7.0

River and Stream Systems

Hazardous lands adjacent to river and stream systems subjected to flooding and erosion.

7.1 Flooding Hazards

In most areas of Ontario, flooding of river and stream systems typically occurs following the spring freshet and may occur again as a result of thunderstorm activity in the summer or increased runoff in the fall. A *flooding hazard limit* will determine the extent of a flood. In Ontario, either storm centred events, observed events, or a flood frequency based event may be used to determine the extent of the flooding hazard limit (or regulatory flood criteria, as was previously defined in the 1988 Flood Plain Planning Policy Statement). These events are:

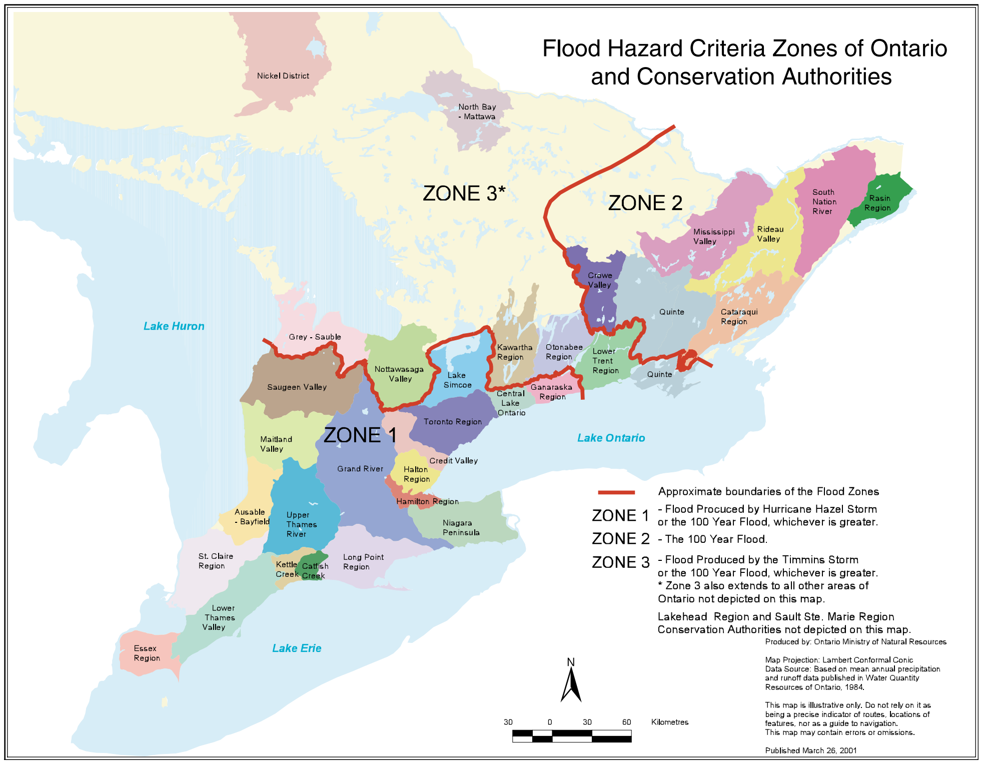
a) **A storm centred event**, either Hurricane Hazel storm (1954) or Timmins storm (1961). A storm centred event refers to a major storm of record which is used for land use planning purposes. The rainfall actually experienced during a major storm event can be transposed over another watershed and when combined with the local conditions, flooding hazard limit can be determined. This centering concept is considered acceptable where the evidence suggests that the storm event could have potentially occurred over other watersheds in the general area.

b) **100 year flood** is a frequency based flood that determined through analysis of precipitation, snow melt, or a combination thereof, having a return period (or a probability of occurrence) of once every 100 years on average, having a 1% chance of occurring or being exceeded in any given year. The 100-year flood is the minimum acceptable standard for defining the *flooding hazard limit*.

c) **An observed event,** which is a flood that is greater that the storm-centred events or greater that the 100 year flood and which was actually experienced in a particular watershed, or portion thereof, as a result of ice jams, and which has been approved as the standard for that specific area by the Minister of Natural Resources.

The map titled "Flood Hazard Criteria in Ontario" illustrates the province of Ontario and the 3 different flood hazard limit criteria zones. An observed event may take place in any part of the province, exceeding either the storm centred events or the 100-year frequency based flood.

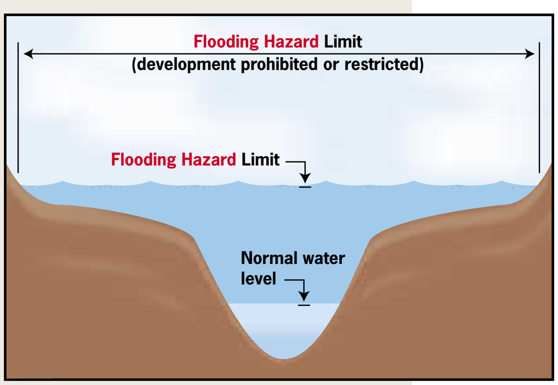
The flooding hazard limit or the floodplain for rivers and stream systems is defined as the area adjacent to the watercourse which would be inundated by the most a flood resulting from either Hurricane Hazel, the Timmins Storm, an observed event, or by the 100 year frequency based event. It has been generally applied to watercourses which drain areas that are equal to or greater than 125 ha.



Within Ontario there are three concepts of floodplain management: one zone concept, two zone concept and in a few exceptional situations, a Special Policy Area concept. Regardless of the concept applied, the overall intent of the policies governing public health and safety should be assured.

