



FOUNDATION INVESTIGATION AND DESIGN REPORT

for

CULVERTS

HIGHWAY 69 FOUR-LANING

FROM 4 KM SOUTH OF ESTAIRE TO 1 KM NORTH OF HIGHWAY 537

G.W.P. 312-99-00

DISTRICT 54, TOWNSHIPS OF BURWASH, SECORD AND DILL

SUDBURY, ONTARIO

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PML Ref.: 03TF012F
Index No.: 212FIR and 213FDR
Geocres No.: 41I-197
January 23, 2006



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Explanation of Terms Used in Report

- Culvert 2
Record of Borehole Sheets and Drawing 1
- Culvert 3
Record of Borehole Sheets and Drawing 2
- Culvert 4
Record of Borehole Sheets and Drawing 3
- Culvert 5
Record of Borehole Sheets and Drawing 4
- Culvert 10
Record of Borehole Sheets and Drawing 5
- Culvert 11
Record of Borehole Sheets and Drawing 6
- Culvert 17
Record of Borehole Sheets and Drawing 7

FOUNDATION INVESTIGATION REPORT
 for
 Culverts
 Highway 69 Four-Laning
 From 4 km South of Estaire to 1 km North of Highway 537
 G.W.P. 312-99-00
 District 54, Townships of Burwash, Secord and Dill
 Sudbury, Ontario

1. INTRODUCTION

Realignment of the 12 km long section of Highway 69 that extends from 4 km south of Estaire to about 1 km north of Highway 537, some 15 km south of Sudbury, is planned. This report was prepared for Totten Sims Hubicki Associates (TSH) on behalf of the Ministry of Transportation of Ontario (MTO).

The study corridor extends from Station 11+286.5 (Burwash Township) to 11+308 (Dill Township), Highway 69 centreline. There are two chainage equations within the project limits:

- 20+066.514 Township of Burwash = 10+000.000 Township of Secord
- 10+760.775 Township of Secord = 10+000.000 Township of Dill

A total of 16 culverts were identified along the study corridor, of which 7 were specified to be investigated under the foundation engineering component of this study. The identification number and location of each culvert where a foundation investigation was conducted are listed below:

Culvert No.	Proposed Centreline Highway 69 Chainage (m)
2	Station 12+071 (Burwash Township)
3	SBL - Station 12+677 (Burwash Township) NBL - Station 12+681 (Burwash Township)
4	SBL - Station 12+882 (Burwash Township) NBL - Station 12+888 (Burwash Township)
5	Station 13+270 (Burwash Township)
10	SBL - Station 10+751 (Secord Township) NBL - Station 10+030 (Dill Township)
11	SBL - Station 11+026 (Dill Township) NBL - Station 11+029 (Dill Township)
17	SBL - Station 18+308 (Burwash Township) NBL - Station 18+303 (Burwash Township)



This report summarises the results of the field investigation conducted at the above culvert locations.

2. SITE DESCRIPTION AND GEOLOGY

The 12 km long section of Highway 69 to be realigned is situated about 15 km south of Sudbury in a wooded region with open swampy areas.

The study area is located in the Precambrian Laurentian peneplane. The topography is irregular in detail and dotted with areas of wet ground separated by steep rock ridges. Pleistocene lacustrine/fluvial deposits and recent swamp sediments have been laid down in depressions and are probably associated with the Nipissing post-glacial stage of the Great Lakes. Gravel and sand deposits also exist in the area. Soil cover over the rock outcrops is generally sparse.

Metasedimentary rocks of the Huronian Supergroup and gneisses of the Grenville Province underlay the alignment. The area has undergone considerable folding, intrusive activity, regional metamorphism and faulting. The bedrock outcrops at many locations throughout the project section.

3. INVESTIGATION PROCEDURES

Most of the field work for the foundation investigation at the culvert locations was conducted in conjunction with preparation of the Swamp and High Fill Crossings Report and the Pavement Design Report (PML Ref.: 03TF013 and 03TF014). Thirteen additional boreholes were drilled in March 2005 when the number and locations of the culverts requiring a foundation investigation were established. Overall, 33 boreholes and 3 dynamic cone penetration tests were carried out at the culvert locations during the period of February 2001 to March 2005. The test locations at each culvert are shown on Drawings 1 to 7.



The boreholes were drilled along and/or adjacent to the alignment of the proposed culverts. It is considered that the information obtained is sufficient for design purposes; some variation in the subsurface stratigraphy along the actual culvert alignment may be encountered during construction.

The test holes were advanced to depths ranging from 0.0 to 26.8 m below existing grade, generally terminating on probable bedrock. The test holes at the location of Culvert 2 were terminated in competent materials (typically compact silt / sand).

The test hole locations were established in accordance with the MTO requirements indicated in the RFP document and in general accordance with the requirements of the MTO Northeastern Region Pavement Design Practices and Guidelines (May 20, 1997). TSH laid out the reference lines of the new highway in the field to be used for determination of the test hole locations. Geodetic elevations were referred to field temporary benchmarks provided by TSH.

The test holes were advanced using a combination of equipment including track-mounted drill rigs, excavators and manual hand sampling. NQ rock coring was performed in one borehole (Culvert 4). The equipment was supplied and operated by contractors working under the full-time supervision of members of our engineering staff.

Representative samples of the soils were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Thin wall (Shelby) tube samples were also recovered at selected locations. 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 of the cohesive soils encountered. The results of the field tests and observations are reported on the Record of Borehole sheets.



The ground water conditions at the borehole locations were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open boreholes. Upon completion of drilling, the boreholes were backfilled with a bentonite/cement mixture in accordance with the MTO guidelines for borehole abandonment procedures.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. The soil samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determination. Atterberg limits tests and grain size distribution analyses were performed on selected soil samples. The laboratory test results are provided on the Record of Borehole sheets.

4. SUMMARISED 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, in situ vane and pocket penetrometer undrained shear strength values as well as ground water observations. The results of laboratory Atterberg limits, grain size distribution analyses and natural moisture content determination are also shown on the Record of Borehole sheets.

The borehole locations and stratigraphic profiles along the alignment of each culvert prepared from the borehole and dynamic cone penetration test data are presented on Drawings 1 to 7. The boundaries between soil strata have been established at the borehole locations only; between boreholes, the boundaries are assumed and may vary.

The shear strength / consistency of the cohesive soils noted on the Record of Borehole sheets and in the subsequent sections of the report is primarily based on in situ vane shear testing (using the MTO 'N' vane according to the procedure described in the Northern Region Pavement Design Practices and Guidelines dated May 1997) and penetrometer tests on recovered samples. Less consideration was given to SPT-'N' values since the shear strength indicated by this technique is less reliable in very soft to soft clayey soils.



A description of the subsurface stratigraphy identified at each culvert is summarised in subsequent sections of the report.

Bedrock was only exposed at Culverts 5 and 17 during the field investigation. Based on visual observation, it was the same as the bedrock identified at the structure locations along the study corridor, predominantly granitic gneiss, high strength, moderately spaced joints, good to excellent quality, slightly to moderately weathered.

Comments concerning the ground water level observed during the field investigation are also provided; the stabilized ground water level was not established. Since the boreholes were located in low lying areas and the native soil comprised relatively impervious clayey material, it is considered that the stabilized water level at each culvert location will be near the high water level observed. Ground water was not observed in the boreholes drilled at the locations of Culverts 5 and 17 where bedrock was contacted within respective depths of 0.9 and 1.3 m below the existing ground surface.

4.1 Culvert 2

Five boreholes and one dynamic cone penetration test were advanced in the vicinity of this culvert. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat deposit overlying cohesionless sand and/or silt. Bedrock was not contacted in any of the test holes at their termination at depths of 9.6 to 19.5 m (elevation 203.2 to 213.5). Ground water was at depths of 0.9 to 5.5 m (elevation 216.9 to 221.6). The strata encountered are summarised below.

4.1.1 Peat

A surficial deposit of peat was present in all the boreholes. The thickness of peat varied between 0.8 m in borehole 601-12NA and 3.2 m in borehole 601-12SA. The peat was amorphous, fine and coarse fibrous in texture, with a moisture content varying between 218 and 692%. The deposit was penetrated at elevation 219.4 to 221.8.



4.1.2 Sand to Silt

Cohesionless sand and/or silt underlay the peat in four boreholes and was below a silty clay deposit in one borehole. The sandy/silty strata were very loose to compact in relative density (SPT-'N' values of 0 to 11). The moisture content of the sand / silt ranged from 19 to 23%. The augering was terminated in the sandy/silty strata at depths of 6.6 to 12.2 m (elevation 210.4 to 216.1).

4.1.3 Silty Clay

A discontinuous layer of cohesive silty clay was encountered between the peat and silt at 2.3 m depth (elevation 220.1) in borehole 601-13NB. The silty clay was 3.2 m thick and very soft to soft in consistency as assessed using SPT-'N' values of 0 to 3.

4.1.4 Ground water

In the process of augering, water was detected at depths of 0.6 to 3.4 m (elevation 219.1 to 221.8) in two boreholes. Upon completion of drilling, ground water was measured in four boreholes to be at depths of 0.9 to 5.5 m (elevation 216.9 to 221.6). Observed ground water levels are subject to seasonal fluctuations and precipitation patterns.

4.2 Culvert 3

Six boreholes and one dynamic cone penetration test were advanced along the alignment and in the vicinity of this culvert. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat deposit overlying non-plastic silt and/or cohesive silty clay / clayey silt. Probable bedrock was contacted at depths of 3.0 to 14.2 m (elevation 216.9 to 227.5). Ground water was at depths of 0.9 to 6.0 m (elevation 225.1 to 229.4). The strata encountered are summarised below.



4.2.1 Peat

A surficial deposit of peat was present in five boreholes. The peat was 0.1 to 0.2, locally 1.2 m thick and fine to coarse fibrous in texture. The deposit was penetrated at elevation 229.1 to 231.0.

4.2.2 Silt to Silty Sand

Silty sand was present surficially in borehole 602-12S. This unit was 900 mm thick and compact in relative density (SPT-'N' value of 11).

Directly beneath the peat in boreholes 602-9S, 602-11S, 602-10N and underlying clayey soils at depths of 2.7 to 6.2 m (elevation 224.9 to 227.8) in boreholes 602-9S, 602-11S, 602-12S, 602-10N, 602-12N was silt / sandy silt. This stratum had a thickness ranging from 0.3 to 8.9 m and was very loose to compact (SPT-'N' values of 1 to 15), with a moisture content of 23 to 30%.

The silt / silty sand above clayey soils was penetrated at depths of 0.9 to 1.2 m (elevation 229.1 to 230.2) and the silt / sandy silt below the clayey soils at 3.0 to 14.2 m (elevation 216.9 to 227.5).

4.2.3 Silty Clay / Clayey Silt

Cohesive silty clay / clayey silt was encountered below the peat in boreholes 602-11N, 602-12N and within the silty/sandy soils at depths of 0.9 to 1.2 m (elevation 229.1 to 230.2) in the remaining boreholes. These deposits were 1.8 to 5.3 m thick and firm to stiff, locally soft in consistency. Pocket penetrometer tests conducted on silty clay samples indicate a shear strength of about 38 kPa. The results of in situ vane shear testing carried out in the silty clay / clayey silt at depths of 4.0 to 5.5 m yielded undisturbed shear strength values in a range of 46 to 72 kPa (soil sensitivity is 2 to 5). The deposits were penetrated at depths of 2.7 to 6.2 m (elevation 224.9 to 227.8).



4.2.4 Bedrock

Probable bedrock was contacted in the boreholes below the native soils at depths of 3.0 to 14.2 m (elevation 216.9 to 227.5).

4.2.5 Ground water

In the process of augering, water was detected at depths of 0.9 to 6.0 m (elevation 225.1 to 229.4) in four boreholes. Upon completion of drilling, ground water was measured in boreholes 602-9S, 602-12S, 602-10N to 602-12N to be at depths of 1.2 to 5.2 m (elevation 225.9 to 229.1). No water was observed in borehole 602-11S during or upon completion of drilling. Observed ground water levels are subject to seasonal fluctuations and precipitation patterns.

4.3 Culvert 4

Five boreholes were drilled near this culvert. The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat deposit overlying non-plastic silt and/or cohesive clayey silt / silty clay. Cobbles were identified in one borehole. Bedrock / probable bedrock was contacted at depths of 16.3 to 26.8 m (elevation 206.4 to 217.0). Ground water was at depths of 0.0 to 14.6 m (elevation 218.7 to 233.2). The strata encountered are summarised below.

4.3.1 Peat / Topsoil

A surficial deposit of peat was present in four boreholes. The peat was 200 to 500 mm thick and fine to coarse fibrous in texture. This deposit had a moisture content of about 26% and was penetrated at elevation 231.7 to 233.1.

A 200 mm thick layer of topsoil underlay 300 mm of snow / ice in borehole 602-30N and was penetrated at elevation 232.7.



4.3.2 Silt

Directly beneath the peat / topsoil in boreholes C4-2, C4-3 and 602-30N was non-plastic silt. This unit was 0.9 to 2.5 m thick and loose in relative density (SPT-'N' values of 5 to 8). The moisture content of the silt was about 22%. The unit was penetrated at depths of 1.2 to 3.0 m (elevation 230.2 to 231.0).

4.3.3 Clayey Silt / Silty Clay

Cohesive strata of clayey silt and/or silty clay were encountered below the peat in boreholes C4-1, 602-30S and below the silt in the remaining boreholes. The cohesive soils had a thickness of 8.9 to 16.1 m (the silty clay in borehole 602-30N contained a 1.9 m thick layer of silt at 4.5 m depth) and were soft to hard, typically firm to stiff in consistency. Pocket penetrometer tests conducted on cohesive soil samples indicate shear strength values of 13 to 150 kPa, typically 75 to 150 kPa. The results of in situ vane shear testing carried out in the silty clay at depths of 6.7 to 13.1 m yielded the undisturbed shear strength values in a range of 28 to 88 kPa (soil sensitivity is 2 to 6). The moisture content was 17 to 31% in the clayey silt and 22 to 56% in the silty clay units. The cohesive soils were penetrated at depths of 11.9 to 16.3 m (elevation 217.0 to 221.3).

4.3.4 Silt / Sand

Except for borehole 602-30S, underlying the silty clay at depths of 11.9 to 14.6 m (elevation 217.9 to 221.3) was silt. The thickness of this unit increased from 1.6 m in borehole C4-1 to 14.9 m in borehole 602-30N. The silt was very loose to dense (SPT-'N' values of 0 to 36). The unit had a moisture content of 16 to 29% and was penetrated at depths of 16.2 to 26.8 m (elevation 206.4 to 216.3). It is noteworthy that cobbles were present within the silt at 22.6 m depth (elevation 209.6) at the east end of the culvert alignment.

A 1.5 m thick layer of sandy silt was identified below the silt at a depth of 16.2 m (elevation 216.3) in borehole C4-1. The sandy silt was loose (SPT-'N' value of 6) with a moisture content of 14%.



Gravelly sand of 700 mm thickness was revealed below the sandy silt at 17.7 m depth (elevation 214.8) at the west end of the culvert alignment. This stratum was dense (SPT-'N' value of 20 per 0.15 m penetration) and overlay bedrock.

4.3.5 Bedrock

Bedrock / probable bedrock was contacted below the native soils at depths of 16.3 to 26.8 m (elevation 206.4 to 217.0) in all the boreholes. The bedrock cored in borehole C4-1 had a recovery of 100%. The RQD determined from two rock cores was in a narrow range of 98 to 100%, thus indicating an excellent quality rock.

4.3.6 Ground water

In the process of augering, water was detected at depths of 4.0 to 5.8 m (elevation 226.7 to 228.2) in four boreholes. Upon completion of drilling, ground water was measured in three boreholes to be at depths of 0.0 to 14.6 m (elevation 218.7 to 233.2). Observed ground water levels are subject to seasonal fluctuations and precipitation patterns.

