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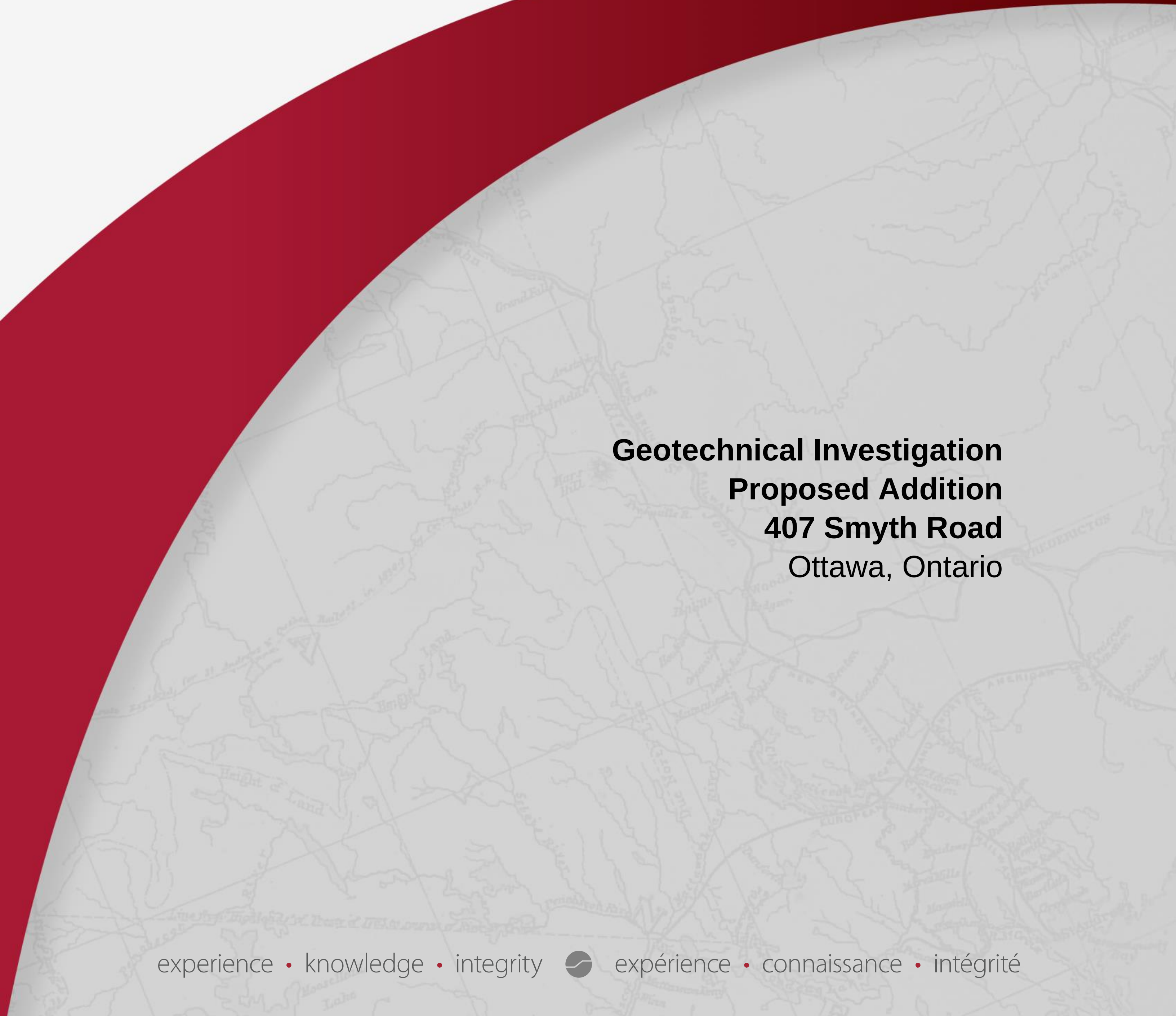

Geotechnical Investigation
Proposed Addition
407 Smyth Road
Ottawa, Ontario

experience • knowledge • integrity   expérience • connaissance • intégrité

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Submitted to:

Integrated Design Engineering + Architecture Inc. (IDEA)
595 Byron Avenue
Ottawa, ON
K2A 4C4

Geotechnical Investigation Proposed Addition 407 Smyth Road

Ottawa, Ontario

November 24, 2022
Project: 65189.01

experience • knowledge • integrity

GEMTEC Consulting Engineers and Scientists Limited
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Ottawa, ON, Canada
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November 24, 2022 File: 65189.01

Integrated Design Engineering + Architecture Inc. (IDEA)
595 Byron Avenue
Ottawa, Ontario
K2A 4C4

Attention: Leah Guerra, B.Sc. (Acc), BAAS, M.Arch., OAA

Re: Geotechnical Investigation
Proposed Addition
407 Smyth Road
Ottawa, Ontario

Enclosed is our geotechnical investigation report for the above noted project, in accordance with our proposal dated August 28, 2020. This report was prepared by Gregory Davidson, P.Eng. and Brent Wiebe, P.Eng.

p.p. Greg Davidson, P.Eng.
Geotechnical Engineer

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VP Operations – Ontario
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GD/BW

Enclosures
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1.0 INTRODUCTION

This report presents the results of a subsurface investigation carried out for the proposed addition to be constructed at 407 Smyth 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 hand augerholes, 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 August 28, 2020.

Following the completion of the geotechnical investigation GEMTEC Consulting Engineers and Scientists Limited (GEMTEC) was also engaged to carry out a Multi-channel Analysis of Surface Waves (MASW) investigation.

2.0 BACKGROUND

2.1 Project Description

It is understood that plans are being prepared for the construction of an addition to the existing building located at 407 Smyth Road. It is understood that the addition will include a two (2) storey, 400 square metre section and a three (3) storey, 2,000 square metre section and will be located to the north of the existing building. It is understood that the proposed addition will include a basement level. It is further understood that the development will also include the construction of a new access roadway and parking areas.

2.2 Site Geology

Based on surficial geology maps of the Ottawa area and available borehole information from previous developments in the area, the site is expected to be underlain by glacial till. Bedrock geology maps of the Ottawa area show that the overburden has a thickness of about 1 to 2 metres and is underlain by shale of the Carlsbad formation.

Fill material associated with previous development should be expected at the site.

3.0 SUBSURFACE INVESTIGATION

The field work for the borehole investigation was carried out on October 13, 2020. At that time, seven (7) boreholes, numbered 20-1 to 20-4, inclusive and 20-8 to 20-10, inclusive, were advanced at the site within the footprint of the proposed addition and access roadway and parking areas using a truck mounted drill rig supplied and operated by George Downing Estate Drilling Ltd. of Grenville-Sur-La-Rouge, Quebec. The boreholes were advanced to depths between approximately 1.5 and 4.6 metres below existing grade. Due to limited access for the drill rig, hand augerholes were advanced at the proposed locations of boreholes 20-5 to 20-7. The hand augerholes were advanced to depths ranging from about 0.6 to 1.0 metres below existing grade.

Standard penetration tests were carried out in the boreholes at regular depth intervals and samples of the soils encountered were recovered using a 50 millimetre diameter split barrel sampler. Samples from the hand augerholes were recovered from the flights of the auger.

The field work was supervised throughout by a member of our engineering staff who directed the drilling operations and logged the samples and boreholes.

One (1) standpipe piezometer was installed and sealed in the bedrock in borehole 20-3 to allow subsequent measurement of the groundwater levels at the site. The groundwater level was measured on October 26, 2020.

Following completion of the drilling, the soil samples were returned to our laboratory for examination by a geotechnical engineer. The laboratory testing included water content and grain size distribution testing.

One (1) groundwater sample obtained from the standpipe piezometer installed in borehole 20-3 was sent to Paracel Laboratories Limited for basic chemical testing related to corrosion of buried concrete and steel.

The results of the boreholes are provided on the Record of Borehole sheets in Appendix A. The locations of the boreholes and hand augerholes are shown on the Borehole Location Plan, Figure 1. The results of the laboratory classification testing are provided on the Record of Borehole sheets and in Appendix B. The results of the chemical analysis related to corrosion of buried steel and concrete on the soil sample collected is provided in Appendix C.

The borehole/hand augerhole locations were selected by GEMTEC. The ground surface elevations at the location of the boreholes were determined using a Trimble R10 global positioning system. The elevations are referenced to 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 and hand augerholes are given on the Record of Borehole sheets in Appendix A. The 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 and augerhole locations may vary from the conditions encountered in the test holes. 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 groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. Groundwater conditions may vary seasonally or as a consequence of construction activities in the area.

4.2 Boreholes

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

4.2.1 Existing Pavement Structure

A surficial layer of asphaltic concrete was encountered at boreholes 20-1, 20-2, 20-4, 20-9 and 20-10 which were advanced through the existing access road/parking area. The thickness of the asphaltic concrete is about 40 millimetres. The asphaltic concrete is underlain by a granular bases/subbase layer which can be described as brown to grey, crushed sand and gravel with some silt. The base/subbase material has a thickness ranging from about 240 millimetres to 970 millimetres and extends to depths ranging from about 0.3 to 1.0 metres below existing grade.

The results of grain size distribution testing carried out on samples of the granular base/subbase material are provided on the Soils Grading Chart in Appendix B and summarized in Table 4.1.

Table 4.1 – Summary of Grain Size Distribution Testing (Base/Subbase Material)

Borehole	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt & Clay (%)
20-2	1	0.15 – 0.76	36	49	15
20-4	1	0.15 – 0.76	41	47	12
20-9	1	0.15 – 0.76	46	38	16
20-10	1	0.15 – 0.76	37	50	13

The moisture content testing on samples of the granular base/subbase material indicate moisture contents ranging from about 3 to 5 percent.

4.2.2 Topsoil

A surficial layer of topsoil was encountered at boreholes 20-3 and 20-8 advanced in grassed areas. The topsoil can be described as dark brown sandy silt that contains organic material. The topsoil has a thickness ranging from about 130 to 200 millimetres.

4.2.3 Fill Material

Fill material was encountered below the surficial topsoil and/or pavement structure at all borehole locations at depths ranging from about 130 to 970 millimetres below existing grade. The fill material is variable across the site but can generally be described as brown to grey sand/silty sand and gravelly sand with varying amounts of gravel, clay and organic material and brown to grey silty clay with varying amounts of gravel and sand. Where fully penetrated, the fill material has a thickness ranging from about 1.3 to 2.3 metres and extends to depths ranging from about 1.6 to 3.1 metres below existing grade. Borehole 20-9 and 20-10 were terminated within the fill material at a depth of about 1.5 metres below existing grade.

Standard penetration tests (SPT) carried out in fill material gave N values ranging from 4 to 31 blows per 0.3 metres of penetration, which reflects a loose to dense relative density.

The results of grain size distribution testing carried out on samples of the fill material are provided on the Soils Grading Chart in Appendix B and summarized in Table 4.2.

Table 4.2 – Summary of Grain Size Distribution Testing (Fill Material)

Borehole	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
20-8	1	0 – 0.61	31	54	15	
20-8	2	0.61 – 1.22	4	47	25	24
20-9	2	0.76 – 1.37	15	45	21	19
20-10	2	0.76 – 1.37	14	53	20	13

The moisture content testing on samples of the fill material indicate moisture contents ranging from about 5 to 16 percent.