One-zone concept: Using this, planning authorities determine the flooding hazards limit, based on the 100-year flood or major storm-centred event, and prohibit all development or site alteration within those boundaries. This is the most effective way of minimizing threats to public health or safety or property damage. The one zone concept is the preferred approach for the management of flooding hazards within river and stream systems as it provides the most cost effective means of minimizing potential threats to life and risks of property damage and social disruption. Where the one zone concept is applied, the entire flood plain or the entire flooding hazard limit defines the floodway (figure 6)

Figure 6: One Zone Concept, Flooding Hazard Limit



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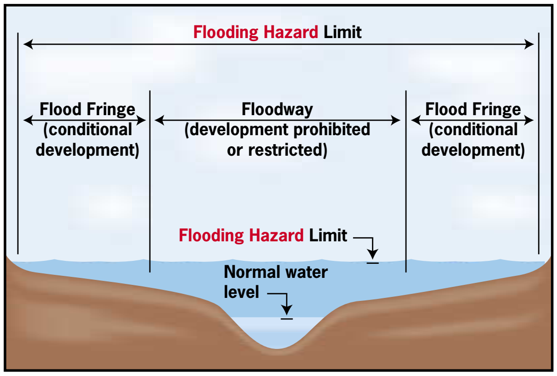
Two-zone concept: This concept identifies the floodway and the flood fringe. The floodway refers to that portion of the floodplain where development and site alteration would cause a threat to public health and safety and property damage. In other words it is that portion of the floodplain required for the safe passage of flood flow and/or that area where flood depths and/or velocities are considered to be such that they pose a potential threat to life and property damage. (See figure 7). The flood fringe is the portion of the flood plain where development may be permitted subject to **certain established standards and procedures**. Because conditions vary, there is no province wide standard for determining the more hazardous areas of flood plains. But some factors to take into account include depth **of water: velocity of flow, combined depth and velocity, vehicle access and structural integrity**. These factors along with critical depth and velocity limits are discussed in the Technical Guide, River and Stream Systems, Flooding Hazard Limit.

Figure 7: Two Zone Concept, Flooding Hazard Limit. Two Zone Concept consists of a Floodway and Flood Fringe



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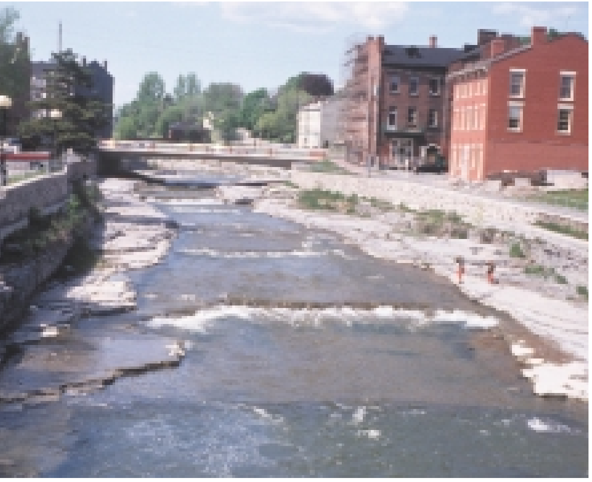
Under Policy 3.1.2 (c), **along rivers and streams, no development or site alteration should be allowed in the floodway.** (figure 7)

In some unique or exceptional situations, communities are allowed to continue uses in a flood plain if the area is officially designated as a **Special Policy Area** (SPA). The application of the SPA concept is really limited to those areas, which are essential for the continued viability of existing uses; e.g. historical sites or old neighbourhoods built before flood plain policies came into effect. Official SPA designation by government is a detailed procedure that requires analysis of technical information and other flood plain management measures and close cooperation with several ministries. The Ministers of Natural Resources and Municipal Affairs and Housing can designate Special Policy Areas provided all conditions for public health and safety are satisfied.

Portions of the city of Cambridge and Town of Port Hope (left) have been designated as Special Policy Areas



The exceptions to this are structures, which by their nature must be located in the floodway (e.g. supporting structures for bridges), appropriate flood or erosion control works and minor additions or non-structural passive uses that don't affect flood flows.

7.2 Erosion hazards

Erosion hazards mean the loss of land, due to human or natural processes, that pose a threat to life and property. The erosion hazard limit is determined using the 100-year erosion rate (the average annual rate of recession extended over a hundred year time span), and includes allowances for toe erosion, slope stability, access during emergencies. The erosion hazard component of river and stream systems is intended to address both, erosion potential of the actual river and stream bank, as well as erosion or potential slope stability issues related to valley walls through which rivers flow. The application of the erosion hazard limit will depend on whether the watercourse flows through a well defined valley system and is confined within a valley corridor or whether it flows through landscapes that are relatively flat, and is not confined or bounded by valley walls.

River bank erosion

Slope failures cause devastating damages to homes, highways and can be fatal. In most cases, damage is exacerbated by human modification of the slope. Almost any modification increases the risk of slope movement. Slope failures can be triggered by atmospheric processes,

River bank erosion

(heavy rainfall), geologic processes (earth tremors, freeze-thaw soil action), human modification, or typically, a combination of all of the above. Therefore, slope failures occur nearly everywhere that slopes exist. Generally, areas where precipitation is ample and that have moderate to steep slopes are most at risk. Human activities and modifications of slopes almost always increase the risk of slope failure, especially in areas already susceptible to these natural hazards.

Generally, development should not occur on or on top of valley walls because the long-term stability of the slope, and therefore public health and safety, cannot be guaranteed. Development should be set back from the top of valley walls far enough to avoid increases in loading forces on the top of the slope, changes in drainage patters that would compromise slope stability or exacerbate erosion of the slope face, and loss of stabilizing vegetation on the slope face.

Valley erosion

Where the valley wall is over-steepened or subject to active toe erosion, development should be set farther back from the top of the valley wall so that the development will also be safe from erosion and slope failure in the long term. This is likely the case when the slope is steeper than the suggested stable slope allowance (3 horizontal to 1 vertical distance) or when the toe of the slope is within 15 metres of the river or stream bank.

Many planning authorities have identified erosion hazards in the their planning documents. conservation authorities administer the Fill, Construction and Alteration to Waterways Regulations under the *Conservation Authorities Act* and have a long history in identifying and managing hazardous lands. The erosion hazard limit approaches are intended to identify and provide provincial direction and methods. The principles and approaches are intended to apply consistently across Ontario, but allow for flexibility to address local needs and issues.

Slope failure

To determine the appropriate erosion setback for river and stream systems, engineers consider the following components:

1) Toe erosion allowance, or the setback that ensures safety if the toe of the slope adjacent to the river or stream erodes and weakens the bank, increasing the risk of slumping. Includes:

- average annual recession rate, based on 25 years of data to determine the toe erosion allowance over a 100-year planning horizon.
- 15-metre toe erosion allowance measured inland horizontally and perpendicular to the toe of the watercourse slope where the distance between the watercourse and the base of the valley wall is 15 metres or less
- toe erosion allowance based on a valid study, which is based on 25 years of erosion data.
- toe erosion allowance based on soil types and hydraulic processes (flow rates, volume, etc.), based on observations or analytical studies, and where the watercourse is 15 metres or less from the base of the valley wall. (Table) detailed information on this table, its use and other toe erosion concepts are included in the River and stream Systems Technical Guide for Erosion Hazard Limit.

