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Coastal Priorities Properties
200 - 2240 Chippendale Road
West Vancouver, B.C.
V7S 3J5

Attention: Behzad Foroutan

September 5, 2017
File: 15265

Re: Geotechnical Investigation Report - Proposed Mixed Use Development
899 Esquimalt Road and 896 Wollaston Street, Victoria, B.C.

1.0 INTRODUCTION

We understand that a new mixed use development is proposed for the above referenced site. No development plans are available at this time, though we understand that the development will include a twelve storey tower and three storey townhomes with slabs-on-grade at the north and south sides of the site respectively. A two level below grade parkade is contemplated at the north side to accommodate the grade change across the site. We expect heavy reinforced concrete construction above and below grade for the tower and wood framed construction for the townhomes.

This report describes the results of our geotechnical investigation of the site and provides geotechnical recommendations for the design and construction of the proposed development. This report has been prepared exclusively for Coastal Priorities Properties, for their use and the use of others on their design and construction team for this project. We assume that the City of Victoria would rely on this report during their building permit review process.

2.0 SITE DESCRIPTION

The site encompasses a commercial lot and a residential lot which are developed with a three storey and one storey building, respectively. The lots are bound by Esquimalt Road to the north, Head Street to the west, Wollaston Street to the south, and adjacent commercial and single family residential lots to the east. The site slopes from north to south for a grade differential of approximately 8 metres, based on the City of Victoria GIS map. A bedrock outcrop is visible in the central portion of the site.

The site location relative to the surrounding developments is shown on our Drawing No. 15265-01, following the text of this report.

3.0 FIELD INVESTIGATION

GeoPacific completed a geotechnical investigation of the site on August 9, 2017 using a track-mounted drill rig supplied and operated by On-Track Drilling of Coquitlam, B.C. At that time a total of seven solid stem auger test holes were advanced to depths of between 0.6 and 4.9 metres below grade, where effective refusal was encountered at all locations. In addition, two Dynamic Cone Penetration Test (DCPT) soundings were advanced to depths of 0.6 and 1.5 metres, where effective refusal was encountered as well. All test holes

were supervised by a geologist from office who logged and sampled the soils encountered. The test holes were backfilled in accordance with provincial requirements following the completion of each test hole.

The approximate locations of our test holes are shown on our Drawing No. 15265-01, following the text of this report.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

The subsurface soil conditions generally consist of asphalt or topsoil over fill then marine clay over glacial till then bedrock. Topsoil was encountered in the landscaped areas and is 0.3 to 0.8 metres thick. Asphalt was encountered at one of the driveways and is 40 mm thick. The asphalt and topsoil are underlain by compact to dense, sand to sand and gravel fill which extends to a depth of 0.6 and 1.4 metres below grade. The fill is underlain by a 0.6 to 1.0 metre thick marine, very stiff to hard silty clay layer near the south property line of the site. The clay extends to a depth of between 1.5 and 2.4 metres below grade. At the south side of the central bedrock outcrop, the fills and clay are underlain by glacial till consisting of dense to very dense silty sand to sand and gravel. The till extends to a depth of between 2.1 and 4.9 metres below grade. The fills at the north side and the till at the south side are underlain by bedrock based on our observations at the surface of the site and during drilling.

The detailed test hole logs are presented in Appendix A of this report.

4.2 Groundwater Conditions

The static groundwater table was not encountered during our investigation. However, perched groundwater was encountered near the upper contact of the bedrock as well as within sandy zones of the glacial till. We expect that perched groundwater accumulates at the upper contact of the glacial till as well during wetter periods.

5.0 DISCUSSION

5.1 General

We understand that the development will consists of a twelve storey tower over a two level parkade and three storey townhomes with slabs-on-grade. We expect column and walls loads would be relatively heavy for for the tower and light for the townhomes.

The very stiff to hard marine clay, dense to very dense glacial till and bedrock are suitable to support the tower and townhomes on conventional spread foundations.

Excavations at the north side would encounter bedrock at a shallow depth, therefore any below grade levels at the north side would need to be blasted in to achieve the required depths. Excavations could be extended through the fills, marine clay, and glacial till with excavators, though large boulders in the till may require splitting/blasting to facilitate their removal. An upper, weathered portion of the bedrock may be present which can be commonly removed with excavators as well.