4.2.4 Bedrock

Shale bedrock was encountered at boreholes 20-1 to 20-4, inclusive and 20-8 at depths ranging between about 1.5 to 3.1 metres below existing grade (elevations 74.4 to 75.4 metres, geodetic). The shale bedrock can be described as grey and highly weathered. It should be noted that the boreholes could be advanced to depth through the weathered bedrock using augers. Boreholes

20-1 to 20-4, inclusive and 20-8 were terminated within the shale bedrock at depths ranging between about 1.8 to 4.6 metres below existing grade (elevations 72.3 to 75.2 metres, geodetic).

Based on examination of the recovered bedrock samples after exposure to the air, it is considered possible that the shale is of the Billings formation. The implications of Billings formation shale on the construction of the addition and corresponding protective measures are discussed in the Bedrock Excavation section of our report (5.2.2).

4.3 Hand Augerholes (20-5 to 20-7)

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

4.3.1 Topsoil

A surficial layer of topsoil was encountered at surface grade at all hand augerhole locations (20-5 to 20-7, inclusive). The topsoil consist of brown sandy silt which contains organic material. The topsoil has a thickness ranging from about 100 to 200 millimetres.

4.3.2 Fill Material

Fill material was encountered below the surficial topsoil at all hand augerhole locations. The fill material is variable across the site but can generally be described as brown gravelly sand with some silt and clay and brown silty sand with trace to some amounts of gravel and clay. All hand augerholes were terminated within the fill material at depths ranging from about 0.6 to 1.0 metres below existing grade due to hand auger refusal in gravel and/or on inferred cobbles.

The results of grain size distribution testing carried out on sample of the fill material are provided on the Soils Grading Chart in Appendix B and summarized in Table 4.3.

Table 4.3 – Summary of Grain Size Distribution Testing (Fill Material)

Borehole	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
20-7	2	0.15 – 0.9	30	47	12	11

The moisture content testing on a sample of the fill material indicates a moisture content of 16 percent.

4.4 Groundwater

A standpipe piezometer was installed and sealed in the bedrock in borehole 20-3. The groundwater level in the standpipe was about 3.8 metres below existing grade (elevation 73.0 metres, geodetic) on October 26, 2020.

It should be noted that the groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.5 Soil Chemistry Relating to Corrosion

The results of chemical testing of a groundwater sample from the standpipe piezometer installed in borehole 20-3 are provided in Appendix C and summarized in Table 4.4.

Table 4.4 – Chemical Testing of Soil Samples

BH	pH	Sulphate Content (milligrams per litre)	Chloride Content (milligrams per litre)	Resistivity (Ohm metres)	Conductivity (mircosiemens per centimetre)
20-3	7.3	1,040	7,240	0.48	20,700

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.

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 resulting from previous uses or activities of this site or adjacent properties, and/or resulting from the introduction onto the site from materials from off-site sources are outside the terms of reference for this report.

5.2 Proposed Building Addition

5.2.1 Overburden Excavation

Based on the boreholes advanced in the vicinity of the proposed building addition, the overburden excavations will be carried out mostly through topsoil, existing pavement structure and fill material. The sides of the excavation 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.

In the event that a granular pad is necessary below the foundations, the excavations should be sized to accommodate a pad of imported granular material which extends at least 0.5 metres horizontally beyond the edge of the footings and down and out from this point at 1 horizontal to 1 vertical, or flatter.

5.2.2 Bedrock Excavation

At the time of preparation of this report, the underside of footing level was not known; however, bedrock was encountered at depths ranging from about 1.6 to 3.1 metres below existing grade (elevations 74.5 to 75.4 metres, geodetic; therefore, bedrock excavation may be required for the proposed building addition.

The highly weathered shale bedrock at this site should be able to be removed using large hydraulic excavating equipment. Further bedrock removal at this site, if required, 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, however, to protect workers, the sides of the excavation should be scaled to remove all loose rock material.

In order to reduce over break and/or under break of the bedrock in areas where the excavation will be carried out next to an existing site service and along the perimeter of the excavation, it is suggested that the limit of excavation be defined by line drilling on close centres. 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.

The vibration effects of hoe ramming are usually minor and localized. Monitoring of the hoe ramming could 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 Vibration Monitoring section of this report.

It is noted that the bedrock contains near vertical joints and bedding planes. Therefore, some vertical and horizontal over break of the bedrock should be expected. The bedrock below founding level will likely break at a horizontal bedding plane below the design depth of the footings, which may necessitate thickening of the footings and/or lowering of the footings.

As indicated above, the potential exists for Billings formation shale at this site, which is susceptible to expansion when exposed to oxygen. **To avoid possible heaving of the shale bedrock in the short and long term, the surface of any exposed bedrock should be covered with a 50 to 75 millimetre thick layer of 30 MPa sulphate resistance concrete immediately after excavation. The depth of excavation should be considered in order to accommodate this concrete layer below the underside of footing elevation.**

5.2.3 Excavation Adjacent to Existing Building

To reduce the potential for undermining of the foundations for the existing building, the excavations should not encroach within the zone extending downwards and outwards from the existing foundation at an inclination of 1 vertical to 1 horizontal. We recommended that the foundation conditions for the existing building be obtained to confirm the excavation requirements.

Additional comments could be provided once the relative elevations of the existing and proposed underside of foundations are known. From a geotechnical perspective, it is suggested that the foundations for the proposed addition match those for the existing building, if feasible.

5.2.4 Groundwater Management

The groundwater level on October 26, 2020, was at about 3.8 metres below existing grade (elevation 73.0 metres, geodetic). The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation. As such, some groundwater pumping may be required at the time of the construction of the footings, if the underside of footing elevation is below the groundwater level.

Groundwater inflow from the overburden or bedrock excavation should be controlled by pumping from filtered sumps within the excavations to a suitable outlet. It is not expected that short term pumping during excavation will have a significant effect on nearby structures and services.

Based on the measured groundwater levels and anticipated excavation depths (i.e., about 2 to 3 metres), it is not expected that a water taking permit (e.g., EASR or PTTW) from the The Ministry of the Environment, Conservation and Parks will be required. This can be confirmed once the excavation depths are finalized.

5.2.5 Foundations

As previously indicated, we recommend that the foundation conditions for the existing building be obtained. This information can be used to identify suitable founding depths for the proposed addition. The proposed foundations should not encroach within the zone extending downwards and outwards from the existing building foundations at an inclination of 1 vertical to 1 horizontal.

Based on the results of the investigation, the proposed addition could be founded on/within bedrock, or on a pad of engineered fill above bedrock. All fill material should be removed below the proposed foundations and floor slabs.

In areas where subexcavation of disturbed material or fill is required below proposed founding level, the grade could be raised with compacted granular material (engineered fill). The engineered fill should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type II and should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. To provide adequate spread of load beneath the footings, the engineered fill should extend horizontally at least 0.5 metres beyond the footings and then down and out from this point at 1 horizontal to 1 vertical, or flatter. The excavations for the foundation should be sized to accommodate this fill placement.

The spread footing foundations should be sized using the bearing pressures provided in Table 5.1.

Table 5.1 – Foundation Bearing Pressures

Subgrade Material	Geotechnical Reaction at Servicability Limit State (kilopascals)	Factored Geotechnical Resistance at Ultimate Limit State (kilopascals)
Weathered shale bedrock or a pad of engineered fill above shale bedrock	150[1,2]	250

Notes:

1. Provided that the subgrade surface and engineered fill are prepared as described in this report, the post construction total and differential settlement of the footings at SLS should be less than 25 and 20 millimetres, respectively.

2. The above bearing pressure assumes that all soil, and disturbed or loosened bedrock is removed from the bearing surface. Allowance should be made in the contract for concrete fill below the foundations due to vertical overbreak of the bedrock and the concrete layer to protect exposed bedrock from drying/expansion.

5.2.6 Frost Protection of 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.

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

5.2.7 Basement 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 fill 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.

In accordance with the Ontario Building Code, the following alternatives could be considered for drainage of the basement foundation walls:

- Damp proof the exterior of the foundation walls and backfill the walls with free draining, non-frost susceptible sand or sand and gravel such as that meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type I or II. OR

- Damp proof the exterior of the foundation walls and install an approved proprietary drainage material on the exterior of the foundation walls and backfill the walls with native material or imported soil.

A perforated plastic foundation drain with a surround of clear crushed stone should be installed on the exterior of the foundation walls in areas of the building which contain a basement level. The drain should be installed below the level of the basement slab and should outlet by gravity to a storm sewer or a sump from which the water is pumped. To avoid loss of sand backfill into the voids in the clear stone (and possible post construction settlement of the ground around the building), a nonwoven geotextile should be placed between the clear stone and any sand backfill material.

Foundation walls that are backfilled with a 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:

- $P_o = K_o (\gamma H + q)$

Where,

- P_o = At rest earth pressure at the bottom of the foundation wall (kilopascals)
- K_o = At rest earth pressure coefficient (0.50)
- γ = Unit weight of backfill material (22 kilonewtons per cubic metre)
- H = Height of foundation wall (metres)
- q = Uniform surcharge at ground surface behind the wall to take into account traffic, equipment, or stockpiled soil (typically 10 kilopascals)

Where conditions dictate, allowance should be made in the structural design of the foundation walls for loads due to ground supported vehicles/equipment. For example, the horizontal active load due to a uniform, vertical live load adjacent to the foundation wall could be determined using a horizontal earth pressure coefficient, K_o, of 0.50, times the vertical live load. The effects of other vertical loads (point loads, line loads, compaction loads, etc.) adjacent to or near the foundation walls could be provided, if required.

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.

5.2.8 Seismic Site Class and Liquefaction Potential

Based on the results of the Multi-channel Analysis of Surface Waves (MASW) testing and according to Table 4.1.8.4.A of the Ontario Building Code, 2012, Site Class B could be used for the seismic design of the structure. The results of the MASW investigation are provided in Appendix D.

In our opinion the soils at this site are not considered to be liquefiable or collapsible under seismic loads.

5.2.9 Basement Slab Support (Heated Areas Only)

To provide predictable settlement performance of the basement slab, all fill and debris should be removed from the slab area. The base for the floor slab should consist of at least 200 millimetres of OPSS Granular A or 19 millimetre clear crushed stone.

City of Ottawa documents allow recycled asphaltic concrete and concrete to be used in Granular A and Granular B Type II materials. Since the source of recycled material cannot be determined, it is suggested that any granular materials used beneath the floor slab be composed of virgin material (100 percent crushed rock) only, for environmental reasons.

OPSS Granular A material 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. Clear, crushed stone should be nominally compacted in maximum 300 millimetre thick lifts with 3 passes of vibratory compaction equipment.

If well graded granular material (such as OPSS Granular A) is used, rather than clear crushed stone below the basement floor slab, we suggest that drainage be provided by means of perforated plastic pipes spaced at about 6 metres horizontally or as required to link any hydraulically isolated areas to the perimeter drain or sump area. For clear crushed stone, perforated plastic pipes should be used to link any hydraulically isolated areas in the basement. The drains should outlet to a sump or gravity sewer.

If any areas of the building are to remain unheated during the winter period, thermal protection of the slab on grade may be required. Further details on the insulation requirements could be provided, if necessary.

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. The sulphate content of any imported granular material placed below the floor slab should be assessed to determine the appropriate exposure class for the concrete.

5.3 Access Roadway/Parking Areas

5.3.1 Subgrade Preparation

It is understood that a new access road and parking areas are to be constructed. In preparation for the construction of the access roadway and parking areas at this site, all surficial topsoil should be removed. It is not considered necessary to remove all the earth fill material from below the proposed parking area, provided that any soft, wet or deleterious material is subexcavated and replaced.

