

Golder Associates Ltd.

2180 Meadowvale Boulevard
Mississauga, Ontario, Canada L5N 5S3
Telephone (905) 567-4444
Fax (905) 567-6561



REPORT ON

**FOUNDATION INVESTIGATION AND DESIGN
HARWOOD AVENUE UNDERPASS STRUCTURE
HIGHWAY 401 HARWOOD AVENUE TO
CARRUTHERS CREEK DRIVE
TOWN OF AJAX MUNICIPALITY OF DURHAM
W.P. 124-99-00
MINISTRY OF TRANSPORTATION, ONTARIO
CENTRAL REGION, DISTRICT 6, TORONTO**

Submitted to:
Totten Sims Hubicki Associates
300 Water Street
Whitby, Ontario
L1N 9J2

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May 2001



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PART A

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1.0 INTRODUCTION

Golder Associates Ltd. has been retained by Totten Sims Hubicki Associates (TSH) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation for the site of the proposed Highway 401 underpass at Harwood Avenue. The project is part of the MTO plan to expand Highway 401 to a future Core / Distributor system, which requires replacement of existing and construction of proposed intersections to accommodate the Highway 401 improvements. This project addresses the proposed Harwood Avenue bridges over the existing CN and GO Transit rail lines and over the existing and future Highway 401 and the approaches within 20 m of the structures.

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

The proposed horizontal and vertical alignment of the proposed bridge structure were provided to us in hard format by TSH in October 2000. A General Arrangement plan for the overpass structures was provided to us by TSH in January 2001.

The terms of reference for the scope of work are outlined in our proposal P01-1141, dated May 1999.

The subsurface information found in the following reports prepared by others was utilized in the preparation of this report.

- "Widening of Southbound Harwood Avenue Bridge Over Highway 401", W.P. 133-78-01, Site 22-121, GEOCRE No. 30M14464, dated February 1980, carried out by the MTO; and
- "Foundation Investigation - Retaining Walls and Structure Modification at Harwood Avenue", GO-ALRT Pickering to Oshawa, dated August 1983, carried out by Dominion Soil Investigation Inc. for the MTO.

2.0 SITE DESCRIPTION

The site is located at the intersection of Highway 401 and Harwood Avenue in the Town of Ajax, Regional Municipality of Durham. The existing Harwood Avenue is carried over Highway 401 by twin three-span bridge structures to the north of the ramp for Highway 401 EBL to / from Harwood Avenue. To the south of the ramp, Harwood Avenue is carried over the CN Rail and GO Transit tracks by twin three-span bridge structures.

Highway 401 and the adjacent tracks have been constructed in cut in the area of the project site with overall slopes of about 2 horizontal to 1 vertical. The grade of the existing Highway 401 is at about Elevation 104.5 m at the bridges and the existing highway embankment on the north side of Highway 401 slopes up to about Elevation 109.5 m to the existing Highway 401 WBL ramp to / from Harwood Avenue. A retaining exists between the two bridge structures to the north of the existing Highway 401. The top of the rail bed for the tracks to the south of Highway 401 are at about Elevation 100 m. A retaining wall separates the existing Highway 401 EBL ramp to / from Harwood Avenue between the ramp and tracks and is up to about 6 m high. The ground surface rises from the south limit of the tracks to the tableland at about Elevation 108 m.

Outside of the existing roadways, there is a relatively thin vegetation cover consisting of bushes, trees and grass at this site.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between November 2 and 17, 2000 at which time a total of five boreholes were put down at the site. Further investigation was carried out on April 13 and 17, 2001 at which time Boreholes 00-33 and 00-34 were put down. Boreholes 00-1 to 00-3 and 00-34 were put down near the limits of the proposed north abutment. Borehole 00-4 was advanced near the north limit of the proposed north pier and Boreholes 00-33 and 00-5 were put down about 15 m and 20 m south of the proposed south abutment. These boreholes were supplemented with subsurface information from previous reports as referenced in Section 1.0. The relevant boreholes from these reports include Boreholes 83-10 and 83-11, located near the east and west limits of the proposed south pier and Boreholes 83-19 to 83-21 located from west to west near and along the proposed south abutment.

The current investigation was carried out using a truck-mounted D-90 and a track-mounted D-50 auger drill rig that were supplied and operated by Master Soil Investigations Ltd of Toronto. The boreholes were advanced to depths of between 3.5 m and 12.2 m below the existing ground surface. Samples of the overburden were obtained at 0.75 m to 1.5 m intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration test (SPT) procedure. Groundwater conditions in the open boreholes were observed throughout the drilling operations. Piezometers, consisting of a 0.3 m long slotted section threaded onto 12 mm diameter rigid PVC tubing, were installed in selected boreholes to permit monitoring of the groundwater levels at these locations. The boreholes were backfilled using bentonite pellets in accordance with the MTO guidelines.

The fieldwork was supervised on a full-time basis by a member of our engineering staff who located the staked boreholes in the field, directed the drilling, sampling, and in-situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to our laboratory in Mississauga for further examination. Index and classification tests consisting of water content determinations, Atterberg limits tests, and grain size analyses were carried out on selected samples.

The borehole locations were established in the field by TSH prior to our mobilization to the site. The elevations and northing and easting co-ordinates of the boreholes drilled for this investigation were provided to us by TSH; the locations are shown in plan on Drawing 1. The northing and easting co-ordinates are referenced to the UTM NAD83 co-ordinate system and the elevations are referenced to the geodetic datum.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

From published geologic information, the site is located in the physiographic region known as the Iroquois Plain which formed part of the lakebed of the former Lake Iroquois after the last glaciation period during the Pleistocene Epoch. The Iroquois Plain in the area of the subject site primarily consists of glacial tills of a heterogeneous mixture of sand, silt, clay and gravel with numerous cobbles and boulders. It is thought that at least two distinct glaciations have occurred in the area. The most recent tills in the area were deposited in the form of drumlins (elongated, oval shaped hills). Recent glaciolacustrine and glaciofluvial deposits of sands, silts, gravel and clays, have been deposited in the depressions between these hills. At depth, the till is underlain by bedrock consisting of thinly bedded, dark grey, calcareous shale of the Whitby Formation. (Reference: "The Physiography of Southern Ontario", 3rd Edition, Chapman and Putnam, 1984).

4.2 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the laboratory tests carried out on selected samples, are given on the attached Record of Borehole sheets and on Figures 1 to 4 following the text of this report. The relevant borehole logs from previous investigations carried out by others as referenced in Section 1.0 are found in Appendix A and B. The stratigraphic boundaries shown on the borehole sheets are inferred from non-continuous sampling and therefore represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations. An interpretive model of the soil stratigraphy is shown on Drawings 1 and 2.

In summary, the subsoils in the area of the proposed bridge structures consist of topsoil and fill surficial layers of varying thickness that are underlain by an upper till deposit. The upper till varies from clayey silt till to silt / sand till and contains interlayers of silt and sand as is generally found above about Elevation 90 m to 93 m. Below this elevation exists a lower deposit of silty clay till that extends to at least Elevation 86.5 m in the south area of the site. The till deposits are hard / very dense and are characterized by Standard Penetration Test (SPT) 'N' values of generally greater than 100 blows per 0.3 m of penetration. Bedrock was not encountered in the current or previous investigations in this area. Shale bedrock of the Whitby Formation was encountered at about Elevation 82 m at the proposed Highway 401 overpass at Carruthers Creek located to the east of the subject site.

A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Topsoil

A layer of topsoil was encountered surficially in all of the current boreholes and in Boreholes 83-19 to 83-21 from the previous investigation. The thickness of the topsoil was measured at about 100 mm to 200 mm in the boreholes, except in Borehole 00-1 where the topsoil is about 0.8 m thick. Standard Penetration testing (SPT) carried out within the topsoil in Borehole 00-1 measured an 'N' value of 16 blows for 0.3 m of penetration, which indicates a compact state of packing.

4.2.2 Fill Materials

Silty Sand to Sand Fill

A layer of silty sand to sand, some silt, some gravel was encountered surficially in Borehole 00-34 below the topsoil in Boreholes 00-2 and 00-5 and below the clayey silt fill in Borehole 00-4. The silt / sand fill was found to be about 0.7 m to 1.5 m thick in these boreholes. Standard Penetration testing (SPT) carried out within the silt / sand fill measured 'N' values of between 11 and 31 blows per 0.3 m of penetration, which indicates a compact to dense state of packing. In general, the silt / sand fill is compact. The natural water content measured on three selected samples of the silt / sand fill ranged from about 5 to 10 percent, with an average of about 8 percent.

About 0.9 m and 1.8 m of sand fill with some gravel was also encountered below about 75 mm of asphalt pavement in Boreholes 83-10 and 83-11, respectively, which were put down through the existing roadway. About 1 m of sand fill with some gravel and silt was also encountered in Borehole 83-21. In Borehole 80-3 a layer of loose sandy silt fill was encountered surficially and extends to about 3.1 m depth.

Clayey Silt Fill

A layer of clayey silt fill with some sand and gravel was encountered below the topsoil in Boreholes 00-3 and 00-4 where it is about 0.7 m and 3 m thick, respectively, and below the silty sand fill in Boreholes 00-2, 00-5 and 00-34 where it is about 0.7 m to 1.5 m thick. Clayey silt fill was also encountered surficially in Borehole 80-5 and is about 2.7 m thick. Occasional organic material was noted within the clayey silt fill in Borehole 00-3. The clayey silt fill is firm to hard in consistency with SPT 'N' values of between 4 and 30 blows per 0.3 m of penetration measured within the layer. In general, the clayey silt fill is firm to very stiff. The natural water content for selected samples of the clayey silt fill ranged from about 5 to 21 percent, with an average of about 14 percent.

4.2.3 Organic Silty Sand and Peat

Below the fills in Borehole 00-2 exists a deposit of organic silty sand and peat that has a fibrous texture. The organic content was measured at about 5 percent on a selected sample of the deposit. Standard Penetration testing (SPT) carried out within the organic deposit measured an 'N' value of 13 blows per 0.3 m of penetration, which indicates a compact state of packing. The water content for a selected sample of the organic deposit was measured at about 24 percent, which stands in contrast to the lower water contents measured in the overlying fills and underlying till deposits and is indicative of the presence of organic matter.

A cohesive organic deposit was also encountered below the fill in Borehole 80-5, located in the vicinity of Borehole 00-2. The measured SPT 'N' value of 5 blows per 0.3 m of penetration indicates the organic deposit is firm at this location. The measured organic content and water content of about 5 and 21 percent, respectively, is consistent with the same parameters measured for a selected sample of the organic material from Borehole 00-2. The measured liquid limit and plasticity index of about 40 and 20 percent, respectively, indicate that the organic material is of medium plasticity.

4.2.4 Upper Glacial Till

Below the fills exists an upper glacial till deposit that varies from clayey silt, some to with sand, trace to some gravel to silt / sand, trace to some gravel, trace clay. Occasional cobbles were noted within the upper till based on resistance / grinding of the augers. The upper till is interlayered with silt / sand deposits that range in thickness from about 0.3 m to 3.3 m. Grain size distribution curves for selected samples of the clayey silt till and silt / sand till are shown on Figures 1 and 2, respectively. Grain size distribution curves for selected samples of silt interlayers are shown on Figure 3. The upper till is very dense / hard with Standard Penetration Test (SPT) 'N' values of generally greater than 100 blows per 0.3 m of penetration measured within the till and interlayers.

The natural water content for selected samples of the upper till deposit from the current boreholes range from about 2 to 12 percent, with an average of about 8 percent. In general, the measured water contents decrease with depth. Atterberg limits testing carried out on the clayey silt portion of the upper till from the current boreholes measured an average liquid limit and plasticity index of about 18 and 6 percent, respectively. The results indicate that the clay is of low plasticity as shown on Figure 4. The measured water contents of the clayey silt till are below the measured plastic limit of the deposit. Atterberg limits testing carried out on three selected samples of the silt / sand till from the current investigation (Borehole 00-1, Sample 4, Borehole 00-2, Sample 9 and Borehole 00-34, Sample 8) gave non-plastic results.

The current boreholes (i.e. Boreholes 00-1 to 00-5, 00-33 and 00-34) and the shallower boreholes put down previously (Boreholes 80-3 and 80-5) were terminated within the upper till deposits above about Elevation 96.5 m. The previous deeper boreholes (i.e. from the 1983 investigation) indicate that the upper till extends to between about Elevation 90 m and 93 m.

4.2.5 Lower Silty Clay to Clay Glacial Till

A deposit of grey, silty clay to clay till was encountered in the deepest boreholes at the site (Boreholes 83-10, 83-11, and 83-19 to 83-21). The silty clay to clay till is hard in consistency with SPT 'N' values of greater than 100 blows per 0.3 m of penetration measured within the deposit. An unconfined compression test carried out on a selected sample of the lower till (Borehole 83-19, Sample 10) measured an undrained shear strength of about 500 kPa. The natural water content of selected samples of the silty clay to clay till were measured at about 10 percent. The clay till generally is of intermediate plasticity based on laboratory testing carried out in the same deposit encountered at the proposed Carruthers Creek site to the east of the site, with typical liquid limit and plasticity indices of 42 and 22 percent, respectively.

