Locating Un-Permitted Pennsylvania Bluestone Mines Using Image Analysis

- Matthew Cavanaugh
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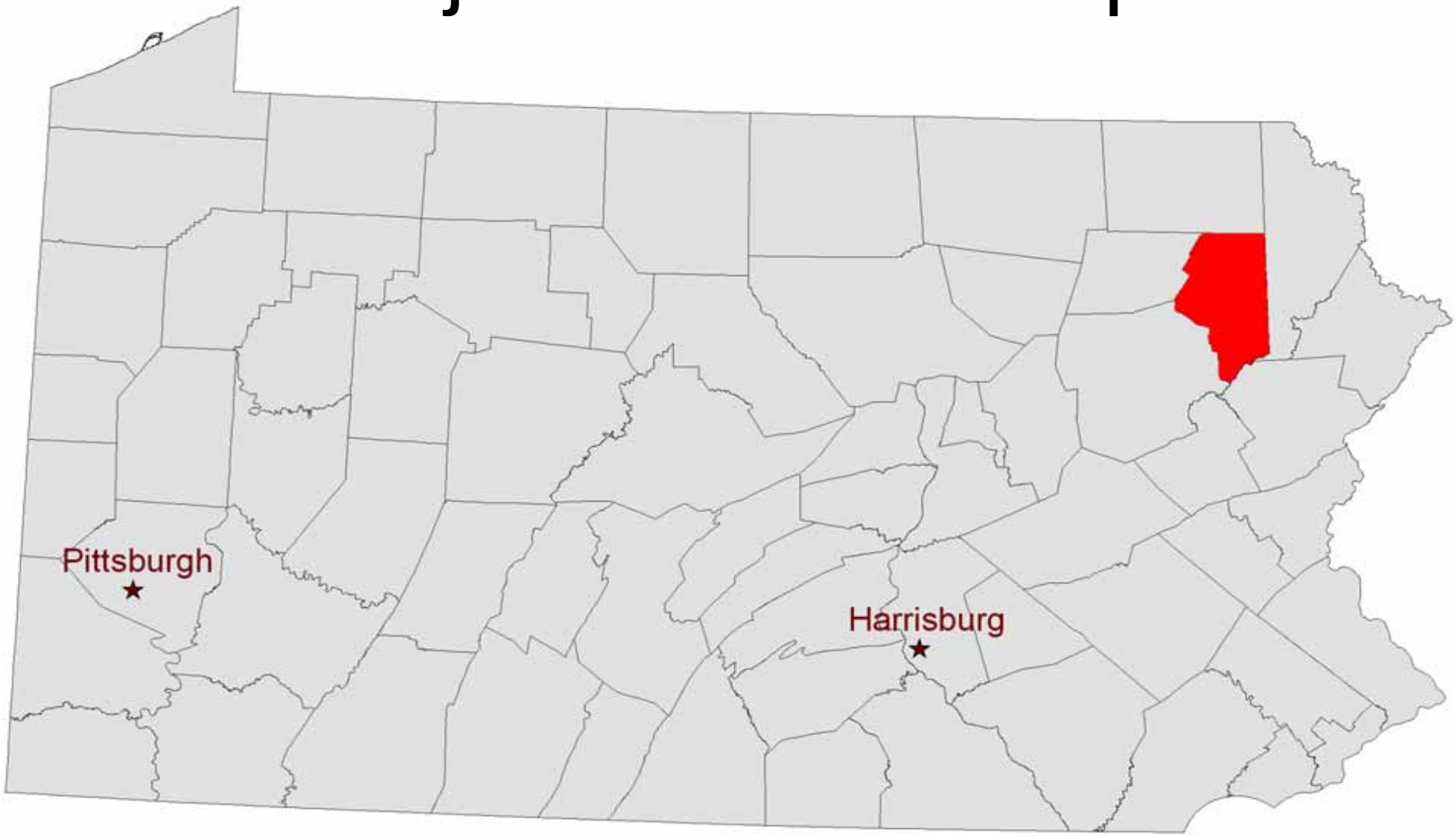
Project Location Map



What is Bluestone?

