February 12, 2013

260 Lake Avenue Kelowna, B.C. V1Y 5W7

Attention: Marianne Hill

Subject: Geotechnical Assessment for a Proposed Residential Home Lot 5, Block D, DL 14, Plan 2220, ODYD 250 Lake Avenue, Kelowna, B.C.

1.0 Introduction

At your request, Calibre Geotechnical Engineering Ltd. conducted a geotechnical assessment for a proposed residential home at the northeast corner of Lake Avenue and Maple Street, in Kelowna. The objective of the geotechnical assessment was to provide recommendations pertaining to the development of a residential home on the property.

Terms of reference for this assessment were provided in a Memorandum, Item .1), addressed to the Land Use Management Department (BD), from the City of Kelowna Development Engineering Manager, dated August 15, 2012 (City File No.: Z12-0059).

Authorization to proceed with this work was provided by you, the property owner, on January 15, 2013.

2.0 Site Description and Proposed Development

The site is located at the northeast corner of Lake Avenue and Maple Street, in Kelowna. The property is bounded by Maple Street to the west, Lake Avenue to the south, a lane to the north, and a residential home to the east.

At the time of our investigation, a lawn, several large trees and landscaping covered the property. The property is relatively flat and several feet lower than the surrounding grades.



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We understand that the new residential home will be positioned to preserve several large trees, and that the home will have a crawl space.

3.0 Data Review and Field Investigation

Calibre Geotechnical Engineering Ltd. has reviewed published geologic reports on the subject area. As well, on January 24, 2013, we supervised the excavation of two test pits on the property. Observations made in the field were recorded on log sheets (see attached test pit logs), and photographs of the test pits are also attached.

The purpose of the field investigation was to determine the general subsurface conditions beneath the proposed building site, and identify any soil or water conditions, which might affect the method of construction or constraints to development on the property.

4.0 Geologic Conditions

- General Geology: The geology map of the Okanagan Valley (Bulletin No. 46, British Columbia Department of Mines and Petroleum Resources, by H. Nasmith, 1962) indicates that the site is underlain by alluvial fans, deltas, and associated gullies and stream channel sediments. The site-specific subsurface conditions are provided in the following sections.
- **Soil Conditions:** The site soil profile at the test pit locations can be generally described as follows:
 - a surficial layer of Grass Sod over TOPSOIL. The layer is silty, had frequent roots throughout, and is soft, wet and dark brown. The topsoil layer is 8 inches thick at our test pit locations, and is found over...
 - a natural deposit of SILT. The silt is non-plastic, firm, moist, and medium yellowish brown with rust mottled staining throughout. The silt becomes fine grained sandy, soft to firm, wet, and dark grey below 18 inches in TP-1, and 26 inches in TP-2. Note that the ground elevation was 8 inches higher at TP-2 relative to TP-1, so that the elevation where the silt changed to being wet and dark grey is the same in both test pits. This wet and dark grey elevation corresponds to the permanent groundwater elevation. The silt extended to at least the bottom of each test pit.

For a more detailed description of the soil encountered during our investigation refer to the attached test pit logs and photographs.



• **Groundwater Conditions:** At the time of our investigation most soils encountered in the test pits were moist to wet, becoming wet below the groundwater table. The depth to the groundwater level, below existing local grades, was 18 to 26 inches at TP-1 and TP-2, respectively. We would expect the groundwater level to fluctuate slightly across the site relative to the level of the water in Okanagan Lake, and the amount of rainfall and runoff.

For a more detailed description of the subsurface groundwater conditions, refer to the attached test pit logs and photographs.

5.0 **Recommendations**

Based on the results of our geotechnical assessment, we believe the site is well suited for the proposed residential home. We believe that by implementing the following recommendations, there will be no negative impact on the site, or on surrounding properties.

- We recommend that all fill material, and any loose, soft, or disturbed soils be removed to expose a subgrade of undisturbed, natural, firm, yellowish brown silt beneath the proposed building area. The natural silt was found at a depth of 8 inches in TP-1 and TP-2.
- The final elevation of the stripped subgrade surface should be no deeper than 4.0 feet below the existing centerline road grade of Maple Street, measured from the point immediately west of the centre of the proposed lot.
- It should be noted that the allowable bearing pressure of the exposed subgrade could be reduced if the materials are disturbed during construction. Therefore, we recommend that the excavation should be carried out with a small tracked excavator equipped with a smooth-mouthed clean-up bucket to minimize disturbance.
- Depending upon the time of year, excavation for removal of the topsoil and roots within the building envelope area of the proposed building area may be close to the groundwater level. We believe that several sumps and pumps would be required to dewater the excavation if the groundwater level is close to the underside of the excavation.
- We recommend that a geotechnical engineer from Calibre Geotechnical Engineering Ltd. confirm the bearing capacity of the stripped subgrade surface throughout the site during construction.



