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# Geotechnical Investigation
# Proposed Mixed Use Building
# 5986-5992 Hazeldean Road

Ottawa, Ontario

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Submitted to:

Argue Construction Ltd.
2900 Carp Road
Carp, Ontario
K0A 1L0

# Geotechnical Investigation Proposed Mixed Use Building 5986-5992 Hazeldean Road

Ottawa, Ontario

August 21, 2019
Project: 61730.62

GEMTEC Consulting Engineers and Scientists Limited
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August 21, 2019 File: 61730.62

Argue Construction Ltd.
2900 Carp Road
Carp, Ontario
K0A 1L0

Attention: Keith Riley, Chief Estimator and Project Manager

**Re: Geotechnical Investigation, Proposed Mixed Use Building, 5986-5992 Hazeldean Road, Ottawa, Ontario**

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Please find enclosed our geotechnical investigation report for the above noted project based on the scope of work provided in our proposal dated June 7, 2019. This report was prepared by Mr. Joseph Berkers, and reviewed by Mr. Brent Wiebe, P.Eng.

Do not hesitate to contact the undersigned if you have any questions or require additional information.

Joseph Berkers

Brent Wiebe, P.Eng.

JB/BW

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## 1.0 INTRODUCTION

This report presents the results of a subsurface investigation carried out for the proposed mixed use building to be constructed at 5896-5992 Hazeldean Road in Ottawa, Ontario. The purpose of the investigation was to identify the general subsurface conditions at the site by means of a limited number of boreholes and, based on the factual information obtained, to provide engineering guidelines on the geotechnical design aspects of the project, including construction considerations that could influence design decisions.

The subsurface investigation was carried out in general accordance with our proposal dated June 7, 2019.

## 2.0 BACKGROUND

### 2.1 Project Description

It is understood that consideration is being given to constructing a new multi-storey, mixed-use building. Current development plans include demolishing an existing commercial structure on the west portion of the property and residential structure on the east portion of the subject property, followed by construction of a new three-storey, mixed-use, wood frame building along the west side of the subject property, with a footprint of about 557 square metres (6,000 square feet). It is understood that the building will be of slab on grade (i.e., basementless) construction. An access roadway (fire route) and parking areas are also part of the proposed development. The commercial business on the east portion of the subject site is to remain unchanged.

### 2.2 Review of Geology Maps

Surficial geology maps of the Ottawa area indicate that the site is underlain by near surface (i.e., 0 to 1 metre below ground surface) limestone bedrock of the Bobcaygeon formation. Fill material associated with the existing development should also be anticipated.

## 3.0 SUBSURFACE INVESITGATION

The field work for the borehole investigation was carried out on July 22, 2019. At that time, four (4) boreholes, numbered 19-1 to 19-4, were advanced at the site using both hollow stem auger and rotary diamond drilling techniques, supplied and operated by George Downing Estate Drilling Ltd. of Grenville-sur-la-Rouge, Quebec. The boreholes were advanced to depths between approximately 1.0 and 8.4 metres below existing surface grade.

Auger and split spoon samples were obtained where possible within the overburden deposits. The underlying bedrock was cored in boreholes 19-1, 19-2 and 19-4 using N size rotary diamond drilling equipment to identify the type and quality of the bedrock. Well screens were sealed in the bedrock at boreholes 19-1, 19-2 and 19-4.

Following the borehole drilling work, the soil and bedrock samples were returned to our laboratory for examination by a geotechnical engineer. Descriptions of the subsurface conditions logged in the boreholes advanced at the site are provided on the Record of Borehole sheets in Appendix A.

The field work was supervised throughout by a member of our engineering staff.

The borehole locations were selected by GEMTEC Consulting Engineers and Scientists Limited (GEMTEC) personnel. The ground surface elevations at the location of the boreholes were determined using a Trimble R10 global positioning system. The elevations are referenced to a geodetic datum and are considered to be accurate within the tolerance of the instrument.

## 4.0 SUBSURFACE CONDITIONS

### 4.1 General

The soil and groundwater conditions logged in the boreholes are given on the Record of Borehole sheets in Appendix A. The borehole logs indicate the subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. Subsurface conditions at other than the borehole locations may vary from the conditions encountered in the boreholes. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and GEMTEC does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The following presents an overview of the subsurface conditions encountered in the boreholes advanced during this investigation.

### 4.2 Existing Granular Pavement Structure

Boreholes 19-1, 19-2 and 19-3 encountered a layer of asphaltic concrete varying in thickness from 50 to 60 millimetres. Base/subbase material was encountered, varying in thickness from 0.5 to 1.0 metres, underlying the asphaltic concrete in boreholes 19-1, 19-2 and 19-3 and at ground surface in borehole 19-4. The base/subbase material encountered can generally be described as grey, crushed sand and gravel, with trace to some silt.

The results of a grain size distribution test carried out on a sample of the base/subbase material from borehole 19-1 is provided in Appendix B.

### 4.3 Fill Material

Fill material, having a thickness of between about 0.1 and 0.3 metres, was encountered below the existing pavement structure in boreholes 19-3 and 19-4 at depths of 0.7 and 0.5 metres (elevation 117.4 and 117.5 metres), respectively. The composition of the fill material can generally be described as dark brown clayey silt with some gravel and trace sand in borehole 19-3 and dark brown clayey sandy silt with some gravel in borehole 19-4.

### 4.4 Bedrock

Bedrock was encountered in boreholes 19-1, 19-2 and 19-4 at depths of 0.9, 1.1 and 0.6 metres below ground surface (elevation 116.8, 116.5, and 117.0 metres), respectively, and cored to depths varying from 8.0 to 8.4 metres below ground surface (elevation 109.9 to 109.3 metres). Auger refusal on inferred bedrock occurred at 1.0 metres below ground surface (elevation 117.1 metres) in borehole 19-3.

The bedrock recovered from the boreholes showed a total core recovery (TCR) of 93 to 100 percent, solid core recovery (SCR) of 31 to 98 percent, and rock quality designation (RQD) values of 17 to 86 percent. The bedrock can generally be described as grey faintly to slightly weathered, very poor to good quality, limestone bedrock. The results of unconfined compressive strength tests on four samples of the recovered bedrock core are provided in Appendix C and indicate compressive strengths ranging from 69 to 77 Megapascals. Based on these results the bedrock can be classified as strong.

### 4.5 Groundwater Levels

The groundwater levels measured in the well screens on July 31, 2019 are summarized in Table 4.1.

**Table 4.1 – Groundwater Levels**

| Borehole | Material | Groundwater elevation (m) July 31, 2019 | Groundwater depth (m) July 31, 2019 |
|---|---|---|---|
| 19-1 | Bedrock | 112.9 | 4.8 |
| 19-2 | Bedrock | 112.4 | 5.2 |
| 19-4 | Bedrock | 112.2 | 5.8 |

The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

### 4.6 Soil Chemistry Relating to Corrosion

The results of chemical testing on a groundwater sample recovered from borehole 19-2 are provided in Appendix D and summarized in Table 4.2.

**Table 4.2 – Summary of Groundwater Corrosion Testing**

| Parameter | Borehole 19-2 |
|---|---|
| Chloride Content (mg/L) | 970 |
| Resistivity (Ohm.m) | 2.81 |
| pH | 7.6 |
| Sulphate Content (mg/L) | 113 |

## 5.0 RECOMMENDATIONS AND GUIDELINES

### 5.1 General

The information in the following sections is provided for the guidance of the design engineers and is intended for the design of this project only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

This report includes only the geotechnical aspects of the subsurface conditions at this site. The results and recommendations associated with the Phase One and Phase Two Environmental Site Assessments are to be provided in separate reports.

