Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

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patersongroup

Hydrogeological Assessment

Proposed Residential Development
879 River Road
Ottawa, Ontario

Prepared For

Richcraft Group of Companies

March 29, 2018

Report PG4479-1

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APPENDICES

1.0 INTRODUCTION

Paterson Group (Paterson) was commissioned by Richcraft Group of Companies to prepare a hydrogeological assessment for the proposed residential development to be located at 879 River Road in Ottawa, Ontario (refer to Figure 1 - Key Plan within Appendix 1).

Subsurface information was obtained from the geotechnical investigation carried out to determine the subsoil and groundwater conditions at the site by means of test holes.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains the investigation findings and includes hydrogeological assessments pertaining to the proposed program as understood at the time of writing this report.

1.1 Proposed Project

It is our understanding that the proposed residential development, to be located on the east side of River Road and north of Rideau Road, consists of the municipal address 879 River Road.

The subject site consists of an approximate 3.2 hectare undeveloped property consisting of agricultural fields. Two residential buildings occupy the northwest corner of the property while a heavily treed area occupies the northeast corner. The property is relatively flat and at grade with River Road, with an approximate 3 m deep ravine running across the site. It is bordered to the north by forested areas, to the east by agricultural properties, to the south by agricultural and residential properties and to the west by River Road.

2.0 SITE CONDITIONS

Physical Setting

As previously noted, the subject site is located on the east side of River Road and contains a mixture of agricultural lands and densely treed areas. Site topography is relatively flat, with average elevations of 90 m above sea level (asl) along the eastern portion of the property and average elevations of 89.5 m asl along the western portion. Elevations provided for the drainage ditch that crosses the property indicates an east to west drainage direction, with elevations of approximately 89 m asl at the eastern edge of the property and 86 m asl at the western edge. There were no named water bodies known to exist on the subject site.

According to available mapping, the subject site is located in the Ottawa Valley Clay Plains physiographic region. The region is characterized by relatively flat clay plains interrupted by rock ridges, which is generally consistent with field observations at the subject site.

2.1 Geology

Surficial Geology

The field program for the geotechnical investigation was carried out on January 11, 2018. A total of 6 boreholes were advanced to a maximum depth of 6.7 m. The borehole locations were distributed in a manner to provide general coverage of the subject site. The approximate locations of the boreholes are shown on Drawing PG4402-1 - Test Hole Location Plan included in Appendix 2

Overburden soils identified during the geotechnical field investigation were generally consistent with available mapping for the area. Soils typically consisted of topsoil underlain by silty sand, which was further underlain by a very stiff to stiff silty clay deposit that became grey and stiff to firm with depth.

Specific details of the soil profile at each test hole location are presented on the Soil Profile and Test Data sheets included in Appendix 2.

Bedrock

Based on available geological mapping, the subject site is located in an area where the bedrock consists of dolomite of the Oxford formation, with an estimated overburden thickness ranging from 10 to 15 m.

Karst Features

The term “karst” refers to a geologic formation characterized by the dissolution of carbonate bedrock, such as limestone or dolostone. In order for karstification to occur, precipitation must be allowed to infiltrate the top of the bedrock to dissolutionally enlarge previously existing joints and bedding planes. Given the depth of surficial soils overlying the dolomite bedrock that are non-conducive to groundwater infiltration, it is highly unlikely that karstification is occurring.

2.2 Hydrogeology

Existing Aquifer Systems

Aquifer systems may be defined as geological media, either overburden soils or fractured bedrock, which permit the movement of groundwater under hydraulic gradients. Although groundwater has been observed within the overburden soils at the subject site, the composition of materials does not allow for the development of significant water supply wells. Water supply wells in the vicinity are instead likely found in bedrock aquifers.

Bedrock aquifer mapping, provided by Natural Resources Canada Urban Geology of the National Capital Region mapping, was reviewed as part of this assessment. Using this tool, the Oxford formation aquifer system was identified as the only water supply aquifer system in the vicinity of the study area.

The Oxford formation aquifer system is present throughout the study area. While there are no wells extending into this aquifer on the subject site, wells completed within this formation located in proximity to the site reported encountering water-bearing fractures at depths typically ranging from 15 to 25 m bgs.

Groundwater Levels

Groundwater was observed in the piezometers installed in the overburden at the borehole locations. Based on a review of water well records, groundwater is also present in the bedrock at depth.

Groundwater levels in the overburden at the subject site were observed to vary from 0.4 to 2.98 m bgs at the time of the geotechnical field investigation. It should be noted that groundwater levels may have been influenced by surface water infiltrating the backfilled boreholes. Subsequent groundwater level readings within the piezometers can be influenced by perched water in the backfill material within the borehole.

Groundwater levels are also influenced by seasonal variations in temperature and precipitation. As such, long-term groundwater levels are also estimated based on other factors such as colour and consistency of the recovered soil samples. Based on these observations, the long-term groundwater level at the subject site is expected to range from approximately 3.5 to 4.5 m bgs.

Hydraulic Gradients

Vertical hydraulic gradients were not measured at the subject site as the previous studies completed did not warrant the installation of monitoring well nests.

With respect to horizontal hydraulic gradients, due to the nature of the water levels obtained from field work conducted at the site (piezometers), the absolute direction of horizontal hydraulic gradients was not determined. However, using the available data, it was possible to approximate the horizontal hydraulic gradients in the overburden material given that the horizontal hydraulic gradient between any 2 points is the slope of the hydraulic head between those points:

$$i=h2-h1/L$$

Where: i=horizontal hydraulic gradient
h=water level (m bgs)
L=horizontal distance between test hole locations

Using the above noted formula, the horizontal hydraulic gradient was observed to have an approximate south-to-southeast orientation and a magnitude ranging from 0.01 to 0.006. Shallow groundwater flow in the vicinity of the subject site is expected to reflect local topography. Regional groundwater flow is considered to be in a westerly direction, towards the Rideau River.

