	SS	142												
546.7																	
13.0	Silt some clay and sand		2	SS	111												
544.2																	
15.5	Glacial Till Het. mixture of clayey silt, some sand occasional gravel		3	SS	115		540										1 12 60 27
535.2	Hard		4	SS	123												
24.5	Weathered Shale		5	SS	103												1 31 50 18
531.7	Shale Bedrock		6	SS	13976"												
28.0	End of Borehole																
	Note: Water level not established																

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



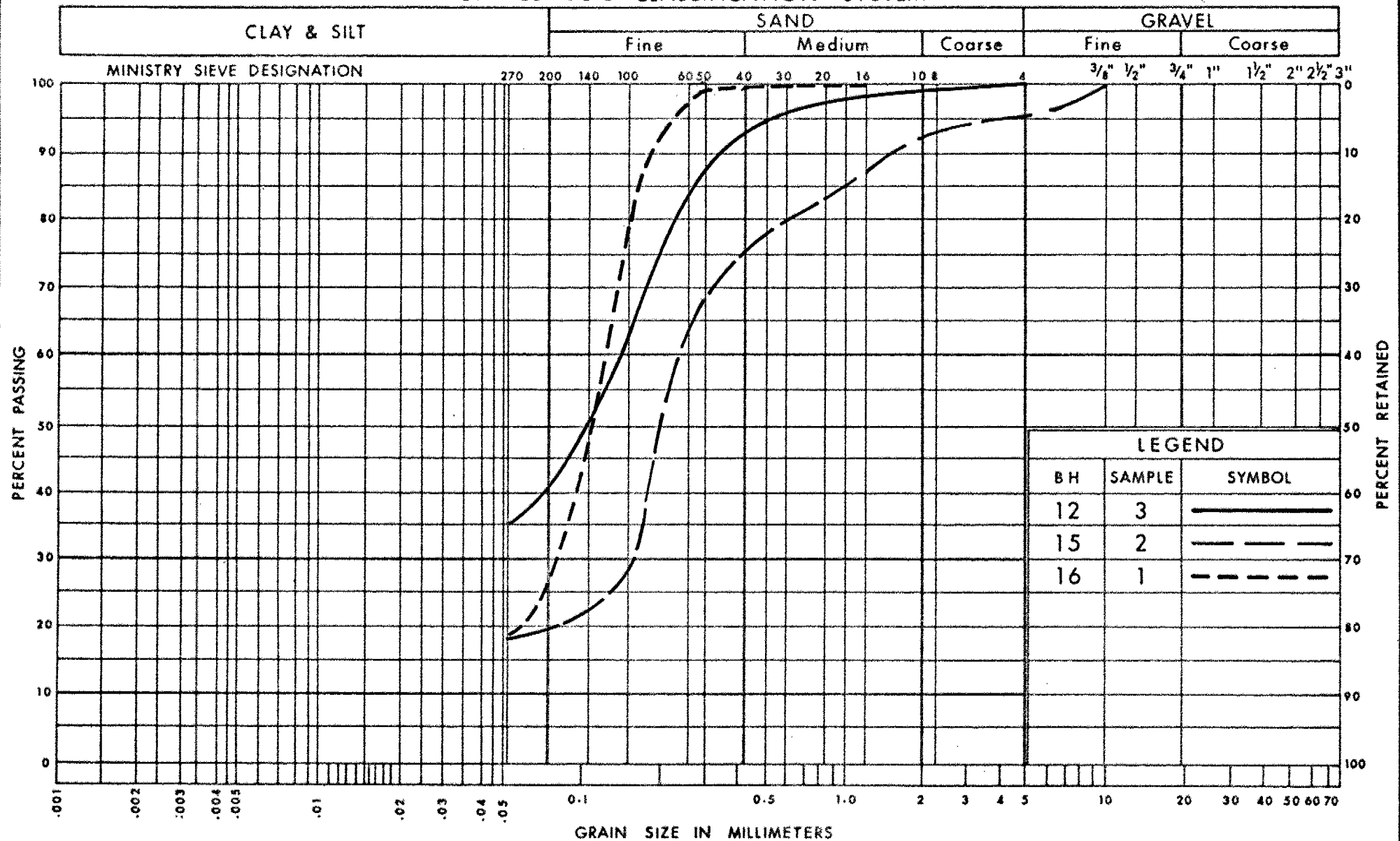
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILT
TRACE OF SAND & CLAY