The lower clay till[✓] has generally encountered below about Elevations 90 m to 93 m in the boreholes, and extends to at least Elevation 86.5 m.

4.3 Groundwater Conditions

Water levels were monitored in the open boreholes at the time of the current fieldwork. In addition, piezometers were installed in Boreholes 00-2, 00-4, 00-33 and 00-34 from the current investigation and in all the relevant boreholes from the 1983 investigation, except in Borehole 83-20. Details of the piezometer readings are found on the relevant borehole records following the text of this report.

Boreholes 00-2 to 00-5 installed in the boreholes outside the areas of the highway and rail cuts 00-33 and 00-34 were dry upon completion of drilling. Water was encountered at 6.1 m depth (Elevation 101.0 m) in Borehole 00-1 following completion of drilling. Measurements taken on May 4, 2001, in the piezometers indicate groundwater levels at Elevations 104.6 m and 104.9 m on the north side of the highway and Elevation 103.3 m on the south side of the rail tracks. A water level at Elevation 97.7 m was measured in the borehole installed on the north side of the highway within the existing road cut. It is likely that this groundwater level is influenced by utility trenches within the roadway. The piezometers installed in the previous boreholes indicate that the groundwater level is at between Elevations 103 m and 104 m at the borehole locations, except for Borehole 83-21 located to the east of the proposed bridges where the groundwater level was

measured at Elevation 101 m. It should be noted that the water level readings in the previous boreholes were made prior to the railway cut and associated regrading of Highway 041. These water level measurements are summarized in the table below.

| <i>Location</i> | <i>Borehole</i> | <i>1983</i> | <i>December 27, 2000</i> | <i>February 25, 2001</i> | <i>May 4, 2001</i> |
|-----------------|-----------------|-------------|--------------------------|--------------------------|--------------------|
| North Abutment | 00-34 | | | | 104.9 |
| | 00-2 | | | | 104.6 |
| North Pier | 00-4 | | 98.5 | Dry | 97.7 |
| South Pier | 83-10 | 104.5 | | | |
| | 83-11 | 103.2 | | | |
| South Abutment | 00-33 shallow | | | | 103.3 |
| | 00-33 deep | | | | 103.2 |
| | 83-19 | 103.5 | | | |
| | 83-21 | 101.0 | | | |

Based on the above measurements, the original groundwater table sloped downward slightly toward the south. The highway and rail cuts have resulted in a groundwater lowering within the actual road and rail cuts; however, there has not been significant impact on the groundwater table at distances of as little as 10 m from the crest of the existing permanent cut slope.

It should be noted that the groundwater level is subject to seasonal fluctuations; higher groundwater level conditions might be observed after heavy rainfall or during snow melt.

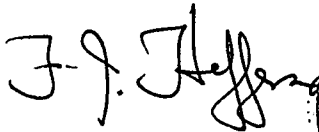
GOLDER ASSOCIATES LTD.



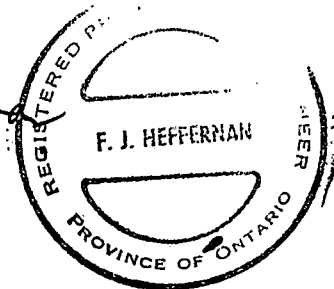
Dan K. Breeze, P.Eng.



Anne S. Poschmann, P.Eng.
Principal



Fintan J. Heffernan, P.Eng.,
Designated MTO Contact



DKB/ASP/FJH/clg

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PART B

**FOUNDATION DESIGN REPORT
HARWOOD AVENUE UNDERPASS STRUCTURE
HIGHWAY 401 HARWOOD AVENUE TO
CARRUTHERS CREEK DRIVE
TOWN OF AJAX MUNICIPALITY OF DURHAM
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CENTRAL REGION, DISTRICT 6, TORONTO**

5.0 ENGINEERING RECOMMENDATIONS

5.1 General

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

It is understood that Highway 401 will be widened to the north of the existing alignment to form a core / collector distribution system in this area. In order to accommodate the widening, the existing twin bridge structures that carry Harwood Avenue over Highway 401 and the CN Rail and Go Transit tracks will be replaced with new twin, three-span bridge structures. It is understood that the existing structures will be removed and that the new structures will be located immediately west of the existing northbound structure. In addition, the soldier pile and timber lagging retaining walls will be removed along the Highway 401 EBL ramp from / to Harwood Avenue, which consist of over 100 tensioned ground anchors.

The existing Highway 401 and rail track grades are at about Elevation 104.5 m and 100.0 m, respectively, and have been formed in cut in the area of the subject site. The cut slopes are at an overall inclination of about 2 horizontal to 1 vertical and rise to about Elevation 109.5 m north of Highway 401 and Elevation 108 m to the south the tracks. The proposed grade of Harwood Avenue at the bridge structures will be at about 111 m and will require approaches up to 2.5 m high.

The original bridge over Highway 401, built in 1960, is founded on spread footings placed at about Elevation 103 m. The southbound bridge was widened with perched abutments above Elevation 106 m and center pier at about Elevation 103.4 m. The CN / GO bridge, built in 1984, is founded on spread footings placed at about Elevation 98.6 m (north abutment), 96.7 m (north pier), 98.6 m (south pier), and 102.2 m (south abutment).

5.2 Bridge Foundations

5.2.1 General

The predominant soil deposit at this site consists of an upper clayey silt to silt / sand till deposit which contains interlayers of silt and sand up to about 3.3 m thick. The deposit is hard / very dense, with measured Standard Penetration Test (SPT) 'N' values of generally greater than 100 blows per 0.3 m of penetration. The upper till deposit extends to about Elevation 90 m to 93 m and is underlain by a more plastic hard lower silty clay till that is also characterized by SPT 'N' values of greater than 100 blows per 0.3 m of penetration. This lower till extends to at least Elevation 86.5 m as noted in the boreholes. Bedrock was not encountered at this site but is known to exist in the form of shale of the Whitby Formation at about Elevation 83 m some 800 m to the east of the subject site. The measured groundwater levels vary from about Elevation 104.9 m at the north limits of the bridge to about Elevation 103.3 m at the south limits of the bridge. The groundwater table within the limits of the existing highway and rail tracks has been influenced by the cuts made to construct the road / rail. A water level at Elevation 97.7 m was measured within the highway cut.

The native soils at relatively shallow depth are suitable for support of the proposed abutments and piers on shallow foundations. Deep foundations at this site are not considered appropriate due to the hard / very dense tills which are present at the proposed founding levels. Pre-augering to the full pile depth would be required in order to advance the piles and cobbles / boulders present within the tills would present difficulties with both the pre-augering and the pile installation.

acceptable

5.2.2 Spread Footings on Native Soils

5.2.2.1 Geotechnical Resistance

The bridge abutments may be supported on spread footings placed below any fill and topsoil and founded within the undisturbed hard clayey silt and very dense silt / sand upper till deposit. Based on the General Arrangement drawing provided, it is understood that the north abutment and north pier footings will be founded at about Elevation 102 m; the south pier footing will be founded at about Elevation 99.5 m and the south abutment footing will be founded at about Elevation 97.5 m. Therefore, the south abutment and south pier footings will be as much as 6 m below the groundwater level at the site and the north abutment footing will be founded about 3 m below the groundwater level. It is expected that the north pier will be above the groundwater level where the road cut has lowered the groundwater table.

Abutment and pier spread footings placed a minimum of 1.5 m below the lowest surrounding grade and may be designed using the geotechnical resistances provided in the following table. These geotechnical resistances assume a minimum width of 5 m for the south abutment and a minimum width of 4.0 m for the remaining foundation units. It should also be noted that the resistance given for the south abutment is based on the founding level of Elevation 97.5 m where the spread footing will be placed on the silt and / or clay till interlayers. If the south abutment footing can be raised to be maintained above Elevation 99 m, the ULS and SLS resistances as given for the south pier may be used for design of the south abutment. If the north abutment footing encounters the silt layer found to Elevation 101.9 m in Borehole 00-34, the footing should be lowered to reach the underlying very dense till.

| <i>Foundation Element</i> | <i>Highest Acceptable Founding Level (m)</i> | <i>Factored Geotechnical Resistance At Ultimate Limit States (ULS)</i> |
|---------------------------|--|--|
| North Abutment | Elevation 105 m | 1,000 kPa |
| North Pier | Elevation 102 m | 1,000 kPa |
| South Pier | Elevation 105 m | 1,000 kPa |
| South Abutment | Elevation 105 m | 800 kPa |

The geotechnical resistance at Serviceability Limit States (SLS) will be dependent on the size, configuration and founding level of the footing. For the above footing widths, it is calculated that the total settlement for footings under the above design geotechnical resistances at ULS will be less than 25 mm and ULS design will therefore govern. The geotechnical resistances at ULS given in the above table may be assumed for SLS design.

The geotechnical resistances provided herein are given under the assumption that the loads will be applied perpendicular to the surface of the footings; where the load is not applied perpendicular to the surface of the footing, inclination of the load should be taken into account in accordance with the Ontario Highway Bridge Design Code (OHBD C).

5.2.2.2 Resistance to Lateral Forces

Resistance to lateral forces / sliding resistance between the concrete footings and native soils should be calculated in accordance with Section 6-8.4.3 of the OHBD C assuming the following unfactored coefficients of friction between the concrete and the founding soils:

| | |
|--------------------------------------|--------|
| North Abutment, North and South Pier | - 0.47 |
| South Abutment | - 0.43 |

5.2.2.3 Frost Protection

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

5.2.2.4 Construction Considerations

The proposed founding levels of Elevations 99.5 m and 97.5 m for the south pier and south abutment, respectively, will be as much as 6 m below the groundwater level as measured at the south abutment (Elevation 103.3 m). For the north abutment, the founding level is expected to be about 3 m below the groundwater level. Some water inflow into footing excavations should be expected; however, the quantity of seepage through the till is anticipated to be minimal. There will be more seepage occurring through the sand and silt interlayers within the till deposit as encountered in the boreholes. Pumping from well-filtered sumps placed at the base of the excavation should provide sufficient groundwater control during foundation excavations; however, some precautions should be taken to preserve the integrity of the founding soils as outlined below.

The founding soils are sensitive to disturbance and softening due to water seepage or ponding and mud coat placement will be required at the base of the footing excavations to protect the founding soils against softening due to upward water seepage. For the north and south abutments where the excavation will be 3 m and 6 m below the groundwater level, respectively, the general excavation for the footing should be carried out in narrow strips with a mud coat placed immediately after the founding level is reached and the base cleaned. Prolonged exposure without protection of the mud coat will allow the upward water seepage to soften the founding soils. The cleaned excavation base should be inspected by qualified geotechnical personnel prior to placing the mud coat. It should be noted that the water levels could be higher during wet periods of the year.

5.3 Lateral Earth Pressure

The lateral earth pressures acting on the bridge abutment walls will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill, on the magnitude of surcharge including construction loadings and on subsequent movement of the structures. The following recommendations are made concerning the design of the abutment walls:

- Select free-draining granular fill such as that meeting the specifications of the Ontario Provincial Standard Specifications (OPSS) Granular A or B Type II, but with less than 5 percent passing the #200 sieve, should be used as backfill behind walls. All granular

fill should be compacted in lifts of loose thickness not greater than 200 mm, to at least 95 percent of the material's Standard Proctor maximum dry density.

- Longitudinal drains and weep holes should be installed to provide drainage of the granular backfill.
- The granular fill may be placed either in a zone with width equal to at least 1.2 m behind the back of the wall stem (Case I) or within a wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical extending up and back from the footing (Case II) in accordance with OHBDC.
- If the structural support allows movement of the top of the wall of at least 0.5 percent of the retained height (unrestrained structure), "active" earth pressures may be used in the geotechnical design of the structure. If the support does not allow sufficient lateral movement (restrained structure), "at rest" pressures should be assumed for geotechnical design.
- A compaction surcharge equal to 16 kPa should be included in the lateral earth pressures for the structural design of the wall stem. Other surcharge loadings should also be accounted for in the design, as required.
- For Case I, the lateral earth pressures are based on the in-situ soils (native till) and the following parameters may be assumed:

| | |
|---------------------------------------|----------------------|
| Soil Unit Weight | 21 kN/m ³ |
| Coefficient of Lateral Earth Pressure | |
| "active" | 0.27 |
| "at rest" | 0.43 |

- For Case II, the lateral earth pressures are based on the granular fill as placed; the following parameters may be assumed:

| | Granular A | Granular B |
|---------------------------------------|----------------------|----------------------|
| | | <i>Type II</i> |
| Soil Unit Weight | 22 kN/m ³ | 21 kN/m ³ |
| Coefficient of Lateral Earth Pressure | | |
| "active" | 0.27 | 0.31 |
| "at rest" | 0.43 | 0.47 |

It should be noted that the above design parameters assume level backfill and ground surface behind the wall. Where there is sloping ground behind the wall, the coefficient of lateral earth pressure must be adjusted (increased) to account for the slope. Other aspects of the abutment granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD-3501.00.

