DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 40P9-34

DIST. 3 REGION

W.P. No. 533-91-02

CONT. No. 96-37

W. O. No.

STR. SITE No. 35-576

HWY. No. 6

LOCATION Hwy 6 & 24 N-E/W Ramp Under C.N.R

No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

Ministry
of
Transportation
Ontario

**FILE No.** _____ **DATE** _____

**REMARKS** NEAREST INVESTIGATION
HWY 6 & CNR SUBWAY
W.P. 109-68-09 SITE # 35-407
GEOCRES # 40P9-14

| W.P.#1 | C.N.R. RE/WR (REFER. |
|---|---|
| POINT M.T.O. DWG.-E-153-6-1) | |
| N 4 820875.809 | |
| E 242779.056 | B/R EL.322.383 |
| POC 10+143.876 | N-E/W RAMP |
| HOT 10+000.000 | C.N.R. TRACK |

| W.P.#2 ℄ TRACK & PROF.CONTROL | (N-E/W RAMP) |
|---|---|
| N 4 820874.525 | |
| E 242779.421 | B/R EL.322.385 |
| POC 10+145.214 | N-E/W RAMP |
| HOT 10+001.129 | C.N.R. TRACK |

| W.P.#3 ℄ TRACK & ℄ NORTH BRGS | |
|---|---|
| N 4 820890.176 | BRG.SEAT |
| E 242784.103 | T/C EL.319.400 |
| HOT 9+984.790 | B/R EL.322.360 |

| W.P.#4 ℄ TRACK & ℄ SOUTH BRGS | |
|---|---|
| N 4 820859.039 | BRG.SEAT |
| E 242774.788 | T/C EL.319.450 |
| HOT 10+017.290 | B/R EL.322.409 |

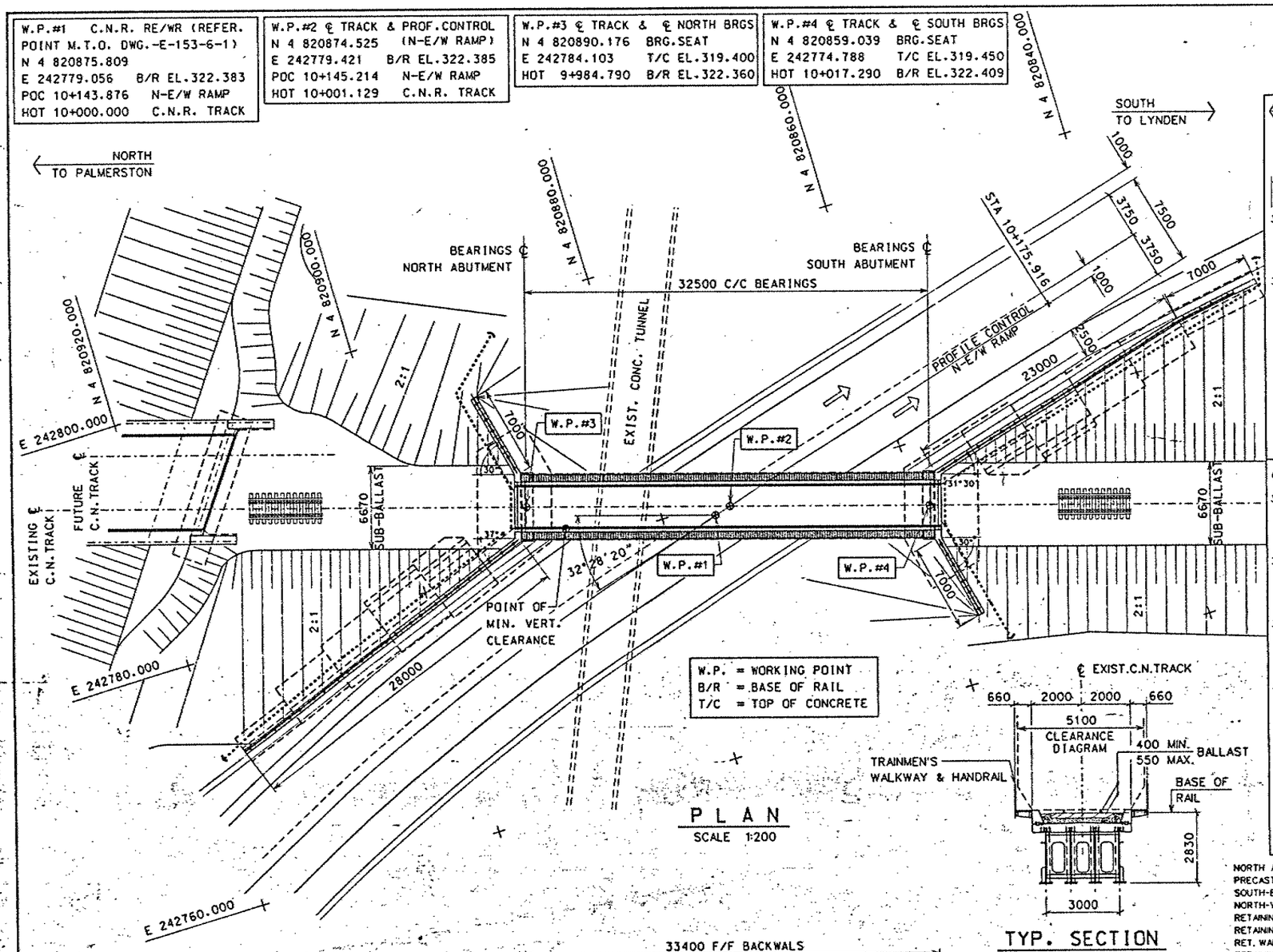
# METRIC

DIMENSIONS ARE IN METERS AND/OR MILLIMETERS UNLESS OTHERWISE SHOWN

DISTRICT No 2
CONT No 96-37
WP No 533-91-02

C.N.R. SUBWAY AT HANLON EXPRESSWAY
GENERAL ARRANGEMENT

SHEET 219




## PLAN

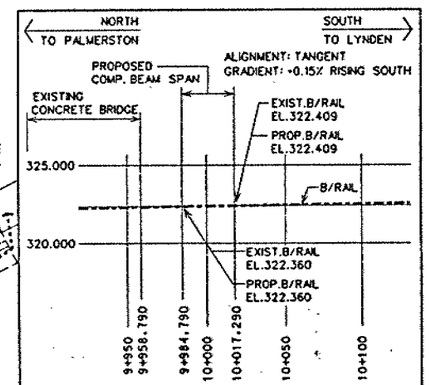
SCALE 1:200

W.P. = WORKING POINT
B/R = BASE OF RAIL
T/C = TOP OF CONCRETE



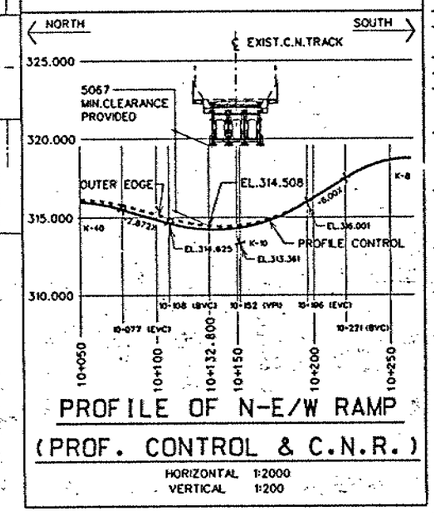

## TYP. SECTION

COMPOSITE BEAM SPAN
SCALE 1:100




## BASE OF RAIL PROFILE

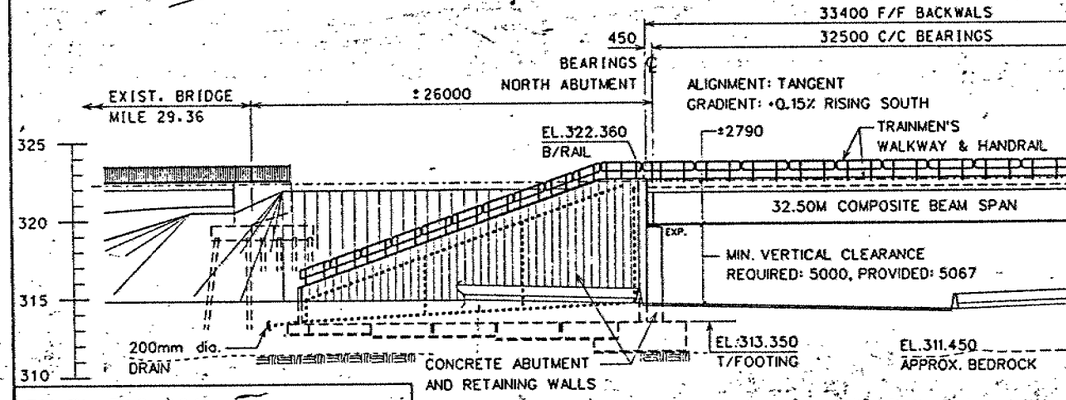
HORIZONTAL 1:2000
VERTICAL 1:200




## PROFILE OF N-E/W RAMP

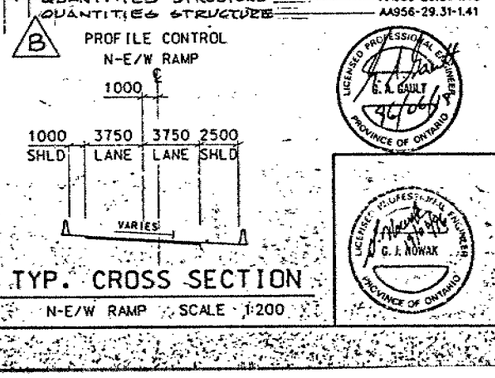
(PROF. CONTROL & C.N.R.)

