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Geotechnical Investigation

Proposed Residential Development
232 Donald B. Munro Drive
Village of Carp, Ontario

Prepared For

Tartan Homes

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Report: PG5628-1 Revision 1

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Tartan Homes to conduct a geotechnical investigation for a future residential development site to be located on 232 Donald B. Munro Drive in the Village of Carp (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the geotechnical 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.

2.0 Proposed Development

It is understood that a future residential development is being considered at the subject site. Associated parking areas, local roadways and landscape areas are also anticipated as part of the future residential development. It is expected that the proposed development will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current geotechnical investigation was carried out on September 28, 2021 and consisting of advancing a total of five test pits down to a maximum depth of 4m below existing ground surface. A previous investigation was also completed at the subject site on December 22, 2020. At that time, a total of five (5) boreholes were advanced down to a maximum depth of 6.0 m below existing ground surface. The test hole locations were distributed in a manner to provide general coverage of the subject site and taking into consideration underground utilities and site features. The test hole locations are shown on Drawing PG5628-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were drilled using a track-mounted auger drilling rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The drilling procedures consisted of auguring to the required depths at the selected location and sampling the overburden.

Sampling and In Situ Testing

The soil samples were recovered from the auger flights and using a 50 mm diameter split-spoon sampler. The samples were initially classified on site, placed in sealed plastic bags and transported to our laboratory. The depths at which the auger and split-spoon samples were recovered from the boreholes 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.

The subsurface conditions observed in the test pits were recorded in detail in the field. The soil profiles are logged on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Groundwater

Flexible polyethylene standpipes were installed in all boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

Sample Storage

All samples will be stored in the laboratory for a period of one (1) month after issuance of this report. They will then be discarded unless we are otherwise directed.

3.2 Field Survey

The test hole locations and ground surface elevation at each test hole location were surveyed by Paterson using a handheld GPS and referenced to a geodetic datum. The location of the test holes and ground surface elevation at each test hole location are presented on Drawing PG5628-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the test holes were examined in our laboratory to review the results of the field logging. Four (4) samples were submitted for Atterberg Limits testing, one (1) sample for shrinkage limit testing, and two (2) sample for grain size distribution testing.

All test results are included in Appendix 1 and further discussed in Subsection 4.2 of the current report. The results of the unidimensional consolidation testing are presented on the Consolidation Test sheets in Appendix 1.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures, one of which was collected from test hole BH 5-20. The sample was submitted to determine the concentration of sulphate and chloride, the resistivity, and the pH of the samples. The results are presented in Appendix 1 and are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The ground surface across the subject site is relatively flat, with an upslope towards the northeast portions of the subject site. The subject site was observed to be intercepted by a water course running at the center in the north-south direction. Random piles of fill were observed at different locations across the site. The height of these fill piles ranged between 1 to 3m. According to historical aerial photos of the site, the fill piles were imported to the site between 2009 and 2010 and again in 2017, as shown in Figures 2, 3, and 4. An organic cover was observed at the top of the existing fill.

To the south, the site is bordered by Donald B. Munro Drive followed by a residential development, to the west by residential dwellings and associated landscaped areas, to the east by a residential dwelling, and to the north by a mature treed area sloping upwards from south to north.

4.2 Subsurface Profile

Generally, the soil profile at the test hole locations consists of fill material and/or topsoil at ground surface. The fill material consists of dark brown silty clay to silty sand with crushed stone and gravel and traces of roots overlying very stiff to stiff brown silty clay and/or glacial till. Stiff to firm grey silty clay was encountered below the very stiff to stiff brown silty clay layer at the locations of BH3-20, BH4-20, and BH5-20. Practical refusal to augering was encountered at BH1-20, BH2-20 and BH4-20. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profile encountered at each test hole location.

Bedrock

Based on available geological mapping, the bedrock in the subject area consists of intrusive rocks of the Syenite and Monzonite formation, with an overburden drift thickness of 3 to 25 m depth.

Grain Size Distribution and Hydrometer Test

Two sieve analyses were completed to classify selected soil samples according to the Unified Soil Classification System (USCS). The results are summarized in Table 1 and presented in Appendix 1.

Table 1 - Grain Size Distribution and Hydrometer Testing

Test Hole	Sample	Gravel (%)	Sand (%)	Silt and Clay (%)
TP 1-21	G5	0	53.4	46.6
TP 3-21	G4	0	1.9	98.1

Atterberg Limit Tests

Four selected silty clay samples were submitted for Atterberg Limit testing. The test results indicate that both low and high plasticity silty clays are anticipated at the subject site. The results are summarized in Table 2 and presented in Appendix 1.

Table 2 - Summary of Atterberg Limits Test Results

Test Hole	Sample No.	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
TP 1-21	G3	38	19	19
TP 2-21	G5	66	28	38
TP 3-21	G3	61	28	33
TP 4-21	G5	41	16	25

Shrinkage Test

The shrinkage limit and shrinkage ratio of the tested silty clay sample (TP 1-21 G4) were found to be 18.1% and 1.86, respectively.

4.3 Groundwater

Groundwater infiltration levels were recorded within the open test pits at the time of excavation. Furthermore, groundwater levels were measured within the installed standpipes during the previous investigation on January 4, 2021. Based on the groundwater observations and readings, the groundwater levels recorded ranged from 0.8 to 4.4 m below existing ground surface. The measured groundwater levels are presented in Table 3 below:

Table 3 – Summary of Groundwater Levels

Test Hole Number	Ground Surface Elevation (m)	Measured Groundwater Level / Groundwater Infiltration for Test Pits		Dated Recorded
		Depth (m)	Elevation (m)	
BH 1-20	110.12	1.9	108.22	January 4, 2021
BH 1A-20	110.12	2.9	107.22	
BH 2-20	114.12	1.92	112.2	
BH 3-20	108.5	4.4	104.1	
BH 4-20	111.65	0.78	110.87	
BH 5-20	105.05	0.92	104.13	

Note: The ground surface elevation at each borehole location was referenced to a geodetic datum.

It should be noted that surface water can become perched within a backfilled borehole, which can lead to higher than normal groundwater readings. Long-term groundwater levels can also be estimated based on the observed color and consistency of the recovered soil samples. Based on these observations, the long-term groundwater table can be expected at approximately 3.0 m to 4.0m below existing grade. The ground water observations are noted on the applicable Soil Profile and Test Data sheet presented in Appendix 1.

It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater levels could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for a residential development. It is anticipated that residential buildings will be founded over a very stiff to stiff brown silty clay, compact silty sand or compact glacial till bearing surface. Where existing fill is encountered below the footings of settlement-sensitive structures, a geotechnical evaluation of the fill should be completed to determine if the underlying fill is suitable to remain in place and a proof-rolling program would improve the fill layer's compactness. Alternatively, an engineered granular fill pad can be placed over a proof-rolled fill layer, which is reviewed and approved by Paterson personnel at the time of construction.

Due to the presence of a sensitive silty clay layer, areas of the site will be subjected to grade raise restrictions. If a higher permissible grade raise is required, preloading with or without surcharge, lightweight fill and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction and differential settlements.

Depending on depth of services and building foundations, bedrock removal may be required within the southeastern portion of the site.

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

5.2 Site Grading and Preparation

Stripping Depth

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

Fill Placement

Fill placed for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The imported fill material should be tested and approved prior to delivery. The fill should be placed in maximum 300 mm thick loose lifts and compacted by 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 settlement of the ground surface is of minor concern. These materials should be spread in lifts with a maximum thickness of 300 mm and compacted by the tracks of the spreading equipment to minimize voids. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls, unless used in conjunction with a geocomposite drainage membrane, such as Miradrain G100N or Delta Drain 6000.

Consideration could be given to placing the proposed footings and floor slabs over the existing fill, free of deleterious materials and organics, provided the fill is approved by Paterson at the time of construction. The approved existing fill material should be proof-rolled using suitable compaction equipment under dry conditions, tested and approved by Paterson personnel. Also, a minimum 300 mm thick granular pad, consisting of a Granular A crushed stone, compacted to 98% of its SPMDD is recommended to be placed at footing level over the approved fill subgrade. Where the fill is deemed inadequate below the proposed footings, the fill should be sub-excavated below the design underside of footing and replaced with engineered fill, such as OPSS Granular A or Granular B Type II and compacted to a minimum 98% of the material's SPMDD. The engineered fill should be extended a minimum 300 mm horizontally beyond the footing face in all directions at footing level and throughout the lateral support zone of the footing.

Bedrock Removal

Where encountered, bedrock removal can be accomplished by hoe ramming where only a small quantity of bedrock needs to be removed. Sound bedrock may be removed by line drilling and controlled blasting and/or hoe ramming.

Prior to considering blasting operations, the blasting effects on the existing services, buildings, and other structures should be addressed. A pre-blast or pre-construction survey of the existing structures located in the proximity of the blasting operations should be carried out prior to commencing site activities. The extent of the survey should be determined by the blasting consultant and should be sufficient to respond to any inquiries or claims related to the blasting operations.

As a general guideline, peak particle velocities (measured at the structures) should not exceed 25 mm/s during the blasting program to reduce the risks of damage to the existing surrounding structures. The blasting operations should be planned and conducted under the supervision of a licensed professional engineer who is also an experienced blasting consultant.

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.

5.3 Foundation Design

Bearing Resistance Values (Conventional Shallow Foundation)

Based on the subsurface profile encountered, it is anticipated that the proposed buildings will be founded over a native, silty sand, silty clay, or glacial till bearing surface, or on an engineered granular fill pad placed over a proof-rolled fill layer, reviewed and approved by Paterson personnel at the time of construction.

Bearing resistance values for footings placed on a bearing surface consisting of undisturbed native soil are provided in Table 4 below. Footings bearing on an undisturbed, very stiff to stiff, brown silty clay, and compact, silty sand and glacial till, designed using the bearing resistance values at SLS provided in Table 2, will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

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, in the dry, prior to the placement of concrete footings.

Table 4 - Bearing Resistance Values

Bearing Surface	Bearing Resistance Values at SLS (kPa)	Factored Bearing Resistance Values at ULS (kPa)
Very Stiff to Stiff Brown Silty Clay	150	250
Compact, Brown Silty Sand	100	200
Compact Glacial Till	200	400
Engineered Fill Pad over Approved Fill	150	250

Notes:
- ULS - Ultimate Limit States
- SLS - Serviceability Limit States
- A geotechnical resistance factor of 0.5 was applied to the provided bearing resistance values at ULS

Permissible Grade Raise and Settlements

Due to the presence of the silty clay deposit, a permissible grade raise restriction is recommended. The recommended grade raise restrictions are shown on Drawing PG5628-2 - Permissible Grade Raise Plan in Appendix 2. A post-development groundwater lowering of 0.5 m was considered in our permissible grade raise calculations.