- Pennsylvania Bluestone is a type of sandstone found in the northeastern region of PA and southern region of New York.
- Bluestone is used for decorative purposes such as:
  - Sidewalks
  - Walls
  - Countertops
- The stone currently has a high market value, which makes it appealing to illegal miners.
  - $300.00/ton

Project Background

- Pilot project to use GIS to locate illegal surface mining operations
- Lackawanna County was chosen because of the availability of surface permit data
- PA DEP requires all bluestone operations have a “Bluestone Small Non-Coal Permit”
- Un-permitted operations are subject to fines and penalties
  - Up to $1000.00/day

Aerial Imagery-Orthophoto

- Orthophoto's used as the base layer in the project
  - obtained from the Pennsylvania Spatial Data Access (PASDA) website
  - Created by PAMAP Program administered by DCNR

Aerial Imagery-Orthophoto

- Chosen because
  - Age (2005)
  - Horizontal accuracy (1-foot resolution)
  - Color (locating features)
  - Availability (no charge, covers project area)

Aerial Imagery-Infrared

- Infrared used to conduct land classification
  - obtained from PASDA
  - Created as part of the National Agricultural Imagery Program (NAIP) by the U.S. Department of Agriculture

Aerial Imagery-Infrared

- Chosen because
  - Accurate (1-meter resolution)
  - Most recent (2004)
  - Color (RGB Bands)
  - Leaf-on conditions (land classification)

