SNOW AVALANCHE
MAP AMENDMENT
REPORT

for

VAIL MEADOWS
AVALANCHE PATH
VAIL, COLORADO

Prepared for:

Mr. Rick Schierberg
Peregrine Group Development
1400 16th Street, Suite 400
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Prepared by:

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and

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February 1, 2019

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February 1, 2019

Mr. Rick Schierberg
Peregrine Group Development
1400 16th Street, Suite 400
Denver, CO 80202
Via email

RE: Snow Avalanche Map Amendment Rport
5002 Snowshoe Lane, Lot: 23 Vail Meadows F1, Vail, Colorado

Dear Mr. Schierberg:

This report presents a summary of data and analyses in support of amending the Snow Avalanche Hazard Zones for the referenced site. This report is based on new snow, weather and avalanche data, as well as advances in terrain analysis and avalanche dynamics modeling methods. The recommended avalanche hazard map is shown in Figure 9.

If you have any questions, please contact me at (970) 275-1548 or Chris Wilbur at (970) 247-1488.

Sincerely,

Arthur I. Mears, P.E.
Avalanche-control engineer

Contents

Figures

1. Introduction

Figure 1 shows the original avalanche hazard map for the East Vail area prepared by Art Mears in 1975 (Ref. 1). The Vail Meadow avalanche path is labeled number 1. The town of Vail's official avalanche hazard map shows High, Moderate and Avalanche Influence Zones (Figure 2). The official map appears to be consistent with an avalanche study by Hydro Triad in 1977 (Figure 3 from Ref. 2).

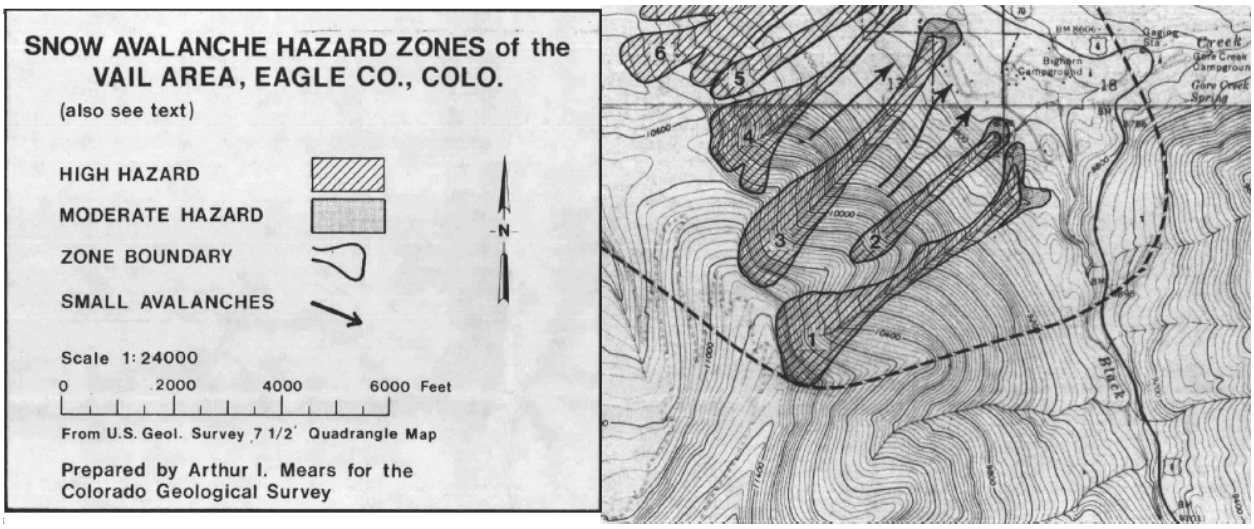

Figure 1 – 1975 Avalanche Hazard Map
(Source: Ref. 3)