If higher than permissible grade raises are required, preloading with or without a surcharge, lightweight fill, and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction total and differential settlements.

Footings bearing on an undisturbed soil bearing surface and designed using the bearing resistance values provided herein will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

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 glacial till, silty sand with clay and engineered fill bearing media when a plane extending down and out from the bottom edges of the footing, at a minimum of 1.5H:1V, passes only through in situ soil or engineered fill of the same or higher capacity as that of the bearing medium. In unfractured bedrock, a plane with a slope of 1H:6V can be used.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class D** for foundations constructed at the subject site. A higher site class, such as Class C may be provided for foundations constructed within the east portion of the subject site. However, the higher site class will need to be confirmed by a site-specific seismic shear wave velocity test. The soils underlying the subject site are not susceptible to 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 within the footprint of the proposed building, the native soils and bedrock surface will be considered an acceptable subgrade upon which to commence backfilling for floor slab construction.

Where existing fill, free of deleterious material and significant organic content, is encountered below the basement slab, provisions should be made to proof-rolling the soil subgrade using heavy vibratory compaction equipment prior to placing any fill. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Types I or II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab (outside the zones of influence of the footings). It is recommended that the upper 200 mm of sub-floor fill consists of OPSS Granular A crushed stone. All backfill material within the footprint of the proposed buildings (but outside the zones of influence of the footings) should be placed in maximum 300 mm thick loose layers and compacted to at least 95% of its SPMDD. Within the zones of influence of the footings, the backfill material should be compacted to a minimum of 98% of its SPMDD.

5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structure. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction of 30 degrees and a bulk (drained) unit weight of 20 kN/m^3.

However, undrained conditions are anticipated (i.e. below the groundwater level). Therefore, the applicable effective (undrained) unit weight of the retained soil can be taken as 13 kN/m3, where applicable. A hydrostatic pressure should be added to the total static earth pressure when using the effective unit weight. However, if a full drainage system is being implemented and approved by Paterson at the time of construction, hydrostatic pressure can be omitted in the structural design.

Lateral Earth Pressures

The static horizontal earth pressure (p_o) can be calculated using a triangular earth pressure distribution equal to $K_o \cdot \gamma \cdot H$ where:

K_o = at-rest earth pressure coefficient of the applicable retained soil (0.5)
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)

An additional pressure having a magnitude equal to $K_o \cdot q$ and acting on the entire height of the wall should be added to the above diagram for any surcharge loading, q (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be used in conjunction with the seismic loading case.

Actual earth pressures could be higher than the “at-rest” case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

Seismic Earth Pressures

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}).

The seismic earth force (ΔP_{AE}) can be calculated using $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$ where:

a_c = $(1.45-a_{max}/g)a_{max}$
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)
g = gravity, 9.81 m/s^2

The peak ground acceleration, (a_{max}), for the site area is 0.257 g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero.

The earth force component (P_o) under seismic conditions can be calculated using $P_o = 0.5\ K_o\ \gamma\ H^2$, where $K_o = 0.5$ for the soil conditions noted above.

The total earth force (P_{AE}) is considered to act at a height, h (m), from the base of the wall, where:

$$h = \{P_o \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\}/P_{AE}$$

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.

5.7 Pavement Design

Car only parking areas and local residential roadways are expected at this site. The subgrade material will consist of native soil and fill and possibly bedrock at some locations within the east portion of the site. The proposed pavement structures are presented in Tables 5 and 6.

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 II material.

Table 5 – 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 fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil.	

Table 6 – Recommended Pavement Structure – Local Residential Roadways

Thickness (mm)	Material Description
40	**Wear Course –** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Wear Course –** HL-8 or Superpave 19 Asphaltic Concrete
150	**BASE –** OPSS Granular A Crushed Stone
400	**SUBBASE –** OPSS Granular B Type II
Subgrade – Either fill, in-situ soil, 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. The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable compaction equipment.

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.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed buildings. The system should consist of a 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 underground parking structure. The clear stone should be wrapped in a non-woven geotextile. The pipe should have a positive outlet, such as a gravity connection to the storm sewer or sump pump pit.

Underfloor Drainage

Underfloor drainage may be required to control water infiltration for the lower basement area. For preliminary design purposes, we recommend that 150 mm diameter perforated PVC pipes be placed at every bay opening. The spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

Foundation Backfill

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, unless used in conjunction with a drainage geocomposite, such as Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose. A waterproofing system should be provided to the elevator pits (pit bottom and walls).

6.2 Protection of Footings Against Frost Action

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

Other exterior unheated footings, such as those for isolated exterior piers and retaining walls, are more prone to deleterious movement associated with frost action. These should be provided with a minimum 2.1 m thick soil cover (or insulation equivalent).

The footings located along parking garage entrance may require protection against frost action depending on the founding depth. Unheated structures, such as the access ramp wall footings, may be required to be insulated against the deleterious effect of frost action. A minimum of 2.1 m of soil cover alone, or a minimum of 0.6 m of soil cover, in conjunction with foundation insulation, should be provided.

6.3 Excavation Side Slopes

The side slopes of excavations in the 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 excavation to be undertaken by open- cut methods (i.e. unsupported excavations). Where space restrictions exist, or to reduce the trench width, the excavation can be carried out within the confines of a fully braced steel trench box.

Unsupported Side Slopes

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 a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

In bedrock, almost vertical side slopes can be used provided that all loose rock and blocks with unfavorable weak planes are removed or stabilized.

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

Bedding and backfill materials should be in accordance with the most recent Material Specifications and Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the Township of Arnprior. 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 or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 95% of the material's standard Proctor maximum dry density.

It should generally be possible to re-use the moist, not wet, silty sand/sandy silt and or silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Any stones greater than 200 mm in their longest dimension should be removed from these materials prior to placement. Well fractured bedrock should be acceptable as backfill for the lower portion of the trenches when the excavation is within bedrock provided the rock fill is placed only from at least 300 mm above the top of the service pipe and that all stones are 300 mm or smaller in their longest dimension.

The backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce potential differential frost heaving. The backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

6.5 Groundwater Control

Groundwater Control for Building Construction

Based on our observations, it is anticipated that groundwater infiltration into the excavations should be low to moderate and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations. 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.

Permit to Take Water

It is anticipated that groundwater infiltration into the excavation should be low to moderate and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of the shallow excavation. 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.

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, typically between 50,000 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 MECP 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 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a moderate to slightly aggressive corrosive environment.

6.8 Landscaping Considerations

Tree Planting Restrictions

In accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines), Paterson completed a soils review of the site to determine applicable tree planting setbacks. Atterberg limits testing was completed for recovered silty clay samples at selected locations throughout the subject site. Grain size distribution and hydrometer testing were also completed on selected soil samples. The above noted soil samples were recovered from elevations below the anticipated design underside of footing elevation and 3.5 m depth below anticipated finished grade. The results of our testing are presented in Subsection 4.2 and in Appendix 1.

Based on the results of our review, two tree planting setback areas are present within the proposed development. The two areas are detailed below and have been outlined in Drawing PG5628-2 – Permissible Grade Raise and Tree Planting Setback Recommendations presented in Appendix 2.

Area 1 - No Tree Planting Setbacks

Based on the subsoil profile at the test hole locations, silty sand will be encountered at the future footing elevations at the locations identified on Drawing PG5628-3- Tree Planting Setback Recommendations. As a result, no tree planting restrictions are required for Area 1.

Area 2 - Low/Medium Sensitivity Clay Soils

A low to medium sensitivity clay soil is present within the subject site. The following tree planting setbacks are recommended for areas identified on Drawings PG5628-3- Tree Planting Setback Recommendations. It should be noted that in areas where design finished grades and top of the silty clay layer is greater than 3.5 m, no tree planting setbacks will be required. This will be defined by the geotechnical consultant by a lot-by-lot basis upon review of the site grading plan.

Large trees (mature height over 14 m) can be planted within Area 2 provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits may be reduced to 4.5 m for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the following conditions are met:

- ➢ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the center of the tree trunk and verified by means of the Grading Plan as indicated procedural changes below. Based on our review of the silty clay crust at the founding elevation, this number can be lowered to 1.9 m due to the depth of the groundwater table and our assessment of the impacts of tree planting on the founding medium.

- A small tree must be provided with a minimum of 25 m^3 of available soil volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

- The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

- The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).

- Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

Aboveground Swimming Pools, Hot Tubs, Decks and Additions

The in-situ soils are considered to be acceptable for in-ground swimming pools. Above ground swimming pools must be placed at least 5 m away from the residence foundation and neighboring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer`s requirements.

Additional grading around the hot tub should not exceed permissible grade raises. Otherwise, hot tub construction is considered routine, and can be constructed in accordance with the manufacturer’s specifications.

Additional grading around proposed deck or addition should not exceed permissible grade raises. Otherwise, standard construction practices are considered acceptable.

7.0 Recommendations

It is recommended that the following be carried out once the masterplan and site development are determined:

- Review master grading plan from a geotechnical perspective, once available.
- Observation of all bearing surfaces prior to the placement of concrete.
- Sampling and testing of the concrete and fill materials.
- 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.

All excess soils, with the exception of engineered crushed stone fill, generated by construction activities that will be transported on-site or off-site should be handled as per *Ontario Regulation 406/19: On-Site and Excess Soil Management*.

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

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, Paterson requests immediate notification to permit reassessment of our recommendations.

The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine the suitability and completeness for their intended construction schedule and methods. Additional testing may be required for their purposes.

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 Tartan Homes or their agents is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
October 4, 2021
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Maha K. Saleh, P.Eng. (Prov.)

