GEOTECHNICAL HAZARD ASSESSMENT

New Single-Family Residence

283 (Lot 15) Castley Heights
Lake Cowichan, BC

Legal Address:
Lot 15, Section 5, Renfrew District (Situated in Cowichan Lake District), Plan VIP54940, PID 017-909-252

Prepared For:
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Attention:
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May 30, 2025

File No.: E4490.01
Revision No.: 00
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DISCLAIMER, ACKNOWLEDGMENTS, AND LIMITATIONS

1. Lewkowich Engineering Associates Ltd. (LEA) acknowledges that this report, from this point forward referred to as "the Report," may be used by the Town of Cowichan Lake (TOLC) as a precondition to the issuance of a development and/or building permit. It is acknowledged that Approving Officers and/or Building Officials of the TOLC may rely on this Report when making a decision on application for development of the land. It is acknowledged that this Report and any conditions contained in the Report may be included in a restrictive covenant under Section 56 of the Community Charter and registered against the title of the Property at the discretion of the TOLC.
2. This Report has been prepared in accordance with standard geotechnical engineering practice solely for and at the expense of Iconic Island Dwellings Ltd. We have not acted for or as an agent of the TOLC in the preparation of this Report.
3. The conclusions and recommendations submitted in this Report are based upon information from relevant publications, a visual site assessment of the property, encountered and inferred subsurface conditions, available floodplain mapping, current construction techniques, and generally accepted engineering practices. No other warrantee, expressed or implied, is made. If unanticipated conditions become known during construction or other information pertinent to the development becomes available, the recommendations may be altered or modified in writing by the undersigned.
4. The conclusions and recommendations submitted in this Report are based upon the data obtained from a limited number of subsurface explorations. Subgrade conditions are known only at the locations of the explorations and have been used to infer subgrade conditions throughout the site in preparation of this Report. The nature and extent of subgrade variation throughout the site may not become evident until construction or further investigation.
5. Future construction shall be carried out within the requirements and recommendations of the Environmental Consultant (if applicable), any defined jurisdictional bylaws, or any existing restrictive covenants, whichever is more stringent. Any environmental and/or jurisdictional limitations may supersede the recommendations in this Report.
6. This Report was authored, to the best of our knowledge at the time of issuance, with considerations for local requirements specific to the Authority Having Jurisdiction (AHJ) and their standards for the preparation of such reports, the 2024 British Columbia Building Code (BCBC), and current engineering standards. Updates to bylaws, policies, or requirements of the AHJ, or updates to the BCBC or professional practice guidelines, may impact the validity of this Report.
7. This Report has been prepared by Stuart Crossfield, P.Geo., P.L.Eng., and reviewed by Chris Hudec, M.A.Sc, P.Eng., both adequately experienced and are also members in good standing with the Engineers and Geoscientists of British Columbia (EGBC).

EXECUTIVE SUMMARY

1. The following is a brief synopsis of the property, assessment methods, and findings presented in the Report. The reader must read the Report in its entirety; the reader shall not rely solely on the information provided in this summary.
2. The subject property, Lot 15 (283) Castley Heights, Lake Cowichan, BC, from this point forward referred to as "the Property," is located in Vancouver Island within the jurisdictional boundaries of the TOLC. The proposed development for the Property at the time of this Report consists of a new single-family residence.
3. A site-specific hazard assessment was conducted to identify any potential geotechnical hazards for the proposed development. Two hazards were identified and addressed in this Report: flooding from Cowichan Lake and slope stability.
4. The Report finds the Property is not at risk of flooding due to the greater than 20m of elevation difference between it and the mapped Flood Construction Level (FCL) of 167.33m CGVD28.
5. The Report concludes the slope within the Property is in a globally stable condition based on static and seismic slope stability analysis.
6. The findings confirm the land is considered safe for the use intended, provided the recommendations in this Report are followed.

List of Abbreviations Used in the Report

Abbreviation	Title
AHJ	Authority Having Jurisdiction
BCBC	British Columbia Building Code
CGVD	Canadian Geodetic Vertical Datum
DPA	Development Permit Area
EGBC	Engineers and Geoscientists of British Columbia
FCL	Flood Construction Level
LEA	Lewkowich Engineering Associates Ltd.
MoE	Ministry of Environment
PGA	Peak Ground Acceleration
TOLC	Town of Lake Cowichan

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1.0 INTRODUCTION

1.1 General

a. As requested, LEA has carried out a Geotechnical Hazard Assessment of the subject Property with respect to the proposed development. This Report provides a summary of our findings and recommendations.

1.2 Background

a. We understand the proposed development consists of a new single-family residence built on sloping topography including a rear/basement foundation wall. We understand the new construction will be of conventional construction methods and will include typical cast-in-place concrete foundations system.

b. The Property is within the jurisdictional limits of the TOLC and is zoned Urban Core (R-3). As per the TOLC Official Community Plan[1], we understand the Property is within a geohazard DPA 2 for Floodplain and Steep Slopes. Therefore, a Geotechnical Assessment and report is required to assist in determining what conditions or requirements shall be included in the development permit so that the proposed development is protected from the identified natural hazards and no increase in hazard is posed to existing development on or near the Property.

1.3 Assessment Methodology

a. This assessment included a desktop review of relevant background information, including applicable TOLC bylaws,[1] available development plans, registered covenants on title, aerial photographs, and published geology, topography, and floodplain mapping. Please refer to the list of references at the end of this Report. Further information has been gathered from LEA experience in the neighbourhood.

b. An initial site reconnaissance was conducted on April 23, 2025, to visually assess site conditions throughout the Property.

c. A subsurface investigation was carried out on May 8, 2025, using a Bobcat E50 excavator. Two TPs (TP 25-01 and TP 25-02) were advanced within the Property near the proposed location of the future residence. The TPs were backfilled upon completion of the investigation.

d. Our assessment included evaluation of the global stability of the sloping terrain under both static and seismic conditions. A two-dimensional slope model was developed and assessed using slope stability analysis software. The slope stability analysis was completed to determine if the Property would be affected by a potential slope hazard.

e. This assessment was prepared with consideration of the referenced EGBC professional practice guidelines, Landslide Assessments in British Columbia.[2] Please refer to the attached EGBC assurance statement.

1.4 Covenant Review

a. As part of our assessment, we have reviewed the legal title of the Property, specifically relative to any restrictive covenants that may impact the conclusions or recommendations made in this Report. No geotechnical covenants were found that will impact the geotechnical conclusions in this Report.

2.0 SITE CONDITIONS

2.1 Physical Setting

a. The Property is located on southeastern Vancouver Island within the town of Lake Cowichan. The Property is between North Shore Road and River Road.

b. The Property is immediately bordered by similar R-3 properties to the south, and an undeveloped lot to the north, Castley Heights to the east and a rural property to the west. Please refer to Figure 2.1 below.