Table: Minimum toe erosion allowance – where river is within 15 m of slope toe

Type of material Native Soil Structure	Evidence of active erosion* or where the bankfull flow velocity is greater than competent flow velocity	No evidence of active erosion		
		bankfull width		
		< 5 m	5-30 m	> 30 m
Hard rock (e.g. granite)	0 – 2 m	0 m	0 m	1 m
Soft rock (shale, limestone), cobbles, boulders	2 - 5 m	0 m	1 m	2 m
Clays, clay-silt, gravels	5 – 8 m	1 m	2 m	4 m
Sand, silt	8 – 15 m	1 – 2m	5 m	7 m

2) Stable slope allowance, or the setback that ensures safety if the slumping or slope failure occur. The stability of slopes can be affected by everything from increases in loading, such as the placement of buildings, and changes in drainage patterns to erosion of the toe of a slope and loss of stabilizing vegetation on the slope face.

- The stable slope allowance is determined by using a horizontal allowance measured landward from the toe erosion allowance equivalent to three times the height of the slope (3:1) OR through a valid study. The 3:1 is considered a minimum allowance.

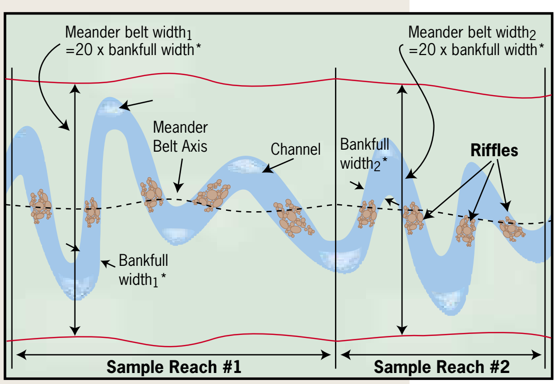
Erosion access allowance provides a route for machinery to undertake periodic repairs as well as emergency vehicles

The Technical Guide, River and Streams Erosion Hazard Limit provides additional details concerning appropriate slope stability allowances.

3) Meander belt allowance, or the setback that keeps development from being affected by river and stream meandering.

- The meander belt allowance is normally used when planning authorities are considering development along unconfined river and stream systems flowing. The allowance is determined to ensure that development is not placed in harm's way, but also to ensure that the flow of water and its associated natural processes, including erosion, are maintained.
- Meander belt allowance: The term meander belt allowance is the maximum extent that a water channel migrates. Other terms associated with meander belts are amplitude, wavelength, bend radius, bankfull width, point bars, pools, riffles and concave and convex banks. A meandering channel is a series of interconnected reaches. A reach is a length of channel over which the channel characteristics are stable or similar. For each reach, the meander belt should be centred on a line of axis drawn through the middle of the meanders or riffle zones, a line that essentially divides each of the meanders in half.
- The width of a meander belt can be determined by analyzing the bankfull channel width of the largest amplitude meander. The meander belt allowance is defined as 20 times the bankfull channel width of the reach and centred on the meander belt axis. When determining the meander belt for these relatively straight reaches, the meander belt should be centred on the mid-line of the channel (see figure 8).

Figure 8



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*** Use bankfull channel width of largest amplitude meander in the reach to determine the meander belt width.**

4) Erosion access allowance, or the setback needed to ensure there's a big enough safety zone for people and vehicles to enter and exit an area during an emergency, such as a slope failure or flooding.

This is the final component used to determine the landward limit of the erosion hazards and should be applied within confined, and unconfined systems. The erosion access allowance is always applied in addition to the flooding hazard limit on river and stream systems.

Planning authorities should provide erosion access allowance for 1) access during emergencies, 2) regular maintenance or repair failed structures and 3) protection from external events that affect an erosion prone area (for example, a low-level earthquake in Ontario's quake zone along the St. Lawrence or Ottawa rivers).The suggested minimum erosion allowance for river and stream systems should be six metres.

Examples of confined systems

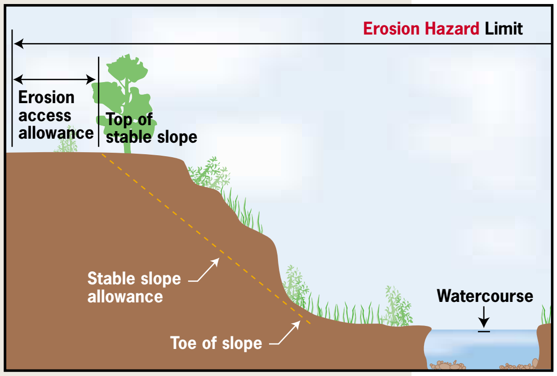
Applying the Erosion Hazard Limit

In Ontario, rivers and streams come in many different shapes and sizes. This is as a result of geological and climatic controls on the landscape, which dictate how much water, which way the water will flow and how the channel will look. To define the erosion hazard limits for river and stream systems, it is important to understand the landforms through which they flow. While there are many different types of systems, the application of the erosion hazard limit for rivers and stream systems is based on two simplified landforms:

> **Confined Systems: are those where the watercourse is located within a valley corridor, either with or without a floodplain, 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 15m) or removed from the toe of the valley slope (more than 15 m). The watercourse can contain perennial, intermittent or ephemeral flows and may range in channel configuration, from seepage and natural springs to detectable channels.**
>
> **Unconfined Systems: are 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.**

Unlike the flooding hazard limit, there is no drainage area criteria before the erosion hazard limit can be applied. Therefore, the erosion hazard limit can be applied to streams and watercourses draining less than 125 ha, virtually everywhere there is a stream, regardless of its size, or whether it is intermittent or permanent.

