IMPROVING KARST SINKHOLE MAPPING IN KENTUCKY USING LIDAR

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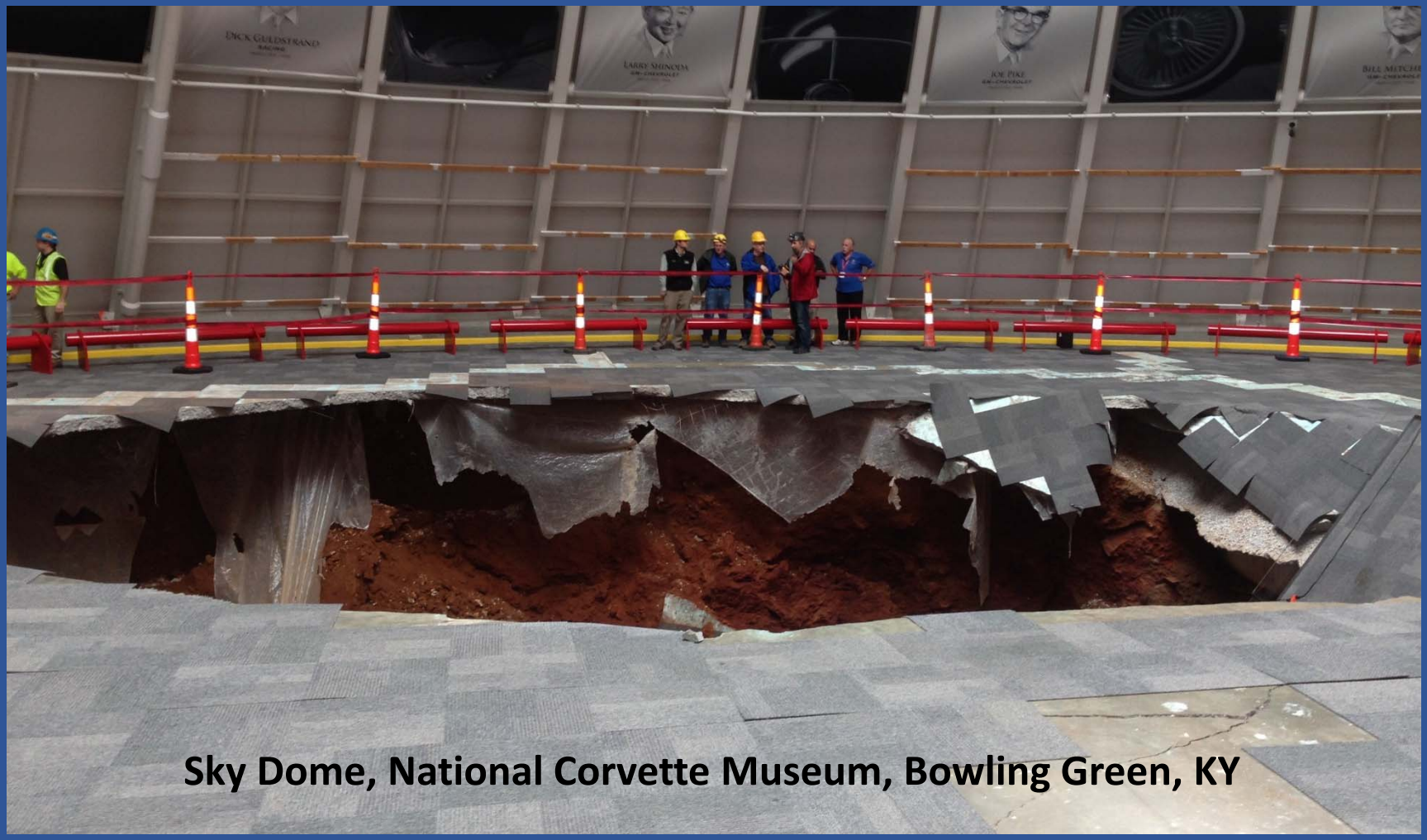
Outline

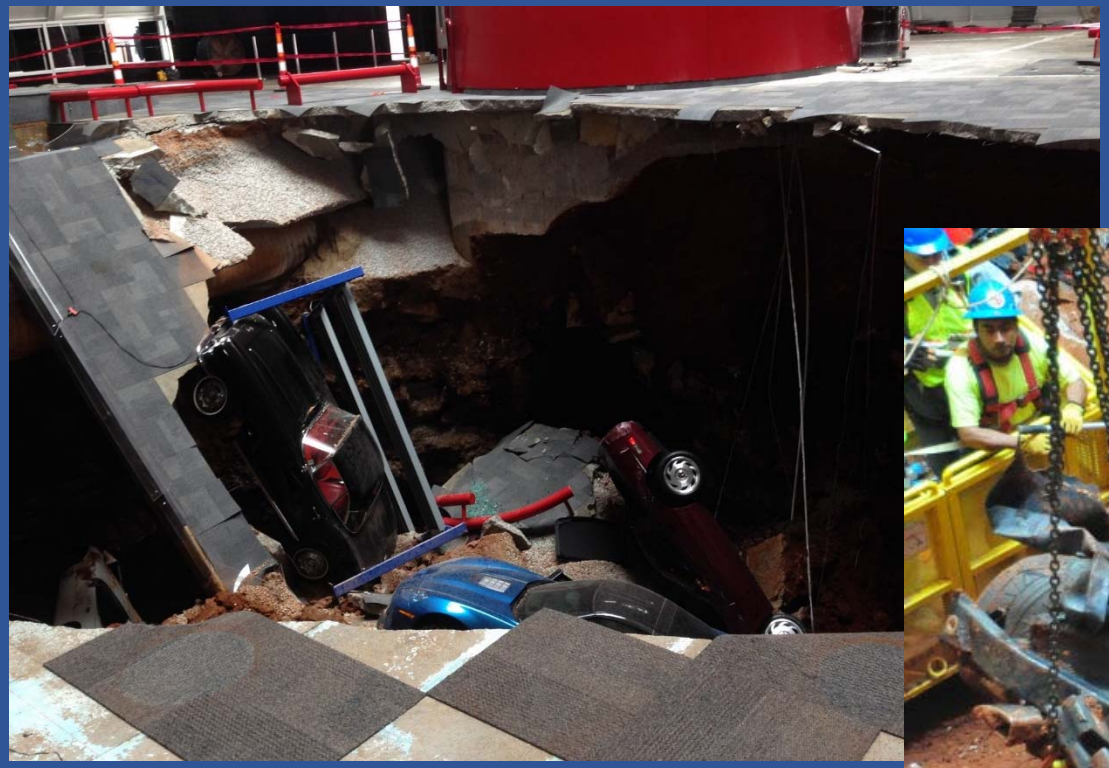
- Why we are interested in sinkholes
- Sinkhole Detection using LiDAR
  - Study site – Floyds Fork Watershed
  - Sinkhole extraction process
  - Field Inspection
- Potential of LiDAR in wetland mapping

Sinkholes: A Geologic Hazard



Sky Dome, National Corvette Museum, Bowling Green, KY

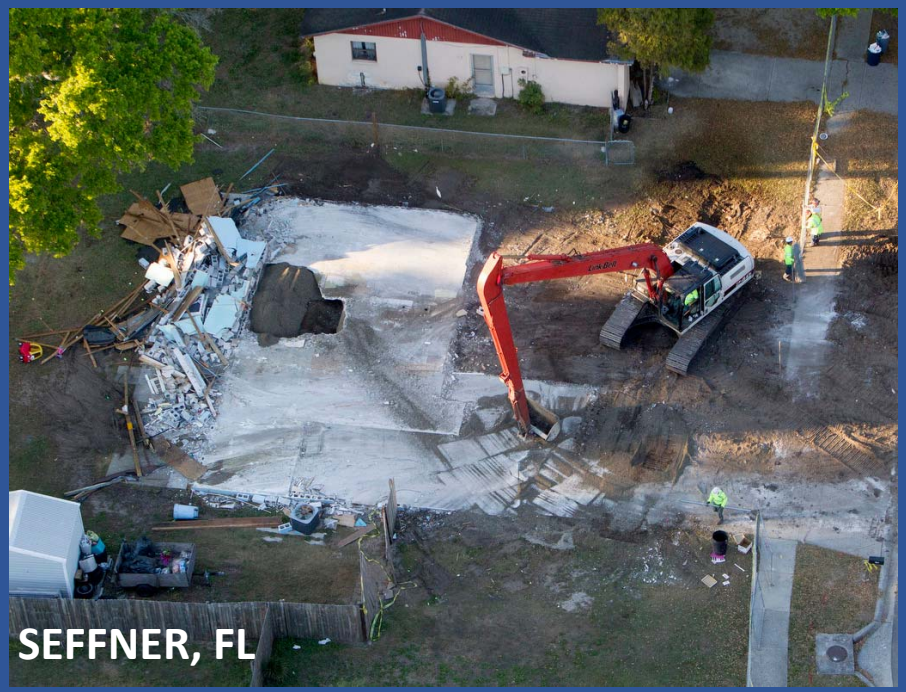
Sinkholes: A Geologic Hazard



Sky Dome, National Corvette Museum, Bowling Green, KY

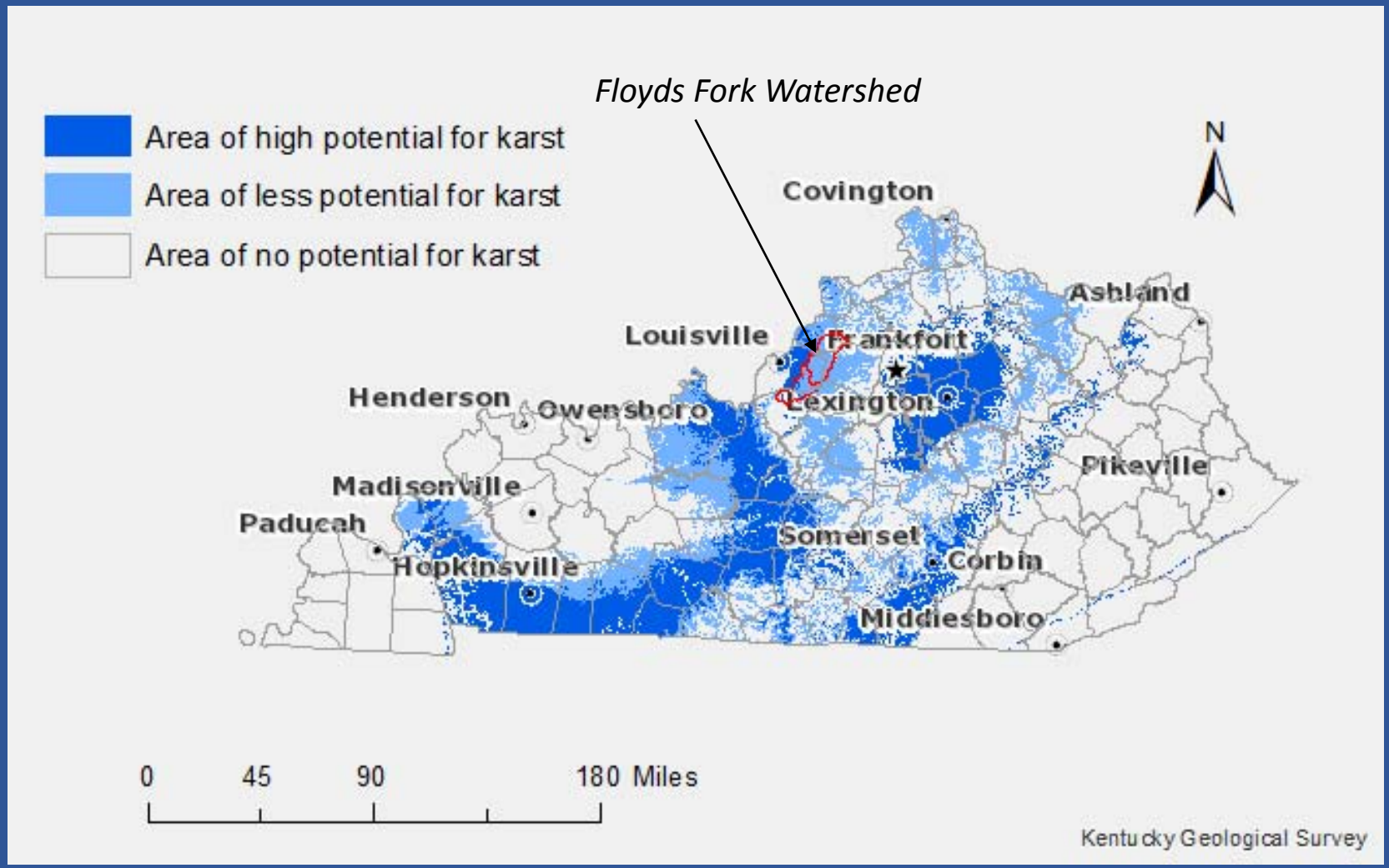
http://www.autoblog.com/2014/04/10/national-corvette-museum-says-last-sinkhole-car-extracted-videos/

