Landslide Mapping Using LiDAR: Kenton and Campbell Counties, Kentucky

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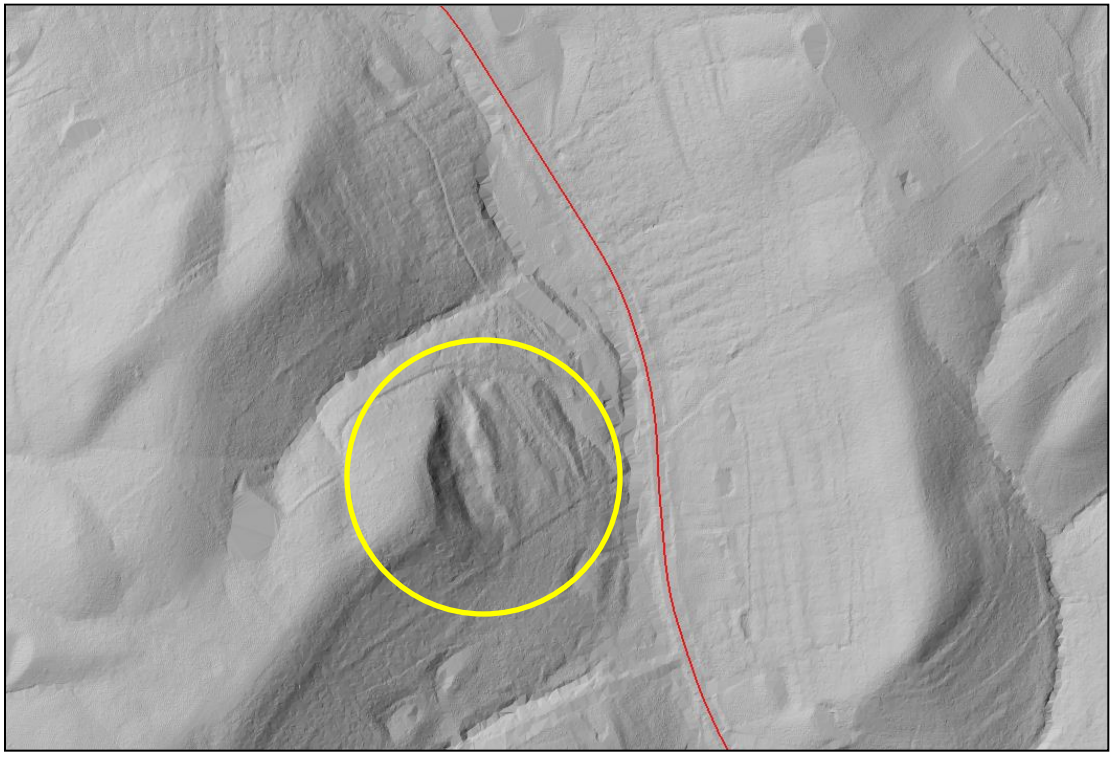
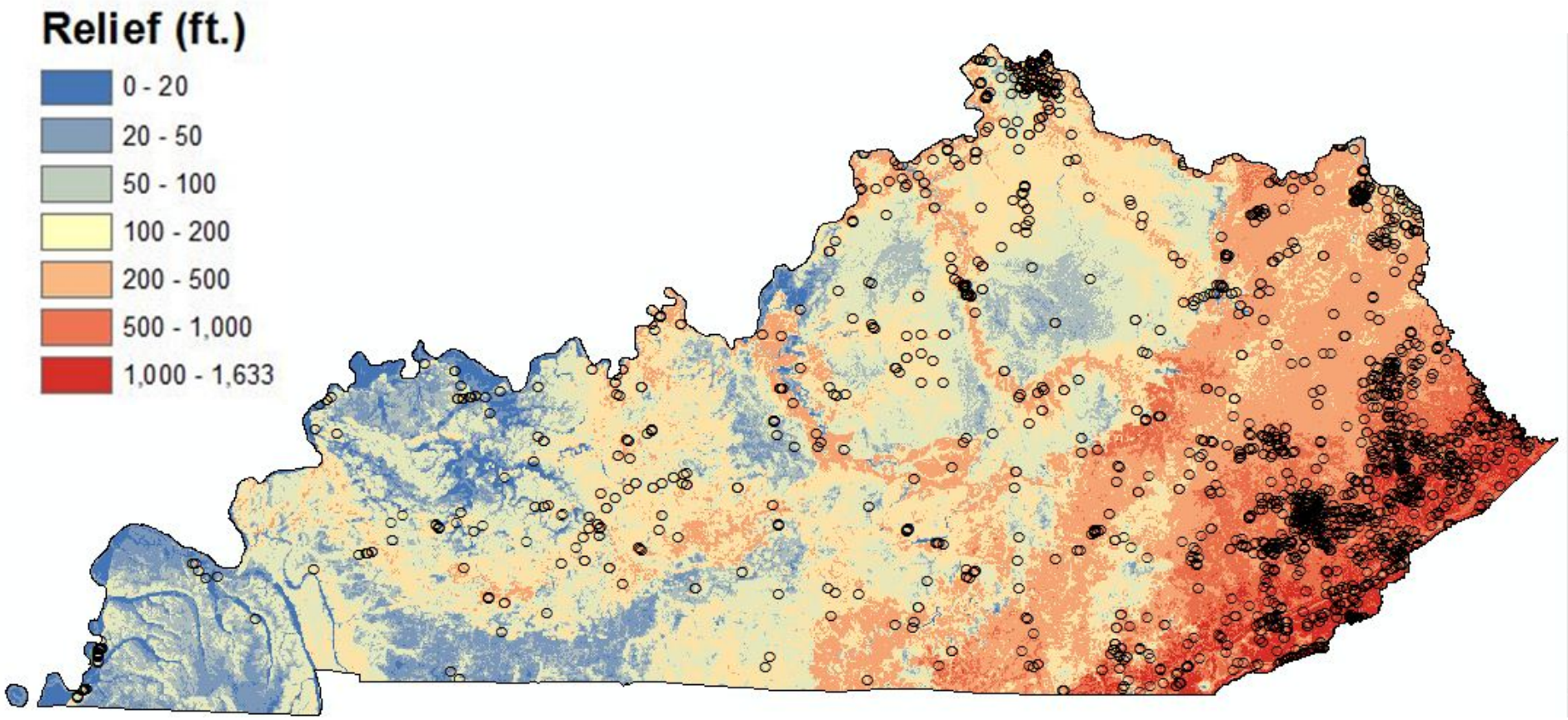


