

# Mapping of Potential Landslide Hazards in King County

November 1, 2016

Green River Community College

Presented by

**Department of Natural Resources and Parks**

Water and Land Resources Division

River and Floodplain Management Section

and

**Department of Permitting and Environmental Review**



**King County**

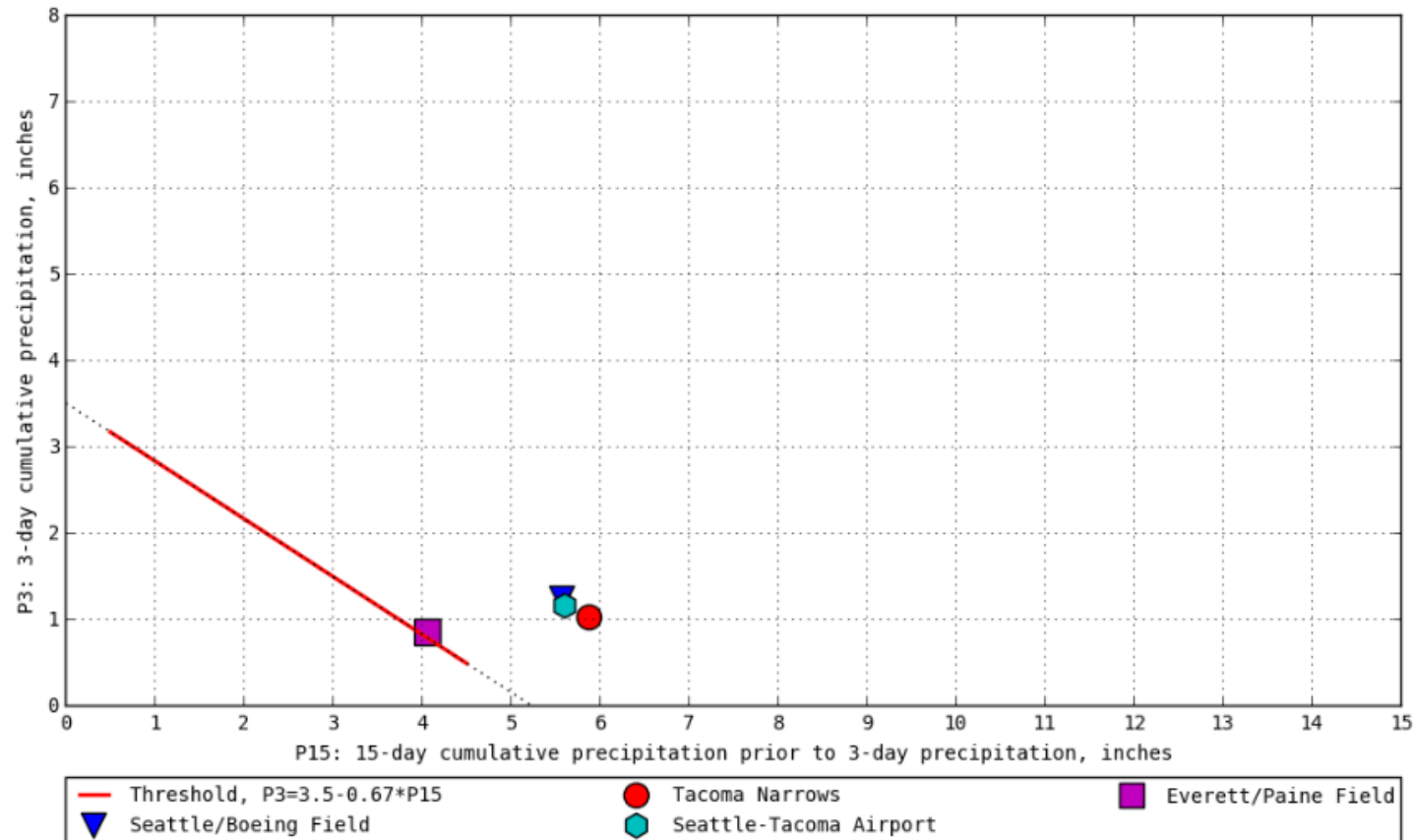


**KING COUNTY  
FLOOD CONTROL  
DISTRICT**

# Rainfall Relative to Threshold

## Cumulative Precipitation Threshold

Current conditions near Seattle, Washington,  
with respect to cumulative precipitation threshold for the occurrence of landslides  
USGS PROVISIONAL DATA  
SUBJECT TO REVISION  
Data last updated: 01 Nov 2016, 11:59.



Graph shows cumulative precipitation threshold for landslides (red line) and most recent update of 3-day and prior 15-day cumulative precipitation at selected National Weather Service Gages (symbols). Landslides are likely to occur on days when precipitation totals exceed the threshold (plot above or to the right of the red line). Landslides are unlikely to occur when precipitation totals plot below the red line, in the lower left corner of graph. Please direct questions or comments regarding this information to Rex Baum (baum [at] usgs [dot] gov).

# Presentation Outline

- **Welcome and Introductions**
- **Landslide Types**
- **New Mapping Products**
  - River Corridor Mapping
  - Department of Permitting and Environmental Review's Map of Potential Landslide Hazards
- **Resources**
- **Question and Answer**

# Introductions

## Department of Natural Resources and Parks

John Bethel, Geologist, WA LEG

Sevin Bilir, Geologist, WA LHG

Jeanne Stypula, Supervising Engineer, PE

## Department of Permitting and Environmental Review

Greg Wessel, Geologist, WA LEG

### Resources

- WA State Department of Natural Resources, Geologic Hazards Section, Division of Geology & Earth Resources
  - ❖ Trevor Contreras
  - ❖ Kate Mickelson
- Comments Central – 3 ways to ask questions
- Handouts (Agenda, Landslide FAQs, iMap tutorial, additional info)

## **Some Introductory Comments**

- **We live in landslide country**
- **Why landslide mapping now?**
- **Why two mapping efforts?**
- **Hazard vs. Risk**

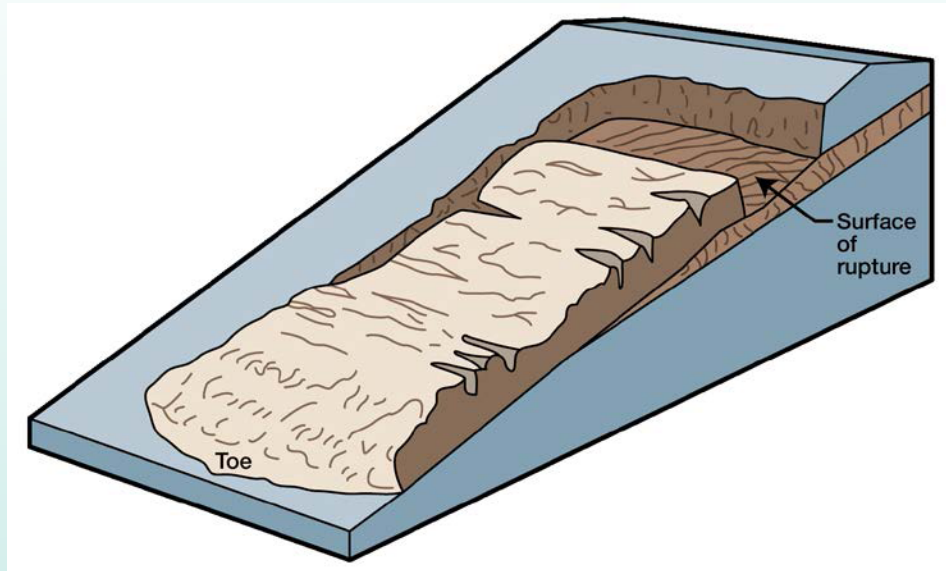


# Types of Landslide Hazards in King County

- Shallow debris slides
- Fans and debris flows
- Deep-seated landslides
- Rock fall
- Rock avalanches
- Snow avalanches



# Shallow Debris Slides



(Source: USGS Fact Sheet: Landslide Types and Processes, 2004-3072. <http://pubs.usgs.gov/fs/2004/3072/pdf/fs2004-3072.pdf>)

**BNSF Railway  
Everett to Seattle**



[View landslide video \(external link\)](#)



