



**REPORT TO THE JUAN DE FUCA LAND USE COMMITTEE
MEETING OF TUESDAY, NOVEMBER 15, 2016**

SUBJECT **Floodplain Exemption for Lot 10, Section 2, Renfrew District, Plan VIP83339 – 3521 Waters Edge Drive**

ISSUE

A request has been made for a floodplain exemption in order to construct a single-family dwelling within the floodplain setbacks specified in Part 5 of the Juan de Fuca Land Use Bylaw, 1992, Bylaw No. 2040.

BACKGROUND

The vacant 1.17 ha property is located on Waters Edge Drive in Jordan River and is zoned Rural Residential 2A (RR-2A) in Juan de Fuca Land Use Bylaw, 1992, Bylaw No. 2040. The property is bounded by RR-2A zoned properties to the east and west, Waters Edge Drive to the north, and the Strait of Juan de Fuca to the south (Appendix 1). The applicants now propose to construct a single-family dwelling (Appendix 2).

The parcel was created in June 2007 as part of a 63-lot subdivision. As a condition of subdivision, a geotechnical engineer assessed the parcels for hazards, and the preliminary report (Appendix 3) was secured as a covenant on title. The covenant restricts building construction until such time as a site specific review has been conducted by a geotechnical engineer. An additional covenant was registered on title as part of the subdivision process restricting building within 30 m and not less than 4 m above the natural boundary of the sea.

The floodplain regulations, as outlined in Part 5, Section 2.0 (2)(e) of Bylaw No. 2040, specify that the floodplain setback is a horizontal distance from the crest of the slope equal to three times the height of the bank. Since the height of the embankment is approximately 45 m, the setback from the crest of the slope is approximately 135 m.

As the proposed building site is within the floodplain setback, the applicant has requested a floodplain exemption pursuant to Section 524(7)(b) of the *Local Government Act (LGA)*. In support of the exemption, a geotechnical engineer's report has been submitted, which specifies that a 15 m setback from the crest of the slope is safe for Lot 10 provided that the Engineer's recommendations are followed (Appendix 4).

ALTERNATIVES

That the Land Use Committee recommends to the Capital Regional District Board:

1. That floodplain exemption DV000051 for Lot 10, Section 2, Renfrew District, Plan VIP83339 be granted subject to the following conditions:
 - a) That development of the property comply with the recommendations outlined in the professional geotechnical engineer's report prepared by Ryzuk Geotechnical, dated October 4, 2016;
 - b) That the building setback be verified by survey prior to completion of the building permit; and
 - c) That the professional geotechnical engineer's report prepared by Ryzuk Geotechnical, dated October 4, 2016, be secured via a restrictive covenant registered on title pursuant to section 524(8)(c) of the *Local Government Act*.
2. That floodplain exemption DV000051 be denied.

3. Refer the application back to staff for additional information.

LEGISLATIVE IMPLICATIONS

Section 524 of the *LGA* authorizes local governments to designate areas as floodplains and to specify flood levels, setbacks and other related provisions. Part 5 of Bylaw No. 2040 outlines requirements for floodplain management. Local government may exempt a person from the floodplain bylaw pursuant to Section 524(7) of the *LGA*.

PUBLIC CONSULTATION IMPLICATIONS

There is no statutory or bylaw requirement to notify members of the public about a request for a floodplain exemption. Notice of the Land Use Committee meeting is posted on the CRD website and in the newspaper. Any comments received from the public will be presented at the November 15, 2016, Land Use Committee meeting.

LAND USE IMPLICATIONS

The parcel is partially designated as a foreshore and steep slope development permit area in the Shirley/Jordan River Official Community Plan, Bylaw No. 3717. However, since the proposed building site is outside of the foreshore and steep slope development permit areas, a development permit is not required. Staff also note that the subject property is located outside the inundation zone for Jordan River that has been assessed by BC Hydro. The inundation zone relates to the area at risk of a catastrophic failure of the Diversion Dam brought about by a major earthquake.

The January 8, 2007, geotechnical engineer's assessment of the property identified previous erosion of the foreshore slope and the potential for ongoing instability in the steep ocean foreshore slopes and recommended building setbacks from the slope crest. More accurate setbacks from the slope crest were to be determined at the time of construction. The report considered a frequency of occurrence of a potential hazard in terms of a 10% probability in 50 years.

The floodplain regulations, as outlined in Part 5, Section 2.0 (2)(e) of Bylaw No. 2040, specify that the floodplain setback for a slope that is subject to erosion by the sea is a horizontal distance from the crest of the slope equal to three times the height of the bank. Since the height of the embankment is approximately 45 m, the setback from the crest of the slope is approximately 135 m. This setback encompasses the entire property.

The slope stability review by Ryzuk Geotechnical, dated October 4, 2016, is specific to Lot 10, and was conducted using the current slope stability guidelines of the 2012 *BC Building Code* (2% within 50 year probability of seismic event). The 2007 engineer's report did not specify a setback from the slope for lot 10 and the ridge of the slope has since been altered. Ryzuk Geotechnical conducted a stability analysis of the foreshore slope and assessed the severity of toe erosion identified in 2007. Part of the ridge has been removed and excavated fill has been placed to the north of the building site towards the road. The foreshore slope is now approximately 45 m in height with an inclination of 35 degrees. Vegetation on the center of the slope has been pruned and cleared with stumps remaining.

The engineer confirmed that 15 m is an adequate set back from the crest of the slope for the proposed residence, which includes a full basement. Additional habitable structures and the placement of fill on the property should be set back at least 20 m from the top of bank as indicated on the survey plan, unless supplementary geotechnical assessment indicates that a lesser setback would be acceptable. The recommended setback is designed to protect the residence over its lifetime, although there does remain some risk of loss of land from surficial slides. However, provided that the recommendations outlined in the report are implemented, it is the Engineer's professional opinion that the location of the proposed residence is safe from geologic

hazard and suitable for the use intended. Based on this opinion, the report meets the requirements of Section 524(7)(b) of the *LGA*. Therefore, staff recommend that the floodplain exemption be granted subject to the conditions outlined in the Ryzuk Geotechnical report (Appendix 4), the report being secured via a restrictive covenant, and verification of the building foundation location by a BC Land Surveyor.

CONCLUSION

The applicant has requested a floodplain exemption on Lot 10, Section 2, Renfrew District, Plan VIP83339 for the purpose of constructing a single-family dwelling. A report, prepared by Ryzuk Geotechnical, specifies a minimum 15 m setback for the single-family dwelling from the crest of the slope, and provides specific recommendations for building construction to ensure the structure is safe for the use intended. A 20 m setback is recommended for all future development on the property. Staff recommend exempting the subject property from the floodplain setback subject to the conditions of the geotechnical report, securing the report via a restrictive covenant, and verification of the building location by a BC Land Surveyor.

RECOMMENDATION

That the Land Use Committee recommends to the Capital Regional District Board:

That floodplain exemption DV000051 for Lot 10, Section 2, Renfrew District, Plan VIP83339 be granted subject to the following conditions:

- a) That development of the property comply with the recommendations outlined in the professional geotechnical engineer's report prepared by Ryzuk Geotechnical, dated October 4, 2016;
- b) That the building setback be verified by survey prior to completion of the building permit; and
- c) That the professional geotechnical engineer's report prepared by Ryzuk Geotechnical, dated October 4, 2016, be secured via a restrictive covenant registered on title pursuant to section 524(8)(c) of the *Local Government Act*.

