



**FINAL
GEOTECHNICAL INVESTIGATION REPORT
225 HUNTMAR DRIVE
OTTAWA, ONTARIO**

**Enterprise Holdings
2300 Stevenage Drive
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1 INTRODUCTION

DST Consulting Engineers Inc. (DST) was retained by Enterprise Holdings (Enterprise) to conduct a geotechnical investigation for the proposed commercial development located on the currently vacant parcel of land at 225 Huntmar Drive in Ottawa, Ontario. The geotechnical investigation was completed in general accordance with the work plan described in DST's proposal dated January 7, 2016 (DST Reference No. TS-SO-022154). Authorization to proceed with this investigation was provided by Mr. Ryan Firlotte of Enterprise Holdings.

DST completed a Phase II Environmental Site Assessment (ESA) of the site in conjunction with this geotechnical investigation. The results of the Phase II ESA are reported under separate cover.

This report is prepared for the sole use of Enterprise and any use of the report, or any reliance on it by any other party, is the responsibility of such party.

This geotechnical engineering report is subject to the limitations shown in Appendix A.

2 PROJECT DESCRIPTION

The site for the proposed development is located at 225 Huntmar Drive in Ottawa, Ontario, at the southwest corner of Palladium Drive and Huntmar Drive intersection. Currently, the site is a vacant, landscaped area. The location of the site is shown in Figure1, Appendix B.

It is understood that the proposed development will consist of a 320 m² slab-on-grade commercial building with an attached 690 m² garage (car and truck bays) centrally located on the vacant parcel of land. The design finished floor elevation will be Elevation 101.95 m for the building and Elevation 101.86 m for the car and truck bays. It is our understanding the site grades will be raised to a maximum of 0.63 m (630 mm).

3 SCOPE OF SERVICES

The purpose of this geotechnical investigation is to provide geotechnical engineering commentary and recommendations regarding the design and construction of the proposed commercial building, parking lot and installation of municipal services.

DST has completed the following scope of work to meet the project requirements:

Fieldwork:

- Placement of four (4) boreholes within the proposed building footprint; three (3) of which were advanced to 10.4 m depth and one (1) advanced to auger refusal on the inferred bedrock at a 12.9 m depth. Bedrock material was sampled by coring a 4.2 m length.
- Placement of four (4) boreholes within the proposed parking lot area and advanced to depths ranging from 4.3 to 5.2 m.
- Installation of monitoring wells and standpipe piezometer in seven (7) of the boreholes for the purpose of retrieving groundwater samples for the Phase II ESA and monitoring of the groundwater levels.
- Survey of the borehole locations and geodetic elevations by an Ontario Land Surveyor (OLS).
- Laboratory testing which included the following:
 - Moisture content determination on all recovered soil samples.
 - Grain size analysis on selected soil samples.
 - Atterberg limit determination on selected soil samples.
 - Chemical analyses of selected soil samples to assess the potential of sulphate attack on buried concrete structures and corrosion potential on buried steel structures.

Engineering Analyses and Reporting:

The geotechnical engineering report will include site and borehole location plans, borehole logs and laboratory test results and will discuss the following:

- Assessment of the subsurface soil, bedrock and groundwater conditions at the eight (8) borehole locations.
- Site grade raise restriction, if applicable.
- Foundation recommendations.
- Seismic site classification.
- Liquefaction potential of subsurface soils during a seismic event.
- Slab-on-grade construction.
- Frost penetration and protection.
- Installation of underground services including pipe bedding and backfill.
- Backfill Requirements.
- Excavation and de-watering during construction.

- Pavement structure design for outdoor paved parking lot.
- Corrosion potential of subsurface soils.
- Tree planting.

4 FIELD INVESTIGATION AND LABORATORY TESTING

4.1 Field Investigation

The field work was conducted on March 4 to 9, 2016 and consisted of eight (8) boreholes (BHs 16-1 to -8). Boreholes 16-1, 16- 2, 16-7 and 16-8 were advanced at the proposed parking lot location to depths ranging from 4.3 m to 5.2 m. Boreholes 16-3, 16-4, 16-5, 16-6 were advanced within the proposed building footprint to depths ranging from 10.4 m to 17.1 m below the existing grade. The borehole locations are shown in Figure 2, Appendix B.

The borehole locations and geodetic elevations were determined on site by an Ontario Land Surveyor (OLS).

The boreholes were advanced using a rubber-tired CME-750 drill rig equipped with geotechnical soil sampling and rock coring capabilities. The borehole work was supervised on a full time basis by a geotechnical representative from DST.

Standard penetration tests (SPTs) were undertaken in each borehole at regular depth intervals with soil samples retrieved by the split spoon sampler. The undrained shear strength of the clayey soil was measured in situ by performing the field vane test. The bedrock was cored in one (1) borehole using conventional N size coring equipment. Standpipe piezometers (19 mm diameter pipe) and monitoring wells (50 mm diameter pipe) were installed in seven (7) boreholes for groundwater sampling (as part of the Phase II ESA) and groundwater level monitoring purposes. All boreholes were backfilled on completion of drilling, sampling and standpipe piezometer installations.

The subsurface stratigraphy encountered in each borehole was recorded by the DST representative and the recovered soil samples and bedrock cores were labelled accordingly and submitted to the laboratory for detailed visual examination and laboratory testing.

4.2 Laboratory Testing

Laboratory testing of the soil samples consisted of moisture content determination on all samples.

Grain size analysis, Atterberg Limits determination and chemical analyses consisting of pH, chloride, conductivity, resistivity and sulphate parameters were conducted on selected soil samples. .

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered in the boreholes are provided in the borehole logs shown in Appendix C and discussed below. The moisture contents, grain size analysis and Atterberg Limits are shown on the borehole logs in Appendix C. The laboratory test results of the grain size analysis and Atterberg limits are shown in Appendix D.

5.1 Topsoil

A surficial topsoil layer was encountered in all eight (8) boreholes. The approximate thickness of the topsoil is 300 mm.

5.2 Fill

A cohesive (silt-clay) fill with various portions of sand was encountered beneath the topsoil in all eight (8) boreholes. The fill extends to depths of 1.4 to 2.2 m (Elev.100.0 to 99.1 m). SPT 'N' values obtained within the fill range from 0 to 8, indicating the fill is in a very soft to firm consistency. Rootlets were also encountered within the fill material. The moisture content of the tested samples range from 29% to 70%. The results from grain size analysis and Atterberg Limits determination conducted on selected samples of the fill are provided in Tables 5.1 and 5.2, respectively.

Table 5.1 Summary of Grain Size Analysis Results

| Sample ID | Sample Depth (m) | % Clay | % Silt | % Sand | % Gravel |
|------------------|-------------------------|---------------|---------------|---------------|-----------------|
| BH 1 SS1 | 0.0 – 0.6 | 27 | 65 | 8 | 0 |
| BH 4 SS2 | 0.8 – 1.4 | 21 | 64 | 15 | 0 |
| BH 7 SS2 | 0.8 – 1.4 | 19 | 77 | 5 | 0 |

Table 5.2 Summary of Atterberg Limits

| Sample ID | Sample Depth (m) | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index (%) |
|-----------|------------------|------------------|-------------------|----------------------|
| BH 8 SS2 | 0.8 – 1.4 | 35 | 20 | 15 |

5.3 Clay - silty

The fill is underlain by native silty clay in all eight (8) boreholes to the termination of all boreholes except in BH 16-5, where silt clay extends to a depth of 10.2 m (Elev. 91.1 m). In the following, the clay layer is described in two distinct layers – upper brown clay and lower grey clay.

5.3.1 Upper Brown Clay

The upper brown clay extends to depths of 1.4 to 4.3 m (Elev. 100.0 to 96.9 m). The field vane test results range from 48 to greater than 167 kPa indicating a firm to very stiff consistency. The moisture content of the tested samples range from 30% to 40%. The results from Atterberg Limits determination conducted on selected samples of the upper brown clay are provided Table 5.3.

Table 5.3 Summary of Atterberg Limits

| Sample ID | Sample Depth (m) | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index (%) |
|-----------|------------------|------------------|-------------------|----------------------|
| BH 1 SS4 | 2.3 – 2.9 | 38 | 22 | 16 |
| BH 4 SS5 | 3.0 – 3.6 | 34 | 19 | 16 |

5.3.2 Lower Grey Clay

The lower grey clay extends to depths of 3.4 to 10.4 m (Elev. 98.0 m to 91.0 m). The field vane test results range from 31 to greater than 120 kPa indicating a firm to very stiff consistency. The moisture content of the tested samples range from 42% to 59%. The results from Atterberg Limits determination conducted on selected samples of the lower grey clay are provided in Table 5.4.

Table 5.4 Summary of Atterberg Limits

| Sample ID | Sample Depth (m) | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index (%) |
|------------|------------------|------------------|-------------------|----------------------|
| BHMW 2 SS7 | 4.6 – 5.2 | 54 | 28 | 26 |
| BHMW 3 SS5 | 4.0 – 4.6 | 43 | 20 | 23 |
| BHMW 3 SS9 | 9.1 – 9.7 | 37 | 23 | 15 |
| BHMW 6 SS7 | 4.6 – 5.2 | 43 | 23 | 21 |

5.4 Silt and Clay

A silt and clay layer extends to depths of 10.2 to 12.9 m (Elev. 91.1 to 88.4 m) in BHMW16-5. SPT 'N' values obtained within the silt and clay is 0 and 1, indicating a very soft consistency. The moisture content of the tested samples range from 15% to 22%. The results from Atterberg Limits determination conducted on selected samples of the silt and clay are provided in Table 5.5.

Table 5.5 Summary of Atterberg Limits

| Sample ID | Sample Depth (m) | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index (%) |
|-----------|------------------|------------------|-------------------|----------------------|
| BH 5 SS10 | 10.7 – 11.3 | 36 | 19 | 17 |

5.5 Bedrock

Limestone bedrock was encountered in Borehole BH16-5 at 12.9 m depth (Elev. 88.4 m). The presence of bedrock in Borehole BH16-5 was proven by advancing the borehole 4.2 m into the bedrock from 12.9 to 17.1 m depth (Elev. 88.4 to 84.2 m). The Total Core Recovery (TCR) is 97 to 100%. The Rock Quality Designation (RQD) values range from 89 to 97% which corresponds to a rating of good to excellent quality rock.

5.6 Groundwater

Groundwater levels were measured in the standpipe piezometers and monitoring wells installed in Boreholes BHs 1, 2, 3, 4, 6, 7 and 8 upon completion of geotechnical investigation and the

measurements are summarized in Table 5.6. The groundwater levels may fluctuate seasonally and in response to climatic conditions.

Table 5.6 Summary of Groundwater Level Measurements

| Location | Borehole Surface Elevation (m) | Groundwater Depth (m) March 7, 2016 | Groundwater Elevation (m) March 7, 2016 | Groundwater Depth (m) April 7, 2016 | Groundwater Elevation (m) April 7, 2016 |
|-----------|--------------------------------|-------------------------------------|---|-------------------------------------|---|
| BH 16-1 | 101.5 | 0.7 | 100.8 | 0.9 | 100.6 |
| BHMW 16-2 | 101.3 | 0.5 | 100.8 | 0.8 | 100.5 |
| BHMW 16-3 | 101.4 | 0.6 | 100.8 | 0.9 | 100.5 |
| BH 16-4 | 101.4 | 1.4 | 100.0 | 2.1 | 99.3 |
| BHMW 16-6 | 101.4 | 0.7 | 100.7 | 1.0 | 100.4 |
| BH 16-7 | 101.6 | 0.7 | 100.9 | 0.9 | 100.7 |
| BH 16-8 | 101.2 | 0.9 | 100.3 | 1.0 | 100.2 |

6 CHEMICAL TEST RESULTS ON SELECTED SOIL SAMPLES

Selected soil samples were submitted to ALS Laboratories for chemical analyses (pH, sulphate, resistivity, conductivity and chloride) to assess the potential for corrosion and sulphate attack on buried concrete and steel structures.

The results are presented below in Table 6.1 with copies of the Laboratory Certificate of Analyses provided in Appendix D.

Table 6.1: Chemical Test Results – Soil samples

| Sample ID | Moisture (%) | Sulphate (mg/kg) | Chloride (mg/kg) | pH | Conductivity (umhos/cm) | Resistivity (ohm - cm) |
|-------------------|--------------|------------------|------------------|------|-------------------------|------------------------|
| BH2 @ 3.3 m depth | 28.6 | 59 | 329 | 7.84 | 455 | 2200 |
| BH4 @ 7.9 m depth | 39.5 | 155 | <20 | 7.95 | 213 | 4690 |
| BH6 @ 5.6 m depth | 37.4 | 404 | <20 | 7.83 | 318 | 3140 |

The analytical results of the soil samples were compared with applicable Canadian Standards Association (CSA) standards as shown in Table 6.2 below.

