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Geotechnical Investigation
Proposed Residential Structure
240 Ferland Avenue
Ottawa, Ontario

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Submitted to:

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Ottawa, ON
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Geotechnical Investigation
Proposed Residential Structure
240 Ferland Avenue
Ottawa, Ontario

April 14, 2021
Project: 63115.04 - R1

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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation conducted by GEMTEC Consulting Engineers and Scientists Limited (GEMTEC) for a residential structure to be located at 240 Ferland Street 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.

This investigation was carried out in accordance with our proposal dated May 28, 2019.

2.0 PROJECT AND SITE DESCRIPTION

2.1 Project Description

Plans are being prepared to construct a 10-unit residential building (stacked townhomes) on the parcel of land located at the north-east corner of the intersection of Ferland Street and Jolliet Avenue in Ottawa, Ontario. The property is currently undeveloped due to the recent demolition of a 5-unit residential structure. The site location is provided on the Borehole Location Plan, Figure 1.

Based on the design information provided to us, the property has a surface area of about 710 square metres. The proposed development will have a footprint of about 240 square metres, and will consist of a 3-storey wood structure with a basement level. The structure is anticipated to be fully serviced (water, sanitary and storm services). The underside of footing elevation is proposed as 55.02 metres.

3.0 SUBSURFACE INVESTIGATION

The fieldwork for this investigation was carried out on January 13, 2020. At that time, George Downing Estate Drilling Ltd. advanced three (3) boreholes, numbered 20-1 to 20-3, inclusive, at the site using a track mounted drill rig. The boreholes were advanced to depths ranging from about 5.3 to 6.1 metres below surface grade.

Standard penetration tests (SPT) were carried out in the boreholes and samples of the soils encountered were recovered using a 50 millimetre diameter split barrel sampler. Standpipe piezometers were installed in each of the boreholes.

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

Following completion of the drilling, the soil samples were returned to our laboratory for examination by a geotechnical engineer. Selected samples were submitted for moisture content and grain size distribution testing. A groundwater sample collected from the well screen in borehole 20-3 was sent to Agat Laboratories Ltd. for basic chemical testing relating to corrosion of buried concrete and steel.

The results of the boreholes are provided on the Record of Borehole sheets in Appendix A. The approximate locations of the boreholes are shown on the Borehole Location Plan, Figure 1. The results of the laboratory classification tests on the soil samples are provided on the Soils Grading Chart in Appendix B. The results of the chemical analysis of the groundwater sample relating to corrosion of buried concrete and steel are provided in Appendix C.

The borehole locations were selected by GEMTEC and positioned on site relative to existing features. The ground surface elevations at the location of the boreholes were determined using our Trimble R10 GPS survey equipment. The elevations are referenced to datum CGVD28.

4.0 SUBSURFACE CONDITIONS

4.1 General

The subsurface conditions described below indicate the conditions at the specific test locations only. Boundaries between zones are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the frequency and recovery of samples, the method of sampling and the uniformity of the subsurface conditions. Subsurface conditions at other than the test locations may vary from the conditions encountered in boreholes.

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

The results of the boreholes are provided on the Record of Boreholes sheet in Appendix A. The following presents an overview of the subsurface conditions.

4.2 Fill Material

Fill material was encountered from ground surface at all of the borehole locations. The fill material generally consists of brown, grey brown, and dark brown silty sand with varying amounts of gravel and clay, as well as brown fine to medium grained sand with trace gravel. Organic material, brick and debris from the demolition work were also noted in the fill material.

The thickness of the fill material ranges from about 0.3 to 1.6 metres.

Standard penetration tests carried out in the fill material gave N values ranging between 3 and 83 blows per 0.3 metres of penetration. The higher N values reflect frozen soil conditions. As such, the average N value in the fill material is about 5 blows per 0.3 metres of penetration, which reflects a loose relative density.

Moisture content testing carried out on fill samples from borehole 20-2 indicate a moisture content ranging between about 10 and 22 percent.

4.3 Peat

An organic deposit of peat was encountered below the fill material at all of the borehole locations at depths ranging from 0.3 to 1.6 metres below ground surface.

The peat deposit is dark brown to black and contains trace wood and roots. The thickness of the peat ranges from about 0.3 metres to 1.5 metres at the borehole locations and extends to between 1.9 and 2.3 metres below ground surface.

Standard penetration tests carried out in the peat gave N values of about 3 blows per 0.3 metres of penetration, which reflects a very loose relative density.

Moisture content testing carried out on a peat sample from borehole 20-2 indicates a moisture content of about 191 percent.

4.4 Marl

An organic deposit of marl was encountered below the peat at all of the borehole locations at depths ranging from 1.9 to 2.3 metres below ground surface.

The marl consists of light brown silty clay with trace white shells. The thickness of the marl ranges from about 0.8 metres to 1.2 metres at the borehole locations and extends to between 2.7 and 3.1 metres below ground surface (elevation 53.8 to 54.2 metres).

Standard penetration tests carried out in the marl gave N values of WH (static weight of hammer and drill rods) per 0.3 metres of penetration, which reflects a very soft consistency.