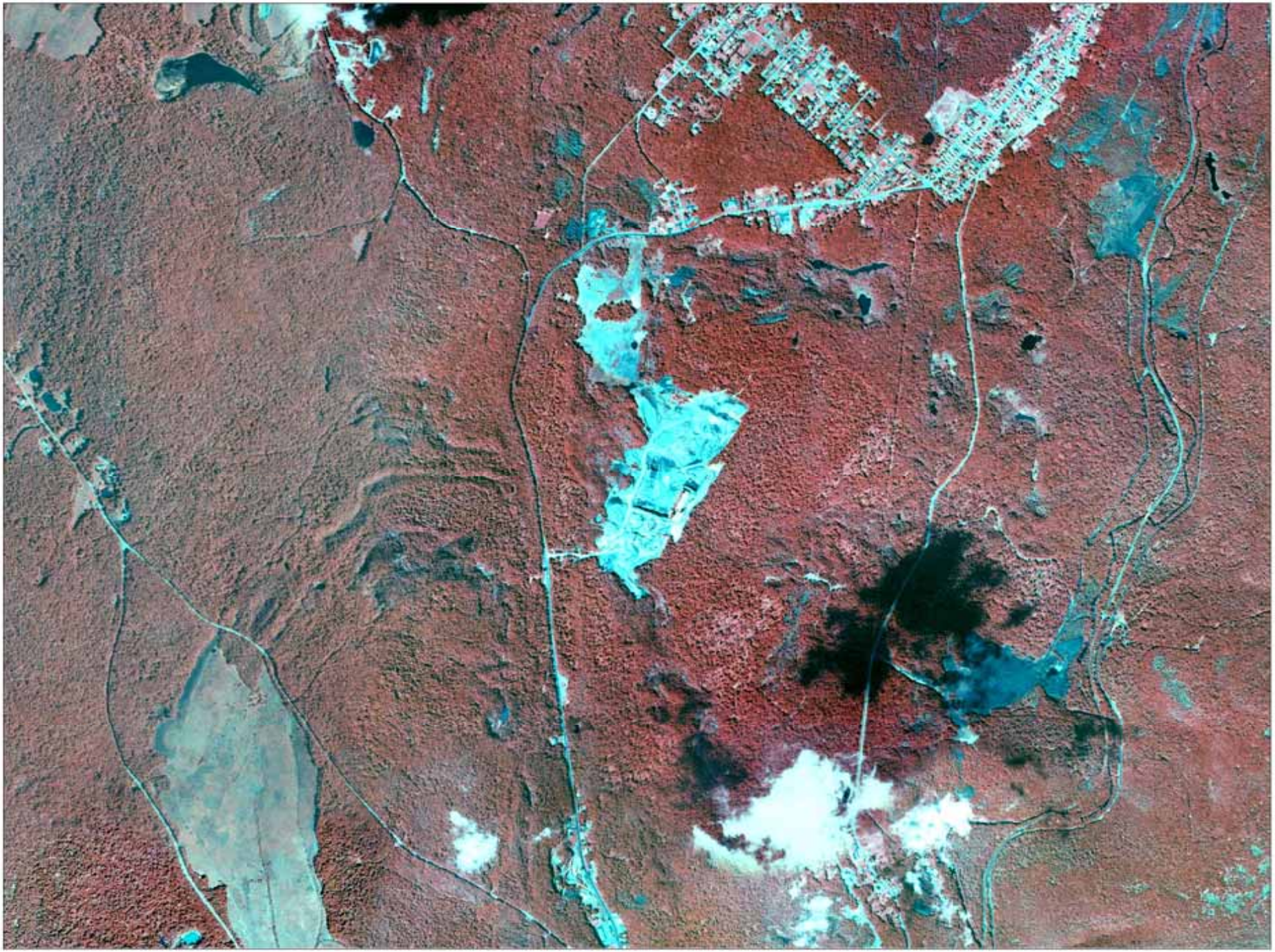


Image Preparation

- Image Conversion
  - Infrared image (.tif) to Erdas Imagine (.img) file
- Image importing
  - .img infrared image into ArcMap project
  - Overlay on top of orthophoto's
- Adjust band colors
  - To highlight disturbed ground areas

