An Improved DEM Processing Model to More Accurately Locate Sinkholes in Southwestern Ohio

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Outline

- What is karst
- Methods
  - ID shallow features
  - Clean up
- Review of karst areas

What is Karst

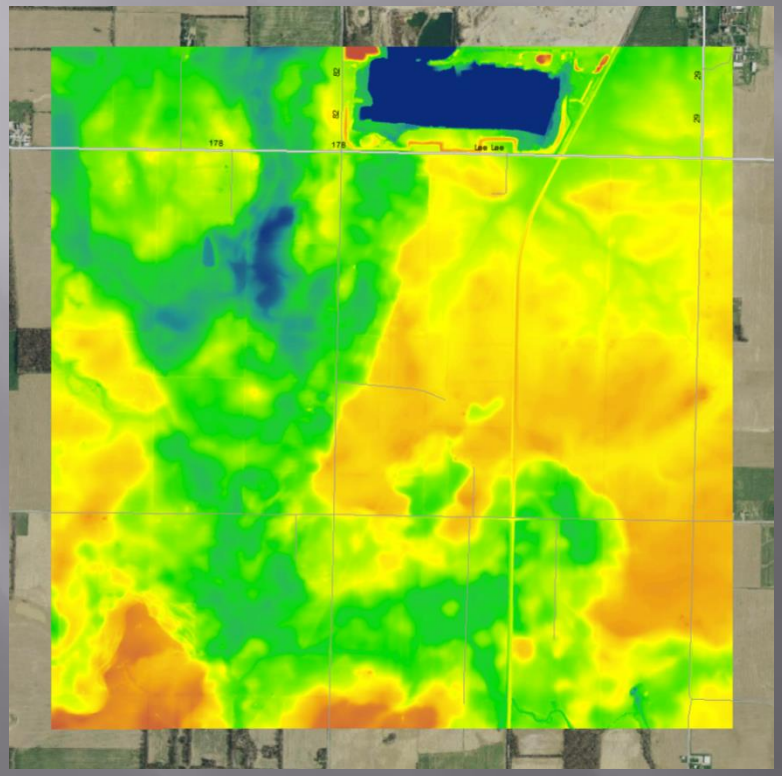
- Forms by dissolution of
  - Carbonates (limestone or dolomite)
  - Evaporites (gypsum or salt)
- Characterized by
  - Sinkholes
  - Disappearing streams
  - Caves
  - Springs

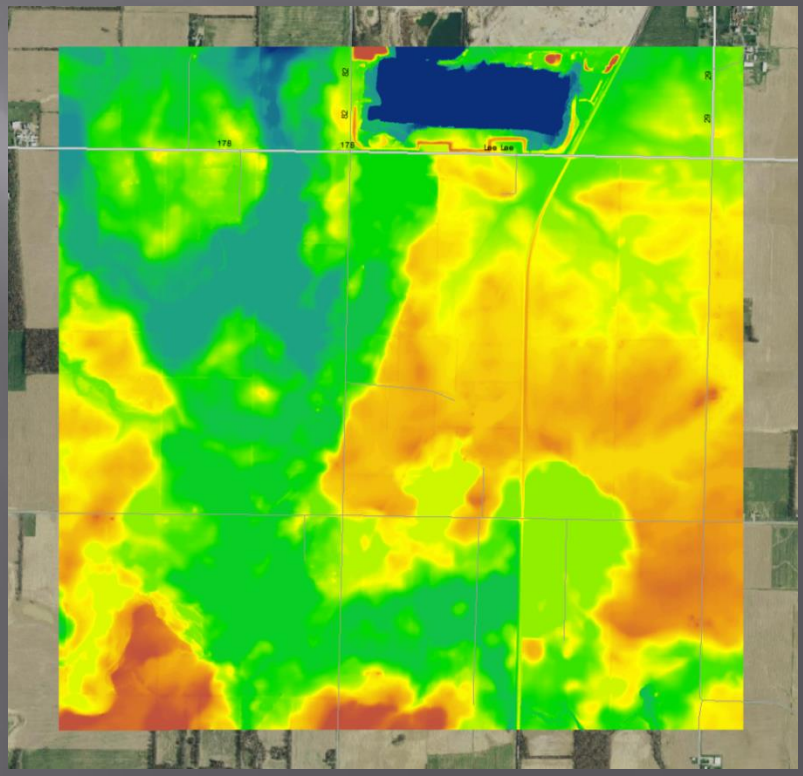
Methods

- Extract depressions from DEM
- Automate removal of very small and very shallow depressions
- Manually check remaining depressions in Arc
- Field verify.

Fill (Spatial Analyst)

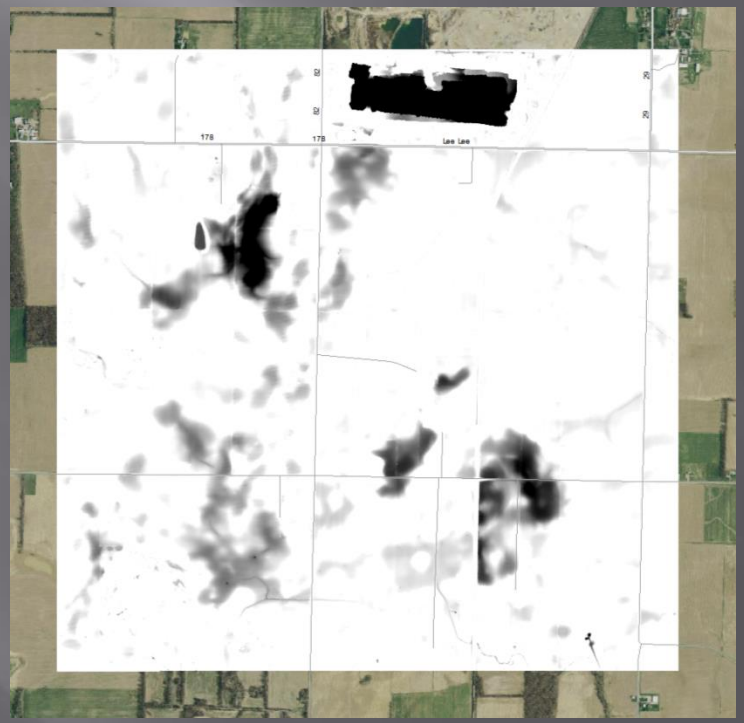
- Removes low enclosed areas.





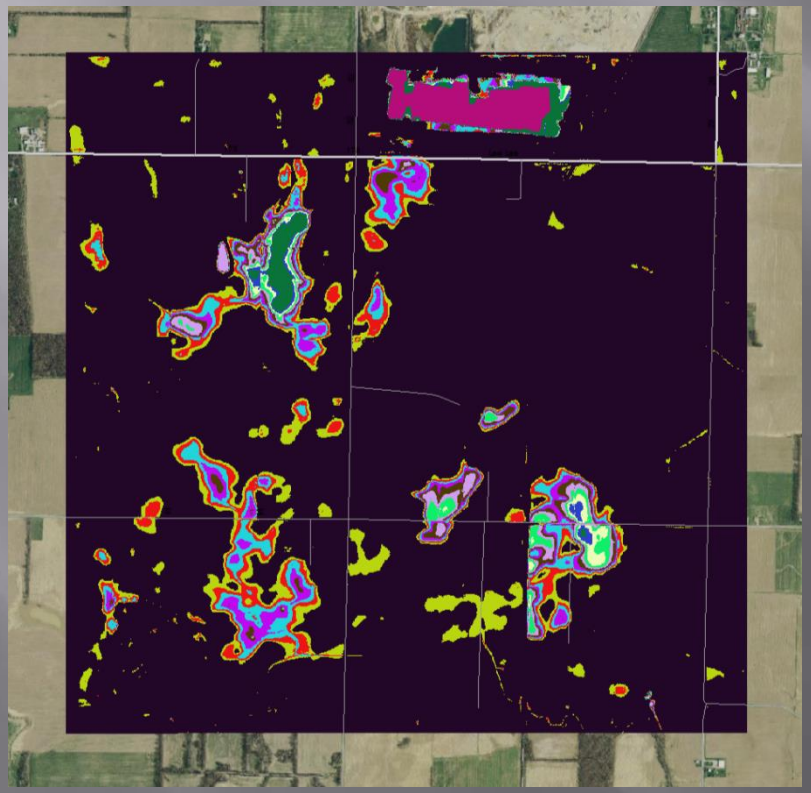
Minus (Spatial Analyst)

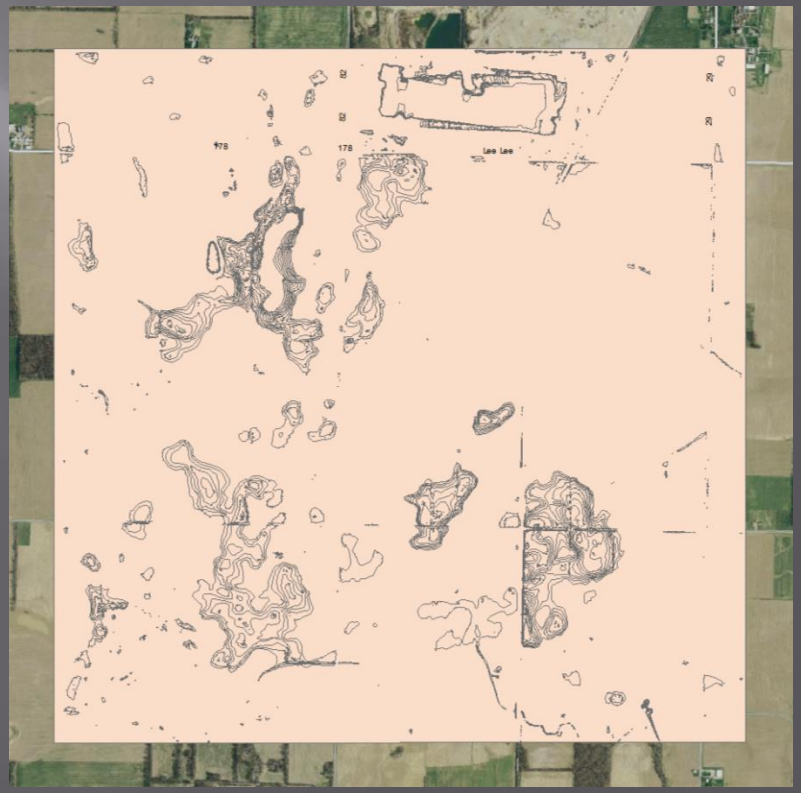
- Subtract the filled from the unfilled.
  - Exports a raster of just the enclosed lows.
- Reclassify (spatial analyst) using gridcode.
  - >0 to 1 = 1
  - 1 to 2 = 2
  - 2 to 3 = 3
  - …



Raster to Polygon

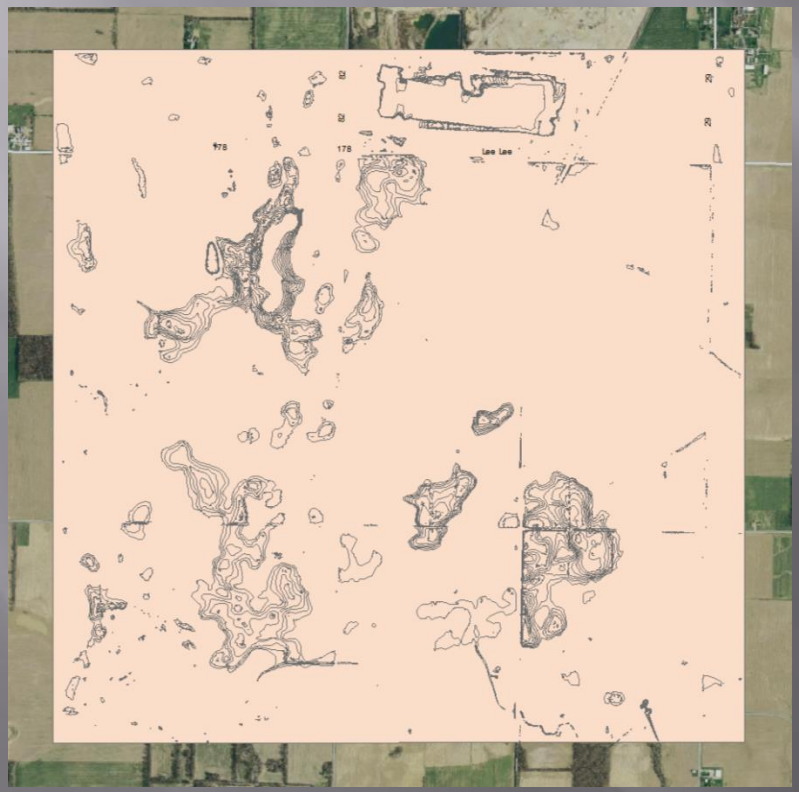
- Convert .grid to a feature class in a geodatabase using raster to polygon. This allows editing.

