

FOUNDATION INVESTIGATION AND DESIGN REPORT
FOR
CULVERTS
HIGHWAY 69 FOUR-LANING
FROM 6.7 KM NORTH OF HIGHWAY 537 NORTHERLY 2.8 KM
G.W.P. 5556-02-00
HIGHWAY 69, DISTRICT 54
TOWNSHIP OF DILL, SUDBURY

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August 2003

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FOUNDATION INVESTIGATION REPORT

For
Culverts
Highway 69 Four-Laning
From 6.7 km North of Highway 537 Northerly 2.8 km
G.W.P. 5556-02-00
Highway 69, District 54
Township of Dill, Sudbury

INTRODUCTION

This report summarizes the results of the foundation investigation carried out for construction of the culverts along the realigned section of Highway 69 that extends from 6.7 km north of Highway 537 northerly 2.8 km and is located about 7 km south of Sudbury. Realignment of this section of Highway 69 to the east is planned. The investigation was conducted for Totten Sims Hubicki Associates (TSH) on behalf of the Ontario Ministry of Transportation (MTO).

A total of seven culverts will be constructed along the study corridor. For the purposes of this report, the culverts have been designated by the following numbers:

CULVERT No.	ROADWAY	PROPOSED CENTRELINE HIGHWAY 69 CHAINAGE (m)
1	Highway 69 (New)	Station 17+403
2	Highway 69 (New)	Station 17+690
3	Highway 69 (New)	Station 17+946
4	Highway 69 (New)	Station 18+340
5	Highway 69 (New)	Station 18+447
6	Highway 69 (New)	Station 19+176
7	N-W Ramp	Station 19+208

This report pertains to the proposed culverts and associated bedding/backfill zones.

PHYSIOGRAPHY AND GEOLOGY

The area is part of the Precambrian Laurentian peneplane. In general, the topography is relatively flat but quite irregular in detail with many small lakes separated by steep rock ridges. The soil cover in the region is typically shallow but can vary substantially in thickness over short distances. The soil in low areas between rock ridges typically consists of lake and/or alluvial deposits with local areas comprising sand and gravel deposits. Soil on the rock outcrops is generally sparse. Swamp environments have developed in areas of poor drainage. The area is generally wooded with open sections in the swamps.

The bedrock formations are of Precambrian age and are largely composed of veined, banded and homogeneous pink and grey gneisses produced by injection and granitization of metamorphic gneisses of various types.

INVESTIGATION PROCEDURES

The field work for this study was carried out in the period of February 3 to May 11, 2003 and consisted of 35 boreholes advanced to depths of 0.3 to 22.7 m below grade and five dynamic cone penetration tests performed to depths of 6.5 to 16.3 m at or near the locations of the proposed culverts. Since the culvert locations had not been finalized until the field investigation was nearing completion, the testholes were located at the assumed location of the culverts. Additional testholes were put down to investigate areas where some data was either missing or not considered representative.

The Record of Borehole and Record of Penetration Test sheets, Drawings that show the location of the testholes, as well as the Figures which illustrate the results of the laboratory tests (Plasticity Charts and Grain Size Distribution Charts) are provided in Appendix A. The data for each culvert is presented separately in the Appendix.

TSH staked out the alignment of the highway and ramps. Peto MacCallum Ltd. selected the testhole locations with reference to the control lines staked out by TSH. The ground surface elevations at the testholes were established in the field by Peto MacCallum Ltd. and referred to geodetic benchmarks provided by TSH.

The boreholes were advanced using continuous flight hollow stem augers, NW wash boring and NQ diamond rock coring equipment, powered by a track-mounted CME-75 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of members of our engineering staff.

Representative samples of the overburden were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. In situ vane shear and pocket penetrometer testing was also performed to further assess the shear strength parameters of the cohesive soils.

The groundwater conditions in the boreholes were closely monitored during the field work. Upon completion of drilling, the boreholes were backfilled in accordance with the MTO procedures.

Soils were identified in the field according to the MTO Soil Classification procedures. All of the recovered soil samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determinations. Atterberg limits testing and grain size distribution analyses were carried out on selected soil samples. The test results are presented on the relevant Record of Borehole sheets and Figures in Appendix A.

SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole and Record of Penetration Test sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, boundary elevations, standard and dynamic cone penetration test data as well as in situ vane shear and pocket penetrometer test results, groundwater observations and moisture content determinations. The results of laboratory Atterberg limits testing and grain size distribution analyses are also shown on the Record of Borehole sheets.

The locations of the boreholes and dynamic cone penetration tests are presented on Drawing 1 (Culvert 1), Drawing 2 (Culvert 2), Drawing 3 (Culvert 3), Drawing 4/5 (Culverts 4 and 5) and Drawing 6/7 (Culverts 6 and 7).

In general, the subsurface stratigraphy revealed in the boreholes comprised topsoil or peat overlying native deposits of cohesionless silt/sand and/or cohesive clayey silt/silty clay/clay mantling bedrock/inferred bedrock contacted at depths of 0.3 to 19.0 m below existing grade. A description of the subsurface stratigraphy identified at each culvert is summarized in the following paragraphs. Further details along with a list of the boreholes drilled at each culvert are provided in Table II.

Culvert 1

Nine boreholes were drilled along the alignment of culvert 1. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial topsoil or peat underlain by native deposits of silt and sand, containing discontinuous layers of clayey silt or silty clay, overlying bedrock. Bedrock/probable bedrock was contacted at depths of 4.1 to 15.3 m (elevation 215.8 to 227.3). Groundwater was at depths of 1.6 to 6.8 m (elevation 224.3 to 229.1). The results of the Atterburg Limits and Grain Size Distribution tests conducted on selected samples are provided on Figures 1-1 to 1-6.

Topsoil/Peat

A surficial topsoil layer was penetrated in boreholes 701-6S, 701-10S, 701-12S, 701-6NA, 701-6NB and 701-7N; fibrous peat was encountered surficially in boreholes 701-13S, 701-4M and 701-6N. The thickness of the topsoil ranged from 200 to 400 mm and that of the peat from 300 to 400 mm. Both units were penetrated at elevation 230.5 to 231.1.

Silt/Sandy Silt

Non-plastic silt and/or sandy silt with discontinuous layers of clayey silt, silty clay and/or sand was encountered beneath the topsoil/peat in boreholes 701-6S, 701-10S, 701-12S, 701-6NA, 701-6NB and 701-7N. This unit was also encountered below clayey silt or silty clay layers at depths of 2.8 to 6.1 m (elevation 224.6 to 228.7) in boreholes 701-10S, 701-12S, 701-13S, 701-4M, 701-6N, 701-6NA and 701-7N.

This deposit was very loose to compact, with a moisture content between 18 and 29%.

The silt/sandy silt was penetrated in boreholes 701-6S, 701-10S, 701-13S, 701-6N, 701-6NA and 701-7N at depths of 4.1 to 13.7 m (elevation 217.6 to 227.3). Boreholes 701-12S, 701-4M and 701-6NB were terminated in this unit at depths of 6.0 to 8.1 m (elevation 222.6 to 225.0) due to refusal on probable bedrock.

Sand/Silty Sand

Underlying the silt/sandy silt deposit at depths of 7.6 to 13.7 m (elevation 217.6 to 223.5) in boreholes 701-10S, 701-6N and 701-6NA was cohesionless sand or silty sand. A 3.6 m thick layer of sand was revealed within the silt at 4.0 m depth (elevation 226.7) in borehole 701-6NB.

In boreholes 701-6N and 701-6NB, the sand/silty sand was very loose (N not exceeding 4), with a moisture content in a range of 26 to 29%. This unit was compact (N of 15) and had a moisture content of about 10% in borehole 701-10S.

Boreholes 701-10S, 701-6N and 701-6NA were terminated in the sand/silty sand at depths of 14.2 to 15.3 m (elevation 215.8 to 216.9) due to refusal on probable bedrock.

Clayey Silt/Silty Clay

Discontinuous layers of cohesive clayey silt or silty clay were encountered below the peat (elevation 230.7 to 230.8) in boreholes 701-13S, 701-4M, 701-6N and within the silt deposit at 1.2 m depth (elevation 229.5 to 230.2) in boreholes 701-10S, 701-12S, 701-6NA, 701-7N. The thickness of these layers ranged from 1.6 to 4.9 m.

The consistency of the clayey silt / silty clay was soft to stiff, typically firm. A field vane test performed in the silty clay in borehole 701-13S indicated an undrained shear strength in excess of 100 kPa. Pocket penetrometer tests indicate that the shear strength of the clayey silt/silty clay ranges from 15 to 75 kPa, typically 25 to 40 kPa.

Two Atterberg Limits tests were performed on samples retrieved from boreholes 701-12S and 701-7N. The liquid and plastic limits of the clayey silt were 26 and 19 and the silty clay 38 and 19, respectively. The moisture content of the unit ranged from 20 to 40%.

Bedrock

Bedrock/inferred bedrock was contacted below the native soil at depths of 4.1 to 15.3 m (elevation 215.8 to 227.3) in all the boreholes. Two dynamic cone penetration tests carried out near the north and south ends of the culvert met refusal on probable bedrock at respective depths of 12.0 and 12.6 m (elevation 218.8 and 218.7).

Rock cores were retrieved from boreholes 701-6S and 701-7N. The bedrock is described as granitic gneiss. The measured core recovery varied between 82 and 100%. The RQD determined from the rock cores was typically in a range of 82 to 98% (23% in the initial 500 mm in borehole 701-6S), indicating a good to excellent quality rock. A detailed rock core description is presented in Table I, appended.

Groundwater

Water was observed in all boreholes except borehole 701-12S. In the process of augering, water was detected at depths of 1.6 to 6.8 m (elevation 224.3 to 229.1) in boreholes 701-6S, 701-10S, 701-13S, 701-4M, 701-6N, 701-6NB and 701-7N. Upon completion of drilling, water was measured to be at depths of 2.3 to 7.6 m (elevation 223.5 to 229.0) in boreholes 701-6S, 701-10S, 701-13S, 701-4M, 701-6N, 701-6NA, 701-6NB and 701-7N.

Culvert 2

Six boreholes were drilled along the alignment of culvert 2. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial fill/peat underlain by native deposits of silt/sand and clayey silt overlying bedrock. The bedrock/inferred bedrock was contacted at depths of 3.4 to 16.3 m (elevation 231.0 to 244.6). Groundwater was at depths of 0.0 to 4.0 m (elevation 243.2 to 247.6).

Fill

A surficial layer of fill was present in boreholes CV8-1, 701-28S and 701-17NA. The fill was 0.9 to 1.5 m thick and consisted of sand and gravel, sand or reworked native silt.

Peat

Fibrous peat was present surficially in boreholes CV8-2, 701-27SA and 701-17N. The peat was 100 to 200 mm thick.

Silt/Clayey Silt

A silt/clayey silt deposit was encountered below the fill or peat (sand in borehole 701-17N) at depths of 0.2 to 1.5 m (elevation 245.3 to 247.1). This deposit was 0.9 to 7.3 m thick and extended to elevation 238.9 to 245.9. The silt layers in this deposit were cohesionless, ranged in thickness from 0.9 to 5.6 m and were very loose to compact (N of 2 to 15).

The clayey silt layers were cohesive, firm to stiff and had a thickness of 0.9 to 6.4 m. Three pocket penetrometer tests performed on selected samples of this deposit indicated a minimum undrained shear strength of 100 kPa.

The boreholes penetrated the silt/clayey silt deposit at typical depths of 5.5 to 8.2 m (elevation 238.9 to 242.1), locally 2.1 m (elevation 245.9) in borehole 701-28S.

Sand

An 800 mm thick layer of cohesionless sand was encountered below the peat at a depth of 100 mm in borehole 701-17N. A cohesionless sand deposit was also encountered below the silt/clayey silt deposit in all boreholes except borehole CV8-2. This unit was loose to very loose (locally compact), with a confirmed thickness varying between 1.3 and 8.1 m.

Bedrock

Bedrock/inferred bedrock was contacted in all the boreholes at depths of 3.4 to 16.3 m (elevation 231.0 to 244.6).

The bedrock is described as gabbro. The measured core recovery was 88 to 100%. The RQD determined from the rock cores was in a range of 57 to 98%, indicating a fair to excellent quality rock. Details of the rock core description are presented in Table I, appended.

Groundwater

Water was observed in all boreholes except borehole 701-28S during or upon completion of drilling. In the process of augering, water was detected at depths of 1.5 to 4.0 m (elevation 243.2 to 246.1). Upon completion of drilling, groundwater was measured to be at depths of 0.0 to 3.6 m (elevation 243.6 to 247.6).

Culvert 3

Four boreholes were drilled along the alignment of culvert 3. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat overlying successive native deposits of clay, silty clay and silt underlain by boulders over bedrock. The bedrock/inferred bedrock was contacted at depths of 11.3 to 19.0 m (elevation 230.9 to 238.6). Groundwater was measured in the median borehole at 4.2 m depth (elevation 245.7). The results of the Atterburg Limits and Grain Size Distribution tests conducted on selected samples are provided on Figures 3-1 to 3-7.

Peat

Fibrous peat was present surficially in all the boreholes. The peat was 200 to 400 mm thick, with a moisture content determined in one sample of 58%. This unit was typically penetrated at elevation 249.4 to 249.7 (248.5 in borehole 702-2S).

Clay

With the exception of borehole 702-2M, a 2.4 to 4.2 m thick cohesive clay deposit was encountered below the peat and extended to elevation 245.4 to 247.0.

The consistency of the clay generally decreased with depth from stiff to soft. The undrained shear strength determined by a field vane test performed at the bottom of this unit in borehole 702-2M was in excess of 100 kPa. The results of pocket penetrometer testing conducted on samples of the unit indicate that the shear strength of the clay varies between 35 and 160 kPa.

Three Atterberg Limits tests on representative samples of the unit were performed in boreholes 702-2S, 702-2M and 702-3N. The liquid and plastic limits for the clay were in a range of 54 to 59 and 22 to 24, respectively. The moisture content of the unit varied between 32 and 50%.

Silty Clay

A cohesive silty clay deposit was encountered below the clay at depths of 2.7 to 4.5 m (elevation 245.4 to 247.0) in all the boreholes. This unit was firm and 2.4 to 4.5 m thick.

Seven field vane tests were performed at various depths within this deposit. The undrained shear strength ranged from 25 to 45 kPa, with a sensitivity index of 2 to 5. The results of two pocket penetrometer tests yielded a shear strength of less than 15 kPa; we consider this low value to be indicative of sample disturbance.

Two Atterberg Limits tests on representative samples of the unit from boreholes 702-2S and 702-2M indicate the liquid and plastic limits range from 45 to 49 and 21 to 22 respectively. The moisture content of the unit varied between 29 and 54%.

The silty clay was penetrated at depths of 6.9 to 8.1 m (elevation 241.6 to 243.0).

Clayey Silt

A 2.2 m thick layer of very soft cohesive clayey silt was encountered below the silty clay at 6.9 m depth (elevation 243.0) in borehole 702-3N.

One Atterberg Limits test was performed in this unit and gave liquid and plastic limits of 25 and 18 respectively. The moisture content of the clayey silt was about 33%.

Silt

The silty clay/clayey silt was underlain by non-plastic silt in all the boreholes. In addition, 700 mm of this unit was revealed below the peat in borehole 702-2M. The silt was loose to very loose (N not exceeding 9) and had a moisture content of 20 to 34%. This unit was 6.5 and 7.3 m thick in boreholes 702-1SA and 702-3N respectively. Boreholes 702-2M and 702-2S were terminated in the unit at respective depths of 11.3 and 11.9 m (elevation 238.6 and 237.0) due to refusal on probable bedrock.

Boulders/Bouldery Sand

A 1.8 and 2.6 m thick layer of boulders or bouldery sand was encountered below the silt at depths of 13.7 and 16.4 m (elevation 236.0 and 233.5) in boreholes 702-1SA and 702-3N, respectively.

Bedrock

Bedrock/inferred bedrock was contacted at depths of 11.3 to 19.0 m (elevation 230.9 to 238.6) in all the boreholes.

The bedrock is described as steatite. The measured core recovery was typically 64 to 100% (35% in the initial 600 mm in borehole 702-3N). The RQD determined from the rock cores improved with depth from very poor (12 to 23% in the initial 1.8 to 2.1 m) to excellent (up to 95%). Details of the rock core description are presented in Table I, appended.

Groundwater

Water was observed in borehole 702-2S during drilling at the peat/clay boundary (elevation 248.5) and measured in borehole 702-2M upon completion of drilling at 4.2 m depth (elevation 245.7).

Culvert 4

Three boreholes were drilled along the alignment of culvert 4. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat underlain by native deposits of clay and silt overlying bedrock. The bedrock/inferred bedrock was contacted at depths of 5.6 to 11.7 m (elevation 239.0 to 245.3). Groundwater was measured in the median borehole to be at 0.2 m depth (elevation 250.7). The results of the Atterburg Limits and Grain Size Distribution tests conducted on selected samples are provided on Figures 4-1 to 4-5.

Peat

Fibrous peat was present surficially in all the boreholes. The peat ranged in thickness from 0.9 to 2.0 m and had a moisture content of 642%. This unit was penetrated at elevation 248.6 to 249.7.

Clay

Cohesive clay was encountered directly beneath the peat at depths of 1.2 to 2.0 m (elevation 248.6 to 249.7) in all the boreholes. This unit was 1.8 to 3.6 m thick and penetrated at elevation 246.1 to 247.7.

The clay was firm in consistency. Three field vane tests performed in the unit yielded undrained shear strength values in a range of 30 to 40 kPa, with a sensitivity index of 3 to 5. A pocket penetrometer test conducted on the clay sample indicated a shear strength in the order of 100 kPa.

The liquid and plastic limits of the clay determined in an Atterberg Limits test were 60 and 23, respectively. The moisture content of the unit was about 44%.

Silt

Underlying the clay in all the boreholes was non-plastic silt. In addition, the silt was revealed below the silty clay at 8.8 m depth (elevation 241.9) in borehole 704-2N. This upper silt unit was 0.9 m thick and had a moisture content of 31%. The lower silt unit was 2.9 m thick, with a moisture content decreasing to 20%. The relative density of the unit was loose to very loose (N of 1 to 6).

Silty Clay

Cohesive silty clay was encountered at 3.9 m depth (elevation 246.8) in borehole 704-2N. The thickness of the silty clay was 4.9 m.

The consistency of this unit ranged from soft to firm. Two field vane tests performed at various depths gave undrained shear strength values in a range of 20 to 25 kPa (soil sensitivity of 3).

The liquid and plastic limits for the silty clay determined in an Atterberg Limits test were 44 and 22 respectively. The moisture content of the unit varied between 34 and 62%.

Bedrock

Bedrock/inferred bedrock was contacted below the silt at a depth of 5.6 m (elevation 245.0 to 245.3) in boreholes 704-2S, 704-1MA and 11.7 m (elevation 239.0) in borehole 704-2N. A dynamic cone penetration test met refusal on probable bedrock at 7.5 m depth (elevation 243.5).

The bedrock is described as metasedimentary. The measured core recovery was 88 to 100%. The RQD determined from the rock cores was typically in a range of 41 to 52% (24% in the initial 400 mm in borehole 704-2N), indicating a poor to fair quality rock. Details of the rock core description are presented in Table I, appended.

Groundwater

Water was measured in borehole 704-1MA to be at 0.2 m depth (elevation 250.7).

Culvert 5

Three boreholes were drilled along the alignment of culvert 5. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat overlying native deposits of clayey silt, silty clay and clay underlain by silt over bedrock. The bedrock/inferred bedrock was contacted at depths of 10.0 to 14.7 m (elevation 237.1 to 242.0). Groundwater was at a depth of 0.2 m (elevation 251.8). The results of the Atterburg Limits and Grain Size Distribution tests conducted on selected samples are provided on Figures 5-1 to 5-7.

Peat

Fibrous peat was present surficially in all the boreholes. The peat was typically 200 to 400 mm thick, with a moisture content of 227%. This unit was penetrated at elevation 251.5 to 251.8.

Clayey Silt

Directly beneath the peat in all the boreholes was cohesive clayey silt. This unit was 1.0 to 2.1 m thick. The consistency of the unit was firm to stiff. Pocket penetrometer testing conducted on the clayey silt yielded a shear strength of 110 to 125 kPa.

The liquid and plastic limits for the clayey silt determined in three Atterberg Limits tests were 24 to 31 and 18 to 19 respectively. The moisture content of the unit was 31 to 35%.

Silty Clay

Underlying the clayey silt at depths of 1.2 to 2.4 m (elevation 249.4 to 250.8) was cohesive silty clay. In addition, this unit was revealed below a clay deposit at 7.2 m depth (elevation 244.6 to 244.8). The thickness of the upper layer varied between 1.8 and 3.0 m, the lower layer 2.1 to 6.2 m.

The consistency of the silty clay was soft to stiff, typically firm. Four field vane tests performed in the unit yielded undrained shear strength values in a range of 30 to 40 kPa, with a sensitivity of 2 to 5. Pocket penetrometer testing indicated a shear strength of 25 kPa.

The liquid and plastic limits for the silty clay determined in four Atterberg Limits tests were 37 to 42 and 20 to 21, respectively. The moisture content of the unit varied between 26 and 53%.

Clay

Cohesive clay was encountered within the silty clay unit at depths of 4.2 to 4.3 m (elevation 247.6 to 247.8) in all the boreholes. The clay was 2.9 to 3.0 m thick.

The consistency of the clay was firm. Six field vane tests performed in this unit gave undrained shear strength values in a range of 30 to 42 kPa, with a sensitivity index of 4 to 5.

The liquid and plastic limits for the clay determined in two Atterberg Limits tests were 55 to 57 and 22 to 23 respectively. The moisture content of the unit was 59 to 68%.

Silt

Non-plastic silt was revealed below the silty clay at depths of 9.3 and 13.4 m (elevation 242.7 and 238.4) in boreholes 705-2S and 705-2N respectively. The silt was very loose (N of 2 to 3) and ranged in thickness from 0.7 to 1.3 m.

Bedrock

Bedrock/inferred bedrock was contacted below the silty clay or silt at depths of 10.0 to 14.7 m (elevation 237.1 to 242.0) in all the boreholes.

The bedrock is described as granitic gneiss. The measured core recovery was 92 to 100%. The RQD determined from the rock cores was ranged from 46 to 60% in borehole 705-2S (poor to fair quality rock) and from 89 to 97% in borehole 705-2N (excellent quality rock). Details of the rock core description are presented in Table I, appended.

Groundwater

Water was measured in borehole 705-2M at a depth of 0.2 m (elevation 251.8).

Culvert 6

Six boreholes were drilled along the alignment of culvert 6. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat underlain by a native deposit of clayey silt overlying bedrock. The bedrock/inferred bedrock was contacted at depths of 0.3 to 4.5 m (elevation 240.7 to 245.7). Groundwater was measured in one borehole to be at 0.2 m depth (elevation 244.7). The results of the Atterburg Limits and Grain Size Distribution tests conducted on selected samples are provided on Figures 6-1 and 6-2.

Peat

Fibrous peat was present surficially in boreholes 706-10S, 706-10M and 706-9N. The thickness of the peat was 1.2 m in borehole 706-9N and 100 to 300 mm in the other two boreholes. Borehole 706-10S was terminated in the peat on probable bedrock at 0.3 m depth (elevation 245.0).

Clayey Silt

Cohesive clayey silt was encountered at depths of 0.3 to 1.2 m (elevation 244.0 to 246.0) in all boreholes except borehole 706-10S. This unit was 0.3 to 1.9 m thick.

The consistency of the unit was soft to stiff. A field vane test performed in borehole 706-9N yielded an undrained shear strength of 95 kPa (soil sensitivity of 9).

The liquid and plastic limits for the clayey silt determined in an Atterberg Limits test were 34 and 21 respectively. The moisture content of the unit was about 28%.

Boreholes 701-11S, 706-10M and 706-9NA were terminated in this unit on probable bedrock at depths of 0.6 to 2.2 m (elevation 242.9 and 245.7).

Sandy Silt

A 1.5 m thick layer of sandy silt was identified below the clayey silt at 3.0 m depth (elevation 242.2) in borehole 706-9N. The sandy silt was very loose in relative density and had a moisture content of about 27%. Borehole 706-9N was terminated in this deposit on probable bedrock at a depth of 4.5 m (elevation 240.7).

Bedrock

Bedrock/inferred bedrock was contacted at depths of 0.3 to 4.5 m (elevation 240.7 to 245.7).

The bedrock is described as metasedimentary. The measured core recovery was typically 82 to 100%, locally 32%. The RQD determined from the rock cores was typically in a range of 65 to 100% (18% in a 600 mm run started at 5.2 m depth), indicating a fair to excellent quality rock. Details of the rock core description are presented in Table I, appended.

Groundwater

Water was measured in borehole 706-9NA to be at 0.2 m depth (elevation 244.7).

Culvert 7

Three boreholes were drilled along the alignment of culvert 7. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat underlain by native deposits of silt and clay overlying bedrock. The bedrock/inferred bedrock was contacted at depths of 2.5 to 6.5 m (elevation 238.7 to 242.6). Groundwater was measured in one borehole to be at 0.1 m depth (elevation 244.8).

Peat

Fibrous peat was present surficially in boreholes 710-NW18 and 710-NW19. The thickness of the peat was 200 and 500 mm respectively.

Silt/Sandy Silt

Non-plastic silt was encountered below the peat in borehole 710-NW19 and below 1.3 m of water in borehole 710-NW16 at respective depths of 0.6 and 1.5 m (elevation 244.5 and 243.4). The silt was 1.5 to 1.9 m thick and loose to very loose in relative density.

A 900 mm thick layer of sandy silt was identified at 3.0 m depth (elevation 242.3) in borehole 710-NW18.

Clay/Silty Clay

Cohesive deposits of clay and silty clay were revealed at depths of 0.5 and 3.0 m (elevation 244.8 and 241.9) in boreholes 710-NW18 and 710-NW16 respectively. The clay was 2.5 m thick and very soft in consistency. The moisture content of this deposit was 45%.

The silty clay was 1.5 m thick and was soft in consistency. A field vane test performed in this deposit yielded an undrained shear strength of about 20 kPa (soil sensitivity of 3).

Sand and Gravel

A 200 mm thick layer of sand and gravel was encountered below the silty clay at 4.5 m depth (elevation 240.4) in borehole 710-NW16.

Bedrock

Bedrock/inferred bedrock was contacted in the boreholes at depths of 2.5 to 4.7 m (elevation 240.2 to 242.6). A dynamic cone penetration test carried out near the north end of the culvert met refusal on probable bedrock at 6.5 m depth (elevation 238.7).

The bedrock is described as metasedimentary. The measured core recovery was 92 to 100%. The RQD determined from the rock cores was in a range of 88 to 100%, indicating a good to excellent quality rock. Details of the rock core description are presented in Table I, appended.

Groundwater

Water was measured in borehole 710-NW16 to be at 0.1 m depth (elevation 244.8).

Observed groundwater levels are subject to seasonal fluctuations and rainfall patterns.