Sinkholes:
A Geologic Hazard

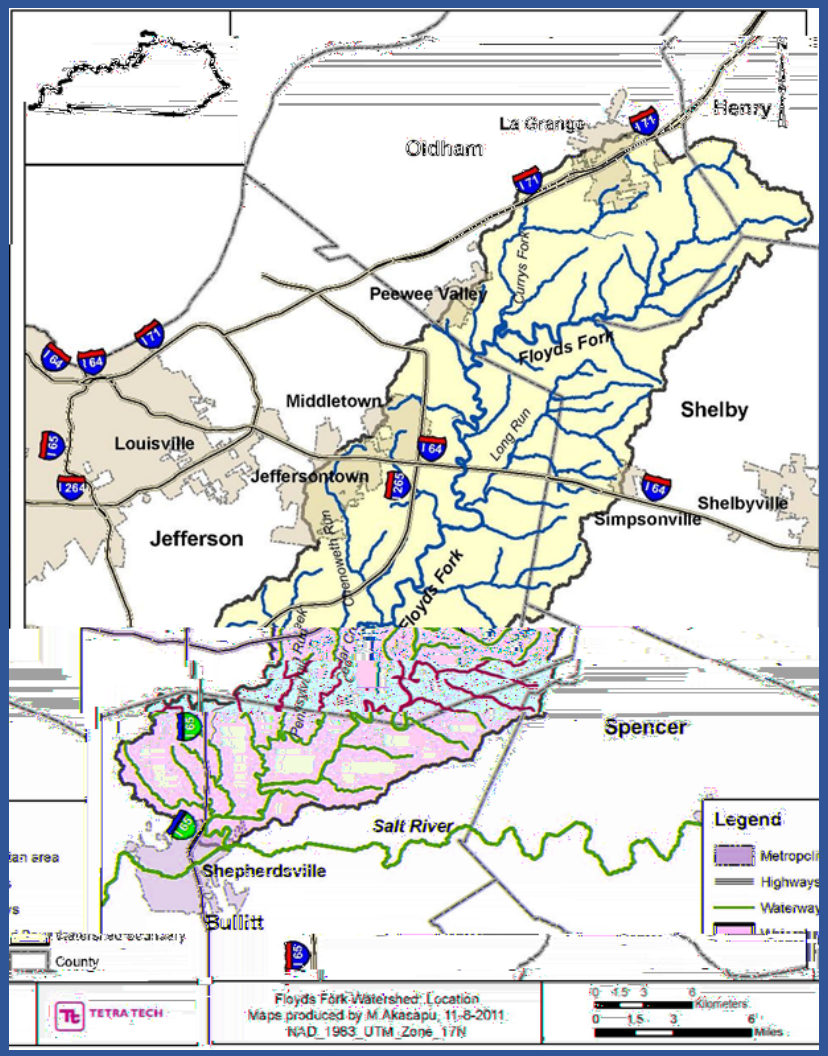


(Dirk Shadd/Tampa Bay Times/MCT)

Kentucky Karst Areas



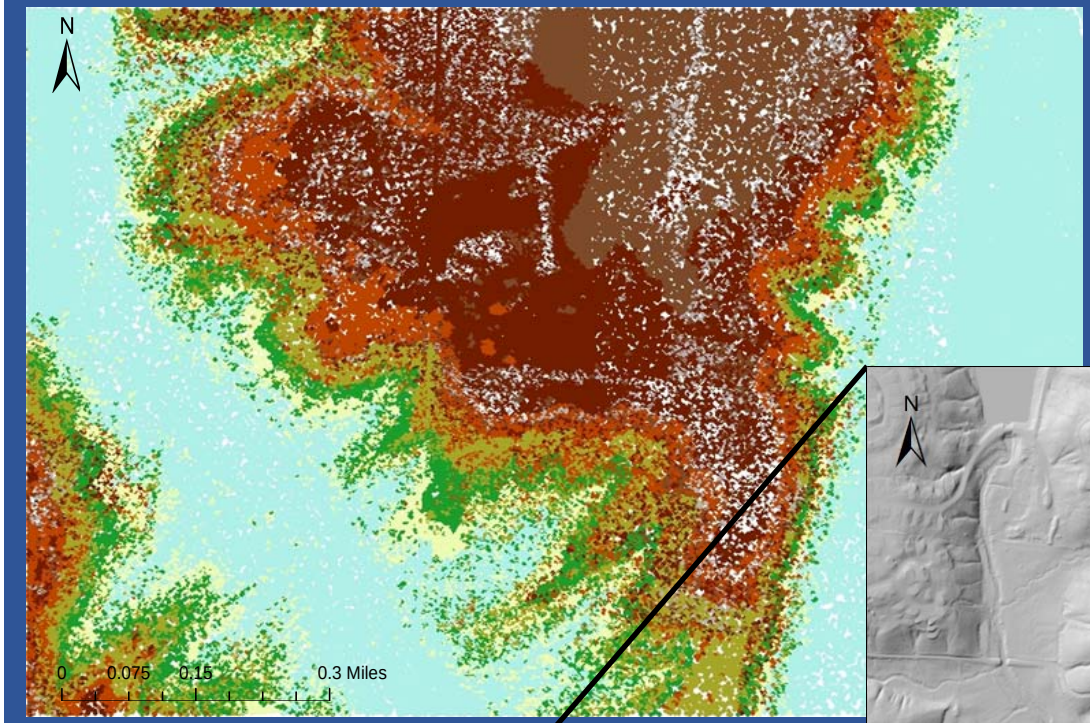
Floyds Fork Watershed



- The watershed is impaired by nutrients, organic enrichment, fecal coliform, and sedimentation.
- US Environmental Protection Agency and Kentucky Division of Water are studying water flow and contaminants in the watershed.
- 90% underlain by carbonates and many sinkholes have developed.

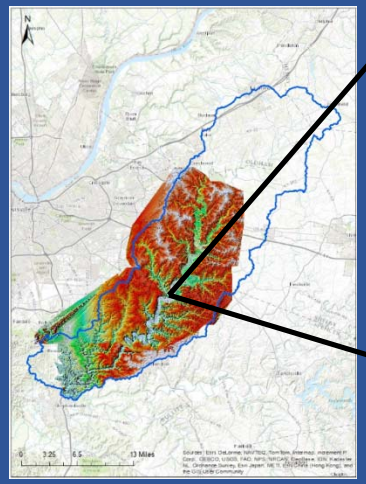
(http://water.ky.gov/watershed/pages/floydsfork.aspx)

