patersongroup

Geotechnical
Engineering

Environmental
Engineering

Hydrogeology

Geological
Engineering

Materials Testing

Building Science

Archaeological Services

Geotechnical Investigation
Proposed Residential Development
3252 Navan Road - Ottawa

Prepared For

Claridge Homes (Gladstone)

October 9, 2020

Report: PG5224-1 Revision 2

Paterson Group Inc.
Consulting Engineers
154 Colonnade Road South
Ottawa (Nepean), Ontario
Canada K2E 7J5

Tel: (613) 226-7381
Fax: (613) 226-6344
www.patersongroup.ca

Table of Contents

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Claridge Homes (Gladstone) to conduct a geotechnical investigation for the proposed residential development to be located at 3252 Navan Road in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2). The objective of the investigation was to:

☐ determine the subsurface soil and groundwater conditions by means of boreholes and monitoring well program.

☐ provide preliminary geotechnical recommendations for the foundation design of the proposed buildings and provide geotechnical construction precautions which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. The report contains our findings and includes geotechnical recommendations pertaining to the design and construction of the proposed development as understood at the time of 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. Therefore, the present report does not address environmental issues.

2.0 Proposed Development

Details of the proposed development were not available at the time of issuance of this report. Based on current available information, it is expected that the proposed development will consist of low rise residential dwellings and townhouse style housing. Local roadways and residential driveways are also anticipated for the proposed development. It is further anticipated that the site will be serviced by future municipal services.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the current investigation was carried out on May 16, 17 and 22, 2019 as well as September 5, 2019. At that time, thirteen boreholes were completed to a maximum depth of 10.7 m below existing ground surface. A supplemental field investigation was carried out on September 10 and 11, 2020. At that time, thirteen boreholes were completed to a maximum depth of 11.3 m below existing ground surface. The test hole locations were placed in a manner to provide general coverage taking into consideration site access, features and underground utilities. The test hole locations for the current investigation are presented on Drawing PG5224-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were completed using a portable drill rig or a track-mounted auger drill rig operated by a two person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer from the geotechnical division. The testing procedure consisted of augering to the required depths and at the selected locations sampling the overburden.

Sampling and In Situ Testing

Soil samples were recovered from the auger flights, and using a 50 mm diameter split-spoon sampler or a thin walled Shelby tube in combination with a fixed piston sampler. The split-spoon samples were placed in sealed plastic bags and the Shelby tubes were sealed at both ends on site. All the samples were transported to our laboratory. The depths at which the auger and split-spoon samples were recovered from the boreholes are shown as AU and SS, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

A 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.

The overburden thickness was evaluated by a dynamic cone penetration test (DCPT) completed. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

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

Groundwater

51 mm diameter groundwater monitoring wells were installed in all the boreholes to monitor the groundwater level subsequent to the completion of the sampling program. The groundwater observations are discussed in Subsection 4.3 and presented in the Soil Profile and Test Data sheets in Appendix 1.

Sample Storage

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

3.2 Field Survey

The test hole locations were determined by Paterson personnel and surveyed in the field by Annis O'Sullivan Vollebekk Ltd. The locations of the boreholes are presented on Drawing PG5224-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from our field investigation were examined in our laboratory to collaborate the field findings.

A total of 5 representative soil samples were submitted for Atterberg limits testing as part of the current geotechnical investigation.

4.0 Observations

4.1 Surface Conditions

The subject site is currently occupied by a earthworks/landscaping contractor. A 2 storey structure of slab on grade construction used as office space is located on the north portion of the site near Navan Road. Numerous stockpiles of different type of fill and landscaping material are piled further south with laneways to allow movement of heavy equipment between them. Fill material was noted to have been placed to extend the level working area towards the center of the property. This platform created a slope approximately 6 m in heigth. The south portion of the site slopes down toward the Prescott-Russell Trail Link and is covered by mature trees and vegetation.

4.2 Subsurface Profile

Generally, the soil profile encountered at the test hole locations consists of a layer of fill composed mainly of silty sand with trace clay and some construction debris overlying a stiff to very stiff brown silty clay crust followed by a deep, stiff to firm grey silty clay deposit. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profile encountered at each test hole location.

Bedrock

Based on available geological mapping, the bedrock in the area is part of the Billings formation, which consists of shale. Also, based on available geological mapping, the overburden thickness is expected to range from 25 to 50 m.

4.3 Groundwater

Groundwater level readings were recorded on May 30 and 31, 2019 as well as September 9, 2019 at the monitoring well locations. The groundwater level readings are presented in the Soil Profile and Test Data sheets in Appendix 1. It should be noted that surface water can become trapped within a backfilled borehole that can lead to higher than typical groundwater level observations. Long-term groundwater level can also be estimated based on the observed color, moisture levels and consistency of the recovered soil samples. Based on these observations, the long-term groundwater level is expected between 3 to 4 m depth. It should be noted that groundwater levels are subject to seasonal fluctuations, therefore the groundwater levels could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for a residential development. However, due to the presence of the sensitive silty clay layer, a proposed development will be subjected to grade raise restrictions.

For areas where the existing fill and deleterious material is encountered below the proposed building footprint, it is recommended to sub-excavate the building footprint to a native silty clay bearing surface and reinstate with a compact fill approved by Paterson at the time of construction. It should be further noted that our permissible grade raise restrictions provided in Subsection 5.3 may be adjusted once settlement monitoring data is available to determine the current settlement rate associated with the existing fill piles within the west and central portions of the current development phase.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures. The existing fill, where free of organics and deleterious materials, should be proof-rolled by a vibratory roller making several passes and approved by Paterson personnel. Poor performing fill should be removed and reinstated with a compacted engineered fill as detailed below.

Fill Placement

Fill used for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II or approved alternative. Granular material should be tested and approved prior to delivery to the site. The fill should be placed in loose lifts of 300 mm thick or less and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building areas should be compacted to at least 98% of the Standard Proctor Maximum Dry Density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill and beneath parking areas where settlement of the ground surface is of minor concern. In landscaped areas, these materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of the SPMDD.

Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

Proof Rolling

For the proposed driveways and roadways, proof rolling of the subgrade is required in areas where the existing fill, free of organics and deleterious materials, is encountered. It is recommended that the subgrade surface be proof-rolled **under dry conditions and above freezing temperature** by an adequately sized roller making several passes to achieve optimum compaction levels. The compaction program should be reviewed and approved by the geotechnical consultant at the time of construction.

5.3 Foundation Design

Bearing Resistance Values

Using continuously applied loads, footings for the proposed buildings can be designed using the bearing resistance values presented in Table 2.

Table 2 - Bearing Resistance Values

Bearing Surface	Bearing Resistance Value at SLS (kPa)	Factored Bearing Resistance Value at ULS (kPa)
Stiff Brown Silty Clay	100	200
Firm Grey Silty Clay	60	120
Engineered Fill	100	200

Note: Strip footings, up to 1.5 m wide, and pad footings, up to 3 m wide, can be designed using the above noted bearing resistance values.

The bearing resistance values 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, prior to the placement of concrete for footings.

Bearing resistance values for footing design should be determined on a per lot basis at the time of construction.

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 the in-situ bearing medium soils 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.

Settlement

The total and differential settlements will be dependent on characteristics of the proposed buildings. For design purposes, the total and differential settlements are estimated to be 25 and 20 mm, respectively. A post-development groundwater lowering of 0.5 m was assumed.

The potential post construction total and differential settlements are dependent on the position of the long term groundwater level when buildings are situated over deposits of compressible silty clay. Efforts can be made to reduce the impacts of the proposed development on the long term groundwater level by placing clay dykes in the service trenches, reducing the sizes of paved areas, leaving green spaces to allow for groundwater recharge or limiting planting of trees to areas away from the buildings. However, it is not economically possible to control the groundwater level.

Permissible Grade Raise Recommendations

Based on the undrained shear strength testing results and our experience with the local silty clay deposit, we have determined permissible grade raise restrictions for the current development phase. The recommended permissible grade raise restrictions are presented on Drawing PG5224-2 - Permissible Grade Raise Plan in Appendix 2. It is important to note that the grade raise restrictions presented are given from original native ground surface elevation. Due to the presence of the existing fill layer, it is recommended that a settlement monitoring program be completed to confirm if the permissible grade raise restrictions can be adjusted due to effect of the fill piles. It is recommended that a series of settlement plates be installed within the fill area and periodic settlement monitoring be completed by Paterson to verify the on-going settlement rate of the underlying silty clay deposit. Details of the recommended settlement monitoring program can be provided once preliminary grading has been determined for the current development phase.

The following options could be used alone or in combination, where grade raise exceedances occur. Where limited grade raise is proposed over the existing fill lightweight fill (LWF) can be used. LWF consists of EPS (expanded polystyrene) Type 19 or 22 blocks or other light weight materials which allow for raising the grade without adding a significant load to the underlying soils. However, these materials are expensive and, in the case of the EPS, are more difficult to use under the groundwater level, as they are buoyant, and must be protected against potential hydrocarbon spills. Use lightweight fill within the interior of the garage and porch areas to reduce the fill related loads.

Provided sufficient time is available to induce the required settlements, consideration could be given to surcharging the subject site. Settlement plates to monitor long term settlement should be installed at selected locations within the existing fill pile. Once the desired settlements have taken place, the surcharged portion can be removed and the site is considered acceptable for development.

5.4 Design for Earthquakes

A seismic site response **Class E** should be used for design of the proposed buildings at the subject site according to the OBC 2012. The soils underlying the site are not susceptible to liquefaction.

5.5 Basement Slab/Slab-on-Grade Construction

With the removal of all topsoil and deleterious fill, containing organic matter, within the footprints of the proposed buildings, the native soil surfac, approved engineered fill pad or approved existing fill will be considered an acceptable subgrade on which to commence backfilling for floor slab construction.

Any soft areas should be removed and backfilled with appropriate backfill material. A clear crushed stone fill is recommended for backfilling below the floor slab for limited span slab-on-grade areas, such as front porch or garage footprints. It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone below basement floor slabs.

5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structure. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction of 30 degrees and a bulk (drained) unit weight of 20 kN/m^3. The applicable effective (undrained) unit weight of the retained soil can be taken as 13 kN/m^3, where applicable.

Lateral Earth Pressures

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

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

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

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

Seismic Earth Pressures

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}). The seismic earth force (ΔP_{AE}) can be calculated using $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$ where:

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

The peak ground acceleration, (a_{max}), for the Ottawa area is 0.32g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero.

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

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

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

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

5.7 Pavement Structure

For design purposes, the pavement structure presented in the following tables could be used for the design of driveways, local residential streets and roadways with bus traffic. It should be noted that for residential driveways and car only parking areas, an Ontario Traffic Category A is applicable. For local roadways and roadways with bus traffic, an Ontario Traffic Category B and Category D should be used for design purposes, respectively.

Table 3 - Recommended Pavement Structure - Driveways

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

Table 4 - Recommended Pavement Structure - Local Residential Roadways

Thickness (mm)	Material Description
40	**Wear Course -** Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 5 - Recommended Pavement Structure - Roadways with Bus Traffic

Thickness mm	Material Description
40	**Wear Course -** Superpave 12.5 Asphaltic Concrete
50	**Upper Binder Course** - Superpave 19.0 Asphaltic Concrete
50	**Lower Binder Course** - Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
600	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material. Weak subgrade conditions may be experienced over service trench fill materials. This may require the use of a geotextile, thicker subbase or other measures that can be recommended at the time of construction as part of the field observation program.

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for driveways and local roadways and PG 64-34 asphalt cement should be used for roadways with bus traffic. The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable vibratory equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on 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 load carrying capacity.

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

5.8 Slope Stability

A slope stability analysis was modeled in SLIDE, a computer program which permits a two-dimensional slope stability analysis calculating several methods including the Bishop's method, which is a widely accepted slope analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to forces favoring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable. However, due to intrinsic limitations of the calculation methods and the variability of the subsurface soil and groundwater conditions, a factor of safety greater than 1.0 is generally required for the failure risk to be considered acceptable. A minimum factor of safety of 1.5 is generally recommended for conditions where the slope failure would comprise occupied structures. An analysis considering seismic loading was also completed. A peak ground acceleration of 0.32G was considered for the sections for the seismic loading condition. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

Six slope sections were studied for the subject slopes, see Drawing PG5224-1 - Test Hole Location Plan in Appendix 2 for the section locations. It should be noted that details of the slope height and slope angle at the cross-section locations are presented in Figures 2A through 7B in Appendix 2. The slope details were based on available historic topographic data and topographic information from a recent site visit by Paterson.

Various stockpiles of material were noted based on our site visits and review of aerial photographs. Figure 2A and 3A show the slope section with the presence of the stockpiled material under static conditions. It is expected that the stockpiles will be relocated as part of the proposed development. Therefore, the subject slope was then analyzed as presented in Figures 2B, 2C, 3B and 3C without the presence of stockpiled material.

Figures 4A to 7B present the results of our slope stability analysis for the existing slope located adjacent to the east property boundary. A 2 to 6 m wide, ditch watercourse runs near or at the toe of the existing slope. The subject section of the watercourse was noted to be approximately 600 mm deep up to the normal high watermark. Photographs from our recent site visit are presented in Appendix 2. Based on the preliminary grading plan, an open space block will be created for the ditch watercourse and proposed slope between the watercourse and finished grading at the rear lot line of the adjacent buildings. The preliminary grading details for the proposed development indicate that sufficient space is available to provide a 3H:1V slope from the rear property line to the adjacent watercourse.

Existing Slope within Proposed Development

The stable slope limit is defined by the extent of the lowest slip circle analyzed behind the top of slope where the minimum factor of safety calculated is less than 1.5. The static analysis results for slope sections (Sections A and B) along the slope within the proposed development are presented in Figures 2B and 3B, respectively. The factor of safety for the slope was greater than 1.5 for the slope sections analysed.

The results of the analyses with seismic loading for Sections A and B are shown in Figures 2C and 3C, respectively. The results indicate that the factor of safety for the section A is greater than 1.1. Based on the results, Section A is considered stable under seismic loading. However, a factor of safety less than 1.1 was noted for Section B, therefore, a slope stability setback would be required, if the existing slope were not re-graded as part of the proposed development. A stable slope setback of 8.7 m at Section B will be required if the existing slope is not modified. However, the existing slope will be re-graded as part of the proposed development. It is recommended that the proposed grading provide a 3H:1V profile or flatter for any subject slopes required as part of the proposed development.

Slope adjacent to Ditch Watercourse

The static analysis results for slope sections along the ditch watercourse are presented in Sections C to F (Figures 4A and 7A). The factor of safety for the existing slope was greater than 1.5 for the slope sections analysed, with the exception of Sections D and F. A stable slope allowance setback from top of existing slope was presented in Figures 5A and 7A for Sections D and F, respectively. However, as previously noted, it is expected that the existing slope will be re-graded to provide a stable slope shaped to a 3H:1V profile or flatter as part of the proposed development. Therefore, a stable slope allowance will not be required for the future slope to be re-shaped along the watercourse.

The results of the analyses when considering seismic loading for the slope along the watercourse are shown in Figures 4B, 5B, 6B and 7B. The results indicate that the factor of safety for the section A is greater than 1.1 with the exception of Sections D and F. A stable slope allowance setback from top of existing slope was presented in Figures 5B and 7B for Sections D and F, respectively. However, as previously noted, it is expected that the existing slope will be re-graded to provide a stable slope shaped to a 3H:1V profile or flatter as part of the proposed development. Therefore, a stable slope allowance will not be required for the future slope to be re-shaped along the watercourse.

Limit of Hazard Lands

Based on available information for the proposed development, it is expected that the existing slope along the ditch watercourse will be reshaped to provide a stable slope within the future, open space block. Therefore, a stable slope allowance will not be required for the subject slope. It is recommended to reshape the area to a maximum 3H:1V slope or flatter and reinstate vegetation by placing 100 to 150 mm of topsoil mixed with hardy seed and/or an erosion control blanket.

A toe erosion allowance is not required for the subject slope due to the absence of active erosion along the slope toe. It is expected, that a grassed face slope will be sufficient to provide resistance to any surficial erosion that could occur. Also, based on the absence of active erosion, a 6 m erosion access allowance is not required for the subject slope. **Therefore, a limit of hazard lands setback line can be applied along the top of the ditch watercourse bank since an allowance setback is not required for the future slope to be constructed adjacent to the watercourse.**

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

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

Backfill against the exterior sides of the foundation walls should consist of free-draining, non frost susceptible granular materials. The site 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 G100N) connected to a drainage system is provided.

6.2 Protection Against Frost Action

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

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for other exterior unheated footings.

6.3 Excavation Side Slopes

The excavations for the proposed development will be mostly through a stiff silty clay. Where excavation is above the groundwater level to a depth of approximately 3 m, the excavation side slopes should be stable in the short term at 1H:1V. Flatter slopes could be required for deeper excavations or for excavation below the groundwater level. Where such side slopes are not permissible or practical, temporary shoring should be used. The subsoil at this site is considered to be mainly a Type 2 or 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

The slope cross-sections recommended above are for temporary slopes. Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

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.

It is expected that deep service trenches in excess of 3 m will be completed using a temporary shoring system designed by a structural engineer, such as stacked trench boxes in conjunction with steel plates. The trench boxes should be installed to ensure that the excavation sidewalls are tight to the outside of the trench boxes and that the steel plates are extended below the base of the excavation to prevent basal heave (if required).

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

6.4 Groundwater Control

Due to the relatively impervious nature of the silty clay materials, it is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations.

Permit to Take Water

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

For typical ground or surface water volumes being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

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.

6.5 Winter Construction

The subsurface 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. Precautions should be taken if winter construction is considered for this project.

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, 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.

The trench excavations should be constructed in a manner that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. In addition, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure. Additional information could be provided, if required.

6.6 Landscaping Considerations

Tree Planting Restrictions

In accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines), Paterson completed a soils review of the site to determine applicable tree planting setbacks. Atterberg limits testing was completed for the recovered silty clay samples at selected locations throughout the subject site. The soil samples were recovered from elevations 2.1 m below the current ground surface elevation. The results of our testing are presented in Appendix 1.

Based on the results of the representative soil samples, the subject site is considered as a **low/medium** sensitivity area for tree planting according to the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines)

Since the modified plasticity limit (PI) generally does not exceed 40%, large trees (mature height over 14 m) can be planted at the subject site provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space).

Based on our testing results, tree planting setback limits should be 4.5 m for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the following conditions are met:

☐ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the Grading Plan as indicated procedural changes below.

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

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

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

☐ Grading surround the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree).

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

7.0 Recommendations

It is recommended that the following be completed once the master plan and site development are determined:

☐ Complete a supplemental geotechnical investigation to further evaluate the effect of the existing fill and further detail permissible grade raise restriction.

☐ Review detailed grading plan(s) from a geotechnical perspective.

☐ Review proposed changes to the existing slopes.

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

☐ 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 placing backfilling materials.

☐ Observation of clay seal placement at specified locations.

☐ 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 Paterson’s recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with Paterson's present understanding of the project. Paterson requests permission to review the grading plan once available. Paterson's recommendations should be reviewed when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and the test hole log are furnished as a matter of general information only. 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, Paterson requests to be notified immediately in order to permit reassessment of the recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Claridge Homes (Gladstone) 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.

LICENSED PROFESSIONAL ENGINEER
Oct. 16, 2020
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Joey R. Villeneuve, M.A.Sc., P.Eng.

David J. Gilbert, P.Eng.

Report Distribution:

❑ Claridge Homes (Gladstone)
❑ Paterson Group

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

BOREHOLE LOGS BY OTHERS

SYMBOLS AND TERMS

ATTERBERG LIMITS TESTING RESULT

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 10, 2020

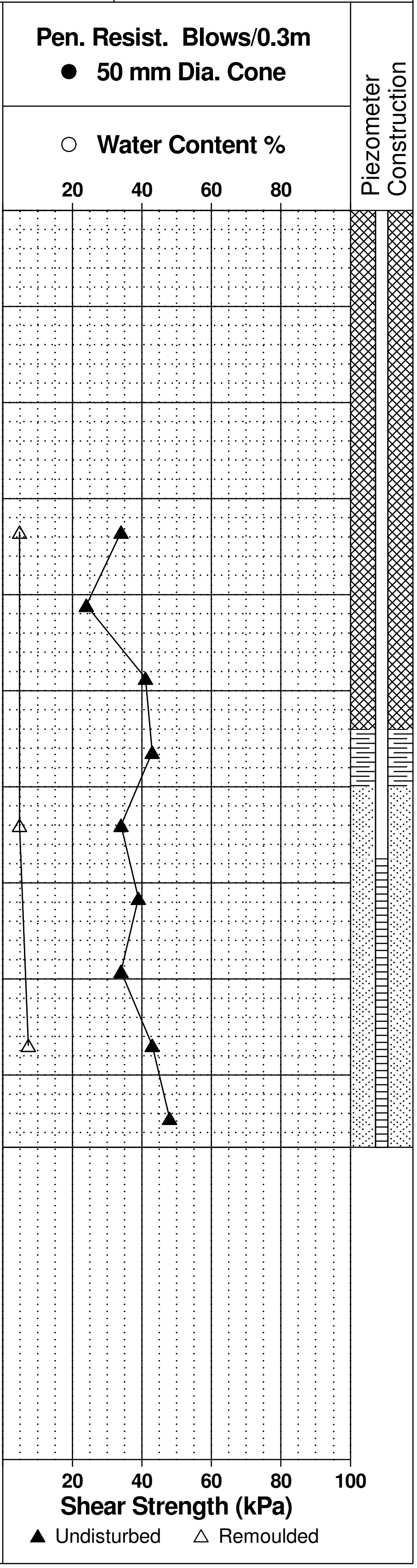
FILE NO. PG5224

HOLE NO. BH 1-20

SOIL DESCRIPTION	
GROUND SURFACE	
FILL: Brown silty sand, trace gravel and cobbles	0.76
FILL: Grey-brown silty clay, trace sand and gravel	0.97
FILL: Brown silty sand, trace gravel	2.39
Firm, grey **SILTY CLAY**	9.75
End of Borehole (Piezometer damaged - Sept. 18, 2020)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	75	23
SS	3	100	21
SS	4	100	2
SS	5	100	P
SS	6	100	P
SS	7	50	
SS	8	50	P
SS	9	79	P

