STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
VICKI S. McCONNELL, STATE GEOLOGIST

Deep-Landslide Susceptibility Map of the City of Silverton, Marion County, Oregon

2012

Base Map:

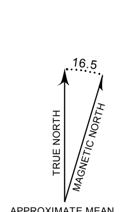
Lidar-derived elevation data are from the Oregon Lidar Consotrium, 2007. Digital elevation model (DEM) consists of a 3-foot square elevation grid that was converted into a hillshade image with sun angle at 315 degrees at a 45 degree angle from horizontal. The DEM is multiplied by 5 (vertical exaggeration) to enhance slope areas.

Orthophoto is from Oregon Geospatial Enterprise Office, 2005 and consists of 2005 orthophoto draped over DEM with transparency.

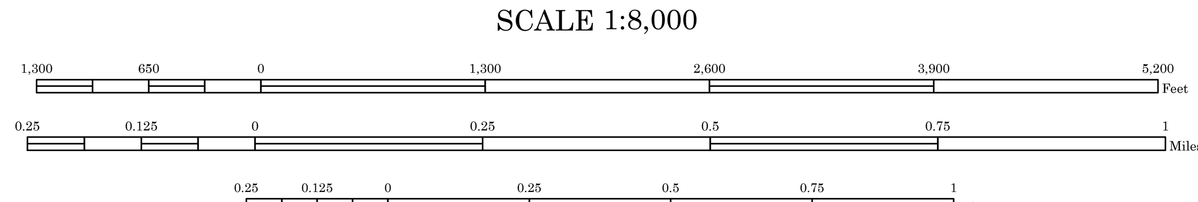
Projection: North American Datum 1983, UTM zone 10 north.

Software: MapInfo Professional 8.0, Esri ArcMap 9.2, Adobe Illustrator CS2.

Source File: Rocks\Publications\Silverton.mxd.



SCALE 1:8,000



Cartography by William J. Burns, Oregon Department of Geology and Mineral Industries

Outside agency review by Rich Barstad, City of Silverton

IMPORTANT NOTICE
This map depicts landslide susceptibility zones developed on the basis of limited data. The susceptibility zones were created following the protocol defined by Burns (2008). This map cannot serve as a substitute for site-specific investigations by qualified practitioners. Site-specific data may give results that differ from those shown on this map.

Open-File Report O-12-05

Regional Landslide Hazard Maps of the City of Silverton, Marion County, Oregon

by William J. Burns and Katherine A. Mickelson

Partial funding provided by the City of Silverton (IA No. 41460-11242008)

PLATE 3

EXPLANATION

This map depicts susceptibility to deep landslides in the portion of this quadrangle. For the purpose of this map, deep seated landslides are defined as those with a depth to the failure plane of greater than 4.5 m (15 feet) (Burns, 2008). This susceptibility map is not regulatory, and revisions can happen when new information regarding factors that affect landslide susceptibility is found or new landslides occur. Therefore, it is possible that susceptible areas within the map area were not identified or actual landslides occurred after the map was prepared.

This susceptibility map was prepared by combining three factors: 1) landslide inventory data, 2), head scarp buffers, and 3) geologic units and slope angles. The landslide inventory data were taken from the complementary inventory map. The combinations of these factors comprise the relative susceptibility hazard zones: High, Moderate, and Low. The deep-landslide susceptibility data are displayed on top of a base map that consists of an aerial photograph (orthorectified) overlain on the lidar-derived digital elevation model. For additional detail on how this map was developed see Burns (2008).

This susceptibility map is intended to provide users with relative hazard information regarding deep-seated landslide susceptibility within the quadrangle. The map is not intended to replace site-specific engineering geologic and geotechnical investigations. It is intended that this map will provide useful information to guide regional and site-specific investigations for future developments, to assist in regional planning, and to reduce risk in areas where moderate and high hazards intersect vulnerable population.

DEEP-LANDSLIDE SUSCEPTIBILITY CLASSIFICATION

Each landslide susceptibility hazard zone shown on this map was developed according to a classification scheme that uses a number of specific factors. The classification scheme was developed by the Oregon Department of Geology and Mineral Industries (DOGAMI) (Burns, 2008). The symbology used to display these hazard zones is explained below.

Landslide Susceptibility Zones: This map uses color to show the relative degree of hazard. Each zone is a combination of several factors.

HIGH: High susceptibility to deep landslides.

MODERATE: Moderate susceptibility to deep landslides.