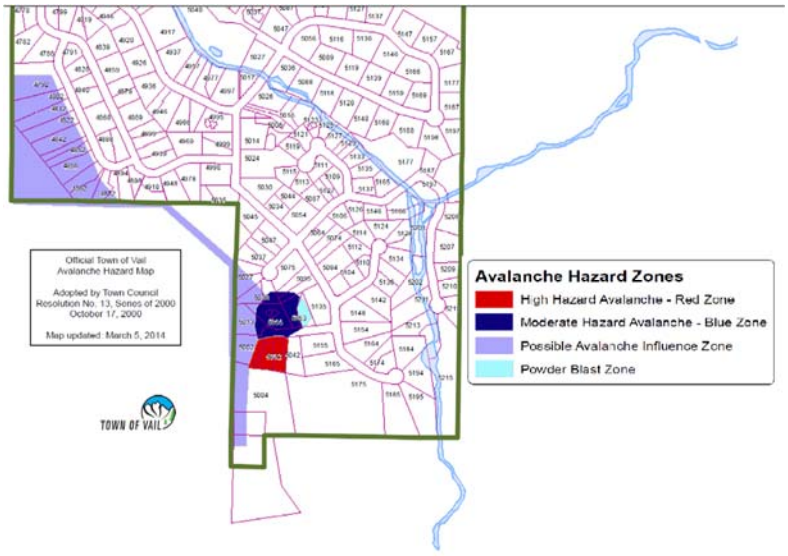

Figure 2 – Excerpt from Town of Vail Official Avalanche Hazard Map

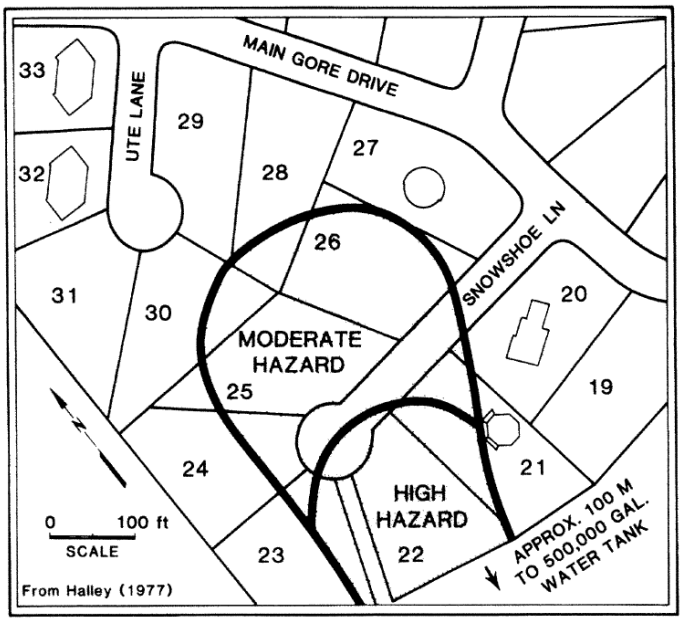

Figure 3 – Hydro-Triad Vail Meadow Avalanche Hazard Map

Many changes have occurred since the previous avalanche hazard maps were prepared. These changes include:

- Growth of trees in the avalanche path;
- Additional weather and snowpack data from Vail;
- Additional history of avalanches and debris flows in the Vail Valley;
- Substantial updates to the available avalanche-dynamics and debris flow models;
- Availability of more detailed topographic mapping and aerial photography.

This study utilizes new data and methods to assess the avalanche hazards for the Vail Meadow avalanche path. For additional details on the assumptions, data, methods and limitations, refer our August 8, 2018 report, *Snow Avalanche and Debris Flow Hazard Analysis and Recommendations* prepared for Mr. Rick Schierberg of the Peregrine Group Development.

2. Methods

The snow avalanche and debris flow hazards were evaluated using a combination of qualitative and quantitative methods, including:

1. Site observations made by Chris Wilbur, P.E. on August 5, 2018.

2. Analysis of aerial photos of various dates and sources (Town of Vail, Eagle County, Google Earth, Bing Maps);
3. Terrain analysis using high quality topographic maps with 2 foot contours provided by the town of Vail GIS Department.
4. Review of historic weather data, include data from Eagle County airport, Vail Coop (058575) and Vail Mountain snow course (842) and SNOTEL, Vail Pass Snow Course (06K15);
5. Avalanche dynamic modeling with the Swiss program, RAMMS, Version 1.6.2 utilizing a 2-meter resolution digital elevation model (DEM) developed from data provided by the town of Vail GIS Department.
6. Our experience with debris flows and snow avalanche hazard assessments and mitigation in the Vail Valley and throughout the Rocky Mountains.

3. Terrain

The Vail Meadows avalanche path has a total vertical drop of about 2600 feet. It has an E-NE-facing starting zone[1] of about 50 acres, and consists of a shallow bowl below timberline. The track[2] has a gradient of 41 percent and is confined to a channel at top, flowing onto an open slope near bottom. The runout zone[3] begins where the avalanche hits 100-foot high hill directly, and part of the avalanche flow is deflected east of the hill, part goes over top, and most of the flow is deflected to the valley west of the hill. The runout zone slopes 9-degrees or less.