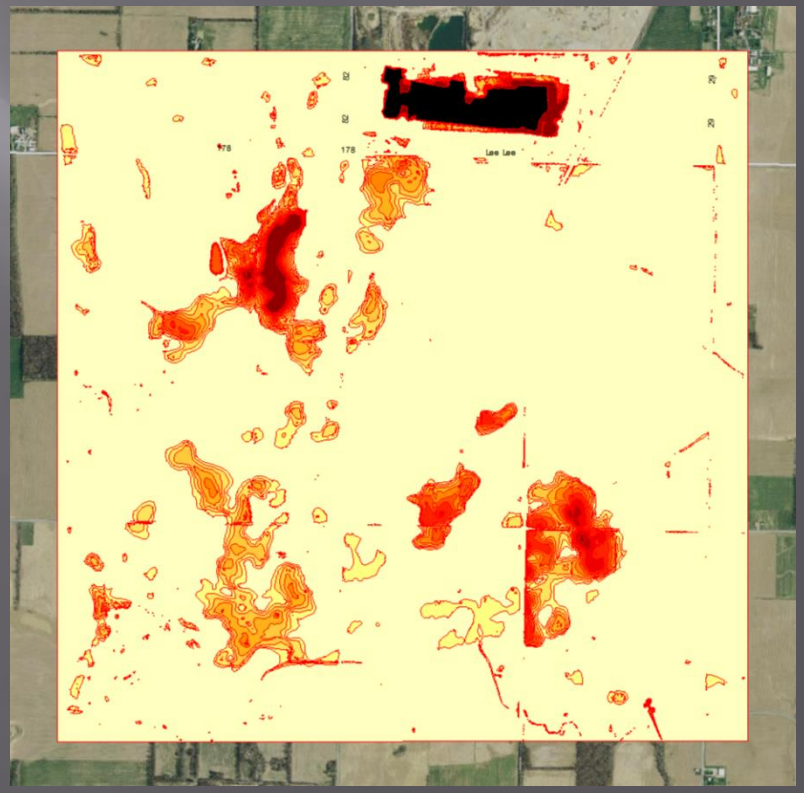




Color

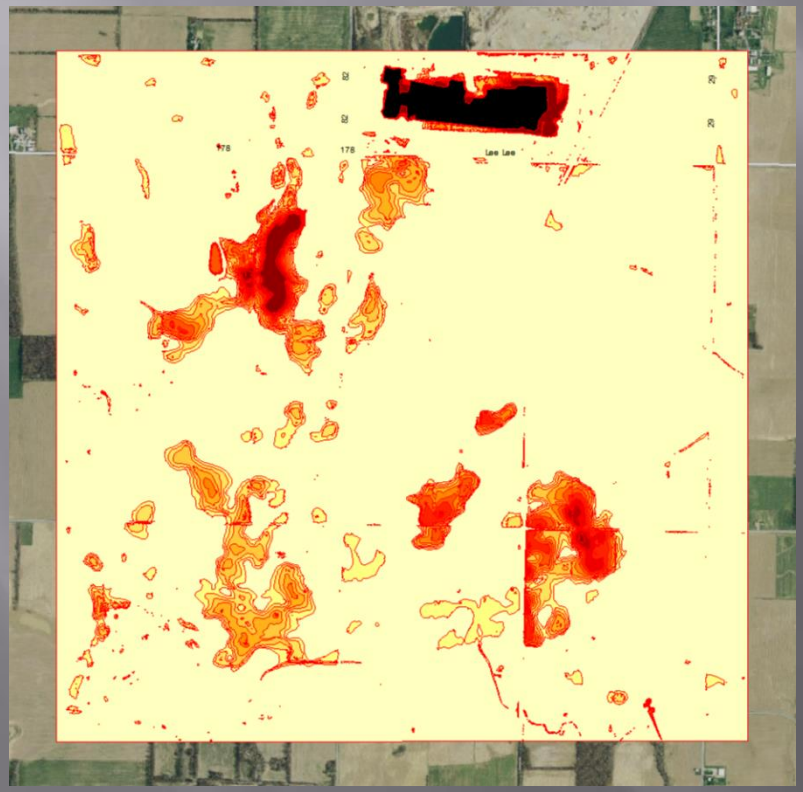
- Assign a custom color ramp to gridcode.





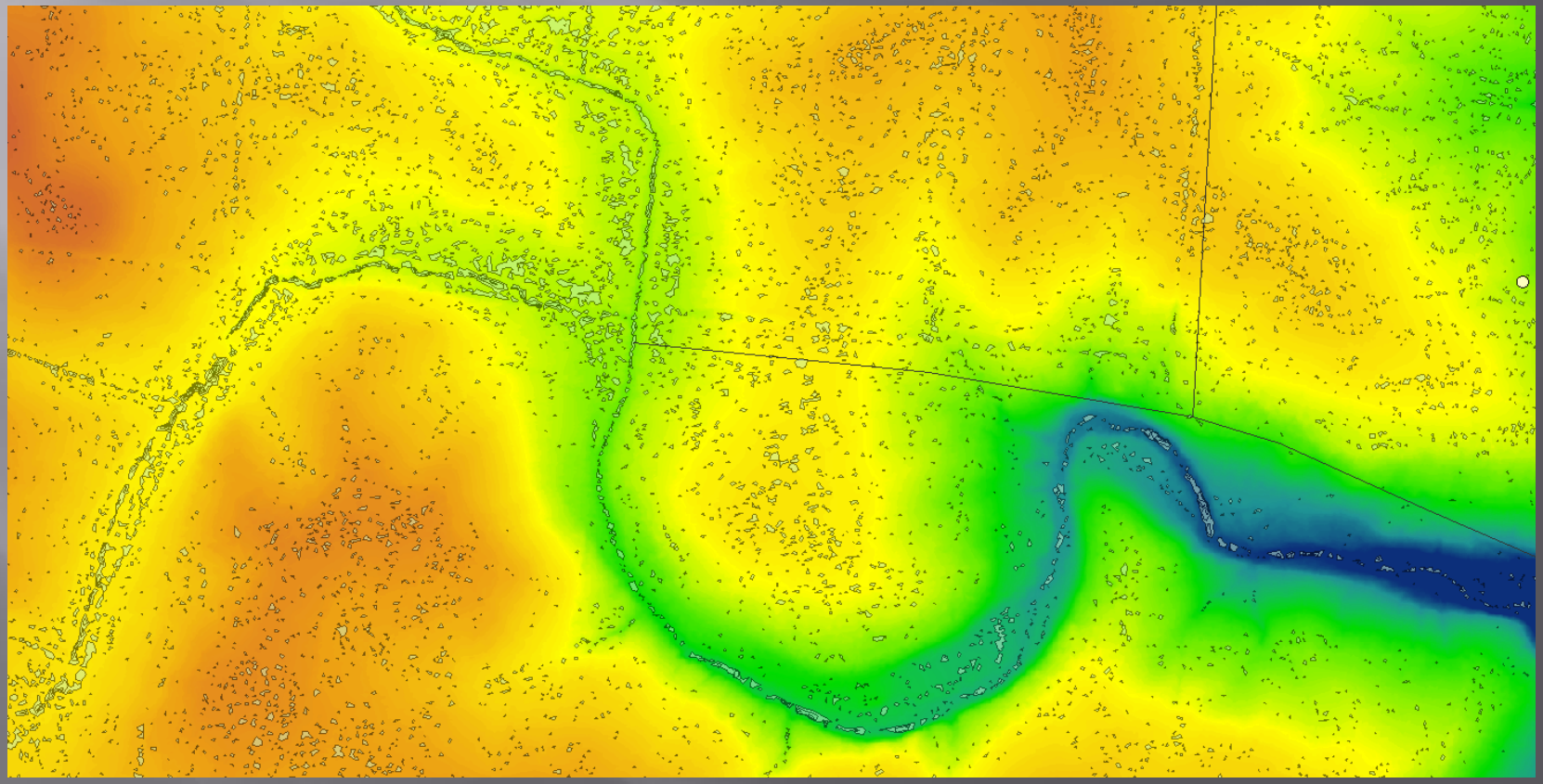
Cleaning Up

- Begin Removing Polygons (especially >0-1ft)
  - Note what happens if 0-1 is used instead of >0-1.



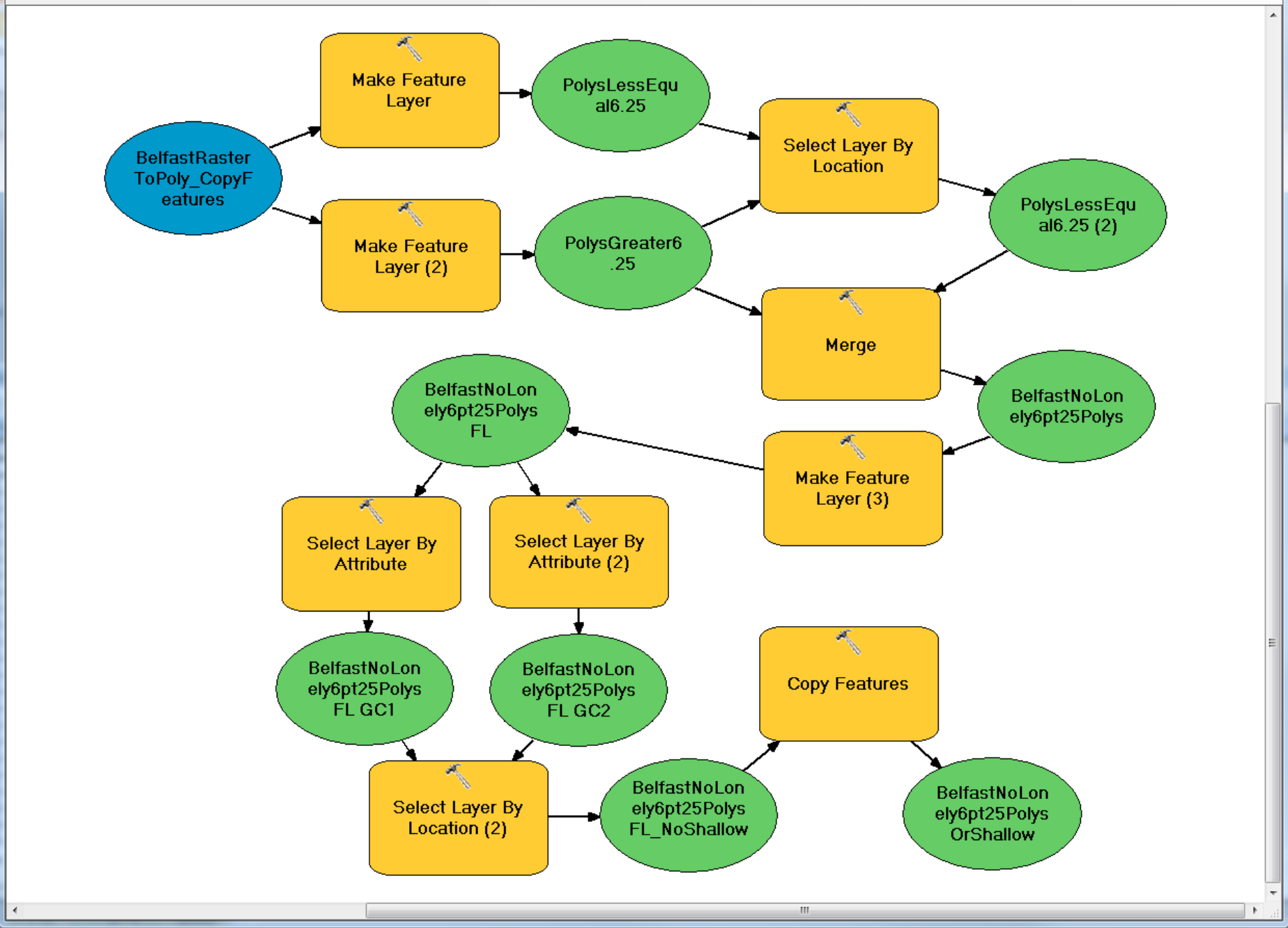
Small Polygons

- Features such as ground roughness, ditches, and waves on bodies of water contribute millions of tiny polygons.
- How to delete these isolated depressions without affecting the larger groups of polygons?