# Concerns with Shallow Debris Slides

- Can move quickly
- Can be highly destructive

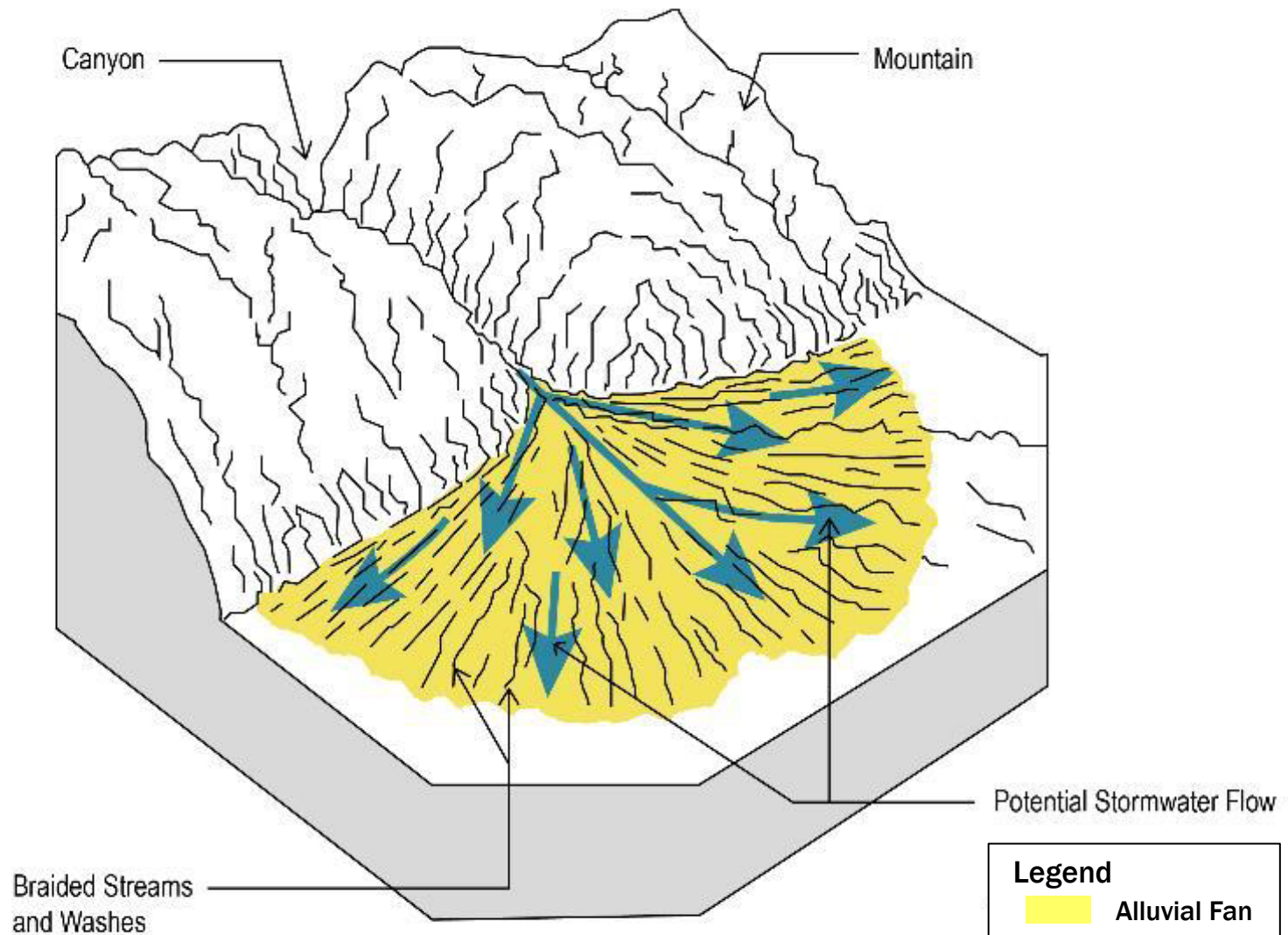


(Photo courtesy of WA Department of Ecology)

4/14/97



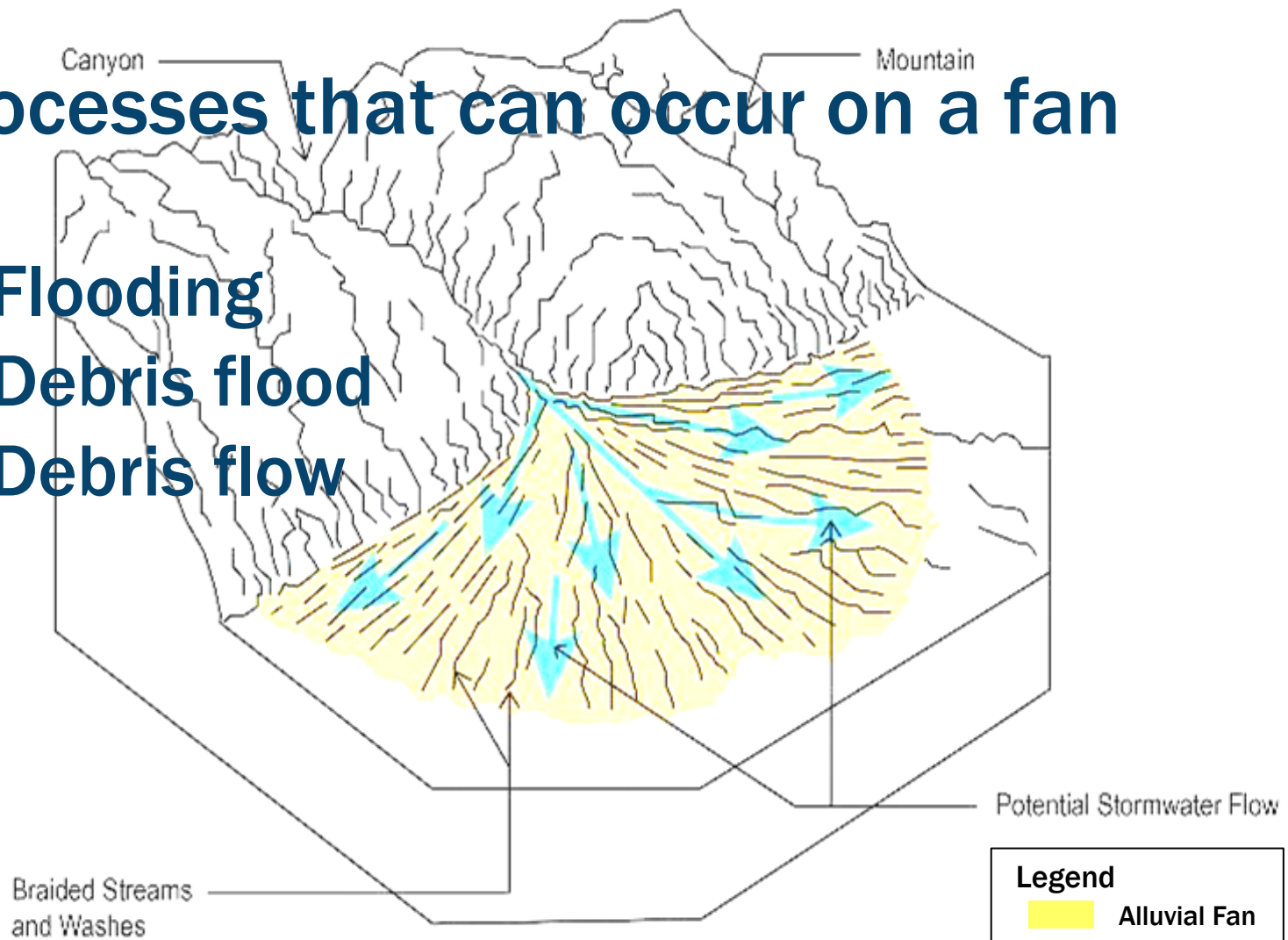
# Depositional Fans



# Depositional Fans

## Processes that can occur on a fan

- Flooding
- Debris flood
- Debris flow





**Flooding, Issaquah Creek**





**Debris Flood, Green Valley Rd. SE**





**Debris Flow, Washington Pass, SR 20**

# Concerns on Depositional Fans

- Flooding, Channel Migration, Debris Impact
- Hazard depends on process

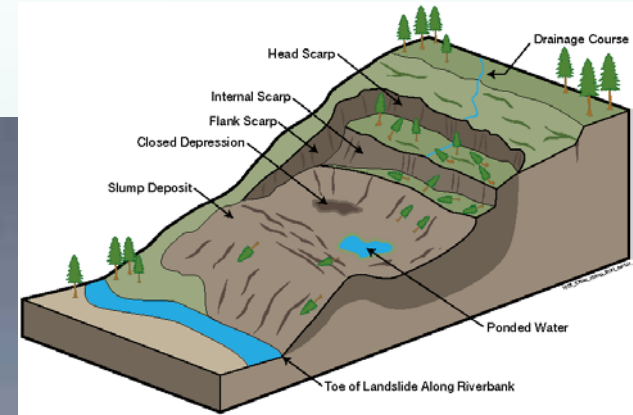
Residence near Clough Creek



Debris flood on Deer Creek (2012)



# Deep-Seated Landslides



# Concerns with Deep-Seated Landslides

- Can be remobilized
- Hazard depends on location on slide
- Can travel long distances

Aldercrest Banyon Landslide, Kelso, WA  
(1998 - 1999)

- 57 homes were destroyed



(Source: J. Rogers)



Landslide offset along a residential access road, Cedar River.