Figure 4 shows the Vail Meadows avalanche path on a Bing aerial photograph. Figure 5 shows a slope map. Photos are shown in Figures 8 and 9.

[1] The *Starting Zone* of an avalanche is the area where snow releases, accelerates and increases in mass.
[2] The *Track* of an avalanche is the area where maximum velocity and mass are attained.
[3] The *Runout Zone* is the area where avalanches decelerate, deposit and come to a stop.

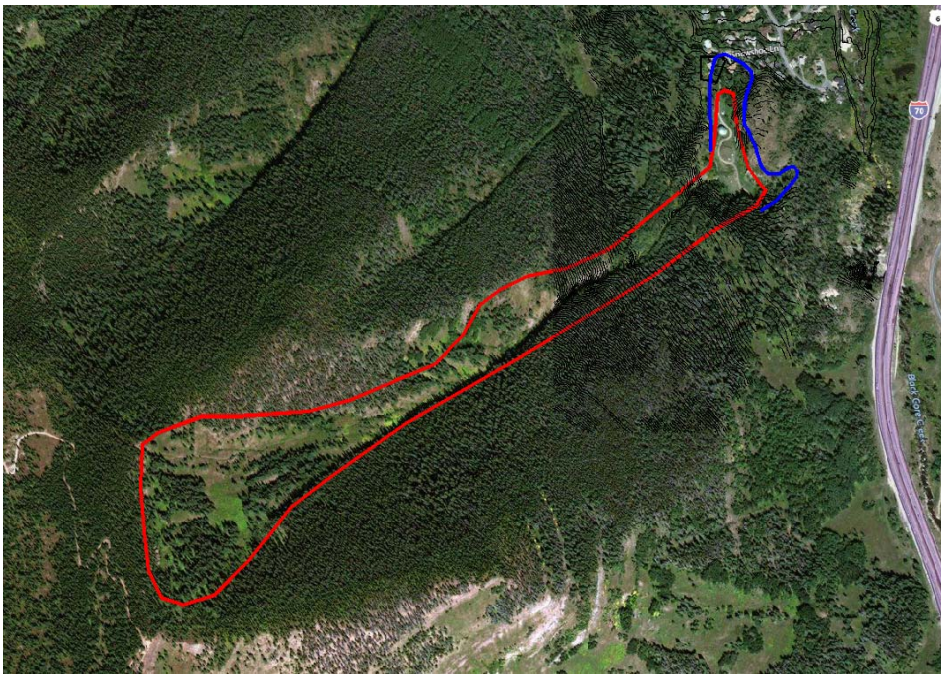

Figure 4 – Approximate Outline of the Vail Meadows Avalanche on Bing Aerial Photo

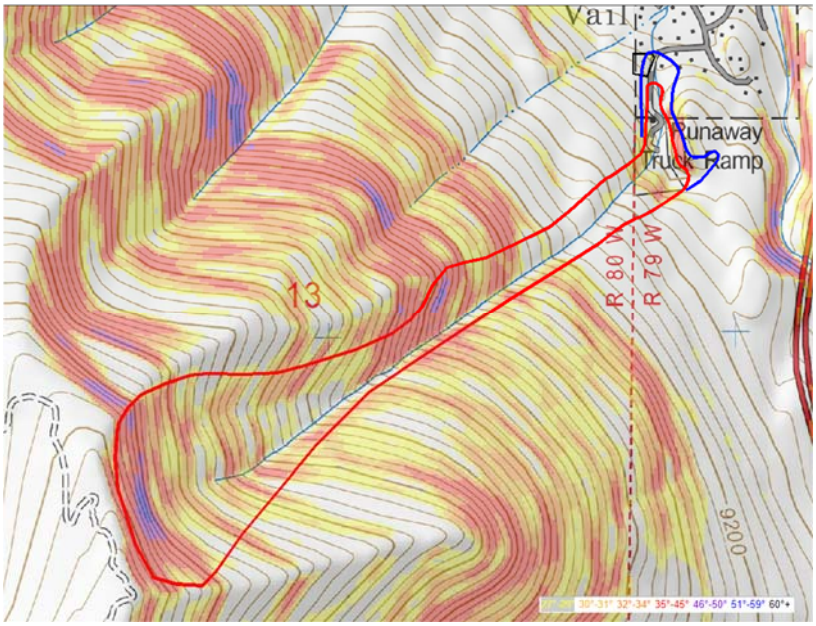

Figure 5 – Vail Meadows Avalanche Slope Angle Map
(source: Caltopo.com)

Figure 6 – Photos looking up and down Avalanche Path

Figure 7 – Photo of “Impact Hill”
(Art Mears photos, September 2017)

4. Avalanche Dynamics Modeling

Figure 8 shows a simulation with predicted maximum flow heights that represents current forest conditions for the design-magnitude avalanche. The model calibration was based on our experience with other avalanches in Colorado, including well-documented historic avalanches.

