

GEOCRE'S No. 30M13-145DIST. 6 REGION W.P. No. 530-91-00CONT. No. W. O. No. STR. SITE No. HWY. No. 9LOCATION Deep Cuts & High FillsW of Hwy 50 Easterly to Simcoe CoNo of PAGES - Ed. 10

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

Golder Associates Ltd.

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



REPORT

**HIGHWAY 9 WIDENING
FROM 0.3 km EAST OF ALBION 5th LINE ROAD
EASTERLY TO 0.3 km WEST OF SIMCOE ROAD 10
AGREEMENT NUMBER 9720-7411-2575
W. P. 530-91-00, CENTRAL REGION**

Submitted to:

Cole, Sherman & Associates
75 Commerce Valley Drive East
Thornhill, Ontario
L3T 7N9

DISTRIBUTION:

- 2 Copies - Ministry of Transportation,
Central Region, Ontario
- 2 Copies - Cole, Sherman & Associates,
Thornhill, Ontario
- 2 Copies - Golder Associates Ltd.,
Mississauga, Ontario

April 1999

981-1168

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
PART A – FIELD INVESTIGATION	
1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION	2
3.0 INVESTIGATION PROCEDURES	3
4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY	4
4.1 Site Geology.....	4
4.2 Site Stratigraphy	4
PART B – FOUNDATION DESIGN	
5.0 Engineering Recommendations	16
5.1 General	16
5.2 Deep Cuts and High Fills	16
5.2.1 Deep Cuts	18
5.2.2 High Fills.....	18
5.3 Culverts	21

List of Abbreviations and Symbols
Record of Borehole Sheets
Drawings N1168001 to N1168005
Figures 1 to 10
Appendix A

PART A – FIELD INVESTIGATION

**HIGHWAY 9 WIDENING
FROM 0.3 km EAST OF ALBION 5th LINE ROAD
EASTERLY TO 0.3 km WEST OF SIMCOE ROAD 10
AGREEMENT NUMBER 9720-7411-2575
W.P. 530-91-00, CENTRAL REGION**

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION	2
3.0 INVESTIGATION PROCEDURES	3
4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY	4
4.1 Site Geology.....	4
4.2 Site Stratigraphy	4

1.0 INTRODUCTION

Golder Associates Ltd. has been retained by Cole, Sherman & Associates (Cole, Sherman) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a geotechnical investigation for the proposed widening of Highway 9. The project involves improvements to approximately 8 km of Highway 9 from 0.3 km east of Albion 5th Line Road south easterly to 0.3 km west of Simcoe Road 10 north. The project extends from Station 16+400 through Station 19+012 / 17+310 at the intersection with Highway 50 and to Station 22+700 at the west limit of the project. Incorporated into the project is widening of the highway from two to four lanes, rehabilitation of the existing roadway, improvements of intersections, signalization and illumination.

This report addresses the proposed deep cut and high fill areas (greater than 4.5 m in depth / height), retaining wall in the area of Old Humber River channel and proposed culvert extensions associated with the widening of the highway. The locations of the deep cuts, high fills, retaining wall and culvert extensions were identified by Cole, Sherman. The road profile and horizontal alignment of the proposed widening were shown on the drawing provided to us by Cole, Sherman.

The purpose of the geotechnical investigation is to determine the subsurface conditions at the site of the proposed deep cuts, high fills, retaining wall and culvert extension areas by drilling boreholes, and carrying out in-situ tests and laboratory tests on selected samples. The terms of reference for the scope of work are outlined in our proposal letter P81-8033, dated March 26, 1998. The work was carried out in accordance with our Quality Control Plan for Foundation Design Services, dated September 24, 1998.

In addition, the results of the investigation to establish / conform the presence of the old abutment footing at the existing Humber River Bridge are included into this report in Appendix A.

2.0 SITE DESCRIPTION

The site is located along Highway 9, from 0.3 km east of Albion 5th Line Road south easterly to 0.3 km west of Simcoe Road 10 north. The highway is a two lane divided highway with adjoining shoulders.

The topography of the site is undulating. The existing two lane Highway 9 intersects frequent hills where it was built in cut and crosses lowlands where it is carried by high embankments. The existing cuts are as much as 11.6 m in depth and the embankments are up to 7.2 m in height. The highway is carried over several streams by concrete box and CS pipe culverts. Approximately 0.8 km west of Highway 50, Highway 9 crosses Humber River, a tributary of Lake Ontario. The existing Humber River Bridge is a single span rigid frame structure. To the west of Humber River, the existing highway is adjacent to the Old Humber River channel.

The existing cut slopes are well vegetated; vegetation cover on both sides of the existing highway consists of trees, shrubs and grass. The road embankment slopes are also well vegetated with grass. The existing slopes were inspected for the signs of instability. There was no evidence of instability of the existing slopes.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between November 30 and December 5, 1998 and between January 19 and 23, 1999. At this time twenty-three boreholes were put down at selected locations along Highway 9, within the areas of the proposed deep cuts, high fills, retaining wall and at the proposed culvert extensions.

The boreholes were drilled using a bombardier mounted CME 55 drill rig supplied and operated by Master Soil Investigation of North York, except for Boreholes 15 and 15A to 15C, that were drilled using portable / hand augering drilling equipment. In the boreholes drilled using the power auger drill rig, samples of the soils were obtained at regular intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedures; auger samples were collected from the hand augered holes. Boreholes were terminated between 1.4 m and 18.6 m depth. Groundwater conditions in the open boreholes were observed throughout the drilling operations and upon completion of drilling. Piezometers were installed in selected boreholes to permit monitoring of the groundwater levels at the site.

The field work was supervised on a full-time basis by a members of our technical staff who located the boreholes in the field, cleared the locations of the boreholes for buried services, directed the drilling, sampling and in-situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labeled containers and transported back to our laboratory in Mississauga for further examination. Index and classification tests were carried out on selected samples. The results of the testing are shown on the Record of Borehole sheets and on Figure 1 to Figure 10.

The locations of the boreholes were established in the field by our personnel with reference to the staked out alignment of Highway 9. Ground surface elevations at the borehole locations were inferred from the profile drawing provided by Cole, Sherman and are referenced to Geodetic Datum. The borehole locations and ground surface elevations are summarized in Table 1. The northing and easting co-ordinates of the borehole locations are indicated on the Record of Borehole sheets; the locations of the boreholes are shown on Drawings N1168001 to N1168005, "Highway 9, Borehole Locations", attached.

TABLE 1

**SUMMARY OF BOREHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS
HIGHWAY 9
W.P. 530-91-00**

<i>Borehole No.</i>	<i>Station</i>	<i>Offset from Hwy 9</i>	<i>Elevation (m)</i>
<i>West of Highway 50</i>			
1	16+875	18.0 m N	319.1
2	17+023	14.0 m S	306.0
3	17+745	24.0 m N	304.0
4	18+525	5.0 m N	289.8
5	18+530	6.0 m S	289.8
6	18+575	20 m S	284.0
7	18+650	30.0 m N	301.0
8	18+812	19.0 m N	294.2
9	18+825	6.0 m S	297.5
15	18+505	21.0 m N	284.0
15A	18+485	19.0 m N	284.0
15B	18+535	22.0 m N	284.1
15C	18+520	22.0 m N	284.0
18	17+945	16.0 m N	286.2
19	18+030	16.0 m N	285.0
20	18+070	14.4 m N	285.0
21	18+130	12.0 m N	285.0
<i>East of Highway 50</i>			
10	17+675	40.0 m N	316.8
11	17+375	8.5 m N	304.0
12	17+750	9.0 m S	308.2
13	18+060	15.0 m N	294.6
14	18+388	16.0 m S	290.5

EXCEL S/FINALDAT/1100/981-1168/1999/81168DT3

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 Oak Ridges Moraine. The surficial geology of the area is comprised of ice-contact stratified drift of glacial origin deposited during the retreat of the Wisconsin glacier. The hills of the moraine comprise of typically sand and gravel. Deposits of glaciolacustrine silt, clay and fine sands, deposited probably due to local ponding, are encountered in the lower lying areas and at the edges of the Oak Ridges Moraine.

The local physiography is characterized by thick overburden soils consisting mainly of sands, silts and silty clays.

4.2 Site Stratigraphy

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

A detailed description of the subsurface conditions along the Highway 9 alignment as encountered at the boreholes put down in each area of deep cut, high fill, along retaining wall and culvert extension is provided in the following sections.

Station 16+875 to Station 16+900 - Deep Cut Area

Borehole 1 was put down at Station 16+875 at the crest of the existing slope, approximately 18 m north of the centerline of the existing highway.

Approximately 80 mm of topsoil overlies a very loose to loose silty sand. At 1.4 m depth, the silty sand grades to sand containing trace to some silt and trace gravel. Occasional silt and clayey silt lenses and seams were noted in this deposit. The sand is compact to very dense with Standard

Penetration Test (SPT) 'N' values ranging from 21 blows for 0.3 m of penetration to 59 blows per 0.3 m penetration. The measured natural water content for samples of this deposit varies from 3 per cent to 24 per cent. Grain size distribution test results for one sample of the sand are shown on Figure 1.

The sand extends to the depth of about 9.8 m investigated in this borehole.

The open borehole was dry on completion of drilling operations. A piezometer was installed in this borehole to monitor the groundwater conditions. Details of the piezometer installation and water level measurements are shown on the attached Record of Borehole sheet. The piezometer with the tip at the base of the borehole was dry on December 09, 1998. The groundwater level is expected to fluctuate seasonally and is expected to be higher during wet periods of the year.

Station 17+023 – Concrete Culvert Extension Area

Borehole 2 was put down at Station 17+023, at the south end of the existing concrete culvert, approximately 14 m south of the centerline of the existing Highway 9. The subsoils encountered in the borehole consist of approximately 50 mm of topsoil overlying silty sand, which in turn overlies a deposit of sand. The silty sand with trace gravel and trace rootlets is loose to compact. Standard Penetration Test (SPT) 'N' values range from 7 blows for 0.3 m of penetration to 13 blows per 0.3 m penetration. The natural water content measured on a sample of the silty sand was 11 per cent. The silty sand extends to approximately 2.2 m depth and overlies a deposit of sand with trace to some silt, trace gravel and occasional sandy silt and clayey silt seams. The sand is dense to very dense; Standard Penetration Test (SPT) 'N' values ranging from 32 blows for 0.3 m of penetration to 73 blows per 0.3 m penetration were measured within this deposit. The sand extends to the depth of 6.7 m investigated in this borehole. The natural water content measured on sand samples varies from 5 per cent to 19 per cent.

The open borehole was dry on completion of drilling operations. A piezometer was installed in this borehole to monitor the groundwater conditions. Details of the piezometer installation and water level measurements are shown on the attached Record of Borehole sheet. The piezometer was dry on December 09, 1998. The groundwater level is expected to fluctuate seasonally and is expected to be higher during wet periods of the year.

Station 17+700 to Station 17+750 - Deep Cut Area

Borehole 3 was put down at Station 17+745, some 24 m north of the centerline of the existing Highway 9. Borehole 3 was advanced to about 8.1 m depth. In summary, the subsoils encountered in the borehole consist of topsoil overlying a silty sand and sand.

Approximately 60 mm of topsoil overlies silty sand with trace gravel and occasional rootlets. The silty sand is loose to dense. Standard Penetration Test (SPT) 'N' values ranging from 9 blows for 0.3 m of penetration to 41 blows per 0.3 m penetration were measured in this deposit. The silty sand extends to 2.7 m depth. The measured natural water content on two samples of silty sand were 9 per cent and 12 per cent. The silty sand is underlain by an extensive sand deposit with trace to some silt and gravel and occasional sandy silt seams. The sand is dense to very dense; Standard Penetration Test (SPT) 'N' values range from 30 blows for 0.3 m of penetration to in excess 50 blows per 0.3 m penetration. The measured natural water content varies from 2 per cent to 4 per cent.

The open borehole was dry on completion of drilling operations. No piezometer was installed in this borehole.

Station 17+945 to Station 18+130 – Retaining Wall

A total of four boreholes were put down along the alignment of the proposed retaining wall to be located on the north side of Highway 9, along the Old Humber River channel. Borehole 18, located at Station 17+945 and Borehole 19, at Station 18+030, were advanced to a depth of about 6.6 m below the existing ground surface. Borehole 20 located at Station 18+070 and Borehole 21 located at Station 18+130, were extended to depths of 9.6 m and 12.7 m, respectively. All boreholes are near the toe of the embankment slope at offsets ranging from 12 m to 16 m relative to the existing Highway 9 centerline.

In summary, the soils consist of a surficial deposit containing various amounts of organic matter and ranging from clayey silt and silty sand to organic silt. The surficial deposit overlies an extensive granular deposit consisting of sand and gravel, silt and silty sand.

In the western portion of the site, at the location of Borehole 18, a firm clayey silt deposit was encountered extending from ground surface to about 1.5 m depth and at the location of Borehole 19, a very loose organic silt extends to about 1.2 m depth. The measured natural water content on one sample of organic silt was 137 per cent. In Boreholes 20 and 21, located in the eastern portion of the site, a deposit of silty sand with trace to some organic matter extends from ground surface to depths between 1.4 m and 2.1 m. The silty sand is compact to dense. Standard Penetration Test (SPT) 'N' values ranging from 23 blows for 0.3 m of penetration to 36 blows per 0.3 m penetration were measured in this deposit. The measured natural water content on three samples of silty sand range from 14 per cent to 24 per cent.

The silty sand in Boreholes 20 and 21 and organic silt in Borehole 19 are underlain by a deposit of sand and gravel with trace silt and occasional cobbles. The sand and gravel is compact to dense; Standard Penetration Test (SPT) 'N' values range from 10 blows for 0.3 m of penetration to 34 blows per 0.3 m penetration. The sand and gravel extends to about 2.4 m depth in Borehole 19 and 3.1 m depth in Borehole 21. The base of sand and gravel in Borehole 20, that is at the closest location to the Old Humber River channel, was at about 5 m depth. The measured natural water content varies from 5 per cent to 16 per cent. Grain size distribution test results for one sample of the sand and gravel are shown on Figure 8.

The surficial clayey silt in Borehole 18 and sand and gravel deposit in the remainder of the boreholes are underlain by a granular deposit consisting of silt, sand and silty sand. This finer granular deposit is typically compact to very dense; Standard Penetration Test (SPT) 'N' values typically range from 18 blows for 0.3 m of penetration to in excess 50 blows per 0.3 m penetration, except in Borehole 21, where the upper about 1.4 m of the deposit is loose. The sand in Boreholes 18 and 19 was encountered to the 6.6 m depth investigated in the borings. The silt and silty sand was encountered to the depths of 9.6 m and 12.7 m investigated in Boreholes 20 and 21, respectively. In Borehole 21, approximately 1.9 m thick interlayer of sand and gravel was encountered within the silt to silty sand deposit at about 9.9 m depth. The natural water content measured on the samples of the silt and sand deposits varies from 10 per cent to 23 per cent. Grain size distribution test results for one sample of sand and two samples of the silt are shown on Figures 9 and 10.

The water levels in the open boreholes varied between 0.6 m and 0.9 m below ground surface on completion of drilling operations. Piezometers were installed in Boreholes 18, 19 and 21 to monitor the groundwater conditions. Details of the piezometer installations and water level measurements are shown on the attached Record of Borehole sheets.

The following table summarizes the groundwater conditions at the locations of the boreholes.

<i>Borehole</i>	<i>Station</i>	<i>Water Level in Open Borehole at Completion of Drilling</i>		<i>Water Level in Piezometer on February 3, 1999</i>	
		<i>Depth (m)</i>	<i>Elevation (m)</i>	<i>Depth (m)</i>	<i>Elevation (m)</i>
18	17+945	0.6	285.6	0.6	285.6
19	18+030	0.9	284.1	1.3	283.7
20	18+070	0.6	284.4	N/A	N/A
21	18+130	0.9	284.9	1.00	284.8

Groundwater level is expected to fluctuate seasonally and is expected to be higher during wet periods of the year.

Station 18+500 to Station 18+575 – High Fill Area

Seven boreholes, numbered Boreholes 4 to 6, 15 and 15A to 15C, were put down within this section of the project. Boreholes 4 and 5 were put down at the north and south edges of the existing road embankment at Station 18+525 and Station 18+530, respectively. Borehole 4 was advanced to 8.1 m depth and Borehole 5 was drilled to 11.1 m depth. Borehole 6 was drilled at Station 18+575, about 20 m south of the centerline of the existing Highway 9, at the toe of the road embankment. Boreholes 15 and 15A to 15C were put down on the north side of the road embankment between Station 18+485 and Station 18+535.

Boreholes 4 and 5, put down through the existing embankment encountered about 7.3 m and 7.5 m of fill materials. In the upper 0.6 m to 0.8 m portion of the embankment, the fill consists of compact sand and gravel. Underlying the sand and gravel fill is a sandy silt fill with trace clay, trace gravel and occasional silt, sand and clayey silt lenses. The sandy silt fill is loose to dense and extends to about 5.5 m depth. Standard Penetration Test (SPT) 'N' values ranging from 6 blows for 0.3 m of penetration to 36 blows per 0.3 m penetration were measured in this fill. The measured natural water content varies from 4 per cent to 12 per cent. Grain size distribution test results for

one sample of the silty sand fill are shown on Figure 2. The sandy silt fill is underlain by another fill consisting of silty sand with trace clay and gravel. The silty sand fill is loose to compact; 'N' values of 7 blows for 0.3 m of penetration and 14 blows per 0.3 m penetration were measured in the silty sand fill. Measured natural water contents of 15 per cent and 16 per cent were obtained for samples of this fill. The fill extends to 7.3 m and 7.5 m depth. Underlying the sandy silt fill is a fill consisting of sand with trace silt and gravel. The sand fill is loose; SPT 'N' values ranging from 6 blows for 0.3 m of penetration to 9 blows per 0.3 m penetration were measured in this fill. Measured natural water content of 14 per cent and 16 per cent were obtained for samples of the sand fill. The sand fill extends to 10.2 m depth in Borehole 5 and was encountered to the base of Borehole 4 at 8.1 m depth. The sand fill in Borehole 5 is underlain by a native deposit of compact sandy silt extending to the depth investigated of about 11 m.

Borehole 6 was put down at Station 18+575, approximately 20 m south of the centerline of Highway 9, at the toe of the existing embankment. The subsoils encountered in the borehole consist of clayey silt fill underlain by organic clayey silt, which in turn overlies clayey silt. The clayey silt fill is stiff and extends to about 0.9 m depth. Underlying the fill is a deposit of organic clayey silt. The organic clayey silt is very soft to stiff; SPT 'N' values ranging from 3 blows for 0.3 m of penetration to 15 blows per 0.3 m penetration were measured in this deposit. Measured natural water contents of 43 per cent and 144 per cent were obtained for samples of this organic deposit. The percentage of organic matter diminishes with depth. The organic clayey silt extends to 3.5 m depth and grades to clayey silt. The clayey silt is very stiff; one 'N' value of 26 blows per 0.3 m penetration was obtained in this deposit. The clayey silt deposit was encountered to the base of the borehole at approximately 5.0 m depth.

Boreholes 15, 15A to 15C were put down at the toe of the road embankment between Stations 18+485 and Station 18+535, in the distance ranging from 19.5 m to 22 m north of the centerline of Highway 9. These boreholes were drilled using portable / hand auger equipment. A layer of fill about 0.9 m and 1.5 m thick was encountered in Boreholes 15 and 15B, extending from the ground surface. This fill material consists of silty sand and sand and was likely generated during road embankment construction. The silty sand fill in Borehole 15 overlies about 1 m of fibrous peat and about 0.6 m of clayey silt. In Borehole 15, a layer of clayey silt with trace of fibrous organic matter and trace of sand was encountered to the base of the borehole at approximately 1.5 m depth.

The fibrous peat was also encountered in Borehole 15 to the depth of about 3 m investigated at the borehole location.

The water level in open Boreholes 4 and 5 was noted at 6 m depth and in Borehole 6, the water level was measured at 1.5 m depth on completion of drilling operations. Piezometers were not installed in these boreholes. The water level in Boreholes 15, 15A to 15C was encountered at ground surface. The groundwater level is expected to fluctuate seasonally and is expected to be higher during wet periods of the year.

Station 18+625 to Station 18+675 – Deep Cut Area

Borehole 7 was put down at Station 18+650, some 30 m north of the centerline of the existing Highway 9. Borehole 7 was advanced to about 13.9 m depth.

Extending from ground surface is about 3.5 m of loose to compact sand with trace organic matter (rootlets) in the upper 1.5 m of the deposit. The measured natural water content ranges from 1 per cent to 11 per cent. Grain size distribution test results for one sample of the sand are shown on Figure 3. A layer of sandy silt with trace clay, approximately 3.6 m in thickness, underlies the upper sand. The sandy silt is compact with two measured N values of 28 blows and 32 blows per 0.3 m of penetration. The base of the sandy silt is at 7.1 m depth. The lower sand underlying the sandy silt is dense to very dense. Standard Penetration Test (SPT) 'N' values ranging from 34 blows for 0.3 m of penetration to 52 blows per 0.3 m penetration were measured in this deposit. The measured natural water content on two samples of the lower sand are 2 per cent and 14 per cent. Approximately 1.6 m thick interlayer of clayey silt with some sand was encountered at 11.5 m depth within the lower sand deposit. The clayey silt is hard with one measured Standard Penetration Test (SPT) 'N' value of 81 blows per 0.3 m penetration.

The open borehole was dry on completion of drilling operations. A piezometer was installed in this borehole to monitor the groundwater conditions. Details of the piezometer installation and water level measurements are shown on the attached Record of Borehole sheet. The piezometer with the tip at the base of the borehole was dry on December 09, 1998.

