GEOPACIFIC CONSULTANTS

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Fabric Living Developments Ltd.
202 – 837 W Hastings Street
Vancouver, B.C.
V6C 3N9

January 25, 2024
File: 22015

Attention: Kiegan Scharnberg

Re: Preliminary Hydrogeological Investigation Report: Proposed Residential Development 461-475 E 16th Ave, Vancouver, BC

1.0 INTRODUCTION

We understand a new residential development is proposed at the above referenced site. Architectural design drawings provided by Francl Architecture (dated 27th November 2023) indicate that the site could accommodate a 21-storey tower over a 4-level parkade. The P4 slab is shown at an elevation of 34.28 m geodetic.

This report presents the preliminary results of a project specific hydrogeological investigation and makes preliminary recommendations for the design and construction of the proposed residential development pertaining to groundwater management. This document has been prepared with reference to the City of Vancouver's Groundwater Management Bulletin (last amended February 2023). It has been prepared exclusively for Fabric Living Developments Ltd., for their use, the use of others on their design team, and the City of Vancouver for use in the development and permitting process.

2.0 SITE DESCRIPTION

The site is an assembly of four lots and is bounded by a municipal lane to the north, a single-family home to the east, a 3-storey townhouse building to the west, and E 16th Avenue to the south. The site is rectangular in shape measuring approximately 40 m north-south by 37 m east-west and is approximately flat at an elevation of about 46.5 m geodetic. The site has an area of 1.495 m^2. At the time of our investigation, each lot was currently improved with a single-family residential home towards the north with a garage/shed in the south.

Based on the information provided by Fabric Living Developments Ltd., it is understood that both the eastern and western neighbouring buildings were constructed on piles. The property is located within the Mount Pleasant Bog identified on the City of Vancouver's Peat Areas Map, last revised in 2002, which is also somewhat consistent with our experience with projects in the area. There is evidence throughout the area surrounding the site of the impacts of peat and the associated unavoidable long term ground settlement caused by natural degradation of the organic matter.

The location of the site relative to existing properties is shown in our Drawing No. 22015-01, following the text of this report.

3.0 FIELD INVESTIGATION

The subsurface ground conditions were investigated on October 28, 2022, using a sonic drill rig supplied by Blue Max Drilling, of Surrey, BC. At this time, two test holes were advanced to 18.3 m and 16.8 m below local grades. Dynamic Cone Penetration Test (DCPT) sounding were conducted at both test hole locations to determine the relative density/consistency of the soils encountered. Monitoring wells were installed at both test hole locations at the time of drilling.

The soil conditions were logged in the field, and representative samples were collected for further classification. All test holes were backfilled and sealed in accordance with provincial abandonment requirements following classification, sampling, and logging.

The results of the test hole investigation are presented in Appendix A, following this report. The approximate locations of the test holes with respect to the site boundaries are shown in our Drawing No. 22015-01 following the text of this report.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

According to the Geological Survey of Canada's Surficial Geology Map 1484A, this region is understood to be underlain by bog deposits of upland peat overlying Vashon Drift glacial deposits with bedrock more than 10 m of the surface. Based on Vancouver's Old Streams Map, it appears that an old stream is located within or near the proposed development site. Subsurface conditions should be expected to vary from surrounding strata at the location of the old stream.

The soil profile encountered in the investigations generally consists of a thin layer fill over peat, over clayey silt, over glacial till, and over siltstone. A detailed description of the strata profile is given below:

Fill

Sand and gravel fill is observed to a maximum depth of 0.15 m below existing grades. The fill consists of grey loose sand and gravel. In general, the fill was noted to be dry to moist.

Peat

Peat was observed at all test hole locations below the surficial fill and is found to be approximately 1.5 m in thickness. The peat is described as soft, dark brown, fibrous, and wet. The moisture content of the peat increased with depth and ranged from 40.9% to 395.5% indicating that the peat is highly compressible under new loading. Peat will also be subject to long term unavoidable settlements caused by the gradual decay of the organic constituent within this material. Based on the peat thickness encountered, the site is located on the margin of the Mount Pleasant Bog.

Clayey Silt

The peat is underlain by a soft clayey silt layer which extends to a depth of approximately 3 m at the boreholes. Moisture contents are within the range of 30.6% to 42.7%, and in conjunction with a soft to firm consistency of the deposit, it is likely to exhibit moderate compressibility under a nominal stress change. It is considered highly sensitive to mechanical disturbance.