- We recommend that, as the subgrade surface is being exposed, it be protected immediately with a minimum 12 inch thick pad of drain rock fill placed over a woven Amoco 2006 geotextile fabric (or equivalent), under the direction of the geotechnical engineer.
- The drain rock material should be clean, uniform, rounded, and 2 inches in diameter. The drain rock should be placed and spread in one horizontal lift. The tracked excavator should not run over the drain rock. The surface of the drain rock pad should be compacted with a light 300 to 500 pound plate tamper under direction the geotechnical engineer.
- Standard strip and spread footings are a feasible foundation system and can be constructed according to Part 9 of the 2012 British Columbia Building Code requirements. However, a structural engineer may still be required to design the foundations with a relatively low bearing pressure (see next bullets).
- We recommend that strip and pad foundations founded on the pad of drain rock fill, as described above, can be designed with a maximum allowable bearing pressure of 900 psf.
- The settlement of foundations designed for these bearing pressures should be within the normally acceptable limits of up to about 1 inch total settlement and up to about ³/₄ inch in about 30 feet differential settlement.
- Strip footings should not be less than 2 feet wide. Pad spread footings should not be less than 3 feet wide.
- The frost protection depth should be a minimum of 2 feet for all exterior footings.
- Prior to construction of the crawl space concrete or skim coat slab, the area should be prepared as outlined above. To raise the grade beneath the proposed floor slab, we recommend that additional 2 inch sized drain rock be used for this purpose.
- Any topsoil or natural silt on this site is considered unsuitable for use as engineered fill. The soils may be reused as general landscape fill.
- The test pits were excavated at the locations as indicated on the attached Test Pit Location Plan. In the situation where a portion of the proposed building or driveway is found to be located over a test pit, we recommend that the test pit be over excavated and replaced with drain rock under the direction of the geotechnical engineer.



Based on the terms of reference in the Memorandum, Item .1), addressed to the Land Use Management Department (BD), from the City of Kelowna Development Engineering Manager, dated August 15, 2012 (City File No.: Z12-0059), we provide the following additional recommendations.

- i) Area ground water characteristics, including any springs and overland surface drainage courses traversing the property. Identify any monitoring required: As described in Section 4.0, the groundwater level is known to be between 18 and 26 inches below the proposed development site. No springs or overland drainage courses were identified on the site. We believe that no monitoring program is required.
- ii) *Site suitability for development*: From a geotechnical point of view, the site is well suited for the proposed development.
- iii) Any special requirements for construction of roads, driveways, utilities and building structures: We estimate that the existing soil conditions have a CBR value of 3, therefore a City of Kelowna minimum pavement section can be used in design of any widening of Maple Street or Lake Avenue (i.e. 2 inches (50 millimetres) of asphalt; 3 inches (75 millimetres) of granular base; and 11 inches (275 millimetres) of granular sub-base). However, we would recommend that the 3 inches of granular base materials be increased to a minimum of 4 inches. We suggest that the driveway be constructed with a minimum of 4 inches of granular base over 12 inches of granular sub-base material, over a layer of filter cloth placed on the natural silt. The driveway surface can then be left as is, or covered with asphalt or concrete. Ensure the building structure foundations are supported on a pad of drain rock fill as described above. A minimum basement elevation (MBE) is recommended due to the potential for a higher groundwater table. The minimum basement floor slab elevation can be as deep as 3.0 feet below the existing centerline road grade of Maple Street, measured from the point immediately west of the centre of the proposed lot. The basement should have a sump pump (see next paragraph).
- iv) *Recommendations for roof drains and perimeter drains*: Roof drains should be discharged away from foundation walls, (i.e. a minimum of 3 feet), onto splash pads or into landscaped areas. Water collected from patios, driveways, or other hard surfaces should not be allowed to accumulate against foundation walls. We recommend that the site layout ensure that drainage is away from any proposed building structure. Minimum landscape gradients of 1.5 percent are



recommended to reduce the risk of ponding in localized areas. Perimeter drains should not be required based on the subsurface soil and groundwater conditions encountered, and the recommended site preparation recommendations. A sump pump is recommended for the crawl space.

- v) Site soil characteristics (i.e. fill areas, sulphate content, unsuitable soils such as organic material, etc.): No fill material was encountered in TP-1 or TP-2. The natural outwash sediments (i.e. silt and sandy silt) generally have a very low sulphate content and therefore, we believe that sulphate resistant concrete should not be required for this site. Unsuitable organic material appears typical for this area, being on the order of 8 inches thick.
- vi) *Recommendations for items that should be included in a Restrictive Covenant:* From a geotechnical point of view, there are no recommendations for items, **except** for the recommendations outlined in this portion of the report (i.e. minimum basement depth requirements), that should be included in a Restrictive Covenant.
- vii) Any items required in other sections of this document (i.e. the August 15, 2012, *Memorandum*): None.

6.0 Design and Field Reviews

Calibre Geotechnical Engineering Ltd. should be given the opportunity to review plans on the final building locations and drainage plans prior to construction, to ensure that we have adequately communicated the intent of our recommendations.