Station 18+811 – Concrete Culvert Extension Area

Borehole 8 was put down at Station 18+811, at the north end of the existing concrete culvert, approximately 18 m north of the centerline of the existing Highway 9. The subsoils encountered in the borehole consist of approximately 50 mm of topsoil overlying silty sand fill and sandy silt. The silty sand fill contains trace rootlets and extends to approximately 0.6 m depth. The fill overlies sandy silt with trace clay and gravel and occasional rootlets. The sandy silt is compact to dense; Standard Penetration Test 'N' values ranging from 11 blows for 0.3 m of penetration to 47 blows per 0.3 m penetration were measured within this deposit. The sand extends to the depth of about 4.4 m investigated in this borehole. The natural water content measured on the samples of the sandy silt fill and silty sand varies from 18 per cent to 20 per cent.

The open borehole was dry on completion of drilling operations. A piezometer was installed in this borehole to monitor the groundwater conditions. Details of the piezometer installation and water level measurements are shown on the attached Record of Borehole sheet. The water level in the piezometer was measured at 1.7 m depth on December 09, 1998. The groundwater level is expected to fluctuate seasonally and is expected to be higher during wet periods of the year.

Station 18+825 to Station 18+875 – High Fill Area

Borehole 9 was put down at Station 18+825 at the edge of the existing embankment of Highway 9, approximately 6 m south of the centerline of the highway. Borehole 9 was advanced to about 6.6 m depth. In summary, subsoils encountered in the borehole consist of fill materials overlying silty clay.

The fill materials extend to about 5.7 m depth. In the upper 0.6 m portion of the embankment, the fill consists of dense sand and gravel. Underlying the sand and gravel fill is a fill consisting of sandy silt with trace clay and trace gravel. The sandy silt fill is compact and extends to about 2.1 m depth. Standard Penetration Test 'N' values of 26 blows and 28 blows per 0.3 m penetration were measured in the sandy silt fill. The sandy silt fill is underlain by another fill consisting of sand and silt with trace clay and gravel. The sand and silt fill is loose; SPT 'N' values of 8 blows and 9 blows per 0.3 m penetration were measured in this fill. Grain size distribution test results for one sample of the sand and silt fill is shown on Figure 4. The sand and silt fill extends to 5.7 m depth.

The natural water content measured on a sample of the sandy silt fill was 10 per cent and on two samples of the sand fill was 12 per cent and 16 per cent.

The fill in Borehole 9 is underlain by a native deposit of silty clay with some sand. The silty clay is very stiff. One SPT 'N' value of 17 blows for 0.3 m of penetration was measured in this deposit. The silty clay extends to 6.55 m depth investigated in the borehole. The natural water content measured on one sample of the silty clay was 15 per cent.

The water level in the open borehole was measured at approximately 6 m depth on completion of drilling operations. No piezometer was installed in this borehole.

Station 17+375 to Station 17+375 (East of Highway 50) – High Fill Area

Borehole 11 was put down at Station 17+375 at the edge of the embankment of the existing Highway 9, approximately 8.5 m north of the centerline of the highway. Borehole 11 was advanced to about 9.6 m depth. In summary, subsoils encountered in the borehole consist of approximately 7.1 m of fill materials overlying native silty clay.

The upper approximately 0.6 m of the embankment comprises of compact sand and gravel fill. The sand and gravel fill is underlain by a silty sand with trace gravel and trace clay. The silty sand is compact to dense; Standard Penetration Test 'N' values between 16 blows per 0.3 m penetration to 46 blows per 0.3 m of penetration were measured in this fill. The water content measured on two samples of this fill were 6 per cent and 10 per cent. Grain size distribution test results for one sample of silty sand are shown on Figure 5. Underlying the silty sand fill is a clayey silt fill. The clayey silt fill is very stiff; Standard Penetration Test 'N' value of 20 blows per 0.3 m penetration was measured in the clayey silt fill. The fill is underlain at 5.8 m depth by a native silty clay with some sand. The silty clay is hard; SPT 'N' values between 44 blows and 84 blows per 0.3 m penetration were measured in this deposit. The silty clay extends to 9.6 m depth investigated in the borehole. The natural water content of two samples of the silty clay is 13 per cent and 14 per cent.

The open borehole was dry on completion of drilling operations. A piezometer was installed in this borehole to monitor the groundwater conditions. Details of the piezometer installation and water

level measurements are shown on the attached Record of Borehole sheet. The water level in the piezometer was measured at 7.1 m depth on December 09, 1998. The groundwater level is expected to fluctuate seasonally and is expected to be higher during wet periods of the year.

Station 17+500 to Station 17+675 – Deep Cut Area

Borehole 10 was put down at Station 17+675 (east of Highway 50), some 40 m north of the centerline of the existing Highway 9. Borehole 10 was advanced to approximately 18.6 m depth.

Approximately 80 mm of topsoil overlies a fill consisting of about 0.6 m of loose silty sand and 1.3 m of stiff to very stiff clayey silt. The fill extends to 2.0 m depth. The natural water content measured on a sample of the silty sand fill was 6 per cent and on a sample of clayey silt fill was 19 per cent. A deposit of sand to silty sand approximately 3.3 m thick underlies the fill. The sand to silty sand is compact to dense; Standard Penetration Test (SPT) 'N' values range from 24 blows for 0.3 m of penetration to 33 blows per 0.3 m penetration. A measured natural water content of 4 per cent was obtained for one sample of the sand. The sand to silty sand extends to 5.3 m depth.

An extensive deposit of silty clay underlies the sand to silty sand deposit. Occasional silt and sandy silt seams were noted in the silty clay deposit. A 1.8 m thick layer of very dense silty sand with clayey silt lenses was encountered at 7.0 m depth within the silty clay.

The silty clay is very stiff to hard with measured 'N' values ranging from 26 blows to in excess of 55 blows per 0.3 m of penetration. The silty clay extends to 18.6 m depth investigated in the borehole. The measured natural water content varies from 12 per cent to 21 per cent. Atterberg Limit tests indicate liquid limits of 21 per cent and 24 per cent and plasticity indices of 8 per cent.

The open borehole was dry on completion of drilling operations. No piezometer was installed in this borehole.

Station 17+750 to Station 17+775 – Deep Cut Area

Borehole 12 was put down at Station 17+750 (east of Highway 50), some 9 m south of the centerline of the existing Highway 9, at the toe of the slope. Borehole 12 was advanced to approximately 5.0 m depth.

Approximately 0.6 m of compact sand fill extends from ground surface. The sand fill is underlain by stiff to hard silty clay. The measured Standard Penetration Test (SPT) 'N' values range from 12 blows for 0.3 m of penetration to 38 blows per 0.3 m penetration in the silty clay deposit. The natural water content of 14 per cent to 18 per cent were measured on the samples of the silty clay. The silty clay extends to 5.0 m depth investigated in the borehole.

The open borehole was dry on completion of drilling operations. A piezometer was installed in this borehole to monitor the groundwater conditions. Details of the piezometer installation and water level measurements are shown on the attached Record of Borehole sheet. The piezometer was dry on December 09, 1998.

Station 18+060 – Concrete Culvert Extension Area

Borehole 13 was put down at Station 18+060, at the north end of the existing concrete culvert, approximately 15 m north of the centerline of Highway 9. The subsoils encountered in the borehole consist of approximately 50 mm of topsoil overlying silty sand fill and native sandy silt.

The silty sand fill comprises trace gravel, trace rootlets and frequent topsoil lenses. The fill is loose and extends to 0.7 m depth. Underlying the silty sand fill is a native deposit of sandy silt. Trace clay, occasional sand seams and oxidation staining were noted in this deposit. The sandy silt is loose to compact; Standard Penetration Test (SPT) 'N' values range from 5 blows for 0.3 m of penetration to 25 blows per 0.3 m penetration. Grain size distribution test results for a sample of the sandy silt are shown on Figure 6. The natural water content measured on sandy silt samples varies from 18 per cent to 24 per cent. The sandy silt extends to the depth of about 6.7 m investigated in this borehole.

The water level in the open borehole was measured at 5.8 m depth on completion of drilling operations. A piezometer was installed in this borehole to monitor the groundwater conditions. Details of the piezometer installation and water level measurements are shown on the attached Record of Borehole sheet. The water level in the piezometer was measured at 3.2 m depth on December 09, 1998. Groundwater level is expected to fluctuate seasonally and is expected to be higher during wet periods of the year.

Station 18+388 – Concrete Culvert Extension

Borehole 14 was put down at Station 18+388, at the south end of the existing concrete culvert, approximately 16 m south of the centerline of Highway 9. The subsoils encountered in the borehole consist of approximately 60 mm of topsoil overlying sandy silt fill and native sandy silt.

The sandy silt fill contains trace clay and gravel and frequent topsoil lenses. The sandy silt is loose to compact and extends to 2.2 m depth. Underlying the sandy silt fill is a native deposit of sandy silt containing trace clay and gravel. The sandy silt is loose to compact; Standard Penetration Test (SPT) 'N' values range from 4 blows for 0.3 m of penetration to 23 blows per 0.3 m penetration. The sandy silt extends to the depth of 8.2 m investigated in this borehole. The natural water content measured on sandy silt samples varies from 19 per cent to 22 per cent.

Grain size distribution test results for samples of the silty clay till are shown on Figure 7.

The water level in the open borehole was measured at 3.2 m depth on completion of drilling operations. A piezometer was installed in this borehole to monitor the groundwater conditions. Details of the piezometer installation and water level measurements are shown on the attached Record of Borehole sheet. The water level in the piezometer was measured at 1.1 m depth on December 09, 1998. The groundwater level is expected to fluctuate seasonally and is expected to be higher during wet periods of the year.

PART B – FOUNDATION DESIGN

**HIGHWAY 9 WIDENING
FROM 0.3 km EAST OF ALBION 5th LINE ROAD
EASTERLY TO 0.3 km WEST OF SIMCOE ROAD 10
AGREEMENT NUMBER 9720-7411-2575
W.P. 530-91-00, CENTRAL REGION**

5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the geotechnical aspects of design of the proposed widening of Highway 9. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

The works described in this report are associated with the proposed deep cut and high fill areas (areas where required cuts and fills are greater than 4.5 m), retaining wall and proposed culvert extensions. The locations of the deep cuts, high fills retaining wall and culvert extensions were identified by Cole, Sherman. The road profile and horizontal alignment of the proposed widening were shown on the preliminary drawing provided to us by Cole, Sherman.

5.2 Deep Cuts and High Fills

It is understood that there are several areas along the alignment of Highway 9 where deep cuts and high fills are required to accommodate the proposed widening of the highway. The locations and depths / heights of the cuts and fills as identified are summarized in Table 2, below. The simplified stratigraphy as encountered at each of the relevant boreholes and recommendations for the slope geometry at each deep cut and high fill site are also presented in the Table 2.

TABLE 2

**SUMMARY OF INFORMATION
HIGHWAY 9 - DEEP CUT AND HIGH FILL AREAS
W.P. 530-91-00**

Location		Depth / Height (m)	Road Grade Elevation (m)	Relevant Borehole(s)			Simplified Soil Stratigraphy Depth of Deposit (m)	Slope Inclination (H:V)	
Deep Cut	High Fill			No.	Station	Elevation (m)		Existing	Recommended
West of Highway 50									
16+875 lt. to 16+900 lt.		6.0 to 6.2	314	1	16+875 lt.	319.1	topsoil (0.00 - 0.08) very loose silty sand (0.08 - 1.40) compact to very dense sand (1.40 - 9.75)	2.0 : 1	
17+700 lt. to 17+750 lt.		5.4 to 6.5	301.3 - 299.2	3	17+745 lt.	304.0	topsoil (0.00 - 0.06) loose to dense silty sand (0.06 - 2.70) dense to very dense sand (2.70 - 8.10)	2.2 : 1	2.0 : 1
	18+500 to 18+575	4.6 to 7.2	289.2 - 291.2	4	18+525 lt.	289.8	compact sand and gravel FILL (0.0 - 0.7) loose to dense sandy silt / silty sand FILL (0.7 - 7.5) loose sand FILL (7.5 - 8.1)	2.1 : 1	2.0 : 1 Subexcavation of the organics
				5	18+530 rt.	289.8	compact sand and gravel FILL (0.0 - 0.6) loose to compact sandy silt / silty sand FILL (0.6 - 7.3) loose sand FILL (7.3 - 10.2) compact sandy silt (10.2 - 11.1)	1.5 : 1	
				6	18+575 rt.	284.0	very soft to stiff organic clayey silt (0.9 - 3.5) very stiff clayey silt (3.5 - 5.0)	1.7 : 1	
				15	18+505 lt.	284.0	Loose silty sand FILL (0.0-0.9) Loose peat (0.9-2.0) Stiff clayey silt (2.0-2.6)	2.0:1	
				15A	18+485	284.0	Loose peat (0.0-3.1)		
				15B	18+535	284.1	Loose sand (0.0-1.5)		
				15C	18+520	284.0	Soft to firm silty clay (0.0-1.4)		
18+625 lt. to 18+675 lt.		6.9 to 9.4	292.6 - 293.8	7	18+650 lt.	301.0	loose to compact sand (0.0 - 3.5) compact to dense sandy silt (3.5 - 7.1) dense to very dense sand (7.1 - 11.5) hard clayey silt (11.5 - 13.1) very dense sand (13.1 - 13.9)	2.0 : 1	
	18+825 to 18+875 rt.	4.5 to 5.2	297.8 - 299.2	9	18+825 rt.	297.5	dense sand and gravel FILL (0.0 - 0.6) compact sandy silt FILL (0.6 - 2.1) loose sand and silt FILL (2.1 - 5.7) very stiff silty clay (5.7 - 6.6)	2.2 : 1	2.0 : 1

NOTES: rt. south side of Highway 9
lt. north side of Highway 9

TABLE 2

**SUMMARY OF INFORMATION
HIGHWAY 9 - DEEP CUT AND HIGH FILL AREAS
W.P. 530-91-00**

Location		Depth / Height (m)	Road Grade Elevation (m)	Relevant Borehole(s)			Simplified Soil Stratigraphy Depth of Deposit (m)	Slope Inclination (H:V)	
Deep Cut	High Fill			No.	Station	Elevation (m)		Existing	Recommended
East of Highway 50									
	17+325 to 17+375	5.4 to 6.4	303.0 - 304.3	11	17+375 lt.	304.0	compact sand and gravel FILL (0.0 - 0.6) compact to dense silty sand FILL (0.6 - 3.5) very stiff clayey silt FILL (3.5 - 5.8) hard silty clay (5.8 - 9.6)	2.0 : 1	
17+500 lt. to 17+675 lt.		6.3 to 11.6	307.6 - 309.2	10	17+675 lt.	316.8	topsoil and loose silty sand FILL (0.0 - 0.7) stiff to very stiff clayey silt FILL (0.7 - 2.0) compact to dense sand (2.0 - 5.3) hard silty clay (5.3 - 7.0) very dense silty sand (7.0 - 8.8) very stiff to hard silty clay (8.8 - 18.6)	2.0 : 1	2.0 : 1
17+750 rt. to 17+775 rt.		8.6 to 9.8	308.4 - 307.9	12	17+750 rt.	308.2	compact sand FILL (0.0 - 0.6) stiff to hard silty clay (0.6 - 5.0)	2.1 : 1	

WORD S/FINALDAT/1100/981-1168/1999/81168DT2

NOTES: rt. south side of Highway 9
 lt. north side of Highway 9

5.2.1 Deep Cuts

The permanent slopes will be up to 11.6 m high and typically will be formed within dense sands west of Highway 50. To the east of Highway 50, the one deep cut area will be formed within interlayered dense sands and hard silty clay. The groundwater table is below the proposed cut slope base. 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 should be provided for cut areas where the total slope height is greater than 8 m.

Although there was no evidence in the boreholes / soil samples of the presence of perched water tables within the cut areas, the layered nature of the soil strata is such that perched groundwater could occur at some times of the year. The cut slopes should be inspected by geotechnical personnel during construction and provision should be made in the contract documents for placement of a granular blanket on the slope in the event that improved drainage to the slope is required. The granular blanket material should meet the specifications for fine aggregates in accordance with OPSS 1002.

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

5.2.2 High Fills

Three high fill areas extending from Stations 18+500 to 18+575 and Stations 18+825 to 18+875 to the west of Highway 50, and from Stations 17+325 to 17+375 to the east of Highway 50 are present within the project limits.

Within the two high fill areas located immediately to the east (between Stations 17+325 and 17+375) and to the west of Highway 50 (from Stations 18+825 to 18+875), the boreholes put down through the existing road embankment encountered variable fill materials underlain by very stiff to hard silty clay. The existing embankments are 4.5 m to 6.4 m high with side slopes at about 2H:1V.

In the high fill area, located some 400 m west of Highway 50 between Stations 18+500 and 18+575, the boreholes put down at the toe of the existing embankment on both sides of the road

indicate the presence of organic deposits. Borehole 6, put down on the south side of the road indicates that about 2.5 m of organic clayey silt is present overlying very stiff silty clay and in Boreholes 15 and 15A to 15C, located on the north side of the road as much as 3 m of peat was encountered in the borings. Organic deposits were not encountered in the boreholes put down through the embankment extended to below the elevation where the organic clayey silt was found outside the embankment. This data indicates that the organic deposit was likely generally removed from within at least the traveled width of Highway 9. The existing embankment is up to 7.2 m high with side slopes ranging from 1.5H:1V to 2.1H:1V.

In general, topsoil and organic deposits should be stripped from below the widened areas of the fill embankment. At the high fill area located between Stations 18+500 and 18+575, subexcavation of the organic material will require excavations up to 3.5 m deep immediately at the toe of the embankment on both sides of the road.

The groundwater table is at about 1.7 m and 1.3 m depths at the high fill area located to the west and east of Highway 50, respectively, and excavations / stripping topsoil for the embankment construction will be carried out likely above the ground water table. At the high fill area extending between Stations 18+500 and 18+575, the groundwater table was at about 1 m below the ground level at the south side of the road embankment and at the ground level on the north side of the embankment and excavations will be extended below the groundwater level. The excavation and backfilling should be carried out in narrow strips perpendicular to the existing embankment. The excavation limits should be in accordance with OPSD 203.05 (MOD). The backfill material could consist of granular fill meeting Granular B Type II specifications (OPSS 1010); however it is likely that groundwater inflow to the excavation will be sufficiently high that backfilling with adequate compaction using this material will not be possible without some form of water control. In this regard, consideration should be given to placement of coarser layer such as clear stone drainage layer, from which water entering the excavation could be pumped from a sump. The subgrade at this location consists of silty clay and the lower layer of the coarse granular fill should be worked into the subgrade to provide a working base. The clear stone would have to be separated from the overlying Granular B by an appropriately graded granular filter or a non-woven geotextile.

Construction of the embankment above the groundwater level may be carried out using earth borrow (in accordance with OPSS 212) or Select Subgrade Material (in accordance with OPSS 1010), depending on material available. The excavated soils from the areas of deep cuts are generally considered suitable. The existing embankments should be benched in accordance with OPSD 208.01 to ensure that the new fill is keyed into the existing fill and to minimize differential settlement between the new and the existing embankment.

All embankment fill should be placed in regular lifts with loose thickness not exceeding 300 mm, and be compacted to at least 95 per cent of the material's Standard Proctor maximum dry density. The final lift prior to placement of the granular subbase or base course should be compacted to 100 per cent of the Standard Proctor maximum dry density. Inspection and field density testing should be carried out by qualified geotechnical personnel during all fill placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved.

The embankment side slopes should be maintained not steeper than 2 horizontal to 1 vertical. Provided that the organic deposits are subexcavated where present and replaced, the stability of the proposed embankments is considered sufficient. Vegetation cover should be established on all slopes to protect embankment fill against surficial erosion.

At the high fill area located between Station 18+500 and 18+575, it is understood that consideration is being given to steepening the side slopes as much as possible in order to minimize the base width and consequent impact on the Ballycroy Swamp land. The use of soil reinforcement would permit some steepening of the slope. It should be noted, however, that this area requires subexcavation of organic deposits for the embankment widening. Proper subexcavation and backfilling is essential to ensure overall stability of the steepened embankment. The reinforced slope could consist of suitable fill materials placed and properly compacted supplemented with geogrid. The extent of geogrid reinforcement will govern the final slope angle possible; it may be feasible to achieve a slope as steep as 1H:1V. Further design input will be required if this approach is to be adopted.

5.3 Culverts

It is understood that four culverts located along the alignment of Highway 9 within the project area are to be extended to accommodate the proposed widening of the highway. The locations of the culverts to be widened with the existing invert elevations were provided to us by Cole, Sherman and are summarized in Table 3, below. The subsurface information at the sites of the proposed culvert widening was obtained from four boreholes; one borehole drilled at each culvert widening site. The locations of these boreholes and subsurface conditions encountered in the relevant boreholes are summarized in the above noted table.

Based on the results of the boreholes, the founding soils will vary at each of the culvert location and will consist of loose to compact sand and silty sand. A factored geotechnical resistance of 75 kPa can be used for design of the culverts founded within the silty sand and sandy silt with the inverts as indicated in the above table. Prior to construction of the culvert, all topsoil, organic and other deleterious materials should be stripped and the bearing stratum should be inspected by the geotechnical personnel. In general, the founding soils are at or below the local water table and are susceptible to disturbance from water seepage and the construction vehicle operations. In this regard, the box culverts should be founded on a granular pad consisting of at least 300 mm of crusher run limestone or equivalent to provide a working base for construction. Heavy construction equipment should be restricted from travelling on the exposed bearing soils.

Factored
ULS; SLS?

The invert elevations of the proposed extended culverts are at approximately the same level as the existing culverts and only minor excavations will be required for the construction. Groundwater control will be required to allow placement of the working pad without disturbance of the founding soils. Surface water should be directed away from the open excavations for the culvert construction. At some locations, construction techniques may indicate that a greater subexcavation and more material are required which should be addressed in the construction specification. The final decision regarding depth of subexcavation should be made in the field during construction by geotechnical personnel.

The backfill adjacent to the box culvert should be in accordance with OPSD 803.01. It should be a free draining non-frost susceptible granular material placed in maximum 300 mm loose lifts and uniformly compacted to 95 per cent of standard Proctor maximum dry density.