Hydraulic Conductivity

The hydraulic conductivity values were conservatively estimated based upon previous experience at similar sites in the area, information obtained from the results of the geotechnical field program and typical published values for similar stratigraphy. The values are interpreted to be in the order of 1×10^{-4} to 1×10^{-7} m/sec for silty sand and 1×10^{-7} to 1×10^{-10} m/sec for silty clay.

Groundwater Recharge and Discharge

In general, groundwater will follow the path of least resistance from areas of higher hydraulic head to areas of lower hydraulic head. While upward and downward hydraulic gradients may be indicative of discharge and recharge respectively, other factors must be considered.

Based on the hydraulic conductivity estimates obtained from previous studies and published literature, the silty clay overburden is generally considered to act as a confining layer. It is our interpretation that groundwater will generally flow laterally through the upper layer of silty sand/weathered brown silty clay, as opposed to vertically upwards or downwards through overburden soils with lower hydraulic conductivity such as the grey silty clay. As such, the volume of recharge occurring within the site boundaries is expected to be minimal.

With regards to discharge zones, neither the topographical or geological conditions are suitable for discharge to be occurring at the subject site.

3.0 POTENTIAL IMPACTS

3.1 Adverse Effects on Adjacent Structures

The overburden in the area generally consists of topsoil overlying a silty sand layer which is further underlain by a deep silty clay deposit. The potential dewatering volumes due to groundwater infiltration into the excavation footprints are anticipated to be low to moderate depending on the volume of perched water encountered within the silty sand overlying the silty clay. Additionally, given the nature of the development (low lying residential housing and associated servicing), the duration of any excavation on site is expected to be short term in duration. As such, any effects related to ground surface settlement due to the water taking activities during construction are expected to be negligible.

3.2 Adverse Effects on Neighbouring Water Wells

A search of the Ontario Water Well Records online mapping database and the Groundwater Information Network (GIN) indicates there are 36 wells within 500 m of the site as depicted on Drawing PG4479-1 - MOECC Water Well Location Plan included in Appendix 1. However, upon investigation it was determined that a number of the wells in the area are monitoring wells and not for water supply. Additionally, the water supply wells noted to potentially remain in use generally extended to the bedrock aquifer, well beyond the maximum depth of any excavation that may take place as part of the proposed development. Construction activities at the site are therefore not expected to cause any interference to the water supply of surrounding properties or other negative impacts.

A series of calculations were carried out on theoretical radii of influence for a typical servicing trench excavation withdrawing water from the upper 3 to 5 m of the saturated zone. These calculations were completed based on Sichardt (1992) using the equation:

$$R = r_e + 3000*\Delta h(k^{0.5})$$

- R = radius of influence (m)
- r_e = equivalent radius of excavation (m)
- Δh = thickness of drawdown within the aquifer (m)
- k = hydraulic conductivity (m/sec)

For the purposes of completing the calculations, the following assumptions were made:

- ❑ r_e = 7.96 m
- ❑ k = 1 x 10^{-7} m/sec, based upon our experience in the area and published values.
- ❑ Δh = 3 to 5 m, to review potential minimum/maximum variable conditions.

Using the above equation and assumptions, a radius of influence of approximately 3 to 5 m will develop as a steady state condition, extending from the edge of the excavation, in the area of the subject site.

Given the hydrogeological characteristics of the subject site, the theoretical radii of influence for the potential excavations related to the development and the depth of the water supply wells within 500 m, a long-term groundwater monitoring program is not required to be implemented based on our review.

In the interest of public perception, consideration may be given to undertaking a baseline subdivision sampling program. The premise of the program is to obtain groundwater quality information from the water supply wells in the vicinity of the proposed development prior to the project commencing. This ensures that all parties involved (developer, homeowner and City of Ottawa) are protected should a concern arise during or after construction.

3.3 Groundwater

A search of the MOECC Brownfields Environmental Site Registry was conducted as part of the assessment of the site, neighbouring properties and the general area of the site. Using a search radius of 1 km provided no recorded Brownfield sites in that area. No concerns were identified in the review of the MOECC Brownfields database.

It is anticipated that the material on site will be disposed of or re-used as per the MOECC policy, *Management of Excess Soil - A Guide for Best Management Practices* dated January, 2014.

The groundwater that is pumped from site excavations must be managed in an appropriate manner. The contractor will be required to implement a water management program to dispose of the pumped water.

4.0 STATEMENT OF LIMITATIONS

The recommendations provided in this report are in accordance with our present understanding of the project.

A hydrogeological review of this nature is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations. Should any conditions at the site be encountered which differ from those at the test locations, we request notification 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 Richcraft Group of Companies or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Michael Laflamme, GIT

David J. Gilbert, P.Eng.

