Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Noise & Vibration Studies

Geotechnical Investigation

Proposed Multi-Storey Buildings
Greystone Village - Phase 3
Scholastic Drive - Ottawa, Ontario

Prepared For

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Report PG5383-1
Revision 1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by eQ Homes to conduct a geotechnical investigation for the proposed multi-storey buildings to be located at Greystone Village - Phase 3 along Scholastic Drive in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the geotechnical investigation were to:

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

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

2.0 Proposed Development

Based on the available drawings, the proposed development is understood to consist of 2 multi-storey buildings with a shared underground parking garage which will occupy most of the site footprint, and which will extend down to approximate geodetic elevation 56 m. At finished grades, landscaped areas will generally surround the proposed buildings. A retaining wall is also proposed around the northwest corner of the site.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the geotechnical investigation was conducted on July 15 and 16, 2020, and consisted of 4 boreholes advanced to a maximum depth of 16.6 m below the existing ground surface. Previous geotechnical investigations by others included a total of 14 boreholes advanced at, or in the vicintiy of, the subject site to a maximum depth of 25.3 m below the existing ground surface. The approximate locations of the boreholes are shown on Drawing PG5383-1 - Test Hole Location Plan included in Appendix 2.

All boreholes were advanced using a track-mounted auger drill rig, which was operated by a two-person crew. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer. The drilling procedure consisted of augering to the required depths at the selected locations, and sampling and testing the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using two different techniques, namely, sampled directly from the auger flights (AU) or collected using a 50 mm diameter split-spoon (SS) sampler. All samples were visually inspected and initially classified on site and subsequently placed in sealed plastic bags. All samples were transported to our laboratory for further examination and classification. 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 presented in Appendix 1.

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

Undrained shear strength testing, using a vane apparatus, was carried out at regular intervals of depth in cohesive soils.

The overburden thickness was evaluated by a dynamic cone penetration test (DCPT) completed at BH 4-20, BH 14-206, and BH 14-209. 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.

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

Groundwater

Groundwater monitoring wells were installed in BH 1-20 and BH 4-20, and standpipes were installed in BH 2-20 and BH 3-20, to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

Sample Storage

All samples from the current geotechnical 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 from the current geotechnical investigation were selected by Paterson to provide general coverage of the proposed development taking into consideration the existing site features and underground utilities. The test hole locations and ground surface elevation at each test hole location were surveyed by Paterson with respect to a geodetic datum. The previous boreholes by others are also understood to be referenced to a geodetic datum. The location of the test holes and ground surface elevation at each test hole location are presented on Drawing PG5383-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging. Two (2) soil samples from the subject site were submitted for grain size distribution analysis. An additional 10 soil samples from the previous boreholes by others in the vicinity of the subject site were submitted for grain size distribution analysis and three (3) were submitted for atterberg limits testing. The results of the laboratory testing are provided in Appendix 1.

Two (2) soil samples from the previous boreholes by others in the vicinity of the subject site were submitted for unidimensional consolidation testing. The testing results are provided in Appendix 1.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was analyzed to determine its concentration of sulphate and chloride along with its resistivity and pH. The laboratory test results are shown in Appendix 1 and the results are discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently undeveloped with several fill piles located throughout the site. The site is bordered by recreational land followed by the Rideau River to the east, Deschatelets Avenue to the south, the existing Deschatelets Building to the west, and vacant land followed by Oblates Avenue to the north. The existing ground surface across the site generally slopes downward from southwest to northeast, from approximate geodetic elevation 65 to 60 m.

4.2 Subsurface Profile

Overburden

The subsurface conditions at the site generally consist of an approximate 1.2 to 3 m thickness of fill below the existing ground surface. Generally, the fill varied from a silty sand to a clayey silt with some gravel and occasional brick, wood, ash, and mortar.

A silty clay deposit was encountered underlying the fill. The silty clay deposit consisted of a hard to very stiff, grey/brown silty clay to clayey silt crust, becoming a stiff, grey silty clay below approximate depths of 2.5 to 4.5 m.

A silty sand was encountered underlying the silty clay at approximate depths of 10.7 to 14.5 m, corresponding to approximate geodetic elevation 50 m across most of the site, but increasing to approximate geodetic elevation 53 m on the southern end of the site. A layer of sandy silt to silt with some clay and sand was also encountered in BH 1-20 and BH 2-20 at depths of 13.5 m.

Practical refusal of the DCPTs were encountered in BH 4-20, BH 14-206 and BH 14-209 at approximate depths of 21.6, 21.6 m and 29.5 m, respectively.

Bedrock

At BH 15-8, a black to dark grey shale bedrock was cored from an approximate depth of 31.7 to 33.4 m.

Based on available geological mapping, the bedrock at the subject site consists of shale of the Billings formation with a drift thickness of 25 to 50 m.

Laboratory Testing

Atterberg limits testing, as well as associated moisture content testing was carried out by others on recovered silty clay/clayey silt samples throughout the subject site. The results of the Atterberg limits tests are presented in Table 1 and on the Plasticity Chart in Appendix 1. The moisture content testing results are presented on the soil profile and test data sheets by others. The test samples classify as inorganic clays of low plasticity (CL) in accordance with the Unified Soil Classification System.

Table 1 - Atterberg Limits Results

Test Hole	Sample	LL (%)	PL (%)	PI (%)	Classification
BH14-204	SS6	21	15	9	CL
BH14-205	TP7	33	18	15	CL
BH14-205	TP9	37	20	17	CL
BH14-206	SS5	43	17	26	CL
BH14-209	SS5	24	15	9	CL

Notes: LL: Liquid Limit; PL: Plastic Limit; PI: Plasticity Index; CL: Inorganic Clay of Low Plasticity

Grain size distribution analyses were completed on 2 selected soil samples. The results of the analyses are summarized in Table 1 below and are presented on the Grain Size Distribution Results sheets in Appendix 1.

Table 2 - Summary of Grain Size Distribution Analysis

Test Hole	Sample	Gravel (%)	Sand (%)	Silt & Clay (%)
BH 1-20	SS9	0	34.1	65.9
BH 2-20	SS9	0	20.4	79.6

From the grain size analyses, the samples collected from boreholes BH 1-20 and BH 2-20 are classified as a sandy silt and silt with some sand, respectively.

4.3 Groundwater

Groundwater levels were measured on July 22, 2020 in the monitoring wells and standpipes installed in the boreholes from the current geotechnical investigation. The observed groundwater levels are summarized in Table 3 on the following page.

Table 3 - Summary of Groundwater Level Readings

Test Hole	Ground Surface Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Recording Date
BH 1-20*	61.00	Blocked	-	July 22, 2020
BH 2-20	63.06	2.04	61.02	July 22, 2020
BH 3-20	62.85	6.60	56.25	July 22, 2020
BH 4-20*	63.80	2.42	61.38	July 22, 2020

Note: - The ground surface elevations are referenced to a geodetic datum.
-Asterisk (*) denotes a groundwater monitoring well location.

It should be noted that the groundwater levels could be influenced by surface water infiltrating the backfilled boreholes. Long-term groundwater levels can also be estimated based on the observed colour and consistency of the recovered soil samples.

Based on these observations, the long-term groundwater table can be expected at approximately 5 to 6 m below ground surface. The recorded groundwater levels are provided on the applicable Soil Profile and Test Data sheet presented in Appendix 1.

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

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered suitable for the proposed development. Based on the subsurface conditions encountered at the test holes and the anticipated building loads, it is recommended that the foundation for the proposed multi-storey buildings consist of a raft foundation bearing on an undisturbed, stiff silty clay bearing surface.

Further, foundations for the underground parking levels beyond the footprints of the proposed multi-storey buildings are expected to consist of conventional spread footings placed on the undisturbed, stiff silty clay bearing surface, depending on the structural loading requirements.

Given the proximity of the underground parking levels to the property lines, it is expected that a temporary shoring system will be required to support the excavation sides. As the excavation is not anticipated to extend to the underlying silty sand deposit, it is acceptable that the temporary shoring system can consist of a soldier pile and lagging system. This is discussed further in Section 6.3.

Due to the presence of a deep silty clay deposit, a permissible grade raise restriction is required for the subject site.

5.2 Site Grading and Preparation

Stripping Depth

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

Fill Placement

Fill used for grading beneath the proposed building should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building should be compacted to at least 98% of the material’s standard Proctor maximum dry density (SPMDD).

Non-specified existing fill, along with site-excavated soil, can be used as general landscaping fill where settlement of the ground surface is of minor concern. This material should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If this material is to be used to build up the subgrade level for areas to be paved, it should be compacted in thin lifts to at least 95% of the material's SPMDD.

Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless used in conjunction with a composite drainage membrane.

Protection of Subgrade (Raft Foundation)

Since the subgrade material will consist of a silty clay deposit, it is recommended that a minimum 75 mm thick lean concrete mud slab be placed on the undisturbed subgrade shortly after the completion of the excavation. The main purpose of the mud slab is to reduce the risk of disturbance of the subgrade under the traffic of workers and equipment.

The final excavation to the raft bearing surface level and the placing of the mud slab should be done in smaller sections to avoid exposing large areas of the silty clay to potential disturbance.

Pressure Relief Chamber

To prevent the long term dewatering of adjacent structures surrounding the site, a pressure relief chamber is recommended to be installed along with collection pipes within the silty clay deposit. The collection pipe trenching should extend along the proposed building perimeter and lead to the pressure relief chamber. It is suggested that the pressure relief chamber be incorporated into the lowest section of the lowest level of underground parking. Figure 2 - Pressure Relief Chamber in Appendix 2 provides an example of the required pressure relief chamber. Once the pressure relief chamber and associated piping is installed, the proposed raft slab can be constructed. The purpose of the pressure relief chamber will be as follows:

- ❑ Manage any water infiltration along the founding surface during the excavation program.
- ❑ Manage the water infiltration during the pouring of the raft slab to prevent water flow in the fresh concrete.
- ❑ Manage water infiltration below the raft slab until sufficient load is applied to resist any potential hydrostatic uplift.

- ❑ Regulate the discharge valve to control water infiltration once the raft slab is in place and over the long term to manage the hydrostatic pressure to permit any repairs associated with any water infiltration.
- ❑ Once sufficient load is applied to the raft slab, the pressure relief valve will be fully closed to prevent any further dewatering.

Hydrostatic Pressure

With the fully closed valve within the pressure relief chamber and a perfectly watertight foundation, it is expected that a maximum hydrostatic pressure of **15 kPa** will be developed over the long term and should be incorporated in the design of the raft foundation and the foundation walls.

5.3 Foundation Design

Conventional Strip and Pad Footings

Foundations for the underground parking levels beyond the footprints of the proposed multi-storey buildings are recommended to consist of strip footings, up to 3 m wide, and pad footings, up to 6 m wide, placed over an undisturbed, stiff silty clay bearing surface at bearing resistance values at Serviceability Limit State (SLS) of **120 kPa** and factored bearing resistance values at Ultimate Limit States (ULS) of **180 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

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

Raft Foundation for Multi-Storey Buildings

Based on the anticipated building loads, the proposed multi-storey buildings are recommended to be supported on raft foundations. Finished grades have not been provided at the time of issuance of this report, however, it is expected that the raft foundation will extend to approximate geodetic elevation 56 m.

The amount of settlement of the raft slab will be dependent on the sustained raft contact pressure. The loading conditions for the contact pressure are based on sustained loads, that are generally taken to be 100% Dead Load and 50% Live Load. The contact pressure provided considers the stress relief associated with the soil removal required for 2 levels of underground parking.

For 2 levels of underground parking, a bearing resistance value at SLS (contact pressure) of **225 kPa** will be considered acceptable for a raft supported on the undisturbed, stiff silty clay. The factored bearing resistance (contact pressure) at ULS can be taken as **350 kPa**. For this case, the modulus of subgrade reaction was calculated to be **8 MPa/m** for a contact pressure of **225 kPa**.

The raft foundation design is required to consider the relative stiffness of the reinforced concrete slab and the supporting bearing medium. A geotechnical resistance factor of 0.5 was applied to the bearing resistance values at ULS.

Based on the following assumptions for the raft foundation, the proposed multi-storey buildings can be designed using the above parameters with a total and differential settlement of 25 and 15 mm, respectively.

Permissible Grade Raise Recommendations

Due to the presence of the silty clay deposit, a permissible grade raise restriction of **2 m** is recommended for grading at the subject site.

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

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class D**. Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code 2012 for a full discussion of the earthquake design requirements.

5.5 Basement Floor Slab

Where raft foundations are utilized, a sub-slab granular layer of OPSS Granular A crushed stone will be required to allow for the installation of sub-floor services above the raft slab foundation. The thickness of the OPSS Granular A crushed stone will be dependent on the piping requirements.

Where footings are utilized, it is recommended that the upper 200 mm of sub-floor fill consists of 19 mm clear crushed stone. Further, a sub-slab drainage system, consisting of lines of perforated drainage pipe subdrains connected to a positive outlet, should be provided underlying the basement 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 proposed 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.

Where undrained conditions are anticipated (i.e. below the groundwater level), the applicable effective (undrained) unit weight of the retained soil can be taken as 13 kN/m^3, where applicable. A hydrostatic pressure should be added to the total static earth pressure when using the effective unit weight.

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

Car only parking areas and access lanes are anticipated at this site. The proposed pavement structures are presented in Tables 4 and 5.

Table 4 - Recommended Pavement Structure - Car Only Parking Areas

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

Table 5 - Recommended Pavement Structure - Access Lanes and Ramp	
Thickness (mm)	**Material Description**
40	Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete
50	Binder Course - HL-8 or Superpave 19.0 Asphaltic Concrete
150	BASE - OPSS Granular A Crushed Stone
450	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	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project. If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 99% of the material's SPMDD.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

For the proposed underground parking levels, it is understood that the building foundation walls will be placed in close proximity to the site boundaries. Therefore, it is recommended that the foundation walls be blind poured against a drainage system and waterproofing system fastened to the shoring system.

Waterproofing of the foundation walls is recommended and the membrane is to be installed from 3 m below finished grade down the foundation walls to the bottom of foundation.

It is also recommended that a composite drainage system, such as Delta Drain 6000 or equivalent, be installed between the waterproofing membrane and the foundation wall, and extend from the exterior finished grade to the founding elevation (underside of raft or footing). The purpose of the composite drainage system is to direct any water infiltration resulting from a breach of the waterproofing membrane to the building sump pit. It is recommended that 150 mm diameter sleeves at 3 m centres be cast in the foundation wall at the perimeter footing or raft slab interface to allow the infiltration of water to flow to an interior perimeter underfloor drainage pipe. The perimeter drainage pipe should direct water to sump pit(s) within the lower basement area. These recommendations are summarized on Figure 3 - Water Suppression System, which is provided in Appendix 2.

A waterproofing system should also be provided for any elevator pits (pit bottom and walls).

Foundation Raft Slab Construction Joints

It is expected that the raft slab will be poured in sections. For the construction joint at each pour, a rubber water stop along with a chemical grout (Xypex or equivalent) should be applied to the entire vertical joint of the raft slab. Furthermore, a rubber water stop should be incorporated in the horizontal interface between the foundation wall and the raft slab.

Sub-slab Drainage

Sub-slab drainage will be required to control water which infiltrates through the raft foundation, or to control water underlying the basement slab in areas where footings are utilized. For design purposes, we recommend that 150 mm diameter perforated pipes be placed along the interior perimeter of the foundation walls and within the building at approximate 6 m spacing. The spacing of the sub-slab drainage system should be confirmed at the time of backfilling the floor completing the excavation when water infiltration can be better assessed.

Foundation Backfill

Where sufficient space is available, backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be used for this purpose.

Pressure Relief Chamber

The pressure relief chamber will be used to control the groundwater infiltration and hydrostatic pressure created by tanking the lower level of underground parking. To avoid uplift on the raft foundation slab prior to having sufficient loading to resist uplift, it is recommended that the water infiltration be pumped via the pressure relief chamber during construction.

The valve of the pressure relief chamber can be gradually closed during construction as the loading is applied to resist hydrostatic pressure. Once sufficient load is available to resist the full hydrostatic pressure, the valve of the pressure relief chamber can be adjusted and closed to minimize water infiltration volumes.

6.2 Protection of Footings Against Frost Action

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

Exterior unheated footings, such as those for isolated exterior piers and loading docks, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

The foundations for the underground parking levels are expected to have sufficient frost protection due to the founding depth. However, unheated structures such as access ramps may require insulation against the deleterious effect of frost action.

6.3 Excavation Side Slopes

The side slopes of excavations in the overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. Based on the depth of the proposed structure and the proximity to property lines, it is anticipated that a temporary shoring system will be required to support the excavation.

Unsupported Excavations

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be excavated at 1H:1V or shallower. The shallower slope is required for excavation below groundwater level. The subsurface soils are considered to be a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

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

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

A trench box is recommended to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain open for extended periods of time.

Temporary Shoring

Temporary shoring is anticipated to be required to support the overburden soils during the proposed building excavation. The design and approval of the shoring system will be the responsibility of the shoring contractor and the shoring designer who is a licensed professional engineer and is hired by the shoring contractor. It is the responsibility of the shoring contractor to ensure that the temporary shoring is in compliance with safety requirements, designed to avoid any damage to adjacent structures and include dewatering control measures.

In the event that subsurface conditions differ from the approved design during the actual installation, it is the responsibility of the shoring contractor to commission the required experts to re-assess the design and implement the required changes. Furthermore, the design of the temporary shoring system should take into consideration a full hydrostatic condition which can occur during significant precipitation events.

The temporary shoring system is recommended to consist of a soldier pile and lagging system which could be cantilevered, anchored or braced.

Any additional loading due to street traffic, construction equipment, adjacent structures and facilities, etc., should be added to the earth pressures described below. The earth pressures acting on the shoring system may be calculated using the following parameters.

Table 6 - Soil Parameters

Parameters	Values
Active Earth Pressure Coefficient (K_a)	0.33
Passive Earth Pressure Coefficient (K_p)	3
At-Rest Earth Pressure Coefficient (K_o)	0.5
Unit Weight (γ), kN/m^3	21
Submerged Unit Weight (γ), kN/m^3	13

The active earth pressure should be calculated where wall movements are permissible while the at-rest pressure should be calculated if no movement is permissible. The dry unit weight should be calculated above the groundwater level while the effective unit weight should be calculated below the groundwater level.

The hydrostatic groundwater pressure should be included to the earth pressure distribution wherever the effective unit weight are calculated for earth pressures. If the groundwater level is lowered, the dry unit weight for the soil should be calculated full weight, with no hydrostatic groundwater pressure component.

For design purposes, the minimum factor of safety of 1.5 should be calculated.