5.4 Excavations and Temporary Cut Slopes

Excavations for footing construction will extend through the fill and upper till deposits consisting of clayey silt and silt / sand. At the proposed bridge structures, the excavations for the footings will be up to about 4 m in depth below existing ground surface. Cobbles and boulders are inherent in the glacial deposits as encountered at this site and should be expected during excavation. The excavation bases will be up to 5.5 m below the groundwater level in the southern portion of the site as measured in the piezometers. Temporary open cut slopes should be maintained no steeper than 1 horizontal to 1 vertical (1H:1V). Where space restrictions dictate, the excavation could also be carried out within a fully braced excavation.

Water seepage inflow into the excavations through the silt / sand till and sandy interlayers should be expected. Pumping from well-filtered sumps located at the base of the excavation within the glacial till should provide adequate groundwater control during foundation excavations. Sumps should be maintained outside the actual footing limits. Surface water run-off should be directed away from the excavations at all times.

5.4.1 Temporary Excavation Support

All excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Ontario Occupational Health & Safety Act. The native soils at this site would be classified as Type I soil.

Where space is restricted and will not permit open cuts for footing construction, a temporary support system should be installed to support the sides of the excavation and permit the use of vertical cuts. The temporary support system could consist of soldier piles and lagging where the piles would be socketted into pre-augered holes extended into the very dense / hard till deposit below the excavation base. Some cobbles and boulders should be expected during augering for the soldier pile installation. Support to the soldier pile and lagging wall system could be in the form of struts and walers or rakers and anchors for the footing excavations.

The design of braced soldier pile and lagging walls should be based on a rectangular earth pressure distribution using the design parameters given below. Where the support to the wall is provided by anchors or rakers, the wall design should be based on a triangular earth pressure distribution using the design parameters given below. The raker / anchor support must be designed to accommodate the loads applied from pressures and surcharge pressures from area, line or point loads as well as the impact of sloping ground behind the system.

Unfactored triangular earth pressure distribution (p in kN/m^2 ; increasing with depth), can be calculated as follows:

$$p = K_a \gamma H$$

where

$$H = \text{the height of the excavation at any point in metres}$$
$$K_a = 0.3 \text{ for level ground behind excavation}$$
$$\gamma = \text{soil unit weight} = 22 \text{ kN/m}^3$$

Unfactored rectangular earth pressure distribution (p in kN/m^2 ; constant with depth), can be calculated as follows:

$$p = K \gamma H$$

where

$$H = \text{the height of the excavation}$$
$$K = 0.2 \text{ for level ground behind excavation}$$
$$\gamma = \text{soil unit weight} = 22 \text{ kN/m}^3$$

Passive toe restraint to the soldier piles may be determined using a triangular pressure distribution acting over an equivalent width equal to three times the pile socket diameter. The coefficient of passive lateral earth pressure, K_p , for the socket within the very dense / hard till may be taken as 5.0.

The soldier piles will be socketted into the very dense clayey silty sand / silty sand till deposit below the groundwater level. The soil unit weight should be taken as 22 kN/m^3 and the unit weight of water should be taken as 9.8 kN/m^3 . A groundwater level at Elevation 104 m can be assumed at the bridge footing locations.

5.5 Embankment Construction

On the general arrangement drawing, the proposed grade of Harwood Avenue is shown at about Elevation 111 m, which indicates that the approach embankments would be up to 2.5 m in height.

Topsoil and fill deposits should be stripped from below the fill embankment areas and all subgrade soils proof-rolled prior to fill placement. Construction of the embankment above the prepared subgrade may be carried out using clean earth fill meeting specifications OPSS 212 or Select Subgrade Material meeting specifications with OPSS 1010, depending on material availability. All embankment fill should be placed in regular lifts with loose thickness not exceeding 300 mm, and be compacted to at least 95 percent of the material's Standard Proctor maximum dry density. The

final lift prior to placement of the granular subbase or base course should be compacted to 100 percent of the Standard Proctor maximum dry density. Inspection and field density testing should be carried out by qualified geotechnical personnel during all fill placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved. The permanent soil slopes of the embankment should be maintained not steeper than 2 horizontal to 1 vertical (2H:1V). Vegetation cover should be established on all soil slopes to protect embankment fill against surficial erosion, as per OPSS 572.

The embankment subgrade soils consist of hard / very dense till. Providing that the embankment subgrade is properly prepared, the embankment with side slopes maintained at 2 horizontal to 1 vertical would be stable. The embankment loading will result in settlement of the underlying silty clay till, however, the majority of this settlement will occur during construction and is expected to be small.

5.6 Permanent Cuts

It is understood that the proposed Highway 401 to the north of the existing Highway 401 will be formed within open cut at a grade of about Elevation 104.5 m. The permanent slopes will be up to 8 m high and typically will be formed within the hard clayey till or very dense silt / sand till. Topsoil and surficial fill were encountered at the ground surface during borehole drilling. It is considered that permanent cuts with slopes formed not steeper than 2 horizontal to 1 vertical (2H:1V) will be stable. Mid height benches, 2 m in width, should be provided for cut areas where the total slope height is 6 m or greater than 6 m.

5.7 Ground Anchor / Ramp and Retaining Wall Removal

Based on our review of the available details of the anchored retaining wall along the W-N/S Ramp on the south side of Highway 401, the suggested sequence of removal is as follows:

- 1) Excavate ramp fill to 0.5 m above the upper level of anchors.
- 2) Destress the upper row of anchors. *→ more explicit { what stress is on anchors*
- 3) Excavate between the anchors and around the anchors to a level half way between the upper and lower levels of anchors.
- 4) Cut and remove the upper level of anchors where exposed and remove the upper portion of the wall to the current excavation level.

- 5) Excavate ramp fill to 0.5 m above the lower level of anchors.
- 6) Destress the lower level of anchors.
- 7) Excavate between the anchors and around the anchors.
- 8) Cut and remove the lower level of anchors as required and remove the lower portion of the wall.


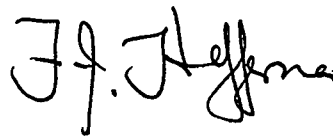
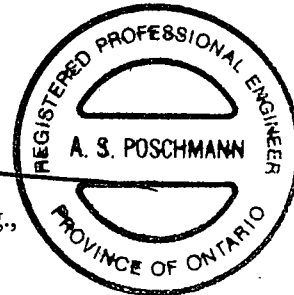
The anchor removal procedures should be submitted by the Contractor to the Contract Administrator for review to ensure that the anchor removal procedures are affording proper safety measures at all times.

Vegetation cover should be established on all permanent cut slopes to prevent surficial erosion on the slope face.

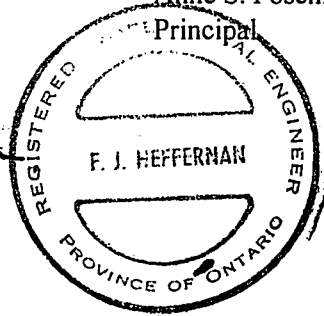
GOLDER ASSOCIATES LTD.



Dan K. Breeze, P.Eng.


Anne S. Poschmann, P.Eng.,
Principal

Fintan J. Heffernan, P.Eng.,
Designated MTO Contact



DKB/ASP/FJH/clg

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LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

(b) Cohesive Soils

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

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

IV. SOIL TESTS

w water content
 w_p plastic limit
 w_l liquid limit
C consolidation (oedometer) test
CHEM chemical analysis (refer to text)
CID consolidated isotropically drained triaxial test¹
CIU consolidated isotropically undrained triaxial test with porewater pressure measurement¹
 D_R relative density (specific gravity, G_s)
DS direct shear test
M sieve analysis for particle size
MH combined sieve and hydrometer (H) analysis
MPC Modified Proctor compaction test
SPC Standard Proctor compaction test
OC organic content test
 SO_4 concentration of water-soluble sulphates
UC unconfined compression test
UU unconsolidated undrained triaxial test
V field vane (LV-laboratory vane test)
 γ unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

S:\FINAL\DAT\ABBREV\2000\LOFA-D00.DOC

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (con't.)

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

(c) Hydraulic Properties

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

(d) Consolidation (one-dimensional)

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

(e) Shear Strength

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

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

2. Shear strength = (Compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering.

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

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

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

Description and Notes

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

Abbreviations

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

+³, ×³: Numbers refer to Sensitivity **○³%** STRAIN AT FAILURE

RECORD OF BOREHOLE No 00-2

1 OF 1

METRIC

PROJECT 001-8019F

W.P. 124-99-00

LOCATION N 4856926.6; E 343187.5

ORIGINATED BY PKS

DIST 6 HWY 401

BOREHOLE TYPE 108mm Solid Stem Augers

COMPILED BY DKB

DATUM Geodetic

DATE Nov. 16/00

CHECKED BY ASP

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|----------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | |
| 109.3 | GROUND SURFACE | | | | | | | 20 40 60 80 100 | | 20 40 60 | | | | | |
| 0.9 | Topsoil | | 1 | SS | 31 | | 109 | | | | | | | | |
| | Silty Sand to Sand, some silt, some gravel Dense to compact Grey brown Moist (Fill) | | 2 | SS | 29 | | 108 | | | | | | | | |
| 107.8 | Clayey Silt, some sand and gravel Stiff Brown Moist (Fill) | | 3 | SS | 13 | | 107 | | | | | | | | |
| 107.1 | Organic Silty Sand and Peat, Fibrous Compact Black Moist | | 4 | SS | 13 | | 106 | | | | | | | | |
| 106.3 | Organic content of sample 4 = 4.5% | | 5 | SS | 105/15 | | 105 | | | | | | | | |
| 3.1 | Silty Sand, trace gravel and clay Very dense Grey Moist (Glacial Till) | | 6 | SS | 95 | | 104 | | | | | | | | |
| 105.5 | Clayey Silt, trace to some sand, trace gravel Hard Brown Moist (Glacial Till) | | 7 | SS | 55/08 | | 103 | | | | | | | 2 9 80 9 | |
| 3.8 | | | 8 | SS | 50/08 | | 102 | | | | | | | | |
| 103.2 | Silty Sand to Silt and Sand, trace to some gravel, trace clay Very dense Grey Wet to dry below 9.2m depth (Glacial Till) | | 9 | SS | 100/13 | | 101 | | | | | | | 6 46 44 4 | |
| 6.1 | Non-plastic atterberg limits test result for sample 9. | | 10 | SS | 100/08 | | 100 | | | | | | | | |
| | | | 11 | SS | 100/08 | | 99 | | | | | | | | |
| | | | 12 | SS | 100/08 | | 98 | | | | | | | | |
| 97.1 | END OF BOREHOLE | | | | | | | | | | | | | | |
| 12.2 | Notes: 1. Open borehole dry upon completion of drilling. 2. Piezometer blocked at 1.5m depth (Elev. 107.8m) on Dec.27/00. 3. Water level in piezometer frozen at ground surface on Feb.9/01. 4. Water level measured in piezometer at 4.7m depth (Elev.104.6m) on May.4/01. | | | | | | | | | | | | | | |

ON MOT 001-8019.GPJ ON MOT.GDT 15/5/01

| PROJECT 001-8019F | | | | RECORD OF BOREHOLE No 00-3 | | | | 1 OF 1 | | METRIC | | | | | |
|--|---|------------|---------|---------------------------------------|------------|----------------------------|-----------------|---|----|--------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| W.P. 124-99-00 | | | | LOCATION N 4856940.4; E 343183.8 | | | | ORIGINATED BY PKS | | | | | | | |
| DIST 6 HWY 401 | | | | BOREHOLE TYPE 108mm Solid Stem Augers | | | | COMPILED BY DKB | | | | | | | |
| DATUM Geodetic | | | | DATE Nov. 17/00 | | | | CHECKED BY ASP | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | |
| 108.9 | GROUND SURFACE | | | | | | 20 | 40 | 60 | 80 | 100 | | | | |
| 8.9 | Topsoil | | 1 | SS | 25 | | | | | | | | | | |
| | Clayey Silt, some sand and gravel, occasional organics Firm to very stiff Brown Moist (Fill) | | 2 | SS | 20 | | | | | | | | | | |
| | | | 3 | SS | 7 | | | | | | | | | | |
| | | | 4 | SS | 17 | | | | | | | | | | |
| 105.9 | | | | | | | | | | | | | | | |
| 3.1 | Silty Sand, trace to some gravel, trace clay Very dense Brown Moist (Glacial Till) | | 5 | SS | 125 | | | | | | | | | | |
| 105.4 | | | | | | | | | | | | | | | |
| 3.5 | END OF BOREHOLE | | | | | | | | | | | | | | |
| Note: Open borehole dry upon completion of drilling. | | | | | | | | | | | | | | | |