The chemical sulphate content analyses for representative soil sample tested indicate a sulphate concentration of 59 mg/kg (0.0059 %) to 404 mg/kg (0.0404%) in soil. The results were compared with Canadian Standards Association (CSA) Standards A23.1 for sulphate attack potential on concrete structures and possess a “negligible” risk for sulphate attack on concrete material and accordingly, conventional GU or MS Portland cement may be used in the construction of the proposed concrete elements.

The pH value for the soil samples was reported to be in a range from 7.83 to 7.95, indicating a durable condition against corrosion. These results were evaluated using Table C1 of Building Research Establishment (BRE) Digest 363 (SD1 - 2005). The pH is greater than 5.5 indicating the concrete will not be exposed to attack from acids. The chloride content of the selected soil sample was also compared with the threshold level and present negligible concrete corrosion potential. Resistivity and conductivity was found to be ranges from 2200 to 4690 ohm-cm and 213 to 455 umhos / cm respectively for the samples analysed from BH2, BH4 and BH6.

Table 6.2: Additional requirements for concrete subjected to sulphate attack

| Class of Exposer | Degree of Exposer | Water soluble Sulphate in soil sample (%) | Cementing Material to be used |
|------------------|-------------------|---|-------------------------------|
| S-1 | Very Severe | > 2.0 | HS or HSb |
| S-2 | Severe | 0.20 – 2.0 | HS or HSb |
| S-3 | Moderate | 0.10 – 0.20 | MS, MSb, LH, HS, or HSb |

* Information from Table 3 of CSA Standards A23.1-04

7 GEOTECHNICAL SOIL DESIGN PARAMETERS

Based on the in-situ and laboratory tests carried out, the following parameters shown in Table 7.1 below are suggested as design parameters for the soil types encountered in the boreholes. The internal friction angles of granular materials were estimated from standard penetration tests (SPTs) applying Wolff (1989) which provides an empirical correlation between SPT and internal friction angle.

The internal friction angles of cohesive materials were estimated from Atterberg Limits test results applying Kenney (1959) which provides an empirical correlation between plasticity index and internal friction angle.

Table 7.1 Geotechnical Soil Design Parameters

| Material | Total Unit Weight, γ_v (kN/m ³) | Undrained Shear Strength, c_u (kPa) | Internal Friction, Φ (°) |
|------------------|---|--|-------------------------------|
| Silt-Clay Fill | 19 | - | 27 |
| Brown Silty Clay | 19 | 48 to greater than 167 kPa (100) | 27 |
| Grey Silty Clay | 18 | 31 to greater than 120 kPa (50) | 25 |

The number presented in brackets can be used for design purposes.

8 DISCUSSION AND RECOMMENDATIONS

The general site stratigraphy consists of a surficial topsoil layer overlying silty clay fill underlain by native silty clay, silt and clay, overlying limestone bedrock. The presence of bedrock was proven in one (1) borehole. The groundwater level ranges from 0.8 to 2.1 m below the existing grade level (Elev. 100.7 to 99.3 m).

Unless noted otherwise, foundation design parameters are given for static, vertically and concentrically loaded foundations in compression. Dynamic, lateral, eccentric and uplift design parameters can be provided upon request, if applicable.

All foundation design recommendations presented in this report are based on the assumption that an adequate level of construction monitoring during foundation excavation and installation will be provided. An adequate level of construction monitoring is considered to be:

- a) For shallow foundations: examination of all excavation surfaces prior to fill placement to ensure the integrity of the subgrade.
- b) For earthwork and underground services: full-time monitoring and compaction testing.

8.1 Site Grade Raise

It is understood that the design finished floor elevation will be Elevation 101.95 m for the building and Elevation 101.86 m for the car and truck bays. It is also our understanding that the site grades will be raised to a maximum of 0.63 m (630 mm).

The site is underlain by a fill (disturbed/reworked silty clay) over native firm to very stiff silty clay that is prone to settlement when overstressed by external loads that are close to or exceed the pre-consolidation pressure or yield stress of the silty clay. External loads include loads imposed by building foundations (such as footings), site grade raise and lowering of the groundwater level during construction.

Based on our analysis and assuming the SLS value for footings indicated in subsequent sections of this report and an assumed maximum long term groundwater lowering of 1.0 m the site grade raise should be restricted to the proposed grade raise of 0.63 m (630 mm). This grade raise limits the total settlement of the foundations to 25 mm in the long term.

8.2 Shallow Footings

Based on a review of the site and grading plan provided by the client, it is our understanding that the proposed commercial building will be one (1) storey with no basement (underside footing elevation is unknown) with a slab on grade (elevation unknown). Shallow (strip and spread) footings founded in native soils (silty clay) are considered suitable for the proposed development of this site. Shallow (strip and spread) footings are not recommended to be placed within the fill. Based on the boreholes information, native silty clay material was found at depths varying between 1.4 and 2.2 m below existing grade (Elev. 100.0 to 99.1 m).

In addition, depth of the native cohesive inorganic soil may vary within the proposed building footprint and, thus, a step down shallow foundation may be considered in order to ensure a consistent subgrade material beneath the proposed foundation. The step down depth of the footing should be checked by DST to confirm the underlying silty clay is not overstressed by the lowered footing.

8.2.1 Strip Footing

The geotechnical resistance at ultimate limit states (ULS) and estimated bearing pressures based on serviceability limit state (SLS), to limit maximum settlements to 25 mm or less, for strip footing founded on the native inorganic undisturbed silty clay are provided in Table 8.1 below. For these bearing pressures to be realized, soil cover of either 1.5 m or 2 m is required above the footings as shown in the Table 8.1. A minimum distance of one footing width is required between adjacent footings.

Table 8.1 Geotechnical resistances and reactions for strip footings on native undisturbed soil

| Depth (m) | Width of Footing (B) (m) | Ultimate Bearing Capacity (kPa) | Resistance at ULS (kPa) | Reaction at SLS (kPa) |
|-----------|--------------------------|---------------------------------|-------------------------|-----------------------|
| 1.5 | 0.5 | 530 | 265 | 110 |
| | 1.0 | 530 | 265 | 60 |
| | 1.5 | 530 | 265 | 45 |
| 2.0 | 0.5 | 530 | 265 | 110 |
| | 1.0 | 540 | 270 | 60 |
| | 1.5 | 540 | 270 | 45 |

Total settlement is not expected to exceed 25 mm with differential settlement less than 20 mm. In situations where column loads dictate footings wider than those widths provided are required, the geotechnical engineer should be contacted with specific column loads, and options can possibly be developed.

Bearing areas will require very careful preparation. Following excavation all bearing surfaces should be cleaned of all fill, organic (such as topsoil), loose, disturbed, or slough material prior to concrete placement. Bearing surfaces should be protected at all times from rain, freezing temperatures and the ingress of groundwater before, during and after construction.

All foundation excavations and bearing surfaces should be inspected by a qualified geotechnical engineer to confirm the integrity of the bearing surface prior to concrete placement.

8.2.2 Square Footings

Square footing elements for the building should be founded on the native inorganic undisturbed silty clay deposit. Spread footings may be designed using limit state static bearing pressures listed in the Table 8.2. For these bearing pressure to be realized soil cover of either 1.5 m or 2 m is required above the footing as described below. Minimum and maximum footing widths of 1.0 to 2.5 m are recommended respectively. A minimum distance of one footing width is also required between adjacent footings.

Table 8.2 Geotechnical resistances and reactions for square footings on native undisturbed soil

| Depth (m) | Width of Footing (B) (m) | Ultimate Bearing Capacity (kPa) | Resistance at ULS (kPa) | Reaction at SLS (kPa) |
|-----------|--------------------------|---------------------------------|-------------------------|-----------------------|
| 1.5 | 1.0 | 630 | 315 | 170 |
| | 1.5 | | | 100 |
| | 2.0 | | | 75 |
| | 2.5 | | | 60 |
| 2 | 1.0 | 640 | 320 | 170 |
| | 1.5 | | | 100 |
| | 2.0 | | | 75 |
| | 2.5 | | | 60 |

8.3 Seismic Site Classification

In accordance with Table 4.1.8.4.A of the 2012 Ontario Building Code (OBC), a seismic site class of D should be used for footings founded on the native silty clay at this site.

8.4 Liquefaction Potential of Subsurface Soils during a Seismic Event

The subsurface soils below the foundation level are not considered to have a potential to liquefy during a seismic event.

8.5 Slab-On-Grade

Based on the information at the boreholes locations, the proposed building footprint will be underlain by existing fill to depths ranging from 1.4 to 2.2 m (Elev. 100.0 to 99.1 m). The existing fill is not considered suitable for supporting the slab-on-grade. Therefore, the floor slab may be designed and constructed as a slab-on-grade constructed on an engineered fill pad as discussed below.

All topsoil, fill and deleterious material should be excavated and removed from within the slab footprint to the surface of the native silty clay. The exposed clay subgrade should be evaluated by a geotechnical engineer prior to placement of the engineered fill. Once the exposed subgrade has been approved, the site grades within the floor slab area may be raised by the placement of engineered fill to the underside of the granular base of the slab. The engineered fill should consist of Ontario Provincial Standard Specification (OPSS) Granular B Types I or II placed in 300 mm

maximum loose lift thicknesses, with each lift compacted to 98% standard Proctor maximum dry density (SPMDD). Once the slab subgrade has been prepared, the floor slab may be constructed on a 200 mm thick compacted bed of 19 mm clear stone.

The slab should be structurally independent from walls and columns, which are supported by the foundations. This is to reduce any structural distress that may occur as a result of differential soil movement. If it is intended to place any internal non-load bearing partitions directly on the slab-on-grade, such walls should also be structurally independent from other elements of the building founded on the conventional foundation system so that some relative vertical movement of the walls can occur freely.

The subgrade beneath the slab-on-grade should be protected at all times from rain, snow, freezing temperatures, excessive drying and the ingress of water. This applies during and after the construction period.

Some relative movement between the slab-on-grade floor and adjacent walls or foundations and differential movement within the slab should be anticipated. Generally, if the recommendations outlined in this report are followed, these movements are estimated to be less than 10 mm.

The finished exterior grade should be sloped away from the building to prevent ponding of surface water close to the exterior walls of the building.

8.6 Frost Protection

8.6.1 Building Foundations

Based on the Ministry of Environment published data, which is based on an 85% probability, the design freezing index for Ottawa has been estimated to be 1,000 degrees-days Celsius (1,832 degree-days Fahrenheit). Based on this data, the calculated depth of frost penetration for silty clay for an area assumed to have been kept clear of snow cover will be in the order of 1.8 m.

To limit the effects of frost penetration, a minimum depth of soil cover of 1.5 m is required for perimeter footings of heated structures provided the structure is heated to at least 18 degrees Celsius and there is some heat loss through the foundation wall and floor. Where earth cover is less than required, thermal rigid insulation or a combination of insulation and soil cover should be provided. DST can provide additional information regarding thermal rigid insulation, if required.

8.6.2 Underground Services

The underground services should be located below the depth of frost penetration of 1.8 m and in accordance with City of Ottawa specifications. For example, the City of Ottawa specifies watermains require a soil cover above the obvert of the pipe of 2.4 m. Where the available soil cover is less than the required 2.4 m, thermal rigid insulation should be used as specified in the City of Ottawa Drawing No. W22.

8.7 Pipe Bedding

Pipe bedding should be in accordance with the City of Ottawa Standard Drawings.

The bedding material over the silty clay should be placed on a layer of non-woven geotextile to act as a separation membrane to minimize the loss of the bedding material into the subgrade. This geotextile should extend across the trench bottom and up the sides of the pipe invert level. The bedding material should be compacted to at least 95% SPMDD with appropriate equipment such as low energy vibratory plate tamper.

Compaction of the pipe bedding materials will likely prove problematic where the subgrade consists of soft/loose material, which is sensitive to disturbance. Where compaction proves difficult, a sub-bedding of 150 to 300 mm OPSS Granular B Type II or the placement of 600 mm blast rock punched into the subgrade may be considered to provide a stable base. The surface of the blast rock should be covered by a geotextile prior to placement of the design pipe bedding.