DEPTH (m)	ELEV. (m)
0	85.59
1	84.59
2	83.59
3	82.59
4	81.59
5	80.59
6	79.59
7	78.59
8	77.59
9	76.59



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

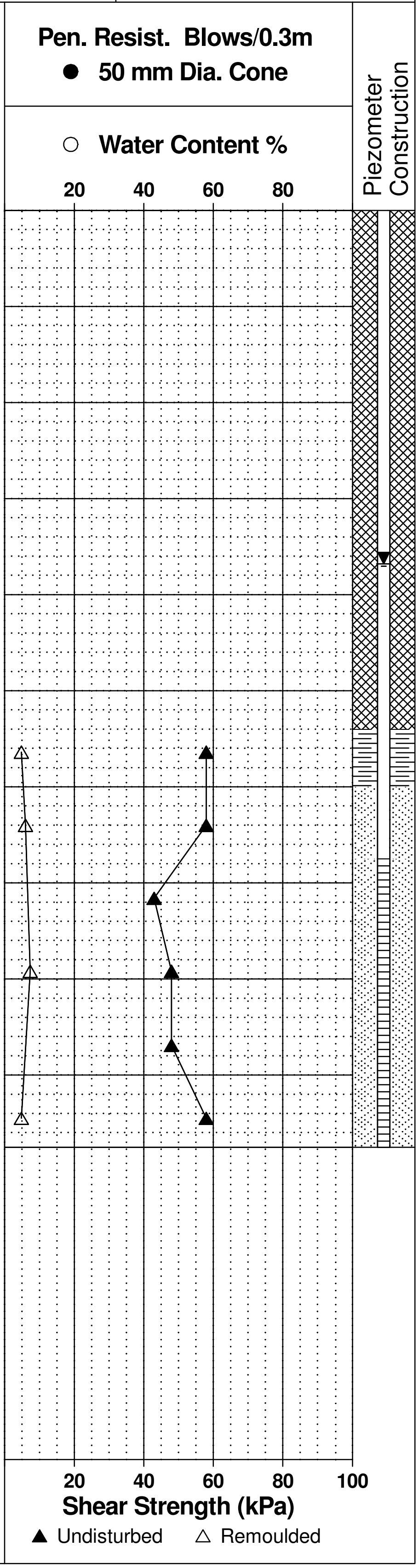
DATE September 10, 2020

FILE NO. PG5224

HOLE NO. BH 2-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Topsoil with construction debris and gravel — 0.60		AU	1		
FILL: Grey silty clay with roots, asphalt, gravel and brick — 2.29		SS	2		6
		SS	3		18
Stiff to firm, brown **SILTY CLAY** - grey by 6.1m depth — 9.75		SS	4		10
		SS	5		9
		SS	6		
		SS	7		4
End of Borehole (GWL @ 3.68m - Sept. 18, 2020)					

DEPTH (m)	ELEV. (m)
0	83.59
1	82.59
2	81.59
3	80.59
4	79.59
5	78.59
6	77.59
7	76.59
8	75.59
9	74.59



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** September 10, 2020

FILE NO. PG5224

HOLE NO. BH 3-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20, 40, 60, 80)	Monitoring Well Construction
GROUND SURFACE						0	83.22		
FILL: Brown silty sand with topsoil and construction debris		AU	1						
						1	82.22		
1.52									
FILL: Grey silty clay with sand and construction debris		SS	2	38	16				
						2	81.22		
2.29									
		SS	3	75	6				
Stiff to firm, brown **SILTY CLAY**						3	80.22		
		SS	4	54	7				
- grey by 3.8m depth						4	79.22		
4.42		SS	5	92	6				
End of Borehole									

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

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG5224**

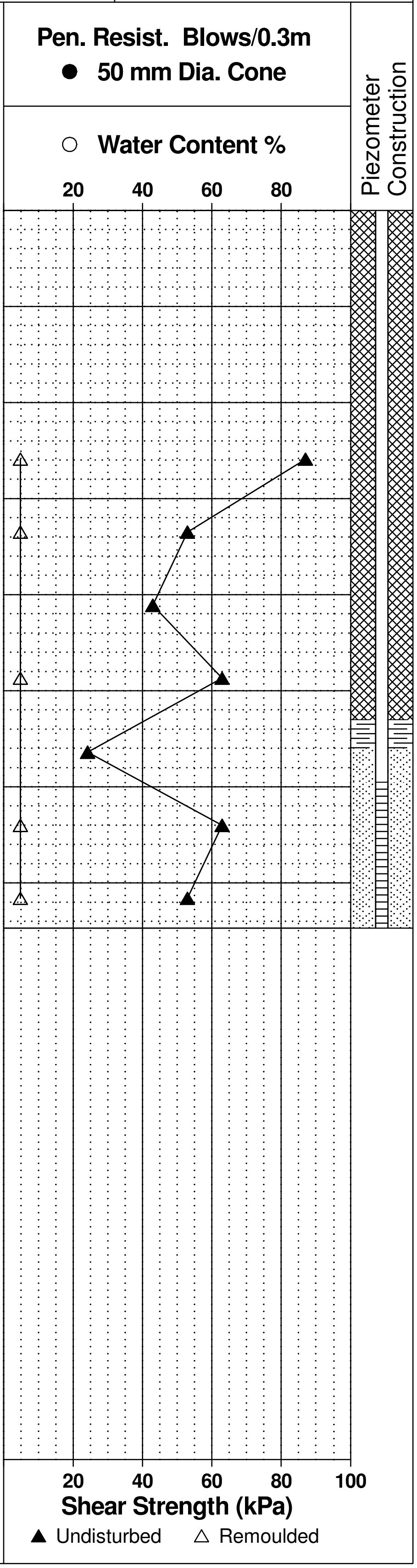
REMARKS

HOLE NO. **BH 4-20**

BORINGS BY CME-55 Low Clearance Drill

DATE September 10, 2020

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	70.66
TOPSOIL 0.15	AU	1				
Stiff, brown **SILTY CLAY**	SS	2	83	7	1	69.66
- grey by 1.5m depth	SS	3	92	5		
					2	68.66
					3	67.66
- firm to stiff by 3.8m depth					4	66.66
	SS	4	75	P		
					5	65.66
					6	64.66
	SS	5	83	P		
					7	63.66
7.47						
End of Borehole						
(Piezometer damaged - Sept. 18, 2020)						



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 11, 2020

FILE NO. **PG5224**

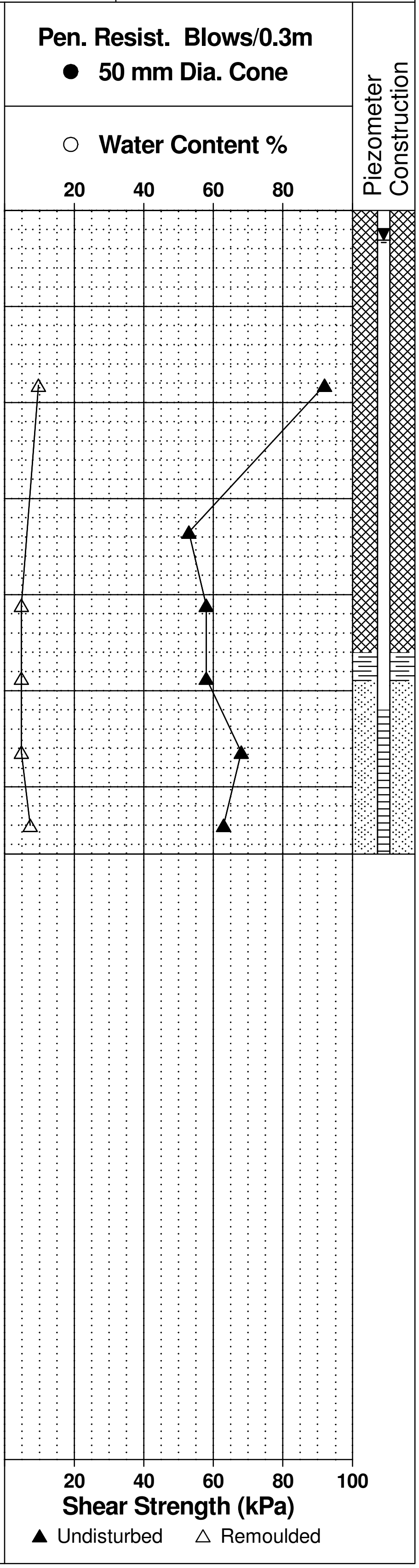
HOLE NO. **BH 5-20**

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	69.68
TOPSOIL	0.20	AU	1				
Stiff, brown **SILTY CLAY,** trace organics to 0.9m depth.		SS	2	75	4	1	68.68
- grey by 1.4m depth		SS	3	100	P	2	67.68
						3	66.68
		SS	4	50	P	4	65.68
		SS	5	83	P	5	64.68
	6.70					6	63.68

Dynamic Cone Penetration Test commenced at 6.70m depth and cone was pushed to 24.0m depth.

Practical DCPT refusal at 24.56m depth.

(GWL @ 0.31m - Sept. 18, 2020)



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

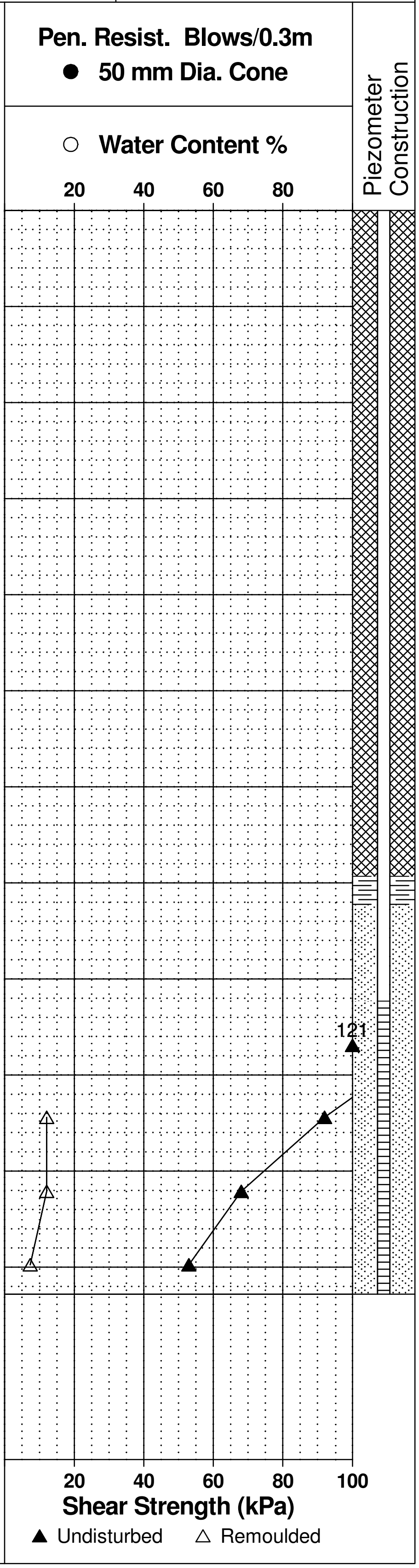
DATE September 11, 2020

FILE NO. PG5224

HOLE NO. BH 6-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty sand, trace gravel, cobbles, topsoil and construction debris		AU	1		
2.29		SS	2	0	7
FILL: Brown silty sand, trace clay, gravel and construction debris		SS	3	29	8
4.57		SS	4	21	10
FILL: Grey silty clay, trace organics, gravel and construction debris		SS	5	21	7
		SS	6	17	7
7.16		SS	7	67	14
FILL: Brown silty clay with sand 7.62		SS	8	67	15
Very stiff to stiff, brown **SILTY CLAY,** trace sand seams		SS	9	79	8
- grey by 9.1m depth		SS	10	96	P
11.28		SS	11	96	P
End of Borehole (Piezometer damaged - Sept. 18, 2020)					

DEPTH (m)	ELEV. (m)
0	81.73
1	80.73
2	79.73
3	78.73
4	77.73
5	76.73
6	75.73
7	74.73
8	73.73
9	72.73
10	71.73
11	70.73



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

SOIL PROFILE AND TEST DATA

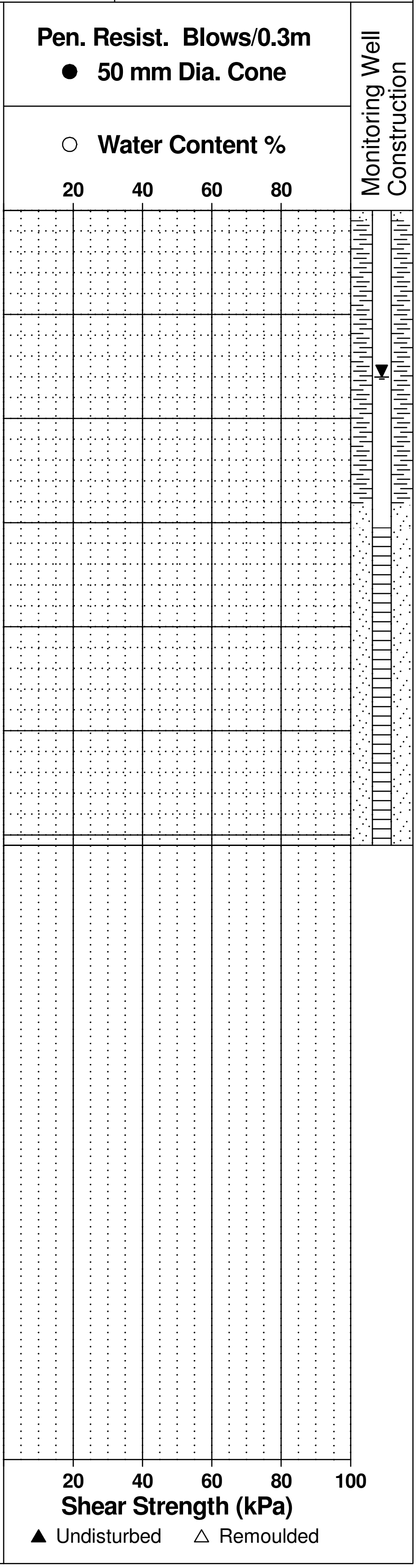
Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY CME 55 Power Auger
DATE 2019 May 16
FILE NO. PG5224
HOLE NO. BH 1

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	85.78
FILL: Brown silty sand with crushed stone and gravel 0.51	AU	1				
FILL: Brown silty clay, trace gravel 1.37	SS	2	33	14	1	84.78
FILL: Brown silty sand 2.59	SS	3	75	6	2	83.78
Brown **SILTY CLAY**	SS	4	100	6		
	SS	5	100	4	3	82.78
- grey by 3.8m depth	SS	6	100	4	4	81.78
	SS	7	100	1	5	80.78
6.10	SS	8	100	W	6	79.78

End of Borehole

(GWL @ 1.60m - May 31, 2019)



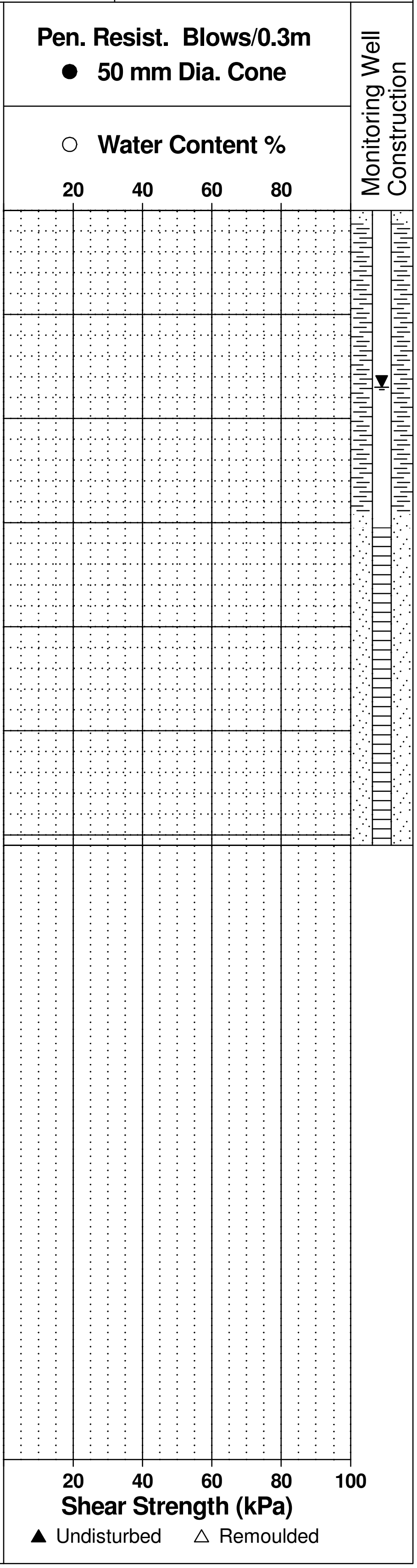
patersongroup Consulting Engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY CME 55 Power Auger
DATE 2019 May 16
FILE NO. PG5224
HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	85.67
FILL: Brown silty sand, some gravel, trace clay		AU	1				
		SS	2	21	15	1	84.67
		SS	3	79	13		
2.29						2	83.67
Brown **SILTY CLAY**		SS	4	46	7		
						3	82.67
- grey by 3.8m depth		SS	5	100	5		
		SS	6	100	4	4	81.67
		SS	7	100	W	5	80.67
		SS	8	100	W		
6.10						6	79.67
End of Borehole							
(GWL @ 1.70m - May 30, 2019)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM

REMARKS

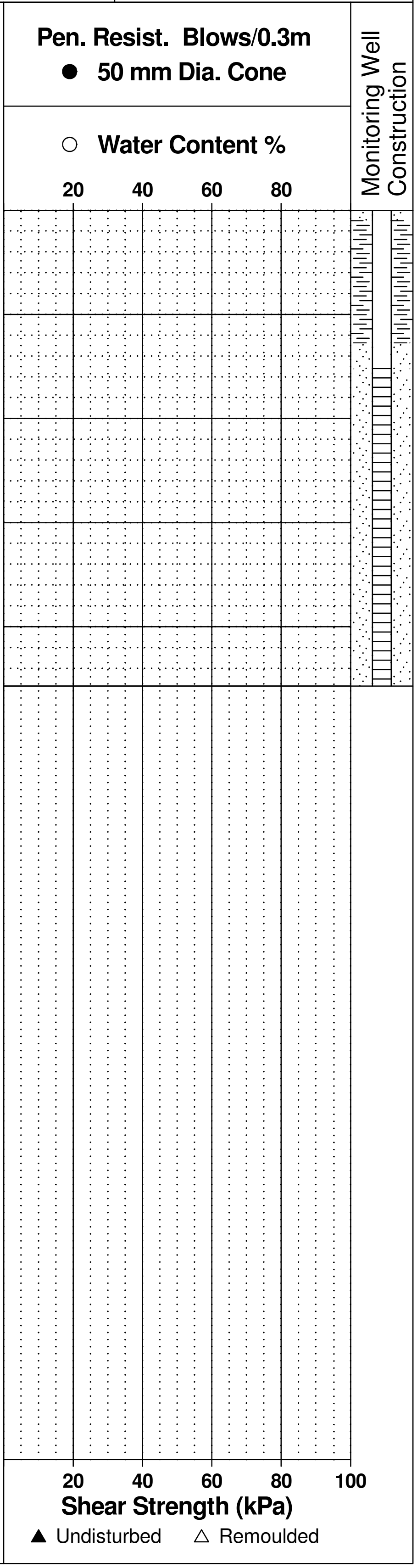
BORINGS BY CME 55 Power Auger

DATE 2019 May 16

FILE NO. PG5224

HOLE NO. BH 3

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	
FILL: Brown silty sand with gravel	AU	1				
	SS	2	71	18	1	
1.52						
Brown **SILTY CLAY**	SS	3	83	7	2	
- grey by 2.3m depth	SS	4	100	3	3	
	SS	5	100	3		
	SS	6	100	1	4	
4.57						
End of Borehole						
(MW damaged - May 30, 2019)						



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM

REMARKS

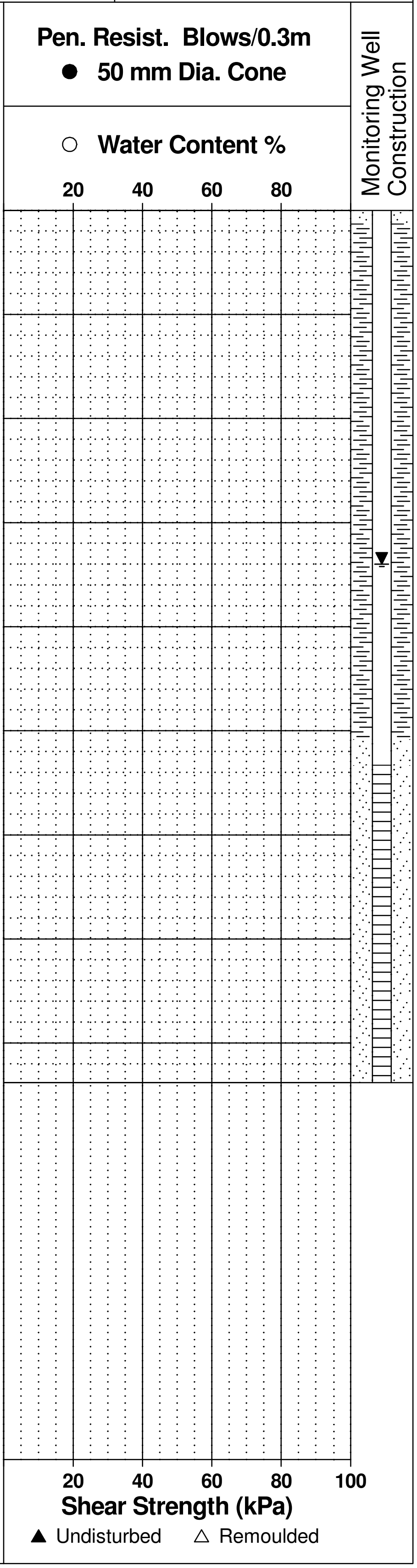
BORINGS BY CME 55 Power Auger

DATE 2019 May 16

FILE NO. PG5224

HOLE NO. BH 4

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	
FILL: Brown silty sand with gravel	0.60	AU	1				
FILL: Brow nsilty sand with clay, gravel and sandstone, trace organics	1.37	SS	2	33	27	1	
Brown **SILTY CLAY**		SS	3	58	9	2	
		SS	4	88	7		
		SS	5	100	7	3	
		SS	6	100	9	4	
		SS	7	100	7	5	
		SS	8	100	4		
- grey by 6.1m depth		SS	9	100	2	6	
		SS	10	100	2	7	
	8.38	SS	11	100		8	
End of Borehole (GWL @ 3.40m - May 30, 2019)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

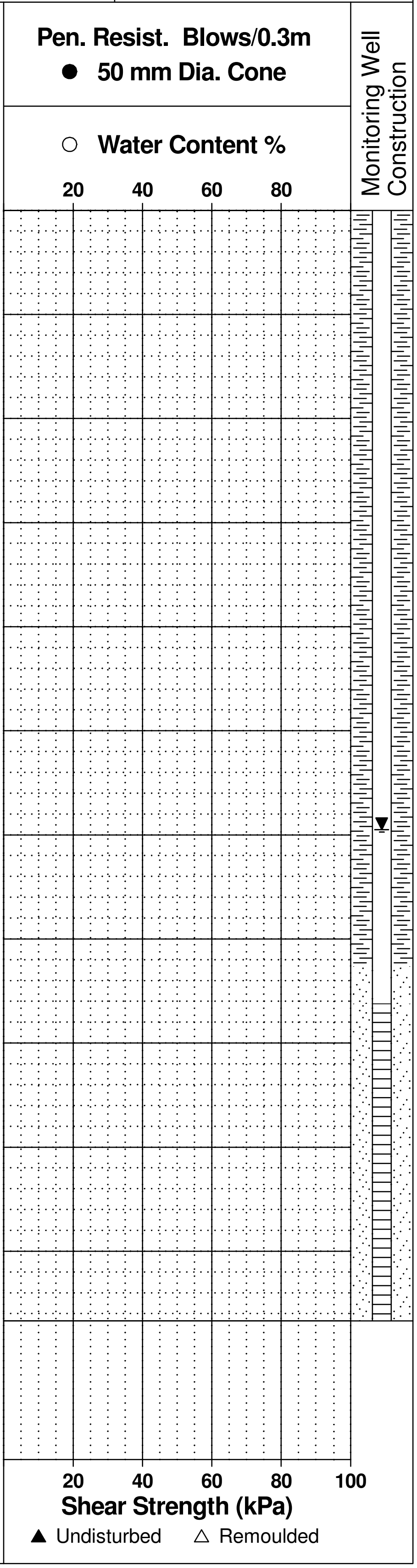
DATE 2019 May 17

FILE NO. PG5224

HOLE NO. BH 5

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand, some gravel and brick	AU	1		
	SS	2	33	8
	SS	3	54	9
	SS	4	29	14
	SS	5	58	5
	SS	6	42	15
	SS	7	38	6
6.10	SS	8	12	5
Brown **SILTY CLAY**	SS	9	79	21
	SS	10	100	15
	SS	11	100	8
- grey by 8.4m depth	SS	12	88	4
	SS	13	100	2
10.67	SS	14	100	1
End of Borehole				
(GWL @ 5.95m - May 30, 2019)				