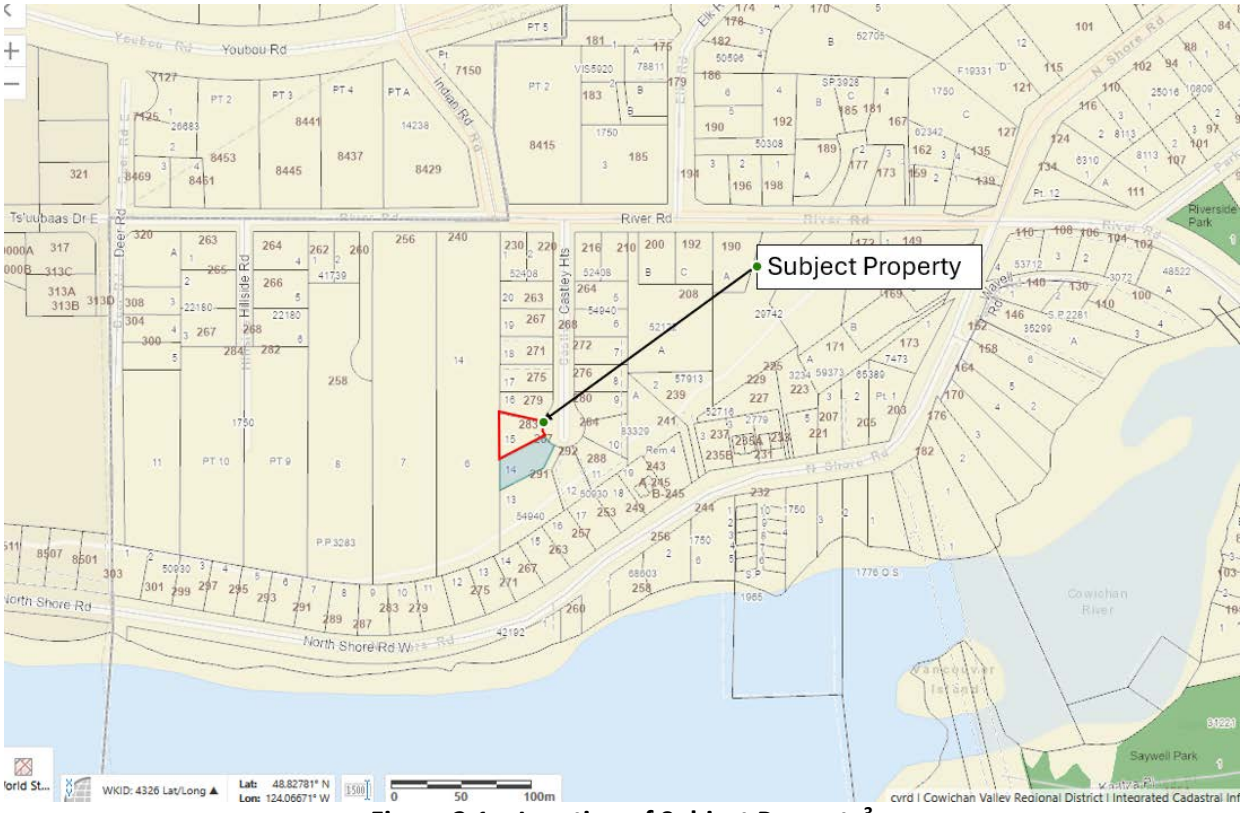


Figure 2.1 – Location of Subject Property[3]

2.2 Terrain and Features

a. In general, the local terrain within the Property and surrounding neighbourhood consists of a typically consistent moderate slope (15 to 18deg) rising up from the southeast property line (Castley Heights) up to the northwest direction.

b. The total elevation difference across the Property from southeast to northwest is 11m over a horizontal distance of 33m. This corresponds to a slope inclination of approximately 33% or 18 degrees.

c. At the time of our assessment, the Property remains undeveloped with mainly low lying brush and a few mature trees at the rear and fence line.

2.3 Regional Geology

a. Surficial geology for the area is classified as moraine deposits, consisting of well-drained, gravelly sandy loam (strongly cemented pan), with minor composition of fluvial deposits, of very gravelly, loamy sand (generally level landscape position).[4]

b. Bedrock geology for the area is classified as the Nanaimo Group, comprised of undivided sedimentary rocks from the upper Cretaceous period, generally consisting of boulder, cobble, and pebble conglomerate, coarse to fine sandstone, siltstone, shale, and/or coal.[5]

2.4 Soil Conditions

a. Relatively consistent soil strata were encountered during the subsurface investigation. The main soil strata are summarized in Table 2.4 below. Detailed descriptions of the subsurface conditions are provided on the attached TP logs (TP 24-01 and TP 24-02).

Table 2.4 – Summary of Encountered Soil Strata

Soil Stratum No.	Soil Description	Depth Range (m)	
		From	To
1	Silty SAND, some gravel, trace organics (roots), loose, dark brown, moist (Fill).	0.0	0.4
2	Sandy SILT/ silty SAND, trace gravel, trace organics, firm/compact, grey brown, moist to wet.	0.4	0.9
3	SAND and GRAVEL, some silt, trace cobble, dense, brown to blue-grey, moist to wet.	0.9	1.5 (refusal)

b. Test pits were excavated to practical refusal with the smooth cleanup bucket within very dense soils.

Photo 2.4.: Test pit TP25-01 soil conditions.

2.5 Groundwater Conditions

a. Minor to moderate groundwater seepage was encountered during the subsurface investigation from sand lenses at 1.35m.

b. We anticipate a perched groundwater table within more permeable layers above the low permeable very dense, silt, sand and gravel materials. We further expect moderate to heavy groundwater flow rates may be encountered based on our experience with neighbouring developments.

c. Groundwater levels can be expected to fluctuate seasonally with cycles of precipitation. Groundwater conditions at other times and locations can differ from those observed at the time of our assessment.

3.0 COWICHAN LAKE FLOODING

a. Historically, floodplain information for Cowichan Lake was prepared and provided by the provincial government, specifically the MoE Water Management Branch.[5] This existing mapping was issued in 1984 and established a 200-year FCL of 167.33m CGVD28, which included an allowance for freeboard.

b. Based on the attached site survey the lowest elevation on the subject Property is 187.5m CGVD28. The

Property is therefore a little over 20m in elevation above the mapped FCL.

c. LEA concludes there is no flood hazard for the Property, and no further review is required.

4.0 SLOPE STABILITY

4.1 Stability Assessment

a. We reviewed the terrain surrounding the Property and there are no significant slopes above / off-property that would be a hazard for the proposed development.

b. The Property contains a moderate slope that measures approximately 12m to 16m in height and has a relatively uniform slope angle of approximately 18 degrees. The subsurface conditions consist of up to 1m of a trace organic, compact silty sand, gravel, overlying dense silty sand and gravel glacial till. The slope is vegetated with grasses. Refer to Photo 4.1 below.

Photo 4.1: Typical slope conditions from aerial photograph

c. The slope was inspected for signs of global instability (i.e., tension cracks, slumping, seepage, erosion, etc.), and none were observed. The slope is relatively uniform and featureless with respect to evidence of instability. The majority of the trees on the slope displayed vertical growth patterns, which is another

indication of stable slope conditions.

d. We understand that future development would require to be incised into the slope based on the attached Site Plan.

e. Excluding circumstances where indicators of global instability are present, it is generally accepted that dense soil slopes that are less than 2 Horizontal to 1 Vertical (2H:1V / 27 degrees) are considered to be in both a static and seismically stable condition. Considering the natural slope is comprised of dense sand, silt and gravel mixture or glacial till and is less than 18 degrees (3H to 1V), there are no anticipated global slope stability issues.

f. As per EGBC guidelines and a Class 1 assessment, this was verified by completing a pseudo-static limit equilibrium slope stability analysis using GeoStudio Slope/W software. The analysis was performed for both static and 2% in 50-year seismic conditions (kh equal to k15), with a target FoS of 1.5 for the static condition and 1.0 for the seismic condition. The analysis considered global rotational failures employing the Morgenstern-Price method.

g. The stability analysis was performed using effective stress conditions and frictional soil parameters as estimated based on published soil parameters, nearby well logs and LEA experience with similar soil conditions.

h. Based on our assessment of test pits and nearest well logs, a perched groundwater level was applied to the upper sandy silt layer while the lower static piezometric level was established at roughly 6m below ground surface.

i. The results of the stability analysis are summarized in Table 4.1 below. The detailed Slope/W output plots may also be found attached to this Report.

Table 4.1: Summary of Slope Stability Results

Analysis	Factor of Safety (FoS)
Static	> 3.29
Seismic	> 1.36

j. The stability analysis confirms the slope is in a globally stable condition and meets minimum FoS for both static and seismic conditions.

