

GEOCRES No:

31B-73

FOUNDATION INVESTIGATION

**W.P. 177-89-02, SITE 16-308
RAMP 416 SB CONNECTION
OVER RAMPS W-N & N-W
HWY. 401-416 INTERCHANGE
DISTRICT 9, OTTAWA
GEOCRES # 31B-73
MINISTRY OF TRANSPORTATION OF ONTARIO**

**SUBMITTED TO
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Report

on

Foundation Investigation

for

W.P. 177-89-02, Site 16-308
Ramp 416 SB Connection
Over Ramps W-N & N-W
Hwy. 401-416 Interchange
District 9, Ottawa

Jacques, Whitford Limited

April, 1992

Project No. 10204

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Appendix 1

Explanation of Terms Used in Report

Record of Boreholes

Figure 1 - 3: Grain Size Distribution

Figure 4 - 5: Plasticity Chart

Figure 6 : Cut Slope Protection

Appendix 2

Drawing No. 1778902-A - Bore Hole Locations & Soil Strata

FOUNDATION INVESTIGATION REPORT

for

**WP 177-89-02 Site 16-308
Ramp 416 SB Connection
Over Ramps W-N & N-W
Hwy. 401-416 Interchange
District 9, Ottawa**

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out at the above noted site in the Township of Edwardsburg, Ontario. The investigation was carried out in accordance with our proposals dated December 11, 1990 and February 20, 1992. Authorization to carry out the work was provided by the Delcan Corporation.

This report contains factual information together with discussion and recommendations pertaining to the subsurface conditions.

2.0 SITE DESCRIPTION AND GEOLOGY

The site is located about 200 metres west of the existing Highway 16 about 1.5 kilometres north of the existing intersection of Highways 16 and 401. The topography of the proposed site is generally flat, except in the area immediately north of the proposed north abutment where the existing ground surface slopes downward from south to north at about 6% grade. The site is densely treed.

Physiographically, the site lies in the area known as the Glengarry Till Plain. The surface consists of morainic ridges and drumlins together with intervening clay flats and swamps. Bedrock underlying the overburden consists of Ordovician dolostone of the Oxford Formation. Overburden thickness in the area is in the order of 15 m.

3.0 PROCEDURE

3.1 Field Investigation

Prior to the onset of the drilling investigation, the necessary utility check clearances were obtained by our site personnel.

The field work for this investigation was carried out between April 17 and 29, 1991 and on March 30, 1992. A total of 11 boreholes, (numbered 91-1 to 91-8, and 92-1 to 92-3) were put down at the site. Boreholes 91-1 and 91-8 were put down at the approach fill locations. Boreholes 91-2 to 91-7 inclusive were put down at the initially proposed founding locations. Boreholes 92-1 to 92-3 inclusive were put down near revised founding locations. The borehole locations are indicated on Drawing No. 1778902-A provided in Appendix 2.

All boreholes were put down using a track-mounted power auger drill suitably equipped for soil and bedrock sampling. Due to the high cobble and boulder content of the overburden, hollow stem augers, N-sized casing and rock coring techniques were employed during the course of the investigation to advance the boreholes within the overburden.

The boreholes were put down to depths ranging from 2.3 m to 18.4 m. Borehole 91-4 was terminated after coring in NX-size 2.4 m into bedrock. The remaining boreholes were terminated at depths of 2.3 m to 12.0 m.

The overburden soils encountered were sampled by means of a split tube sampler during the performance of Standard Penetration Tests (SPT) (ASTM D1586). Sampling was intended to be conducted on a near continuous basis (intervals of 0.76 m). Due to the high cobble and boulder content in the overburden below depths ranging from 2.5 m to 6 m, the SPT conducted yielded limited penetration of typically less than 150 mm. Sampling below these depths was therefore restricted.

All soil samples recovered were stored in moisture-proof bags and were returned to our Ottawa laboratory for detailed classification and testing.

Standpipe piezometers 25 mm in diameter were installed in Boreholes 91-1 to 91-5, 91-7, 91-8, 92-1 to 92-3 between depths of 2.3 m and 10.3 m. Monitoring wells 58 mm in diameter were installed in Boreholes 91-4 and 91-6 between depths of 11.4 m and 18.4 m. The monitor well in Borehole 91-4 was installed and sealed within the bedrock to monitor its water level.

The piezometers and the monitoring wells installed in the 1991 investigation were backfilled with sand within the perforated lengths. A bentonite seal was then placed in the boreholes prior to backfilling with soil cuttings to near the ground surface. A bentonite surface seal was then provided and the ground surface was mounded to prevent water infiltration. Groundwater samples were collected from the monitor wells and were subjected to chemical testing. The piezometers installed in the 1992 investigation were backfilled with native materials.

3.2 Survey

The borehole locations and ground surface elevations of Boreholes 91-1 to 91-8 were surveyed by Delcan Corporation personnel after completion of the field work. Boreholes 92-1 to 92-3 were surveyed by Jacques Whitford personnel using boreholes put down in the previous investigation and survey monuments as benchmarks. The elevations are referenced to Geodetic datum. The borehole coordinates and elevation data is summarized on Drawing 1778902-A in Appendix 2.

3.3 Laboratory Testing

To identify the properties of the soil samples collected during the field investigation, the following laboratory tests were carried out:

- Detailed visual classification,
- Natural moisture content,
- Sieve and hydrometer analyses,
- Atterberg Limits determination.

Samples remaining after testing will be stored in our laboratory for a period of six months after issuance of the final report. They will then be discarded unless we are directed otherwise.

4.0 RESULTS OF THE INVESTIGATION

4.1 Subsurface Conditions

The subsurface conditions observed in the boreholes are presented in detail on the Record of Boreholes provided in Appendix 1. An Explanation of Terms used in Report is also provided in Appendix 1. The laboratory test results are summarized in the Record of Boreholes and also on Figures 1 to 4 in Appendix 1.

The ground surface elevations at the borehole locations varied from El. 93.4 m to El. 98.4 m at the time of the investigation. The subsurface soils at the boreholes consist of topsoil overlying sand / sand and gravel / clayey silt, overlying a heterogeneous mixture of sandy silt, some clay and glacial, occasional boulders (glacial till), underlain by dolostone bedrock. The bedrock surface was encountered at El. 82.4 m (a depth of 16.0 m) in Borehole 91-4. The groundwater level within the overburden was observed between El. 92.4 m and El. 98.2 m, and within the bedrock at El. 96.3 m.

A brief discussion of the observed subsurface conditions is provided below. Specific details of the subsurface materials should be obtained from the Record of Boreholes.

4.1.1 Topsoil

A surficial layer of topsoil was encountered in all boreholes. The thickness of the topsoil layer ranges from 100 mm to 300 mm.

4.1.2 Sand

Sand, trace to some silt was encountered underlying the topsoil in Boreholes 91-1, 91-4 to 91-8, 92-1 and 92-3. The thickness of the sand layer where encountered ranges from 0.1 m to 1.6 m.

The SPT conducted in the sand layer yielded N values ranging from 1 to 6, except in Borehole 92-3, indicating a denseness of very loose to loose. In Borehole 92-3, the SPT conducted yielded a N value of 20, indicating a denseness of compact. Based on visual identification the sand is classified as a cohesionless material.

4.1.3 Sand and Gravel

Sand and gravel, some silt was encountered underlying the sand layer in Boreholes 91-1. The thickness of the sand and gravel layer is approximately 3.4 m.

The SPT conducted in the sand and gravel layer yielded N values ranging from 33 to 52, indicating a denseness of compact to very dense. Laboratory sieve analysis of a representative sample indicated a grain size distribution of 49% gravel, 40% sand and 11% silt and clay size particles (Figure 1 in Appendix 1). Based on visual identification and laboratory tests, the sand and gravel material is classified as cohesionless.

4.1.4 Clayey Silt

Clayey silt was encountered underlying the sand and gravel in Boreholes 91-1, and underlying the topsoil in Boreholes 91-2, 91-3 and 92-2. The thickness of the clayey silt when encountered ranges from 0.2 m to 1.6 m.

The clayey silt has a consistency of soft to firm. Laboratory tests of a representative sample indicated a grain size distribution of 0% sand and gravel, 75% silt and 25% clay size particles (Figure 2 in Appendix 1), and a moisture content of 35%. Atterberg Limits determination yielded a liquid limit of 35% and a plasticity index of 13% (Figure 4 in Appendix 1). Based on visual identification and laboratory tests, the clayey silt can be classified as a cohesive material of low to intermediate plasticity.

4.1.5 Heterogeneous Mixture of Sandy Silt, some Clay and Gravel, occasional Boulders (Glacial Till)

A heterogeneous mixture of sandy silt, some clay and gravel, occasional boulders (glacial till) was encountered in all boreholes beneath the surficial overburden materials described above. The surface of the glacial till was encountered at elevations ranging from El. 89.3 m to El. 98.2 m (depths of 0.2 m to 4.1 m). In Borehole 91-4 where bedrock was proven by coring, the thickness of the glacial till is 15.8 m.