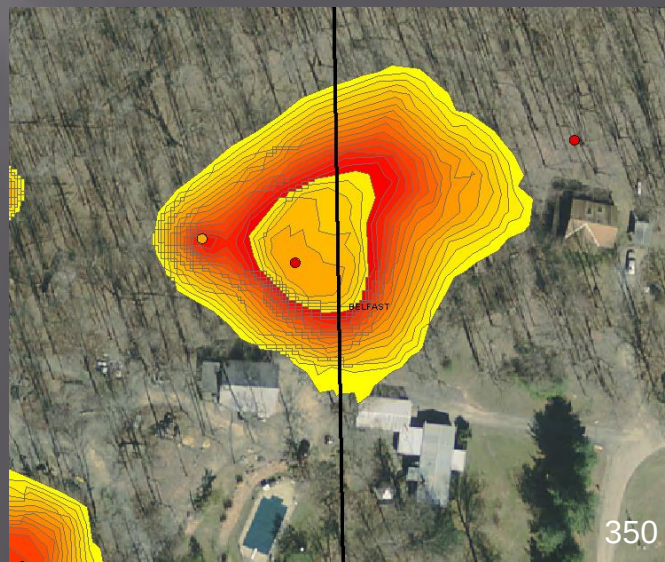
BelfastDeleteSmallPolys

Model Edit Insert View Windows Help



Cleaning Up

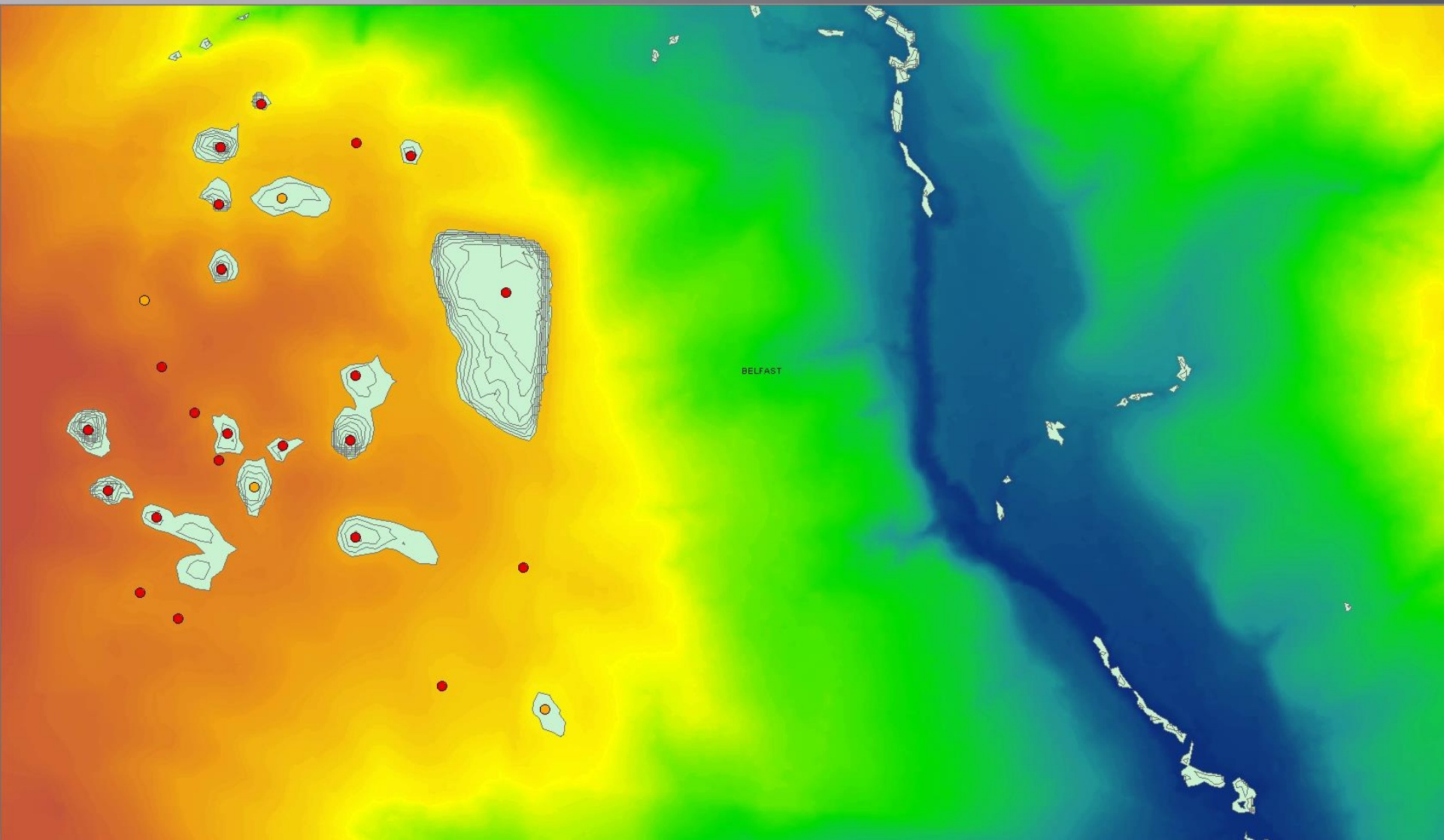
- Initial processing (fill and minus) : 3,540,000 total polygons.
- Automatic model to remove isolated small and shallow polygons: 747,000 remaining.
  - Removed polys smaller than 6.25ft^2 (data resolution).
  - Removed polys shallower than 1ft.
- Manual removal
  final count: 36,000 polygons.
  - Streams
  - Roads
  - Aerial



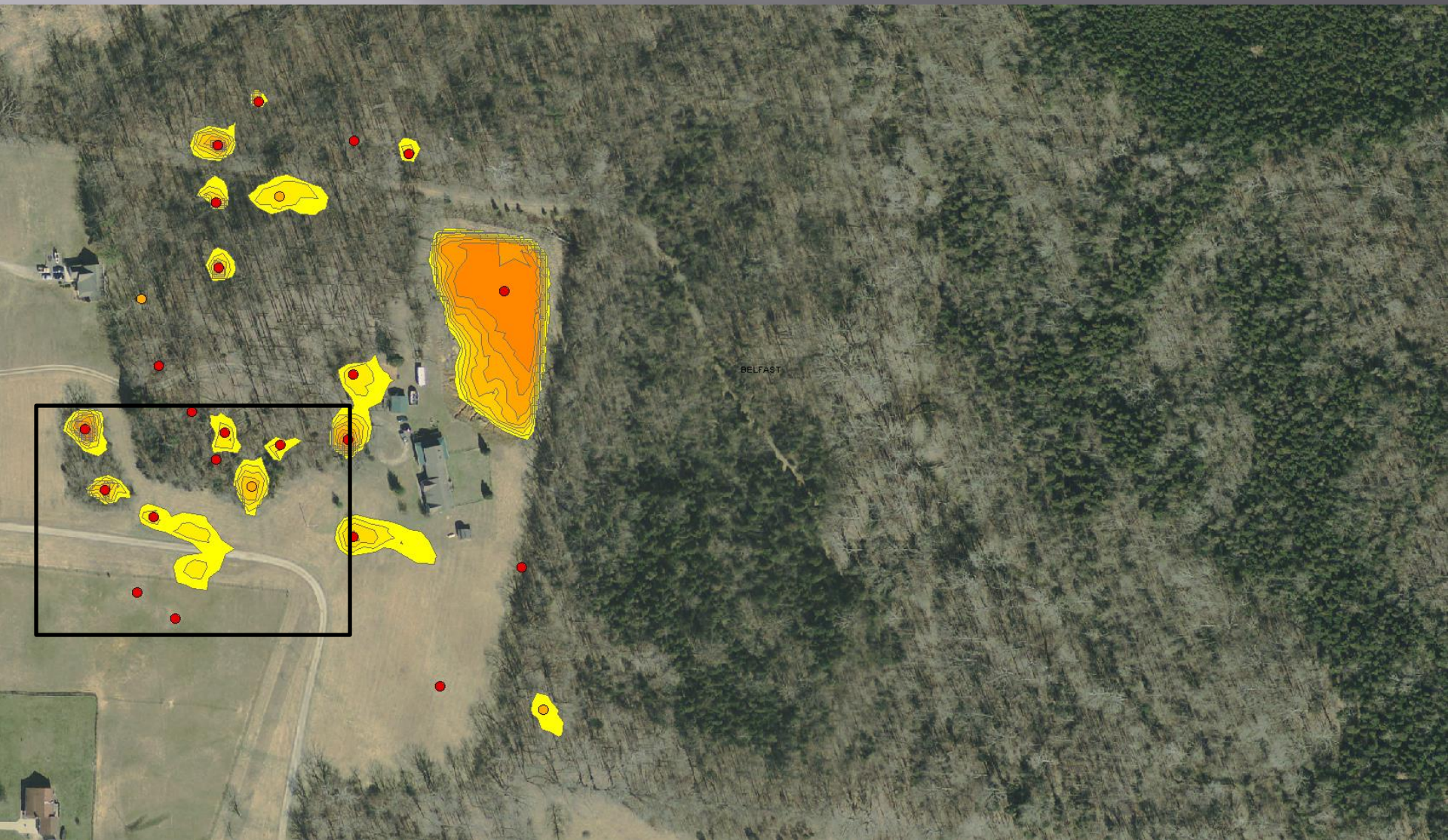
Results of Initial Processing

Results of Automatic Model

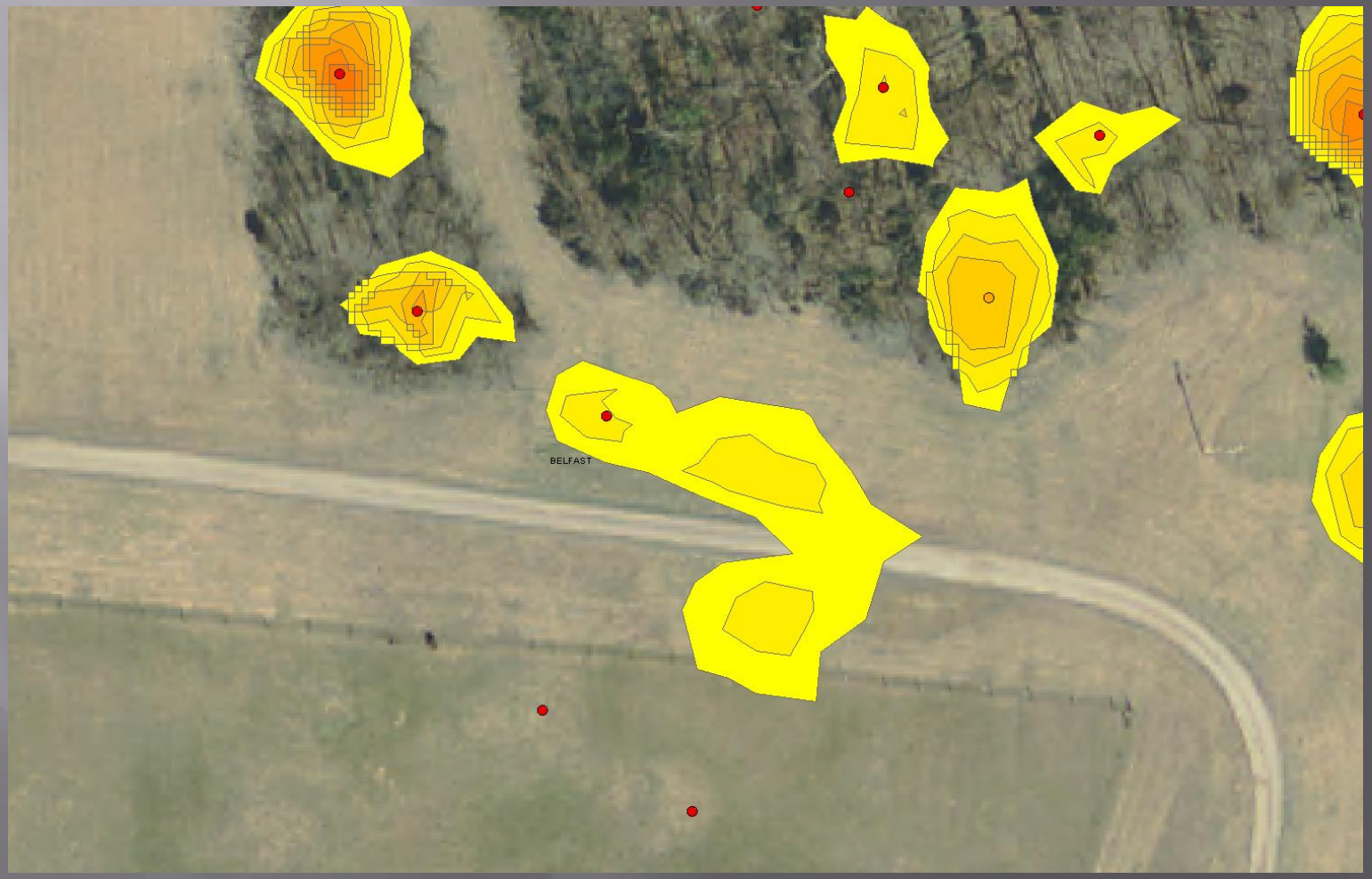
Results of Automatic Model on DEM

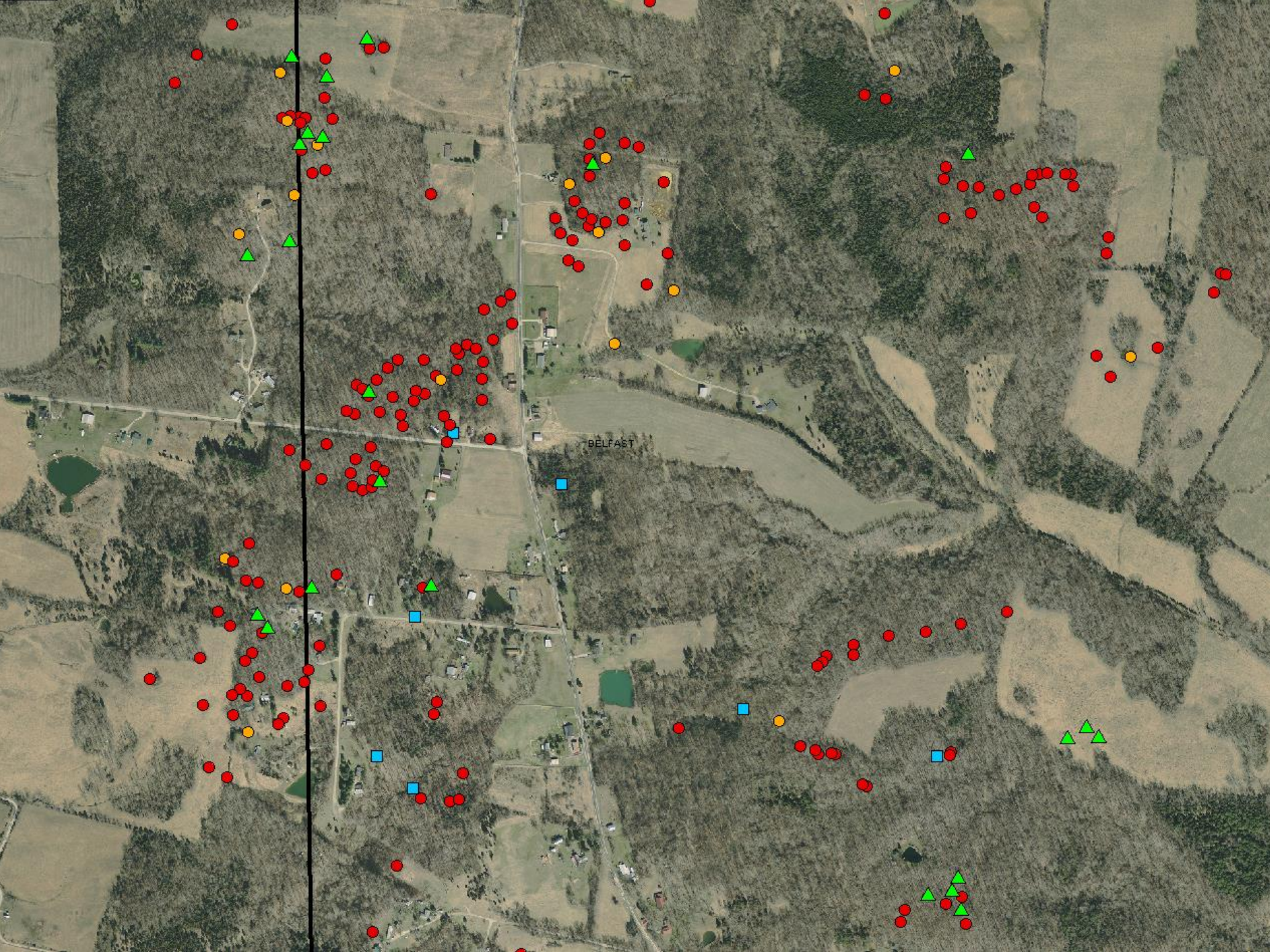


Final Results Including Field Verification



Benefit of Including >0-1ft.




