



**PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT
for
HIGH FILLS AND EMBANKMENT OVER SWAMPS
FUTURE HIGHWAY 11/17
FROM 1.5 KM SOUTH OF HIGHWAY 17 SOUTH JUNCTION ON
HIGHWAY 11 NORTHERLY 5.4 KM
CITY OF NORTH BAY
AGREEMENT NUMBER 5004-E-0062
G.W.P. 5748-04-00
DISTRICT OF SUDBURY, ONTARIO**

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PART A
PRELIMINARY FOUNDATION INVESTIGATION REPORT
for
High Fills and Embankment Over Swamps
Future Highway 11/17
From 1.5 km South of Highway 17 South Junction on
Highway 11 Northerly 5.4 km
City of North Bay
G.W.P. 5748-04-00
District of Sudbury, Ontario

1. INTRODUCTION

This report summarizes the results of the foundation investigation carried out at the high fill and embankment over swamp areas along the future Highway 11/17 in the City of North Bay, District of Sudbury, Ontario. This preliminary report was prepared for Stantec Consulting Ltd. (Stantec) on behalf of the Ministry of Transportation of Ontario (MTO).

The contemplated highway corridor section extends from 1.5 km south of the Highway 17 South Junction on Highway 11 northerly 5.4 km within the City of North Bay. A chainage equation occurs about 115 m north of the south junction on Highway 11/17. The chainages increase from Sudbury and from Huntsville to the equation change location. The equation change is as follows:

Station back 16+974.22 = Station ahead 19+215.96 (south)

For this project, the alignment was assumed to run northerly from Huntsville to Sudbury, although part of the alignment orientation is to the west. The investigations were carried out along the following sections of high embankment fill and swamp crossings on the future Highway 11/17. For ease of reference, Peto MacCallum Ltd. (PML) designated the study sections by sequential numbers in the 100 series. The new ramps at the existing Highway 11 and Highway 17 South Junction Interchange cross swamps that were simply designated by the ramp names.

PML Swamp Designation	Location
Swamp 101	Sta. 16+700 to 16+974; Sta. 19+216 to 19+100 (*)
Swamp 102	Sta. 16+490 to 16+600
Swamp 103	Sta. 16+180 to 16+340
Swamp 104	Sta. 16+080 to 16+180
Swamp 105	Sta. 14+900 to 15+000



PML Swamp Designation	Location
Swamp 106	Sta. 14+720 to 14+800
Swamp 107	Sta. 14+200 to 14+680
E/W-N Ramp, S-W, W-N Ramp	At Highway 11 and Highway 17 I/C

(*) Refer to chainage equation change described previously.

Two additional areas with potential foundation problems along the preferred main alignment were also investigated on a preliminary basis. One is located north of the Northgate Square Mall (approximately from Sta. 15+850 to 15+950) and the second on the Chapais Street extension.

A set of three plans showing the investigated sections and the layout of the test holes is attached as Drawings EMB-1 to EMB-3.

This report summarizes the results of the preliminary foundation investigation carried out at the high embankment fill and swamp crossing areas along the new future Highway 11/17 in North Bay.

2. SITE DESCRIPTION AND GEOLOGY

The investigated alignment of the new future Highway 11/17 is located to the geographic north and east of the existing Highway 11/17. The highway is planned on new alignment from about Sta. 14+150, about 400 m east of the current O'Brien Street intersection. A major culvert carries the Chippewa Creek under Highway 11/17, about 150 m east of O'Brien Street. The corridor also crosses one unnamed creek east of Trout Lake Road and borders the Johnston Creek between the Ontario Northland Railway (ONR) embankment and Mud Lake Road. Site photographs are included in Appendix A.

The topography of the investigated sections is characterized by generally hilly, flat terrain, bedrock outcrops and local areas of wet ground, including open water sections north of the Highway 11 and Highway 17 interchange, south of Seymour Street and Delaney Lake (Mud Lake).

Numerous bedrock outcrops were observed along the new future Highway 11/17 corridor. Between the outcrops, native soil cover typically comprised sand, sandy and/ or clayey silt and



silty clay. Swamp deposits, including peat and soft clay, exist within the poorly drained swampy areas overlying more competent mineral soil (sands/silts) and bedrock.

The project site is situated in the Algonquin Highlands physiography region within the Canadian Shield. The surficial geology is characterized by glacial and post glacial lacustrine sediments and till mantling the Precambrian bedrock.

3. INVESTIGATION PROCEDURES

The subsurface investigations were carried out during the period of March 23 to April 30, 2007. A total of 36 test holes (boreholes or test pits) were drilled/excavated at the site for foundation investigation purposes.

The boreholes were advanced using continuous flight solid and hollow stem augers through the soil cover with a track-mounted D-50 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a PML field supervisor. Where boreholes were located over open water swamps covered by thin ice, light weight tripod and washboring equipment, supplied and operated by a specialist drilling contractor, was used to advance the boreholes. Where required due to poor access and the general terrain comprised bedrock outcrops, the test holes were advanced with an excavator. These test pits were logged on Record of Borehole sheets with the borehole type noted as advanced with excavators.

Soil samples were recovered from the boreholes at regular 0.75 and 1.5 m intervals of depth using the standard penetration test method. In the test pits, representative chunk samples were obtained. The relative density or consistency of the soils encountered in the test pits were estimated by probing and observation of the test pit walls and the recovered soils samples.

Soils were identified in accordance with the MTO soil classification manual procedures. The groundwater conditions in the boreholes were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, where encountered, by measuring the groundwater level in the open holes. The test holes were backfilled with a bentonite/cement mixture where required in accordance with the MTO guideline and MOE Reg. 903 for borehole abandonment.



The locations of the test holes were surveyed by Del Bosco Surveying Ltd. All elevations in this report are reported in metres.

The recovered soil samples were returned to our laboratory in Toronto for detailed visual examination, laboratory testing and classification. The laboratory testing program consisted of natural moisture content determinations, grain size distribution analyses and Atterberg limits of the recovered soil samples. The laboratory grain size distribution charts are reported on Figures GS-1 to GS-5. The Atterberg plasticity test results are shown on the Figures PC-1, PC-2 and PC-3. All of the test results are summarized on the Record of Borehole sheets.

4. SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration test data, particle size distributions, Atterberg limits and moisture content determinations.

A general description of the subsurface conditions encountered at the investigated areas is provided in Table 1 and a summary of the findings is given below for each swamp and interchange ramp.

4.1 Swamp 101 (Sta. 16+700 16+974; Sta. 19+216 to 19+100)

A total of six boreholes, designated boreholes 101-1 to 101-6, were advanced at swamp 101 to the depths of 1.4 to 5.2 m. Four boreholes (101-2 to 101-5) were drilled from the top of the 0.6 to 0.9 m deep ice and water. Two boreholes (101-1 and 101-6) were drilled through discontinuous sand fill. Peat was encountered in all boreholes except in borehole 101-1. The peat was underlain by a discontinuous layer of silty clay and/or clayey silt, which was locally underlain by a sand deposit (borehole 101-6). Discontinuous silt and sand and silty sand were also encountered below the peat. The clayey and sandy soils mantled probable bedrock in all boreholes.



4.1.1 Fill

A surficial fill unit of loose to compact brown sand with silt and containing gravel and cobbles was encountered in borehole 101-6. The thickness/depth of the fill is about 1.4 m extending to elevation 209.2. One standard penetration test N value of 10 blows was obtained.

4.1.2 Peat

Dark brown peat was found in all boreholes except in borehole 101-1 below 0.6 to 1.4 m of fill or ice and water. The thickness of the peat was about 0.2 to 0.3 m, extending to depths of 0.9 to 1.6 m, elevations 207.6 to 209.0.

4.1.3 Silty Clay

A discontinuous deposit of cohesive grey silty clay was encountered below the peat deposit in boreholes 101-5 and 101-6. The thickness of the silty clay varies from 1.6 to 2.0 m. The deposit extended to depths of 3.2 m, elevations 205.7 to 207.4. The consistency of the silty clay was very soft to stiff. N values ranged from 1 to 10.

The moisture content of this deposit was 35 and 50%. The Atterberg liquid limits of the silty clay samples were 37 and 44 and the plastic limits 19 and 20 giving plasticity index values of 18 and 24. The plasticity chart of the deposit is presented in Figure PC-1 and the grain size distribution charts are presented in Figure GS-1.

4.1.4 Clayey Silt

A discontinuous cohesive grey clayey silt some sand trace gravel was encountered in boreholes 101-4 and 101-5 below the peat and silty clay, respectively. The thickness of this deposit varies from 0.5 to 0.6 m, and the soil extended to depths of 1.7 and 3.8 m, elevations 205.1 and 207.1, terminating on probable bedrock. The consistency of the clayey silt is very soft to soft. N values of 1 and 4 were obtained.



The moisture content of the deposit was 28%. The Atterberg liquid and plastic limits of the clayey silt were 28 and 17, for a computed plasticity index of 11. The plasticity chart of the deposit is shown in Figure PC-2 and the grain size distribution chart is included in Figure GS-2.

4.1.5 Silt and Sand/Silty Sand

Cohesionless grey silt and sand and silty sand deposits were encountered in boreholes 101-2 and 101-3 below the peat layers. The thickness of these deposits varied from 1.1 to 1.8 m. The soils extended below the top of ice surface to depths of 2.0 and 2.7 m, elevations 206.1 and 207.0. The silt and sand/silty sand were loose to compact. N values varied from 4 to 26 blows.

The moisture content of these deposits varied from 11 to 18%. The grain size distribution charts are included in the Figure GS-3 envelope.

4.1.6 Sand/Sand and Silt

Cohesionless compact to dense grey sand with variable silt content trace to some gravel was encountered at ground surface in borehole 101-1, below the silty sand/silt and sand in boreholes 101-2 and 101-3 and below the silty clay in borehole 101-6. The thickness of the deposit varied from 0.8 to 2.0 m, extending to depths of 1.4 to 5.2 m, elevations 205.3 to 205.5 in boreholes 101-2, 101-3 and 101-6 and to elevation 208.4 in borehole 101-1. The N values ranged from 18 to 52.

The moisture content of the deposit was about 11%. The grain size distribution charts of the deposit are included in the Figure GS-3 envelope.

4.1.7 Bedrock

Bedrock was inferred by refusal to further advance in the test holes. The depth to the bedrock surface varies from 1.4 to 5.2 m, elevations 205.1 to 208.4.



4.1.8 Groundwater

The alignment crosses open water 0.6 to 0.9 m deep in boreholes 101-2, 101-3, 101-4 and 101-5. The top of water/ice was at about elevations 208.8 to 209.0 at the time of the investigation. Groundwater was also found in borehole 101-6 at the depth of 4.0 m from the ground surface, elevation 206.6. Groundwater was not encountered in borehole 101-1. The groundwater table is susceptible to fluctuations due to seasonal and rainfall patterns.

4.2 Swamp 102 (Sta. 16+490 to 16+600)

The field investigation program of swamp 102 that is crossed by the Seymour Street embankment comprised four test holes. Borehole 102-2 encountered an exposed bedrock outcrop. The other three boreholes were advanced to depths of 0.6 to 2.0 m before encountering refusal to further advance due to probable bedrock. One borehole was drilled from the top of the ice surface.

The subsurface soil stratigraphy generally comprises a localized fill, dark brown peat or sand at ground surface underlain by organic clayey silt which is in turn underlain by sand and gravel covering bedrock.

4.2.1 Fill

Localized surficial brown sand fill was encountered in borehole 102-3. The thickness/depth of the sand fill is about 1.2 m, extending to elevation 211.3. The N values varied from 10 to over 23 blows per 150 mm penetration (sampler bouncing) indicating that the fill extended to probable bedrock level.

4.2.2 Peat

A layer of dark brown peat about 0.9 m thick was encountered in borehole 102-4 below 0.4 m of water and ice. The peat extended to 1.3 m depth below the ground surface, elevation 208.9. The moisture content of one sample of the peat was about 665%.



4.2.3 Organic Clayey Silt

A discontinuous organic clayey silt deposit was encountered below the peat unit in borehole 102-4. This deposit was 0.4 m thick, extending to 1.7 m below the ground surface, elevation 208.5. The moisture content was about 50%.

4.2.4 Sand/Sand and Gravel

Cohesionless brown sand some silt and sand and gravel were encountered at the ground surface in boreholes 102-1 and below the organic silt in borehole 102-4. The thickness of this deposit varies from 0.3 m to 0.6 m, extending to depths of 0.6 and 2.0 m, elevations 208.2 and 210.9. The relative density of the soil units is considered to be compact. One N value of 27 was obtained.

The grain size distribution chart from one particle size analysis of the sand and gravel is presented on Figure GS-4.

4.2.5 Bedrock

An outcrop of bedrock exists at the ground surface in borehole 102-2, elevation 211.0. Bedrock was inferred by refusal to further advance of the sampler or augers at the other three borehole locations. The depths to the bedrock/inferred bedrock vary from the surface to 2.0 m, elevations 208.2 to 211.3.

4.2.6 Groundwater

Groundwater was not encountered in boreholes 102-1, 102-2 and 102-3. Ice (open water) 0.4 m deep was found at borehole 102-4 after augering through the ice surface. The top of the ice was at about elevation 210.2. The groundwater table is susceptible to fluctuations due to seasonal and rainfall patterns.



4.3 Swamp 103 (Sta. 16+180 to 16+340)

Swamp 103 comprises open water at the western end of Delaney Lake (Mud Lake), an extensive rock outcrop to the south, and the shallow embankment of Mud Lake Road and shallow soil cover or locally exposed bedrock to the north of the Lake. The alignment crosses over an extensive rock outcrop bordered along the west by the Johnston Creek which drains Delaney Lake northwesterly.

The field investigation program of swamp 103 comprised two test boreholes designated 103-1 and 103-2. The depths of the boreholes vary from 1.7 to 3.3 m and terminated by refusal on probable bedrock.

The soil stratigraphy comprises a surficial peat unit over cohesionless sand deposit which mantles inferred bedrock.

4.3.1 Peat

A surficial deposit of dark brown peat was encountered in borehole 103-2. The peat extended to a depth of about 1.4 m, elevation 203.6. Moisture content determinations of 358 to 536% were obtained in the peat.

4.3.2 Sand

A deposit of loose to dense cohesionless sand some silt trace to with gravel was encountered in the two boreholes drilled. The deposit had a thickness of 1.7 to 1.9 m, extending to depths of 1.7 to 3.3 m, elevations 201.7 to 207.2. N values varied from 8 to 48 blows.

The natural moisture content of the sand ranged from 11 to 19%. The grain size distribution charts of samples of the sand are presented in Figures GS-3 and GS-4.



4.3.3 Bedrock

Bedrock was inferred in both boreholes by refusal to further advance of the sampler. The depth of probable bedrock was 1.7 to 3.3 m below the ground surface, elevations 201.7 to 207.2. The bedrock outcrops at numerous locations along the alignment as verified visually.

4.3.4 Groundwater

Groundwater was encountered in borehole 103-1 only. Upon completion of drilling, the groundwater table was at a depth of 1.0 m from the existing ground surface, elevation 207.9. The water level in Delaney Lake was at about elevation 204.5 at the time of the investigation. The groundwater table is susceptible to fluctuations due to seasonal and rainfall patterns.

4.4 Swamp 104 (Sta. 16+080 to 16+180)

The swamp 104 area is located to the south of the ONR embankment and is bordered along the west by the Johnston Creek.

The field investigation program of swamp 104 comprised the two test pits 104-1 and 104-2. The subsurface stratigraphy comprises boulders at surface over probable bedrock.

4.4.1 Boulders

Both test pits encountered boulders mixed with topsoil at the ground surface. The layers of boulders were 300 mm thick and extended to 0.3 m depth, elevations 205.3 and 207.6.

4.4.2 Bedrock

Both test pits terminated by refusal to further advance on probable bedrock at 0.3 m depth below the existing ground surface. The elevations of the probable bedrock surface are 205.3 to 207.6. It is noted that extensive bedrock outcrops were noted in the vicinity of the two test pits during the field work.



4.4.3 Groundwater

No groundwater was encountered in either of the test pits. Surface water flow was noted in the ditches along the ONR embankment and draining into the Johnston Creek.

4.5 Swamp 105 (Sta. 14+900 to 15+000)

Swamp 105 is located in a low area between rock outcrops. The field investigation program of swamp 105 comprised two boreholes, designated 105-1 and 105-2 advanced to depths of 3.8 and 6.6 m and included a dynamic cone penetration test carried out from 4.5 to 9.1 m depth at a location 1.5 m west of borehole 105-1.

The subsurface stratigraphy generally comprised surficial peat layers underlain by loose to compact sand that was underlain in borehole 105-1 by a discontinuous stratum of silty clay that is underlain by a silt deposit.

4.5.1 Peat

A surficial deposit of dark brown peat was encountered in both boreholes extending to depths of 0.1 and 1.2 m, elevations 213.4 to 214.6. The moisture content determination of the peat is about 330%.

4.5.2 Sand

A deposit of loose to compact sand trace silt was encountered in both boreholes. The thickness of the sand varied from 2.6 to 3.9 m, and the deposit extended to depths of 3.8 to 4.0 m, elevations 210.7 to 210.8. The sand extended to bedrock in borehole 105-2. N values ranged from 3 to 26 in the deposit.

The typical values of the natural moisture determination of the sand were about 19 to 20%. The grain size distribution charts of two recovered sand samples are included in the Figure GS-3 envelope.



4.5.3 Silty Clay

A discontinuous layer of cohesive silty clay was encountered in borehole 105-1 below the sand deposit. The silty clay is 1.7 m thick, extending to a depth of 5.7 m from the ground surface, elevation 209.0. The consistency of the silty clay is soft. One field vane shear strength of 20 kPa was measured in the borehole.