David J. Gilbert, P.Eng

Report Distribution:

☐ Tartan Homes (3 copies)
☐ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

ATTERBERG LIMIT TESTING RESULTS

GRAIN SIZE DISTRIBUTION AND HYDROMETER TESTING RESULTS

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
232 Donald B. Munro Drive, Ottawa, Ontario

DATUM Geodetic

REMARKS

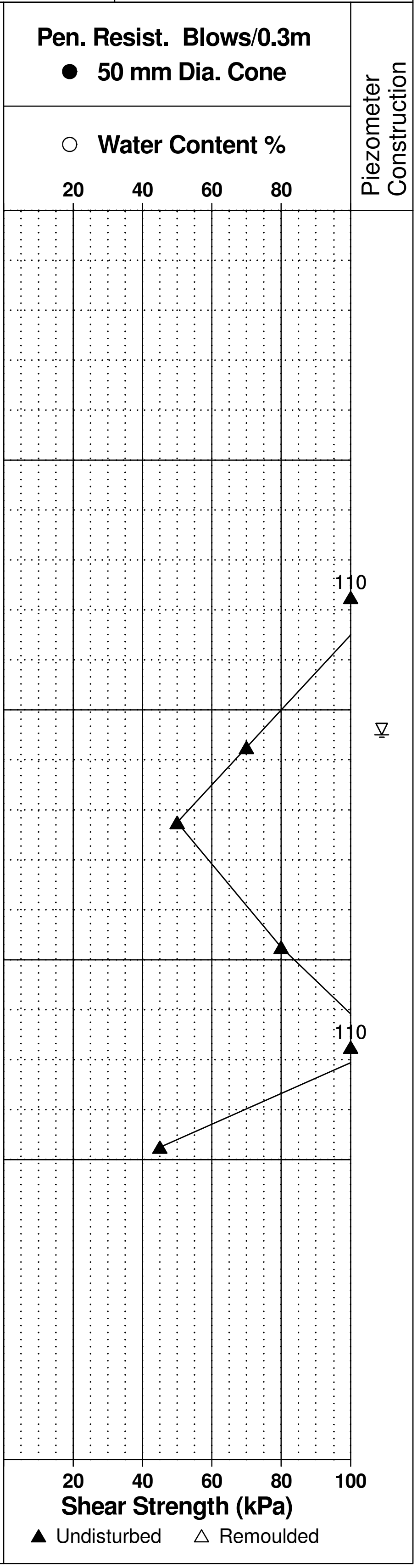
BORINGS BY Excavator

DATE September 28, 2021

FILE NO. PG5628

HOLE NO. TP 1-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	106.88
TOPSOIL	■	G	1				
0.35							
Compact, brown **SILTY SAND**		G	2				
1.10						1	105.88
Very stiff to stiff, brown **SILTY CLAY** with sand	▨	G	3				
		G	4			2	104.88
		G	5				
						3	103.88
- firm and grey by 3.5m depth							
3.80							
End of Test Pit (Groundwater infiltration at 2.1m depth)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
232 Donald B. Munro Drive, Ottawa, Ontario

DATUM Geodetic

REMARKS

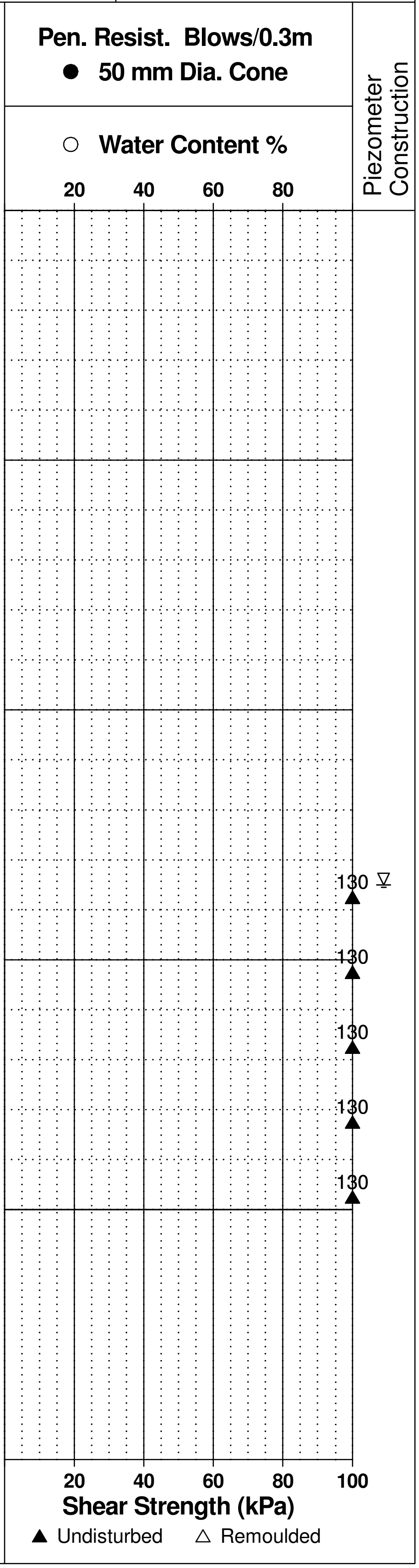
BORINGS BY Excavator

DATE September 28, 2021

FILE NO. PG5628

HOLE NO. TP 2-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	111.00
TOPSOIL 0.25		G	1				
Compact, brown **SILTY SAND** 1.00		G	2			1	110.00
Compact, brown **SILTY SAND,** some gravel, occasional cobbles 1.20		G	3				
Compact, brown **SILTY SAND,** trace clay 2.60		G	4			2	109.00
Hard, brown **SILTY CLAY** - grey by 3.2m depth 4.00		G	5			3 4	108.00 107.00
End of Test Pit (Groundwater infiltration at 2.7m depth)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
232 Donald B. Munro Drive, Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG5628**

REMARKS

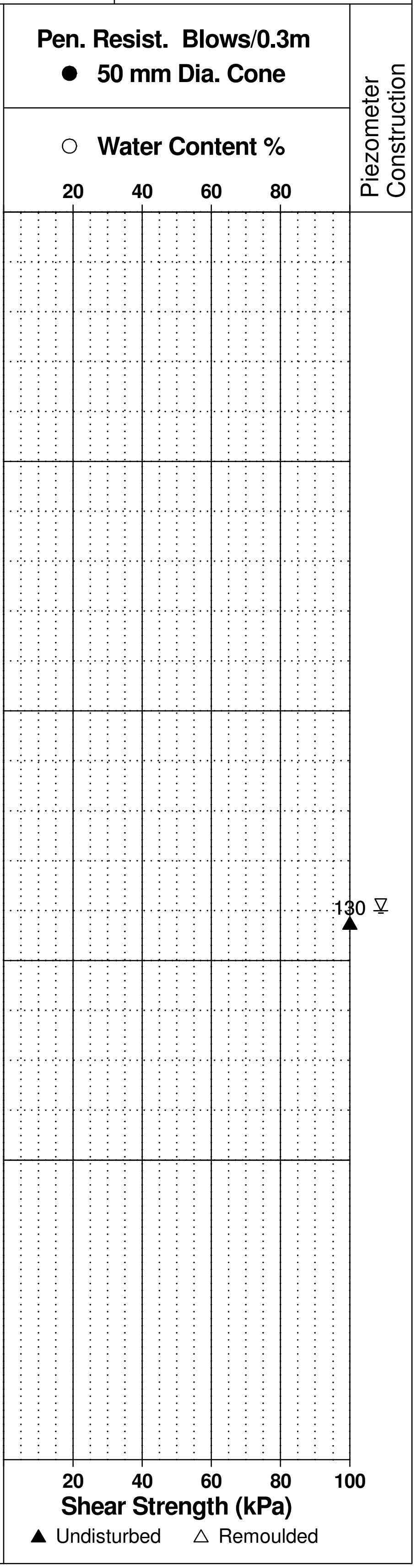
HOLE NO. **TP 3-21**

BORINGS BY Excavator

DATE September 28, 2021

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.25	G	1		
Compact, brown **SILTY SAND**	1.30	G	2		
Hard to very stiff, brown **SILTY CLAY**	3.80	G G G	3 4 5		
End of Test Pit (Groundwater infiltration at 2.8m depth)					

DEPTH (m)	ELEV. (m)
0	111.85
1	110.85
2	109.85
3	108.85



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
232 Donald B. Munro Drive, Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Excavator

DATE September 28, 2021

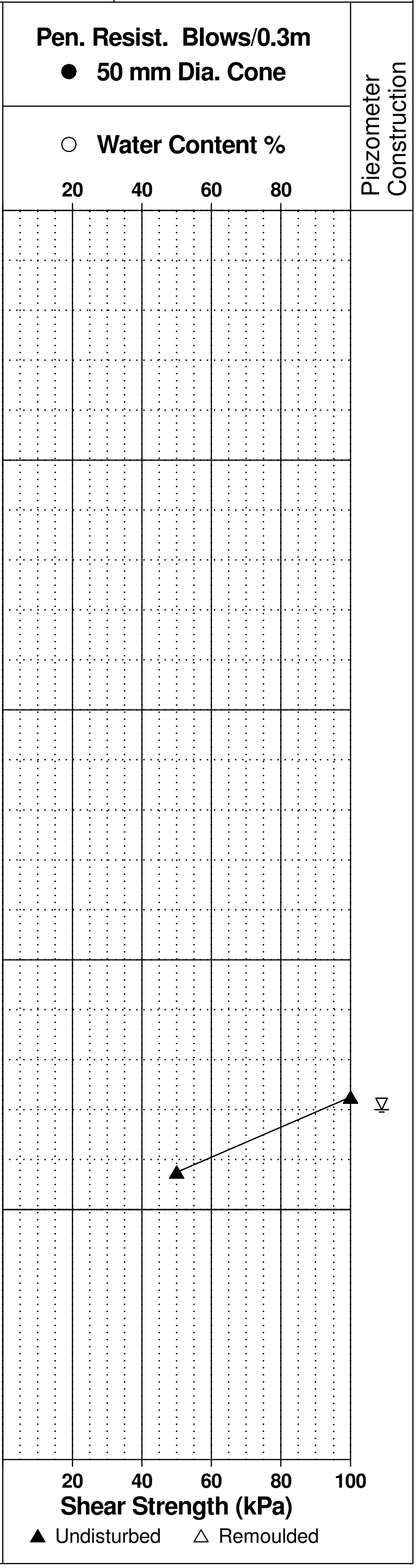
FILE NO. PG5628

HOLE NO. TP 4-21

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.20
Compact, brown **SILTY SAND,** trace clay	3.40
Very stiff to stiff, brown **SILTY CLAY,** trace clay - grey by 3.8m depth	3.90
End of Test Pit (Groundwater infiltration at 3.6m depth)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
G	1		
G	2		
G	3		
G	4		
G	5		

DEPTH (m)	ELEV. (m)
0	109.68
1	108.68
2	107.68
3	106.68
4	105.68



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
232 Donald B. Munro Drive, Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5628

REMARKS

HOLE NO. TP 5-21

BORINGS BY Excavator

DATE September 28, 2021

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE					0	111.39	
TOPSOIL 0.15	G	1					
	G	2					
					1	110.39	
	G	3					
Compact, brown **SILTY SAND**					2	109.39	
							∇
	G	4					
					3	108.39	
4.00	G	5			4	107.39	
End of Test Pit (Groundwater infiltration at 2.8m depth)							

