



30 September 2019

Our Ref: 292

*292 letter 2019-09-30*

Ballard Fine Homes Ltd.

#1-546 Island Highway W Parksville, BC V9P 1H2

Attention: Mr. Darren Gaudreault

**Re: Limited Geotechnical Assessment**

**Proposed Development at Lot C, Laburnum Road, Qualicum Beach**

Dear Sir,

## Introduction

At your request, we have carried out a Limited Geotechnical Assessment at the site of a Proposed Development at Lot C, Laburnum Road, Qualicum Beach, British Columbia.

The work comprised a limited walkover, the results of which are summarized herein, together with excavated test pits to assess the subsurface conditions. This report includes recommendations for foundations and site development.

This work was carried out in accordance with our proposal, and the relevant Engineers and Geoscientists of BC Guidelines for "Geotechnical Engineering Services for Building Projects".

## Site Visit

We visited the site on August 8, 2019.

## Location

The legal address of the property is Lot C Plan VIP71752 District Lot 17&78 Land District 35. It is an irregular-shaped parcel of land of about 7.3 acres in area.

## Topography

The site topography may be summarised as a gentle slope (about 5° to 10° down to the north).

## Vegetation

There was some vegetation on the site (refer site photographs).



Figure 1: Site Location relative to local landmarks. The site is shaded in grey. North is towards the top of the page. Do not scale.

## Drainage

No specific drainage features were observed.

## Existing Development

There was no existing development, although some trees had been cleared in a corridor along which the test pits were excavated.

## Geology

Reference to published geology maps indicates that the site is underlain by undifferentiated sedimentary rocks of the Nanaimo Group, which formed in the Late Cretaceous Period of Geological Time. Quaternary sediments comprising a veneer of glaciomarine material (e.g. till) were mapped in close proximity to the site.

No rock was observed in the field.



*Figure 2: View to the south.*



*Figure 3: View of the site towards the North.*



*Figure 4: View towards the north from near the southern part of the site.*



*Figure 5: Typical view of the subsurface conditions encountered.*



Figure 6: Geology Map (from BC MapPlace). The quaternary geology is mapped in light blue.

## Field Work

### Methods

A total of four (4) test pits, numbered from TH 1 to TH 4 as shown on the Test Pit Location Plan, Drawing No. 292-1 (attached) were excavated by a Hitachi hydraulic-powered, tracked excavator.

### Results

The excavations exposed consistent conditions at all locations. The topsoil development was limited to a depth of about 0.2m, overlying dense or very stiff, moist, fine to medium grained gravelly silty sand/sandy silt with fines of low plasticity to a depth of 1.8m, overlying dense grey silt.

No groundwater was observed during the relatively short time during which the pits remained open for logging and sampling purposes.

It should be noted that groundwater levels and flows are transient, and are affected by such factors as preceding climatic conditions and soil and rock permeability.

## Proposed Development

We understand that the proposed development comprises residential buildings.

No further details are known at this stage.



## Discussion and Recommendations

No rock was encountered, contrary to the mapping of the geology. Notwithstanding this, the quaternary sediments represent good founding materials for roads, infrastructure and structures.

### Building Footings

#### Frost

We recommend that the building footings are founded at least 0.6m below the ground surface, to mitigate the risk of frost heave.

#### Bearing

Building footings should be founded on native soil or rock, and proportioned for a maximum dependable bearing capacity of 150kPa (Ultimate Limit State Design) or 100kPa allowable bearing capacity (for Serviceability Limit State or Working Stress Design) (to be confirmed by a geotechnical engineer). Footings should not be founded on non-engineered fill.

#### Seismic

The site may be regarded as Class C for Seismic Characteristics.

The Peak Ground Acceleration (PGA) for the design earthquake (1 in 2,475 years, which has a 2% chance of occurring within a 50 year design period) is 0.39g.