Considerations for Adjacent Structures

As noted in Section 4.1, the existing Deschatelets Building is located to the west of the subject site. Based on previous investigations conducted by Paterson for that structure, the underside of footing is generally located at approximate geodetic elevation 63 m, and is bearing on a hard to stiff silty clay.

The proposed building excavation, which is anticipated to extend to approximate geodetic elevation 56 m, will generally be more than 8 m horizontally from the existing Dechatelets Building, with the exception of the southwest corner of the site where the proposed building excavation will be setback approximately 5 m from the existing Deschatelets Building. Given the setback of the proposed building excavation from the existing Deschatelets Building, and the subsurface conditions at the site consisting of a hard to stiff silty clay, the excavation is not anticipated to impact the existing structure.

6.4 Pipe Bedding and Backfill

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe, should consist of OPSS Granular A or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 98% of the material's standard Proctor maximum dry density.

It should generally be possible to re-use the moist (not wet) brown silty clay above the cover material if the operations are carried out in dry weather conditions.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.5 m below finished grade) and above the cover material should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the material standard Proctor maximum dry density.

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

6.5 Groundwater Control

Due to the relatively impervious nature of the silty clay and existing groundwater level, it is anticipated that groundwater infiltration into the excavations should generally 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.

Groundwater Control for Building Construction

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

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

Long-term Groundwater Control

Our recommendations for the proposed building's long-term groundwater control are presented in Subsection 6.1. Any groundwater which breaches the building's perimeter groundwater infiltration control system will be directed to the proposed building's sump pit. Provided the proposed groundwater infiltration control system and the tanked system are properly implemented and approved by the geotechnical consultant at the time of construction, it is expected that groundwater flow will be very low to negligible (less than 2,000 L/day). A more accurate estimate can be provided at the time of construction, once the pressure relief chamber valve is closed and full hydrostatic pressure is applied to the structure.

Impacts on Neighbouring Properties

As the proposed multi-storey building will be founded below the long term groundwater level, a groundwater infiltration control system has been recommended to mitigate the effects of groundwater infiltration. Any long term dewatering of the site will be minimal and should have no adverse effects to the surrounding buildings or structures. The short term dewatering during the excavation program will be managed by the excavation contractor, as discussed above.

6.6 Winter Construction

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

The subsoil conditions at this site mostly consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters, 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 carried out in a manner to avoid the introduction of frozen materials, snow or ice into the trenches.

6.7 Corrosion Potential and Sulphate

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

6.8 Slope Review

Based on our review of available topographic mapping, the bank of the Rideau River located to the east of the subject site has a height of 6 to 8 m with an incline of approximately 1H:1V to 2H:1V.

Given the height and incline of the bank of the Rideau River, and that the subject site limits are located approximately 25 to 30 m from the top of the bank, the site is considered to be beyond any Hazard Lands associated with the global stability of the adjacent slope/bank of the Rideau River.

6.9 Landscaping Considerations

Given the proposed development will include an underground parking garage, the foundations are expected to be located approximately 6 to 10 m below finished grades. Accordingly, the foundations are considered to be located well below the depth of influence from tree roots.

Therefore, there are no tree planting setbacks required from the proposed building, from a geotechnical perspective. Further testing of the clay soils per the City of Ottawa's "Tree Planting in Sensitive Marine Clay Soils - 2017 Guidelines" is also not considered to be required, given the proposed depth of the building foundations.

6.10 Global Stability Analysis

The retaining wall located along the northwest corner of the subject site, which has a height greater than 1 m, was analyzed for global stability. The global stability analysis of the retaining wall was conducted using SLIDE, a computer program which permits a two-dimensional stability analysis using several methods including the Bishop's method, which is a widely used and accepted analysis method. A horizontal acceleration of 0.16 g (50% of PGA = 0.32g) was utilized for the seismic analysis.

The result for the global stability analysis under static conditions at Section A is shown on Figure 4, which is provided in Appendix 2. The result of the global stability analysis indicates that the factor of safety exceeds 1.5 under static conditions.

The result for the global stability analysis under seismic conditions at Section A is shown on Figure 5, which is provided in Appendix 2. The result of this analysis indicates that the factor of safety exceeds 1.1 under seismic conditions.

Therefore, the proposed retaining located along the northwest corner of the subject site are considered stable, from a global stability perspective.

7.0 Recommendations

A materials testing and observation services program is a requirement for the provided foundation design data to be applicable. The following aspects of the program should be performed by the geotechnical consultant:

- ❑ Review of the grading plan from a geotechnical perspective.
- ❑ Review of the Contractor's design of the temporary shoring system
- ❑ Observation of all bearing surfaces prior to the placement of concrete.
- ❑ Inspection and approval of the installation of the pressure relief chamber.
- ❑ Inspection of the foundation waterproofing and all foundation drainage systems.
- ❑ Sampling and testing of the concrete and fill materials used.
- ❑ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- ❑ Observation of all subgrades prior to backfilling.
- ❑ Field density tests to determine the level of compaction achieved.
- ❑ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued, upon request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations provided in this report are in accordance with our present understanding of the project. We request permission to review our recommendations when the drawings and specifications are completed.

A geotechnical investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request immediate notification to permit reassessment of our recommendations.

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

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than eQ Homes or their agents is not authorized without review by Paterson for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Kevin A. Pickard, EIT

Scott S. Dennis, P.Eng.

Report Distribution

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- ❏ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

SOIL PROFILE AND TEST DATA SHEETS BY OTHERS

PLASTICITY CHARTS BY OTHERS

CONSOLIDATION TESTING RESULTS BY OTHERS

GRAIN SIZE DISTRIBUTION ANALYSIS RESULTS

GRAIN SIZE DISTRIBUTION ANALYSIS RESULTS BY OTHERS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - Greystone Village Phase 3
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE July 15, 2020

FILE NO. PG5383

HOLE NO. BH 1-20

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	61.00
FILL: Brown silty sand, some gravel, crushed stone, trace clay					1	60.00
1.52						
Advanced borehole directly to 7.5m with casing and wet rotary drilling					2	59.00
					3	58.00
					4	57.00
					5	56.00
Brown to grey **SILTY CLAY**					6	55.00
					7	54.00
	SS	1	100	2	8	53.00
	SS	2	100	P		
	SS	3	100	P	9	52.00
	SS	4	92	6	10	51.00
10.67						
	SS	5	33	30	11	50.00
	SS	6	62	28		
Compact, grey **SILTY SAND**					12	49.00
	SS	7	50	37		
	SS	8	58	16	13	48.00
- SANDY SILT, trace clay from 13.7 to 14.3m depth	SS	9	42	9	14	47.00
	SS	10	38	13		
15.09					15	46.00
End of Borehole						
(Monitoring well blocked - July 22, 2020)						

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

○ Water Content %

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

Monitoring Well Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - Greystone Village Phase 3
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

DATE July 15, 2020

FILE NO. PG5383

HOLE NO. BH 2-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	63.06
FILL: Brown silty sand, some gravel, crushed stone, trace cobbles (to 1.52)						1	62.06
Advanced borehole directly to 7.5m with casing and wet rotary drilling						2	61.06
						3	60.06
						4	59.06
						5	58.06
Brown to grey **SILTY CLAY**						6	57.06
						7	56.06
		SS	1	83	5	8	55.06
		SS	2	96	4	9	54.06
(to 9.91)		SS	3	100	2		
Grey **CLAYEY SILT** (to 10.67)		SS	4	58	13	10	53.06
Dense to compact, grey **SILTY SAND**		SS	5	4	35	11	52.06
		SS	6	4	29	12	51.06
		SS	7	38	29		
		SS	8	42	45	13	50.06
- SILT, some clay and sand from 13.7 to 14.3m depth		SS	9	83	4	14	49.06
(to 15.09)		SS	10	42	17	15	48.06
End of Borehole							
(GWL @ 2.04m - July 22, 2020)							

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

○ Water Content %

20 40 60 80

Piezometer Construction

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - Greystone Village Phase 3
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5383

REMARKS

HOLE NO. BH 3-20

BORINGS BY Track-Mount Power Auger

DATE July 16, 2020

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty sand, some gravel and crushed stone	1.52				
Advanced borehole directly to 7.5m with casing and wet rotary drilling; Brown to grey **SILTY CLAY**	12.04	SS	1	100	P
		SS	2	50	6
		SS	3	83	7
		SS	4	100	3
		SS	5	100	P
		SS	6	100	P
Grey **CLAYEY SILT,** trace sand	12.40				
Dense to very dense, grey **SILTY SAND**	15.09	SS	7	67	30
		SS	8	75	37
		SS	9	54	56
		SS	10	88	99
End of Borehole					
(GWL @ 6.60m - July 22, 2020)					

DEPTH (m)	ELEV. (m)
0	62.85
1	61.85
2	60.85
3	59.85
4	58.85
5	57.85
6	56.85
7	55.85
8	54.85
9	53.85
10	52.85
11	51.85
12	50.85
13	49.85
14	48.85
15	47.85

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

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - Greystone Village Phase 3
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5383

REMARKS

HOLE NO. BH 4-20

BORINGS BY Track-Mount Power Auger **DATE** July 16, 2020

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
FILL: Brown silty sand, some gravel and crushed stone	1.52
Advanced borehole directly to 9.0m with casing and wet rotary drilling. Brown to grey **SILTY CLAY**	12.02
Dense to very dense, grey **SILTY SAND**	16.61
Dynamic Cone Penetration Test commenced at 16.61m depth.	

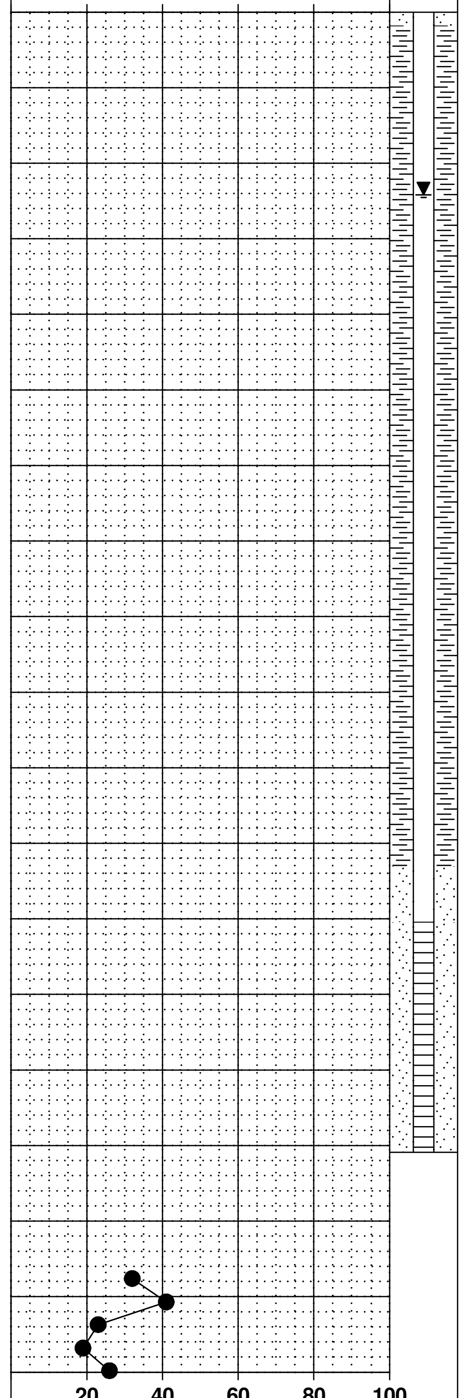
SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	100	P
SS	2	100	P
SS	3	96	3
SS	4	100	P
SS	5	58	46
SS	6	75	45
SS	7	92	42
SS	8	38	62
SS	9	50	33
SS	10	38	61

DEPTH (m)	ELEV. (m)
0	63.80
1	62.80
2	61.80
3	60.80
4	59.80
5	58.80
6	57.80
7	56.80
8	55.80
9	54.80
10	53.80
11	52.80
12	51.80
13	50.80
14	49.80
15	48.80
16	47.80
17	46.80
18	45.80

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

○ Water Content %

Monitoring Well Construction



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - Greystone Village Phase 3
Ottawa, Ontario

DATUM Geodetic

REMARKS

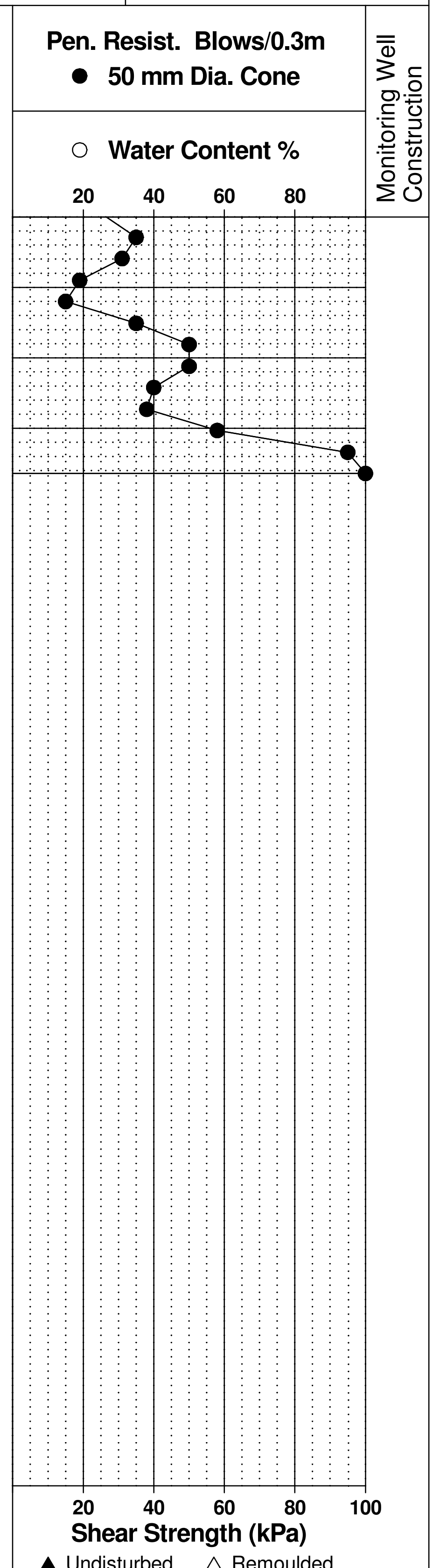
BORINGS BY Track-Mount Power Auger

DATE July 16, 2020

FILE NO. PG5383

HOLE NO. BH 4-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						18	45.80
						19	44.80
						20	43.80
						21	42.80
21.64							
End of Borehole Practical DCPT refusal at 21.64m depth. (GWL @ 2.42m - July 22, 2020)							



SYMBOLS AND TERMS

SOIL DESCRIPTION

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

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

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

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

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

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

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

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

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

ROCK DESCRIPTION

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

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

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

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = D60 / D10

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

CONSOLIDATION TEST

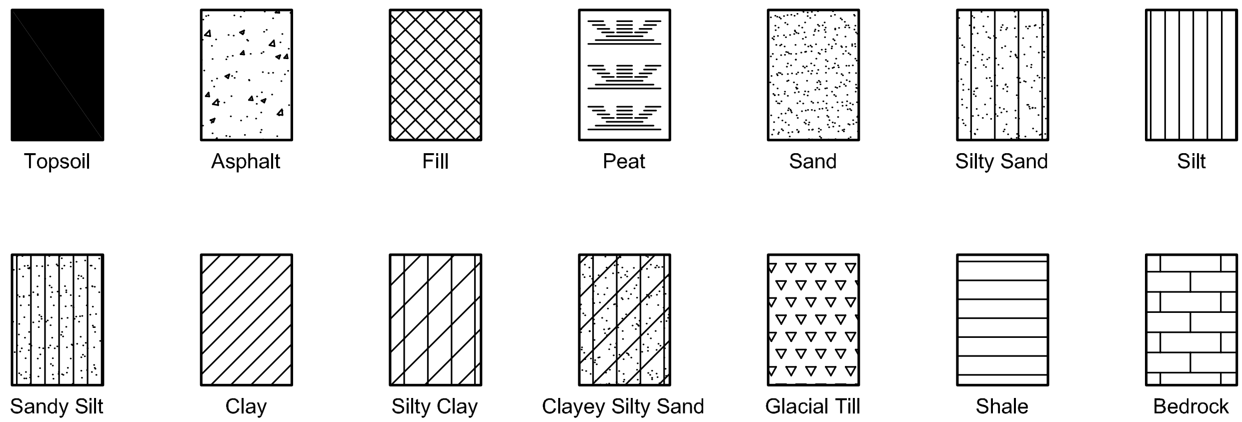
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

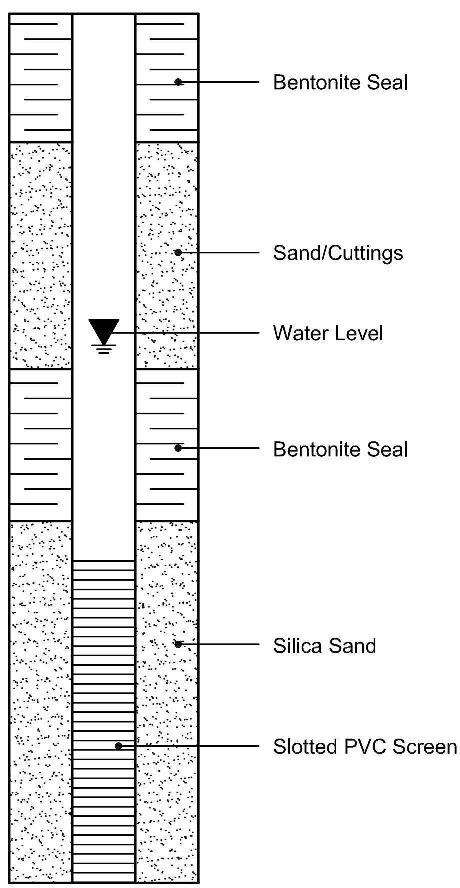
SYMBOLS AND TERMS (continued)

