# DIGITAL MAPPING TECHNIQUES 2015

The following was presented at DMT'15
(May 17-20, 2015 - Utah Geological Survey,
Salt Lake City, UT)

The contents of this document are provisional

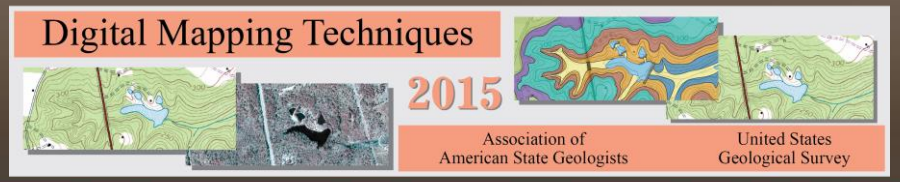
See Presentations and Proceedings
from the DMT Meetings (1997-2015)

http://ngmdb.usgs.gov/info/dmt/

# Geologic Hazard Mapping & ArcScan

## AN IMAGE PROCESSING APPROACH

Ben Erickson, M.S., P.G.
Hazard Mapping Geologist



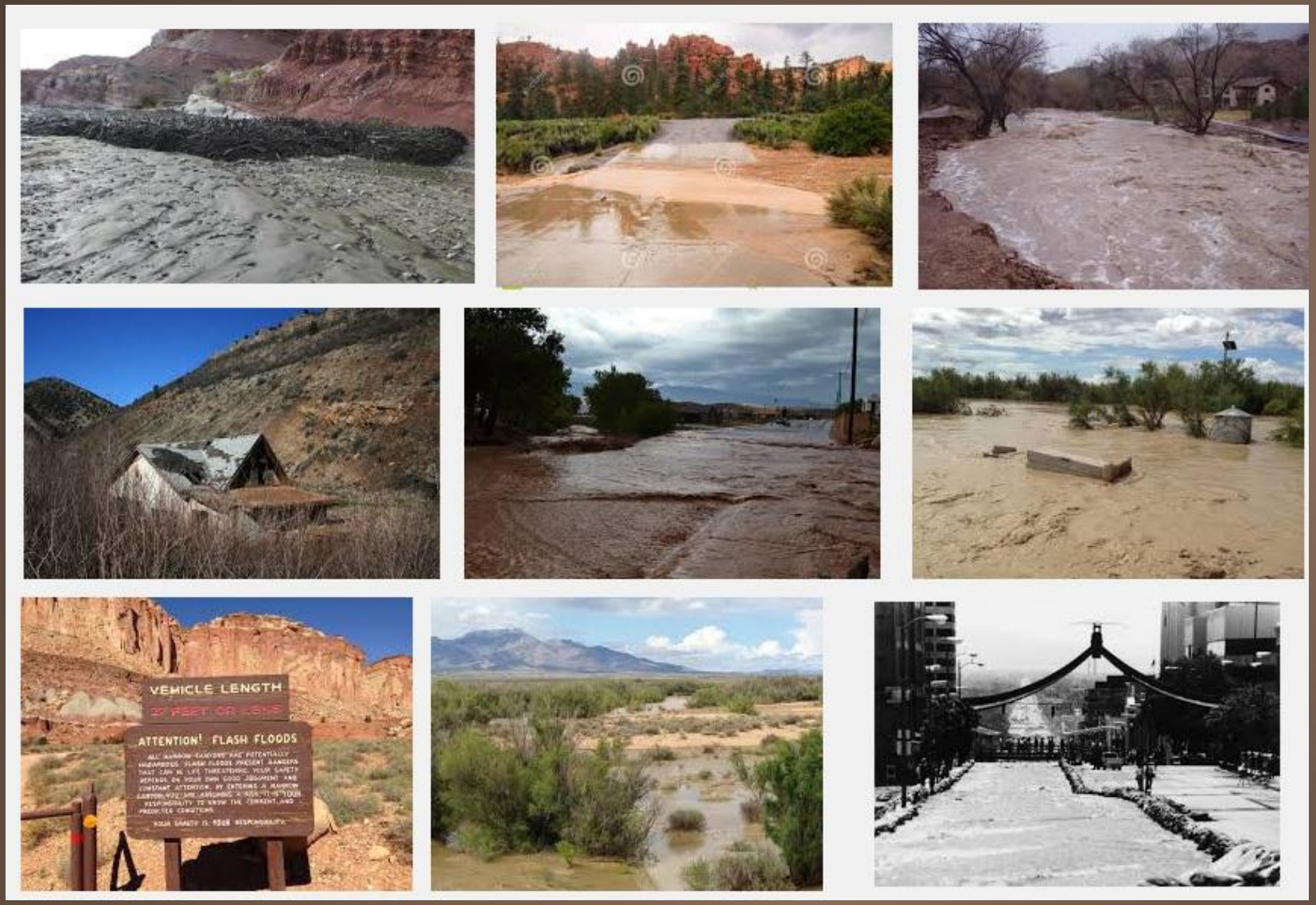
# Hazard Mapping

- In 2008, a hazard mapping initiative was created through state legislative funding.
- Four dedicated hazard mapping initiative geologists with the assistance of hazard mapping geologist in Southern Utah.
- Maps are based on 7.5' quadrangle maps using geologic and other data.

http://geology.utah.gov/map-pub/maps/geologic-hazard-maps/

- Quadrangle Hazard Maps
  - Earthquake hazard
    - Surface fault rupture and liquefaction
  - Landslide hazard
    - Landslides and rockfalls
  - Flood hazard
    - Flooding by creeks, rivers, and other drainages; flash floods, sheetflow, and debris flows
  - Problem soil and rock hazard
    - Expansive soil and rock, collapsible soil, shallow bedrock, soil piping and erosion, and windblown sand
  - Other hazards
    - Radon gas and shallow groundwater

# Flood Hazard Focused Mapping




A Google image search for Utah Flooding. The search demonstrates a need for flood hazard mapping within the state.

# Flood Hazard Focused Mapping

## 2002 Santaquin, UT Fire Related Debris Flow

Part of our mapping initiative is to explain the variety of flood types and raise awareness and identify their hazard.

# Springville, UT 1952 Flood

THE HERALD APPRECIATES NEWS OF YOU and YOUR FAMILY AT ANYTIME

The Springville Herald

LEASE, BUY, SELL or HAVE A JOB DONE? See Page 2

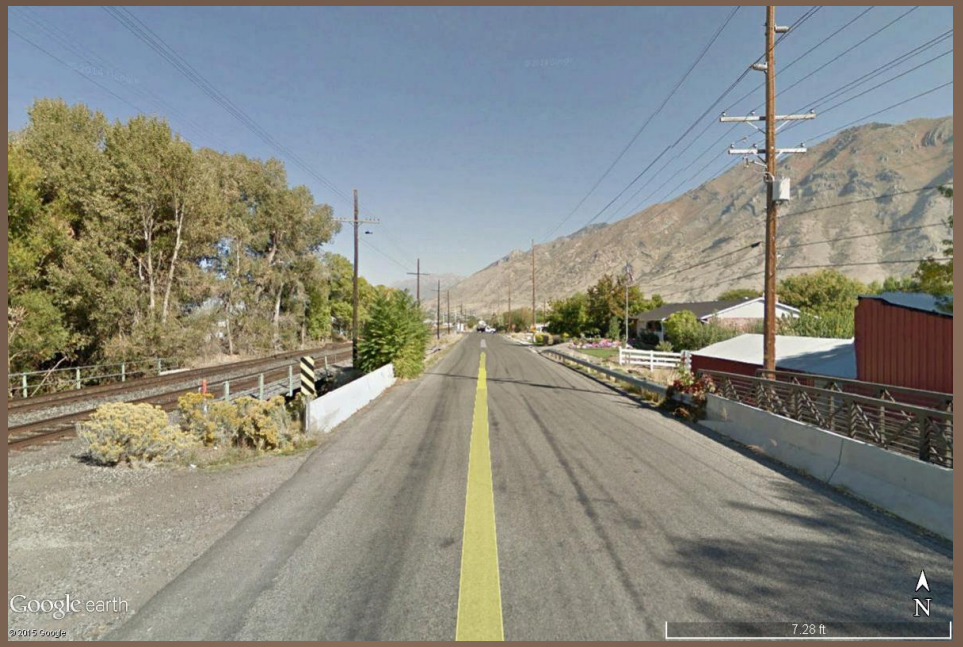
Volume Sixty-three — The Springville (Utah) Herald, Thursday, May 1, 1952 — Price 10 Cents — Number Eighteen

Rampaging Flood Waters of Hobble Creek Result in State of Emergency in Springville

Hobble Creek Leaves Destruction Along Its Path ...


Floods are quickly forgotten over time; growing up in Springville I was unware of the extent of flood potential and past events. Further development in the city has encroached on the flood plains and many residents are unware of the hazard.

# Springville, UT 1952 Flood




1952 Flooding

2013 Google Street View

A time comparison between 1952 and 2013. Much of the flooded land now has residential development and would be highly susceptible to flooding.

# Flood Hazard Focused Mapping

- Utah's need for detailed flood hazard mapping, beyond FEMA FIRM maps.
- U.S. Army Corps of Engineers (USACE) wanting to assist states with projects.
- Contracting with USACE in 2013.
  - In-kind cost share funding
  - 44 quadrangles
  - Digitize geologic and FEMA FIRM maps
  - Develop web platform for finished maps
  - 2 ½ year project

- Flood Hazard Mapping Technique
  - Based on the geologic conditions of various mapped units, such as depositional environments and age.
  - DEM, available LiDAR, aerial photos.
  - Supplement other flood-hazard maps already used in land-use planning and regulation (FEMA Flood maps).
  - Show flooding hazards not on FIRM maps, such as debris flows.

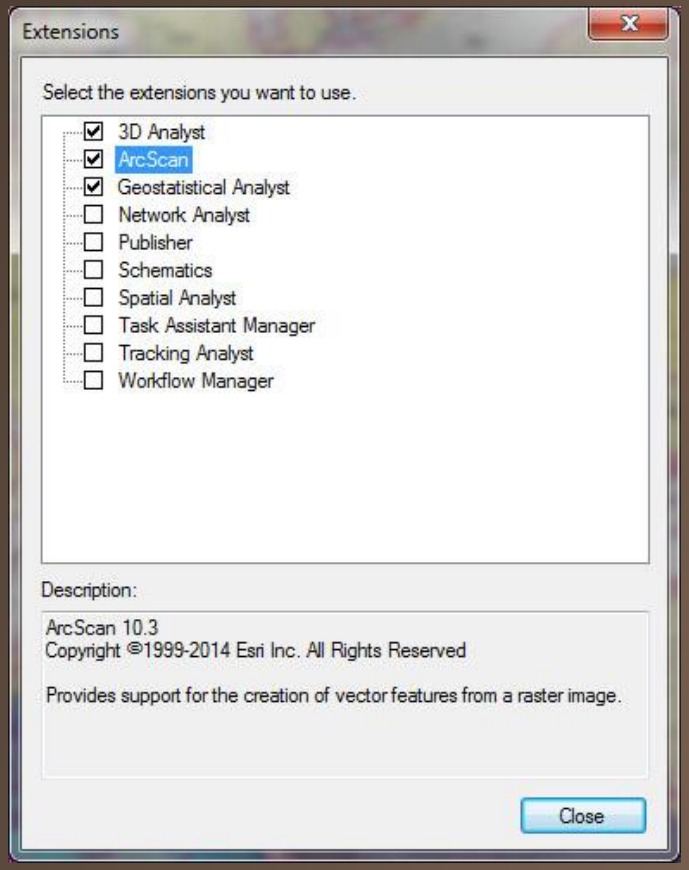
# Project Challenges

- USACE
  - Misinterpreted scope
    - Over focus on FEMA FIRM digitization
    - Lack of funding for geologic map digitization
    - Much lower prioritization of web platform map
  - Change in their manager
- Quadrangle substitutions
- We start digitizing geologic maps, as needed
  - 5 maps USACE completed
  - 14 maps need digitizing

# Digitizing Maps

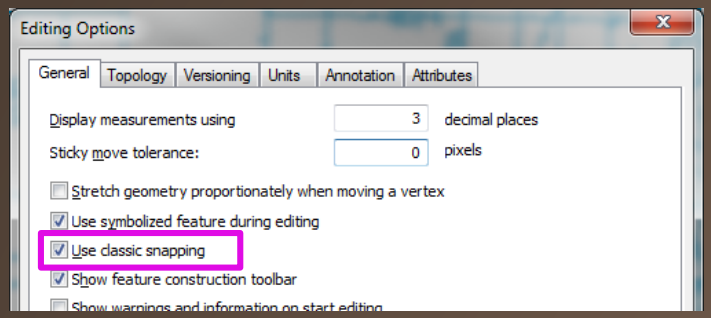
- Different methods
- Primarily, manual line tracing
- Hours of line tracing
- Precision to line tracing is paramount for high quality duplicate maps
- More hours of line tracing
- Ensure edits are saved
- Hours of line tracing
- Finished line tracing

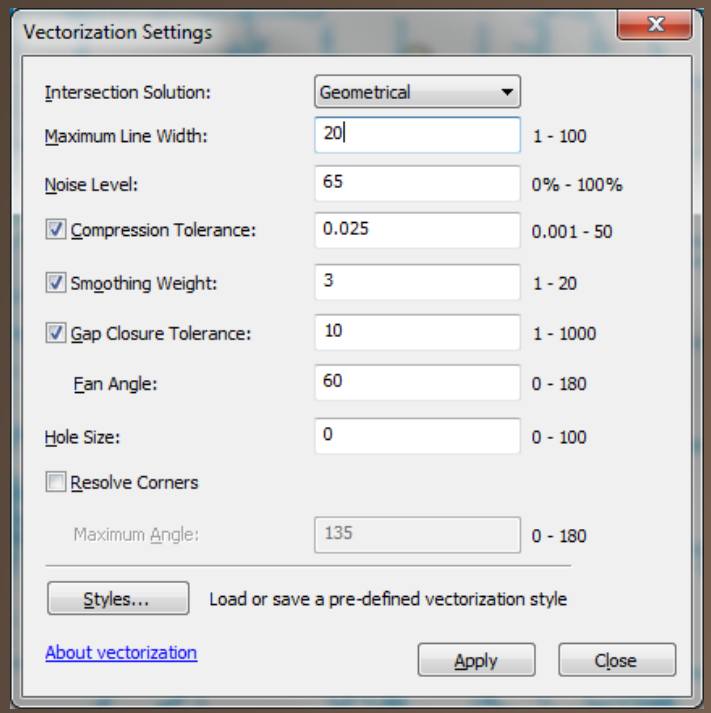
# ESRI ArcScan



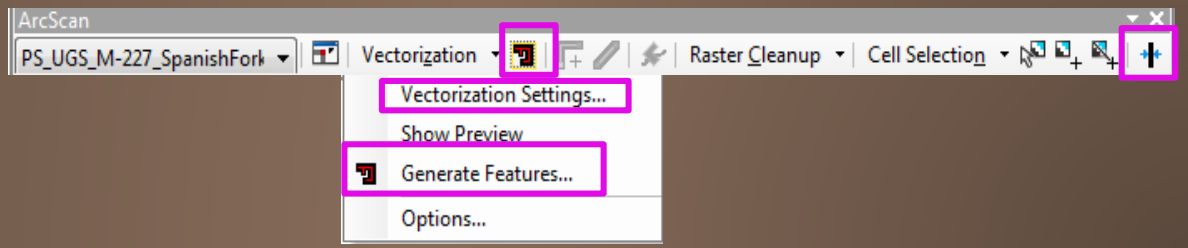

- What is it?
  - An ArcMap extension
- Why is it used?
  - Automates features detection
  - Makes your digitizing life easier
- How does it work?
  - Identifies difference between two colors
  - Pixel recognition
  - Creates a line or polygon based on pixel width

# ArcScan Settings

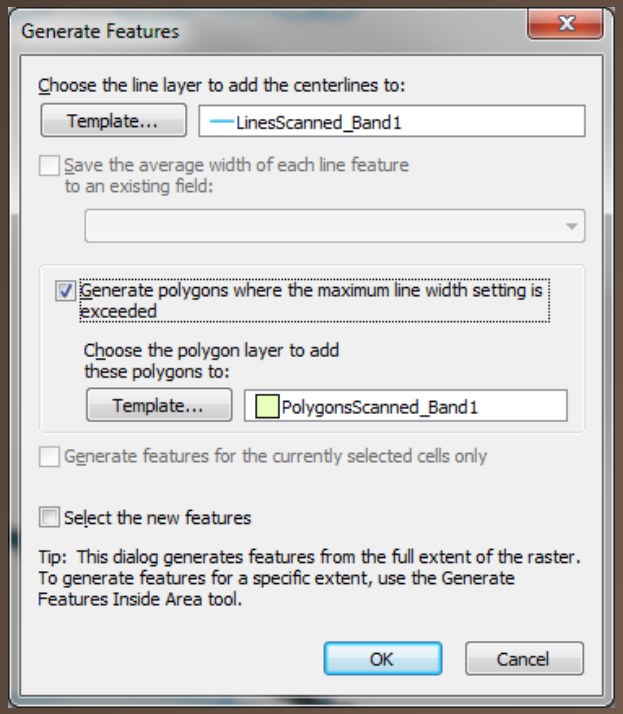


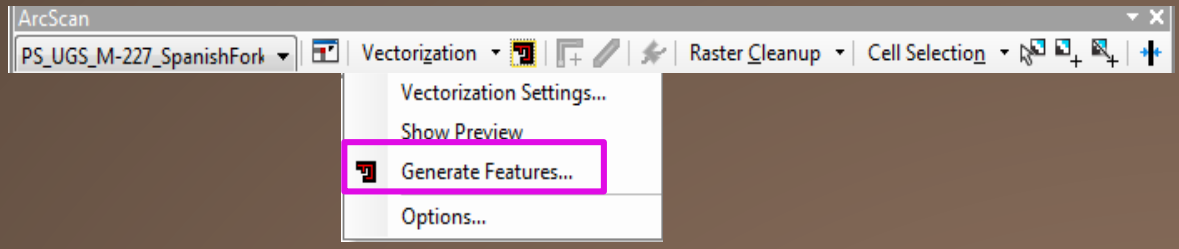




- Editing Options
  - Uses Classic Snapping
- ArcScan Tool Bar
  - Active when editing features
  - Select layer for vector scanning
  - Determine pixel width "Raster Line Width" tool for vector settings 
  - "Generate Features Inside Area" will generate within a drawn polygon 
  - "Generate Features…" will open options for full layer generation