4.2 Site Grading

a. Considering the sloping topography of the land, we expect some land terracing, cut/fill operations, and/or retaining walls may be required as part of the development.

b. Any permanent soil slopes should not exceed 2H:1V for maintenance-free slopes, subject to geotechnical review.

c. Adequate setback, benching, and/or subjacent support shall be reviewed by a Geotechnical Engineer for any foundations in proximity to slopes.

d. Any permanent slopes should be finished with consideration for erosion control. Terracing and protective vegetative or rock facing are common methods of erosion control. Other methods of erosion control may be considered upon request.

e. Any proposed retaining walls exceeding 1.2m in height must be designed by a Structural and/or Geotechnical Engineer as per EGBC requirements.

f. Stacked rock walls could present a rockfall hazard for downslope development. Therefore, any stacked rock wall should include a level (flat) "no-build" rockfall zone at the base of the wall with a minimum lateral distance equal to the wall height. Any proposed stacked rock walls exceeding 1.2m in height must be designed and inspected during construction by a Geotechnical Engineer.

g. LEA shall be consulted prior to the re-use of any on-site materials, for re-use as structural fill, permanent slopes, retaining wall backfill, or otherwise.

4.3 Slope Maintenance

a. It should be noted that landslides can occur due to human activity (i.e. excavation, placement of fill, removal of vegetation, etc.) or failure of civil infrastructure (i.e. leakage/rupture of underground water and sewer mains, stormwater disposal from existing development, etc.).

b. Minimizing the infiltration of water into the slope is essential to reducing the risk of slope movement. It is important that water does not pond near the crest of slope. Surface water from precipitation events, collected stormwater, or from any other drainage system must be prevented from flowing in a concentrated manner down the slope. The concentrated discharge of collected stormwater can lead to erosion, earth movement, or slope failure.

c. Where possible, the existing native vegetation cover on the slope should be maintained to control surficial erosion.

5.0 DESIGN PHASE

5.1 Foundation Design

a. Prior to construction, the foundation areas should be stripped to remove all unsuitable materials to provide an undisturbed natural subgrade for footing support.

b. We anticipate all surficial loose soils will require removal to expose competent dense glacial till subgrade. Due to the sensitivity of the finer grained soils to the elevated groundwater seepage, we expect loosening and softening of the subgrade soils will occur if left exposed. We therefore recommend over-excavation

by 100mm to 150mm and replacement using a well graded, 19mm crush, sand and gravel structural fill.

c. Foundation loads should be supported on natural undisturbed material or structural fill, approved for use as a bearing stratum by our office, and may be designed using the following values.

   i. For foundations constructed on structural fill, placed and compacted as outlined in Section 6.2 of this Report, an SLS bearing pressure of 75 kPa and a ULS bearing pressure of 100 kPa may be used for design purposes. These values assume a minimum 0.45m footing embedment depth.

d. Exterior footings should be provided with a minimum 0.45m depth of ground cover for frost protection.

e. The Geotechnical Engineer should evaluate the subsurface conditions at the time of construction to confirm that soil and/or groundwater conditions do not materially differ to those encountered during the subsurface investigation and that footings are based on appropriate and properly prepared founding material.

5.2 Seismic Criteria

a. As per the 2024 BCBC (Division B, Part 4, Table 4.1.8.4-B), the encountered and inferred subsurface conditions would be classified as “Site Class D” (stiff soil).

5.3 Lateral Earth Pressures

a. Preliminary lateral earth pressure coefficients (K) for the design of cast-in-place concrete retaining walls are outlined below. Note that these values are based on assumed conditions and should be considered as preliminary. Further assessment will be required after the dimensions of the proposed structure and backslope conditions have been determined. Any future retaining wall construction within the Property should be reviewed by a Structural and/or Geotechnical Engineer.

b. It is assumed that there will be a level (0° from horizontal) backslope and no additional surcharge on the wall. Note that any backslope or surcharge will increase the lateral earth pressure coefficients.

c. An average soil friction angle of 30 degrees has been used to calculate the lateral earth pressure coefficients. It is assumed that retained soils are free draining, well compacted, cohesionless sands and gravels, with a unit weight of 21 kN/m^3.

d. The seismic condition is based on 2020 National Building Code interpolated seismic hazard values for the Property location, considering a 2% in 50 year probability of exceedance and firm ground conditions, which provides a PGA of 0.694g.

e. The Mononobe-Okabe Method has been used to calculate the seismic active lateral earth pressure coefficient (K_{aE}). The static active lateral earth pressure coefficient (K_a) has been calculated using Coulomb’s theory. The static passive lateral earth pressure coefficient (K_p) has been calculated using Rankine’s theory. Refer to Table 5.3.1 below for design values.

Table 5.3.1: Lateral Earth Pressure Coefficients

Earth Pressure Condition	Lateral Earth Pressure Coefficient (K)	
Static Active	K_a	0.29
Static Passive	K_p	3.00
Seismic Active	K_{aE}	0.63

f. The thrust resulting from each earth pressure condition may be calculated using the relationship in Table 5.3.2 below. A minimum uniform static load of 12 kPa shall be considered for compaction forces.

Table 5.3.2: Thrust from Lateral Earth Pressure Relationship

$P = 0.5 * K * \gamma * H^2$
P = Thrust (kN/m length of wall)
K = Lateral Earth Pressure Coefficient
γ = Soil Unit Weight (kN/m^3)
H = Height of Wall (m)

g. The seismic active coefficient provides a value that combines both static and dynamic forces to determine total active thrust (P_{aE}). The static component (P_a) acts through a point that is approximately H/3 above the toe of the wall. The dynamic component (ΔP_{aE}) acts through a point at approximately 0.6H above the toe of the wall. The total active thrust may then be considered to act at a height from the base of the wall using the relationship in Table 5.3.3 below.

Table 5.3.3: Height from Base of Wall for Total Active Thrust

$h = \frac{P_a * \left(\frac{H}{3}\right) + \Delta P_{aE} * (0.6H)}{P_{aE}}$
h = Height from Base of Wall for Total Active Thrust (m)
P_a = Static Active Thrust (kN/m)
P_{aE} = Total Active Thrust (kN/m)
$\Delta P_{aE} = P_{aE} - P_a$ = Dynamic Active Thrust (kN/m)
H = Height of Wall (m)

h. The presented lateral earth pressure coefficients are based on fully drained backfill conditions, through the use of free draining granular backfill and foundation drainage.

6.0 CONSTRUCTION PHASE

6.1 General Excavation – Future Building Sites

a. Prior to construction, all unsuitable materials should be removed to provide a suitable base of support. Unsuitable materials include any non-mineral material such as vegetation, topsoil, peat, fill, or other materials containing organic matter, as well as any soft, loose, or disturbed soils.

b. We anticipate all surficial soils will require removal to expose competent dense silty sand and gravel subgrade. The depth to competent subgrade as encountered within the TPs was 0.9m.

c. Excavation work should conform to Occupational Health and Safety guidelines. Any excavations deeper than 1.2m should be reviewed in the field by a Qualified Professional. For preliminary planning purposes, we expect the surficial compact to dense soils may be temporarily stable at a 1H:1V slope configuration, assuming no seepage.

d. Groundwater ingressing into any excavations should be controlled with a perimeter ditch located just outside of the building areas, connected to positive drainage.

e. Prior to placement of concrete footings, any bearing soils that have been softened, loosened, or otherwise disturbed during the course of construction, should be removed or else compacted following our recommendations for structural fill. Compaction will only be feasible if the soil has suitable moisture content and if there is access to heavy compaction equipment. If no structural fill is placed, a smooth-bladed clean up bucket should be used to finish the excavation.

f. The Geotechnical Engineer is to confirm the removal of unsuitable materials and approve the exposed competent inorganic subgrade, prior to the placement of any structural fill material.