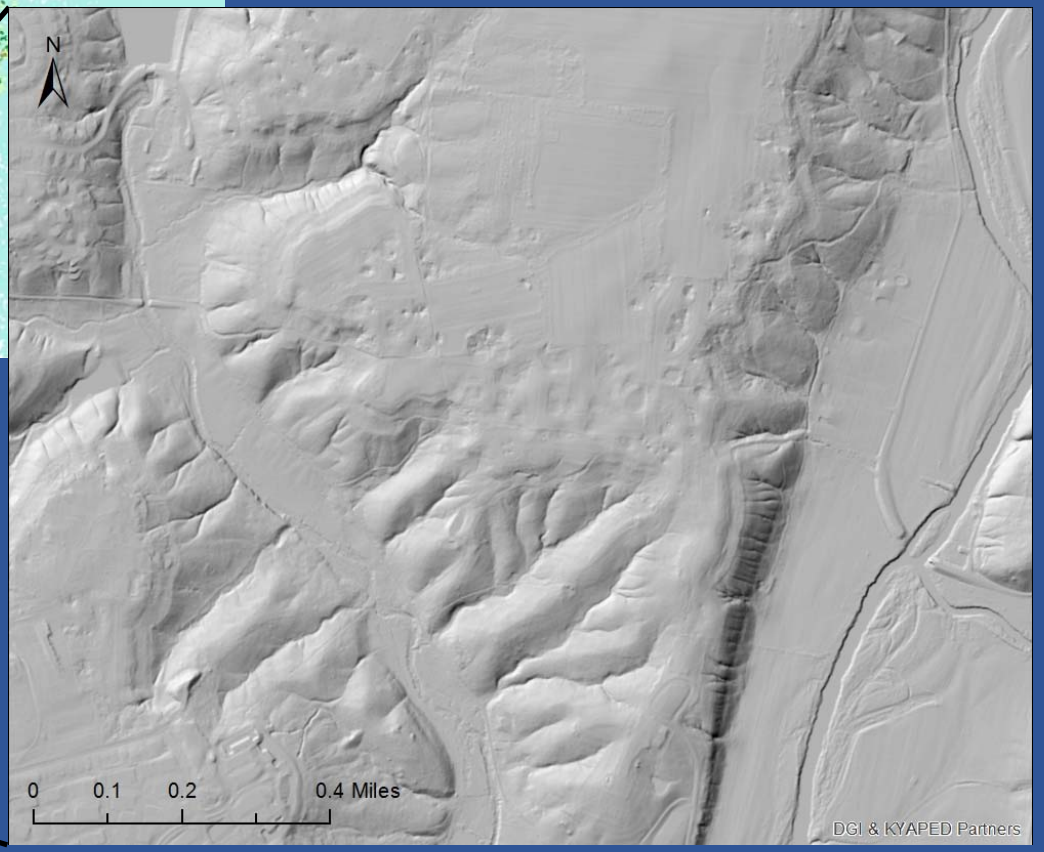
Generate DEM from LiDAR Ground Points



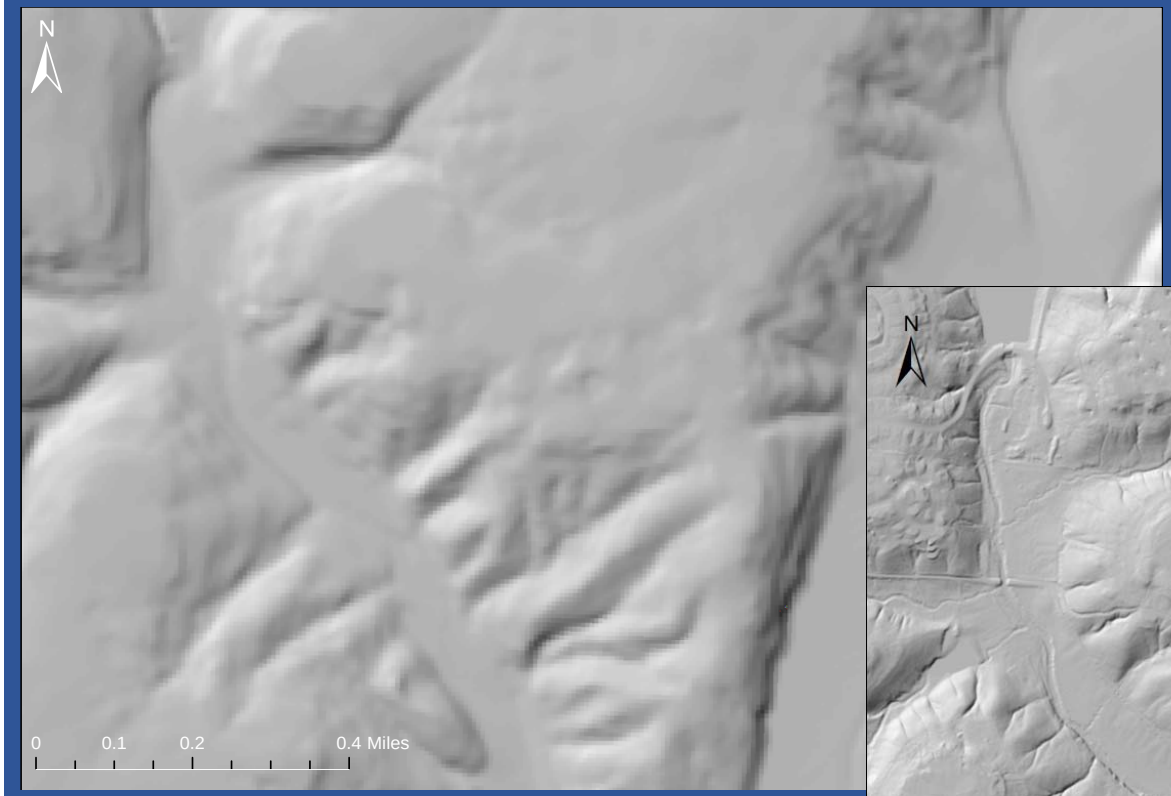
All LiDAR Points

Shaded Relief DEM from LiDAR Ground Points



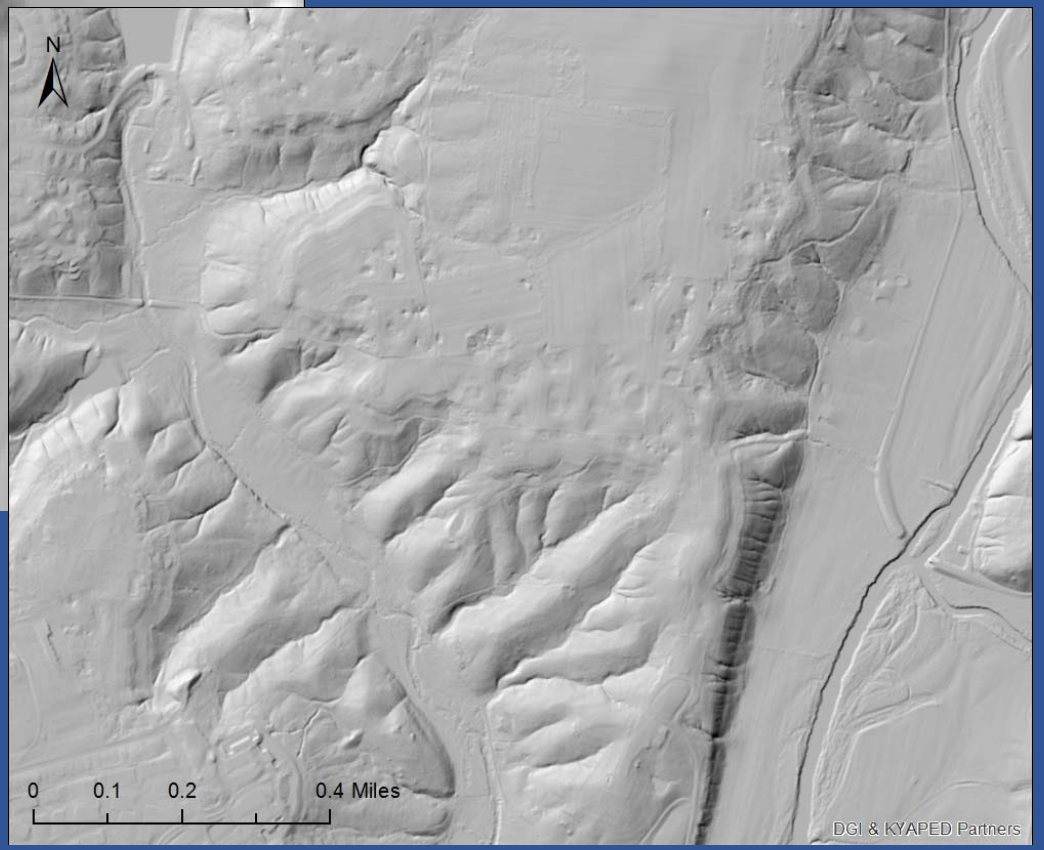


Compare DEM Hillshades

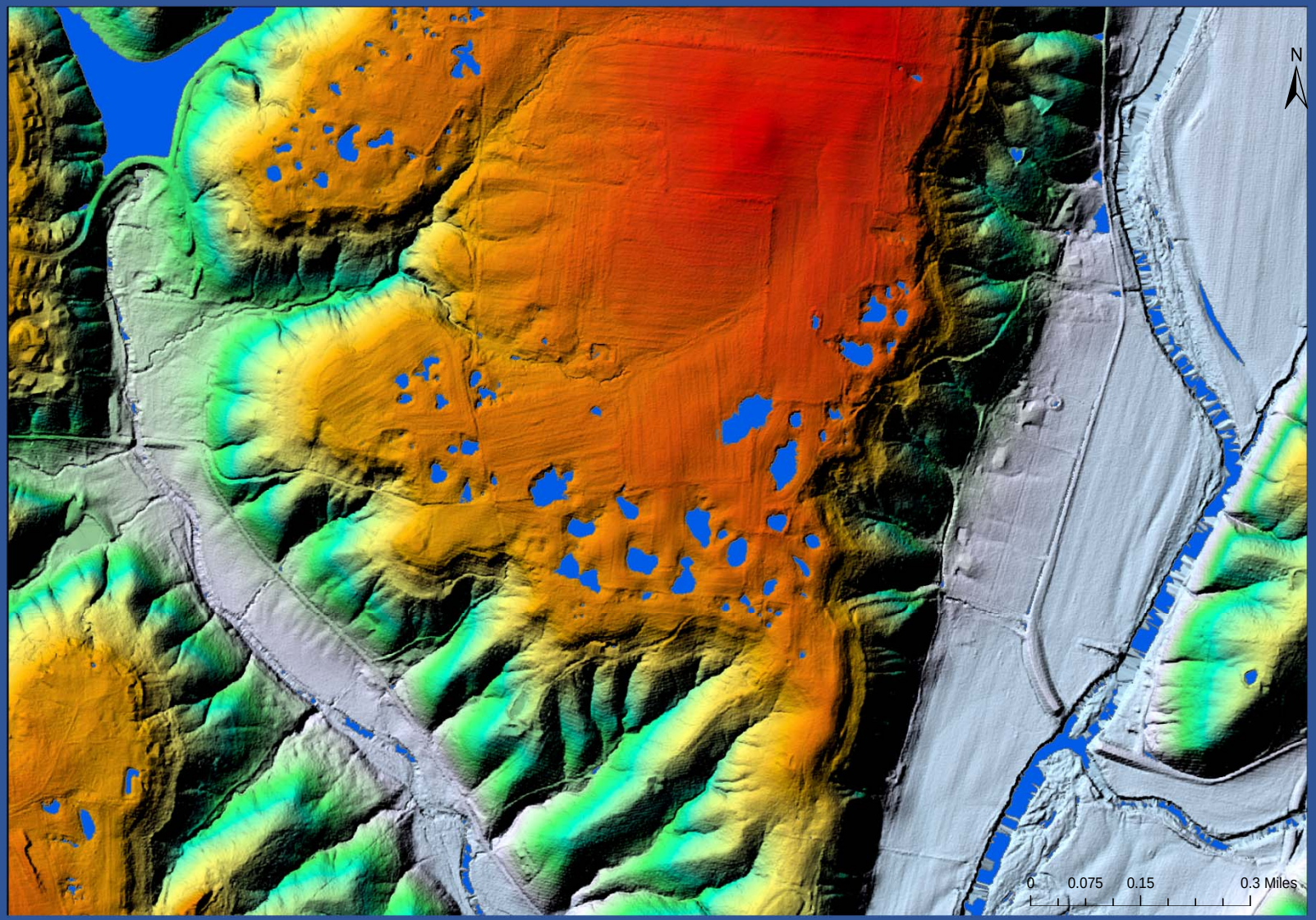


USGS 10M DEM

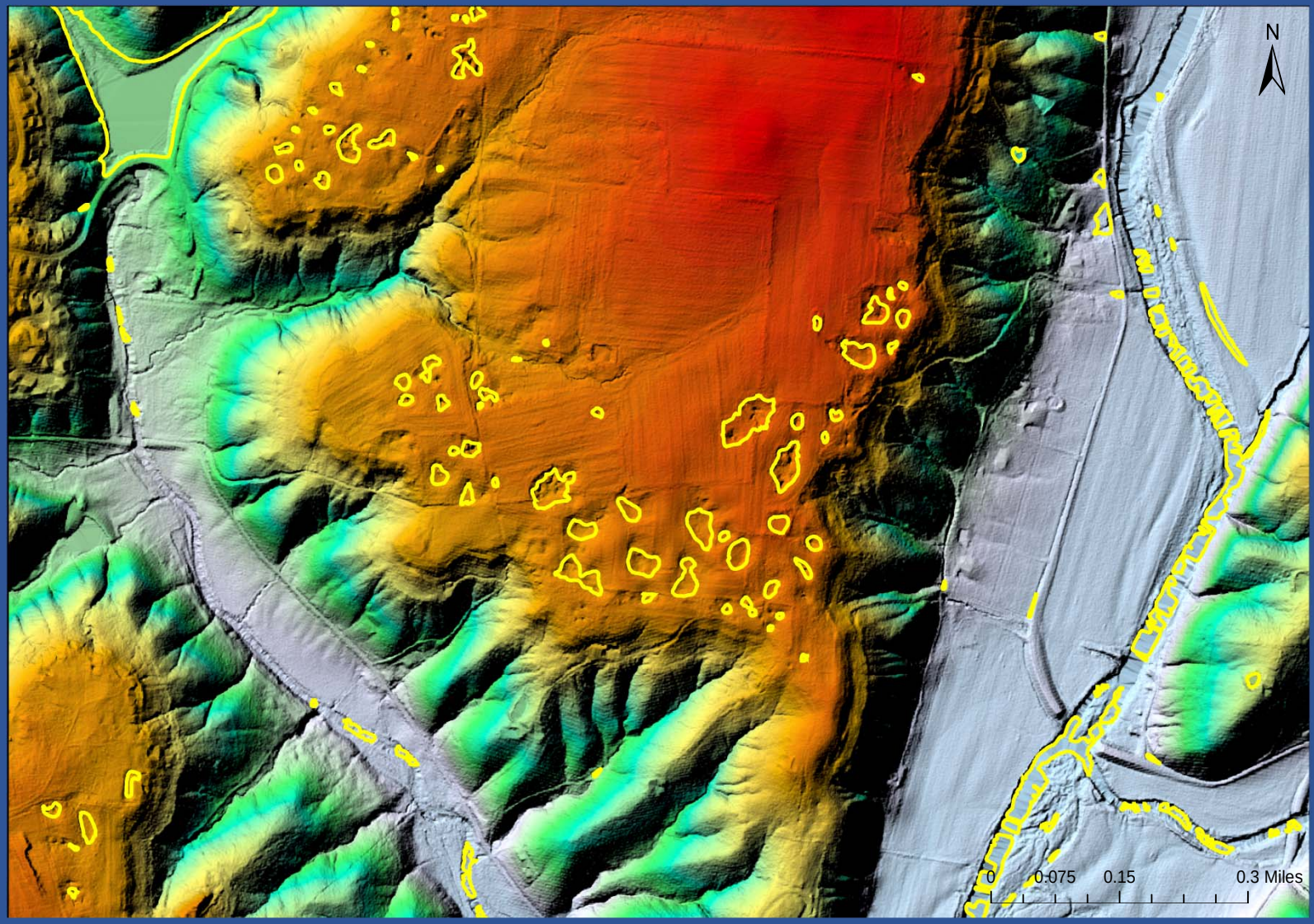
5ft DEM from LiDAR



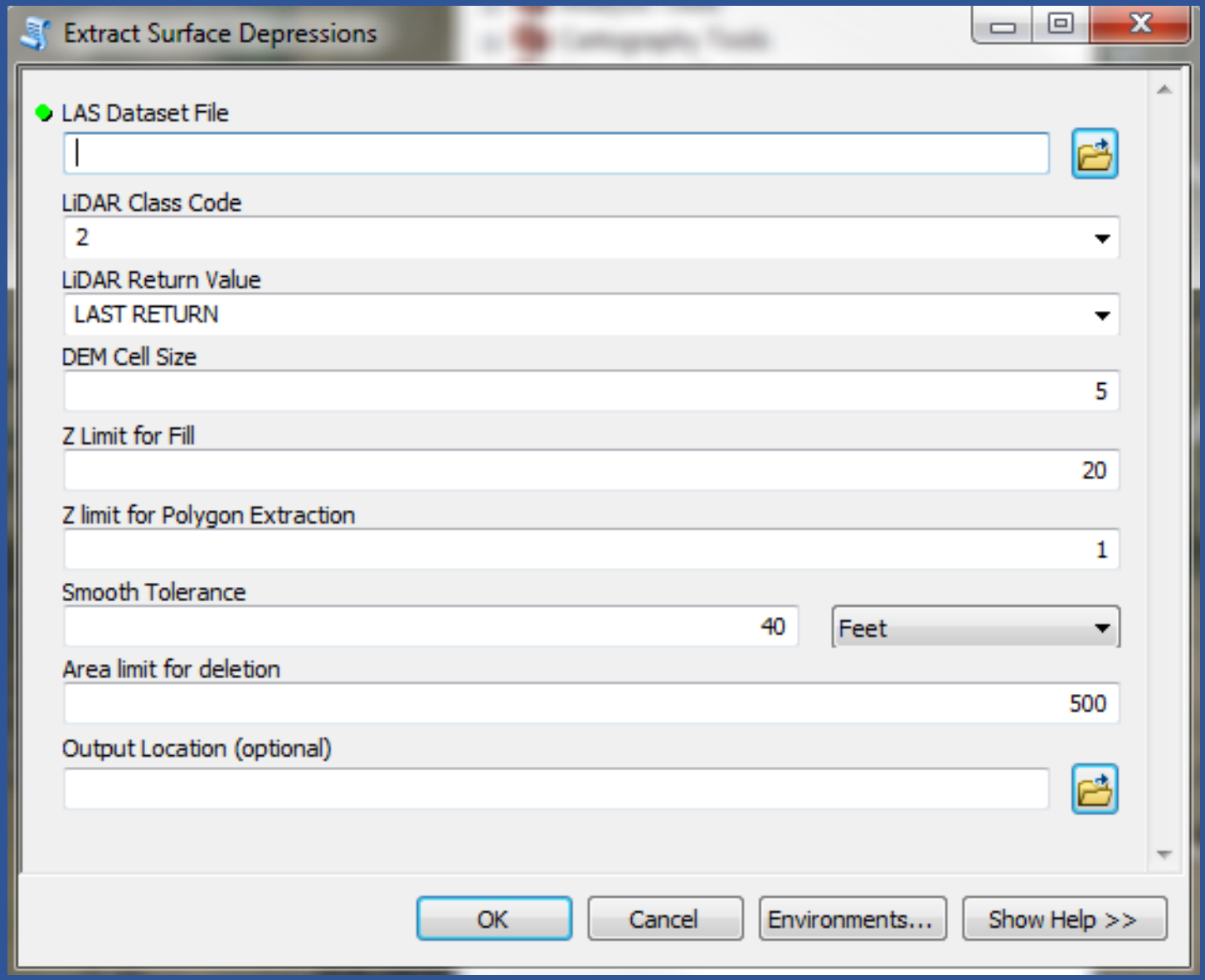