### 5.2 Proposed Building

#### 5.2.1 Excavation

The excavation for the footings of the proposed structure will be carried out mostly through asphaltic concrete, granular pavement structure, fill material, and bedrock.

#### 5.2.1.1 Overburden Excavation

The sides of the excavation in overburden should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the fill material at this site can be classified as Type 3 soil and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical, or flatter.

The existing fill material, granular pavement structure, and asphaltic concrete should be removed from the building area.  Based on the results of the boreholes, an allowance should be made for subexcavation of the fill and former topsoil to elevation 116.4 metres.

In areas where space constraints dictate, the sides of the excavation could be supported with temporary shoring.  If required, geotechnical parameters for the selection and design of temporary shoring could be provided.

#### 5.2.1.2 Bedrock Excavation

If bedrock removal is required due to proposed grades, bedrock removal at this site could be carried out using hoe ramming techniques in conjunction with line drilling on close centres.  The sides of the bedrock excavation should stand near vertical.

Line drilling on close centres would reduce, not prevent, over break and under break of the bedrock excavation and would assist in defining the limit of excavation next to existing structures and services.  It is suggested that allowance be made for line drilling 75 to 100 millimetre diameter holes on 200 to 300 millimetre centres.  Blasting techniques are likely not a viable alternative for bedrock removal for this project.

The vibration effects of hoe ramming are usually minor and localized.  Monitoring of the hoe ramming should be carried out, at least initially, to measure the vibrations to ensure that they are below the acceptable threshold value.  Further details on vibration monitoring are provided in the Vibration Monitoring section of this report (Section 6.2).

#### 5.2.1.3 Groundwater Management

The groundwater levels on July 31, 2019 ranged from about 4.8 to 5.8 metres below ground surface (elevation 112.9 to 112.2 metres) in boreholes 19-1, 19-2, and 19-4, which is below the bedrock surface in all cases.  Therefore, if the building is to be founded on or above bedrock, groundwater inflow into the excavation should not be a concern.

If it does occur, groundwater inflow from the overburden deposits should be relatively small and controlled by pumping from filtered sumps within the excavation.  It is not expected that short term pumping during excavation will have a significant effect on nearby structures and services.

### 5.2.2 Spread Footing Design

Based on the results of the investigation, the building will likely be founded on bedrock.  Spread footing foundations bearing on or within the competent limestone bedrock could be sized using a factored bearing resistance at Ultimate Limit State of 500 kilopascals.  This bearing pressure assumes that all soil and any weathered or fractured rock is removed from the bearing surfaces.

Post construction settlements from spread footings founded on or within competent limestone bedrock should be negligible, provided that all loose and disturbed bedrock is removed from the footing areas.

### 5.2.3 Frost Protection of the Foundations

All exterior footings for heated portions of the structure should be provided with at least 1.5 metres of earth cover for frost protection purposes. Footings located within unheated portions of the building or isolated footings outside the building footprint should be provided with at least 1.8 metres of earth cover for frost protection purposes. If the required depth of earth cover is not practicable, a combination of earth cover and polystyrene insulation could be considered.

The requirement for minimum depths of soil cover for frost protection could likely be waived for footings founded on or within relatively sound bedrock. An evaluation of the frost susceptibility of the bedrock at subgrade level could be carried out by geotechnical personnel at the time of construction.

Further details regarding the insulation of foundations, if required, could be provided upon request.

### 5.2.4 Foundation Wall Backfill and Drainage

To avoid frost adhesion and possible heaving, the foundations should be backfilled with imported, free-draining, non-frost susceptible granular material meeting OPSS Granular B Type I or II requirements. The backfill should be placed in maximum 200 millimetre thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using suitable vibratory compaction equipment.

Where areas of hard surfacing (concrete, sidewalk, pavement, etc.) abut the proposed building, a gradual transition should be provided between those areas of hard surfacing underlain by non-frost susceptible granular wall backfill and those areas underlain by existing frost susceptible materials to reduce the effects of differential frost heaving. It is suggested that granular frost tapers be constructed from the bottom of the excavation or 1.5 metres below finished grade, whichever is less, to the underside of the granular base/subbase material for the hard surfaced areas. The frost tapers should be sloped at 1 horizontal to 1 vertical, or flatter.

Perimeter foundation drainage is not considered necessary for the slab on grade (i.e., basementless) structure, provided that the floor slab level is above the exterior finished grade.

### 5.2.5 Lateral Earth Pressures

Foundation walls that are backfilled with granular material such as that meeting OPSS Granular B Type I or II requirements should be designed to resist “at rest” earth pressures calculated using the following formula:

$P_o = 0.5\ K_o\ \gamma\ H^2$

where;

- $P_o$: Static “At Rest” thrust (kN/m);
- $\gamma$: Moist material unit weight (kN/m$^3$);
- $K_o$: “At Rest” earth pressure coefficient;
- H: Wall height (m).

Seismic shaking can increase the forces on the retaining wall. The total “At Rest” thrust acting on the walls ($P_{oe}$) during a seismic event should be calculated using the following formula:

$P_{oe} = 0.5\ K_{oe}\ \gamma\ H^2$

where;

- $P_{oe}$: Total “At Rest” thrust (kN/m);
- $\gamma$: Moist material unit weight (kN/m$^3$);
- $K_{oe}$: Dynamic “At Rest” earth pressure coefficient;
- H: Wall height (m).

The static thrust component ($P_o$) acts at a point located H/3 above the base of the wall. During seismic shaking, the total “At Rest” thrust ($P_{oe}$) acts at a point located about H/2 above the base of the wall. It should be noted that the total “At Rest” thrust, $P_{oe}$, is composed of a static component and a dynamic component.

For design purposes, the parameters provided in Table 5.1 can be used to calculate the thrust acting on the walls during static and seismic loading conditions.

**Table 5.1 – Summary of Design Parameters (Building Foundation Walls)**

| Parameter | OPSS Granular B Type II |
|---|---|
| Material Unit Weight, $\gamma$ (kN/m$^3$) | 22 |
| “At Rest” Earth Pressure Coefficient, $K_o$, assuming horizontal backfill behind the structure | 0.41 |
| Dynamic “At Rest” Earth Pressure Coefficient, $K_{oe}$, assuming horizontal backfill behind the structure | 0.41[1] |

Notes:

1) According to the 2015 Ontario Building Code, the peak ground acceleration (PGA) for 5992 Hazeldean Road is 0.25 for Site Class C. Using the method suggested by Mononobe and Okabe, assuming a horizontal seismic coefficient, $k_h$, of 0.25 (PGA) and that the vertical seismic coefficient, $k_v$, is zero, the calculated dynamic "At Rest" earth pressure coefficient ($K_{oe}$) during a seismic event would not exceed the static "At Rest" earth pressure coefficient ($K_o$) calculated using conventional earth pressure theory. In other words, although it is expected that seismic shaking will increase the earth pressures acting on the walls, there is a level of conservatism in the static "At Rest" earth pressure coefficient, $K_o$, that covers both static and dynamic conditions.