HORIZONTAL 1:2000
VERTICAL 1:200




## ELEVATION

SCALE 1:200




## TYP. CROSS SECTION

N-E/W RAMP SCALE 1:200

BM EL.312.901m
TOP OF NE BOLT OF TRAFFIC SIGNAL & LS WEST OF HANLON NORTH OF HWY 24
18.91 LT 16+703.1 C/L HANLON EXPRESSWAY

EL.306.706 APPROX. EXIST. CONC. TUNNEL 3.353m dia.

## GENERAL NOTES:

STRUCTURE DESCRIPTION:

- A NEW STEEL BEAM SPAN WITH COMPOSITE DECK, SUPPORTED ON NEW ABUTMENTS IS TO BE BUILT, TO CARRY ONE C.N. TRACK OVER N-E/W RAMP - INTERCHANGE AT HANLON EXPRESSWAY AND WELLINGTON STREET
- THE TRACK ALIGNMENT AND GRADE ELEVATIONS TO REMAIN UNCHANGED

SPECIFICATIONS:

- DESIGN AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH A.R.E.A. MANUAL CHAPTER 8 AND 15, LATEST EDITION
- MATERIAL:
  - STRUCTURAL STEEL: C.S.A. CAN3-G40.21-M92, GRADE 350 AT
  - CONCRETE: C.S.A. CAN3-A23.1, -A23.2-M90
  - REINFORCING STEEL: C.S.A. CAN3-G30.18-M92

DESIGN LOADS:

- LIVE LOAD - COOPER E90 - DIESEL IMPACT
- DESIGN BALLAST DEPTH - 700mm

CLASS OF CONCRETE:

- DECK - 35MPa, REMAINDER - 30MPa

CLEAR COVER TO REINFORCING STEEL:

- FOOTINGS ---------- 100 : 25
- ABUTMENTS, WINGWALLS & RETAINING WALLS-FRONT FACE--- 80 : 20
  -BACK FACE--- 70 : 20
- DECK - TOP ---------- 60 : 20
- DECK - BOTTOM AND SIDES ---------- 50 : 10
- REMAINDER (UNLESS OTHERWISE NOTED) ---------- 70 : 20

REINFORCING STEEL:

- REINFORCING STEEL SHALL BE GRADE 400-BILLET STEEL, DEFORMED BARS BARS MARKED WITH THE PREFIX "C" DENOTE COATED BARS

SAFE BEARING PRESSURES:

- ABUTMENT AND RETAINING WALL FOOTINGS ON NATURAL SOIL: S.L.S. TYPE II - 500KPa, U.L.S. - 900KPa

CONSTRUCTION NOTES:

- FOR CONSTRUCTION NOTES REFER TO DRAWING AA956-29.31-1.3

NEAREST STATION:

- GUELPH JUNCTION MILE 30.00, FERGUS SUBDIVISION

REFERENCE DRAWINGS:

- M.T.O. SITE PLAN E-153-6-1

## LIST OF DRAWINGS:



B.A. Gault, P.ENG.
SENIOR STRUCTURAL ENGINEER

| No. | Date | Revision | By/Par |
|---|---|---|---|
| B | 96-06-19 | LIST OF DRAWINGS & ISSUED FOR TENDER | P.P. |
| A | 96-04-11 | ADDITIONAL DRAWING ADDED TO LIST | C.P. |

Region: Southern Ontario | District: | Subdivision: FERGUS | Mile: Mile 29.31

HANLON EXPRESSWAY
GUELPH, ONTARIO
GENERAL ARRANGEMENT

SITE:35-5761 DWG. 1

Drawn M.C. | Designed Conception | Checked Verification G.C. | Scale Schelle 1:200 U.N. | Date 31-10-94

Office of Chief Engineer
Bureau de l'Ingénieur en chef

File Reference 29.31 FERGUS | Drawing Number Dessin Numéro AA956-29.31-1.1 | B

FILE COPY

# ENGINEERING MATERIALS OFFICE

## FOUNDATION DESIGN SECTION

CONT 96-37

WP 533-91-02 DIST 3

HWY 6 & 24 STR SITE 35-576

Proposed Hwy. 6 N-E/W Ramp Structure
(CNR Subway)

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GEOCRES 40P9-34 DATE JUL 27 1993

FOUNDATION INVESTIGATION REPORT

For

Proposed Hwy. 6 N-E/W Ramp Structure

(CNR Subway)

W.P. 533-91-02, Site 35-576

Hwy. 6 & 24, District 3, Stratford

## INTRODUCTION

This report summarizes the results of a foundation investigation conducted in conjunction with the proposed Hwy. 6 N-E/W ramp structure that will carry traffic beneath the existing CNR line (known as the Fergus subdivision) to Wellington Street (Hwy. 24). A rigid frame, single span subway structure will support the railroad tracks. Retaining walls have also been proposed on either side of the structure. The structures are components of the proposed upgrading of the Hwy. 6/ Hwy. 24 intersection in the City of Guelph.

## SITE DESCRIPTION AND GEOLOGY

The site is located approximately fifty(50) metres west of the existing four(4) span Hwy. 6/ CNR subway structure in the City of Guelph, Wellington County. The existing structure is a four span concrete beam structure that is located approximately two hundred(200) metres north of the existing Wellington Street (Hwy. 24) and Hanlon Expressway (Hwy. 6)

intersection. The Manor Motel is located on the northeast quadrant of the intersection and a gas station and a hardware store are located west of the intersection in close proximity of the proposed ramp roadway.

The site is characterized by a rolling terrain incised by excavation cuts. Prominent excavations exist at the existing Hwy. 6/CNR subway structure south approach and also north of the proposed ramp where apparently a sand and gravel pit once existed. Excavation slopes at the CNR tracks at the site are approximately three(3) to five(5) metres high and stable at approximately 3H:1V. The land is covered by grassland and small clusters of trees are located within the site area.

An existing 3.4 m diameter tunnel within the rock at the site underlies the proposed ramp structure. The tunnel which has an invert elevation of 303.1 m serves as a storm relief sewer. An open channel collects stormwater north of the site and water is then pumped within the tunnel beneath the tracks and south of Wellington Street, where the stormwater exits through a 3.4 m x 7.6 m multi-plate super span structure into an open channel. The stormwater eventually flows into the Speed River located further south at the site. A concrete block pumphouse and inlet shaft are present at the toe of the existing north railroad slope situated just west of the proposed S-E/W ramp alignment.

Physiographically, the site is located within the region known as the "Guelph Drumlin Field". Within this area, there are approximately 300 drumlins of all sizes. The drumlins in this

area are not closely spaced and there is intervening low lying grounds between the drumlins. This is for the reason that during the most recent Wisconsinan Glaciation period (approximately 12,000 years ago), the ice which moulded this field advanced from the southeast whilst the receding glacier moved perpendicular to this direction. As a result, the drainage of the ice front was directed to lower and lower outlets and hence the drumlin field is furrowed by parallel valleys running perpendicular to the trend of the drumlins. Along the sides of these valleys there are broad sand and gravel terraces.

As a product of the glacial activity the general landform pattern consists of drumlins or groups of drumlins fringed by gravel terraces. The dominant soil materials associated with these features are the unstratified, unsorted drumlin tills consisting of a heterogeneous mixture of gravels, sand and silts and the deep gravel terraces of the old meltwater spillways. Overburden in the site area is underlain by dolostones of the Amabel and Guelph Formations. Native overburden thicknesses are relatively shallow at the site and usually less than eleven(11) metres.

## INVESTIGATION PROCEDURES

### GENERAL

Soil and rock data and inherent properties were obtained by conducting both an in situ field investigation and laboratory analysis. Details of the field investigation and laboratory testing

program are discussed below.

The fieldwork for this project was conducted between 93 02 12 and 93 03 03 and consisted of a total of eleven(11) boreholes. The boreholes were advanced to depths ranging from 6.9 metres to 13.6 metres below the ground surface. All boreholes were advanced using conventional track mounted Central Mining Equipment (CME) 55 drilling units. Hollow stem augering techniques were used to penetrate the overburden at the site.

Disturbed subsoil samples were retrieved in the overburden using a 50 mm diameter split spoon sampler driven in accordance with the Standard Penetration Test (SPT-ASTM D1586). An automatic hydraulic tripping hammer mechanism was used to impart the standard driving energy. Samples were generally retrieved at 0.76 m intervals within a 5 metre significant depth of a potential shallow foundation elevation and at 1.5 m intervals beyond this depth.

Bedrock underlying the overburden was cored up to 3.2 metres in depth using conventional rock coring techniques. A NX core barrel within NW casing was used in the coring process.

All subsoil samples were identified in the field and then properly sealed in plastic containers to preserve natural moisture contents in the soil. The samples were then transported to the laboratory where additional visual classifications were carried out and pertinent laboratory tests were conducted as described in the next section below.