Prior to placing granular material for the access road and parking areas, the exposed earth fill should be proof rolled with a vibratory roller (8 to 10 tonne) under the supervision of the geotechnical engineer. Care should be taken in the vicinity of the existing building to reduce potential for damage to the existing structure. Any soft areas should be subexcavated and replaced with suitable (dry) earth borrow that is frost compatible with the materials exposed on the sides of the area of subexcavation.

Similarly, should it be necessary to raise the parking area grade at this site, material which meets OPSS specifications for select subgrade material or earth borrow. The Billings shale bedrock should not be used as grade raise fill below parking areas or roadways due to the potential for disintegration of the material when allowed to dry.

The elect subgrade material or earth borrow should be placed in maximum 300 millimetre thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using vibratory compaction equipment.

Truck traffic should be avoided on the loading area pavement subgrade surface.

5.3.2 Pavement Structure

For the parking areas, the following minimum pavement structure is suggested:

- 60 millimetres of hot mix asphaltic concrete HL3 Fine paced in one (1) 60 millimetre layer, over;
- 150 millimetres of OPSS Granular A base over;
- 450 millimetres of OPSS Granular B, Type II subbase

For the access roadway, the following minimum pavement structure is suggested:

- 90 millimetres of hot mix asphaltic concrete (40 millimetres of Superpave 12.5, over 50 millimetres of Superpave 12.5, over;
- 150 millimetres of OPSS Granular A base over;
- 450 millimetres of OPSS Granular B, Type II subbase

The above pavement structures assume that the 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 parking lot subgrade surface and the granular subbase material, or a combination of both, to prevent pumping and disturbance to the subbase material. The contractor should be made responsible for their construction access.

5.3.3 Asphalt Cement Type

Performance grade PG 58-34 asphalt cement should be specified.

5.3.4 Pavement Transitions

As part of the new access roadway and parking area construction, the new pavement may abut the existing pavement at Smyth Road. 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) 40 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.

5.3.5 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 catch basins or ditches to promote drainage of the pavement granular materials.

Any catch basins should be equipped with minimum 3 metre long stub drains extending in two directions at the subgrade level.

5.3.6 Granular Material Compaction

The granular base and subbase materials should be compacted in maximum 300 millimetre thick lifts to at least 99 percent of the standard Proctor maximum dry density value.

5.4 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in the groundwater sample from borehole 20-93 is 1,040 milligrams per litre. According to Canadian Standards Association (CSA) 'Concrete Materials and Methods of Concrete Construction', the concentration of sulphate of the groundwater can be classified as moderate. For this value, any concrete that will be in contact with the groundwater could be batched with moderate sulphate-resistant (MS) cement. The design of any concrete should take into consideration freeze thaw effects and the presence of chlorides or other de-icing chemicals.

Based on the conductivity and pH of the groundwater sample, the groundwater can be classified as very aggressive towards unprotected steel. It is noted that the corrosivity of the groundwater could vary throughout the year due to the application of sodium chloride for de-icing.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Site Servicing

For the purposes of this report, we have assumed that the proposed addition will be serviced by connecting to existing services within the main building. If required, geotechnical recommendations and guidelines could be provided as the design progresses for the installation of any new services. Excavation for the any site services should be carried out as described in Sections 5.1.1 and 5.1.2.

6.2 Winter Construction

Provision must be made during construction to prevent freezing of any soil or any frost susceptible bedrock below the level of any existing structures or services. Freezing of the soil or bedrock could result in heaving related damage to structures or services.

6.3 Effects of Construction Induced Vibration

Some of the construction operations (such as excavation, hoe ramming, 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. Assuming that any excavating is carried out in accordance with the guidelines in this report, the magnitude of the vibrations will be much less than that required to cause damage to the nearby structures or services in good condition, but may be felt at the nearby structures. We recommend that preconstruction surveys be carried out on the adjacent structures so that any damage claims can be addressed in a fair manner and that that vibration monitoring be carried out to measure the vibrations during any bedrock excavation to check that they are below the acceptable threshold value of 50 millimetres per second.

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 sources of contamination, are outside the terms of reference for this report.

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.

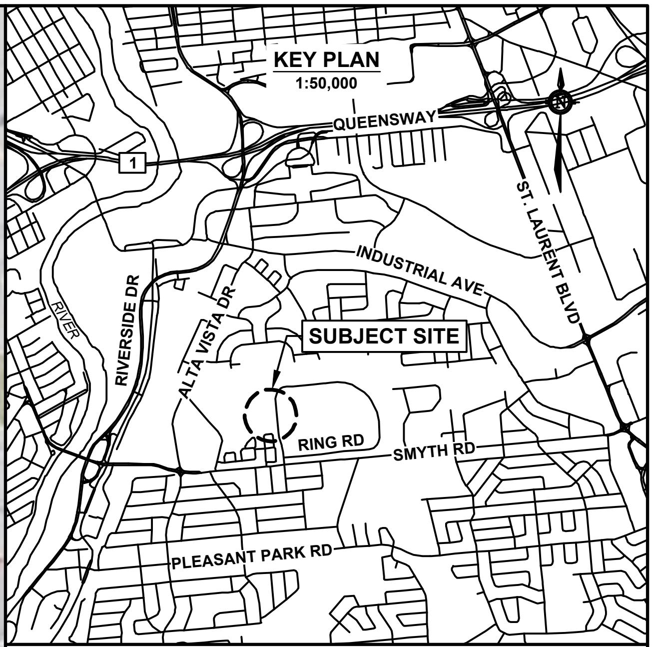
The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed excavations do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. The subgrade surfaces for the addition and parking areas/access roadway 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.

We trust this report is sufficient for your purposes. If you have any questions or require additional information, please contact the undersigned.

p.p. Greg Davidson, P.Eng.

Brent Wiebe, P.Eng.
Senior Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
B.D. WIEBE
100060438
24 Nov 2022
PROVINCE OF ONTARIO



LEGEND

⌖ **BOREHOLE LOCATION IN PLAN**
(current investigation by GEMTEC)

BH # ← BH 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
INTEGRATED DESIGN ENGINEERING & ARCHITECTURE INC. (IDEA)

Project
65189.01

GEOTECHNICAL INVESTIGATION
RONALD McDONALD HOUSE
407 SMYTH ROAD
OTTAWA, ONTARIO

Drwn by	Chkd by
S.L.	G.D.

Date
OCTOBER, 2020

Rev.
0

FIGURE 1

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

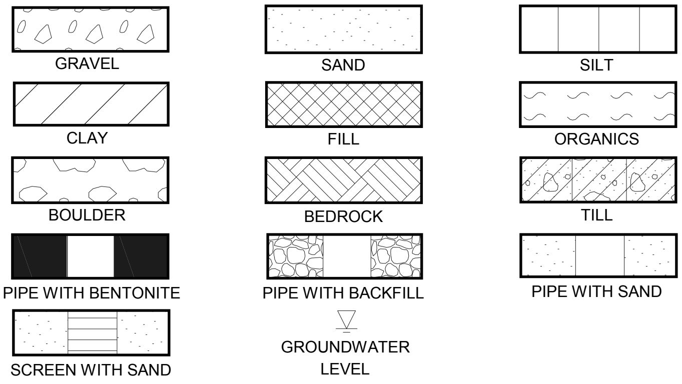
PENETRATION RESISTANCE

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.

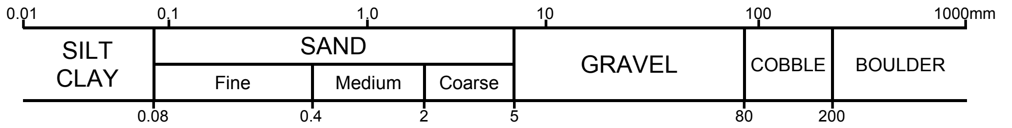
Dynamic Penetration Resistance
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive a 50 mm (2 in.) diameter 60° cone attached to 'A' size drill rods for a distance of 300 mm (12 in.).

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.

GEMTEC

descriptive terms.pub
Modified May 2018

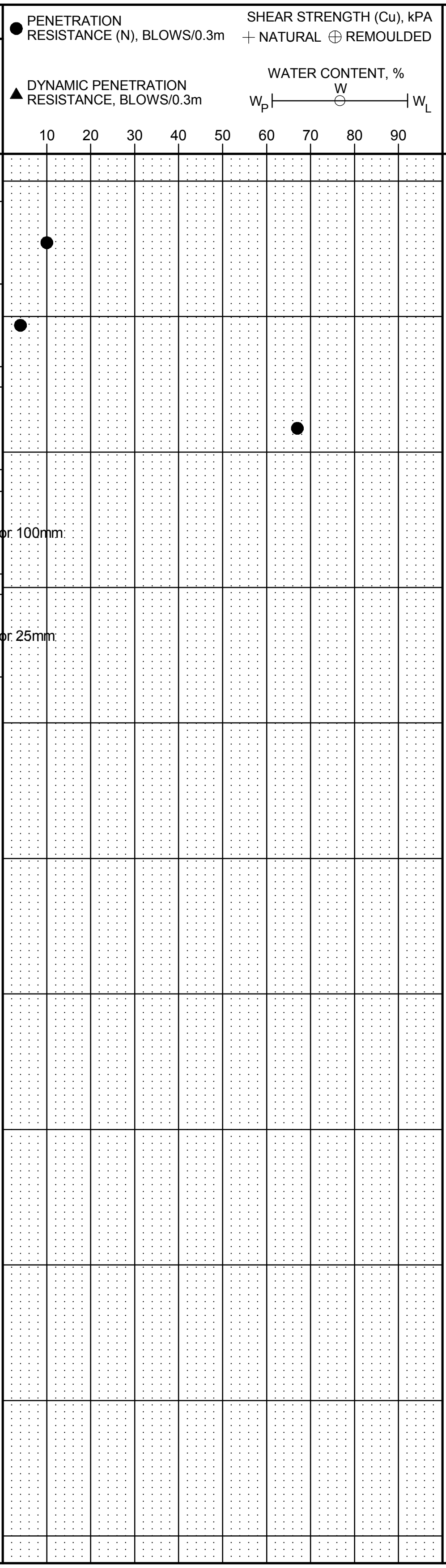
RECORD OF BOREHOLE 20-1

CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020

BORING METHOD: Power Auger – Hollow Stem Auger (210mm OD)

DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
Ground Surface		76.57						
Asphaltic Concrete		0.04						Backfilled with auger cuttings
Grey crushed sand and gravel, some silt (BASE/SUBBASE MATERIAL)		76.19 0.38						
Brown to grey brown silty clay, trace to some sand and gravel (FILL MATERIAL)		74.94 1.63	1 2	SS SS	255 355	10 4		
Grey highly weathered SHALE BEDROCK -Billings		72.91 3.66	3 4 5	SS SS SS	380 125 25	67 >50 for 100mm >50 for 25mm		
End of Borehole								



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

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LOGGED: G.D.
CHECKED: B.W.

