Conservation Halton Guidelines for Slope Stability Assessments for Valleys

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Final

Conservation Halton

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CONSERVATION HALTON GUIDELINES

Conservation Halton (CH) strives to protect life and property from natural hazards such as flooding and erosion and to prevent environmental degradation, loss of natural features and their ecological and hydrological functions, and pollution near or within natural features. To do this, CH undertakes a wide range of programs and services.

In the planning and development process, CH exercises the following roles and responsibilities:

- A regulatory agency under Section 28 of the *Conservation Authorities Act*;
- A body with delegated authority under Section 3 of the Provincial Policy Statement, to represent the 'Provincial Interest' regarding natural hazards in the review of municipal policy documents and planning applications under the *Planning Act*;
- A public commenting body under the *Planning Act, Clean Water Act* and other Acts and Provincial Plans;
- A service provider for environmental advice and technical clearance to municipalities in accordance with signed *Memoranda of Agreement*;
- A resource management agency operating on a local watershed basis; and
- A landowner in the watershed.

CH's Planning and Regulations staff (i.e., environmental planners, regulations officers, ecologists, water resource engineers, technologists, and hydrogeologists) work together on interdisciplinary teams to deliver timely and comprehensive reviews and advice to provincial agencies, municipalities and landowners across CH's jurisdiction.

Through recent changes to the *Conservation Authorities Act* and enactment of Ontario Regulation 686/21, the Province identified and confirmed the programs and services that are mandatory for a Conservation Authority (CA) to undertake (i.e., Category 1 programs and services), which includes a range of programs and services related to managing risks associated with natural hazards. This includes a CA's Provincially delegated responsibility to comment on applications made under the *Planning Act*, as well as to provide comments, technical support, or information to a planning authority under the *Planning Act*, to ensure decisions are consistent with the natural hazard policies of the PPS and conform with the natural hazard policies of provincial plans.

Section 28 (1) of the Conservation Authorities Act allows conservation authorities to make regulations to protect life and property from natural hazards. CH's regulation is Ontario Regulation 162/06. Under Ontario Regulation 162/06, CH regulates:

- All development in or adjacent to river or stream valleys, wetlands and surrounding lands where development could interfere with the hydrologic function of the wetland, Lake Ontario shorelines, and hazardous lands such as karst and any prescribed allowances
- Alterations to a river, creek, stream or watercourse; and
- Interference with wetlands.

Permission is required from CH for undertaking the above noted works within regulated areas. Any development, which in the opinion of the CA, does not affect the control of flooding, erosion, pollution, conservation of land, or dynamic beaches may be approved or approved with conditions. Interference to watercourses and wetlands may be approved, approved with conditions, or refused. CH's Board-approved Policies and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document outlines the policies and technical requirements which must be met before permission may be granted. As part of a CH permit application, an applicant must demonstrate that CH's Board-approved policies and technical standards can be met.

CH also provides technical advice to its municipal partners on a range of environmental matters through service agreements or Memoranda of Understanding/Agreement (MOU/MOA). Technical advice is also provided to municipal partners in CH's capacity as a public commenting body and a resources management agency.

These Guidelines provide clear expectations regarding the criteria and approaches that are acceptable to CH and are used by staff to assess the technical merits of slope stability assessments. Applicants proposing development within, or near, confined or semi-confined valleys, must follow these Guidelines. By doing so, quicker and more consistent reviews, fewer resubmissions, and faster approvals are anticipated.

These Guidelines are specific to CH and do not replace or supersede any other federal, provincial, or municipal requirement.

OBJECTIVE	The purpose of the **Guidelines for Slope Stability Assessments for Valleys** is to: • **Identify CH's** requirements for a Slope Stability Assessment submission; and • **Outline CH's** key expectations for Slope Stability Assessments.
APPLICATION & USE	Applies to all slope stability engineering submissions associated with *Planning Act* and *Ontario Regulation 162/06* permit applications. These Guidelines have been developed for: • **Qualified professionals** such as geotechnical engineers and other qualified persons tasked to guide the preparation of slope stability assessments • **CH staff** to facilitate quicker and more consistent reviews and assess the technical merits of slope stability assessments • **Landowners** when considering new or altered development
ADDITIONAL REFERENCE MATERIALS (to be read in conjunction with this document)	• Ontario Regulation 162/06 Halton Region Conservation Authority: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses, 2006 • Policies and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document (November 26, 2020). • Provincial Policy Statement, Section 3.1 (2020) • Technical Guide - River and Stream Systems: Erosion Hazard Limit, Ministry of Natural Resources, 2002 • Geotechnical Principles for Stable Slopes, Terraprobe Limited and Aqua Solutions, June 1998
VERSION	**Version 1.0** This version of the Guidelines for Slope Stability Assessments for Valleys was presented and endorsed by the Board of Directors on XXXX, 2020. The Guidelines may be updated from time to time. For more information, visit https://www.conservationhalton.ca/policies-and-guidelines.

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Abbreviations

The following table lists the various abbreviations used within this document:

TABLE 0-1: LIST OF ABBREVIATIONS

CH	Conservation Halton	**O. Reg 162/06**	Ontario Regulation 162/06
FOS	Factor of Safety	**STOB**	Stable Top of Bank
OLS	Ontario Land Surveyor	**TOB**	Top of Bank

Section 1 Introduction

Streams and valleys are dynamic systems that are subject to erosive forces, including instream erosion and surface erosion, as well as unstable slopes. These areas are regulated under Ontario Regulation 162/06 (O.Reg 162/06). When development is proposed within or near a confined or semi-confined valley system an assessment of erosion hazards may be required. The assessment is used to ensure that new development is located away from areas susceptible to erosion hazards where there is an unacceptable risk to public heath or safety or property damage or to ensure that development associated with existing uses does not create new or aggravate existing hazards.

The purpose of this guideline is to:

- Identify Conservation Halton's (CH) requirements for Slope Stability Assessments; and
- Outline CH's key expectations for Slope Stability Assessments.

This document focuses primarily on CH's expectations related to slope stability assessments. Other disciplines may also be relevant such as water resource engineering, fluvial geomorphology, hydrogeology and ecological restoration. Consultation with Conservation Halton is advised to ensure the appropriate guidelines are used.

1.1 Document Outline

This document is divided into three sections.

- **Section 1 – Introduction** – Provides an overview of Conservation Halton's role in the review of slope stability assessments and general requirements for assessments.

- **Section 2 – Stable Top of Bank Assessments** – Outlines requirements for establishing the location of the *stable top of bank*.

- **Section 3 – Existing Development on the Valley Slope** – Outlines requirements for assessing potential slope stability impacts resulting from alterations to existing development within valleys.

These guidelines are not intended to be a comprehensive document on slope stability assessments but rather to act as a complement to provincial documents, accepted geotechnical principles, and technical literature.