### Earthworks

We are not aware of the extent of earthworks that may be involved in this project, but we suspect that these will be limited. The following recommendations should be observed:

1. Cuts are not to exceed 1.2m height without specific engineering comment, which may include recommendations for support.
2. Cuts should be limited to a maximum height of 3m.
3. Cut slopes in soil are not to exceed 1V:2H without specific engineering appraisal during construction, and should be protected against erosion and covered with appropriate vegetation or else supported by an engineer-designed retaining wall.
4. Cut slopes in Rock (if encountered) are not to exceed 1V:1H without specific engineering comment.
5. Fill should not exceed 1.5m depth.
6. Fill slopes should not exceed 1V:3H, and should be protected against erosion and covered with appropriate vegetation or else supported by an engineer-designed retaining wall.
7. Fill placed for the support of buildings and services should be placed in accordance with the Site Preparation Measures, and would then be regarded as "engineered fill".

### Site Preparation Measures

- Install temporary and/or permanent drainage so that excavations do not become saturated.



- Excavate to design level in areas of cut and request a geotechnical engineer to confirm the design values of bearing capacity;
- In fill areas, request a geotechnical engineer to confirm that the exposed foundation material does not contain obvious soft or loose zones; then place approved fill material in layers not exceeding 200mm loose thickness, and compact with appropriate compacting equipment to the satisfaction of the geotechnical engineer. No fill shall be placed when the fill material or subgrade is wet or frozen.

## Further Geotechnical Engineering

It is possible that the Town of Qualicum Beach may require a geotechnical engineer to provide a letter of assurance for Construction Review. If this is the case, then we will need to be engaged to prepare a British Columbia Building Code Schedule B, and you will need to provide us with your design drawings, the relevant geotechnical requirements Building Permit (including the BP number), and your proposed construction schedule.

We request a minimum of 24 hours' notice prior to attending the site. Following satisfaction with the construction monitoring, we would prepare a BC Building Code Schedule C-B.

Should a different building be proposed than that for which this report was prepared, or if a building is to be located elsewhere on the lot, then further geotechnical input may be required.

You should immediately advise us should subsurface conditions encountered during construction vary from those described in this report.

## Closure

It is our professional opinion that the site is safe for the use intended. We trust that this meets your present requirements. Should you have any questions, please do not hesitate to contact the undersigned at your earliest convenience.

Yours truly,

**Core Geotechnical Inc.**

Bruce Grayson, P.Eng.

Director

Attach:

- I. General Notes
- II. Test Pit Location Plan



# GENERAL NOTES

This report comprises the results of a site investigation carried out in accordance with normally-accepted methods for a specific purpose and client as defined in the introductory section(s) of the document. The report should not be used by other parties or for other purposes without prior consultation with this firm, as it might not contain adequate or appropriate information for extrapolation.

## LOGGING

The information on the Logs (Test Bores, Test Holes, Natural Exposures etc.) has been based on a visual and tactile assessment except at the discrete locations where test information has been reported (eg field and/or laboratory results).

Reference should be made to our standard sheets for the definition of our logging procedures (Soil and/or Rock Descriptions, as appropriate).

## GROUNDWATER

Unless otherwise indicated, the water levels given on the logs are the levels of free water or seepage in the test hole recorded at the given time of measuring. The measured ground water level may be affected by the method of investigation (for example, if rotary drilling is utilised, drilling fluids will be pumped into the ground).

The actual groundwater level may differ from the recorded level depending on material permeabilities. Further variations of this level could occur with time due to such effects as seasonal and tidal fluctuations or construction activities. Final confirmation of levels can only be made by appropriate instrumentation techniques and programmes.

## SAMPLING

Samples extracted during the fieldwork phase of a site investigation may be 'disturbed' or 'undisturbed' (as indicated on the logs) depending on the intended mature and purpose of the sample as well as the practicable method of extraction, transportation, extrusion and testing. This aspect should be taken into account when assessing test results which must of necessity reflect the effects of such disturbance.

Generally, 'disturbed' samples would be suitable for visual identification, moisture content determination, Atterberg Limits testing, compaction and California bearing ratio (CBR) testing, amongst others.

The amount sampled is also a limiting factor in the suitability for testing purposes, for example, a minimum of 10 kg is necessary for compaction and CBR testing.

'Undisturbed' samples are normally necessary for laboratory testing such as shrink-swell tests. These samples are obtained by pushing a thin-walled, mild steel tube with a machined cutting edge into the soil, and extracting the assembly. The soil (normally of nominal 50 mm diameter) is extruded at the laboratory prior to testing.