CLOSURE


The field work was carried out under the supervision of Mr. F. Portela, Mr. M. Rapsey, Mr. R. Elliot, Ms. S. Heino and direction of Mr. C. Nascimento, P.Eng., Senior Foundation Engineer. The equipment was supplied by Marathon Drilling Co.

The report was prepared by Mr. G.O. Degil, Ph.D., Senior Project Supervisor, and was reviewed by Mr. D.W. Kerr, M. Eng., P.Eng., Chief Foundation Engineer. Mr. B.R. Gray, M.Eng., P.Eng., Designated MTO Contact, conducted an independent review of the report.

Yours very truly

Peto MacCallum Ltd.




Dennis W. Kerr, M.Eng., P.Eng.
Chief Foundation Engineer




Brian R. Gray, M.Eng., P.Eng.
Designated MTO Contact

GD:ld

TABLE I - FIR

ROCK CORE DESCRIPTION
CULVERTS
HIGHWAY 69 FOUR-LANING
FROM 6.7 KM NORTH OF HIGHWAY 537 NORTHERLY 2.8 KM
DISTRICT 54, TOWNSHIP OF DILL, SUDBURY, ONTARIO
GWP 5556-02-00, MTO CONSULTANT AGREEMENT NO. 5005-A-000163

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	SAMPLE NO.	DEPTH (m)	RECOVERY %	RQD %	DEPTH (m)	DESCRIPTION
701-6S	4	4.1 – 4.6	82	23	4.1 – 7.7	GRANITIC GNEISS: light grey, fine to medium crystalline, medium to high strength, unweathered, occasional concentrations of black biotite, with very close to close becoming close to moderate spaced dipping discontinuities, smooth planar to smooth undulating, slightly altered to tight. Becoming garnetiferous at depth, occasional serpentine layers near partings, very poor becoming good to excellent quality.
	5	4.6 – 6.1	99	98		
	6	6.1 – 7.7	91	86		
701-7N	11	9.3 – 10.8	98	98	9.3 – 12.3	GRANITIC GNEISS: light grey fine to medium crystalline with occasional bands of fine crystalline and coarse crystalline, high strength, unweathered, occasional concentrations of black biotite, with pyrite inclusions at depth, with close to wide spaced dipping discontinuities, rough planar, tight, occasional green mineralization on parting surface, good to excellent quality.
	12	10.8 – 12.3	100	82		

Originated: FP
Compiled: JFW
Checked: VV/CN

TABLE 1 - FIR

ROCK CORE DESCRIPTION
CULVERTS
HIGHWAY 69 FOUR-LANING
FROM 6.7 KM NORTH OF HIGHWAY 537 NORTHERLY 2.8 KM
DISTRICT 54, TOWNSHIP OF DILL, SUDBURY, ONTARIO
GWP 5556-02-00, MTO CONSULTANT AGREEMENT NO. 5005-A-000163

HOLE NO.	SAMPLE NO.	CORE RECOVERY			CORE DESCRIPTION	
		DEPTH (m)	RECOVERY %	RQD %	DEPTH (m)	DESCRIPTION
CV2-1	7	9.8 – 10.6	100	57	9.8 – 12.9	GABBRO: Black or dark green, fine to medium crystalline, with occ. porphyritic texture, with occ. white quartz layers, high to very high strength, unweathered, close to moderate spaced flat to dipping joints, rough planar, oxidized to tight, with occ. white residue on partings, fair to excellent quality.
	8	10.6 – 12.1	100	98		
	9	12.1 – 12.9	97	97		
CV2-2	6	7.1 – 7.5	88	81	7.1 – 10.3	GABBRO: Grey to black, fine crystalline, with pyrite inclusions, high to very high strength, unweathered, close to moderate spaced flat to dipping joints, rough planar, oxidized, with white residue or encrustation on partings, with 50 mm thick pink, green and black alteration zone with slickensides, fair to excellent quality.
	7	7.5 – 9.1	97	90		
	8	9.1 – 10.3	100	60		

Originated: FP
Compiled: JFW
Checked: VV/CN

TABLE I - FIR

ROCK CORE DESCRIPTION
CULVERTS
HIGHWAY 69 FOUR-LANING
FROM 6.7 KM NORTH OF HIGHWAY 537 NORTHERLY 2.8 KM
DISTRICT 54, TOWNSHIP OF DILL, SUDBURY, ONTARIO
GWP 5556-02-00, MTO CONSULTANT AGREEMENT NO. 5005-A-000163

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	SAMPLE NO.	DEPTH (m)	RECOVERY %	RQD %	DEPTH (m)	DESCRIPTION
702-1SA	11	15.5 – 16.7	77	19	15.5 – 19.1	STEATITE: dark green to black (possible biotite or chlorite), fine to medium grained, breaks down readily to very fine and talc-like residue, low to medium strength, very close to moderate spaced discontinuities, smooth planar to undulating slickensided, tight, very poor becoming excellent quality below 17.6 m.
	12	16.7 – 17.6	67	14		
	13	17.6 – 19.1	100	95		
702-3N	13	19.0 – 19.6	35	23	19.0 – 22.7	STEATITE: dark green to black, (possible biotite or chlorite), fine to medium grained, breaks down readily to very fine powder, low strength, unweathered, very close to close spaced, becoming moderate spaced dipping discontinuities, smooth planar, tight, very poor becoming fair to good quality. (Soapy texture)
	14	19.6 – 20.8	82	12		
	15	20.8 – 21.1	64	57		
	16	21.1 – 22.7	98	82		

Originated: FP
Compiled: JFW
Checked: VV/CN

TABLE I - FIR

ROCK CORE DESCRIPTION
CULVERTS
HIGHWAY 69 FOUR-LANING
FROM 6.7 KM NORTH OF HIGHWAY 537 NORTHERLY 2.8 KM
DISTRICT 54, TOWNSHIP OF DILL, SUDBURY, ONTARIO
GWP 5556-02-00, MTO CONSULTANT AGREEMENT NO. 5005-A-000163

HOLE NO.	CORE RECOVERY				CORE DESCRIPTION	
	SAMPLE NO.	DEPTH (m)	RECOVERY %	RQD %	DEPTH (m)	DESCRIPTION
704-2S	4	5.6 – 7.1	98	52	5.6 – 8.3	METASEDIMENTARY: banded dark grey, green and pink, fine grained, high to very high strength, unweathered, with close spaced flat to dipping discontinuities, smooth to rough planar, tight, occasional with dark green mineralization or serpentinization along partings, fair quality.
	5	7.1 – 8.3	100	50		
704-2N	9	11.7 – 12.1	88	24	11.7 – 14.6	METASEDIMENTARY: banded grey, pink and red, fine grained, high to very high strength, unweathered, with very close to close spaced dipping to vertical discontinuities, smooth to rough planar, to rough undulating, tight, with dark green mineralization or serpentinization on parting surface locally with carbonate infilling, with occasional quartz layer, poor quality.
	10	12.1 – 13.4	100	41		
	11	13.4 – 14.6	98	41		

Originated: FP
Compiled: JFW
Checked: VV/CN

TABLE I - FIR

ROCK CORE DESCRIPTION
CULVERTS
HIGHWAY 69 FOUR-LANING
FROM 6.7 KM NORTH OF HIGHWAY 537 NORTHERLY 2.8 KM
DISTRICT 54, TOWNSHIP OF DILL, SUDBURY, ONTARIO
GWP 5556-02-00, MTO CONSULTANT AGREEMENT NO. 5005-A-000163

HOLE NO.	CORE RECOVERY				CORE DESCRIPTION	
	SAMPLE NO.	DEPTH (m)	RECOVERY %	RQD %	DEPTH (m)	DESCRIPTION
705-2S	8	10.0 – 11.1	100	60	10.0 – 13.2	GRANITIC GNEISS: grey, fine crystalline, high strength, unweathered, with close spaced flat to dipping discontinuities, rough planar, tight to oxidized with green mineralization and pyrite on partings, with vertical joint from 11.67 to 12.20 m depth, poor to fair quality.
	9	11.0 – 11.9	100	50		
	10	11.7 – 13.2	97	46		
705-2N	11	14.7 – 16.3	92	89	14.7 – 17.8	GRANITIC GNEISS: grey, fine crystalline, high strength, unweathered, with moderate spaced flat discontinuities, rough planar, tight, occasional vertical cross joint, dark green mineralization on partings, some pyrite inclusions, good to excellent quality.
	12	16.3 – 17.8	100	97		

Originated: FP
Compiled: JFW
Checked: VV/CN

TABLE 1 - FIR

ROCK CORE DESCRIPTION
CULVERTS
HIGHWAY 69 FOUR-LANING
FROM 6.7 KM NORTH OF HIGHWAY 537 NORTHERLY 2.8 KM
DISTRICT 54, TOWNSHIP OF DILL, SUDBURY, ONTARIO
GWP 5556-02-00, MTO CONSULTANT AGREEMENT NO. 5005-A-000163

HOLE NO.	CORE RECOVERY				CORE DESCRIPTION	
	SAMPLE NO.	DEPTH (m)	RECOVERY %	RQD %	DEPTH (m)	DESCRIPTION
706-8NA	2	3.0 – 4.1	82	65	3.0 – 6.2	METASEDIMENTARY: banded dark green, pink and white, fine grained, high to very high strength, unweathered, with close to moderate spaced dipping to vertical discontinuities, smooth to rough planar, tight, with dark green mineralization on some partings.
	3	4.1 – 5.2	100	100		
	4	5.2 – 5.8	32	18		
	5	5.8 – 6.2	93	93		
710-NW18	3	3.9 – 4.5	92	88	3.9 – 7.1	METASEDIMENTARY: banded grey, green and pink and pink, fine grained, high to very high strength, unweathered, with close spaced dipping discontinuities, smooth to rough planar, tight, with dark green mineralization on partings, with vertical cross joint/fault (sample 4) slickensides or partings, 2 to 5 mm aperture infilled with green silty gouge good to excellent quality.
	4	4.5 – 5.9	100	100		
	5	5.9 – 7.1	96	96		

Originated: FP
Compiled: JFW
Checked: W/CN

TABLE II - FIR
INFERRED SUBGRADE CONDITIONS
CULVERTS
HIGHWAY 69 FOUR-LANING
FROM 6.7 KM NORTH OF HIGHWAY 537 NORTHERLY 2.8 KM
DISTRICT 54, TOWNSHIP OF DILL, SUDBURY, ONTARIO
GWP 5556-02-00, MTO CONSULTANT AGREEMENT NO. 5005-A-000163

PROJECT SECTION	APPROXIMATE LOCATION (AT CENTERLINE MEDIAN)	CULVERT NO.	AVERAGE ⁽¹⁾ EXISTING GRADE ELEVATION	APPLICABLE TEST HOLES	SUMMARIZED SUBSURFACE CONDITIONS ⁽²⁾
Highway 69 (New)	Sta. 17+403	1	231.0 Range: 230.7 to 231.4	Boreholes 701-6S, 701-10S, 701-12S, 701-13S, 701-4M, 701-6N, 701-6NA, 701-6NB, 701-7N Penetration Tests 701-11S, 701-9N	A 200 to 400 mm thick layer of topsoil or peat underlain by native deposits of very loose to compact silt and sand, containing discontinuous layers of soft to stiff clayey silt or silty clay, overlying bedrock/inferred bedrock contacted at depths of 4.1 to 15.3 m
	Sta. 17+690	2	247.2 Range: 246.0 to 248.0	Boreholes CV2-1, CV2-2, 701-27SA, 701-28S, 701-17N, 701-17NA Penetration Test 701-27SA	100 to 200 mm of peat or 0.9 to 1.5 m of fill underlain by native deposits of very loose to compact silt/sand and firm to stiff clayey silt overlying bedrock/inferred bedrock contacted at depths of 3.4 to 16.3 m
	Sta. 17+946	3	249.6 Range: 248.9 to 249.9	Boreholes 702-1SA, 702-2S, 702-2M, 702-3N	A 200 to 400 mm thick layer of peat overlying successive native deposits of stiff to very soft clay, silty clay, clayey silt and loose to very loose silt underlain by boulders over bedrock/inferred bedrock contacted at depths of 11.3 to 19.0 m
	Sta. 18+340	4	250.8 Range: 250.6 to 251.0	Boreholes 704-2S, 704-1MA, 704-2N Penetration Test 704-2NA	A 0.9 to 2.0 m thick layer of peat underlain by soft to stiff silty clay and loose to very loose silt overlying bedrock/inferred bedrock contacted at depths of 5.6 to 11.7 m
	Sta. 18+447	5	251.9 Range: 251.8 to 252.0	Boreholes 705-2S, 705-2M, 705-2N	A 200 to 400 mm thick layer of peat overlying soft to stiff clayey silt, silty clay and clay underlain by very loose silt over bedrock/inferred bedrock contacted at depths of 10.0 to 14.7 m
	Sta. 19+176	6	245.3 Range: 244.9 to 246.3	Boreholes 706-10S, 706-11S, 706-10M, 706-8NA, 706-9N, 706-9NA	A 0.1 to 1.2 m thick layer of peat underlain by soft to firm clayey silt overlying bedrock/inferred bedrock contacted at depths of 0.3 to 4.5 m
	Sta. 19+208	7	245.1 Range: 244.9 to 245.3	Boreholes 710-NW16, 710-NW18, 710-NW19 Penetration Test 710-NW17	A 200 to 500 mm thick layer of peat underlain by loose silt and soft to very soft clay overlying bedrock/inferred bedrock contacted at depths of 2.5 to 6.5 m

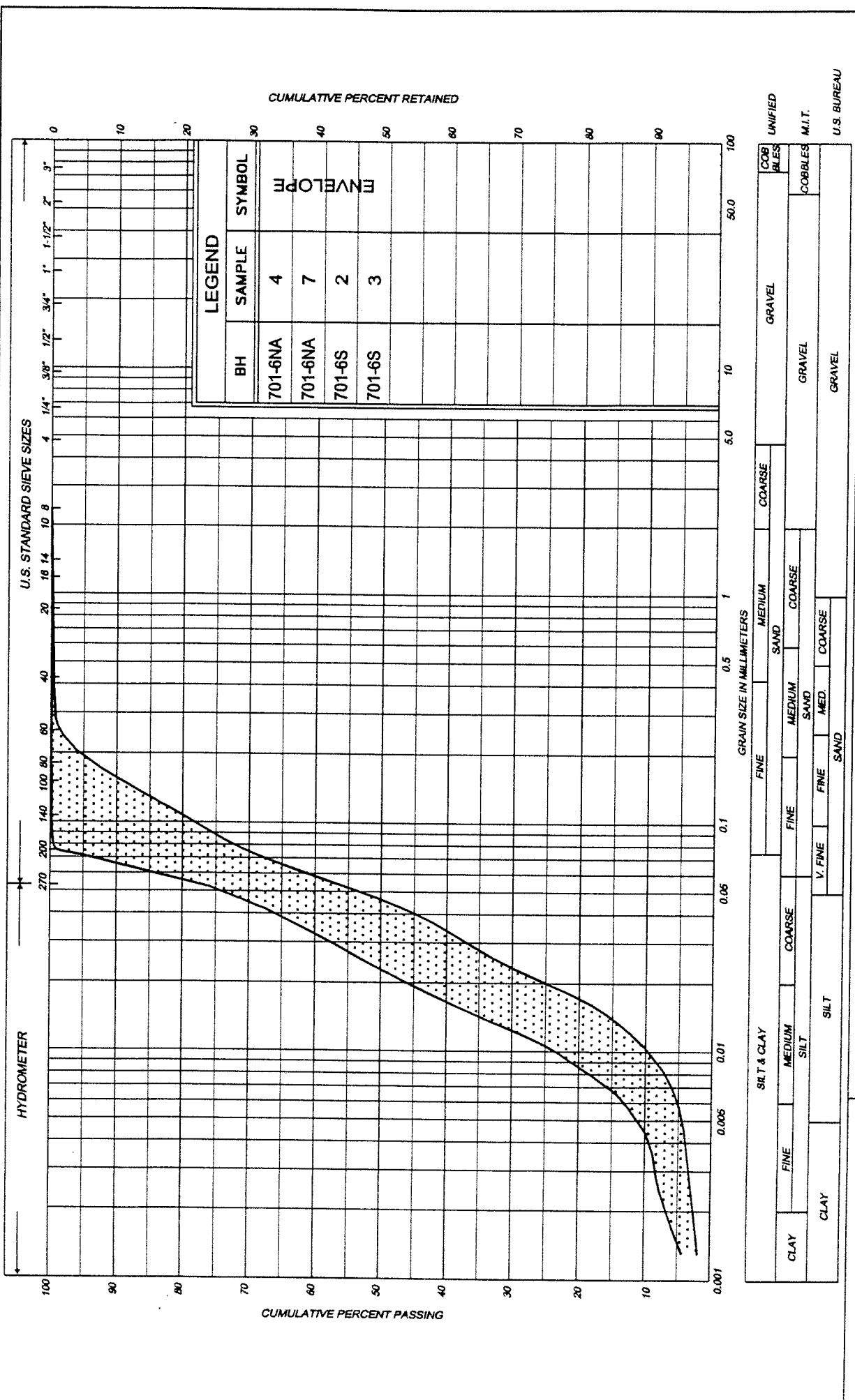
(1) Average elevation based on ground elevation of applicable test holes
(2) At time of field investigation

APPENDIX A

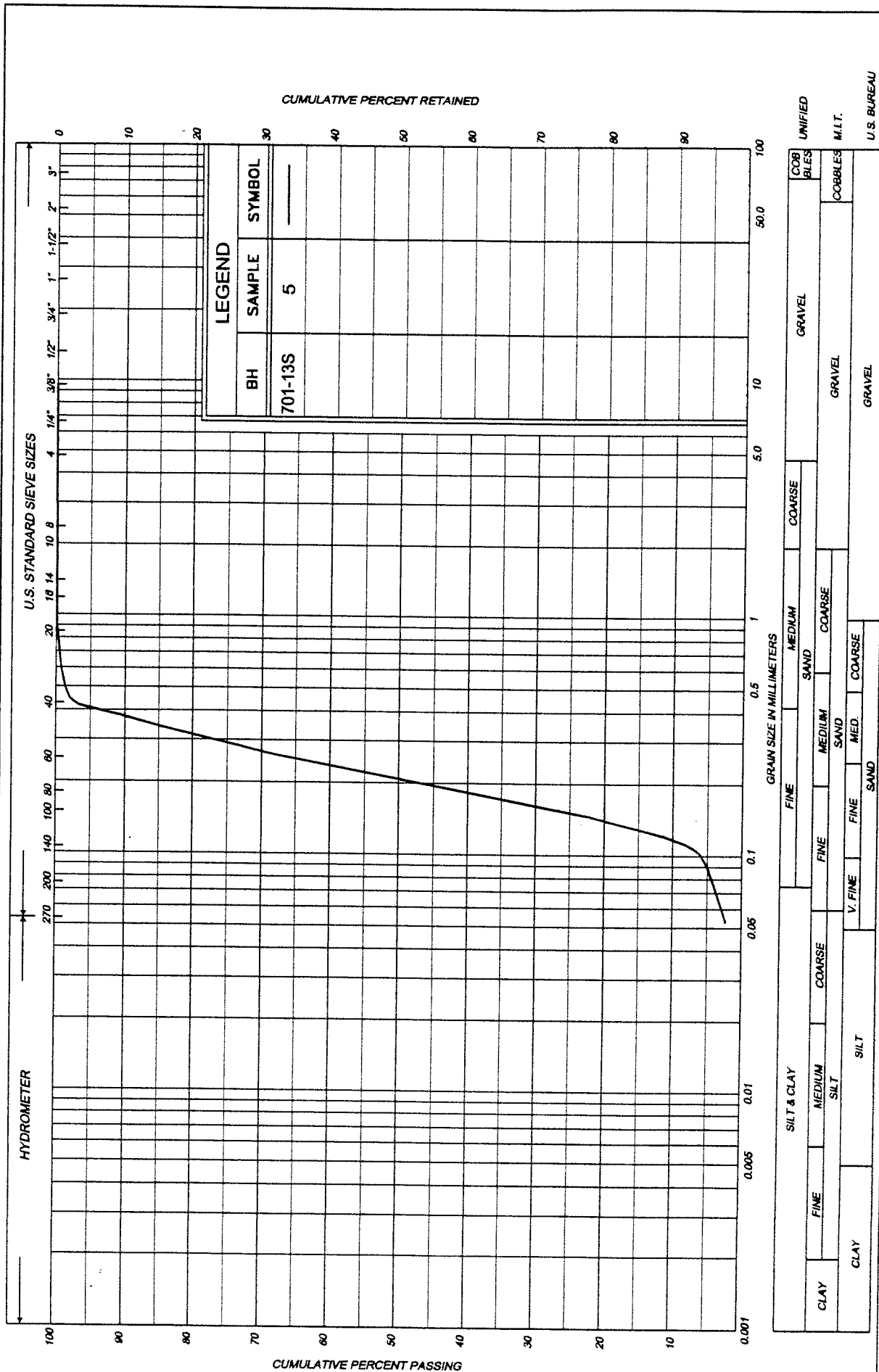
- **PLASTICITY CHARTS**
- **GRAIN SIZE DISTRIBUTION CHARTS**
- **LIST OF ABBREVIATIONS**
- **RECORD OF BOREHOLE AND
RECORD OF PENETRATION TEST SHEETS**
- **DRAWINGS**

CULVERT 1

- **PLASTICITY CHARTS**
Figures 1-1 and 1-2
- **GRAIN SIZE DISTRIBUTION CHARTS**
Figures 1-3 to Figures 1-6
- **RECORD OF BOREHOLE AND
PENETRATION TEST SHEETS**
- **DRAWING 1**



GRAIN SIZE DISTRIBUTION
SILT trace SAND, trace CLAY to
SANDY SILT trace CLAY



GRAIN SIZE DISTRIBUTION SAND trace SILT

FIG No 1-6
 HIGHWAY 69
 G.W.P No. 5556-02-00

U.S. BUREAU

RECORD OF BOREHOLE No 701-6S

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta 17+362.5 o/s 58m Lt CL Med. Culvert 7 ORIGINATED BY RE
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + NQ Coring COMPILED BY PC
DATUM Geodetic DATE February 04, 2003 CHECKED BY CLK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
231.3	Ground Surface							20 40 60 80 100						GR SA SI CL	
0.0	Topsoil		1	SS	4		231							0 14 79 7	
0.4	Silt, trace to some sand trace clay						230								
	Loose Grey Moist														
	Gray/brown		2	SS	7										
	Wet						229								
			3	SS	6		228								
227.3	Granitic Gneiss Bedrock		4	RC NQ	REC 82%		227							RQD 23%	
4.1			5	RC NQ	REC 99%		226							RQD 98%	
			6	RC NQ	REC 91%		225							RQD 86%	
223.6	End of borehole Refusal on probable bedrock						224								
7.7															
	2003 02 04														
	Water level observed during drilling														
	Water level measured after drilling														

RECORD OF BOREHOLE No 701-10S

1 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+375, o/s 68m Lt. CL Med. ORIGINATED BY RE
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 06, 2003 CHECKED BY Cez

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								20 40 60 80 100										
231.4	Ground Surface																	
0.0	Topsoil		1	SS	6		231											
0.3	Silt, trace sand trace clay																	
230.2	Loose Brown Moist																	
1.2	Silty clay, trace sand		2	SS	8		230											
	Firm Brown Moist																	
228.7	Silt, trace sand trace clay						229											
2.8	Loose Brown Wet /Grey		3	SS	9		228											
							227											
	Very loose		4	SS	1		226											
			5	SS	4		225											
							224											
			6	SS	WR**		223											
			7	SS	4		222											
							221											
	fine sand																	
	Loose		8	SS	5		220											
			9	SS	4		219											
							218											
217.7	Sand, fine to medium with silt trace gravel		10	SS	15		217											
216.9	Compact Grey Wet																	
214.9	End of borehole																	
	Cont'd																	

RECORD OF BOREHOLE No 701-10S

2 of 2

METRIC

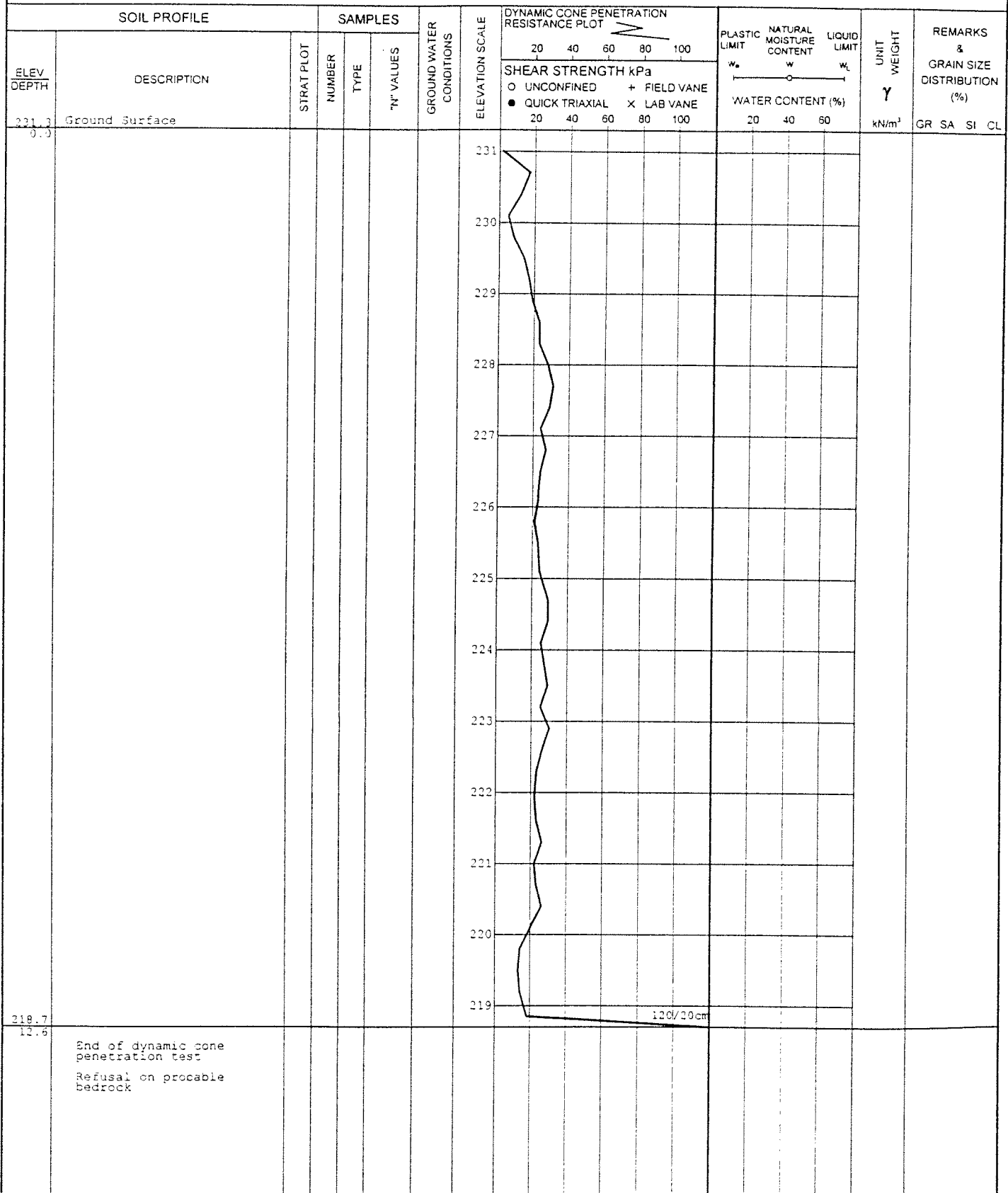
G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+375, o/s 68m Lt. CL Med. ORIGINATED BY RE
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 06, 2003 CHECKED BY CL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
							20	40	60	80	100					
231.4	Cont'd Refusal on probable bedrock															
	• 2003 02 06 ▽ Water level observed during drilling ▽ Water level measured after drilling ■ Penetrometer test WR** Refers to penetration under weight of rods only															