TABLE 3

**Summary of Cuvert Information
Highway 9
W.P. 530-91-00**

Culvert Location	Culvert Size (m)	Culvert Invert Elevation (m)	Relevant Borehole(s)		Simplified Soil Stratigraphy (elevation of top of deposit in metres)
			No.	Station	
West of Highway 50					
17+023	0.91 x 0.91 x 25.63	306.04 rt. 305.17 lt.	2	17+023 rt.	topsoil (306.0) loose to compact silty sand (305.9) dense to very dense sand (303.8)
18+811	1.22 x 1.22 x 32.90	291.75 rt 293.05 lt	8	18+811 lt.	topsoil (294.2) loose silty sand FILL (294.1) compact to dense sandy silt (293.4)
East of Highway 50					
18+060	0.91 x 0.61 x 25.4	293.94 rt 294.01 lt	13	18+060 lt.	topsoil (294.6) loose silty sand FILL (294.5) loose to compact sandy silt (293.9)
18+388	1.20 x 0.91 x 29.52	289.05 rt 289.16 lt	14	18+388 rt.	topsoil (290.5) loose to compact sandy silt FILL (290.44) loose to compact sandy silt (289.3)

L S/FINAL/DAT/1100/981-1168/1999/ARI-TI-3

5.4 Retaining Wall

5.4.1 General

It is understood that a retaining wall approximately 200 m long, is required along Highway 9 in the vicinity of the Old Humber River channel, as part of the embankment widening. The proposed retaining wall will extend on the north side of Highway 9 from approximately Station 17+950 to Station 18+150 and will vary in height from about 4 m at the west end to about 2.5 m at the east end of the wall alignment.

It is understood that two retaining wall systems are being considered; a mechanically reinforced soil retaining wall and a reinforced concrete cantilever retaining wall.

The surficial deposits along the proposed retaining wall alignment range in composition from clayey silt to organic silt and silty sand and range in thickness from 1.2 m to 2.1 m. In the eastern portion of the wall (18+075 to 18+150), the surficial deposit consists of compact to dense silty sand with trace to some organic matter and extends from ground surface to depths of between 1.4 m and 2.1 m. In the western portion of the wall (17+950 to 18+075), the surficial deposit ranges from about 1.2 m of organic silt in the central area to about 1.5 m of firm clayey silt in the west.

The surficial deposits overlie an extensive granular deposit consisting of compact to dense sand and gravel, silt and silty sand. The water levels in the open boreholes varied between 0.6 m and 0.9 m below ground surface on completion of drilling operations. Water levels measured in the piezometers vary between 0.6 m and 1.3 m depth (between Elevation 283.7 m at Borehole 19 in the central area and Elevation 285.6 m in Borehole 18 at the west end). The water table appears to slope downward toward the Old Humber River channel (from the east and west ends of the wall toward the center).

Given the nature / variability of the surficial deposits at the site, subexcavation of the organics and clayey silt in the western portion of the wall is required for both wall systems unless piled foundations are used. For both wall systems, the subexcavation and placement of granular fills will require some form of groundwater control to maintain the integrity of the founding soils. This groundwater control would be required for spread footing construction for the full length of the wall given the relatively high groundwater level. A reinforced soil wall system may not require the

groundwater control in the eastern portion of the wall if the levelling pad can be maintained at a depth of less than 0.6 m. On a technical basis, given the variation of subsoil conditions and the dewatering requirements, a reinforced soil wall system which is relatively flexible in comparison with the reinforced concrete wall appears to be the best solution.

The reinforced earth retaining wall may not, however, be the most economical solution and a cost comparison should be completed.

5.4.2 Reinforced Soil Retaining Wall System

A mechanically reinforced soil retaining wall system consists of earth reinforced with metal or fabric strips or grids integrated with a granular fill which is placed and compacted in layers. A facing material, typically pre-cast concrete blocks or panels mechanically fastened to the reinforcing strips or grids is used to form the face of the reinforced earth structure and to prevent the loss of fill material.

Assuming a nominal depth for the levelling pad, the founding stratum for the wall would comprise the compact to dense silty sand in the eastern portion of the wall and clayey silt and organic silt in the western portion the wall. The compact to dense silty sand deposit is considered suitable for the support of the wall provided that the founding soils are not disturbed during excavation.

The clayey silt and organic silt as encountered in the western portion of the site to about 1.5 m depth are not considered suitable as the founding strata for the wall. If the wall was founded on these deposits, as much as 0.25 m of long-term settlement of these deposits would be anticipated under the load imposed by 4 m high road embankment. These deposits should, therefore, be subexcavated and the grade be raised to the founding level using granular fill. The extent and depth of the subexcavation will be subject to inspection during removal of the organic and clayey deposits.

Groundwater control will have to be implemented prior to excavation below the groundwater level in order to excavate these deposits without loosening of the sand / sand and gravel founding soils underlying the organic silt and clayey silt due to upward seepage. In this regard, prior to excavation, the groundwater table should be lowered to at least 0.5 m below the base of the excavation. The

design of the dewatering system should be carried out by a qualified dewatering specialist. It is anticipated that the groundwater lowering can be accomplished by a system of dewatering wells installed into the granular deposits underlying the organics / clayey silts and operating prior to excavation.

Fill meeting the specifications for OPSS Granular B or A may be used to backfill the excavation. Clearstone must not be used at this site due to the potential for ongoing migration of fines into the clearstone and consequent long-term settlement. The granular fill should be placed in regular lifts and compacted to at least 95 per cent of the material's Standard Proctor maximum dry density.

A factored bearing capacity at Ultimate Limit State of 150 kPa and capacity at Serviceability Limit States of 100 kPa may be assumed for the wall and levelling pad founded on the undisturbed native silty sand deposit or granular fill placed to raise the grade. An effective stress friction angle of 30 degrees for the silty sand or granular fill founding soils can be used for design.

The detailed design of reinforced earth type walls is typically carried out by the wall supplier. However, Golder Associates should check the global stability of the wall once the configuration has been finalized.

5.4.3 Cantilever Retaining Wall System

For the cantilever retaining wall system option, the wall could be supported on shallow footings founded within / on the undisturbed native sand / silty sand / sand and gravel deposit. This deposit was encountered below 1.2 m to 1.5 m depth in the western portion of the wall alignment and extended essentially from the ground surface in the eastern portion of the wall alignment.

A minimum soil cover of 1.2 m depth below the lowest grade adjacent to the footing should be provided for frost protection. Between Station 18+150 and 18+075, the footing may be stepped to maintain a minimum soil cover of 1.2 m below the lowest grade adjacent to the footing for frost protection. A founding level of Elevation 283.5 m may be assumed for design between Stations 18+075 and 18+000 to maintain the footing below the organic silt. For the remainder of the wall, the footing may be stepped up to about Elevation 284 m, to maintain the footing below the clayey silt.

The footings should be founded on properly prepared bearing surfaces. The groundwater table varies between 0.6 m and 1.3 m depth (between Elevation 283.7 m and Elevation 285.6 m) and excavations for the foundation construction will be carried out below the ground water table. Prior to excavation, the groundwater table will have to be lowered to about 0.5 m below the base of the excavation for the foundation construction. As discussed above, the use of a system of dewatering wells operating prior to excavation will be required at this site.


A factored capacity at Ultimate Limit State (ULS) of 150 kPa may be assumed for strip footings with a maximum ratio of horizontal to vertical load of 0.3. Movement joints will be required in order to minimize the effect of differential settlement resulting from different founding systems. A capacity at Serviceability Limit States of 100 kPa may be assumed for design.


A coefficient of sliding between the concrete footing and bearing soil, equal to 0.4 may be assumed for design, provided the base of the footing excavation is kept dry and is properly prepared by removal of soft / loosen material.


For the design of the retaining wall, a coefficient of lateral earth pressure of 0.30 should be used, assuming that the wall is backfilled with free draining granular fill material meeting the specification for OPSS Granular B. As a minimum, the fill should be placed within the wedge-shaped zone defined by a 60 degree line extending up and back from the bottom of the rear face of the footing. Positive drainage in the form of drains and / or weep holes should be provided. The granular backfill should be placed in regular lifts not exceeding 300 mm, and uniformly compacted with the lightest compaction equipment capable of achieving the require 95 per cent Standard Proctor maximum density, to avoid compaction stresses imposed on the wall during construction.

Alternatively, the retaining wall can be supported on piles or caissons, however, this option would likely be more expensive than the options described above.

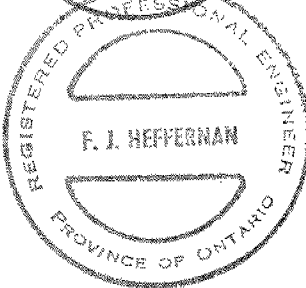
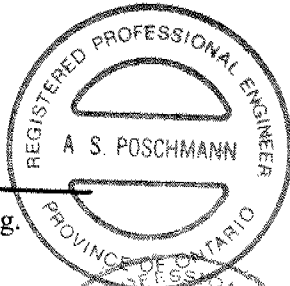
GOLDER ASSOCIATES LTD.


Anna M. Piascik, P.Eng.


Anne S. Poschmann, P.Eng.
Principal


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

AMP/ASP/FJH/amp/clg
WORD S/FINAL/DAT/1100/981-1168/1999/81168DR1



LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Penetration Resistance; N_6 :

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

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT):

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

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

IV. SOIL TESTS

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

Note:

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

LIST OF SYMBOLS

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

I GENERAL

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

II STRESS AND STRAIN

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

III SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (con't.)

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

(c) Hydraulic Properties

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

(d) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_a	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 $= \sigma'_p / \sigma'_{vo}$

(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

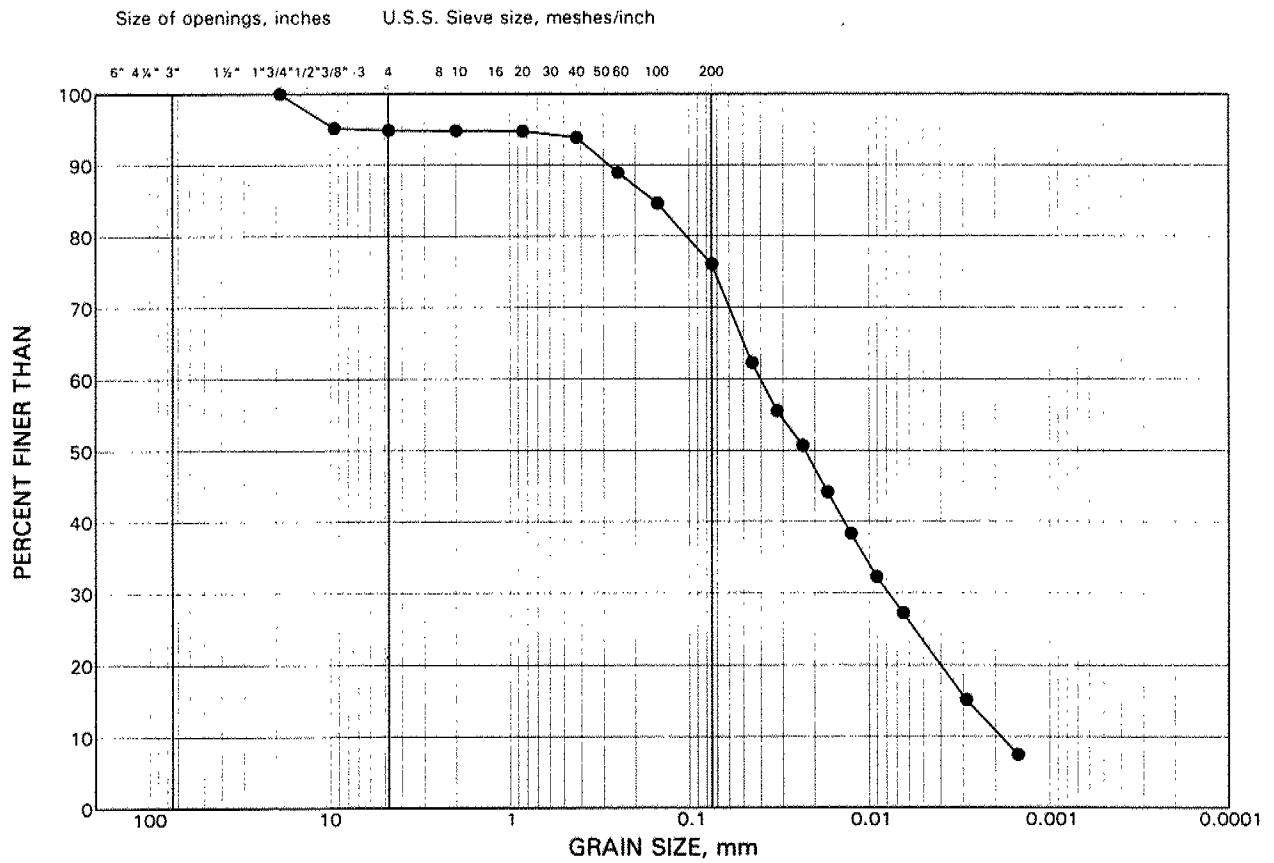
Notes: 1. $\tau = c' + \sigma' \tan \phi'$
2. Shear strength = (Compressive strength)/2

FIGURE 1

4.4

GRAIN SIZE DISTRIBUTION Sandy Silt (Fill)

FIGURE 2



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

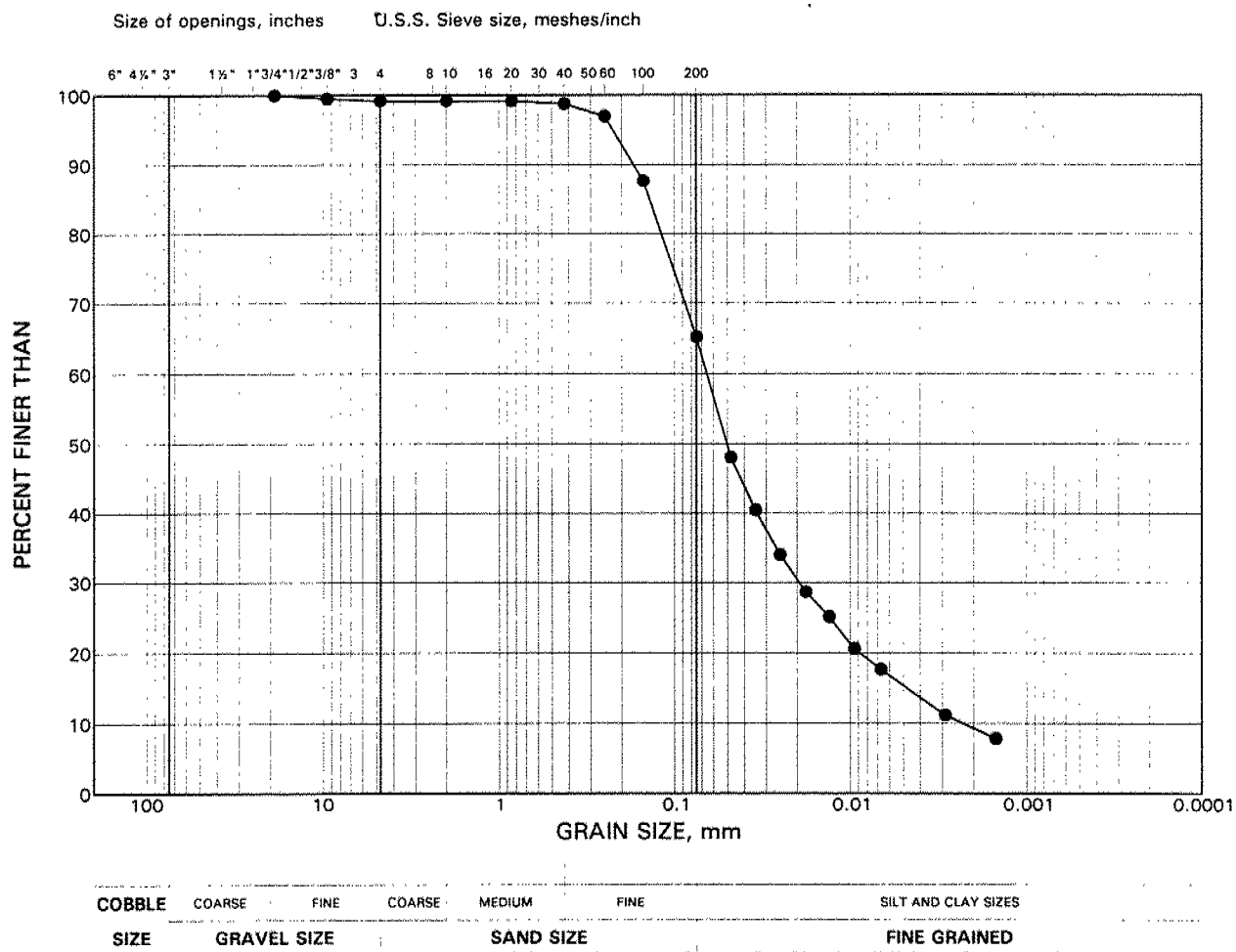
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	5	6	4.3

GRAIN SIZE DISTRIBUTION

Sandy Silt

FIGURE 3



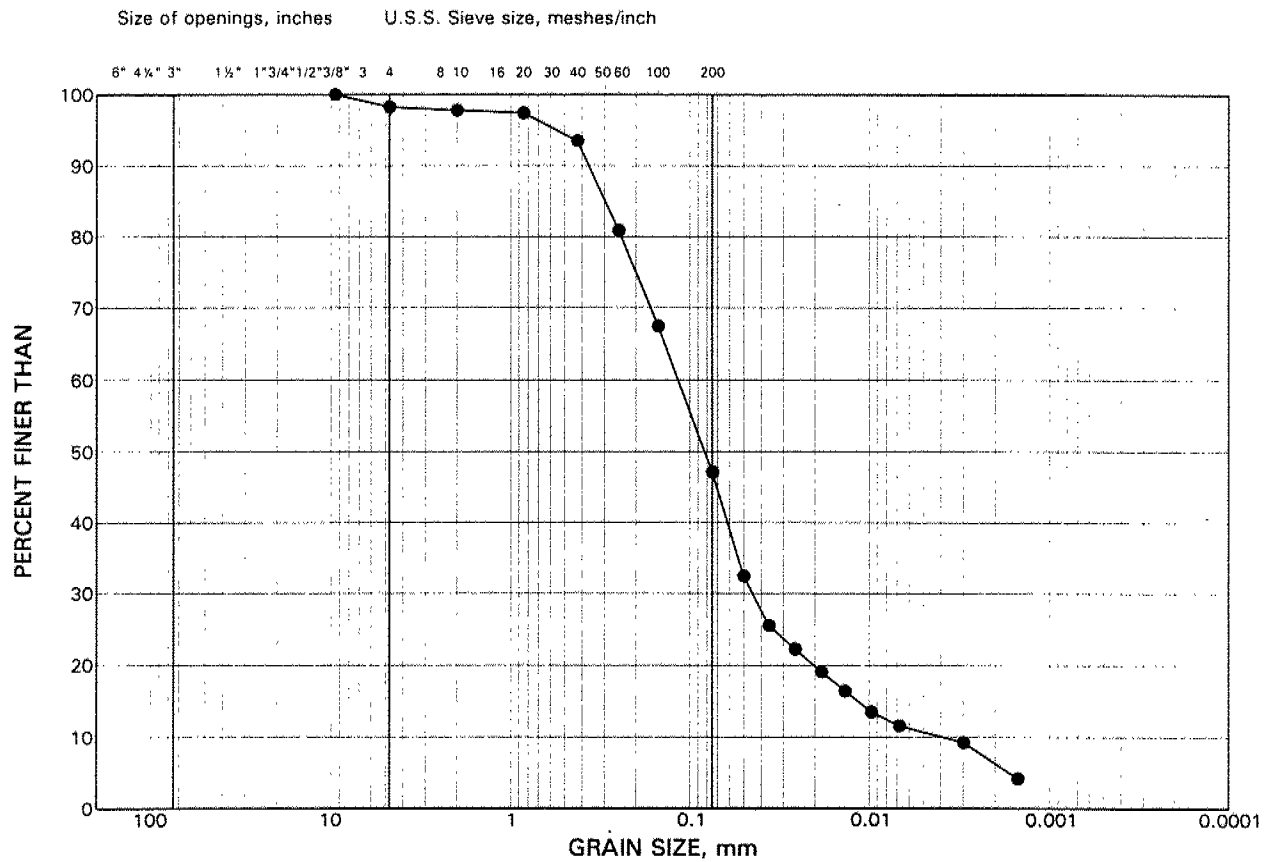
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	7	7	6.6