Submitted By:	Emma Taylor, MCIP, RPP, Planner
Concurrence:	Iain Lawrence, Manager, Local Area Planning
Concurrence:	Kevin Lorette, P.Eng., MBA, General Manager, Planning & Protective Services
Concurrence:	Bob Lapham, MCIP, RPP, Chief Administrative Officer

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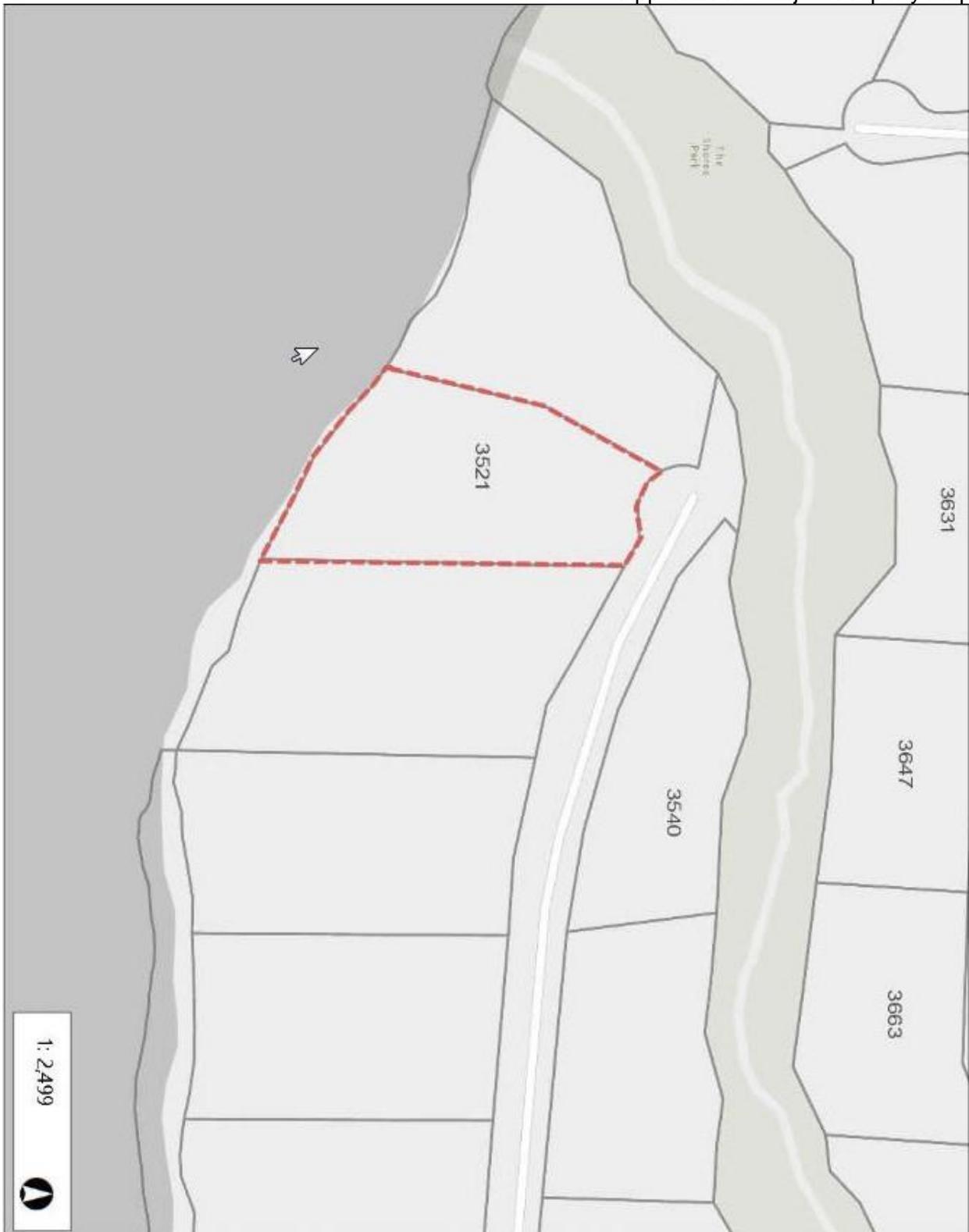
Appendix 1: Subject Property Map

Appendix 2: Site Plan

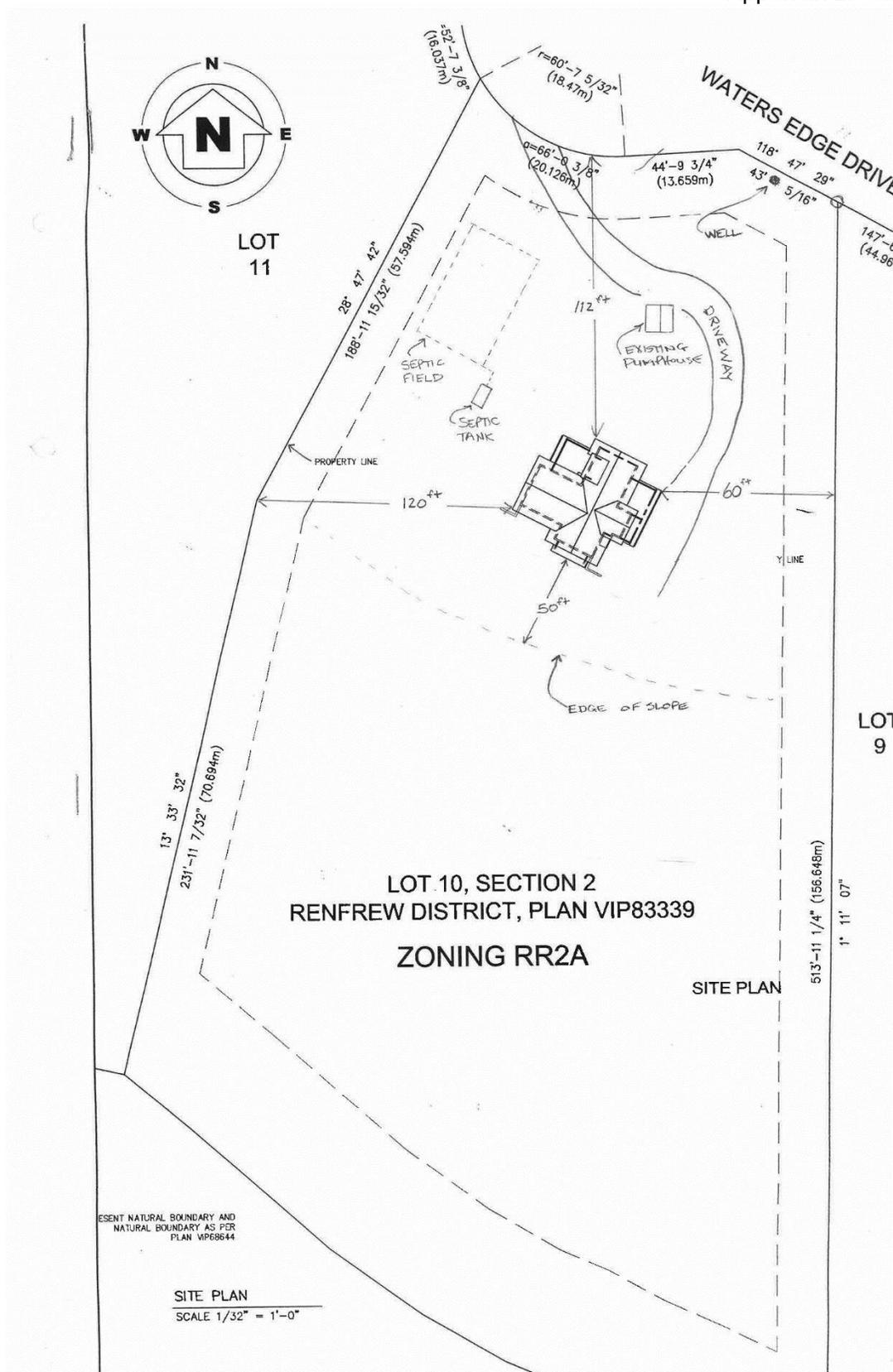
Appendix 3: Levelton Engineering Solutions Report, January 8, 2007

