# BULLETIN

# BUILDING ON OR ADJACENT TO SLOPES

The City of Coquitlam has adopted Zoning Bylaw and Building Bylaw amendments regarding building on or adjacent to slopes, with several changes to ensure that houses and other structures are built on stable ground. The updates simplify the approval process and incorporate revisions to the Engineers and Geoscientists of BC (EGBC) Professional Practice Guidelines, slope hazard management policies for other BC authorities and international geotechnical literature related to landslide processes.

Key changes in the revised approach are as follows:

1. **Simplified approval process** – The new process only allows building on or adjacent-defined slopes based on the recommendations of a geotechnical assessment, completed by a qualified professional and submitted to the satisfaction of the Chief Building Official. This removes the requirement for a Council variance application relative to building on slopes. This also relieves staff from having to apply predetermined setbacks based on severity of slope as prescribed in the repealed table in the Zoning Bylaw.
2. **Reduced maximum slope and consideration for slope height** – The maximum slope requiring review has been adjusted from **36% to 32%,** and the assessment requirements are adjusted depending on the height of the slope and corresponding risk.
3. **Revised definitions** – The definitions for **crest, toe**, and **adjacent slope** have been revised. A supporting figure is included in this document, with the full definitions available within the updated Zoning and Building Bylaws.
4. **Increased scope** – There are no longer any exemptions for special building types, and the requirements also apply to stand-alone building permits.
5. **Minor survey changes** – The building permit application survey now requires **slope contours at 1m intervals** to support the calculation of the building slope.