RECORD OF PENETRATION TEST No 701-11S

1 of 1 METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta 17+387.5 o/s 58m Lt. CL Med. ORIGINATED BY RE
DIST S4 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY PC
DATUM Geodetic DATE February 06, 2003 CHECKED BY cy



RECORD OF BOREHOLE No 701-12S

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+400, o/s 12m Lt. CL Med. ORIGINATED BY RE
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 06, 2003 CHECKED BY 47

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					
230.9	Ground Surface																
0.0	Topsoil		1	SS	10												
0.3	Silt, trace sand trace clay Compact Brown Moist						230										
229.7																	
1.2	Silty clay, trace sand Firm Light brown Moist		2	SS	4		229										
			3	SS	5		228										
227.8																	
3.7	Silt, trace sand trace clay Loose Grey Moist						227										
			4	SS	6		226										
225.0							225										
6.0	End of borehole Refusal on probable bedrock * Borehole dry on completion of drilling																

METRIC

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
231.1	Ground Surface								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE 20 40 60 80 100						WATER CONTENT (%) 20 40 60		

[illegible]

RECORD OF BOREHOLE No 701-4M

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+407, CL Med. ORIGINATED BY EP
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE March 04, 2003 CHECKED BY Ciy

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
231.0	Ground Surface																
0.0	Peat, fine fibrous		1	SS	12												
0.3	Dark brown Clayey silt trace sand Stiff Brown Moist silty clay seams Varved		2	SS	10												
228.0	Silt, trace clay trace sand Loose to Brown Wet very loose		3	SS	4												
3.0			4	SS	7												
225.5	Sandy silt trace clay Very loose Brown Wet		5	SS	WR**												
5.5																	
223.7	End of borehole Refusal on probable bedrock																
7.3																	

RECORD OF BOREHOLE No 701-6N

1 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+400, o/s 19m Rt. CL Med. ORIGINATED BY EP
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE March 03, 2003 CHECKED BY Cb

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 Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100	20 40 60 80 100					
231.1	Ground Surface												
0.0	Peat, fine fibrous		1	SS	6								
0.3	Dark brown Silty clay, trace fine sand		2	SS	5								
	Firm Brown Moist												
	silt seams		3	SS	6								
226.7	Silt, trace clay trace sand		4	SS	10								
4.4	Compact Brown Wet		5	SS	15								
223.5	Silty sand trace gravel		6	SS	WR**								
7.6	Very Brown Wet Loose		7	SS	WR**								
	trace clay		8	SS	3								
			9	SS	4								
			10	SS	1								

Cont'd

RECORD OF BOREHOLE No 701-6N

2 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+400, o/s 19m Rt. CL Med. ORIGINATED BY EP
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE March 03, 2003 CHECKED BY CH

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100					
231.1													
215.9	Cont'd					216							
13.3	End of borehole Refusal on probable bedrock • 2003 03 03 ▽ Water level observed during drilling ▼ Water level measured after drilling ■ Penetrometer test WR** Refers to penetration under weight of rods only												

RECORD OF BOREHOLE No 701-6NA

1 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+400, o/s 12m Rt. CL Med. ORIGINATED BY RE
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 07, 2003 CHECKED BY Cg

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	20 40 60 80 100	20 40 60 80 100					
231.1	Ground Surface														
0.0	Topsoil		1	SS	7		231								
0.3	Silt, trace sand trace clay														
229.9	Loose Light Moist brown						230								
1.2	Silty clay trace sand		2	SS	8										
	Firm to Brown Moist Soft						229								0 2 46 52
			3	SS	4		228								
227.3	Silt, trace sand trace clay														
3.9	Loose Grey Moist to wet		4	SS	6		227								
			5	SS	6		226								0 1 96 3
							225								
							224								
223.5	Sandy silt trace clay		6	SS	1		223								
7.6	Very Grey Wet loose		7	SS	WR**		222								0 30 67 3
			8	SS	WR		221								
			9	SS	4		220								
							219								
217.6	Sand, medium to coarse trace silt trace gravel		10	SS	50/12cm		218								
13.5	Very Brown Moist dense						217								
216.9	End of borehole														
14.2	Refusal on probable bedrock														

RECORD OF BOREHOLE No 701-6NB

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta 17+400 o/s 37m Rt. CL Med. ORIGINATED BY RE
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 05, 2003 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
230.7	Ground Surface							20	40	60	80	100				
0.0	Topsoil															
0.2	Silt, trace sand trace clay Loose Grey Wet		1	SS	50/8cm		230								186	
			2	SS	10		229									
							228									
	sandy silt		3	SS	5		227									
226.7							226									
4.0	Sand, trace silt trace gravel Very loose Brown Wet		4	SS	WR**		225									
							224									
			5	SS	1		223									
223.1																
7.6	Silt, trace fine sand trace clay		6	SS	15											
222.6																
8.1	Compact Brown Moist End of borehole Refusal on probable bedrock															
<div>* 2003 02 05</div> <div>▽ Water level observed during drilling</div> <div>▼ Water level measured after drilling</div> <div>WR** Refers to penetration under weight of rods only</div>																

* 2003 02 05

▽ Water level observed
during drilling

▽ Water level measured
after drilling

WR** Refers to penetration
under weight of rods
only

RECORD OF BOREHOLE No 701-7N

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta 17+412.5 b/s 57m Rt. CL Med. Culvert 7
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + NO Coring
DATUM Geodetic DATE February 03, 2003
ORIGINATED BY RE
COMPILED BY PC
CHECKED BY C4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							x LAB VANE	
230.7	Ground Surface						20	40	60	80	100	20	40	60	GR SA SI CL			
0.0	Topsoil																	
0.2	Silt, trace sand trace clay																	
229.5	Very loose Grey Moist		1	SS	2													
1.2	Clayey silt some sand																	
	Firm Grey Moist		2	SS	6										0 12 73 15			
			3	SS	4													
			4	SS	5													
	Wet		5	SS	7										0 1 97 12			
			6	SS	5													
			7	SS	7													
224.5	Silt, trace sand trace clay		8	SS	WR**													
0.1	Very loose to loose Grey Wet																	
			9	SS	1													
			10	SS	50/8cm													
221.4	Granitic gneiss Bedrock sound		11	RC NQ	REC 98%										RQD 98%			
9.3			12	RC NQ	REC 100%										RQD 82%			
219.4	End of borehole																	
12.3	Refusal on probable bedrock																	
	2003 02 03																	
	Water level observed during drilling																	
	Water level measured after drilling																	
	WR** Refers to penetration under weight of rods only.																	

1 of 1 METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+437.5, o/s 55m Rt. CL Med. ORIGINATED BY RE
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY PC
DATUM Geodetic DATE February 07, 2003 CHECKED BY ML

MOT DCPT SWAMP 701.GPJ ON MOT.GDT 6/2/03 6:29:30 PM

$+^7 \cdot X^5$: Numbers refer to Sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10

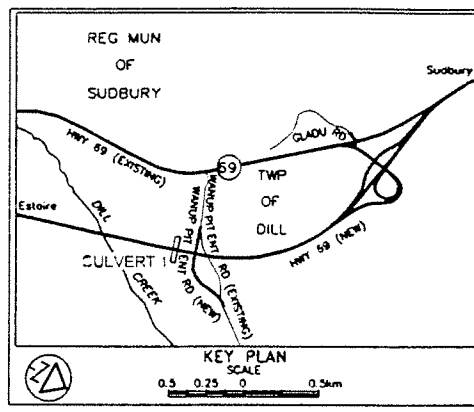
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 5556-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE
From 6.7km North of Highway 537 Northerly 2.8km
CULVERT 1
BOREHOLE LOCATIONS

SHEET

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CONSULTING ENGINEERS



- LEGEND**
- Borehole
 - Dynamic Cone Penetration Test (Cone)
 - Borehole & Cone
 - N Blows/0.3m (Std. Pen Test, 475 J / blow)
 - CONE Blows/0.3m (60° Cone, 475 J / blow)
 - W L at time of investigation Feb 2003
 - Head
 - ARTESIAN WATER Encountered
 - PIEZOMETER

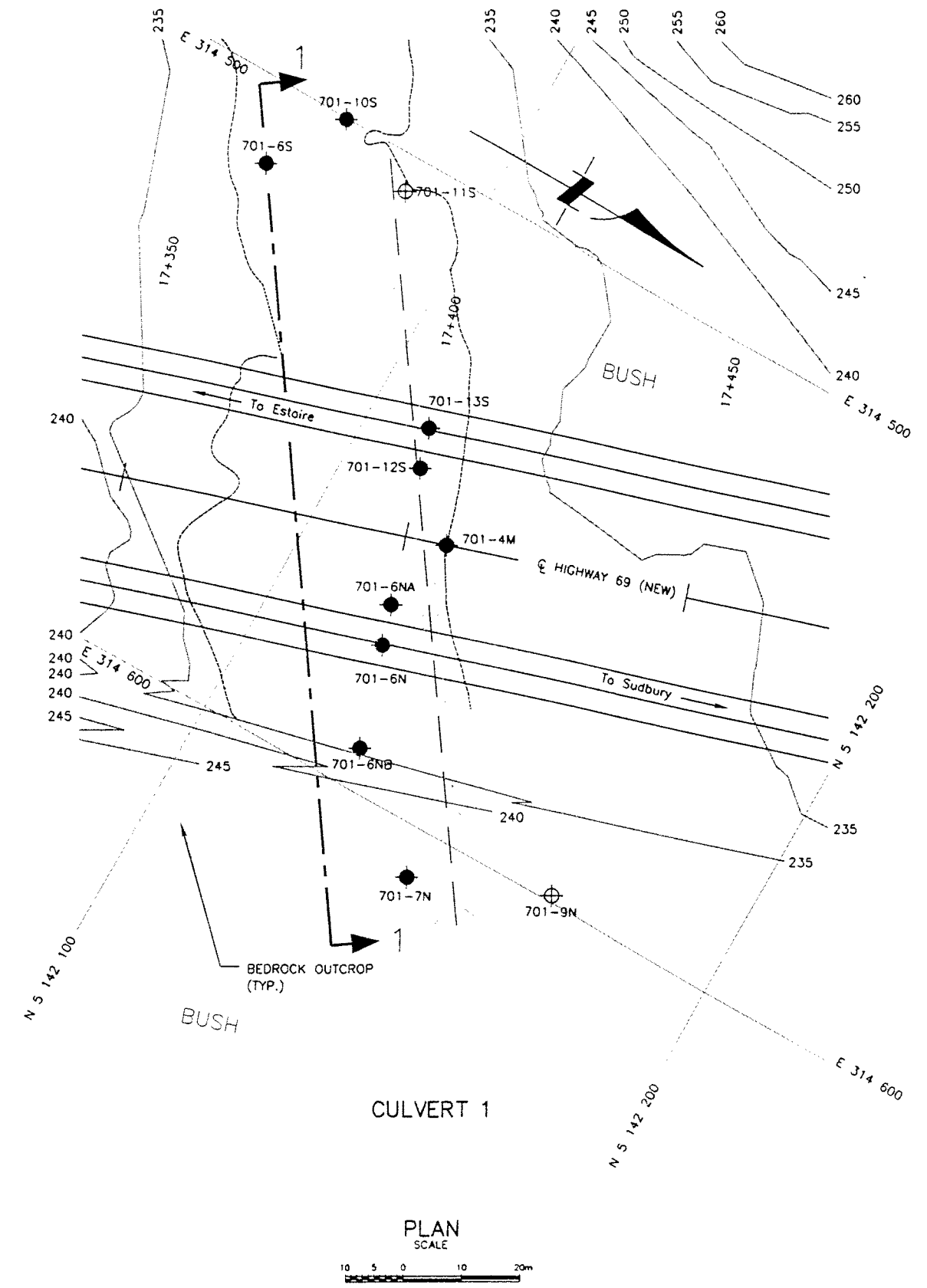
BH No	ELEVATION	STA	o/s CL MED
701-4M	231.0	17+407	CL
701-6N	231.1	17+400	19.0m Rt
701-6NA	231.1	17+400	12.0m Rt
701-6NB	230.7	17+400	37.0m Rt
701-7N	230.7	17+412.5	57.0m Rt
701-9N	230.8	17+437.5	55.0m Lt

(Legend Continues)

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

DATE	BY	DESCRIPTION

Geocres No. 42L-167		
HWY No. 69		OPST 54
SUBM'D PC CHECKED VV	DATE AUG 13, 2003	SITE
DRAWN MM CHECKED GD/CN	APPROVED DWK	DWG 1



(Legend Continued)

BH No	ELEVATION	STA	o/s CL MED
701-6S	231.3	17+362.5	58.0m Lt
701-10S	231.4	17+375	68.0m Lt
701-11S	231.3	17+387.5	58.0m Lt
701-12S	230.9	17+400	12.0m Lt
701-13S	231.1	17+400	19.0m Lt

NOTE:
REFER TO DRAWING 1A FOR SECTION 1-1

REF No E-HWY69N-ALIGN.dwg; April 2003
Civ7and9.dwg; February 2003
Peto.dwg; March 2003
I_bpi07.dwg; December 2002

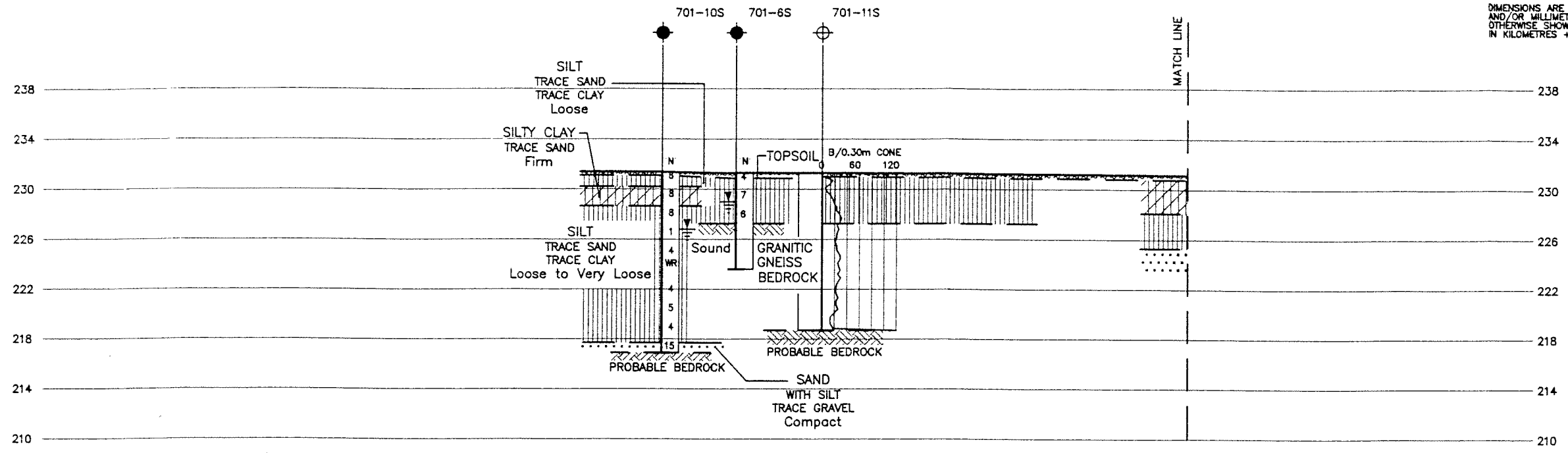
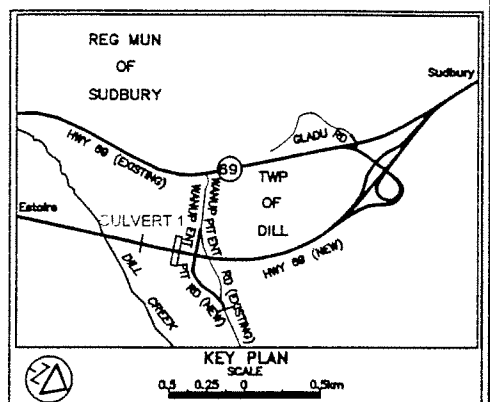
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 5556-02-00

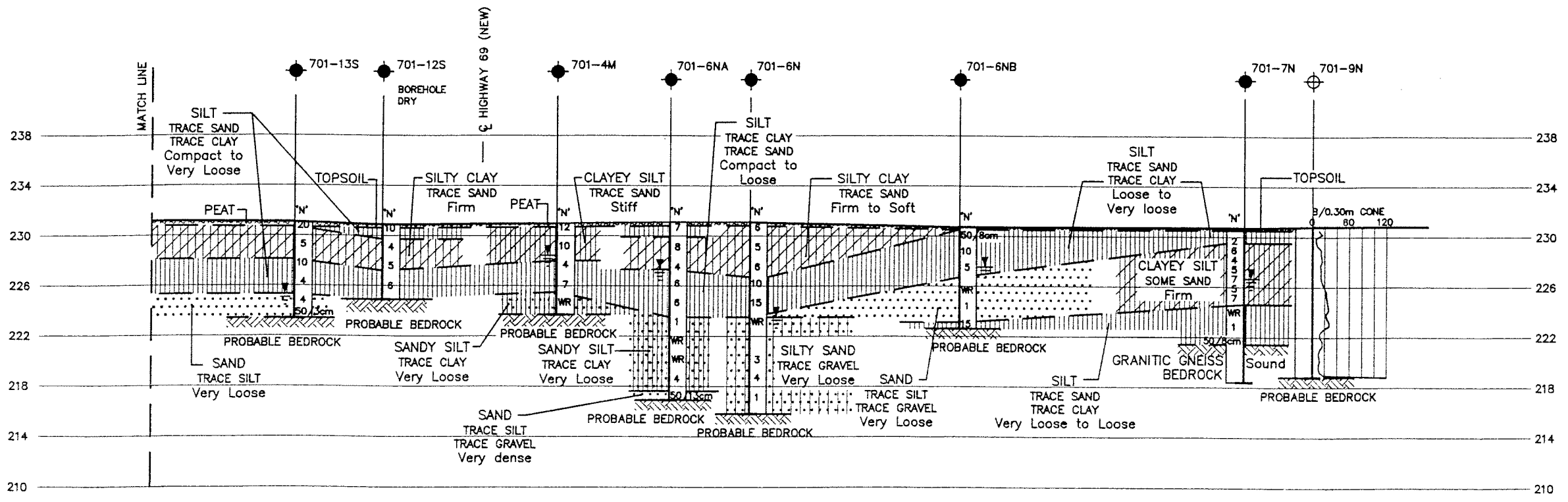
HIGHWAY 69
HIGHWAY 69 FOUR LANE
From 6.7km North of Highway 537 Northerly 2.8km
CULVERT 1
SOIL STRATA

SHEET

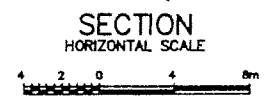
Peto MacCallum Ltd.
CONSULTING ENGINEERS



CULVERT 1
SECTION 1-1



CULVERT 1
SECTION 1-1 (Continued)



LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE Blows/0.3m (60° Cone, 475 J / blow)
- W L at time of Investigation Feb-May 2003
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	STA	p/s CL MED
(Refer to drawing 1 for co-ordinates)			

(Legend Continues)

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

NOTE:
REFER TO DRAWING 1 FOR PLAN

REF No E-HWY69N-ALIGN.dwg; April 2003
CIV7and9.dwg; February 2003
PETO.dwg; March 2003
I_bpl07.dwg; December 2002

DATE	BY	DESCRIPTION

Geocres No. 42L-167

HWY No	69	DIST	54
SUBMIT	PC	CHECKED	WV
DATE	AUG 13, 2003	SITE	
DRAWN	MM	CHECKED	GD/CN
APPROVED		DWG	1A

CULVERT 2

- **RECORD OF BOREHOLE AND
PENETRATION TEST SHEETS**
- **DRAWING 2**

RECORD OF BOREHOLE No CV8-1

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 63 Sta. 17+680, o/s 35.5m Lts. CL Med. Culvert 9 ORIGINATED BY EP
DIST 54 HWY 63 BOREHOLE TYPE C.F.H.S.A., NW Wash Boring and NQ Coring COMPILED BY PC
DATUM Geodetic DATE May 10, 2003 CHECKED BY Cy

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	20 40 60 80 100					
248.0	Ground Surface													
247.0	Sand and gravel trace silt													
247.0	Brown (FILL)													
246.0	Silt, trace sand trace clay													
246.0	Compact Brown Dry													
245.0	Clayey silt Varved		1	SS	11									
244.0	Stiff to firm Brown Moist													
243.0	silt lenses		2	SS	4									
242.0	Grey Wet													
241.0	silty sand lenses		3	SS	2									
240.0														
239.0			4	SS	6									
238.0														
237.0			5	SS	WR**									
236.0														
235.0			6	SS	WR									
234.0	Sand, fine to coarse with silt													
233.0	Very Grey Saturated loose													
232.0			7	RC NQ	REC 100%									RQD 57%
231.0	Gabbro Bedrock													
230.0	Sound		8	RC NQ	REC 100%									RQD 98%
229.0			9	RC NQ	REC 97%									RQD 97%
228.0	End of borehole													
* 2003 05 10 ■ Penetrometer test ∇ Water level observed during drilling WR** Refers to penetration under weight of rods only														

RECORD OF BOREHOLE No CV8-2 1 of 1 METRIC

G.W.P. 5556-02-00 LOCATION Hwy. 69 Sta. 17+700, o/s 39.0m Rt. CL Med. Culvert 9 ORIGINATED BY FP
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A., NW Wash Boring and NQ Coring COMPILED BY PC
DATUM Geodetic DATE May 10 and 11, 2003 CHECKED BY CA

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			
246.0	Ground Surface														
0.0	Peat, fine fibrous		1	SS	4										
0.2	Dark brown Clayey silt, trace sand														
	Stiff Brown Moist		2	SS	5										
243.3	Silt, trace clay sandy silt seams		3	SS	15										
2.7	Compact Brown Wet														
	Very loose		4	SS	4										
			5	SS	WR**										
238.9	Gabbro Bedrock		6	RC NQ	REC 88%										RQD 81%
7.1	Sound		7	RC NQ	REC 97%										RQD 90%
			8	RC NQ	REC 100%										RQD 60%
235.7	End of borehole														
10.3															

* 2003 05 10

▽ Water level
observed during
drilling
■ Penetrometer test

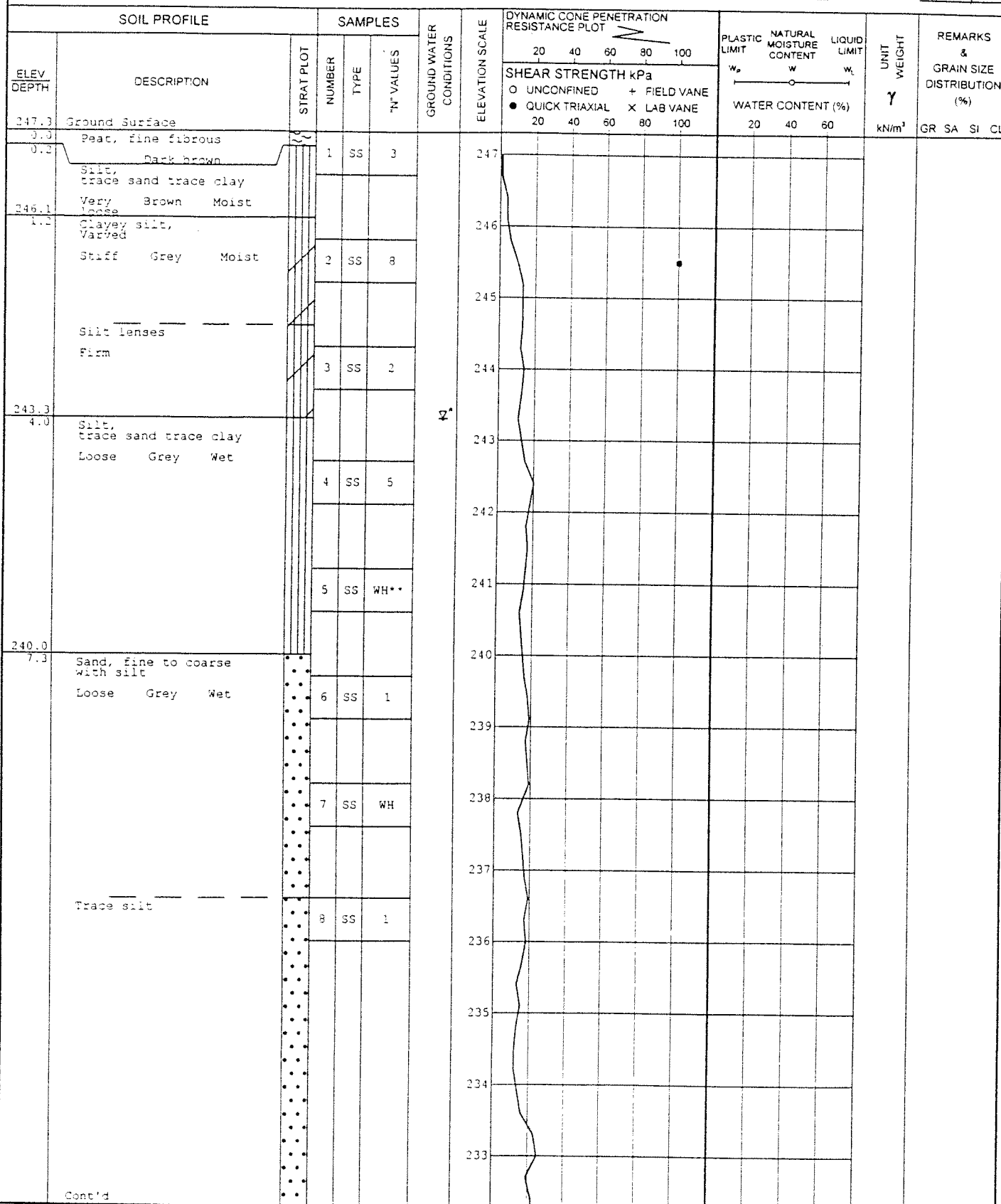
WR** Refers to
penetration under
weight of rods only

RECORD OF BOREHOLE No 701-27SA

1 of 2

METRIC

G.W.P. 3556-02-00 LOCATION Hwy 69 Sta. 17+675, o/s 16m Lt. CL Med. ORIGINATED BY EP
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. & Dynamic Cone Penetration Test COMPILED BY PC
DATUM Geodetic DATE May 11, 2003 CHECKED BY Cy



Cont'd

RECORD OF BOREHOLE No 701-27SA

2 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+675, o/s 16m Lt. CL Med. ORIGINATED BY FP
DIST 54 HWY 69 BOREHOLE TYPE C.F.W.S.A. & Dynamic Cone Penetration Test COMPILED BY PC
DATUM Geodetic DATE May 11, 2003 CHECKED BY C4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w_p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
247.3								20 40 60 80 100						
231.3	Cont'd	• •					232	○ UNCONFINED + FIELD VANE						
18.4	End of borehole							● QUICK TRIAXIAL X LAB VANE						
231.3								20 40 60 80 100						
16.3	End of dynamic cone penetration test						231		120/10cm					
	<div>* 2003 05 11</div> <div>▽ Water level observed during drilling</div> <div>WH** Refers to penetration under weight of rods and hammer</div>													

RECORD OF BOREHOLE No 701-28S

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+700, 3/s 15m Lt. CL Med. ORIGINATED BY pp
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE April 27, 2003 CHECKED BY cy

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					
249.0	Ground Surface																
247.0	Mixed sand, gravel Compact Brown Moist (FILL)		1	SS	13												
246.8																	
246.3	Silt, trace sand trace clay Compact Grey/ Moist brown		2	SS	13												
245.3																	
245.1	Sand, trace silt Compact Brown Moist																
244.6	trace gravel		3	SS	17												
244.6	End of borehole Refusal on probable bedrock																
	* Borehole dry on completion of drilling																

RECORD OF BOREHOLE No 701-17N

1 of 1

METRIC

G.W.P 5556-02-00

LOCATION Hwy 69 Sta. 17+675, o/s 15.5 Rt. CL Med.

