Geotechnical Investigation Report

Proposed Commercial Gas Bar
3500 Hawthorne Rd,
Ottawa, ON

Prepared for:
2520333 Ontario Inc..

Prepared by:
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Project No. 121620528

June 2017

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1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by 2520333 Ontario Inc. to carry out a geotechnical investigation at the site of a proposed commercial development located at 3500 Hawthorne Road in Ottawa, ON. It is understood the proposed development will include a commercial gas bar including a one storey convenience store, gas pumps with an overhead canopy and underground services.

This report has been prepared specifically and solely for the project described herein. It presents the factual results of the investigation and provides geotechnical recommendations for the design and construction of the proposed development.

Limitations associated with this report and its contents are provided in the statement of conditions included in Appendix A.

2.0 PROPOSED DEVELOPMENT

A commercial gas bar is proposed to be located at 3500 Hawthorne Road, located within the northwest corner of the intersection of Hawthorne Road and Hunt Club Road. The development will include a single storey building, approximately 230 m^2. The development will also include a paved parking area, gas pumps with an overhead canopy and underground services. The site location is shown on the Key Plan, Drawing No. 1 provided in Appendix B. The site is currently a vacant grassed lot with some shrubs and trees. There is a subdivision located on the west and north side of the site.

3.0 SCOPE OF WORK

The scope of work for the geotechnical investigation includes the following:

- Carry out a field investigation, consisting of six (6) test pits to a depth of 4 m or refusal on bedrock, if shallower;
- Collect bulk soil samples at regular intervals in the test pits;
- Perform laboratory tests including moisture content, grain size distribution and corrosion analysis (pH, sulphate, resistivity and chlorides) on selected soil samples;
- Survey the ground surface elevation at the test pit locations using a Trimble GPS unit;
- Document the results of the field and laboratory programs in a geotechnical investigation report with geotechnical recommendations including:
  - Geotechnial Resistances (ULS and SLS) for foundation design;
  - Excavation and backfill requirements;

- Frost protection recommendations;
- Potential of liquefaction;
- Site preparation (stripping, grading, filling);
- Pavement design and pavement structure recommendations;
- Seismic site classification according to the 2012 Ontario Building Code (OBC);
- Bedding and backfill for services.

4.0 INVESTIGATION PROCEDURES

4.1 TEST PIT INVESTIGATION

Prior to carrying out the investigation, Stantec Consulting Ltd. (Stantec) marked out the proposed test pit locations. As a component of our standard procedures and due diligence, Stantec arranged to have the test pit locations cleared of both public and private underground utilities.

The field program was carried out on May 4, 2017 and consisted of nine test pits. The test pit locations are shown on Drawing No. 2 in Appendix B.

The test pits were advanced using a backhoe. The subsurface stratigraphy encountered in the test pit was recorded in the field by experienced Stantec personnel. The test pits were terminated at refusal on bedrock; the depth to bedrock ranged from 0.8 m to 2.8 m. Test pits were backfilled the excavated material and tamped in place.

All recovered soil samples were stored in moisture-proof bags, labelled accordingly and returned to the Stantec Ottawa laboratory for detailed classification and testing.

4.1 SURVEY

The test pit locations were surveyed using a Trimble GPS unit with decimeter accuracy. Accuracy may be affected by satellite coverage at the time of survey.

4.2 LABORATORY TESTING

All samples returned to the laboratory were subjected to detailed visual examination and additional classification by a geotechnical engineer. Select samples were tested for moisture content and gradation analysis. Three (3) soil samples were submitted to Paracel Laboratories in Ottawa, Ontario for the determination of pH, chloride content, soluble sulphate and resistivity.

The results of the laboratory tests are discussed in the text of this report and are provided on the Test Pit Records in Appendix C and the figures in Appendix D.

Soil samples will be stored for one (1) month after issuance of the final report unless directed otherwise by the Client.

5.0 RESULTS OF INVESTIGATION

In general, the subsurface soil profile at the test pit locations consisted of topsoil underlain by fill or sandy silty clay followed by bedrock. Detailed descriptions of the subsurface soil conditions are presented on the Test Pit Records provided in Appendix C. Laboratory test results are shown on the Test Pit Records as well as in Appendix D.

The test pit records depict conditions at a particular location and at the particular times indicated. Subsurface soil and groundwater conditions between test pits and at locations away from the test pits locations could vary from those indicated on the test pit logs.

An explanation of the symbols and terms used on the Test Pit Records is also provided in Appendix C.

5.1 SUBSURFACE SOIL CONDITIONS

The following sections summarize the soil conditions.

5.1.1 Topsoil

Topsoil was encountered at ground surface, the topsoil thickness ranged from 240 mm to 450 mm.

5.1.2 Fill

A layer of fill ranging from silty sand with gravel to silty gravel with sand was encountered beneath the topsoil in Test Pits 17-1, 17, 2, 17-7 and 17-8. The thickness of the fill ranged from 0.7 m to 2.4 m. The moisture content of this material ranged from 11% to 30%.

Three samples of this material were submitted for gradation testing and yielded the following results:

- Gravel: 21 to 40%
- Sand: 30 to 54%
- Fines (clay and silt size particles): 25 to 41%

According to the Unified Soil Classification System (USCS), this material can be classified as a silty sand with gravel (SM) to silty gravel with sand (GM). The grain size distribution curves are shown on Figure No. 1 in Appendix D.

5.1.3 Sandy Silty Clay to Silty Clay with Sand

A layer of clay was encountered beneath the topsoil in Test Pits 17-3, 17-4, 17-5, 17-6 and 17-9. The thickness of the clay ranged from 0.5 m to 0.6 m. The moisture content of this material ranged from 19% to 23%.

Three samples of this material were submitted for gradation testing and yielded the following results:

- Gravel: 1 to 2%
- Sand: 20 to 35%
- Silt: 33 to 41%
- Clay: 27 to 41%

According to the Unified Soil Classification System (USCS), this material can be classified as a sandy silty clay (CL-ML) to silty clay with sand (CL-ML). The grain size distribution curves are shown on Figure No. 2 in Appendix D.

5.1.4 Bedrock

All test pits were advanced until bedrock was encountered. The depth to bedrock ranged from 0.8 m to 2.8 m below grade (elevation 83.2 m to 81.2 m) with the upper portion of the bedrock weathered at some locations. The bedrock at the site is shale of the Carlsbad formation which is a pyritic shale.

Pyritic Shale

In Ottawa, the pyritic shale of the Billings or Carlsbad formations typically present the following constraints to construction projects.

- The initial bacterial oxidation of pyrite produces ferrous sulphate and ferric sulphate which both attack concrete (ie. sulphate attack).
- The weathering in the combined presence of water and oxygen produces sulphuric acid which results in an acidic environment that is aggressive towards steel and concrete.
- The sulphuric acid reacts with calcite seams (or thin layers) found within the shale converting it to gypsum. When calcite converts to gypsum, its volume increases by a factor of two which can result in destructive heaving; floor slabs and lightly loaded structures are particularly prone. The Billings and Carlsbad shale are colloquially referred to as “expansive shale”.

Autotrophic bacteria consume oxygen in the oxidation process and are believed to be most active between temperatures of 30 to 35 degrees Celsius. Restricting the air supply is generally viewed as an effective method of minimizing both the chemical and bacterial oxidation process.

The following conditions are typically considered favorable to the oxidation process.