RECORD OF BOREHOLE 20-2

CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020

BORING METHOD: Power Auger, Hollow Stem Auger (210mm OD)

● 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

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
Ground Surface	77.30						
Asphaltic Concrete	0.04						Backfilled with auger cuttings
Grey crushed sand and gravel, some silt (BASE/SUBBASE MATERIAL)		1	SS	255	27	M	
Brown to grey brown silty clay, trace to some sand and gravel (FILL MATERIAL)	76.33 0.97	2	SS	280	17		
		3	SS	380	17		
		4	SS	255	33		
Grey highly weathered SHALE BEDROCK -Billings	74.46 2.84	5	SS	25	>50 for 50mm		
End of Borehole	73.64 3.66						

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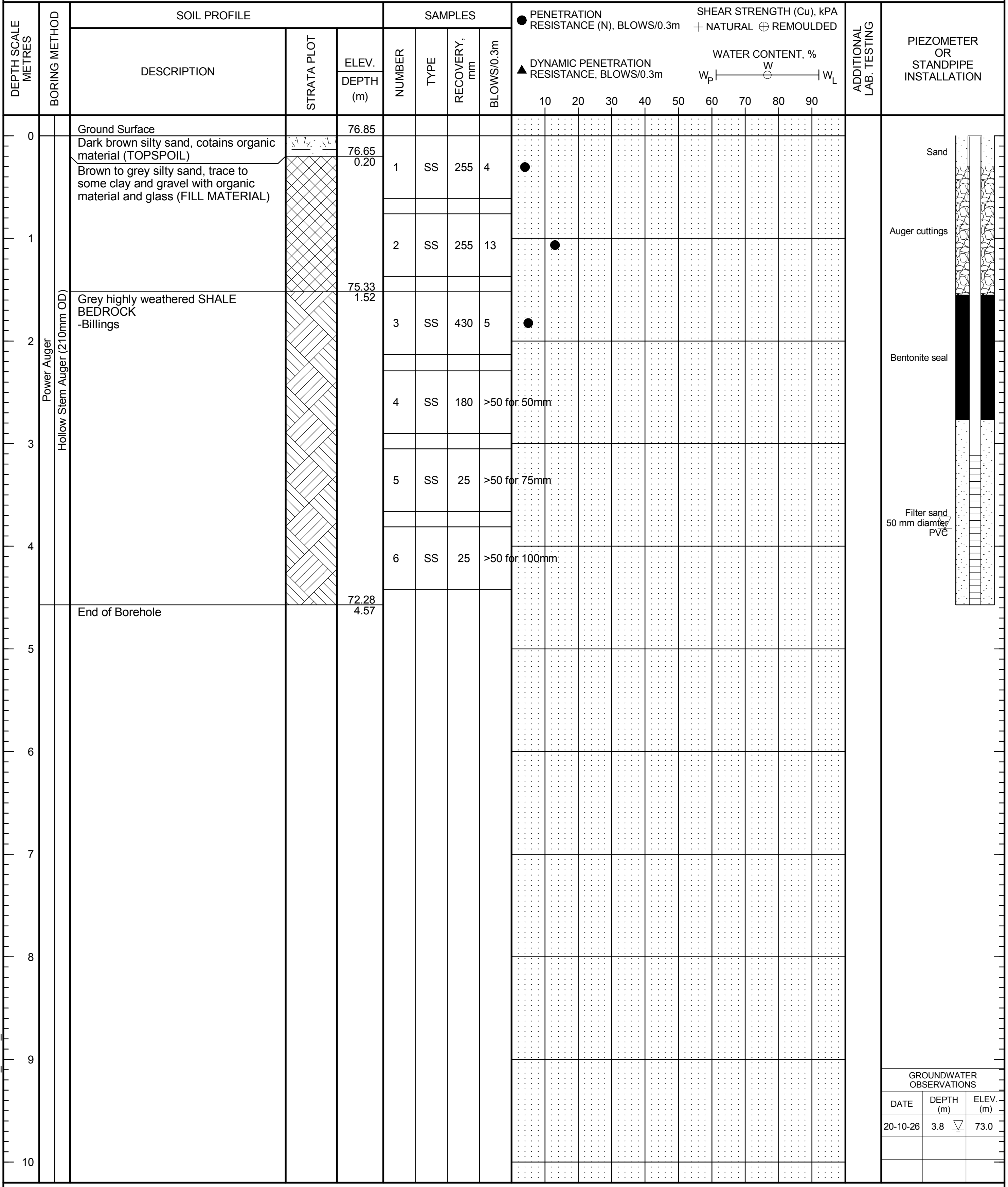
Consulting Engineers and Scientists

LOGGED: G.D.
CHECKED: B.W.

RECORD OF BOREHOLE 20-3

CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020



DESCRIPTION	ELEV. / DEPTH (m)
Ground Surface	76.85
Dark brown silty sand, cotains organic material (TOPSPOIL)	76.65 0.20
Brown to grey silty sand, trace to some clay and gravel with organic material and glass (FILL MATERIAL)	75.33 1.52
Grey highly weathered SHALE BEDROCK -Billings	72.28 4.57
End of Borehole	

NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
1	SS	255	4
2	SS	255	13
3	SS	430	5
4	SS	180	>50 for 50mm
5	SS	25	>50 for 75mm
6	SS	25	>50 for 100mm

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20-10-26	3.8 ▽	73.0

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LOGGED: G.D.
CHECKED: B.W.

RECORD OF BOREHOLE 20-4

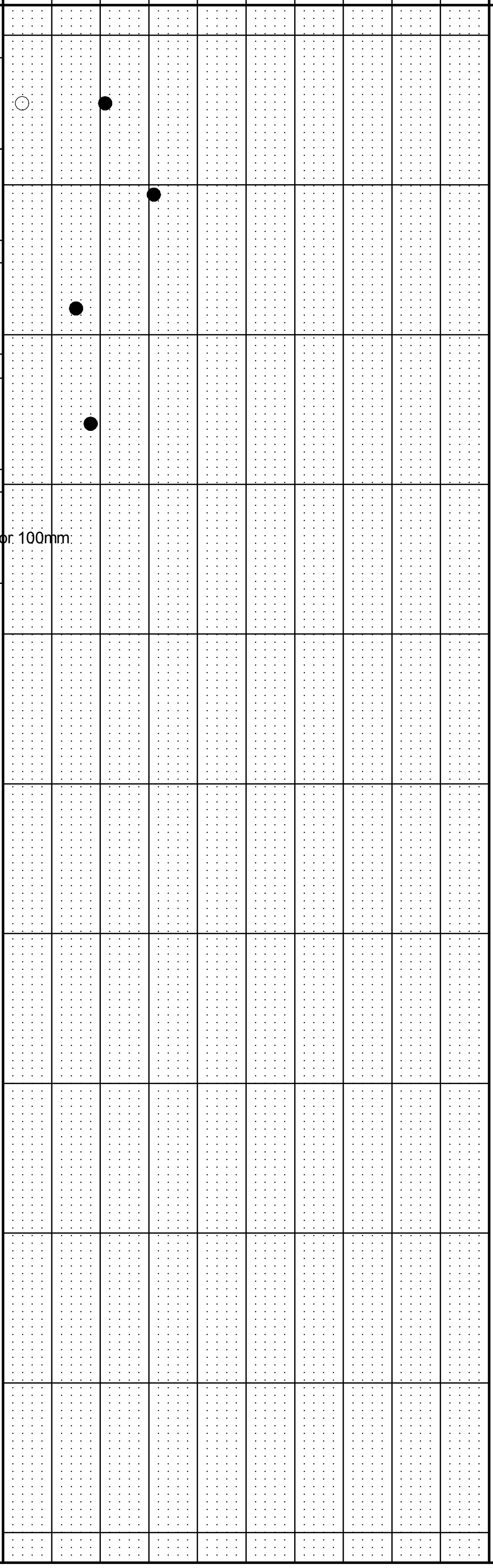
CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020

BORING METHOD: Power Auger, Hollow Stem Auger (210mm OD)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
Ground Surface	77.48						
Asphaltic Concrete	0.04						Backfilled with auger cuttings
Grey crushed sand and gravel, some silt (BASE/SUBBASE MATERIAL)	76.72 0.76	1	SS	205	21	M	
Brown to grey brown silty clay, trace to some sand and gravel (FILL MATERIAL)		2	SS	50	31		
		3	SS	255	15		
	74.43 3.05	4	SS	305	18		
Grey highly weathered SHALE BEDROCK -Billings	73.82 3.66	5	SS	25	>50 for 100mm		
End of Borehole							

● 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



DEPTH SCALE METRES: 0 – 10

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CHECKED: B.W.

GEO - BOREHOLE LOG 65189.01_GINT_2020-10-20.GPJ GEMTEC 2018.GDT 10-31-20

RECORD OF BOREHOLE 20-5

CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES				PENETRATION RESISTANCE (N), BLOWS/0.3m ● SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED ▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m WATER CONTENT, % W_P W W_L 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m			
0	Hand Auger	Ground Surface		76.09							
		Brown sandy silt, contains oragnic material (TOPSOIL)		75.89 0.20	1	GS					
		Brown silty sand, trace to some clay and gravel (FILL MATERIAL)		75.14 0.95	2	AS					Backfilled with auger cuttings
1		End of Borehole									
2											
3											
4											
5											
6											
7											
8											
9											
10											

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CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: G.D.

CHECKED: B.W.

RECORD OF BOREHOLE 20-6

CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020

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

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		76.53						
0	Hand Auger	Brown sandy silt, contains oragnic material (TOPSOIL)		76.43 0.10	1	GS				Backfilled with auger cuttings
		Brown silty sand, trace to some clay and gravel (FILL MATERIAL)		75.93 0.60	2	AS				
		End of Borehole								
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

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Consulting Engineers and Scientists

LOGGED: G.D.
CHECKED: B.W.

RECORD OF BOREHOLE 20-7

CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020

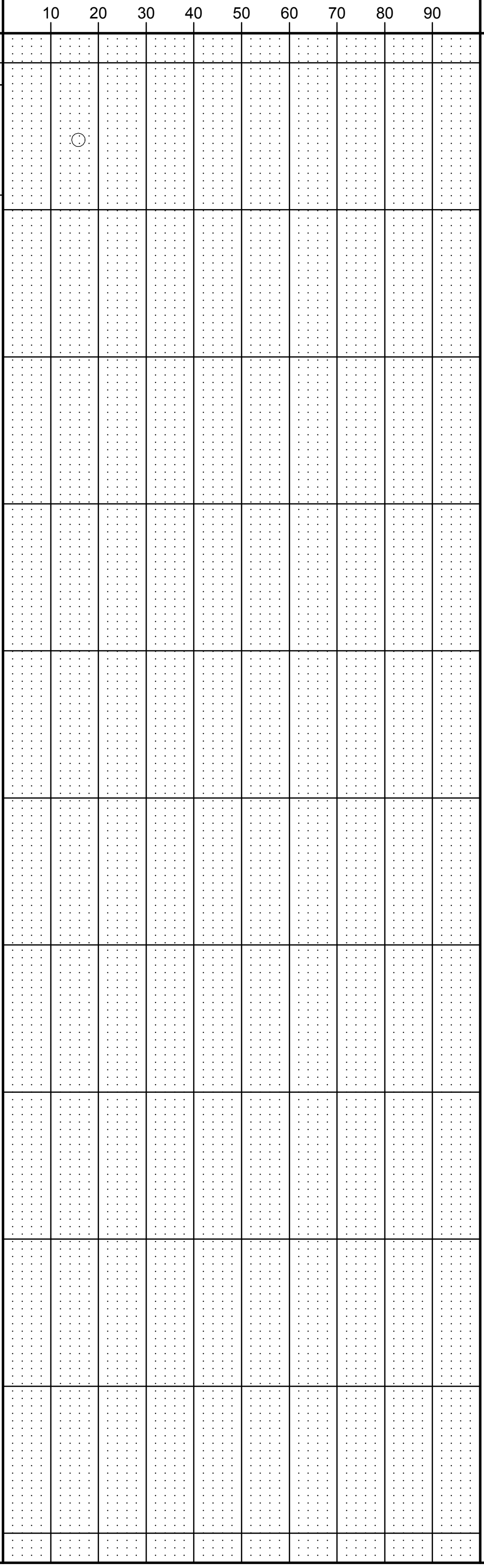
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, mm	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		77.54						
	Hand Auger	Brown sandy silt, contains oragnic material (TOPSOIL)		77.39 0.15	1	GS				
		Brown gravelly sand, some silt and clay (FILL MATERIAL)		76.64 0.90	2	AS			MH	Backfilled with auger cuttings
1		End of Borehole								
2										
3										
4										
5										
6										
7										
8										
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



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CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: G.D.
CHECKED: B.W.