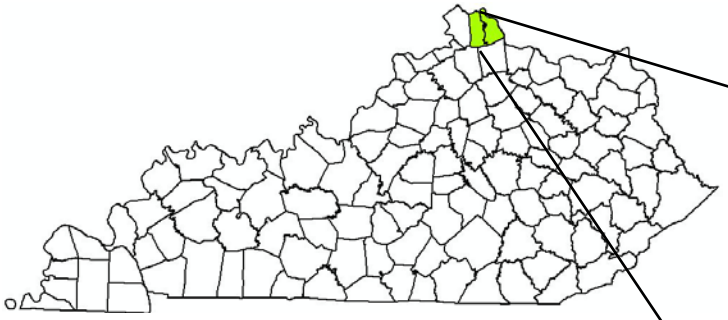
12th Annual Technical Forum

GEOHAZARDS IN TRANSPORTATION IN THE APPALACHIAN REGION
July 31 – Aug 2nd, 2012
Beckley, WV

Kentucky Landslide Locations



Kenton and Campbell Counties, KY



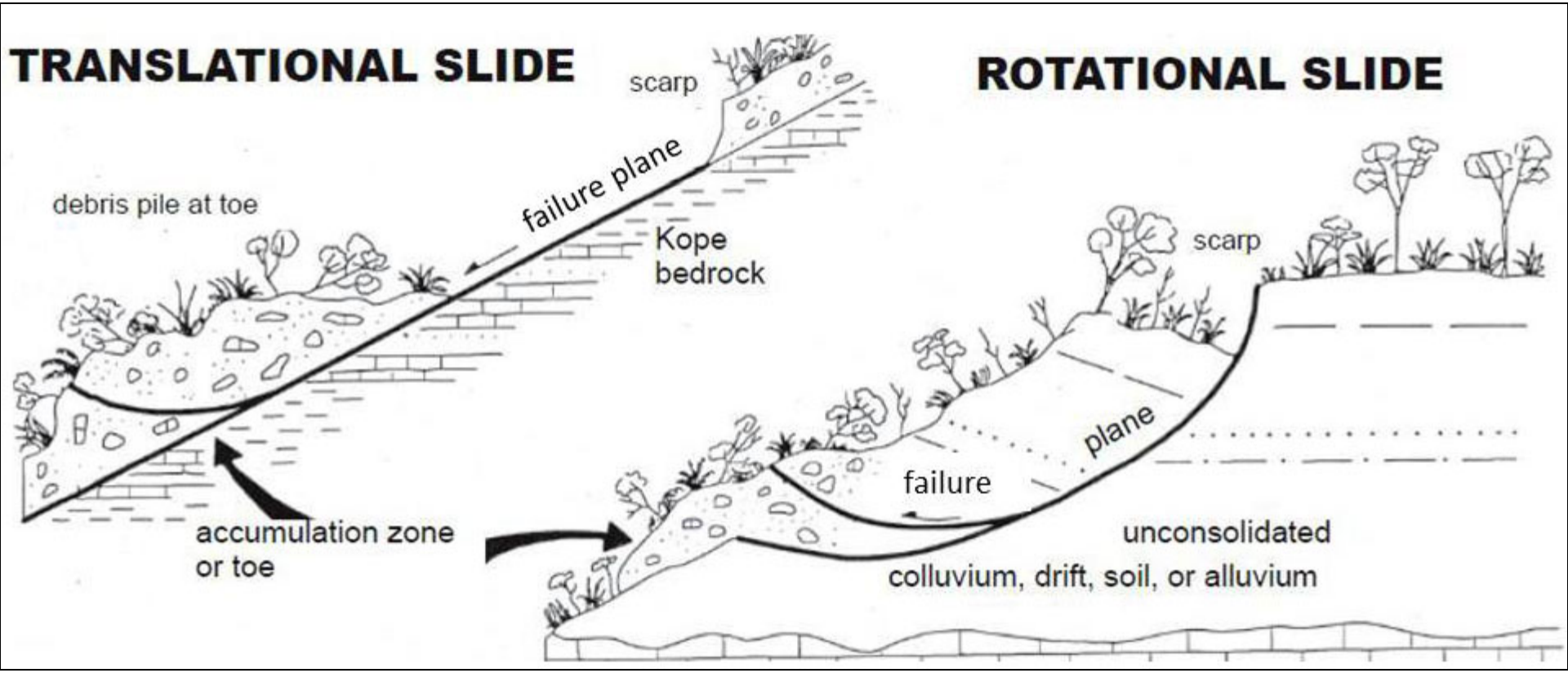
The Problem

Natural geology, topography, and decades of slope modification make Kenton and Campbell Counties susceptible to landslides, many recurring.

Example costs:

- 71 landslide geotechnical reports from KYTC…unknown cost
- 55 landslides located from other sources
- April-May 2011 storms cost KYTC District 6 over $4 million
- FEMA is about to submit a letter of intent for a 2.5 million dollar stabilization project in Bellevue, Ky. Campbell Co.