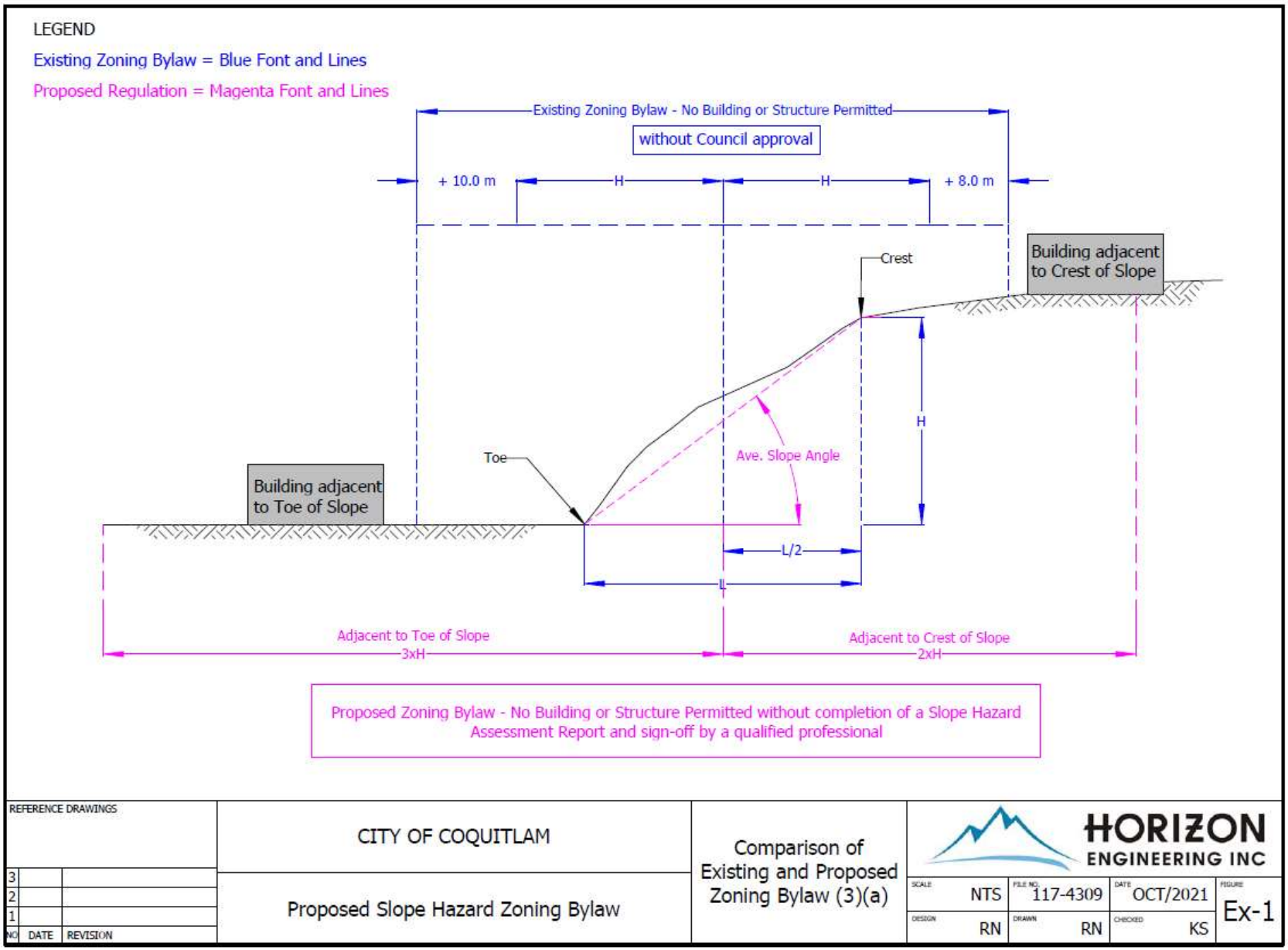
**Timing**

Council approved the bylaw adjustments on Monday, Feb. 28, 2022. The adjustments will be required for any applications submitted afterTuesday, March 1, 2022, and optional for any 'in-stream' applications.

**Additional Information**

Detailed material outlining the various scenarios and corresponding Slope Hazard Assessment requirements is available to support the qualified professional to complete the report. A new **slope reference layer** has also been included within QtheMap..

# PROPOSED SLOPE HAZARD ZONING BYLAW




| REFERENCE DRAWINGS | | | CITY OF COQUITLAM | Comparison of Existing and Proposed Zoning Bylaw (3)(a) | HORIZON ENGINEERING INC | | | |
|---|---|---|---|---|---|---|---|---|
| 3 | | | Proposed Slope Hazard Zoning Bylaw | | SCALE NTS | FILE NO. 117-4309 | DATE OCT/2021 | FIGURE Ex-1 |
| 2 | | | | | DESIGN RN | DRAWN RN | CHECKED KS | |
| 1 | | | | | | | | |
| NO | DATE | REVISION | | | | | | |

# SLOPE HAZARD ASSESSMENT REPORT CRITERIA AND CHECKLISTS

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## Background

This document provides criteria to assist a **Building Official** and **Qualified Professional** to determine the type of **slope assessment** that should be carried out to support the **Development or Building Permit Application** for a structure to be located either on a slope or adjacent to the crest or toe of a slope.

- The **Slope Hazard Assessment Criteria** provided in **Table 1** is for a building located **at the crest of a slope.**
- The **Slope Hazard Assessment Criteria** provided **in Table 2** is for a building located **below a slope.**

For a development located on a slope with comparatively gentle sloping terrain, or where the proposed building is sufficiently set back from either the crest or toe of slope areas, a slope assessment may not be required.

- Site conditions that allow for **exclusion of a slope hazard assessment** are defined in:
  - **Table 1** for a building located **at the crest of slope**
  - **Table 2** for a building located **below a slope.**
- **Figures 1, 2, and 3** graphically **depict these specific cases.**

As presented in **Tables 1 and 2**, the slope height, slope angle, setback distance and whether there are any known slope issues in the local area are the parameters used to determine whether a **Preliminary Slope Hazard Assessment** or a **Detailed Slope Hazard Assessment** will be required.

## Slope Hazard Assessment Reports

A **Slope Hazard Assessment Report** should provide sufficient details and rationale to support professional opinions or conclusions regarding satisfying the required level of slope hazard "safety." Checklists of items/issues to be considered for **Preliminary or Detailed Assessment Reports** are included to guide the level of detail and rigour required.

- **Check List "A"** has a list of items the **Preliminary Slope Hazard Assessment** report should address.
- **Check List "B"** provides a list of items to be addressed in a **Detailed Slope Hazard Assessment** report.

At the discretion of the **Building Official**, an independent peer review may be required if the details and rationale in the **Slope Hazard Assessment Report** are not comprehensive and/or for sites with comparatively high slopes where the consequences of a slope failure may be more significant.