Silty Sand and Gravel (Glacial Till)

The clayey silt is underlain by silty sand and gravel (glacial till). The silty sand and gravel glacial till is found to be dense to very dense and extends to a depth of 5.5 m and 4.6 m at test holes TH22-01 and Th22-02, respectively. The moisture content of the till is determined to range from 12.8% to 13.3% based on our laboratory analysis. The silty sand and gravel were noted to be dense to very dense, grey, and moist. All DCPT soundings encountered refusal within this stratum.

Sand to Sandy Silt (Glacial Till)

The silty sand and gravel are underlain by dense sand to sandy silt extending to a depth of 9.1 m in both test hole locations. The thickness of the sand layer is approximately 1.2 m and 2.4 m in TH22-01 and TH22-02, respectively. The moisture contents of the sand and sandy silt layer range from 17.5% to 18.2% and 15.2% to 24.3%, respectively.

Silt (Glacial Till)

The sandy silt is underlain by very stiff silt, grey, and slightly moist to dry. This deposit began at a depth of approximately 9.1 m at both test hole locations. The moisture content of the silt is determined to range from 8.3% to 12.1%.

Siltstone (Tertiary)

The glacial deposit of silt is underlain by siltstone at the depth of approximately 13.7 m below the existing grades and extends post the exploration depths at the test hole. The moisture content of the siltstone is determined to range from 10.8% to 15.4%. Although not observed at our test holes, Tertiary siltstone can contain “nodules” or “floaters” that through chemical alteration have become very hard.

For a detailed account of the subsurface condition, refer to the auger hole logs in Appendix A of this report. Geotechnical laboratory testing certificates are included in Appendix ‘B’. All depths are referenced from the existing ground surface at the test hole locations.

5.0 GROUNDWATER CONDITIONS

5.1 General Groundwater Conceptualisation

The site is located within the mapped extent of the Vancouver Quadra Aquifer (Aquifer No.49). However, the result of our drilling investigation proves that this formation is not present within the area of the site and as such will not be discussed further.

The site is partly situated within the mapped extent of the Mount Pleasant Peat Bog, as shown on the City of Vancouver’s Groundwater Areas of Concern Website (City of Vancouver, 2024). The northwest corner of the site is outside of the mapped peat zone. Peat soils are at risk of settlement from construction related dewatering and as such require special consideration. It should be noted that peat soils settle naturally over-time due to degradation of the biological material of which they comprise, and evidence of this settlement is evident in the surrounding area.

5.2 Hydrogeological Units

The following hydrogeological units were identified during our investigation of the site:

Fill was noted at both drilling locations. Fill soils are not anticipated to be a significant source of groundwater, though some perched groundwater may be present within these surficial soils. Groundwater inflows resulting from excavation into this material are likely to be limited to short-term inflows of perched groundwater and is expected to be heavier during the wetter winter and spring months of the year.

The peat soils encountered at the site have the potential to store significant amounts of perched groundwater within the soil matrix. Peat soils tend to act as a sponge, whereby groundwater is generally retained within the soil unless a stress is enacted on the peat which would cause it to release groundwater in storage. We anticipate that, during excavation, some perched groundwater will be released from the peat within the site boundary though this would not be a constant source of groundwater and would drain rapidly. We understand that the peat soil would be removed from with the site boundary during excavation. The peat will remain in the surrounding area to the east and south of the site, though we anticipate these soils would not be affected by the proposed development as a perched groundwater table is not expected to be present given the results of our drilling investigation.

The clayey silt, present below the peat soils, is not expected to be a source of perched groundwater. Clayey soils typically have a high moisture content, though the water is stored within the soil matrix such that is does not actively drain under passive conditions. Therefore, we do not anticipate there any perched groundwater inflows resulting from excavation through these soils.

Variable silt, sand and gravel glacial till was noted at all investigation locations and extended beyond the depth of investigation. In the area of the site, glacial till is generally understood to act as an aquitard, i.e., a material which limits the horizontal and vertical movement of groundwater. Some groundwater inflows are expected from the glacial till material, though these are anticipated to be limited to short term transient inflows of perched groundwater from more permeable and sandy lenses. In our experience, groundwater inflows resulting from glacial till generally reduce, relatively rapidly, to a near negligible rate.