The moisture content of the silty clay was about 42%.

4.5.4 Silt

A discontinuous deposit of low plasticity silt was encountered in borehole 105-1 below the silty clay and extended/was inferred to below 9.1 m depth, elevation 205.6. The clayey silt had a loose to dense relative density. Based on the standard penetration and dynamic cone penetration test results (N values of 3 to 30 blows) the relative density generally increased with depth.

The moisture content of the silt is about 30%. The Atterberg liquid and plastic limits were 23 and 19 giving a low plasticity index of 4. The plasticity chart of the silt is presented in Figure PC-3 and the grain size distribution chart in Figure GS-5.

4.5.5 Bedrock

Borehole 105-2 was terminated on probable bedrock at 3.8 m depth, elevation 210.8. Bedrock was not contacted in borehole 105-1 that was terminated at 9.1 m depth, elevation 205.6 in the competent silt layer.

4.5.6 Groundwater

Groundwater was encountered in borehole 105-2 only. The groundwater table was at 0.3 m depth from the ground surface, elevation 214.3 at completion of borehole drilling. The groundwater table is susceptible to fluctuations due to seasonal and rainfall patterns.



4.6 Swamp 106 (Sta. 14+720 to 14+800)

Swamp 106 is located to the right of the new alignment and north of the existing Hydro One facilities. The field investigation program of swamp 106 comprised the two boreholes 106-1 and 106-2, advanced to the depths of 2.8 and 4.3 m respectively.

The local subsurface stratigraphy generally comprises a surficial deposit of peat underlain by sand which is in turn underlain by a discontinuous stratum of silty sand till encountered at borehole 106-2. The boreholes terminated by refusal on probable bedrock.

4.6.1 Peat

A surficial deposit of dark 100 to 600 mm thick peat was encountered in both boreholes. The peat extended to 0.1 to 0.6 m depths, elevations 219.6 to 220.2. The moisture content of the peat was about 780%.

4.6.2 Sand and Silty Sand

A deposit of silty sand and sand with silt was encountered in both boreholes. The thickness of the sand is about 2.2 to 2.3 m, extending to elevations 217.4 to 217.9. The sand is loose to typically compact. N values varied from 3 (one value at surface) to 24.

One moisture content determination on the sand was about 13%. The grain size distribution chart of the sand is presented in Figure GS-3.

4.6.3 Silty Sand Till

A localized deposit of dense glacial till comprising silty sand some clay trace gravel was encountered in borehole 106-2 at 2.4 m depth, elevation 217.9. The till is about 1.9 m thick, extending to the 4.3 m termination depth of borehole 106-2, elevation 216.0. The N value obtained on the silty sand till was 49.



The grain size distribution chart of the silty sand till is included in the Figure GS-3 envelope.

4.6.4 Bedrock

Both boreholes were terminated on probable bedrock. The inferred bedrock surface depth varied from 2.8 to 4.3 m, elevations 216.0 to 217.4.

4.6.5 Groundwater

Groundwater was encountered in both boreholes. During drilling the groundwater was noted at 0.3 to 0.7 m below the ground surface. The groundwater table observed upon completion of drilling was at the ground surface, elevations 220.2 and 220.3. The groundwater table is susceptible to fluctuations due to seasonal and rainfall patterns.

4.7 Swamp 107 (Sta. 14+200 to 14+680)

Swamp 107 extended along a low lying, brush covered area between Frost Street and the proposed Chapais Street/Chippewa Street extension. The field investigation of swamp 107 comprised seven boreholes, designated boreholes 107-1 to 107-6 and 107-1A.

The subsurface stratigraphy generally comprised a surficial deposit of peat underlain by cohesionless loose to compact sand, which is underlain by a discontinuous stratum of clayey or sandy silt deposit. The boreholes were terminated by refusal on probable bedrock.

4.7.1 Peat

A surficial deposit of peat was encountered in boreholes 107-1A and 107-2 to 107-6. The thickness of the peat varies from 100 mm to 1.1 m with a typical thickness range of 100 to 300 mm. This deposit was penetrated at depths ranging from 0.1 to 1.1 m, elevations 219.8 to 222.8. The moisture content determinations on the peat were 78, 455 and 665%.



4.7.2 Sand

Cohesionless very loose to compact sand trace to some silt was encountered in all the boreholes except in boreholes 107-1 and 107-1A. The thickness of this deposit ranged from 400 mm to 1.5 m. The soil unit extended to depths of 0.9 to 1.8 m, elevations 219.2 to 222.0. The standard penetration test N values ranged from 2 to 19.

The natural moisture content typically ranged from 16 to 20%. The grain size distribution chart is included in the Figure GS-3 envelope.

4.7.3 Clayey Silt

Discontinuous firm clayey silt was encountered in borehole 107-5. The clayey silt is about 0.5 m, extending to the 1.4 m termination depth of borehole 107-5, elevation 218.7. One N value of 6 blows was obtained in borehole 107-5.

The natural moisture content of the clayey silt was about 32%. The plasticity chart of the clayey silt is presented in Figure PC-2 and the grain size distribution chart in Figure GS-2. The Atterberg liquid and plastic limits are 33 and 22 respectively and the corresponding plasticity index is 11.

4.7.4 Sandy Silt, Silt With Sand

Discontinuous deposits of compact sandy silt or silt with sand were encountered in boreholes 107-4 and 107-6 respectively. The deposits were 1.0 and 1.3 m thick, extending to depths of 1.9 and 3.1 m, elevations 218.8 and 218.0, respectively. The N values in the deposits ranged from 14 to 22.

The natural moisture content of the sandy silt/silt with sand deposits varied from 16 to 22%.

4.7.5 Bedrock

All the boreholes encountered outcrops or were terminated on the probable bedrock surface. The depths to the bedrock surface varied from 0.0 to 3.1 m, elevations 218.0 to 223.5.



4.7.6 Groundwater

Groundwater was encountered in all the boreholes except in boreholes 107-1 and 107-1A. The water table observed after drilling varied from the surface to 1.0 m below the existing ground surface, elevations 219.8 to 222.8. The groundwater is susceptible to fluctuations due to seasonal and rainfall patterns.

4.8 E/W-N Ramp (Highway 11 and Highway 17 Interchange)

The ramp crosses partially over fill placed on the adjacent property to the northeast of the alignment. Part of the ramp alignment crosses over open water (borehole EWN-2). The field investigation program in the proposed E/W-N ramp of the Highway 11 and Highway 17 interchange comprised of five boreholes, designated boreholes EWN-1 to EWN-5.

Borehole EWN-1 was located on a bedrock outcrop and boreholes EWN-2 to EWN-6 were advanced to the depths 0.6 to 8.2 m.

The subsurface stratigraphy generally comprises surficial fill or peat underlain by localized clayey silt which is underlain by sand with gravel over boulders or inferred bedrock.

4.8.1 Fill

A surficial unit of fill comprising compact to very dense sand trace to some silt trace gravel was encountered in boreholes EWN-3, EWN-4 and EWN-5. The fill was fully penetrated in borehole EWN-5 at 5.7 m depth, elevation 205.3. Boreholes EWN-3 and 4 terminated by refusal on probable boulders at 3.0 and 0.6 m depths, elevations 211.3 and 213.5, respectively. After re-drilling these two boreholes about 1.0 to 1.5 m west from the original locations, refusals were obtained at 0.5 and 1.5 m depths. N values of 18 to 75 were obtained in the fill.

The moisture content of the fill ranged from 7 to 13%. Two grain size distribution charts are included in the Figure GS-3 envelope.



4.8.2 Peat

A discontinuous dark brown peat deposit was encountered in borehole EWN-2 below 0.9 m of ice and water. The thickness of the peat is about 0.6 m, extending below the ice surface to 1.5 m depth, elevation 207.5.

4.8.3 Clayey Silt

A 0.8 m thick discontinuous deposit of very stiff clayey silt was encountered in borehole EWN-5. The deposit extended to 6.5 m depth, elevation 204.5. One N value of 29 was obtained.

The Atterberg plasticity chart is presented in Figure PC-2 and the grain size distribution chart is included in Figure GS-2. The moisture content of the clayey silt was about 28%. The liquid and plastic limits of the clayey silt were 25 and 13 indicating a plasticity index of 12.

4.8.4 Sand

A discontinuous compact to very dense deposit of sand with silt trace gravel about 1.7 m thick was encountered in borehole EWN-5. The deposit extended to 8.2 m depth, elevation 202.8. N values obtained in this deposit ranged from 23 to 58 blows.

The natural moisture content of the sand deposit was about 10%.

4.8.5 Bedrock

Bedrock was inferred by refusal to further advance below the sand at 8.2 m depth, elevation 202.8 in borehole EWN-5. An outcrop was observed at the location of borehole EWN-1 at elevation 209.7.



4.8.6 Groundwater

Groundwater was not encountered in boreholes EWN-1, EWN-3 and EWN-4. Ice and water 0.9 m deep were encountered in borehole EWN-2, drilled from the top of the ice surface. Groundwater was also observed during drilling at borehole EWN-5 at 6.0 m depth, elevation 205.0. The groundwater is susceptible to fluctuations due to seasonal and rainfall patterns.

4.9 S-W and W-N Ramps (Highway 11 and Highway 17 I/C)

Boreholes SW-1, SW-2, WN-1 and WN-2 were advanced on the alignments of the proposed S-W and W-N ramps to depths of 0.0 to 5.0 m.

The subsurface stratigraphy along these ramps is variable, comprising exposed rock or bedrock at shallow depth near Highway 17 (boreholes WN-1 and SW-2) and fill where the alignments near the proposed E/W-N ramp. Generally the soil stratigraphy comprised surficial fill made up of sand with gravel and boulders and/or peat overlying localized silty clay, sandy silt and sand deposits over bedrock.

4.9.1 Fill

A surficial unit of fill made up of sand trace silt with gravel and containing scattered boulders was encountered in boreholes WN-1 and WN-2. The thickness/depth of the fill was 0.6 and 2.3 m, elevations 206.6 to 211.1, however the fill in borehole WN-2 maybe thicker/deeper than recorded since the borehole was terminated by refusal on inferred boulders. The sand fill has an inferred compact relative density. Recorded N values were 17 and over 50 blows for less than 300 mm penetration with the sampler bouncing on boulders present within the fill.

The moisture content of the sand fill varied from 9 to 13%.



4.9.2 Organic Clayey Silt

A deposit of dark brown soft organic clayey silt was encountered in borehole SW-1 below a 200 mm thick layer of ice. This deposit was 0.8 m thick, extending to a depth of 1.0 m from the top of the ice surface, elevation 208.0.

The natural moisture content of the organic clayey silt was 65%.

4.9.3 Silty Clay

A 1.0 m thick discontinuous deposit of greyish brown cohesive and soft silty clay trace sand was encountered in borehole SW-1 below the organic clayey silt. This deposit extended to 2.0 m depth, elevation 207.0. One N value of 3 was obtained in the silty clay.

The natural moisture content of the deposit varied from 40 to 50%. The Atterberg liquid and plastic limits of the silty clay were 40 and 17, with a computed plasticity index of 23. The plasticity chart of the deposit is included in Figure PC-1. The grain size distribution chart of the silty clay is presented in Figure GS-1.

4.9.4 Sandy Silt

A localized 0.9 m thick deposit of grey compact sandy silt was encountered in borehole SW-1 below the silty clay layer. The sandy silt extended to a depth of 2.9 m, elevation 206.1. One N value of 27 was obtained in the sandy silt.

4.9.5 Sand with Gravel

A 2.1 m thick deposit of compact to very dense sand with gravel was encountered in borehole SW-1 below the sandy silt layer. This deposit extended to the 5.0 m termination depth of the borehole, elevation 204.0. N values of 19 and over 50 (67 for 25 cm, bouncing on probable bedrock) were obtained in the deposit.



One natural moisture of about 15% was determined on the deposit. The grain size distribution chart representing the soil is presented in Figure GS-4.

4.9.6 Bedrock

Bedrock/inferred bedrock was encountered in boreholes SW-1, SW-2 and WN-1. The depths to the bedrock vary from outcrop at the surface (borehole SW-2) to 5.0 m (borehole SW-1), elevations 204.0 to 209.4. Borehole WN-2 was terminated by refusal on probable boulders.

4.9.7 Groundwater

Groundwater was encountered in boreholes SW-1, WN-1 and WN-2 at depths varying from the surface to 1.5 m, elevations 206.9 to 211.9. A section of the S-W ramp crosses an open water swamp. The groundwater levels are susceptible to fluctuations due to seasonal and rainfall patterns.

4.10 Additional Investigated Areas

4.10.1 Chapais Street/Chippewa Street Extension

One additional test pit designated TP-1 was carried out in a low-lying swampy location between the end of Chapais Street and the future Highway 11/17 corridor. The test pit was put down in an area covered with up to 0.3 m of water beyond the test pit location and encountered peat overlying a grey clayey silt deposit. The test pit could not be advanced further than 2.1 m due to the excessive surface water inflow into the hole.

4.10.1.1 Peat

A layer of peat about 600 mm thick was encountered at the surface of the test pit. The deposit extended to 0.6 m depth, elevation 219.4. The water content of the peat was 341%.



4.10.1.2 Clayey Silt

The cohesive clayey silt extended to the 2.1 m termination depth of the test pit and was judged to be in a stiff condition. One penetrometer test in the soil indicated a undrained shear strength of 60 kPa.

The water content of the silty clay was 25%. The Atterberg liquid and plastic limits were 24 and 17 resulting in a plasticity index of 7. The plasticity chart and grain size distribution chart of the material are included in Figures PC-2 and GS-2, respectively.

4.10.1.3 Groundwater

During and at completion of the excavation the groundwater was at ground surface about elevation 220.0. The groundwater level is susceptible of seasonal fluctuations and variations due to precipitation patterns.

4.10.2 Section Adjacent to Northgate Square Mall

One test pit designated TP-2 was dug in the area of the main alignment adjacent to the Northgate Square Mall and between the ONR embankment and Laurentian Avenue. The test pit was excavated in an area currently covered with numerous fragments of asphaltic concrete, based on visual inspection. The encountered stratigraphy comprised fill covering a topsoil layer that was found over silty sand with gravel overlying bedrock.

4.10.2.1 Fill

The fill comprised locally of a mixture of cobbles and boulders in a silty sand matrix, and contained pieces of asphaltic concrete likely originating from the removal of an old pavement. The fill extended locally to 2.3 m depth, elevation 207.4. The fill was judged to be in a loose to compact relative density.



4.10.2.2 Topsoil

A 200 mm thick layer of topsoil was found below the fill and extended to 2.5 m depth, elevation 207.2.

4.10.2.3 Silty Sand

Below the topsoil, the test pit encountered a layer of native cohesionless silty sand with gravel. The soil extended to about 3.3 m depth, elevation 206.4. The soil was judged to be in a compact condition.

4.10.2.4 Bedrock

Bedrock was encountered in the test pit at 3.3 m depth, elevation 206.4. The bedrock was also noted at the ground surface on the future alignment near Laurentian Avenue.

4.10.2.5 Groundwater

Water was encountered in the test pit at a depth of 3.2 m, elevation 206.5. The water level may vary due to seasonal fluctuations and precipitation patterns.

5. MISCELLANEOUS

The subsurface investigation was carried out under the supervision of Mr. M. Rapsey, assistance of Mr. N. Rahman and direction of Mr. C.M.P. Nascimento, P.Eng., Senior Project Engineer. Walker Drilling Ltd. supplied the drilling equipment and Bruman Leasing Ltd. supplied the excavator. The laboratory testing was carried out by the PML laboratory in Toronto.

This report was prepared by Mr. C.M.P. Nascimento, P.Eng., with assistance of Mr. T. Xue, P.Eng., and reviewed by Mr. B.R. Gray, MEng., P.Eng., MTO Designated Principal Contact.

PART B
PRELIMINARY FOUNDATION DESIGN REPORT

for
High Fills and Embankment Over Swamps
Future Highway 11/17
From 1.5 km South of Highway 17 South Junction on
Highway 11 Northerly 5.4 km
City of North Bay
G.W.P. 5748-04-00
District of Sudbury, Ontario

6. ENGINEERING RECOMMENDATIONS

6.1 General

Part B of this report provides preliminary foundation engineering comments and recommendations regarding key issues in design and construction of the embankment in high fill and swamp areas along the proposed future Highway 11/17 in North Bay.

In summary, PML designated the areas investigated by swamps 101 to 107, E/W-N, S-W and W-N ramps. Two additional areas with potential foundation problems were also investigated along the proposed Chapais Street/Chippewa Street extension north of the future Highway 11/17 alignment (identified by TP-1) and on the main alignment adjacent to the Northgate Square Mall parking lot (identified by TP-2). The corridor and the location of each area are shown on the attached Drawings EMB-1 to EMB-3.

Reference is made to the Record of Borehole sheets and Table 1 - Summary of Subsoil Conditions appended to the report in connection to the following discussions.

The recommendations are preliminary and solely based on the results of the limited subsurface investigation described in Part A of this report. Comments made on construction concerns are provided only to highlight those aspects which could affect the preliminary design of the project.



In general, the construction of the future Highway 11/17 through North Bay is feasible from the foundations point of view. Swamp excavations should be backfilled with rockfill to provide adequate stability in view of the expected under water excavation and construction. The rockfill should be carried at least 1.5 m above the swamp levels due to potential drainage concerns. Above this level the embankment may be constructed of earth or rockfill.

6.2 High Fill Embankments

The future Highway 11/17 through North Bay extends along terrain characterized by relatively uniform to gently sloping topography. Exposed rock knobs and ridges are noted along the alignment. The area has mixed drainage characteristics with local areas of good drainage and also poorly drained swampy sections.