STRATA PLOT

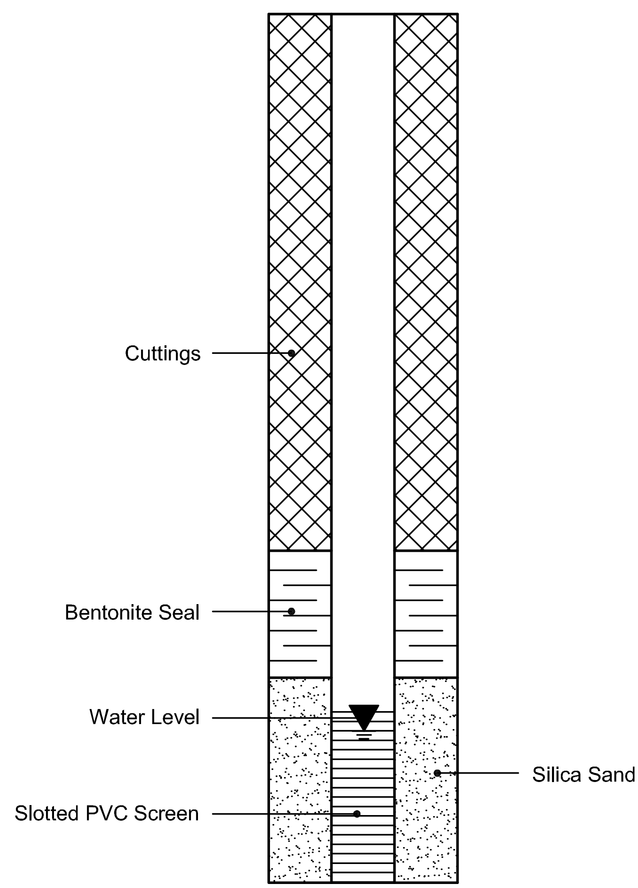


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



PROJECT: 1668819-5100

RECORD OF BOREHOLE: 14-204

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: August 31, 2014

DATUM: Geodetic

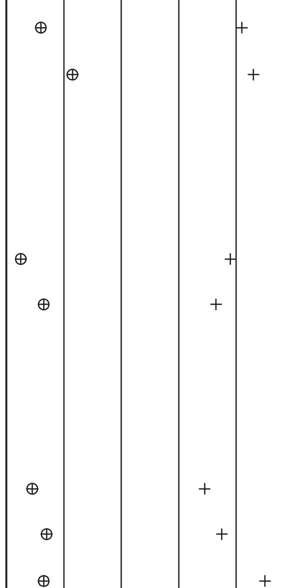
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

DEPTH SCALE METRES	SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING
	GROUND SURFACE	60.07				
0	ASPHALTIC CONCRETE	0.03				
	FILL - (SM) SILTY SAND, some clayey silt layers, trace gravel; grey brown; non-cohesive, moist, loose		1	SS	8	
	FILL - (SP) SAND, fine, trace silt; grey brown; non-cohesive, moist to wet, loose	59.46 / 0.61	2	SS	8	MH
1			3	SS	7	
2	(ML) CLAYEY SILT, some sand; grey; cohesive, w>PL, stiff	58.24 / 1.83	4	SS	3	
	(CI/CH) SILTY CLAY to CLAY; grey, with sandy silt seams; cohesive, w>PL, stiff	57.63 / 2.44	5	SS	2	
3			6	SS	2	
5			7	SS	2	
6			8	SS	PH	
7	End of Borehole	52.45 / 7.62				
8						
9						
10						

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				PIEZOMETER OR STANDPIPE INSTALLATION
20	40	60	80	10^{-6}	10^{-5}	10^{-4}	10^{-3}	
SHEAR STRENGTH Cu, kPa (nat V. + Q - ● ; rem V. ⊕ U - ○)				WATER CONTENT PERCENT (Wp ⊢—○W—⊣ Wl)				
20	40	60	80	20	40	60	80	



DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DWM

CHECKED: CK

MIS-BHS 001 1668819.GPJ GAL-MIS.GDT 6/15/17 JM

PROJECT: 1668819-5100

RECORD OF BOREHOLE: 14-205

LOCATION: See Site Plan

BORING DATE: August 1, 2014

DATUM: Geodetic

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	64.29
ASPHALTIC CONCRETE	0.05
FILL - (SM) SILTY SAND, some silty clay, trace to some gravel, trace organics; grey brown; non-cohesive, dry, loose	
FILL - (ML) CLAYEY SILT, some fine sand; grey brown; cohesive, moist, stiff	63.38 / 0.91
(CI/CH) SILTY CLAY to CLAY, trace fine sand; grey brown, fissured (WEATHERED CRUST); cohesive, w<PL, very stiff	62.77 / 1.52
(CL-ML) SILTY CLAY to CLAYEY SILT, trace fine sand; grey brown; cohesive, w>PL, stiff	61.24 / 3.05
(CI) SILTY CLAY, trace sand; grey with black streaks and mottling; cohesive, w>PL, stiff	58.19 / 6.10

SAMPLE NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING
1	SS	6	
2	SS	9	
3	SS	10	
4	SS	5	
5	SS	3	
6	SS	PH	
7	TP	PH	C
8	SS	PH	
9	TP	PH	C

Chart headings: 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)

PIEZOMETER OR STANDPIPE INSTALLATION:
- Flush Mount Protective Casing
- Bentonite Seal
- Native Backfill
- Bentonite Seal
- Silica Sand
- Standpipe 'B'
- Silica Sand
- Bentonite Seal
- Native Backfill

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DWM

CHECKED: CK

PROJECT: 1668819-5100

RECORD OF BOREHOLE: 14-205

SHEET 2 OF 3

LOCATION: See Site Plan

BORING DATE: August 1, 2014

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Column headings: DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)) | SAMPLES (NUMBER, TYPE, 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 ---

Boring method: Power Auger, 200 mm Diam. (Hollow Stem) to 18.89 m; DCPT below.

Description	Elev. / Depth (m)	Sample Number	Type	Blows/0.30m	Shear Strength	Additional Lab. Testing
(CI) SILTY CLAY, trace sand; grey with black streaks and mottling; cohesive, w>PL, stiff		10	SS	PH		
(CI/CH) SILTY CLAY to CLAY, trace silty sand and silt seams; grey; cohesive, w>PL, very stiff	52.10 / 12.19	11	SS	PH	>96 +, >96 +	
(ML) CLAYEY SILT, some silty clay layers; grey; cohesive, w>PL, stiff	50.58 / 13.71	12	SS	WH		
(ML) SILT, some sand, trace clay and gravel; grey; non-cohesive, wet, loose	49.84 / 14.45	13	SS	5		
(ML) SILT, some fine sand; grey; non-cohesive, wet, compact	49.04 / 15.25	14	SS	16		
		15	SS	11		
(SM) SILTY SAND, fine; grey, with silt seams; non-cohesive, wet, compact	46.00 / 18.29	16	SS	25		MH
Possible Silty Sand	45.40 / 18.89					

Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Piezometer or standpipe installation: Native Backfill; Bentonite Seal; Silica Sand; Standpipe 'A'; Silica Sand; Bentonite Seal; Cave

WL in Standpipe 'A' at Elev. 57.84 m on Sept. 9, 2014

WL in Standpipe

CONTINUED NEXT PAGE

PROJECT: 1668819-5100

RECORD OF BOREHOLE: 14-205

LOCATION: See Site Plan

BORING DATE: August 1, 2014

DATUM: Geodetic

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	TYPE	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 ---									
20	DCPT			44.18 / 20.11							'B' at Elev. 61.20 m on Sept. 9, 2014
		Possible Glacial Till									
21											
22											
23											
24											
25											
26								105			
								174			
				37.47 / 26.82				211			
27		End of Borehole Dynamic Cone Penetration Test Refusal									
28											
29											
30											

MIS-BHS 001 1668819.GPJ GAL-MIS.GDT 6/15/17 JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DWM

CHECKED: CK

PROJECT: 14-1122-0005-5100

RECORD OF BOREHOLE: 14-206

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: August 6-7, 2014

DATUM: Geodetic

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)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH Cu, kPa
	GROUND SURFACE	63.24				
0	FILL/TOPSOIL - (SM) SILTY SAND; brown; moist	0.00				
	FILL - (SM) SILTY SAND, some gravel; brown, with cobbles; non-cohesive, dry to moist, compact to loose	0.15	1	SS	11	
1			2	SS	8	
	FILL - (CI/CL) SILTY CLAY, some sand; brown, friable; cohesive, w<PL, stiff	62.02 / 1.22	3	SS	2	
2	(ML) CLAYEY SILT, some sand; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	61.41 / 1.83	4	SS	7	
			5	SS	2	
3			6	SS	PH	
4						>96 +
	(CI/CH) SILTY CLAY to CLAY; grey, with black streaks; cohesive, w>PL, stiff	58.67 / 4.57	7	SS	PH	
6			8	TP	PH	
8			9	SS	PH	
9			10	TP	PH	
10	(CI/CH) SILTY CLAY to CLAY, trace silt seams; grey, with black streaks and white shells; cohesive, w>PL, very stiff	52.57 / 10.67				
11			11	SS	PH	
						>96 +
						>96 +
12	(ML) SILT, trace fine sand; grey; non-cohesive, wet, very loose	51.05 / 12.19	12	SS	1	
13	(SM) SILTY SAND, fine; grey, with silt seams; non-cohesive, wet, very loose to compact	49.98 / 13.26	13	SS	1	
14			14	SS	3	
			15	SS	9	
15						

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 NEXT PAGE

DEPTH SCALE 1 : 75

Golder Associates

LOGGED: DWM

CHECKED: CK

PROJECT: 14-1122-0005-5100

RECORD OF BOREHOLE: 14-206

LOCATION: See Site Plan

BORING DATE: August 6-7, 2014

DATUM: Geodetic

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	TYPE	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* ---									
15	Power Auger 200 mm Diam. (Hollow Stem)	(SM) SILTY SAND, fine; grey, with silt seams; non-cohesive, wet, very loose to compact									
					16	SS	8				
16											
17					17	SS	15				
18					18	SS	WR				
19	DCPT	Possible Silty Sand		44.34 18.90							
20		Possible Glacial Till		43.13 20.11							
21								150			
								225			
		End of Borehole Dynamic Cone Penetration Test Refusal		41.60 21.64							
22											
23											
24											
25											
26											
27											
28											
29											
30											

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: DWM

CHECKED: CK

PROJECT: 14-1122-0005-5100

RECORD OF BOREHOLE: 14-209

LOCATION: See Site Plan

BORING DATE: August 7-8, 2014

DATUM: Geodetic

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	64.72 / 0.00
ASPHALTIC CONCRETE	0.10
FILL - (GW) sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE); non-cohesive, dry	64.11 / 0.61
FILL - (SM) SILTY SAND, trace gravel; dark grey to black, with brick fragments and organics; non-cohesive, dry, compact	63.50 / 1.22
FILL - (SM) SILTY SAND, fine; brown; non-cohesive, moist, compact	
(CI/CH) SILTY CLAY to CLAY, trace fine sand seams; grey brown (WEATHERED CRUST); cohesive, w<PL, very stiff	62.44 / 2.28
(ML) CLAYEY SILT, some sand; grey brown (WEATHRED CRUST); cohesive, w>PL, very stiff	60.15 / 4.57
(CI/CH) SILTY CLAY to CLAY, trace sand; grey, with white shells; cohesive, w>PL, stiff	58.62 / 6.10
(CL-ML) SILTY CLAY to CLAYEY SILT; grey; cohesive, w>PL, stiff	57.10 / 7.62
(CI/CH) SILTY CLAY to CLAY; grey, with black streaks; cohesive, w>PL, stiff to very stiff	53.29 / 11.43
(ML) SILT, trace to some sand; grey; non-cohesive, wet, very loose	52.38 / 12.34
(SM) SILTY SAND; grey; non-cohesive, wet, loose to very loose	51.01 / 13.71
(SM) SILTY SAND; grey, with silt seams; non-cohesive, wet, compact to loose	

SAMPLES

NUMBER	TYPE	BLOWS/0.30m
1	SS	12
2	SS	13
3	SS	10
4	SS	5
5	SS	2
6	SS	PH
7	TP	PH
8	SS	PH
9	TP	PH
10	SS	PH
11	SS	6
12	SS	PH
13	SS	16
14	SS	21

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)

Field vane results: >96 + (approx. 4.0 m); >96 + (approx. 4.3 m); >96 + (approx. 11.0 m); >96 + (approx. 11.3 m)

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

- Flush Mount Protective Casing
- Silica Sand and Cuttings
- Bentonite Seal
- Native Backfill
- Bentonite Seal
- Silica Sand
- Standpipe 'B'
- Silica Sand
- Bentonite Seal
- Native Backfill
- Bentonite Seal
- Silica Sand
- Standpipe 'A'
- Cave

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 75

Golder Associates

LOGGED: DWM

CHECKED: CK

PROJECT: 14-1122-0005-5100

RECORD OF BOREHOLE: 14-209

LOCATION: See Site Plan

BORING DATE: August 7-8, 2014

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

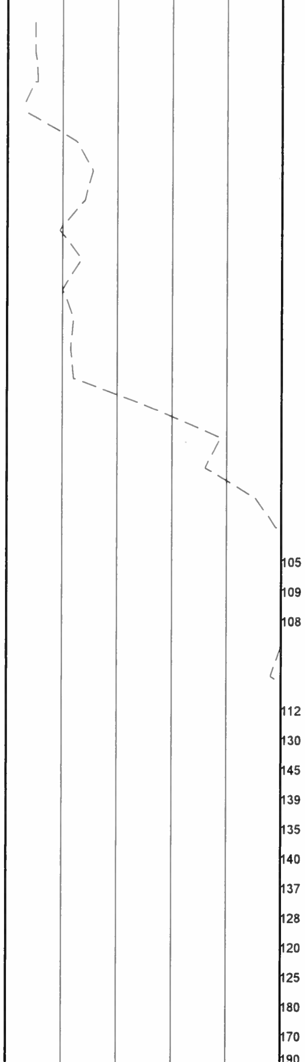
— CONTINUED FROM PREVIOUS PAGE —

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
15	Power Auger, 200 mm Diam. (Hollow Stem)	(SM) SILTY SAND; grey, with silt seams; non-cohesive, wet, compact to loose					
				15	SS	10	
17				16	SS	5	Cave
				17	SS	8	
19	DCPT	Possible Silty Sand	45.82 / 18.90				WL in Standpipe 'A' at Elev. 57.93 m on Sept. 9, 2014; WL in Standpipe 'B' at Elev. 62.57 m on Sept. 9, 2014
22.55		Possible Glacial Till	42.17 / 22.55				
29.50		End of Borehole Dynamic Cone Penetration Test Refusal	35.22 / 29.50				

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



MIS-BHS 001 1411220005-5000.GPJ GAL-MIS.GDT 12/12/14 JM

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: DWM
CHECKED: CK

PROJECT: 1525113

RECORD OF MONITORING WELL: 15-103

SHEET 1 OF 1

LOCATION: N 5030324.8 ;E 369420.7

BORING DATE: March 18, 2015

DATUM: Geodetic

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)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] (ND = Not Detected)
GROUND SURFACE	63.36				
FILL - (GW) sandy GRAVEL; non-cohesive, moist	0.00				
FILL - (SM) SILTY SAND; brown, contains ash, wood, brick, and mortar; non-cohesive, moist, compact	62.60 / 0.76	1	SS	19	ND
(CI/CH) SILTY CLAY; grey brown; cohesive, w>PL	61.99 / 1.37	2	SS	17	ND
		3	SS	7	ND
		4	SS	5	ND
		5	SS	5	ND
		6	SS	2	
(CI/CH) SILTY CLAY; grey; cohesive, w>PL	58.03 / 5.33	7	SS	1	
Probable (CI/CH) SILTY CLAY; grey; cohesive	57.42 / 5.94				
End of Borehole	55.74 / 7.62				

HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected

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:
- Bentonite Seal
- Native Backfill
- Bentonite Seal
- Silica Sand
- 51 mm Diam. PVC #10 Slot Screen

W.L. in Screen at 4.830 m depth on March 24, 2015

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: BM

CHECKED: TDR

PROJECT: 1525113

RECORD OF MONITORING WELL: 15-104

SHEET 1 OF 1

LOCATION: N 5030376.5 ;E 369442.5

BORING DATE: March 17, 2015

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Boring method: Power Auger, 200 mm Diam. (Hollow Stem)

DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] (ND = Not Detected)
GROUND SURFACE	59.84				
FILL - (SM) SILTY SAND; dark brown; non-cohesive, moist	0.00				
FILL - (SW) SAND, some low plastic fines; contains rust and black discolouration; non-cohesive, moist, compact	59.08 / 0.76	1	SS	14	ND
(CI/CH) SILTY CLAY; grey brown, contains silty sand seams; cohesive, w>PL	58.32 / 1.52	2	SS	6	ND
(CI/CH) SILTY CLAY; grey; cohesive, w>PL	57.55 / 2.29	3	SS	4	ND
		4	SS	4	ND
		5	SS	3	ND
		6	SS	WH	
		7	SS	WH	
		8	SS	WH	
End of Borehole	53.13 / 6.71				

Other column headings: HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected (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; DEPTH SCALE METRES (0–10).

PIEZOMETER OR STANDPIPE INSTALLATION:
- Bentonite Seal
- Silica Sand
- 51 mm Diam. PVC #10 Slot Screen
- W.L. in Screen at 2.575 m depth on March 24, 2015

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: BM

CHECKED: TDR

MIS-BHS 001 1525113-1000.GPJ GAL-MIS.GDT 07/06/16 JEM

RECORD OF MONITORING WELL: 15-105

PROJECT: 1525113

SHEET 1 OF 1

LOCATION: N 5030351.0 ;E 369407.9

BORING DATE: March 18, 2015

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] (ND = Not Detected)	PIEZOMETER OR STANDPIPE INSTALLATION
0	GROUND SURFACE	63.31					
	FILL - (GW) sandy GRAVEL; brown; non-cohesive, moist	0.00					Bentonite Seal
1	FILL - (SM) SILTY SAND, trace gravel; dark brown to black, contains ash, brick, and mortar; non-cohesive, moist, loose to dense	62.55 / 0.76	1	SS	8	⊕	
							Native Backfill
2			2	SS	7	⊕	Bentonite Seal
			3	SS	38		Silica Sand
3	(CI/CH) SILTY CLAY; grey brown; cohesive, w>PL	60.26 / 3.05	4	SS	6	⊕ ND	
4			5	SS	4	⊕ ND	
	(CI/CH) SILTY CLAY; grey; cohesive, w>PL	58.74 / 4.57					51 mm Diam. PVC #10 Slot Screen
5			6	SS	WH	⊕ ND	
			7	SS	WH	⊕ ND	
6	End of Borehole	57.37 / 5.94					
							W.L. in Screen at 2.880 m depth on March 24, 2015

Other column headings: HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected (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; STRATA PLOT.