The siltstone bedrock, like the overlying glacial till, is expected to act as an aquitard. Groundwater may be stored in discrete fracture zones within this soil though we do not anticipate that this soil will be encountered given the P4 slab elevation being about 1.5 m above the upper contact of the siltstone.

Given the geological conditions encountered, groundwater inflows are anticipated to be relatively light.

5.3 Groundwater Monitoring Wells

Two groundwater monitoring wells were installed at the site during the October 2022 site investigation. The purpose of the monitoring well installations is to monitor groundwater levels over time and to use the resultant data to inform the detailed design stage for the project. The following table is a summary of groundwater monitoring wells installed at the site:

Table 1 – Summary of Groundwater Monitoring Wells

Well No.	Elevation (m geo)*	Geology	Screened Section	
			(m bgs)	(m geo)
MW22-01	46.5	Siltstone	16.8 – 18.3	31.20 – 29.70
MW22-02			15.3 – 16.8	29.70 – 28.20

***Surface elevations are estimated from City of Vancouver**

After installation of the groundwater monitoring wells, where groundwater was noted, they were developed using a bailer. The bailer was used to remove up to 3 well volumes, or until the well went dry, whichever occurred first. The purpose of the development is to improve connectivity between the well and the surrounding soil and to remove any smearing or mud associated with the drilling process.

5.4 Manual Groundwater Monitoring

Manual water levels were measured, by GeoPacific Consultants, using a handheld water level meter at selected boreholes on the following dates;

Table 2 – Manual Groundwater Level Summary

Well No.	Nov 13th, 2021		June 6th, 2023	
	(m bgs)	(m geo)	(m bgs)	(m geo)
MW22-01	2.2	44.3	-	-
MW22-02	2.3	44.2	1.45	45.05

Groundwater monitoring is on-going at the site and additional water level monitoring and pressure transducer data will be included in the final hydrogeological investigation report for the site.

5.5 BC Water Atlas

A search of the BC Water Atlas was undertaken on the 25th of January 2024. The search confirmed that there are no well records mapped within 500 m of the site. The search further confirmed that the Quadra Aquifer is mapped as being present below the site, though this was not encountered during our drilling investigation and as such will not be considered further.

6.0 PRELIMINARY IMPACT ASSESSMENT

To satisfy the City of Vancouver's Groundwater Bulletin, GeoPacific conducted an impact assessment to demonstrate that there will be no significant impacts resulting from groundwater at the site:

I. *Ground Subsidence*

In some cases, dewatering can cause ground subsidence. This can have associated negative impacts on adjacent properties and city infrastructure. Peat was noted at the site, at both drilling locations, to depths of up to 1.5 m. Groundwater was not observed within the peat during drilling, though geotechnical lab testing results indicate that the moisture content of the peat ranges between 40.9% and 395.2%. This suggests that the peat is moderately to highly compressible under loading, though as discussed previously, the on-site peat will be removed as part of the proposed excavation.

The risk of subsidence is therefore from off-site peat deposits that may be impacted by dewatering at the site. The proposed passive dewatering methods at the site are unlikely to have any noticeable impact on off-site peat soils, though we recommend that some additional shallow groundwater wells are installed to determine whether a groundwater table is present within the peat and to determine whether the water level in the peat dries out during the summer months. If a seasonal variation in the peat water level can be proven, then this would be evidence that subsidence would not occur from any preferential draining of groundwater perched in these soils to the proposed excavation face.

II. *Impacts to Nearby Wells*

As confirmed by GeoPacific's search of the BC Water Atlas on Jan 24th, 2024, no active abstraction wells exist within 500 m of the site. Therefore, there is likely to be no impact to abstraction wells resulting from the proposed works.

III. *Surface Water and Historic Streams*

There are no surface water courses or historic streams mapped on or adjacent to the site. Therefore, there is likely to be no impact to either surface water or historic streams from the proposed development.

If the project design changes, then this report should be revisited and updated.

7.0 PRELIMINARY GROUNDWATER MANAGEMENT PLAN

Any groundwater ingress and precipitation during construction will be directed to a sump. The sump is to be constructed at the low point(s) of the excavation to the specifications outlined on the Erosion and Sediment Control Plan. Water will then be pumped from the sump to the onsite water treatment system which includes CO2 adjustment, settling tanks and mechanical filtration. Discharge water will then be directed to a catch basin adjacent to the site. The City of Vancouver may request that the rate of groundwater flow being pumped from the site is monitored. Flow monitoring reports should be emailed to groundwater@vancouver.ca on a monthly basis.

