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Geotechnical Investigation

Proposed Residential Development
Oakridge Gate - Trim Road
Ottawa, Ontario

Prepared For

Ashcroft Homes

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Report: PG2401-1 Revision 1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Ashcroft Homes to conduct a geotechnical investigation for a proposed residential development located west of the existing Oakridge Gate Subdivision and east of Trim Road, in the City of Ottawa (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the current investigation was to:

- ☐ Determine the subsoil and groundwater conditions at this site by means of boreholes.
- ☐ Provide geotechnical recommendations pertaining to design of the proposed development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of this present investigation. A Phase I Environmental Site Assessment (ESA) was conducted by Paterson for the subject site. The results and recommendations of the Phase I - ESA are presented under separate cover.

2.0 Proposed Development

Based on the preliminary conceptual drawings provided by Ashcroft Homes, it is our understanding that the proposed residential development will consist of 11 residential blocks (town houses and condominium flats) constructed in two phases (Phases 1 and 2, Areas ‘A’ and ‘B’ respectively) with associated car parking and local roadways. It is further anticipated that the proposed development will be serviced by municipal services.

The current investigation was carried out within the limits of Phase 1.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the geotechnical investigation was carried out on June 10, 2011. At that time, a total of three (3) boreholes were distributed in a manner to provide general coverage of the proposed development. The locations were determined in the field by Paterson personnel taking into consideration site features and underground services. Locations of the test holes are shown in Drawing PG2401-1 - Test Hole Location Plan included in Appendix 2.

Boreholes were advanced using a track-mounted auger drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer from our geotechnical department. The drilling procedures consisted of advancing each test hole to the required depths at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples from boreholes were recovered from the auger flights or a 50 mm diameter split-spoon sampler. All soil samples were classified on site, placed in sealed plastic bags and were transported to our laboratory for visual inspection. The depths at which the auger and split spoon samples were recovered from the test holes are shown as AU and SS, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split spoon samples. The SPT results are recorded as "N" values on the Soil Profile and Test Data sheets. The "N" value is the number of blows required to drive the split spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Undrained shear strength testing was carried out in cohesive soils using a field vane apparatus.

Subsurface conditions observed in the boreholes were recorded in detail in the field. Reference should be made to the Soil Profile and Test Data sheets presented in Appendix 1 for specific details of the soil profile encountered at the test hole locations.

Groundwater

Flexible standpipes were installed in all boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. Groundwater measurements were subsequently made on June 15, 2011.

Sample Storage

All samples will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless we are otherwise directed.

3.2 Field Survey

The borehole locations and ground surface elevations at the borehole locations were surveyed by Paterson field personnel. The ground surface elevations at the test hole locations were referenced to a temporary benchmark (TBM), consisting of the top of spindle of the fire hydrant located at the southeast corner of the intersection of Breezewood Street and Hallendale Street. An arbitrary elevation of 100.00 m was assigned to the TBM. The locations and ground surface elevations of the boreholes, and the location of the TBM are presented on Drawing PG2401-1 - Test Hole Location Plan, in Appendix 2.

3.3 Laboratory Testing

All soil samples recovered from the subject site were sealed in plastic bags and visually examined in our laboratory to review the results of the field logging.

4.0 Observations

4.1 Surface Conditions

The subject site is currently vacant former agricultural land which is predominately grass covered. A gravel surfaced access lane connects the occupies the north portion of the site to Trim Road and provided access for the existing fill piles that are present on the eastern portion of the subject site. The site is bordered to the east by single family residential dwellings, to the north and south by vacant land and to the west by Trim Road followed by residential development.

The greater part of the site, with the exception of the fill piles, is relatively flat and slightly below grade of neighbouring properties and adjacent roadways.

4.2 Subsurface Profile

Based on the soil profile encountered at the test hole locations, the soil profile consists of a thin surficial sandy clay overlying a deep, very stiff to firm, silty clay deposit. The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Silty Clay

The upper 3 to 3.5 metres of the silty clay deposit has been desiccated to a hard to stiff brown to gray-brown “crust”. The grey silty clay has measured shear strengths of between 35 and 40 kPa. All boreholes were terminated in the firm grey silty clay.

Consolidation testing was not conducted on the silty clay as part of this investigation. However, the silty clay is inferred to be overconsolidated based on its shear strength, and testing conducted on samples from nearby projects.

