Geotechnical Engineering

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Geotechnical Investigation
Clarke Lands Development - Stage 1
Strandherd Road at Clarke Fields Drive
Ottawa, Ontario

Prepared For

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APPENDICES

1.0 INTRODUCTION

Paterson Group Inc. (Paterson) was retained by Minto Communities Inc. (Minto) to conduct supplementary geotechnical investigative works in 2015 and 2016 for the Clarke Lands - Stage 1 residential development, consisting of the east part of the Clarke Lands, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan).

The first preliminary stage of investigation was conducted in 2005, of which four (4) boreholes are located within the subject development. The second stage of investigation was conducted in 2009 and included six (6) boreholes within the subject development. Paterson Report PG1984-1 was prepared at the completion of this stage of investigation. Two (2) additional boreholes were put down in or adjacent to the subject parcel in 2011, as part of an investigation concentrated on the lands to the west.

The current 2015 and 2016 stages of the investigation included twelve (12) and eleven (11) boreholes, respectively, drilled in a manner to reduce disturbance to in situ testing and relatively undisturbed samples. These investigative works are described in detail in this report. Of the 12 boreholes from 2015, only 9 are within or adjacent to the subject study area.

The purpose of the current report is to provide geotechnical recommendations pertaining to the proposed Clarke Lands residential development, based on the results of the current and previous test holes and associated field and laboratory testing.

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 previously completed by Paterson for the Clarke Lands, and is reported under separate cover.

2.0 PROPOSED DEVELOPMENT

The Clarke Lands residential development area will generally consist of low to medium density residential development arranged in one or a combination of single family, town home and/or terrace home style dwellings. The development will be serviced by local subdivision roadways and municipal services.

The subject Clarke Lands residential development area is bordered to the west by the future Clarke Fields Drive collector road, and then lands proposed for school development, to the north by the existing Barrhaven Mews residential development, and then Strandherd Road, to the east by the Kennedy-Burnett Drain, then commercial development, and to the south by vacant future development land, held by another land owner, and then the future Chapman Mills Drive extension.

The subject Clarke Lands residential development parcel consists of cleared level land, recently used for agricultural purposes. The property was originally relatively flat, with the ground levels in the northeast part of the development parcel about 0.5± m higher than those in the southwest. Currently there are several stockpiles of fill materials on the site, as well as levelled fill materials, primarily in the south and west parts of the site.

3.0 SCOPE OF INVESTIGATION WORK

Paterson has conducted current and previous investigative work on the Clarke Lands residential development parcel. It is considered important to provide in this compilation document all the factual information from previous investigations that is of use for the geotechnical evaluation of the Clarke Lands Stage 1.

As such, the factual geotechnical investigation work that is included with this geotechnical report, is as follows:

☐ Eleven (11) boreholes were put down during the 2016 geotechnical investigation program. The logs for these boreholes are provided in Appendix 1.
☐ Twelve (12) boreholes were put down during the 2015 geotechnical investigation program. The logs for nine (9) of these boreholes are within or adjacent to the subject site and are provided in Appendix 1.
☐ Six (6) boreholes were put down during the 2009 Clarke Lands Stage 1 investigation. The logs for these boreholes are provided in Appendix 1.
☐ Seven (7) boreholes were put down during the 2011 geotechnical investigation program, conducted to the west of the Stage 1 investigation. The logs for two (2) of these boreholes are within or adjacent to the subject site and are provided in Appendix 1.
☐ Four (4) boreholes are included from the preliminary overall Clarke Lands investigation in 2005. The logs for these boreholes are provided in Appendix 1.
☐ Consolidation testing was conducted as part of the 2016 (8 tests) geotechnical investigation, and applicable part of the 2015 (8 tests) geotechnical investigation, and from the applicable boreholes from the previous (13 tests) investigations. The consolidation test sheets for all these tests are provided in Appendix 2.

- ☐ Tabular summaries of subsurface information are provided for information from the current test holes in Table 1A, and the previous test holes in Table 1B, both in Appendix 2.
- ☐ Tabular summaries of the consolidation test results from the current test holes are provided in Table 2A, and from the previous test holes are provided in Table 2B, both in Appendix 2

The purpose of this compiled geotechnical investigation report for the Clarke Lands residential development parcel has been to:

- ☐ Present the results of our current and previous investigative findings in a comprehensive stand-alone geotechnical report for Clarke Lands residential development.
- ☐ Provide geotechnical recommendations for the design and construction of the various aspects of the proposed development, especially permissible grade raises, bearing resistance values, servicing, housing and pavement.

4.0 METHOD OF INVESTIGATION

4.1 Field Investigation

Both the previous (2005, 2009 and 2011) and current (2015 and 2016) boreholes were put down using a track-mounted CME-55 power auger drill rig operated by a crew of two. All fieldwork was conducted under the full-time supervision of a staff member of our geotechnical division under the direction of a senior engineer.

The drilling procedure, for the previous (2005, 2009 and 2011) boreholes, consisted of augering to the required depths at the selected locations and sampling and testing the soils encountered. Hollow-stem augers allowed for the use of the augers as casing. However, it appears that the use of this conventional drilling procedure introduced potential disturbance into the in situ testing and sampling of the sensitive silty clay underlying the site, during the withdrawal of the auger plug prior to testing and sampling.

The drilling procedure, for the current (2015 and 2016) boreholes, consisted of using “wash boring” rotary drilling methods to advance an open casing. This method reduces the sampling disturbance, as compared to the hollow-stem augering method, but is slower and requires the use of drilling water, to be supplied by a water truck. However, the wash boring method has proven to provide the conditions to obtain the most accurate in situ shear strength test results and the best quality “undisturbed” soil samples possible.

Sampling and In Situ Testing

Soil samples were recovered from the boreholes using a 50 mm diameter split-spoon sampler or 73 mm diameter thin walled Shelby tubes. The split spoon soil samples were classified on site and placed in sealed plastic bags. The Shelby tubes were recovered from the borehole using a piston sampler, were sealed with caps at both ends and protected from disturbance during the entire process. Auger samples were recovered from the upper part of the boreholes, and grab samples were recovered from the shear vane. All samples were transported to our laboratory. The depths at which the auger, grab, split spoon and Shelby tube samples were recovered from the boreholes are shown as AU, G, SS and TW samples, respectively, on the Soil Profile and Test Data sheets in Appendix 1. Transportation of the samples was completed in general accordance with ASTM D4220-95 (2007) - Standard Practice for Preserving and Transporting Soil Samples.

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. This testing was done in general accordance with ASTM D1586-11 - Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.

Undrained shear strength testing, using field shear vane apparatus in boreholes was carried out in the cohesive soils encountered. This testing was done in general accordance with ASTM D2573-08 - Standard Test Method for Field Vane Shear Test in Cohesive Soil.

The depth to inferred bedrock was evaluated during the course of the investigation by conducting dynamic cone penetration testing (DCPT) to practical refusal. The DCPT was completed at twelve (11) of the current boreholes, and eight (8) of the previous boreholes. At one (1) borehole, the depth to inferred bedrock was evaluated by practical split spoon sampler refusal.

The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. In general, the cone was pushed without driving through part of the clay prior to starting the DCPT. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment of penetration. At present there is no ASTM standard for the DCPT.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles from the applicable current boreholes, plus selected boreholes from the previous investigation stages, are presented on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Groundwater

Flexible standpipes were installed in each of the boreholes to permit monitoring of the groundwater levels within the silty clay subsequent to the completion of the sampling program for each stage of investigation.

4.2 Field Survey

All the test hole locations were referenced accurately in the field and the ground surface elevation at the time of the fieldwork was referenced to geodetic datum. Note that for the older investigation stages, the recorded ground elevation may have changed due to subsequent site activities, such as placement and spreading of fill materials.

The locations and ground elevations of the current (2015 and 2016) and previous (2005, 2009 and 2011) boreholes are presented on Drawing PG1984-6, in Appendix 3.

4.3 Laboratory Testing

A total of 146 soil samples were recovered from the applicable current boreholes during the course of the investigation, including 42 Shelby tube samples. The split spoon and auger samples were visually examined in our laboratory to review the results of the field logging. Shelby tube samples were saved and stored for future testing purposes.

The Shelby tube samples that were used for consolidation testing were processed to determine the water content, as well as to record a description of the soil. Atterberg Limits testing was conducted on a portion of the tested samples to determine the plasticity characteristics of the soil.

To provide additional geotechnical data pertaining to the permissible grade raises for the site and to provide information for settlement analyses, selected undisturbed samples of the silty clay stratum, recovered using a piston sampler in Shelby tubes, were subjected to consolidation testing in our laboratory. Sixteen (16) Shelby tube samples from the current (2015 and 2016) boreholes were submitted for unidimensional consolidation testing.

The current consolidation test results are plotted and tabulated (Table 2A) in Appendix 2 and are discussed under subsection 6.3 of this report. The consolidation test results from the applicable portions of the previous investigations are summarized in Table 2B, and the plots are also provided in Appendix 2. Atterberg Limits test results are also provided in Appendix 2.

5.0 OBSERVATIONS

5.1 Surface Conditions

The subject Clarke Lands Stage 1 lands are bordered to the west by a school parcel and then future stages of the Clarke Lands development, to the north by Barrhaven Mews residential development, and then Strandherd Road, to the east by the Kennedy-Burnett Drain, then commercial development, and to the south by vacant future development land.

The Clarke Lands Stage 1 parcel consisted of cleared level land, recently used for agricultural purposes. The property was originally relatively flat, with the ground levels in the northeast part of the development parcel about 0.5±m higher than those in the southwest. It has since been subjected to the placement and stockpiling of unselected fill materials. Reference should be made to Table 1A for the present and interpreted original ground elevations at the current boreholes.

5.2 Subsurface Profile

Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profile at each borehole location that is on, or adjacent to, Clarke Lands Stage 1.

Existing fill deposits of between 0.6 m and 2.8 m in thickness, with a mean thickness of 1.5 m, were encountered at 16 of the 20 current boreholes. A 0.2 to 0.3 m thick topsoil or cultivated soil layer was encountered at 2 boreholes, having been stripped from the greater part of the subject parcel.

The inorganic native soil profile underlying the site consists primarily of a thick layer of sensitive silty clay that underlies the existing fill and/or topsoil. The thickness of the silty clay layer is estimated to generally range from about 12 to 15 m, although it was determined to be 8.2 m at BH19-16. The clay is inferred to be underlain, at depth, by a glacial till layer and, in turn, the bedrock surface.

Silty Clay

Silty clay was encountered immediately beneath the existing fill and/or topsoil at all test hole locations. The upper portion of the silty clay layer has been weathered to a very stiff to stiff brown to grey crust. Within Clarke Lands Stage 1, for the current investigations, the crust extends to depths varying between 3.0 m (BHs 21-16 and 22-13) and 5.2 m (BHs 7-15 and 16-16) below the original ground surface level, with a mean underside of crust depth of 4.2 m. The interpreted level of the underside of the stiff crust is tabulated for each borehole location in Table 1A, in Appendix 2.

Grey silty clay was encountered below the weathered crust at all test hole locations. In situ shear vane field testing carried out within the sampled depths of this layer yielded undrained shear strength values generally ranging from 30 kPa to more than 50 kPa. A few isolated shear strength of 25 kPa were encountered. These values are indicative of a firm (occasionally soft) to stiff consistency.

The results of the shear strength tests conducted in the current and previous boreholes located within and adjacent to the Clarke Lands Stage 1 parcel have been plotted against elevation and this information is provided graphically on Figure 1, in Appendix 2.

Based on Atterberg Limits testing conducted on samples of the silty clay from this and the previous investigations, the silty clay is somewhat variable in plasticity. The silty clay can generally be classified as a clay of high or low plasticity (CH or CL), although one test indicated a silt of low plasticity (ML). Results of the Atterberg Limits testing of samples recovered on and adjacent to Clarke Lands Stage 1 are provided in Appendix 2.

Sixteen (16) samples of the silty clay from Clarke Lands Stage 1 were subjected to unidimensional consolidation testing under the current investigative work. Thirteen (13) samples from the previous boreholes included with this report were previously subjected to unidimensional consolidation testing. The plotted results of all the recent and previous test samples that are within or adjacent to Clarke Lands Stage 1, are presented in Appendix 2 and are discussed and interpreted under subsections 6.3 and 6.4. All the consolidation test results are summarized in Tables 2A and 2B, in Appendix 2.

The consolidation test results indicate that the silty clay is overconsolidated with overconsolidation ratios for the tested samples (with acceptable disturbance ratios) varying between 1.5 and 2.5. For purposes of comparison and analyses, it is assumed that the clay crust thickness (ignoring existing fill) is 3 m and the low pre-development groundwater level is 2.5 m.

Glacial Till

A glacial till deposit was encountered below the silty clay in many of the test holes, and was inferred by DCPT test results in other test holes. The glacial till consists of a fine soil matrix of grey silty sand or sandy silt mixed with gravel, cobbles and boulders.

The results of SPT testing conducted within the glacial till layer had N values ranging from 2 to over 50 blows per 300 mm increment of penetration, indicating a compactness condition that ranges from loose to very dense.

Practical Refusal to DCPT/Inferred Bedrock

Practical refusal to DCPT testing was observed at depths of 11.5 to 14.9 m below the ground surface. This information is shown in parentheses on the Test Hole Location Plans, in Appendix 3, and summarized in Table 1, in Appendix 2.

Based on available geological mapping, the bedrock in the area is expected to range from 10 to 15 m. The bedrock is shown to be part of the March formation, which consists of interbedded sandstone and dolomite.

5.3 Groundwater

Groundwater levels were measured in the standpipe installations in the boreholes subsequent to the completion of the respective fieldwork programs. The groundwater level (GWL) readings from the current boreholes are summarized in Table 3A, and selected previous boreholes in Table 3B, in Appendix 2.

The measured groundwater levels range from elevation 90.7 m to 92.2 m, with a mean of elevation 91.7 m. The measured groundwater levels have been fairly similar throughout the period covered by the investigations.

No readings were provided for standpipe installations that appeared to be blocked or could not be found and were assumed to have been removed, or destroyed. The groundwater levels recorded in BH 5-15 and BH4 (2009) were very low, compared to the other observations, and the level of the underside of stiff clay crust, and these installations were inferred to be blocked or to have not completely stabilized by the applicable time of reading.

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

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 Geotechnical Assessment

The Clarke Lands Stage 1 residential development will include one or a combination of single family dwellings, town homes and terrace homes, as well as local streets.

The subsoil conditions at this site generally consist of a deep stiff to firm silty clay deposit. From a geotechnical viewpoint, the development of the subject lands will require moderate grade raises, for the routine shallow footing foundations expected to be used. The grade raises will be necessary to address site servicing constraints, such as meeting the hydraulic grade line requirements and maintaining sufficient cover over the service pipe obvert levels. The geotechnical considerations to site development are further discussed in the following sections.

6.2 Site Grading and Preparation

Stripping Depth

Topsoil and any deleterious fill, such as that containing organic materials, should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures to expose inorganic subgrade media. Much of the existing fill that has been placed on the subject property has not been consolidated during placement and, as such may have to be removed and replaced with compactive effort if it is to remain under pavements or other structures.

Fill Placement

Fill used for grading beneath building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A, Granular B Type II, Granular B Type I or select subgrade material. This material should be tested and approved prior to delivery to the site. Testing may consist of the suppliers own Quality Control testing, or samples can be submitted to the geotechnical consultant for testing. Initial acceptance testing can consist of gradation analyses and comparison to OPSS MUNI 1010 (Nov, 2013) gradation limits.

The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Engineered fill placed beneath the buildings should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD) value. Engineered fill placed below the subgrade level for pavements should be compacted to at least 95% of its SPMDD value. The materials comprising the pavement structures should be compacted to at least 100% of their SPMDD values.

The laboratory testing reference for the specified density is ASTM D698-07 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).

Site-excavated soil, along with non-specified existing fill, 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 at least compacted by the tracks of the spreading equipment to minimize voids.

If site-excavated soil 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. These materials should meet the requirements for Select Subgrade Material (SSM) under OPSS MUNI 1010 (Nov, 2013). Non-specified existing fill and site-excavated soils, are not suitable as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

6.3 Foundation Design

Limit States Design

The Ontario Building Code (OBC 2006) Part 9 residential structures that are proposed for the development will be founded on sensitive silty clay. As such, it is a requirement that the foundations for the proposed structures be designed according to the requirements of Part 4 of the OBC 2012.

Limit States Design is the only design method permitted under Part 4 of OBC 2012. As such, the footing foundations for the structures are required to be designed for the Bearing Resistance at Serviceability Limit States (SLS) and the Factored Bearing Resistance at Ultimate Limit States (ULS).

The bearing resistance at SLS pertains to the permissible (geotechnical) serviceability or deformation-related bearing resistance. Unfactored foundation loads are used in conjunction with the bearing resistance at SLS values. For the subject development, the bearing resistance at SLS value can be established on a lot-by-lot basis, based on traditional shear strength testing and bearing capacity formulae used to establish the old working stress “allowable bearing pressure” values, provided the effects of grade raise and groundwater position stresses have been considered.

The factored bearing resistance at ULS pertains to the ultimate (geotechnical) capacity of the bearing medium, reduced by a geotechnical resistance factor. The geotechnical resistance factor is 0.5 for footing foundations. Factored loads are used in conjunction with the factored bearing resistance at ULS values.

Bearing Resistance at SLS (Allowable Bearing Pressure)

Founding conditions at the site are favourable for the construction of dwellings provided that the grade raise is within an acceptable range. Based on the soil profile encountered at the site, it is anticipated that stiff silty clay will generally be encountered at founding levels. This material is a suitable bearing stratum upon which to found footings for the support of the dwellings.

The bearing resistance at SLS value will be assigned on a lot-by-lot basis based on a bearing medium evaluation by the geotechnical consultant at the time of construction.

For foundation design purposes it is recommended that a footing size “matrix” be prepared for each house model for bearing resistance at SLS values of 100, 85 and 70 kPa, so the proper footing widths can easily be used once the appropriate bearing resistance at SLS is assigned. Generally the higher bearing resistance values will be applicable where grade raises are higher, so the footing level is closer to the original ground surface and the lower bearing resistance values will be applicable where grade raises are lower and the footing level is closer to the base of the stiff clay crust.

The factored bearing resistance at ULS values (incorporating a geotechnical resistance factor of 0.5) for the above-tabulated cases can be determined by multiplying the applicable bearing resistance at SLS value by 1.5.

The City of Ottawa Building Services Branch has implemented a sensitive soils foundation design and field review protocol that has been implemented by Minto and their geotechnical and structural engineering consultants on other applicable projects. The sensitive soils protocol is a comprehensive and holistic methodology that ensures that the structural design incorporates the geotechnical design elements. In addition, the construction-related elements, such as field measured shear strengths, underside of footing levels, grade raises, are checked or reviewed during construction and compared with the design assumptions, so modifications can be made where the results of the field observations warrant, and otherwise, as-built conditions can be confirmed to be according to design assumptions.

Bearing Surface or Bearing Medium Preparation

The bearing pressures are provided on the assumption that the footings will be placed on undisturbed soil bearing surfaces. An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Where fill is required to raise the grade below the footing level, the fill located within the zone of influence of the footings should consist of engineered fill. Reference should be made to subsection 6.2 for a description of the recommended alternatives of engineered granular fill (i.e. OPSS Granular A or Granular B Type II placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of its SPMDD).

The zone of influence of the footing is considered to extend out and down from the edges of the footing at a slope of 1H:1V, or flatter, to the undisturbed in situ soil. The bearing resistance at SLS (allowable bearing pressure against shear failure) values for footings placed on the engineered fill can generally be taken as the same appropriate values as applicable for the subgrade soils. The appropriate bearing resistance at SLS can be confirmed as part of the field observation by geotechnical personnel at the time of construction.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a stiff to very stiff silty clay above the groundwater table 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 of the same or higher capacity as the bearing medium soil.

Potential Post Construction Total and Differential Settlements

In addition to the shear failure case, consideration must be given to potential post construction settlements when determining the bearing resistance at SLS (allowable bearing pressure) values. The potential settlements can occur due to the compression of the deep silty clay deposit under the loads from the footings, the grade raise fill pressures and groundwater lowering effects.

The foundation loads to be considered for the settlement analyses are the continuously applied loads, which can be taken as the unfactored dead loads and a portion of the unfactored live loads. We have conservatively considered 50% of the live load as part of the continuously applied loads, for the residential structures anticipated at this site.

Settlement analyses carried out to estimate the potential post construction differential and total settlements at this site consider a continuously applied wall load of between 30 and 45 kN/m on footings designed based on the shear strength. Actual footing widths for construction will generally be based on the results of the individual lot assessments at the time of construction, using the full live and dead loads (wall load of up to 60 kN/m) and the shear strength profile of the bearing medium soil.

Acceptable Total and Differential Settlements

The following discussion is based on the assumption that maximum acceptable total and differential settlements for the proposed structures are 25 and 20 mm, respectively.

Consolidation Testing

A total of 29 consolidation tests were carried out on undisturbed sensitive clay samples recovered from current (16 tests) or previous (13 tests) boreholes within or adjacent to the Clarke Lands Stage 1 property. The results of the applicable consolidation testing are plotted and tabulated in Appendix 2 of this report.

The shear strength tests conducted in the twenty (20) current wash boring method boreholes located within and adjacent to the Clarke Lands Stage 1 parcel have been plotted against elevation and this information is provided graphically in Figure 2, in Appendix 2.

Value p'_c is the preconsolidation pressure of the sample and p'_o is the effective overburden pressure (for the applicable groundwater level, as noted in the table). The difference between these values is the available preconsolidation. The increase in stress on the soil due to the cumulative effects of the fill surcharge, the footing pressures, the slab loadings and the lowering of the groundwater cannot exceed the available preconsolidation if the potential total and differential settlements are to be maintained within tolerable limits for the proposed development.

The values C_{cr} and C_c are the recompression and compression indices, respectively, and are a measure of the compressibility of the soil due to stress increases below and above the preconsolidation pressures. The higher values for the C_c, as compared to the C_{cr}, illustrate the increased settlement potential above, as compared to below, the preconsolidation pressure.

It should be noted that the values of p'_c, p'_o, C_{cr} and C_c are determined using standard engineering practices and are estimates only.

Groundwater Level Considerations

The effective overburden stress, p'_o, is directly influenced by the groundwater level. While the groundwater levels were measured at the time of the fieldwork, the levels tend to vary, especially seasonally, and this has an impact on the available preconsolidation. Lowering the groundwater level increases the p'_o and therefore reduces the available preconsolidation. Higher than tolerable settlements could be induced by a significant lowering of the groundwater level. The groundwater levels within Clarke Lands Stage 1 were measured at elevations varying between 90.7 and 92.2 m, with a mean elevation of 91.7 m.

The effective overburden stresses for the consolidation test samples, provided in Table 2, in Appendix 2, were estimated using a conservatively low groundwater depth of 2.5 metres (from the original ground elevation). Similarly, long-term low groundwater levels of 2.5 m depth below original ground level, were used for Clarke Lands Stage 1 for the determination of the p'_o values for the settlement analyses carried out for the present investigation. This relates to a mean long-term low groundwater level of 90.2 m, as compared to the mean measured groundwater level of 91.7 m.

It has been considered that the groundwater level will vary seasonally and may be affected by other factors that could reduce groundwater infiltration as part of development (pavements, storm sewers, etc.) or promote groundwater depletion (trees, dry seasons, etc). As such, our analyses considered the post-development long term groundwater level at a position 0.5 m lower than the assumed long-term low seasonal groundwater level of 2.5 m below OGS (original ground surface).

6.4 Recommended Grade Raise Limits

Settlement Analyses Results and Discussion

Settlement analyses were carried out by this firm to estimate the potential post construction differential and total settlements at this site in order to provide recommendations for grade raise limits.

Our analyses considered a long-term groundwater level drawdown of 0.5 m, used approximately 80% of the estimated soil overconsolidation, continuously applied foundation wall loads of 50 kPa on a 0.9 m wide footing (i.e. continuously applied wall loads of 45 kN/m), and conventional slab-on-fill garage construction. The foundation load represents full dead load and 50% of live load, as discussed previously.

Analyses were also conducted for conditions where lightweight fill (LWF) material is used under the garage (and porch) slab-on-grade of conventional residential singles and town homes. The LWF, as described later in this report, is used to reduce the weight of the garage fill and, thereby, reduce the estimated settlement of the garage footings, which are the limiting serviceability design case for a conventional house.

For use in the designing of the road grading, analyses were conducted for permissible grade raises of the road centre line. These analyses do not include the stresses from the housing structures. Depending on the depth of the governing soil layer, these road grade raises are similar to, or slightly higher, than the permissible grade raises at the house for the case using LWF.

Based on geotechnical considerations, and the above-noted criteria, permissible grade raises for conventional (i.e. no LWF) construction, and construction where LWF is used within the garage and porch cavities and for road centre lines have been determined at each of the current (2015 and 2016) borehole locations and are summarized in Table 4 (fill thickness) and Table 5 (finished grade), on the following pages.

Other than for the centre line of road case, the basic grade raise limits for conventional construction are referenced with respect to the garage of the houses, as this is the most critical grading condition for the structures, in terms of differential settlement, for conventional slab-on-fill garage construction. The basic permissible grade raise is limited by settlement of the garage and, as such, can be exceeded by at least 0.3 m if techniques are used to reduce the settlement of the garage (and slab-on-fill porch) portion of the house, as described below.

Techniques to Reduce Settlements

The techniques that can be used to reduce the garage (and porch) settlement include using lightweight fill (such as EPS foam insulation) in garages and slab-on-fill porches and/or using structural garage and porch floor slabs over a basement or cold storage.

The differential settlements will be somewhat dependent on the design of the buildings. Differential settlements can result in the cracking of foundation walls and other structural/serviceability problems (deformation of door and window frames, etc).

TABLE 4: PERMISSIBLE GRADE RAISES - FILL THICKNESS

Borehole Number	Interpreted Original Ground Elevation (m)	Permissible Grade Raise Thickness (m)		
		Conventional House Construction	House with LWF in Garage and Porch	Centre Line of Road
BH4-15	92.1	1.4	1.7	1.7
BH5-15	92.3	1.8	2.1	2.2
BH6-15	92.6	1.5	1.8	2.0
BH7-15	92.4	1.6	1.9	2.0
BH8-15	93.0	1.5	1.8	2.0
BH9-15	92.5	1.7	2.0	2.0
BH10-15	92.6	2.1	2.4	2.5
BH11-15	92.8	1.8	2.1	2.3
BH12-15	92.8	1.4	1.7	1.7
BH13-16	92.6	1.6	1.9	2.0
BH14-16	92.4	1.6	1.9	2.0
BH15-16	92.6	1.7	2.0	2.1
BH16-16	92.8	1.7	2.0	2.0
BH17-16	93.2	1.5	1.8	1.8
BH18-16	92.9	1.8	2.1	2.1
BH19-16	93.1	1.5	1.8	1.9
BH20-16	93.0	1.5	1.8	1.9
BH21-16	93.0	1.5	1.8	2.0
BH22-16	92.8	1.8	2.1	2.2
BH23-16	92.3	1.5	1.8	1.9

Permissible Grade raises are estimated at a typical house (not stacked housing) using:

❑ interpretation of the consolidation test information;
❑ interpretation of the shear strength test results;
❑ 80% of available preconsolidation pressure & long-term groundwater lowering of 0.5 m;
❑ an assumed grade raise fill unit weight of 18 kN/m^3;
❑ stresses typical of conventional slab-on-fill garage construction, including footing loads;
❑ use of up to 1.5 m thickness of EPS - LWF in garages and porches for LWF case; and
❑ centreline of road grade raise without stresses from house structures.

TABLE 5: PERMISSIBLE GRADE RAISES - FINISHED GRADES

Borehole Number	Interpreted Original Ground Elevation (m)	Permissible Grade Raise Elevation (m)		
		Conventional House Construction	House with LWF in Garage and Porch	Centre Line of Road
BH4-15	92.1	93.5	93.8	93.8
BH5-15	92.3	94.1	94.4	94.5
BH6-15	92.6	94.1	94.4	94.6
BH7-15	92.4	94.0	94.3	94.4
BH8-15	93.0	94.5	94.8	95.0
BH9-15	92.5	94.2	94.5	94.5
BH10-15	92.6	94.7	95.0	95.1
BH11-15	92.8	94.6	94.9	95.1
BH12-15	92.8	94.2	94.5	94.5
BH13-16	92.6	94.2	94.5	94.6
BH14-16	92.4	94.0	94.3	94.4
BH15-16	92.6	94.3	94.6	94.7
BH16-16	92.8	94.5	94.8	94.8
BH17-16	93.2	94.7	95.0	95.0
BH18-16	92.9	94.7	95.0	95.0
BH19-16	93.1	94.6	94.9	95.0
BH20-16	93.0	94.5	94.8	94.9
BH21-16	93.0	94.5	94.8	95.0
BH22-16	92.8	94.6	94.9	95.0
BH23-16	92.3	93.8	94.1	94.2

Permissible Grade raises are estimated at a typical house (not stacked housing) using:
❑ interpretation of the consolidation test information;
❑ interpretation of the shear strength test results;
❑ 80% of available preconsolidation pressure & long-term groundwater lowering of 0.5 m;
❑ an assumed grade raise fill unit weight of 18 kN/m^3;
❑ stresses typical of conventional slab-on-fill garage construction, including footing loads;
❑ use of up to 1.5 m thickness of EPS - LWF in garages and porches for LWF case; and
❑ centreline of road grade raise without stresses from house structures.

The potential post construction total and differential settlements are influenced by the position of the long-term groundwater level when building over thick deposits of compressible silty clay. While efforts can be made to reduce the impacts of the residential development on the long-term groundwater level, by placing clay dykes or seepage barriers in the service trenches, reducing the sizes of paved areas, leaving green spaces to allow for groundwater recharge and limiting the planting of trees to areas away from the buildings, it is not economically possible in the context of a residential development to control the level of the groundwater.

Based on the above, it is prudent to allow for some level of post-development groundwater lowering, although the low permeability clay soils in the study area are not conducive to rapid groundwater fluctuations and groundwater lowering. It is recommended that a long-term groundwater lowering of 0.5 m be considered when estimating settlements at this site. The levels of the foundations, and in turn the foundation drainage systems, for the grading presently proposed, will generally be above the estimated long-term low groundwater level of 2.5 m depth below OGS.

Means to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the dwellings, etc) should be implemented for the proposed development. It is not possible to economically prevent all potential cracking of foundation walls and slabs in residential construction using standard construction practices. It should be noted that building on thick silty clay deposit increases the likelihood of house movements and therefore of cracking. It is recommended that reinforcing steel be provided in the foundation walls of all structures to make the structures more resistant to the effects of differential settlement.

6.5 Seismic Design

The Ontario Building Code (OBC 2006) Part 9 residential structures that are proposed for the development will be founded on sensitive silty clay. As such, it is a requirement that the foundations for the proposed structures be designed according to the requirements of Part 4 of the OBC 2012. This requires that the seismic provisions under Part 4 of the OBC 2012 be considered.

Clarke Lands Stage 1 should be classified as Site Class D. The inferred bedrock depths do not exceeding 17 m below the highest proposed footing levels. Assuming a conservative shear wave velocity of 120 m/s for the grey clay overburden, and a conservative shear wave velocity of 1,500 m/s for the bedrock, the average shear wave velocity of the upper 30 m profile, Vs_{30}, is estimated to be well in excess of **180 m/s** throughout Clarke Lands Stage 1.

Figure 3, in Appendix 2 provides a summary of a conservative estimate of the Vs_{30}, of 231 m/s, for conditions at Clarke Lands Stage 1, which is within the range of 180 m/s and 360 m/s for Site Class D. Therefore, a seismic **Site Class D** is applicable for the Clarke Lands Stage 1 development site as per Table 4.1.8.4.A of the OBC 2006.

6.6 Basement Slab/Slab-on-Grade Construction

With the removal of all organic soils, unspecified fill and deleterious materials, within the footprints of the proposed buildings, the native inorganic soil surface will be considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. The upper 150 mm of sub-slab fill should consist of 19 mm clear stone under basement slabs. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of the SPMDD.

Where slab-on-grade floors are to be constructed, the use of OPSS Granular B Type I, or Type II, with a maximum particle size of 50 mm, is recommended. The upper 150 mm of sub-slab fill should consist of OPSS Granular A crushed stone for slab-on-grade floors.

In areas where existing fill has to be removed under singles or town homes, it is expected that the fill will be removed to suitable subgrade and that engineered granular fill pads will be prepared under individual houses or blocks of town homes. These pre-engineered building pads will cover the areas of the footings and the interior floor areas and should extend sufficiently beyond the perimeter footings to meet the lateral support recommendations provided at the end of section 6.3 of this report.

6.7 Site Servicing

Trench Stability

Trench Support

The installation of the proposed sewers in soils can be carried out safely within the confines of a trench box or in an open cut. An open cut in overburden materials will require that all side slopes be cut back at 1H:1V or shallower to maintain stability. If a shoring system (i.e. trench box) is used to support the walls of the cut, the trench box design should, for safety purposes, allow for additional surcharge pressures associated with construction equipment and stockpiled fill materials above the cut.

The interpretation of the soil descriptions in the Occupational Health and Safety Act, Regulations for Construction Projects, for purposes such as trench box design, should be undertaken by experienced geotechnical personnel. The information provided in the Soil Profile and Test Data sheets in Appendix 1 can be consulted for this purpose, with due consideration that the information is only accurate at the applicable test hole locations, and in consideration that the contractor's equipment and methods, as well as the depth of the excavation, can have a significant effect on the actual earth pressures in force at the time of construction.

Basal Stability

There is a potential for basal heave to occur in deep excavations in firm to soft clay at the site. Our calculations indicate that there is a factor of safety against base heave of 2 for cuts of up to 5.5 metres in depth, and a factor of safety of 1.5 for cuts of 7.5 metres in depth for clays with a shear strength of 25 kPa. Generally minimum measured shear strengths are in excess of 25 kPa.

Deeper cuts will tend to have lower factors of safety and, therefore, increasing basal instability. Trenches with factors of safety of less than 2.0 against basal heave tend to be problematic with respect to squeezing of the excavation base and sides.

Improved basal stability can be provided by keeping excavation lengths shorter and trench widths narrower. Cutting back the sides of the excavation at shallower slopes and/or "benching" the top of the excavation sides, also provides increased stability in this regard. The beneficial effects of the benching are improved by widening the benches and increasing the depth of the benches. Excavated materials can exert a surcharge and should not be placed beside the top of the trench cut. These materials should be placed a lateral distance equivalent to a minimum of 1.5 times the trench depth away from the side of the trench in order to minimize their surcharge effects. Where the work area for the shovel is weak, the use of steel plates, beams and/or wood timbers, under the front of its tracks should be considered.

Trenching, Supporting and Backfilling Procedures

Native trench fill materials that have just been placed, unless they have been thoroughly compacted using padfoot compaction equipment (which is generally not the case) can be considered to be very weak. As such, the backfilling of the trench with difficult to compact grey clay native fill materials should be accomplished by ramping with a small dozer or loader, working back and forth on a shallow ramp, and placing the native fill in thin lifts.

It is recommended that the bedding and granular cover material be of a uniform density to provide optimum support to the pipe. Compaction of the bedding and cover materials will also enhance the stability of the trench during backfilling.

Improved performance of the pipe installation can be effected by using a combination of the following techniques:

❏ Employ benching techniques to reduce the effective trench depth.

❏ Properly support the excavator with plates and/or beams to distribute equipment surcharges beyond just the trench heading to the sides of the trench.

❏ Keep unsupported trench lengths as short as practical.

❏ Use the drier, upper, soils for trench backfilling and discard the wetter, lower, grey soils for use as general fill in landscaped areas, such as the boulevards. This will provide time for the wetter soil to dry out, while the better soil is used immediately in the trenches.

❏ Use layered ramping techniques, with a loader or dozer, supplemented with a padfoot compactor, to backfill the trench. Follow-up as close as practical with the backfilling to the completion of the pipe installation and cover and the moving of the trench box.

❏ Bulk up granular cover material against the sides of the trench box to provide granular material to fill the voids created by the walls of the trench box as it is moved forward.

❏ Take particular care when moving away from drainage structures, such as manholes, to backfill carefully behind the trench box with the excavator, as backfilling by ramping will not be practical.

Trench Dewatering

Low to moderate rates of groundwater flow into excavations below the water table should be expected. The contractor should be prepared to pump water from the excavation to enable the installation of services to be carried out in the dry. It is expected that routine pumping from within the confines of the excavation will suffice where excavations are in clay. If onerous groundwater conditions develop, more elaborate dewatering may be required to deal with localized problems.

Sewer Installation

Pipe Bedding

The bedding for the proposed sewer installations should be constructed according to Ontario Provincial Standard Specifications (OPSS), as amended by City of Ottawa specifications. Class "B" granular bedding is suitable for the support of sewer pipes in trenches placed through the in situ soils. The same material should be used up to the spring line of the pipe. The pipe cover material (i.e. 300 mm or greater above the pipe) should consist of an imported granular backfill material having a maximum stone size no greater than 25 mm.

All granular backfill materials should be uniformly compacted to a minimum of 95 percent of their Standard Proctor maximum dry density (SPMDD) values. However, the uniformity of the density of the bedding and cover materials, especially the bedding under the pipe invert and haunches is often more important to optimizing the structural performance of the pipe as whether the target density is achieved.

Seepage Barriers - Clay Seals

In order to minimize the potential consolidation of the compressible clay deposit, it is very important that no long-term groundwater lowering occur. To prevent the granular pipe bedding and pipe cover from acting as a “french” drain, it is recommended that clay dykes or seals be installed along service trenches situated below the water table.

The clay seals should be as per Standard Drawing No. S8 of the Department of Public Works and Services, Infrastructure Services Branch, of the City of Ottawa. The basic standard drawing requires a minimum seal length of 1.0 m, but it is recommended by this firm that the seals should be at least 1.5 m long (in the trench direction).

The seals should extend from trench wall to trench wall and should extend from no shallower than the frost line (1.8 m below finished grade) and, by the standard, to the underside of the road structure, and fully penetrate the bedding, sub-bedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay from the crust placed in maximum 225 mm thick loose layers compacted to a minimum of 95% of the material’s SPMDD.

The clay seals should be placed at the site and/or development phase boundaries and at strategic locations at no more than 60 m intervals in the service trenches. The seals should not be located at pipe joint locations.

Re-Use of Site Excavated Material

The excavated soils can be used as backfill in the trenches above the engineered pipe cover material. This material should be sufficiently compacted to ensure that the voids are expelled from the soil mass. The ability to compact the silty clay soils will depend in large part on the moisture content of the silty clay soil. Silty clay and clayey silt should be compacted using a padfoot equipment.

The planned use of the site excavated clay as backfill should take into consideration that clay worked in the presence of free water (i.e. rainy weather) can become difficult to manage as backfill material. The upper brown silty clay is preferred to the underlying wetter grey silty clay for use as trench backfill.

The use of site excavated trench backfill will require closer supervision of the backfilling operations, as compared to the use of OPSS Granular B Type I backfill. The compactive effort required to compact the in situ soil and fill is expected to be comparable to that required to compact OPSS Granular B Type I material, provided groundwater influx is not a problem. Taking this into consideration, the use of site excavated soils as trench backfill is a viable alternative, in our opinion.

In areas where service trenches are located within 3 metres of residential foundations, such as rear yard catch basin leads, it will be necessary to backfill the portions of the trench below the foundation level with imported granular materials, ensuring that a compaction of 95 percent or more of its Standard Proctor maximum dry density (SPMDD) is achieved.

Watermain Construction

Bedding and Backfill for Watermains

The bedding and backfill for the proposed watermain installations should be constructed according to Ontario Provincial Standard Specifications (OPSS), as amended by City of Ottawa specifications. The bedding conditions for watermains in the in situ soils within the study area are considered to be favourable. Class "B" bedding is suitable for the support of watermains in trenches through the in situ soils.

Site excavated soils are considered suitable for re-use as backfill for trenches through soil. Reference can be made to the native backfilling recommendations for sewers for guidelines for the watermain trench backfilling operations.

Thrust Blocks

The details of standard thrust blocks are shown on Standard Drawing Nos W25.3 and W25.4 of the City of Ottawa. The blocking details provided require typical soil bearing capacities of 100 to 199 kPa for clays. Because of geotechnical considerations, however, the bearing capacity is dependent on the direction of application of the load.

Thrust blocks resisting lateral loads should be sized on a pro-rata basis (as compared to the 100 to 199 kPa range) using the standard drawings and the allowable lateral soil bearing capacity. Those resisting (downward) vertical loads should be sized based on the allowable vertical soil bearing capacity.

Within the upper stiff silty clay soils, an allowable lateral soil bearing capacity of 125 kPa can be used, based on a soil cover of at least 2.4 metres (below finished grade), and an allowable vertical soil bearing capacity of 150 kPa can be used, which conform to Table 1 in W25.4. Within the deeper, firm to soft soils, an allowable lateral soil bearing capacity of 60 kPa can be used, based on a soil cover of at least 2.4 metres, and an allowable vertical soil bearing capacity of 80 kPa can be used, which requires increasing the dimensions from Table 1 of W25.4.

6.8 Pavement Design

With the complete removal of all topsoil and any loose and/or organic existing fill, the uppermost in situ soils are suitable subgrade media for roadway construction.

Recommended pavement material thicknesses for subdivision roads and subdivision collector roads (City of Ottawa standards) are provided in Tables 6 and 7, on the following page.

All granular base and subbase materials are required to be compacted to a minimum of 100 percent of Standard Proctor maximum dry density (SPMDD).

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

It can be foreseen that, depending on the time between the installation of services and the ensuing roadway construction, localized or extensive soft areas could be present over service trenches. In these localized areas, it may be necessary to subexcavate deleterious materials, and replace them with suitable, well compacted, OPSS select subgrade material and/or imported granular fill, providing tapers or transition point treatment, where applicable.

TABLE 7: RECOMMENDED PAVEMENT MATERIAL THICKNESSES MEDIUM DUTY - LOCAL SUBDIVISION ROADS			
Depth in Pavement Profile (mm)		**Layer Thickness (mm)**	**Pavement Material Description**
From	**To**		
0	40	40	**Wear Course:** SP 12.5 Asphaltic Concrete
40	90	50	**Binder Course:** SP 19.0 Asphaltic Concrete
90	240	150	**BASE:** OPSS Granular A
240	615	375	**SUBBASE:** OPSS Granular B Type II
615	615+	---	**SUBGRADE:** In situ soil and/or well compacted inorganic existing fill and/or native trench fill materials.

TABLE 8: RECOMMENDED PAVEMENT MATERIAL THICKNESSES HEAVY DUTY - COLLECTOR ROADS - BUS TRAFFIC			
Depth in Pavement Profile (mm)		**Layer Thickness (mm)**	**Pavement Material Description**
From	**To**		
0	50	50	**Wear Course:** SP 12.5 Asphaltic Concrete
50	150	100	**Binder Course:** SP 19.0 Asphaltic Concrete
150	300	150	**BASE:** OPSS Granular A
300	750	450	**SUBBASE:** OPSS Granular B Type II
750	750+	---	**SUBGRADE:** In situ soil and/or well compacted inorganic existing fill and/or native trench fill materials.