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

○ Water Content %

20 40 60 80

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5628

REMARKS

HOLE NO. BH 1-20

BORINGS BY CME-55 Low Clearance Drill

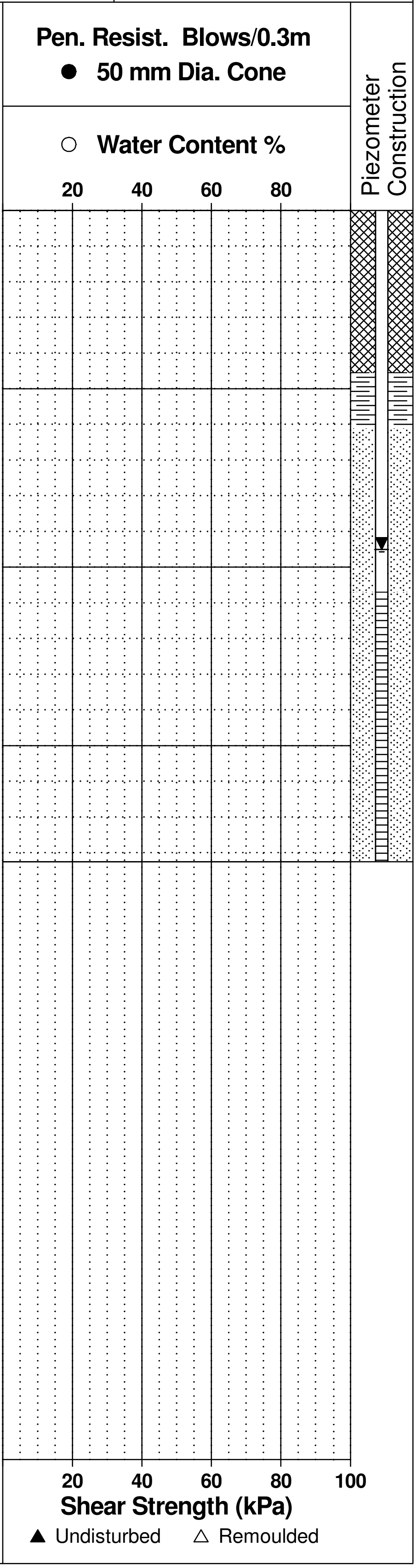
DATE 2020 December 22

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	110.12
FILL: Dark brown silty clay with sand, and trace rootlets	AU	1				
- Compact, brown silty sand by 0.76 m depth	SS	2	58	12	1	109.12
- Becoming very loose by 1.5 m depth	SS	3	58	2	2	108.12
2.28						
GLACIAL TILL: Compact brown silty sand with gravel, cobbles and boulders	SS	4	42	12	3	107.12
- Loose by 3.04 m depth	SS	5	33	8		
3.65						

End of Borehole

Practical refusal to augering at 3.65 m depth

(GWL @ 1.90 m depth - Jan 4, 2021)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE 2020 December 22

FILE NO. PG5628

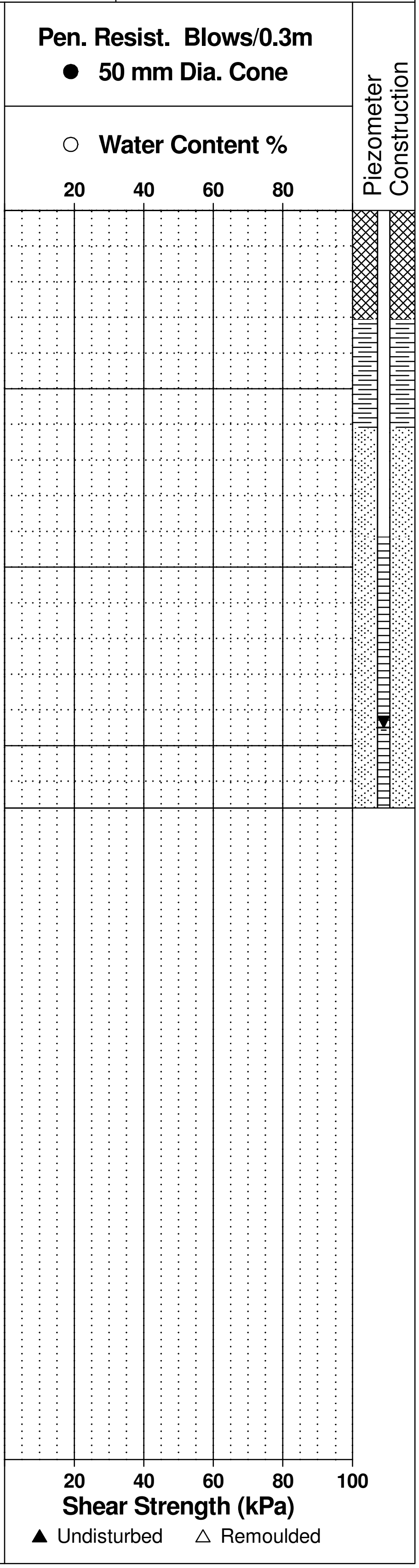
HOLE NO. BH 1A-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	110.12
OVERBURDEN							
						1	109.12
						2	108.12
2.89 **GLACIAL TILL:** Very dense brown silty sand with gravel cobbles and boulders 3.35	^^^	SS	1	42	50+	3	107.12

End of Borehole

Practical refusal to augering at 3.35 m depth

(GWL @ 2.90 m depth - Jan 4, 2021)



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE 2020 December 22

FILE NO. PG5628

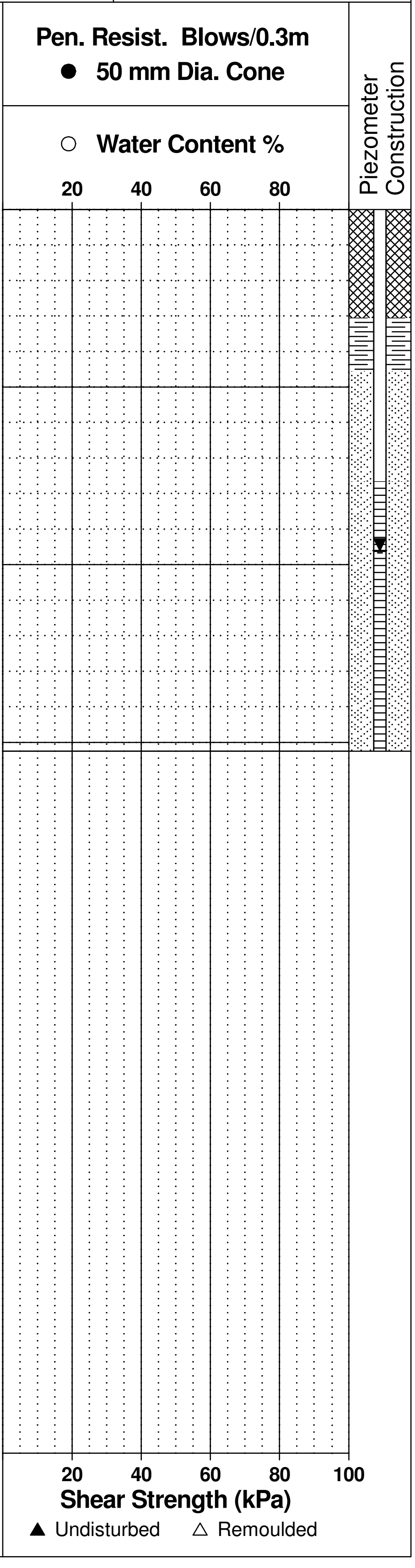
HOLE NO. BH 2-20

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	114.12
FILL: Crushed stone with brown silty sand and rootlets	AU	1				
0.76						
Very stiff to stiff, brown **SILTY CLAY**	SS	2	75	12	1	113.12
	SS	3	100	12		
1.98					2	112.12
GLACIAL TILL: Very dense to dense brown silty sand trace gravel, cobbles, boulders and clay	SS	4	58	50+		
3.05	SS	5	25	50+	3	111.12

End of Borehole

Practical refusal to augering at 3.05 m depth

(GWL @ 1.92 m depth - Jan 4, 2021)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
Ottawa, Ontario

DATUM Geodetic

REMARKS

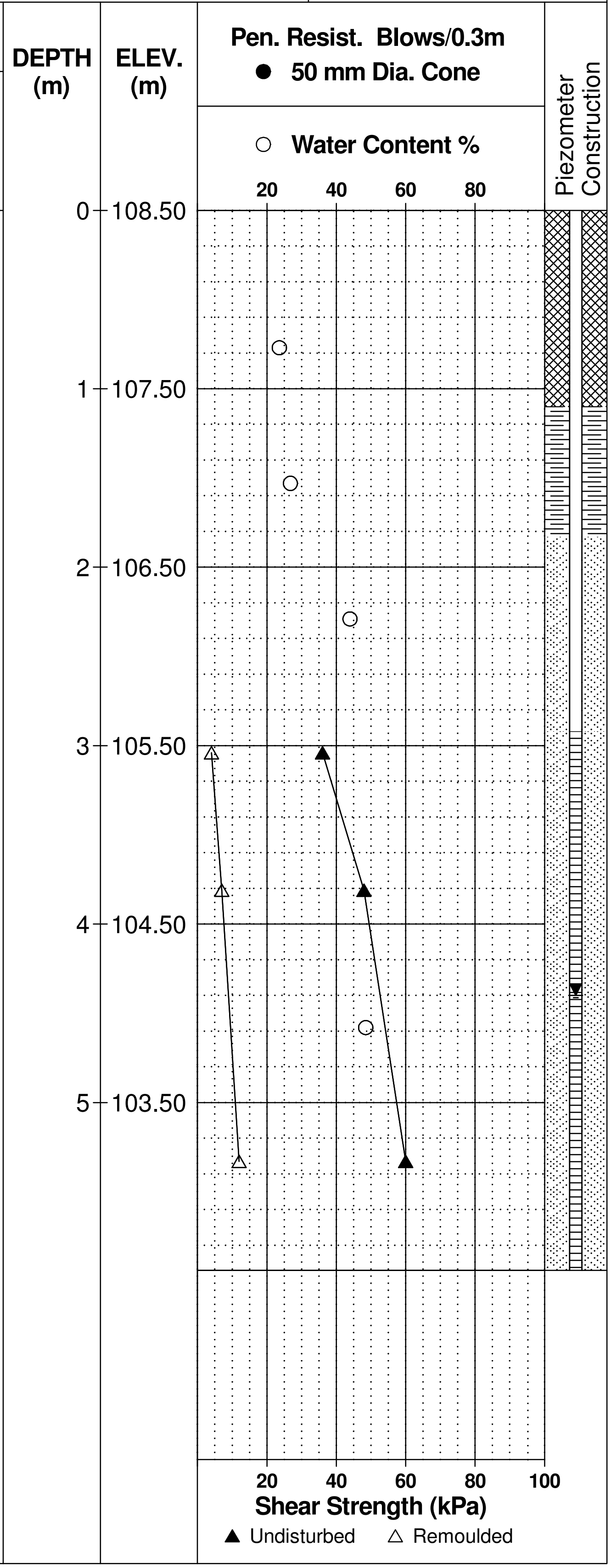
BORINGS BY CME-55 Low Clearance Drill

DATE 2020 December 22

FILE NO. PG5628

HOLE NO. BH 3-20

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand, with gravel trace clay 0.61	AU	1		
Stiff brown **SILTY CLAY**	SS	2	100	4
2.10		3	92	4
Firm to stiff grey **SILTY CLAY**		4	100	WH
- Firm by 4.0 m depth				
		5	100	
- Stiff by 5.33 m depth 5.94				
End of Borehole (GWL @ 4.40 m depth - Jan 4, 2021)				