Bedrock

Based on available geological mapping, the subject site is located in an area where the bedrock consists of either interbedded limestone and dolomite of the Gull River formation or interbedded limestone and shale of the Lindsay formation. The overburden drift thickness is estimated to range from 15 to 25 m.

4.3 Groundwater

The measured groundwater levels from piezometers installed at the boreholes are presented in Table 1. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could be different at the time of construction.

Table 1 - Summary of Groundwater Level Readings

Test Hole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 1	98.26	0.78	97.48	June 15, 2011
BH 2	98.45	0.46	97.99	June 15, 2011
BH 3	98.52	0.40	98.12	June 15, 2011

Note: The ground surface elevations at the test hole locations were referenced to the TBM consisting of the top of spindle of the fire hydrant located at the southeast corner of the intersection of Breezewood Street and Hallendale Street. An arbitrary elevation of 100.00 m was assigned to the TBM.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for the proposed residential development. It is expected that the proposed residential buildings will be founded on conventional footings founded on a very stiff to stiff silty clay bearing medium. Pavement construction and site service installation are expected to be relatively conventional for silty clay conditions.

The above and other considerations are discussed in the following paragraphs.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil, and any deleterious fill, such as those containing organic materials, should be stripped from under any buildings and other settlement sensitive structures.

Fill Placement

Fill used for grading purposes beneath the proposed buildings, 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. It should be placed in lifts no greater than 300 mm in thickness and compacted using suitable compaction equipment for the specified lift thickness. Fill placed beneath the building areas should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and be compacted at minimum by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls, unless a composite drainage blanket connected to a perimeter drainage system is provided.

5.3 Foundation Design

Bearing Resistance Values

Footings, up to 2 m wide, placed on an undisturbed, stiff silty clay bearing surface can be designed using a bearing resistance at serviceability limit states (SLS) value of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) value of **225 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, have been removed prior to the placement of concrete for footings.

Settlement and Permissible Grade Raise

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

Based on interpretation of the in situ shear strength of the grey silty clay, a preliminary permissible grade raise of **1.2 m** above present ground native surface levels is appropriate for conventional two-storey wood-frame housing. Greater grade raises may be feasible on the basis of further geotechnical investigation and analyses.

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. Above the groundwater level, adequate lateral support is provided to a very stiff to stiff silty clay or engineered fill when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil or engineered granular fill, as described above.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class D** for the foundations considered at this site, based on an assumed maximum bedrock depth of 20 m below the proposed foundation level. The soils underlying the proposed shallow foundations are not susceptible to seismic liquefaction.

Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Basement Slab

With the removal of all topsoil and deleterious fill, such as those containing organic materials, within the footprint of the proposed buildings, the native soil surface or existing fill approved by the geotechnical consultant at the time of construction will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction.

Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular B Type II, with a maximum particle size of 50 mm, is recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-floor fill consists of 19 mm clear crushed stone. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

5.6 Pavement Design

Car only parking and local roadways are anticipated at this site. The proposed pavement structures are shown in Tables 2 and 3.

Table 2 - Recommended Pavement Structure - Car Only Parking Areas

Thickness (mm)	Material Description
50	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - Either inorganic in situ soils, existing fill approved by the geotechnical consultant, or OPSS Granular B Type I or II material placed over in situ soil.

Table 3 - Recommended Pavement Structure - Local Roadways

Thickness (mm)	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - Either inorganic in situ soils, existing fill approved by the geotechnical consultant, or OPSS Granular B Type I or II material placed over in situ soil.

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type I or Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable compaction equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

Due to the impervious nature of the subgrade materials consideration should be given to installing subdrains during the pavement construction as per City of Ottawa standards. The subdrain inverts should be approximately 300 mm below the subgrade surface. The subgrade surface should be crowned or shaped to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for the proposed structures. The system should consist of a 100 to 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at 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, as such, are not recommended for re-use as backfill against the foundation walls. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be used for this purpose, unless a composite drainage material connected to the perimeter drainage system is provided.

6.2 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 in this regard.

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for exterior unheated footings that are not located adjacent to a heated building area, such as wing walls and isolated exterior pier foundations.

6.3 Excavation Side Slopes

The side slopes of excavations in the soil and fill overburden materials should be either cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations).

Excavation side slopes above the groundwater level, extending to a maximum depth of 3 m, should be cut back at 1H:1V or flatter. Flatter excavation slopes are required below the groundwater level.