4.4 Culvert 5

Five boreholes were drilled along the alignment and in the vicinity of this culvert. The subsurface stratigraphy revealed in the boreholes comprised a surficial topsoil layer overlying cohesionless sand and/or shallow bedrock. Boulders were identified in two boreholes. Bedrock / probable bedrock was contacted at depths of 0.0 to 0.9 m (elevation 218.4 to 220.4). The strata encountered are summarised below.

4.4.1 Topsoil

A surficial layer of topsoil was present in all boreholes except borehole C5-2 put down at the centreline of Highway 69. The topsoil had a thickness of 100 to 200 mm and was penetrated at elevation 218.4 to 220.6.



4.4.2 Sand

Directly beneath the topsoil in boreholes 603-11N and 603-11S was cohesionless sand with boulders. This unit was 700 and 800 mm thick respectively. The sand was penetrated at 0.9 m depth (elevation 219.7 and 219.8).

4.4.3 Bedrock

Bedrock was exposed in the borehole advanced at the centreline of the highway. Probable bedrock was contacted below the topsoil or sand at depths of 0.1 to 0.9 m (elevation 218.4 to 219.8).

4.4.4 Ground water

No ground water was observed in any of the boreholes in the course of the field work. Generally, however, ground water levels are subject to seasonal fluctuations and precipitation patterns.

4.5 Culvert 10

Six boreholes were drilled along the alignment and in the vicinity of this culvert. The subsurface stratigraphy revealed in the boreholes comprised a surficial peat deposit overlying cohesionless sand / silt underlain by cohesive silty clay / clay. Probable bedrock was contacted at depths of 5.3 to 24.1 m (elevation 198.3 to 216.0). Ground water was at depths of 0.9 to 5.2 m (elevation 215.6 to 221.4). The strata encountered are summarised below.

4.5.1 Peat

A surficial deposit of peat was present in all the boreholes. The peat was 0.3 to 0.9, locally 2.4 m thick and fine to coarse fibrous in texture. The deposit had a moisture content of 210% (one determination) and was penetrated at elevation 218.9 to 221.6.



4.5.2 Sand / Silt

Directly beneath the peat in most boreholes was cohesionless sand / silt. In borehole C10-3, however, a 1.1 m thick layer of firm silty clay was identified between the peat and sand. These strata had a total thickness of 0.9 to 5.3 m and were very loose to compact, locally dense (SPT-'N' values of 1 to 33). The silt had a moisture content of about 29% (one determination). The upper sandy/silty strata were penetrated at depths of 2.6 to 6.1 m (elevation 216.0 to 219.6).

The sand and/or silt was also revealed within or below clayey material at depths of 7.0 and 11.6 m (elevation 214.2 and 210.8) in boreholes C10-3 and 612-27S respectively. The sand / silt units were 3.4 m thick, compact in the former borehole and 4.7 m thick, loose to very loose in the latter. The moisture content of the silt in borehole 612-27S ranged from 30 to 37%.

4.5.3 Silty Clay / Clay

Cohesive silty clay was encountered below the sandy/silty soils at depths of 2.6 to 6.1 m (elevation 215.3 to 219.6) in boreholes 612-25S, 612-27S and C10-1 to C10-3. This unit was 4.4 to 19.6 m thick and firm to stiff, locally soft in consistency. The results of in situ vane shear testing carried out in the silty clay at various depths yielded the undisturbed shear strength values in a range of 15 to 100 kPa (soil sensitivity is 3 to 6). The unit was penetrated at depths of 7.0 to 22.3 m (elevation 200.0 to 214.2).

A 7.8 m thick layer of cohesive clay was identified below the silt at 16.3 m depth (elevation 206.1) in borehole 612-27S. The clay was soft to stiff and had a moisture content of 42 to 48%.

4.5.4 Bedrock

Probable bedrock was contacted below the native soils at depths of 5.3 to 24.1 m (elevation 198.3 to 216.0).



4.5.5 Ground water

In the process of augering, water was detected at depths of 0.9 to 4.6 m (elevation 216.8 to 221.4) in all the boreholes. Upon completion of drilling, ground water was measured in boreholes C10-1 to C10-4 to be at depths of 1.8 to 5.2 m (elevation 215.6 to 219.5). Observed ground water levels are subject to seasonal fluctuations and precipitation patterns.

4.6 Culvert 11

Three boreholes and one dynamic cone penetration test were advanced in the near vicinity of this culvert. The subsurface stratigraphy revealed in the boreholes comprised a surficial peat deposit overlying cohesive soils underlain by cohesionless silt / sand. Probable bedrock was contacted at depths of 2.6 to 16.1 m (elevation 204.7 to 218.1). Ground water was at the ground surface (elevation 220.7 to 220.8). The strata encountered are summarised below.

4.6.1 Peat

A surficial deposit of peat was present in all the boreholes. The thickness of peat varied between 0.2 m in borehole 101-18N and 7.3 m in borehole 101-11S. The peat was amorphous, fine and coarse fibrous in texture, with a moisture content ranging from 259 to 713%. The deposit was penetrated at elevation 213.4 to 220.6.

4.6.2 Clayey Soils

Directly beneath the peat in the boreholes was cohesive clay, silty clay or clayey silt. These soils were 1.6 to 6.5 m thick and very soft to firm in consistency. The results of in situ vane shear testing carried out in the clay (borehole 101-17N) yielded the undisturbed shear strength values of 38 and 52 kPa (soil sensitivity is 8 and 13). The moisture content of the silty clay identified in borehole 101-18N was in a range of 29 to 68%. The cohesive soils were penetrated at depths of 5.7 to 8.9 m (elevation 211.8 to 215.1).



4.6.3 Silt to Sand

Silt / sandy silt was encountered below the clayey soils at depths of 5.7 to 8.9 m (elevation 211.8 to 215.1). This unit was 1.6 to 9.4 m thick and very loose to very dense (SPT-'N' values of 1 to 50). The silt / sandy silt had a moisture content of 23 to 29% and was penetrated at depths of 10.5 to 16.1 m (elevation 204.7 to 210.2).

Underlying the silt at 13.3 m depth (elevation 207.5) in borehole 101-17N was cohesionless sand. This stratum was 2.6 m thick and compact to very dense (SPT-'N' values of 10 to 78).

4.6.4 Bedrock

Probable bedrock was contacted below the native soils at depths of 2.6 to 16.1 m (elevation 204.7 to 218.1).

4.6.5 Ground water

Both during and upon completion of drilling, ground water was at the ground surface (elevation 220.7 to 220.8) in all the boreholes. Observed ground water levels are subject to seasonal fluctuations and precipitation patterns.

4.7 Culvert 17

Three boreholes were drilled along the alignment of this culvert. The subsurface stratigraphy revealed in the boreholes comprised a surficial peat deposit and/or cohesionless silty sand underlain by shallow bedrock. Cobbles and boulders were identified in one borehole. Bedrock / probable bedrock was contacted at depths of 0.0 to 1.3 m (elevation 249.1 to 250.7). The strata encountered are summarised below.



4.7.1 Peat

A surficial deposit of peat was present in the borehole put down at the west end of the culvert alignment. The peat was 500 mm thick and coarse fibrous in texture. The deposit was penetrated at elevation 250.8.

4.7.2 Silty Sand

Cohesionless silty sand was encountered surficially in borehole C17-2 and below the peat in borehole C17-1. The thickness of this unit was 400 and 800 mm thick respectively. The silty sand was penetrated at respective depths of 0.4 and 1.3 m (elevation 250.7 and 250.0).

It is noteworthy that cobbles and boulders were identified within the unit at the west end of the culvert alignment.

4.7.3 Bedrock

Bedrock was exposed in the borehole advanced at the east end of the culvert alignment. Probable bedrock was contacted below the silty sand at depths of 0.4 and 1.3 m (elevation 250.7 and 250.0) in boreholes C17-2 and C17-1 respectively.

4.7.4 Ground water

No ground water was observed in any of the boreholes in the course of the field work. Generally, however, ground water levels are subject to seasonal fluctuations and precipitation patterns.



5. CLOSURE

The field work was carried out under the supervision of Mr. F. Portela, C.E.T., and the direction of Mr. B.R. Gray, MEng, P.Eng. The equipment was supplied by Marathon Drilling Co. Ltd. The laboratory testing was conducted in the PML Toronto laboratory.

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

Yours very truly

Peto MacCallum Ltd.

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GD:gd-mi

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 601-11S 2 of 2 METRIC

G.W.P. 312-99-00 LOCATION New Hwy 69 Sta. 12+050, o/s 29.2m Lt. Burwash Twp. ORIGINATED BY AJS
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. & Dynamic Cone Penetration Test COMPILED BY PC
 DATUM Geodetic DATE March 15, 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					
207.7	Cont'd																
203.2 19.5	End of dynamic cone penetration test																
	* Borehole dry on completion of drilling																

RECORD OF BOREHOLE No 601-12SA 1 of 2 METRIC

G.W.P. 312-99-00 LOCATION New Hwy 69 Sta. 12+075, o/s 28.4m Lt. Burwash Twp. ORIGINATED BY FP
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. & Dynamic Cone Penetration Test COMPILED BY PC
 DATUM Geodetic DATE March 21, 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	20	40	60	80						100	20
222.6	Ground Surface																	
0.0	Peat, fine fibrous Dark brown Wet																	
	Amorphous Brown																	
219.4	Sand, trace silt trace clay Grey Wet																	
218.6	Sand and silt, trace clay Grey Wet																	
217.3	Silt, trace sand trace clay Grey Wet																	
210.4	End of borehole																	

Cont'd

RECORD OF BOREHOLE No 601-12SA 2 of 2 METRIC

G.W.P. 312-99-00 LOCATION New Hwy 69 Sta. 12+075, o/s 28.4m Lt. Burwash Twp. ORIGINATED BY FP
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. & Dynamic Cone Penetration Test COMPILED BY PC
 DATUM Geodetic DATE March 21, 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			20	40	60	80	100						20
207.6	Cont'd																	
207																		
206																		
205																		
204.3	End of dynamic cone penetration test																	
18.3																		
	* 2003 03 21																	
	▼ Water level measured after drilling																	

RECORD OF BOREHOLE No 601-5M 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION New Hwy 69 Sta. 12+075, o/s 9.4m Lt. Burwash Twp. ORIGINATED BY CB
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 15, 2003 CHECKED BY _____

SOIL PROFILE		STRAT PLOT	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		NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
222.5	Ground Surface																	
0.0	Peat, fine fibrous Dark brown		1	SS	4													
						▽*												
			2	SS	WR**													
219.8																		
2.7	Sand, coarse trace silt trace clay Very loose Grey Wet		3	SS	WR	▽*												
217.7			4	SS	3													
4.8	Silt, trace sand trace clay Loose to compact Grey Wet		5	SS	8													
			6	SS	8													
			7	SS	11													
212.9																		
9.6	End of borehole																	

* 2003 03 15
 ▽ Water level observed during drilling
 ▼ Water level measured after drilling
 WR** Refers to penetration under the weight of rods only

RECORD OF BOREHOLE No 601-12NA 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION New Hwy 69 Sta. 12+075, o/s 9.1m Rt. Burwash Twp. ORIGINATED BY FP
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 21, 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	20	40	60	80						100	SHEAR STRENGTH kPa
											○ UNCONFINED	+	FIELD VANE					
											● QUICK TRIAXIAL	×	LAB VANE	WATER CONTENT (%)				
														20	40	60		
222.6	Ground Surface																	
0.0	Peat, fine fibrous Dark brown Wet																	
221.8																		
0.8	Sand, fine to medium trace silt Brown Wet																	
	coarse Grey																	
218.8																		
3.8	Silt, trace sand trace clay Grey Wet																	
213.5																		
9.1	End of borehole																	

* 2003 03 21
 Water level measured after drilling

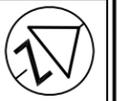
RECORD OF BOREHOLE No 601-13NB 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION New Hwy 69 Sta. 12+100, o/s 43.7m Rt Burwash Twp. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY F.P.
 DATUM Geodetic DATE April 07, 2004 CHECKED BY _____

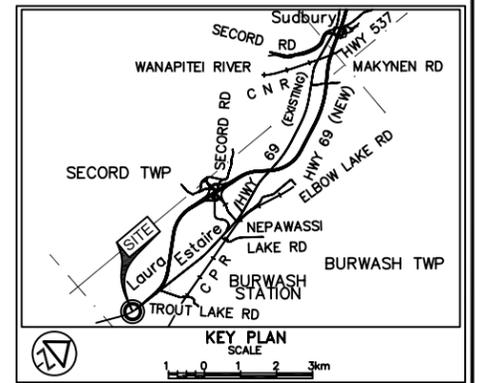
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
222.4	Ground Surface															
0.0	Peat, coarse fibrous Dark brown fine fibrous		1	SS	32											
			2	SS	WH**											
220.1																
2.3	Silty clay with clayey silt seams Very Grey Wet soft to soft		3	SS	WH											
			4	SS	3											
216.9																
5.5	Silt, trace sand with clayey silt seams Loose Grey Wet		5	SS	5											
			6	SS	6											
	trace clay Compact		7	SS	10											
			8	SS	11											
211.1																
11.3	End of borehole															
210.2																
12.2	End of dynamic cone penetration test															

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

CONT No
 GWP No 312-99-00
**HIGHWAY 69
 CULVERT 2**
 HIGHWAY 69 FOUR-LANING FOR 12 km
 From 4 km South of Estaire to 1 km North of Hwy 537
BOREHOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

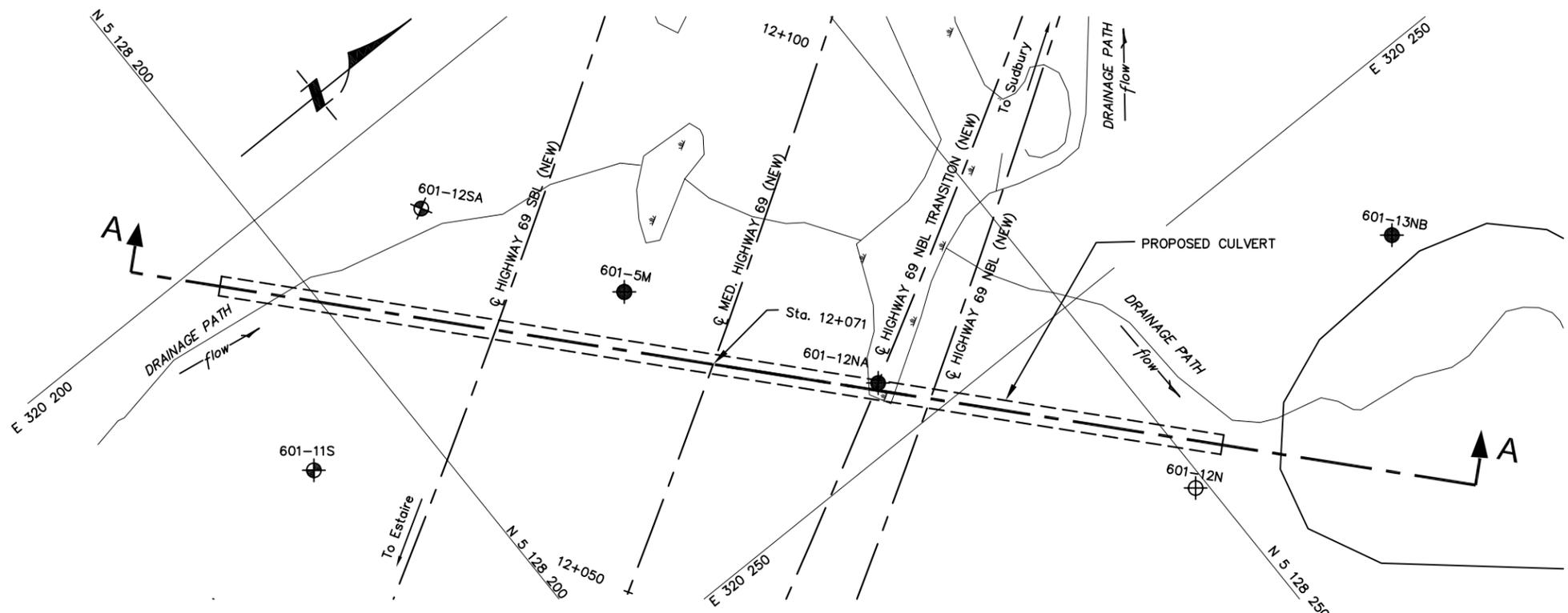
- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE Blows/0.3m (60° Cone, 475 J / blow)
- W L at time of investigation Mar 2003 & Apr 2004
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

BH No	ELEVATION	STATION	o/s
601-5M	222.5	Sta. 12+075	CL
601-11S	222.7	Sta. 12+050	19m Lt.
601-12SA	222.6	Sta. 12+075	19m Lt.
601-12N	222.6	Sta. 12+075	43m Rt.
601-12NA	222.6	Sta. 12+075	19m Rt.
601-13NB	222.4	Sta. 12+100	52m Rt.