Heavy construction traffic should not be allowed to operate adjacent to foundation walls for the proposed building (within about 2 metres horizontal) during construction, without the approval of the designers.

### 5.2.6 Slab on Grade Support

To provide predictable settlement performance of the floor slab, the existing pavement structure and any fill or organic material or disturbed soil and debris should be removed from the slab area. The base for the floor slab should consist of at least 300 millimetres of OPSS Granular A. OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular A material. Since the source of recycled material cannot be determined or controlled, it is suggested that any imported Granular A materials be composed of 100 percent crushed rock only, for environmental reasons.

All imported granular materials placed below the proposed floor slab should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density value.

Underfloor drainage is not considered necessary provided that the floor slab level is above the finished exterior grade.

The floor slab should be wet cured to minimize shrinkage cracking and slab curling. The slab should be saw cut to about 1/3 the thickness of the slab as soon as curing of the concrete permits, in order to minimized shrinkage cracks.

Proper moisture protection with a vapour retarder should be used for any slab on grade where the floor will be covered by moisture sensitive flooring material or where moisture sensitive equipment, products or environments will exist. The "Guide for Concrete Floor and Slab Construction", ACI 302.1R-04 should be considered for the design and construction of vapour retarders below the floor slab.

## 5.3 Seismic Site Class and Liquefaction Potential

Based on the results of the subsurface investigation, the site classification for seismic site response may be taken as Site Class C. Due to the fact that the foundations will likely bear on or within the bedrock, Site Class A or B could likely be assigned to this site, however, in accordance with the Ontario Building Code, shear wave velocity testing would be required to improve the classification to above Site Class C.  Significant savings in the structural and mechanical design and construction costs could be realized by improving to Seismic Site Class A or B therefore, we recommend shear wave velocity testing at this site.  The designers and structural engineer could be consulted regarding the potential savings related to improving the seismic site classification.

There is no potential for liquefaction of the overburden deposits at this site.

## 5.4 Grade Raise Restriction and Site Grading

The proposed building will be founded on or within near surface bedrock, therefore, there are no grade raise restrictions for this site from a geotechnical perspective.  As part of the overall site grading for the proposed addition and access roads/parking areas, grades should be proposed to promote drainage away from all structures and hard surface areas to ditches and/or catch basins.

## 5.5 Pavement Reinstatement

### 5.5.1 Subgrade Preparation

In preparation for the construction of the access roadways and parking areas, any loose/soft, wet, organic, deleterious and fill materials should be removed from the proposed subgrade surface. Any grade raise fill for the roadway/parking areas could consist of material which meets OPSS specifications for Granular B Type I or II, Select Subgrade Material, or suitable earth borrow.  The granular materials, Select Subgrade Material or earth borrow should be placed in maximum 300 millimetres thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using vibratory compaction equipment.

The subgrade surfaces should be proof rolled with a 10 tonne (minimum) smooth steel drum roller and shaped and crowned to promote drainage of the granular materials.

### 5.5.2 Flexible Pavement Structure

For the light duty parking areas to be used by light vehicles (cars, etc.) the following minimum pavement structure is recommended:

- 60 millimetres of Superpave 12.5 (Traffic Level B, hot mix asphalt placed in a single lift); over
- 150 millimetres of OPSS Granular A base; over
- 300 millimetres of OPSS Granular B Type II (or 450 millimetres of Granular B Type I), subbase.

For heavy duty parking areas and access roadways to be used by heavy truck traffic (including emergency vehicles) the suggested minimum pavement structure is:

- 40 millimetres of Superpave 12.5 (Traffic Level B), over;
- 60 millimetres of Superpave 19.0 (Traffic Level B), over;
- 150 millimetres of OPSS Granular A base; over
- 450 millimetres of OPSS Granular B Type II (or 525 millimetres of Granular B Type I), subbase

The existing granular material generally meets OPSS Granular B Type II requirements and therefore could be re-used as granular subbase material. The material should be stockpiled on site for approval by geotechnical personnel prior to re-use.

The above pavement structure assumes that any trench backfill is adequately compacted, and that the access roadway and parking lot subgrade surfaces are prepared as described in this report. If the subgrade surfaces become disturbed or wetted due to construction operations or precipitation, the granular subbase thickness given above may not be adequate and it may be necessary to increase the thickness of the subbase and/or to incorporate a woven geotextile separator between the subgrade surfaces and the granular subbase material. The adequacy of the design pavement thickness should be assessed by geotechnical personnel at the time of construction.

If the granular pavement materials are to be used by construction traffic, it may be necessary to increase the thickness of the granular subbase layer, install a woven geotextile separator between the roadway subgrade surface and the granular subbase material, or a combination of both, to prevent disturbance to the subbase material. The contractor should be made responsible for their construction access.

### 5.5.3 Asphalt Cement Type

Performance grade PG 58-34 asphalt cement should be specified for Superpave asphaltic concrete mixes.

### 5.5.4 Pavement Transitions

As part of the roadway/parking lot construction, the new pavement will abut the existing pavement at various locations. The following is suggested to improve the performance of the joint between the new and the existing pavements:

- Neatly saw cut the existing asphaltic concrete;
- Remove the asphaltic concrete and slope the bottom of the excavation within the existing granular base and subbase at 1 horizontal to 1 vertical, or flatter, to avoid undermining the existing asphaltic concrete.
- To avoid cracking of the asphaltic concrete due to an abrupt change in the thickness of the roadway granular materials where new pavement areas join with the existing

pavements, the granular depths should taper up or down at 5 horizontal to 1 vertical, or flatter, to match the existing pavement structure.

- Remove (mill off) 30 millimetres of the existing asphaltic concrete to a distance of 300 millimetres at the joint and tack coat the asphaltic concrete at the joint in accordance with the requirements in OPSS 310.

### 5.5.5 Pavement Drainage

Adequate drainage of the pavement granular materials and subgrade is important for the long term performance of the pavement at this site. The subgrade surfaces should be crowned and shaped to drain to the catch basins to promote drainage of the pavement granular materials. Catch basins should be equipped with 3 metre long stub drains extending in at least 2 directions.

### 5.5.6 Granular Material Compaction

The granular base and subbase materials should be compacted in maximum 200 millimetre thick lifts to at least 98 percent of the standard Proctor maximum dry density value.

## 5.6 Proposed Services

### 5.6.1 Excavation

In the overburden, the excavation for flexible service pipes should be in accordance with Ontario Provincial Standard Drawing (OPSD) 802.010 for Type 3 soil. The excavation for rigid service pipes should be in accordance with OPSD 802.031 for Type 3 soil. The sides of the excavations within overburden soils should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the soils at this site can be classified as Type 3 soils. Therefore, for design purposes, allowance should be made for 1 horizontal to 1 vertical, or flatter, excavation slopes. As an alternative or where space constraints dictate, the service installations could be carried out within a tightly fitting, braced steel trench box, which is specifically designed for this purpose.

Based on the results of the boreholes, bedrock removal may be required in order to install the site services. The excavation for flexible and rigid service pipes in bedrock should be in accordance with OPSD 802.013 and 802.033, respectively. Where required, the excavation of the bedrock can likely be carried out using large excavation equipment in conjunction with pneumatic hoe ramming equipment. Line drilling on close centres could be used to reduce, not prevent, over break and under break of the bedrock excavation and to define the limit of excavation next to existing structures and services. For the bedrock at this site, it is suggested that allowance be made for line drilling 75 to 100 millimetre diameter holes on 200 to 300 millimetre centres.