The undisturbed native soils at this site are considered to be mainly Type 2 and 3 soils 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 the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

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.

6.4 Pipe Bedding and Backfill

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe should consist of OPSS Granular A. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to a minimum of 95% of the material’s SPMDD.

Generally, it should be possible to re-use the moist (not wet) silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty clay should be given a sufficient drying period to decrease its moisture content to an acceptable level to make compaction possible prior to being re-used. The silty clay, when wet, will be difficult to reuse due to its high fines content which makes compacting this material without an extensive drying period impractical.

Trench backfill material within the frost zone (approximately 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material’s SPMDD.

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches that are located in the areas underlain by sensitive silty clay. The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. Generally, the seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the material's SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches.

6.5 Groundwater Control

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

The rate of flow of groundwater into the excavation through the overburden should be low to moderate. It is anticipated that pumping from open sumps will be sufficient to control the groundwater influx through the sides of the excavations.

If the anticipated pumping volumes exceed 400,000 L/day of ground and/or surface water, a temporary Minstry of the Environment and Climate Change (MOECC) permit to take water (PTTW) would be required for this project during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MOECC.

For typical ground or surface water volumes being pumped during the construction phase, typically between 25,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MOECC review of the PTTW application.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project.

The subsoil conditions at this site consist of frost susceptible materials. In the 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 use of straw, propane heaters and tarpaulins or other suitable means. In this regard, the base of the excavations 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.

Trench excavations and pavement construction are also difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be taken if such activities are to be carried out during freezing conditions. Additional information could be provided, if required.

6.7 Landscaping Considerations

Tree Planting Restrictions

The proposed residential dwellings are located in a low to moderate sensitivity area with respect to tree planting over a silty clay deposit. It is recommended that trees placed within 4 m of the foundation wall shall consist of low water demanding trees with shallow root systems that extend less than 1.5 m below ground surface. Trees placed greater than 4 m from the foundation wall may consist of typical street trees, which are typically moderate water demand species with roots extending to a maximum depth of 2 m below ground surface.

It is well documented in the literature, and is our experience that fast growing trees located near buildings founded on cohesive soils that shrink on drying can result in long-term differential settlements of the structures. Tree varieties that have the most pronounced effect on foundations are seen to consist of poplars, willows and some maples (i.e. Manitoba maples) and, as such, they should not be considered in the landscaping design.

7.0 Recommendations

It is a requirement for the foundation design data provided herein to be applicable that the following material testing and observation program be performed by the geotechnical consultant.

☐ Review of the Grading Plan for geotechnical considerations.

☐ 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.

☐ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be retained to review the Grading Plan once available. Also, our recommendations should be reviewed when the project drawings and specifications are complete.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request that we be notified immediately in order to permit reassessment of our 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 Ashcroft Homes or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Nathan Christ

LICENSED PROFESSIONAL ENGINEER
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Report Distribution:

☐ Ashcroft Homes (3 copies)
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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

patersongroup **Consulting Engineers**

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Trim Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on the southeast corner of Breezewood Street and Hallendale Street. An arbitrary elevations of 100.00m was assigned to the

REMARKS TBM.