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG5628**

REMARKS

HOLE NO. **BH 4-20**

BORINGS BY CME-55 Low Clearance Drill

DATE 2020 December 22

SOIL DESCRIPTION

GROUND SURFACE

TOPSOIL

0.30

Loose dark brown to brown **SILTY SAND** with trace organics

1.52

Very stiff to stiff brown **SILTY CLAY**

- Grey by 3.5 m depth

4.41

GLACIAL TILL: Loose to dense silty sand with clay, gravel, cobbles and boulders

5.94

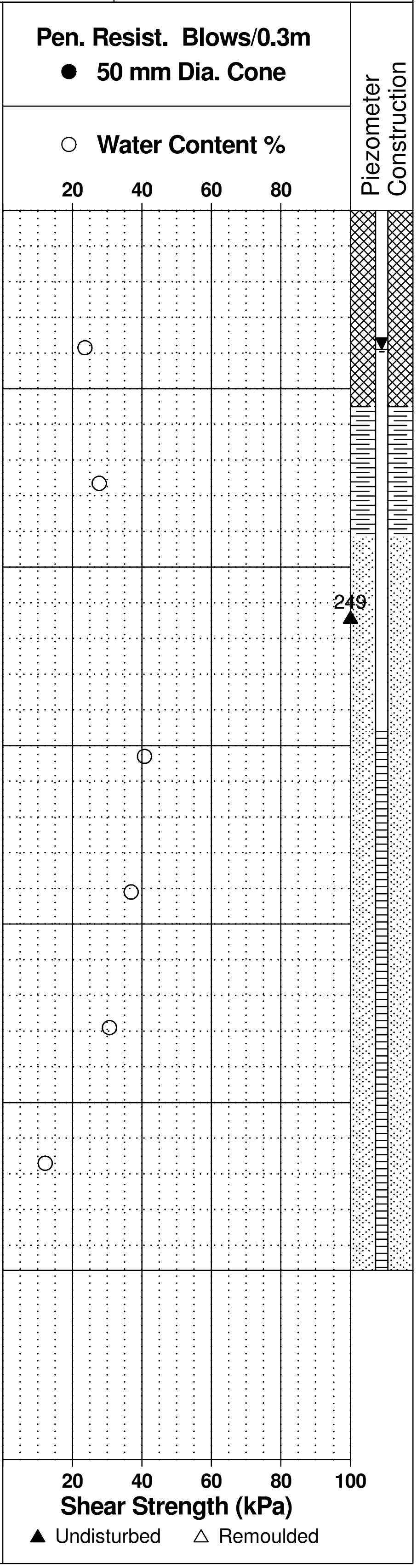
End of Borehole

Borehole terminated on possible oversized boulder or bedrock surface.

(GWL @ 0.78 m depth - Jan 4, 2021)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	67	4
SS	3	100	7
SS	4	100	10
SS	5	100	7
SS	6	75	10
SS	7	42	50+

DEPTH (m)	ELEV. (m)
0	111.65
1	110.65
2	109.65
3	108.65
4	107.65
5	106.65



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Develoment - Carp Subdivision
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

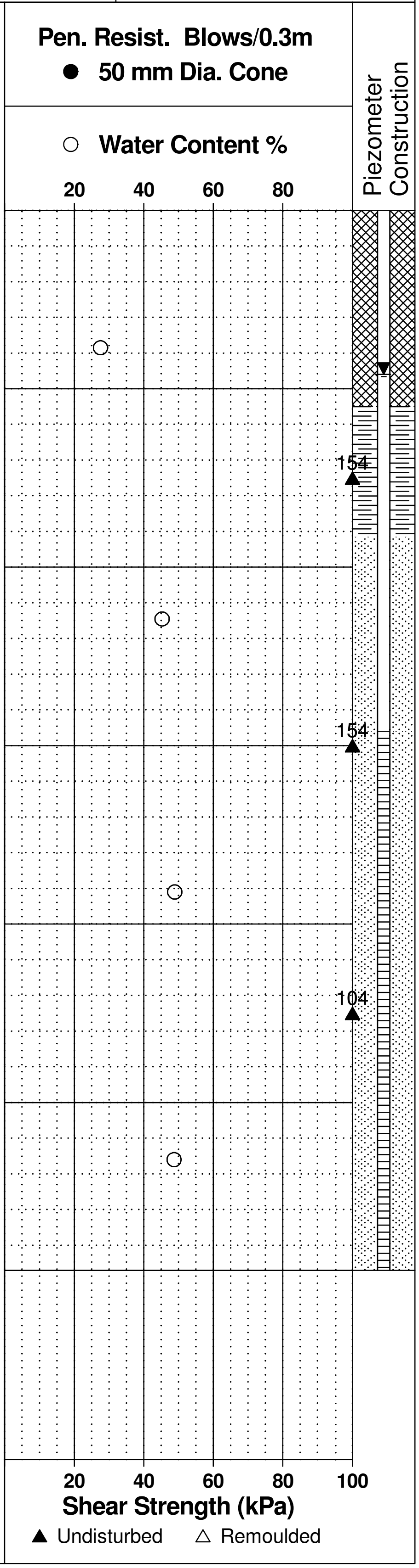
DATE 2020 December 22

FILE NO. PG5628

HOLE NO. BH 5-20

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL	AU	1		
0.61				
Very stiff to stiff brown **SILTY CLAY**	SS	2	75	4
	SS	3	100	5
3.35				
Stiff grey **SILTY CLAY**	SS	4	100	5
	SS	5	100	WH
5.94				
End of Borehole				
(GWL @ 0.92 m depth - Jan 4, 2021)				

DEPTH (m)	ELEV. (m)
0	105.05
1	104.05
2	103.05
3	102.05
4	101.05
5	100.05



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

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)

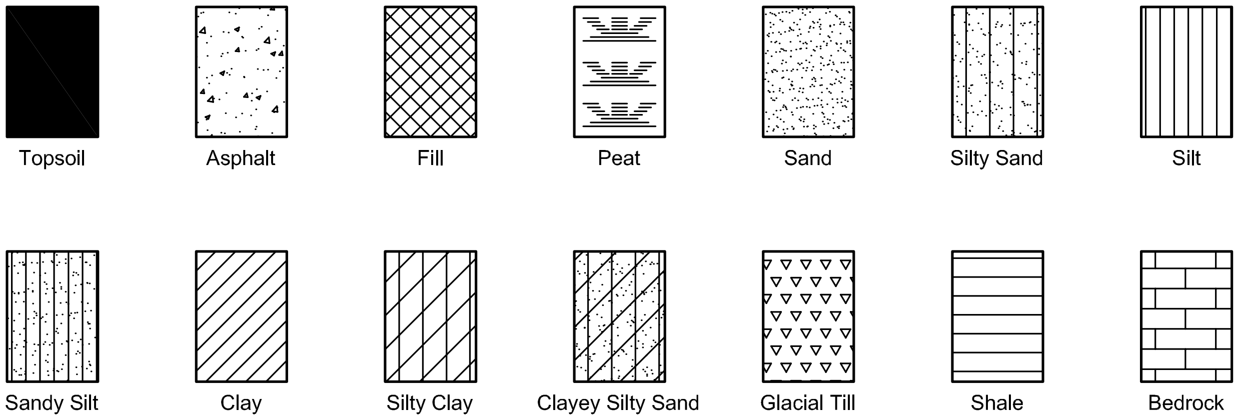
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

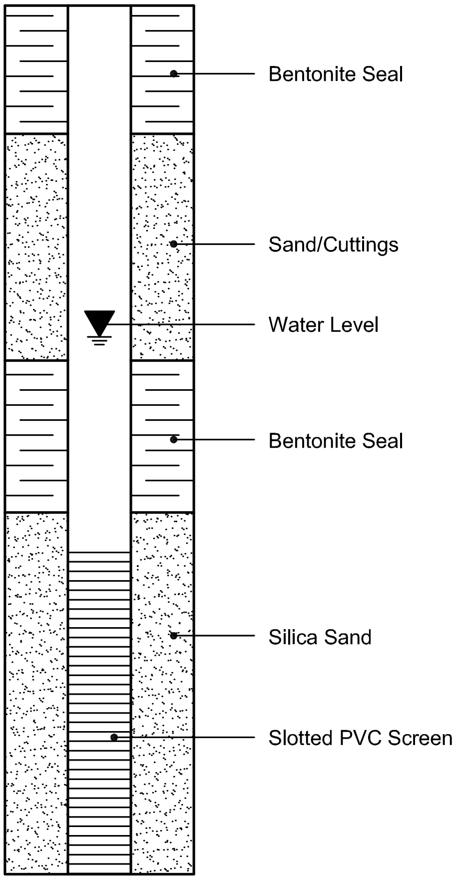
SYMBOLS AND TERMS (continued)