Groundwater seepage into excavations is not expected. If groundwater seepage into the excavations does occur it should be controlled, as necessary, by pumping from within the excavations. Short term pumping during excavation is not expected to have any significant effect on nearby structures and services.

### 5.6.2 Pipe Bedding

The bedding for sewers and watermains should be in accordance with OPSD 802.010 and 802.031 for flexible and rigid pipes in Type 3 soils, respectively. The bedding for flexible and rigid service pipes in bedrock should be in accordance with OPSD 802.013 and 802.033, respectively.

The bedding for service pipes should consist of at least 150 millimetres of crushed stone meeting OPSS requirements for Granular A. Cover material, from spring line to at least 300 millimetres above the tops of the pipes, should consist of granular material, such as that meeting OPSS Granular A.

Where bedrock excavation is required, some overbreak should be expected and allowance should be made for thickening the bedding material, as required.

In areas where the subsoil is disturbed or where unsuitable material (fill or organic material) exists below the pipe subgrade level, the disturbed/unsuitable material should be removed and replaced with a subbedding layer of compacted granular material, such as that meeting OPSS Granular B Type I or II. To provide adequate support for the sewer pipes in the long term in areas where subexcavation of material is required below design subgrade level, the excavations should be sized to allow a 1 horizontal to 1 vertical or 2 horizontal to 1 vertical spread of granular material down and out from the bottom of the pipes.

The granular bedding and subbedding materials should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value.

The use of clear crushed stone should not be permitted on this project.

### 5.6.3 Trench Backfill

In areas where the service trench will be located below or in close proximity to existing or future areas of hard surfacing (pavement, sidewalk, etc.), acceptable native materials should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetration in order to reduce the potential for differential frost heaving between the area over the trench and the adjacent hard surfaced area. The depth of frost penetration in exposed areas can normally be taken as 1.8 metres below finished grade. Where native backfill is used, it should match the native materials exposed on the trench walls. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material, imported granular material conforming to OPSS Granular B Type I, or well shattered and graded excavated bedrock.

It is anticipated that most of the inorganic overburden materials encountered during the subsurface investigation will be acceptable for reuse as trench backfill. Any former topsoil and existing asphaltic concrete should be wasted from the trench. If on site excavated bedrock is used as backfill within the service trench, it should be mostly 300 millimetres, or smaller, in size and should be well graded. To prevent ingress of fine material into voids in the blast rock, the upper surface of the blast rock should be blinded with well graded crushed stone, such as OPSS Granular B Type II.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the parking area, the trench backfill should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. Rock fill should be placed in maximum 500 millimetre thick lifts and compacted with the haulage and spreading equipment. The specified density for compaction of the backfill materials may be reduced where the trench backfill is not located below or in close proximity to existing or future areas of hard surfacing and/or structures.

### 5.7 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in a sample of the groundwater collected from borehole 19-2 was found to be 113 mg/L. According to the Canadian Standards Association “Concrete Materials and Methods of Concrete Construction” (CSA A23.1-14 Table 3), the concentration of sulphate in the groundwater recovered from borehole 19-2 is less than the minimum concentration for ‘Moderate’ sulfate exposure (150 to 1500 milligrams of sulphate per litre). Therefore any concrete in contact with the native soil or bedrock could be batched with General Use (GU) cement. Other factors (structurally reinforced or non-structurally reinforced, freeze-thaw environment, chloride exposure) should be considered in selecting the Class of Exposure and associated air entrainment and concrete mix proportions for any concrete.

Based on the resistivity and pH of the groundwater, the groundwater sampled from borehole 19-2 can be classified as aggressive toward unprotected steel. The manufacturer of any buried steel elements that will be in contact with the groundwater should be consulted to ensure that the durability of the intended product is appropriate. It is noted that the corrosivity of the groundwater could vary throughout the year due to the application of de-icing chemicals.

## 6.0 ADDITIONAL CONSIDERATIONS

### 6.1 Winter Construction

Provision must be made to prevent freezing of any soil below the level of any footings, slabs or services. Freezing of the soil could result in heaving related damage.

Any service trenches should be opened for as short a time as practicable and the excavations should be carried out only in lengths which allow all of the construction operations, including backfilling, to be fully completed in one working day. The materials on the sides of the trenches should not be allowed to freeze. In addition, the backfill should be excavated, stored and replaced without being disturbed by frost or contaminated by snow or ice.

## 6.2 Landscaping

From a geotechnical perspective, there are no restrictions to landscaping with respect to City Guidelines for clay soils.

## 6.3 Vibration Monitoring

Some of the construction operations (such as granular material compaction, excavation, hoe ramming, foundation construction etc.) will cause ground vibration on and off of the site. The vibrations will attenuate with distance from the source, but may be felt at nearby structures. We recommend that preconstruction surveys be carried out on the adjacent structures and that vibration monitoring be carried out during the construction, or at least initially, so that any construction related claims can be dealt with in a fair manner.

## 6.4 Disposal of Excess Soil

It is noted that the professional services retained for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination, including naturally occurring source of contamination, will be addressed by the Phase One and Phase Two Environmental Site Assessment (ESA) reports provided separately.

## 6.5 Design Review and Construction Observation

The details for the proposed construction were not available to us at the time of preparation of this report. It is recommended that the final design drawings be reviewed by the geotechnical engineer as the design progresses to ensure that the guidelines provided in this report have been interpreted as intended.

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed excavations do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. The subgrade surfaces for the building and site should be inspected by experienced geotechnical personnel to ensure that suitable materials have been reached and properly prepared. The placing and compaction of earth fill and imported granular materials should be inspected to ensure that the materials used conform to the grading and compaction specifications. In accordance with Ontario Building Code requirements, full time compaction testing is required for engineered fill below buildings.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact our office.

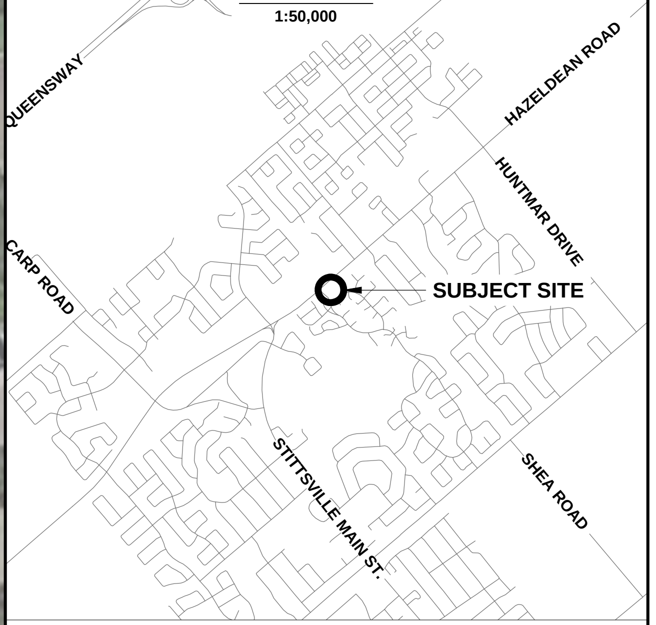
Joseph Berkers, B.Eng.

LICENSED PROFESSIONAL ENGINEERS
B.D. WIEBE
100060438
Aug 22, 2019
PROVINCE OF ONTARIO

Brent Wiebe, P.Eng.