- Features that allow air to enter the pyritic rock
- Drained conditions or low groundwater table
- Fissures or crushed zones in drained rock
- Vertical cuts, such as utility trenches, permitting lateral air entry into the rock mass
- A warm basement environment particularly close to the shale

- Use of excavated shale as a fill material, which maximizes rock surface exposure to oxygen

Common considerations when constructing within the expansive pyritic shale include:

- Excavate without disturbing the rock mass to avoid airflow within newly created fractures.
- Within building excavations, cover exposed pyritic shale with a 50 mm mudmat within 24 hours of exposure; for vertical faces such as utility trenches and footing excavations, shotcrete or other spray-on sealing membranes may be used. This includes areas to be later backfilled.
- Within building excavations, if possible excavate to a single level to avoid vertical faces within footing and utility trenches, otherwise protection of vertical faces is required.
- Within building excavations, if footing and utility trenches are excavated and backfilled within 24 hours, backfilling with concrete to the top of rock would protect the vertical faces.
- Use sulphate resistance concrete in areas exposed to the rock, including buried pipes.
- Insulate basement floors where spaces will have above normal temperatures.
- Avoid lowering the water table to a level lower than the top of rock left beneath the building.
- Avoid drained shafts or pits that could lower the water table beneath the building. If elevator pits, or similar features, are required, the design should include water-tight constructions.
- Do not use pyritic shale as a rock-fill or a crushed soil borrow source.
- Pyritic shale that will have a minimum of 1.0 m of natural soil cover is generally left untreated.
- Shale underlying heave sensitive structures or utilities should be protected from exposure to prevent differential movements. Shale underlying pavements, sidewalks, and landscaped areas are typically left unprotected but may require heave related maintenance in the long-term.
- Where the shale is left unprotected, consider the impact of a corrosive acidic environment on buried features including metallic bodies (column bases, piping, conduits, etc.); protection of horizontal and vertical shale faces within 24 hours of exposure may be warranted on this basis.
- Permanently exposed pyritic rock faces will rapidly deteriorate from their initial exposed condition.
- Inclusion of a vapour barrier beneath the slabs-on-ground to provide protection against aggressive vapours which may accumulate beneath the concrete slabs.

5.2 GROUNDWATER

During the field investigation, water was observed entering the excavation at depths of 0.6 m, 0.8 m and 2.8 m for test pits TP17-5, TP17-6 and TP17-8, respectively.

Fluctuations due to seasonal variations or precipitation events should be anticipated.

6.0 DISCUSSIONS AND RECOMMENDATIONS

6.1 GENERAL

The following geotechnical issues are deemed to be significant to the proposed development:

- The existing bedrock at the site is considered acceptable for spread footing foundations and slab-on-grade for lightly loaded structures.
- The fill material and silty clay will need to be excavated from beneath the building footings. This layer of material is highly susceptible to frost heave; the design should consider using insulation beneath unheated concrete slabs and sidewalks. Potential damage from frost heave beneath exterior concrete slabs such as sidewalks can be reduced by placing a 100 mm thick layer of insulation beneath the concrete.
- Groundwater or surface water runoff may be encountered during excavation and may require the use of dewatering techniques.

6.2 SITE PREPARATION

6.2.1 Building Shallow Foundations

All existing topsoil, fill, silty clay and any deleterious material should be excavated and removed from beneath the building foundation. Subexcavation of the fill material may be required in areas where the fill is within the influence zone of the footing. The influence zone is defined as the area within a 1 horizontal to 1 vertical projection downward and away from the edge of the footing to competent material (bedrock). Bearing material will require inspection by geotechnical personnel to verify design bearing pressures. Building foundations should be placed directly on clean undisturbed bedrock.

Structural Fill should be used to raise the grade where required. Structural Fill should consist of OPSS Granular B Type II or OPSS Granular A. It should be placed in lifts no thicker than 300 mm and compacted to at least 100% Standard Proctor Maximum Dry Density (SPMDD).

6.2.2 Floor Slab

All existing topsoil and other deleterious material such as surficial vegetation and organic material should be entirely removed from beneath the slabs. Prepared subgrades should be inspected by geotechnical personnel prior to placement of fill or concrete. The existing fill could remain beneath the footprint of the building slab provided the fill is surface compacted to at least 98% SPMDD. Any loose or disturbed areas should be subexcavated and replaced with Structural Fill. A layer of free draining granular material such as OPSS Granular A at least 200 mm in thickness should be placed immediately beneath the floor slab for leveling, drainage and support purposes. This material should be compacted to at least 100% SPMDD.

6.2.3 Re-Use of Site Generated Material

The overburden soils observed on site have a high clay and silt content. The existing materials will not be reusable as grading fills or subgrade fill. It is noted that compaction is highly dependent on the moisture content of the material, thus the amount of re-useable material will be dependent on the natural moisture content, weather conditions and the construction techniques at the time of excavation and placement.

6.2.4 Asphalt Areas

All existing topsoil and other deleterious materials such as vegetation, and organic material should be entirely removed from beneath the proposed paved areas to the satisfaction of the geotechnical personnel. The exposed subgrade should be proof-rolled in the presence of a geotechnical inspector using heavy compaction equipment. All soft or disturbed areas revealed during subgrade inspections or proof-rolling should be removed to a depth of 500 mm and replaced with compacted Structural Fill.

If partial depth reconstruction of the asphalt areas is proposed, the exposed subgrade should be proof-rolled in the presence of a geotechnical inspector using heavy compaction equipment. All soft or disturbed areas revealed during subgrade inspections or proof-rolling should be removed to a depth of 500 mm and replaced with compacted Structural Fill.

6.2.5 Additional Considerations

If winter construction is anticipated, the following is recommended to be included in the contract:

- Foundations shall be constructed on non-frozen ground only; where non-frozen ground includes the material at surface and all underlying soils. The non-frozen nature of the ground must be confirmed by a geotechnical inspection within 1 hour of concrete placement.
- Following construction of footings, temporary frost protection must be provided to avoid freezing of the bearing surface and for protection of the concrete during curing.
- Foundations shall be backfilled with free-draining granular material and drainage shall be provided to prevent lifting of the foundations due to adfreeze during the construction period.
- Full-time inspection and testing services is required during earthworks in winter conditions.

6.3 FOUNDATIONS

6.3.1 Shallow Foundations

Conventional spread and strip footing foundations could be considered for the building. Foundations should be founded on clean undisturbed bedrock.

We have calculated the resistances at Ultimate Limits States (ULS) and reactions at Serviceability Limits States (SLS) for spread (square) and strip footings for the development. The values are provided below in Table 6.1.

Table 6.1: Geotechnical Resistance for Shallow Foundations on Bedrock

Foundation Type	**Footing Width (m)**	**Geotechnical Resistance at ULS (kPa)**
Strip Footing	0.6 to 1.0	900
Spread footing	0.6 to 2.0	1000

The factored geotechnical bearing resistance at Ultimate Limit States (ULS) incorporates a resistance factor of 0.5. The geotechnical reaction at Serviceability Limit States (SLS) is the bearing pressure that corresponds to 25 mm of settlement. The settlement of foundations founded on rock is expected to be negligible, thus the ULS resistance governs.

6.3.2 Frost Penetration Depth

All perimeter and interior footings within a 1 m distance from the exterior walls require a minimum frost protection equivalent to a soil cover of 1.5 m for protection against frost action.

Footings in unheated areas or exterior footings should have a minimum frost protection equivalent to a soil cover of at least 1.8 m. Footings placed on sound bedrock require only half the frost cover. Where proposed footings have insufficient soil cover for frost protection, the use of insulation will be required.

A layer of silt clay was observed in the test pits. This layer of material is highly susceptible to frost heave; the design should consider using insulation beneath unheated concrete slabs and sidewalks. Potential damage from frost heave beneath exterior concrete slabs such as sidewalks can be reduced by placing 100 mm of insulation beneath the concrete.

6.4 FLOOR SLAB

The recommendations provided herein are based on the assumption that the average net slab loads will not exceed 12 kPa. Should a greater average load be proposed, the geotechnical consultant should review the recommendations presented herein.

The floor slab constructed as recommended above may be designed using a soil modulus of subgrade reaction, k, of 30 MPa/m. Non-structural slab-on-grade units should float independently of all load-bearing walls and columns.

Where construction is undertaken during winter months, floor slab subgrades should be protected from freezing. Alternatively, the floor slab subgrade must be completely thawed then proof rolled prior to placing concrete.

6.5 TEMPORARY EXCAVATIONS & GROUNDWATER CONTROL

The overburden soils should be classified as Type 3 soil as defined by the Occupational Health and Safety Act and Regulations for Construction Projects. Within Type 3 soils, open cut excavations must be sloped no steeper than one horizontal to one vertical (1H:1V) from the bottom of the trench.

Excavations deeper than 2 m and within 10 m of adjacent structures may require a temporary shoring system and should be reviewed by a geotechnical engineer. It is the responsibility of the contractor to select and design the excavation and support method.