GRAIN SIZE DISTRIBUTION

Sand and Silt

FIGURE 4



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

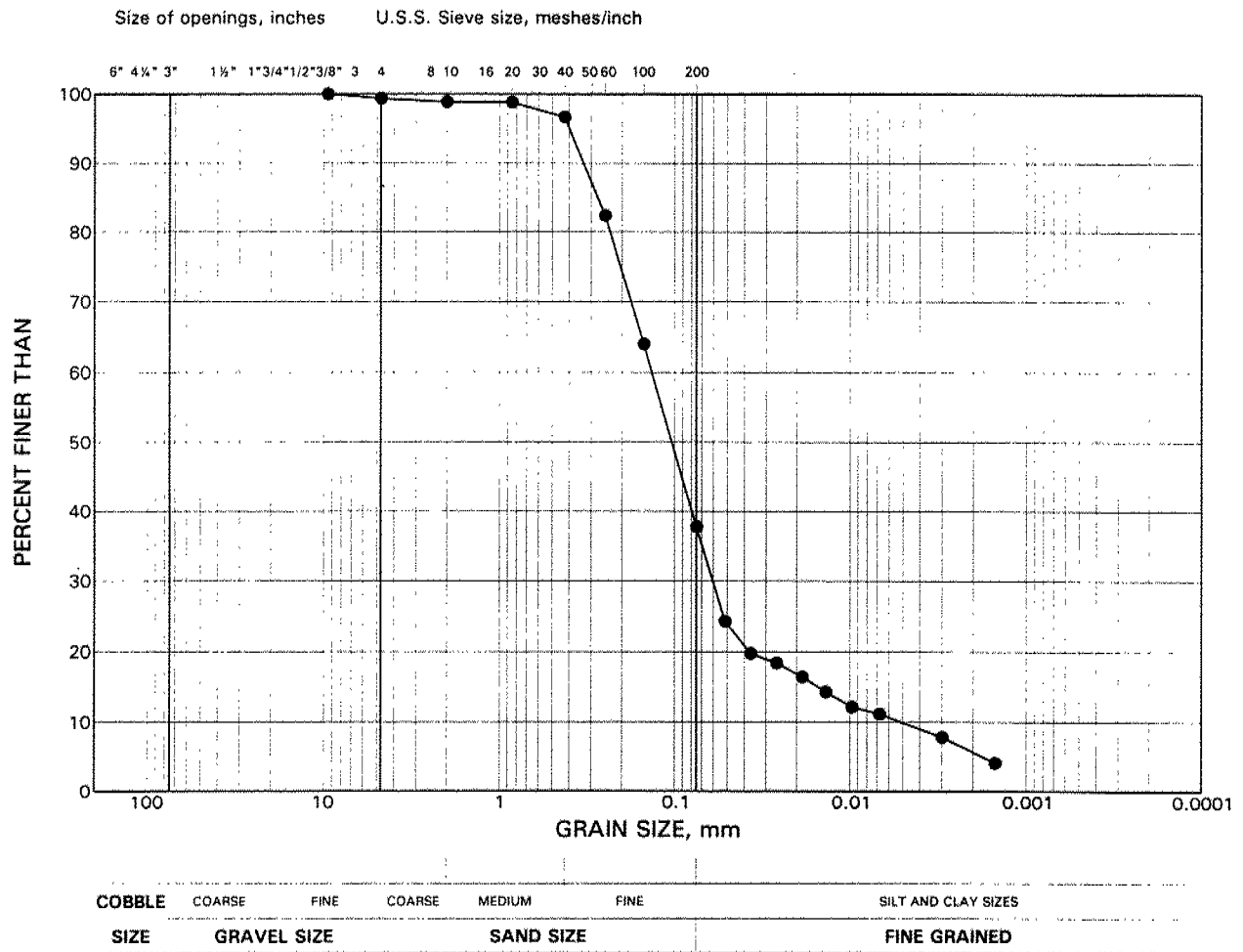
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	9	5	3.5

GRAIN SIZE DISTRIBUTION

Silty Sand (Fill)

FIGURE 5



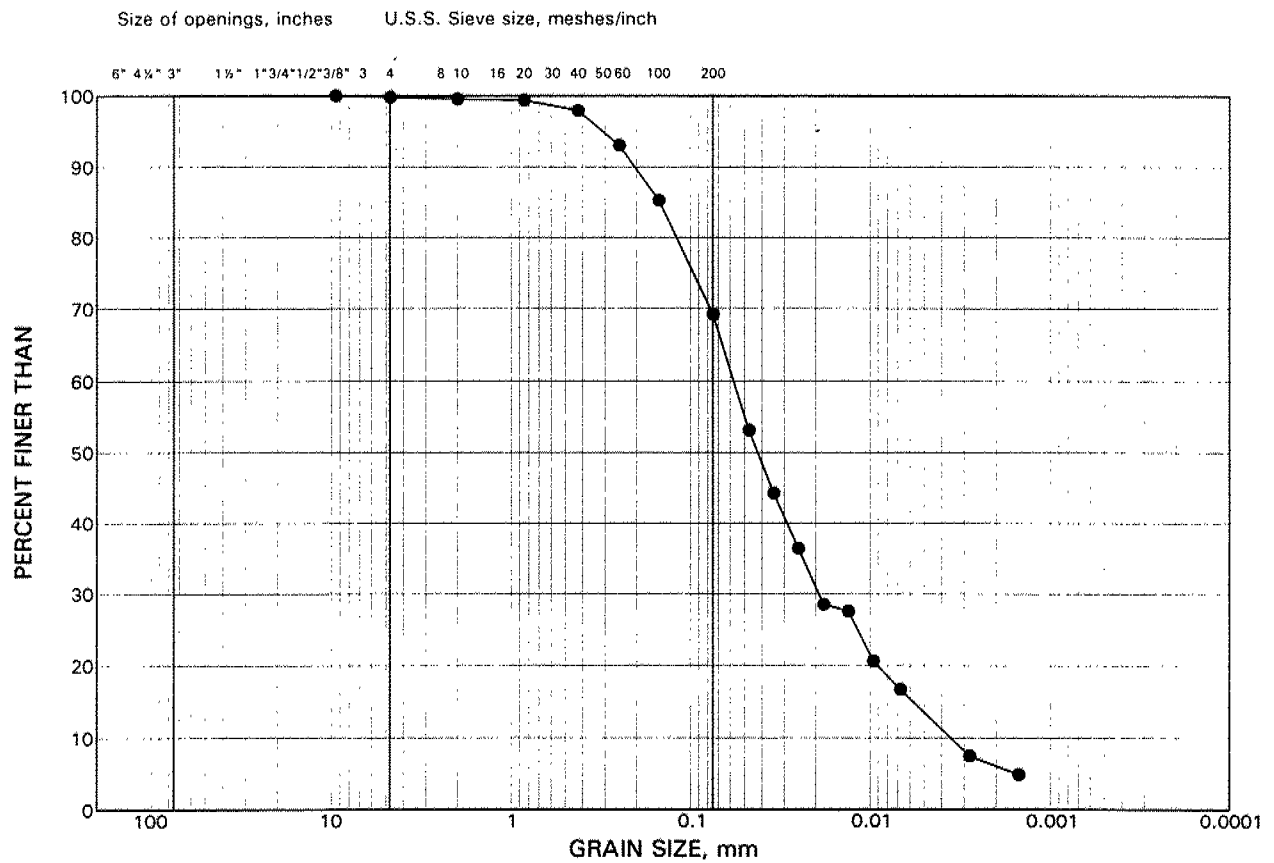
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	11	3	2.0

GRAIN SIZE DISTRIBUTION

Sandy Silt

FIGURE 6



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

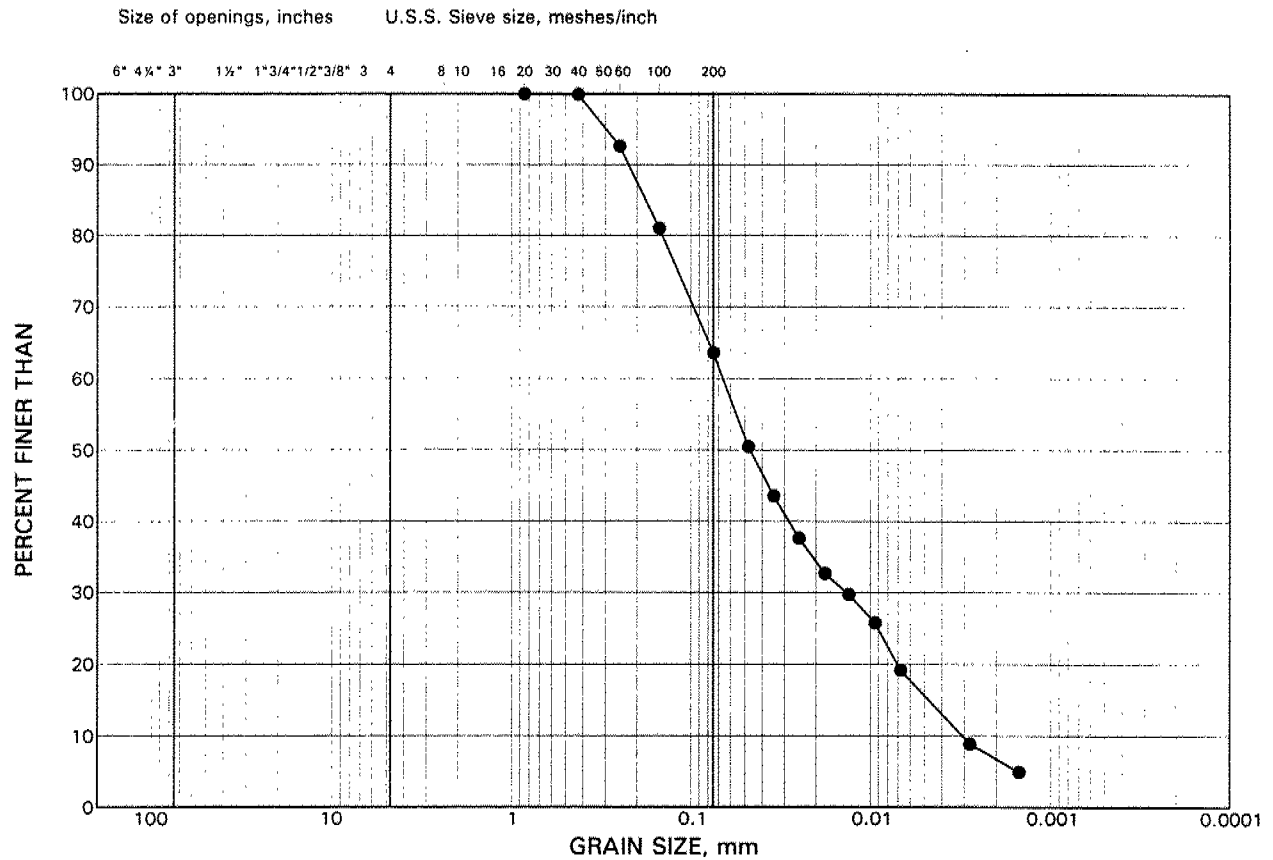
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	13	6	4.4

GRAIN SIZE DISTRIBUTION

Sandy Silt

FIGURE 7



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

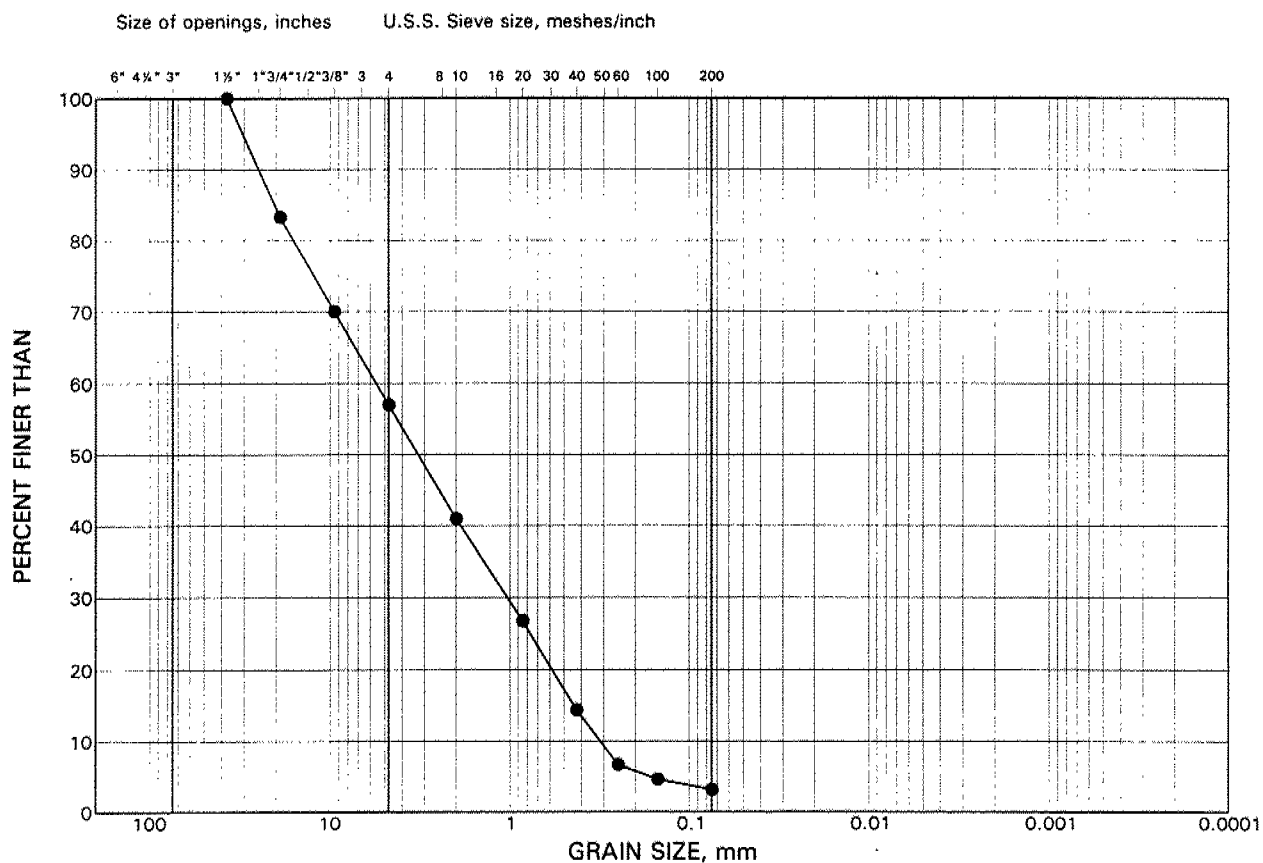
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	14	8	5.2

GRAIN SIZE DISTRIBUTION

Sand and Gravel

FIGURE 8



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	20	3	2.5

GRAIN SIZE DISTRIBUTION

Sand

FIGURE 9

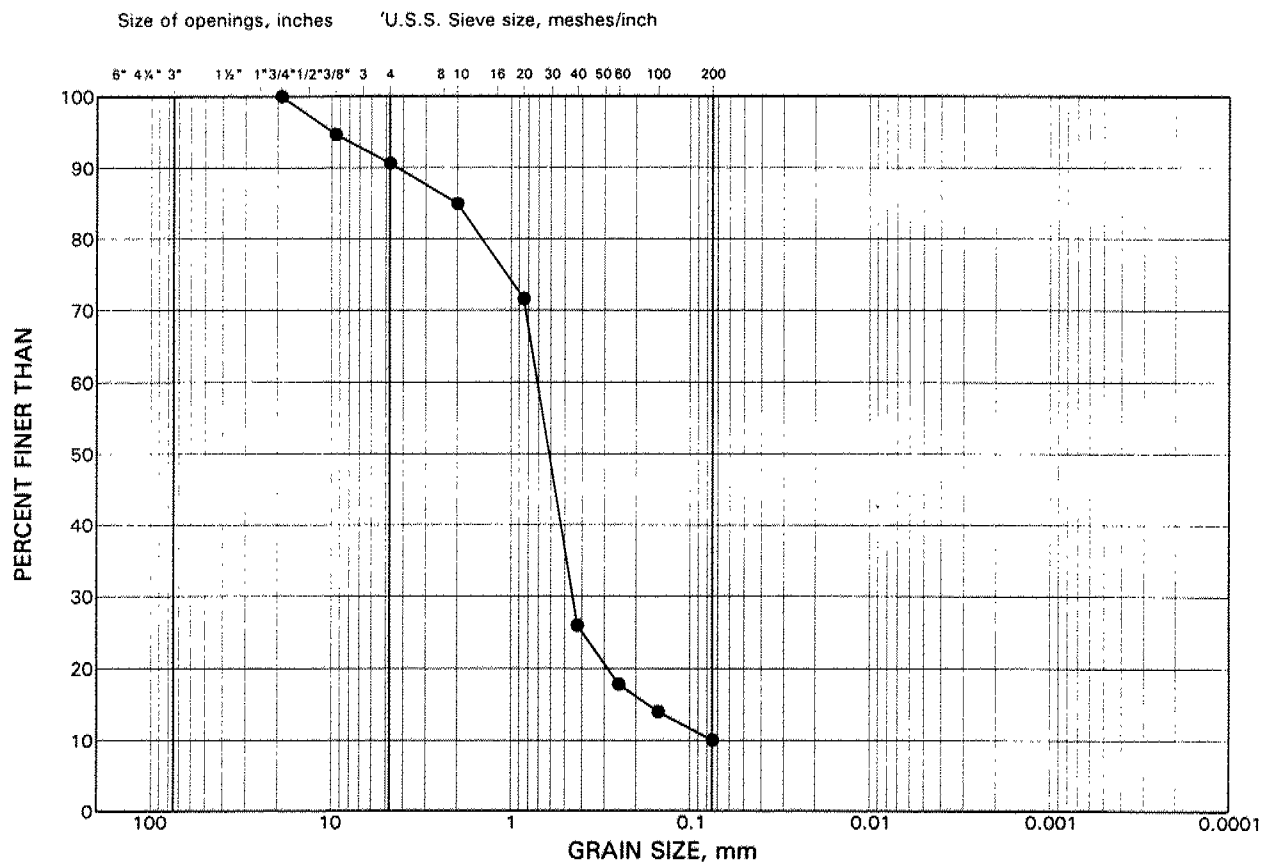


FIGURE 10



SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
--------	----------	--------	----------

Goldier Associates

APPENDIX A

Golder Associates Ltd.

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



April 08, 1999

981-1168

Cole, Sherman & Associates
75 Commerce Valley Drive East
Thornhill, Ontario
L3T 7N9

ATTENTION: Mr. J. Lyle, P.Eng.

**RE: ADDITIONAL FOUNDATION INVESTIGATION
HUMBER RIVER BRIDGE
HIGHWAY 9, FROM 0.3 km EAST OF ALBION 5TH LINE ROAD (S)
EASTERLY TO 0.3 km WEST OF SIMCOE ROAD 10 (N)
AGREEMENT NUMBER 9720-7411-2575
W.P. 530-91-00**

Dear Sirs:

This letter presents the results of a geotechnical investigation carried out at the above noted site. The purpose of the investigation was to establish / confirm the presence of the old abutment footings located north and adjacent to the existing bridge spanning the Humber River. These footings, if encountered, could be in conflict with the footings required for the proposed bridge widening.

Investigation Procedures

The fieldwork for this investigation was carried out on March 19, 1999 and April 06, 1999. On March 19, 1999 four (4) probeholes were advanced within the area of the anticipated old west foundation footprint. The probeholes were labeled as PH1 through PH4. The probehole locations were selected by Mr. Alan Cox, P.Eng. of Cole, Sherman who was on-site during the drilling operation. The probeholes were advanced with a bombardier-mounted B-57 power auger drill rig, using 114 mm outside diameter solid stem continuous flight augers, supplied and operated by Master Soil Investigations Ltd. of North York, Ontario. The probeholes extend to about 7.6 m below the existing ground surface. At this time, the east side of the Humber River was not accessible; probeholes were not put down within the east foundation footprint at this time.

Further investigation was carried out on April 06, 1999 at which time two (2) probeholes within the area of the anticipated old east foundation footprint and one (1) probehole within the old west foundation footprint were put down at the site. The probeholes were labeled as PH5 through PH7. Probing was carried out by Sonic Soil Sampling of Concord, Ontario using portable Pionjar 120 probing equipment. The probeholes were advanced to depths of between 5.5 m and 6.5 m. The soil conditions were observed in each of the probings.

The locations of the probeholes are shown on Figure 1. The drawing of the footprint for the old abutment foundations was provided to us in digital format by Cole, Sherman.

Utility clearances and full-time supervision of the drilling was carried out by a member of our engineering staff. The elevations of the probeholes were surveyed by a member of our engineering staff based on a known spot elevation provided by Cole, Sherman (Elevation 286.106 m, top of northwest curb on bridge). It is understood the spot elevation is referenced to geodetic datum.

Investigation Results

In general, the subsoils at the probehole locations consist of about 3 m of granular fill materials (in Probeholes 1 to 4) and 0.2 m to 0.3 m of topsoil (in Probeholes 5 through 7) underlain by a clayey silt fill and native clayey silt which in turn is underlain by a sandy silt till. Trace organic matter decreasing with depth was noted in the clayey silt fill. A compact sandy silt till with traces of clay and gravel was encountered near the base of Probeholes 5 through 7.

The following table summarizes the information for each probehole.

<i>Borehole</i>	<i>Ground Surface Elevation (m)</i>	<i>Depth of Borehole Base Elevation (m)</i>	<i>Approximate Depth to Native Soils (m)</i>
1	285.70	7.6 (278.1)	3
2	285.52	7.6 (277.92)	3
3	285.27	7.6 (277.67)	3
4	285.54	7.6 (277.94)	3
5	282.95	6.5 (276.45)	1
6	282.71	5.5 (277.21)	1
7	284.00	6.5 (277.5)	0.3

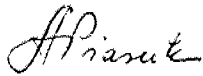
Conclusions

The purpose of the investigation was to establish / confirm the presence of the old abutment footings, which would be in conflict with the footings required for the proposed bridge widening, if encountered. Based on the drawing provided, the Humber River level is about Elevation 282.0 m. The probeholes were advanced to depths ranging from 5.5 m to 7.6 m or to levels ranging from Elevation 276.5 m to Elevation 278.1 m. No grinding or resistance to augering was observed during probehole drilling, which could have indicated the presence of old foundations at the probehole locations.

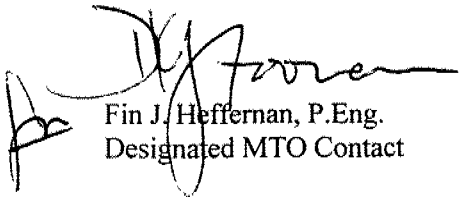
We trust that this letter meets with your approval. Should you have any questions regarding this letter, please contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.