## KEY PLAN

1:50,000



## LEGEND

- ⊕ **BOREHOLE LOCATION IN PLAN**
  (current investigation by GEMTEC)
- ⊖ **BOREHOLE WITH MONITORING WELL**
  (current investigation by GEMTEC)

**BH #** ← BOREHOLE ID

**XX.XX** ← GROUND SURFACE ELEVATION, IN METRES
GEODETIC DATUM

Scale

1:500

0 10 20 30m

GEMTEC
CONSULTING ENGINEERS
AND SCIENTISTS

32 Steacie Drive
Ottawa, ON K2K 2A9
Tel: (613) 836-1422
www.gemtec.ca
ottawa@gemtec.ca

Drawing

BOREHOLE LOCATION PLAN

Client

ARGUE CONSTRUCTION LTD.

Project

61730.62

GEOTECHNICAL INVESTIGATION
5986-5992 HAZELDEAN ROAD
OTTAWA, ONTARIO

| Drwn by | Chkd by |
|---|---|
| P.C. | J.B. |

| Date | Rev. | |
|---|---|---|
| AUGUST 2019 | 0 | **FIGURE 1** |

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# APPENDIX A

List of Abbreviations and Terminology
Record of Borehole Sheets

# ABBREVIATIONS AND TERMINOLOGY USED ON RECORDS OF BOREHOLES AND TEST PITS

| SAMPLE TYPES | |
|---|---|
| AS | Auger sample |
| CA | Casing sample |
| CS | Chunk sample |
| BS | Borros piston sample |
| GS | Grab sample |
| MS | Manual sample |
| RC | Rock core |
| SS | Split spoon sampler |
| ST | Slotted tube |
| TO | Thin-walled open shelby tube |
| TP | Thin-walled piston shelby tube |
| WS | Wash sample |

| SOIL TESTS | |
|---|---|
| w | Water content |
| PL, $w_p$ | Plastic limit |
| LL, $w_L$ | Liquid limit |
| C | Consolidation (oedometer) test |
| $D_R$ | Relative density |
| DS | Direct shear test |
| $G_S$ | Specific gravity |
| M | Sieve analysis for particle size |
| MH | Combined sieve and hydrometer (H) analysis |
| MPC | Modified Proctor compaction test |
| SPC | Standard Proctor compaction test |
| OC | Organic content test |
| UC | Unconfined compression test |
| γ | Unit weight |

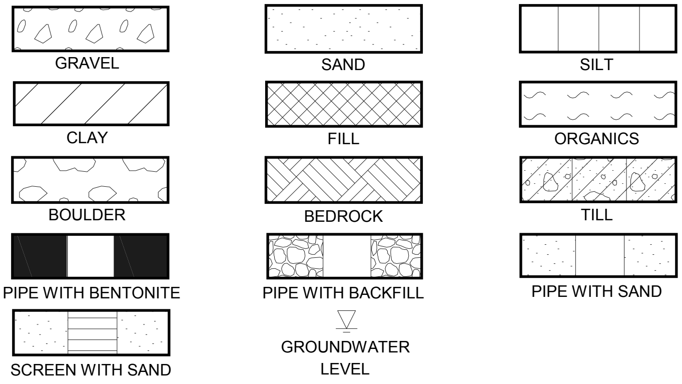
## PENETRATION RESISTANCE

**Standard Penetration Resistance, N**
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 millimetres (30 in.) required to drive a 50 mm split spoon sampler for a distance of 300 mm (12 in.). For split spoon samples where less than 300 mm of penetration was achieved, the number of blows is reported over the sampler penetration in mm.

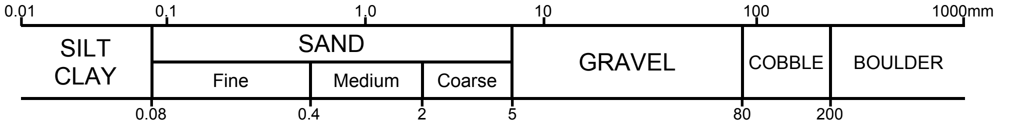
**Dynamic Penetration Resistance**
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive a 50 mm (2 in.) diameter 60° cone attached to 'A' size drill rods for a distance of 300 mm (12 in.).

| | |
|---|---|
| WH | Sampler advanced by static weight of hammer and drill rods |
| WR | Sampler advanced by static weight of drill rods |
| PH | Sampler advanced by hydraulic pressure from drill rig |
| PM | Sampler advanced by manual pressure |

| COHESIONLESS SOIL Compactness | | COHESIVE SOIL Consistency | |
|---|---|---|---|
| SPT N-Values | Description | Cu, kPa | Description |
| 0-4 | Very Loose | 0-12 | Very Soft |
| 4-10 | Loose | 12-25 | Soft |
| 10-30 | Compact | 25-50 | Firm |
| 30-50 | Dense | 50-100 | Stiff |
| >50 | Very Dense | 100-200 | Very Stiff |
| | | >200 | Hard |



## GRAIN SIZE



## DESCRIPTIVE TERMINOLOGY

(Based on the CANFEM 4th Edition)

0 10 20 35

| TRACE | SOME | ADJECTIVE | noun > 35% and main fraction |
|---|---|---|---|
| trace clay, etc | some gravel, etc. | silty, etc. | sand and gravel, etc. |

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# LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

| WEATHERING STATE | |
|---|---|
| Fresh | No visible sign of rock material weathering |
| Faintly weathered | Weathering limited to the surface of major discontinuities |
| Slightly weathered | Penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material |
| Moderately weathered | Weathering extends throughout the rock mass but the rock material is not friable |
| Completely weathered | Rock is wholly decomposed and in a friable condition but the rock and structure are preserved |

| CORE CONDITION |
|---|
| **Total Core Recovery (TCR)**<br>The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run |
| **Solid Core Recovery (SCR)**<br>The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run. |
| **Rock Quality Designation (RQD)**<br>The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completed broken core to 100% for core in solid segments. |

| BEDDING THICKNESS | |
|---|---|
| Description | Thickness |
| Thinly laminated | < 6 mm |
| Laminated | 6 - 20 mm |
| Very thinly bedded | 20 - 60 mm |
| Thinly bedded | 60 - 200 mm |
| Medium bedded | 200 - 600 mm |
| Thickly bedded | 600 - 2000 mm |
| Very thickly bedded | 2000 - 6000 mm |

| DISCONTINUITY SPACING | |
|---|---|
| Description | Spacing |
| Very close | 20 - 60 mm |
| Close | 60 - 200 mm |
| Moderate | 200 - 600 mm |
| Wide | 600 -2000 mm |
| Very wide | 2000 - 6000 mm |

| ROCK QUALITY | |
|---|---|
| RQD | Overall Quality |
| 0 - 25 | Very poor |
| 25 - 50 | Poor |
| 50 - 75 | Fair |
| 75 - 90 | Good |
| 90 - 100 | Excellent |

| ROCK COMPRESSIVE STRENGTH | |
|---|---|
| Comp. Strength, MPa | Description |
| 1 - 5 | Very weak |
| 5 - 25 | Weak |
| 25 - 50 | Moderate |
| 50 - 100 | Strong |
| 100 - 250 | Very strong |