The SPT conducted in the glacial till layer yielded N values generally from 30 to over 150, indicating a denseness from compact to very dense, and generally in the dense to very dense range. Some high N values are attributed to the presence of cobbles and boulders.

The results of laboratory testing are provided on the Record of Boreholes, on Figures 3 and 5 in Appendix 1, and are summarized below:

Property	Range	# Tests	Average
Moisture Content (%)	6 - 15	41	8
Liquid Limit (%)	15 - 23	4	18
Plastic Limit (%)	11 - 14	4	12
Plasticity Index(%)	3.5 - 8.7	4	5.4
Grain size			
% Gravel	7 - 22	7	15
% Sand	27 - 45	7	38
% Silt and Clay	39 - 55	7	47
% Silt	41 - 46	2	43
% Clay	8 - 9	2	9

The above grain-size distributions represent only the minus 38 mm fraction (split spoon samples) of the glacial till. Cobbles and boulders are also present in this material. If the coarser portion is to be included, the actual percentage of fines would be less than that indicated above. During the investigation, coring techniques were used in order to advance the boreholes through the glacial till upon hollow stem auger refusal. Frequent pieces of boulders (up to 0.6 m in size) were retained in the core barrel. Based on the above tests and visual identification, the glacial till can be classified as inorganic and cohesionless.

4.1.5 Bedrock

Bedrock was encountered and proven by coring in NQ-size in Borehole 91-4. The bedrock surface at this location was encountered at El. 82.4 m (a depth of 16.0 m). The bedrock is a grey, unweathered, limy dolostone with close to moderately close spaced horizontal fractures. The bedrock is of good to excellent quality (RQD ranging from 85% to 96%). Core recoveries varied between 95% and 96%. The average RQD over 2.4 m of rock cored was 91% indicating an overall rock mass quality of excellent.

4.2 Groundwater

Groundwater levels were recorded during drilling and in standpipe piezometers after drilling. The standpipes and monitoring wells in all the boreholes were installed in the overburden, except in Borehole 91-4 where the monitoring well was sealed in the bedrock. The observed groundwater levels are summarized on the Record of Boreholes and on the following table.

GROUNDWATER LEVELS

Borehole	May 10, 1991		March 30, 1992	
	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
91-1	0.4	93.0	0.5	92.9
91-2	0.2	96.5	0.2	96.5
91-3	0.4	97.1	0.3	97.2
91-4				
(Bedrock)	2.1	96.3	2.1	96.3
(Overburden)	0.2	98.2	1.2	97.2
91-5	0.1	97.9	-0.1	98.1
91-6	0.3	98.0	0.4	97.9
91-7	0.0	97.7	-0.2	97.9
91-8	0.0	97.5	0.0	97.5
92-1	-	-	5.6	92.4
92-2	-	-	2.0	94.7
92-3	-	-	-	-

Groundwater levels observed in Boreholes 92-1 to 92-3 may not be representative since they were recorded the same day the piezometers were installed.

Groundwater levels are subject to seasonal fluctuations and can vary from the values given in this report.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Proposed Development

The site is located about 200 metres west of the existing Highway 16 some 1.5 kilometres north of the existing intersection of Highways 16 and 401 in the Township of Edwardsburg, Ontario (refer to the Key Plan provided on Drawing No. 1778902-A in Appendix 2).

The proposed bridge structure is part of the Highway 416 development. The Highway 416 SBL Connection structure is to span Ramp N-W and Ramp W-N, connecting the Hwy 416 SBL to the existing Highway 16. The proposed Highway 416 SBL Connection structure is to consist of the following components:

- Excavation (cut slope) of up to about 6.5 m in depth for the proposed Ramp N-W and Ramp W-N.
- A one-lane five-span fly-over structure spanning Ramp N-W and Ramp W-N.
- The structures will be supported by four (4) piers, and two (2) abutments with associated approach fills.
- The East Abutment footing is proposed to be founded at Elevation 95.0 m \pm .
- The West Abutment footing is proposed to be founded at Elevation 94.0 \pm . The retaining wall extending approximately 15 m from the north side of the abutment is proposed to be founded at Elevation 95.0 \pm .
- The footing for Pier #1 is proposed to be founded at Elevation 88.0 \pm . Piers #2 and #3 is proposed to be founded at Elevation 89.5 \pm . Pier #4 is proposed to be founded at Elevation 87.0 \pm .
- Fill heights at the abutment locations are to range from approximately 2.9 m to 3.0 m. Within 30 m from the structure, maximum fill height (west abutment approach fill) is in the order of 6 m.

An initial field borehole program was carried out in 1991. Since that time, a revision of the layout of the structure has been proposed. As a result, the pier and the abutment locations have been changed.

5.2 Geotechnical Assessment

The profile of the proposed structure dictates that footings of the abutments are to be placed at about 2.5 m to 3 m below existing ground surface. Due to the very dense nature of the glacial till at this site, all structure foundations including the abutments and the piers may be placed on conventional spread footings placed on the native undisturbed glacial till. Spread footings placed on the surficial deposits overlying the glacial till is not recommended.

The cut slope for the proposed underpass will be excavated through the surficial clayey silt and sand, and into the native glacial till. A cut slope of 2 horizontal to 1 vertical would satisfy the overall stability requirement. However measures to prevent surficial instability due to erosion and groundwater seepage will be required.

The approach fills of up to about 6 m in height may be constructed using side slopes of 2H:1V for granular borrow, or side slopes of 2.5H:1V for fine-grained borrow. No embankment stability and settlement problems are anticipated.

This report contains our detailed recommendations in the following areas:

- 1) Structure Foundations
- 2) Abutment Backfill
- 3) Highway 416 Excavation
- 4) Approach Fills
- 5) Construction Considerations

5.3 Structure Foundations

5.3.1 East Abutment

In accordance with the information supplied by Delcan Corporation, the underside of the abutment footing at the East Abutment location is proposed to be placed at about El. 95.0 m. This elevation is about 3 metres below the existing ground surface and at least 2 metres below the top of the glacial till identified at the borehole put down at the proposed East Abutment location (Borehole 92-1).

All footings must have a minimum earth cover of 1.8 m for frost protection. Spread footings placed on the glacial till at El. 95.0 m or below at this location may be designed based on the following bearing pressures:

Factored Bearing Capacity at U.L.S.	600 kPa
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Bearing Capacity at S.L.S. Type II	400 kPa
------------------------------------	---------

The above bearing pressures have been calculated based on a footing width (B) of 3 m. The S.L.S. Type II bearing pressure has been calculated assuming that a total settlement of 25 mm is satisfactory.

Sliding resistance between the concrete footing and the foundation soil should be calculated in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. using an unfactored friction coefficient of 0.53.

To protect the glacial till from being disturbed due to weather, construction activities and seepage, it is recommended that a working slab of lean concrete 150 mm in thickness be placed on the bearing surfaces within four (4) hours after footing excavation.

5.3.2 West Abutment

The West Abutment footing is proposed to be founded at Elevation 94.0 m \pm . Borehole 92-2 which was put down at the proposed West Abutment indicates that the top of the glacial till is at Elevation 95.0 at this location.

The retaining wall extending approximately 15 m from the north side of the abutment is proposed to be founded at Elevation 95.0±. Borehole 92-3 which was put down at the approximate location of the north wing wall indicates that the top of the glacial till at this location is about Elevation 94.5.

It is recommended that all footings for the West Abutment including the north retaining wall be founded on glacial till and not on the surficial overburden deposits overlying the till. Based on the above discussions, it is anticipated that the main footing will be founded on till. However, it is recommended that the north retaining wall footing be designed to be deepened to Elevation 94.5 m or below. The footing bearing surface must be approved by a geotechnical engineer prior to concrete placement.

For footings founded on approved, undisturbed glacial till, the following bearing capacities are recommended:

Factored Bearing Capacity at U.L.S.	600 kPa
-------------------------------------	---------

Bearing Capacity at S.L.S. Type II	400 kPa
------------------------------------	---------

A footing width of 3 m and an allowable settlement of 25 mm have been assumed in the calculation.

Frost cover requirement, sliding resistance, and the requirement of a lean concrete working slab recommended above for the East Abutment are also applicable for the West Abutment.

5.3.3 Piers

As mentioned in Section 5.1, all piers are proposed to be founded at or below Elevation 89.5 m. The boreholes put down at the proposed site indicate that all pier footings will be placed on glacial till. The following bearing capacities are recommended for spread footings placed on approved undisturbed glacial till at El. 89.5 m or below:

Factored Bearing Capacity at U.L.S.	750 kPa
-------------------------------------	---------

Bearing Capacity at S.L.S. Type II	500 kPa
------------------------------------	---------

A footing width of 3 m and an allowable settlement of 25 mm have been assumed in the calculation.