APPENDIX 1

Figure 1 - Key Plan

Drawing PG4479-1 - MOECC Water Well Location Plan

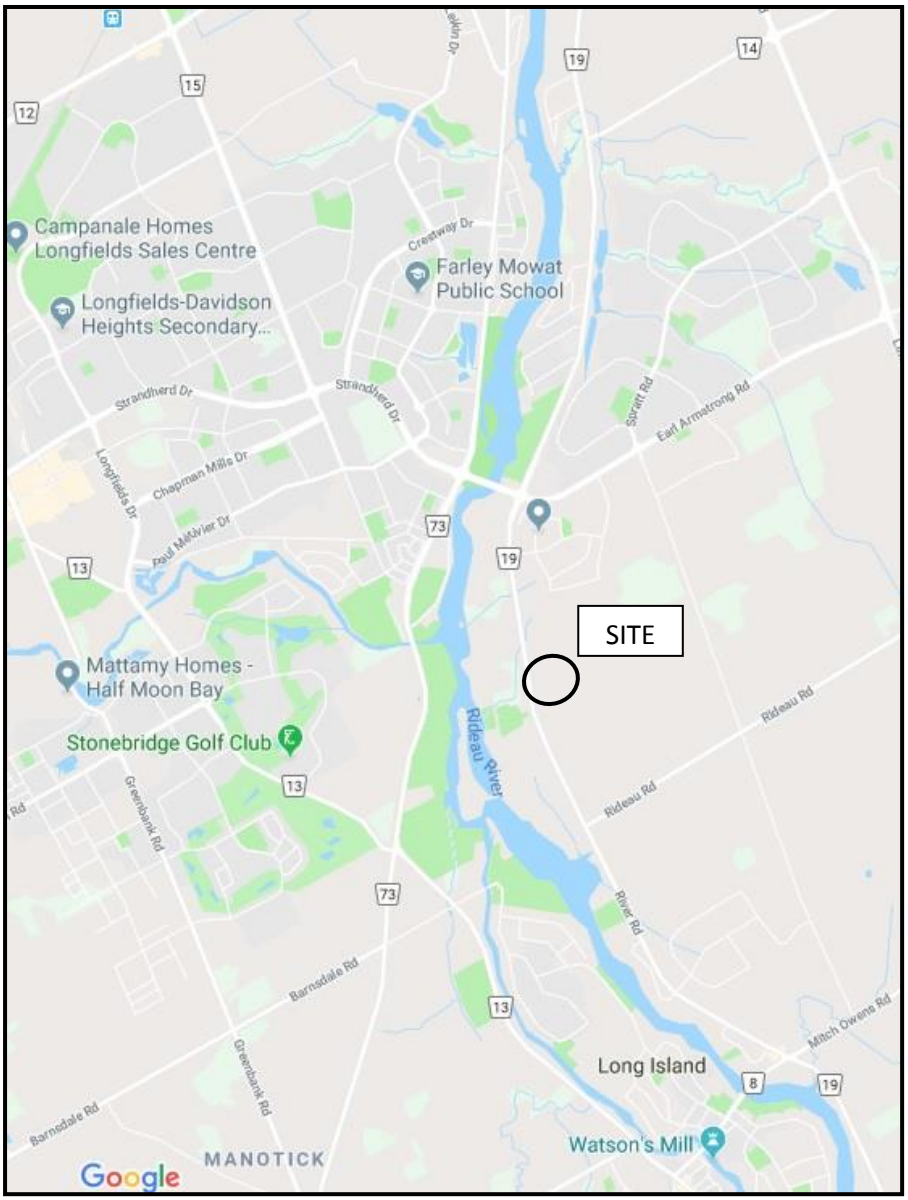
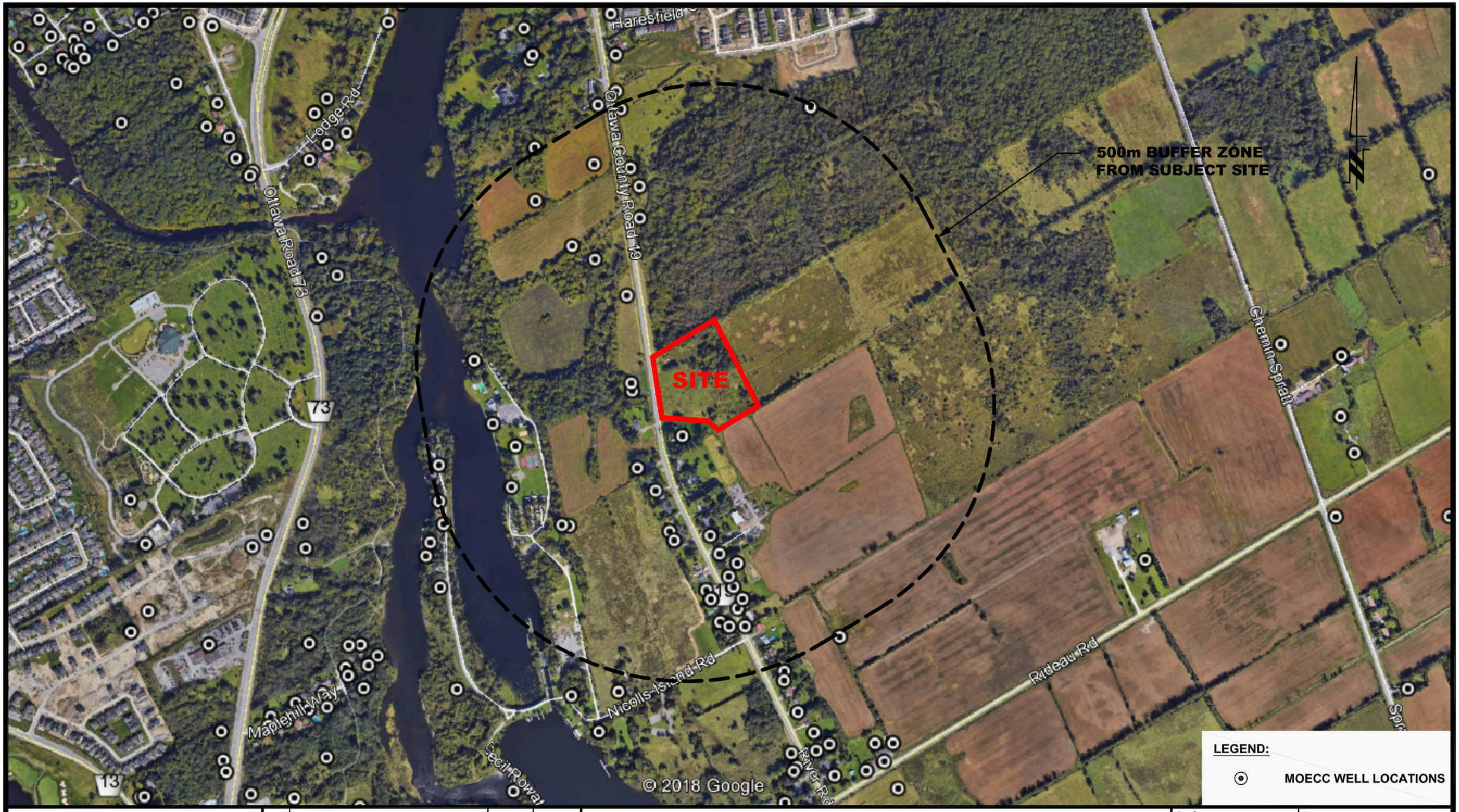


