

G.I.-30 SEPT. 1976

GEOCRES No. 3165-181DIST. 9 REGION           W.P. No. 121-87-06CONT. No. 94-22W. O. No.           STR. SITE No. 3-545HWY. No. 416LOCATION Cedarview Rd. UnderpassNo of PAGES -=====  
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.           REMARKS:



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## **FOUNDATION DESIGN SECTION**

# **foundation investigation and design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

*CONT 94-22*

WP 121-87-06

DIST 9

HWY 416

STR SITE 3-54~~4~~5

Cedarview Road/Hwy. 416 Underpass

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FOUNDATION INVESTIGATION REPORT  
For  
Cedarview Road/Hwy. 416 Underpass  
W.P. 121-87-06, Site 3-5445  
District 9, Ottawa

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. A two span structure has been proposed to carry the Cedarview Road connection over Hwy. 416. The report describes the subsurface conditions at the site and contains recommendations pertaining to structure foundations and related earthworks.

SITE DESCRIPTION AND GEOLOGY

The site is located within an abandoned landfill site in an area known as the Bruce Pit in the City of Nepean, Ottawa-Carleton Municipality. It is located approximately 150 metres east of the existing Cedarview Road within and adjacent to an existing unpaved parking lot. A neighbourhood high school and recreational arena are situated on the opposite (west) side of Cedarview Road. The CNR railtracks intersects existing Cedarview Road approximately 200 metres north of the site, and Knoxdale Road intersects Cedarview Road approximately 2 kilometres south of the site.

The hilly terrain and gently undulating surface topography provides ideal routes for bicycle paths and tobogganning on the site. The land is therefore presently used primarily as a recreational area. The land consists of grassland, localized shrubs and woodlands. Two large ponds are also present immediately northwest of the site.

The Bruce Pit was used as a quarry during the 1940's, 1950's and 1960's as suppliers excavated the resource of cohesionless sand and gravels at the site. In addition, a small municipal landfill had operated at the site from approximately 1948 to the early 1960's.

Physiographically, the site lies in the area known as the Ottawa Valley Clay Plains founded in the lowlands of the St. Lawrence. The native subsoil within this area consists of clay plains interrupted by ridges of rock or sand. At the site, a ridge of cohesionless silts, sands and gravels are present overlying dolostone bedrock of the Oxford Formation.

The overburden was deposited during and immediately following the Wisconsin glaciation approximately 12,000 years ago during the Pleistocene Epoch, at which time the area was depressed from the effect of the glaciation. Following the retreat of the glacier, the brackish waters of the Champlain Sea flooded the area and then gradually receded as the land rebounded with the deposition of sediments to its present level. Bedrock is of the Lower Ordovician Period.

### INVESTIGATION PROCEDURE

Soil and rock properties were obtained by in situ and laboratory testing conducted. The procedures employed are discussed below. In addition, information pertaining to the aerial extent and composition of the fill material within the general Bruce Pit area, groundwater flow and quality and gas generation of the fill material was referenced from a report produced by Conestoga-Rovers and Associates entitled "Abandoned LandFill Site Investigation-Bruce Pit", dated August, 1988. This report summarizes an environmental study of the area.

### Field Investigation

The fieldwork for the investigation was carried out between 90 12 17-21 and 91 01 15 and consisted of five(5) sampled boreholes. Three(3) of the boreholes were advanced at the structure foundation locations and one(1) borehole at either approach. In addition, four(4) boreholes accompanied by three(3) dynamic cone penetration tests and one dynamic cone penetration test borehole were advanced in conjunction with a previous investigation (see W.P. 125-87-00) in the area of the proposed realigned Cedarview Road at the east approach to the proposed structure. All boreholes have been included on the site plan illustrating the borehole locations and proposed structure on Drawing No. 1218706-A in the Appendix.

The boreholes were advanced to depths ranging from 6.6 metres to 25.7 metres below the existing ground surface whilst the dynamic cone penetration tests were advanced to depths ranging from 2.4 m to 6.0 m. Track mounted CME equipment employing hollow stem augering techniques and casing/washboring methods were used to advance the boreholes in the overburden. Disturbed subsoil samples were

retrieved generally at 0.7 m intervals for the surficial 9 metres, at 1.5 m intervals from 9 metres to 15 metres and at 3 m intervals thereafter. Sample retrieval was conducted in accordance with the Standard Penetration Test (ASTM D1586).

Conventional rock coring methods were applied in retrieving rock core samples. Conventional AX and BX core barrels within AW and BW casing respectively was used in the coring of rock.

All samples retrieved in the overburden and all rock core samples were identified in the field and then returned to the laboratory for applicable testing.

Groundwater levels were obtained throughout the duration of the Field Investigation by monitoring the levels in the open boreholes and sealed piezometers installed. All open boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of the boreholes was provided by the Eastern Region Surveys and Plans.

#### Laboratory Analysis

To identify the behaviour and gradation of the overburden and to determine the physical index properties of the rock, some laboratory testing was performed. These tests included:

- 1) Atterberg Limit Tests
- 2) Grain Size Distributions
- 3) Natural Moisture Contents
- 4) Rock Core Logging

Laboratory test results have been summarized in the subsequent section of this report entitled "Subsurface Conditions" and are illustrated on corresponding figures and boreholes included in the attached Appendix.

### SUBSURFACE CONDITIONS

The variation in the subsoil stratigraphy within the surficial 4 to 5 metres confirms that the site is indeed an abandoned landfill site. The proposed structure location appears to be in a disposal area consisting of a number of fill material types. A clean sand fill was found surficially at some locations either directly on fill material of a different composition or directly on the native cohesionless sand deposit. The thickness of this fill material is in the order of 1.2 to 2.0 metres. At the proposed west abutment location (BH 17-1), a fill material consisting of an irregular mixture of clayey silt, sand and gravel with traces of ash and wood exists. This material extended to a depth of 5.3 metres below the natural ground surface. A sand fill material containing traces of black cinder, bottles, bricks, concrete and wood also exists at the site. This material was found underlying the clean sand fill at BH's 17-2 and 17-3 and has a thickness ranging from 3.4 metres to 4.6 metres. A fourth type of fill material exists at the east approach along the proposed realigned Cedarview Road. This fill material underlies a shallow cover of clean sand fill and consists of domestic refuse. A large quantity of this refuse appears to have been burned. This refuse material extended for a thickness of approximately 1.1 to 2.6 metres.

Underlying the fill material, the native material consists of a cohesionless deposit that varies in composition from a sand with traces of silt to a gravelly sand. This deposit extends for a thickness ranging from 13 metres to 15.2 metres.

A heterogeneous mixture of silt, sand, gravel, cobbles and boulders underlies the sand to gravelly sand stratum at the site. This stratum exists at an elevation ranging from 76 m to 79.1 m and has a thickness ranging from 2.8 m to 5.8 m.

The heterogeneous mixture of silt, sand, gravel, cobbles and boulders overlies dolostone bedrock. The bedrock surface exists at an elevation of 73.2± m.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater level established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. No. 1218706-A.

A detailed description of the subsurface conditions encountered is given below.

#### Fill Material

As discussed above, four different fills types exist at the site. Each fill type is described below. In addition, data and information pertaining to the environmental aspects of the fill (groundwater quality, gas generation, hydrocarbon characteristics, organic vapours, etc) is contained in an environmental assessment report produced by Conestoga-Rovers & Associates entitled "Abandoned Landfill Site Investigation". The report also defines the aerial extent of the fill material and identifies the composition of the material as determined by shallow and deep trenches and test pits. This information can be used to supplement the factual contents of this report.

#### Sand, trace of Silt

A sand fill that contains traces of silt exists as a surficial cover at some locations across the site. This fill is brown in colour and based on 'N' values as determined by the Standard Penetration Test ranging from 2 blows/0.3 m to 11 blows/0.3 m, the soil can be categorized as having a very loose to compact denseness. A grain size distribution curve determined by mechanical sieve and hydrometer analysis illustrating the gradation of this material is illustrated in Figure 1 in the Appendix.

The thickness of this fill material varies from 1.2 m to 2.0 m.

#### Irregular mixture of Clayey Silt, Sand and Gravel with traces of Ash, Organics and Wood

Fill material consisting of an irregular mixture of clayey silt, sand and gravel with traces of ash and wood also exists at the site. The material is brown with



inclusions of the black ash organics and ash-covered wood. The thickness of this material varies from 1.2 m to 5.3 m across the site.