Frost cover requirement, sliding resistance, and the requirement of a lean concrete working slab recommended above for the abutments are also applicable for the piers.

5.4 Abutment Backfill

The abutments should be backfilled with free draining material such as OPSS Granular 'A' or Granular 'B', to prevent hydrostatic pressure buildup.

Computation of earth pressures should be in accordance with Section 6-6.1.2.1 of the O.H.B.D.C. For abutments that are designed to allow rotation, active earth pressure may be used for design. For rigidly tied structures, the at-rest earth pressure should be used for design, unless the stem can deflect enough (approximately 0.05 percent of the wall height) to establish the active pressure. For a horizontal backfill, the following parameters are recommended for design:

	Granular 'A'	Granular 'B'
Bulk unit weight, γ (kN/m ³)	22.8	21.2
Effective friction angle, ϕ'	35°	30°
At Ultimate Limit States		
Coefficient of active earth pressure (K_a)	0.34	0.41
Coefficient of earth pressure at rest (K_o)	0.51	0.58
At Serviceability Limit States		
Coefficient of active earth pressure (K_a)	0.27	0.33
Coefficient of earth pressure at rest (K_o)	0.43	0.50

Compaction of the granular backfill near the walls should be carried out using hand-operated equipment to prevent overstressing the abutment walls. Weep holes should be provided in the abutment walls to drain any accumulated water within the backfill.

5.5 Ramps W-N & N-W Excavation

5.5.1 Slope Angle

The maximum cut depth is in the order of 6.5 metres. The cut slope will be made through the surficial clayey silt and sand, and into the glacial till. Permanent cut side slopes should be no steeper than 2 horizontal to 1 vertical. Recommendations for temporary cut slopes are provided in Section 5.7.2.

5.5.2 Slope Protection

The above recommended slope angles would have an adequate factor of safety against long term overall instability. However measures to protect against surface sloughing due to groundwater seepage, freeze/thaw effects and erosion will be required. At the time of the investigation, the ground water level within the overburden was encountered within 0.5 m from the ground surface. Fluctuations in the groundwater level can be expected. To protect against surficial instability, the following is recommended (Figure 6 in Appendix 1):

- A subdrain should be installed at the toe of the cut slope.
- A granular blanket 600 mm in thickness should be installed on the entire cut slope surface. The granular blanket should consist of OPSS Granular 'A' material.
- A crest ditch should be installed to direct runoff away from the slope.
- Normal slope vegetation should be established in accordance with MTO standards as soon as possible after construction.

Water collected from the drainage system recommended above must be directed to a positive discharge.

5.6 Approach Fills

Within 30 m from the proposed structure, fill placement of up to 6 m is proposed for the approach fills. Forward and side slopes of 2H:1V are recommended for stability purposes fills constructed of granular borrow or select subgrade materials. If fine-grained borrow materials are to be used, toward and side slopes of 2.5H:1V would be appropriate. No stability problems are anticipated both in the longitudinal and transverse directions provided that the fill is constructed with slopes as recommended above.

All organic and deleterious materials should be stripped and removed prior to fill placement within the entire fill area. Based on the approach fill boreholes (Boreholes 91-1 and 91-8), the anticipated depth of stripping is in the order of 100 mm.

The exposed surface should be proof rolled and soft areas removed prior to fill placement. The fills should be placed and compacted in accordance with OPSS 212 and 501.

Settlement of the embankment and the underlying soil is not expected to exceed 25 mm. It is recommended to place the fill early in the construction stage, and to delay the paving, to allow any time dependent portions of these settlements to take place.

To protect against surficial instability, normal slope vegetation should be established in accordance with MTO standards as soon as possible after construction.

5.7 Construction Considerations

5.7.1 Dewatering

Excavations for spread footings at this site are expected to be below the groundwater table. The surficial cohesionless sand is expected to be unstable under seepage. Although the glacial till has a dense to very dense in situ density, due to its high sand and silt content, it may become unstable under heavy runoff and seepage conditions. Dewatering may be achieved by a combination of conventional ditches and pumping from sumps techniques. Other dewatering alternatives can also be considered. The more economical and practically feasible dewatering alternative should be selected. It is the responsibility of the contractor to lower the groundwater below the excavation base, and to construct the footings in the dry without disturbing the underlying foundation soils.

5.7.2 Temporary Excavations

Temporary excavations less than 1.2 m in depth may be carried out with vertical side slopes. Temporary excavations more than 1.2 m in depth should be undertaken using slopes no steeper than 1 horizontal to 1 vertical. Where seepage is noted, flatter side slopes may be required or alternatively a shoring system may be utilized at locations under space constraints.

5.8 Groundwater Chemistry

Two (2) groundwater samples were submitted to Areco Canada Inc. in Ottawa for pH, sulphate and chloride testing. The test results are summarized below:

Borehole	pH	Sulphate (ppm)	Chloride (ppm)
90-4	8.4	29	1.0
90-6	7.6	93	2.3

The above results indicate that the potential degree of sulphate attack on concrete and the potential degree of attack on exposed steel are both negligible.

6.0 MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Y. Larochelle, Engineer In Training, utilizing equipment owned and operated by Marathon Drilling Co. Ltd.

The report was written by Y. Larochelle and C. Kwok, Project Engineer, and approved by G. Kack, Project Manager.

Respectfully submitted,

JACQUES, WHITFORD LIMITED



A handwritten signature in black ink, appearing to read "C. C. Kwok".

Charles C.K. Kwok, M.Sc., P.Eng.
Project Engineer



A handwritten signature in black ink, appearing to read "Gordon Kack".

Gordon J. Kack, M.E.Sc., P.Eng.
Project Manager



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:

R Q D (%)	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'_{v0}	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						

RECORD OF BOREHOLE No 91-1

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 182.0; E 384 167.8 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.K.K.
 DATUM Geodetic DATE April 21, 1991 CHECKED BY G.J.K.

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	WATER CONTENT (%)	10 20 30			
93.4	Ground Surface															
92.9	Topsoil		1	SS	1		May 10, 1991									
92.5	Sand trace to some silt Very Loose Reddish-Brown		2	SS	33		March 30, 1992									
	Sand and Gravel, some silt Dense to Very Dense Brown		3	SS	39											
			4	SS	52											
			5	SS	34											
89.5	Clayey Silt		6	SS	19											
4.1	Soft to Firm Brown		7	SS	80/100											
88.6	Het. Mixture of Sandy Silt, some clay and gravel, occ. boulders (Glacial Till) Compact Grey															
4.8	End of Borehole															

RECORD OF BOREHOLE No 91-2

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 150.0; E 384 207.0 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing COMPILED BY C.K.K.
 DATUM Geodetic DATE April 23, 1991 CHECKED BY G.J.K.

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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
96.7	Ground Surface						20	40	60	80	100	10	20	30	
0.1	Topsoil	1	SS	2		May 10, 1991, March 30, 1992									
	Clayey Silt	2	SS	2											
95.3	Soft to Firm Brown														0 0 75 25
1.4	Het. Mixture of Sandy Silt, some clay and gravel, occ. boulders (Glacial Till) Very Dense	3	SS	81											
		4	SS	23	0 cm	Native Backfill									
		5	SS	40	8 cm										16 44 (40)
							</								

RECORD OF BOREHOLE No 91-3

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 129.8; E 384 227.5 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing COMPILED BY C.K.K.
 DATUM Geodetic DATE April 23, 24, 1991 CHECKED BY G.J.K.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20	40	60	80	100	W _p	W		
97.5	Ground Surface															
97.2	Topsoil					May 10, 1991, March 30, 1992										
0.3	Clayey Silt Soft to Firm					Seal										
96.5	Brown															
1.0	Het. Mixture of Sandy Silt, some clay and gravel, occ. boulders (Glacial Till) Compact to Very Dense		1	SS	27											
			2	SS	59	Native Backfill										
	Brown Grey		3	SS	60/10	cm										
			4	SS	161											
						Seal										
			5	SS	50/5	Sand 91 Backfill										
			6	SS	100/10	Piezometer										
88.6			7	Ss	120/10											
8.9	End of borehole															

RECORD OF BOREHOLE No 91-4

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 106.5; E 384 260.3 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing, Rock Coring COMPILED BY C.K.K.
 DATUM Geodetic DATE April 17 to 19, 1991 CHECKED BY G.J.K.