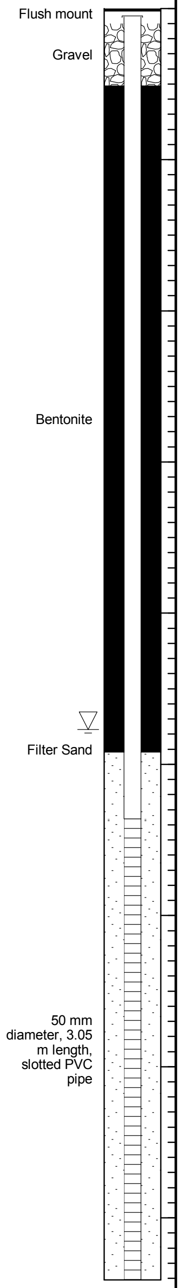
# RECORD OF BOREHOLE 19-1

CLIENT: Argue Construction Ltd.
PROJECT: Geotechnical & Phase II Investigation
JOB#: 61730.62
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 22 2019

| BORING METHOD | SOIL PROFILE DESCRIPTION | ELEV. DEPTH (m) | NUMBER | TYPE | RECOVERY, mm | BLOWS/0.3m | PENETRATION RESISTANCE (N), BLOWS/0.3m / SHEAR STRENGTH (Cu), kPA / WATER CONTENT, % |
|---|---|---|---|---|---|---|---|
|  | Ground Surface | 117.66 |  |  |  |  |  |
| Power Auger<br>Hollow Stem Auger (210mm OD) | Asphaltic concrete | 0.06 |  |  |  |  |  |
|  | Grey crushed sand and gravel, some silt (BASE/SUBBASE MATERIAL) |  | 1 | AS |  |  |  |
|  |  |  | 2 | SS | 25 |  |  |
| Diamond Rotary Core<br>HQ (89mm OD) | Grey, faintly to slightly weathered LIMESTONE | 116.77<br>0.89 | 3 | RC |  |  | TCR = 100%, SCR = 89%, RQD = 24% |
|  |  |  | 4 | RC |  |  | TCR = 100%, SCR = 98%, RQD = 61% |
|  |  |  | 5 | RC |  |  | TCR = 98%, SCR = 86%, RQD = 79% |
|  |  |  | 6 | RC |  |  | TCR = 98%, SCR = 70%, RQD = 65% |
|  |  |  | 7 | RC |  |  | TCR =100 %, SCR =87 %, RQD =58 % |
|  |  |  | 8 | RC |  |  | TCR = 93%, SCR = 87%, RQD = 62% |
|  | End of borehole | 109.25<br>8.41 |  |  |  |  |  |

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

| DATE | DEPTH (m) | ELEV. (m) |
|---|---|---|
| 19-07-31 | 4.8 ▽ | 112.9 |

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LOGGED: M.L.
CHECKED: J.B.

# RECORD OF BOREHOLE 19-2

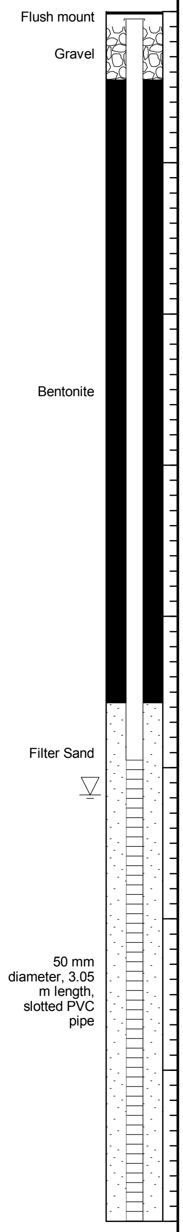
CLIENT: Argue Construction Ltd.
PROJECT: Geotechnical & Phase II Investigation
JOB#: 61730.62
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 22 2019

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED
WATER CONTENT, % $W_P$ —W— $W_L$
10 20 30 40 50 60 70 80 90

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE DESCRIPTION | ELEV. DEPTH (m) | SAMPLES NUMBER | TYPE | RECOVERY, mm | BLOWS/0.3m | | ADDITIONAL LAB. TESTING |
|---|---|---|---|---|---|---|---|---|---|
| 0 | Power Auger<br>Hollow Stem Auger (210mm OD) | Ground Surface | 117.53 | | | | | | |
| | | Asphaltic concrete | 0.05 | | | | | | |
| | | Grey crushed gravel, some sand, trace silt (BASE/SUBBASE MATERIAL) | | 1 | AS | | | | |
| | | | 116.46<br>1.07 | 2 | SS | 75 | | | |
| 1 | Diamond Rotary Core<br>HQ (89mm OD) | Grey, faintly to slightly weathered LIMESTONE | | 3 | RC | | | TCR = 100%, SCR = 45%, RQD = 45% | |
| 2 | | | | 4 | RC | | | TCR = 100%, SCR = 97%, RQD = 54% | |
| 3 | | | | 5 | RC | | | TCR = 100%, SCR = 98%, RQD = 81% | |
| 5 | | | | 6 | RC | | | TCR = 99%, SCR = 94%, RQD = 74% | |
| 6 | | | | 7 | RC | | | TCR = 100%, SCR = 96%, RQD = 86% | |
| 7 | | | 109.53<br>8.00 | 8 | RC | | | TCR = 96%, SCR = 88%, RQD = 42% | |
| 8 | | End of borehole | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

| DATE | DEPTH (m) | ELEV. (m) |
|---|---|---|
| 19-07-31 | 5.2 ▽ | 112.4 |

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LOGGED: M.L.
CHECKED: J.B.

# RECORD OF BOREHOLE 19-3

CLIENT: Argue Construction Ltd.
PROJECT: Geotechnical & Phase II Investigation
JOB#: 61730.62
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 23 2019

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED
WATER CONTENT, % $W_P$ ⊢ W ⊖ ⊣ $W_L$
10 20 30 40 50 60 70 80 90

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE DESCRIPTION | ELEV. DEPTH (m) | SAMPLES NUMBER | TYPE | RECOVERY, mm | BLOWS/0.3m | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | Power Auger | Ground Surface | 118.02 | | | | | | |
| | | Asphaltic concrete | 0.06 | | | | | | Asphaltic cold mix |
| | | Light grey, crushed, gravel, trace sand and silt (BASE/SUBBASE MATERIAL) | 117.64<br>0.38 | 1 | AS | | | | Auger cuttings |
| | Hollow Stem Auger (210mm OD) | Dark grey, crushed, sand and gravel, some silt (BASE/SUBBASE MATERIAL) | 117.36<br>0.66 | 2 | AS | | | | |
| 1 | | Dark brown clayey silt, some gravel, trace sand (FILL MATERIAL) | 117.05<br>0.97 | 3 | AS | | | | |
| | | Auger refusal on inferred bedrock<br>End of borehole | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |

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LOGGED: A.N.
CHECKED: J.B.