The use of the “cow-path” technique of placing granulars may assist in these cases, namely placing the granular base in a double thick “path” down the middle of the road over the services and then spreading the material out with the dozer or loader prior to grading and compacting.

The use of a woven geotextile, or preferably a biaxial geogrid over a non-woven geotextile, could be of some to significant benefit, with or without thickening the granular subbase, where onerous subgrade conditions prevail, especially over the trenches.

Guidelines in this regard can be provided by the geotechnical consultant at the time of construction (if required). These are considerations for localized conditions at time of construction, and geotextiles or geosynthetics are not a general requirement.

It is recommended that the road structure granular layers be protected from surface water. 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.

The pavement structure should maintain a suitable crown to shed water towards the available storm sewer catch basins. Consideration should be given to the placement of subdrains along the pavement edge for major roads, or “stubby” drains, leading into the catch basins at the subgrade level.

7.0 DESIGN AND CONSTRUCTION PRECAUTIONS

7.1 Foundation Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for the proposed dwellings. The system should consist of a 100 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, such as clean sand or OPSS Granular B Type I material. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill unless a composite drainage system (such as system Platon or Miradrain 6000 or G100N), connected to a drainage system is provided.

7.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures, including attached garages, 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.

Exterior unheated footings, such as those for isolated exterior piers and wing walls may require more soil cover or a combination of soil cover and insulation.

7.3 Excavation Side Slopes

The side slopes of excavations in the soil and fill overburden materials should either be 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 building excavations to be undertaken by open-cut methods (i.e. unsupported excavations). Where space restrictions exist, or to minimize the trench width for municipal services, the excavation can be carried out within the confines of a fully braced steel trench box or other acceptable shoring systems.

Unsupported excavation side slopes, extending to a maximum depth of 3.0 m, should be cut back at 1H:1V, or shallower.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Unsupported slopes in excess of 3.0 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.

7.4 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 silty clay should be low due to the relatively impervious nature of this material. It is anticipated that pumping from open sumps will be sufficient to control the groundwater influx through the sides of the excavations (with flatter excavation slopes being used below groundwater level).

The developer may need to register with the Ontario Ministry of Environment and Climate Change’s (MOECC’s) new Environmental Activity and Sector Registry (EASR) process for this project if more than 50,000 L/day (and less than 400,000 L/day) are to be pumped during the construction phase (routine flows). Paterson can assist with this process.

Pumping of more than 400,000 L/day requires a temporary MOECC permit to take water (PTTW). At lead time of 4 to 6 months should be allowed for completion of the application and the review and issuance of the permit by the MOECC.

7.5 Winter Construction

Precautions must be taken if winter construction is considered for this project. The subsoil conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the 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 excavation and backfilling and pavement construction are also difficult to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Additional information could be provided, if required.

7.6 Corrosion Potential and Sulphate

Three (3) soil samples have been submitted, from the previous investigations, for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The samples were submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the soil. The analytical test results are presented in Appendix 1 and are discussed below.

The results of analytical testing show that the sulphate content is less than 0.1% (1 mg/g) in all the samples. This result is indicative that Type GU (general use) cement, as per CSA A23.1 Section 4.2.1.1.2, is appropriate for this site.

The chloride content is less than 400 mg/g and the pH of the sample is greater than 5. These results indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site. Two (2) of the resistivity values are greater than 3,000 ohm-cm and are indicative of a moderate to aggressive corrosive environment. One (1) of the resistivity values is less than 3,000 ohm-cm and is indicative of a severe to very aggressive corrosive environment.

The appropriate concrete exposure class is “N”, for soil contact based on chloride content, where freezing and thawing (F-1 or F-2 exposure class) is not an issue.

7.7 Landscaping Considerations

The subject site is located in an area of moderately sensitive silty clay deposits with regards to tree planting. For the proposed development, it is expected that final grade raises will be approximately 0.8 to 1.8 m above existing grades. Therefore, it is expected that the combination of the proposed finished grades and the thickness of the underlying weathered clay crust will provide approximately 4 to 5 m thick buffer to the underlying firm grey silty clay deposit.

In our opinion, tree planting for this subject development should be limited to low water demand trees. The minimum permissible distance from the foundation will depend on the nature of the tree, the depth of the clay crust and the final grade raise in relation to the permissible grade raise. For low water demand trees, the minimum permissible distance can be set at 4.5 for this site. In critical areas, the minimum permissible tree planting distance can be improved by installing various tree damage preventative measures such as:

❏ Exfiltration trenches with a moisture retention barrier
❏ Root barrier systems with water delivery systems
❏ Separation barriers
❏ Additional foundation reinforcement and support

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.

8.0 MATERIAL TESTING AND OBSERVATION SERVICES

A sensitive soils foundation design and field review protocol has been implemented by Minto and their geotechnical and structural engineering consultants for projects on sensitive silty clay soils. The sensitive soils inspection protocol is a comprehensive and holistic methodology that ensures that the structural design incorporates the geotechnical design elements. In addition, the construction-related elements, such as field measured shear strengths, underside of footing levels, grade raises, are checked or reviewed during construction and compared with the design assumptions, so modifications can be made where the results of the field observations warrant, and otherwise, as-built conditions can be confirmed to be according to design assumptions.

As such, the following material testing and field review observation program should be performed by the geotechnical consultant:

❑ Evaluation of all bearing media, including the putting down of a hand auger and shear vane hole below the footing level, prior to the forming of footings.

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

❑ Inspection of the placement of lightweight fill (LWF) materials, where required.

❑ Sampling and testing of the concrete and granular 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 and follow-up field density tests to ensure that the specified level of compaction has been 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 demand, based on the completion of a satisfactory materials testing and field review observation program by the geotechnical consultant.

9.0 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 plans, once prepared, for conformance to our recommendations.

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

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from 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 Minto Communities Inc. 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.

A.J. Tovell

LICENSED PROFESSIONAL ENGINEER
Jun 6-16
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46812509
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PROVINCE OF ONTARIO

Andrew J. Tovell, P.Eng.

Report Distribution

- ☐ Minto Communities Inc. (3 copies)
- ☐ J.L. Richards and Assoc. Ltd. (1 copy)
- ☐ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS:

BH4-15 to BH12-15, Inclusive
BH13-16 to BH23-16, Inclusive
BH1 to BH6, Inclusive (2009)
BH7 and BH8 (2011)
BH6-05 to BH9-05, Inclusive (2005)

Symbols and Terms

Analytical Test Results

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

REMARKS

BORINGS BY CME 75 Power Auger

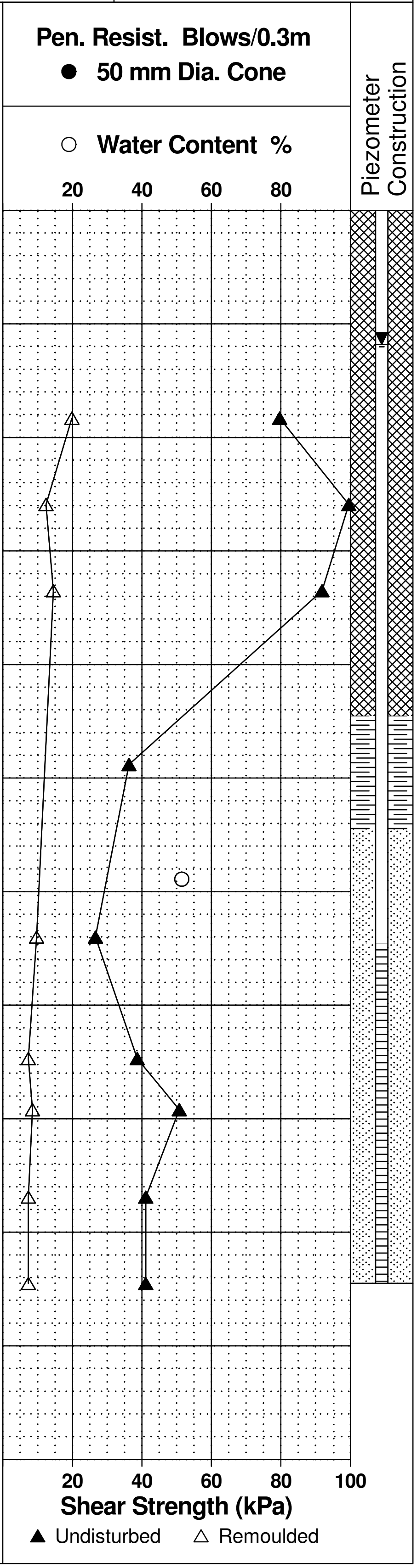
DATE March 5, 2015

FILE NO. PG1984

HOLE NO. BH 4-15

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Very stiff to stiff, brown **SILTY CLAY**	▨	AU	1		
	▨	SS	2	100	6
3.40					
Firm to stiff, grey **SILTY CLAY**	▨	TW	3	100	
	▨	TW	4	92	
9.45					
Dynamic Cone Penetration Test commenced at 9.45m depth. Cone pushed to 11.9m depth					

DEPTH (m)	ELEV. (m)
0	91.84
1	90.84
2	89.84
3	88.84
4	87.84
5	86.84
6	85.84
7	84.84
8	83.84
9	82.84
10	81.84
11	80.84



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

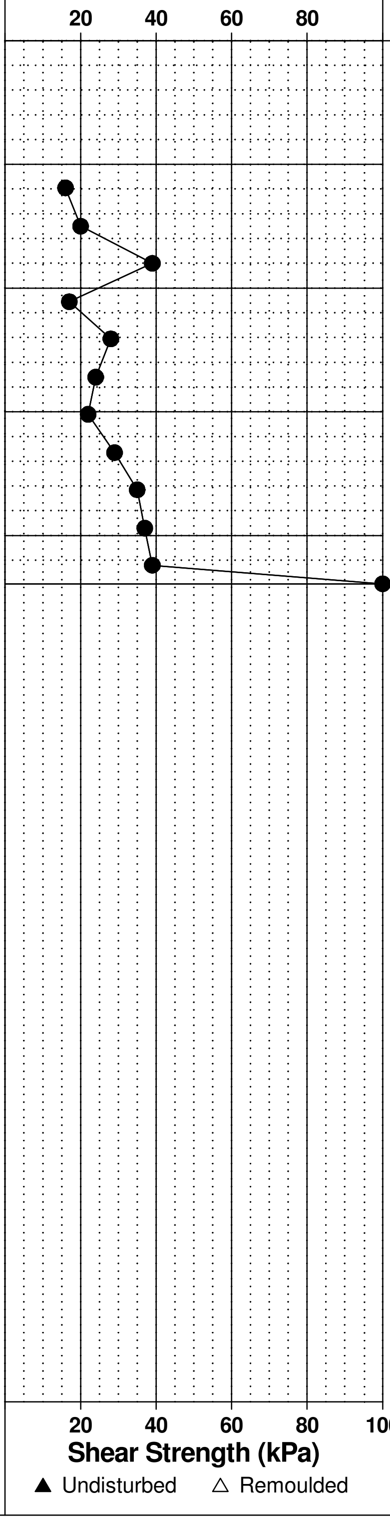
REMARKS

HOLE NO. BH 4-15

BORINGS BY CME 75 Power Auger

DATE March 5, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE						11	80.84		
						12	79.84		
Inferred firm to stiff cohesive soil over compact to dense glacial till						13	78.84		
						14	77.84		
15.39						15	76.84		
End of Borehole Practical DCPT refusal at 15.39m depth (GWL @ 1.18m-March 19, 2015)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

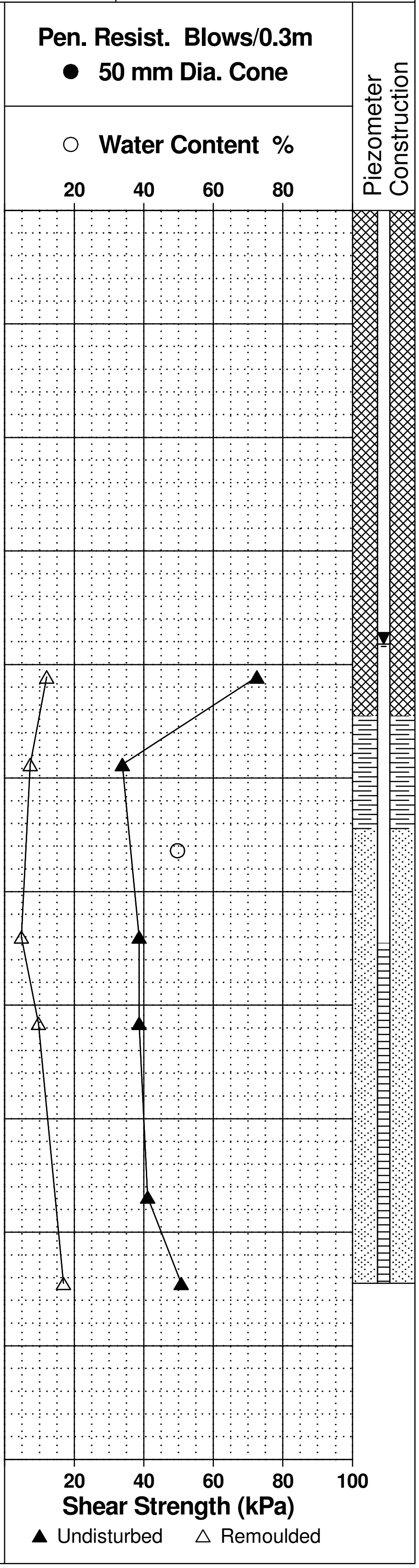
REMARKS

HOLE NO. **BH 5-15**

BORINGS BY CME 75 Power Auger

DATE March 6, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.44
FILL: Brown silty clay, some sand and cobbles		AU	1				
		SS	2	75	9	1	92.44
1.42							
Very stiff to stiff, brown **SILTY CLAY,** some sand		SS	3	100	12	2	91.44
		SS	4	100	8	3	90.44
		SS	5	100	5	4	89.44
4.50							
Firm to stiff, grey **SILTY CLAY**		TW	6	97		5	88.44
						6	87.44
						7	86.44
		TW	7	98		8	85.44
						9	84.44
9.45							
Dynamic Cone Penetration Test commenced at 9.45m depth. Cone pushed to 11.0m depth.						10	83.44
						11	82.44



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

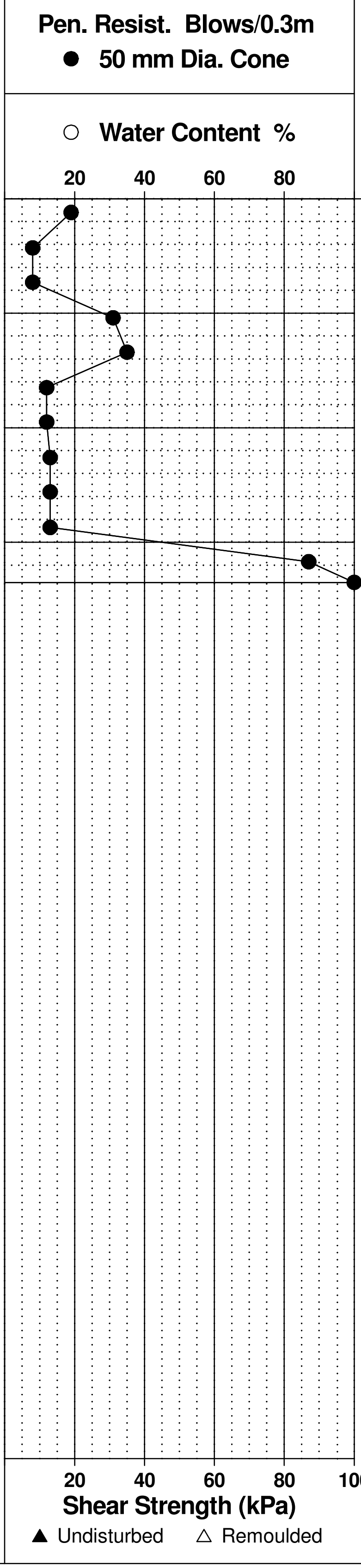
REMARKS

HOLE NO. BH 5-15

BORINGS BY CME 75 Power Auger

DATE March 6, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
						11	82.44
						12	81.44
Inferred firm to stiff cohesive soil over compact to dense glacial till							
						13	80.44
						14	79.44
14.35							
End of Borehole Practical DCPT refusal at 14.35m depth (GWL @ 3.82m-March 19, 2015)							



Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

REMARKS

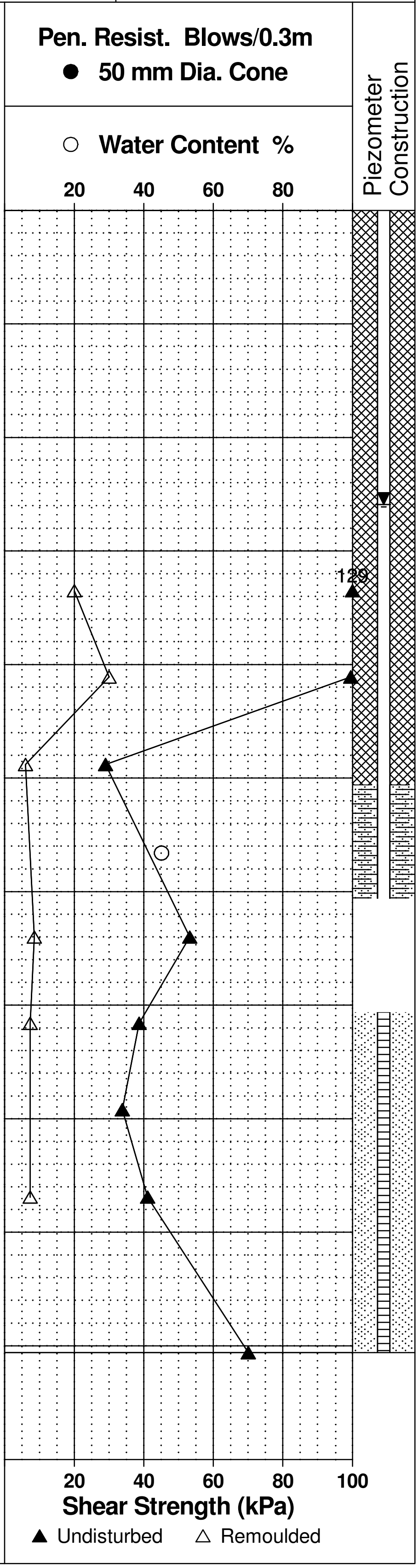
HOLE NO. **BH 6-15**

BORINGS BY CME 75 Power Auger

DATE March 6, 2015

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand with gravel, trace cobbles	AU	1		
	SS	2	60	50+
1.45				
FILL: Brown silty clay, some sand and gravel	SS	3	71	12
1.98				
Very stiff to stiff, brown **SILTY CLAY,** some sand	SS	4	75	7
4.60				
Firm, grey **SILTY CLAY**	TW	5	95	
	TW	6	100	
10.06				
End of Borehole				
(GWL @ 2.59m-March 19, 2015)				

DEPTH (m)	ELEV. (m)
0	94.30
1	93.30
2	92.30
3	91.30
4	90.30
5	89.30
6	88.30
7	87.30
8	86.30
9	85.30
10	84.30



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

REMARKS

HOLE NO. **BH 7-15**

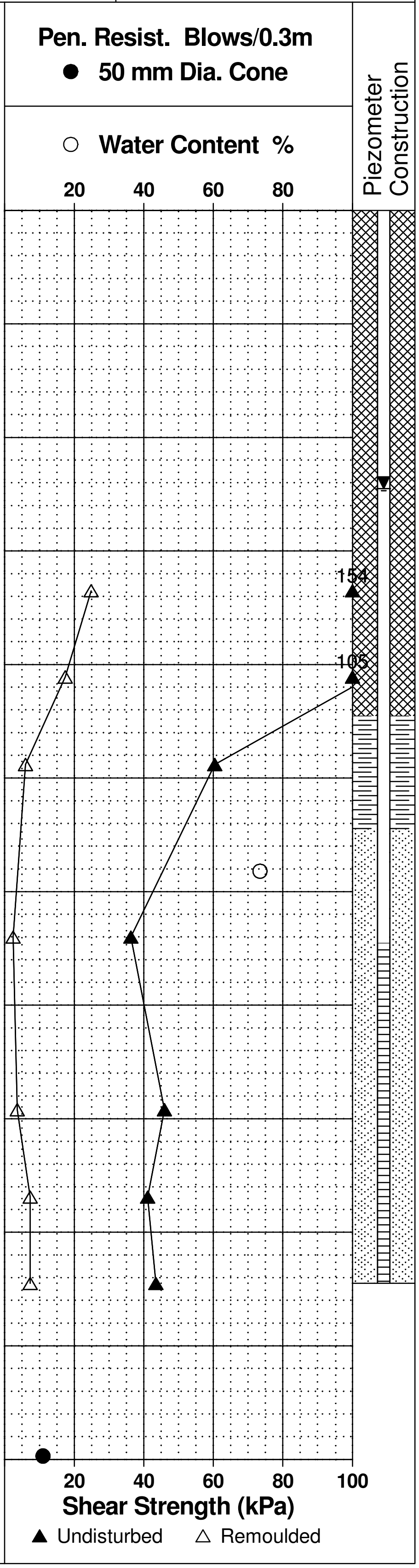
BORINGS BY CME 75 Power Auger

DATE March 9, 2015

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
FILL: Brown silty sand with gravel, trace cobbles	1.98
Very stiff to stiff, brown **SILTY CLAY,** some sand	5.00
Firm, grey **SILTY CLAY**	9.45
Dynamic Cone Penetration Test commenced at 9.45m depth. Cone pushed to 10.8m depth.	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	100	79
SS	3	75	12
SS	4	100	6
TW	5	96	
TW	6	60	

DEPTH (m)	ELEV. (m)
0	94.05
1	93.05
2	92.05
3	91.05
4	90.05
5	89.05
6	88.05
7	87.05
8	86.05
9	85.05
10	84.05
11	83.05



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

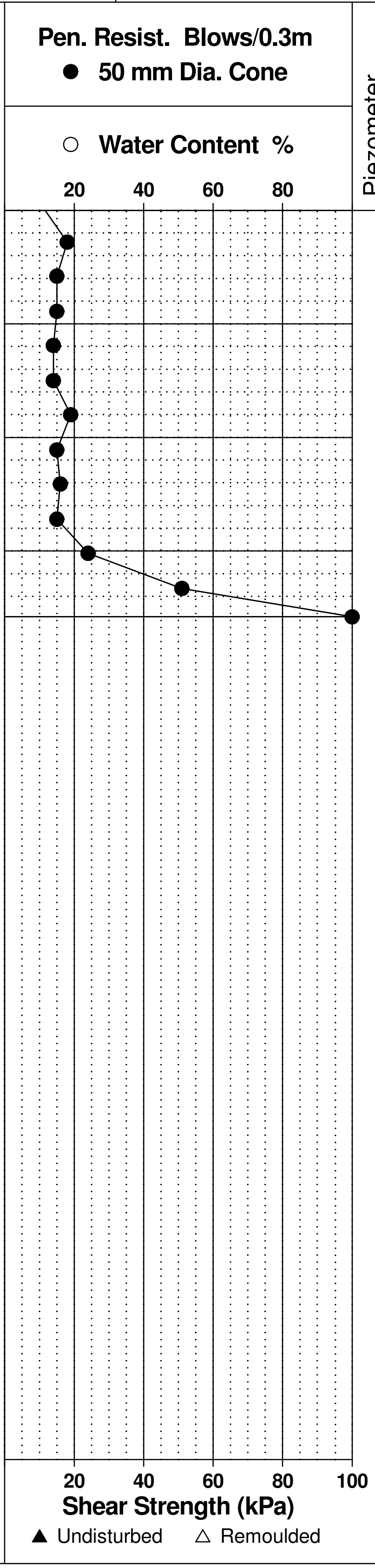
REMARKS

HOLE NO. **BH 7-15**

BORINGS BY CME 75 Power Auger

DATE March 9, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE								
Inferred firm to stiff cohesive soil over compact to dense glacial till						11	83.05	
						12	82.05	
						13	81.05	
						14	80.05	
14.58								
End of Borehole Practical DCPT refusal at 14.58m depth (GWL @ 2.45m-March 19, 2015)								



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

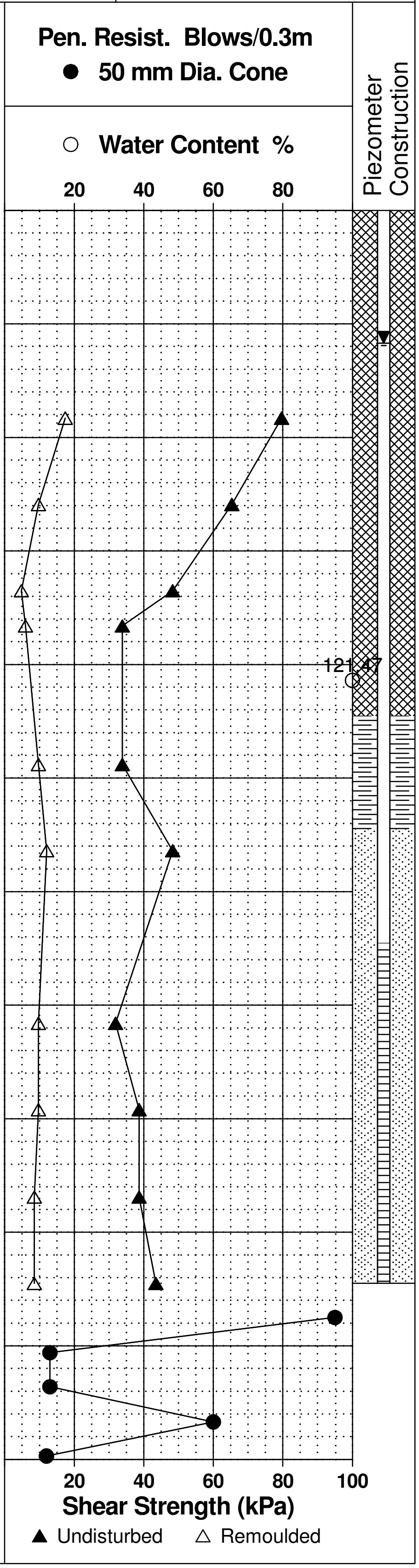
REMARKS

HOLE NO. **BH 8-15**

BORINGS BY CME 75 Power Auger

DATE March 9, 2015

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	92.71
	AU	1				
	SS	2	100	7	1	91.71
Very stiff to stiff, brown **SILTY CLAY,** some sand					2	90.71
3.00					3	89.71
	TW	3	93		4	88.71
					5	87.71
Firm, grey **SILTY CLAY**					6	86.71
	TW	4	98			
					7	85.71
					8	84.71
					9	83.71
9.45						
Dynamic Cone Penetration Test commenced at 9.45m depth.					10	82.71
					11	81.71



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
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DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

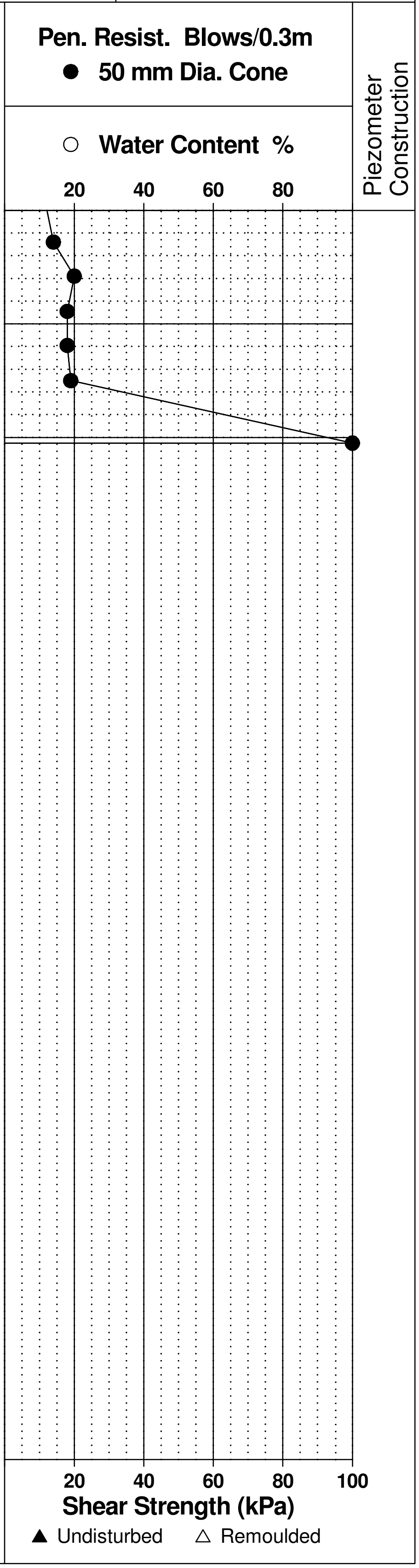
REMARKS

HOLE NO. BH 8-15

BORINGS BY CME 75 Power Auger

DATE March 9, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						11	81.71
Inferred firm to stiff cohesive soil over compact to dense glacial till						12	80.71
13.05						13	79.71
End of Borehole Practical DCPT refusal at 13.05m depth (GWL @ 1.17m-March 19, 2015)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

REMARKS

HOLE NO. **BH 9-15**

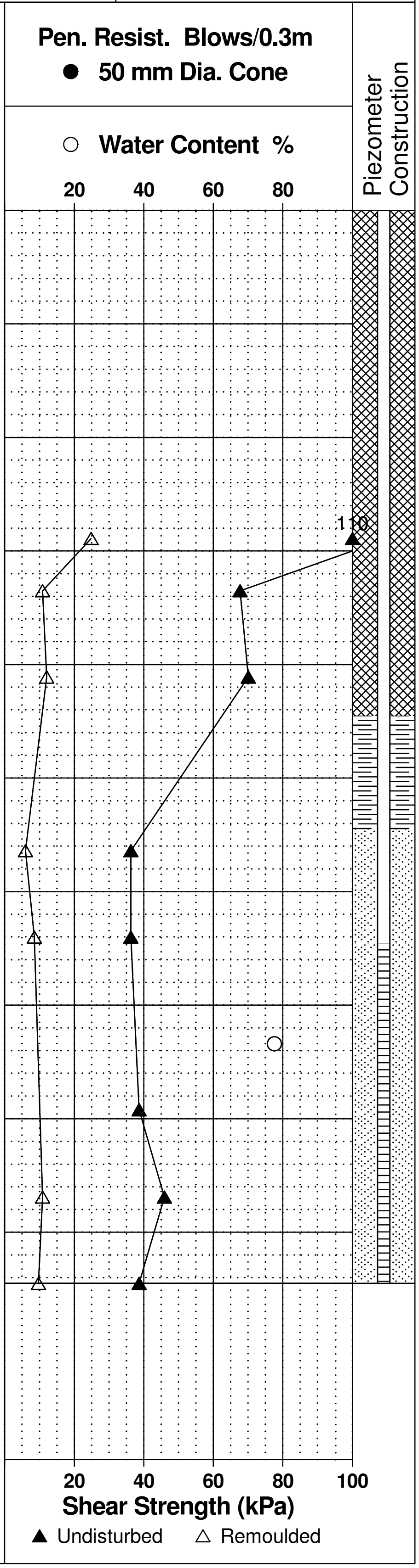
BORINGS BY CME 75 Power Auger

DATE March 9, 2015

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
FILL: Brown silty clay with gravel, some cobbles	1.01
Very stiff to stiff, brown **SILTY CLAY**, some sand	4.20
Firm, grey **SILTY CLAY**	9.45
End of Borehole (Piezometer blocked at 0.82m depth - March 19, 2015)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	75	18
SS	3	100	5
TW	4	96	
TW	5	99	

DEPTH (m)	ELEV. (m)
0	93.23
1	92.23
2	91.23
3	90.23
4	89.23
5	88.23
6	87.23
7	86.23
8	85.23
9	84.23



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

REMARKS

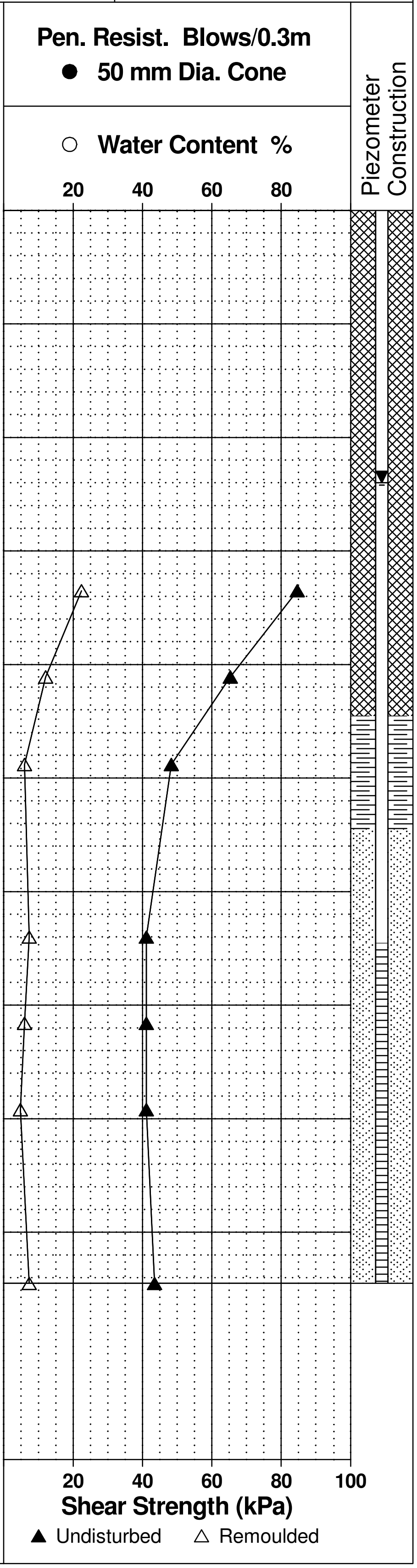
BORINGS BY CME 75 Power Auger

DATE March 10, 2015

FILE NO. PG1984

HOLE NO. BH10-15

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	94.38
FILL: Brown to black silty clay, some sand and gravel, trace cobbles		AU	1				
		SS	2	100	50+	1	93.38
		SS	3	54	11		
2.08						2	92.38
Very stiff to stiff, brown **SILTY CLAY,** some sand		SS	4	100	7		
						3	91.38
						4	90.38
4.60							
						5	89.38
Firm, grey **SILTY CLAY**		TW	5	22			
						6	88.38
						7	87.38
						8	86.38
		TW	6	92			
						9	85.38
9.45							
End of Borehole							
(GWL @ 2.40m-March 19, 2015)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

REMARKS

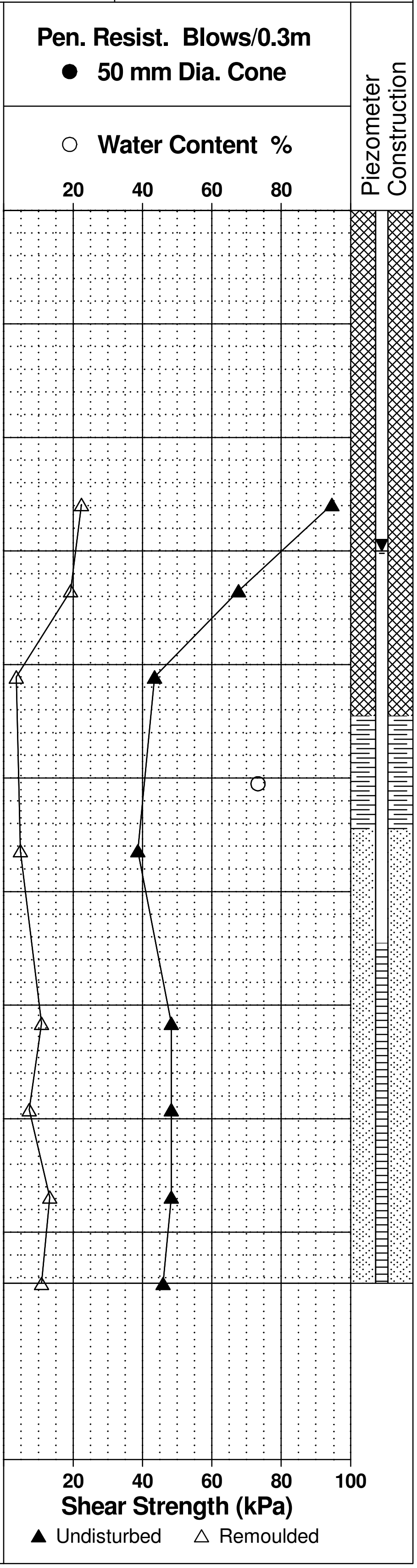
BORINGS BY CME 75 Power Auger

DATE March 10, 2015

FILE NO. PG1984

HOLE NO. BH11-15

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	93.88
FILL: Brown silty clay, some sand and gravel	AU	1				
	SS	2	8	7	1	92.88
1.42						
Very stiff to stiff, brown **SILTY CLAY,** some sand	SS	3	100	5		
					2	91.88
					3	90.88
3.80						
Firm, grey **SILTY CLAY**					4	89.88
	TW	4	98			
					5	88.88
					6	87.88
	TW	5	100			
					7	86.88
					8	85.88
					9	84.88
9.45						
End of Borehole						
(GWL @ 3.00m-March 19, 2015)						



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

REMARKS

HOLE NO. BH12-15

BORINGS BY CME 75 Power Auger

DATE March 11, 2015

SOIL DESCRIPTION

GROUND SURFACE

FILL; Brown silty clay with sand and gravel, some cobbles

1.45

Very stiff to stiff, brown **SILTY CLAY,** some sand

4.50

Firm, grey **SILTY CLAY**

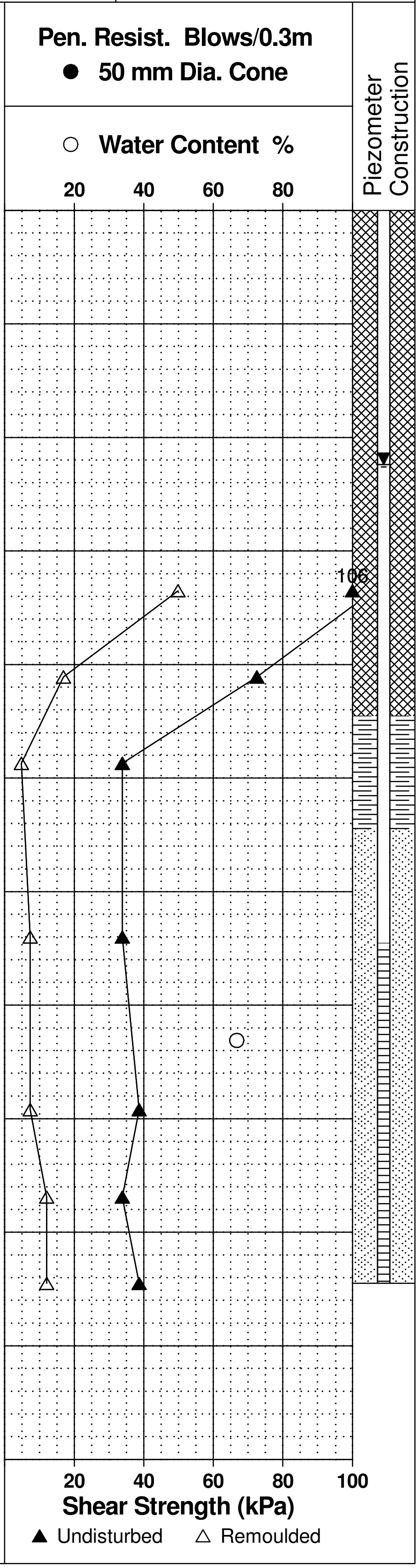
9.45

Dynamic Cone Penetration Test commenced at 9.45m depth. Cone pushed to 11.1m depth.