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					
98.4	Ground Surface															
0.1	Topsoil															
0.2	Sand trace to some silt, Very Loose Brown	1	SS	1												
	Het. Mixture of Sandy Silt, some clay and gravel, occ. boulders (Glacial Till) Compact to Very Dense Brown Grey	2	SS	21												
		3	SS	89												
		4	SS	42												
		5	SS	32												
		6	SS	45												
		7	SS	59												
		8	SS	202/ 18 cm												
		9	SS	189/ 20 cm												
		10	SS	240/ 14 cm												
		11	SS	240 14 cm												
		12	SS	184												
82.4																
16.0	Bedrock Limy Dolostone Good to Excellent	13	NQ RC	REC 95%												
		14	NQ RC	REC 96%												
80.0																
18.4	End of borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 91-5

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 088.9; E 384 292.3 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing COMPILED BY C.K.K.
 DATUM Geodetic DATE April 24 to 26, 1991 CHECKED BY G.J.K.

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			20	40	60	80	100		
98.0	Ground Surface												
0.1	Topsoil		1	SS	6								
96.9	Sand, trace to some silt Loose Brown												
1.1	Het. Mixture of Sandy Silt, some clay and gravel, Brown & Grey occ. boulders Grey (Glacial Till) Dense to Very Dense		2	SS	61								
			3	SS	43								
			4	SS	124								
			5	SS	85/ 12cm								
			6	SS	140/ 12cm								
			7	SS	200/ 12cm								
89.4			8	SS	150/ 10cm								
8.6	End of borehole												

RECORD OF BOREHOLE No 91-6

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 073.4; E 384 324.5 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing COMPILED BY C.K.K.
 DATUM Geodetic DATE April 25 to 26, 1991 CHECKED BY G.J.K.

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					
98.3	Ground Surface																
	Topsoil																
0.3	Sand, trace to some silt						98										
97.3	Loose Brown						May 10, 1991, March 30, 1992										
1.0	Het. Mixture of Sandy Silt, some clay and gravel, occ. boulders (Glacial Till)		1	SS	6		97										
	Loose to Very Dense Brown Grey		2	SS	50/8		Native Backfill										
							Seal										
			3	SS	64		94										
							Sand Backfill										
			4	SS	45		93										
							92										
			5	SS	88		91										
			6	SS	132		90										
			7	SS	99		89										
							Piezometer										
			8	SS	130/15cm		88										
							87										
86.3			9	SS	68												
12.0	End of borehole																

RECORD OF BOREHOLE No 91-7

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 060.5; E 384 362.2 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.K.K.
 DATUM Geodetic DATE April 29, 1991 CHECKED BY G.J.K.

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	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp	W	W _L			
97.7	Ground Surface												
0.1	Topsoil												
0.3	Sand trace to some silt, Brown	1	SS	10									
	Het. Mixture of Sandy Silt, some clay and gravel, occ. boulders (Glacial Till) Compact to Very Dense	2	SS	37									
		3	SS	15									
		4	SS	35									
		5	SS	65									
		6	SS	57									
		7	SS	44									
92.5													
5.2	End of borehole												

RECORD OF BOREHOLE No 91-8

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 053.2; E 384 390.8 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.K.K.
 DATUM Geodetic DATE April 29, 1991 CHECKED BY G.J.K.

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					
97.5	Ground Surface															GR SA SI CL
0.1	Topsoil															
0.2	Sand trace to some silt, Loose, Brown	1	SS	4												
	Het. Mixture of Sandy Silt, some clay and gravel, occ. boulders (Glacial till) Brown	2	SS	9												
		3	SS	39												
		4	SS	92												
94.2		5	SS	50/												
3.3	End of Borehole															

RECORD OF BOREHOLE No 92-1

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 057.8; E 384 372.9 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.K.K.
 DATUM Geodetic DATE March 30, 1992 CHECKED BY G.J.K.

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					
98.0	Ground Surface																GR SA SI CL
	Topsoil																
0.2	Sand, trace to some																
97.1	silt																
0.9	Compact Brown		1	SS	16		97										
	Het. Mixture of Sandy		2	SS	16		96										
	Silt, some clay and																
	gravel, occ. boulders		3	SS	77		95										
	(Glacial Till)																
	Compact to Very Dense		4	SS	46		94										
	Brown		5	SS	84		93										
	Grey		6	SS	100/13		92										
							91										
			7	SS	59		90										
							89										
			8	SS	58		88										
			9	SS	48												
87.7			10	SS	187/23												
10.3	End of Borehole																

RECORD OF BOREHOLE No 92-2

METRIC

W P 177-89-02 LOCATION Co-ords: N 4 958 151.7; E 384 200.0 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.K.K.
 DATUM Geodetic DATE March 30, 1992 CHECKED BY G.J.K.

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		
96.7	Ground Surface															
0.1	Topsoil		1	SS	3											
	Clayey Silt Soft to Firm Brown		2	SS	36											
95.0			3	SS	55											
1.7	Het. Mixture of Sandy Silt, tract to some gravel, occ. boulders (Glacial Till) Dense to Very Dense															
94.4																
2.3																
	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 92-3

METRIC

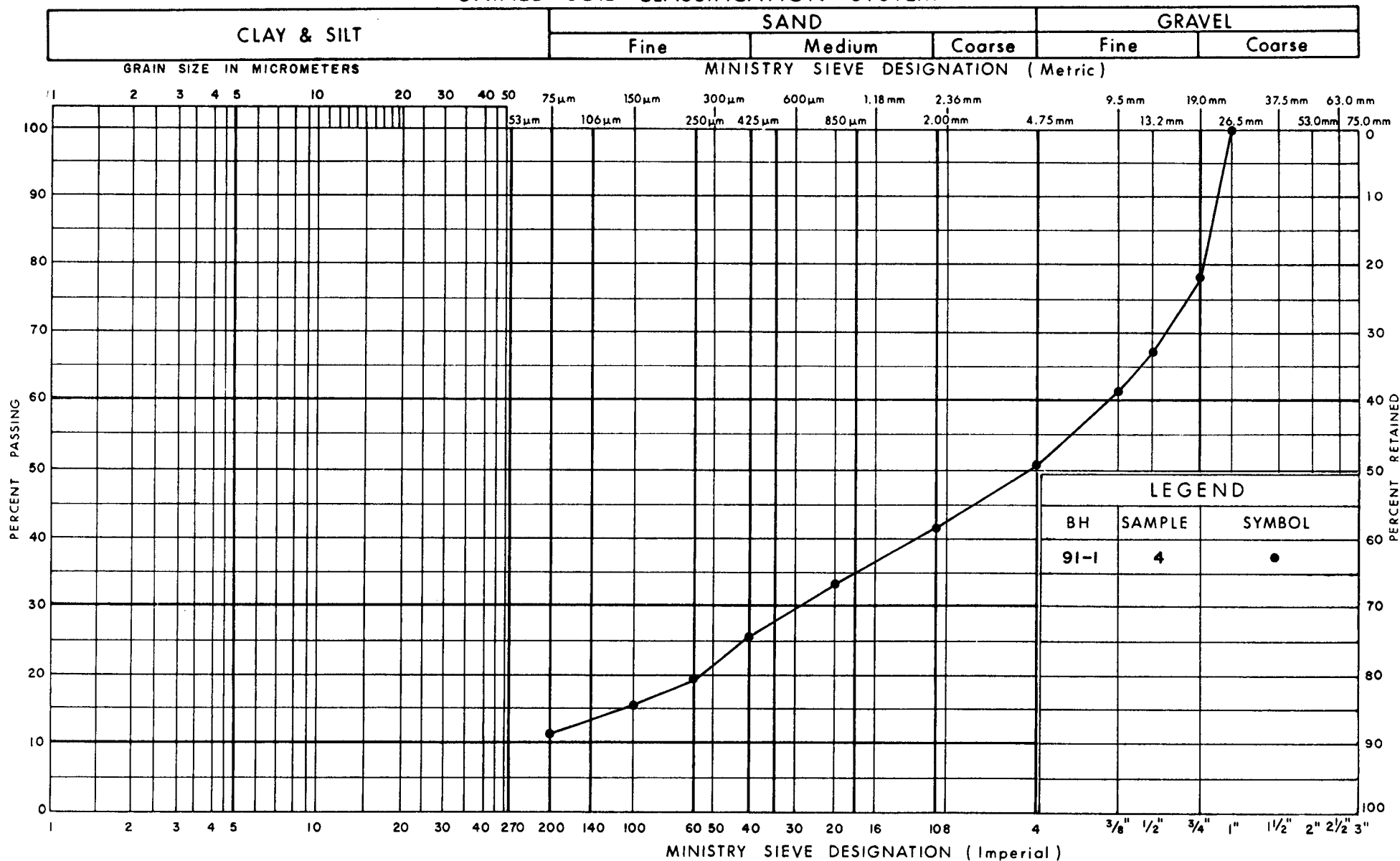
W P 177-89-02 LOCATION Co-ords: N 4 958 162.9; E 384 190.3 ORIGINATED BY Y.L.
 DIST HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.K.K.
 DATUM Geodetic DATE March 30, 1992 CHECKED BY G.J.K.