Extract Depression Features



Create Depression Polygons



Depression Extraction Tool



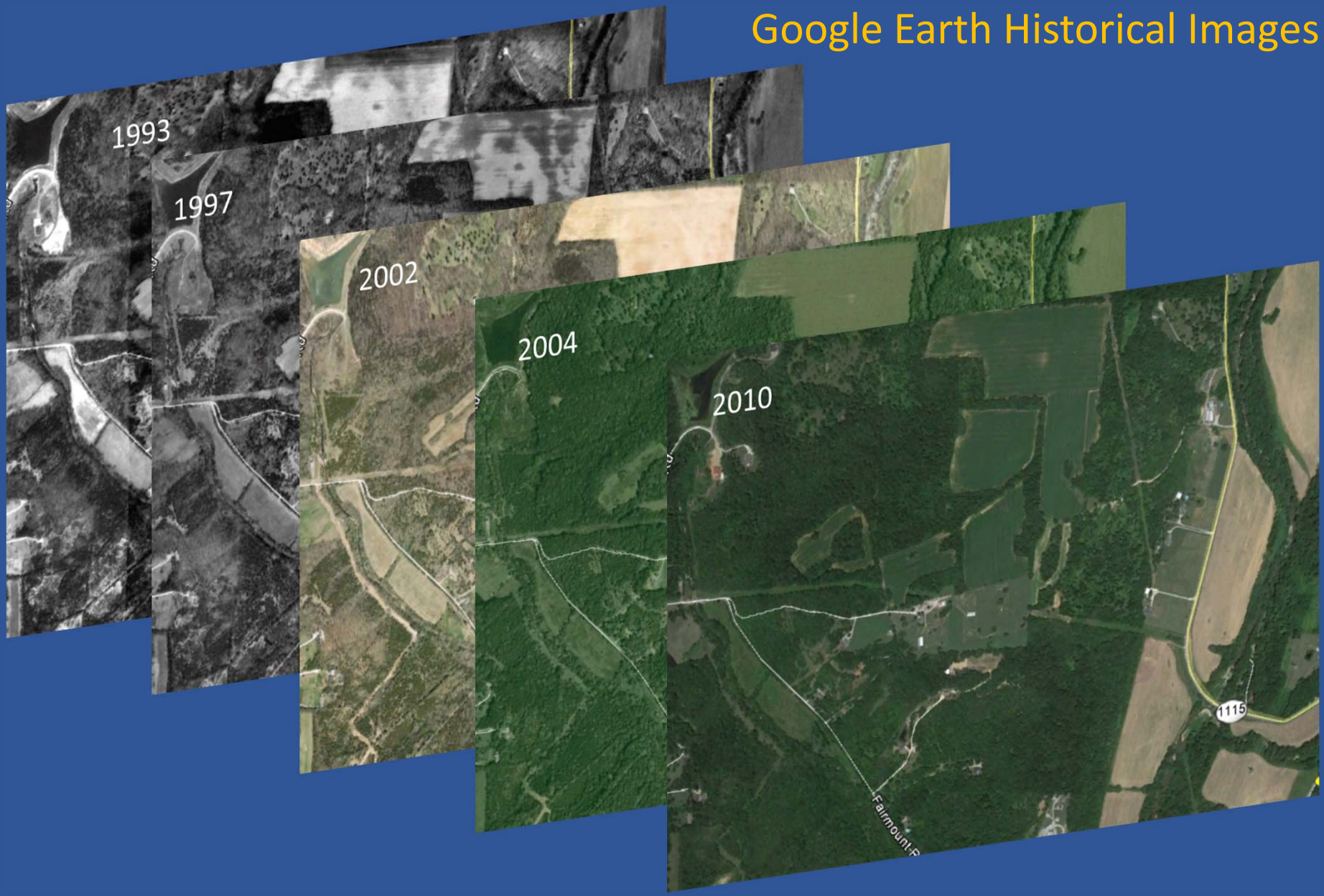
Inspect Polygons for Probable Sinkholes

KY DGI Maps

Bing Maps

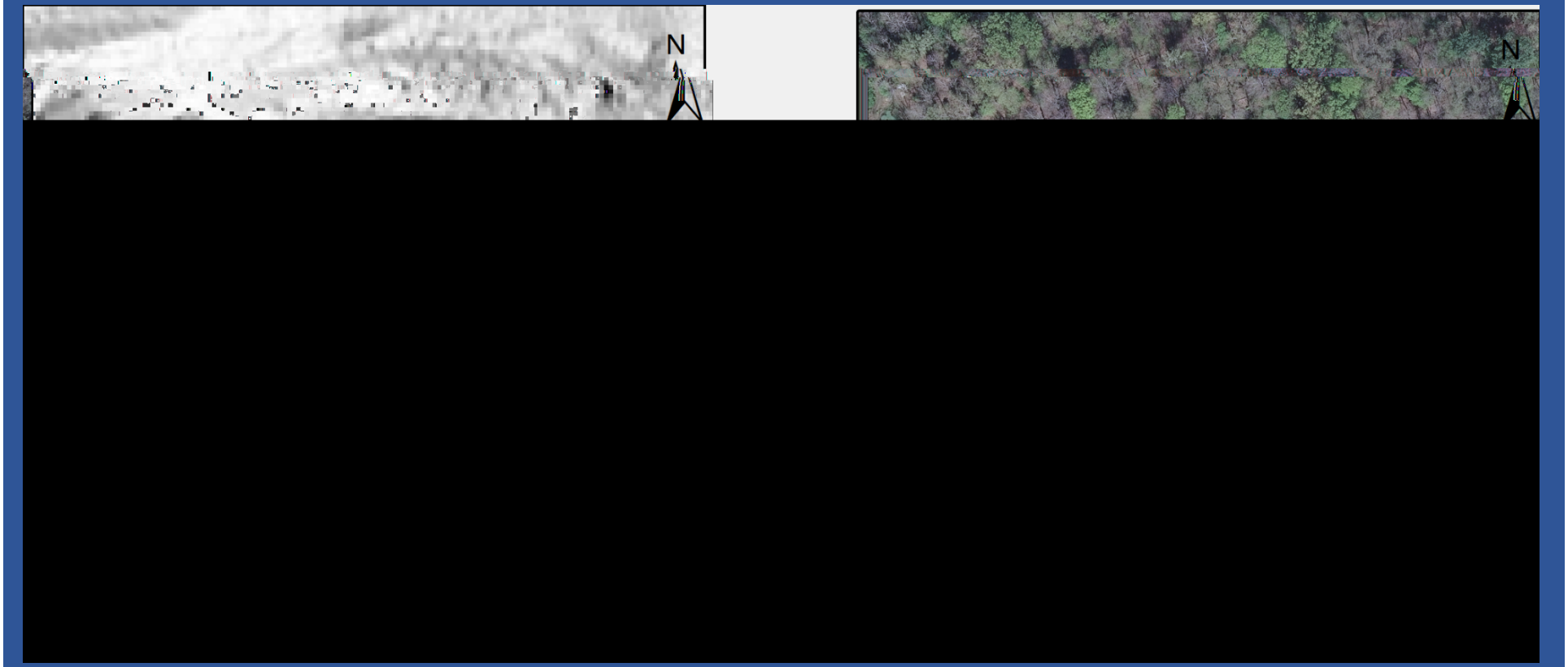
Inspect Polygons for Probable Sinkholes

Google Earth Historical Images



Polygon Classification

a) Probable sinkholes

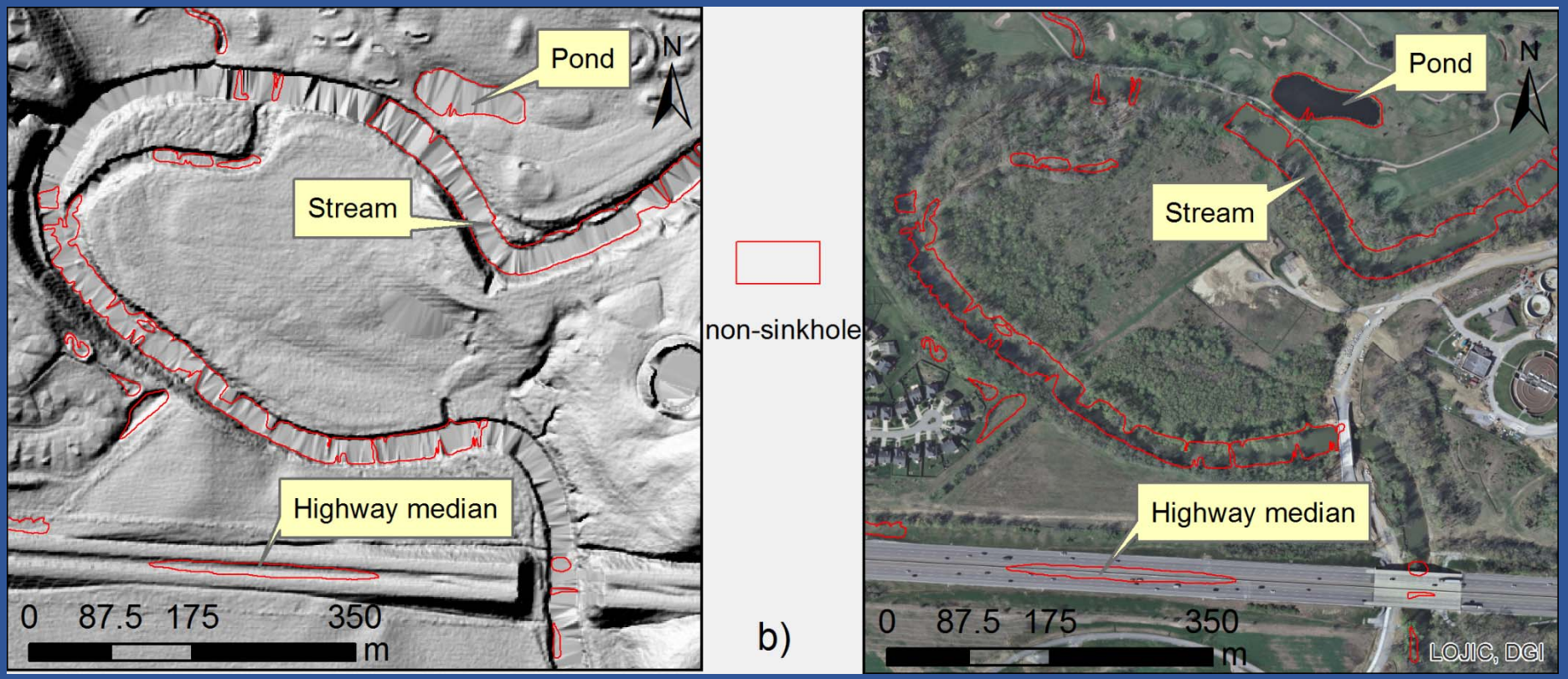


