

Avalanche Hazard Investigations, Zoning, and Ordinances, Utah, Part 2

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ABSTRACT: The Wasatch Mountains of Utah are known as home to the 2002 Winter Olympics as well as having an abundance of avalanche history and avalanche hazard terrain that threatens ski areas, highways, and backcountry. Avalanche professionals historically have been drawn to and/or produced from this region resulting in an abundance of publications and research. Still, the subject of avalanche zoning continues to be neglected by developers and governmental approval agencies at communities encroaching on the foothills of the Bonneville Shoreline into avalanche terrain not previously developed. The first and only avalanche hazard ordinance adopted by a county (Scroggin/Batatian, ISSW 2004) is now being challenged by developers. While geologists continue to improve natural hazards mapping for earthquakes, landslides, and debris flows, avalanche hazards have not been included. This presentation will present a slide show and computer terrain analysis of recent large avalanches that have dropped over 5000 vertical feet to existing and proposed development areas as well as inspire a discussion on ways to address the problem both physically and politically. Potential solutions and ways to identify how to assist developers and governmental agencies will be presented.

KEYWORDS: Avalanche Zoning, Ordinance, Governmental Approvals, Utah,

1. INTRODUCTION

In 2002 the first avalanche zoning guidelines for a county in Utah was taken into state ordinance (www.avalanche.org/~issw2004/issw_previous/2004/proceedings/pdf/papers/073.pdf). In 2008 it remains the only ordinance in the state and most other counties do not require or more often do not know when to require avalanche zoning in the land planning and approvals process.

2. DISCUSSION

At the 2004 ISSW we presented a review of the development of the first and only avalanche hazard zoning ordinance and subsequent guidelines for planning and development in avalanche hazard terrain for Salt Lake County, Utah. Although avalanche hazard, control, and forecasting are long time traditional common professions with significant notable history at

Salt Lake County ski areas (Alta, Snowbird, Brighton, Solitude) and Utah Department of Transportation (UDOT) highways of Big Cottonwood Canyon, Little Cottonwood Canyon and Provo Canyon, a process for recognition of avalanche hazard and subsequent legal ordinance for the planning and development of high end real estate outside of the ski areas and into the foothills and canyons near avalanche areas did not exist. In 2002 the Utah State Legislature and Salt Lake County Council accepted section 19.75.083 Avalanche Considerations into ordinance. The code essentially is a slightly modified version of existing ordinances from ski area towns in the western United States which had already recognized and mapped avalanche hazard areas and required a process of review for development purposes. Most of these towns had modeled their ordinances primarily after Swiss zoning guidelines.

Essentially, the ordinances in the west require studies to define a *Red Zone* as a no build zone for inhabited residences because avalanches are too frequent or too large to mitigate, or both. A *Blue Zone* allows for building of inhabited residences if the avalanche is not too frequent and too destructive, i.e., if

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engineering mitigation is feasible, adapting a top limit numerical value of avalanche impact pressure, generally defined as 600 lbs/sq.ft. when 'measured as a plate perpendicular to avalanche flow'.

The Salt Lake ordinance is still in affect and has been used on a number of development applications ranging from near ski areas to the foothills of the Wasatch Front where large avalanche basins or direct steep slopes linger over development areas.

At least 6 other counties in Utah have similar avalanche terrain along the Wasatch Front. Some of these counties have been and continue to experience unprecedented hillside and canyon development of high end homes, condominiums, hotels, and resorts. Recent history has shown the capability of very large avalanches reaching the valley bench as well as low elevations smaller events on steep slopes directly above homesites.

Salt Lake County still has the only avalanche ordinance in the state and serves as a model for analysis for this author. Avalanche studies are sometimes required in other counties depending on whether planning staff decide to require the study. But often the matter goes unattended. Making matters more complicated, many small towns have incorporated within large counties and hold a small planning staff that often does not include disciplines relating to natural hazards. As studies for debris flows, earthquakes, and landslides continue to be frequently required, avalanche hazard studies are rare or often become a burden on the developer in the 11th hour of the approvals process.