# Generate Features…

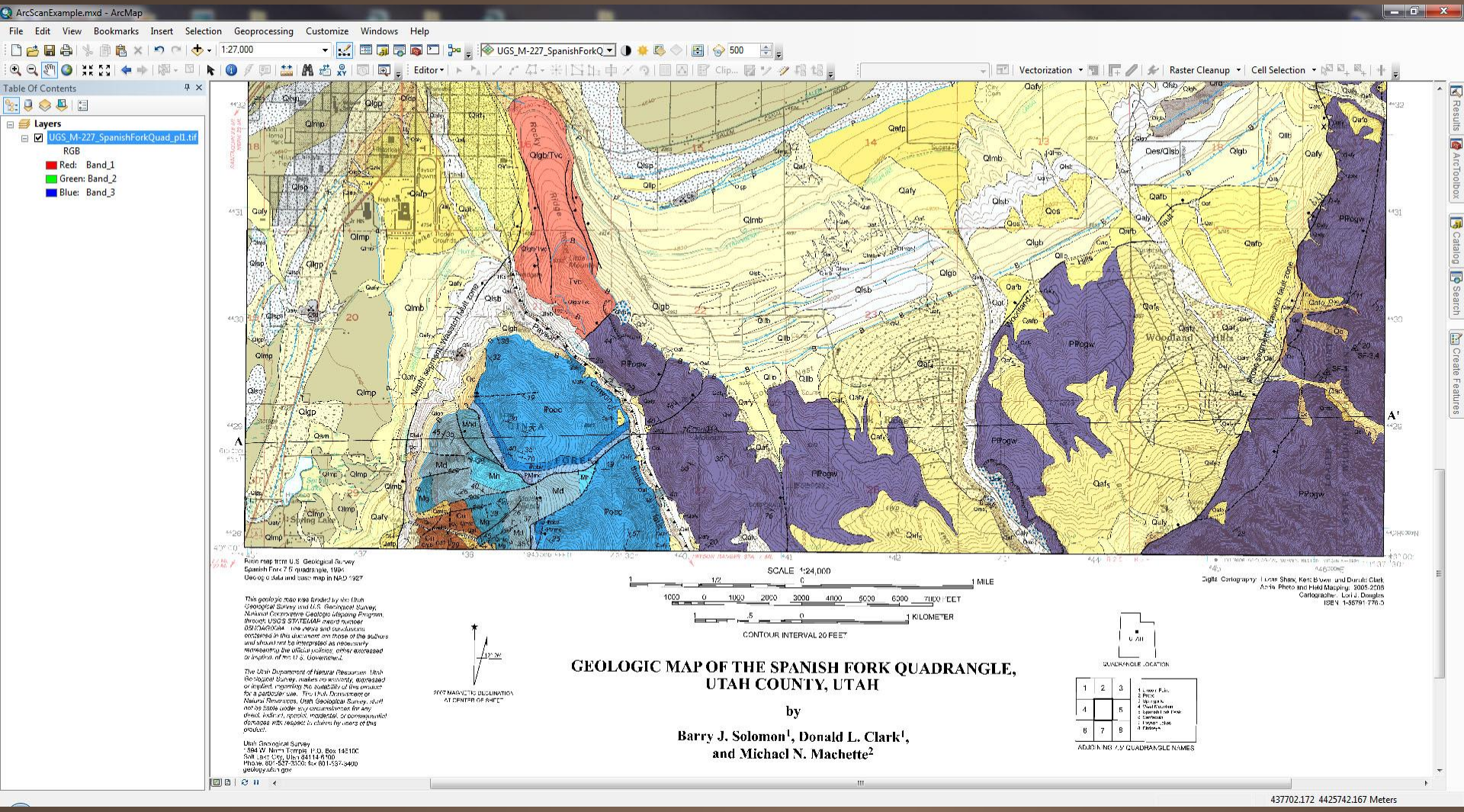



- Generate Features Options
  - Must have layers turned on
  - Enable/disable polygon generation
  - Option to select new features when generated
  - Generation will take a few seconds to minutes

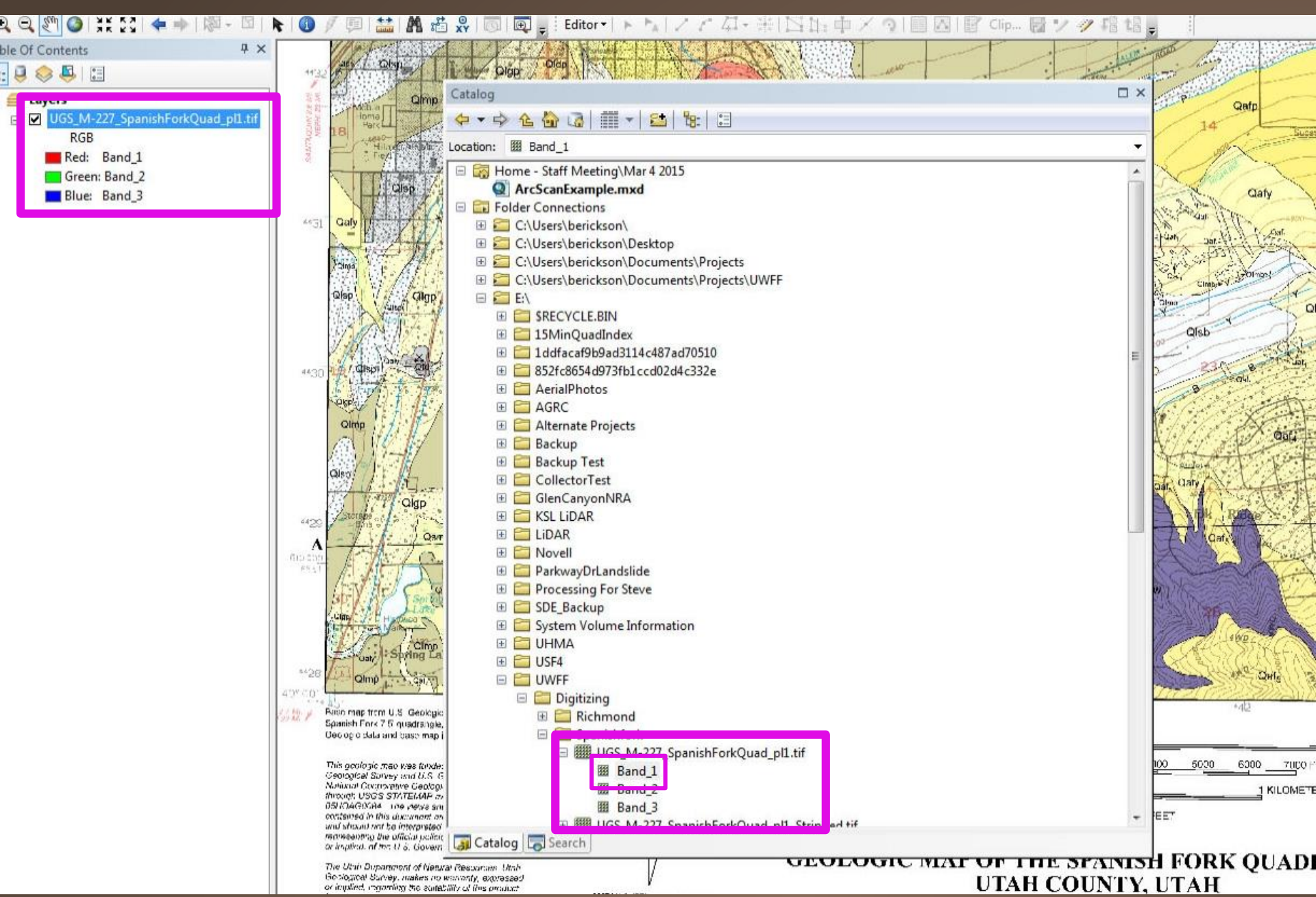
# First Attempt

- Load a georeferenced map

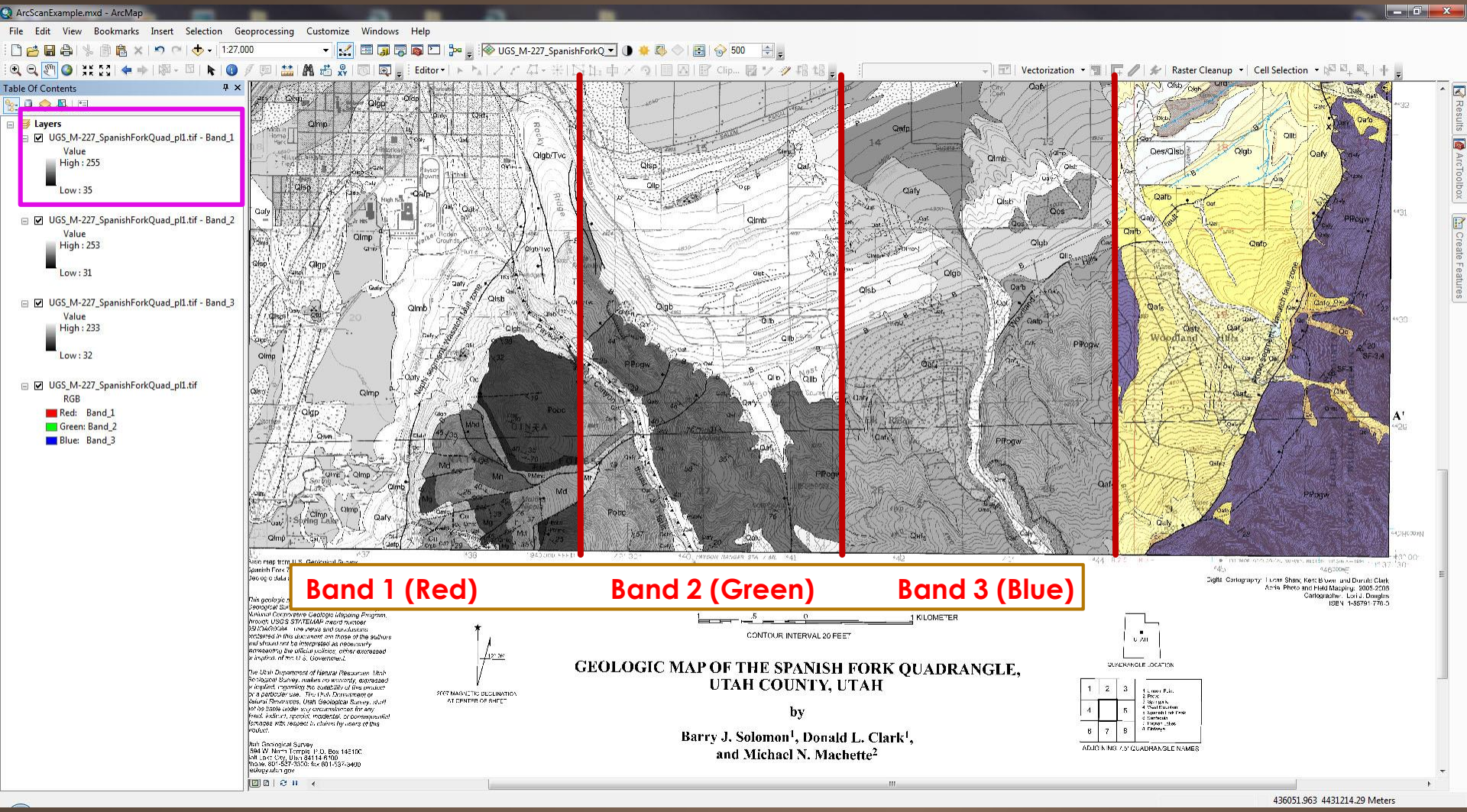

ArcScanExample.mxd - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
Table Of Contents
Layers
UGS_M-227_SpanishForkQuad_pl1.tif
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
GEOLOGIC MAP OF THE SPANISH FORK QUADRANGLE, UTAH COUNTY, UTAH
by
Barry J. Solomon[1], Donald L. Clark[1], and Michael N. Machette[2]
SCALE 1:24,000
CONTOUR INTERVAL 20 FEET
Utah Geological Survey
Digital Cartography: Lucas Shaw, Kent Brown, and Donald Clark
Cartographer: Lori J. Douglas
ISBN 1-55791-776-5
437702.172 4425742.167 Meters

# First Attempt

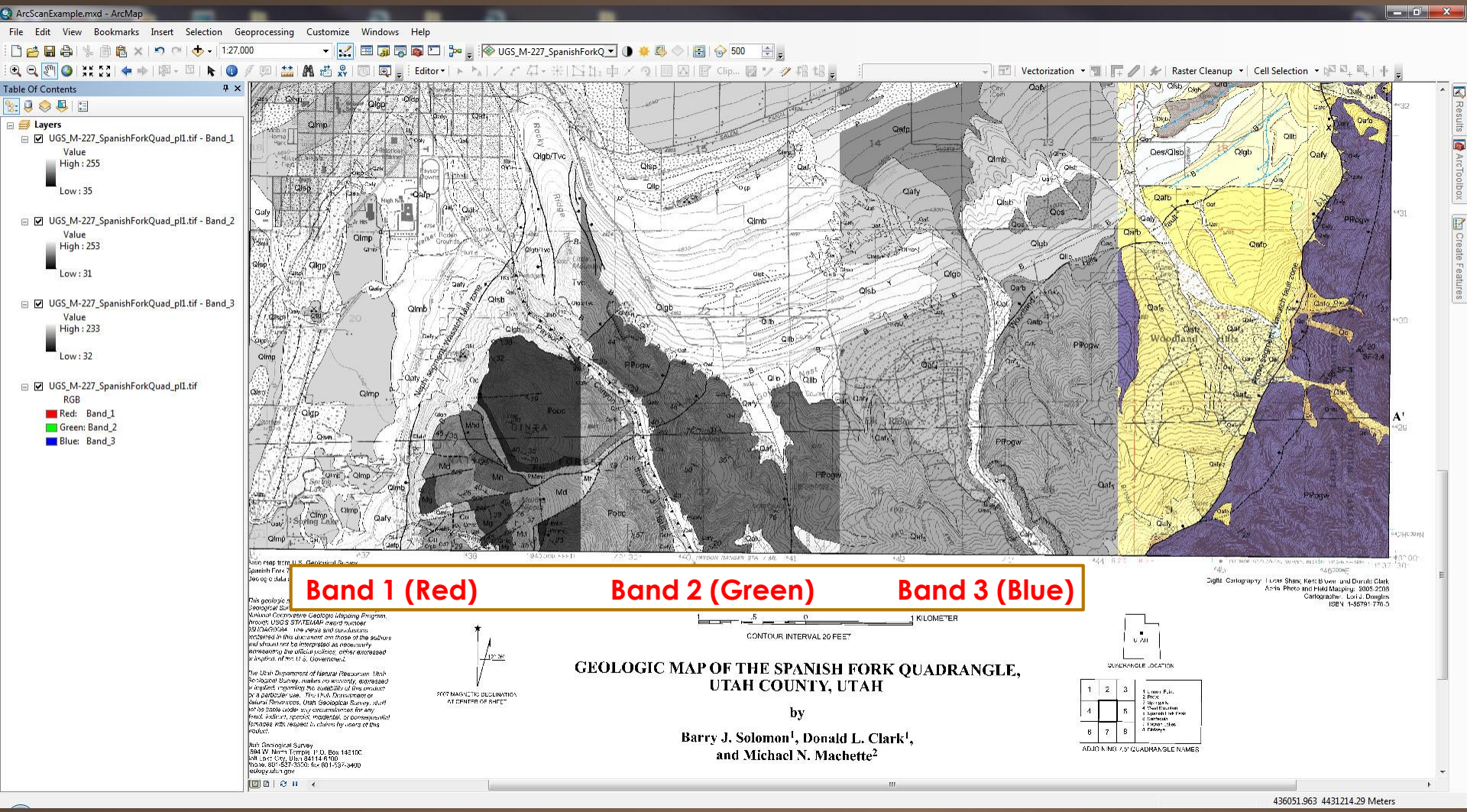
- Load a georeferenced map
- **Load individual bands of the color raster**




An example of how to load a single color band for a image file using ArcCatalog for ArcScan processing.



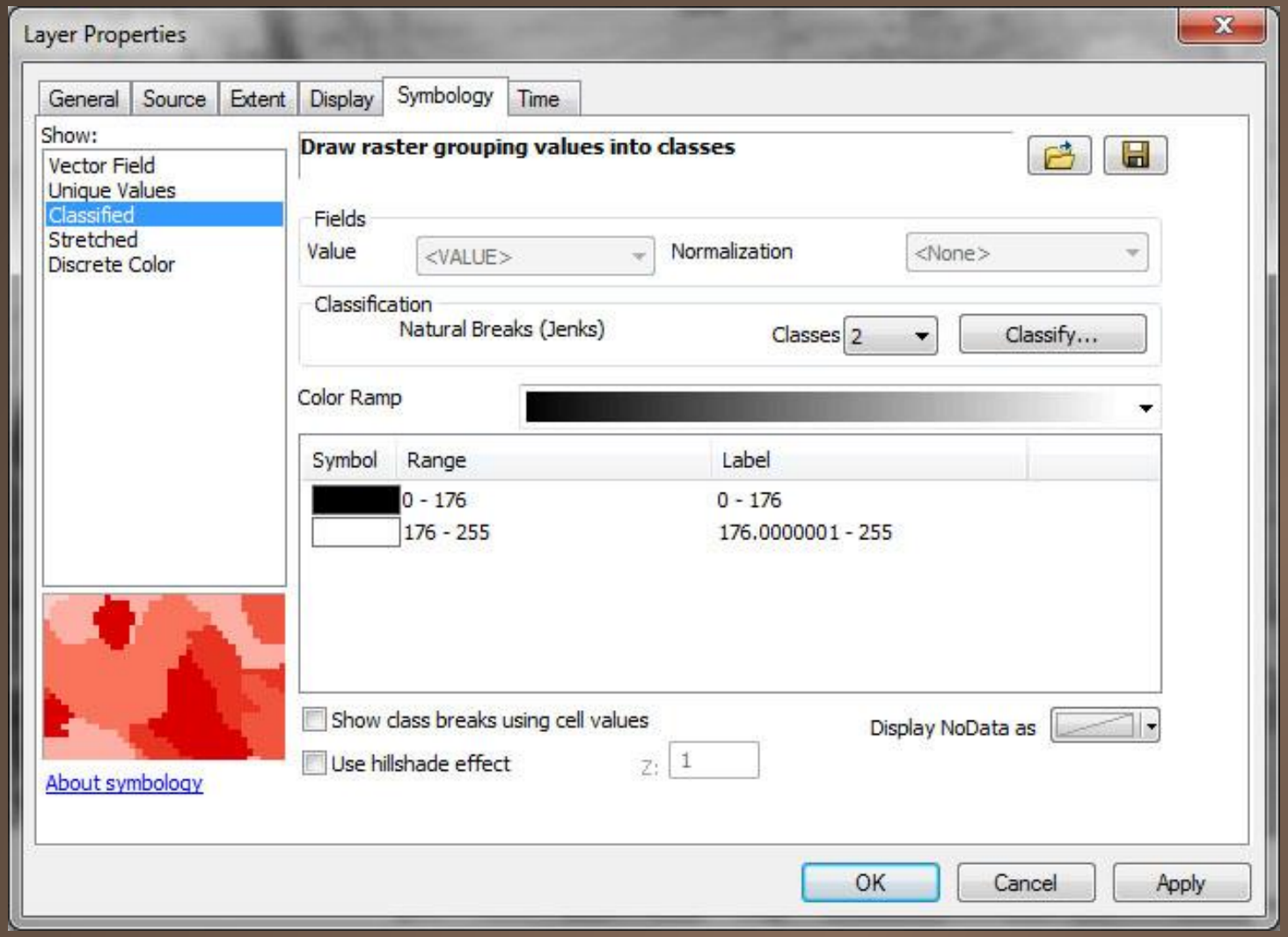

A comparison of the RGB colors of the image file and how different colors change the grayscale representation.