DEPTH (m)	ELEV. (m)
0	82.34
1	81.34
2	80.34
3	79.34
4	78.34
5	77.34
6	76.34
7	75.34
8	74.34
9	73.34
10	72.34



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM

REMARKS

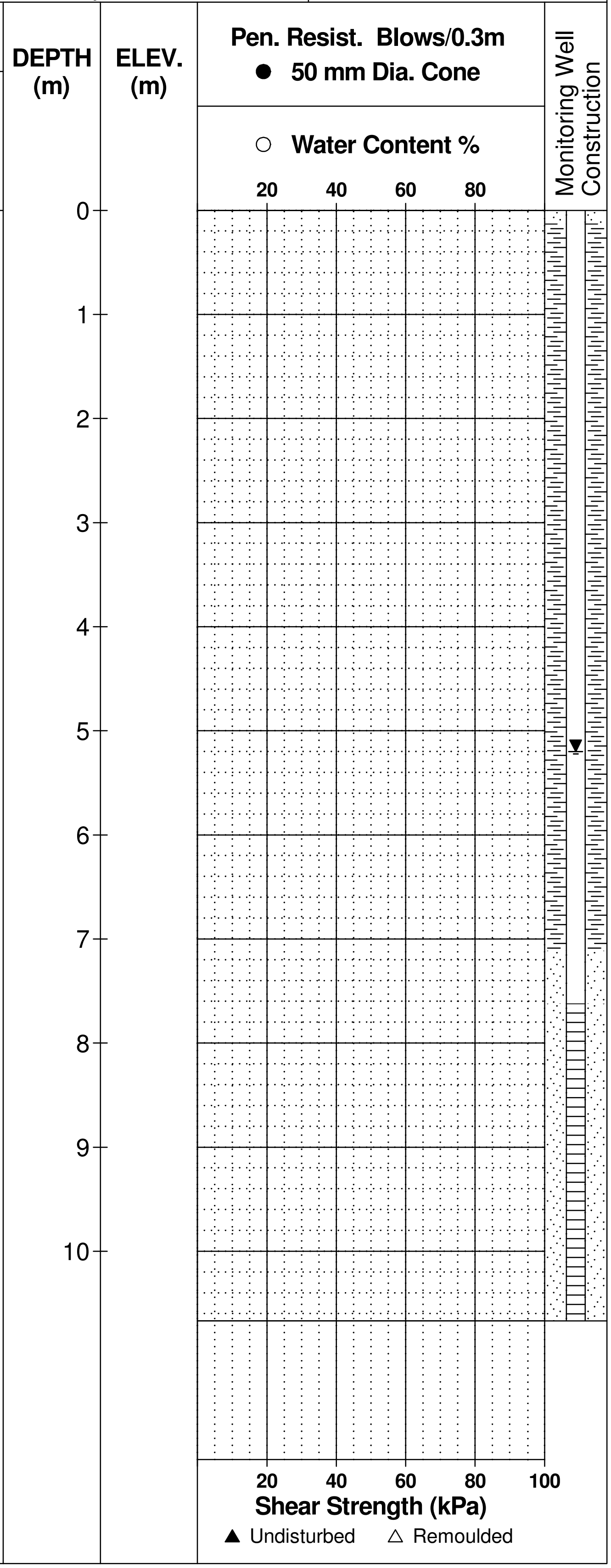
BORINGS BY CME 55 Power Auger

DATE 2019 May 17

FILE NO. PG5224

HOLE NO. BH 6

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand with gravel, some clay, trace brick and topsoil	AU	1		
	SS	2	58	16
	SS	3	33	7
	SS	4	71	7
	SS	5	62	8
	SS	6	75	22
	SS	7	71	8
	SS	8	67	20
6.86	SS	9	46	8
Brown **SILTY CLAY** - grey by 8.4m depth	SS	10	88	15
	SS	11	100	7
	SS	12	100	5
	SS	13	100	2
10.67	SS	14	100	W
End of Borehole (GWL @ 5.20m - May 30, 2019)				



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5224

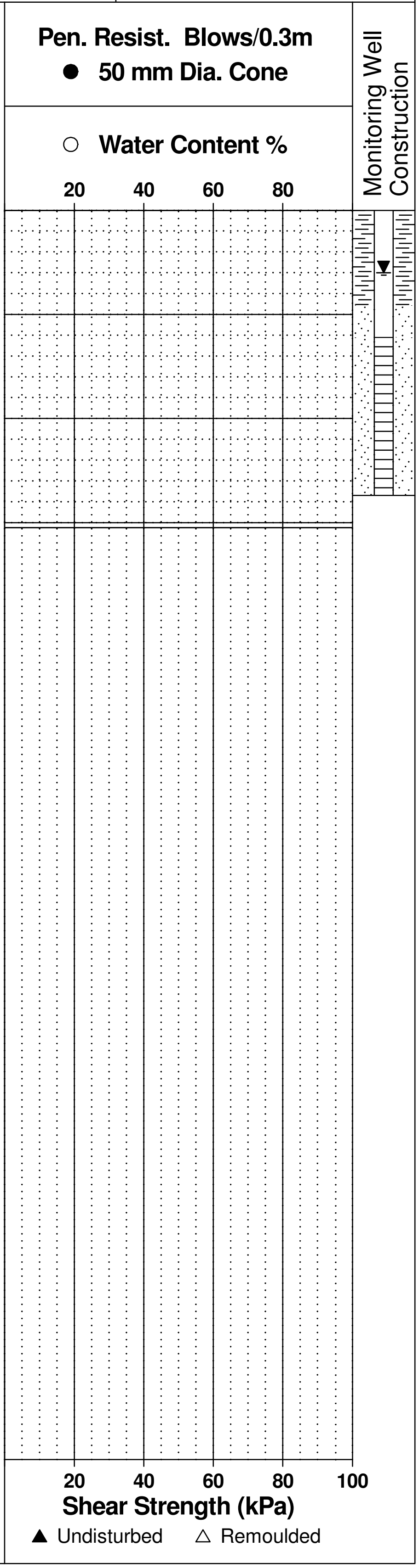
REMARKS

HOLE NO. BH 7

BORINGS BY Portable Drill

DATE May 22, 2019

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	73.97
TOPSOIL 0.30		SS	1	100			
Brown **SILTY CLAY** 0.71							
		SS	2	100		1	72.97
Brown **SILTY CLAY**		SS	3	100			
- grey by 1.8m depth		SS	4	100		2	71.97
3.05		SS	5	100		3	70.97
End of Borehole (GWL @ 0.60m - June 3, 2019)							



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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

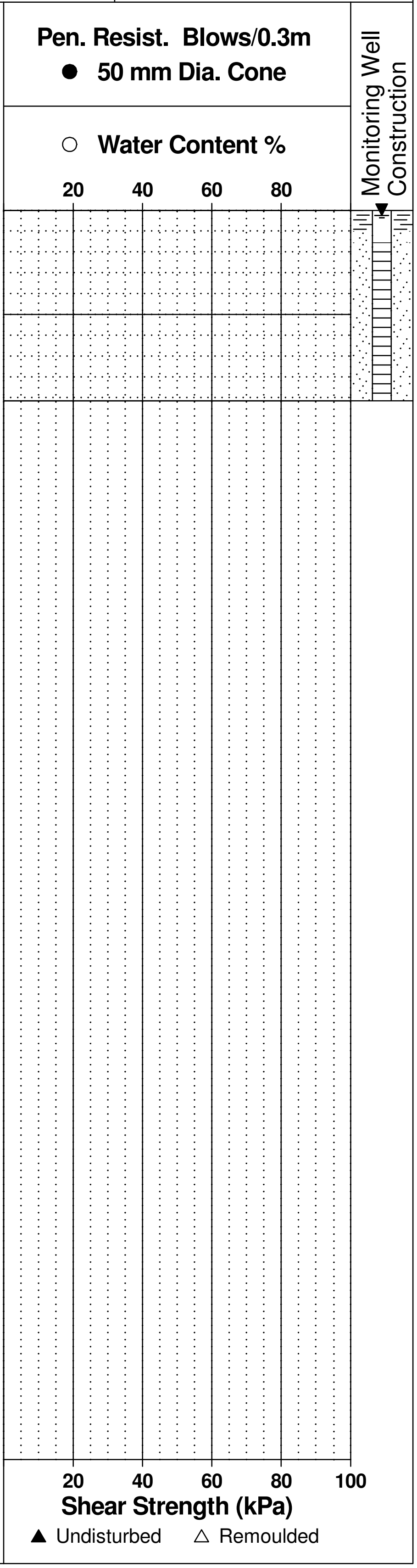
BORINGS BY Portable Drill

DATE May 22, 2019

FILE NO. PG5224

HOLE NO. BH 8

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	71.09
TOPSOIL 0.28		SS	1	12			
Grey **SILTY SAND** 0.91		SS	2	58		1	70.09
Brown **SILTY CLAY** - grey by 1.5m depth 1.83		SS	3	100			
End of Borehole (GWL @ 0.05m - June 3, 2019)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

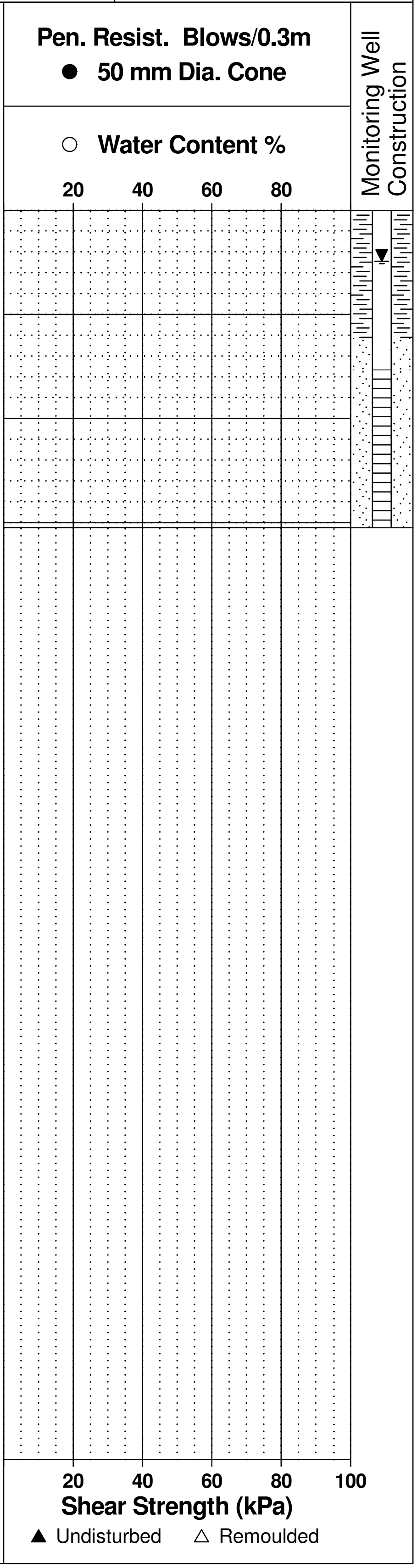
BORINGS BY Portable Drill

DATE 2019 May 22

FILE NO. PG5224

HOLE NO. BH 9

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	69.49
TOPSOIL 0.15		SS	1	62			
		SS	2	71		1	68.49
Brown **SILTY CLAY**		SS	3	100			
		SS	4	100		2	67.49
3.05		SS	5	100		3	66.49
End of Borehole (GWL @ 0.49m - June 3, 2019)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5224

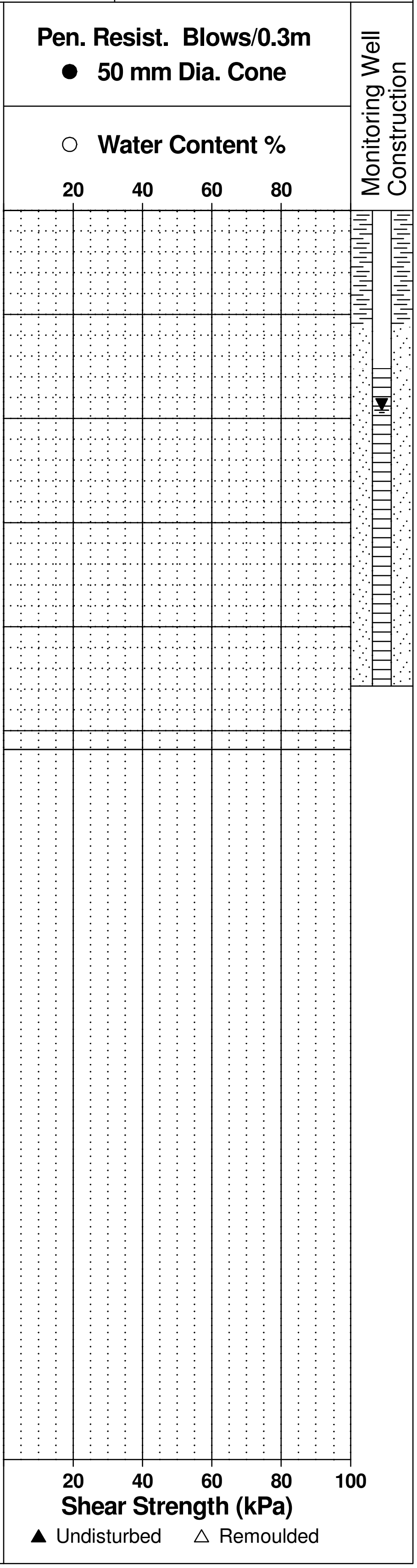
REMARKS

HOLE NO. BH10

BORINGS BY CME 55 Power Auger

DATE 2019 September 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.03
FILL: Brown silty clay, trace sand and gravel 0.81							
Compact to loose, brown **SILTY SAND**		SS	1	75	10	1	85.03
		SS	2	88	24	2	84.03
2.82		SS	3	88	9		
Brown **SILTY CLAY**		SS	4	100	2	3	83.03
- grey by 3.3m depth		SS	5	100	W	4	82.03
5.18		SS	6	100	W	5	81.03
End of Borehole (GWL @ 1.92m - Sept. 9, 2019)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM

REMARKS

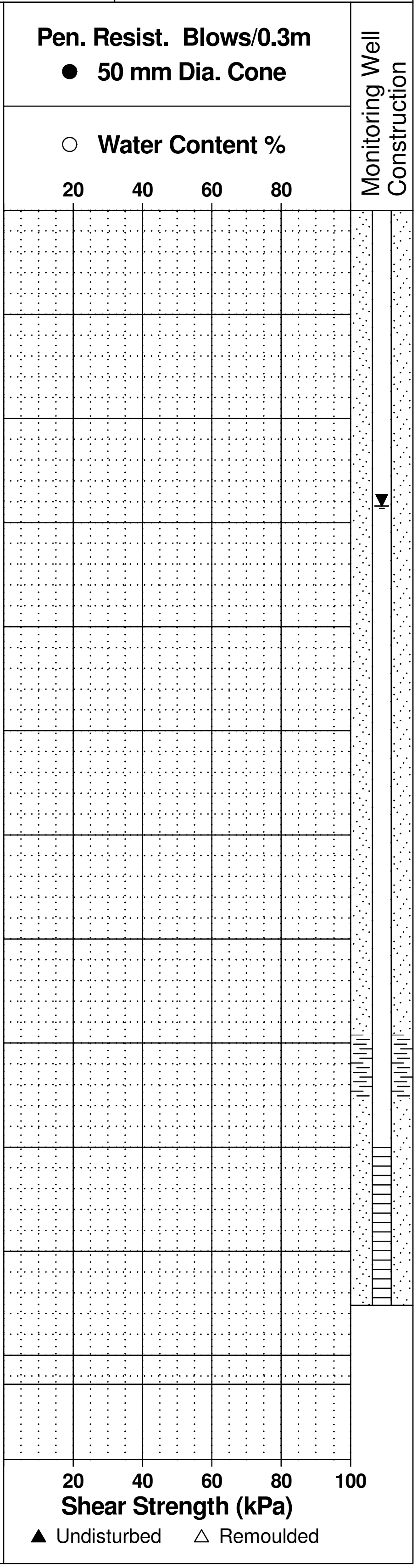
BORINGS BY CME 55 Power Auger

DATE 2019 September 5

FILE NO. PG5224

HOLE NO. BH11

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	
OVERBURDEN						1 – 6	
6.10							
Grey SILTY CLAY	▨	SS	1	100	1		
	▨	SS	2	100		7	
	▨	SS	3	100		8	
	▨	SS	4	100			
	▨	SS	5	100		9	
	▨	SS	6	100		10	
	▨	SS	7	100		11	
11.28							
End of Borehole (GWL @ 2.84m - Sept. 9, 2019)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5224

REMARKS

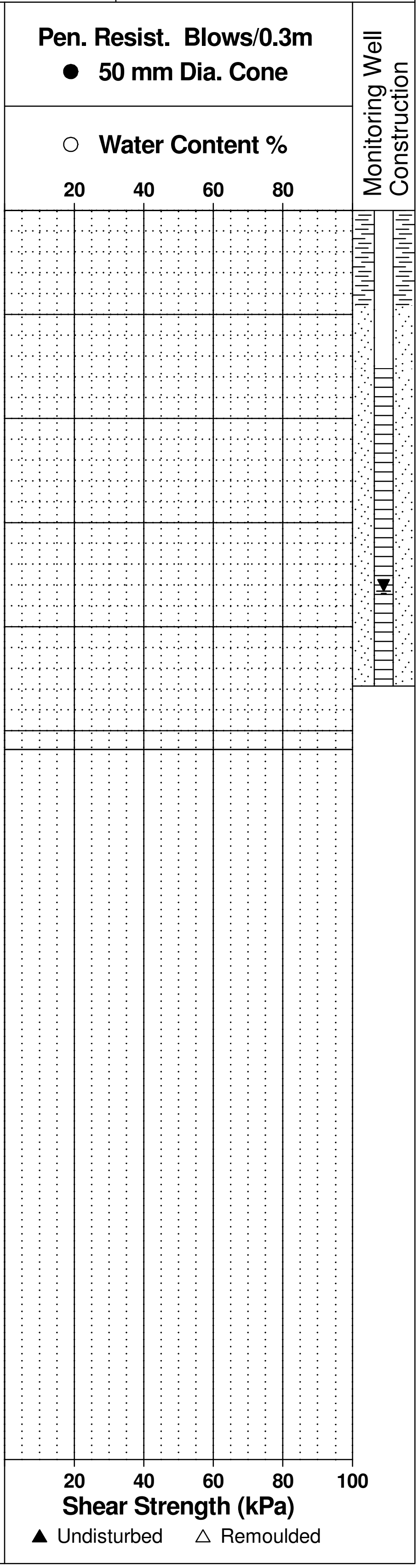
HOLE NO. BH12

BORINGS BY CME 55 Power Auger

DATE 2019 September 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or ROD
GROUND SURFACE					
FILL: Brown silty sand with gravel		SS	1	79	30
1.27					
Compact, grey **SILTY SAND**		SS	2	75	12
2.11					
Brown to grey **SILTY CLAY**		SS	3	100	1
		SS	4	100	W
		SS	5	100	W
		SS	6	100	W
5.18					
End of Borehole (GWL @ 3.66m - Sept. 9, 2019)					

DEPTH (m)	ELEV. (m)
0	85.14
1	84.14
2	83.14
3	82.14
4	81.14
5	80.14



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
3252 Navan Road
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2019 September 5

FILE NO. PG5224

HOLE NO. BH13

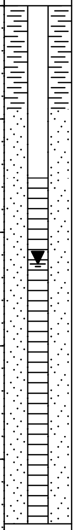
SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	
FILL: Brown silty sand with gravel, trace cobbles and boulders		SS	1	58	24	1	
1.52							
Compact, brown **SILTY SAND**		SS	2	58	18	2	
		SS	3	17	42		
3.05						3	
Brown **SILTY SAND**		SS	4	100	4		
- grey by 3.8m depth		SS	5	100	3	4	
		SS	6	100	W	5	
5.18							
End of Borehole							
(GWL @ 2.28m - Sept. 9, 2019)							

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

○ Water Content %
20 40 60 80

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

Monitoring Well Construction



PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-1

SHEET 1 OF 1

LOCATION: See Site Plan

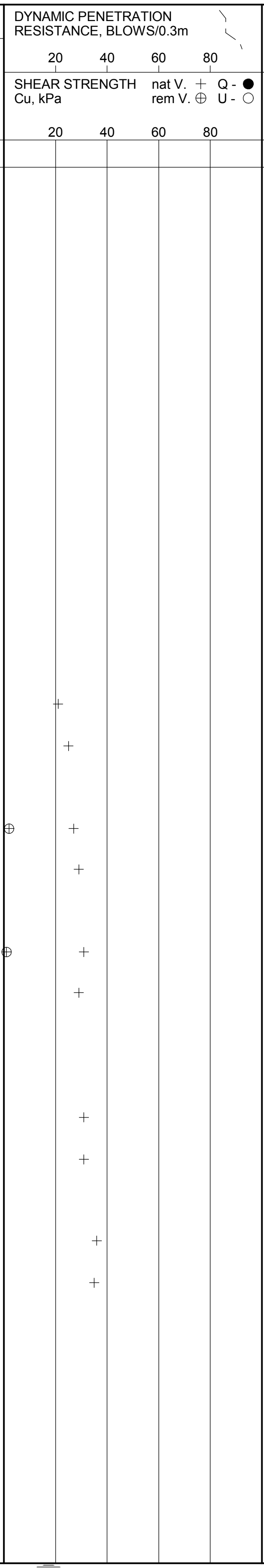
BORING DATE: January 12, 2016

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE	86.29			
0	Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE	0.02			
		FILL - Stone dust	0.12	1	AS	-
		TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive	85.99 0.30			
		(SP) SAND; brown; non-cohesive, moist to wet, compact				
1				2	SS	12
				3	SS	12
2				4	SS	16
3		(CI/CH) SILTY CLAY to CLAY; grey and red brown; cohesive, w>PL, soft	83.24 3.05	5	SS	WH
4		(CI/CH) SILTY CLAY to CLAY; grey and red brown, with black mottling; cohesive, w>PL, firm	82.02 4.27			
6				6	SS	WH
8		End of Borehole	78.06 8.23			



HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

▽

WL in open borehole at 2.13 m depth below ground surface upon completion of drilling

DEPTH SCALE
1 : 50

LOGGED: PAH
CHECKED:

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-1A

SHEET 1 OF 1

LOCATION: See Site Plan

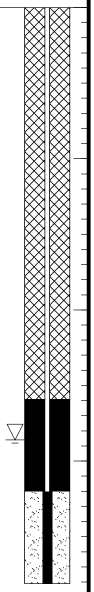
BORING DATE: January 12, 2016

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ├─○W─┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.24							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil descriptions refer to Record of Borehole 16-1		0.00							Native Backfill
3											Bentonite Seal
					1	TP	PH			C	Standpipe
		End of Borehole		82.43 3.81							WL in Standpipe at Elev. 83.38 m on Jan. 22, 2016



DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED:

MIS-BHS 001 07-1121-0232.GPJ GAL-MIS.GDT 08/31/16 JM

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: January 12, 2016

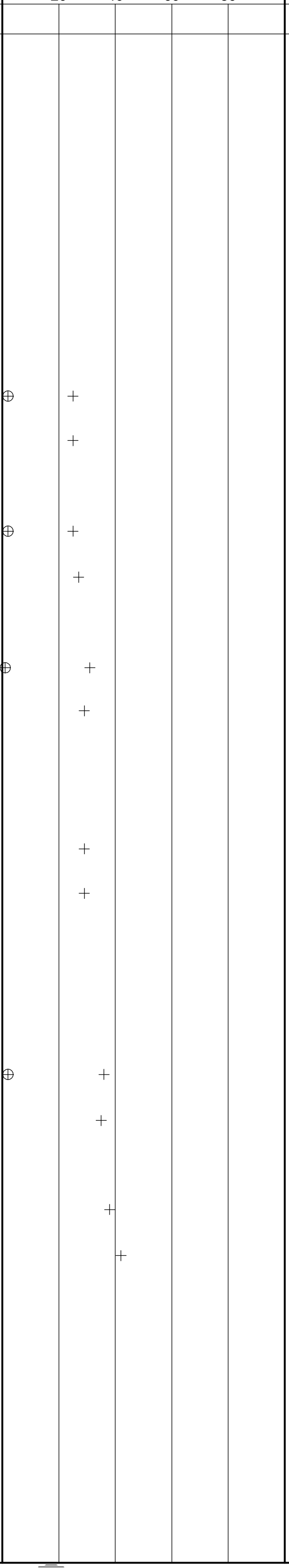
DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger 200 mm Diam. (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
	GROUND SURFACE	84.33			
0	TOPSOIL - (SM) SILTY SAND; dark brown; non-cohesive	0.00	1	AS	-
	(SP) SAND; grey brown, thinly laminated; non-cohesive, wet, loose	0.12			
1			2	SS	6
	(CI/CH) SILTY CLAY to CLAY; grey and red brown, with black mottling; cohesive, w>PL, firm	83.17 1.16			
2			3	SS	WH
5			4	SS	WH
6			5	SS	PM
8	End of Borehole	76.10 8.23			



HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl; 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION: ∇

WL in open borehole at 0.50 m depth below ground surface upon completion of drilling

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: PAH
CHECKED:

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-2A

SHEET 1 OF 1

LOCATION: See Site Plan

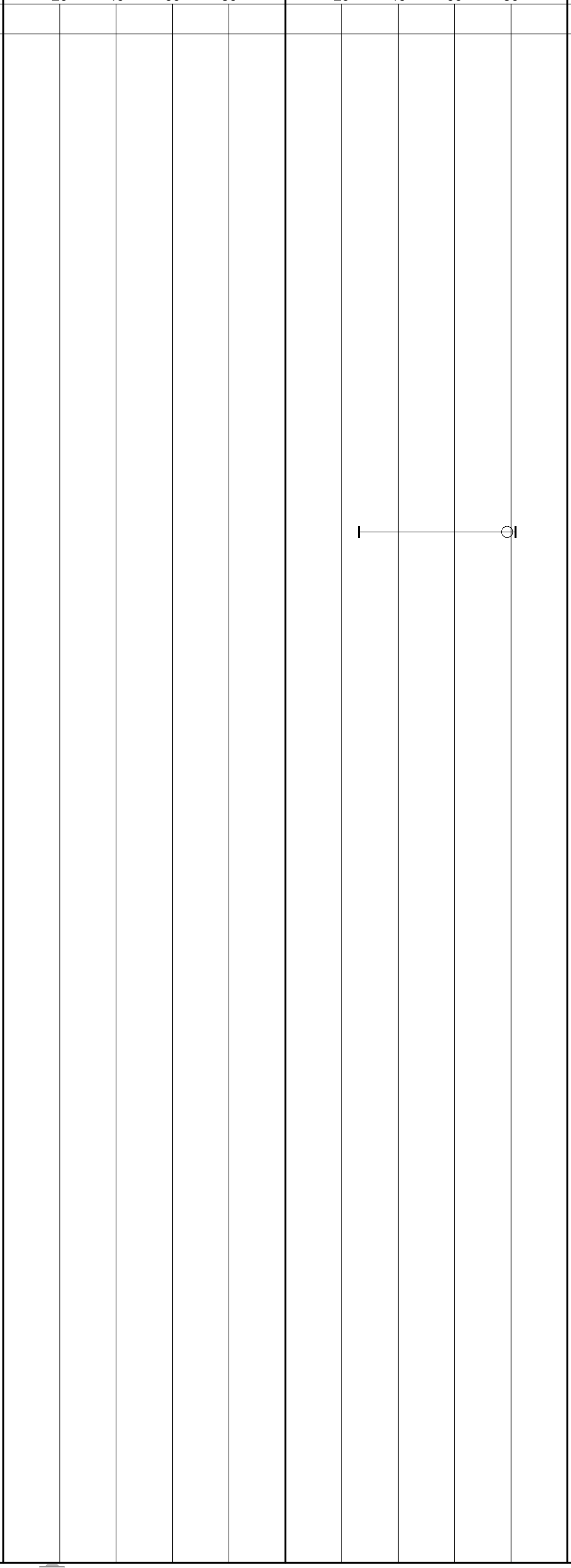
BORING DATE: January 12, 2016

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		84.33							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil descriptions refer to Record of Borehole 16-2		0.00							
					1	TP	PH			C	
		End of Borehole		80.67 3.66							



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED:

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-3

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: January 12, 2016

DATUM:

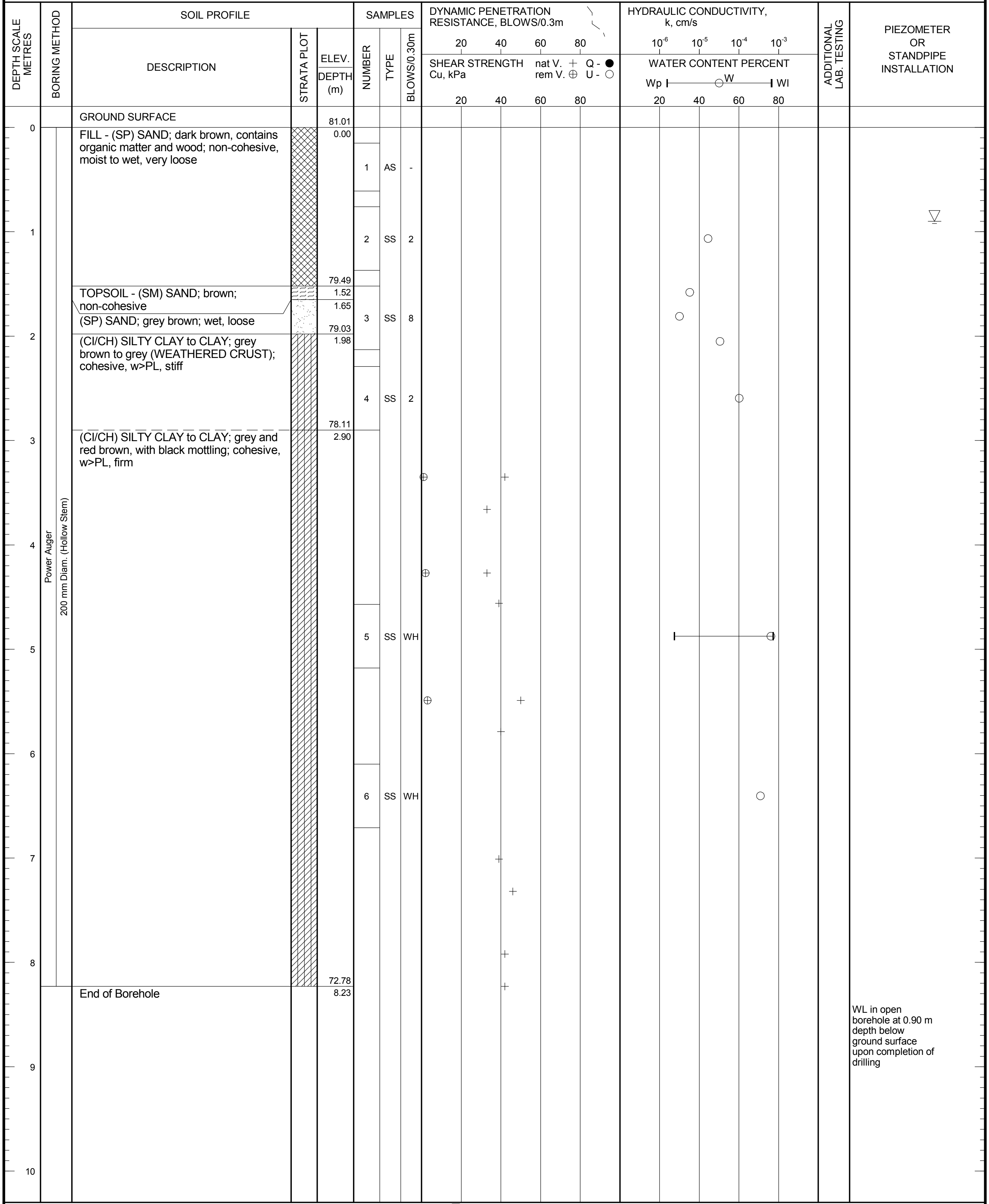
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger
200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	81.01
FILL - (SP) SAND; dark brown, contains organic matter and wood; non-cohesive, moist to wet, very loose	0.00
TOPSOIL - (SM) SAND; brown; non-cohesive	79.49 1.52
(SP) SAND; grey brown; wet, loose	1.65
(CI/CH) SILTY CLAY to CLAY; grey brown to grey (WEATHERED CRUST); cohesive, w>PL, stiff	79.03 1.98
(CI/CH) SILTY CLAY to CLAY; grey and red brown, with black mottling; cohesive, w>PL, firm	78.11 2.90
End of Borehole	72.78 8.23

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	AS	-
2	SS	2
3	SS	8
4	SS	2
5	SS	WH
6	SS	WH



WL in open borehole at 0.90 m depth below ground surface upon completion of drilling

DEPTH SCALE
1 : 50

LOGGED: PAH

CHECKED:

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-3A

SHEET 1 OF 1

LOCATION: See Site Plan

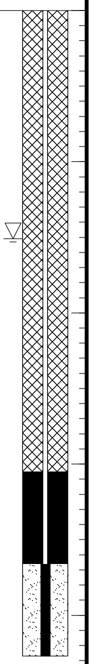
BORING DATE: January 12, 2016

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		81.01							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil descriptions refer to Record of Borehole 16-3		0.00							
1											
											Native Backfill ▽
2											
3											
											Bentonite Seal
4					1	TP	PH		⊢———○⊣		Standpipe
		End of Augerhole		76.74 4.27							
											WL in Standpipe at Elev. 78.50 m on Jan. 22, 2016
5											
6											
7											
8											
9											
10											



MIS-BHS 001 07-1121-0232.GPJ GAL-MIS.GDT 08/31/16 JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED:

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-4

SHEET 1 OF 1

LOCATION: See Site Plan

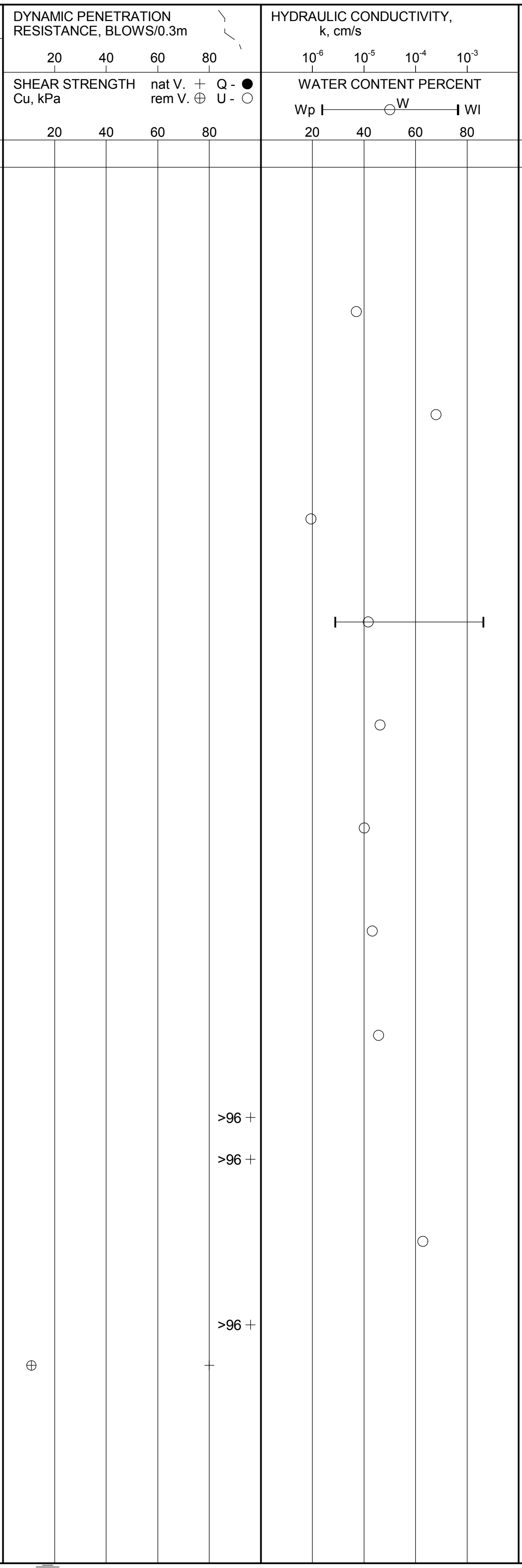
BORING DATE: January 13, 2016

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE	82.07			
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL - (OL) ORGANIC SILT, trace gravel; dark brown, contains sand, clay, wood, and debris; non-cohesive, moist, loose	0.00			
1				1	SS	6
				2	SS	8
2				3	SS	8
			79.17			
3		(CI/CH) SILTY CLAY to CLAY; grey brown and red brown, highly fissured (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	2.90	4	SS	10
4				5	SS	8
5				6	SS	9
				7	SS	8
6				8	SS	6
8				9	SS	WH
			73.23			
9		End of Borehole	8.84			
10						



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Open borehole dry upon completion of drilling

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED:

RECORD OF BOREHOLE: 16-5

PROJECT: 07-1121-0232-7000

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: January 13, 2016

DATUM:

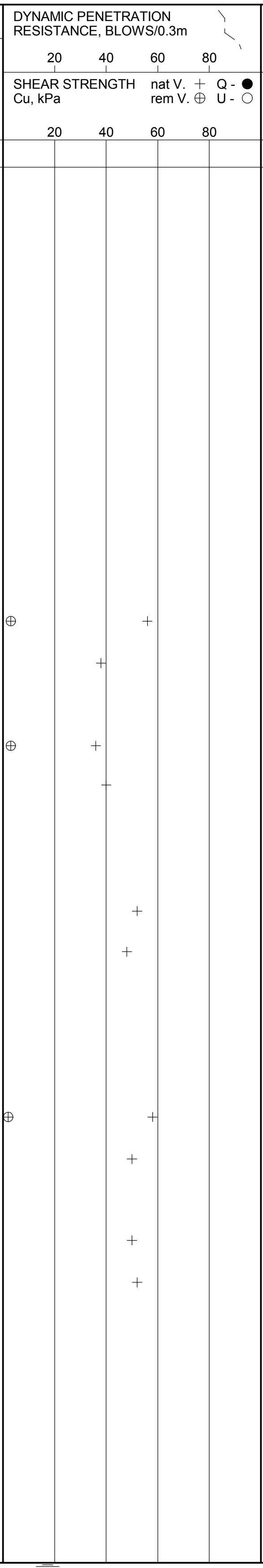
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
GROUND SURFACE		72.24
TOPSOIL - (ML) CLAYEY SILT and sandy SILT; dark brown; non-cohesive		0.00
(CI/CH) SILTY CLAY to CLAY; grey brown, highly fissured (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff		72.02 0.22
(CI/CH) SILTY CLAY to CLAY; grey and red brown, with black mottling; cohesive, w>PL, firm to stiff		68.89 3.35
End of Borehole		64.01 8.23

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	6
2	SS	6
3	SS	2
4	SS	PM
5	SS	PM



HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢ ○W ⊣ Wl — 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Open borehole dry upon completion of drilling

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

LOGGED: PAH

CHECKED:

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-6

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: January 14, 2016

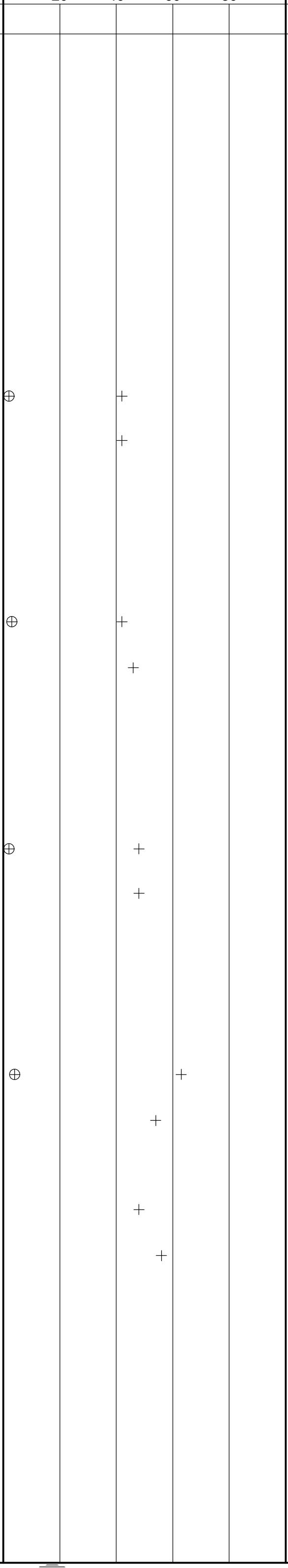
DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
		GROUND SURFACE		70.50
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SP) SAND; brown; non-cohesive		0.00
		(CI/CH) SILTY CLAY to CLAY; grey brown, highly fissured (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	▨	0.08
2		(CI/CH) SILTY CLAY to CLAY; grey and red brown, with black mottling; cohesive, w>PL, firm to stiff	▨	68.52 1.98
8		End of Borehole		62.27 8.23

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	4
2	SS	1
3	TP	PH
4	SS	PM
5	SS	PM



HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl; 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Open borehole dry upon completion of drilling

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED:

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-101

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: June 18, 2016

DATUM:

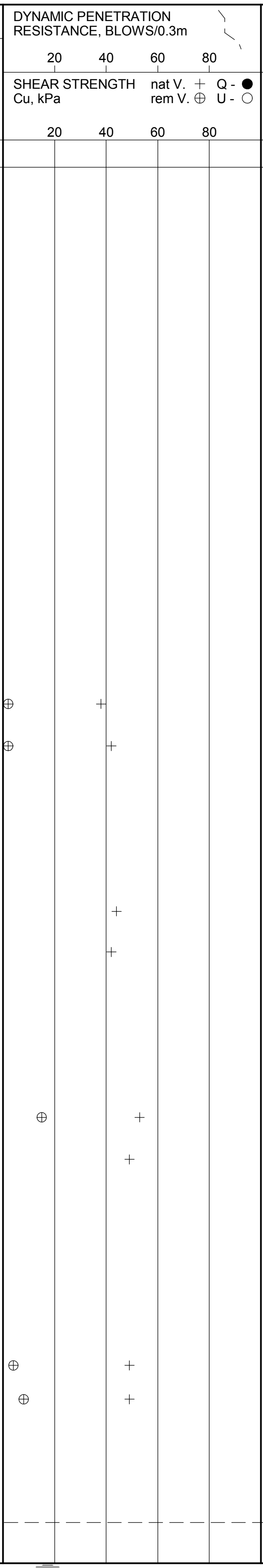
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	73.67
TOPSOIL	0.00
(CI/CH) SILTY CLAY to CLAY; grey brown, contains rootlets (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	73.34 0.33
(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm to stiff	70.62 3.05

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	5
2	SS	4
3	SS	1
4	SS	WH
5	SS	WH
6	SS	WH
7	TP	PH
8	SS	WH



HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl; 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION: Cuttings

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: JB

CHECKED: TMS

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-101

SHEET 2 OF 2

LOCATION: See Site Plan

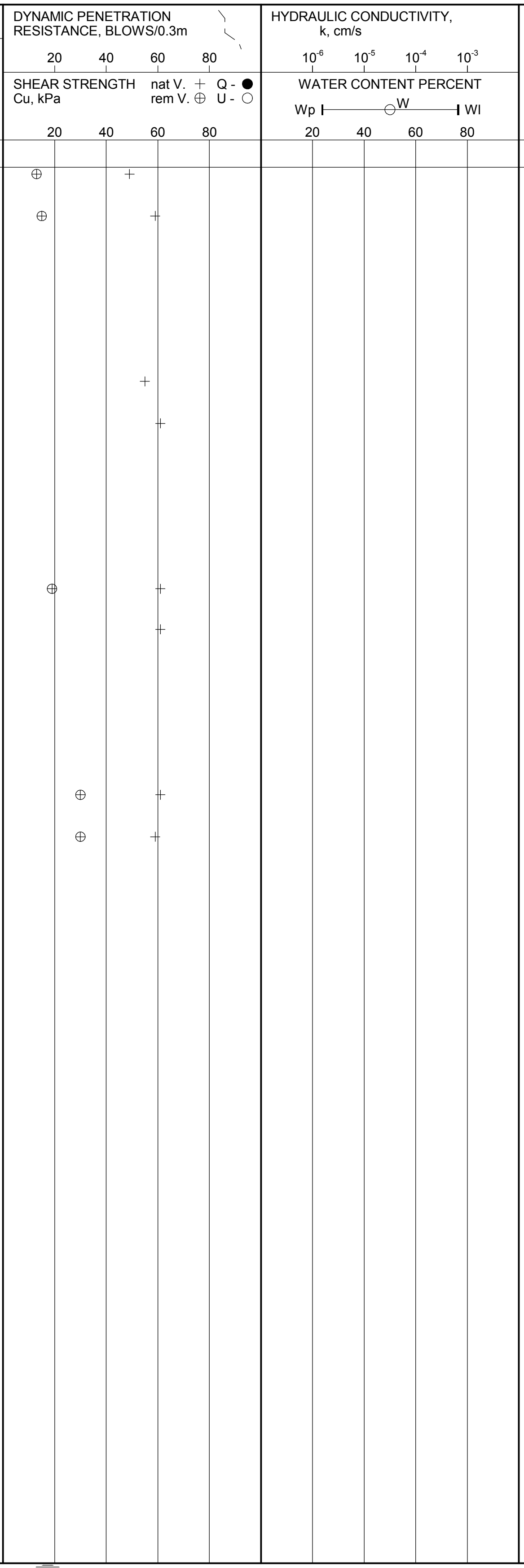
BORING DATE: June 18, 2016

DATUM:

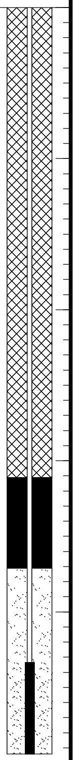
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING
		--- CONTINUED FROM PREVIOUS PAGE ---					
10	Power Auger 200 mm Diam. (Hollow Stem)	(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm to stiff					
11				9	SS	WH	
12				10	SS	WH	
13							
14				11	TP	PH	
				12	SS	-	
15		End of Borehole	58.73 14.94				
16							
17							
18							
19							
20							



PIEZOMETER OR STANDPIPE INSTALLATION



Cuttings

Bentonite Seal

Silica Sand

Standpipe

W.L. in Standpipe at 0.53 m above ground surface on August 24, 2016

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: JB

CHECKED: TMS

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-102

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: June 18, 2016

DATUM:

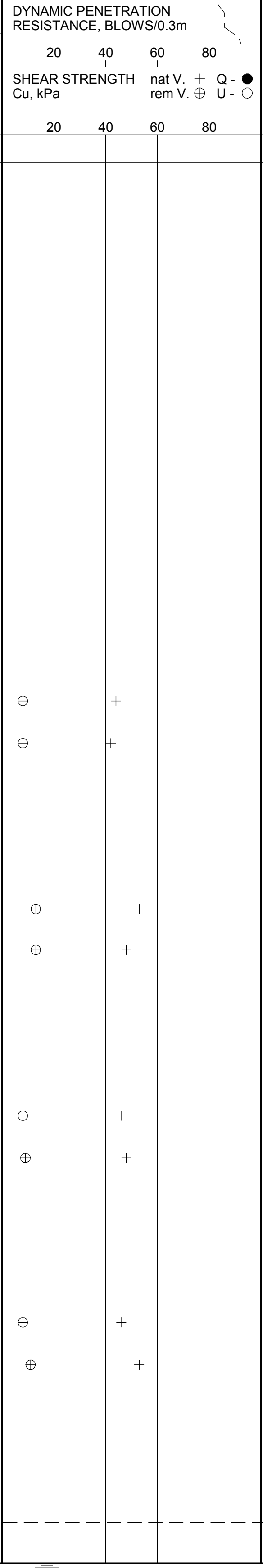
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	73.91
TOPSOIL	0.00
(SM) SILTY SAND; grey brown; non-cohesive, moist	73.63 0.28
(CI/CH) SILTY CLAY to CLAY; grey brown, contains rootlets (WEATHERED CRUST); cohesive, w>PL, stiff to very stiff	73.15 0.76
(CI/CH) SILTY CLAY; grey; cohesive, w>PL, firm to stiff	70.86 3.05

NUMBER	TYPE	BLOWS/0.30m
1	SS	5
2	SS	4
3	SS	1
4	SS	WH
5	SS	WH
6	SS	WH
7	TP	PH
8	TP	PH
9	SS	-



HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl: 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

LOGGED: JB

CHECKED: TMS

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-102

SHEET 2 OF 2

LOCATION: See Site Plan

BORING DATE: June 18, 2016

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	SOIL PROFILE STRATA PLOT	SOIL PROFILE ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10		(CI/CH) SILTY CLAY; grey; cohesive, w>PL, firm to stiff	▨	63.55	9	SS	-	⊕ + ⊕ +			
		End of Borehole		10.36							
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: JB

CHECKED: TMS

PROJECT: 07-1121-0232-7000

RECORD OF BOREHOLE: 16-103

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 18, 2016

DATUM:

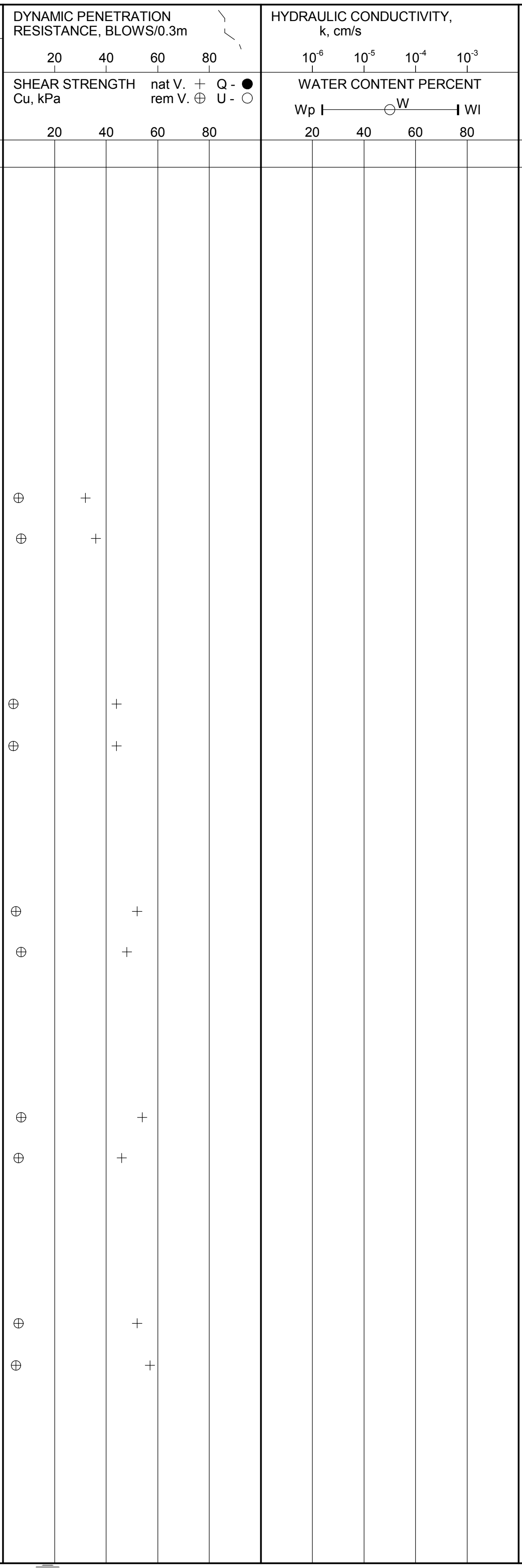
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger
200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	71.00
TOPSOIL	0.00
(SM) SILTY SAND; brown grey; non-cohesive, moist	70.77 0.23
(CI/CH) SILTY CLAY to CLAY; grey brown, contains rootlets (WEATHERED CRUST); cohesive, w>PL	70.39 0.61
(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm to stiff	68.87 2.13
End of Borehole	62.16 8.84

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	4
2	SS	WH
3	SS	WH
4	SS	WH
5	SS	WH
6	SS	WH



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: JB

CHECKED: TMS

PROJECT: 05-1120-041

RECORD OF BOREHOLE: 05-3

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: May 10, 2005

DATUM: Geodetic

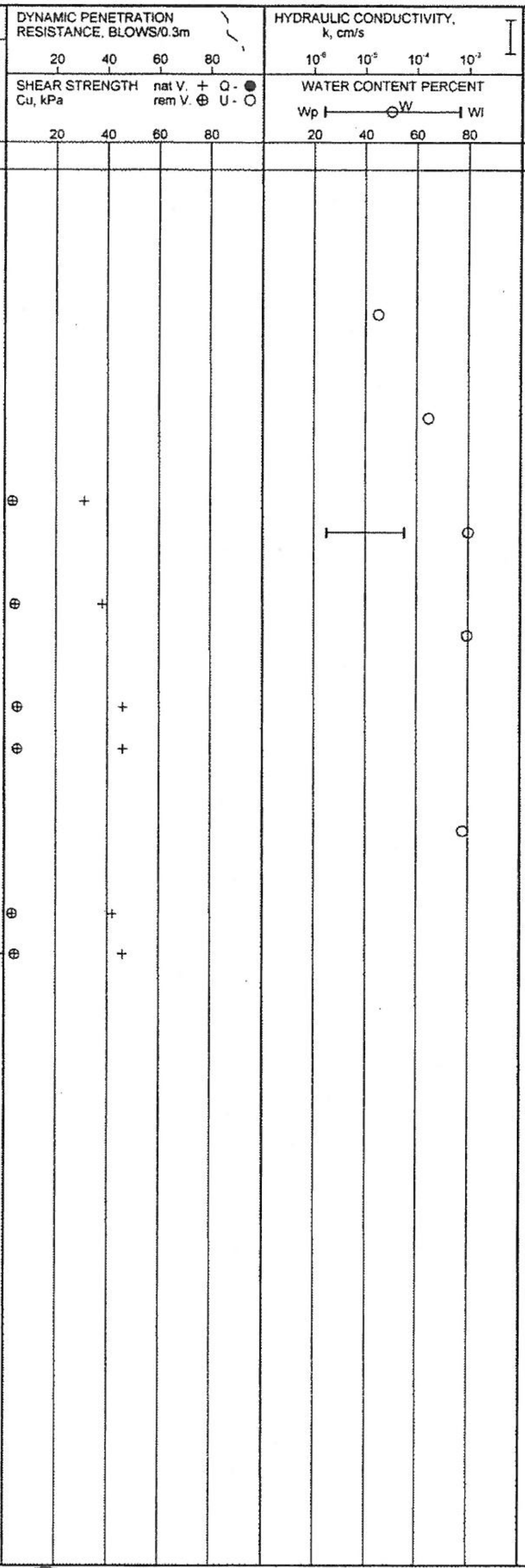
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	69.86
Brown sandy TOPSOIL	0.00
Very stiff grey brown SILTY CLAY, trace red brown layer (Weathered Crust)	69.65 0.21
Firm grey SILTY CLAY, trace red brown layer, trace black organic matter	67.73 2.13
End of Borehole	64.07 5.79

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	7	
2	50 DO	1	
3	73 TP	PH	C
4	50 DO	PM	
5	50 DO	PM	



PIEZOMETER OR STANDPIPE INSTALLATION

- Bentonite Seal
- Native Backfill
- Bentonite Seal
- Standpipe
- Bentonite Seal
- Native Backfill

Water level in standpipe at elev. 68.96m on July 11, 2005

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: K.S.L.
CHECKED: T.M.S.

PROJECT: 05-1120-041

RECORD OF BOREHOLE: 05-11

SHEET 1 OF 1

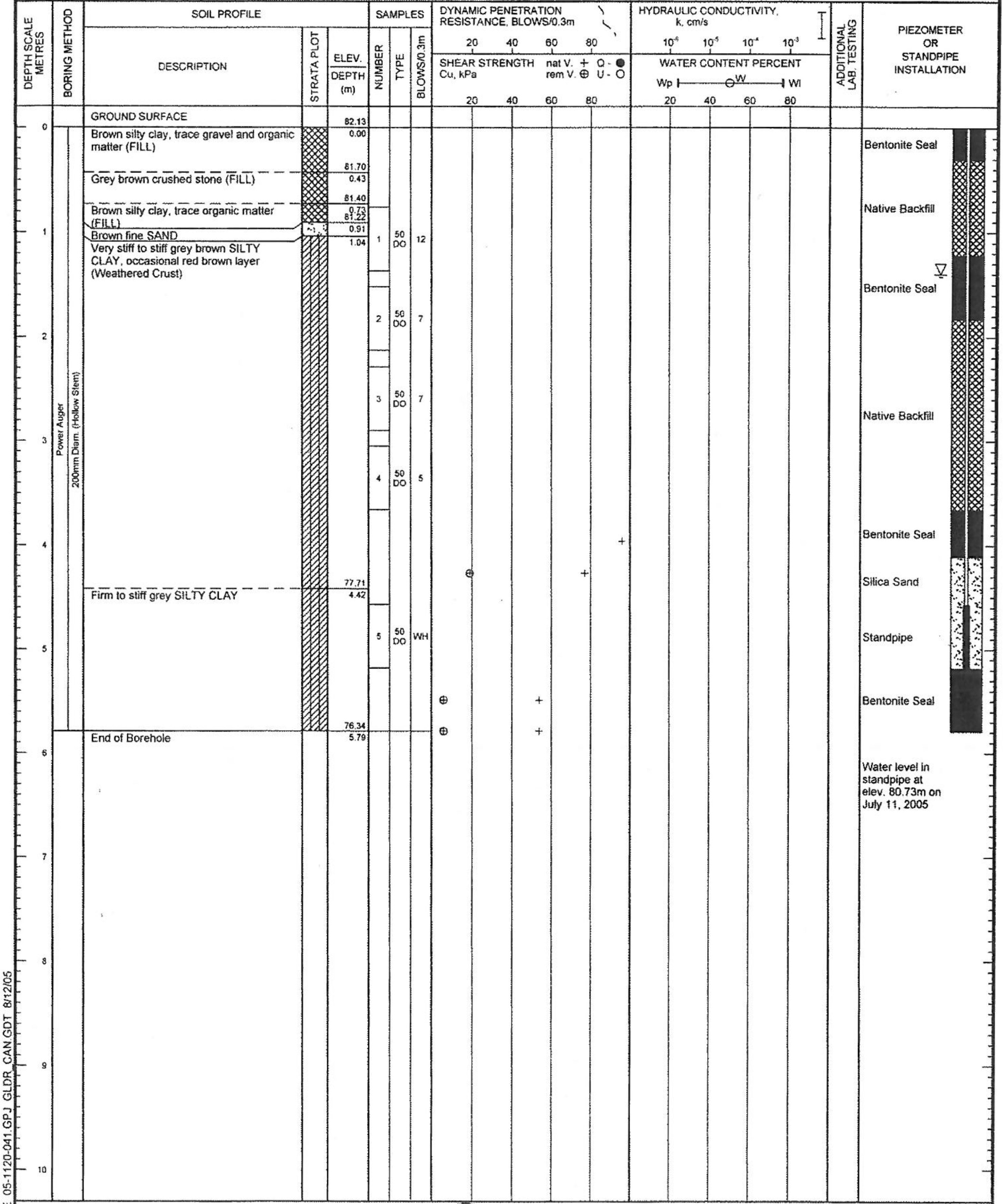
LOCATION: See Site Plan

BORING DATE: May 12, 2005

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	82.13
Brown silty clay, trace gravel and organic matter (FILL)	0.00
Grey brown crushed stone (FILL)	81.70 0.43
Brown silty clay, trace organic matter (FILL)	81.40 0.73
Brown fine SAND	81.22 0.91
Very stiff to stiff grey brown SILTY CLAY, occasional red brown layer (Weathered Crust)	1.04
Firm to stiff grey SILTY CLAY	77.71 4.42
End of Borehole	76.34 5.79

NUMBER	TYPE	BLOWS/0.3m
1	50 DO	12
2	50 DO	7
3	50 DO	7
4	50 DO	5
5	50 DO	WH

PIEZOMETER OR STANDPIPE INSTALLATION

- Bentonite Seal
- Native Backfill
- Bentonite Seal
- Native Backfill
- Bentonite Seal
- Silica Sand
- Standpipe
- Bentonite Seal

Water level in standpipe at elev. 80.73m on July 11, 2005

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: D.J.S.
CHECKED: T.M.S.

PROJECT: 05-1120-041

RECORD OF BOREHOLE: 05-12

SHEET 1 OF 1

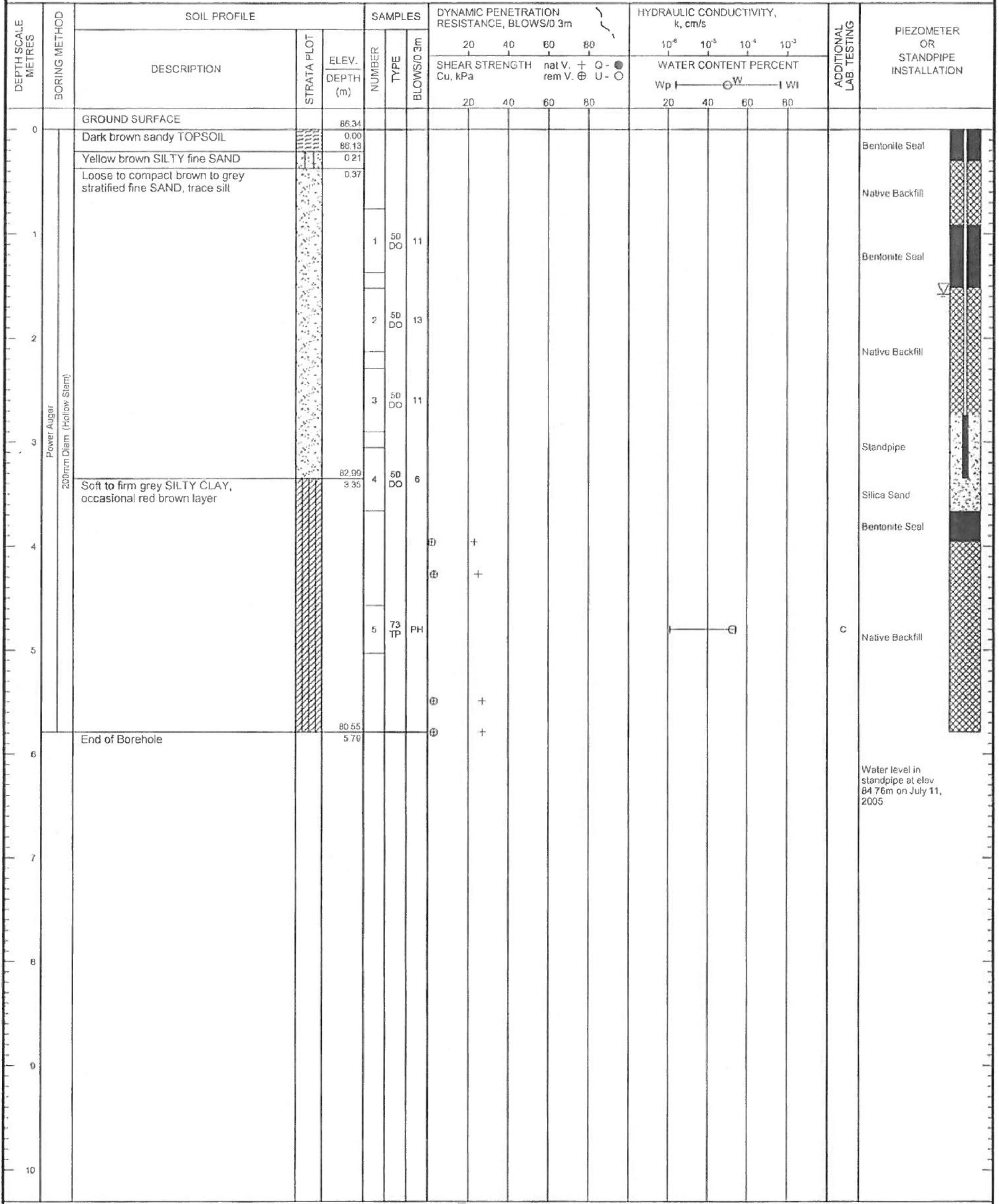
LOCATION: See Site Plan

BORING DATE: May 11, 2005

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



DESCRIPTION	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	86.34			
Dark brown sandy TOPSOIL	0.00			
Yellow brown SILTY fine SAND	86.13 0.21			
Loose to compact brown to grey stratified fine SAND, trace silt	0.37	1	50 DO	11
		2	50 DO	13
		3	50 DO	11
Soft to firm grey SILTY CLAY, occasional red brown layer	82.99 3.35	4	50 DO	6
		5	73 TP	PH
End of Borehole	80.55 5.79			

Bentonite Seal

Native Backfill

Bentonite Seal

Native Backfill

Standpipe

Silica Sand

Bentonite Seal

Native Backfill

Water level in standpipe at elev 84.76m on July 11, 2005

DEPTH SCALE

1 : 50

LOGGED: D.J.S.

CHECKED: T.M.S.

SYMBOLS AND TERMS

SOIL DESCRIPTION

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

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the relative strength of cohesionless soils is the compactness condition, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm. An SPT N value of “P” denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

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

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

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

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

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

ROCK DESCRIPTION

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

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

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

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube, generally recovered using a piston sampler
G	-	"Grab" sample from test pit or surface materials
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

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

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

Cc - Concavity coefficient = $(D30)^2$ / (D10 x D60)
Cu - Uniformity coefficient = D60 / D10

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

CONSOLIDATION TEST

p'_o - Present effective overburden pressure at sample depth
p'_c - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below p'_c)
Cc - Compression index (in effect at pressures above p'_c)

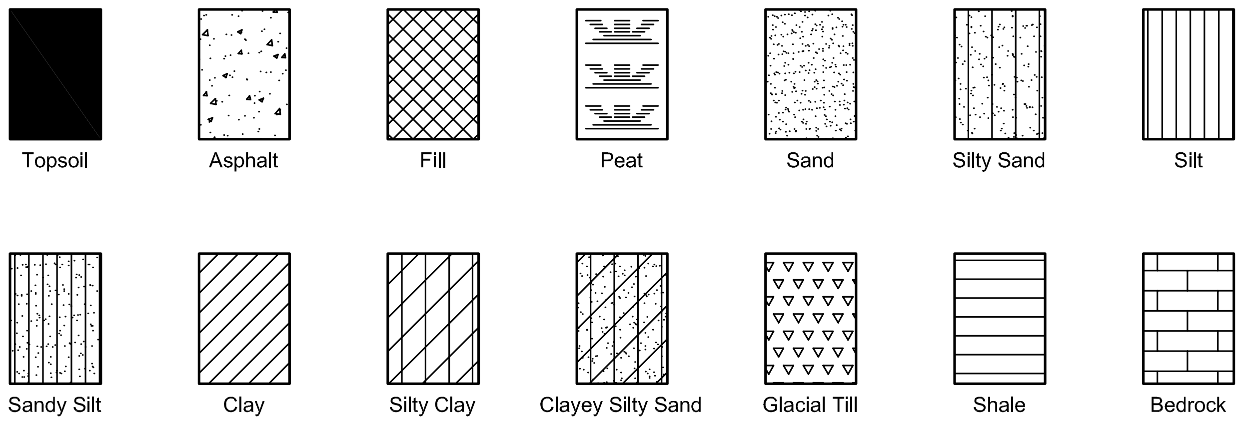
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

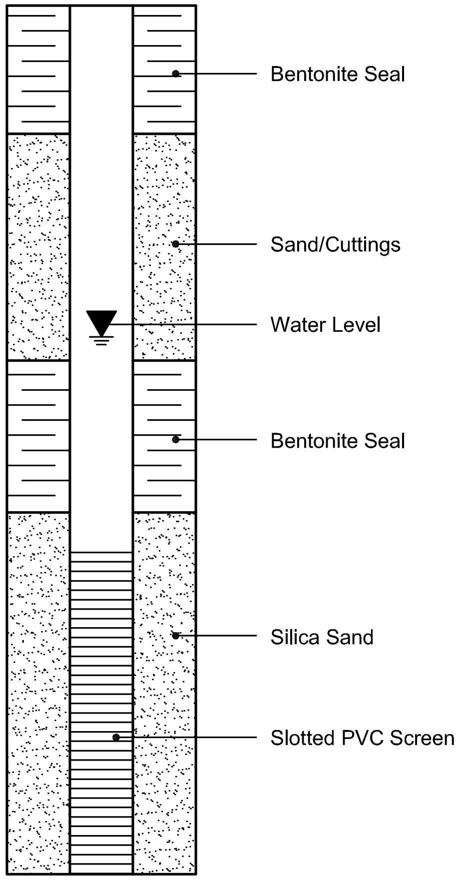
SYMBOLS AND TERMS (continued)