BELFAST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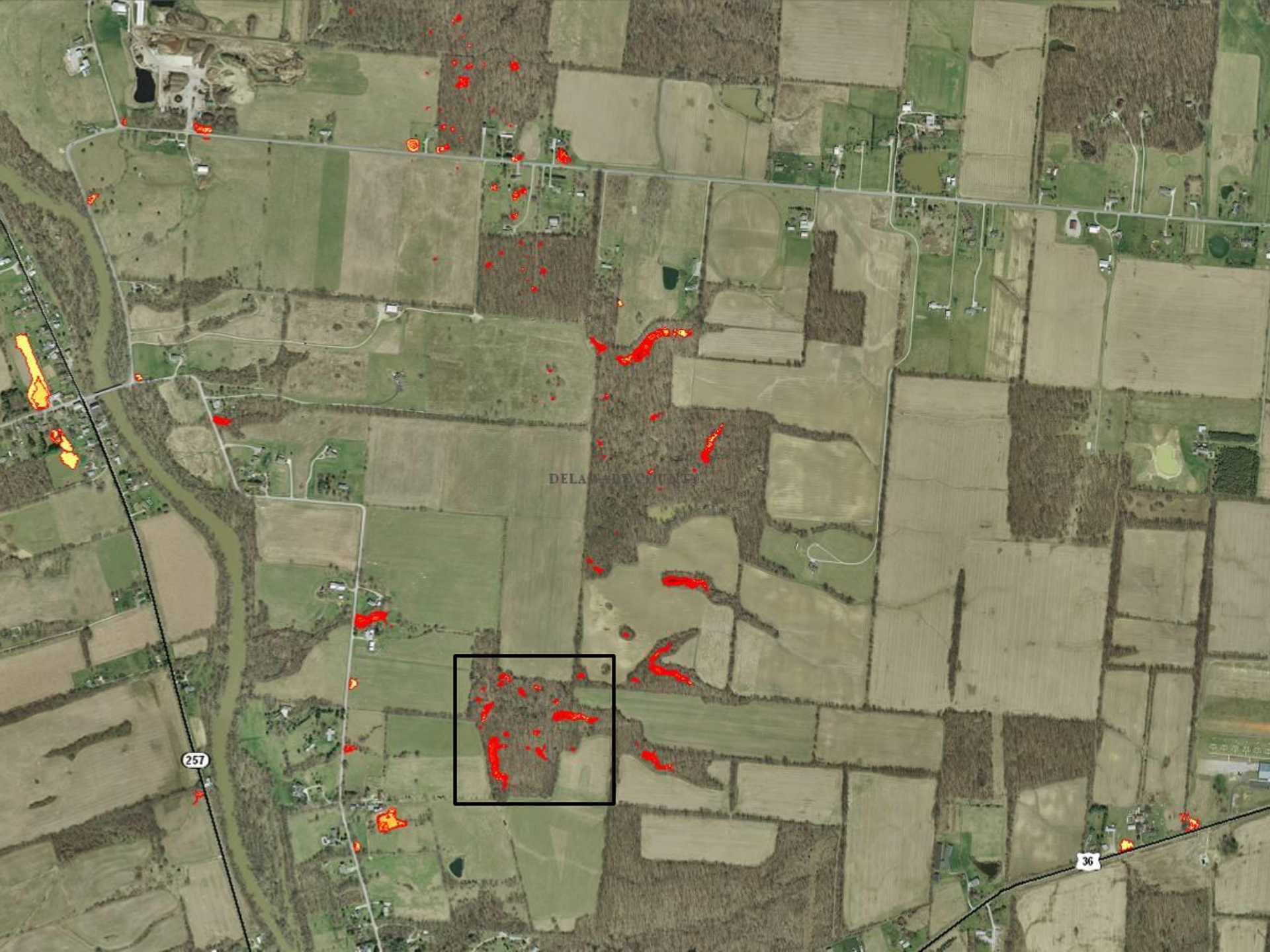
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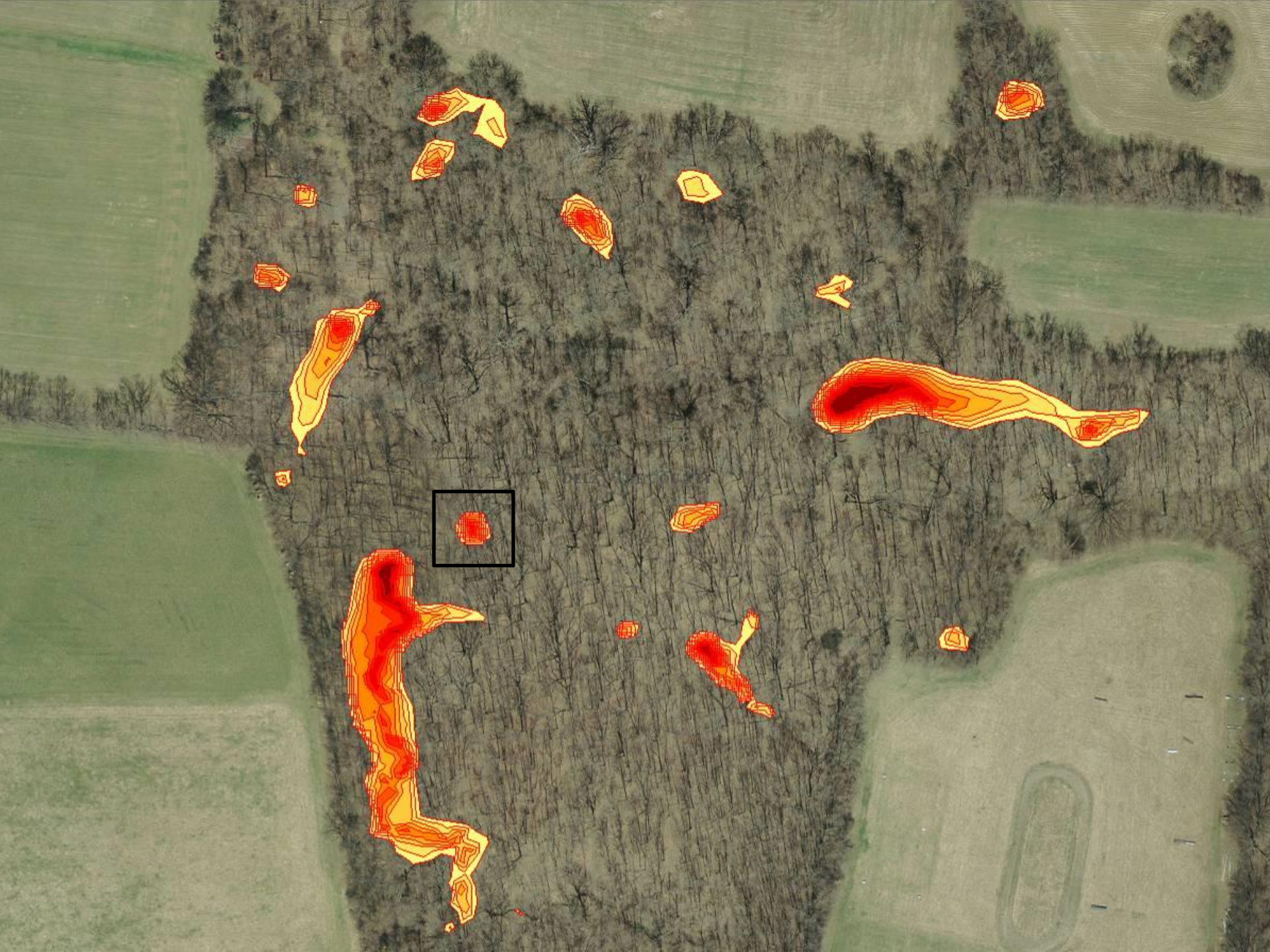
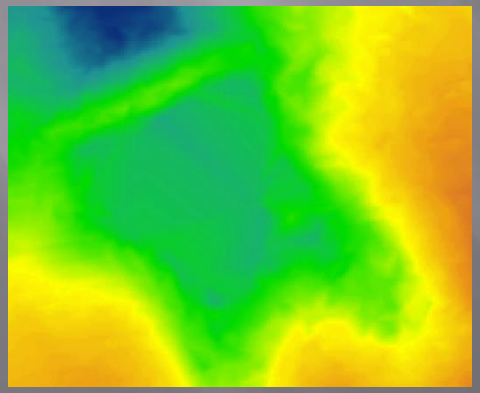


Field Verification

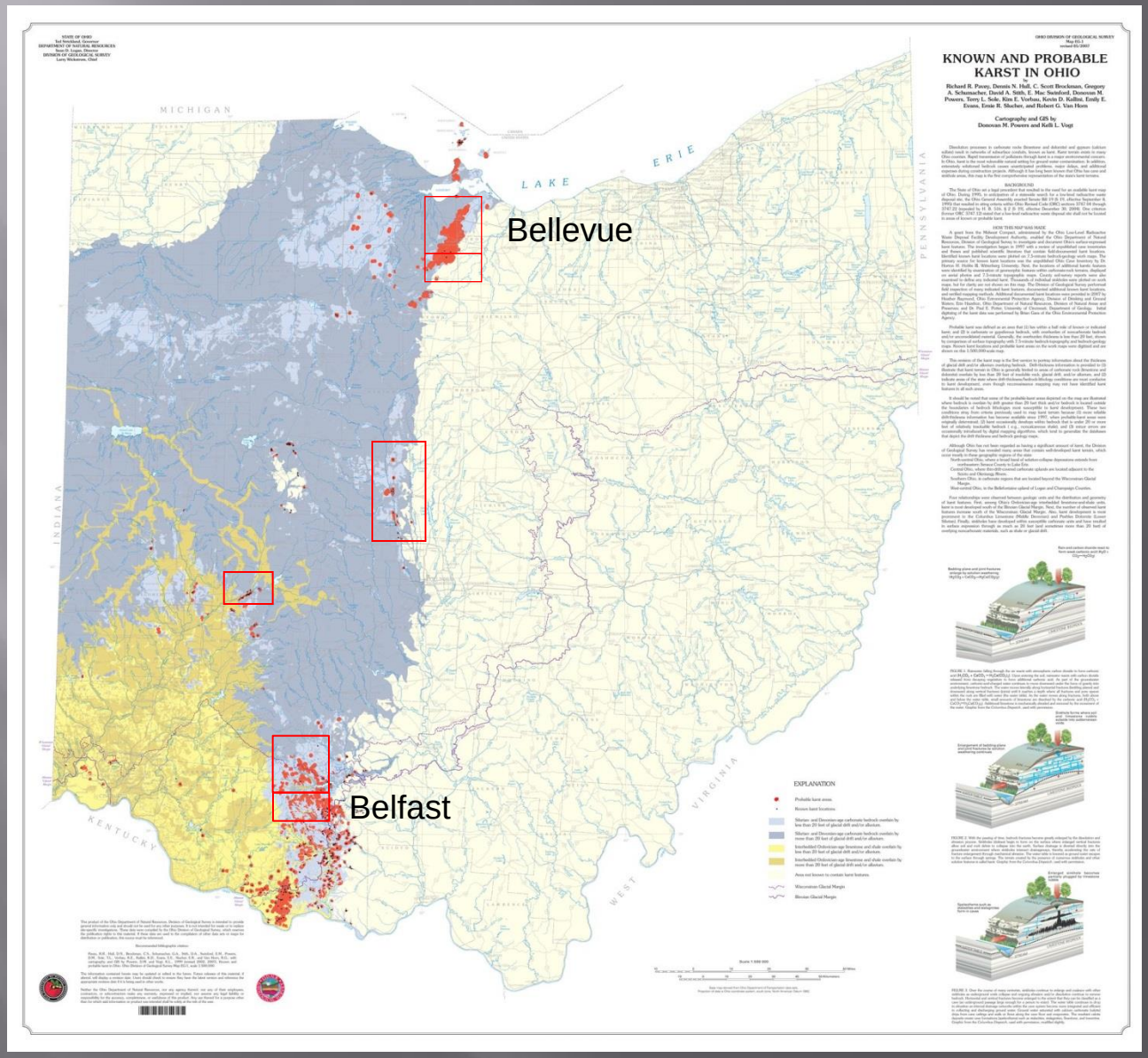
- Stream bank/water reflections
- Culverts/ bridges
- Storm drains
- Foundations
- Ponds