Land Use Classification

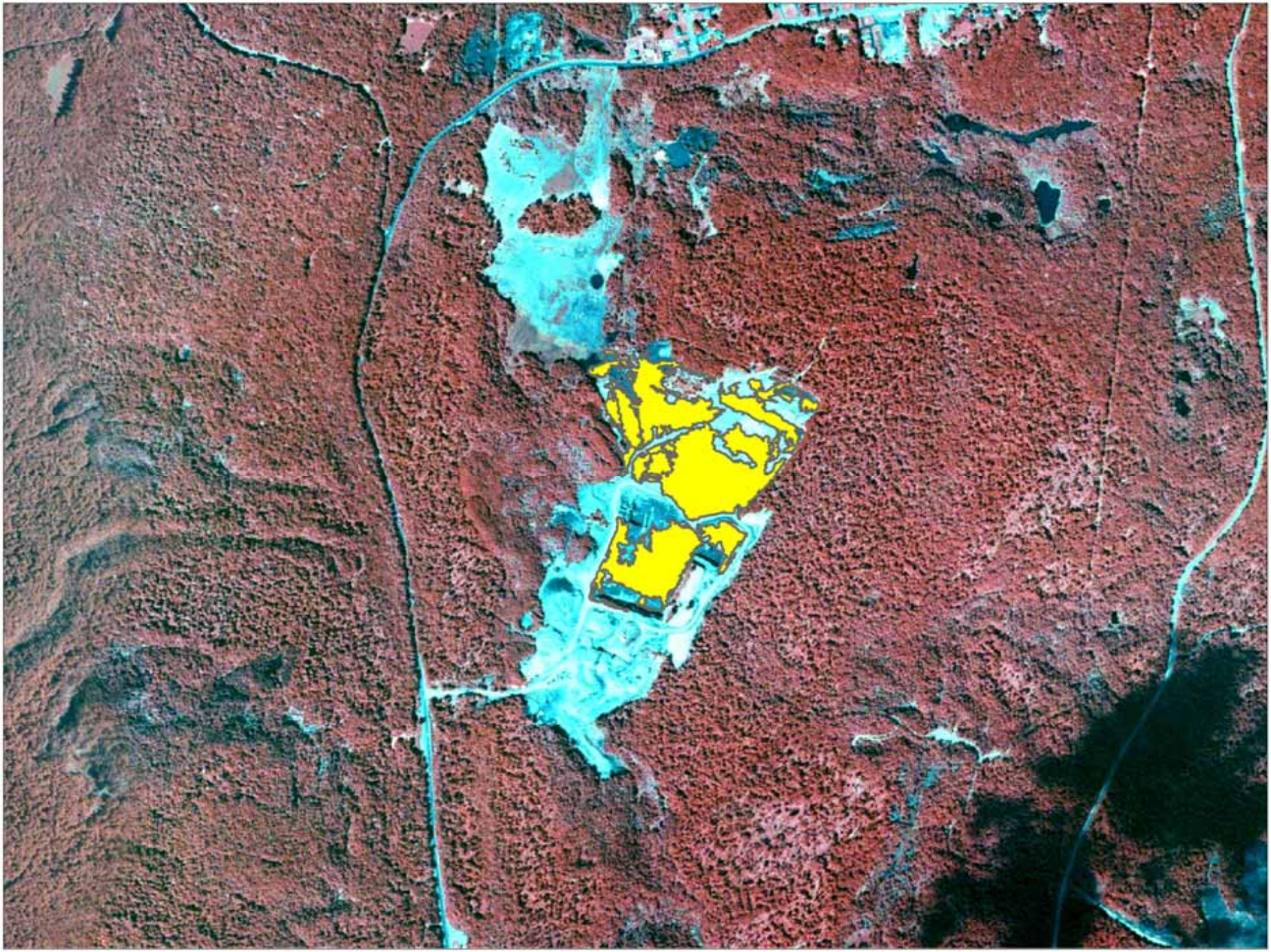
- Goal was to classify and extract disturbed ground areas from surrounding land cover types
- Used a “supervised classification” method to classify different land cover types
- “Supervised classification” allows for the user to create “Spectral Signatures”

Supervised Classification

1. Create a spectral signature polygon shapefile of different land cover types

2. Using this shapefile, create a feature polygon, placing the first vertice on a pixel value of the land type being classified

3. After first vertice is established, use the “Seed” tool to automatically trace surrounding areas having same pixel value