6.2 Structural Fill

a. Where fill is required to raise areas that will support buildings, slabs, or pavements, structural fill should be used. The Geotechnical Engineer should first approve the exposed subgrade in fill areas, to confirm the removal of all unsuitable materials.

b. Structural fill should not be placed on sloping ground; sloping ground should first be benched and leveled prior to the placement of structural fill.

c. Structural fill should be inorganic sand and gravel. If structural fill placement is to be carried out during the wet season, material with a fines content limited to 5% passing the 75µm sieve should be used, as such a material will not be overly sensitive to moisture, allowing compaction during rainy periods of weather.

d. Structural fill should be compacted to a minimum of 95% of Modified Proctor maximum dry density (ASTM D1557) in foundation and floor slab areas, as well as in paved roadway and parking areas.

e. Structural fills under foundations (including any isolated pad footings), roadways, and pavements should

include the zone defined by a plane extending down and outward a minimum 0.5m from the outer edge of the foundation at an angle of 45 degrees from horizontal to ensure adequate subjacent support. This support zone is shown in Figure 6.2 below.

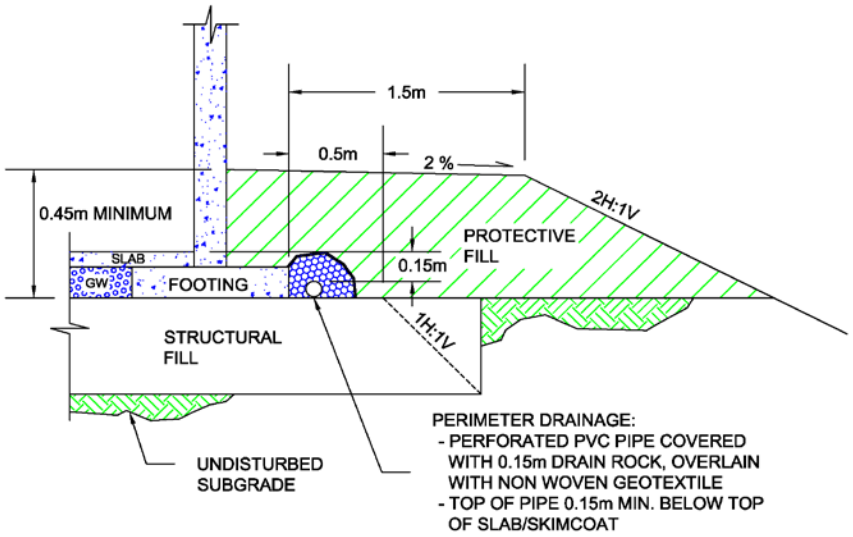


Figure 6.2 – Typical Section, Structural Fill

f. Compaction of fill should include moisture conditioning as needed to bring the soils to the optimum moisture content and compacted using vibratory compaction equipment in lift thicknesses appropriate for the size and type of compaction equipment used.

g. A general guideline for maximum lift thickness is no more than 100mm for light hand equipment such as a "jumping-jack," 200mm for a small roller, and 300mm for a large roller or heavy (>500 kg) vibratory plate compactor or a backhoe mounted hoe-pac or a large excavator mounted hoe-pac, as measured loose.

h. It should be emphasized that the long-term performance of buildings and slabs is highly dependent on the correct placement and compaction of underlying structural fills. Consequently, we recommend that structural fills be observed and approved by the Geotechnical Engineer. This would include approval of the proposed fill materials and performing a suitable program of compaction testing during construction.

6.3 Foundation Drainage

a. As indicated in Section 2.5, the property will likely exhibit shallow groundwater seepage conditions during construction, and potentially have groundwater seepage year round. Conventional requirements of the 2024 BCBC pertaining to building drainage are not considered adequate and will require additional measures to ensure the installed measures will adequately dewater the soils around the residence.

b. In addition to the standard BCBC requirements for permanent dewatering, we recommend the following additional measures:

   i. Install additional and separate curtain drain on the upslope side of the foundation roughly 1m away

from footings, as well as two rows of interior sub-slab drainage connecting to rear/outside curtain drain all wrapped in fabric.

ii. Install rubberized asphalt compound (Blueskin WP 200 membrane or approved alternate) around all exterior walls to provide a high-performance waterproofing barrier.

iii. Install a high-density polyethylene drainage core (Delta-Drain or approved alternate) against the Blueskin membrane. This will protect the Blueskin and allow incoming water to flow freely down to the perimeter drain, thus preventing the build-up of hydrostatic pressure against the foundation. The drainage membrane shall be installed as per manufacturer specifications (with the membrane's fabric layer facing out / facing the backfill). OR: The backfill material along the foundation wall must be comprised of a clear, 19mm fractured drain rock or a "clean" free-draining sand and gravel material. This will provide a capillary break between the foundation and slope; reducing the amount of hydrostatic pressure against the foundation. The use of 19mm fractured drain rock would require the placement of a non-woven geotextile between the excavation cut (wall) and the drain rock to prevent the migration of fines into the drain rock, which would reduce the hydraulic conductivity of the drain rock.

iv. The foundation should be designed in a manner so that the interior slab elevation is a minimum 0.5m above the perimeter drain invert. This will mitigate groundwater "upwelling", which is a result of hydrostatic pressure. Infill material shall comprise of free-draining pitrun sand and gravel (same as exterior).

c. All the above options may be utilized for maximum perimeter drainage management.

d. Placement of a minimum thickness of 150mm of drain rock between under-slab fill and concrete slabs is strongly recommended.

e. Footing "knock-outs" are recommended at the lowest area of the perimeter so that any buildup of water within the footing perimeter can escape to the exterior perimeter drain system. Pony walls should also include knock-outs as they may prevent water from draining/escaping to the lower exterior knock-outs.

f. The system should be attached to a municipal storm service at the front of the property. The installation of an infiltration facility or "rock pit" is not recommended due to the shallow groundwater conditions, which are not conducive to stormwater infiltration.

g. The final site grades shall be sloped to direct surface water away from the building and foundation areas.

h. The Geotechnical Engineer is to confirm the correct installation of foundation drainage during construction.

6.4 Stormwater Management

a. Runoff from paved areas, roof drains, and perimeter foundation drains should be collected and piped to

the existing storm sewer.

b. We understand LEA is providing a detailed Stormwater Management Plan under separate cover and will be consistent with the requirements presented in this Report.

7.0 CONCLUSIONS

7.1 Local Government Conformance Statement

a. From a geotechnical point of view, and provided the recommendations in this Report are followed, the land is considered safe for the use intended (defined for the purposes of this Report as a new single-family residence), with the probability of a geotechnical failure resulting in property damage of less than:

i. 2% in 50 years for geotechnical hazards due to seismic events, including slope stability;

ii. 10% in 50 years for all other geotechnical hazards.

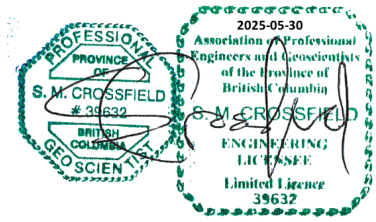
7.2 Geotechnical and Quality Assurance Statement

a. The 2024 BCBC requires that a Geotechnical Engineer be retained to provide Geotechnical Assurance services for the construction of buildings that are outside of Part 9 of the BCBC. Geotechnical Assurance services include review of the geotechnical components of the plans and supporting documents, and responsibility for field reviews of these components during construction.

8.0 CLOSURE

a. Lewkowich Engineering Associates Ltd. appreciates the opportunity to be of service on this project. If you have any comments, or additional requirements at this time, please contact us at your convenience.

Respectfully Submitted,
Lewkowich Engineering Associates Ltd.