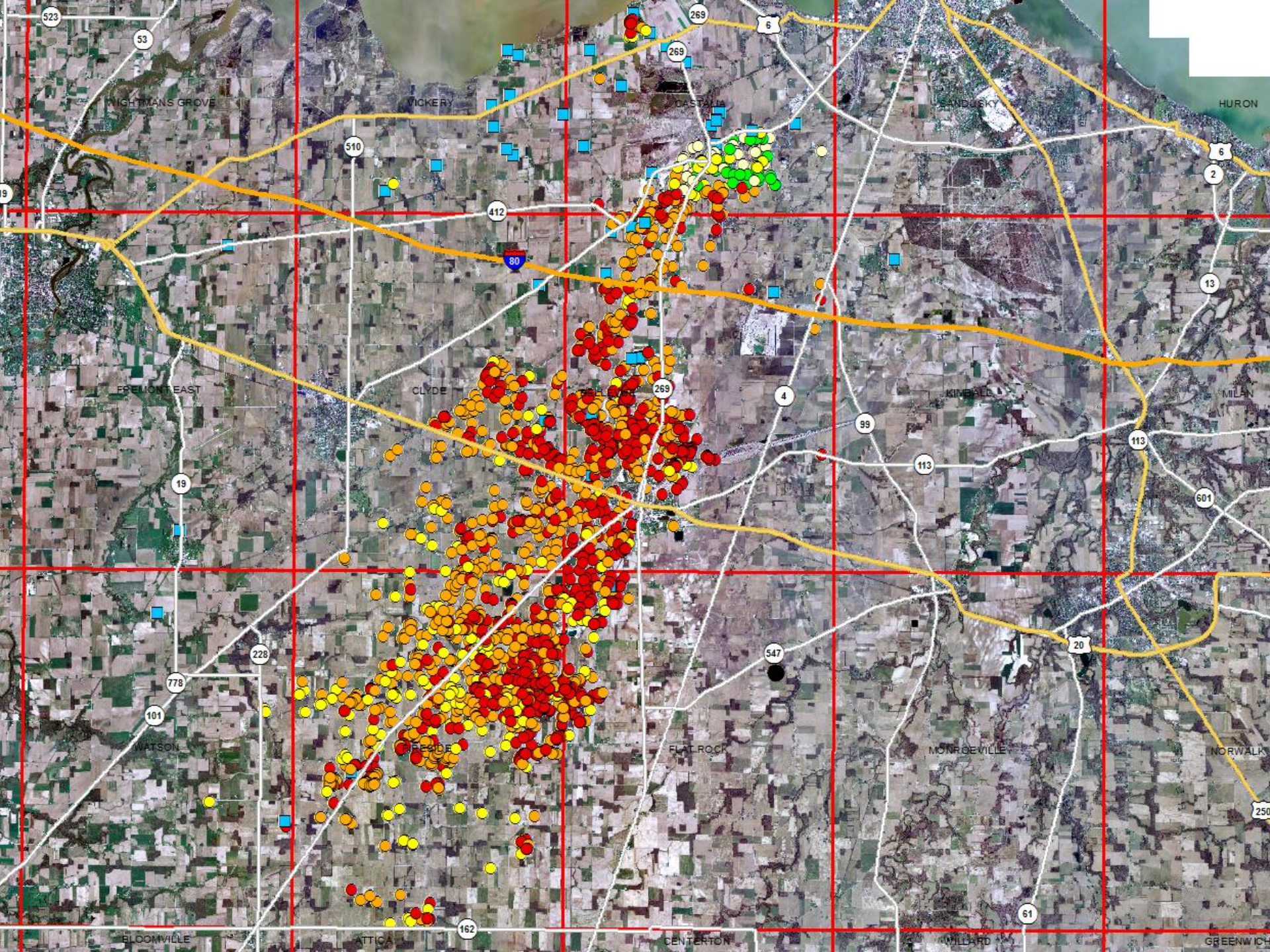


Failing drain tile

Known and Probable Karst in Ohio

Map EG-1, revised 05/2007

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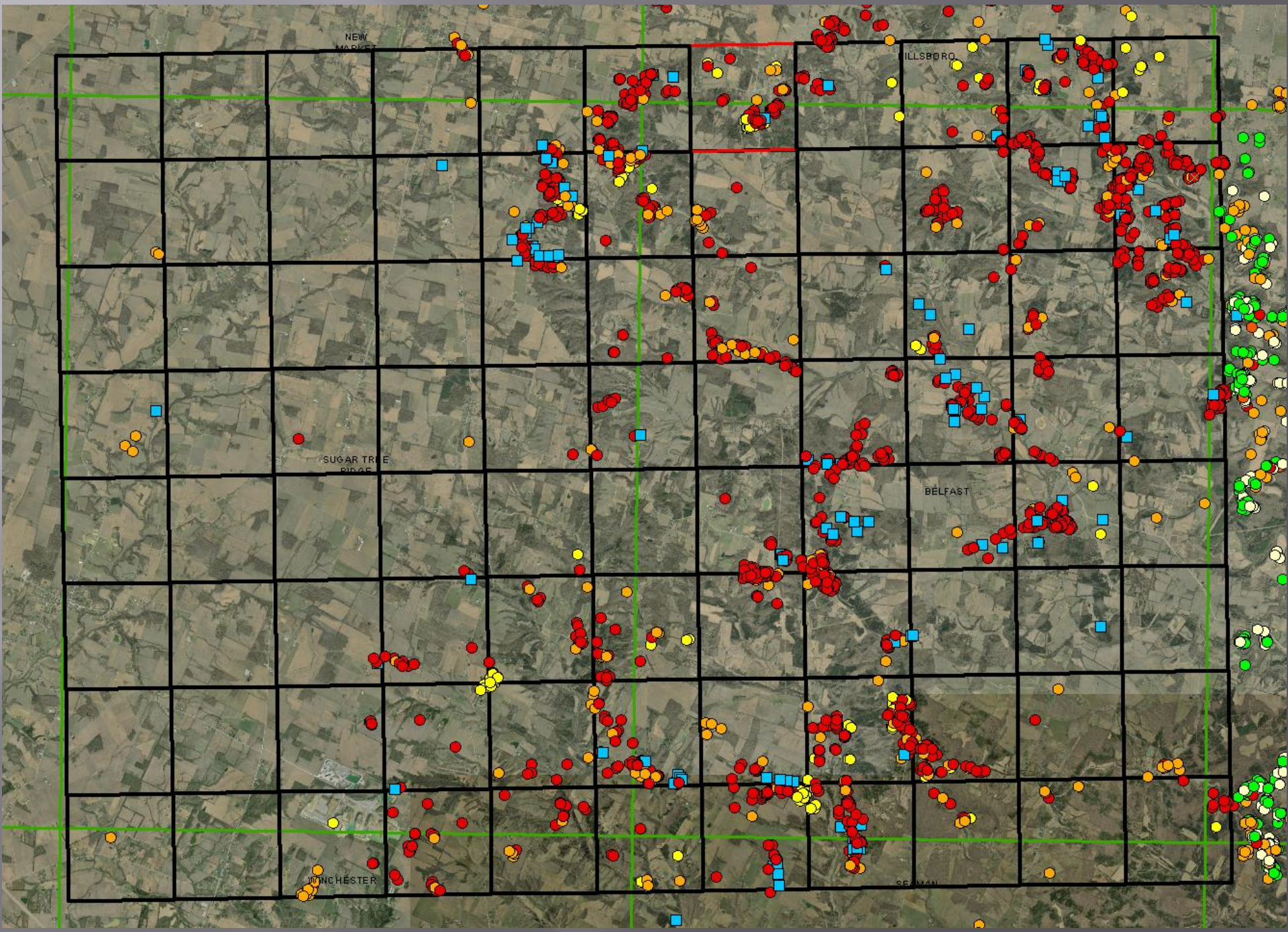
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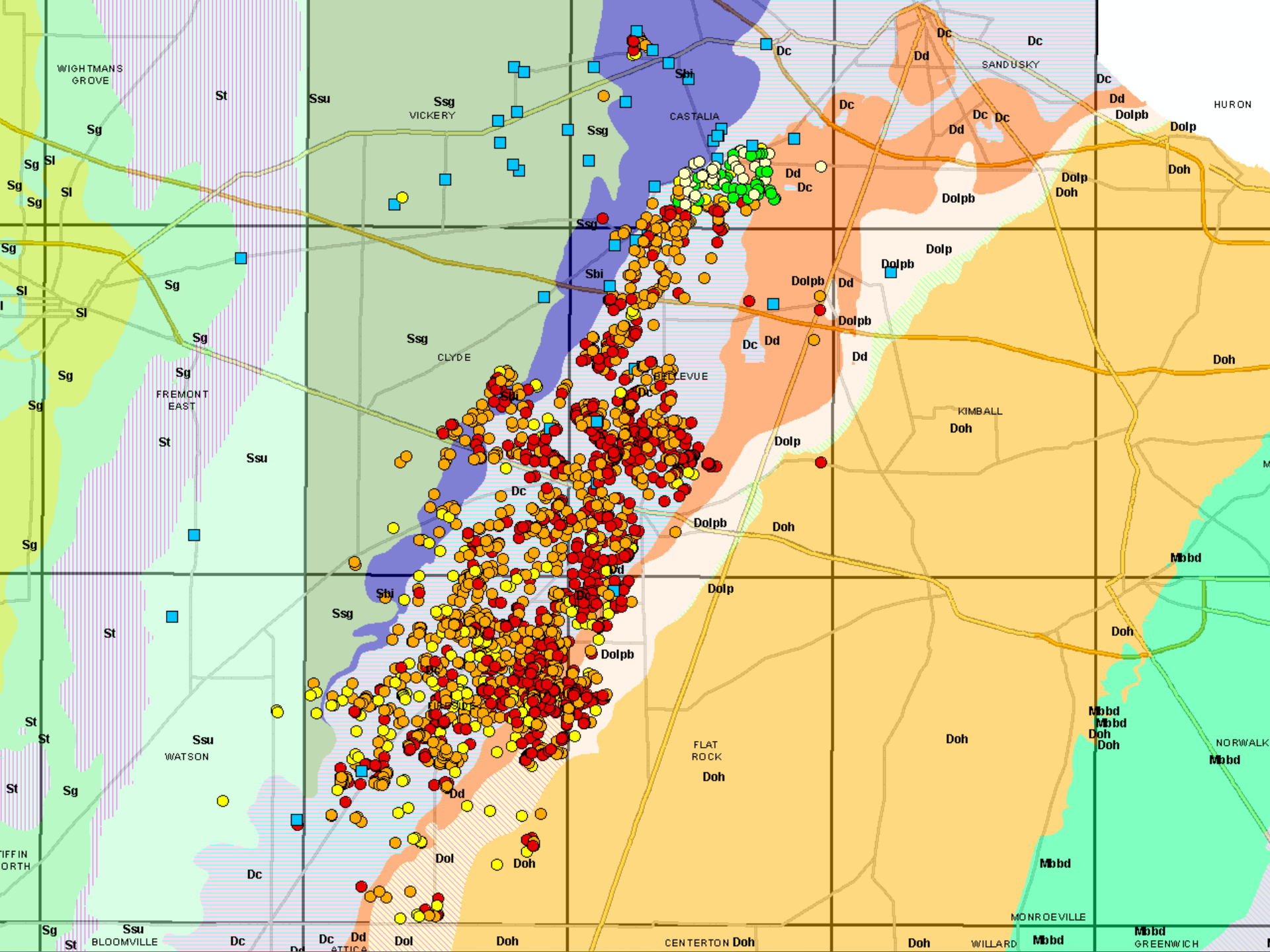
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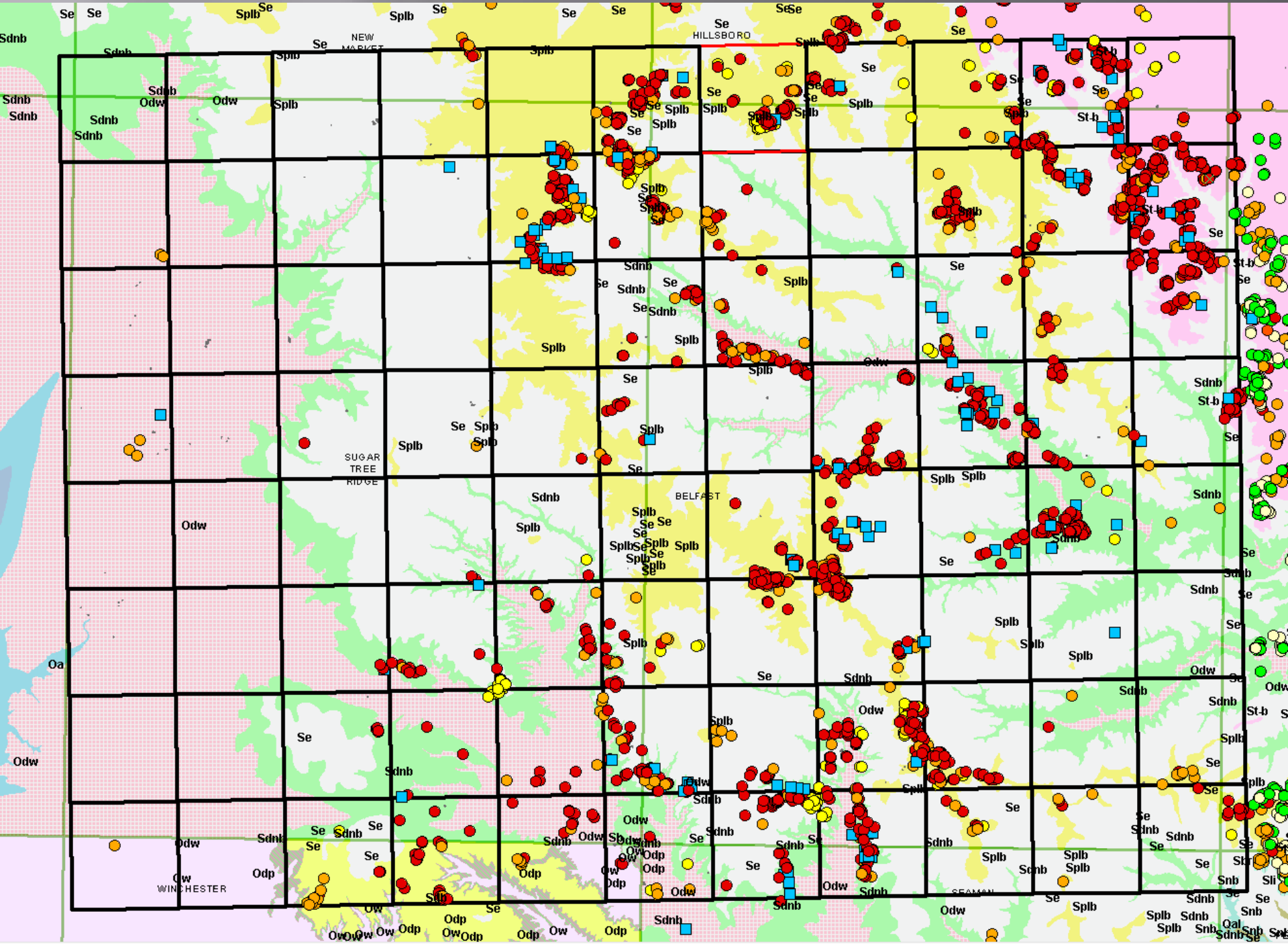