Depth scale: 0–10 m

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: TDR

PROJECT: 1525113

RECORD OF MONITORING WELL: 15-107

SHEET 1 OF 1

LOCATION: N 5030396.9 ;E 369366.5

BORING DATE: March 18, 2015

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Boring method: NW Rods / Open Hole

DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] (ND = Not Detected)	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	64.62					
Portland Cement CONCRETE	0.00					Bentonite Seal
FILL - (SW) SAND, trace non-plastic fines; brown; non-cohesive, moist	0.15	1	SS	-	ND	
		2	SS	-	ND	Native Backfill
FILL - (CI/CH) SILTY CLAY; brown, contains sand seams; cohesive, w>PL	63.25 / 1.37	3	SS	-	ND	
(CI/CH) SILTY CLAY; grey brown; cohesive, w>PL	62.64 / 1.98	4	SS	-	ND	Bentonite Seal
		5	SS	-	ND	Silica Sand
		6	SS	-		
		7	SS	-	ND	
		8	SS	-		51 mm Diam. PVC #10 Slot Screen
		9	SS	-		
End of Borehole	58.52 / 6.10					

W.L. in Screen at 1.810 m depth on March 24, 2015

Other column headings: DEPTH SCALE METRES; STRATA PLOT; HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected (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

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: BM

CHECKED: TDR

PROJECT: 1668819

RECORD OF BOREHOLE: 17-1

LOCATION: See Site Plan

BORING DATE: January 16-17, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	63.82
FILL - (SM) SILTY SAND, some gravel; brown; non-cohesive, wet, very loose to compact	0.00
(CL/CI) SILTY CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	61.99 / 1.83
(ML) sandy SILT; brown; non-cohesive, wet, very loose to loose	60.77 / 3.05
(CI) SILTY CLAY; grey with black organic mottling; cohesive, w>PL, stiff to very stiff	59.71 / 4.11

SAMPLE NUMBER	TYPE	BLOWS/0.30m
1	SS	29
2	SS	3
3	SS	4
4	SS	6
5	SS	4
6	SS	2
7	SS	1
8	SS	WH
9	SS	WH
10	SS	WH

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 NEXT PAGE

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 1668819

RECORD OF BOREHOLE: 17-1

LOCATION: See Site Plan

BORING DATE: January 16-17, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Boring method: Power Auger, 200 mm Diam. (Hollow Stem)

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE METRES	SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)
10	(CI) SILTY CLAY; grey with black organic mottling; cohesive, w>PL, stiff to very stiff	
13.72	(ML) SILT, trace sand; grey; non-cohesive, wet, loose	50.10 / 13.72
14.48	(SM-ML) Layered SILTY SAND and sandy SILT; grey; non-cohesive, wet, compact	49.34 / 14.48

SAMPLE NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING
11	TP	PH	
12	SS	1	
13	SS	4	
14	SS	20	
15	SS	24	
16	SS	13	MH
17	SS	15	M
18	SS	16	
19	SS	11	M
20	SS	10	MH
21	SS	15	

Shear strength (Cu, kPa): nat V. +, rem V. ⊕; one nat V. value noted >96 at approx. 11.9 m.

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

RECORD OF BOREHOLE: 17-1

PROJECT: 1668819

LOCATION: See Site Plan

BORING DATE: January 16-17, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20	Power Auger	(SM-ML) Layered SILTY SAND and sandy SILT; grey; non-cohesive, wet, compact		21	SS	15		
21	Wash Boring, NW Casing			22	SS	25		
		(SM-ML) Layered SILTY SAND and sandy SILT; grey; non-cohesive, wet, dense to very dense	42.48 21.34	23	SS	45		
22				24	SS	46		
23				25	SS	57		
				26	SS	64		
24		(SM) SILTY SAND, some gravel; grey, contains shale fragments, cobbles, and boulders (GLACIAL TILL); non-cohesive, wet, dense	39.59 24.23	27	SS	36		
25				28	SS	>50		
		End of Borehole Sampler Refusal	38.57 25.25					

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

Depth scale: 26, 27, 28, 29, 30

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: SAT

PROJECT: 1668819

RECORD OF BOREHOLE: 17-2

LOCATION: See Site Plan

BORING DATE: January 11, 2017

DATUM: Geodetic

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)	SAMPLE NUMBER	TYPE	BLOWS/0.30m
	GROUND SURFACE	63.99			
0	FILL/TOPSOIL - (ML) sandy SILT; dark brown	0.00			
	FILL - (CL) SILTY CLAY, some sand, trace gravel; dark brown, contains sand seams; non-cohesive, moist	0.15	1	SS	5
	FILL - (SM) SILTY SAND; brown, contains brick fragments, aluminum and mortar; non-cohesive, moist, loose to very loose	63.23 0.76	2	SS	7
1–2			3	SS	2
	FILL - (ML) sandy SILT to CLAYEY SILT; brown, contains alluminum; non-cohesive, moist, very loose	61.70 2.29	4	SS	WH
	(CI/ML) SILTY CLAY to CLAYEY SILT; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	61.25 2.74			
3			5	SS	6
4			6	SS	3
5			7	SS	2
	(CI) SILTY CLAY; grey, contains silt layers; cohesive, w>PL, stiff to very stiff	58.50 5.49			
6			8	SS	2
8			9	SS	1
9			10	TP	PH
10	*CONTINUED NEXT PAGE*				

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

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: KM

CHECKED: SAT

PROJECT: 1668819

RECORD OF BOREHOLE: 17-2

LOCATION: See Site Plan

BORING DATE: January 11, 2017

DATUM: Geodetic

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	TYPE	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	Power Auger 200 mm Diam. (Hollow Stem)	(CI) SILTY CLAY; grey, contains silt layers; cohesive, w>PL, stiff to very stiff									
11					11	SS	1				
12								>96 +			
					12	SS	1				
13				50.27 / 13.72							
14		(ML) SILT, some sand; grey; non-cohesive, wet, very loose to loose			13	SS	3				
					14	SS	6				
15					15	SS	9				
16				47.99 / 16.00							
		(SM-ML) Layered SILTY SAND and sandy SILT; grey; non-cohesive, wet, compact			16	SS	20				
17				46.62 / 17.37	17	SS	15				
		End of Borehole									
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: KM

CHECKED: SAT

PROJECT: 1668819

RECORD OF BOREHOLE: 17-3

LOCATION: See Site Plan

BORING DATE: January 12-13, 2017

DATUM: Geodetic

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	TYPE	BLOWS/0.30m	SHEAR STRENGTH Cu, kPa (nat V. + / rem V. ⊕)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		59.91						
0	Power Auger, 200 mm Diam. (Hollow Stem)	FILL - (SM) SILTY SAND; brown, contains organic matter; non-cohesive, wet, loose to compact		0.00	1	SS	6			
1					2	SS	10			
		(CI) SILTY CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff		58.39 / 1.52	3	SS	2		CHEM	
2								>96 +		
								>96 +		
3		(CI) SILTY CLAY; grey; cohesive, w>PL, stiff		56.86 / 3.05	4	SS	WH			
4					5	TP	PH			
5–6										
6					6	SS	WH			
7–8					7	SS	1			
9					8	SS	WH			
10		CONTINUED NEXT PAGE								

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

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

MIS-BHS 001 1668819.GPJ GAL-MIS.GDT 6/15/17 JM

PROJECT: 1668819

RECORD OF BOREHOLE: 17-3

LOCATION: See Site Plan

BORING DATE: January 12-13, 2017

DATUM: Geodetic

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	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT (Wp ⊢ ○W ⊣ Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Power Auger 200 mm Diam. (Hollow Stem)	(CI) SILTY CLAY; grey; cohesive, w>PL, stiff		49.24 / 10.67				⊕ +; ⊕ +			
11		(ML) SILT, trace sand; grey; non-cohesive, wet, loose			9	SS	6				
					10	SS	6		○		
12				47.72 / 12.19							
		(SM-ML) Layered SILTY SAND and sandy SILT; grey; non-cohesive, compact			11	SS	17				
13					12	SS	11				
14				45.58 / 14.33	13	SS	10		○	MH	
		End of Borehole									
15											
16											
17											
18											
19											
20											

MIS-BHS 001 1668819.GPJ GAL-MIS.GDT 6/15/17 JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

RECORD OF BOREHOLE: 17-4

PROJECT: 1668819

LOCATION: See Site Plan

BORING DATE: January 13, 2017

SAMPLER HAMMER, 64kg; DROP, 760mm

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	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		60.27							
0	Power Auger, 200 mm Diam. (Hollow Stem)	FILL - (SM) SILTY SAND; brown, contains brick fragments; non-cohesive, moist, compact to loose		0.00							
1					1	SS	18				
		(CI) SILTY CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff		58.44 / 1.83	2	SS	6				
2–3					3	SS	2		Wp–W plotted		
3		(CI) SILTY CLAY; grey; cohesive, w>PL, stiff		57.22 / 3.05	4	SS	1				
4								⊕ / + (field vane tests)			
5					5	TP	PH		Wp–W plotted	C	
5–6								⊕ / + (field vane tests)			
6					6	SS	WH				
7								⊕ / + (field vane tests)			
8					7	SS	1		W plotted		
8–9								⊕ / + (field vane tests)			
9					8	SS	WH				
10											

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 1668819

RECORD OF BOREHOLE: 17-4

LOCATION: See Site Plan

BORING DATE: January 13, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m
10	Power Auger, 200 mm Diam. (Hollow Stem)	(CI) SILTY CLAY; grey; cohesive, w>PL, stiff	49.60 / 10.67			
11		(ML) SILT, trace sand; grey; non-cohesive, wet, loose to compact		9	SS	10
			48.08 / 12.19	10	SS	12
12–13		(SM-ML) Layered SILTY SAND and sandy SILT; grey; non-cohesive, wet, loose to compact		11	SS	10
			46.71 / 13.56	12	SS	11
		End of Borehole				

Column headings: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, 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

Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 1668819

RECORD OF BOREHOLE: 17-5

SHEET 1 OF 3

LOCATION: See Site Plan

BORING DATE: January 17-18, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE	60.07					
0	FILL - (SM) SILTY SAND, trace gravel; brown, contains brick fragments; non-cohesive, wet, compact	0.00	1	SS	31		Bentonite Seal
1			2	SS	11		
	FILL - (SP) SAND; brown; non-cohesive, wet, loose	58.76 1.31	3	SS	4		
2	(CI) SILTY CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	57.78 2.29	4	SS	4		Native Backfill and Bentonite
3			5	SS	3		
	(CI) SILTY CLAY; grey with black organic mottling, contains silt layers; cohesive, w>PL, stiff	56.41 3.66					
5			6	SS	WH		Bentonite Seal
6			7	SS	WH		Silica Sand
7							Standpipe 'B'
8			8	TP	PH	C	Silica Sand
9			9	SS	WH		Native Backfill and Bentonite
10	*CONTINUED NEXT PAGE*						

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

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

RECORD OF BOREHOLE: 17-5

PROJECT: 1668819

LOCATION: See Site Plan
BORING DATE: January 17-18, 2017
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Column headings: DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)) | SAMPLES (NUMBER, TYPE, 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 ---

Boring method: Power Auger, 200 mm Diam. (Hollow Stem) (10 m to approx. 14.5 m); Wash Boring, NW Casing (approx. 14.5 m to 20 m)

DESCRIPTION	ELEV. / DEPTH (m)
(CI) SILTY CLAY; grey with black organic mottling, contains silt layers; cohesive, w>PL, stiff	
(ML) SILT, trace sand; grey; non-cohesive, wet, loose	49.40 / 10.67
(ML-SM) Layered SILTY SAND and sandy SILT; grey; non-cohesive, wet, loose to very dense	47.73 / 12.34
(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); cohesive, wet, dense to very dense	40.72 / 19.35

NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING
10	SS	6	MH
11	SS	6	
12	SS	7	M
13	SS	11	
14	SS	12	
15	SS	11	MH
16	SS	20	
17	SS	12	M
18	SS	15	
19	SS	35	
20	SS	55	
21	SS	55	
22	SS	42	

Piezometer or standpipe installation:
- Native Backfill and Bentonite
- Bentonite Seal
- Silica Sand
- 32 mm Diam. PVC #10 Slot Screen 'A'
- Silica Sand
- Cave and Bentonite

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DG
CHECKED: SAT

RECORD OF BOREHOLE: 17-5

PROJECT: 1668819

SHEET 3 OF 3

LOCATION: See Site Plan

BORING DATE: January 17-18, 2017

DATUM: Geodetic

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	TYPE	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 ---									
20	Wash Boring / NW Casing	(SM) SILTY SAND, some gravel; grey, contains cobbles and boulders (GLACIAL TILL); cohesive, wet, dense to very dense			22	SS	42				
21					23	SS	51				Cave and Bentonite
				38.38	24	SS	>50				
		End of Borehole Sampler Refusal		21.69							
22											W.L. in Standpipe 'B' at Elev. 57.13 on Mar. 16, 2017 W.L. in Screen 'A' at Elev. 56.68 on Mar. 16, 2017
23											
24											
25											
26											
27											
28											
29											
30											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 1668819

RECORD OF BOREHOLE: 17-6

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: January 12, 2017

DATUM: Geodetic

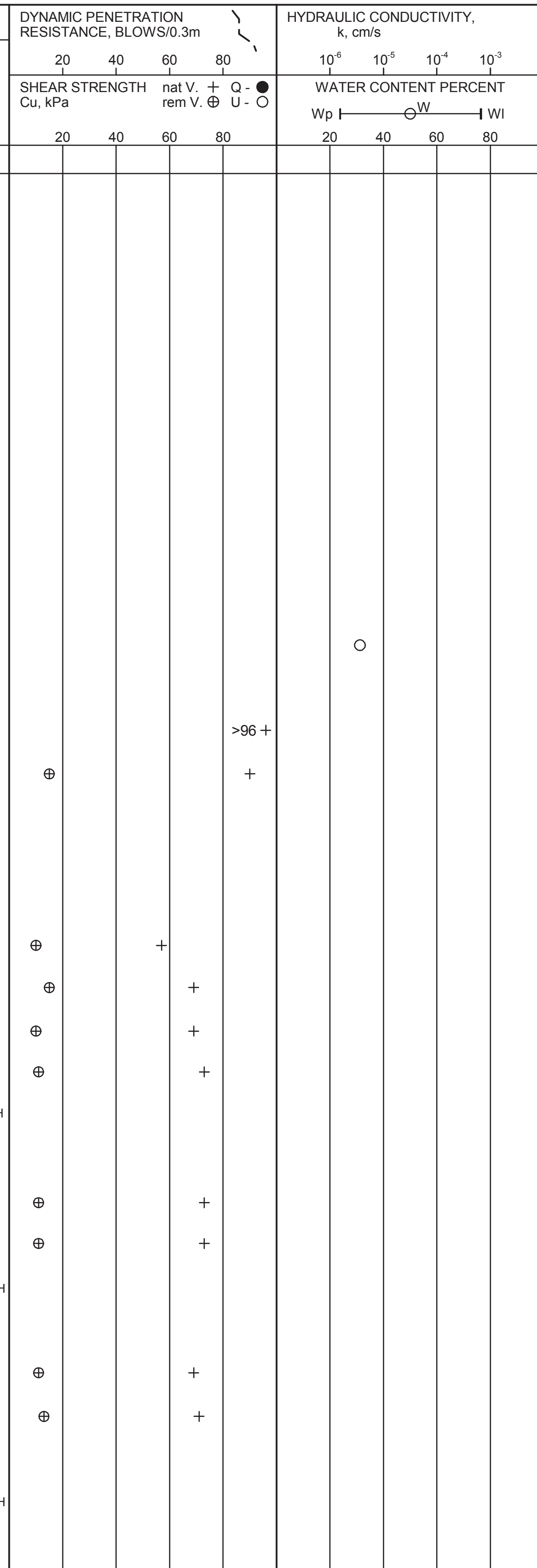
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Boring method: Power Auger, 200 mm Diam. (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE – DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)
	GROUND SURFACE		62.44
0	FILL - (SM) SILTY SAND; brown, contains silty clay pockets; non-cohesive, moist, compact to loose	crosshatched	0.00
2.59	(CI/CH) SILTY CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL, stiff to very stiff	hatched	59.85 / 2.59
4.57	(CI) SILTY CLAY; grey with black organic mottling; cohesive, w>PL, stiff	hatched	57.87 / 4.57
10	*CONTINUED NEXT PAGE*		

SAMPLE NUMBER	TYPE	BLOWS/0.30m
1	SS	11
2	SS	4
3	SS	4
4	SS	7
5	SS	4
6	SS	1
7	TP	PH
8	SS	WH
9	SS	WH



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

PROJECT: 1668819

RECORD OF BOREHOLE: 17-6

LOCATION: See Site Plan

BORING DATE: January 12, 2017

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

--- CONTINUED FROM PREVIOUS PAGE ---

Depth Scale (Metres)	Boring Method	Soil Profile – Description	Elev. / Depth (m)	Sample Number	Type	Blows/0.30m	Shear Strength Cu, kPa	Additional Lab. Testing
10	Power Auger, 200 mm Diam. (Hollow Stem)	(CI) SILTY CLAY; grey with black organic mottling; cohesive, w>PL, stiff					>96	
11				10	SS	WH		
12			49.84 / 12.60	11	SS	WH		
		(ML) SILT, trace sand; grey; non-cohesive, wet, loose to compact						
13				12	SS	7		MH
14			47.96 / 14.48	13	SS	15		
		(SM-ML) SILTY SAND to sandy SILT, fine; grey; non-cohesive, wet, compact		14	SS	22		
15			46.59 / 15.85	15	SS	15		
16		End of Borehole						
17								
18								
19								
20								

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)