Rock core samples were also identified in the field and physical index properties were determined by visual examination and also by measurement of rock quality designations (RQD's) and rock core recovery. All rock core were placed in standard rock core boxes and carefully transported to the laboratory.

Groundwater levels were determined by monitoring the water levels in the open boreholes. All boreholes were backfilled upon completion of the fieldwork.

Laboratory Analyses

All subsoil samples were carefully visually examined in the laboratory in accordance with the procedures outlined in the Visual Method described in Chapter 2 of the MTO Soil Classification Manual. Natural moisture contents and soil gradations were determined by conducting the appropriate laboratory tests on representative samples. Sample preparation and testing was conducted in accordance with the MTO Laboratory Testing Manual.

Detailed rock core logging was conducted in the laboratory by an in-house resident geologist. The rock core logging includes descriptions of colour, grain size, bedding, jointing and strength.

Laboratory test results have been summarized below in the subsequent section of this report entitled "Subsurface Conditions" and are illustrated on the corresponding boreholes and

figures included in the Appendix to this report.

## SUBSURFACE CONDITIONS

### General

The subsurface conditions at the site consists of an extensive surficial native deposit comprised of a heterogeneous mixture of gravel, sand and silt underlain by dolostone bedrock. The heterogeneous mixture of gravel, sand and silt has a thickness ranging from 5.5 to 10.6 metres and has a denseness ranging from very loose to very dense. In general, however, its denseness ranges from compact to very dense. The dolostone bedrock is of the Guelph Formation and the bedrock surface elevation varies from 309.5 m to 312.4 m.

A plan of the site illustrating the locations and elevations of the boreholes and proposed structure foundation locations is shown on Dwg. No. 5339102-A in the Appendix. The proposed profile grade of the N-E/W ramp roadway and a stratigraphical section profile is also shown. The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation are shown on the stratigraphical profile section and also on the individual Record of Borehole sheets in the Appendix.

Detailed soil/rock descriptions are given below.

## SOIL/ROCK DESCRIPTIONS

### Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till)

The native surficial deposit at the site consists of a heterogeneous mixture of gravel, sand and silt that extends to depths ranging from 5.5 metres to 10.6 metres. This deposit is an unsorted, unstratified material of glacial till origin and as characteristic of these deposits, also contains boulders and cobbles. The deposit is predominantly brown, although traces of organics present within the surficial one to two metres gives the deposit a blackish hue at some locations.

A grain size distribution envelope produced by mechanical sieve and hydrometer analysis is given in Figure 1 in the Appendix. The results reveal a broad range of particle sizes ranging primarily from silt to gravel. The envelope does not include particle sizes larger than gravel. The broad range of particle sizes is typical of deposits of glacial till origin.

The 'N' values as determined by the Standard Penetration Test range from 4 blows/0.3 m to 60 blows/0.3 m indicating a denseness ranging from very loose to very dense. The larger 'N' values may be a reflection of the presence of the larger particle sizes in the deposit. In general, 'N' values exceed 10 blows/0.3 m and hence can be categorized as having a compact to very dense state of denseness. It appears that the material south of the CNR slope is of a "looser" denseness than the material elsewhere on the site.

Bedrock

The bedrock that underlies the heterogeneous mixture of gravel, sand and silt at the site consists of a light coloured dolostone of the Guelph Formation. Bedrock surface elevations ranged from 309.5 m to 312.4 m with surface elevations gradually increasing in a northward direction.

The dolostone bedrock is a chemical sedimentary rock that is medium grained. The rock is unweathered to slightly weathered and is featured by a porous "vug" texture and stylolites. The rock is very pale orange to yellowish brown and contains thin horizontal beds and very close to moderately close spaced vertical fractures. Detailed descriptions of the bedrock are attached in the Appendix in a report entitled "Description of Rock Core".

An assessment of the quality and strength of the rock was carried out by measuring core recoveries and Rock Quality Desginations (RQD's) in the field and physical index property testing. Recoveries were all at 100% and RQD's ranged from 10% to 100%. In general, however recoveries ranged from 50% to 90% indicating that the rock is of fair to good quality.

## DISCUSSION AND RECOMMENDATIONS

In conjunction with the proposed revamping of the interchange at the Hanlon Expressway (Hwy. 6) and Wellington Street (Hwy. 24), a new CNR subway structure has been proposed immediately west of the existing Hwy. 6-CNR Subway structure. The new structure will be one of two alternatives: a single span rigid frame or a beam type structure. The span of both althernatives will be approximately 11 m, with a width of 30 m and a skew span length of 14.5 m. The new structure will support the CNR tracks and enable transportation of vehicular traffic from Hwy. 6 North to Hwy. 24 East and West. Retaining walls have also been proposed on either side of the new structure parallel to the ramp roadway. The retaining walls will taper in height from approximately six(6) metres to two(2) metres.

The existing ground surface varies across the site from approximately 316.3 m to 322.1 m. The proposed Hwy. 6 profile grade varies from 315.5 m to 317.1 m. Therefore excavation cuts ranging in depth from approximately 1.5 m to 6.5 metres will be required to facilitate the construction of the structures and ramp roadway.

A plan illustrating the proposed structures and profile grade is shown on Dwg. No. 5339102-A in the Appendix. Recommendations to facilitate the design and construction of the proposed structure foundations and related earthworks are included in the purview of this report.

## 1) CNR SUBWAY STRUCTURE FOUNDATIONS

In view of the competent nature and denseness of the native heterogeneous mixture of gravel, sand and silt below the proposed Hwy. 6 profile grade, it is recommended that the CNR subway structure be founded on conventional shallow foundations or spread footings supported by the native soil at or below Elevation 315 m. All footings must be protected against frost penetration by providing a minimum 1.2 m earth cover or equivalent frost protection. Therefore, the selection of the footing elevation below the proposed profile grade must reflect this requirement. For purposes of the O.H.B.D.C., all footings found on the native heterogeneous mixture of gravel, sand and silt as described above can be designed as summarized in Table 1 below.

| Table 1 - Spread Footings on Native Soil | |
|---|---|
| Factored Capacity at U.L.S. (kPa) | Bearing Capacity at S.L.S. Type II (kPa) |
| 900 | 500 |

The bearing capacity at the Serviceability Limit State (S.L.S.) Type II represents the bearing pressure that will produce 25 mm of total or differential settlement.

The capacities tabulated in Table 1 pertain to vertical normal loads only. Reductions of

bearing capacities to account for inclined loadings shall conform to factors provided in Section 6-7.3.3.5 of the O.H.B.D.C.

The sliding resistance of the spread footing founded on the native soil can be computed by employing an unfactored angle of friction of 35° between the concrete footing and the bedrock surface. Should additional horizontal resistance to sliding be required, shear keys can be incorporated. The passive resistance of the shear key can be computed using an angle of internal friction of 35° and a bulk unit weight ($\gamma$) of 20 kN/ $m^3$. The lateral resistance of shallow foundations shall be computed in accordance with Section 6-7.3.3.2 of the O.H.B.D.C.

Any loosened material at the founding elevation shall be removed and replaced with mass concrete or compacted Granular 'A' material. In addition, to protect the founding surface against weathering and disturbance caused by construction activity, it is recommended that a 100 mm thick lean mix concrete coating be placed on the native soil surface within four(4) hours of exposure.

## BACKFILL TO STRUCTURE

### Material

It is recommended that Granular 'A' or Granular 'B' material be placed within a wedge

behind the abutments bounded by a plane rising as shown in OPSD 3501. The application of this granular material combined with weep holes in the abutment walls or pipe subdrains to drain any accumulation of water in the backfill will prevent hydrostatic pressure build-up. Furthermore, this granular material can be effectively compacted and is not frost susceptible.

Design parameters of the soil are given in Table 2 below. Computations of lateral earth pressure shall be in accordance with Section 6-6.1.2 of the O.H.B.D.C.

**Table 2 - Backfill Properties**

| | Granular 'A' | Granular 'B' |
|---|---|---|
| Angle of Internal Friction ($\phi$) (unfactored) | 35° | 30° |
| Unit Weight (kN/m$^3$), $\gamma$ | 22.8 | 21.2 |
| *Coefficient of Active Earth Pressure ($K_a$) - S.L.S. | 0.27 | 0.33 |
| - U.L.S. | 0.33 | 0.40 |
| *Coefficient of Earth Pressure at Rest ($K_o$) - S.L.S. | 0.43 | 0.50 |
| - U.L.S. | 0.50 | 0.58 |

*These earth pressure coefficients apply to horizontal backfill surfaces only. The appropriate consideration shall be given to account for sloping backfill. The coefficient of earth pressure at rest shall be applied for rigid and unyielding walls.

Backfilling and Compaction

The backfill shall be placed in 300 mm lifts in accordance with OPSS 902 series and compacted to achieve the target maximum dry density as outlined in OPSS 501.070.08. The backfill shall be constructed in such a manner that the maximum differential in backfill heights on alternating sides of the rigid box structure does not exceed 300 mm at any one time.

Heavy vibratory equipment should be avoided in the backfill construction adjacent to the structure. It is therefore recommended that hand compaction equipment be employed in backfilling behind the abutments within a lateral distance equal to the current height of fill above the wall footing, in order to minimize deflection or possible damage of the wall. A special provision shall be included in the contract documents to impose this restriction.