## LABORATORY TESTING

Laboratory testing is normally carried out in accordance with appropriate standards (or specific ones, if requested). All testing will be carried out in a sub-contracted laboratory. Where tests are used which are not covered by standard procedures, details are given in the report.

All soil properties (as measured by laboratory testing) exhibit inherent variability and thus a certain statistical number of tests is required in order to predict an average property with any degree of confidence. The site variability of soil strata, future changes in moisture and other conditions and the discrete sampling positions must also be considered when assessing the representative nature of the laboratory programme.

Certain laboratory tests provide interpreted soil properties as derived by conventional mathematical procedures. The applicability of such properties to engineering design must be assessed with due regard to the site, sample condition, procedure and the proposed development.

## INTERPRETATION OF RESULTS

The discussion and any recommendations contained within this report are normally based on a site evaluation from discrete test hole data. Generalised or idealised subsurface conditions (including any cross-sections contained in the report) have been assumed or prepared by interpolation and /or extrapolation of these data. As such, these conditions are an interpretation and must be considered as a guide only.

## CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions used for this report can occur, particularly between discrete test hole locations. Furthermore, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed in this report should be referred to this firm for appropriate assessment and comment.

## FOUNDATION DEPTH

Where referred to in the report, the recommended depth of any foundation (piles, caissons, footings, etc.) is an engineering estimate of the depth to which they should be constructed. The estimate is influenced and perhaps limited by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications based upon this report should provide for variations in the final depth depending upon the ground conditions at each point of support.

## REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in this report for the inclusion in the contract documents or engineering specification of the subject development, such reproduction shall include all of the report, including appendices (if any).

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# SOIL DESCRIPTION

Core Geotechnical Inc. describes a soil in terms of its visual and tactile properties. This sheet is intended to complement test logs and, relates to field samples and exposures as applicable. The description involves an evaluation of each of the items listed below and is in general agreement with the Canadian Foundation Engineering Manual.

## SOIL TYPE

The soil type is described according to its estimated grain size composition and the tactile behaviour (plasticity) of fines (silt and clay fraction). The following table provides a guideline for the basis of the soil description:

Soil Classification	Particle Size
Silt and Clay (differentiated by Atterberg Limits Tests)	< 0.06 mm (the 0.075 mm sieve size is commonly used in practice)
Sand	0.06 - 0.2 mm (fine), 0.2 - 0.6 mm (medium), 0.6 - 2 mm (coarse)
Gravel	2 - 6 mm (fine), 6 - 20 mm (medium), 20 - 60 mm (coarse)
Cobble	60 - 200 mm
Boulder	> 200 mm

Where a soil contains one main soil type with up to 5% of a secondary soil type, it is described as having a trace of the secondary soil type. Similarly, if the proportion of the secondary soil type is within the range of 5 - 12%, it is described as having some of the secondary soil type. If the soil has 12 - 50% of the secondary soil type, the secondary soil type is used as an adjective in the description, eg Sandy CLAY, where the main soil type is clay, with up to 50% sand by weight. A soil with, say, 20% gravel, 30% sand and 50% clay would be described as a Gravelly Sandy CLAY.

## STRENGTH (CONSISTENCY/RELATIVE DENSITY)

This assessment is based on the effort required to penetrate and/or mould the soil, and is an indicator of the shear strength.

Granular soils are generally described in terms of relative density (density index) as listed in the Canadian Foundation Engineering Manual. These soils are inherently difficult to assess, and normally a penetration test procedure (SPT or CPT) is used in conjunction with published correlations. Alternatively, in-situ density tests may be carried out in conjunction with minimum and maximum density (laboratory) tests.

Cohesive soils can be assessed by direct measurement (eg shear vane, pocket penetrometer [shown as PP\* on the logs]) or estimated approximately by tactile means and/or the aid of a geological pick as given in the following table. It is emphasised that a 'design' shear strength must take cognisance of the in-situ moisture content and the possible variation of moisture with time, climate, and other factors.