SAMPLE

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	42	5
SS	3	100	9
SS	4	100	4
TW	5	69	
TW	6	100	

DEPTH (m)	ELEV. (m)
0	93.96
1	92.96
2	91.96
3	90.96
4	89.96
5	88.96
6	87.96
7	86.96
8	85.96
9	84.96
10	83.96
11	82.96



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

REMARKS

HOLE NO. BH12-15

BORINGS BY CME 75 Power Auger

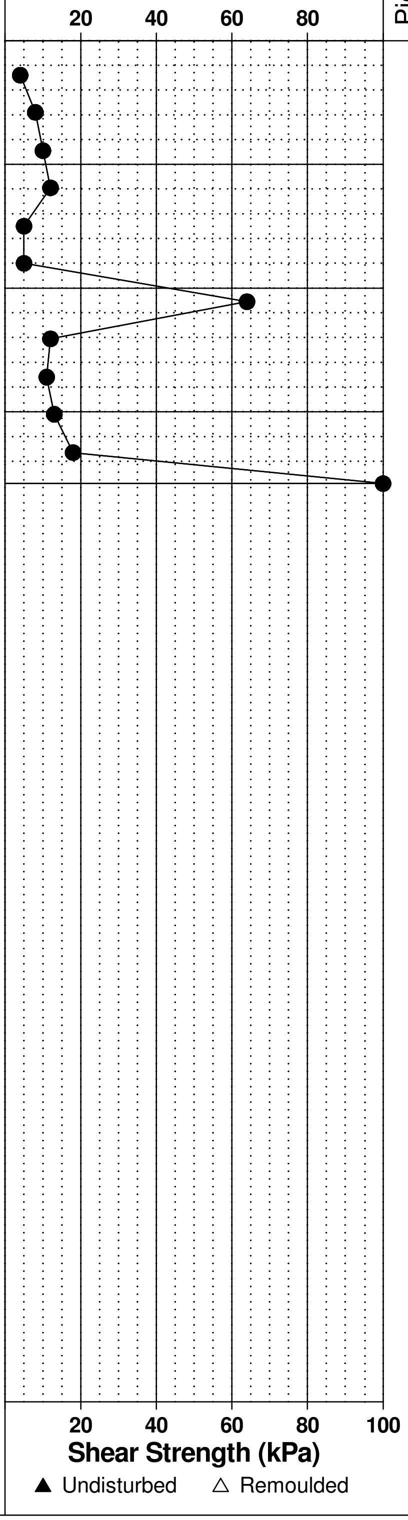
DATE March 11, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						11	82.96
						12	81.96
Inferred firm to stiff cohesive soil over compact to dense glacial till						13	80.96
						14	79.96
14.58							
End of Borehole Practical DCPT refusal at 14.58m depth (GWL @ 2.24m-March 19, 2015)							

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

○ Water Content %

Piezometer Construction



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

REMARKS

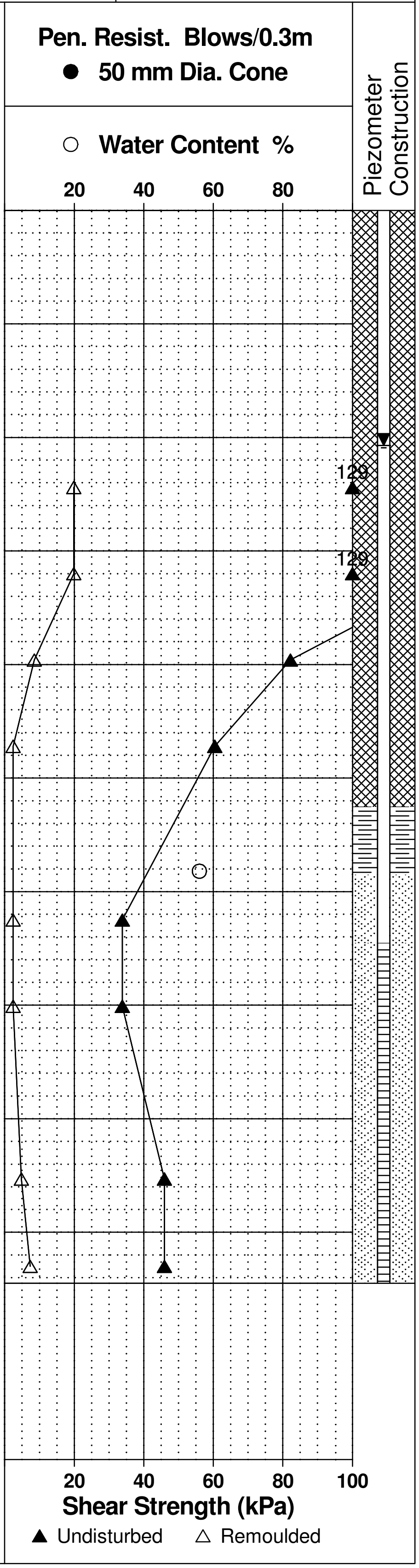
HOLE NO. BH13-16

BORINGS BY CME 55 Power Auger

DATE April 21, 2016

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	93.99
FILL: Brown silty sand, some gravel, cobbles and boulders, trace clay 0.60	AU	1				
FILL: Brown silty clay, some sand, gravel and cobbles	SS	2	0	9	1	92.99
1.83	SS	3	25	4	2	91.99
Very stiff, brown **SILTY CLAY,** trace sand	G	4			3	90.99
3.80					4	89.99
Stiff to firm, grey **SILTY CLAY**	G	5			5	88.99
	TW	6	100		6	87.99
	G	7			7	86.99
	TW	8	100		8	85.99
9.45					9	84.99
End of Borehole	G	9				

(GWL @ 2.07m-May 12, 2016)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

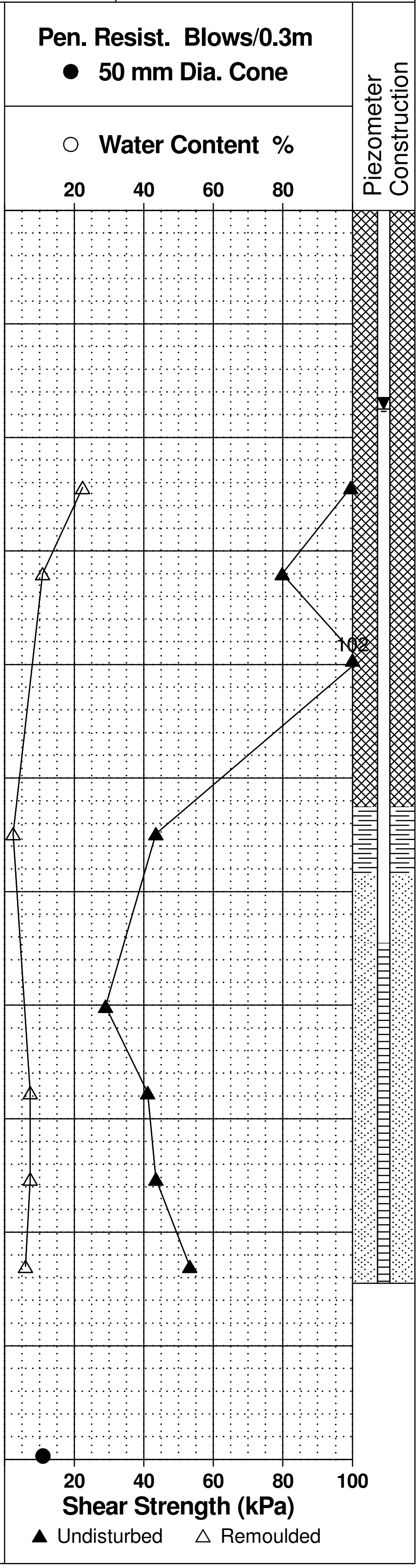
REMARKS

HOLE NO. BH14-16

BORINGS BY CME 55 Power Auger

DATE April 21, 2016

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	93.49
FILL: Dark brown sandy silt with gravel, cobbles and organic matter	AU	1				
	SS	2	46	7	1	92.49
1.68						
Very stiff, brown **SILTY CLAY,** trace sand	SS	3	62	5		
					2	91.49
	G	4				
					3	90.49
	G	5			4	89.49
4.30						
Stiff to firm, grey **SILTY CLAY**	TW	6	71		5	88.49
					6	87.49
	TW	7	79			
	G	8			7	86.49
					8	85.49
					9	84.49
9.45						
Dynamic Cone Penetration Test commenced at 9.45m depth. Cone pushed to 10.7m depth.					10	83.49
					11	82.49



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

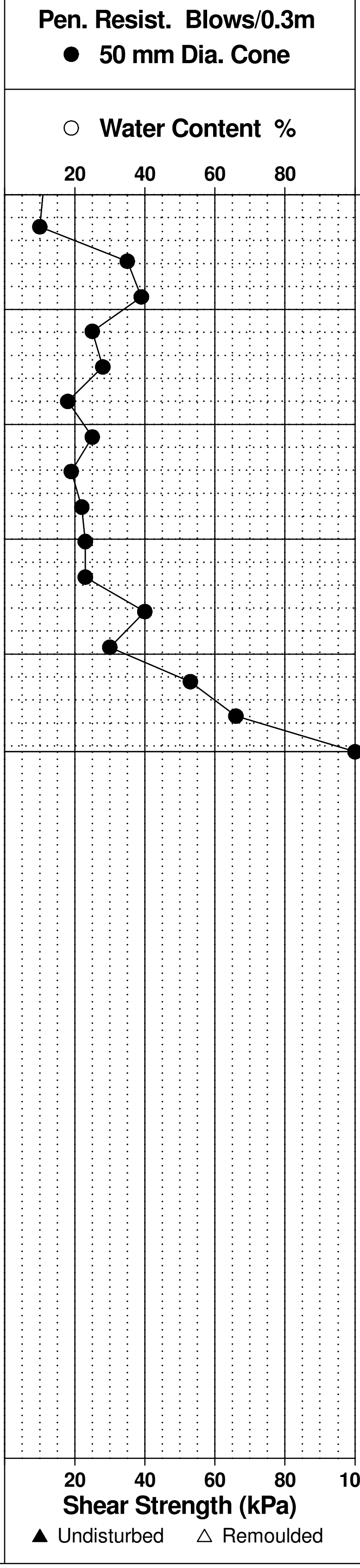
REMARKS

HOLE NO. BH14-16

BORINGS BY CME 55 Power Auger

DATE April 21, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						11	82.49	
						12	81.49	
Inferred stiff cohesive soil over compact to dense glacial till						13	80.49	
						14	79.49	
						15	78.49	
15.85								
End of Borehole Practical DCPT refusal at 15.85m depth (GWL @ 1.75m-May 12, 2016)								



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

REMARKS

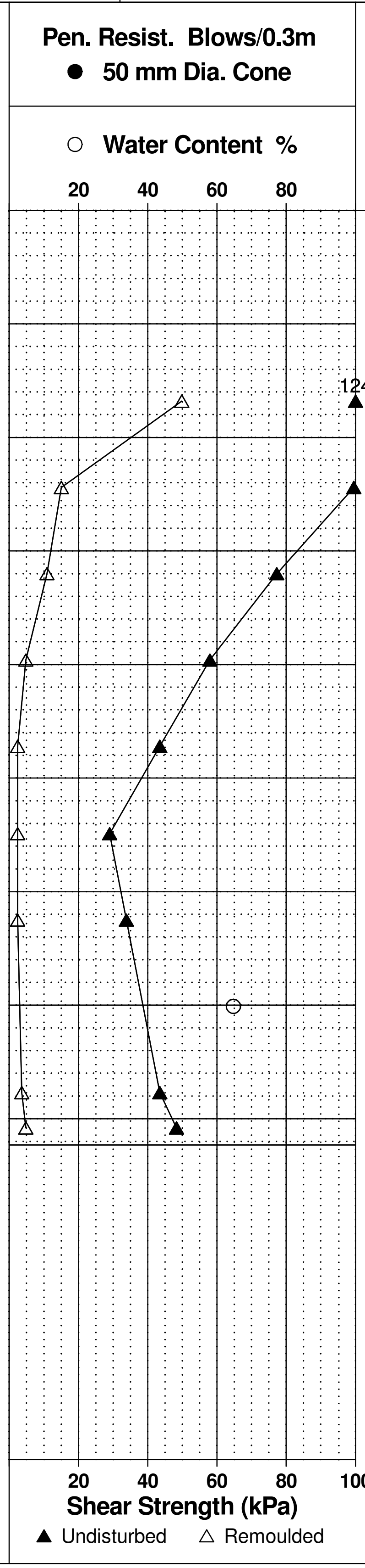
BORINGS BY CME 55 Power Auger

DATE April 28, 2016

FILE NO. PG1984

HOLE NO. BH14A-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	93.49	
FILL: Brown silty clay, some gravel and cobbles	▨	AU	1					
	▨	SS	2	25	6	1	92.49	
1.68								
Very stiff to stiff, brown **SILTY CLAY,** some sand seams	▨					2	91.49	
	▨					3	90.49	
3.80								
	▨					4	89.49	
	▨					5	88.49	
Stiff to firm, grey **SILTY CLAY**	▨					6	87.49	
	▨	TW	3	100		7	86.49	
	▨					8	85.49	
8.23								
End of Borehole								



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

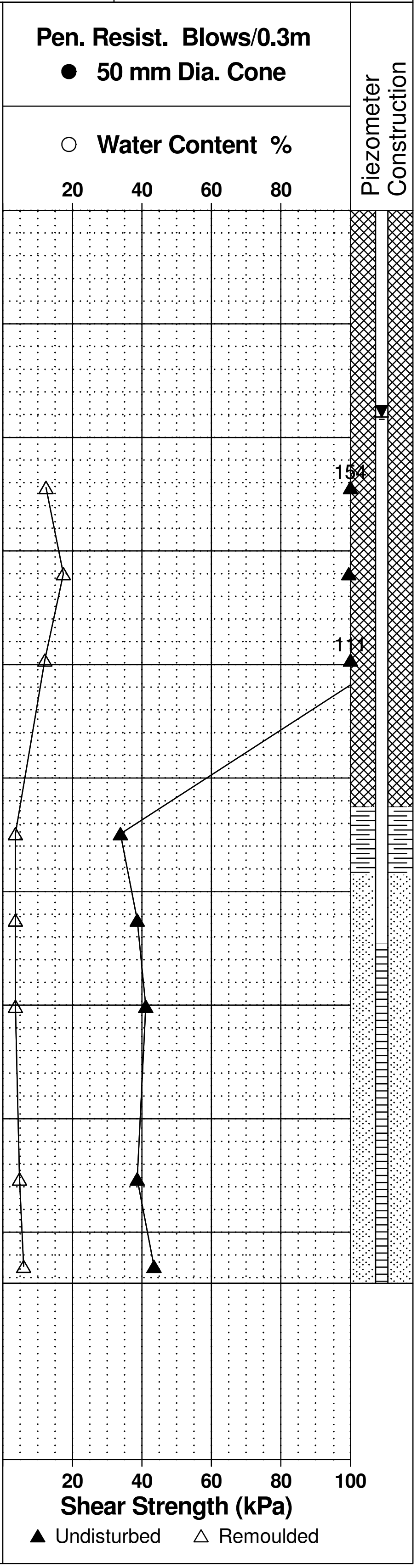
DATE April 22, 2016

FILE NO. PG1984

HOLE NO. BH15-16

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown clayey silt with sand, gravel and cobbles 0.46	AU	1		
FILL: Brown slty clay, some gravel	SS	2	54	7
1.80	SS	3	83	4
Very stiff, brown **SILTY CLAY,** some sand	G	4		
4.30	G	5		
Stiff to firm, grey **SILTY CLAY**	TW	6	96	
	G	7		
	TW	8	100	
9.45	G	9		
End of Borehole				
(GWL @ 1.82m-May 12, 2016)				

DEPTH (m)	ELEV. (m)
0	93.96
1	92.96
2	91.96
3	90.96
4	89.96
5	88.96
6	87.96
7	86.96
8	85.96
9	84.96



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

REMARKS

HOLE NO. BH16-16

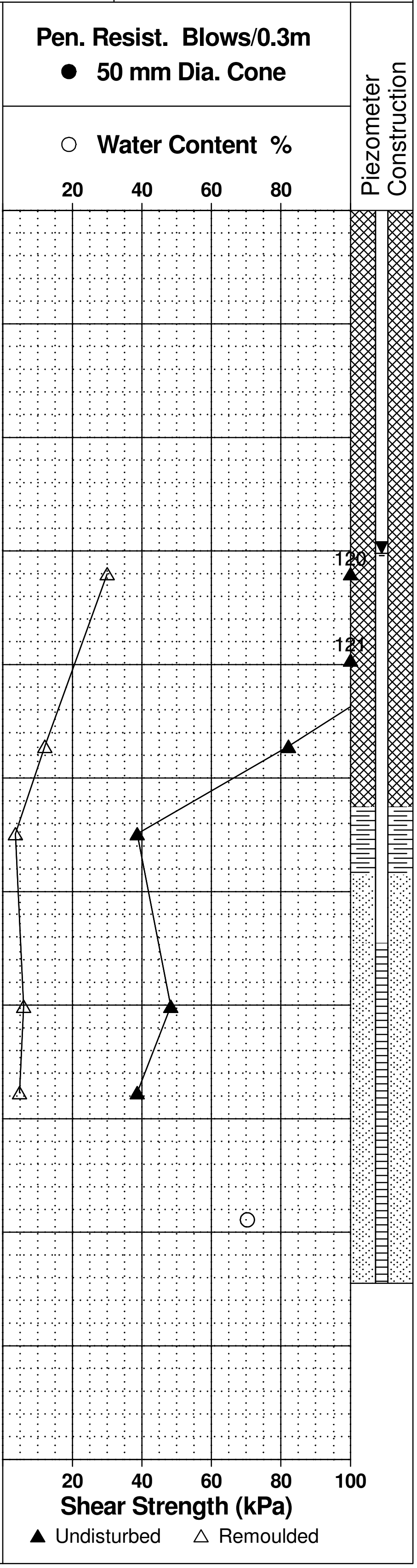
BORINGS BY CME 55 Power Auger

DATE April 22, 2016

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
FILL: Crushed stone with sand, some silt	0.36
FILL: Brown sand with gravel, trace cobbles	1.40
FILL: Brown silty clay, some sand and gravel, trace organics	2.80
Very stiff, brown **SILTY CLAY,** some sand	4.30
Stiff to firm, grey **SILTY CLAY**	9.45
Dynamic Cone Penetration Test commenced at 9.45m depth. Cone pushed to 14.0m depth.	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	79	25
SS	3	46	13
SS	4	62	9
G	5		
G	6		
TW	7	100	
G	8		
TW	9	100	

DEPTH (m)	ELEV. (m)
0	94.89
1	93.89
2	92.89
3	91.89
4	90.89
5	89.89
6	88.89
7	87.89
8	86.89
9	85.89
10	84.89
11	83.89



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

REMARKS

HOLE NO. BH16-16

BORINGS BY CME 55 Power Auger

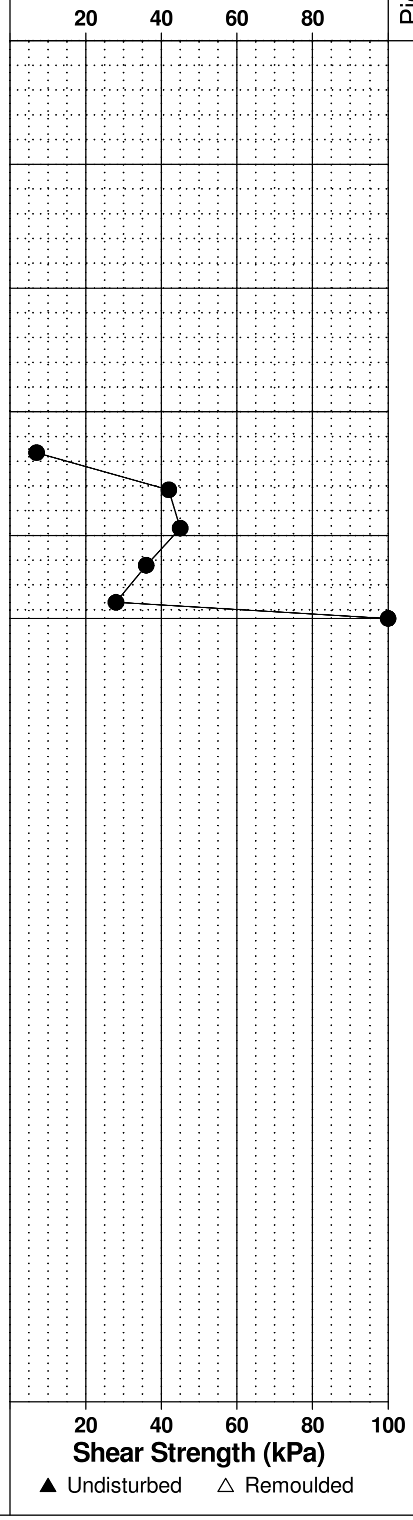
DATE April 22, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						11	83.89
						12	82.89
Inferred firm to stiff cohesive soil over compact to dense glacial till						13	81.89
						14	80.89
15.67						15	79.89
End of Borehole Practical DCPT refusal at 15.67m depth (GWL @ 3.02m-May 12, 2016)							

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

○ Water Content %

Piezometer Construction



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

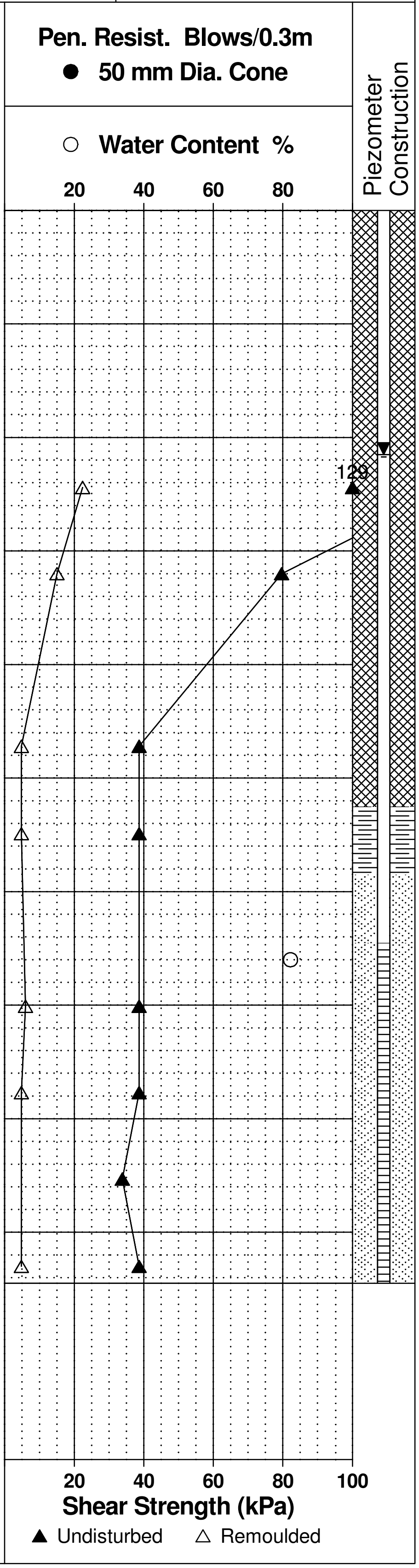
REMARKS

HOLE NO. BH17-16

BORINGS BY CME 55 Power Auger

DATE April 22, 2016

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	94.01
FILL: Brown silty sand, some gravel and cobbles — 0.60	AU	1				
FILL: Brown silty clay, some gravel — 1.07	SS	2	54	4	1	93.01
Very stiff, brown **SILTY CLAY,** some sand	SS	3	67	6	2	92.01
— 2.80	G	4				
Stiff to firm, grey **SILTY CLAY**					3	91.01
	TW	5	100		4	90.01
					5	89.01
	G	6				
					6	88.01
	TW	7	100			
					7	87.01
	G	8				
					8	86.01
					9	85.01
— 9.45						
End of Borehole (GWL @ 2.15m-May 12, 2016)						



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

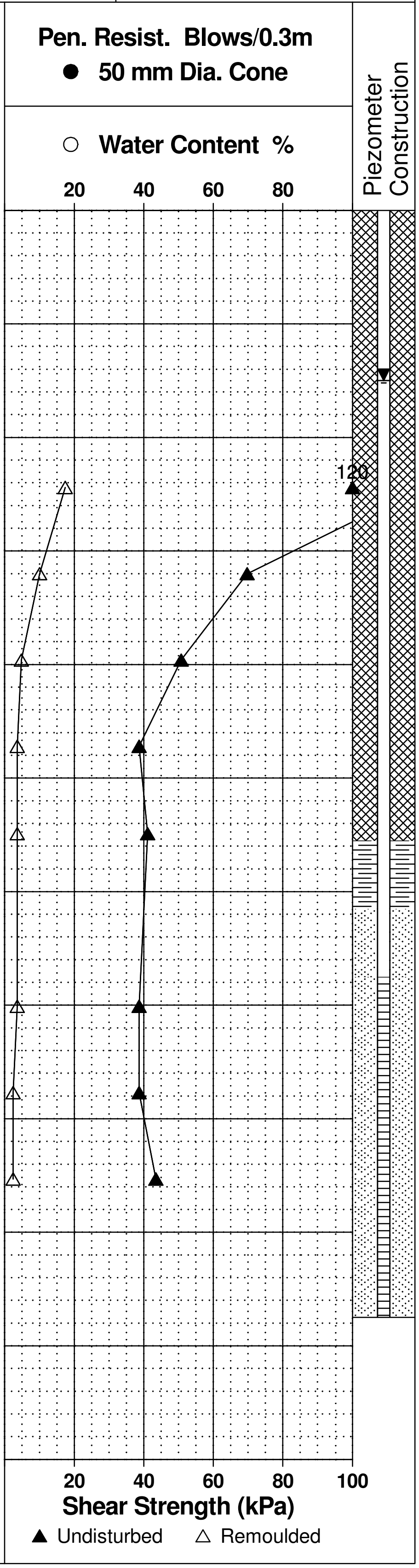
REMARKS

HOLE NO. **BH18-16**

BORINGS BY CME 55 Power Auger

DATE April 25, 2016

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	93.45
FILL: Brown silty clay, some gravel and organics	AU	1				
0.60						
TOPSOIL						
0.84	SS	2	62	10	1	92.45
Very stiff, brown **SILTY CLAY,** some sand	SS	3	100	5	2	91.45
2.80						
	G	4			3	90.45
	G	5			4	89.45
					5	88.45
	G	6				
Stiff to firm, grey **SILTY CLAY**					6	87.45
	TW	7	100			
					7	86.45
	G	8			8	85.45
					9	84.45
	TW	9	100			
9.75						
Dynamic Cone Penetration Test commenced at 9.75m depth. Cone pushed to 13.7m depth.					10	83.45
					11	82.45



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

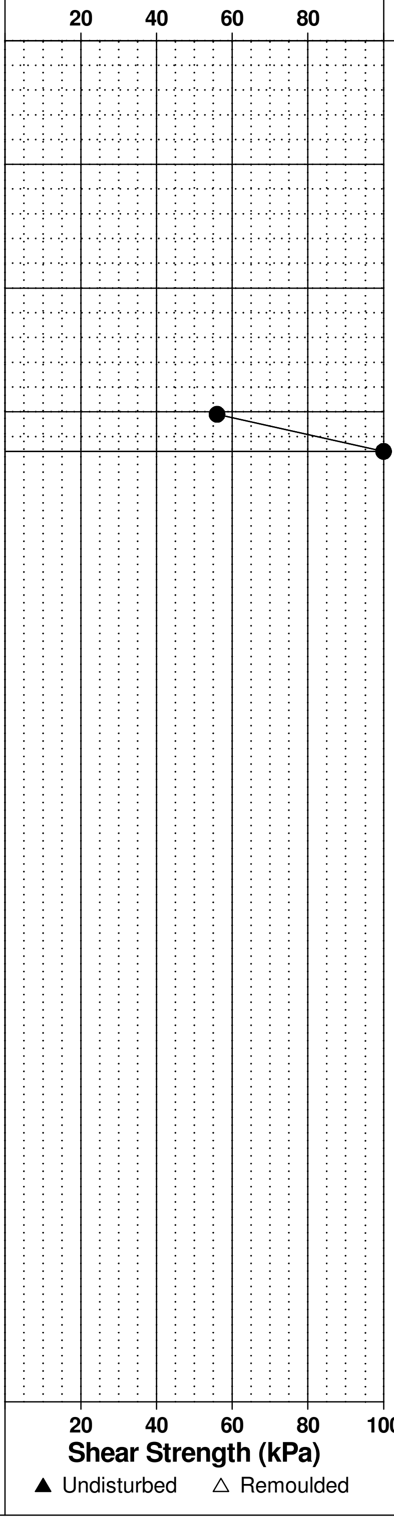
REMARKS

HOLE NO. BH18-16

BORINGS BY CME 55 Power Auger

DATE April 25, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			20 40 60 80	
GROUND SURFACE						11	82.45		
						12	81.45		
Inferred stiff cohesive soil over dense glacial till						13	80.45		
						14	79.45		
14.32									
End of Borehole Practical DCPT refusal at 14.32m depth (GWL @ 1.50m-May 12, 2016)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 25, 2016

FILE NO. PG1984

HOLE NO. BH19-16

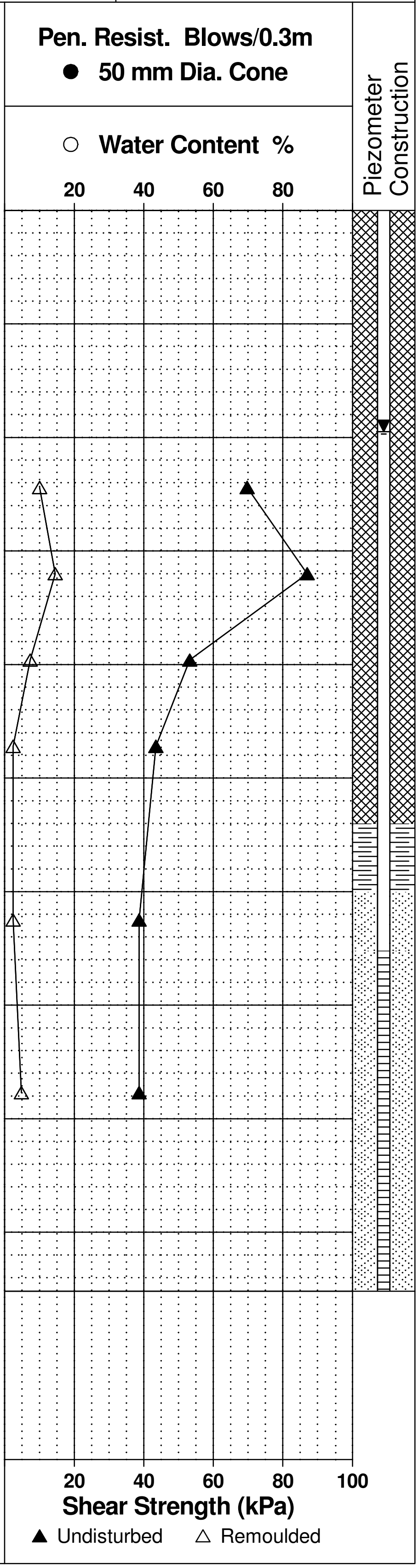
SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty clay, some gravel, cobbles, trace boulders	AU	1		
1.07	SS	2	29	5
Very stiff, brown **SILTY CLAY,** some sand	SS	3	100	6
2.20				
Stiff to firm, grey **SILTY CLAY**	G	4		
	G	5		
	TW	6	86	
	TW	7	100	
8.23				
GLACIAL TILL: Dense, grey silty sand with gravel	G	8		
9.52	SS	9		50+

End of Borehole

Practical refusal at 9.52m depth

(GWL @ 1.95m-May 12, 2016)

DEPTH (m)	ELEV. (m)
0	94.04
1	93.04
2	92.04
3	91.04
4	90.04
5	89.04
6	88.04
7	87.04
8	86.04
9	85.04



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

REMARKS

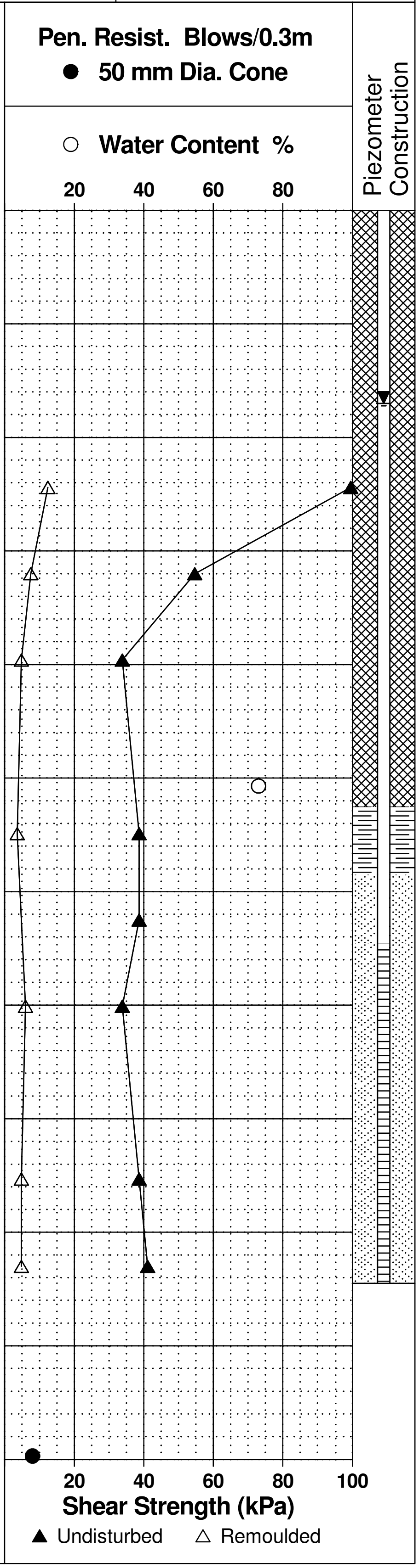
HOLE NO. BH20-16

BORINGS BY CME 55 Power Auger

DATE April 25, 2016

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand with gravel, cobbles, some boulders	AU	1		
1.07	SS	2	42	11
Very stiff, brown **SILTY CLAY,** some sand	SS	3	100	4
2.20				
Stiff to firm, grey **SILTY CLAY**	G	4		
	TW	5	100	
	G	6		
	TW	7	100	
9.45				
Dynamic Cone Penetration Test commenced at 9.45m depth. Cone pushed to 10.7m depth.				

DEPTH (m)	ELEV. (m)
0	93.63
1	92.63
2	91.63
3	90.63
4	89.63
5	88.63
6	87.63
7	86.63
8	85.63
9	84.63
10	83.63
11	82.63



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 25, 2016

FILE NO. PG1984

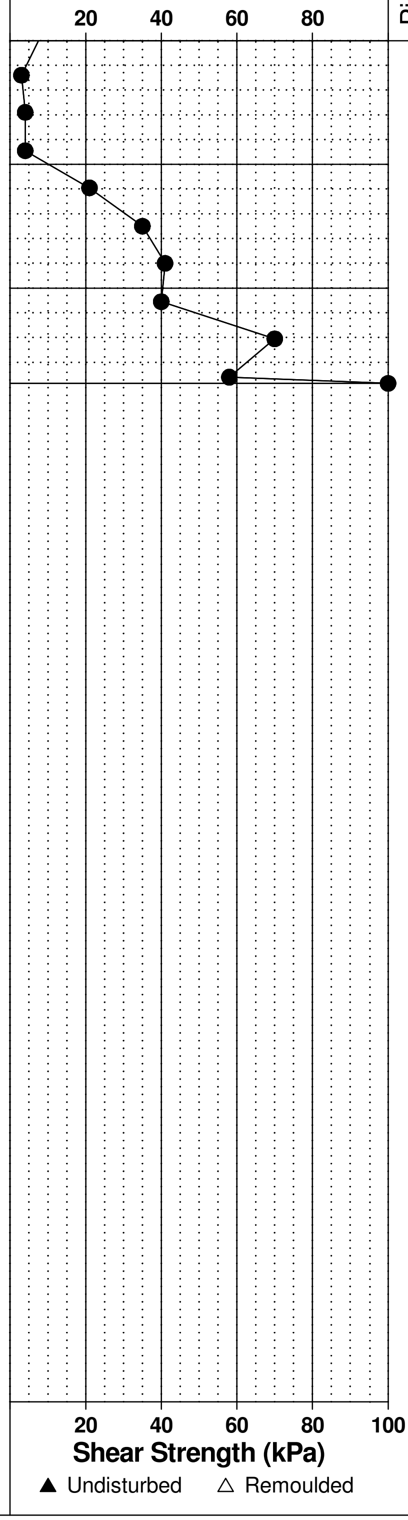
HOLE NO. BH20-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						11	82.63
Inferred firm to stiff cohesive soil over compact to compact to dense glacial till						12	81.63
						13	80.63
13.77							
End of Borehole Practical DCPT refusal at 13.77m depth (GWL @ 1.70m-May 12, 2016)							

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

○ **Water Content %**

Piezometer Construction



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

REMARKS

HOLE NO. **BH21-16**

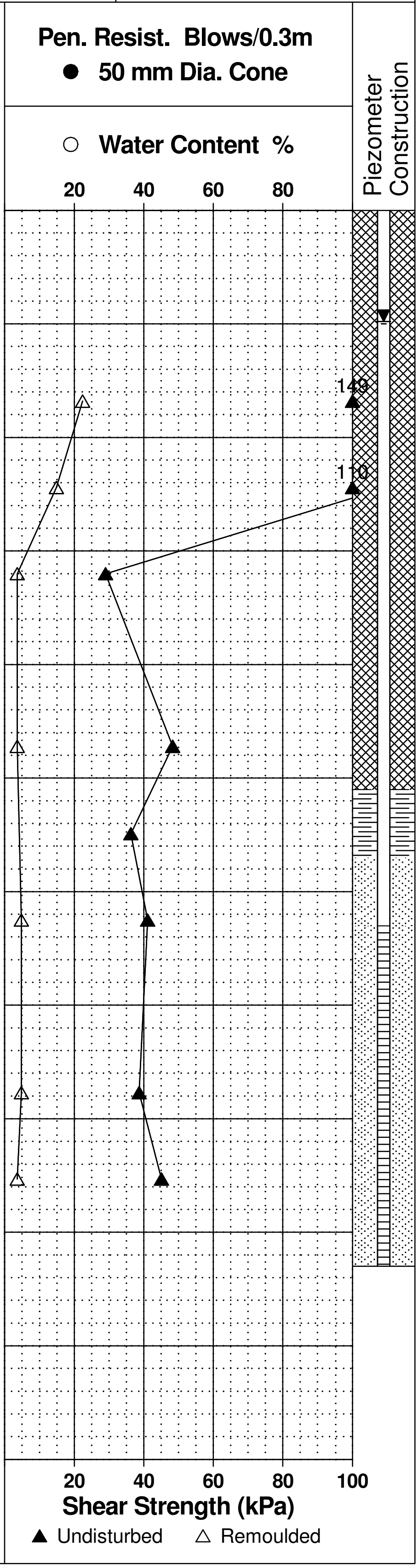
BORINGS BY CME 55 Power Auger

DATE April 26, 2016

SOIL DESCRIPTION	
GROUND SURFACE	
FILL: Brown clayey silt, trace sand and gravel	0.60
Very stiff, brown **SILTY CLAY,** some sand	2.80
Stiff to firm, grey **SILTY CLAY**	8.63
GLACIAL TILL: Grey silty sand, some gravel	9.30
Dynamic Cone Penetration Test commenced at 9.30m depth. Cone pushed to 12.2m depth.	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	100	6
G	3		
TW	4	100	
G	5		
TW	6		
G	7		
SS	8	100	2

DEPTH (m)	ELEV. (m)
0	92.93
1	91.93
2	90.93
3	89.93
4	88.93
5	87.93
6	86.93
7	85.93
8	84.93
9	83.93
10	82.93
11	81.93



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

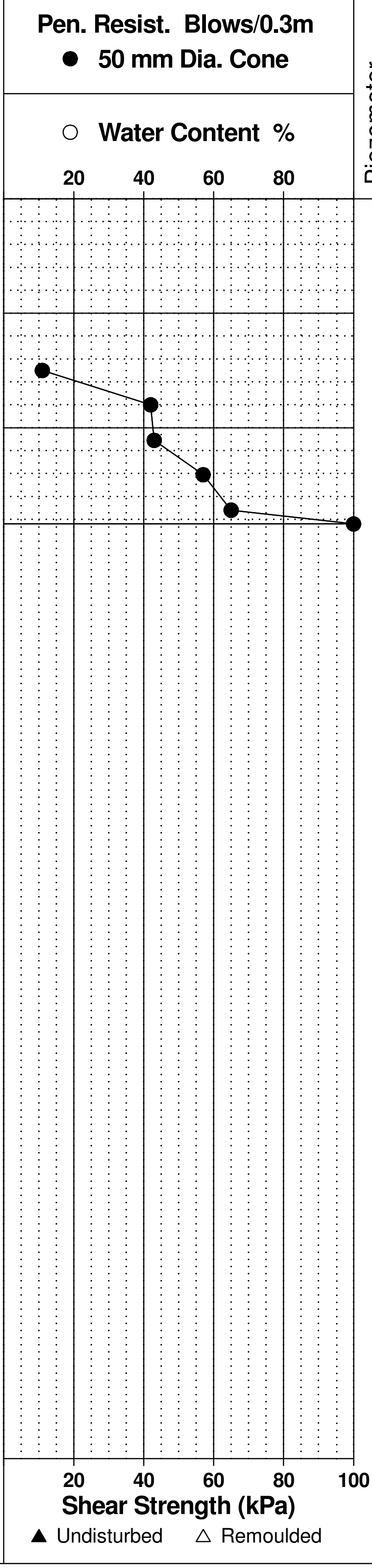
REMARKS

HOLE NO. BH21-16

BORINGS BY CME 55 Power Auger

DATE April 26, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						11	81.93
Inferred compact to dense glacial till						12	80.93
						13	79.93
13.84							
End of Borehole Practical DCPT refusal at 13.84m depth (GWL @ 0.98m-May 12, 2016)							



Piezometer Construction

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 26, 2016

FILE NO. PG1984

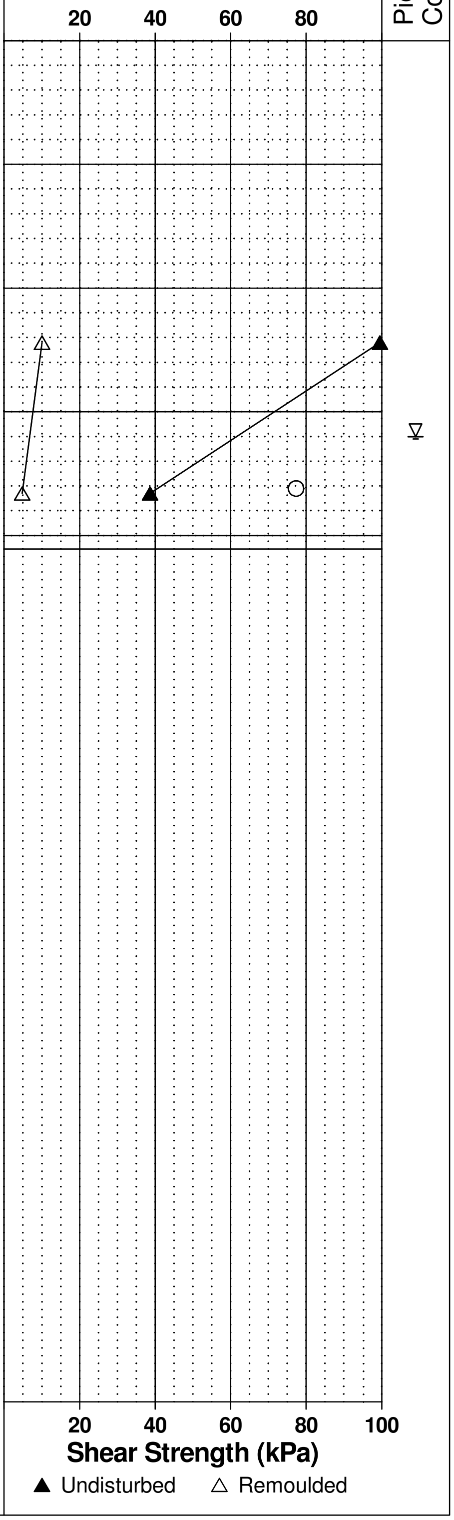
HOLE NO. BH21A-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.93
Inferred **SILTY CLAY**	▨					1	91.93
2.30	▨					2	90.93
Stiff to firm, brown to grey **SILTY CLAY**	▨	TW	1	91		3	89.93
4.11	▨					4	88.93
End of Borehole							

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

○ Water Content %

Piezometer Construction



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

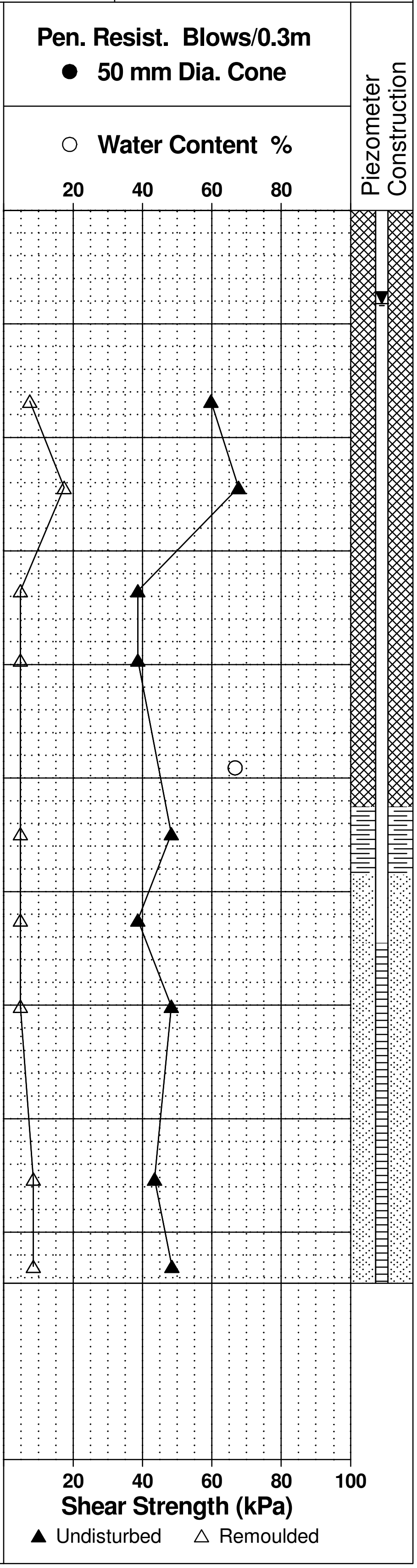
REMARKS

HOLE NO. **BH22-16**

BORINGS BY CME 55 Power Auger

DATE April 26, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	92.56
Stiff, brown **SILTY CLAY,** some sand		AU	1				
		SS	2	100	2	1	91.56
						2	90.56
3.00						3	89.56
Firm, grey **SILTY CLAY**		G	3			4	88.56
		TW	4	100		5	87.56
		G	5			6	86.56
						7	85.56
		TW	6	100		8	84.56
						9	83.56
9.45							
End of Borehole							
(GWL @ 0.82m-May 12, 2016)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. **PG1984**

REMARKS

HOLE NO. **BH23-16**

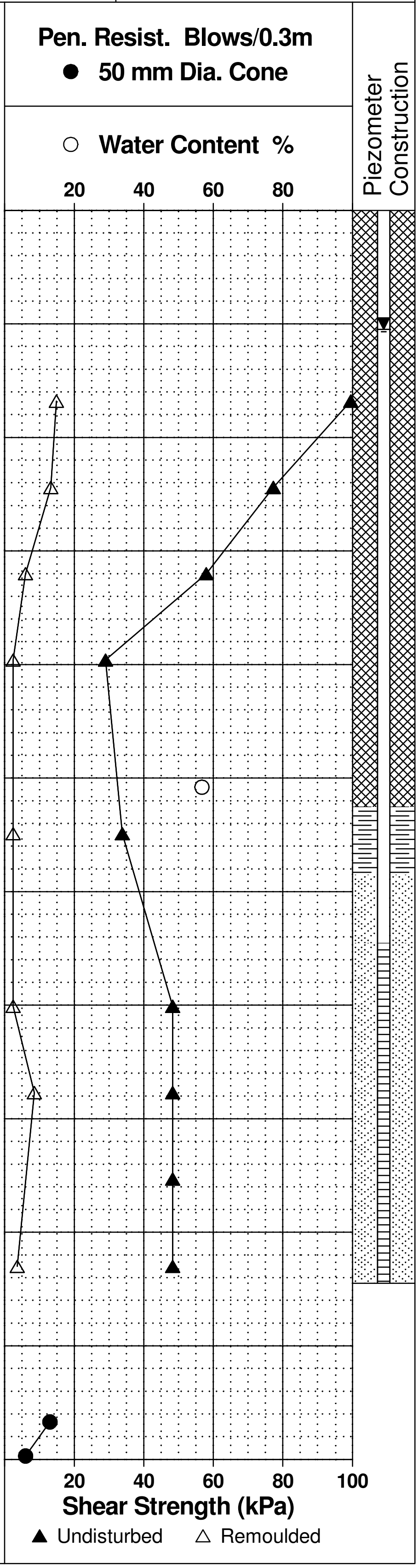
BORINGS BY CME 55 Power Auger

DATE April 28, 2016

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.30
Very stiff to stiff, brown **SILTY CLAY,** some sand	3.40
Stiff to firm, grey **SILTY CLAY**	9.45
Dynamic Cone Penetration Test commenced at 9.45m depth. Cone pushed to 10.4m depth.	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	75	5
G	3		
TW	4	100	
TW	5	100	
G	6		

DEPTH (m)	ELEV. (m)
0	92.29
1	91.29
2	90.29
3	89.29
4	88.29
5	87.29
6	86.29
7	85.29
8	84.29
9	83.29
10	82.29
11	81.29



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development - Clarke Lands
Strandherd Drive, Ottawa, Ontario

DATUM Ground surface elevations provided by J.L. Richards and Associates Ltd.