Heavy compaction equipment should not be used until a minimum of 800 mm of compacted backfill has been placed over the pipe, and should be used in accordance with Ontario Provincial Standard Drawing (OPSD) 808.010, "Pipe Protection against Heavy Construction Equipment". During backfilling operation, care should be taken to ensure that the backfilling proceeds in equal stages simultaneously on both sides of the pipe. It should be noted that service trenches completed within the underlying native silty clay will be prone to rapid deterioration under joint action of water and excessive foot, or small equipment traffic. Accordingly, care should be taken to keep the base of the excavation as dry as possible and to limit the amount of activity within the trench between excavation to final grade and pipe installation.

8.8 Backfill Requirements

8.8.1 Building

Backfill against foundations should consist of an Ontario Provincial Standard Specifications (OPSS) Granular B Types I or II fill material. Exterior building backfill beneath settlement sensitive hard surfaces such as sidewalks, interlocking paving stones and paved surfaces should be compacted to 95% SPMDD. In areas where the settlement sensitive hard surfaces will extend from the building exterior over the building backfill zone and non-backfilled zone, 1H:1V frost tapers should be provided from a 1.5 m depth. Landscaped areas or areas that are not settlement sensitive may be compacted to 90% SPMDD.

8.8.2 Underground Services

The quality of the trench backfill will affect the performance of the pavement as well as other structures existing above and beside the service trenches. Therefore, general trench backfilling should be carried out in a manner compatible with requirements of pavement structures and other adjoining structures and utilities.

All trenches should be backfilled with inorganic soil, debris free, compacted to achieve at least 95% SPMDD throughout and 98% SPMDD in the upper 300 mm below pavement structure. Trench backfill should be carried out in lifts not to exceed 300mm in thickness, and should be within $\pm 2\%$ of its optimum moisture content and compacted with suitable compaction equipment. Trench backfill placed in the upper 1.5 m should be similar in nature with the soils exposed in the trench walls or alternatively 3H:1V frost tapers should be constructed. Below 1.5 m, the trench backfill should consist of approved site generated materials or imported OPSS Select Subgrade Material (SSM). As noted above, these materials should be compacted to 95% SPMDD. Utility chambers (manholes) should be backfilled using Granular B Type II material.

Any fill required to be imported should conform to OPSS requirements for SSM or Granular B Types I or II materials.

The proposed service trenches should be provided with water stops (clay seals) as per City of Ottawa Detail S8 to minimize potential long term groundwater lowering in the area. The spacing of the water stops can be provided once details regarding the site servicing are available.

The water stops should be constructed full width from trench bottom to underside of roadway

pavement structure (subbase). The water stops should consist of compactible clay material placed in lifts not thicker than 300 mm and compacted to 95% SPMDD.

The underground services should be installed in a series of short lengths with the maximum permissible length of open trench limited to 10 m. No excavations should be allowed to be left open overnight, weekends or holidays. The suggested measures would ensure stability of the excavated trenches as well as adjacent buildings and/or structures.

8.9 Excavations

8.9.1 Excavation

Excavations for the development are anticipated to extend into the fill and silty clay and very likely will extend below the groundwater level. Excavations for this project should be carried out in accordance with the requirements of the Occupational Health and Safety Act of Ontario.

Excavation of the soils may be undertaken with large mechanical equipment capable of removing possible debris within the fill. The contractor should have suitable equipment to excavate the soils shown on the borehole logs and to meet the requirements of the project schedule and construction methodology.

Excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA). The subsurface soils are considered to be Type 3 soil and the excavation side slopes must be cut back at 1H:1V gradient as specified in OHSA. Local flattening of the side slopes may be required in zones of persistent seepage.

If open cut, unsupported excavations are not feasible, the excavations will have to be undertaken within the confines of a supported excavation such as a prefabricated support system (trench box) and engineered support system (shoring system). These systems must be designed and installed in accordance with OHSA.

No surface surcharges should be placed closer to the edge of the excavation than a distance equal to the depth of the excavation, unless an excavation support system is designed and incorporated to accommodate such surcharge.

Attention should be paid to structures or buried service lines close to the excavation. As a general guideline, if a line projected down at 30 degrees from the horizontal from the base of foundations of

adjacent structures intersects the extent of the proposed excavation, underpinning or special shoring techniques may be required to avoid damaging earth movements.

8.9.2 Dewatering

It is anticipated that excavations will extend below the groundwater level. Groundwater control during construction may be achieved by conventional sump pump techniques. High capacity pumps may be required in zones of persistent seepage.

It is to be noted that dewatering effort will depend on a number of factors, including excavation depth, season and weather conditions, and the length of time the excavations are open. It should be left to the contractor to determine the means and methods of dewatering necessary to meet the project requirements and align with their construction methodology and schedule.

It should be realized that dewatering within compressible deposits (silty clay/silt) can cause ground settlement and such ground settlement would extend laterally beyond the immediate area of dewatering. It is recommended that the contractor assess the likely impact of dewatering, and use methods which will control dewatering impact on nearby existing structures and services to tolerable levels. A pre-construction survey documenting the existing conditions of nearby settlement-sensitive facilities/infrastructure should be completed.

8.10 Pavement Design

It is understood that the development will include outdoor parking lot and access roads. Table 8.3 below summarizes proposed pavement structure designs for the parking lot and access roads for light (cars) and heavy (garbage and fire trucks).

Table 8.3 Parking lot and access road pavement design recommendation

| Material | Structure Layer Minimum Thickness (mm) |
|---|---|
| Super pave 12.5 Level C Asphalt (PG58-34) | 50 90 (loading areas and truck route) |
| OPSS Granular A Base | 150 |
| OPSS Granular B (Type II) subbase | 300 |

Paving is to be completed in accordance with OPSS.MUNI 1151 and OPSS 310 and related Special Provisions or applicable City of Ottawa standards.

Design grades should ensure that there are no low points where water can stand within the pavement structure. Grades should be uniform with positive slopes. The integrity of the subgrade and pavement structure layers must be protected and maintained during construction against water, frost and traffic. To assist with the overall drainage of the pavement structure, 150 mm diameter sock wrapped perforated PVC subdrains should be installed at all catchbasins and extend 3m from the four (4) sides of the catchbasin.

Prior to constructing the subbase, the subgrade should be cleaned and free of any topsoil and organic materials, debris and deleterious materials. The subgrade shall be compacted to 95% SPMDD and sloped for drainage at a minimum of 3%.

Excavation of the existing and reinstatement of the granular base material should be such that the surface of the new pavement matches the elevation of the existing pavement surface, as adjusted during the detailed design. Construction traffic is to be controlled to minimize damage and protect the integrity of the subgrade, base and subbase layers during construction. Butt joints, step joints, and tack coating are recommended to tie the new pavement with the existing pavement. At the transition where the new pavement structure meets the existing pavement structure, the subgrade is to be transitioned at a slope of 3 horizontal to 1 vertical (3H: 1V).

All granular pavement materials should meet Ontario Provincial Standard Specification OPSS.MUNI 1010 requirements and should be compacted to at least 98% of SPMDD. In particular, it is imperative that the fines content does not exceed the 8% limit specified by OPSS for Granular A and 10 % specified for OPSS Granular B Type II. Asphaltic concrete should also be produced and placed in accordance with OPSS standards. Compaction efforts must be inspected and approved by a geotechnical engineer or his representative. All methods should be in accordance with applicable OPSS standards.

Compaction efforts must be inspected and approved by a qualified professional. All methods should be in accordance with applicable OPSS standards.

8.11 Tree Planting Restriction

This site is underlain by sensitive marine clay. Therefore, the planting of trees should be in accordance with the City of Ottawa document titled, "Trees and Foundation Strategy in Areas of Sensitive Marine Clay in the City of Ottawa", dated September 9, 2005. Trees that do not meet the requirements outlined in the 2005 document should be equipped with a tree barrier root system.

8.12 Monitoring During Construction

All foundation design recommendations presented in this report are based on the assumption that an adequate level of construction monitoring by qualified geotechnical personnel during construction will be provided. An adequate level of construction monitoring is considered to be: a) for deep and shallow foundations: full-time monitoring and design review during construction; and b) for earthworks: full-time quality control and compaction testing.

An important purpose of providing an adequate level of monitoring is to check that recommendations, based on data obtained at discrete borehole locations, are relevant to other areas of the site.

In order to provide an adequate level of construction monitoring, qualified geotechnical personnel should manage and supervise the following tasks during construction:

Shallow Foundations:

Confirm that materials and methods meet specifications.

Inspect foundation subgrades.

Inspect excavation.

Review shallow foundation installation/testing methods.

Review compaction testing records.

Provide review comments, including any discrepancies found with respect to specifications as well as this report, and the need for any modifications to the design or methods.

Earthworks:

Confirm that materials and methods meet specifications.

Inspect subgrade prior to fill placement.

Quality control of fill material.

Review compaction testing records.

Pavement:

Confirm that materials and methods meet specifications and mix design.

An adequate level of construction monitoring for granular pavement materials is considered to be inspection of the subgrade and compaction testing. An adequate level of construction monitoring for asphalt paving is considered full-time monitoring and testing of the compaction, asphalt cement content, gradation and Marshall properties of the mix.

9 REFERENCES

Bowles Joseph E., (1988). *Foundation Analysis and Design, Fourth Edition*, McGraw-Hill Book Company.

Wolff, T.F. (1989), *Spreadsheet Applications in Geotechnical Engineering*, PWS Publishing Company, Boston, MA.

Occupational Health and Safety Act and Regulations for Construction Projects, Ministry of Labour, Publications Ontario

Canadian Geotechnical Society (2006). *Canadian Foundation Engineering Manual*.

Special Provisions SSP110S13, Amendment to Ontario Provincial Standard Specification OPSS 1010, April 2004, Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material.

Ontario Building Code (2012), Ontario Regulation 350/06

10 LIMITATIONS OF REPORT

A description of limitations which are inherent in carrying out site investigation studies is given in Appendix A, and forms an integral part of this report.

For DST CONSULTING ENGINEERS INC.



Susan Potyondy, P.Eng.
Key Client Liaison
Infrastructure Client Group



Masud Karim, Ph.D., P. Eng.
Sr. Associate/Regional Manager

APPENDIX A

LIMITATIONS OF REPORT

LIMITATIONS OF REPORT

GEOTECHNICAL STUDIES

The data, conclusions and recommendations which are presented in this report, and the quality thereof, are based on a scope of work authorized by the Client. Note that no scope of work, no matter how exhaustive, can identify all conditions below ground. Subsurface and groundwater conditions between and beyond the test hole may differ from those encountered at the specific locations tested, and conditions may become apparent during construction which were not detected and could not be anticipated at the time of the site investigation. Conditions can also change with time. It is recommended practice that DST Consulting Engineers be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the test holes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavation, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

Unless otherwise noted, the information contained herein in no way reflects on environmental aspects of either the site or the subsurface conditions.

The comments given in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs, e.g. the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusion as to how the subsurface conditions may affect their work.

Any results from an analytical laboratory or other subcontractor reported herein have been carried out by others, and DST Consulting Engineers Inc. cannot warranty their accuracy. Similarly, DST cannot warranty the accuracy of information supplied by the Client.