Stuart Crossfield, P.Geo., P.L.Eng.
Engineering Geologist

Reviewed by:

May 30, 2025

Chris Hudec, M.A.Sc., P.Eng.
Senior Project Engineer

9.0 ATTACHMENTS

1. Sketch Markup with Building Footprint of Kenyon Wilson Professional Land Surveyors, Titled “Topographic Survey of: Lot 15, Section 5, Renfrew District (Situated in Cowichan Lake District), Plan VIP54940”, dated January 19, 2024.
2. LEA, Topographic Site Plan, Drawing E4490-01, Dated May 7, 2025
3. LEA, Test Pit Logs, TP 25-01 and TP 25-02, dated May 8, 2025.
4. LEA, Slope/W plots (2 plots).
5. EGBC Geohazard Assurance Statement.

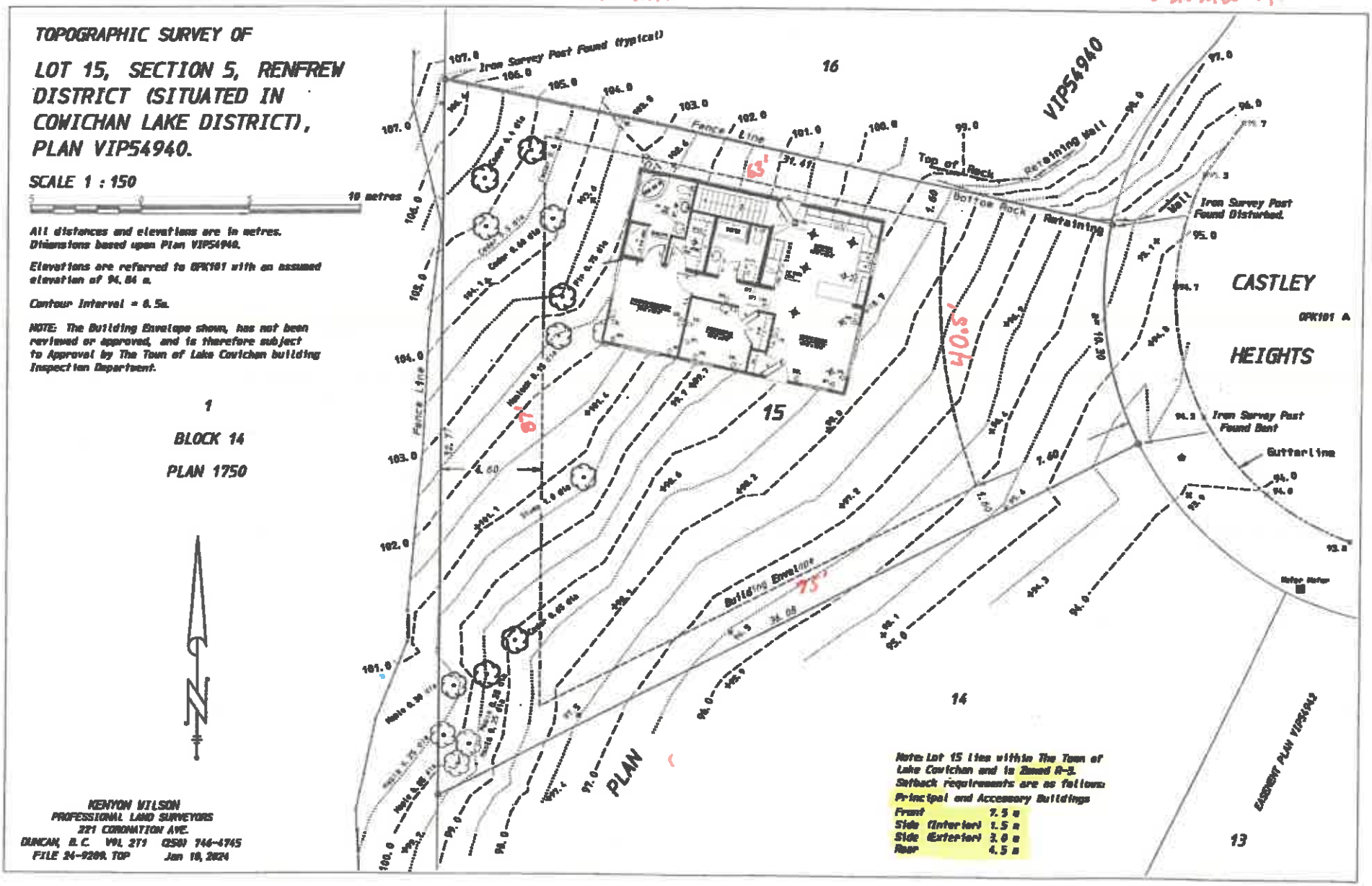
10.0 REFERENCES

1. Town of Lake Cowichan, Bylay No. 1097-2023. A Bylaw to Adopt an Official Community Plan for the Town of Lake Cowichan, December 19, 2023.
2. Engineers and Geoscientists of British Columbia, Landslide Assessments in British Columbia, Version 4.1, published March 1, 2023.
3. Cowichan Valley Regional District interactive web-map.
4. BC Ministry of Environment, Soils of South Vancouver Island British Columbia, Soil Survey Report No. 44, Sheet 2, 1986.
5. Province of BC, interactive web-map, iMapBC, accessed May 2025.
6. BC Ministry of Environment, Water Management Branch, Floodplain Mapping Cowichan Lake, Dwg No. 84-33-3, Sheet 1 of 6, dated June 1984.

Proposed Location.