FILE NO. PG1984

REMARKS

HOLE NO. BH23-16

BORINGS BY CME 55 Power Auger

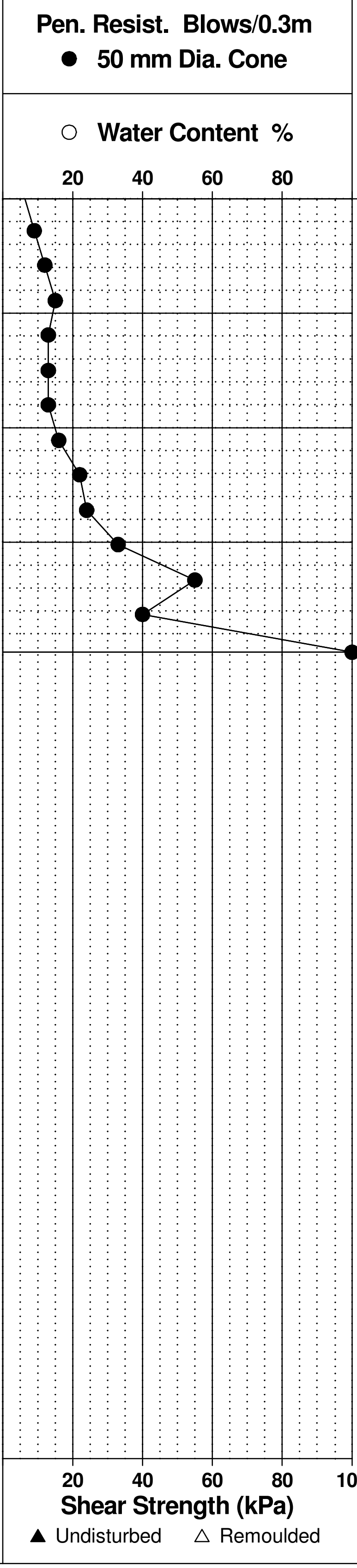
DATE April 28, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
						11	81.29
						12	80.29
Inferred firm to stiff cohesive soil over compact to dense glacial till						13	79.29
						14	78.29
14.96							

End of Borehole

Practical DCPT refusal at 14.96m depth

(GWL @ 1.05m-May 12, 2016)



Piezometer Construction

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Clarke Lands Stage 1 Development
Ottawa, Ontario

DATUM TBM - Cut cross in concrete slab, east side of Kennedy Burnett Drain at Strandherd Drive. Geodetic elevation = 93.941m.

REMARKS

BORINGS BY CME 55 Power Auger

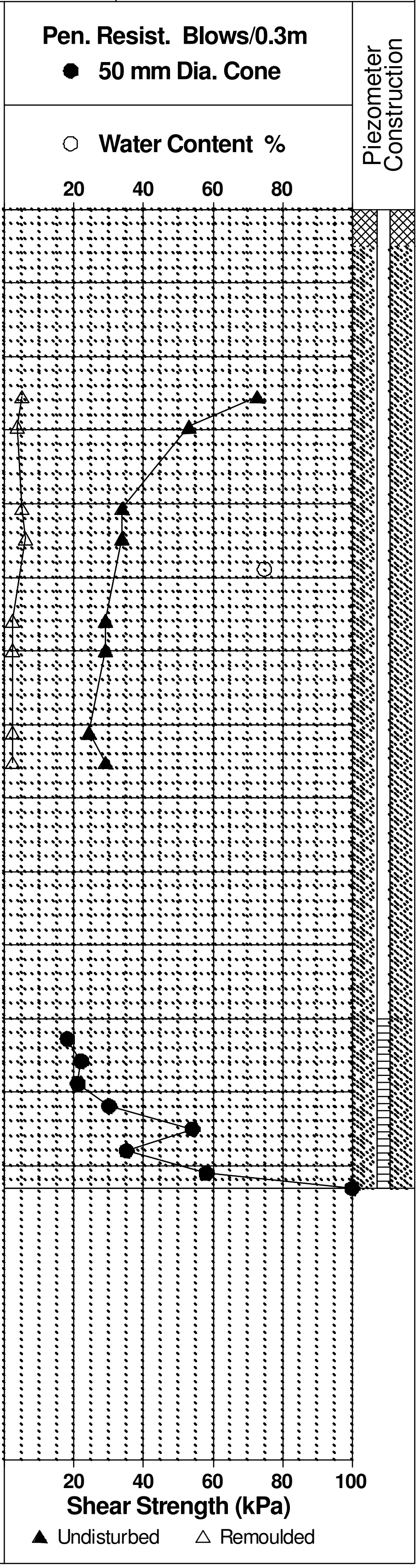
DATE 16 December 2009

FILE NO. **PG1984**

HOLE NO. **BH 1**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE			
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.25		AU	1		
Very stiff, brown to grey **SILTY CLAY**		SS	2	83	2
		SS	3	75	4
3.00					
Firm, grey **SILTY CLAY**		TW	4	88	
		TW	5	88	
		TW	6	88	
		TW	7	88	
8.23					
Dynamic Cone Penetration Test commenced @ 8.23m depth. Cone pushed to 10.4m depth.					
13.31					
End of Borehole Practical DCPT refusal @ 13.31m depth (Piezometer blocked - Jan. 12/10)					

DEPTH (m)	ELEV. (m)
0	93.03
1	92.03
2	91.03
3	90.03
4	89.03
5	88.03
6	87.03
7	86.03
8	85.03
9	84.03
10	83.03
11	82.03
12	81.03
13	80.03



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Clarke Lands Stage 1 Development
Ottawa, Ontario

DATUM TBM - Cut cross in concrete slab, east side of Kennedy Burnett Drain at Strandherd Drive. Geodetic elevation = 93.941m.

REMARKS

BORINGS BY CME 55 Power Auger

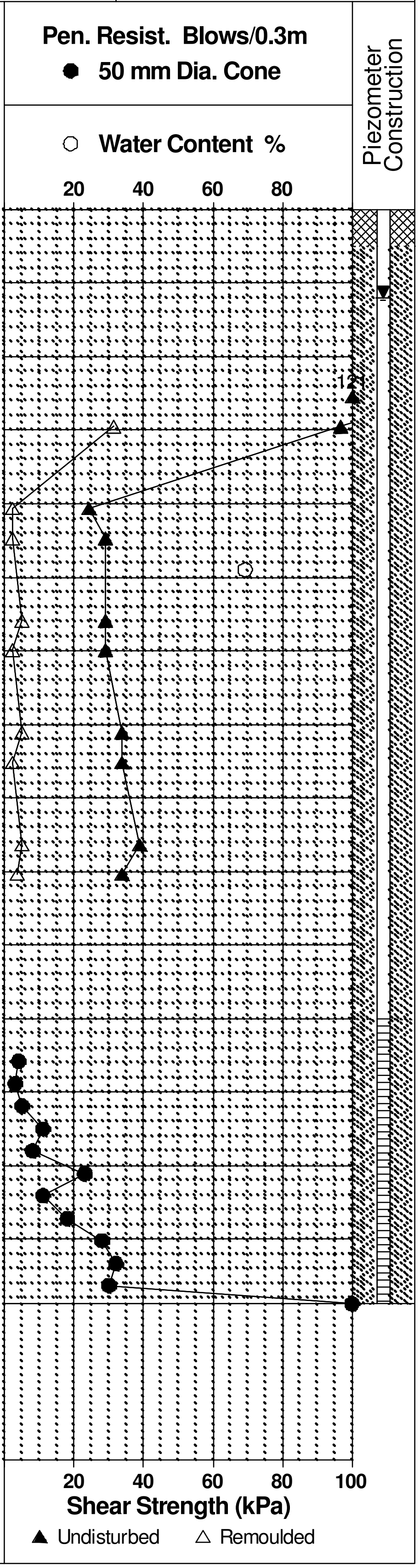
DATE 16 December 2009

FILE NO. PG1984

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.25		AU	1		
Very stiff to stiff, brown to grey **SILTY CLAY**		SS	2	83	3
		SS	3	83	5
3.40		TW	4	88	
Firm, grey **SILTY CLAY**		TW	5	88	
		TW	6	88	
		TW	7	88	
9.04					
Dynamic Cone Penetration Test commenced @ 9.04m depth. Cone pushed to 11.3m depth.					
14.88					
End of Borehole Practical DCPT refusal @ 14.88m depth (GWL @ 1.20m-Jan. 12/10)					

DEPTH (m)	ELEV. (m)
0	92.98
1	91.98
2	90.98
3	89.98
4	88.98
5	87.98
6	86.98
7	85.98
8	84.98
9	83.98
10	82.98
11	81.98
12	80.98
13	79.98
14	78.98



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Clarke Lands Stage 1 Development
Ottawa, Ontario

DATUM TBM - Cut cross in concrete slab, east side of Kennedy Burnett Drain at Strandherd Drive. Geodetic elevation = 93.941m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 16 December 2009

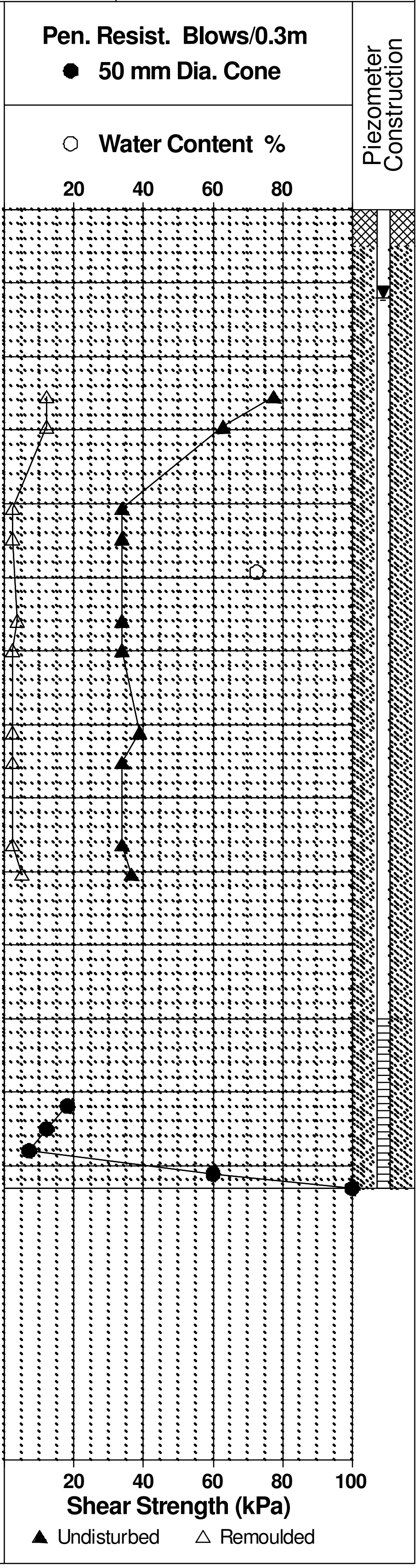
FILE NO. PG1984

HOLE NO. BH 3

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
TOPSOIL	0.30
Very stiff to stiff, brown to grey **SILTY CLAY**	3.20
Firm, grey **SILTY CLAY**	9.04
Dynamic Cone Penetration Test commenced @ 9.04m depth. Cone pushed to 11.9m depth.	13.31
End of Borehole Practical DCPT refusal @ 13.31m depth (GWL @ 1.20m-Jan. 12/10)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	83	2
SS	3	75	3
TW	4	88	
TW	5	88	
TW	6	88	
TW	7	88	

DEPTH (m)	ELEV. (m)
0	92.92
1	91.92
2	90.92
3	89.92
4	88.92
5	87.92
6	86.92
7	85.92
8	84.92
9	83.92
10	82.92
11	81.92
12	80.92
13	79.92



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Clarke Lands Stage 1 Development
Ottawa, Ontario

DATUM TBM - Cut cross in concrete slab, east side of Kennedy Burnett Drain at Strandherd Drive. Geodetic elevation = 93.941m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 17 December 2009

FILE NO. PG1984

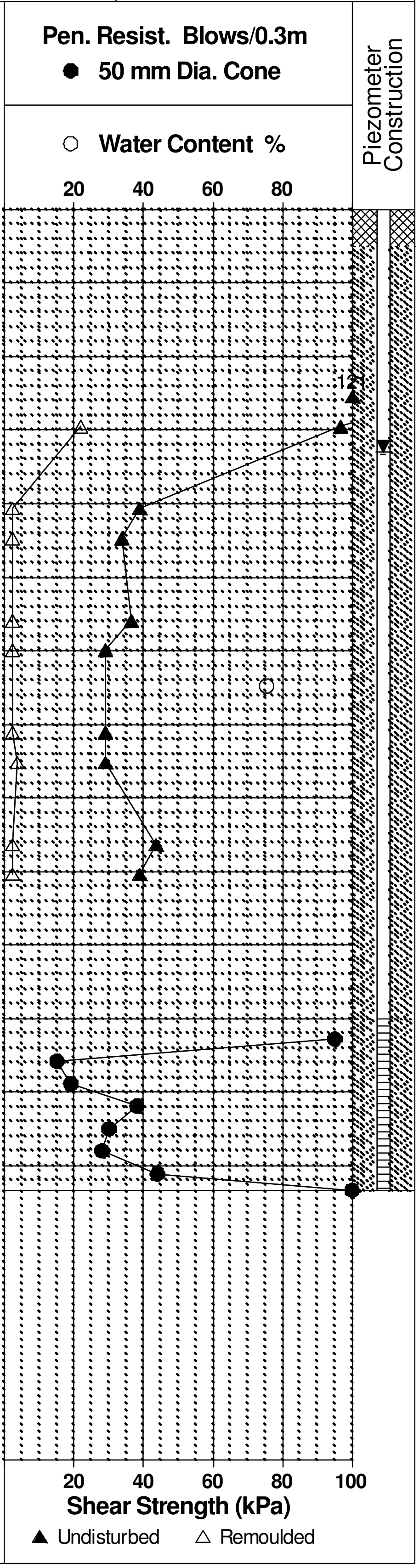
HOLE NO. BH 4

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	92.82
TOPSOIL 0.30	AU	1				
Very stiff to stiff, brown to grey **SILTY CLAY**	SS	2	83	3	1	91.82
	SS	3	100	1	2	90.82
3.40					3	89.82
Firm, grey **SILTY CLAY**	TW	4	88		4	88.82
	TW	5	88		5	87.82
	TW	6	88		6	86.82
					7	85.82
	TW	7	88		8	84.82
9.04					9	83.82
Dynamic Cone Penetration Test commenced @ 9.04m depth. Cone pushed to 11.0m depth.					10	82.82
					11	81.82
					12	80.82
13.34					13	79.82

End of Borehole

Practical DCPT refusal @ 13.34m depth

(GWL @ 3.30m-Jan. 12/10)



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Clarke Lands Stage 1 Development
Ottawa, Ontario

DATUM TBM - Cut cross in concrete slab, east side of Kennedy Burnett Drain at Strandherd Drive. Geodetic elevation = 93.941m.

REMARKS

BORINGS BY CME 55 Power Auger

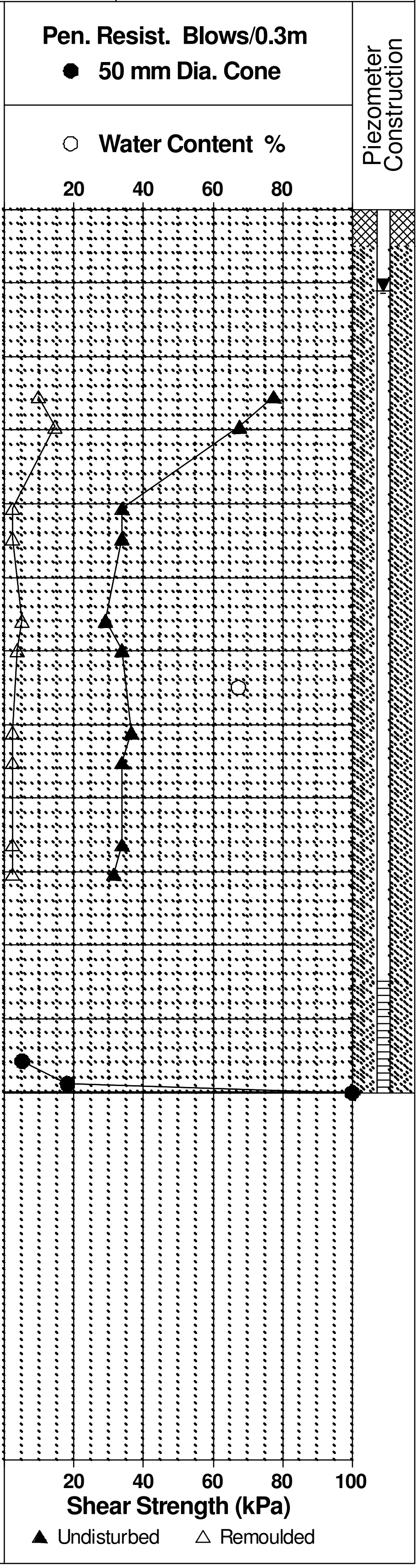
DATE 17 December 2009

FILE NO. PG1984

HOLE NO. BH 5

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.30	AU	1		
Very stiff to stiff, brown to grey **SILTY CLAY**	SS	2	83	4
	SS	3	75	3
3.20				
Firm, grey **SILTY CLAY**	TW	4	88	
	TW	5	88	
	TW	6	88	
	TW	7	88	
9.04				
Dynamic Cone Penetration Test commenced @ 9.04m depth. Cone pushed to 11.3m depth.				
12.01				
End of Borehole Practical DCPT refusal @ 12.01m depth (GWL @ 1.10m-Jan. 12/10)				

DEPTH (m)	ELEV. (m)
0	92.89
1	91.89
2	90.89
3	89.89
4	88.89
5	87.89
6	86.89
7	85.89
8	84.89
9	83.89
10	82.89
11	81.89
12	80.89



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Clarke Lands Stage 1 Development
Ottawa, Ontario

DATUM TBM - Cut cross in concrete slab, east side of Kennedy Burnett Drain at Strandherd Drive. Geodetic elevation = 93.941m.

REMARKS

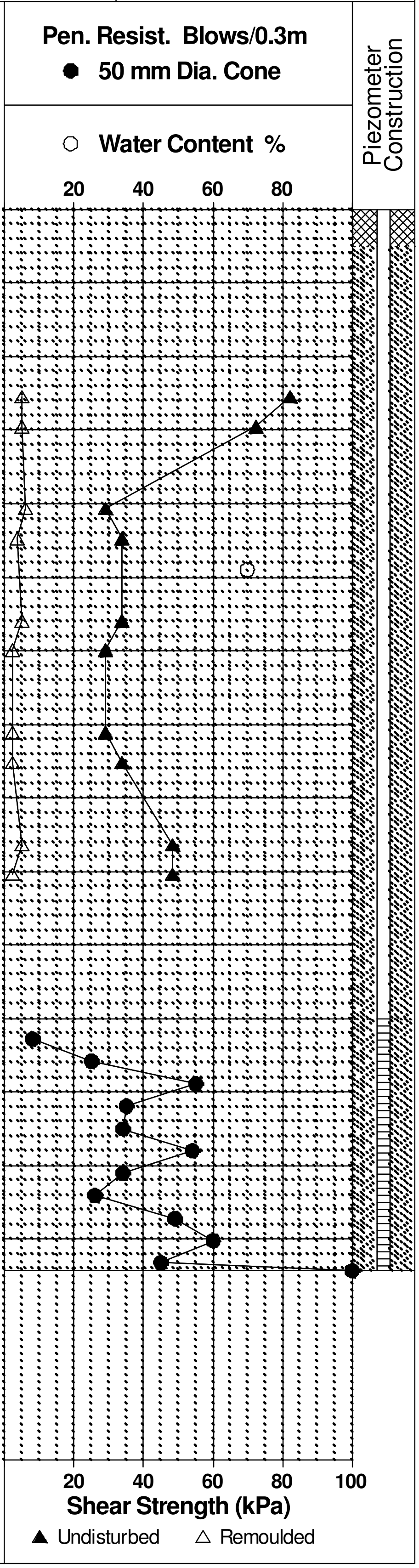
BORINGS BY CME 55 Power Auger

DATE 17 December 2009

FILE NO. PG1984

HOLE NO. BH 6

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	92.66
TOPSOIL 0.30	AU	1				
Very stiff to stiff, brown to grey **SILTY CLAY**	SS	2	83	3	1	91.66
	SS	3	100	4	2	90.66
3.20					3	89.66
Firm, grey **SILTY CLAY**	TW	4	88		4	88.66
	TW	5	88		5	87.66
	TW	6	88		6	86.66
	TW	7	88		7	85.66
					8	84.66
9.04					9	83.66
Dynamic Cone Penetration Test commenced @ 9.04m depth. Cone pushed to 11.0m depth.					10	82.66
					11	81.66
					12	80.66
					13	79.66
					14	78.66
14.43						
End of Borehole Practical DCPT refusal @ 14.43m depth (Piezometer destroyed - Jan. 12/10)						



patersongroup **Consulting Engineers**

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Clarke Lands
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

FILE NO. **PG1984**

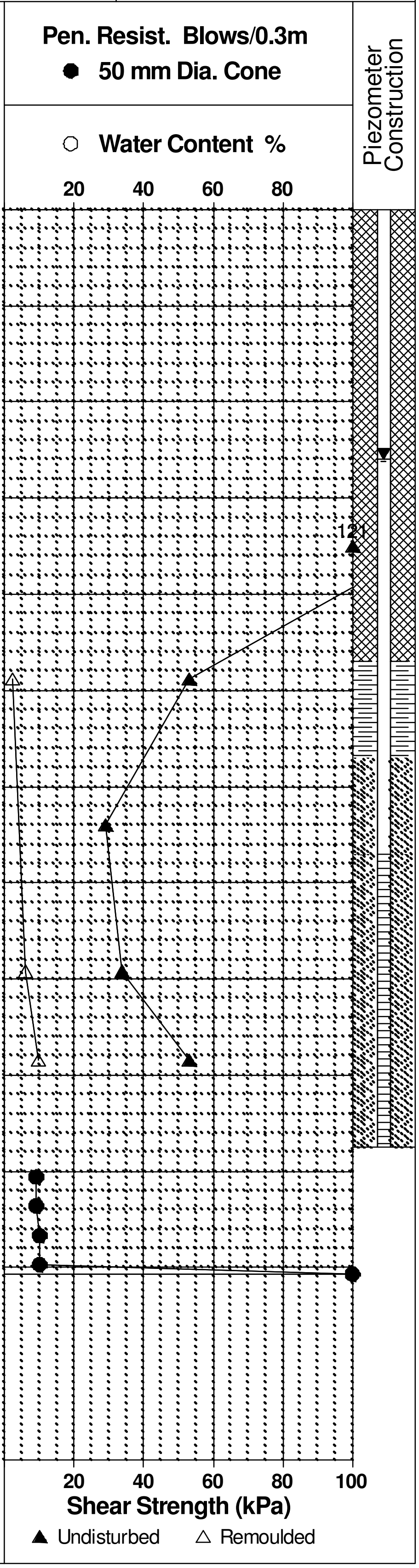
REMARKS

HOLE NO. **BH 7**

BORINGS BY CME 75 Power Auger

DATE 4 February 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.96
FILL: Brown silty sand with gravel, trace clay		SS	1	100	70		
		SS	2	100	11	1	92.96
1.45							
Very stiff to stiff, brown **SILTY CLAY**		SS	3		7	2	91.96
		SS	4		4		
						3	90.96
		SS	5		W	4	89.96
4.80						5	88.96
Firm to stiff, grey **SILTY CLAY**		TW	6			6	87.96
		TW	7			7	86.96
						8	85.96
						9	84.96
9.75		TW	8				
Dynamic Cone Penetration Test commenced @ 9.75m depth						10	83.96
						11	82.96
11.07							
End of Borehole Practical DCPT refusal @ 11.07m depth (GWL @ 2.60m-Feb. 10/11)							



patersongroup Consulting Engineers

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Clarke Lands
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

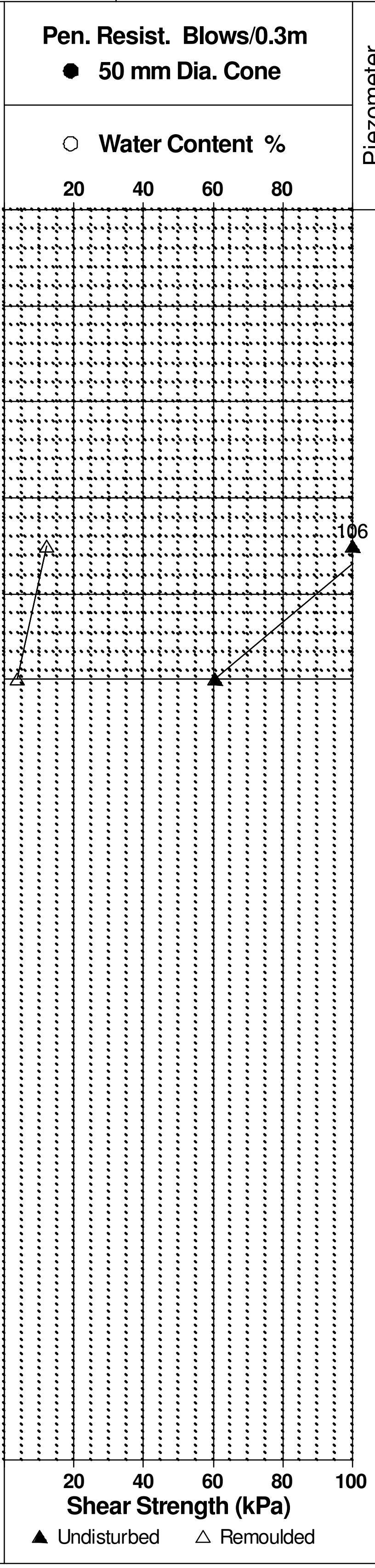
BORINGS BY CME 75 Power Auger

DATE 4 February 2011

FILE NO. PG1984

HOLE NO. BH 7B

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0		
FILL: Brown silty sand with gravel, trace clay						1		
1.45								
Very stiff to stiff, brown **SILTY CLAY**						2 3		
		TW	6			4		
4.88								
End of Borehole								



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Clarke Lands
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 75 Power Auger

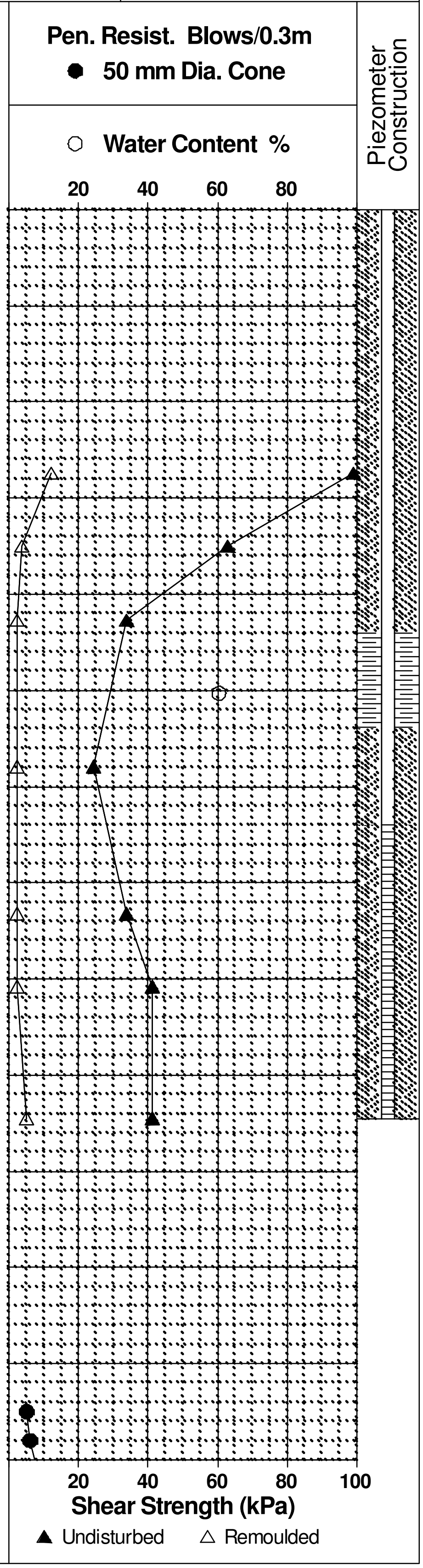
DATE 4 February 2011

FILE NO. PG1984

HOLE NO. BH 8

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Loose to compact, brown **SILTY SAND**	0.60	SS	1	92	30
Very stiff to stiff, brown **SILTY CLAY**	3.60	SS	2	92	7
		SS	3		3
Firm, grey **SILTY CLAY**	9.45	TW	4		
		TW	5		
		TW	6		
Dynamic Cone Penetration Test commenced @ 9.45m depth. Cone pushed to 12.2m depth					

DEPTH (m)	ELEV. (m)
0	92.29
1	91.29
2	90.29
3	89.29
4	88.29
5	87.29
6	86.29
7	85.29
8	84.29
9	83.29
10	82.29
11	81.29
12	80.29
13	79.29



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Clarke Lands
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 75 Power Auger

DATE 4 February 2011

FILE NO. PG1984

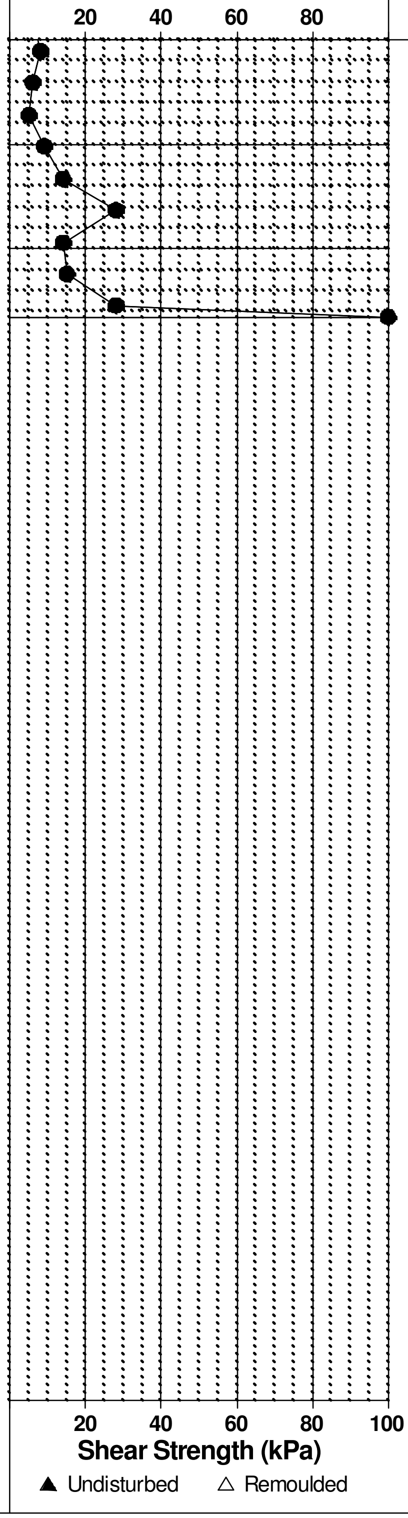
HOLE NO. BH 8

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						13	79.29
						14	78.29
						15	77.29
15.65							
End of Borehole Practical DCPT refusal @ 15.65m depth (Standpipe blocked - Feb. 10/11)							

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

○ Water Content %

Piezometer Construction



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

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Clarke Lands, Cedarview Road at Strandherd Drive
Ottawa (Nepean), Ontario

DATUM Ground surface elevations provided by Stantec Consulting Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 17 NOV 05

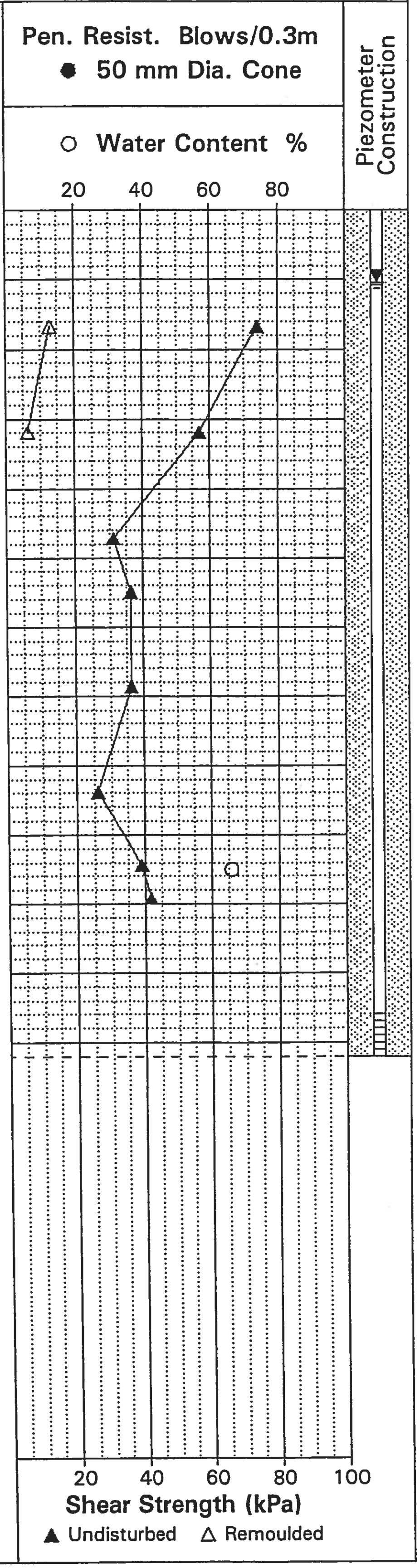
FILE NO. PG0706

HOLE NO. BH6-05

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
TOPSOIL	0.25
Very stiff to stiff, brown **SILTY CLAY** with sand seams - stiff and grey-brown by 1.8m depth - firm and grey by 3.4m depth	11.13
GLACIAL TILL: Loose, grey silty sand with gravel, cobbles and boulders	12.19
End of Borehole (GWL @ 1.04m-Nov. 25/05)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	71	7
SS	2	100	2
SS	3	100	1
TW	4	100	
SS	5	100	1
TW	6	100	
SS	7	100	1
SS	8	92	8

DEPTH (m)	ELEV. (m)
0	92.20
1	91.20
2	90.20
3	89.20
4	88.20
5	87.20
6	86.20
7	85.20
8	84.20
9	83.20
10	82.20
11	81.20
12	80.20



SOIL PROFILE & TEST DATA

Geotechnical Investigation
Clarke Lands, Cedarview Road at Strandherd Drive
Ottawa (Nepean), Ontario

DATUM Ground surface elevations provided by Stantec Consulting Ltd.

REMARKS

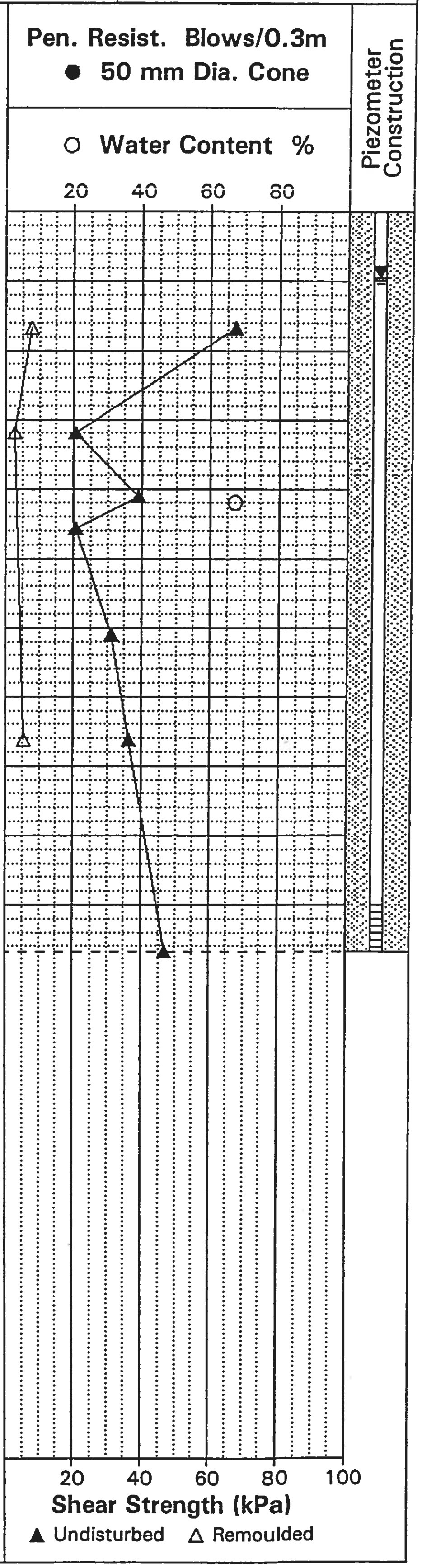
BORINGS BY CME 55 Power Auger

DATE 17 NOV 05

FILE NO. PG0706

HOLE NO. BH7-05

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.13
TOPSOIL 0.25							
Very stiff to stiff, brown **SILTY CLAY** with sand seams		SS	1	75	5	1	92.13
						2	91.13
- firm by 2.2m depth		SS	2	100	2		
- soft and grey by 2.9m depth						3	90.13
		TW	3	95		4	89.13
						5	88.13
		TW	4	94			
- firm by 6.0m depth						6	87.13
		SS	5	100	1	7	86.13
						8	85.13
9.60						9	84.13
GLACIAL TILL: Loose, grey silty sand with gravel, cobbles and boulders 10.67						10	83.13
		SS	6	25	6		
End of Borehole							
(GWL @ 0.94m-Nov. 25/05)							

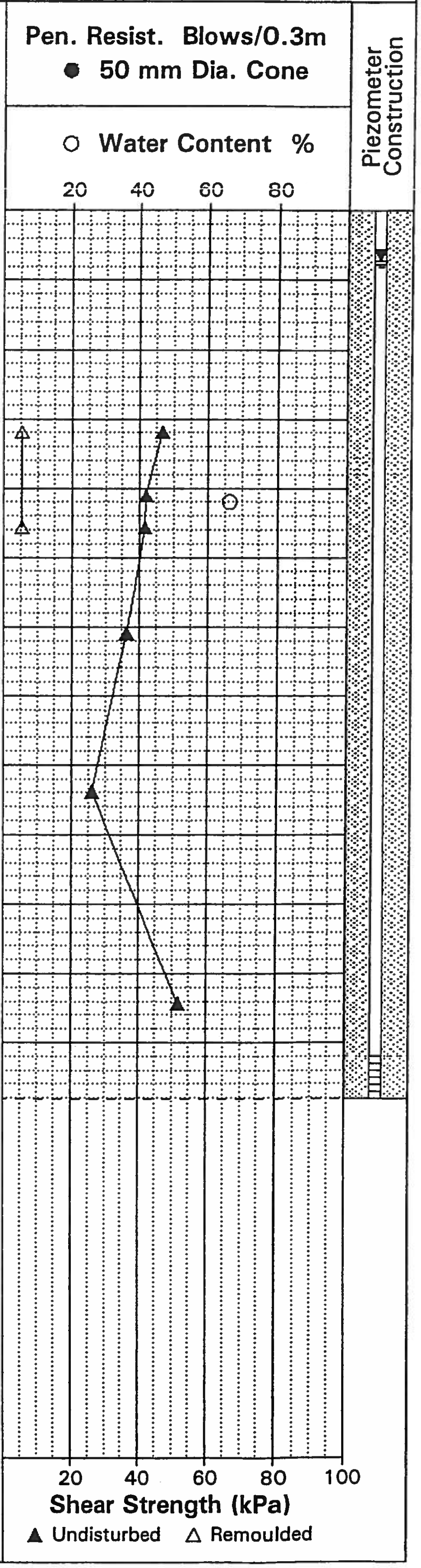


SOIL PROFILE & TEST DATA

Geotechnical Investigation
Clarke Lands, Cedarview Road at Strandherd Drive
Ottawa (Nepean), Ontario

DATUM Ground surface elevations provided by Stantec Consulting Ltd.
REMARKS
BORINGS BY CME 55 Power Auger
DATE 13 OCT 05
FILE NO. PG0706
HOLE NO. BH8-05

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.89
TOPSOIL 0.33							
Loose, brown **SILTY SAND**, trace clay 1.12		SS	1	58	9	1	91.89
Stiff to firm, brown **SILTY CLAY**, trace sand		SS	2	100	2	2	90.89
		SS	3	100	1		
- firm and grey by 2.9m depth						3	89.89
		TW	4	86		4	88.89
						5	87.89
		TW	5	100		6	86.89
		SS	6	100	1	7	85.89
		TW	7	100		8	84.89
						9	83.89
		SS	8	100	1	10	82.89
		TW	9	100		11	81.89
11.60							
GLACIAL TILL: Compact, grey silty sand with gravel, cobbles and boulders 12.80		SS	10	50	21	12	80.89
End of Borehole							
(GWL @ 0.73m-Nov. 25/05)							



patersongroup Consulting Engineers

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

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Clarke Lands, Cedarview Road at Strandherd Drive
Ottawa (Nepean), Ontario

DATUM Ground surface elevations provided by Stantec Consulting Ltd.