ON MOT 001-8019.GPJ ON MOT.GDT 15/5/01

| PROJECT 001-8019F | | | | RECORD OF BOREHOLE No 00-4 | | | | 1 OF 1 | | METRIC | | | | | | |
|-------------------|---|------------|---------|---------------------------------------|------------|----------------------------|-----------------|---|----|--------|-----|---------------------------------|-------------------------------------|--------------------------------|------------------|---|
| W.P. 124-99-00 | | | | LOCATION N 4856898.0; E 343172.9 | | | | ORIGINATED BY PKS | | | | | | | | |
| DIST 6 HWY 401 | | | | BOREHOLE TYPE 108mm Solid Stem Augers | | | | COMPILED BY DKB | | | | | | | | |
| DATUM Geodetic | | | | DATE Nov.2/00 | | | | CHECKED BY ASP | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | |
| 104.0 | GROUND SURFACE | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 0.0 | Topsoil | | 1 | SS | 30 | | | | | | | | | | | |
| 0.1 | Clayey Silt, some sand, trace gravel | | | | | | | | | | | | | | | |
| 103.3 | Hard Brown Moist (Fill) | | 2 | SS | 15 | | | | | | | | | | | |
| 0.8 | Silty Sand, trace clay and trace gravel | | | | | | | | | | | | | | | |
| | Compact Brown Wet (Fill) | | 3 | SS | 11 | | | | | | | | | | | |
| 101.8 | | | 4 | SS | 100/05 | | | | | | | | | | | |
| 2.3 | Clayey Silt, some sand, trace gravel occasional cobbles | | | | | | | | | | | | | | | |
| | Hard Grey Moist (Glacial Till) | | 5 | SS | 100/10 | | | | | | | | | | | |
| | | | 6 | SS | 100/05 | | | | | | | | | | | |
| | | | 7 | SS | 100/15 | | | | | | | | | | | |
| | | | 8 | SS | 100/10 | | | | | | | | | | | |
| 96.6 | END OF BOREHOLE | | 9 | SS | 100/02 | | | | | | | | | | | |
| 7.5 | | | | | | | | | | | | | | | | |

Note:

1. Open borehole dry upon completion of drilling.
2. Water level measured in piezometer at 5.5m depth (Elev. 98.5m) on Dec.27/00.
3. Piezometer dry on Feb.25/01.
4. Water level measured in piezometer at 6.3m depth (Elev. 97.7m) on May 4, 2001.

ON MOT 001-8019.GPJ ON MOT.GDT 15/5/01

| PROJECT 001-8019F | | | RECORD OF BOREHOLE No 00-5 | | | 1 OF 1 | | | METRIC | | | | | | | | | | | | | |
|-------------------|---|------------|---------------------------------------|------|------------|--|-----------------|---|---|--|--|-------------|-------------------|--|---------------------------------------|---|--|--|-------------|--|------------|--|
| W.P. 124-99-00 | | | LOCATION N 4856795.0; E 343232.0 | | | ORIGINATED BY PKS | | | | | | | | | | | | | | | | |
| DIST 6 HWY 401 | | | BOREHOLE TYPE 108mm Solid Stem Augers | | | COMPILED BY DKB | | | | | | | | | | | | | | | | |
| DATUM Geodetic | | | DATE Nov.17/00 | | | CHECKED BY ASP | | | | | | | | | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT | | | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | | | | |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED | | | | | WATER CONTENT (%) | | | γ | | | GR SA SI CL | | | |
| 108.0 | GROUND SURFACE | | | | | | | 20 40 60 80 100 | | | | | | | | | | | | | | |
| 8.9 0.1 | Topsoil | | 1 | SS | 26 | | | | | | | | | | | | | | | | | |
| 107.2 0.8 | Silty Sand, some gravel Compact Brown Moist (Fill) | | 2 | SS | 29 | | 107 | | | | | | | | | | | | | | | |
| | Clayey Silt, some sand and gravel Very stiff to firm Brown Moist (Fill) | | 3 | SS | 4 | | 106 | | | | | | | | | | | | | | | |
| 105.7 2.3 | Clayey Silt, some to with sand, trace gravel Hard Brown Moist (Glacial Till) | | 4 | SS | 95 | | 105 | | | | | | | | | | | | | | 2 23 60 10 | |
| 104.6 3.4 | END OF BOREHOLE | | 5 | SS | 100/15 | | | | | | | | | | | | | | | | | |
| | Note: Open borehole dry upon completion of drilling. | | | | | | | | | | | | | | | | | | | | | |

ON MOT 001-8019.GPJ ON MOT.GDT 15/5/01

+³, X³: Numbers refer to Sensitivity **○³%** STRAIN AT FAILURE

RECORD OF BOREHOLE No 00-34

1 OF 1

METRIC

PROJECT 001-8019F

W.P. 124-99-00

LOCATION N 4856951.0; E 343181.0

ORIGINATED BY PKS

DIST 6 HWY 401

BOREHOLE TYPE 114mm Solid Stem Augers

COMPILED BY DKB

DATUM Geodetic

DATE April 13/01

CHECKED BY ASP

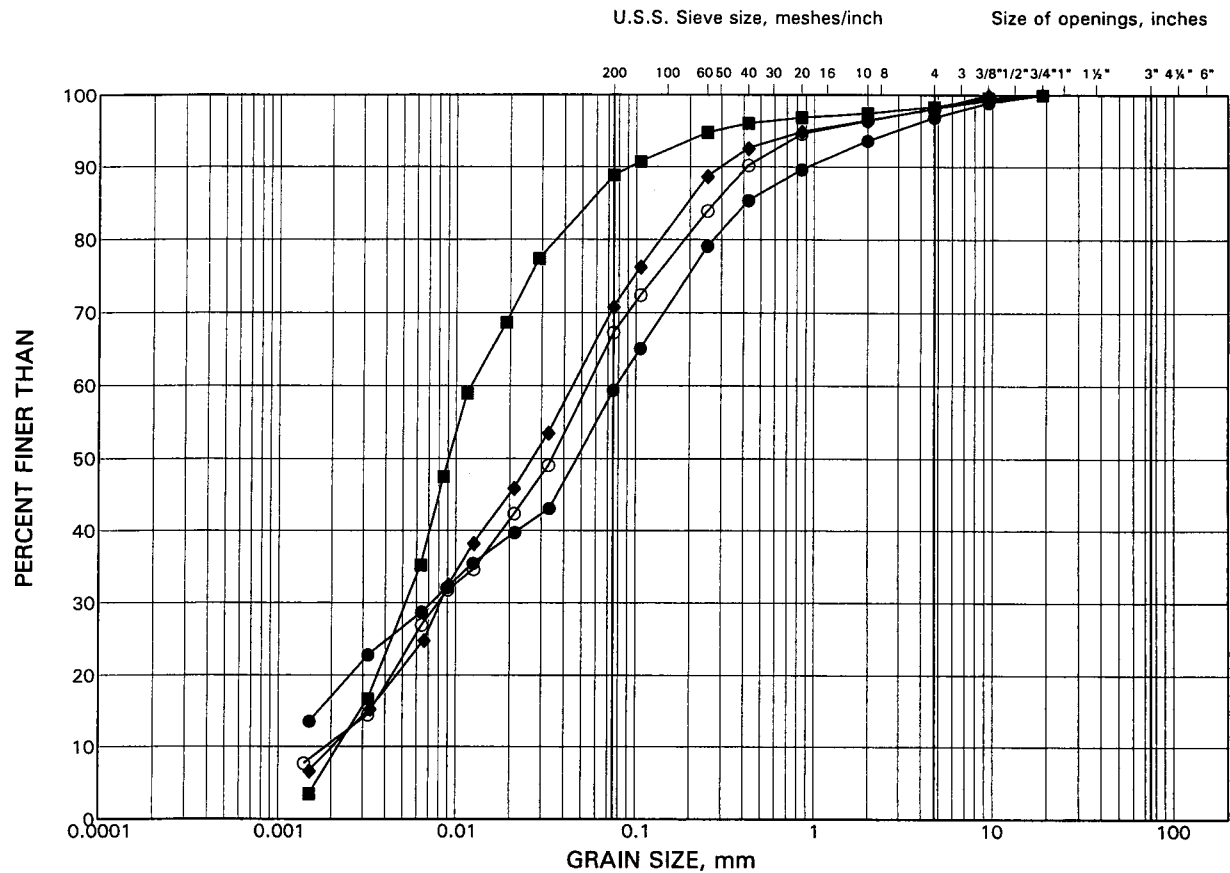
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | | WATER CONTENT (%) | |
| | | | | | | | | 20 40 60 80 100 | | | | | 20 40 60 | | | | | GR SA SI CL | |
| 108.7 | GROUND SURFACE | | | | | | | | | | | | | | | | | | |
| 0.0 | Silty Sand, some gravel Compact Brown Moist (Fill) | | 1 | SS | 17 | | | | | | | | | | | | | | |
| | | | 2 | SS | 29 | | | | | | | | | | | | | | |
| 107.2 | | | | | | | | | | | | | | | | | | | |
| 1.5 | Silty Clay to Clayey Silt, some sand and gravel Very stiff Brown Moist (Fill) | | 3 | SS | 19 | | | | | | | | | | | | | | |
| 106.5 | | | | | | | | | | | | | | | | | | | |
| 2.2 | Silty Sand, trace to some gravel, trace clay, occ. cobbles Dense to very dense Brown Moist becoming wet below 3.8m depth (Glacial Till) | | 4 | SS | 42 | | | | | | | | | | | | | | |
| | | | 5 | SS | 110 | | | | | | | | | | | | 6 64 30 0 | | |
| | | | 6 | SS | 105/15 | | | | | | | | | | | | | | |
| | | | 7 | SS | 100/15 | | | | | | | | | | | | | | |
| 103.4 | | | | | | | | | | | | | | | | | | | |
| 5.3 | Silt, trace to some sand, trace clay and gravel Very dense Grey Wet | | 8 | SS | 100/15 | | | | | | | | | | | | 2 10 86 2 | | |
| | non-plastic Atterberg Limits result for sample 8 | | | | | | | | | | | | | | | | | | |
| 101.9 | | | | | | | | | | | | | | | | | | | |
| 6.8 | Silty Sand, trace to some gravel, trace clay, occ. cobbles Very dense Grey Wet (Glacial Till) | | 9 | SS | 100/15 | | | | | | | | | | | | | | |
| | | | 10 | SS | 100/15 | | | | | | | | | | | | | | |
| 97.9 | | | | | | | | | | | | | | | | | | | |
| 10.8 | END OF BOREHOLE | | 11 | SS | 100/10 | | | | | | | | | | | | | | |
| | Note: 1. Open borehole dry upon completion of drilling. 2. Water level measured in piezometer at 3.8m depth (El.104.9m) on May 4,2001. | | | | | | | | | | | | | | | | | | |

ON MOT 001-8019.GPJ ON MOT.GDT 18/5/01

GRAIN SIZE DISTRIBUTION

Clayey Silt (Glacial Till)

FIGURE 1



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

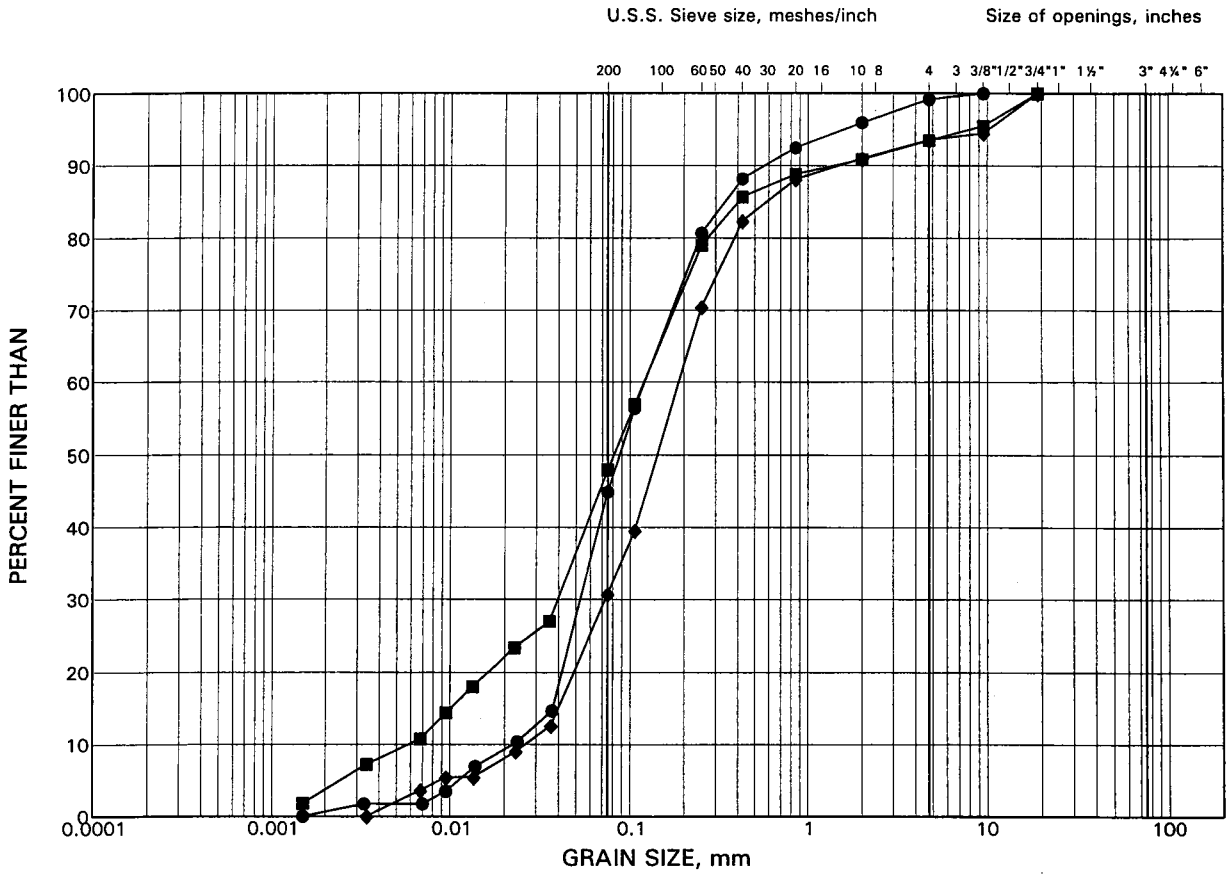
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION (m) |
|--------|----------|--------|---------------|
| ● | 00-1 | 9 | 99.5 |
| ■ | 00-2 | 7 | 104.8 |
| ◆ | 00-5 | 4 | 105.5 |
| ○ | 00-33 | 3 | 98.7 |