A **Preliminary Slope Hazard Assessment** is an initial or overview assessment carried out by a qualified **Professional Engineer** or **Professional Geoscientist** to determine the presence, location, and extent of a slope hazard with respect to a proposed development on or adjacent to a slope. The requirement for a **Detailed Assessment** may be determined as a result of a **Preliminary Site Assessment.**

# SLOPE HAZARD ASSESSMENT REPORT CRITERIA AND CHECKLIST

**Preliminary and Detailed Slope Hazard Assessment Criteria**

When a **Preliminary Slope Hazard Assessment** is applicable for a **Property**, the accompanying report should contain sufficient information so that the **Building Official** can understand the site conditions and rationale that support the professional opinion regarding the slope hazard condition.

The **Preliminary Slope Hazard Assessment** should provide sufficient information and rationale to justify a conclusion there is **no** potential or existing slope hazard that may adversely affect the **Property** or affect adjacent land / property.

The report will need to include recommendations to ensure "safe" conditions, or recommend that a **Detailed Slope Hazard Assessment** be carried out if there is **an existing or potential slope hazard** that may adversely affect the **Property** or affect adjacent land/property.

A **Detailed Slope Hazard Assessment** should be completed in accordance with the latest version of the Engineers and Geoscientists BC (EGBC), "Guideline for Legislated Landslide Assessments for Proposed Residential Developments in BC".

A **Landslide Assurance Statement** (Appendix D from the aforementioned EGBC Guideline) is to be provided with any **Slope Hazard Assessment Report.**

Assessment methodologies and design of structures (including retaining walls) should be determined by the **Qualified Professional** in line with:

- "Guidelines for Geotechnical Engineering Services for Building Projects," published by Engineers and Geoscientists BC (latest version); and,
- "Professional Practice Guidelines Retaining Wall Design," published by Engineers and Geoscientists BC (latest version).

**Slope Hazard Assessment Reports** that support **Building Permit Applications** should provide geotechnical design and construction recommendations, including for the geotechnical field reviews required during construction.

***See the following Checklists and Examples***

# ***CHECKLIST A – PRELIMINARY SLOPE HAZARD ASSESSMENT REPORTS***

A **Preliminary Slope Hazard Assessment Report** should include, but not be limited to, the following items, where applicable:

- ☐ Prepared by a qualified **Professional Engineer** or **Professional Geoscientist** who is registered with the **Engineers and Geoscientists of British Columbia**
- ☐ Provides background and site information (typically obtained from available literature) regarding:
  - ☐ site location (civic address and/or legal description) and surrounding land / developments;
  - ☐ local surficial and/or bedrock geology (e.g. published Geological Survey of Canada map);
  - ☐ documented surface and/or ground water conditions (e.g. creeks, seepage, water table, etc.);
  - ☐ current site conditions (e.g. topography, existing development, underground services, retaining walls, etc.);
  - ☐ previous site development and/or historical land use (e.g. fill placed to raise grades, former ground improvement / stabilization works, buried ravine, buried tanks, abandoned infrastructure, etc.);
  - ☐ the proposed development (e.g. building footprint, proposed site grades, retaining walls, etc.); and
- ☐ Topographic survey that:
  - ☐ is prepared by a registered **British Columbia Land Surveyor**;
  - ☐ was completed within a reasonable time period prior to the report date to ensure accurate data reflecting current site conditions;
  - ☐ encompasses the **Property** or proposed development area;
  - ☐ extends beyond the crest and toe of slope areas;
  - ☐ provides slope contours at 1 metre interval;
  - ☐ shows the footprint of structures that may be affected by a slope hazard.
- ☐ A site reconnaissance has:
  - ☐ been carried out on, and if required, beyond the **Property**:
    - ☐ within a reasonable time period (e.g. 1 year) prior to the report date that ensures the site conditions, observations, and report contents are still representative of current site conditions;
    - ☐ that includes a traverse of the sloping terrain;

  OR

  has <u>not</u> been carried out and justification or rationale is provided for why not.
- ☐ Provides description(s) and/or data:
  - ☐ to define the site, slope geometry, and/or relevant terrain feature (i.e. slope angles, slope heights, benches, terraces, ravines, gullies, retaining walls, etc.);

  of the weather condition during the site reconnaissance;

- ☐ that identifies
  - ☐ there are no indicator signs of any potential or existing slope instability or slope hazard on the Property or that may affect the Property;