REMARKS

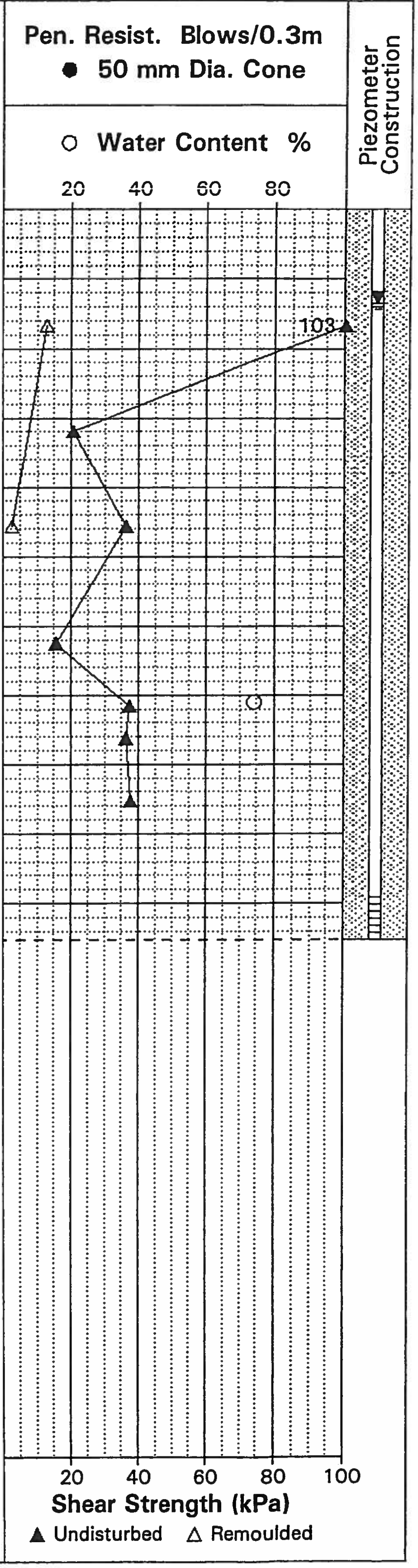
BORINGS BY CME 55 Power Auger

DATE 17 NOV 05

FILE NO. PG0706

HOLE NO. BH9-05

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.14
TOPSOIL 0.25							
Very stiff to stiff, brown **SILTY CLAY** with sand seams		SS	1	75	4	1	92.14
- stiff to firm and brown-grey by 1.8m depth		SS	2	100	1	2	91.14
- soft to firm and grey by 3.0m depth						3	90.14
		TW	3	96		4	89.14
						5	88.14
		SS	4	100	1	6	87.14
		TW	5	96		7	86.14
						8	85.14
9.14						9	84.14
GLACIAL TILL: Very loose, grey silty sand with gravel, cobbles and boulders		SS	6	100	3		
		SS	7	67	2	10	83.14
10.52 End of Borehole							
(GWL @ 1.35m-Nov. 25/05)							



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

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

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

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

ROCK DESCRIPTION

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

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

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

SAMPLE TYPES

SS - Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))

TW - Thin wall tube or Shelby tube

PS - Piston sample

AU - Auger sample or bulk sample

WS - Wash sample

RC - Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC% - Natural moisture content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic limit, % (water content above which soil behaves plastically)
PI - Plasticity index, % (difference between LL and PL)

Dxx - Grain size which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2 / (D10 \times D60)$
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)

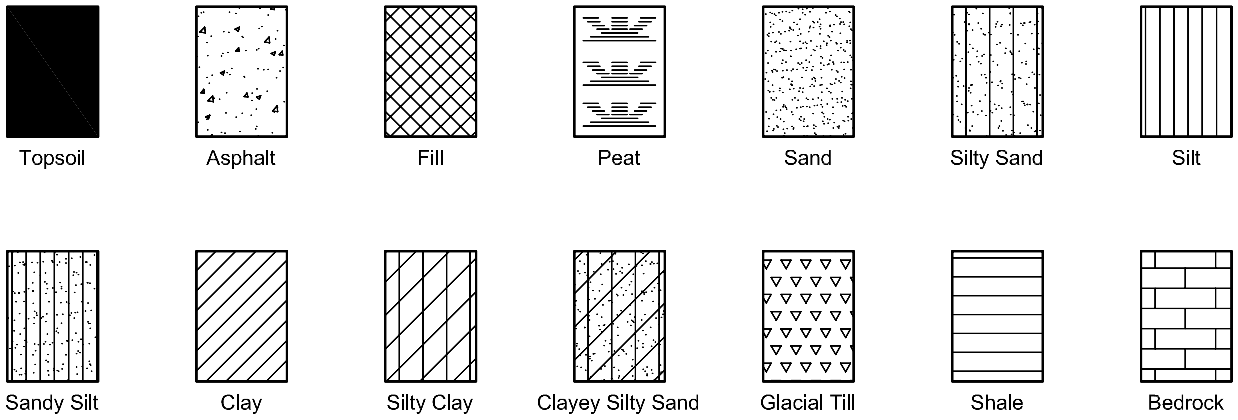
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

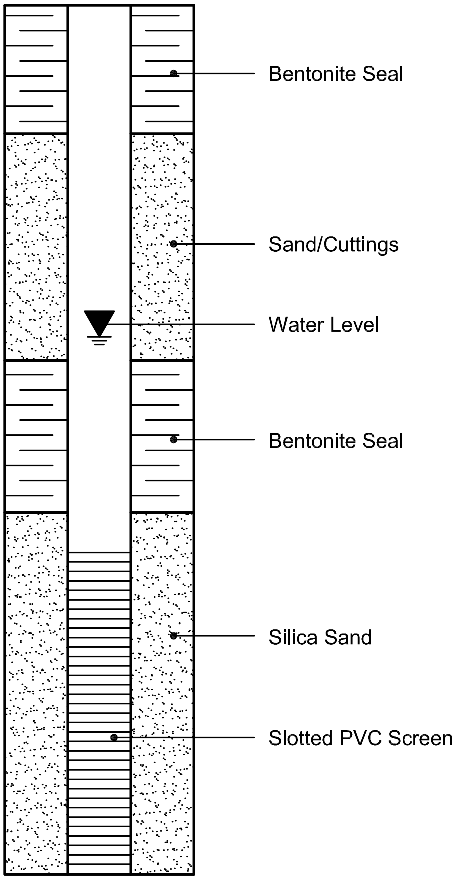
SYMBOLS AND TERMS (continued)

STRATA PLOT

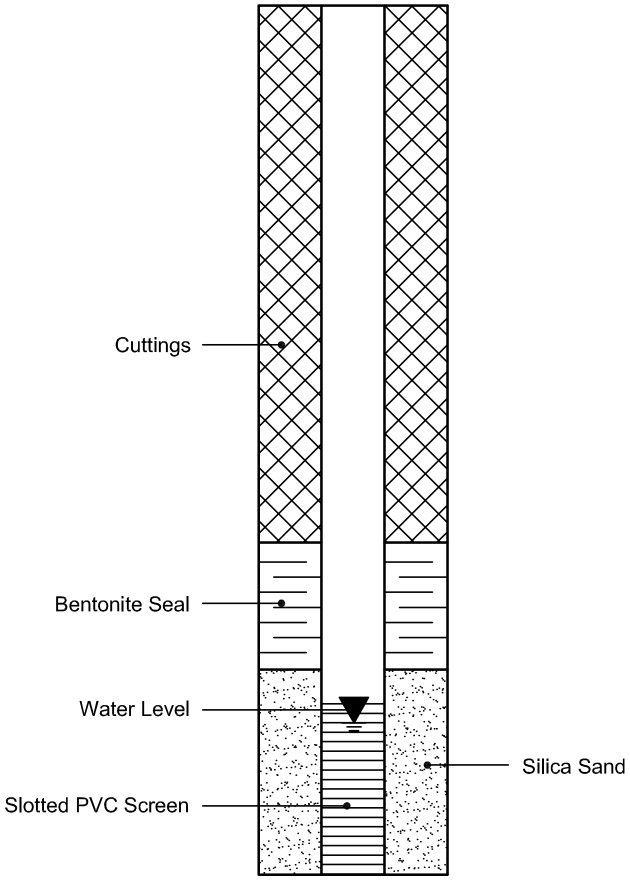


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Report Date: 08-Mar-2011

Client: **Paterson Group Consulting Engineers**

Order Date:2-Mar-2011

Client PO: 10298

Project Description: PG1974

	Client ID:	BH3-SS4	-	-	-
	Sample Date:	01-Feb-11	-	-	-
	Sample ID:	1110097-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	89.9	-	-	-
General Inorganics					
pH	0.05 pH Units	7.03	-	-	-
Resistivity	0.10 Ohm.m	31.0	-	-	-
Anions					
Chloride	5 ug/g dry	41	-	-	-
Sulphate	5 ug/g dry	519	-	-	-

Paracel Laboratories Ltd.

Order #: K2965

Certificate of Analysis

Report Date: 30-Nov-2005
Order Date: 21-Nov-2005

Client: **Paterson Group Inc.**
Client PO: **2874**

Project: **PG0706**

Matrix: Soil

Parameter	Sample ID: Sample Date: MDL/Units	BH-1 SS3 18/11/2005 K2965.1	BH-4 SS2 18/11/2005 K2965.2
Chloride	5 ug/g	310	40
Sulphate	5 ug/g	170	20
pH	0.05 pH units	7.53	7.42
Resistivity	0.1 ohm.m	16	47

APPENDIX 2

Tables 1A and 1B: Summary of Subsurface Information

Tables 2A and 2B: Summary of Consolidation Test Results

Tables 3A and 3B: Summary of Groundwater Levels

Consolidation Test Sheets

Atterberg Limits Results

Figure 2: Shear Strength Profile - Clarke Lands - Stage 1

Figure 3: Seismic Site Class - OBC 2012

TABLE 1A:
SUMMARY OF SUBSURFACE INFORMATION (Page 1 of 2)
CLARKE LANDS - STAGE 1 - CURRENT INVESTIGATION
Strandherd Road at Clarke Fields Drive, Ottawa (Nepean), Ontario

Test Hole Number	**Ground Elevation (m)**	**Interpreted Original Ground Surface**		**Underside of Stiff Clay Crust**		**Inferred Bedrock Surface Level**	
		Depth (m)	**Elevation (m)**	**Depth (m)**	**Elevation (m)**	**Depth (m)**	**Elevation (m)**
Clarke Lands - 2015 Testing Program:							
BH 4-15	91.84	-0.30	92.14	4.20	87.64	15.39	76.45
BH 5-15	93.44	1.12	92.32	4.50	88.94	14.35	79.09
BH 6-15	94.30	1.68	92.62	4.50	89.80	<10.1	<84.2
BH 7-15	94.05	1.68	92.37	5.20	88.85	14.58	79.47
BH 8-15	92.71	-0.30	93.01	3.30	89.41	13.05	79.66
BH 9-15	93.23	0.71	92.52	4.60	88.63	<9.5	<83.7
BH 10-15	94.38	1.88	92.50	4.80	89.58	>9.5	<84.9
BH 11-15	93.88	1.12	92.76	3.80	90.08	>9.5	<84.4
BH 12-15	93.96	1.15	92.81	4.50	89.46	14.58	79.38
Clarke Lands - 2016 Testing Program:							
BH 13-16	93.99	1.53	92.46	5.00	88.99	>9.5	<84.5
BH 14-16	93.49	1.38	92.11	4.50	88.99	15.85	77.64
BH 15-16	93.96	1.50	92.46	5.00	88.96	>9.5	<84.5
BH 16-16	94.89	2.50	92.39	5.20	89.69	15.67	79.22
BH 17-16	94.01	0.77	93.24	4.00	90.01	>9.5	<84.5
BH 18-16	93.45	0.60	92.85	4.00	89.45	14.32	79.13
BH 19-16	94.04	0.77	93.27	4.20	89.84	9.52	84.52
BH 20-16	93.63	0.77	92.86	3.40	90.23	13.77	79.86
BH 21-16	92.93	0.30	92.63	3.00	89.93	13.84	79.09
BH 22-16	92.56	-0.30	92.86	3.00	89.56	>9.5	<83.1
BH 23-16	92.29	0.00	92.29	3.40	88.89	14.96	77.33

Note:
1. Interpreted original ground surface assumed 0.3 m of topsoil above the uppermost inorganic soil surface.
2. Inferred bedrock surface is the depth of practical refusal of the dynamic cone penetration test (DCPT) in all boreholes except for BH 19-16, that encountered practical split spoon sampler refusal. All other boreholes terminated in a silty clay stratum.

TABLE 1B:
SUMMARY OF SUBSURFACE INFORMATION (Page 2 of 2)
CLARKE LANDS - STAGE 1 - PREVIOUS INVESTIGATIONS
Strandherd Road at Clarke Fields Drive, Ottawa (Nepean), Ontario

Test Hole Number	Ground Elevation (m)	Interpreted Original Ground Surface		Underside of Stiff Clay Crust		Inferred Bedrock Surface Level	
		Depth (m)	Elevation (m)	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
Clarke Lands - 2009 Testing Program:							
BH 1-09	93.03	0.00	93.03	3.00	90.03	13.31	79.72
BH 2-09	92.98	0.00	92.98	3.40	89.58	14.88	78.10
BH 3-09	92.92	0.00	92.92	3.20	89.72	13.31	79.61
BH 4-09	92.82	0.00	92.82	3.40	89.42	13.34	79.48
BH 5-09	92.89	0.00	92.89	3.20	89.69	12.01	80.88
BH 6-09	92.66	0.00	92.66	3.20	89.46	14.43	78.23
Clarke Lands - 2011 Testing Program:							
BH 7-11	93.96	1.15	92.81	5.00	88.96	11.07	82.89
BH 8-11	92.29	-0.30	92.59	3.80	88.49	15.65	76.64
Clarke Lands Preliminary - 2005 Testing Program							
BH6-05	92.20	0.00	92.20	3.40	88.80	>12.2	<80.0
BH7-05	93.13	0.00	93.13	2.80	90.33	>10.7	<82.5
BH8-05	92.89	0.00	92.89	2.60	90.29	>12.8	<80.1
BH9-05	93.14	0.00	93.14	2.80	90.34	>10.5	<82.6

Note:
1. Most of these boreholes were put down prior to site development activities, so the ground elevation is also the original ground elevation.
2. Inferred bedrock surface is the depth of practical refusal of the dynamic cone penetration test (DCPT). All the 2005 boreholes terminated in the glacial till stratum, below the base of the silty clay.

TABLE 2A:
SUMMARY OF CONSOLIDATION TEST RESULTS (Page 1 of 2)
CLARKE LANDS STAGE 1 - CURRENT INVESTIGATION
Strandherd Road at Clarke Fields Drive, Ottawa (Nepean), Ontario

Sample No.	Ground Elev. (m)	Depth (m)	Elevation (m)	p'_c (kPa)	p'_o (kPa)	O.C. (kPa)	Ccr	Cc	W.C. (%)	Sample Quality
Clarke Lands - 2015 Testing Program:										
BH4-15-TW4	91.84	5.89	85.95	110	67	43	0.017	0.973	52	A
BH5-15-TW6	93.44	5.64	87.80	114	56	58	0.015	1.105	50	A
BH6-15-TW5	94.30	5.66	88.64	101	53	48	0.020	0.890	45	A
BH7-15-TW5	94.05	5.82	88.23	96	53	43	0.038	1.321	73	A - P
BH8-15-TW3	92.71	4.14	88.57	107	55	52	0.026	1.878	121	A
BH9-15-TW5	93.23	7.34	85.89	117	68	49	0.029	2.966	78	A
BH11-15-TW4	93.88	5.05	88.83	110	54	56	0.020	1.355	73	A
BH12-15-TW6	93.96	7.31	86.65	110	68	42	0.027	2.000	67	A
Clarke Lands - 2016 Testing Program:										
BH13-16-TW6	93.99	5.82	88.17	67	56	11	0.024	0.738	56	D
BH14-16-TW3	93.49	7.01	86.48	87	66	21	0.035	1.101	65	P
BH16-16-TW9	94.89	8.89	86.00	101	71	30	0.019	1.732	70	A
BH17-16-TW6	94.01	6.60	87.41	101	65	36	0.028	2.099	82	A
BH20-16-TW5	93.63	5.07	88.56	104	60	44	0.020	2.261	73	A
BH21-16-TW1	92.93	3.62	89.31	74	51	23	0.027	1.738	77	A
BH22-16-TW4	92.56	4.91	87.65	117	59	58	0.018	1.711	67	A
BH23-16-TW4	92.29	5.08	87.21	137	60	77	0.023	1.366	57	A

Notes:
1. Effective overburden pressure, p'_o, is based on an average crust thickness of 3.0 m, an estimated long-term low groundwater depth of 2.5 m and a mean unit weight for the grey clay of 16.0 kN/m^3. The original ground elevation is used for p'_o estimates.
2. The last column presents the quality assessment of the test sample: A = Acceptable P = Poor (Likely Disturbed) D = Disturbed

TABLE 2B:
SUMMARY OF CONSOLIDATION TEST RESULTS (Part 2 of 2)
CLARKE LANDS - STAGE 1 - PREVIOUS INVESTIGATIONS
Strandherd Road at Clarke Fields Drive, Ottawa (Nepean), Ontario

Sample No.	Ground Elev. (m)	Depth (m)	Elevation (m)	p'_c (kPa)	p'_o (kPa)	O.C. (kPa)	Ccr	Cc	W.C. (%)	Sample Quality
Clarke Lands Stage 1 - 2009 Testing Program:										
BH1-09 - TW5	93.03	4.89	88.14	90	59	31	0.028	2.060	75	A
BH2-09 - TW5	92.98	4.90	88.08	113	59	54	0.023	1.444	69	A
BH3-09 - TW5	92.92	4.93	87.99	105	59	46	0.029	1.150	72	P
BH4-09 - TW6	92.82	6.48	86.34	107	69	38	0.023	2.657	75	A
BH5-09 - TW6	92.89	6.50	86.39	118	69	49	0.018	0.420	67	A
BH6-09 - TW5	92.66	4.90	87.76	101	59	42	0.024	1.443	70	P
Clarke Lands Stage 2 - 2011 Testing Program:										
BH7-11 - TW7	93.96	7.31	86.65	100	65	35	0.016	1.199	61	P
BH8-11 - TW4	92.29	5.03	87.26	107	67	40	0.014	1.076	60	A
BH8-11 - TW5	92.29	6.60	85.69	92	70	22	0.028	1.856	79	P
Clarke Lands Preliminary - 2005 Testing Program										
BH6-05 - TW6	92.20	9.50	82.70	142	82	60	0.015	2.230	66	A
BH7-05 - TW3	93.13	4.20	88.93	93	50	43	0.029	1.210	67	P
BH8-05 - TW4	92.89	4.20	88.69	124	50	74	0.015	1.517	66	A
BH9-05 - TW5	93.14	7.10	86.04	100	68	32	0.018	3.070	74	A

Notes:

1. Effective overburden pressure, p'_o, is based on an average crust thickness of 3.0 m, an estimated long-term low groundwater depth of 2.5 m and a mean unit weight for the grey clay of 16.0 kN/m^3. The original ground elevation is used for p'_o estimates.
2. The last column presents the quality assessment of the test sample: A = Acceptable P = Poor (Likely Disturbed) D = Disturbed

TABLE 3A:
SUMMARY OF GROUNDWATER LEVELS (Page 1 of 2)
CLARKE LANDS - STAGE 1 - CURRENT INVESTIGATION
Strandherd Road at Clarke Fields Drive, Ottawa (Nepean), Ontario

Borehole Number	Ground Elevation (m)	Measured Groundwater Level (m)		Recording Date
		Depth	Elevation	
Clarke Lands - 2015 Testing Program:				
BH 4-15	91.84	1.18	90.66	March 19, 2015
BH 5-15	93.44	3.82	89.62	March 19, 2015
BH 6-15	94.30	2.59	91.71	March 19, 2015
BH 7-15	94.05	2.45	91.60	March 19, 2015
BH 8-15	92.71	1.17	91.54	March 19, 2015
BH 9-15	93.23	Blocked	N/A	March 19, 2015
BH 10-15	94.38	2.40	91.98	March 19, 2015
BH 11-15	93.88	3.00	90.88	March 19, 2015
BH 12-15	93.96	2.24	91.72	March 19, 2015
Clarke Lands - 2016 Testing Program:				
BH 13-16	93.99	2.07	91.92	May 12, 2016
BH 14-16	93.49	1.75	91.74	May 12, 2016
BH 15-16	93.96	1.82	92.14	May 12, 2016
BH 16-16	94.89	3.02	91.87	May 12, 2016
BH 17-16	94.01	2.15	91.86	May 12, 2016
BH 18-16	93.45	1.50	91.95	May 12, 2016
BH 19-16	94.04	1.95	92.09	May 12, 2016
BH 20-16	93.63	1.70	91.93	May 12, 2016
BH 21-16	92.93	0.98	91.95	May 12, 2016
BH 22-16	92.56	0.82	91.74	May 12, 2016
BH 23-16	92.29	1.05	91.24	May 12, 2016

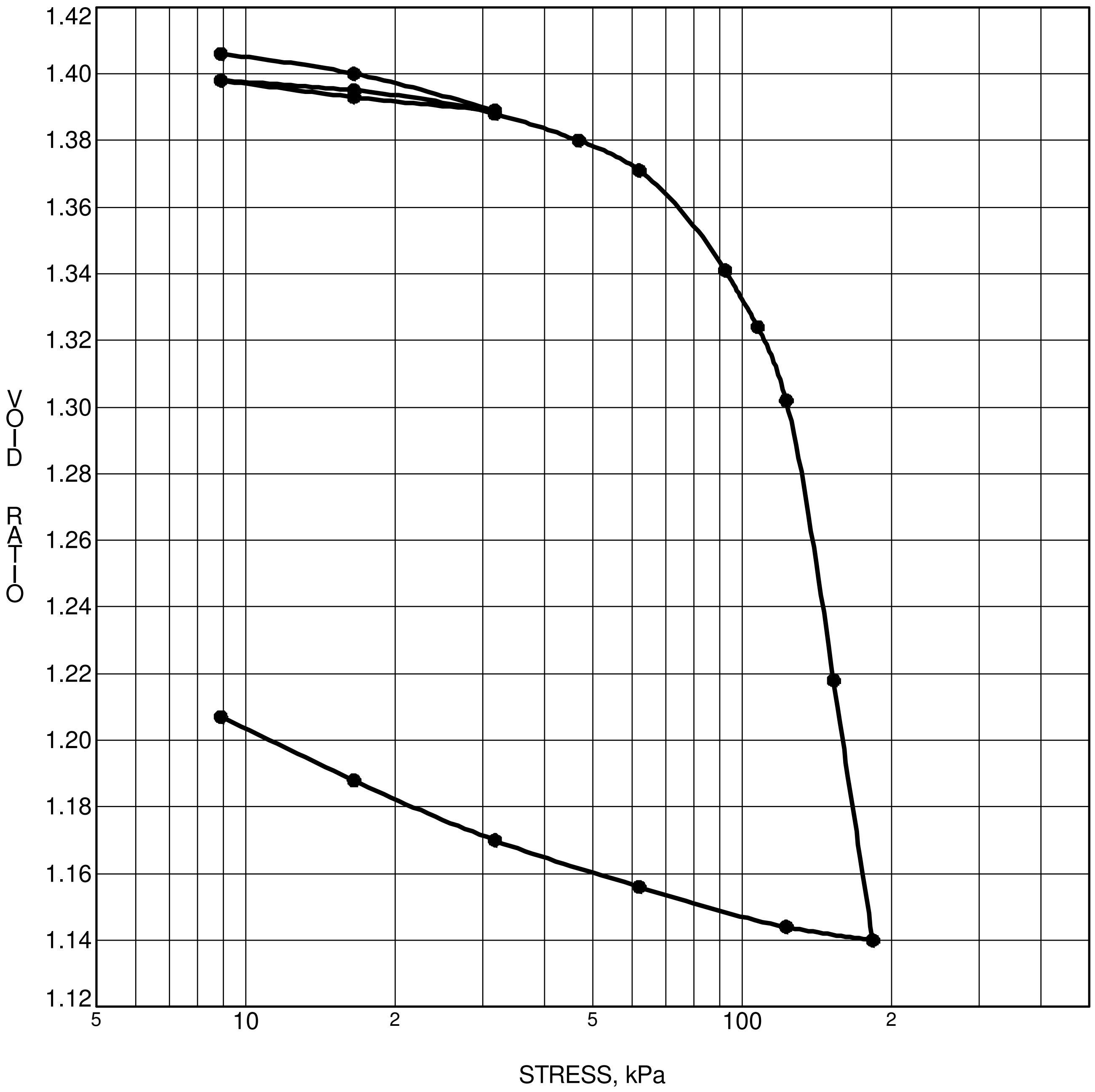
Notes: 1. The reading in BH 5-15 was low, compared to the depth of the base of the stiff clay crust, and is assumed to have not stabilized by the time of reading.

TABLE 3B:
SUMMARY OF GROUNDWATER LEVELS (Page 2 of 2)
CLARKE LANDS - STAGE 1 - PREVIOUS INVESTIGATIONS
Strandherd Road at Clarke Fields Drive, Ottawa (Nepean), Ontario

Borehole Number	Ground Elevation (m)	Measured Groundwater Level (m)		Recording Date
		Depth	Elevation	
Clarke Lands Stage 1 - 2009 Testing Program:				
BH 2-09	92.98	1.20	91.78	January 12, 2010
BH 3-09	92.92	1.20	91.72	January 12, 2010
BH 4-09	92.82	3.30	89.52	January 12, 2010
BH 5-09	92.89	1.10	91.79	January 12, 2010
Clarke Lands Stage 2 - 2011 Testing Program:				
BH 7-11	93.96	2.60	91.36	February 10, 2011
Clarke Lands Preliminary - 2005 Testing Program				
BH7-05	93.13	0.94	92.19	November 25, 2005
BH8-05	92.89	0.73	92.16	November 25, 2005
BH9-05	93.14	1.35	91.79	November 25, 2005

Notes:

1. The standpipe installations in several boreholes, that have not been recorded above, were dry and assumed to be blocked.
2. The reading in BH 4 was low, compared to the depth of the base of the stiff clay crust, and is assumed to have not stabilized by the time of reading.



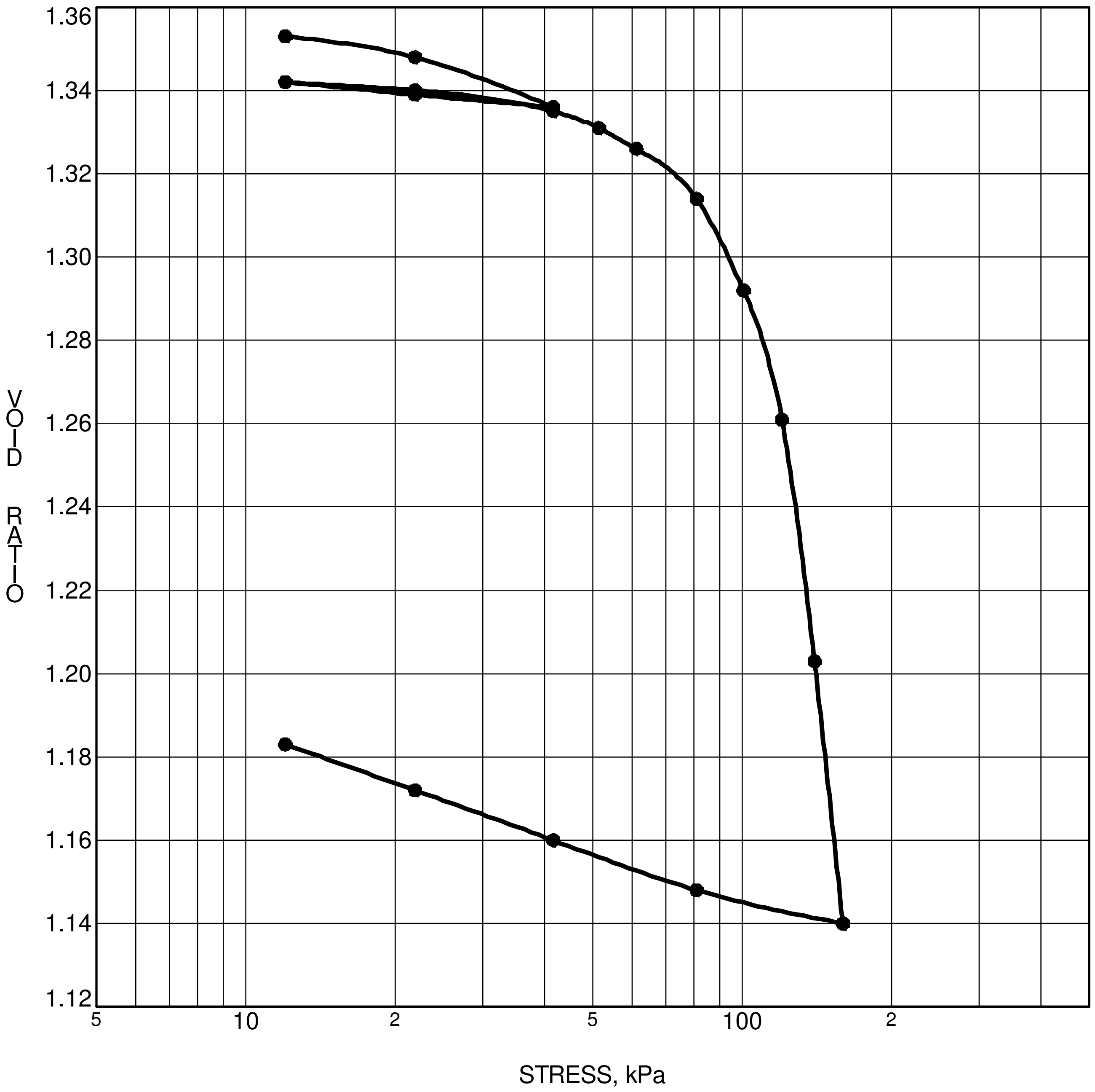
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 4-15**	p'_o	**67** kPa	Ccr	**0.017**
Sample No.	**TW 4**	p'_c	**110** kPa	Cc	**0.973**
Sample Depth	**5.89** m	OC Ratio	**1.6**	Wo	**51.5** %
Sample Elev.	**85.95** m	Void Ratio	**1.416**	Unit Wt.	**17.0** kN/m ^{3}

CLIENT	**Minto Communities Inc.**	FILE NO.	**PG1984**
PROJECT	**Geotechnical Investigation - Prop. Residential Development - Clarke & Mion Lands**	DATE	**12/03/2015**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 5-15**	p'$_o$	**56** kPa	Ccr	**0.015**
Sample No.	**TW 6**	p'$_c$	**114** kPa	Cc	**1.105**
Sample Depth	**5.64** m	OC Ratio	**2.0**	Wo	**49.7** %
Sample Elev.	**87.80** m	Void Ratio	**1.366**	Unit Wt.	**17.0** kN/m ^{3}

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke & Mion Lands**

DATE **19/03/2015**

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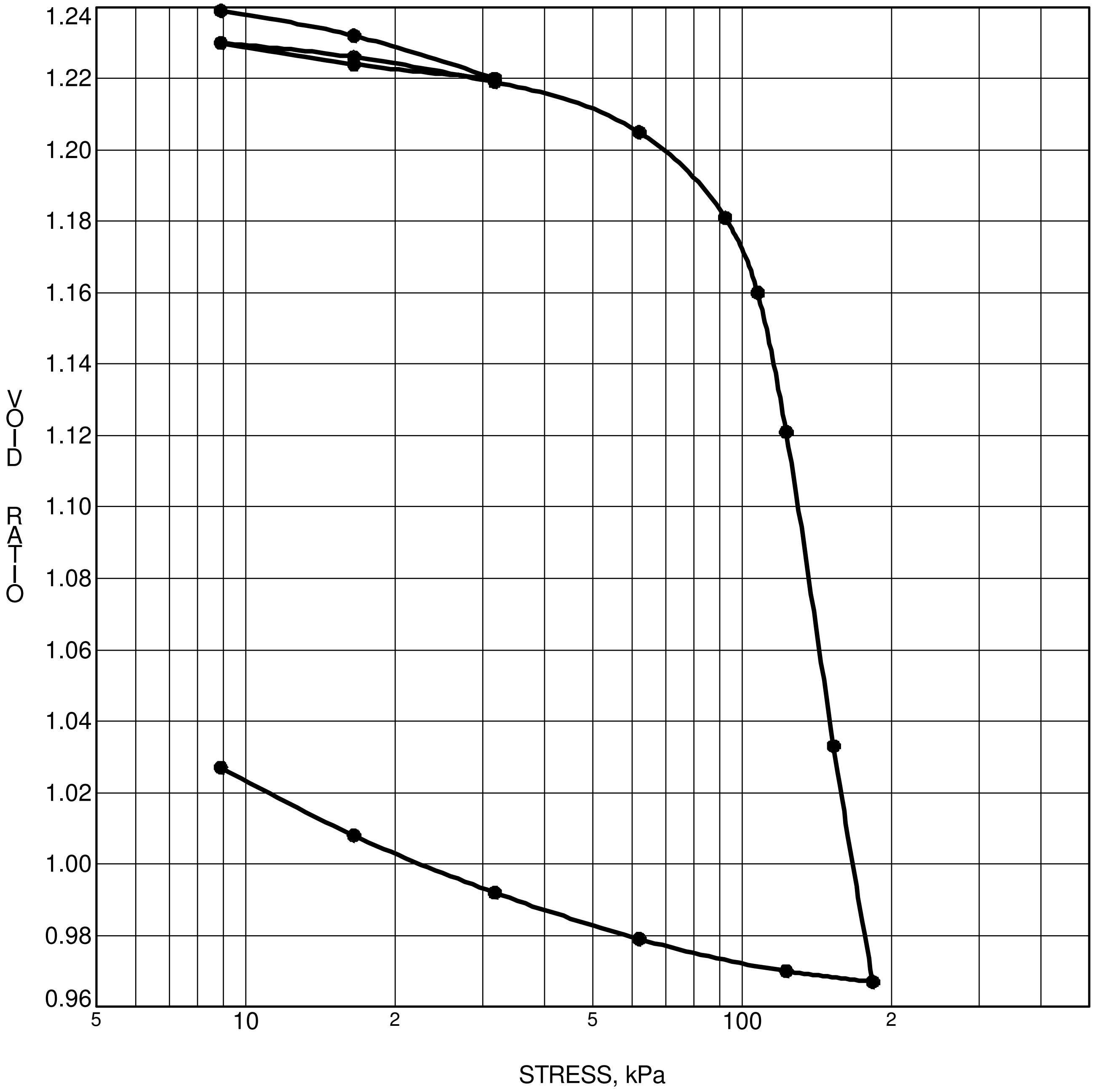
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 6-15**	p'_o	**53** kPa	Ccr	**0.020**
Sample No.	**TW 5**	p'_c	**101** kPa	Cc	**0.890**
Sample Depth	**5.66** m	OC Ratio	**1.9**	Wo	**45.1** %
Sample Elev.	**88.64** m	Void Ratio	**1.24**	Unit Wt.	**17.4** kN/m^3

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke & Mion Lands**

DATE **19/03/2015**

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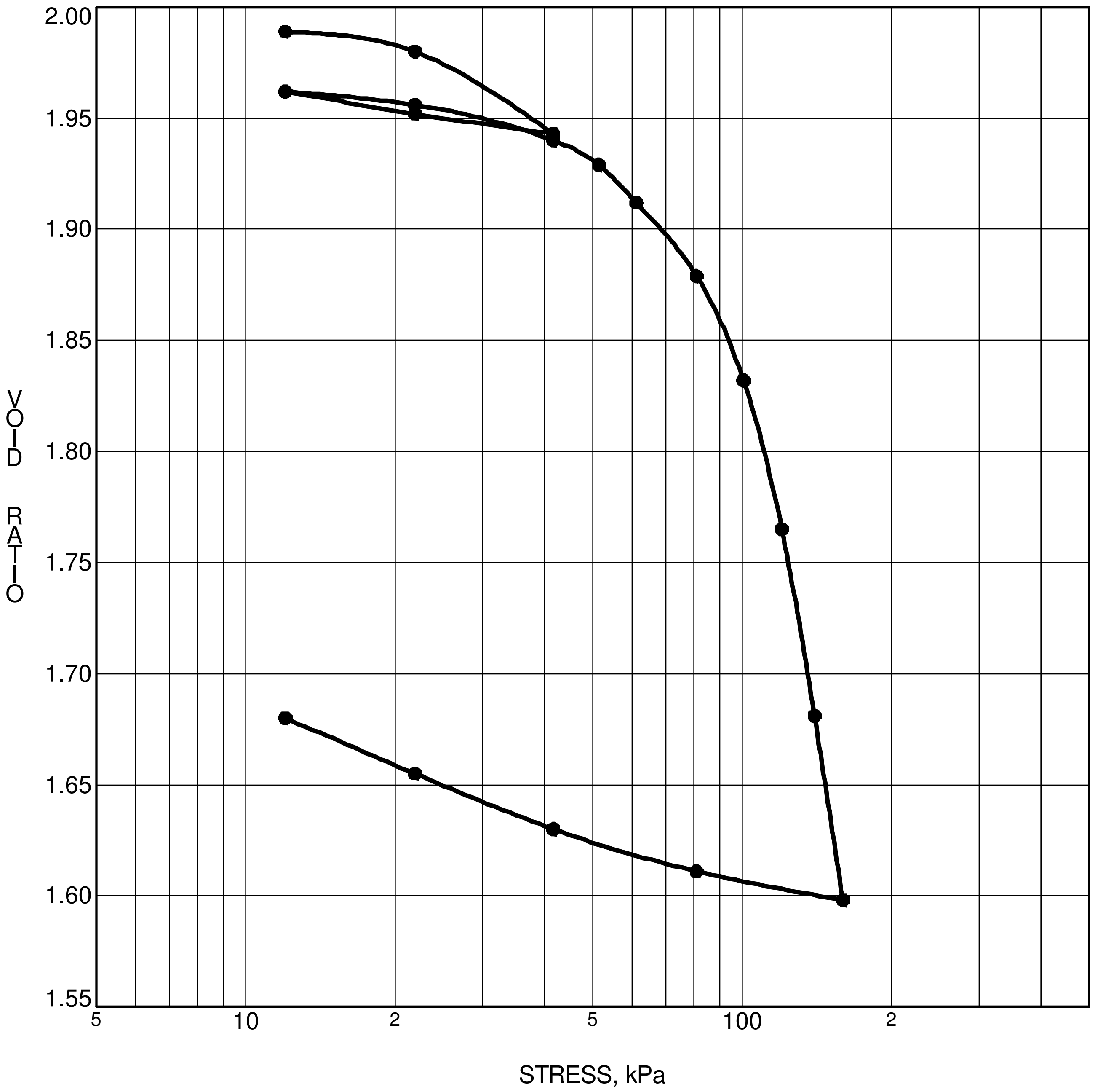
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 7-15**	p'_o	**53** kPa	Ccr	**0.038**
Sample No.	**TW 5**	p'_c	**96** kPa	Cc	**1.321**
Sample Depth	**5.82** m	OC Ratio	**1.8**	Wo	**73.4** %
Sample Elev.	**88.23** m	Void Ratio	**2.02**	Unit Wt.	**15.5** kN/m ^{3}

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PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke & Mion Lands**