# RECORD OF BOREHOLE 19-4

CLIENT: Argue Construction Ltd.
PROJECT: Geotechnical & Phase II Investigation
JOB#: 61730.62
LOCATION: See Borehole Location Plan, Figure 1

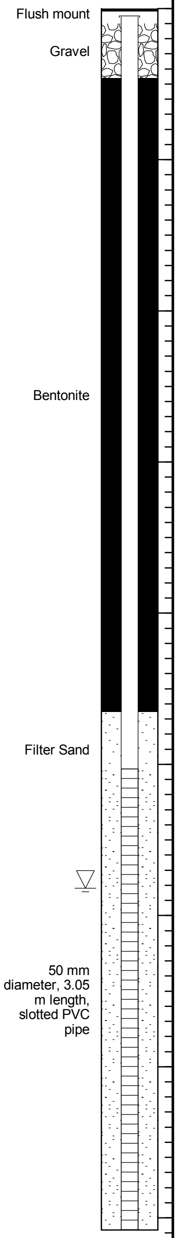
SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Jul 23 2019

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE DESCRIPTION | ELEV. DEPTH (m) | SAMPLES NUMBER | TYPE | RECOVERY, mm | BLOWS/0.3m |
|---|---|---|---|---|---|---|---|
| 0 | | Ground Surface | 117.98 | | | | |
| | Diamond Rotary Core<br>HQ Casing | Grey, crushed, sand and gravel, trace silt (BASE/SUBBASE MATERIAL) | | 1 | SS | 330 | |
| | | Dark brown clayey sandy silt, some gravel (FILL MATERIAL) | 117.47<br>0.51 | | | | |
| 1 | | Grey, faintly to slightly weathered LIMESTONE | 0.58 | 2 | RC | 762 | TCR: 97%; SCR: 90%; RQD: 81% |
| 2 | Diamond Rotary Core<br>HQ (89mm OD) | | | 3 | RC | 1524 | TCR: 100%; SCR: 57%; RQD: 45% |
| 3–4 | | | | 4 | RC | 1575 | TCR: 100%; SCR: 85%; RQD: 28% |
| 5 | | | | 5 | RC | 1499 | TCR: 98%; SCR: 67%; RQD: 63% |
| 6–7 | | | | 6 | RC | 1499 | TCR: 98%; SCR: 77%; RQD: 48% |
| 7–8 | | | | 7 | RC | 610 | TCR: 100%; SCR: 31%; RQD: 17% |
| 8 | | End of borehole | 109.90<br>8.08 | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA
+ NATURAL ⊕ REMOULDED
WATER CONTENT, %
$W_P$ ⊢ W ⊖ ⊣ $W_L$
10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

| DATE | DEPTH (m) | ELEV. (m) |
|---|---|---|
| 19-07-31 | 5.8 ▽ | 112.2 |

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CHECKED: J.B.

# APPENDIX B

## Materials Laboratory Testing
## Grain Size Tests

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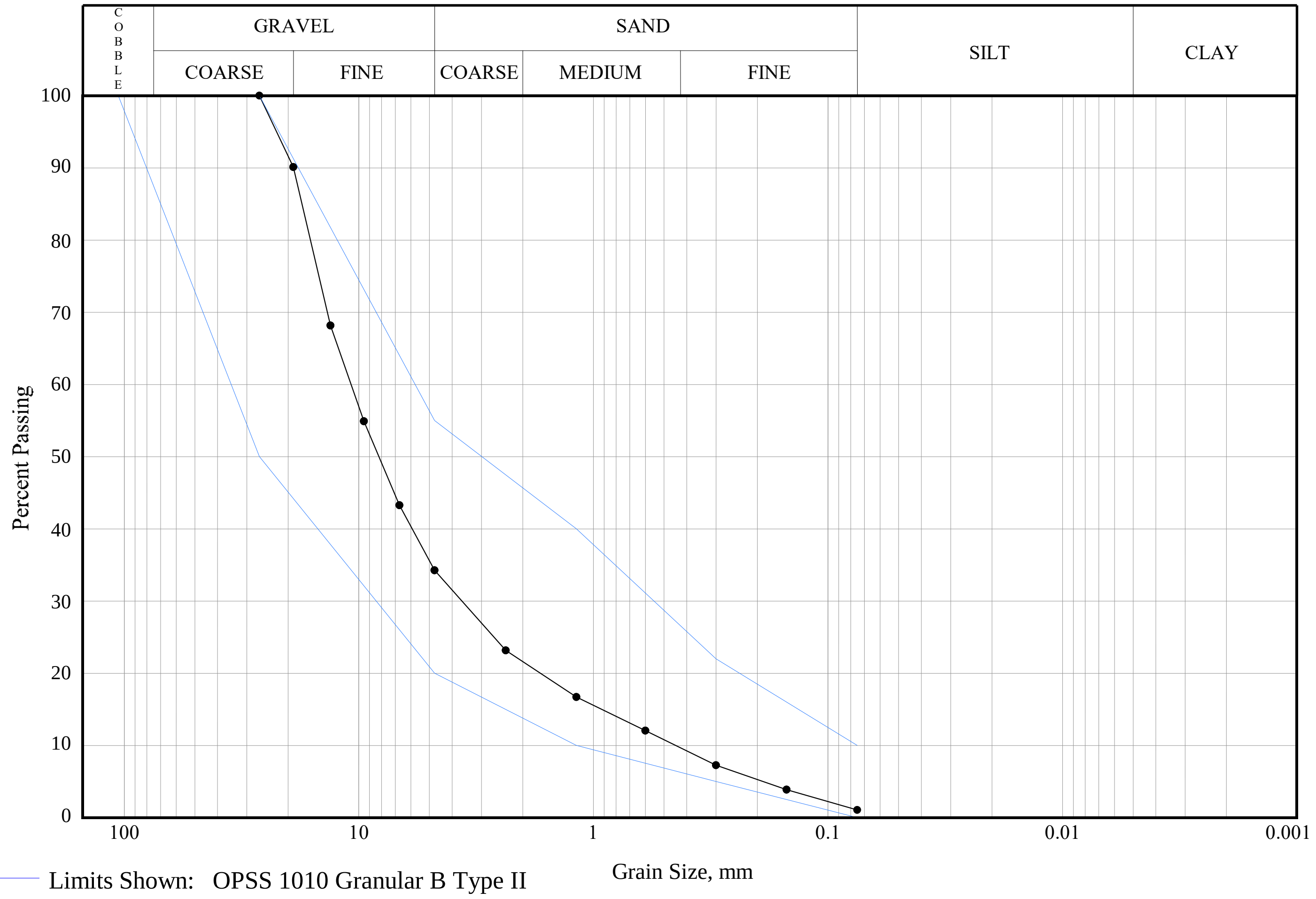
Consulting Engineers and Scientists

Client: Argue Construction Ltd.
Project: 5986 – 5992 Hazeldean Road
Project #: 6173062

# Soils Grading Chart



| Line Symbol | Sample | Borehole/ Test Pit | Sample Number | Depth | % Cob.+ Gravel | % Sand | % Silt | % Clay |
|---|---|---|---|---|---|---|---|---|
| ● | Roadway Base/Subbase Material | 19-01 | 01 |  | 65.8 | 33.2 | 1.1 |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

| Line Symbol | CanFEM Classification | USCS Symbol | $D_{10}$ | $D_{15}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{85}$ | % 5-75μm |
|---|---|---|---|---|---|---|---|---|---|
| ● | Sandy gravel , trace silt | GW | 0.45 | 0.92 | 3.63 | 8.20 | 10.78 | 17.46 | --- |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |

# APPENDIX C

Unconfined Compressive Strength Tests
Photographs of Bedrock Core
Figures C1 to C3