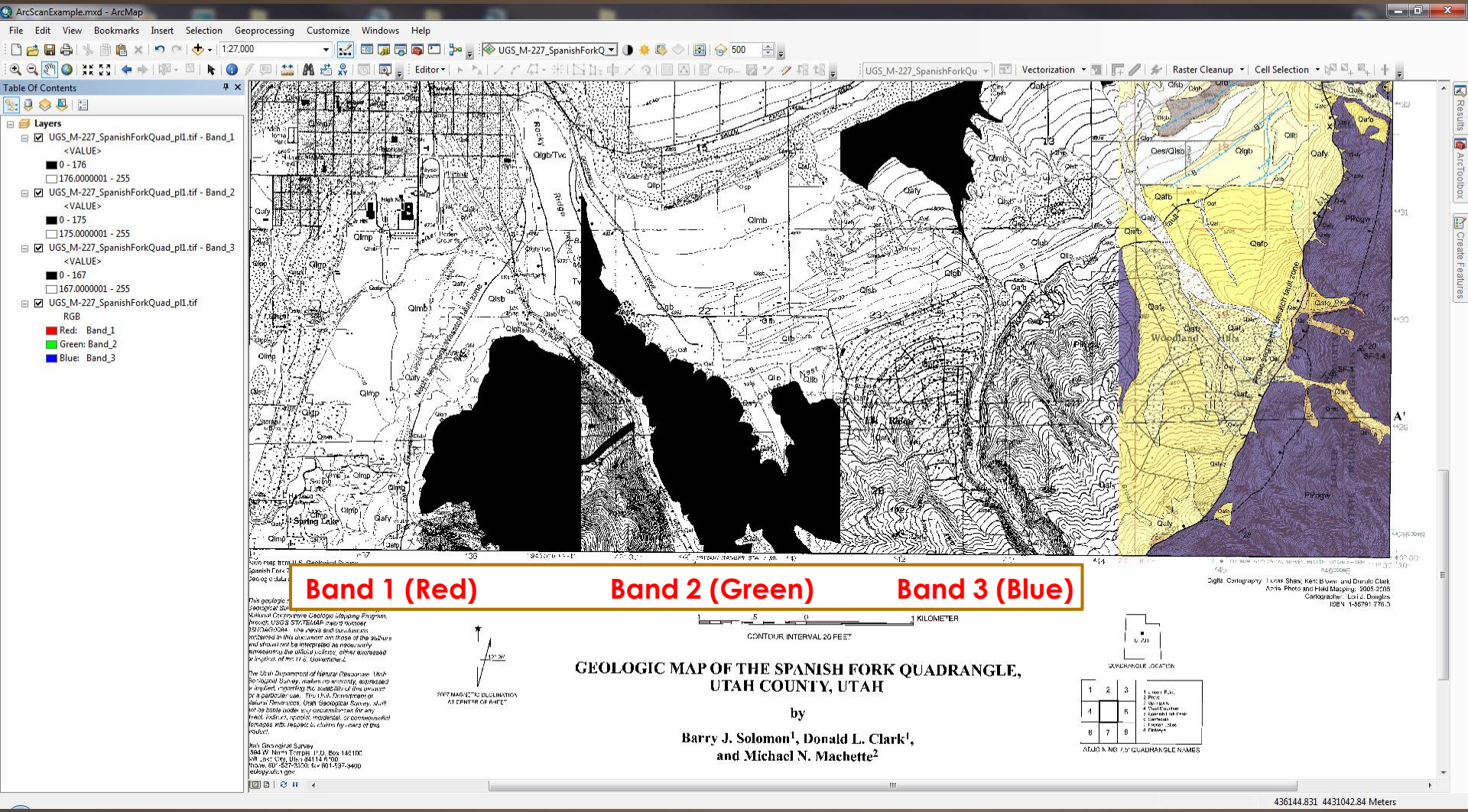

Removal of RGB color boundary lines for better comparison.

# First Attempt

- Load a georeferenced map
- Load individual bands of the color raster
- **Set the Symbology to Classified using 2 Classes (Unique Values is also acceptable)**



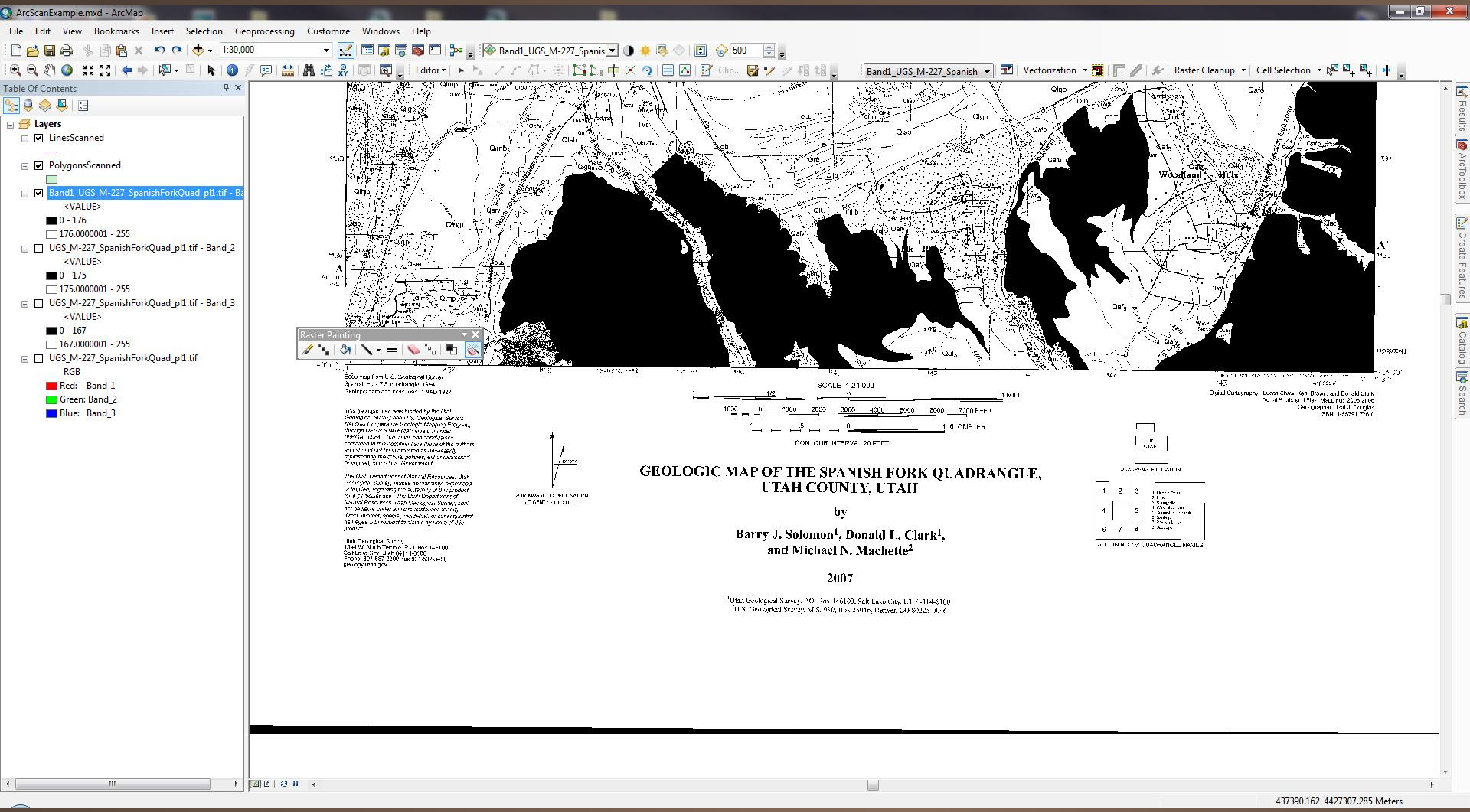

Set the Symbology to Classified using 2 Classes, defining black from white. Unique Values can also be used for color classification.



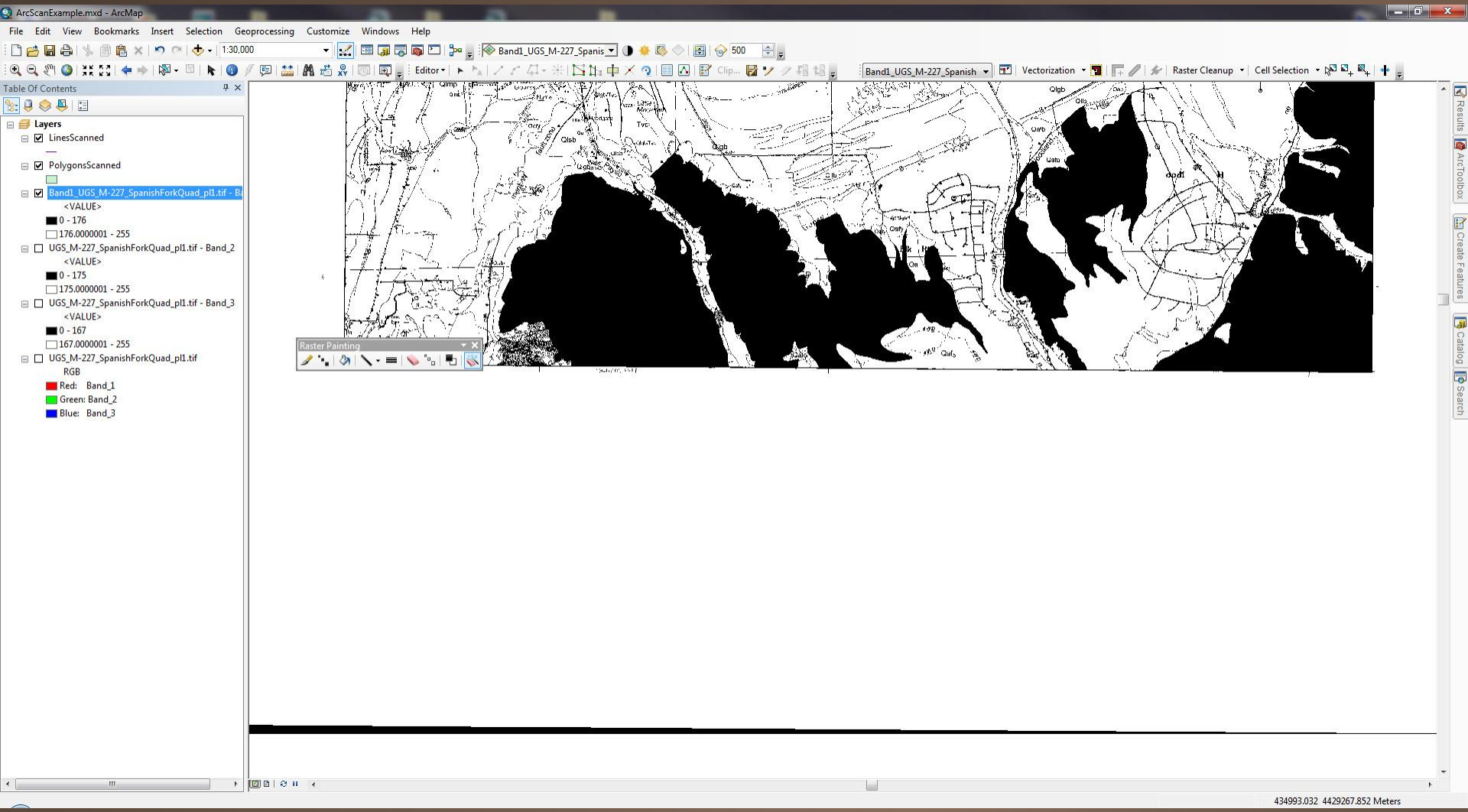

Results of black and white classification of the RGB values.

# First Attempt

- Load a georeferenced map
- Load individual bands of the color raster
- Set the Symbology to Classified using 2 Classes (Unique Values is also acceptable)
- **Turn on ArcScan toolbar, start an editing session for lines and polygon features, use Raster Painting toolbar to cleanup the raster**



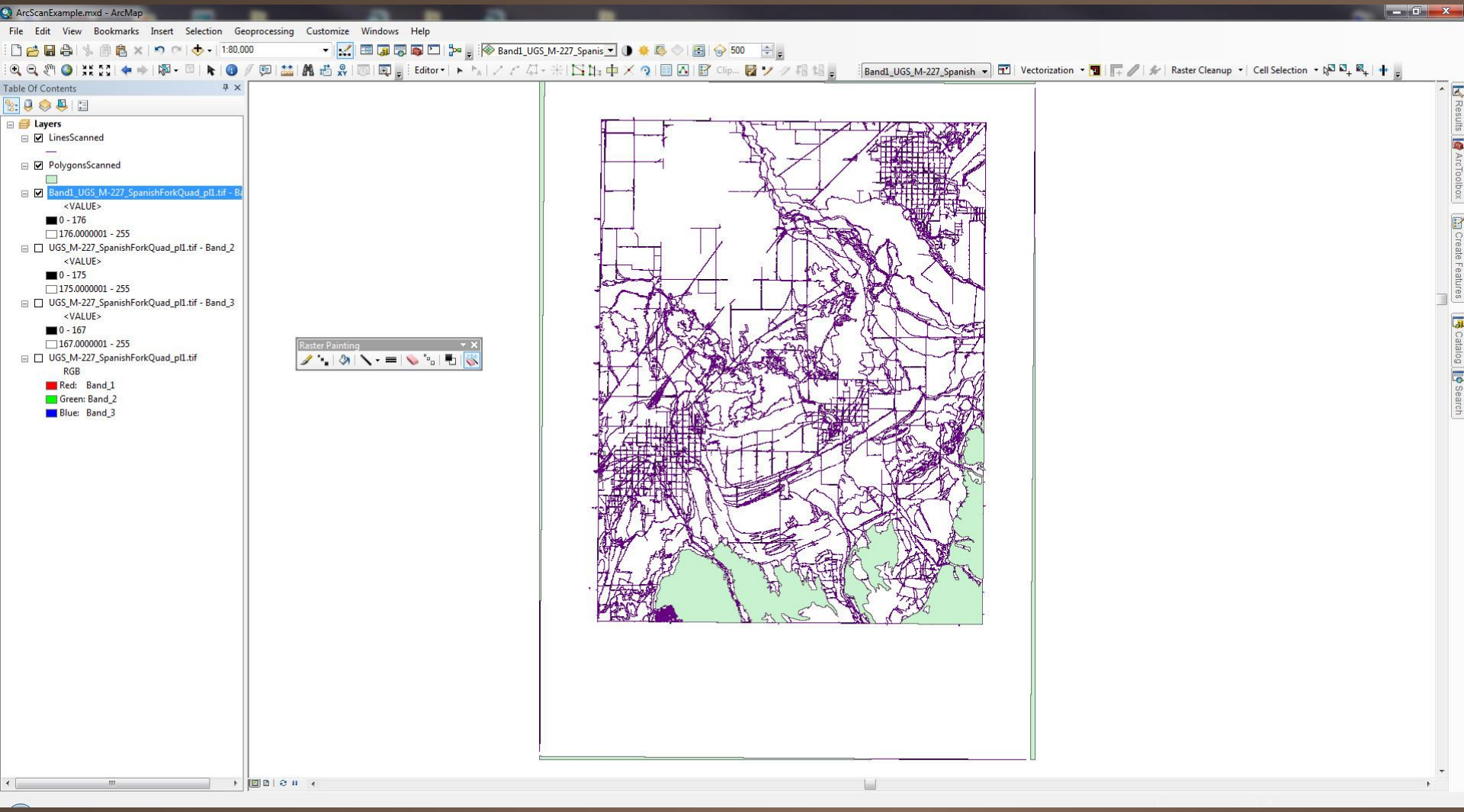

Red band selected for ArcScan processing. Turn on ArcScan toolbar, start an editing session for lines and polygon features.



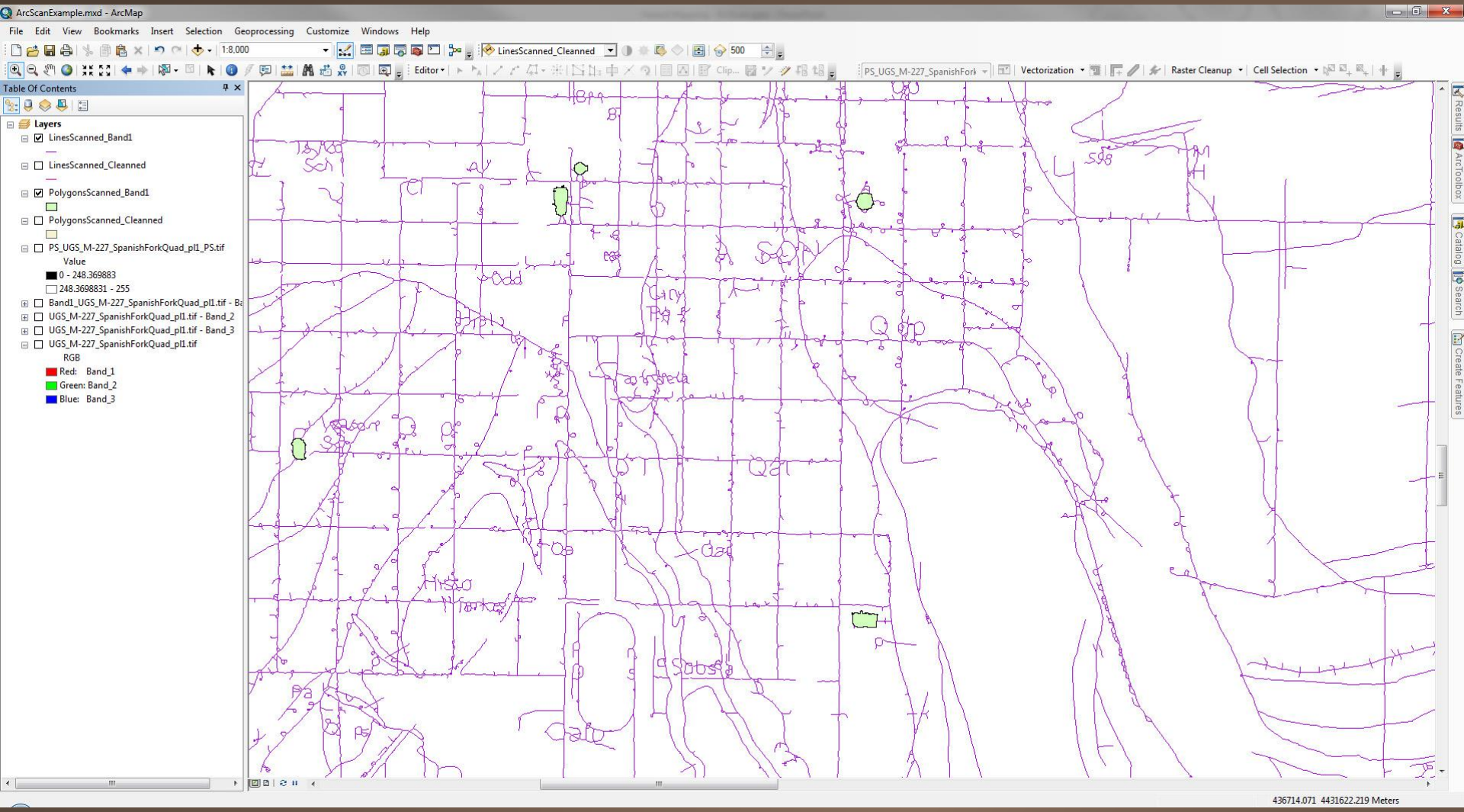

Enable Raster Painting toolbar to cleanup the raster.

