

G.I.-30 SEPT. 1976

GEOCRES No. 31E-113.

DIST. 52 REGION

W.P. No. 208-90-01

CONT. No.

W. O. No.

STR. SITE No. 42-46

HWY. No. 69

LOCATION Hwy 69 & Musquash River

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 208-90-01 DIST 11
HWY 69 STR SITE 42-46

Musquash River Bridge

DISTRIBUTION

P. Furst (2)
J. McDougall
G. Todd
S. Wilson (2)
B. Farago
G.E. Greene
E.A. Joseph
D.J. Armatage (Cover Only)
F. Bacchus (Cover Only)
File

FOUNDATION INVESTIGATION REPORT
For
Musquash River Bridge
W.P. 208-90-01, Site 42-46
Highway 69, District 11, Huntsville

INTRODUCTION

This report summarizes the results of a foundation investigation which was carried out, at the above-captioned site, for a proposed three-span bridge to carry the new Highway 69 southbound lanes across the Musquash River.

This report applies to the proposed bridge structure and its immediate approaches within about 20 m of the abutments; ie. between stations 20+340 and 20+445 (approximately).

SITE DESCRIPTION

The site is located along Highway 69, at Musquash River, about 35 to 55 m to the west of the centreline of an existing bridge, between Stations 20+340 and 20+445 (approximately), within Lot 15, Concession X, Gibson Township, District of Muskoka.

Throughout this area, the existing Highway 69 consists of a roadway with single lanes, running in both the north and south directions. Through a series of rock cuts and embankments, the highway traverses undulating topography consisting of rock knolls of gneissic bedrock separated by low swampy or wooded areas. The direction of flow of the Musquash and several other rivers, in the area, indicates that drainage is generally towards the west; ie. towards Georgian Bay.

At this location, the existing Highway 69 crosses the Musquash River on a two-lane three-span bridge, which appears to be in good condition and positioned about 3 to 4 m above the river. Approaches on the north and south sides of the bridge cross swampy areas, about 370 and 300 m long, respectively. In these areas, the highway has been constructed on top of an embankment, from 4 to 6 m high.

In this area, the Musquash River is approximately 50 to 60 m wide. Its banks are generally grassed, indicating that erosion is not a significant problem, at least up to the river's edge. At the time of our investigation, the river was found to be a maximum of about 3 to 4 m deep. However, the elevation of the river is known to vary greatly and in March 1991, it appears to have been about 2.4 m higher than in June 1992 when our investigation was carried out. We understand that some of the fluctuations in the elevation of the river are being controlled by the Big Eddy Dam, which is operated by Ontario Hydro and located upstream of the bridge.

PROCEDURES

The fieldwork, was carried out between June 9 and 30, 1992. Four boreholes (Boreholes 1 to 4), were advanced to depths of 15.1 to 20.9 m. In order to prove bedrock, three of the boreholes were extended by coring to depths of 16.8 to 22.6 m, using conventional diamond drilling (BXL) techniques.

The boreholes were advanced by casing and wash boring, using a diamond drilling machine, placed on top of a small, anchored raft.

Two other probings (Boreholes 5 and 6) were advanced by casing and wash boring, in the abutment areas (ie. on land), using the same diamond drilling apparatus. The information, from these probings, was used to supplement boreholes, which were previously drilled, in the abutment and approach areas, under Reference No. W.P. 215-89-00(C).

Soil samples were recovered using a 50 mm OD split spoon sampler, driven into the soil in accordance with the specifications of the Standard Penetration Test (ASTM D 1586). Field vane tests were also carried out wherever soft to firm cohesive soils were encountered in the boreholes. Dynamic cone penetration tests were carried out adjacent to all but one (ie. Borehole 6) of the sampled boreholes.

The locations of the boreholes which were completed by raft-mounted equipment, were determined by our field representative, using stakes which were placed on the banks of the river, by the Northern Region Surveys and Plans Office.

During the investigation, the river level experienced relatively large fluctuations (about 1 metre). The fluctuations were constantly monitored by referencing them to stakes, (with the elevation of the water level marked on them) which were placed in the river by the Surveys and Plans Office. At each location, the borehole information, was adjusted to a mean river level elevation.

The soil samples, which were obtained in the field, were examined in the laboratory, by visual and tactile methods. Moisture content, Atterberg Limits and grain size distribution tests were conducted on several selected soil samples. Two consolidation tests were also carried out on samples obtained from this zone, which were used to supplement another consolidation test, which was carried out, during the previous investigation. The results of all of the laboratory testing are shown on Figures 1 to 3.

SUBSURFACE CONDITIONS

Beneath standing water, up to 3.6 m deep, the stratigraphy generally consists of an upper discontinuous layer (up to 2.2 m thick) of sandy silt to sand and silt overlying a deposit of silty clay to clay, up to 2.5 m thick. The clay, in turn, overlies a major cohesionless deposit consisting of upper and lower zones of sand and silt to silty fine sand and fine to medium (occasionally gravelly) sand, respectively.

Details of the soil and groundwater conditions, at Boreholes 1 to 6, are shown on the borehole log sheets, appended at back of this report. This information is supplemented by Boreholes 3-8 and 3-9 and Boreholes 3-6, 3-7, 3-10 and 3-11, which were, respectively, drilled in the abutment and approach areas, under Reference No. W.P. 215-89-00(C). The logs, for these previous boreholes, have been included in Appendix 2.

The locations of the boreholes, drilled in abutment and pier locations, along with stratigraphical profiles, based on this data, are shown on Drawing No. 2089001A. The following paragraphs summarize the stratigraphy.

Water

Where Boreholes 1 to 4 were drilled, the mean depth of the river, ranged from 1.5 to 3.6 m. However, during the investigation, the elevation of the river fluctuated by about one metre (ie. between elevations of 194.1 to 195.1 m), due to the Big Eddy Dam, which was located upstream of the existing bridge.

It also appears that, at the time of the investigation, the river was relatively low, since a much higher elevation (ie. 197.8 m) was recorded, in March 1991.

Sand and Silt to Silty Sand (Upper Cohesionless Deposit)

Boreholes 1 and 2, contacted a layer of grey, sand and silt to silty sand, from 0.6 to 2.2 m thick, in the bed of the river. Similar material was found at the surface at Borehole 3-9, from the previous investigation (Ref. No. W.P. 215-89-00(C)). This cohesionless, fluvial deposit, was found to contain occasional organics consisting of root fibres, small pieces of wood, stem and other plant material.

Two samples, obtained from this deposit, had moisture contents of 26 and 54 percent.

Penetration resistances or 'N'-values, which were found to be less than 3 blows/0.3 m, indicate generally loose conditions, in these soils.

Silty Clay to Clay

Beneath the upper sand and silt to silty sand, at Boreholes 1 and 2, and in the bed of the river at Boreholes 3 and 4, a soft, grey, silty clay to clay, from 0.9 to 2.5 m thick, was encountered.

Some typical properties of this soil, as determined by laboratory testing on several representative samples, are as follows:

<u>Property</u>	<u>Range</u>	<u>Average</u>
Moisture Content (%)	40-71	60
Liquid Limit (%)	46-64	55
Plastic Limit (%)	17-24	21
Unit Weight (kN/m	15.4-17.7	16.6

The results of the Atterberg Limits tests, which have been plotted on Figure 1, indicate that this soil can be classified as a silty clay to clay.

'N'-values, which were measured in this deposit, were found to be generally less than 2 blows/0.3 m. In some instances, 0 blows/0.3 m were recorded, meaning that the sampler and rods simply sank under their own self weight.

Vane shear strength tests, which were carried out, during this and the previous investigation (Ref. No. W.P. 215-89-00(C)), were found to range from 12 to 50 kPa but averaged about 17 kPa (ie. if both the highest and lowest values are neglected).

Two consolidation tests, were carried out on samples obtained, during this investigation. The results of these tests, along with one other test, which was carried out during the previous investigation (ie. W.P. 215-89-00(C)), are presented on Figure 2.

The preconsolidation pressures, from all three tests, ranged from 92 to 95 KPa, which is somewhat more than the overburden pressure, indicating that the clay has been slightly preconsolidated.

The two tests, carried out on samples obtained from the south side of the river, both gave initial void ratios of 1.44 and compression indices of 0.96 and 0.98, respectively. However, a test carried out on a sample, obtained from the clay encountered on the north side of the river (ie. BH6-Sample 1, also shown on Figure 2), gave an initial void ratio of 1.1 and compression index of 0.53, indicating slightly better compressibility characteristics.

Silt to Medium Sand (Lower Cohesionless Deposit)

Beneath the clay to clayey silt layer described above, Boreholes 1 to 4 contacted a major deposit of sandy silt to medium sand, from 10.2 to 13.8 m thick, at depths of 4.8 to 5.8 m (or elevations of 188.9 to 189.4 m).

Grain size distribution tests, which are shown on Figure 3, indicate that the soils, from this deposit, have from 5 to 90 percent silt, 0 to 5 percent clay, 5 to 95 percent sand-sized (and, in one sample, up to 30 percent gravel-sized) particles. These results, as well as visual and tactile examination of all of the soil samples obtained, indicate that this deposit of cohesionless soils may be generally subdivided into an upper capping of silt to silty sand which is, in turn, underlain by a coarser fine to medium sand.

In addition, at Boreholes 3, 4 and 6, the deposit may be further subdivided where the soil, becomes much more gravelly, in close proximity to the bedrock surface. It should be noted, that, in this area, occasional boulders were encountered (particularly at Borehole 3).

Moisture contents, measured in several soil samples obtained from this deposit, ranged from 7 to 44 (average of 22) percent.

Penetration resistances ranging from 0 blows/0.3 m (ie. the rods and sampler simply sank under their own self-weight) to up to 462 blows/0.3 m, indicate that these soils are generally loose but can become dense to very dense, close to the bedrock surface.

Gneissic Bedrock

Boreholes 1 to 6 reached bedrock (or where coring was not carried out, the assumed bedrock surface) at depths ranging from 15.1 to 20.9 m, or elevations of 173.9 to 178.5 m. Using information obtained from the previous investigation (Ref. No. W.P. 215-89-00), it appears that the undulating, bedrock surface generally slopes down towards the north, from approximately Station 20+320 to Station 20+420. North of Station 20+420, the bedrock surface begins to rapidly rise once again.

The bedrock consists of a greyish black to very light grey, medium to coarse-grained, unweathered to slightly weathered, biotite-hornblende gneiss. Tactile examination of the core samples obtained indicates that this rock can be considered strong. Additional details of the bedrock core samples obtained are included in Appendix 1 entitled "Rock Core Description".

Groundwater Conditions

The groundwater table, is extensively controlled by the level of Musquash River which constantly fluctuates due to an upstream hydro dam. At the time of the investigation, the river level fluctuated between elevations of 194.1 to 195.1 m, although elevations of at least 197.8 m were recorded in March 1991.

At Boreholes 5 and 6, which were drilled on the abutments, the groundwater table ranged from an elevation of 195.5 to 195.8 m.

