



# Slope Stability Management Framework

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For the assessment, evaluation, prioritization and mitigation of slope stability concerns.

**2013/06/19**

The Slope Stability Management Framework provides guidance to City administration to assess slope stability risks to public safety, City owned land and City owned infrastructure; and determine the most appropriate course of action in accordance with the Slope Stability Management Policy.

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## **BACKGROUND**

The Slope Stability Management Framework (the Framework) provides guidance to City Administration to assess slope stability risks to public safety, City infrastructure, City owned land (City land) or adjacent private land and determine the most appropriate course of action in accordance with the Slope Stability Management Policy (the Policy). The Framework also includes a list of strategies for private land owners as a guide to help reduce the effect of slope stability concerns on their land. The Framework is available at [calgary.ca](http://calgary.ca) or by contacting 3-1-1.

## **PURPOSE**

The Framework is intended to:

- support the implementation of the Policy by guiding the assessment, prioritization, evaluation, and mitigation of slope stability concerns
- address slope stability concerns in a consistent, cost-effective and timely manner in accordance with the Slope Stability Policy and other City policies and practices
- inform citizens of the risks of instability on natural slopes and adjacent lands, and inform them of their responsibilities on their lands related to slope stability

## **SCOPE**

The Framework applies to City land where slope stability may pose a risk to public safety, City infrastructure or City land; and to privately owned land where slope stability may pose a risk to public safety.

## **DEFINITIONS**

For the purposes of the Framework:

- “City infrastructure” means to manmade assets owned and maintained by The City including but not limited to utilities, roads, sidewalks, pathways, bridges, and sport fields.
- “Factor of Safety” or “FOS” means a calculated ratio commonly used to indicate the stability of a slope. The FOS is the ratio by which the strength of the soil exceeds the strength required to prevent a failure. A FOS greater than one indicates that the soil strength is greater than that required to prevent failure. A FOS less than one indicates the slope is unstable.
- “mitigation measure(s)” means any actions taken in order to lessen or eliminate identified slope stability risks to public safety, City infrastructure, City land or adjacent private land.
- “risks to public safety” means a safety concern arising from slope instability within City land or private land.
- “slope stability concern” means shallow or deep seated slope failures, tension cracks, localized slumping, slope surface erosion, river bank erosion or scour, and other concerns typically associated with slope stability.

## **PART I. SLOPE STABILITY CONCERNS ON CITY LAND**

### **The City's actions**

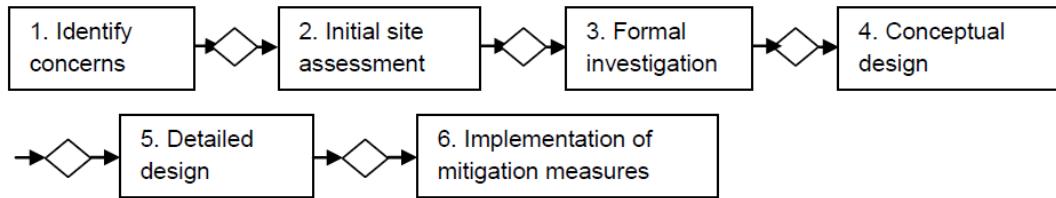
The City will:

- Conduct an initial assessment of reported slope stability concerns and seek to mitigate public safety concerns as a first priority.
- Conduct the appropriate level of technical review of slope stability concerns that have the potential to affect public safety, City land or infrastructure.
- Use the Triple Bottom Line (TBL) approach to evaluate a range of potential options and determine the most appropriate course of action, considering slope stabilization may not be appropriate.
- Consider allowing slope movements to occur naturally and reassess the slope as conditions change where risks to public safety can be mitigated.
- Seek to mitigate slope stability risks and prevent damage to City land and infrastructure focusing on public safety and City infrastructure essential for day-to-day operations.

### **Project stages**

When slope stability concerns arise on City land, The City will conduct an initial site assessment to determine potential next steps. Not all identified concerns will become slope stability projects. The typical stages of large projects are described below.

Figure 1: Slope stability project stages



◇ At the end of each stage The City will determine potential next steps based on available information, project priority and funding availability.

#### 1. Identify Concerns

Slope stability concerns may be identified by the City or by the public. The public can report non-emergency slope stability concerns by calling 3-1-1. Emergency situations should be reported to 9-1-1. Once a concern is identified, The City will determine if the reported concern is related to slope stability, threatens public safety and requires an initial site assessment.

Outcome:

- Concerns requiring assessment will move on to the next stage based on their priority.

#### 2. Initial Site Assessment

Public safety is the primary concern at this stage. The City will conduct an initial site assessment, which may include a high-level review of the following:

- potential public safety concerns
- magnitude of the concern
- potential effects on City land and City infrastructure
- potential effects on adjacent land owners
- potential cause(s)
- site history
- existing and past concerns
- other relevant information

**Outcomes:**

- The City will address safety concerns immediately and seek to prevent further damage to City land and infrastructure.
- The City will determine if a formal investigation or another action is required. Timing of the investigation will depend on project priority and funding availability.