Moisture content testing carried out on marl samples from borehole 20-2 indicate a moisture content ranging between about 59 and 208 percent.

4.5 Silty Clay

A 0.4 metre thick layer of firm, grey silty clay was encountered below the marl at a depth of about 2.7 metres below ground surface in borehole 20-1. Based on sample appearance, the silty clay has a firm consistency.

4.6 Sand

A deposit of brown, fine to medium grained sand trace silt was encountered below the marl at borehole 20-2 at a depth of about 3.1 metres below ground surface. The thickness of the sand at the borehole location is about 0.8 metres.

A standard penetration test carried out in the sand deposit gave an N value of 13 blows per 0.3 metres of penetration, which reflects a compact relative density.

The results of grain size distribution testing of the sand sample recovered 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 - Sand

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt & Clay (%)
20-2	5	3.1 – 3.7	0	94.7	5.3

Moisture content testing carried out on the sand sample indicates a moisture content of about 13 percent.

4.7 Silty Sand

A deposit of grey silty sand with trace gravel was encountered below the silty clay at borehole 20-1, below the sand at borehole 20-2, and below the marl at borehole 20-3 at depths of about 3.1 and 3.8 metres below ground surface.

All of the boreholes were terminated within the silty sand deposit at depths of 5.3 and 6.1 metres below ground surface.

Standard penetration tests carried out in the sand deposit gave N values ranging between 13 and 71 blows per 0.3 metres of penetration, which reflects a compact to very dense relative density.

The results of grain size distribution testing of a sample of the silty sand 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

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt & Clay (%)
20-2	6	3.8 – 4.4	5.0	66.8	28.2

Moisture content testing carried out on samples of the silty sand deposit indicate moisture contents ranging from about 9 to 13 percent.

4.8 Inferred Bedrock

Borehole 20-1 encountered refusal on the inferred bedrock surface at a depth of about 5.3 metres below the ground surface (elevation 51.6 metres).

It should be noted that auger refusal can occur on boulders and may not necessarily represent the surface of the bedrock.

4.9 Groundwater Levels

The groundwater levels were measured on January 15, 2020 in the well screens installed in the boreholes. At that time, the groundwater level was measured at about 3.8 to 3.9 metres below ground surface (elevation 53.0 and 53.1 metres).

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.

4.10 Groundwater Chemistry Relating to Corrosion

The results of chemical testing on a groundwater sample recovered from the well screen in borehole 20-3 are provided in Appendix C and are summarized in Table 4.3.

Table 4.3 – Summary of Corrosion Testing - Groundwater

Parameter	Borehole 20-3
Chloride Content (µg/L)	65,100
Conductivity (µS/cm)	1,220
pH	7.62
Sulphate (µg/L)	74,700

5.0 PROPOSED RESIDENTIAL STRUCTURE

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 provided in the Phase Two Environmental Assessment report.

5.2 Excavation

The excavations for the foundations should be taken through any fill material, organic soils (peat, marl), silty clay, or otherwise deleterious material to expose undisturbed, native sand deposit. Based on the results of the boreholes, it is anticipated that the excavation will extend to about elevation 53.8 to 53.9 metres (about 3.1 metres depth).

The sides of the excavations 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 overburden can be classified as Type 3 soil and allowance should be made for excavation side slopes of 1 horizontal to 1 vertical extending upwards from the base of the excavation. Flatter side slopes, 3 horizontal to 1 vertical, may be required in the peat and marl.

Alternatively, where space constraints dictate, temporary shoring of the overburden soil along the perimeter of the excavation could be considered for this project. Soil parameters for shoring design could be provided, if required.

5.3 Excavation Next to Existing Structures

The excavation for the proposed structure should not encroach below a line extending down and out from the footings for the existing structure at 1 horizontal to 1 vertical. The separation distance should be increased if loose sandy deposits, organic deposits (peat/marl), or water bearing deposits exist below the level of the existing footings; and

It is recommended that the foundation conditions for the adjacent structures be determined as part of the design.

5.4 Groundwater Management

The underside of footing elevations of the proposed structure are proposed as 55.02 metres. However, it is anticipated that the maximum excavation depth for the proposed dwelling will be advanced to the level of the native sand or silty sand deposits in order to remove the deleterious material from within the building footprint (i.e., to between elevation 53.8 and 53.9 metres). The groundwater level measured on January 15, 2020 ranged between elevation 53.0 and 53.1 metres. As such, excavation below the groundwater level is not anticipated. Additional groundwater level monitoring is recommended to identify the seasonal fluctuation in the groundwater levels. Depending on the seasonal fluctuations in the groundwater level, it may be necessary to avoid excavation for the foundations during wet periods of the year, such as early spring. As a minimum, the groundwater level should be confirmed prior to excavation.

Based on available information, it is anticipated that the water takings for this project, if any, will be less than 50,000 litres per day. As such, an Environmental Activity and Sector Registry (EASR) is not likely to be required for this project.