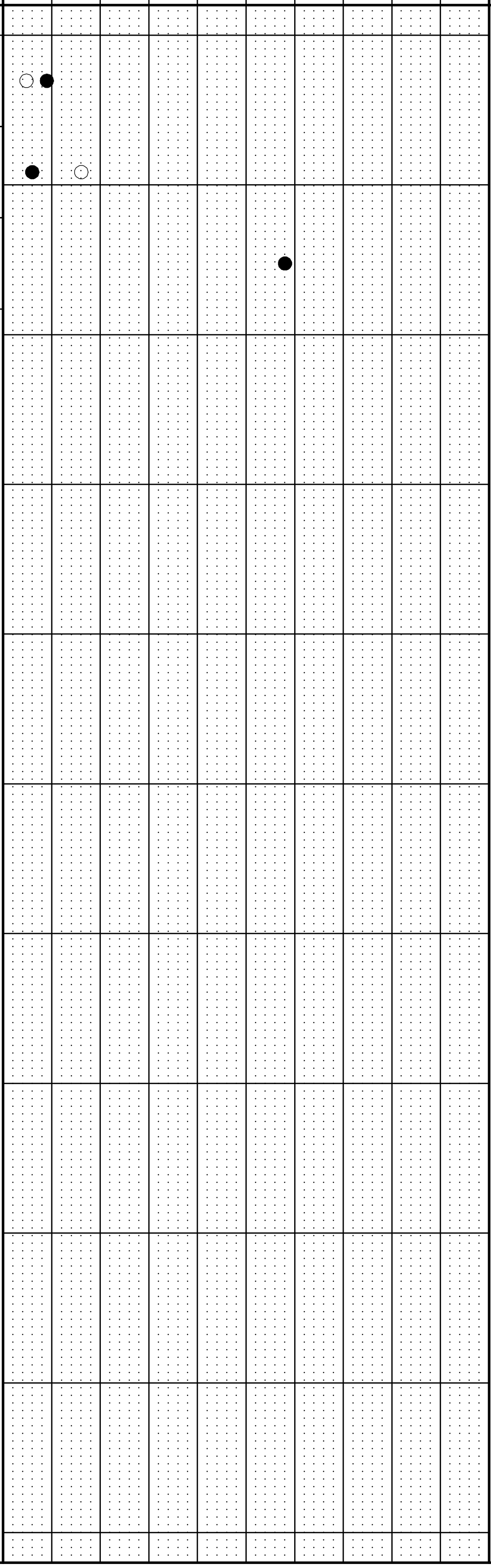
RECORD OF BOREHOLE 20-8

CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020

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		Ground Surface	77.08						
	Power Auger Hollow Stem Auger (210mm OD)	Dark brown sandy silt, contains organic material (TOPSOIL)	76.95 0.13						Backfilled with auger cuttings
		Brown gravelly sand, some silt (FILL MATERIAL)		1	SS	255	9	M	
		Brown silty clayey sand, trace gravel (FILL MATERIAL)	76.47 0.61	2	SS	230	6	MH	
1				3	SS	205	58		
		Grey highly weathered SHALE BEDROCK -Billings	75.35 1.73 1.83						
2		End of Borehole							
3									
4									
5									
6									
7									
8									
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



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CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: G.D.
CHECKED: B.W.

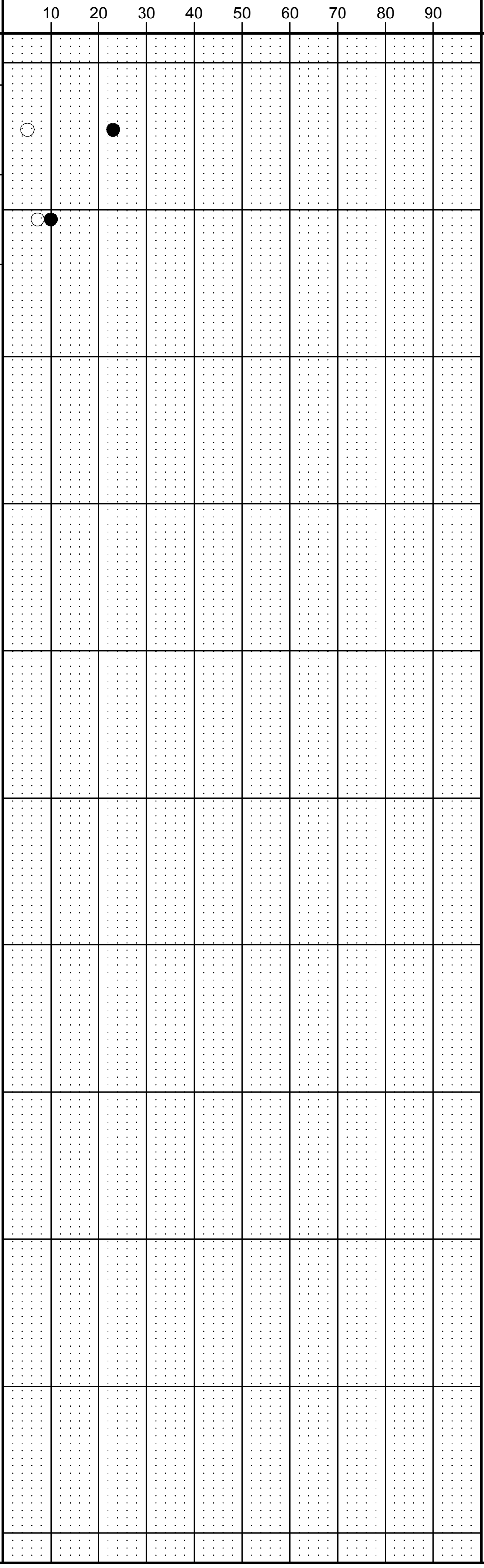
RECORD OF BOREHOLE 20-9

CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	Ground Surface	77.10						
Power Auger Hollow Stem Auger (210mm OD)	Asphaltic Concrete	0.04						Backfilled with auger cuttings
	Brown crushed sand and gravel, some silt (BASE/SUBBASE)	76.82 0.28						
	Brown silty sand, trace to some clay and gravel (FILL MATERIAL)	75.58 1.52	1	SS	305	23	M	
			2	SS	305	10	MH	
	End of Borehole							

● 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



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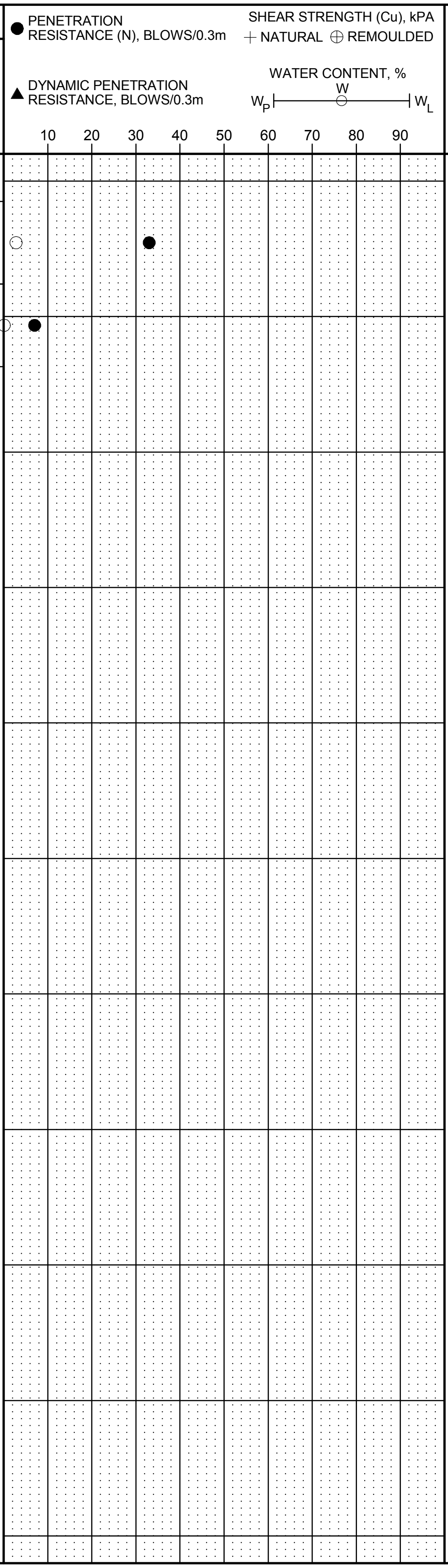
LOGGED: G.D.
CHECKED: B.W.

RECORD OF BOREHOLE 20-10

CLIENT: Integrated Design Engineering + Architecture Inc. (IDEA)
PROJECT: Proposed Buiuldin Addition - 407 Smyth Road
JOB#: 65189.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Oct 13 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Hollow Stem Auger (210mm OD)	Ground Surface		77.40						
		Asphaltic Concrete		0.04						Backfilled with auger cuttings
		Brown crushed sand and gravel, some silt (BASE/SUBBASE)		76.43 0.97	1	SS	305	33	M	
1		Brown, fine to coarse grained sand, some gravel, silt and clay (FILL MATERIAL)		75.88 1.52	2	SS	255	7	MH	
		End of Borehole								
2										
3										
4										
5										
6										
7										
8										
9										
10										