ORIGINATED BY RE

DIST 54

HWY 59

BOREHOLE TYPE Continuous Flight Hollow Stem Augers

COMPILED BY PC

DATUM Geodetic

DATE March 05, 2003

CHECKED BY *ch*

[illegible]

RECORD OF BOREHOLE No 701-17NA 1 of 1 METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Std. 17+700, o/s 15m Rt. CL Med. ORIGINATED BY EP
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE May 11, 2003 CHECKED BY cz

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
247.5	Ground Surface															
0.0	Mixed silt (FILL)															
246.1	Clayey silt Firm Grey Wet to stiff		1	SS	5											
245.2	Silt, trace clay sandy silt lenses Very loose Grey Wet to loose		2	SS	2											
			3	SS	6											
243.1	Sand, fine to coarse with silt Very loose Grey Wet		4	SS	1											
			5	SS	1											
			6	SS	1											
			7	SS	WH**											
235.7	End of borehole															
11.9	Refusal on probable bedrock															
	2003 05 11															
	▽ Water level observed during drilling															
	▼ Water level measured after drilling															
	WH** Refers to penetration under weight of rods and hammer															

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

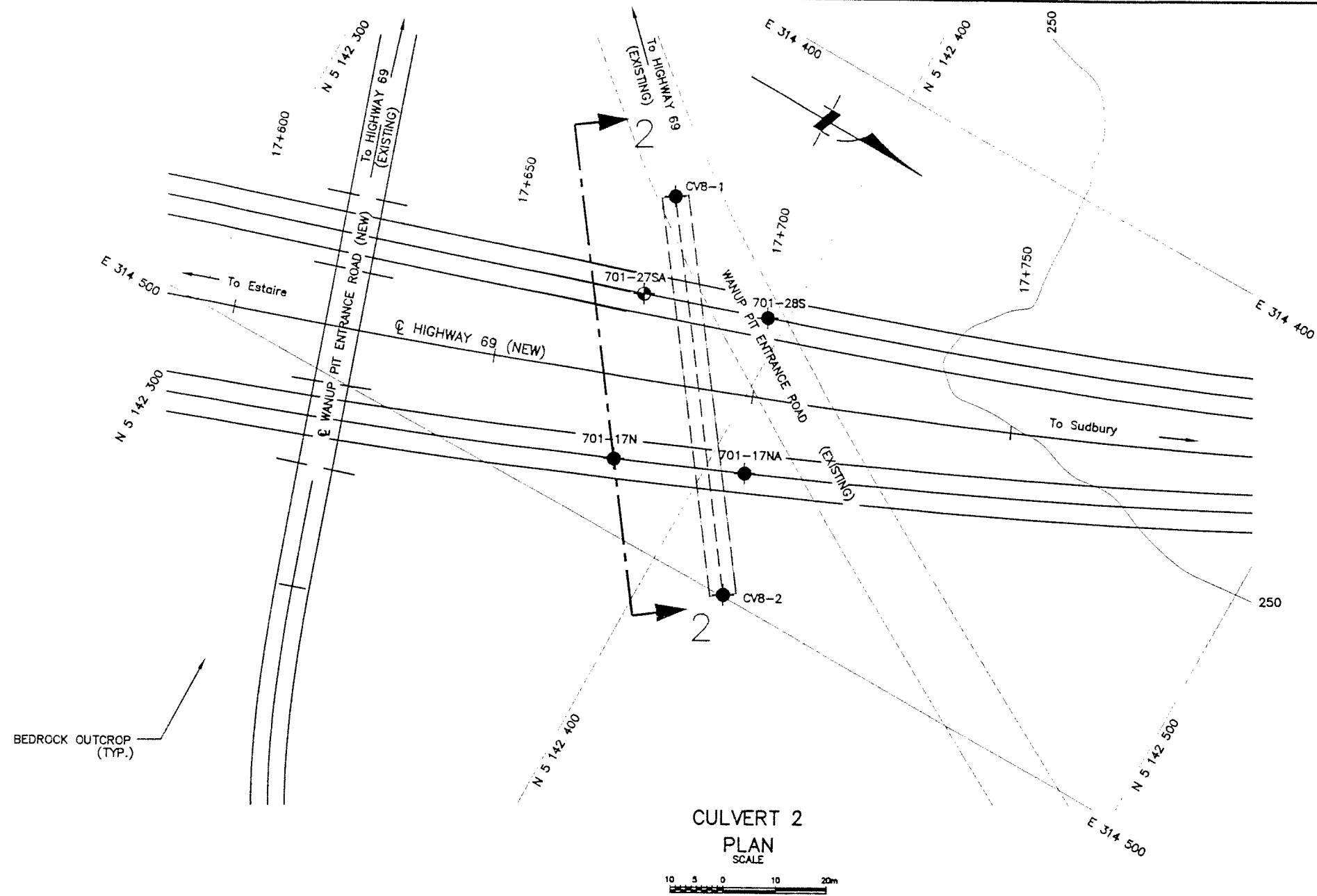
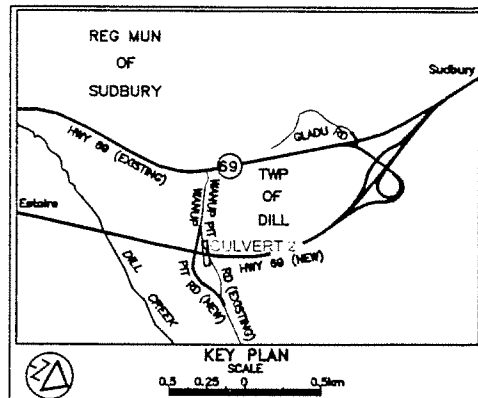
CONT No
GWP No 5556-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE
From 6.7km North of Highway 537 Northerly 2.8km
CULVERT 2
BOREHOLE LOCATIONS



SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



LEGEND			
	Borehole		
	Dynamic Cone Penetration Test (Cone)		
	Borehole & Cone		
N	Blows/0.3m (Std. Pen Test, 475 J / blow)		
CONE	Blows/0.3m (60° Cone, 475 J / blow)		
	W L at time of investigation Feb-May 2003		
	Head		
	ARTESIAN WATER Encountered		
	PIEZOMETER		

BH No	ELEVATION	STA	p/s CL MED
701-17N	248.2	17+675	15.5m Rt
701-17NA	247.6	17+700	15.0m Rt
701-27SA	247.3	17+675	18.0m Lt
701-28S	248.0	17+700	15.0m Lt
CV2-1	248.0	17+680	35.5m Lt
CV2-2	248.0	17+700	38.0m Rt

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

DATE	BY	DESCRIPTION

NOTE:
REFER TO DRAWING 2A FOR SECTION 2-2

REF No E-North_South-des-preferred.dwg; Jan 2003
PETO.dwg; March 2003
L_bpi07.dwg; July 2001

Geocree No.	42L-167
HWY No	69
SUBMIT	PC
CHECKED	VV
DATE	AUG 13, 2003
SITE	
DRAWN	MM
CHECKED	GD/CN
APPROVED	DWK
DWG	2

METRIC

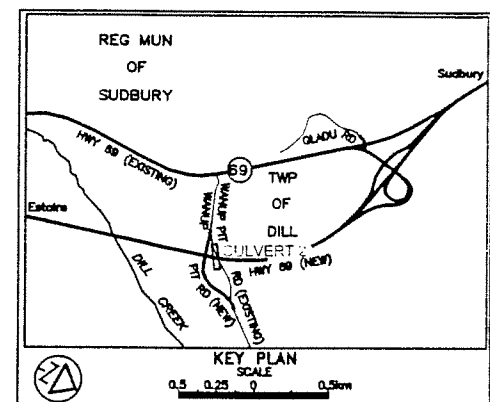
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 5556-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE
From 8.7km North of Highway 537 Northerly 2.8km
CULVERT 2
SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



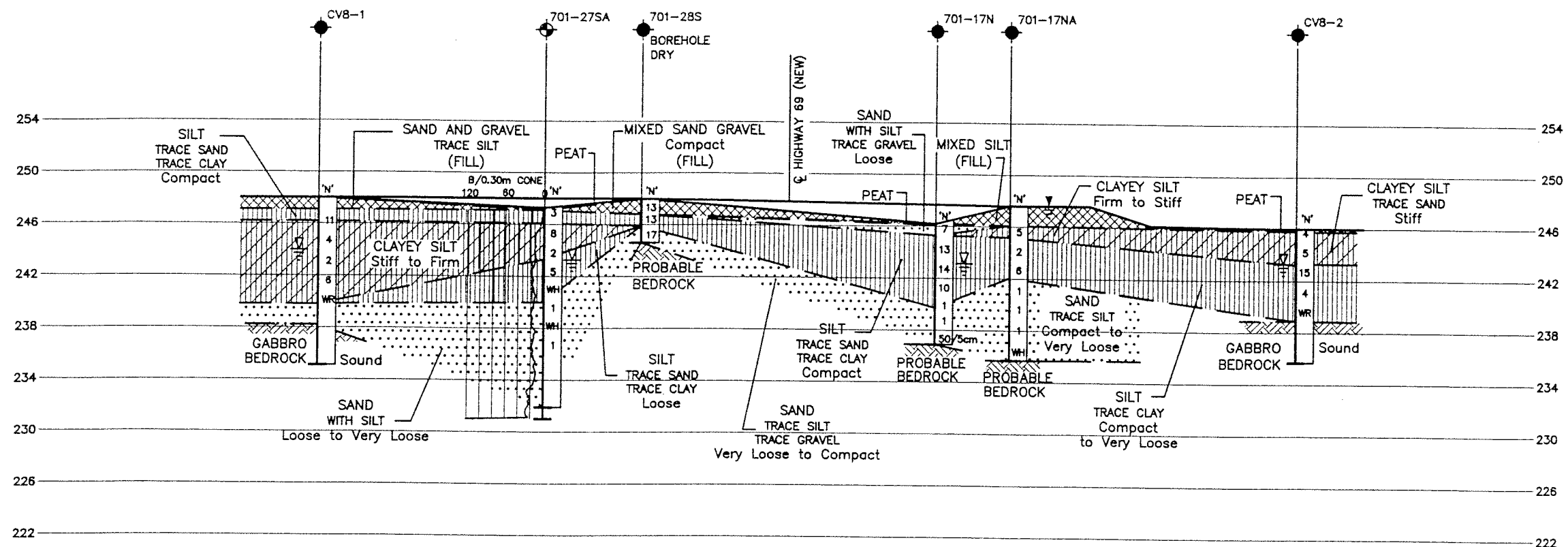
LEGEND	
	Borehole
	Dynamic Cone Penetration Test (Cone)
	Borehole & Cone
N	Blows/0.3m (Std. Pen Test, 475 J / blow)
CONE	Blows/0.3m (80° Cone, 475 J / blow)
	W L at time of investigation Feb-May 2003
	Head
	ARTESIAN WATER Encountered
	PIEZOMETER

BH No	ELEVATION	STA	p/s CL MED
(Refer to drawing 2 for co-ordinates)			

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

DATE	BY	DESCRIPTION

Geocore No. 42L-167					
HWY No 69					54
SUBMIT PC	CHECKED VV	DATE AUG 13, 2003	SITE		
DRAWN MM	CHECKED/CM	APPROVED DMK	DWG	2A	



CULVERT 2
2-2

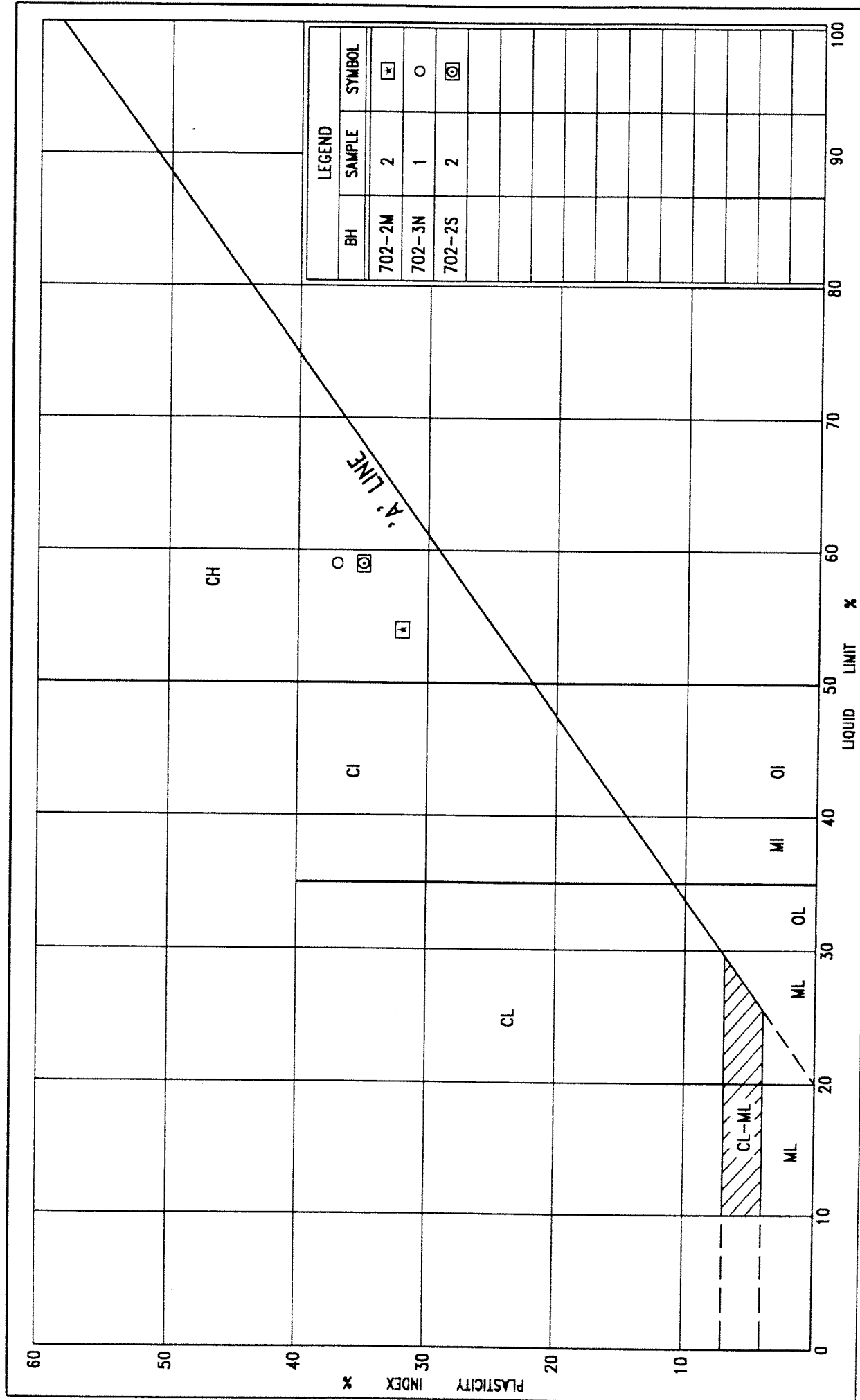
SECTION
HORIZONTAL SCALE
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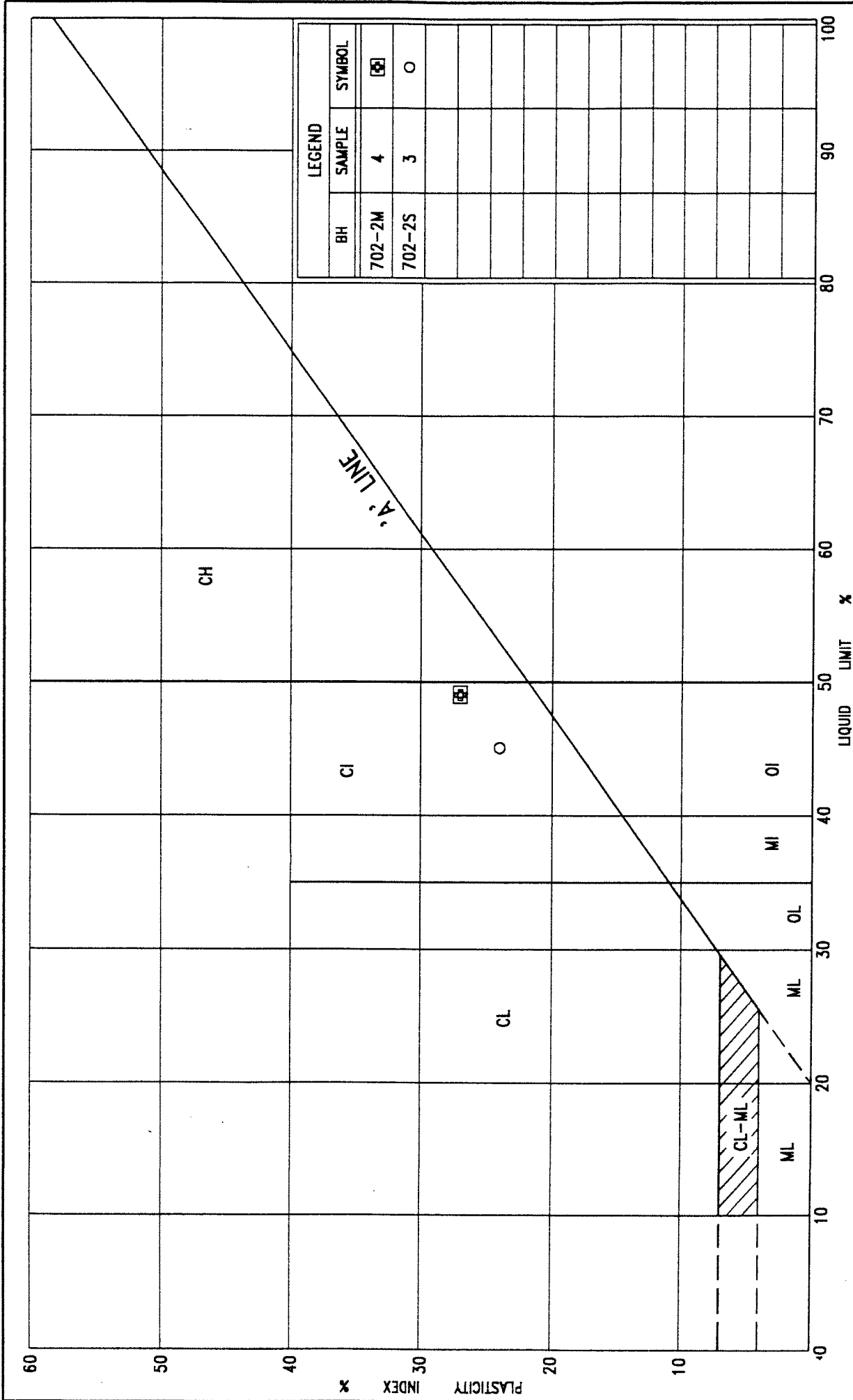
NOTE:
REFER TO DRAWING 2 FOR PLAN

REF No E-North_South-des-preferred.dwg; Jan 2003
PETO.dwg; March 2003
I_bp107.dwg; July 2001

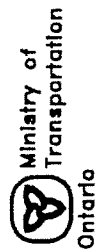
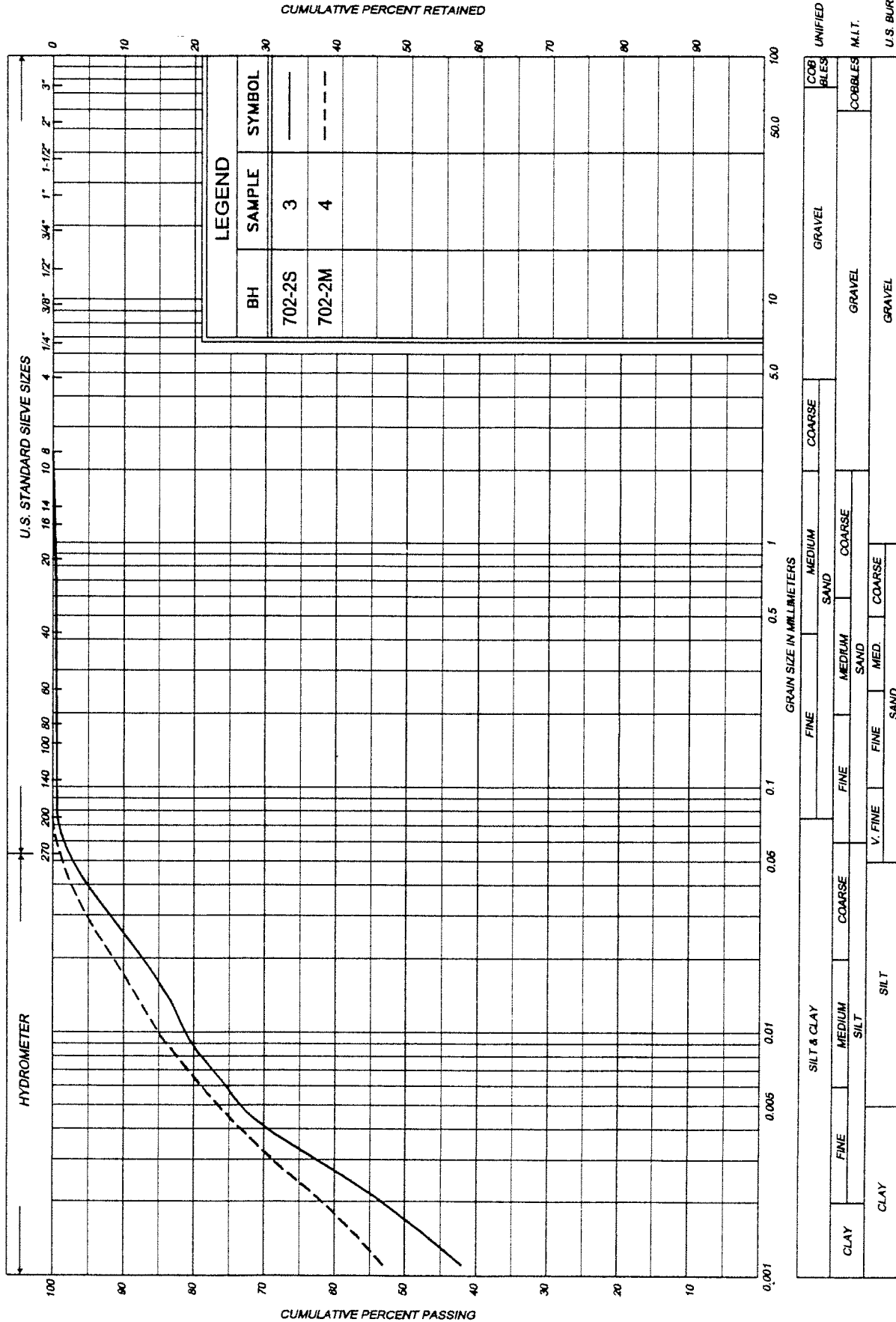
CULVERT 3

- **PLASTICITY CHARTS**
Figures 3-1 to 3-3
- **GRAIN SIZE DISTRIBUTION CHARTS**
Figures 3-4 to 3-7
- **RECORD OF BOREHOLE AND
PENETRATION TEST SHEETS**
- **DRAWING 3**





	PLASTICITY CHART SILTY CLAY to SILTY CLAY trace SAND (CI)		FIG No	3-2
			HIGHWAY 69	
			G.W.P. No. 5556-02-00	



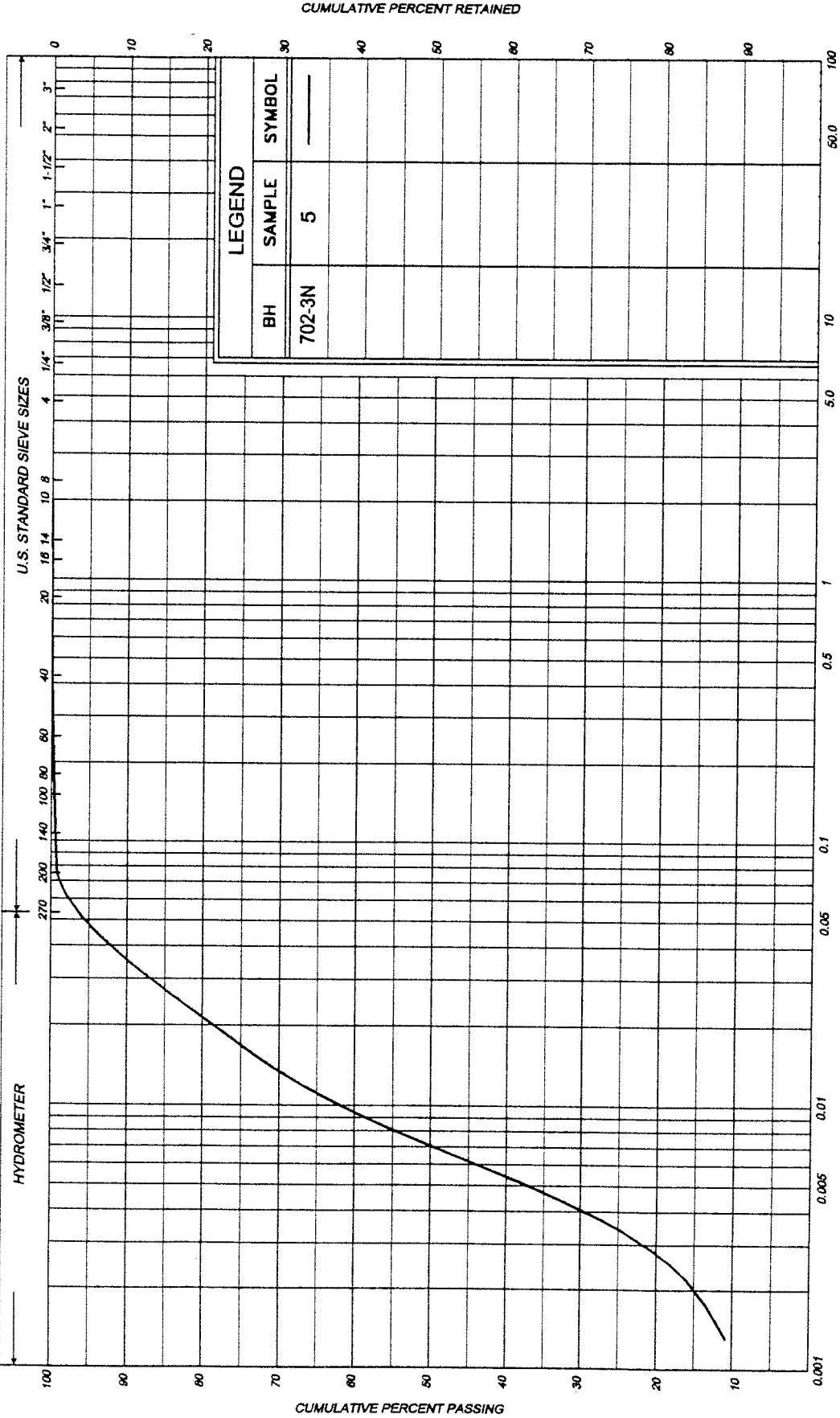
GRAIN SIZE DISTRIBUTION SILTY CLAY trace SAND (ci)