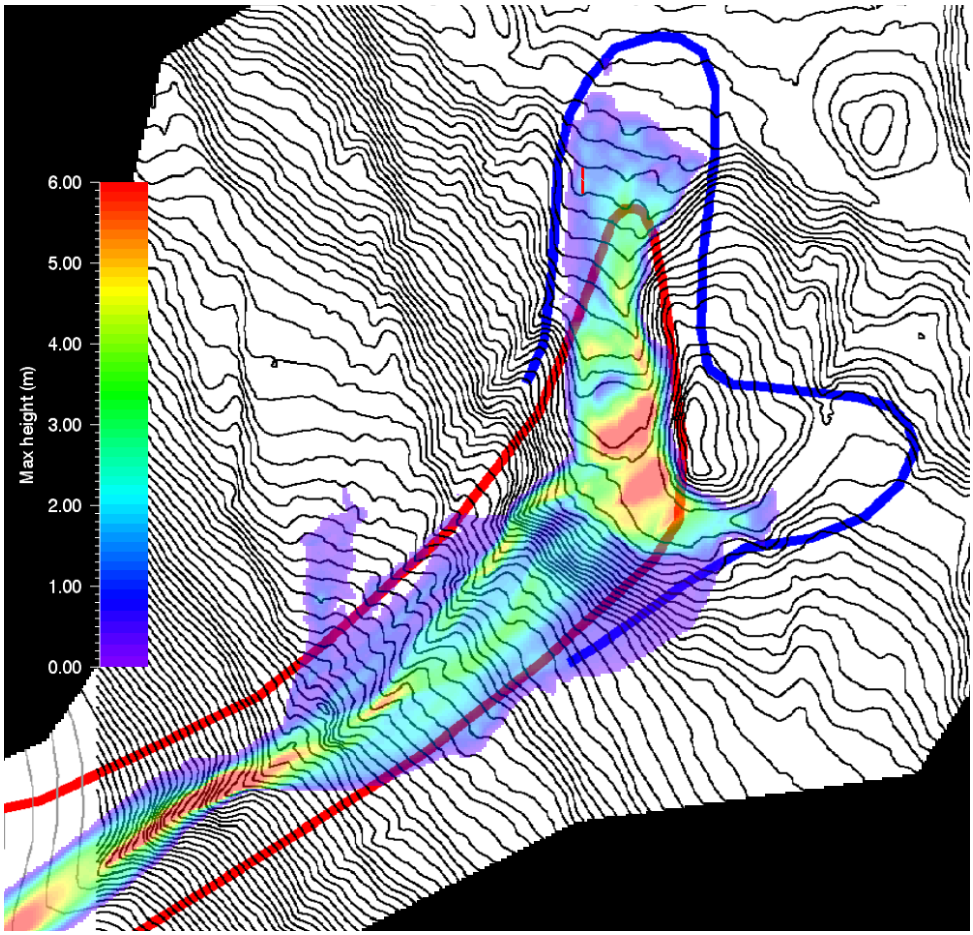

Figure 8 – Maximum Flow Heights of 100-year Design Avalanche
(Red/Blue zones shown from CGS/Mears 1975 map)

5. Summary of Findings

Based on the observations, analyses and methods described in this report, we conclude that forest growth, especially in the avalanche track, has reduced the size and runout distance of the design magnitude avalanche since previous mapping efforts of the 1970s. Recent history, including weather and avalanche records also support adjusting the avalanche hazard zones.