Settlement

Provided that the material selection and compaction procedure is carried out as described

above, settlement of the backfill will be minimal and expected to be less than 25 mm. This settlement will be the result of loading caused by the self weight of the backfill and is expected to be realized almost instantaneously.

## 2) RETAINING WALLS OR EXCAVATION CUT SLOPES

### General

Excavation cuts are required within the existing soils as mentioned previously to facilitate the advancement of the Hwy. 6 N-Hwy. 24 E/W ramp roadway. Retaining walls have been proposed to support the soils adjacent to the roadway. The retaining walls can be the conventional reinforced concrete walls or mechanically stabilized reinforced earth walls. Alternatively, consideration can be given to simply sloping the excavation at a stable gradient. These alternatives are described below. The alternate which is deemed the most economical and technically feasible shall be selected.

### Retaining Wall Design Criteria

The design of retaining walls must satisfy the following criteria:

(1) Bearing Capacity

(2) Overturning

(3) Sliding

(4) Global Stability

These design parameters are discussed below.

## CONVENTIONAL REINFORCED CONCRETE WALLS

### Bearing Capacity

All the retaining walls can be founded on conventional spread footings located within the native heterogeneous mixture of gravel, sand and silt. In view of the varying denseness of the deposit, bearing capacities have been provided for selected segments of the proposed retaining walls. The bearing capacities and founding elevations have been summarized in Table 3 below.

**Table 3 - Retaining Wall Bearing Capacities**

| Station | Factored Capacity at U.L.S. (kPa) | Bearing Capacity at S.L.S. Type II (kPa) | Founding Elevation (m) |
|---|---|---|---|
| 10+025-10+120 | 900 | 500 | ≤315.5 |
| 10+120-10+180 | 900 | 500 | ≤315 |
| 10+180-10+220 | 700 | 200 | 316 |

The bearing capacity at the Serviceability Limit State (S.L.S. Type II) represents the bearing pressure that will yield 25 mm of total or differential settlement.

The capacities tabulated in Table 3 pertain to vertical normal loads only. Reductions of bearing capacities to account for inclined loadings shall conform to factors provided in Section 6-7.3.3.5 of the O.H.B.D.C.

Any loosened material at the founding elevation shall be removed and replaced with mass concrete or compacted Granular 'A' material. Particular attention shall be given to the retaining walls proposed south of the CNR subway structure (Stations 10+180 to 10+220) because of the presence of weaker, looser material at this location. Furthermore, to protect the founding surface against weathering and disturbance caused by construction activity, it is recommended that a 100 mm thick lean mix concrete coating be placed on the native soil surface within four(4) hours of exposure.

Overturning

To avoid overturning problems, the lever arm of the base resultant must be positioned such that the base pressure remains compressive over the entire base width and therefore the resultant pressure acts within the middle third of the base.

To facilitate the design computation for overturning, earth pressures and possible surcharge pressures are two geotechnical loads that must be considered. In view of the fact that the retaining walls will be constructed within an excavation cut, OPSD 3504 is applicable and a Granular 'A' or Granular 'B' material is recommended within the wedge between the retaining structure and the native material. Design parameters of the soil to compute lateral earth pressures are given in Table 2.

Surcharge pressures shall be computed in accordance with Section 6-6.1.2.4 of the O.H.B.D.C.

The backfill shall be placed and compacted as previously discussed in conjunction with the CNR Subway structure.

Sliding

The factor of safety against sliding between the concrete footing and the underlying soil must be adequate. The design parameters given in Table 2 can be used in computing the lateral thrust. Sliding Resistance can be computed using the angles of friction between the concrete footing and the underlying soil tabulated in Table 4.

| Table 4 - Sliding Resistance Computation | | | |
|---|---|---|---|
| Material | Station | Elevation (m) | Unfactored Angle of Internal Friction ($\phi$) ° |
| Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) | 10+025 to 10+180 | 322-315 <315 | 30° 35° |
| | 10+180 to 10+220 | 318-310 | 30° |

Global Stability

In view of the competent and cohesionless nature of the native material at the site, there are no global, deep seated type of instabilities anticipated.

## MECHANICALLY STABILIZED REINFORCED EARTH RETAINING WALLS

A mechanically stabilized reinforced earth retaining walls is an alternative retaining wall that can be employed at the site. The design criteria described in conjunction with the conventional reinforced concrete retaining walls are also applicable to the reinforced earth retaining wall. Overturning and sliding are addressed in the "internal stability" computation

retaining wall. Overturning and sliding are addressed in the "internal stability" computation that is produced by the supplier of the reinforced earth retaining wall system.

An MTO Task Force committee has just recently completed a report that outlines generic specifications and criteria for the acceptability of reinforced earth retaining wall systems. This report, which also includes a generic special provision that outlines specifications for materials, equipment, construction performance of the reinforced earth retaining walls is available and can be obtained from our office. Should a reinforced earth retaining wall system be selected, it is recommended that a site specific special provision be included in the contract documents.

In the cost analysis, there must be a cognizance of the fact that additional excavation may be required to facilitate the installation of the reinforcement strips. As a rule of thumb, an embedment of 0.7 H, where H is the retaining wall height, can be used in preliminary estimates.

## OPEN EXCAVATION CUT SLOPES

As an alternative to a retaining wall design, major consideration should be given to simply cutting back the slopes. Subsurface conditions are favourable because of the granular nature of the native soil and low groundwater. Therefore, the slopes, which are up to 6.5 metres in depth can be designed at 2H:1V.

It is however prudent that the slopes be designed such that the surficial stability is maintained. This can be achieved by protecting all exposed slopes with an effective erosional control protection scheme. Seeding or sodding the slopes and a surface runoff drainage system at the toe of the slope can be designed to achieve this protection.

## CONSTRUCTION CONSIDERATIONS

## TEMPORARY SHORING AND CONSTRUCTION STAGING

In order to maintain railway traffic during the CNR subway structure construction, a temporary shoring and construction staging scheme will be required. The prudence of coordinating the temporary shoring with the construction staging is hereby emphasized. One viable scheme involving a soldier pile-lagging wall is described below. The construction of the protection scheme shall comply with OPSS 902.07.01 and OPSS 538 and 539 series. The Contractor shall submit a proposed construction method for approval in accordance with OPSS 902.04.01.

### Soldier Pile - Timber Lagging Shoring Wall

A shoring system consisting of steel-H piles and timber lagging spanning the soldier piles is recommended. It is suggested that the soldier piles be installed in preaugered holes or alternatively driven to the design tip elevation. It should be cautioned however that the soil

can become impenetratable to driven piles at approximately Elevation 314 m because of the denseness of the material at this depth. Soldier piles installed in the preaugered holes can be terminated in either the native overburden or socketted in the bedrock if necessary. However augered holes in the bedrock shall be scutinized carefully to avoid any influence on the underlying storm relief sewer tunnel. Soldier piles shall be positioned within the preaugered hole and annular concrete toe should be placed to ensure the lateral rigidity of the soldier pile. The annular space above the concrete toe can be filled with a lean mix concrete.

The Contractor shall ensure that no soil sloughs into the preaugered hole during excavation and construction.

Shoring Design

The design of the shoring system shall include the appropriate earth pressures computed in accordance with Section 6-6.1.2 of the O.H.B.D.C. The loadings induced by any surcharge train traffic shall be incorporated in the design in accordance with Section 6-6.1.2.4 of the code. Lateral earth pressures can be computed using the soil design parameters tabulated in Table 4. Rock design parameters are given in Table 5 below.

| Table 5 - Rock Shoring Design Parameters | | | |
|---|---|---|---|
| Type | Elevation (m) | Bulk Unit Weight ($kN/m^3$) | Unconfined Compressive Strength (kPa) |
| Dolostone | <311.5 | 23 | 10,000 |

*Tip Elevation must be selected in consideration of underlying tunnel.

The shoring system must be designed to satisfy earth pressure equilibrium. The depth of excavation necessary at the site renders a cantilever wall as an unlikely feasible design. Therefore, the shoring system can incorporate soil or rock anchors or alternatively horizontal struts as part of a braced excavation system. Bond stresses between the grout and soil/rock for the anchor design are given in Table 6 below.

Consideration can be given in designing the temporary retaining walls such that they also become permanent retaining walls. This concept was employed in the design of retaining walls for the GO Transit East projects (see GO Transit contracts GGE 310 to 315 inclusive). The concept involves designing double corrosion protection permanent anchors involving grout and plastic sheathing and using precast concrete panels as facing units. Layers of geotextile and miradrain and geofoam were placed behind the concrete lagging to provide for filter, drainage and insulation requirements. Futher details of this scheme can be obtained from this office.

| Table 6 - Anchor Design | |
|---|---|
| Soil/Rock | Bond Stress (kPa) |
| Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) | 75 |
| Dolostone Bedrock | 100 |

Soil/rock anchors shall be installed such that no soil loss is experienced during the process. It is recommended that a NSSP be included in the contract documents that specifies the installation and performance and proof testing of the anchors.

Excavation and Dewatering

The groundwater table at the site was generally at or slightly above the bedrock surface at the time of the investigation. Excavations are expected to be advanced to depths above the water table and therefore no dewatering problems are anticipated at the site.