Landslide Types



Kenton and Campbell Co., landslides

Creep and generations of failure

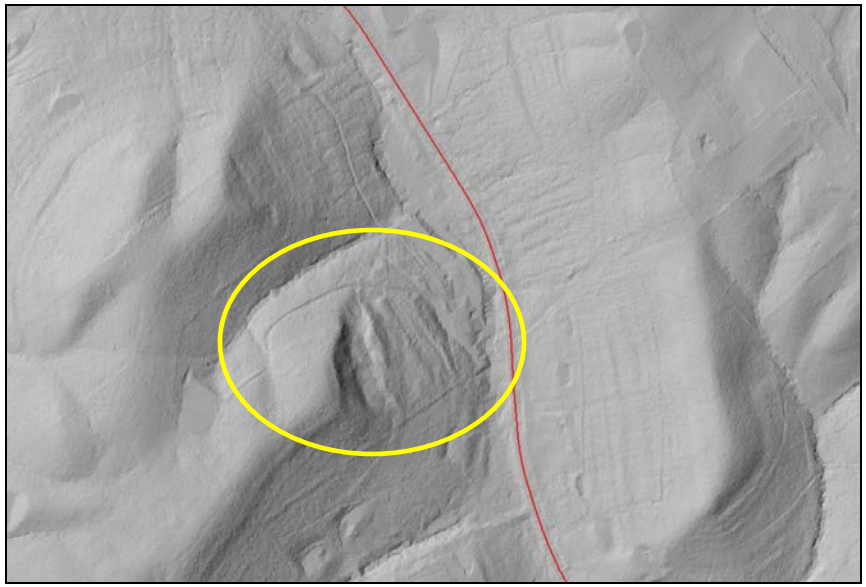
Kenton and Campbell Co. landslides

Creep and generations of failure

Kenton and Campbell Co. landslides

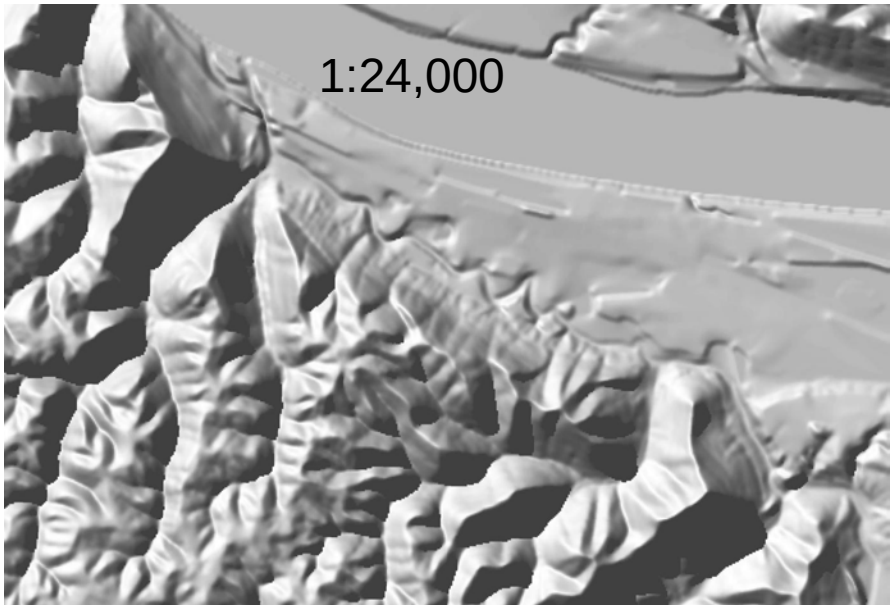
Light Detection and Ranging (LiDAR) Project

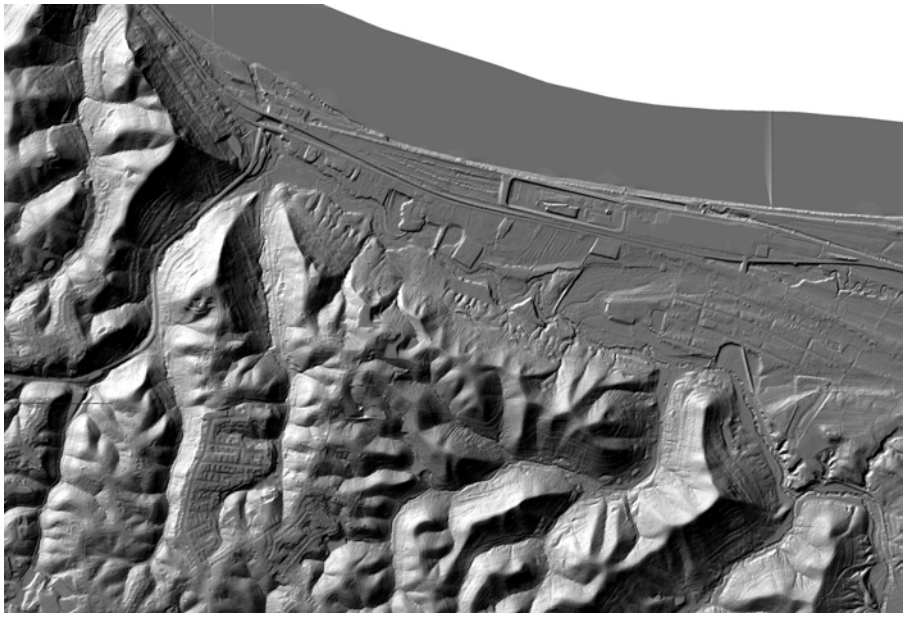
- Purpose: develop a methodology using LiDAR data in the geologic setting of Kenton and Campbell Co. and to document landslides



- LiDAR flown in 2007. Data provided by the NKAPC
- Modeled after other states: OR, WA
- Completed March 2011, grant from the USGS Landslides Hazards Program

10 m DEM-hillshade, Campbell Co., Ky.
Vs.
1 m resolution LiDAR

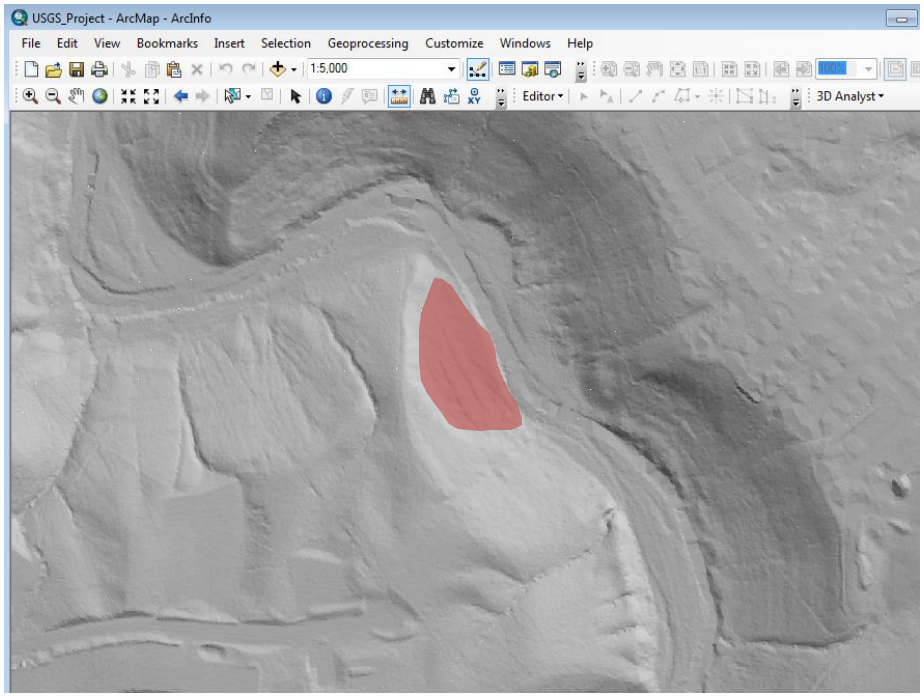




Bare earth model

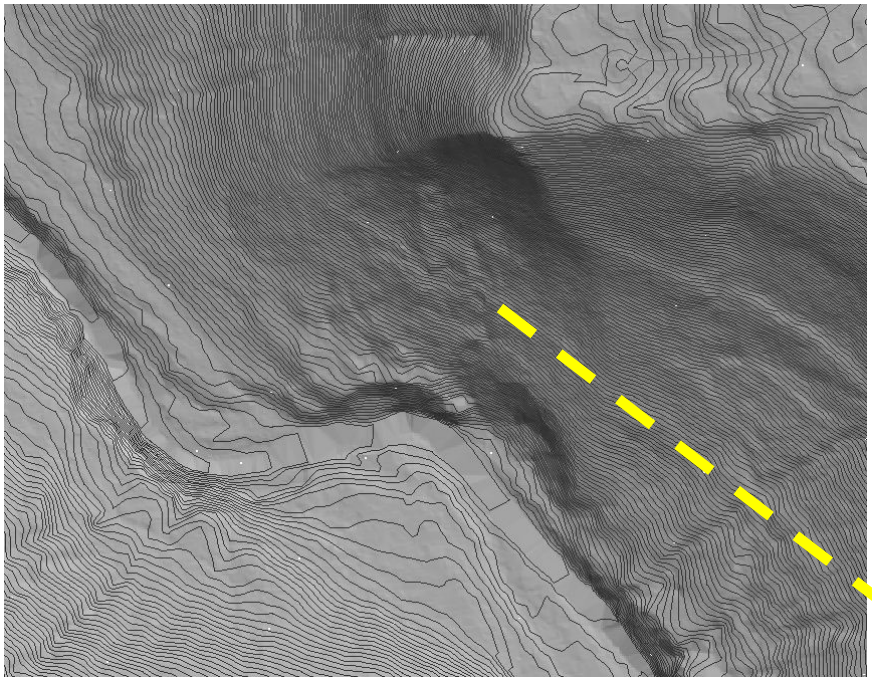
Methodology

- Used Quick Terrain Modeler to create hillshade DEM's from the LAS files
- Add DEM's to ArcMap for visualization, spatial analysis, and digitization