In the case of temporary shoring design the following lateral earth pressure parameters are recommended for preliminary design.

Table 6.2: Lateral Soil Parameters

Parameters	OPSS Granular A	OPSS Granular B Type II / Existing Site Fills	Silty Clay
Unit Weight (kN/m^3)	22	22	18
Angle of Internal Friction, (degrees)	35°	32°	28°
Coefficient of Active Earth Pressure, K_a	0.27	0.31	0.36
Coefficient of Passive Earth Pressure, K_p	3.69	3.25	2.77
Coefficient of Earth Pressure at Rest, K_o	0.43	0.47	0.53

Groundwater and/or surface run-off may be encountered during excavation and construction. It is expected that groundwater may be controlled by sump and pumping methods. The silty clay deposit encountered in the test pits is a low permeability material, the sand and gravel fill encountered in the test pits has a higher permeability. It is anticipated that construction activities and groundwater dewatering can be carried out at less than 50,000 L/day, thus a Ministry of the Environment and Climate Change Permit to Take Water (PTTW) is not required for temporary groundwater dewatering of excavations.

The quality of groundwater that may be removed during the construction activities should be assessed at that time to determine if it may be disposed of directly to the local sanitary/storm sewer without treatment, under a permit that would be required from the City of Ottawa Sewer Use Program. Construction contractor has the responsibility to obtain a permit under the City of Ottawa Sewer Program and testing/discharge of water to sanitary or storm sewer.

6.6 UNDERGROUND STORAGE TANKS

It is understood that four (4) underground petroleum storage tanks will be installed. These will be located on the east side of the site.

As indicated in Section 5.2 above, groundwater was encountered at depths ranging from 0.6 m to 2.8 m, however it may fluctuate seasonally. The tanks should be designed to resist uplift pressures from a groundwater level at ground surface.

A typical tank installation should consist of; i) a 0.3 m thick concrete slab, with anchor bolts installed at the required; ii) a minimum of 0.3 m of approved backfill between the tank and the concrete slab; iii) 0.75 m of approved backfill over the tank; and iv) 0.15 m of gravel base and asphalt. The on-site fill and clay is not suitable for backfill in the storage tank areas.

6.7 PAVEMENT STRUCTURE RECOMMENDATIONS

The proposed development includes asphalt parking areas and drive-thru access roads. It is anticipated that the parking area will be used by cars and small delivery trucks (2 to 3 axle trucks). The recommended pavement structures are illustrated in Table 6.3.

Table 6.3: Recommended Asphalt Pavement Structure Design

Material	Heavy Duty - Drive-Thru, Fire and Truck Routes
SP 12.5 (surface course asphalt)	40 mm
SP 19 (base course asphalt)	50 mm
OPSS Granular A Base	150 mm
OPSS Granular B Type II Sub-base	500 mm

In preparation for construction of new pavements, the finished sub-grade surface should be proof-rolled and compacted to identify the presence of soft, wet, or deflecting areas; such areas should be removed and replaced with approved engineered fill.

The finished sub-grade surface must be compacted to achieve a minimum of 98% of the materials SPMDD immediately prior to placement of the granular materials.

All granular materials should be tested and approved by a geotechnical engineer prior to delivery to the site. Both base and subbase materials should be compacted to at least 100% SPMDD. Asphalt should be compacted to at least 97% Marshal bulk density.

The finished sub-grade surface should be graded to promote positive drainage away from the area of the pavements. It is recommended that the sub-grade surface be sloped towards catch basin structures at a minimum cross-fall of 2% across the parking lots and reduced to 1% along the perimeter curb line. Sub-drain stubs with a minimum length of 3 m extending from the catch basin and manhole locations are recommended at low points in the sub-grade to prevent ponding of water and promote positive drainage.

6.7.1 Concrete Sidewalks

The design and construction of the sidewalks slabs should include a granular base layer consisting of a minimum of 200 mm of compacted OPSS Granular A. The design should also include positive drainage away from the edge of the building and beyond the limits of the concrete. Frost heave of sidewalks could be minimized by constructing frost tapers and extending the granular base to 1.2 m below ground surface.

Potential damage from frost heave beneath exterior concrete slabs such as sidewalks can also be reduced by placing 100 mm thick layer of insulation beneath the concrete.

6.8 SEISMIC CONSIDERATIONS

The subsurface conditions were compared with Section 4.1.8.4.A of the 2012 Ontario Building Code (OBC). The soils consist of fill or silty clay underlain by bedrock at 0.8 to 2.8 m below ground surface. Based on the information, the seismic site response for the site is Class C – Very dense soil and soft rock.

The site soils beneath the foundations are not considered to be susceptible to soil liquefaction.

6.9 PIPE BEDDING AND BACKFILL

Bedding for utilities should be placed in accordance with the pipe design requirements. It is recommended that a minimum of 150 mm to 200 mm of OPSS Granular A be placed below the pipe invert as bedding material. Granular pipe backfill placed above the invert should consist of Granular A material. A minimum of 300 mm vertical and side cover should be provided. These materials should be compacted to at least 95% SPMDD.

Backfill for service trenches in landscaped areas may consist of excavated material replaced and compacted in lifts. Where the service trenches extend below paved areas, the trench should be backfilled with OPSS Select Subgrade Material from the top of the pipe cover to within 1.2 m of the proposed paved surface, placed in 300 mm thick lifts and compacted to at least 95% SPMDD. The material used within the upper 1.2 m and below the subgrade line should be similar to that exposed in the trench walls to prevent differential frost heave, placed in 300 mm thick lifts and compacted to at least 95% SPMDD. Different abutting materials within this zone will require a 3 horizontal to 1 vertical frost taper in order to minimize the effects of differential frost heaving.

Excavations for catch basins and manholes should be backfilled with compacted granular material. A 3 horizontal to 1 vertical frost taper should be built within the upper 1.2 m. The joints between catch basin or manhole sections must be wrapped with non-woven geotextile.

It should be noted that reuse of the site generated material will be highly dependent on the material's moisture content at time of placement.

Backfill should be compacted in lifts not exceeding 300 mm.

6.10 CEMENT TYPE AND CORROSION POTENTIAL

Three samples of the site soil were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The analysis results are summarized in Table 6.4.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the subsurface environment. The results are provided to aid in the selection of coatings and corrosion protection systems for items such as steel pipe in contact with the soil and groundwater at the site.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. The soluble sulphate concentrations indicate that a low degree of sulphate attack is expected for concrete in contact with soil and water. General Use (GU) Portland cement is therefore considered suitable for use at this site.

Table 6.4: Results of Chemical Analysis

Test Pit No.	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-m)
TP17-2	BS-1	0.2 – 2.4	7.66	11	37	54.8
TP17-4	BS-1	0.3 – 0.9	6.87	21	14	107
TP17-8	BS-1	1.0 – 2.8	7.31	9	178	35.5

6.11 TREE PLANTING RESTRICTIONS

The soil at the site is not considered sensitive to settlement from the water demand from trees. Tree planting restrictions are not required at this site.

7.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of the 2520333 Ontario Inc. who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Limited should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

This report was prepared by Katurah Firdawsi and reviewed by Christopher McGrath.

Yours very truly,

STANTEC CONSULTING LTD.