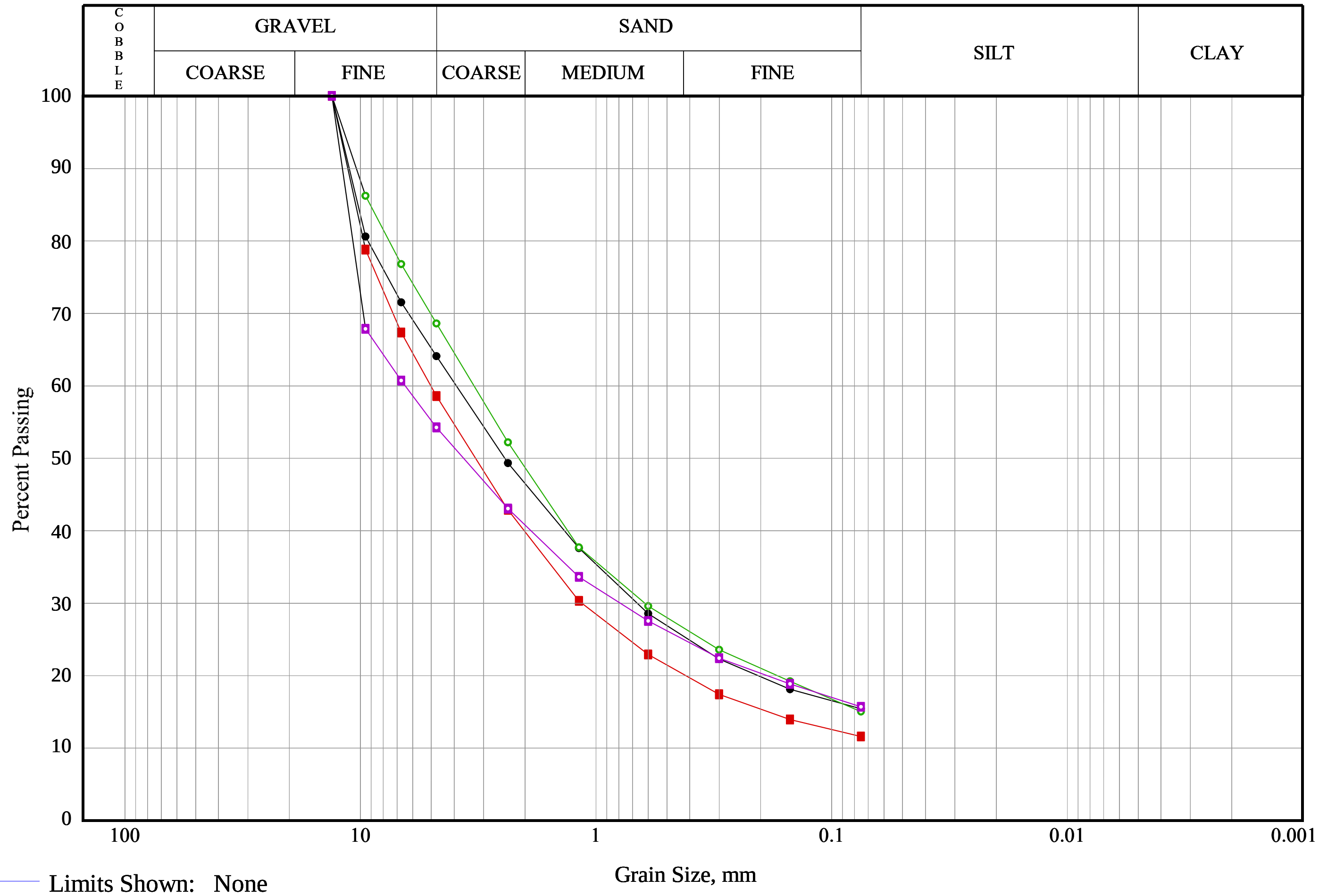


LOGGED: G.D.
CHECKED: B.W.

APPENDIX B

Laboratory Testing
Soils Grading Chart

GEMTEC Consulting Engineers and Scientists	Client:	Integrated Design Engineering + Architecture Inc. (IDEA)	Soils Grading Chart
	Project:	Geotechnical Study, Ronald McDonald House	
	Project #:	65189.01	



Limits Shown: None

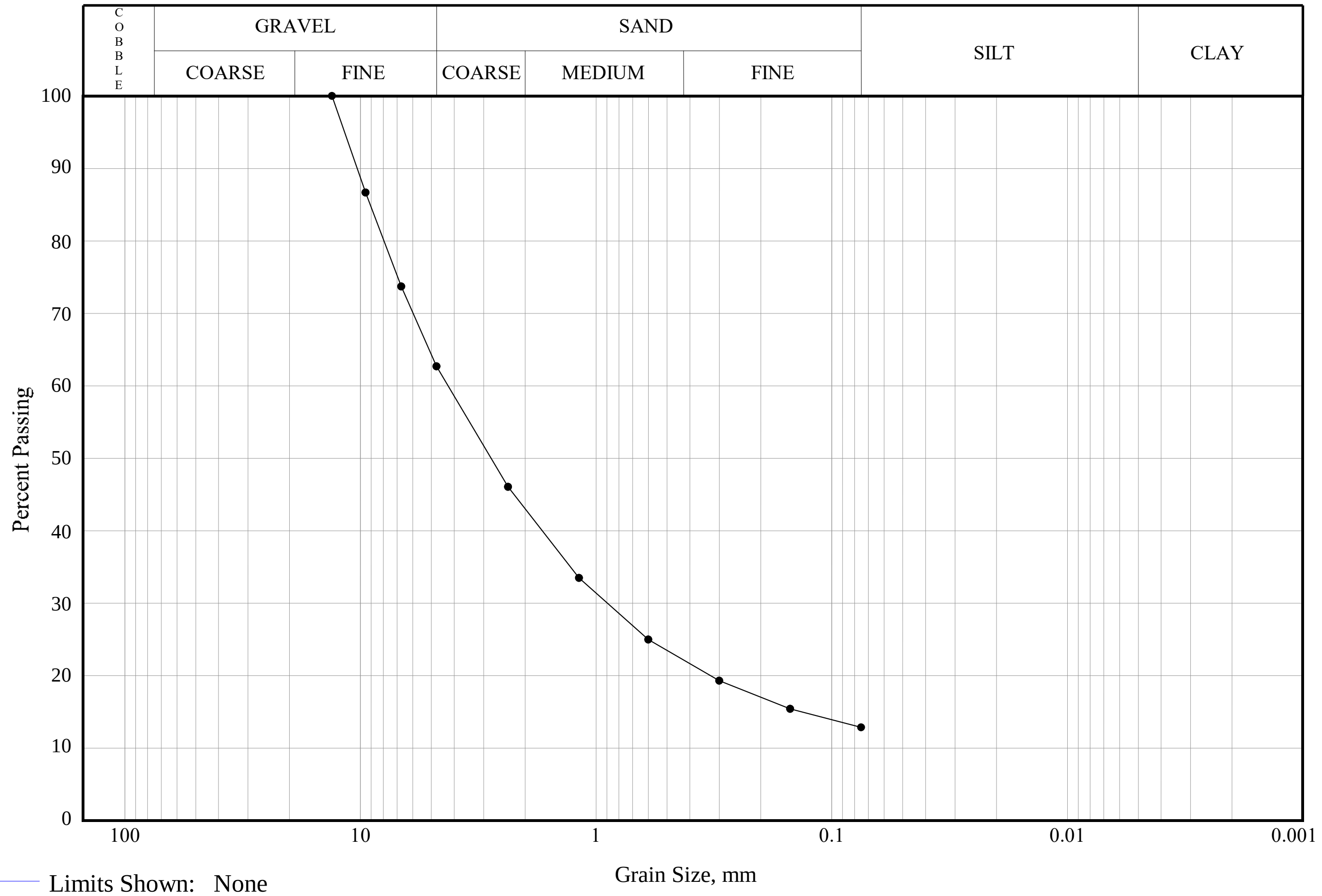
Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
—●—	Base/Subbase	20-02	SA 1	0.15-0.76	35.9	48.7	15.4	
—■—	Base/Subbase	20-04	SA 1	0.15-0.76	41.4	47.0	11.6	
—○—	Fill Material	20-08	SA 1	0-0.61	31.4	53.6	15.0	
—□—	Base/Subbase	20-09	SA 1	0.15-0.76	45.8	38.6	15.7	

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
—●—	Sand and gravel , some silt	N/A	---	---	0.67	2.44	3.92	10.24	---
—■—	Sand and gravel , some silt	N/A	---	0.19	1.15	3.24	5.02	10.46	---
—○—	Gravelly sand , some silt	N/A	---	---	0.62	2.13	3.29	9.08	---
—□—	Gravel and sand , some silt	N/A	---	---	0.79	3.65	6.45	11.32	---

GEMTEC
Consulting Engineers and Scientists

Client: Integrated Design Engineering + Architecture Inc. (IDEA
Project: Geotechnical Study, Ronald McDonald House, 407 Smyt
Project #: 6518901

Soils Grading Chart



Limits Shown: None

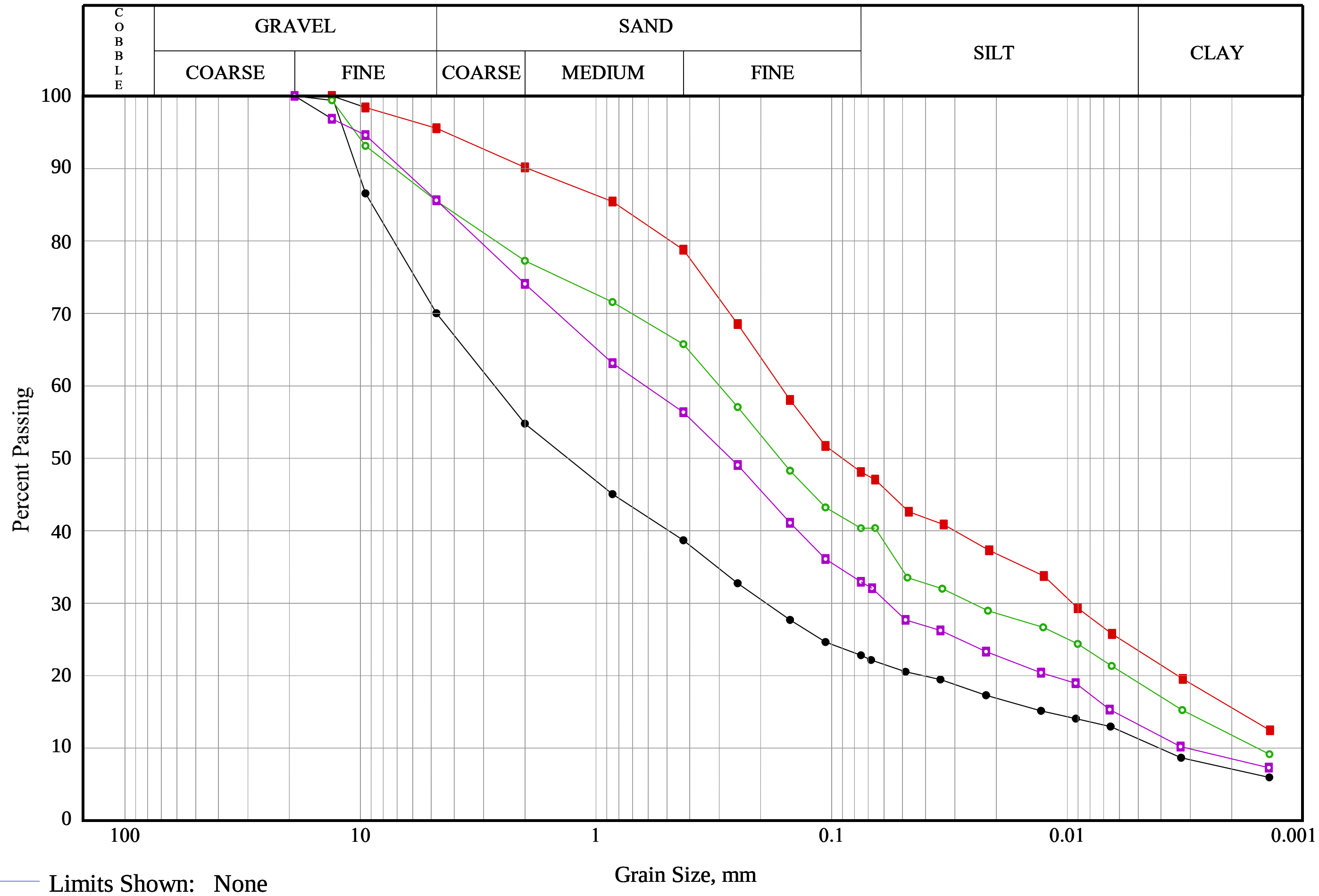
Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
—●—	Base/Subbase	20-10	SA 1	0.15-0.76	37.3	49.8	12.8	

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
—●—	Sand and gravel , some silt	N/A	---	0.13	0.90	2.79	4.24	9.08	---