Appendix 4: Ryzuk Geotechnical Report, October 4, 2016

Appendix 1: Subject Property Map



Appendix 2: Site Plan



Appendix 3: Levelton Engineering Solutions Report, January 8, 2007

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Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16.14.00

SCHEDULE A

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Construction Materials
Building Science
Geotechnical
Metallurgy and Corrosion
Environmental
Analytical Chemistry
Physical Testing

Attention: [REDACTED]

Dear Sir:

**RE: Geotechnical Summary Report
Proposed 63-Lot Shores at Jordan River Subdivision
Lot 1, Section 2, Jordan River, BC**

1. Introduction

Levelton Consultants Ltd (Levelton) was retained by 0745324 BC Ltd. to provide geotechnical review and materials testing services for the proposed two phase sixty three Lot residential subdivision known as the Shores at Jordan River. Our services included a design component that was focussed towards the determination of geotechnical setbacks for habitable structures and a construction support component that was provided in support of the civil design of roadways. At the time of writing, materials testing services were on-going for the majority of the roads.

This report presents the results of our geotechnical assessment for setback requirements for habitable structures from steep slopes. It also provides a summary of the testing results to date in support of a request from 0745324 BC Ltd. to gain authorization from the MOT to pave the roadways in Phase 1 of the subdivision. We anticipate that a supplementary letter report will need to be provided by Levelton once the testing is complete.

The project civil engineer, Focus Corporation, has developed recommendations for stormwater management that are reported under separate cover. Levelton's work was completed in general accordance with our proposal of October 16, 2006.

Richmond Victoria Nanaimo Courtenay Surrey Abbotsford Prince Rupert Calgary

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2. Background Information

The site is located on the south side of West Coast Road, immediately west of the town of Jordan River. The Strait of Juan de Fuca borders the property on the south side and West Coast Road borders the north and east sides of the property. The site occupies an area of approximately seventy eight hectares, as shown in Figures 1 and 2. Once complete, the subdivision will comprise sixty three single family residential lots that will be developed in two phases. The two phases are separated by the First Creek gully, which trends southwest through the site. Phase 1 comprises twenty five Lots and is located on the south side of First Creek. Phase 2 comprises the remaining thirty eight Lots and is located north of First Creek. The subdivision layout is shown in Figure 2.

The BC Ministry of Transportation (MOT) issued a preliminary layout approval (PLA) for the subdivision on June 16, 2006, subject to a series of conditions. One of the conditions identified on the PLA was the need to retain a geotechnical engineer to assess the potential for a natural hazard to exist on the lands. It was identified in the PLA that the geotechnical engineer should consider the frequency of occurrence of a potential hazard in terms of a 10% probability in 50 years. That return period corresponds to the design earthquake as defined in Building Regulation M268 of the recently adopted 2006 BC Building Code.

Mr. Carl Miller P.Eng., and Mr. Alec Morse, P.Eng. of Levelton's engineering staff visited the site at intervals during the course of construction. Based on our review of the site, it is our opinion that the potential natural hazard that is referred to in the MOT PLA pertains solely to the potential for instability in the steep ocean foreshore slope and/or in the First Creek river valley slopes. As such, the potential hazard has influence on the oceanfront Lots 1 through 11, 15, 16 and 26 and creek side Lots 19, 20, 21, 22, 25 and 27 through 32. Based on our reconnaissance of the site, we are not aware of other geotechnical natural hazards that would need to be considered in the design and construction of the subdivision. Accordingly, our design services have focussed towards the assessment of the stability of the steep slopes and the development setback from the crest of the slopes for habitable structures.

We are aware that a large underground metaliferous (copper) mine was worked in the early part of the twentieth century in an area north east of the subject property. Our research indicated that the abandoned workings of the mine were located approximately 1 mile upstream from the mouth of the Jordan River, on the east side of the river. Mining continued at intervals until about 1950 and resumed again in 1960's until a final closure in 1974. We are not aware of any commercial mining activity at that location since then.

Levelton obtained the available maps of the mining operations from the Ministry of Mines to establish that the workings were not of a concern to the subject property. The information indicated that all

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activity occurred east of the Jordan River and, therefore, the risk of adverse geotechnical impact on the site was considered to be negligible.

3. Slope Stability Review and Assessment

3.1 Slope Reconnaissance

The site is largely forested with an undulating topography that ranges from sea level up to an elevation of about 75 m with the majority of the land to be developed lying between elevations of 40 to 75 m above sea level. The foreshore slope that bounds the southern edge of the subdivision ranges in height from about 45 to 55 m, the lower approximately 10 m of which typically becomes flatter. The inclination of the upper portion of the slope ranges from 30 to 40 degrees, as determined from survey provided to Levelton by the Focus Corporation. The First Creek valley side slopes increase in height from a minimum of about 8 m at the upper end of the valley to a maximum of close to 36 m at the ocean front. The inclination of the valley slopes range from typically 30 to 38 degrees with locally steeper slopes and areas of benching.

The foreshore slope was well vegetated with a mix of mature evergreen and deciduous trees and a dense understory that required the use of machete to gain access. No signs of apparent instability or old landslides were observed in the upper and mid sections of the slope. The shape of the tree trunks in these areas was, in general, relatively straight and not deformed through slope creep. A traverse of the toe of the slope indicated that groundwater seepage from the lower portion of the slope was common to Lots 1 to 11 and 26. A number of large diameter spruce (1.5 m dia.) were observed in the toe area below Lots 4, 5, 8, 10 and in the First Creek mouth between Lots 11 and 26. The trees were estimated to be several hundred's of years in age.

Marine toe erosion appeared to be quite limited, likely due to the heavy armouring of cobbles, boulders and large woody debris on the foreshore. An estimated 0.5 to 0.8 m of toe erosion was noted at Lot 2, in the small bay area at Lot 5 and again at Lot 10. Indications of local sloughing and slope creep in the lower portion of the slope was evident from leaning trees and from local areas of slope material piled against tree trunks/stumps at Lots 7, 8 and 10. The vegetation in the lower area was very dense and difficult to access.

First Creek was accessed at the mouth and traversed into the site. It was noted that the vegetation of the valley slopes was quite dense and that several large diameter spruce were present in the flatter mouth area. The creek was present in the lower portion of the valley but disappeared to ground at an estimated elevation of 15m above high tide. Local sloughing and some distortion (pistol-butting) in tree stem growth was observed although no large scale or deep seated type movements were noted.

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3.2 Subsurface Conditions

Soil exposures on both the oceanfront and creek side slopes were limited. An outcropping of heavily over-consolidated, hard, grey, clayey silt with a blocky texture was observed at sea level at the toe of Lot 1. A small exposure of very dense fine grained sand was observed at an estimated elevation of 15 m above high tide on the north side of First Creek. Soil exposures in the upper plateau level of the site were abundant and include compact to dense well graded sand and gravel with cobbles. The thickness of the sand and gravel in road cut exposures ranged up to approximately 6 m.

A number of water wells were being advanced at the time of our assessment. Levelton periodically reviewed the soil cuttings from several holes and corresponded with the waterwell contractor, Drillwell Enterprises Ltd., with respect to changes in lithology and depth to groundwater. The notes taken by Drillwell Enterprises Ltd, indicated that the surficial sand and gravel extended to depths of typically 20 to 25 m and was underlain by very dense, till-like clayey sand. Groundwater was encountered towards the interface of the sand and gravel with the till-like soils, which is supportive of the observations in First Creek.

