

Western Area—Landslide Inventory of Eastern Multnomah County, Oregon

2017

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PLATE 1

INTRODUCTION

Eastern Multnomah County is home to the scenic Columbia River Gorge and its linked tourism and recreational opportunities, the I-54 transportation corridor, and significant permanent population and industry. This area is also home to significant landslide hazards. The high landslide hazard combined with dense development results in high risk. The purpose of this project is to provide accurate, detailed landslide inventory maps to help communities in this region become more aware of and resilient to landslide hazards.

EXPLANATION

This map is an inventory of existing landslides in the study area. The landslide inventory is one of the essential data layers used to determine regional landslide susceptibility. This landslide inventory is not regulatory, and revisions can happen when new information regarding landslides is found or when future (new) landslides occur. Therefore, it is possible that landslides within the mapped area were not identified or occurred after the map was prepared.

The inventory map was prepared by following the Protocol for Inventory Mapping of Landslide Deposits from Light Detection and Ranging (Lidar) Imagery developed by Burns and Madin (2009). The three primary tasks included compilation of previously mapped landslides (including review of the Statewide Landslide Information Layer for Oregon, release 3.2 (Burns, 2014)), lidar-based morphologic mapping of landslide features, and review of aerial photographs. Landslides identified by these methods were digitally compiled into a GIS database at varying scales. While the protocol recommends data use at a map scale of 1:8,000, and the geodatabase contains data at 1:8,000 or better, for representation purposes the data have been visualized on the map scale at 1:12,000. Each landslide data was also annotated with classifications for activity, depth of failure, movement type, and confidence of interpretation. The landslide data are displayed on top of a base map that consists of an aerial photograph (orthorectified) overlaid on the lidar-derived hillshade image.

This landslide inventory map is intended to provide users with basic information regarding landslides within the study area. The geologic, terrain, and climate conditions that led to landslides in the past may provide clues to the location and conditions of future landslides, and it is intended that this map will provide useful information to develop regional landslide susceptibility maps, to guide site-specific investigations for future developments, and to assist in regional planning and mitigation of existing landslides.

LANDSLIDE CLASSIFICATION

Each landslide shown on this map has been classified according to a number of specific characteristics identified at the time the data were recorded in the GIS database. The classification scheme was developed by the Oregon Department of Geology and Mineral Industries (Burns and Madin, 2009). Several significant landslide characteristics recorded in the data base are portrayed with symbology on this map. The specific characteristics shown for each landslide are the activity of the landslide, landslide features, deep or shallow failure, confidence of landslide interpretation, and type of landslide movement. These landslide characteristics are determined primarily on the basis of geomorphic features, or landforms, observed for each landslide. The symbology used to display these characteristics is explained below.

LANDSLIDE ACTIVITY: Each landslide has been classified according to the relative age of last movement. This map displays only color to show the relative age of activity.

- HISTORIC AND/OR ACTIVE** (movement less than 150 years ago): The landslide appears to have moved within historic time or is currently moving (active).
- PRE-HISTORIC OR ANCIENT** (movement greater than 150 years ago): Landslide features are slightly eroded and there is no evidence of historic movement. In some cases, the observed landslide features have been greatly eroded and/or covered with deposits that result in smoothed and subdued morphology.

LANDSLIDE FEATURES: Because of the high resolution of the lidar-derived topographic data, some additional landslide features were identified. These include:

- HEAD SCARP ZONE AND FLANK ZONE:** The head scarp or upper most scarp, which in many cases exposes the primary failure plane (surface of rupture), and flanks or zone zones.
- HEAD SCARP LINE AND INTERNAL SCARP LINES:** Upper most extent of the head scarp and internal scarps within the body of the landslide. Hatching is in the down-dropped direction.

DEPTH OF FAILURE: The depth of landslide failure was estimated from scarp height. Failures less than 4.5 m (15 ft) deep are classified as shallow-seated and failures greater than 4.5 m (15 ft) deep are classified as deep-seated.