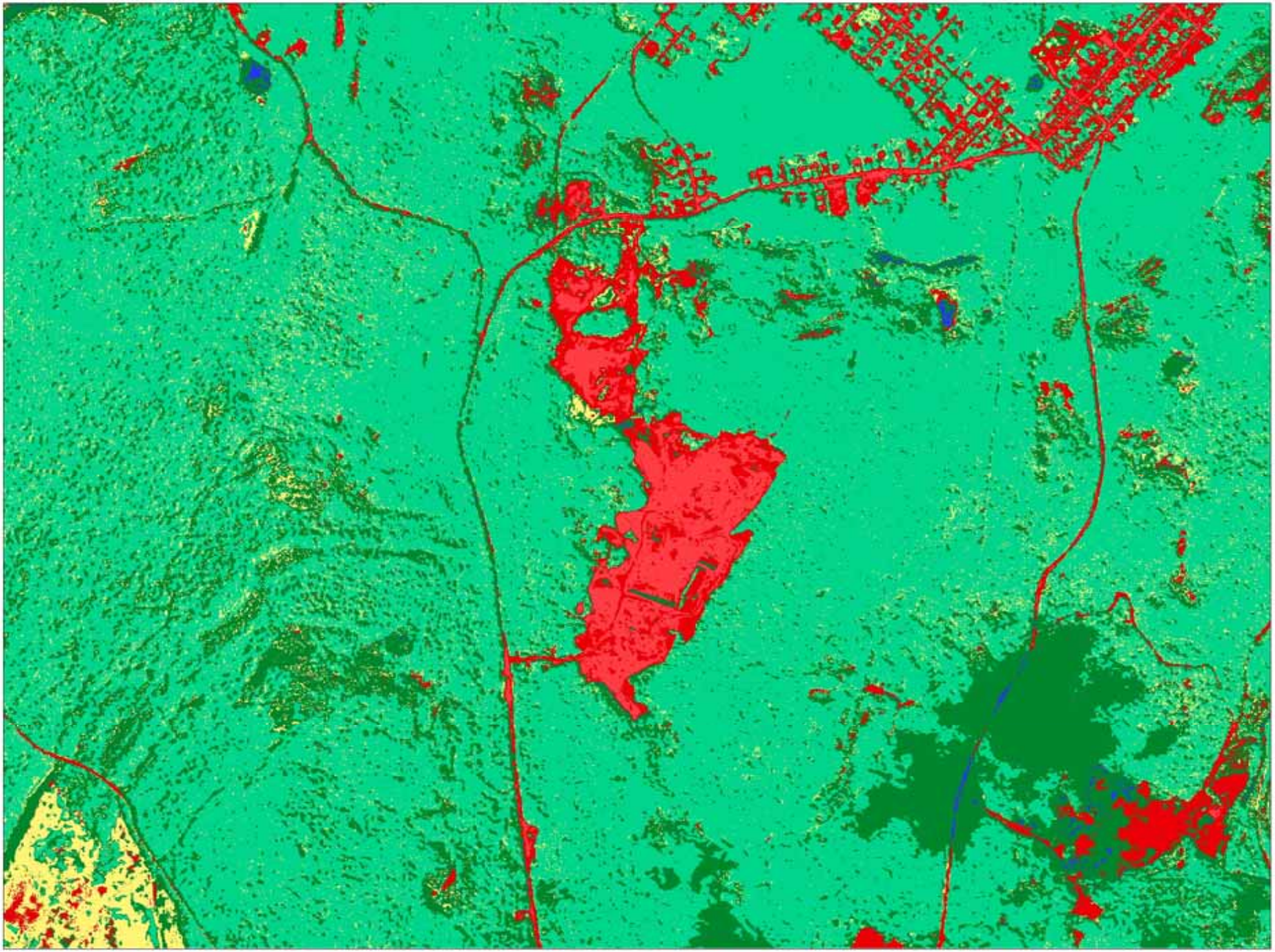


Supervised Classification (cont.)