Boulders and Cobbles

Boulders and cobbles are present in the native deposit at the site. It is recommended that a NSSP be included in the contract documents that identifies the presence of these large particle sizes to avoid any potential contractual delay claim by the Contractor should these

boulders and cobbles be encountered.

Temporary Slopes

Temporary slopes within the native heterogeneous mixture of gravel, sand and silt shall not be steeper than 1.5H:1V.

## MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, utilizing equipment owned and operated by Malones Soil Samples. Logging of the rock core in the laboratory was carried out by D. Williams, Petrographer.

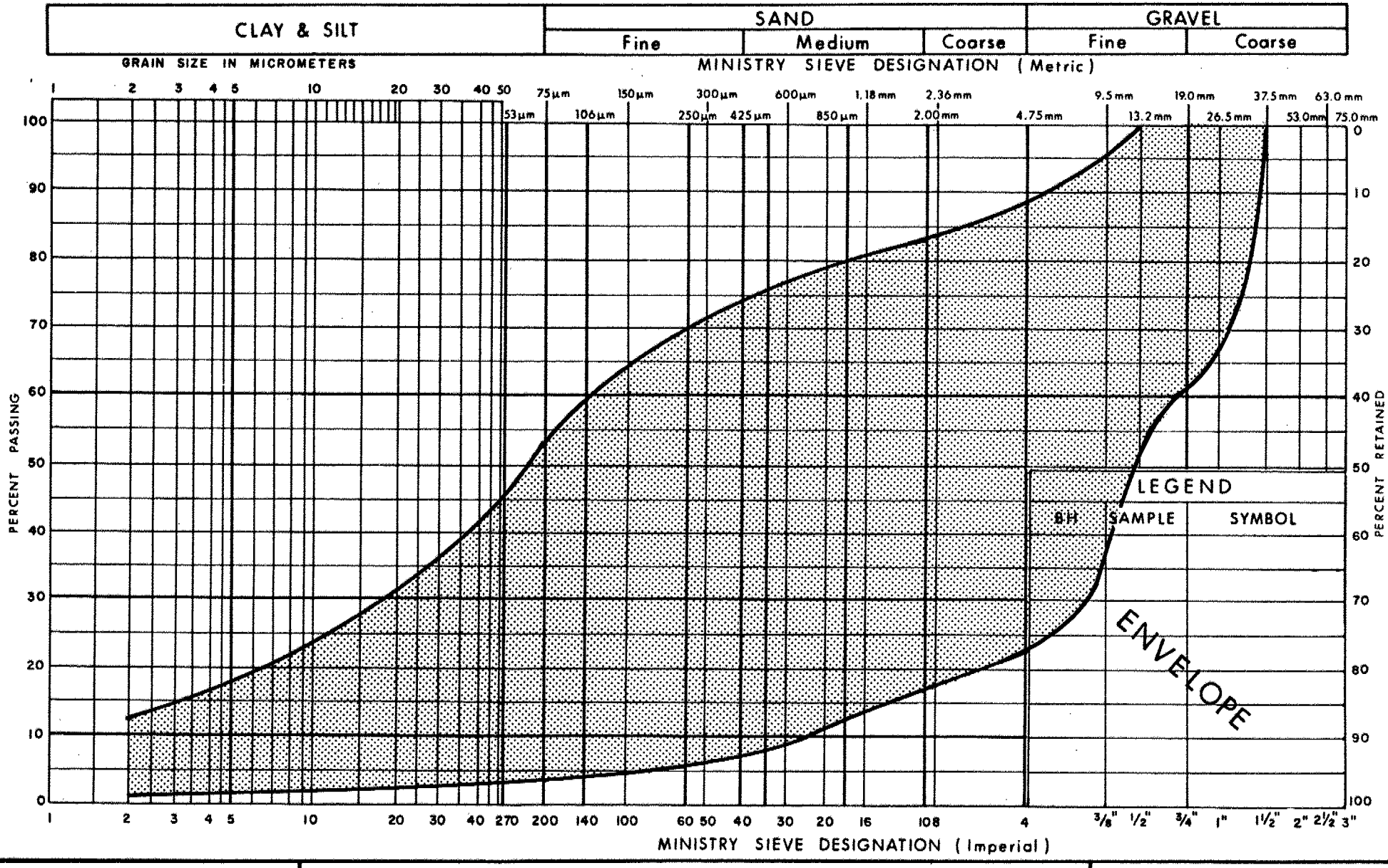
The project was carried out by T. Sangiuliano under the general supervision of P. Payer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by P. Payer and approved by Mr. M. Devata, Chief Foundation Engineer.

T. Sangiuliano, P.Eng.
Foundation Engineer


M. Devata, P.Eng.
Chief Foundation Engineer

# APPENDIX

# UNIFIED SOIL CLASSIFICATION SYSTEM




Ministry of Transportation
Ontario

## GRAIN SIZE DISTRIBUTION

HETEROGENEOUS MIXTURE OF

GRAVEL, SAND & SILT, ( Glacial Till )

FIG No 1

W P 533 - 91 - 02

# EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

| $c_u$ (kPa) | 0 - 12 | 12 - 25 | 25 - 50 | 50 - 100 | 100 - 200 | >200 |
|---|---|---|---|---|---|---|
| | *VERY SOFT* | *SOFT* | *FIRM* | *STIFF* | *VERY STIFF* | *HARD* |

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

| N (BLOWS/0.3m) | 0 - 5 | 5 - 10 | 10 - 30 | 30 - 50 | >50 |
|---|---|---|---|---|---|
| | *VERY LOOSE* | *LOOSE* | *COMPACT* | *DENSE* | *VERY DENSE* |

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

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

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

| SPACING | 50mm | 50 - 300mm | 0.3m - 1m | 1m - 3m | >3m |
|---|---|---|---|---|---|
| JOINTING | *VERY CLOSE* | *CLOSE* | *MOD. CLOSE* | *WIDE* | *VERY WIDE* |
| BEDDING | *VERY THIN* | *THIN* | *MEDIUM* | *THICK* | *VERY THICK* |

# ABBREVIATIONS AND SYMBOLS

## FIELD SAMPLING

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

## STRESS AND STRAIN

| | | |
|---|---|---|
| $u_w$ | kPa | PORE WATER PRESSURE |
| $r_u$ | 1 | PORE PRESSURE RATIO |
| $\sigma$ | 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

| | | |
|---|---|---|
| $m_v$ | $kPa^{-1}$ | COEFFICIENT OF VOLUME CHANGE |
| $C_c$ | 1 | COMPRESSION INDEX |
| $C_s$ | 1 | SWELLING INDEX |
| $C_\alpha$ | 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 |
| $\sigma'_{vo}$ | 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 |
| $S_t$ | 1 | SENSITIVITY = $\frac{c_u}{\tau_r}$ |

## PHYSICAL PROPERTIES OF SOIL

| | | |
|---|---|---|
| $\rho_s$ | $kg/m^3$ | DENSITY OF SOLID PARTICLES |
| $\gamma_s$ | $kN/m^3$ | UNIT WEIGHT OF SOLID PARTICLES |
| $\rho_w$ | $kg/m^3$ | DENSITY OF WATER |
| $\gamma_w$ | $kN/m^3$ | UNIT WEIGHT OF WATER |
| $\rho$ | $kg/m^3$ | DENSITY OF SOIL |
| $\gamma$ | $kN/m^3$ | UNIT WEIGHT OF SOIL |
| $\rho_d$ | $kg/m^3$ | DENSITY OF DRY SOIL |
| $\gamma_d$ | $kN/m^3$ | UNIT WEIGHT OF DRY SOIL |
| $\rho_{sat}$ | $kg/m^3$ | DENSITY OF SATURATED SOIL |
| $\gamma_{sat}$ | $kN/m^3$ | UNIT WEIGHT OF SATURATED SOIL |
| $\rho'$ | $kg/m^3$ | DENSITY OF SUBMERGED SOIL |
| $\gamma'$ | $kN/m^3$ | UNIT WEIGHT OF SUBMERGED SOIL |

| | | |
|---|---|---|
| e | 1,% | VOID RATIO |
| n | 1,% | POROSITY |
| w | 1,% | WATER CONTENT |
| $S_r$ | % | DEGREE OF SATURATION |
| $w_L$ | % | LIQUID LIMIT |
| $w_p$ | % | PLASTIC LIMIT |
| $w_s$ | % | SHRINKAGE LIMIT |
| $I_p$ | % | PLASTICITY INDEX = $w_L - w_p$ |
| $I_L$ | 1 | LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$ |
| $I_C$ | 1 | CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$ |
| $e_{max}$ | 1,% | VOID RATIO IN LOOSEST STATE |

| | | |
|---|---|---|
| $e_{min}$ | 1,% | VOID RATIO IN DENSEST STATE |
| $I_D$ | 1 | DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$ |
| D | mm | GRAIN DIAMETER |
| $D_n$ | mm | n PERCENT - DIAMETER |
| $C_U$ | 1 | UNIFORMITY COEFFICIENT |
| h | m | HYDRAULIC HEAD OR POTENTIAL |
| q | $m^3/s$ | RATE OF DISCHARGE |
| v | m/s | DISCHARGE VELOCITY |
| i | 1 | HYDRAULIC GRADIENT |
| k | m/s | HYDRAULIC CONDUCTIVITY |
| j | $kN/m^3$ | SEEPAGE FORCE |