Atterberg Limit tests were carried out to evaluate the behaviour of the fine grained portion of this material (less than 75 micrometres) and the results of the tests performed on two representative samples are illustrated in Figure 2 in the Appendix. The results reveal that the fine grained portion of the material is cohesive and of low plasticity with liquid limits ( $W_L$ ) ranging from 28% to 34% and the plasticity index ranging from 7% to 15%. Consequently, the fine grained portion of the material can be identified as clayey silt.

Grain size distribution curves determined by mechanical sieve and hydrometer analysis illustrating the gradation of this material is shown in Figure 3.

Based on 'N' values derived from the Standard Penetration Test ranging from 2 blows/0.3 m to 11 blows/0.3 m, the consistency of the soil can be described as ranging from very soft to firm.

#### Sand with traces of Cinder, Bottles, Bricks, Concrete, and Wood

A third type of fill material consisting of a brown sand that contains traces of cinder, bottles, bricks, concrete and wood is also present at the site. The main component of the fill is the cohesionless sand. The thickness of this fill is in the order of 3.4 metres.

Standard Penetration Tests carried out in this material produced 'N' values ranging from 3 blows/0.3 m to 7 blows/0.3 m. Consequently, this material can be described as having a very loose to loose denseness.

#### Domestic Refuse with Cinder

Underlying the relatively clean surficial sand fill at the easterly locations of the site exists fill material composed of a heterogeneous mixture of incinerated domestic garbage, in the form of cinder and ash, plastics, cloths and wood chips. The refuse varies in thickness from 1.1 to 2.6 metres. The presence of the black cinder and ash illustrates that a large quantity of the refuse has

been burned and consequently, the fill material generally possesses cohesionless characteristics. The state of decomposition also indicates that the refuse had been placed some time ago.

The 'N' values obtained from the Standard Penetration Test vary from 2 blows/0.3 m to 12 blows/0.3 m indicating that the domestic refuse is in a loose to compact state of condition. A strong methane odour is also present in the fill.

#### Sand to Gravelly Sand

Underlying the fill material at the site, the main native deposit consists of a cohesionless soil that ranges from a sand to a gravelly sand. Traces of silt are also present in the deposit. The thickness of the deposit ranges from 13 to 15.2 m extending to an elevation of 76 m to 79.1 m. The deposit appears to become more coarse grained and hence more gravelly at the western portion of the site adjacent to the west abutment. A grain size distribution envelope as determined by mechanical sieve and hydrometer analysis illustrating the gradation of the deposit is shown in Figure 4.

As discussed in the "Groundwater Conditions" of this report, the groundwater table at the time of the investigation existed at an elevation of 88 m to 87 m and hence approximately 9 metres of the deposit is submerged beneath the groundwater table. Consequently, soil cave-in occurred in the open borehole due to unbalanced hydrostatic head when borehole advancement penetrated the submerged sands. Casing and washboring techniques were required to advance the borehole under these conditions.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 76 blows/0.3 m to 100 blows/0.3 m and consequently the deposit can be described as having a denseness ranging from loose to very dense. In general, 'N' values exceed 30 blows/0.3 m and consequently, the deposit has a dense to very dense denseness.

### Heterogeneous mixture of Sand, Gravel, Cobbles and Boulders (Glacial Till)

Underlying the extensive deposit of sand to gravelly sand, a deposit consisting of a heterogeneous mixture of sand, gravel, cobbles and boulders exists. The unsorted deposit is a glacial till deposit that is present at depths ranging from 19.7 m to 21.2 m below the ground surface. The thickness of this deposit varies from 4.4 m to 2 metres across the site.

Grain size distribution curves as determined by mechanical sieve and hydrometer analysis illustrating the gradation of the deposit for the grain sizes less than 75 mm (smaller than cobble size) is shown in Figure 5 in the Appendix.

Sampling in the upper thickness of the deposit was carried out by retrieving disturbed samples in accordance with the Standard Penetration Test (ASTM D1586). The 'N' values determined by this test procedure ranged from 20 blows/0.3 m to 50 blows/0.3 m. In the lower thickness of the deposit, rock coring methods were required to facilitate sampling and borehole advancement. Core recovery results in this deposit have been included in the "Rock Core Description" provided in the Appendix to the report.

### Bedrock

The heterogeneous mixture of sand, gravel, cobbles and boulders (Glacial Till) is directly underlain by dolostone bedrock of the Oxford Formation. The bedrock surface exists at an elevation of approximately 73 metres with the depths from the natural ground surface varying from 22.8 m to 24.1 m. The bedrock was cored in both the AX and BX size in thickness ranging from 1.2 m to 1.6 m.

The dolostone bedrock is brownish grey in colour and is fine to medium grained. The bedrock is generally unweathered to only slightly weathered and has moderately close to very close spaced fractures that are flat, smooth and planar to undulating.

Core recoveries and Rock Quality Designations (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Core recoveries were 100% while RQD's varied between 75 and 90% indicating that the rock is medium strong.

Detailed descriptions of the bedrock, summarizing the rock core logging performed in the laboratory are attached in the Appendix.

#### Groundwater Conditions

Observation of the groundwater level was carried out by measuring the water level in the open boreholes and also in seal piezometers installed. Piezometers were installed in the boreholes with the annular space occupied by 10 mm pea gravel and the piezometer tip confined between a lower and upper bentonite seal approximately 0.3 metres in thickness. Piezometers were installed in the native sand deposit as illustrated in the Record of Boreholes attached in the Appendix.

Groundwater levels determined at the time of the investigation ranged from 5.4 m to 9.5 m below the existing ground surface. These depths correspond to an elevation ranging from 88 m to 87 m suggesting that the elevation of the water table at the time of the investigation was constant. The wider range in the depths to the water reflect the variation in the surface topography at the site.

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

## DISCUSSION AND RECOMMENDATIONS

It is proposed to realign the existing Cedarview Road approximately 160 metres east of its existing alignment at the site location. The proposed centreline of Hwy. 416 is to be located approximately 100 metres east of the existing Cedarview Road. Consequently, a two span structure of equal length (27 m-27 m) has been proposed to carry motorists, pedestrians and cyclists from the realigned Cedarview Road over the Hwy. 416 to facilities located west of the existing Cedarview Road. The Cedarview Connection Underpass structure will be approximately 11 metres in width comprised of a two lane roadway, a bicycle path and a sidewalk.

The proposed profile grade for the structure is 98± metres and the proposed Hwy. 416 grade is 92± metres. Perimeter and median drainage swales will render the Hwy. 416 grade at elevation 91 m at the approach cut toe and at elevation 90 metres at the pier. Consequently, excavation cuts in the order of magnitude of 7 to 8 metres will be required to facilitate the advancement of the Hwy. 416 at the site.

A plan illustrating the proposed structure and profile grade is illustrated in Dwg. No. 1218706-A in the Appendix.

To facilitate the design and construction of the proposed structure foundations and related earthworks, the following foundation and geotechnical recommendations have been provided in the scope of this report.

- 1) Structure Foundations
- 2) Approach Embankments
- 3) Hwy. 416 Roadway Design Subexcavation
- 4) Construction Considerations
- 5) Environmental Considerations

## STRUCTURE FOUNDATIONS

In view of the competent nature of the native sand to gravelly sand subsoil at an elevation corresponding to the proposed Hwy. 416 grade, all structure foundations can be founded on spread footings. Hence, a closed-type abutment design can be selected.

Alternatively, abutment foundations can be supported on a compacted Granular 'A' pad. In this case, open-type abutments can be perched above the proposed Hwy. 416 grade.

Designs and construction details of both alternatives are described below. The alternative or combination thereof that proves to be the most economical and technically feasible shall be selected.

### Shallow Foundations - Spread Footings on Native Soil

All foundations can be founded on spread footings bearing on the native sand to gravelly sand deposit at or below El. 90.5 m. For purposes of the O.H.B.D.C., the bearing capacities as tabulated in Table 1 below are provided.

Table 1 - Spread Footings

<u>Structure</u>	<u>Factored Capacity at U.L.S. (kPa)</u>	<u>Bearing Capacity at S.L.S. Type II (kPa)</u>
Abutments & Piers	900	400

The bearing capacities provided were computed using a footing width (B) equal to 4 metres and a depth of embedment (D) of 1.8 metres. All footings shall be protected against frost penetration by providing a 1.8 metre earth cover or equivalent frost protection.