3. SALT LAKE ORDINANCE IS CHALLENGED

It wasn't long for some property owners to object to the Salt Lake County ordinance, including at least one local ski area. The objections, although not fully disclosed in a public format, apparently seem to relate to two primary points. First, the limitation of a *Red Zone* being related to frequency was challenged as a random restriction on land ownership rights. Second, the top cap of engineering impact pressure value was challenged as outdated and not consistent with enhanced structural engineering technology.

The too frequent argument for designation of a *Red Zone* did not fly well with the property owners at a ski area that had plans for a large condo/hotel project in a frequent avalanche

path. The plans included certified structural engineering for impact pressures and operations systems for safety during high hazard periods as the project is within a longstanding '*interlodge*' zone. The *interlodge* zone is where systems and legal ordinances are in place for control of avalanches for highway and ski town safety. During *interlodge*, roads are closed and people are restricted to avalanche safe areas by law while avalanche control is performed or until conditions stabilize to an acceptable level, as determined by professional avalanche forecasters and enforced by alpine trained law enforcement. The system is similar to other ski towns in the U.S. and recognizes that many of the frequent avalanches are intentionally controlled, thus altering the natural frequency, in order to reduce the probability of very large and/or unpredicted avalanches

Subsequently, a revised ordinance was proposed by the opponents and is under review by the Salt Lake County Attorney as well as to third party professionals. The revised ordinance may make sense for the specific site in the *interlodge* zone but requires review for a county wide sweeping ordinance in a very large county with avalanche terrain and homesites in canyons and hillsides not associated with a ski area.

The proposed revised language removes the frequency limitation as well as the top cap for impact pressure. Essentially, the language suggests the avalanche area can be developed subsequent to a study to define impact pressure and approved engineering mitigation from a licensed structural engineer from the State of Utah approve the design. Frequency of the avalanche is included in the study, but not as a denial point in the approvals process.

As this seems to make sense for the development area in an *interlodge* zone, it begs discussion and third party input as to the future potential for development in frequent avalanche paths in areas that do not and will not have an avalanche control and forecasting program. Implications for safety may relate not only to personal property rights but to safety of non property owners who may be present on the site (postal service, retail operators) as well as the preparedness of the local jurisdiction to train and respond to avalanche rescue situations.

Chapter 19.75.083 Avalanche considerations
(Current Salt Lake County Code)

19.75.083 Avalanche considerations.

A. Development of structures for human occupancy is not permitted within an avalanche special study area, or in other areas where avalanche hazards may exist, unless a detailed avalanche hazard analysis is performed, as described in Section 19.75.060, by a qualified avalanche expert.

B. If the avalanche analysis indicates that the site may be impacted by avalanches, the report shall delineate the following areas:

1. A "red zone" of high avalanche potential [return period of twenty-five years or less, and/or impact pressures over six hundred pounds per square foot (psf)] within which critical facilities or structures for human occupancy are not permitted;

2. A "blue zone" (return period between twenty-five and three hundred years, and impact pressures less than six hundred psf) within which critical facilities or structures for human occupancy shall only be permitted when at least one of the following requirements has been met:

a. The structure is designed to incorporate direct protection measures that address the estimated impact forces (flowing snow/debris and powder blast loading). The estimated impact forces shall be calculated by the avalanche expert. The structure shall be designed by, and the plans stamped by, a qualified structural engineer licensed in the State of Utah; or

b. Appropriate engineering controls (i.e. deflection structures, snow retention nets, dams, etc.) are designed and installed to mitigate the avalanche hazard. Design or performance criteria for engineered mitigation measures (including estimated impact forces, flow heights, location and dimensions of the mitigation structures) and all supporting modeling or other analyses, calculations, and assumptions, shall be calculated by the avalanche expert and included in the report. Final design plans and specifications for engineered mitigation must be signed and stamped by a qualified professional geotechnical or structural engineer, as appropriate, licensed in the State of Utah. (Ord. 1500 (part), 2002)

Chapter 19.75.083 Avalanche Considerations.
(Proposed Language Change)

A. Development of structures for human occupancy is not permitted within an avalanche special study area, or in other areas where avalanche hazards may exist, unless a detailed avalanche hazard analysis is performed, as described in Section 19.75.060, by a qualified avalanche expert.