BORINGS BY CME 55 Power Auger

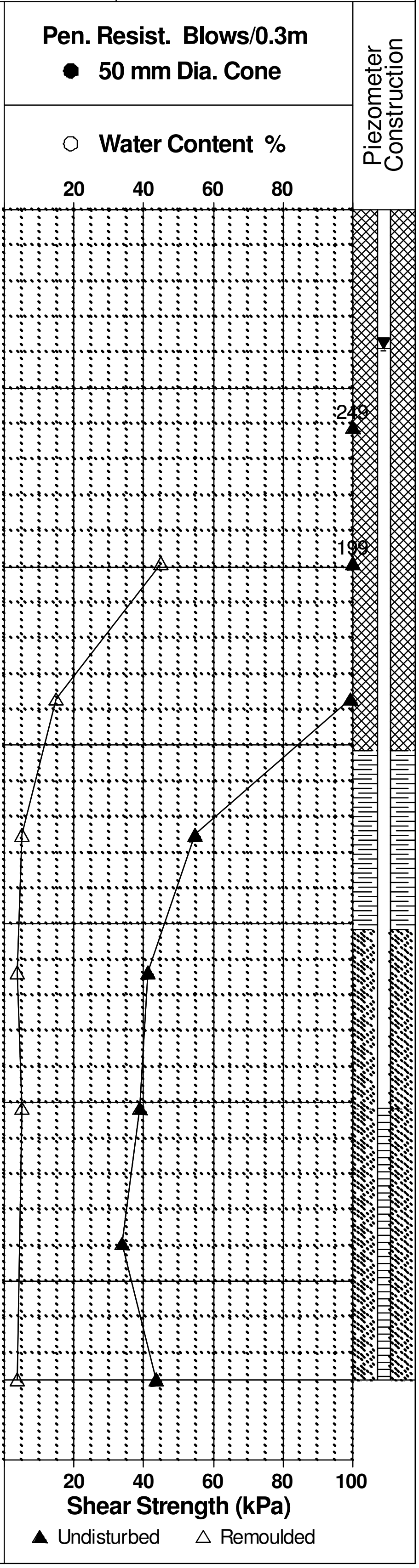
DATE 10 June 2011

FILE NO. **PG2401**

HOLE NO. **BH 1**

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Brown **SILTY CLAY** with sand	0.30	AU	1		
Hard to stiff, brown **SILTY CLAY** - stiff to firm and grey by 2.9m depth	6.55	AU	2		
End of Borehole (GWL @ 0.78m-June 15/11)					

DEPTH (m)	ELEV. (m)
0	98.26
1	97.26
2	96.26
3	95.26
4	94.26
5	93.26
6	92.26



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Trim Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on the southeast corner of Breezewood Street and Hallendale Street. An arbitrary elevations of 100.00m was assigned to the

REMARKS TBM.

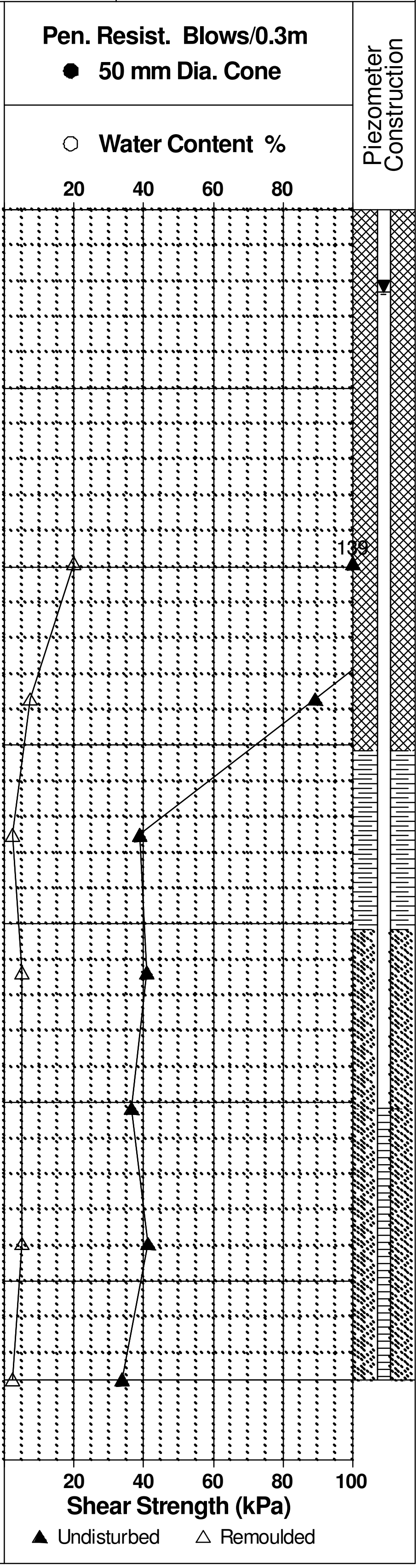
BORINGS BY CME 55 Power Auger

DATE 10 June 2011

FILE NO. PG2401

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.45
Brown **SILTY CLAY** with sand 0.30		AU	1				
		AU	2				
		SS	3	92	10	1	97.45
						2	96.45
Hard to stiff, brown **SILTY CLAY** - firm and grey by 2.9m depth						3	95.45
						4	94.45
						5	93.45
						6	92.45
6.55							
End of Borehole (GWL @ 0.46m-June 15/11)							



patersongroup **Consulting Engineers**

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Trim Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located on the southeast corner of Breezewood Street and Hallendale Street. An arbitrary elevations of 100.00m was assigned to the TBM.