The magnitude of settlement as a result of the applied pressures tabulated in Table 1 is expected to be within 25 mm provided that the founding soil is not loosened by construction or related activities. Any loosened soil and/or fill

material at the founding depth shall be removed and replaced with compacted granular material or mass concrete. To preserve the founding soil against construction disturbances and also against the elements of weathering, it is recommended that a working slab comprised of granular material or mass concrete be placed on the soil.

The reduction for inclination of loading on the shallow foundation shall be carried out in accordance with Section 6-7.3.3.5 of the O.H.B.D.C. The founding soil is granular and consequently, the corresponding curves for the appropriate depth/width (D/B) ratio shall be used.

The computation of the sliding resistance of the foundation soil shall be computed in accordance with Section 6-7.3.3.5 of the O.H.B.D.C. An unfactored friction angle of  $32^\circ$  can be used between the concrete footing and the native soil. If additional sliding resistance is required, consideration can be given to employing shear keys beneath the footing. The passive resistance developed by the shear key can be computed using the aforementioned unfactored friction angle of  $32^\circ$  and a unit weight of  $21 \text{ kN/m}^3$ .

#### Compacted Granular 'A' Pad

Alternatively, abutment foundations can be founded on a well compacted Granular 'A' pad with the base of the pad located at an elevation of 90.5 metres. It is imperative that all loosened material and any fill material be subexcavated prior to the placement of the Granular 'A' pad. The Granular 'A' pad shall be constructed as illustrated in Figure 6 in the Appendix. The granular pad shall be constructed to a minimum 1 metre edge distance from the top of the footing to the crest of the pad and with 1H:1V slopes. All footings must be protected against frost penetration and consequently a 1.8 m earth cover or equivalent frost penetration is required. All loosened and/or organic material shall be subexcavated prior to the granular pad placement. For purposes of the O.H.B.D.C. and for the conditions described above, the bearing capacities tabulated in Table 2 below can be used in the foundation design.

Table 2 - Perched Abutment on Granular Pad

Factored Capacity at U.L.S. = 900 kPa  
Bearing Capacity at S.L.S. Type II = 350 kPa

Settlement of the granular pad foundation as a result of the applied footing pressure will be elastic in nature and consequently is expected to take place during or immediately following the construction period. The magnitude of this settlement is anticipated to be within 25 mm, provided the granular material is not loosened by construction or related activities.

The Granular 'A' material must be placed and compacted to achieve 100% of the Proctor maximum dry density as outlined in OPSS 501.08.02 (Method A). Quality control in the form of material inspection and field density measurements shall be conducted.

Reduction for the inclination of loading on the shallow foundation shall be carried out in accordance with Section 6.7.3.3.5 of the O.H.B.D.C.

The computation of the sliding resistance of the foundation shall be computed in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. An unfactored friction angle of 35° can be used between the concrete footing and the Granular 'A' material.

#### APPROACH EMBANKMENTS

At the proposed structure, excavation cuts in the order of 7 metres will be required at the west approach and approximately 2.5 to 3 metres of approach fill superimposing a depth of excavation of 4 metres will be required at the east approach. The excavation cut will be advanced primarily in the fill material present at the site. Discussion of the stability, settlement and construction of the approaches to the structure, as well as the lateral earth pressures that can be anticipated at the abutment structure locations are provided below.



### Slope Stability

The composition of the forward slopes at the proposed structure will vary due to the non-uniform nature of the fill material placed at the site. It is recommended that all slopes, both longitudinal cut slopes along the Hwy. 416 cut and transverse slopes of approach fills placed at the east abutment, be constructed at 2H:1V. The cut slopes should be further protected by placing a 0.6 m thick granular blanket consisting of free draining material such as Granular 'A' material on the cut slopes. Normal slope vegetation cover should be established as soon as possible after completion of the excavation cut to control surface erosion.

Localized slope sloughing can develop during the excavation of the cut slopes due to the irregular composition of the fill material. Should this development occur, overexcavation of the cut slopes may be required such that the sloughed material and any anomaly in the fill material is removed. In such a case, the protective granular blanket may have to be extended deeper from the surface of the slope.

In locations where excavation cuts are advanced in fill material consisting of domestic refuse, it is recommended that this material be protected from surface runoff infiltration so that leachate generation is minimized. This can be achieved by the placement of a low permeability soil cap composed of suitable clay material (see OPSS 1205).

### Settlement of East Approach Fills

The settlement of the east approach fills, as a result of (a) the elastic recompression of the native subsoil caused by the embankment loading and (b) settlements within the fill itself are anticipated to be less than 25 mm in magnitude. It is expected that these settlements will be realized during or immediately following construction.

### Lateral Earth Pressure on Structure

Free draining material such as Granular 'A' or Granular 'B' shall be used within a wedge behind the abutments bounded by a plane rising at 60° to the horizontal as shown in Figure 6-9.6.1 of the O.H.B.D.C. The application of granular material combined with weep holes in the abutment walls to drain any accumulation of water in the backfill will prevent hydrostatic pressure build-up. Design parameters of soil are given in Table 5 below.

Table 5 - Backfill Properties

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction ( $\phi$ ) (unfactored)	35°	30°
Unit Weight (kN/m <sup>3</sup> )	22.8	21.2
*Coefficient of Active Earth Pressure (K <sub>a</sub> )		
- S.L.S.	0.27	0.33
- U.L.S.	0.33	0.4
*Coefficient of Earth Pressure at Rest (K <sub>o</sub> )		
- S.L.S.	0.43	0.5
- U.L.S.	0.5	0.58

\*These earth pressure coefficients apply to horizontal backfill surfaces only.  
The appropriate consideration shall be given to account for sloping backfill.

The earth pressure coefficient at rest is to be used in design if the abutments are rigid and unyielding.

### Embankment Construction

In the construction of the embankment fills, all loosened and/or organic material should be excavated for their fill depth within the plan limits prior to fill placement. The fills should be placed and compacted according to MTO Specifications and standards (OPSS 206.07.07 and 501 series).

Heavy compaction equipment should not be used behind the abutment walls within a lateral distance equal to the current height of fill above the wall footing in order to avoid imposing damage or deflection to the wall during the fill placement.

#### HWY. 416 ROADWAY DESIGN SUBEXCAVATION

It is recommended that all fill material that presently exists below the proposed Hwy. 416 grade be subexcavated and replaced with suitable subbase and base material as per current MTO requirements.

#### CONSTRUCTION CONSIDERATIONS

- 1) In the construction of the shallow foundations, a concrete working slab should be provided immediately following excavation to protect the bearing surface of the founding soil at the footing location from the effects of weathering and other disturbances.
- 2) In view of the depressed water table at the time of the investigation, it is anticipated that the water table will remain below the founding elevation of either the spread footings or the pile caps, and consequently, no dewatering problems are anticipated during foundation construction.
- 3) Temporary slopes excavated within the fill material at the site shall not be steeper than 2H:1V.

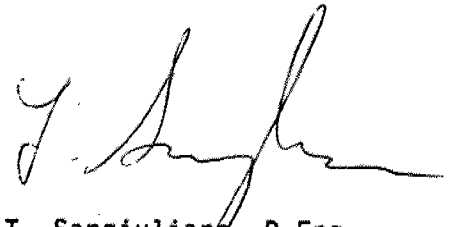
#### ENVIRONMENTAL CONSIDERATIONS

Results of an environmental investigation regarding fill extent and composition, gas generation and characteristics and groundwater flow and quality have been provided in a report prepared by Conestoga-Rovers and Associates entitled "Abandoned Landfill Site Investigation - Bruce Pit". Details of this information can be obtained from this report. Environmental considerations including the limits of excavation and disposal of the fill material and environmental monitoring programs are beyond the scope of this report.

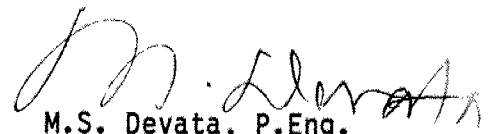
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano Foundation Engineer and F. Tannous, Engineering Trainee, utilizing equipment owned and operated by Johnston Drilling Ltd. and Marathon Drilling. Rock Core logging in the laboratory was carried out by D. Williams, Petrographer.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer, and approved by M.S. Devata, Chief Foundation Engineer.