The planned grade raise of about 6.0 m above the existing embankment crossing the Chippewa Creek should be investigated during Detail Design to evaluate the consequences of the additional loading on the existing concrete culvert and embankment fill.

Grade changes up to 14 m high of the existing ground are proposed along the preferred route some sections. These locations are listed on the following table.

LOCATION OF SIGNIFICANT GRADE CHANGES
 HIGH FILL AND EMBANKMENT OVER SWAMP

LOCATION	PML REF. NO. WITHIN SECTION	APPROXIMATE STATION	GRADE CHANGE(**) (m)	
			FILL	CUT
Existing Chippewa Creek Crossing	—	13+820 to 14+020	6	—
Frost Street to south of Future Chapais Street Underpass	106, 107	14+200 to 14+820	—	4
Undeveloped Section at Hydro One Yard	—	14+820 to 14+920	—	6
	105	14+920 to 15+000	0.5	—
Undeveloped Section at Corpus Christi School to Trout Lake Road	—	15+000 to 15+200	—	6
	—	15+200 to 15+420	9	—
Trout Lake Road to ONR Overhead	—	15+500 to 16+020	12	—



**LOCATION OF SIGNIFICANT GRADE CHANGES
 HIGH FILL AND EMBANKMENT OVER SWAMP**

LOCATION	PML REF. NO. WITHIN SECTION	APPROXIMATE STATION	GRADE CHANGE(**) (m)	
			FILL	CUT
ONR Overhead to Mud Lake Road / Delaney Lake	104, 103	16+080 to 16+180	14	–
Mud Lake Road/Delaney Lake to South of Seymour Road	102	16+320 to 16+600	14	–
South of Seymour Road to Highway 11 and Highway 17 I/C	101	16+600 to 16+974 (*) 19+216 to 19+190	6	–

Notes: (*) Equation change: Stations back 16+974.22 = Stations ahead 19+215.96.

(**) Approximate maximum fill height or cut depth indicated on Table.

In general, the height of the embankment fill of the future Highway 11/17 varies from 2 to 14 m. It is recommended that the design allows for a minimum 1.5 m embankment height above the level of the swamps to minimize the drainage concerns.

In sections of the earthfill or rockfill where the height exceeds 8 or 10 m, respectively, benches with a minimum 2.0 m width will be required according to OPSD-202.010 in design of the embankments. A copy of the Ontario Provincial Standard Drawing (OPSD) is provided with this report in Appendix B. According to the requirement of the Northeastern Region Engineering Directive NRE-98-200, widening of the embankment platforms is required. A minimum platform widening of 2.0 m each side (4.0 m total) is required on Highways 11, 17, 69 and 400 in swamp environments. The minimum requirements may be waived when the swamp treatment eliminates uncertainty regarding embankment performance (e.g. full excavation to bedrock) during Detail Design.



6.3 Embankments Over Swamps

6.3.1 Subsurface Conditions

The typical subsurface stratigraphy encountered during the geotechnical investigation in the swamps comprises peat overlying discontinuous strata of clayey silt and/or silty clay underlain by discontinuous strata of cohesionless silt or sand mantling probable bedrock. In some sections, the groundwater is close to the ground surface, and open water sections up to 1.0 m deep occur in the swamps. A summary of the subsurface soil conditions under the alignment of each embankment over swamps is provided in Table 1.

6.3.2 Embankment Foundation Treatment

The following methods of embankment and foundation treatment over swamp areas were taken into account:

- Excavation of highly compressible soils
- Preloading of embankments
- Partial excavation and preloading
- Use of lightweight fill material
- Use of wick drains

A brief discussion of each treatment option is provided in the following sections of the report.

6.3.2.1 Excavation of Highly Compressible Soils

The standard method of construction of embankments applied by MTO in areas where low strength compressible soils exist is to remove these soils to the depth of competent soil to support the embankments ("firm bottom") and backfill the excavation following the procedures noted in OPSD-203.010. "Firm bottom" in this report was generally referred to loose to compact



cohesionless silts or sands as they have low compressibility, short-term consolidation process and are considered to be competent to supporting the overlying proposed embankments in general.

The depths of excavation to remove the peat and cohesive soils overlying competent soil or bedrock would extend to 0.5 to 6.3 m from the existing ground surface. The advantages and disadvantages of this treatment are listed in the following table.

Advantages	Disadvantages
<ul style="list-style-type: none"> • Minimal post-construction settlement due to consolidation of the competent cohesionless subgrade soils left in place • Cost effective 	<ul style="list-style-type: none"> • Disposal of large quantities of peat • Environmental impacts • Significant post-construction settlement of rockfill

6.3.2.2 Preloading of Embankments

This treatment option requires the removal of the surficial organic deposits such as organic silts and peat and replacement with more competent material such as rockfill. Additional earth fill (typically granular material to be used later in the pavement structure) is placed on the platform fill above the final design embankment level. This surcharge fill remains in place for the period of time required to induce at least most of the consolidation of the underlying cohesive soils left in place.

The advantages and disadvantages of this treatment are listed below:

Advantages	Disadvantages
<ul style="list-style-type: none"> • Effectively reduces the post-construction settlement of the embankment platform 	<ul style="list-style-type: none"> • Extended period of time required to induce the required magnitude of settlement • Requires anticipated production of pavement granular materials for use as surcharge



6.3.2.3 Partial Excavation Plus Preloading

This treatment option involves excavation of the surficial organic soils including peat and other compressible soil to a selected depth (typically the 10 to 12 m limit of excavation of the long stick excavators) followed by placement of the rockfill and surcharge. The excavation depth and the surcharge height are strategically selected based on the requisite consolidation within the available construction period. The depth of excavation and the height of surcharge load are to be optimized in locations where an extensive thickness of compressible soils exists.

The advantages and disadvantages of this treatment are listed below:

Advantages	Disadvantages
<ul style="list-style-type: none">• Effectively reduces the post-construction settlement of the embankment platform• Reduces the time required for preloading• Allows treatment of swamps with compressible soils deeper than the depth reachable by the long stick excavators	<ul style="list-style-type: none">• Extended period of time required to induce the required magnitude of settlement• Requires anticipated production of granular materials for use of surcharge

This treatment is not considered to be applicable to this project as the depth of the required excavation is typically less than the long stick reach for excavation.

6.3.2.4 Use of Lightweight Fill

The use of lightweight fill materials to reduce the pressure imposed on the subgrade soils by the embankments and thereby reduce the magnitude of post-construction settlement is a suitable treatment option in some situations where excavation of compressible soils are not feasible. For the subject site, however the load imposed by rockfill or earthfill would be adequately supported by the foundation soils below or excavation of compressible soils is feasible, therefore this treatment is not required.



Advantages	Disadvantages
<ul style="list-style-type: none">• Reduced foundation soil excavation	<ul style="list-style-type: none">• Lightweight fill not locally available• Environmental impacts during transportation• Impact to existing pavement system during transportation to site• High cost

6.3.2.5 Use of Wick Drains

Wick drains are used to increase the rate of consolidation of the native cohesive subsoil under the weight of surcharge loadings and thereby minimize the magnitude of post-construction settlement of the embankment surface. This option can be applied where the thickness and the depth of the cohesive subsoil are so extensive that it is impractical to remove by excavation. This method is not considered cost-effective for this project as the depth and/or thickness of the highly compressive cohesive subsoil strata are relatively small.

6.4 Selection Criteria and Suggested Treatment

The recommended swamp treatment method for each section of the roadway embankments under consideration was chosen using the following criteria:

- Good performance, minimize the post-construction settlement of the embankment surface due to consolidation of the embankment fill and subgrade material
- Minimize the environmental impacts due to construction
- Construction constraints, including schedule
- Cost-effectiveness

The recommended treatment option will be the excavation of the compressible soils including peat and cohesive deposits and the placement of rockfill in accordance with SP 206S03. The recommended geometry of excavation is in accordance with OPSD-203.010.



6.5 Embankment Settlements

The magnitude of the post-construction settlements of the embankment platform and the time required for essential completion of the settlement during the construction period will be a function of the embankment height, and its composition as well as the thickness and pertinent engineering properties of the subgrade soils.

Settlement resulting from consolidation of the rockfill was based on the following research document prepared by MTO (RR229 dated March 1983).

- Rockfill Above Grade

Total settlement is about 0.5% of the rockfill height provided the fill is placed in accordance with SP 206S03.

- Rockfill Below Grade

Total settlement up to 2% of the rockfill thickness since the rockfill is end dumped and placed in a relatively large lift with minimum or no compaction effort.

About 50% of the estimated total settlement occurs during the first year following the placement of the rockfill and the remaining 50% will occur at a progressively decreasing rate during the following 5 to 10 year period.

Considering the proposed alignment and expected excavation depths, the estimated embankment platform settlement is expected to be a maximum of 130 mm with typical values in the 30 to 50 mm range.

6.6 Construction Considerations

As discussed in the previous sections (Section 6.3 and 6.4), the conventional embankment design and construction procedures for the rockfill embankment should be suitable above or below the ground surface or under the water table. The local earth cut materials and/or aggregate sources if available may be used to construct earth fill embankments from 1.5 m above the groundwater table.



It is recommended that all the existing peat, topsoil and cohesive soils be excavated to the depth of competent soil ("Firm Bottom") as they are highly compressible and in some conditions, not capable of supporting the weight of the embankment fill to be placed.

"Firm Bottom" was generally defined as minimum loose to compact cohesionless sand or silts ($N \geq 8$ blows/0.3 m) or stiff cohesive clays ($C_u \geq 50$ kPa).

The rockfill and other embankment fill should be placed in accordance with the SP 206S03 and compacted in accordance with OPSS 501 and SP 105S10.

It is anticipated that the swamp and deep cuts will be accomplished by standard MTO method and using conventional sump pumping techniques. Construction of rockfill embankments over swamps will be feasible under water in sections crossing open water. Requirements for existing road protection should be considered at the Detail Design phase of the project.

7. SCOPE OF ADDITIONAL INVESTIGATION

The recommendations and discussions in this report are preliminary and are based on the interpretation of the factual information obtained from a limited number of test holes. Detailed foundation investigations are recommended for each swamp and high fill section during the Detail Design phase of the project. In particular, the depth and extent of highly compressible soils in swamps and low-lying areas should be investigated in further detail with additional boreholes.

The recommended scope of field work for Detail Design is listed in the attached Table 4.



8. CLOSURE

This preliminary Foundation Design Report (Part B) was prepared by Mr. C.M.P. Nascimento, P.Eng., Senior Project Engineer with the assistance of Mr. T. Xue, P.Eng., and was reviewed by Mr. B.R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

Yours very truly

Peto MacCallum Ltd.

A handwritten signature in blue ink, appearing to read "C.M.P. Nascimento", is written over the circular professional engineer stamp.

Carlos M.P. Nascimento, P.Eng.
Senior Project Engineer



A handwritten signature in blue ink, appearing to read "Brian R. Gray", is written over the circular professional engineer stamp.

Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact



CN/BRG:cn/lmr



TABLE 1
SUMMARY OF SUBSOIL CONDITIONS

PML SWAMP/ HIGH FILL DESIGNATION	ALIGNMENT SECTION (STA. TO STA.)	NO. OF TEST HOLES	FILL THICKNESS (m)	PEAT /TOPSOIL THICKNESS (m)	DEPTH TO BOTTOM OF CLAYEY SILT/ SILTY CLAY (m)	DEPTH TO BOTTOM OF SILT, SAND & GRAVEL (m)	DEPTH TO PROBABLE BEDROCK (m)	NOTES AND/OR SOIL STRATIGRAPHY
MAINLINE								
101	16+700 to 16+974; 19+216 to 19+100	6	0 – 1.4 (one borehole)	0.2 – 0.3	1.7 – 3.8 (3 boreholes)	1.4 – 5.2	1.4 – 5.2 (Elev. 205.1 – 208.4)	Four boreholes were advanced from the top of the ice surface over 0.6 to 0.9 m deep water. One borehole was advanced through sand fill. Peat was encountered in all boreholes (except in borehole 101-1), and was underlain by a discontinuous stratum of silty clay and/or clayey silt in 3 boreholes. The peat and silty clay were also underlain by cohesionless silt and sand. Probable bedrock was contacted in all boreholes. Groundwater was found at the surface (open water) in four boreholes and at 4.0 m depth in one borehole.
102	16+490 to 16+600	4	0 – 1.2 (one borehole)	0.0 – 0.9	1.7 (Organic)	0.6 – 2.0	0.0 – 2.0 (Elev. 208.2 – 211.3)	Fill/peat, clayey silt and/or sand were encountered above refusal on probable bedrock in 3 boreholes. Bedrock outcrops at borehole 102-2. Groundwater was only found in one borehole at the surface.
103	16+180 to 16+340	2	Not Found	0.0 – 1.4	Not Found	1.7 – 3.3	1.7 – 3.3 (Elev. 201.7 – 207.2)	Localized peat and sand were encountered above refusal on probable bedrock. Bedrock outcrops along alignment. Swamp borders Delaney Lake (Mud Lake). Groundwater was found in one borehole at 1.0 m depth after drilling.
104	16+080 to 16+180	2	Not Found	Not Found	Not Found	0.3 (boulders)	0.3 (Elev. 205.3 – 207.6)	Boulders were encountered at ground surface. Depth to bedrock is 0.3 m. Section extends over rock outcrop with shallow soil cover. No groundwater was found.



TABLE 1
SUMMARY OF SUBSOIL CONDITIONS

PML SWAMP/ HIGH FILL DESIGNATION	ALIGNMENT SECTION (STA. TO STA.)	NO. OF TEST HOLES	FILL THICKNESS (m)	PEAT /TOPSOIL THICKNESS (m)	DEPTH TO BOTTOM OF CLAYEY SILT/ SILTY CLAY (m)	DEPTH TO BOTTOM OF SILT, SAND & GRAVEL (m)	DEPTH TO PROBABLE BEDROCK (m)	NOTES AND/OR SOIL STRATIGRAPHY
Area adjacent to Northgate Square Mall	15+850 to 15+950	1	2.3	0.2 (buried)	Not found	3.3	3.3 (El. 206.4)	Asphalt pieces found in fill that comprised of mixed cobbles, boulders and silty sand. Native soil comprises silty sand with gravel. Bedrock encountered in test pit. Groundwater was at 3.2 m depth.
105	14+900 to 15+000	2 + 1 Cone Test	Not Found	0.1 – 1.2	5.7 (1 borehole)	3.8 – > 9.1	3.8 – >9.1 (Elev. <205.6 – 210.8)	Two boreholes and one cone test encountered peat and sand, locally underlain by silty clay and silt. Only one borehole terminated on probable bedrock. Groundwater was found at 0.3 m depth in one of the boreholes.
106	14+720 to 14+800	2	Not Found	0.1 – 0.6	Not Found	2.8 – 4.3 (silty sand till in one borehole)	2.8 – 4.3 (Elev. 216.0 – 217.4)	The boreholes were terminated on probable bedrock. Peat, sand, silty sand and silty sand till were encountered. Groundwater at surface at completion of drilling.
107	14+200 to 14+680	7	Not Found	0.1 – 1.1	1.4 (1 borehole)	0.9 – 3.1 (5 boreholes)	0.0 – 3.1 (Elev. 218.0 – 223.5)	Bedrock outcrops in one borehole. Six other boreholes were advanced to 1.1 to 3.1 m (refusal on probable bedrock). Peat, sand, isolated clayey silt and sandy silt were encountered. Groundwater table depth varies from 0.0 to 1.0 m.



TABLE 1
SUMMARY OF SUBSOIL CONDITIONS

PML SWAMP/ HIGH FILL DESIGNATION	ALIGNMENT SECTION (STA. TO STA.)	NO. OF TEST HOLES	FILL THICKNESS (m)	PEAT /TOPSOIL THICKNESS (m)	DEPTH TO BOTTOM OF CLAYEY SILT/ SILTY CLAY (m)	DEPTH TO BOTTOM OF SILT, SAND & GRAVEL (m)	DEPTH TO PROBABLE BEDROCK (m)	NOTES AND/OR SOIL STRATIGRAPHY
HIGHWAY 11 AND HIGHWAY 17 INTERCHANGE RAMP								
E/W-N Ramp	At Highway 11 and Highway 17 I/C	5	0.0 – 5.7 (3 boreholes)	0.6 (below 0.9 m of water in one borehole)	6.5 (1 borehole)	8.2 (1 borehole)	0.0 – 8.2 (Elev. 202.8 – 209.7)	Bedrock outcrops in one borehole. Four boreholes were advanced to depths of 0.6 to 8.2 m through fill/peat, clayey silt, sand. Groundwater table depth varies from 0.0 to 6.0 m.
S-W and W-N Ramps	At Highway 11 and Highway 17 I/C	4	0.0 – 2.3 (2 boreholes)	Not Found	1.0 – 2.0 (1 borehole with 0.8 m organic clayey silt)	0.0 – 5.0 (1 borehole)	0.0 – 5.0 (Elev. 204.0 – 209.4)	Bedrock outcrops in one borehole. Three other boreholes were advanced to probable bedrock or boulders through fill, localized silty clay, sandy silt and sand with gravel. Groundwater table varies from 0.0 to 1.5 m deep.
CHAPPAIS STREET EXTENSION								
Chapais Street Extension (TP-1)	50 to 250 m north of new Highway 11/17 (toward Chapais Street end)	1	Not found	0.6	> 2.1	Not found	Not found	Groundwater at surface of test pit. Open water noted beyond test pit location. Swamp is likely connected to swamp 106 investigated for the mainline.



TABLE 2
LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE	DATE
OPSS 501	Construction Specification for Compacting	November 2005
SP 105S10	Construction Specification for Compaction	November 2004
SP 206S03	Construction Specification for Grading	November 2006
OPSD-202.010	Slope Flattening Using Excess Material on Earth or Rock Embankment	November 2005
OPSD-203.010	Embankments Over Swamp - New Construction	November 2005
NRE 98-200	Northeastern Region Directive - Platform Widening	October 28, 1998

Note: A complete list of applicable standard specifications should be compiled at the Detail Design stage.