FIG No 1

WP 159-75-03

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
SAND
SOME SILT

FIG No 2

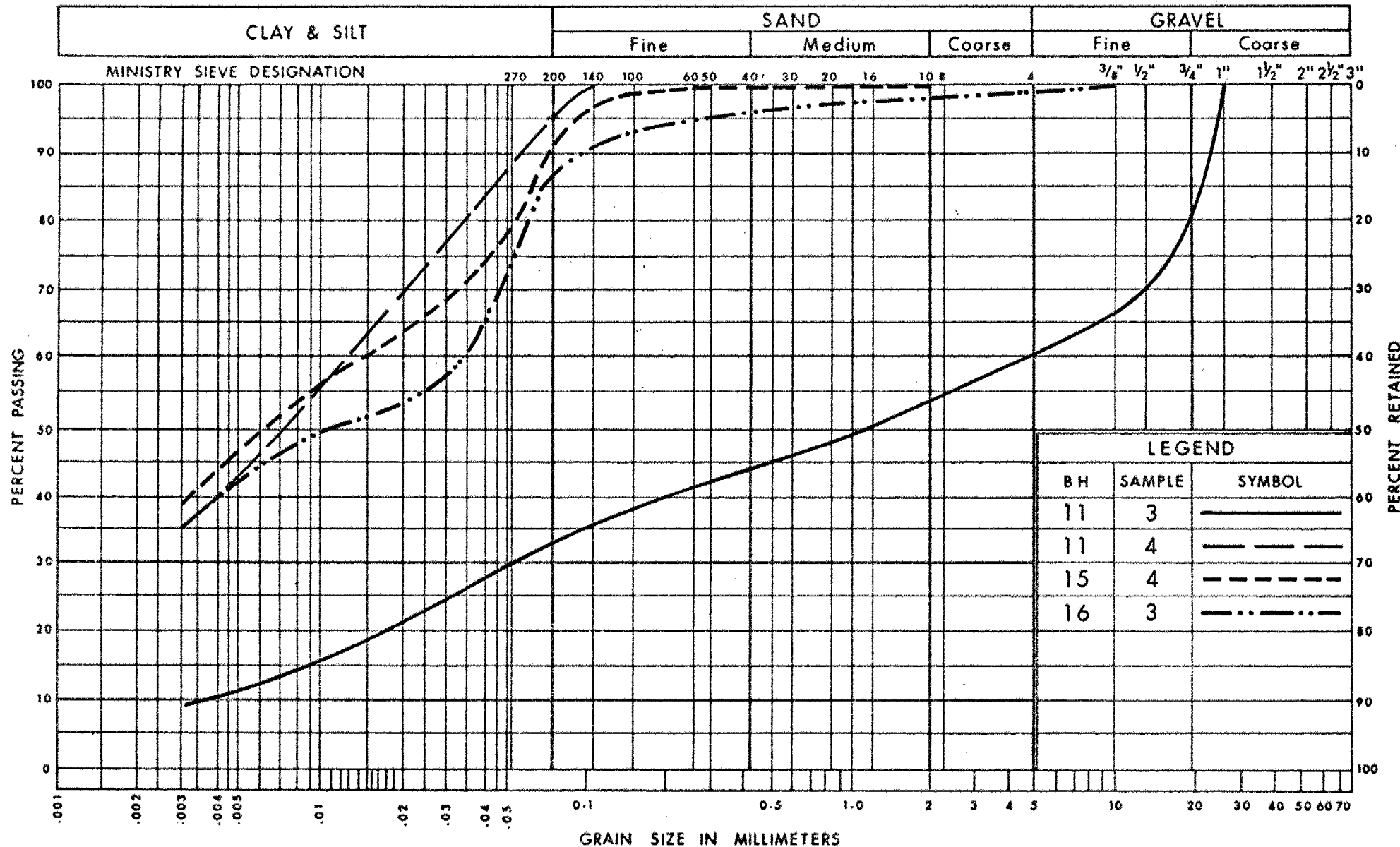
W P 159 - 75 - 03



Ontario

Ministry of
Transportation and
Communications

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION GLACIAL TILL

HET MIX OF CLAYEY SILT, SOME SAND, OCC GRAVEL

FIG No 3

W P 159-75-03

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $C\bar{U}$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_q', N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