5.5 Foundations

The native sand and silty sand deposits at this site are considered suitable for the support of the residential structure on conventional spread footing foundations. The following comments are provided based on the conditions encountered in the boreholes.

- The foundations will likely be founded within the native sand or silty sand deposits or on engineered fill overlying the native sand and silty sand.

- In any areas where the proposed founding level is above the level of the native deposits or where subexcavation of disturbed material is required below proposed founding level, imported granular material (engineered fill) should be used.

- The engineered fill, if required, should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular A, Granular B Type I or II. The granular materials should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. Allowance should be made for a woven geotextile separator between the native subgrade soil and engineered fill.

- To allow spread of load beneath the footings, the engineered fill should extend horizontally at least 0.3 metres beyond the outside edges of the footings and then down and out from the edges of the footings at 1 horizontal to 1 vertical, or flatter. The excavation for the residential structure should be sized to accommodate this fill placement.

- Currently, OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular A material. Since the source of recycled material cannot be determined, it is suggested that any granular materials used below founding level be composed of virgin material only, for environmental reasons.

- Based on the results of the borehole investigation, spread footing foundations founded on or within undisturbed, native deposits of sand or silty sand, or on engineered fill material above the native deposits could be sized based on an allowable bearing value of 125 kilopascals.

- The allowable bearing pressure provided above is based on settlement. The post construction total and differential settlement of footings should be less than 25 and 20 millimetres, respectively, provided that all loose or disturbed soil is removed from the bearing surfaces prior to placing concrete and provided that any engineered fill material used is placed and compacted as described above.

- Based on the provided drawings, the finished exterior grades at this site will be similar to the existing grades. Provided that all deleterious materials, including the silty clay, is removed from the building footprint, no grade raise restrictions are required for this project.

Consideration could be given to founding the structure on deep foundations (i.e. helical piles or alternative) in order to minimize the excavation size. For this case, a structural slab will also be required. Soil parameters for a helical pile foundation can be provided, if required.

5.6 Frost Protection of Foundations

All exterior footings in any heated parts of the structure should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated footings located outside of the building footprint or footings located within unheated areas of the dwellings (i.e. garage, isolated piers) should be provided with at least 1.8 metres of frost cover. If the required depth of earth cover for foundations is not practicable, a combination of earth cover and extruded polystyrene insulation could be considered. The amount of frost cover can be reduced in equal parts by the thickness of non-frost susceptible fill (engineered fill) placed below the footings.

If the foundation and\or basement floor slab is insulated in a way that reduces heat loss towards the surrounding soil, the required depth of earth cover over the footings should conform to that of an unheated structure (i.e. 1.8 metres).

5.7 Basement Foundation Wall Backfill and Drainage

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

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

A conventional, perforated perimeter drain should be provided at founding level and either drained by gravity to the storm sewer, or connected to a sump pit equipped with a pump to discharge the water to storm sewer.

Where the backfill will ultimately support a pavement structure or walkway, it is suggested that the backfill materials be compacted in maximum 200 millimetre thick loose lifts to at least 95 percent of the standard Proctor dry density value. In landscaped areas, where some settlement of the backfill is acceptable, the material could be compacted in maximum 200 millimetre thick lifts to at least 90 percent of the standard Proctor dry density value.

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 native materials and/or compressible organic material to reduce the effects of differential frost heaving and differential settlement. It is suggested that granular frost tapers be constructed from 1.5 metres below ground surface to the underside of the granular base/subbase material for the hard surfaced areas. The frost tapers should be sloped at 2 horizontal to 1 vertical, or preferably flatter.

5.8 Basement Slab Support

To provide predictable settlement performance of the basement slab, organic material (peat/marl), disturbed soil, and other deleterious materials should be removed from the slab area.

The base for the floor slab should consist of at least 300 millimetres of OPSS Granular A or 19 millimetre clear crushed stone with a non-woven geotextile meeting OPSS 1860 Class I requirements wherever the clear stone will be in contact with the native soils. The OPSS Granular A should be compacted in maximum 150 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. Nominal compaction of the clear stone with at least 2 passes of a diesel plate compactor is recommended to consolidate the material into place.

Based on the proposed underside of footing elevation and the measured groundwater level, underfloor drains will not be required at this site.

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 minimize shrinkage cracks.

Proper moisture protection with a vapour retarder should be used for the basement floor slab 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 site is underlain by peat and marl deposits. The decay of organic material, such as peat, can also produce methane gas. Based on the above, soil gas control should be provided for the basement floor slab in accordance with Clause 9.13.4 of the Ontario Building Code (2012) and SB-9 of the MMAH Supplementary Guidelines to the Ontario Building Code.

5.9 Seismic Site Classification and Liquefaction Potential

Based on the results of the investigation, and provided that the fill material and all organic (peat/marl) and deleterious materials are removed from the building footprint, it is recommended that seismic Site Class C be used for the design of the residential structure at this site.

In our opinion, there is no potential for liquefaction of the overburden deposits at this site.