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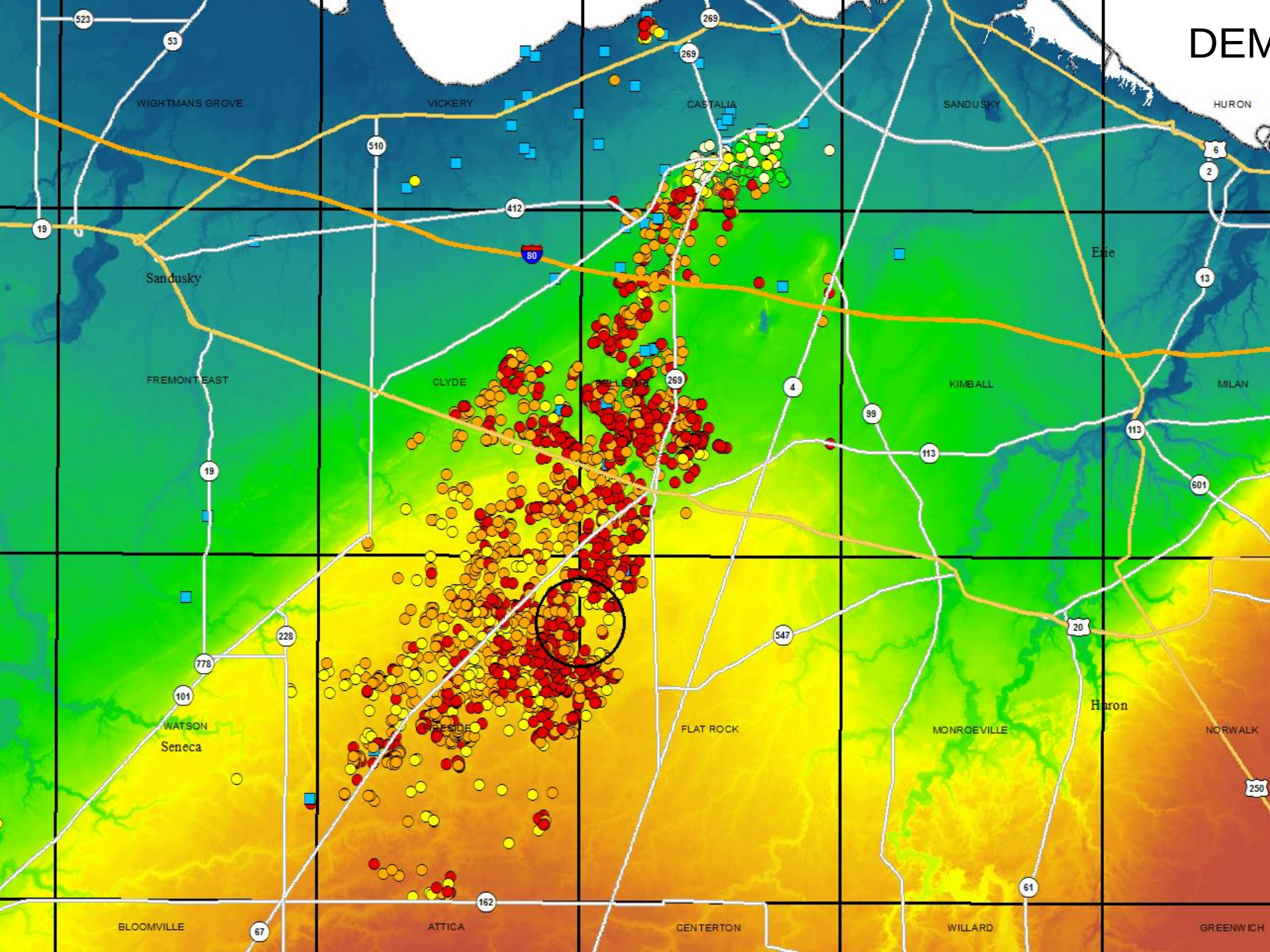
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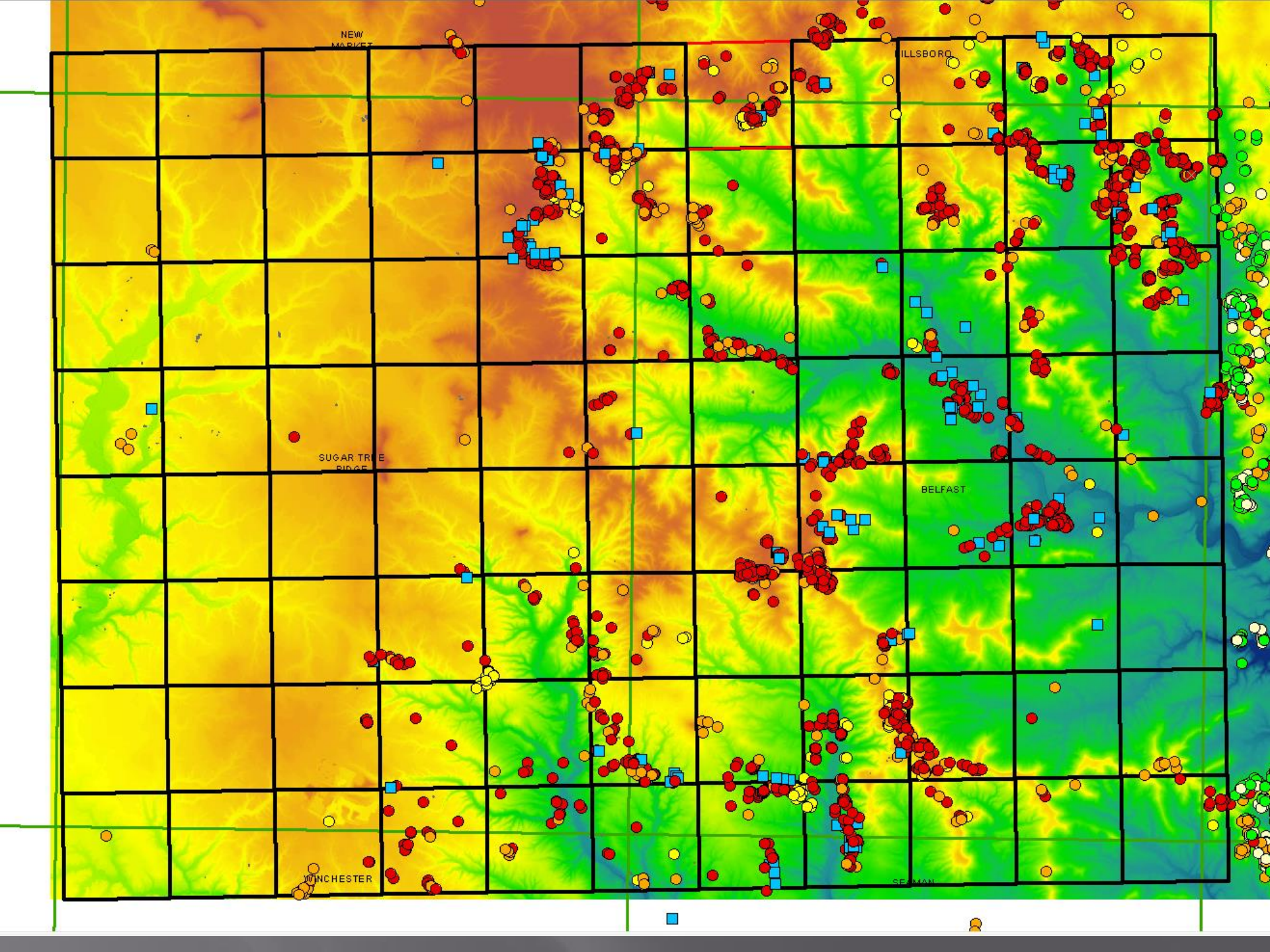
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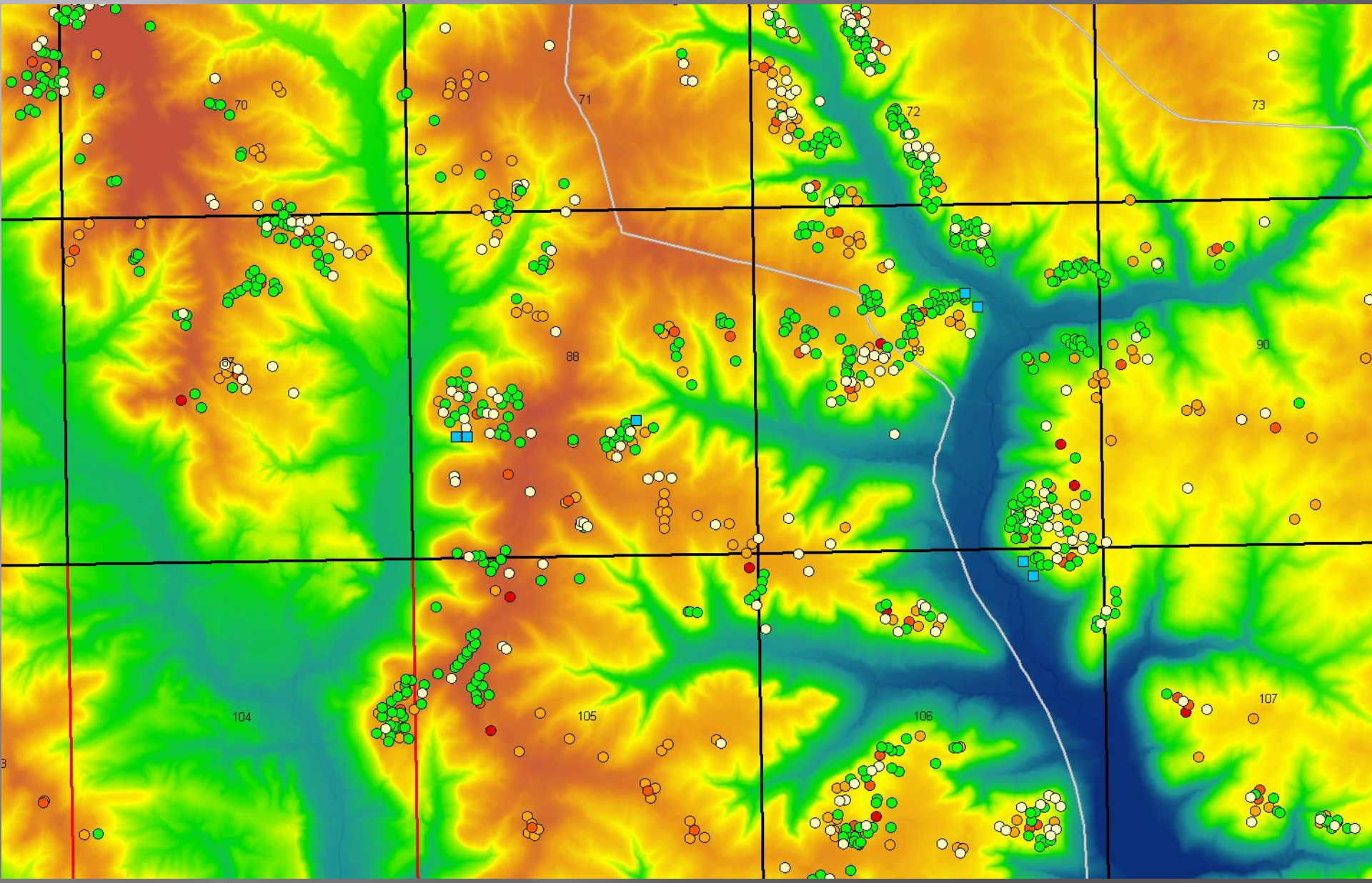
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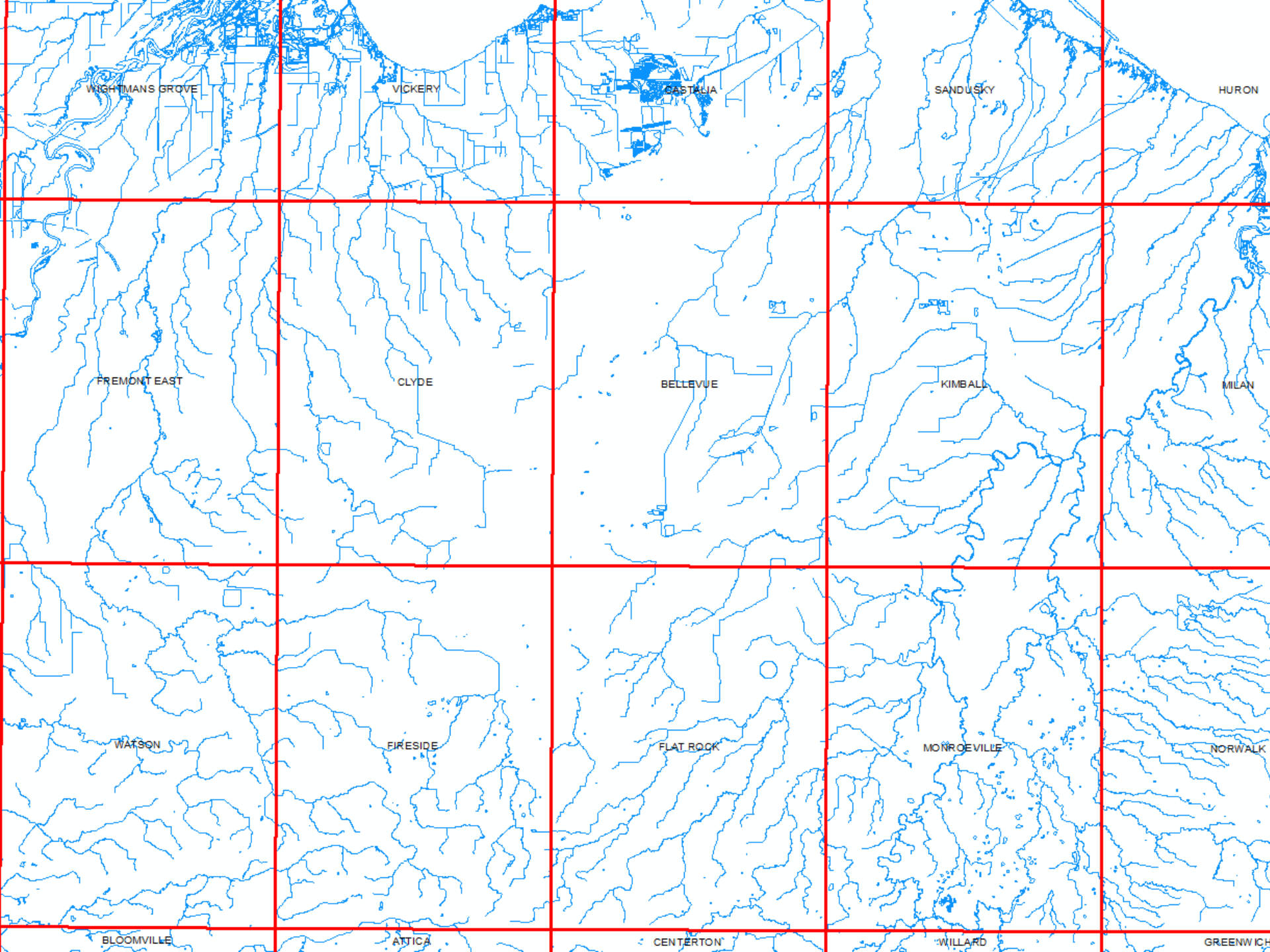
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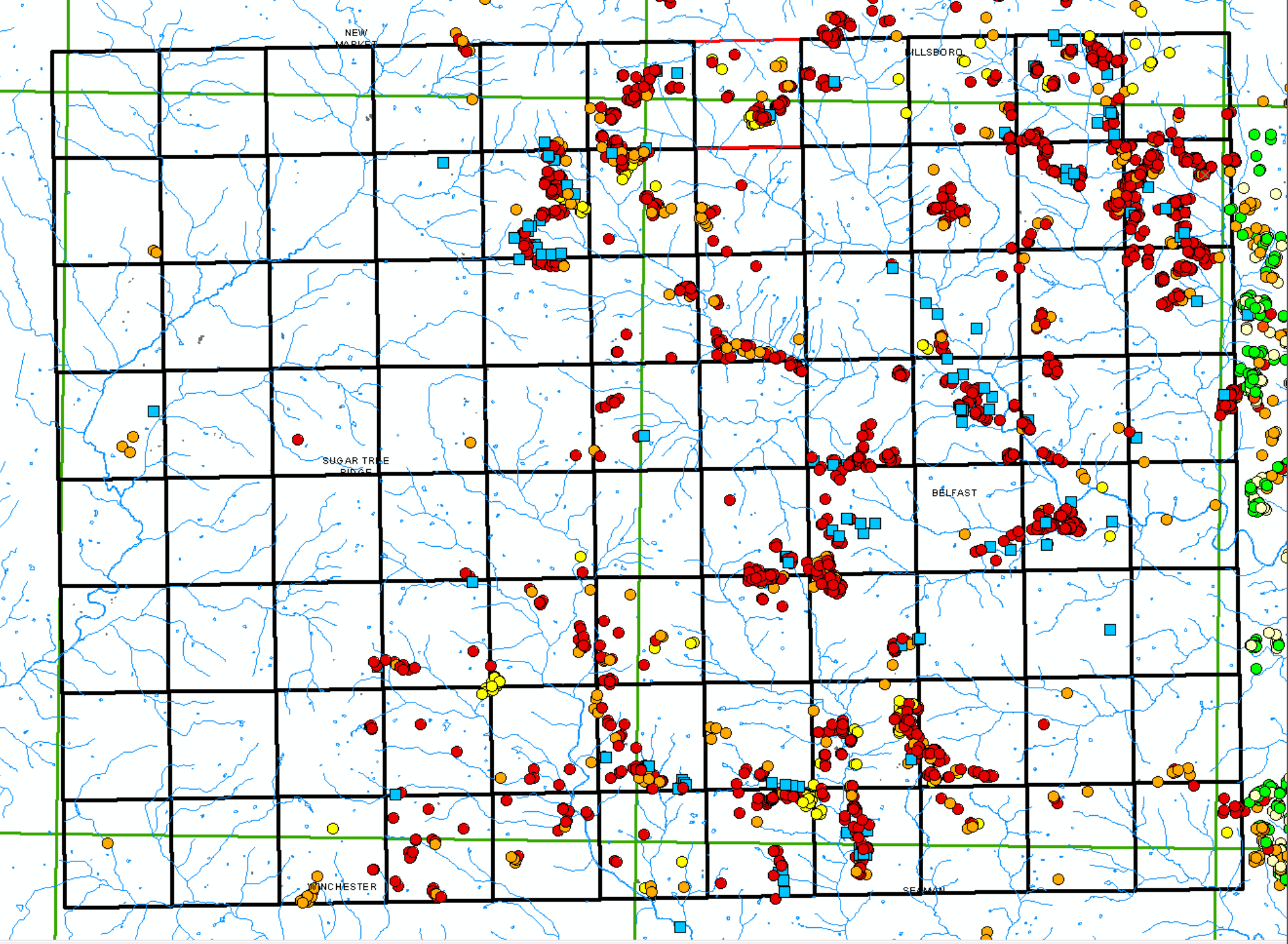