The subsurface soil conditions are not prone to liquefaction or any other forms of ground softening under the design earthquake defined under the 2012 BCBC.

We confirm that the proposed development is feasible from a geotechnical perspective provided that our recommendations are adhered to.

6.0 RECOMMENDATIONS

6.1 Site Preparation

We expect that the tower will be founded on bedrock and the townhomes will founded on very stiff to hard clay, or glacial till.

Prior to the construction of any footings or floor slabs, we recommend that all vegetation, topsoil, fill, organic soils, loose/disturbed or otherwise deleterious soils be removed to expose a subgrade of very stiff to hard clay, dense to very dense glacial till or bedrock.

Foundations can be constructed directly on a prepared bedrock surface free of any loose debris. Any grade reinstatement for footings deigned to be supported on bedrock should be done with lean mix concrete having an unconfined compressive strength of 5MPa.

Grade reinstatement beneath the townhomes, if required, should be done using engineered fill. In the context of this report, engineered fill is defined as clean sand to sand and gravel, compacted in 300 mm thick loose lifts to a minimum of 95% Modified Proctor maximum dry density at a moisture content within 2% of optimum for compaction.

6.2 Foundations and Bearing Capacity

The tower will be founded on the competent bedrock using conventional foundations. We expect that the bedrock will provide satisfactory support for the proposed development on conventional strip and pad foundations. We recommend that footings are designed using a Serviceability Limit States (SLS) bearing pressure of 2MPa.

The townhomes will be founded on very stiff to hard clay or engineered fill and the footings should be designed using an SLS bearing pressure of 120 kPa. For footings bearing on very dense glacial till, the SLS bearing pressure should be taken as 500 kPa.

Factored Ultimate Limit States (ULS) bearing pressures may be taken as 2 times the SLS bearing pressures provided.

We expect that the settlement of footings designed as recommended should be negligible both total and differential, well below typical structural tolerances of 25 mm total and 2 mm per metre span differential.

Irrespective of SLS bearing pressures, footings should not be less than 450 mm in width for strip footings and not less than 600 mm in width for square or rectangular footings. Footings supported on soil must be buried a minimum of 450 mm below grade for frost protection.

The geotechnical engineer shall be contacted for the review of all foundation subgrades.

6.3 Seismic Design of Foundations

We expect that this development will be submitted for permitting after the release of the upcoming 2017 BC Building Code slated for release later this year. We expect the site to be classified as Site Class A for footings underlain by less than 3 metres of soil and to be Site Class C for footings underlain by 3 metres of soil or more. This must be confirmed once the new building code has been released and prior to building permit application.

The new building code is expected to adopt the National Building Code of Canada 2015 seismic model. Therefore, we anticipate a design peak ground acceleration on firm ground for the 1 in 2475 year return period design earthquake is 0.58g (Natural Resources Canada, site coordinates: 48.430 deg. N, 123.400 deg W).

The subsurface soils are not considered prone to ground liquefaction or other forms of ground softening caused by the design earthquake.

6.4 Slab-On-Grade Floors Preparation

The floor slabs should be underlain by a minimum of 150 mm of 19 mm clear crushed gravel fill to inhibit upward migration of moisture beneath the slab. In addition, under slab drains will likely be required beneath the floor slab on grade to control groundwater inflows. Elevator pits and sumps may be tanked rather than lowering the perimeter drainage system in these areas.

The crushed gravel fill should be compacted to a minimum of 95% of the ASTM D1557 (Modified Proctor) maximum dry density at a moisture content that is within 2% of optimum for compaction.

The geotechnical engineer shall be contacted for the review of the slab subgrade and underslab materials and compaction.

6.5 Foundation Drainage

A perimeter drainage system will be required for below grade structures to prevent the development of water pressure on the foundation walls and the basement floor slabs. Groundwater flows are expected to be light, likely less than 50 litres/minute, for the entire excavation. These flow rates should be confirmed at the time of construction.