6.0 SITE SERVICES

6.1 Subgrade Surface

The fill material, peat, and marl at this site are not considered suitable for the support of the services and should be removed from below the proposed service pipes. Based on the soils encountered in the boreholes at this site, it is considered that the subgrade surface for the proposed site services should consist of silty clay, sand, silty sand or engineered fill above the silty clay, sand, or silty sand.

In areas where the subgrade is disturbed or where unsuitable material (fill or organic material) exists below sewer 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 II (50 millimetre minus crushed stone). To provide adequate support for the service 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 2 vertical spread of granular material down and out from the sides of the pipe(s). The use of clear crushed stone as a bedding or subbedding material should not be permitted on this project.

6.2 Groundwater Management

Provided that the excavation does not extend below the groundwater level, it is anticipated that any groundwater infiltration can be controlled using pumps from within sump pits inside of the excavation. If the excavation does extend below the groundwater level, groundwater inflow into the excavation could be significant.

Additional groundwater management details are provided in Section 5.4.

6.3 Pipe Bedding

The bedding for the proposed storm and sanitary sewers and watermain should consist of at least 150 millimetres of crushed stone meeting OPSS requirements for Granular A.

Cover material, from pipe spring line to at least 300 millimetres above the tops of the pipes, should consist of OPSS Granular A. The granular bedding and cover materials for the service pipes should be compacted in maximum 150 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value.

Due to the possible presence of hydrogen sulphide gas and methane gas within the native organic material on site, a relatively low permeability seepage barrier should be installed along the service pipes. The seepage barrier could be located adjacent to the proposed building. The barrier should begin at subgrade level and extend vertically through the granular pipe bedding and granular surround/cover, and horizontally across the full width of the service trench excavation. The seepage barrier could consist of a 1.5 metre wide dyke of compacted weathered silty clay, or a synthetic impermeable membrane.

6.4 Trench Backfill

In areas where the service trench will be located below or in close proximity to existing or future areas of hard surfacing (pavements, sidewalks, etc.), it is suggested that the backfill material match the excavated soils exposed on the sides of the excavation within the depth of seasonal frost penetration. This procedure will reduce the potential for differential frost heaving between the area over the trench and the adjacent hard surfaced area. The fill material found on site can be stockpiled and re-used for this purpose. Any peat, marl or any other organic deleterious materials should not be re-used as backfill material and should be wasted from the trench excavation.

If peat and/or marl are encountered in the trench excavation within the zone of frost penetration, the fill material found on site could also be used as backfill material in the area adjacent to the peat and/or marl. In this case, some minor differential frost heaving should be expected above the service trench.

The depth of frost penetration in exposed (snow cleared) areas can normally be taken as 1.8 metres below finished grade. Backfill below the zone of seasonal frost penetration could consist of either acceptable earth borrow material, or imported granular material conforming to OPSS Granular B Type I or II.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadways, parking areas, sidewalks, etc., the trench backfill should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. The specified density may be reduced to 90 percent of the standard Proctor dry density in areas where the trench backfill is not located below or in close proximity to existing or future roadways, parking areas, sidewalks, etc. and provided that some settlement above the trench is acceptable.

6.5 Winter Construction

The soils that exist at this site are frost susceptible. In order to carry out the work during freezing temperatures and maintain adequate performance of the trench backfill as a roadway subgrade, the 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 sides of the trenches should not be allowed to freeze.

7.0 ACCESS ROADWAY AND PARKING AREAS

7.1 Design Options

The site is underlain by fill, peat and marl. The fill material may not have been compacted during its initial placement and could compress with time. The peat and marl are organic deposits that will likely compress significantly (settle) following construction.

Two possible options could be considered for the design of the pavement structure:

- Construct the pavement structure on or within the fill material, peat, and marl.
- Remove the existing fill material, peat and marl, below the pavement structure.

These options are discussed in more detail below.

Option 1: Construct the Pavement Structure on or within the Existing Fill Material.

In preparation for the access roadway and parking area construction at this site, all surficial topsoil and any soft, wet or deleterious materials should be removed from the proposed roadway and parking area. Assuming that the grades are not lowered, it is expected that the subgrade will consist of fill material and/or peat.

The fill subgrade surface should be proof rolled under dry conditions using a smooth drum roller following the removal of the fill material to the pavement subgrade level. Any soft areas that are evident from the proof rolling should be subexcavated and replaced with compacted earth borrow material that is frost compatible with the earth fill materials that are exposed around the area of subexcavation.

In areas where fill material is encountered at the subgrade level, a nonwoven geotextile meeting OPSS 1860 Class II requirements should be placed over the subgrade surface. All seams in the geotextile should overlap at least 0.3 metres. In addition, it is suggested that a bi-axial geogrid, such as Terrafix 1500 or equivalent, should be provided above the geotextile. All seams in the geogrid should also overlap by at least 0.3 metres. If a geogrid and geotextile combination are to be placed, consideration could also be given to using Terrafix Combigrid or equivalent, which is a manufactured product that combines a geogrid with a fibre matrix.