Denny Mt, Alpentel area



# Concerns with Rock Falls

- Fast moving
- Pose a serious threat to anything in their path

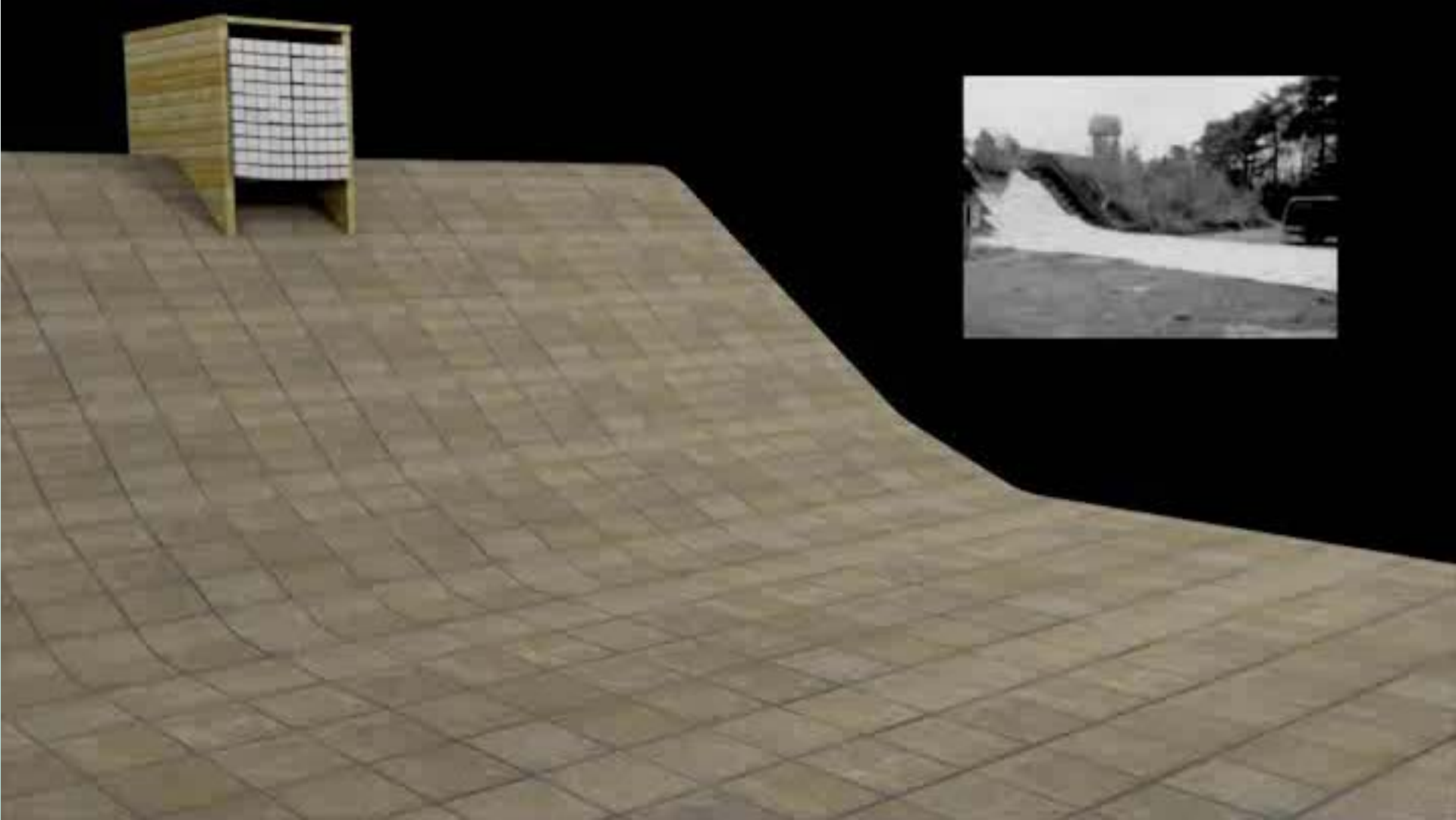


Boulder on Highway 2, Tumwater Canyon (2010)

“Huge boulder flattens 300-year-old house,” Northern Italy (2014)



# Video of Rock Avalanche Simulation



*View landslide video (external link)*



# Concerns with Rock Avalanches



Mt Si area

North Fork Snoqualmie River



- Fast moving
- Pose a serious threat to anything in their path



# Snow Avalanches



***Large scale avalanche control***

(Source: King County OEM)



***Small accidental slab avalanche***

(Source: NAC,  
[http://www.nwac.us/observations/pk/262/  
December 2015](http://www.nwac.us/observations/pk/262/December%202015))

# SR 530 (Oso) Landslide



# New King County Landslide Products

## ■ River Corridor Mapping:

- Mapping effort funded by the Flood Control District to be used along river corridors to better understand flood-related hazards in these areas.

## ■ Potential Landslide Hazards Mapping:

- Mapping effort funded by the Department of Permitting and Environmental Review for unincorporated areas with residential development to be used by the public and County to inform on whether a potential hazard exists and further information is needed to gain permits.