  OR

  - ☐ there are indicator signs of potential or existing slope instability or slope hazard;
  - ☐ the type of identified slope hazard (e.g. landslide, rockfall, debris flow, soil creep, etc.);
  - ☐ location of identified slope instability or slope hazard;
  - ☐ the estimated location, extent, and/or size of the identified slope instability or slope hazard; and
- ☐ Evaluates the slope instability or slope hazard with consideration of:
  - ☐ the current site and slope conditions;
  - ☐ the proposed development and expected changes in site conditions;
  - ☐ surface water impacts (e.g. slope erosion, misdirected water flow, creek avulsion, scour, etc.);
  - ☐ ground water impacts (e.g. lowering water table, intercepting seepage, artesian flow, etc.);
  - ☐ potential impacts to downslope and/or adjacent structures or properties; and
  - ☐ climate change.
- ☐ Provides a conclusion that there is
  - ☐ no identified slope instability or slope hazard that may adversely impact the site/proposed development or be initiated from the site to impact surrounding areas;

  OR

  - ☐ an identified slope instability or slope hazard, and
    - ☐ provides recommendations to address the slope instability or slope hazard, and/or
    - ☐ recommends a **Detailed Slope Hazard Assessment** be carried out.
- ☐ Includes a **Landslide Assessment Assurance Statement** (Appendix D from the EGBC Landslide Assessment Guidelines) that is completed, signed, sealed and dated by the **Qualified Professional**.

Where a **Preliminary Slope Hazard Assessment** report will support a **Building Permit Application** for either a new house, retaining wall, pool, outbuilding or building addition, geotechnical design and construction recommendations should be provided.

# ***CHECKLIST B – DETAILED SLOPE HAZARD ASSESSMENT REPORT***

A **Detailed Slope Hazard Assessment Report** should include, but not be limited to, the following items, where applicable:

- ☐ Prepared by a qualified **Professional Engineer** or **Professional Geoscientist** who is registered with the **Engineers and Geoscientists of British Columbia**
- ☐ Provides background and site information (typically obtained from available literature) regarding:
  - ☐ site location (civic address and/or legal description) and surrounding land / developments;
  - ☐ local surficial and/or bedrock geology (e.g. published Geological Survey of Canada map);
  - ☐ documented surface and/or ground water conditions (e.g. creeks, seepage, water table, etc.);
  - ☐ current site conditions (e.g. topography, existing development, underground services, retaining walls, etc.);
  - ☐ previous site development and/or historical land use (e.g. fill placed to raise grades, former ground improvement / stabilization works, buried ravine, buried tanks, abandoned infrastructure, etc.);
  - ☐ the proposed development (e.g. building footprint, proposed site grades, retaining walls, etc.)
- ☐ Topographic survey that:
  - ☐ is prepared by a registered **British Columbia Land Surveyor;**
  - ☐ was completed within a reasonable time period prior to the report date to ensure accurate data reflecting current site conditions;
  - ☐ encompasses the Property or proposed development area;
  - ☐ extends beyond the crest and toe of slope areas;
  - ☐ provides slope contours at 1 metre interval;
  - ☐ shows the footprint of structures that may be affected by a slope hazard;
- ☐ A site reconnaissance has:
  - ☐ been carried out on, and if required, beyond the **Property**:
    - ☐ within a reasonable time period (e.g. 1 year) prior to the report date that ensures the site conditions, observations, and report contents are still representative of current site conditions;
    - ☐ that includes a ground traverse at a detailed level of intensity to allow characterization and delineation of existing and/or potential slope hazard area(s);

  OR
  - ☐ <u>not</u> been carried out and justification or rationale is provided for why not.
- ☐ Field work (site investigation) has been carried out to characterize the local soil stratigraphy and/or bedrock condition by:
  - ☐ assessing local soil exposures and/or bedrock outcrops (including rock joint mapping, when applicable);

- ☐ advancing test holes (e.g. test pits, auger drill holes, Standard Penetration Test soundings, etc.);
- ☐ installing one or more ground water monitoring well(s) (e.g. standpipe piezometer);
- ☐ measurement of local ground water level(s).

☐ Provides description(s) and/or data:

- ☐ to define the site, slope geometry, and/or relevant terrain feature (i.e. slope angles, slope heights, benches, terraces, ravines, gullies, retaining walls, etc.);
- ☐ of the weather condition during the site reconnaissance;
- ☐ that identifies:
  - ☐ there are no indicator signs of any potential or existing slope instability or slope hazard on the Property or that may affect the Property;

  OR

  - ☐ there are indicator signs of potential or existing slope instability or slope hazard;
  - ☐ the type of identified slope hazard (e.g. landslide, rockfall, debris flow, soil creep, etc.);
  - ☐ location of identified slope instability or slope hazard;
  - ☐ the estimated location, extent, and/or size of the identified slope instability or slope hazard.