PIEZOMETER OR STANDPIPE INSTALLATION

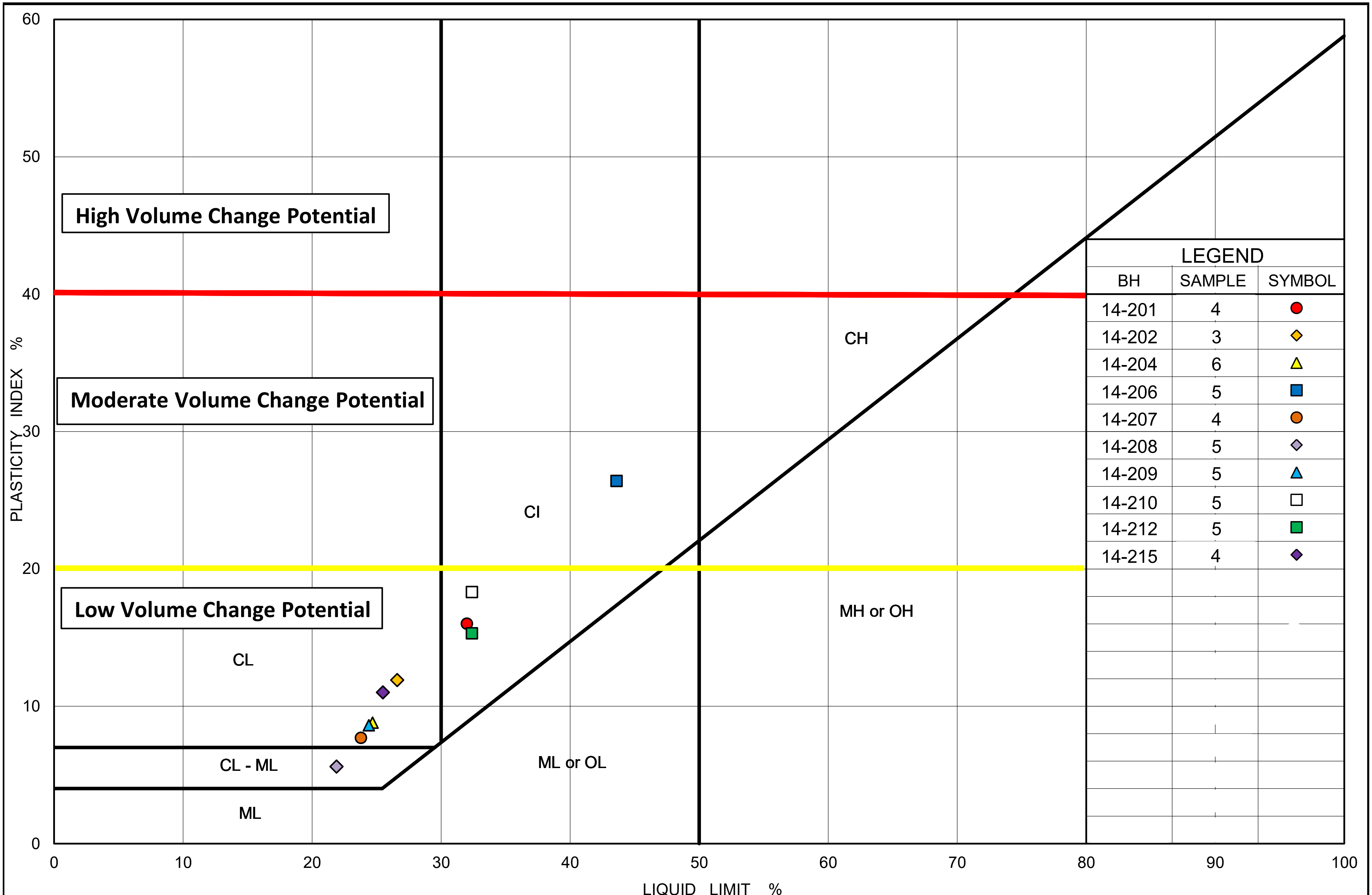
MIS-BHS 001 1668819.GPJ GAL-MIS.GDT 6/15/17 JM

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: DG

CHECKED: SAT

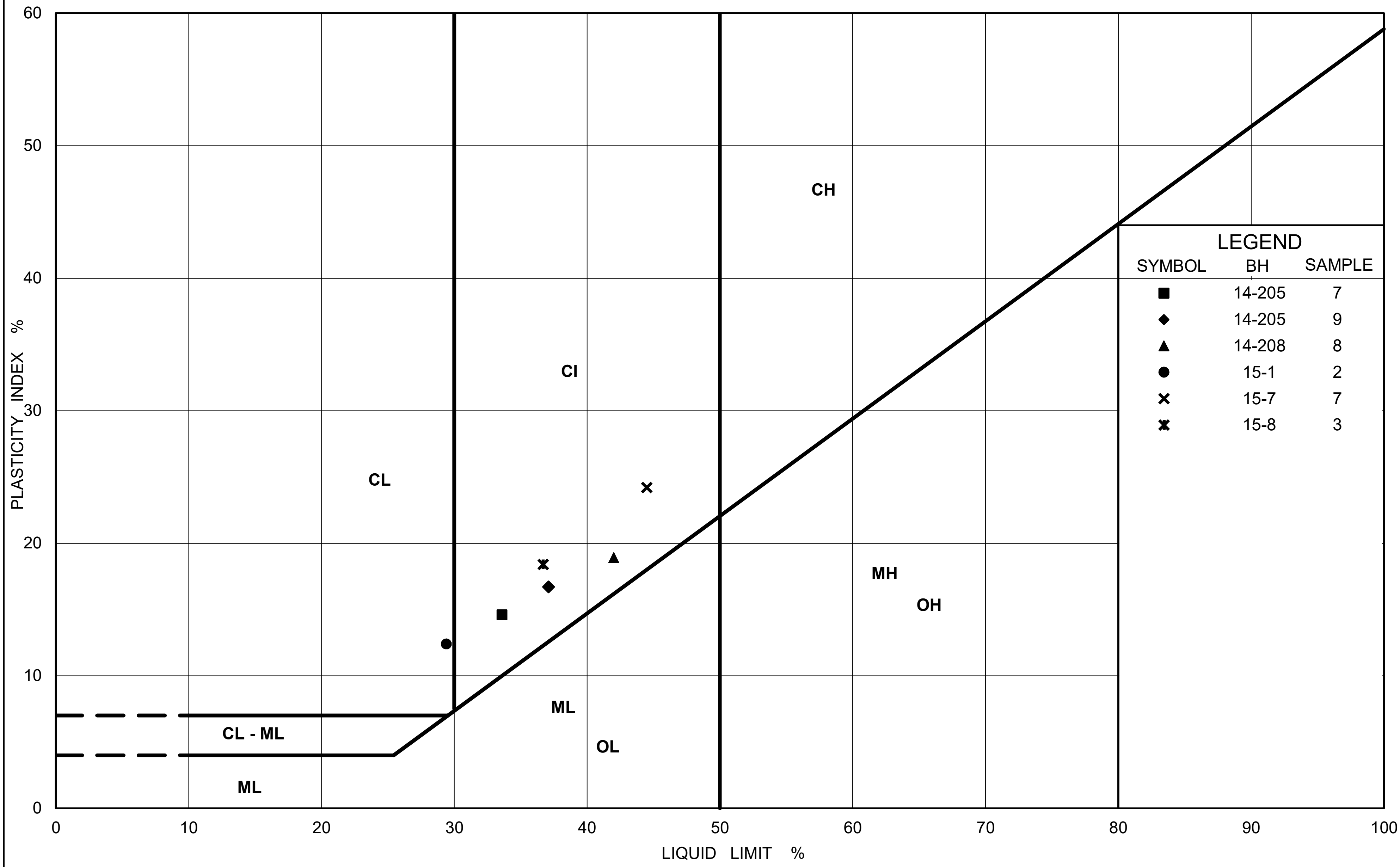


PLASTICITY CHART
Oblates Development

Figure No. 1

Project No. 14-1122-0005

Checked By: SAT



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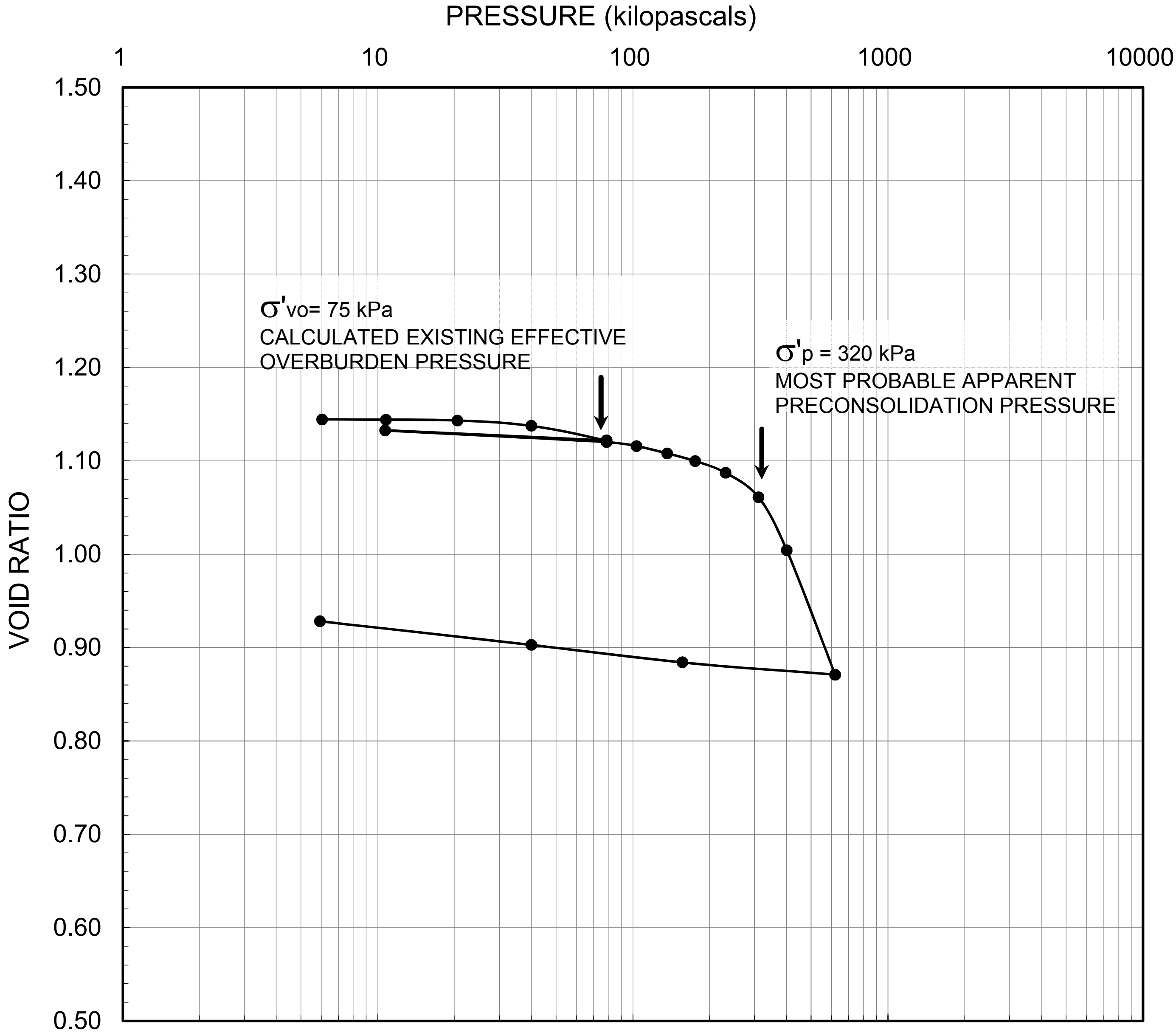
PLASTICITY CHART

Figure : 4

Project No.: 14-1122-0005

Compiled By : MI Checked By : CNM



LEGEND

Borehole: 17-4	w_i = 42%	S_o = 100%	γ = 17.8 kN/m³
Sample: 5	w_f = 34%	e_o = 1.14	G_s = 2.75
Depth (m): 5.0	w_l = 38%	C_c = 0.70	
Elevation (m): 55.3	w_p = 18%	C_r = 0.015	

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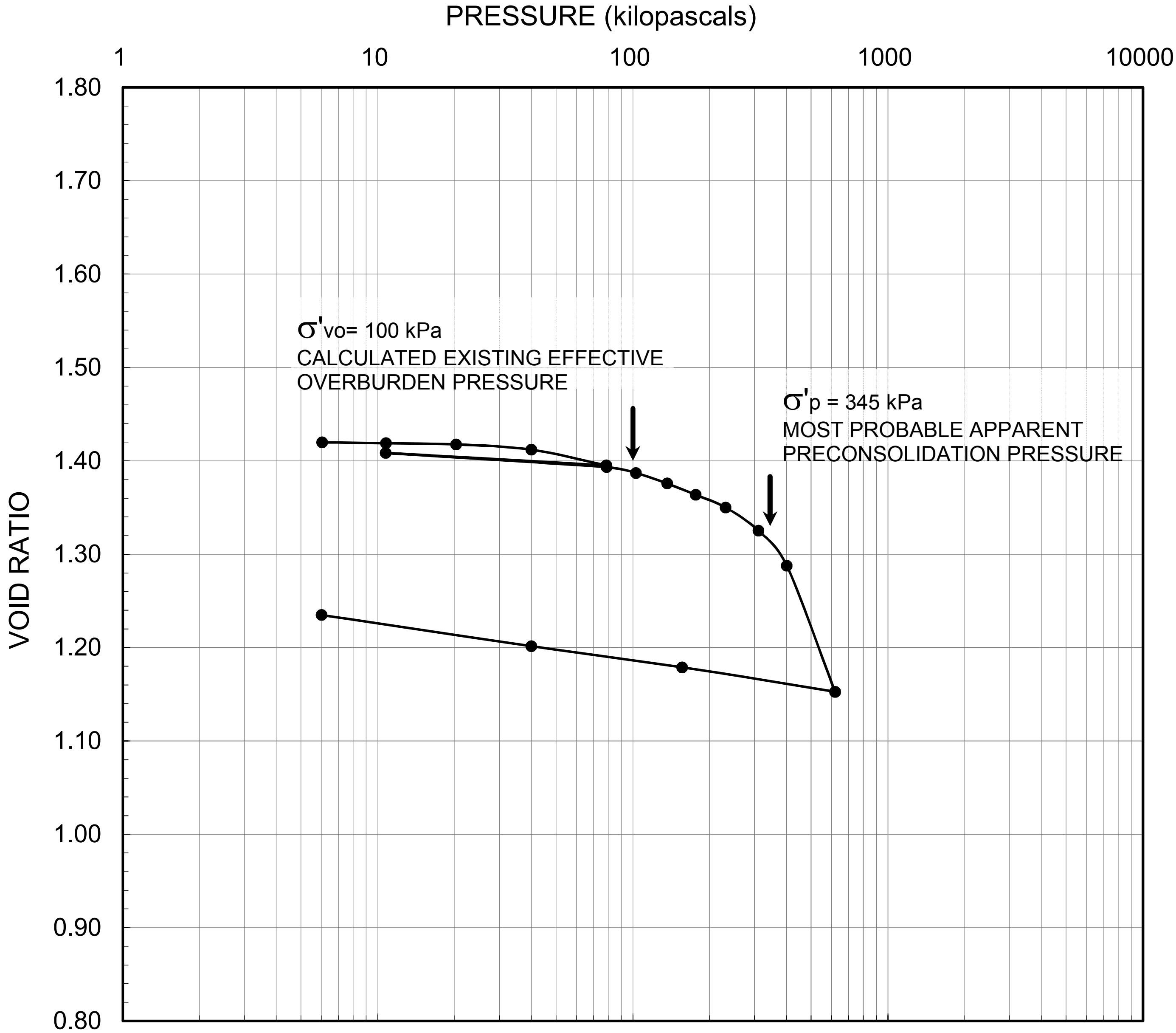
SCALE	AS SHOWN	TITLE	
DATE	04/28/17		
CADD	N/A	**CONSOLIDATION TEST RESULTS**	
ENTERED	CW		
FILE No. Consolidation summary	CHECK CNM		
PROJECT No. 1668819 REV. 1	REVIEW SAT		FIGURE **2**

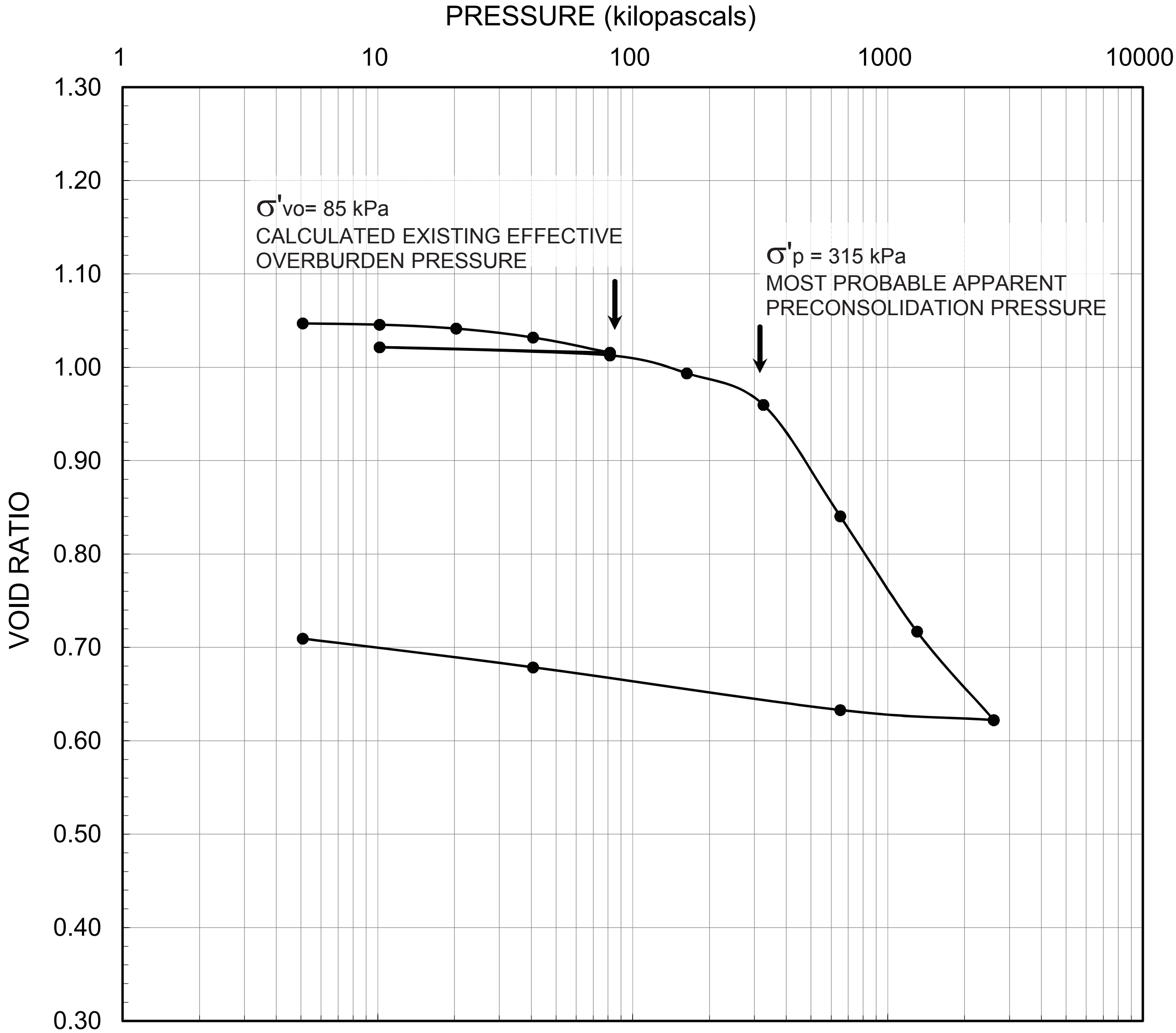


LEGEND

Borehole:	17-5	w_i = 51%	S_o = 100%	γ = 16.9 kN/m³
Sample:	8	w_f = 46%	e_o = 1.42	G_s = 2.76
Depth (m):	8.0	w_l = 45%	C_c = 0.71	
Elevation (m):	52.1	w_p = 23%	C_r = 0.018	