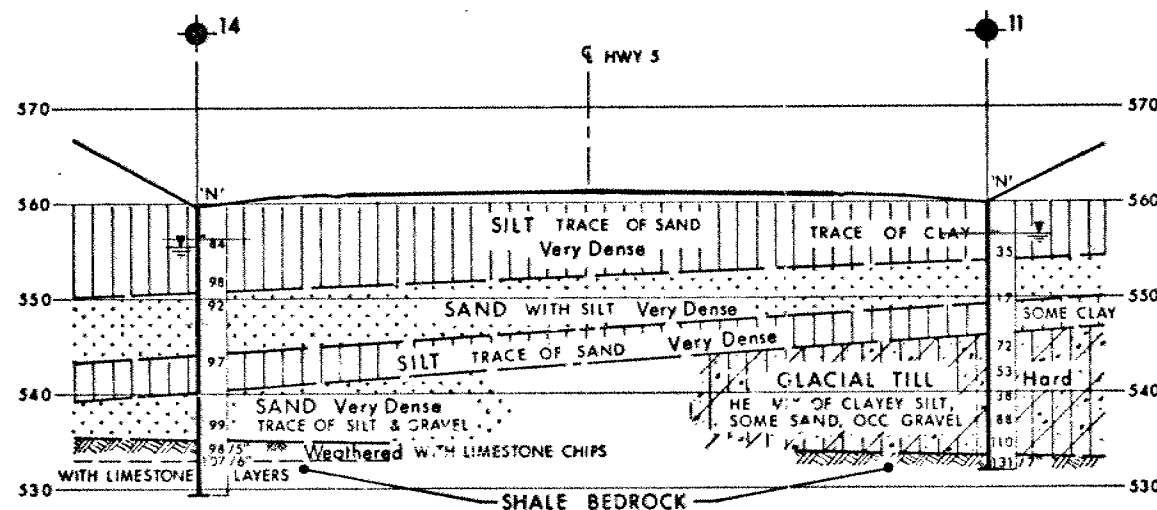
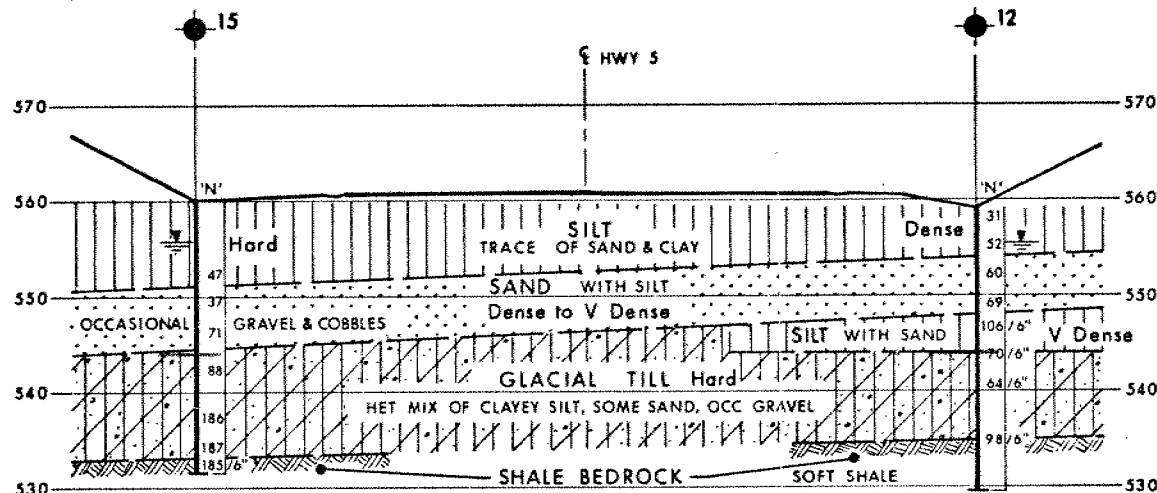
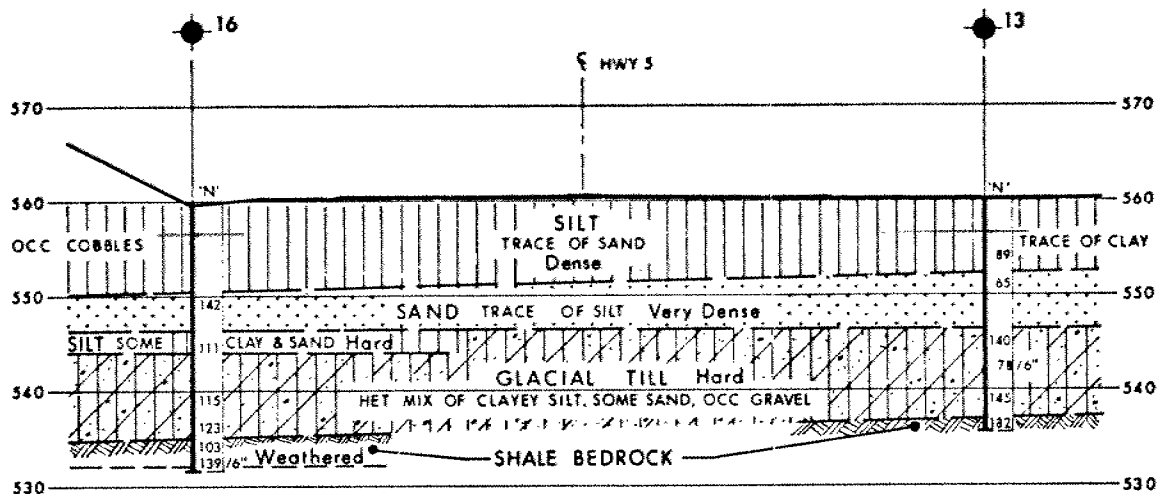
STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

