



Debris Flow Hazards in the District of North Vancouver

District of North Vancouver, North Vancouver, B.C.

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On November 23, 1995, a significant debris flow occurred at Upper Mackay Creek in the District. This event involved a surge of about 7,000 m³ of debris (rocks, soil and organic matter) into the residential area of Ranger Avenue during a heavy rainstorm, resulting in considerable damage to homes, property and District infrastructure. While debris flows have been identified as a hazard on steep creeks in southwest BC since the late 1970s, this event was the first recorded debris flow to affect a developed area of the District.

District's Debris Flow Program

Following the 1995 Upper Mackay Creek debris flow, the District initiated a comprehensive debris flow program. The first step involved mitigating the hazard at upper Mackay Creek by restoring the creek channel, completing a detailed creek study, and constructing a 13,000 m³ debris basin. These works were completed in 1996/97 at a cost of almost \$2 million.

The second step in the program involved completion of an overview study of debris flow hazards to identify risks on other steep creeks in the District. This study culminated in publication of the Overview Report on Debris Flow Hazards (Kerr Wood Leidal Associates and EBA Engineering Consultants) in April 1999. The Overview Report identified thirteen creeks in the District having a very high or high risk. While debris flows were the primary focus of the study, debris floods were also considered.

Detailed Debris Flow Studies

Kerr Wood Leidal Associates completed the detailed studies of the highest risk creeks over a period of several years. The study details are contained in ten individual reports that were published in January 2004:

Grouse Mountain Zone

- Mackay Creek (including Grouse Creek)
- Mosquito Creek

Deep Cove Zone

- Deep Cove Creeks (Panorama Creek, Matthews Creek, Gavles Creek, Cove Creek, Cleopatra Creek, Martin Creek, Francis Creek)

Indian Arm Zone

- Ostler Creek and Allan Creek
- Sunshine Creek and Scott-Goldie Creek
- Percy Creek and Vapour Creek
- Shone Creek
- Holmden Creek
- Coldwell Creek and Friar Creek
- Clegg Creek

What is a Debris Flow?

A debris flow is a form of channelized landslide that may occur during unusually wet weather on a steep mountain creek with abundant debris sources. A debris flow can reach a speed of 40 km/h, carry car-sized boulders, and have a volume of many thousand cubic metres. A debris flow may also have a peak discharge that is up to 50 times higher than a peak flood event. Debris flows pose a significant hazard to development located near a creek channel or on a creek fan.



Upper Mackay Creek Debris Basin

What is a Debris Flood?

A debris flood is a water flood with an unusually large amount of sediment and/or wood debris. In general, debris floods are considered less hazardous than debris flows, but more hazardous than water floods.



Boulders Transported by Debris Flow

Hazard, Consequence and Risk

The detailed studies provide a comprehensive assessment of the hazards from debris flows and debris floods for each creek. The hazard is expressed in terms of probability and magnitude. Probability is an indicator of how often a debris flow or debris flood of a particular magnitude is expected to occur. Magnitude refers to the size of the event in terms of total volume and peak discharge.

The design event is a 500-year return period debris flow or debris flood. Such an event will, on average, be equaled or exceeded once in any 500-year period. Put another way, within any 50-year period there is a 10% chance that a 500-year return period event will occur.

For each creek, the potential consequence of a debris flow and/or debris flood is also assessed. This refers to the assets that may be damaged during the design event (typically buildings, roads and infrastructure). The level of risk is then rated as a combination of hazard and consequence, recognizing that both factors are necessary to give rise to a significant risk. Virtually all of the study area creeks exceed the target level of risk and would require at least some mitigative measures to mitigate the risk.



Debris Source Area



Unstable Channel



Creek Fan

Mitigative Measures

Mitigative measures may include land use planning, warning systems, mitigation structures, and creek management measures. Land use planning is particularly valuable in ensuring that new development either avoids natural hazard areas, or includes an adequate degree of protection. Warning systems may have a role to play in certain situations, but is not generally appropriate as a primary mitigative measure. In most cases, adequate mitigation involves some form of mitigation structure.

Types of Mitigative Structures

- a debris basin or debris barrier to intercept and contain a debris flow above the developed area
- channelization works to 'funnel' a debris flow through a developed area
- a deflection berm to divert a debris flow to an undeveloped area where it will not cause damage
- creek works to stabilize a creek channel through a critical area

To mitigate the identified risks on the study creeks within the District, the reports review potential mitigative measures for each creek. Some possible alternatives have been identified, including conceptual designs and preliminary construction cost estimates. Where appropriate, the most promising alternative has been identified, however, this is subject to consultation with District departments, land owners, government agencies and other stakeholders. The District is now initiating such consultations, and will report to Council regarding program options when this has been completed.

Further Information

The detailed study reports can be viewed at the District libraries or downloaded from the District's web page at www.dnv.org. Comments can be submitted to the District by e-mail at debris_flows@dnv.org.