In any case, the groundwater table is subject to daily fluctuations as well as the normal rise in elevation which occurs during the spring freshet and during and immediately following any periods of prolonged heavy rainfall.

DISCUSSIONS and RECOMMENDATIONS

General

Highway 69 currently crosses the Musquash River over a two-lane, three-span bridge, which is about 35 years old. The south pier and abutment of the existing bridge have been founded on spread footings placed directly on bedrock. However, the north pier and abutment have been founded on steel tube piles, approximately 0.4 m in diameter. There appear to be no obvious problems with the existing bridge. It should be noted, however, that at the location of the existing bridge, bedrock was found to be at significantly shallower depth than along the alignment for the new bridge.

It is proposed to use the existing bridge, for the northbound traffic and to construct a new sub-parallel, two-lane bridge, between 35 and 55 m to the west of the existing one, in order to carry the southbound traffic across the river. The inner span of this new, three-span bridge, will be supported by piers.

At the approaches (ie. within 20 m of the north and south abutments of this new bridge), it is currently proposed to raise the grade by up to 2.5 m and 2 m, respectively. The proposed embankments, which will be located immediately to the north and south of the approaches, are discussed in our report (Ref. No. W.P. 215-89-00(C)).

Design Considerations

South Abutment and Approaches

Stability analyses were carried out for the proposed location of the south abutment. Our analyses have shown that in its present location, adequate stability cannot be obtained even if lightweight fill is used in its construction. It is therefore recommended that the south abutment be moved about 5 m further to the south.

Even if the south abutment is moved about 5 m further to the south, in order to obtain adequate stability, lightweight fill (ie. blast furnace slag) must be used within 7 m of the new south abutment location and the forward and side slopes should be constructed at 2H:1V.

As noted in our report (Ref. No. 215-89-00(C)), in order to maintain an adequate factor of safety, south of the abutment, the side slopes for the rockfill approaches must be designed at no steeper than 2H:1V and 7 m wide one-third-height berms will be required.

North Abutment and Approaches

On the north side of the river, the soil conditions were found to be slightly better. In this case, both the forward and side slopes of the abutments and approaches may be steepened to 1.5H:1V if rockfill is used in their construction. Berms will not be required on the north side.

Although the recommendations for the approaches are based on the grades, which are currently being proposed, we understand that, due to environmental constraints, the grades may need to be raised even further. Should this be the case, this office should be contacted, since the recommendations for the embankment slopes, given above, will no longer apply.

Foundations

Since the soils overlying the bedrock are quite weak, spread footings cannot be considered and the loads for the bridge will have to be supported on deep foundation units. Both piles and caissons have been considered but the selection should be based on cost.

Piled Foundations - Abutments

For piles driven to bedrock, or into gravelly sand (such as at the south end of the North Abutment ie. Borehole 6) at the abutment areas, the following design values may be assumed, in accordance with the O.H.B.D.C.:

	<u>HP 310X79</u>	<u>HP 310X110</u>
Factored Axial Capacity at U.L.S.	1150 kN	1600 kN
Axial Capacity at S.L.S. Type II	825 kN	1150 kN
Ultimate Capacity for Hiley Formula	2475 kN	3450 kN

Based on the information obtained during this and the previous investigation (W.P. 215-89-00 (C)), it appears that the piles will be founded at or below the following elevations:

	<u>North Abutment</u> <u>(m)</u>	<u>South Abutment</u> <u>(m)</u>
West End	173.5	178.5
East End	178.0	178.0

It should be noted, however, that the elevations given above, should only be considered approximate, since our investigations have shown that the elevation of the bedrock surface plunges rapidly and can change considerably over a very short distance. In addition, if the south abutment is moved 5 m to the south as recommended, the elevations of the pile tips for that abutment will be somewhat higher (ie. approximately 180 to 181.5 for the west end and 179.5 to 181 m for the east end of the south abutment).

In addition, it should also be noted that if the piles are installed immediately or slightly after the fill has been placed, the capacities given above would have to be slightly reduced due to downdrag forces. This particularly refers to the north abutment, where rockfill (ie. rather than lightweight fill) has been proposed. For instance, at the north abutment, the pile capacities would have to be reduced by 10 percent.

To minimize such reductions in pile capacity, it is recommended that the abutment areas be surcharged by 0.5 m for as long a period as possible but preferably, for at least 4 months, prior to the installation of the piles. Additional recommendations regarding surcharging etc. will be given in the section on "Settlement".

Since it is unlikely that sufficient sockets can be obtained with piles driven into strong, gneissic bedrock, only about 5 percent of the above stated values can be assumed for lateral capacity. Additional lateral capacity would have to be obtained from the lateral component of battered piles, provided the orientation of the batter is at a practical angle with the bedrock. This detail can best be assessed during the preliminary review.

Piled Foundations - Piers

The loads at the pier locations, may also be placed on piles.

For piles driven at the pier locations, similar design values and comments, as those given above for the abutments, may be assumed for piles founded on dense gravelly sand or on bedrock, at or below the following elevations:

	North Pier (m)	South Pier (m)
West End	174.5	178.5
East End	175.0	175.5

As mentioned in the previous section, the elevations given above should only be considered approximate.

At the piers, due to the depth of water and the relatively weak underlying soils, the lateral capacities can only be obtained through the lateral component of battered piles.

In addition, it should be noted that, at the south end of the proposed bridge, where gravelly sand was encountered, (ie. Boreholes 3, 4 and 6), occasional boulders may be encountered. This particularly refers to the west end of the north pier (ie. Borehole 3), where, at least one boulder was cored through.

In order to minimize or eliminate dewatering requirements, pile bent construction may be considered. In this case, once the piles are installed at the piers, it is recommended that hollow steel tubes slightly larger than the diameter of the pile be pushed into the bed of the river below the scour depth. The space between the pile and the hollow steel tube should be thoroughly cleaned of all debris and concrete tremied in to fill the annular space.

Construction of Piled Foundations

All piles should be driven to bedrock. However, if the piles should end above the bedrock surface, pile driving should be controlled by the Hiley Formula as per MTO standards SS103-10 or SS103-11 using the ultimate pile capacities referred to previously.

In order to minimize damage, all piles installed on this project, must be fitted with reinforcing plates welded to the flanges as per OPSD 3301.

At some locations, such as at the north abutment and the south pier, the piles may have a tendency to skip over the bedrock surface. In these areas slight alignment problems may arise and somewhat longer piles may be required. At worst, some of the piles may have to be replaced or added in these areas.

Oslo, or similar, rock points installed and driven in accordance with OPSD 3304 and OPSS 903, respectively, may be considered. Once the locations and orientations of the piles have been determined (ie. during the preliminary design stage), the use of such methods will be determined and recommendations will be provided by this office.

Caissons

Caissons may also be considered for this project. For caissons founded at or below the elevations given above for piles, in unweathered to slightly weathered gneissic bedrock, the following

design values for the Factored Axial Capacity at U.L.S. may be assumed in accordance with the O.H.B.D.C.:

	<u>Caisson Diameter (m)</u>		
	0.91	1.07	1.22
Factored Axial Capacity at U.L.S	8000 kN	10750 kN	14000 kN

The axial capacity at S.L.S. Type II will not govern for caissons founded on bedrock, since the loads required to produce detrimental settlement of the structure will be much larger than the recommended values for the factored capacity at U.L.S.

As noted in the section on piled foundations, at the abutments, the above-stated capacities may have to be slightly reduced, due to downdrag forces, depending upon the length of time that the surcharging of the site is allowed to occur. Without such surcharging (ie. 0.5 m of fill for at least 4 months), the capacities given above, would have to be reduced by 10 percent.

Preliminary allowable lateral capacities may be estimated using the procedures used in the design of high mast light poles and the following unfactored parameters:

Sandy Silt to Sand:	Unit Weight = 18 kN/m ³ ϕ = 30 degrees
Silty Clay to Clayey Silt:	Unit Weight = 17 kN/m ³
Piers:	qu = 20 kPa
North Abutment:	qu = 60 kPa
South Abutment:	qu = 40 kPa
Gneiss:	Unit Weight = 25 kN/m ³ qu = 20000 kPa

However, if caissons are the selected foundation option, this office can provide more details regarding allowable lateral capacities for caissons of specific diameters.

In order to gain any significant lateral capacity, caissons would likely have to be socketed a minimum of half their diameter into unweathered to slightly weathered gneiss. However, under no circumstances should the socket be less than 0.3 m at any point around the circumference of the caisson.

It should be noted that where the rock surface dips rapidly (such as at the north abutment and the south pier), it may be difficult to provide a suitable socket. If socketing to a sufficient depth is not feasible, then depending upon the desired lateral resistance, the caissons may also have to be dowelled-in.

It should be recognized that caissons will be difficult to install since they will have to penetrate a significant depth of loose sand, below the groundwater table. Groundwater infiltration may have to be controlled by using drilling mud or other techniques. The base of all caissons must be inspected immediately prior to pouring. A NSSP will be provided by the Foundation Design Section for caisson construction, if caissons are selected as the desired foundation option.

Backfill Against Abutments

Free-draining granular fill or rockfill, with the following properties may be used against the north abutment walls to prevent the buildup of hydrostatic pressures behind them, in accordance with the O.H.B.D.C.:

	<u>Granular 'A'</u>	<u>Granular 'B'</u>	<u>Rockfill</u>
Angle of Internal Friction (ϕ)	35	30	35
Unit Weight (kN/m^3)	22.8	21.2	18.0
Coeff. of Active Earth Pressure (K_a)	0.27	0.33	0.27
Coeff. of Earth Pressure at Rest (K_o)	0.43	0.5	0.43

Behind the south abutment walls, lightweight fill (ie. blast furnace slag) should be used, as long as it is free draining. A non-standard special provision should be provided for the grain size distribution and the placement and compaction of lightweight fill.

The angle of internal friction given above for Granular 'A' may be used for lightweight fill, although, a unit weight of 11.5 kN/m^3 should be assumed.

For abutments founded on caissons and any structural walls attached to them, the coefficient of earth pressure at-rest must be assumed. However, for abutments placed on piles, the coefficient of active earth pressure may be used.

For retaining structures other than the abutments, retained soil system walls can be considered.

Frost Protection

For pile caps, frost protection should consist of a minimum of 2.0 m of earth cover or equivalent insulation.

Alternatively, at the piers, the pile caps may be brought up to the underside of the bridge deck. Such construction would be required to avoid cofferdams.

Construction Considerations and Settlements

Piles

The settlements of piles or caissons founded on bedrock, will be negligible. The settlements of piles founded within gravelly sand (such as at the south end of the North Abutment where a rather extensive deposit was encountered - ie. Borehole 6), are also expected to be negligible.

Abutments and Approaches

Consolidation tests were carried out on soil samples obtained from the silty clay to clay deposit on both sides of the river. Based on these results as well as estimates of the compression of the cohesionless deposit underlying the clay, the total settlement of the abutments and approaches on the north and south sides of the river, may be expected to be up to about 0.2 m and 0.5 m, respectively.

