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Geotechnical Engineering
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January 10, 2018
PG4331-LET.01

368 Chapel Street Inc.
368 Chapel Street
Ottawa, ON
K1K 1M8

Attention: **Mr. Nizar Salem**

Subject: **Geotechnical Investigation**
Proposed Residential Building Addition
368 Chapel Street - Ottawa

Dear Sir,

Paterson Group (Paterson) was commissioned by 368 Chapel Street Inc. to conduct a geotechnical investigation for a proposed residential building addition to be located at 368 Chapel Street in the City of Ottawa, Ontario.

The proposed project is understood to consist of an third floor addition to the existing two-storey building footprint, as well as, a new three-storey expansion with one basement level, an access lane and landscaped areas.

1.0 Field Investigation

The field program for the current investigation was conducted on December 1, 2017, and consisted of drilling three (3) boreholes to a maximum depth of 3.1 m. The boreholes were drilled using a geoprobe drill rig. The test holes were reviewed in the field by Paterson personnel under the direction of a senior engineer from the geotechnical division. The testing procedure consisted of augering to the required depths and at the selected locations sampling the overburden.

The boreholes were placed in a manner to provide general coverage of the site taking into consideration existing site features and underground services. The approximate location of the test holes are shown on Drawing PG4331-1 - Test Hole Location Plan attached to the present report.

2.0 Field Observations

The subject site is currently occupied by a 2-storey residential dwelling with associated landscaped areas, mature trees and an access lane. The ground surface at the subject site is relatively flat and generally at grade with Chapel Street. The site is bounded by residential properties to the north, west, and south, and by Chapel Street to the east.

Generally, the subsurface profile encountered at the borehole locations consisted of either topsoil or asphalt at the ground surface overlying fill consisting of brown silty sand mixed with some clay, gravel and construction debris. A glacial till deposit was encountered below the fill layer at approximate depths of 1.2 to 2 m below the existing ground surface, and consisted of silty sand with silty clay and gravel. Practical refusal to augering was encountered at each borehole location at approximate depths between 1.9 m and 3.1 m. Refer to the Soil Profile and Test Data sheets attached for specific details of the soil profile encountered at the borehole locations.

Based on available geological mapping, the bedrock within the area consists of Shale of the Billings formation with an overburden thickness that ranges between 3 and 5 m.

Groundwater was observed at depths ranging between 1.5 and 2.1 m at the time of the field investigation. Both piezometers were blocked at the time of recording on December 8, 2017. It should be noted that groundwater levels are subject to seasonal fluctuations and that groundwater conditions could vary at the time of construction.

3.0 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for the proposed building additions. The proposed residential building is expected to be founded on conventional shallow foundations placed on either an undisturbed, glacial till or a clean, shale bedrock bearing surface.

Site Grading and Preparation

Topsoil, asphalt, and fill, containing deleterious or organic materials or construction debris, should be stripped from under any building, paved areas, pipe bedding and other settlement sensitive structures. Care should be taken to not disturb adequate bearing surfaces during site preparation activities.

Existing foundation walls and other construction debris should be entirely removed from within the proposed building addition perimeter. Under paved areas, existing construction remnants such as foundation walls should be excavated to a minimum of 1 m below final grade.

Bedrock Removal

If encountered, bedrock removal may be possible by hoe-ramming for areas where only a small quantity of bedrock is to be removed. However, dependent on the proposed foundation elevation and the condition of the bedrock, line-drilling in conjunction with hoe-ramming may be required to remove the bedrock.

Vibration Considerations

Construction operations could cause vibrations, and possibly, sources of nuisance to the community. Therefore, means to reduce the vibration levels as much as possible should be incorporated in the construction operations to maintain a cooperative environment with the residents.

Two parameters determine the recommended vibration limit: the maximum peak particle velocity and the frequency. For low frequency vibrations, the maximum allowable peak particle velocity is less than that for high frequency vibrations. As a guideline, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 50 mm/s above a frequency of 40 Hz (interpolate between 12 and 40 Hz). These guidelines are for current construction standards. These guidelines are above perceptible human level and, in some cases, could be very disturbing to some people. A pre-construction survey is recommended to minimize the risks of claims during or following the construction of the proposed building.