4. Once sufficient land type signatures are collected, the "maximum likelihood" classification rule was applied

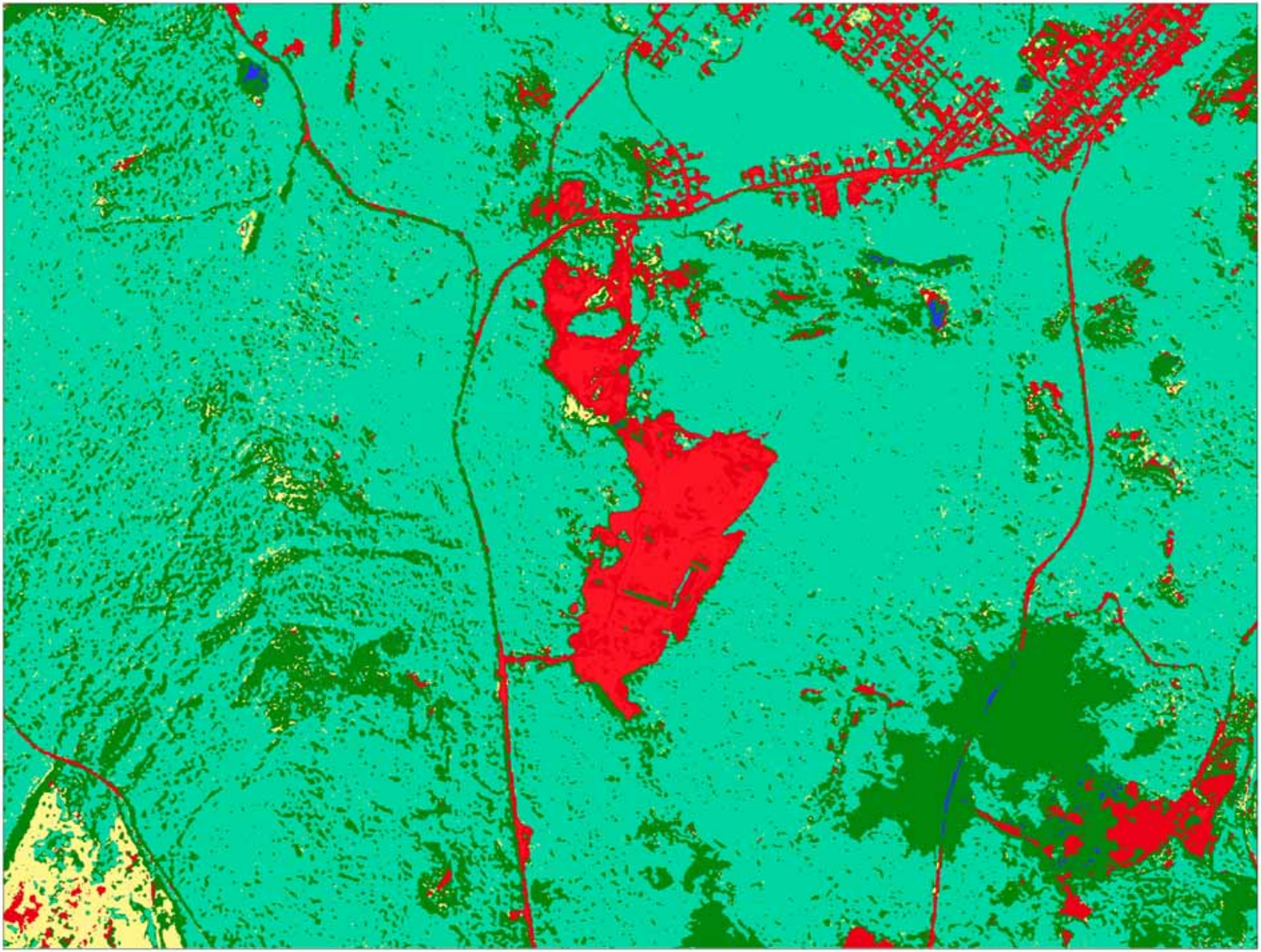
   – Classifies the entire infrared image into separate land types