It should be noted, that a portion of this settlement will be due to compression of the underlying cohesionless deposit. Therefore, some of this settlement will take place, during the construction period.

However, the bulk of the settlement will take place due to consolidation of the underlying silty clay to clayey silt. Therefore, under the plan limits of the embankments, ie. in the abutments and approach areas within 20 m behind the abutments, it is recommended that all of the existing peat and other unsuitable soils must be stripped throughout the full-width of the proposed abutment, approach areas and under the areas for the forward slopes down to an elevation of 194.5 m.

Where is
peat or
drainage?

Most of the material may be replaced by rockfill. However, within 7 m behind the new south abutment location, the material must be replaced by lightweight fill, in order to maintain stability. In any case, wherever piles are to be installed, the maximum particle size for rockfill or other fill materials should be limited to 75 mm. The material may be end-dumped below the groundwater table.

At the north abutment, if lightweight fill is used, it will also help to reduce the downdrag forces acting on the piles or caissons. For instance, if the organic materials and soft underlying clay is excavated down to elevation 194.5 and lightweight fill is also used to replace the excavated material, the capacity of the piles or caissons would only need to be reduced by about 7 percent.

In order to eliminate the need to reduce the capacity of the piles or caissons, and cause most of the post construction settlements to take place, it is recommended that the approaches and abutment areas be overbuilt by 0.5 m. The settlement of these embankments should be allowed to take place for as long as possible but preferably for a period of at least four months. After that time, the embankments may be bladed off, the slopes flattened to their final grades and the piles installed.

Excavations and Dewatering

The depth of excavation and the type and extent of dewatering, at this site, will depend upon the river level elevation, at the time the excavation is carried out. As noted previously, the river is known to be subject to wide seasonal, as well as daily fluctuations.

Therefore, at excavations in the abutment areas, it would be preferable to do them when the river level is at its seasonal low. This may help to avoid sheeting and/or expensive dewatering, in these areas.

In the abutment areas, as long as the elevation of the river is below the bottom of the excavation, excavations with side slopes of 2H:1V to depths of up to 3.0 m can be carried out within the thin upper capping of sand and silt and the underlying silty clay to clay. The excavation edge closest to the river should be kept at least 2.0 m above the river level elevation, leaving a small 'dike', which separates the excavation from the river.

Under such conditions, it is anticipated that surface water and groundwater infiltration may be handled by pumping from properly filtered sumps. Should the river level rise above the bottom of the excavation, depending on the river's proximity, sheeting and/or more extensive dewatering measures may be required. However, the dewatering requirements are the responsibility of the Contractor and the Contractor's proposal should be submitted to this office for review.

For the two piers, construction techniques such as pile bents should be considered. Due to the subsurface conditions below the river bed (ie. a thin layer - as little as 2 m thick - of soft clay underlain by a loose cohesionless sand) cofferdam construction would likely be difficult and expensive. However, if any major

excavations are being proposed for this area or any other areas at the site, this office should be provided with detailed drawings of the proposed excavations, as well as the highest river level elevation, which is expected to occur, during the construction.

Erosion Protection / Scour

The forward slopes will require erosion protection at the abutments. In these areas, at least 0.6 m of rock protection (minimum size of .03 m³) should be placed to at least the elevation of the proposed high water level used in the design of the bridge. The rock protection should probably extend down the slope, along the base of the river for at least 20 m and for a distance of at least 20 m on either side of the centreline of the bridge. However, the extent of the rock protection will depend extensively on hydrological effects and the final grading and shape of the river channel beneath and either side of the bridge.

The piers must also be protected from the effects of scour and ice loading. For piles, some protection will be provided by placing steel tubes around the piles and filling them with concrete as suggested in the section on Piles. However, once the extent of scour and ice loading has been determined, the Foundation Design Section will be available for consultation with the Hydrology Section on the type and extent of protection required. In any case, this office would like to review the drawings for any suggested slope, channel or pier protection.

MISCELLANEOUS

The field investigation was supervised by R. Freymond, using equipment owned and operated by Master Soil Investigation Inc.

This report was written by J. Blair, Project Foundation Engineer, reviewed by D. Dundas, Senior Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.



John A. Blair

John A. Blair, P.Eng.
Project Foundation Engineer

M. Devata

M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
f_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kn/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kn/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kn/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kn/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $\frac{w_L - w_p}{w_p}$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kn/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m ³	SEEPAGE FORCE
γ'	kn/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 208-90-01 LOCATION N 4 986 692.4 E 282 851.1 ORIGINATED BY RF
DIST 11 HWY 69 BOREHOLE TYPE Wash Boring/Cone Test COMPILED BY RF
DATUM Geodetic DATE 92-06-22 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
194.2	Water Surface													
0.0	Water						194							
192.6	River Bottom													
1.5	Sand and Silt Traces of Wood, Stem and Root Fibres Grey Loose		1	SS	2		192						w=54	
190.5			2	SS	2									
3.7	Silty Clay to Clayey Silt, Some Sand Layers Grey, Soft		3	SS	2		190							
189.4			4	SS	1									
4.8	Slightly Cohesive		5	SS	2		188							
			6	SS	2									
	Sandy Silt to Sand		7	SS	2		186							
	Grey		8	SS	32									
	Loose to Dense		9	SS	5		184						w=44	
	Silt Layer		10	SS	8									0 5 90 5
			11	SS	5		182							
	Sandy Silt, Grey													
	Sand, Brown		12	SS	22		180							
179.1	Very Dense		13	SS	100	/25cm								0 95 (5)
15.1	Bedrock		14	RC	REC	100%								RQD 30%
	Biotite Hornblende Gneiss		15	RC	REC	100%								RQD 96%
	Unweathered to		16	RC	REC	100%								RQD 100%
177.4	Slightly Weathered		17	RC	REC	100%								RQD 100%
16.8	End of Borehole													
	Note: • Mean river level at the time of drilling.													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 208-90-01 LOCATION N 4 986 693.2 E 282 862.8 ORIGINATED BY RF
DIST 11 HWY 69 BOREHOLE TYPE Wash Boring/Cone Test COMPILED BY RF
DATUM Geodetic DATE 92-06-18 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)			
194.2	Water Surface													
0.0	Water						194							
192.3	River Bottom													
191.7	Sand and Silt Greyish Brown, Loose, Traces of Plant Fibres		1	SS	0 **		192							
2.5	Silty Clay to Clayey Silt		2	SS	2									
	Grey		3	TW	PH		190							
189.2	Soft		4	SS	0 **									
5.1			5	SS	0 **		188							
	Slightly Cohesive		6	SS	3									
			7	SS	6		186							
	Sandy Silt to Sand		8	SS	5		184							
	Sandy Silt, Loose		9	SS	4		182							
	Sand, Loose to Dense		10	SS	13		180							
	Brown to Grey		11	WS***	-		178							
			12	WS***	-									
			13	SS	69		176							
175.7	Very Dense		14	SS	100									
18.5	Bedrock		15	RC	REC		174							
	Biotite Hornblende Gneiss		16	RC	REC									
	Unweathered to Slightly Weathered		17	RC	REC									
172.5			18	RC	REC									
21.7	End of Borehole													
Note: • Mean river level at the time of drilling. ** Split Spoon sank under weight of rods. *** WS indicates a Wash Sample.														

RECORD OF BOREHOLE No 3

1 OF 1 METRIC

W.P. 208-90-01 LOCATION N 4 986 719.8 E 282 856.9 ORIGINATED BY RF
DIST 11 HWY 69 BOREHOLE TYPE Wash Boring/Cone Test COMPILED BY RF
DATUM Geodetic DATE 92-06-10 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
194.3	Water Surface															
0.0	Water						194									
191.4	River Bottom						192									
2.9	Silty Clay to Clay Grey		1	SS	1		190									
189.1	Soft to Firm		2	SS	0 **		188									
5.3	Slightly Cohesive		3	SS	0 **		186									
	Sandy Silt to Sand		4	SS	4		184									
			5	SS	3		182									
			6	SS	4		180									
			7	SS	8		178									
	Clayey		8	SS	3		176									
			9	SS	0 **		174									
	Loose						172									
	Compact to Dense		10	SS	15											
	Sandy Silt, Grey															
	Sand, Brown															
			11	WS ***	-											
	Sand, Compact to Dense		12	SS	41											
	Gravelly Sand (Till-Like), Very Dense		13	SS	60											
174.4	Boulders		14	RC	REC	94%										RQD 68%
19.9	Bedrock Biotite Hornblende Gneiss		15	RC	REC	98%										RQD 77%
171.7	Unweathered to Slightly Weathered		16	RC	REC	98%										RQD 100%
22.6	End of Borehole															
Note: * Mean river level at the time of drilling ** Split Spoon sank under weight of rods. *** WS indicates Wash Sample																

RECORD OF BOREHOLE No 4

1 OF 1 METRIC

W.P. 208-90-01 LOCATION N 4 986 720.4 E 282 868.7 ORIGINATED BY RF
 DIST 11 HWY 69 BOREHOLE TYPE Wash Boring/Cone Test COMPILED BY RF
 DATUM Geodetic DATE 92-06-24 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
194.7	Water Surface																
0.0	Water																
191.1	River Bottom																
3.6	Trace Organics		1	SS	2												
188.9	Silty Clay to Clay Grey Soft		2	SS	2												
5.8	Slightly Cohesive		3	SS	2												
	Sandy Silt to Sand		4	SS	5												
	Loose		5	SS	8												
	Compact to Dense		6	SS	34												
	Sandy Silt, Grey		7	SS	6												
	Sand, Brown		8	SS	18												
	Compact to Dense Very Dense		9	WS**	-												
			10	WS**	-												
			11	WS**	-												
	Gravelly Sand		12	WS**	-												
			13	SS	100												
			14	SS	100												
173.8			15	SS	100												
20.9	End of Borehole Probable Bedrock																
Note: ■ Mean river level at the time of drilling. ** WS indicates a Wash Sample																	

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 208-90-01 LOCATION N 4 986 681.2 E 282 860.5 ORIGINATED BY RF
DIST 11 HWY 69 BOREHOLE TYPE Wash Boring/Cone Test COMPILED BY RF
DATUM Geodetic DATE 92-06-25 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE									
196.4	Ground Surface												
0.0	Probable Sand and Silt												
194.9													
1.5	Probable Silty Clay to Clayey Silt		1	TW	PH								
189.4													
7.0	Probable Sandy Silt to Sand												
178.5													
17.9	End of Borehole Probable Bedrock Note: • W.L. measured on 92-07-13. Coved at 9.90m.												