A limited subsurface exploration program was undertaken by Levelton Engineering Ltd. in the 1990's. The investigation at that time was focussed towards the use of the site as a possible sand and gravel pit. All test holes were terminated in dense, clean, sand and gravel. No seepage was encountered in those test pits.

3.3 Discussion on Slope Stability

In order to assist in our assessment of the stability of the ocean foreshore and creek slopes, and to determine appropriate setback distances from the crest for the siting of habitable structures, Levelton has undertaken an assessment of the stability of the natural slopes. We note that the determination of a geotechnical building setback distance from the crest of a slope includes a review of the slope geometry, slope materials, vegetation, external loads, erosion, ground and surface water. The following sub-section briefly identifies the slope instability mechanisms and includes a brief explanation of the slope stability model used for static and dynamic (earthquake) conditions.

Based on the geometry, slope materials, and features at this site, Levelton anticipates two types of landslides that may affect the lots and they are described as:

- Shallow translational slides: which may occur at any point along the steep slopes but will likely be limited to approximately a 2m depth; and

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- Deep-seated slides: which may occur under static or dynamic conditions where a steep back scarp leads down to a compound failure surface where the majority of lateral movement takes place close to the interface of the sand and gravel with the dense till.

The triggering event that causes slope instability may be from natural means, man-made causes or a combination of both. The two lists below highlight frequent causes of slope instability that potentially can affect this site.

Natural events which can cause slope instability at this site include:

- Excessive rainfall creating high groundwater tables;
- Loss of vegetation by strong wind events or fire;
- Toe erosion from the ocean or from the creek; and
- Earthquakes.

Man-made events which can cause slope instability at this site include:

- Redirected surface and ground water to the slope;
- Placement of fill materials at the crest and over the slope;
- Loss of vegetation through logging activities; and
- Change in slope geometry from construction of access trails to the toe of the slope (cut and fill).

The majority of these landslide initiation mechanisms would result in a shallow translational slide. However, it is the potential for a deep-seated compound failure that governs our recommended geotechnical setback distance. In particular, the dynamic or earthquake scenario has the potential for reaching the farthest from the crest of the slope. A brief discussion of the static and dynamic slope stability analysis for the deep-seated landslide is provided in the following section.

3.4 Slope Stability Analysis

Levelton completed slope stability analyses for a number of surveyed sections down the slope using the subsurface information described above. The computer model SlopeW Limit Equilibrium Slope Stability Software was used to model the deep seated stability of the slope. Table 1 summarizes the values used in the stability analysis.

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Table 1: Slope Stability Model Parameters – Long term drained case

Material	Soil Unit Weight (kN/m ³)	Cohesion (kPa)	Phi angle (degrees)
Dense Sand and Gravel	22	0	38
Dense Sand and Silt	22	0	40
Hard Till	22	0	42

An effective stress analysis was carried out on select lots using site specific survey data as provided through Focus to assess the long term stability of the slope. Two separate slope stability analysis were completed: static and dynamic. The static analysis represents the most common loading and water table conditions. The dynamic analysis includes the external earthquake acceleration to the ground. The design earthquake used for the dynamic case was the 1 in 475 year event for which both the MOT PLA permit and the December 14, 2006 Building Regulation M268 pertain. The Pacific Geoscience Centre was contacted and provided the seismic design information that is attached to this report. The peak ground acceleration values used in the analysis were reduced in accordance with the procedures described by Marcuson et al (1990).

The development setback was considered in terms of a theoretical factor of safety against deep seated sliding of 1.5 in the static analysis and above 1.0 for the 1 in 475 year dynamic analysis. As noted, the calculated setback results from the two cases were similar, as summarized in Table 2.

Table 2. Summary of Preliminary Geotechnical Setback for Habitable Structures

Lot No.	Setback under Static Conditions (m)	Setback under Dynamic (1 in 475 yr)	Recommended Minimum Geotechnical Setback (m)
1	19	19	19
3	17.5	17.5	17.5
4	14	13	14
7	25	25	25
11	21	21	21 ¹
15	14	14.5	14.5
16	24	24.5	24.5
19	22	22	22
20	2	2	6 ²
21	3	3	6 ²
26	0	0	6 ²
28	0	0	6 ²
31	18	19	19

Note: ¹ Lot 11 has creek and foreshore setbacks along with a crest ridge that we anticipate will be removed during site preparation. The tabled value reflects our anticipated final configuration and needs to be reviewed during design.

² The minimum recommended preliminary geotechnical setback is 6 m regardless of assessment due the potential requirements for access and uncertainty of conditions near the slope crest.

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For the purpose of the MOT PLA, Levelton has developed a preliminary development setback line from an interpolation of the site specific slope stability analysis provided in Table 2. The interpolated preliminary setback line is shown on Figure 3 and its application discussed below.

4. Discussion and Recommendations

4.1 General

In general, the site is considered to be geotechnically suitable for the intended use of a single family home residential subdivision. Away from the steep slopes, the ground conditions are dominated by a thick deposit of compact to dense, relatively free draining sand and gravel. This natural deposit provides opportunity for favourable road subgrade and foundation support for proposed single family dwellings.

Our site assessment indicates that the potential natural hazard referred to in the MOT PLA relates to the steep slopes along the ocean foreshore and along First Creek. It is proposed that the potential hazard to habitable structures be mitigated through a development setback, as described in Section 4.2.

Road construction for the subdivision is nearing completion. Periodic field reviews have been made during the course of construction and it is our opinion that the construction meets with the intent and requirements of the MOT PLA as described in Section 4.3.

Stormwater management is discussed in two separate documents (Phase 1 and 2) prepared by Focus Corporation. Drainage considerations are outlined in Section 4.4, below.

4.2 Potential Geotechnical Hazards and Siting of Habitable Buildings

As described in Section 3, it will be necessary for habitable structures to be setback from the crest of the ocean foreshore slope and from the crest of First Creek. We note that riparian and municipal setbacks may also apply to the lots and that the minimum preliminary geotechnical setback given in Table 2 may not be the governing setback.

The geotechnical development setback is intended to site the habitable structures sufficiently far back from the crest of a slope that the potential for slope instability to impact the buildings over the normal design lifetime of the structures is acceptably low. For this project, the MOT has defined that criterion as being an approximately 10% chance of exceedance in 50 years. It is important to note that the use of a development setback does not preclude the potential of future instability in the area between the slope crest and the setback. There are active processes on and adjacent to a number of the lots which can influence stability. Notable processes include the potential for toe erosion and

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earthquake shaking along with the man-made influences described in Section 3. It is possible that a loss of land, property value and enjoyment could result from future instability.

The interpolated preliminary setback line that is shown on Figure 3 is intended to provide the information necessary to meet the requirements of the MOT's PLA. This line should be considered preliminary in nature and we note that site specific geotechnical investigations may be undertaken to refine and/or determine an actual setback for a given property. In particular, site specific assessments should be undertaken if the proposed development of a property anticipates significant grade changes.

The definition of the slope crest is subject to interpretation and it is recommended that the Geotechnical Engineer visit each lot prior to house construction to define the crest and necessary setback distances for the building envelope.

As noted in Section 3.3, there are active natural processes along with the potential for man-made changes that can negatively impact the stability of a slope. We would advise that owner's make themselves aware of the processes discussed herein and that, in particular, an annual review of the slope toe area be conducted to review possible wave erosion and implement action, if needed.

In terms of foundation bearing for the proposed structures, we anticipate that a shallow foundation system supported on an approved surface of the native compact to dense sand and gravel will be suitable for foundation support. The excavated materials will be loosened by the excavation process and it will be necessary to recompact loosened material prior to the placement of foundation concrete. We recommend that an allowable bearing capacity of 150 kPa be utilized for foundation design subject to field review and conformation of bearing soils.