☐ Evaluates the slope instability or slope hazard with consideration of:

- ☐ the current site and slope conditions;
- ☐ the proposed development and expected changes in site conditions;
- ☐ surface water impacts (e.g. slope erosion, misdirected water flow, creek avulsion, scour, etc.);
- ☐ ground water impacts (e.g. lowering water table, intercepting seepage, artesian flow, etc.);
- ☐ potential impacts to downslope and/or adjacent structures or properties;
- ☐ climate change.

Engineering analysis that:

- ☐ includes one or more sections depicting the slope model geometry, stratigraphy (including weathered zones, if applicable), and ground water table;
- ☐ presents the method of analysis and any assumptions (e.g. sub-horizontal stratigraphy) including rationale for the assumptions;
- ☐ lists the input parameters (e.g. soil types, thicknesses, friction angles, cohesion values, and unit weights);
- ☐ considers ground water conditions including seasonal variability;
- ☐ determines the Factor of Safety against global slope failure under static conditions for current and proposed site conditions including minimum Factor of Safety at the proposed building footprint;

- ☐ determines the **Factor of Safety** against global slope failure under design seismic conditions for the proposed site conditions including predicted seismic slope displacement at the proposed building footprint;
- ☐ estimates a likelihood or probability of occurrence of a landslide, if a risk analysis is implemented;
- ☐ estimates the landslide runout distance or potential downslope impact area of a slope hazard.

☐ Provides discussions or conclusions regarding:

- ☐ the results of the field work and engineering analysis (including results of sensitivity analyses);
- ☐ the slope hazard type, extent, and potential impact to the subject property and/or adjacent land / developments;
- ☐ the level of landslide / slope hazard "safety" (i.e. based on slope stability **Factor of Safety**, quantitative risk analysis, or **Frequency-Number of Fatality** plot); and
- ☐ a comparison of the analysis / investigation results to the required level of landslide / slope hazard "safety" indicating that
  - ☐ there is no identified slope instability or slope hazard that may adversely impact the site / proposed development and/or be initiated from the site to impact surrounding areas, and
    - ☐ no specific slope maintenance work is required; OR
    - ☐ slope maintenance work is required with recommendations provided;

  OR
  - ☐ there is an identified slope instability or slope hazard that may adversely impact the site / proposed development and/or be initiated from the site to impact surrounding areas, and recommendations are provided to
    - ☐ improve the slope stability or slope hazard to satisfy "safety" requirements; OR
    - ☐ implement an **As Low As Reasonably Practicable** (ALARP) strategy;

  OR
  - ☐ the required level of "safety" is not practicable to achieve at the site or for the proposed development *(supporting rationale for this extreme case is to be provided in the report*).

☐ Includes a **Landslide Assessment Assurance Statement** (Appendix D from the EGBC Landslide Assessment Guidelines) that is completed, signed, sealed, and dated by the **Qualified Professional**.

Potential adoption of an **As Low As Reasonably Practicable** (ALARP) strategy regarding development at the **Property** is to be discussed with the **Building Official** and which is expected to be subject to an independent peer review.

☐ **Building Official** recommends an independent **Peer Review**.

# ***CHECKLIST B – DETAILED SLOPE HAZARD ASSESSMENT REPORT***

Where a **Detailed Slope Hazard Assessment** report will support a **Building Permit Application** for either a new house, retaining wall, pool, outbuilding, or building addition, geotechnical design and construction recommendations should be provided.

***This information has been prepared to provide information only. It is not a legal document. If any contradiction exists between this document and the relevant City bylaws, codes or policies, the texts of the bylaws, codes or policies shall be legal authority***