GRAIN SIZE DISTRIBUTION

Silt and Sand (Glacial Till)

FIGURE 2



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

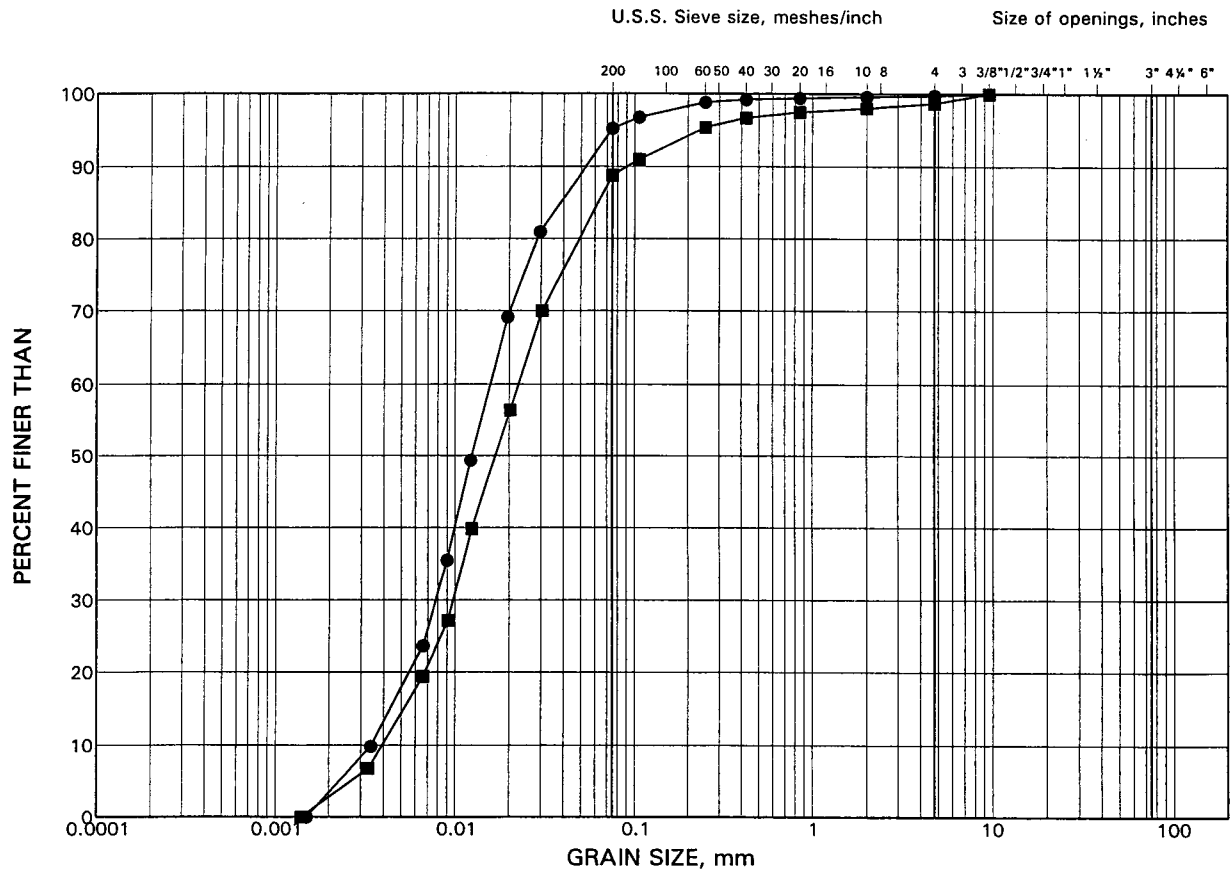
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION (m) |
|--------|----------|--------|---------------|
| ● | 00-1 | 6 | 103.1 |
| ■ | 00-2 | 9 | 101.7 |
| ◆ | 00-34 | 5 | 105.2 |

GRAIN SIZE DISTRIBUTION

Silt

FIGURE 3

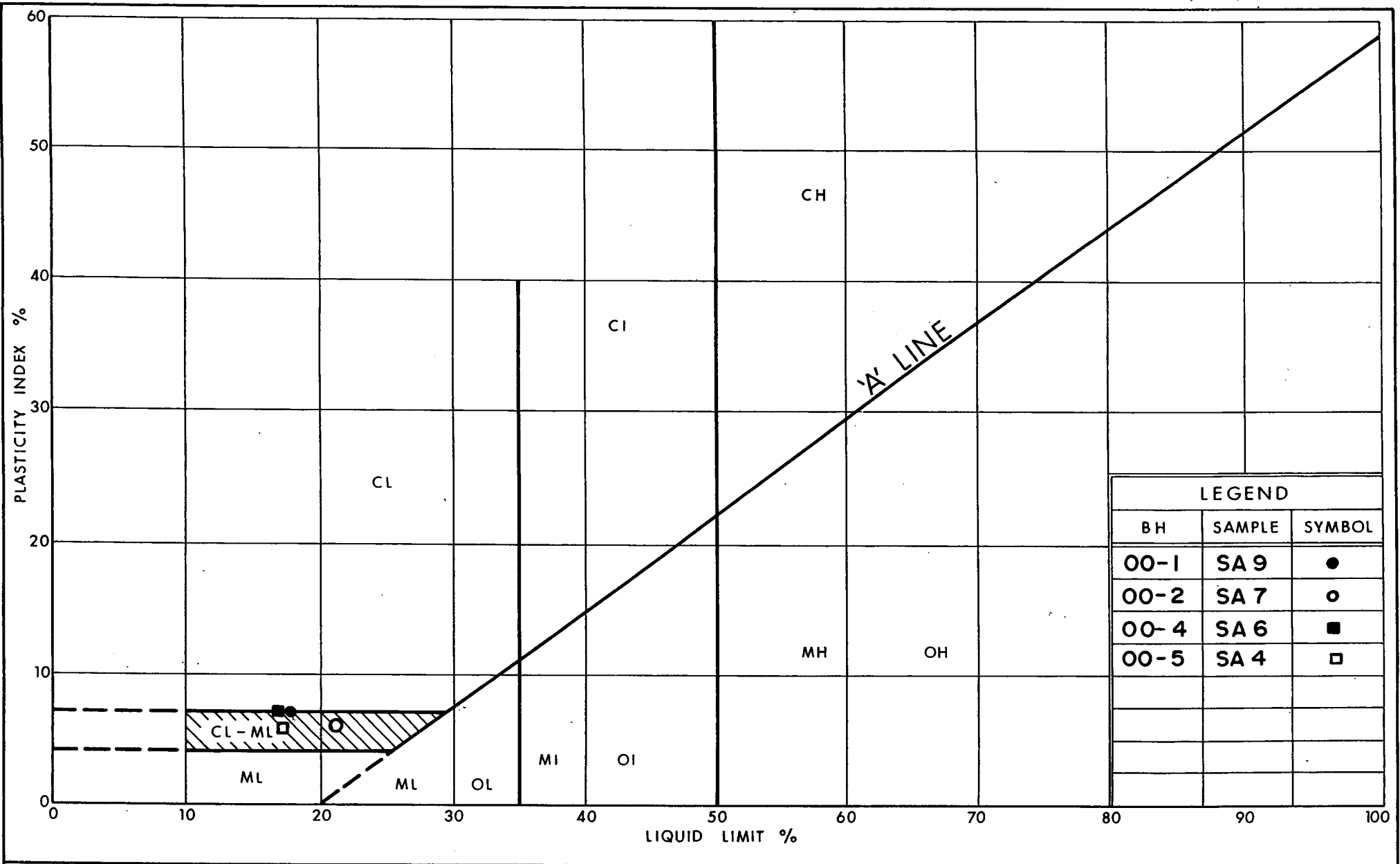


| | | | | | | | |
|---------------------|--|-----------|--------|--------|-------------|--------|--------|
| SILT AND CLAY SIZES | | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE |
| FINE GRAINED | | SAND SIZE | | | GRAVEL SIZE | | SIZE |

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION (m) |
|--------|----------|--------|---------------|
| ● | 00-1 | 4 | 104.5 |
| ■ | 00-34 | 8 | 102.5 |

Oct 75, FF-S-21



| LEGEND | | |
|--------|--------|--------|
| BH | SAMPLE | SYMBOL |
| 00-1 | SA 9 | ● |
| 00-2 | SA 7 | ○ |
| 00-4 | SA 6 | ■ |
| 00-5 | SA 4 | □ |
| | | |
| | | |
| | | |
| | | |



Ministry of
Transportation

Ontario

PLASTICITY CHART
CLAYEY SILT (GLACIAL TILL)

FIG No **4**
W P **124-99-00**

APPENDIX A

**RELEVANT RECORD OF BOREHOLE SHEETS
"WIDENING OF SOUTHBOUND HARWOOD AVENUE BRIDGE OVER
HIGHWAY 401", W.P. 133-78-01, SITE 22-121, GEOCRETS NO. 30M14-64,
DATED FEBRUARY 1980, CARRIED OUT BY THE MTO**

ORIGINATED BY BL

COMPILED BY MM

CHECKED BY

Note Water Level
Not Established

RECORD OF BOREHOLE No 5

4056908.1, 343176.6

133-78-01

LOCATION Co-ords. N 15 934 738, E 1 125 908

ORIGINATED BY MM

6 HWY 401

BOREHOLE TYPE Hollow Stem Augers and Cone Test

COMPILED BY MM

DST 6

DATE December 7, 1979

CHECKED BY V.J.

DST 6

Geodetic

SOIL PROFILE

SAMPLES

GROUND WATER CONDITIONS

ELEVATION SCALE

DYNAMIC CONE PENETRATION RESISTANCE PLOT

20 40 60 80 100

SHEAR STRENGTH

○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL x LAB VANE

PLASTIC LIMIT

NATURAL MOISTURE CONTENT

LIQUID LIMIT

W_p

W

W_L

WATER CONTENT (%)

10 20 30

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

ELEV
DEPTH

DESCRIPTION

STRAT PLOT

NUMBER

TYPE

'N' VALUES

Ground Surface

0.0

Fill
Clayey silt
Some sand

1

SS

4

349.7

Black with organics

2

SS

5

9.0

Heterogeneous mixture
Silt, sand and
gravel
(Glacial Till)
Very dense

3

SS

49

4

SS

112

5

SS

50/2"

6

SS

100/4"

7

SS

100/5"

350

340

338.2
20.5

End of Borehole

* No groundwater encountered

OM
SZ

0 33 58 9

4 25 70 1

8 43 48 1

APPENDIX B

**RELEVANT RECORD OF BOREHOLE SHEETS
"FOUNDATION INVESTIGATION - RETAINING WALLS AND STRUCTURE
MODIFICATION AT HARWOOD AVENUE",
GO-ALRT PICKERING TO OSHAWA, DATED AUGUST 1983, CARRIED OUT BY
DOMINION SOIL INVESTIGATION INC FOR THE MTO**