- SHALLOW-SEATED LANDSLIDE:** Estimated failure plane depth is less than 4.5 m (15 ft).
- DEEP-SEATED LANDSLIDE:** Estimated failure plane depth is greater than 4.5 m (15 ft).

CONFIDENCE OF INTERPRETATION: Each landslide was classified according to the confidence that the mapper assigns based on the likelihood that the landslide actually exists. Landslides are mapped on the basis of characteristic morphology, and the confidence of interpretation is based on how clearly visible that morphology is. As a landslide ages, weathering (primarily through erosion) degrades the characteristic morphologies produced by landsliding. With time, landslide morphologies may become so subtle that they resemble morphologies produced by geologic processes and conditions unrelated to landsliding.

Landslides may have several different types of morphologies associated with them, and we define confidence through a simple point system (see table below) associated with these features. The point system is based on a ranking of four primary landslide features with a ranking of 0 to 10 points per feature. For example, if during mapping, the head scarp and toe of a landslide were identifiable and clearly visible, the mapper would supply 10 points for the head scarp and 10 points for the toe, equaling 20 points, which would be associated with a moderate confidence of identification.

The visual display of this landslide characteristic is through the use of different line styles as shown below.

	HIGH CONFIDENCE (>20 points)
	MODERATE CONFIDENCE (11-20 points)
	LOW CONFIDENCE (<10 points)

Landslide Feature	Points
Head scarp	0-10
Flanks	0-10
Toe	0-10
Internal scarps, sag ponds, compression ridges, etc.	0-10*

* Applied only once so that total points do not exceed 20.

CLASSIFICATION OF MOVEMENT: Each landslide was classified with the type of landslide movement. There are five types of landslide movement: slide, flow, fall, topple, and spread. These movement types are combined with material type to form the landslide classification. Not all combinations are common in nature, and not all are present in this quadrangle.

Type of Movement	Rock	Debris	Soil
Fall	RF rock fall	DF debris fall	EF earth fall
Topple	RT rock topple	DT debris topple	ET earth topple
Slide-rotational	RS-R rock slide-rotational	DS-R debris slide-rotational	ES-R earth slide-rotational
Slide-translational	RS-T rock slide-translational	DS-T debris slide-translational	ES-T earth slide-translational
Lateral spread	RSP rock spread	DSP debris spread	ESP earth spread
Flow	RFL rock flow	DFL debris flow	EFL earth flow
Complex	C complex or combinations of two or more types (for example, ES-R + EFL)		

Falls are near-vertical, rapid movements of masses of materials, such as rocks or boulders. The rock debris sometimes accumulates at talus at the base of a cliff.

Topples are distinguished by forward rotation about some pivotal point, below or low in the mass.

Slides are downslope movements of soil or rock on a surface of rupture (failure plane or shear zone).

- Rotational slides move along a surface of rupture that is curved and concave.
- Translational slides displace along a planar or undulating surface of rupture, sliding out over the original ground surface.

Spreads are commonly triggered by earthquakes, which can cause liquefaction of an underlying layer and extension and subsidence of commonly cohesive materials overlying liquefied earth.