FILE NO. **PG1984**

DATE **06/04/2015**

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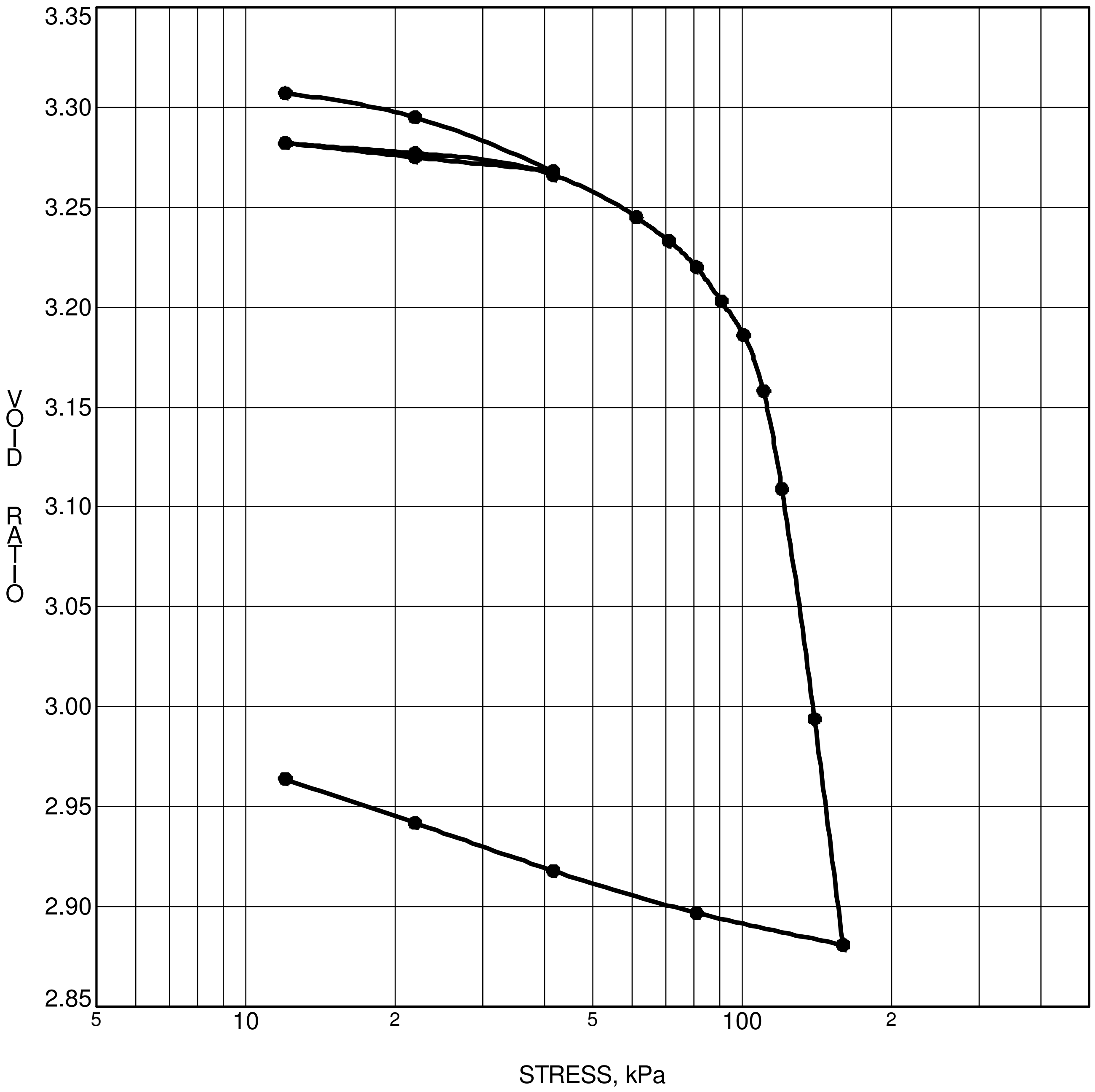

CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 8-15**	p'o	**55** kPa	Ccr	**0.026**
Sample No.	**TW 3**	p'c	**107** kPa	Cc	**1.878**
Sample Depth	**4.14** m	OC Ratio	**1.9**	Wo	**121.5**%
Sample Elev.	**88.57** m	Void Ratio	**3.34**	Unit Wt.	**16.7** kN/m ^{3}

CLIENT	**Minto Communities Inc.**	FILE NO.	**PG1984**
PROJECT	**Geotechnical Investigation - Prop. Residential Development - Clarke & Mion Lands**	DATE	**26/03/2015**

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

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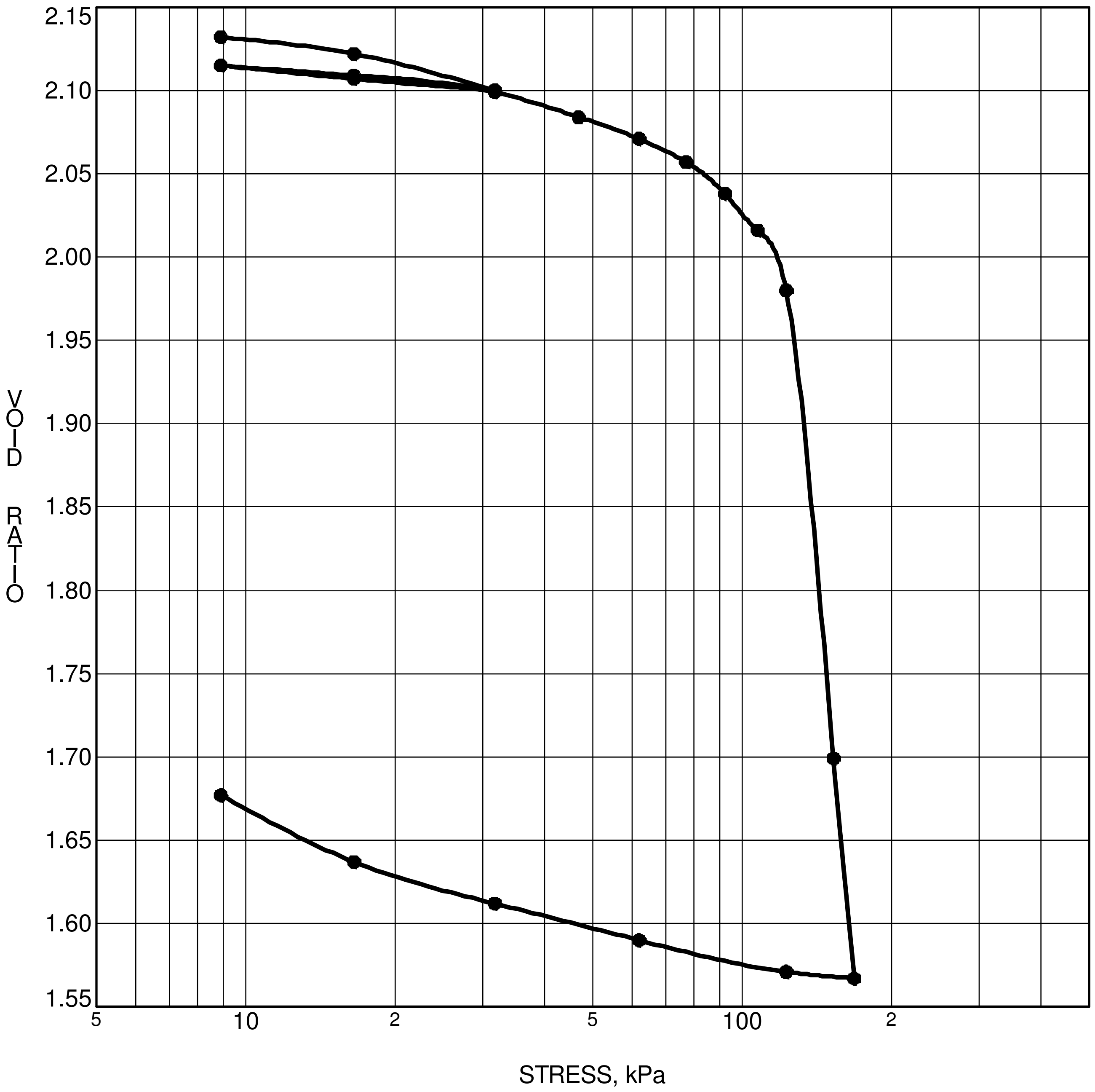

CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 9-15**	p'$_o$	**68** kPa	Ccr	**0.029**
Sample No.	**TW 5**	p'$_c$	**117** kPa	Cc	**2.966**
Sample Depth	**7.34** m	OC Ratio	**1.7**	Wo	**77.6** %
Sample Elev.	**85.89** m	Void Ratio	**2.134**	Unit Wt.	**15.3** kN/m ^{3}

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke & Mion Lands**

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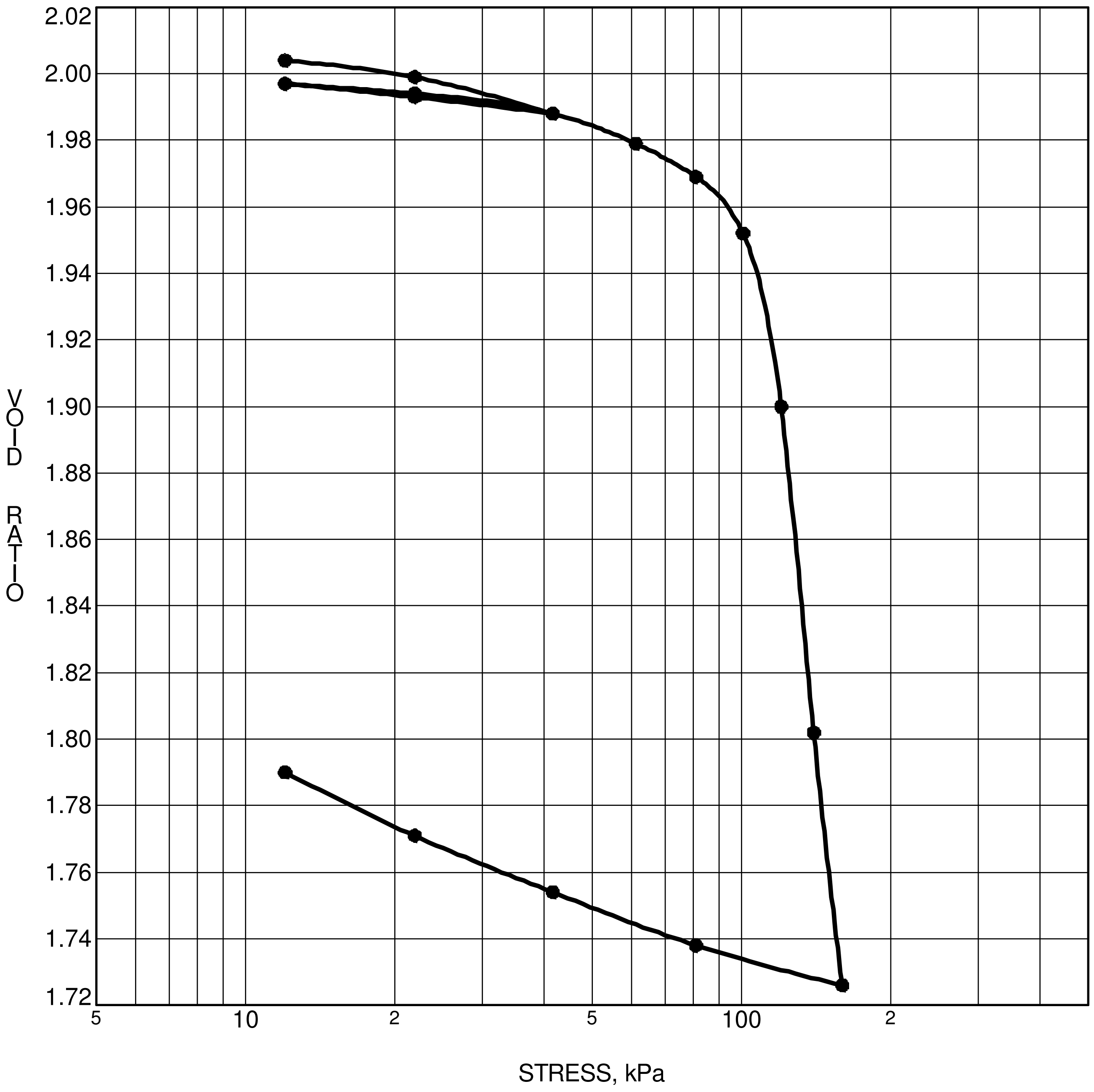

CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH11-15**	p'$_o$	**54** kPa	Ccr	**0.020**
Sample No.	**TW 4**	p'$_c$	**110** kPa	Cc	**1.355**
Sample Depth	**5.05** m	OC Ratio	**2.0**	Wo	**73.3** %
Sample Elev.	**88.83** m	Void Ratio	**2.016**	Unit Wt.	**16.0** kN/m^3

CLIENT **Minto Communities Inc.**

PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke & Mion Lands**

FILE NO. **PG1984**

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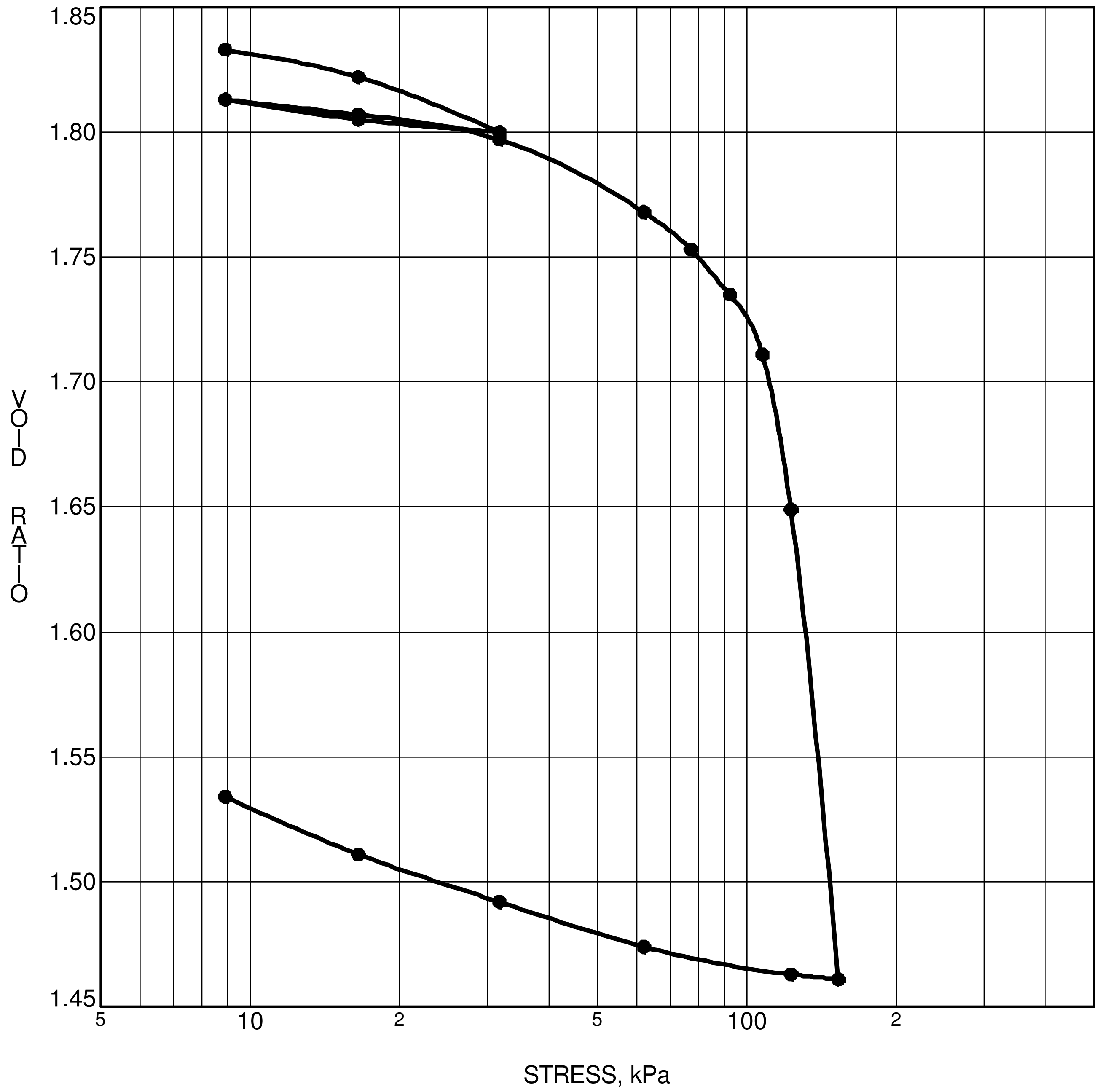
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY

Borehole No.	**BH12-15**	p'_o	**68** kPa	Ccr	**0.027**
Sample No.	**TW 6**	p'_c	**110** kPa	Cc	**2.000**
Sample Depth	**7.31** m	OC Ratio	**1.6**	Wo	**66.8** %
Sample Elev.	**86.65** m	Void Ratio	**1.836**	Unit Wt.	**15.8** kN/m^3

CLIENT	**Minto Communities Inc.**	FILE NO.	**PG1984**
PROJECT	**Geotechnical Investigation - Prop. Residential Development - Clarke & Mion Lands**	DATE	**23/03/2013**

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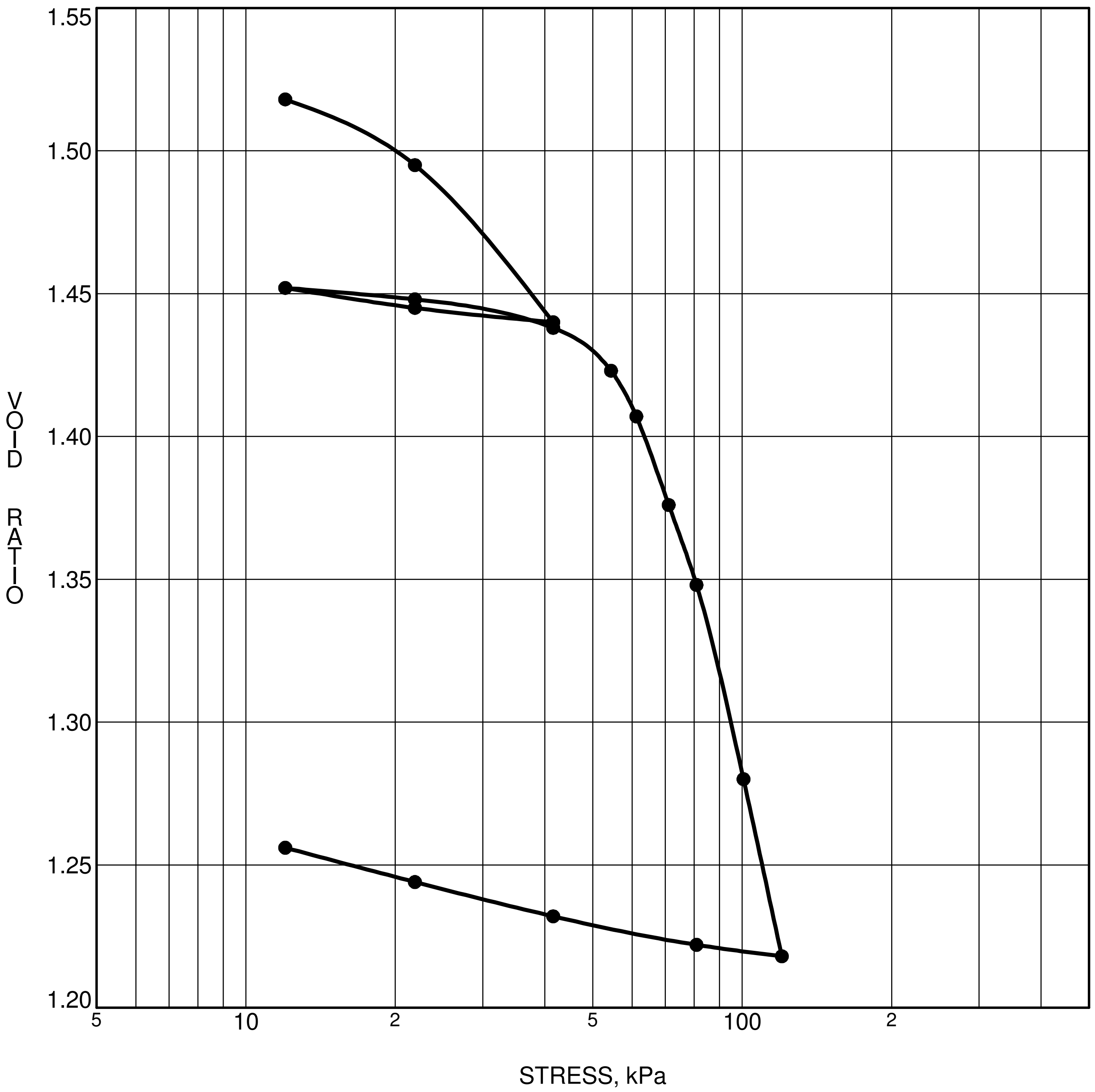
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH13-16**	p'o	**56** kPa	Ccr	**0.024**
Sample No.	**TW 6**	p'c	**67** kPa	Cc	**0.738**
Sample Depth	**5.82** m	OC Ratio	**1.2**	Wo	**56.0** %
Sample Elev.	**88.17** m	Void Ratio	**1.54**	Unit Wt.	**16.6** kN/m^3

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke Lands**

DATE **29/04/2016**

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

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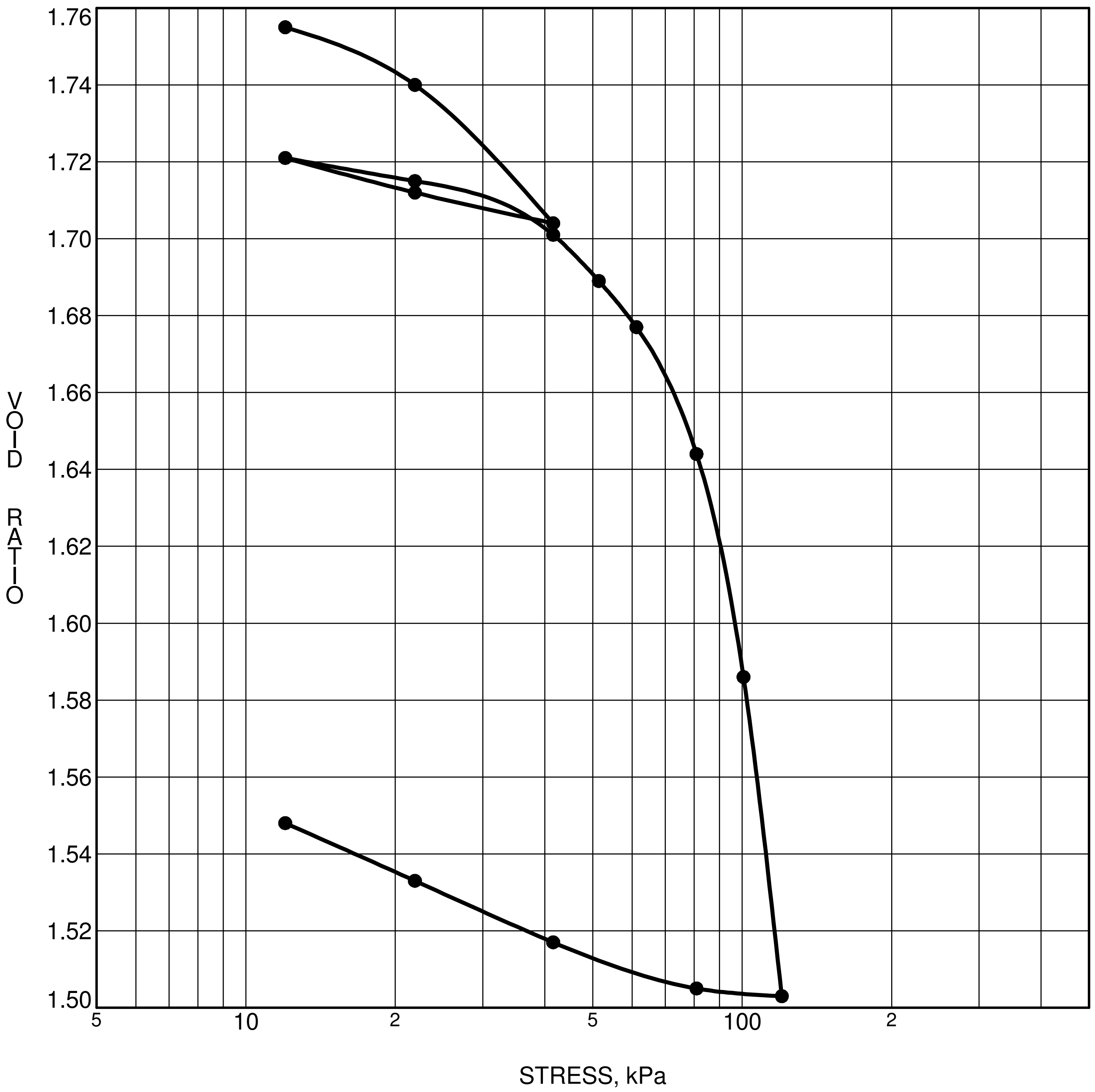

CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH14A-16**	p'o	**66** kPa	Ccr	**0.035**
Sample No.	**TW 3**	p'c	**87** kPa	Cc	**1.101**
Sample Depth	**7.01** m	OC Ratio	**1.3**	Wo	**64.7** %
Sample Elev.	**86.48** m	Void Ratio	**1.78**	Unit Wt.	**16.0** kN/m^3

CLIENT **Minto Communities Inc.**
PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke Lands**

FILE NO. **PG1984**
DATE **13/05/2016**

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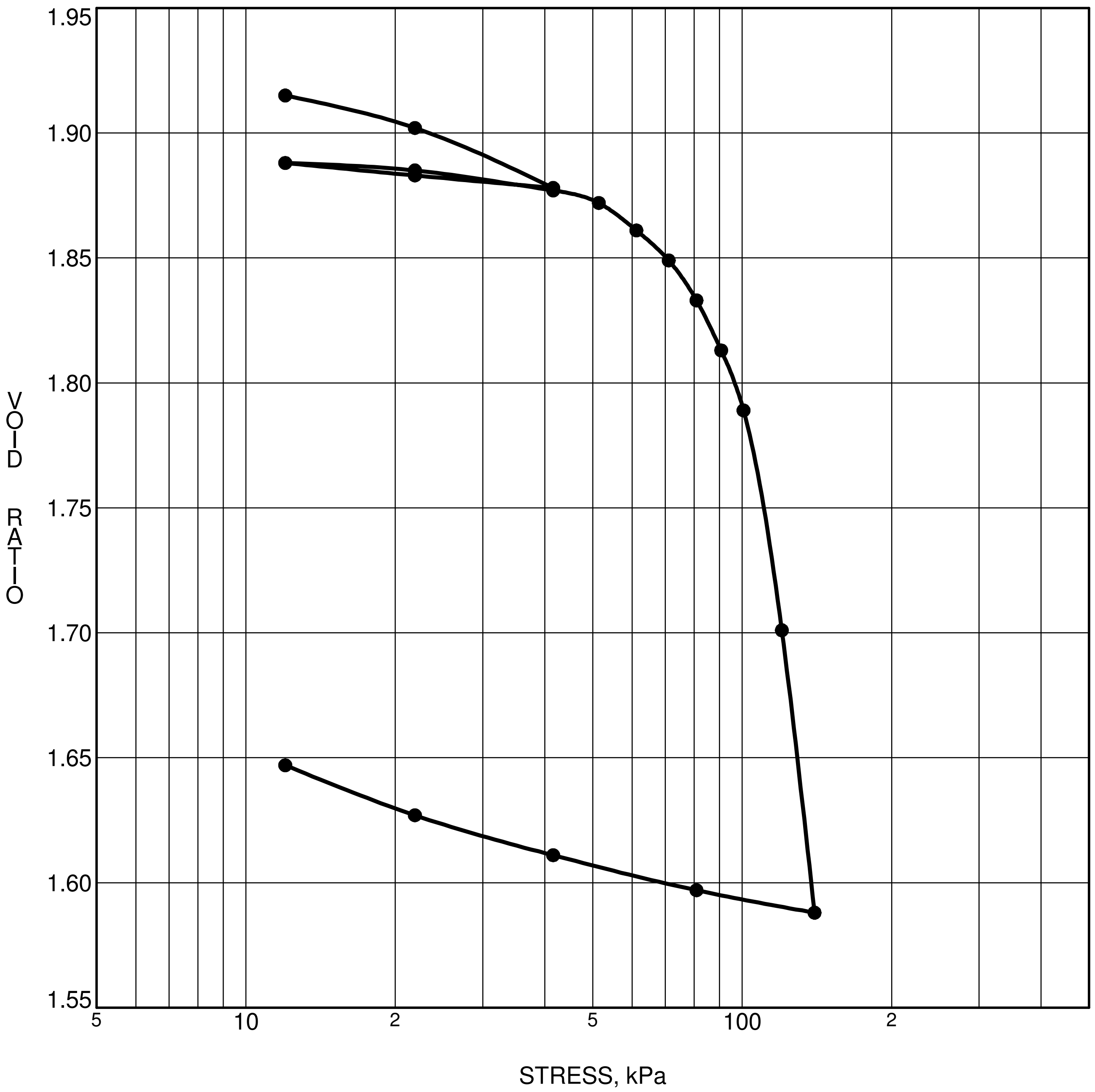
CONSOLIDATION TEST



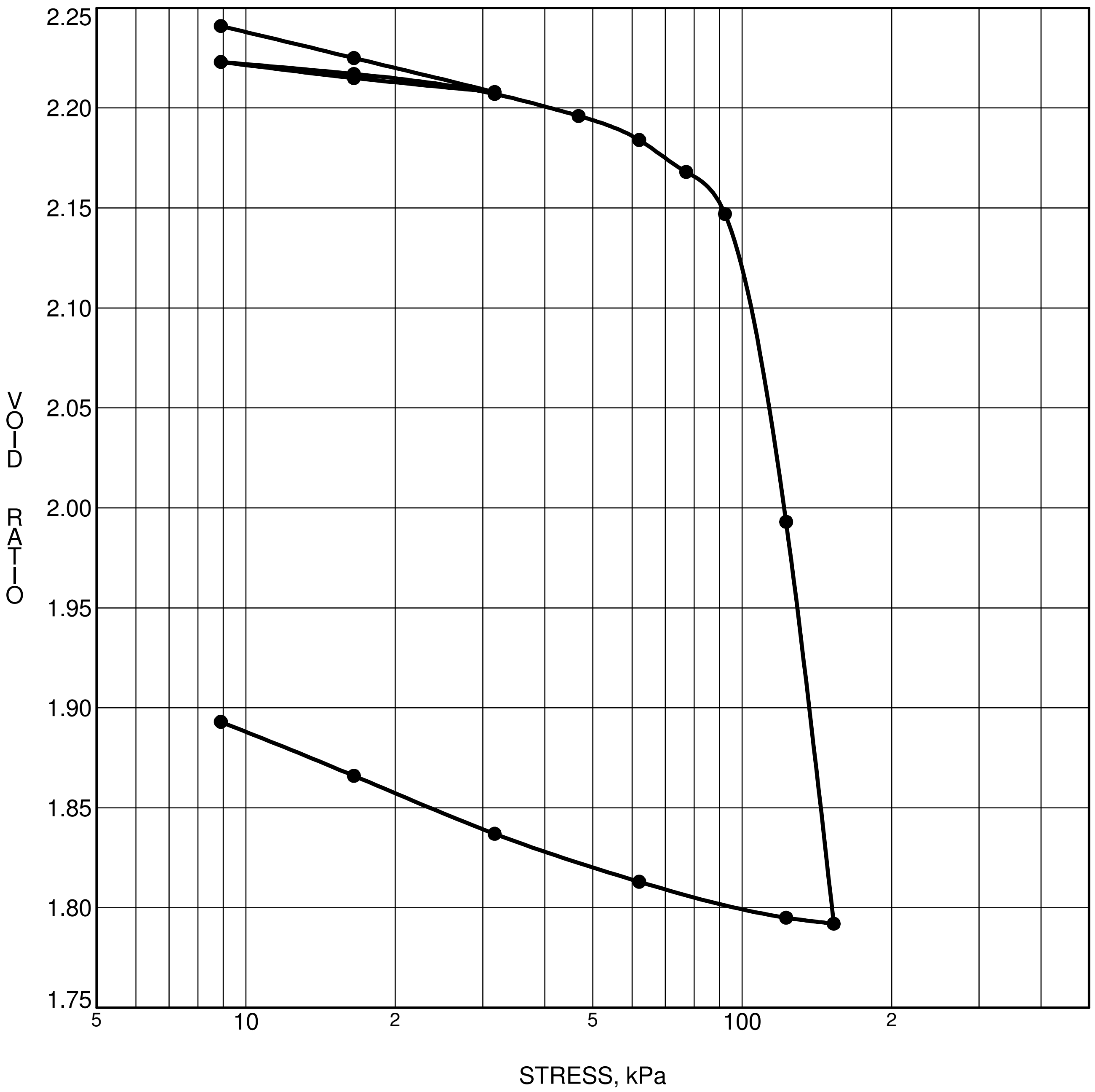
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	BH16-16	p'o	71 kPa	Ccr	0.019
Sample No.	TW 9	p'c	101 kPa	Cc	1.732
Sample Depth	8.89 m	OC Ratio	1.4	Wo	70.3 %
Sample Elev.	86.00 m	Void Ratio	1.934	Unit Wt.	15.7 kN/m ^{3}

CLIENT	**Minto Communities Inc.**	FILE NO.	**PG1984**
PROJECT	**Geotechnical Investigation - Prop. Residential Development - Clarke Lands**	DATE	**29/04/2016**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH17-16**	p'o	**65** kPa	Ccr	**0.028**
Sample No.	**TW 7**	p'c	**101.4** kPa	Cc	**2.099**
Sample Depth	**6.60** m	OC Ratio	**1.6**	Wo	**82.2** %
Sample Elev.	**87.41** m	Void Ratio	**2.26**	Unit Wt.	**15.1** kN/m^3

CLIENT **Minto Communities Inc.**

PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke Lands**

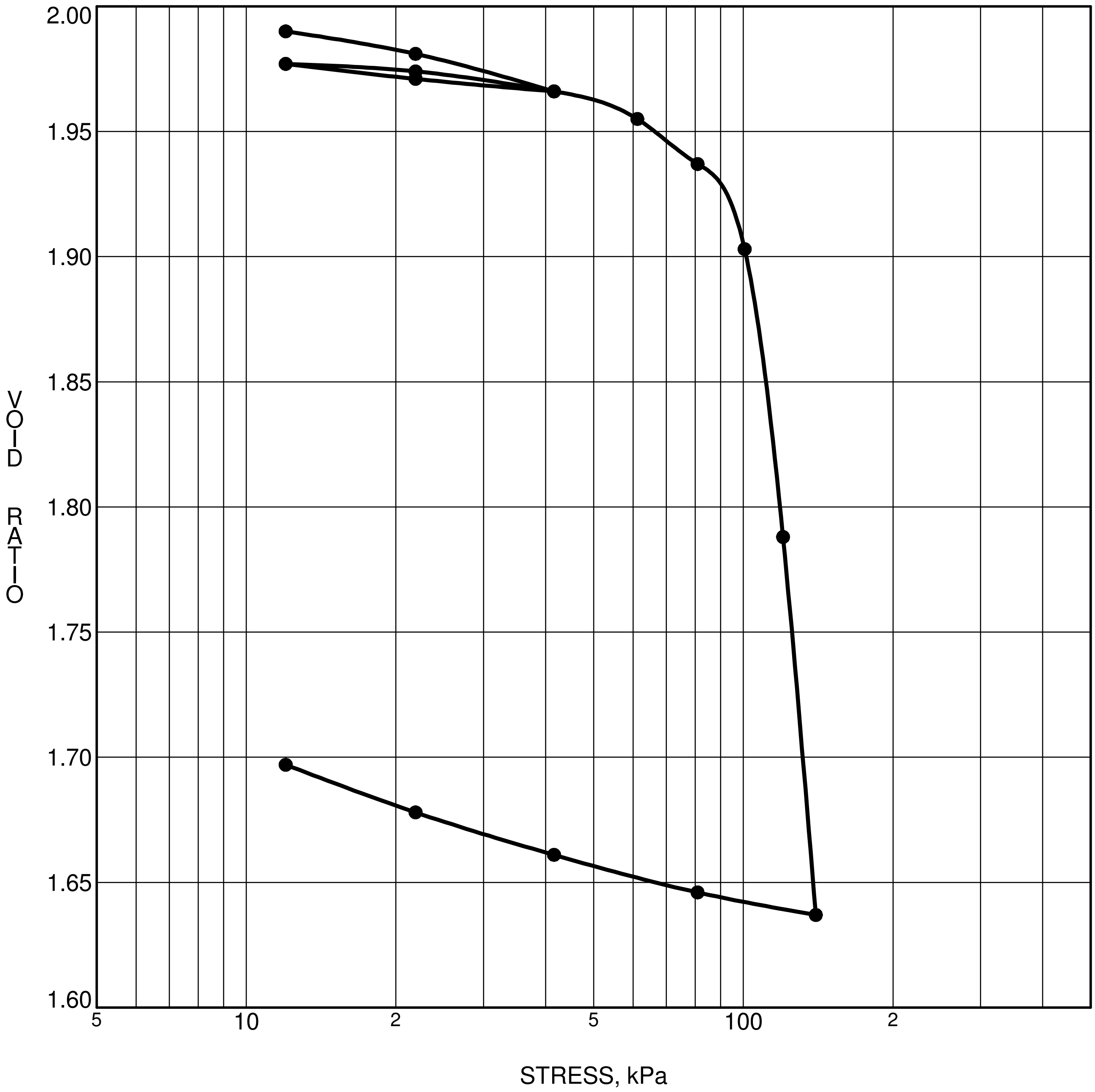
FILE NO. **PG1984**

DATE **02/05/2016**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH20-16**	p'_o	**60** kPa	Ccr	**0.020**
Sample No.	**TW 5**	p'_c	**104** kPa	Cc	**2.261**
Sample Depth	**5.07** m	OC Ratio	**1.7**	Wo	**73.0** %
Sample Elev.	**88.56** m	Void Ratio	**2.008**	Unit Wt.	**15.5** kN/m ^{3}

CLIENT **Minto Communities Inc.**

PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke Lands**

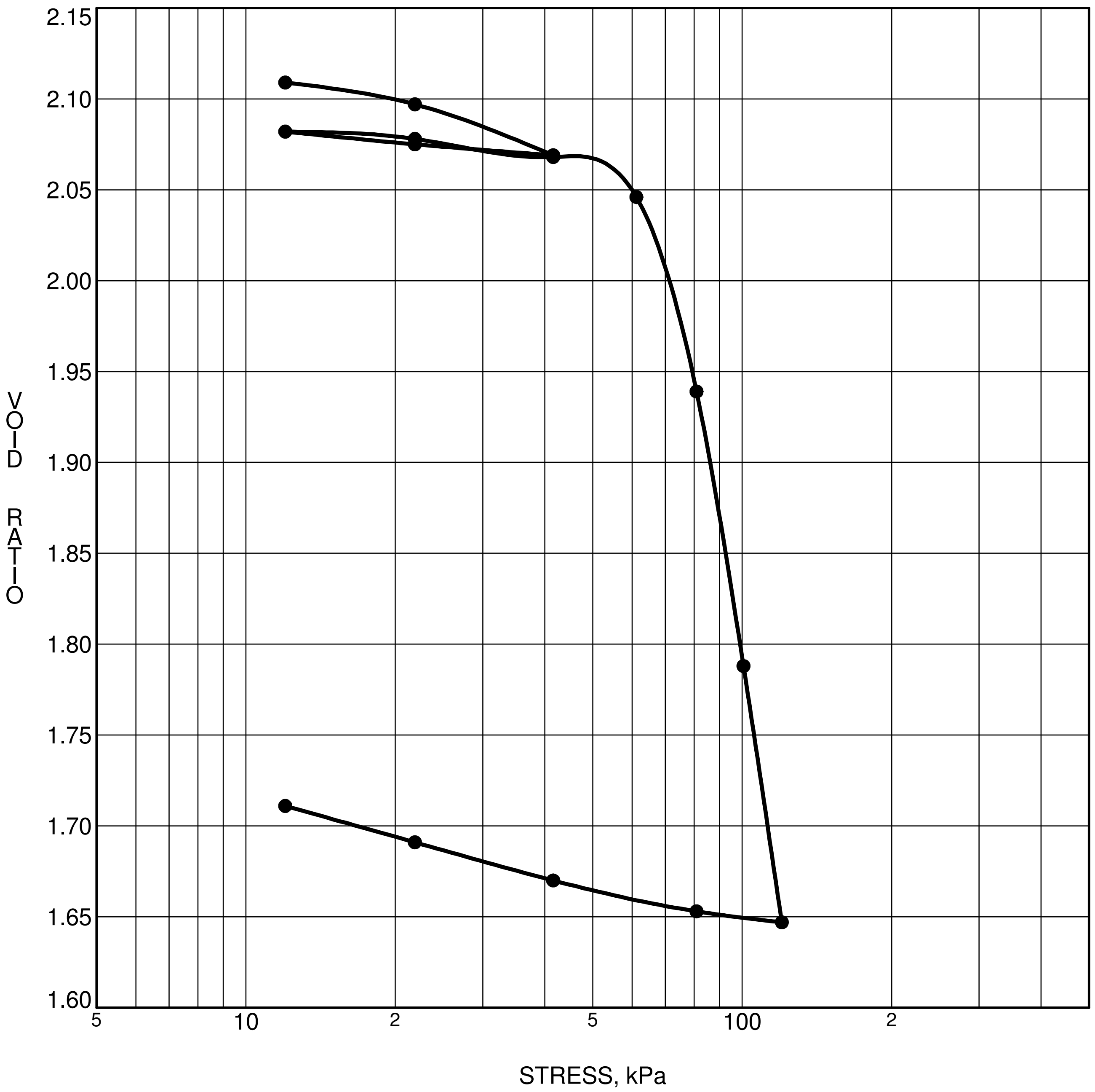
FILE NO. **PG1984**

DATE **06/05/2016**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH21A-16**	p'o	**51** kPa	Ccr	**0.027**
Sample No.	**TW 1**	p'c	**74** kPa	Cc	**1.738**
Sample Depth	**3.62** m	OC Ratio	**1.5**	Wo	**77.3** %
Sample Elev.	**89.31** m	Void Ratio	**2.126**	Unit Wt.	**15.3** kN/m ^{3}

