# Forest Sciences

## Prince Rupert Forest Region

*Extension Note # 19*
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## Assessing Gullies

**Research Issue Groups:**

- Forest Biology
- Forest Growth
- Soils
- Wildlife Habitat
- Silviculture
- Ecosystem Inventory and Classification
- Biodiversity
- Ecosystem Management
- Hydrology
- Geomorphology
- Extension

### Introduction

Gullies are features found on hillsides and are characterized by a catchment area and steep sides, and generally (but not always) by a steep headwall and a fan. They are formed by erosion, and can be a hazard for forestry operations, regardless of where they are located in British Columbia. The Forest Practices Code (FPC) recognizes gullies in **coastal** districts and calls for the Gully Assessment Procedure (GAP) to identify the potential for debris flows and debris floods. This Extension Note provides some background on the GAP and a framework for assessing gullies in **interior** districts.

### Gullies - a definition

Gullies are erosional features caused by combinations of: channeled surface water; subsurface water; and mass wasting processes. Characteristically, gullies have steep sideslopes, but beyond that, many other features such as gradient and the presence of streams can vary significantly. They are common features throughout British Columbia and are found in a range of materials and landscape positions. They can be found on the edges of outwash terraces; in deep glacial morainal, colluvial, marine, and glaciomarine deposits; and carved into bedrock on hillsides. Gullies are still developing in some cases, and in others they represent relict erosional features from immediate post glacial times.

The type of gullies assessed using the GAP are hillside gullies that are cut into bedrock or surficial materials. Specific criteria are used to define the features of these gullies, such as slope angles, depth and length, and potential downstream impact.

### The GAP - an overview

Details of the GAP are presented in the FPC guidebook. This section provides an overview of the procedure. The GAP has both technical and management aspects. The technical aspects of the GAP are based on research in coastal BC,

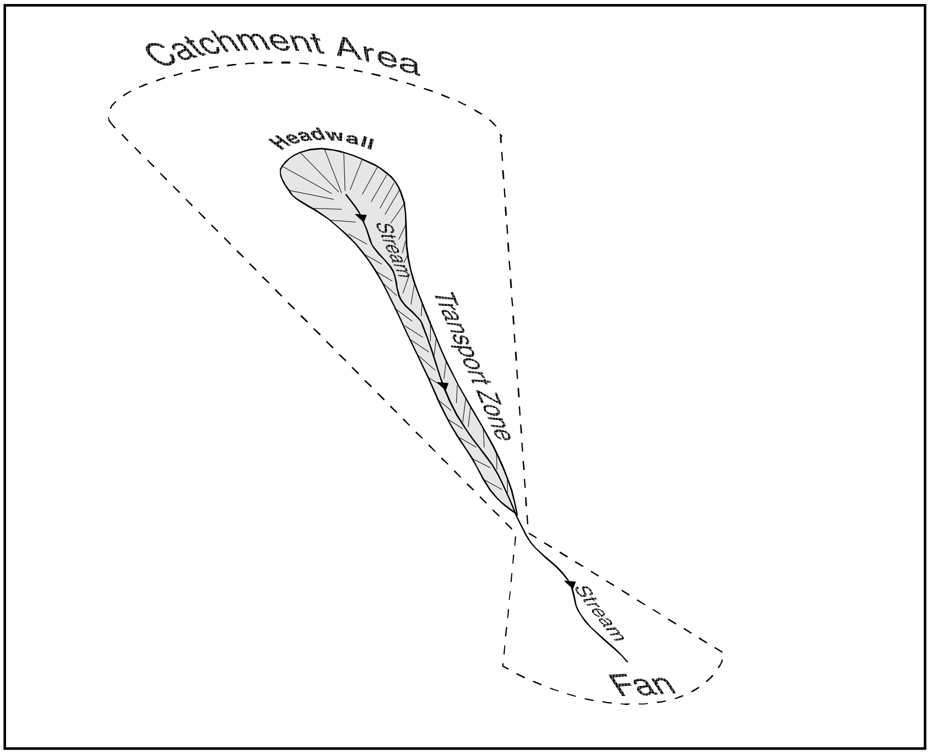


***Figure 1. Components of a gully system.***

primarily the Queen Charlotte Islands, and the management aspects are based on operational experience from throughout the coast. While there has been operational experience with gullies in the interior of BC, the research hasn't been done to support a quantitative gully assessment procedure.

The GAP identifies gullies as systems, with four components: a catchment area, a steep headwall, a transport zone, and a fan. Gully systems always have a drainage area and a transport zone. Fans may not be present if the transport zone directly enters a larger stream (the fan materials are constantly eroded). Headwalls may not be present in broken or benched terrain. Aspects of all four components are assessed for hazard potential.

The GAP was designed to identify the level of hazard in a gully system with regards to debris flows and debris floods. Debris flows, commonly called debris torrents, are rapidly moving channelized landslides containing a mixture of fine and coarse sediment, woody debris and a moderately high water content. They frequently scour the gully transport zone to bedrock. They can be initiated by a landslide from the adjacent open slopes (within the catchment area), from the gully headwall or sidewalls, or from within the gully transport zone channel itself (mobilization of a debris jam). Debris floods are essentially major runoff events that move streambed materials (including boulders) and organic debris.
The hazards for debris flows and debris floods are determined following both office and fieldwork. The hazard assessments are then used to develop management strategies, that cover pre- and post-logging activities, including restoration prescriptions.