TABLE 3
SUMMARY OF SUBSOIL CONDITIONS AND APPLICABLE TREATMENT

PML SWAMP / HIGH FILL DESIGNATION	ALIGNMENT SECTION (STA. TO STA.)	FILL HEIGHT (m)	DEPTH TO COMPETENT SOIL (m)	DEPTH TO PROBABLE BEDROCK (m)	TYPICAL SOIL PROFILE	APPLICABLE TREATMENTS	
						TREATMENT METHOD ⁽¹⁾⁽²⁾	EXCAVATION DEPTH (m)
101	16+700 to 16+974; 19+216 to 19+100 (Note equation change)	6.0	1.7 – 3.8	1.4 – 5.2 (El. 205.1 – 208.4)	Peat under open water swamp or fill underlain by discontinuous silty clay and/or clayey silt that is underlain by discontinuous strata of silt and sand, mantling probable bedrock	OPSD 203.010 Embankment slope as shown ⁽³⁾ . Back Slope 1H:1V	1.7 – 3.8
102	16+490 to 16+600	8.0	1.7	0.0 – 2.0 (El. 208.2 – 211.3)	Fill/peat underlain by a discontinuous stratum of clayey silt underlain by sand or sand and gravel deposits mantling probable bedrock	OPSD 203.010 Embankment slope as shown ⁽³⁾ . Back Slope 1H:1V	1.7
103	16+180 to 16+340	14.0	0.0 – 1.4	1.7 – 3.3 (El. 201.7 – 207.2)	Peat underlain by sand deposits mantling probable bedrock	OPSD 203.010 Embankment slope as shown. Back Slope 1H:1V	1.4
104	16+080 to 16+180	12.0	0.3	0.3 (El. 205.3 – 207.6)	Boulders mantling probable bedrock	OPSD 203.010 Embankment slope as shown. Back Slope 0.5H:1V	0.5



TABLE 3
SUMMARY OF SUBSOIL CONDITIONS AND APPLICABLE TREATMENT

PML SWAMP / HIGH FILL DESIGNATION	ALIGNMENT SECTION (STA. TO STA.)	FILL HEIGHT (m)	DEPTH TO COMPETENT SOIL (m)	DEPTH TO PROBABLE BEDROCK (m)	TYPICAL SOIL PROFILE	APPLICABLE TREATMENTS	
						TREATMENT METHOD ⁽¹⁾⁽²⁾	EXCAVATION DEPTH (m)
Area adjacent to Northgate Square Mall	15+850 to 15+950	7.0	N/A ⁽⁴⁾	3.3 (El. 206.4)	Fill over buried topsoil underlain by silty sand with gravel, mantling bedrock	N/A ⁽⁴⁾	N/A ⁽⁴⁾
105	14+900 to 15+000	On Cut 6.0	1.2 – 5.7	3.8 – >9.1 (El. <205.6 – 210.8)	Peat and sand underlain by discontinuous silty clay and silt deposits mantling probable bedrock	Swamp treatment not applicable to earth/rock cuts	1.2 – 5.7 ⁽⁵⁾
106	14+720 to 14+800	On Cut 4.0	0.1 – 0.6	2.8 – 4.3 (El. 216.0 – 217.4)	Peat underlain by sand that is locally underlain by silty sand till mantling probable bedrock	Swamp treatment not applicable to earth/rock cuts	0.6 ⁽⁵⁾
107	14+200 to 14+680	On Cut 4.0	0.0 – 1.4	0.0 – 3.1 (El. 218.0 – 223.5)	Peat underlain by sand that is locally underlain by clayey or sandy silt deposits mantling probable bedrock	Swamp treatment not applicable to earth/rock cuts	1.4 ⁽⁵⁾
E/W-N Ramp	At Highway 11 and Highway 17 I/C	5.0	0.0 – 6.5	0.0 – 8.2 (El. 202.8 – 209.7)	Peat or fill with boulders underlain by localized clayey silt and sand mantling probable bedrock and rock outcrops	OPSD 203.010 Embankment slope as shown ⁽³⁾ . Back Slope 1H:1V	6.5
S-W and W-N Ramps	At Highway 11 and Highway 17 I/C	2.0	0.0 – 2.3	0.0 – 5.0 (El. 204.0 – 209.4)	Fill with boulders or organic clayey silt underlain by discontinuous silty clay underlain by sandy silt and sand with gravel mantling probable bedrock	OPSD 203.010 Embankment slope as shown ⁽³⁾ . Back Slope 1H:1V	2.3



TABLE 3
SUMMARY OF SUBSOIL CONDITIONS AND APPLICABLE TREATMENT

PML SWAMP / HIGH FILL DESIGNATION	ALIGNMENT SECTION (STA. TO STA.)	FILL HEIGHT (m)	DEPTH TO COMPETENT SOIL (m)	DEPTH TO PROBABLE BEDROCK (m)	TYPICAL SOIL PROFILE	APPLICABLE TREATMENTS	
						TREATMENT METHOD ⁽¹⁾⁽²⁾	EXCAVATION DEPTH (m)
Chapais Street Extension	50 to 250 m north of Future Highway 11 / 17	Est. 6.0	> 2.1	< 2.1	Peat underlain by stiff clayey silt. Site is partially an open water swamp. Depth to bedrock estimated to be less than 10 m	OPSD 203.010 Embankment slope as shown ⁽³⁾ . Back Slope 1H:1V	> 2.1

Notes:

- (1) Embankment slope refers to minimum embankment slope below grade on OPSD-203.010.
- (2) Back slope refers to temporary slope in swamp excavation shown on OPSD-203.010.
- (3) Rockfill is recommended to backfill swamp excavations below the grade due to high water table.
- (4) Subject to Detail Design investigations the fill is considered suitable for reuse as part of the embankment fill.
- (5) Deeper excavations will be required to accommodate the design level of the highway platform



TABLE 4
SCOPE OF FOUNDATION SUBSURFACE INVESTIGATION FOR DETAIL DESIGN

STATIONS	REMARKS	EXISTING DATA	NO. OF TEST HOLES
Main Alignment From O'Brien Street to Highway 11 and Highway 17 Interchange			
13+820 to 14+020	Existing crossing of Chippewa Creek, up to 6 m fill	No data available	–
14+200 to 14+680	Low-lying swampy area, up to 4.0 m cut	Up to 3.1 m to bedrock	7
14+720 to 14+800	Low-lying swampy area, up to 4.0 m cut	Up to 4.3 m to bedrock	2
14+820 to 14+920	Up to 6 m deep cut	No data – outcrop	–
14+920 to 15+000	Low-lying swamp area, about 0.5 m fill	Up to 5.7 m to competent soil	2
15+000 to 15+200	Up to 6 m deep cut	No data – outcrop	–
15+200 to 15+420	Up to 9 m high fill	No data	–
15+500 to 15+800	Up to 9 m high fill	No data	–
15+850 to 15+950	Up to 7 m high fill, fill area at Northgate Square Mall	2.3 m of fill, 3.3 m to bedrock	1
15+950 to 16+020	Up to 12 m high fill	No data	–
16+080 to 16+180	Up to 12 m high fill, rock outcrop sections	0.3 m to bedrock	2
16+180 to 16+320	Up to 14 m high fill, Delaney Lake (Mud Lake) low-lying area	Up to 3.3 m to bedrock	2
16+490 to 16+600	Up to 8 m high fill, low-lying swampy area	Up to 2.0 m to bedrock	4
16+700 to 16+974; 19+216 to 19+190 (*)	Up to 6 m high fill, open water swamp	Up to 5.2 m to bedrock	6



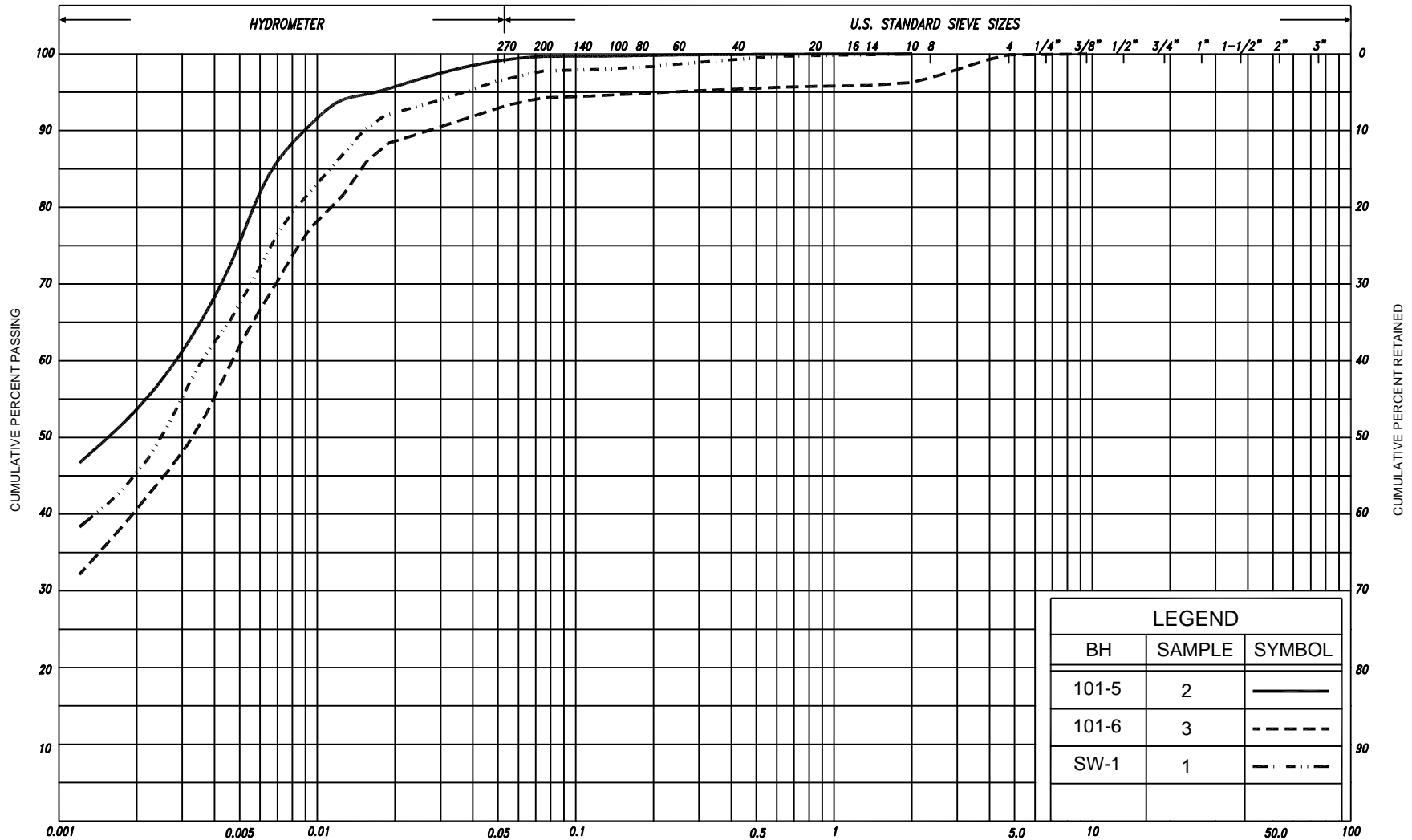
TABLE 4
SCOPE OF FOUNDATION SUBSURFACE INVESTIGATION FOR DETAIL DESIGN

STATIONS	REMARKS	EXISTING DATA	NO. OF TEST HOLES
Alignment of Chapais Street/Chippewa Street Extension			
50 to 250 m north of new mainline (toward Chapais Street end)	Low-lying partial open water/swampy area, estimated up to 6 m fill	Over 2.1 m of peat and clayey silt. Bedrock not found	1
Highway 11 and Highway 17 Interchange			
E/W-N Ramp	Open water swamp and existing fill section , up to 5 m high fill	Up to 8.2 m to bedrock	5
W-N and S-W Ramps	Low-lying swamp and existing fill sections, up to 2 m high fill	Up to 5.0 m to bedrock	4

Notes:

(*) Equation change: Station back 16+974.22 = Station ahead 19+215.96.

Foundation investigations are recommended for sections with proposed cuts equal or deeper than 4 m and fills higher than 6 m. In addition, all low-lying swampy areas are recommended for foundation investigation.



SILT & CLAY				FINE SAND			MEDIUM SAND		COARSE SAND	GRAVEL		COBBLES	UNIFIED
CLAY	SILT			FINE SAND			MEDIUM SAND			GRAVEL			M.I.T.
	SILT			V. FINE	FINE	MED.	COARSE	GRAVEL			COBBLES		U.S. BUREAU

GRAIN SIZE DISTRIBUTION

SILTY CLAY

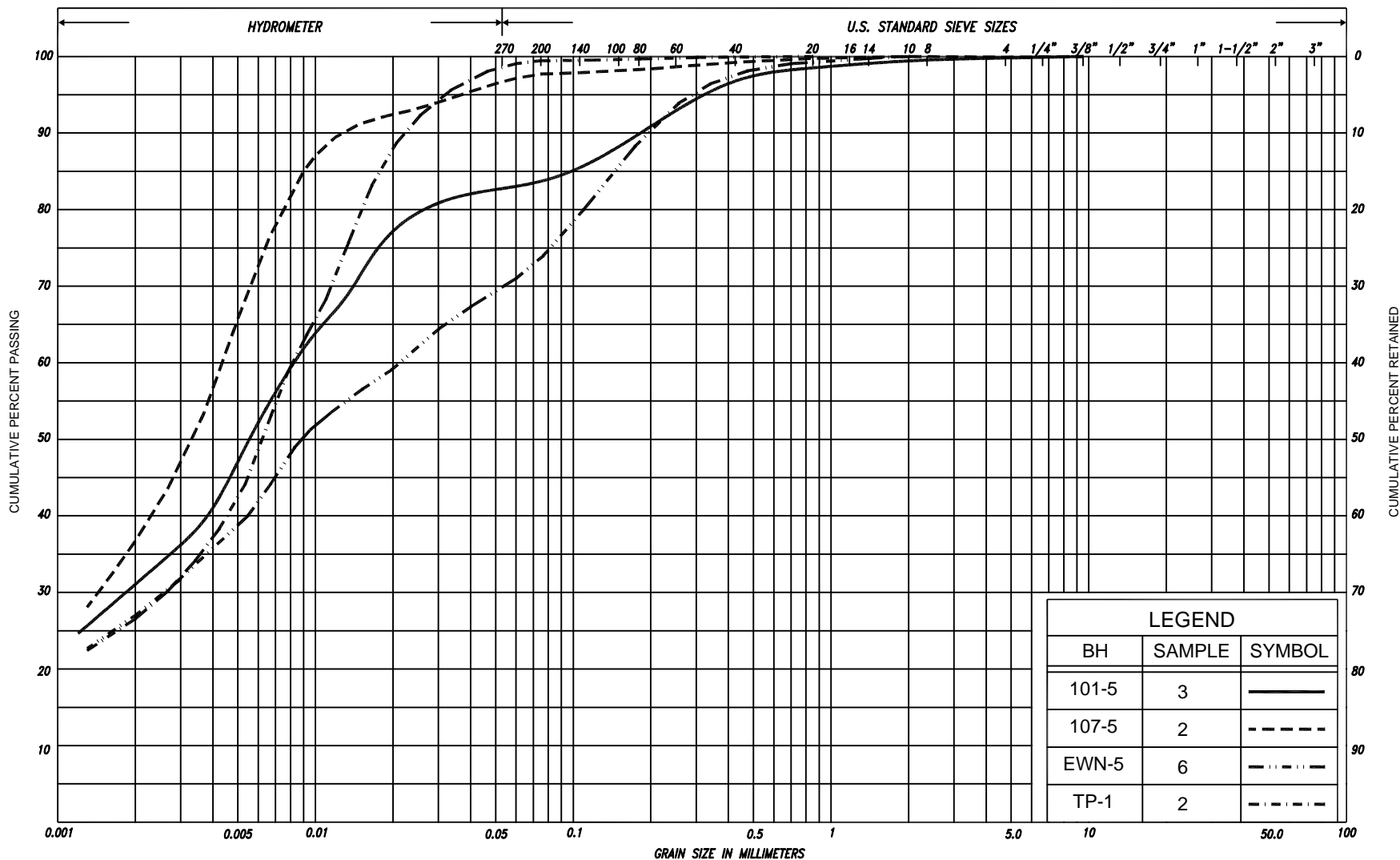


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FIG No. GS-1

HWY 11/17

G.W.P. No. 5748-04-00



SILT & CLAY					FINE		MEDIUM		COARSE		GRAVEL			COBBLES	UNIFIED		
					SAND												
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.
	SILT																
CLAY		SILT			V. FINE	FINE	MED.	COARSE		GRAVEL							U.S. BUREAU
					SAND												