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 kPa								WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								10 20 30		
96.2																		
0.1	Topsoil						96											
	Sand, some silt, trace gravel Compact Brown		1	SS	20		95					○						
94.5			2	SS	64		Native Backfill					○						
1.7	Het. Mixture of Sandy Silt to Silty Sand, some gravel, occ. boulders (Glacial Till) Very Dense Brown						94											
92.7			3	SS	183		93					○						
3.5	End of Borehole																	
	No groundwater seepage during drilling																	

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

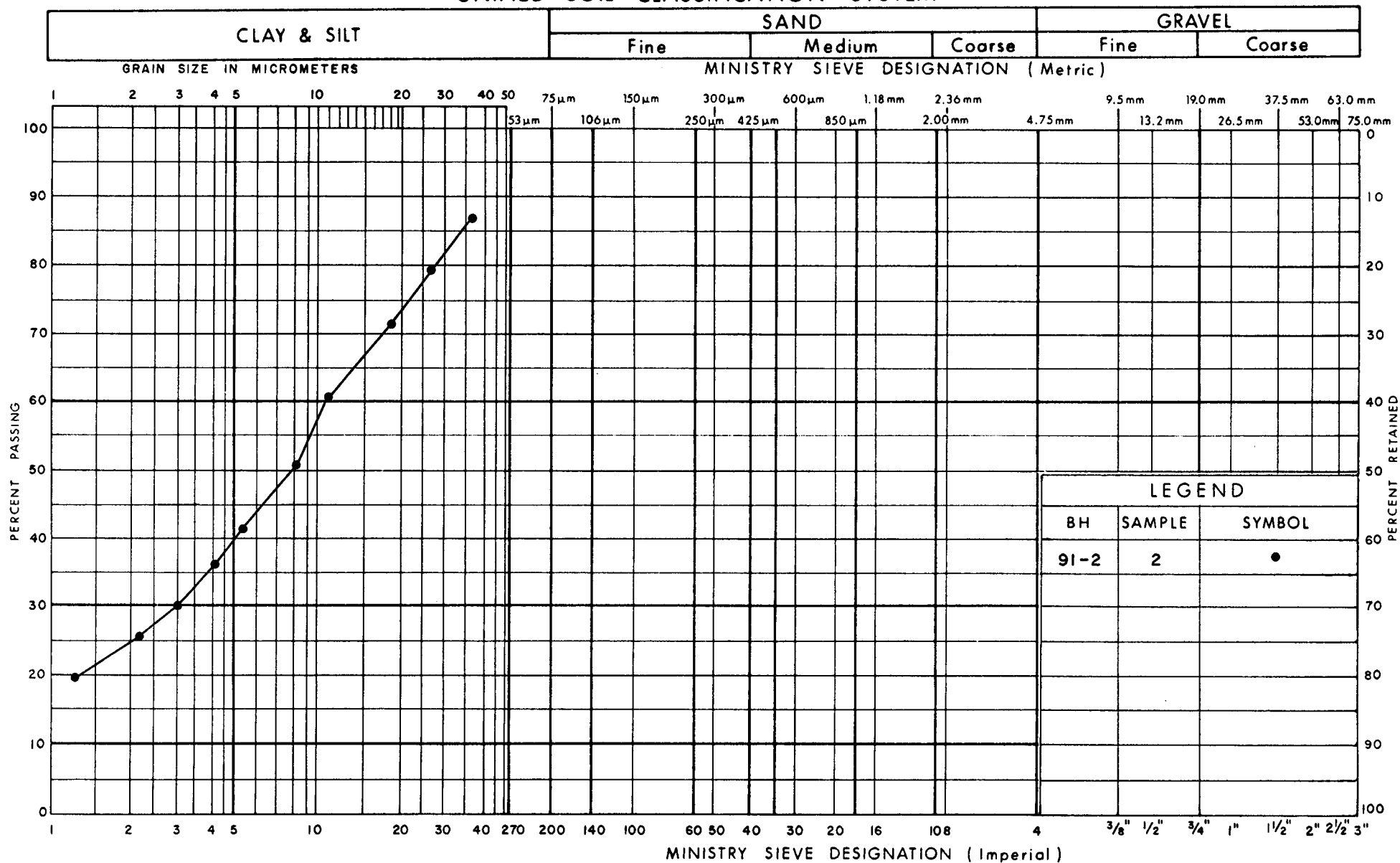
GRAIN SIZE DISTRIBUTION

SAND & GRAVEL

FIG No 1

W P 177-89-02

UNIFIED SOIL CLASSIFICATION SYSTEM



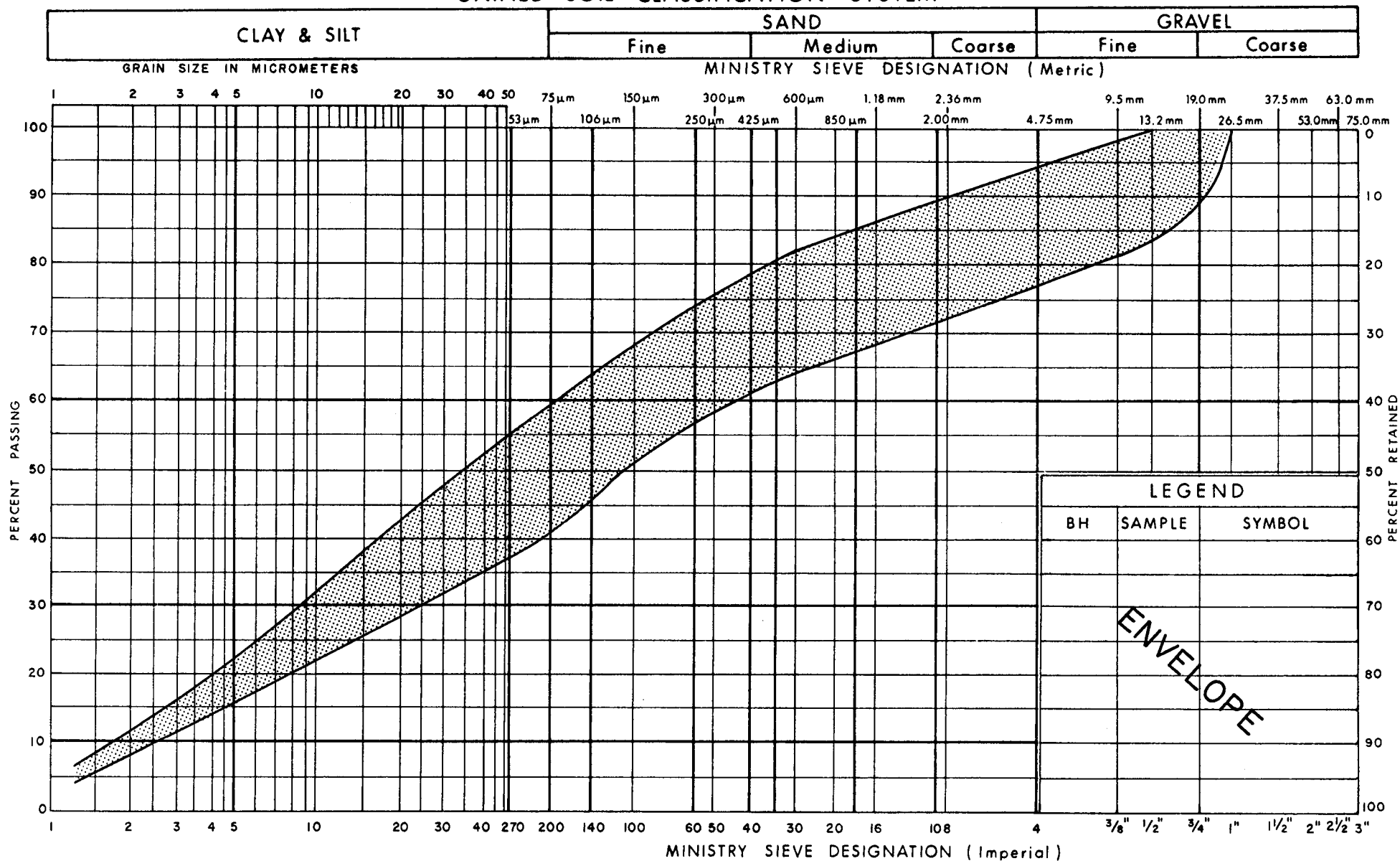
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION CLAYEY SILT