Term	Tactile Properties	Unconfined Compressive Strength, $q_u$ (kPa)
Very Soft	Extrudes from fingers without difficulty. Soil may tend to flow.	<25
Soft	Extrudes from fingers when squeezed.	25 -50
Firm	Thumb may penetrate with moderate effort. Moulded by light finger pressure.	50 - 100
Stiff	Moulded by moderate finger pressure.	100 - 200
Very Stiff	Moulded by strong finger pressure.	200 - 400
Hard	Depending on moisture condition, may be moulded by very strong finger pressure or may tend to	>400
Friable	Soil is sugary, or crumbles without meaningful result on a pocket penetrometer.	

## MOISTURE

The moisture condition of the soil is most applicable for cohesive soils as an aid to the assessment of consistency and workability. The moisture condition may be related to the estimated plastic limit ( $W_p$  or PL) eg  $m < W_p$  where the soil is assessed as being drier than the estimated plastic limit (In the field, this is often assessed by an inability for the soil to roll out into threads of 3 mm diameter.);  $m = W_p$  where the soil is assessed as being approximately at the plastic limit, ie it may just be rolled out into threads of 3 mm diameter; and  $m > W_p$ , where the soil is assessed as being wetter than the plastic limit (ie the soil is able to be rolled into threads of less than 3 mm diameter).

Non-cohesive soils may be described as being either Dry (dusty, dry to the touch), Moist (damp, no visible water) or Wet (visible free water, saturated condition). Ground water observations are noted on all test logs.

## COLOUR

Colour may be an aid to the correlation of data between test locations and for subsequent excavation operations. The prominent colour is noted, followed by (mottled, streaked, stained etc) secondary colours as applicable. Colour is usually described at field moisture condition, however, both wet and dry colours may be recorded.

## OTHER TERMS

Some other terms which the layperson may not be familiar with might be used in the description of a soil. In most cases these would be referenced in The Canadian Foundation Engineering Manual. Some of the more common of these terms are outlined below:

- Fill - soil which has not been laid down by nature, ie it has been man-made.
- Till - natural soil compacted and abraded under the weight and movement of a glacier.
- Alluvium - natural soil laid down in streams, lakes, estuaries, dunes etc.
- Residual - soil derived from rock weathered in-situ
- Colluvium - soil deposited by natural transport down a slope (also called slopewash)
- Talus- debris such as cobbles and boulders, generally at the toe of a slope
- Glacio-Marine – soil deposited in a marine environment beneath a glacier



# ROCK DESCRIPTION

Core Geotechnical Inc. describes a rock based on methods described in the Canadian Foundation Engineering Manual, together with local practice. This sheet is intended to complement test logs, and relates to cored rock, field samples and exposures as applicable. The description involves an evaluation of each of the items listed below and is in general agreement with the Canadian Foundation Engineering Manual.

## ROCK TYPE

The rock type is described according to its assessed origin (ie sedimentary, igneous volcanic/hypabyssal, pyroclastic, igneous plutonic, and metamorphic) and estimated grain (crystal, clast, phenoclast etc) size composition. The following table provides a guideline for the basis of the rock type description:

SEDIMENTARY			IGNEOUS				METAMORPHIC
Clastic	Non-Clastic		Acid	Intermediate	Basic	Pyroclastic (e.g. Ash / Bombs)	
	<i>Chemical</i>	<i>Organic</i>					
Conglomerate Sandstone Siltstone Claystone Shale	Limestone Chert Gypsum	Coal	<b>Volcanic</b> (e.g. Lava) <i>Fine Grained</i>	Rhyolite	Trachyte	Basalt	Grade Low ↑ High Gneiss Quartzite Schist Slate Phyllite
			<b>Hypabyssal</b> (e.g. Sill) <i>Medium Grained</i>	Porphyry		Dolerite	
			<b>Plutonic</b> (e.g. Batholith) <i>Coarse Grained</i>	Granite	Syenite, Diorite	Gabbro	

## SEDIMENTARY ROCKS

Sandstone and Conglomerate are defined as rocks containing more than 50% of sand sized grains and gravel sized fragments, respectively. Similarly, Claystone and Siltstone are defined as rocks containing more than 50% of clay or sericitic material, and silt sized granular particles, respectively, AND where the rock is not laminated. Laminated rocks containing more than 50% of clay and/or silt sized particles are defined as shale. Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, eg clayey sandstone, sandy shale.