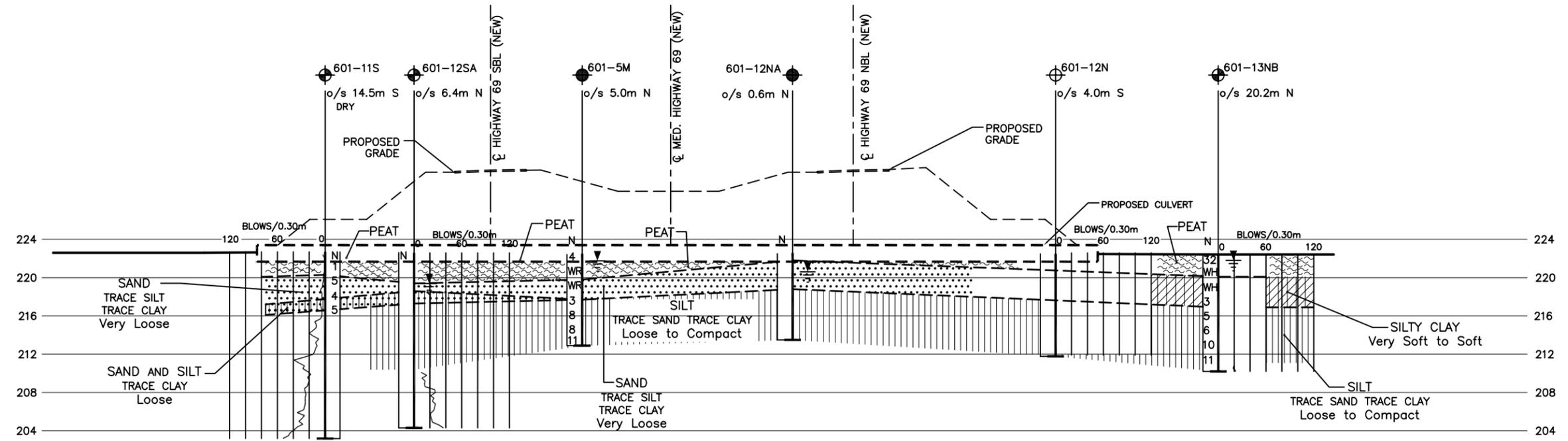
NOTE
 The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

DATE	BY	DESCRIPTION

Geocres No. 411-197
 HWY No 69 DIST 54
 SUBM'D GD CHECKED GD DATE JAN, 23, 2006 SITE
 DRAWN NA CHECKED DWK APPROVED BRG DWG 1



PLAN
 SCALE
 5 0 5 10m



SECTION A-A
 SCALE
 5 0 5 10m

REF No E-Hwy69-S-des.dwg; 5568 culverts_04-11-15.dwg; November 2004
 1_BPL05; October 2002



RECORD OF BOREHOLE No 602-9S 1 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+662.5, o/s 34m Lt. Burwash Twp. ORIGINATED BY RE
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 22, 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	20	40	60	80						100	20
231.1	Ground Surface																	
0.0	Peat, coarse fibrous	[Strat Plot]	1	SS	1													
0.1	Dark brown Silt, trace sand trace clay																	
229.9	Very loose Brown/grey Dry																	
1.2	Silty clay trace sand																	
	Firm Brown/grey Moist		2	SS	8													
228.4																		
2.7	Clayey silt, trace sand																	
	Stiff Grey Moist		3	SS	3													
			4	SS	2													
224.9																		
6.2	Silt, trace fine sand trace clay		5	SS	6													
	Loose Grey Moist																	
	Compact		6	SS	11													
			7	SS	12													
			8	SS	6													
219.5																		
11.6	Sandy silt, trace clay trace gravel																	
	Very loose Brown Moist		9	SS	4													
217.7																		
13.4	End of borehole																	
	Refusal on probable bedrock																	

Cont'd

RECORD OF BOREHOLE No 602-9S 2 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+662.5, o/s 34m Lt. Burwash Twp. ORIGINATED BY RE
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 22, 2003 CHECKED BY _____

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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	W _p	w	W _L		
216.1	Cont'd																
	* 2003 03 22																
	▽ Water level observed during drilling																
	▼ Water level measured after drilling																
	■ Penetrometer test																

RECORD OF BOREHOLE No 602-12S 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+687.5, o/s 34.5m Lt. Burwash Twp. ORIGINATED BY CB
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 18, 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	20	40	60	80					
230.5	Ground Surface															
0.0	Silty sand, trace gravel Compact Brown Moist	•	1	SS	11											
229.6																
0.9	Silty clay, trace sand Stiff Brown Moist	▨	2	SS	9											
227.8																
2.7																
227.5	Silt, trace sand trace clay															
3.0	<u>Brown Wet</u> End of borehole Refusal on probable bedrock															
	* 2003 03 18 ▽ Water level observed during drilling ▼ Water level measured after drilling															

RECORD OF BOREHOLE No 602-11S 2 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+675, o/s 19m Lt. Burwash Twp. ORIGINATED BY RE
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 22, 2003 CHECKED BY _____

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT CONTENT			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	W _p	w	W _L		
216.1	Cont'd Refusal on probable bedrock * Borehole dry on completion of drilling ■ Penetrometer test																

RECORD OF PENETRATION TEST No 602-11SA 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+687.5, o/s 4m Lt. Burwash Twp. ORIGINATED BY CB
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY PC
 DATUM Geodetic DATE March 18, 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									
230.4 0.0	Ground Surface						20	40	60	80	100						
							230										
							229										
							228										
							227										
							226										
							225										
							224										
							223										
221.9 8.5	End of dynamic cone penetration test						222										

RECORD OF BOREHOLE No 602-11N 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+687.5, o/s 4m Rt. Burwash Twp. ORIGINATED BY CB
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 18, 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								
						20	40	60	80	100						
230.4	Ground Surface															
0.1	Peat, fine fibrous Dark brown Silty clay, trace sand Firm Brown Moist		1	SS	8											
			2	SS	7											
	Wet		3	SS	3											
			4	SS	7											
226.2	Clayey silt, trace sand Stiff Grey Wet															
4.2																
225.0	End of borehole Refusal on probable bedrock															
5.4																

RECORD OF BOREHOLE No 602-10N 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+675, o/s 19m Rt. Burwash Twp. ORIGINATED BY MR
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 23, 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	20	40	60	80					
230.3	Ground Surface															
0.0	Peat, coarse fibrous															
0.2	Dark brown		1	SS	7											
	Silt, trace sand trace clay															
229.1	Loose Brown Moist															
1.2	Silty clay, trace sand															
	Firm Brown Moist		2	SS	6											
	Soft Wet															
226.8	Silt, trace sand trace clay															
3.5	Loose Brown Wet															
	Grey		4	SS	8											
223.1	Sandy silt trace clay trace gravel															
7.2	Very loose Grey Wet		6	SS	3											
221.8	End of borehole															
8.5	Refusal on probable bedrock															

* 2003 03 23
 ▼ Water level measured after drilling
 ■ Penetrometer test

RECORD OF BOREHOLE No 602-12N 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+687.5, o/s 34.5m Rt. Burwash Twp. ORIGINATED BY CB
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 18, 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	20	40	60	80					
230.3 0.0	Ground Surface Peat, fine fibrous Dark brown		1	SS	31											
229.1 1.2	Clayey silt, trace sand Stiff Grey Wet		2	SS	10											0 4 63 33
227.6 2.7	Silty clay, trace sand Stiff Grey Wet		3	SS	9											
225.8 4.5	Silt, trace sand trace clay Loose Grey Wet		4	SS	8											0 2 89 9
			5	SS	5											0 4 91 5
223.1 7.2	End of borehole Refusal on probable bedrock															

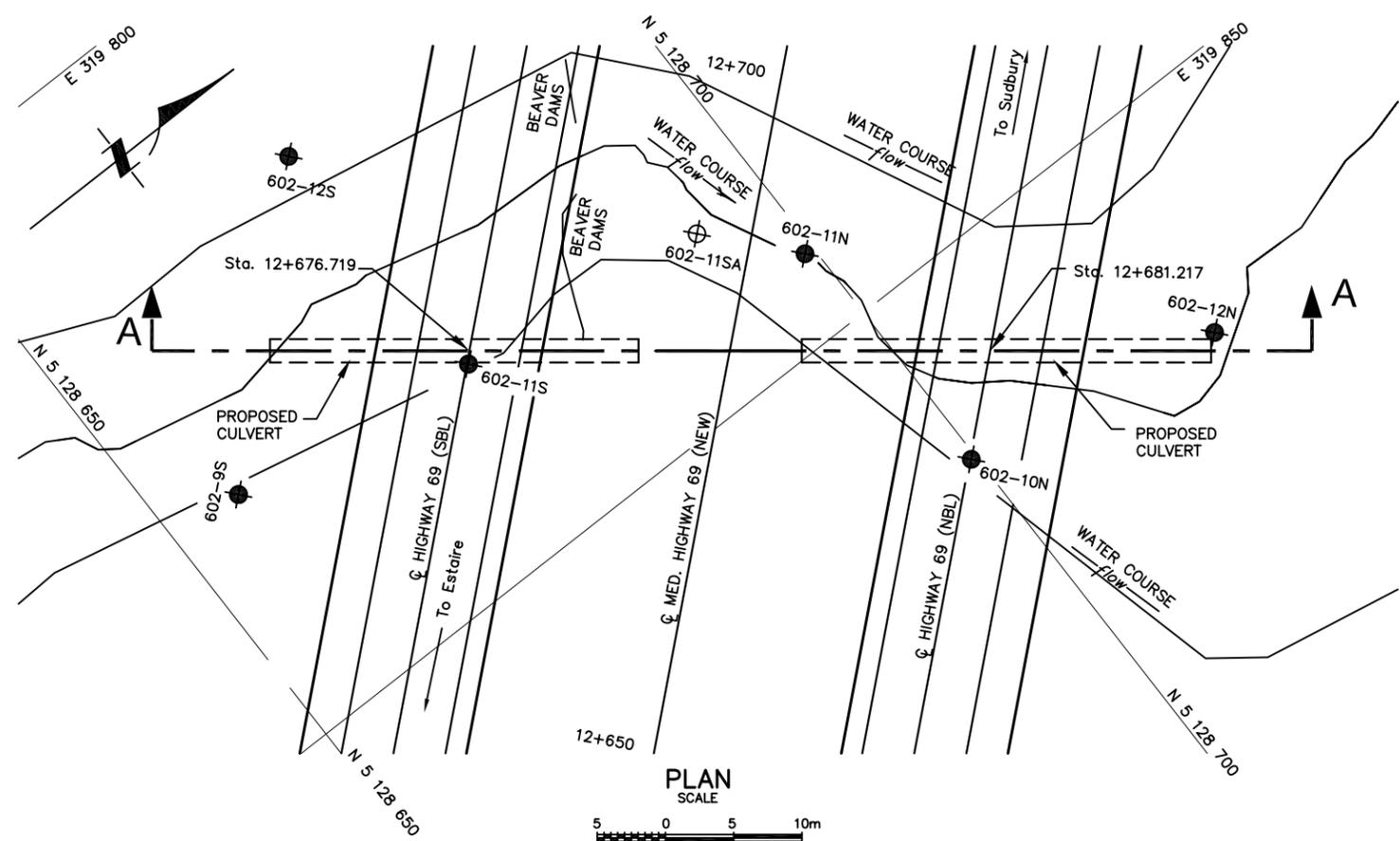
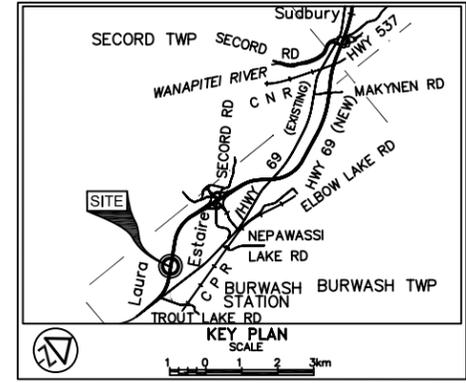
* 2003 03 18
 Water level observed during drilling
 Water level measured after drilling

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

CONT No
 GWP No 312-99-00
**HIGHWAY 69
 CULVERT 3**
 HIGHWAY 69 FOUR-LANING FOR 12 km
 From 4 km South of Estaire to 1 km North of Hwy 537
BOREHOLE LOCATIONS & SOIL STRATA

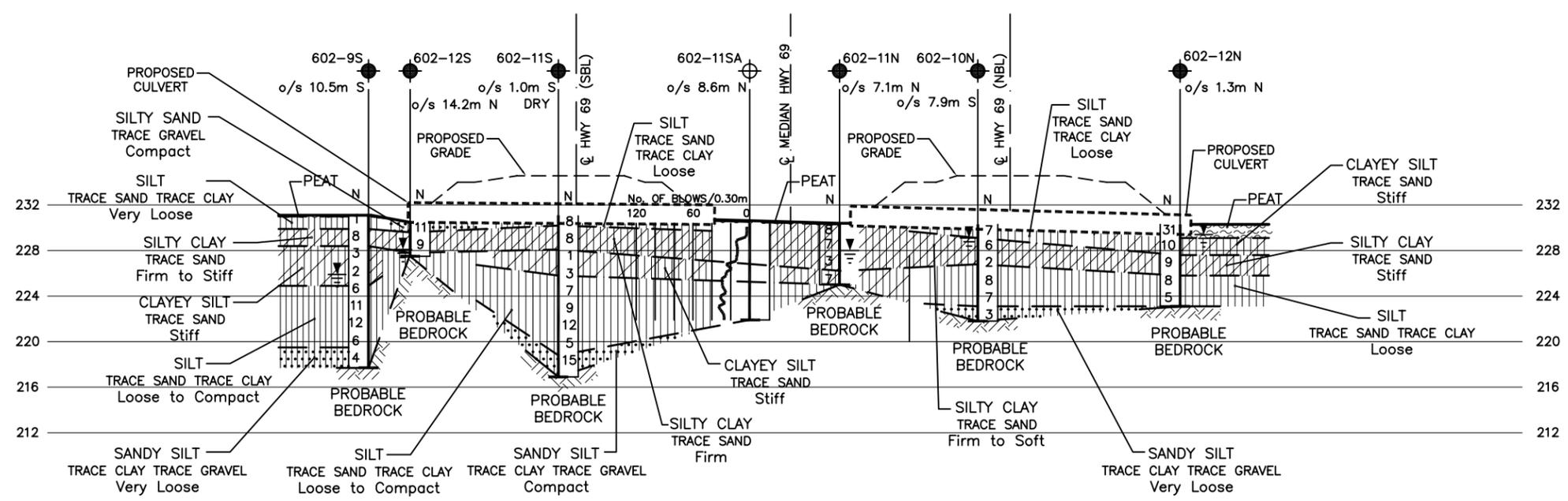


SHEET



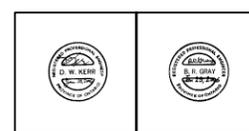
LEGEND

- 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 March 2003
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER



BH No	ELEVATION	STATION	o/s
602-10N	230.3	12+675	19m Rt
602-11N	230.4	12+687.5	4m Rt
602-12N	230.3	12+687.5	34.5m Rt
602-9S	231.1	12+662.5	34m Lt
602-11S	231.1	12+675	19m Lt
602-11SA	230.4	12+687.5	4m Lt
602-12S	230.5	12+687.5	34.5m 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. 411-197

HWY No	69	DIST	54
SUBM'D	GD	CHECKED	GD
DATE	JAN. 23, 2006	SITE	
DRAWN	NA	CHECKED	DWK
APPROVED	BRG	DWG	2

REF No E-Hwy69-S-des.dwg; 5568 culverts_04-11-15.dwg; November 2004
 1_BPL05; October 2002

RECORD OF BOREHOLE No C4-1 1 of 2 **METRIC**

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 12+880, o/s 33 m Lt. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + NQ Rock Coring COMPILED BY G.D.
 DATUM Geodetic DATE March 18, 2005 CHECKED BY _____

SOIL PROFILE		STRAT PLOT	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		NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
232.5	Ground Surface															
0.0	Peat, fine fibrous		1	SS	7											
232.0	Dark brown															
0.5	Silty clay, trace sand															
	Stiff Brown Moist to Very Stiff		2	SS	11											
	Grey															
			3	SS	12											
228.5	Clayey silt, trace sand with silt lenses															
4.0	Hard Grey Moist		4	SS	38											
226.7	Silty clay, trace sand															
5.8	Firm Grey Wet		5	SS	3											
			6	SS	2											
			7	SS	2											
			8	SS	2											
			9	SS	11											
			10	SS	6											
217.9																
14.6																

Cont'd

+7, X⁵: Numbers refer to Sensitivity
 20
 15—○—5 (% STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 602-30S 1 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+875, o/s 19m Lt. Burwash Twp. ORIGINATED BY FP
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 17, 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	20						40	60	80	100	20
233.3	Ground Surface																	
0.0	Peat, coarse fibrous																	
0.2	Dark brown Silty clay, trace sand		1	AS	2													
	Stiff Grey/ Moist brown																	
			2	SS	9													
	Brown																	
			3	SS	8													
	Grey																	
			4	SS	11													
	Firm to stiff Wet																	
			5	SS	8													
	Varved																	
	Red/grey		6	SS	1													
			7	SS	1													
	Grey																	
			8	SS	WR**													
	clayey silt lenses																	
			9	SS	3													
	Trace gravel		10	SS	7													
218.7																		
14.6																		

Cont'd

+⁷, X⁵

Numbers refer to Sensitivity

20
15—○—5
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 602-30S 2 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+875, o/s 19m Lt. Burwash Twp. ORIGINATED BY FP
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 17, 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	20	40	60	80					
218.3	Cont'd															
	Clayey silt, trace sand with silt seams		11	SS	1											
	Very loose Grey Wet															
217.0																
16.3	End of borehole															
	Refusal on probable bedrock															
	* 2003 03 17															
	▽ Water level observed during drilling															
	▼ Water level measured after drilling															
	WR** Refers to penetration under the weight of rods only															
	■ Penetrometer test															

RECORD OF BOREHOLE No C4-2 1 of 2 **METRIC**

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 12+885, CL ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.
 DATUM Geodetic DATE March 19, 2005 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			20	40	60	80	100						20
232.2	Ground Surface																	
0.0	Peat, fine fibrous		1	SS	5													
0.3	Dark brown Silt, trace sand, trace clay																	
231.0	Loose Brown Moist																	
1.2	Clayey silt, trace sand																	
1.2	Very Stiff Brown Moist		2	SS	12						150							
229.5	Silty clay, trace sand																	
2.7	Very Stiff Brown Moist		3	SS	12													
	Stiff to Firm Grey Wet																	
	with silt lenses																	
	Soft		4	SS	13													
	varved																	
	Firm																	
			5	SS	12													
			6	SS	1													
			7	SS	1													
			8	SS	1													
			9	SS	2													
219.1	Silt, trace clay, trace sand																	
13.1	Loose Grey Wet		10	SS	6													
217.2																		

RECORD OF BOREHOLE No 602-30N 1 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 12+875, o/s 19m Rt. Burwash Twp. ORIGINATED BY SH
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY PC
 DATUM Geodetic DATE March 17, 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								
						20	40	60	80	100						
233.2	Top of Ice															
0.0	Snow/Ice															
230.7	Topsoil		1	SS	5											
0.5	Silt, with sand trace clay Loose Brown/ Moist grey		2	SS	8											
230.2	Silty clay, trace sand Firm Grey Wet		3	SS	4											
3.0	Silt, trace sand trace clay Compact Grey Moist		4	SS	12											
228.7	Silty clay trace sand Firm Grey Wet		5	SS	4											
6.4	Silt, trace sand trace clay Very loose to loose		6	SS	WH**											
226.8	Silt, trace sand trace clay Very loose to loose		7	SS	WH											
11.9	Silt, trace sand trace clay Very loose to loose		8	SS	WH											
221.3	Silt, trace sand trace clay Very loose to loose		9	SS	1											
221.3	Silt, trace sand trace clay Very loose to loose		10	SS	6											

Cont'd

+ , X⁵ :

Numbers refer to Sensitivity



(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C4-3

1 of 2

METRIC

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 12+890, o/s 33 m Rt. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.
 DATUM Geodetic DATE March 19, 2005 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								
						20	40	60	80	100						
232.2 0.0	Ground Surface Peat, fine fibrous Dark brown		1	SS	5											
231.7 0.5	Silt, trace sand, trace clay Loose Brown Moist															
230.7 1.5	Clayey silt, trace sand Very Stiff Brown Moist		2	SS	11						150					
229.6 2.6	Silty clay, trace sand Very Stiff to Stiff Brown Moist Grey		3	SS	11											
			4	SS	16											
	Firm		5	SS	3											
			6	SS	1											
			7	SS	1											
	with silt lenses		8	SS	1											
220.0 12.2	Silt, trace sand, trace clay, with clayey silt seams Very loose to Compact Grey Wet		9	SS	1											
			10	SS	4											
217.2	Cont'd															

METRIC

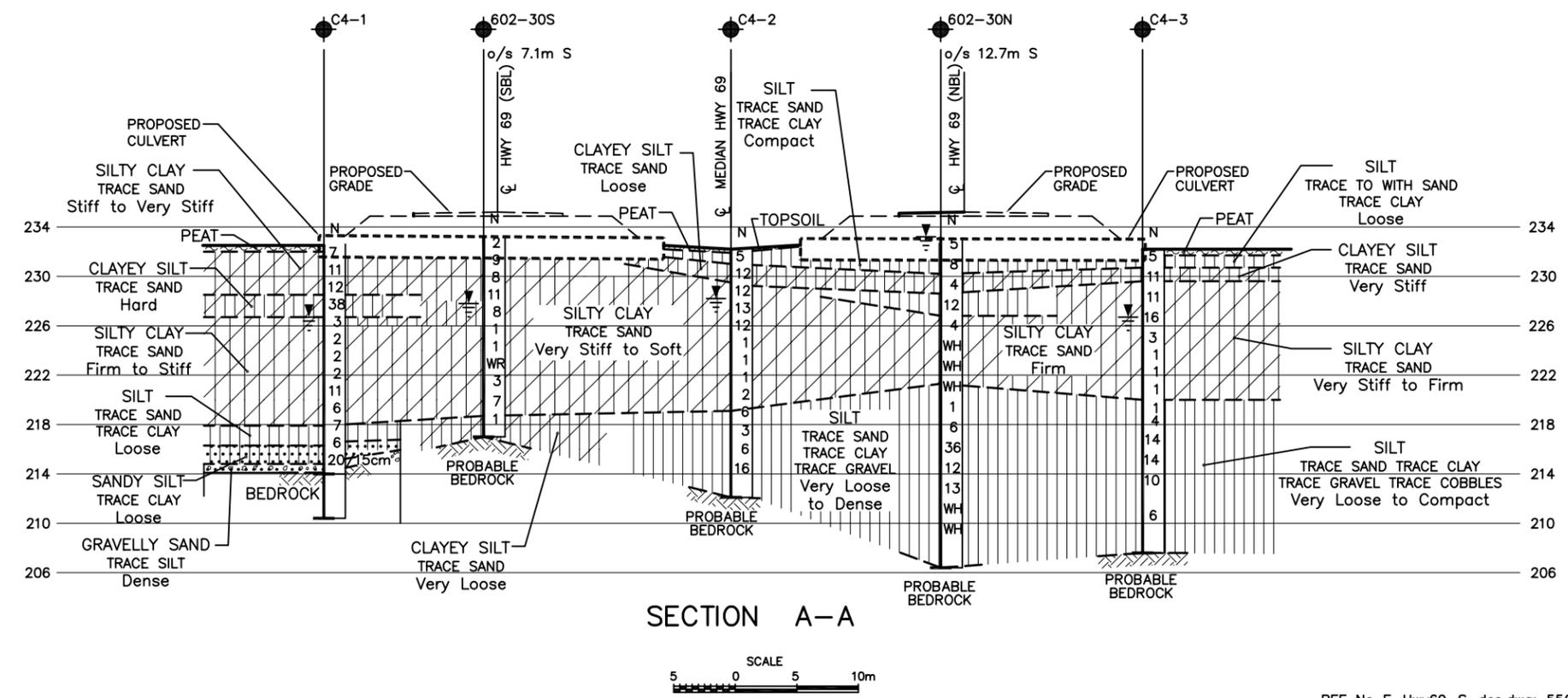
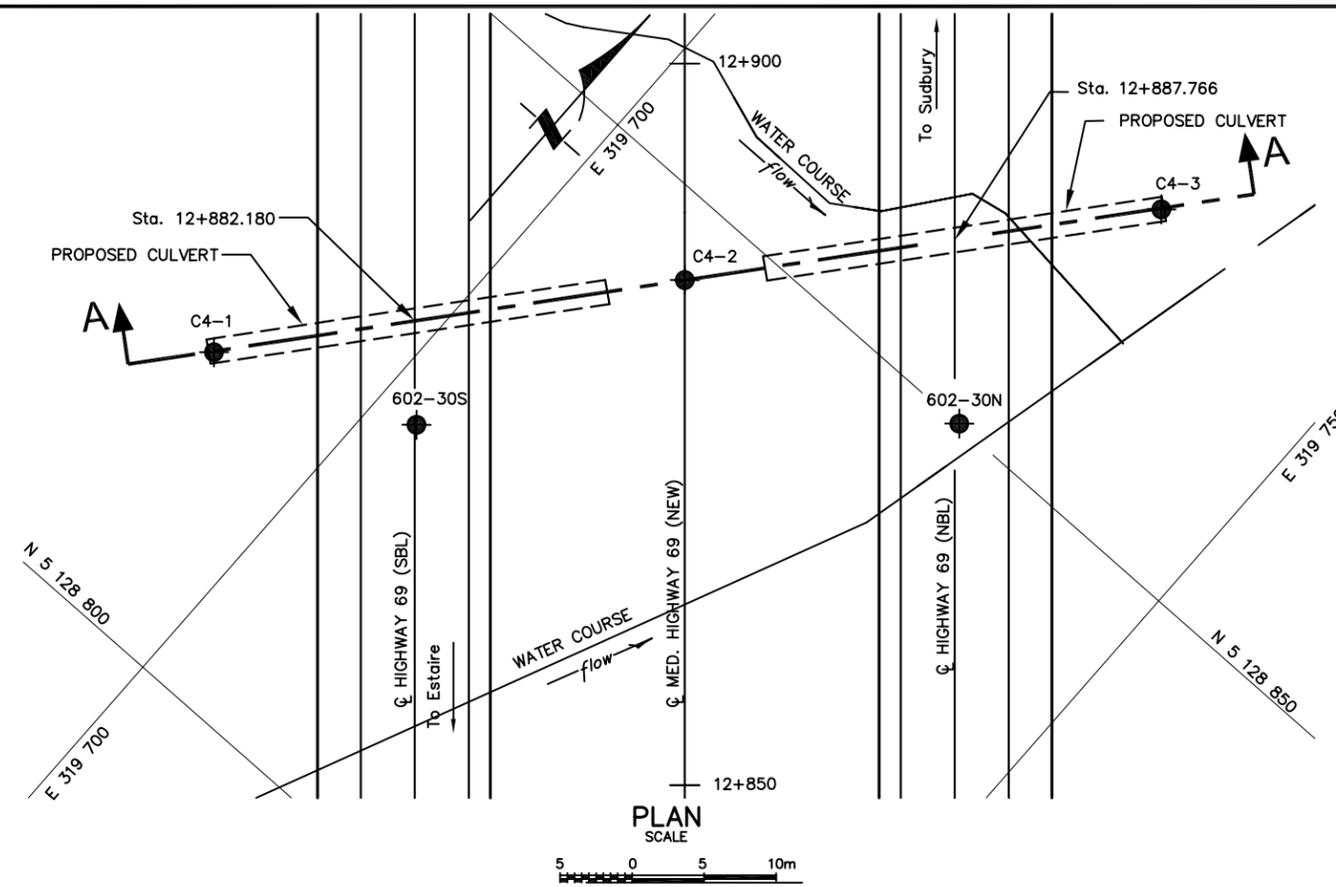
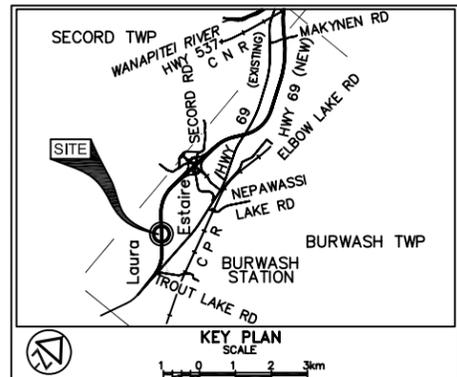
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 312-99-00



SHEET

**HIGHWAY 69
CULVERT 4**
HIGHWAY 69 FOUR-LANING FOR 12 km
From 4 km South of Estaire to 1 km North of Hwy 537
BOREHOLE LOCATIONS & SOIL STRATA

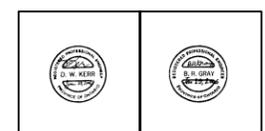


LEGEND

- 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 Mar 2003 & Mar 2005
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	STA	o/s CL Med
C4-1	232.5	12+880	33m Lt
C4-2	232.2	12+885	CL
C4-3	232.2	12+890	33m Rt
602-30N	233.2	12+875	19m Rt
602-30S	233.3	12+875	19m 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. 411-197

HWY No 69	GD	CHECKED GD	DATE JAN. 23, 2006	DIST 54
SUBM'D	MM/NA	CHECKED DWK	APPROVED BRG	SITE
DRAWN	MM/NA	CHECKED DWK	APPROVED BRG	DWG 3

REF No E-Hwy69-S-des.dwg; 5568 culverts_04-11-15.dwg; November 2004
1_BPL05; October 2002