# First Attempt

- Load a georeferenced map
- Load individual bands of the color raster
- Set the Symbology to Classified using 2 Classes  (Unique Values is also acceptable)
- Turn on ArcScan toolbar, start an editing session, and clean up the image
- **Run scan automation**



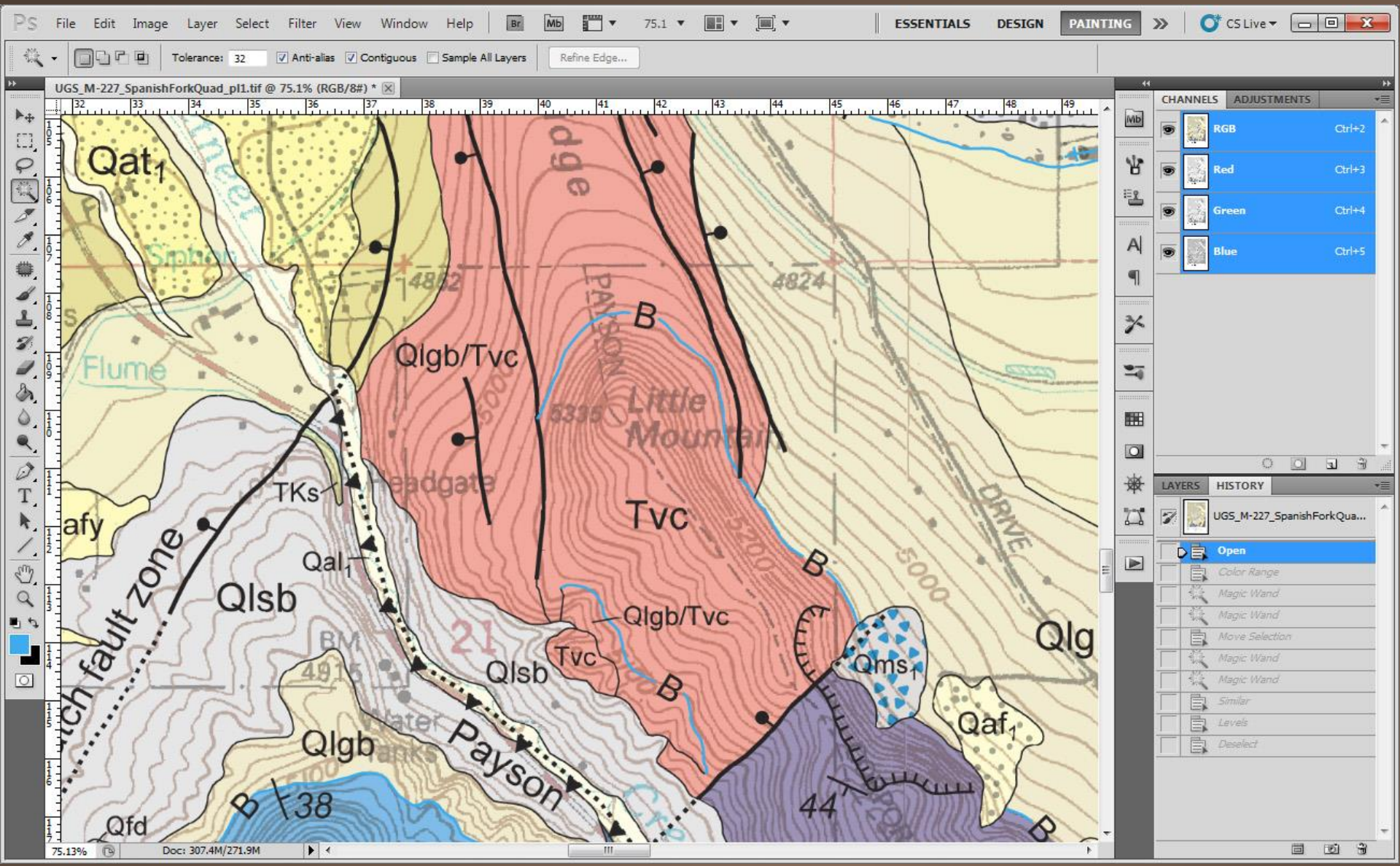

Results from the First Attempt of running ArcScan.



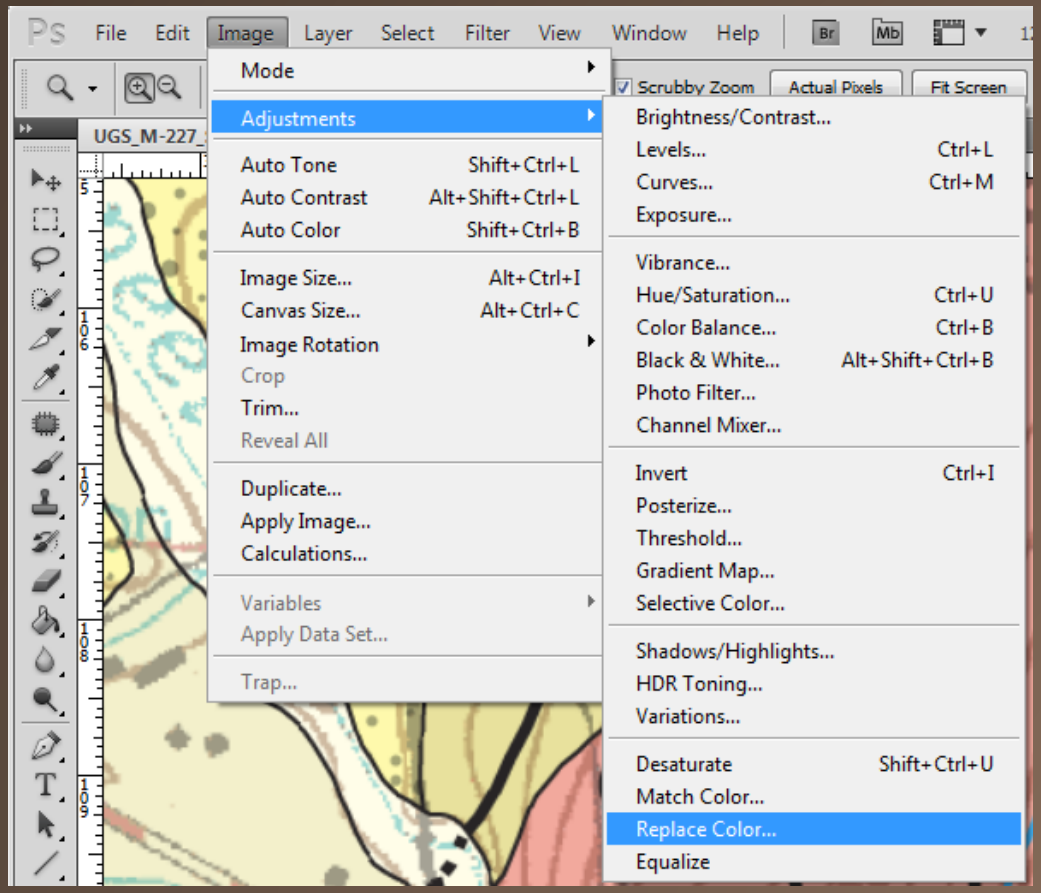

A zoomed in view of the roads and contact lines of the first ArcScan attempt.

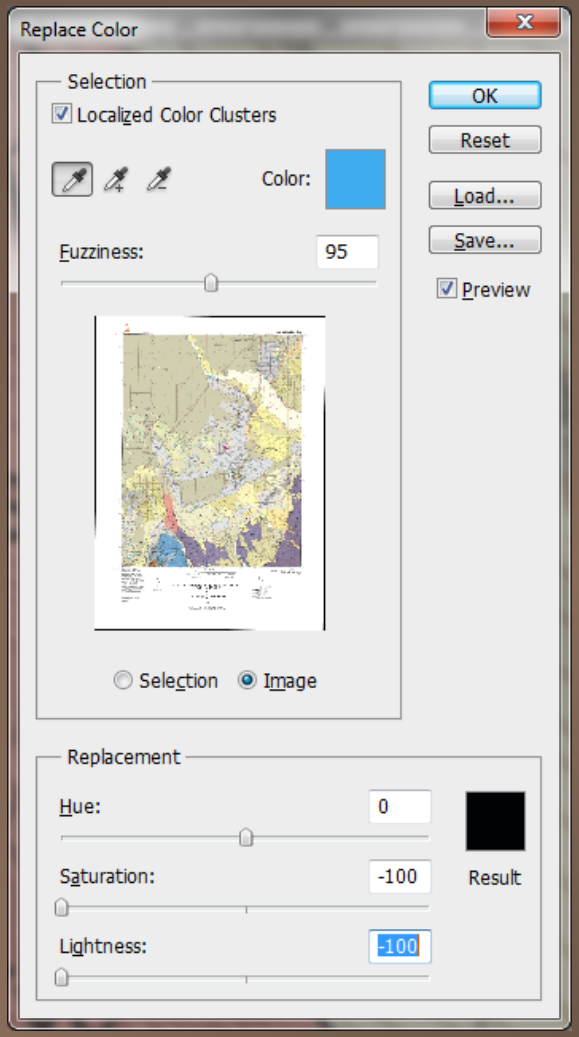
# Current Workflow

- Use an image processor (Photoshop or GIMP) to convert the TIFFs to two colors
  - Change non-black boundary lines to black

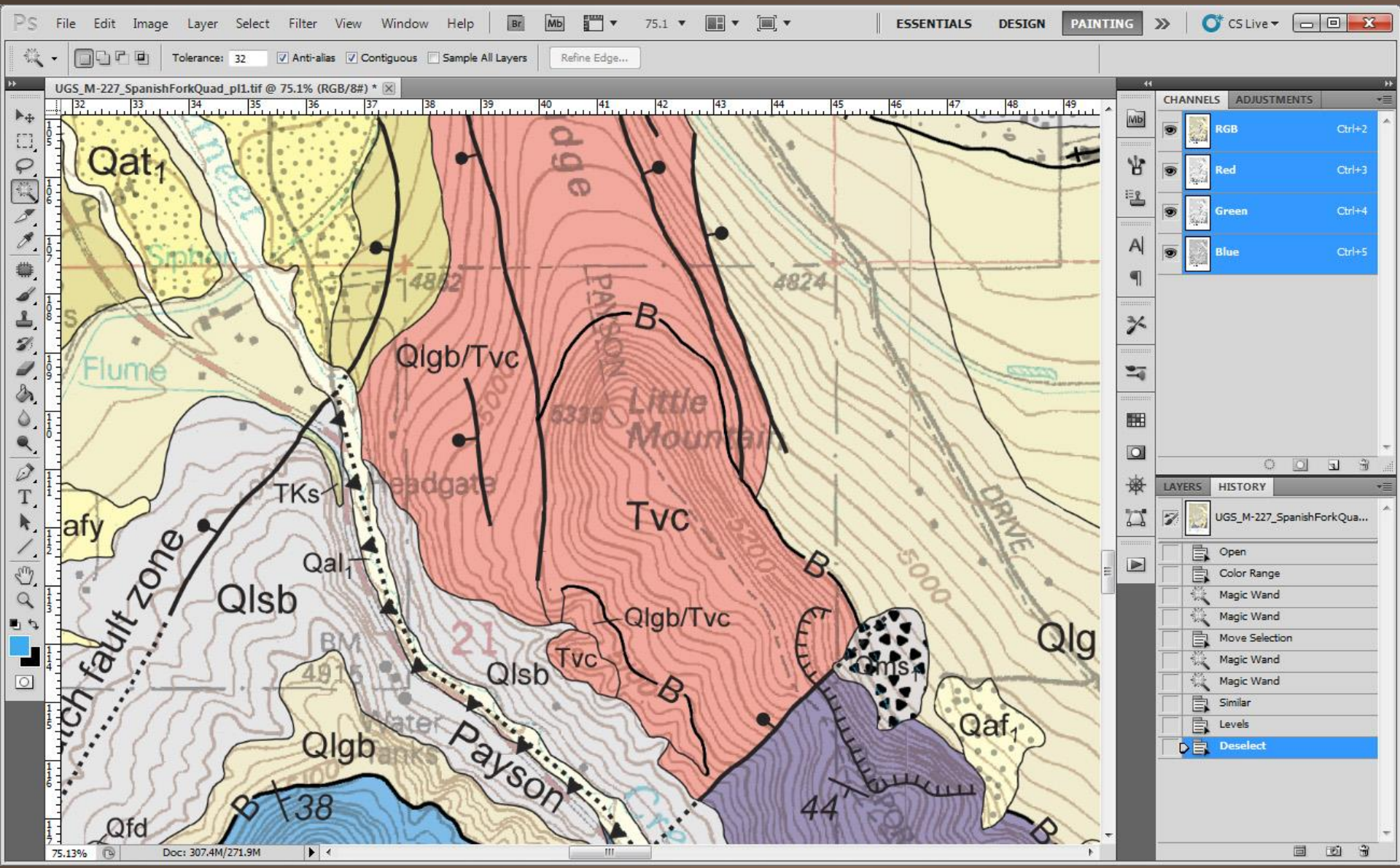



Load georeferenced image into an image processor.



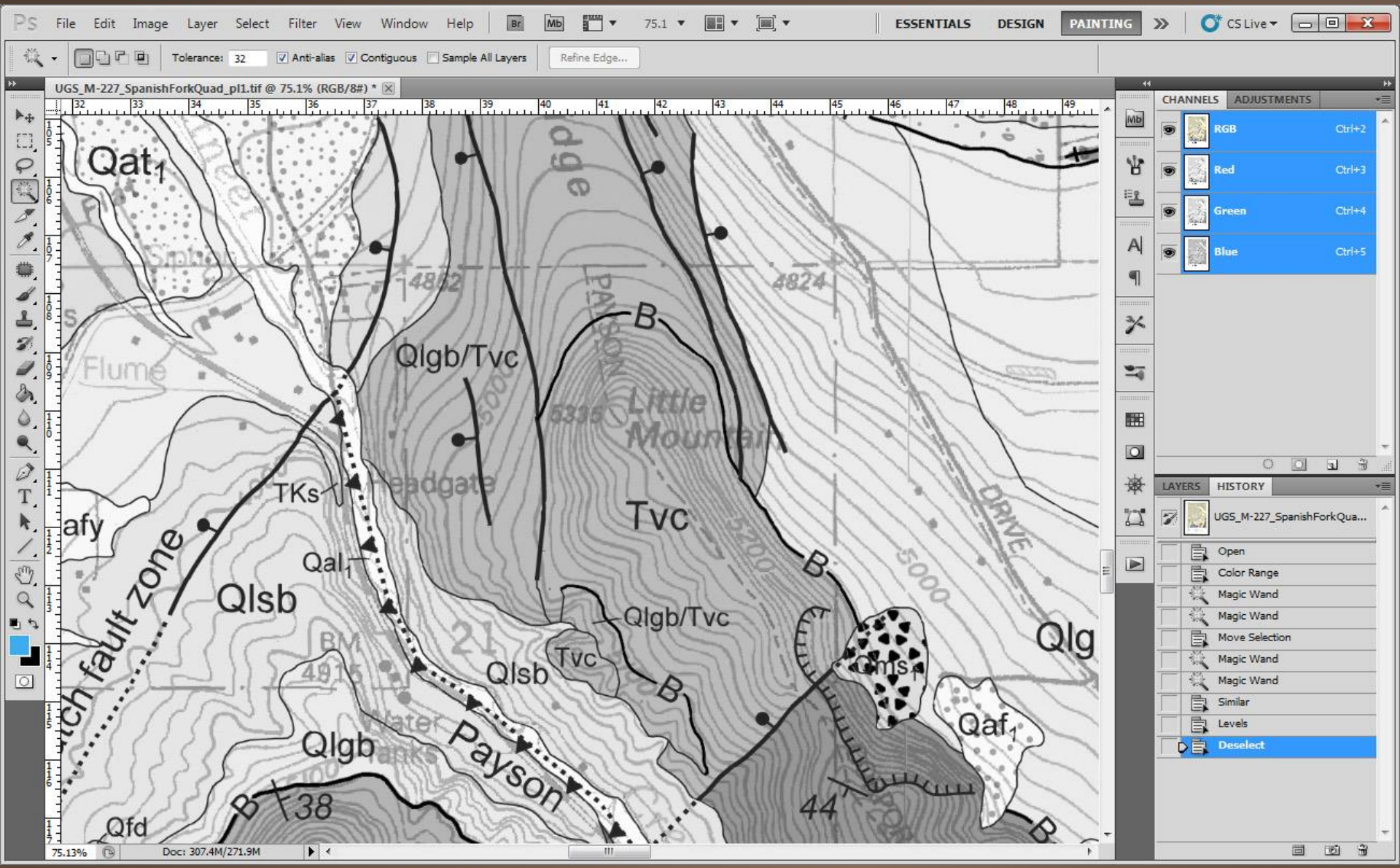

Change colors that need to be recognized to black.




Result of the color change.