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June 13, 2017
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APPENDIX A

Statement of General Conditions

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

APPENDIX B

Drawing No. 1 – Key Plan

Drawing No. 2 – Test Pit Location Plan

T:\Autocad\Drawings\Project Drawings\2017\121620528\GIS\121620528_Key Plan.mxd Revised: 2017-05-30 By: gbriones

Legend

— —	Watercourse (Intermittent)
——	Watercourse (Permanent)
🟩	Wooded Area

0 500 1,000 metres

1:15,000 (at original document size of 8.5x11)

Stantec

Project Location
3500 Hawthorne Road
Ottawa, Ontario

Project No.121620528
Prepared by Gliceria Briones
on 2017-05-30

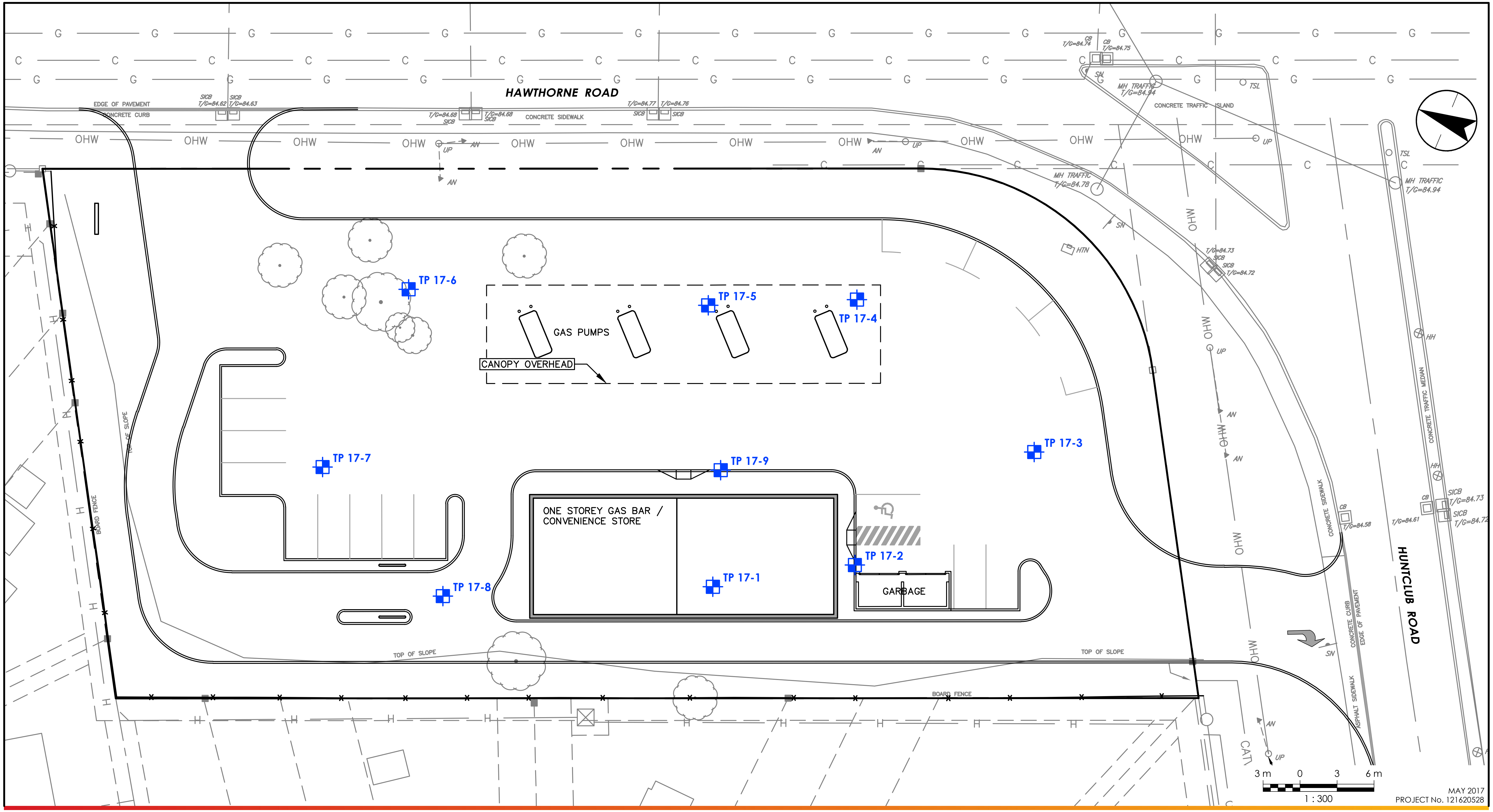
Client/Project
2520333 ONTARIO INC.
PROPOSED COMMERCIAL DEVELOPMENT

Drawing No.
1

Title
Key Plan

Notes
1. Coordinate System: NAD 1983 UTM Zone 18.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2016.
3. Imagery provided by ESRI ©2017.

T:\Autocad\Drawings\Project Drawings\2017\121620528\121620528_Test Pit.dwg
2017/05/30 2:20 PM By: Briones, Gliceria



MAY 2017
PROJECT No. 121620528

Stantec

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LEGEND

⊕ APPROXIMATE TEST PIT LOCATION

NOTES

1. COORDINATE SYSTEM: NAD 1983 MTM ZONE 9.
2. BASE PLAN PREPARED BY STANTEC COMMUNITY DEVELOPMENT GROUP. FILENAME 160401284-DB.DWG, 2017\03\22

Client/Project

2520333 ONTARIO INC.

PROPOSED COMMERCIAL DEVELOPMENT
3500 HAWTHORNE ROAD, OTTAWA, ONTARIO

Drawing No.

2

Title

TEST PIT LOCATION PLAN

APPENDIX C

Symbols and Terms Used on Borehole and Test Pit Records

Test Pit Records

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

▼	measured in standpipe, piezometer, or well
▽	inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_U	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

↧	Single packer permeability test; test interval from depth shown to bottom of borehole
⌶	Double packer permeability test; test interval as indicated
○↓	Falling head permeability test using casing
▽↓	Falling head permeability test using well point or piezometer

Stantec

TEST PIT RECORD

N: 5 024 708 E: 453 166

TP17-1

1 of 1

CLIENT 2520333 Ontario Inc.

LOCATION 3500 Hawthorne Rd, Ottawa, ON

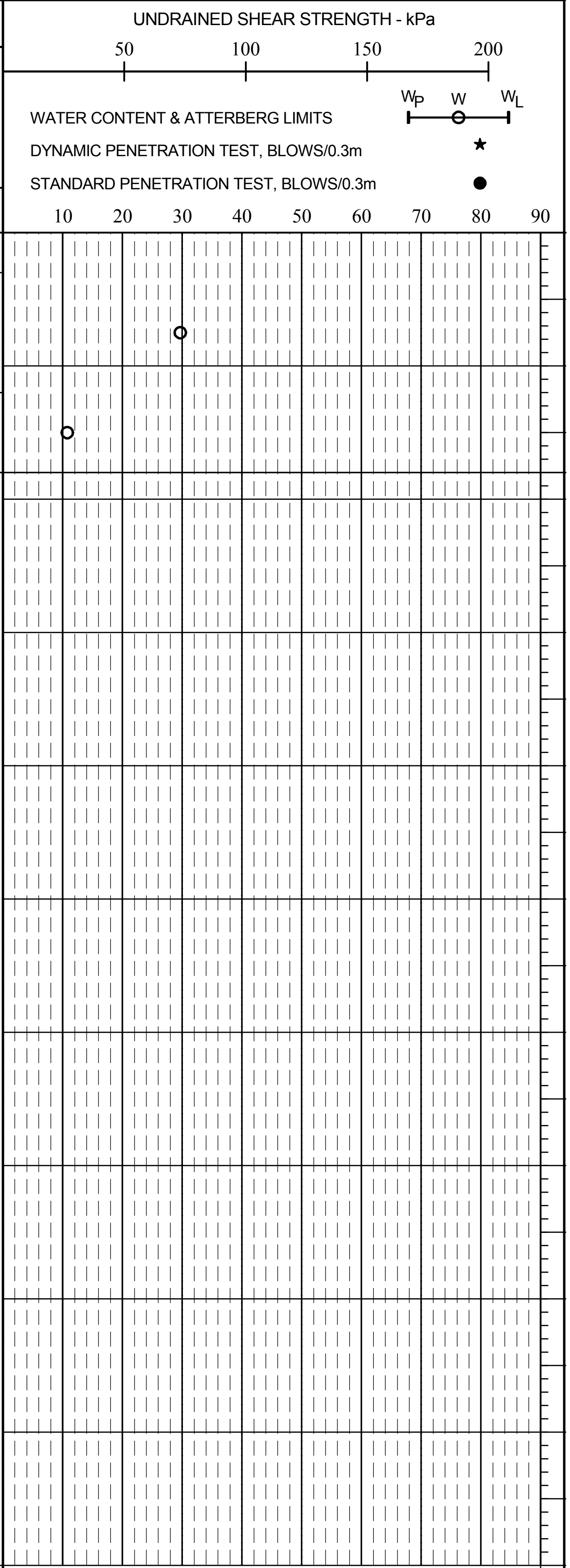
DATES: BORING May 4, 2017 WATER LEVEL

BOREHOLE No. TP17-1

PROJECT No. 121620528

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	83.91							
0	83.6	300 mm TOPSOIL						
1	82.7	FILL: brown silty gravel with sand (GM) - frequent cobbles	▨		BS	1		
2	82.1	FILL: dark brown silty sand with gravel (SM) - some clay - frequent cobbles/boulders, shale pieces	▨		BS	2		
		End of Test Pit on Bedrock						
3								
4								
5								
6								
7								
8								
9								
10								



∇ Inferred Groundwater Level

$\blacktriangledown$ Groundwater Level Measured in Standpipe

▣ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ______

Date ______

TEST PIT RECORD

N: 5 024 698 E: 453 172

TP17-2

CLIENT 2520333 Ontario Inc.