FIGURE 1

KEY PLAN



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NO.	REVISIONS	DATE	INITIAL
0			

RICHCRAFT GROUP OF COMPANIES

HYDROGEOLOGICAL ASSESSMENT
879 RIVER ROAD

OTTAWA, ONTARIO

Title:

MOECC WATER WELL LOCATION PLAN

Scale: 1:7500	Date: 03/2018
Drawn by: MPG	Report No.: PG4479-1
Checked by: ML	Dwg. No.: PG4479-1
Approved by: CDS	Revision No.: 0

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APPENDIX 2

Soil Profile and Test Data

Drawing PG4402-1 - Test Hole Location Plan

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
879 River Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations interpolated from recent completed topographic survey by Annis, O'Sullivan, Vollebekk Ltd.

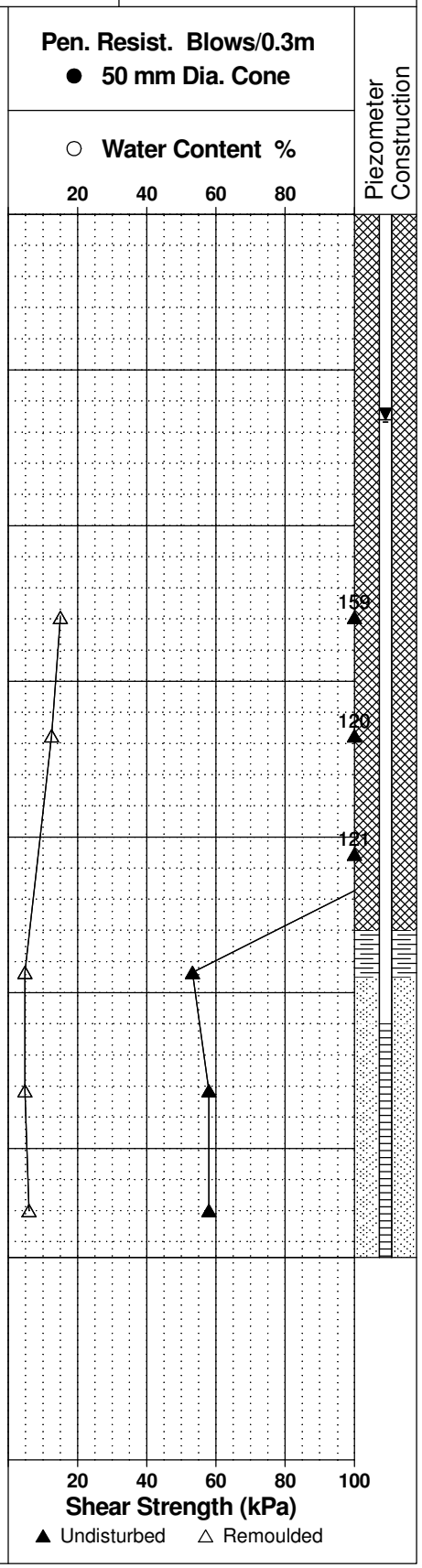
FILE NO. PG4402

REMARKS

HOLE NO. BH 1

BORINGS BY CME 55 Power Auger **DATE** January 11, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	90.00
FILL: Brown silty sand, some topsoil, trace gravel		AU	1				
0.28							
Loose, brown **SILTY SAND**		SS	2	50	7	1	89.00
1.68		SS	3	100	3	2	88.00
Very stiff to stiff, brown **SILTY CLAY,** some sand		SS	4	100	P		
		SS	5	100	P	3	87.00
- grey by 3.8m depth		SS	6	100	P	4	86.00
		SS	7	100	P	5	85.00
		SS	8	100	P	6	84.00
		SS	9	100	P		
6.70							
End of Borehole							
(GWL @ 1.32m - Jan. 22, 2018)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
879 River Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations interpolated from recent completed topographic survey by Annis, O'Sullivan, Vollebekk Ltd.