# Department of Natural Resources and Parks

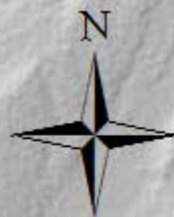
**John Bethel**

**Environmental Scientist/Engineering Geologist**





# Tolt River Valley

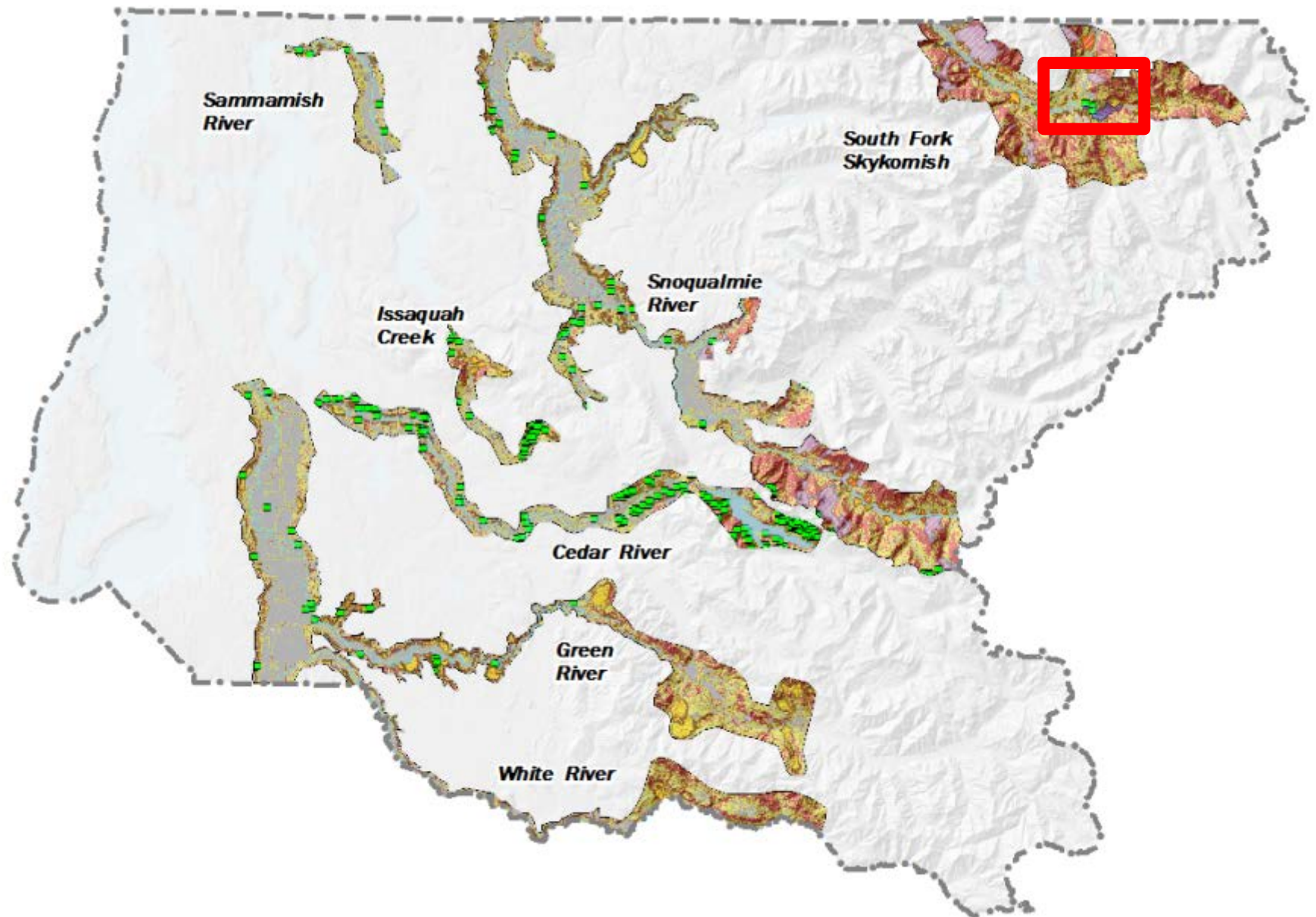


# Landslide Types Mapped in River Corridors

- Shallow debris slides
- Fans and debris flows
- Deep-seated landslides
- Rock fall
- Rock avalanches




















# River Corridor Landslide Hazard Map

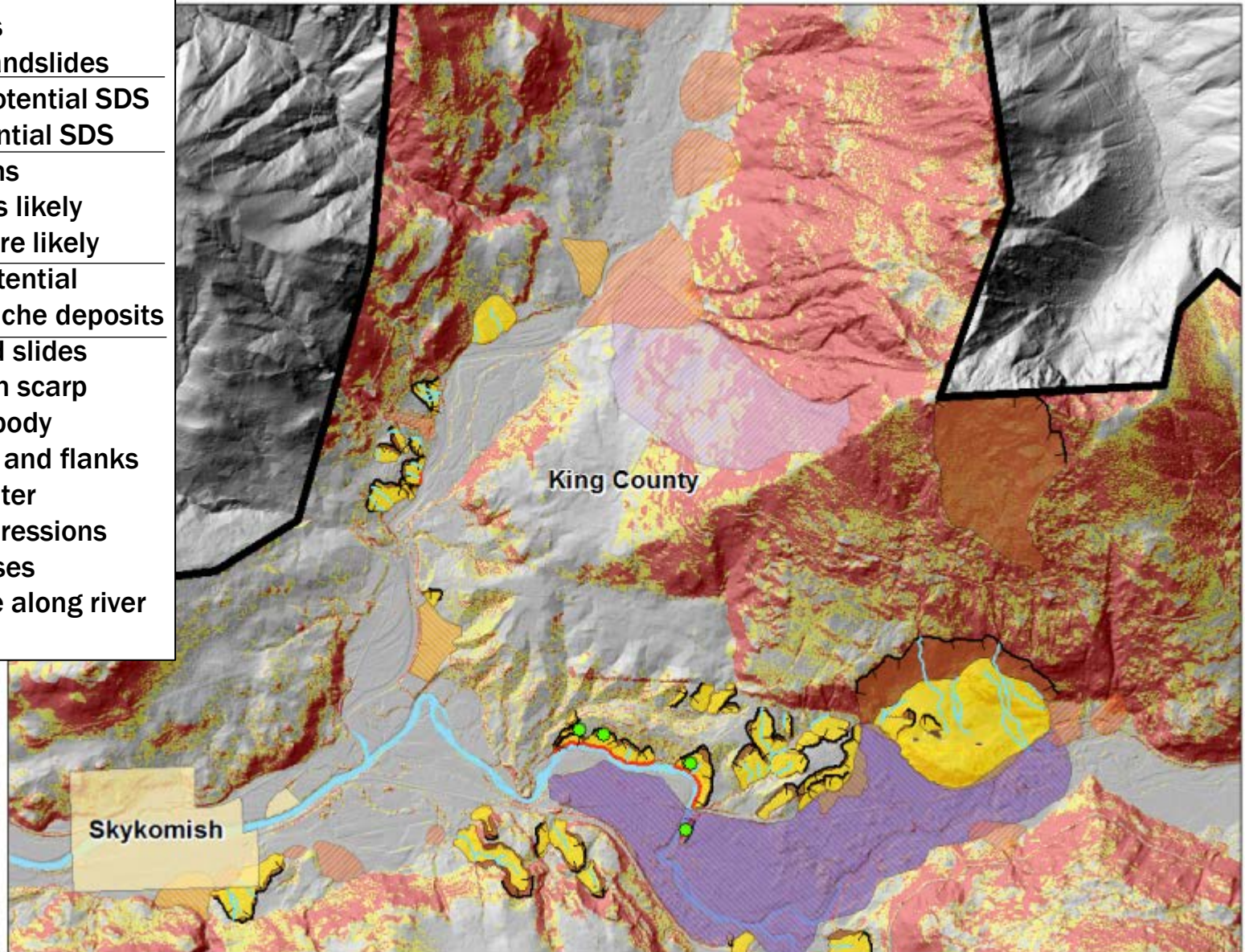




# River Corridor Landslide Hazard Map

## Legend

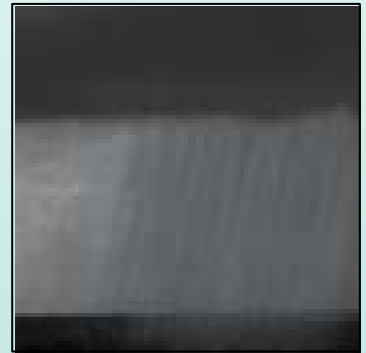
-  Study Limits
-  Historical Landslides
-  Moderate potential SDS
-  Severe potential SDS
-  Lowland Fans
-  Alpine - less likely
-  Alpine - more likely
-  Rock fall potential
-  Rock avalanche deposits
-  Deep-seated slides
-  Top of main scarp
-  Landslide body
-  Headscarp and flanks
-  Ponded water
-  Closed depressions
-  Watercourses
-  Toe of slide along river





# Considerations in Using Map Information

- Timing and probability of future movement
- Impacts from climate change
- Effects from earthquakes



# Uses of River Corridor Mapping

- Intended to support King County river corridor planning and capital projects for flood risk reduction.
- It may also be of use to:
  - City and County emergency planners
  - Transportation and utility managers
  - Geotechnical consultants
  - Residents

# Department of Permitting and Environmental Review

**Greg Wessel**

**Environmental Scientist/Engineering Geologist**



# Basic principles for mapping and regulating geologic hazards

- Both justification and authority should be clear.
- Specific and understandable criteria: definitions are important.
- Only qualified geologists with applicable experience.
- In line with existing codes.
- Recurrence intervals are important, if known (When is a landslide not a hazard?).