B. If the avalanche analysis indicates that the site may be impacted by avalanches, the report shall determine the following: 1) calculated impact forces on the proposed building from flowing snow/debris, powder blast loading, roof loads and other forces, as applicable; and, 2) frequency (recurrence interval, or return period).

C. The report shall include recommendations to mitigate the impact forces either by designing and engineering the building to resist the entire sliding and resting forces (both flowing snow/debris and powder blast loading), or by installing engineered mitigation devices elsewhere on the site; or by other means appropriate for the site conditions.

D. Design or performance criteria for engineered buildings or mitigation devices (including flow depths, flow heights and velocity, impact forces, location, angles and dimensions of the structures), shall be calculated by the avalanche expert and submitted in the report. Any engineered building shall be designed by and the plans stamped by a P.S.E. Any engineered mitigation device (deflection structures, snow retention nets, dams, etc) shall be designed by a P.E., P.G., or P.S.E. Associated appurtenances, components and attachments, e.g., mechanical, plumbing, electrical, fuel storage, etc. shall be constructed and designed to the same engineering standards as the buildings and mitigation devices.

E. All analysis and engineering shall be subject to third party review by a qualified professional. Any associated costs of third party review shall be borne by the applicant.

Figure 1, Existing Salt Lake County Avalanche Ordinance versus proposed changes

4. OTHER COUNTIES IN UTAH

Other counties along the Wasatch Front corridor that lay within similar avalanche hazard potential as Salt Lake County and are also experiencing rapid real estate growth into the foothills and canyons include, from the north to south, Cache, Weber, Davis, Morgan, Summit, Wasatch, Utah, and Sanpete.



Figure 2, Utah Counties inset

Class 4 to 5 large avalanches originating from high mountain ridgetops and running to the valley level along these counties have been recently observed and studied by the author and others in Weber County, Davis County, and Utah County.



Figure 3, Buckley Avalanche, Utah County



Figure 4, Buckley Avalanche, Utah County



Figure 5, Buckley Avalnache, Utah County



Figure 6, Transported Tree at Woodland Hills



Figure 7, Woodland Hills reached the valley bench (subdivision lots) 3 times in 4 years