Examples of unconfined systems



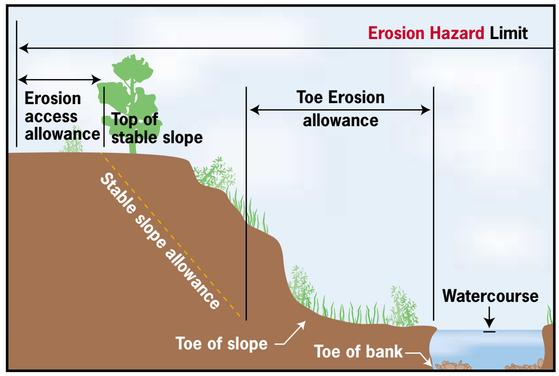


Figure 9b: Confined System, Erosion hazard limit where toe of valley slope is located less than 15 metres from the watercourse.

Figure 9a: Confined System, Erosion Hazard limit where toe of valley slope is located more than 15 metres from the watercourse

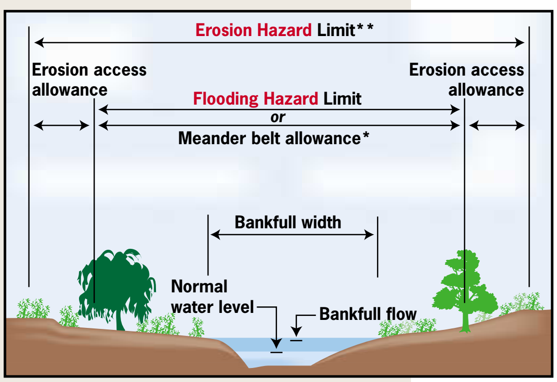
Erosion Hazard Limit in Confined Systems is defined by:

Toe erosion allowance (from Table 2, OR 100 times the average annual recession rate of the toe) OR as determined by a valid study, plus stable slope allowance (suggested 3:1) OR as determined by a valid study, plus erosion access allowance 6 metres OR as determined by a valid study. (Figure 9a)

Erosion Hazard Limit in Unconfined Systems is defined by:

Flooding hazard limit OR meander belt allowance (20 times the bankfull channel width centred over the meander belt axis) OR as determined by a valid study, plus erosion access allowance (6 metres OR as determined by a valid study). (Figure 10).

Figure 10



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* The bankfull channel width with the largest amplitude meander in the reach is used to determine Meander Belt Width.

**Erosion access allowance is also added to the flooding hazard limit, when known,to define the erosion hazard limit.

The two simplified valley and corridor landforms presented here are intended to demonstrate the need to either incorporate a slope stability component or a meander-belt width component in determining the appropriate development setbacks. In many cases, both approaches will need to be used as one side of the corridor may have a valley wall (confined) and the other may not (unconfined). In addition, there are many different types of valleys, containing various slope angles, heights, dimensions, terraces and surficial deposits, which will require further consideration.

A river typically flows through many landforms and land- uses (agricultural, forested, urban) and exhibits many features. The best method to address erosion hazard limits is not through site specific studies, but through subwatershed management approaches, where all hazardous lands are identified through upfront analysis, and appropriate regulatory mechanisms for land use planning are adopted to address the entire system.

The same river flows through steep valleys, gently rolling hills or meanders through areas that are flat

8.0

Hazardous Sites

Lemieux landslide in Ontario in 1993.

Hazardous site policies generally cover 1) unstable soils, such as sensitive marine clays (lead clays) and organic soils and 2) unstable bedrock, such as karst formations. Technical details concerning identification and management of hazardous site is provided in the Technical Guide – Hazardous Sites.

8.1 Unstable soils: Sensitive marine clays (Leda clay)

These clays were deposited as sediment during the last glacial period in the Champlain Sea. Undisturbed, the clays can appear as solid and stable. But when disturbed by excessive vibration, shock or when they become saturated with water, the clays can turn to liquid, sometimes in minutes.

The triggers that bring on the change can vary: earthquakes, thunder, heavy traffic, blasting, heavy rainfall or water from spring runoff, loss of vegetation, or placement of heavy buildings or fill on the site.

The resulting failures or earthflows are particularly dangerous as they can involve many hectares of land. In Lemieux, Ontario a series of retrogressive failures resulted in approximately 30 ha (i.e. 75 acres) of land sliding into the South Nation River in 1993. In Saint Jean-Vianney, Quebec, in 1971, a series of slides and slumps engulfed numerous homes and resulted in the loss of 30 lives.

Of all the slope failures in Canada, Leda clay failures have the 2nd highest rate of occurrence, next to rock falls. Leda clays dominate significant portions of southeastern Ontario.

Information on sensitive marine clays is available on maps from the Geological Survey of Canada, or information from conservation authorities. The South Nation Region Conservation Authority has extensive Leda clay deposits in their watershed and has mapped many of the areas where they occur.

Planning authorities should be concerned about sensitive marine clay areas everywhere, not just along rivers and streams.

To determine the extent of the hazardous site a **horizontal allowance of 1.5 times the distance of the previous failure measured landward from the toe of the failure** is used **OR as a study, using accepted geotechnical; engineering and scientific principles may be undertaken. (Figure 11a, 11b)**

Unstable soil

Figure 11a

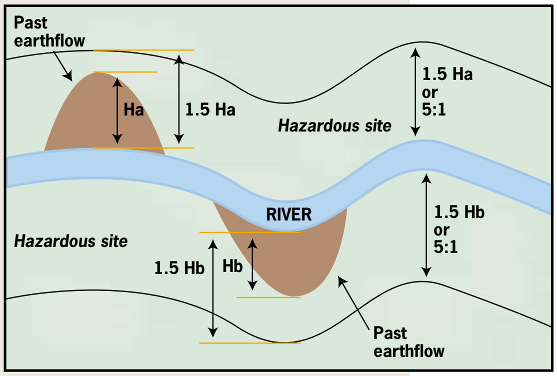

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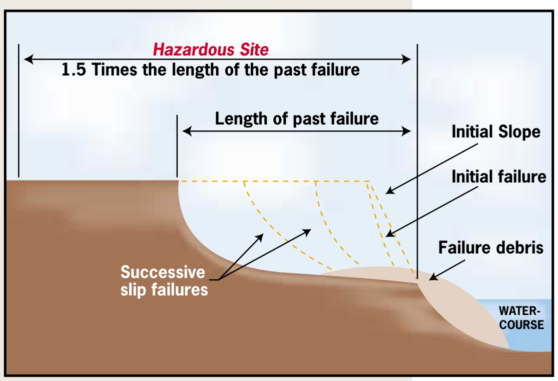
Figure 11b



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If there is no evidence of a previous retrogressive failure, calculate the hazardous area as **the horizontal allowance of five times the height of the slope measured landward from the toe of the slope OR as determined by a valid study. (Figure 12)**

Applying either of these approaches is only good for the first slope failure.