LOCATION 3500 Hawthorne Rd, Ottawa, ON

DATES: BORING May 4, 2017 WATER LEVEL

BOREHOLE No. TP17-2

PROJECT No. 121620528

DATUM Geodetic

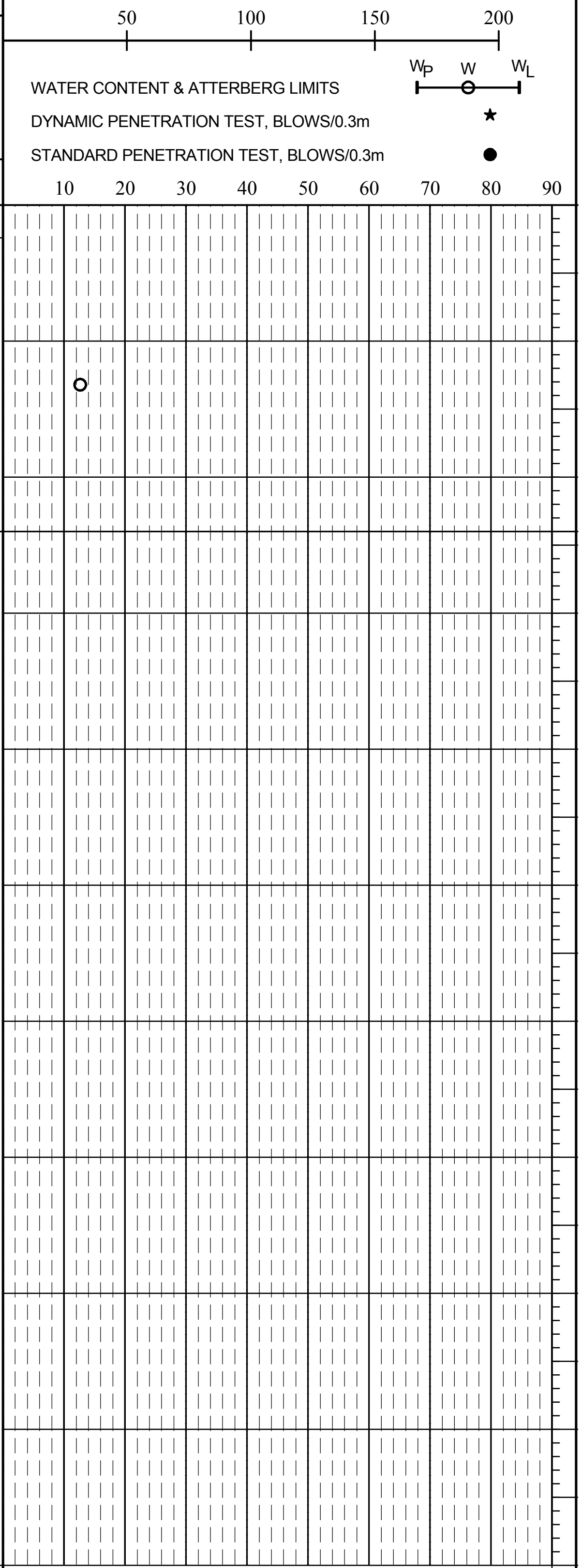
DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES			
					TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	**83.81**							
	83.6	240 mm TOPSOIL						
		FILL: silty sand with gravel (SM) - frequent crushed shale pieces			BS	2		
	81.4	End of Test Pit on Bedrock						

UNDRAINED SHEAR STRENGTH - kPa

WATER CONTENT & ATTERBERG LIMITS

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●



∇ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

STN13-STAN-GEO 121620528 - 3500 HAWTHORNE.GPJ SMART.GDT 5/31/17

Stantec

TEST PIT RECORD

N: 5 024 687 E: 453 186

1 of 1

TP17-3

CLIENT 2520333 Ontario Inc.

LOCATION 3500 Hawthorne Rd, Ottawa, ON

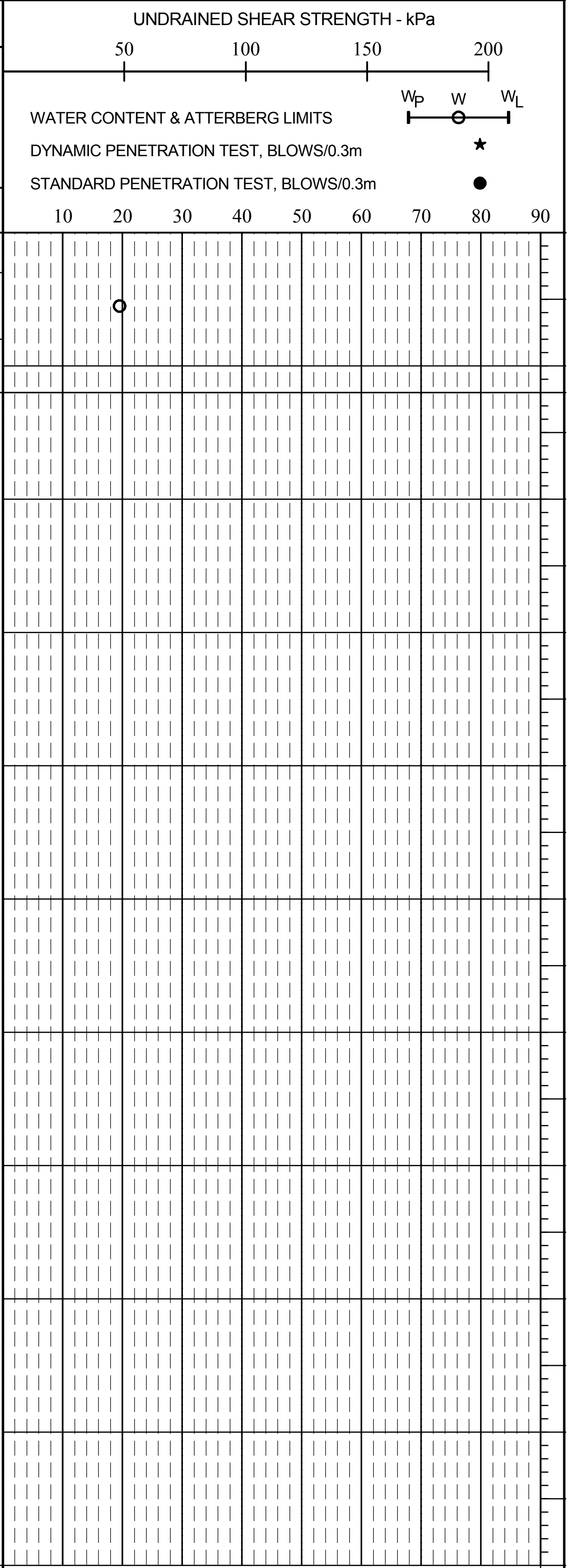
DATES: BORING May 4, 2017 WATER LEVEL

BOREHOLE No. TP17-3

PROJECT No. 121620528

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	84.02							
0	83.7	300 mm TOPSOIL						
	83.2	Light brown sandy silty CLAY (CL-ML)			BS	1		
1	82.8	Weathered shale BEDROCK						
		End of Test Pit						
2								
3								
4								
5								
6								
7								
8								
9								
10								



$\underline{\nabla}$ Inferred Groundwater Level

$\blacktriangledown$ Groundwater Level Measured in Standpipe

▣ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ________

Date ________

TEST PIT RECORD

N: 5 024 705 E: 453 192

TP17-4

CLIENT 2520333 Ontario Inc.