# TABLE 1: Slope Hazard Assessment Criteria – Building Located at *Crest* of Slope

**TABLE 1: Slope Hazard Assessment Criteria - Building Located at Crest of Slope** *Version R1 20211221*

| | SLOPE HEIGHT ( H ) | SLOPE ANGLE | SETBACK FROM CREST OF SLOPE ( C ) | KNOWN SLOPE ISSUES IN LOCAL AREA | TYPE OF SLOPE ASSESSMENT | PEER REVIEW | Concept Geometry | |
|---|---|---|---|---|---|---|---|---|
| CASE A | All Values | ≤ 18° | All Values | NO | Not Required | Not Applicable | | |
| | | | | YES | Preliminary | At Discretion of Building Official | | |
| CASE B | ≤ 3 m | > 18° to ≤ 45° | > 3m | NO | Not Required | Not Applicable | Case B1 | Figure 1 |
| | | | ≤ 3m | | Preliminary | | Case B2 | |
| | | > 45° | > (1.0V : 2.0H) AND ≥ 3m | | Not Required | | Case B3 | |
| | | | ≤ (1.0V : 2.0H) OR < 3m | | Preliminary | | Case B4 | |
| | | All Values | All Values | YES | | At Discretion of Building Official | | |
| CASE C | > 3 m to < 9m | > 18° to ≤ 27° | > 3m | NO | Not Required | Not Applicable | Case C1 | Figure 2 |
| | | | ≤ 3m | | Preliminary | | Case C2 | |
| | | > 27° | > (1.0V : 2.0H) | | | | Case C3 | |
| | | | ≤ (1.0V : 2.0H) | | Detailed | At Discretion of Building Official | Case C4 | |
| | | All Values | All Values | YES | | | | |
| CASE D | 9 m and higher | > 18° to ≤ 27° | > 3m | NO | Not Required | Not Applicable | | |
| | | | ≤ 3m | | Preliminary | At Discretion of Building Official | | |
| | | > 27° | > (1.0V : 2.0H) | | | | | |
| | | | ≤ (1.0V : 2.0H) | | Detailed | | | |
| | | All Values | All Values | YES | | YES | | |

*Notes:*

1. *A 1.0V : 2.0H setback is the horizontal distance associated with the intersection of this line to the ground surface.*
2. *Levels of Assessment (Preliminary and Detailed) are defined in accompanying text of this document*
3. *Peer Review at the Discretion of the Building Official may be based on the compliance of the Slope Hazard Assessment Report with the Check List for Slope Hazard Assessment Reports, attached to this document, or other criteria as may be determined by the Building Official.*
4. *Slope Issues in Local Area includes landslide activity, issues with site conditions due to existing or previous developments, ground water conditions, potential impacts to or from neighouring lands, etc.*

# TABLE 2: Slope Hazard Assessment Criteria – Building Located *Below* the Slope

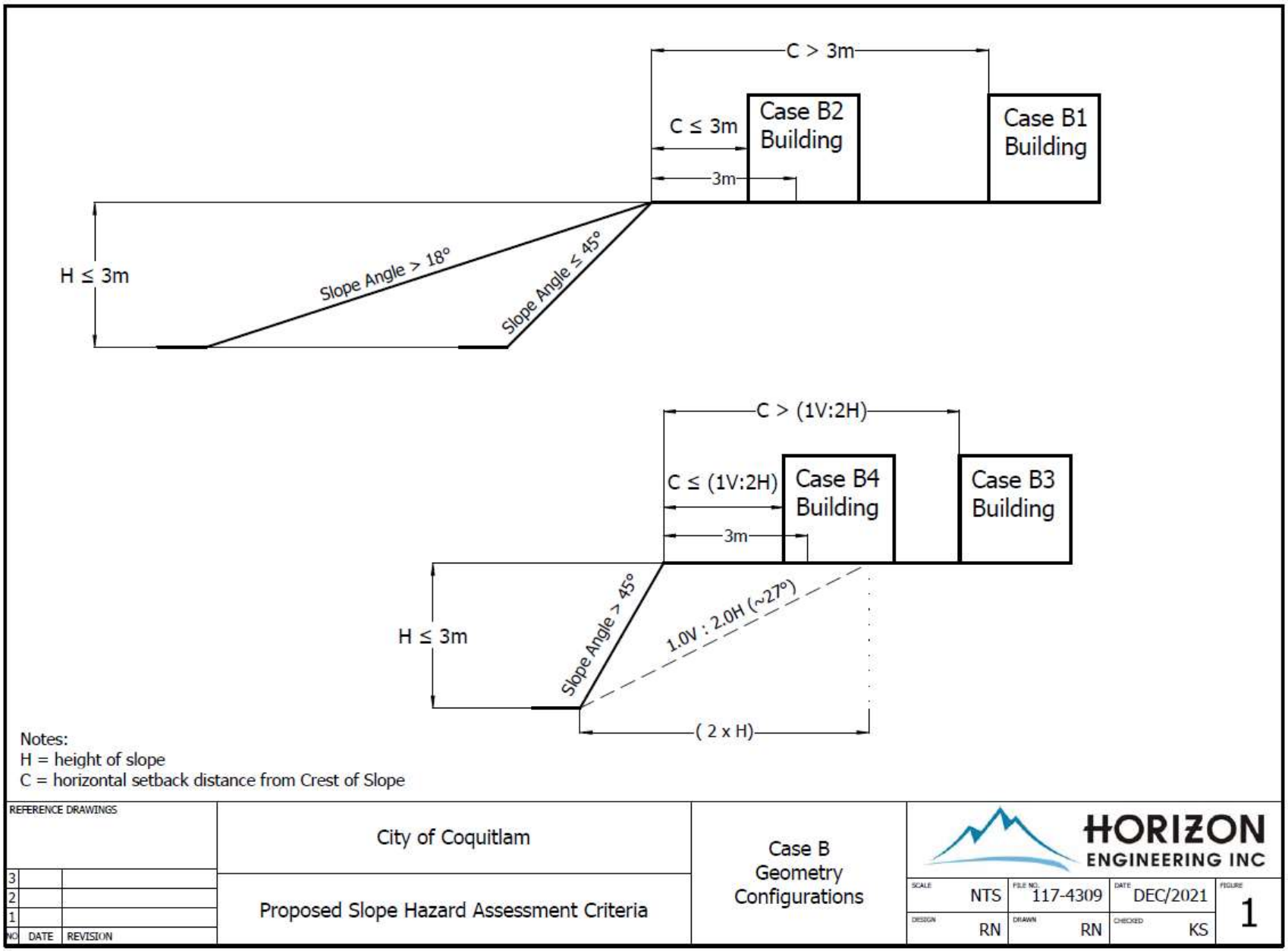
**TABLE 2: Slope Hazard Assessment Criteria - Building Located Below the Slope** *Version R1 20211221*