Golder Associates

SCALE	AS SHOWN	TITLE	CONSOLIDATION TEST RESULTS
DATE	04/28/17		
CADD	N/A		
ENTERED	CW		
FILE No. Consolidation summary	CHECK	CNM	
PROJECT No. 1668819 REV. 1	REVIEW	SAT	FIGURE 3



LEGEND

Borehole: 14-205	w_i = 37%	S_o = 98%	γ = 18.2 kN/m³
Sample: 7	w_f = 26%	e_o = 1.05	G_s = 2.78
Depth (m): 6.4	w_l = 34%	C_c = 0.40	
Elevation (m): 57.9	w_p = 19%	C_r = 0.010	

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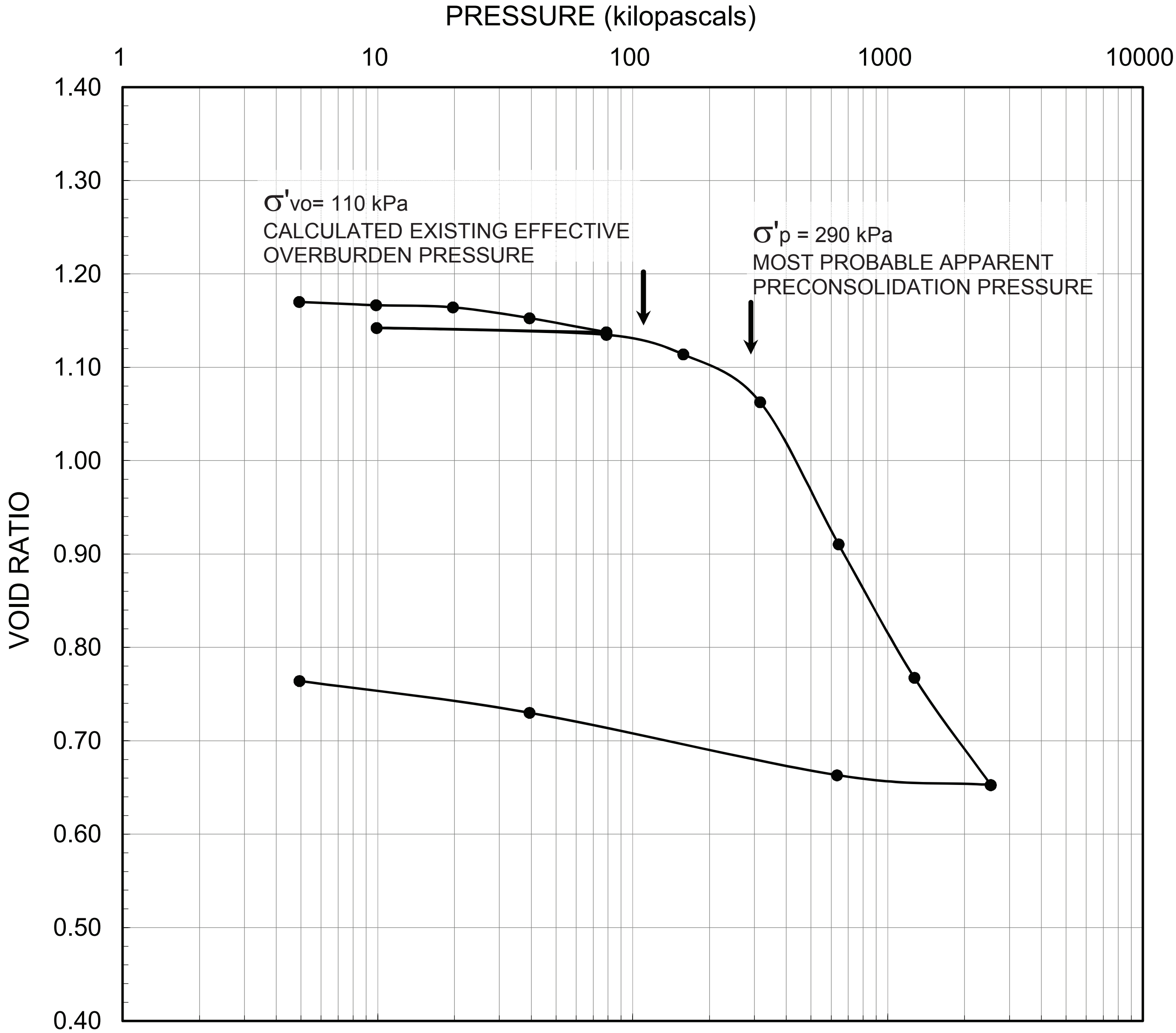
SCALE	AS SHOWN	TITLE	CONSOLIDATION TEST RESULTS
DATE	12/10/14		
CADD	N/A		
ENTERED	CW		
FILE No.	Consolidation summary	CHECK	CNM
PROJECT No.	14-1122-0005	REV.	2
REVIEW	CK	FIGURE	5



LEGEND

Borehole: 14-205	w_i = 42%	S_o = 100%	γ = 17.8 kN/m³
Sample: 9	w_f = 29%	e_o = 1.17	G_s = 2.77
Depth (m): 9.5	w_l = 37%	C_c = 0.49	
Elevation (m): 54.8	w_p = 20%	C_r = 0.008	

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SCALE	AS SHOWN
DATE	12/10/14
CADD	N/A
ENTERED	CW
CHECK	CNM
REVIEW	CK

FILE No. Consolidation summary

PROJECT No. 14-1122-0005 REV. 2

TITLE

CONSOLIDATION TEST RESULTS

FIGURE 6

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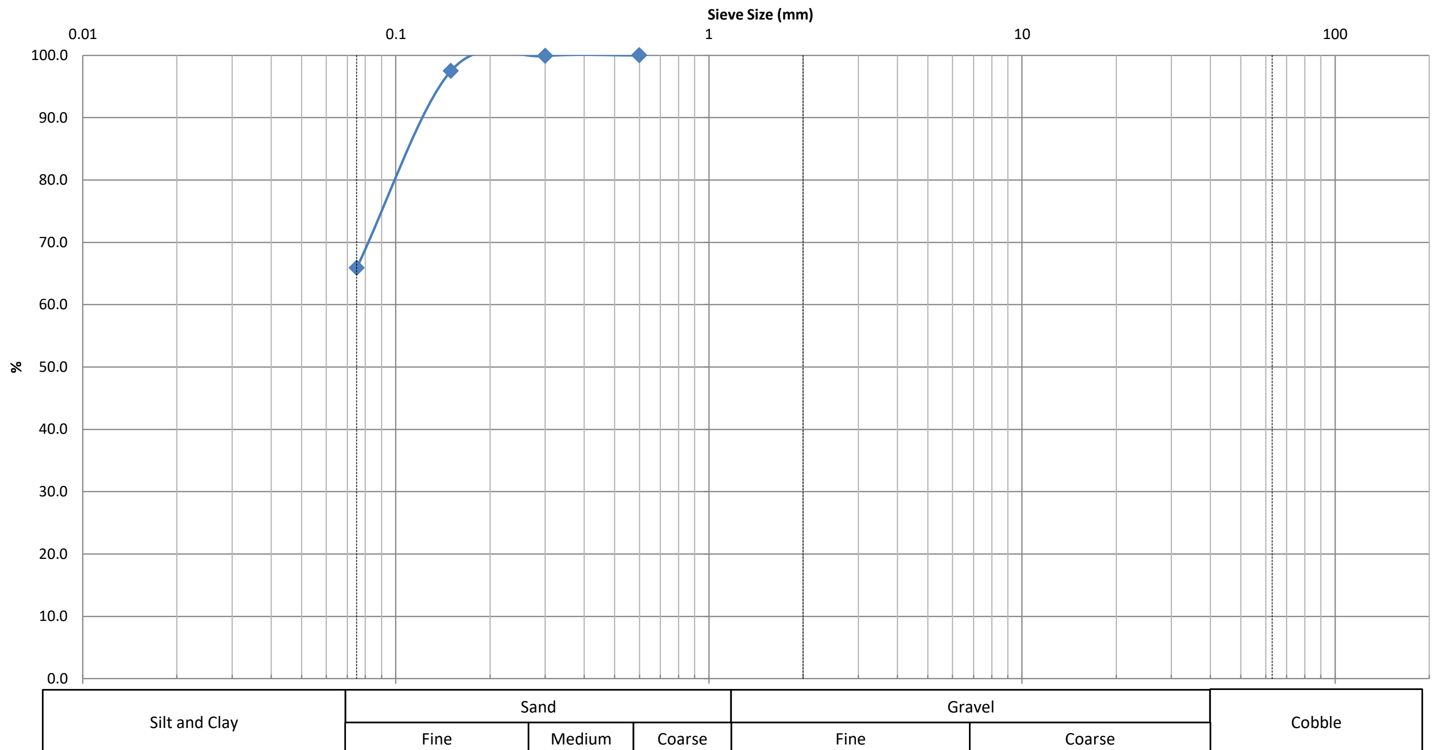
SIEVE ANALYSIS **ASTM C136**

CLIENT:	Regional Group	DESCRIPTION:	Fine Aggregate	FILE NO:	PG5383
CONTRACT NO.:	-	SPECIFICATION:	**Sand**	LAB NO:	17938
PROJECT:	Greystone Phase 3 - Scholastic Dr. @ Oblats Ave	INTENDED USE:	-	DATE RECEIVED:	15-Jul-20
		PIT OR QUARRY:	-	DATE TESTED:	20-Jul-20
DATE SAMPLED:	15-Jul-20	SOURCE LOCATION:	BH1-20 - SS9	DATE REPORTED:	22-Jul-20
SAMPLED BY:	-	SAMPLE LOCATION:	45' - 47'	TESTED BY:	R.C/D.G/D.K/D.B



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
									1.51	6.8
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)		Clay (%)	
	0.6	0.068	0.032	0.01	0.0	34.1	65.9			

Comments:

REVIEWED BY:	Curtis Beadow	Joe Fosyth, P. Eng.

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SIEVE ANALYSIS
ASTM C136

CLIENT:	Regional Group	DESCRIPTION:	Fine Aggregate	FILE NO.:	PG5383
CONTRACT NO.:	-	SPECIFICATION:	Sand	LAB NO.:	17938
PROJECT:	Greystone Phase 3 - Scholastic Dr. @ Oblats Ave	INTENDED USE:	-	DATE REC'D:	15-Jul-20
		PIT OR QUARRY:	-	DATE TESTED:	20-Jul-20
DATE SAMPLED:	15-Jul-20	SOURCE LOCATION:	BH1-20 - SS9	DATE REP'D:	22-Jul-20
SAMPLED BY:	-	SAMPLE LOCATION:	45' - 47'	TESTED BY:	R.C/D.G/D.K/D.B

WEIGHT BEFORE WASH	469.5
WEIGHT AFTER WASH	191.4

SIEVE SIZE (mm)	WEIGHT RETAINED	PERCENT RETAINED	PERCENT PASSING	LOWER SPEC	UPPER SPEC	REMARK
150						
106						
75						
63						
53						
37.5						
26.5						
19						
16						
13.2						
9.5						
6.7						
4.75						
2.36						
1.18						
0.6	**0.0**	0.0	**100.0**			
0.3	**0.5**	0.1	**99.9**			
0.15	**11.9**	2.5	**97.5**			
0.075	**159.9**	34.1	**65.9**			
PAN	**191.4**					
SIEVE CHECK FINE		0.00	0.3% max.			**REFERENCE MATERIAL**

OTHER TESTS	**RESULT**	**LAB NO.**	**RESULT**

REVIEWED BY:	**Curtis Beadow**	**Joe Forsyth, P. Eng.**

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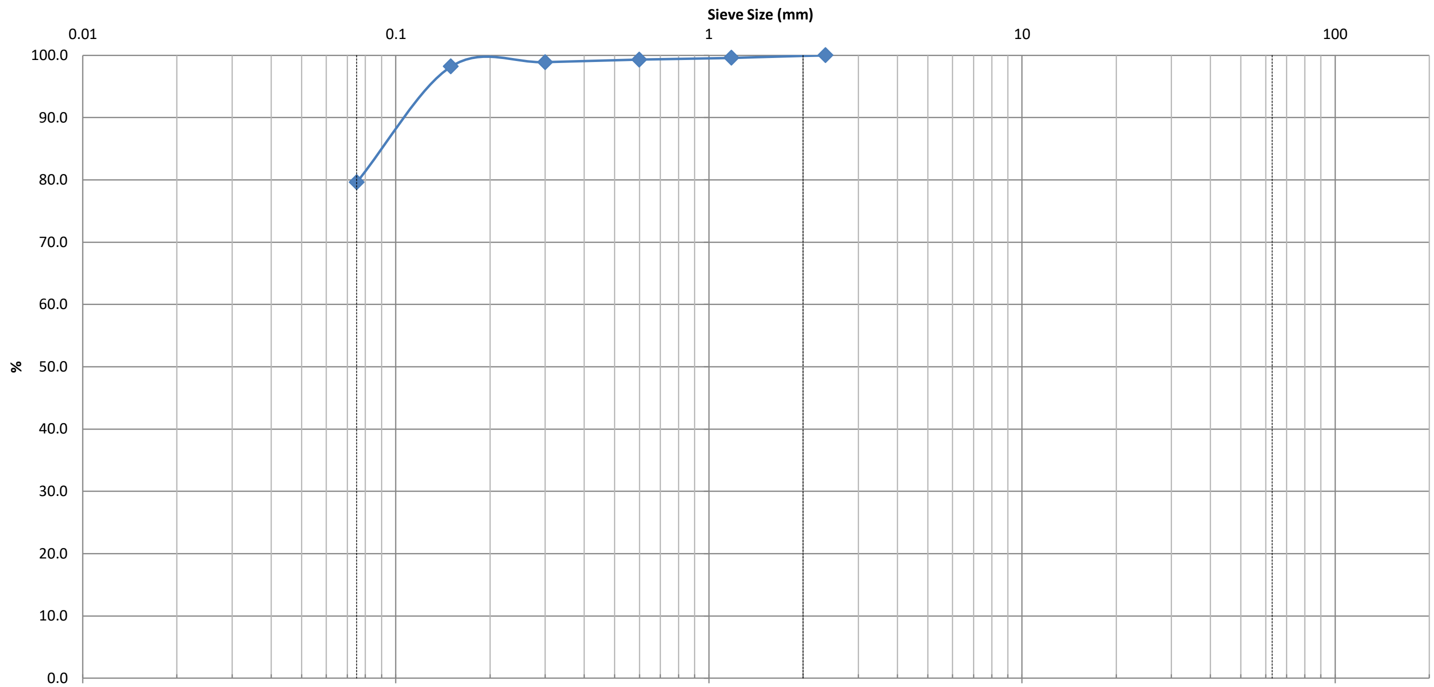
SIEVE ANALYSIS ASTM C136

CLIENT:	Regional Group	DESCRIPTION:	Fine Aggregate	FILE NO:	PG5383
CONTRACT NO.:	-	SPECIFICATION:	**Sand**	LAB NO:	17937
PROJECT:	Greystone Phase 3	INTENDED USE:	-	DATE RECEIVED:	15-Jul-20
		PIT OR QUARRY:	-	DATE TESTED:	20-Jul-20
DATE SAMPLED:	15-Jul-20	SOURCE LOCATION:	BH2-20 - SS9	DATE REPORTED:	22-Jul-20
SAMPLED BY:	-	SAMPLE LOCATION:	45' - 47'	TESTED BY:	R.C/D.G/D.K/D.B



Silt and Clay	Sand			Gravel		Cobble
	Fine	Medium	Coarse	Fine	Coarse	

Identification	**Soil Classification**				**MC(%)**	**LL**	**PL**	**PI**	**Cc**	**Cu**
									0.94	2.7
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)		Clay (%)	
	2.36	0.032	0.019	0.012	0.0	20.4	79.6			

Comments:

REVIEWED BY:	**Curtis Beadow**	**Joe Fosyth, P. Eng.**

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SIEVE ANALYSIS
ASTM C136

CLIENT:	Regional Group	DESCRIPTION:	Fine Aggregate	FILE NO.:	PG5383
CONTRACT NO.:	-	SPECIFICATION:	Sand	LAB NO.:	17937
PROJECT:	Greystone Phase 3	INTENDED USE:	-	DATE REC'D:	15-Jul-20
		PIT OR QUARRY:	-	DATE TESTED:	20-Jul-20
DATE SAMPLED:	15-Jul-20	SOURCE LOCATION:	BH2-20 - SS9	DATE REP'D:	22-Jul-20
SAMPLED BY:	-	SAMPLE LOCATION:	45' - 47'	TESTED BY:	R.C/D.G/D.K/D.B