Fill Placement

Engineered fill placed for grading beneath the proposed building footprint, unless otherwise specified, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill should be tested and approved prior to delivery to the site. The fill should be placed in maximum lift thickness of 300 mm and compacted with suitable compaction equipment. Fill placed beneath the building should be compacted to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD).

Non-specified existing fill along with site-excavated soil could be placed as general landscaping fill where surface settlement is of minor concern. The existing materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If the existing materials are to be placed to increase the subgrade level for areas to be paved, the non-specified existing fill should be compacted in 300 mm lifts and compacted to a minimum density of 95% of the respective SPMDD.

Foundation Design

Bearing Resistance Values

Footings placed on an undisturbed, compact glacial till bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **200 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **350 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS.

An undisturbed, glacial till bearing surface consists of one from which all topsoil, fill, loose rock and any other deleterious materials have been removed prior to the placement of concrete for footings.

Footings placed on a clean, shale bedrock bearing surface can be designed using a bearing resistance value at SLS of **500 kPa** and a factored bearing resistance value at ULS of **900 kPa**.

A clean, surface-sounded bedrock bearing surface should be free of loose materials, and have no near surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer.

Footings designed using the bearing resistance values at SLS given above will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

Footings bearing on an acceptable bedrock bearing surface and designed for the bearing resistance values provided herein will be subjected to negligible potential post-construction total and differential settlements.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a glacial till bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1H:1V (or flatter) passes only through in situ glacial till, or a material of the same or higher capacity.

Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for foundations constructed at the subject site. A higher site classification, such as Class A or B, can be provided if site specific shear wave velocity testing is completed. Refer to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements. The soils underlying the subject site are not susceptible to liquefaction.

Basement Slab

With the removal of all topsoil and deleterious materials, within the footprint of the proposed buildings, the native soil or engineered fill surface will be considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. The upper 150 to 200 mm of the sub-slab fill should consist of 19 mm clear crushed stone.

4.0 Design and Construction Precautions

Foundation Drainage and Backfill

A perimeter foundation drainage system is recommended to be provided for the proposed structure. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, placed at the base of the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and are not recommended for placement as backfill against the foundation walls, unless placed in conjunction with a drainage geocomposite such as Miradrain G100N, Delta Drain 6000 or an approved equivalent. The drainage geocomposite should be connected to the perimeter foundation drainage system. Otherwise, imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be placed for foundation backfill.

Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum of 1.5 m thick soil cover (or equivalent) should be provided.

Exterior unheated footings, such as isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

Excavation Side Slopes

The side slopes of excavations in the overburden soils should be sloped back at acceptable slopes from the start of the excavation until the structure is backfilled. The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides. Slopes in excess of 3 m in height should be periodically inspected by Paterson in order to detect if the slopes are exhibiting signs of distress.

If sufficient room for slopes is unavailable due to existing structures or property boundaries, a temporary shoring system may be required. Underpinning may also be required for the existing neighbouring structures, dependent on their existing foundation elevations relative to the foundation elevations of the proposed building.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.

Winter Construction

If winter construction is considered for this project, precautions should be provided for frost protection. The subsurface soil conditions mainly consist of frost susceptible materials. In presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the installation of straw, propane heaters and tarpaulins or other suitable means. The excavation base should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

The trench excavations should be completed in a manner to avoid the introduction of frozen materials, snow or ice into the trenches. Where excavations are constructed in proximity of existing structures, precaution to adversely affecting the existing structures due to the freezing conditions should be provided.

5.0 Recommendations

A materials testing and observation services program is a requirement for the provided foundation design recommendations to be applicable. The following aspects of the program should be performed by Paterson:

❑ Observation of all bearing surfaces prior to the placement of concrete.

❑ Sampling and testing of the concrete and fill materials used.

❑ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.

❑ Observation of all subgrades prior to backfilling.

❑ Field density tests to determine the level of compaction achieved.

A report confirming that the construction has been conducted in general accordance with Paterson's recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

6.0 Statement of Limitations

The recommendations provided in the report are in accordance with Paterson’s present understanding of the project. Paterson requests permission to review the recommendations when the drawings and specifications are completed.