Safety concerns which may vary from tripping hazards to loss of life can be addressed through erosion mitigation, amenity or infrastructure closures, detours, evacuations, emergency repairs or other appropriate measures.

**3. Formal Investigation**

Formal investigations or technical reviews are intended to evaluate potential risks from a geotechnical perspective, identify potential public safety concerns, assess the risk of slope failure, identify potential effects on City land and infrastructure, determine potential causes of the slope instability, and provide recommendations for potential mitigation measures. Structural, hydro-geological, archaeological, environmental and biophysical studies may also be required by municipal, provincial and federal policies and legislation depending on the type and location of the concern.

Investigations will be typically conducted by qualified external consultants, such as a civil or geotechnical engineering firms registered with the Association of Professional Engineers and Geoscientists of Alberta (APEGA). Consultants will work closely with City business units who own or operate affected lands or assets throughout the project. Decision on potential mitigation measures and next steps will take into account the TBL considerations listed in Schedule A.

**Outcomes:**

- Communication with municipal, provincial and federal regulatory agencies, and the public as required.
- Selection of potential mitigation measures that fit with existing policies and regulatory requirements
  - The project may move to conceptual design based on project priority and funding availability, if required.
  - When engineering design is not required, the project may move directly to implementation based on project priority and funding availability

- When the selected measure is to allow the slope movement to occur naturally and reassess the slope as conditions change, The City will communicate the decision to affected stakeholders

#### 4. Conceptual Design

Qualified consultants will prepare conceptual designs potential measures under consideration. The City will evaluate each potential measure taking into account the TBL considerations listed in Schedule A.

Outcomes:

- Evaluation of potential measures and selection of best mitigation measure(s)
- The project may move to detail design based on project priority and funding availability

#### 5. Detailed Design

Qualified consultants to create a detailed design of the selected mitigation measure(s). The design will serve as the basis on which to conduct a more detailed review of economic, social, environmental and other considerations, which may alter the course of the City's actions or the design of the final mitigation measure and its priority.

Outcome:

- Move to implementation of the mitigation measure(s) based on project priority and funding availability

#### 6. Implementation

Mitigation measures will be implemented on a priority basis as budget allows, in compliance with municipal, provincial and federal legislation, guidelines, policies and best practices. Projects will typically be implemented by a qualified contractor after a tendering process in accordance with City policies. The City may implement a project in stages to manage the available budget.

#### **Project Funding**

Costs to mitigate slope stability concerns may include geotechnical borehole drilling, scientific analysis, geotechnical investigations, engineering design and construction. Costs vary depending on the type, location, cause, site accessibility, and other factors.

Slope stability projects on City land are mainly funded through Capital Program 129 - 45: Hillsides which is currently allocated \$500,000 per year. The current budget level is sufficient for preliminary geotechnical investigation however; it is insufficient for the average project work required. High priority projects requiring additional budget are brought to Council on a case by case basis.

Slope instability resulting in damage to City infrastructure as a direct result of an extreme weather may be totally or partially funded by Disaster Recovery Program (DRP) provincial

funding subject to the eligibility criteria and project guidelines set forth by the Government of Alberta. Each eligible project is reviewed by the provincial government on a case-by-case basis.

## **PART II. SLOPE STABILITY CONCERNS ON PRIVATE LAND**

There are natural risks associated with stability of slopes and adjacent land. The City strives to mitigate the risks associated with slope instability by restricting development to areas with a FOS of at least 1.5. However, the slope instability risks cannot be completely eliminated.

There is a desire by the public to own land adjacent to natural slopes due to the land's aesthetic value. This section provides information on the Policy as it applies to private property, and includes additional information for property owners.

### **The City's Actions**

The City will:

- Restrict new development to areas with an FOS of at least 1.5 to ensure urban development is reasonably safe from slope instability.
- Inform citizens of inherent risks of instability surrounding natural slopes and their responsibilities on their land related to slope stability through The City's website and other communication tools.
- Conduct the appropriate level of technical review and seek to mitigate slope stability concerns on private property where public safety or public infrastructure are at risk.

The City may:

- Consider mitigating slope stability concerns where a City action, City land or infrastructure are the suspected cause of the concerns, if appropriate, having regard to all of the circumstances.
- Recognizing each situation is unique, conduct the appropriate level of investigation or technical review and collaborate with private land owners in order to mitigate slope stability concerns on private land on a case-by-case basis.

### **Investigation**

In cases where as a result of investigation on City land, The City becomes aware of a potential safety concern on private property, The City may:

- share the results of existing investigations with the affected landowners and adjacent residents;
- advise the affected landowners and adjacent residents of inherent risks and their obligations; and
- assist land owners in their efforts to minimize damage to their lands by providing copies of historical geotechnical reports, site history, sharing other available relevant information, providing access to City lands and facilitate coordination of concurrent investigations on private property and City land.