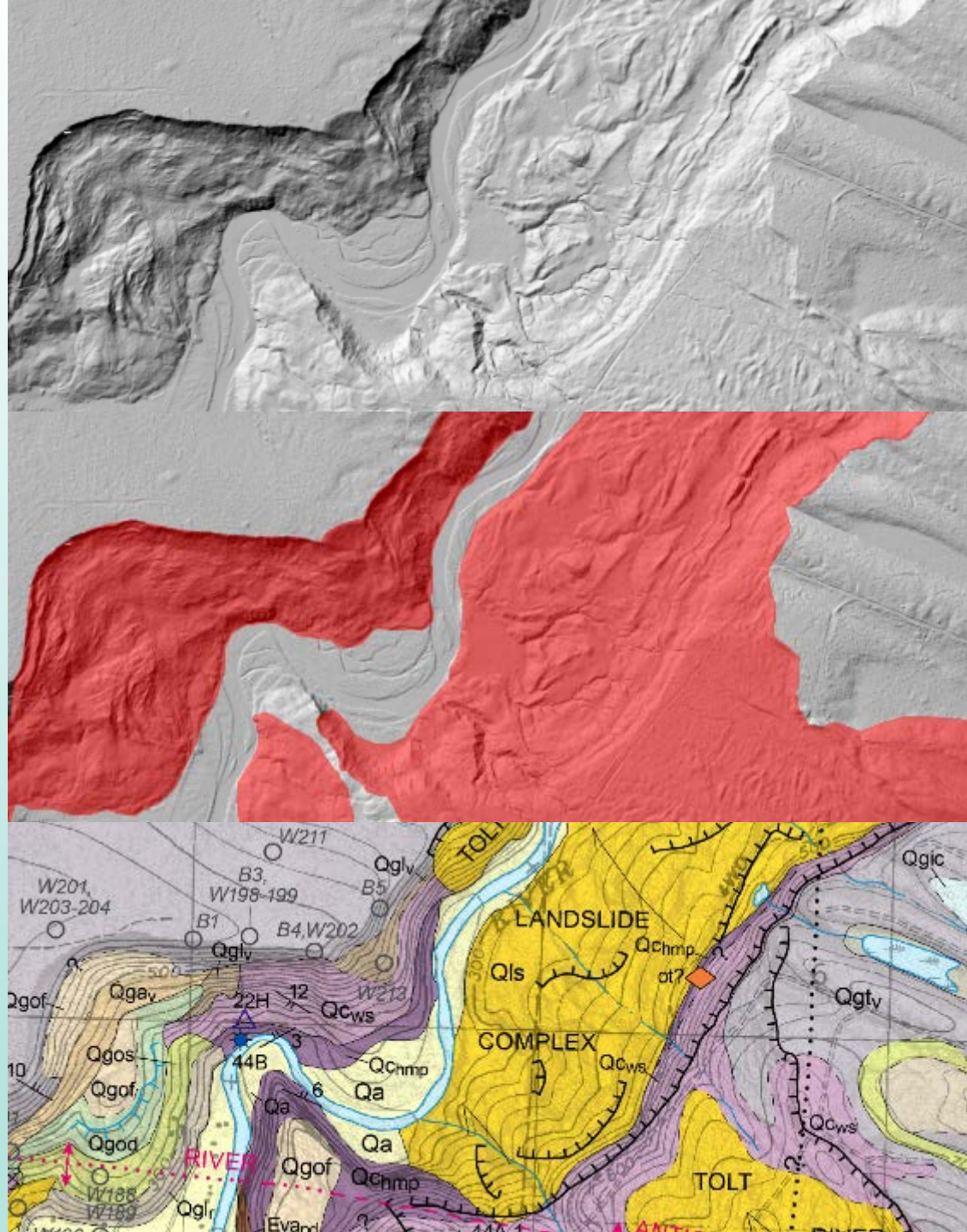
# **KCC 21A.24.280 Landslide hazard areas — development standards and alterations**

- A buffer is required from all edges of the landslide hazard area. Without a geotechnical study, the buffer is 50 feet wide.
- Alterations in a landslide hazard area located on a slope less than forty percent are allowed if:
  1. The proposed alteration will not decrease slope stability on contiguous properties; and
  2. The risk of property damage or injury resulting from landsliding is eliminated or minimized through mitigation.
- Mitigation may include avoidance or engineering (special structural design additions).

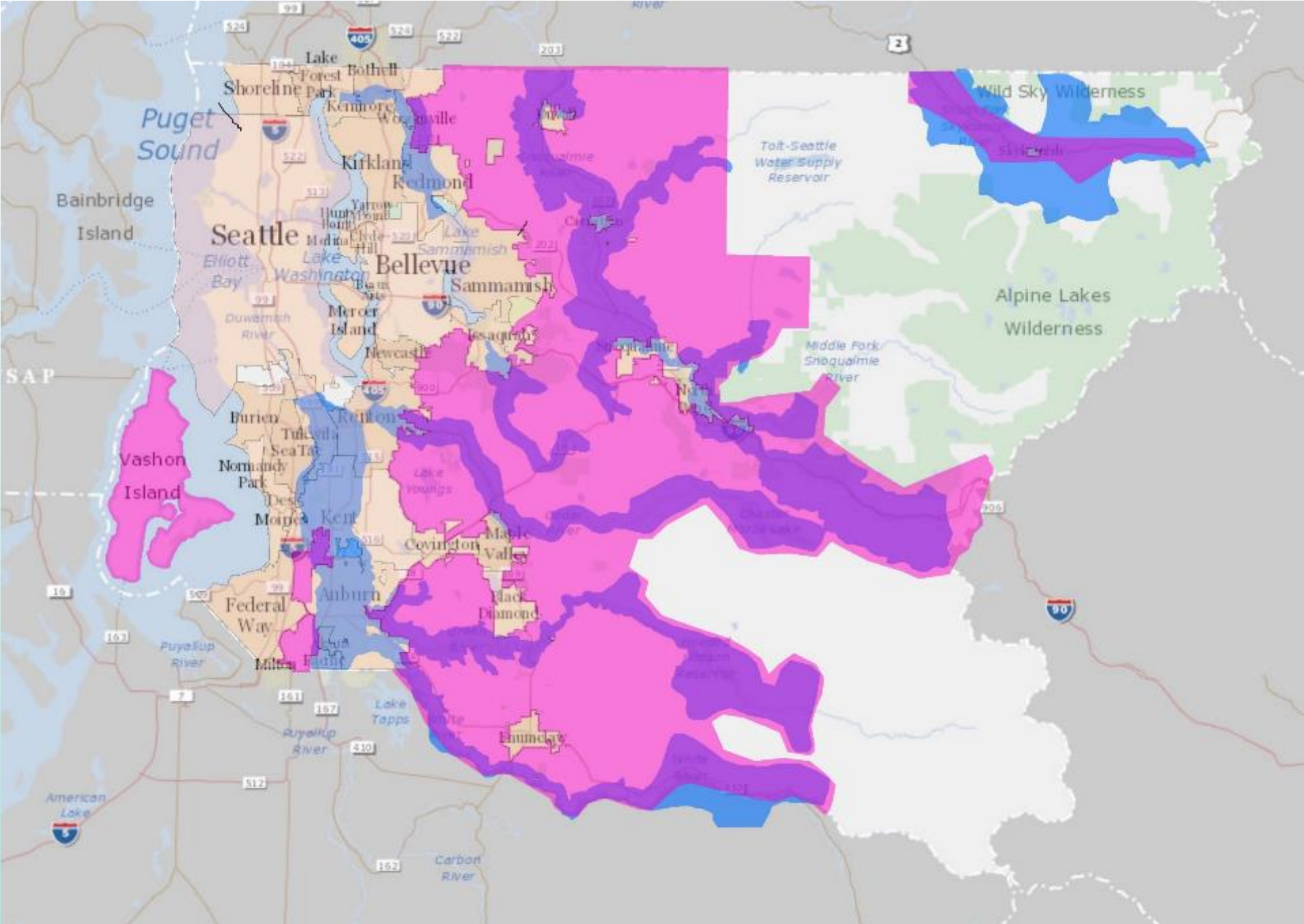
# KCC 21A.24.310 Steep slope hazard areas — development standards and alterations

- A buffer is required from all edges of the steep slope hazard area. Without a geotechnical study, the buffer is 50 feet wide.
- New development on or near a steep slope is only allowed if accompanied by a geotechnical study that confirms there will be no adverse impact from the development, either to the development itself or to adjacent properties. (Note: this is essentially the same standard to which landslide hazards are held.)
- As with landslide hazards, mitigation may be required for development on or near steep slopes.