8.0 DISCUSSION

We understand a new residential development is proposed at the above referenced site. Architectural design drawings provided by Francl Architecture (dated 27th November 2023) indicate that the site could accommodate a 21-storey tower over a 4-level parkade. The P4 slab is shown at an elevation of 34.28 m geodetic.

This report presents a preliminary review of the hydrogeological conditions encountered at the site. Our investigation suggests that some perched groundwater is likely to be encountered during excavation, though this is anticipated to be relatively minor and would entirely comprise of temporary perched groundwater inflows that would steadily decrease as any perched groundwater stored either at the contact of the less permeable soils or from within discrete sandy lenses within the till drains into the excavation.

We anticipate that any dewatering required during excavation would be entirely passive and would utilise conventional sumps and sump pumps for dewatering.

We anticipate a conventional parkade construction method would be appropriate at this site where a perimeter and underslab drainage system is incorporated into the design to prevent water pressure acting on the basement floor slab with underslab fills hydraulically connected to the building's perimeter drainage system and sump.

Due to the presence of peat soils at the site, we recommend that some additional monitoring wells be installed to investigate the presence of groundwater within the peat and to determine if seasonal variation occurs. We also recommend that slug testing and a groundwater seepage analysis be completed to enable an estimate of likely groundwater seepage rates both during and post-construction. We would summarise the findings of the additional monitoring and testing as part of a Final Hydrogeological Investigation Report that would be suitable for submission to the City of Vancouver in support of a Development Permit Application.

9.0 CLOSURE

This report has been prepared exclusively for our client and the City of Vancouver for the purpose of providing preliminary recommendations pertaining to groundwater management for the proposed development. The report remains the property of GeoPacific Consultants Ltd. and unauthorized use of, or duplication of, this report is prohibited. The report should be considered as preliminary and may need to be updated once detailed design drawings become available.

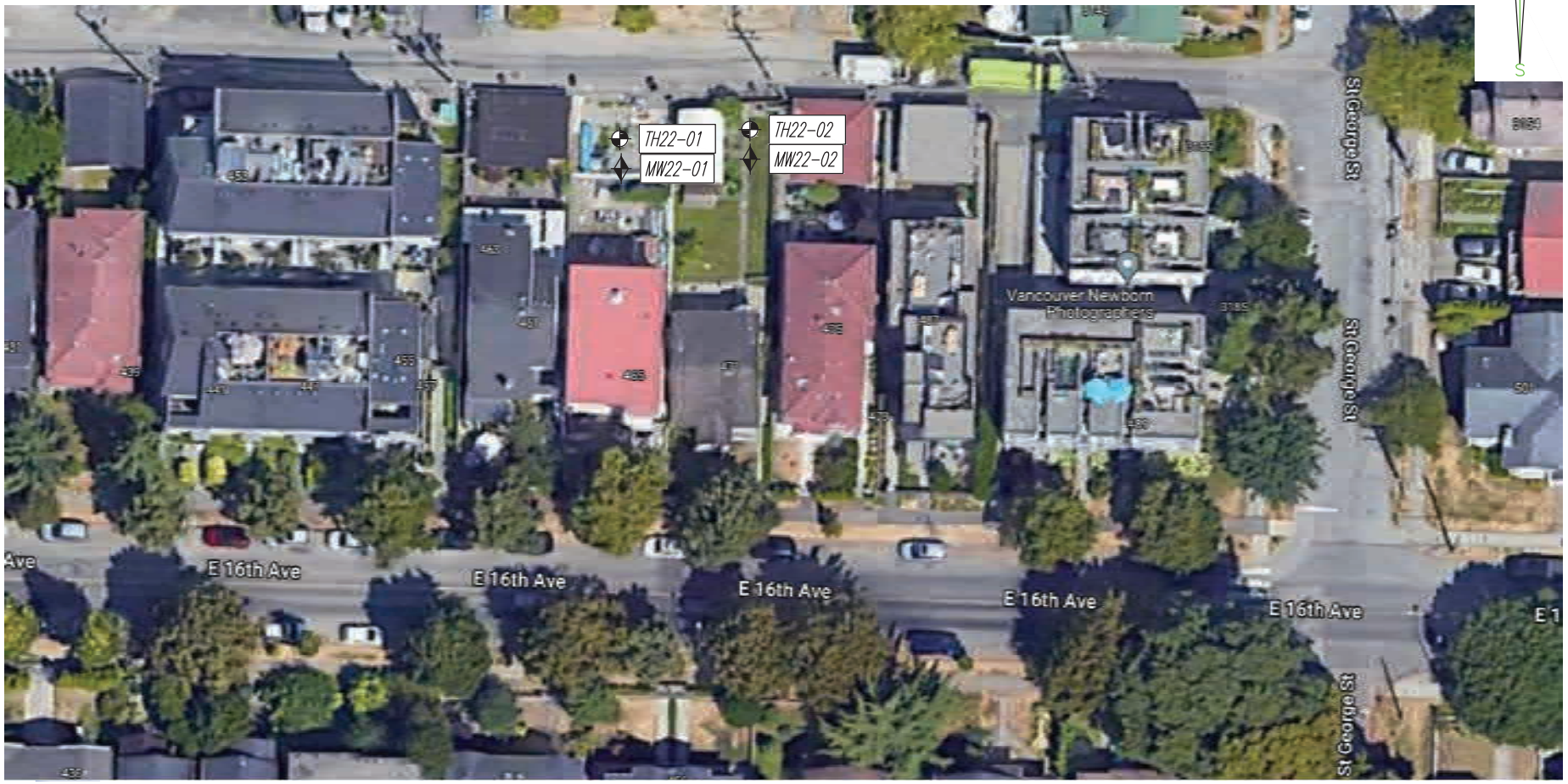
We are pleased to be of assistance to you on this project and we trust that our comments and recommendations are both helpful and sufficient for your current purposes. If you would like further details or would like clarification of any of the above, please do not hesitate to call.