Anna M. Piascik, P.Eng.
Geotechnical Engineer



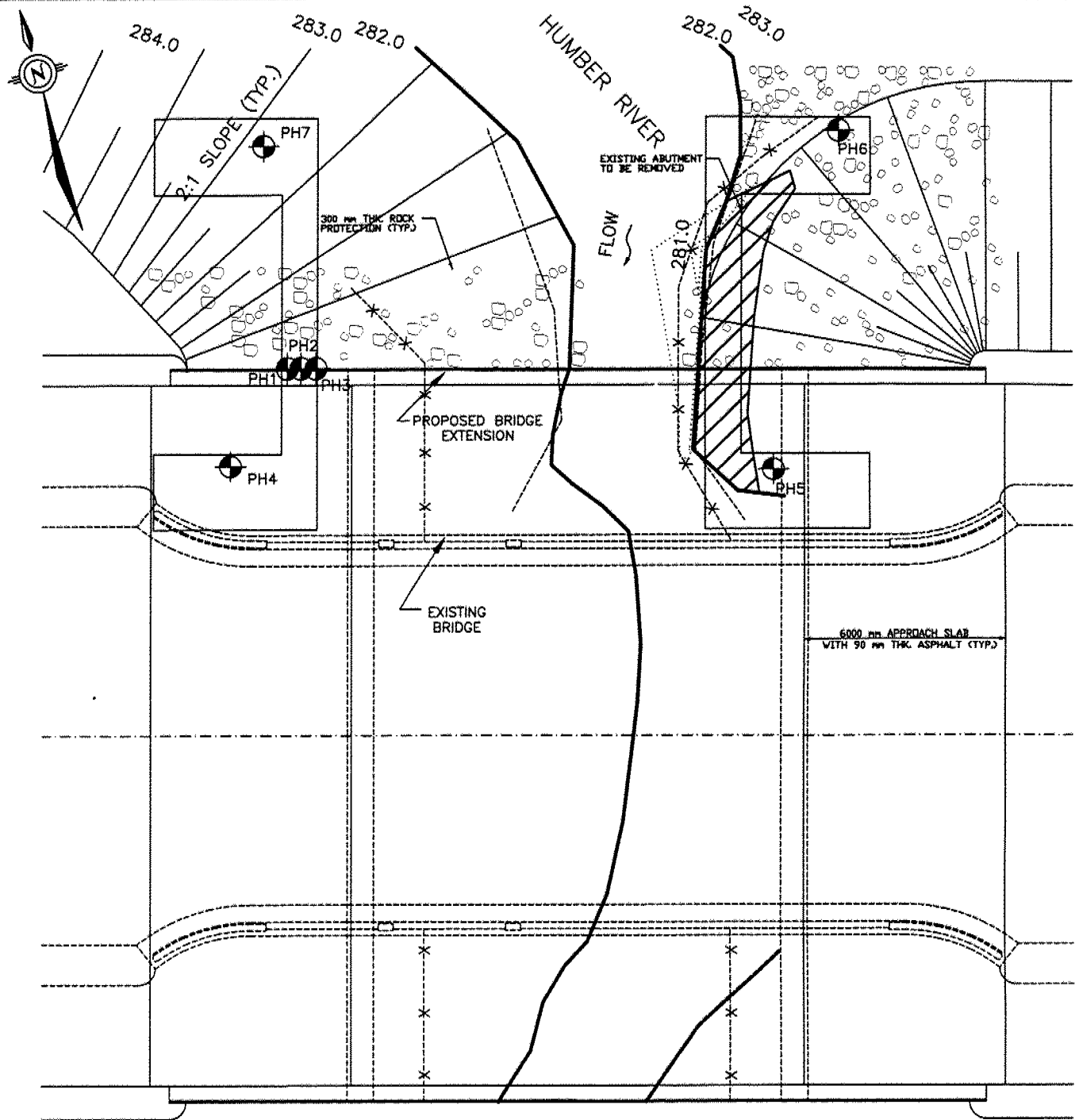
Fin J. Heffernan, P.Eng.
Designated MTO Contact

AMP/FJH/clg
WORD S/FINAL.DAT/1100/981-1168/1999/81168DL1

Attachment(s): Figure 1

PROBEHOLE LOCATION PLAN

FIGURE 1



0 2.5 5 10(metres)

SCALE 1:300

Date APRIL...1999.....

Project 981-1168.....

Golder Associates

Drawn..PS.....

Chkd .P.K.B.....

N1168001.DWG

1:300

W.P. 530-91-00
DIST. HWY 9, CENTRAL REGION
LOCATION: STA 16+875, O/S 18.0m N

RECORD OF BOREHOLE 1

BORING DATE: DEC. 1, 1998

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○	WATER CONTENT, PERCENT Wp ----- W ----- Wl 20 40 60 80			
0		GROUND SURFACE	319.10								
		TOPSOIL	0.08	1	50 DO	3					BENTONITE SEAL
1		Silty sand, trace gravel, trace rootlets. Very loose to loose Brown		2	50 DO	7					
			317.70								
			1.40								
2		Sand, trace to some silt, trace clay, trace gravel, occ. silt lenses. Compact to very dense Brown		3	50 DO	23					
				4	50 DO	24					
3				5	50 DO	44					BACKFILL
4				6	50 DO	48					
		- clayey silt seam at 4.6m depth		7	50 DO	21					
5				8	50 DO	30					
6				9	50 DO	35					
		- silt seam at 8.3m depth		10	50 DO	59					
			309.35								
			9.75								
10		END OF BOREHOLE									

NOTES:
1. OPEN BOREHOLE DRY ON COMPLETION OF DRILLING.
2. PIEZOMETER DRY ON DEC. 9/98.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1168002.BHS

DATA INPUT: SIB JAN 8/99

SOIL46

W.P. 530-91-00

RECORD OF BOREHOLE 2

SHEET 1 OF 1

DIST. HWY 9, CENTRAL REGION

BORING DATE: DEC. 1, 1998

DATUM: GEODETIC

LOCATION: STA 17+023, O/S 14.0m S

PROJECT: 981-1168



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

0	CHE-55 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE		306.00																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
---	---	----------------	--	--------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

NOTES:
1. OPEN BOREHOLE
DRY ON
COMPLETION
OF DRILLING
2. PIEZOMETER DRY
ON DEC. 9/98.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1168003.BHS

DATA INPUT: SIB JAN. 11/99

SOILM6

W.P. 530-91-00
 DIST. HWY 9, CENTRAL REGION
 LOCATION: STA 17+745, O/S 24.0m N

RECORD OF BOREHOLE 3

BORING DATE: DEC. 1, 1998

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa nat V - + O - ● rem V - ⊕ U - ○	WATER CONTENT, PERCENT Wp ----- W ----- Wl 20 40 60 80				
0		GROUND SURFACE	304.00								
		TOPSOIL	0.08	1	50 DO 9						
1		Silty sand, trace clay, trace gravel, occ. rootlets. Loose to dense Brown		2	50 DO 15						
2				3	50 DO 41						
			301.30 2.70	4	50 DO 30						
3		Sand, trace to some silt and gravel, occ. sandy silt seams. Dense to very dense Brown		5	50 DO 30						
4				6	50 DO 36						
5				7	50 DO 46						
6				8	50 DO 50/15						
7											
8			295.92 8.08	9	50 DO 78						
		END OF BOREHOLE									

NOTE:
 OPEN BOREHOLE
 DRY ON
 COMPLETION
 OF DRILLING

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1168004.BHS

W.P. 530-91-00
 DIST. HWY 9, CENTRAL REGION
 LOCATION: STA 18+525, O/S 5.0m N

RECORD OF BOREHOLE 4

BORING DATE: DEC 1, 1998

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp — W — Wl		
				DEPTH (m)							
0	CME-55 POWER AUGER BORING 100mm DIA. SOLID STEM AUGERS	GROUND SURFACE		289.80							
		Sand and gravel, trace organics. Compact Brown (FILL)		0.00	1	50 DO	21				
1		Sandy silt, trace clay and gravel, occ. silt and clayey silt lenses. Loose to dense Brown (FILL)		289.04	2	50 DO	16				
				0.76	3	50 DO	8				
2					4	50 DO	36				
					5	50 DO	30				
3					6	50 DO	32				
4											
5											
6			Silty sand, trace clay, trace gravel. Compact Grey (FILL)		284.30	7	50 DO	14			
7											
8		Sand, trace silt, trace gravel. Loose Grey (FILL)		282.30	8	50 DO	9				
		END OF BOREHOLE		281.72							
9											
10											

NOTE:
WATER LEVEL IN
OPEN BOREHOLE
AT 6m DEPTH
ON COMPLETION
OF DRILLING

NOTE:
 WATER LEVEL IN
 OPEN BOREHOLE
 AT 8m DEPTH
 ON COMPLETION
 OF DRILLING

DATA INPUT: SIB JAN. 11/89

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1169005 BH-9

W.P. 530-91-00
 DIST. HWY 9, CENTRAL REGION
 LOCATION: STA 18+530, O/S 6.0m S

RECORD OF BOREHOLE 5

BORING DATE: NOV. 30, 1998

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp	W		
0	CME-55 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE	289.80 0.00	1	50 DO	20					
		Sand and gravel to sand, trace gravel. Compact Brown (FILL)	289.20 0.60	2	50 DO	16					
1		Sandy silt, trace clay and gravel, occ. sandy silt lenses. Loose to compact Brown (FILL)		3	50 DO	24					
				4	50 DO	24					
2				5	50 DO	6					
				6	50 DO	16					
3				7	50 DO	17					
4			284.40 5.40	8	50 DO	7					
5		Silty sand, trace gravel, trace clay. Loose Grey (FILL)									
6											
7		282.50 7.30	9	50 DO	8						
8	Sand, trace gravel, trace silt. Loose Brown and grey (FILL)										
9											
10			10	50 DO	6						
CONTINUED ON NEXT PAGE											

DATA INPUT: SIB JAN.11/99

SOIL M6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1168025 BHS

DATA INPUT: SIB JAN 11/99
SOILM6

W.P. 530-91-00
DIST. HWY 9, CENTRAL REGION
LOCATION: STA 18+530, O/S 6.0m S

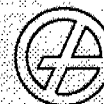
RECORD OF BOREHOLE 5

BORING DATE: NOV. 30, 1998

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	NUMBER	TYPE		WATER CONTENT, PERCENT	Wp		
10	CME-55 POWER AUGER 100mm DIA. S & A.	CONTINUED FROM PREVIOUS PAGE								
11		Sandy silt, trace clay. Compact Grey		11	50 DO					
12		END OF BOREHOLE								
13										
14										
15										
16										
17										
18										
19										
20										

NOTE:
WATER LEVEL IN
OPEN BOREHOLE
AT 6m DEPTH
ON COMPLETION
OF DRILLING

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1168006 BHS
SOIL M6
DATA INPUT: SIB JAN 11/99

W.P. 530-91-00
DIST. HWY 9, CENTRAL
LOCATION: STA 18+575, O/S 20.0m S

RECORD OF BOREHOLE 6

BORING DATE: DEC. 5, 1998

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + Q - ● rem V - ⊕ U - ○	WATER CONTENT, PERCENT Wp ----- W ----- Wl 20 40 60 80		
				DEPTH (m)								
0	CME-55 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE		284.00 0.00								
		Clayey silt, some sand, some gravel, trace organics. Stiff Grey (FILL)			1	50 DO	8					
1		Organic Clayey Silt, trace gravel. Very soft to stiff Black		283.09 0.91	2	50 DO	3					
					3	50 DO	10					
2					4	50 DO	15					
3					5	50 DO	5					
4			Clayey silt, some sand. Very stiff Grey		280.49 3.51	6	50 DO	26				
5					8	50 DO						
			END OF BOREHOLE		278.97 5.03							
6												
7												
8												
9												
10												

NOTE:
WATER LEVEL IN
OPEN BOREHOLE
AT 1.5m DEPTH
ON COMPLETION
OF DRILLING.

NOTE:
WATER LEVEL IN
OPEN BOREHOLE
AT 1.5m DEPTH
ON COMPLETION
OF DRILLING.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1188007.BHS

DATA INPUT: SIB JAN 8/99

SOIL M6

W.P. 530-91-00

DIST. HWY 9, CENTRAL REGION

LOCATION: STA 18+650, O/S 30.0m N

RECORD OF BOREHOLE 7

BORING DATE: NOV. 30, 1998

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH Cu, kPa	nat V - + Q - ● rem V - ⊕ U - ○	WATER CONTENT, PERCENT Wp — W — Wl	20 40 60 80				
0	CME-55 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE	301.00 0.00	1	50 DO	6					BENTONITE SEAL		
1		Sand, trace silt, trace organics to 1.2m depth. Loose to compact Brown		2	50 DO	6							
2				3	50 DO	11							
3				4	50 DO	13							
4				5	50 DO	12							
5		Sandy silt, trace clay, trace gravel. Compact to dense Grey		6	50 DO	28						BACKFILL	
6				7	50 DO	32							
7				293.90 7.10	8	50 DO	34						
8													
9		Sand, trace silt, occ. silt seams. Dense to very dense Brown to greyish brown											MH
10	CONTINUED ON NEXT PAGE												

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

NY 158007 BHS

DATA INPUT: SIB JAN 9/99

SOIL M6

W.P. 530-91-00
 DIST HWY 9, CENTRAL REGION
 LOCATION: STA 18+650, O/S 30.0m N

RECORD OF BOREHOLE 7

BORING DATE: NOV. 30, 1998

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER TYPE	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp W Wl				
10	CME-55 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	CONTINUED FROM PREVIOUS PAGE									
11		Sand, trace silt, occ. silt seams. Dense to very dense Brown to greyish brown		10	50 DO	52					
12		Clayey silt, some sand. Hard Brown		11	50 DO	81					
13		Sand, trace silt. Very dense Brown		12	50 DO	50					
14		END OF BOREHOLE									

NOTES:
 1. OPEN BOREHOLE
 DRY ON
 COMPLETION OF
 DRILLING.
 2. PIEZOMETER DRY
 ON DEC. 9/98.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1168008.BHS

W.P. 530-91-00
 DIST. HWY 9, CENTRAL REGION
 LOCATION: STA 18+811, O/S 19.0m N

RECORD OF BOREHOLE 8

BORING DATE: DEC. 1, 1998

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



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

0	CME-55 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE		294.20												
		Topsoil		0.05	1	50 DO	5									
		Silty sand, trace gravel, trace rootlets. Loose Brown (FILL)		293.44												
				0.78												
1					2	50 DO	11									
			Sandy silt, trace gravel and clay, occ. organic rootlets and oxidation staining. Compact to dense Brown													
					3	50 DO	23									
2					4	50 DO	27									
3					5	50 DO	24									
4					6	50 DO	47									
		END OF BOREHOLE		289.78												
				4.42												
5																
6																
7																
8																
9																
10																

NOTES:
1. OPEN BOREHOLE DRY ON COMPLETION OF DRILLING.
2. WATER LEVEL IN PIEZOMETER AT 1.7m DEPTH ON DEC. 9/98.

NOTES:
 1. OPEN BOREHOLE DRY ON COMPLETION OF DRILLING.
 2. WATER LEVEL IN PIEZOMETER AT 1.7m DEPTH ON DEC. 9/98.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

DATA INPUT: SIB JAN 8/99

SOILM6

N1168093 BHS

DATA INPUT: SIB JAN 11/99

SOIL.M6

W.P. 530-91-00
 DIST. HWY 9, CENTRAL REGION
 LOCATION: STA 18+825, O/S 6.0m S

RECORD OF BOREHOLE 9

BORING DATE: NOV.30, 1998

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	net V - + rem V - @ U - O			WATER CONTENT, PERCENT Wp ----- W ----- Wl 20 40 60 80
				DEPTH (m)								
0	CME-55 POWER AUGER BORING 100mm DIA. SOLID STEM AUGERS	GROUND SURFACE		297.50								
		Sand and gravel, trace asphalt fragments. Dense Brown (FILL)		0.00	1	50 DO	36					
				296.89								
			0.61									
1		Sandy silt, trace clay, trace gravel. Compact Brown (FILL)			2	50 DO	28					
					3	50 DO	28					
2				295.40								
			2.10									
			295.10									
			2.40	4	50 DO	9						
3		Sand and silt, trace gravel, trace clay. Loose Brown (FILL)										
					5	50 DO	8					
4					6	50 DO	8					
					7	50 DO	9					
5												
			291.80									
			5.70									
6	Silty clay, some sand. Very stiff Brown			8	50 DO	17						
			290.95									
			6.55									
7	END OF BOREHOLE											
8												
9												
10												

NOTE:
WATER LEVEL IN
OPEN BOREHOLE
AT 6m DEPTH
ON COMPLETION
OF DRILLING.

MH



NOTE:
 WATER LEVEL IN
 OPEN BOREHOLE
 AT 6m DEPTH
 ON COMPLETION
 OF DRILLING.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1168010.BHS

W.P. 530-91-00
 DIST. HWY 9, CENTRAL REGION
 LOCATION STA 17+675, O/S 40.0m N

RECORD OF BOREHOLE 10

BORING DATE: DEC. 2, 1998

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + Q - ● rem V - ⊕ U - ○			WATER CONTENT, PERCENT Wp — W — Wi 20 40 60 80
				DEPTH (m)								
0	CME-55 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE		316.80								
		Topsoil		0.08	1	50 DO	5					
		Silty sand, trace rootlets. Loose Brown (FILL)		316.11 0.69								
1		Clayey silt, trace sand, occ. silt lenses, occ. organic lenses. Stiff to very stiff Brown (FILL)			2	50 DO	11					
2				314.80 2.00	3	50 DO	24					
		Sand, trace to some silt to silty sand, trace gravel. Compact to dense Brown										
3					4	50 DO	31					
4				5	50 DO	33						
5												
6		Silty Clay, some sand. Hard Brown		311.50 5.30	6	50 DO	41					
7												
8												
9												
					</							

DATA INPUT: SIB JAN. 8/99

SOLM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

DIST. HWY 9, CENTRAL REGION

BORING DATE: DEC. 2, 1998

DATUM: GEODETIC

LOCATION: STA 17+675, O/S 40.0m N

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k _v , cm/s		ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	ELEV. DEPTHS (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH C _u , kPa	WATER CONTENT, PERCENT w _p — w — w _L		
10	CME-55 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	CONTINUED FROM PREVIOUS PAGE								
11		Silty Clay, trace sand, occ. sandy silt seams. Very stiff to hard Brown — becoming grey at 13m depth		9	SD DO	57				
12				10	SD DO	26		O		
13				11	SD DO	39				
14				12	SD DO	62		O		
15				13	SD DO	44		O		
16				14	SD DO	55/.15				
17				298.21 18.59						
18		END OF BOREHOLE								
19										
20										

NOTE:
OPEN BOREHOLE DRY ON COMPLETION OF DRILLING.

NOTE:
OPEN BOREHOLE
DRY ON
COMPLETION
OF DRILLING.

DEPTH SCALE

1 to 50

Goldier Associates

LOGGED: DKB

CHECKED: AMP

N1166011.BHS

SOLM6
DATA INPUT: SIB JAN 11/99

W.P. 530-91-00
DIST. HWY 9, CENTRAL REGION
LOCATION: STA 17+375, O/S 8.5m N

RECORD OF BOREHOLE 11

BORING DATE: DEC 4, 1998

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE				
0	CME-35 POWER AUGER BORING 100mm DIA. SOLID STEM AUGERS	GROUND SURFACE	304.00 0.00	1	50 DO	24			BENTONITE SEAL
		Sand and gravel. Compact Brown (FILL)	303.39 0.61						
1		Silty sand, trace gravel, trace clay, occ. silt seams. Compact to dense Brown (FILL)		2	50 DO	16			
				3	50 DO	44			
2				4	50 DO	46			
				5	50 DO	36			
3			300.50 3.50						
4		Clayey silt, some sand. Very stiff to hard Brown (FILL)		6	50 DO	20			
5									
				298.20 5.80					
6		Silty clay, some sand. Hard Brown		7	50 DO	44			
7									
			294.40 9.60						
8			8	50 DO	54				
9			9	50 DO	84				
10		END OF BOREHOLE							

NOTES:
1. OPEN BOREHOLE DRY ON
COMPLETION OF DRILLING.
2. WATER LEVEL IN PIEZOMETER
AT 7.1m DEPTH ON DEC.9/98.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

W.P. 530-91-00
DIST. HWY 9, CENTRAL REGION
LOCATION: STA 17+750, O/S 9.0m S

RECORD OF BOREHOLE 12

BORING DATE: DEC. 1, 1998

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH				WATER CONTENT, PERCENT	
								Cu, kPa	nat V - + rem V - ⊕			Q - ● U - ○	Wp
0	CME-55 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE		308.20									
		Sand, trace silt, trace gravel, trace rootlets. Compact Brown (FILL)		0.00	1	50 DO	17						
				307.80									
				0.60									
1		Silty clay, trace sand, trace gravel. Stiff to hard Brown			2	50 DO	12						
					3	50 DO	26						
2													
				4	50 DO	32							
				5	50 DO	30							
4													
				6	50 DO	38							
				7	50 DO	26							
5		END OF BOREHOLE		303.17									
				5.03									
6													
7													
8													
9													
10													

BACKFILL

BENTONITE SEAL

SAND FILTER

CAVED

NOTES:
1. OPEN BOREHOLE DRY ON COMPLETION OF DRILLING.
2. PIEZOMETER DRY ON DEC. 9/98.

NOTES:
1. OPEN BOREHOLE
DRY ON
COMPLETION
OF DRILLING.
2. PIEZOMETER DRY
ON DEC. 9/98.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

N1166013 BHS

W.P. 530-91-00

RECORD OF BOREHOLE 13

SHEET 1 OF 1

DIST. HWY 9, CENTRAL REGION

BORING DATE: DEC. 2, 1998

DATUM: GEODETIC

LOCATION: STA 1B+060, O/S 15.0m N

PROJECT: 981-1168



CME-55 POWER AUGER BORING
108mm DIA. SOLID STEM AUGERS

DATA INPUT: SIB JAN. 8/99

SOILM8

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + Q - ● rem V - ⊕ U - ○			WATER CONTENT, PERCENT Wp — W — Wt 20 40 60 80
				DEPTH (m)								
0	CME-SS POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE		294.60								
		Topsoil		0.06	1	50 DO	9					
		Silty sand, trace clay, trace gravel, frequent topsoil lenses.		293.90								
		Loose Brown (FILL)		0.70	2	50 DO	5					
1												
2												
3												
4		Sandy silt, trace clay, trace gravel, occ. sand seams, occ. oxidation staining. Loose to compact Brown			5	50 DO	5					
5												
6												
7		END OF BOREHOLE		287.90 6.70	8	50 DO	25					
8												
9												
10												

NOTES:
1. WATER LEVEL IN
OPEN BOREHOLE
AT 5.8m DEPTH
ON COMPLETION
OF DRILLING.
2. WATER LEVEL
IN PIEZOMETER
AT 3.2m DEPTH
ON DEC. 9/98.