If another failure occurs, the allowances have to be re-calculated.

8.2 Unstable Soils: Organic Soils

Organic and peat soils are formed by humification, the decomposition of vegetative and organic materials into humus. This rotting process can release various humic acids to the ground water system and create methane gas, which is highly explosive.

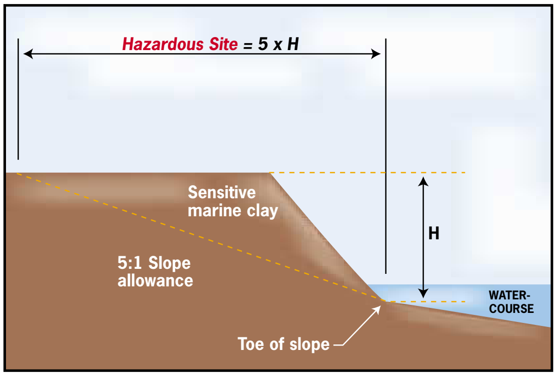
Is a soil organic? Determine the percentage weight loss of the soil when it is heated. If the loss is five to 80 per cent, the soil is organic—which means a wide variety of soils are organic.

Peat soils are the most common organic soil type. An estimated 25 per cent of Ontario's landscape is covered with peat soils. The problem with peat soils and other organic soils is they lack structure, erode easily and compress so much they usually can't support structures.

Because of their nature, defining "areas of provincial interest" for organic soils is site specific. It's not practical to prescribe just one approach because the size, extent and severity of potential hazards, such as structure collapse and methane gas escapes depend on local conditions.

For more information about organic soils and their location, consult staff at MNR field offices; maps available at Ministry of Northern Development and Mines offices; or the Geologic Survey of Canada.

Figure 12



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Typical features of Karst topography

8.3 Unstable Bedrock: Karst Formations

Unstable bedrock sites in Ontario are usually karst formations. Karst formations—named after the Karst region in Yugoslavia where these formations are common—are areas where water flowing over and through limestone and dolomite bedrock deposits creates sinkholes, trenches and underground caverns.

Karst formation character and size depends on how acidic surface water is, the rate at which the rock dissolves, number of fractures and fissures in the rock, distance the water will percolate from surface to water table and the presence of impermeable layers above or below the limestone/dolomite layers.

Karst formations, in which there are undetected sinkholes, trenches and caverns, are dangerous. In 1981, in Florida, the collapse and sudden appearance of sinkholes in a karst formation swallowed cars, pavement and entire homes.

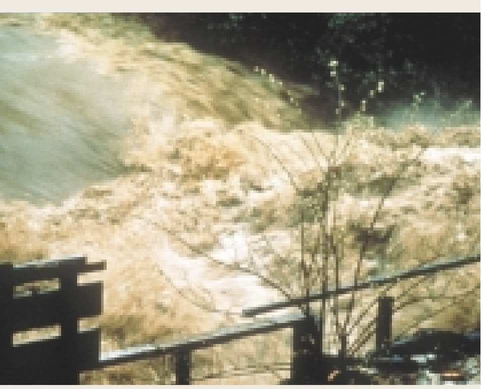
As with unstable organic soils, there is no one formula for defining a hazardous area associated with karst formations. Defining the "area of provincial interest" is a site-specific process. The size, extent and severity of the hazards depend on local conditions.

Karst formations are found in areas along the Niagara Escarpment, including the Bruce Peninsula, the Guelph/Rockwood/Elora area of Wellington County and in portions of eastern Ontario. See also the *MNR Technical Guide for Hazardous Sites (1996)*.

Limestone trench – Karst Topography

Dynamic beach

Connecting channel



Floodway

9.0

Addressing the Hazards

Policy 3.1.1 defines the areas of provincial interest and states that development shall be directed away from *hazardous lands* that are subject to natural hazards on the Great Lakes – St. Lawrence River System, Large Inland Lakes, rivers and stream systems and hazardous sites.

Planning authorities are required to "have regard to" these areas, and where these areas are presently not defined, studies should be undertaken to determine extent of hazardous lands in order to develop appropriate setbacks and management plans for these areas.

9.1 Where Development Must Not Occur - Policy 3.1.2

This policy identifies areas where development must not occur, because the risks posed to public health and safety cannot be appropriately addressed within a planning or engineering context. The areas defined in policy 3.1.2 would be considered "no development" areas.

No development should be allowed within the defined portions of a dynamic beach (Policy 3.1.2). And planning authorities should be very careful in defining what areas are dynamic beaches. They should consider many factors—physical characteristics, duration and frequency of flooding, accuracy of engineering studies, exposure to wave actions, wind patterns, and many others—and err on the side of caution.

Under Policy 3.1.2 (b), **development should not be allowed on defined portions of the 100-year flood level along connecting channels (St. Mary's, St. Clair, Detroit, Niagara and St. Lawrence rivers).** As with dynamic beaches, planning authorities should take the same care in defining the hazards in these areas and in considering all the factors. The cautions about protection structures also apply along connecting channels.

Under Policy 3.1.2 (c), **along rivers and streams, no development or site alteration should be allowed in the floodway.** The exceptions to this are; structures which by their nature must be located in the floodway (e.g. supporting structures for bridges); appropriate flood or erosion control works; minor additions or non-structural passive uses that don't affect flood flows; or if the area has been designed as a Special Policy Area (SPA).

9.2 Exercising Flexibility

Policy 3.1.3 is intended to provide some flexibility for municipalities in addressing or implementing policy 3.1.1. Policy 3.1.3 identifies the matters to be addressed should *development* and *site alteration* be considered within the "areas of provincial interest". The overall intent is to direct development away from these areas in order to lessen risks associated with

Protection structures: can mitigate some hazards. Care must be taken to ensure the structure address the problem and that the problems aren't transferred to neighbours.

hazardous lands, however, it is recognized that there are some circumstances where flexibility may be exercised provided that a number of conditions are met. The policy outlines these specific conditions. If a municipality is faced with a development proposal in a defined and known hazardous land as defined in policy 3.1.1 and is excluded from 3.1.2 then the development may proceed; provided that all these conditions are met in accordance to established and accepted scientific principles. The municipality ultimately reserves the right to approve the development in the first place.