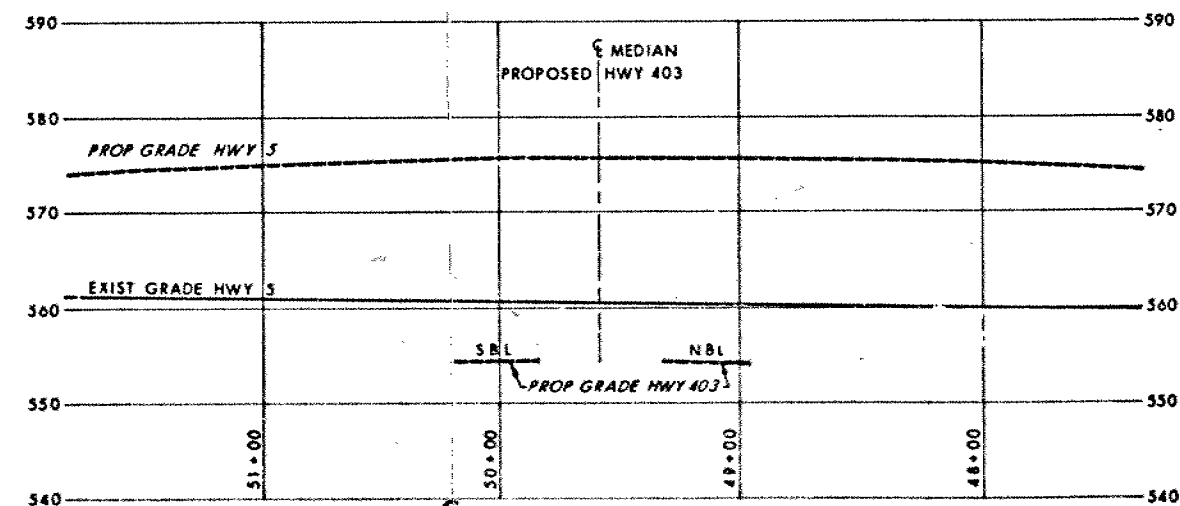
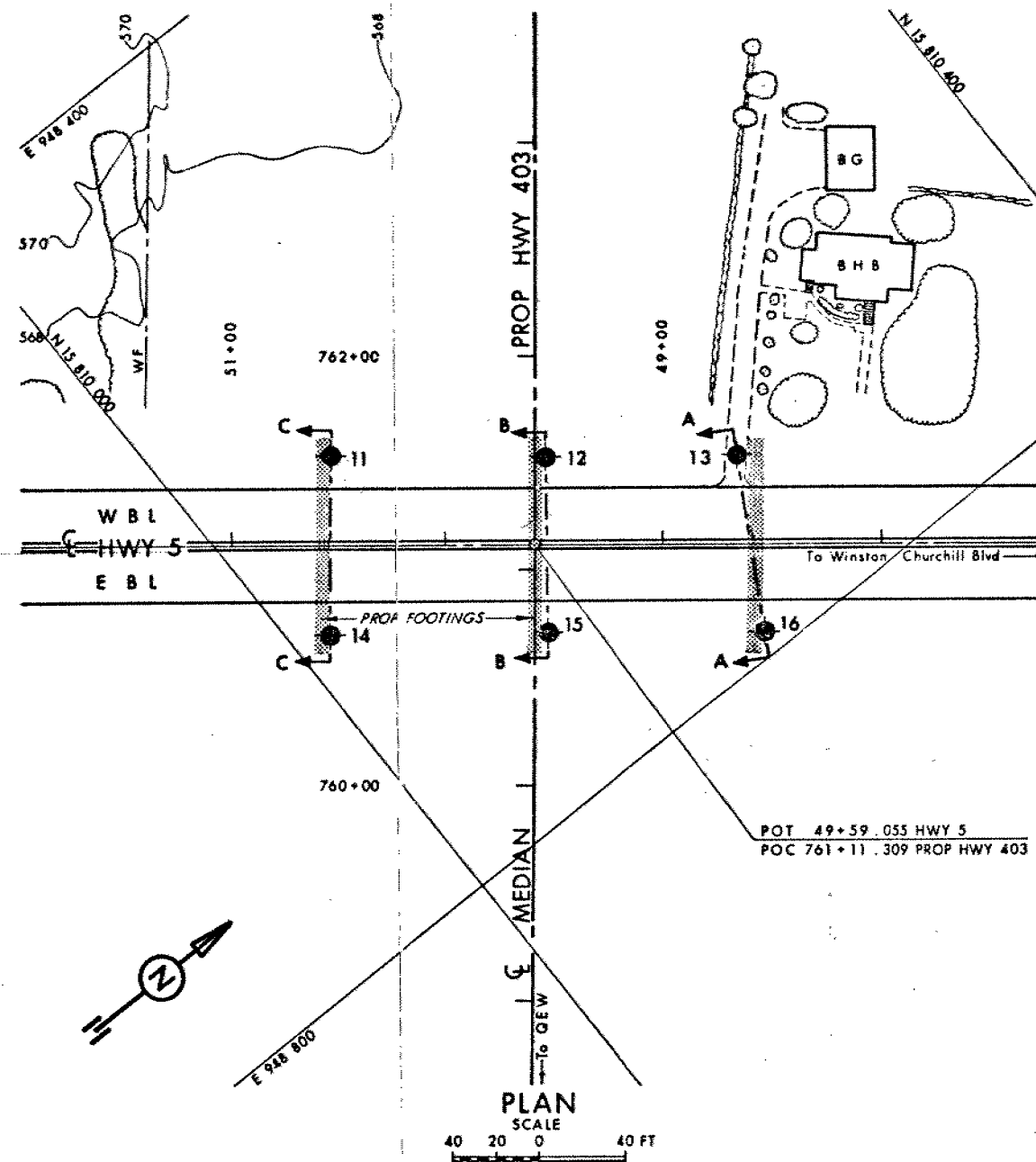
h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS



SECTIONS

SCALE
10 5 0 10 FT



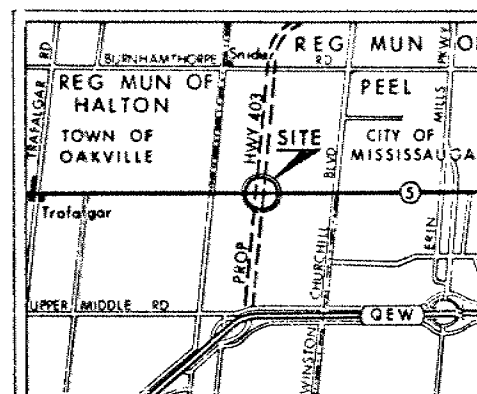
CONT No
WP No 159-75-03

HWY 5 UNDERPASS

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- ↓ WL at time of investigation July 1977
- WL for Bore Holes 13 & 16 not established

No	ELEVATION	CO ORDINATES NORTH	EAST
11	560.0	15 810 069	948 600
12	559.1	15 810 147	948 662
13	560.1	15 810 217	948 715
14	559.8	15 810 017	948 664
15	560.1	15 810 097	948 726
16	559.7	15 810 175	948 789

-NOTE-

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

REVISIONS	DATE	BY	DESCRIPTION

HWY 403 PROPOSED HWY 403
 SLOPE 1:1.5
 DATE Aug 25, 1977
 DRAWN R.S. CHECKED R.S.
 REF: De laun Cather, DWG 911-703 June 1977

Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

78 09 28

Mr. W. Lin

Re: Hwy. 403 Underpass at Hwy. 5
W.P. 159-75-03, Site 10-281
Hwy. 403, District 4, Hamilton

We have reviewed the final bridge drawings. Our comments are as follows.