# RECORD OF BOREHOLE No 1 — 1 OF 1 — METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 895.0; E 242 779.5 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 03 01 CHECKED BY PP

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES: NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, * QUICK TRIAXIAL, + FIELD VANE, x LAB VANE) | WATER CONTENT (%) (PLASTIC LIMIT $w_P$, NATURAL MOISTURE CONTENT $w$, LIQUID LIMIT $w_L$) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 322.1 | Ground Surface | | | | | | | 20 40 60 80 100 | 10 20 30 | | |
| 0.0 | Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown | | 1 | SS | 37 | | | | | | |
| | | | 2 | SS | 20 | | 320 | | | | |
| | | | 3 | SS | 19 | | 318 | | o | | 51 43 5 1 |
| | Compact to Dense | | | | | | | | | | |
| | Very Dense | | 4 | SS | 100 | | 316 | | | | |
| | | | 5 | SS | 51 | | | | | | |
| | | | 6 | SS | 66 | | | | o | | 15 48 28 9 |
| | | | 7 | SS | 106 | /25cm | 314 | | | | |
| | | | 8 | SS | 120 | | | | o | | 10 46 36 8 |
| | | | 9 | SS | 60 | /3cm | | | | | |
| | trace Dolostone fragments | | 10 | SS | ** | ▼* | 312 | | | | |
| 311.5 | | | | | | | | | | | |
| 10.6 | Dolostone Bedrock Weak, Unweathered | | 11 | RC | REC 100% | | | | | | RQD = 10% |
| 310.0 | | | | | | | 310 | | | | |
| 12.1 | End of Borehole | | | | | | | | | | |

* 93 03 02

** Sampler Bouncing

$+^3$, $x^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

# RECORD OF BOREHOLE No 2 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 860.0; E 242 790.5 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 03 02 CHECKED BY PP

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES: NUMBER | TYPE | 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) 10 20 30 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 321.7 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown, Very Dense | | 1 | SS | 62 | | 320 | | | | |
| | Compact | | 2 | SS | 17 | | | | | | |
| | | | 2 | SS | 26 | | 318 | | o | | 55 38 6 1 |
| | | | 4 | SS | 60 | | 316 | | | | |
| | | | 5 | SS | 52 | | | | o | | 30 31 30 9 |
| | | | 6 | SS | 60 | /15cm | 314 | | | | |
| | | | 7 | SS | 60 | /13cm | | | | | |
| | | | 8 | SS | 80 | | | | | | |
| 311.5 | | | 9 | SS | 60 | /3cm ▼ | 312 | | | | |
| 10.2 | Dolostone Bedrock Weak, Unweathered | | 10 | RC | REC 100% | | | | | | RQD = 69% |
| | | | 11 | RC | REC 100% | | 310 | | | | RQD = 100% |
| 308.4 | | | | | | | | | | | |
| 13.3 | End of Borehole * 93 03 03 | | | | | | | | | | |

+³, ×⁵: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 3 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 881.5; E 242 770.5 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 03 01-02 CHECKED BY PP

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100 | PLASTIC LIMIT $w_P$ NATURAL MOISTURE CONTENT $w$ LIQUID LIMIT $w_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 321.8 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown | | 1 | SS | 23 | | 320 | | | | |
| | | | 2 | SS | 17 | | 318 | | | | |
| | Compact / Dense to Very Dense | | 3 | SS | 46 | | 316 | | | | |
| | | | 4 | SS | 30 | | | | | | |
| | | | 5 | SS | 52 | | 314 | | | | |
| | | | 6 | SS | 47 | | | | | | |
| | | | 7 | SS | 100 | | | | | | |
| | | | 8 | SS | 60 | /13cm | 312 | | | | |
| 311.2 | | | 9 | SS | 60 | /10cm ▼* | | | | | |
| 10.6 | Dolostone Bedrock Weak, Unweathered | | 10 | RC | REC 100% | | 310 | | | | RQD = 71% |
| 308.2 | | | 11 | RC | REC 100% | | | | | | RQD = 88% |
| 13.6 | End of Borehole * 93 03 03 | | | | | | | | | | |

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 851.0; E 242 779.5 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 03 03 CHECKED BY PP

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100 | PLASTIC LIMIT $w_P$ NATURAL MOISTURE CONTENT w LIQUID LIMIT $w_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | GR SA SI CL |
| 322.0 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown | | 1 | SS | 30 | | 320 | | ○ | | 60 32 6 2 |
| | | | 2 | SS | 18 | | 318 | | | | |
| | | | 3 | SS | 10 | | 316 | | | | |
| | | | 4 | SS | 14 | | | | | | |
| | Compact to Dense | | 5 | SS | 18 | | | | | | |
| | Dense to Very Dense | | 6 | SS | 37 | | 314 | | ○ | | 29 59 10 2 |
| | | | 7 | SS | 86 | | | | | | |
| | | | 8 | SS | 60 | /15cm | | | | | |
| 311.4 | | | 9 | SS | 72 | ▼* | 312 | | | | |
| 10.6 | Dolostone Bedrock Weak, Unweathered | | 10 | RC | REC 100% | | | | | | RQD = 63% |
| 309.9 | | | | | | | 310 | | | | |
| 12.1 | End of Borehole | | | | | | | | | | |
| | * 93 03 04 | | | | | | | | | | |

$+^3$, $\times^5$ : Numbers refer to Sensitivity

$\frac{20}{15}\diamond\frac{5}{10}$ (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 6 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 837.5; E 242 795.5 ORIGINATED BY TS
DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS
DATUM Geodetic DATE 93 02 12 CHECKED BY PP

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE, 20 40 60 80 100 | PLASTIC LIMIT $w_P$ — NATURAL MOISTURE CONTENT $w$ — LIQUID LIMIT $w_L$; WATER CONTENT (%) 10 20 30 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | GR SA SI CL |
| 318.2 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogenous Mixture of Gravel, Sand and Silt (Glacial Till) Brown, Compact to Dense | | 1 | SS | 43 | | 318 | | | | |
| | | | 2 | SS | 27 | | 316 | | | | |
| | | | 3 | SS | 15 | | | | ○ | | 55 38 6 1 |
| | | | 4 | SS | 14 | | 314 | | | | |
| | | | 5 | SS | 15 | | | | | | |
| | | | 6 | SS | 16 | | | | ○ | | 78 18 (4) |
| | | | 7 | SS | 24 | | 312 | | | | |
| 310.6 | | | A | SS | ** | ▼ | | | | | |
| 7.6 | Dolostone Bedrock Weak, Unweathered to Slightly Weathered | | 9 | RC | REC 100% | | 310 | | | | RQD = 83% |
| 309.1 | | | | | | | | | | | |
| 9.1 | End of Borehole | | | | | | | | | | |

* 92 02 15
** Sampler Bouncing

$+^3$, $\times^5$ : Numbers refer to Sensitivity

$\frac{20}{15}\diamond\frac{5}{10}$ (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 7 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 820.0; E 242 788.5 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 02 12 CHECKED BY PP

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (10 20 30) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 318.6 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown with Black, trace Organics | | 1 | SS | 20 | | 318 | | | | |
| | Brown, Very Loose to Compact | | 2 | SS | 15 | | 316 | | | | |
| | | | 3 | SS | 4 | | | | | | |
| | | | 4 | SS | 6 | | 314 | | | | |
| | | | 5 | SS | 11 | | | | o | | 47 46 (7) |
| | | | 6 | SS | 20 | | | | | | |
| | | | 7 | SS | 24 | | 312 | | o | | 54 40 (6) |
| | Dense | | 8 | SS | 45 | | | | | | |
| 309.5 | | | 9 | SS | ** | * | 310 | | | | |
| 9.1 | Dolostone Bedrock Weak, Unweathered to Slightly Weathered | | 10 | RC | REC 100% | | | | | | RQD = 86% |
| | | | 11 | RC | REC 100% | | 308 | | | | RQD = 92% |
| 306.3 | | | | | | | | | | | |
| 12.3 | End of Borehole | | | | | | | | | | |

* 93 02 15

** Sampler Bouncing

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 8 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 803.5; E 242 803.5 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 02 12 CHECKED BY PP

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 318.2 | Ground Surface | | | | | | | | | | |
| 0.0 | Brown with Black, trace Organics | | | | | * | 318 | | | | |
| | Brown | | 1 | SS | 29 | | | | | | |
| | Heterogeneous Mixture of Gravel, Sand and Silt | | 2 | SS | 27 | | 316 | | o | | 38 35 23 4 |
| | (Glacial Till) | | 3 | SS | 22 | | | | | | |
| | Compact | | | | | | | | | | |
| | Dense to Very Dense | | 4 | SS | 47 | | | | o | | 32 51 (17) |
| | | | 5 | SS | 35 | | 314 | | | | |
| | | | 6 | SS | 35 | | | | | | |
| | | | 7 | SS | 110 | /23cm | 312 | | | | |
| | | | 8 | SS | 81 | | | | | | |
| 310.0 | | | | | | | 310 | | | | |
| 8.2 | Dolostone Bedrock Weak, Unweathered | | 9 | RC | REC 100% | | | | | | RQD = 66% |
| 308.4 | | | | | | | | | | | |
| 9.8 | End of Borehole | | | | | | | | | | |