Main Floor

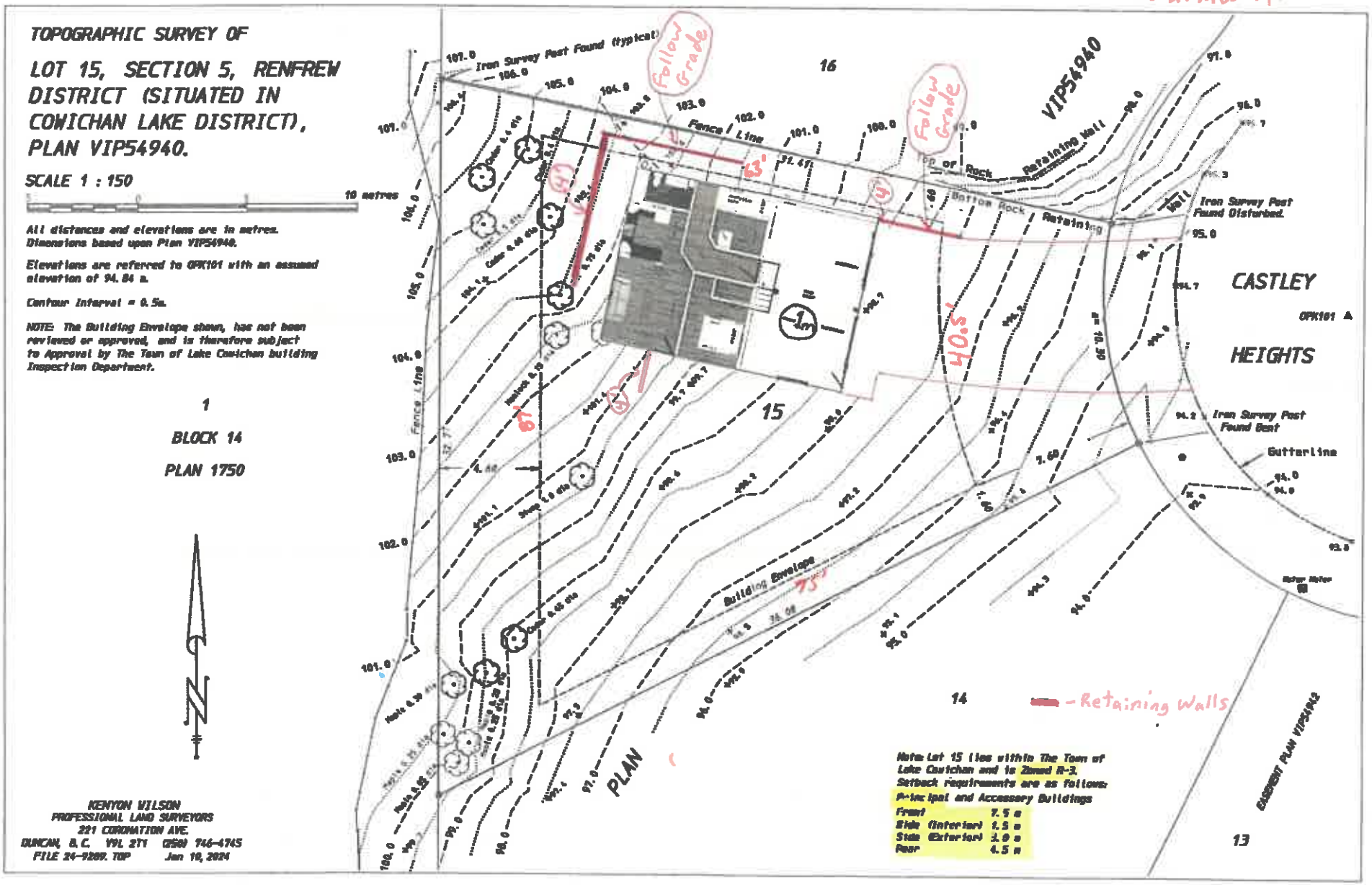
Warmuth

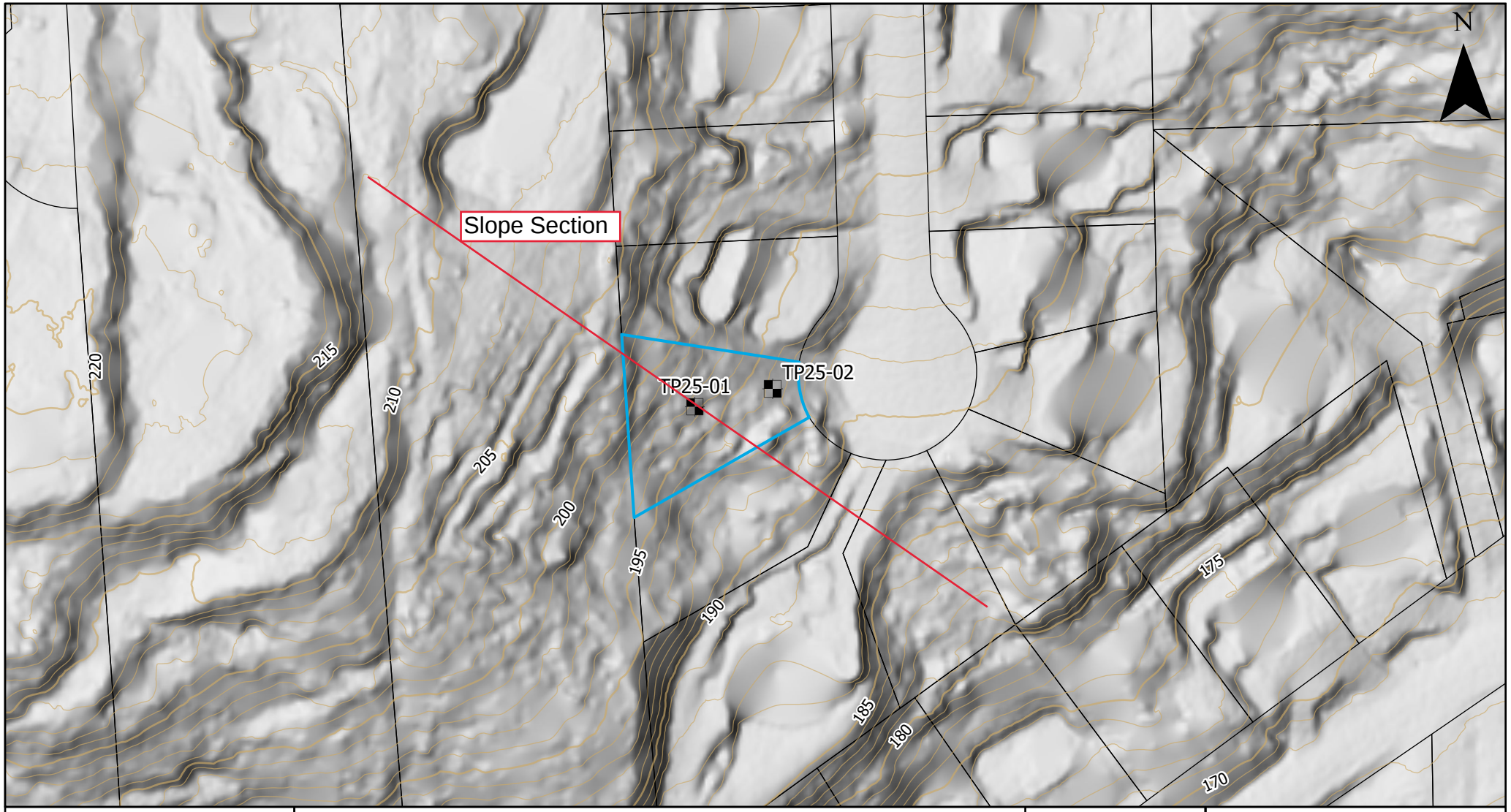


Proposed Location

Lower Level

Warmuth





Legend

- Subject Property
- Property Lines
- Test Pits
- Contour
  - 1m
  - 5m

PROJECT NAME

283 Castley Heights (Lot 15), Lake Cowichan, BC

Drawing No.
E4490-01

DRAWING TITLE

Topographic Site Plan

Date: 2025-05-07

Drawn By: TA

LEGAL DESCRIPTION

Lot 15, Plan VIP54940, Section 5, Renfrew Land District, Situated in Cowichan Lake District, PID: 017-909-252

Lidar Aquisition Date: 2019
Coordinate System: NAD 1983 CSRS UTM Zone 10N
Vertical Datum: CGVD 2013

Lewkowich Engineering Associates Ltd.

0 10 20 30 Meters

Lewkowich Engineering Associates Ltd.

TEST PIT LOG

File Number: E4490 TP25-01
Client: Iconic Island Dwellings Ltd.
Project: 283 Castley Heights,
Location: Lake Cowichan, BC

Coordinates: 48.8253368 N, -124.0655183 W

Depth (m)	Soil Symbol	Description
		Ground Surface
0.0		0.0-0.45m Silty SAND, some gravel, trace organics (roots), loose, dark brown, dry [FILL]
0.5		0.45-0.6m Sandy SILT, trace organics (roots), soft to firm, dark brown, moist
		0.6-1.35m SAND & GRAVEL, some silt, dense, grey, moist
1.0		Lenses of Medium SAND, compact, brown, moist
		End of Hole at 1.35m. No Groundwater Encountered. Fill Encountered to 0.45m.
1.5		
2.0		

Logged By: Spencer Woodward, GIT Date: May 8, 2025
Reviewed By: Stuart Crossfield, P.Geo, P.L.Eng. Page 1 of 1
Digging Method: Deere 50-P Excavator

1900 Boxwood Road,
Nanaimo, BC, V9S 5Y2
Phone: 250-756-0355
Fax: 250-756-3831
Email: geotech@lewkowich.com

Lewkowich Engineering Associates Ltd.