# Current Workflow

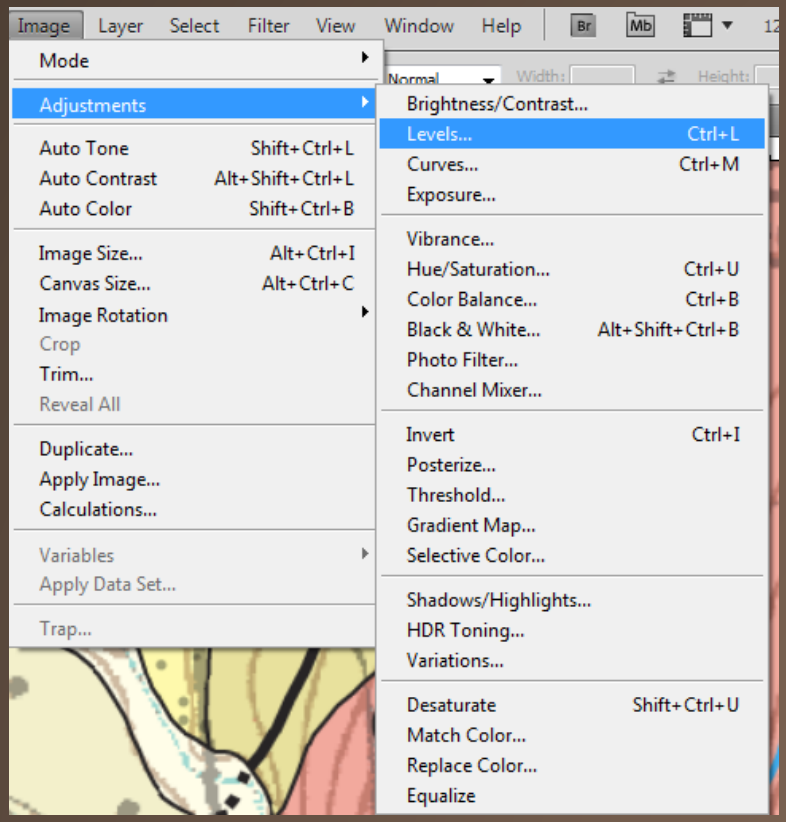
- Use an image processor (Photoshop or GIMP) to convert the TIFFs to two colors
  - Change non-black boundary lines to black
  - **Change colors to grayscale**

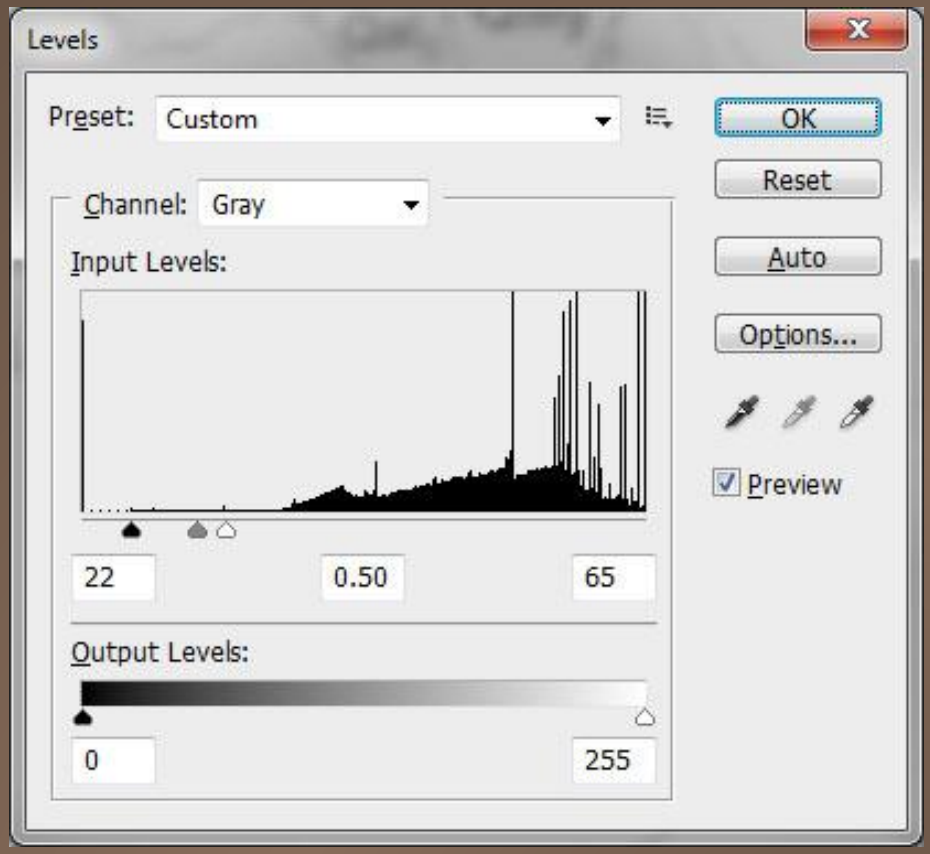



Change colors to grayscale in Image → Mode → Grayscale

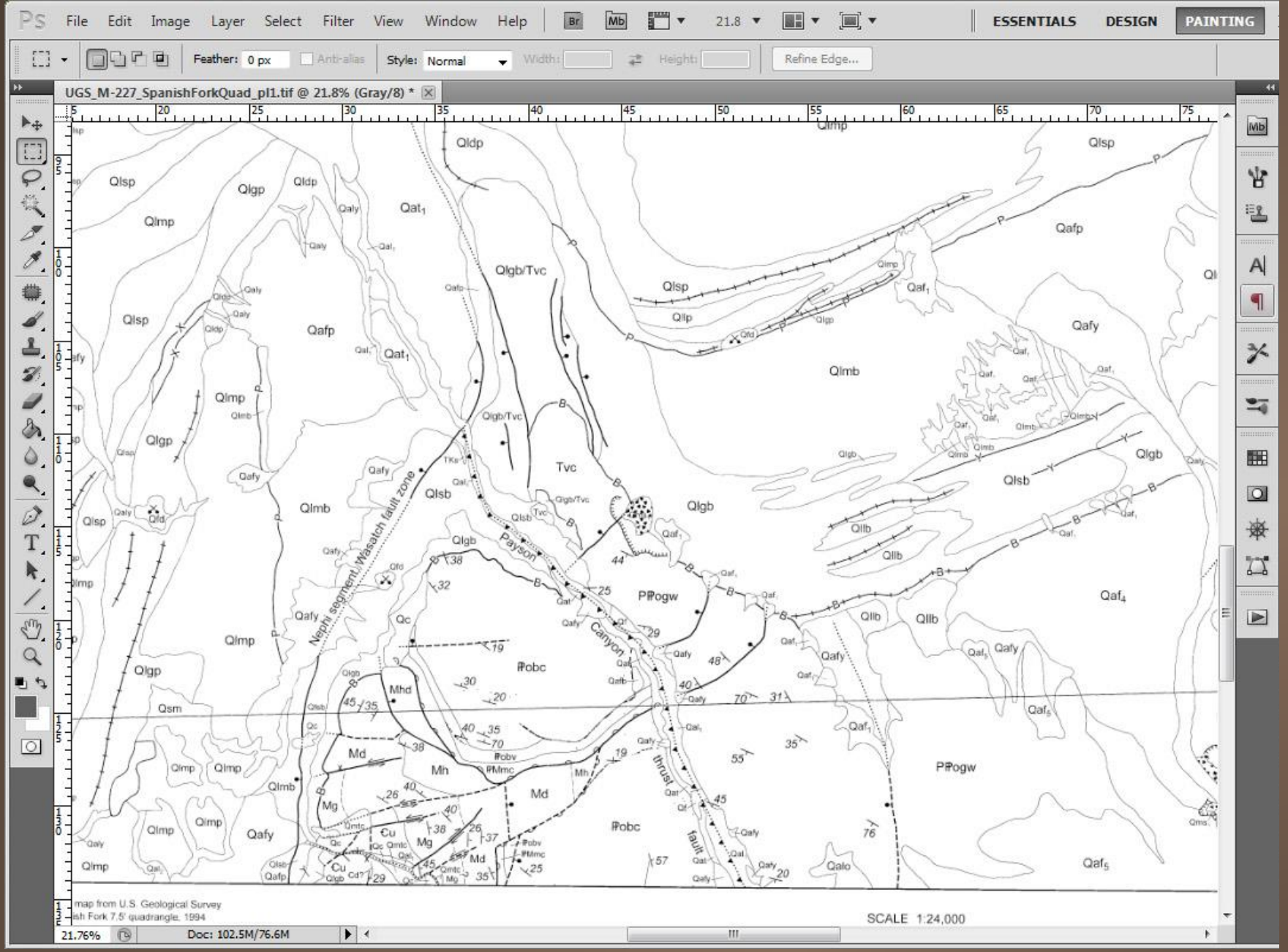
# Current Workflow

- Use an image processor (Photoshop or GIMP) to convert the TIFFs to two colors
  - Change non-black boundary lines to black
  - Change colors to grayscale
  - **Adjust levels of lines to black and everything else to white**



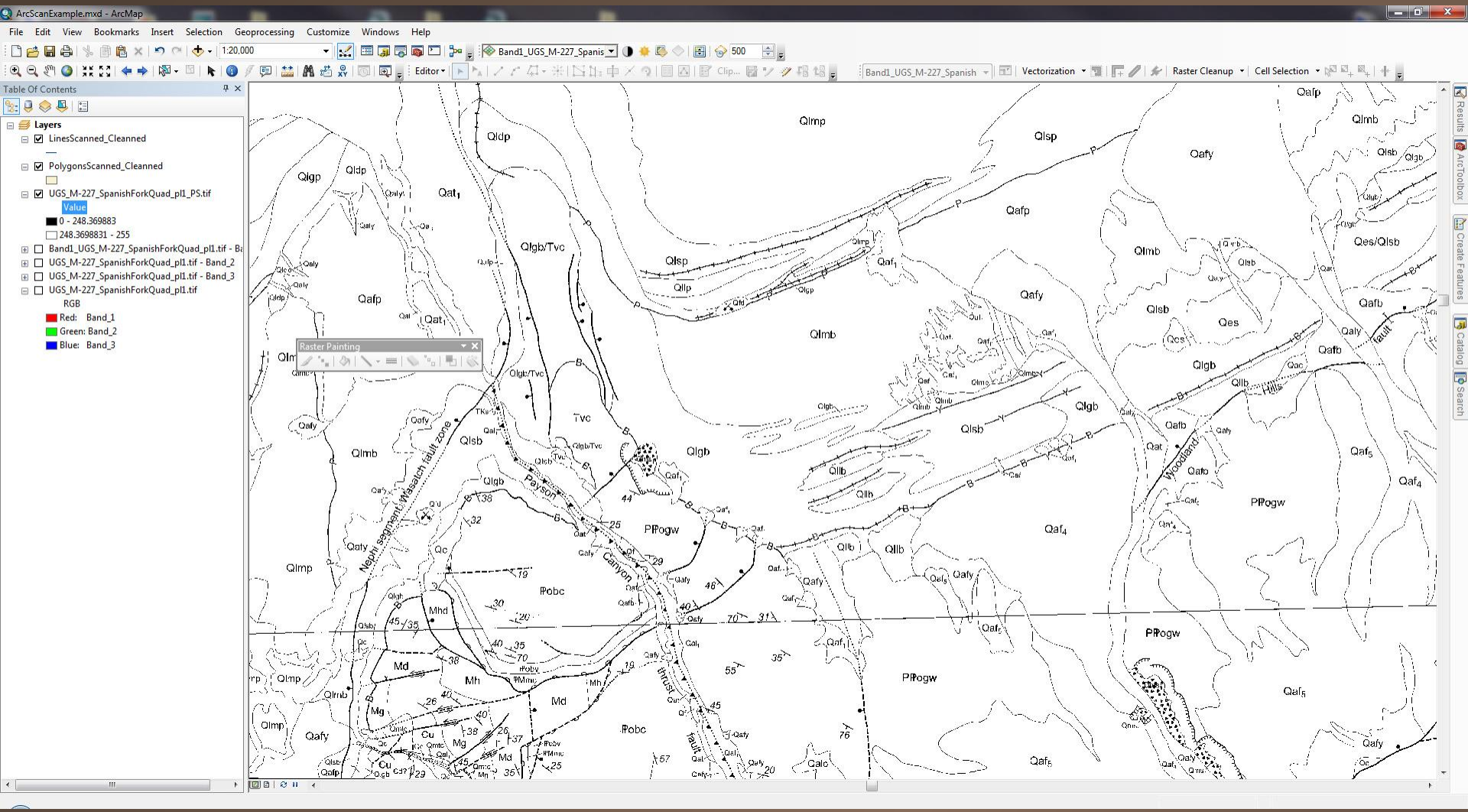

Adjust image levels of lines to identify black compared to the rest of the image.



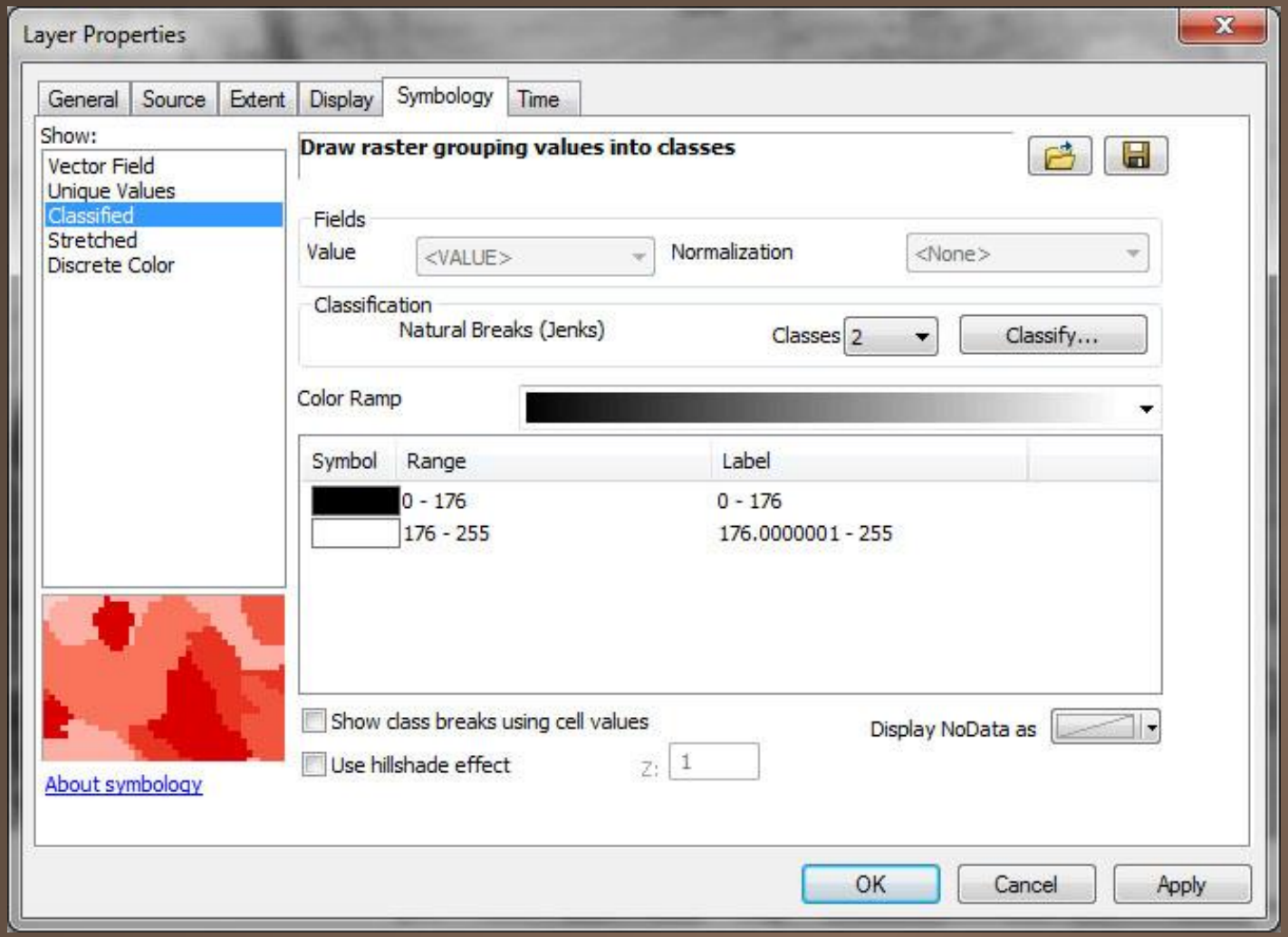

Results of level adjustments showing only geologic lines and labels.

# Current Workflow

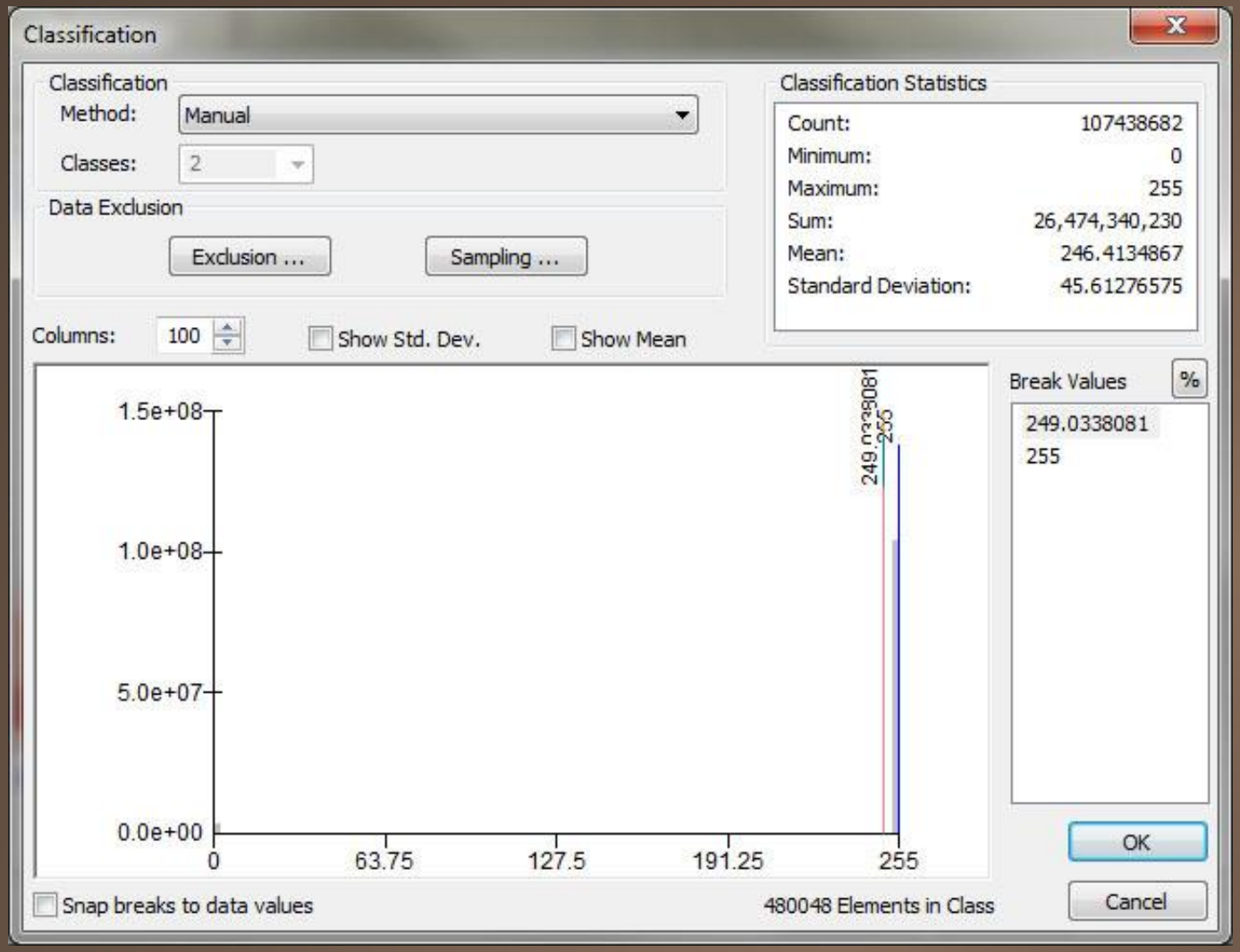
- Use an image processor to convert the TIFFs to two colors
  - Change non-black boundary lines to black
  - Change colors to grayscale
  - Adjust levels of lines to black and everything else to white
- **Load grayscale TIFF in ArcMap (copy the .tfw file from the original accompanying TIFF and rename it to match the name of the grayscale file). Follow the same steps to classify, clean, and automate scans**