FIG No 2

W P 177 - 89 - 02

UNIFIED SOIL CLASSIFICATION SYSTEM

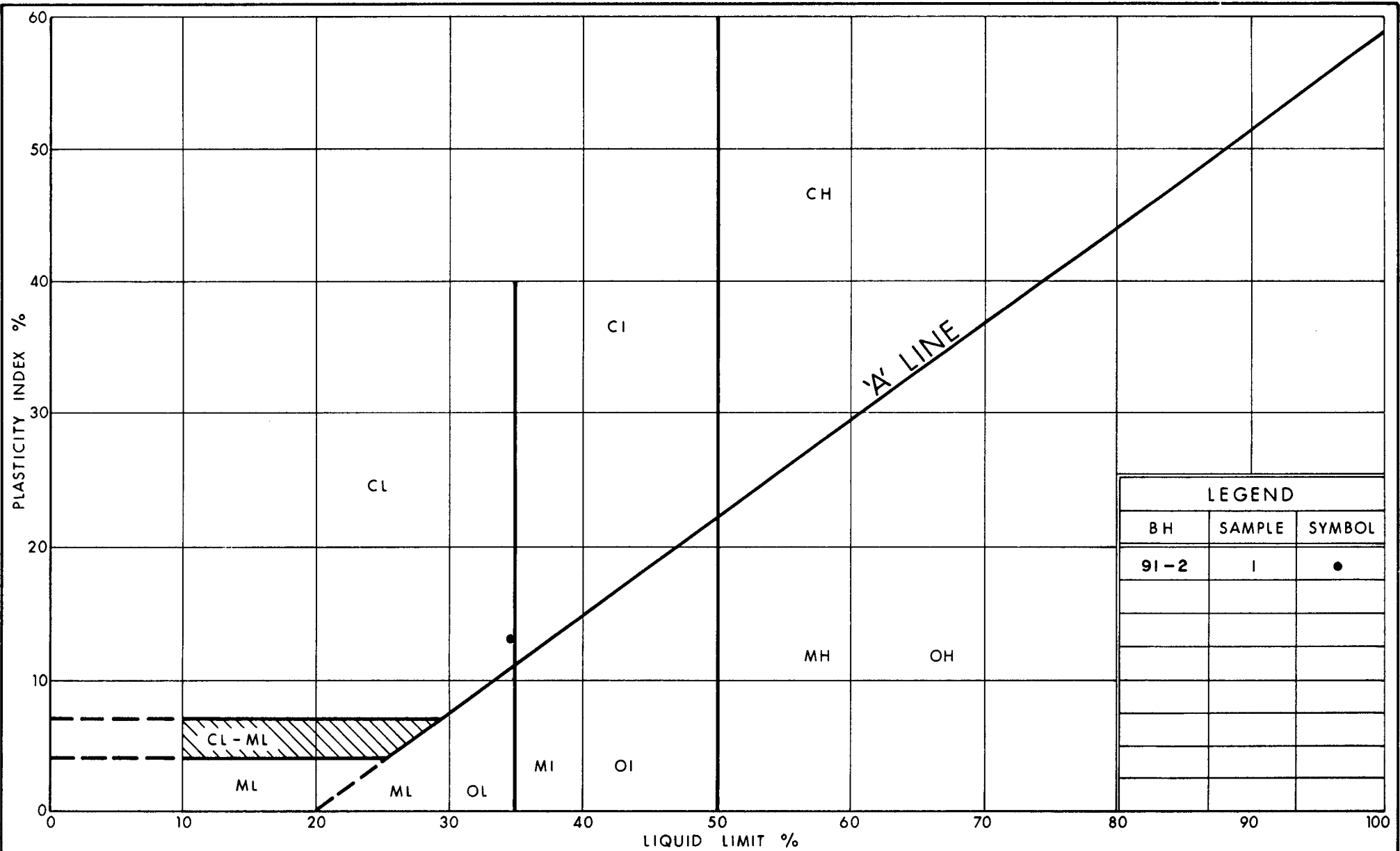


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Transportation

GRAIN SIZE DISTRIBUTION
 HET MIXTURE OF SANDY SILT,
 SOME CLAY & GRAVEL, OCCASIONAL BOULDERS (Glacial Till)