6.6 Earth Pressures on Foundation Walls

Earth pressures against buried foundation walls are dependent on factors such as, available lateral restraint along the wall, surcharge loads, backfill materials, compaction of the backfill and drainage conditions.

The foundation wall is expected to be partially yielding and fully restrained between the parking floors and backfilled with a free draining granular soil. We recommend the following earth pressures:

Static:Triangular soil pressure distribution of 4.5H kPa, where H is equal to the total wall height in metres.

Seismic:Inverted triangular soil pressure distribution of 5H kPa, where H is equal to the total wall height in metres.

The preceding loading recommendations assume that the foundation walls will be backfilled with free draining granular fill with perimeter drainage installed such that hydrostatic pressures against the foundation walls are eliminated.

The geotechnical engineer should be contacted for the review of all backfill materials and procedures.

6.7 Temporary Excavations

We expect that the upper very stiff to hard clay, dense to very dense glacial till and weathered bedrock can be cut at 4V:3H and near vertical below in competent bedrock. The upper fills and topsoil should be benched back from the top of the cut at a distance equal to the thickness of these soils.

The soils and weathered bedrock should be protected with poly sheeting. Excavations exceeding 1.2 metres in depth will require review by a professional geotechnical engineer, prior to worker-entry per WorkSafeBC requirements.

For any deeper excavations contemplated at the south side where soils are thicker, shoring could be used to allow for vertical excavations. We expect that the upper fills, clay and glacial till can be supported using conventional shotcrete and post-tensioned anchor shoring.

Some monitoring benchmarks would need to be established on the adjacent streets and buildings to permit monitoring of exposed cuts in the future. Locally mesh secured with rock bolts may be required to stabilize rock that is heavily jointed or weathered. We recommend a photographic pre-construction survey of the surrounding infrastructure and buildings, prior to any work at the site.

7.0 DESIGN AND CONSTRUCTION REVIEWS

The preceding sections make recommendations for the design and construction of the proposed mixed use development. We recommend that GeoPacific be retained to review certain aspects of the design and construction. It is important that these reviews are carried out to ensure that our intentions have been adequately communicated. It is also important that any contractors working on the site review this document prior to commencing their work.

It is the responsibility of the contractors working on-site to inform GeoPacific a minimum of 48 hours in advance that a field review is required. In summary, reviews are required by geotechnical engineer for the following portions of the work.

1. Excavation	Review of soil and rock cuts and rock support requirements
2. Foundation	Review of foundation subgrade.
3. Slab on-grade	Review of subgrade and underslab fill materials and compaction.
4. Backfill	Review of backfill materials and placement against foundation walls.

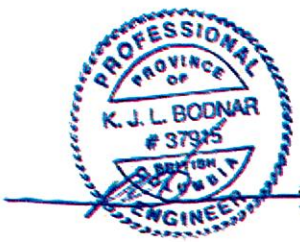
8.0 CLOSURE

This report has been prepared exclusively for our client, for their use and the use of others on their design and construction team and the City of Victoria for their permit review process. The report has been prepared based on information provided to us. Once the development plans area available we should review this report to ensure that our recommendations remain valid. If you would like further details or require clarification, please do not hesitate to contact the undersigned.

We are pleased to assist you with this project and we trust this information is helpful and sufficient for your purposes at this time. However, please do not hesitate to call if you should require any clarification.

For:
GeoPacific Consultants Ltd.

Reviewed by



Kevin Bodnar, M.Eng., P.Eng.
Principal

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

LEGEND:

△ TH#-# - TEST HOLE (TH) LOCATION

SITE PLAN

*TEST LOCATIONS ARE APPROXIMATE

REFERENCE:

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DATE:	09-Aug-2017	
DRAWN BY: ZH	APPROVED BY: KB	REVIEWED BY: ZH
SCALE: AS SHOWN		

PROPOSED MIXED USE DEVELOPMENT

899 ESQUIMALT RD & 896 WOLLASTON ST, VICTORIA, BC

TEST HOLE SITE PLAN

FILE NO: 15265

DWG. NO: 15265-01

REVISIONS:
A.
B
C.