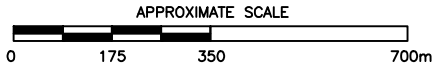
APPENDIX B

FIGURES



SOURCES:
1. GOOGLE EARTH © 2016 GOOGLE

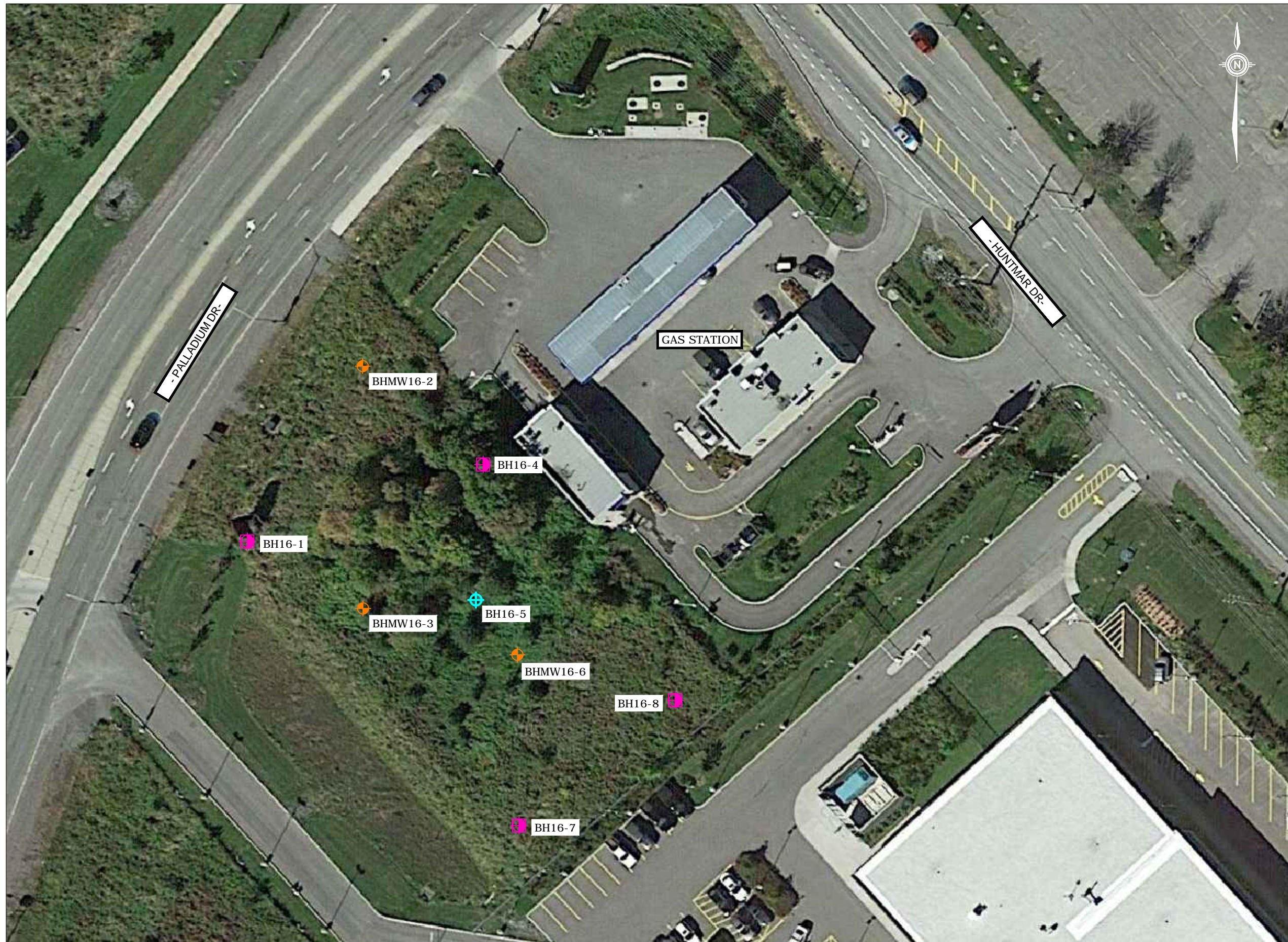
NOTE:
1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE ASSOCIATED TECHNICAL REPORT.



| | | | |
|-------------------------|----------|------------------------------|----------|
| 0 | 15/04/16 | FINAL | E.D. |
| REV | DATE | ISSUE | APPROVAL |
| DRAWN BY R.P. | | DATE April 2016 | |
| PROJECT MANAGER K.S. | | PROJECT NO.: TS-SO-022154 | |
| FIGURE No.: FIGURE 1 | | | |




| |
|--|
| PROJECT TITLE GEOTECHNICAL INVESTIGATION - PROPOSED COMMERCIAL DEVELOPMENT - 225 HUNTMAR DRIVE, OTTAWA, ON |
| DRAWING TITLE SITE LOCATION MAP |

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LEGEND:

-  APPROXIMATE LOCATION OF BOREHOLE/MONITORING WELL BHMW16-6
-  APPROXIMATE LOCATION OF BOREHOLE BH16-5
-  APPROXIMATE LOCATION OF BOREHOLE / STANDPIPE PIEZOMETER BH16-8

| REV | DATE | ISSUE | APPROVAL |
|-----|----------|-------|----------|
| 0 | 15/04/16 | FINAL | E.D. |

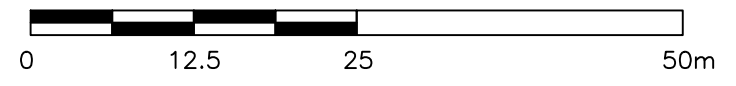
PROJECT TITLE
 GEOTECHNICAL INVESTIGATION -
 PROPOSED COMMERCIAL DEVELOPMENT -
 225 HUNTMAR DRIVE, OTTAWA, ON

DRAWING TITLE
 BOREHOLE LOCATION PLAN

| | |
|---------------------|------------------------------|
| DESIGNED BY K.S. | SCALE As Shown |
| DRAWN BY R.P. | DATE April 2016 |
| APPROVED BY K.S. | PROJECT NO.: TS-SO-022154 |

FIGURE 2

APPROXIMATE SCALE



APPENDIX C
BOREHOLE LOGS

EXPLANATION OF TERMS USED IN REPORT

SPT 'N' VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE OF THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51 mm O.D. SPLIT BARREL SAMPLES TO PENETRATE 0.3 m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76 m. FOR PENETRATION OF LESS THAN 0.3 m 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 (DCPT): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51 mm 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 0.3 m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS

TEXTURAL CLASSIFICATION OF SOILS

| BOULDERS | COBBLES | GRAVEL | SAND | SILT | CLAY |
|---------------------|--------------|---------------|------------------|-------------------|--------------------|
| GREATER THAN 200 mm | 75 TO 200 mm | 4.75 TO 75 mm | 0.075 TO 4.75 mm | 0.002 TO 0.075 mm | LESS THAN 0.002 mm |

COARSE GRAIN SOIL DESCRIPTION (50% GREATER THAN 0.075 mm)

| TERMINOLOGY | TRACE OR OCCASIONAL | SOME | WITH | ADJECTIVE (e.g. SILTY OR SANDY) | AND (e.g. SAND AND SILT) |
|-------------|---------------------|-----------|-----------|---------------------------------|--------------------------|
| | LESS THAN 10% | 10 TO 20% | 20 TO 30% | 30 TO 40% | 40 TO 60% |

CONSISTENCY*: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (C_u) AND SPT 'N' VALUES AS FOLLOWS

| C_u (kPa) | 0 – 12 | 12 – 25 | 25 – 50 | 50 - 100 | 100 - 200 | > 200 |
|-------------------|-----------|---------|---------|----------|------------|-------|
| N (BLOWS / 0.3 m) | <2 | 2 - 4 | 4 - 8 | 8 - 15 | 15 - 30 | >30 |
| | VERY SOFT | SOFT | FIRM | STIFF | VERY STIFF | HARD |

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

| N (BLOWS / 0.3 m) | 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, 100 mm+ IN LENGTH EXPRESSED AS A PERCENTAGE OF THE LENGTH OF THE CORING RUN.

THE **ROCK QUALITY DESIGNATION (R.Q.D)** FOR MODIFIED RECOVERY IS:

| R.Q.D (%) | 0 – 25 | 25 – 50 | 50 – 75 | 75 – 90 | 90 – 100 |
|-----------|-----------|---------|---------|---------|-----------|
| | VERY POOR | POOR | FAIR | GOOD | EXCELLENT |

LEGEND OF RECORDS FOR BOREHOLES: SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

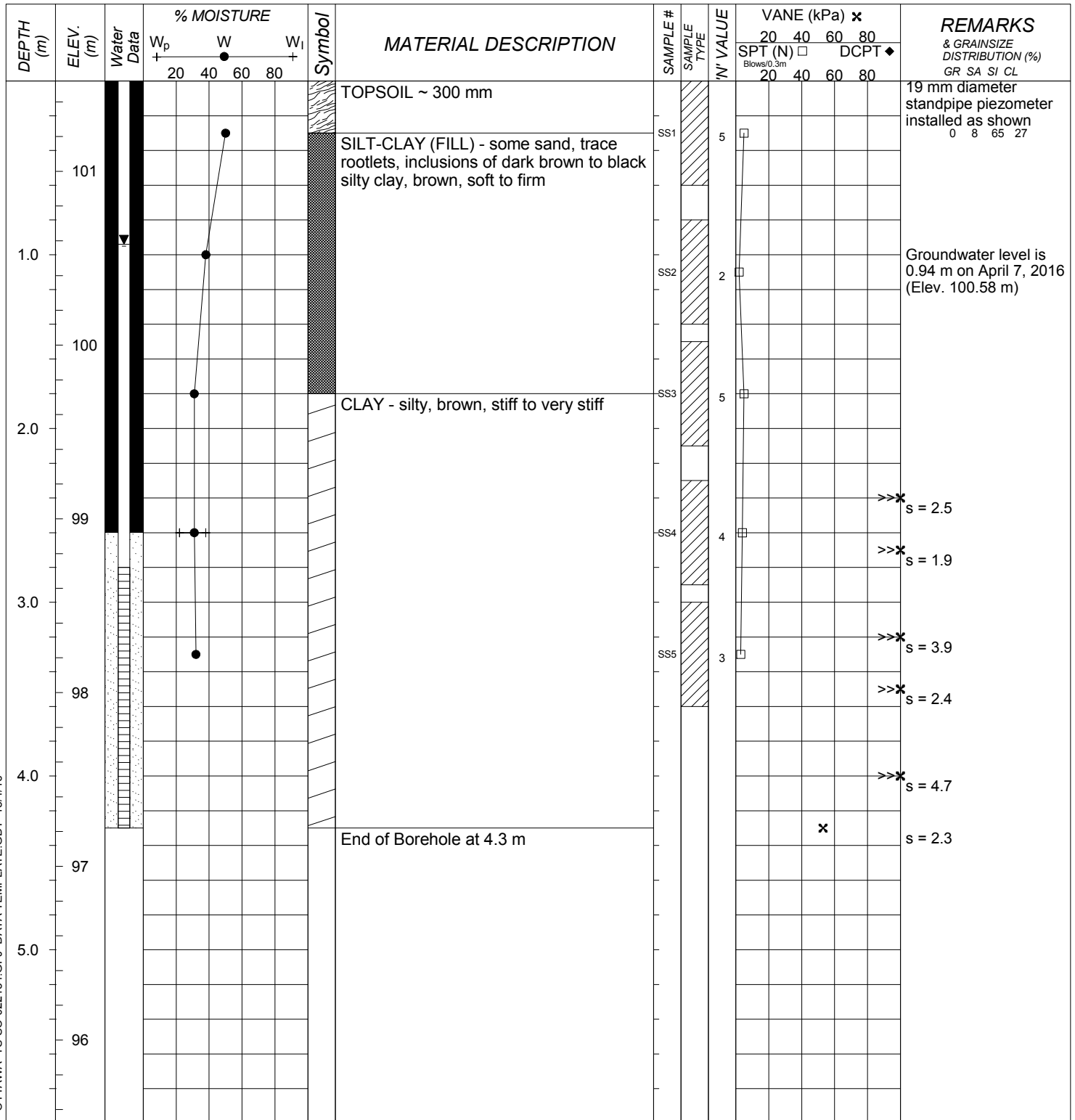
| | | | |
|---|--|---|-------------------------------------|
| SS | SPLIT SPOON SAMPLE | WS | WASH SAMPLE |
| TW | THIN WALL SHELBY TUBE SAMPLE | AS | AUGER (GRAB) SAMPLE |
| PH | SAMPLER ADVANCED BY HYDRAULIC PRESSURE | TP | THIN WALL PISTON SAMPLE |
| WH | SAMPLER ADVANCED BY SELF STATIC WEIGHT | PM | SAMPLER ADVANCED BY MANUAL PRESSURE |
| SC | SOIL CORE | RC | ROCK CORE |
|  | WATER LEVEL | $SENSITIVITY = \frac{UNDISTURBED\ SHEAR\ STRENGTH}{REMOVED\ SHEAR\ STRENGTH}$ | |

*HIERARCHY OF SOIL STRENGTH PREDICTION: 1) LABORATORY TRIAXIAL TESTING. 2) FIELD INSITU VANE TESTING. 3) LABORATORY VANE TESTING. 4) SPT VALUES. 5) POCKET PENETROMETER.