STRATA PLOT

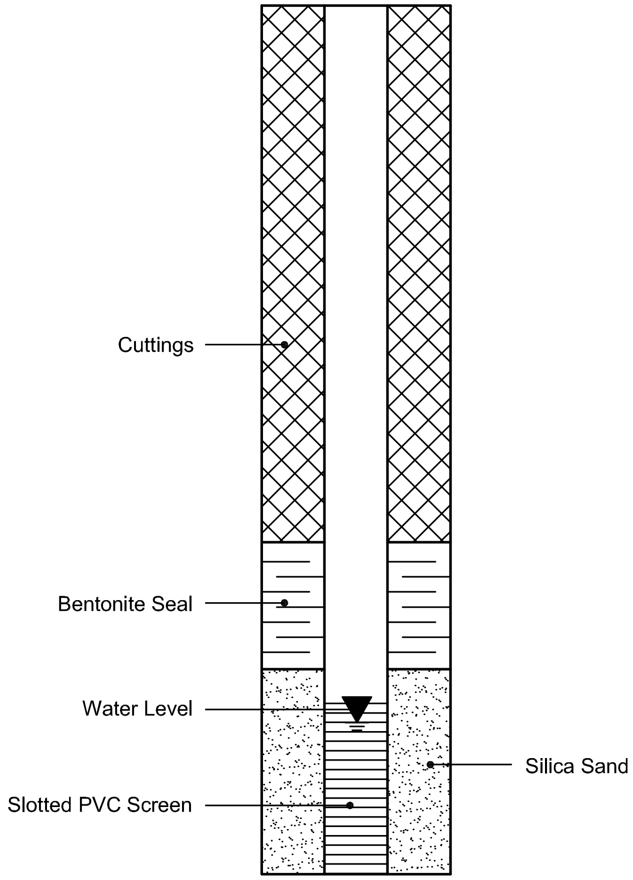


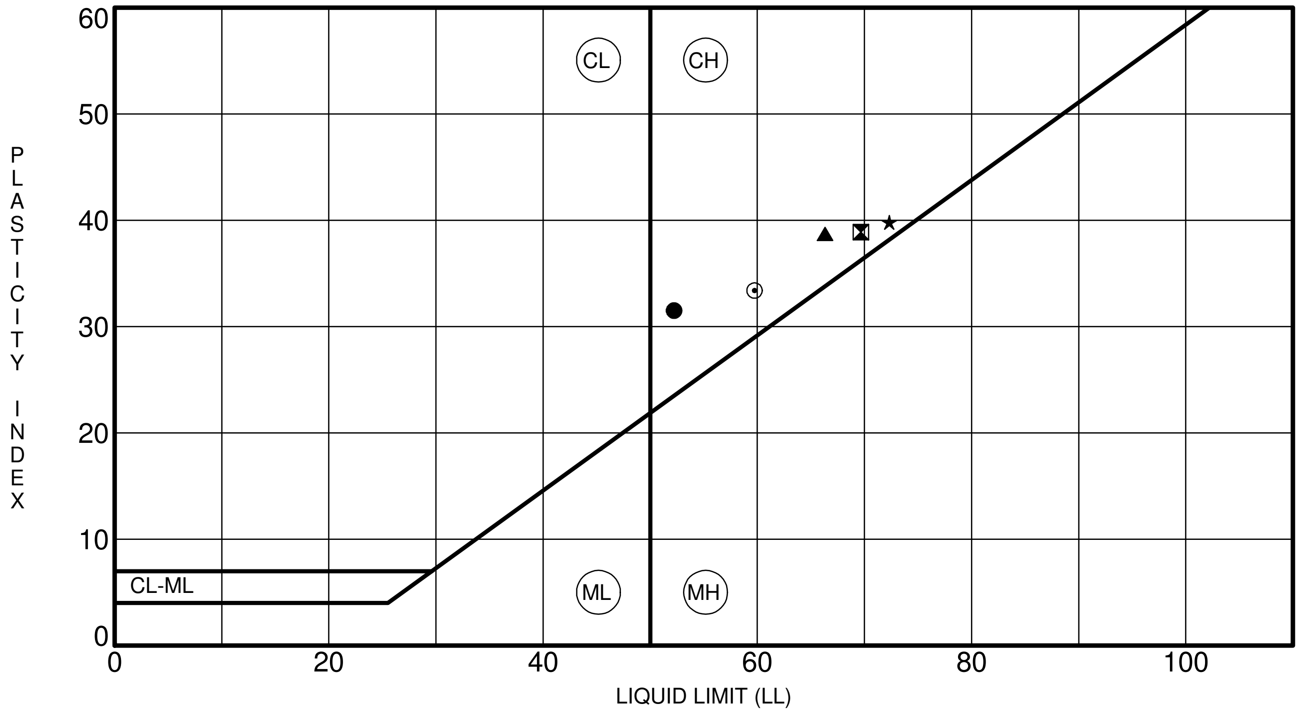
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH 2-20 SS 4**	**52**	**21**	**32**		**CH - Inorganic clays of high plasticity**
⧗	**BH 3-20 SS 4**	**70**	**31**	**39**		**CH - Inorganic clays of high plasticity**
▲	**BH 4-20 SS 3**	**66**	**28**	**39**		**CH - Inorganic clays of high plasticity**
★	**BH 5-20 SS 2**	**72**	**32**	**40**		**CH - Inorganic clays of high plasticity**
⊙	**BH 6-20 SS10**	**60**	**26**	**33**		**CH - Inorganic clays of high plasticity**

CLIENT	**Claridge Homes**	FILE NO.	**PG5224**
PROJECT	**Geotechnical Investigation - 3252 Navan Road**	DATE	**11 Sep 20**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2A - 7B - SLOPE STABILITY CROSS SECTIONS

PHOTOGRAPHS FROM SITE VISIT

DRAWING PG5224-1 - TEST HOLE LOCATION PLAN

DRAWING PG5224-2 - PERMISSIBLE GRADE RAISE PLAN

FIGURE 1

KEY PLAN

patersongroup

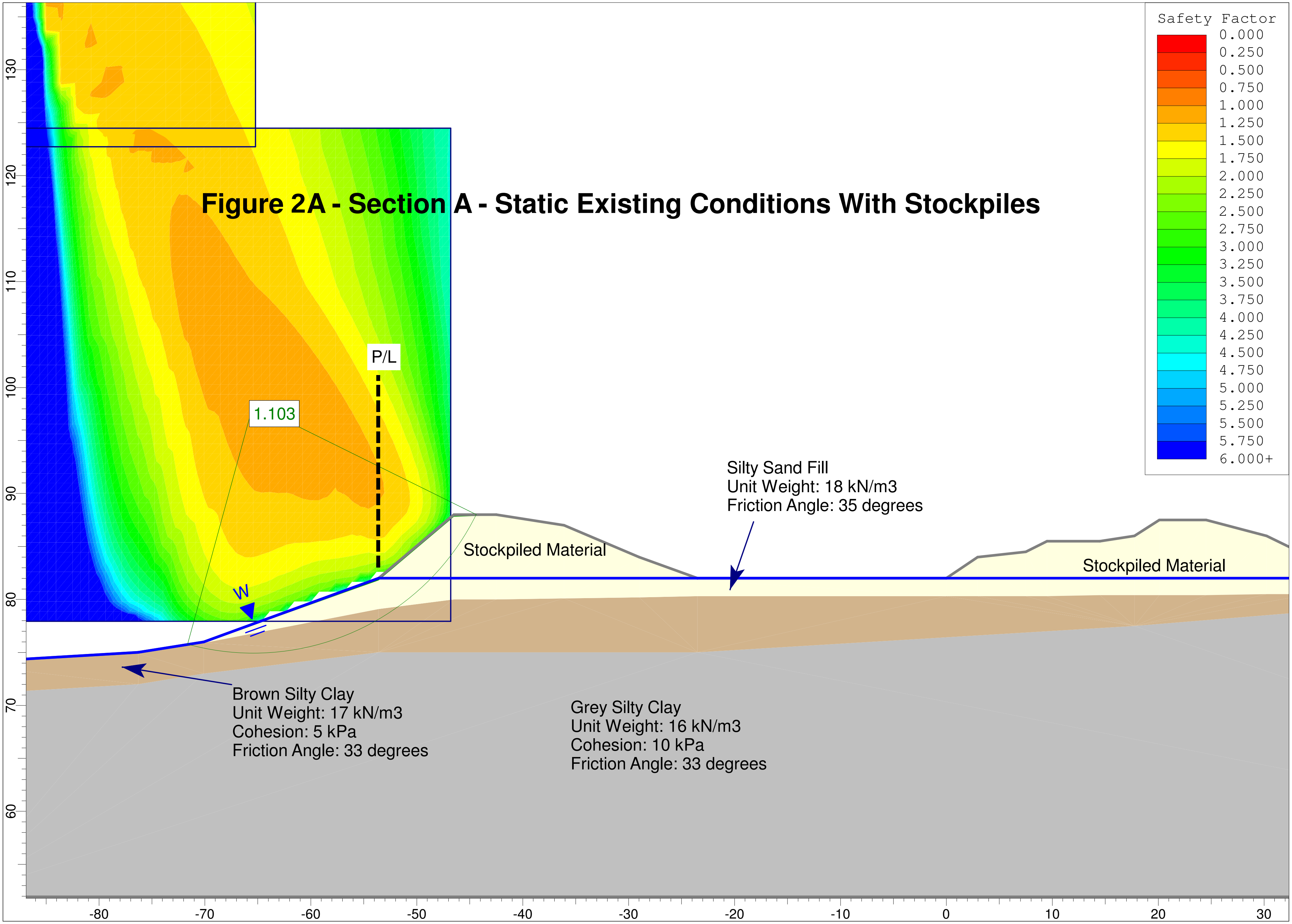
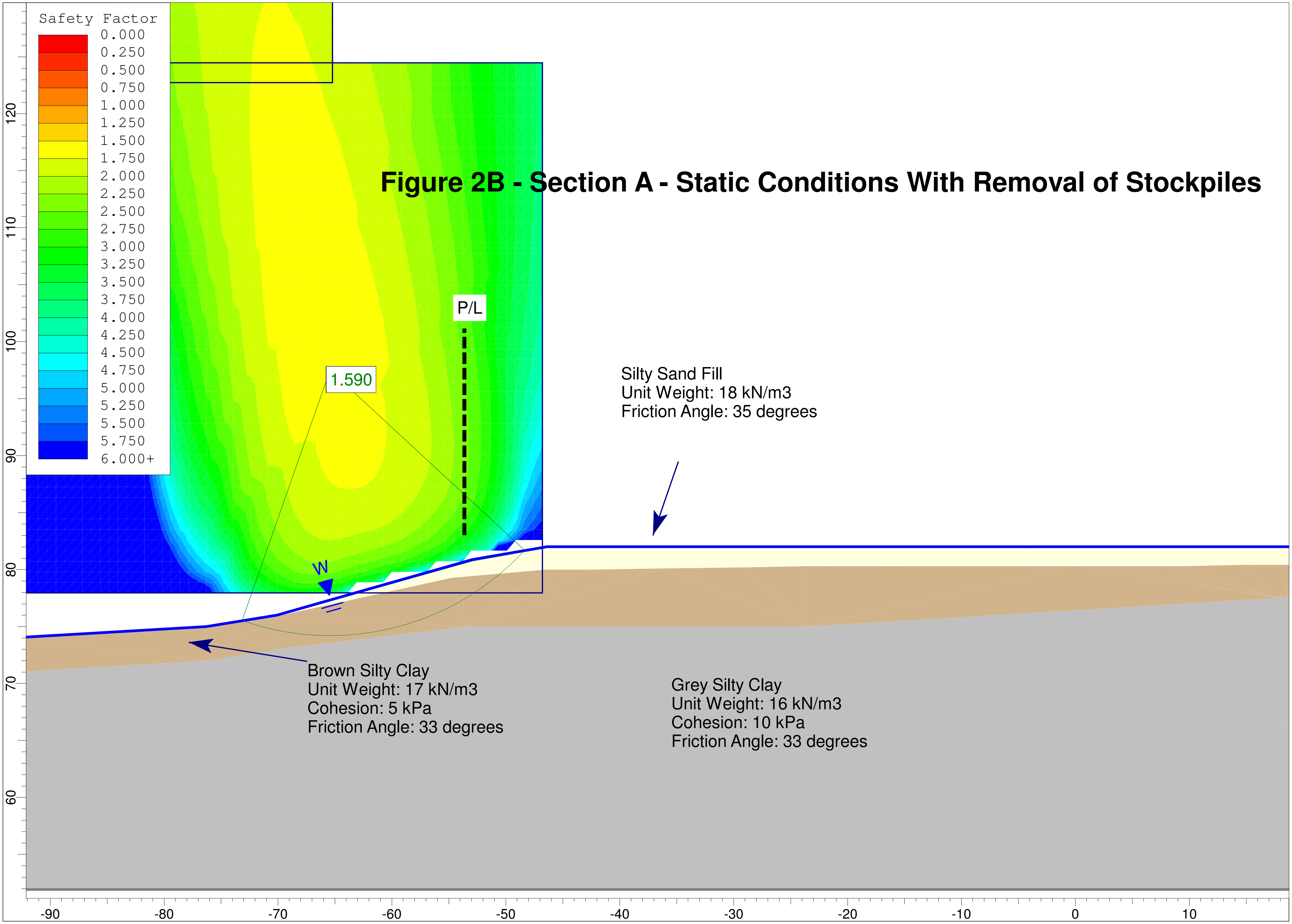