The client should be aware that any information pertaining to soils and all test hole logs are furnished as a matter of general information only and test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from the test locations, Paterson requests immediate notification to permit reassessment of the recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than 368 Chapel Street Inc., or their agents is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Best Regards,

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
January 10, 2018
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Colin Belcourt, M.Eng.

David J. Gilbert, P.Eng.

Attachments

- ❏ Soil Profile and Test Data sheets
- ❏ Symbols and Terms
- ❏ Drawing PG4331-1 - Test Hole Location Plan

Report Distribution

- ❏ 368 Chapel Street Inc. (3 copies)
- ❏ Paterson Group (1 copy)

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Addition - 368 Chapel Street
Ottawa, Ontario

DATUM TBM - Bolt on bottom flange of fire hydrant located in front of 370 Chapel Street. An elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY Geoprobe

DATE December 1, 2017

FILE NO. PG4331

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	99.72		
Asphaltic concrete 0.05									
FILL: Crushed stone 0.15									
FILL: Sandy clay with silt, trace gravel and brick		SS	1	33	3				
		SS	2	33	8	1	98.72		
1.22									
GLACIAL TILL: Grey-brown silty sand with clay, gravel, cobbles and boulders		SS	3		5				
1.93		SS	4		50+				▽
End of Borehole									
Practical refusal to augering at 1.93m depth									
(Piezometer pinched and dry to 1.16m - Dec. 8, 2017)									
(GWL @ 1.8m depth based on field observations)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Addition - 368 Chapel Street
Ottawa, Ontario

DATUM TBM - Bolt on bottom flange of fire hydrant located in front of 370 Chapel Street. An elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY Geoprobe

DATE December 1, 2017

FILE NO. PG4331

HOLE NO. BH 2

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.33
TOPSOIL	0.15						
FILL: Brown silty clay with brick	1.22	SS	1	0	4		
		SS	2	33	8	1	98.33
FILL: Construction debris	1.47						
FILL: Brown sandy clay, trace ash and construction debris	1.83	SS	3	83	6		
GLACIAL TILL: Dark brown silty sand, some clay, gravel, cobbles and boulders	2.34	SS	4		28	2	97.33

End of Borehole

Practical refusal to augering at 2.34m depth

(Piezometer pinched and dry to 1.12m - Dec. 8, 2017)

(GWL @ 2.1m depth based on field observations)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Addition - 368 Chapel Street
Ottawa, Ontario

DATUM TBM - Bolt on bottom flange of fire hydrant located in front of 370 Chapel Street. An elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY Geoprobe

DATE December 1, 2017

FILE NO. PG4331

HOLE NO. BH 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	99.56		
Inferred **FILL**						1	98.56		
1.22									
FILL: Brown sandy clay with shale		SS	1	58	1				∇
1.98						2	97.56		
GLACIAL TILL: Brown sand with clay, silt, gravel, cobbles and boulders		SS	2	83	24				
		SS	3	83	32	3	96.56		
3.15		SS	4		50+				
End of Borehole Practical refusal to augering at 3.15m depth (GWL @ 1.5m depth based on field observations)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation 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 layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	‘N’ Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	‘N’ Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2$ / (D10 x D60)
Cu	-	Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

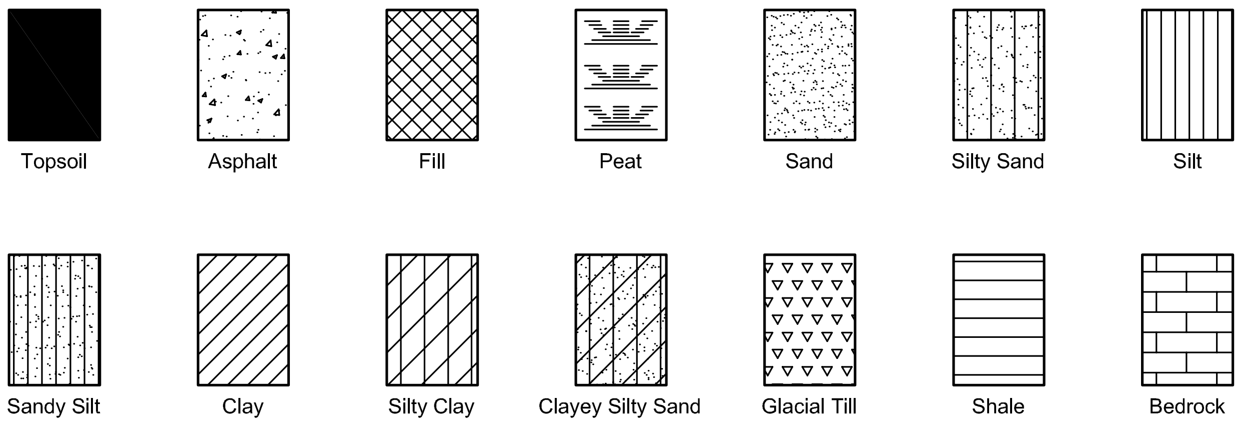
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