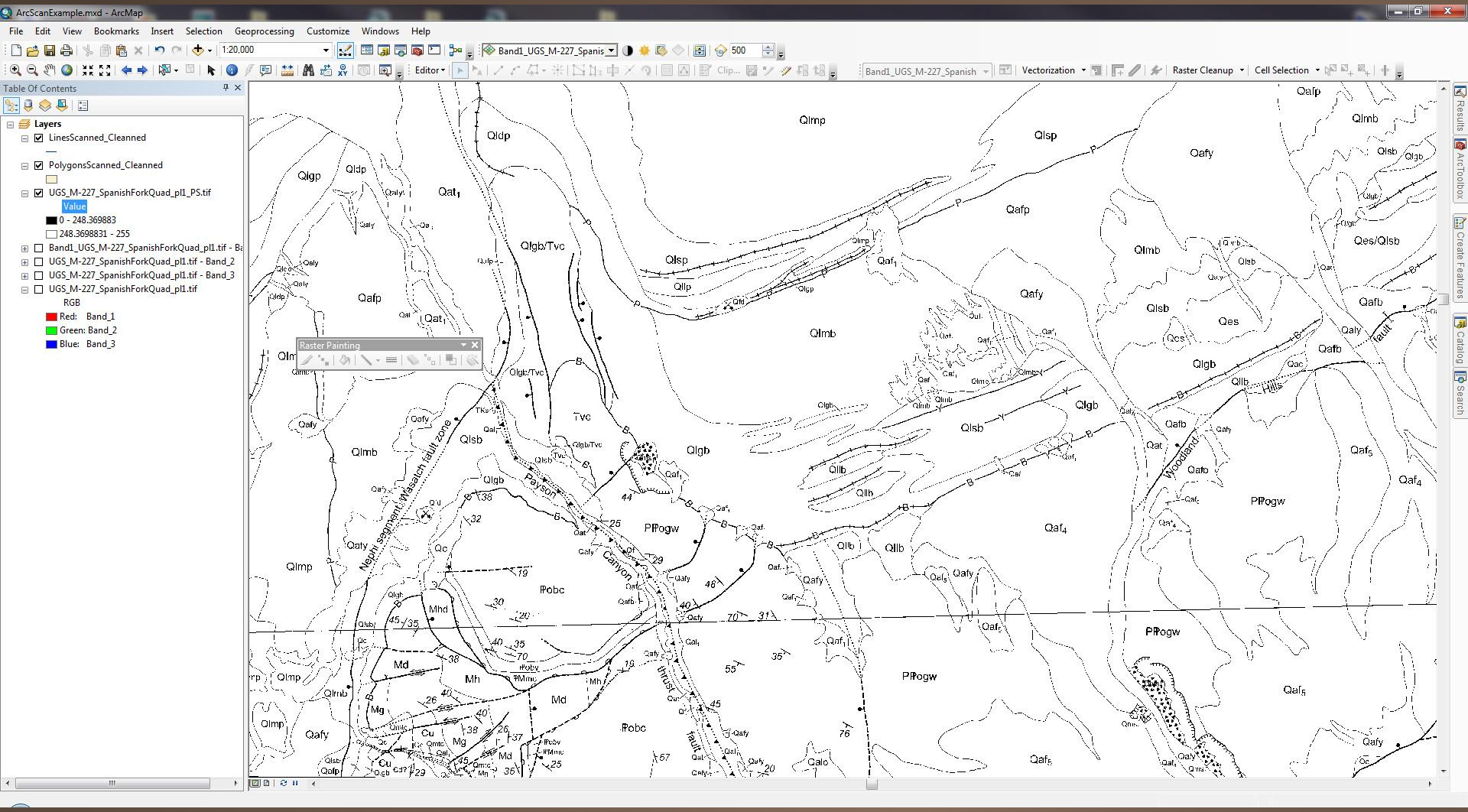

Load the adjusted image file into ArcMap, ensure the original accompanying world file is copied and renamed.




Change the image symbology to classified with 2 classes



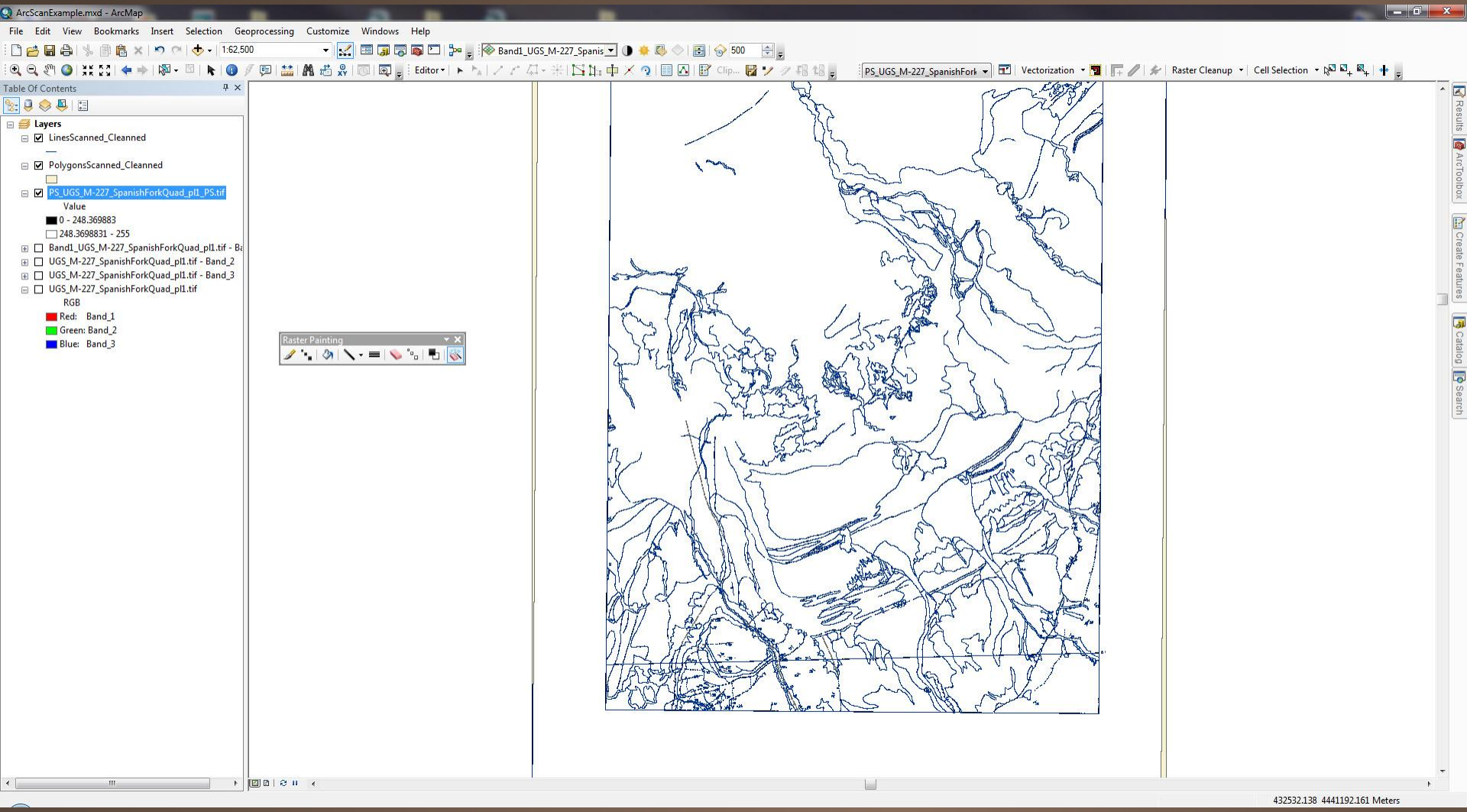

You can adjust the classes to identify white from black. The large number should represent the color white.



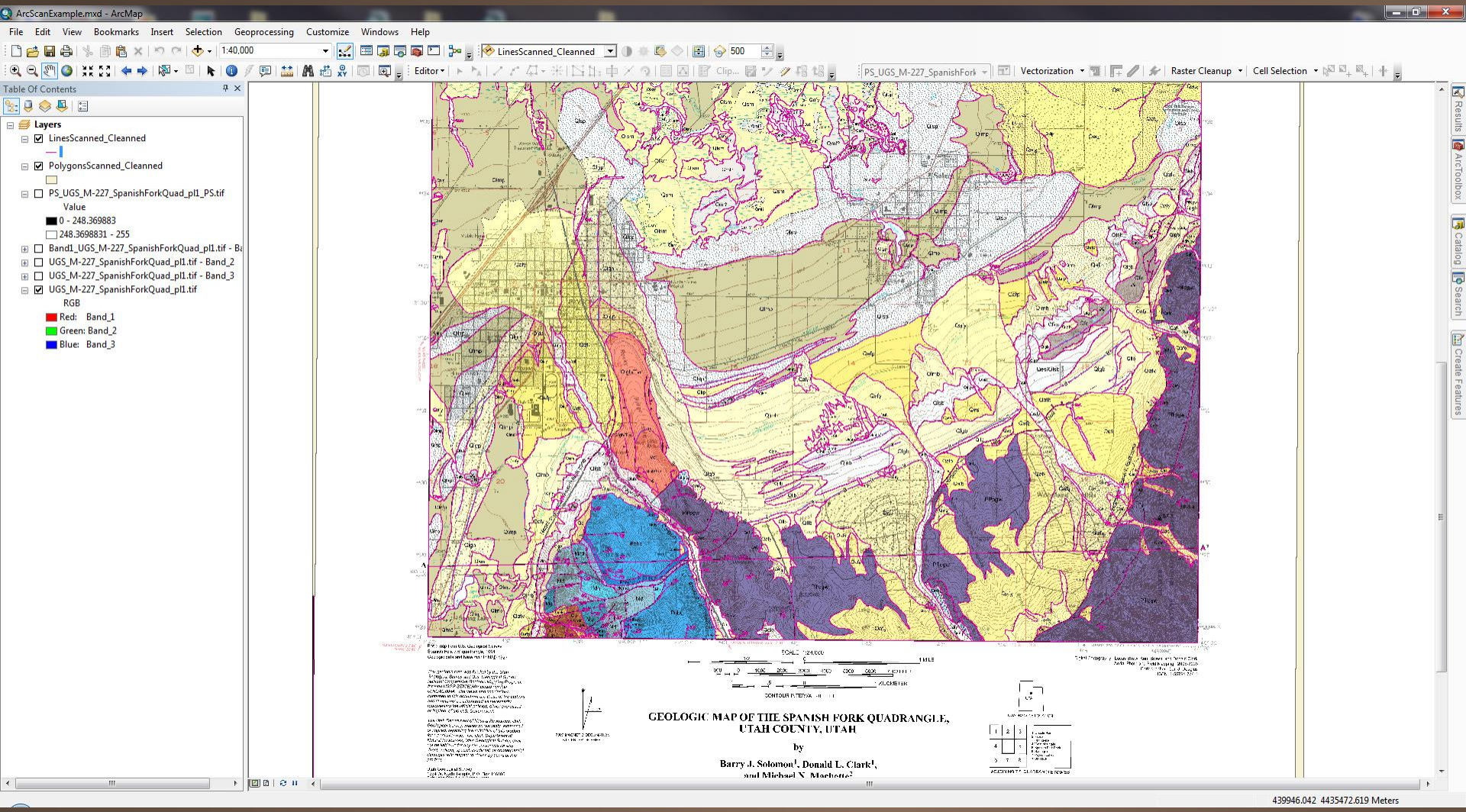

The resulting map after symbology change.

# Current Workflow

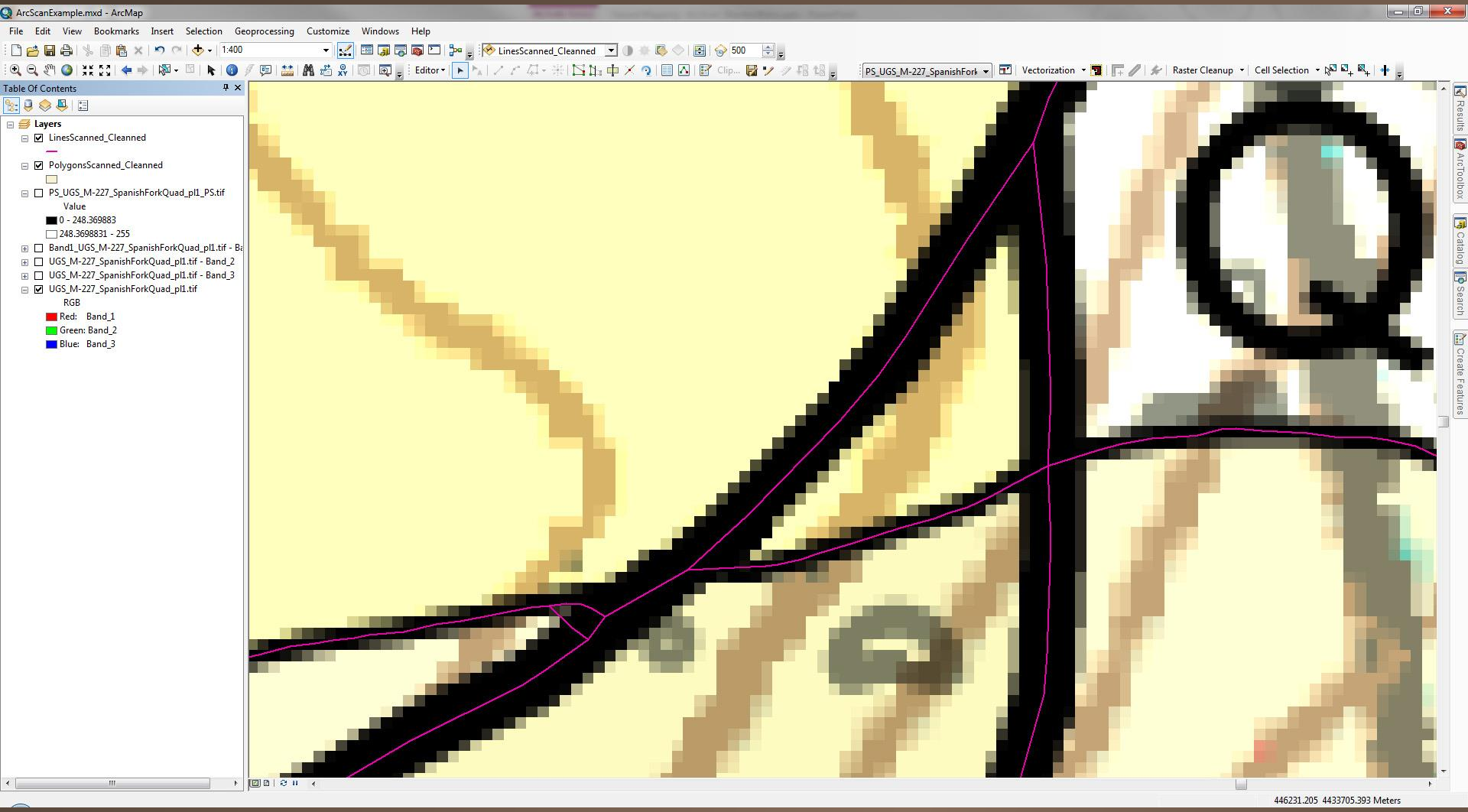
- Use an image processor to convert the TIFFs to two colors
  - Change non-black boundary lines to black
  - Change colors to grayscale
  - Adjust levels of lines to black and everything else to white
- Load grayscale TIFF in ArcMap (copy the .tfw file from the original accompanying TIFF and rename it to match the name of the grayscale file). Follow the same steps to classify, clean, and automate scans.
- **Review the resulting features**



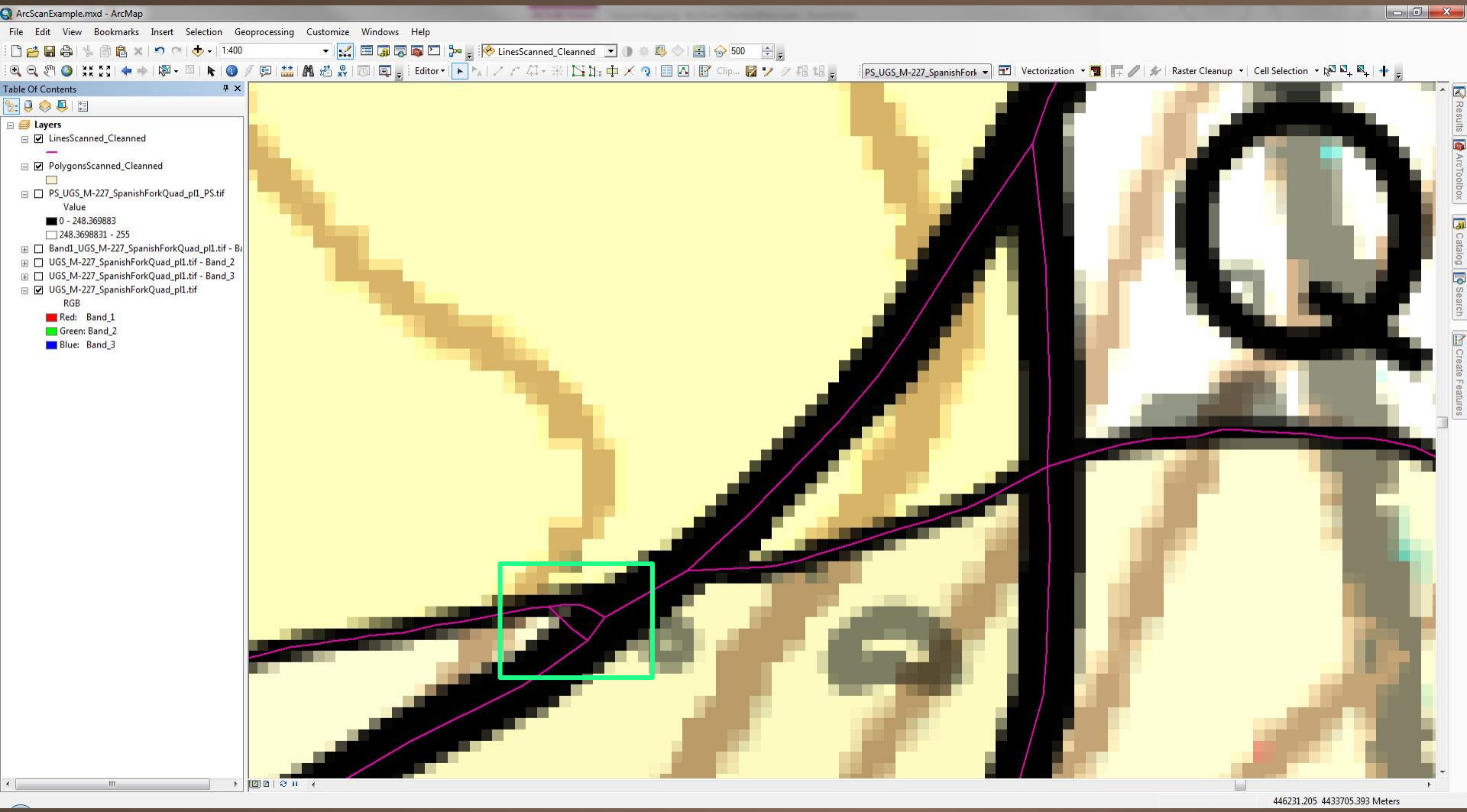

The resulting features after ArcScan processing.