| | SLOPE HEIGHT ( H ) | SLOPE ANGLE | SETBACK FROM TOE OF SLOPE ( T ) | KNOWN SLOPE ISSUES IN LOCAL AREA | TYPE OF SLOPE ASSESSMENT | PEER REVIEW | Concept Geometry | |
|---|---|---|---|---|---|---|---|---|
| CASE E | All Values | ≤ 18° | All Values | NO | Not Required | Not Applicable | Case E1 | Figure 3 |
| | | | | YES | Preliminary | At Discretion of Building Official | | |
| CASE F | ≤ 3 m | > 18° | > 3m | NO | Not Required | Not Applicable | Case F1 | Figure 3 |
| | | | ≤ 3m | | Preliminary | | Case F2 | |
| | | | All Values | YES | At Discretion of Building Official | At Discretion of Building Official | | |
| CASE G | > 3 m to < 9 m | > 18° | ≥ Preliminary Runout Zone | NO | Not Required | Not Applicable | Case G1 | Figure 3 |
| | | | < Preliminary Runout Zone | | Detailed | At Discretion of Building Official | Case G2 | |
| | | All Values | All Values | YES | | | | |
| CASE H | 9 m and higher | > 18° | ≥ Preliminary Runout Zone | NO | At Discretion of Building Official | Not Applicable | | |
| | | | < Preliminary Runout Zone | | Detailed | At Discretion of Building Official | | |
| | | All Values | All Values | YES | | YES | | |

Notes:

1. *A structure seated on the slope is considered to be setback < 1m from the toe of slope.*
2. *The Preliminary Runout Zone (PRZ) is based on a 18° (or 32%) line extending down from the crest of slope to determine the horizontal setback distance measured from the toe of slope. The horizontal distance from the slope crest to* ***PRZ = 3.0 x H*** *.*
3. *Level of Assessments (Preliminary and Detailed) are defined in accompanying text of this document*
4. *Peer Review at the Discretion of the Building Official may be based on the compliance of the Slope Hazard Assessment Report with the Check List for Slope Hazard Assessment Reports, attached to this document, or other criteria as may be determined by the Building Official.*
5. *Slope Issues in Local Area includes landslide activity, issues with site conditions due to existing or previous developments, ground water conditions, potential impacts to or from neighouring lands, etc.*