It's tempting to contemplate development in areas where structures could almost eliminate risk. But past experience shows that many protection works and structures don't last, are expensive and can:

- Create new hazards
- Aggravate existing hazards on adjacent properties
- Cause environmental damages or destroy natural systems that protect other areas.
- Cost more than they are worth. The cost of maintaining protection works and replacing them continually increases. Many owners cannot afford to replace structure 20 years old—the average maximum length of time structures last.

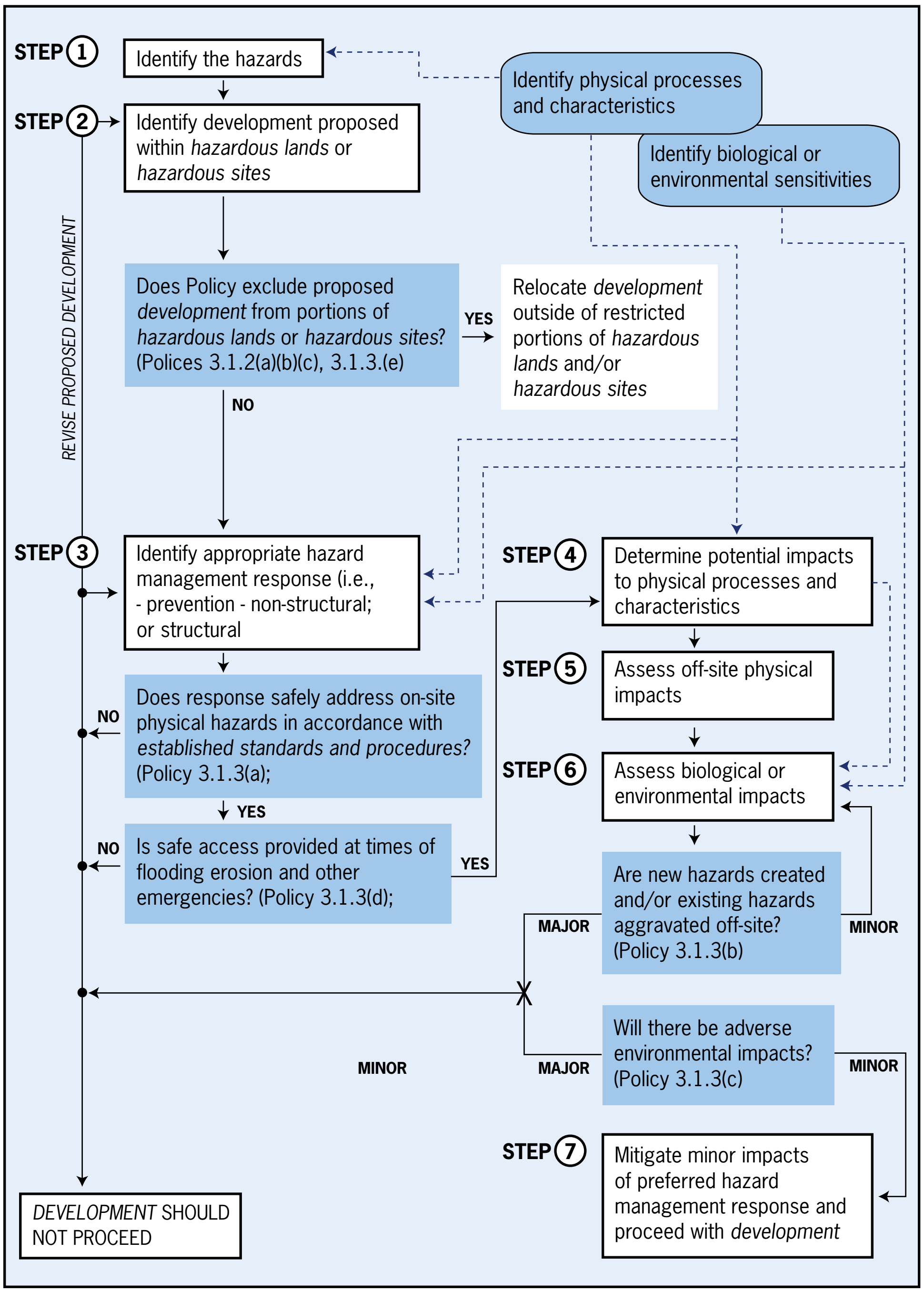
9.3 Seven Steps for hazard identification and management

This seven-step procedure focuses on basic questions and issues that should be addressed when planning authorities are reviewing a development proposal within hazard lands and hazardous sites. This is not quite a one-size-fits-all procedure because some hazards are more complex than others – for example, a shoreline subject to flooding, erosion and dynamic beach movement versus an isolated karst formation. So the level of evaluation should fit the size, severity and type of risks and the potential physical and biological impacts that may result. The seven steps are summarized in figure 13.

STEP 1 – Identify the hazards

What are the hazards and what are their boundaries? As already noted, hazardous lands include lands adjacent to the shorelines of the Great Lakes-St. Lawrence River system and large inland lakes which are impacted by *flooding, erosion and dynamic beach hazards* and lands adjacent to *river and stream systems* which are impacted by *flooding and/or erosion hazards*, and *hazardous sites*.

FIGURE 13 Suggested 7 Step Procedure: Addressing the Hazards



Know the physical process and characteristics (e.g. soils, seepage areas, erosion potential, etc).

STEP 2 – Identify the type of development within the hazardous lands or sites

Within the least hazardous areas, what kind of development is being considered? How big? This has to be defined because it will determine what protection will be needed.

Usually, development is either 1) multi-lot, large lot or large-scale development, 2) residential infilling, redevelopment, additions and alterations or 3) non-habitable buildings and structures.

Development and site alterations should not be permitted within *defined portions of dynamic beaches*, the *100-year flood level along connecting channels*, or in a *floodway*. Nor should institutional uses or essential emergency services or the disposal, manufacture, treatment or storage of hazardous substances be allowed within hazardous lands or sites.