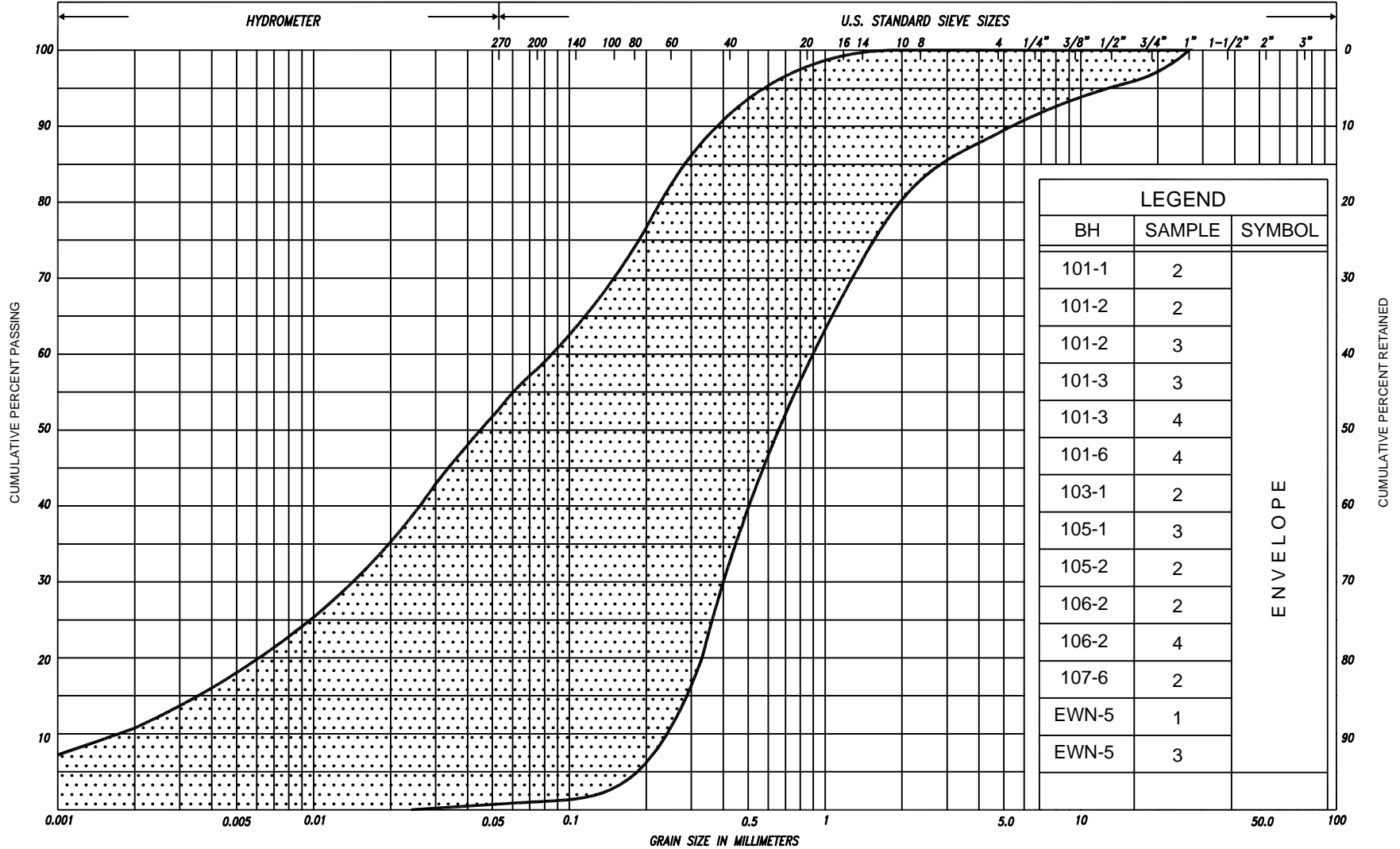
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace to with sand

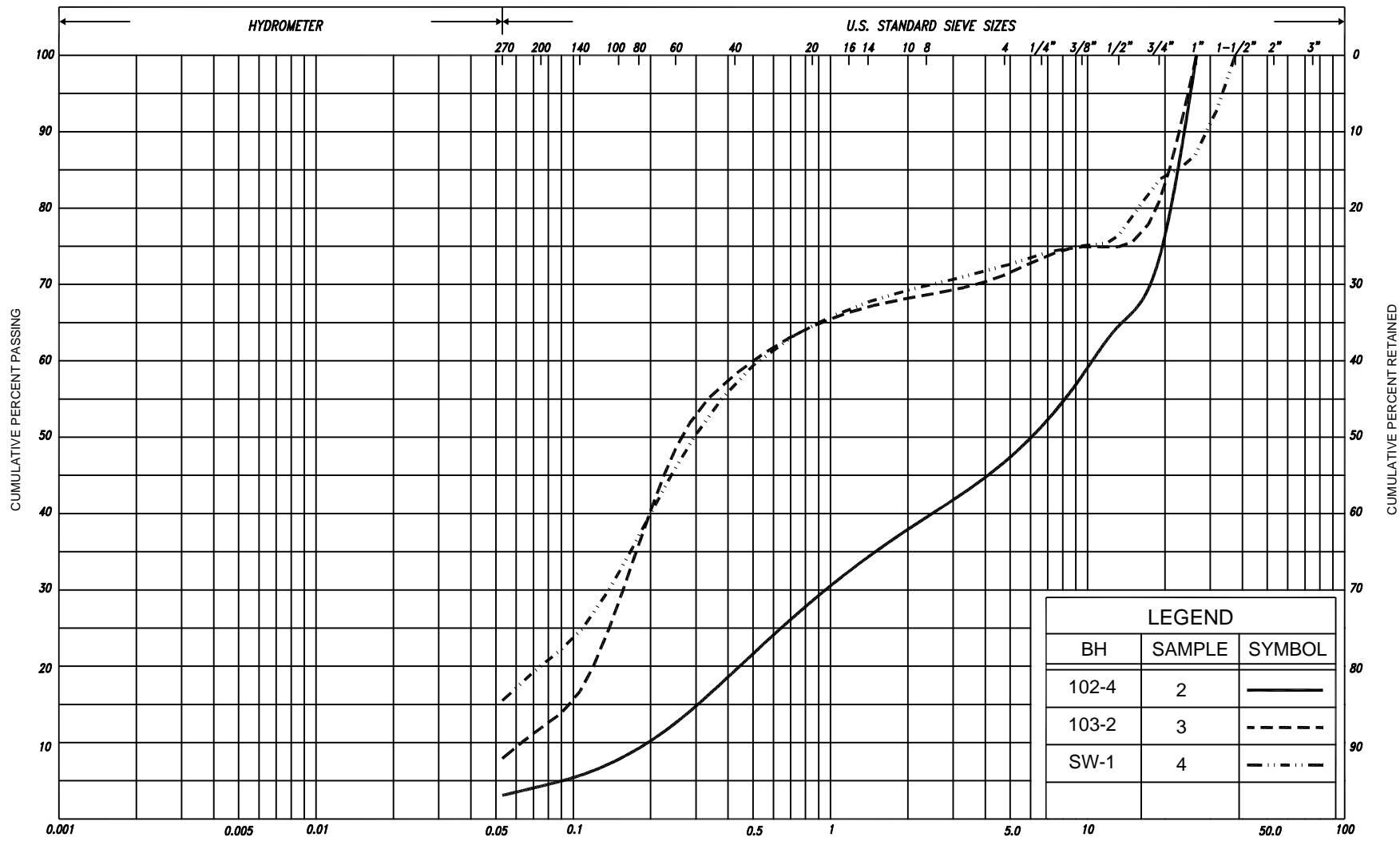
FIG No. GS-2

HWY 11/17

G.W.P. No. 5748-04-00



SILT & CLAY				FINE			MEDIUM			COARSE			GRAVEL		COB BLES	UNIFIED
CLAY				FINE			MEDIUM			COARSE			GRAVEL		COBBLES	M.I.T.
CLAY				SILT			V. FINE			FINE			MED.		COARSE	U.S. BUREAU

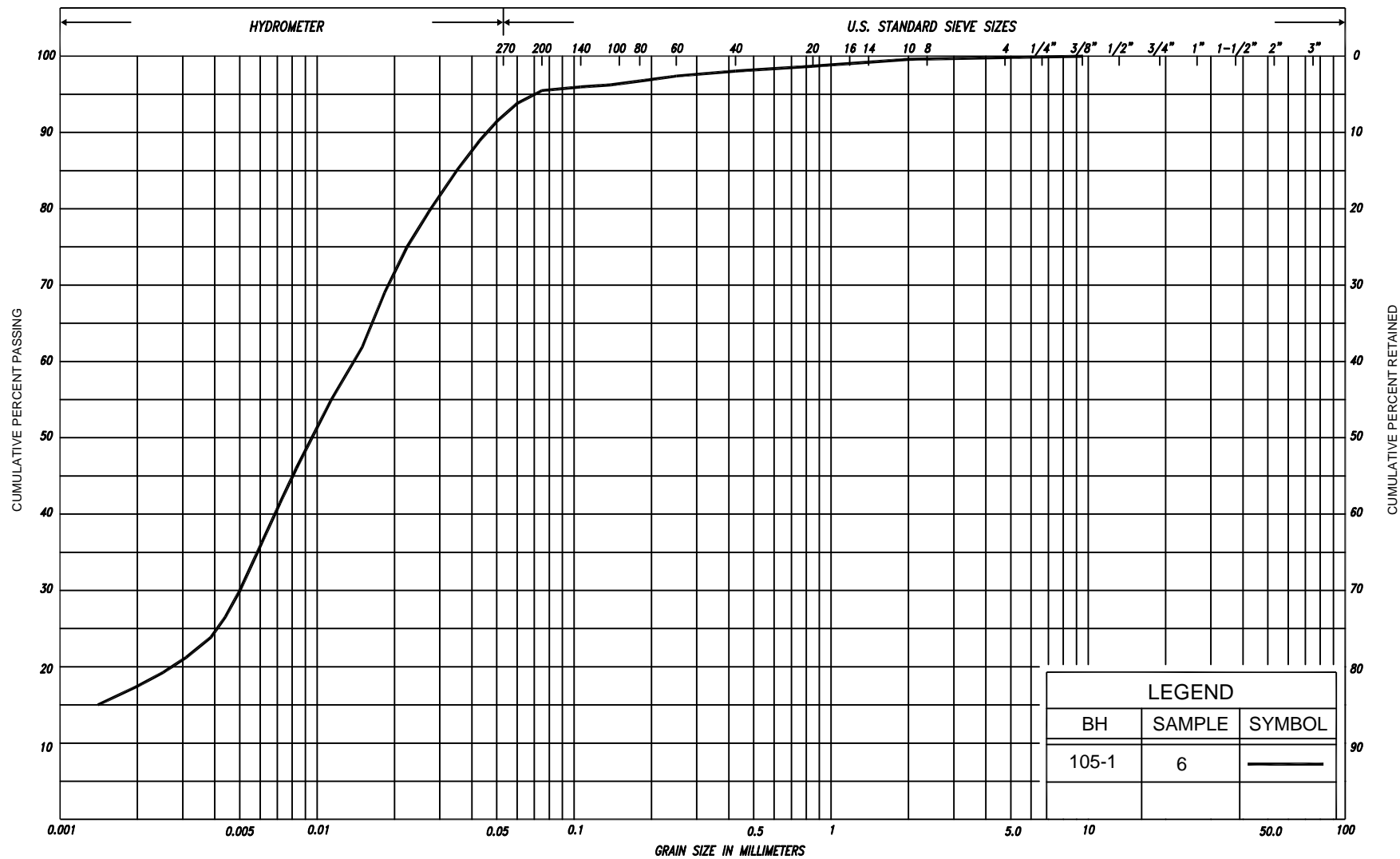


LEGEND		
BH	SAMPLE	SYMBOL
102-4	2	————
103-2	3	- - - - -
SW-1	4	- · - · - ·

SILT & CLAY				FINE			MEDIUM			COARSE			GRAVEL			COB BLES	UNIFIED		
				SAND															
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.		
	SILT						SAND												
CLAY		SILT				V. FINE	FINE	MED.	COARSE		GRAVEL							U.S. BUREAU	
						SAND													

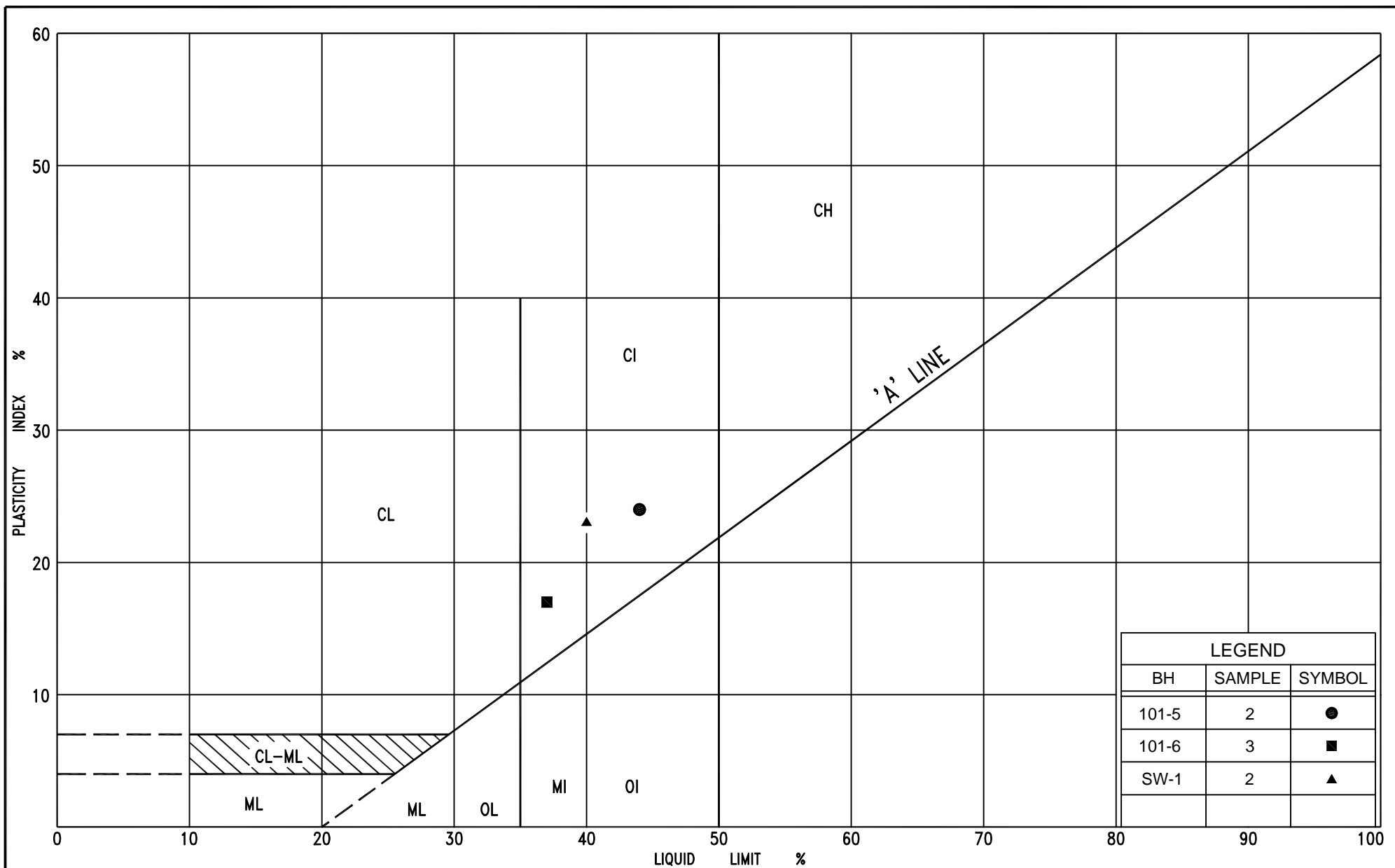
GRAIN SIZE DISTRIBUTION

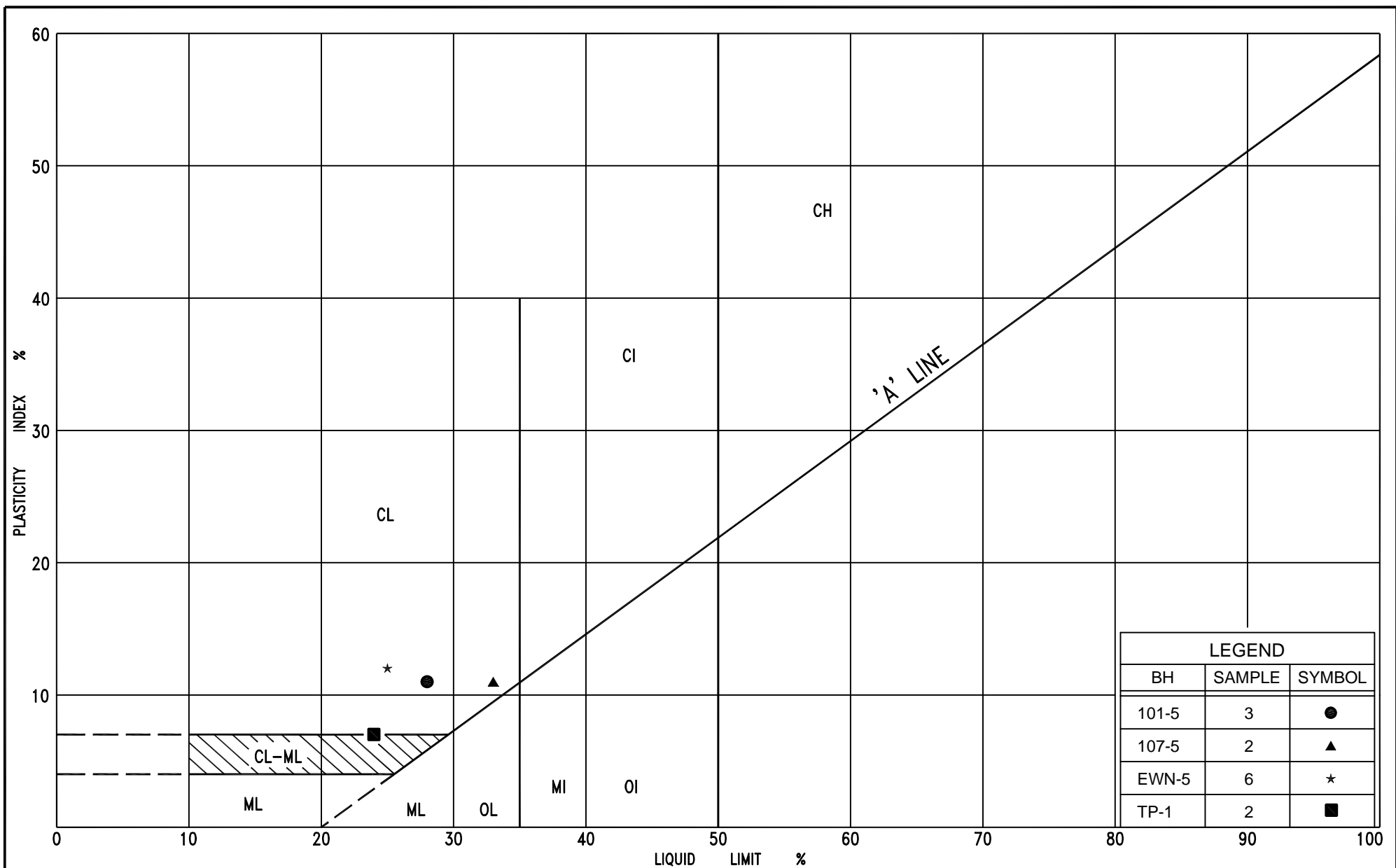
Sand and/or Gravel



LEGEND		
BH	SAMPLE	SYMBOL
105-1	6	—

SILT & CLAY				FINE		MEDIUM		COARSE		GRAVEL			COBBLES	UNIFIED		
				SAND												
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	M.I.T.
	SILT						SAND									
CLAY		SILT			V. FINE		FINE		MED.		COARSE		GRAVEL			U.S. BUREAU
					SAND											