1. Since excavation for the pier footings will be carried out below groundwater in granular soil, a dewatering scheme will be required to prevent 'boiling' of the base of the excavation. If sheeting is used, it should be extended at least 1 1/2 feet into the cohesive glacial till stratum.
2. The abutment footings can be constructed by carrying out oversized excavation and pumping from sumps.
3. The 3" mass concrete should be poured immediately after completion of the footing excavation.

B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs

cc: G.C.E. Burkhardt
D. MacDonald
Files ✓

Mr. W. L. Lin
Design Engineer
Central Section
Structural Office , West Building

Soil Mechanics Section
Engineering Materials Office
3rd Floor, Central Building

Mr. R.E. Haynes

78 04 26

Re: Hwy. 403 Underpass at Hwy. 5
W.P. 159-75-03, Site 10-281
District 4, Hamilton

Further to your memorandum of 78 04 21, we have reviewed your newly proposed footing formation levels in relation to our subsurface data and recommend the following for your design purposes:

<u>Footing Location</u>	<u>Elev.</u>	<u>Allowable Pressure</u>	<u>Lateral Resistance</u>
East Abutment	557	2.5 tsf	coef.of friction=0.55
Centre Pier	544	4.0 tsf	Adhesion = 2 tsf
West Abutment	557	2.5 tsf	coef. of friction=0.55

B. Ly

B. Ly
Senior Engineer

BL/ig

cc: Files ✓



Memorandum

To: Mr. C. Mirza,
Head, Soil Mechanics Section,
Central Bldg., Third Floor,

From: Structural Office,
2nd Floor, West Building,
Downsview.

Attention: Mr. B. Ly

Date: 78 04 21

Our File Ref.

In Reply to

Subject: Hwy. 403 Underpass at Hwy. 5
W.P. 159-75-03, Site 10-281
District 4, Hamilton

The proposed bottom of footing elevations for the above structure are given below:

	<u>Station</u>	<u>Elev.</u>
East Abutment	48 + 59.055	557
Pier	49 + 59.055	544
West Abutment	50 + 59.055	557

With this new information, would you please confirm whether the bearing capacity recommended in the foundation report may be increased. In addition, would you please recommend a design value for the co-efficient of friction between the soil and underside of footing.

R.E. Haynes

R. E. Haynes,
Structural Project Engineer.

REH/mh

c.c. W. Lin
G.C.E. Burkhardt

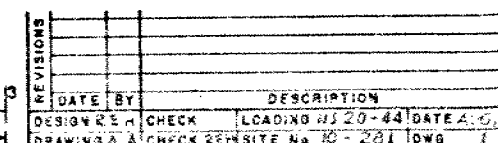


G.I.-30 SEPT. 1976

GEOCRES No. 30M12-127DIST. 4 REGION W.P. No. 159-75-03CONT. No. 79-31W. O. No. STR. SITE No. 10-281HWY. No. 403LOCATION Hwy 5 underpassNo. of PAGES -