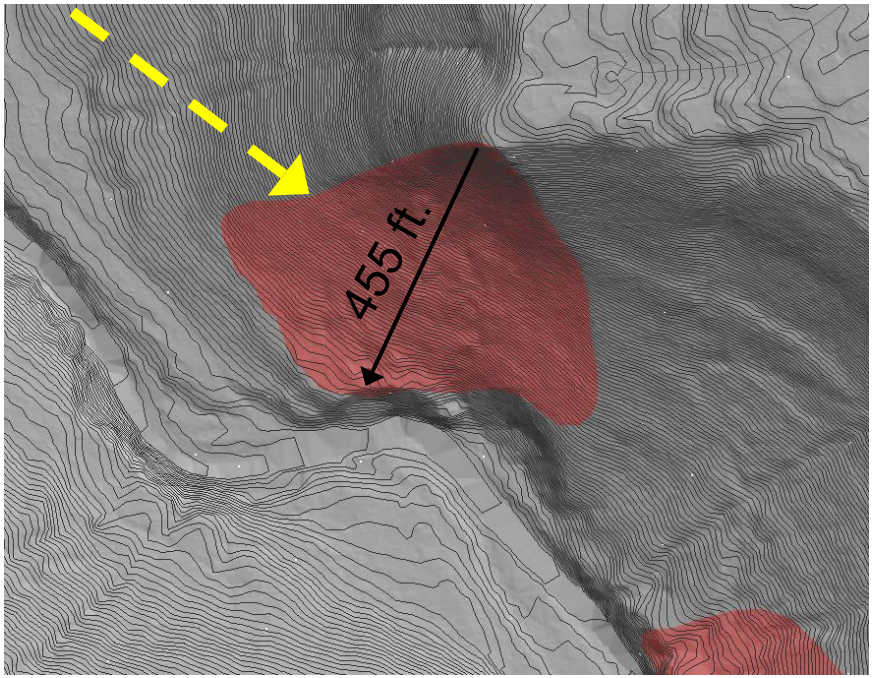


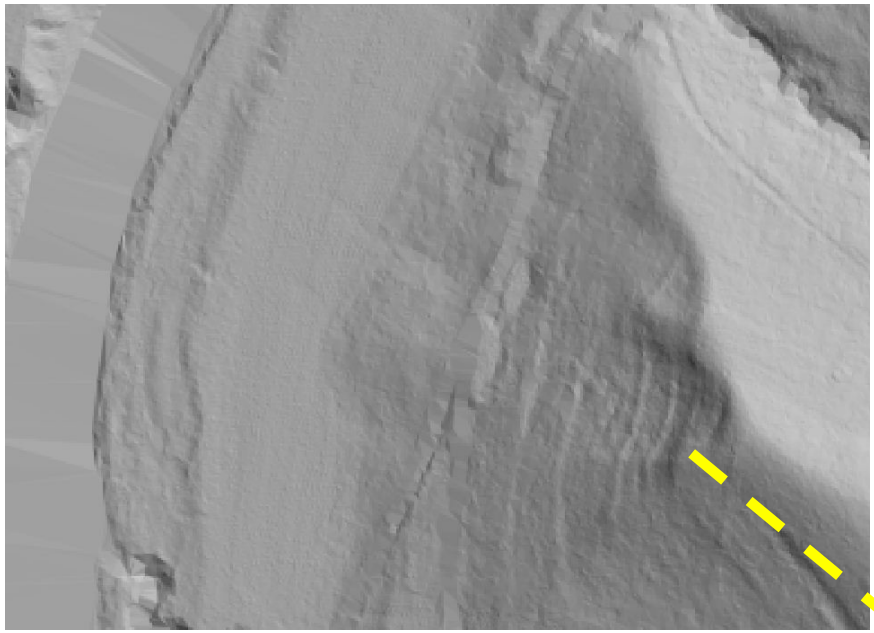
- Systematic panning looking for
  - Hummocky surface
  - Steep scarp, flanks
  - Thick toe
  - Concavity
- Reexamined potential landslides in QTM
- Performed field checking