LOG OF BOREHOLE BH 16-1

DST REF. No.: **TS-SO-022154**
 CLIENT: **Enterprise Holdings**
 PROJECT: **Commercial Building**
 LOCATION: **225 Huntmar Drive, Ottawa, Ontario**
 SURFACE ELEV.: **101.52 metres**

Drilling Data
 METHOD: **Hollow Stem Auger**
 DIAMETER: **200 mm**
 DATE: **9 March 2016**
 COORDINATES: **5021491.848 m N, 457877.637 m E**



BOREHOLE (STANDARD) - OTTAWA TS-SO-022154.GPJ DATA TEMPLATE.GDT 18/4/16



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SAMPLE TYPE LEGEND

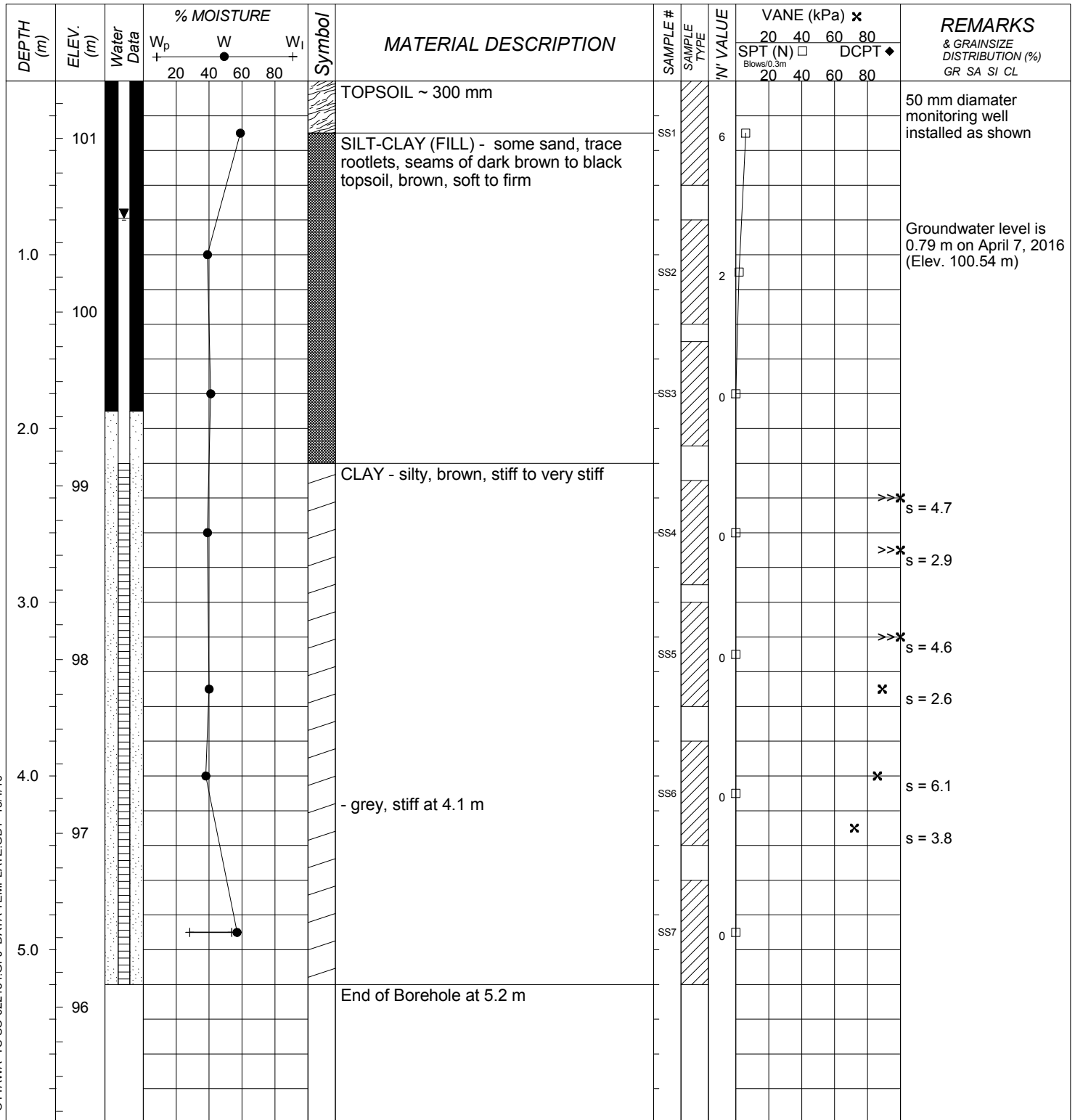
| | | |
|--------------------|---------------------|-----------|
| Auger Sample | Rock Core | Bentonite |
| Split Spoon Sample | Hiller Peat Sampler | Sand |
| Bulk Sample | 70mm Thin Wall Tube | |

ENCLOSURE 1

LOG OF BOREHOLE BHMW 16-2

DST REF. No.: TS-SO-022154
 CLIENT: Enterprise Holdings
 PROJECT: Commercial Building
 LOCATION: 225 Huntmar Drive, Ottawa, Ontario
 SURFACE ELEV.: 101.33 metres

Drilling Data
 METHOD: Hollow Stem Auger
 DIAMETER: 200 mm
 DATE: 9 March 2016
 COORDINATES: 5021516.06 m N, 457898.528 m E



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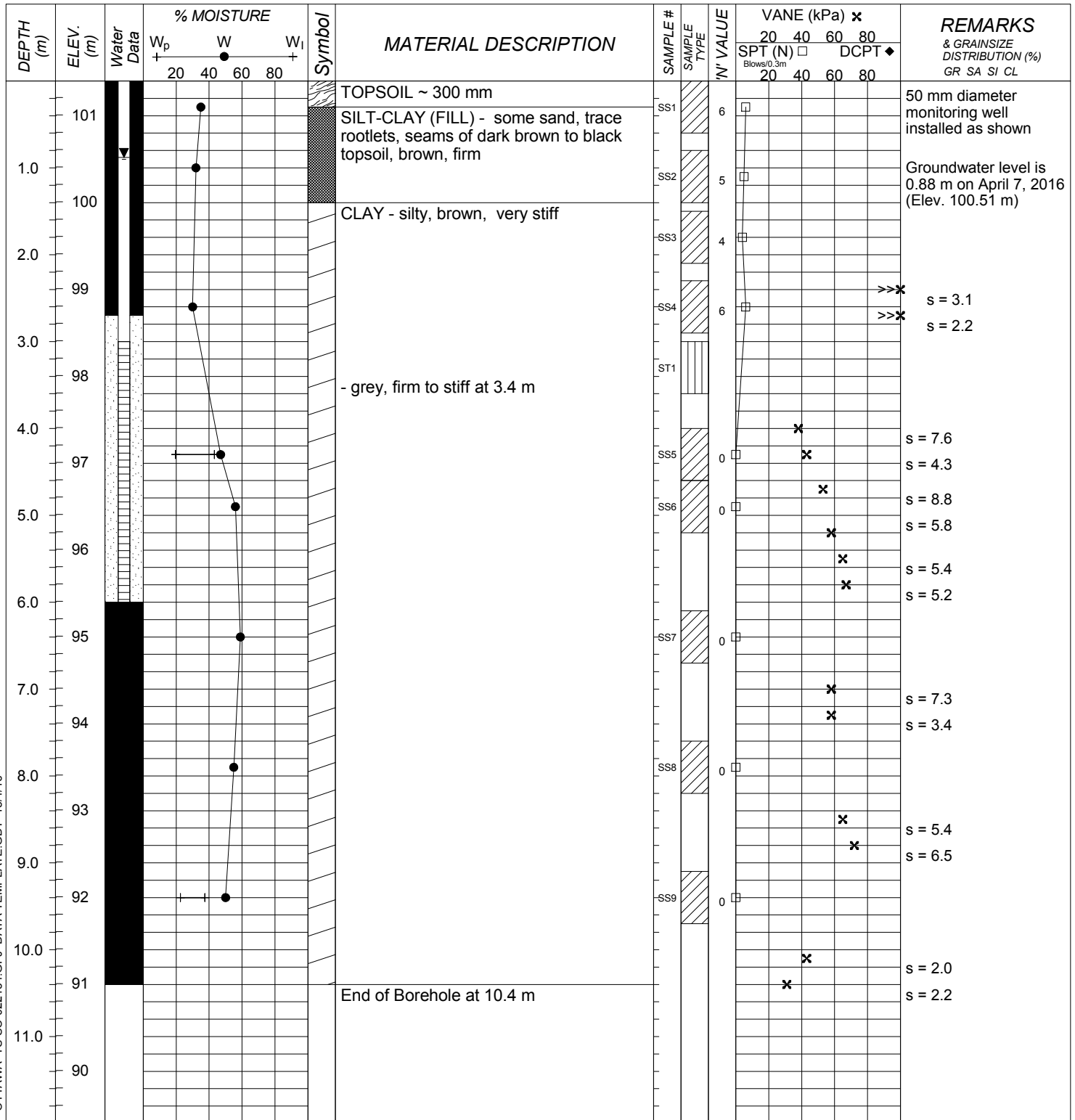
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|--------------------|---------------------|-----------|
| Auger Sample | Rock Core | Bentonite |
| Split Spoon Sample | Hiller Peat Sampler | Sand |
| Bulk Sample | 70mm Thin Wall Tube | |

ENCLOSURE 2

LOG OF BOREHOLE BHMW 16-3

DST REF. No.: TS-SO-022154
 CLIENT: Enterprise Holdings
 PROJECT: Commercial Building
 LOCATION: 225 Huntmar Drive, Ottawa, Ontario
 SURFACE ELEV.: 101.39 metres

Drilling Data
 METHOD: Hollow Stem Auger
 DIAMETER: 200 mm
 DATE: 8 March 2016
 COORDINATES: 5021480.062 m N, 457896.137 m E



BOREHOLE (STANDARD) - OTTAWA TS-SO-022154.GPJ DATA TEMPLATE.GDT 18/4/16



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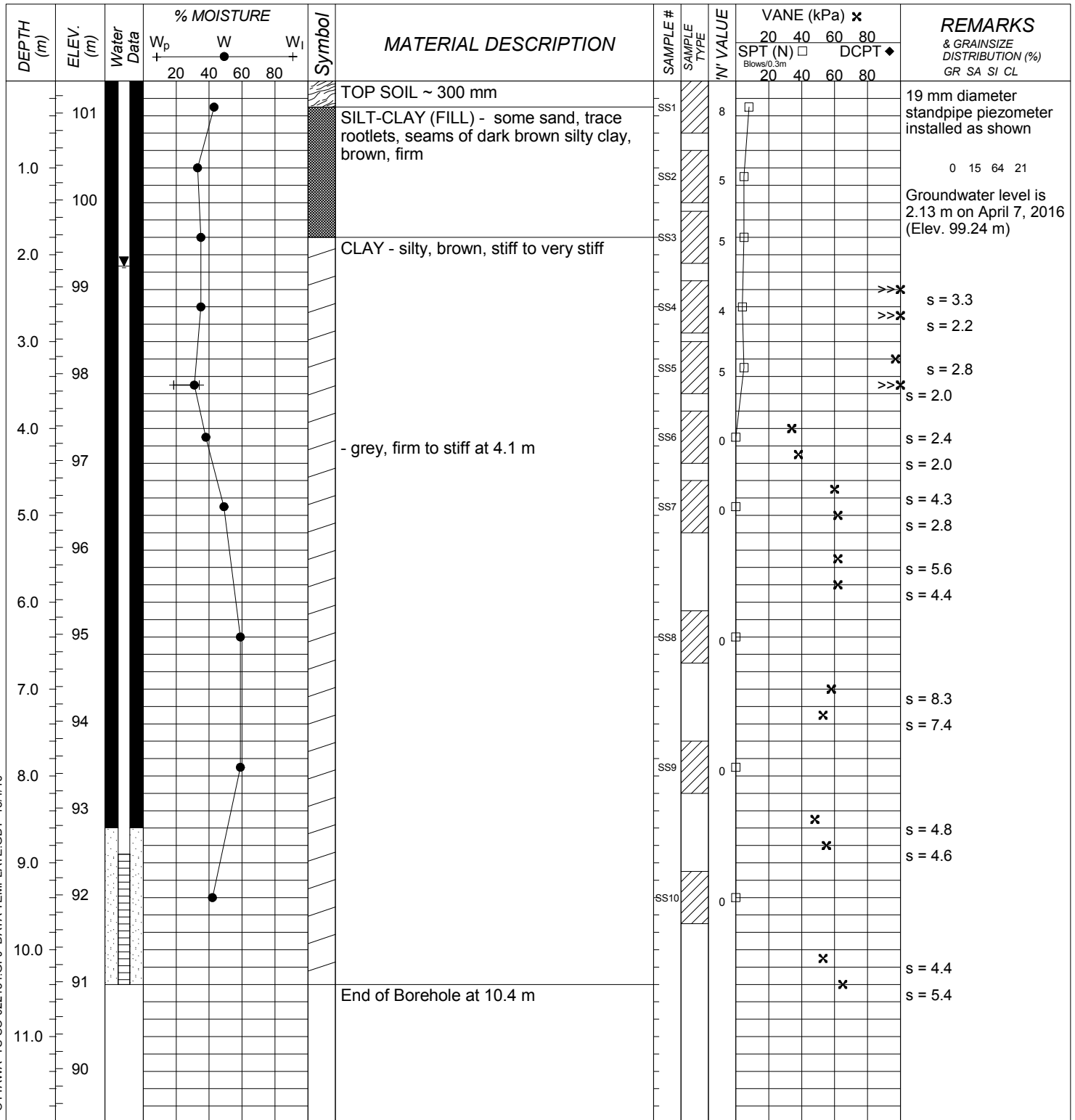
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|--------------------|---------------------|-----------|
| Auger Sample | Rock Core | Bentonite |
| Split Spoon Sample | Hiller Peat Sampler | Sand |
| Bulk Sample | 70mm Thin Wall Tube | |