RECORD OF BOREHOLE No 10

METRIC

W P 470-711-612 LOCATION Co-ords 4,856,858N; 343,217E ORIGINATED BY S.D.
DIST 6 HWY 60-ALRT BOREHOLE TYPE Hollow Stem Augering and Washboring COMPILED BY S.D.
DATUM GEODETIC DATE 1983 07 31 CHECKED BY L.S.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|--|------------|---------|------|------------|-------------------------|-----------------|--|----|----|----|---------------------------------|-------------------------------|--------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | | | | | |
| 109.2 | Ground Level | | | | | | | | | | | | | | | |
| 0.0 | 75 mm Asphalt Pavement Fill - sand, some gravel. | | | | | | | | | | | | | | | |
| 107.4 | Compact Brown | | 1 | SS | 15 | | | | | | | | | | | |
| 1.8 | Silty sand, trace gravel, slightly cemented glacial till | | | | | | | | | | | | | | | |
| | Damp to moist | | 2 | SS | 43 | | | | | | | | | | | |
| | Dense | | | | | | | | | | | | | | | |
| | Very dense | | 3 | SS | 60 | 0.15m | | | | | | | | | | |
| | Brown | | | | | | | | | | | | | | | |
| | Grey | | 4 | SS | 50 | 0.02m | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 125 | 0.15m | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 70 | 0.12m | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 7 | SS | 50 | 0.07m | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 8 | SS | 70 | 0.05m | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 9 | SS | 80 | 0.10m | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 10 | SS | 60 | 0.05m | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 93.0 | | | | | | | | | | | | | | | | |
| 16.2 | Silty clay, some sand, trace gravel, glacial till. | | 11 | SS | 80 | 0.15m | | | | | | | | | | |
| 91.5 | Hard Grey Damp | | | | | | | | | | | | | | | |
| 17.7 | Clay Damp Glacial Till Hard Dark grey | | 12 | SS | 80 | 0.15m | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 89.2 | | | 13 | SS | 70 | 0.15m | | | | | | | | | | |
| 20.0 | End of Borehole | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to Sensitivity 20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 11

METRIC

W P 470-711-612 LOCATION Co-ords 4,856,847N; 343,186E ORIGINATED BY S.D.
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Augering and Washboring COMPILED BY S.D.
DATUM GEODETIC DATE 1983 08 01 CHECKED BY L.S.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|------------------------------------|-------------------------------------|-----------------------------------|----------------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | | |
| 108.9 | Ground Level | | | | | | | | | | | | GR SA SI CL |
| 0.0 | Asphalt Pavement | | | | | | | | | | | | |
| 108.0 | Fill - sand and gravel | | | | | | | | | | | | |
| 0.9 | Silty sand, some gravel, glacial till. | | 1 | SS | 28 | | 108 | | | | | | |
| | Porous Damp | | | | | | | | | | | | |
| | compact | | 2 | SS | 92 | | 106 | | | | | | |
| | Very dense, slightly cemented | | | | | | | | | | | | |
| | Brown with rusty discolorations | | 3 | SS | 70 | /0.07m | 104 | | | | | | |
| | Grey | | 4 | SS | 100 | /0.10m | 102 | | | | | | |
| 101.6 | Fine sand, some silt, trace gravel | | 5 | SS | 70 | /0.10m | 100 | | | | | | |
| 7.3 | Very dense Saturated | | | | | | | | | | | | |
| 100.8 | Silty sand, some gravel slightly cemented, glacial till | | 6 | SS | 70 | /0.07m | 98 | | | | | | |
| 8.1 | Grey Damp | | 7 | SS | 100 | /0.07m | 96 | | | | | | |
| | with occasional saturated fine sand lenses | | 8 | SS | 50 | /0.0m | 94 | | | | | | |
| | Very dense | | 9 | SS | 80 | /0.07m | 92 | | | | | | |
| | | | 10 | SS | 70 | /0.15m | 90 | | | | | | |
| 92.7 | Clay | | | | | | 88 | | | | | | |
| 16.2 | Glacial till Grey | | 11 | SS | 105 | | | | | | | | |
| | Hard Damp | | 12 | SS | 60 | /0.15m | | | | | | | |
| | | | 13 | SS | 52 | /0.15m | | | | | | | |
| 87.3 | | | 14 | SS | 61 | /0.15m | | | | | | | |
| 21.6 | End of Borehole | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 19

METRIC

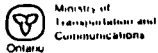
W P 470-711-612 LOCATION Co-ords 4,856,798N; 343,211E ORIGINATED BY S.D.
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Augering and Washboring COMPILED BY S.D.
DATUM GEODETIC DATE 1983 08 04 and 05 CHECKED BY L.S.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 107.1 | Ground Level | | | | | | | | | | | | | | | | |
| 0.0 | Topsoil | | | | | | | | | | | | | | | | |
| 0.2 | Silty sand, trace of gravel slightly cemented, glacial till. Very dense Dry to damp Light brown Grey | | 1 | SS | 84 | PIEZOMETER | 106 | | | | | | | | | | |
| | | | 2 | SS | 60 | | 104 | | | | | | | | | | |
| | | | 3 | SS | 100 | | 102 | | | | | | | | | | |
| 101.6 | | | | | /0.13m | SEAL | | | | | | | | | | | |
| 5.5 | Silty fine sand, saturated Grey Silt seam | | 4 | SS | 70 | | 100 | | | | | | | | | | |
| | | | 5 | SS | 105 | | | | | | | | | | | | 0 17 83 0 |
| 98.6 | Very dense | | | | | | | | | | | | | | | | |
| 8.5 | Clay till Grey Damp | | 6 | SS | 50 | | 98 | 9 | | | | | o | | | 21.7 | |
| 97.1 | Hard | | | | /0.05m | | | | | | | | | | | | |
| 10.0 | Silty sand, trace gravel, slightly ce- mented glacial till. Clay seam Grey Damp | | 7 | SS | 100 | | 96 | | | | | | o | | | | |
| | | | 8 | SS | 70 | | 94 | | | | | | o | | | | |
| | | | 9 | SS | 100 | | | | | | | | | | | | |
| 92.8 | Very dense | | | | /0.12m | | | | | | | | | | | | |
| 14.3 | Clay till Dark grey with light grey silt lenses. Damp Hard | | 10 | SS | 50 | | 92 | p | | | | | o | | | 22.3 | |
| | | | 11 | SS | 80 | | 90 | | | | | | | | | | |
| | | | 12 | SS | 50 | | 88 | | | | | | | | | | |
| | | | | | /0.10m | | | | | | | | | | | | |
| 87.1 | | | 13 | SS | 50 | | | | | | | | | | | | |
| | | | | | /0.08m | | | | | | | | | | | | |
| 20.0 | End of Borehole | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 20

METRIC

W P 470-711-612 LOCATION Co-ords 4,856,804N; 343,233E ORIGINATED BY S.D.
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Augering and Washboring COMPILED BY S.D.
 DATUM GEODETIC DATE 1983 08 08 CHECKED BY L.S.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|--|-------------|---------|------|------------|-------------------------|-----------------|--|-----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | 100 | | | | | |
| 107.9 | Ground Level | | | | | | | | | | | | | |
| 0.0 | 100501 | | | | | | | | | | | | | |
| 0.2 | Silty sand, slightly cemented, glacial till. | | | | | | | | | | | | | |
| | Dense | | 1 | SS | 33 | | 106 | | | | | | | |
| | Very dense | | | | | | | | | | | | | |
| | Brown | | | | | | | | | | | | | |
| | Dry to damp | | | | | | | | | | | | | |
| 102.1 | | | | | | | 104 | | | | | | | |
| 5.8 | Fine sand, some silt. | | 4 | SS | 50 | | 102 | | | | | | | |
| 101.2 | | | | | | | | | | | | | | |
| 6.7 | Silty sand, glacial till. | | | | | | 100 | | | | | | | |
| | Grey Damp | | | | | | | | | | | | | |
| 99.4 | Very dense | | | | | | | | | | | | | |
| 8.5 | Sand, some gravel, trace of silt. | | 6 | SS | 100 | | 98 | | | | | | | |
| 98.1 | Very dense Saturated Brown | | | | | | | | | | | | | |
| 9.8 | Silt, slightly cohesive with silty clay layers. | | 7 | SS | 50 | | 96 | | | | | | | |
| | Saturated | | | | | | | | | | | | | |
| | V. Dense Grey to Hard | | 8 | SS | 70 | | 94 | | | | | | | |
| 94.8 | | | | | | | | | | | | | | |
| 13.1 | Sand, trace of silt. | | 9 | SS | 100 | | 92 | | | | | | | |
| 93.9 | Very Grey Saturated dense | | | | | | | | | | | | | |
| 14.0 | Silty sand, trace gravel, slightly cemented glacial till. | | 10 | SS | 50 | | 90 | | | | | | | |
| | Grey Damp | | | | | | | | | | | | | |
| 91.7 | Very dense | | | | | | 88 | | | | | | | |
| 16.2 | Clay, with occasional embedded angular gravel glacial till | | 11 | SS | 100 | | | | | | | | | |
| | Damp | | | | | | | | | | | | | |
| | Dark grey | | 12 | SS | 100 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | Hard | | 13 | SS | 90 | | | | | | | | | |
| 86.4 | | | 14 | SS | 100 | | | | | | | | | |
| 21.5 | End of Borehole | | | | | | | | | | | | | |

+3, x5: Numbers refer to Sensitivity

20
15
10
5
0
5
10
15
20
(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 21

METRIC

| | | | | | |
|-------|-------------|----------|------------------------------|---------------|-------------------------------------|
| W P | 470-711-612 | LOCATION | Co-ords 4,856,813N; 343,255E | ORIGINATED BY | S.D. |
| DIST | 6 | HWY | GO-ALRT | BOREHOLE TYPE | Hollow Stem Augering and Washboring |
| DATUM | GEODETIC | DATE | 1983 08 09 | COMPILED BY | S.D. |
| | | | | CHECKED BY | L.S.R. |

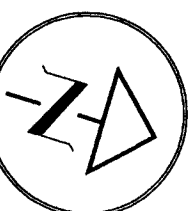
[illegible]

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

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

DIST. 6 HWY. 401
CONT No.
WP No. 124-99-00

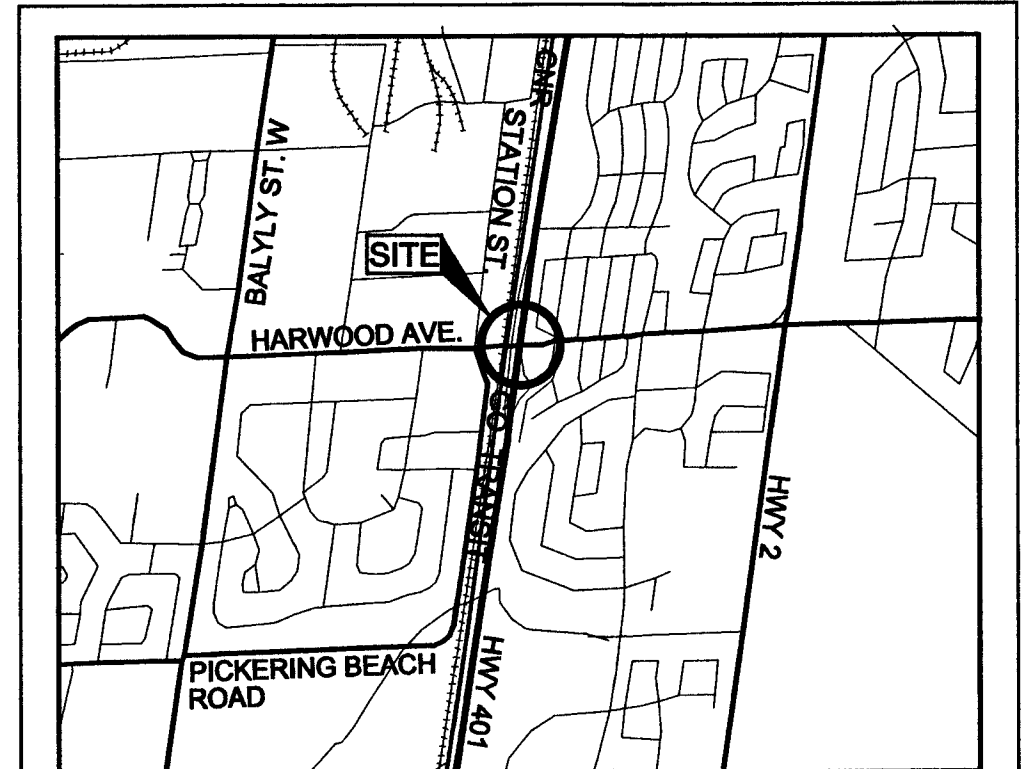


**HARWOOD AVE./HWY. 401
UNDERPASS (SITE 22-121)**
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

LEGEND

- Borehole - Current Golder Associates Ltd. Investigation
- Borehole - Previous Investigation by Dominion Soil Investigation dated August 1983
- ⊕ Borehole - Previous Investigation by MTO, dated February, 1980 (Geocres No. 30M14-164)
- Seal
- Piezometer
- N Standard Penetration Test value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer, May 4, 2001 (Current Boreholes) and August 1983 (83 series Boreholes)
- WL upon completion of drilling

| No. | ELEVATION | LOCATION | |
|-------|-----------|-----------|----------|
| | | NORTHING | EASTING |
| 00-1 | 107.1 | 4856921.3 | 343164.9 |
| 00-2 | 109.3 | 4856926.6 | 343187.5 |
| 00-3 | 108.9 | 4856940.4 | 343183.8 |
| 00-4 | 104.0 | 4856898.0 | 343172.9 |
| 00-5 | 108.0 | 4856795.0 | 343232.0 |
| 00-33 | 108.0 | 4856680.0 | 343232.0 |
| 00-34 | 108.7 | 4856951.0 | 343181.0 |
| 83-10 | 109.2 | 4856858.0 | 343217.0 |
| 83-11 | 108.9 | 4856847.0 | 343186.0 |
| 83-19 | 107.1 | 4856798.0 | 343211.0 |
| 83-20 | 107.9 | 4856804.0 | 343233.0 |
| 83-21 | 107.4 | 4856813.0 | 343255.0 |
| 80-3 | 109.4 | 4856916.0 | 343192.0 |
| 80-5 | 109.3 | 4856908.0 | 343177.0 |