4.3 Roadways

The road system is shown on Figures 2 and 3. Phase 1 of the subdivision includes Road E and F. We understand that the originally planned Road G has been deleted. Phase 2 includes Roads A through D. A typical cross section provided by the MOT indicated that the road structure should consist of:

Material	Thickness (mm)
Class 1 medium mix hot asphalt	55
25 mm well graded base course	150
75 mm pit-run - SGSB	150
	Approved subgrade

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Subsequently, it was identified by the MOT that the 75 mm material should be a crushed base course as opposed to pit run SGSB.

The subgrade throughout the site comprises sand and gravel. MOT and Focus have undertaken field reviews and proof rolling of the subgrade. Levelton has attended site periodically to undertake compaction test results. Final compaction tests taken to date for Roads E and F in Phase 1 of the subdivision, and for a portion of Road A in Phase 2, have met or exceeded the MOT requirements for roads E and F, as indicated in Appendix 1.

Our site observations indicate that road construction carried out to date has mainly consisted of excavation into the native sand and gravel and thorough compaction of the road subgrade with a heavy steel drum, vibratory roller. Some areas of structural filling were required to provide the design elevations of the roads. Filling was carried out in approximate 300mm thickness lifts, also compacted with the vibratory roller.

Gradation compliance testing to date has been undertaken for the following materials. Test results are included in Appendix 1.

Material	Testing and Comments
<u>Natural Subgrade</u>	
Road A	Gradation – 6.7% fines
Road B	Gradation – 3.0% fines
Road C	Gradation – 9.7% fines
Road D	No testing
Road E	Gradation – 6.3 and 4.2% fines
Road F	Gradation – 9 and 11% fines
<u>25 mm well graded base course</u>	Gradation – 4.5 % fines met MOT
<u>75 mm crush gravel</u>	Gradation – 4.3 % fines met MOT

* fines indicates material passing the 0.075 mm sieve size.

Further compaction testing and asphalt testing is to be undertaken to verify conformance with MOT specification requirements. Test results will be provided under separate cover once complete.

4.4 Drainage Considerations

The presence of a permeable native sand and gravel deposit and a relatively deep watertable affords opportunity for in-ground disposal of stormwater from roofs and from perimeter foundation drains. If in-ground disposal is to be considered, we recommend that a specific lot review be

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completed by the Geotechnical Engineer once the lot development and roof area are known. We note that any private in-ground disposal system requires maintenance to remain effective.

Stormwater management for roadways is presented in two separate documents (Phase 1 and 2) prepared by Focus Corporation.

4.5 Further Geotechnical Input

This preliminary report has been prepared to address the MOT's PLA requirements with respect to the potential for a natural hazard and options that might be available to mitigate the hazard to level considered to be acceptable under their criteria of a 10 percent chance of exceedance in 50 years. In terms of quality assurance testing for the construction of roads and underground infrastructure for the subdivision, there have been periodic reviews throughout that process and further work is expected, the results of which would be presented under separate letter.

With respect to the proposed individual residential structures that are to be developed on the private Lots at some time in the future, there will need to be specific geotechnical review completed on a Lot by Lot basis for the steep slope properties to address the geotechnical items presented herein. We anticipate that such studies could lead to a refinement of the preliminary interpolated setback line that is present herein.

5. Limitation and Closure

This report has been prepared for the exclusive use of 0745324 BC Ltd. for application to the proposed development at the captioned site. The report has been prepared in accordance with standard geotechnical engineering practice. No other warrantee, expressed or implied, is made.

Any use of this report by an unauthorized third party, or any reliance on, decisions made, or actions taken based on it by such third parties, are their responsibility. Levelton does not accept responsibility for damages suffered, if any, by an unauthorized third party as a result of their use of this report. The BC Ministry of Transportation is considered to be an authorized third party and may rely on the report subject to the terms of engagement under which it was prepared. Contractors should make their own interpretation of the soil logs and the site conditions for the purposes of bidding and performing work on the site.

The discussion and recommendations contained in this report are based on information obtained from discrete locations. Subsurface conditions are based on well records and exposures and actual soil and groundwater conditions may vary. It is recommended that confirmatory reviews be completed to verify the preliminary setbacks presented herein.

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We trust that this report is satisfactory for your current requirements. If any questions should arise or further information be required, please contact the writer at your convenience.

Yours truly,
LEVELTON CONSULTANTS LTD.

Reviewed by:

Carl Miller
A circular professional engineer seal for Carl Miller, M.Sc., P.Eng., with the number 907. The seal includes the text "PROFESSIONAL ENGINEER" and "C. MILLER".

Don Kaluza

Per:
Carl Miller, M.Sc., P.Eng.
Senior Geotechnical Engineer

Don Kaluza P.Eng.
Senior Geotechnical Engineer

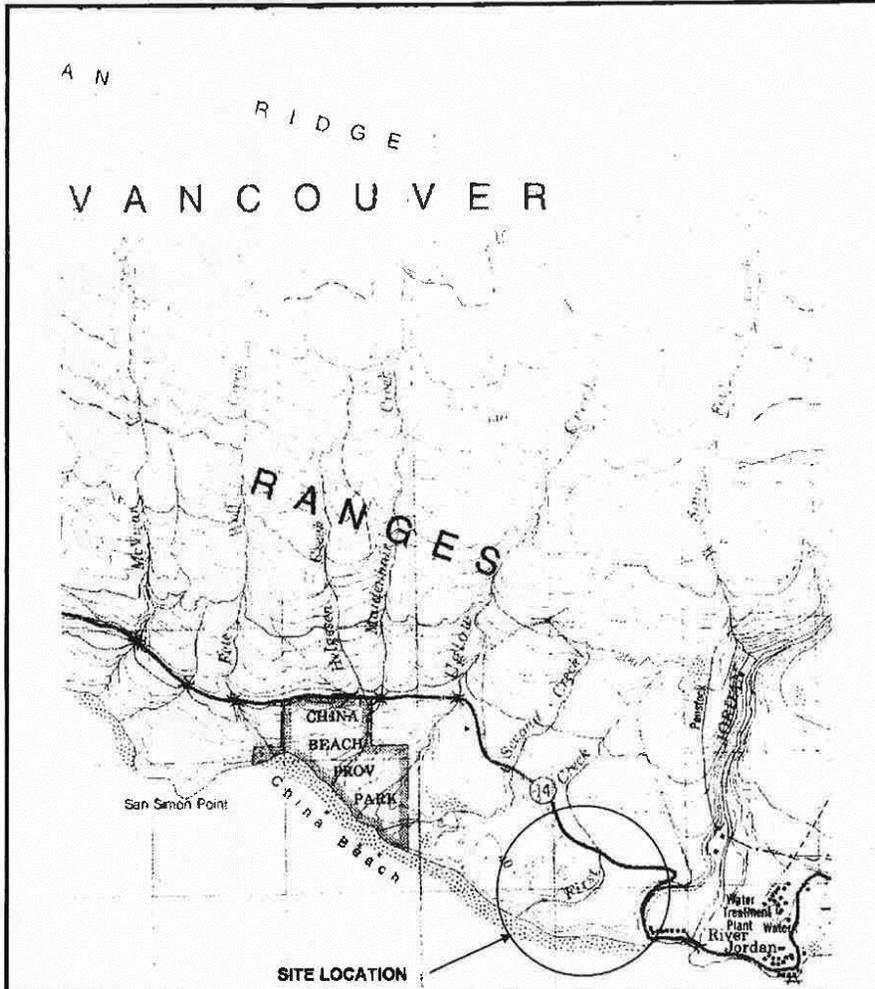
Attachments: Figures 1 to 3
Pacific Geoscience Seismic Design Calculations
Appendix 1. Construction Test Reports