Figure 8, Broad Hollow Hit the Water Tank



Figure 9, Big Slide Canyon, Mapleton

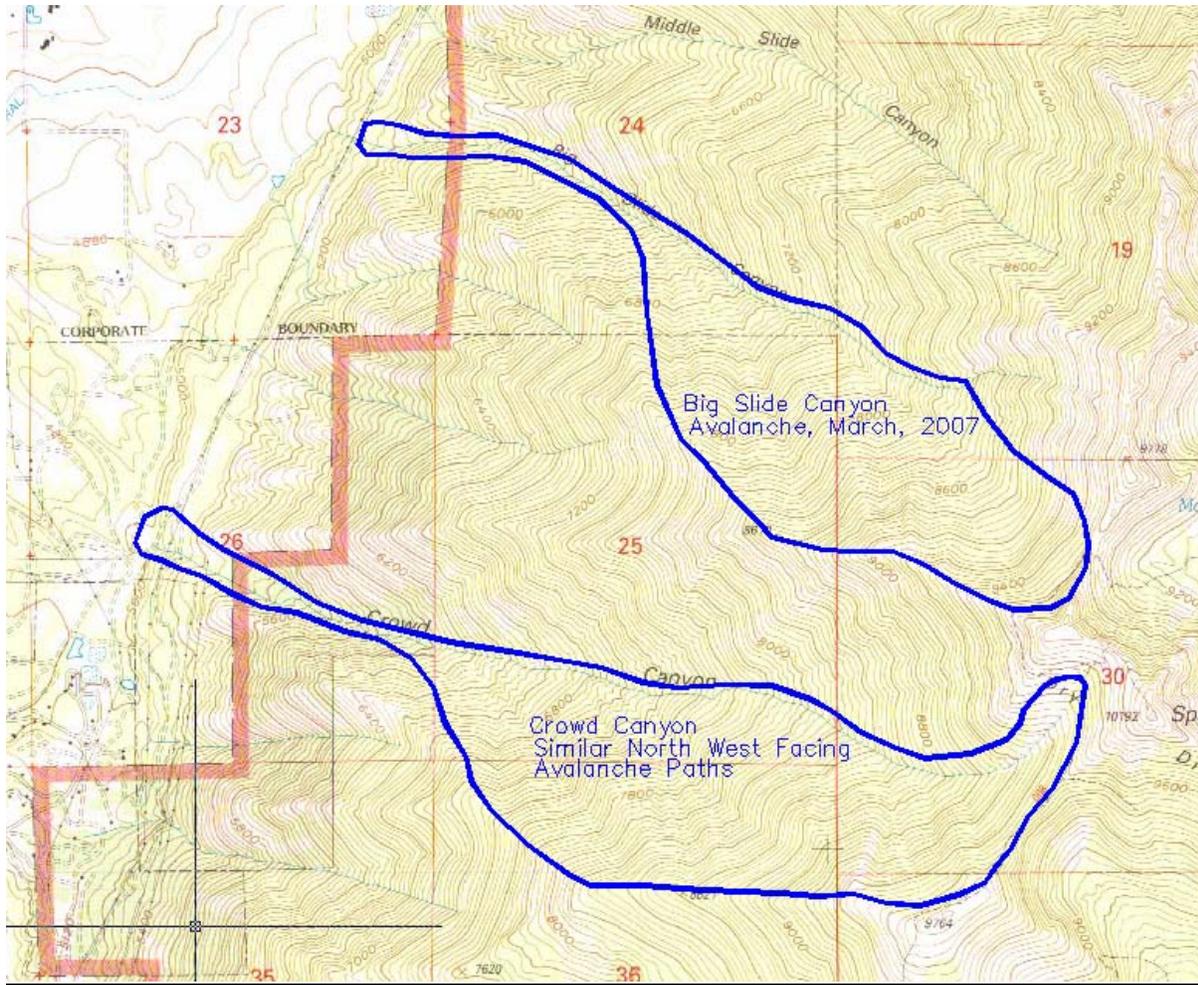


Figure 10. Big Slide Canyon has been a relatively frequent runner, in this case dropping from 10,000 feet to 5,000 feet. These events confirmed the ability neighbor Crowd Canyon to threaten a new Mapleton Community. Design of the community layout was subsequently changed in the design process.



Figure 11, Tree section showing avalanche asymmetrical dendrochronology deposited in run out zone on valley bench at Big Slide Canyon



Figure 12, Polecat Canyon at North Ogden, Weber County

Avalanche zoning reports have been prepared by the author in counties where avalanche hazard ordinance did not exist. In these cases, design and analysis guidelines from the Salt Lake County Code were used. While researching requirements for other counties, some avalanche language was found.

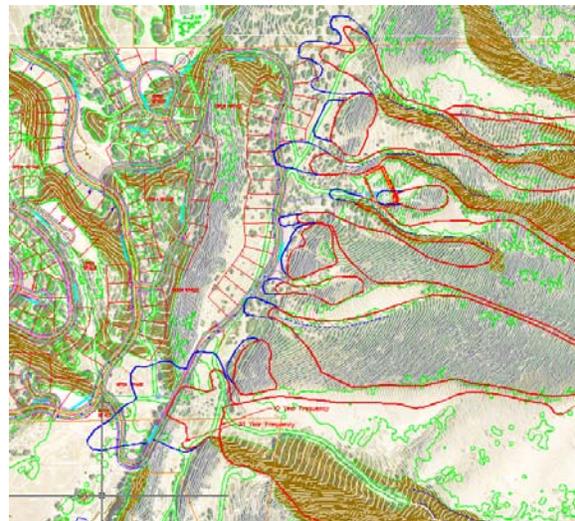


Figure 13, Red and Blue Zones for a new community in Mapleton, Utah County. Mapleton is incorporated inside of Utah County, and subsequently has its own planning staff and development ordinance. The avalanche hazard study was not triggered by the planning staff but by the developers consulting engineer.