RECORD OF BOREHOLE No C5-1

1 of 1

METRIC

W.P. 312-99-00 LOCATION Hwy 69, Sta. 13+265, o/s 54 m Lt. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Manual Hand Sampler COMPILED BY G.D.
 DATUM Geodetic DATE March 09, 2005 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					
218.5	Ground Surface																
0.0	Topsoil																
0.1	End of borehole Refusal on probable bedrock																
	* Borehole dry on completion of drilling																

RECORD OF BOREHOLE No 603-11S 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 13+275, o/s 19m Lt. Burwash Twp. ORIGINATED BY CB/RE
 DIST 54 HWY 69 BOREHOLE TYPE Manual Hand Sampling COMPILED BY PC
 DATUM Geodetic DATE April 28, 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	20	40	60	80					
220.7	Ground Surface															
0.0	Topsoil	•														
0.1	Sand, trace silt trace gravel, boulders	•														
219.8	Brown Moist	•														
0.9	End of borehole Refusal on probable bedrock	•														
	* Borehole dry on completion of drilling															

RECORD OF BOREHOLE No C5-2

1 of 1

METRIC

W.P. 312-99-00 LOCATION Hwy 69, Sta. 13+270, CL ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Manual Hand Sampler COMPILED BY G.D.
 DATUM Geodetic DATE March 09, 2005 CHECKED BY _____

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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	W _p	w	W _L			
220.4 0.0	Ground Surface																
	Bedrock at surface																
	* Borehole dry																

RECORD OF BOREHOLE No 603-11N 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 13+275, o/s 19m Rt. Burwash Twp. ORIGINATED BY CB/RE
 DIST 54 HWY 69 BOREHOLE TYPE Manual Hand Sampling COMPILED BY PC
 DATUM Geodetic DATE April 28, 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					
220.6	Ground Surface															
0.0	Topsoil															
0.2	Sand, trace silt trace gravel Brown Moist					220										
219.7	boulders															
0.9	End of borehole Refusal on probable bedrock															
	* Borehole dry on completion of drilling															

RECORD OF BOREHOLE No C5-3

1 of 1

METRIC

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 13+272, o/s 54 m Rt. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Manual Hand Sampler COMPILED BY G.D.
 DATUM Geodetic DATE March 09, 2005 CHECKED BY _____

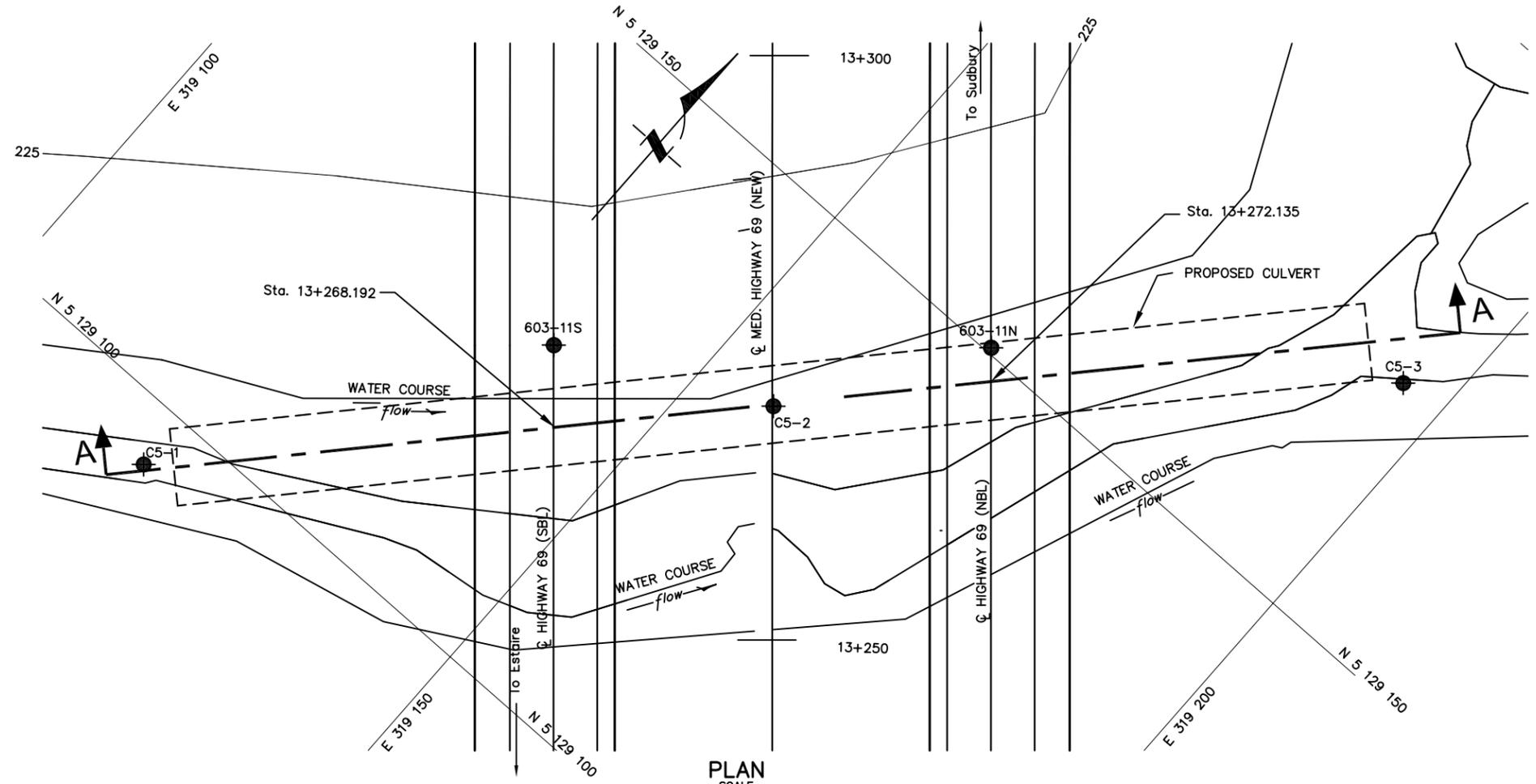
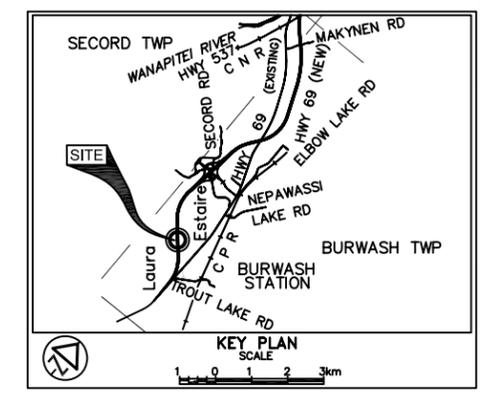
SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
219.0 0.0	Ground Surface																
0.2	Topsoil End of borehole Refusal on probable bedrock																
	* Borehole dry on completion of drilling																

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

CONT No
 GWP No 312-99-00
**HIGHWAY 69
 CULVERT 5**
 HIGHWAY 69 FOUR-LANING FOR 12 km
 From 4 km South of Estaire to 1 km North of Hwy 537
BOREHOLE LOCATIONS & SOIL STRATA



SHEET



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 Apr 2003 & Mar 2005
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

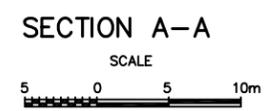
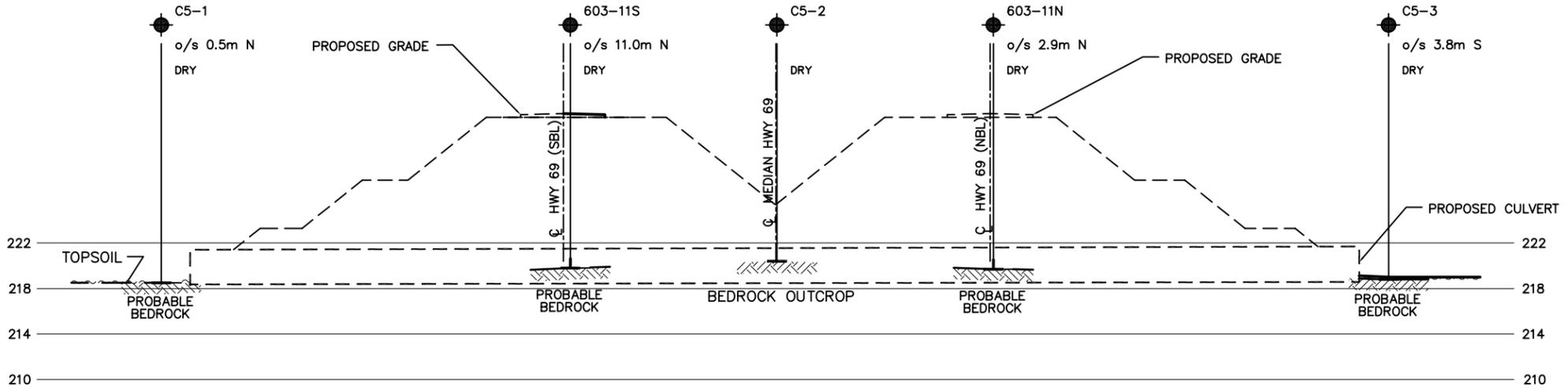
BH No	ELEVATION	STA	o/s CL Med
C5-1	218.5	13+265	54m Lt
C5-2	220.4	13+270	CL
C5-3	219.0	13+272	54m Rt
603-11N	220.6	13+275	19m Rt
603-11S	220.7	13+275	19m Lt

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. 411-197

HWY No	69	DIST	54
SUBM'D	GD	CHECKED	GD
DATE	JAN. 23, 2006	SITE	
DRAWN	NA	CHECKED	DWK
APPROVED	BRG	DWG	4



REF No E-Hwy69-S-des.dwg; 5568 culverts_04-11-15.dwg; November 2004
 1_BPL05; October 2002

RECORD OF BOREHOLE No 612-25S 1 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69 Sta. 10+725, o/s 34m Lt. Secord Twp. ORIGINATED BY FP
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. & NW Wash Boring COMPILED BY PC
 DATUM Geodetic DATE April 14, 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								
						20	40	60	80	100	20	40	60		GR SA SI CL	
222.3 0.0	Ground Surface Peat, fine fibrous Dark brown		1	SS	12											
221.4 0.9	Sand, fine to coarse trace gravel trace silt Very loose Grey Wet															
220.6 1.7	Silt, trace sand trace clay Very loose Grey Wet		2	SS	4											
219.6 2.7	Silty clay, Firm Grey Wet to stiff		3	SS	2											
	with sand seams trace gravel		4	SS	1											
			5	SS	1											
			6	SS	WH**											
			7	TW	PH											
			8	SS	WH											
			9	SS	WH											
			10	TW	PH											

Cont'd

RECORD OF BOREHOLE No C10-1 2 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 10+007, o/s 3 m Lt. Dill Twp ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.
 DATUM Geodetic DATE March 22, 2005 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
											○ UNCONFINED	+	FIELD VANE				
											● QUICK TRIAXIAL	×	LAB VANE				
											WATER CONTENT (%)						
											20	40	60				
205.8			11	SS	5												
			12	SS	2												
202.2 18.6	End of borehole Refusal on probable bedrock		13	SS	29/18cm												

* 2005 03 22
 ▽ Water level observed during drilling
 ▼ Water level measured after drilling

RECORD OF BOREHOLE No C10-2 1 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 10+013.5, o/s 10 m Rt. Dill Twp ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.
 DATUM Geodetic DATE March 22, 2005 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								
220.8	Ground Surface															
0.0	Peat, fine fibrous Dark brown		1	SS	4											
219.9						220										
0.9	Sand, trace silt Dense Brown Wet to Compact		2	SS	33	219										
	Loose					218										
			3	SS	8	217										
216.8						216										
4.0	Silty clay Firm Grey Wet to Stiff		4	SS	2	215										
	with silt lenses					214										
			5	SS	2	213										
			6	SS	3	212										
			7	SS	WH**	211										
			8	SS	3	210										
			9	SS	3	209										
			10	SS	3	208										
						207										
						206										

Cont'd

RECORD OF BOREHOLE No C10-2 2 of 2 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 10+013.5, o/s 10 m Rt. Dill Twp ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.
 DATUM Geodetic DATE March 22, 2005 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	20	40	60	80						100	20
205.8			11	SS	3													
						205												
						204												
203.6 17.2	End of borehole Refusal on probable bedrock		12	SS	9													
	* 2005 03 22 ▽ Water level observed during drilling ▼ Water level measured after drilling WH** Refers to penetration under weight of rods and hammer																	

RECORD OF BOREHOLE No C10-3 1 of 1 **METRIC**

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 10+037, o/s 19 m Rt. Dill Twp ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.
 DATUM Geodetic DATE March 22, 2005 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	20	40	60	80						100	20
221.2	Ground Surface																	
0.0	Peat, fine fibrous		1	SS	1													
220.6	Dark brown																	
0.6	Silty clay, trace sand																	
	Firm Grey Wet																	
219.5	Sand, trace silt		2	SS	12													
1.7	Compact Brown Wet																	
218.6	Silty clay, trace sand, with sandy silt lenses		3	SS	3													
2.6	Firm Grey Wet																	
214.2	Silt, trace sand, trace clay		6	SS	12													
7.0	Compact Grey Wet																	
212.4	Sand, trace gravel, trace silt		7	SS	11													
8.8	Compact Grey Wet																	
210.8	End of borehole																	
10.4	Refusal on probable bedrock																	

RECORD OF BOREHOLE No C10-4 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 10+048, o/s 36 m Rt. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.
 DATUM Geodetic DATE March 22, 2005 CHECKED BY _____