STRATA PLOT

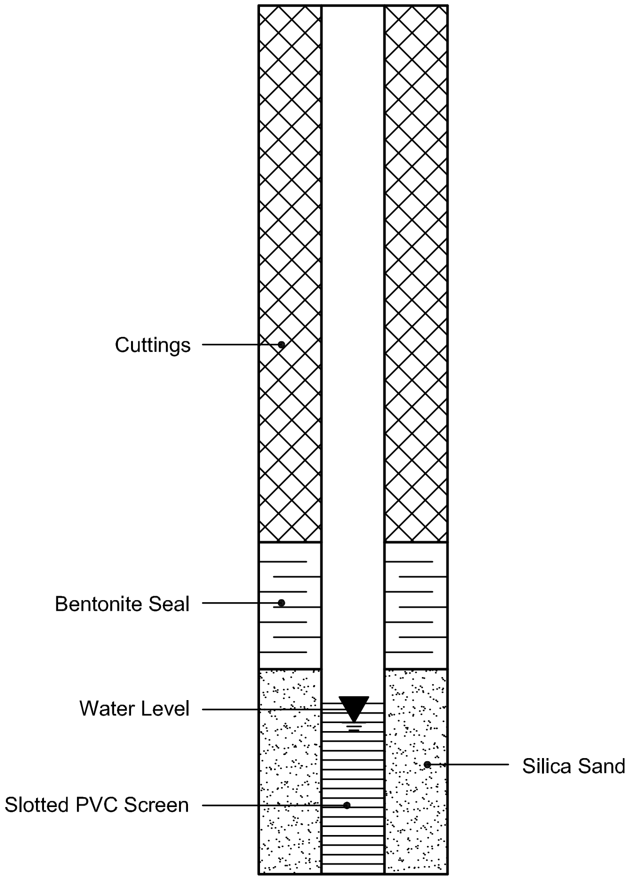


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Client: Paterson Group Consulting Engineers

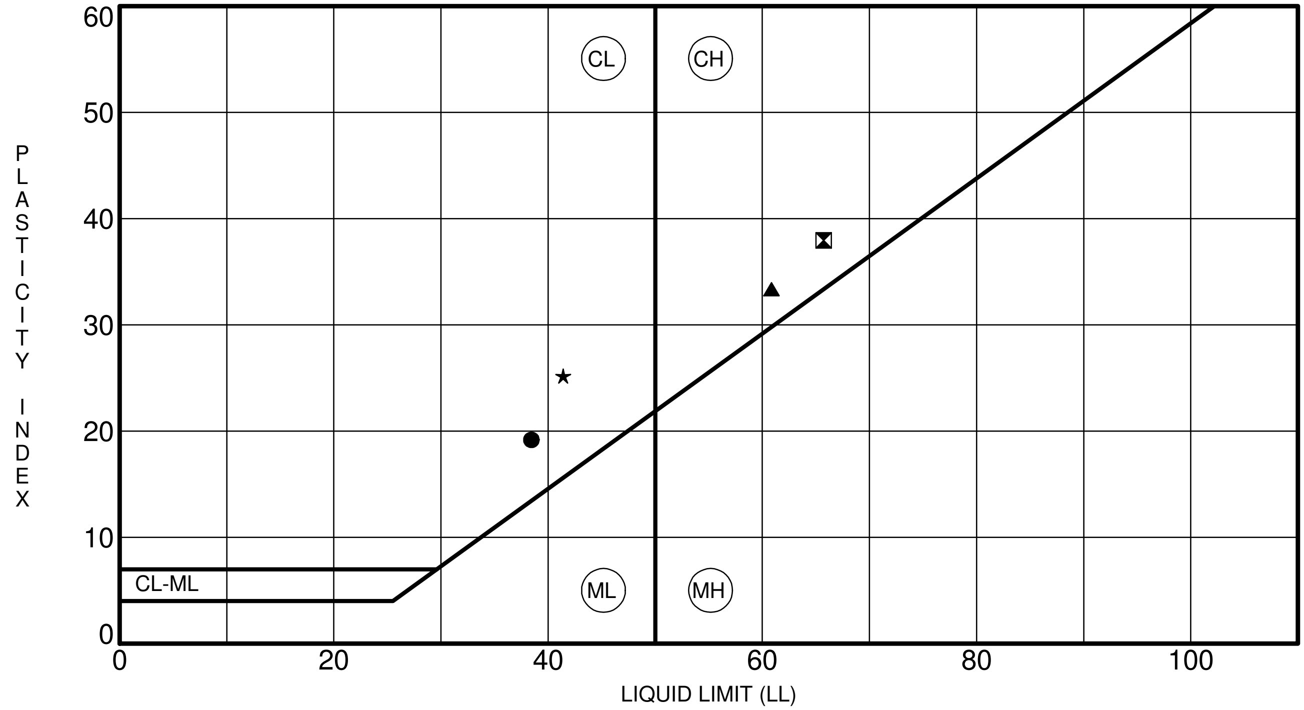
Client PO:

Report Date: 31-Dec-2020

Order Date: 23-Dec-2020

Project Description: PG5628

	Client ID:	BH5-SS5	-	-	-
	Sample Date:	22-Dec-20 09:00	-	-	-
	Sample ID:	2052262-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	68.5	-	-	-
General Inorganics					
pH	0.05 pH Units	7.85	-	-	-
Resistivity	0.10 Ohm.m	48.0	-	-	-
Anions					
Chloride	5 ug/g dry	18	-	-	-
Sulphate	5 ug/g dry	35	-	-	-



Specimen Identification		LL	PL	PI	Fines	Classification
●	**TP 1-21 G3**	**38**	**19**	**19**		**CL - Inorganic clays of low plasticity**
⧗	**TP 2-21 G5**	**66**	**28**	**38**		**CH - Inorganic clays of high plasticty**
▲	**TP 3-21 G3**	**61**	**28**	**33**		**CH - Inorganic clays of high plasticty**
★	**TP 4-21 G5**	**41**	**16**	**25**		**CL - Inorganic clays of low plasticity**

CLIENT **Tartan Homes**

PROJECT **Geotechnical Investigation - Proposed Residential Develoment - Carp Subdivision**

FILE NO. **PG5628**

DATE **28 Sep 21**

patersongroup **Consulting Engineers**

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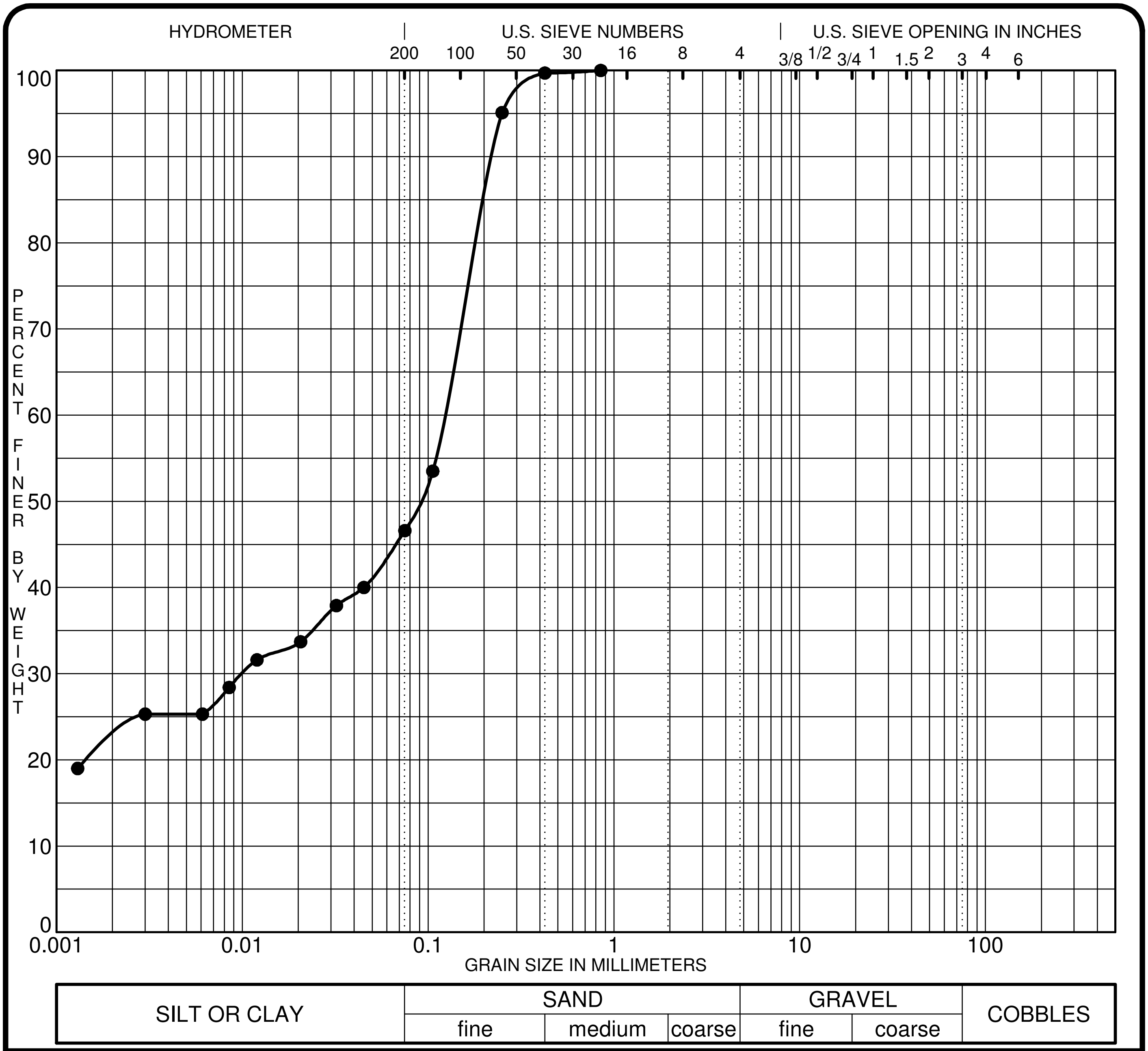
ATTERBERG LIMITS' RESULTS



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP 1-21**	**G5**	**CL - Inorganic clays of low plasticity**						
☒									
▲									
★									

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 1-21**	**G5**	**0.85**	**0.12**	**0.010**		**0.0**	**53.4**	**46.6**	
☒										
▲										
★										