REMARKS

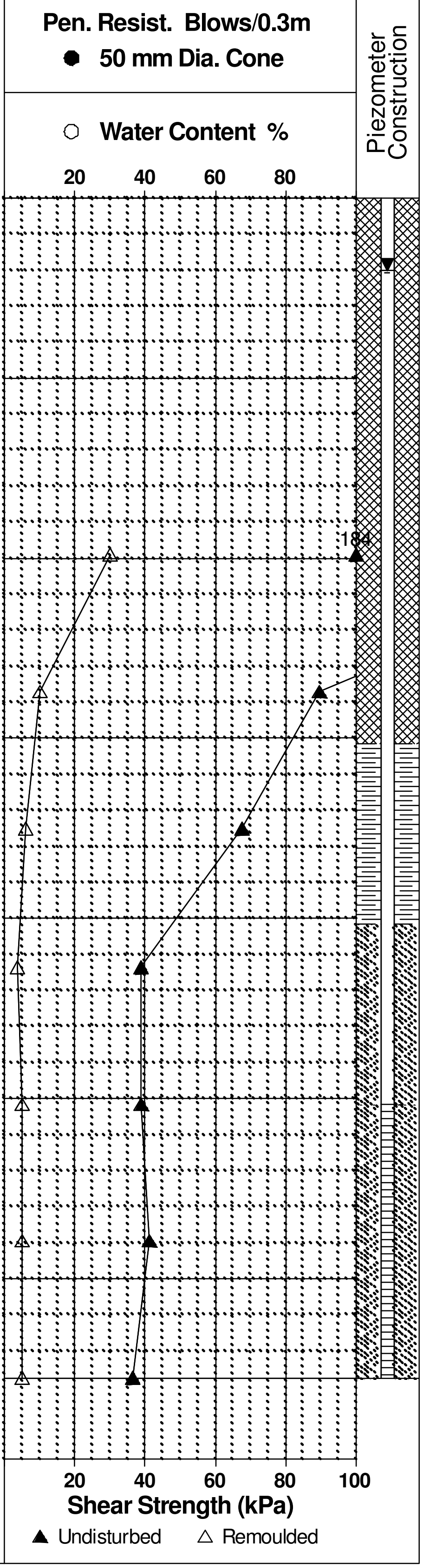
BORINGS BY CME 55 Power Auger

DATE 10 June 2011

FILE NO. **PG2401**

HOLE NO. **BH 3**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.52
Brown **SILTY CLAY** with sand 0.30		AU	1				
		AU	2				
		SS	3	100	11	1	97.52
						2	96.52
Hard to stiff, brown **SILTY CLAY** - stiff to firm and grey by 2.9m depth						3	95.52
						4	94.52
						5	93.52
						6	92.52
6.55							
End of Borehole (GWL @ 0.40m-June 15/11)							



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 relative strength of cohesionless soils is the compactness condition, 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. An SPT N value of “P” denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	‘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 shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

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, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity: $S_t < 2$
Medium Sensitivity: $2 < S_t < 4$
Sensitive: $4 < S_t < 8$
Extra Sensitive: $8 < S_t < 16$
Quick Clay: $S_t > 16$

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 NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, 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, generally recovered using a piston sampler
G - "Grab" sample from test pit or surface materials
AU - Auger sample or bulk sample
WS - Wash sample
RC - Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC% - Natural water 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 at 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 = $(D30)^2 / (D10 \times D60)$
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)

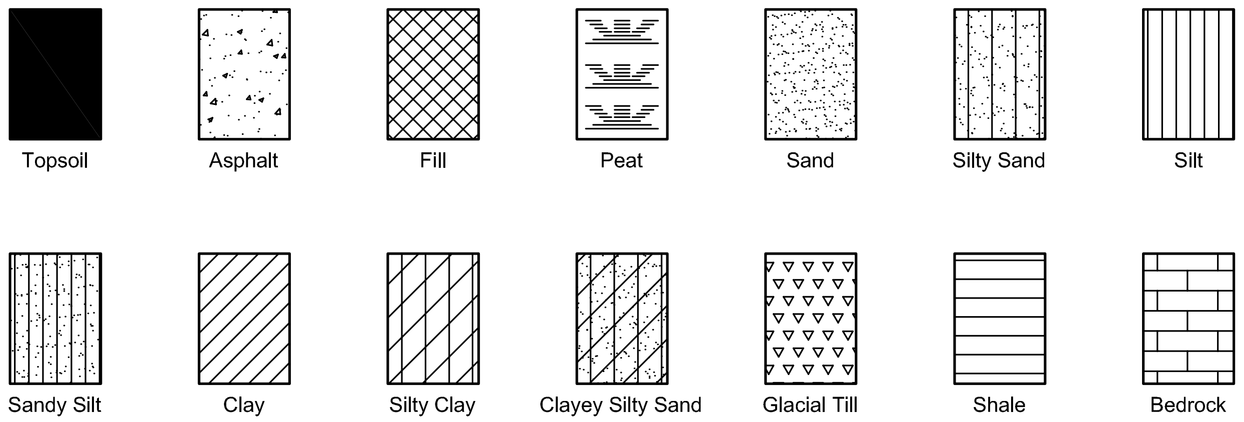
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