Status: Registered

Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16:14:00

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	PROJECT: THE SHORES OF JORDAN RIVER				
	TITLE: SITE LOCATION PLAN				
	CLIENT: [REDACTED]				
FIGURE NO.: 1	DATE: NOVEMBER 2006	FILE NO.: 506-0164	SCALE: NTS	DRAWN BY: KS	REV NO.:

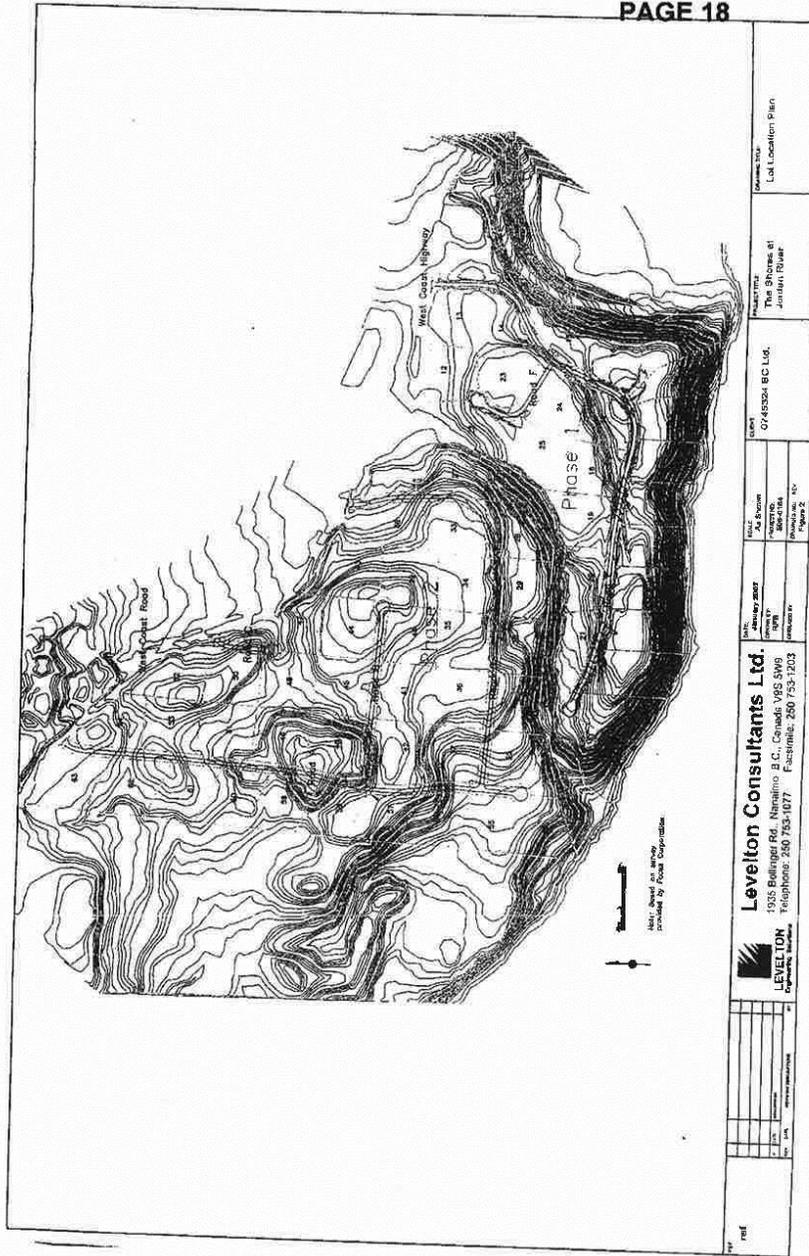
Levelton Consultants Ltd., 1935 Bollinger Road, Nanaimo, B.C. V9S 5W9 Phone: 250/753-1077 Fax: 250/753-1203 Email: nanaimo@levelton.com

Status: Registered

Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16:14:00

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<p>Levelton Consultants Ltd. 5935 Bellinger Rd., Nanaimo B.C., Canada V9S 5W9 Telephone: 250 753-1077 Fax: 250 753-1203</p>	<p>DATE: 07/25/2014 DRAWN BY: J. Brown CHECKED BY: J. Brown PROJECT: Phase 1 SHEET: 18 of 21</p>	<p>PROJECT: Phase 1 ROAD: West Coast Highway</p>	<p>DATE: 07/25/2014 DRAWN BY: J. Brown CHECKED BY: J. Brown PROJECT: Phase 1 SHEET: 18 of 21</p>	<p>DATE: 07/25/2014 DRAWN BY: J. Brown CHECKED BY: J. Brown PROJECT: Phase 1 SHEET: 18 of 21</p>
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Status: Registered

Doc #: FB67168

RCVD: 2007-06-29 RQST: 2014-12-04 16:14.00

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2005 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8896
 Western Canada English (200) 363-8500 Facsimile (250) 363-8888

Requested by: Carl Miller, Levelton

October 04, 2006

Site Coordinates: 48.4194 North 124.0688 West

User File Reference: Jordan River

National Building Code ground motions:

2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
1.020	0.793	0.404	0.179	0.470

Notes: Spectral and peak hazard values are determined for firm ground (NBCC 2005 soil class C - average shear wave velocity 580-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 85 percent of interpolated values are within 2 percent of the calculated values. Warning: You are in a region which would be affected by the ground motion from a Cascadia subduction event. The interpolator includes consideration of the deterministic ground motions from Cascadia for 0.0021, 0.001 and 0.000404 per annum probabilities, but not for 0.01 per annum.

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.242	0.538	0.698
Sa(0.5)	0.163	0.414	0.508
Sa(1.0)	0.081	0.211	0.259
Sa(2.0)	0.039	0.087	0.120
PGA	0.121	0.254	0.337

References

National Building Code of Canada 2005 NRCC no. 47889; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.8.2, and 8.2.1.3

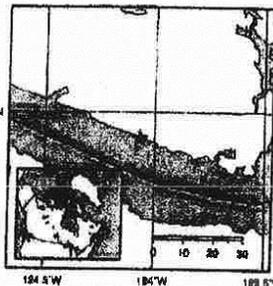
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2005, Structural Commentaries NRCC no. 46192
 Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxxx
 Fourth generation seismic hazard maps of Canada: Grid values to be used with the 2005 National Building Code of Canada (in preparation)

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Aussi disponible en français



Canada

END OF DOCUMENT

Appendix 4: Ryzuk Geotechnical Report, October 4, 2016

RYZUK GEOTECHNICAL

Engineering & Materials Testing

28 Crease Avenue, Victoria, BC, V8Z 1S3 Tel: 250-475-3131 Fax: 250-475-3611 www.ryzuk.com

October 4, 2016
File No: 8-7528-1



Attn: Dear [Redacted]

Re: Geohazard Assessment – 3521 Waters Edge Drive (Lot 10) – Jordan River, BC

As requested, we attended the above referenced site in September 2015 to assess the geotechnical conditions as such relate to the proposed construction of a single family residence on the property. We have recently received survey information for the site and have undertaken a stability analysis, and subsequently revisited the site specifically to assess the severity of toe erosion previously reported by others. Our observations and recommendations in this regard are contained herein. Our work has been undertaken in accordance with, and is subject to, the attached Terms of Engagement.

At the time of our original assessment, the ground descended slightly from the road and then rose gradually towards the crest of a ridge, then descended towards the shoreline of the Strait of Juan de Fuca. Subsequently, part of the ridge has been removed, and the excavated material has been placed as fill in the low area near the road (outside of the proposed building footprint).