## STRENGTH

This assessment refers to the strength of the rock substance, not the strength of the rock mass. The strength of the rock substance is estimated by the Point Load Strength Index  $I_{s(50)}$  and normally refers to the average of the strength measured in the direction perpendicular to the bedding, and the strength measured parallel to the bedding, for sedimentary rocks. The table below describes the strength classifications used by this firm:

Term	Abbr.	Field Guide	$I_{s(50)}$ (MPa)
<b>Extremely Low</b>	EL	Easily remoulded by hand to a material with soil properties.	<0.03
<b>Very Low</b>	VL	May be crumbled in the hand. Sandstone is "sugary" and friable.	<0.1
<b>Low</b>	L	The core* may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	<0.3
<b>Medium</b>	M	The core* can be broken by hand with considerable difficulty. Readily scored with knife.	<1
<b>High</b>	H	The core* cannot be broken with unaided hands, can be slightly scratched or scored with knife.	<3
<b>Very High</b>	VH	The core* cannot be broken readily with hand held hammer. Cannot be scratched with pen knife.	<10
<b>Extremely High</b>	EH	The core* is difficult to break with hand held hammer. Rings when struck with a hammer.	>10

\*A piece of core 150 mm long and 50 mm diameter

## WEATHERING

The assessment of weathering does not imply engineering behaviour, however it may assist in identification. No distinction is drawn between chemical weathering and alteration for most engineering purposes. These procedures are collectively described as weathering using the following terms which do not describe the related strength change. Carbonate rocks may not necessarily conform to this classification.

Term	Abbreviation	Definition
<b>Extremely Weathered</b>	EW	The rock exhibits soil-like properties though the texture of the original rock is still evident.
<b>Highly Weathered</b>	HW	Limonite staining or colour change affects the whole of the rockmass and other signs of chemical or physical decomposition are evident.
<b>Moderately Weathered</b>	MW	Staining extends throughout the whole of the rockmass and the original colour is no longer recognisable.
<b>Slightly Weathered</b>	SW	Partial staining or discolouration of the rockmass, usually by limonite, has taken place.
<b>Fresh</b>	Fr	Rockmass unaffected by weathering.