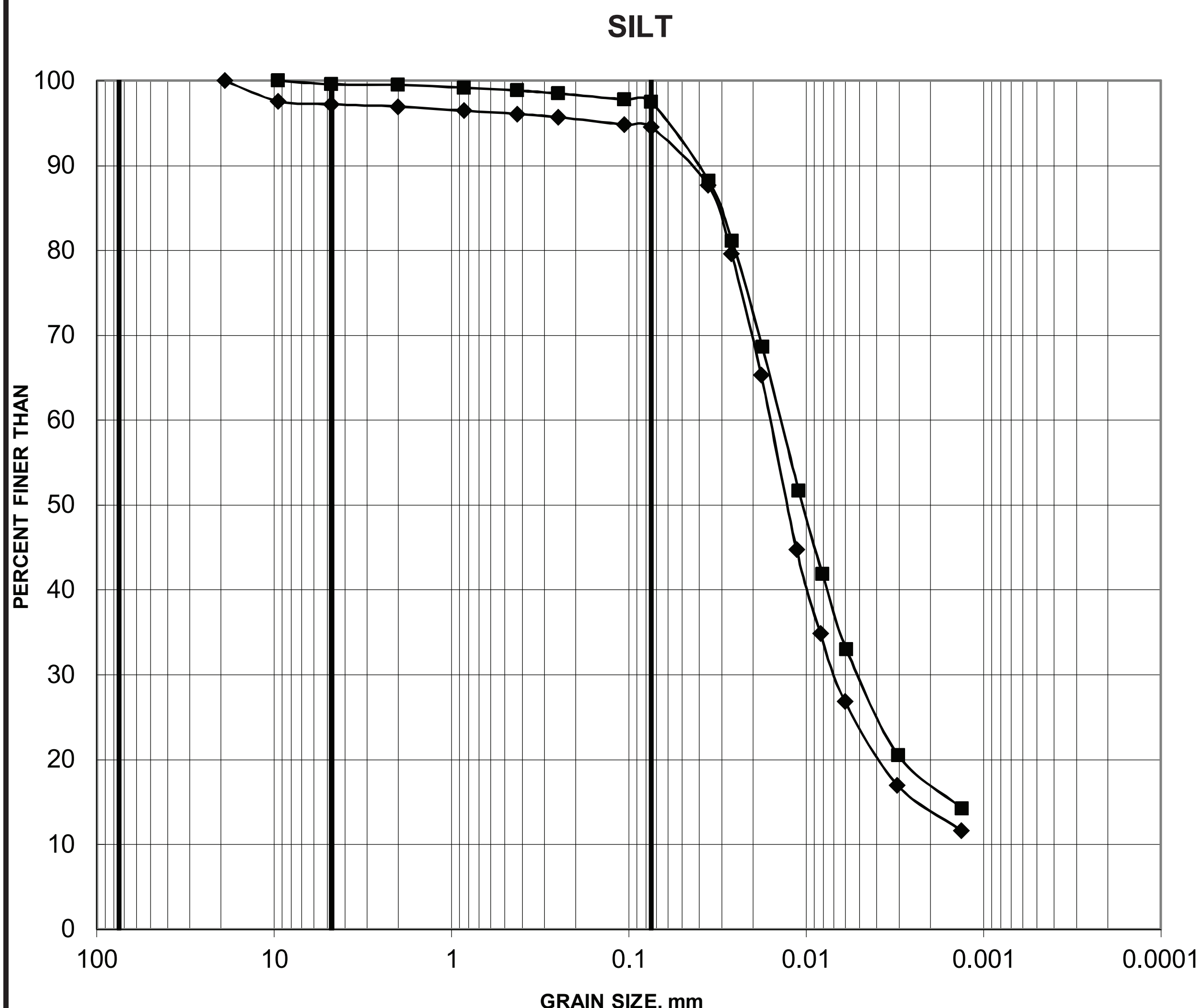
WEIGHT BEFORE WASH	451.5
WEIGHT AFTER WASH	107.2

SIEVE SIZE (mm)	WEIGHT RETAINED	PERCENT RETAINED	PERCENT PASSING	LOWER SPEC	UPPER SPEC	REMARK
150						
106						
75						
63						
53						
37.5						
26.5						
19						
16						
13.2						
9.5						
6.7						
4.75						
2.36	**0.0**	0.0	**100.0**			
1.18	**1.6**	0.4	**99.6**			
0.6	**3.3**	0.7	**99.3**			
0.3	**5.0**	1.1	**98.9**			
0.15	**8.0**	1.8	**98.2**			
0.075	**91.9**	20.4	**79.6**			
PAN	**107.2**					

SIEVE CHECK FINE	0.00	0.3% max.	**REFERENCE MATERIAL**	
OTHER TESTS		**RESULT**	**LAB NO.**	**RESULT**

REVIEWED BY:	**Curtis Beadow**	**Joe Forsyth, P. Eng.**

GRAIN SIZE DISTRIBUTION	FIGURE 4



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
17-5	10	10.67-11.28
17-6	12	12.95-13.56

Project: 1668819

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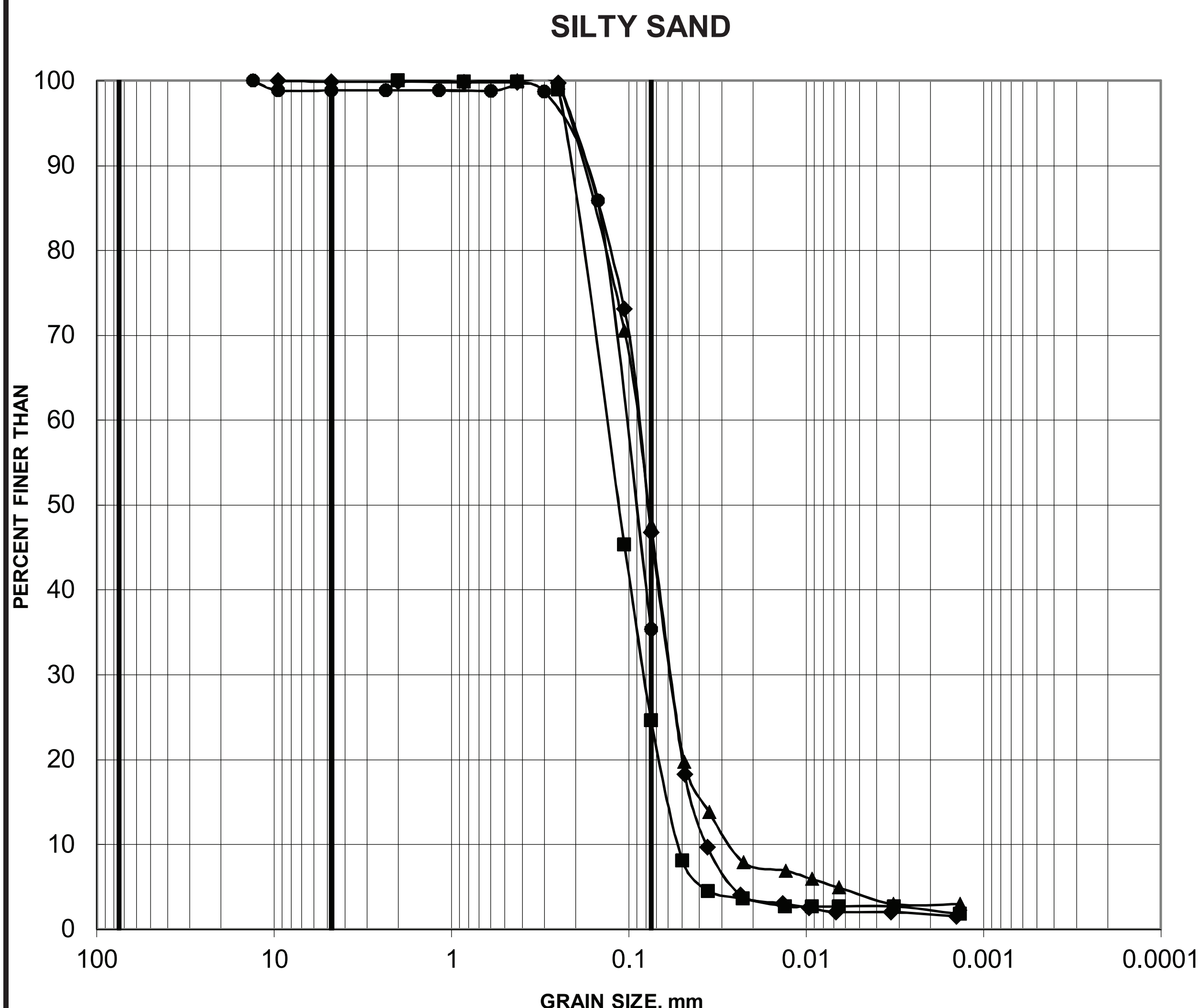
Created by:	CW
Checked by:	CNM

GRAIN SIZE DISTRIBUTION

FIGURE 5



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
17-1 (■)	16	16.00-16.61
17-1 (●)	19	18.29-18.90
17-1 (◆)	20	19.05-19.66
17-3 (▲)	13	13.72-14.33

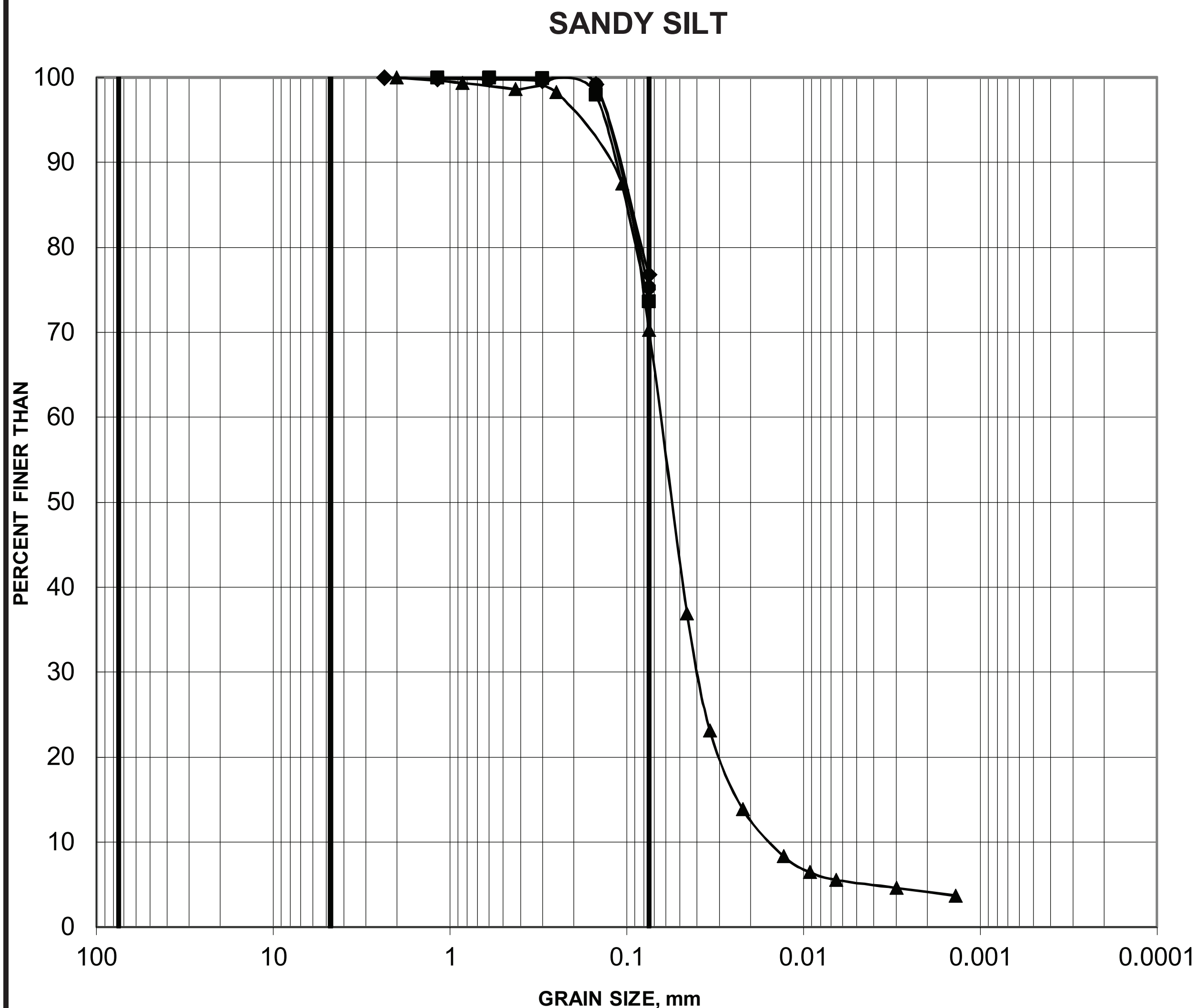
Project: 1668819

Golder Associates

Created by: CW

Checked by: CNM

GRAIN SIZE DISTRIBUTION	FIGURE 6



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Borehole	Sample	Depth (m)
17-1	17	16.76-17.37
17-5	12B	12.34-12.80
17-5	15	14.48-15.09
17-5	17	16.00-16.61

Project: 1668819

Golder Associates

Created by: CW
Checked by: CNM

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 29950

Report Date: 23-Jul-2020

Order Date: 17-Jul-2020

Project Description: PG5383

	Client ID:	BH3-20- SS1	-	-	-
	Sample Date:	16-Jul-20 12:00	-	-	-
	Sample ID:	2029552-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	68.4	-	-	-
General Inorganics					
pH	0.05 pH Units	7.57	-	-	-
Resistivity	0.10 Ohm.m	32.8	-	-	-
Anions					
Chloride	5 ug/g dry	10	-	-	-
Sulphate	5 ug/g dry	77	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2 - PRESSURE RELIEF CHAMBER DETAIL

FIGURE 3 - WATER SUPPRESSION SYSTEM

FIGURE 4 - GLOBAL STABILITY - STATIC ANALYSIS

FIGURE 5 - GLOBAL STABILITY - SEISMIC ANALYSIS

DRAWING PG5383-1 - TEST HOLE LOCATION PLAN

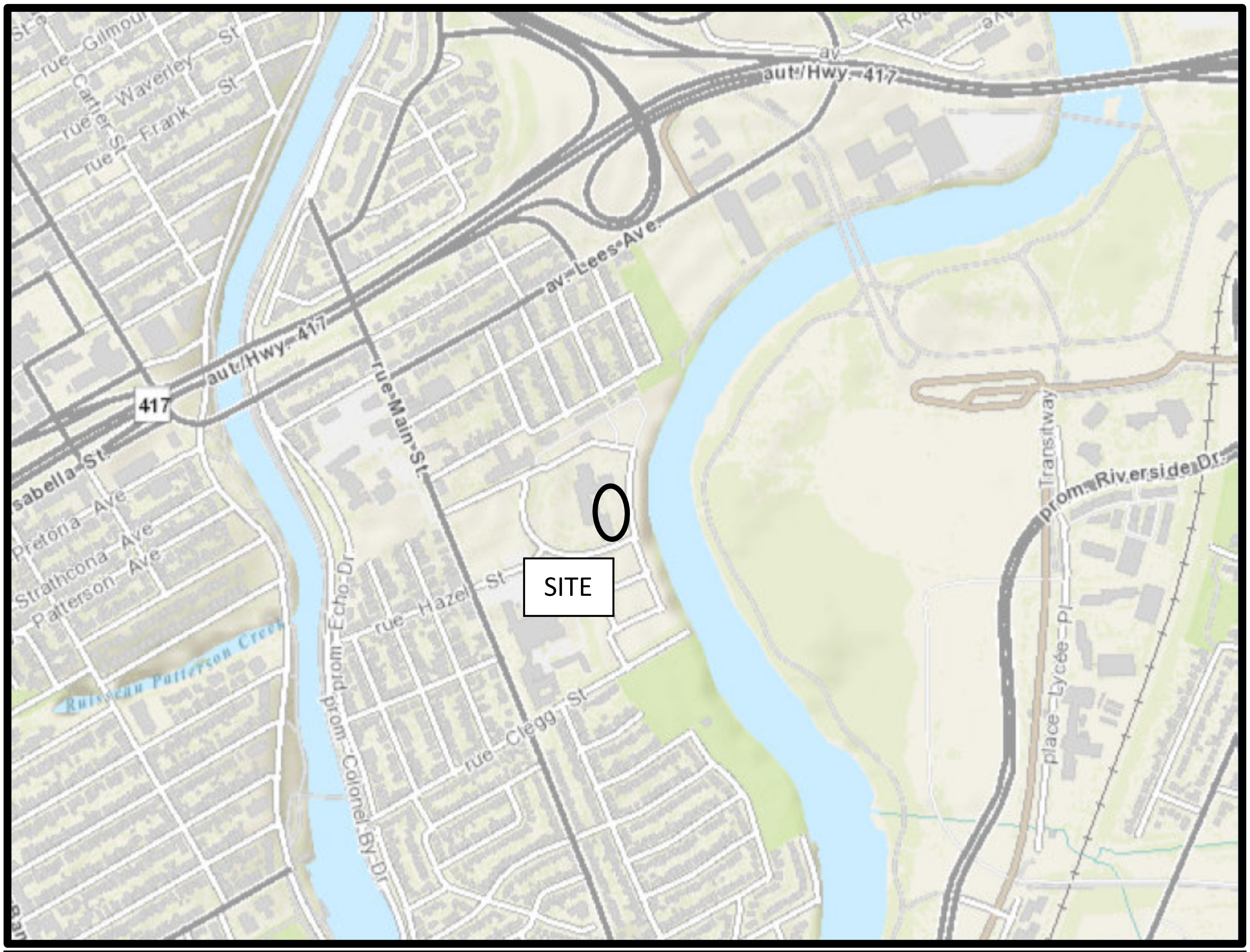


FIGURE 1

KEY PLAN

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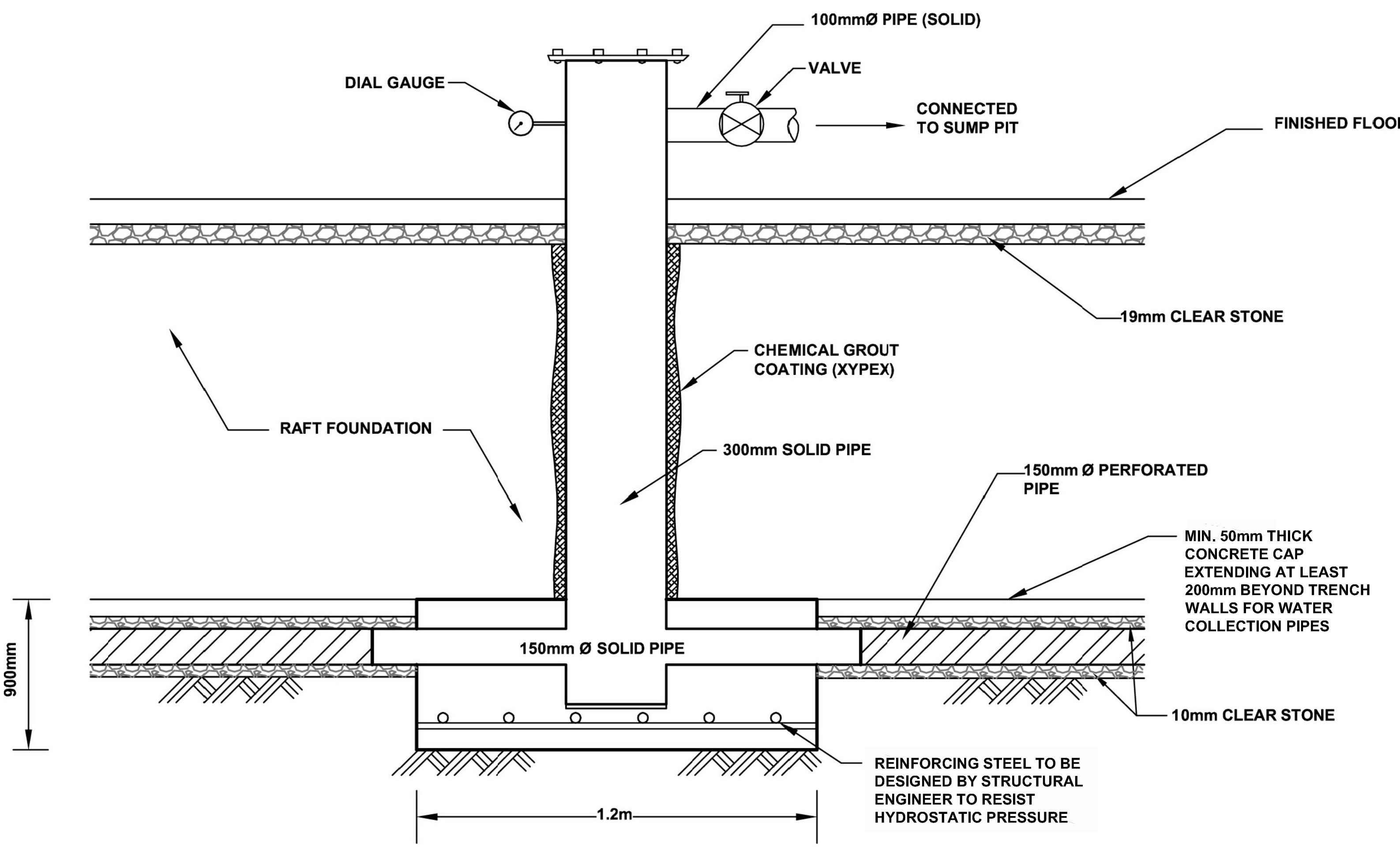