The foreshore slope is now approximately 45 m in height and is moderately steep with an inclination of approximately 35 degrees, as shown on the attached Sketch Plan provided by Brad Cunnin Land Surveyor and dated June 16, 2016. A small bench or skid road is present approximately 15 m down from the crest. Native soils were observed throughout the site and within the slope to consist of very dense sandy gravel with trace cobbles. The slope is well vegetated on its eastern and western edges with mature trees while the center of the slope is devoid of trees and vegetated with low lying brush, with some previously existing alders and maples having been cut down or heavily pruned, while leavings stumps and root systems intact.

An investigation was undertaken in 2006 by Levelton Consultants Ltd. (Levelton) for the subdivision that contains this lot, and the resulting report from January 8, 2007 forms part of a covenant over this development. The Levelton report provided preliminary setbacks from the crest of the slope for

Ryzuk Geotechnical

██████████
3521 Waters Edge Drive – Jordan River, BC

October 4, 2016

habitable structures, but noted that these could be refined based on more detailed lot-specific assessments, and also commented that the exact position of the crest of the slope was open to some interpretation. A preliminary recommended setback was not specified for Lot 10, but for Lot 11 it was 21 m.

As noted earlier, recent grading has removed the crest of the ridge on Lot 10, such that the foreshore slope is now lower than it was in 2006, and the slope and new crest have been accurately surveyed. We understand that you propose to construct the residence approximately 15 m from the crest of the slope and that the residence is to have a full basement. We have undertaken a stability analysis using computer modeling of the slope under seismic loading in consideration of the current design earthquake, using the slope geometry as determined by the recent survey. Based on our analysis, the proposed location of the residence would be adequately set back from the top of the foreshore slope. Our analysis also considers the fact that the residence will have a basement, which effectively increases the setback relative to a building constructed at grade. However, for any future construction of habitable structures on this lot, we recommend a minimum setback of 20 m from the “top of bank” as indicated on the attached survey plan, unless a supplementary geotechnical assessment indicates that a lesser setback would be acceptable.

The Levelton report noted some minor erosion of the toe of the slope on a few of the lots, including Lot 10, by wave action. As such, Lot 10 is subject to a floodplain setback requirement under Part 5, Section 2.2 (e) of CRD Bylaw No. 2040, unless a “floodplain exemption” is granted, on the recommendation of a qualified engineer. The floodplain requirement specifies setbacks that in many cases are much larger than those in the noted geotechnical covenant.

The earlier report does not indicate where on the property this erosion was noted. During our recent supplementary site visit we examined the shoreline in detail and did not see any indication of significant erosion anywhere along this lot or adjacent lots, so we suspect that whatever minor erosion was evident in late 2006 has healed and the toe of the slope is now largely protected by the presence of abundant boulders, cobbles and large woody debris along the foreshore, as was noted on other lots in the vicinity by Levelton. It should also be noted that the impact of any toe erosion that did occur would be expected to be limited to shallow translational slides on the lower slope, whereas the governing mechanism for determining setbacks has been found to be seismically induced larger scale slides. In consideration of this, we recommend that the required floodplain exemption be granted for this lot.

We expect that foundations for the proposed residence will consist of typical concrete spread footings. The footings could be readily supported on the native sandy gravel anticipated throughout the site. Foundations bearing on such, or suitably compacted select fill material placed atop, can be dimensioned assuming an allowable bearing capacity of 145 kPa (3000 psf). Runoff from the building or paved areas should not be allowed to flow over the crest of the slope, where it could contribute to erosion, and should be directed back towards the road if possible. Also, no fill should be placed within 20 m of the crest of the slope.

It is important to note that the setback recommended above is designed to protect the residence itself over its lifetime. There remains some risk of the loss of a portion of the front yard (possibly a



October 4, 2016

3521 Waters Edge Drive – Jordan River, BC

significant portion) over time, resulting from one or more shallow surficial slides. Careful control of site development, including implementation of the recommendations provided above, will reduce but not eliminate this risk.

Given the above and provided our recommendations are followed, it is our professional opinion that the location of the proposed residence is safe from geologic hazard and that the land may be safely used for the use intended, that being for a single family residence. Our assessment has taken into account a design seismic event with 2% probability of exceedance in 50 years in accordance with the current BC Building Code and Section 56 of the Community Charter. Our assessment in terms of the recommended floodplain exemption is in accordance with Section 524 of the Local Government Act.

We trust that the above is suitable for your purposes at present. Please don't hesitate to contact our office if you have any questions.

Sincerely,
Ryzuk Geotechnical

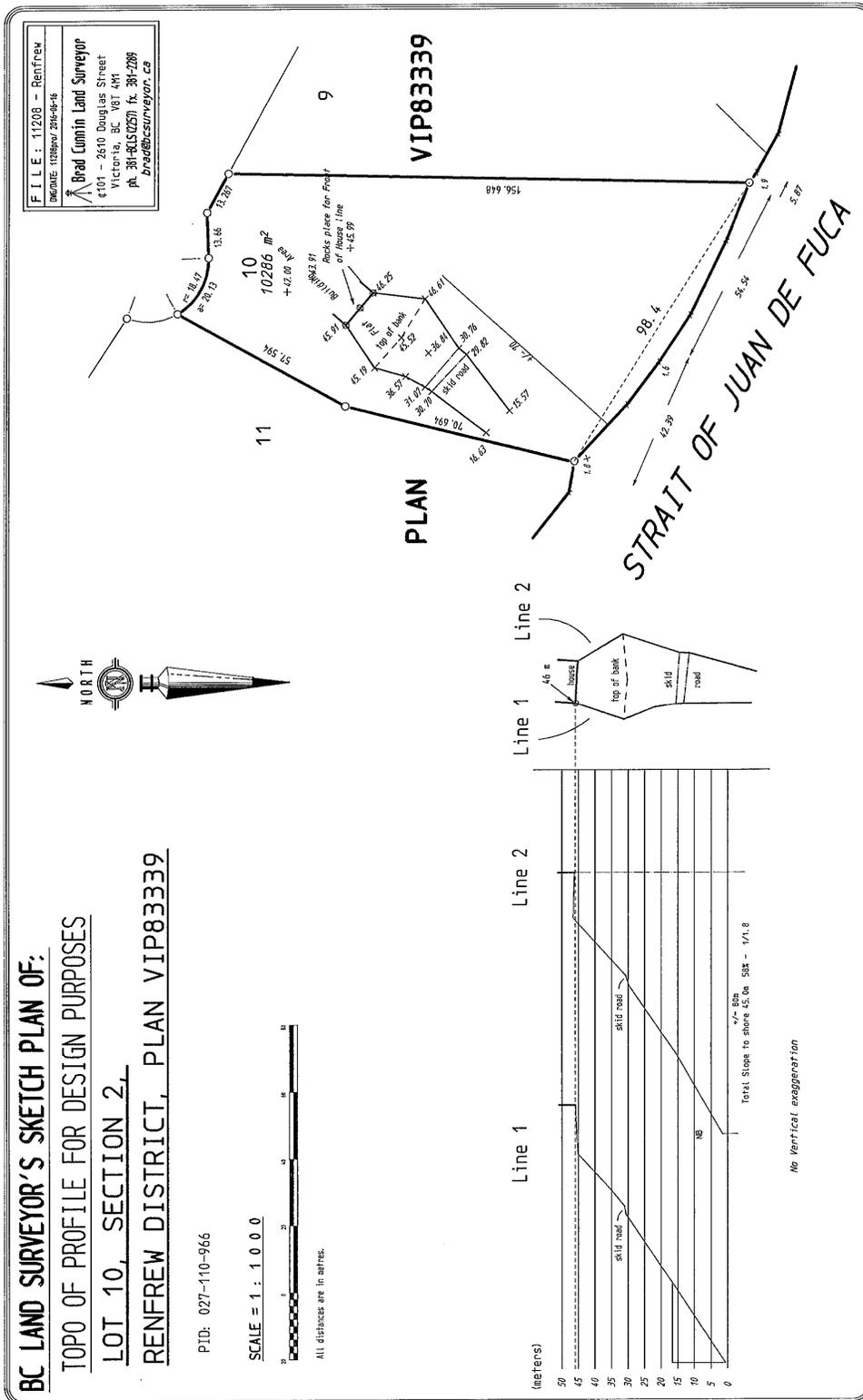

Jessica Gagne, EIT
Project Engineer


Bruce Dagg, P.Eng.
Senior Geotechnical Engineer



- Attachments - Terms of Engagement
- Sketch Plan prepared by Brad Cunnin Land Surveyor and dated June 16, 2016

cc: CRD (Juan de Fuca) Building Inspections (By Email: bijdf@crd.bc.ca)
Attn: Mike Matlo, RBO
Heidema Engineering Ltd. (By Email: heidema.peter@telus.net)
Attn: Peter Heidema, P.Eng.