Example: LiDAR derived hillshade DEM with contours



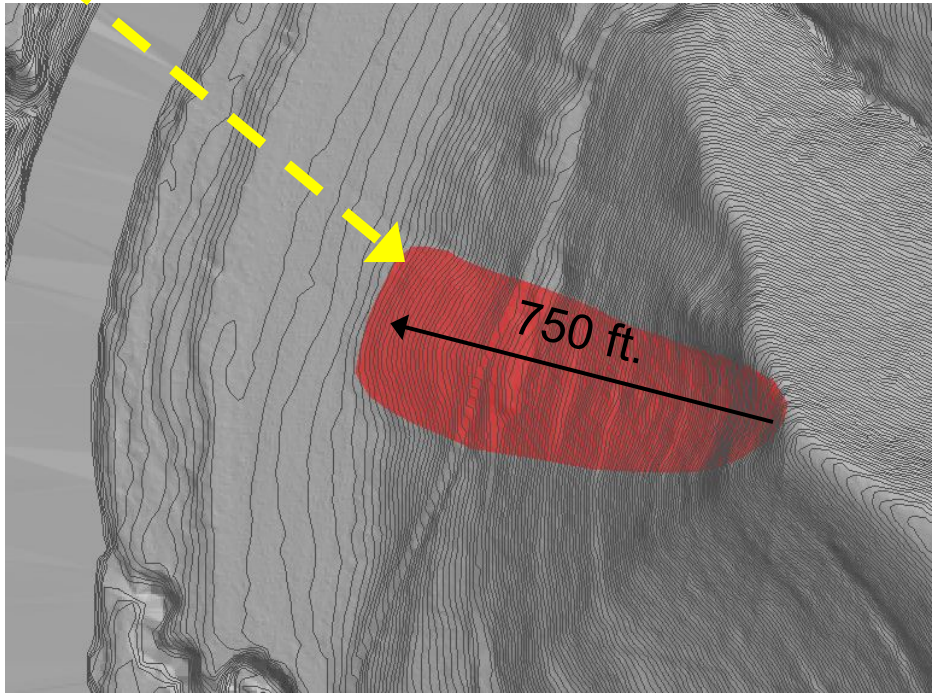
Mapped landslide

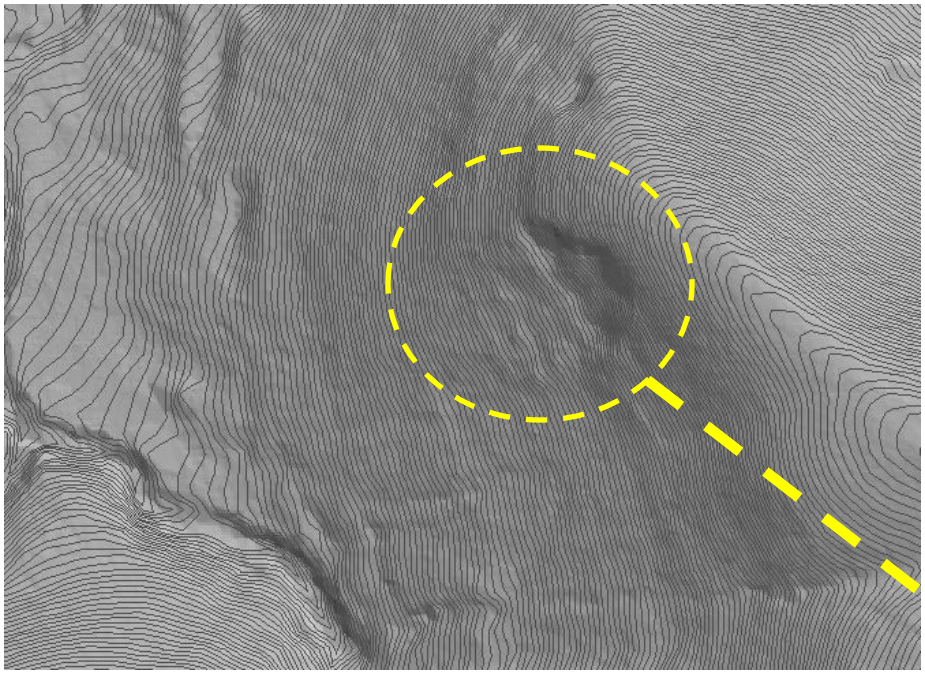




Example: LiDAR derived hillshade DEM without contours

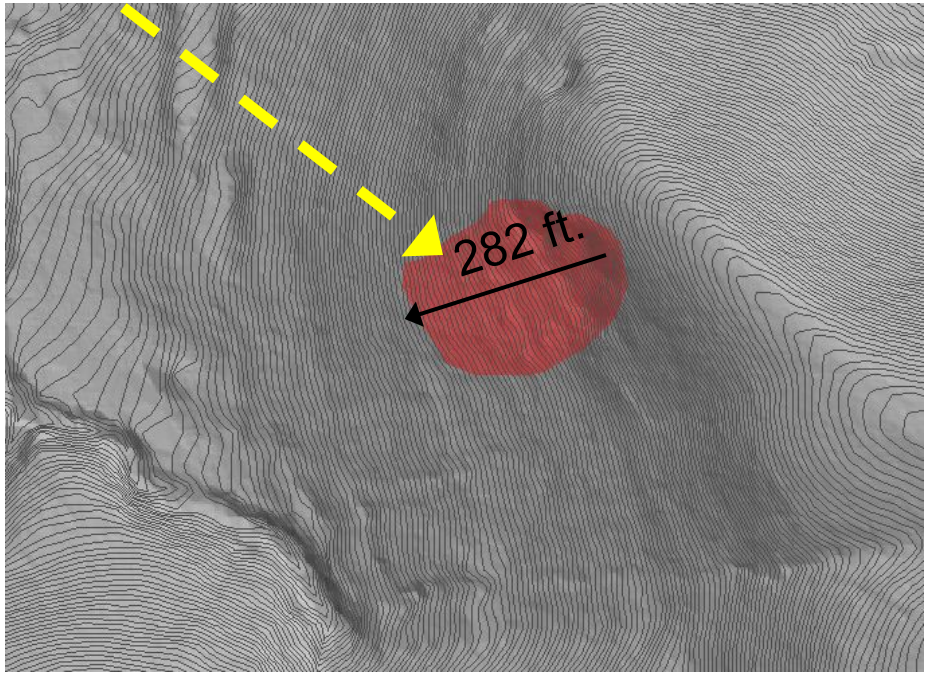
Mapped landslide



