456

JAN/13/00

Detailed Avalanche Map Study, Edelweiss Drive: Hemlock, Valley, B.C.

David McClung, Ph.D., P.Geo.
D&E McClung Enterprises Ltd.

Introduction

This study provides detailed mapping and information on avalanche hazards for portions of Hemlock Valley. This study follows the first stage preliminary map and information contained in the report compiled by Thurber Engineering Ltd. in early 1999. The present study contains more detailed information about avalanche zoning mapping as a complement to the previous study. The basic conclusions and information in the first study are not altered here but more information (and more detail) is provided and recommendations are given. The earlier study was based on drawing an avalanche hazard line (expected return periods for avalanches in the range 300-500 years.)

The areas studied here are all on the slopes of Mt Keenan. The sub-areas are grouped in three parts proceeding from south to north:
1. the area around the sewage lagoons off of the southeast slopes of Mt. Keenan
2. further north along Snowmist Drive and at the cul-de-sac at Snowmist Place 3. the area along Edelweiss Drive from southwest to north east from where it intersects the Hemlock Valley Road to its terminus in the north.

Observations and methods

The conclusions in this report are based on:

1. state-of-the-art modelling for return period determination based on statistical scaling of runout (McClung, 2000), extreme runout distance measurements from the coast mountains (Nixon and McClung, 1993) with scaling adapted from start zone locations at Mt Keenan and the terrain profiles below the start locations

2. extensive field investigations (4 complete days in the field) including walking through almost the entirety of the terrain below Mt Keenan for the three sub-areas including observations of forest cover, avalanche penetration -not visible from air photos- and terrain to help locate "islands of safety" in the terrain

32

3. observations of the area with snow on the ground including locations of avalanche deposits and damage from avalanches for the winter of '98-'99.

4. extensive historical air photo searches

5. an interview with a local resident who witnessed and filmed avalanches from Mt Keenan in the winter of '98-'99.

6. an interview with Brad Buck: avalanche forecaster at Hemlock Valley Ski Area

Results by sub-area

Risk zone and mapping scheme for Edelweiss Drive, Hemlock Valley

For Edelweiss Drive, a map was produced with the following scheme.

RED: Terrain in the potential runout zone of an established avalanche path or runout below steep terrain with a potential start zone unaffected by forest cover. Effects of avalanches are possible with significant destructive potential.

BLUE: Terrain subject to small avalanches either running through forest cover to reach the unforested slopes above Edelweiss Drive or area with potential for small avalanches initiating on the terrain immediately above Edelweiss Drive. Avalanche effects likely but rarely occurring and expected avalanche sizes small.

YELLOW: Terrain which is shielded from avalanches either by terrain features or protective forest cover. Alteration of forest cover by human or avalanche effects could result alteration of these areas. Avalanche effects unlikely but possible.

NOTES on MAP: Any area not coloured by one of the three described (white areas) above has not been mapped. Map zoning accuracy decreases with distance above Edelweiss Drive because emphasis was placed on possible building sites and residential areas adjacent (above and below) to the road.

Equivalent colour coding for Sewage Lagoon Area and Snowmist Drive Area

A colour coded map was not made for these two areas. However, with respect to the detailed map along Edelweiss Drive, equivalent colour codes can be specified for the Sewage Lagoon area and Snowmist Drive/Snowmist Place. These are:

Sewage Lagoon area: RED and Snowmist Drive/Snowmist Place: YELLOW. These specifications are consistent with the reports of Mears (1982) and Stethem (1980).

1. Sewage lagoon area: colour code RED

This area is essentially all subject to avalanche penetration on short enough time scales to designate it a RED zone: expected return periods less than 30 years. Any further building in this area should take into account design impact forces (including possible powder component for dry avalanches). Stethem (1980) made a report on possible impact forces for the existing building north of the lagoons. An avalanche penetrated the fence upslope of the lagoons during winter of '99 and ran into the lagoons.