APPENDIX A - TEST HOLE LOGS

Test Hole Log: TH17-01

File: 15265
Project: PROPOSED MIXED USE DEVELOPMENT
Client: COASTAL PRIORITIES PROPERTIES
Site Location: 899 ESQUIMALT RD. & 896 WOLLASTON ST., VICTORIA, BC

GEOPACIFIC CONSULTANTS
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INFERRED PROFILE

Depth (ft)	Depth (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	17.5				Elevations based on VicMap contour data
			Topsoil [FILL] loose TOPSOIL fill, some sand and gravel, black, trace roots, dry	0.0				
2				16.9				
			Sand [FILL] compact SAND fill, some gravel, brown, dry	0.6 16.6 0.9				
4	1		***Clay*** very stiff to hard silty CLAY, orange-brown, dry	16.0 1.5	22.9			
6			***Sand and gravel [Glacial till]*** very dense silty SAND and GRAVEL till, brown, slightly moist		9.8			Minor water seepage @ 2.1 m
8	2							
10								
	3			14.1				
12			***Sand [Glacial till]*** very dense silty SAND till, trace gravel, grey, slightly moist to moist	3.4				
14	4		moist to wet @ 4.6 m		9.6			Perched water @ 4.6 m
16				12.6				
	5		End of Borehole	4.9				Auger refusal @ 4.9 m (bedrock)
18								
20	6							
22								
24	7							

Logged: ZH
Method: Solid stem auger
Date: 09-Aug-2017

Datum: +17.5 m ASL
Figure Number: A.01

Test Hole Log: TH17-02

File: 15265
Project: PROPOSED MIXED USE DEVELOPMENT
Client: COASTAL PRIORITIES PROPERTIES
Site Location: 899 ESQUIMALT RD. & 896 WOLLASTON ST., VICTORIA, BC

GEOPACIFIC CONSULTANTS
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Tel: 604-439-0922 Fax:604-439-9189

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	17.5				Elevations based on VicMap contour data
		Topsoil [FILL] loose TOPSOIL fill, some gravel, trace sand, black, trace roots, dry	0.0 – 16.7				
1		***Sand and gravel [FILL]*** compact to dense SAND and GRAVEL fill, fine grained sand, brown, dry	0.8 – 16.1	3.8	3, 9, 37, >50, >50		
2		***Clay*** very stiff to hard silty CLAY, orange-brown, trace gravel, dry	1.4 – 15.1	25.3			DCPT refusal @ 1.5 m
3		***Sand and gravel [Glacial till]*** very dense silty SAND and GRAVEL till, brown, slightly moist	2.4				Minor water seepage @ 2.4 m
4		slightly moist to moist @ 3.7 m					Perched water @ 3.7 m
		End of Borehole	4.3 – 13.2				Auger refusal @ 4.3 m (bedrock)
5							
6							
7							

Logged: ZH
Method: Solid stem auger
Date: 09-Aug-2017

Datum: +17.5 m ASL
Figure Number: A.02
Page: 1 of 1

Test Hole Log: TH17-03

File: 15265
Project: PROPOSED MIXED USE DEVELOPMENT
Client: COASTAL PRIORITIES PROPERTIES
Site Location: 899 ESQUIMALT RD. & 896 WOLLASTON ST., VICTORIA, BC

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Depth (ft / m)	Symbol	SOIL DESCRIPTION (INFERRED PROFILE)	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface	23.0				Elevations based on VicMap contour data
		Asphalt (40 mm)	0.0		28		
1		**Sand and gravel [FILL]**					
2		compact to dense SAND and GRAVEL fill, brown, dry	22.4		>50		DCPT refusal @ 0.6 m
3 / 1			0.6				Auger refusal @ 0.6 m (bedrock)
4		End of Borehole					
5							
6 / 2							
7							
8							
9							
10 / 3							
11							
12							
13 / 4							
14							
15							
16 / 5							
17							
18							
19							
20 / 6							
21							
22							
23 / 7							
24							
25							

Logged: ZH
Method: Solid stem auger
Date: 09-Aug-2017

Datum: +23.0 m ASL
Figure Number: A.03
Page: 1 of 1

Test Hole Log: TH17-04

File: 15265
Project: PROPOSED MIXED USE DEVELOPMENT
Client: COASTAL PRIORITIES PROPERTIES
Site Location: 899 ESQUIMALT RD. & 896 WOLLASTON ST., VICTORIA, BC