The pavement structure should be composed of the following:

- 50 millimetres of hot mix asphaltic concrete
- 150 millimetres of OPSS Granular A
- 450 millimetres of OPSS Granular B Type II (50 millimetre minus crushed stone)

Settlement of the access roadway and parking area, and cracking of the asphaltic concrete and curbs should be expected with this option. Patching, padding and/or resurfacing of the pavement structure should be undertaken on an as needed basis. Alternatively, a gravel surfaced access roadway and parking area could be considered at this site.

Option 2: Remove the Existing Fill, Peat and Marl Prior to the Construction of the Pavement

With this option the existing fill, peat and marl would be removed from below the proposed pavement structure and replaced with OPSS Select Subgrade Material or OPSS Granular B Type I or II to significantly reduce or eliminate settlement of the pavement structure. To provide adequate support, the excavation for the removal of the fill, peat and marl should extend beyond the bottom edge of the pavement structure at a slope of 1 to 1 vertical. Based on the current plans and given the expected depth of these deposits, a vertical excavation would be required along the property line, necessitating the use of a shoring system.

The grades below the roadway and parking area could be raised up to the design level of the roadway and parking area with materials meeting OPSS specifications for Select Subgrade Material, OPSS Granular B Type I, or OPSS Granular B Type II. The fill material should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value.

The pavement structure should be composed of the following:

- 50 millimetres of hot mix asphaltic concrete
- 150 millimetres of OPSS Granular A
- 300 millimetres of OPSS Granular B Type II (50 millimetre minus crushed stone)

Although this option will provide the best pavement performance, the cost for the removal and replacement of the fill, peat and marl will be significant and may be cost prohibitive. Furthermore, as indicated previously, to avoid disturbance to the adjacent structures, the excavation should be located beyond a line extending down and out from the edges of the adjacent foundations at 1 horizontal to 1 vertical, of flatter. The separation distance should be increased if peat or marl, loose sandy deposits, or water bearing deposits exist below the level of the existing footings. GEMTEC should be consulted prior to excavation if any of these conditions are encountered.

7.2 Compaction of Granular Materials

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. For Option 1, it may be necessary to place and compact the OPSS Granular B Type II subbase in one lift.

Adequate drainage of the pavement granular materials and subgrade is important for the long term performance of the pavement at this site. Where storm sewers are used to convey surface water runoff, the catch basins should be provided with minimum 3 metre long perforated stub drains which extend in at least two directions from each catch basin at pavement subgrade level.

7.3 Effects of Disturbance and Construction Traffic

The pavement structure provided for Option 2 assumes that the subgrade level is at most about 0.5 metres below the existing ground surface and that the roadway subgrade surface is prepared as described in this report. If the roadway subgrade surface becomes disturbed or wetted due to construction operations or precipitation, the Granular B Type II thickness given above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase. The adequacy of the design pavement thickness should be assessed by geotechnical personnel at the time of construction.

The contractor should ensure that the roadway subgrade is adequately protected from precipitation and freezing temperatures.

If the granular pavement materials are to be used by construction traffic, it may be necessary to increase the thickness of the Granular B Type II to prevent pumping and disturbance to the subbase material.

8.0 ADDITIONAL CONSIDERATIONS

8.1 Corrosion of Buried Concrete and Steel

The measured sulphate concentration from the groundwater sample recovered from the well screen in borehole 20-3 is 74,700 micrograms per litre. According to Canadian Standards Association (CSA) “Concrete Materials and Methods of Concrete Construction”, the concentration of sulphate can be classified as low. Therefore any concrete in contact with the native soil or groundwater could be batched with General Use (GU) cement. The effects of freeze thaw in the presence of de-icing chemical (sodium chloride) use on the roadway should be considered in selecting the air entrainment and the concrete mix proportions for any concrete.

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

8.2 Effects of Construction Induced Vibration

Some of the construction operations (such as granular material compaction, excavation, 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. The magnitude of the vibrations should be much less than that required to cause damage to the nearby structures or services that are in good condition. There is potential that some nearby houses may be founded on fill or organic deposits, and may be susceptible to damage due to construction induced vibration. Therefore, we recommend that pre-construction surveys be carried out on the adjacent structures and that vibration monitoring be carried out during the construction, at least initially, so that any damage claims can be addressed in a fair manner.

8.3 Winter Construction

The soils that exist at this site are frost susceptible and are prone to ice lensing. In the event that construction is required during freezing temperatures, the soil below the footings and floor slab should be protected immediately from freezing using rigid insulation, straw, propane heaters and insulated tarpaulins, or other suitable means.

8.4 Monitoring Well Abandonment

The monitoring wells installed as part of this investigation should be decommissioned by a licensed well technician. The well abandonment could be carried out in advance of or during the construction.

8.5 Design Review and Construction Observation

The final details of the proposed residential structure have not been reviewed. It is recommended that the 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 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 provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact our office.