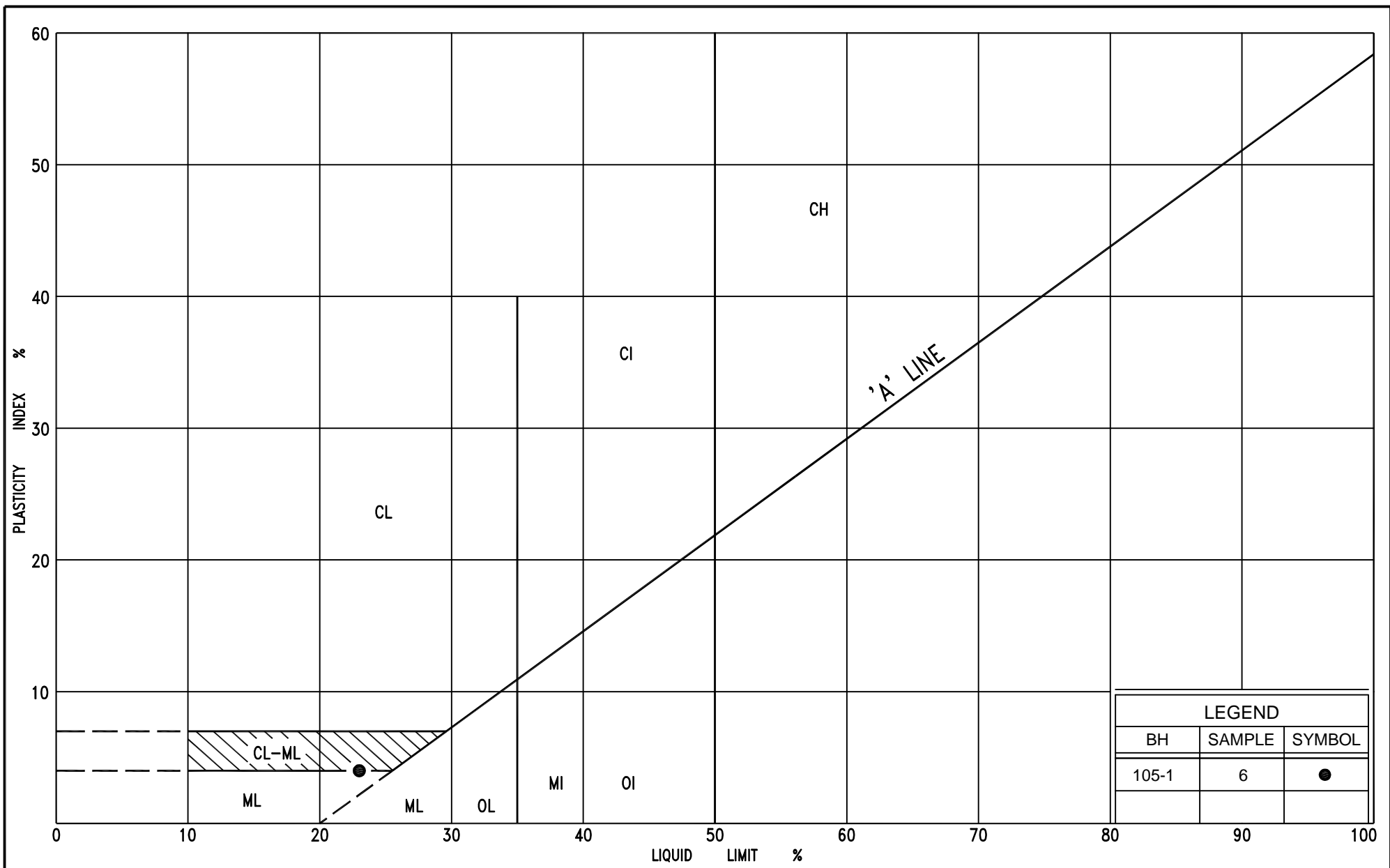
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PLASTICITY CHART
CLAYEY SILT, trace to with sand

FIG No. PC-2

HWY 11/17

G.W.P. No. 5748-04-00



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PLASTICITY CHART

SILT some clay trace sand, trace gravel

FIG No. PC-3

HWY 11/17

G.W.P. No. 5748-04-00

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
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 = $w_L - w_p$	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^2	SEEPAGE FORCE
e	1, %	VOID RATIO						

METRIC

20
15 — 5 (%) STRAIN AT FAILURE
10

METRIC


+⁷, ×⁵: Numbers refer to Sensitivity

20
15 — ○ — 5
10

(%) STRAIN AT FAILURE

METRIC

+⁷, ×⁵: Numbers refer to Sensitivity



(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 101-4

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 129 783 N; 309 939 E ORIGINATED BY N.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Tripod and Washboring COMPILED BY T.X.
 DATUM Geodetic DATE March 24, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
208.8	Top of Ice					▽*		20	40	60	80	100	20	40	60	kN/m ³	GR SA SI CL
0.0	Ice/water																
207.9							208										
0.9	Peat, fine fibrous																
207.6	Dark brown		1	SS	1												
1.2	Clayey silt																
207.1	thin layers of fine sand																
1.7	Very soft Grey Wet																
	End of borehole																
	Refusal on probable bedrock																

RECORD OF BOREHOLE No 101-5

1 of 1


METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 129 735 N; 309 999 E ORIGINATED BY N.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Tripod and Washboring COMPILED BY T.X.
 DATUM Geodetic DATE March 24, 2007 CHECKED BY C.N.

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									
208.9 0.0	Top of Ice Ice/water					▽*		20	40	60	80	100					GR SA SI CL
208.0 0.9	Peat, fine fibrous Dark brown		1	SS	2		208										0 1 45 54
207.7 1.2	Silty clay, trace sand layered		2	SS	1		207										
	Very soft Grey Wet						206										
205.7 3.2	Clayey silt some sand, trace gravel		3	SS	4												1 15 53 31
205.1 3.8	Soft Grey Wet End of borehole Refusal on probable bedrock																
	* 2007 03 24																
	▽ Water level observed during drilling																
	▽ Water level measured after drilling																

METRIC

+⁷, ×⁵: Numbers refer to Sensitivity



(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 102-1

1 of 1

METRIC

G.W.P.	5748-04-00	LOCATION	Co-ords: 5 130 190 N; 309 822 E	ORIGINATED BY	M.R.
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DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.

DATUM Geodetic DATE March 23, 2007 CHECKED BY C.N.

[illegible]

RECORD OF BOREHOLE No 102-2

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 130 155 N; 309 735 E ORIGINATED BY M.R.
DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
DATUM Geodetic DATE March 23, 2007 CHECKED BY C.N.

SOIL PROFILE				SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							GR	SA	SI	CL
211.0	Ground Surface																				
0.0	Bedrock at surface																				
	* Borehole dry																				

RECORD OF BOREHOLE No 102-3

1 of 1

METRIC




G.W.P. 5748-04-00 LOCATION Co-ords: 5 130 128 N; 309 841 E ORIGINATED BY M.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 23, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE																
212.5	Ground Surface							20	40	60	80	100												
0.0	Sand some silt, some gravel Compact Brown Moist		1	SS	10		212																	
211.3	(FILL)		2	SS	23/ 15cm																			
1.2	End of borehole Refusal on probable bedrock Sample 2: Sampler bouncing 																							

1 of 1

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _P	W	W _L		GR	SA	SI	CL
210.2 0.0	Ground Surface					* ▽* ▽*														
209.8 0.4	Ice																			
	Peat, fine fibrous																			
	Dark brown		1	SS	1															
208.9 1.3	Organic clayey silt																			
208.5 1.7	Soft Olive Moist																			
208.2 1.7	Soft brown		2	SS	27															
208.2 2.0	Sand and gravel, trace silt																			
	Compact Brown Wet																			
	End of borehole																			
	Refusal on probable bedrock																			
	* 2007 03 24 ▽ Water level observed during drilling ▽ Water level measured after drilling																			

RECORD OF BOREHOLE No 103-1										1 of 1		METRIC					
G.W.P. 5748-04-00		LOCATION Co-ords: 5 130 453 N; 309 714 E				ORIGINATED BY M.R.											
DIST Sudbury		HWY 11/17		BOREHOLE TYPE Continuous Flight Hollow Stem Augers				COMPILED BY T.X.									
DATUM Geodetic		DATE March 23, 2007				CHECKED BY C.N.											
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									
208.9	Ground Surface																
0.0	Sand, with silt trace clay, trace gravel	•	1	SS	35	 208											
	Dense _____ Brown _____ Wet _____ layers of sandy silt	•	2	SS	48												
207.2		•	3	SS	20/ 15cm												
1.7	End of borehole Refusal on probable bedrock																
	* 2007 03 24  Water level observed during drilling  Water level measured after drilling																

1 of 1

METRIC

Foundation Design


SOIL PROFILE						SAMPLES					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
205.0 0.0	Ground Surface Peat, fine fibrous Dark brown Frozen		1	AS	-	*	204	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	W _P W W _L WATER CONTENT (%)	kN/m³	GR SA SI CL
203.6 1.4	Sand with gravel some silt Compact Grey Wet to loose trace silt		2	SS	2		203			358 536	(12)
201.7 3.3	End of borehole Refusal on probable bedrock		3	SS	26		202				
	* Borehole dry		4	SS	8						
			5	SS	20/ 15cm						

RECORD OF BOREHOLE No 104-1

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 130 573 N; 309 667 E ORIGINATED BY M.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 23, 2007 CHECKED BY C.N.

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									
207.9	Ground Surface																
0.0	Boulders																
0.3	End of borehole Refusal on probable bedrock																
	* Borehole dry																

RECORD OF BOREHOLE No 104-2

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 130 462 N; 309 630 E ORIGINATED BY M.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 23, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p W W _L				WATER CONTENT (%)			
205.6	Ground Surface	•						20	40	60	80	100								
0.0	Boulders	•																		
0.3	End of borehole Refusal on probable bedrock	•																		
	* Borehole dry																			

RECORD OF BOREHOLE No 105-1

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 131 553 N; 309 134 E ORIGINATED BY M.R.
DIST Sudbury HWY 11/17 BOREHOLE TYPE C. F. H. S. A. + Dynamic Cone Penetration Test COMPILED BY T.X.
DATUM Geodetic DATE March 24, 2007 CHECKED BY C.N.

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									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
					WATER CONTENT (%)												
214.7	Ground Surface						20	40	60	80	100						
0.0	Peat, fine fibrous		1	SS	3								○				
0.1	Dark brown																
	Sand, trace silt																
	Compact Rusty Wet		2	SS	21								○				
	to loose brown																
			3	SS	8								○			0 99 (1)	
	Grey																
			4	SS	8								○				
210.7																	
4.0	Silty clay																
	Soft Grey Wet		5	SS	2									○			
209.0																	
5.7	Silt, some clay																
	trace sand, trace gravel																
	occ. thin layers of silty		6	SS	6											1 4 78 17	
	clay																
208.1	Loose Grey Wet												H ○				
6.6	End of borehole																
	Probable Silt some clay																
	Compact																
	to dense																
205.6																	
9.1	End of dynamic cone penetration test																
	C.F.H.S.A. denotes continuous flight hollow stem augers																
	Dynamic cone penetration test from 4.5m depth in borehole drilled 1.5m west of original hole.																
	* Borehole dry																

RECORD OF BOREHOLE No 105-2

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 131 553 N; 309 194 E ORIGINATED BY M.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 24 & 25, 2007 CHECKED BY C.N.

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										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						× LAB VANE		
214.6	Ground Surface							20	40	60	80	100								
0.0	Peat, fine fibrous with decayed wood Dark brown					▼*	214													
213.4			1	SS	5	▽*										327				
1.2	Sand, trace silt						213													
	Loose to Grey Wet compact		2	SS	4												0 94 (6)			
							212													
			3	SS	8															
							211													
210.8			4	SS	26															
3.8	End of borehole Refusal on probable bedrock																			
<div>* 2007 03 24 & 25</div> <div>▽ Water level observed during drilling</div> <div>▼ Water level measured after drilling</div>																				

METRIC



20
15 — 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 106-2

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 131 714 N; 309 056 E ORIGINATED BY M.R.
DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
DATUM Geodetic DATE March 24, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				w _p	w	w _L		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
WATER CONTENT (%)																
220.3	Ground Surface							20	40	60	80	100				
0.0	Peat, fine fibrous															
0.1	Dark brown		1	SS	3											
219.6	Sand, trace silt															
0.7	Compact Dark brown Wet		2	SS	18											
	Silty sand, trace clay															
	Compact Brown/ Wet															
	grey trace gravel		3	SS	20											
217.9	Silty sand															
2.4	some clay, trace gravel															
	Dense Grey Moist															
	(TILL)		4	SS	49											
216.0	End of borehole															
4.3	Refusal on probable bedrock															
* 2007 03 24																
 Water level observed during drilling																
 Water level measured after drilling																

* 2007 03 24

▽ Water level observed during drilling

▼ Water level measured after drilling

RECORD OF BOREHOLE No 107-1

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 131 775 N; 308 9346 E ORIGINATED BY M.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 25, 2007 CHECKED BY C.N.

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

RECORD OF BOREHOLE No 107-1A

1 of 1


METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 131 791 N; 308 907 E ORIGINATED BY M.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 25, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
221.5	Ground Surface					*		20	40	60	80	100	20	40	60					
0.0	Peat, fine fibrous						221													
	Dark brown																			
220.4			1	SS	WH**											665				
1.1	End of borehole																			
	Refusal on probable bedrock																			
	* Borehole dry																			
	WH** Denotes penetration due to weight of rods and hammer																			

METRIC

+⁷, ×⁵: Numbers refer to Sensitivity



(%) STRAIN AT FAILURE

METRIC

ON_MOT VER3 05TF058.GPJ ON_MOT.GDT 11/6/2007 12:31:34 PM

20
15 — 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 107-6

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 131 950 N; 308 525 E ORIGINATED BY M.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 25, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
221.1	Ground Surface							20	40	60	80	100						
0.0	Peat, fine fibrous Dark brown		1	SS	11		221											
0.3	Sand some silt, trace gravel Compact Brown Wet																	
219.3	Silt, with sand		3	SS	14		220											
1.8	Compact Light Wet brown						219											
218.0							218											
3.1	End of borehole Refusal on probable bedrock																	
<div>* 2007 03 25</div> <div> Water level observed during drilling</div> <div> Water level measured after drilling</div>																		

RECORD OF BOREHOLE No EWN-1

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 129 882 N; 309 914 E ORIGINATED BY N.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 22, 2007 CHECKED BY C.N.

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									
209.7	Ground Surface							20	40	60	80	100					
0.0	Bedrock at surface																
	* Borehole dry																

1 of 1

METRIC

Foundation Design

SOIL PROFILE						SAMPLES			<div>GROUND WATER CONDITIONS</div>	<div>ELEVATION SCALE</div>	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	<div>UNIT WEIGHT</div> <div>γ</div> <div>kN/m³</div>	REMARKS & GRAIN SIZE DISTRIBUTION (%) <div>GR SA SI CL</div>	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)						
209.0 0.0	Top of Ice Ice and water																
208.1 0.9	Peat, fine fibrous rock fragments		1	SS	WH**												
207.5 1.5	Dark brown End of borehole Refusal on probable boulder																
<div>* 2007 03 24</div> <div><div>▽</div> Water level observed during drilling</div> <div><div>▼</div> Water level measured after drilling</div> <div>WH** Denotes penetration under weight of rods and hammer</div>																	

RECORD OF BOREHOLE No EWN-3

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 129 755 N; 310 104 E ORIGINATED BY M.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 22, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR
214.3	Ground Surface							20	40	60	80	100								
0.0	Fine to coarse sand with gravel, trace silt cobbles						214													
	Compact Dark Dry brown		1	SS	18		213													
			2	SS	50/0cm															
	_____						212													
	Wet																			
	(FILL)		3	SS	28															
211.3																				
3.0	End of borehole																			
	Refusal on probable boulder																			
	Sample 2: Sampler bouncing																			
	Borehole moved 1.5m west - Refusal at 1.5m depth																			
	* Borehole dry																			

RECORD OF BOREHOLE No EWN-4

1 of 1

METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 129 662 N; 310 212 E ORIGINATED BY M.R.
 DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
 DATUM Geodetic DATE March 22, 2007 CHECKED BY C.N.