   – End result is a classified image that consists of all land types classified



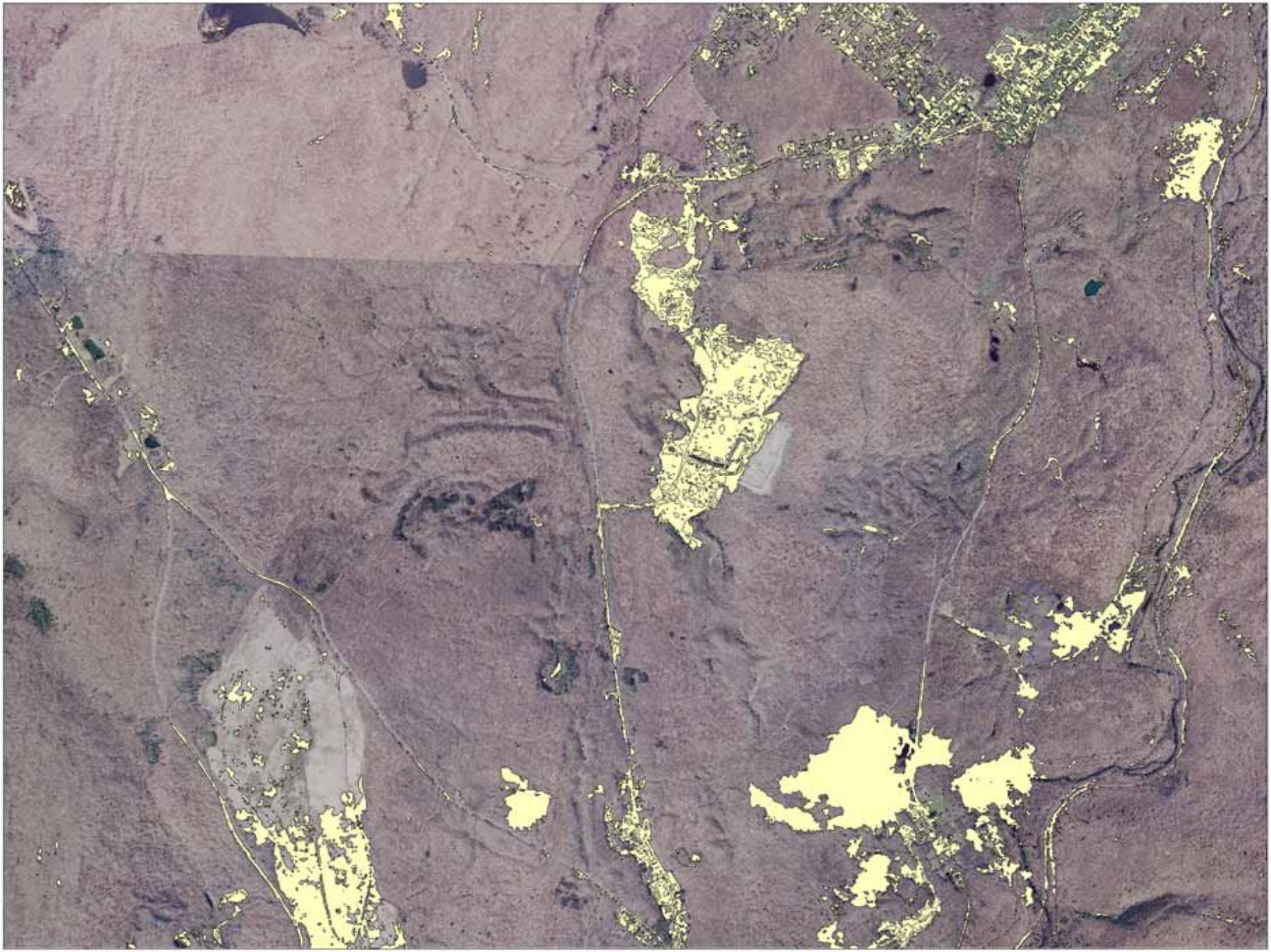
Post-Classification Processing

- Applied a “majority filter” to the image to reduce the speckled effect (smoothing) of the classified image
  - Combines the most abundant pixels values within a user specified area



Convert Raster to Feature

- Converted the smoothed image to feature polygons
  - Allows for individual selection of each land use type
  - Extracted ground disturbance polygons
- Result is an overlay of disturbed ground areas
  - Easier to work with than the entire land classification set
  - Shows areas of disturbed ground concentrations



Results

- Using the PAMAP Orthophoto's, 37 possible illegal operations were located by overlaying:
  - Extracted disturbed ground areas