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

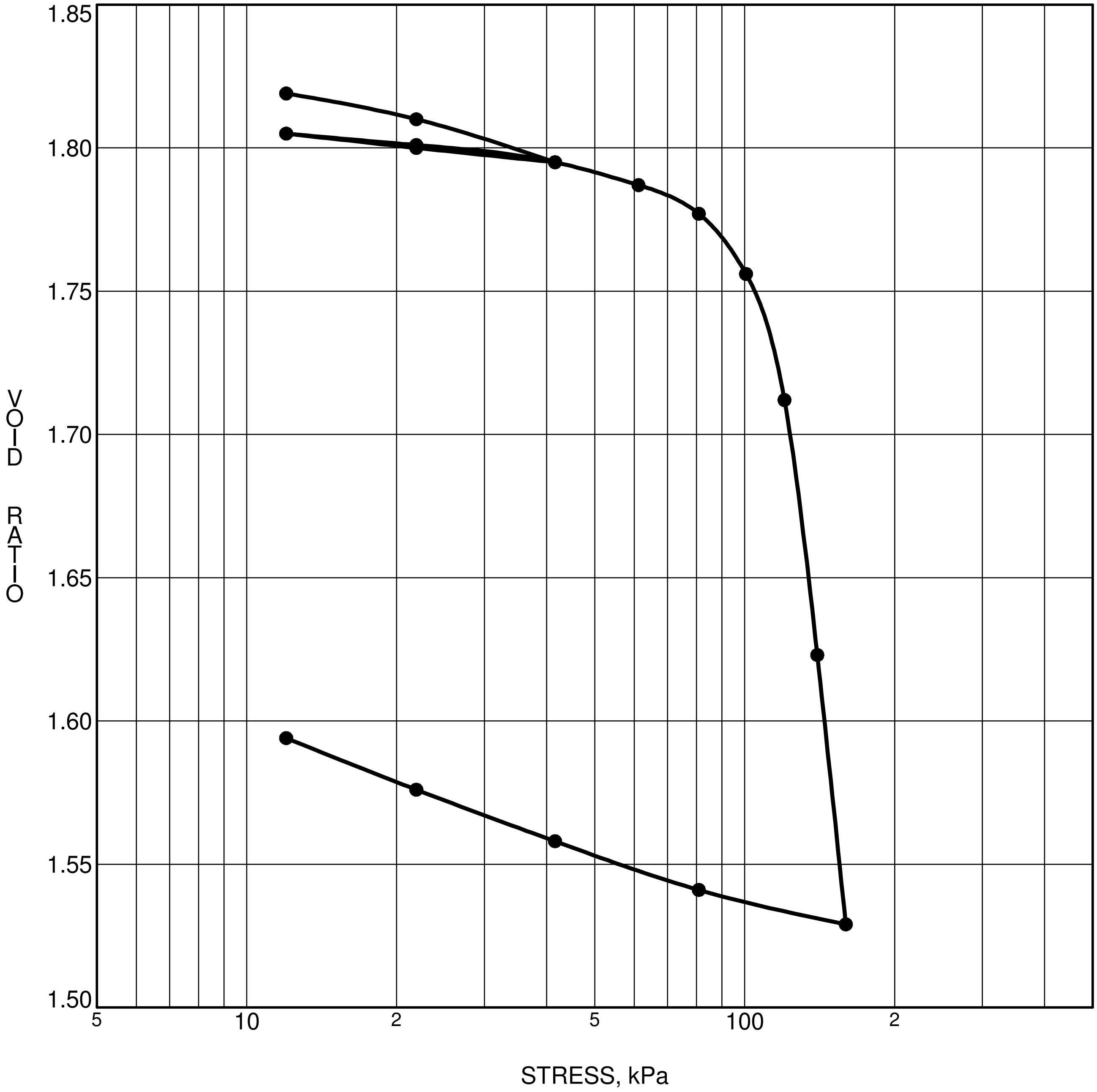
PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke Lands**

DATE **06/05/2016**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



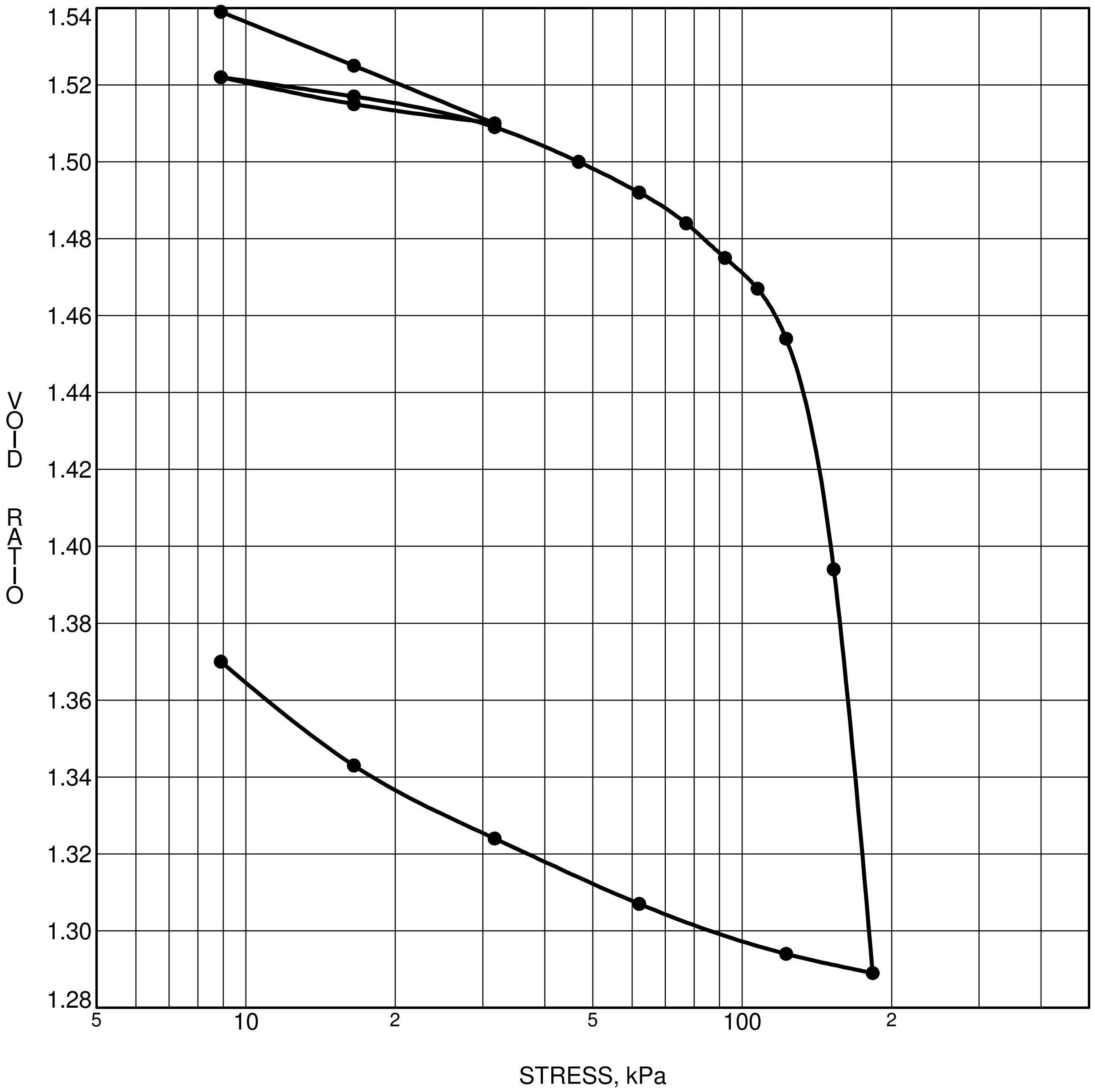
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH22-16**	p'o	**59** kPa	Ccr	**0.018**
Sample No.	**TW 4**	p'c	**117** kPa	Cc	**1.711**
Sample Depth	**4.91** m	OC Ratio	**2.0**	Wo	**66.7** %
Sample Elev.	**87.65** m	Void Ratio	**1.835**	Unit Wt.	**15.9** kN/m ^{3}

CLIENT	**Minto Communities Inc.**	FILE NO.	**PG1984**
PROJECT	**Geotechnical Investigation - Prop. Residential Development - Clarke Lands**	DATE	**13/05/2016**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH23-16**	p'_o	**60** kPa	Ccr	**0.023**
Sample No.	**TW 4**	p'_c	**137** kPa	Cc	**1.366**
Sample Depth	**5.08** m	OC Ratio	**2.3**	Wo	**56.7** %
Sample Elev.	**87.21** m	Void Ratio	**1.56**	Unit Wt.	**16.5** kN/m ^{3}

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

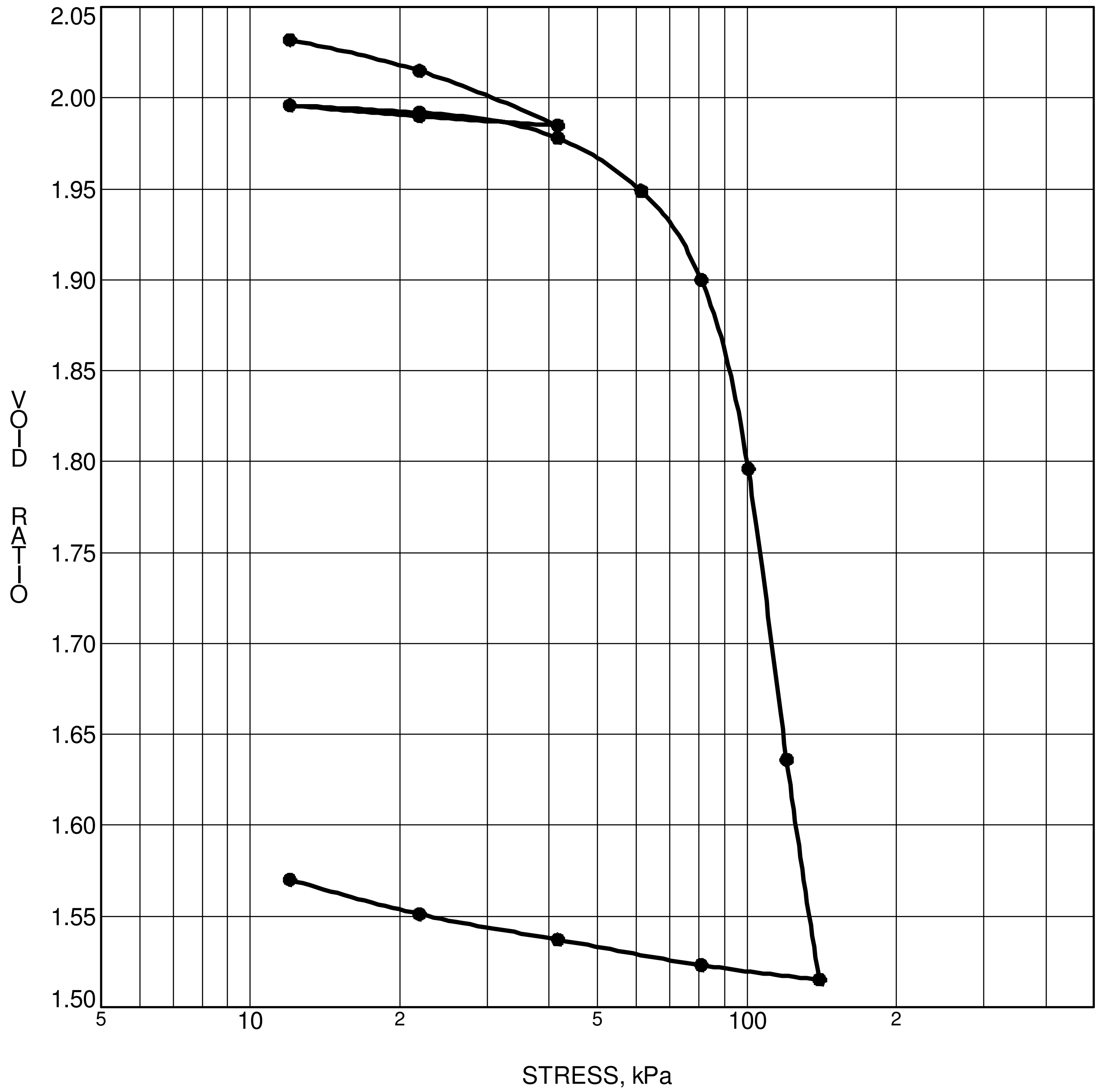
PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke Lands**

DATE **09/05/2016**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 1**	p'_o	**57** kPa	Ccr	**0.028**
Sample No.	**TW 5**	p'_c	**90** kPa	Cc	**2.060**
Sample Depth	**4.89** m	OC Ratio	**1.6**	Wo	**74.8** %
Sample Elev.	**88.14** m	Void Ratio	**2.057**	Unit Wt.	**15.4** kN/m^3

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

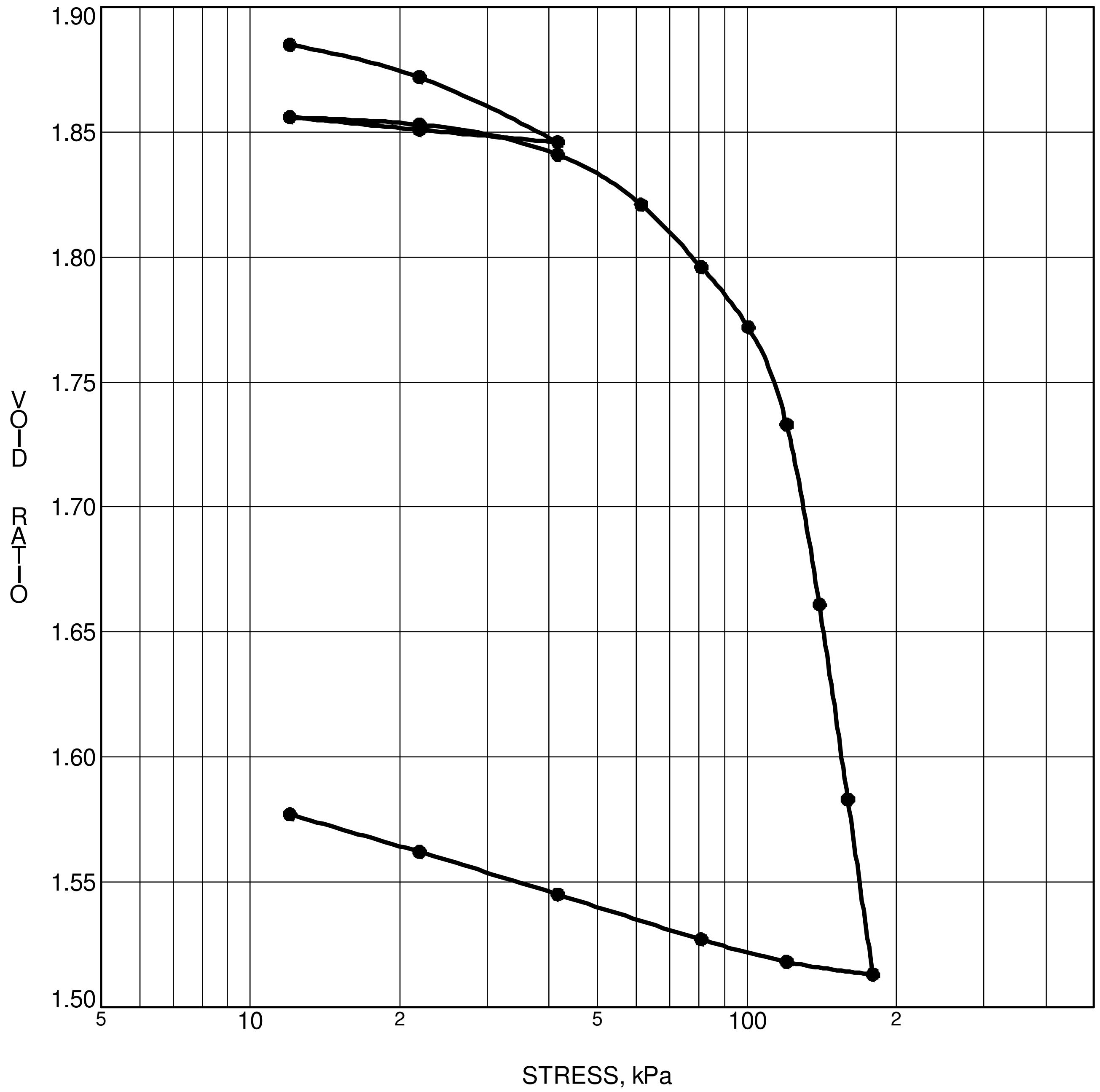
PROJECT **Geotechnical Investigation - Clarke Lands Stage 1 Development**

DATE **01/11/10**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



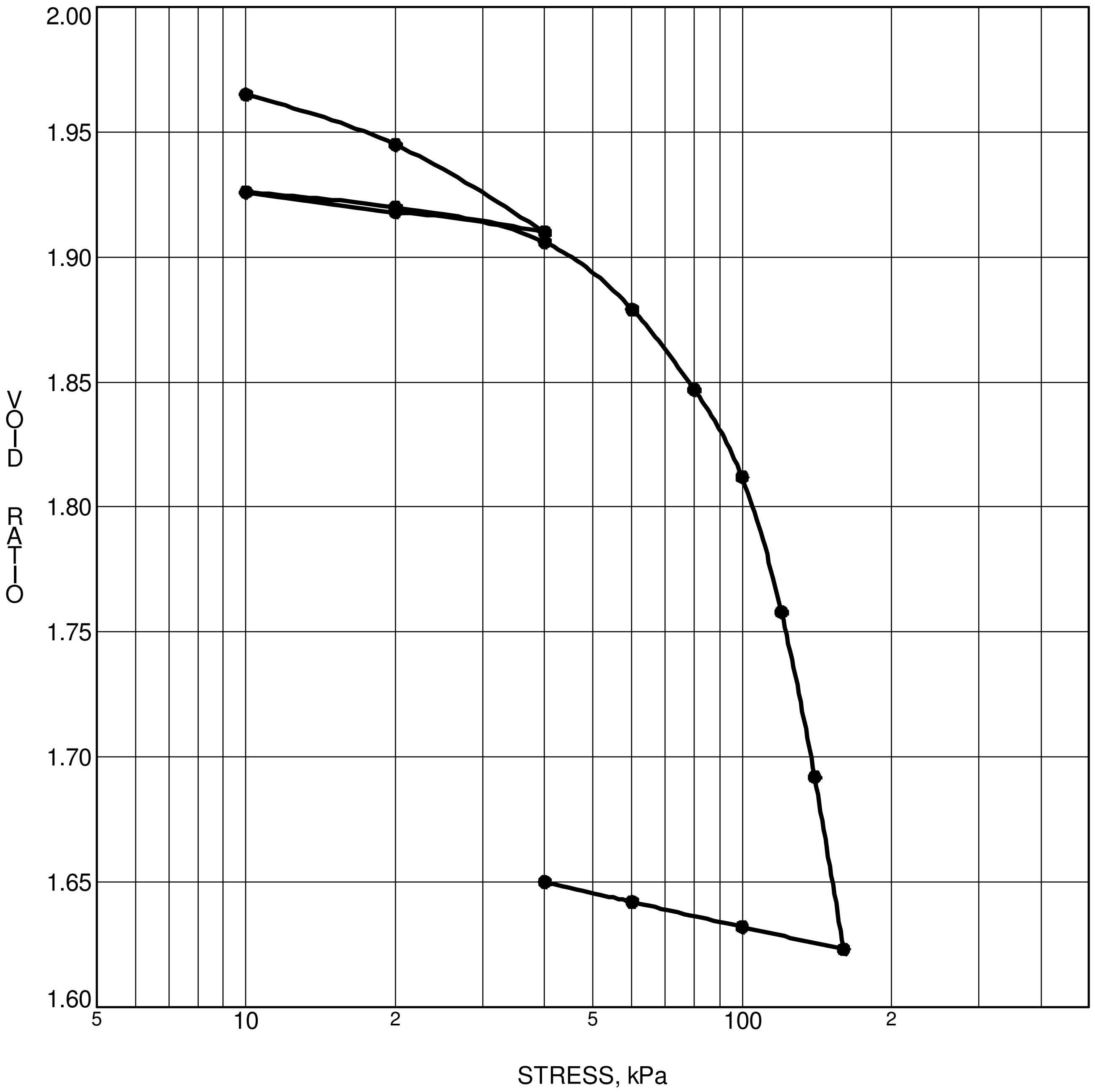
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	BH 2	p'_o	57 kPa	Ccr	0.023
Sample No.	TW 5	p'_c	113 kPa	Cc	1.444
Sample Depth	4.9 m	OC Ratio	2.0	Wo	69.2 %
Sample Elev.	88.08 m	Void Ratio	1.903	Unit Wt.	15.6 kN/m^3

CLIENT	**Minto Communities Inc.**	FILE NO.	**PG1984**
PROJECT	**Geotechnical Investigation - Clarke Lands Stage 1 Development**	DATE	**01/12/10**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



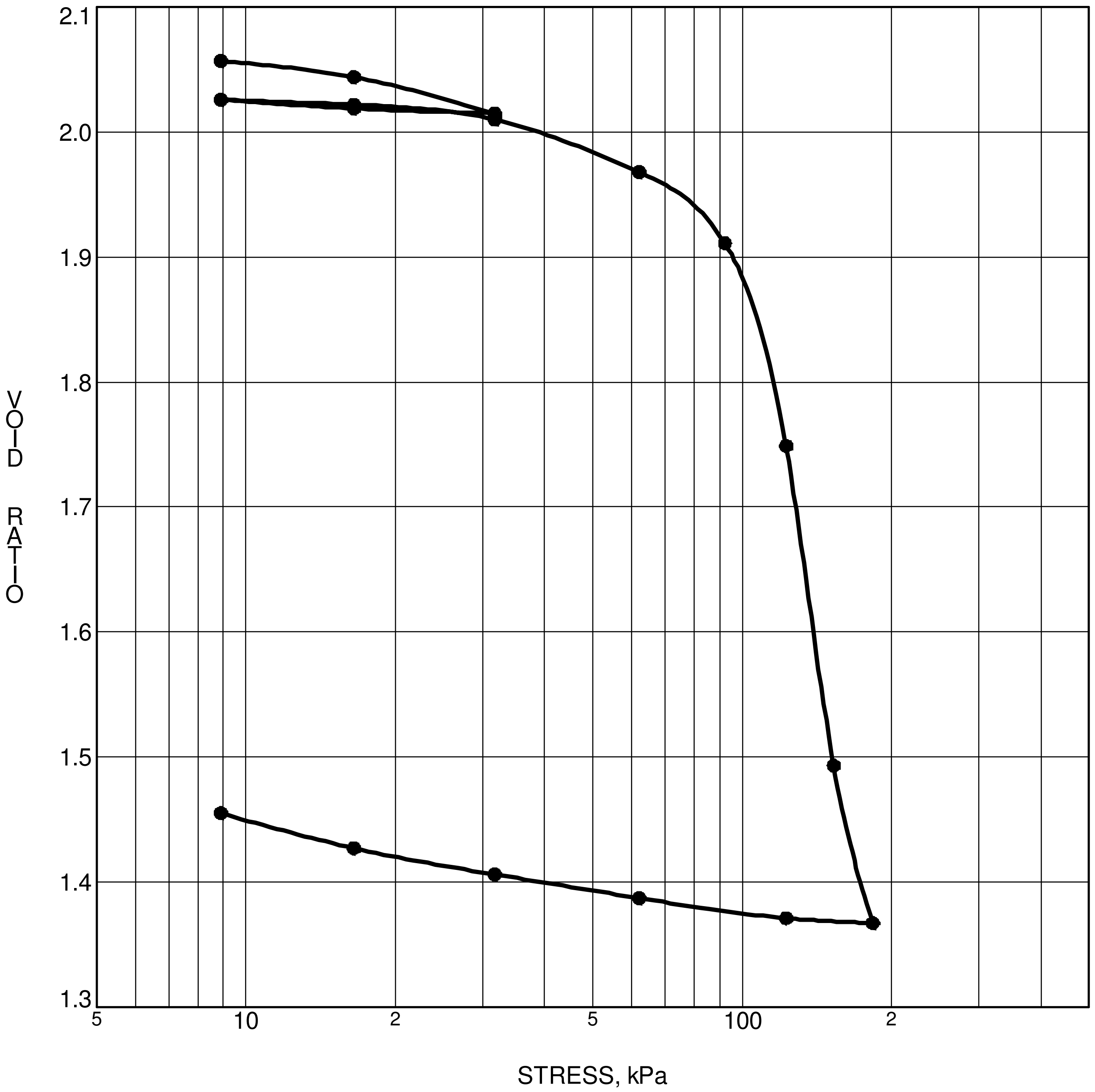
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 3**	p'$_o$	**57** kPa	Ccr	**0.029**
Sample No.	**TW 5**	p'$_c$	**105** kPa	Cc	**1.150**
Sample Depth	**4.93** m	OC Ratio	**1.8**	Wo	**72.5** %
Sample Elev.	**87.99** m	Void Ratio	**1.995**	Unit Wt.	**15.5** kN/m^3

CLIENT	**Minto Communities Inc.**	FILE NO.	**PG1984**
PROJECT	**Geotechnical Investigation - Clarke Lands Stage 1 Development**	DATE	**01/06/10**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 4**	p'_o	**66** kPa	Ccr	**0.023**
Sample No.	**TW 6**	p'_c	**107** kPa	Cc	**2.657**
Sample Depth	**6.48** m	OC Ratio	**1.6**	Wo	**75.4** %
Sample Elev.	**86.34** m	Void Ratio	**2.073**	Unit Wt.	**15.4** kN/m ^{3}

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

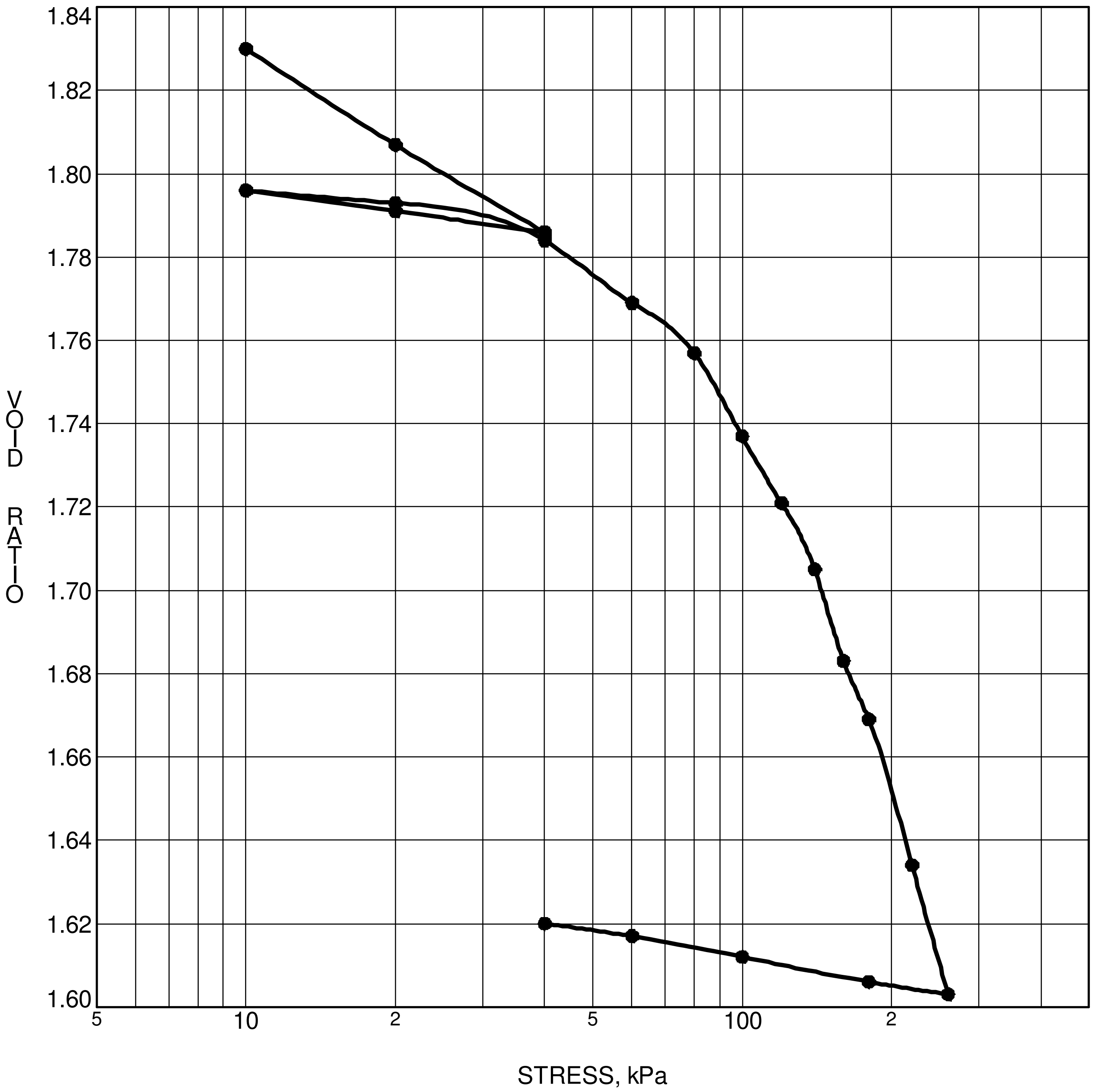
PROJECT **Geotechnical Investigation - Clarke Lands Stage 1 Development**

DATE **01/12/10**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



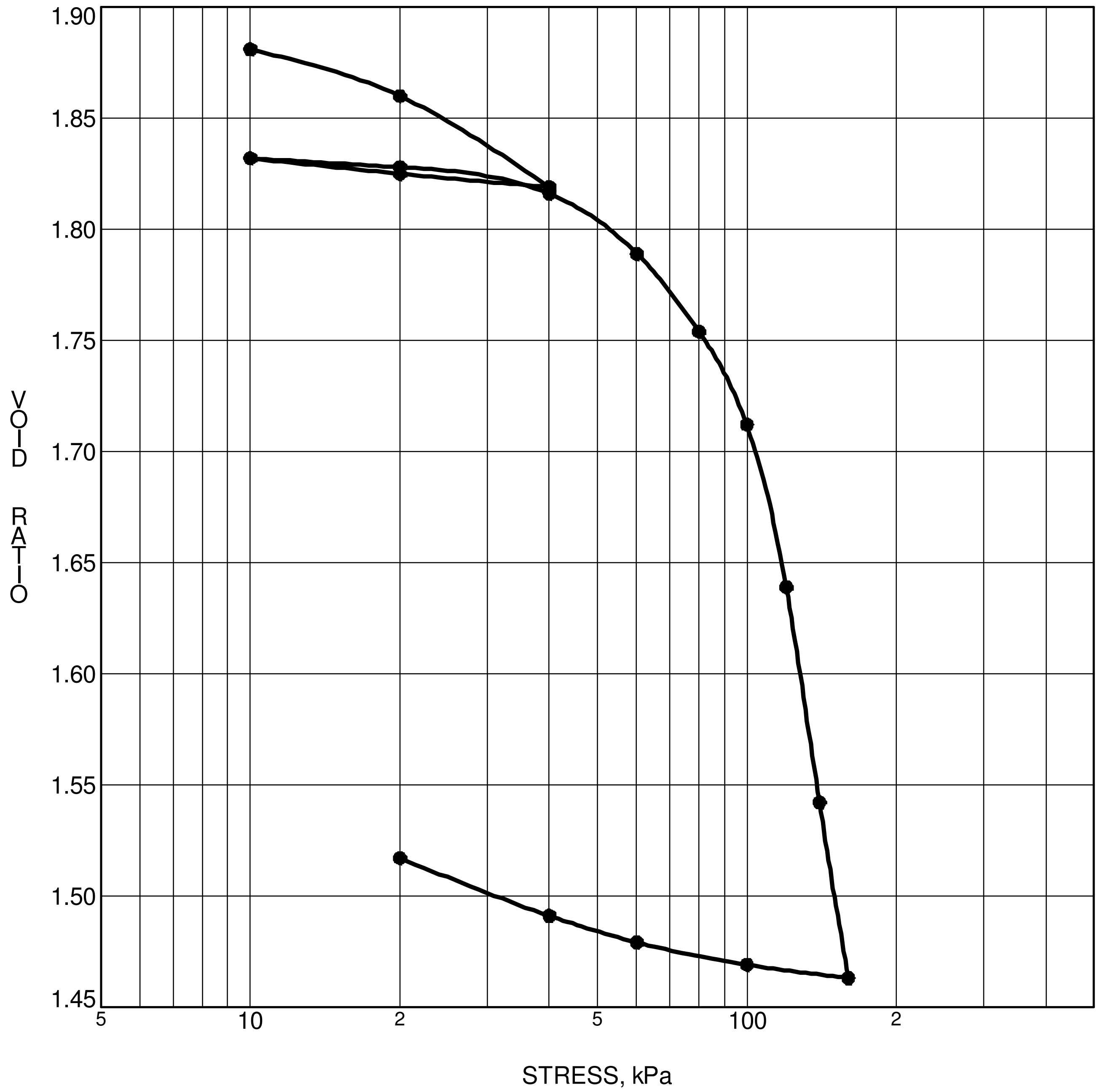
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 5**	p'_o	**66** kPa	Ccr	**0.018**
Sample No.	**TW 6**	p'_c	**118** kPa	Cc	**0.420**
Sample Depth	**6.5** m	OC Ratio	**1.8**	Wo	**67.3** %
Sample Elev.	**86.39** m	Void Ratio	**1.85**	Unit Wt.	**15.8** kN/m^3

CLIENT	**Minto Communities Inc.**	FILE NO.	**PG1984**
PROJECT	**Geotechnical Investigation - Clarke Lands Stage 1 Development**	DATE	**01/08/10**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	BH 6	p'_o	57 kPa	Ccr	0.024
Sample No.	TW 5	p'_c	101 kPa	Cc	1.443
Sample Depth	4.9 m	OC Ratio	1.8	Wo	69.8 %
Sample Elev.	87.76 m	Void Ratio	1.92	Unit Wt.	15.7 kN/m^3

CLIENT **Minto Communities Inc.**

PROJECT **Geotechnical Investigation - Clarke Lands Stage 1 Development**

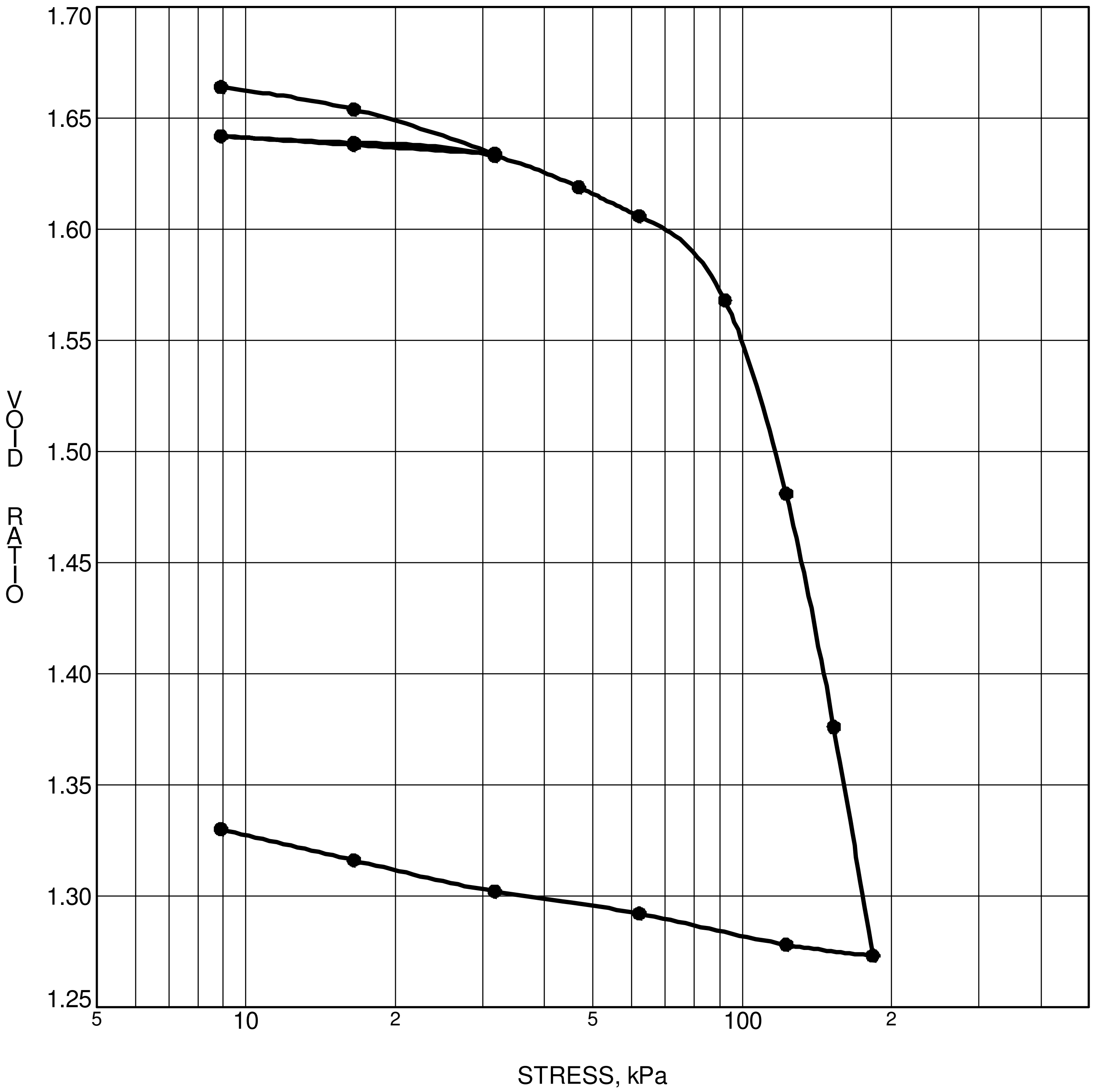
FILE NO. **PG1984**

DATE **01/12/10**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 7**	p'_o	**65** kPa	Ccr	**0.016**
Sample No.	**TW 7**	p'_c	**100** kPa	Cc	**1.199**
Sample Depth	**7.31** m	OC Ratio	**1.5**	Wo	**61.2** %
Sample Elev.	**86.65** m	Void Ratio	**1.684**	Unit Wt.	**16.2** kN/m^3

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

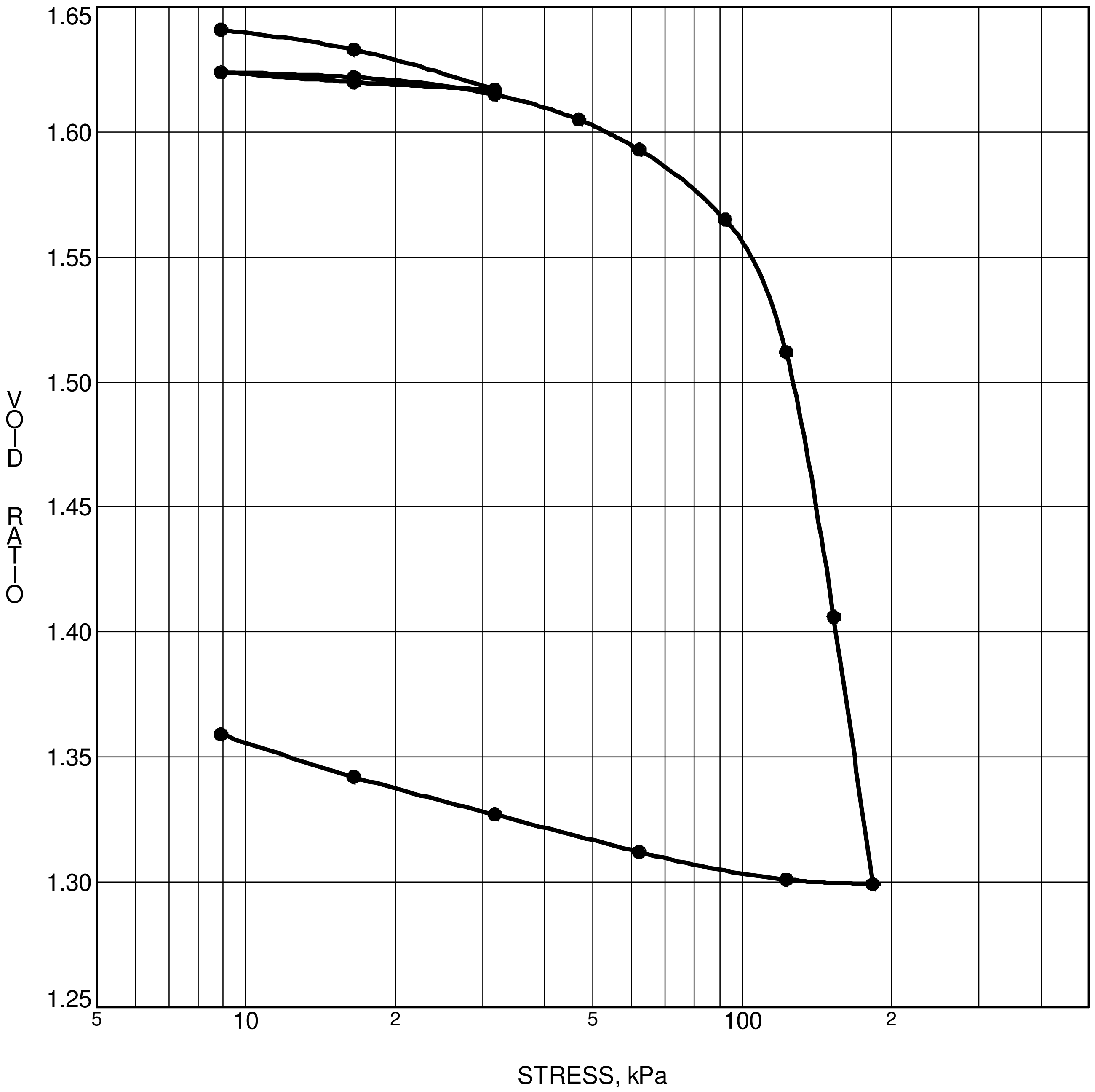
PROJECT **Geotechnical Investigation - Proposed Residential Development - Clarke Lands**

DATE **02/25/2011**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 8**	p'_o	**67** kPa	Ccr	**0.014**
Sample No.	**TW 4**	p'_c	**107** kPa	Cc	**1.076**
Sample Depth	**5.03** m	OC Ratio	**1.6**	Wo	**60.4** %
Sample Elev.	**87.26** m	Void Ratio	**1.66**	Unit Wt.	**16.3** kN/m ^{3}