T. Sangiuliano, P.Eng.  
Foundation Engineer



M.S. Devata, P.Eng.  
Chief Foundation Engineer

## APPENDIX

## 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
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

# ROCK CORE DESCRIPTION

## WP 121-87-06

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	18	23.80-24.10	100	0	23.80-24.10	OVERBURDEN (boulder till).
	19	24.10-25.66	100	75	24.10-25.66	DOLOSTONE, brownish grey; fine to medium crystalline; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat, planar to undulating, smooth.
3	18	22.56-23.22	77	29	22.56-22.84	OVERBURDEN (boulder till).
	19	23.22-24.44	100	90	22.84-24.44	DOLOSTONE, brownish grey; fine to medium crystalline; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat, planar to undulating, smooth.

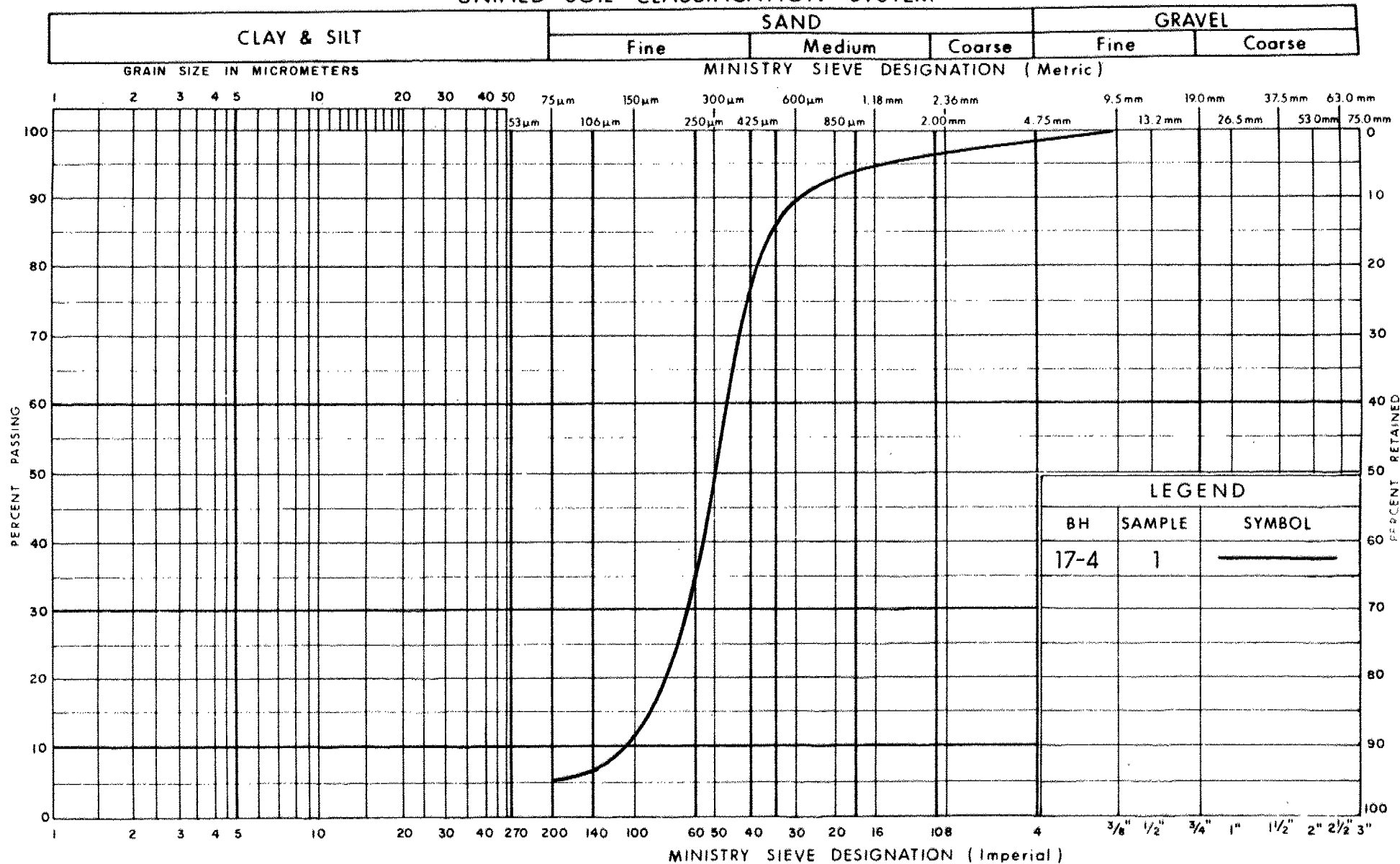
\*CR = CORE RECOVERY

\*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

## UNIFIED SOIL CLASSIFICATION SYSTEM



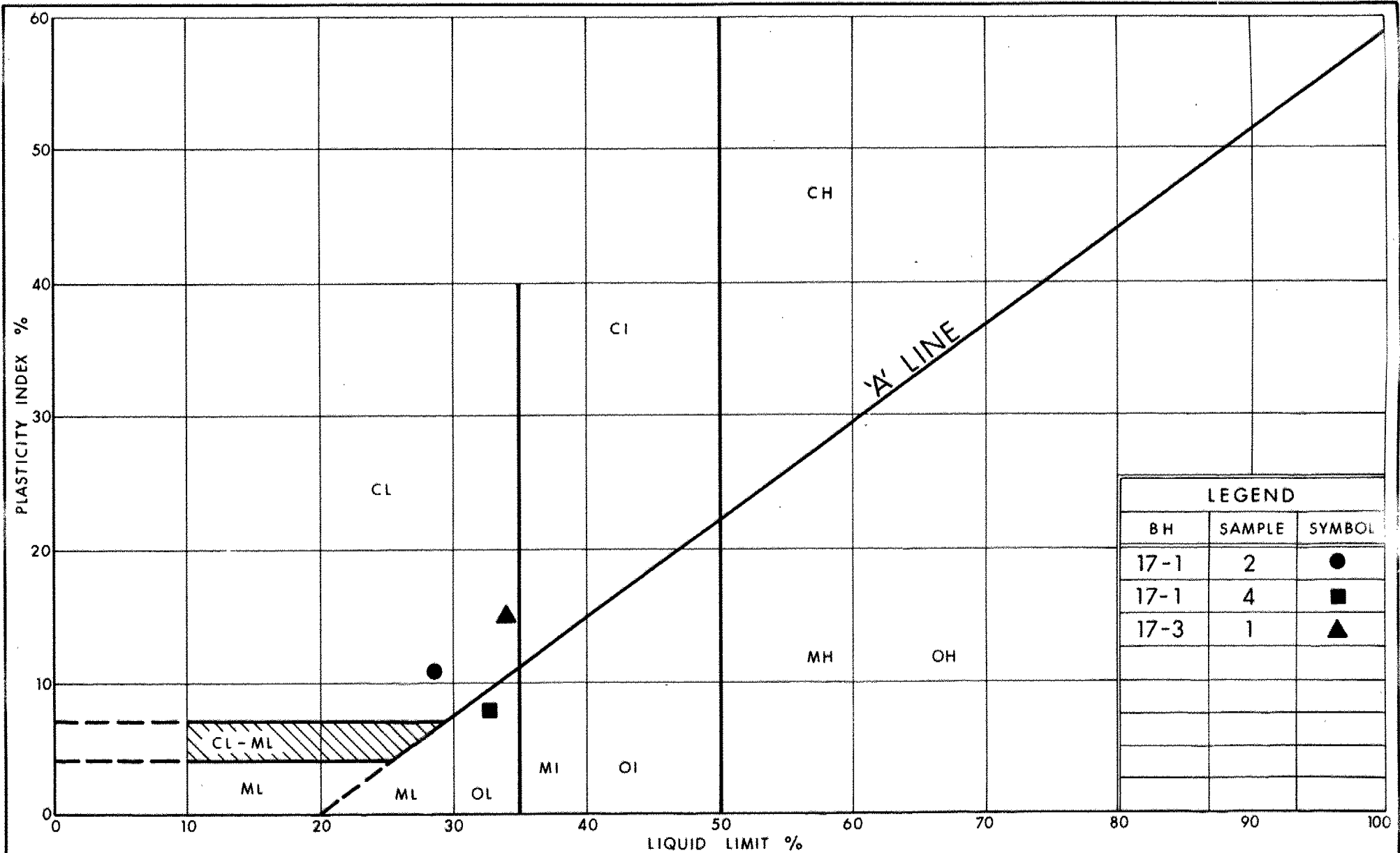
Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION SAND TRACE SILT (FILL)