* GWL not established

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 10 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 907.0; E 242 765.0 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 03 03 CHECKED BY PP

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (10 20 30) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 318.1 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogenous Mixture of Gravel, Sand and Silt (Glacial Till) Brown, Very Dense | | 1 | SS | 40 | | 316 | | | | |
| | Compact | | 2 | SS | 19 | | | | | | |
| | | | 3 | SS | 95 | | | | | | |
| | | | 4 | SS | 30 | | 314 | | | | |
| | | | 5 | SS | 120 | | | | | | |
| 312.2 | | | 6 | SS | 60 | /10cm | | | | | |
| 5.9 | Dolostone Bedrock Weak, Unweathered | | 7 | RC | REC 100% | | 312 | | | | RQD = 67% |
| 310.6 | | | | | | | | | | | |
| 7.5 | End of Borehole | | | | | | | | | | |
| | * 93 03 04 | | | | | | | | | | |

$+^3$, $\times^5$ : Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

# RECORD OF BOREHOLE No 11 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 917.0; E 242 770.0 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 02 15 CHECKED BY PP

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES: NUMBER | SAMPLES: TYPE | SAMPLES: 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (10 20 30) | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 318.0 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown | | | | | | | | | | |
| | | | 1 | SS | 19 | | 316 | | | | |
| | | | 2 | SS | 29 | | | | o | | 33 39 22 6 |
| | Compact | | | | | | | | | | |
| | Dense to Very Dense | | 3 | SS | 43 | | | | | | |
| | | | 4 | SS | 67 | | 314 | | | | |
| | Cobbles and Boulders | | 5 | SS | 60 | /3cm ▼ | | | | | |
| 312.4 | | | 6 | SS | 60 | /8cm | | | | | |
| 5.6 | Dolostone Bedrock Weak, Unweathered to Slightly Weathered | | 7 | RC | REC 100% | | 312 | | | | RQD = 78% |
| 310.9 | | | | | | | | | | | |
| 7.1 | End of Borehole ▼ 93 02 16 | | | | | | | | | | |

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\diamond\frac{5}{10}$ (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 13 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 932.0; E 242 762.0 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 02 15 CHECKED BY PP

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100 | PLASTIC LIMIT $w_P$ NATURAL MOISTURE CONTENT $w$ LIQUID LIMIT $w_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | |
| 317.8 Ground Surface | | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown Compact / Very Dense | | | | | DRY * | | | | | |
| | | | 1 | SS | 11 | | 316 | | | | |
| | | | 2 | SS | 61 | | | | | | |
| | | | 3 | SS | 66 | | | | | | |
| | | | 4 | SS | 60 | /15cm | 314 | | | | |
| | | | 5 | SS | 60 | /15cm | | | | | |
| 312.0 | Boulders and Cobbles | | 6 | SS | 85 | /28cm | | | | | |
| 5.8 | Dolostone Bedrock Weak, Unweathered to Slightly Weathered | | 7 | RC | REC 100% | | 312 | | | | RQD = 57% |
| 310.8 | | | | | | | | | | | |
| 7.0 | End of Borehole | | | | | | | | | | |
| | * 93 02 16 | | | | | | | | | | |

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

# RECORD OF BOREHOLE No 14 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 950.5; E 242 740.0 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 02 15 CHECKED BY PP

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (10 20 30) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 318.0 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) | | | | | DRY | | | | | |
| | Loose | | 1 | SS | 7 | | 316 | | | | |
| | Dense to Very Dense | | 2 | SS | 30 | | | | o | | 13 43 35 9 |
| | | | 3 | SS | 76 | | | | | | |
| | | | 4 | SS | 60 | /13cm | 314 | | o | | 12 37 40 11 |
| | | | 5 | SS | 60 | /13cm | | | | | |
| | | | 6 | SS | 54 | | | | | | |
| 311.4 | | | 7 | SS | 60 | /8cm | 312 | | | | |
| 6.6 | Dolostone Bedrock Weak, Unweathered to Slightly Weathered | | 8 | RC | REC 100% | | | | | | RQD = 60% |
| 309.9 | | | | | | | 310 | | | | |
| 8.1 | End of Borehole | | | | | | | | | | |
| | • 93 02 16 | | | | | | | | | | |

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 15 1 OF 1 METRIC

W.P. 533-91-02 LOCATION Co-ords: N 4 820 986.0; E 242 723.0 ORIGINATED BY TS

DIST 3 HWY 6 BOREHOLE TYPE HS Auger, NW Casing, NX Core COMPILED BY TS

DATUM Geodetic DATE 93 02 15 CHECKED BY PP

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE * QUICK TRIAXIAL x LAB VANE 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 10 20 30 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 316.3 | Ground Surface | | | | | | | | | | |
| 0.0 | Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown | | | | | DRY * | 316 | | | | |
| | | | 1 | SS | 33 | | | | | | |
| | | | 2 | SS | 31 | | 314 | | o | | 41 38 (20) |
| | Dense | | | | | | | | | | |
| | Very Dense | | 3 | SS | 83 | | | | | | |
| | | | 4 | SS | 71 | | | | | | |
| | | | 5 | SS | 60 | /10cm | 312 | | | | |
| 310.8 | Boulders and Cobbles | | 6 | SS | 100 | /5cm | | | | | |
| 5.5 | Dolostone Bedrock Weak, Unweathered to Slightly Weathered | | 7 | RC | REC 100% | | 310 | | | | RQD = 75% |
| 309.4 | | | | | | | | | | | |
| 6.9 | End of Borehole | | | | | | | | | | |

* 93 02 16

+³, x⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

# ROCK CORE DESCRIPTION
## WP 533-91-02



| CORE RECOVERY | | | | | CORE DESCRIPTION | |
|---|---|---|---|---|---|---|
| BH# | RC# | DEPTH (m) | % CR* | % RQD* | DEPTH (m) | DESCRIPTION |
| 1 | 11 | 10.59-12.12 | 100 | 10 | 10.59-12.12 | **DOLOSTONE** (with abundant small vugs and some larger vugs up to 2 cm in diameter, commonly containing calcite crystals; corals common), very pale orange to moderate brown; medium grained; weak; unweathered to slightly weathered (moderately weathered, 10.59-11.71 m); fractures close to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough. |
| 2 | 10<br>11 | 10.21-11.73<br>11.73-13.26 | 100<br>100 | 69<br>100 | 10.21-13.26 | **DOLOSTONE** (with abundant small vugs and some larger vugs up to 3 cm in diameter; corals common), very pale orange to pale yellowish brown; medium grained; weak; unweathered to slightly weathered; fractures moderate to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough. |
| 3 | 10<br>11 | 10.59-12.12<br>12.12-13.64 | 100<br>100 | 71<br>88 | 10.59-13.64 | **DOLOSTONE** (with stylolites, abundant small vugs, and some larger vugs up to 2 cm in diameter; stromatoporoids common), very pale orange to pale yellowish brown; medium grained; weak; unweathered to slightly weathered; fractures moderate to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough. |
| 4 | 10 | 10.59-12.12 | 100 | 63 | 10.59-12.12 | **DOLOSTONE** (with abundant small vugs and some larger vugs up to 3 cm in diameter; stromatoporoids and corals common), very pale orange to medium grey; medium grained; weak; unweathered to slightly weathered (moderately weathered, 10.59-10.80 m); fractures moderate to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough. |

***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

# ROCK CORE DESCRIPTION
## WP 533-91-02



| CORE RECOVERY | | | | | CORE DESCRIPTION | |
|---|---|---|---|---|---|---|
| BH# | RC# | DEPTH (m) | % CR* | % RQD* | DEPTH (m) | DESCRIPTION |
| 6 | 9 | 7.62-9.14 | 100 | 83 | 7.62-9.14 | **DOLOSTONE** (with stylolites, abundant small vugs, and some larger vugs up to at least 5 cm in diameter; corals common), white to very pale orange to pale yellowish brown; medium grained; weak; unweathered to slightly weathered; fractures moderate to close spaced, flat to near vertical, undulating to planar, smooth to rough. |
| 7 | 10<br>11 | 9.24-10.77<br>10.77-12.29 | 100<br>100 | 86<br>92 | 9.24-12.29 | **DOLOSTONE** (with abundant small vugs and some larger vugs up to at least 3 cm in diameter, commonly containing calcite crystals; corals and stromatoporoids common), very pale orange to pale yellowish brown; medium grained; weak; unweathered to slightly weathered; fractures wide to close spaced, flat to near vertical, undulating to planar, smooth to rough. |
| 8 | 9 | 8.23-9.75 | 100 | 66 | 8.23-9.75 | **DOLOSTONE** (with abundant small vugs and some larger vugs up to at least 5 cm in diameter), very pale orange to medium grey; medium grained; weak; unweathered to slightly weathered; fractures moderate to very close spaced, flat to near vertical, undulating to planar, smooth to rough. |
| 10 | 7 | 5.94-7.47 | 100 | 67 | 5.94-7.47 | **DOLOSTONE** (with abundant small vugs and some larger vugs up to at least 5 cm in diameter, commonly containing calcite crystals; corals common), white to very pale orange; medium grained; weak; unweathered to slightly weathered; fractures moderate to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough. |
| 11 | 7 | 5.56-7.09 | 100 | 78 | 5.56-7.09 | **DOLOSTONE** (with abundant small vugs and some larger vugs up to 3 cm in diameter; corals common), white to very pale orange to pale yellowish brown; medium grained; weak; unweathered to slightly weathered; fractures wide to very close spaced, flat to near vertical, undulating to planar, smooth to rough. |