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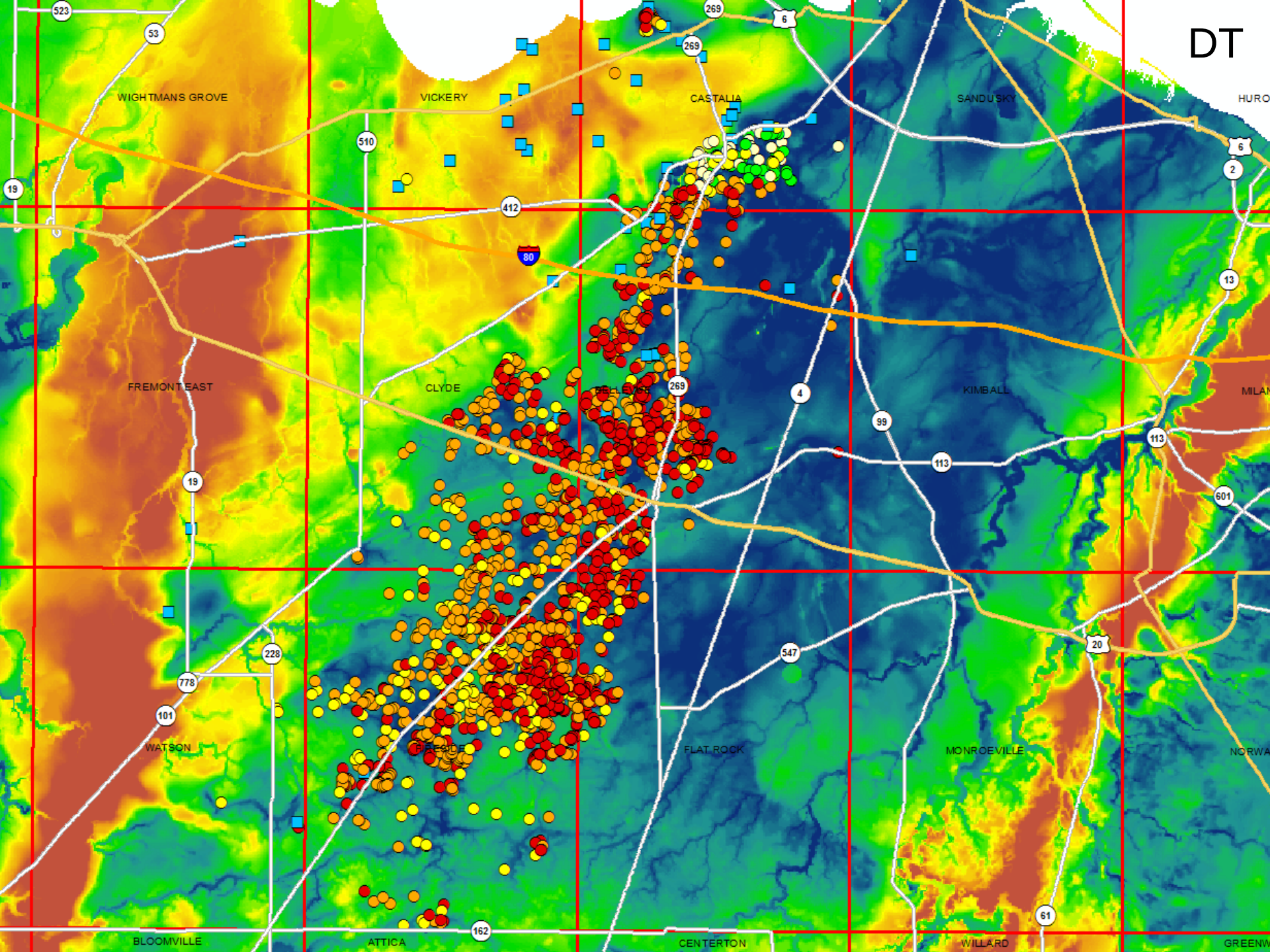
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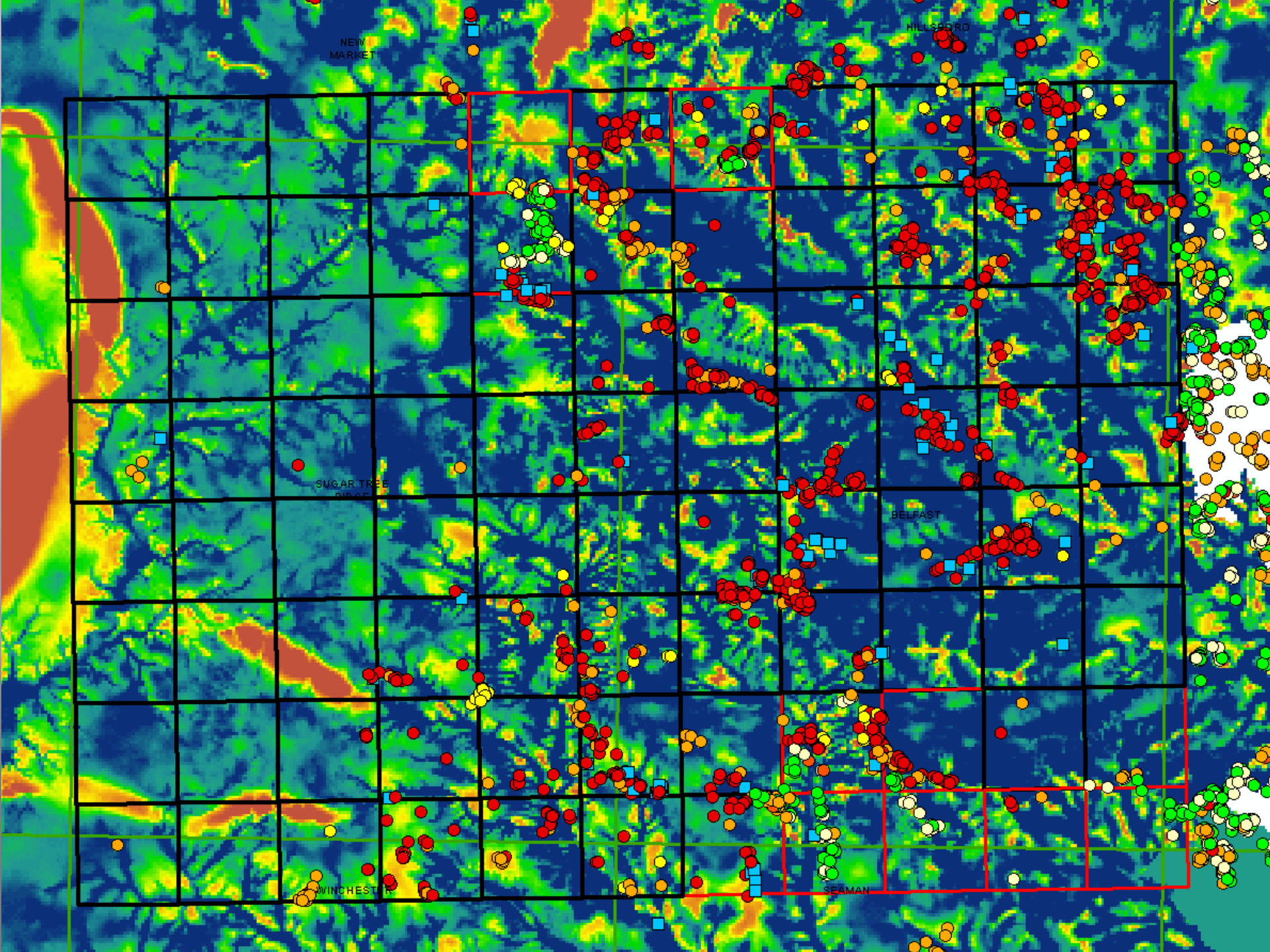
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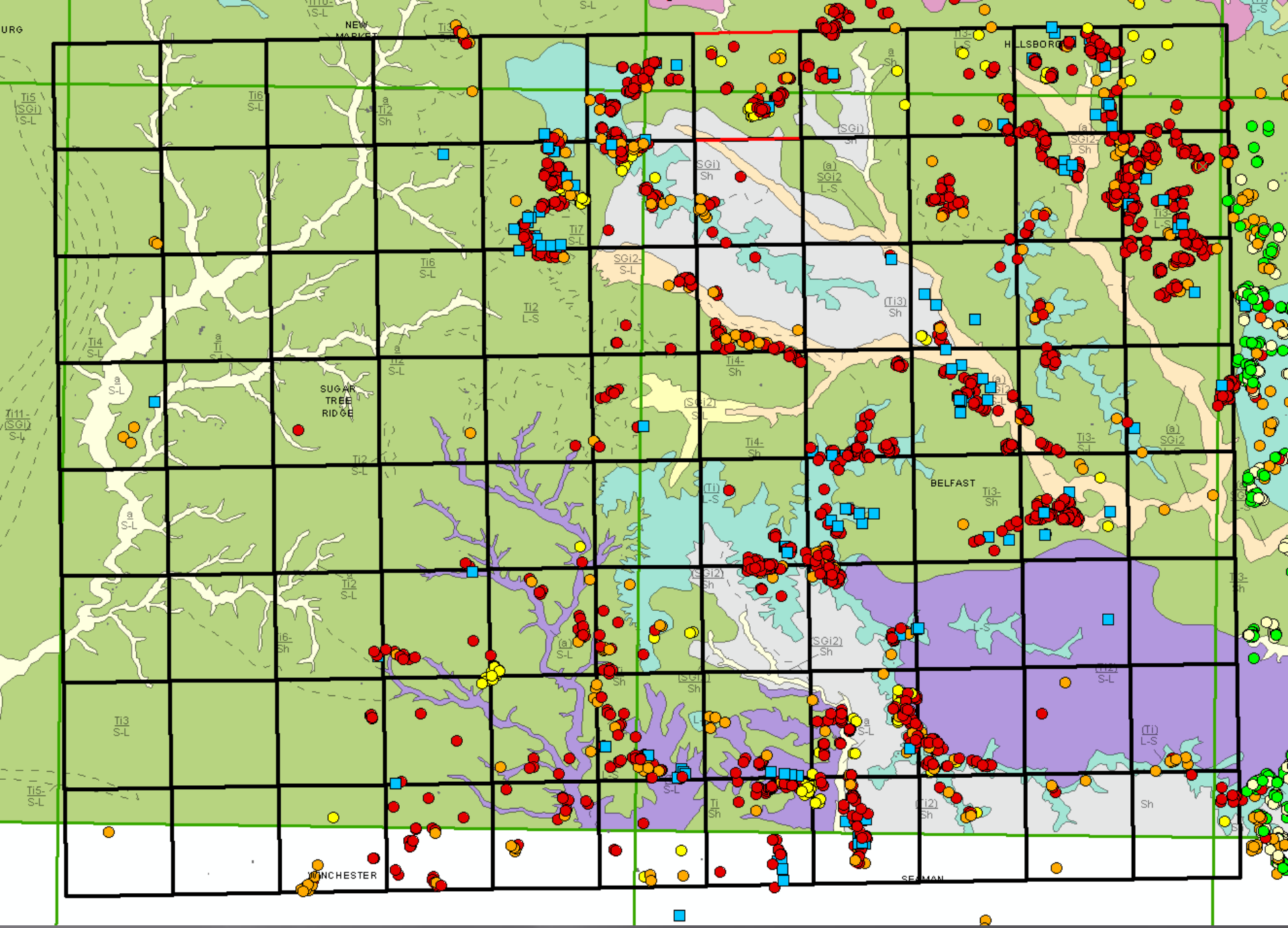
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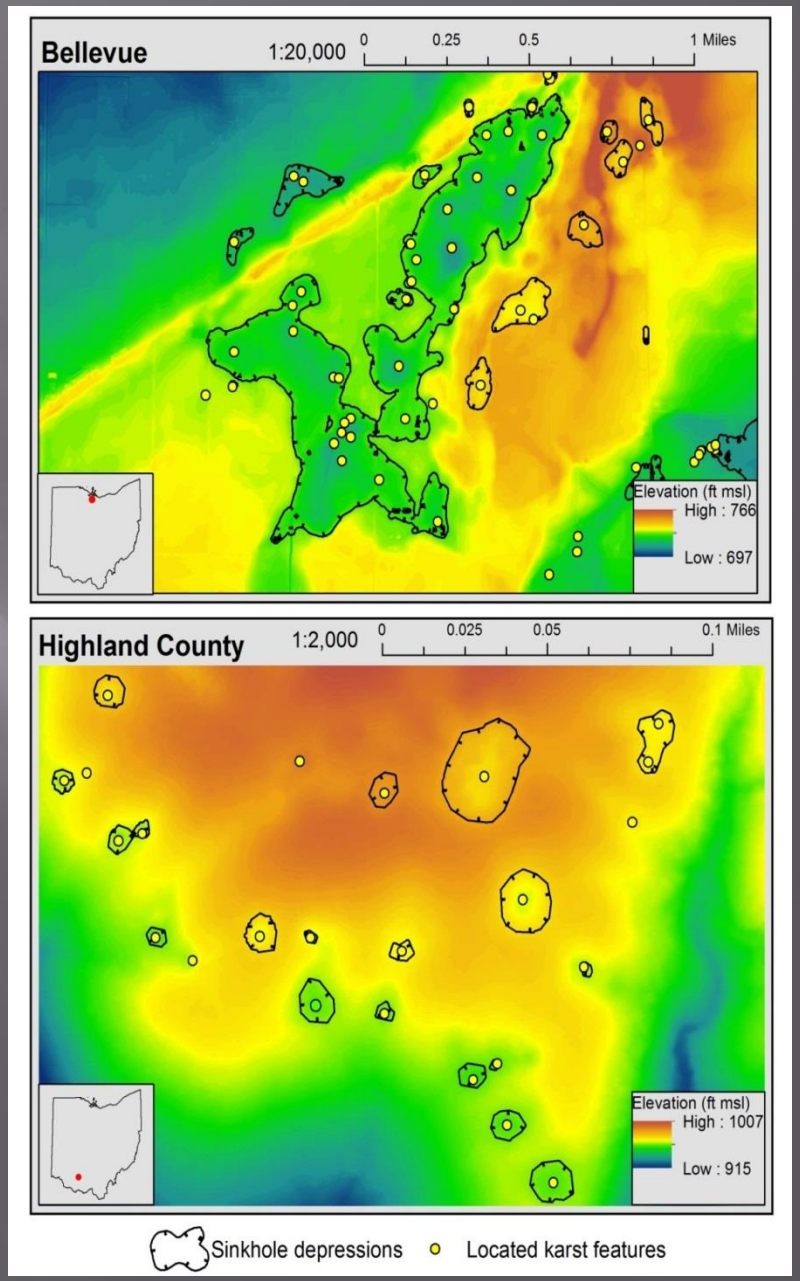
Karst Compared