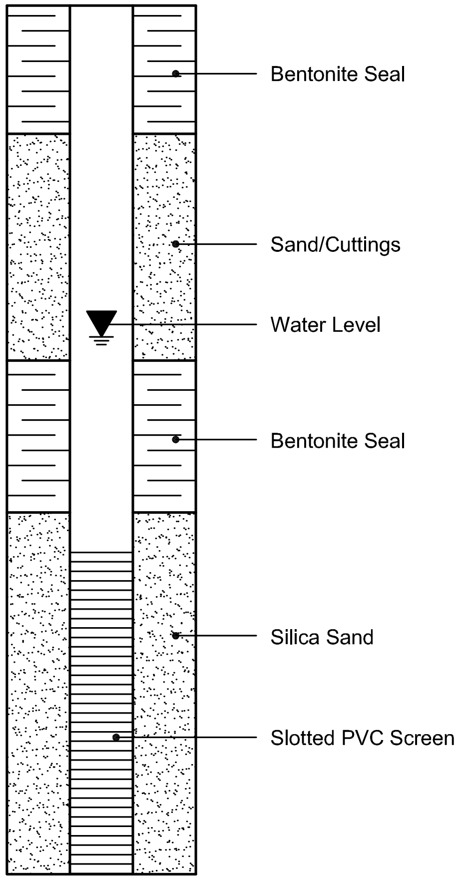
SYMBOLS AND TERMS (continued)

STRATA PLOT

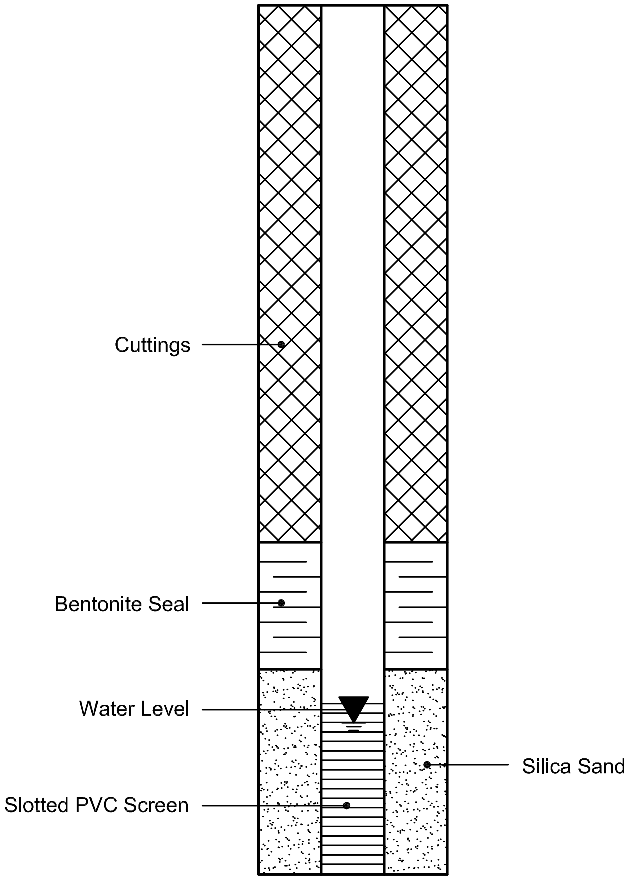


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG2401-1 - TEST HOLE LOCATION PLAN