NOTES:
1. WATER LEVEL IN
OPEN BOREHOLE
AT 5.8m DEPTH
ON COMPLETION
OF DRILLING.
2. WATER LEVEL
IN PIEZOMETER
AT 3.2m DEPTH
ON DEC. 9/98.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

NT168014.BHS
DATA INPUT: SIB JAN. 9/99
SOIL.M6

W.P. 530-91-00
DIST. HWY 9, CENTRAL REGION
LOCATION: STA 18+388, O/S 16.0m S

RECORD OF BOREHOLE 14

BORING DATE: DEC. 2, 1998

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp W Wt			
0		GROUND SURFACE	290.50								
		Topsoil	0.06	1	50 DO	5					BENTONITE SEAL
1		Sandy silt, trace clay, trace gravel, frequent topsoil lenses. Loose to compact Brown to mottled brown/grey (FILL)	289.20	2	50 DO	6					
2			1.30	3	50 DO	21					BACKFILL
3				4	50 DO	23					
4				5	50 DO	12					
5		Sandy silt, trace clay, trace gravel. Loose to compact Grey		6	50 DO	4					
6				7	50 DO	4					
7				8	50 DO	5					MH
8				9	50 DO	11					SAND FILTER
		END OF BOREHOLE	282.27 8.23								

NOTES:
1. WATER LEVEL IN OPEN BOREHOLE AT 3.2m DEPTH ON COMPLETION OF DRILLING.
2. WATER LEVEL IN PIEZOMETER AT 1.1m DEPTH ON DEC. 9/98.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: DKB

CHECKED: AMP

W.P. 530-91-00
DIST. HWY 9, CENTRAL
LOCATION: STA. 18+505 o/s 21m N

RECORD OF BOREHOLE 15

BORING DATE: JAN. 19/99

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + Q - ● rem V - ⊗ U - ○			WATER CONTENT, PERCENT Wp ----- W ----- Wl 20 40 60 80
0	HAND AUGER	GROUND SURFACE		284.00 0.00								
		Silty Sand, some fibrous organics Loose Brown (FILL)			1	AS						
1		Fibrous Peat, trace silt Loose Black		283.09 0.91	2	AS						
2		Clayey Silt, trace sand Stiff Grey		282.02 1.98	3	AS						
3		END OF BOREHOLE		281.41 2.59								
		Note: Refusal to hand auger penetration at 2.59m depth										
4												
5												
6												
7												
8												
9												
10												

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: CG

CHECKED: DB

NOTE:
WATER LEVEL IN
OPEN HOLE AT
GROUND SURFACE.

N116815A BHS

DATA INPUT: SIB FEB. 8/99

SOLM6

W.P. 530-91-00
 DIST. HWY 9, CENTRAL
 LOCATION: STA. 18+485 o/s 19.5m N

RECORD OF BOREHOLE 15A

BORING DATE: JAN. 20/99

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH				WATER CONTENT, PERCENT	
								nat V - + rem V - ⊗	Q - ● U - ○			Wp	W
0		GROUND SURFACE		284.00 0.00									
1	HAND AUGER	Fibrous Peat, trace silt Loose Black		1	AS						>355.1		
2				2	AS						>327.3		
3		END OF BOREHOLE		280.95 3.05									
4		Note: Refusal to hand auger penetration at 3.05m depth											
5													
6													
7													
8													
9													
10													

NOTE:
WATER LEVEL IN
OPEN HOLE AT
GROUND SURFACE

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: CG

CHECKED: DB

N11615B BHS

W.P. 530-91-00
 DIST. HWY 9, CENTRAL
 LOCATION: STA. 18+535 o/s 22m N

RECORD OF BOREHOLE 15B

BORING DATE: JAN. 20/99

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 9B1-116B



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp ----- W ----- Wl 20 40 60 80				
0	HAND AUGER	GROUND SURFACE	284.10 0.00	1 AS							
1		Sand, trace to some silt, trace fibrous organics and gravel Loose Brown to grey (FILL)		2 AS							
2		END OF BOREHOLE	282.58 1.52								
3											
4											
5											
6											
7											
8											
9											
10											

NOTE:
WATER LEVEL IN
OPEN HOLE AT
GROUND SURFACE

DATA INPUT: SIB FEB. 8/99

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: CG

CHECKED: AMP

NY18815C BHS

W.P. 530-91-00

RECORD OF BOREHOLE 15C

SHEET 1 OF 1

DIST. HWY 9, CENTRAL

BORING DATE: JAN. 20/99

DATUM: GEODETIC

LOCATION: STA. 18+520 o/s 22m N

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + rem V - ⊗	Q - ● U - ○	WATER CONTENT, PERCENT Wp — W — Wi		
0	HAND AUGER	GROUND SURFACE	284.00 0.00								
1		Clayey Silt trace black fibrous organics, trace sand Soft to firm Brown		1	AS						
2				2	AS						
1.37		282.63									
1.37		END OF BOREHOLE	1.37								
		Note: Refusal to hand auger penetration at 1.37m depth									
2											
3											
4											
5											
6											
7											
8											
9											
10											

NOTE:
WATER LEVEL IN
OPEN BOREHOLE AT
GROUND SURFACE

DATA INPUT: SIB FEB. 8/99

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: CG

CHECKED: DB

W.P. 530-91-00
DIST. HWY 9, CENTRAL
LOCATION: STA. 17+945 o/s. 16m N

RECORD OF BOREHOLE 18

BORING DATE: JAN. 22/99

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE		BLOWS/0.3m	SHEAR STRENGTH Cu, kPa			WATER CONTENT, PERCENT Wp W Wl
0		GROUND SURFACE	286.20 0.00								
1		Clayey Silt, trace to some sand, trace gravel, trace organics Firm Brown	284.66 1.52	1	50 DO	6					
2		Sand, trace to some silt and gravel Compact to very dense Brown		2	50 DO	41					
3				3	50 DO	19					
4				4	50 DO	40					
5				5	50 DO	62					
6				6	50 DO	64					
7		END OF BOREHOLE	279.65 6.55								
8											
9											
10											

Notes:
1. Water level
in open borehole
at 0.61m depth
(Elev. 285.6m)
upon completion
of drilling.
2. Water level
in piezometer
at 0.6m depth
(Elev. 285.6m)
on Feb. 1/99.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: CG

CHECKED: AMP

N1168019 BHS

W.P. 530-91-00
 DIST. HWY 9, CENTRAL
 LOCATION: STA: 18+030 o/s 16m N

RECORD OF BOREHOLE 19

BORING DATE: JAN. 21/99

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + rem V - ⊗ U - ○			Q - ● U - ○	WATER CONTENT, PERCENT Wp — W — Wl 20 40 60 80
0	CME-45 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE		285.00 0.00									
1		Organic Silt, trace to some sand, trace gravel Very loose Dark brown			1	50 DO	3						
			283.78 1.22										
2		Sand and Gravel, trace silt Compact Brown		2	50 DO	10							
3		Sand, trace to some silt, trace gravel Compact to very dense Brown	282.58 2.44	3	50 DO	28							
4		Sand and gravel seam at 3.2m depth		4	50 DO	44							
5					5	50 DO	44						
6													
7					6	50 DO	66						
8													
9													
10													
		END OF BOREHOLE		278.45 6.55									

Notes:

1. Water level in open borehole at 0.9m depth (Elev.284m) upon completion of drilling.

2. Water level in piezometer at 1.3m depth (Elev.283.7m) on Feb.1/99.

Notes:
 1. Water level
 in open borehole
 at 0.9m depth
 (Elev. 284m)
 upon completion
 of drilling.
 2. Water level
 in piezometer
 at 1.3m depth
 (Elev. 283.7m)
 on Feb. 1/99.

DATA INPUT: SIB FEB 8/99

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: CG

CHECKED: AMP

N168020.BHS
DATA INPUT: SIB FEB 6/99
SOIL.M6

W.P. 530-91-00
DIST. HWY 9, CENTRAL
LOCATION: STA. 18+070 o/s 14.4m N

RECORD OF BOREHOLE 20

BORING DATE: JAN. 21/99

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH				WATER CONTENT, PERCENT	
								Cu, kPa	nat V - + rem V - @ U - O			Wp	Wt
0	CME-45 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE		285.00 0.00									
1		Silty Sand trace to some gravel, trace to some organics Compact Brown to dark grey			1	50 DO	23						
2		Sand and Gravel, trace silt Compact to dense Brown occ. cobbles noted at 2.3m depth		283.63 1.37	2	50 DO	34						
3				3	50 DO	11					M		
4				4	50 DO	20							
5				5	50 DO	36							
6		Silt, trace to some sand, trace gravel, trace clay Dense to very dense Grey		279.97 5.03	6	50 DO	37				MH		
7				7	50 DO	70							
8				8	50 DO	98							
9													
10		END OF BOREHOLE		275.40 9.60									

Note:
Water level in
open borehole
at 0.8m depth
(Elev.284.4m)
upon completion
of drilling.

Note:
Water level in
open borehole
at 0.6m depth
(Elev. 284.4m)
upon completion
of drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: CG

CHECKED: AMP

N1168021 BHS
DATA INPUT: 518 FEB. 6/99
SOIL M6

W.P. 530-91-00
DIST. HWY 9, CENTRAL
LOCATION STA. 18+130 o/s 12m N

RECORD OF BOREHOLE 21

BORING DATE: JAN. 21/99

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp — W — Wt		
				DEPTH (m)							
0	CME-45 POWER AUGER BORING 108mm DIA. SOLID STEM AUGERS	GROUND SURFACE		285.80 0.00							
1		Silty Sand, trace to some gravel, trace to some organics Compact to dense Brown			1	50 DO	25				CAVED
2					2	50 DO	36				
3		Sand and Gravel, trace silt Compact Brown		283.67 2.13	3	50 DO	22				BENTONITE SEAL
4		Silty Sand, trace gravel Loose Brown		282.75 3.05	4A	50 DO	8				
5					4	50 DO	7				
6		Silt, trace sand Compact Grey		281.38 4.42	5	50 DO	18				SAND
7		Silt, some sand to Silty Sand, trace gravel trace clay Compact to dense Brown		280.47 5.33	6	50 DO	26				
8					7	50 DO	22				
9						8	50 DO	39			
10				275.89 9.91							CAVED
CONTINUED ON NEXT PAGE											

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: CG

CHECKED: AMP

N1168021.BHS

DATA INPUT: SIB FEB. 6/99

SOLM6

W.P. 530-91-00
 DIST. HWY 9, CENTRAL
 LOCATION: STA. 18+130 o/s 12m N

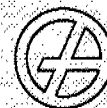
RECORD OF BOREHOLE 21

BORING DATE: JAN. 21/99

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1168



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + Q - ● rem V - ⊕ U - ○	WATER CONTENT, PERCENT Wp ----- W ----- Wl 20 40 60 80			
10	CME-45 POWER AUGER BORING 106mm DIA. SOLID STEM AUGERS	CONTINUED FROM PREVIOUS PAGE										
11		Sand and Gravel, trace silt Very dense Brown		9	50 DO	50						
12		Silty Sand, trace gravel Dense Brown	274.05 11.75	10	50 DO	45						
13		END OF BOREHOLE	273.15 12.65									
14												
15												
16												
17												
18												
19												
20												

Notes:
 1. Water level
 in open borehole
 at 0.9m depth upon
 completion of drilling.
 2. Water level in
 piezometer at 1.0m
 depth (Elev. 284.8m)
 on Feb. 1/99.

CAVED

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: CG

CHECKED: AMP

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

CONT. No.
WP No. 530-91-00

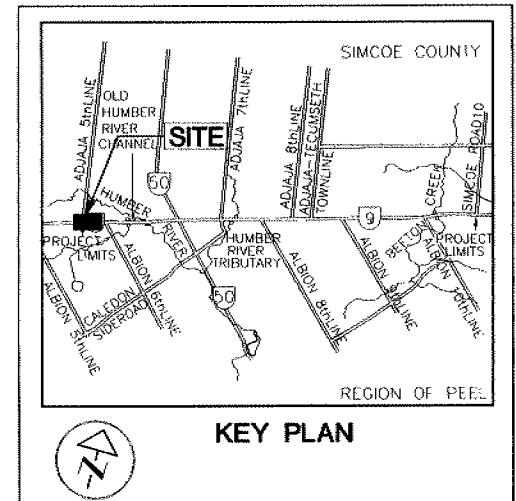
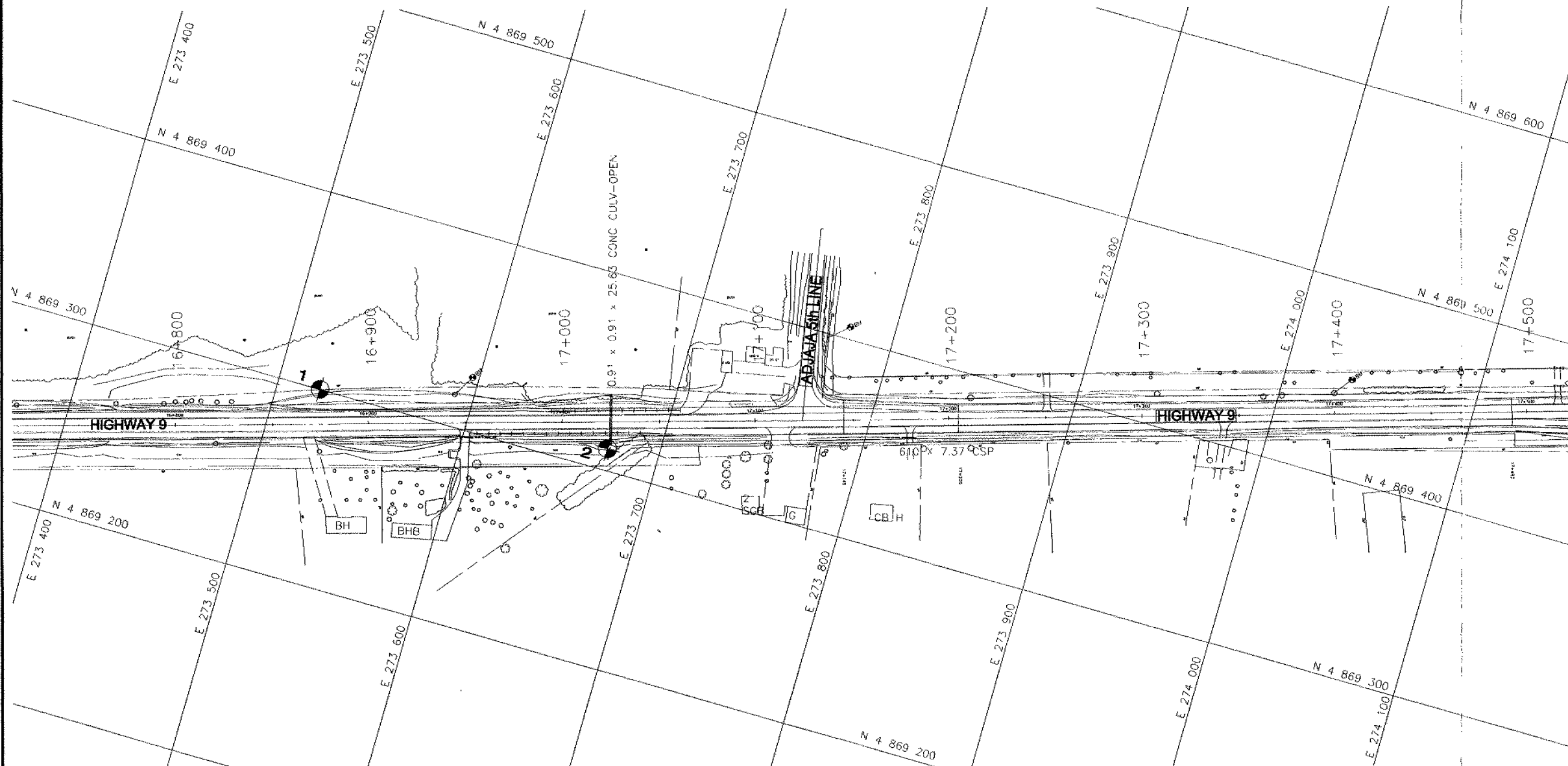


HIGHWAY 9
Sta. 16+800 to Sta. 17+500
BORE HOLE LOCATIONS







Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



LEGEND

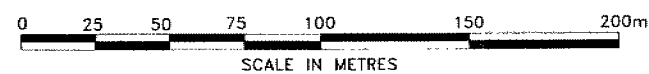
- | | |
|---|---|
|  | Bore Hole |
|  | Dynamic Cone Penetration Test (Cone) |
|  | Bore Hole & Cone |
| N | Blows/0.3m (Std. Pen. Test, 475 j/blow) |
| Cone | Blows/0.3m (60° Cone, 475 j/blow) |
|  | WL at time of investigation Dec. 9, 1998. |

No.	ELEVATION	COORDINATES	
		NORTHING	EASTING
1	319.1	4 869 300	273 522
2	306.0	4 869 311	273 674

NOTES

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

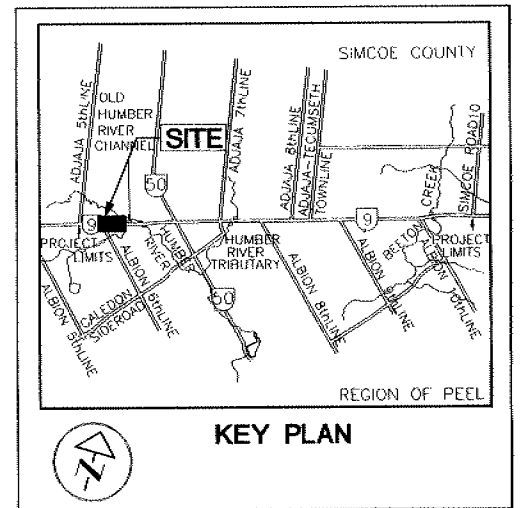
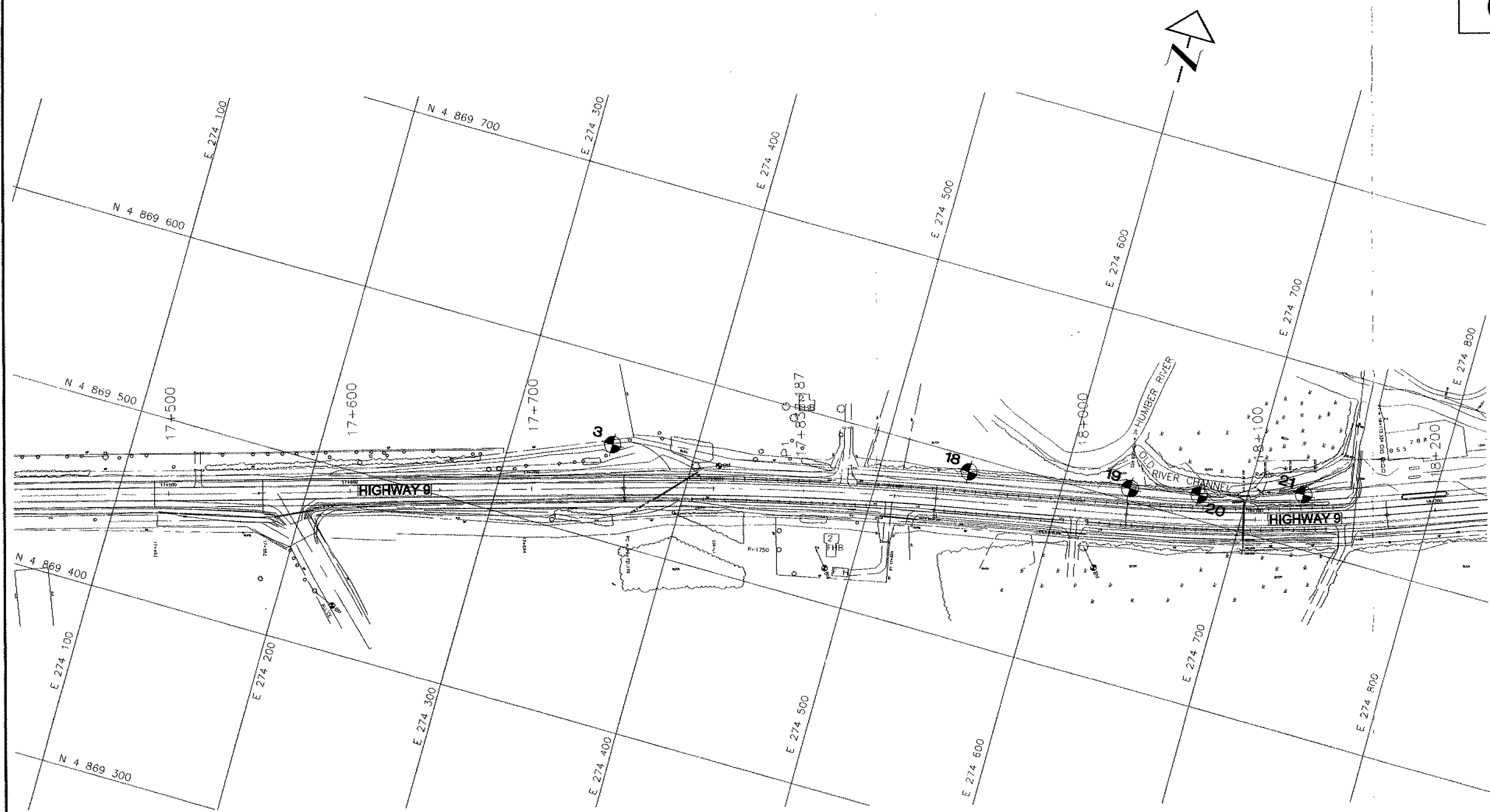
PLAN



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

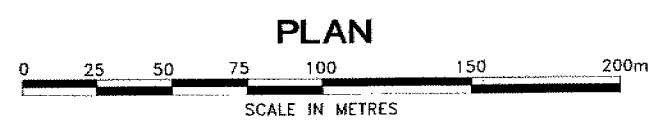
Geocres No.