These Guidelines are specific to CH and do not replace or supersede any other federal, provincial or municipal requirement. Pre-consultation with CH and municipal agency staff is encouraged in conjunction with the use of this document.

1.2 Conservation Halton's Role in Reviewing Slope Stability Assessments

CH protects, manages, and enhances the area within its jurisdiction (see Figure 1-1) through a wide variety of programs and services, including the administration of regulations and the provision of planning services.

Section 28 (1) of the Conservation Authorities Act allows conservation authorities to make regulations to protect life and property from natural hazards. CH's regulation is Ontario Regulation 162/06. Under Ontario Regulation 162/06 (O. Reg. 162/06), CH regulates:

- All development in or adjacent to river or stream valleys, wetlands and surrounding lands where development could interfere with the hydrologic function of the wetland, Lake Ontario shorelines, or hazardous lands such as karst and any associated allowances;
- Alterations to a river, creek, stream or watercourse; and
- Interference with wetlands.

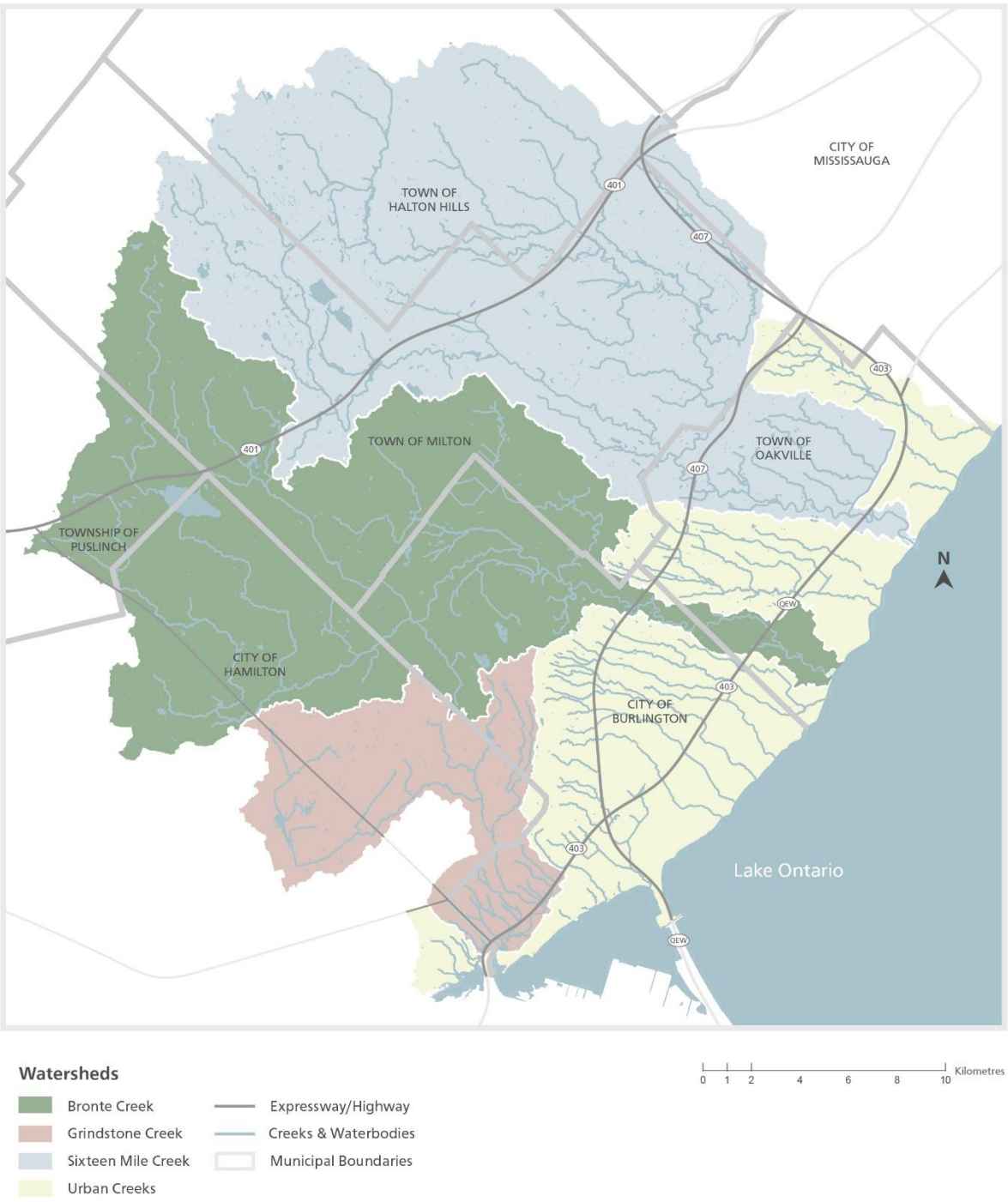
Permission is required from CH for undertaking any development within regulated areas. "Development" means,

a) the construction, reconstruction, erection or placing of a building or structure of any kind,
b) any change to a building or structure that would have the effect of altering the use or potential use of the building or structure, increasing the size of the building or structure or increasing the number of dwelling units in the building or structure,
c) site grading, or
d) the temporary or permanent placing, dumping or removal of any material, originating on the site or elsewhere.

Permission may be granted where the control of flooding, erosion, dynamic beaches, pollution or the conservation of land will not be affected by the development. CH's Board-approved *Policies and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document* (2020) outlines the policies and technical requirements which must be met before permission may be granted. As part of a CH permit application, an applicant must demonstrate that CH's Board-approved policies and technical standards can be met to the satisfaction of CH.

In addition, CH provides plan review services to municipalities for environmental advice and technical clearance. CH has delegated authority from the Ministry of Northern Development, Mines, Natural Resources and Forestry to represent the 'Provincial Interest' regarding natural hazards, as outlined in Section 3.1 of the Provincial Policy Statement, in the review of municipal policy documents and planning applications under the *Planning Act*. CH's review of slope stability assessments provides for a streamlined and integrated assessment of the merits of the proposal that is linked to all of CH roles and responsibilities.

FIGURE 1-1 CONSERVATION HALTON WATERSHEDS



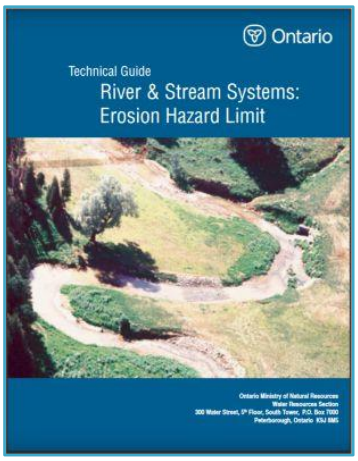
1.3 Qualified Professional(s) and Standard Industry Practices

As outlined in Section 2.1, CH staff will determine through a site visit or based on previous knowledge / information for a site if a slope stability assessment is required. The slope stability assessment must be completed by a qualified geotechnical engineer (P.Eng.) and may require input from a hydrogeologist, fluvial geomorphologist (P. Geo.), Ontario Land Surveyor (OLS), water resources engineer (P.Eng.), structural engineer (P.Eng), arborist, and/or ecologist. The final report must be signed, dated and sealed by a Professional Engineer.