Figure 2A - Section A - Static Existing Conditions With Stockpiles

Figure 2B - Section A - Static Conditions With Removal of Stockpiles



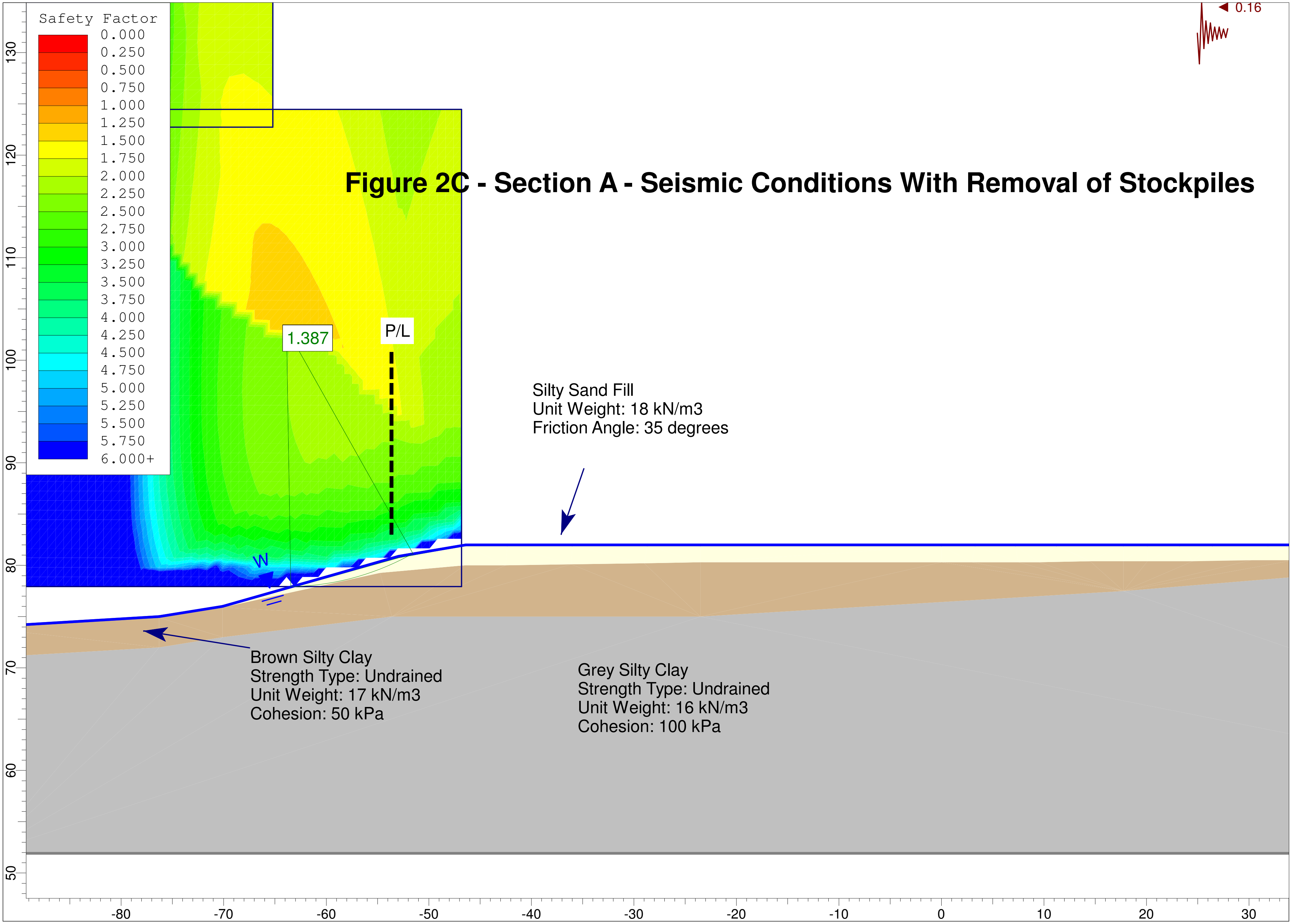


Figure 2C - Section A - Seismic Conditions With Removal of Stockpiles

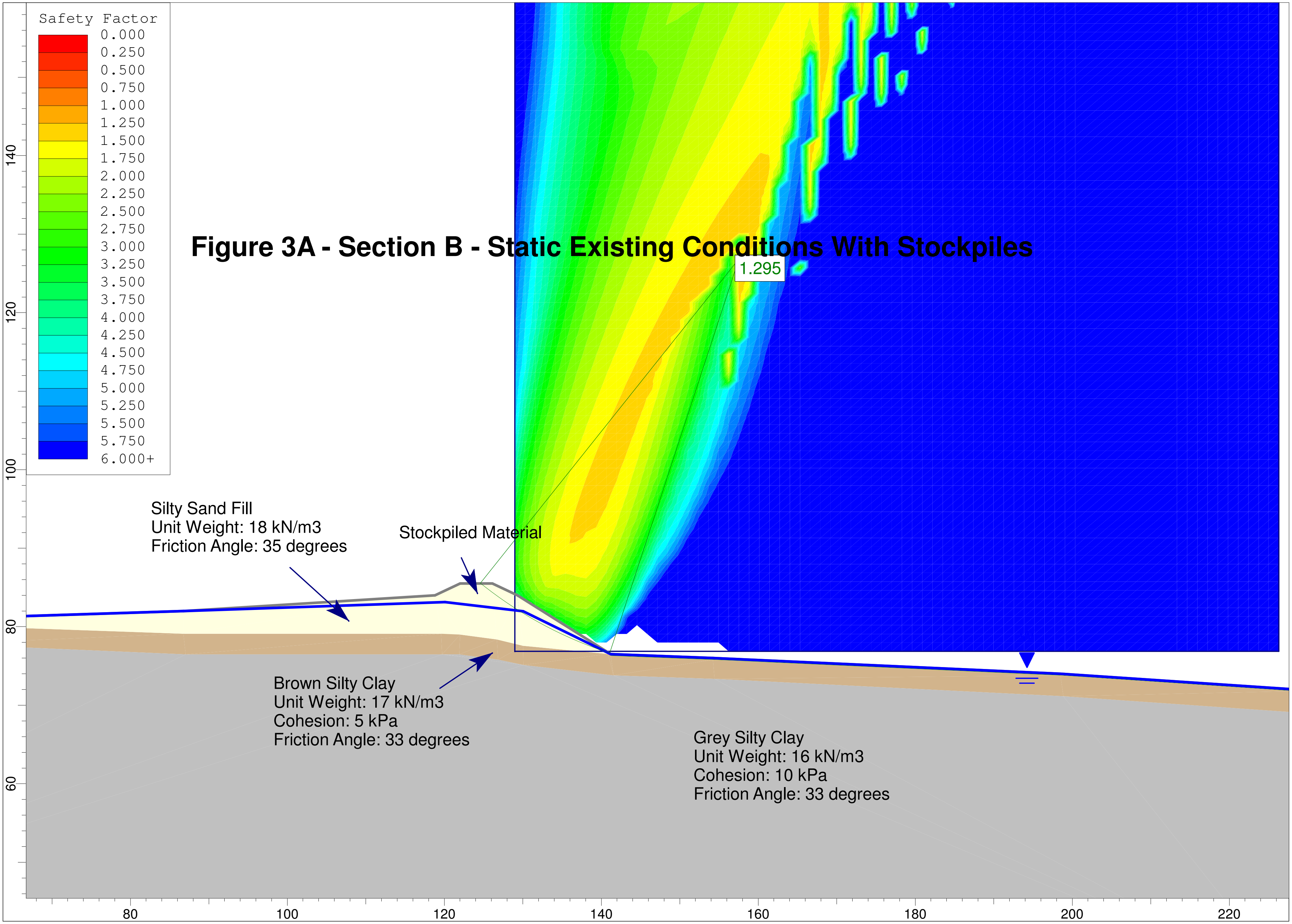


Figure 3A - Section B - Static Existing Conditions With Stockpiles

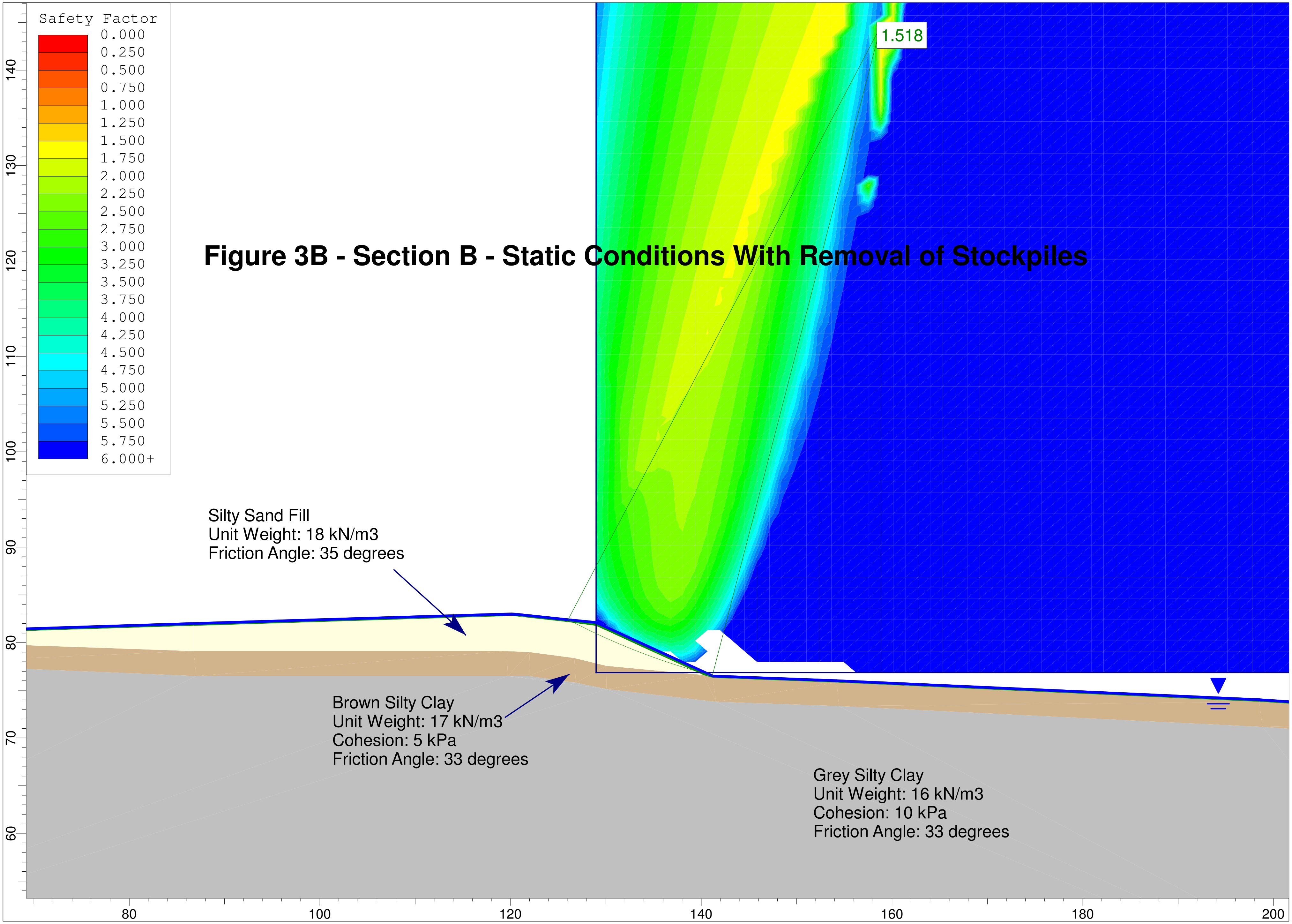


Figure 3B - Section B - Static Conditions With Removal of Stockpiles

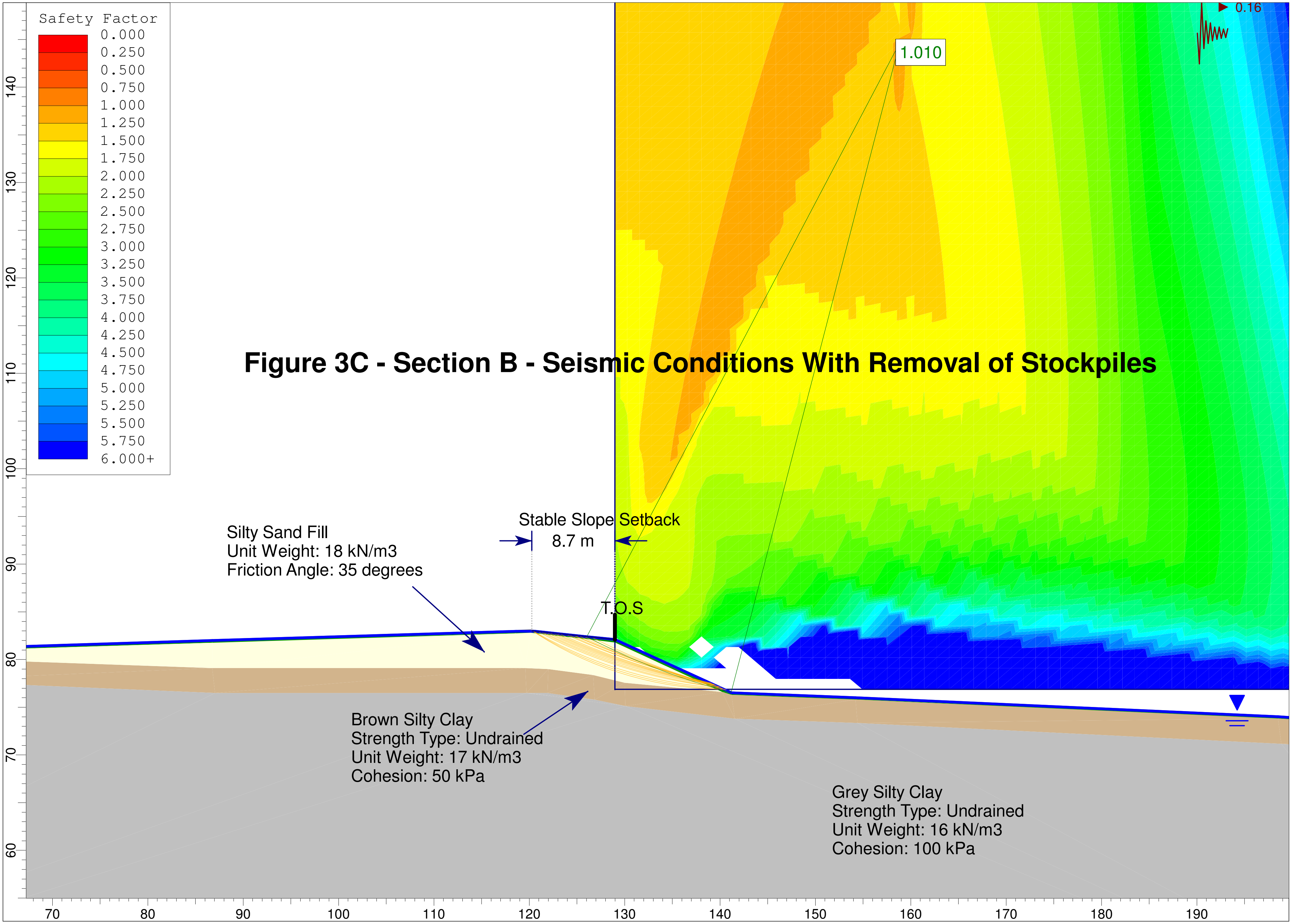
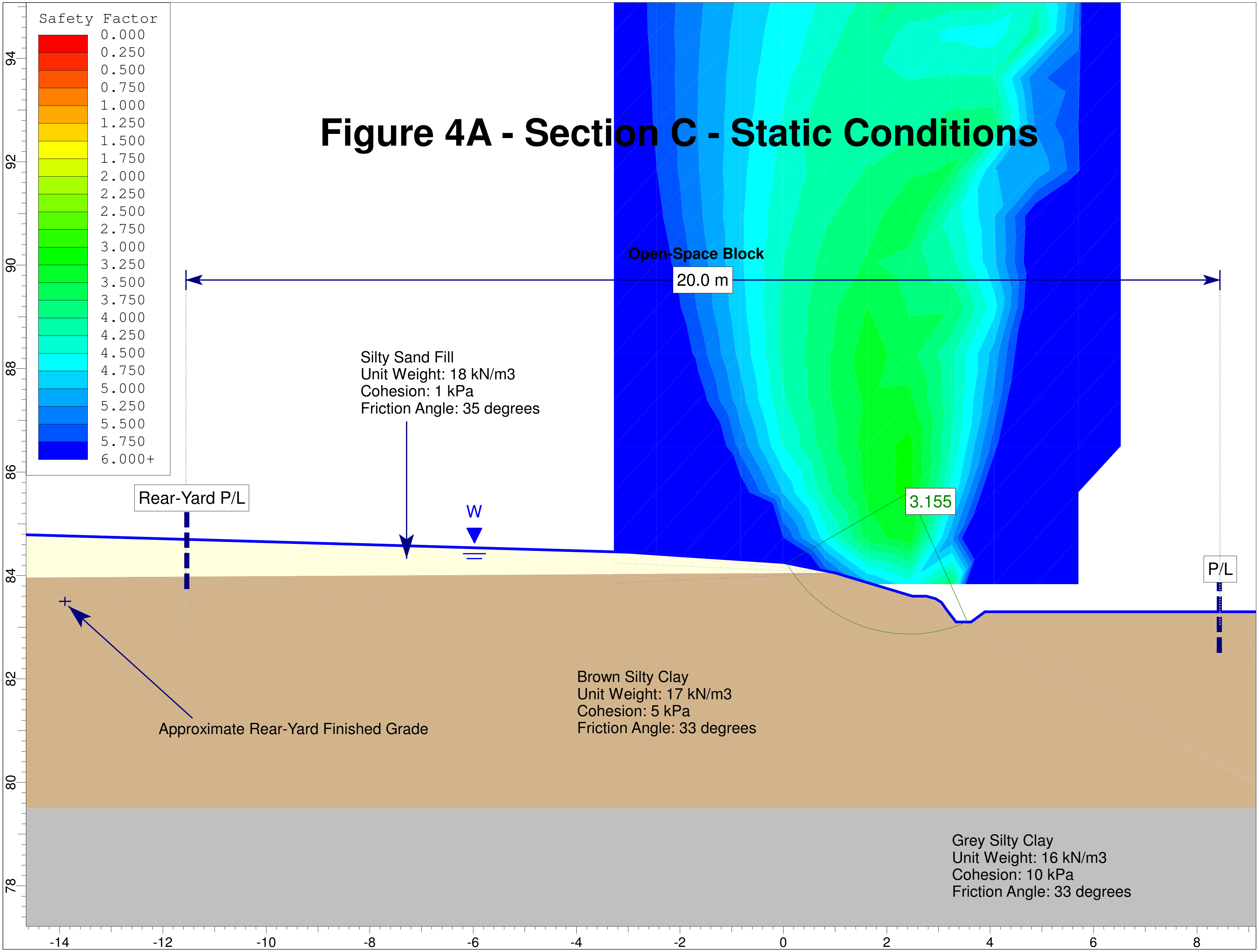


Figure 3C - Section B - Seismic Conditions With Removal of Stockpiles

Figure 4A - Section C - Static Conditions



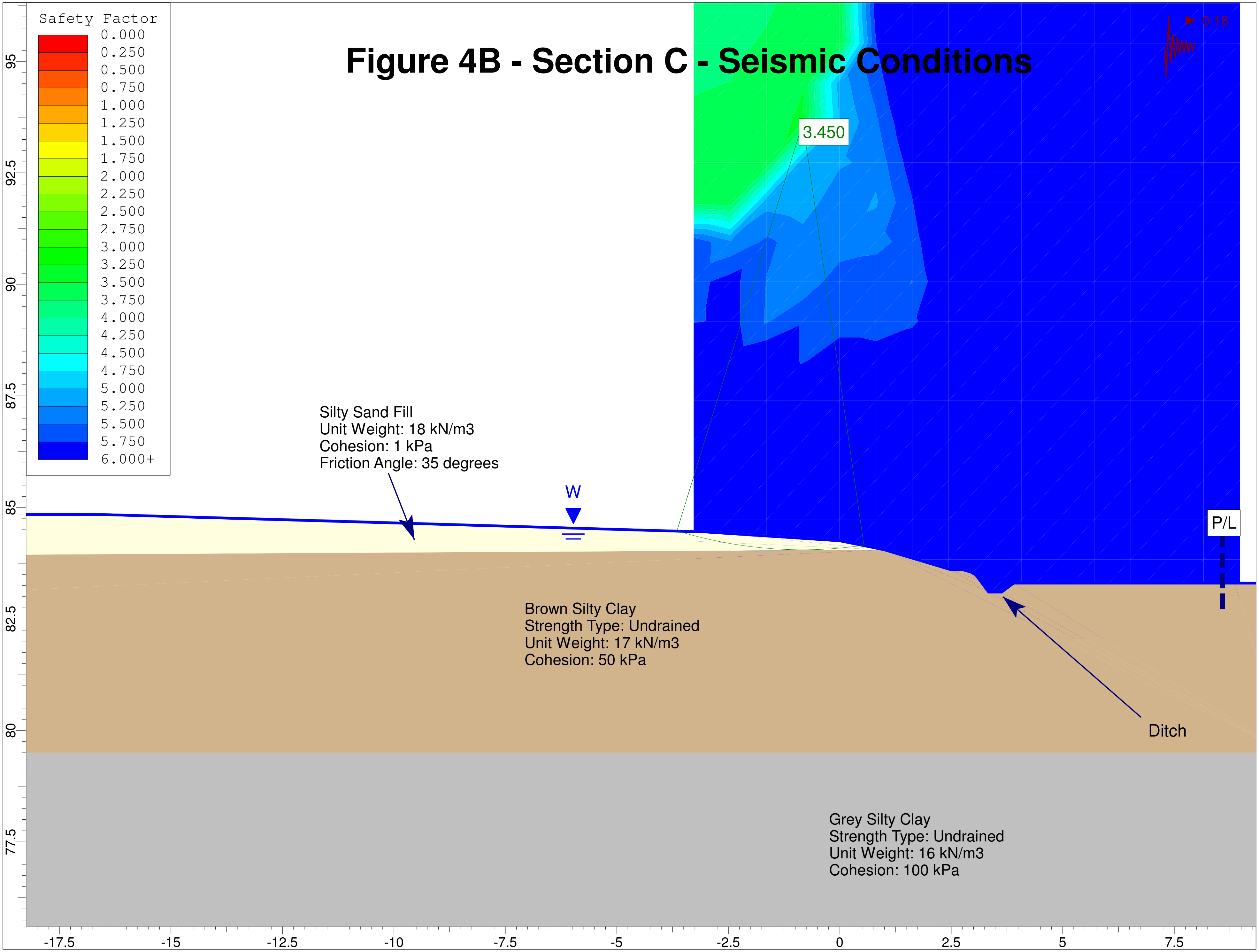


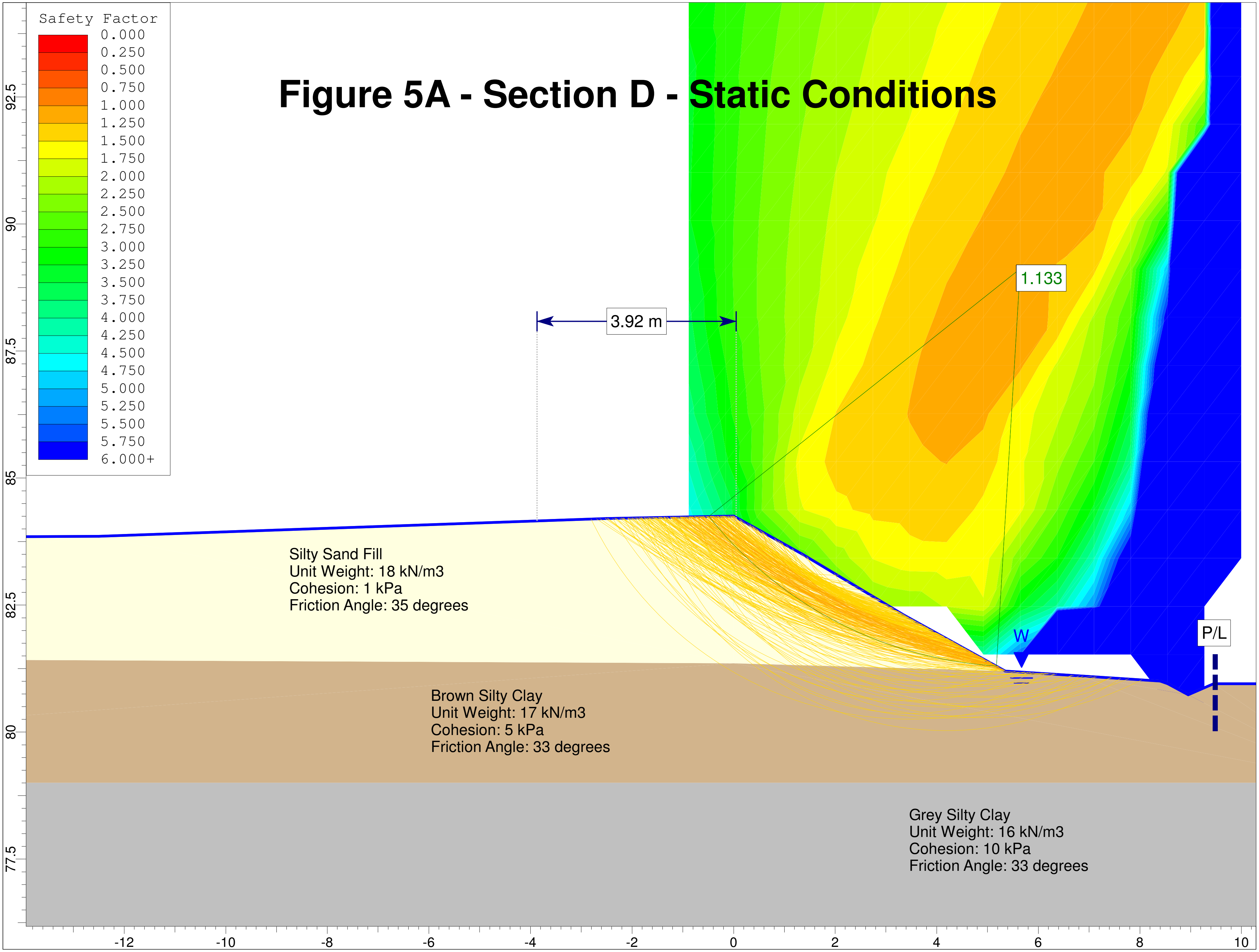
Figure 4B - Section C - Seismic Conditions

Silty Sand Fill
Unit Weight: 18 kN/m3
Cohesion: 1 kPa
Friction Angle: 35 degrees

Brown Silty Clay
Strength Type: Undrained
Unit Weight: 17 kN/m3
Cohesion: 50 kPa

Grey Silty Clay
Strength Type: Undrained
Unit Weight: 16 kN/m3
Cohesion: 100 kPa

Figure 5A - Section D - Static Conditions



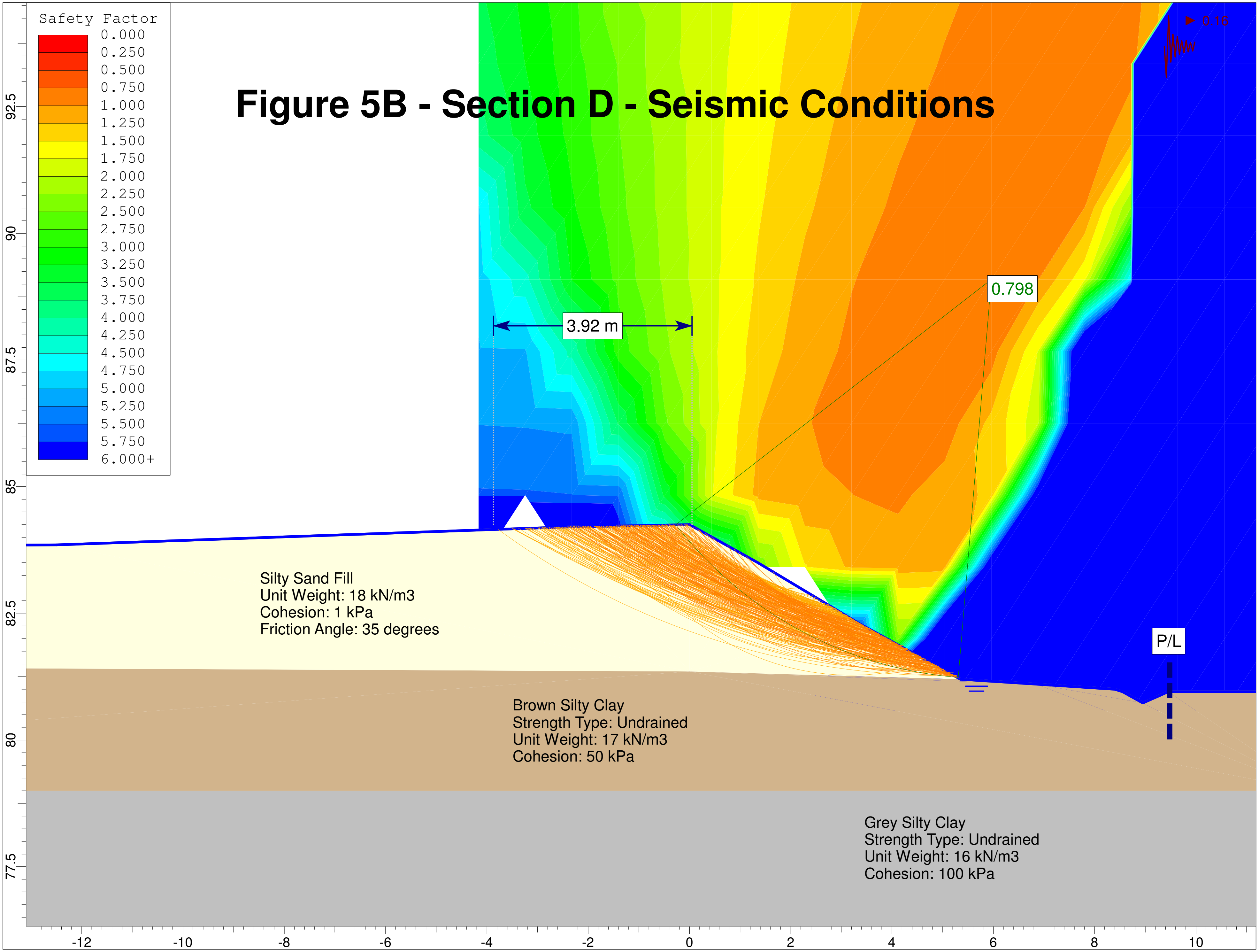
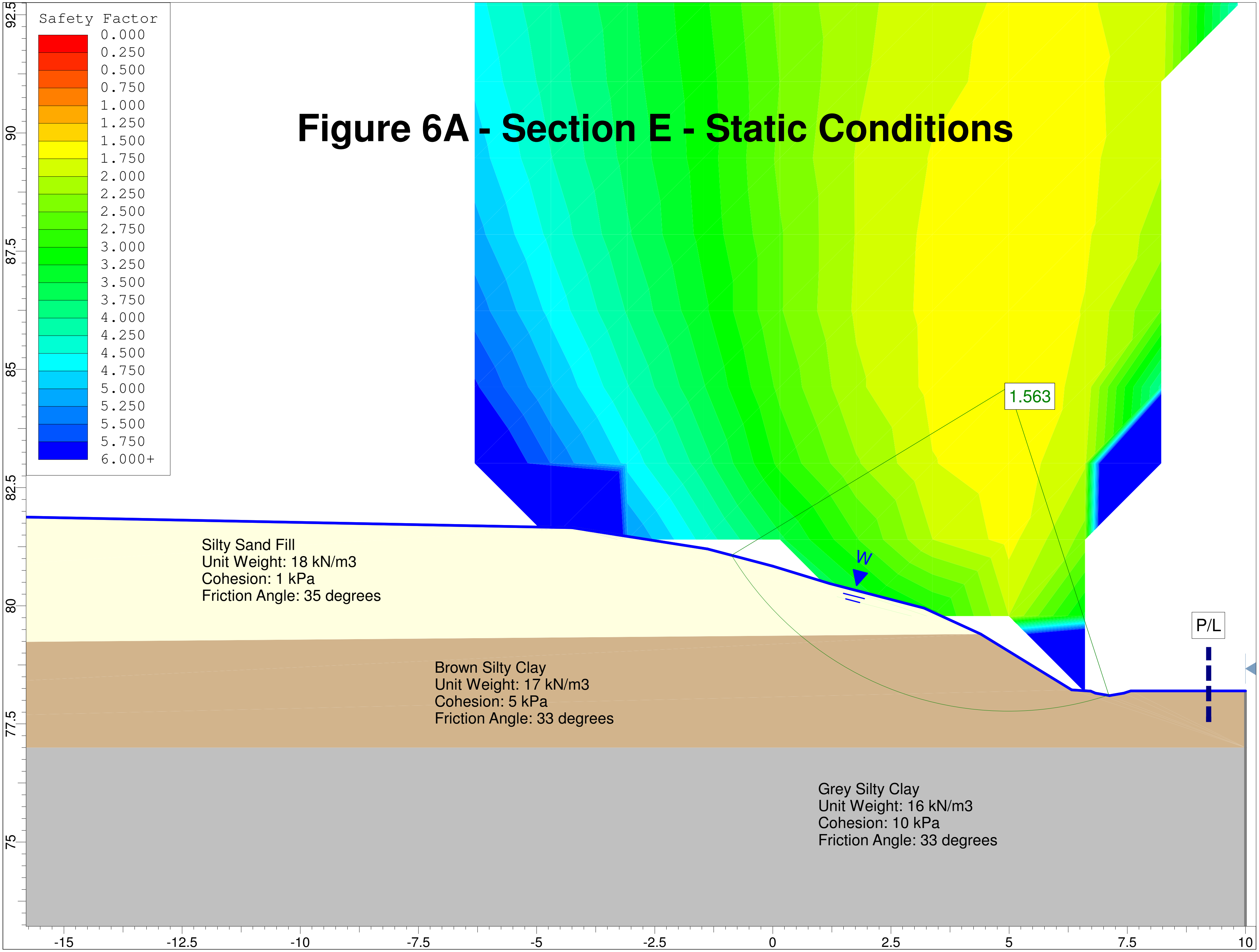