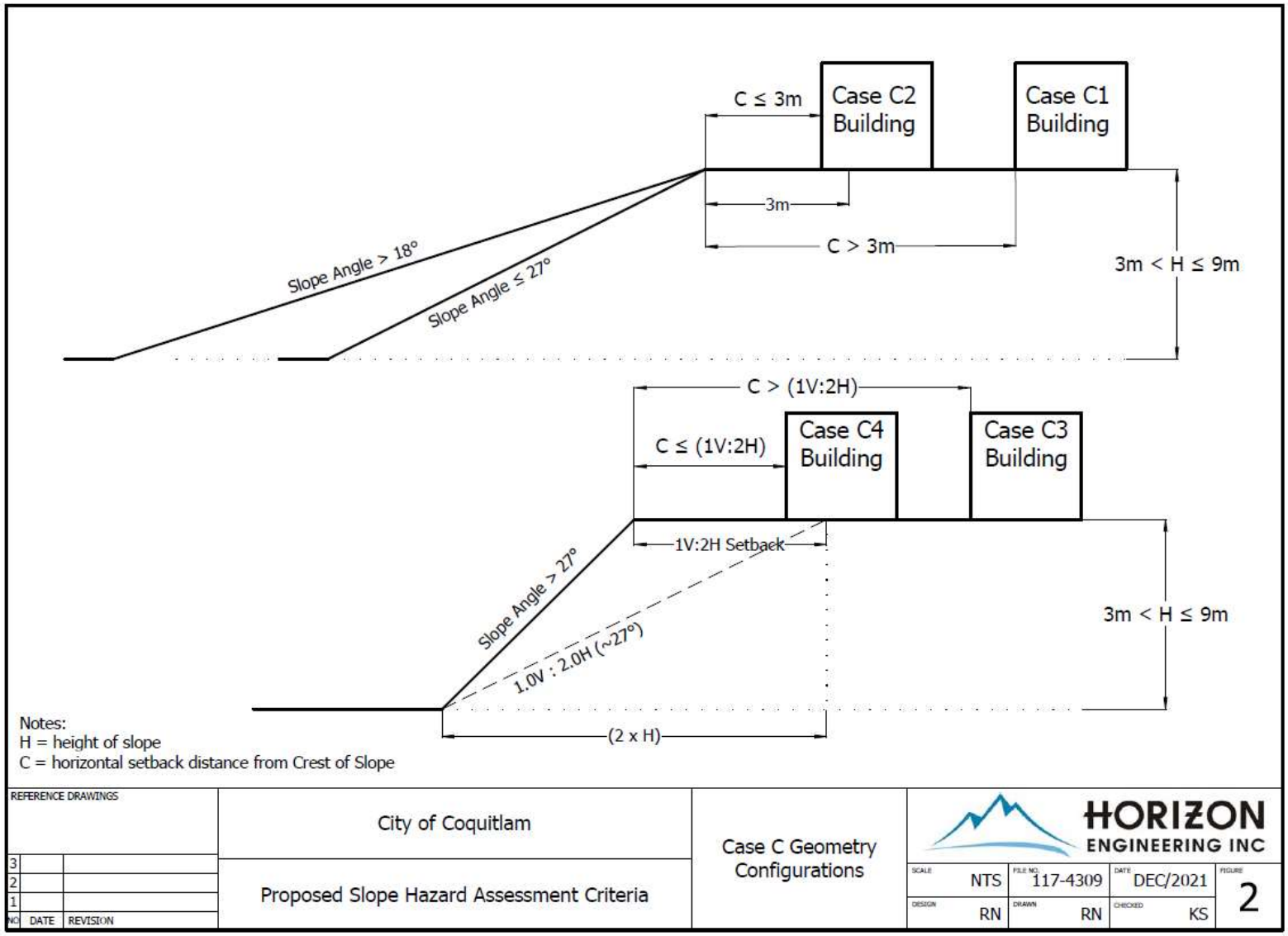
# Proposed Slope Hazard Assessment Criteria – Case B Geometry Configurations




Notes:
H = height of slope
C = horizontal setback distance from Crest of Slope

| REFERENCE DRAWINGS | City of Coquitlam | Case B Geometry Configurations | HORIZON ENGINEERING INC |
|---|---|---|---|
| NO. DATE REVISION | Proposed Slope Hazard Assessment Criteria | | SCALE NTS · FILE NO. 117-4309 · DATE DEC/2021 · FIGURE 1 |
| 3 | | | DESIGN RN · DRAWN RN · CHECKED KS |
| 2 | | | |
| 1 | | | |

# Proposed Slope Hazard Assessment Criteria – Case C Geometry Configurations



# Proposed Slope Hazard Assessment Criteria – Cases E, F and G Geometry Configurations