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									
214.1 0.0	Ground Surface Sand, some silt						214	20	40	60	80	100					
213.5 0.6	Compact Brown/ Moist grey (FILL) End of borehole Refusal on probable boulder Borehole moved 1.0m west - Refusal at 0.5m depth * Borehole dry																

RECORD OF BOREHOLE No EWN-5

1 of 1




METRIC

G.W.P. 5748-04-00 LOCATION Co-ords: 5 129 539 N; 310 276 E ORIGINATED BY M.R.
DIST Sudbury HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY T.X.
DATUM Geodetic DATE March 22, 2007 CHECKED BY C.N.





SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _P	W	W _L		WATER CONTENT (%)	GR	SA	SI
211.0 0.0	Ground Surface Sand some silt, trace gravel Compact Grey Dry																			
			1	SS	28							○					9	76	(15)	
			2	SS	66							○								
	————— Mottled brown/grey		3	SS	27							○					6	74	(20)	
			4	SS	54							○								
	————— Mottled dark brown/ black																			
	(FILL)		5	SS	75							○								
205.3 5.7	Clayey silt with sand, trace gravel																			
204.5 6.5	Very stiff Brown Wet		6	SS	44							○					0	26	47 27	
	Sand with silt, trace gravel																			
	Dense to Grey/ Moist compact brown																			
202.8 8.2	End of borehole Refusal on probable bedrock		7	SS	23							○								
	 <																			

RECORD OF BOREHOLE No SW-1										1 of 1		METRIC	
G.W.P. 5748-04-00		LOCATION Co-ords: 5 129 668 N; 310 020 E				ORIGINATED BY M.R.							
DIST Sudbury		HWY 11/17		BOREHOLE TYPE Continuous Flight Hollow Stem Augers				COMPILED BY T.X.					
DATUM Geodetic		DATE March 22, 2007				CHECKED BY C.N.							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa	W _p	W	W _L	γ	GR SA SI CL
209.0	Top of Ice												
0.0	Ice												
0.2	Organic clayey silt												
	Soft Dark Wet brown												
208.0			1	SS	3		208						0 2 53 45
1.0	Silty clay, trace sand layered occ. silt partings												
	Soft Brown/ Wet grey		2	SS	3		207						
207.0													
2.0	Sandy silt, some gravel												
	Compact Grey Wet		3	SS	27		206						
206.1													
2.9	Sand with gravel some silt, trace clay						206						
	Compact Grey Wet to very dense		4	SS	19		205						28 52 (20)
204.0													
5.0	End of borehole		5	SS	67/ 25cm		204						
	Refusal on probable bedrock												
<p>* 2007 03 22</p> <p>▽ Water level observed during drilling</p> <p>▼ Water level measured after drilling</p>													

RECORD OF BOREHOLE No SW-2										1 of 1		METRIC					
G.W.P. 5748-04-00		LOCATION Co-ords: 5 129 559 N; 310 161 E				ORIGINATED BY M.R.											
DIST Sudbury		HWY 11/17		BOREHOLE TYPE Continuous Flight Hollow Stem Augers				COMPILED BY T.X.									
DATUM Geodetic		DATE March 22, 2007				CHECKED BY C.N.											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					W _p W W _L			γ	GR SA SI CL
							20 40 60 80 100	○ UNCONFINED	+	FIELD VANE	20 40 60 80 100	WATER CONTENT (%)					
209.4	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

RECORD OF BOREHOLE No WN-1										1 of 1		METRIC					
G.W.P. 5748-04-00		LOCATION Co-ords: 5 129 532 N; 310 193 E				ORIGINATED BY M.R.											
DIST Sudbury		HWY 11/17		BOREHOLE TYPE Excavator				COMPILED BY T.X.									
DATUM Geodetic		DATE April 30, 2007				CHECKED BY C.N.											
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									
207.2	Ground Surface						20	40	60	80	100						
0.0	Sand with gravel trace silt					207											
206.6	Dark brown (FILL) Wet																
0.6	End of test pit																
	Refusal on probable bedrock																
	Test pit excavated in ditch 1.2m deep																
	* 2007 04 30																
	 Water level observed after drilling																

RECORD OF BOREHOLE No WN-2										1 of 1		METRIC					
G.W.P. 5748-04-00		LOCATION Co-ords: 5 129 612 N; 310 196 E				ORIGINATED BY M.R.											
DIST Sudbury		HWY 11/17		BOREHOLE TYPE Continuous Flight Hollow Stem Augers				COMPILED BY T.X.									
DATUM Geodetic		DATE March 22, 2007						CHECKED BY C.N.									
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									
213.4	Ground Surface		1	SS	50/15cm		20	40	60	80	100						
0.0	Sand with silt, with gravel boulders occ. pieces of plastic (PVC) Compact Brown Wet (FILL)		2	SS	17												
			3	SS	50/5cm												
211.1	End of borehole Refusal on probable boulders Samples 1 and 3: sampler bouning * 2007 03 22 ▽ Water level observed during drilling																

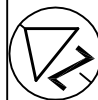
<div style="display: flex; justify-content: space-between;"> RECORD OF BOREHOLE No TP 1 1 of 1 METRIC </div>											
G.W.P. 5748-04-00		LOCATION Co-ords. 5 131 937 N; 309 066 E.				ORIGINATED BY M.R.					
DIST Sudbury		HWY 11/17		BOREHOLE TYPE Excavator		COMPILED BY T.X.					
DATUM Geodetic		DATE April 30, 2007				CHECKED BY C.N.					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L		
220.0	Ground Surface										
0.0	Peat, coarse fibrous		1	CS	-						
	Dark brown										
219.4	Clayey silt, trace sand										
0.6	Stiff Grey Wet		2	CS	-						
217.9											
2.1	End of borehole										
Test pit dug on proposed embankment location of Chapais Street extension Note: co-ordinates were estimated from site plans * 2007 04 30  Water level observed during drilling  Water level measured after drilling											

METRIC

20
15 — 5 (%) STRAIN AT FAILURE
10

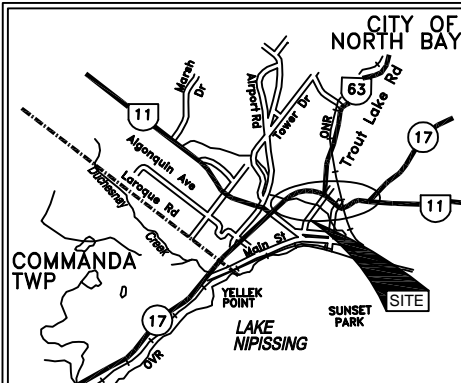
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 5748-04-00
FUTURE HIGHWAY 11/17
STA. 13+300 TO 15+000
BOREHOLE LOCATIONS



SHEET

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE
2 0 2 4 6 km

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-April 2007
- Location, Number and Direction of Photograph

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
105-1	214.7	5 131 553	309 134
105-2	214.6	5 131 553	309 194
106-1	220.2	5 131 746	309 021
106-2	220.3	5 131 714	309 056
107-1	223.5	5 131 775	308 946
107-1A	221.5	5 131 791	308 907
107-2	221.0	5 131 782	308 849
107-3	223.1	5 131 842	308 806
107-4	220.7	5 131 850	308 723
107-5	220.1	5 131 884	308 624
107-6	221.1	5 131 950	308 525
TP-1	220.0	5 131 937	309 066

(Legend Continues)

- NOTE -

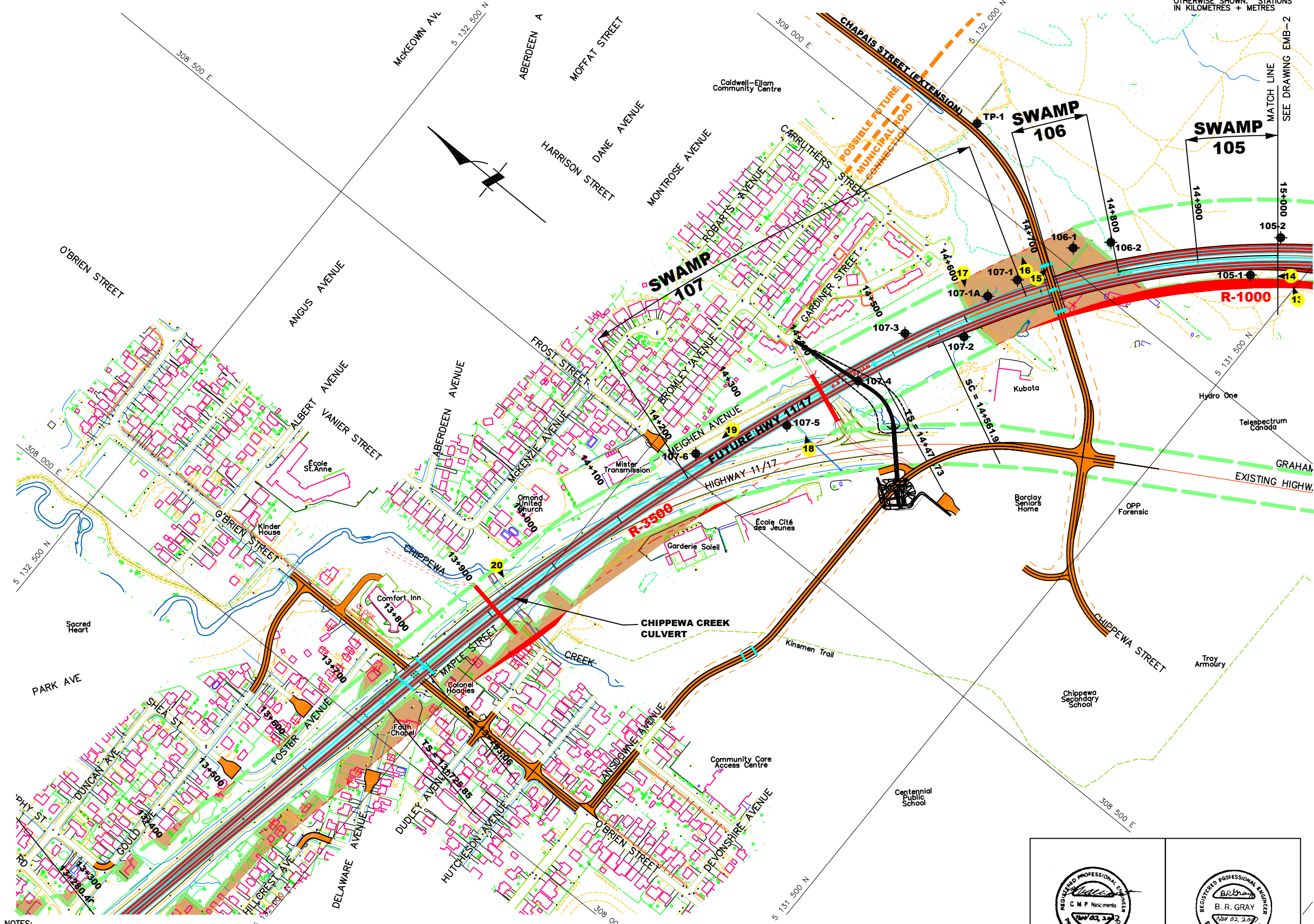
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 31L-119

HWY No	11/17	DIST	SUDBURY
SUBM'D	MR	CHECKED	CN
DRAWN	NA	CHECKED	CN
DATE	NOV. 02, 2007	APPROVED	BRG
SITE	--	DWG	EMB-1

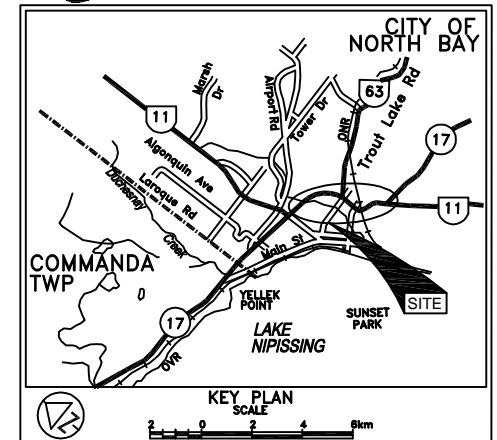
REF No.: STANTEC DRAWING: 580_Preferred_Plan_Foundations.dwg
dated April 09, 2007



- NOTES:
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
 - COORDINATES AT BOREHOLE LOCATIONS WERE PROVIDED BY DEL BOSCO SURVEYING LTD.
 - COORDINATES OF TEST PIT TP-1 ARE APPROXIMATE.

PLAN
SCALE
50 0 50 100m





- 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 2007
 - Location, Number and Direction of Photograph

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
102-1	211.5	5 130 190	309 822
102-2	211.0	5 130 155	309 735
102-3	212.5	5 130 128	309 841
102-4	210.2	5 130 079	309 789
103-1	208.9	5 130 453	309 714
103-2	205.0	5 130 319	309 691
104-1	207.9	5 130 573	309 667
104-2	205.6	5 130 462	309 630
TP-2	209.7	5 130 732	309 527

(Legend Continues)

- NOTE -

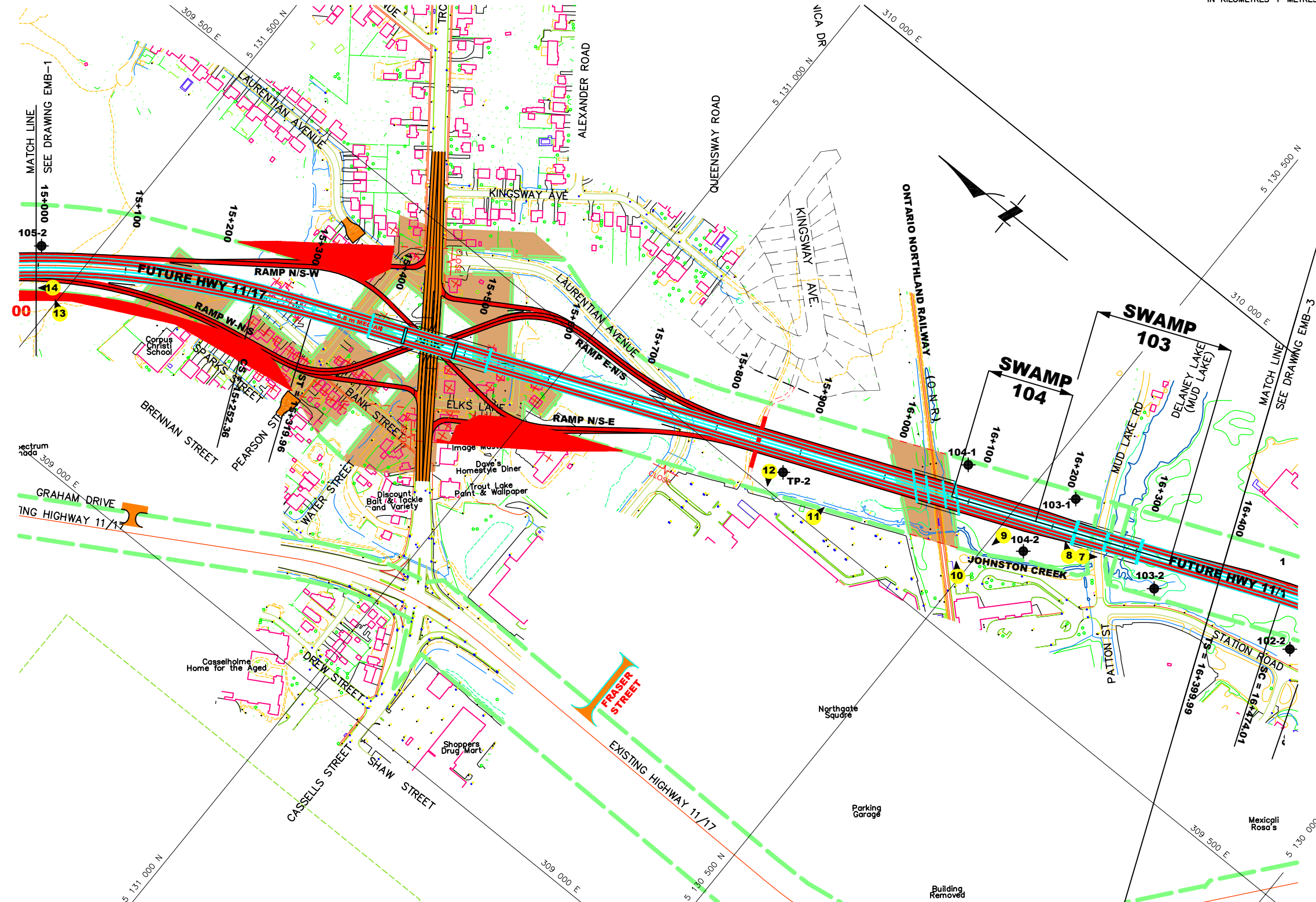
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 31L-119

HWY No	11/17	DIST	SUDBURY
SUBM'D	MR	CHECKED	CN
DATE	NOV. 02, 2007	SITE	--
DRAWN	NA	CHECKED	CN
APPROVED	BRG	DWG	EMB-2

REF No.: STANTEC DRAWING: 580_Preferred_Plan_Foundations.dwg
dated April 09, 2007



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- COORDINATES OF TEST PIT TP-2 ARE APPROXIMATE.