TEST PIT LOG

File Number: E4490 TP25-02
Client: Iconic Island Dwellings Ltd.
Project: 283 Castley Heights,
Location: Lake Cowichan, BC

Coordinates: 48.8253337 N, -124.0653493 W

Depth (m)	Description
	Ground Surface
0.0	0.0-0.4m Silty SAND, some gravel, trace cobble, trace organics (roots), loose, dark brown, dry [FILL]
0.5	0.4-0.6m Sandy SILT, trace organics (roots), soft, dark brown, moist
	0.6-0.9m Silty SAND, trace gravel, loose to compact, grey brown, moist
1.0	0.9-1.5m SAND & GRAVEL, some silt, compact to dense, blue grey, wet
	Lenses of Coarse SAND, compact, grey, wet
1.5	End of Hole at 1.50m. Minor to Moderate Groundwater Seepage Encountered at 1.35m. Fill Encountered to 0.40m.
2.0	

Logged By: Spencer Woodward, GIT Date: May 8, 2025
Reviewed By: Stuart Crossfield, P.Geo, P.L.Eng. Page 1 of 1
Digging Method: Deere 50-P Excavator

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1.0		Lenses of Medium SAND, compact, brown, moist
		End of Hole at 1.35m. No Groundwater Encountered. Fill Encountered to 0.45m.
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2.0		

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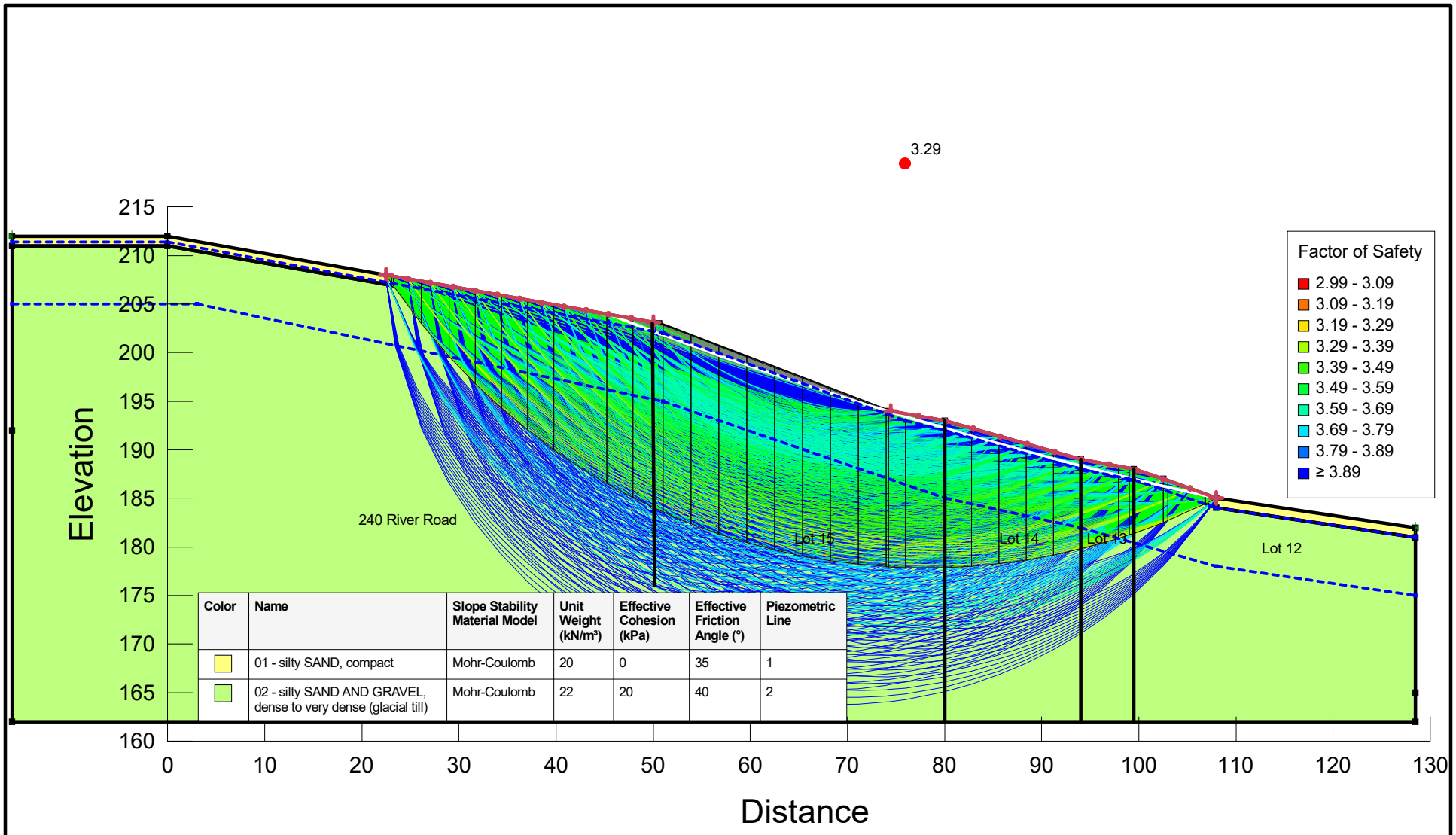
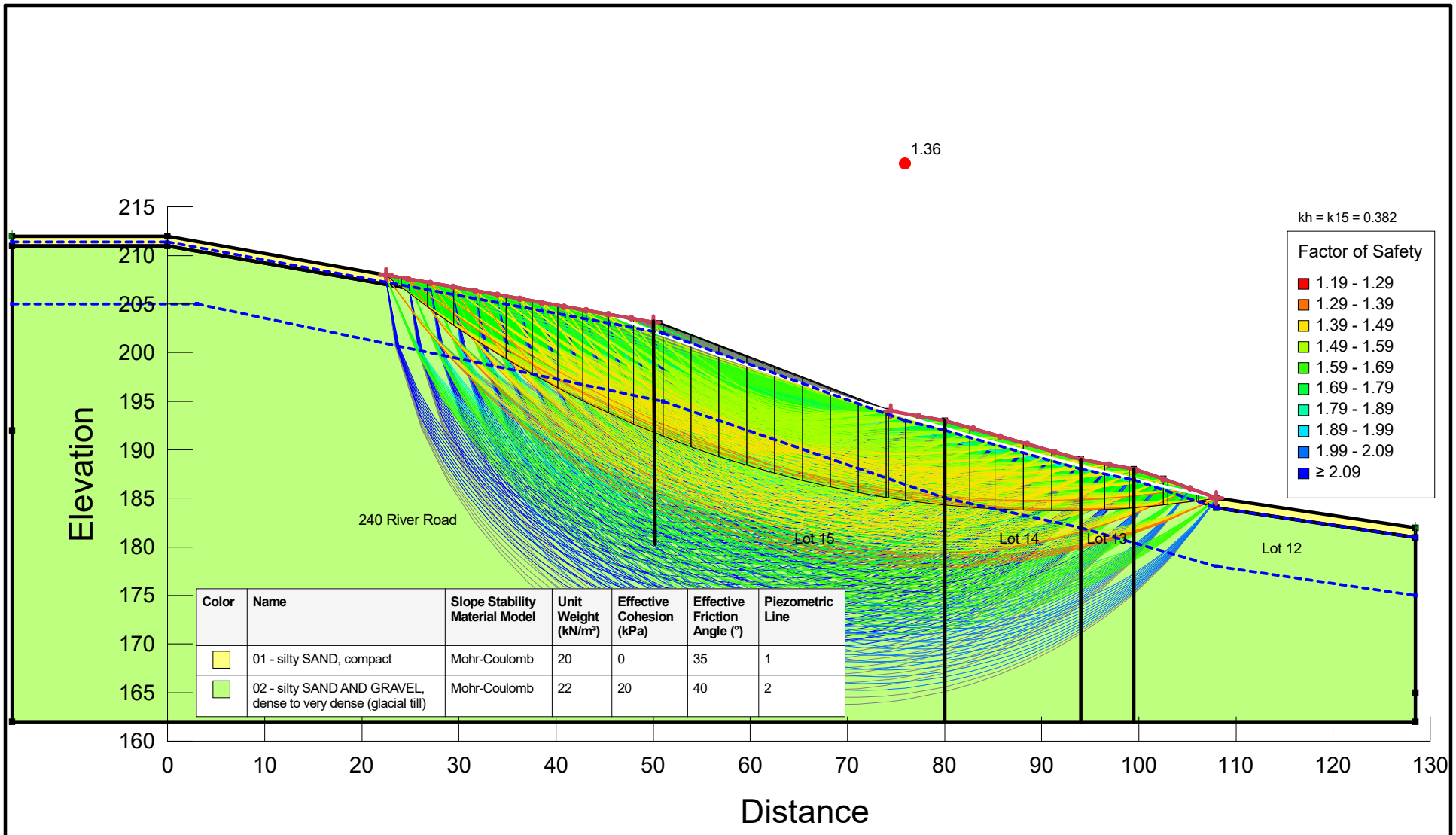


Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	01 - silty SAND, compact	Mohr-Coulomb	20	0	35	1
	02 - silty SAND AND GRAVEL, dense to very dense (glacial till)	Mohr-Coulomb	22	20	40	2

SLOPE/W Analysis Static	
E4490 - Lot 15 Slope Stability Model 2.gsz	
2025-05-13	1:586



Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	01 - silty SAND, compact	Mohr-Coulomb	20	0	35	1
	02 - silty SAND AND GRAVEL, dense to very dense (glacial till)	Mohr-Coulomb	22	20	40	2

SLOPE/W Analysis Seismic
E4490 - Lot 15 Slope Stability Model 2.gsz
2025-05-13 1:586

LANDSLIDE ASSESSMENT ASSURANCE STATEMENT

Notes: This statement is to be read and completed in conjunction with the Engineers and Geoscientists BC *Professional Practice Guidelines – Landslide Assessments in British Columbia* ("the guidelines") and the current *BC Building Code* (*BCBC*), and is to be provided for Landslide Assessments (not floods or flood controls), particularly those produced for the purposes of the *Land Title Act*, *Community Charter*, or *Local Government Act*. Some jurisdictions (e.g., the Fraser Valley Regional District or the Cowichan Valley Regional District) have developed more comprehensive assurance statements in collaboration with Engineers and Geoscientists BC. Where those exist, the Qualified Professional is to fill out the local version only. Defined terms are capitalized; see the Defined Terms section of the guidelines for definitions.

To: The Approving Authority (or Client)

Date: May 30, 2025 File# E4464

Town of Cowichan Lake

39 South Shore Road, PO Box 860, Lake Cowichan, BC

Jurisdiction/name and address

With reference to (CHECK ONE):

- ☐ A. *Land Title Act* (Section 86) – Subdivision Approval
- ☑ B. *Local Government Act* (Sections 919.1 and 920) – Development Permit
- ☑ C. Community Charter (Section 56) – Building Permit
- ☐ D. Non-legislated assessment

For the following property (the "Property"):

Lot 15 Castley Heights, Lake Cowichan, BC

Civic address of the Property

The undersigned hereby gives assurance that they are a Qualified Professional and a professional engineer or professional geoscientist who fulfils the education, training, and experience requirements as outlined in the guidelines.

I have signed, authenticated, and dated, and thereby certified, the attached Landslide Assessment Report on the Property in accordance with the guidelines. That report must be read in conjunction this statement.

In preparing that report I have:

[CHECK TO THE LEFT OF APPLICABLE ITEMS]

- ✓ 1. Collected and reviewed appropriate background information
- ✓ 2. Reviewed the proposed Residential Development or other development on the Property
- ✓ 3. Conducted field work on and, if required, beyond the Property
- ✓ 4. Reported on the results of the field work on and, if required, beyond the Property
- ✓ 5. Considered any changed conditions on and, if required, beyond the Property
- 6. For a Landslide Hazard analysis or Landslide Risk analysis, I have:
  - ✓ 6.1 reviewed and characterized, if appropriate, any Landslide that may affect the Property
  - ✓ 6.2 estimated the Landslide Hazard
  - ✓ 6.3 identified existing and anticipated future Elements at Risk on and, if required, beyond the Property
  - ✓ 6.4 estimated the potential Consequences to those Elements at Risk
- 7. Where the Approving Authority has adopted a Level of Landslide Safety, I have:
  - ___ 7.1 compared the Level of Landslide Safety adopted by the Approving Authority with the findings of my investigation
  - ___ 7.2 made a finding on the Level of Landslide Safety on the Property based on the comparison
  - ___ 7.3 made recommendations to reduce Landslide Hazards and/or Landslide Risks

8. Where the Approving Authority has **not** adopted a Level of Landslide Safety, or where the Landslide Assessment is not produced in response to a legislated requirement, I have:
   - ☑ 8.1 described the method of Landslide Hazard analysis or Landslide Risk analysis used
   - ☑ 8.2 referred to an appropriate and identified provincial, national, or international guideline for Level of Landslide Safety
   - ☑ 8.3 compared those guidelines (per item 8.2) with the findings of my investigation
   - ☑ 8.4 made a finding on the Level of Landslide Safety on the Property based on the comparison
   - ☑ 8.5 made recommendations to reduce Landslide Hazards and/or Landslide Risks
- ☑ 9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections

Based on my comparison between:

[CHECK ONE]

☐ the findings from the investigation and the adopted Level of Landslide Safety (item 7.2 above)
☑ the appropriate and identified provincial, national, or international guideline for Level of Landslide Safety (item 8.4 above)

Where the Landslide Assessment is not produced in response to a legislated requirement, I hereby give my assurance that, based on the conditions[1] contained in the attached Landslide Assessment Report:

A. SUBDIVISION APPROVAL

☐ For subdivision approval, as required by the *Land Title Act* (Section 86), "the land may be used safely for the use intended"
[CHECK ONE]
- ☐ with one or more recommended additional registered Covenants
- ☐ without an additional registered Covenant(s)

B. DEVELOPMENT PERMIT

☑ For a development permit, as required by the *Local Government Act* (Sections 488 and 491), my report will "assist the local government in determining what conditions or requirements it will impose under subsection (2) of [Section 491]"
[CHECK ONE]
- ☐ with one or more recommended additional registered Covenants
- ☐ without an additional registered Covenant(s)

C. BUILDING PERMIT

☑ For a building permit, as required by the *Community Charter* (Section 56), "the land may be used safely for the use intended"
[CHECK ONE]
- ☐ with one or more recommended additional registered Covenants
- ☐ without any additional registered Covenant(s)

[1] When seismic slope stability assessments are involved, Level of Landslide Safety is considered to be a "life safety" criteria, as described in Commentary JJJ of the *National Building Code of Canada* (*NBC) 2015*, Structural Commentaries (User's Guide – NBC 2015: part 4 of division B). This states:

> "The primary objective of seismic design is to provide an acceptable level of safety for building occupants and the general public as the building responds to strong ground motion; in other words, to minimize loss of life. This implies that, although there will likely be extensive structural and non-structural damage, during the DGM (design ground motion), there is a reasonable degree of confidence that the building will not collapse, nor will its attachments break off and fall on people near the building. This performance level is termed 'extensive damage' because, although the structure may be heavily damaged and may have lost a substantial amount of its initial strength and stiffness, it retains some margin of resistance against collapse."

Stuart Crossfield, P.Geo., P.L.Eng.

Name (print)

May 30, 2025

Date

1900 Boxwood Road

Address

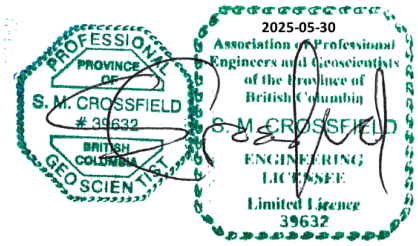
Nanaimo, BC V9S 5Y2

250 756 0355

Telephone

geotech@lewkowich.com

Email



(Affix PROFESSIONAL SEAL and signature here)

The Qualified Professional, as a registrant on the roster of a registrant firm, must complete the following:

I am a member of the firm Lewkowich Engineering Associates Ltd.

(Print name of firm)

with Permit to Practice Number 1001802

(Print permit to practice number)

and I sign this letter on behalf of the firm.