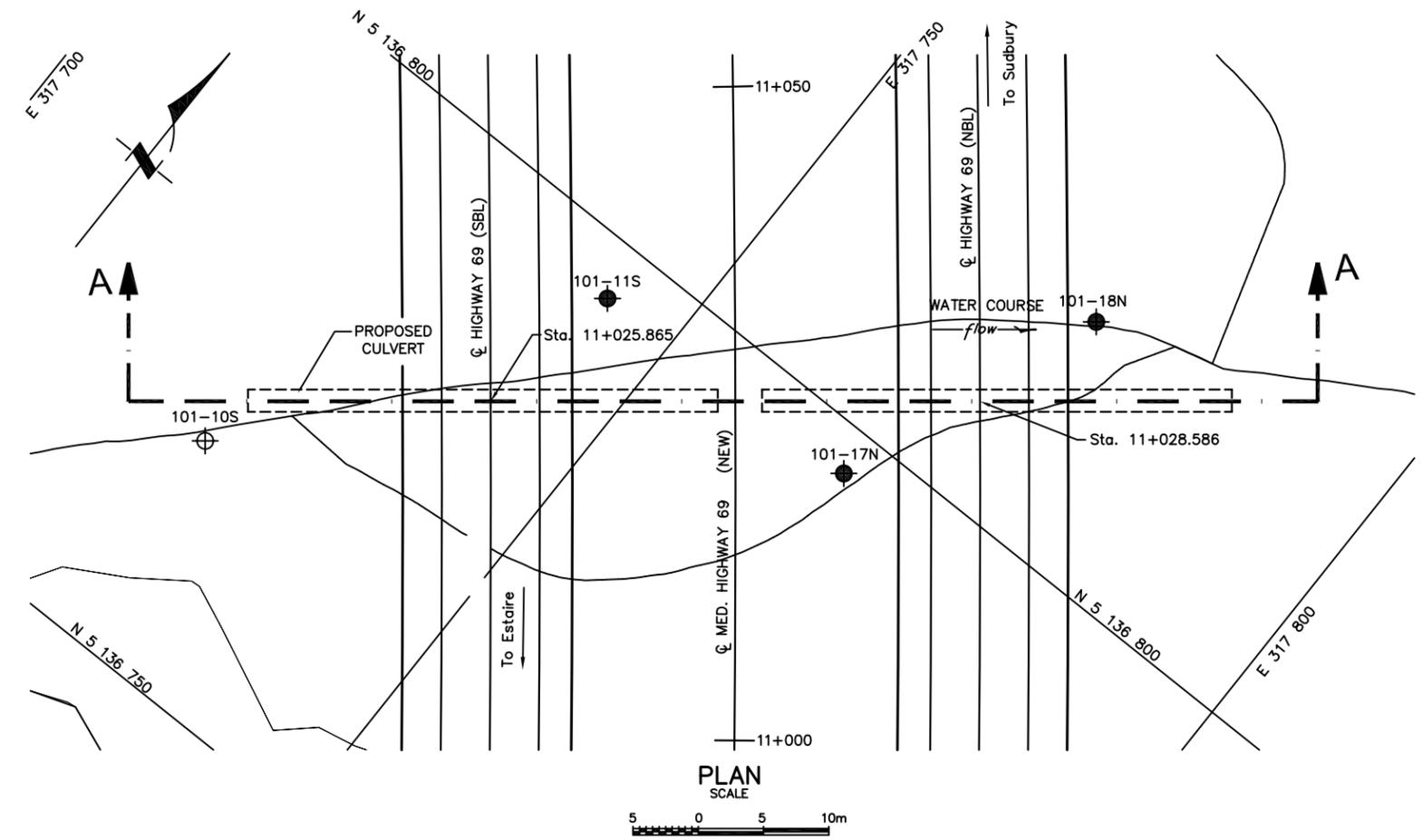
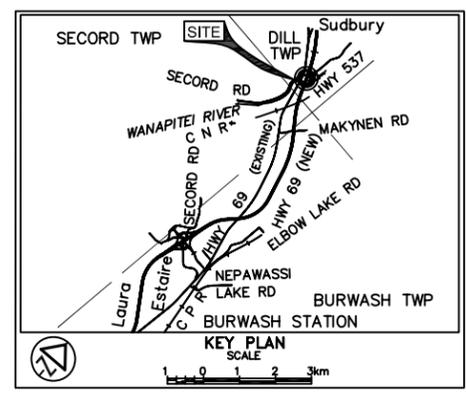
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _p	w		
221.3	Ground Surface															
0.0	Peat, fine fibrous Dark brown		1	SS	1											
			2	SS	3											
218.9	Sandy silt, trace clay Very loose Grey Wet to Loose															
2.4																
			3	SS	3											
			4	SS	5											
216.0	End of borehole Refusal on probable bedrock															
5.3																

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

CONT No
 GWP No 312-99-00
**HIGHWAY 69
 CULVERT 11**
 HIGHWAY 69 FOUR-LANING FOR 12 km
 From 4 km South of Estaire to 1 km North of Hwy 537
BOREHOLE LOCATIONS

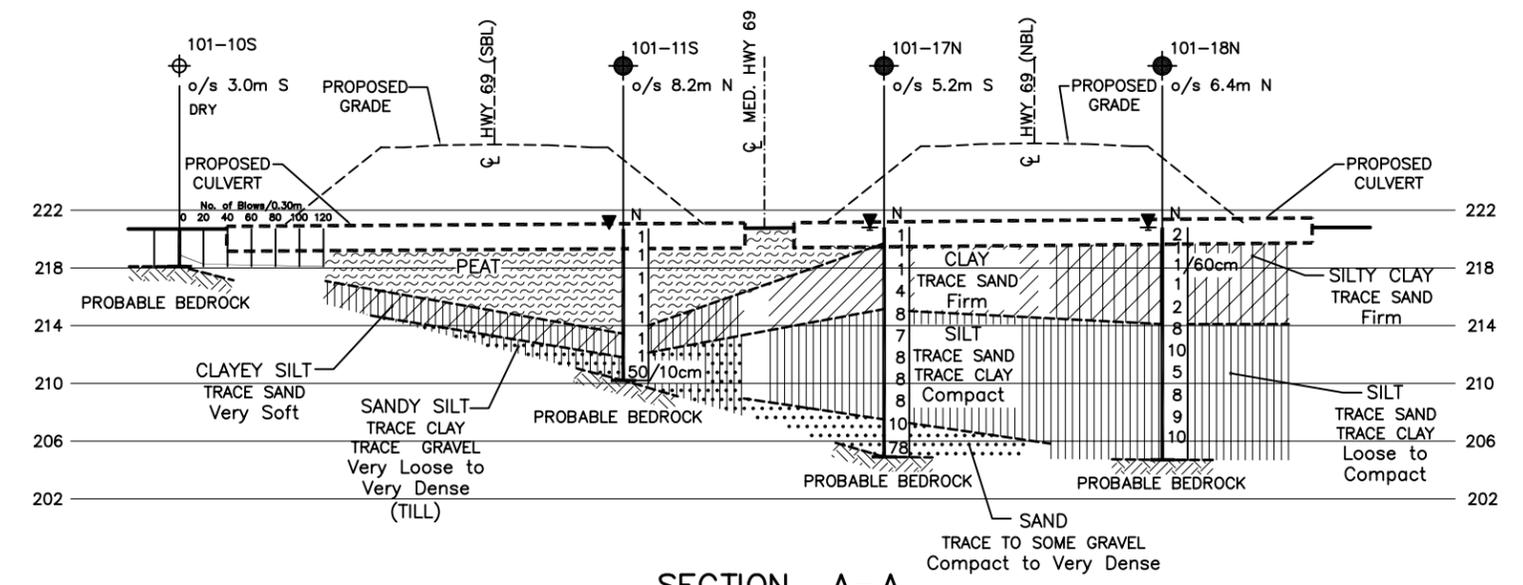


PML Peto MacCallum Ltd.
 CONSULTING ENGINEERS



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. 2001
- Head
- ARTESIAN WATER
Encountered
- PIEZOMETER



BH No	ELEVATION	STATION	o/s CL Med.
101-10S	220.7	11+023	40.5m Lt.
101-11S	220.7	11+034	10m Lt.
101-17N	220.8	11+020.5	8.5m Rt.
101-18N	220.8	11+032	28m Rt.

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

REF No E-Hwy69-S-des.dwg; 5568 culverts_04-11-15.dwg; November 2004
 1_BPL05; October 2002

Geocres No. 411-197

HWY No	GD	CHECKED	DATE	DIST
69	GD	GD	JAN. 23, 2006	54
SUBM'D	NA	CHECKED	DWK	APPROVED
DRAWN	NA	CHECKED	DWK	APPROVED
			BRG	DWG
				6

RECORD OF PENETRATION TEST No 101-10S 1 of 1 METRIC

G.W.P. 327-91-00 LOCATION New Hwy 69 Sta. 11+023, o/s 40.5m Lt ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY F.P.
 DATUM Geodetic DATE February 20, 2001 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			20	40	60	80	100						20
220.7 0.0	Ground Surface																	
218.1 2.6	End of dynamic cone penetration test Refusal on probable bedrock																	

RECORD OF BOREHOLE No 101-11S 1 of 1 METRIC

G.W.P. 327-91-00 LOCATION New Hwy 69 Sta. 11+034, o/s 10m Lt ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY D.H.
 DATUM Geodetic DATE February 18, 2001 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	20	40	60	80						100	SHEAR STRENGTH kPa	
											○ UNCONFINED	+	FIELD VANE						
											● QUICK TRIAXIAL	×	LAB VANE	WATER CONTENT (%)					
														20	40	60			
220.7	Ground Surface																		
0.0	Peat, fine fibrous Dark brown		1	AS	1													386	
			2	SS	1														259
			3	SS	1														511
			4	SS	1														713
	amorphous		5	SS	1														336
213.4	Clayey silt, trace sand		6	SS	1														135
7.3	Very soft Grey/Wet green																		
211.8	Sandy silt, trace clay, trace gravel		7	SS	1														
8.9	Very loose to very dense Grey/Wet																		
	(TILL)		8	SS	50/10cm														
210.2	End of borehole																		
10.5	Refusal on probable bedrock																		

RECORD OF BOREHOLE No 101-17N 1 of 2 METRIC

G.W.P. 327-91-00 LOCATION New Hwy 69 Sta. 11+020.5, o/s 8.5m Rt ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY D.H.
 DATUM Geodetic DATE February 15, 2001 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	20	40	60	80						100	20
220.8	Ground Surface																	
0.0	Peat, fine fibrous Dark brown		1	SS	1													
219.7	Clay, trace sand Firm Grey Wet		2	SS	1													0 2 32 66
1.1	Interbedded silt seams		3	SS	1													
			4	SS	4													
215.1	Silt, trace sand trace clay Compact Grey Wet		5	SS	8**													
5.7			6	SS	7**													0 5 90 5
			7	SS	8**													
			8	SS	8**													0 10 82 8
			9	SS	8**													
207.5	Sand, fine to medium trace gravel Compact Grey Wet		10	SS	10													
13.3																		
205.8																		

RECORD OF BOREHOLE No 101-17N 2 of 2 METRIC

G.W.P. 327-91-00 LOCATION New Hwy 69 Sta. 11+020.5, o/s 8.5m Rt ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY D.H.
 DATUM Geodetic DATE February 15, 2001 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _p	w			W _L	20
205.8																		
15.0	Cont'd some gravel	••																
204.9	Very dense Grey/green	••••	11	SS	78													
15.9	End of borehole Refusal on probable bedrock	••																
	* 2001 02 15																	
	▽ Water level observed during drilling																	
	▼ Water level measured after drilling																	
	** Low 'N' value due to hydraulic disturbance																	
	At 5.0m water added to hollow stems to equalize pressure																	

RECORD OF BOREHOLE No 101-18N 1 of 2 METRIC

G.W.P. 327-91-00 LOCATION New Hwy 69 Sta. 11+032, o/s 28m Rt ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY D.H.
 DATUM Geodetic DATE February 16, 2001 CHECKED BY _____

SOIL PROFILE		SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
220.8	Ground Surface									
0.0	Peat, coarse fibrous		1	AS	2					
0.2	Dark brown Silty clay, trace sand		2	SS	1					
	Firm Grey Wet									
			3	SS	1/60cm					
	Interbedded silt seams									
			4	SS	1					
			5	SS	2					
214.1	Silt, trace sand, trace clay			6	SS	8				
6.7	Loose Grey Wet to compact									
			7	SS	10					
			8	SS	5					
			9	SS	8					
			10	SS	9					
			11	SS	10					
205.8										

RECORD OF BOREHOLE No 101-18N 2 of 2 METRIC

G.W.P. 327-91-00 LOCATION New Hwy 69 Sta. 11+032, o/s 28m Rt ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY D.H.
 DATUM Geodetic DATE February 16, 2001 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			20	40	60	80	100						20
205.8 15.0	Cont'd Silt, trace sand, trace clay Compact Grey Wet						205											
204.7 16.1	End of borehole Refusal on probable bedrock																	

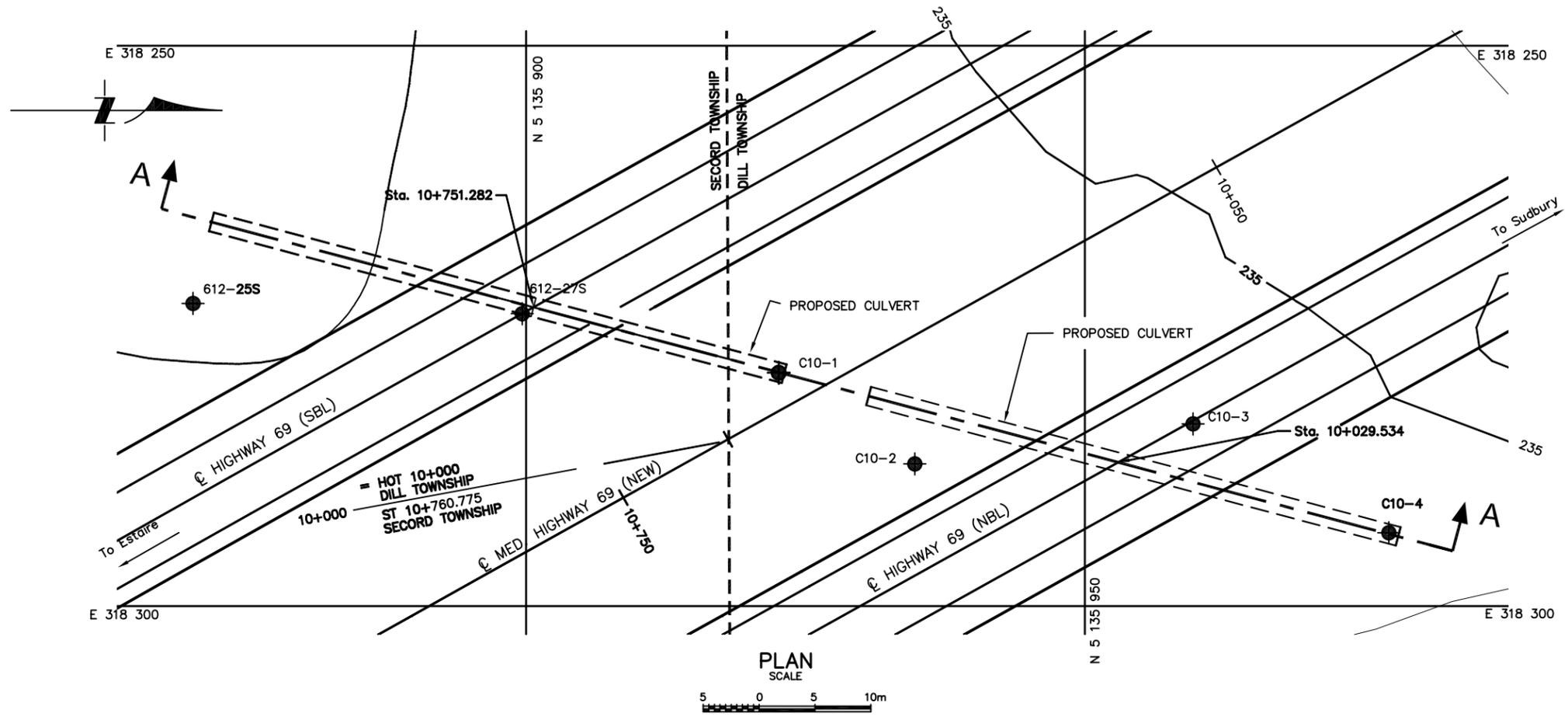
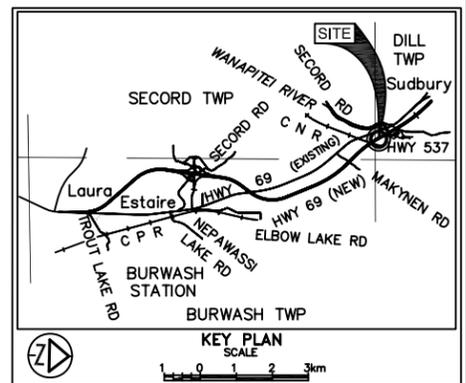
* 2001 02 16
 ▽ Water level measured after drilling
 ■ Penetrometer test

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

CONT No
 GWP No 312-99-00
**HIGHWAY 69
 CULVERT 10**
 HIGHWAY 69 FOUR-LANING FOR 12 km
 From 4 km South of Estaire to 1 km North of Hwy 537
BOREHOLE LOCATIONS & SOIL STRATA

