Delaware LiDAR Data, Derivatives, and Applications

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Delaware Geological Survey

The Delaware Floodplain: Impacts of Severe Storms on Infrastructure in a Low Lying State

Seminar – October 30, 2017

UNIVERSITY OF DELAWARE

Introduction of LiDAR

- Light Detection And Ranging
- Active remote sensing

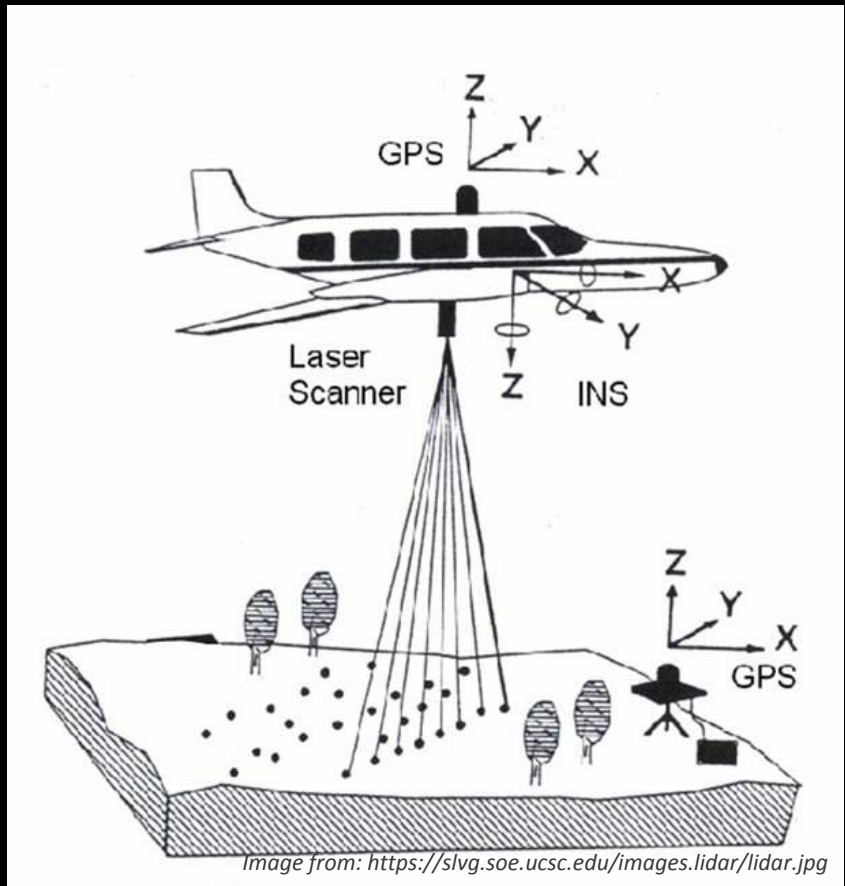


Image from: https://slvg.soe.ucsc.edu/images.lidar/lidar.jpg

Introduction of LiDAR

- Light Detection And Ranging
- Active remote sensing
- Multiple Returns
- Intensity