FIG No 3-5

HIGHWAY 69

G.W.P No. 5556-02-00

U.S. BUREAU										UNIFIED	
										COBBLES	
										M.I.T.	
										GRAVEL	
										GRAVEL	
										SAND	
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LEGEND		
BH	SAMPLE	SYMBOL
702-3N	5	—

GRAVEL SIZE IN MILLIMETERS												COBBLES	UNIFIED
SILT & CLAY				FINE		MEDIUM		SAND		COARSE			
CLAY	FINE	MEDIUM	SILT	COARSE		FINE	MEDIUM	SAND	COARSE		GRAVEL	COBBLES	
CLAY			SILT			V. FINE	FINE	MED.	SAND		GRAVEL		
GRAVEL													U.S. BUREAU



GRAIN SIZE DISTRIBUTION CLAYEY SILT trace SAND (CL)

FIG No 3-6
HIGHWAY 69
G.W.P No. 5556-02-00

RECORD OF BOREHOLE No 702-1SA

1 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+928, o/s 23m Lt. Culvert 9 ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + NQ Rock Coring COMPILED BY PC
DATUM Geodetic DATE March 05, 2003 CHECKED BY CS

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	20 40 60 80 100					
249.7	Ground surface													
0.0	Peat, coarse fibrous													
0.3	Dark brown Clay trace sand													
	Very Brown Moist stiff													
247.0	Silty clay													
2.7	Soft Brown Wet		1	SS	7									
	Firm Grey		2	SS	2									
	Silt layers		3	SS	WR**									
			4	SS	WR									
242.5	Silt, trace sand some clay													
7.2	Very Grey Wet loose to loose		5	SS	3									
			6	SS	3									
			7	SS	7									
			8	SS	WR									
236.0	Boulders													
13.7			9	RC NQ										
	Cont'd													

ON_MOT VER3 SWAMP 702- MARCH 7, 2003.GPJ ON_MOT.GDT 8/2/03 7:32:39 PM

+ X⁵ Numbers refer to
Sensitivity

20
15 5 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 702-1SA

2 of 2

METRIC

G.W.P. 0556-02-00 LOCATION Hwy 69 Sta. 17+929, 313 23m St. Culvert 3
DIST 34 HWY 69 BOREHOLE TYPE C.E.H.S.A. + NO Rock Logging
DATUM Geodetic DATE March 05, 2003
ORIGINATED BY MR
COMPILED BY PC
CHECKED BY C4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
249.7								20	40	60	80	100				
234.2	Cont'd		10	RC NO												
234.2	Steatite Bedrock	fractured	11	RC NO	REC 77%		234									RQD 19%
			12	RC NO	REC 87%		233									RQD 14%
		sound	13	RC NO	REC 100%		232									RQD 95%
230.6	End of borehole						231									
19.1	Borehole charged with drill water															
	Penetrometer test															

RECORD OF BOREHOLE No 702-2S

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+937.5, o/s 22m Lt. ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 07, 2003 CHECKED BY CH

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	20 40 60 80 100					
248.3	Ground Surface													
0.0	Peat, fine fibrous		1	SS	1									
248.5	Dark brown													
0.4	Clay trace sand		2	SS	8									
	Very Brown Moist stiff													
245.3	Silty clay trace sand		3	SS	3									
3.0	Soft Brown Wet													
	silt seams		4	SS	WR**									
	Firm Grey Wet													
241.6	Silt, some clay trace sand		6	SS	2									
7.3	Very Grey Wet Loose		7	SS	1									
	Loose		8	SS	6									
237.0	End of borehole													
11.9	Refusal on probable bedrock													
	• 2003 02 07													
	▽ Water level observed during drilling													
	■ Penetrometer Test													
	WR** Refers to penetration under weight of rods only													

RECORD OF BOREHOLE No 702-2M

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+950, CL ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 08, 2003 CHECKED BY Cg

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	20 40 60 80 100					
249.9	Ground Surface													
0.0	Peat, fine fibrous		1	SS	6									
0.1	Dark brown Silt, trace sand trace clay													
249.0	Loose Brown Moist Clay trace sand						249							
0.9	Very stiff Brown Dry to Moist		2	SS	10		248	125						0 1 38 61
	silt seams													
	Firm		3	SS	4		247							
245.6							246							
4.3	Silty clay Firm Grey Wet		4	SS	WR**		245							0 0 38 62
	Grey/Brown		5	SS	WR		244							
			6	SS	WR		243							
241.8	Silt, trace sand trace clay						242							
8.1	Very loose Grey Wet		7	SS	3		241							0 1 94 5
	Loose		8	SS	9		240							
238.6	End of borehole						239							
11.3	Refusal on probable bedrock													
	2003 02 08													
	Water level measured after drilling													
	Penetrometer test													
	WR** Refers to penetration under weight of rods only													

RECORD OF BOREHOLE No 702-3N

1 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 17+964, o/s 24m Rt. Culvert 9 ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE C.E.H.S.A. + NO Rock Coring COMPILED BY PC
DATUM Geodetic DATE March 06, 2003 CHECKED BY Ay

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIMIT MOISTURE CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p W _n W _L			
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE	WATER CONTENT (%)			
249.9	Ground Surface						20 40 60 80 100			20 40 60		GR SA SI CL	
0.0	Peat, coarse fibrous												
0.3	Dark brown Clay trace sand Stiff Brown Moist												
			1	SS	7			165					0 1 39 60
			2	SS	2								
	Grey Wet												
245.4													
4.5	Silty clay Firm Grey Wet		3	SS	WR**								
			4	TW	PH								
243.0													
6.9	Clayey silt trace sand Very Grey Wet soft		5	SS	WR								0 1 84 15
240.8													
9.1	Silt trace sand trace clay Very loose Grey Wet to loose		6	SS	5								
			7	SS	1								
			8	SS	3								
			9	SS	7								
	Cont'd												

Cont'd

+ X 5

Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 702-3N

2 of 2

METRIC

G.W.P. 3556-02-00 LOCATION Hwy 69 Sta. 17+964, o/s 34m Rt. Culvert 9 ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + NQ Rock Coring COMPILED BY PC
DATUM Geodetic DATE March 06, 2003 CHECKED BY

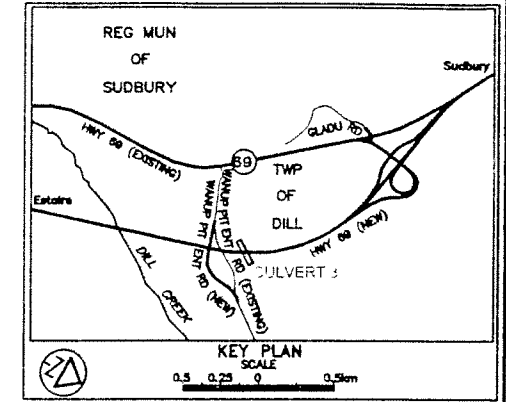
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
249.9								20 40 60 80 100								
	Cont'd		10	SS	WR		234									
	trace gravel, boulders															
233.5							233									
16.4	Bouldery sand		11	RC NQ			232									
			12	RC NQ			231									
230.9							230									
19.0	Steatite Bedrock	fractured	13	RC NQ	REC 35%		229									RQD 23%
			14	RC NQ	REC 32%											RQD 12%
		sound	15	RC NQ	REC 64%											RQD 57%
			16	RC NQ	REC 98%		228									RQD 82%
227.2	End of borehole															
22.7																
	* Borehole charged with drill water															
	■ Penetrometer test															
	WR** Refers to penetration under weight of rods only															

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

CONT No
GWP No 5556-02-00
HIGHWAY 69
HIGHWAY 69 FOUR LANE
From 6.7km North of Highway 537 Northerly 2.8km
CULVERT 3
BOREHOLE LOCATIONS



Peto MacCallum Ltd.
CONSULTING ENGINEERS



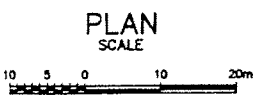
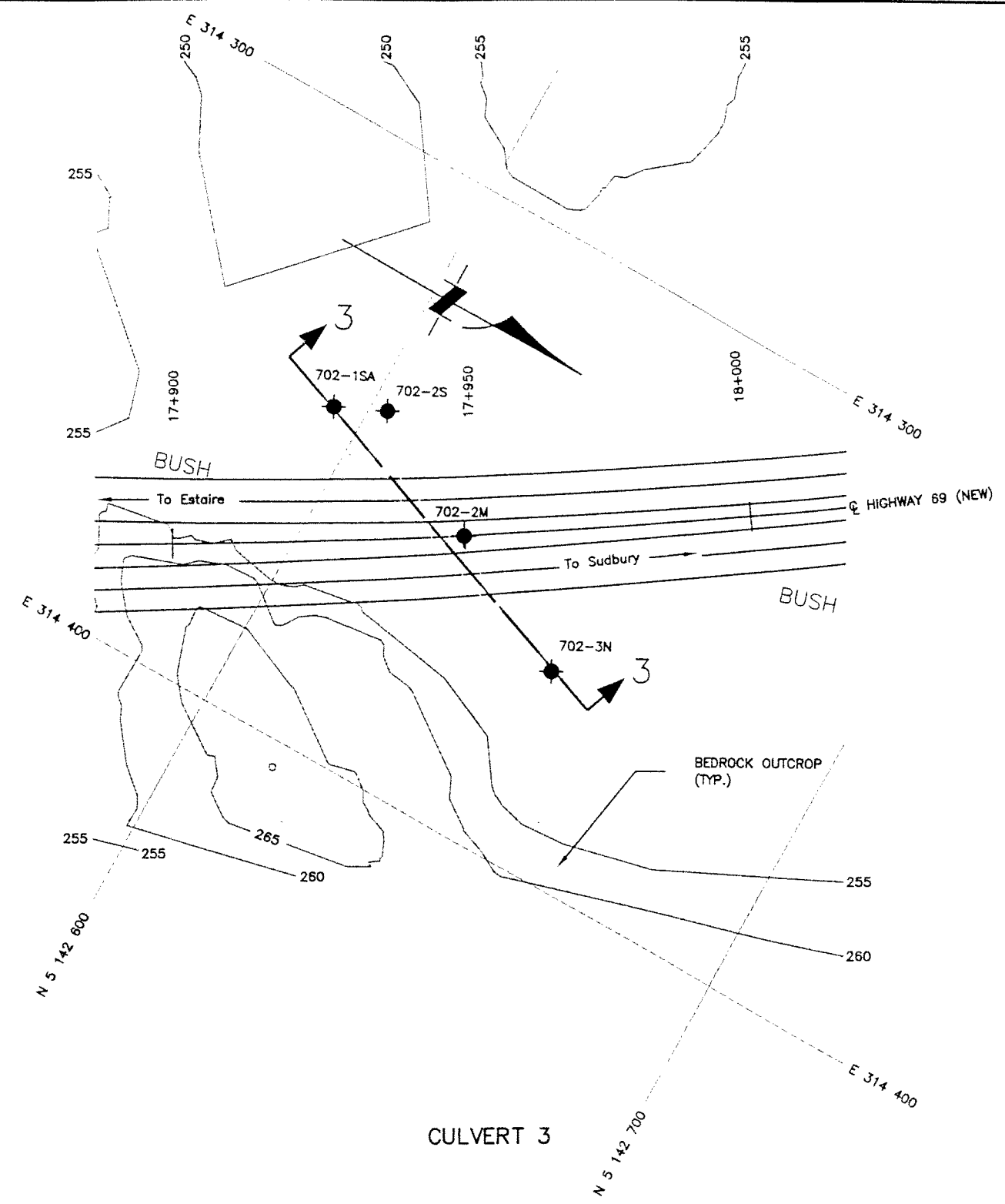
LEGEND	
	Borehole
	Dynamic Cone Penetration Test (Cone)
	Borehole & Cone
N	Blows/0.3m (Std. Pen Test, 475 J / blow)
CONE	Blows/0.3m (60° Cone, 475 J / blow)
	W L at time of investigation Feb 2003
	Head
	ARTESIAN WATER
	Encountered
	PIEZOMETER

BH No	ELEVATION	STA	p/s CL MED
702-2M	248.9	17+950	CL
702-3N	249.9	17+964	24.0m Rt
702-1SA	249.7	17+928	23.0m Lt
702-2S	248.9	17+937.5	22.0m Lt

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 42L-167			
HWY No	69	DIST	54
SUBMIT	PC	CHECKED	VV
DATE	AUG 13, 2003	SITE	
DRAWN	MM	CHECKED	GO/CN
APPROVED	DWK	DWG	3



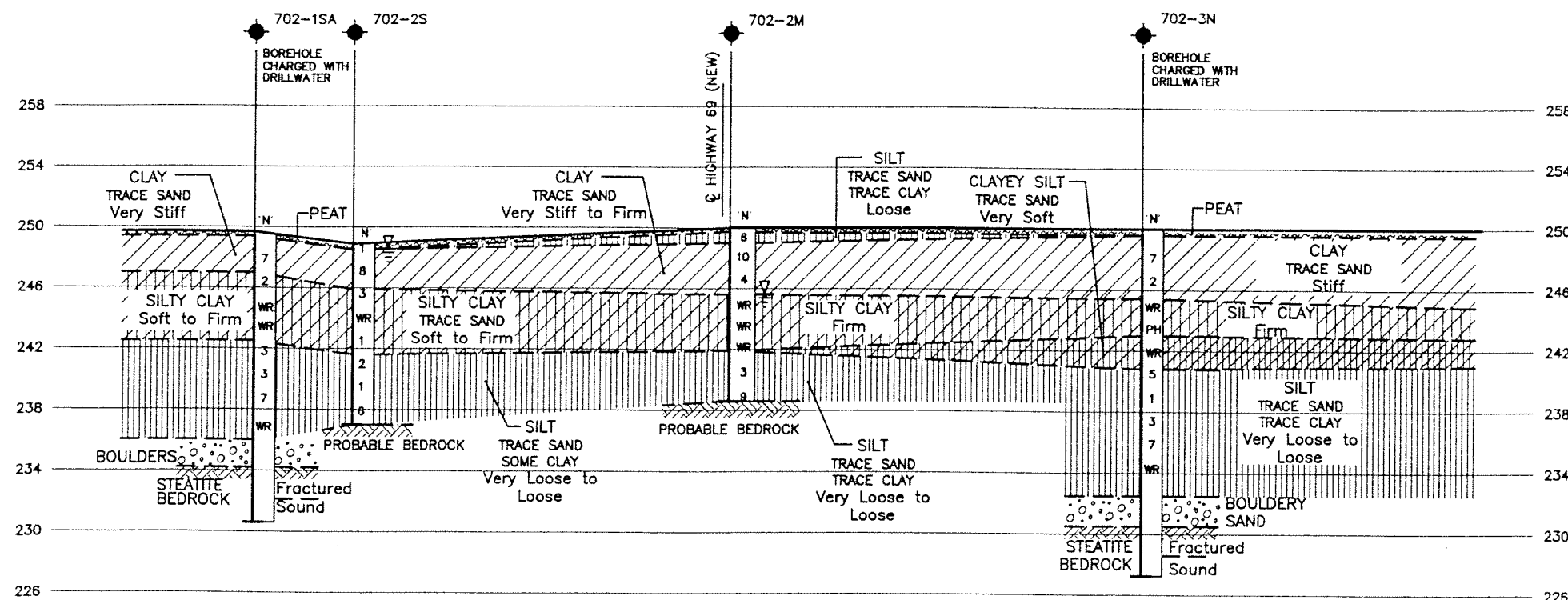
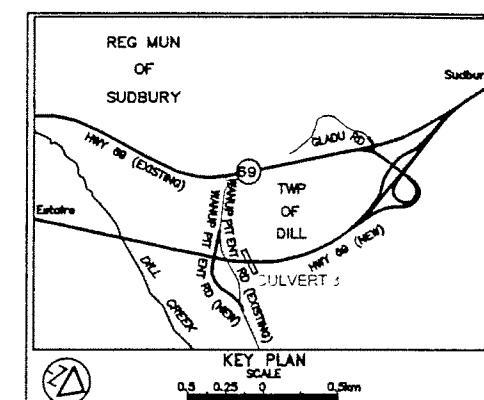
NOTE:
REFER TO DRAWING 3A FOR SECTION 3-3

REF No E-HWY69N-ALIGN.dwg; April 2003
Civ7and9.dwg; February 2003
Peto.dwg; March 2003
L_bpl07.dwg; December 2002

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

HIGHWAY 69
HIGHWAY 69 FOUR LANE
(From 6.7km North of Highway 537 Northerly 2.8km)
CULVERT 3
SOIL STRATA

Peto MacCallum Ltd.
CONSULTING ENGINEERS



SECTION
HORIZONTAL SCALE



REF No E-HWY69N-ALIGN.dwg; April 2003
Civ7and9.dwg; February 2003
Peto.dwg; March 2003
I_bpl07.dwg; December 2002

LEGEND

	Borehole
	Dynamic Cone Penetration Test (Cone)
	Borehole & Cone
N	Blows/0.3m (Std. Pen Test, 475 J / blow)
CONE	Blows/0.3m (80° Cone, 475 J / blow)
	W L at time of Investigation Feb-Apr 2003
	March and April 2003
	Head
	ARTESIAN WATER
	Encountered
	PIEZOMETER

BH No	ELEVATION	STA	o/s CL ME

Refer to drawing 3 for co-ordinates

- NOTE -

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

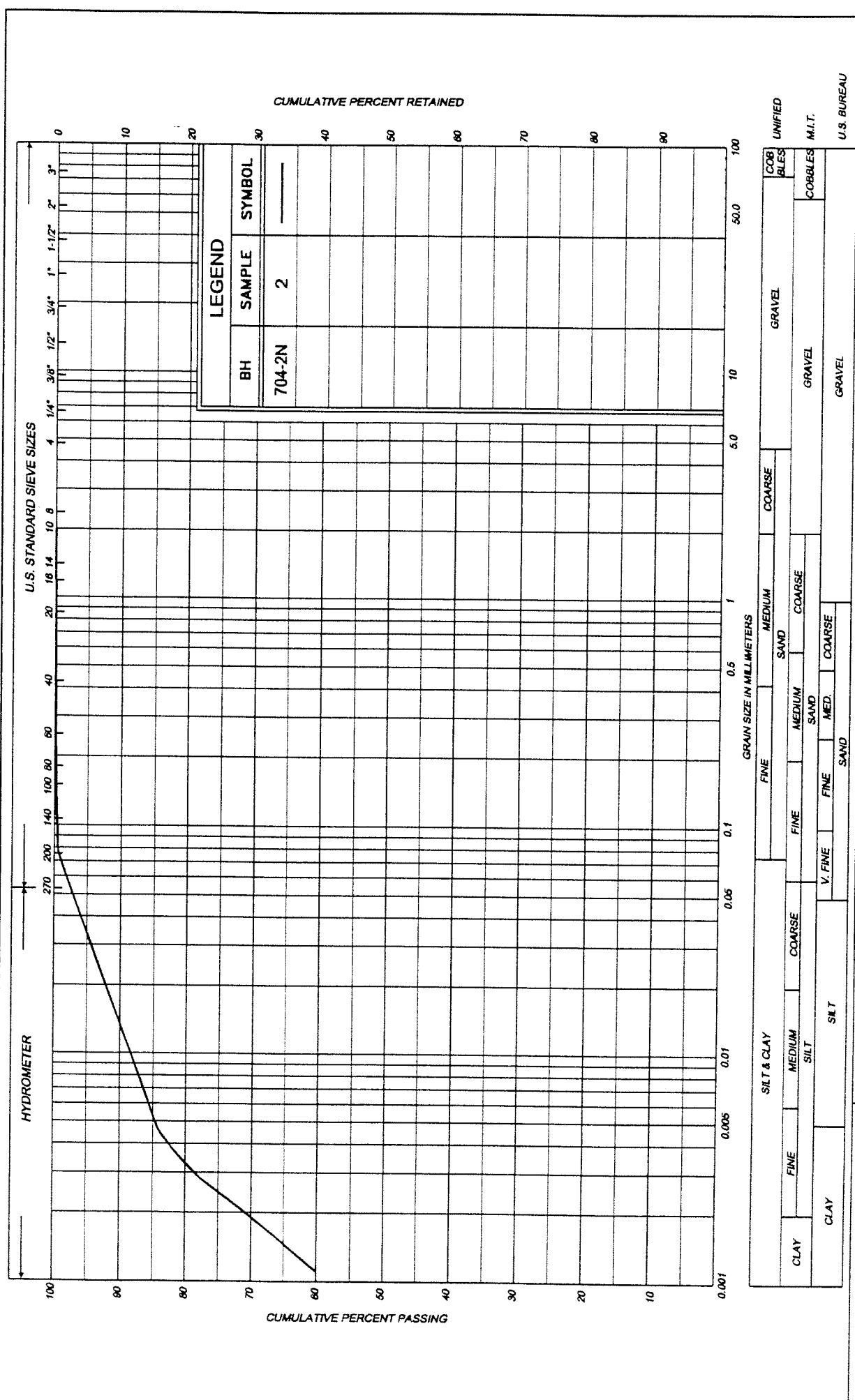
REVISIONS			
DATE	BY	REVISED/TYPE	

Geocres No. 42L-167

HWY No	69	DIST	54
SUBMIT	PC	CHECKED W	DATE AUG 13, 2003
DRAWN	MM	CHECKED CN	APPROVED DWK
			DWG NO 3A

CULVERT 4

- **PLASTICITY CHARTS**
Figures 4-1 to 4-2
- **GRAIN SIZE DISTRIBUTION CHARTS**
Figures 4-3 to 4-5
- **RECORD OF BOREHOLE AND
PENETRATION TEST SHEETS**
- **DRAWING 4/5**



GRAIN SIZE DISTRIBUTION

CLAY trace SAND (CH)

FIG No 4-3

HIGHWAY 69

G.W.P No. 5556-02-00

U.S. BUREAU

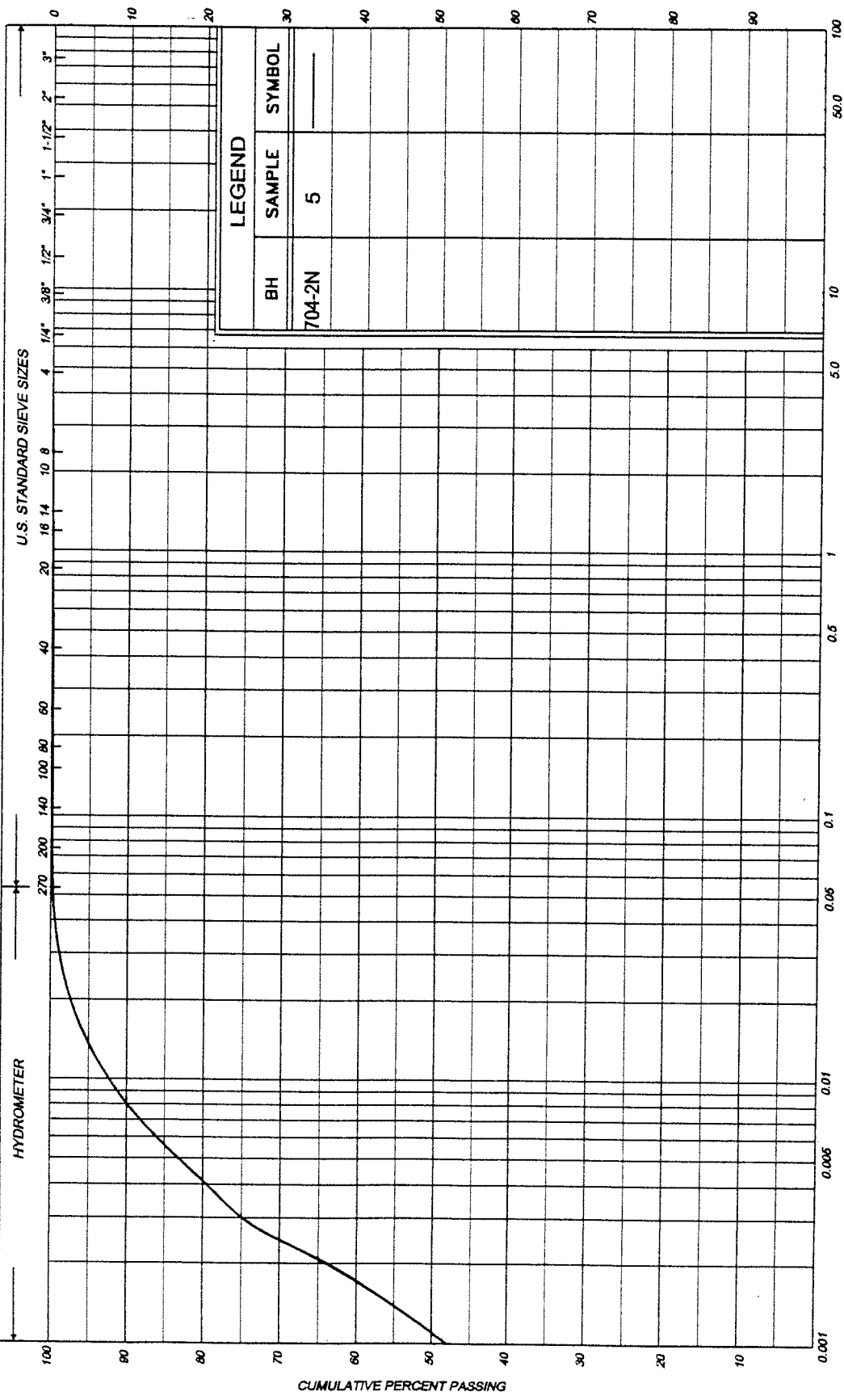
COBBLES

GRAVEL

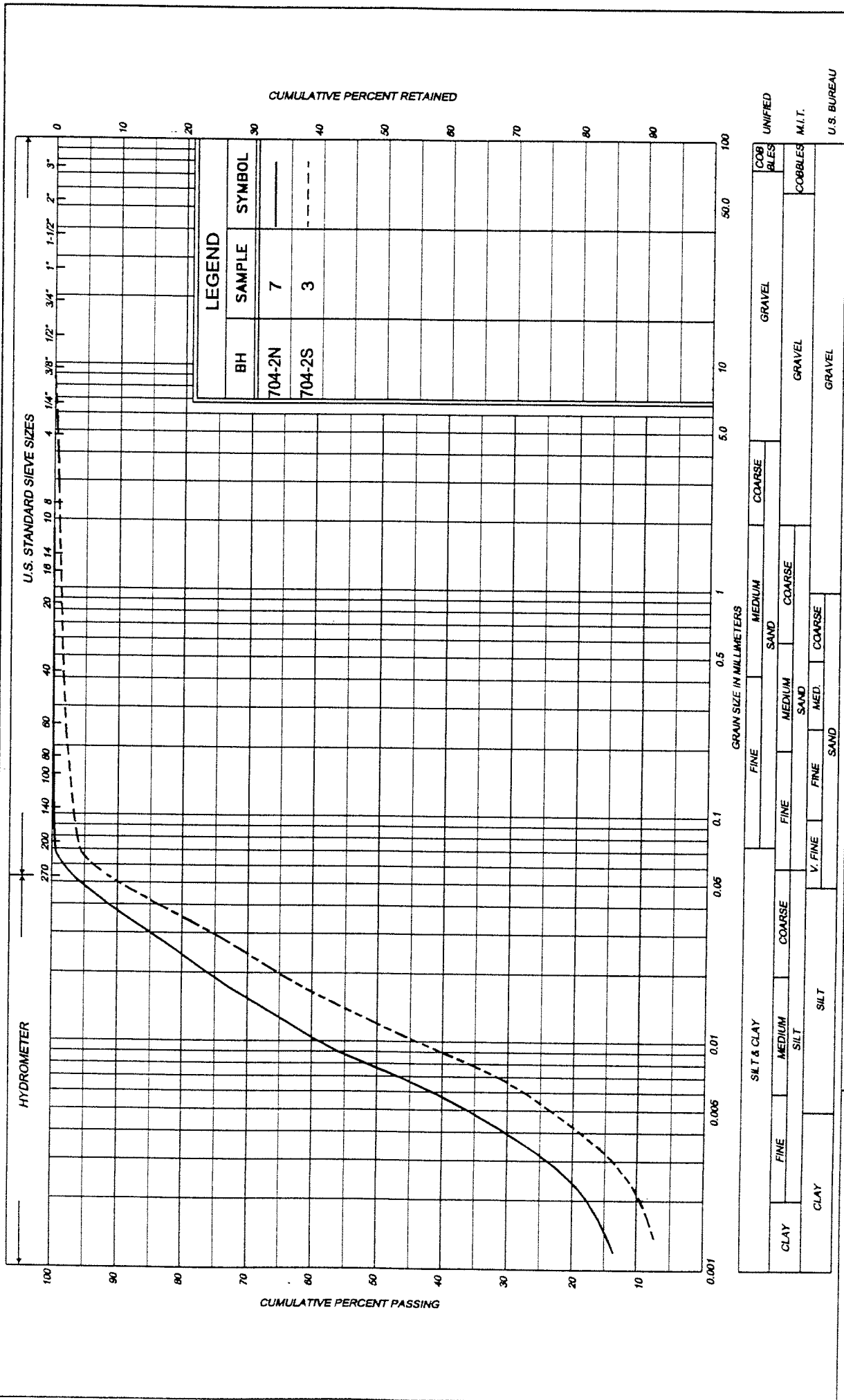
COBBLES


M.I.T.