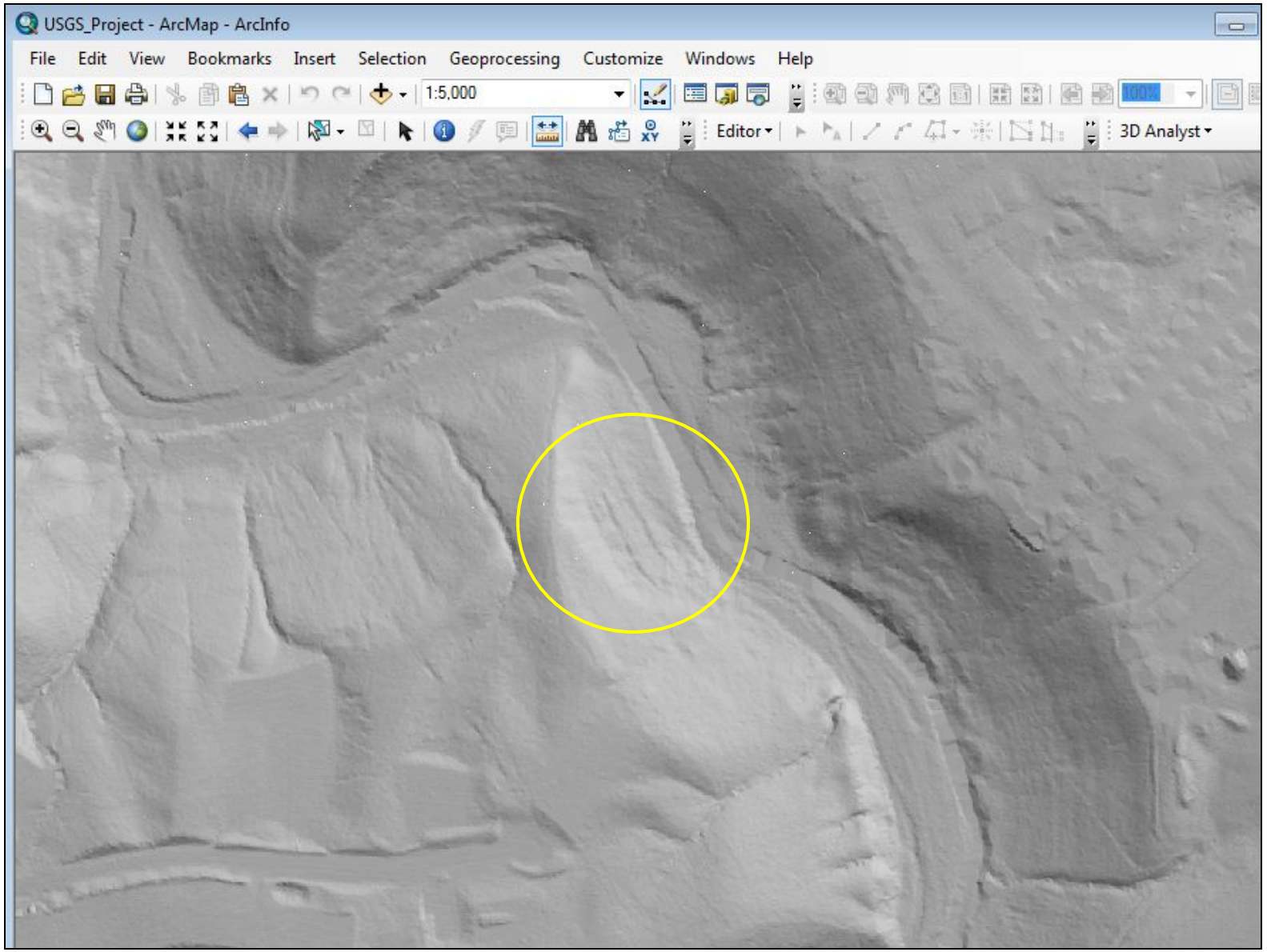


Example: LiDAR derived hillshade DEM with contours

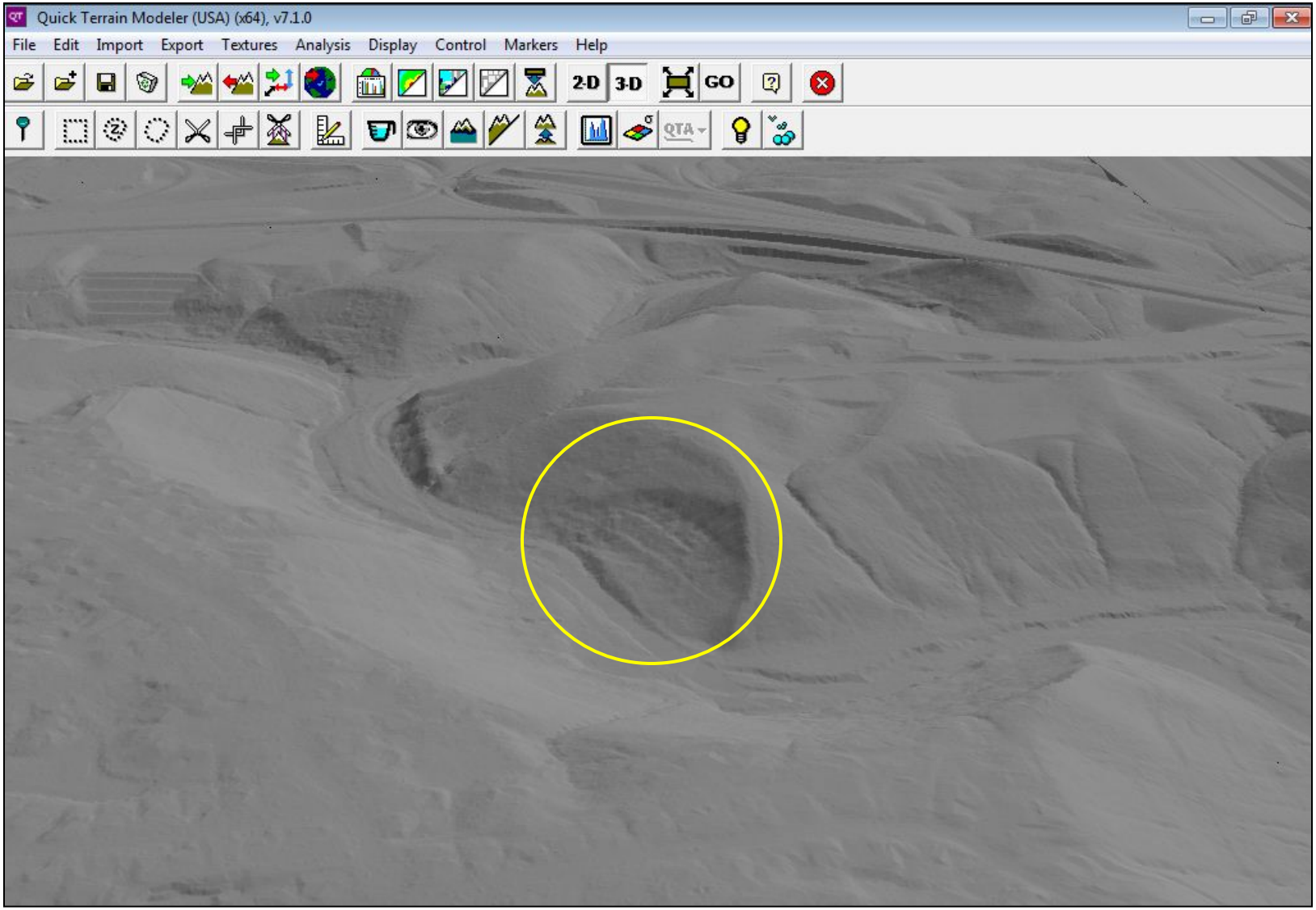
Mapped landslide



Example: potential landslide identified on LiDAR derived hillshade DEM. Azimuth and sun angle at 45º