Luc Bouchard, P.Eng., ing.
Geotechnical Engineer
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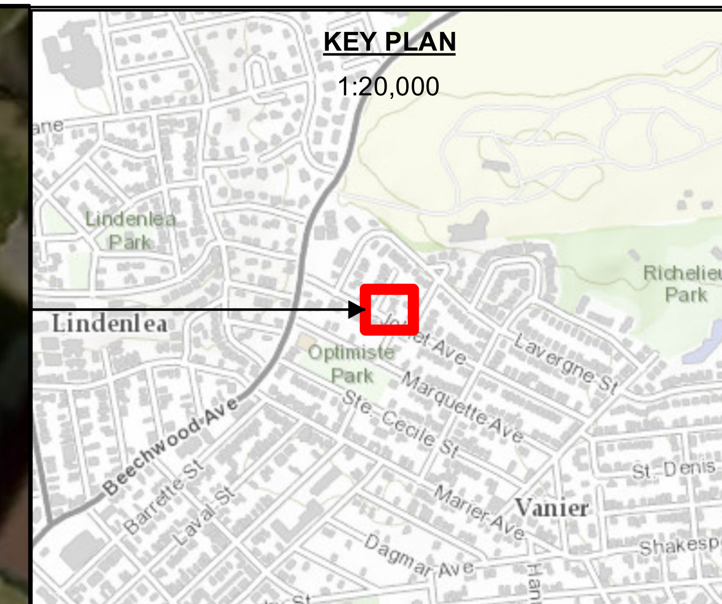
C:\Users\kathryn.maton\Documents\Projects\240 Ferland Street, Ottawa\Mapping\MXD\Geotechnical Investigation\Figure 1 Monitoring Location Plan.mxd



Legend

- Subject Property
- Borehole Location in Plan
- **(99.99)** Ground Surface elevation, in metres Geodetic Datum

References:

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey,

Scale

1:300

0 2.5 5 10 15 20 Meters

GEMTEC
Consulting Engineers and Scientists

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

Client:	**Metro Ottawa-Carleton Real Estate Ltd.**	Project:	63115.04
Location	**240 Ferland Street Ottawa, Ontario**		
Drwn By: K.M.	Chkd By: L.B.	Title	**Borehole Location Plan**
Date: February 2020	Rev. 0	**Figure: 1**	

APPENDIX A

Record of Borehole Sheets
List of Abbreviations and Terminology

RECORD OF BOREHOLE 20-1

CLIENT: Metro Ottawa-Carleton Real Estate Ltd.
PROJECT: 240 Ferland Street, Ottawa, Ontario
JOB#: 63115.04
LOCATION: See Borehole Location Plan, Figure 1

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

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

DESCRIPTION	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
Ground Surface	56.91				
Grey brown, clayey silt, trace sand and gravel (FILL MATERIAL)		1	SS	535	83
Dark brown, silty sand, trace gravel and clay (FILL MATERIAL)	56.55 / 0.36				
Loose, brown, silty sand, trace gravel, brick, wood, miscellanious building debris, organics (FILL MATERIAL)	56.15 / 0.76	2	SS	205	5
Very loose, dark brown to black, organic material (PEAT)	55.39 / 1.52	3	SS	380	4
Very soft, light brown, silty clay, contains white shells (MARL)	55.03 / 1.88	4	SS	455	5
Firm to stiff, grey, SILTY CLAY	54.24 / 2.67				
Very dense, grey, SILTY SAND, trace gravel	53.86 / 3.05	5	SS	100	63
		6	SS	280	64
		7	SS	330	71
End of Borehole Auger Refusal	51.63 / 5.28				

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: Bentonite; Silica Sand; Bentonite; Silica Sand; 1.5m long, 52mm diametre PVC Slotted Pipe

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20/01/15	3.9 ∇	53.1

GEMTEC Consulting Engineers and Scientists

LOGGED: K.M
CHECKED: L.B.

RECORD OF BOREHOLE 20-2

CLIENT: Metro Ottawa-Carleton Real Estate Ltd.
PROJECT: 240 Ferland Street, Ottawa, Ontario
JOB#: 63115.04
LOCATION: See Borehole Location Plan, Figure 1

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

Boring method: Power Auger, Hollow Stem Auger (210mm OD)

Description	Elev. (m) / Depth (m)	Sample Number	Type	Recovery, mm	Blows/0.3m	Additional Lab. Testing
Ground Surface	56.90					
Grey brown, silty sand, some clay (FROZEN FILL MATERIAL)	56.71 / 0.19					
Loose to compact, brown, fine to medium grained sand, trace gravel (FILL MATERIAL)	56.29 / 0.61	1	SS	355	10	
Loose, brown, silty sand, trace to some clay, trace gravel, contains organics (FILL MATERIAL)	55.27 / 1.63	2	SS	405	6	
Very loose, dark brown to black, organic material, trace wood and roots (PEAT)	54.62 / 2.28	3	SS	230	3	
Very soft, light brown, silty clay, contains white shells (MARL)	53.85 / 3.05	4	SS	610	WH	
Compact, brown, fine to medium graine SAND, trace silt	53.09 / 3.81	5	SS	305	13	M
Compact to dense, grey, SILTY SAND, trace gravel	50.80 / 6.10	6	SS	125	25	M
		7	SS	280	17	
		8	SS	255	31	
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); scale 10 20 30 40 50 60 70 80 90

Piezometer or standpipe installation: Bentonite; Silica Sand; Bentonite; Silica Sand; 1.5m long, 52mm diametre PVC Slotted Pipe

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20/01/15	3.9 ∇	53.0

GEMTEC Consulting Engineers and Scientists

LOGGED: K.M
CHECKED: L.B.