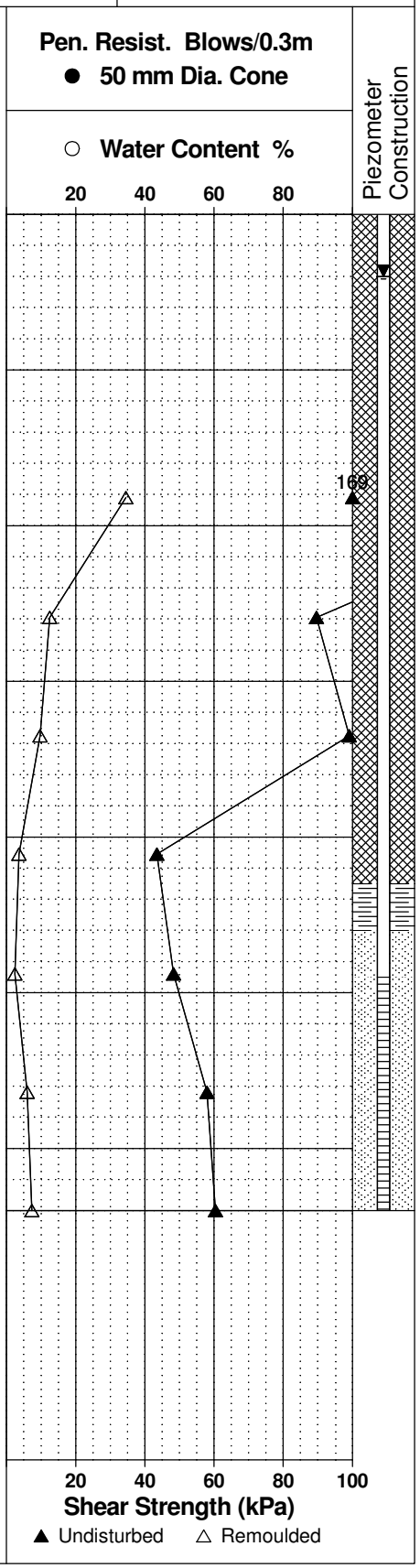
FILE NO. PG4402

REMARKS

HOLE NO. BH 2

BORINGS BY CME 55 Power Auger **DATE** January 11, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	90.10
TOPSOIL 0.40		AU	1				
		SS	2	67	3	1	89.10
		SS	3	75	P	2	88.10
Very stiff to stiff, brown **SILTY CLAY,** trace sand						3	87.10
- firm to stiff and grey by 3.8m depth						4	86.10
						5	85.10
						6	84.10
6.40 End of Borehole							
(GWL @ 0.40m - Jan. 22, 2018)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
879 River Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations interpolated from recent completed topographic survey by Annis, O'Sullivan, Vollebekk Ltd.

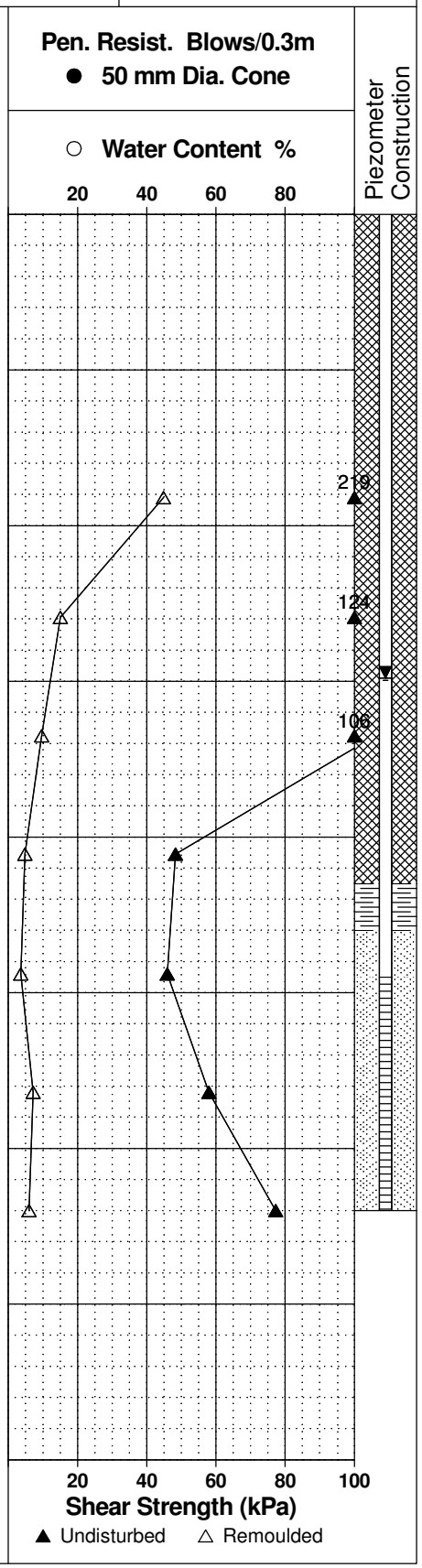
FILE NO. PG4402

REMARKS

HOLE NO. BH 3

BORINGS BY CME 55 Power Auger **DATE** January 11, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	90.00
TOPSOIL 0.33		AU	1				
Loose, brown **SILTY SAND** 0.91		SS	2	62	5	1	89.00
		SS	3	100	P	2	88.00
Very stiff to stiff, brown **SILTY CLAY,** trace sand						3	87.00
- firm to stiff and grey by 3.8m depth						4	86.00
						5	85.00
						6	84.00
6.40							
Dynamic Cone Penetration Test commenced at 6.40m depth. Cone pushed to 12.5m depth.						7	83.00
						8	82.00



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
879 River Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations interpolated from recent completed topographic survey by Annis, O'Sullivan, Vollebekk Ltd.

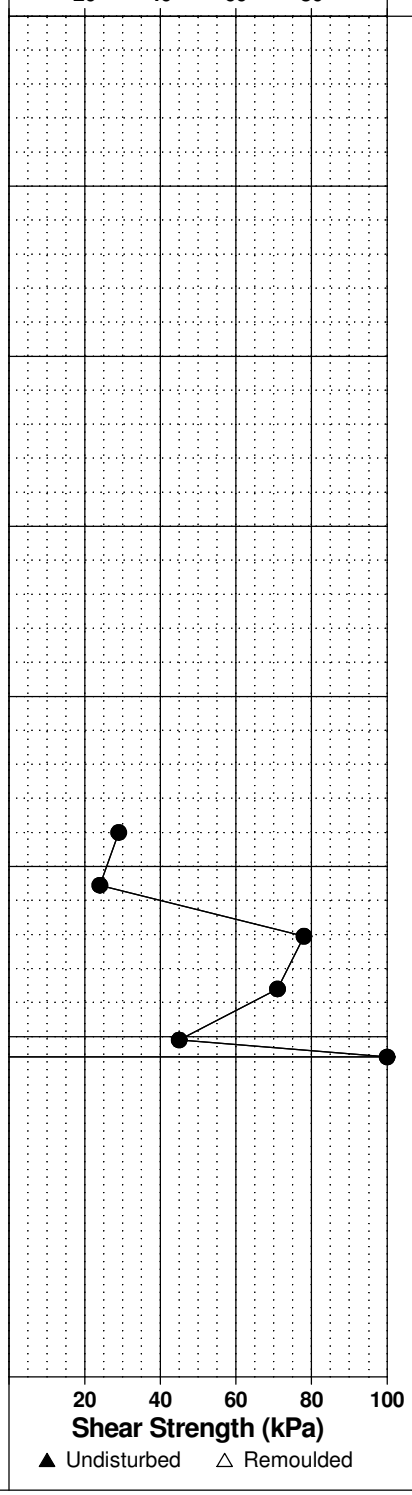
FILE NO. PG4402

REMARKS

HOLE NO. BH 3

BORINGS BY CME 55 Power Auger **DATE** January 11, 2018

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	82.00		
						1	81.00		
						2	80.00		
						3	79.00		
						4	78.00		
						5	77.00		
14.12						6	76.00		
End of Borehole									
Practical DCPT refusal at 14.12m depth.									
(GWL @ 2.98m - Jan. 22, 2018)									



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
879 River Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations interpolated from recent completed topographic survey by Annis, O'Sullivan, Vollebekk Ltd.