UNIFIED



GRAIN SIZE IN MILLIMETERS														COBBLES	UNIFIED
SILT & CLAY				FINE		MEDIUM		SAND		COARSE		GRAVEL			
CLAY	CLAY	FINE	MEDIUM	SILT	COARSE	FINE	MEDIUM	SAND	COARSE	GRAVEL	COBBLES	M.I.T.	U.S. BUREAU		
														V. FINE	FINE



	GRAIN SIZE DISTRIBUTION		FIG No	4-5
	SILT some CLAY to		HIGHWAY 69	
	SILT trace SAND trace CLAY trace GRAVEL		G.W.P No. 5556-02-00	

RECORD OF BOREHOLE No 704-2S

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 18+339, o/s 34.5m Lt. Culvert 10 ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + NQ Rock Coring COMPILED BY PC
DATUM Geodetic DATE February 22, 2003 CHECKED BY cy

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	20 40 60 80 100					
350.6 0.0	Ground Surface													
	Peat, fine fibrous Dark Brown						250							
248.6 2.0	Clay Firm Grey Wet		1	SS	50/3cm		249							
							248							
			2	SS	WR**		247							
246.4 4.2	Silt, trace sand trace clay trace gravel Loose Grey Wet						246							
			3	SS	5									
245.0 5.6	Metasedimentary Bedrock sound						245							
			4	RC NQ	REC 98%		244							RQD 52%
			5	RC NQ	REC 100%		243							RQD 50%
242.3 8.3	End of borehole													
	Boulders at surface													
	* Borehole charged with drill water													
	WR** Refers to penetration under weight of rods only													

RECORD OF BOREHOLE No 704-1MA

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 18+340, CL
DIST 34 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers
DATUM Geodetic DATE February 22, 2003
ORIGINATED BY MR
COMPILED BY PC
CHECKED BY 67

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIMIT MOISTURE CONTENT		UNIT WEIGHT γ	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	
250.9	Ground Surface												
0.0	Peat, fine fibrous boulders Dark Brown												
249.7	Clay												
1.2	Firm Grey Wet		1	SS	3								
			2	SS	1								
246.1	Silt, trace sand trace clay		3	SS	1								
4.8	Very Grey Wet loose												
245.3	End of borehole												
5.6	Refusal on probable bedrock												
	* 2003 02 22												
	Water level measured after drilling												

RECORD OF BOREHOLE No 704-2N

1 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+341, o/s 26m Rt. Culvert 10 ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + NO Rock Coring COMPILED BY PC
DATUM Geodetic DATE February 20, 2003 CHECKED BY ay



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	20 40 60 80 100					
250.7	Top of Ice													
0.0	Ice													
0.3	Peat, fine fibrous Dark Brown		1	SS	1		250					64.2		
249.5	Clay trace sand Very Grey Moist stiff		2	SS	3		249							0 1 28 71
247.7	Silt, trace clay Grey Moist		3	TW	PM		248							
246.8	Silty clay Soft Brown Wet to firm		4	SS	WR**		247							
							246							
							245							
							244							0 0 38 62
							243							
							242							
							241							0 0 83 17
							240							
							239							
							238							
							237							
239.0	Metasedimentary Bedrock sound		9	RC NO	REC 98%									RQD 24%
			10	RC NO	REC 100%									RQD 41%
			11	RC NO	REC 98%									RQD 41%
236.1	End of borehole Cont'd													

RECORD OF BOREHOLE No 704-2N

2 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 18+341, o/s 26m Rt. Culvert 10 ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + NQ Rock Coring COMPILED BY PC
DATUM Geodetic DATE February 20, 2003 CHECKED BY CS

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 (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100			
250.7											
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL	

- Penetrometer test
- Borehole charged with drill water
- WR** Refers to penetration under weight of rods only

RECORD OF PENETRATION TEST No 704-2NA

1 of 1 METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+340, o/s 13m Rt. ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY PC
DATUM Geodetic DATE February 22, 2003 CHECKED BY ay

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
251.0 0.0	Ground Surface												
243.5 7.5	End of dynamic cone penetration test Refusal on probable bedrock												

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

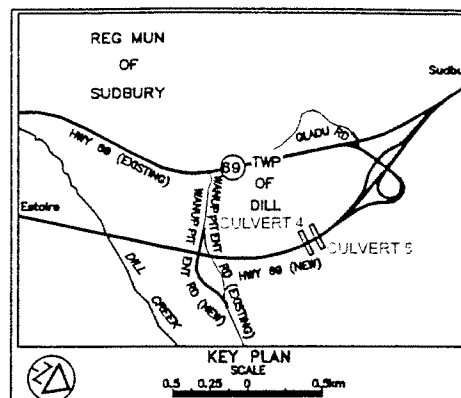
CONT No
GWP No 5556-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE
From 6.7km North of Highway 537 Northerly 2.8km
CULVERTS 4 AND 5
BOREHOLE LOCATIONS



SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



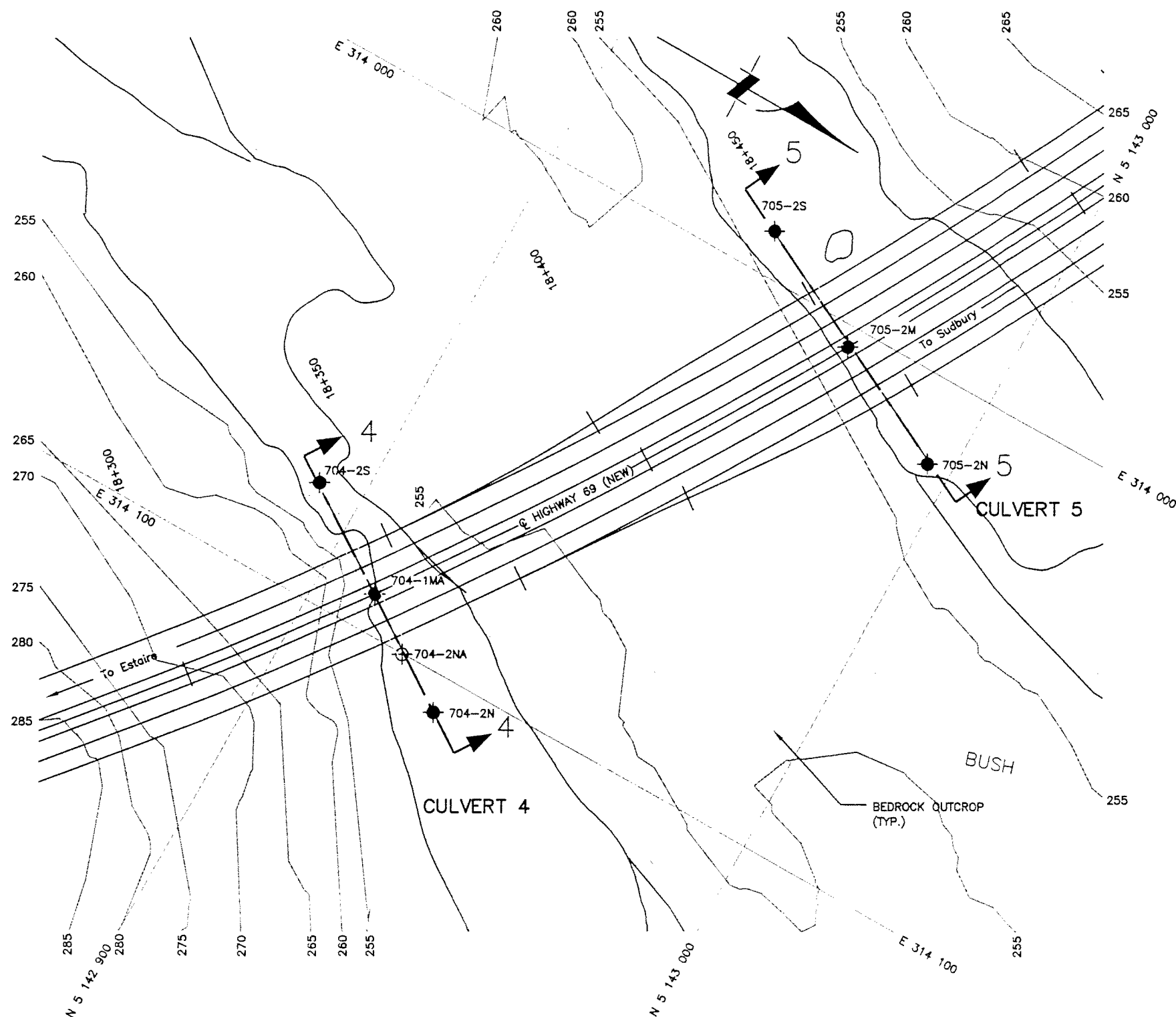
LEGEND	
	Borehole
	Dynamic Cone Penetration Test (Cone)
	Borehole & Cone
N	Blows/0.3m (Std. Pen Test, 475 J / blow)
CONE	Blows/0.3m (80° Cone, 475 J / blow)
	W L at time of investigation Feb 2003
	Head
	ARTESIAN WATER Encountered
	PIEZOMETER

BH No	ELEVATION	STA	a/s CL MED
704-1MA	250.9	18+340	CL
704-2N	250.7	18+341	26.0m Rt
704-2NA	251.0	18+340	13.0m Rt
704-2S	250.8	18+339	24.5m Lt
705-2M	252.0	18+446	CL
705-2N	251.8	18+448	28.0m Rt
705-2S	252.0	18+445	27.0m Lt

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

DATE	BY	DESCRIPTION

Geocres No. 42L-187					
HWY No. 69					
SUBMIT PC	CHECKED VV	DATE AUG 13, 2003	SITE		
DRAWN MM	CHECKED GO/CN	APPROVED DWW	DATE		



PLAN
SCALE



NOTE:
REFER TO DRAWING 4A-5A FOR SECTIONS 4-4 AND 5-5

REF No E-HWY69N-ALIGN.dwg; April 2003
Civ7and9.dwg; February 2003
Peto.dwg; March 2003
I_bpi07.dwg; December 2002

METRIC

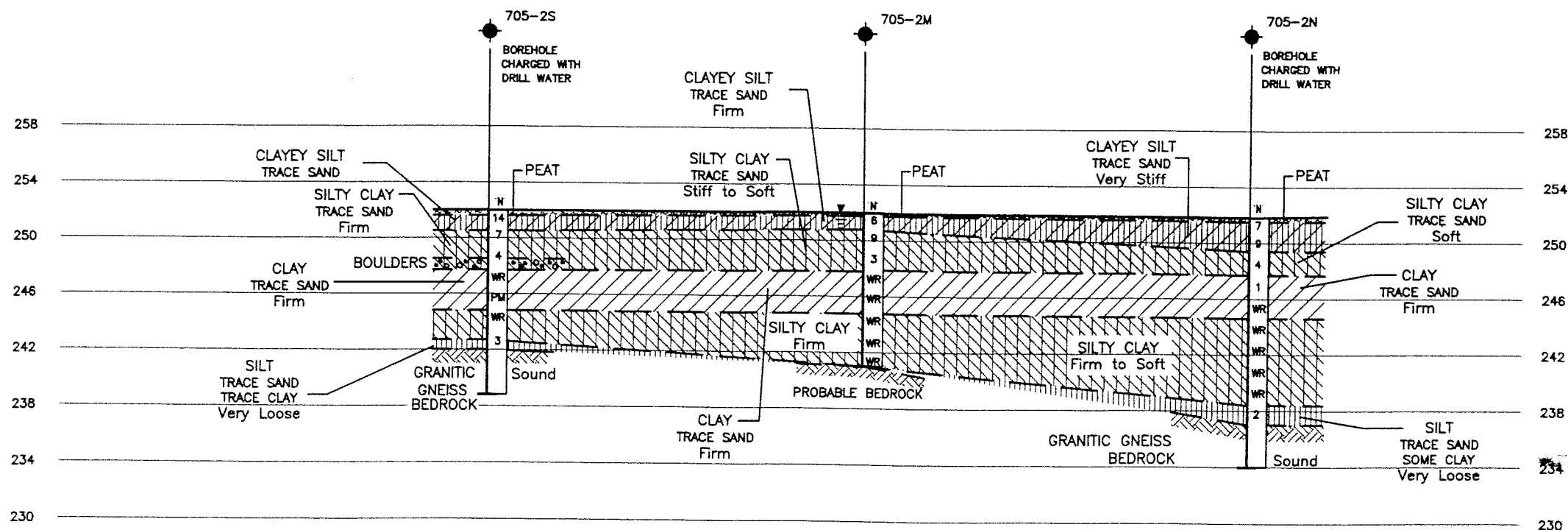
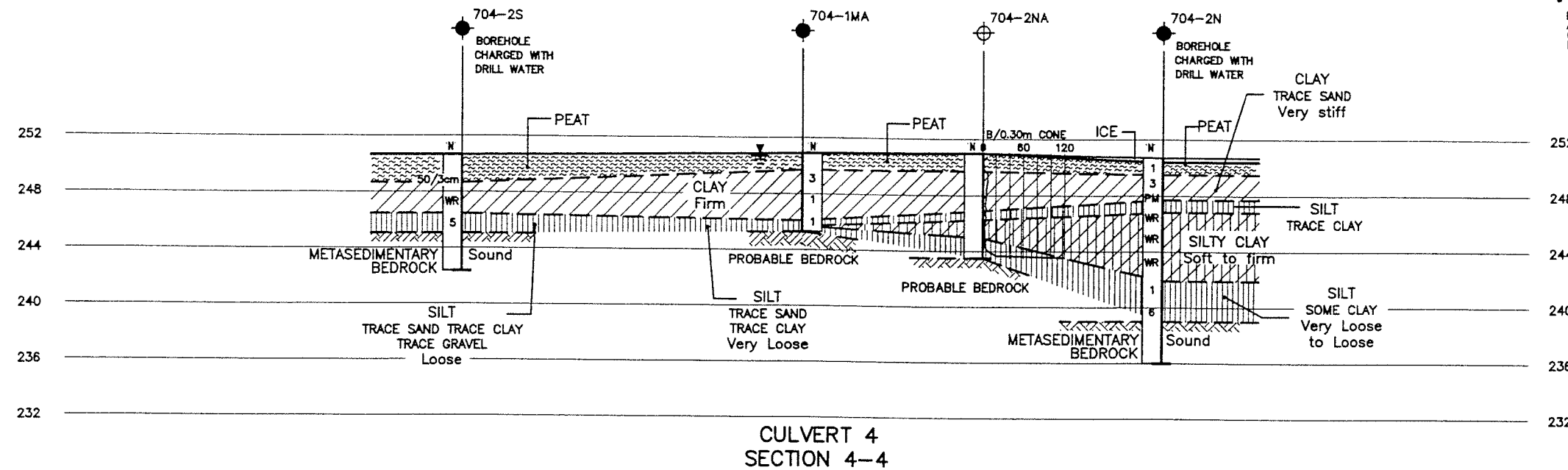
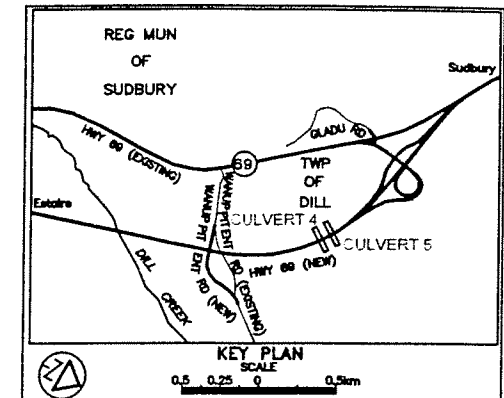
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 5556-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE
(From 6.7km North of Highway 537 Northerly 2.8km)
CULVERTS 4 AND 5
SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



LEGEND			
	Borehole		
	Dynamic Cone Penetration Test (Cone)		
	Borehole & Cone		
N	Blows/0.3m (Std. Pen Test, 475 J / blow)		
CONE	Blows/0.3m (60° Cone, 475 J / blow)		
	W.L. at time of investigation Feb-Apr 2003		
	Head		
	ARTESIAN WATER		
	Encountered		
	PIEZOMETER		

BH No	ELEVATION	STA	o/s CL
(Refer to drawing 4-5 for co-ordinates)			

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

DATE	BY	DESCRIPTION

Geocree No. 42L-167

REVISED	DATE	BY	DESCRIPTION

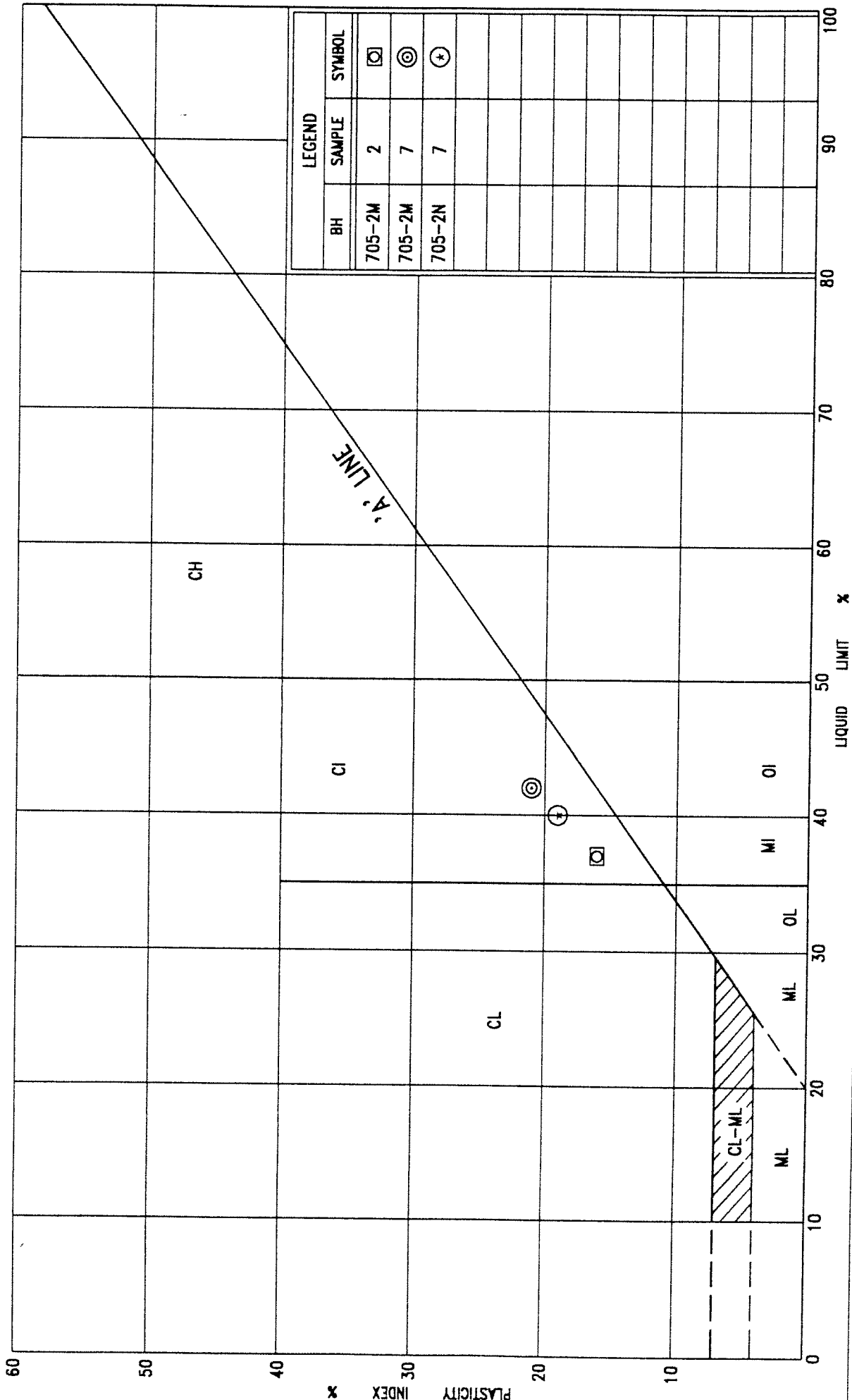
REF No E-North_South-des-preferred.dwg; Jan 2003
PETO.dwg; March 2003
L_bpl07.dwg; July 2001

NOTE:

REFER TO DRAWING 4-5 FOR PLANS

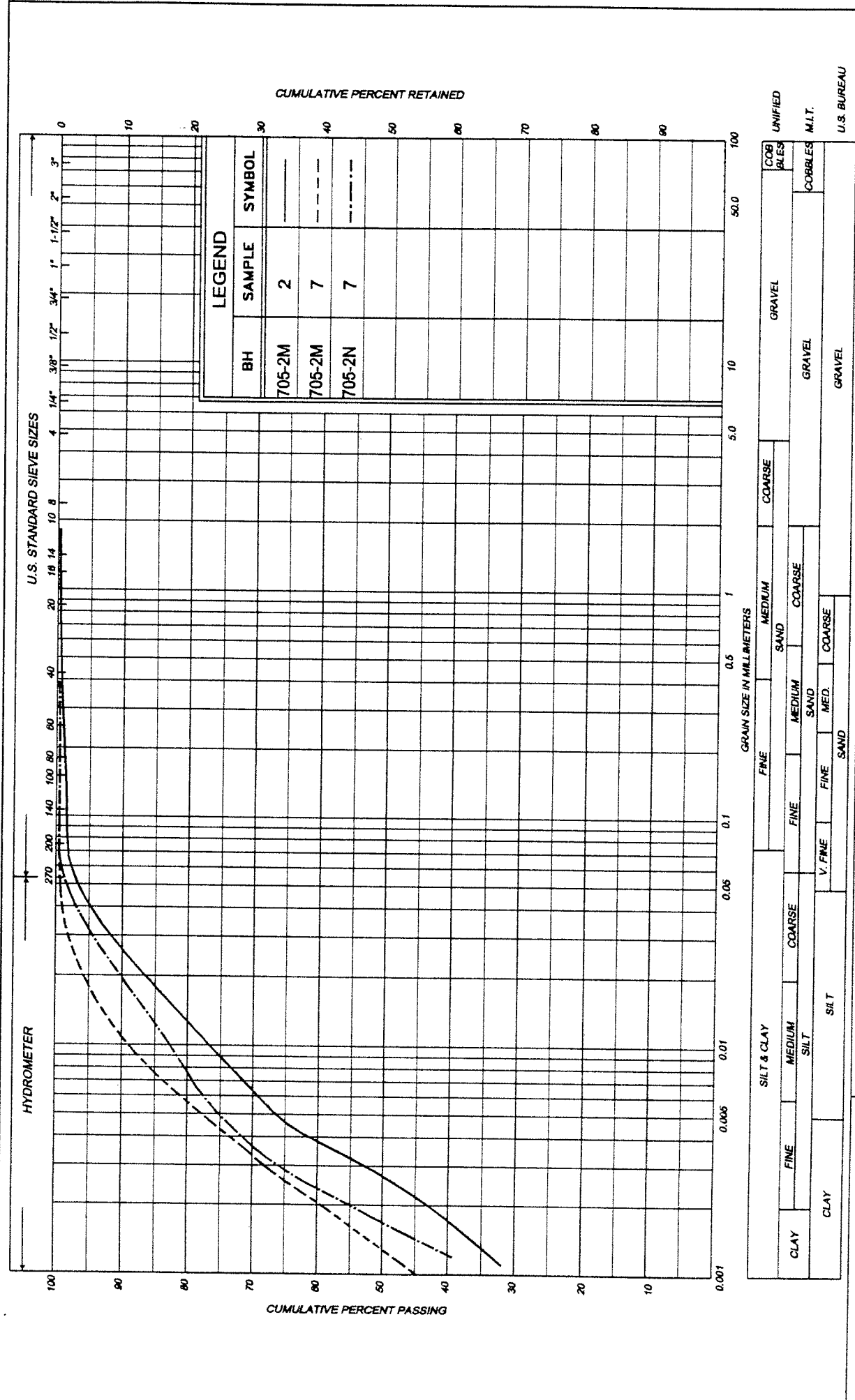
CULVERT 5

- **PLASTICITY CHARTS**
Figures 5-1 to 5-3
- **GRAIN SIZE DISTRIBUTION CHARTS**
Figures 5-4 to 5-7
- **RECORD OF BOREHOLE AND
PENETRATION TEST SHEETS**
- **REFER TO DRAWING 4/5 PROVIDED
WITH CULVERT 4 FOR TEST LOCATIONS**