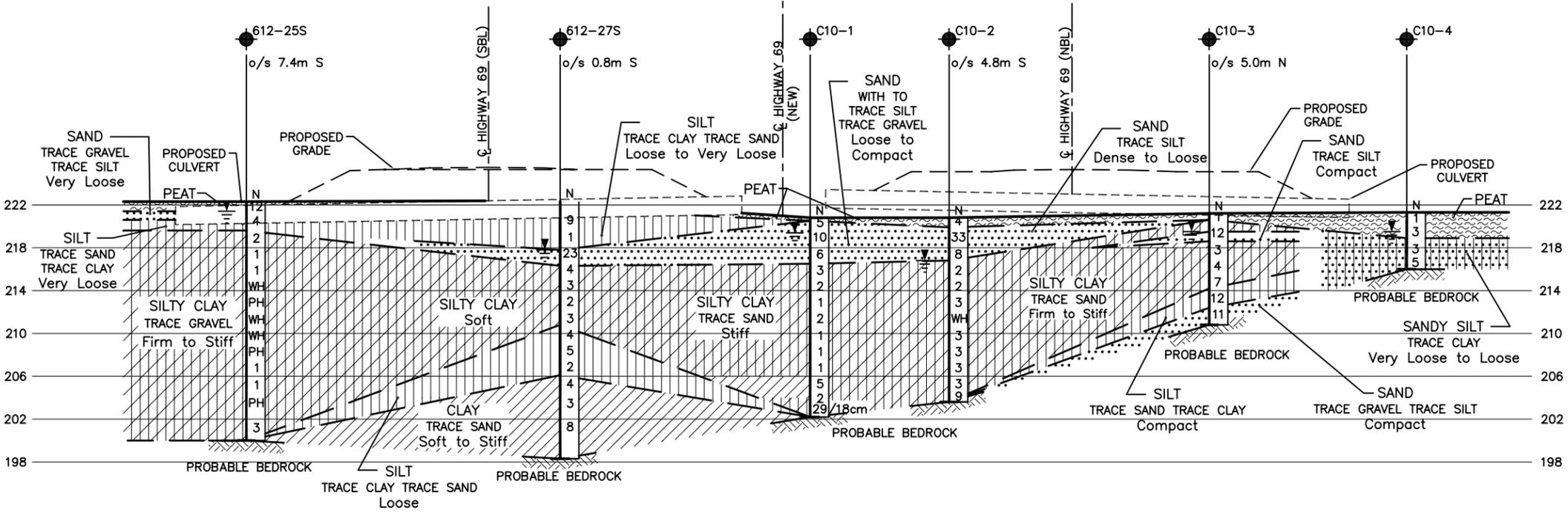


SHEET



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 Apr 2003 & March 2005
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER



BH No	ELEVATION	Sta.	o/s
C10-1	220.8	10+007	3m Lt
C10-2	220.8	10+013.5	10m Rt
C10-3	221.2	10+037	19m Rt
C10-4	221.3	10+048	36m Rt
602-25S	222.3	10+725	34m Lt
602-27S	222.4	10+750	19m Lt

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

SECTION A-A
 SCALE
 5 0 5 10m

REF No E-Hwy69-S-des.dwg; 5568 culverts_04-11-15.dwg; November 2004
 1_BPL05; October 2002



REVISIONS

DATE	BY	DESCRIPTION

Geocres No. 411-197

HWY No	GD	CHECKED	GD	DATE	JAN. 23, 2006	SITE	DIST	54
69	NA	CHECKED	DWK	APPROVED	BRG	DWG	5	

RECORD OF BOREHOLE No C17-1 1 of 1 **METRIC**

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 18+309.5, o/s 36 m Lt. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Excavator COMPILED BY G.D.
 DATUM Geodetic DATE March 10, 2005 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					
251.3	Ground Surface															
0.0	Peat, coarse fibrous															
250.8	Dark brown															
0.5	Silty sand, trace topsoil with cobbles and boulders		1	GS	-											
250.0																
1.3	End of testpit Refusal on probable bedrock															
	* Testpit dry on completion of excavating															

RECORD OF BOREHOLE No C17-2 1 of 1 METRIC

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 18+305, CL ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Excavator COMPILED BY G.D.
 DATUM Geodetic DATE March 10, 2005 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					
251.1	Ground Surface																
0.0	Silty sand, trace topsoil						251										
250.7																	
0.4	End of testpit Refusal on probable bedrock																
	* Testpit dry on completion of excavating																

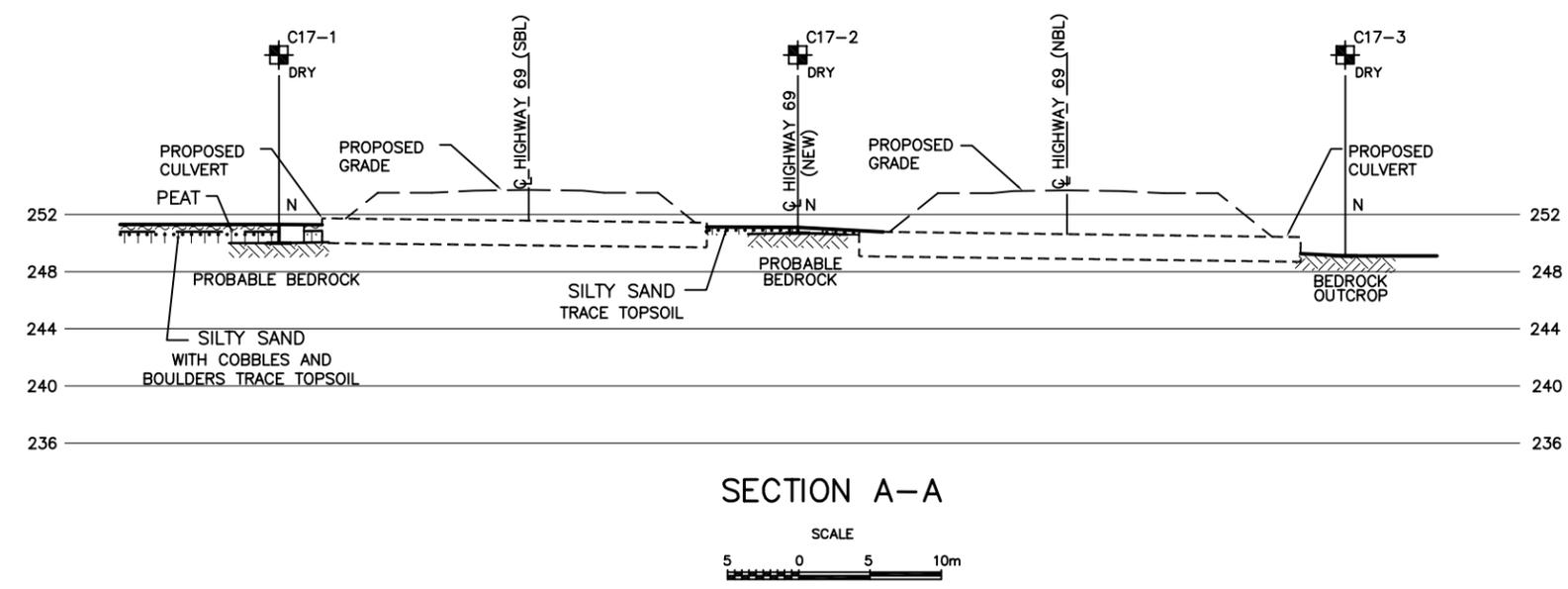
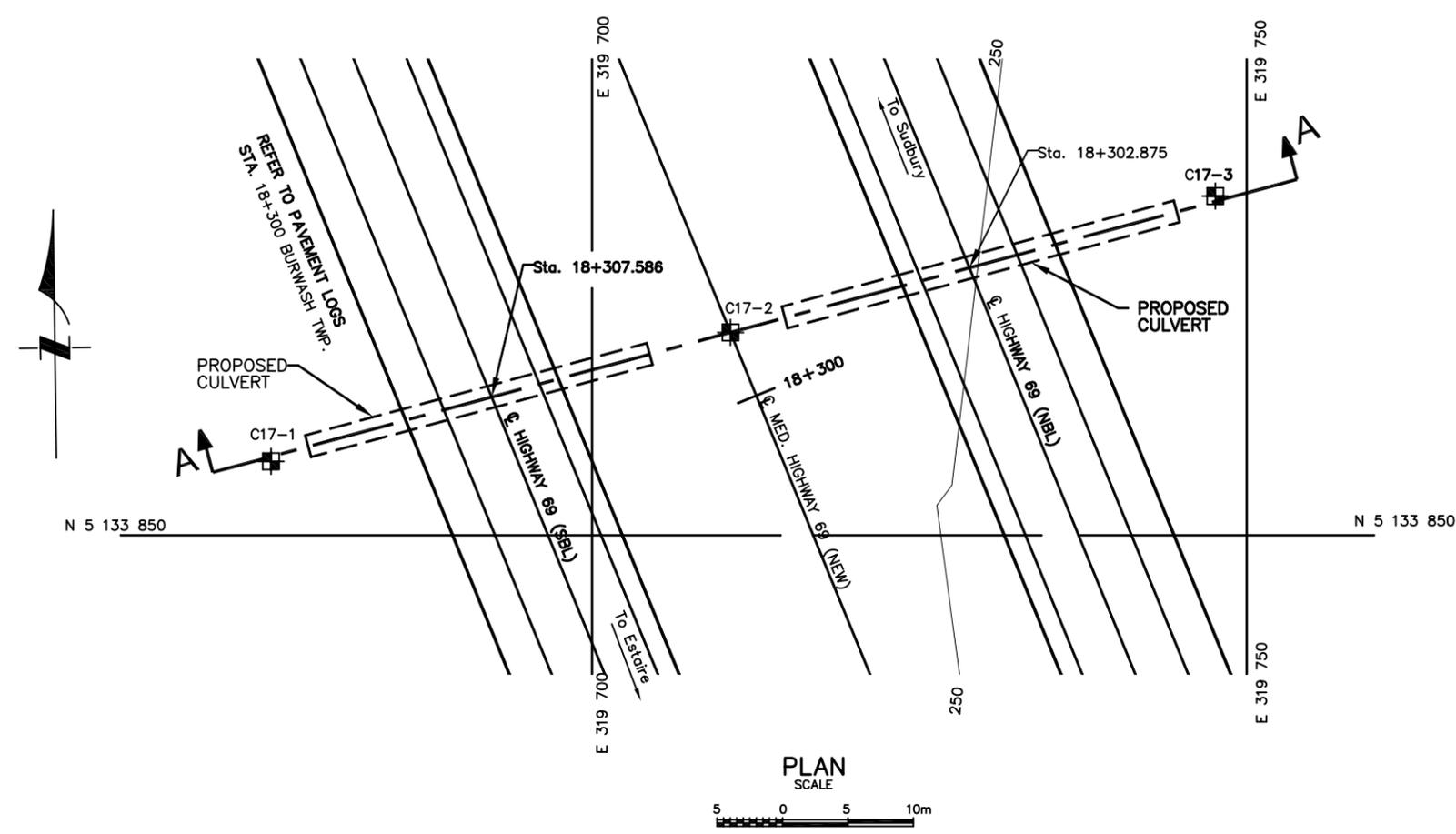
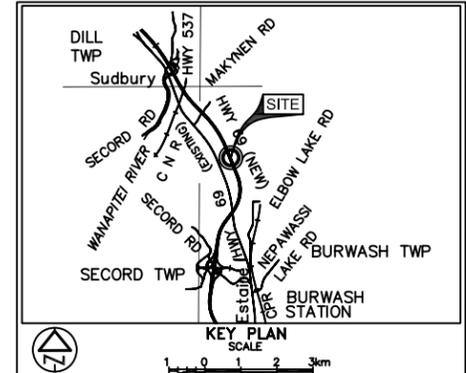
RECORD OF BOREHOLE No C17-3 1 of 1 **METRIC**

G.W.P. 312-99-00 LOCATION Hwy 69, Sta. 18+301, o/s 38 m Rt. ORIGINATED BY F.P.
 DIST 54 HWY 69 BOREHOLE TYPE Excavator COMPILED BY G.D.
 DATUM Geodetic DATE March 10, 2005 CHECKED BY _____

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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	W _p	w	W _L			
249.1 0.0	Ground Surface Bedrock at surface																
	* Dry																

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

CONT No
 GWP No 312-99-00
**HIGHWAY 69
 CULVERT 17**
 HIGHWAY 69 FOUR-LANING FOR 12 km
 From 4 km South of Estaire to 1 km North of Hwy 537
 BOREHOLE LOCATIONS & SOIL STRATA



LEGEND

- Test Pit
- 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 March 2005
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

BH No	ELEVATION	Sta.	o/s
C17-1	251.3	18+309.5	36m Lt
C17-2	251.1	18+305	CL
C17-3	249.1	18+301	38m Rt

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

NOTE:
 SECTIONS ARE PROVIDED SOLELY FOR ILLUSTRATIVE PURPOSES. REFER TO RECORD OF BOREHOLES FOR DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS, IN-SITU TEST DATA AND LABORATORY TEST RESULTS.



REF No E-Hwy69-S-des.dwg; 5568 culverts_04-11-15.dwg; November 2004
 1_BPL05; October 2002

DATE	BY	DESCRIPTION

Geocres No. 411-197

HWY No	69	DIST	54
SUBM'D	GD	CHECKED	GD
DATE	JAN. 23, 2006	SITE	
DRAWN	NA	CHECKED	DWK
APPROVED	BRG	DWG	7



FOUNDATION DESIGN REPORT

for

CULVERTS

HIGHWAY 69 FOUR-LANING

FROM 4 KM SOUTH OF ESTAIRE TO 1 KM NORTH OF HIGHWAY 537

G.W.P. 312-99-00

DISTRICT 54, TOWNSHIPS OF BURWASH, SECORD AND DILL

SUDBURY, ONTARIO

PETO MacCALLUM LTD.
165 CARTWRIGHT AVENUE
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PML Ref.: 03TF012F
Index No.: 213FDR
Geocres No.: 41I-197
January 23, 2006



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- 2. CULVERT FOUNDATIONS 3
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 - 2.2 Culverts on Rockfill 4
 - 2.3 Culverts on Bedrock 7
- 3. CULVERT BACKFILL 8
- 4. EXCAVATION AND GROUND WATER CONTROL 10
- 5. CLOSURE 12

Table 1 - List of MTO Documents Used in Report

FOUNDATION DESIGN REPORT
for
Culverts
Highway 69 Four-Laning
From 4 km South of Estaire to 1 km North of Highway 537
G.W.P. 312-99-00
District 54, Townships of Burwash, Secord and Dill
Sudbury, Ontario

1. INTRODUCTION

This report provides foundation engineering comments and recommendations for the design and construction of 16 culverts along the realigned section of Highway 69 that extends from 4 km south of Estaire to about 1 km north of Highway 537, some 15 km south of Sudbury. The report was prepared for Totten Sims Hubicki Associates (TSH) on behalf of the Ministry of Transportation of Ontario (MTO).

The culverts will be constructed in areas where the embankment fill will be placed along the new alignment of Highway 69. Preliminary information concerning the culvert number, location and embankment height was provided by MTO in a letter to TSH dated January 27, 2005. It is noted in the letter that a foundation investigation is required at 6 culvert sites; culverts numbered 14 to 16 and 20 were not included in the documents.

Detailed information on the culvert locations and invert levels was finalized and documented in a table prepared by TSH on July 5, 2005. For ease of reference, the identification number, location and invert level of each culvert along with the embankment height (reflecting the road grade changes at some culvert locations) and anticipated subgrade are listed below.

It is noted from the available information (January 27, 2005 letter; July 5, 2005 table; GA drawings provided on November 8, 2005) that the embankment fill height at the culvert locations varies widely between 0.5 and 22.0 m and the culverts are 1.2 m wide by 1.2 m high, except for Culvert 1 (1.4 by 1.4 m) and Culvert 5 (6.0 by 2.4 m).