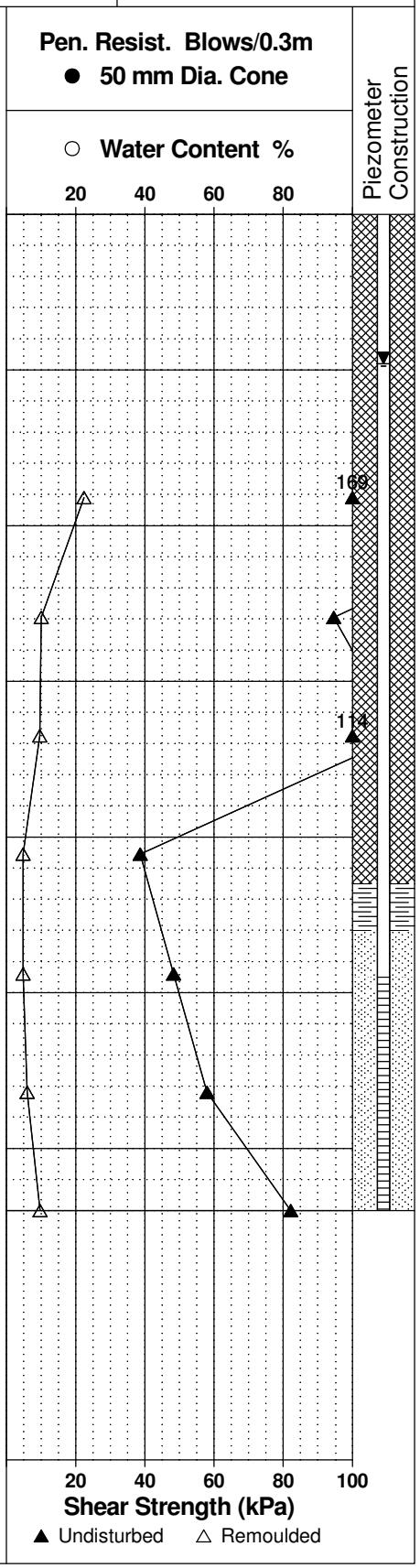
FILE NO. PG4402

REMARKS

HOLE NO. BH 4

BORINGS BY CME 55 Power Auger **DATE** January 11, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.80
TOPSOIL 0.28		AU	1				
		SS	2	58	3	1	88.80
		SS	3	100	P	2	87.80
Very stiff to stiff, brown **SILTY CLAY,** trace sand						3	86.80
- firm to stiff and grey by 3.8m depth						4	85.80
						5	84.80
						6	83.80
6.40 End of Borehole							
(GWL @ 0.96m - Jan. 22, 2018)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
879 River Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations interpolated from recent completed topographic survey by Annis, O'Sullivan, Vollebekk Ltd.

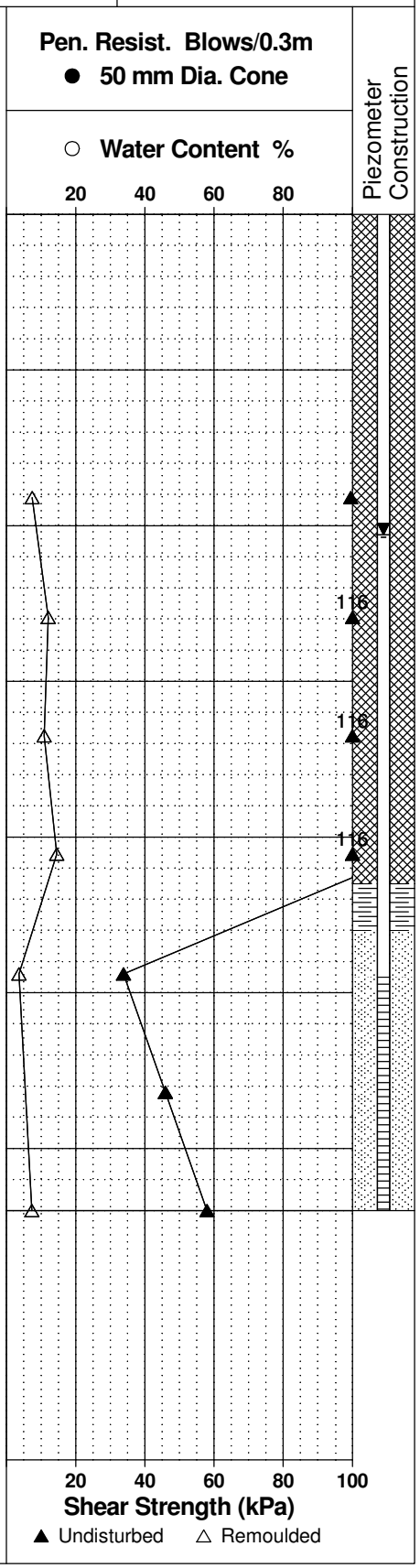
FILE NO. PG4402

REMARKS

HOLE NO. BH 5

BORINGS BY CME 55 Power Auger **DATE** January 11, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	88.50
TOPSOIL 0.43		AU	1				
		SS	2	58	5	1	87.50
		SS	3	67	P	2	86.50
Very stiff to stiff, brown **SILTY CLAY,** trace sand						3	85.50
						4	84.50
- firm to stiff and grey by 4.6m depth						5	83.50
						6	82.50
6.40 End of Borehole							
(GWL @ 2.06m - Jan. 22, 2018)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
879 River Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations interpolated from recent completed topographic survey by Annis, O'Sullivan, Vollebekk Ltd.