STEP 3 – Identify appropriate hazard management responses

If development and site alteration is being considered within the least hazardous areas, they should be undertaken according to established standards and procedures with respect to floodproofing, protection works and access. These standards are further discussed in the Technical Guides referenced earlier.

Completion of this step usually requires in-depth knowledge of the site.

If the standards and procedures cannot be fulfilled, if the hazards cannot be addressed properly or if safe movement to and from the site can't be provided during emergencies, another hazard management response should be selected and/or the proposed development should be revised.

STEP 4 – Determine potential impacts to physical processes and characteristics

Will the development within the hazardous land or site affect the ecology of the area, create new hazards, or aggravate existing hazards? How will local conditions be changed by development? To complete this step, planning authorities must have through knowledge of the physical processes and characteristics of the area.

Assess off-site (e.g. upstream, downstream) physical impacts.

STEP 5 – Assess off-site physical impacts

Will the proposed development change conditions off-site? And how?

The physical impacts are usually either minor or major. Minor physical impacts are not serious, don't last long and can be mitigated by alterations in design or procedures. Major impacts have long-term and permanent adverse impact on the site and neighbouring areas. They can't be mitigated by design changes, timing.

Where new hazards are created or existing hazards aggravated, planners should 1) devise an alternative method of addressing the hazard, 2) revise the development or 3) not permit development.

STEP 6 – Assess biological or environmental impacts

Assess biological impacts (e.g. fish habitat).

In this step, planning authorities evaluate a site's biological or environmental sensitivities and consider how development will affect these values. How will construction affect the littoral zone of the lake, the walleye-spawning site, the dune ecology? Activities that result in the harmful alteration, disruption or destruction of fish habitat, and the discharge of deleterious substances into the waters frequented by fish can result in severe penalties under the *Fisheries Act*.

Environmental concerns should be a part of every facet of the development process. In the past, when impacts were overlooked, it was too costly, impractical or late to remedy or recover affected habitats.

Because events in one area affect other areas, planning authorities should consult with other agencies involved in ecosystem-based resource management to ensure that proposed development does not conflict with resource management in the surrounding landscape.

Planning authorities should evaluate the function and significance of the proposed development area as a habitat and then assess how susceptible the habitat is to disturbance.

Is the particular site part of an important and larger habitat system? Is the habitat a nesting area for endangered wildlife? Is it socially, economically or legally important?

What is the most environmentally-friendly way of developing a site with a hazard? Prevention is foremost as it encourages building in lands free from natural hazards and involves using other non-disruptive, low-impact techniques. Non-structural techniques provide opportunities to enhance environmental conditions, as when shorelines are stabilized with the planting of dune vegetation. Structural protection works have the potential of causing the greatest environmental damage.

How do you evaluate the biological impacts caused by various protection works? Consider the impacts using these criteria:

- **Importance of the site:** For example, many areas along the Great Lakes-St. Lawrence River system are habitat for endangered species, spawning areas, Areas of Natural and Scientific Interest, provincially and locally significant watersheds, Environmentally Significant Areas and Natural Heritage Areas.
- **Geographic extent of the impact:**
  On-site impacts can include:
  - Covering of aquatic plants and floors of lakes and rivers. Destruction of fish spawning beds.
  - Alteration of water levels that affect waterfowl nesting and fishes spawning.
  - Removal of shoreline vegetation that provides shade, bank stabilization and habitat for wildlife.
  - Removal of shoreline rocks, stumps and other material that provide shelter and feeding areas for fish.

Off-site impacts can include:

- Sedimentation of water
- Sedimentation along shore and over spawning beds
- Changes to underwater plant colonies and organisms

Know the importance of the site for other features, e.g.endangered species.

Soil bioengineering and biotechnical stabilization techniques can help mitigate some impacts

- **Duration of effect:** Planning authorities should consider three types of duration: short term (possible siltation of spawning beds), long-term (possible loss of a spawning bed by placement of a shoreline groyne); and post-design duration (when the structure has failed or no longer functions effectively, the environmental effects are hard to predict).
- **Recovery:** A small area of shoreline vegetation that was removed to make way for a road can be re-established fairly quickly, but the alteration of a drainage pattern to a wetland my be irreversible.
- **Mitigation:** measures can be used to alleviate or reduce environmental impacts. When these measures don't substantially reduce environmental impacts, compensation may be considered or required. As an example, the Federal Department of Fisheries and Oceans must approve compensation plans associated with the potential destruction of fish habitat.
- **Cumulative effects:** Although the environmental impact from development may seem small or minimal, the addition of this impact to all others being placed on a stressed ecosystem may have a serious cumulative impact. What is the cumulative impact on a site? It's a question planning authorities should be asking. Biological impacts can be major or minor. If a development can't be done in an environmentally sound manner, consider alternative works or cancel the development.

STEP 7 – Mitigate minor impacts of preferred hazard management response

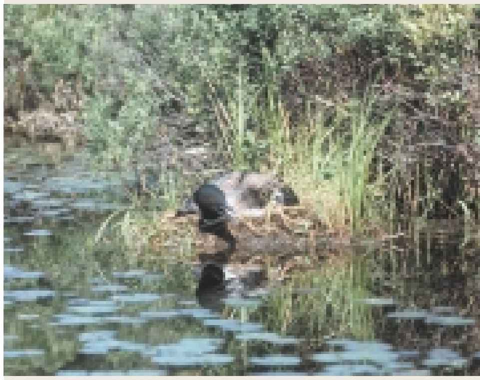
The proposed development and site alteration may proceed where all of the matters outlined in Policies 3.1.2 and 3.1.3, as outlined in Steps 1 through 6, and any minor impacts are mitigated by alterations to the design and/or to the timing and method of installation.

10.0

Ecosystem based planning and Management

Natural hazards are really the result of naturally occurring physical and environmental processes that can result in disaster, particularly if human activities interfere with these processes. Because these are environmental processes, largely influenced by climate and geology, that do not respect municipal or political boundaries, they are best planned and managed for on an integrated or ecosystem based approach.

Hazardous lands on the Great Lakes – St. Lawrence River System (and large inland lakes) which are subjected to flooding, erosion and dynamic beaches are best addressed through integrated shoreline management and planning.