***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

# ROCK CORE DESCRIPTION
## WP 533-91-02



| CORE RECOVERY | | | | | CORE DESCRIPTION | |
|---|---|---|---|---|---|---|
| BH# | RC# | DEPTH (m) | % CR* | % RQD* | DEPTH (m) | DESCRIPTION |
| 13 | 7 | 5.77-7.29 | 100 | 57 | 5.77-7.29 | **DOLOSTONE** (with abundant small vugs and some larger vugs up to at least 4 cm in diameter; corals common), white to very pale orange to pale yellowish brown; medium grained; weak; unweathered to slightly weathered; fractures moderate to very close spaced, flat to near vertical, undulating to planar, smooth to rough. |
| 14 | 8 | 6.61-8.13 | 100 | 60 | 6.61-8.13 | **DOLOSTONE** (with stylolites, abundant small vugs, and some larger vugs up to 4 cm in diameter, commonly containing calcite crystals), white to very pale orange to medium grey; medium grained; weak; unweathered to slightly weathered; fractures moderate to extremely close spaced, flat to dipping, undulating to planar, smooth to rough. |
| 15 | 7 | 5.39-6.91 | 100 | 75 | 5.39-5.49<br>5.49-6.91 | **OVERBURDEN** (till).<br>**DOLOSTONE** (with abundant small vugs and some larger vugs up to at least 5 cm in diameter, commonly containing calcite crystals; corals common), very pale orange to medium grey; medium grained; weak; unweathered to slightly weathered; fractures moderate to very close spaced, flat to near vertical, undulating to planar, smooth to rough. |

***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

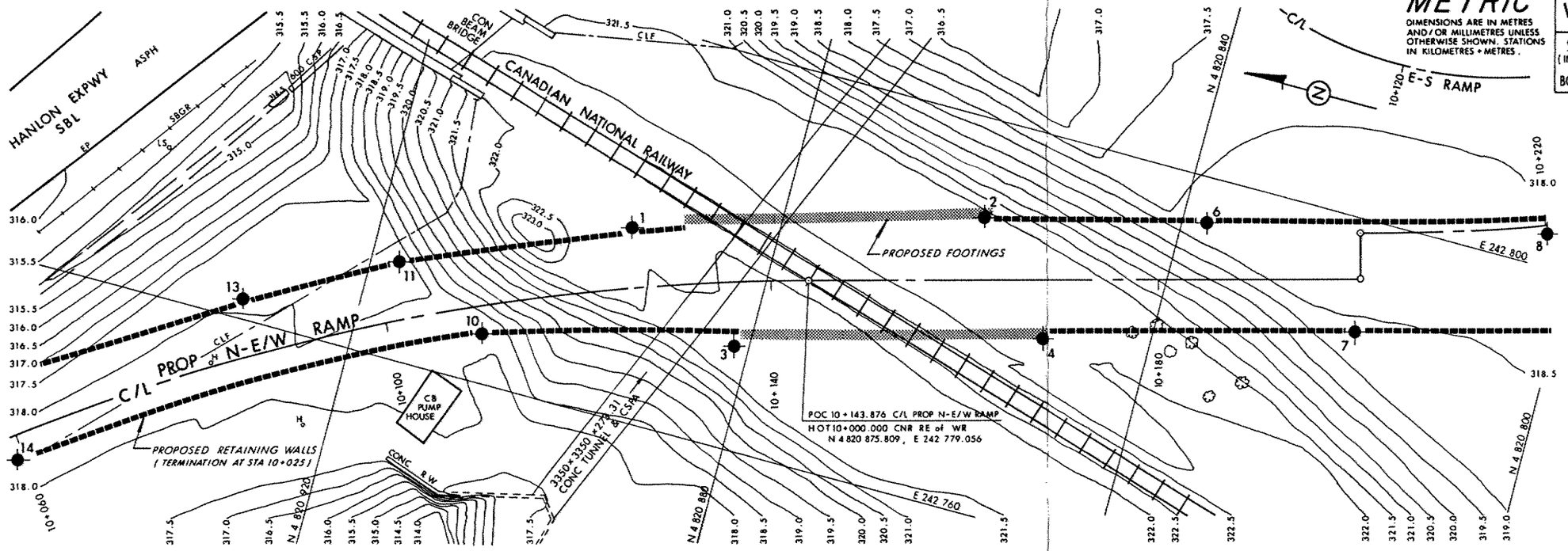
MINISTRY OF TRANSPORTATION, ONTARIO FH-D-207 88 10

CONT No
WP No 533-91-02

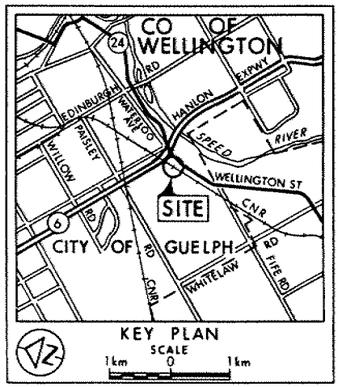
SHEET

CNR & PROP N-E/W RAMP
(INTERCHANGE AT HWY 6 & WELLINGTON ST)
BORE HOLE LOCATIONS & SOIL STRATA

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




PLAN
SCALE 5m 0 5m

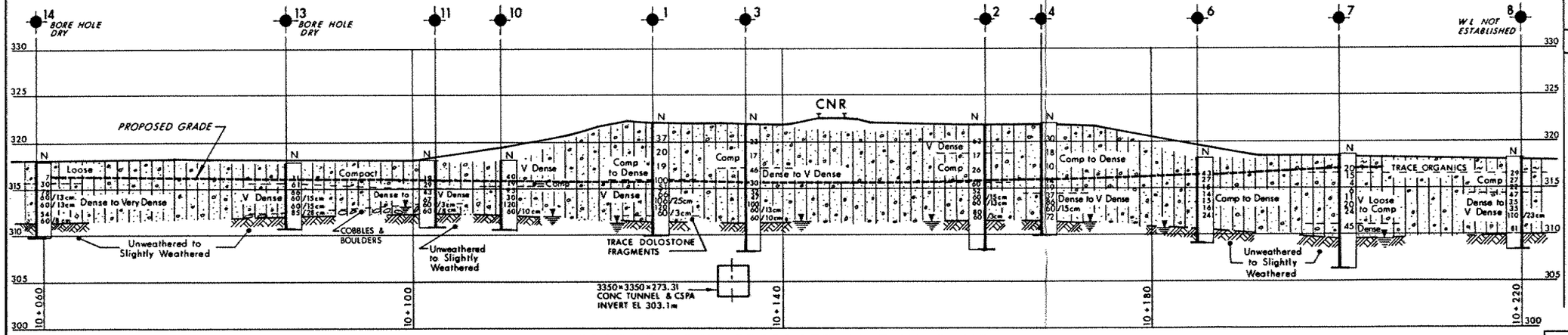



## LEGEND

- 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 1993 02 and 03

## NOTE

FOR BOREHOLE 15 OUTSIDE THE PLAN LIMITS REFER TO RECORD OF BOREHOLE SHEET.




PROFILE C/L PROPOSED N-E/W RAMP
SCALE 5m 0 5m

| No | ELEVATION | CO-ORDINATES NORTH | EAST |
|---|---|---|---|
| 1 | 322.1 | 4 820 895.0 | 242 779.5 |
| 2 | 321.7 | 4 820 860.0 | 242 790.5 |
| 3 | 321.8 | 4 820 881.5 | 242 770.5 |
| 4 | 322.0 | 4 820 851.0 | 242 779.5 |
| 6 | 318.2 | 4 820 837.5 | 242 795.5 |
| 7 | 318.6 | 4 820 820.0 | 242 788.5 |
| 8 | 318.2 | 4 820 803.5 | 242 803.5 |
| 10 | 318.1 | 4 820 907.0 | 242 765.0 |
| 11 | 318.0 | 4 820 917.0 | 242 770.0 |
| 13 | 317.8 | 4 820 932.0 | 242 762.0 |
| 14 | 318.0 | 4 820 950.5 | 242 740.0 |
| 15 | 316.3 | 4 820 986.0 | 242 723.0 |

## SOIL STRATIGRAPHY LEGEND

HETEROGENEOUS MIXTURE OF GRAVEL, SAND & SILT (Glacial Till)

DOLOSTONE BEDROCK Unweathered

=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.

LICENSED PROFESSIONAL ENGINEER A. J. Sangiuliano PROVINCE OF ONTARIO

| REV. | DATE | BY | DESCRIPTION |
|---|---|---|---|
| | | | |

Geocres No 40P9-34

| | | | |
|---|---|---|---|
| HWY No 6 (HANLON EXPWY) | | | DIST 3 |
| SUBM'D TS | CHECKED TS | DATE 1993 07 15 | SITE 35-576 |
| DRAWN RS | CHECKED APPROVED | | DWG 5339102-A |

REF No E-153-6-1, 92 05