HWY. 9		PROJECT NO.: 981-1168		DIST.
SUBMITTAL	CHKD: ASP	DATE: 1998 12 29	SITE	
DRAWN: JFC	CHKD: AMP	APPD.	DWG. N1168001	



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)		
	WL at time of investigation Dec. 9, 1998.		
COORDINATES			
No.	ELEVATION	NORTHING	EASTING
3	304.0	4 869 553	274 355
18	286.2	4 869 592	274 548
19	285.0	4 869 607	274 636
20	285.0	4 869 614	274 674
21	285.8	4 869 629	274 730

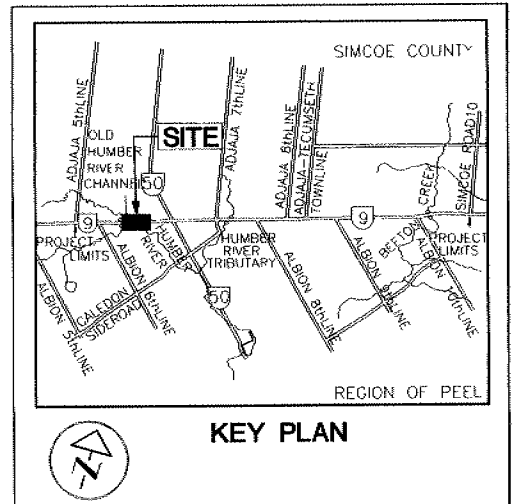
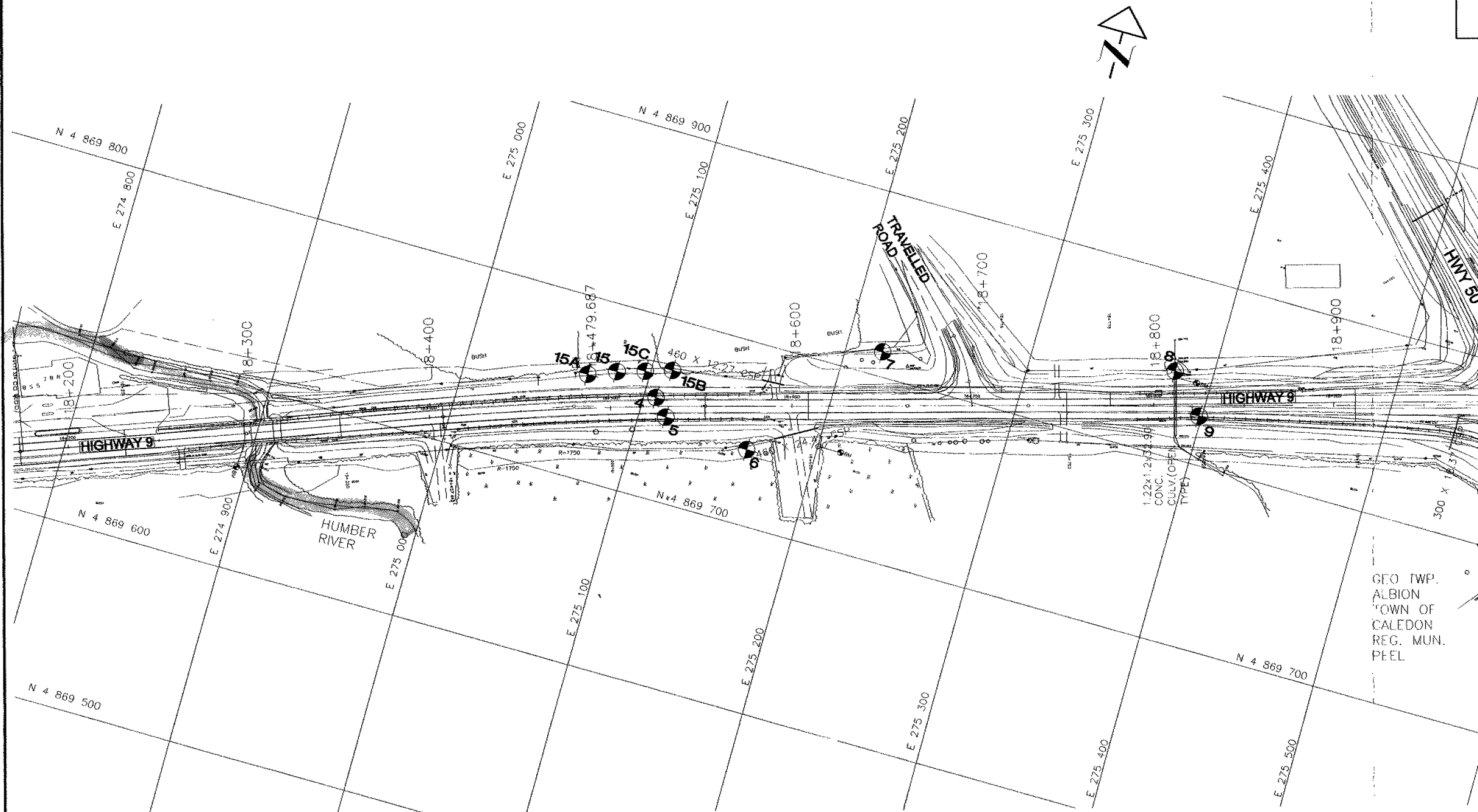
NOTES
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.






NO.	DATE	BY	REVISION

Geocres No.

HWY. 9	PROJECT NO.: 981-1168	DIST.
SUBM'D. AMP	CHKD: ASP	DATE: 1998 12 29
DRAWN: JFC	CHKD: AMP	APPD.
		DWG. N1168002



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)		
WL	WL at time of investigation Dec. 9, 1998.		
No.	ELEVATION	COORDINATES	
		NORTHING	EASTING
4	289.8	4 869 755	275 107
5	289.8	4 869 746	275 115
6	284.0	4 869 741	275 163
7	301.0	4 869 814	275 220
8	294.2	4 869 847	275 379
9	297.5	4 869 826	275 399
15	284.2	4 869 763	275 082
15A	284.0	4 869 758	275 067
15B	285.0	4 869 772	275 111
15C	284.8	4 869 768	275 097

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



NO.	DATE	BY	REVISION

Geocres No.

HWY. 9	PROJECT NO.: 981-1168	DIST.
SUBM'D. AMP	CHKD: ASP	DATE: 1998 12 29
DRAWN: JFC	CHKD: AMP	APPD.

DWG. N1168003

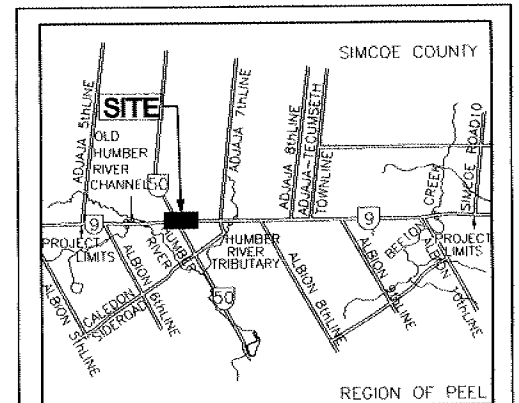


HIGHWAY 9
Sta. 17+309.992 to Sta. 17 +900
BORE HOLE LOCATIONS

SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

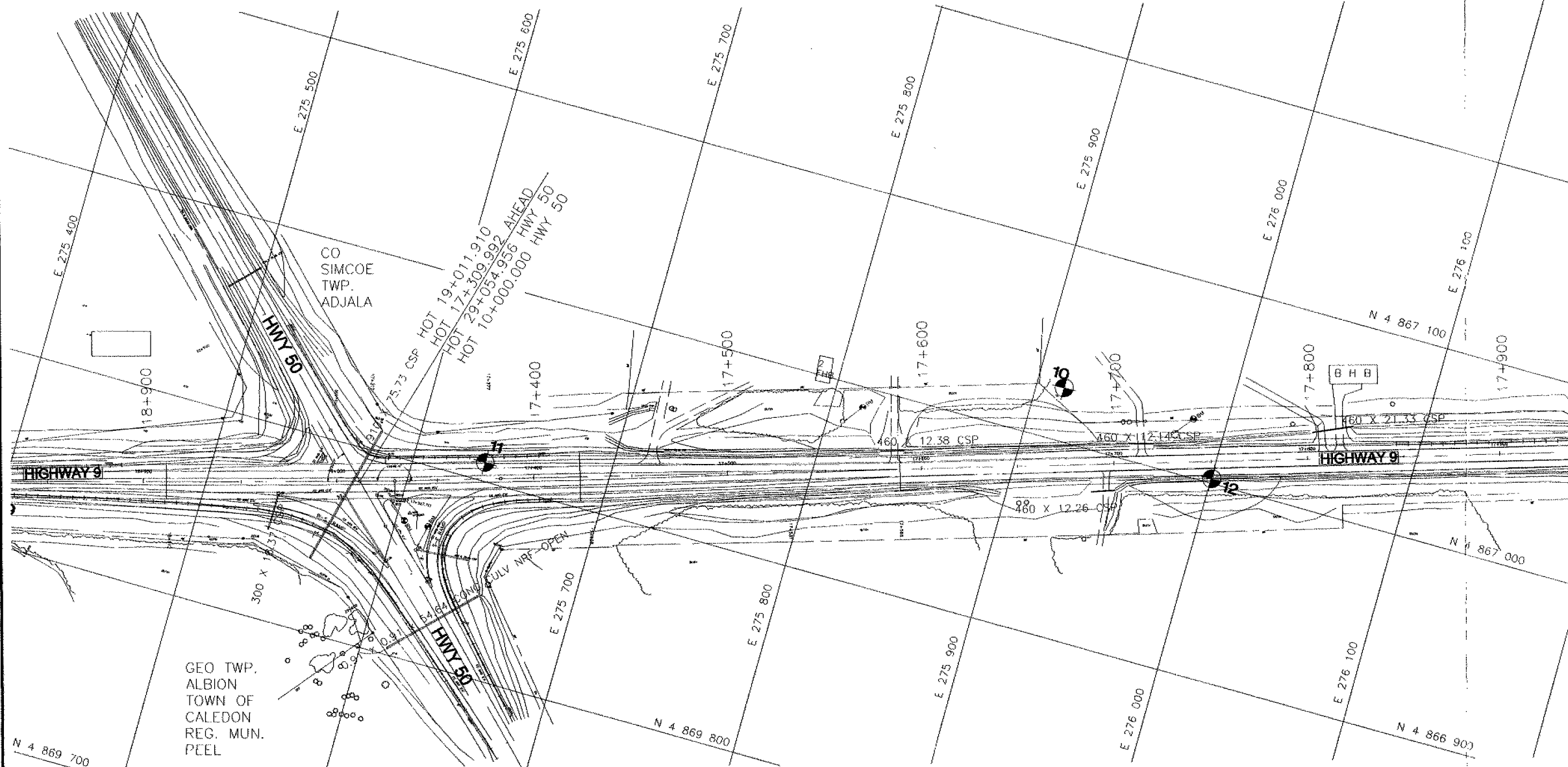
LEGEND

- 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)
- WL at time of investigation Dec. 9, 1998.

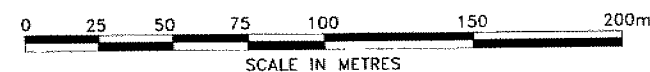
No.	ELEVATION	COORDINATES	
		NORTHING	EASTING
10	316.8	4 870 027	275 914
11	304.0	4 869 910	275 637
12	308.2	4 870 002	276 000

NOTES

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



PLAN



SCALE IN METRES

NO.	DATE	BY	REVISION

Geocres No.

HWY. 9	PROJECT NO.: 981-1158	DIST.
SUBM'D. AMP	CHKD: ASP	DATE: 1998 12 29
DRAWN: JFC	CHKD. AMP	APPD.
		DWG. N1168004

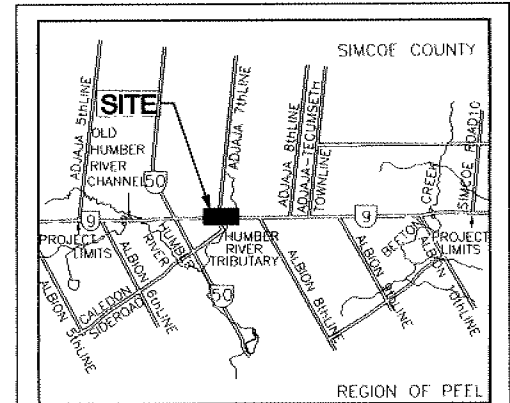


HIGHWAY 9
Sta. 17+900 to Sta. 18+400
BORE HOLE LOCATIONS

SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

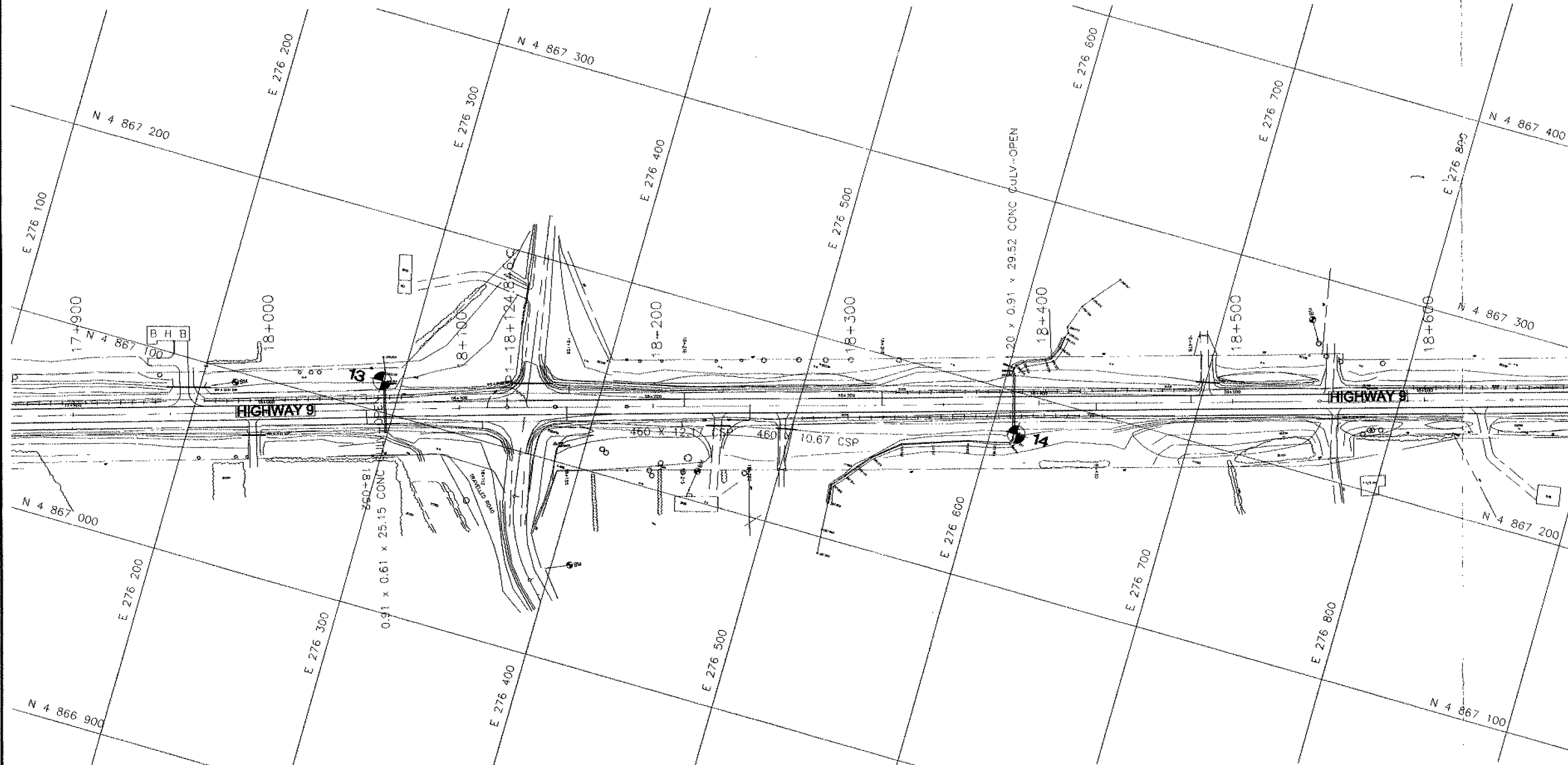
LEGEND

- 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)
- WL at time of investigation Dec. 9, 1998.

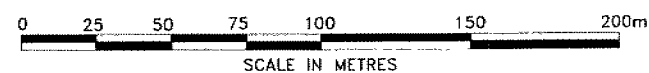
No.	ELEVATION	COORDINATES	
		NORTHING	EASTING
13	294.6	4 870 116	276 290
14	288.9	4 870 179	276 613

NOTES

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



PLAN



SCALE IN METRES

NO.	DATE	BY	REVISION

Geocres No.

HWY. 9	PROJECT NO.: 981-1168	DIST.
SUBM'D. AMP	CHKD: ASP	DATE: 1998 12 29
DRAWN: JFC	CHKD. AMP	APPD.
		DWG. N1168005

Bennett, Betty (MTO)

From: Lacroix, Wayne (MTO)
Sent: Tuesday, October 03, 2000 8:51 AM
To: Bennett, Betty (MTO)
Subject: RE: Contract 2000-0047: Hwy 9 - Proposal for Retaining Wall west of Humber River

Thanks Betty, for the quick response.
Wayne.

-----Original Message-----

From: Bennett, Betty (MTO)
Sent: Monday, October 02, 2000 04:39 PM
To: Lacroix, Wayne (MTO)
Cc: MacLean, Robert (MTO)
Subject: Contract 2000-0047: Hwy 9 - Proposal for Retaining Wall west of Humber River

Wayne,

The drawings from Tensar dated September 29 have been reviewed.

Because of the uncertainty associated with the amount of disturbance created by removing the pile sheeting, it is Tensar's preference to pull the sheeting prior to completing the wall construction. There is greater risk to the performance of the wall if it is fully constructed when the pile sheeting is removed. From our perspective, it would be acceptable to proceed as indicated in their drawings.

As you explained this morning, there may be an environmental restriction that will prevent the Contractor from being permitted to remove the sheeting until next summer. If this is the case, then Tensar could be instructed to construct the wall to completion with the sheet piles in place. Under this scenario, MTO would be required to take responsibility for the wall performance at the time the sheeting is removed.

A couple of comments regarding the notes on page 2 of Tensar's drawings:

Items 1 and 3 refer to a geotechnical engineer to confirm soil parameters and bearing capacity. For an RSS wall, the geotechnical parameters selected are the responsibility of the RSS company based on the Foundation Investigation Report prepared for the retaining wall. Those items should be removed.

Betty

Betty

Sept 29/80

Please see attached
design for RSS wall
on Hwy 9 west of
Humber River on Contract 00-47.

Please call Wayne Jansix
to discuss at 905-939
-7489. Of interest,
is their direction to remove
sheet piling after wall is
2 blocks high to avoid
disturbance after wall is
constructed. Comments?
Please call Wayne on Monday.
Not Mr. Dean.

- 1) INSTALL WALL TO TOP OF 2:1 SLOPE LEVEL
- 2) INSTALL 2:1 SLOPE
- 3) REMOVE STEEL SHEET PILES
- 4) INSTALL REMAINDER OF WALL



FOR CONSTRUCTION 2.

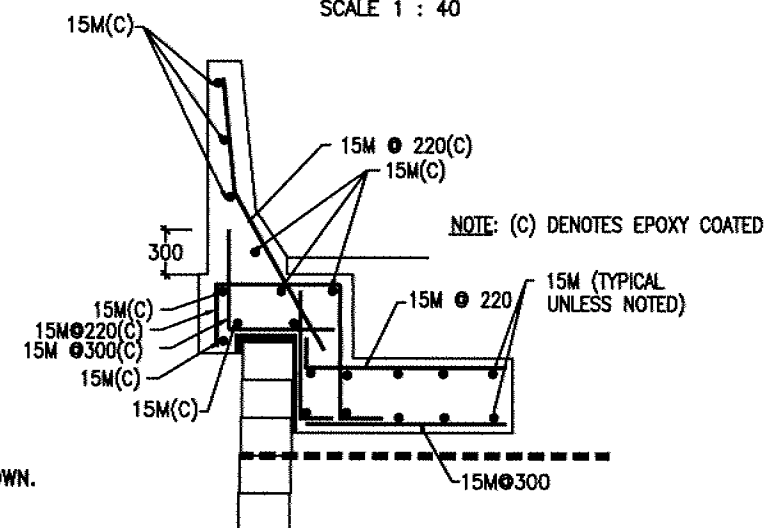
1. BARRIER WALL MATERIAL SPECIFICATIONS:

CONCRETE: 30MPa TO OHBDC.
REINFORCING STEEL: 400MPa TO OHBDC, EPOXY COATED WHERE SHOWN.
COVER TO REINFORCING STEEL: TO OHBDC.
SPACING OF CONTROL JOINTS: 6.0m MAX.
SPACING OF EXPANSION JOINTS: 30.0m MAX.
FOR CONSTRUCTION JOINT DETAILS AND BARRIER WALL TYPES SEE
RETAINING WALL GENERAL ARRANGEMENT DRAWINGS.

2. PROVIDE FIBREBOARD, 12mm THICK, BETWEEN WALL SYSTEM AND ADJACENT STRUCTURES. SECURELY FASTEN FIBREBOARD TO ADJACENT STRUCTURES.