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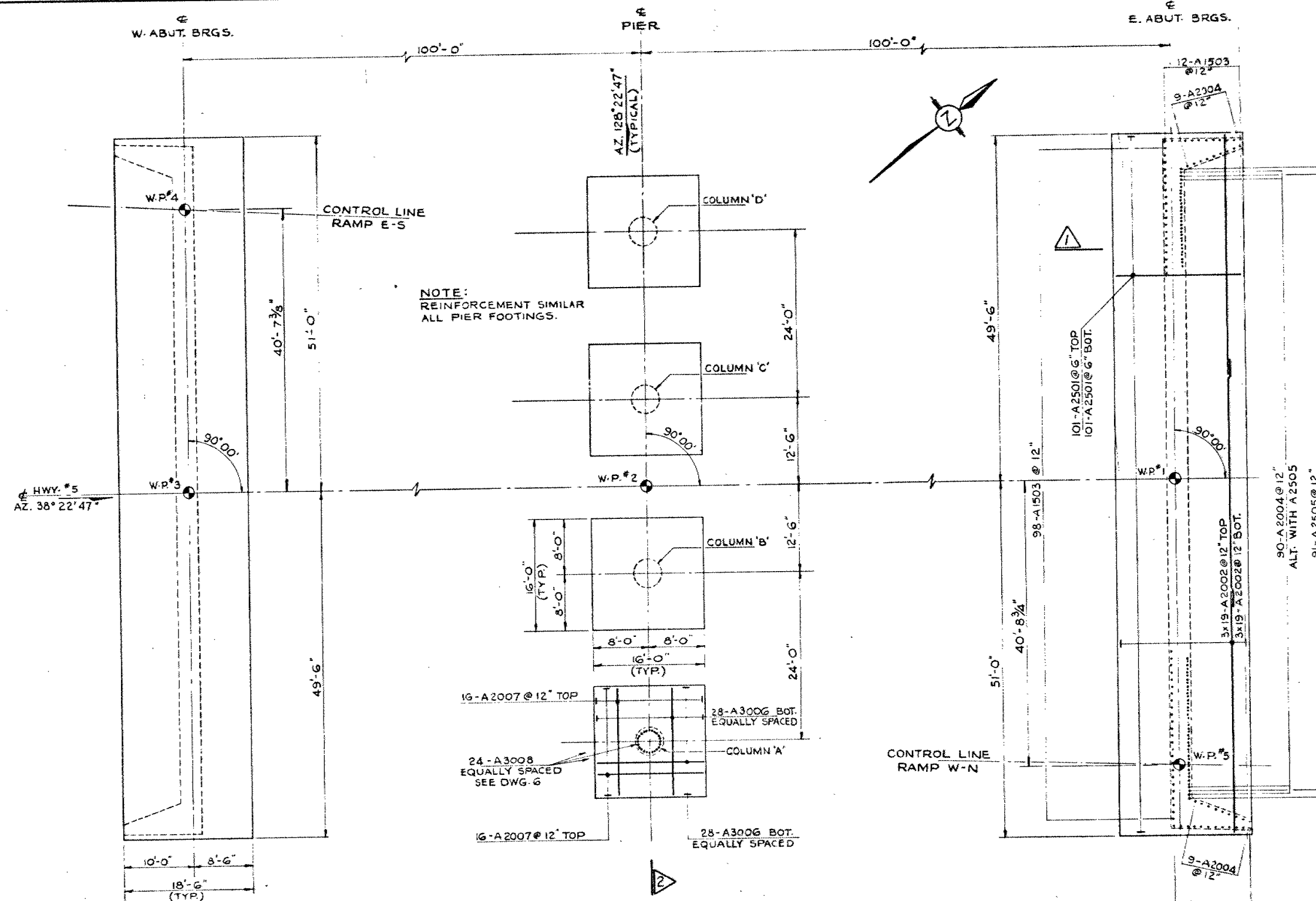
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



CONT No
WP No 153-75-03

HWY. 403 UPASS AT HWY. 5
(Approx. 0.3 Mi. East of Ninth Line Rd.)
FOOTING DETAILS