FIG No 1

W P 121-87-06





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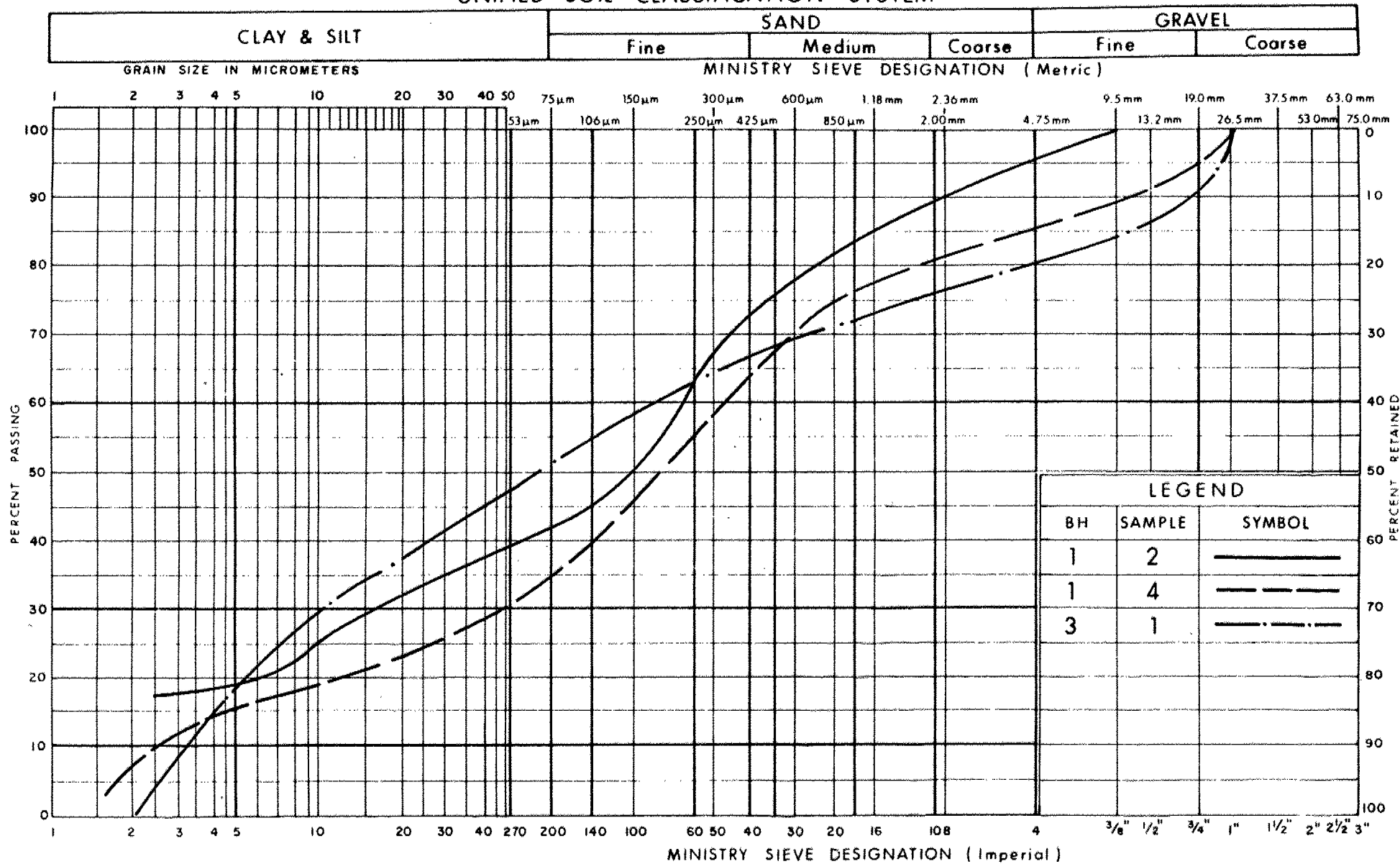
Ontario

PLASTICITY CHART  
IRREGULAR MIXTURE OF CLAYEY SILT, SAND & GRAVEL  
WITH TRACES OF ASH, ORGANICS & WOOD (FILL)

FIG No 2

W P 121-87-06

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

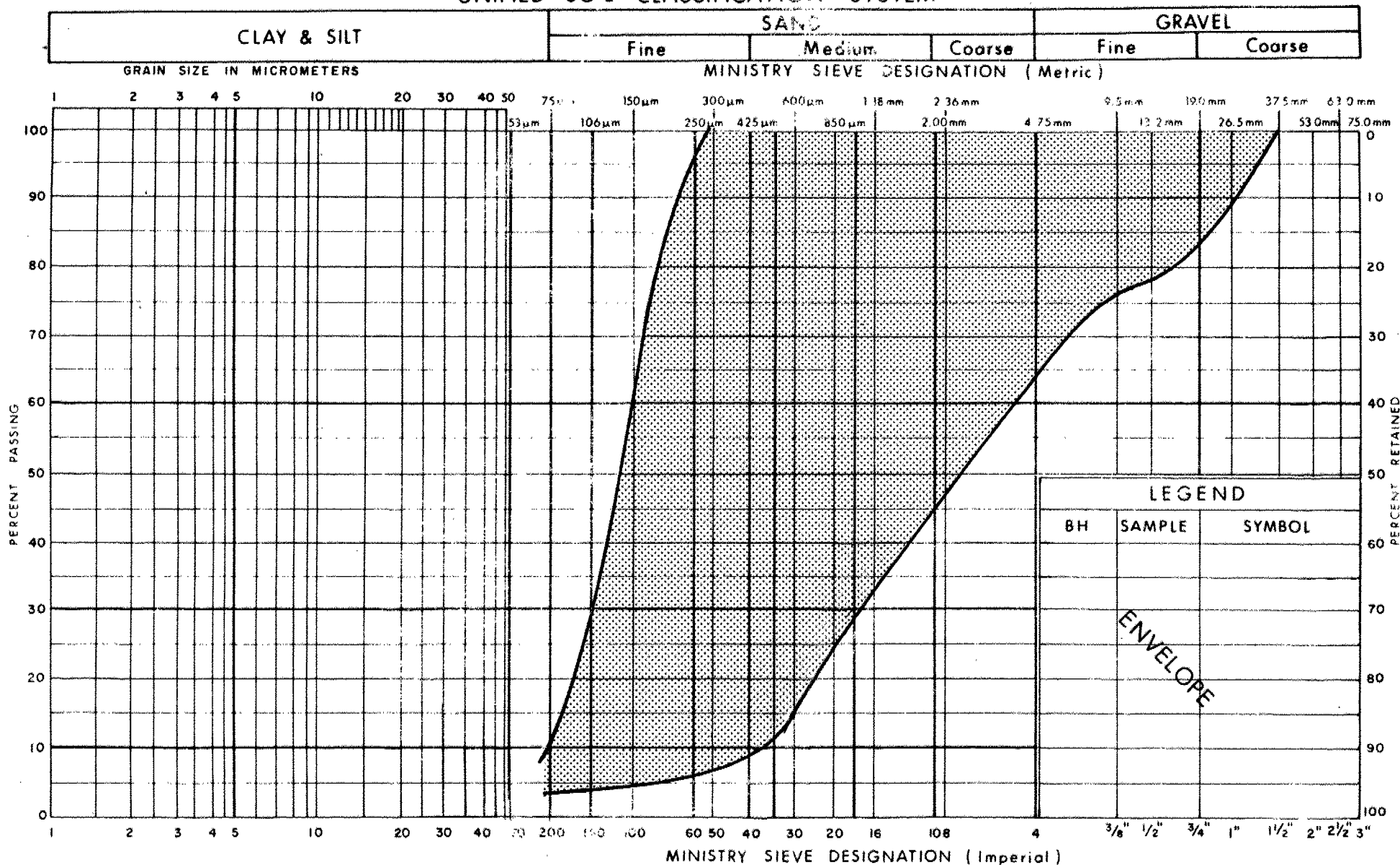
Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**IRREGULAR MIXTURE OF CLAYEY SILT, SAND & GRAVEL**  
**WITH TRACES OF ASH, ORGANICS & WOOD (FILL)**