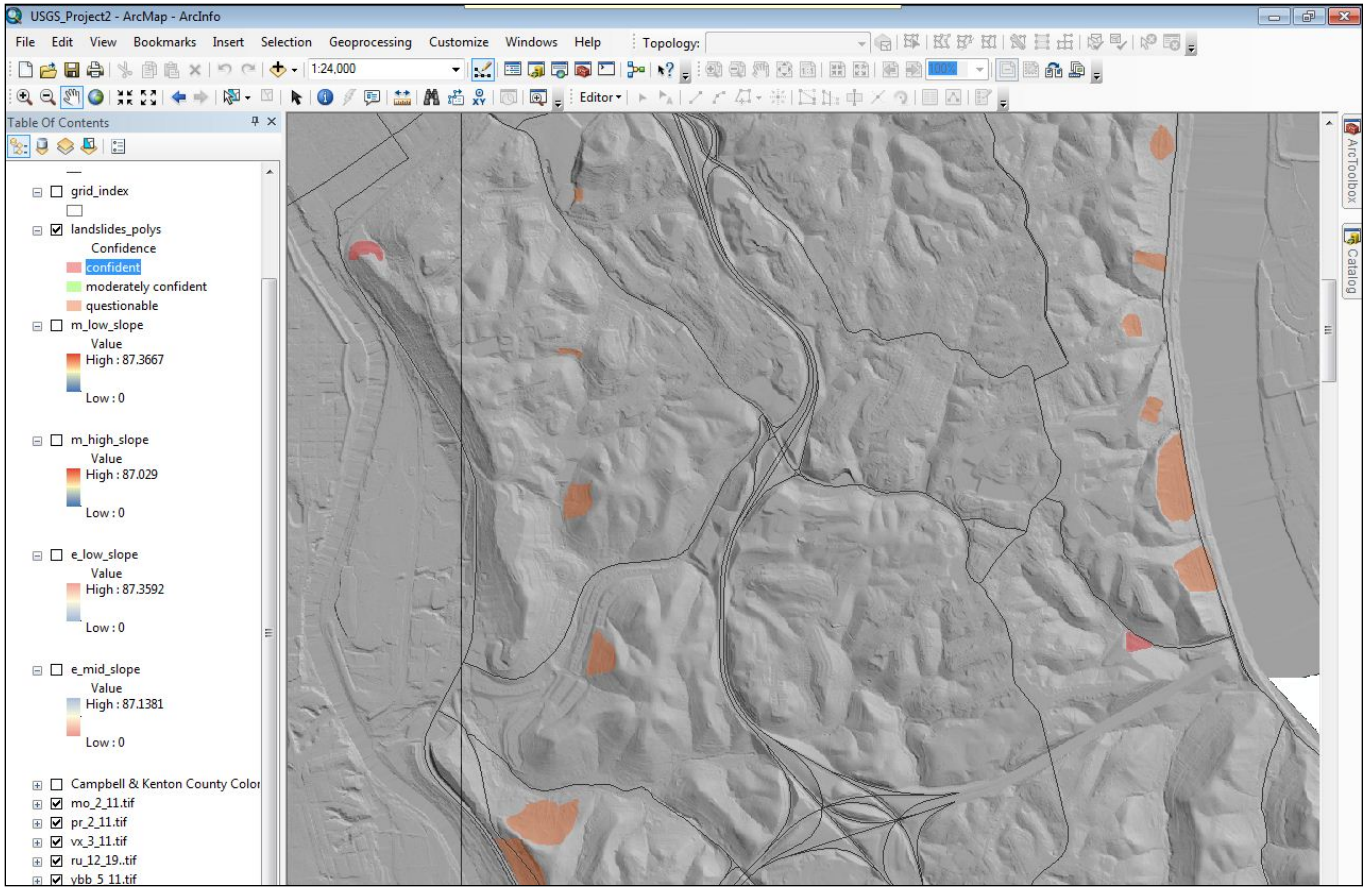


Three-dimensional view of the same landslide in Quick Terrain Modeler. Changing the sun angle and azimuth can make the scarp and flanks stand out. The image was rotated in 3D and the azimuth was changed to 225°.



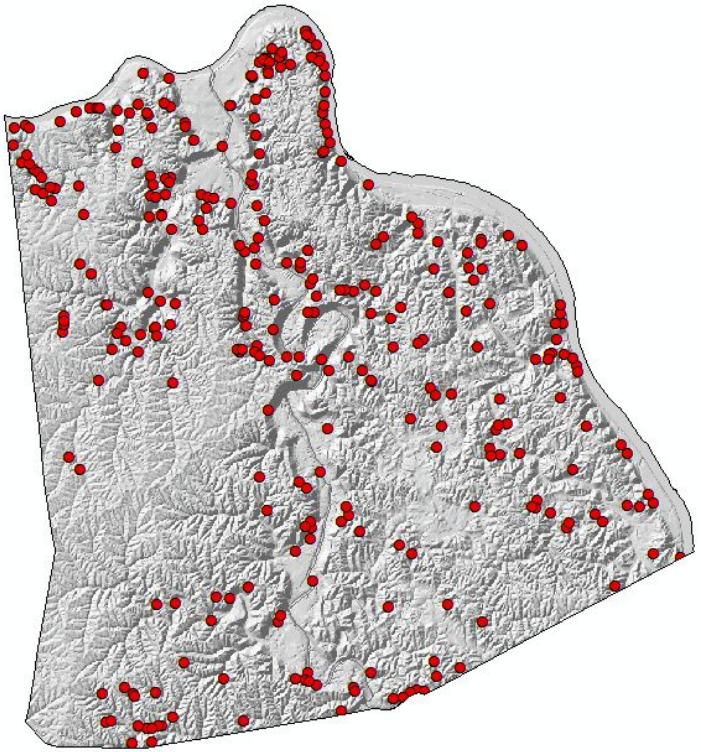
Other Useful Data Sets

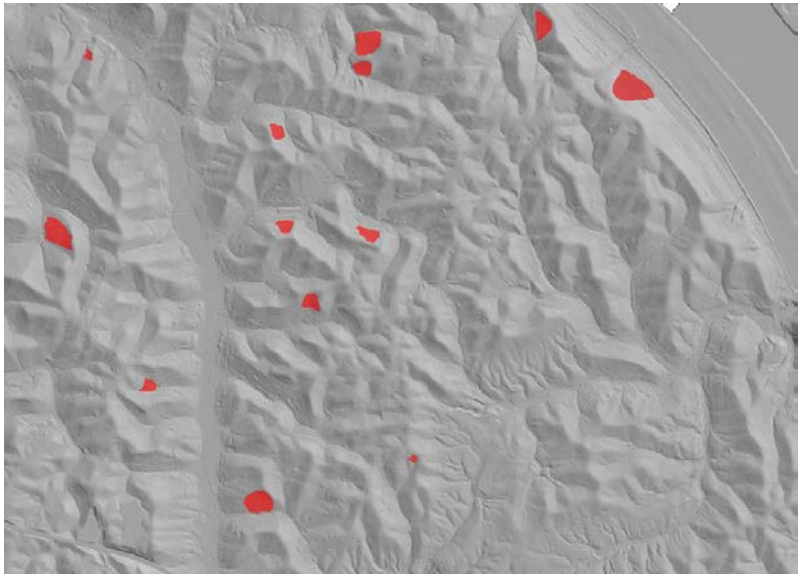
- Topographic contours
- 1:24,000-scale geology
- Slope
- Leaf-off aerial photography
- Roads
- Bing!



Results

- 230 potential landslide extents digitized (polys)
- Approximately 10% were initially attributed with high confidence, rest were questionable
- 45 landslides (approx. 40%) of landslides were field checked
  - ✓ 20 were confirmed
  - ✓ 18 were likely or observed but could not be determined
  - ✓ 7 were not accessible