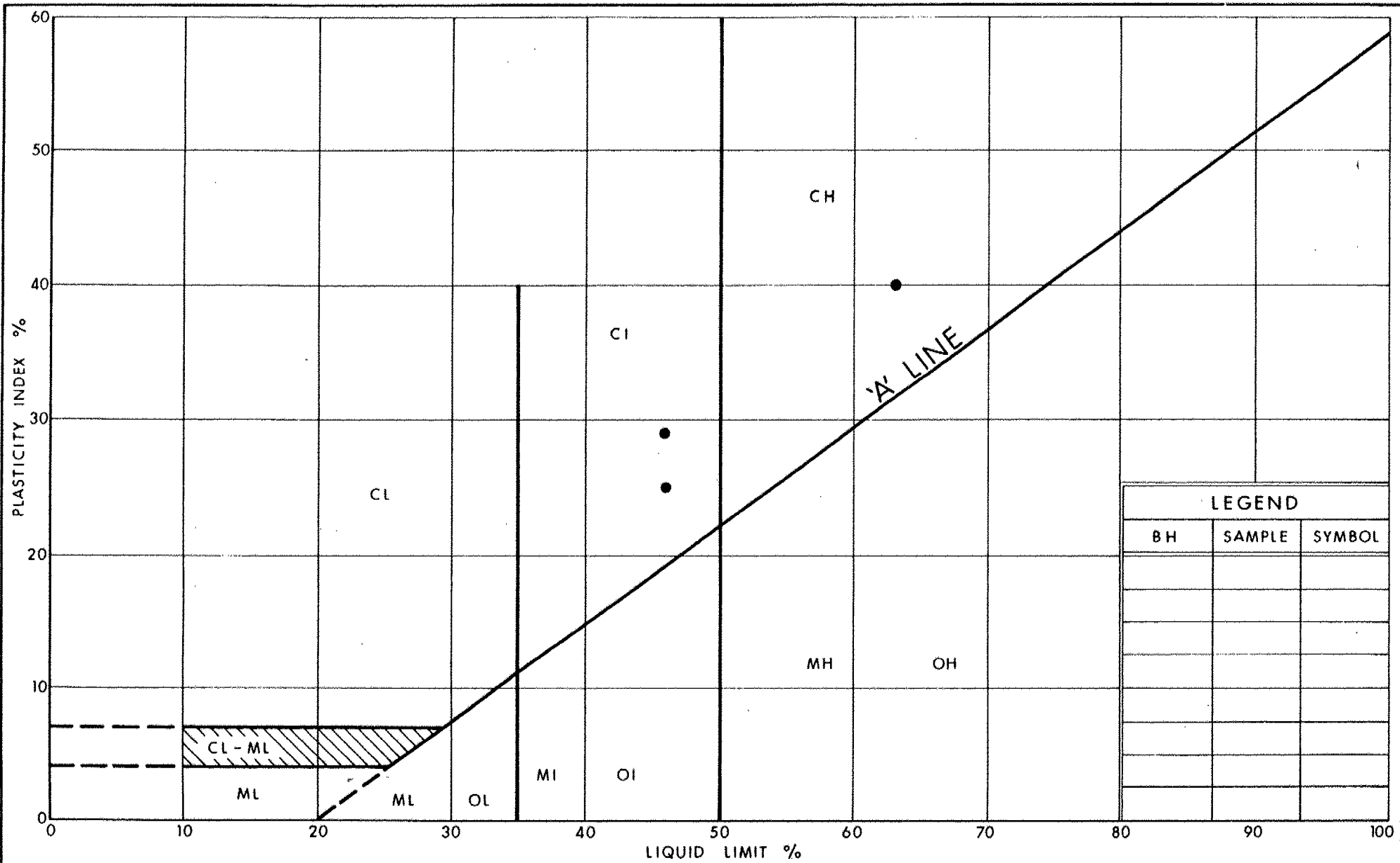
RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 208-90-01 LOCATION N 4 986 734.4 E 282 860 ORIGINATED BY RF
 DIST 11 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY RF
 DATUM Geodetic DATE 92-06-29 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
196.1	Ground Surface												
0.0	Probable Silty Clay to Clay												
			1	TW	-							17.7	
186.3													
9.8	Probable Sandy Silt to Sand												
	Sandy Silt to Sand												
	Loose to Dense												
	Gravelly Sand												
	Very Dense		2	SS	100	/25cm							
173.2													
22.9	End of Borehole												
	Note: • W.L. measured on 92-07-13. Caved at 16.5m.												



Ministry of
Transportation

PLASTICITY CHART SILTY CLAY TO CLAY

FIG No 1

W P 208-90-01

VOID RATIO - PRESSURE CURVES

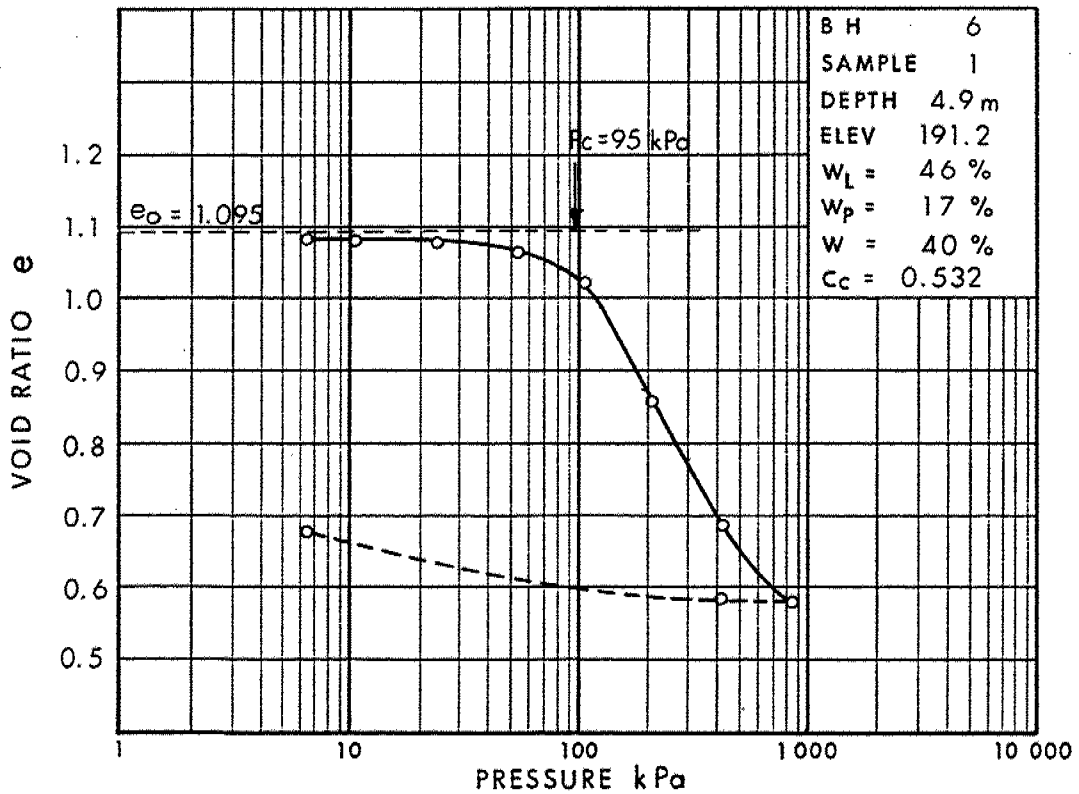
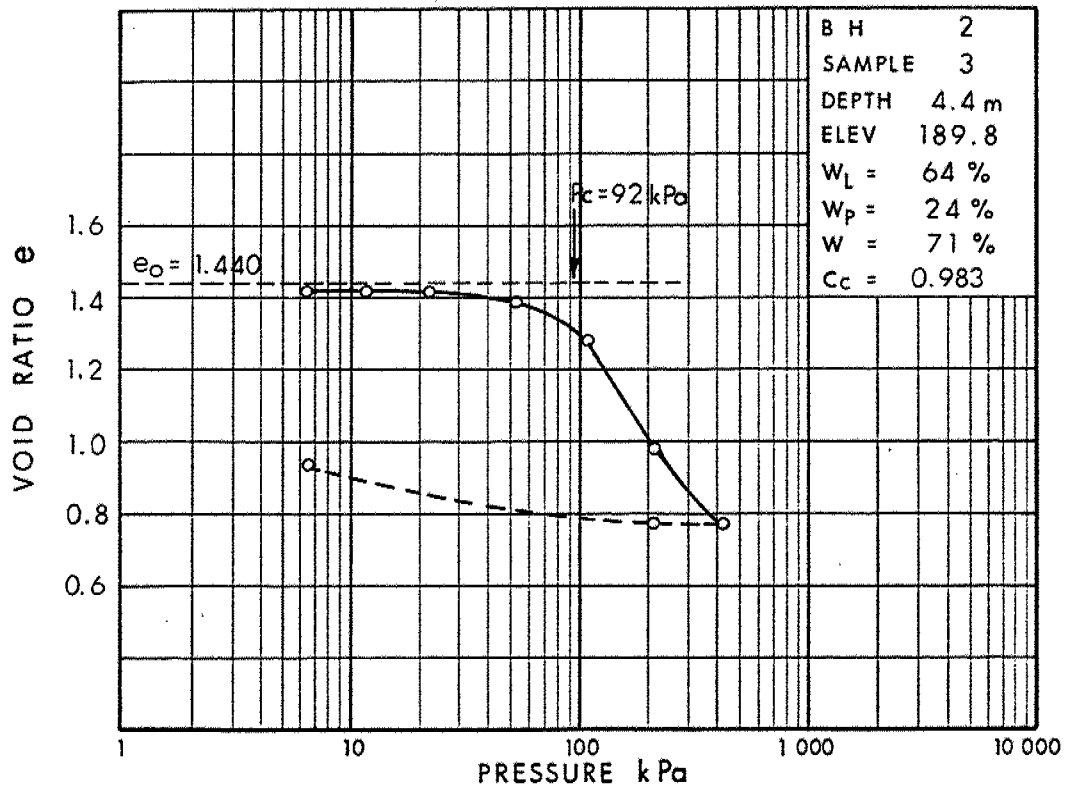