LOCATION 3500 Hawthorne Rd, Ottawa, ON

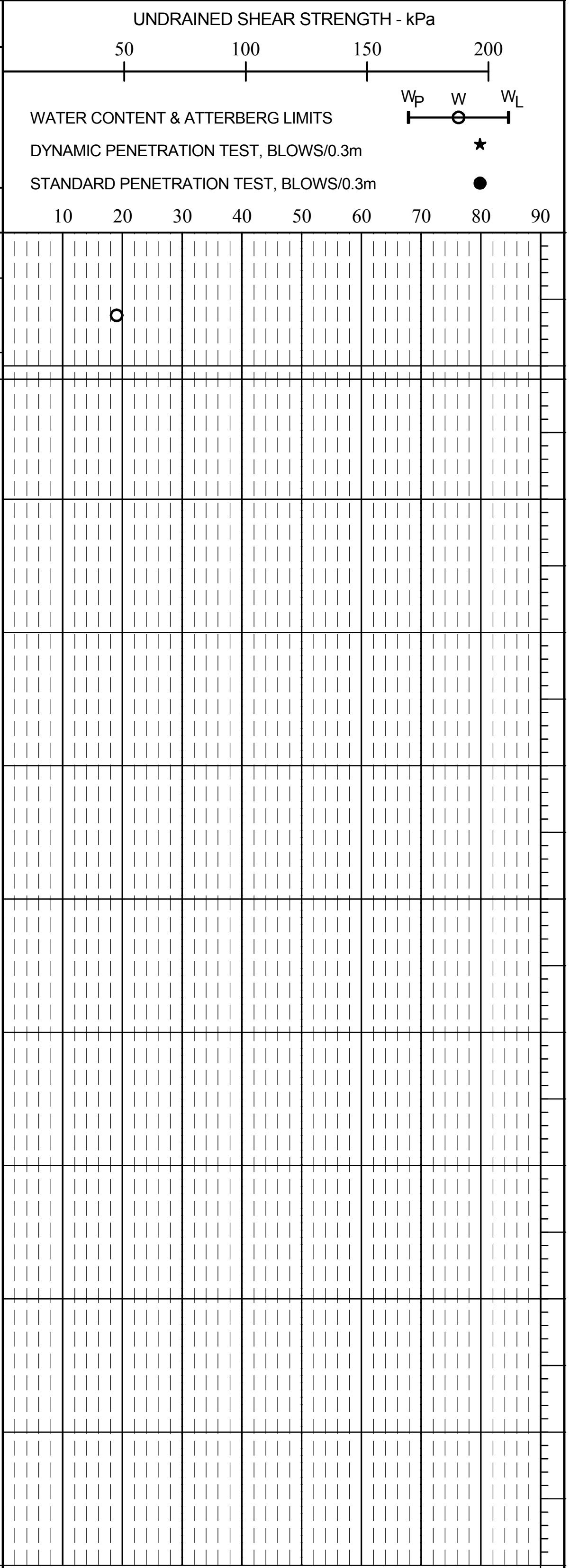
DATES: BORING May 4, 2017 WATER LEVEL

BOREHOLE No. TP17-4

PROJECT No. 121620528

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	**84.10**	340 mm TOPSOIL with black roots						
	83.8	Light brown-orange sandy silty CLAY (CL-ML) - Occasional cobbles			BS	1		
1	83.2	Layered weathered shale BEDROCK						
	83.0	End of Test Pit						
2								
3								
4								
5								
6								
7								
8								
9								
10								



$\underline{\nabla}$ Inferred Groundwater Level

$\blacktriangledown$ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ________

Date ________

Stantec

TEST PIT RECORD

N: 5 024 716 E: 453 187

TP17-5

CLIENT 2520333 Ontario Inc.

LOCATION 3500 Hawthorne Rd, Ottawa, ON

DATES: BORING May 4, 2017 WATER LEVEL

BOREHOLE No. TP17-5

PROJECT No. 121620528

DATUM Geodetic

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	84.07							
0	83.8	300 mm TOPSOIL						
	83.3	Light brown-orange sandy silty CLAY (CL-ML) - Water was entering the excavation at 0.6 m						
1	83.0	Weathered shale BEDROCK						
		End of Test Pit						
2								
3								
4								
5								
6								
7								
8								
9								
10								

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

▣ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ________

Date ________

Stantec

TEST PIT RECORD

N: 5 024 739 E: 453 180

TP17-6

CLIENT 2520333 Ontario Inc.

LOCATION 3500 Hawthorne Rd, Ottawa, ON

DATES: BORING May 4, 2017 WATER LEVEL

BOREHOLE No. TP17-6

PROJECT No. 121620528

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	84.16							
0	83.9	250 mm TOPSOIL with roots						
	83.4	Light brown sandy silty CLAY (CL-ML) - Water was entering the excavation at 0.8 m						
1	83.3	Weathered black shale BEDROCK - water entering excavation at 0.8m						
2		End of Test Pit						
3								
4								
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

∇ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

▣ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ______

Date ______

Stantec

TEST PIT RECORD

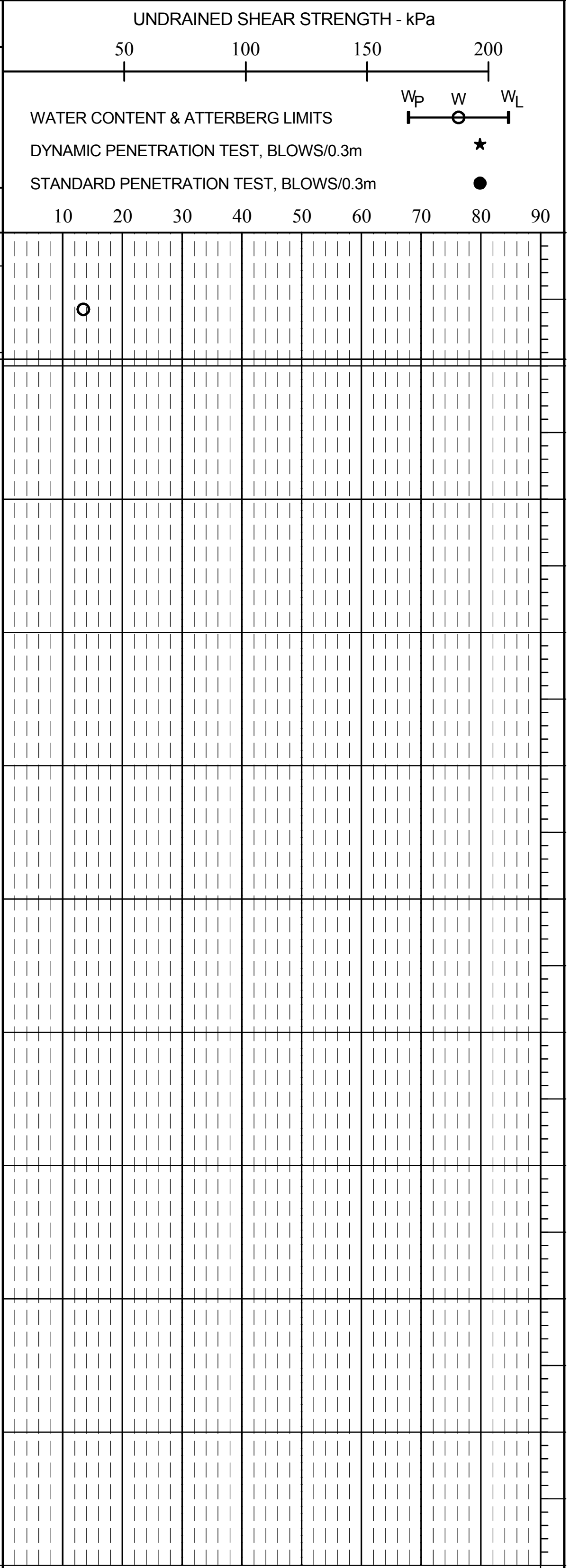
N: 5 024 740 E: 453 164

1 of 1

TP17-7

CLIENT 2520333 Ontario Inc.
BOREHOLE No. TP17-7
LOCATION 3500 Hawthorne Rd, Ottawa, ON
PROJECT No. 121620528
DATES: BORING May 4, 2017 WATER LEVEL
DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	84.06							
0	83.8	250 mm TOPSOIL						
		FILL: silty sand with gravel (SM)			BS	1		
	83.1	- some clay						
1	83.0	- frequent cobbles/boulders and crushed shale pieces						
		Weathered Shale BEDROCK						
		End of Test Pit						
2								
3								
4								
5								
6								
7								
8								
9								
10								



∇ Inferred Groundwater Level

$\blacktriangledown$ Groundwater Level Measured in Standpipe

▣ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ________

Date ________

Stantec

TEST PIT RECORD

N: 5 024 727 E: 453 157

1 of 1

TP17-8

CLIENT 2520333 Ontario Inc.