**Comparison of LiDAR  
hillshade, potential  
landslide hazards, and  
mapped geology,  
lower Tolt River valley,  
King County, WA**  
(geology from Dragovich, et al, 2012)

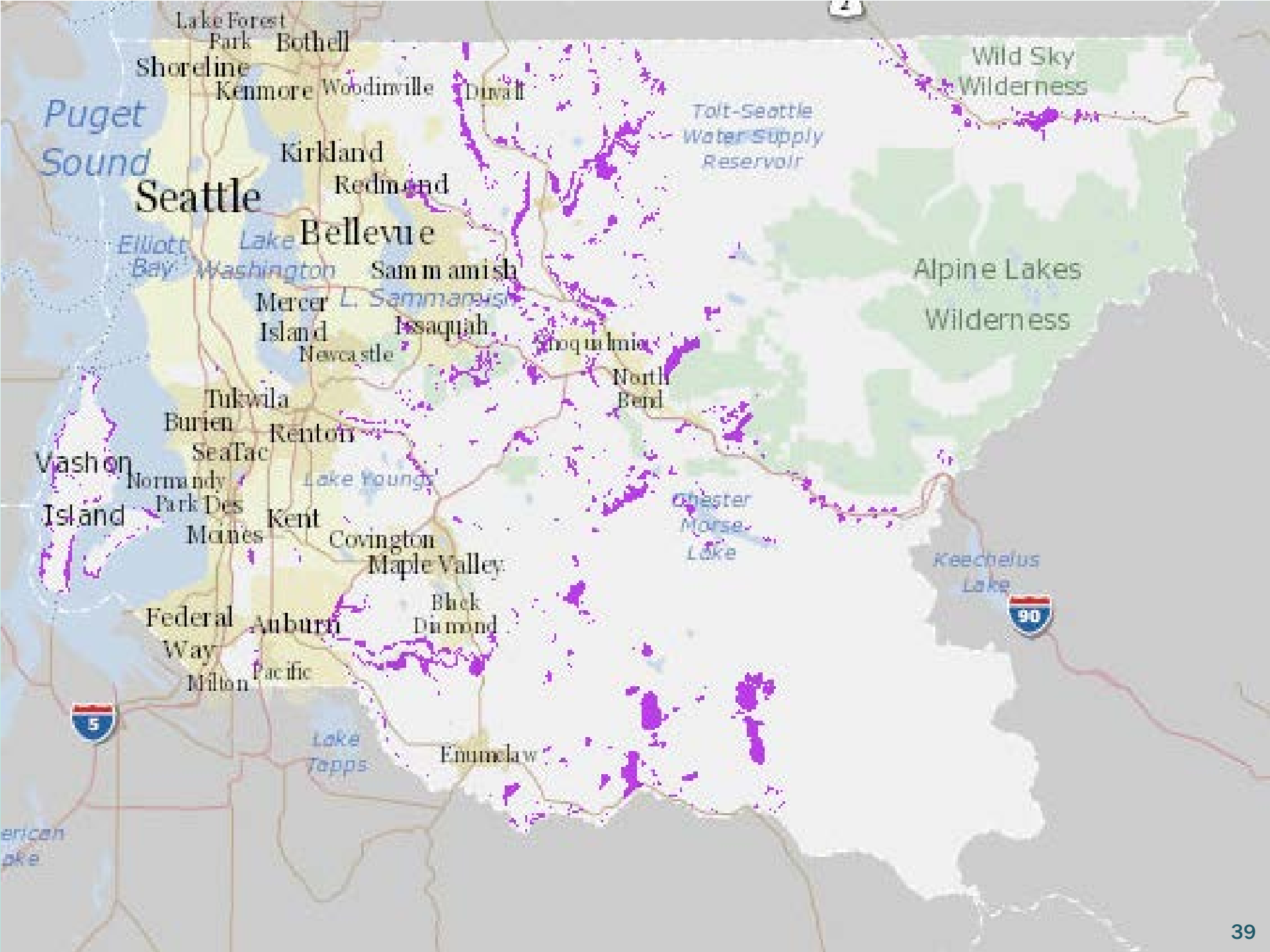






# Landslide Hazards Mapped

- Slumps and other deep-seated landslides
- Rockfalls
- Rock avalanches
- Debris/alluvial fans
- Snow avalanche zones (to a degree)
- Slopes undercut along a shoreline
- Unclassified larger-scale mass wasting
- Landforms suggestive of dominant mass wasting
- Slopes potentially susceptible to shallow landsliding (steep slopes)





## What the mapping is:

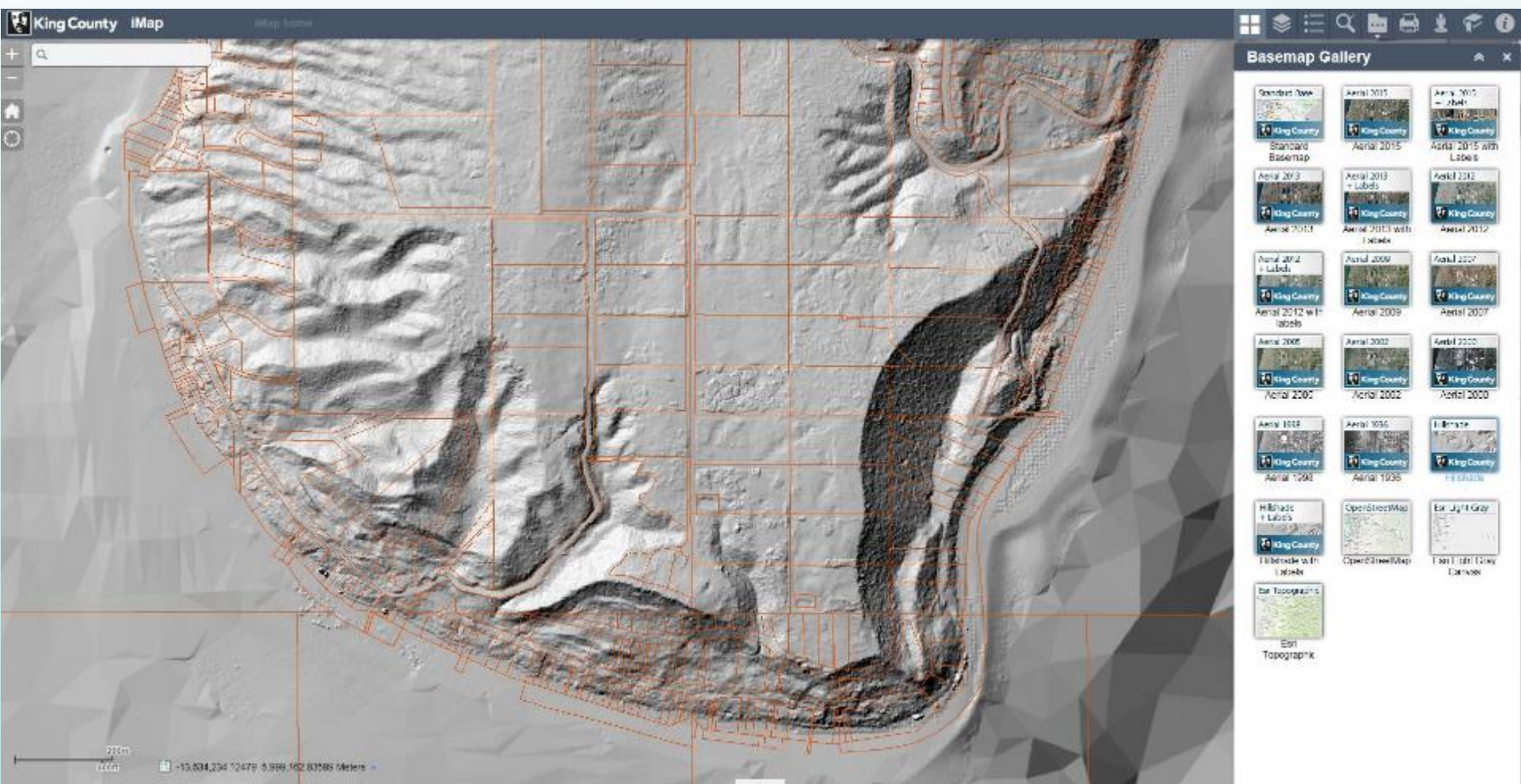
- A reasonable approximation of what may be landslide hazards based upon LiDAR photointerpretation by experienced geologists and the best available geologic mapping, which though best available may not be all that good everywhere.
- No field data were collected to use in creating these maps.