SCALE 1 : 40



BARRIER WALL - REINFORCING

SCALE 1 : 40

RECEIVED
Sept. 29/80
CS

THIS DESIGN IS BASED UPON SPECIFIC PROPERTIES OF TENSKAR PRODUCTS (GEORGES, DRAMAGE COMPOSITES AND EROSION MEDIA), WHICH ARE PROPRIETARY TO THE TENSKAR CORPORATION 1210 CITIZENS PARKWAY, MORRISON CO. 56060. ANY SUBSTITUTION OF THE SPECIFIED PRODUCTS WILL INVALIDATE THIS DESIGN. THIS DRAWING IS BEING FURNISHED FOR USE ON THIS SPECIFIC PROJECT ONLY. ANY PARTY ACCEPTING THIS DOCUMENT DOES SO IN CONFIDENCE AND AGREES THAT IT SHALL NOT BE DUPLICATED WHOLE OR IN PART, NOR DISCLOSED TO OTHERS, WITHOUT THE CONSENT OF TENSKAR DRAIN TECHNOLOGIES, INC.

COPYRIGHT 1995, TENSAR EARTH TECHNOLOGIES, INC.



Earth Technologies, Inc.
5775-B GLENRIDGE DRIVE
LAKESIDE CENTER, SUITE 450
ATLANTA, GEORGIA 30328
Tel. (404) 250-1290

terrafix
geosynthetics inc.

425 Attwell Drive
Rexdale, Ontario
M9W 5C4
Tel:(416) 674-0363

REVISIONS \ ISSUE

0	05/29/00	ISSUED FOR BID
1	07/13/00	ISSUED FOR CONSTRUCTION
2	09/27/00	FOUNDATION DETAIL REVISED—ISSUED FOR CONSTRUCTION

Project No. _____

2000-0521

Date Drawn: _____
 by: *10/10/10*

05/25/00

AS SHOWN

Designed by

RAH

Down by
FALL

RAH

MINISTRY OF TRANSPORTATION, ONTARIO
HWY9-FROM 3km EAST OF ALBION 5th LINE

ALBION

ONTARIO

**MESA RETAINING WALL SYSTEM
TYPICAL SECTION AND BARRIER WALL DETAILS**

Sheet Number

1 OF 3



0 HORIZONTAL 5 = 1 : 250
0 VERTICAL 2.5 = 1 : 125

LEGEND

- | | |
|---------|--|
| □ | MESA UNIT |
| ----- | PROPOSED GRADE |
| ---+--- | CHANGE IN EMBEDMENT LENGTH,
GRADE, OR GEOGRID TERMINATION |
| ----- | TENSAR TYPE UXMESA3 GEOGRID |
| ----- | TENSAR TYPE UXMESA4 GEOGRID |

FOR BARRIER WALL DETAILS SEE DWG. NO. 1

NOTES

ELEVATION STA.18+470 TO STA.18+530
(ELEVATION AT BACK OF WALL)

1. THE SOIL PARAMETERS WERE ASSUMED.
GEOTECHNICAL ENGINEER TO CONFIRM ALL SOIL PARAMETERS IN WRITING TO TERRAFX
GEOSYNTHETICS INC. PRIOR TO COMMENCEMENT OF WALL SYSTEM.

	UNIT WT.	COHESION	FRICTION	ANGLE
REINFORCED SOIL-GRANULAR 'B'	22	0	35	
RETAINED SOIL-EMBANKMENT FILL	20	0	30	
ORGANIC SILT	12.5	0	25	
FOUNDATION SOIL-2" CLEAR STONE	22	0	35	
FOUNDATION BASE-SAND AND GRAVEL	22	0	32	

MINIMUM REQUIRED ALLOWABLE BEARING PRESSURE = 125 kPa

INTERNAL AND EXTERNAL STABILITY OF STRUCTURE:
TO FHWA-SA-96-071

2. DRAINAGE AND GLOBAL STABILITY DESIGN ARE THE RESPONSIBILITIES OF OTHERS.
3. GEOTECHNICAL ENGINEER TO CONFIRM BEARING CAPACITY IN WRITING, PRIOR TO COMMENCEMENT OF CONSTRUCTION OF WALL SYSTEM.
4. STATIONS ARE APPROXIMATE. FOR ACCURATE SETTING OUT DETAILS REFER TO CONSULTING ENGINEER'S DRAWINGS.
5. FOR DETAILS OF CONSTRUCTION PROCEDURE SEE SPECIAL PROVISIONS
6. WHERE LAYERS OF PRIMARY GEOGRID REINFORCING OVERLAP PROVIDE A VERTICAL SPACE OF 75mm BETWEEN THE LAYERS.
7. VEHICLE DESIGN LOADS ON WALL:
VERTICAL LOAD: 12kPa AT TOP OF WALL
8. ITEMS SUPPLIED BY TERRAFIX GEOSYNTHETICS INC.:
 - i) MESA BLOCKS AND CONNECTORS.
 - ii) GEOGRIDS AND SPLICING BODKINS.
 - iii) GEOTEXTILE BEHIND WALL FACE.ALL OTHER MATERIALS ARE SUPPLIED BY OTHERS

HM79-ALBION5th 1

THIS DESIGN IS BASED UPON SPECIFIC PROPERTIES OF TEGSAN PRODUCTS (GEOSOLIDS, DRAINAGE COMPOSITES AND EROSION MEDIA), WHICH ARE PROPRIETARY TO THE TEGSAN CORPORATION 1210 CITIZENS PARKWAY, MORRISTOWN, NJ 07960. ANY SUBSTITUTION OF THE SPECIFIED PRODUCTS WILL INVALIDATE THIS DESIGN. THIS DRAWING IS BEING FURNISHED FOR USE ON THIS SPECIFIC PROJECT ONLY. ANY PARTY ACCEPTING THIS DOCUMENT DOES SO IN CONFIDENCE AND AGREES THAT IT SHALL NOT BE DUPLICATED WHOLE OR IN PART, NOR DISCLOSED TO OTHERS, WITHOUT THE CONSENT OF TEGSAN EARTH TECHNOLOGIES, INC.

COPYRIGHT 1995, TENSAR EARTH TECHNOLOGIES, INC.



Earth Technologies, Inc.
5775-B GLENRIDGE DRIVE
LAKESIDE CENTER, SUITE 450
ATLANTA, GEORGIA 30328
Tel. (404) 250-1290

terrafix
geosynthetics inc.

425 Attwell Drive
Rexdale, Ontario
M9W 5C4
Tel:(416) 674-0363

REVISIONS \ ISSUE		
0	05/29/00	ISSUED FOR BID
1	07/13/00	ISSUED FOR CONSTRUCTION
1	08/27/00	SOIL PARAMETERS REVISED-ISSUED FOR CONSTRUCTION

Project No.	2000-0521
Date Drawn	05/25/00
Scale	AS SHOWN
Designed by	RAH
Drawn by	RAH
Checked by	JFK

MINISTRY OF TRANSPORTATION, ONTARIO
HWY9-FROM 3km EAST OF ALBION 5th LINE

ALHION

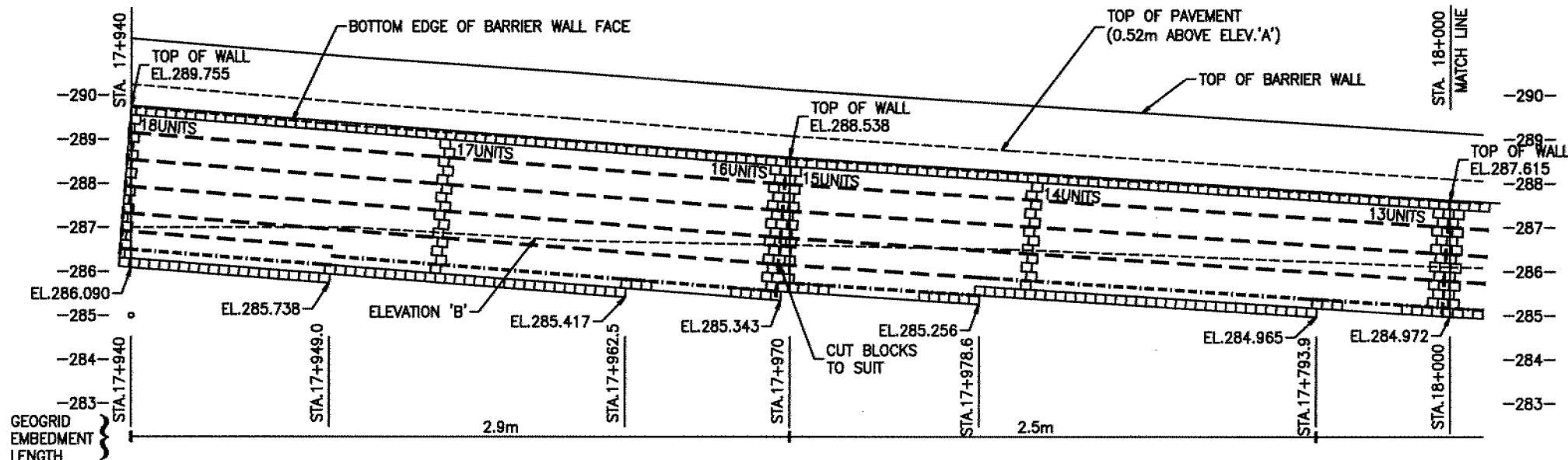
ONTARIO

**MESA RETAINING WALL SYSTEM
ELEVATION STA.18+470 TO 18+530**

Sheet Number

2 OF 3

RECEIVED



**FOR
CONSTRUCTION**



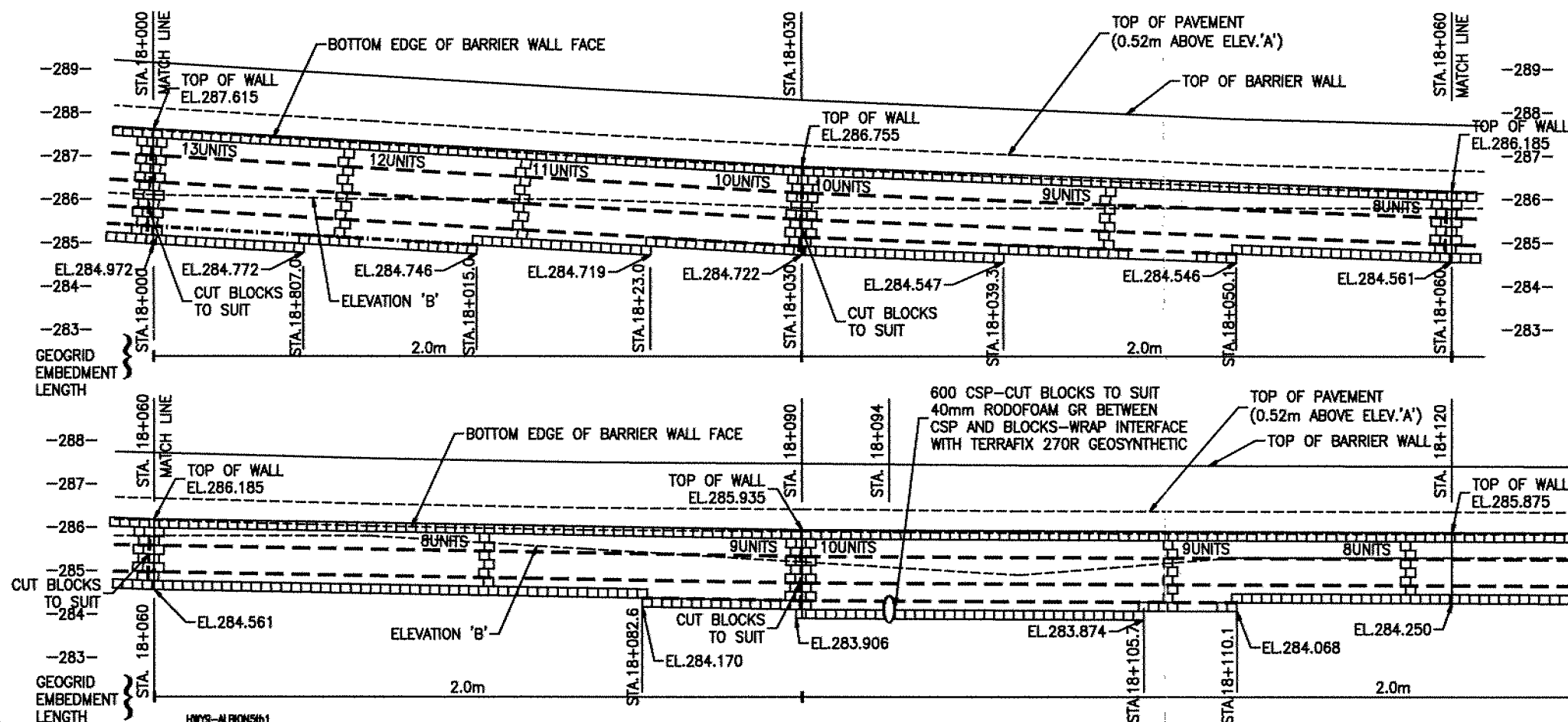
FOR NOTES SEE DWG. NO. 1 AND NO.2

0 HORIZONTAL 5 = 1 : 250
0 VERTICAL 2.5 = 1 : 125

LEGEND

- MESA UNIT
- PROPOSED GRADE
- CHANGE IN EMBEDMENT LENGTH, GRADE OR GEOGRID TERMINATION
- TENSAR TYPE UXMESA3 GEOGRID
- TENSAR TYPE UXMESA4 GEOGRID

**ELEVATION STA.17+940 TO STA.18+140
(ELEVATION AT BACK OF WALL)**



RECEIVED

THIS DESIGN IS BASED UPON SPECIFIC PROPERTIES OF TENSAR PRODUCTS (GEOGRIDS, DRAINAGE COMPOSITES AND GEOTEXTILES) WHICH ARE PROPRIETARY TO THE TENSAR CORPORATION 1210 COLUMBIA PARKWAY, MARIETTA, GA 30067. ANY SUBSTITUTION OF THE SPECIFIED PRODUCTS WILL INVALIDATE THIS DESIGN. THIS DRAWING IS BEING FURNISHED FOR USE ON THIS SPECIFIC PROJECT ONLY. ANY PARTY ACCEPTING THIS DOCUMENT DOES SO IN CONFIDENCE AND AGREES THAT IT SHALL NOT BE REPRODUCED, COPIED OR IN PART, NOR DISCLOSED TO OTHERS, WITHOUT THE CONSENT OF TENSAR EARTH TECHNOLOGIES, INC.

COPYRIGHT 1994, TENSAR EARTH TECHNOLOGIES, INC.

Tensar
Earth Technologies, Inc.
5775-B GLENRIDGE DRIVE
LAKESIDE CENTER, SUITE 450
ATLANTA, GEORGIA 30328
Tel. (404) 250-1290

terrafix
geosynthetics inc.
425 Attwell Drive
Rexdale, Ontario
M9W 5C4
Tel: (416) 674-0363

REVISIONS / ISSUE			
0	05/29/00	ISSUED FOR BID	
1	07/13/00	ISSUED FOR CONSTRUCTION	
2	08/30/00	800 CSP ADDED AT STA.18+084	

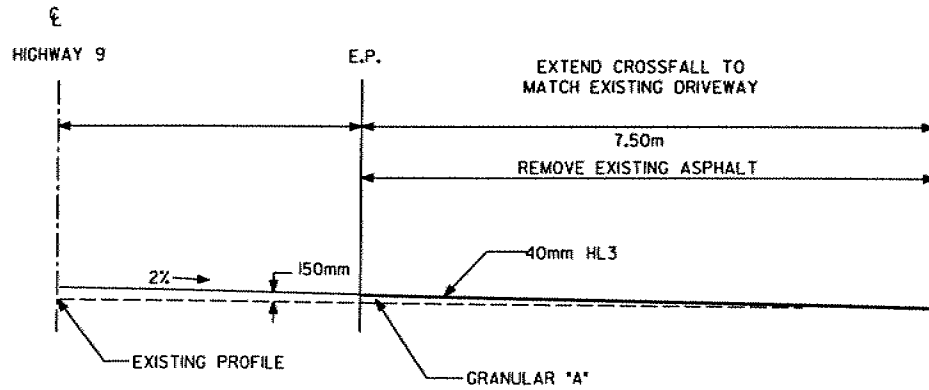
Project No.
2000-0521
Date Drawn
05/25/00
Scale
AS SHOWN
Designed by
RAH
Drawn by
RAH
Checked by
JPK

MINISTRY OF TRANSPORTATION, ONTARIO
HWY9-FROM 3km EAST OF ALBION 5th LINE
ALBION ONTARIO
MESA RETAINING WALL SYSTEM
ELEVATION STA.17+940 TO 18+000
Sheet Number
3 OF 3

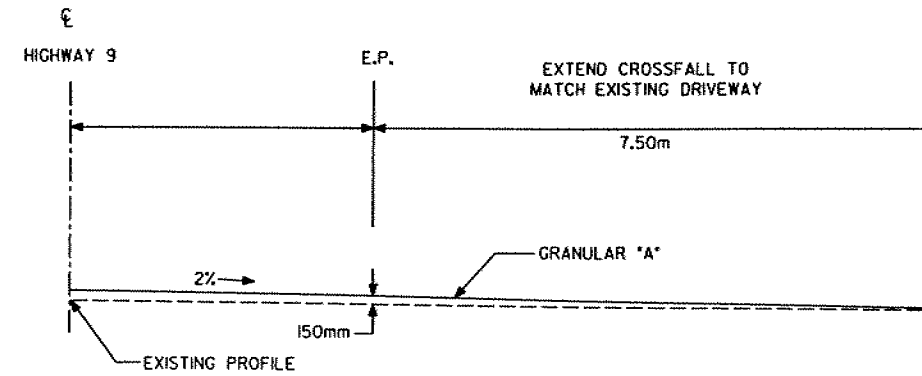
METRIC
DIMENSIONS ARE IN METRES
AND /OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No	CONT No WP No 530-91-00	SHEET 85
TYPICAL SECTIONS		

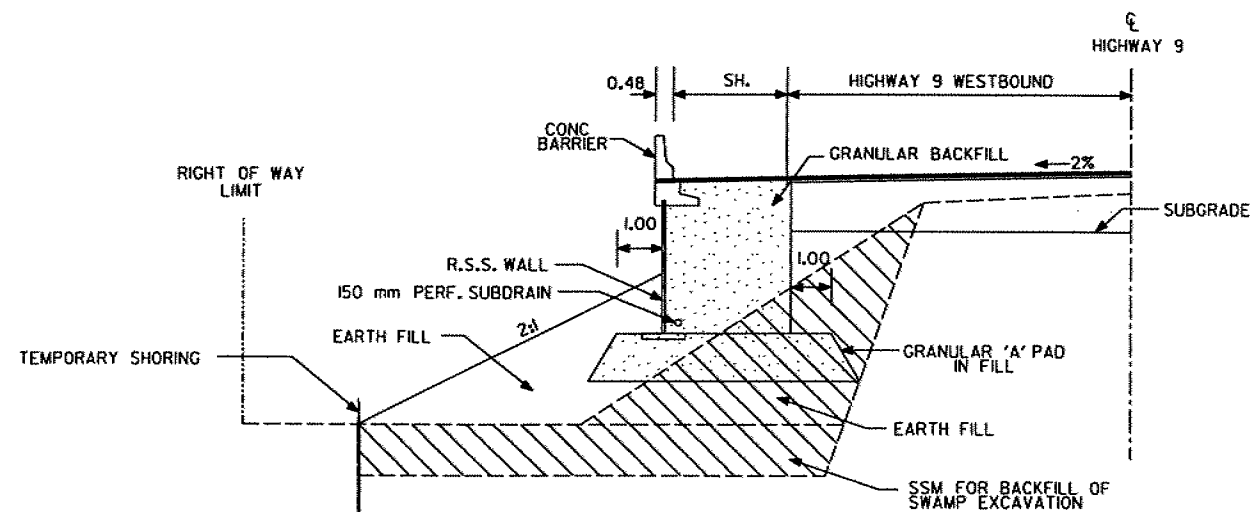
CS COLE
SHERMAN



EXISTING DRIVEWAY TREATMENT
FOR ASPHALT DRIVEWAY

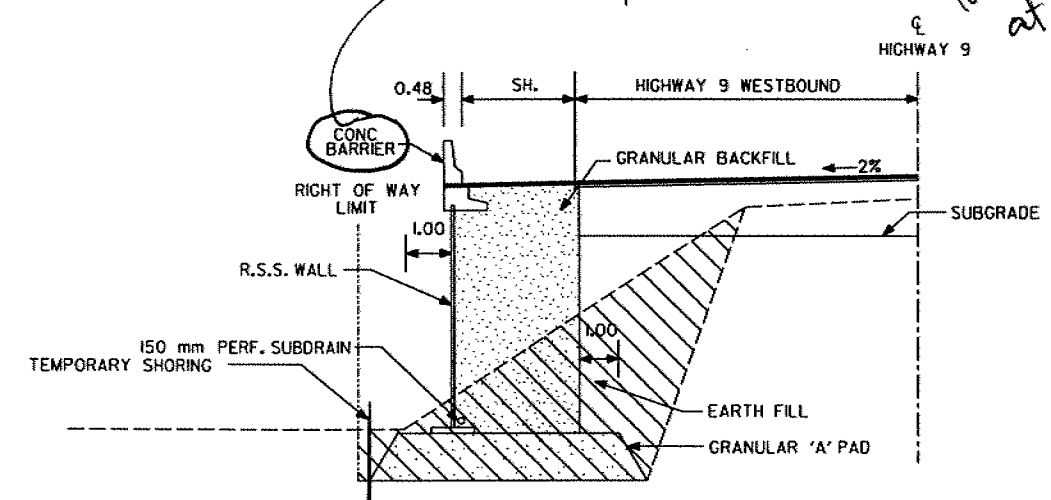


EXISTING DRIVEWAY TREATMENT
FOR GRAVEL DRIVEWAY



TYPICAL SECTION OF RETAINED SOIL SYSTEM- AT BALLY CROY

RSS 2



TYPICAL SECTION OF RETAINED SOIL SYSTEM- AT HUMBER RIVER CHANNEL

RSS 1.

N.T.S.

Requirement for Traffic Barrier
precludes. med. appearance systems.
- environmental requires
that flow of water
at base of
slope
is not blocked