The qualified professionals working on a slope stability assessment for submission to CH must be familiar with standard industry practices, including the following documents:

- ***Technical Guide - River and Stream Systems: Erosion Hazard Limit*** (Ministry of Natural Resources, 2002) (hereafter referred to as MNR Technical Guide); and,

- ***Geotechnical Principles for Stable Slopes*** (Terraprobe Limited and Aqua Solutions, June 1998) (hereafter referred to as Principles Document).



1.4 Validity of the Report

A Slope Stability Assessment is typically considered valid for a period of up to 10 years provided the following criteria can be met:

- No disturbance (natural or human-caused) on or in the immediate vicinity of the slope;
- No changes in the level of imperviousness of the lands draining to the slope;
- No changes to stormwater outlet locations and/or local drainage conditions; and
- No changes in toe erosion potential.

CH staff must be consulted prior to relying on a slope stability assessment report that was previously prepared for a prior project on the site to verify if the assumptions and findings are still valid.

Information from an existing report may be re-used within an updated or scoped new report, subject to validation by the qualified professional. The updated report must clearly state the source and date of any information used from a previous assessment.

Section 2 Stable Top of Bank Assessments

This section outlines CH's expectations related to studies establishing the location of the stable top of bank.

2.1 Components of the Stable Top of Bank and Regulated Area

As part of the *stable top of bank* (*STOB*) analysis, the consultant is required to assess the following:

- The physical *top of bank*;
- *Toe erosion allowance*; and
- *Stable slope allowance*.

The physical *top of bank* is typically identified and staked by CH staff in the field. If a physical *top of bank* (*TOB*) staking is conducted, it will be done in coordination with a qualified Ontario Land Surveyor (OLS). Staff will determine at that time whether additional study by the applicant is required to determine if the physical *TOB* is stable and confirm the location of the *STOB*. Please refer to *Conservation Halton Physical Top of Bank Staking Protocol* (2022) for more guidance on how to stake the TOB.

Toe erosion allowances provide setbacks from watercourses sufficient to account for lateral stream migration and are required where a watercourse is within 15 metres of the *toe of slope*, (Figure 2). The width of the allowance is determined by examining the abutting watercourse feature. The composition of its bed and bank materials and whether the watercourse is actively eroding is used to select the appropriate allowance and establish the location of the stable *toe of slope*. Additional discussion on this procedure is included in Sections 2.2 through 2.5 below.

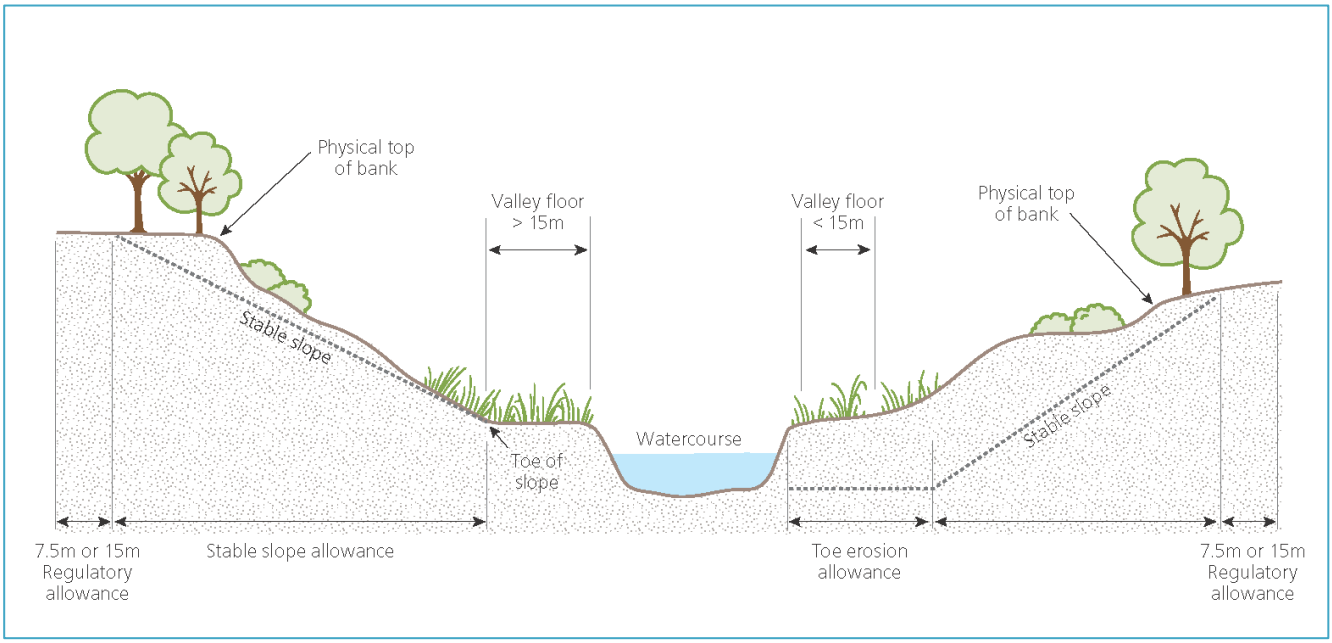
Measured from the stable *toe of slope*, the *stable slope allowance* accommodates stable slope inclinations, which are based on soil, rock, groundwater and other site conditions. Additional discussion is included in Sections 2.1 - 2.4 and Section 2.6.

As per *O.Reg. 162/06*, a regulatory allowance of 7.5 m (24.6 ft.) for minor valley systems and 15 m (49.2 ft.) for major valley systems (i.e., Grindstone, Bronte, and Sixteen Mile Creeks and their tributaries) is applied from the STOB to establish the limits of CH's regulated area associated with a *confined valley system*. CH staff must be consulted to confirm the appropriate allowance. A 6 m (19.7 ft.) erosion access allowance which provides for emergency and maintenance access to the valley lands and as further described within the MNR Technical Guide, is incorporated within CH's regulatory allowance.

CH's regulation limit extends from the greater of the physical top of bank as staked in the field or the stable top of bank as determined by a geotechnical slope stability assessment.

Figure 2-1 illustrates the components of a *confined valley* system.