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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	23.0				Elevations based on VicMap contour data
		Topsoil [FILL] loose TOPSOIL fill, some roots, some sand and gravel, black, dry	0.0 / 22.4				
		Sand [FILL] loose to compact SAND fill, some organics, some gravel, black, dry	0.6 / 21.9				
3 / 1		End of Borehole	1.1				Auger refusal @ 1.1 m (bedrock)
6 / 2							
10 / 3							
13 / 4							
16 / 5							
20 / 6							
23 / 7							
25							

Logged: ZH
Method: Solid stem auger
Date: 09-Aug-2017

Datum: +23.0 m ASL
Figure Number: A.04

Test Hole Log: TH17-05

File: 15265
Project: PROPOSED MIXED USE DEVELOPMENT
Client: COASTAL PRIORITIES PROPERTIES
Site Location: 899 ESQUIMALT RD. & 896 WOLLASTON ST., VICTORIA, BC

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Depth (ft)	Depth (m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
			Ground Surface	19.2				Elevations based on VicMap contour data
0	0		**Topsoil [FILL]** loose TOPSOIL fill, some roots, some sand and gravel, black, dry	0.0				
2				18.6				
			Sand [Till like] dense to very dense silty SAND, till like, orange-brown, trace gravel, dry	0.6				
3	1							
6					7.1			
7	2			17.1				
			End of Borehole	2.1				Auger refusal @ 2.1 m (bedrock)
10	3							
13	4							
16	5							
19	6							
23	7							
25								

Logged: ZH
Method: Solid stem auger
Date: 09-Aug-2017

Datum: +19.2 m ASL
Figure Number: A.05

Test Hole Log: TH17-06

File: 15265
Project: PROPOSED MIXED USE DEVELOPMENT
Client: COASTAL PRIORITIES PROPERTIES
Site Location: 899 ESQUIMALT RD. & 896 WOLLASTON ST., VICTORIA, BC

GEOPACIFIC CONSULTANTS
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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
ft / m		Ground Surface	19.0				Elevations based on VicMap contour data
0 / 0		**Topsoil [FILL]**	0.0				
1		loose TOPSOIL fill, black, dry	18.7				
2		**Sand and gravel [FILL]**	0.3				
3 / 1		compact SAND and GRAVEL fill, some roots, brown, dry	18.2				
4		**Sand [Till like]**	0.8				
5		dense to very dense silty SAND, till like, trace gravel, orange-brown, dry		13.9			
6 / 2		slightly moist after 1.7 m					Minor water seepage @ 1.7 m
7							
8							
9							
10 / 3			16.0	12.2			
11		End of Borehole	3.0				Auger refusal @ 3.0 m (bedrock)
12							
13 / 4							
14							
15							
16 / 5							
17							
18							
19							
20 / 6							
21							
22							
23 / 7							
24							
25							

Logged: ZH
Method: Solid stem auger
Date: 09-Aug-2017

Datum: +19.0 m ASL
Figure Number: A.06
Page: 1 of 1

Test Hole Log: TH17-07

File: 15265
Project: PROPOSED MIXED USE DEVELOPMENT
Client: COASTAL PRIORITIES PROPERTIES
Site Location: 899 ESQUIMALT RD. & 896 WOLLASTON ST., VICTORIA, BC

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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	22.7				Elevations based on VicMap contour data
		Topsoil [FILL]	0.0				
1		loose TOPSOIL fill, black, dry	22.4				
			0.3				
2		***Sand and gravel [FILL]***					
3 / 1		compact SAND and GRAVEL fill, brown, trace silt, dry	21.8				Auger refusal @ 0.9 m (bedrock)
			0.9				
4		End of Borehole					
5							
6 / 2							
7							
8							
9							
10 / 3							
11							
12							
13 / 4							
14							
15							
16 / 5							
17							
18							
19							
20 / 6							
21							
22							
23 / 7							
24							
25							

Logged: ZH
Method: Solid stem auger
Date: 09-Aug-2017

Datum: +22.7 m ASL
Figure Number: A.07
Page: 1 of 1