METRIC

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

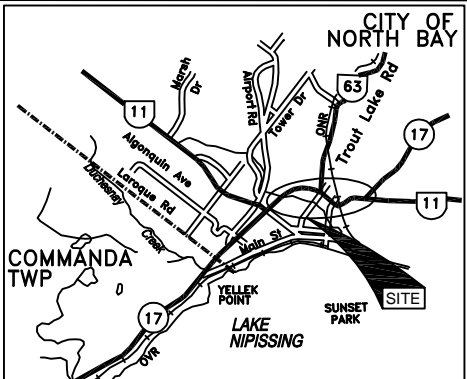
CONT No
GWP No 5748-04-00

FUTURE HIGHWAY 11/17
STA. 16+600 TO 16+974 AND
STA. 19+216 TO 18+200
BOREHOLE LOCATIONS



SHEET

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE
0 2 4 6 km

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 2007
- Location, Number and Direction of Photograph

BH No	ELEVATION	COORDINATES	
		NORTHINGS	EASTINGS
101-1	209.8	5 129 966	309 886
101-2	208.8	5 129 903	309 849
101-3	209.0	5 129 810	309 881
101-4	208.8	5 129 783	309 939
101-5	208.9	5 129 735	309 999
101-6	210.6	5 129 657	309 984
EWN-1	209.7	5 129 882	309 914
EWN-2	209.0	5 129 799	309 984
EWN-3	214.3	5 129 755	310 104
EWN-4	214.1	5 129 662	310 212
EWN-5	211.0	5 129 539	310 276
SW-1	209.0	5 129 668	310 020
SW-2	209.4	5 129 559	310 161
WN-1	207.2	5 129 532	310 193
WN-2	213.4	5 129 612	310 196

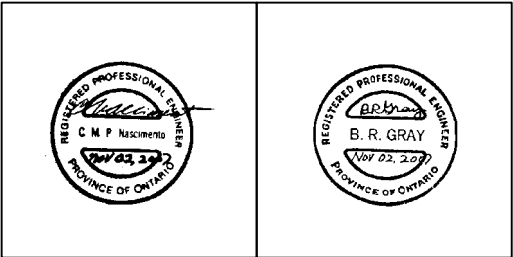
NOTE

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 31L-119

HWY No	11/17	DIST	SUDBURY
SUBM'D	MR	CHECKED	CN
DATE	NOV. 02, 2007	SITE	--
DRAWN	NA	CHECKED	CN
APPROVED	BRG	DWG	EMB-3



REF No.: STANTEC DRAWING: 580_Preferred_Plan_Foundations.dwg
dated April 09, 2007

- NOTES:
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 - COORDINATES AT BOREHOLE LOCATIONS WERE PROVIDED BY DEL BOSCO SURVEYING LTD.

PLAN
SCALE
0 50 100m



APPENDIX A

Site Photographs

(Note: Orientations noted on these photographs refer to the true geographic directions. The location and direction of the photograph views are indicated on Drawings EMB-1, EMB-2 and EMB-3)



Photograph 1 (Sta. 16+920) (Zoom View): Looking southerly from east of Highway 11/17 (in foreground). Existing Highway 11 and Highway 17 interchange structure is to be widened. Rock outcrops occur at the median and east sides of Highway 11 and are visible under the bridge. View of swamp vegetation was captured at bottom of photograph. (September 14, 2005)



Photograph 2 (Sta. 16+900): Looking easterly from Travelodge parking lot at area of proposed Future Highway 11/17 alignment through existing interchange structure and over open water swamp 101. (September 14, 2005)



Photograph 3 (Sta. 16+900): Looking east across bedrock outcrops and open water swamp 101 at existing bouldery fill. Sections of the proposed E/W-N and S-W ramps cross over the fill. (September 14, 2005)



Photograph 4 (Sta. 16+780): Looking east across open water at north end of swamp 101. Note bouldery fill pad beyond edge of water. (September 14, 2005)



Photograph 5 (Sta. 16+560): Looking east across swamp 102 south of Seymour Street from outcrop at edge of Esso Gas Station. Parking lot beyond swamp is on bouldery fill pad. (June 19, 2007)



Photograph 6 (Sta. 16+560): Looking northerly at narrow swamp 102 area north of Seymour Street. (June 19, 2007)



Photograph 7 (Sta. 16+250): Looking southerly across Mud Lake Road end of Delaney Lake (Mud Lake) and at prominent rock outcrop on the Future Highway 11/17 alignment. Embankment likely splays over swamp 103 located west of the outcrop. (June 19, 2007)



Photograph 8 (Sta. 16+220): Looking northeasterly across typical bedrock outcrops and shallow soil cover north of Mud Lake Road (swamp 103). (June 19, 2007)



Photograph 9 (Sta. 16+160): Looking west at ONR station (behind trees) from east of Johnston Creek. Note typical bedrock outcrop at west side of swamp 104. (June 19, 2007)



Photograph 10 (Sta. 16+100): Looking northeasterly along ONR tracks from east end of passenger platform. The Future Highway 11/17 will cross the tracks near the start of the siding rail tracks at centre of photograph. (June 19, 2007)



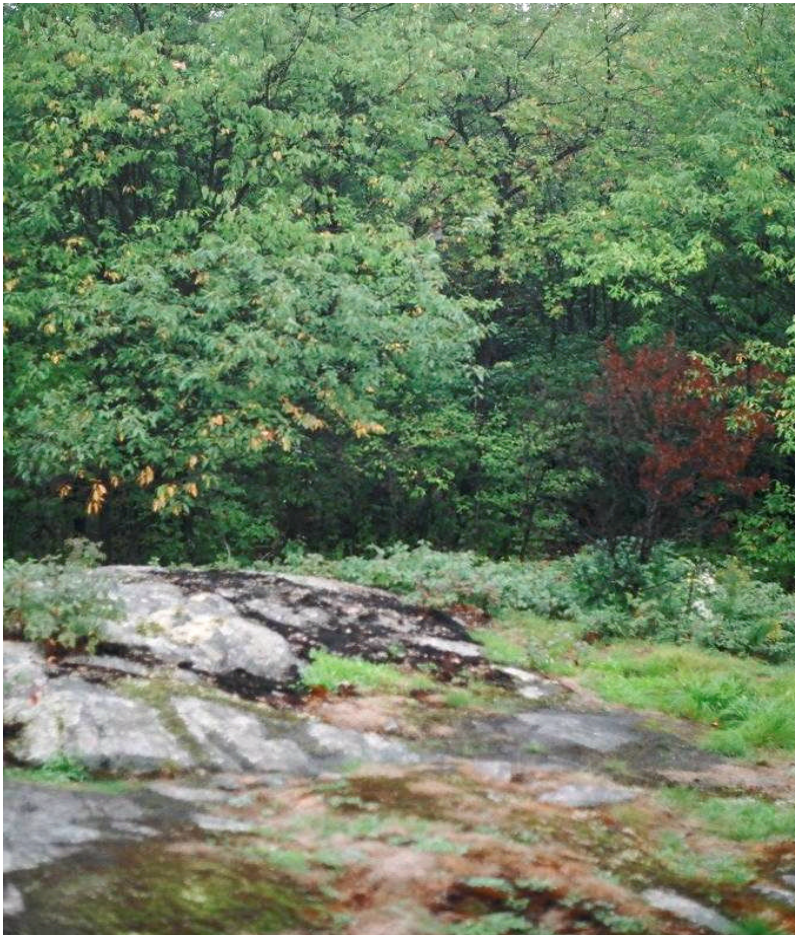
Photograph 11 (Sta. 15+950): Looking southeasterly at ONR embankment from east edge of Northgate Square Mall parking lot with the Johnston Creek in the foreground. The Future Highway 11/17 will cross the ONR at the left of photograph (near hydro pole behind trees). (June 19, 2007)



Photograph 12 (Sta. 15+850): Looking westerly at Northgate Square Mall from top of fill stockpile. Note asphalt pieces at ground surface in foreground. (June 19, 2007)



Photograph 13 (Sta. 15+030): Looking northerly from bedrock outcrops at low area between bedrock outcrop ridges. Terrain is typical of swamp 105. (September 14, 2005)



Photograph 14 (Sta. 15+510): Looking northwesterly at low-lying area between rock outcrops near swamp 105. (September 14, 2005)



Photograph 15 (Sta. 14+680): Looking easterly from top of extensive bedrock outcrop along fence of Hydro One property. Swamp 106 beyond corner of fence. (September 14, 2005)



Photograph 16 (Sta. 14+680): Looking northeasterly from rock outcrop north of Hydro One property. Trees cover extensive low-lying area along proposed Chapais Street extension. (September 14, 2005)



Photograph 17 (Sta. 14+600): Looking southwesterly from south end of Carruthers Street. The Future Highway 11/17 corridor will cross near the pedestrian location. Note thick bush through ravine, along south section of swamp 107. (November 4, 2004)



Photograph 18 (Sta. 14+340): Looking northerly from north shoulder of existing Highway 11/17 west of Meighen Avenue at swampy area near corridor of Future Highway 11/17 (swamp 107). (November 4, 2004).



Photograph 19 (Sta. 14+250): Looking west from east of Frost Street. (O'Brien Street intersection in the distance). B.R. Gray standing near northwest end of swamp 107. (November 4, 2004)

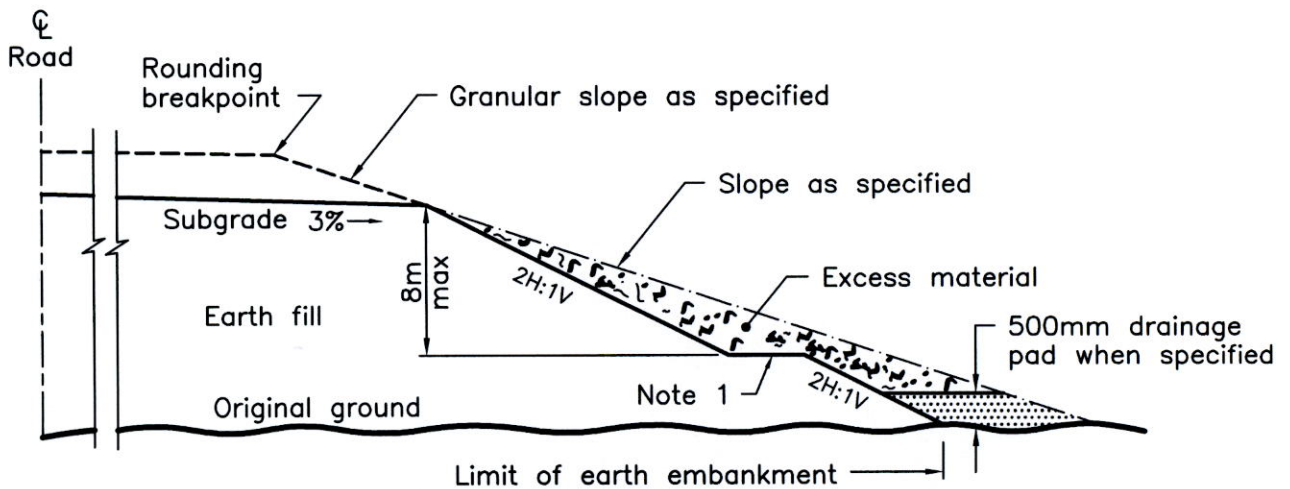


Photograph 20 (Sta. 13+930): Looking south at north end of the Chippewa Creek culvert. Note existing Highway 11/17 embankment and gabion baskets over top of culvert. (November 4, 2004)

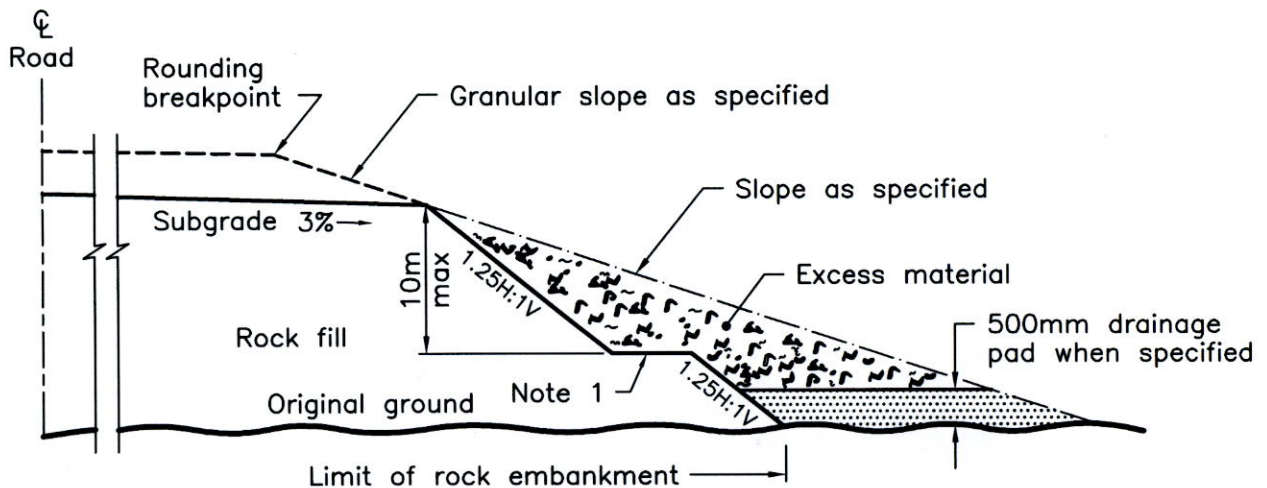


APPENDIX B

Ontario Provincial Standard Drawings
OPSD-202.010 and OPSD-203.010



EARTH EMBANKMENT



ROCK EMBANKMENT

NOTES:

- 1 Benches 2 metres minimum in width are required along slopes at maximum vertical intervals as shown.
- A Height of fill is the vertical difference between top of subgrade and top of original ground measured at new road centreline.
- B Excess material placed shall not extend beyond the right-of-way.
- C All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING

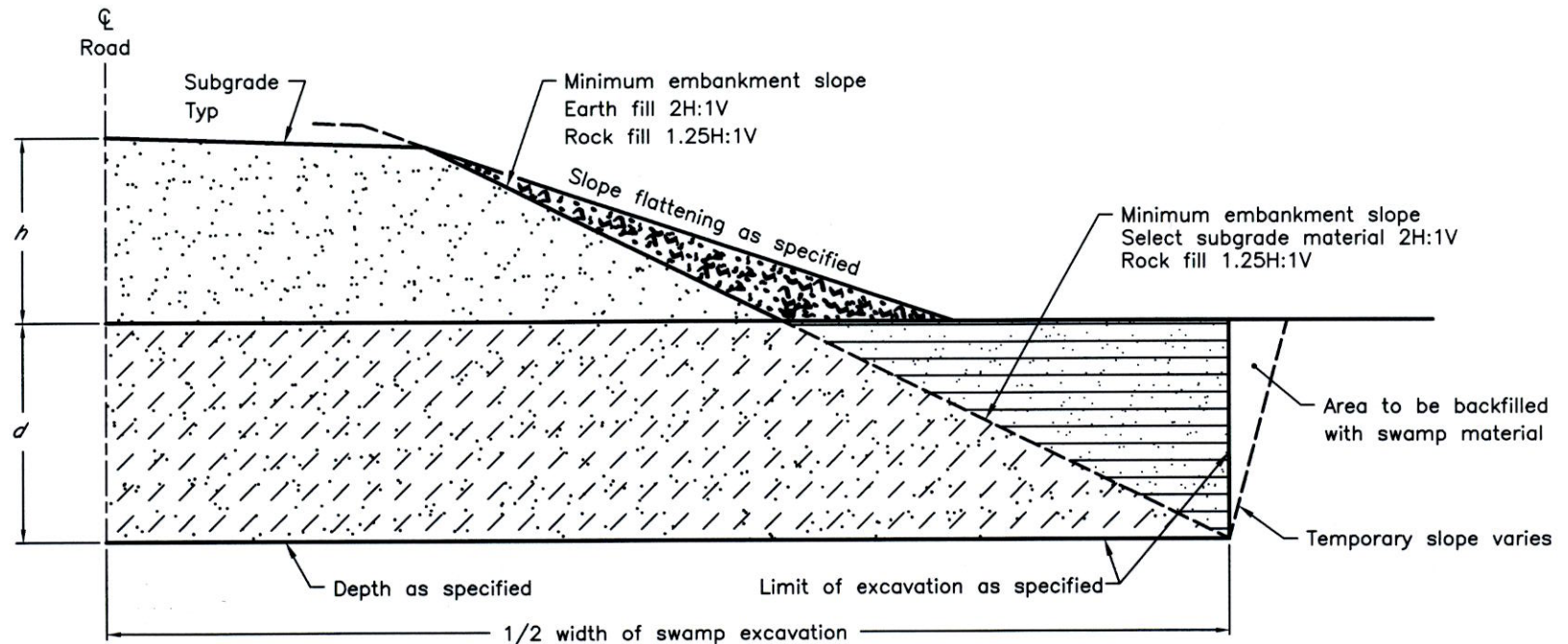
Nov 2005

Rev 1

**SLOPE FLATTENING
USING EXCESS MATERIAL
ON EARTH OR ROCK EMBANKMENT**

OPSD - 202.010





NOTES:

- A For this OPSD, h must be $\leq 4.5\text{m}$ and d must be $\leq 6.0\text{m}$.
- B Height of fill is the vertical difference between top of subgrade and top of swamp elevation measured at new road centreline.
- C For divided roads with median $< 10\text{m}$, excavate swamp material full width.
- D For divided roads with median $\geq 10\text{m}$, excavate swamp material to limits as specified.
- E All dimensions are in millimetres unless otherwise shown.

LEGEND:

- Embankment materials as specified
- Excavated swamp material
- Excavate and backfill as specified
- Excavate and backfill with swamp material

h - Height of fill
 d - Depth of sub-excavation

ONTARIO PROVINCIAL STANDARD DRAWING

Nov 2005 Rev 2

EMBANKMENTS OVER SWAMP

NEW CONSTRUCTION

OPSD - 203.010