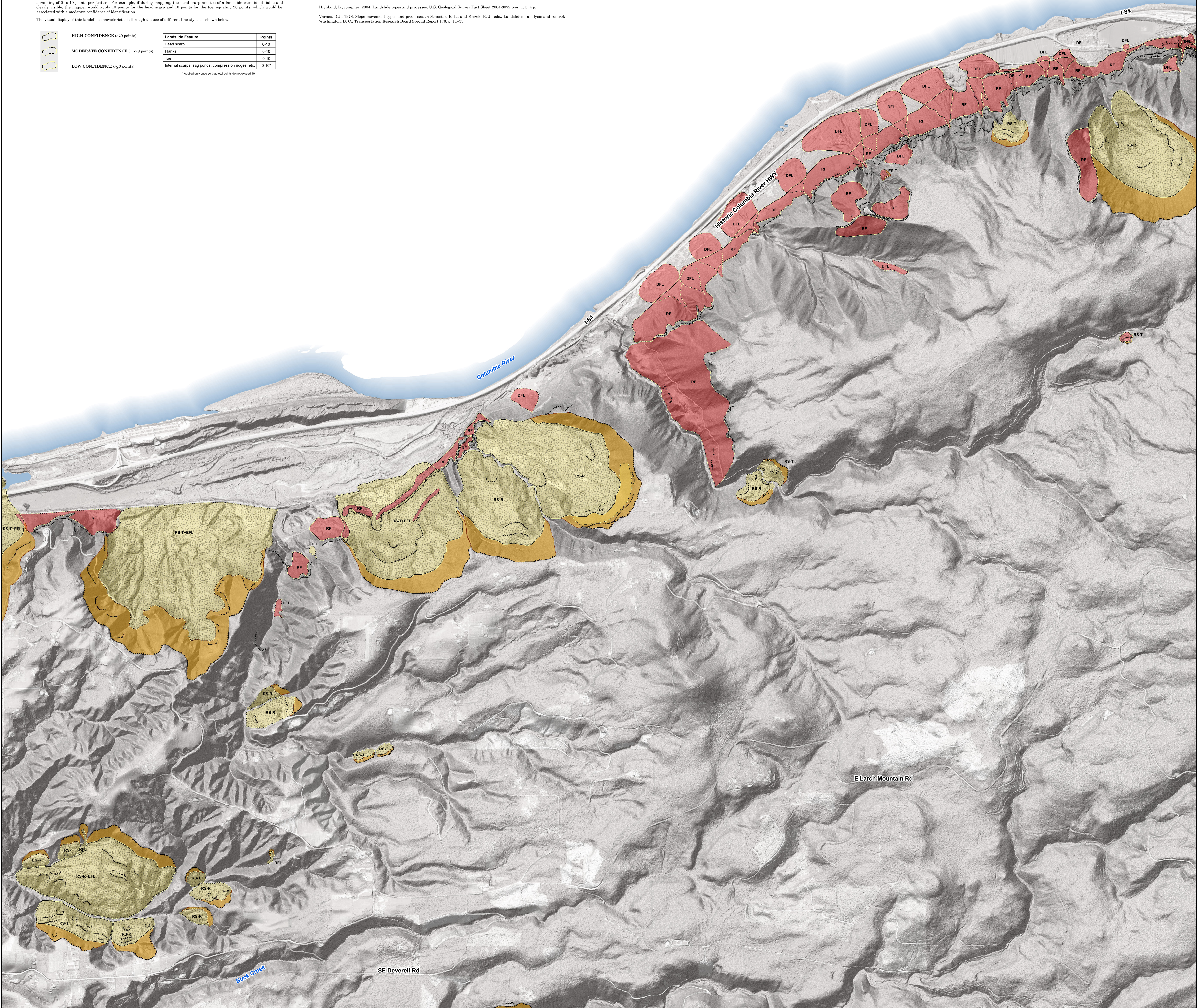
Channeled Debris Flows commonly start on a steep, concave slope as a small slide or earth flow into a channel. As the mixture of landslide debris and water flows down the channel, the mixture picks up more debris, water, and speed, and deposits in a fan at the outlet of the channel.

Earth Flows commonly have a characteristic "hourglass" shape. The slope material liquefies and runs out, forming a bowl or depression at the head.