Fig 2

W P 208-90-01

VOID RATIO - PRESSURE CURVES

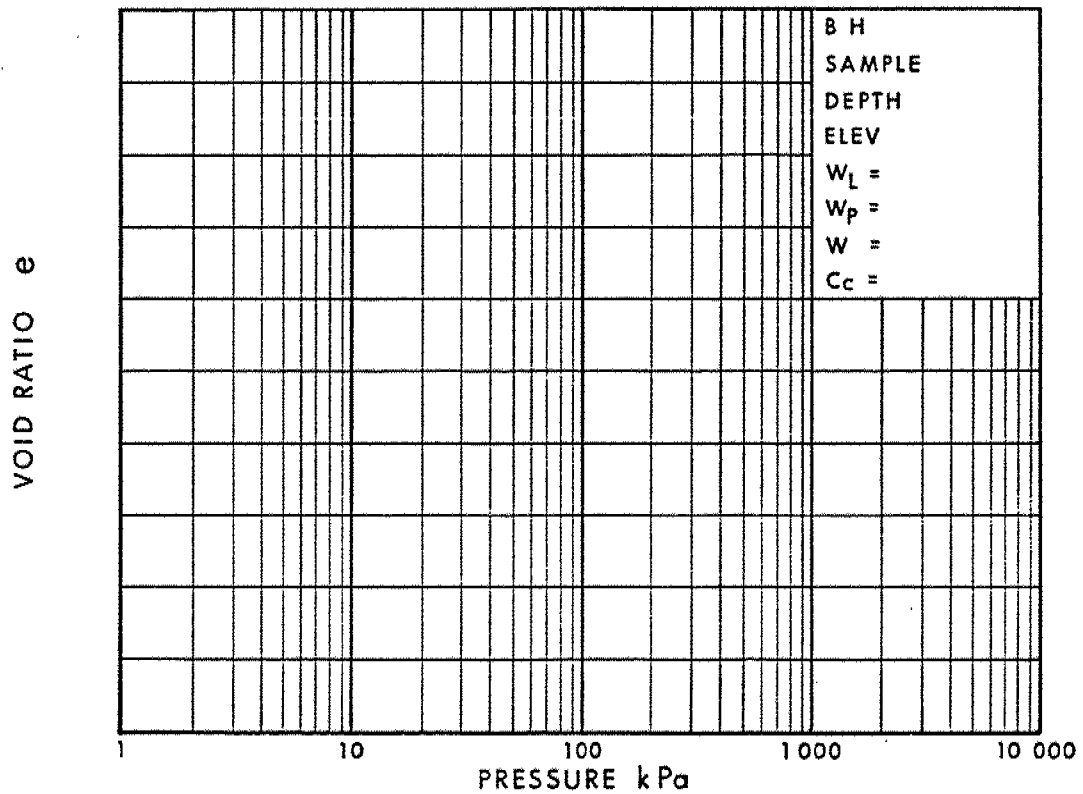
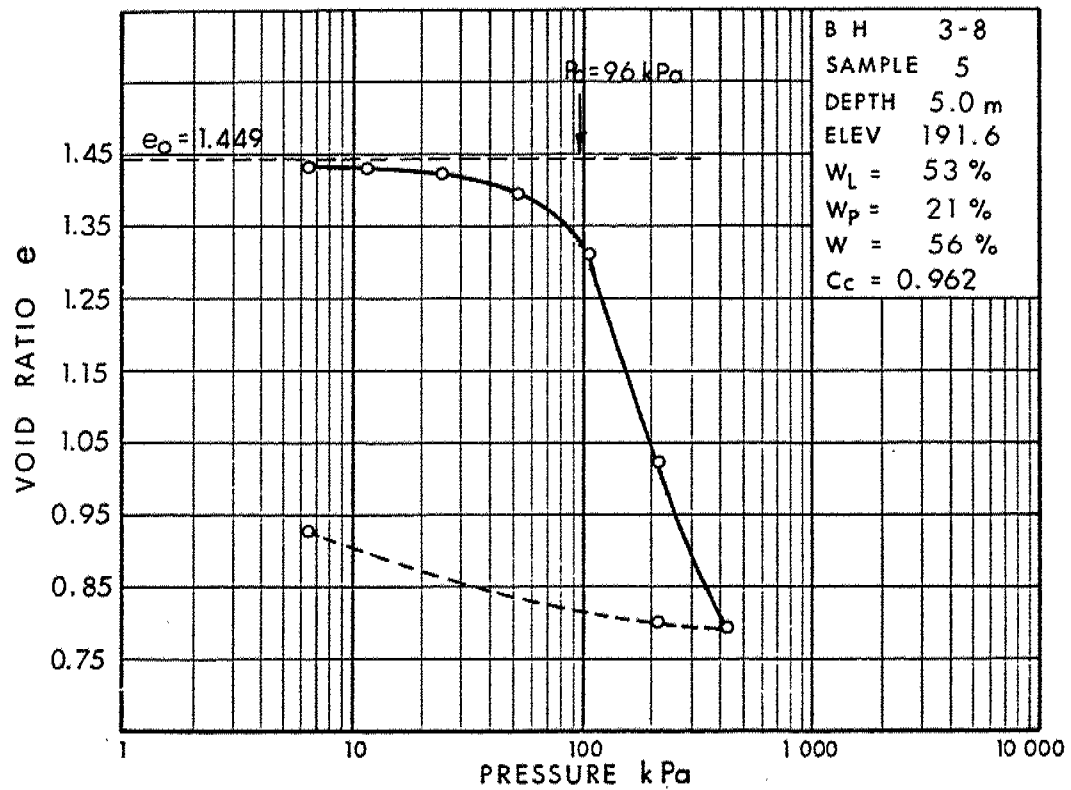


Fig 2A

W P 208-90-01



GRAIN SIZE DISTRIBUTION

SANDY SILT TO SAND

W P 208-90-01

WP 208-90-01

APPENDIX I
ROCK CORE DESCRIPTION

memorandum

235-3696



To: M.S. Devata
Chief Foundation Engineer
Foundation Design Section
Central Building, Room 315

Date: 92 07 22

Attn: J. Blair

From: Soils and Aggregates Section
Engineering Materials Office
Central Building, Room 311

File No: 3162-2-4-113

Re: **Borehole Core Description**
Highway 69/Musquash River, Georgian Bay Township
W.P. 208-90-01

As requested by you, core from three (3) boreholes was logged. A description is appended. Bedrock is **BIOTITE-HORNBLLENDE GNEISS** of the Grenville Province. Depth to bedrock and depth to unweathered to slightly weathered bedrock in each borehole are tabulated below:

Borehole Number	Depth to bedrock in metres below ground surface	Depth to unweathered to slightly weathered bedrock in metres below ground surface
1	15.1	15.1
2	18.5	18.5
3	19.9	19.9

If you have any questions, please contact me.

D. A. Williams.

David A. Williams,
Petrographer.

DAW/jlp
Attachment

ROCK CORE DESCRIPTION

WP 208-90-01

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	14	15.06-15.60	100	33	15.06-16.76	BIOTITE-HORNBLEND GNEISS (garnetiferous), greyish black to very light grey to moderate reddish orange; medium to coarse grained; strong; unweathered to slightly weathered; fractures moderate to very close spaced, dipping to near vertical, planar, smooth.
	15	15.60-16.18	100	96		
	16	16.18-16.28	100	100		
	17	16.28-16.76	100	100		
2	15	18.52-18.85	100	61	18.52-21.69	BIOTITE-HORNBLEND GNEISS (garnetiferous), greyish black to very light grey to moderate reddish orange; medium to coarse grained; strong; unweathered to slightly weathered; fractures wide to very close spaced, dipping to near vertical, planar to undulating, smooth.
	16	18.85-19.52	100	87		
	17	19.52-21.16	100	100		
	18	21.16-21.69	100	100		
3	15	19.30-19.76	94	64	19.30-19.91	OVERBURDEN (boulder till).
	16	19.76-20.98	98	75	19.91-22.58	BIOTITE-HORNBLEND GNEISS (garnetiferous), greyish black to very light grey; medium to coarse grained; strong; unweathered to slightly weathered; fractures moderate to very close spaced, dipping to near vertical, planar to undulating, smooth.
	17	20.98-22.58	98	98		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

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

Logged by: DAW, Soils and Aggregates Section

WP 208-90-01

APPENDIX II

BOREHOLE LOGS FROM REFERENCE NO. 215-89-00 (C)

RECORD OF BOREHOLE No 3-1

1 OF 1

METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+083; 3 m Lt. C/L S.B.L. ORIGINATED BY JB
 DIST 11 HWY 69 BOREHOLE TYPE Cone Test COMPILED BY JB
 DATUM Geodetic DATE April 14, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
197.7	Ground Surface												
0.0	Probable Peat												
	Probable Silty Clay to Clayey Silt						197						
195.0													
2.7	End of Cone Test Refusal - Probable Bedrock							50/8cm					

RECORD OF BOREHOLE No 3-2

1 OF 1

METRIC

W.P. 215-89-00(C) LOCATION Ste. 20+121; 5 m Lt. C/L S.B.L. ORIGINATED BY JB
DIST 11 HWY 69 BOREHOLE TYPE Hollow Stem / Cone Test COMPILED BY JB
DATUM Geodetic DATE April 2, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
197.0	Ground Surface															
0.0	Peat															
195.2	Black, Soft															
0.8	Sand Layer		1	SS	9		196									
	Silty Clay to Clayey Silt		2	SS	3		194									
	Brownish Grey		3	SS	0 **		192									
	Firm to Soft		4	SS	0 **		190									
191.7			5	SS	9		188									
5.3	Fine Silty to Well Graded Sand		6	SS	4											
	Grey		7	SS	12											
	Loose to Compact															
187.7																
9.3	End of Borehole Refusal - Probable Bedrock															
	* W.L. in open borehole on April 14, 1992															
	** Split spoon sank under weight of hammer and rods															

RECORD OF BOREHOLE No 3-3

1 OF 1

METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+160; C/L S.B.L. ORIGINATED BY DR
DIST 11 HWY 69 BOREHOLE TYPE Cone Test COMPILED BY JB
DATUM Geodetic DATE April 13, 1992 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
196.7	Ground Surface												
0.0	Probable Peat												

	Probable Silty Clay to Clayey Silt												

	Probable Sandy Silt to Sand												
181.5													
15.2	End of Cone Test Refusal - Probable Bedrock								120/25cm				

RECORD OF BOREHOLE No 3-4

1 OF 1

METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+200; 2.0 m Lt. C/L S.B.L. ORIGINATED BY DR
DIST 11 HWY 69 BOREHOLE TYPE Hollow Stem / Cone Test COMPILED BY JB
DATUM Geodetic DATE April 6/7, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
186.5	Ground Surface															
0.0	Peat Black, Soft		1	SS	3		196									
195.3	Organic Pockets															
1.2	Silty Clay to Clayey Silt		2	SS	2		194									
	Grey		3	SS	1											
	Soft to Firm		4	SS	1		192									
190.9			5	SS	1		190									
5.6			6	SS	5		188									
	Trace of Clay		7	SS	3											
	Loose		8	SS	13		186									
	Compact		9	SS	12		184									
			10	SS	10		182									
	Sandy Silt to Fine Sand		11	SS	12		180									
	Brownish Grey to Grey		12	SS	13											
177.6			13	SS	11		178									
18.9	End of Borehole															
	Probable Sandy Silt to Fine Sand															
175.5																
21.0	End of Cone Test Refusal - Probable Bedrock * W.L. on April 14, 1992															

RECORD OF BOREHOLE No 3-5

1 OF 1

METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+240; C/L S.B.L. ORIGINATED BY DR
DIST 11 HWY 69 BOREHOLE TYPE Cone Test COMPILED BY JB
DATUM Geodetic DATE April 7, 1992 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
196.5	Ground Surface												
0.0	Probable Peat												

	Probable Silty Clay to Clayey Silt												

	Probable Sandy Silt to Fine Sand												
181.9													
14.6	End of Cone Test Refusal - Probable Bedrock												