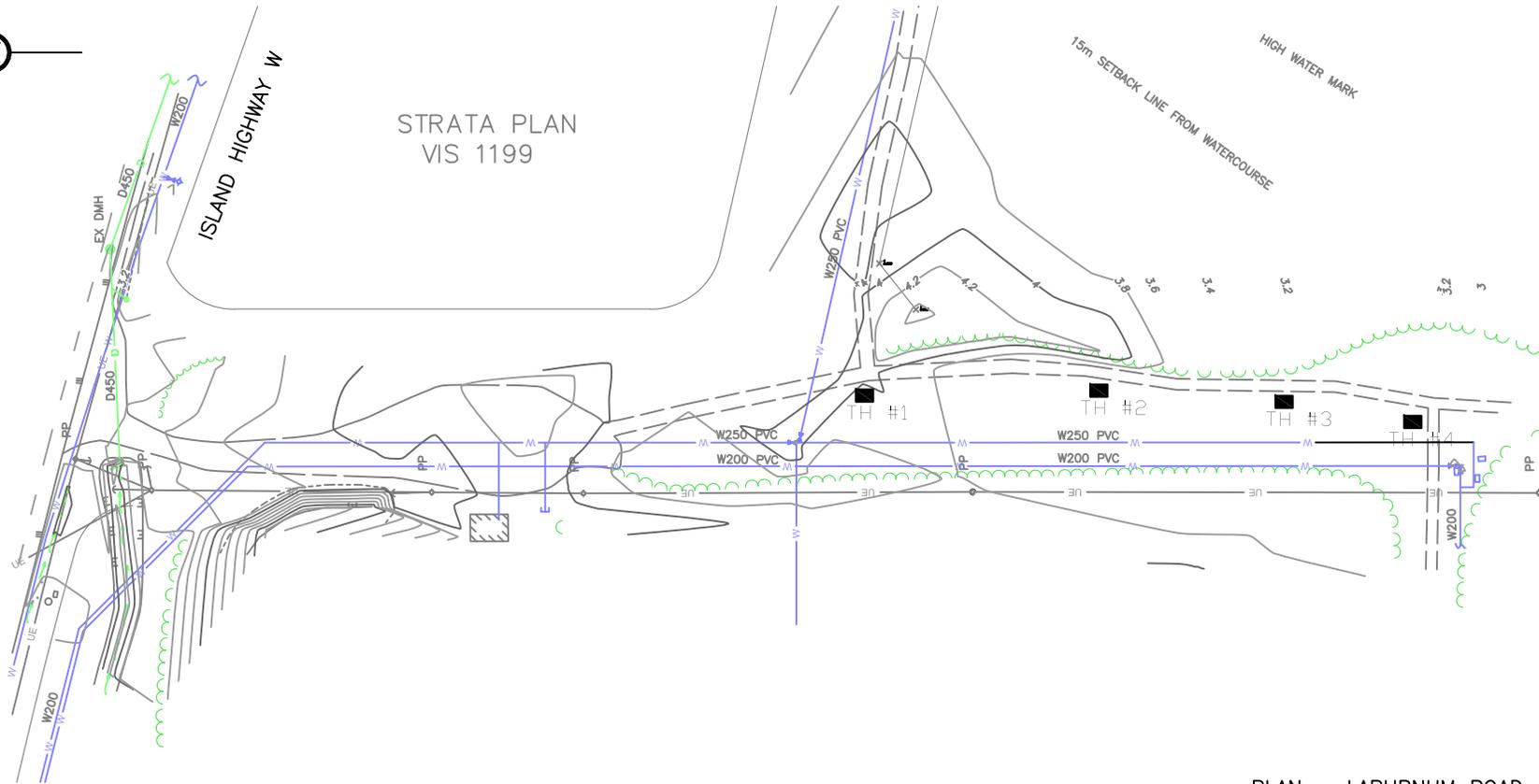
## FRACTURING and BEDDING

These important features can control the overall behaviour of a rockmass. All types of natural fractures across which the core is discontinuous are noted. These fractures include bedding plane partings, joints and other defects but exclude artificial fractures such as drilling breaks. The nature of the defects (joints, partings, seams, zones and veins) is also noted with description, orientation, infilling or coating, shape, roughness, thickness, etc. given generally in accordance the Canadian Foundation Engineering Manual. The spacing of natural fractures excludes bedding partings unless there is evidence that they were separated prior to drilling. This notwithstanding, bedding partings may be considered planes of weakness in an engineering assessment.

Term	Description
<b>Fragmented</b>	The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than the core diameter.
<b>Highly Fractured</b>	Core lengths are generally less than 20 - 40 mm with occasional fragments.
<b>Fractured</b>	Core lengths are mainly 30 mm - 100 mm with occasional shorter and longer sections.
<b>Slightly Fractured</b>	Core lengths are generally 300 mm - 1 m with occasional longer sections and occasional sections of 100 mm - 300 mm.
<b>Unbroken</b>	The core does not contain any fractures.

**Bedding Spacing** may be described based on the thickness of the layering, as follows:

Thinly Laminated	Laminated	Very Thinly Bedded	Thinly Bedded	Medium Bedded	Thickly Bedded	Very Thickly Bedded
<6mm	6mm - 20 mm	20mm - 60 mm	60mm - 200 mm	200mm - 600 mm	600mm - 2 m	> 2m



STRATA PLAN  
VIS 1199

ISLAND HIGHWAY W

15m SETBACK LINE FROM WATERCOURSE  
HIGH WATER MARK

PLAN - LABURNUM ROAD  
H 1:1000



when printed on 8.5" x 11" [Letter] paper  
Taken from Site Plan by J.E. Anderson Associates, file 89548-C1



test hole location at  
Laburnum Road, Qualicum Beach

**Client:** Ballard Fine Homes Ltd.

**Principal:** Darren Gaudreault

**Scale:** 1:1000 | **Drn:** AD | **Chk:** BJG | 27 Sep, 2019

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