ENCLOSURE 3

LOG OF BOREHOLE BH 16-4

DST REF. No.: TS-SO-022154
 CLIENT: Enterprise Holdings
 PROJECT: Commercial Building
 LOCATION: 225 Huntmar Drive, Ottawa, Ontario
 SURFACE ELEV.: 101.37 metres

Drilling Data
 METHOD: Hollow Stem Auger
 DIAMETER: 200 mm
 DATE: 8 March 2016
 COORDINATES: 5021495.941 m N, 457912.653 m E



BOREHOLE (STANDARD) - OTTAWA TS-SO-022154.GPJ DATA TEMPLATE.GDT 18/4/16



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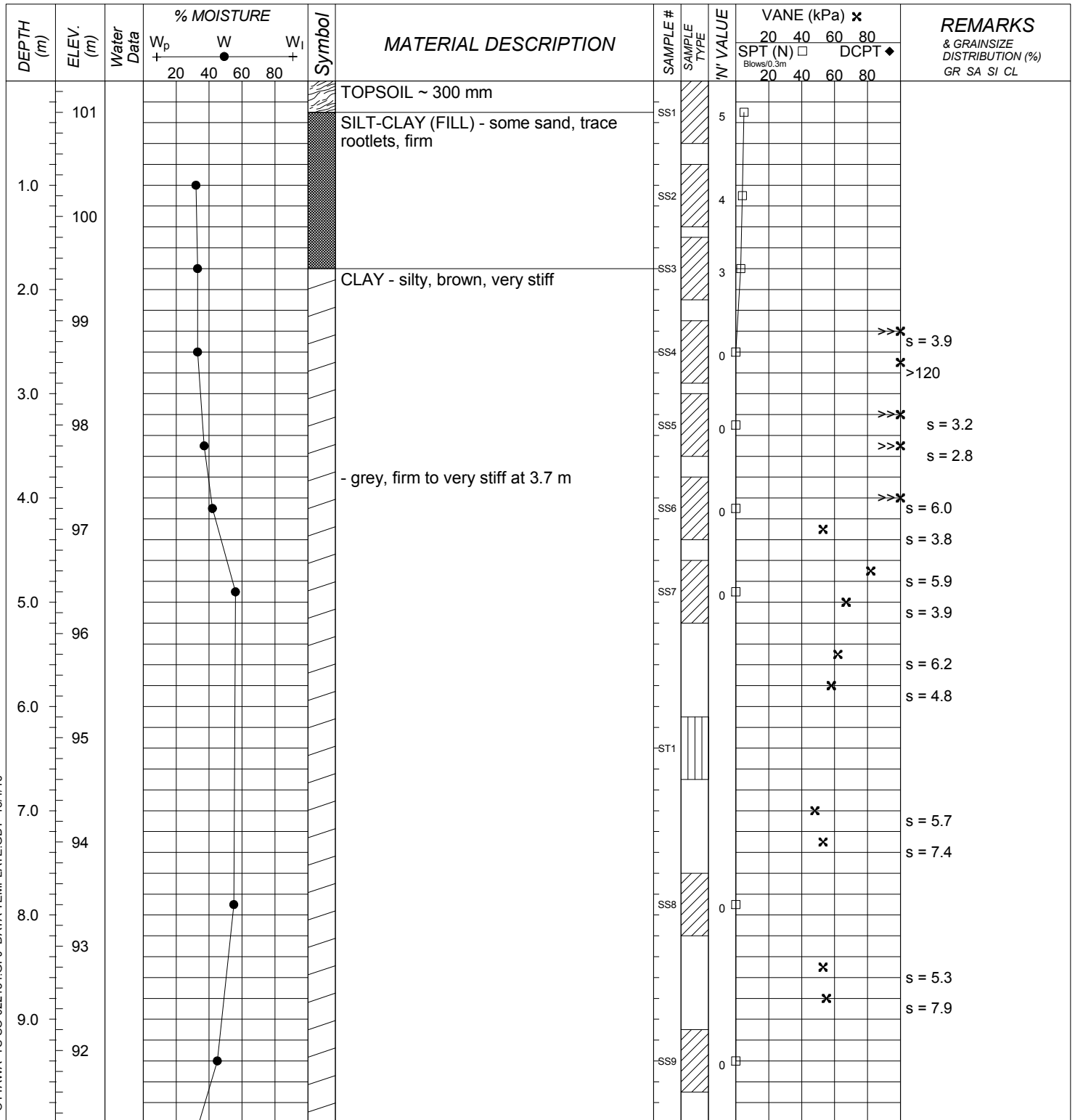
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|--------------------|---------------------|-----------|
| Auger Sample | Rock Core | Bentonite |
| Split Spoon Sample | Hiller Peat Sampler | Sand |
| Bulk Sample | 70mm Thin Wall Tube | |

ENCLOSURE 1

LOG OF BOREHOLE BH 16-5

DST REF. No.: **TS-SO-022154**
 CLIENT: **Enterprise Holdings**
 PROJECT: **Commercial Building**
 LOCATION: **225 Huntmar Drive, Ottawa, Ontario**
 SURFACE ELEV.: **101.30 metres**

Drilling Data
 METHOD: **Hollow Stem Auger**
 DIAMETER: **200 mm**
 DATE: **8 March 2016**
 COORDINATES: **5021480.538 m N, 457913.348 m E**



BOREHOLE (STANDARD) - OTTAWA TS-SO-022154.GPJ DATA TEMPLATE.GDT 18/4/16



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SAMPLE TYPE LEGEND

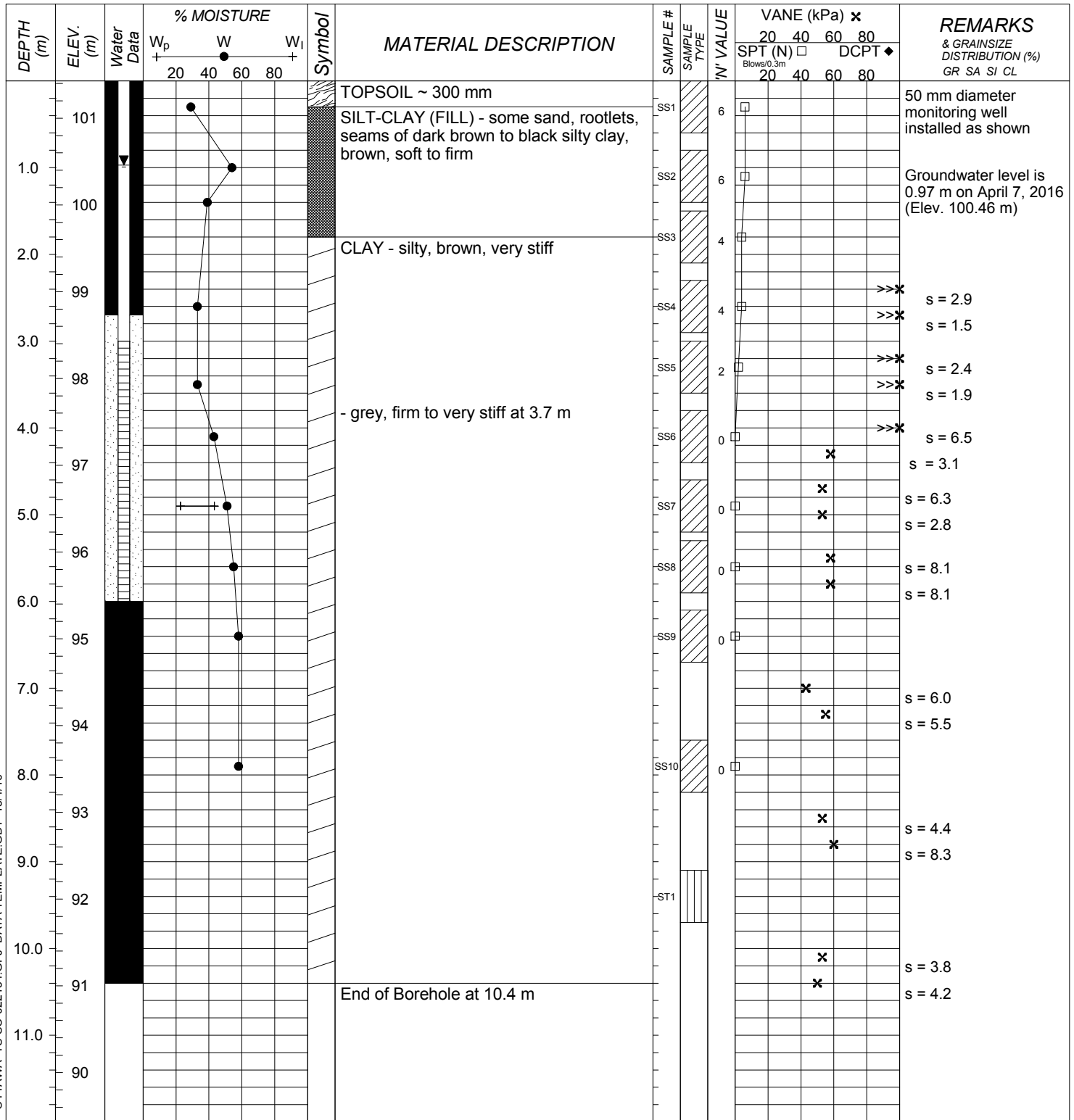
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|--------------------|---------------------|-----------|
| Auger Sample | Rock Core | Bentonite |
| Split Spoon Sample | Hiller Peat Sampler | Sand |
| Bulk Sample | 70mm Thin Wall Tube | |

ENCLOSURE 2

LOG OF BOREHOLE BHMW 16-6

DST REF. No.: TS-SO-022154
 CLIENT: Enterprise Holdings
 PROJECT: Commercial Building
 LOCATION: 225 Huntmar Drive, Ottawa, Ontario
 SURFACE ELEV.: 101.43 metres

Drilling Data
 METHOD: Hollow Stem Auger
 DIAMETER: 200 mm
 DATE: 7 March 2016
 COORDINATES: 5021470.256 m N, 457919.159 m E