RECORD OF BOREHOLE No 3-6

1 OF 1

METRIC

W.P. 215-89-00(C) LOCATION Ste. 20+280; 2 m Rt. C/L S.B.L. ORIGINATED BY JB
DIST 11 HWY 69 BOREHOLE TYPE Hollow Stem / Cone Test COMPILED BY JB
DATUM Geodetic DATE April 10, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
196.5	Ground Surface													
0.0	Peat/Organic Clayey Silt													
195.6	Brownish Grey to Black, Soft													
0.9			1	SS	3		196							
			2	SS	2		194							
			3	SS	1		192							
			4	SS	0 **		190							
			5	SS	1		188							
188.6			6	SS	1		186							
7.9			7	SS	0 **		184							
			8	SS	1		182							
			9	SS	10									
			10	SS	0 **									
			11	SS	2									
181.6														
14.9	End of Borehole Auger Refusal - Probable Bedrock													
	* W.L. immediately upon completion of sampling													
	** Split spoon sank under weight of hammer and rods													

RECORD OF BOREHOLE No 3-7

1 OF 1

METRIC

W.P. 215-89-00(C) LOCATION N 4 986 638.4 E 282 847.2 ORIGINATED BY JB
 DIST 11 HWY 69 BOREHOLE TYPE Cone Test COMPILED BY JB
 DATUM Geodetic DATE April 10, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
196.2	Ground Surface																
0.0	Probable Peat																
	Probable Silty Clay to Clayey Silt																
	Probable Sand and Silt to Silty Fine Sand																
185.2																	
11.0	End of Cone Test Refusal - Possible Boulder or Bedrock												120	18cm			

RECORD OF BOREHOLE No 3-8

1 OF 1

METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+362; Off. 2 m Lt. C/L S.B.L. ORIGINATED BY JB
DIST 11 HWY 69 BOREHOLE TYPE Hollow Stem / Cone Test COMPILED BY JB
DATUM Geodetic DATE April 9, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	w _p	w	w _p	w	w _L	w		
196.6	Ice																
0.0	0.3m Ice, 0.2m Peat																
	Silty Clay to Clayey Silt		1	SS	15		196										
	Trace of Sand		2	SS	1		194										
	Grey		3	SS	2		192										
	Soft to Firm		4	SS	0**		190										
			5	TW	PH		188										
			6	SS	1		186										
189.6			7	SS	0**		184										
7.0	Trace of Clay		8	SS	0**		182										
	Sandy Silt to		9	SS	4		180										
	Fine Sand, Some Silt		10	SS	0**												
	Grey to Brownish Grey		11	SS	0**												
			12	SS	13												
	Loose to Compact		13	SS	77												
179.6	Dense to Very Dense																
178.8	Probable Bedrock ***																
17.8	End of Borehole																

* W.L. on April 10, 1992
** Split spoon sank under weight of hammer and rods
*** Auger and Cone likely skipping off rock surface

RECORD OF BOREHOLE No 3-9

1 OF 1

METRIC

W.P. 215-89-00(C) LOCATION Ste. 20+424; C/L S.B.L. ORIGINATED BY JB
DIST 11 HWY 69 BOREHOLE TYPE Hollow Stem / Cone Test COMPILED BY JB
DATUM Geodetic DATE April 6, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		WATER CONTENT (%)			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	20 40 60	20 40 60		
197.2	Ground Surface													
0.0	Fine to Silty Fine Sand Yellowish Brown Loose to Compact	Topsoil	1	SS	14		196							
195.3			2	SS	18									
1.9	Silty Clay to Clayey Silt, Trace Sand		3	SS	4		194							
			4	SS	4									
			5	SS	0 **		192							
	Brownish Grey to Grey		6	SS	1		190							
	Firm to Stiff		7	SS	0 **		188							
			8	SS	1		186							
185.1			9	SS	0 **		184							
			10	SS	2		182							
12.1	Medium Sand		11	SS	13									
	Brown		12	SS	35									
	Compact to Dense		13	SS	57	/15cm								5 89 (6)
180.0														
17.2	End of Borehole ***													
179.2														
18.0	End of Cone Test *** Probable Bedrock - Cone possibly skipping off rock surface * W.L. immediately upon completion of sampling ** Split spoon sank under weight of hammer and rods									120/20cm				

RECORD OF BOREHOLE No 3-10 1 OF 1 METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+470; C/L S.B.L. ORIGINATED BY JB
 DIST 11 HWY 69 BOREHOLE TYPE Cone Test COMPILED BY JB
 DATUM Geodetic DATE April 7, 1992 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
196.7	Ground Surface											
0.0	Probable Peat											
	Probable Fine Sand											
	Probable Silty Clay to Clayey Silt											
189.1	Probable Fine to Medium Sand											
7.6	End of Cone Test Refusal - Probable Bedrock											

RECORD OF BOREHOLE No 3-11 1 OF 1 METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+520; Off. 1 m Lt C/L S.B.L. ORIGINATED BY JB
 DIST 11 HWY 69 BOREHOLE TYPE Hollow Stem / Cone Test COMPILED BY JB
 DATUM Geodetic DATE April 7, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
196.6	Ground Surface													
0.0	Topsoil		1	SS	13		196							
	Sand Layer		2	SS	2									
	Silty Clay to Clayey Silt		3	SS	1		194							
	Brownish Grey to Grey		4	SS	1									
	Firm to Stiff		5	SS	1		192							
			6	SS	1									
189.4	Sandy		7	SS	27		190							
7.2	Silty Fine Sand		8	SS	46	/20cm								
188.5	Grey, Compact to Dense													
8.1	End of Borehole Refusal - Probable Bedrock													
	* W.L. on April 14, 1992													

RECORD OF BOREHOLE No 3-12 1 OF 1 METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+560; C/L S.B.L. ORIGINATED BY JB
 DIST 11 HWY 69 BOREHOLE TYPE Cone Test COMPILED BY JB
 DATUM Geodetic DATE April 7, 1992 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
196.6	Ground Surface											
0.0	Probable Peat											
	Probable Silty Clay to Clayey Silt											
	Probable Sandy Silt to Fine Sand											
178.6	End of Cone Test Refusal - Probable Bedrock											

RECORD OF BOREHOLE No 3-13 1 OF 1 METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+620; Off. 1 m Rt. C/L S.B.L. ORIGINATED BY JB/DR
 DIST 11 HWY 69 BOREHOLE TYPE Hollow Stem / Cone Test COMPILED BY JB
 DATUM Geodetic DATE April 8, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER ↓ CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
186.6	Ground Surface															
0.0	Peat, Black, Soft															
0.6			1	SS	2		196									
	Sandy		2	SS	2		194									
	Silty Clay to Clayey Silt		3	SS	1											
	Grey		4	SS	0**		192									
	Firm to Stiff		5	SS	0**		190									
188.8			6	SS	3											
7.8	Sandy Silt to Fine Sand		7	SS	13		188									
	Brownish Grey to Grey		8	SS	2		186									0 65 30 4
	Loose to Compact		9	SS	6		184									
182.9																
13.7	End of Borehole															
	Probable Sandy Silt to Fine Sand															
175.3																
21.3	End of Cone Test Refusal - Probable Bedrock															
	* W.L. on April 14, 1992 ** Split spoon sank under weight of hammer and rods															

RECORD OF BOREHOLE No 3-14 1 OF 1 METRIC

W.P. 215-89-00(C) LOCATION Sta. 20+660; C/L S.B.L. ORIGINATED BY DR
 DIST 11 HWY 69 BOREHOLE TYPE Hollow Stem / Cone Test COMPILED BY JB
 DATUM Geodetic DATE April 9, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES		GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100			
196.6	Ground Surface													
0.0	Peat, Black													
0.8	Silty Clay to Clayey Silt Light Grey to Grey Firm to Stiff		1	SS	4									
			2	SS	1									
	Silt Layer		3	SS	2									
			4	SS	0 **									
			5	SS	0 **									
	Sandy		6	SS	6									
187.9														
8.7	Sandy Silt to Fine Sand, Trace Silt Brown to Brownish Grey Loose		7	SS	6									
			8	SS	5									
			9	SS	0 **									
			10	SS	0 **									
180.8														
15.8	End of Borehole Probable Sandy Silt to Fine Sand													
175.0														
21.5	End of Cone Test Refusal - Probable Bedrock * W.L. on April 14, 1992 ** Split spoon sank under weight of hammer and rods													

RECORD OF BOREHOLE No 3-15 1 OF 1 METRIC

W.P. 215-89-00(C) LOCATION Ste. 20+700; Off. 1 m Rt. C/L S.B.L. ORIGINATED BY DR
DIST 11 HWY 69 BOREHOLE TYPE Hollow Stem / Cone Test COMPILED BY JB
DATUM Geodetic DATE April 10, 1992 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
196.7	Ground Surface													
0.0 195.9	Peat Black, Soft													
0.8	Silty Clay to Clayey Silt		1	SS	4									
	Brownish Grey		2	SS	4									
	Stiff to Firm		3	SS	2									
191.5	--- Sand Layer ---		4	SS	22									
5.2	End of Borehole Refusal - Probable Bedrock * W.L. on April 14, 1992													

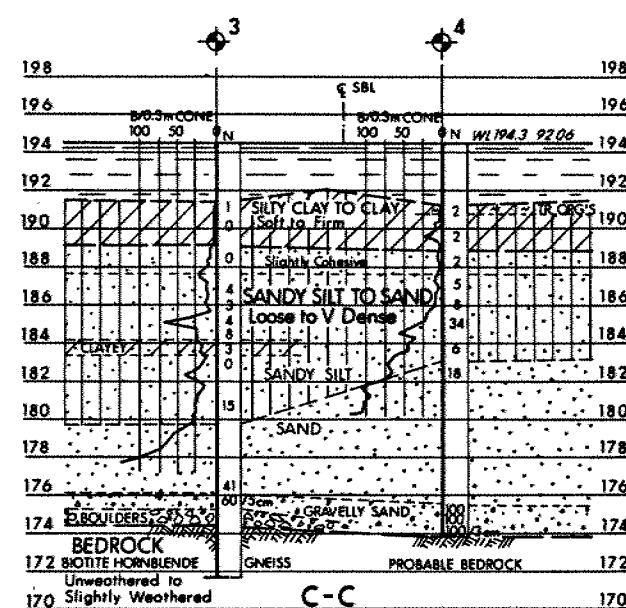
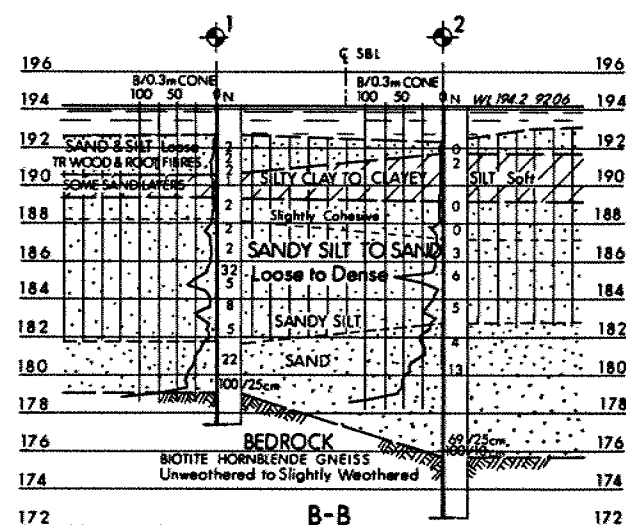
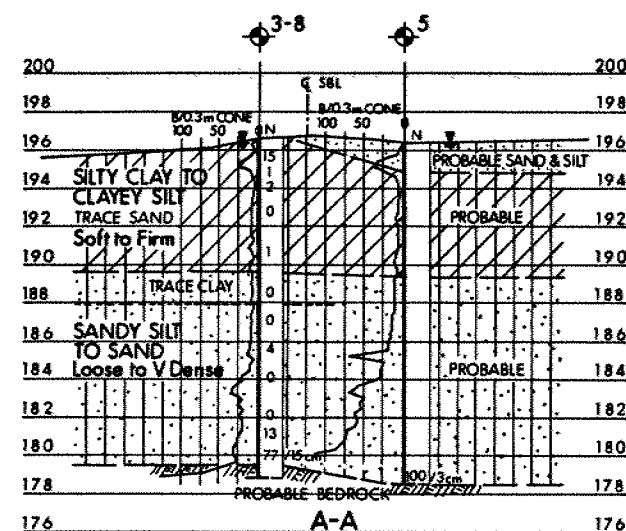
1 OF 1