It was also found that most counties do require studies and have guidelines for:

Earthquake, landslide, debris flow, flood, rockfall, tectonic subsidence.

In Summit County, Utah, where Olympic ski areas consume hundreds of pounds of avalanche control explosives annually, where 2-4 people die each year in backcountry avalanches, and where real estate growth has no recognition of the word 'bubble', the code has this clause:

'Development will not be allowed in an avalanche track'

Most all other counties in Utah have no mention of avalanches but some are similar to Weber County, home of Snow Basin Ski Area (men's and women's downhill, 2002 Winter Olympics):

'As in many counties of the Western U.S., development in Weber County is constrained by the presence of natural and man made hazards. These hazards include avalanche, slope movement, soils categorized

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as having severe building limitations, and slopes exceeding 30%.'

The Weber ordinance continues:
'Not all hazardous sites and conditions have been identified in Weber County; however, development on those sites shall be permitted when projects are studied and designed by a qualified engineering geologist and a Utah Licensed civil engineer, architect and/or engineering geologist and certified to withstand the potential hazard for which it is designed, and that the site is buildable and that the site is safe. This allows development on hazardous sites with the full acknowledgement of the property owner. The use for hazardous sites for open space is encouraged.'

Further on, *'...In the case of a snow avalanche hazard, the report shall be prepared by an experienced avalanche expert.'*

4. CONCLUSION

Some specific problems in the avalanche hazard zoning process in Utah include:

1. Lack of Avalanche Hazard Ordinance
 - a. No legal means to enforce safe development planning
 - b. No report standards
 - c. Disputes on land ownership rights
 - d. Liability concerns
2. Lack of avalanche study *'trigger'* in the approval process
 - a. Planning staff not always aware when to require avalanche hazard study
3. Lack of specific qualified consultant guidelines
 - a. 'Avalanche Expert' loosely defined

To help recognize potential development in avalanche hazard areas, three steps were identified in our 2004 paper that are still valid. Primarily, the intention is to help planners and governmental agencies determine when and how to consider avalanche hazards and when to require an Avalanche Hazard Report:

1. Geologic Hazards Ordinances should be modified to include specific definitions for avalanche reviews. 'Red Zone' (non-buildable) and 'Blue Zone' areas are common across the Western U.S. Public forums should address whether this format is

acceptable or adopt an alternative format.

2. The Avalanche Hazard Special Study Area can be created with a Avalanche Slope Map and posted at the County Planning and Development Services Office and web site to help the planners and developers recognize known and potential hazard areas. These projects can be contracted out or created in house with exceptional recent progress in G.I.S. computer terrain analysis's technology.
3. Planning staff should be trained in understanding general guidelines for avalanche path characteristics.
4. Definitions for Qualified Avalanche Consultant should be clarified.
5. Canadian and European zoning standards should be studied and adapted for the process of review in the U.S.
6. Add the subject of Avalanche Zoning in the Western United States to the ISSW 'Research we'd like to See'.

Salt Lake County Planning and Development should entertain extended third party comment on its proposed revised Geologic Hazards Ordinance, Chapter 19.75, which was approved in July, 2002, the first time that avalanche provisions were written into the zoning code, alongside other geologic hazards including earthquakes, landslides, rock fall and debris flows. Other counties in the state of Utah should consider the issue. Creating site specific Avalanche Hazard Special Study Area Maps can be easier than before with new G.I.S. and CAD terrain analysis technology and combined with known avalanche databases. Developers need to identify potential avalanche hazard areas in the due diligence stage, and County officials should recognize the need for and initiate these studies well in advance of preliminary subdivision design and permitting. Known and discovered avalanche areas should be disclosed on the property plat.

4. REFERENCES

Salt Lake County, 2002: "*Geologic Hazards Ordinance*", Chapter 19.75, Salt Lake County Code of Zoning Ordinances:
www.pwpds.slco.org/zoning/html/geologicHazards.html

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