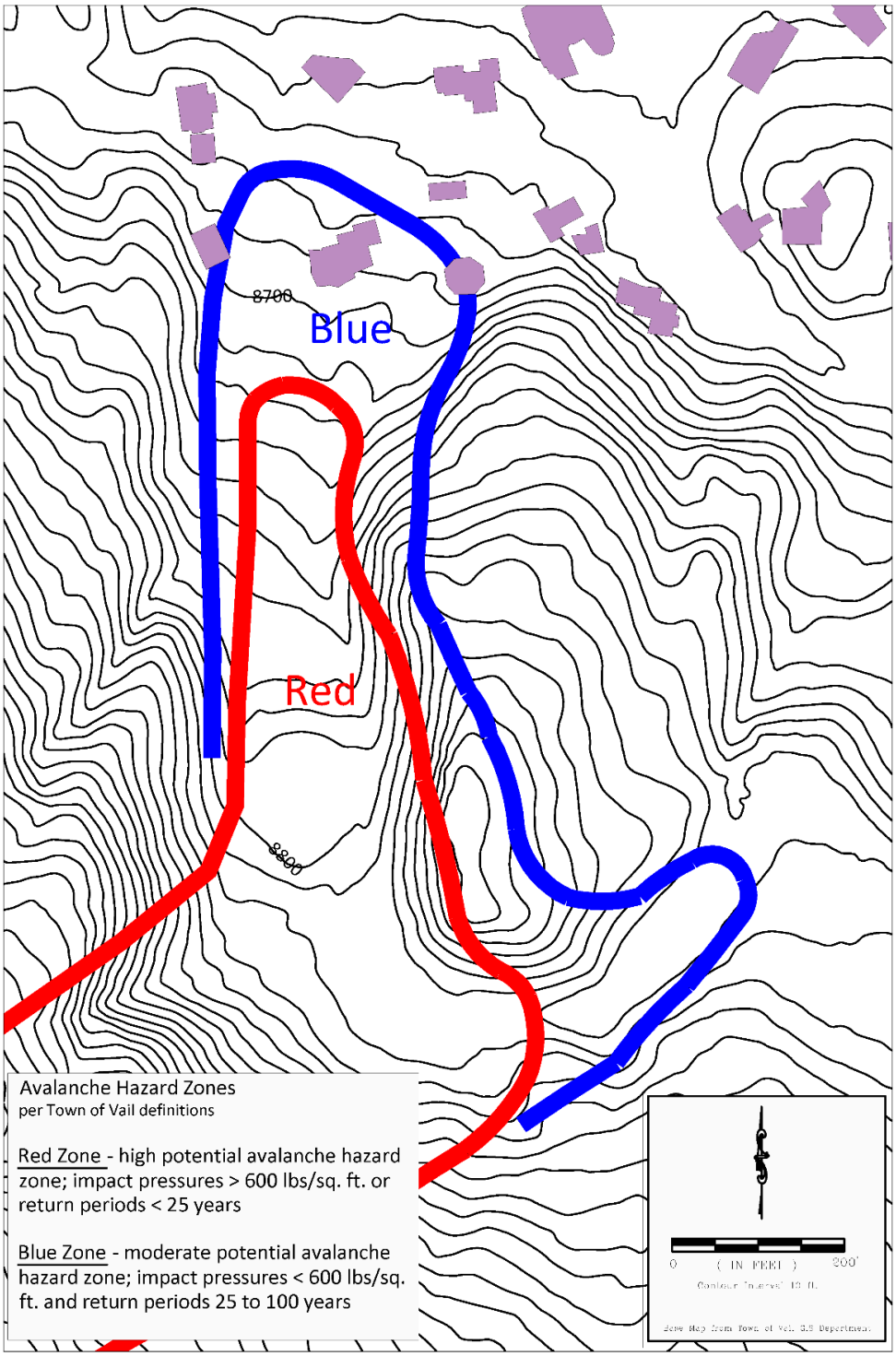

Figure 9 – Recommended Vail Meadows Avalanche Hazard Map

6. Recommendations

Based on the methods and findings described above, we recommend amending the Vail Meadow avalanche hazard zones as shown in Figure 9.

7. References

1. Mears, Arthur I., Snow Avalanche Hazards of the Vail Area, Eagle County, Colorado, Colorado Geological Survey Open File Report, 1975.
2. Oaks Sherry D. & Dexter, Lee, Avalanche Hazard Zoning in Vail, Colorado: The Use of Scientific Information in the Implementation of Hazard Reduction Strategies, Mountain Research and Development, Vol. 7, No. 2 (May, 1987), pp. 157-168, International Mountain Society.

8. Warranty

You as my client should know that while our company can and does attempt to uphold high professional standards, the state of scientific and engineering knowledge is incomplete, and does not permit certainty. The complex phenomena involved in avalanches cannot be perfectly evaluated and predicted, and methods used to predict avalanche behavior change as new research becomes available. While we can and will offer our best professional judgment, we cannot and do not offer any warranty or guarantee of results.