    and
  - Digitized surface permit boundaries

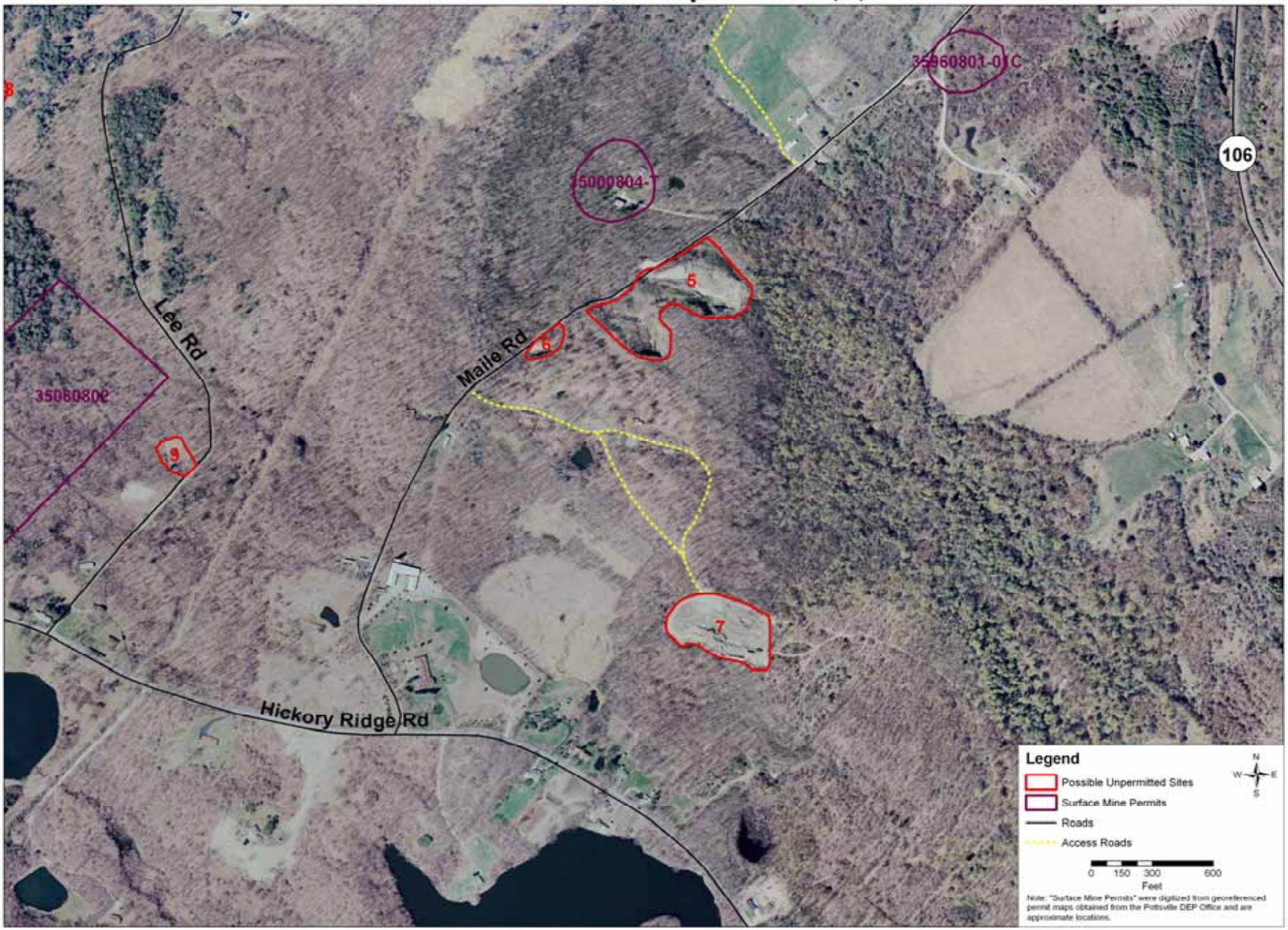
Results (cont.)

- Site location maps were created to aid field staff in locating possible sites
- Maps included:
  - Major roads
  - Site access routes
  - Site ID number

Results (cont.)

- Site location maps have been provided to DEP Surface Mine Inspectors to conduct field inspections
- If field inspections are successful in finding illegal operations, the project will grow into surrounding counties
- Field inspections are currently being organized

Area 2 - Greenfield Twp - Sites 5,6,7



Conclusion

- This project has demonstrated how GIS and remote sensing can be used to efficiently plan and coordinate compliance investigations
- Demonstrated how GIS analysis can be used to conduct preliminary field planning to allow for more focused use of field staff

Thank you

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