RECORD OF BOREHOLE 20-3

CLIENT: Metro Ottawa-Carleton Real Estate Ltd.
PROJECT: 240 Ferland Street, Ottawa, Ontario
JOB#: 63115.04
LOCATION: See Borehole Location Plan, Figure 1

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

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

DESCRIPTION	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
Ground Surface	56.80				
Brown, silty sand, trace gravel, clay, and brick (FROZEN FILL MATERIAL)	56.47 / 0.33	1	SS	355	9
Very loose, dark brown to black, organic material, contains wood (PEAT)		2	SS	405	3
	54.95 / 1.85	3	SS	610	7
Very soft, light brown, silty clay, contains white shells (MARL)		4	SS	610	WH
Compact to dense, grey, SILTY SAND, trace gravel	53.75 / 3.05	5	SS	205	13
		6	SS	280	33
		7	SS	380	40
		8	SS	355	38
End of Borehole	50.70 / 6.10				

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; scale 10 20 30 40 50 60 70 80 90

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION: Bentonite; Silica Sand; Bentonite; Silica Sand; 1.5m long, 52mm diametre PVC Slotted Pipe

GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20/01/15	3.8 ∇	53.0

GEMTEC Consulting Engineers and Scientists

LOGGED: K.M
CHECKED: L.B.

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

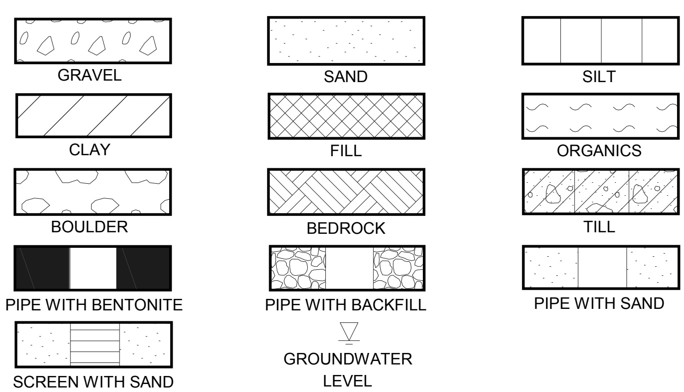
PENETRATION RESISTANCE

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

Scale (mm): 0.01, 0.1, 1.0, 10, 100, 1000mm

SILT CLAY	SAND – Fine	SAND – Medium	SAND – Coarse	GRAVEL	COBBLE	BOULDER
< 0.08	0.08 – 0.4	0.4 – 2	2 – 5	5 – 80	80 – 200	> 200

DESCRIPTIVE TERMINOLOGY

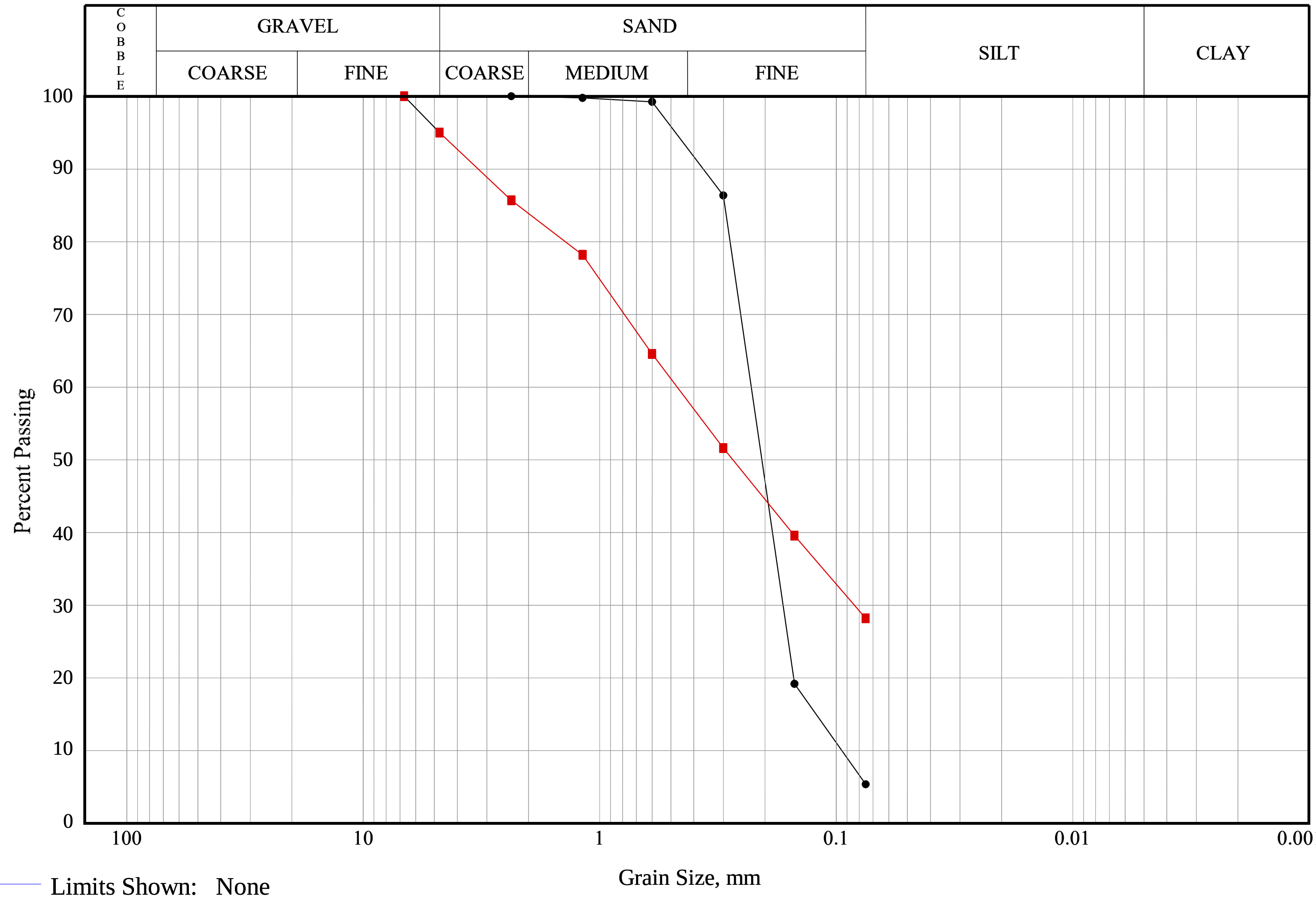
(Based on the CANFEM 4th Edition)