BOREHOLE (STANDARD) - OTTAWA TS-SO-022154.GPJ DATA TEMPLATE.GDT 18/4/16



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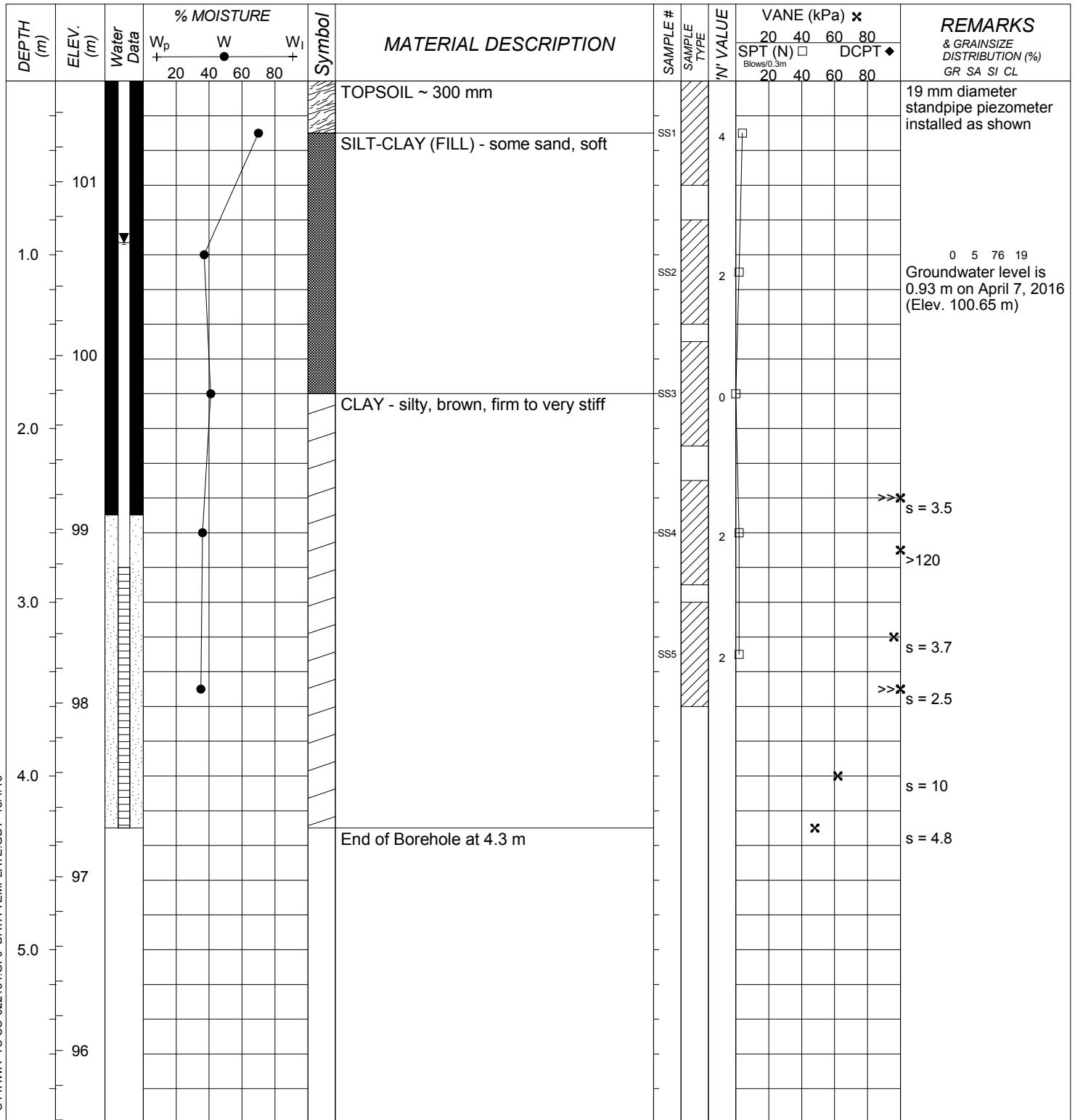
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|--------------------|---------------------|-----------|
| Auger Sample | Rock Core | Bentonite |
| Split Spoon Sample | Hiller Peat Sampler | Sand |
| Bulk Sample | 70mm Thin Wall Tube | |

ENCLOSURE 4

LOG OF BOREHOLE BH 16-7

DST REF. No.: **TS-SO-022154**
 CLIENT: **Enterprise Holdings**
 PROJECT: **Commercial Building**
 LOCATION: **225 Huntmar Drive, Ottawa, Ontario**
 SURFACE ELEV.: **101.58 metres**

Drilling Data
 METHOD: **Hollow Stem Auger**
 DIAMETER: **200 mm**
 DATE: **8 March 2016**
 COORDINATES: **5021445.937 m N, 457917.307 m E**



BOREHOLE (STANDARD) - OTTAWA TS-SO-022154.GPJ DATA TEMPLATE.GDT 18/4/16



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SAMPLE TYPE LEGEND

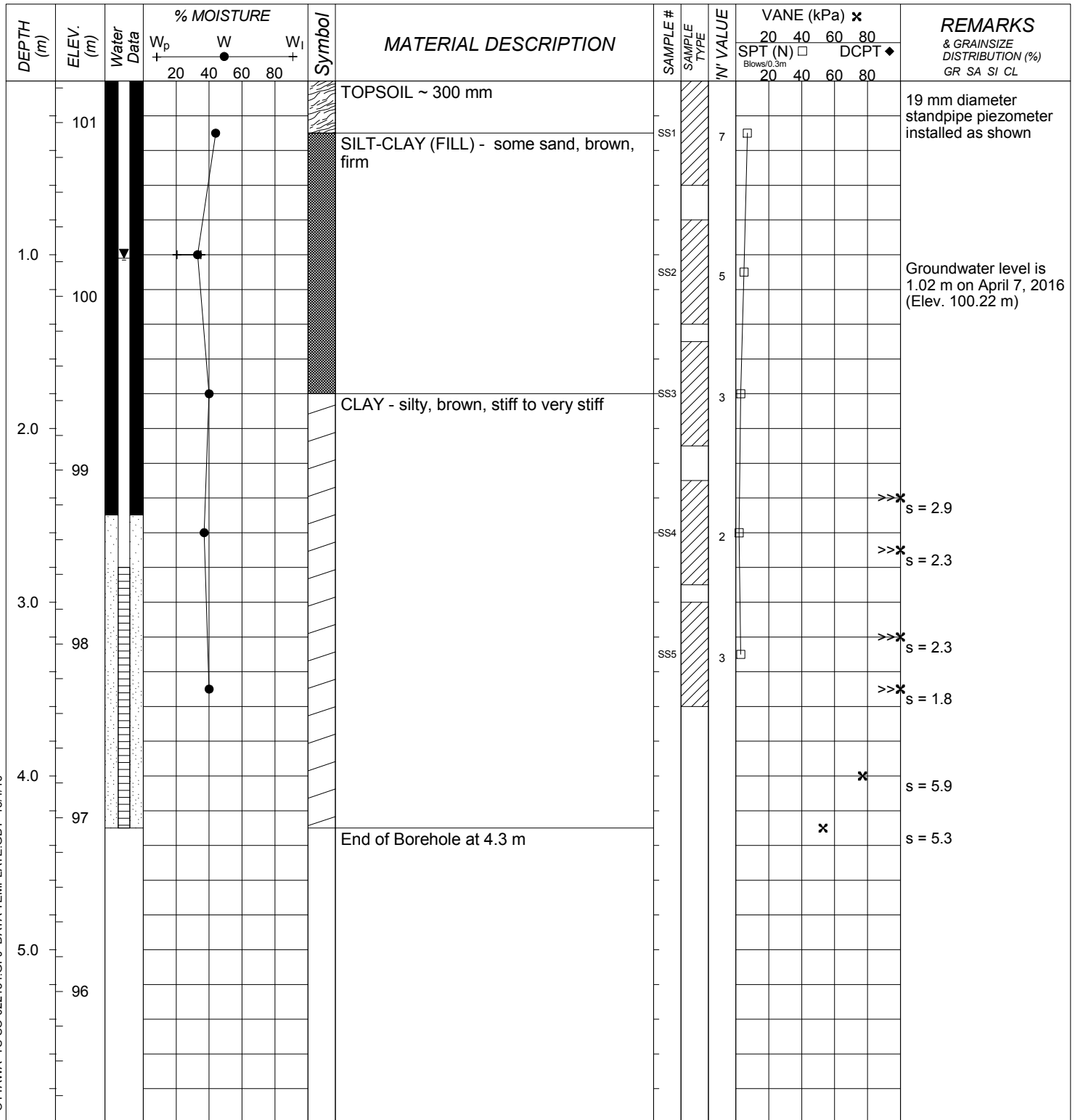
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|--------------------|---------------------|-----------|
| Auger Sample | Rock Core | Bentonite |
| Split Spoon Sample | Hiller Peat Sampler | Sand |
| Bulk Sample | 70mm Thin Wall Tube | |

ENCLOSURE 1

LOG OF BOREHOLE BH 16-8

DST REF. No.: **TS-SO-022154**
 CLIENT: **Enterprise Holdings**
 PROJECT: **Commercial Building**
 LOCATION: **225 Huntmar Drive, Ottawa, Ontario**
 SURFACE ELEV.: **101.24 metres**

Drilling Data
 METHOD: **Hollow Stem Auger**
 DIAMETER: **200 mm**
 DATE: **8 March 2016**
 COORDINATES: **5021464.903 m N, 457941.283 m E**



BOREHOLE (STANDARD) - OTTAWA TS-SO-022154.GPJ DATA TEMPLATE.GDT 18/4/16



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SAMPLE TYPE LEGEND

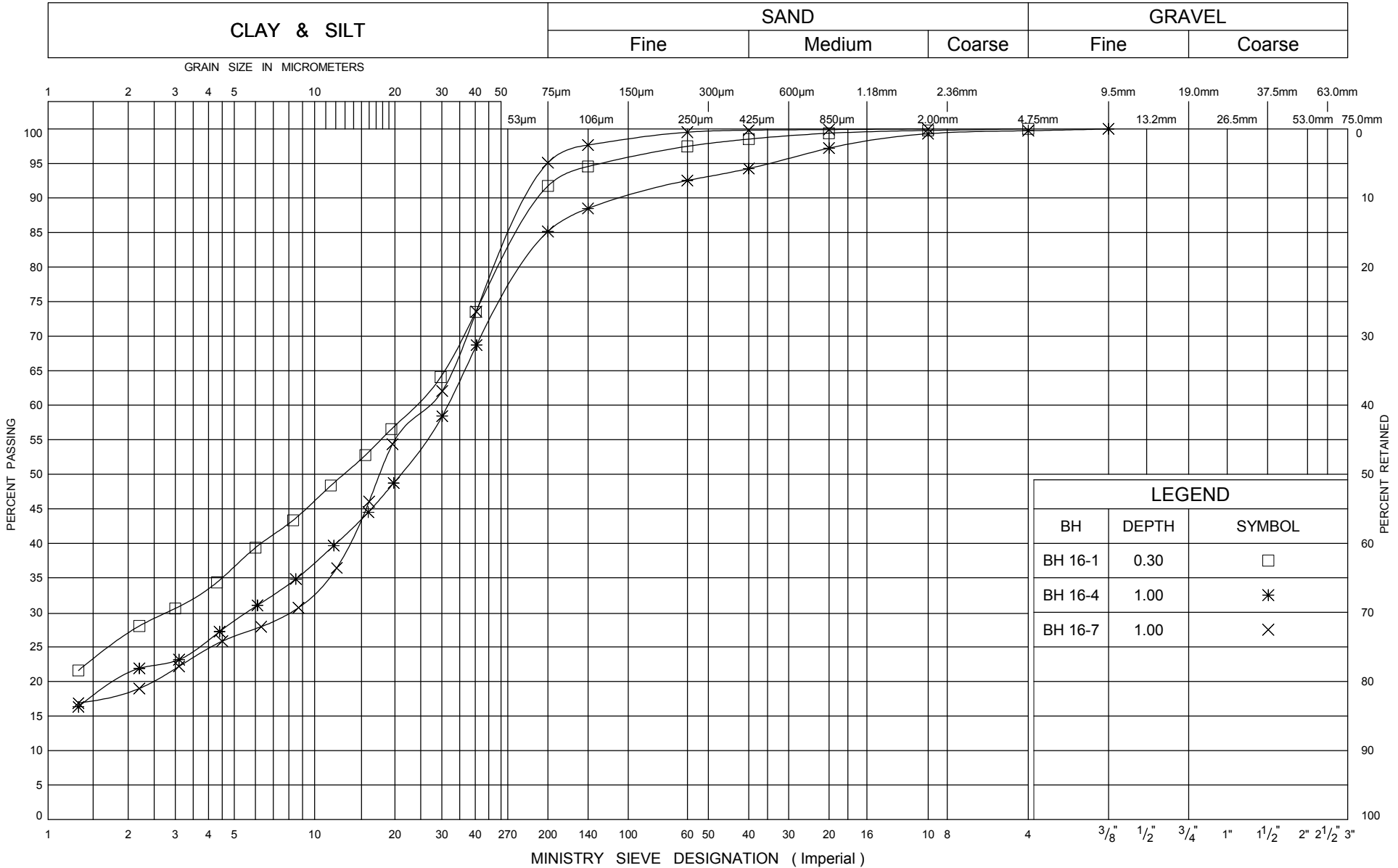
- | | | |
|--------------------|---------------------|-----------|
| Auger Sample | Rock Core | Bentonite |
| Split Spoon Sample | Hiller Peat Sampler | Sand |
| Bulk Sample | 70mm Thin Wall Tube | |