FILE NO. PG4402

REMARKS

HOLE NO. BH 6

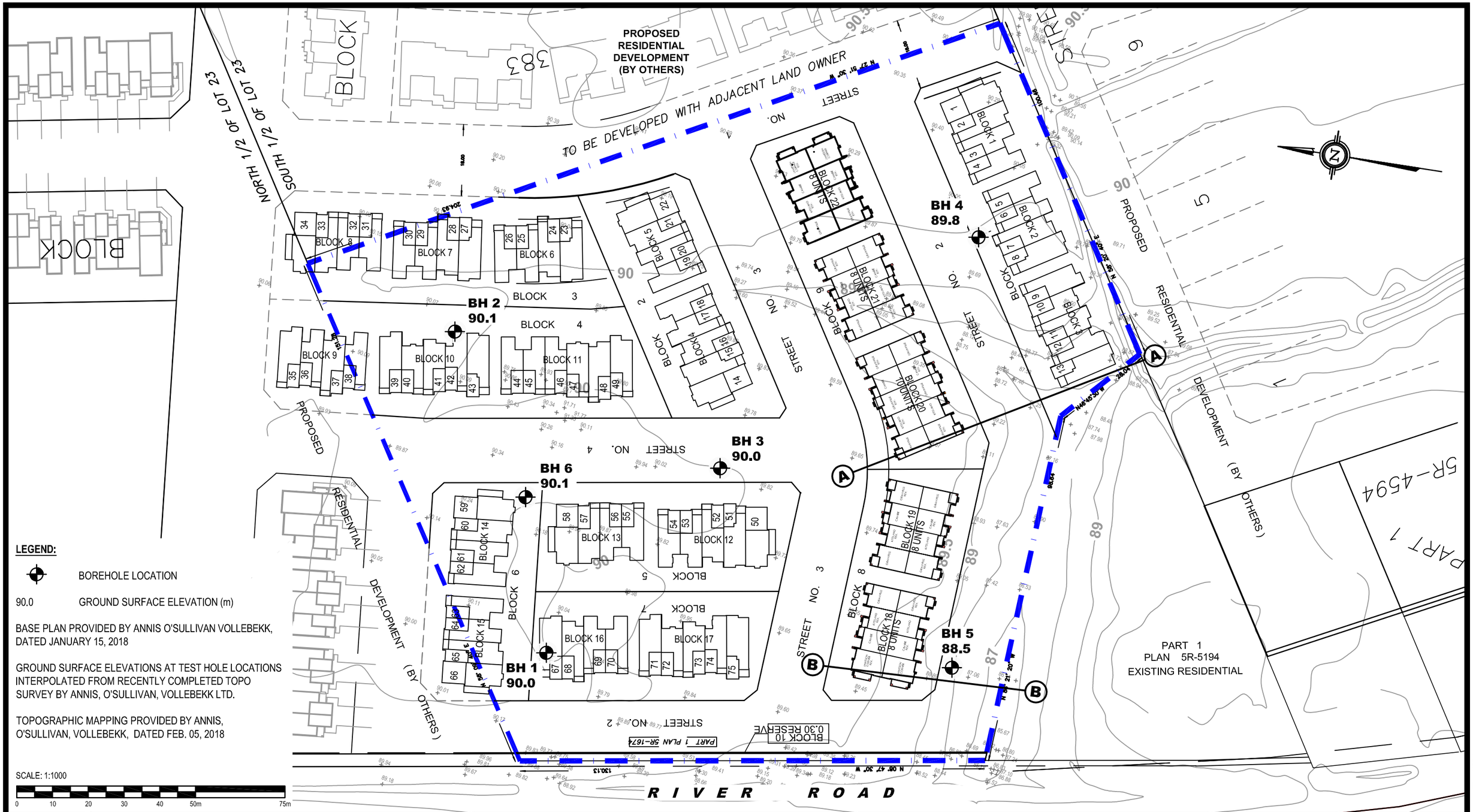
BORINGS BY CME 55 Power Auger **DATE** January 11, 2018

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									
FILL: Brown silty sand, trace gravel, cobbles, topsoil and a piece of brick		AU	1			0	90.10		
0.69									
Loose, brown **SILTY SAND,** some clay		AU	2			1	89.10		
1.52									
End of Borehole									
(BH dry upon completion)									

Pen. Resist. Blows/0.3m: ● 50 mm Dia. Cone; ○ Water Content %; scale 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded



LEGEND:

⌖ BOREHOLE LOCATION

90.0 GROUND SURFACE ELEVATION (m)

BASE PLAN PROVIDED BY ANNIS O'SULLIVAN VOLLEBEKK, DATED JANUARY 15, 2018

GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS INTERPOLATED FROM RECENTLY COMPLETED TOPO SURVEY BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

TOPOGRAPHIC MAPPING PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK, DATED FEB. 05, 2018

SCALE: 1:1000

0 10 20 30 40 50m 75m

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NO.	REVISIONS	DATE	INITIAL
0			

RICHCRAFT GROUP OF COMPANIES

GEOTECHNICAL INVESTIGATION - PROPOSED RESIDENTIAL DEVELOPMENT
879 RIVER ROAD

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1000	Date: 01/2018
Drawn by: RCG	Report No.: PG4402-1
Checked by: FA	Dwg. No.: PG4402-1
Approved by: FA	Revision No.: 0

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APPENDIX 3

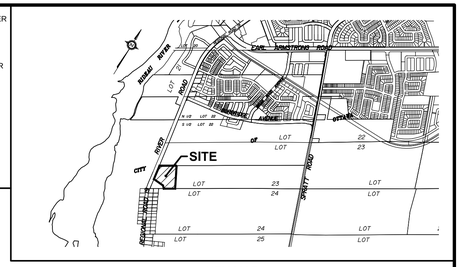
Annis, O'Sullivan, Vollebekk Limited - Draft Plan of Subdivision With Contours