FIGURE 2-1 CONFINED VALLEY SYSTEM



2.2 Field Evaluation & Sample Analysis

The level of investigation undertaken is dependant on several factors and must be justified by the qualified professional with the assistance of a completed Slope Stability Rating Chart (Appendix B) from the MNR Technical Guide. While the Slope Stability Rating Chart is used as a guide in selecting a reasonable level of investigation, staff may request a more robust/additional analysis where deemed appropriate or concerns identified (i.e., inconsistencies in topography, high-risk areas, documented slope failures, etc.).

Field inspections conducted by the qualified professional must evaluate the following components:

- evidence of slope instability,
- location of watercourse feature(s) relative to toe of slope,
- evidence of seepage on the slope,
- evidence of concentrated flow on the slope,
- vegetation condition on the slope,
- evidence of erosion at the slope toe, face or crest, and
- boreholes to determine soil subsurface conditions, if necessary.

Laboratory analysis of soil samples collected from boreholes must be undertaken to establish the properties of the soils, such as grain size distribution, unit weights, etc. Conservative values based on standard industry practices must be assumed within the assessment if laboratory analysis is not completed.

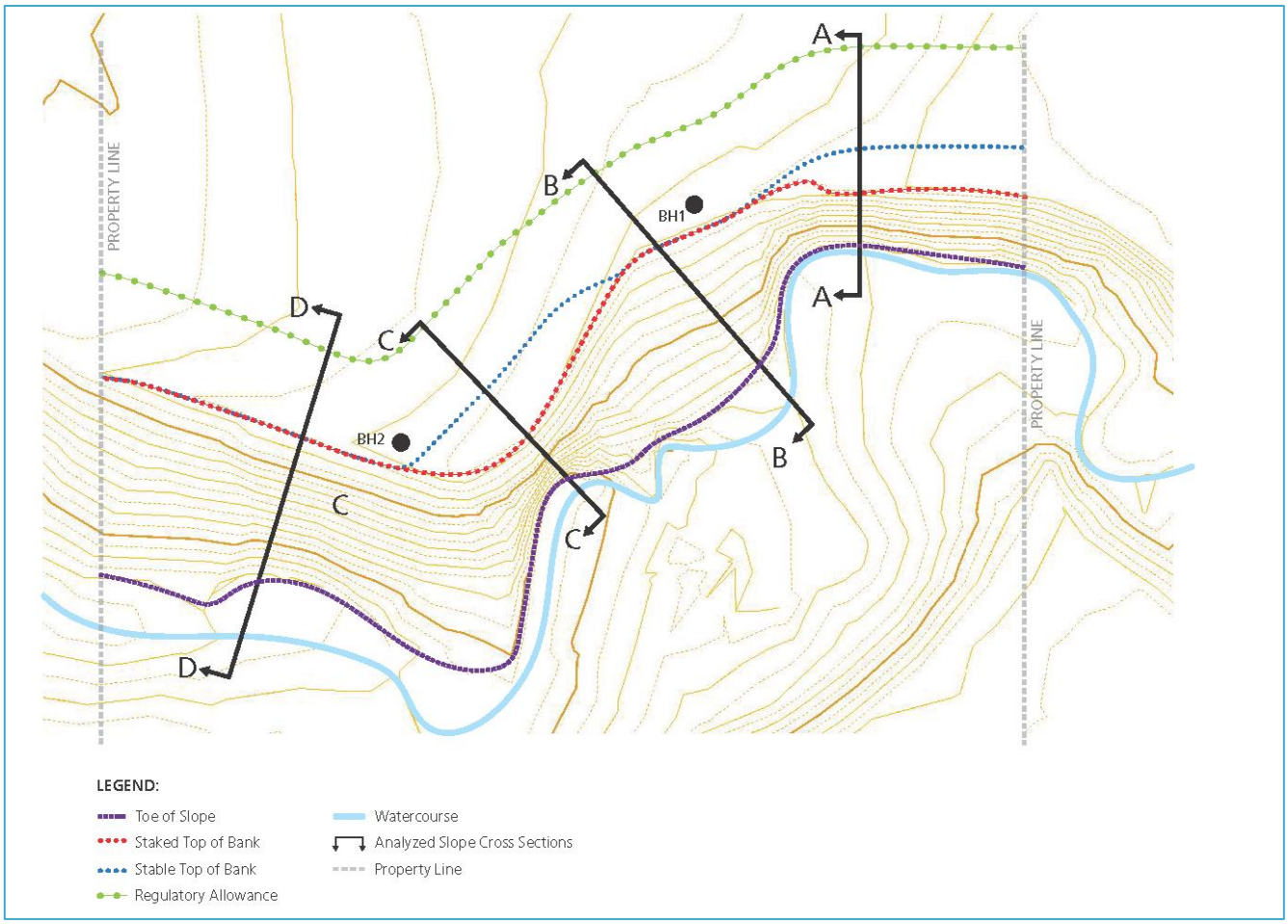
Rock coring and analysis will be required if a stable inclination steeper than 1.4:1 is proposed for shale bedrock.

2.3 Topographic Information

A topographical survey must be completed by an Ontario Land Surveyor (OLS) or qualified engineer (P.Eng.). Additional field measurements by the qualified professional may be used to augment and confirm available survey information.

The topographical data must be used to generate the analysed slope cross-sections. It will also typically be used to illustrate in plan view the findings of the analysis and other relevant aspects of the site assessment (Figure 2-2).

FIGURE 2-2 TYPICAL PLAN VIEW



2.4 Slope Cross-sections

The number of sections analyzed must be based on sound engineering judgment with the justification documented in the report. Cross-sections must represent both typical conditions and the most critical area(s) of the slope. Examples of the critical areas are:

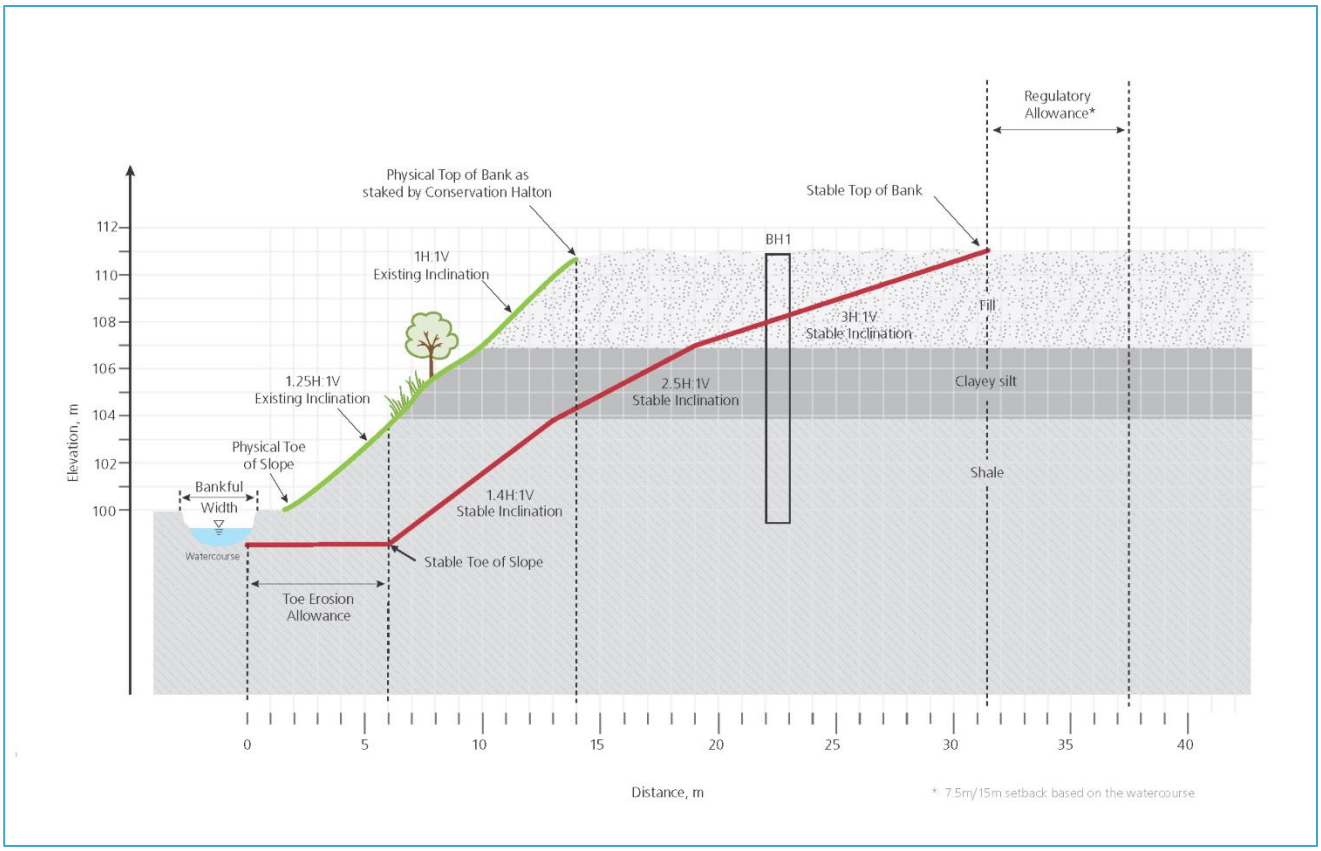
- steep portions of the slope,
- seepage locations,
- greatest toe erosion potential,
- existing drainage feature,
- slope surface erosion,
- existing structure including foundation details,
- excavation and restoration areas,
- overland flow route locations, and/or
- fill slopes.

Each section must be drawn to scale and at a size that is easy to read/understand. Each cross-section must illustrate:

- existing topography,
- soil/bedrock stratigraphy,
- borehole location, if applicable,
- watercourse,
- toe erosion allowance,
- stable slope inclinations,
- stable top of bank,
- points surveyed,
- regulatory allowance (as provided by CH),
- development setbacks (as provided by CH), if applicable, and
- existing and proposed development, if applicable.

Figure 2-3 illustrates a typical cross-section.

FIGURE 2-3 TYPICAL CROSS-SECTION



Note: Cross-section details may be provided on Factor of Safety Analysis figures as per Section 2.6.

2.5 Toe Erosion Allowance

A *toe erosion allowance* provides a setback from the watercourse bank sufficient to account for the lateral migration of the stream over a 100 year period. Where the toe of the slope is within 15 m (49.2 ft.) of the watercourse bank, a *toe erosion allowance* assessment in accordance with the MNR Technical Guide must be provided.

The most common method of establishing the *toe erosion allowance* is based on soil types and hydraulic processes as described in the MNR Technical Guide and shown in Table 2-1; however, a qualified professional must confirm the appropriateness of using this table. Alternative methods of establishing the *toe erosion allowance* as outlined in the MNR Technical Guide will also be considered if appropriately applied. The assessment must clearly outline how the recommended *toe erosion allowance* was determined throughout the study area.

TABLE 2-1 REFERENCE VALUES FOR TOE EROSION PARAMETERS

MINIMUM TOE EROSION ALLOWANCE - River Within 15 m of Slope Toe*

Type of Material Native Soil Structure	Evidence of Active Erosion** OR Bankfull Flow Velocity >Competent Flow Velocity***	No evidence of Active Erosion** OR Bankfull Flow Velocity <Competent Flow Velocity***		
	Range Of Suggested Toe Erosion Allowances	Bankfull Width		
		< 5m	5-30m	> 30m
Hard Rock (granite) *	0 - 2 m	0 m	0 m	1 m
Soft Rock (shale, limestone) Cobbles, Boulders *	2 - 5 m	1 m	1 m	2 m
Stiff/Hard Cohesive Soil (clays, clay silt), Coarse Granular (gravels) Tills *	5 - 8 m	1 m	2 m	4 m
Soft/Firm Cohesive Soil, loose granular, (sand, silt) Fill *	8 - 15 m	1-2 m	5 m	7 m

*Where a combination of different native soil structures occurs, the greater or largest range of applicable toe erosion allowances for the materials found at the site should be applied

**Active Erosion is defined as: bank material is exposed directly to stream flow under normal or flood flow conditions where undercutting, oversteepening, slumping of a bank or down stream sediment loading is occurring. An area may have erosion but there may not be evidence of 'active erosion' either as a result of well rooted vegetation or as a result of a condition of net sediment deposition. The area may still suffer erosion at some point in the future as a result of shifting of the channel. The toe erosion allowances presented in the right half of Table 3 are suggested for sites with this condition. See Step 3.

***Competent Flow Velocity is the flow velocity that the bed material in the stream can support without resulting in erosion or scour.

Ref: Technical Guide - River and Stream Systems: Erosion Hazard Limit 2002 - Ontario Ministry of Natural Resources

In most situations, CH provides no credit for toe erosion protection. Toe erosion protection measures may fail over time and, therefore, the assessment should consider the long-term erosion based on no protection. The analysis should be based on assumed natural conditions at the watercourse and *toe of slope* and the applicable toe erosion allowance determined accordingly. CH may credit toe erosion protection in select circumstances such as robust measures built and maintained by a public agency.

In the absence of a full geotechnical / fluvial geomorphological investigation, a *standard toe erosion allowance* of 15 m (49.2 ft.) must be provided for systems situated in non-cohesive soils and 8 m (26.2 ft.)