NOTES

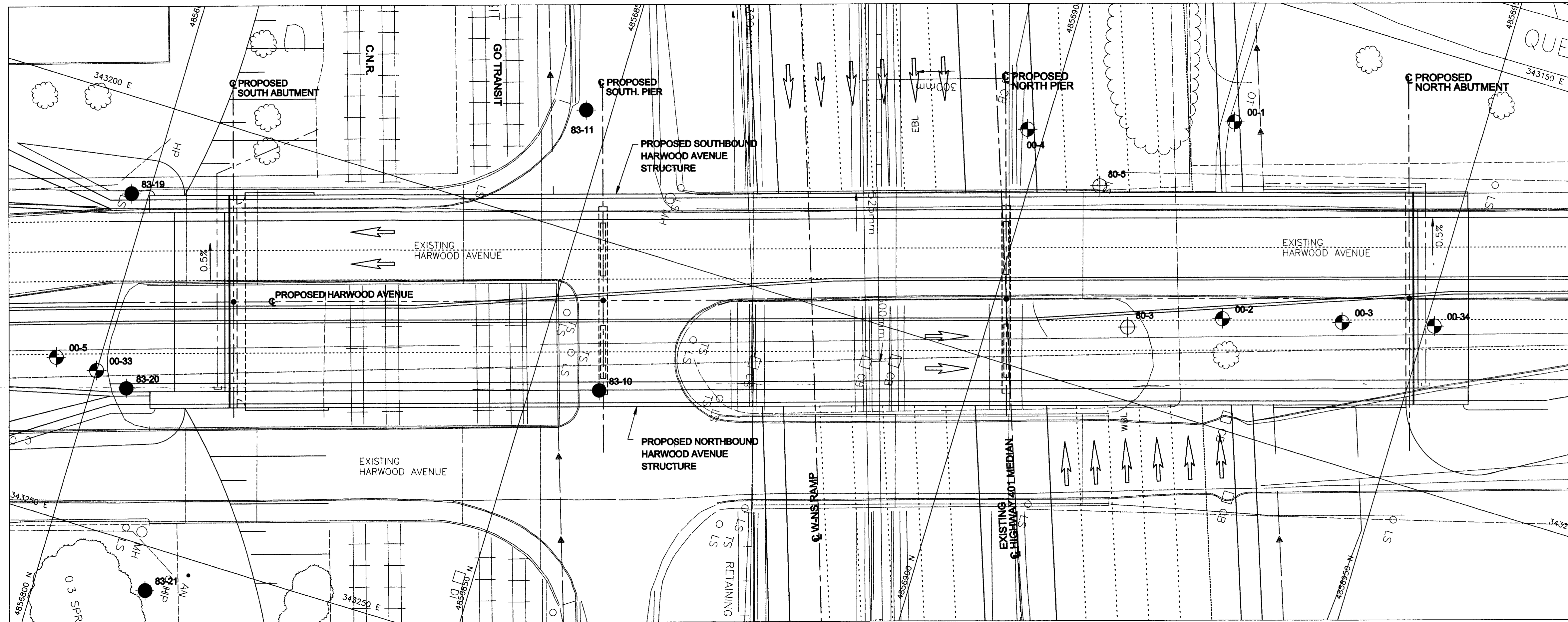
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REFERENCE

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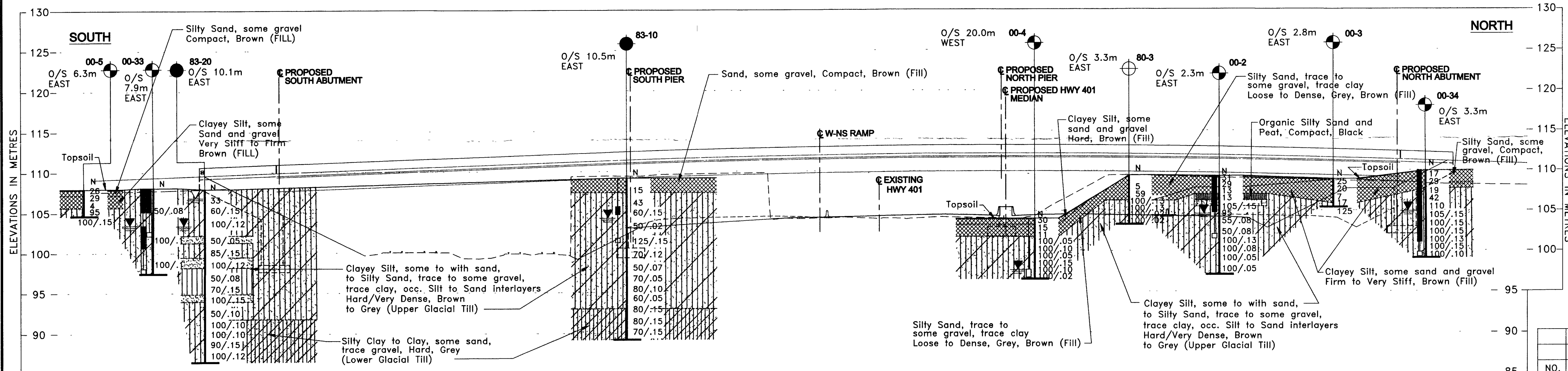
| NO. | DATE | BY | REVISION |
|-----|------|----|----------|
| | | | |

| | | | | | |
|-------------|--|-------------------------|--|----------------|--|
| Geocres No. | | PROJECT NO. 001-8019F-1 | | DIST. 6 | |
| HWY. | | SUBM'D. DKB | | DATE: MAY 2001 | |
| DRAWN: JFC | | CHKD. DKB | | APPD. | |
| | | | | SITE: | |
| | | | | DWG. 1 | |



PLAN

0 5 10 15 20 25 30 METRES
SCALE



PROFILE ALONG PROPOSED HARWOOD AVENUE CENTRELINE

0 5 10 15 20 25 30 METRES
SCALE

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. 6 HWY. 401

CONT No.

WP No. 124-99-00

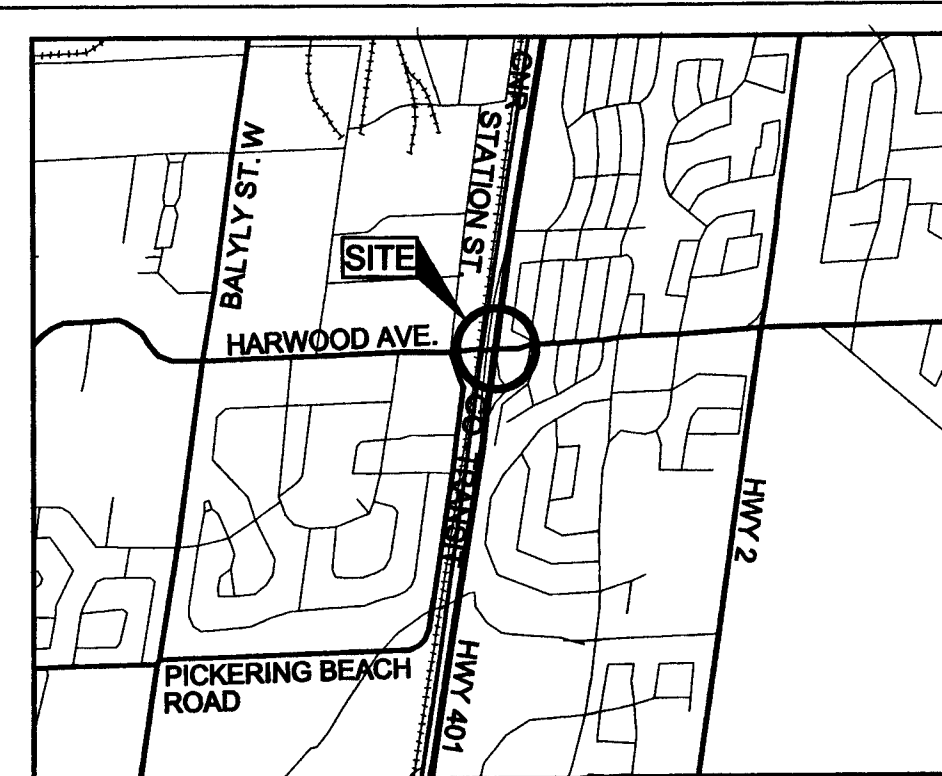
HARWOOD AVE./HWY. 401
UNDERPASS (SITE 22-121)

SOIL STRATA

SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

LEGEND

- Borehole - Current Golder Associates Ltd. Investigation
- Borehole - Previous Investigation by Dominion Soil Investigation dated August 1983
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- WL in piezometer, May 4, 2001 (Current Boreholes) and August 1983 (83 series Boreholes)
- WL upon completion of drilling