0 – 10	10 – 20	20 – 35	35
TRACE	SOME	ADJECTIVE	noun > 35% and main fraction
trace clay, etc	some gravel, etc.	silty, etc.	sand and gravel, etc.

APPENDIX B

Results of Laboratory Index Testing

GEMTEC Consulting Engineers and Scientists		
Client: Metro Development Corp.		Soils Grading Chart
Project: Geotechnical Investigation - 240 Ferland Avenue		
Project #: 6311504		



Limits Shown: None

Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
●— (black)	Sand	20-02	5	3.05-3.66	0.0	94.7	5.3	
■— (red)	Silty Sand	20-02	6	3.81-4.42	5.0	66.8	28.2	

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
●— (black)	Sand , trace silt	N/A	0.09	0.12	0.17	0.21	0.23	0.30	---
■— (red)	Silty sand , trace gravel	N/A	---	---	0.08	0.27	0.47	2.22	---

APPENDIX C

Chemical Analysis of Groundwater
Sample Relating to Corrosion
AGAT Laboratories Order No. 20Z564447

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 20Z564447

PROJECT: 63115.04 - Phase Two ESA

CLIENT NAME: GEMTEC CONSULTING ENGINEERS AND SCIENTISTS

ATTENTION TO: Kathryn Maton

SAMPLING SITE:240 Ferland Street, Ottawa

SAMPLED BY:K. Maton

O. Reg. 153(511) - Metals & Inorganics (Water)

DATE RECEIVED: 2020-01-16

DATE REPORTED: 2020-01-23

		SAMPLE DESCRIPTION:		MW20-3
		SAMPLE TYPE:		Water
		DATE SAMPLED:		2020-01-15
Parameter	**Unit**	**G / S**	**RDL**	**866891**
Antimony	µg/L	20000	1.0	<1.0
Arsenic	µg/L	1900	1.0	<1.0
Barium	µg/L	29000	2.0	892
Beryllium	µg/L	67	0.5	<0.5
Boron	µg/L	45000	10.0	134
Cadmium	µg/L	2.7	0.2	<0.2
Chromium	µg/L	810	2.0	3.5
Cobalt	µg/L	66	0.5	<0.5
Copper	µg/L	87	1.0	<1.0
Lead	µg/L	25	0.5	<0.5
Molybdenum	µg/L	9200	0.5	3.4
Nickel	µg/L	490	1.0	<1.0
Selenium	µg/L	63	1.0	1.0
Silver	µg/L	1.5	0.2	<0.2
Thallium	µg/L	510	0.3	<0.3
Uranium	µg/L	420	0.5	<0.5
Vanadium	µg/L	250	0.4	1.0
Zinc	µg/L	1100	5.0	<5.0
Mercury	µg/L	0.29	0.02	<0.02
Chromium VI	µg/L	140	5	<5
Cyanide	µg/L	66	2	<2
Sodium	µg/L	2300000	2500	54400
Chloride	µg/L	2300000	500	65100
Electrical Conductivity	uS/cm		2	1220
pH	pH Units		NA	7.62
Sulphate	µg/L		500	74700

Certified By: Iris Verástegui

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