FIG No 3

W P 121-87-06

## UNIFIED SOIL CLASSIFICATION SYSTEM



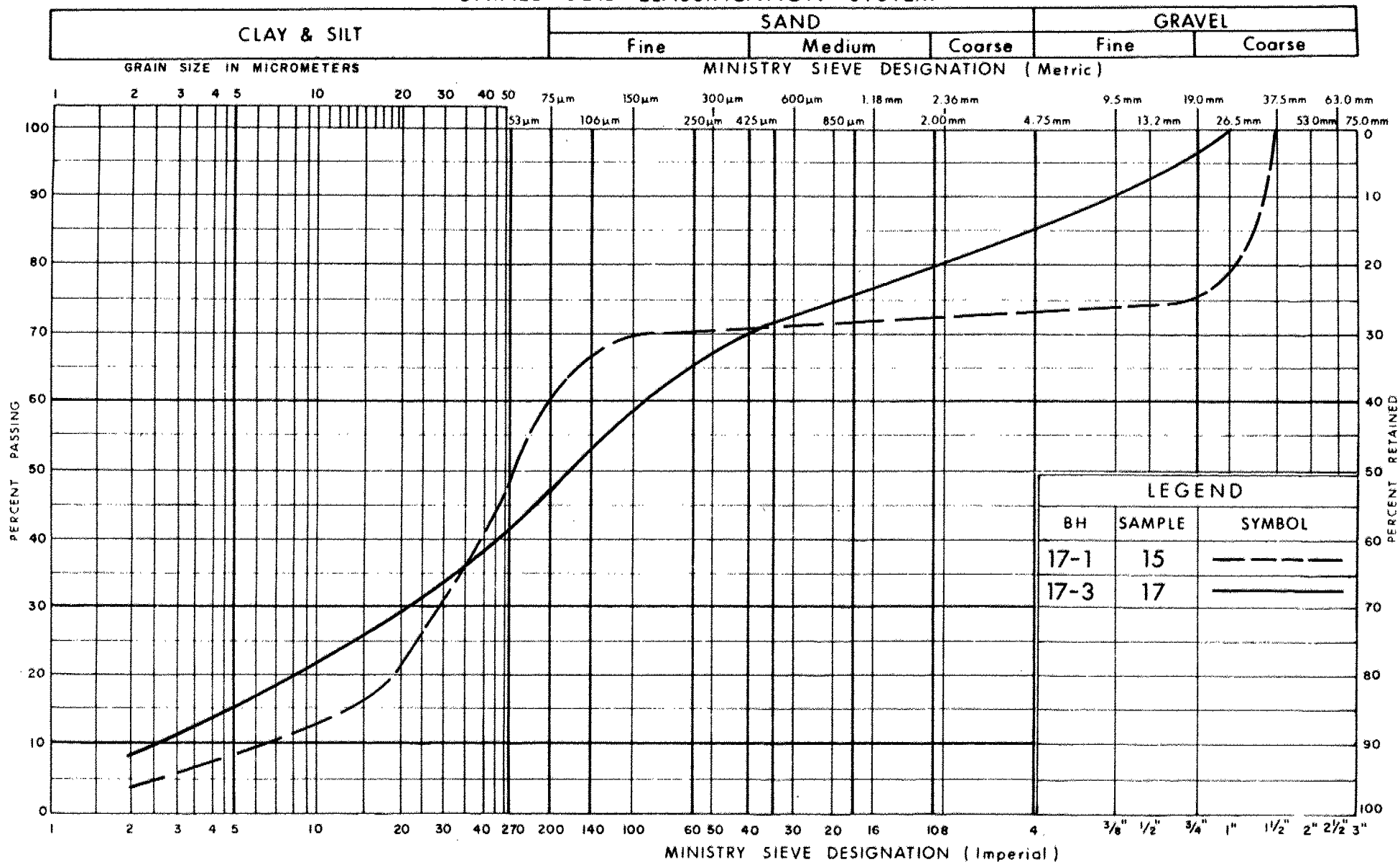
Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION SAND TO GRAVELLY SAND

FIG No 4

W P 121-87-04

## UNIFIED SOIL CLASSIFICATION SYSTEM



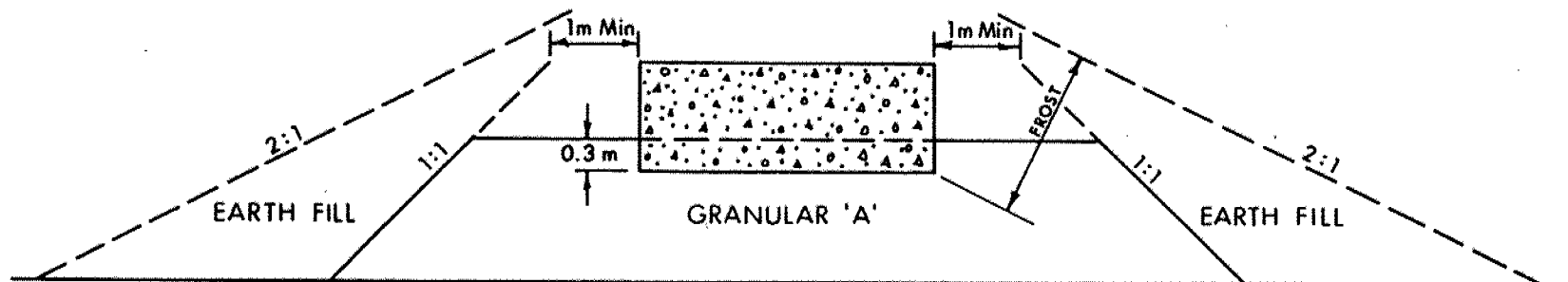
Ontario

Ministry of  
Transportation

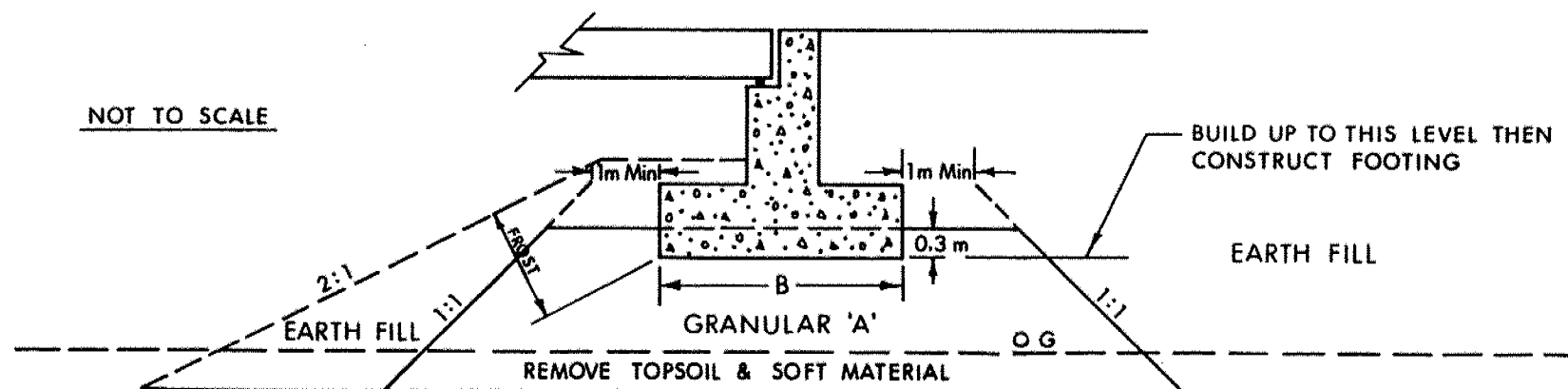
**GRAIN SIZE DISTRIBUTION**  
**HETEROGENEOUS MIXTURE OF SILT, SAND, GRAVEL,**  
**COBBLES & BOULDERS (GLACIAL TILL)**

FIG No 5

W P 121-87-06



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 O STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING.
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