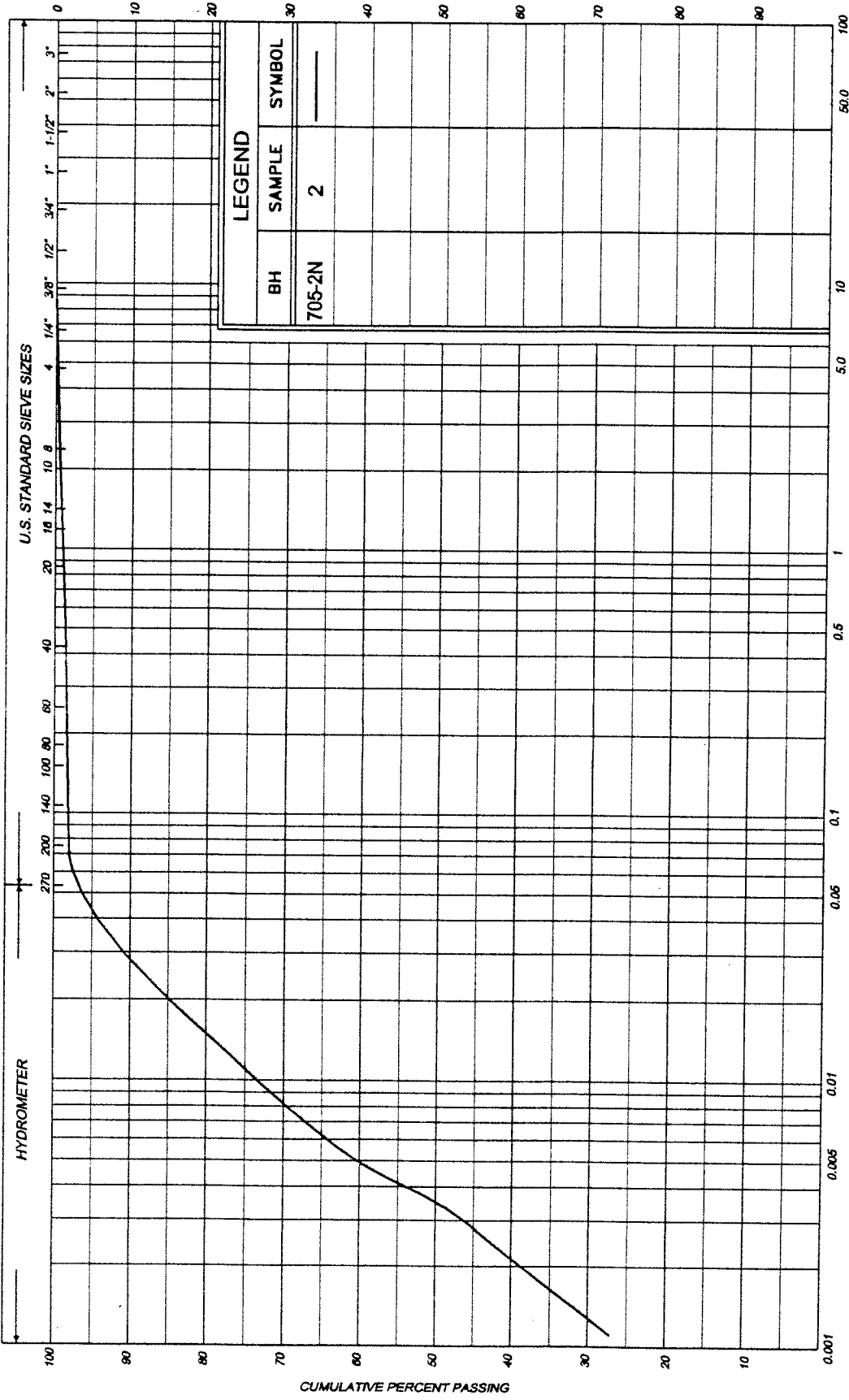


PLASTICITY CHART
SILTY CLAY to SILTY CLAY trace SAND (CI)

FIG No 5-2
HIGHWAY 69
G.W.P. No. 5556-02-00

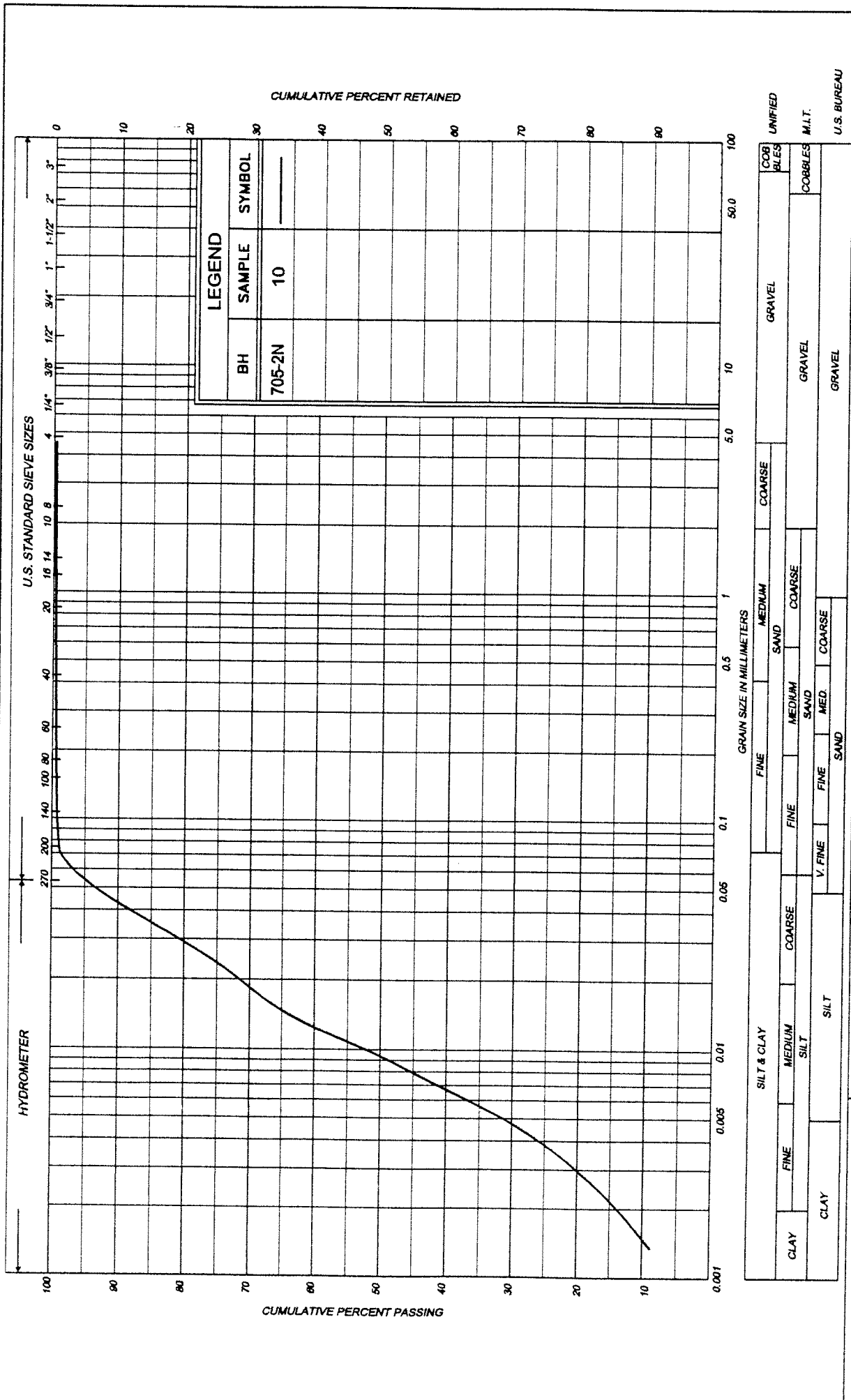


	GRAIN SIZE DISTRIBUTION		FIG No	5-5
	SILTY CLAY to SILTY CLAY trace SAND (CI)		HIGHWAY 69	
			G.W.P. No. 5556-02-00	



LEGEND		
BH	SAMPLE	SYMBOL
705-2N	2	—

GRAIN SIZE IN MILLIMETERS															GRAVEL	COB BLES	UNIFIED
SILT & CLAY			FINE		MEDIUM		SAND		COARSE		GRAVEL		COB BLES				
CLAY	FINE	MEDIUM SILT	COARSE	FINE	MEDIUM	SAND	COARSE	GRAVEL	COB BLES	UNIFIED							
											CLAY	FINE	MEDIUM	SAND	COARSE	GRAVEL	COB BLES
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
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CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
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CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.	SAND	COARSE	GRAVEL	COB BLES							
											CLAY	FINE	MEDIUM SILT	COARSE	V. FINE	FINE	MED.
CLAY	FINE	M															



GRAIN SIZE DISTRIBUTION SILT trace SAND some CLAY

RECORD OF BOREHOLE No 705-2S

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 18+445, o/s 27m Lt. Culvert 11 ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + NQ Rock Coring COMPILED BY PC
DATUM Geodetic DATE February 23, 2003 CHECKED BY CWT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	T _N VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE										
252.0	Ground Surface																	
0.0	Peat, fine fibrous		1	SS	14													
251.6	Dark brown																	
0.4	Clayey silt, trace fine sand																	
	Brown Moist																	
250.5							251											
1.5	Silty clay, trace fine sand		2	SS	7		250											
	Firm Brown Moist																	
							249											
	boulders		3	SS	4		249											
247.7							248											
4.3	Clay trace sand		4	SS	WR**		247											
	Firm Grey Wet																	
							246											
			5	TW	PM													
244.8							245											
7.2	Silty clay		6	SS	WR		244											
	Firm Grey Wet																	
							243											
242.7			7	SS	3													
9.3	Silt, trace sand trace clay						242											
242.0	Very Grey Wet																	
10.0	loose						241							RQD 60%				
	Granitic Gneiss Bedrock		8	RC NQ	REC 100%													
	Sound		9	RC NQ	REC 100%		240							RQD 50%				
			10	RC NQ	REC 97%		239							RQD 46%				
238.3																		
13.2	End of borehole																	
	* Borehole charged with drill water																	
	WR** Refers to penetration under weight of rods only																	

RECORD OF BOREHOLE No 705-2M

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+446, CL ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 22, 2003 CHECKED BY cy

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
252.0	Ground Surface							20 40 60 80 100						
0.0	Peat, fine fibrous							○ UNCONFINED + FIELD VANE						
0.2	Dark brown Clayey silt, trace sand		1	SS	6			● QUICK TRIAXIAL x LAB VANE						
250.8	Firm Brown Moist						251							
1.2	Silty clay trace sand						250							0 2 56 42
	Stiff Brown Moist		2	SS	9									
	Soft Layered						249							
			3	SS	3		248							
247.8	Clay trace sand						247							0 1 27 72
4.2	Firm Grey Wet		4	SS	WR**									
							246							
			5	SS	WR		245							
244.8	Silty clay						244							
7.2	Firm Grey Wet		6	SS	WR									
							243							0 0 43 57
			7	SS	WR		242							
241.0	End of borehole		8	SS	WR		241							
11.0	Refusal on probable bedrock													
	• 2003 02 22													
	Water level measured after drilling													
	WR** Refers to penetration under weight of rods only													

RECORD OF BOREHOLE No 705-2N

1 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+448, o/s 38m Rt. Culvert 11 ORIGINATED BY MR
DIST 54 HWY 59 BOREHOLE TYPE C.F.H.S.A. + NO Rock Coring COMPILED BY PC
DATUM Geodetic DATE March 04, 2003 CHECKED BY CAG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
251.9	Ground Surface							20 40 60 80 100						
0.0	Peat, fine fibrous		1	SS	7									
0.3	Dark brown Clayey silt trace sand													
	Very Brown Moist stiff		2	SS	9									0 2 61 37
249.4	Silty clay trace sand													
2.4	Soft Brown Moist		3	SS	4									
247.6	Clay trace sand													
4.2	Firm Grey Wet		4	SS	1									0 1 28 71
	Brown		5	SS	WR**									
244.6	Silty clay													
7.2	Firm Brown Wet		6	SS	WR									
	Soft		7	SS	WR									0 0 47 53
	Silt layers													
	Grey		9	SS	WR									
239.4	Silt, trace sand some clay													
13.4	Very loose Grey Wet		10	SS	2									0 1 86 13
237.1	Cont'd													

ON_MOT VER3 SWAMP 705- MARCH 4, 2003 GPJ ON_MOT.GDT 6/2/03 6 22:31 PM

+ X⁵: Numbers refer to
Sensitivity


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

RECORD OF BOREHOLE No 705-2N

2 of 2

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+449, o/s 28m Rt. Culvert 11 ORIGINATED BY MR
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + HQ Rock Coring COMPILED BY PC
DATUM Geodetic DATE March 04, 2003 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20 40 60 80 100									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
251.8																	
	Cont'd Granitic Gneiss Bedrock Sound		11	RC NQ	REC 92%		236								RQD 99%		
			12	RC NQ	REC 100%		235								RQD 97%		
234.0 17.8	End of borehole						234										
	<p>* Borehole charged with drill water</p> <p>■ Penetrometer Test</p> <p>WR** Refers to penetration under weight of rods only</p>																

CULVERT 6

- **PLASTICITY CHART**
Figure 6-1
- **GRAIN SIZE DISTRIBUTION CHART**
Figure 6-2
- **RECORD OF BOREHOLE AND
PENETRATION TEST SHEETS**
- **DRAWING 6/7**

RECORD OF BOREHOLE No 706-10S

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+197.5, o/s 22m Lt. ORIGINATED BY SH
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 11, 2003 CHECKED BY

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					
245.3	Ground Surface																
0.0	Peat, coarse fibrous																
0.3	Dark brown End of borehole																
	Refusal on probable bedrock																
	Borehole dry on completion of drilling																

RECORD OF BOREHOLE No 706-11S

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+203, o/s 28.5m Lt. ORIGINATED BY SH
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 18, 2003 CHECKED BY *ay*

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 X LAB VANE 20 40 60 80 100	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								
246.3	Top of Ice												
0.0	Snow/Ice		1	SS	3		246						
0.3	Clayey silt trace sand												
145.4	Soft Gray Wet												
0.6	End of borehole												
	Refusal on probable bedrock												
	Borehole dry on completion of drilling												

RECORD OF BOREHOLE No 706-10M

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+175, CL ORIGINATED BY SH
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 10, 2003 CHECKED BY Jay

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
245.6	Top of Ice																
0.0	Ice																
0.3	Peat, fine fibrous		1	SS	12												
	Dark brown						245										
	Clayey silt, trace sand																
	Soft Brown Moist																
			2	SS	3		244										
243.4	Gray Wet																0 8 62 30
0.0	End of borehole																
	Refusal on probable bedrock																
	* Borehole dry on completion of drilling																

RECORD OF BOREHOLE No 706-8NA

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+157, o/s 32m Rt. Culvert 12 ORIGINATED BY SH
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 18, 2003 CHECKED BY Cy

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	20 40 60 80 100					
245.2	Top of Ice													
0.1	Ice													
244.6	Water													
0.6	Clayey silt, trace sand													
	Fine Brown Wet													
243.4	some gravel		1	SS	23									
1.8	very stiff													
	Bedrock (Unsampled)				NOTE 1									
242.3	Metasedimentary sound		2	RC NQ	REC 82%									RQD 65%
3.0	Bedrock		3	RC NQ	REC 100%									RQD 100%
			4	RC NQ	REC 32%									RQD 18%
			5	RC NQ	REC 93%									RQD 93%
239.0	End of borehole													
0.2	Borehole charged with drill water													
	NOTE 1: Sloping bedrock face from 1.8 m to 3.0 m depth													

RECORD OF BOREHOLE No 706-9N

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+160, o/s 15m Rt. ORIGINATED BY SH
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 10, 2003 CHECKED BY Cy


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			20	40	60	80	100					
245.2	Ground Surface															
0.0	Peat, fine fibrous Dark brown					245										
244.0						244										
1.2	Clayey silt, trace sand Stiff Light Moist brown to wet		1	SS	2	243										
242.2						242										
3.0	Sandy silt some gravel silt layer Very Grey Wet loose		2	SS	4	241										
240.7																
4.5	End of borehole Refusal on probable bedrock Borehole dry on completion of drilling															

RECORD OF BOREHOLE No 706-9NA

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION Hwy 69 Sta. 19+162.5, c/s 32m Rt. ORIGINATED BY SH
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 11, 2003 CHECKED BY CY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
244.3 0.0	Top of Ice Ice/Water					▼		20 40 60 80 100						
244.3 0.6	Clayey silt, trace sand trace gravel Stiff Brown Moist						244							
242.9 2.0	End of borehole Refusal on probable bedrock		1	SS	9		243							
	* 2003 02 11 ▼ Water level measured after drilling													

(Legend Continued)

BH No	ELEVATION	STA	o/s CL MED
706-10S	245.3	19+187.5	22.0m Lt
706-11S	246.3	19+203	28.5m Lt

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

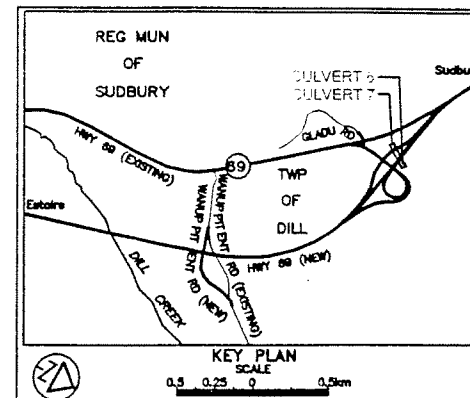
CONT No
GWP No 5556-02-00

HIGHWAY 69
HIGHWAY 69 FOUR LANE
From 6.7km North of Highway 537 Northerly 2.8km
CULVERTS 6 AND 7
BOREHOLE LOCATIONS



SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE Blows/0.3m (60° Cone, 475 J / blow)
- W L at time of investigation Feb 2003
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	STA	o/s Lt EP N-W Ramp
710-NW16	244.9	19+200	5.0m Lt
710-NW17	245.2	19+200	11.5m Rt
710-NW18	245.3	19+211	19.0m Lt
710-NW19	245.1	19+212.5	13.5m Lt
BH No	ELEVATION	STA	o/s CL MED
706-8NA	245.2	19+157	32.0m Rt
706-9N	245.2	19+160	15.0m Rt
706-9NA	244.9	19+162.5	32.0m Rt
706-10M	245.6	19+175	CL

(Legend Continues)

NOTE

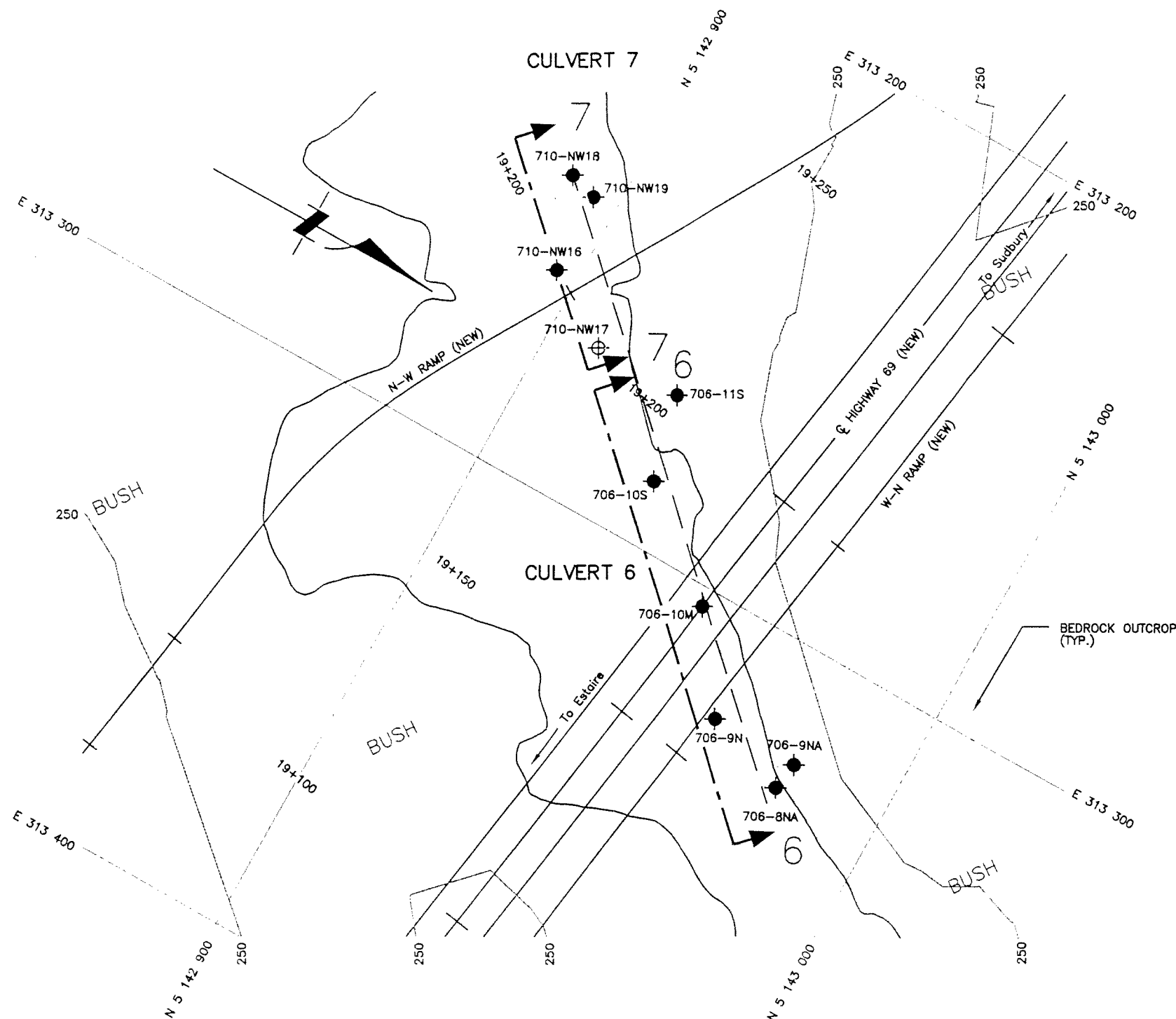
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 42L-167

APP'D	69	CHECKED	WV	DATE	AUG 13, 2003	SITE	54
DRAWN	MM	CHECKED	CD/CN	APPROVED	DWK	DWG	6/7

REF No E-HWY69N-ALIGN.dwg; April 2003
Civ7and9.dwg; February 2003
Peto.dwg; March 2003
I_bpi07.dwg; December 2002



PLAN

SCALE



NOTE:

REFER TO DRAWING 6A-7A FOR
SECTIONS 6-6 AND 7-7

METRIC

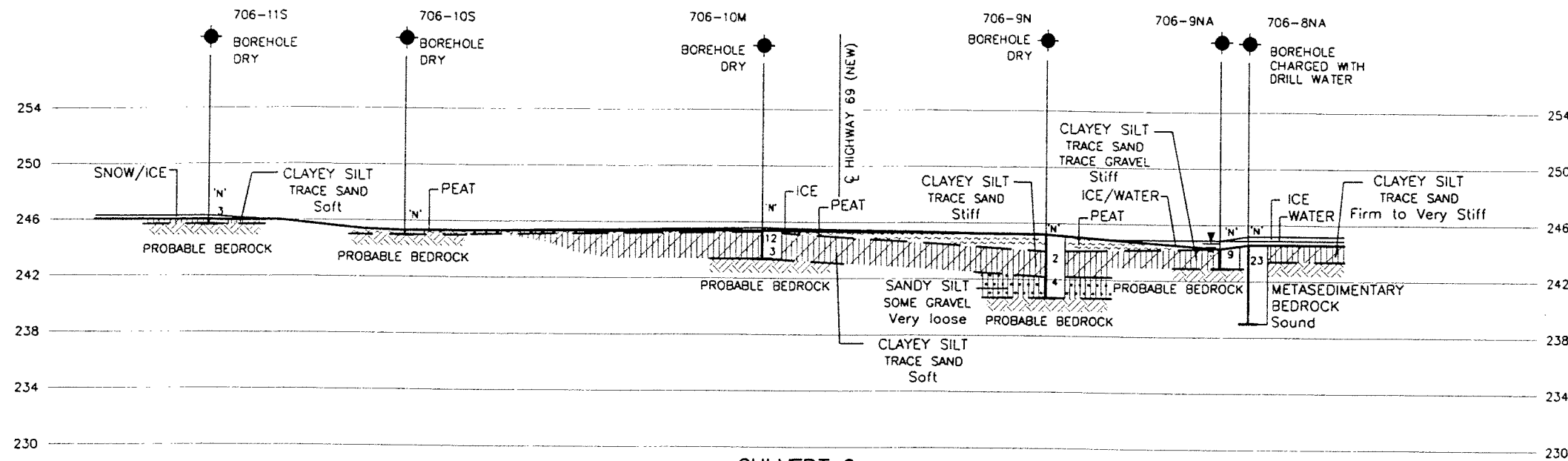
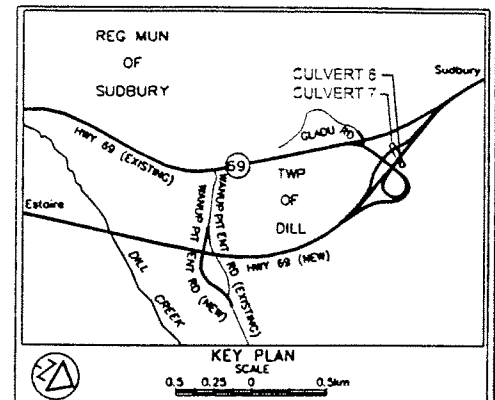
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 5556-02-00