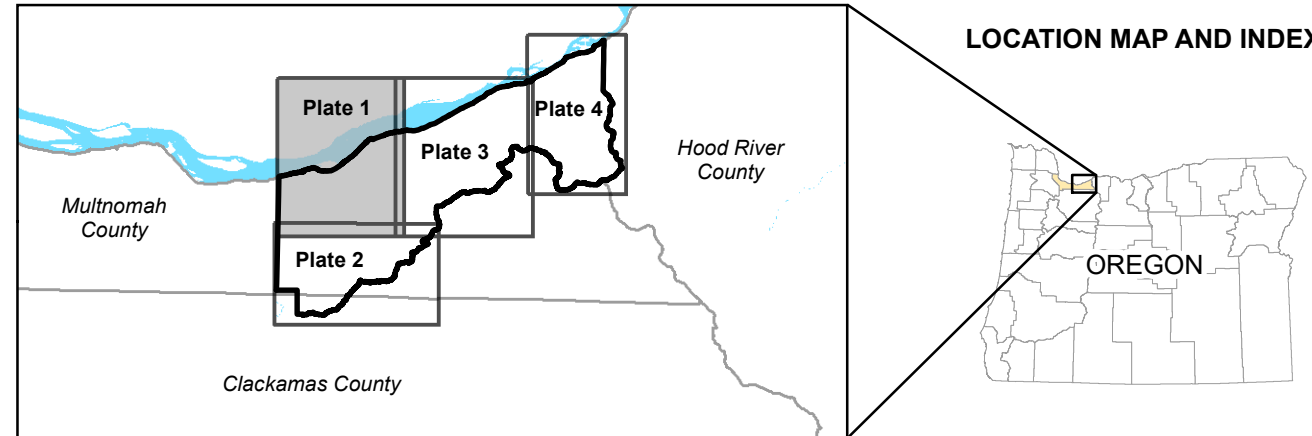
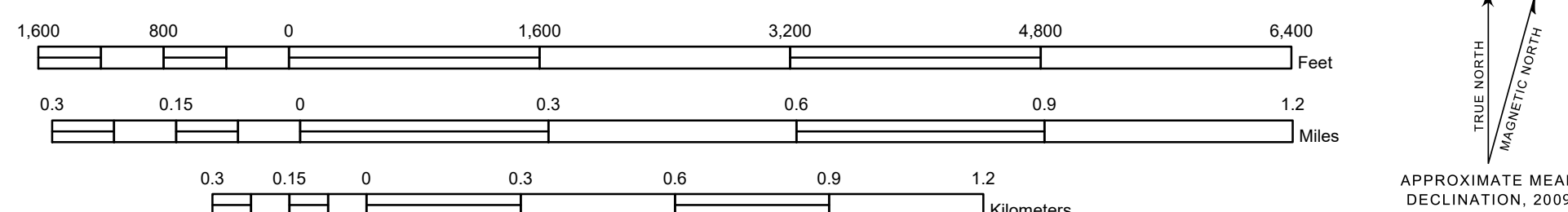
Complex Landslides are combinations of two or more types. An example of a common complex landslide is a slump-earth flow, which usually exhibits slump features in the upper region and earth flow features near the toe.

REFERENCES

- Burns, W.J., 2014. Statewide Landslide Information Database for Oregon, release 3.2. Oregon Department of Geology and Mineral Industries. Web: <http://www.oregongeology.org/publics/>
- 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, 39 p., geodatabase template.
- Highland, L., compiler, 2004. Landslide types and processes. U.S. Geological Survey Fact Sheet 2004-3072 (rev. 1), 13, 4 p.
- Varnes, D.J., 1978. Slide movement types and processes. In: Schuster, R. L., and Krizek, R. J., eds., Landslides—analysis and control: Washington, D. C., Transportation Research Board Special Report 176, p. 11–33.



SCALE 1:12,000



Base Map:

Lidar data for all four plates from DOGAMI Lidar Data Quadrangles LDAQ 2010-01122-R3-Bodall Vol. LDAQ 2010-01122-R1-Multnomah Falls, LDAQ 2010-01122-R2-Snowville Dam, LDAQ 2010-01122-R3-Tanner Butte, and LDAQ 2010-01122-R2-Bull Run.

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 40-degree angle from horizontal. The DEM was multiplied by 1 (vertical exaggeration) to enhance slope areas.

2009 orthophoto imagery from Oregon Geospatial Enterprise Office and is draped over the hillshade image with transparency.

Projection: North American Datum 1983, UTM zone 10.
Source File: Project\00X_Landslide_Book_East_Multnomah County.mxd

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