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

Client: Integrated Design Engineering + Architecture Inc. (IDEA)
Project: Geotechnical Study, Ronald McDonald House
Project #: 65189.01

Soils Grading Chart



Limits Shown: None

Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
●	Fill Material	20-07	SA 2	0.15-0.9	30.0	47.2	11.5	11.3
■	Fill Material	20-08	SA 2	0.61-1.22	4.5	47.4	24.6	23.5
○	Fill Material	20-09	SA 2	0.76-1.37	14.5	45.2	21.3	19.0
□	Fill Material	20-10	SA 2	0.76-1.37	14.4	52.7	19.7	13.3

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
●	Gravelly sand , some silt, some clay	N/A	0.00	0.01	0.19	1.32	2.69	8.90	11.5
■	Silty clayey sand , trace gravel	N/A	---	0.00	0.01	0.09	0.17	0.81	24.6
○	Silty sand , some gravel, some clay	N/A	0.00	0.00	0.03	0.17	0.30	4.50	21.3
□	Sand , some gravel, some silt, some clay	N/A	0.00	0.01	0.06	0.27	0.62	4.54	19.7

APPENDIX C

Groundwater Chemistry Related to Corrosion
Paracel Laboratories Ltd. Order No. 2044054

Report to: Integrated Design Engineering + Architecture Inc. (IDEA)
Project: 65189.01 (November 24, 2022)

Certificate of Analysis

Report Date: 30-Oct-2020

Client: GEMTEC Consulting Engineers and Scientists Limited

Order Date: 26-Oct-2020

Client PO: 65189.01

Project Description: 65189.01

	Client ID:	BH-20-3	-	-	-
	Sample Date:	26-Oct-20 09:00	-	-	-
	Sample ID:	2044054-01	-	-	-
	MDL/Units	Water	-	-	-
General Inorganics					
Conductivity	5 uS/cm	20700	-	-	-
pH	0.1 pH Units	7.3	-	-	-
Resistivity	0.01 Ohm.m	0.48	-	-	-
Anions					
Chloride	1 mg/L	7240	-	-	-
Sulphate	1 mg/L	1040	-	-	-

APPENDIX D

Multi-channel Analysis of Surface Waves (MASW) Letter

GEMTEC
CONSULTING ENGINEERS
AND SCIENTISTS

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www.gemtec.ca

November 2, 2022 File: 65189.01 R1

Integrated Design Engineering + Architecture (IDEA)
595 Byron Avenue
Ottawa, Ontario
K2A 4C4

Attention: Leah Guerra

Re: Multi-channel Analysis of Surface Waves (MASW) Investigation
Ronald McDonald House
407 Smyth Road, Ottawa, Ontario

INTRODUCTION

A Multi-channel Analysis of Surface Waves (MASW) investigation was carried out for the geotechnical study being performed for the Ronald McDonald House at 407 Smyth Road, Ottawa, Ontario.

The fieldwork for the investigation was completed on October 18, 2022 by GEMTEC Consulting Engineers and Scientists Limited (GEMTEC), to supplement the overall geotechnical investigation for the development. At the time of the investigation the general air temperature was about 10 degrees Celsius, and the ground surface was moist and bare. Weather conditions were clear.

MASW fieldwork resulted in the completion of one MASW survey line for characterizing and assessing the shear wave velocities in the soil units and for providing time-averaged shear wave velocities for the upper 30 metres of the site (V_{s30}). Typically, these V_{s30} results are used in conjunction with the 2015 National Building Code of Canada (2015 NBC) to provide a Seismic Site Class designation for structural design considerations.

The location and orientation of the MASW survey line is presented on the MASW Survey Location Plan, Figure 1 (attached following the text of this document).

Survey methodology, procedures, data processing, and results are described in the following sections.

BASIC PRINCIPLES OF MASW SURVEYING

Unlike typical intrusive investigations, the MASW method characterizes the dispersive nature of Rayleigh-type surface waves to evaluate material properties in the near subsurface, as shown illustratively in Figure 2 (attached following the text of this document). Normally, surface waves are considered to be noise in seismic reflection or refraction investigations but during MASW surveys, these waves help characterize the elastic properties of the near subsurface.

During an MASW investigation, the dispersion of the surface waves (assuming a heterogeneous medium) is related to the different phase velocities of the individual frequency components of the wave. Dispersion curves from seismic records are identified using the fundamental mode of the Rayleigh wave after plotting phase velocity versus frequency. The dispersion curve characteristics are utilized in an inversion routine to fit the data to a model using an iterative process to produce a shear wave velocity profile as a function of depth.

DATA ACQUISITION

Surveying at the site was carried out on the eastern side of the building, and the survey line was oriented approximately N-S along a grassy section of the property running parallel to a walking path. Fieldwork was completed using GEMTEC’s in-house equipment operated by GEMTEC’s geophysical investigation specialists.

The MASW surveying used a 12-channel survey layout consisting of twelve 4.5 hertz vertical geophones, a 12-channel geophone cable, a 24-channel geometrics geode, a high-impact polyethylene plate, and a 9-kilogram sledgehammer that functioned as the main seismic source (during active surveying). Geophones were firmly planted into surficial soils using soil penetrating spikes, and geophones were positioned at 3 metre intervals for an overall line length of 33 metres. During active surveying, six shot locations were occupied and included both forward and reverse shot locations at distances ranging from 3 to 15 metres from the end geophones.

Passive data records were also acquired as part of the MASW investigation to collect low frequency ambient noise to extend the depth of investigation and increase data at depth.

Tables 1 and 2, outline the parameters used during both active and passive surveying for the investigation.

Table 1 - Acquisition Parameters for Active Surveying

Acquisition Parameters	Description
Geophones	4.5 Hertz geophones (12 total)
Geophone Interval	3 metres
Survey Line Length	33 metres
Shot Records	6 shot records at 3 - 15 metres from end geophones
Source	9-kilogram sledgehammer and 30 x 30 x 7.5 centimetre impact plate
Sample Interval	0.125 milliseconds
Record Length	2 seconds
Stacking	Up to 5 stacks per shot location

Table 2 - Acquisition Parameters for Passive Surveying

Acquisition Parameters	Description
Geophones	4.5 Hertz geophones (12 total)
Geophone Interval	3 metres
Shot Records	20 shot records (no stacking)
Source	Ambient noise from cultural sources (i.e., traffic)
Sample Interval	2 milliseconds
Record Length	32 seconds

MASW DATA PROCESSING

Data Processing Procedure

MASW shot records were processed by GEMTEC using the SeisimagerSW^{TM} software package (V 6.0.2.1). Initial processing included the conversion of shot records from the time domain to the frequency domain using a Fast Fourier Transform (FFT). The converted data for each of the active and the combined passive shot records were then displayed as phase velocity vs. frequency plots to show fundamental mode dispersion curves (refer to Figure 3, attached following the text of this document). The dispersion curves were used to pick the fundamental mode for each of the active shot locations and combined passive record.

The next processing step included the compilation and smoothing of picked data into a composite record for input into an inversion routine. Inverting the data utilized a Least Squares Method (LSM) to fit the data to a model over five iterations of the inversion. The initial model for the site was constructed using ten horizontally layered units to define the soil and bedrock units at the site.

Passive Data Records – Ambient Noise

A total of twenty passive data records were collected during survey procedures, which attempt to utilize the long offset and low frequency ambient seismic noise typically generated by cultural sources (e.g., vehicular traffic, industrial activities, construction etc.) from surrounding areas. Both passive and active data records were processed individually and combined into a composite data record to generate the final V_{s30} results for each survey line.

DISCUSSION

MASW Survey Results

The results of the MASW survey are attached to this letter in Figure 4 and are displayed as a one-dimensional vertical seismic profile.

The profile also includes the estimated time-averaged shear wave velocity value (V_{s30}) for the upper 30 metres of the survey location. The MASW results for the investigation resulted in a V_{s30} value of 777 metres per second.

Based on Table 4.1.8.4.A of the 2015 NBC, V_{s30} values between 760 and 1500 metres per second result in a Site Class B classification. Table notes for the 2015 NBC should also be consulted and understood before applying these Site Classes based solely on V_{s30} results. As noted in the 2015 NBC, Site Classes A and B must have no more than 3 metres of softer materials between the rock and the underside of the footing or else the Site Class must be reduced to the average properties of the total thickness of softer materials between the footings and rock.

Discussion of Results

MASW results are indirect measurements and V_{s30} values are time-averaged shear wave velocities for the upper 30 metres of the site. When V_{s30} values are used in conjunction with Table 4.1.8.4.-A (2015 NBC) to determine a Site Class, these determinations must also consider the soil characteristics as described in Site Class E and the Notes for Table 4.1.8.4.-A (2015 NBC).

GEMTEC's opinion on the applicable seismic Site Class is based on the data obtained at the time of surveying, as indicated in this document. For best results, MASW surveying requires relatively homogenous and horizontal strata, and avoiding velocity reversals (i.e., asphalt and / or frost over overburden) across the entirety of the survey line.

In completing this investigation, the Geological Survey of Canada Open File 7078, Shear Wave Velocity Measurement Guidelines for Canadian Seismic Site Characterization in Soil and Rock (2012) was used as a guide and consulted throughout the duration of the project.

CLOSURE

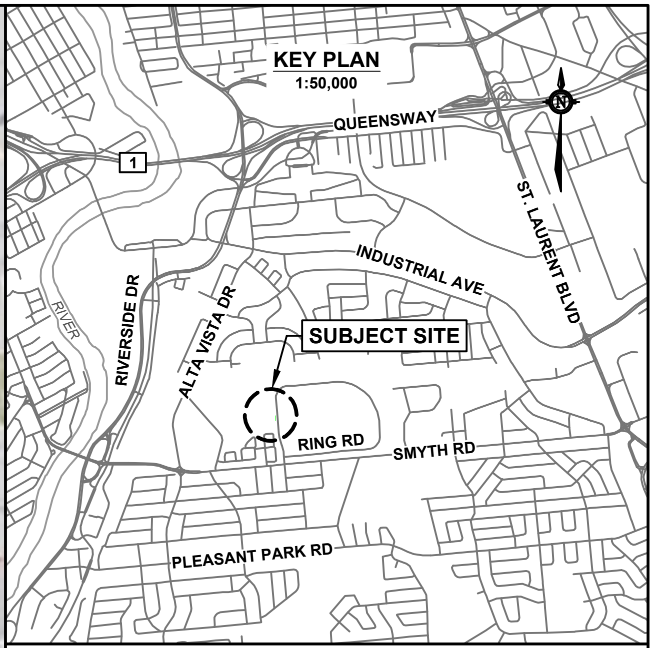
GEMTEC trust this report provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact the below.

Mike West, M.Sc., P.Geo., P.Eng. Geophysicist	William (Bill) Cavers, PMP, P.Eng. Senior Geotechnical Engineer

MW/BWW/BC

Enclosures
N:\Projects\65100\65189.01\04_Deliverables\MASW\65189.01_LET01_MASW_V01_2022-11-02.docx

ATTACHMENTS



KEY PLAN

1:50,000

LEGEND

🟩	MASW SURVEY LINE

Scale

1:500

0 10 20 30m

GEMTEC

CONSULTING ENGINEERS AND SCIENTISTS

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

Drawing

MASW SURVEY LOCATION

Client

INTEGRATED DESIGN ENGINEERING & ARCHITECTURE INC. (IDEA)

Project

65189.01

GEOTECHNICAL INVESTIGATION
RONALD McDONALD HOUSE
407 SMYTH ROAD
OTTAWA, ONTARIO

Drwn by

S.L.