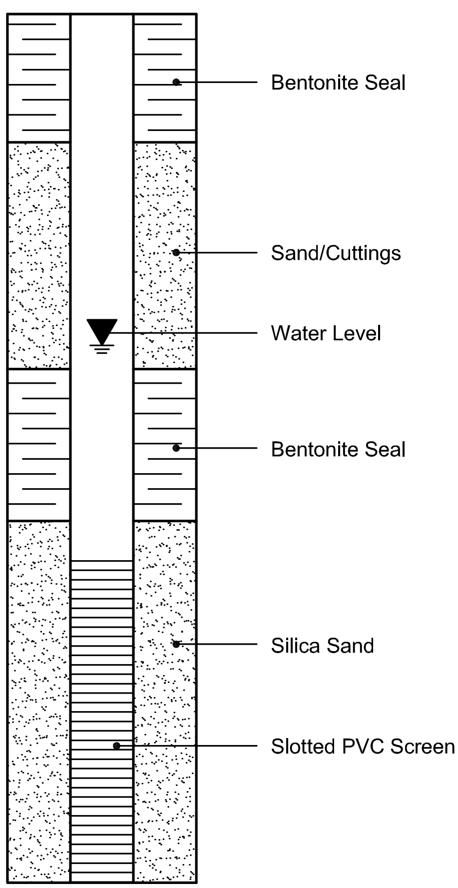
SYMBOLS AND TERMS (continued)