Figure 5B - Section D - Seismic Conditions

Figure 6A - Section E - Static Conditions



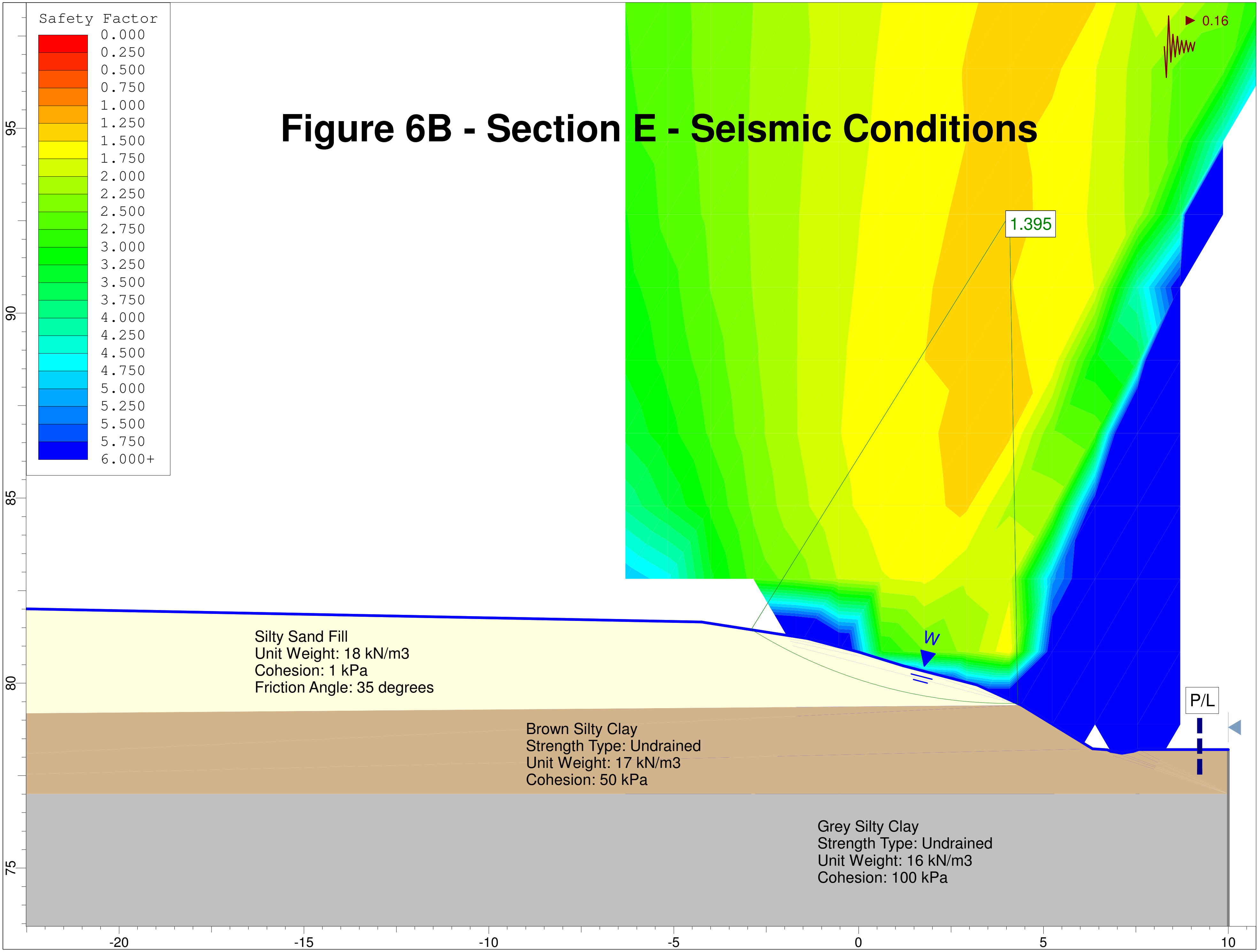


Figure 6B - Section E - Seismic Conditions

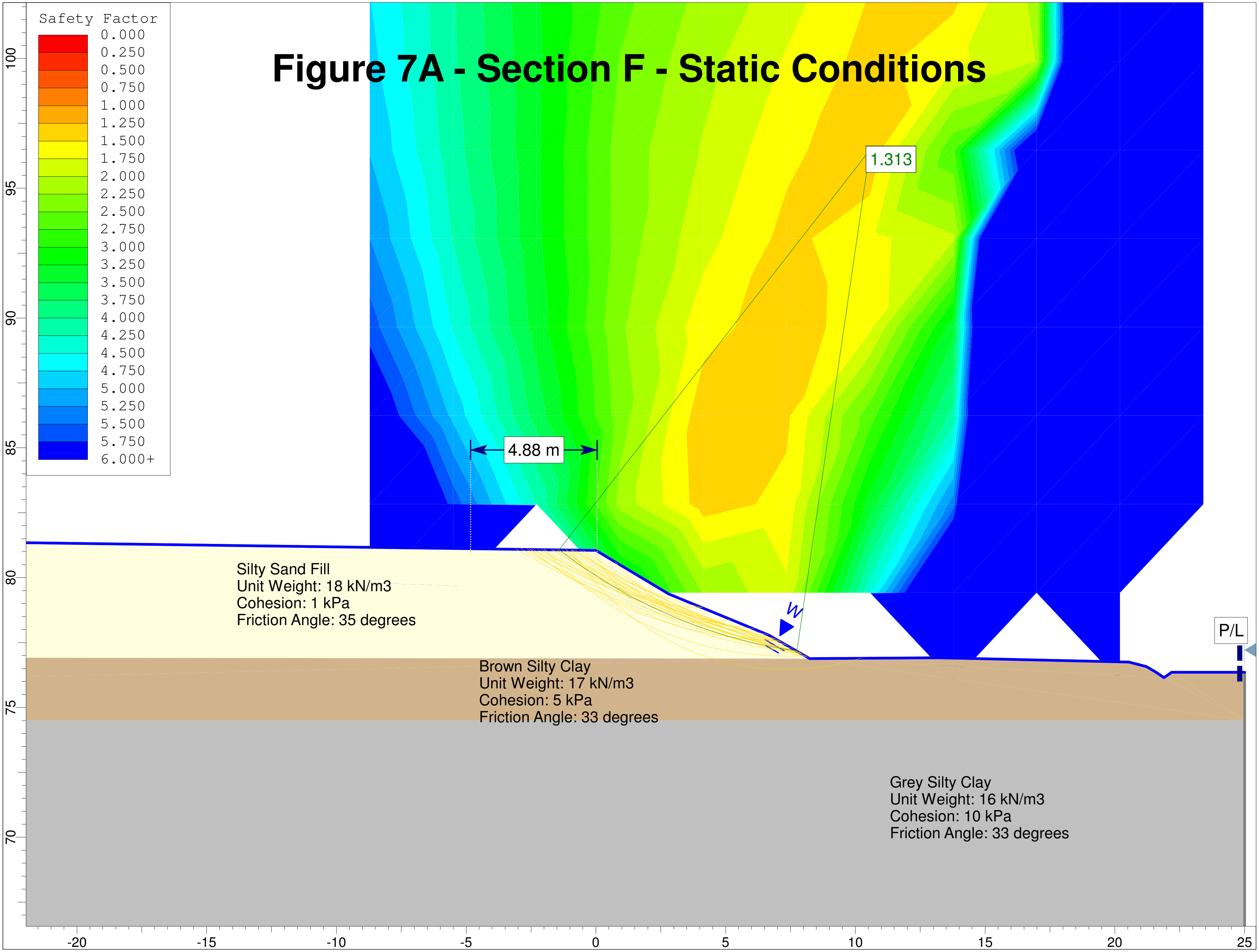
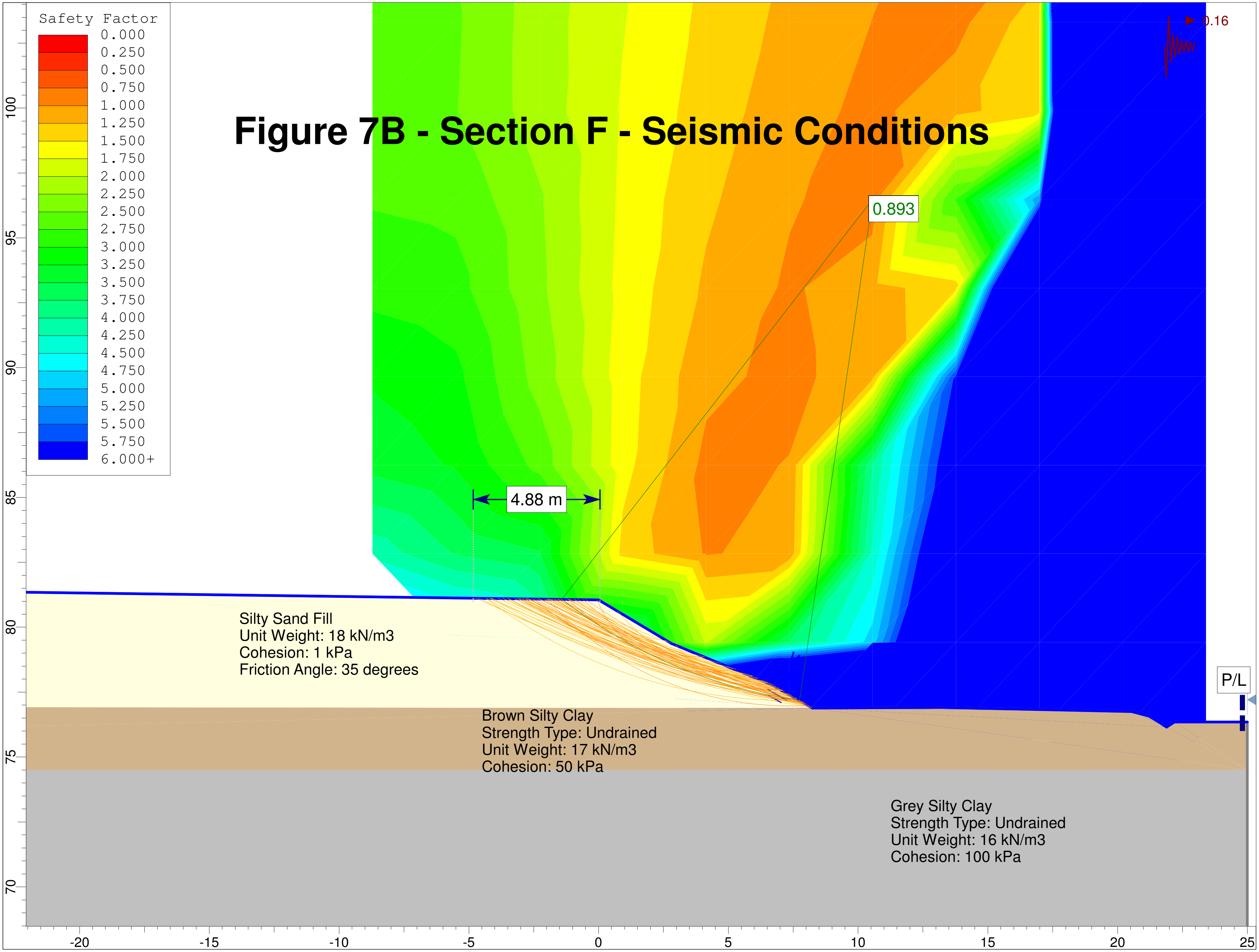


Figure 7A - Section F - Static Conditions

Figure 7B - Section F - Seismic Conditions



Photographs from Site Visit – September 30, 2020

Photo 1: Area of Section C facing north with subject site observed on left portion of photo. Area of ditch observed to be well-vegetated. Prior to our arrival a heavy-rainfall event had taken place which generated a gentle and low-volume flow close to Navan Road and Section C which further became negligible in flow downstream and beyond Section E.

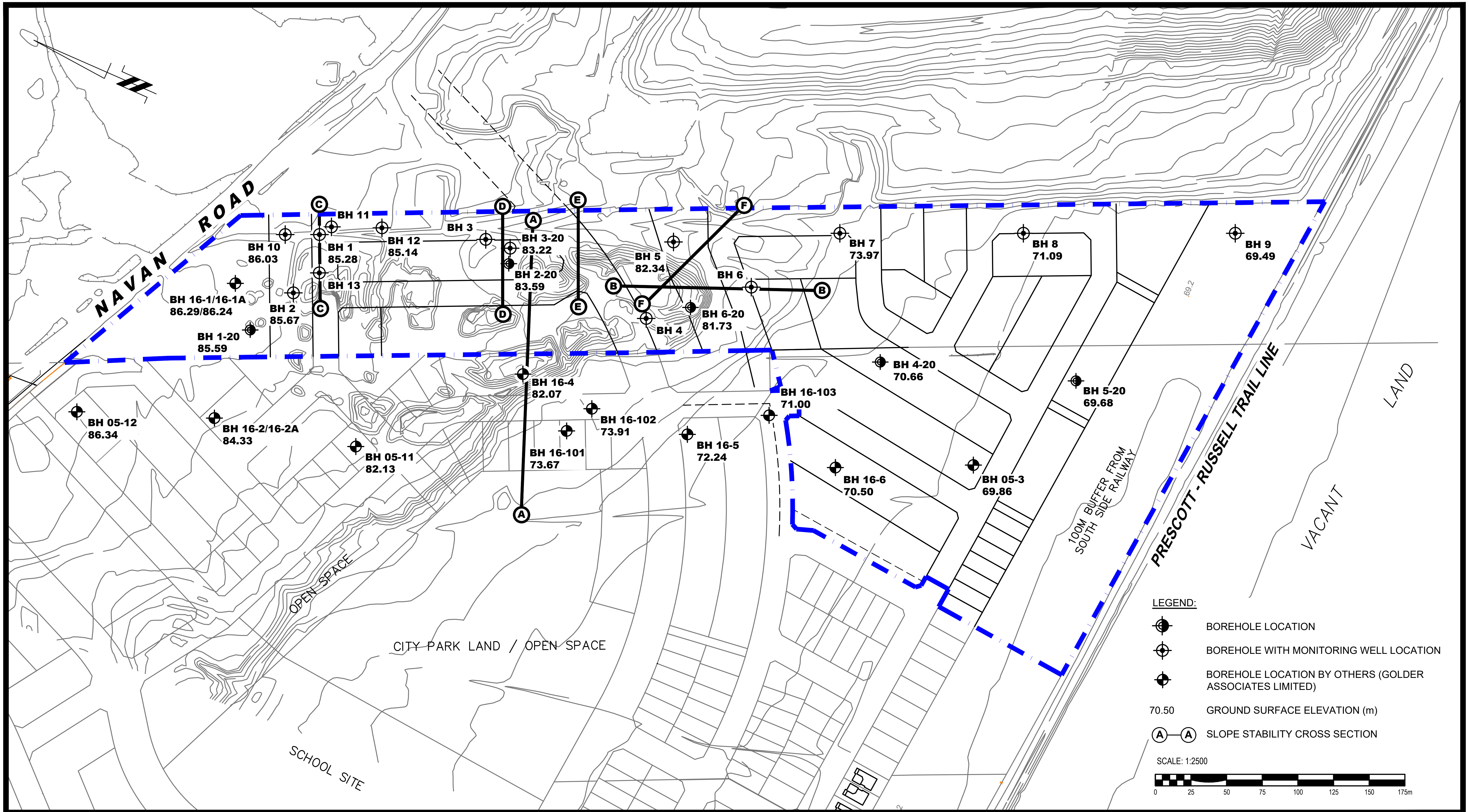
Photo 2: Area of Section C facing north with subject site observed on left portion of photo. No signs of erosion, sloughing or distress noted throughout slope face and section.

Photo 3: Area of Section D facing north with subject site to the left portion of photo. Area observed to be retaining majority of runoff and storm water and well vegetated. Slope face observed to generally consist of compacted sandy fill generated from subject site.

Photo 4: Area of Section E facing south with subject site to right portion of photo. Overburden throughout slope face generally observed to consist of an undsiturbed, stiff brown silty clay with some vegetation covered by a thin layer of fill across the majority of the slope face. No notable signs of erosion, sloughing or distress throughout the slope section were observed.

Photo 5: Area of Section E facing north with subject site to left portion of photo. Majority of ditch alignment observed to be well-vegetated. Water throughout ditch observed to be ponding with no flow, likely runoff from abutting portions of property.

Photo 6: Area of Section F facing south-east with photo taken from top of existing fill pile abutting towards the reviewed slope section. Existing fill side-slope observed to be well-vegetated with no signs of distress. Ground observed to be relatively flat beyond toe of fill pile and throughout valley surrounding the ditch alignment. Area of creek observed to be heavily vegetated with negligible amount of ponding water.



patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
3	ADDED NEW SLOPE STABILITY CROSS SECTIONS	14/10/2020	DP
2	ADDED NEW BOREHOLES (BH 1-20 TO BH 6-20)	21/09/2020	JV
1	UPDATED TO NEW BASE PLAN	04/02/2020	JV

CLARIDGE HOMES (GLADSTONE) INC.

GEOTECHNICAL INVESTIGATION
3252 NAVAN ROAD

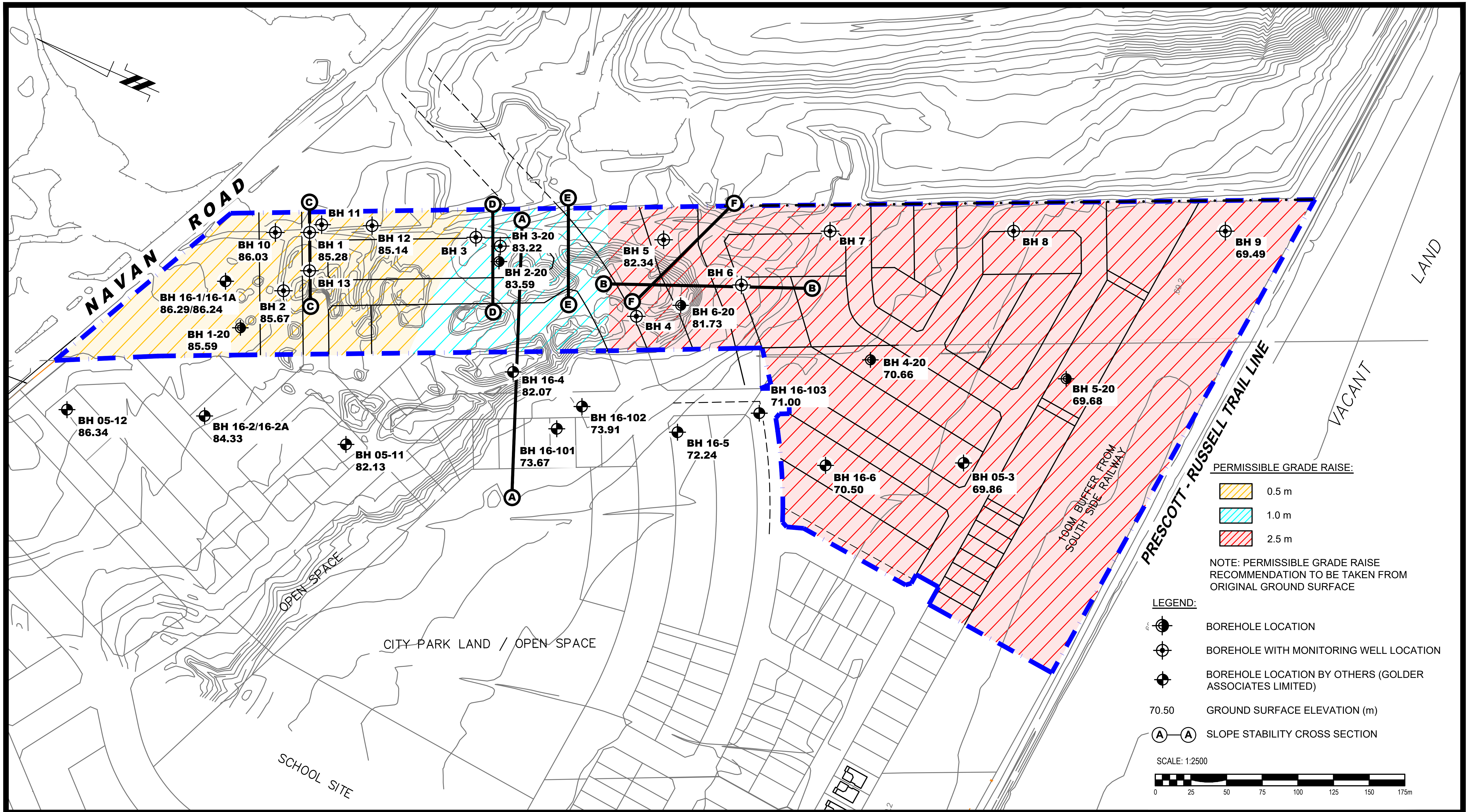
OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:2500
Date: 01/2020
Drawn by: NFRV
Report No.: PG5224-1
Checked by: JV
Dwg. No.: **PG5224-1**
Approved by: DJG
Revision No.: 3

p:\autocad drawings\geotechnical\pg52xx\pg5224\pg5224-1-thlp (rev.03).dwg



patersongroup
consulting engineers

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

3	ADDED NEW SLOPE STABILITY CROSS SECTIONS	14/10/2020	DP
2	ADDED NEW BOREHOLES (BH 1-20 TO BH 6-20)	21/09/2020	JV
1	UPDATED TO NEW BASE PLAN	04/02/2020	JV
NO.	REVISIONS	DATE	INITIAL

CLARIDGE HOMES (GLADSTONE) INC.
GEOTECHNICAL INVESTIGATION
3252 NAVAN ROAD

OTTAWA, ONTARIO

Title:
PERMISSIBLE GRADE RAISE PLAN

Scale: 1:2500
Date: 01/2020
Drawn by: NFRV
Report No.: PG5224-1
Checked by: JV
Dwg. No.: **PG5224-2**
Approved by: DJG
Revision No.: 3

p:\autocad drawings\geotechnical\pg52xx\pg5224\pg5224-1-thlp (rev.03).dwg