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FILE NO. **PG5628**

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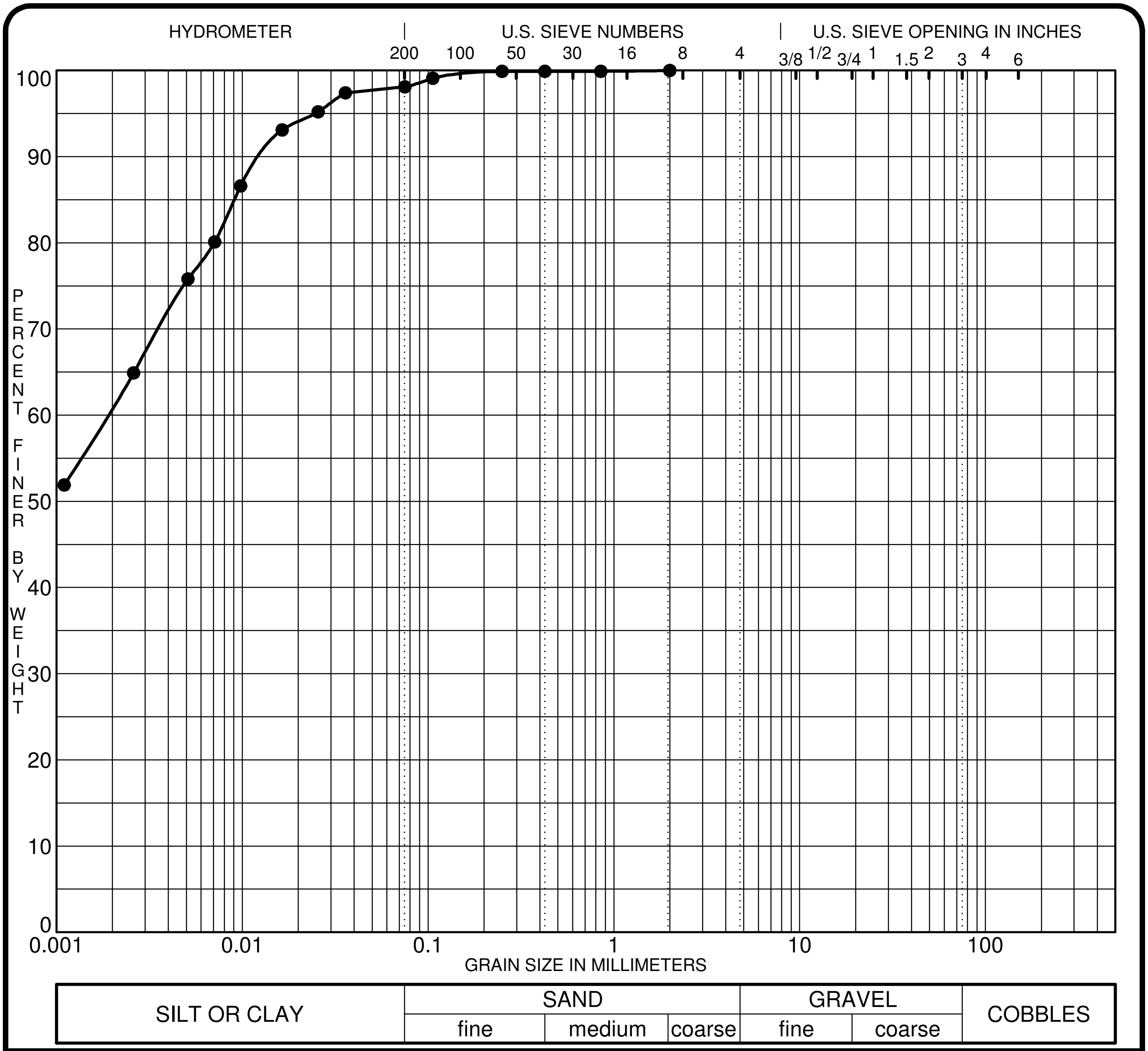
GRAIN SIZE DISTRIBUTION



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP 3-21**	**G4**	**CH - Inorganic clays of high plasticty**						
☒									
▲									
★									

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 3-21**	**G4**	**2.00**	**0.00**			**0.0**	**1.9**	**98.1**	
☒										
▲										
★										

CLIENT **Tartan Homes**

FILE NO. **PG5628**

PROJECT **Geotechnical Investigation - Proposed Residential Develoment - Carp Subdivision**

DATE **28 Sep 21**

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GRAIN SIZE DISTRIBUTION

APPENDIX 2

FIGURE 1 – KEY PLAN

FIGURE 2 – AERIAL PHOTO – 2008

FIGURE 3 – AERIAL PHOTO – 2010

FIGURE 4 – AERIAL PHOTO – 2017

DRAWING PG5628-1 – TEST HOLE LOCATION PLAN

DRAWING PG5628-2 – PERMISSIBLE GRADE RAISE PLAN

DRAWING PG5628-3 – TREE PLANTING SETBACK RECOMMENDATIONS

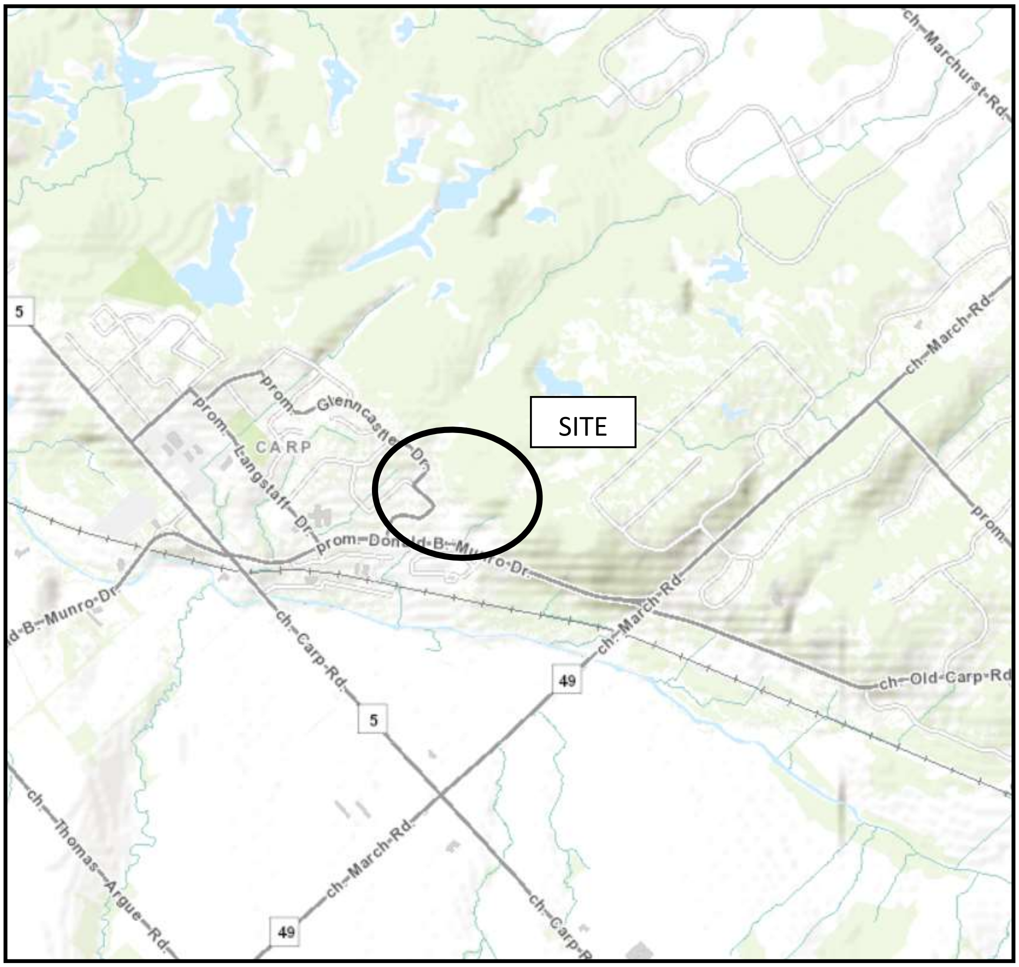

FIGURE 1

KEY PLAN

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FIGURE 2

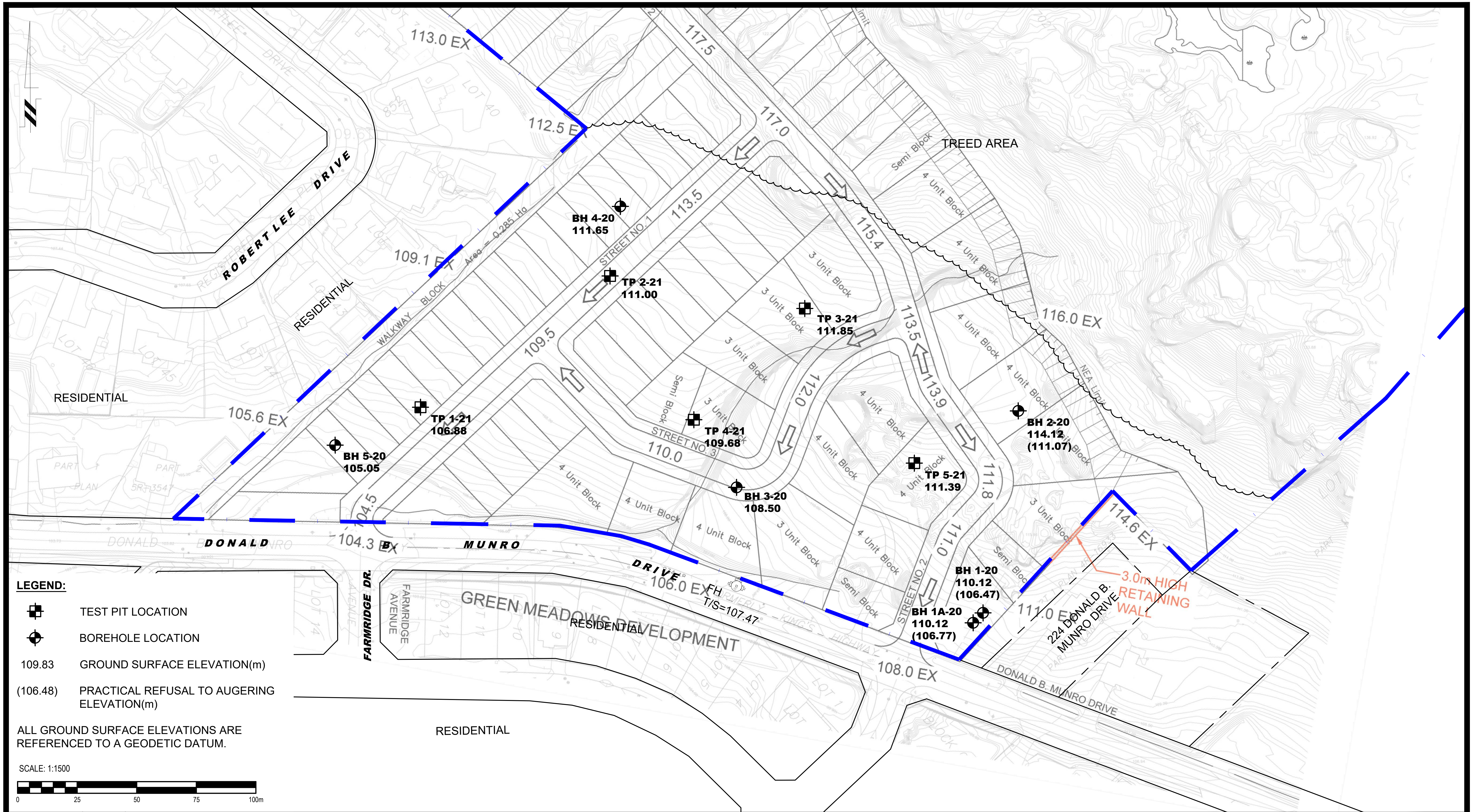
AERIAL PHOTO - 2008

FIGURE 3

AERIAL PHOTO - 2010

FIGURE 4

AERIAL PHOTO - 2017



LEGEND:

▣	TEST PIT LOCATION
⊕	BOREHOLE LOCATION
109.83	GROUND SURFACE ELEVATION(m)
(106.48)	PRACTICAL REFUSAL TO AUGERING ELEVATION(m)

ALL GROUND SURFACE ELEVATIONS ARE REFERENCED TO A GEODETIC DATUM.