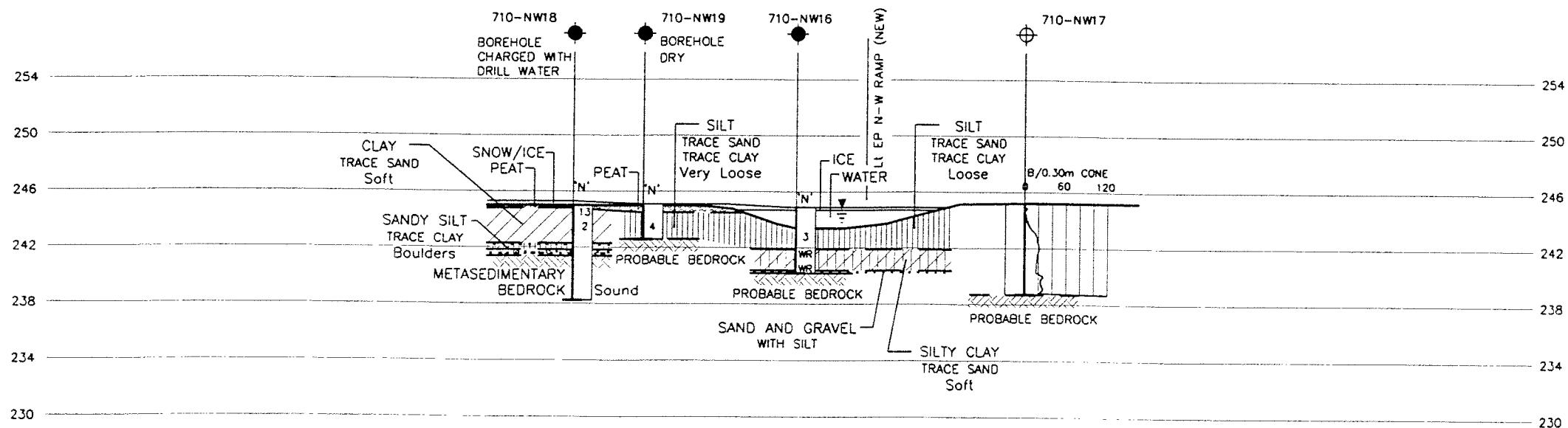
HIGHWAY 69
HIGHWAY 69 FOUR LANE
From 6.7km North of Highway 537 Northerly 2.8km
CULVERTS 6 AND 7
SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



CULVERT 6
SECTION 6-6



CULVERT 7
SECTION 7-7

LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE Blows/0.3m (60° Cone, 475 J / blow)
- W L at time of investigation Feb-Apr 2003
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	STA	o/s CL
Refer to drawing 6-7 for co-ordinates			

NOTE

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

NOTE:
REFER TO DRAWING 6-7 FOR PLANS



REF No E-HWY69N-ALIGN.dwg; April 2003
Clv7and9.dwg; February 2003
PETO.dwg; March 2003
I_bpi07.dwg; December 2002

REVISIONS	DATE	BY	DESCRIPTION

Geocres No.	42L-167
HWY No	69
SUBWD	PC
CHECKED	WV
DATE	AUG 13, 2003
SITE	
DRWN	MM
CHECKED	GD/CN
APPROVED	DNK
DWG	6A/7A

CULVERT 7

- **RECORD OF BOREHOLE AND
PENETRATION TEST SHEETS**
- **REFER TO DRAWING 6/7 PROVIDED
WITH THE INFORMATION FOR CULVERT 6
FOR TEST LOCATIONS**

RECORD OF BOREHOLE No 710-NW16

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION N-W Ramp Sta. 19+200, o/s 5m Lt. of Lt. BP ORIGINATED BY SH
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 11, 2003 CHECKED BY Cy

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
244.9	Top of Ice													
0.3	Ice													
0.3	Water													
243.4							244							
1.5	Silt, trace sand trace clay		1	SS	3		243							
	Loose Brown Moist /grey /wet													
241.9							242							
3.0	Silty clay, trace sand		2	SS	WR**									
	Soft Grey Wet /brown													
240.4							241							
240.9	Sand and gravel with silt		3	SS	WR									
4.7	Brown Wet													
	End of borehole													
	Refusal on probable bedrock													

* 2003 02 11

▼ Water level measured
after drilling

WR** Refers to penetration
under weight of rods
only

RECORD OF PENETRATION TEST No 710-NW17

1 of 1 METRIC







G.W.P. 5555-02-00 LOCATION N-W Ramp Sta. 19+200, o/s 11.5m Rte. of Lt. EP ORIGINATED BY EP
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY PC
DATUM Geodetic DATE February 19, 2003 CHECKED BY CA

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								
245.2 0.0	Ground Surface						<p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED + FIELD VANE</p> <p>● QUICK TRIAXIAL x LAB VANE</p> <p>20 40 60 80 100</p>					
245												
244												
243												
242												
241												
240												
239												
238.7 6.5	End of dynamic cone penetration test Refusal on probable bedrock						120/8 cm					

RECORD OF BOREHOLE No 710-NW18

1 of 1 METRIC

G.W.P. 5556-02-00 LOCATION N-W Ramp Sta. 12+211.0/19m Lt. of Lt. EP/Culvert 12) ORIGINATED BY SH
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 19, 2003 CHECKED BY

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								
245.3	Top of Ice						20 40 60 80 100						
245.3	Snow/Ice												
244.4	Peat, fine to coarse fibrous		1	SS	13		245						
243.5	Dark brown clay, trace sand						244						
	Soft Grey Moist						243						
242.3	Sandy silt, trace clay						242						
241.4	Grey Moist Boulders						241						
241.4	Metasedimentary Bedrock sound		3	RC	REC 93%		240						RQD 88%
			4	RC	REC 100%		239						RQD 100%
			5	RC	REC 96%								RQD 96%
238.3	End of borehole												
238.3	Borehole charged with drill water												

RECORD OF BOREHOLE No 710-NW19

1 of 1

METRIC

G.W.P. 5556-02-00 LOCATION N-W Ramp Sta. 19+212.5, o/s 13.5m Lt. of Lt. EP ORIGINATED BY SH
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
DATUM Geodetic DATE February 11, 2003 CHECKED BY LG

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					
245.1	Ground Surface																
0.1	Ice																
244.9	Peat, coarse fibrous																
0.9	Dark brown																
	Silt, trace sand trace clay																
	Very loose																
	Brown Dry																
	Brown /grey		1	SS	4												
242.6	End of borehole																
1.5	Refusal on probable bedrock																
	Borehole dry on completion of drilling																

**FOUNDATION DESIGN REPORT
FOR
CULVERTS
HIGHWAY 69 FOUR-LANING
FROM 6.7 KM NORTH OF HIGHWAY 537 NORTHERLY 2.8 KM
G.W.P. 5556-02-00
HIGHWAY 69, DISTRICT 54
TOWNSHIP OF DILL, SUDBURY**

Distribution:

3 cc: Totten Sims Hubicki Associates for distribution to MTO
2 cc: Totten Sims Hubicki Associates
1 cc: PML Hamilton
1 cc: PML Toronto

PML Ref.: 03TF002B
Geocres No. 41I-167

August 2003

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CULVERT FOUNDATIONS	3
CULVERT BACKFILL	8
EXCAVATION AND GROUNDWATER CONTROL	11
CLOSURE	12

LIST OF ENCLOSURES:

Table I – FDR: Anticipated Foundation Conditions at the Culverts

FOUNDATION DESIGN REPORT
for
Culverts
Highway 69 Four-Laning
from 6.7 km North of Highway 537 Northerly 2.8 km
G.W.P. 5556-02-00
Highway 69, District 54
Sudbury, Ontario

INTRODUCTION

This report provides geotechnical comments and recommendations for the design and installation of seven culverts along the realigned section of Highway 69 that extends from 6.7 km north of Highway 537 northerly 2.8 km in the Township of Dill and is located about 7 km south of Sudbury. Realignment of this section of Highway 69 to the east is planned. The investigation was conducted for Totten Sims Hubicki Associates (TSH) on behalf of the Ontario Ministry of Transportation (MTO).

The culverts will be constructed in areas where the embankment fill will be placed along the New Highway 69 alignment and interchange ramps. The actual location of the proposed culverts was provided by TSH (reference CAD drawings Nos. E-HWY69N-ALIGN.dwg dated April 2003, E-North_South-des-preferred.dwg dated January 2003, Clv7and9.dwg dated February 2003).

The culverts are designated by the following numbers:

CULVERT No.	ROADWAY	PROPOSED CENTRELINE HIGHWAY 69 CHAINAGE (m)
1	Highway 69 (New)	Station 17+403
2	Highway 69 (New)	Station 17+690
3	Highway 69 (New)	Station 17+946
4	Highway 69 (New)	Station 18+340
5	Highway 69 (New)	Station 18+447
6	Highway 69 (New)	Station 19+176
7	N-W Ramp	Station 19+208

Based on the cross-sections provided by TSH, the embankment fill height at the location of culverts 2 to 7 typically ranges from 4 to 8 m and is 22 m high at the location of culvert 1. Details in this regard along with the invert elevations inferred from the TSH documentation is provided in Table I – FDR.

The culverts will be located in areas where excavation of peat and/or soft compressible clayey soils will be required prior to construction of the embankment for the realigned highway. Recommendations for construction of the embankments at these locations, provided in the “Swamp and High Fill Crossing” report (PML Ref.: 03TF003), called for excavation of these poor quality materials and placement of rockfill in the excavation. Consequently, the subgrade at the location of the culverts will comprise rock fill.

It is considered that the subgrade conditions are suitable for construction of cast-in-place concrete box and/or open footing culverts. Due to the height of the rockfill embankments, and the subgrade composition, precast concrete culverts and rigid pipes do not appear to be suitable. In accordance with the Terms of Reference for the project, steel pipes are also not suitable.

The actual type (box, open footing) will be dependent upon the stream flow characteristics, fish habitat/environmental criteria, structural design considerations, as well as economic and construction constraints.

The subsurface stratigraphy revealed in the boreholes drilled at the culvert locations generally comprised topsoil or peat overlying native deposits of cohesionless very loose to compact silt/sand and/or cohesive very soft to stiff clayey silt/silty clay/clay. These soils mantled bedrock/inferred bedrock at depths of 0.3 to 19.0 m below grade.

CULVERT FOUNDATIONS

The design calls for construction of precast concrete box culverts at each location. We consider this to be appropriate. The dimensions of the culverts are noted in the following table:

Culvert No.	Dimensions	
	Span (m)	Height (m)
1	1.8	1.2
2	2.1	1.8
3	1.2	1.2
4	1.2	1.2
5	1.2	1.2
6	1.8	1.2
7	1.8	1.2

The subgrade at the invert of culverts 1 to 5 after the subgrade treatment for construction of the embankment is complete, will comprise rockfill. The subgrade along the majority of the alignment of culverts 6 and 7 will also comprise rockfill; it is possible that bedrock may also exist at some locations along the alignment of these culverts.

Construction of shallow footings founded on the rockfill to support the culverts is considered to be suitable. Deep foundations will not be suitable due to the extensive and variable thickness of rock fill, particularly at culverts 1 to 5 and the shallow depth to bedrock at culvert 6 and 7, as noted in the table provided in subsequent paragraphs.

The depth of excavation recommended in the "Swamp and High Fill Crossing" report at the culvert locations will result in a significant variation in the rockfill thickness as well as the thickness of the underlying native soil at culverts 1, 2 and 3 as noted in the following table:

CULVERT	ROCKFILL THICKNESS BELOW INVERT LEVEL (m)	THICKNESS OF NATIVE SOIL BELOW ROCKFILL (m)	COMMENTS
1	3 to 6	2 to 11	Thickness of native soil below rockfill is 10 to 11 m near the SBL embankment, 2 to 5 m to the west of the centre line median and 3 to 4 m to the east of the NBL embankment.
2	3 to 8	2 to 12	Thickness of native soil is up to 12 m near the SBL embankment, 9 m near the NBL centreline, 1 and 4 m at the west and east limits of the culvert, respectively.
3	7 to 9	3 to 8	Thickness of native soil is 3 m near centreline median, 5 to 8 m at the south end of the culvert and 7 m at the north end.
4	4 to 9	1 to 2	Thickness of native soil is relatively uniform along the length of the culvert.
5	9 to 13	Less than 1	Thickness of native soil is relatively uniform along the length of the culvert.
6	2 to 3	Less than 1	Thickness of native soil is relatively uniform along the length of the culvert, possible bedrock cut locally.
7	1 to 3	1 to 4	Thickness of native soil is about 4 m, 12 m right of N-W ramp centre line and less than 1 m along the remainder of the culvert, possible bedrock cut locally.

It is expected that the culverts will be constructed a short time (within 90 days) after the rockfill is placed to the subgrade level below the culverts. Significant total and differential foundation settlement along the alignment of some culverts due to "consolidation" of the rockfill below the founding level as well as the soil left in place below the rockfill during and after completion of the embankment is likely to occur if excavation of the soil is limited to the depth recommended in the High Fill and Swamp Crossing Report due to the variable rockfill thickness, the variable thickness of unexcavated soil and variations in the embankment height along the culvert alignment. The computed settlements are provided in the following table:

CULVERT NO.	LOCATION	CONSOLIDATION OF UNEXCAVATED COMPETENT SOIL AND ROCKFILL BELOW CULVERT INVERT (MM) ⁽¹⁾
1	Vicinity of east side of embankment	20 to 40
	Vicinity of NBL centerline	100 to 150
	Vicinity of centerline medium	50 to 100
	Vicinity of SBL centerline	25 to 50
	Vicinity of toe of west side of embankment	25 to 50
2	Vicinity of east side of embankment	20 to 40
	Vicinity of NBL centerline	75 to 100
	Vicinity of SBL centerline	75 to 125
	Vicinity of west side of embankment	20 to 30
3	Vicinity of east side of embankment	40 to 80
	Vicinity of centerline median, NBL centerline and SBL centerline	60 to 100
	Vicinity of west side of embankment	40 to 80
4	Culvert alignment	25 to 50
5	Culvert alignment	25 to 50
6	Culvert alignment	10 to 20
7	Culvert alignment	10 to 20

(1) consolidation during and the 10 year period following completion of the embankment.

The subgrade profile along the culvert alignment could be "shaped" to conform with the predicted settlement to reduce the structural distress that results from the differential settlement as well as minimize the potential for "low areas" in the culvert when settlement is completed. It is recommended however, that the soil is excavated to the bedrock surface along the alignment

of culverts 1, 2 and 3 to minimize the total and differential settlement of the culvert foundations. This excavation will be in addition to that recommended in the Swamp and High Fill Crossing report.

The recommended factored geotechnical resistance at ultimate limit states (ULS) and serviceability limit states (SLS) for each culvert are provided in Table I – FDR. The resistance at SLS allows for 25 mm of settlement of the founding medium due to the stress imposed by the culvert foundations.

The rockfill thickness noted in the column “Anticipated Depth of Subexcavation” in Table I – FDR is based on excavation to the bedrock surface or the practical limit of excavation (15 m), whichever is the lesser value. The material below the depth of excavation recommended in the Swamp and High Fill Crossing report primarily consists of silts and sands below the groundwater table. Consequently, use of a dragline with a practical limit of excavation of 15 m will be required.

The seismic coefficient for the conditions at this site is equal to 1.0.

If bedrock is encountered within 1 m below the subgrade level along the alignment of culverts 6 and 7, Granular A should be used to raise the subgrade to the design level. The granular material should be placed and compacted in accordance with OPSS 501 (Method A). It is considered that rockfill is not suitable when the depth to bedrock is less than 1 m due to the size of the cobbles/boulders in the rockfill.

Mass concrete could also be placed to provide a level founding surface. Alternatively, the rock surface could be “stepped” to follow variations in the bedrock surface elevation thereby creating a level subgrade by a combination of rock excavation and placement of mass concrete.

Mass concrete could also be employed to raise the subgrade to the design level of the footings. The need to expand the plan area at the base of the mass concrete to provide for stress distribution (2V:1H), place reinforcing steel in the mass concrete and/or use high strength concrete to prevent overstressing of the mass concrete will be dictated by the actual thickness of the mass concrete and structural design considerations.

Subject to these comments, the bearing resistance provided for footings bearing on bedrock is considered to be appropriate for mass concrete with an unconfined compressive strength of at least 35 MPa.

Settlement of the culvert subgrade due to "consolidation" of the rockfill below the invert level is estimated to be about 0.5% of the rockfill thickness. Settlement of the rockfill subgrade along the alignment of the culverts due to "consolidation" of the rockfill below the culvert invert (after excavation of the underlying soil as noted previously) is expected to be relatively uniform as indicated in the following table:

CULVERT NO.	CONSOLIDATION ⁽¹⁾ OF ROCKFILL BELOW CULVERT INVERT (mm)
1	30 to 60
2	30 to 60
3	60 to 100
4	30 to 50
5	50 to 75
6	10 to 20
7	10 to 20

(1) During and the 10 year period after completion of construction of the embankment fill based on culvert being constructed immediately following placement of rockfill to the culvert subgrade level.

The rockfill within the zone of influence below the culverts should be placed in accordance with OPSS 206 dated December 1993, amended by Special Provision (Draft dated June 20, 2001). The zone of influence should be defined by an imaginary line inclined at 2H:1V (horizontal to vertical) from a point located at the invert level 1 m beyond the edge of the culvert downward to the bedrock surface.

FOUNDATION DESIGN REPORT

The surface of the rockfill below the subgrade of the culverts should be well knit and carefully chinked in accordance with the requirements of amended OPSS 206. To prevent loss of the granular materials into the voids of the rockfill, a geotextile fabric should be installed directly below the bedding of the culverts. Recommendations in this regard are provided in the next section of this report.

A minimum 300 mm thick layer of compacted granular material should be placed on the rockfill prior to construction of the culvert. The bedding material should comprise Granular A compacted to 100% of standard Proctor maximum dry density in conformance with OPSS 501 (Method A).

Subgrade preparation, cover, backfill and frost treatment for the proposed culverts should be carried out in accordance with the Ontario Provincial Standard – OPSD 803.010. A frost penetration depth of at least 1.7 m should be employed at the site. The rockfill does not require frost tapers.

Preparation of the subgrade should be performed and monitored in accordance with SP 902 S01 (December 2001). This should include site review by geotechnical personnel during placement and compaction of the engineered fill.

CULVERT BACKFILL

Backfill adjacent to the culverts should be placed in general accordance with the OPSD 800 series of drawings. Backfill should be brought up simultaneously on each side of the culvert and operation of heavy equipment within 0.5 times the height of the culvert (each side) restricted to minimize the potential for movement and/or damage of the culvert due to the lateral earth pressure induced by compaction. Refer to OPSD 808.010 for additional requirements for operation of heavy equipment near the culverts.

The granular cover and bedding should be separated from the rockfill by a geosynthetic filter fabric. The filter fabric should conform to OPSS 1860 and comprise a Class II non-woven geotextile with filtration opening size (FOS) of 105 to 210 μm .

The culverts must be designed to support the stress imposed by the overlying fill as well as to resist the unbalanced lateral earth pressure and compaction pressure imposed by the backfill adjacent to the culvert walls.

The lateral earth and water pressure, p , should be computed using the equivalent fluid pressures presented in Section 6.9 of the Canadian Highway Bridge Design Code (CHBDC), CAN/CSA-S6-00, March 2001, or employing the following equation assuming a triangular pressure distribution:

$$p = K (\gamma h_1 + \gamma' h_2 + q) + \gamma_w h_2 + C_p$$

where

K	=	lateral earth pressure coefficient
γ	=	unit weight of free draining granular material above the design water level (kN/m^3)
γ'	=	unit weight of submerged free draining granular material below design water level (kN/m^3)
h_1	=	depth below final grade (m), above design water level
h_2	=	depth below design water level (m)
q	=	any surcharge load (kN/m^2)
γ_w	=	unit weight of water = 9.8 kN/m^3
C_p	=	compaction pressure (refer to clause 6.9.3 of CHBDC)

The following parameters are recommended for design:

PARAMETER	GRANULAR A	GRANULAR B TYPE II	ROCKFILL
Angle of Internal Friction (degrees)	35	32	40
Unit Weight (kN/m ³)	22.8	21.2	18.0
Active Earth Pressure Coefficient (K_a)	0.27	0.31	0.22
At Rest Earth Pressure Coefficient (K_o)	0.43	0.47	0.36
Passive Earth Pressure Coefficient (K_p)	3.69	3.25	4.55

The design water level will be dictated by the flow of water in the watercourses and should be defined by the project hydraulic engineer.

The coefficient of earth pressure at rest should be employed to design rigid and unyielding walls and the active earth pressure coefficient for unrestrained structures.

The horizontal force imposed on the foundations of "open footing" culverts will be resisted in part by the friction force developed between the underside of the footing and the engineered fill. An unfactored friction factor of 0.55 is recommended for footings constructed on granular fill.

A weeping tile system and/or weep holes should be installed to minimize the build-up of hydrostatic pressure behind the wall. The weeping tiles should be surrounded by a properly designed granular filter or geotextile to prevent migration of fines into the system. The drainage pipe should be placed on a positive grade and lead to a frost-free outlet.

The protective measures noted in the OPSD 800 series (in particular OPSD 803.030 and 803.020 for open and box culverts) to deal with erosion (inlet/outlet treatment, headwalls, cut-off walls, etc.) are considered to be appropriate. The backfill should comprise OPSS Granular A or Granular B Type II. The cut-off walls should extend to a depth at least equal to the fluctuation of the water level at each culvert location to prevent flow below the culvert that could erode the bedding material and extend laterally to protect the granular material.

The inlet and outlet protection must be sufficient to prevent erosion adjacent to the culvert as well as scour that could undermine the culvert and/or embankment foundation. The actual design requirements (length and width of the "aprons" at the inlet/outlet of the culvert as well as the rock size, apron thickness and height of erosion protection on the embankment slope) will be dictated by stream hydraulics, stream configuration as well as the water level in the creek and should be established by a hydraulic engineer.

EXCAVATION AND GROUNDWATER CONTROL

It is expected that the subgrade treatment required for construction of road embankments will be completed prior to construction of all the culverts. Consequently, excavation of soil for construction of the culverts should not be required.

If excavation of bedrock is required at culverts 6 and 7, it is important that blasting/excavation of the rock is controlled to prevent fracturing and/or disturbance of the bedrock surface on which footings will be founded. Conventional rock excavation techniques such as blasting (OPSS 120, General Specification for the Use of Explosives, August 1994) and jack-hammering should be suitable. The actual equipment required and method of excavation within the bedrock will be dependent upon the geometry of cut and relative depth of excavation into the bedrock. The need for pre-shearing and pre-splitting to avoid overbreak should not be overlooked.

Reduced charges to minimize overbreak should be considered. Any overblasting/overexcavation should be made the sole responsibility of the contractor and all loosened rock resulting from blasting operations is to be removed by mechanical means. A large excavator equipped with a tiger-toothed bucket in conjunction with a jack-hammer or hoe ram is the preferred method of excavation to shallow-depths in rock at foundation locations.

The excavation width should be 1 m wider than the plan area of the culvert. Near vertical sidewalls may be utilized for excavations in bedrock. Examination of the sidewalls and removal of any loosened rock fragments should be carried out continually for the safety of workmen.

Subject to the season/precipitation patterns, it is expected that conventional sump pumping, perimeter ditches and/or diversion of the stream can readily handle groundwater seepage or surface water entering the excavation for culvert installations. It may be necessary to implement more elaborate measures to control water flow in the event of a major storm and/or flooding at the culverts. The contract documents should have a specific item to clearly state that dewatering of excavations is the contractors responsibility.

Observed groundwater levels are subject to seasonal fluctuations and rainfall patterns.

It is recommended that the work be carried out during the dry months of June to September to minimize the potential for sloughing of the silt/sand, the amount of groundwater inflow to be handled and the volume of surface water, if any, to be diverted from the construction area.

CLOSURE

The report was prepared by Mr. G.O. Degil, Ph.D., Senior Project Supervisor, and reviewed by Mr. D.W. Kerr, M.Eng., P.Eng., Chief Foundation Engineer. Mr. B.R. Gray, M.Eng., P.Eng., Designated MTO Contact, conducted an independent review of the report.



Yours very truly

Peto MacCallum Ltd.

A handwritten signature in black ink, appearing to read "Dennis W. Kerr".

Dennis W. Kerr, M.Eng., P.Eng.
Chief Foundation Engineer



A handwritten signature in black ink, appearing to read "Brian R. Gray".

Brian R. Gray, M.Eng., P.Eng.
Designated MTO Contact

DWK/GD:ld

FOUNDATION DESIGN REPORT

Highway 69 - Culverts
Totten Sims Hubicki Associates

TABLE I – FDR

ANTICIPATED FOUNDATION CONDITIONS
CULVERTS
G.W.P. 5556-02-00
HIGHWAY 69, DISTRICT 54
TOWNSHIP OF DILL, SUDBURY

PROJECT SECTION	APPROXIMATE LOCATION ⁽¹⁾ (AT CENTERLINE MEDIAN)	CULVERT NO.	PROPOSED AVERAGE ROAD ELEVATION ⁽²⁾		RANGE OF EXISTING GROUND ELEVATION ⁽³⁾	APPROXIMATE EMBANKMENT HEIGHT ⁽²⁾ (m)	ANTICIPATED SUBGRADE ⁽⁴⁾	FACTORED BEARING RESISTANCE AT ULS (kPa)	BEARING RESISTANCE AT SLS (kPa)	REMARKS
			PROPOSED INVERT ELEVATION ⁽²⁾							
Highway 69 (New)	Sta. 17+403	1	252.7		230.7 to 231.4	22	3 to 15 m of rockfill	900	350	Note 5
			232.0							
	Sta. 17+690	2	254.3		246.0 to 248.0	8	3 to 15 m of rockfill	900	350	Note 5
			245.5							
	Sta. 17+946	3	256.2		248.9 to 249.9	7	7 to 15 m of rockfill	900	350	Note 5
			250.0							
	Sta. 18+340	4	258.1		250.6 to 251.0	7 to 8	4 to 12 m of rockfill	900	350	Note 5
			252.0							
	Sta. 18+447	5	259.5		251.8 to 252.0	8	9 to 15 m of rockfill	900	350	Note 5
			254.0							
	Sta. 19+176	6	250.4		244.9 to 246.3	4 to 6	1 to 5 m of rockfill; possible bedrock	900	350	Notes 5 and 6 (1 m)
			246.0							
	Sta. 19+208 (NW ramp chainage)	7	252.4		244.9 to 245.3	7 to 8	3 to 7 m of rockfill; possible bedrock	900	350	Notes 5 and 6 (1 m)
			245.8							

Notes:

- (1) Based on PML Drawings Nos. 1 to 5
- (2) Based on the cross-sections provided by TSH
- (3) Based on ground surface elevations at borehole locations
- (4) Based on recommendations for embankment construction contained in Foundation Design Report for Swamp and High Fill, PML Ref. 03TF003 and soil profile revealed in test holes drilled along the culvert alignment
- (5) Use OPSS 803.010, OPSS 422, OPSS 206 and OPSS 501. Rockfill to be placed according to OPSS 206 dated December 1993 amended by Special Provision (Draft dated June 2001)
- (6) Bedrock within the depth shown thus () below the subgrade level to be excavated