## What the mapping is not:

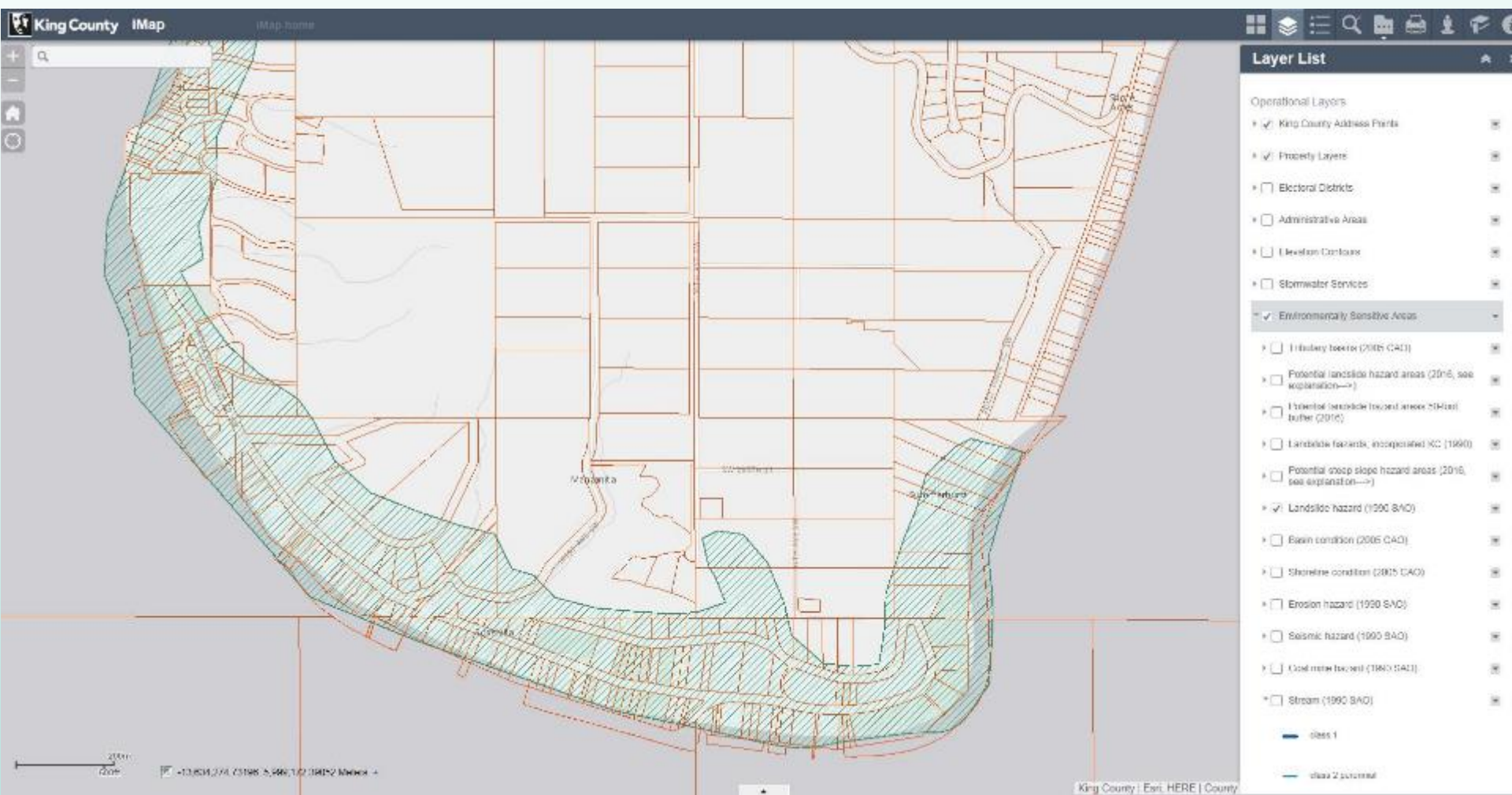
- A definitive representation of landslide hazards.
- No field data were collected to use in creating these maps.
- *Further site-specific investigations are necessary to determine the presence and nature of any hazard and the level of risk.*