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Ottawa, Ontario K2E 7J5
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NO.	REVISIONS	DATE	INITIAL
1	TP 1-21 TO TP 5-21 ADDED	05/10/2021	MS

TARTAN HOMES

GEOTECHNICAL INVESTIGATION
232 DONALD B. MUNRO DRIVE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1500

Date: 09/2021

Drawn by: NFRV

Report No.: PG5628-1

Checked by: MS

Dwg. No.: **PG5628-1**

Approved by: DJG

Revision No.: 1

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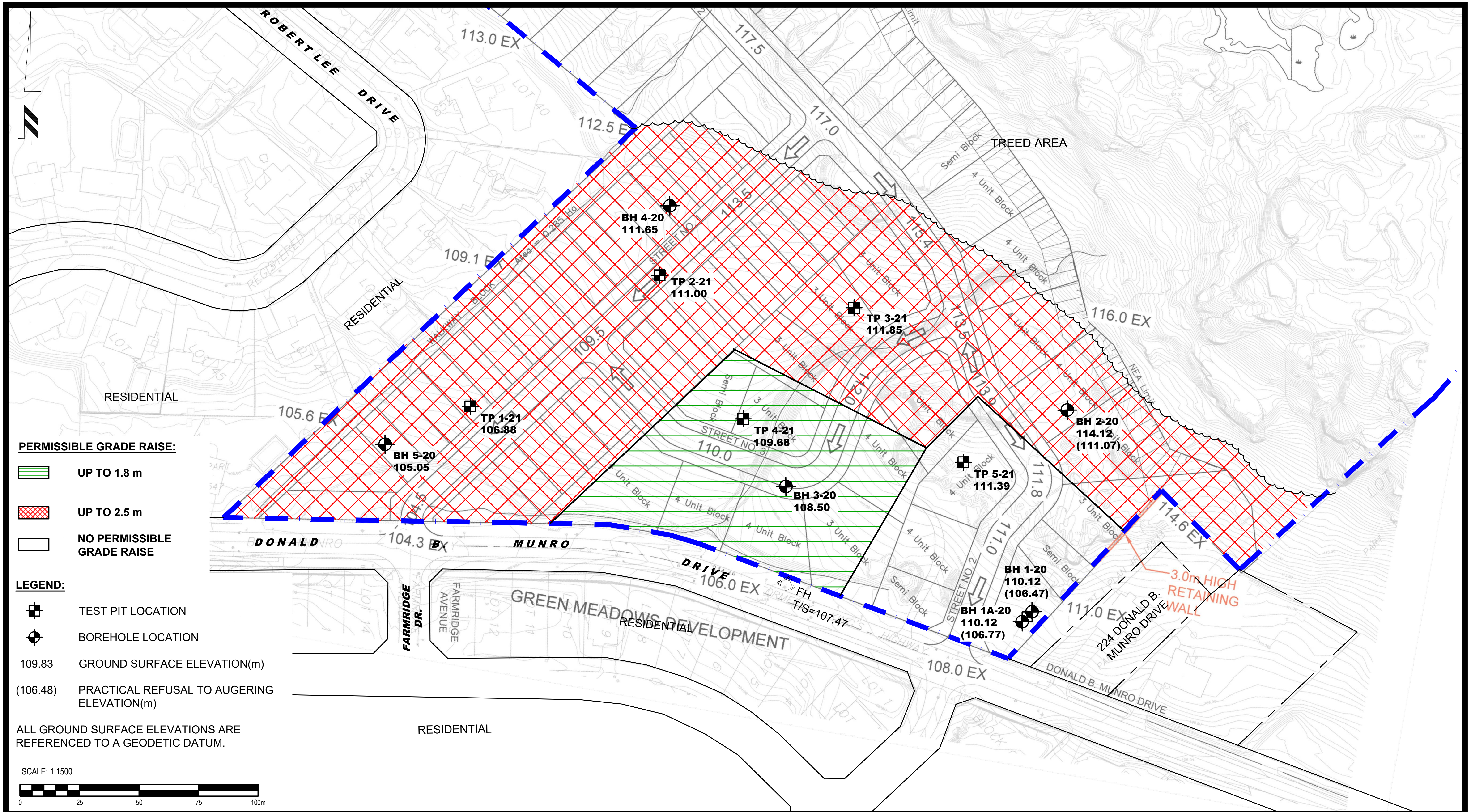

PERMISSIBLE GRADE RAISE:

🟩	UP TO 1.8 m
🟥	UP TO 2.5 m
☐	NO PERMISSIBLE GRADE RAISE

LEGEND:

⊞	TEST PIT LOCATION
⊕	BOREHOLE LOCATION
109.83	GROUND SURFACE ELEVATION(m)
(106.48)	PRACTICAL REFUSAL TO AUGERING ELEVATION(m)

ALL GROUND SURFACE ELEVATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:1500

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NO.	REVISIONS	DATE	INITIAL
1	TP 1-21 TO TP 5-21 ADDED	05/10/2021	MS

TARTAN HOMES
GEOTECHNICAL INVESTIGATION
232 DONALD B. MUNRO DRIVE

OTTAWA, ONTARIO

Title:

PERMISSIBLE GRADE RAISE PLAN

Scale: 1:1500
Drawn by: RCG
Checked by: MS
Approved by: DJG
Date: 01/2021
Report No.: PG5628-1
Dwg. No.: PG5628-2
Revision No.: 1

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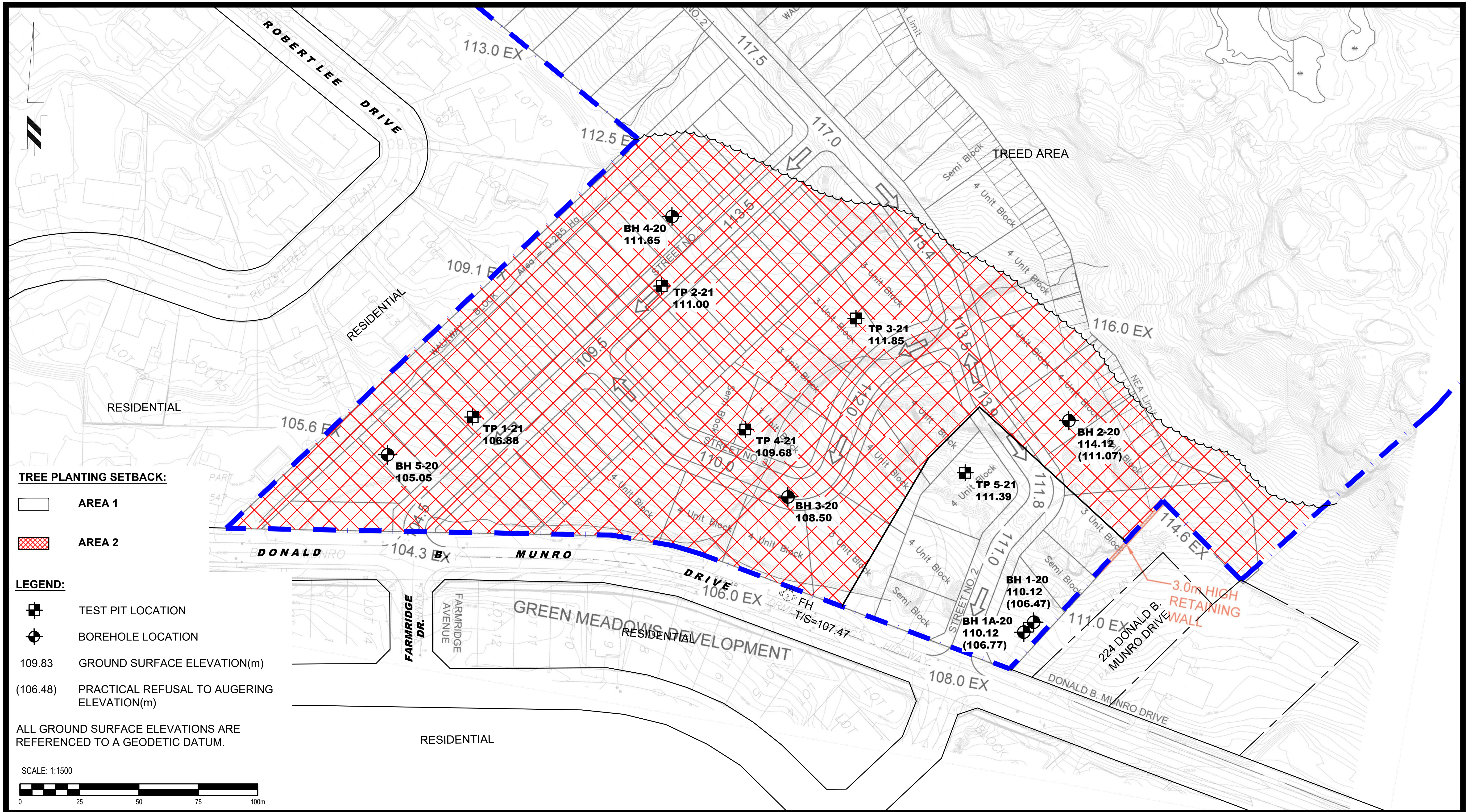

TREE PLANTING SETBACK:

☐	AREA 1
▨	AREA 2

LEGEND:

⊞	TEST PIT LOCATION
⊕	BOREHOLE LOCATION
109.83	GROUND SURFACE ELEVATION(m)
(106.48)	PRACTICAL REFUSAL TO AUGERING ELEVATION(m)

ALL GROUND SURFACE ELEVATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:1500

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NO.	REVISIONS	DATE	INITIAL

TARTAN HOMES
GEOTECHNICAL INVESTIGATION
232 DONALD B. MUNRO DRIVE
OTTAWA, ONTARIO

Title:
TREE PLANTING SETBACK RECOMMENDATIONS

Scale: 1:1500	Date: 10/2021
Drawn by: RCG	Report No.: PG5628-1
Checked by: MS	Dwg. No.: PG5628-3
Approved by: DJG	Revision No.:

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