Shaded-relief
(5-time vertically exaggerated)

Aerial image (Ky DGI)

Polygon Classification

b) Non-sinkholes

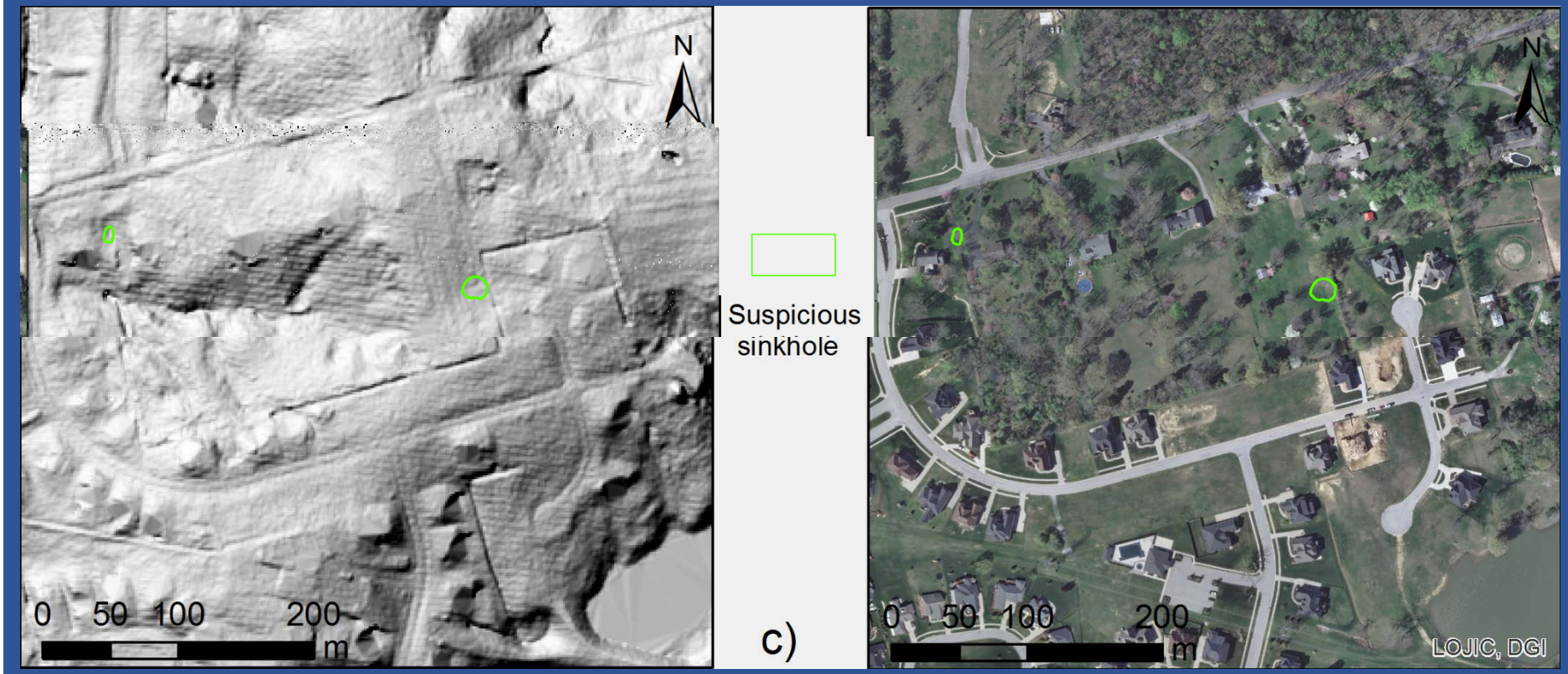


Shaded-relief
(5-time vertically exaggerated)

Aerial image (Ky DGI)

Polygon Classification

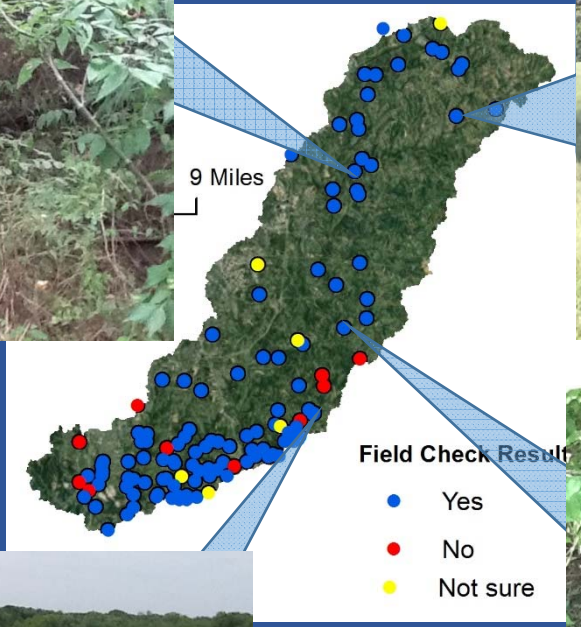
c) Suspicious sinkholes



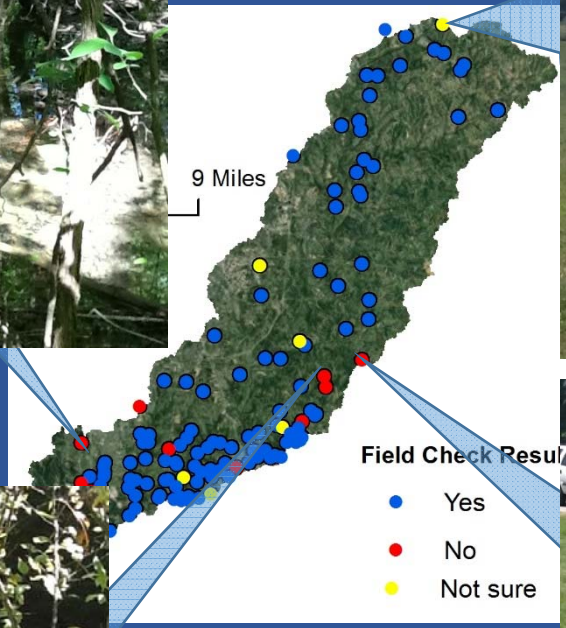
Shaded-relief
(5-time vertically exaggerated)