FIG No 3

W P 177-89-02



LEGEND

BH	SAMPLE	SYMBOL
91-2	I	•

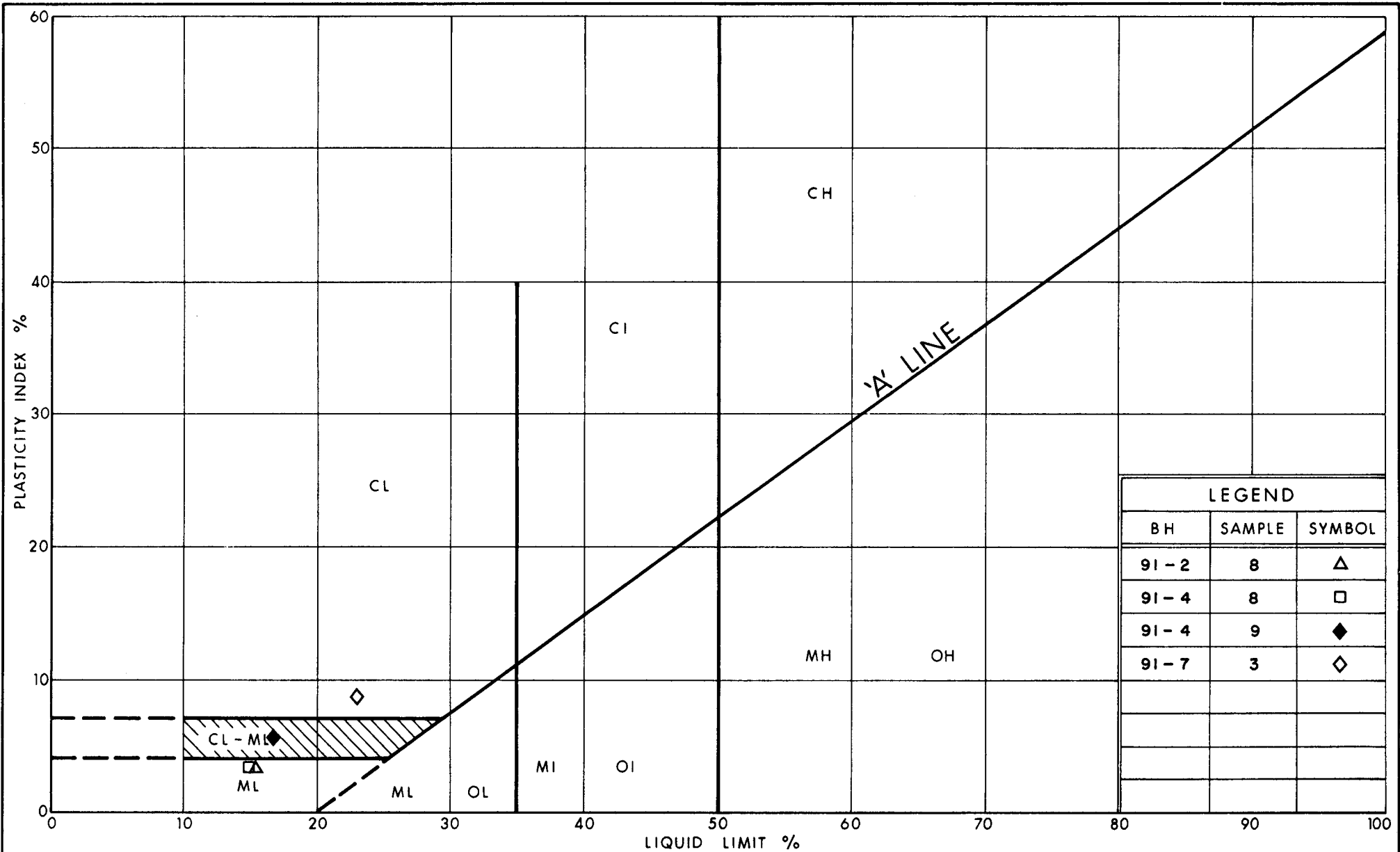


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Transportation
Ontario

PLASTICITY CHART CLAYEY SILT

FIG No 4

W P 177-89-02

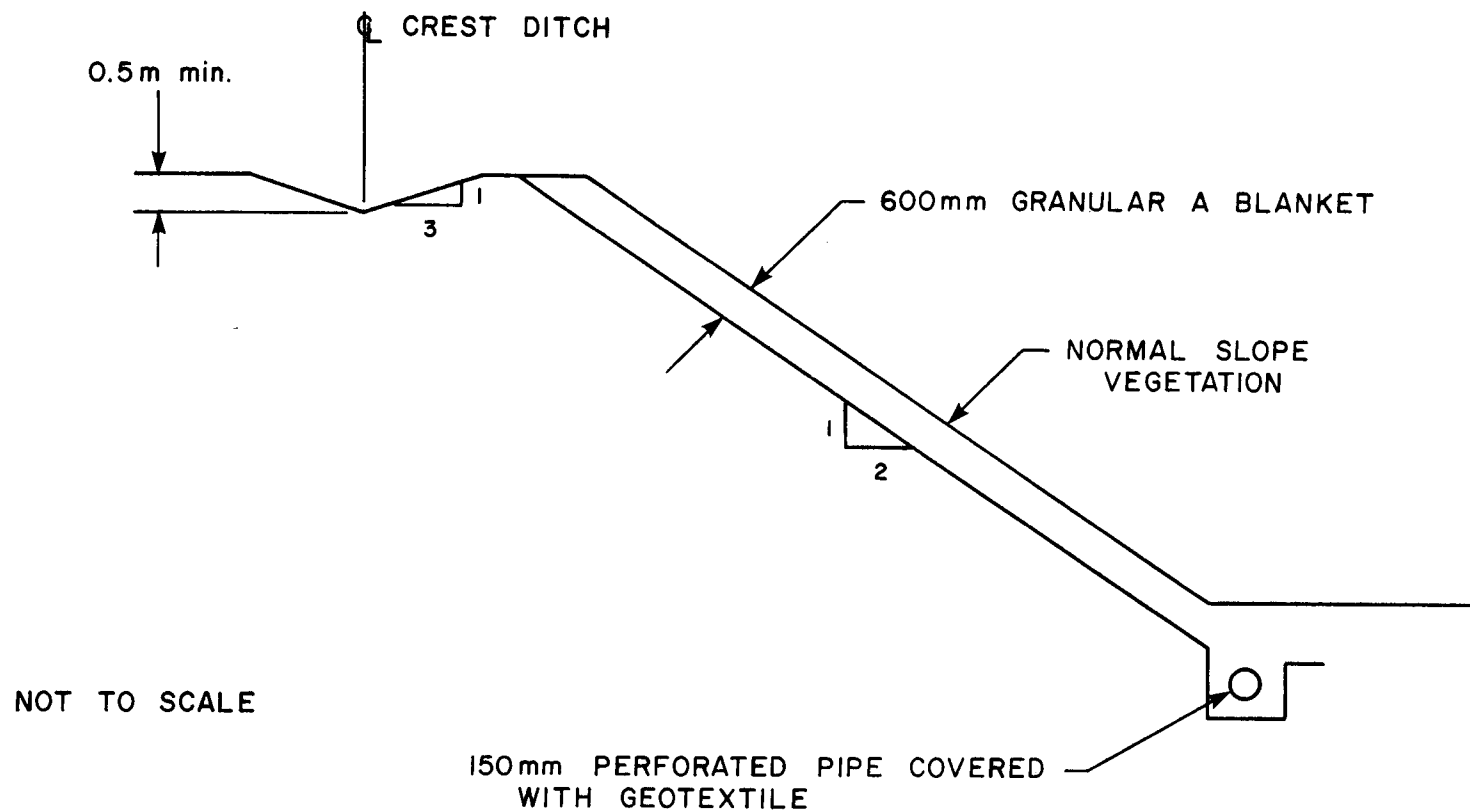


Ministry of
Transportation
Ontario

PLASTICITY CHART
HET MIXTURE OF SANDY SILT,
SOME CLAY & GRAVEL, OCCASIONAL BOULDERS (Glacial Till)

FIG No 5

W P 177-89-02



CUT SLOPE PROTECTION

FIG 6

WP 177-89-02



METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

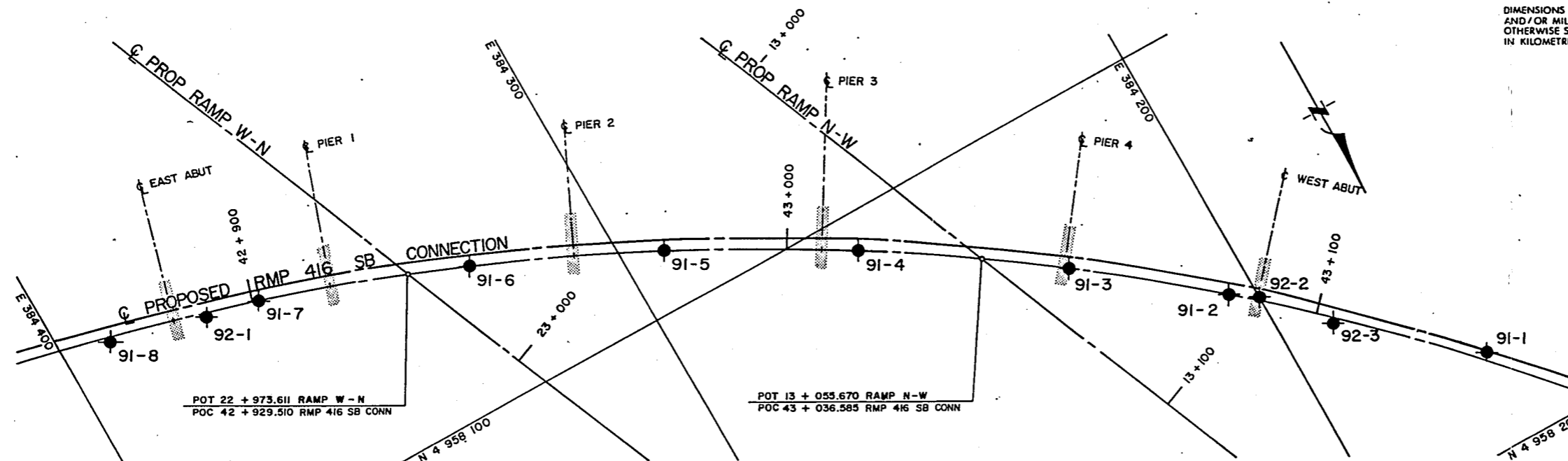
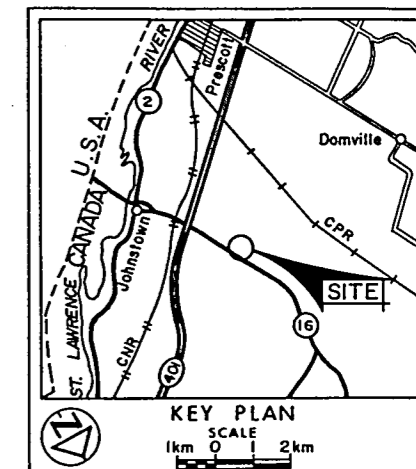
CONT No
WP No 177-89-02

HWY 401/416 INTERCH, RMP 416
SB CONN OVER RMP W-N & N-W
BORE HOLE LOCATIONS & SOIL STRATA



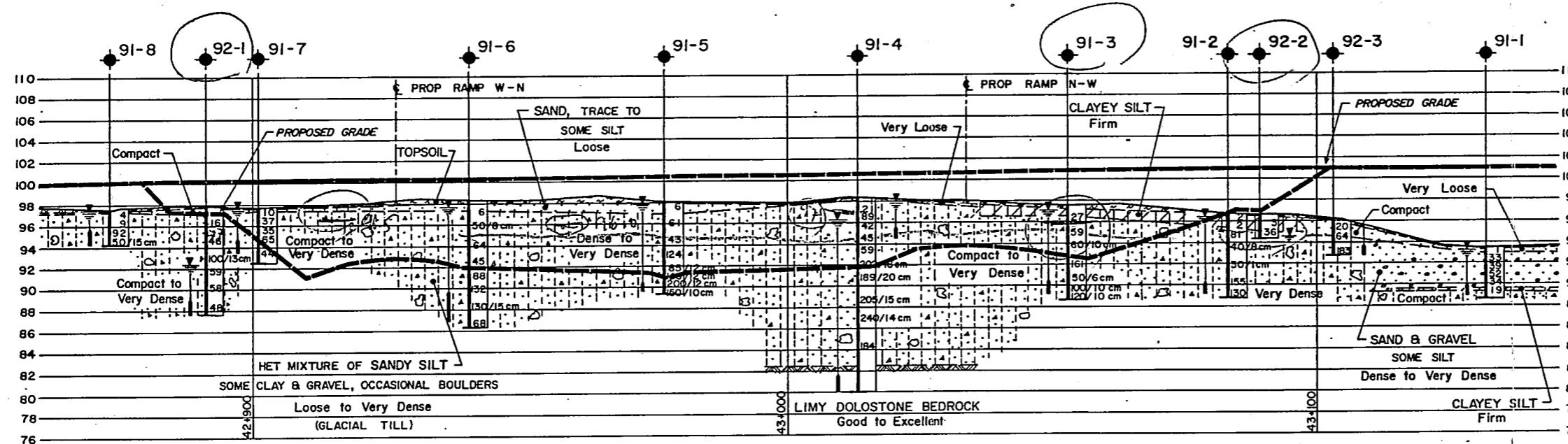
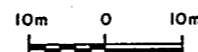
SHEET

JACQUES, WHITFORD LIMITED



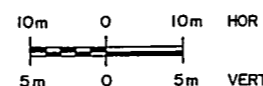
PLAN

SCALE



PROFILE PROPOSED RMP 416 SB CONNECTION

SCALE



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
- W/L in Piezometer
- ⊕ Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
91-1	93.4	4 958 182.0	384 167.8
91-2	96.7	4 958 150.0	384 207.0
91-3	97.5	4 958 129.8	384 227.5
91-4	98.4	4 958 106.5	384 260.3
91-5	98.0	4 958 088.9	384 292.3
91-6	98.3	4 958 073.4	384 324.5
91-7	97.7	4 958 060.5	384 362.2
91-8	97.5	4 958 053.2	384 390.8
92-1	98.0	4 958 057.8	384 372.9
92-2	96.7	4 958 151.7	384 200.0
92-3	92.6	4 958 162.9	384 190.3

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.