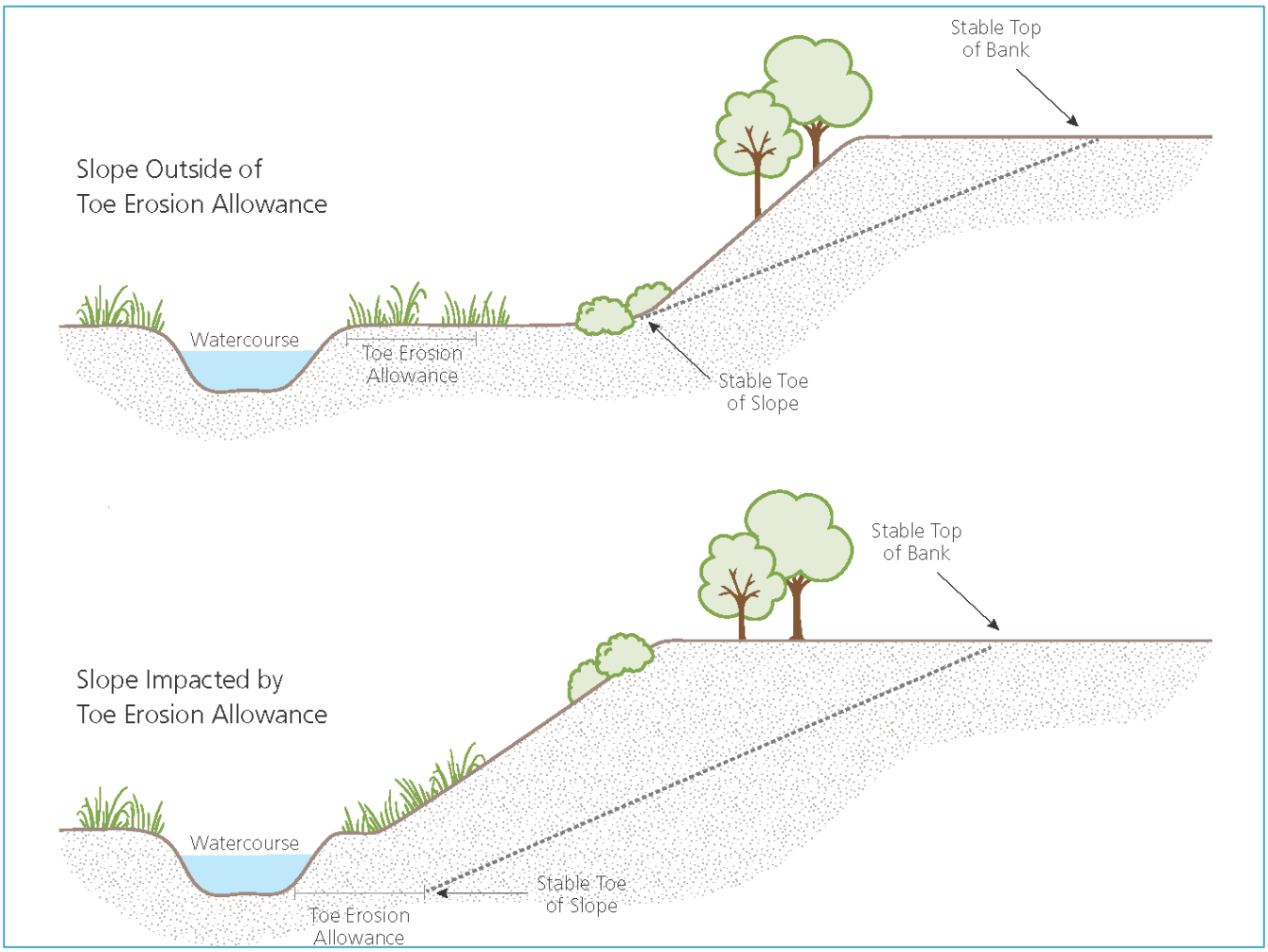
for systems situated in cohesive soils. Where a combination of cohesive and non-cohesive soils is present, the more conservative *toe erosion allowance* should be applied unless adequate justification for a lower value is given.

2.6 Stable Slope Allowance

The *stable slope allowance* is a setback that accounts for the stable inclinations of a slope, which are determined by the local rock/soil stratigraphy, groundwater conditions, and other applicable aspects. The *stable slope allowance* is calculated from either the toe of the valley slope, where the *toe erosion allowance* is less than the distance from the edge of the watercourse to the valley slope, or the **calculated** toe of the valley slope where the *toe erosion allowance* is greater than the distance from the edge of watercourse to the valley slope (Section 2.5).

From the stable *toe of slope*, a gradient line is drawn at the appropriate stable slope inclination(s) to intersect with the tableland. Figure 2-4 illustrates these scenarios.

FIGURE 2-4 STABLE SLOPE ALLOWANCE APPLICATIONS



Future conditions must be assessed and discussed if changes are anticipated that may affect slope stability (e.g., vegetation removal, altered drainage patterns, grading, or additional loads) or potential risk (such as future land use).

Within CH's jurisdiction, the relative strength of the shale bedrock is variable. The material's strength ranges from very competent to weak, depending upon its weathering, cracks, fissures, etc. CH will support a stable slope inclination of 1.4H: 1V for shale. A steeper inclination must be justified by a cored rock analysis. A cored rock analysis would need to determine the material's condition, durability and relative strength, etc. via in-situ sampling and subsequent laboratory analysis.

For the overburden, CH will accept a 3:1 (horizontal to vertical) stable slope inclination without further analysis, except in instances of unconsolidated fill. For slopes steeper than 3:1, a Factor of Safety (FOS) analysis of the slope is required, which typically includes software analysis. Multiple methods of analysis (e.g., Bishop, Spencer, Janbu, Morgenstern/Price, Ordinary, etc.) should be used as part of the assessment. The final recommendations may be based on the most applicable methodology considering site conditions.

FOS analysis must be performed for shallow-seated, deep-seated, and toe failures. Conservative soil parameters should be used in the analysis, unless laboratory testing of soils has been completed. Testing results, if applicable, must be included in the report. It is the qualified engineer's responsibility to select appropriate values and justify the values used.

Surface loads, such as existing buildings located on or near the slope. should be accounted for within the analysis. Retaining structures, other than loading, are typically disregarded in the *stable slope allowance* analysis. The need for seismic analysis is to be determined by the qualified professional based on standard industry practices and an understanding of the project's risks.

An appropriate FOS must be incorporated into the analysis. The minimum FOS supported by CH, for active use, are outlined in Table 2-2.