The features after ArcScan processing overlaid on the image.

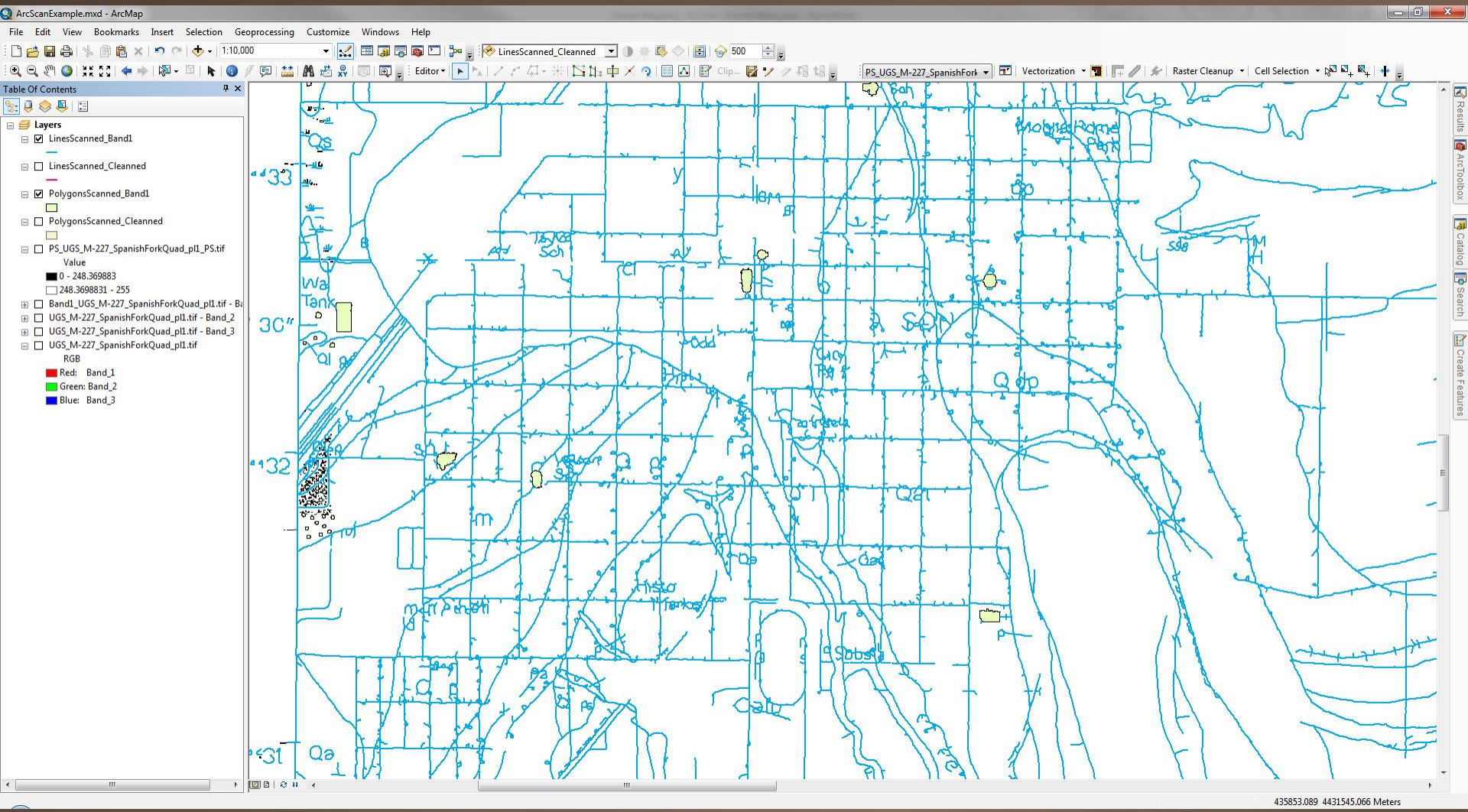



Zoomed features after ArcScan processing overlaid on the image.

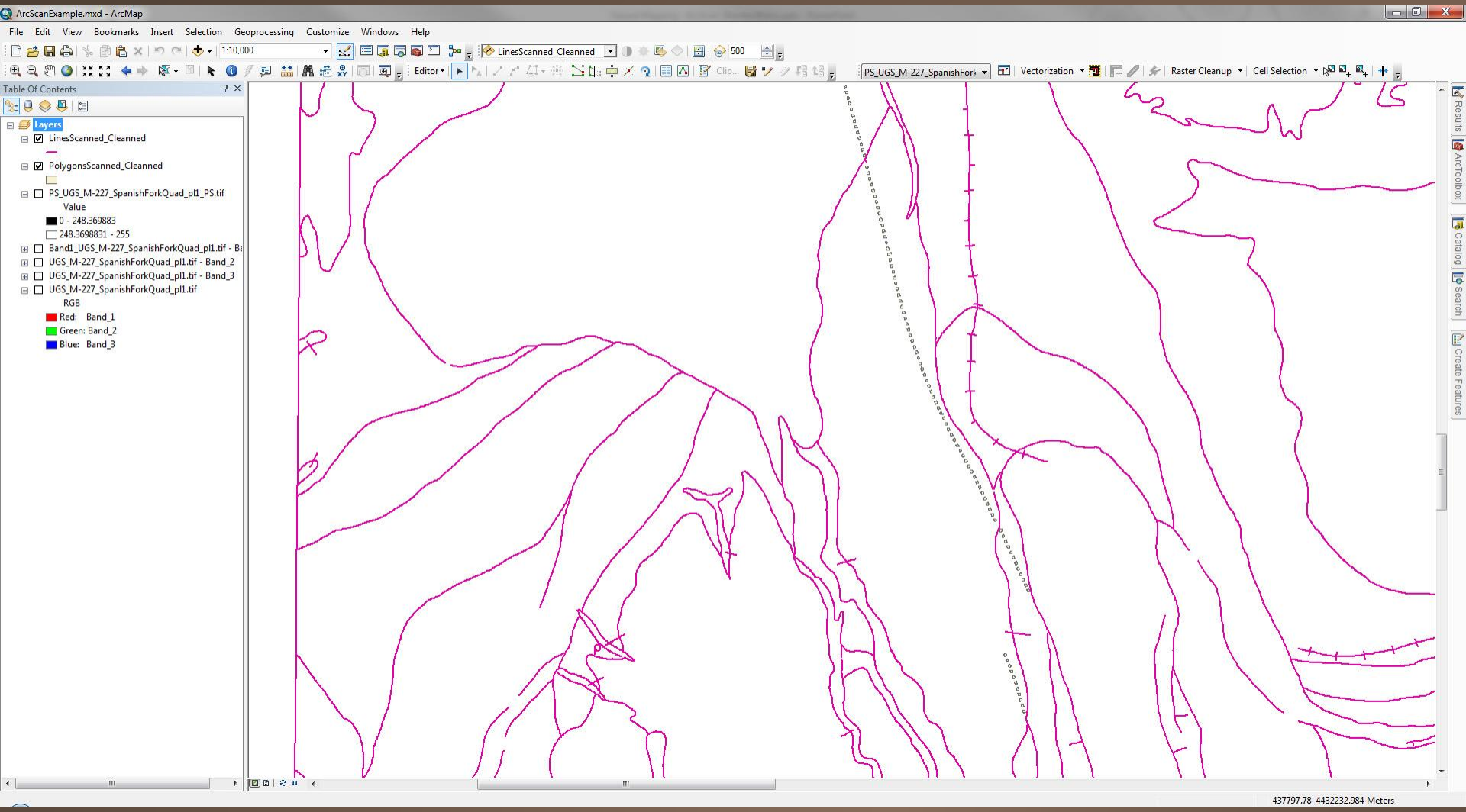



The feature shows potential extra lines after processing.