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

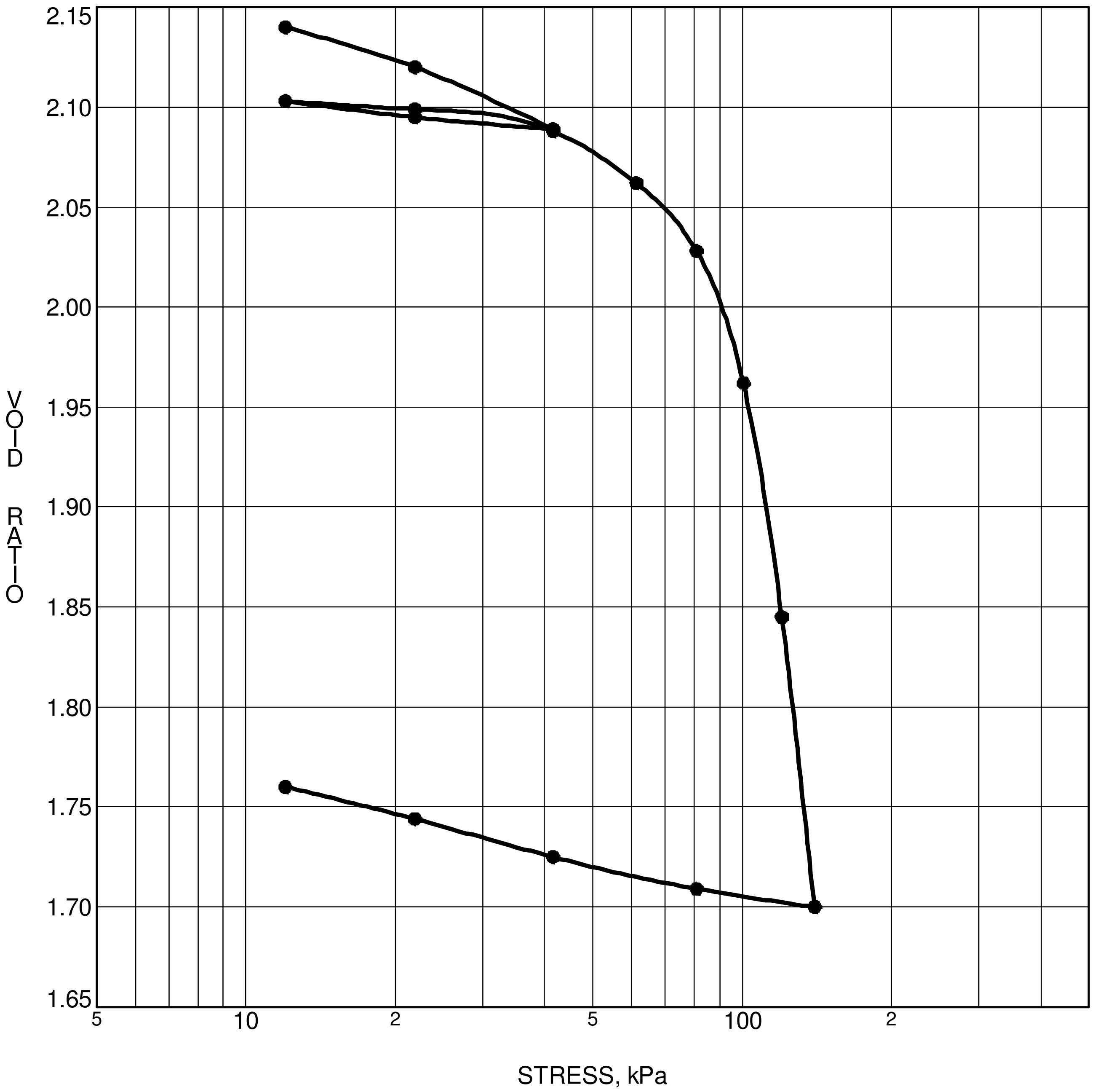
PROJECT **Geotechnical Investigation - Proposed Residential Development - Clarke Lands**

DATE **02/14/2011**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 8**	p'_o	**70** kPa	Ccr	**0.028**
Sample No.	**TW 5**	p'_c	**92** kPa	Cc	**1.856**
Sample Depth	**6.60** m	OC Ratio	**1.3**	Wo	**78.6** %
Sample Elev.	**85.69** m	Void Ratio	**2.162**	Unit Wt.	**15.2** kN/m ^{3}

CLIENT **Minto Communities Inc.**

FILE NO. **PG1984**

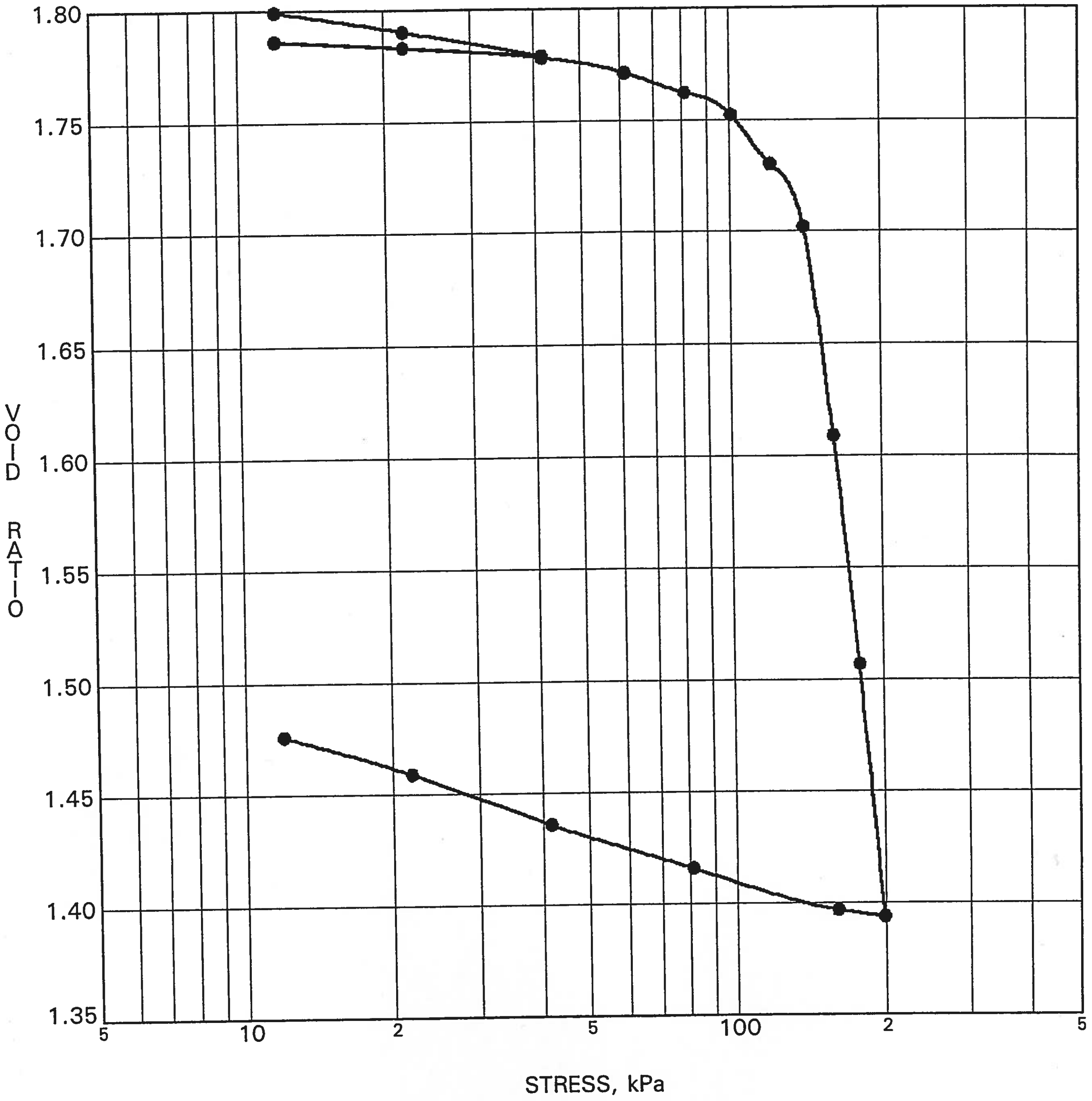
PROJECT **Geotechnical Investigation - Proposed Residential Development - Clarke Lands**

DATE **03/08/2011**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



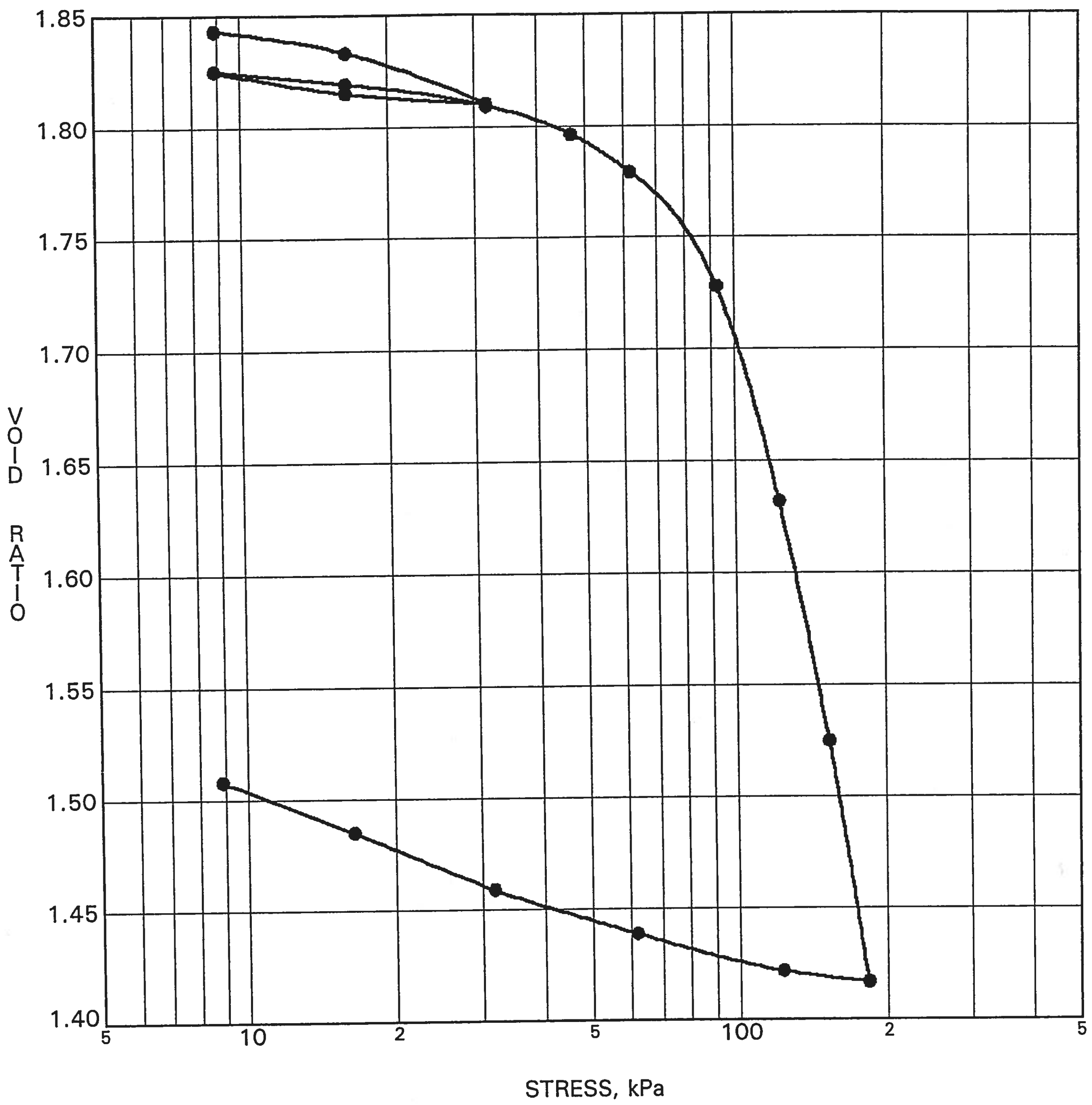
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	BH6-05	p'_o	82 kPa	Ccr	0.015
Sample No.	TW 6	p'_c	142 kPa	Cc	2.230
Sample Depth	9.50 m	OC Ratio	1.7	Wo	65.7 %
Sample Elev.	82.70 m	Void Ratio	1.810	Unit Wt.	15.9 kN/m^3

CLIENT	Minto Developments Inc.	FILE NO.	PG0706
PROJECT	Geotechnical Investigation - Clarke Lands, Cedarview Road at Strandherd Drive	DATE	13/11/05

patersongroup Consulting Engineers

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

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY

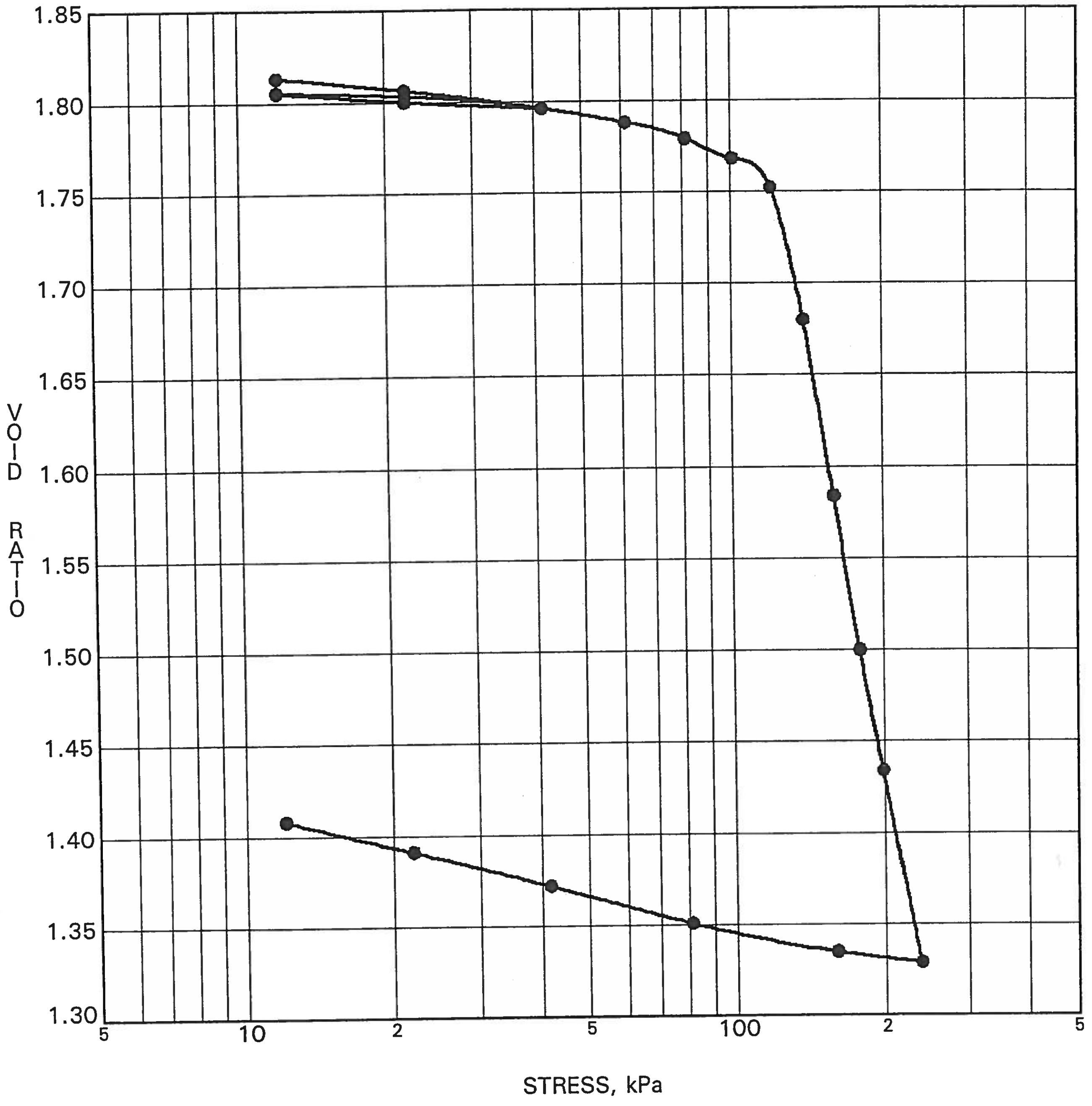
Borehole No.	BH7-05	p'_o	50 kPa	Ccr	0.029
Sample No.	TW 3	p'_c	93 kPa	Cc	1.210
Sample Depth	4.20 m	OC Ratio	1.9	Wo	67.2 %
Sample Elev.	88.93 m	Void Ratio	1.850	Unit Wt.	15.8 kN/m^3

CLIENT	Minto Developments Inc.	FILE NO.	PG0706
PROJECT	Geotechnical Investigation - Clarke Lands, Cedarview Road at Strandherd Drive	DATE	13/11/05

patersongroup Consulting Engineers

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

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY

Borehole No.	BH8-05	p'_o	50 kPa	Ccr	0.015
Sample No.	TW 4	p'_c	124 kPa	Cc	1.517
Sample Depth	4.20 m	OC Ratio	2.5	Wo	66.3 %
Sample Elev.	88.69 m	Void Ratio	1.820	Unit Wt.	15.9 kN/m^3

CLIENT **Minto Developments Inc.**

PROJECT **Geotechnical Investigation - Clarke Lands,**
Cedarview Road at Strandherd Drive

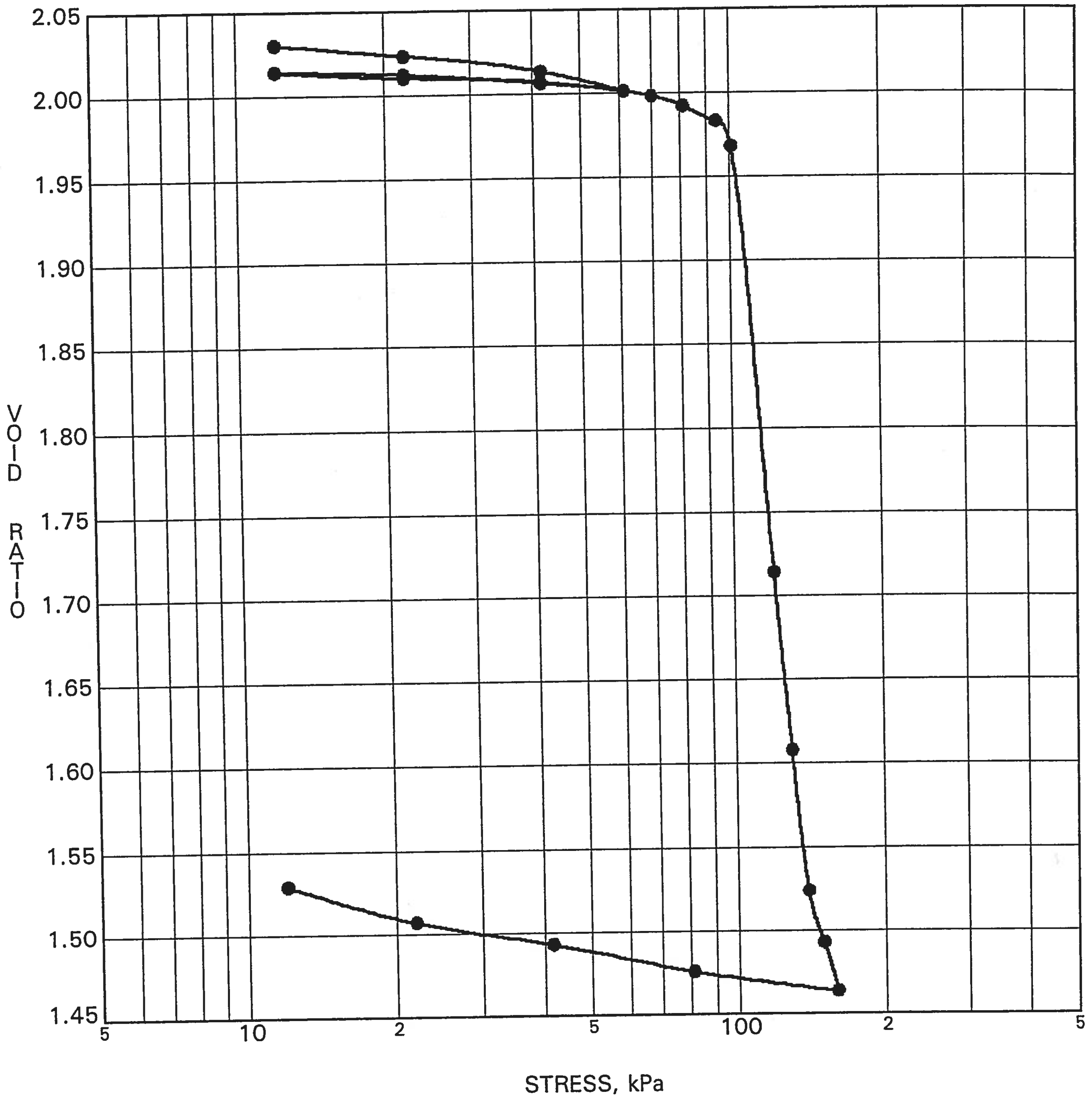
FILE NO. **PG0706**

DATE **28/10/05**

patersongroup **Consulting Engineers**

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

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	BH9-05	p'_o	68 kPa	Ccr	0.018
Sample No.	TW 5	p'_c	100 kPa	Cc	3.070
Sample Depth	7.10 m	OC Ratio	1.5	Wo	74.1 %
Sample Elev.	86.04 m	Void Ratio	2.037	Unit Wt.	15.5 kN/m^3

CLIENT **Minto Developments Inc.**

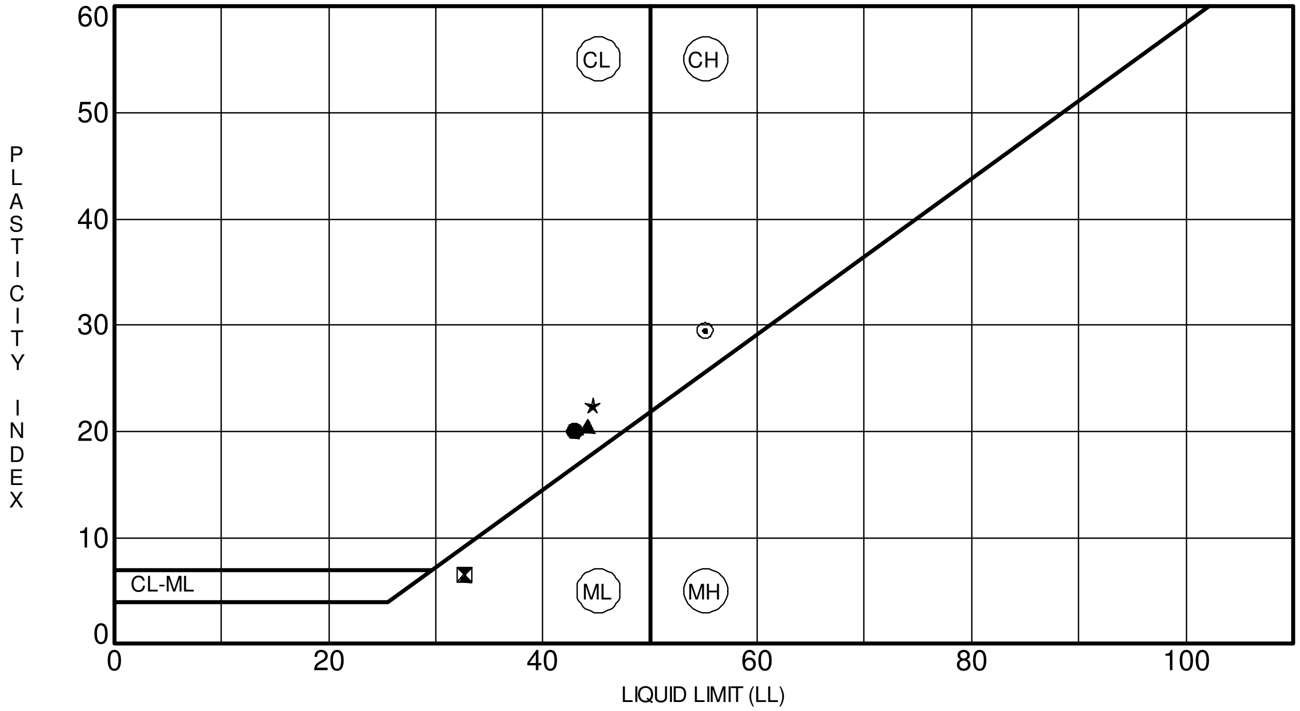
PROJECT **Geotechnical Investigation - Clarke Lands,**
Cedarview Road at Strandherd Drive

FILE NO. **PG0706**

DATE **13/11/05**

patersongroup **Consulting Engineers**
28 Concourse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH 1-15**	**TW 7**	**43**	**23**	**20**		**CL - Inorganic clays of low plasticity**
⊠	**BH 4-15**	**TW 3**	**33**	**26**	**7**		**ML - Silt of low compressability**
▲	**BH 6-15**	**TW 5**	**44**	**24**	**21**		**CL - Inorganic clays of low plasticity**
★	**BH 8-15**	**TW 3**	**45**	**22**	**22**		**CL - Inorganic clays of low plasticity**
⊙	**BH11-15**	**TW 4**	**55**	**26**	**30**		**CH - Inorganic clays of high plasticity**

CLIENT **Minto Communities Inc.**

PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke & Mion Lands**

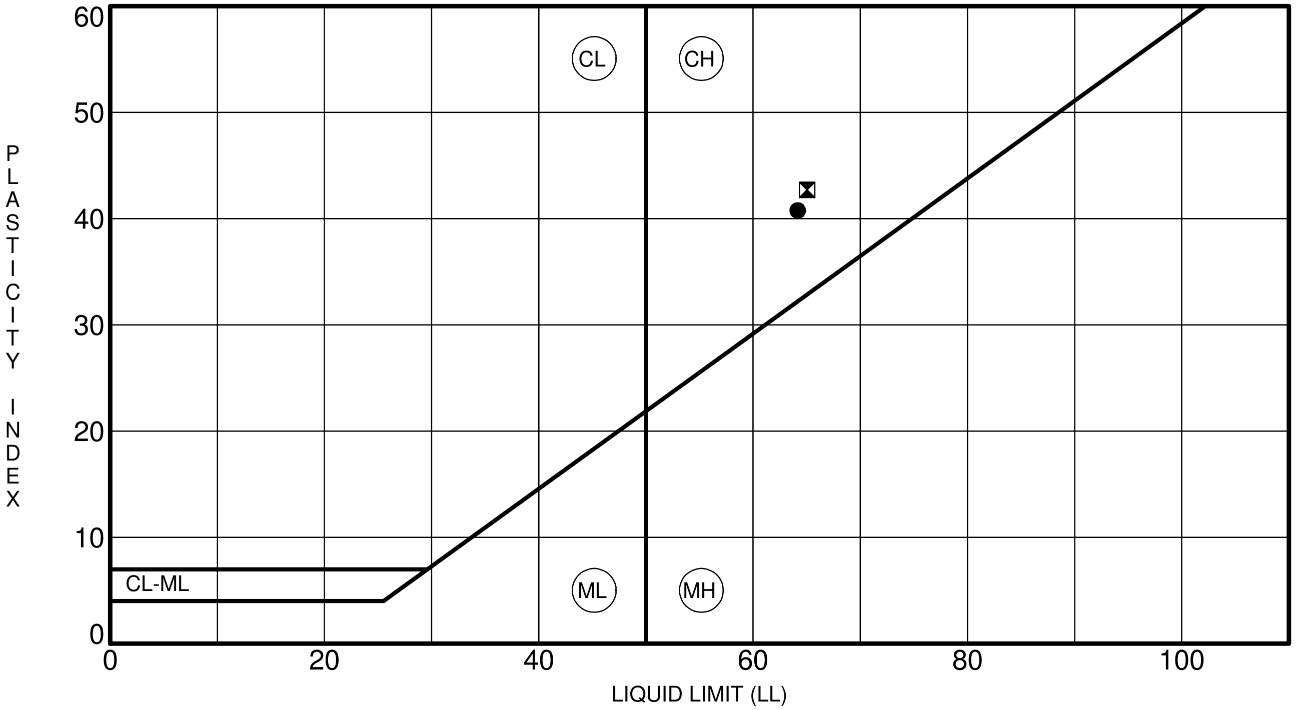
FILE NO. **PG1984**

DATE **10 Mar 15**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS

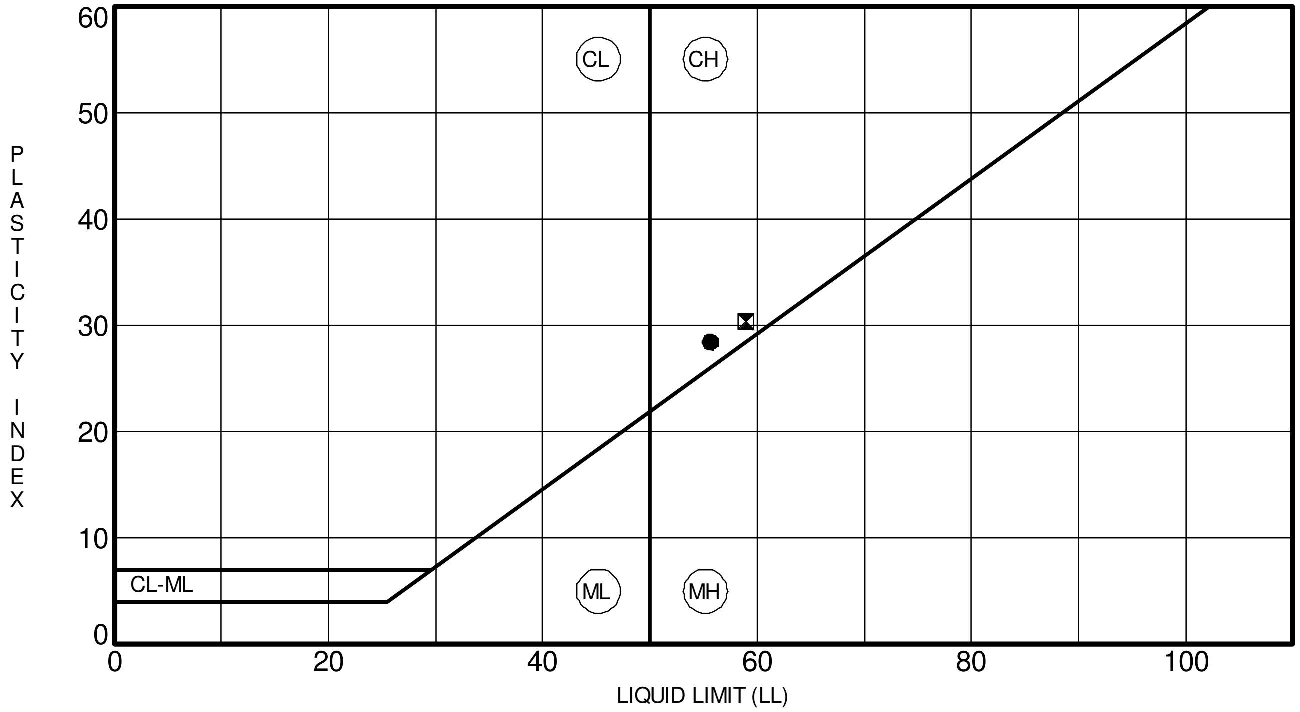


	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH17-16**	**TW 7**	**64**	**23**	**41**		**CH - Inorganic clays of high plasticity**
⧗	**BH21A-16**	**TW 1**	**65**	**22**	**43**		**CH - Inorganic clays of high plasticity**

CLIENT **Minto Communities Inc.**
FILE NO. **PG1984**
PROJECT **Geotechnical Investigation - Prop. Residential Development - Clarke Lands**
DATE **26 Apr 16**

patersongroup **Consulting Engineers**
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH 2**	**TW 5**	**56**	**27**	**28**		**CH-Inorganic clays of high plasticity**
⊠	**BH 5**	**TW 5**	**59**	**29**	**30**		**CH-Inorganic clays of high plasticity**

CLIENT **Minto Communities Inc.**

PROJECT **Geotechnical Investigation - Clarke Lands Stage 1 Development**

FILE NO. **PG1984**

DATE **17 Dec 09**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

ATTERBERG LIMITS' RESULTS

Figure 2: Shear Strength Profile - Clarke Lands - Stage1

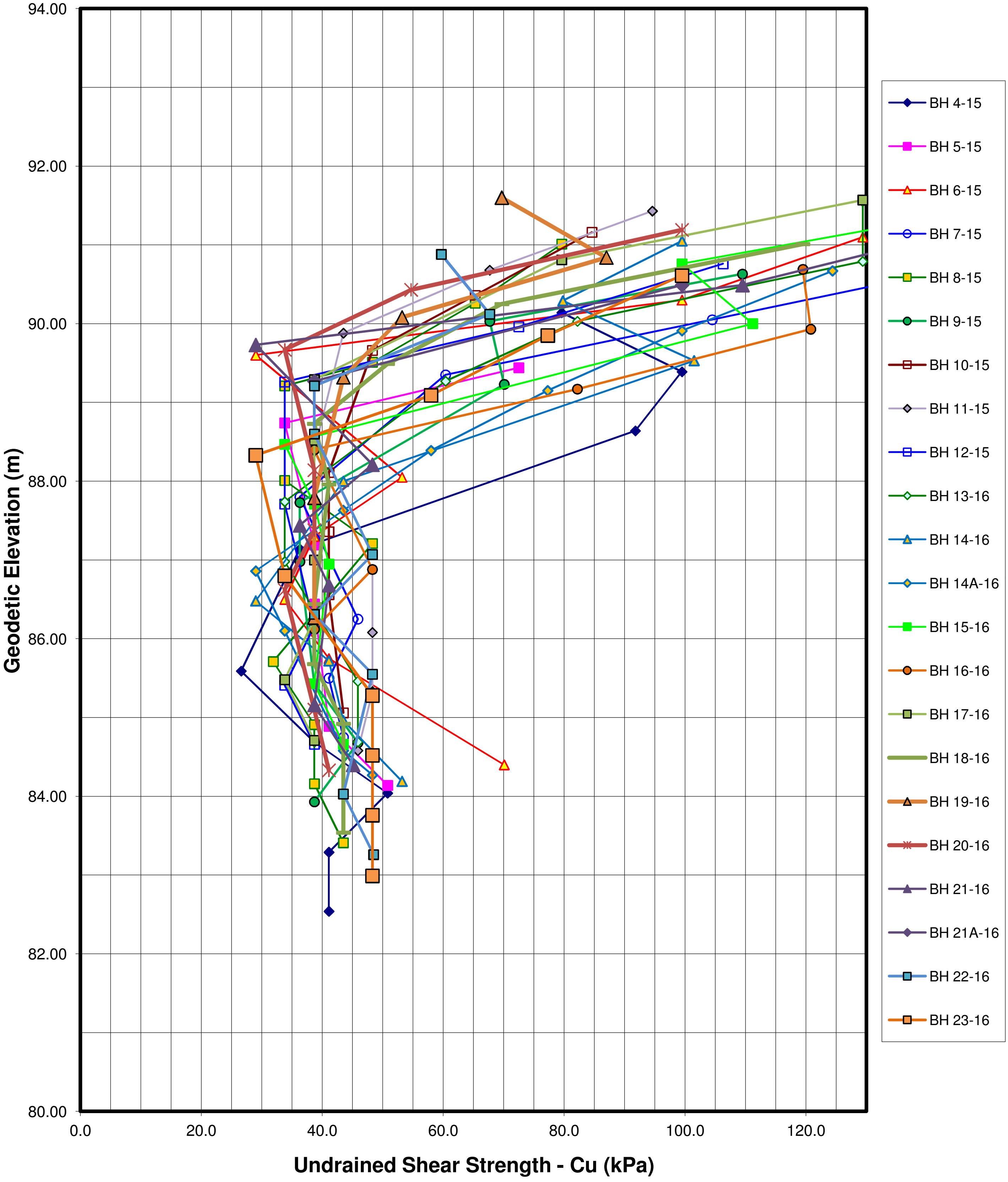


Figure 3: Seismic Site Class - OBC 2012

Project: Clarke Lands - Stage 1 - Assumed Conservative Values
File No: PG1984-REP.02 **Date:** 29-Jun-16

PGA 0.32 **Region:** Ottawa (Nepean)

Layer Description	**Layer Properties**		**Cumulative**	**Thickness**
	Vs	**Thickness**	**Thickness**	**Vs**
silty clay crust	300	3.0	3.0	0.0100
grey silty clay (Vs by eqn)	126.8	0.0	3.0	0.0000
Vs = 125 + 1.1667*Z				
grey silty clay (assumed)	120	13.0	16.0	0.1083
post-glacial clay	200	0.0	16.0	0.0000
glacial till	400	1.0	17.0	0.0025
weak or weathered bedrock	1200	1.0	18.0	0.0008
sound bedrock	1500	12.0	30.0	0.0080
Totals	**N/A**	**30.0**	**N/A**	**0.1297**
Average Shear Wave Velocity =				**231.4**
Site Class for Seismic Response =			**Class**	**D**

Site Class	**Description**	**Vs Min.**	**Vs Max.**	**N60 Range**	**Cu Range**
A	Hard rock	1500	>1500	N/A	N/A
B	Rock	760	1500	N/A	N/A
C	Soft rk VD soil	360	760	N>50	Cu>100
D	Stiff soil	180	360	15<N<50	50<Cu<100
E	Soft soil	0	180	N<15	Cu<50

APPENDIX 3

Figure 1 - Key Plan

Drawing PG1984-6 - Test Hole Location Plan

Drawing PG1984-7 - Permissible Grade Raise Plan

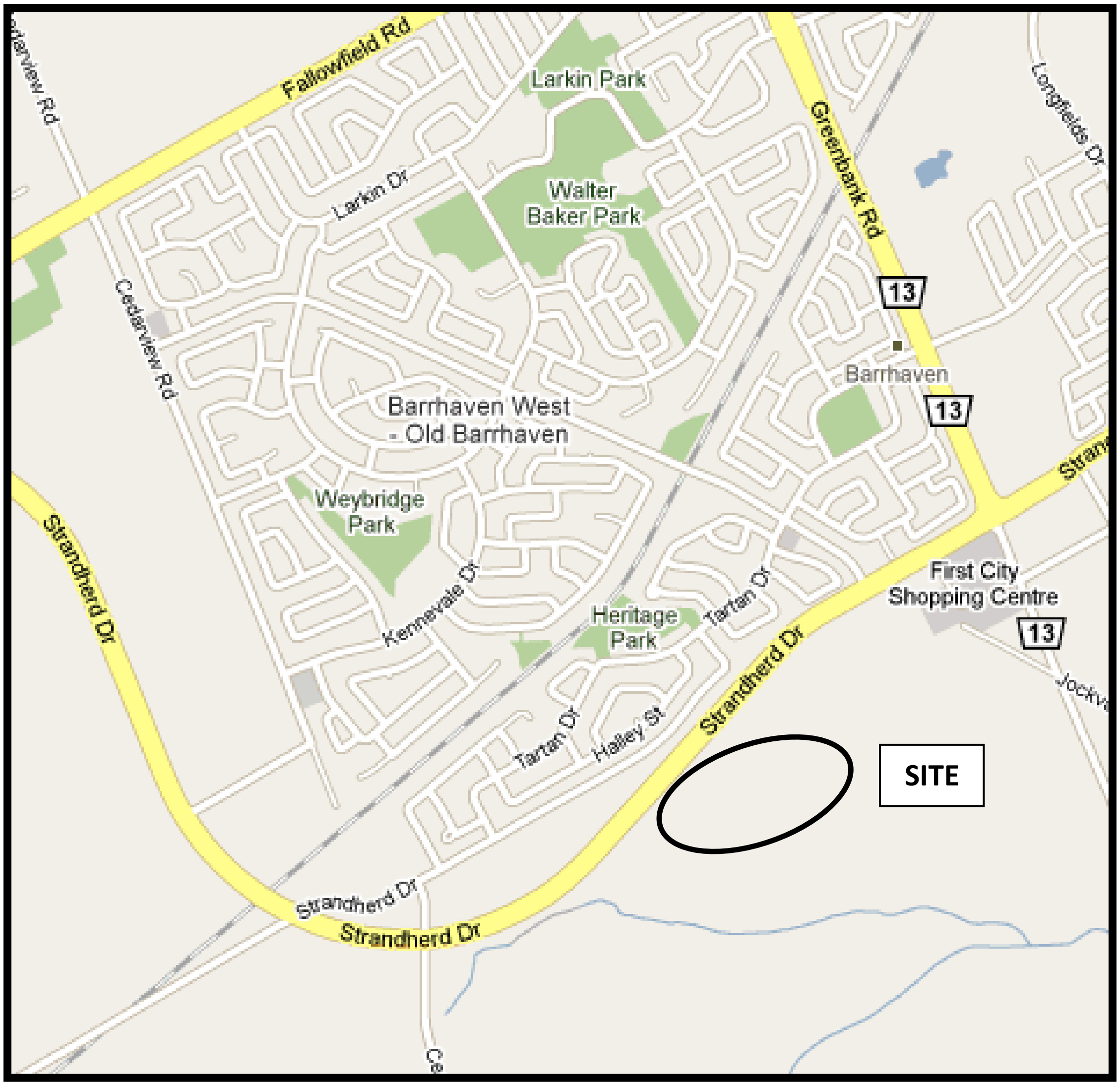


FIGURE 1:

KEY PLAN

LEGEND:

- ⊗ BOREHOLE LOCATIONS
- ⊕ BOREHOLE LOCATIONS, PREVIOUS INVESTIGATIONS
- 91.84 GROUND SURFACE ELEVATION (m)
- (76.45) PRACTICAL DCPT REFUSAL ELEVATION (m)

BASE PLAN, BOREHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS PROVIDED BY J.L. RICHARDS AND ASSOCIATES LIMITED.

patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL
0			

MINTO COMMUNITIES INC.

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT - CLARKE LANDS - STRANDHERD DRIVE
OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Stamp:

Scale: 1:1000
Drawn by: MPG
Checked by: AJT
Approved by: AJT
Date: 05/2016

Report No.: PG1984
Drawing No.: PG1984-6
Revision No.: 0

p:\autocad drawings\geotechnical\pg19xx\pg1984\24051 c conceptual cg1 - standard\pg1984 clarke lands.dwg

PERMISSIBLE GRADE RAISE:

1.4 1.7	GRADE RAISE - CONVENTIONAL GARAGE (m) GRADE RAISE - LWF IN GARAGE AND PORCH (m)
92.6 94.0	ORIGINAL GROUND SURFACE ELEVATION (m) BASIC ALLOWABLE FINISHED GRADE (m)

NOTE: BASIC ALLOWABLE FINISHED GRADE BASED ON CONVENTIONAL GARAGE CONSTRUCTION AND MEASURED AT FRONT OF GARAGE.

LEGEND:

⌖	BOREHOLE LOCATIONS
⌖	BOREHOLE LOCATIONS, PREVIOUS INVESTIGATIONS
91.84	GROUND SURFACE ELEVATION (m)
(76.45)	PRACTICAL DCPT REFUSAL ELEVATION (m)

BASE PLAN, BOREHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS PROVIDED BY J.L. RICHARDS AND ASSOCIATES LIMITED.

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NO.	REVISIONS	DATE	INITIAL
0			

MINTO COMMUNITIES INC.

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT - CLARKE LANDS - STRANDHERD DRIVE
OTTAWA, ONTARIO

Title:

PERMISSIBLE GRADE RAISE PLAN

Stamp:

Scale: 1:1000
Drawn by: MPG
Checked by: AJT
Approved by: AJT
Date: 05/2016
Report No.: PG1984
Drawing No.: PG1984-7
Revision No.: 0