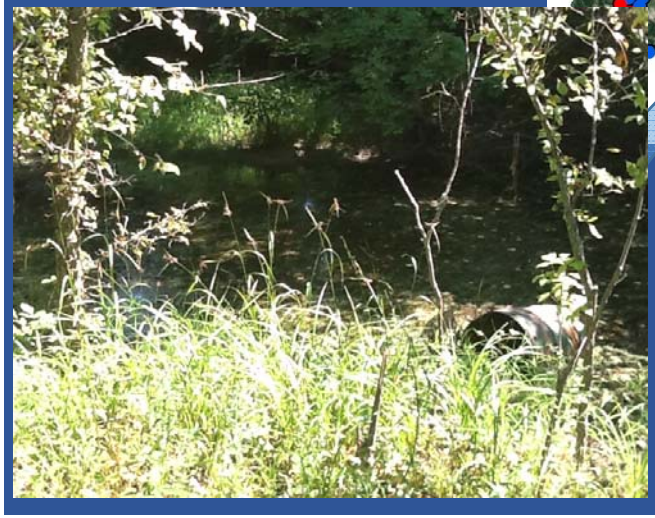
Aerial image (Ky DGI)

Field Check of Probable Sinkholes



Field Check of Probable Sinkholes





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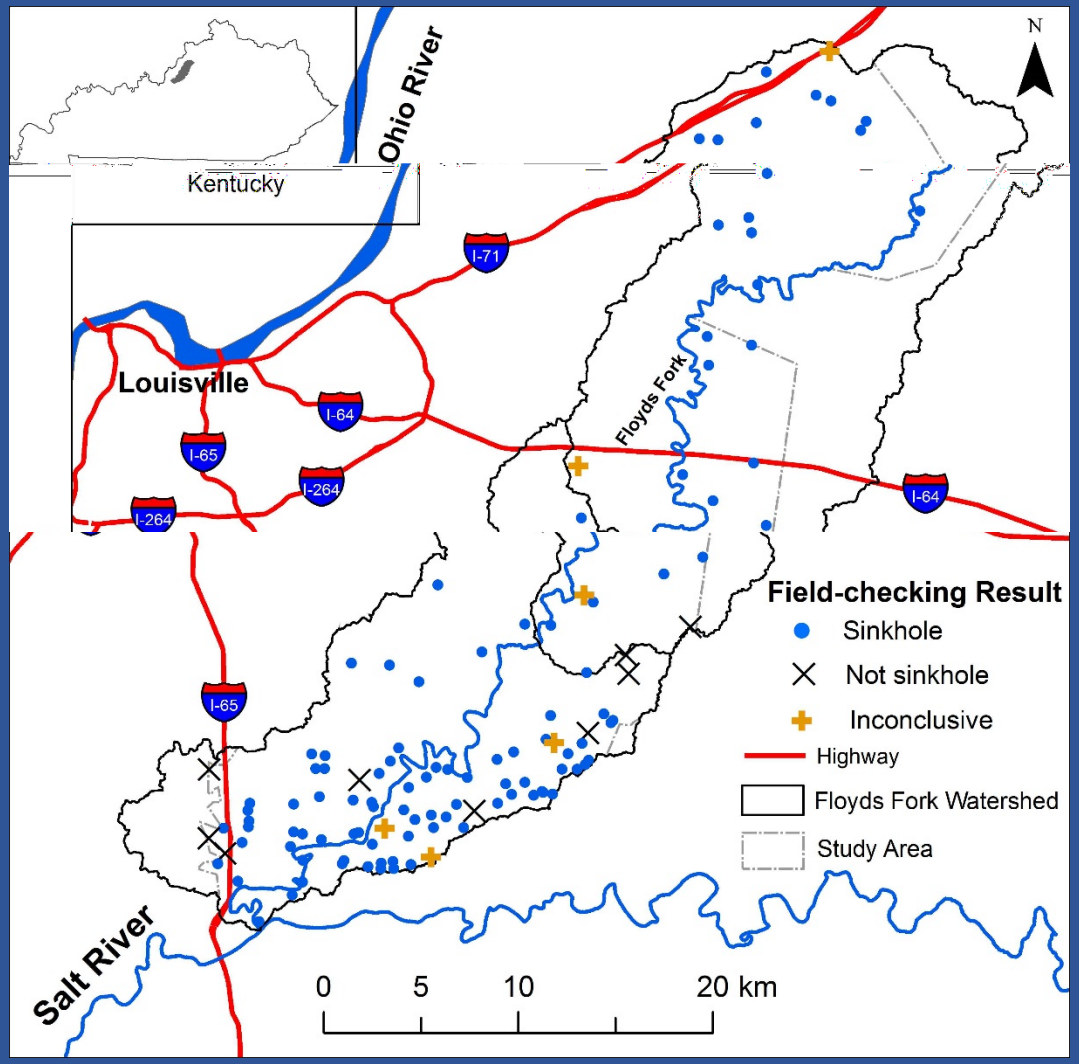


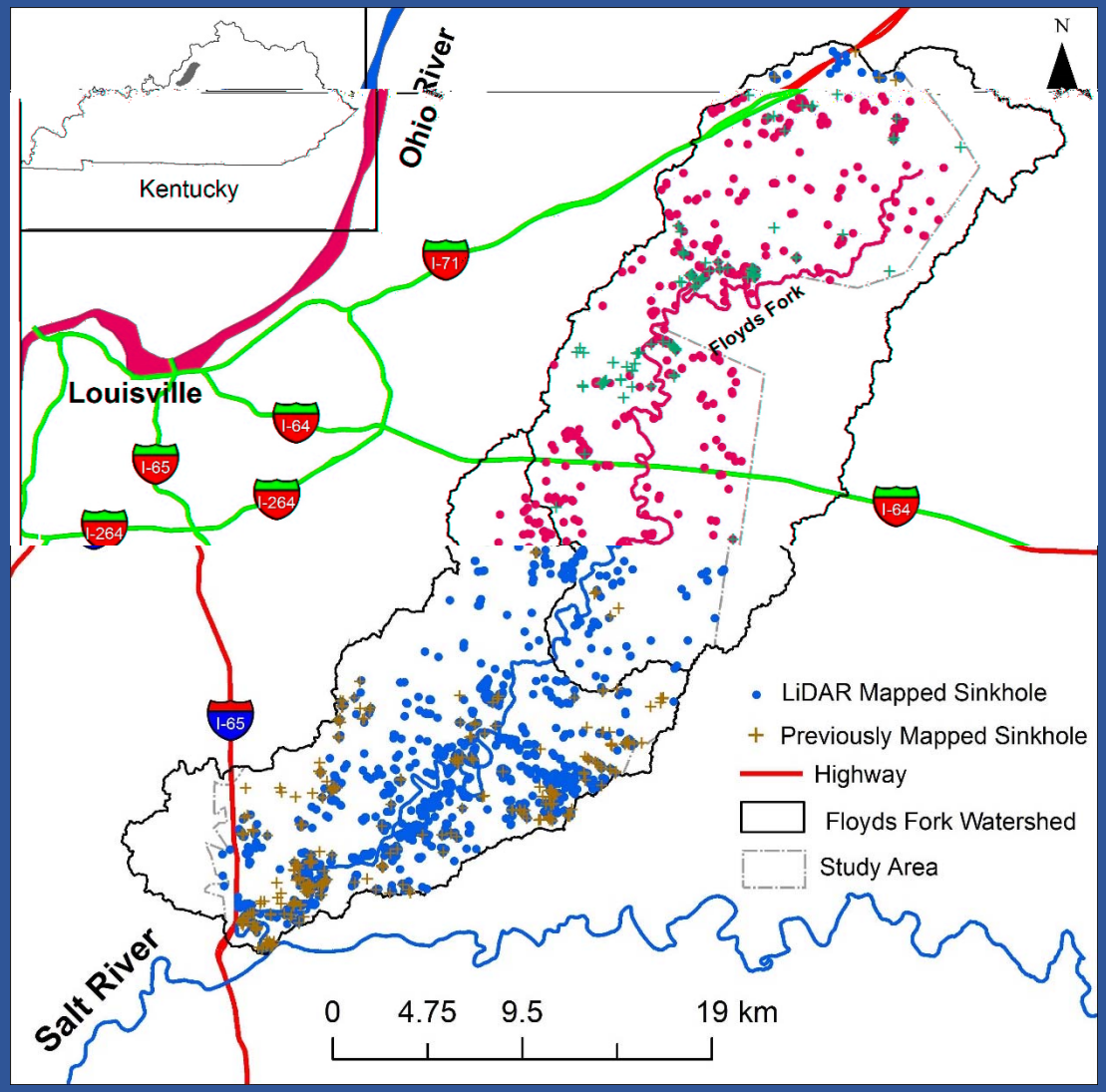
Total checked: **121**

- Sinkholes: **106**
- Non-sinkholes: **9**
- Inconclusive: **6**
- Success rate: **88%**

Statistically, the method's overall success rate for the study area:

80%-93%

Sinkhole Comparison



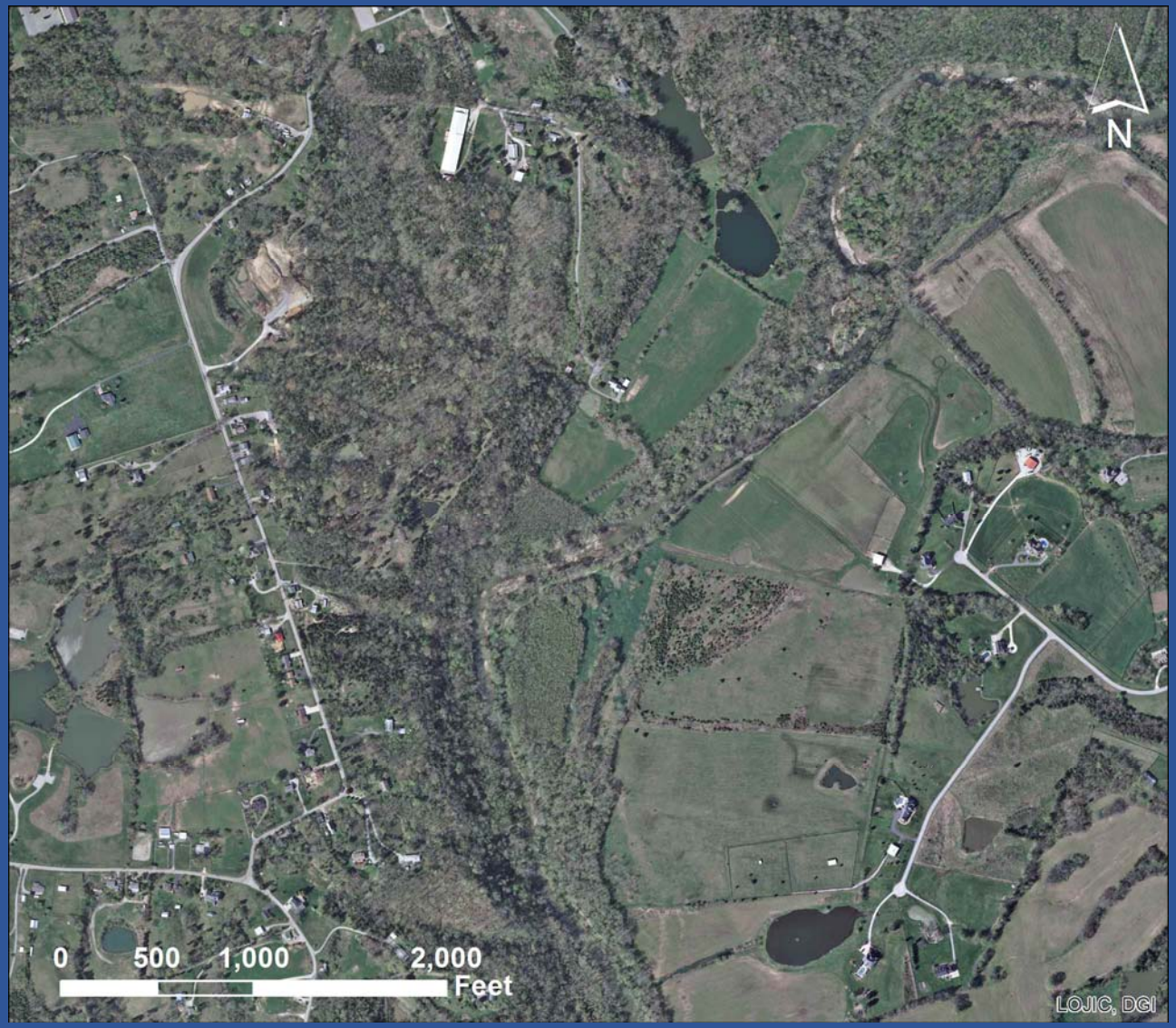
Number of sinkholes

From LiDAR: **1683**

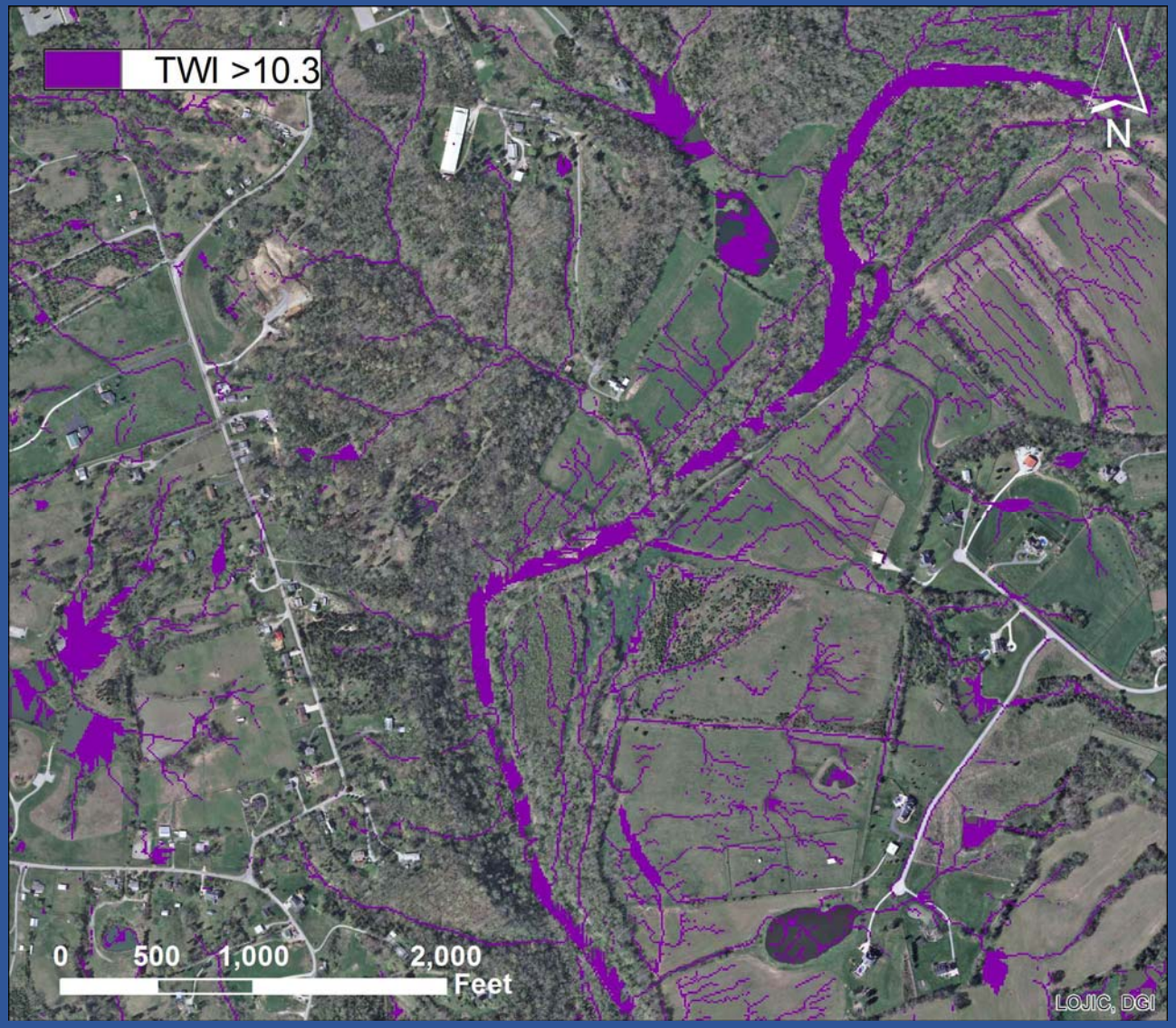
In existing database: **383**

Total Study Area: **224** mi^2

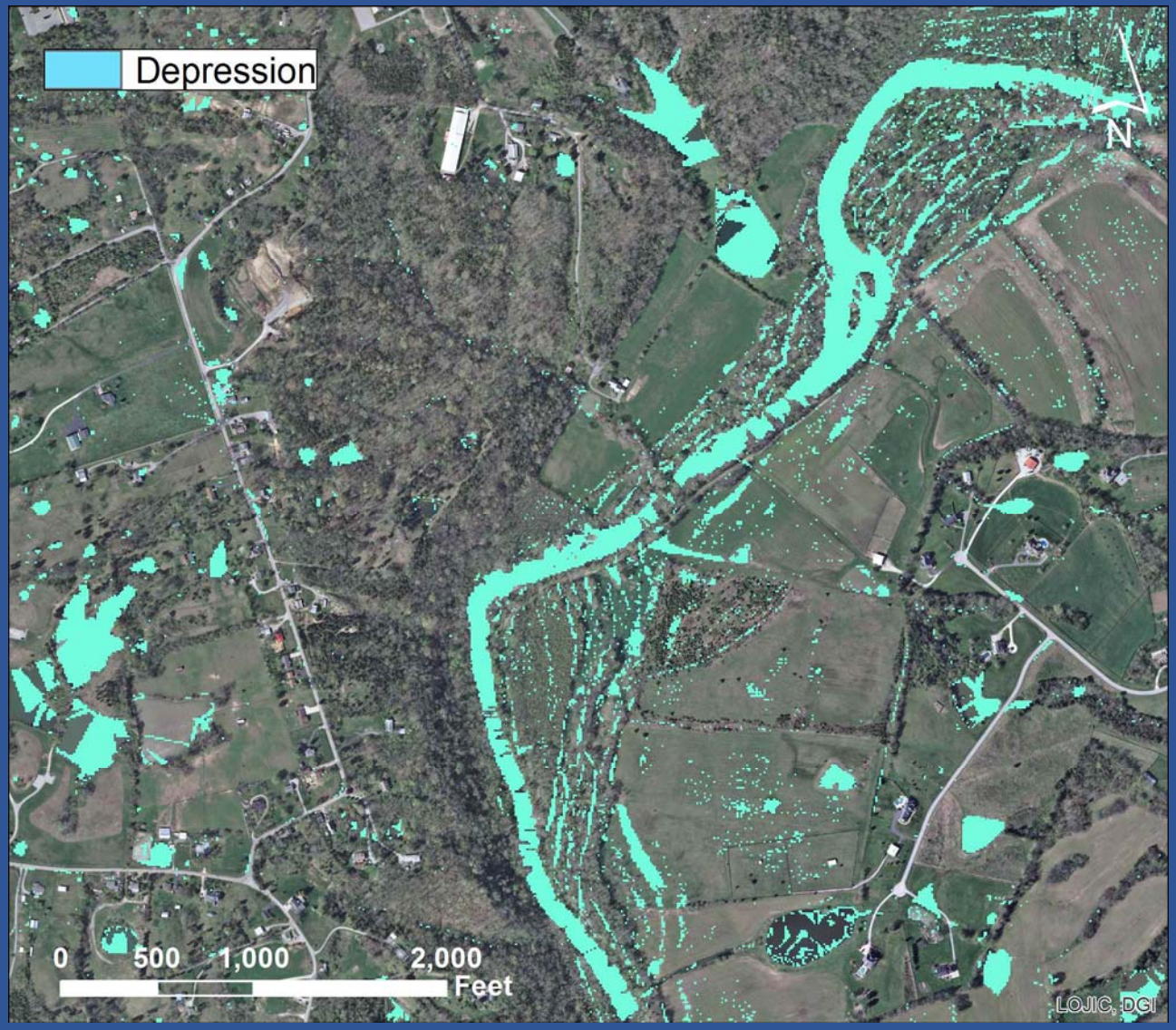
Wetland Delineation



1: Topographic Wetness Index (TWI)