ORIGINATED BY JE

COMPILED BY JE

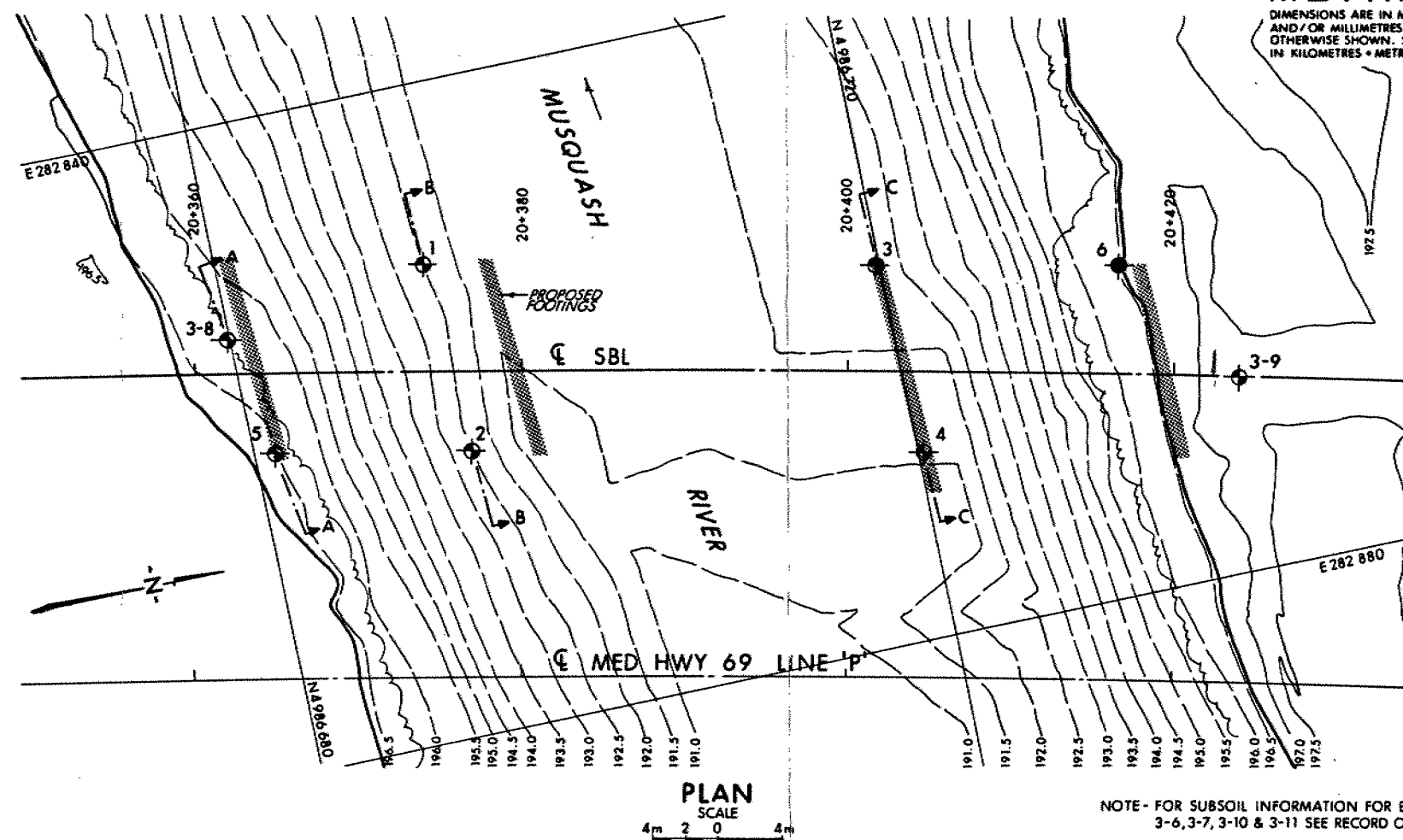
CHECKED BY _____

[illegible]

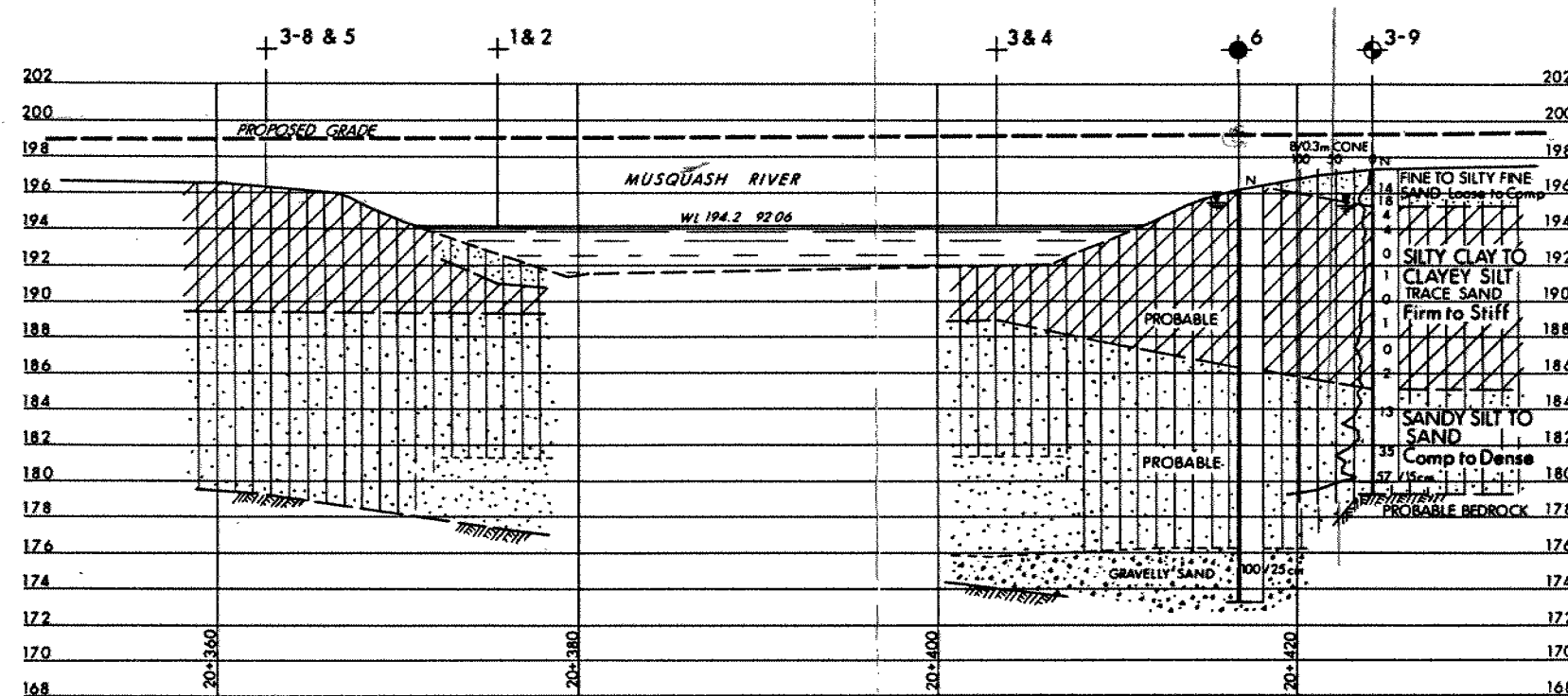


SECTIONS

SCALE
4m 2 0 4m



NOTE - FOR SUBSOIL INFORMATION FOR BORE HOLES
3-6, 3-7, 3-10 & 3-11 SEE RECORD OF BORE HOLE

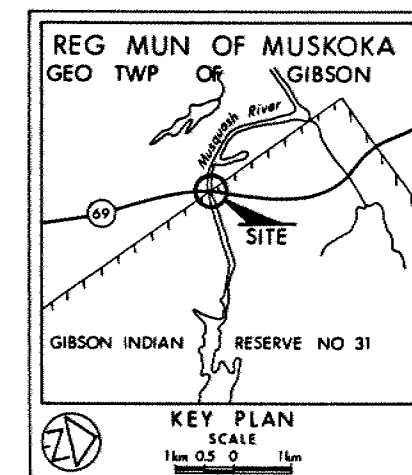


Q PROFILE SBL





SCALE
4m 2 0 4m

METRIC

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



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 9204&06 |

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	194.2	4986 692.4	282 851.1
2	194.2	4986 693.2	282 862.8
3	194.3	4986 719.8	282 856.9
4	194.7	4986 720.4	282 868.7
5	196.4	4986 681.2	282 860.5
6	196.1	4986 734.4	282 860.0
3-6	196.5	4986 598.2	282 841.4
3-7	196.2	4986 638.4	282 847.2
3-8	196.6	4986 679.8	282 853.1
3-9	197.2	4986 740.2	282 868.0
3-10	196.7	4986 785.0	282 879.0
3-11	196.6	4986 833.6	282 889.8

==NOTE==

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

DATE	BY	DESCRIPTION
Geocores No 31E-113		
HWY No 69 SBL		DIST 11
SUBMD JB	CHECKED	DATE 1992 09 30
DRAWN SO	CHECKED	APPROVED
		DWG# 209001-A