Culvert No.	Proposed Centreline Highway 69 Chainage (m)	Embankment ² Height (m)	Invert Level (m)	Embankment ³ Recommendation/ Anticipated Subgrade
1 ⁽¹⁾	Station 11+493 (Burwash Township)	3.0	228.1 - 228.4	Excavation of compressible soil / Rockfill
2 ⁽¹⁾	Station 12+071 (Burwash Township)	8.5 - 9.0	222.0	Excavation of compressible soil / Rockfill
3	SBL - Station 12+677 (Burwash Township) NBL - Station 12+681 (Burwash Township)	3.5 - 4.0	230.6 - 230.8 229.7 - 230.4	Excavation of compressible soil / Rockfill
4	SBL - Station 12+882 (Burwash Township) NBL - Station 12+888 (Burwash Township)	2.5 - 3.0	231.7 - 231.8 231.5 - 231.6	Refer to foundation report prepared by others
5 ⁽¹⁾	Station 13+270 (Burwash Township)	14.0 - 15.0	218.7 - 218.9	Full excavation / Bedrock
6 ⁽¹⁾	Station 13+619 (Burwash Township)	9.0 - 10.0	225.4 - 228.3	Full excavation / Bedrock
7 ⁽¹⁾	Station 14+427 (Burwash Township)	4.0	233.5 - 233.7	Excavation of compressible soil / Rockfill
8 ⁽¹⁾	Station 17+721 (Burwash Township)	6.0 - 8.5	239.6 - 243.7	Full excavation / Bedrock
9 ⁽¹⁾	Station 19+710 (Burwash Township)	21.0 - 22.0	226.0 - 228.0	Excavation of compressible soil / Rockfill
10	SBL - Station 10+751 (Secord Township) NBL - Station 10+030 (Dill Township)	4.0 - 4.5	220.4 - 221.4 220.8 - 221.8	Refer to foundation report prepared by others
11	SBL - Station 11+026 (Dill Township) NBL - Station 11+029 (Dill Township)	5.5 - 6.0	219.4 - 219.7 219.7 - 219.9	Excavation of compressible soil / Rockfill
12	SBL - Station 13+460 (Burwash Township) NBL - Station 13+455 (Burwash Township)	0.5 - 2.5	231.6 - 232.4 230.3 - 230.9	Full excavation / Bedrock
13 ⁽¹⁾	Station 15+369 (Burwash Township)	8.0 - 10.0	243.5 - 245.4	Excavation of compressible soil / Rockfill
17	SBL - Station 18+308 (Burwash Township) NBL - Station 18+303 (Burwash Township)	2.5 - 4.5	250.0 - 250.2 249.0 - 249.4	Full excavation / Bedrock
18	SBL - Station 18+850 (Burwash Township) NBL - Station 18+850 (Burwash Township)	4.5	253.9 253.9	Excavation of compressible soil / Rockfill
19	SBL - Station 19+015 (Burwash Township) NBL - Station 19+100 (Burwash Township)	4.0 - 4.5	253.4 - 253.8 253.3 - 253.4	Excavation of compressible soil / Rockfill

- (1) Single culvert extending over the total width of the SBL and NBL embankments
- (2) Embankment height provided in the table included with the January 27, 2005 letter and deduced from GA drawings.
- (3) Refer to the Swamp and High Fill Crossings report for rockfill embankment construction comments and recommendations (Geocres 411-174; PML Ref.: 03TF013 dated November 17, 2004).



A site specific field investigation was conducted at the location of Culverts 2 to 5, 10, 11 and 17. The subsurface stratigraphy revealed in the boreholes drilled at these culvert locations generally comprised peat overlying native deposits of cohesionless very loose to compact silt/sand and/or cohesive soft to firm clayey silt/silty clay. These soils mantled bedrock/inferred bedrock at depths of 0.0 to 26.8 m below existing grade.

The anticipated subgrade conditions at the remaining culverts were based on the information obtained during the foundation investigation conducted for the "Swamp and High Fill Crossings" report (Geocres 411-174; PML Ref.: 03TF013, dated November 17, 2004) as well as the Pavement Design report (PML Ref.: 03TF014, dated November 30, 2004). This data indicates that the majority of the culverts will be founded on rockfill or bedrock.

The boreholes were drilled along and/or adjacent to the alignment of the proposed culverts. The information is considered to be sufficient for design purposes; some variation in the subsurface stratigraphy along the actual culvert alignment may be encountered during construction.

The preferred subgrade improvement technique at Culverts 4 and 10 was provided by others.

It is considered that the subgrade conditions are suitable for construction of concrete box and/or open footing culverts. 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 consideration and construction constraints.

2. CULVERT FOUNDATIONS

2.1 General

The subgrade at the invert of Culverts 1 to 3, 7, 9, 11, 13, 18 and 19 following completion of the recommended treatment for construction of the embankments noted in the Swamp and High Fill Crossings report referred to previously will comprise rockfill. Shallow bedrock exists along the alignment of Culverts 5, 6, 8, 12 and 17.



Construction of footings founded on rockfill or directly on bedrock to support the culverts is recommended.

Preparation of the subgrade should be performed and monitored in accordance with SP 902S01.

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. Rockfill does not require frost tapers.

The seismic coefficient for the conditions at the 14 culvert sites is 1.0 (Type I soil profile as per clause 4.4.6 of the CHBDC).

Foundation engineering comments and recommendations for Culverts 4 and 10 were provided by others.

2.2 Culverts on Rockfill

Culverts 1 to 3, 7, 9, 11, 13, 18 and 19 will be founded on rockfill.

The magnitude of post construction settlement of the culvert foundation will be primarily dictated by the thickness of the rockfill below the culvert and the time elapsed between placement of the rockfill and construction of the culvert.

It is expected that the culverts will be constructed shortly after the rockfill is placed to the subgrade level below the culverts. The computed settlement of the culvert foundation along the alignment of the culverts resulting from consolidation of the subgrade soils below the rockfill and/or self-weight compaction of the rockfill due to the stress imposed by rockfill above the culvert is provided in the following table:



Culvert No.	Rockfill Thickness Below Culvert Subgrade (m)	Subsurface Conditions Below Rockfill	Computed Settlement ⁽²⁾ (mm)		
			Rockfill ^{(2) (3)}	Subsoil ⁽⁴⁾	Total ⁽⁵⁾
1 ⁽¹⁾	1	Silt/silty sand	20	5	25
2 ⁽¹⁾	1 - 4	Greater than 8 m of sand/silt; bedrock not contacted at termination of drilling	20 - 80	30 - 40	50 - 120
3	4 - 5 (SBL) 3 - 4 (NBL)	4 - 9 m of silt (SBL) 2 - 3 m of silt (NBL)	80 - 100 (SBL) 60 - 80 (NBL)	10 - 20 (SBL) 5 - 10 (NBL)	90 - 120 (SBL) 65 - 90 (NBL)
7 ⁽¹⁾	1 - 4	Bedrock	20 - 80	0	20 - 80
9 ⁽¹⁾	0 - 2	Bedrock or up to 5 m of sand	0 - 40	0 - 40	0 - 80
11	1 - 7 (SBL) 4 - 6 (NBL)	Bedrock or up to 6 m of silt/sand (SBL) 8 - 10 m of silt/sand (NBL)	20 - 140 (SBL) 80 - 120 (NBL)	0 - 20 (SBL) 20 - 30 (NBL)	20 - 160 (SBL) 100 - 150 (NBL)
13 ⁽¹⁾	1 - 2	Bedrock or up to 2 m of silt	20 - 40	0 - 15	20 - 55
18	2 - 6 (SBL) 2 - 5 (NBL)	Bedrock or up to 2 m of silt/sand	40 - 120 (SBL) 40 - 100 (NBL)	0 - 10	40 - 130 (SBL) 40 - 110 (NBL)
19	1 - 3 (SBL) 1 - 2 (NBL)	Bedrock or up to 4 m of cl. silt (SBL) Bedrock or up to 3 m of cl. silt (NBL)	20 - 60 (SBL) 20 - 40 (NBL)	0 - 30 (SBL) 0 - 25 (NBL)	20 - 90 (SBL) 20 - 65 (NBL)

- (1) Single culvert extending over the total width of the SBL and NBL embankments.
- (2) 50% expected during the first year and the remainder in the 10-year period following completion of the embankment.
- (3) Based on 2% of rockfill thickness since it will be placed below the water level.
- (4) Below the embankment platform, decreasing to about 20% of the indicated settlement at the toe of the embankment slope.
- (5) Does not include settlements resulting from the stress induced in rockfill by the culvert foundations. Refer to subsequent paragraphs for additional information in this regard.
- (6) Refer to foundation reports prepared by others for details at the locations of Culverts 4 and 10.

Footings constructed on rockfill should be designed using the following geotechnical resistance at ultimate limit states (ULS) and serviceability limit states (SLS):

Factored Bearing Resistance at ULS = 900 kPa
 Bearing Resistance at SLS = 250 kPa

The resistance at SLS allows for 25 mm of settlement at the founding medium in addition to that provided in the preceding table.



The capability of the culverts to sustain the above settlements as well as the need to shape the invert of the culverts to conform to the predicted settlement and reduce the structural distress that results from the differential settlement as well as minimize 'low areas' in the culvert when settlement is complete should be reviewed by the structural engineer.

Bedrock is at or within 5 m of the rockfill subgrade level of Culvert 9 (embankment height 22 m), 6 m at Culvert 11 (SBL) and 10 m at Culvert 11 (NBL) (embankment height 6 m). The bedrock below the invert of Culvert 9 could be excavated to a depth of 5 m and Culvert 11 (SBL) to a depth of 6 m to reduce the magnitude of differential settlement and avoid the potential for stress concentrations to develop between the yielding rockfill / underlying native soil and the unyielding bedrock that may potentially damage the culvert. The excavated rock at these locations should be replaced with rockfill to raise the subgrade to the design level.

It was recommended in the Swamp and High Fill Crossings report referred to previously that the rockfill be placed in accordance with SP 206S03. This is particularly important above the water level within the zone of influence of the culverts, defined by an imaginary line inclined downwards at 2H:1V from a point located at the invert level 1 m beyond the edge of the culvert.

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 or Granular B Type II compacted to 100% of the standard Proctor maximum dry density in conformance to OPSS 501 (Method A).



If Granular A is employed or the rockfill surface is not chinked in accordance with the requirements of OPSS 206, the granular cover should be separated from the rockfill by a geosynthetic filter fabric to prevent loss of the granular materials into the voids of the rockfill. The filter fabric should conform to OPSS 1860 and comprise a Class II non-woven geotextile with a filtration opening size (FOS) of 105 to 210 μm . The filter fabric should be placed beneath the bedding and extend to the top of the bedding and/or granular cover material.

2.3 Culverts on Bedrock

Culverts 5, 6, 8, 12 and 17 will be founded on bedrock.

Footings bearing on bedrock should be designed using a factored bearing resistance at ULS of 10,000 kPa. Considering the bedrock to be non-yielding, the design will not be governed by settlement criteria since the loading required to produce 25 mm deformation is much larger than the factored resistance at ULS. The bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.7.4 of the Canadian Highway Bridge Design Code (CHBDC), CAN/CSA-S6-00, March 2001.

The depth to bedrock below the invert level of the five culverts where the subgrade consists of shallow bedrock is noted in the following table:

Culvert	Depth to Bedrock Below Invert Level (m)
5	0, locally 0.5 (west end)
6	0
8	< 1.0 (typically)
12	< 0.5
17	0, locally 0.2 (west end)

Mass concrete or Granular A could be placed to level the subgrade where undulations exist in the bedrock 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 its overstressing 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.

For construction considerations regarding rock excavation, reference is made to Section 4 of the report.

3. CULVERT BACKFILL

Backfill adjacent to the culverts should be placed in general accordance with the Ontario Provincial Standard Specifications and 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 minimise the potential for movement and/or damage of the culvert due to the lateral earth pressure induced by compaction. Refer to SP 105S10 for additional comments.

The culverts must be designed to support the stress induced 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 CHBDC or employing the following equation assuming a triangular pressure distribution:

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

- 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 backfill submerged below the design water level (kN/m^3)
 h_1 = depth below final grade (m), above the design water level
 h_2 = depth below the design water level (m)
 q = any surcharge load (kN/m^2)
 γ_w = unit weight of water equal to 9.8 kN/m^3
 C_p = compaction pressure (refer to clause 6.9.3 of CHBDC)
 C_s = earth pressure induced by seismic events, kPa (refer to clause 4.6.4 of CHBDC)
 where \emptyset = angle of internal friction of retained soil (35° for Granular A)
 δ = angle of friction between soil and wall (23.5° for Granular A)

The following parameters are recommended for design:

Parameter	Granular A	Granular B Type II	Rockfill
Angle of Internal Friction (degrees)	35	35	42
Unit Weight (kN/m^3)	22.8	22.8	18.0
Active Earth Pressure Coefficient (K_a)	0.27	0.27	0.20
At-Rest Earth Pressure Coefficient (K_o)	0.43	0.43	0.33
Passive Earth Pressure Coefficient (K_p)	3.69	3.69	5.04

The design should consider both the maximum and minimum water levels which are 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 mobilised between the underside of the footing and the engineered fill. An



unfactored friction factor of 0.7 is recommended for footings constructed on bedrock or granular fill. The horizontal force on the walls of box culverts is resisted by the base slab.

A weeping tile system and/or weep holes should be installed to minimise 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 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 laterally to protect the granular material and 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. The requirements of CHBDC clauses 1.10.5.6 and 1.10.11.6.5 should be applied.

The inlet and outlet protection in accordance with OPSS 511 and 1004 is recommended to prevent erosion adjacent to the culvert as well as scour that could undermine the culvert and/or embankment foundation. The actual design requirements concerning the length and width of the "aprons" at the inlet/outlet of the culvert as well as the rock size, apron thickness, height of erosion protection on the embankment slope and type of material (clay seals at the inlet, drainage and/or filter blankets at the outlet) will be dictated by stream hydraulics, stream configuration as well as the water level in the stream and should be established by a hydraulic engineer. A geotextile should be placed below the rip-rap to minimize the potential for erosion of fine particles from below the treatment.

4. EXCAVATION AND GROUND WATER CONTROL

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

If excavation of bedrock is required, 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 as per OPSS 120 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.

Mechanical means such as 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. Mass concrete could be employed to level minor variations in the bedrock surface.

If blasting is required, a N SSP should be prepared to provide specific direction to the contractor to control the blasting/excavation of the rock to prevent fracturing and/or disturbance of the bedrock surface, require that a blasting specialist be retained to establish the charge to minimize overbreak, advise that any overblasting/overexcavation will be the sole responsibility of the contractor and require that loosened rock resulting from blasting operations be removed by mechanical means.

The excavation width should be 1 m wider than the plan area of the culvert. Near vertical sidewalls may be utilised 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 seasonal fluctuations and precipitation patterns, it is expected that conventional sump pumping techniques, perimeter ditches and/or diversion of the stream can readily handle ground water seepage or surface water inadvertently 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 contractor's responsibility.

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



5. CLOSURE

This report was prepared by Mr. G.D. Degil, PhD, P.Eng., Senior Foundation Engineer, and reviewed by Mr. D.W. Kerr, MEng, P.Eng., Chief Foundation Engineer. Mr. B.R. Gray, MEng, P.Eng., MTO Designated Contact, conducted an independent review of the report.

Yours very truly

Peto MacCallum Ltd.

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GD:gd-mi



TABLE 1
LIST OF MTO DOCUMENTS USED IN REPORT

NO.	TITLE	DATE
OPSD 803.010	Backfill and Cover for Concrete Culverts	November 1999
OPSS 120	General Specification for the Use of Explosives	November 2003
OPSS 501	Construction Specification for Compacting	November 2005
OPSS 511	Construction Specification for Rip-Rap, Rock Protection, and Granular Sheeting	November 2004
OPSS 1004	Material Specification for Aggregates - Miscellaneous	November 2005
OPSS 1860	Material Specification for Geotextiles	November 2004
SP 206S03	Construction Specification for Grading	January 2004
SP 902S01	Excavation and Backfilling of Structures	September 2003
SP 105S10	Construction Specification for Compaction	November 2004