For:
GeoPacific Consultants Ltd.

Reviewed By:

Sean Heffernan, M.Sc., P.Geo.
Senior Hydrogeologist

Matt Kokan, M.A.Sc., P. Eng.
Principal



PTH22-XX – PROPOSED TEST HOLE (PTH) LOCATION

MW22-XX – MONITORING WELL (MW) LOCATION

SITE PLAN

N/A

*TEST LOCATIONS ARE APPROXIMATE

REFERENCE:

GEOPACIFIC CONSULTANTS

DATE:	2022-10-14	
DRAWN BY: RSD	APPROVED BY: MK	REVIEWED BY:
SCALE:	N/A	

FABRIC LIVING DEVELOPMENTS
461 – 475 16TH AVE, VANCOUVER
TEST HOLE LOCATIONS

FILE NO.: 22015

DWG. NO.: 22015-01

REVISIONS:
A.
B.
C.

ORIGINAL PAPER SIZE 8.5"x11"

APPENDIX A

Test Hole Log: TH22-01

File: 22015
Project: Proposed Residential Development
Client: Fabric Living Development
Site Location: 461-475 E 16th Ave, Vancouver

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INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
0–4 / 0–1		***Fill*** Gravel and sand, loose, grey, moist					
4–5 / 1–1.5		***Peat*** Fibrous peat, loose, organics, brown to dark brown in colour, with moisture increasing with depth.	1.5	395.2	4, 3, 2, 1, 2		
5–10 / 1.5–3		***Clayey Silt*** Clayey silt, soft, grey, moist	3.0	42.7	0, 2, 3, 3, 1		
10–18 / 3–5.5		***Silty Sand and Gravel (Glacial Till)*** Silty sand and gravel, compact to very dense, grey, moist	5.5	13.3	16, 30, 35, 44, 41, >50, >50		
18–22 / 5.5–6.7		***Sand (Glacial Till)*** Sand, some silt, compact, grey, moist	6.7	18.2			
22–30 / 6.7–9.1		***Sandy Silt (Glacial Till)*** Sandy silt, compact to dense, grey, moist	9.1	23.7			
30–40 / 9.1–12		***Silt (Glacial Till)*** Silt, very stiff, grey, slightly moist to dry		8.3, 10.9			

Logged: RSD
Method: Sonic Drill Rig
Date: Oct 28,2022

Datum: Existing Grades
Figure Number: A.1

Test Hole Log: TH22-01

File: 22015
Project: Proposed Residential Development
Client: Fabric Living Development
Site Location: 461-475 E 16th Ave, Vancouver