Ecosystem based planning approaches provide a basis for managing and protecting important watershed and coastal values

Hazardous lands adjacent to rivers and stream systems, subjected to flooding and erosion are best addressed through watershed or subwatershed management and planning processes.

The PPS outlines the provincial interest in protecting public health and safety, and provides direction on how this is to be achieved through Policy 1.1.1(e).

A coordinated approach should be achieved when dealing with issues which cross municipal boundaries, including:

2. ecosystem and watershed related issues; and
3. shoreline and riverine hazards

And (f):
Development and land use patterns which may cause environmental or public health and safety concerns will be avoided.

Conservation authorities have a long history of managing natural hazards on a watershed basis. In addition, following the 1985-86 high lake levels on the Great Lakes, conservation authorities have been delegated with responsibility for land use planning and management associated with hazardous lands on the Great Lakes. General guidance for preparing watershed and subwatershed plans as well as integrated shoreline management plans is available in the following documents:

- *Watershed Management on a Watershed Basis: Implementing an Ecosystem Approach, June 1993, MOE/ MNR*
- *Subwatershed Planning, June 1993/MNR*
- *Integrating Water Management Objectives into Municipal Planning Documents, June 1993, MNR*
- *Guidelines for Integrated Shoreline Management, 1987, MNR*

Potential climate change impacts, coupled with population growth and urban expansion require adoption of strategic approaches to ensure that natural hazards become an integral component of society's approach to living with the natural environment and cooperating with it rather than trying to control it. Moving toward the creation of sustainable communities and disaster-resilient communities allows society to increase preparedness and better mitigate against future natural disasters.

11.0

Adaptation

It is safe to conclude that there is a general perception amongst the public that severe weather events and the occurrence of more frequent, intense rainstorm activity is increasing. The state of the science concerning the potential impacts to Ontario's hydrological regime is evolving, however, current information and evidence seems justify public concerns and potential risks to society.

Certainly, Ontarians have experienced extreme weather events in the past, such as the Hurricane Hazel Storm. This storm event was the largest 12-hour rainstorm ever recorded in Ontario up until 1954. The storm was centred over the Humber River in Toronto and affected a 30,000 square kilometer area, dumping over 280 mm of rain in a 2 day period, resulting in the loss of 81 lives and incredible damages to property and infrastructure. Statistically, it is unlikely that such a large rainstorm could occur again, however it remains a possibility. As an example, the Harrow Storm occurred in 1989 over the Town of Harrow in Essex County in southwestern Ontario with a total recorded amount of 450 mm of rain that fell in less than 36 hours. The rainfall event exceeded the Hurricane Hazel Storm, and resulted in close to 100 million dollars of damage.

Many communities in Ontario with flood risks have been mapped and designated as flood risk areas. While these maps and designations provide useful tools to assist municipalities in making planning decisions, they are by no means static and stable over the long term. Increasing urban development, changing land uses, new construction, bridges and other constriction points and infilling result in changes to the hydrolologic regime. Any long term change in climate will also result in a change to the hydrology of the system. Flood risk maps therefore, will need to be updated to account for these changes.

Impacts to Ontario's Great Lakes shorelines, waterbodies and river and stream systems from potential climate change scenarios are not explicitly considered within the Provincial Policy Statement and the application of the Natural Hazards Policies. However, climate change does require new management considerations, and long term adaptation strategies will be needed to address potential changes in precipitation and discharge patterns.

Current projections indicate that, in general, Ontario's total mean annual precipitation will not change, but precipitation patterns will include an increased occurrence of high intensity rainfall events followed by longer periods of dry weather (Environment Canada, 1998). Stream systems may be affected by the increased sporadic flows that are associated with high intensity rainfall events and can increase the potential for localized flooding, stream bank erosion and slope failures. Identifying and protecting river and stream systems and coastal areas from infringement is not only a means of reducing risk to loss of live and property damage, but an example of a good adaptation strategy, allowing for well planned future growth opportunities in many communities.

12.0

Implementation

Recent planning reforms have streamlined the planning system into a "one-window" process. Municipal planning decisions are guided by the policy direction in the PPS, as opposed to comment and input received from each Ministry

Implementation of the Provincial Policy Statement is achieved through the Ministry of Municipal Affairs "One Window Planning Service". Conservation authorities where they exist have been delegated sole commenting responsibility for the Natural Hazards Policies. Depending on the nature of a proposal, approvals or work permits may be required by other agencies. The Ministry of Natural Resources administers the *Lakes and Rivers Improvement Act* and can issue a work permit, approving the location of the work as well as the plans and specifications. If a proposal involves public lands, the *Public Lands Act* may also apply. In addition, conservation authorities administer the Fill, Construction and Alteration to Waterways Regulations under the *Conservation Authorities Act*.

Where information does not exist concerning location of defined hazardous lands, planning authorities are advised to undertake studies to identify potential risks from natural hazards. Such studies are normally undertaken by accredited engineers in the consulting community, in accordance with guidance provided in the suite of natural hazards technical guides.

In many areas of Ontario, particularly where there are conservation authorities, there is a long history and tradition of natural hazard management. Hazardous lands are well defined, understood, managed, and included in watershed management strategies, subwatershed plans, official plans and zoning by-laws. The PPS is not intended to displace current strategies in place, which aim to protect public health and safety from natural hazards. Existing local policies, strategies and approaches have been developed, based on local studies, taking into account physical processes, land use development, social, economic and environment issues. In these areas, planning authorities, together with the community and other stakeholders may wish to re-examine current strategies, to ensure consistency with provincial policy, and if deemed necessary, undertake steps to update local initiatives.

13.0

Summary Statement

The Natural Hazards policies (3.1) speak directly to achieving the 3rd principle of the PPS of the *Planning Act*, aimed at protecting public health and safety and reducing risks to loss of life and property damage. The province, as well as local governments, are often asked to compensate residents and communities, through disaster relief payments for losses incurred as a result of natural disasters, such as floods, erosion and slope failures. The province, through the PPS has delegated responsibility for public health and safety from natural hazards to local planning bodies. These agencies are responsible for the identification of hazard lands and adoption, of land use planning mechanisms to prevent risks from inappropriate or unsafe development in these lands. All citizens and governments have a role to play in reducing risks to loss of life and property, and preventing tragedies from occuring.