SUBJECT TO THE CONDITIONS, IF ANY, SET FORTH IN OUR LETTER DATED

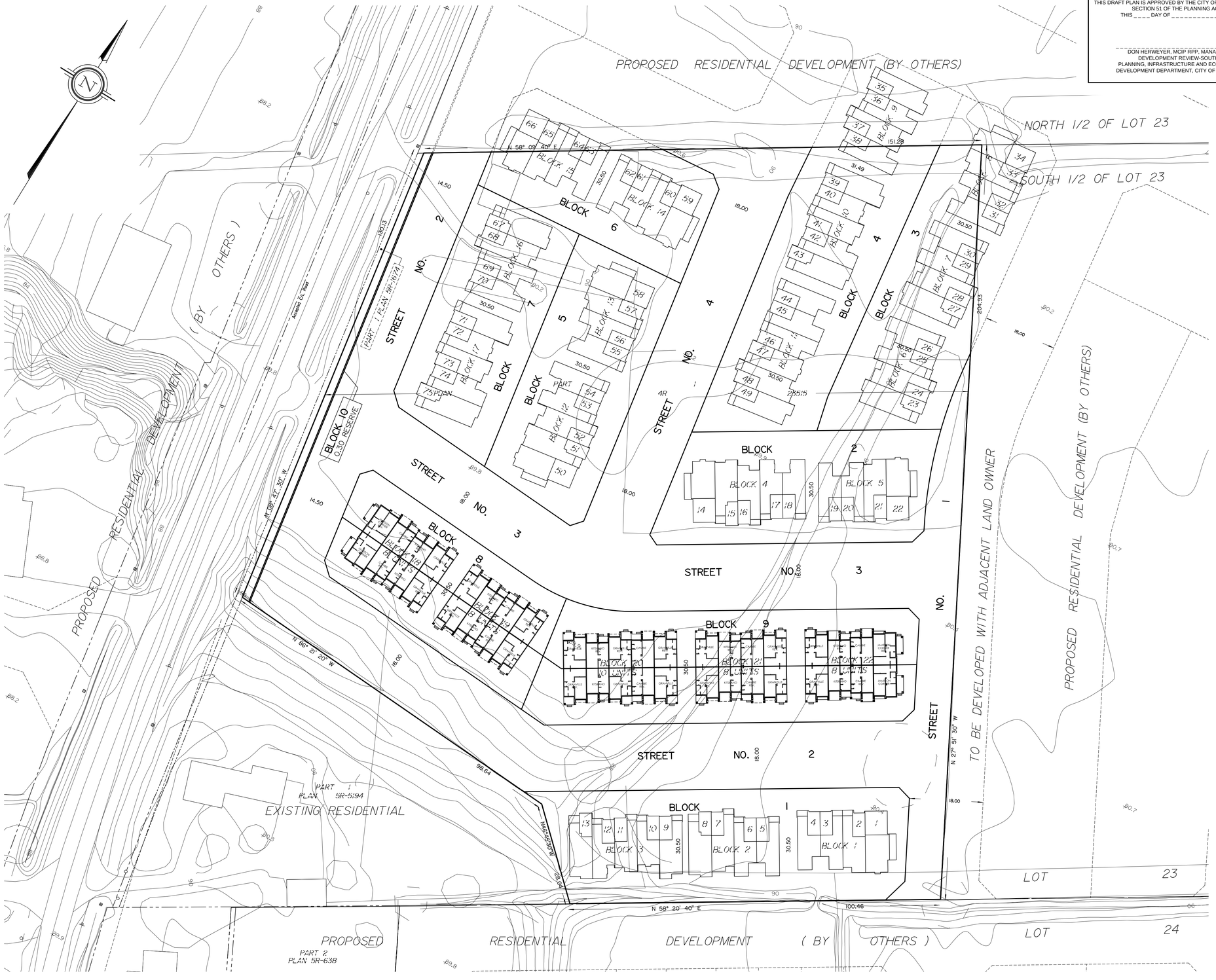
_____

THIS DRAFT PLAN IS APPROVED BY THE CITY OF OTTAWA UNDER SECTION 51 OF THE PLANNING ACT.
THIS ____ DAY OF _____ 20__.

_____
DON HERWEYER, MCIP RPP, MANAGER
DEVELOPMENT REVIEW-SOUTH
PLANNING, INFRASTRUCTURE AND ECONOMIC
DEVELOPMENT DEPARTMENT, CITY OF OTTAWA



KEY MAP
NOT TO SCALE



OPTION C

DRAFT PLAN OF SUBDIVISION OF

PART OF LOT 23
BROKEN FRONT
CONCESSION (RIDEAU FRONT)

Geographic Township of Gloucester

CITY OF OTTAWA

Prepared by Annis , O'Sullivan , Vollebekk Ltd.
January 15, 2018

Metric

DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

SURVEYOR'S CERTIFICATE

I CERTIFY THAT :
The boundaries of the lands to be subdivided and their relationship to adjoining lands have been accurately and correctly shown.

_____ _____
Date Edward M. Lancaster
ONTARIO LAND SURVEYOR

OWNER'S CERTIFICATE

This is to certify that I am the owner of the lands to be subdivided and that this plan was prepared in accordance with my instructions.

_____ _____
Date Steve Grandmont
Authorized Sigining Officer
Richcraft Homes Ltd.
I have the authority to bind the corporation

Number of Units

Towns	75
Singles	0
Back-to-Backs	42

Total Number of Units = 117

ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51-17 OF THE PLANNING ACT

(a) see plan
(b) see plan
(c) see plan
(d) single/multi-family residential housing, park land, open space and institutional
(e) see plan
(f) see plan
(g) see plan
(h) City of Ottawa
(i) see soils report
(j) see plan
(k) sanitary, storm sewers, municipal water, bell, hydro, cable and gas to be available
(l) see plan

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