The City will not investigate slope stability concerns on private property if the instability is a result of natural processes or the actions of private landowners including but not limited to:

- alterations to overland drainage due to erosion of the landscape, excessive irrigation, non-functional eaves troughs, and misdirected downspouts
- landscaping, improper lot drainage, or improper lot maintenance
- lot grading or construction without appropriate permits
- failure to comply with any applicable laws or regulation.

One exception to this rule is when a failing slope has created a safety concern, in which case The City may issue orders against the owner to ensure that the properties are secured and returned to a safe condition.

### **Private Property Owner's Responsibilities**

Land owners are responsible for addressing slope stability concerns on their own land and taking appropriate measures to mitigate or eliminate risks to persons and land. The City will not make recommendations or design solutions for issues on private land. Land owners should seek the advice of qualified professionals for recommendations or designs.

Responsibilities of private land owners applicable to slope stability concerns include but are not limited to the following:

- maintain and remediate for drainage and erosion control on their lots
- investigate slope stability concerns
- mitigate risks and limit their damages
- comply with any and all applicable laws including but not limited to the Land Use Bylaw 1P2007, Drainage Bylaw 37M2005, Occupiers' Liability Act, Building Code and Fire Code, including any orders issued thereunder to take remedial actions
- comply with any and all geotechnical covenants, setback requirements and other restrictions registered on their land title
- do not alter or deviate from approved grading or drainage plans.

### **Preventive Strategies by Private Land Owners**

Land owners should be aware of how their actions may affect slope stability. The following list is offered as a guide to help reduce the effects of slope stability concerns but is not definitive:

- obey all infrastructure closures and detours for your own safety
- avoid infiltration of overland water onto slopes
- avoid unauthorized irrigation, landscaping, grading, excavation or other alteration of natural land and vegetation
- seek professional advice for lot grading, landscaping, construction and alteration of retaining walls and any other alteration of slopes; and

- avoid placement of loads including loose soil and debris over the side of, and atop slopes

Private land owners who are unsure how to maintain their site and prevent slope stability concerns over the long term, should seek the advice of qualified professionals.

## **SCHEDULE A - POTENTIAL MITIGATION MEASURES AND TBL CONSIDERATIONS**

The City will consider a range of potential mitigation measures for each specific concern. The City may consider mitigation measures such as:

- Allowing slope movements to occur naturally and reassess the slope as conditions change where risks to public safety can be mitigated.
- bio-engineering erosion mitigation
- infrastructure repair, relocation, temporary or permanent closures, and decommissioning
- formal or informal slope monitoring; and
- slope stabilization

Potential measures will be evaluated using a TBL approach. Examples of TBL considerations applicable to slope stability are listed below.

### **Economic Considerations**

- Life-cycle cost of existing and proposed infrastructure, including maintenance, replacement, relocation and decommissioning costs
- Efficient use of existing infrastructure and services
- Type and value of infrastructure affected such as utilities, roads, pathways, trails, and retaining structures
- Importance of infrastructure on delivering services to Calgarians
- Savings in energy, infrastructure, maintenance costs, land values, and reduction in demand for air and water pollution control measures associated with retaining natural areas and wetlands

### **Social Considerations**

- Risks to public safety
- Safety and reliability of City infrastructure
- Access to natural areas and recreational amenities such as open areas, sports fields, trails and pathways
- Preservation of the river valley and ravine system as a significant visual and natural amenity feature, and recreational opportunity for Calgarians
- Value of affected City land and infrastructure to the community's quality of life and healthy lifestyle
- Effect of slope stability on adjacent residents, area users and general public.

- Aesthetics
- Stakeholder input

### Environmental Considerations

- Effect of slope stability on the natural environment
- Effect of potential mitigation measures on the natural environment
- Conservation of biodiversity, quality of life, communities and ecosystems
- Environmental protection of scenic landscapes, river valley park system, waterways and wetlands, natural tree stands and prominent escarpments
- Conservation, protection and enhancement water quality and quantity
- Efficient use of resources to reduce Calgary's ecological footprint
- Public access management for protection of natural areas
- Regulatory requirements for environmental protection

### Additional Considerations

- Compliance with Council approved policies and regulatory requirements
- Technical considerations such as site accessibility and construction methodology
- Current and future land use
- Current and planned area projects
- Land and easement requirements
- Site's history of slope instability
- Other site and context specific considerations

## **SUPPORTING POLICIES AND DOCUMENTS**

- 2020 Sustainability Direction. 2010
- Calgary Natural Area Management Plan. 1994
- Calgary Open Space Plan. 2002
- Calgary Transportation Plan. 2009
- Engage! Policy. 2003
- Environmental Development Review Policy. 2006
- Environmental Policy. 2007
- Integrated Risk Management Policy. 2004
- Municipal Development Plan. 2009
- Municipal Government Act.
- Triple Bottom Line Policy Framework. 2011
- Wetland Conservation Plan Policy. 2004
- Slope Adaptive Development Guidelines Policy and Conservation Planning and Design Policy, 2009