STRATA PLOT

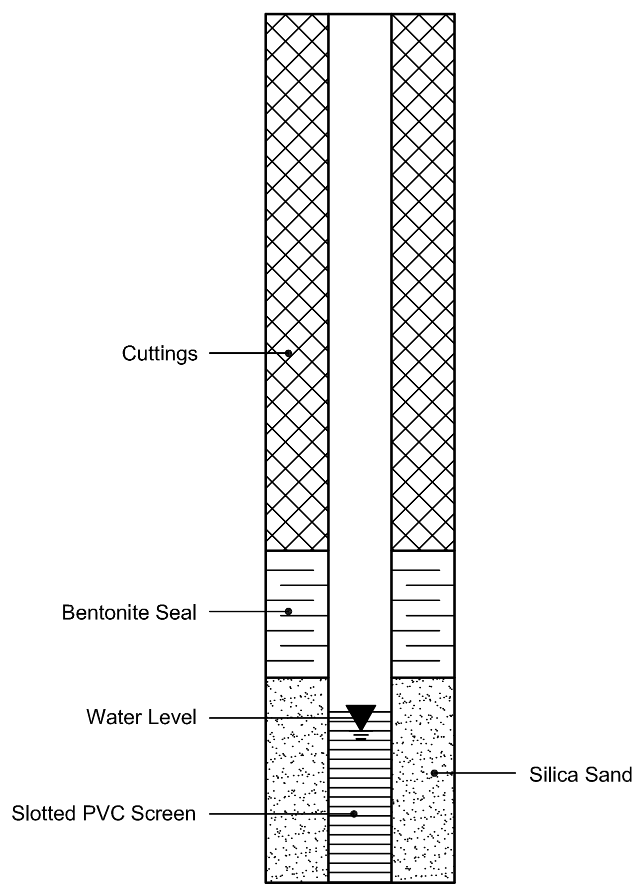


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



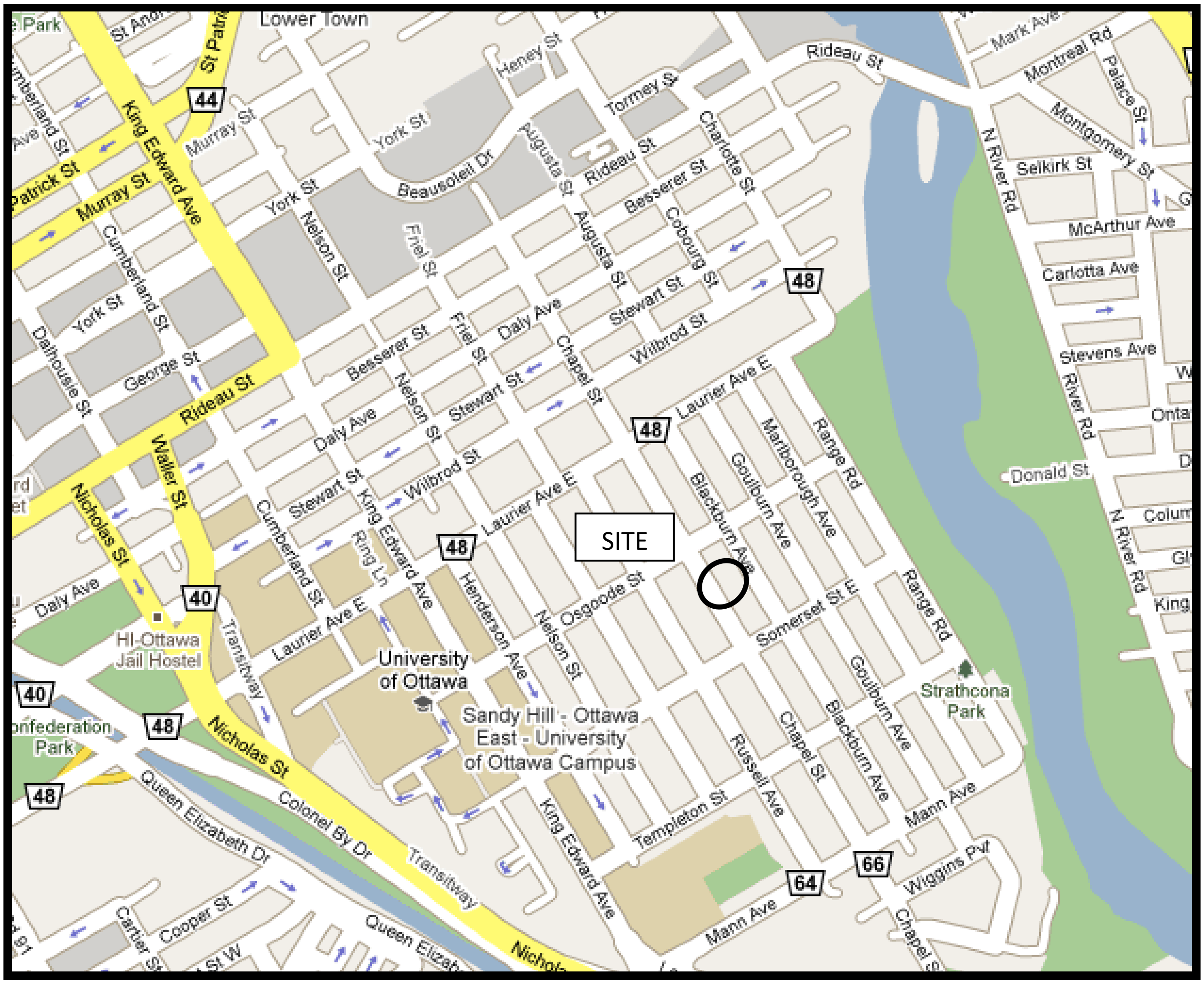
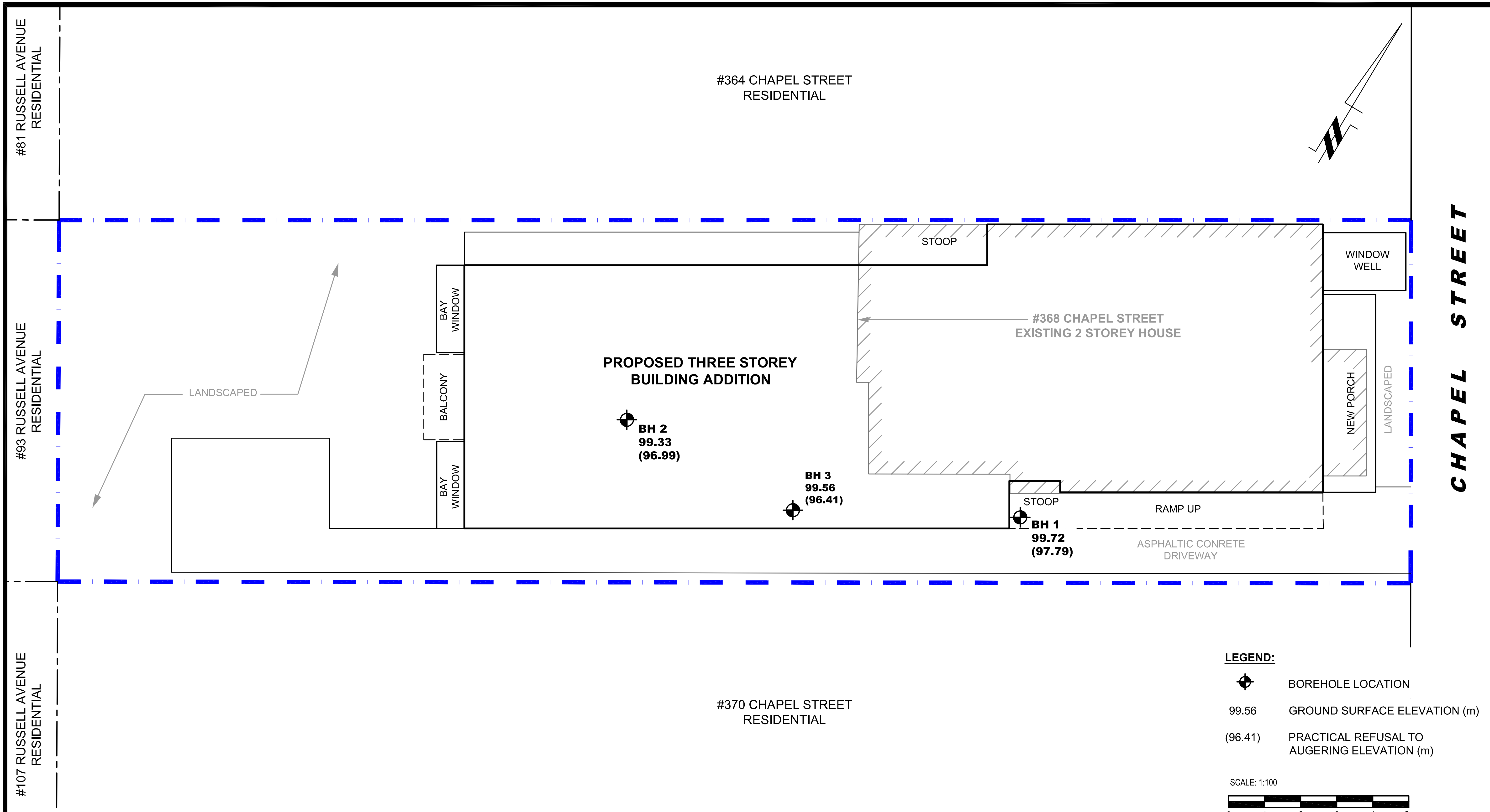


FIGURE 1

KEY PLAN



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NO.	REVISIONS	DATE	INITIAL
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368 CHAPEL STREET INC.

GEOTECHNICAL INVESTIGATION
368 CHAPEL STREET

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:100	Date: 12/2017
Drawn by: RCG	Report No.: PG4331-1
Checked by: CB	Dwg. No.: PG4331-1
Approved by: DJG	Revision No.: 0