Field checking

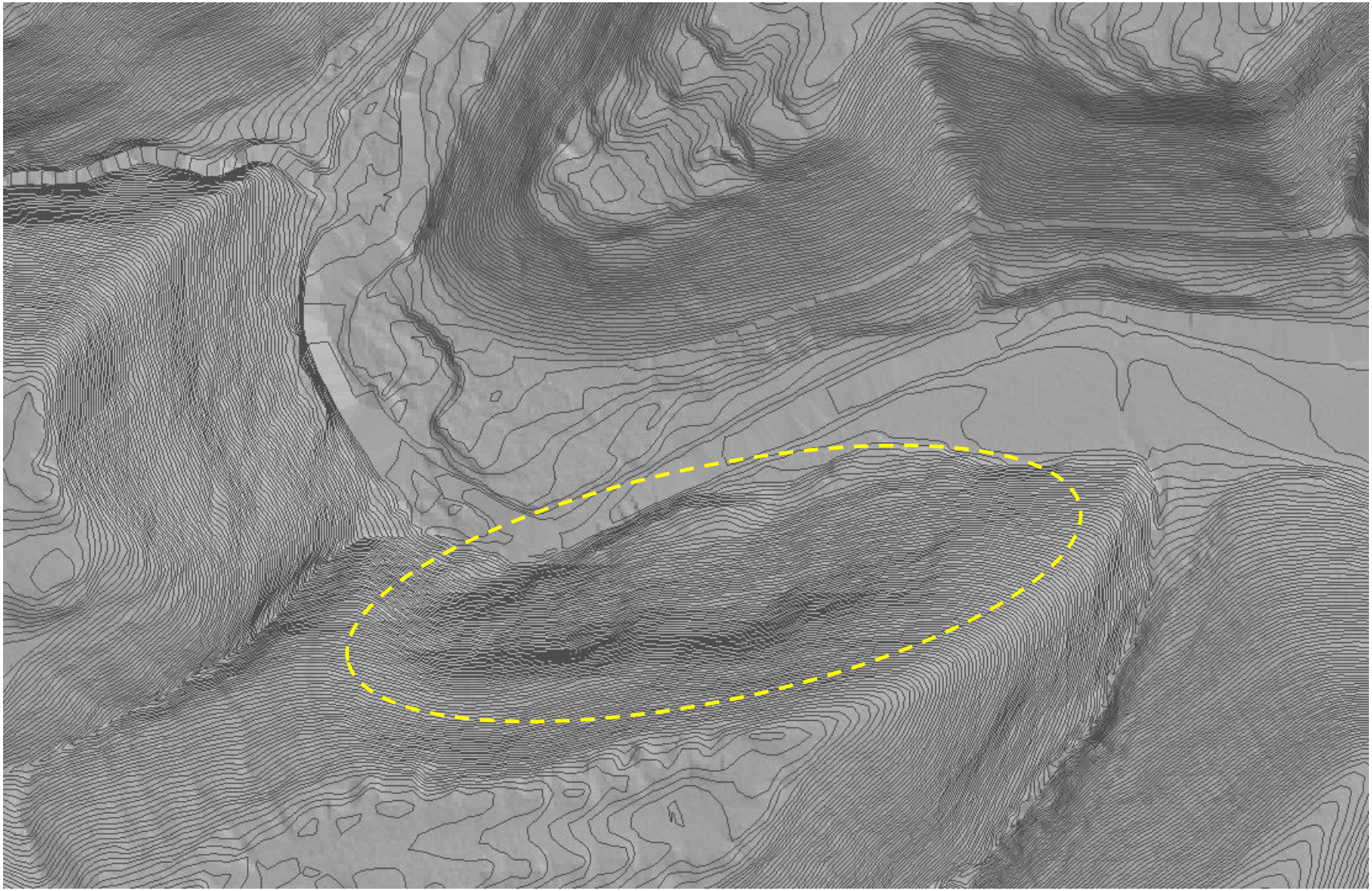
Field checking

Preexisting slides as indications of subsequent failure

3 separate incidences of failure after slope was mapped with landslide from LiDAR

Mudslide/debris flow
in Bellevue, KY.
Campbell Co.
December 2011

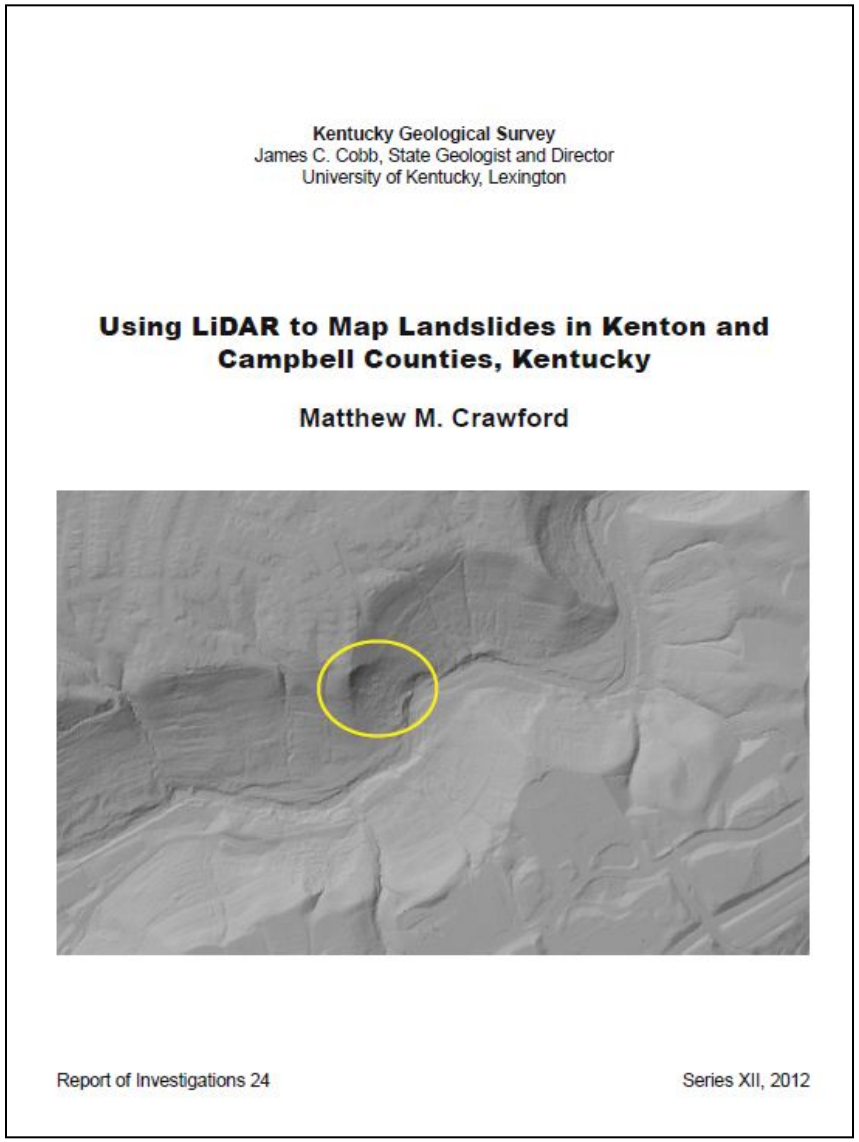
Another example of subsequent failure




November 2011

Conclusions

- Project successfully used LiDAR for identifying potential landslide extents
- Able to map slides in areas not accessible by roads.
- Urbanization of Kenton and Campbell Co. made visualization difficult and probably masked many other existing slides
- Project was limited by time and ability to field check landslides
- Mapping preexisting landslides is an indication of areas susceptible to future slope failure.
- As Kentucky acquires more LiDAR, similar projects will be very beneficial in other landslide prone parts of the state.



Thank you!

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Report - http://kgs.uky.edu/kgsweb/findpubsmain.asp