ENCLOSURE 2

APPENDIX D

LABORATORY TEST RESULTS AND CERTIFICATE OF ANALYSES

UNIFIED SOIL CLASSIFICATION SYSTEM



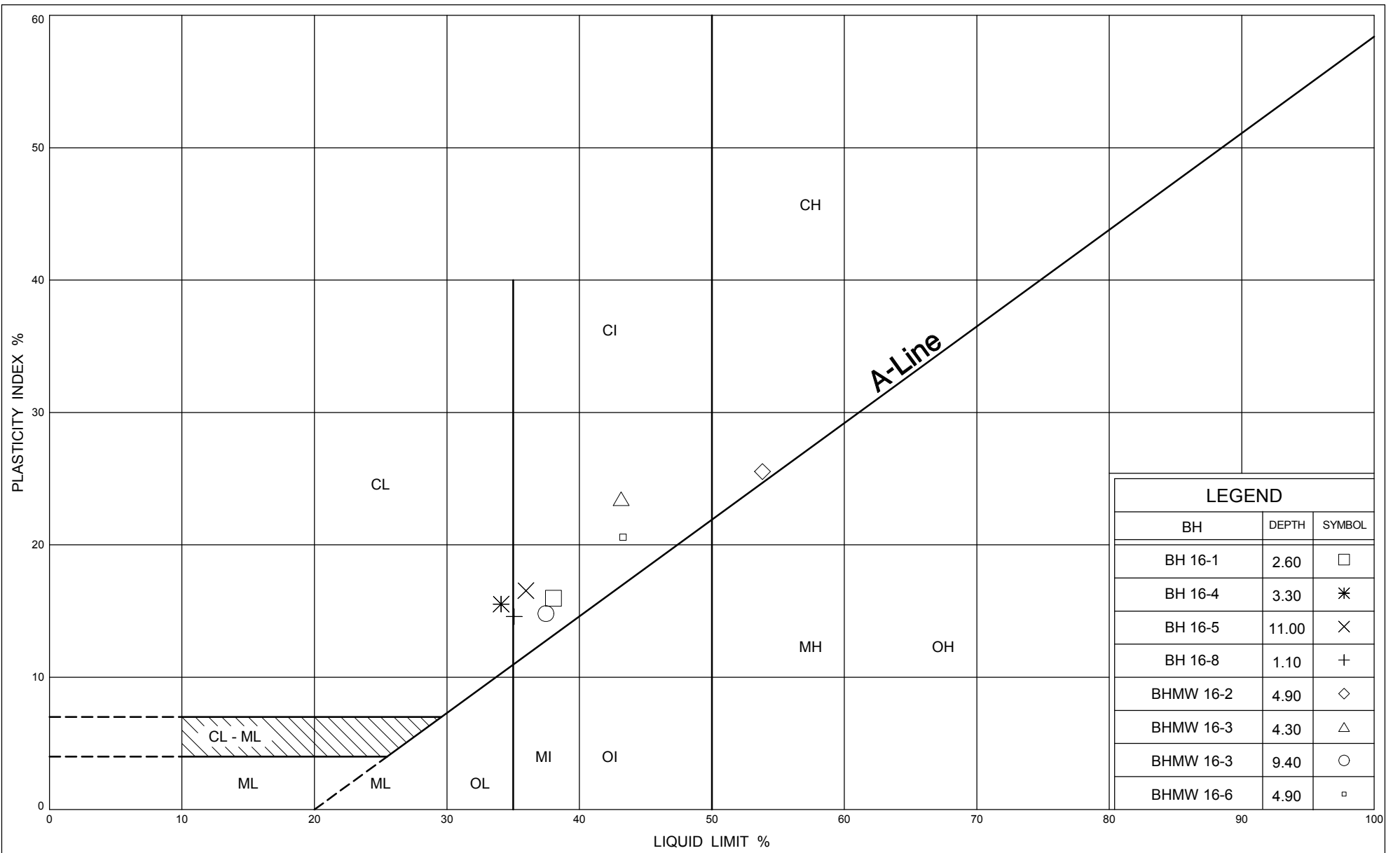
GRAIN SIZE DISTRIBUTION

FINES

ENCLOSURE 1

DST REF# TS-SO-022154

ENTERPRISE HOLDINGS



| LEGEND | | |
|-----------|-------|--------|
| BH | DEPTH | SYMBOL |
| BH 16-1 | 2.60 | □ |
| BH 16-4 | 3.30 | * |
| BH 16-5 | 11.00 | × |
| BH 16-8 | 1.10 | + |
| BHMW 16-2 | 4.90 | ◇ |
| BHMW 16-3 | 4.30 | △ |
| BHMW 16-3 | 9.40 | ○ |
| BHMW 16-6 | 4.90 | ◻ |



PLASTICITY CHART
LOW TO HIGH PLASTIC CLAY

ENCLOSURE 2
DST REF# TS-SO-022154
ENTERPRISE HOLDINGS



DST Thunder Bay
ATTN: Syed Ahmed
DST Consulting Engineers Inc.
605 Hewitson St.
Thunder Bay ON P7B 5V5

Date Received: 07-APR-16
Report Date: 12-APR-16 11:35 (MT)
Version: FINAL

Client Phone: 807-626-1321

Certificate of Analysis

Lab Work Order #: L1753212
Project P.O. #: NOT SUBMITTED
Job Reference: TS-S0-022154
C of C Numbers:
Legal Site Desc:

Rikki Thomson
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 1081 Barton Street, Thunder Bay, ON P7B 5N3 Canada | Phone: +1 807 623 6463 | Fax: +1 807 623 7598
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|--------|------------|------|----------|-----------|-----------|----------|
| L1753212-1 ENTERPRISE HOLDINGS BH2 - SS5 Sampled By: Client on 07-APR-16 @ 10:35 Matrix: Soil | | | | | | | |
| Physical Tests | | | | | | | |
| Conductivity | 455 | | 4.0 | umhos/cm | | 11-APR-16 | R3436162 |
| % Moisture | 28.6 | | 0.10 | % | 08-APR-16 | 09-APR-16 | R3434795 |
| pH | 7.84 | | 0.10 | pH units | | 11-APR-16 | R3436174 |
| Resistivity | 2200 | | 1.0 | ohm*cm | | 11-APR-16 | |
| Leachable Anions & Nutrients | | | | | | | |
| Chloride | 329 | | 20 | mg/kg | 08-APR-16 | 11-APR-16 | R3436544 |
| Anions and Nutrients | | | | | | | |
| Sulphate | 59 | | 20 | mg/kg | 08-APR-16 | 11-APR-16 | R3436544 |
| L1753212-2 ENTERPRISE HOLDINGS BH4 - SS9 Sampled By: Client on 07-APR-16 @ 10:35 Matrix: Soil | | | | | | | |
| Physical Tests | | | | | | | |
| Conductivity | 213 | | 4.0 | umhos/cm | | 11-APR-16 | R3436162 |
| % Moisture | 39.5 | | 0.10 | % | 08-APR-16 | 09-APR-16 | R3434795 |
| pH | 7.95 | | 0.10 | pH units | | 11-APR-16 | R3436174 |
| Resistivity | 4690 | | 1.0 | ohm*cm | | 11-APR-16 | |
| Leachable Anions & Nutrients | | | | | | | |
| Chloride | <20 | | 20 | mg/kg | 08-APR-16 | 11-APR-16 | R3436544 |
| Anions and Nutrients | | | | | | | |
| Sulphate | 155 | | 20 | mg/kg | 08-APR-16 | 11-APR-16 | R3436544 |
| L1753212-3 ENTERPRISE HOLDINGS BH6 - SS8 Sampled By: Client on 07-APR-16 @ 10:35 Matrix: Soil | | | | | | | |
| Physical Tests | | | | | | | |
| Conductivity | 318 | | 4.0 | umhos/cm | | 11-APR-16 | R3436162 |
| % Moisture | 37.4 | | 0.10 | % | 08-APR-16 | 09-APR-16 | R3434795 |
| pH | 7.83 | | 0.10 | pH units | | 11-APR-16 | R3436174 |
| Resistivity | 3140 | | 1.0 | ohm*cm | | 11-APR-16 | |
| Leachable Anions & Nutrients | | | | | | | |
| Chloride | <20 | | 20 | mg/kg | 08-APR-16 | 11-APR-16 | R3436544 |
| Anions and Nutrients | | | | | | | |
| Sulphate | 404 | | 20 | mg/kg | 08-APR-16 | 11-APR-16 | R3436544 |
| | | | | | | | |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

| ALS Test Code | Matrix | Test Description | Method Reference** |
|--|--------|-------------------------|-------------------------|
| CL-WT | Soil | Chloride in Soil | EPA 300.0 |
| EC-WT | Soil | Conductivity (EC) | EPA 9050A |
| A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter. | | | |
| MOISTURE-WT | Soil | % Moisture | Gravimetric: Oven Dried |
| PH-WT | Soil | pH | MOEE E3137A |
| Soil samples are mixed in the deionized water and the supernatant is analyzed directly by the pH meter. | | | |
| RESISTIVITY-CALC-WT | Soil | Resistivity Calculation | APHA 2510 B |
| Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity. | | | |
| RESISTIVITY-CALC-WT | Soil | Resistivity Calculation | MOECC E3138 |
| Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity. | | | |
| SO4-WT | Soil | Sulphate | EPA 300.0 |

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

| Laboratory Definition Code | Laboratory Location |
|----------------------------|---|
| WT | ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA |

Chain of Custody Numbers:
GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwt - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid weight of sample

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1753212

Report Date: 12-APR-16

Page 1 of 2

Client: DST Thunder Bay
 DST Consulting Engineers Inc. 605 Hewitson St.
 Thunder Bay ON P7B 5V5

Contact: Syed Ahmed

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|--------------------|----------|-------------|--------|-----------|----------|------|---------|-----------|
| CL-WT | | Soil | | | | | | |
| Batch | R3436544 | | | | | | | |
| WG2288222-3 | CRM | AN-CRM-WT | | | | | | |
| Chloride | | | 87.6 | | % | | 70-130 | 11-APR-16 |
| WG2288222-4 | DUP | L1753212-3 | | | | | | |
| Chloride | | <20 | <20 | RPD-NA | mg/kg | N/A | 30 | 11-APR-16 |
| WG2288222-2 | LCS | | | | | | | |
| Chloride | | | 101.1 | | % | | 70-130 | 11-APR-16 |
| WG2288222-1 | MB | | | | | | | |
| Chloride | | | <20 | | mg/kg | | 20 | 11-APR-16 |
| EC-WT | | Soil | | | | | | |
| Batch | R3436162 | | | | | | | |
| WG2288251-1 | DUP | L1753212-3 | | | | | | |
| Conductivity | | 318 | 299 | | umhos/cm | 6.2 | 20 | 11-APR-16 |
| WG2289063-1 | LCS | | | | | | | |
| Conductivity | | | 101.1 | | % | | 70-130 | 11-APR-16 |
| MOISTURE-WT | | Soil | | | | | | |
| Batch | R3434795 | | | | | | | |
| WG2288020-2 | LCS | | | | | | | |
| % Moisture | | | 103.2 | | % | | 90-110 | 09-APR-16 |
| WG2288020-1 | MB | | | | | | | |
| % Moisture | | | <0.10 | | % | | 0.1 | 09-APR-16 |
| PH-WT | | Soil | | | | | | |
| Batch | R3436174 | | | | | | | |
| WG2288263-1 | DUP | L1753212-1 | | | | | | |
| pH | | 7.84 | 7.86 | J | pH units | 0.02 | 0.3 | 11-APR-16 |
| WG2288962-1 | LCS | | | | | | | |
| pH | | | 6.98 | | pH units | | 6.7-7.3 | 11-APR-16 |
| SO4-WT | | Soil | | | | | | |
| Batch | R3436544 | | | | | | | |
| WG2288222-3 | CRM | AN-CRM-WT | | | | | | |
| Sulphate | | | 88.1 | | % | | 60-140 | 11-APR-16 |
| WG2288222-4 | DUP | L1753212-3 | | | | | | |
| Sulphate | | 404 | 404 | | mg/kg | 0.1 | 30 | 11-APR-16 |
| WG2288222-2 | LCS | | | | | | | |
| Sulphate | | | 100.2 | | % | | 70-130 | 11-APR-16 |
| WG2288222-1 | MB | | | | | | | |
| Sulphate | | | <20 | | mg/kg | | 20 | 11-APR-16 |

Quality Control Report

Workorder: L1753212

Report Date: 12-APR-16

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Legend:

| | |
|-------|---|
| Limit | ALS Control Limit (Data Quality Objectives) |
| DUP | Duplicate |
| RPD | Relative Percent Difference |
| N/A | Not Available |
| LCS | Laboratory Control Sample |
| SRM | Standard Reference Material |
| MS | Matrix Spike |
| MSD | Matrix Spike Duplicate |
| ADE | Average Desorption Efficiency |
| MB | Method Blank |
| IRM | Internal Reference Material |
| CRM | Certified Reference Material |
| CCV | Continuing Calibration Verification |
| CVS | Calibration Verification Standard |
| LCSD | Laboratory Control Sample Duplicate |

Sample Parameter Qualifier Definitions:

| Qualifier | Description |
|-----------|---|
| J | Duplicate results and limits are expressed in terms of absolute difference. |
| RPD-NA | Relative Percent Difference Not Available due to result(s) being less than detection limit. |

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