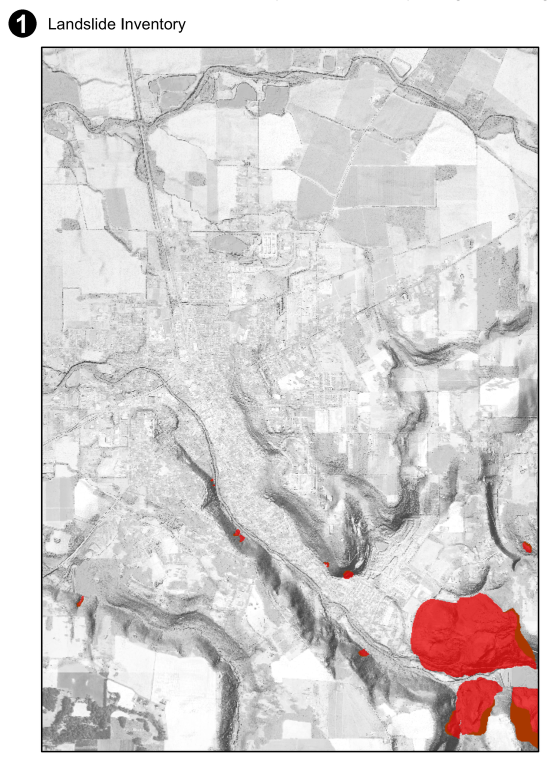
LOW: Low susceptibility to deep landslides.

Hazard Zone Matrix Table

Contributing Factors*	Final Hazard Zone		
	High	Moderate	Low
1 Landslide Inventory	included	—	—
2 Head Scarp Buffers	included	—	—
3 Geologic Units and Slope Angles	—	included	included

*See explanation of corresponding contributing factors below.

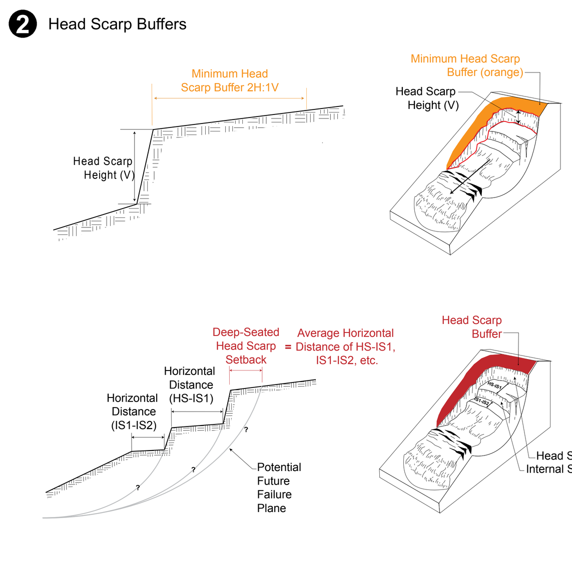
1 Landslide Inventory



Landslide Inventory: This map is an inventory of existing deep-landslide deposits and head scarps in this quadrangle (see accompanying landslide inventory map). This inventory map was prepared by compiling all previously mapped landslides from published and unpublished geologic and landslide mapping, lidar-based geomorphic analysis, and review of aerial photographs. Each landslide was also attributed with classifications for activity, depth of failure, movement type, and confidence of interpretation. The lidar-based landslide inventory mapping protocol (Burns and Madin, 2009) was developed with input from many sources, along with years of experience. This map uses color to show different landslide features across the map.

EXPLANATION
- Deep-Seated Landslide Deposits
- Landslide Head Scarps

2 Head Scarp Buffers



Cross-Section (profile)

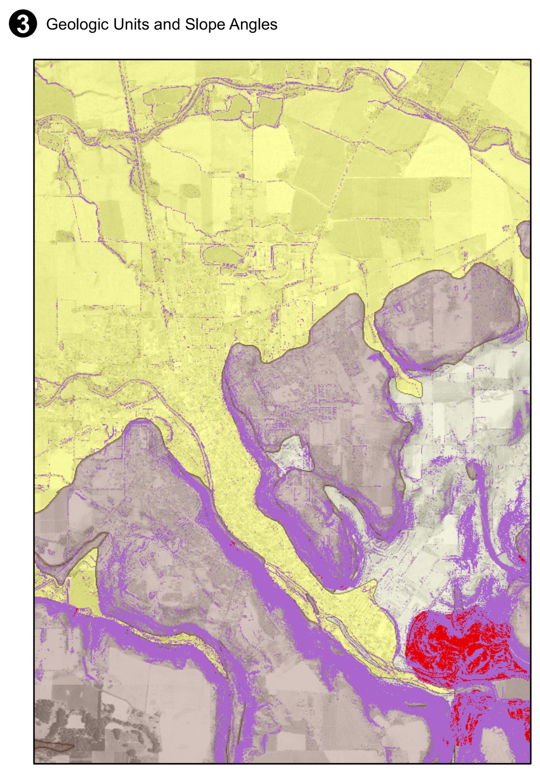
Block Diagram

Buffer for Head Scarps: This buffer was applied to all head scarps from the landslide inventory. In most cases the first buffer results in the minimum buffer distance and the second buffer (described below) results in the maximum buffer distance. In all cases the greater of the two values was used.

The first buffer consists of a 2:1 horizontal to vertical distance (2H:1V). This buffer is different for each head scarp and is dependent on head scarp height. For example, a head scarp height of 2 m (6.5 ft) has a 2H:1V buffer equal to 4 m (13 ft) (Block diagram modified after Highland, 2004)..