Temporary excavation slopes require inspection by a professional engineer in accordance with Worksafe B.C. Guidelines.

Calibre Geotechnical Engineering Ltd. should inspect the stripped subgrade surface prior to placing the filter cloth, during the placement of the drain rock, and after forming the footings.

Calibre Geotechnical Engineering Ltd. should be given the opportunity to assess any changes in plans related to the geotechnical aspects of future development on the site.



7.0 Limitations

Use of this report is subject to the attached Geotechnical Report - General Conditions. The reader's attention is specifically drawn to these conditions, as it is essential that they be followed for the proper use and interpretation of this report.

8.0 Closure

We trust this report meets your present requirements. Should you require any additional information, please contact our office.

For:

Calibre Geotechnical Engineering Ltd.



A. H. Albert Losch, P.Eng. Geotechnical Engineer

Attachments: Test Pit Location Plan (1 page) Test Pit Logs (2 pages) Photographs of Test Pits (2 pages) Geotechnical Report - General Conditions (2 pages)



Attachments



Project: Proposed Residential Home

Location: 250 Lake Avenue, Kelowna

Client: Marianne Hill

Calibre File No: J13-01795

Sample Number Depth (metres) **Pocket Penetration Test Moisture Content** Sample Type Depth (feet) **Soil Description** (%) (kPa) 100 400 500 0 20 40 60 80 100 0 200 300 **Ground Surface** 0.0 0.0 Grass Sod over TOPSOIL silty, frequent roots throughout, soft, wet, dark brown. 0.5 SILT non-plastic, firm, moist, medium yellowish brown with rust mottled staining throughout. 1.0 SA-1 G 1.5 - fine grained sandy, soft to firm, wet, dark grey below 18 0.5 inches. 2.0 SA-2 G 2.5 3.0 1.0 3.5 SA-3 G 4.0 4.5 1.5 END OF TEST PIT AT 5 FEET. WATER TABLE NOTED BELOW 18 INCHES. SLOUGHING WITH DEPTH. 5.0 5.5 6.0 6.5 2.0 **Investigation Date: January 24, 2013** Subcontractor: On-The-Mark Locates Figure No: J13-01795-TP1 Equipment: Kubota KX121-3 Tracked Excavator Calibre Logged By: A.L.

Test Pit: TP-1

Project: Proposed Residential Home

Location: 250 Lake Avenue, Kelowna

Client: Marianne Hill

Test Pit: TP-2

Calibre File No: J13-01795

Depth (metres)	Soil Description	Depth (feet)	Sample Number	Sample Type	Pocket Penetration Test (kPa) (%) 0 100 200 300 400 500 0 20 40 60 80 100
0.0	Ground Surface	0.0-			
-	Grass Sod over TOPSOIL silty, frequent roots throughout, soft, wet, dark brown.	0.0			
-	non-plastic, firm, moist, medium yellowish brown with rust mottled staining throughout.	1.0-	SA-1	G	
-		-		-	
0.5-		1.5	64.2	0	
		2.0	5A-2	G	
-	- inte grained sandy, soπ to firm, wet, dark grey below 26 inches.	2.5	-		
-		3.0	-		
1.0 -		3.5	SA-3	G	
-		4.0			
-		4.5			
1.5	END OF TEST PIT AT 5 FEET. WATER TABLE NOTED BELOW 18 INCHES. SLOUGHING WITH DEPTH.	5.0			
-		5.5			
-		6.0			
2.0 -		6.5			
Investigation Date: January 24, 2013					
Subcontractor: On-The-Mark Locates Equipment: Kubota KX121-3 Tracked Excavator Logged By: A.L. Figure No: J13-01795-TP2					



Photo 1 – TP-1, Topsoil, roots, over natural silt. Dark grey indicates the permanent water table level.



Photo 2 – TP-1, water flowing into test pit.





Photo 3 – TP-2, Topsoil, roots, over natural silt. Dark grey indicates the permanent water table level.



Photo 4 – TP-1, water slowly seeping into test pit.



This report incorporates and is subject to these "General Conditions".

1. USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment. This report and the recommendations contained in it are intended for the sole use of Calibre's client. Calibre does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Calibre's client unless otherwise authorized in writing by Calibre. Any unauthorized use of the report is at the sole risk of the user. This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Calibre. Additional copies of the report, if required, may be obtained upon request.

2. NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned. Classification and identification of geological units are judgmental in nature as to both type and condition. Calibre does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice. Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

3. LOGS OF TEST HOLES

The test hole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

4. STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. Calibre does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

5. SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgmental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

6. PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.



7. SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

8. INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

9. OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

10. DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

11. BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

12. SAMPLES

Calibre will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the client's expense upon written request, otherwise samples will be discarded.

13. STANDARD OF CARE

Services performed by Calibre for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practising under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

14. ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, Calibre has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