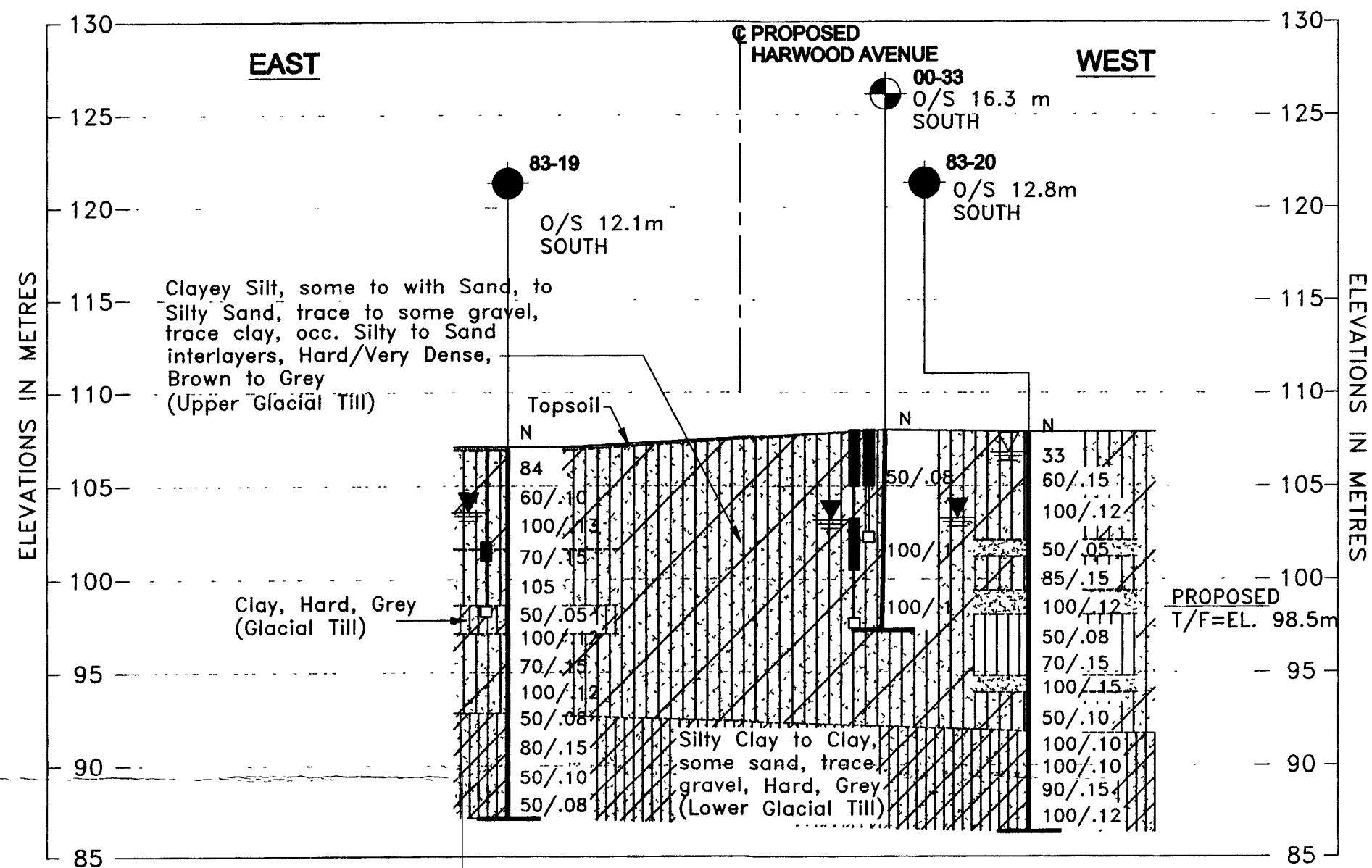
| No. | ELEVATION | LOCATION | |
|-------|-----------|-----------|----------|
| | | NORTHING | EASTING |
| 00-1 | 107.1 | 4856921.3 | 343164.9 |
| 00-2 | 109.3 | 4856926.6 | 343187.5 |
| 00-3 | 108.9 | 4856940.4 | 343183.8 |
| 00-4 | 104.0 | 4856898.0 | 343172.9 |
| 00-5 | 108.0 | 4856795.0 | 343232.0 |
| 00-33 | 108.0 | 4856680.0 | 343232.0 |
| 00-34 | 108.7 | 4856951.0 | 343181.0 |
| 83-10 | 109.2 | 4856858.0 | 343217.0 |
| 83-11 | 108.9 | 4856847.0 | 343186.0 |
| 83-19 | 107.1 | 4856798.0 | 343211.0 |
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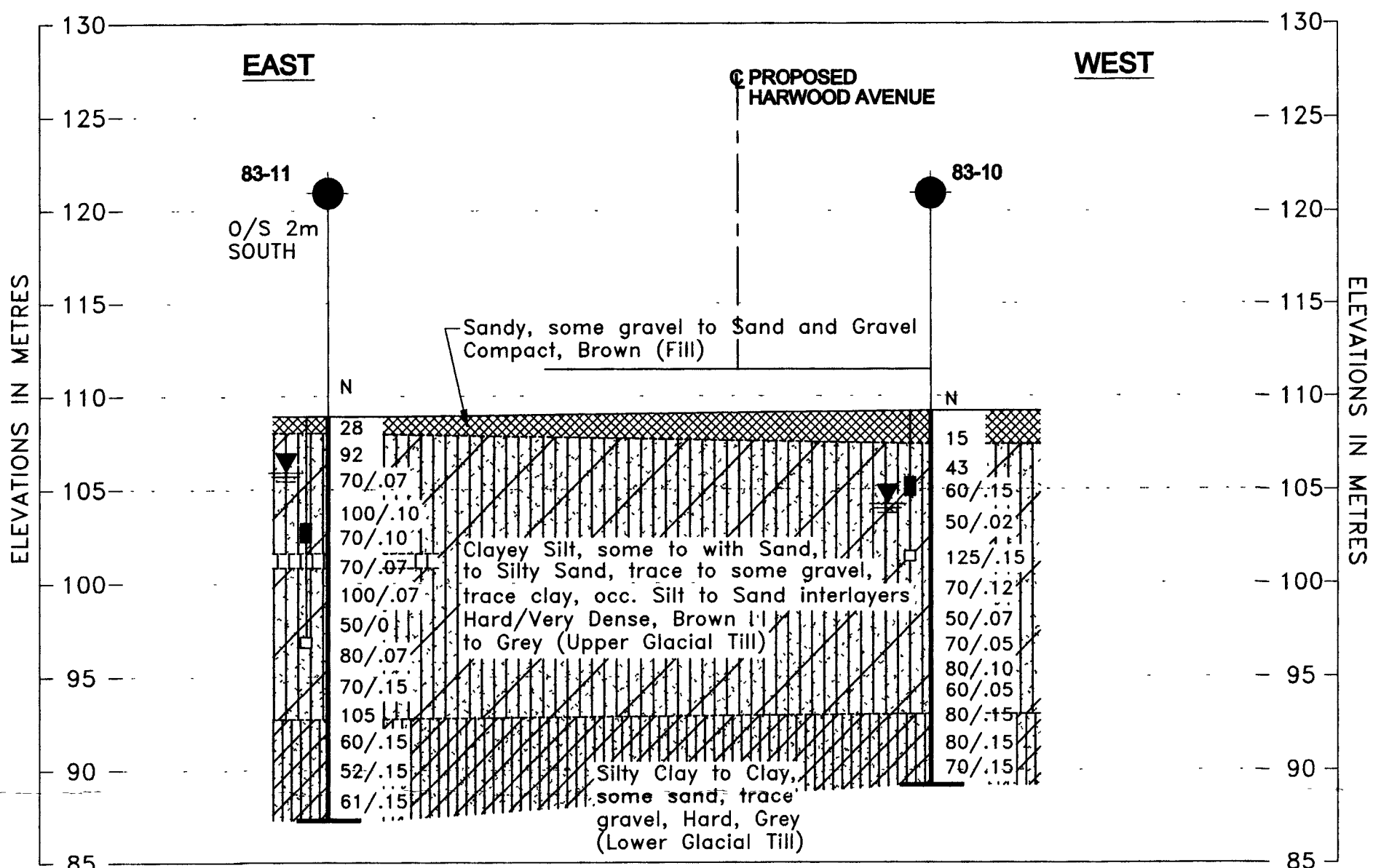
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GENERAL ARRANGEMENT" provided by Totten Sims Hubicki
Dated January 3, 2001.



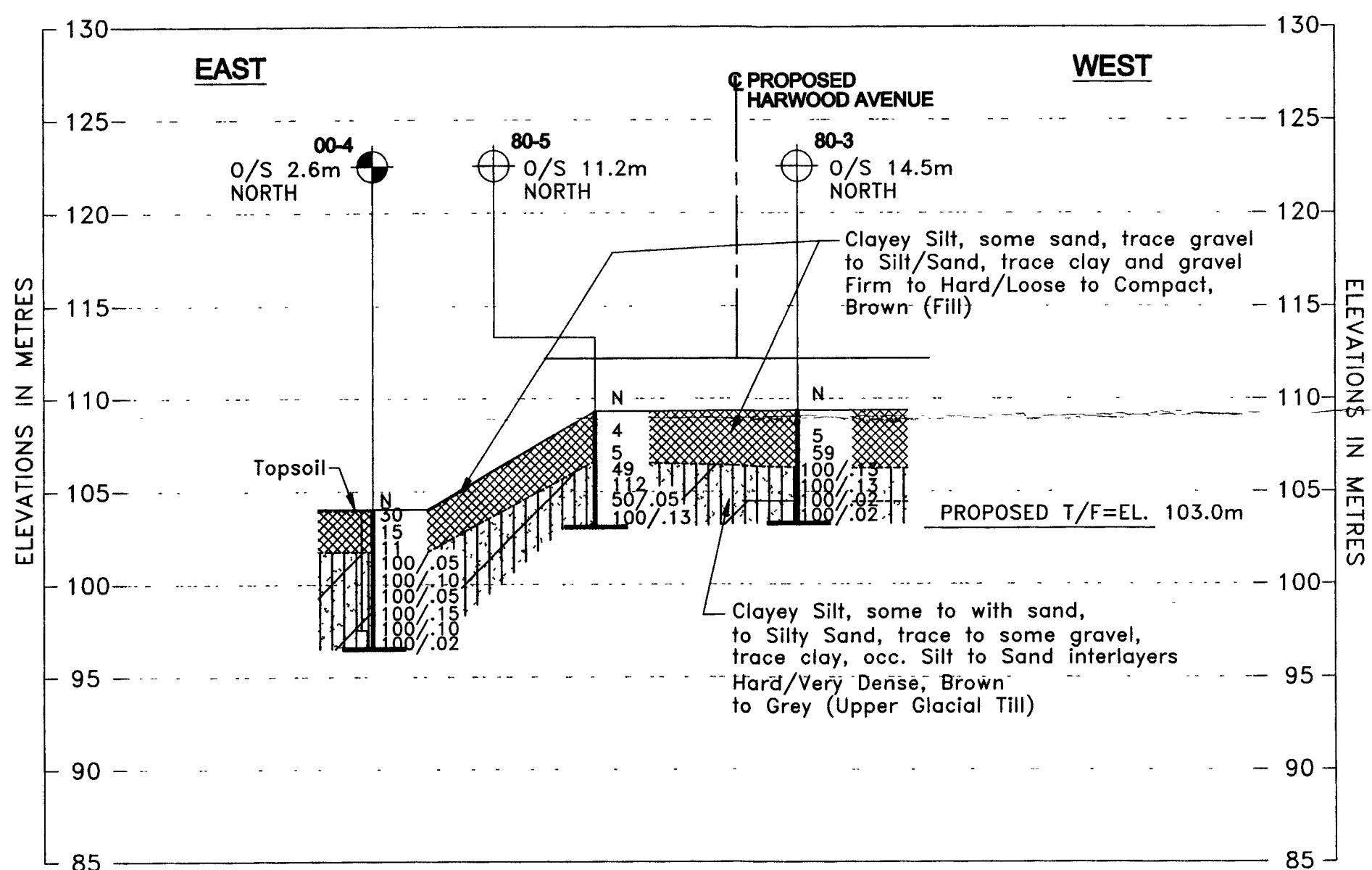
SECTION AT PROPOSED
SOUTH ABUTMENT

0 5 10 15 20 25 30 METRES
SCALE



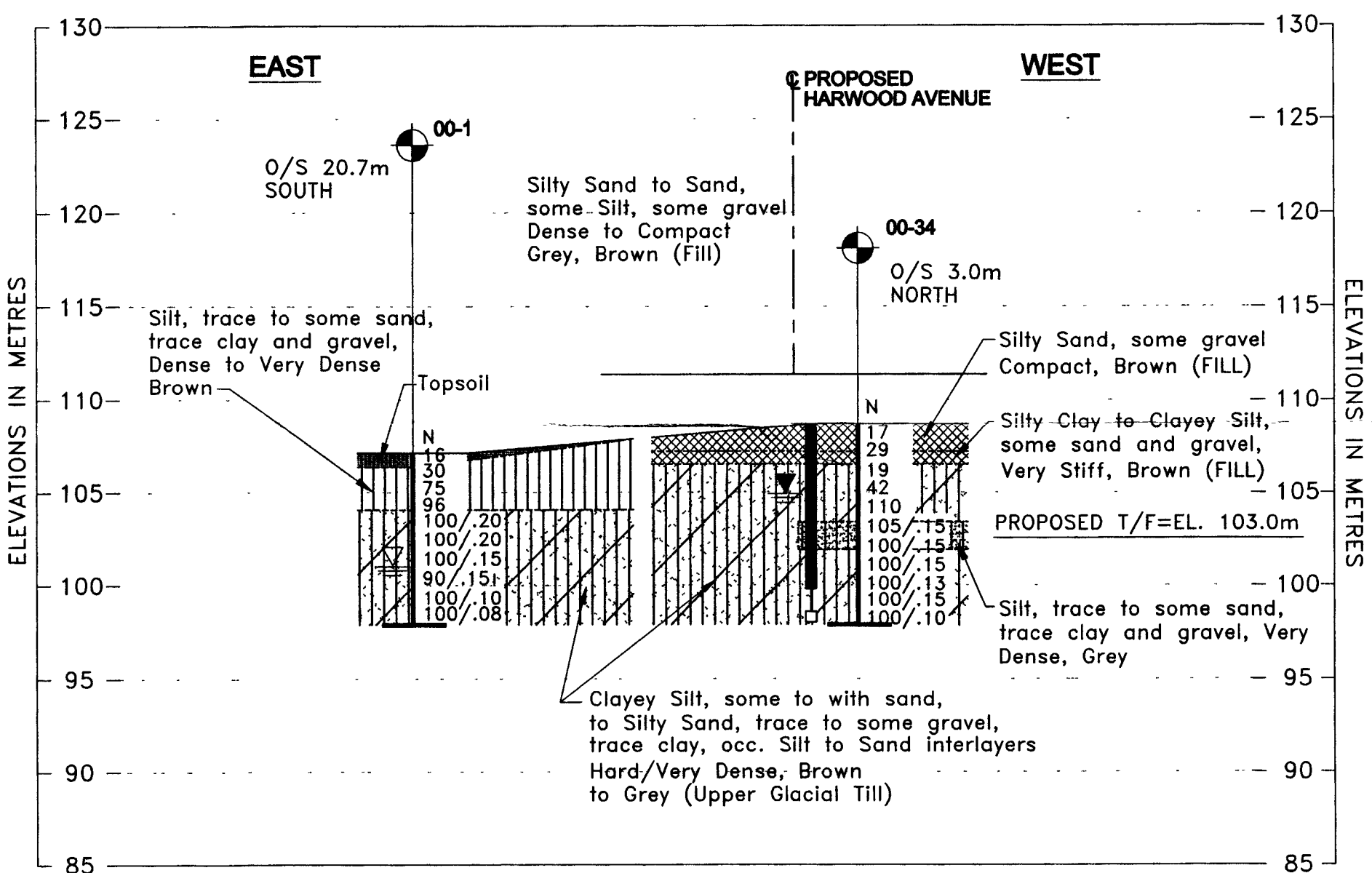
SECTION AT PROPOSED
SOUTH PIER

0 5 10 15 20 25 30 METRES
SCALE



SECTION AT PROPOSED
NORTH PIER

0 5 10 15 20 25 30 METRES
SCALE



SECTION AT PROPOSED
NORTH ABUTMENT

0 5 10 15 20 25 30 METRES
SCALE

| NO. | DATE | BY | REVISION |
|-----|------|----|----------|
| | | | |

| | | | | | |
|-------------|--|-------------------------|--|------------------|--|
| Geocres No. | | PROJECT NO. 001-8019F-1 | | DIST. 6 | |
| HWY. | | CHKD. ASP | | DATE: 2001 02 01 | |
| SUBM'D. DKB | | CHKD. DKB | | SITE: | |
| DRAWN: JFC | | APPD. | | DWG. 2 | |