The GAP is an effective tool for recognizing and managing most aspects of debris flow and debris flood hazards in gullies. However, some aspects of these erosional processes are not included. In addition, there are other erosional hazards associated with gullies that are not assessed by the GAP.

### The GAP - What's missing

The GAP does not include **roads** as an aspect of debris flow or debris flood initiation, their potential contribution to the volume of material involved, nor does it include an assessment of **surface erosion** or **snow avalanches**.

All elements of a gully system can be challenging for road layout, design, construction, maintenance and deactivation: fans; transport zones; headwalls; and open slopes leading into gullies.

Fans can be geomorphically active with channels changing course as materials are brought down through the transport zone. It is not uncommon for roads on fans to have drainage structures that are high and dry, and road segments that are eroded and under water. While site features of fans are assessed in the GAP, fans cannot be assessed in isolation - they are a product of the gully system as a whole.

Transport zones generally have steep sidewalls and gradients, and for roads to cross them generally requires both cuts and fills. Transport zones are so named because they transport water and material - bedload, eroded sidewall material and woody debris. Road drainage structures characteristically are designed to carry anticipated water flows, not bedload and debris. Research indicates that debris flows can have a volume 10 times larger than a water flood. As a result, drainage structures can plug and initiate, or exacerbate, debris flows or debris floods.

Most road layout people recognize the hazards of building roads across gully headwalls - the steepest sections of gully systems. However, due to alignment and grade challenges, construction still occurs. Unless special construction measures are taken, the result is usually the initiation of debris flows.

Open slopes leading into gullies can influence gully hazards in two ways. Failures from roads or logged unstable slopes can enter transport zones, initiating debris flows. Surface and subsurface water intercepted by the road system can be routed directly to the transport zone, causing significant increases in flows, and thus initiating debris flows and floods. The re-routing of water is most pronounced when water is “pirated” from other streams and drainage areas (this can happen both during construction and by inappropriate deactivation of roads).

Surface erosion in gullies can be a significant issue, particularly in fine textured soils. The sidewalls and headwalls are usually very steep, and if soils are exposed they will erode. Once in suspension, sediment deposition in transport zones is very limited due to gradient and water power. Since surface erosion doesn’t directly cause debris flows or debris floods, hazards due to exposed soils are not considered by the GAP. But surface erosion can be a very significant issue in fisheries sensitive stream systems.

Another feature that the GAP does not address is snow avalanching down gully transport zones. Snow avalanches can mobilize inorganic and organic material, leaving similar scour patterns as debris flows. Snow avalanches can also present challenges for road drainage structures.

## Using the GAP as a framework for interior gully systems

The GAP is based on coastal data and management experience. Using the tables in the GAP for interior locations could misrepresent the hazard for debris flows and debris floods. There are several reasons for this. In general, interior locations do not experience the intensity and duration of coastal rainfall events that trigger open slope debris slides, and debris flows and debris floods. As a result, in the interior slopes within a gully system may be steeper, yet stable. Aspects of water transport potential are based on catchment area size, and for the coastal situation this was determined primarily from data on rainfall generated peakflows, not spring radiation snowmelt peakflows. Given differences in peak streamflow generation and slope stability, it is likely that the link between gully geometry and the potential for debris flow initiation is also different between the coast and the interior.

However, the strength of the GAP is that gullies are assessed as systems. What happens in the catchment area and headwalls can directly influence the transport zone, and hence the fan. The linkages are strong, and often immediate.

When planning activities near interior gullies, think gully system when you are making prescriptions for road layout and design, road construction (including drainage structures), logging, post logging debris cleanout or road deactivation.

The relative elements of the GAP are important to bear in mind, even if the absolute numbers aren’t relevant. In particular, downstream values, use of terrain stability maps, water transport potential, and fan destabilization must be considered. The input of sediment from gully wall failures and basic gully geometry are also important factors.

Look to other logged gully systems in the area to develop a sense of what hazards can be. If you sense the hazards are high, call in a qualified geoscientist or engineer.....and join them in their fieldwork.

**Recent positive developments for the Gully Assessment Procedure.**

Several gully research projects have recently been funded by Forest Renewal BC. These projects will provide the GAP with a road assessment component and a refinement of the debris flow initiation potential. Results from the road component will be of direct value to the Watershed Restoration Program and should provide valuable insights for roads crossing interior gully systems.

## Conclusion

The Gully Assessment Procedure is a valuable tool for assessing debris flow and debris flood hazards on the coast. A major strength lies in assessing gullies as systems. Weaknesses in the GAP are that roads are not included as an initiating factor and that surface erosion is not considered.

The approach used in the GAP - treating gullies as systems - is valuable when assessing interior gullies.

*Note:*
*A one and a half day training course on the Gully Assessment Procedure is offered through the BC Forestry Continuing Studies Network. This course is valuable regardless of where in the province you are faced with managing gullied terrain.*

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**Suggested Reading**

Anon. 1995. Gully Assessment Procedures Guidebook. Forest Practices Code. B.C. Min. For. 40p.

VanDine, D.F. 1996. Debris flow control structures for Forest Engineering. Res. Br. B.C. Min. For. Victoria. B.C. Working Paper 22/1996