Chkd by

B.W.

Date

NOVEMBER, 2022

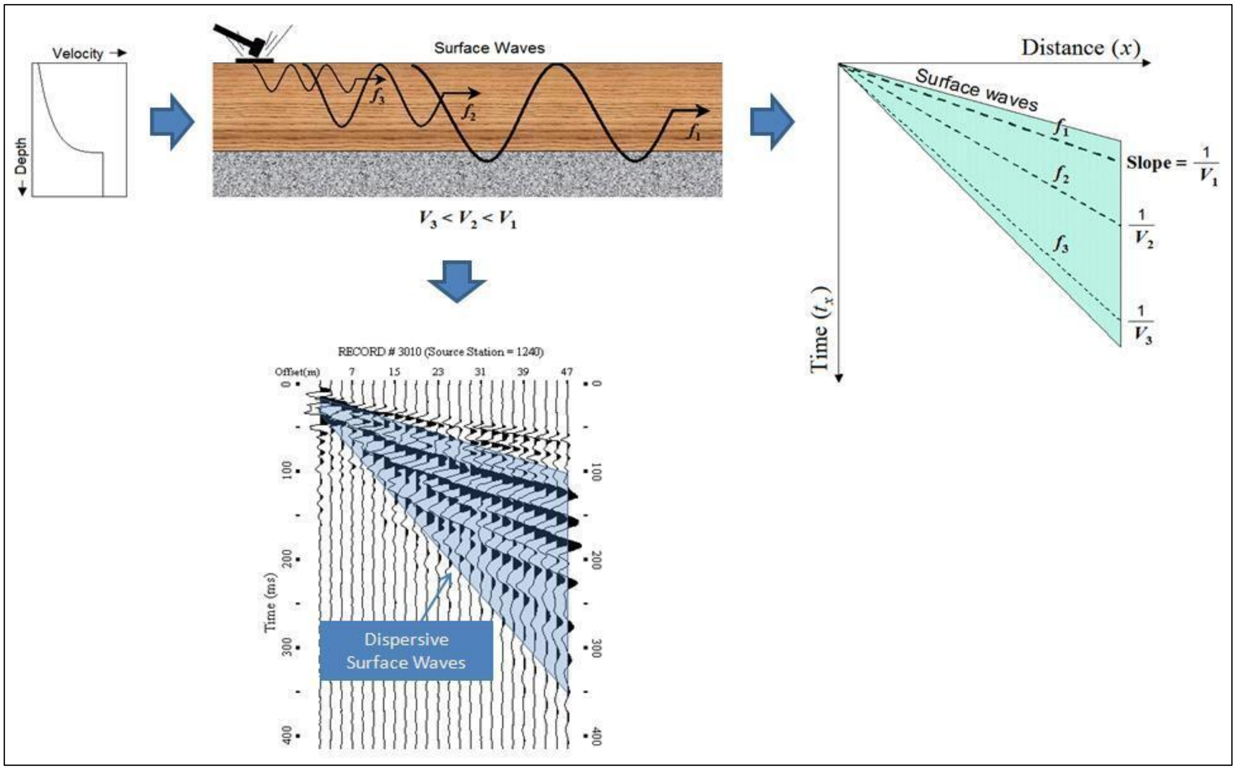
Rev.

0

FIGURE 1

Surface Wave Dispersive Properties and Arrival Data Records (illustrative).

FIGURE 2



www.parkseismic.com/SurfaceWaveSurvey.html

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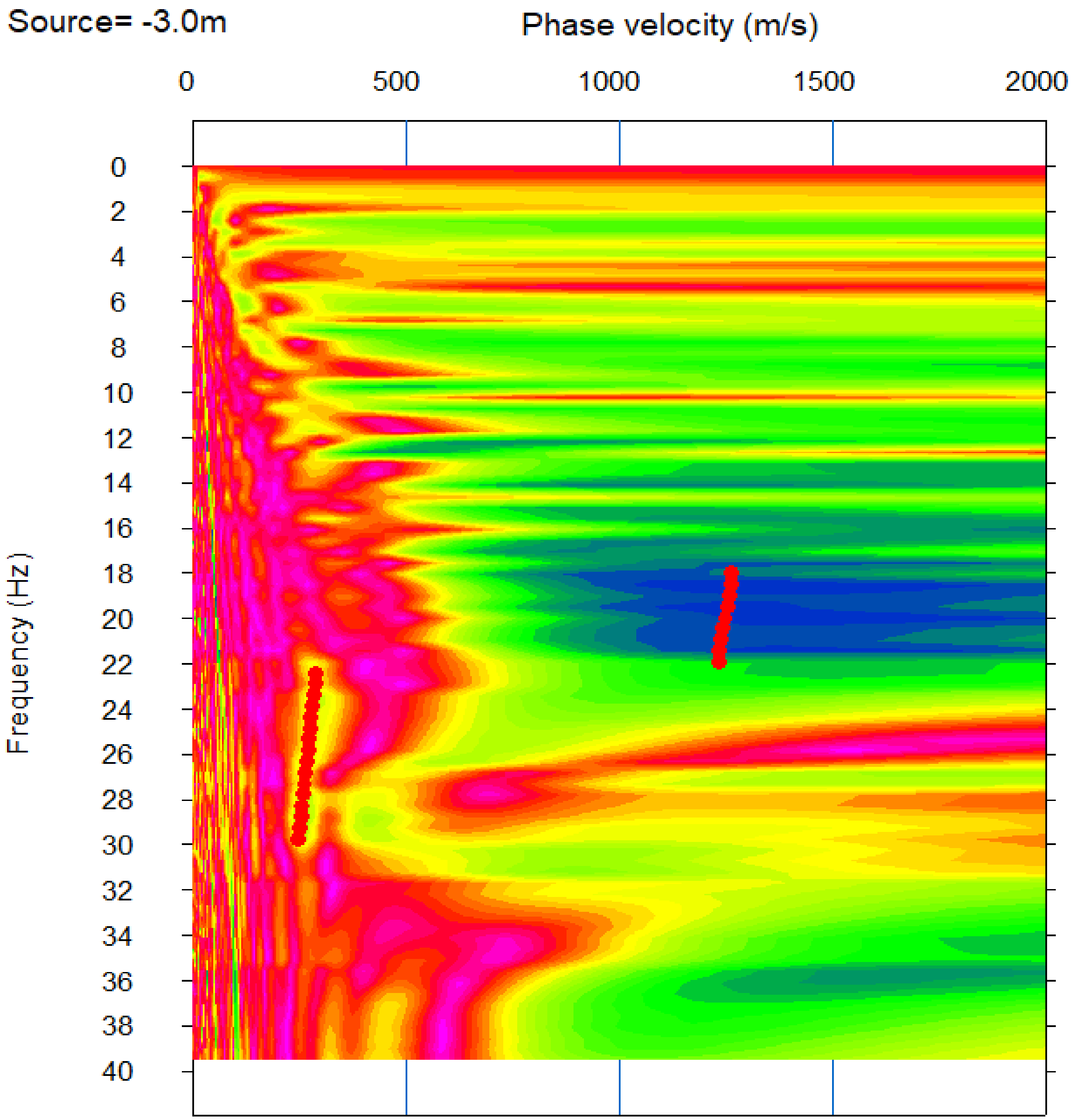
Date: November, 2022
Project: 65189.01

Phase Velocity vs Frequency Plot Displaying the Dispersion Curve and Picks for an Active Shot Record.	FIGURE 3



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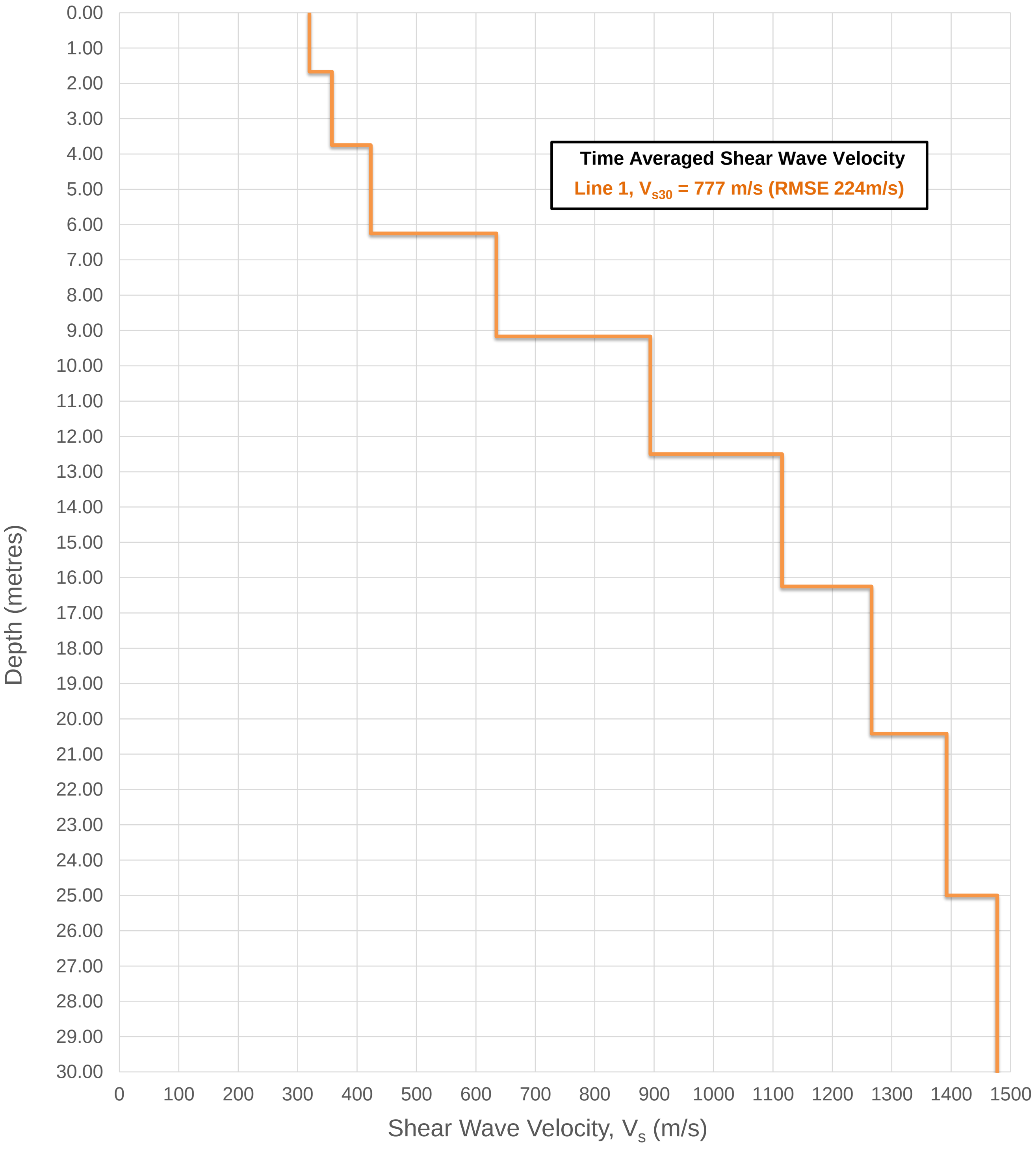
Project: 65189.01

Ronald McDonald House, 407 Smyth Road, Ottawa, Ontario
Modelled Shear Wave Velocity (V_s) vs Depth

FIGURE 4



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Date: November, 2022
Project: 65189.01

experience • knowledge • integrity

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

expérience • connaissance • intégrité