Ontario

Ministry of  
Transportation

ABUTMENT ON COMPACTED FILL  
SHOWING GRANULAR 'A' CORE

FIG No 6

W P 121-87-06

# RECORD OF BOREHOLE No 17-1 1 OF 1 METRIC

W.P. 121-87-06 LOCATION Co-ords N5 020 689.5, E 359 118.5 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE HS AUGER, BW/AW Casing, Washboring, AQ Rock Core COMPILED BY TS  
 DATUM Geodetic DATE 90 12 17-20 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
97.4	Ground Surface													
0.0	Irregular Mixture of Clayey Silt, Sand and Gravel with traces of ash and wood (Fill Material) Brown, Very Soft to Firm		1	SS	6		97							5 53 25 17
			2	SS	2									
			3	SS	2		95							14 51 27 8
			4	SS	4									
92.1			5	SS	11		93							
5.3	Compact Dense to Very Dense		6	SS	9		91							29 68 (3)
			7	SS	30									
	Gravelly Sand trace Silt Brown		8	SS	39		89							36 55 (9)
			9	SS	52									
			10	SS	66		87							27 62 (11)
			11	SS	45									
			12	SS	48		85							
			13	SS	40		83							
			14	SS	34		81							27 61 (12)
79.1			15	SS	50		79							
18.3	Heterogeneous Mixture of Silt, Sand, Gravel, Cobbles and Boulders (Glacial Till) Grey, Very Dense		16	RC	REC 6%		77							27 14 55 4
73.3			17	SS	172		75							RQD = 0%
24.1	Bedrock, Dolostone Grey, Medium Strong Unweathered		18	RC	REC 100%		73							RQD = 0%
25.7	End of Borehole		19	RC	REC 100%									RQD = 75%
	* 90 12 21													

# RECORD OF BOREHOLE No 17-3 1 OF 1 METRIC

W.P. 121-87-06 LOCATION Co-ords N5 020 707.0, E 359 169.5 ORIGINATED BY FT  
DIST 9 HWY 416 BOREHOLE TYPE HS Auger, BW Casing, Washboring, Rock Coring COMPILED BY TS  
DATUM Geodetic DATE 90 12 17-20 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
95.8	Ground Surface													
0.0	Irregular Mixt. of Clayey Silt, Sand and Gravel with traces of Organics (Fill Material)		1	SS	3		95							19 28 43 10
94.6			2	SS	3									1 94 (5)
1.2	Sand with traces of Black Cinder, Bottles and Wood (Fill Material)		3	SS	7		93							
	Brown, Loose to Very Loose		4	SS	6									
91.2			5	SS	7		91							
4.6	Loose		6	SS	34									0 90 (10)
			7	SS	39									
			8	SS	40		89							
	Sand, trace Silt		9	SS	30									
	Compact to Dense		10	SS	29		87							
			11	SS	25									
	Brown		12	SS	6**		85							
	Grey		13	SS	19									
			14	SS	37		83							
			15	SS	47		81							0 90 (10)
			16	SS	35		79							
76.0			17	SS	20		77							
19.8	Heterogeneous Mixture of Silt, Sand, Gravel, Cobbles and Boulders (Glacial Till)						75							16 39 40 5
73.2	Grey, Compact													
22.6	Bedrock, Dolostone		18	RC	REC	77%	73							RQD = 27%
71.4	Grey, Medium Strong		19	RC	REC	100%								RQD = 90%
24.4	Unweathered													
	End of Borehole													
	* 90 12 21													
	** Disturbed Sample (Unbalanced Hydrostatic Head)													

# RECORD OF BOREHOLE No 17-4 1 OF 1 METRIC

W.P. 121-87-08 LOCATION Co-rds N5 020 688.0 E 359 096.0 ORIGINATED BY FT  
 DIST 9 HWY 416 BOREHOLE TYPE HS Auger COMPILED BY TS  
 DATUM Geodetic DATE 90 12 21 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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									
								○ UNCONFINED	+ FIELD VANE								
								● QUICK TRIAXIAL	* LAB VANE								
								20 40 60 80 100									
98.2	Ground Surface																
0.0	Sand, trace silt					DRY *	98									0 94 (6)	
	Brown, Compact																
96.2	(Fill Material)		1	SS	11												
2.0			2	SS	12												
	Compact																
	Very Dense																
	Sand		3	SS	100	/15cm	96									12 82 (6)	
	some gravel, trace silt		4	SS	100	/10cm											
	Brown		5	SS	100	/10cm	95										
			6	SS	100	/15cm											
							94										
88.6			7	SS	100												
9.6	End of Borehole																
	* 90 12 21																



# RECORD OF BOREHOLE No 17-5 1 OF 1 METRIC

W.P. 121-87-06 LOCATION Co-ords N5 020 707.0, E 359 186.0 ORIGINATED BY FT  
 DIST 9 HWY 416 BOREHOLE TYPE HS Auger COMPILED BY TS  
 DATUM Geodetic DATE 90 12 21 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
94.8	Ground Surface													
0.0														
	Loose		1	SS	7									
	Compact to Very Dense		2	SS	42									
	Sand, trace Silt		3	SS	35									
	Brown		4	SS	71									
	Grey		5	SS	61									
			6	SS	53									
85.2	Sand and Silt		7	SS	21									
9.6	End of Borehole													
	90 12 21 * GROUND WATER CONDITIONS													
	PIEZO. NO.													
	GROUND WATER ELEVATION (Metres)													
	1													
	86.8													

# RECORD OF BOREHOLE No 17-6 \*\* 1 OF 1 METRIC

W.P. 121-87-06 LOCATION Co-ords N5 020 683.4, E 359 216.4 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE Cons Test, Hollow Stem Auger COMPILED BY TS  
 DATUM Geodetic DATE 88 11 28 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
91.2	Ground Surface												
0.0	Sand Brown, Compact (Fill Material)		1	SS	10								
89.7			5	SS	40								
1.5	Sand with Occ. Silt seams  Brown, Dense to Very Dense		3	SS	32								
			4	SS	38								
			5	SS	68								
84.6			6	SS	21								
6.6	End of Borehole ** Formerly BH 1 (WP 125-87-00) • 88 11 28												

# RECORD OF BOREHOLE No 17-7 \*\* 1 OF 1 METRIC

W.P. 121-87-06 LOCATION Co-ords N5 020 706.0, E 359 205.1 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test, Hollow Stem Auger COMPILED BY TS  
 DATUM Geodetic DATE 88 11 28 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
93.3	Ground Surface												
0.0	Sand, Brown Very Loose		1	SS	2								
91.8	(Fill Material)		2	SS	2								
1.5	Domestic Refuse (Garbage) with Black Cinder/Ash		3	SS	4								
89.9	(Fill Material)		4	SS	35								
3.4	Sand with Occasional Silt Seams Grey, Dense to Very Dense		5	SS	70								
			6	SS	70								
			7	SS	60								
			8	SS	40								
85.2													
8.1	End of Borehole												
	** Formerly BH 2 (WP 125-87-00)												
	88 11 28 * GROUND WATER CONDITIONS												
	PIEZO. NO. 1												
	GROUND WATER ELEVATION (Metres) 87.8												

# RECORD OF BOREHOLE No 17-8 1 OF 1 METRIC

W.P. 121-87-06 LOCATION Co-rds N5 020 898.7, E 359 213.2 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test, Hollow Stem Auger COMPILED BY TS  
 DATUM Geodetic DATE 88 11 28 CHECKED BY JP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80						100			
92.8	Ground Surface																			
0.0	Sand Brown, Compact (Fill Material)	X	1	SS	12															
91.6		X	2	SS	8															
1.2	Domestic Refuse (Garbage) with Black Cinder/Ash (Fill Material)	X	3	SS	100															
90.5		X	4	SS	60															
2.3	Sand with Occasional Silt seams Grey, Dense to Very Dense	.	5	SS	65															
		.	6	SS	30															
86.2		.																		
6.6	End of Borehole																			
** Formerly BH3 (WP 125-87-00)  88 11 28 * GROUND WATER CONDITIONS <table border="1"> <tr> <th>PIEZO. NO.</th> <th>GROUND WATER ELEVATION (Metres)</th> </tr> <tr> <td>1</td> <td>5.5</td> </tr> </table>		PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	5.5															
PIEZO. NO.	GROUND WATER ELEVATION (Metres)																			
1	5.5																			