APR 3 1992	BOREHOLES 92-1, 92-2 & 92-3 ADDED
DATE	BY DESCRIPTION

Geacres No 318-73

HWY No 416	DIST 9
SUBMIT CKK	CHECKED DATE JUNE 24, 1991 SITE 16-308
DRAWING BB	CHECKED APPROVED DWG 1778902-A

LATEST PLAN DEC 5 1997

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

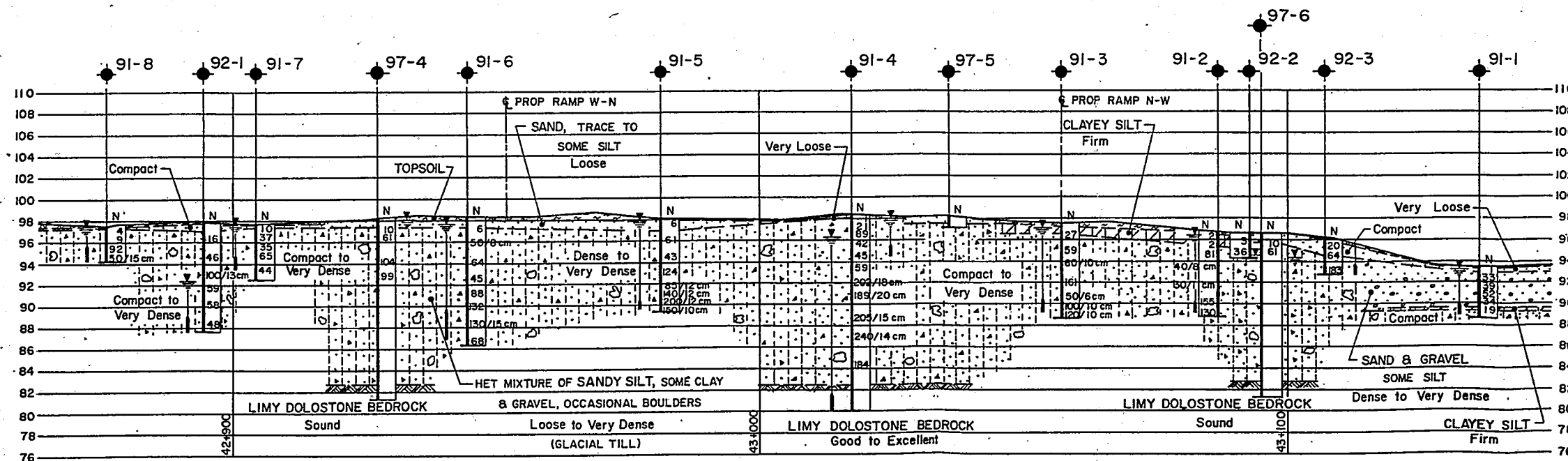
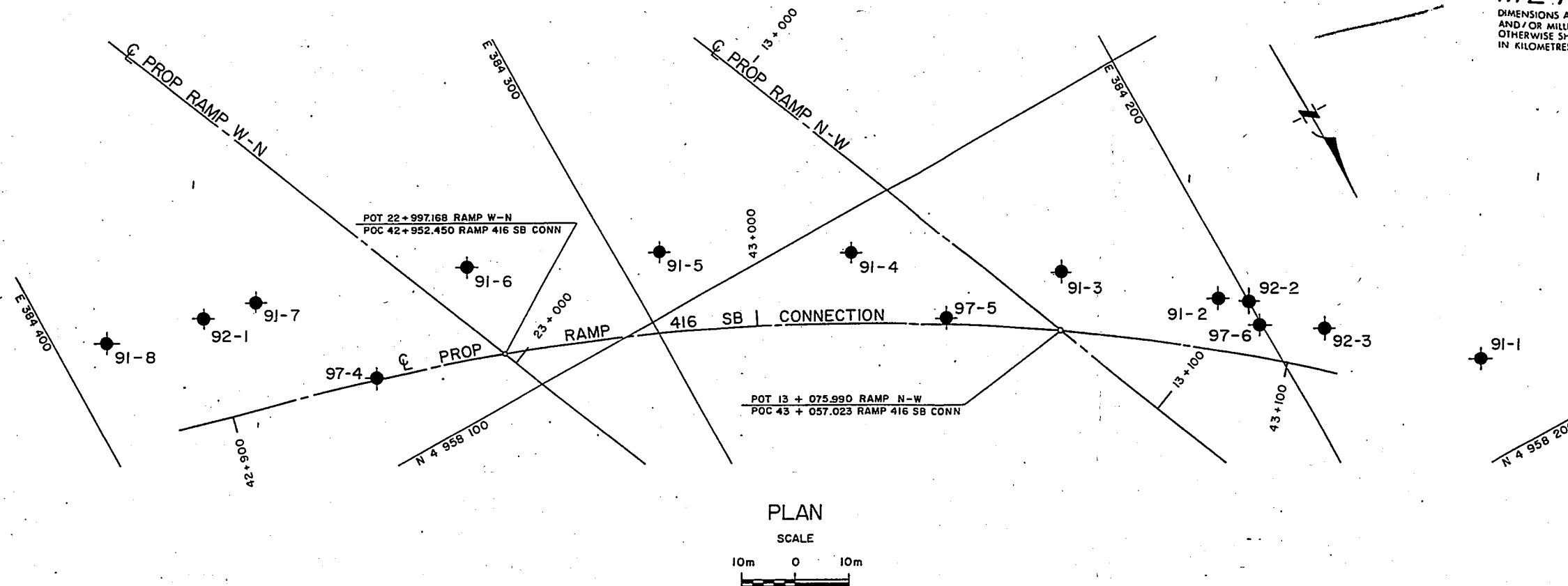
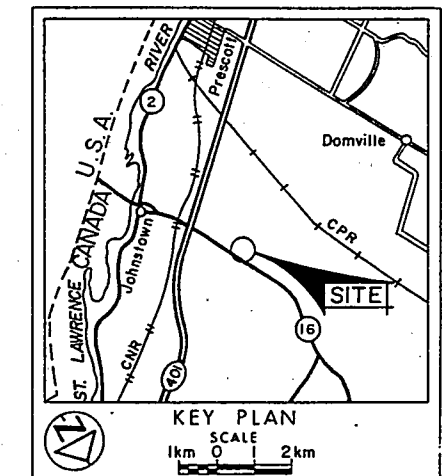
CONT No
WP No 177-89-02

HWY 401/416 INTERCH, RMP 416
SB CONN OVER RMP W-N & N-W
BORE HOLE LOCATIONS & SOIL STRATA

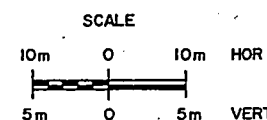


SHEET
181

JACQUES, WHITFORD LIMITED



PROFILE PROPOSED RAMP 416 SB CONNECTION



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
- W L in Piezometer
- Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
91-1	93.4	4 958 182.0	384 167.8
91-2	96.7	4 958 150.0	384 207.0
91-3	97.5	4 958 129.8	384 227.5
91-4	98.4	4 958 106.5	384 260.3
91-5	98.0	4 958 088.9	384 292.3
91-6	98.3	4 958 073.4	384 324.5
91-7	97.7	4 958 060.5	384 362.2
91-8	97.5	4 958 053.2	384 390.8
92-1	98.0	4 958 057.8	384 372.9
92-2	96.7	4 958 151.7	384 200.0
92-3	92.6	4 958 162.9	384 190.3
97-4	98.2	4 958 083.8	384 349.9
97-5	98.3	4 958 126.2	384 251.2
97-6	96.7	4 958 156.7	384 200.4

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 GC 2.01 of OPS Gen. Cond.

APR 3 1998 BOREHOLES 92-1, 92-2 & 92-3 ADDED
DEC 5 1997 BOREHOLES 97-4, 97-5 & 97-6 ADDED

Geocres No 318-73

HWY No 416 DIST 9
SUBMITTAL CHECKED DATE JUNE 24, 1998 SITE 16-308
DRAWN GBB CHECKED APPROVED DWG 2