LOCATION 3500 Hawthorne Rd, Ottawa, ON

DATES: BORING May 4, 2017 WATER LEVEL

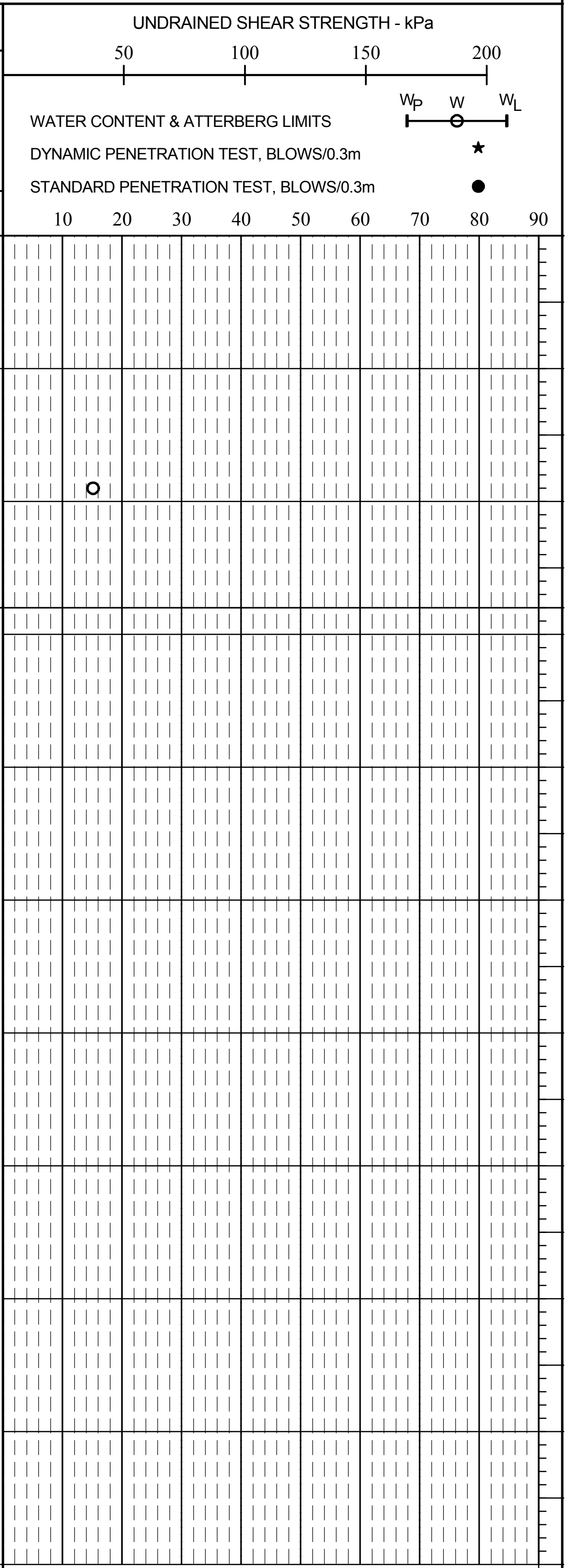
BOREHOLE No. TP17-8

PROJECT No. 121620528

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	84.03	450 mm TOPSOIL / FILL: some concrete and asphalt - layer of asphalt at 0.45 m	▨					
	83.6	FILL: silty sand with gravel (SM) - some clay - frequent cobbles/boulders and crushed bedrock - Water was entering the excavation at 2.8 m	▨		BS	1		
	81.2	End of Test Pit on Bedrock						

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10



∇ Inferred Groundwater Level

$\blacktriangledown$ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Stantec

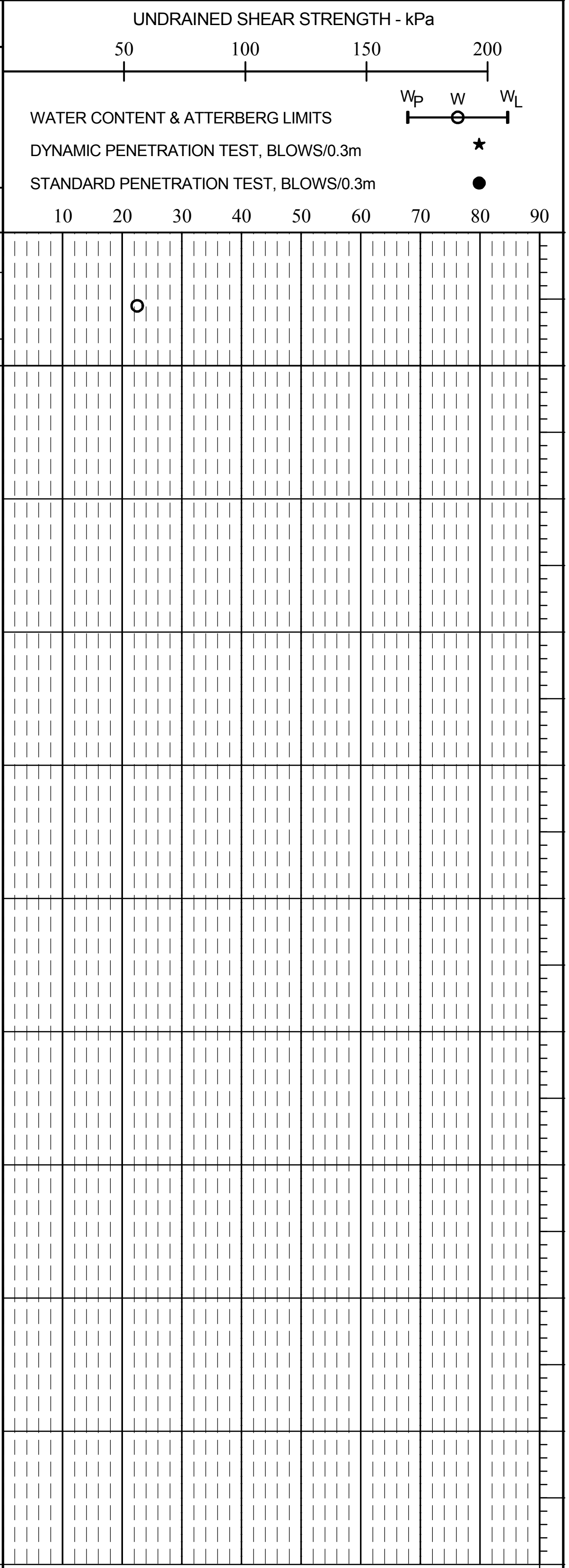
TEST PIT RECORD

N: 5 024 710 E: 453 175

TP17-9

CLIENT 2520333 Ontario Inc.
BOREHOLE No. TP17-9
LOCATION 3500 Hawthorne Rd, Ottawa, ON
PROJECT No. 121620528
DATES: BORING May 4, 2017 WATER LEVEL
DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	83.93							
0	83.6	300 mm TOPSOIL						
	83.1	Brown silty clay with sand (CL-ML)			BS	1		
	82.9	- frequent cobbles						
1		Weathered shale BEDROCK						
		End of Test Pit						
2								
3								
4								
5								
6								
7								
8								
9								
10								