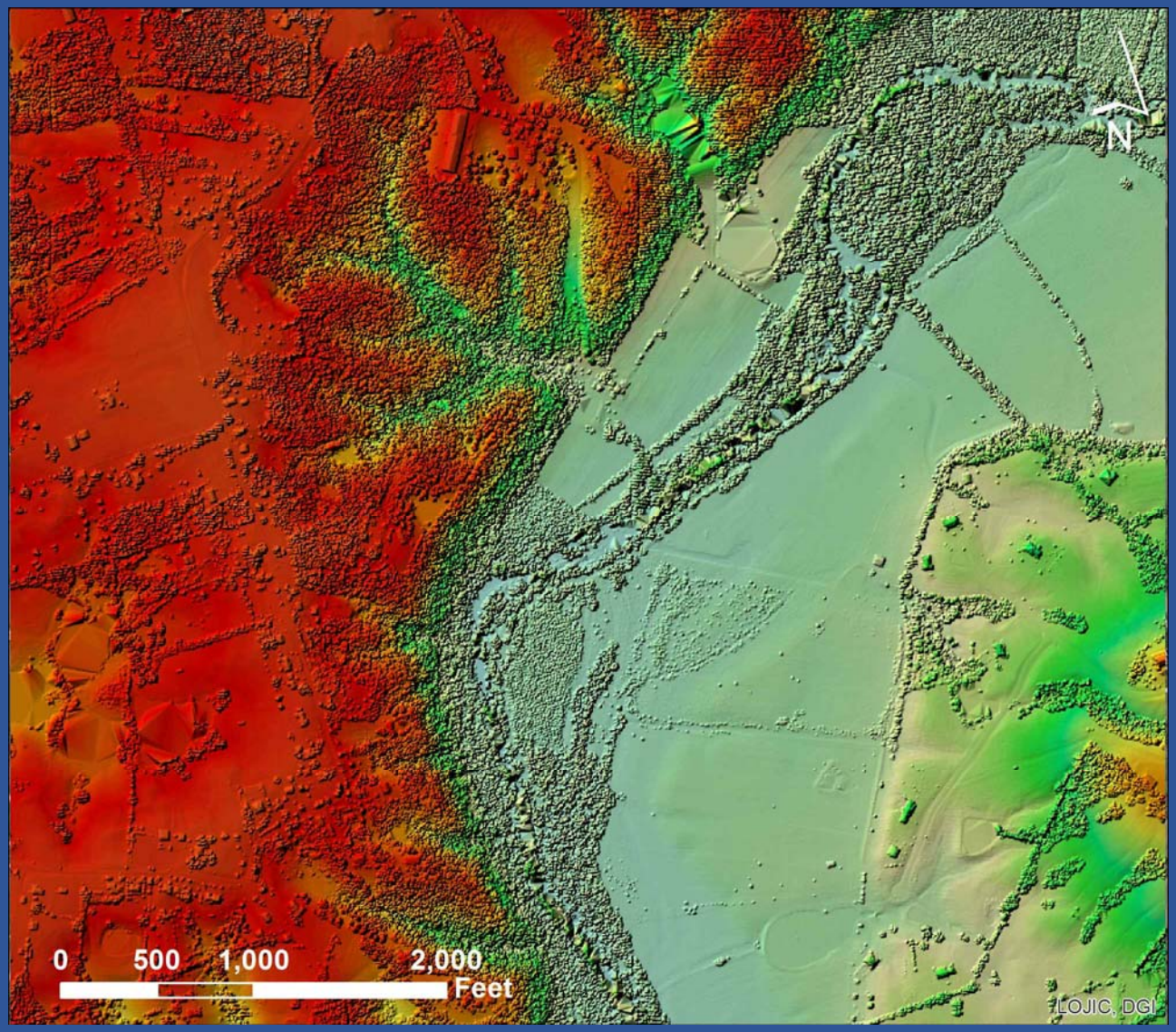


2: Surface Depression

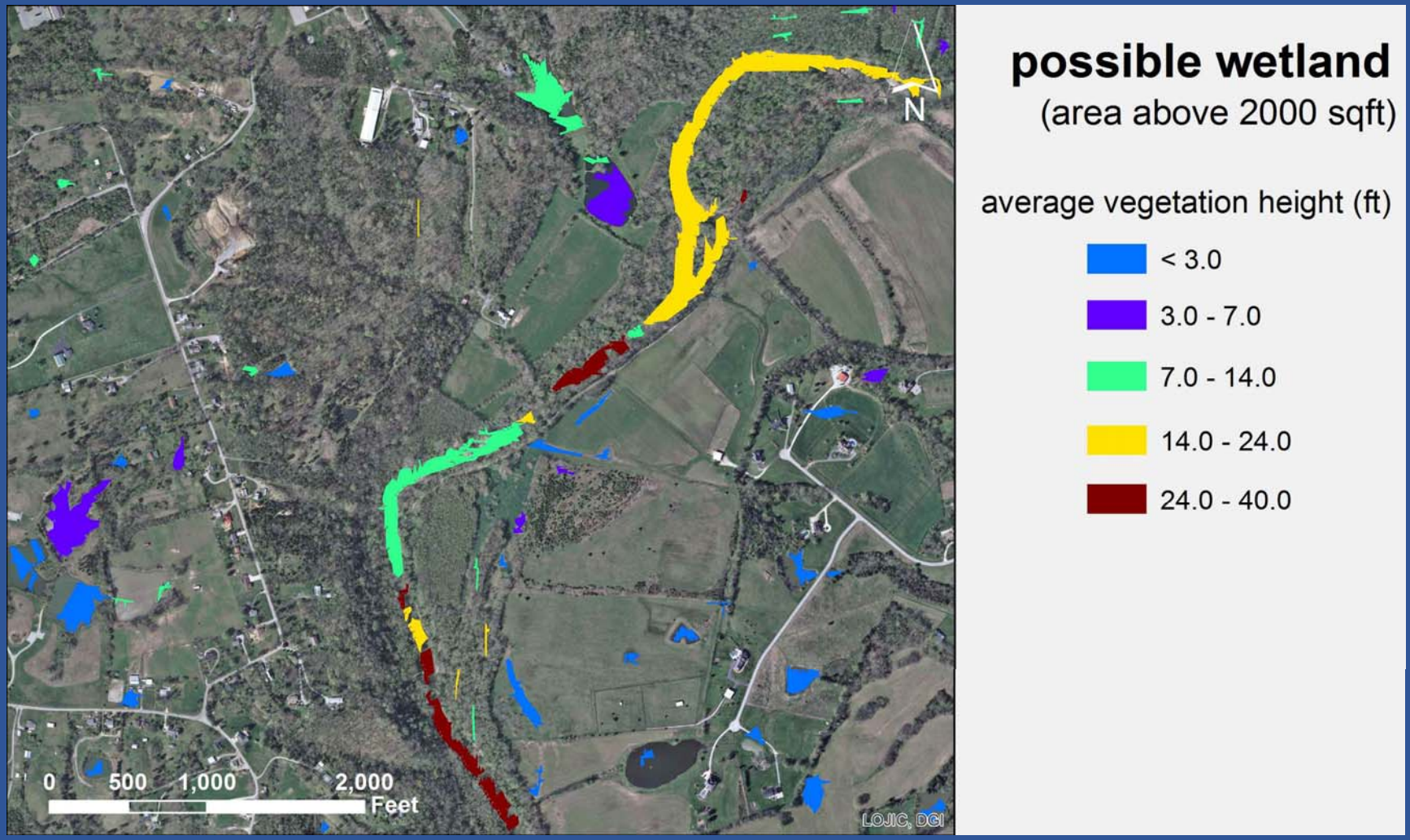


3: Possible Wetlands

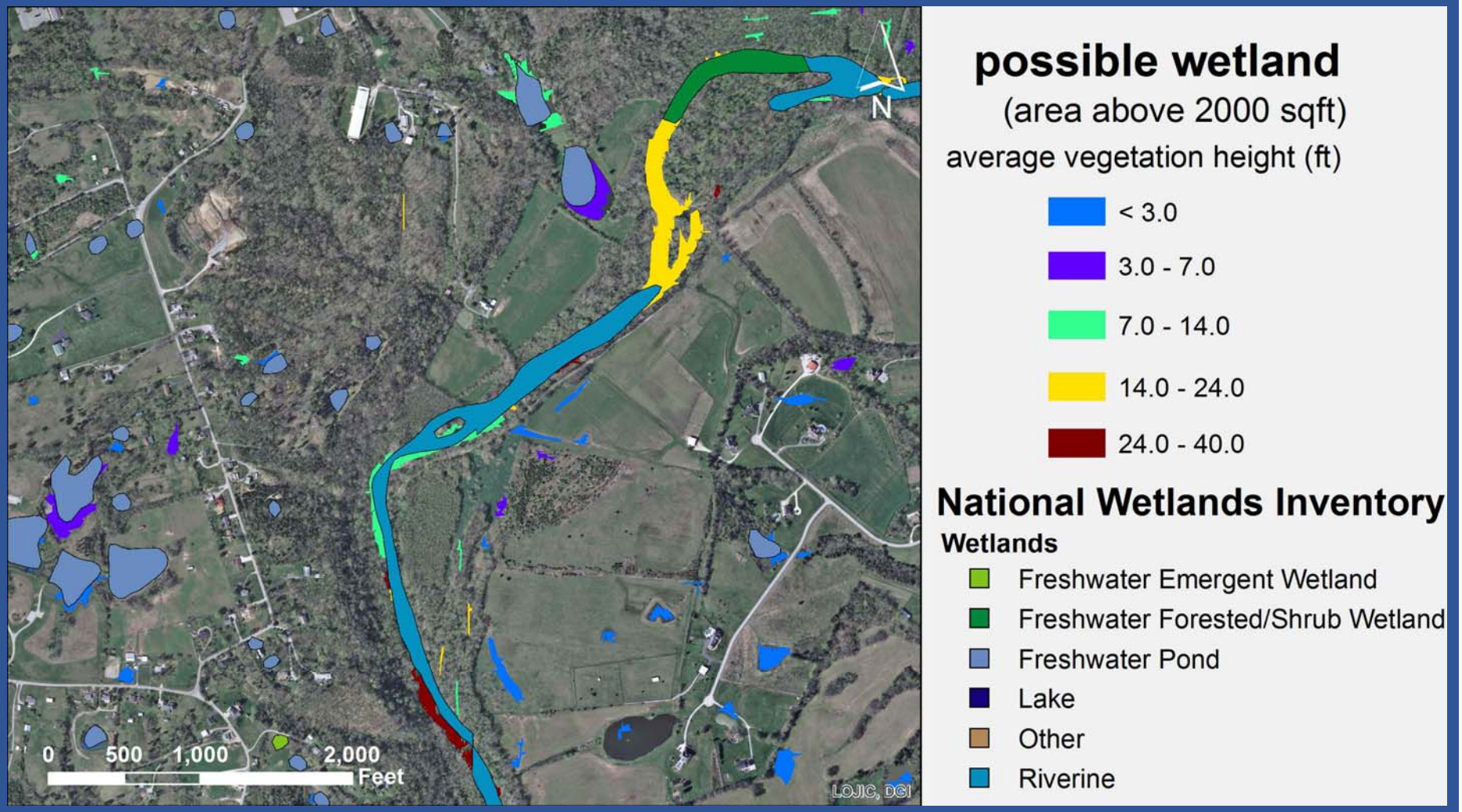
4: Estimate Vegetation Height



Wetlands With Vegetation Height



Compare with National Wetlands Inventory



Conclusions and Future Work

- LiDAR provides a high resolution and high accuracy DEM for sinkhole identification.
- Inspecting aerial images from different sources and times is critical to screen sinkholes from depression features.
- Field verification results demonstrate that the LiDAR sinkhole-mapping procedure is reliable and efficient.
- We are extending this project to Bullitt, Jefferson, and Oldham Counties outside Floyds Fork watershed.

Acknowledgements

- This study is supported by Kentucky Geological Survey.

- LiDAR data are provided by the Louisville/Jefferson County Information Consortium (LOJIC) through Kentucky Division of Geographic Information.

- Field work with help from Liz Adams, Caleb Essex, Bailee Hodelka, Chase Lockhart, Mike Lynch, Brittany Shelton, Richard Smath, and Patrick Whalen.