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

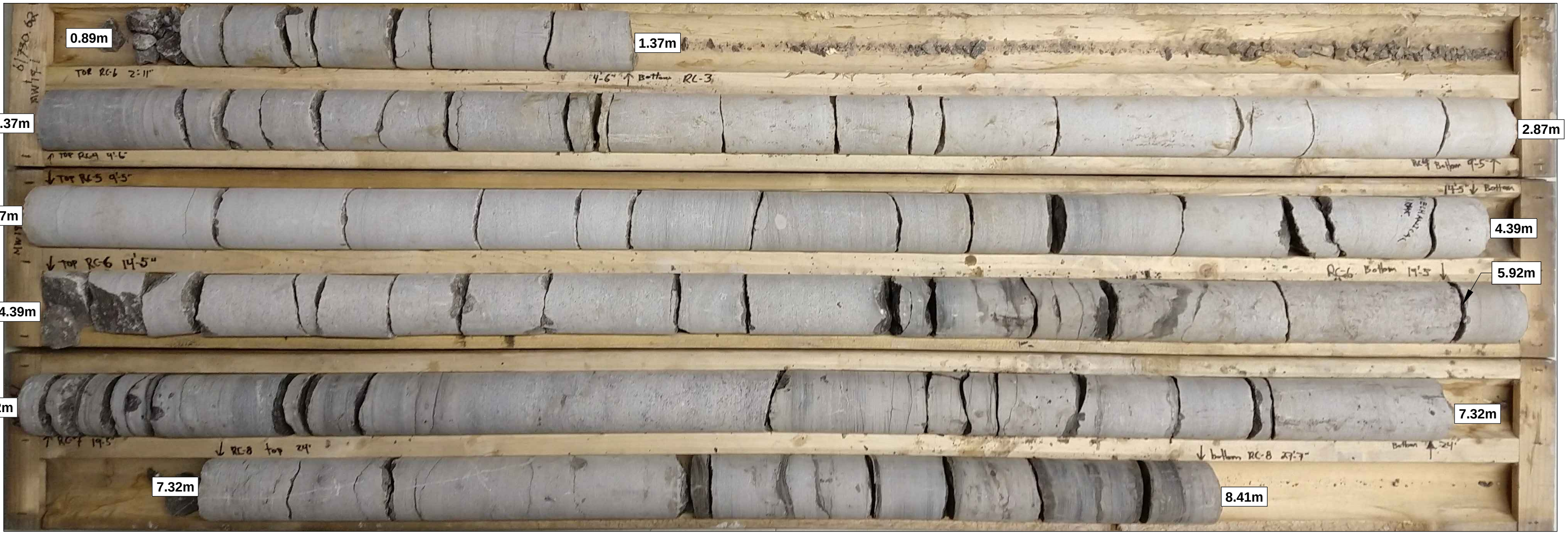
Client: Argue Construction Ltd.
Project: Proposed Mixed Use Building, 5986 – 5992 Hazeldean Road
Project #: 6173062

# Rock Core Compressive Strength

Date/Time Sampled: 19/08/08 8:35:00 AM
Date/Time Tested: 19/08/08 8:35:40 AM

| BH | Sample No | Depth | Description | Diameter, mm | Area, mm² | Length After Capping, mm | L/D | Load, kN | Comp. Str., MPa |
|---|---|---|---|---|---|---|---|---|---|
| 19-02 | 2458 | 1.52-1.73 | Rock Core | 63.0 | 3117 | 105 | 1.66 | 237.490 | 75.1 |
| 19-02 | 2459 | 2.34-2.49 | Rock Core | 63.1 | 3127 | 104 | 1.64 | 243.150 | 76.7 |
| 19-04 | 2456 | 0.58-0.73 | Rock Core | 62.4 | 3058 | 114 | 1.82 | 215.010 | 69.3 |
| 19-04 | 2457 | 1.01-1.35 | Rock Core | 62.4 | 3058 | 122 | 1.96 | 305.270 | 98.5 |

**BOREHOLE 19-1**
**0.89 TO 8.41 mbgs**
**BORING DATE: July 22, 2019**



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32 Steacie Drive, Ottawa, ON K2K 2A9
T: (613) 836-1422 | www.gemtec.ca | ottawa@gemtec.ca

Project
GEOTECHNICAL INVESTIGATION
5986-5992 HAZLDEAN ROAD
OTTAWA, ONTARIO

**FIGURE C1**

File No.
61730.62

ROCKCORE PHOTOGRAPH
BOREHOLE 19-1

**BOREHOLE 19-2**
**1.07 TO 8.00 mbgs**
**BORING DATE: July 22, 2019**

**GEMTEC**
CONSULTING ENGINEERS
AND SCIENTISTS

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Project

GEOTECHNICAL INVESTIGATION
5986-5992 HAZLDEAN ROAD
OTTAWA, ONTARIO

**FIGURE C2**

File No.
61730.62

ROCKCORE PHOTOGRAPH
BOREHOLE 19-2

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**BOREHOLE 19-4**
**1.07 TO 8.00 mbgs**
**BORING DATE: July 22, 2019**

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Consulting Engineers and Scientists
32 Steacie Drive, Ottawa, ON K2K 2A9
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Project
GEOTECHNICAL INVESTIGATION
5986-5992 HAZLDEAN ROAD
OTTAWA, ONTARIO

**FIGURE C3**

File No.
61730.62

ROCKCORE PHOTOGRAPH
BOREHOLE 19-4

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# APPENDIX D

Laboratory Testing
Soil Chemistry Relating to Corrosion

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RESPONSIVE.
RELIABLE.

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# Certificate of Analysis

**GEMTEC Consulting Engineers and Scientists Limited**

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Nicole Soucy

Client PO:
Project: 61730.62
Custody:

Report Date: 9-Aug-2019
Order Date: 1-Aug-2019

**Order #: 1931480**

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

| Paracel ID | Client ID |
|---|---|
| 1931480-02 | MW 19-2(Sewer Use) |

Approved By:

Dale Robertson, BSc
Laboratory Director

## Analysis Summary Table

| Analysis | Method Reference/Description | Extraction Date | Analysis Date |
|---|---|---|---|
| Anions | EPA 300.1 - IC | 8-Aug-19 | 8-Aug-19 |
| pH | EPA 150.1 - pH probe @25 °C | 6-Aug-19 | 6-Aug-19 |
| Resistivity | EPA 120.1 - probe | 8-Aug-19 | 8-Aug-19 |

Certificate of Analysis

**Client: GEMTEC Consulting Engineers and Scientists Limited**

**Client PO:**

Report Date: 09-Aug-2019

Order Date: 1-Aug-2019

**Project Description: 61730.62**

| | | | | | |
|---|---|---|---|---|---|
| | **Client ID:** | MW 19-2(Sewer Use) | - | - | - |
| | **Sample Date:** | 31-Jul-19 12:00 | - | - | - |
| | **Sample ID:** | 1931480-02 | - | - | - |
| | **MDL/Units** | Water | - | - | - |
| **General Inorganics** | | | | | |
| pH | 0.1 pH Units | 7.6 | - | - | - |
| Resistivity | 0.01 Ohm.m | 2.81 | - | - | - |
| **Anions** | | | | | |
| Chloride | 1 mg/L | 970 | - | - | - |
| Sulphate | 1 mg/L | 113 | - | - | - |

experience • knowledge • integrity

| | |
|---|---|
| civil | civil |
| geotechnical | géotechnique |
| environmental | environnementale |
| field services | surveillance de chantier |
| materials testing | service de laboratoire des matériaux |

expérience • connaissance • intégrité