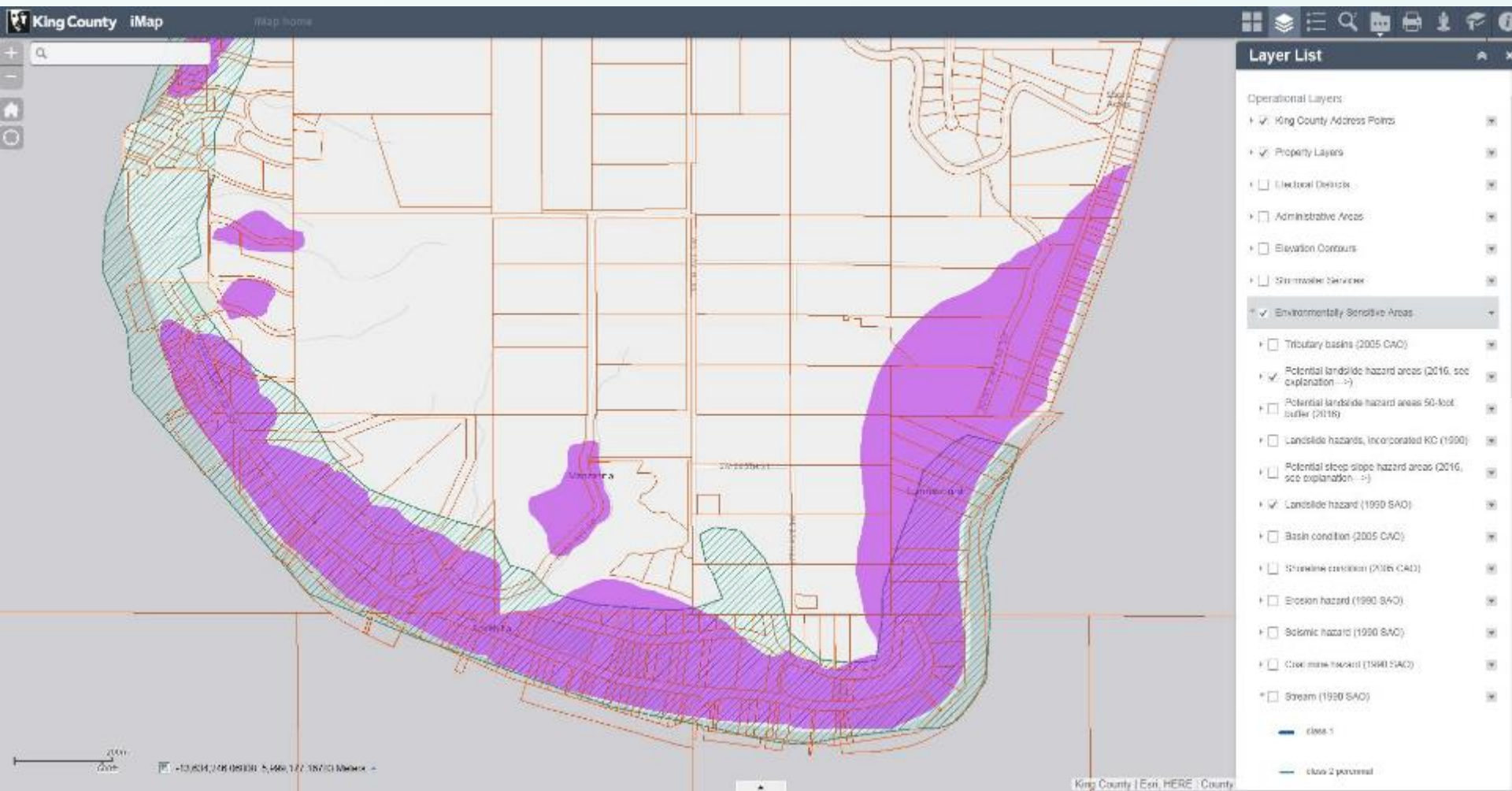


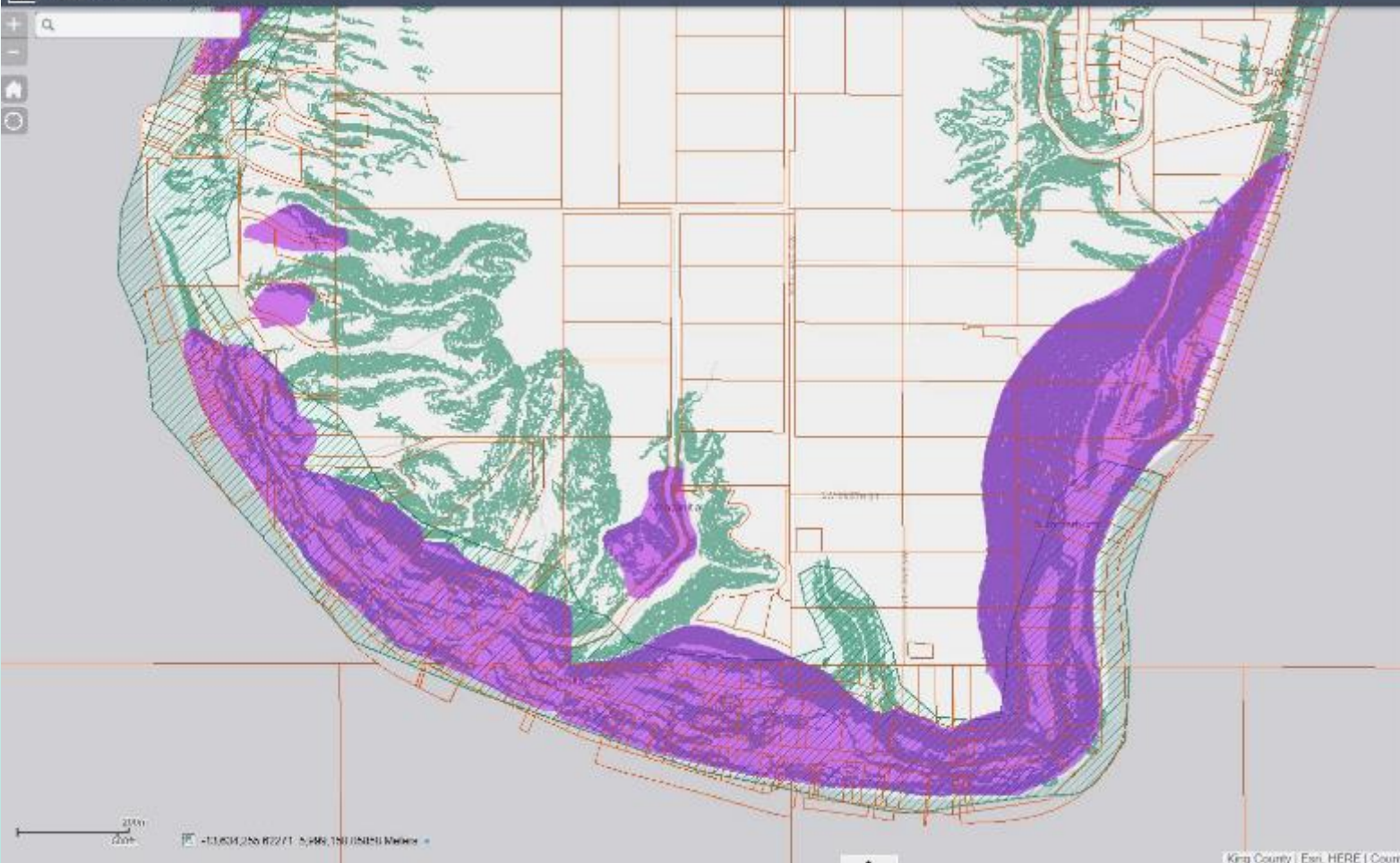










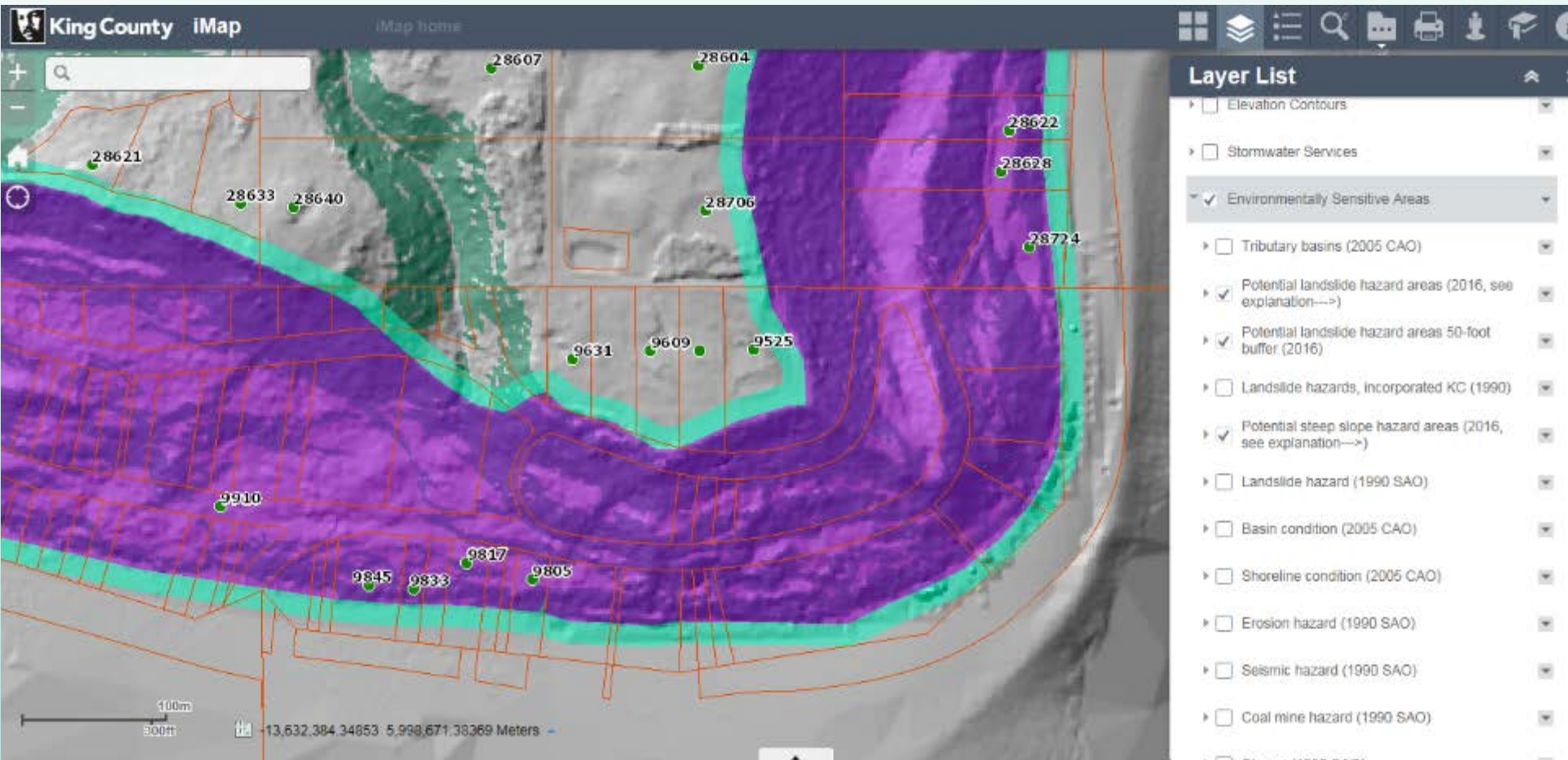


## Layer List

- ☒ King County Address Points
  - ☒ Property Layers
  - ☐ Historical (Zabriskie)
  - ☐ Administrative Areas
  - ☐ Elevation Contours
  - ☐ Streamable Services
  - ☒ Environmentally Sensitive Areas
    - ☐ Tributary basins (2005 CAO)
    - ☒ Potential landslide hazard areas (2016, see explanation-->)
    - ☐ Potential landslide hazard areas 50-foot buffer (2016)
    - ☐ Landslide hazards, Incorporated KC (1990)
    - ☒ Potential steep slope hazard areas (2016, see explanation-->)
    - ☒ Landslide hazard (1997 SAC)
    - ☐ Basin condition (2005 CAO)
    - ☐ Shoreline condition (2005 CAO)
    - ☐ Erosion hazard (1997 SAC)
    - ☐ Seismic hazard (1990 SAC)
    - ☐ Coal mine hazard (1990 SAC)
    - ☐ Stream (1990 SAC)
- class 1
- class 2 potential
- class 2 actual









# King County Landslide Resources

## King County

### Permitting



Department of Permitting and  
Environmental Review



### River Corridors Mapping



River and Floodplain  
Management Section

### King County iMAP



King County GIS Center

### Emergency Management



Office of Emergency Management





## **Department of Natural Resources and Parks**

John Bethel, Geologist, WA LEG

Sevin Bilir, Geologist, WA LHG

Jeanne Stypula, Supervising Engineer, PE

## **Department of Permitting and Environmental Review**

Greg Wessel, Geologist, WA LEG