TERMS OF ENGAGEMENT

GENERAL

Ryzuk Geotechnical (the Consultant) shall render the Services, as specified in the agreed Scope of Services, to the Client for this Project in accordance with the following terms of engagement. The Services, and any other associated documents, records or data, shall be carried out and/or prepared in accordance with generally accepted engineering practices in the location where the Services were performed. No other warranty, expressed or implied is made. The Consultant may, at its discretion and at any stage, engage sub-consultants to perform all or any part of the Services.

Ryzuk Geotechnical is a wholly owned subsidiary of C. N. Ryzuk & Associates Ltd.

COMPENSATION

All charges will be payable in Canadian Dollars. Invoices will be due and payable by the Client on receipt of the invoice without hold back. Interest on overdue accounts is 24% per annum.

REPRESENTATIVES

Each party shall designate a representative who is authorized to act on behalf of that party and receive notices under this Agreement.

TERMINATION

Either party may terminate this engagement without cause upon thirty (30) days' notice in writing. On termination by either party under this paragraph, the Client shall forthwith pay to the Consultant its Charges for the Services performed, including all expenses and other charges incurred by the Consultant for this Project.

If either party breaches this engagement, the non-defaulting party may terminate this engagement after giving seven (7) days' notice to remedy the breach. On termination by the Consultant under this paragraph, the Client shall forthwith pay to the Consultant its Charges for the Services performed to the date of termination, including all fees and charges for this Project.

ENVIRONMENTAL

The Consultant's field investigation, laboratory testing and engineering recommendations will not address or evaluate pollution of soil or pollution of groundwater. The Consultant will cooperate with the Client's environmental consultant during the field work phase of the investigation.

PROFESSIONAL RESPONSIBILITY

In performing the Services, the Consultant will provide and exercise the standard of care, skill and diligence required by customarily accepted professional practices and procedures normally provided in the performance of the Services contemplated in this engagement at the time when and the location in which the Services were performed.

INSURANCE

Ryzuk Geotechnical is covered by Professional Indemnity Insurance as follows:

1. \$ 2,000,000 each and every claim
2. \$ 4,000,000 aggregate
3. \$ 5,000,000 commercial/general liability coverage

LIMITATION OF LIABILITY

The Consultant shall not be responsible for:

1. the failure of a contractor, retained by the Client, to perform the work required for the Project in accordance with the applicable contract documents;
2. the design of or defects in equipment supplied or provided by the Client for incorporation into the Project;
3. any cross-contamination resulting from subsurface investigations;
4. any Project decisions made by the Client if the decisions were made without the advice of the Consultant or contrary to or inconsistent with the Consultant's advice;
5. any consequential loss, injury or damages suffered by the Client, including but not limited to loss of use, earnings and business interruption;
6. the unauthorized distribution of any confidential document or report prepared by or on behalf of the consultant for the exclusive use of the Client
7. Subsurface structures and utilities

V.1.1

The Consultant will make all reasonable efforts prior to and during subsurface site investigations to minimize the risk of damaging any subsurface utilities/mains. If, in the unlikely event that damage is incurred where utilities were unmarked and/or undetected, the Consultant will not be held responsible for damages to the site or surrounding areas, utilities/mains or drilling equipment or the cost of any repairs.

The total amount of all claims the Client may have against the Consultant or any present or former partner, executive officer, director, stockholder or employee thereof under this engagement, including but not limited to claims for negligence, negligent misrepresentation and breach of contract, shall be strictly limited to the amount of any professional liability insurance the Consultant may have available for such claims.

No claim may be brought against the Consultant in contract or tort more than two (2) years after the date of discovery of such defect.

DOCUMENTS AND REPORTING

All of the documents prepared by the Consultant or on behalf of the Consultant in connection with the Project are instruments of service for the execution of the Project. The Consultant retains the property and copyright in these documents, whether the Project is executed or not. These documents may not be used on any other project without the prior written agreement of the Consultant.

The documents have been prepared specifically for the Project, and are applicable only in the case where there has been no physical alteration to, or deviation from any of the information provided to the Consultant by the Client or agents of the Client. The Client may, in light of such alterations or deviations, request that the Consultant review and revise these documents.

The identification and classification as to the extent, properties or type of soils or other materials at the Project site has been based upon investigation and interpretation consistent with the accepted standard of care in the engineering consulting practice in the location where the Services were performed. Due to the nature of geotechnical engineering, there is an inherent risk that some conditions will not be detected at the Project site, and that actual subsurface conditions may vary considerably from investigation points. The Client must be aware of, and accept this risk, as must any other party making use of any documents prepared by the Consultant regarding the Project.

Any conclusions and recommendations provided within any document prepared by the Consultant for the Client has been based on the investigative information undertaken by the Consultant, and any additional information provided to the Consultant by the Client or agents of the Client. The Consultant accepts no responsibility for any associated deficiency or inaccuracy as the result of a miss-statement or receipt of fraudulent information.

JOBSITE SAFETY AND CONTROL

The Client acknowledges that control of the jobsite lies solely with the Client, his agents or contractors. The presence of the Consultant's personnel on the site does not relieve the Client, his agents or contractors from their responsibilities for site safety. Accordingly, the Client must endeavor to inform the Consultant of all hazardous or otherwise dangerous conditions at the Project site of which the Client is aware.

The client must acknowledge that during the course of a geotechnical investigation, it is possible that a previously unknown hazard may be discovered. In this event, the Client recognizes that such a hazard may result in the necessity to undertake procedures which ensure the safety and protection of personnel and/or the environment. The Client shall be responsible for payment of any additional expenses incurred as a result of such discoveries, and recognizes that under certain circumstances, discovery of hazardous conditions or elements requires that regulatory agencies must be informed. The Client shall not bring about any action or dispute against the Consultant as a result of such notification.

FIELD SERVICES

Where applicable, field services recommended for the Project are the minimum necessary, in the sole discretion of the Consultant, to observe whether the work or a contractor retained by the Client is being carried out in general conformity with the intent of the Services. Any reduction from the level of services recommended will result in the Consultant providing qualified certifications for the work.

DISPUTE RESOLUTION

If requested in writing by either the Client or the Consultant, the Client and the Consultant shall attempt to resolve any dispute between them arising out of or in connection with this Agreement by entering into structured non-binding negotiations with the assistance of a mediator on a without prejudice basis. The mediator shall be appointed by agreement of the parties. If a dispute cannot be settled within a period of thirty (30) calendar days with the mediator, the dispute shall be referred to and finally resolved by arbitration under the rules of the arbitrator appointed by agreement of the parties or by reference to a Judge of the British Columbia Court.