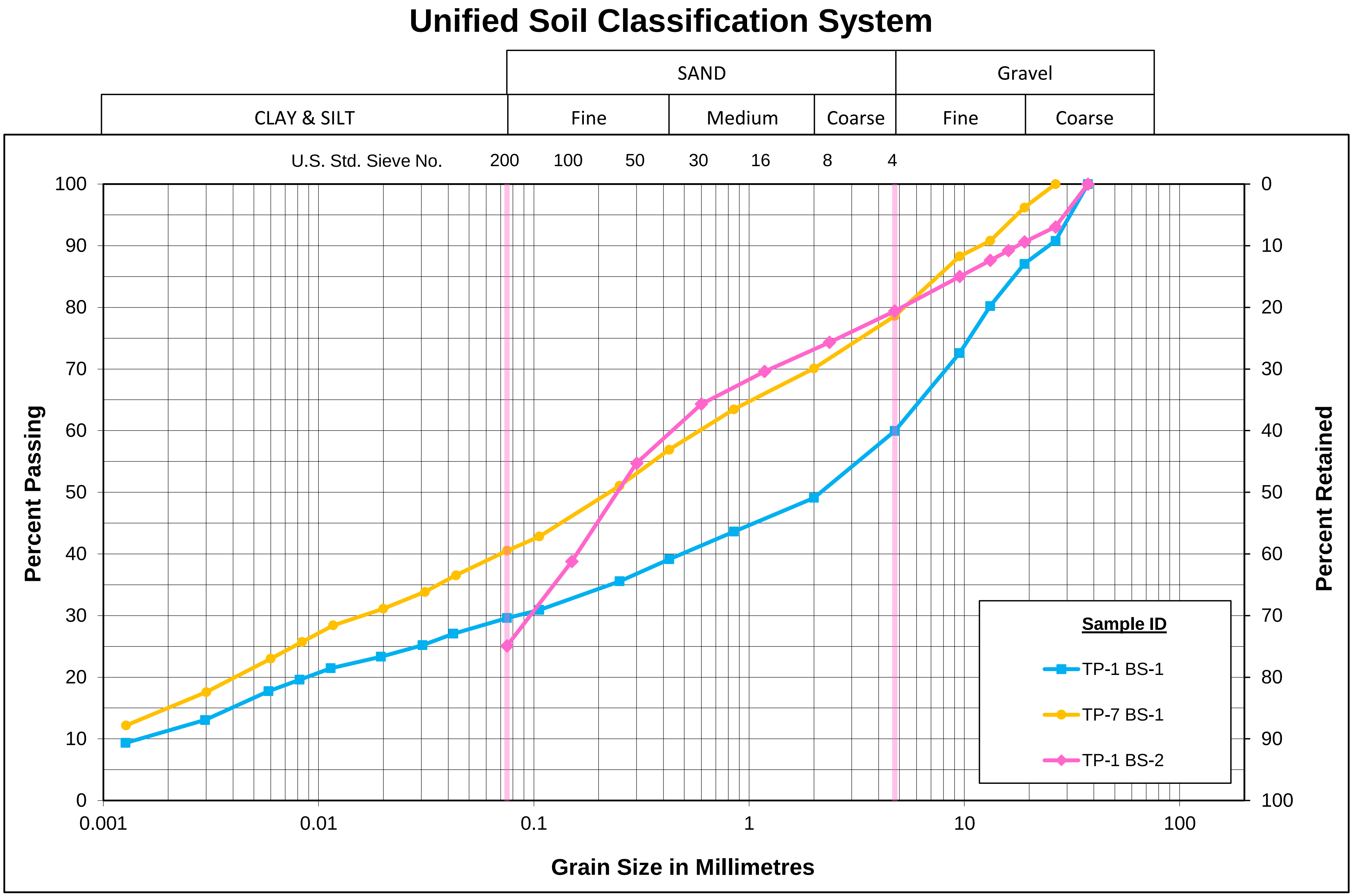
$\underline{\nabla}$ Inferred Groundwater Level
$\underline{\blacktriangledown}$ Groundwater Level Measured in Standpipe

▣ Field Vane Test, kPa
☐ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd ________
Date ________

APPENDIX D

Laboratory Test Results



Stantec

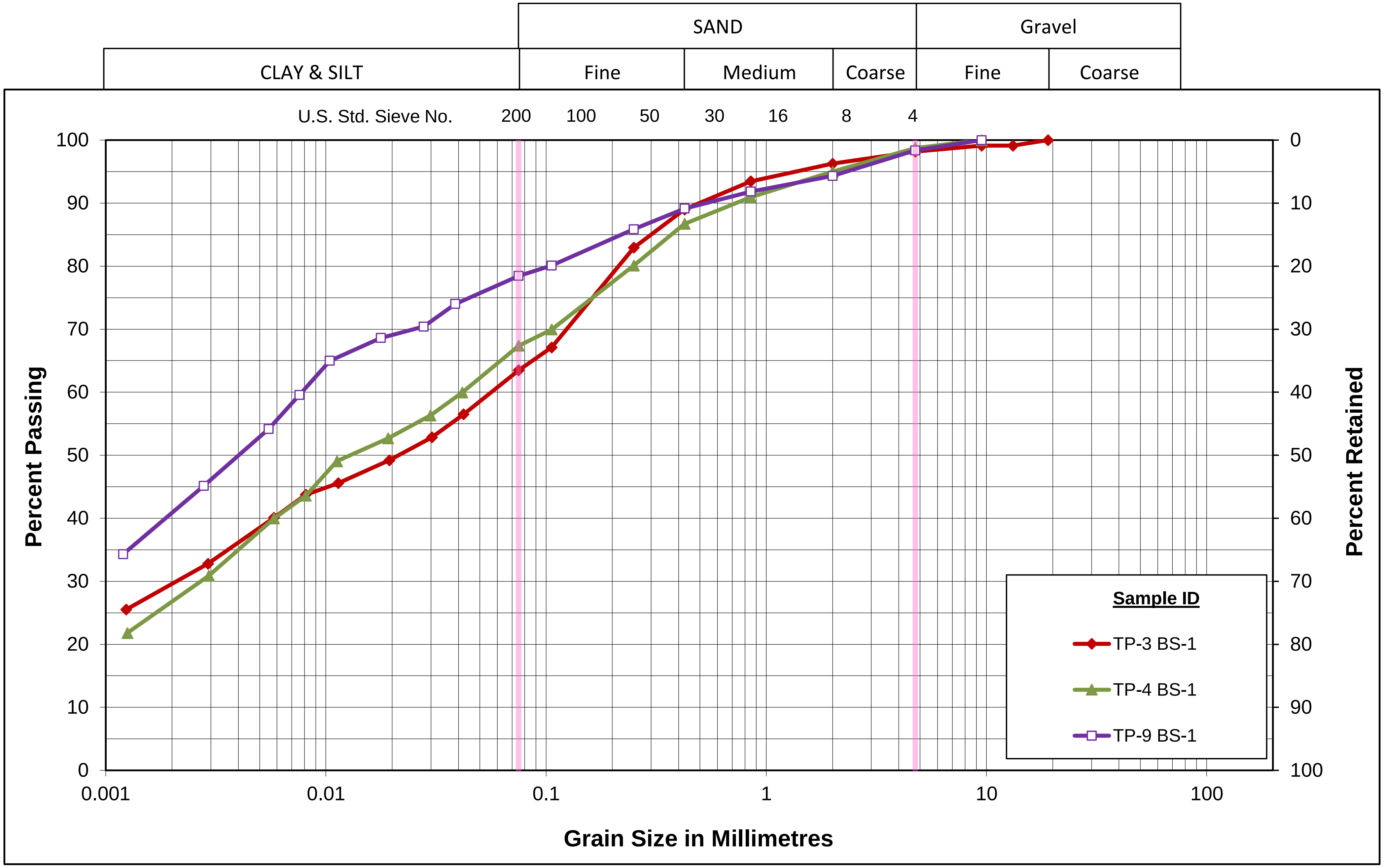
GRAIN SIZE DISTRIBUTION

FILL: Silty Sand with Gravel (SM) to Sity Gravel with Sand (GM)

Figure No. 1

Project No. 121620528

Unified Soil Classification System



Stantec

GRAIN SIZE DISTRIBUTION

Sandy Silty CLAY (CL-ML) to Silty CLAY with Sand (CL-ML)

Figure No. 2

Project No. 121620528