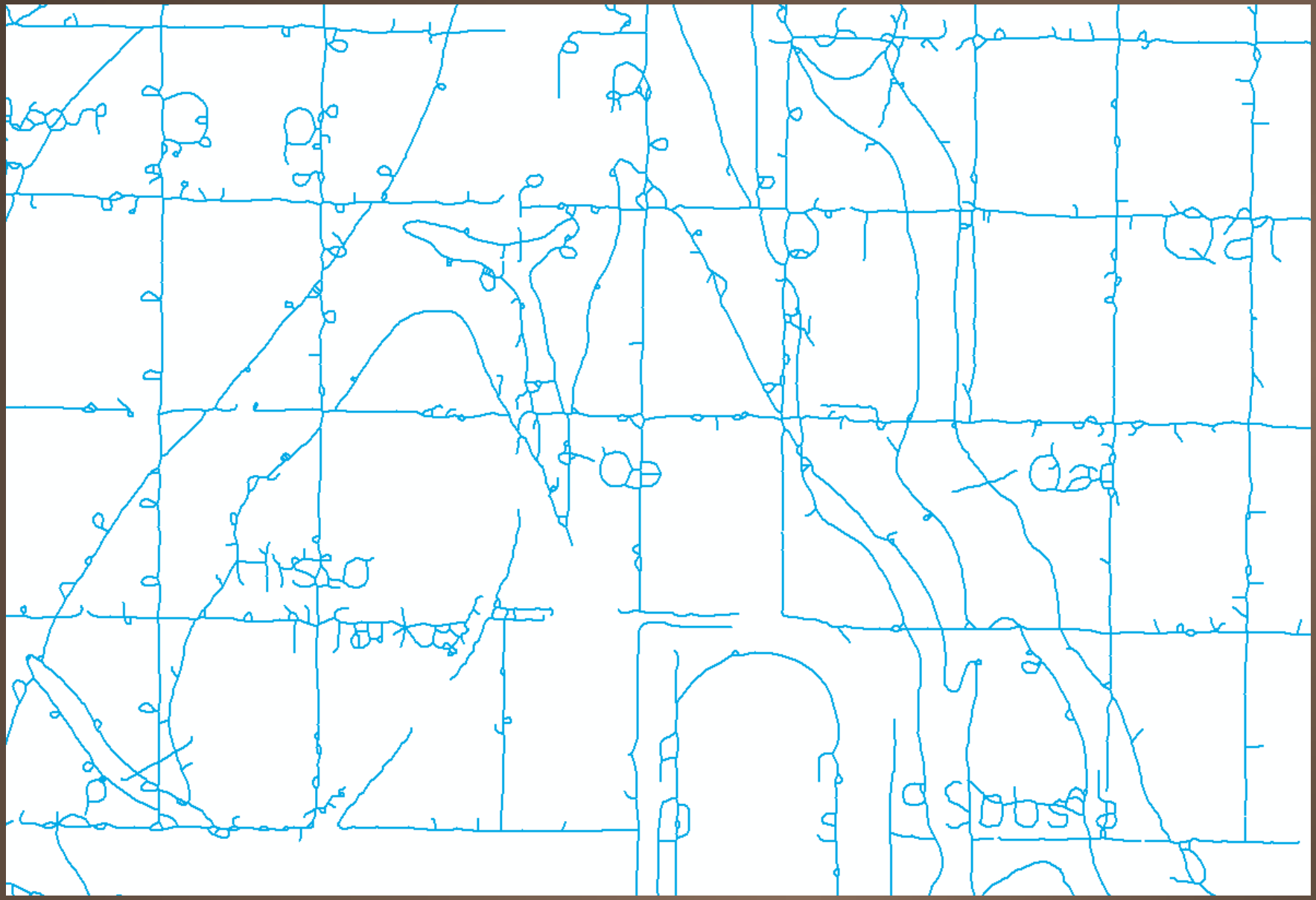
# First Attempt Lines



# Current Workflow Lines

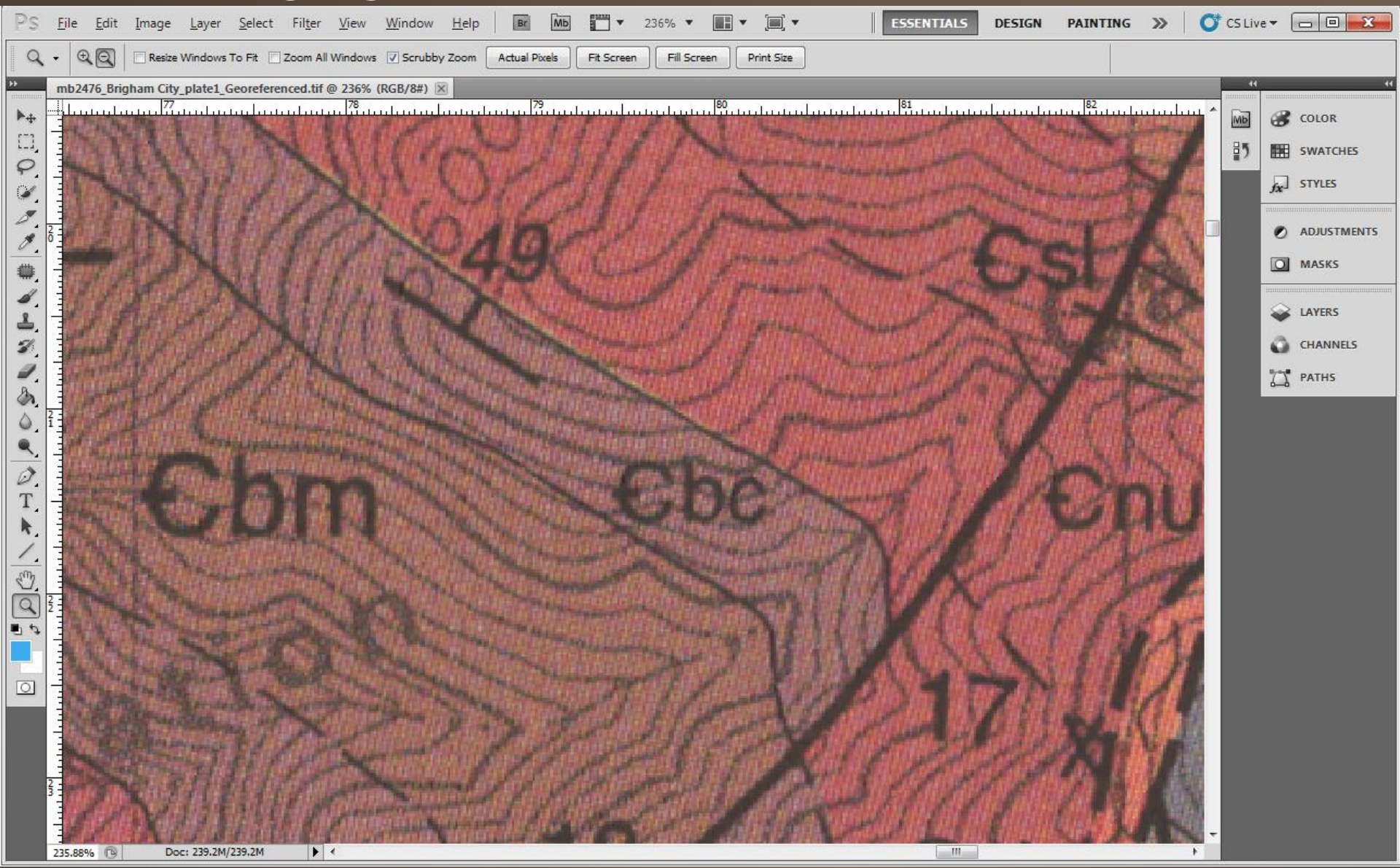


# First Attempt Lines



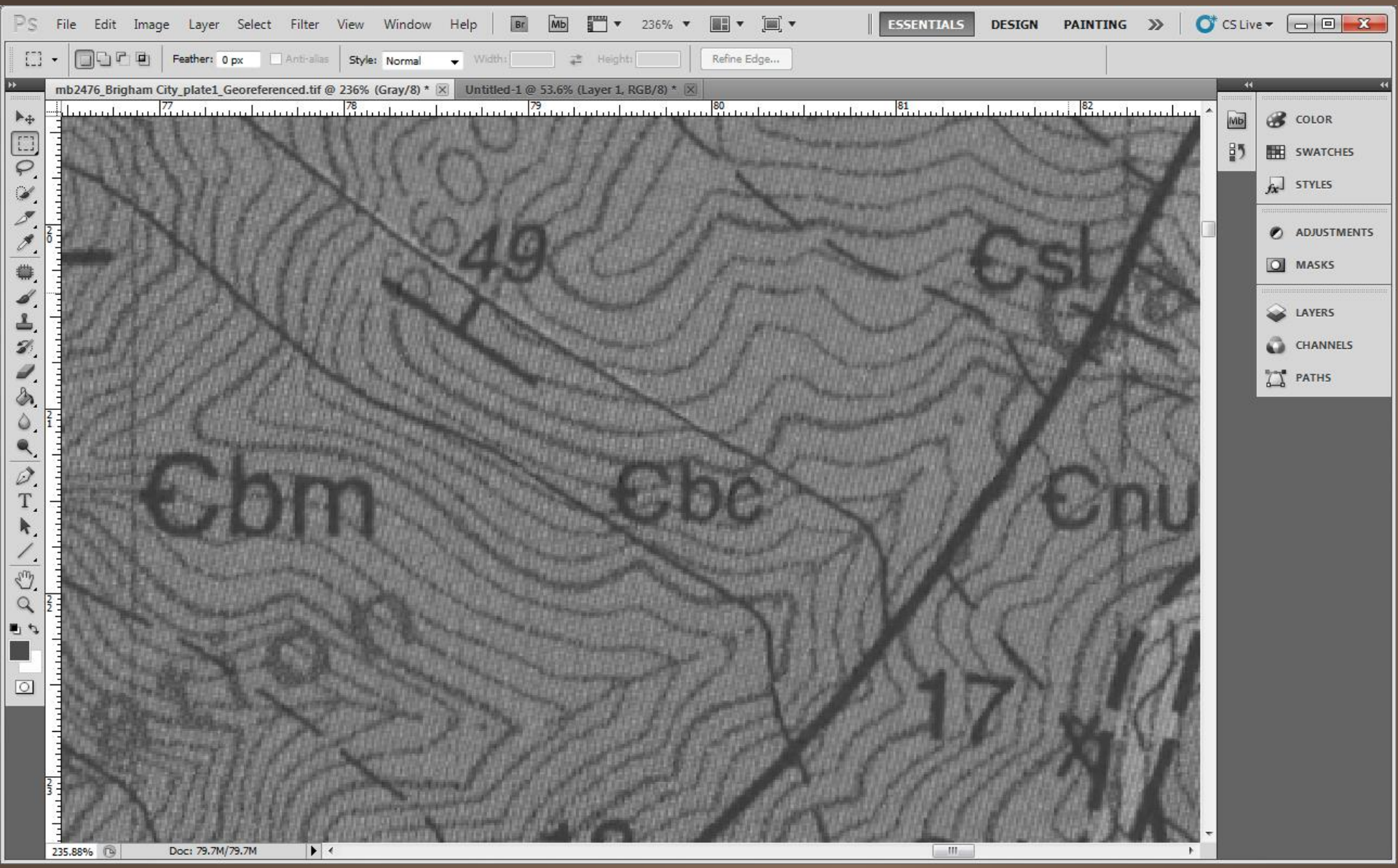
# Current Workflow Lines

# Challenging Map



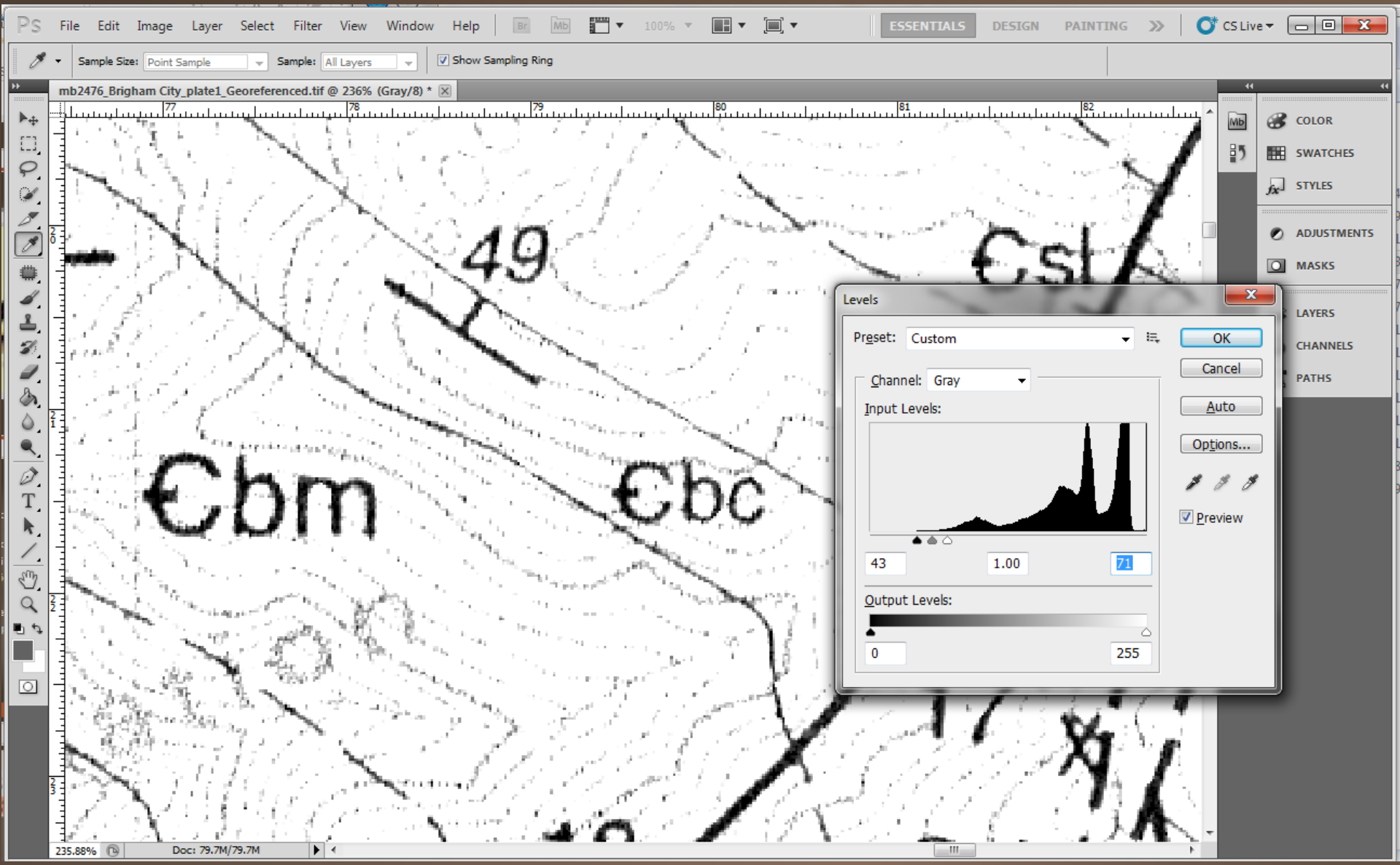

Challenging maps consist of faded, bleeding colors, and blurry lines making it difficult to identify lines to scan.

# Challenging Map Grayscale



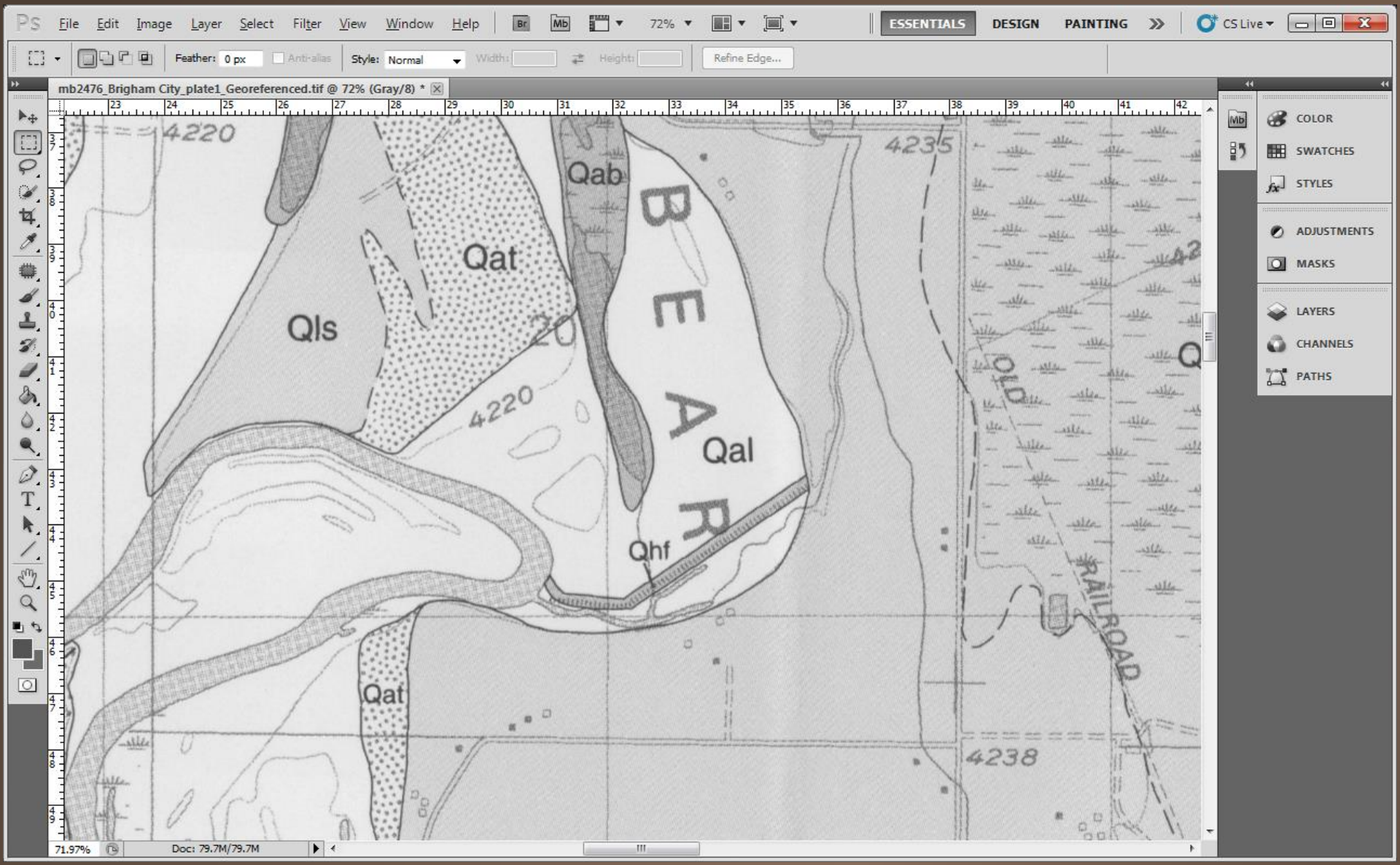

However the same process can get to a point of processing.

# Challenging Map Levels



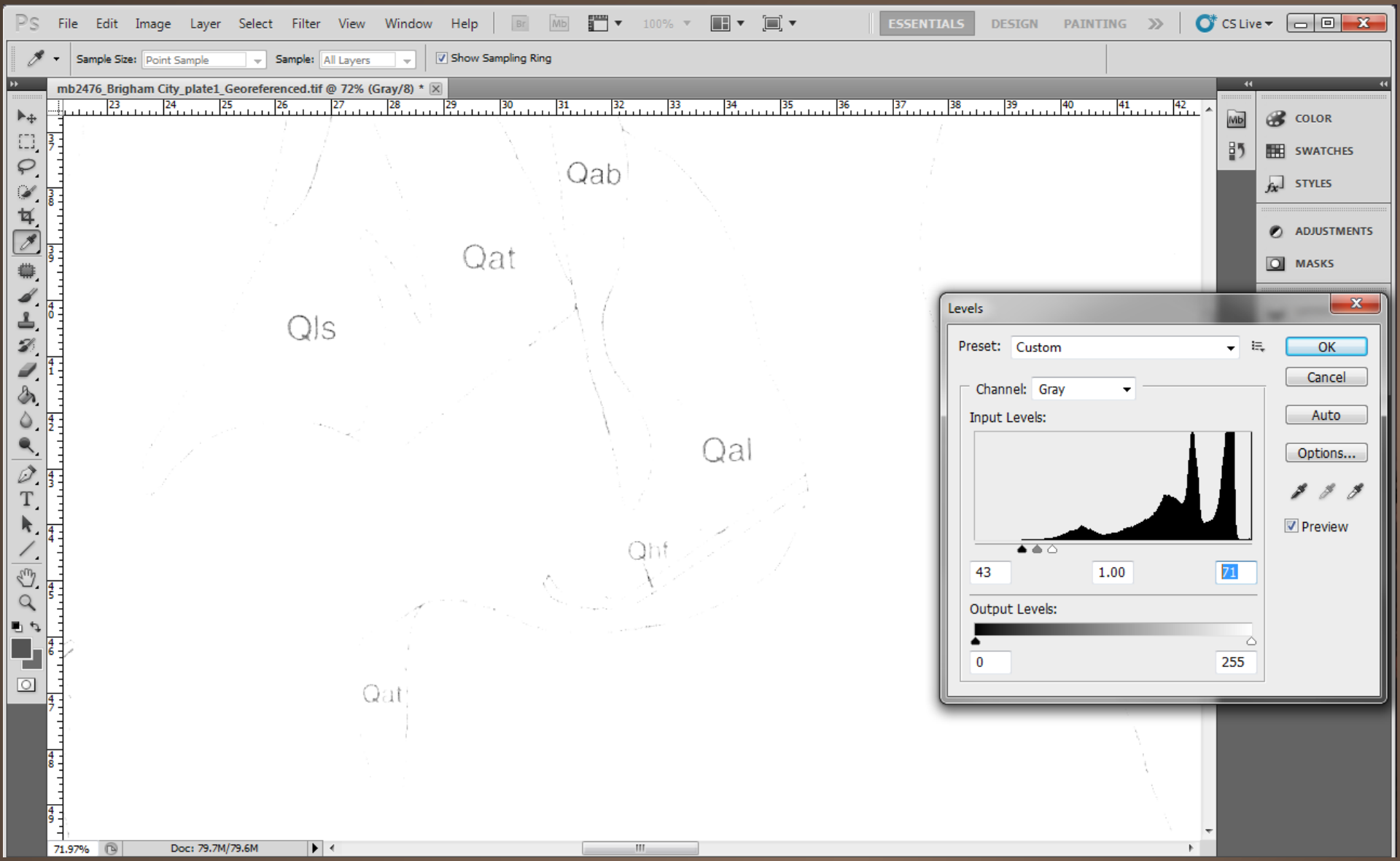

As seen, the level adjustment removes much of the gray but does not eliminate the contour lines.

# Challenging Map Light Grayscale



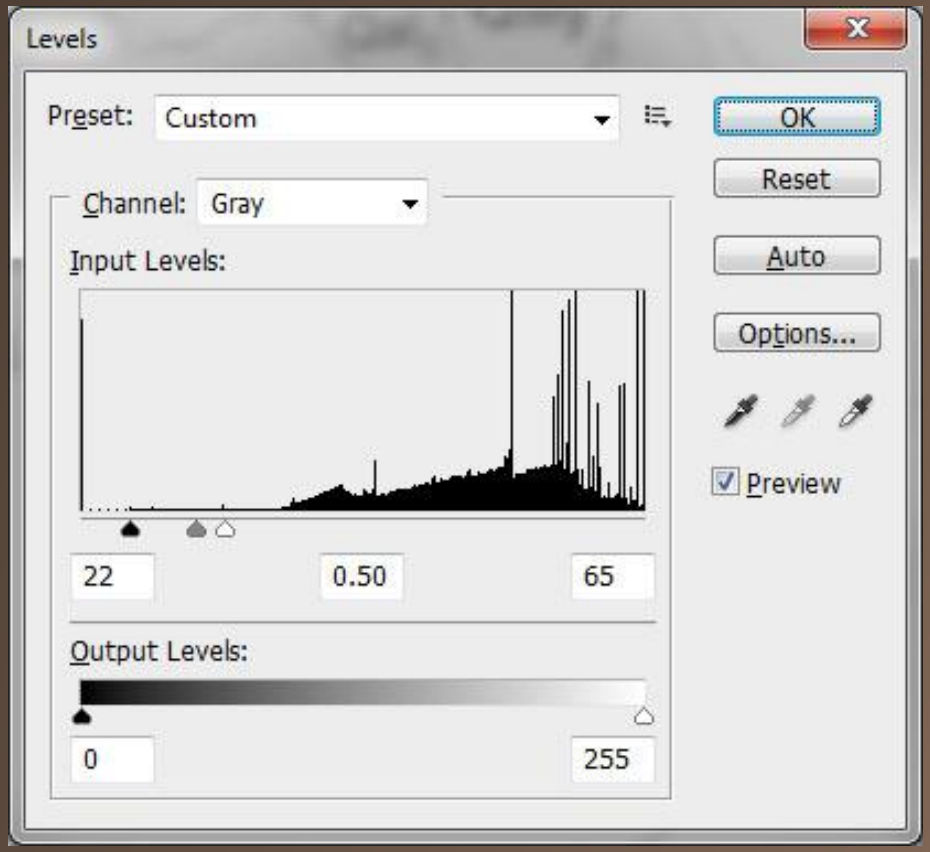

Another part of the map show potential good lines.

# Challenging Map Light Levels

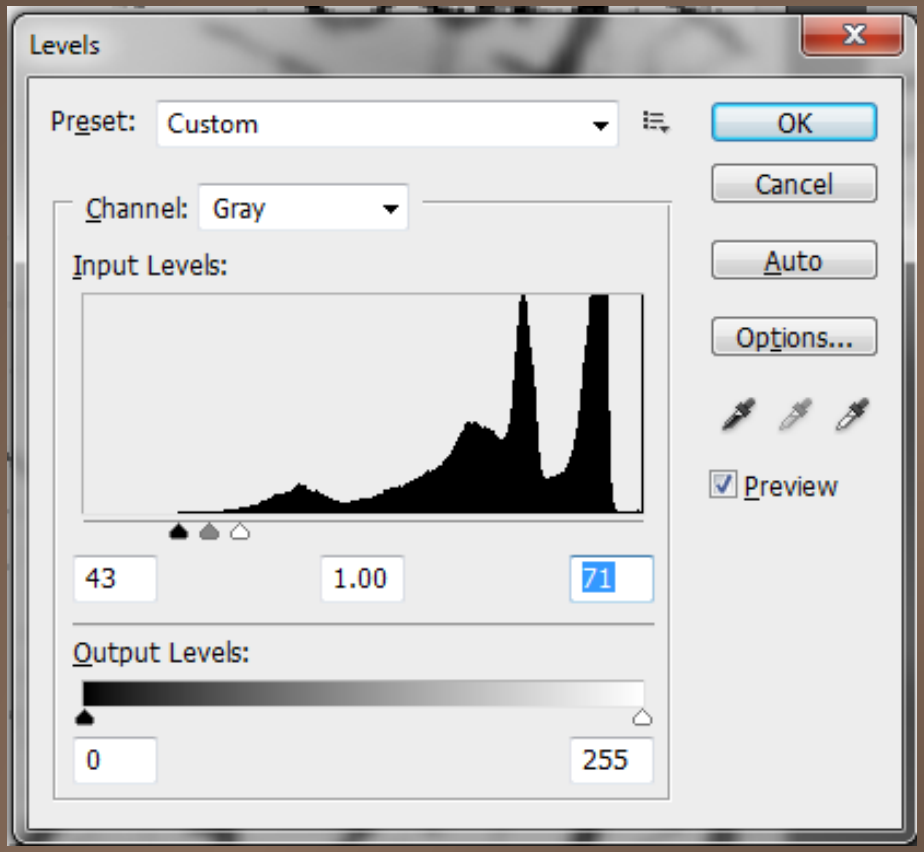



However, when the levels where adjusted for the darker part of the map the lighter part gets faded out. A workaround is to make multiple images.

# Easy Map




# Challenging Map

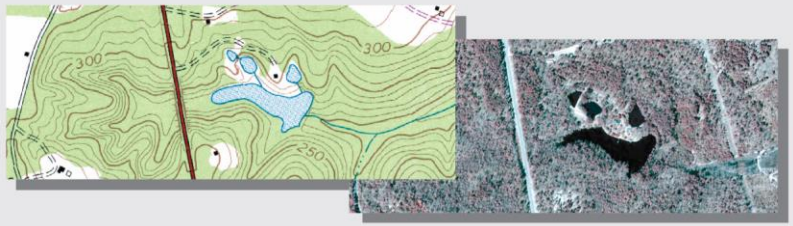



Comparison of the two color levels. The easier map has a wider distribution and more identifiable black colors.

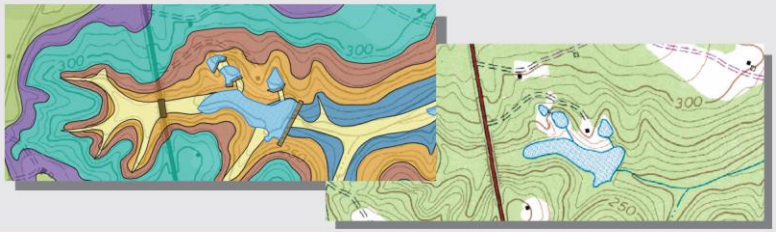
# Results

- A faster method to convert non-digital maps to GIS format
- More precise lines comparable to the original map
- Expanding use of image processing (Photoshop, GIMP)
- High quality scanned maps provide great results
- Divide challenging maps processing into workable rasters
- Take advantage of an ArcMap extension
- Move forward on your mapping project

# Digital Mapping Techniques



2015



Association of American State Geologists

United States Geological Survey

# Thank you

Ben Erickson, M.S., P.G.
Hazard Mapping Geologist
Utah Geological Survey
benerickson@utah.gov
801-537-3379