TABLE 2-2 MINIMUM ACCEPTABLE FACTOR OF SAFETY VALUES

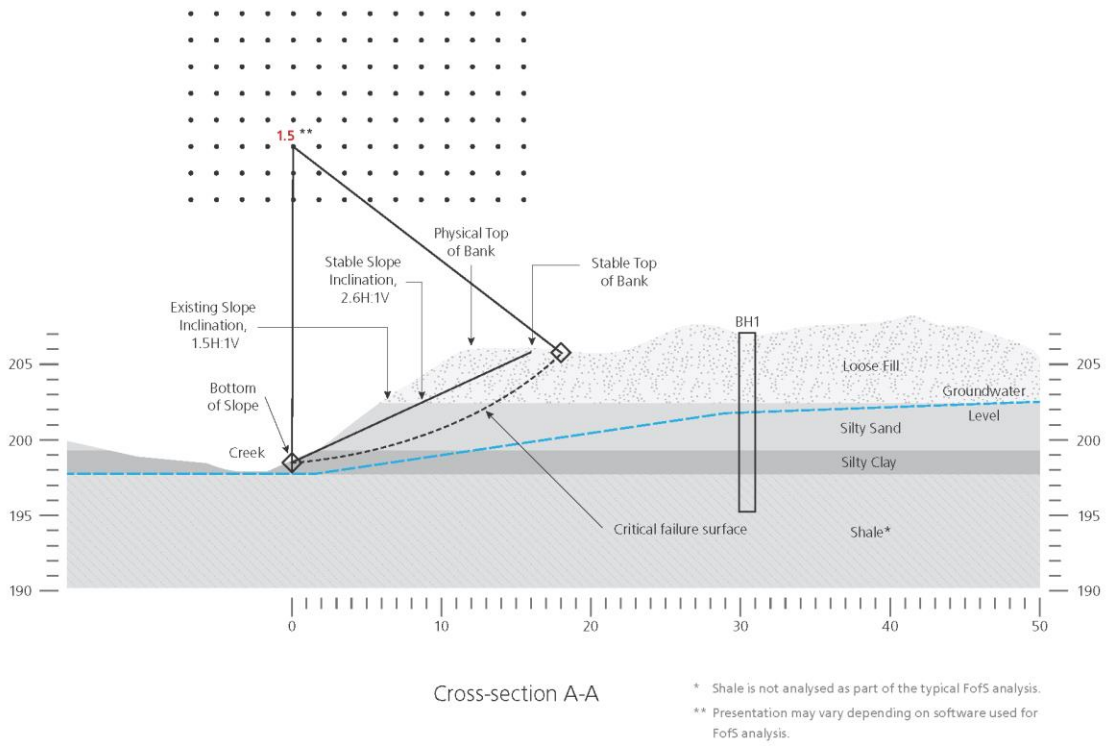
	Minimum FOS
Normal groundwater conditions	**1.5**
Elevated Groundwater conditions*	**1.3**

* Temporary or seasonal conditions after heavy rainfall event; soil drainage conditions should be considered before applying undrained conditions

Higher factors of safety must be used, where warranted, due to the consequences/risks associated with a slope failure (i.e., extreme high risk land-use) or due to soil variability, reliability of data, or other unknowns associated with the analysis.

Results of the software analysis must be presented in the slope stability assessment report. The analysis must demonstrate the inclination of the slope where the minimum required FOS is achieved under both normal and elevated groundwater conditions. The acceptable FOS must not be located on the outer edge of the grid/matrix. FOS contours must be included on the grid. A typical Factor of Safety Analysis is shown in Figure 2-5.

FIGURE 2-5 TYPICAL/MINIMUM FACTOR OF SAFETY ANALYSIS



2.7 Submission Requirements

The level of detail required will depend on the complexity of the project; however, the slope stability assessment report should follow the MNR Technical Guide and the Principles Document and include the components specified in Table 2-3.

TABLE 2-3 SUBMISSION REQUIREMENTS (CHECKLIST)

Item Provided	Components
☐	Project description
☐	Site Location (address and key plan)
☐	A topographical survey plan of the subject site
☐	Description of site conditions based on a recent site visit. Photographs must be included. The description of the site must include the following factors: • Date and time of inspection, including weather conditions, visibility and accessibility • Site topography and slope characteristics including slope height and inclination • Extent of areas draining to the top of slope • Existing and proposed land use • Surface cover (vegetation) • Soil and bedrock stratigraphy or layering • Soil type (composition) • Measured soil density and strength • Groundwater pressure or evidence of groundwater • Nearby watercourse features • Evidence of stream or slope erosion
☐	Discussion of the site's soil/bedrock conditions based on a literature review or knowledge of other investigations in the general area of the subject site
☐	Justification for the level of investigation undertaken, including a completed Slope Stability Rating Chart (Appendix B)
☐	Engineering evaluation of soil/rock – grain size analysis, strength parameters, etc.
☐	*Toe erosion allowance* analysis, including supporting calculations
☐	*Stable slope allowance* analysis, including slope failure/slip analysis
☐	Slope cross-sections
☐	Plan view of the site clearly showing: • cross section locations • watercourse • physical *toe of slope* • staked physical *top of bank* • *stable top of bank* • existing development and proposed development (if applicable) • CH regulatory allowance • Any other development setbacks (if applicable)
☐	Borehole logs and laboratory test results if applicable
Please be advised that based on the results of the Slope Stability Assessment, additional further analysis and/or recommendations for measures that could be implemented to mitigate or address the hazard and risk may be necessary	

Section 3 Existing Valley Development

This section outlines CH's requirements for studies associated with additions/alterations to existing development located in or adjacent to a valley.

3.1 General Submission Requirements

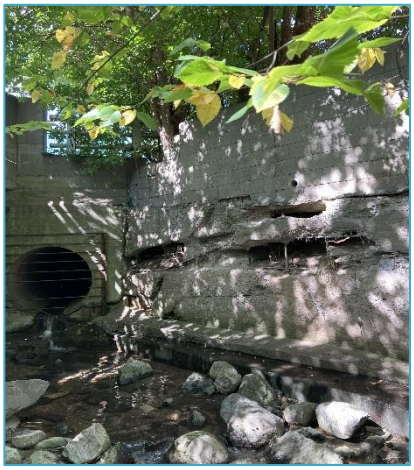
In some cases, protection measures may be needed to improve slope stability to protect existing development or natural areas from the risk of erosion hazards. CH has regulatory policies that allow for alterations to the valley slope or additions/modifications to existing valley development that are minor in nature. **Pre-consultation with CH staff is recommended to determine if the proposed development can be permitted by policy and, if so, what analysis will be required to support the permit application.**

Where there is a proposal to modify existing valley development which is permitted by policy, the need for a geotechnical assessment will be determined during pre-consultation and/or a site visit. Assessments are required to confirm:

- the stability of the existing slope,
- existing and future slope stability is not impacted,
- risk of creating new or aggravating existing erosion hazards is avoided, and
- the potential for increased loading forces on the slope is addressed through appropriate structural design.

The assessment must evaluate both temporary construction impacts and permanent impacts to slope stability, including future access for maintenance.