2. Snowmist Drive area including Snowmist Place: colour code YELLOW.

This area sits under the largest avalanche path of any in the study area. Theoretical estimates show that it is possible for avalanches to penetrate for very long return periods as far as the cul-de-sac. A small avalanche penetrated to within 150 m of the cul-de-sac during the winter of '99. There are, however, three important mitigating effects which make the area safe for building: 1. the historical sequence of airphotos [beginning with 1954 before the area was logged (1963)] shows no large avalanches have penetrated close to the cul-de-sac 2. the forest cover has returned well since 1963, even though it is not yet in a state as it was prior to logging 3. the slope of the ground (downslope) is not high: mostly less than 10^0 and the distances are long :implying that significant speed reduction will occur for avalanches penetrating the area upslope of Snowmist Drive. In order for avalanches to penetrate as far as the cul-de-sac or Snowmist Drive, most likely an initial large avalanche would be needed to destroy part of the forest cover and a second might be required then to penetrate further. Based on the evidence, this is unlikely, and the area is relatively secure for building. Building in this area should be permissible without consideration of avalanches unless the state of the forest cover changes: for example by an initial large avalanche.

Additional notes:
1. The ground slopes gently southward upslope of the cul-de-sac but this would not be significant for a large avalanche.
2. The conclusions above agree with the report of Mears (1982) but not with the report of Freer (1981). The latter prescribes a red zone (equivalent to Swiss definition) at the southern end of Snowmist Drive. The present report and the

report of Mears (1982) suggest no restrictions on building for this area.

3. Edelweiss Drive along its entire length: colour codes as on map

This area consists of a complicated series of problems. The variables are with respect to possible avalanche threats are : a. varying scale (vertical relief, horizontal reach) b. varying sizes and destructive potential (start zone size and steepness) c. varying state of snow cover in start areas d. natural protection from terrain features. e. existing state of return of forest cover varies considerably from south to north.

In order to deal with the complicated pattern of different states of forest cover, possibility of large or small avalanches and terrain a simple risk-decision matrix was developed with the following parameters:
1. avalanche start size: small or large -defined by start zone size
2. forest cover: minimal or adequate protection against small avalanches
3. terrain shielding* effects: non-existent or present

*(terrain shielding means, for example : ridge which can act as natural deflector limiting lateral movement of avalanches, rock bluff which shields terrain below)

4. terrain scale: potential vertical fall of avalanches or horizontal reach to runout zone from potential start position

Detailed description along Edelweiss Drive

Edelweiss Drive: Southeastern portion from start to Larkspur Road

The southeastern part of the terrain above Edelweiss Drive from start to intersection with Larkspur Road generally has steeply sloping terrain (in excess of 15^0 or 25%) which can allow even small avalanches to continue running once they hit the area logged in 1963. Further, much of the terrain has not had adequate return of forest cover to a state which can provide protection against avalanches. These facts, coupled with the Maritime snow climate at Hemlock valley (frequent deep snow) and terrain steep enough for avalanches to start and keep them running combine to work against recommendations for construction of facilities. Inspection of the terrain in this section (southern portion until Larkspur Road) has shown two established avalanche paths (mapped by Mears in 1982) and another small avalanche path, previously unreported (discovered in September, 1999), which

penetrates to about 20 m below the old logging road (now a cross-country ski trail in winter) just south of the condominium near the intersection at Larkspur Road. The more northerly of the two avalanche paths mapped by Mears ran during winter of '98 - '99 to about the same distance below the old logging road: 20-30 m below it. This and the path discovered in September '99 provide clear evidence of the distances small avalanches can penetrate above Edelweiss Drive.

For the terrain above Edelweiss Drive in this section (start to Larkspur Road), no terrain was found which can be said to be free of avalanche potential except a 100 m strip (see map). This section is shielded by a ridge above which would imply only small avalanches could reach the area and the protective forest cover would be sufficient to stop such small avalanches. However, removal of forest cover at the site (as would most likely happen if building took place) would increase the risk to an unacceptable level. With the forest cover in place above the road, the 100 m strip below the road would be suitable for construction without building restrictions. This is due to a combination of two factors mitigating risk: expected avalanches would be small due to terrain shielding by a ridge and the presence of the forest cover above the road.