FIGURE 2 - PRESSURE RELIEF CHAMBER

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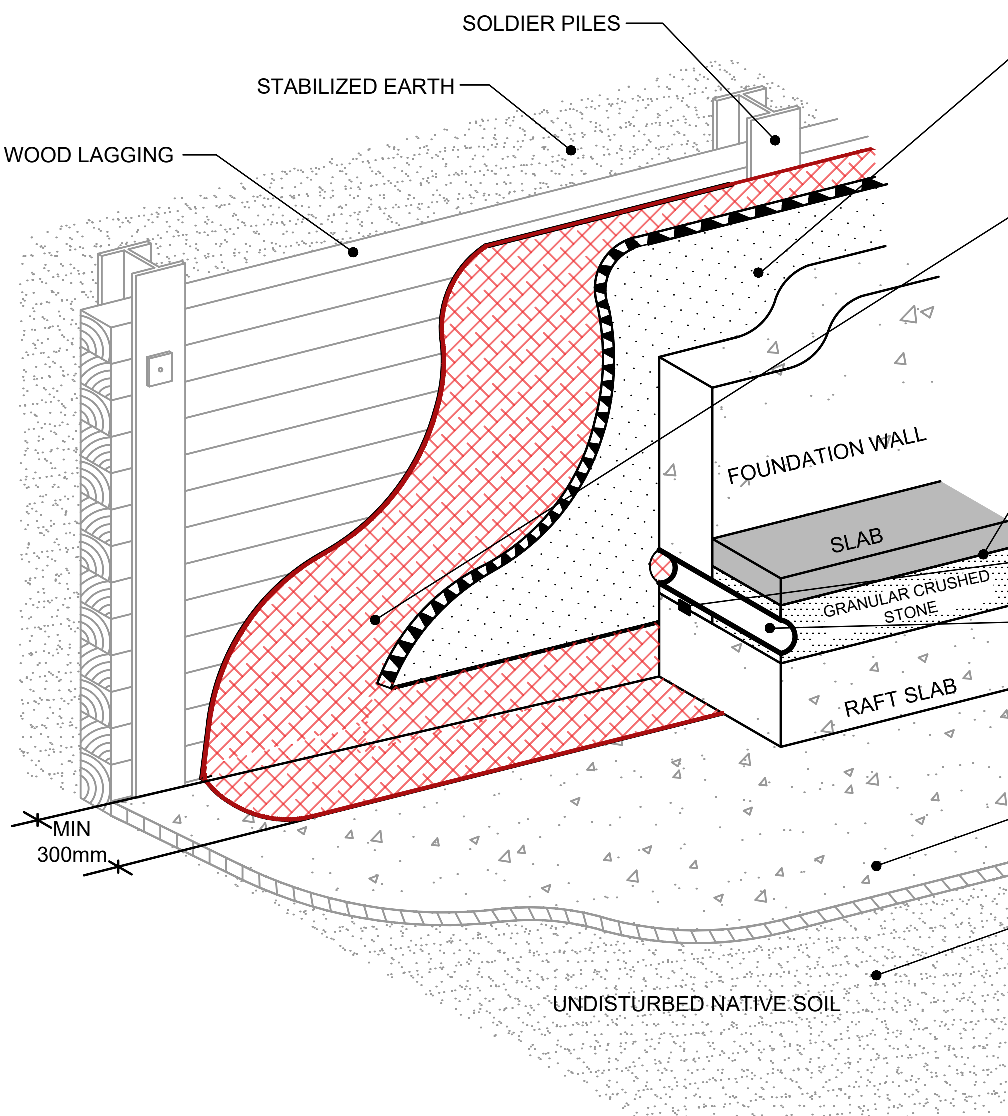
p:\autocad drawings\details\pressure relief chamber.dwg



IT IS RECOMMENDED THAT PERIODIC INSPECTIONS BE COMPLETED BY THE GEOTECHNICAL CONSULTANT AT THE TIME OF CONSTRUCTION DURING THE INSTALLATION OF THE FOUNDATION DRAINAGE AREA.

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REGIONAL GROUP

PROPOSED MULTI-STOREY BUILDINGS
GREYSTONE VILLAGE PHASE 3

OTTAWA, ONTARIO

Title:

WATER SUPPRESSION SYSTEM

Scale: NTS	**Date:** 07/2020
Drawn by: RCG	**Report No.:** PG5383
Checked by: SD	**Drawing No.:** FIG. 3
Approved by: SD	**Revision No.:**

p:\autocad drawings\geotechnical\pg53xx\pg5383\pg5383-fig.3-water suppression system.dwg

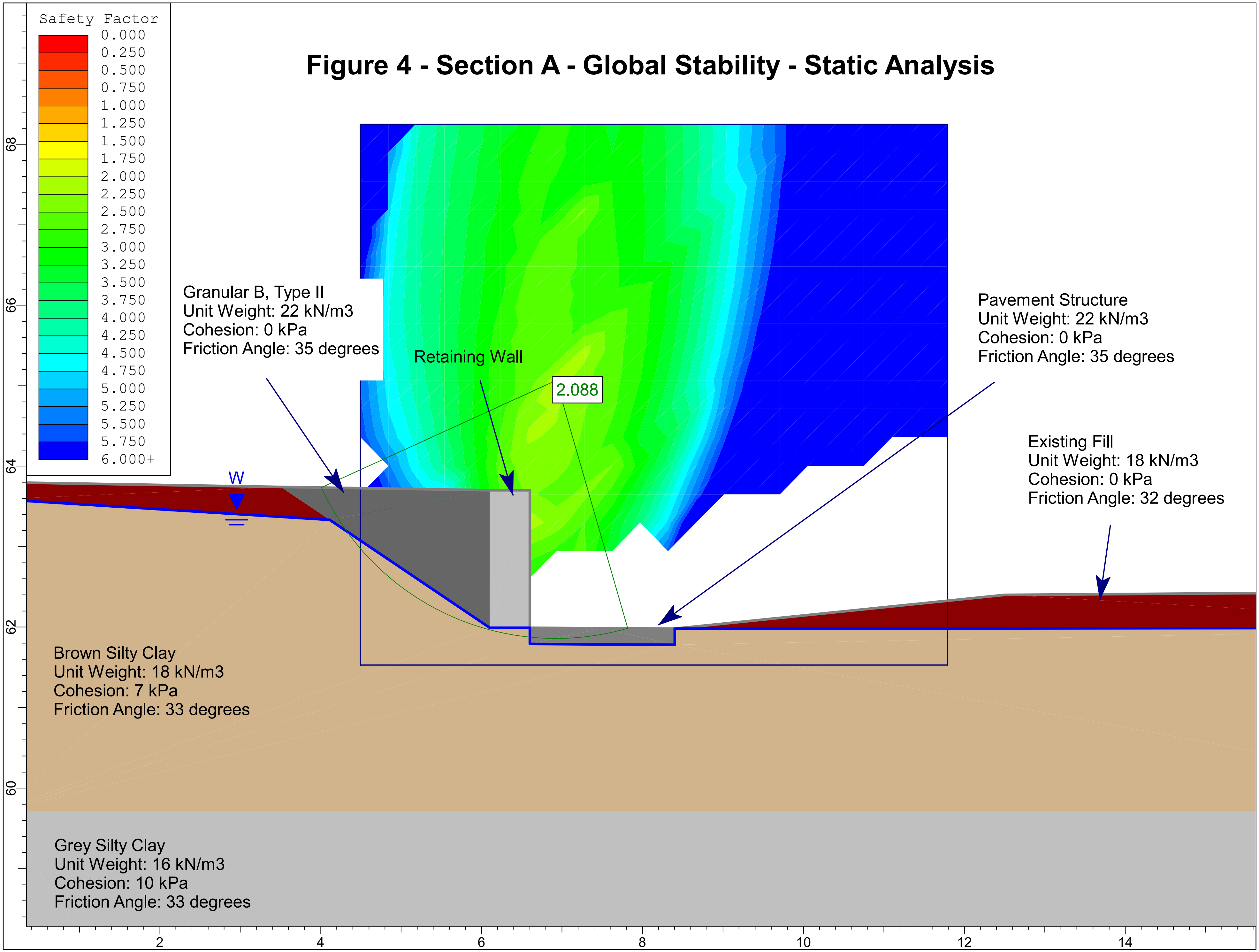


Figure 4 - Section A - Global Stability - Static Analysis
Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Granular B, Type II
Unit Weight: 22 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Retaining Wall
2.088
Pavement Structure
Unit Weight: 22 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Existing Fill
Unit Weight: 18 kN/m3
Cohesion: 0 kPa
Friction Angle: 32 degrees
W
Brown Silty Clay
Unit Weight: 18 kN/m3
Cohesion: 7 kPa
Friction Angle: 33 degrees
Grey Silty Clay
Unit Weight: 16 kN/m3
Cohesion: 10 kPa
Friction Angle: 33 degrees
68
66
64
62
60
2
4
6
8
10
12
14

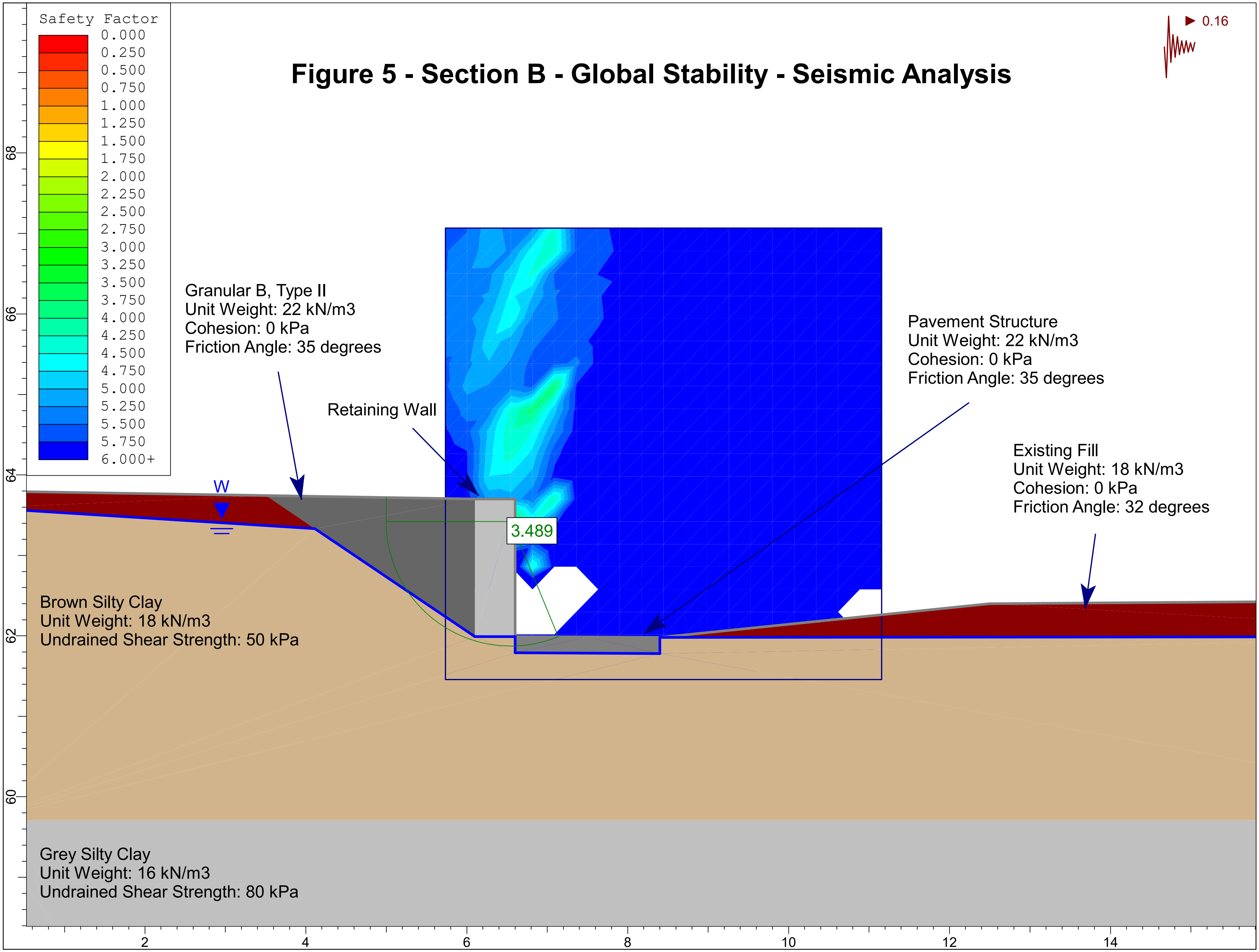
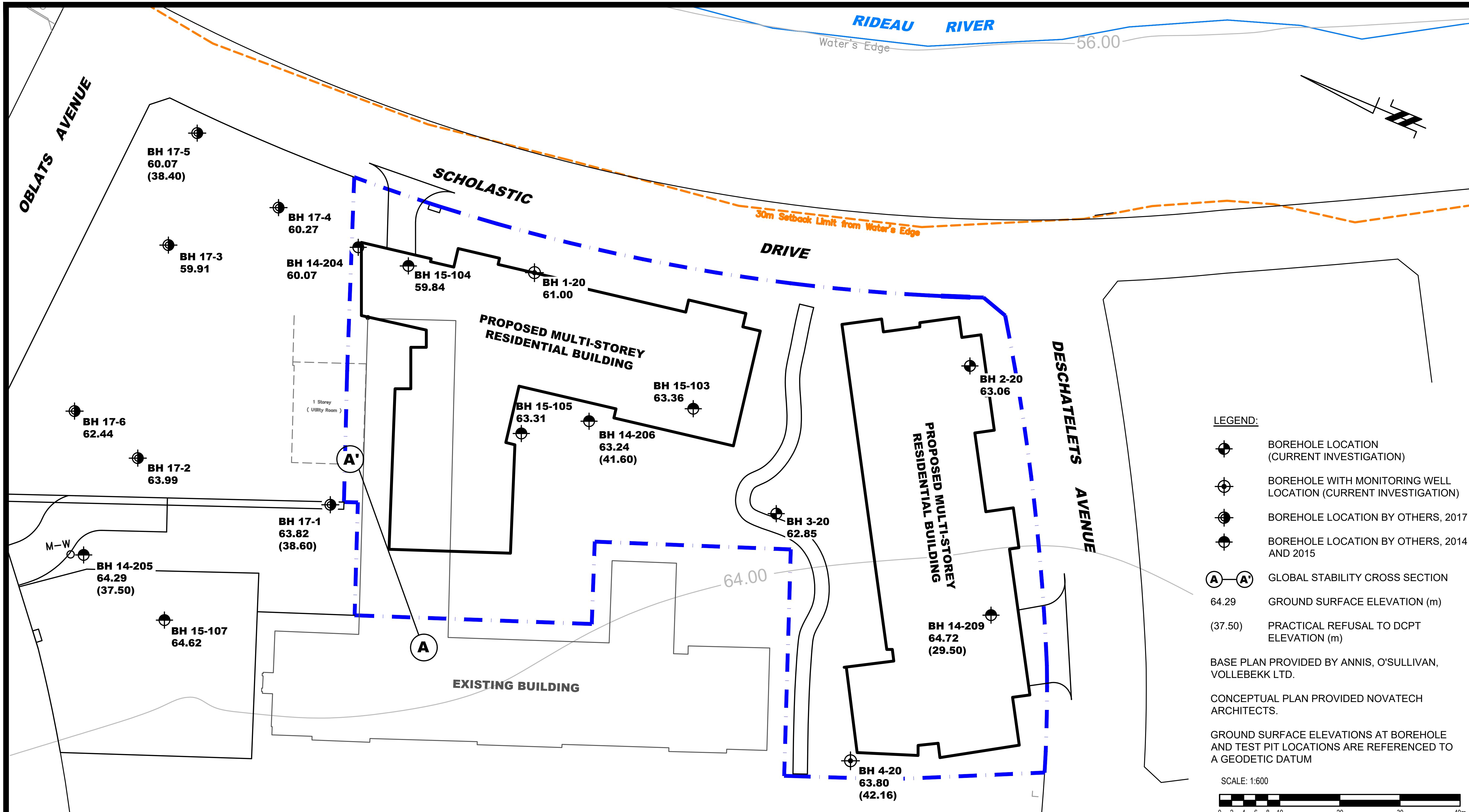


Figure 5 - Section B - Global Stability - Seismic Analysis
Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
0.16
Granular B, Type II
Unit Weight: 22 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Retaining Wall
Pavement Structure
Unit Weight: 22 kN/m3
Cohesion: 0 kPa
Friction Angle: 35 degrees
Existing Fill
Unit Weight: 18 kN/m3
Cohesion: 0 kPa
Friction Angle: 32 degrees
W
3.489
Brown Silty Clay
Unit Weight: 18 kN/m3
Undrained Shear Strength: 50 kPa
Grey Silty Clay
Unit Weight: 16 kN/m3
Undrained Shear Strength: 80 kPa
68
66
64
62
60
2
4
6
8
10
12
14



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NO.	REVISIONS	DATE	INITIAL
1	CONCEPTUAL PLAN UPDATED TO DRAWING GLOBAL STABILITY CROSS SECTION ADDED TO DRAWING	08/03/2022	KP

REGIONAL GROUP

GEOTECHNICAL INVESTIGATION
GREYSTONE VILLAGE PHASE 3

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:600	Date: 07/2020
Drawn by: MPG	Report No.: PG5383-1
Checked by: KP	Dwg. No.: PG5383-1
Approved by: SD	Revision No.: 1

p:\autocad drawings\geotechnical\pg53xx\pg5383\pg5383-1 test hole location plan (rev.01).dwg