LOOKING SOUTH FROM
NORTH ABUTMENT LOCATION

NORTH ABUT. LOCATION
LOOKING NORTH

LOOKING D/STR. FROM
EXISTING BRIDGE

LOOKING NORTH FROM
SOUTH ABUTMENT LOCATION

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

DIST 52 HWY 69
CONT No W.P. 217-89-00
WP No 208-90-01

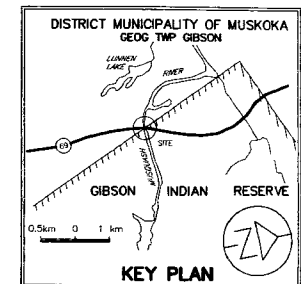


MUSQUASH RIVER BRIDGE
HWY 69 SOUTHBOUND STRUCTURE
GENERAL ARRANGEMENT

SHEET

BOREHOLE			
No.	ELEVATION	COORDINATES	
1	192.600	N 4986692.400	E 282851.100
2	192.300	N 4986693.200	E 282862.800
3	191.400	N 4986719.800	E 282856.900
4	191.100	N 4986720.400	E 282868.700
5	196.400	N 4986681.200	E 282860.500
6	196.100	N 4986734.400	E 282860.000
3-8	196.600	N 4986679.800	E 282853.100
3-9	197.200	N 4986740.200	E 282868.000

WORKING POINTS			
	STATION AT Q MEDIAN	T/A ELEVATIONS	COORDINATES
SOUTH BOUND	W.P. #1	20+358.040	199.570 N 4986675.154 E 282854.277
	W.P. #2	20+377.775	199.670 N 4986694.777 E 282858.139
	W.P. #3	20+404.419	199.805 N 4986721.179 E 282863.790
	W.P. #4	20+421.194	199.890 N 4986737.745 E 282867.605



GENERAL NOTES

- CLASS OF CONCRETE:
- TREMIE
- REMAINDER..... 30 MPa
- CLEAR COVER TO REINFORCING STEEL:
- FOOTINGS..... 100±25
- ABUTMENTS AND WINGWALLS..... 70±20
- PIERS..... 80±20
- DECK: TOP..... 70±20
BOTTOM..... 40±10
- REMAINDER..... 70±20
UNLESS OTHERWISE NOTED.
- REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH PREFIX C DENOTE COATED BARS.

CONSTRUCTION NOTES

- THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEVATIONS BY DEDUCTING THE ACTUAL BEARING THICKNESSES FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.
- NO BACKFILL TO BE PLACED BEHIND ABUTMENTS UNTIL CONCRETE IN DECK HAS REACHED 75% OF ITS SPECIFIED STRENGTH.
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN THE BACKFILL HEIGHTS BE GREATER THAN 500mm.

LIST OF DRAWINGS

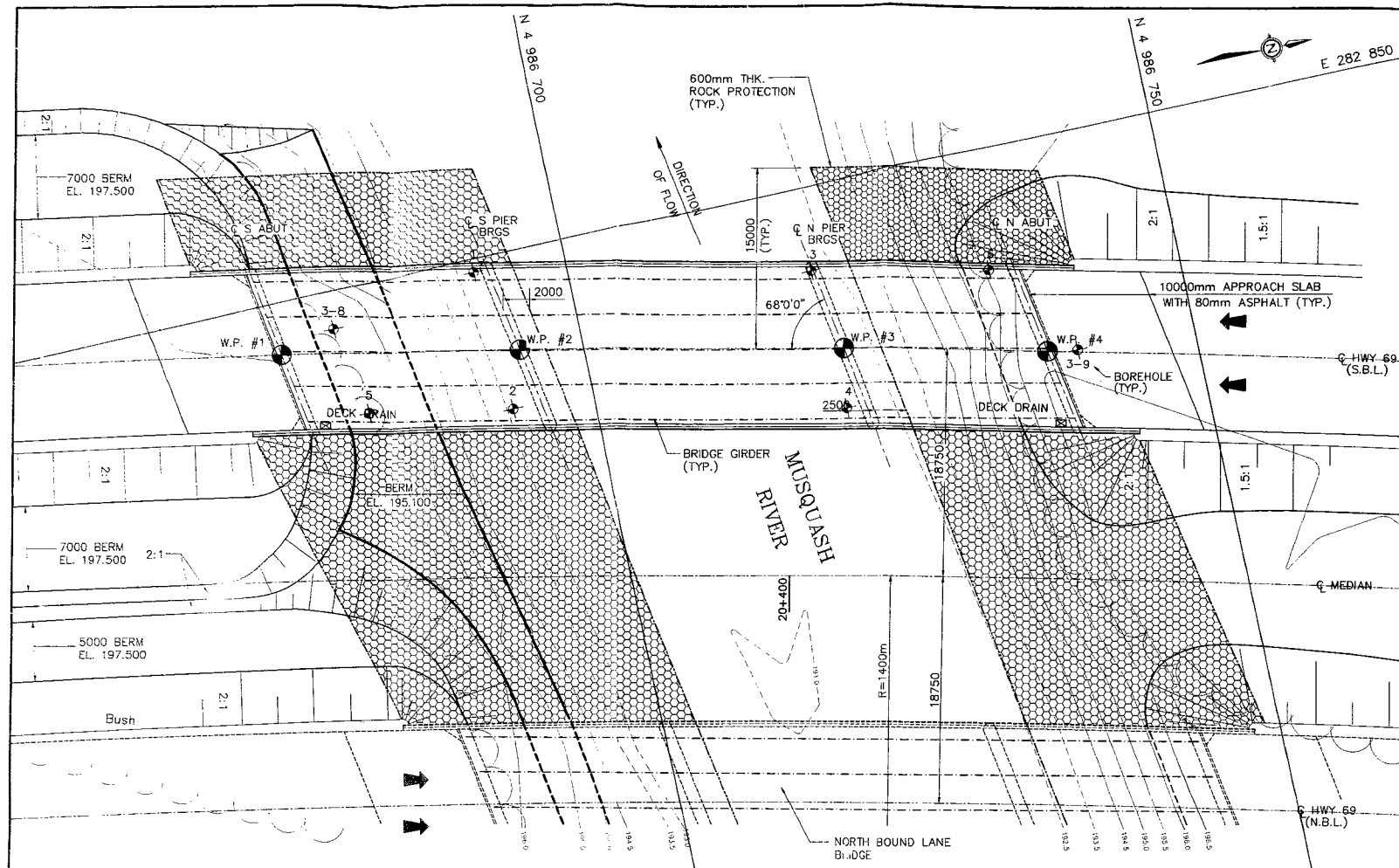
- GENERAL ARRANGEMENT
- FOUNDATION LAYOUT
- ABUTMENTS AND WINGWALLS
- PIERS
- STRUCTURAL STEEL I
- STRUCTURAL STEEL II AND PIER BEARINGS
- DECK DETAILS AND REINFORCEMENT
- BARRIER WALL WITH RAILING
- 1000mm APPROACH SLAB
- STANDARD DETAILS
- QUANTITIES - STRUCTURE

MAR 13 1998

APPLICABLE STANDARD DRAWINGS

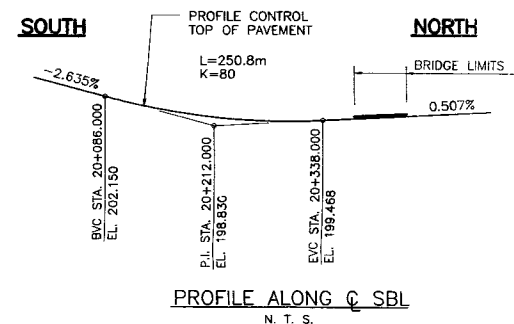
OPSD 3906.02 BRIDGE DECK WATERPROOFING
OPSD 3906.03 BRIDGE DECK WATERPROOFING DETAILS

REVISIONS		DESCRIPTION	
DESIGN	KN	CHK	CODE OHBC '91
DRAWN	HC	CHK	SITE 42-48S
			STRUCT
			SCHEME
			DWG 1



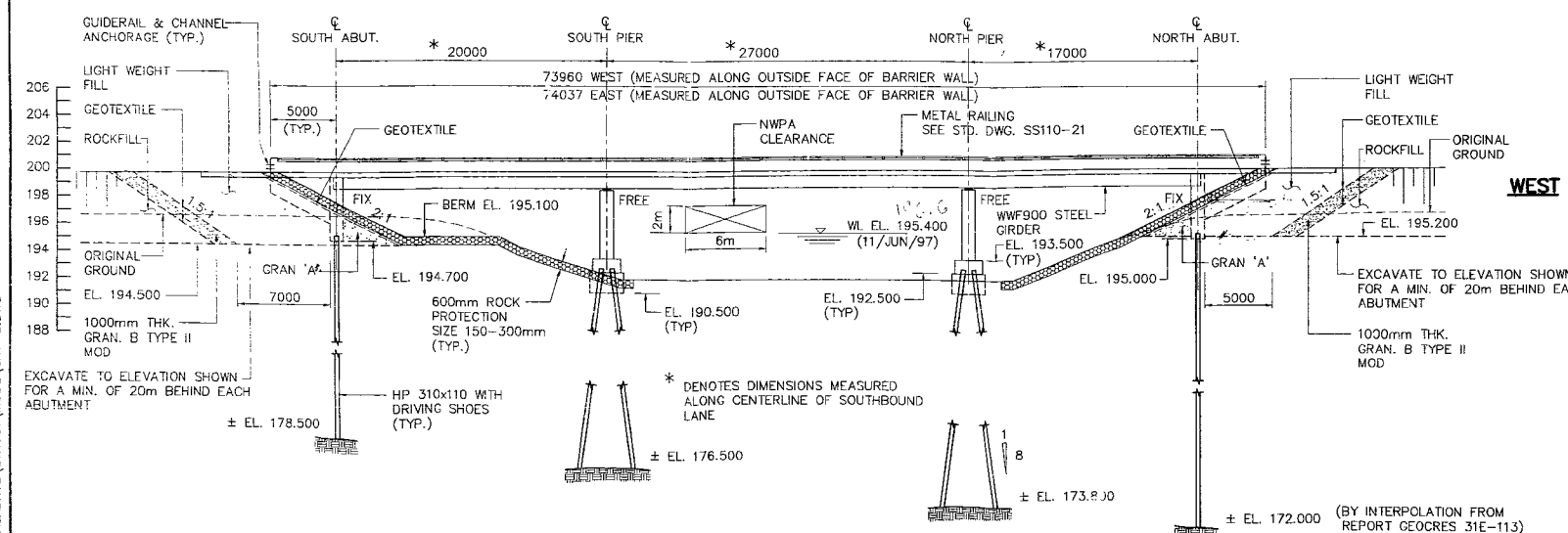
PLAN (SOUTHBOUND)

1 : 250
5m 0m 5m



PROFILE ALONG Q SBL

N. T. S.



EAST ELEVATION (SOUTHBOUND)

1 : 250
5m 0m 5m

NOTES:

- ALL PILES ARE TO BE DRIVEN TO BEDROCK.
- ROCK ELEVATIONS ARE APPROXIMATE WITH REFERENCE TO SOIL INVESTIGATION REPORT GEOCRE 31E-113 (16/MAR./1993).

TYPICAL SOUTHBOUND SECTION

1 : 100

5m 0m 5m

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

B.M. 199.211
BRASS TABLET SET IN
N.E. CORNER BRIDGE
7.1 RT 20+467.3 N.B.L.

J:\CADD\GWS\4000S\4784\ACAD\12\STRUCT\MUSQ\GA1-3.DWG