The second buffer is different for each head scarp and is dependent on the average of the horizontal distance between internal scarps. For example, an average horizontal distance of 50 m (150 ft) has a 2H:1V buffer equal to 100 m (300 ft).

3 Geologic Units and Slope Angles



Geologic Units and Slope Angles: This map is a generalized geologic map that also shows slopes greater than 10 degrees. This map uses color to show different geologic units and slopes across the map.

Using educated judgment, the mapper combined the three subfactors listed below to create the boundary between the moderate and low hazard zones for the deep-landslide susceptibility.

1) Susceptible geologic units or units that contain deep landslides from the inventory.

2) Relative proximity to identified deep landslides from the inventory.

3) Slope angles greater than 10 degrees.

EXPLANATION

Landslide Deposits (from landslide inventory)
- Landslide deposit

Geologic Units (from best available geologic map)
- Recent alluvium
- Mudstone
- Basalt

Slope Angle (degrees) (derived from lidar DEM)
- Greater than 10

LIMITATIONS

The deep-landslide susceptibility map was developed following an established protocol that incorporates several types of data. Several limitations are worth noting and underscore that any regional hazard map useful for regional applications but should not be used as an alternative to site-specific studies in critical areas.

1) Although it is possible to check for errors in the GIS and tabular database, it is not feasible to completely verify all of the original input data.

2) As previously discussed, the protocol to develop deep-landslide susceptibility maps is based on three primary factors: a) landslide inventory, b) head scarp buffers, and c) addition factors. All of these parameters can affect the level of detail and accuracy of the final susceptibility map. Since the maps are based on a subjective combination of factors, all of which have inherent uncertainty, the resultant hazard zones also have uncertainty.

   a. The landslide inventory data have limitations that are discussed in the lidar-based landslide inventory mapping protocol (Burns and Madin, 2009).

   b. Calculation of head scarp buffers is limited based on the head scarp height (first buffer) and an average of the horizontal widths of previous or downslope blocks (second buffer). It is assumed that most large deep-seated landslides have the potential to fail retrogressively upslope; however, this is not always the case.

   c. The additional factors elements are a subjective estimate of the extent of the combination of 4 factors (susceptible geologic units, slopes greater than 10 degrees, relative proximity to identified deep landslides, and educated judgment) made by the author. Since this is based on visual overlap of these 4 factors, the accuracy and resolution of the output data can be substantial overestimated and/or underestimated.

3) The GIS database is a “snapshot” view of current data; and new information regarding landslides can be found or future (new) landslides may occur.

4) Because the lidar-based digital elevation model (DEM) is only a model of elevation, it does not distinguish elevation changes that may be due to the construction of structures like retaining walls. Because it would require extensive field work to locate all of these existing structures and determine the stability of each individual structure, these potential structures have been assumed to be slopes as a conservative approach and therefore must be examined on a site-specific basis.

5) Some landslides and slopes have been mitigated. Again, because it is not feasible to collect detailed site-specific information on every landslide or slope (for example, if it has been mitigated and what level of mitigation was implemented), mitigation has been omitted.

Because of these limitations this map is intended for regional purposes only and cannot replace site-specific investigations. However, the map can serve as a useful tool for estimating the regional landslide hazard and as a starting place for future detailed site-specific maps. Please contact DOGAMI if errors and/or omissions are found so that they can be corrected in future versions of this map.

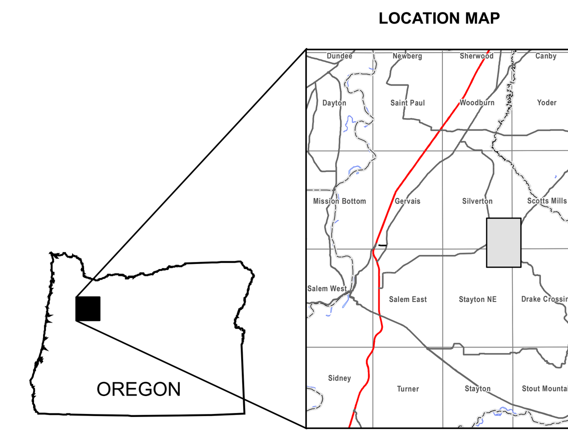
REFERENCES

Burns, W.J., 2008, Regional landslide hazard maps of the southwest quarter the Beaverton quadrangle, West Bull Mountain Planning Area, Washington County, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-08-09, 17 p., scale 1:8,000.

Burns, W.J., and Madin, I.P., 2009, Protocol for inventory mapping of landslide deposits from light detection and ranging (lidar) imagery: Oregon Department of Geology and Mineral Industries Special Paper 42, 30 p.

Highland, L., compiler, 2004, Landslide types and processes, U.S. Geological Survey fact sheet 2004-3072 (ver. 1.1), 4 p.

LOCATION MAP



U.S. Geological Survey 7.5-minute quadrangles and counties are labeled. This map extent shown as gray rectangle.

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