- Bellevue - ~2000 features in six 24K quads
  - Broad sinkholes
  - Poorly clustered
  - Often irregularly shaped
- Belfast - ~2000 features in two 24k quads
  - Smaller sinkholes
  - Very clustered
  - Often very circular



Spahr, 2016

Infrastructure

Groundwater Contamination

Collector

Sinks on topographic highs

Vuggy Limestone (Sdnb)

Plumbing the depths

Soil Piping?

Linear sinking

Spring

Probable Cave, pit >20ft deep


Collector

10-15year old sinkhole 18x25ft, 9ft deep.

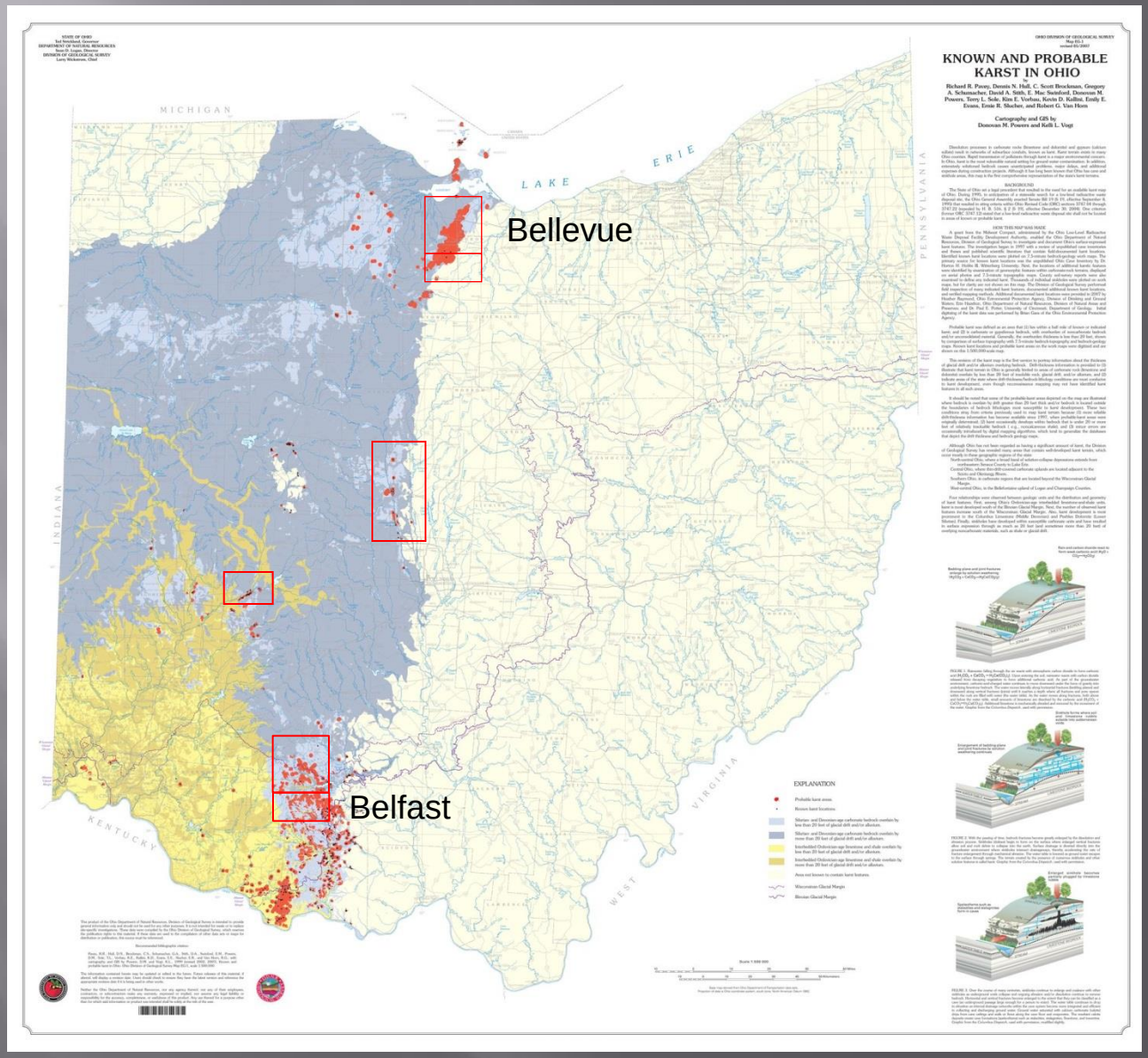
Sink has been stable for 20yrs, 30x30ft, 5ft deep.

Clean sink above spring

Trash filled sink above spring

Known and Probable Karst in Ohio

Map EG-1, revised 05/2007



Processing Summary

- Gridcoding the shallowest polygons from>0-1 instead of 0-1.
  - Advantage: displays complete extent of depressions
  - Disadvantage: adds millions of tiny and shallow depressions
- The automatic model assists in the removal of these tiny features.
  - Removed 78% of polygons in this case
- Manual removal
  - Removed all but 1% of original polygons.

Project Summary

- Karst appears to be morphologically different in different parts of Ohio
- Sinkholes are a conduit to the water table
- Draining water into a sinkhole will likely speed growth
- Filling a sink with trash, bricks, tobacco stems, fence, shingles etc. is unlikely to prevent future growth.