# RECORD OF BOREHOLE No 17-9 " 1 OF 1 METRIC

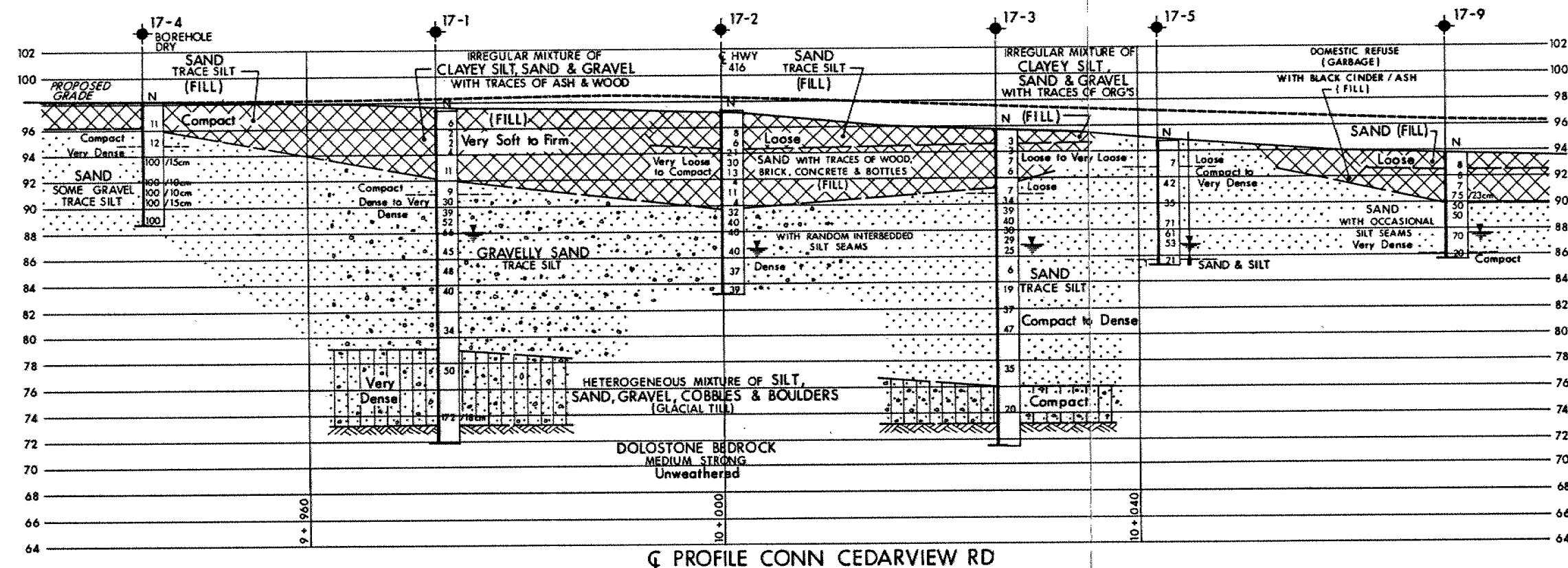
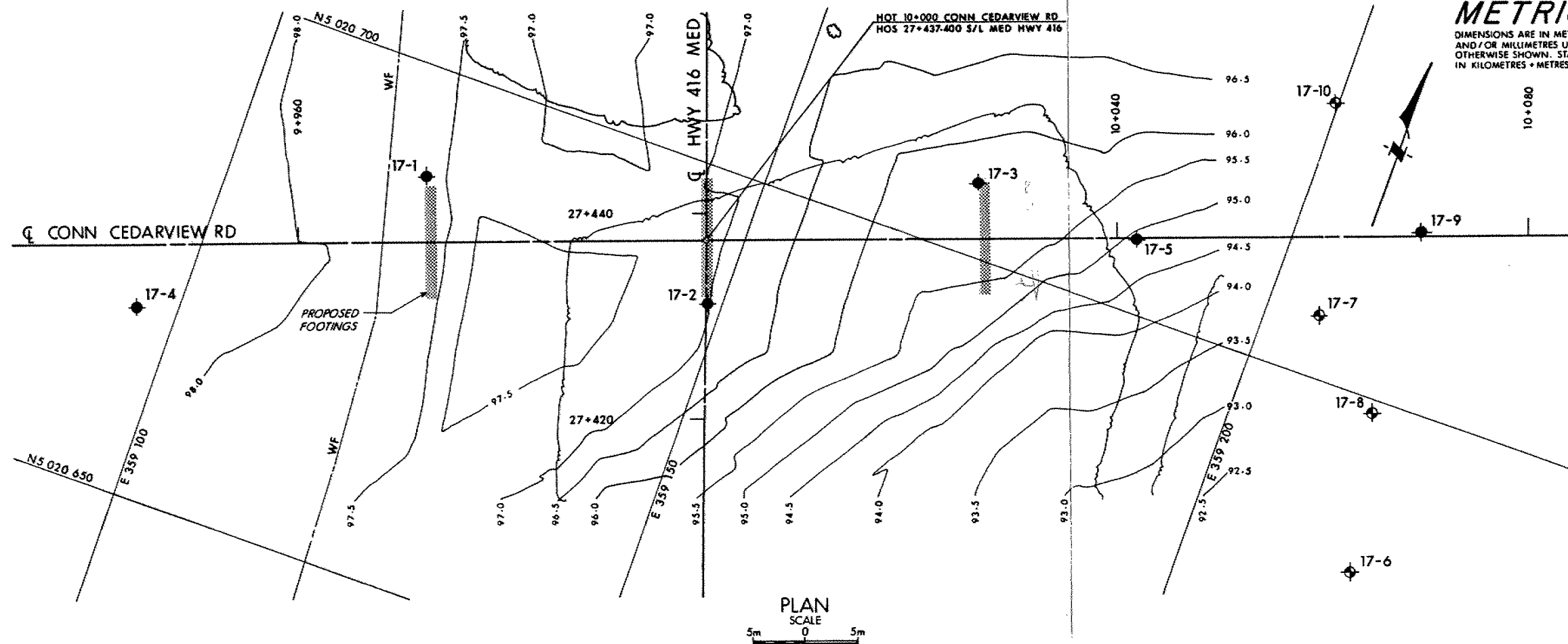
W.P. 121-87-06 LOCATION Co-ords N5 020 717.0, E 358 211.7 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TS  
 DATUM Geodetic DATE 88 11 29 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
93.7	Ground Surface																
0.0	Sand Brown, Loose (Fill Material)		1	SS	8	/23cm	93										
92.5			2	SS	8												
1.2	Domestic Refuse (Garbage) with Black Cinder/Ash (Fill Material)		3	SS	7		91										
			4	SS	75												
89.9			5	SS	50												
3.8	Sand with Occasional Silt seams Grey, Very Dense		6	SS	50		89										
			7	SS	70												
							87										
85.6	Compact		8	SS	20												
8.1	End of Borehole																
	* 88 11 29																
	** Formerly BH4 (WP 125-87-00)																

# RECORD OF BOREHOLE No 17-10" 1 OF 1 METRIC

W.P. 121-87-06 LOCATION Co-ords N5 020 726.0, E 359 199.6 ORIGINATED BY TS  
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test COMPILED BY TS  
 DATUM Geodetic DATE 88 11 29 CHECKED BY JP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
95.4	Ground Surface												
0.0	Probable Sand (Fill Material)												
94.9													
1.5	Probable Sand												
90.3													
6.1	End of Borehole (Cone Test)												
	**Formerly BH 5 (WP 125-87-00)												



SCALE  
5m 0 5m Hor  
4m 2 0 4m Vert

## NOTE

Subsoil information for BH 17-6, 17-7, 17-8, & 17-10 refer to Record of Borehole sheets

REF No E-52-416-15, 89 10

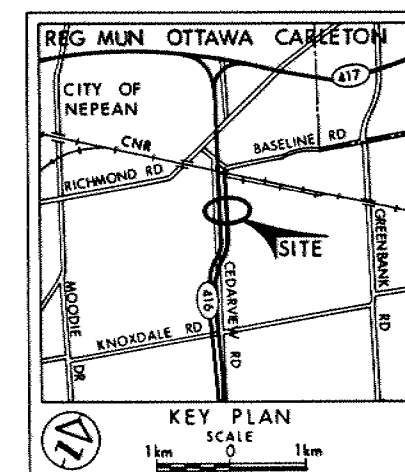
CONT No  
WP No 121-87-06

CEDARVIEW RD UNDERPASS

BORE HOLE LOCATIONS &amp; 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 90 11, 90 12 and 91 01
- W.L. in Piezometer
- Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
17-1	97.4	5 020 689.5	359 118.5
17-2	97.3	5 020 687.0	359 148.6
17-3	95.8	5 020 707.0	359 169.5
17-4	98.2	5 020 668.0	359 096.0
17-5	94.8	5 020 707.0	359 186.0
17-6	91.2	5 020 683.4	359 216.4
17-7	93.3	5 020 706.0	359 205.1
17-8	92.8	5 020 698.7	359 213.2
17-9	93.7	5 020 717.0	359 211.7
17-10	96.4	5 020 726.0	359 199.6

## 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			
Geacres No 31G5-181			
HWY No 416			
SUBMD T5	CHECKED	DATE 91 06 19	DIST 9
DRAWN DT	CHECKED	APPROVED	SITE 3-545
			DWG 1218706-A