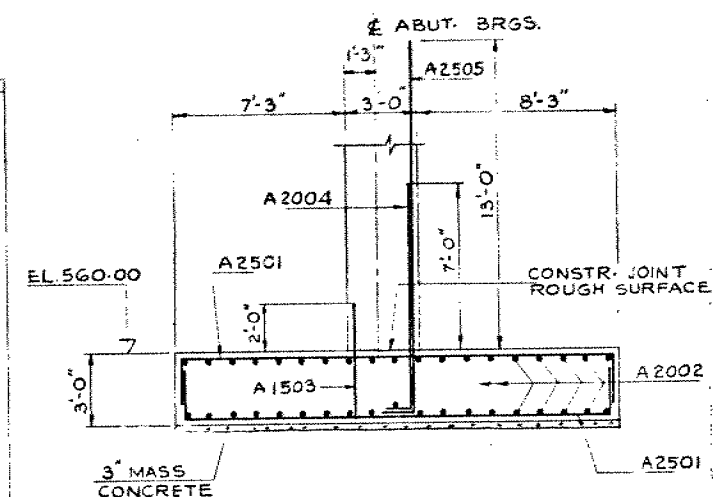
SHEET



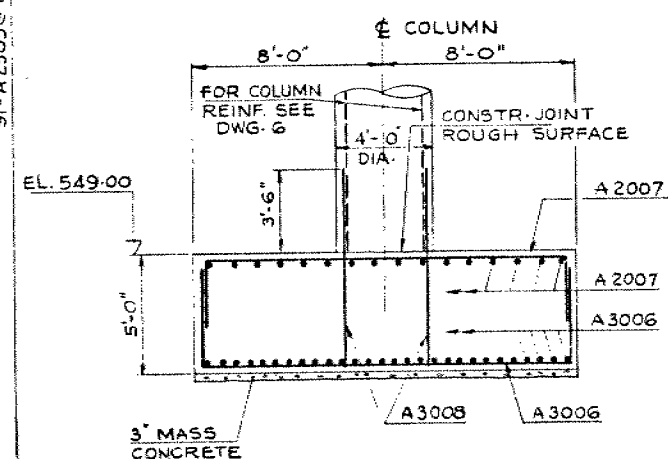
PLAN
1/8" = 1'-0"

CO-ORDINATES				
POINT	STATION	NORTH	EAST	
W.P. 1	48+59.06	810.96.03	948755.23	
W.P. 2	49+59.06	810117.64	948693.15	
W.P. 3	50+59.06	810039.25	948631.06	
W.P. 4	612+96.88	810064.46	948599.22	
W.P. 5	512+99.49	810170.74	948787.16	
COLUMN A	49+59.06	810094.98	948721.76	
COLUMN B	49+59.06	810109.88	948702.34	
COLUMN C	49+59.06	810125.40	948683.35	
COLUMN D	49+59.06	810140.30	948664.53	

NOTE:
REINFORCEMENT SIMILAR
BOTH ABUTMENT FOOTINGS.



1/4" = 1'-0"



2/4" = 1'-0"

NOTE:
MASS CONCRETE TO BE PLACED WITHIN 24 HOURS
AFTER FOOTING EXCAVATION IS COMPLETED.



FOR REDUCED PLAN



REVISION	DATE	BY	DESCRIPTION
DESIGN	LEH	CHECK	LOADING HS 30-40 DATE AUG
DRAWING	3	CHECK	REH SITE No 10-231 DWG 3



Photo 1: Looking west at Site 10-140C, QEW/Highway 403 Exit Ramp to Ford Drive over Joshua Creek.



Photo 2: Looking west at Site 10-161, Trafalgar Road over Highway 403.



Photo 3: Looking south/west at Site 10-162, Royal Windsor Drive over QEW.



Photo 4: Looking east towards Site 24-375, QEW under Winston Churchill Blvd.



Photo 5: Looking north/west at Site 10-282A&B, E-N/S Ramp QEW and Upper Middle Road over W-N Ramp Highway 403.



Photo 6: Looking towards the south abutment at Site 10-283, N-W Ramp Highway 403 over E-N/S Ramp QEW and Upper Middle Road.



Photo 7: Looking north at Site 10-284, QEW over W-N Ramp Highway 403.



Photo 8: Looking south over approximate area of east abutments for Highway 403 N – QEW E Ramp and QEW E – Highway 403 N Ramp



Photo 9: Looking north over area of north abutments of Highway 403 N – QEW E Ramp and QEW E – Highway 403 N Ramp



Photo 10: Looking east at QEW over Ford Drive; Ford Drive S – QEW W Ramp structure site is closer to the camera.



Photo 11: Looking west along Ford Drive at Sites 10-287/10-286/10-285, Highway 403 W-N Ramp/
Ford Drive S - QEW W Ramp over Ford Drive in foreground



Photo 12: Looking north/east from under Site 10-325, E-S Ramp Highway 403 over 2 Highway 403/407
Connections.



Photo 13: Looking south/west towards Site 10-326, Hwy 407 to Hwy 403 over Hwy 403 to Hwy 407.



Photo 14: Looking south/west towards Site 10-327, Ninth Line over Highway 403 to Highway 407.



Photo 15: Ninth Line over 407 W – Highway 403 S Ramp



Photo 16: Looking east at Site 24-384, Highway 403 Underpass at Winston Churchill Blvd.



Photo 17: Looking west past Highway 403 S - Dundas E/W Ramp terminal towards service road over Dundas Street Structure



Photo 18: Looking south/east at Site 10-280, Highway 403 under Burnhamthorpe Road.



Photo 19: Looking north/east at Site 10-281, Highway 403 under Dundas Street West. Looking towards the east abutment.