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INFERRED PROFILE

Depth	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
41 42 43 44 45 13			13.7				
46 47 48 49 50 14 15		***Siltstone (Tertiary)*** Siltstone, very stiff, light grey to grey, slightly moist to dry		15.4			
51 52 53 54 55 16 17							5' screen between 55' to 60'
56 57 58 59 60 18			18.3				
		End of Borehole					
61 62 63 64 65 19 20							
66 67 68 69 70 21							
71 72 73 74 75 22 23							
76 77 78 79 80 24							

Logged: RSD
Method: Sonic Drill Rig
Date: Oct 28,2022

Datum: Existing Grades
Figure Number: A.1

Test Hole Log: TH22-02

File: 22015
Project: Proposed Residential Development
Client: Fabric Living Development
Site Location: 461-475 E 16th Ave, Vancouver

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
0–4 / 0–1		***Peat*** Fibrous peat, loose, organics, brown to dark brown in colour, with moisture increasing with depth.	1.5	40.9	5, 2, 1, 1		
5–9 / 1–2		***Clayey Silt*** Clayey silt, soft, grey, moist to wet	3.0	30.6	3, 3, 4, 5, 8		
10–14 / 3–4		***Silty Sand and Gravel (Glacial Till)*** Silty sand and gravel, compact to very dense, grey, moist	4.6	12.8	35, 25, 24, 33, >50, >50		
15–22 / 5–7		***Sand (Glacial Till)*** Sand, some silt, dense, grey, moist	7.0	17.5			
23–29 / 7–9		***Sandy Silt (Glacial Till)*** Sandy silt, compact to dense, grey, moist Sand seam between 28' to 30'	9.1	15.2 24.3			
30–40 / 9–12		***Silt (Glacial Till)*** Silt, very stiff, grey, slightly moist to dry		11.8			

Logged: RSD
Method: Sonic Drill Rig
Date: Oct 28,2022

Datum: Existing Grades
Figure Number: A.2

Test Hole Log: TH22-02

File: 22015
Project: Proposed Residential Development
Client: Fabric Living Development
Site Location: 461-475 E 16th Ave, Vancouver

GEOPACIFIC CONSULTANTS
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
13				12.1			
			13.7				
14		***Siltstone (Tertiary)*** Siltstone, very stiff, light grey to grey, slightly moist to dry					
15				10.8			5' screen between 50' to 55'
16							
			16.8				
17		End of Borehole					
18							
19							
20							
21							
22							
23							
24							

Logged: RSD
Method: Sonic Drill Rig
Date: Oct 28,2022

Datum: Existing Grades
Figure Number: A.2

APPENDIX B

GEOPACIFIC CONSULTANTS

Vancouver Lab
1779 West 75 Avenue
Vancouver, BC
V6P 6P2

MOISTURE CONTENT
(ASTM D2216)

CLIENT:	FABRIC LIVING DEVELOPMENTS LTD
PROJECT:	EAST 16TH RESIDENTIAL DEVELOPMENT
LOCATION:	461-475 EAST 16TH AVENUE, VANCOUVER

JOB #:	22015
RECEIVED:	31-Oct-22
TESTED:	1-Nov-22

REPORT #:	1

HOLE #:	TH22 - 01	TH22 - 01	TH22 - 01	TH22 - 01	TH22 - 01
DEPTH:	4'	8'	12'	19'	26'
M/C:	395.2%	42.7%	13.3%	18.2%	23.7%

HOLE #:	TH22 - 01	TH22 - 01	TH22 - 01	TH22 - 02	TH22 - 02
DEPTH:	33'	38'	48'	2'	8'
M/C:	8.3%	10.9%	15.4%	40.9%	30.6%

HOLE #:	TH22 - 02	TH22 - 02	TH22 - 02	TH22 - 02	TH22 - 02
DEPTH:	12'	17'	24'	28'	38'
M/C:	12.8%	17.5%	15.2%	24.3%	11.8%

HOLE #:	TH22 - 02	TH22 - 02			
DEPTH:	43'	48'			
M/C:	12.1%	10.8%			

HOLE #:					
DEPTH:					
M/C:					

HOLE #:					
DEPTH:					
M/C:					

COMMENTS:

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Lab Supervisor

Reviewed By: Jakub Szary, B.Sc., AScT

Lab Manager