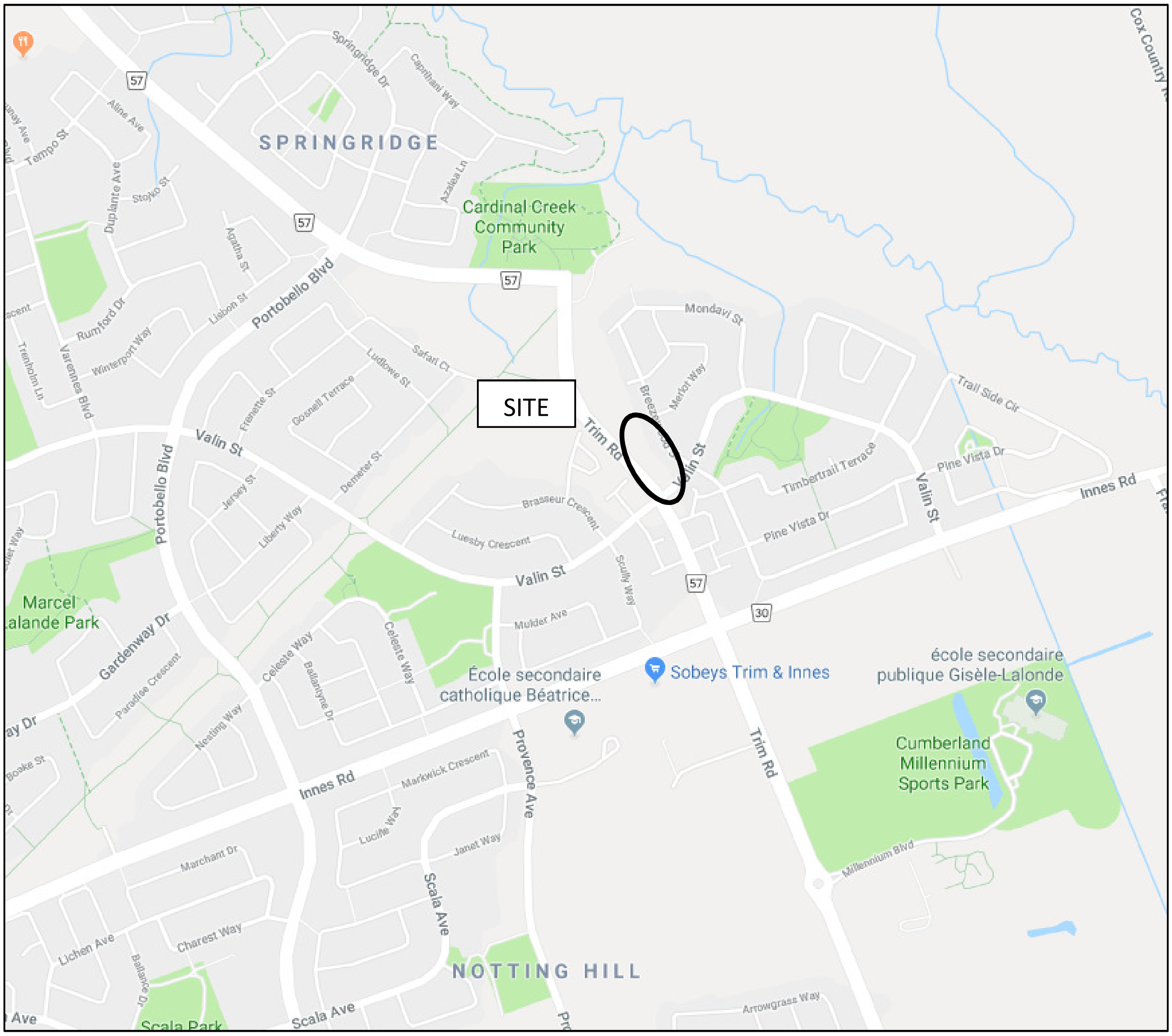
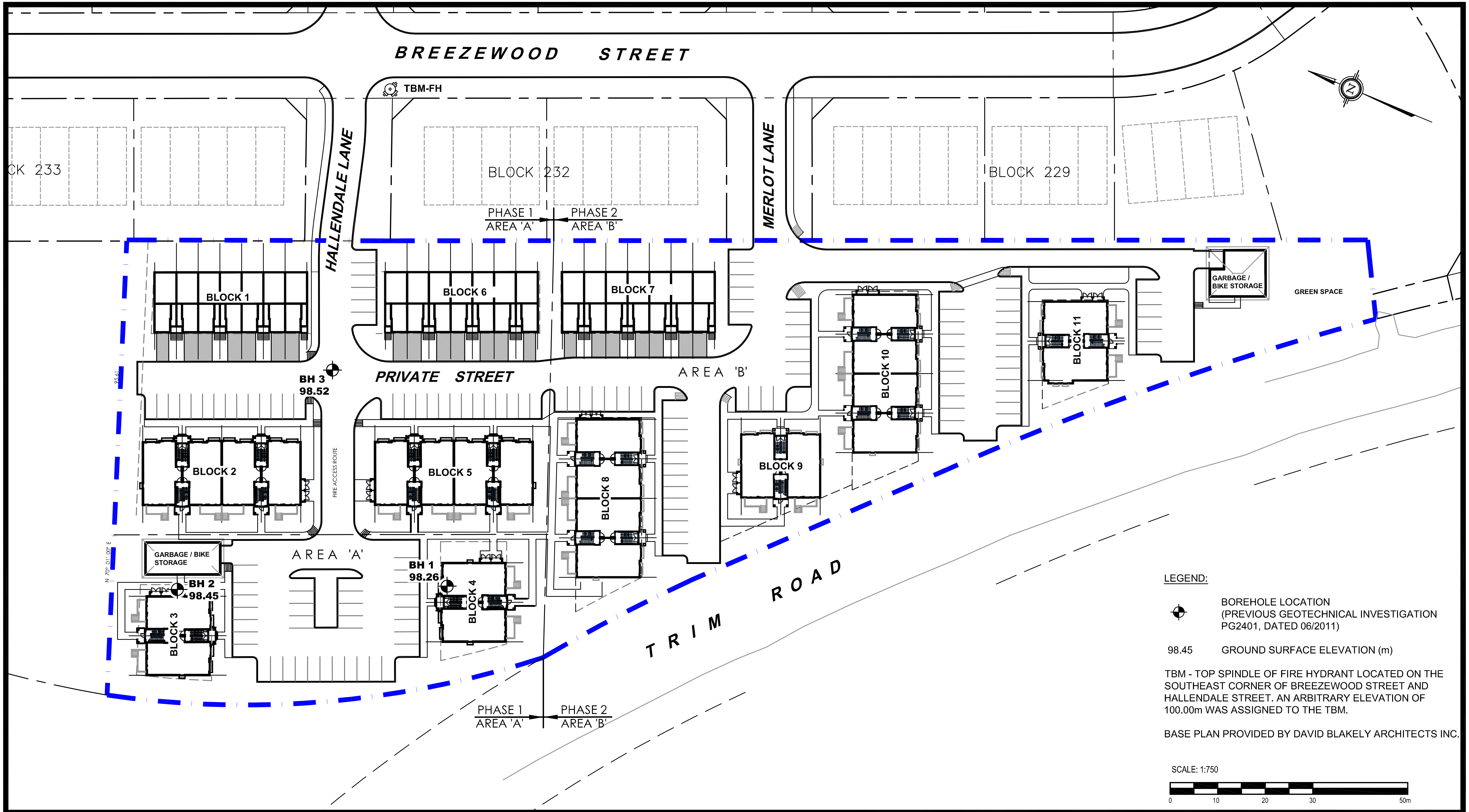


FIGURE 1

KEY PLAN



LEGEND:

⊕	BOREHOLE LOCATION (PREVIOUS GEOTECHNICAL INVESTIGATION PG2401, DATED 06/2011)
98.45	GROUND SURFACE ELEVATION (m)

TBM - TOP SPINDLE OF FIRE HYDRANT LOCATED ON THE SOUTHEAST CORNER OF BREEZEWOOD STREET AND HALLENDALE STREET. AN ARBITRARY ELEVATION OF 100.00m WAS ASSIGNED TO THE TBM.

BASE PLAN PROVIDED BY DAVID BLAKELY ARCHITECTS INC.

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NO.	REVISIONS	DATE	INITIAL
1	UPDATED TO LATEST BASE PLAN	13/12/2017	DJG

ASHCROFT HOMES
GEOTECHNICAL INVESTIGATION
OAKRIDGE GATE - BREEZEWOOD STREET / TRIM ROAD
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:750
Date: 12/2017
Drawn by: RCG
Report No.: PE2326-2
Checked by: DJG
Dwg. No.: PG2401-1
Approved by: DJG
Revision No.: 1

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