For the terrain spanning the intersection with Larkspur Road, one other area is deemed to have low avalanche risk. This area is behind a rock bluff above Larkspur Road. The area includes: the northwestern 20 m of the condominium just south of Larkspur Road and continues past Larkspur Road to the northerly edge of the first house (below Edelweiss Drive) past the corner of Larkspur and Edelweiss Drive Edelweiss Drive. The terrain both upslope and downslope of Edelweiss Road should be free of avalanche hazard except possibly small sluffs on the uphill section of the road coming off the steep rock bluff which provides the protection against larger avalanches.

Areas northwest of Larkspur Road but along Edelweiss Drive

This area contains one section which should be reasonably free of avalanche risk due to protective forest cover and favourable terrain above. It includes the area occupied above the road by two of the last three houses above the road on the northwestern section of Edelweiss Drive but it does not include the last (furthest northwest) section of Edelweiss Drive. Avalanche potential should be low through this section above and below the road provided no alterations take place to the

Recommendations:

The recommendations provided in this report pertain to snow avalanche hazard potential in the residential areas of Hemlock Valley. Hazard assessment within the ski area and other areas not potentially in residential zones are excluded. The original study (Thurber, 1999) contains an avalanche hazard line (AHL) for expected return periods of avalanches on the order of 300-500 years based on terrain and air photo analysis and field inspection. Due to lack of avalanche occurrence data for the study area and the complexity of the range of problems and variables involved, the AHL has considerable uncertainty. The present study, is intended to provide more detail with definition of hazard zones categories as described above and recommendations for the categories given below.

Since there is a range of different types of problems within the coloured zones on the map accompanying this report, it is not possible to give more site specific recommendations for the map colours. Variables include: avalanche size, avalanche path scale (vertical drop and horizontal reach), slope angles and state of return of the forest cover. It is therefore, recommended that slopes above and below Edelweiss Drive within the coloured (RED,BLUE,YELLOW) zones be evaluated individually by a qualified professional (P.Geo. of P.Eng.) with avalanche experience prior to issuing of a building permit. Currently in Hemlock Valley, under section 699(5) of the Municipal Act, a building inspector may request a geotechnical report prior to issuing a building report to ensure the land is safe for the use intended and evaluation by a qualified professional, as described above, is equivalent to such a geotechnical report.

Specific recommendations

1. Building is not recommended on the slopes above Edelweiss Drive except for Yellow Zones (Yellow zone is described above with qualifiers).

2. In regard to forest cover, it is recommended, in general, that no forest cover be removed should building or construction activity be attempted above Edelweiss Drive. This includes parcels within sub-divided boundaries. Such action could have two undesirable effects: 1. forest cover protection for the contemplated construction site could be gone and 2. forest cover protection for property downslope (below the road) would be jeopardized.

Recommendations by colour code (please note descriptions of zones above)

YELLOW: Building permitted provided protective forest cover not altered.

BLUE: Further building possible but not recommended. Detailed site evaluation required and possible mitigation methods must be evaluated.

RED: Further building not permitted without avalanche protection.

Note: Any alteration of forest cover by human or natural effects, including avalanches, will result in re-definition of map zones.

References:

Freer, G. 1981. Snow avalanche hazard- Hemlock Valley, B.C. B.C. Ministry of Trans. and Highways, 5 pp.

McClung, D.M. 1999. Overview avalanche hazard assessment: Hemlock Valley, British Columbia in report submitted to FVRD by Thurber Engineering Ltd.

McClung, D.M. 2000. Extreme avalanche runout in space and time. Canadian Geotechnical Journal.

Mears, A.I. 1982. Avalanche hazard analysis and land-use recommendations at selected portions of Hemlock Bowl British Columbia, 10 pp.

Nixon, D.J. and D.M. McClung, 1993. Snow avalanche runout from two Canadian mountain ranges. Annals of Glaciology 18: 1-6.

Stethem, C. 1980. A report on destructive potential of avalanches at Hemlock Valley sewage treatment plant, 8 pp.