It is the qualified professional(s) responsibility to ensure that a submission supporting development in or within proximity to a *confined* or *semi-confined* valley meets all applicable standards, guidelines, regulations, etc.



3.2 Retaining Walls

CH does not generally support the construction of retaining structures for the purpose of expanding or creating new developable areas. Geotechnical input from a qualified professional is required for the replacement of a retaining wall or new wall required for the protection of existing development. In conjunction with the above requirements, the geotechnical analysis must verify the resulting FOS for global stability and review the bearing capacity calculated by the structural engineer. Bearing capacity, overturning, and sliding calculations must be provided by the structural engineer. Structural details, including foundation, depth of embedment, buttressing, tie-backs, drainage etc. must be discussed by the qualified professional and accompanied by cross-sectional and profile drawings. The submission must also address the potential for surficial erosion through inclusion of a drainage plan, erosion and sediment control plan and a site stabilization/restoration plan, where applicable.

APPENDICES

Appendix A – Definitions

Note: Definitions are from the CH *Policies and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document* (2020) unless noted by a *.

Accepted Geotechnical Principles:

Those principles, methods and procedures involving slope stability analysis which are used and applied in current geotechnical practice and have been reviewed and approved by CH.

Confined Valley System:

Where the watercourse is located within a valley corridor, either with or without a flood plain, and is confined by valley walls. The watercourse may be located at the toe of the valley slope, in close proximity to the toe of the valley slope (less than 15 metres) or removed from the toe of the valley slope (more than 15 metres). The watercourse can contain perennial, intermittent or ephemeral flows and may range in channel configuration, from seepage and natural springs to detectable channels (Understanding Natural Hazards, MNR, 2001). Within CH's watershed, all valleys greater than or equal to 2 metres in height are considered confined systems.

Erosion Hazard:

The loss of land, due to human or natural processes, that poses a threat to life and property. The *erosion hazard* limit is determined using considerations that include the 100-year erosion rate (the average annual rate of recession extended over a one hundred year time span), an allowance for slope stability, and an erosion/erosion access allowance.

Instream Erosion:

The process by which the materials of a stream are worn away by the constant force of flow of water on the channel bottom and banks. This is a natural process which affects the channel plan and profile. Erosive processes, over time, can deepen and widen the channel form. As the channel meanders due to erosion and deposition, valley walls can also be subject to higher erosive forces. This is typically seen when the channel reaches the toe of the valley slope and during high, overbank flow events. *

Major valley system:

The valley systems associated with Grindstone, Bronte or Sixteen Mile Creeks, including all tributaries.

Minor valley system:

All valley systems within CH's jurisdiction other than those associated with Grindstone, Bronte and Sixteen Mile Creeks.

Semi-confined valley System:

A valley at the transition between a confined and *unconfined system* that has characteristics of both types of valley systems. *

Slope Surface Erosion:

The process by which the surface of the valley slope is worn away. Factors affecting slope surface erosion include heavy rainfall which may saturate the slope, runoff from areas adjacent to the slope, direct discharge from pipes to the slope, and instabilities associated with tree loss. This erosion is generally surficial in nature but can contribute over time to deep seated failure. *

Stable Slope Allowance:

The stable slope allowance is the setback from the stable toe of slope that accounts for the stable inclinations of the slope.

Stable Top of Bank (STOB):

As it pertains to valleylands means,

(a) the physical *top of bank* where the existing slope is stable and not impacted by toe erosion; or,

(b) is defined by the toe erosion allowance plus the stable slope allowance where the existing slope is unstable and/or is impacted by toe erosion.

Surface Erosion:

The detachment and transport of soil particles by wind, water, or gravity. *

Toe Erosion Allowance:

The toe erosion allowance is the setback from the watercourse bank that accounts for the lateral migration of a stream over a 100 year period.

Toe of Slope:

The lowest point on a slope, where the surface gradient changes from relatively shallow to relatively steep.

Top of Bank (TOB):

The point of the slope where the downward inclination of the land begins, or the upward inclination of the land levels off. This point is situated at a higher topographic elevation of land than the remainder of the slope. There may be situations where there are interruptions in the valley slope by plateau (terrace) areas.

Unstable Slopes:

Unstable slopes are slopes steeper than their natural angle of stability. Over time, these slopes are subject to adjustment to obtain the natural stable inclination. *

Unconfined System:

Those systems where the watercourse is not located within a valley corridor with discernable slopes, but relatively flat to gently rolling plains and is not confined by valley walls. The watercourse can contain perennial, intermittent or ephemeral flows and may range in channel configuration, from seepage and natural springs to detectable channels. Within CH's watershed, all valleys less than 2 metres in height are considered unconfined systems.

Valley/Valleylands:

Depressional features associated with a river or stream, whether or not they contain a watercourse.

Appendix B – Slope Stability Rating Chart

SLOPE STABILITY RATING CHART

Site Location:	File No.
Property Owner:	Inspection Date:
Inspected By:	Weather:

1.	**SLOPE INCLINATION**		
	degrees	**horiz. : vert.**	
	a) 18 or less	3 : 1 or flatter	0
	b) 18 - 26	2 : 1 to more than 3:1	6
	c) more than 26	steeper than 2 : 1	16
2.	**SOIL STRATIGRAPHY**		
	a) Shale, Limestone, Granite (Bedrock)		0
	b) Sand, Gravel		6
	c) Glacial Till		9
	d) Clay, Silt		12
	e) Fill		16
	f) Leda Clay		24
3.	**SEEPAGE FROM SLOPE FACE**		
	a) None or Near bottom only		0
	b) Near mid-slope only		6
	c) Near crest only or, From several levels		12
4.	**SLOPE HEIGHT**		
	a) 2 m or less		0
	b) 2.1 to 5 m		2
	c) 5.1 to 10 m		4
	d) more than 10 m		8
5.	**VEGETATION COVER ON SLOPE FACE**		
	a) Well vegetated; heavy shrubs or forested with mature trees		0
	b) Light vegetation; Mostly grass, weeds, occasional trees, shrubs		4
	c) No vegetation, bare		8
6.	**TABLE LAND DRAINAGE**		
	a) Table land flat, no apparent drainage over slope		0
	b) Minor drainage over slope, no active erosion		2
	c) Drainage over slope, active erosion, gullies		4
7.	**PROXIMITY OF WATERCOURSE TO SLOPE TOE**		
	a) 15 metres or more from slope toe		0
	b) Less than 15 metres from slope toe		6
8.	**PREVIOUS LANDSLIDE ACTIVITY**		
	a) No		0
	b) Yes		6
	SLOPE INSTABILITY RATING VALUES INVESTIGATION RATING SUMMARY		**TOTAL**

Ref: Technical Guide - River and Stream Systems: Erosion Hazard Limit 2002 – Ontario Ministry of Natural Resources