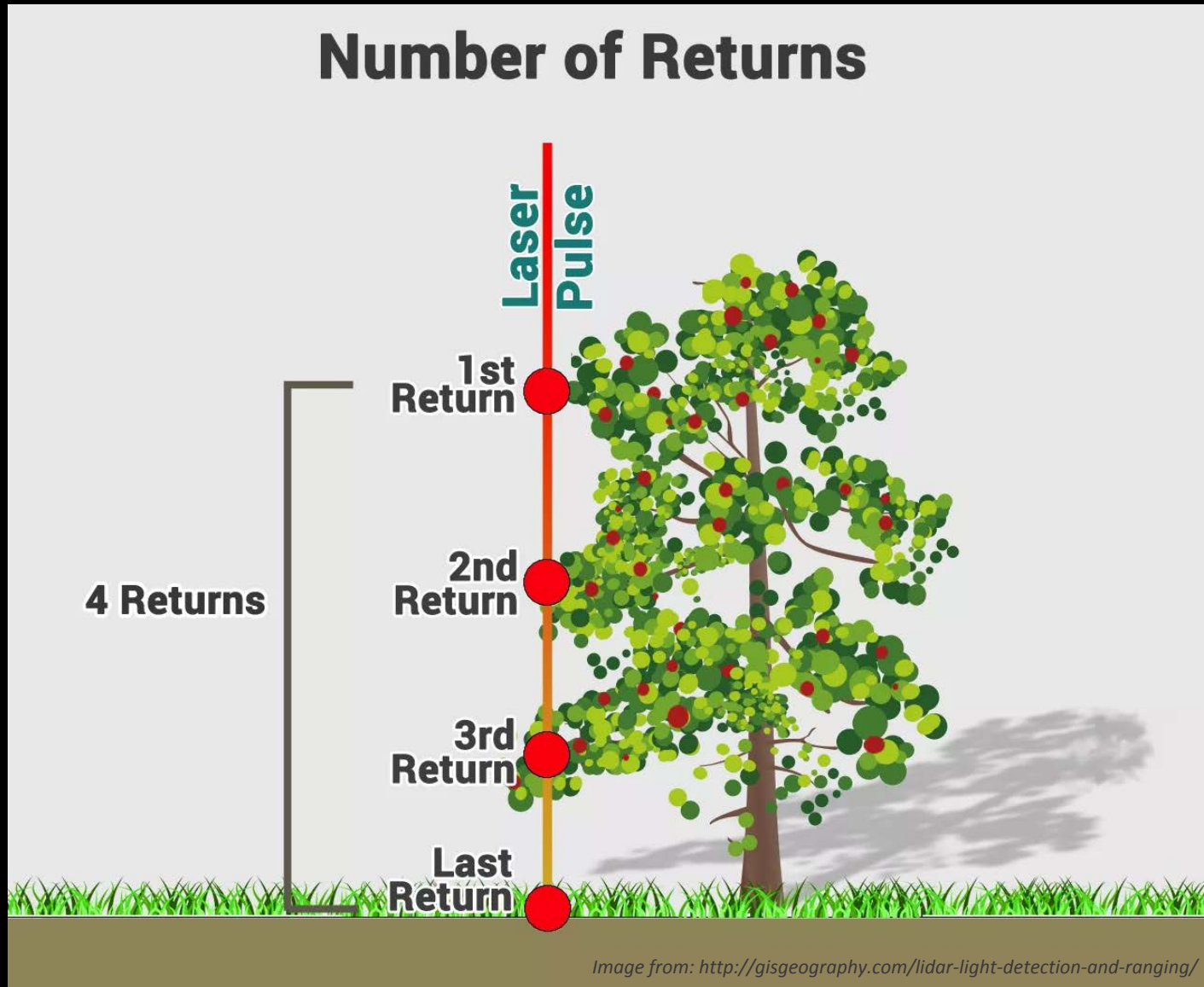
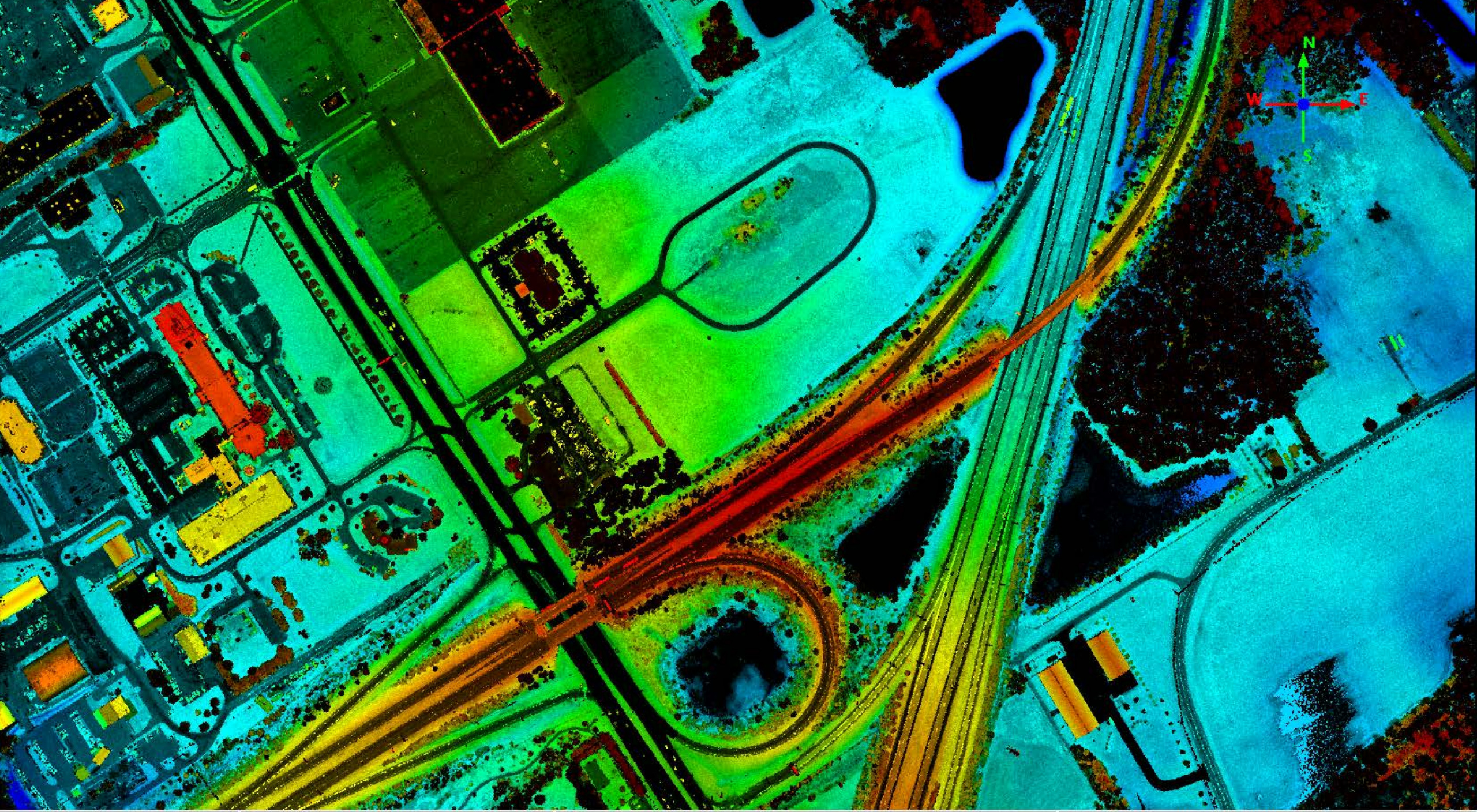


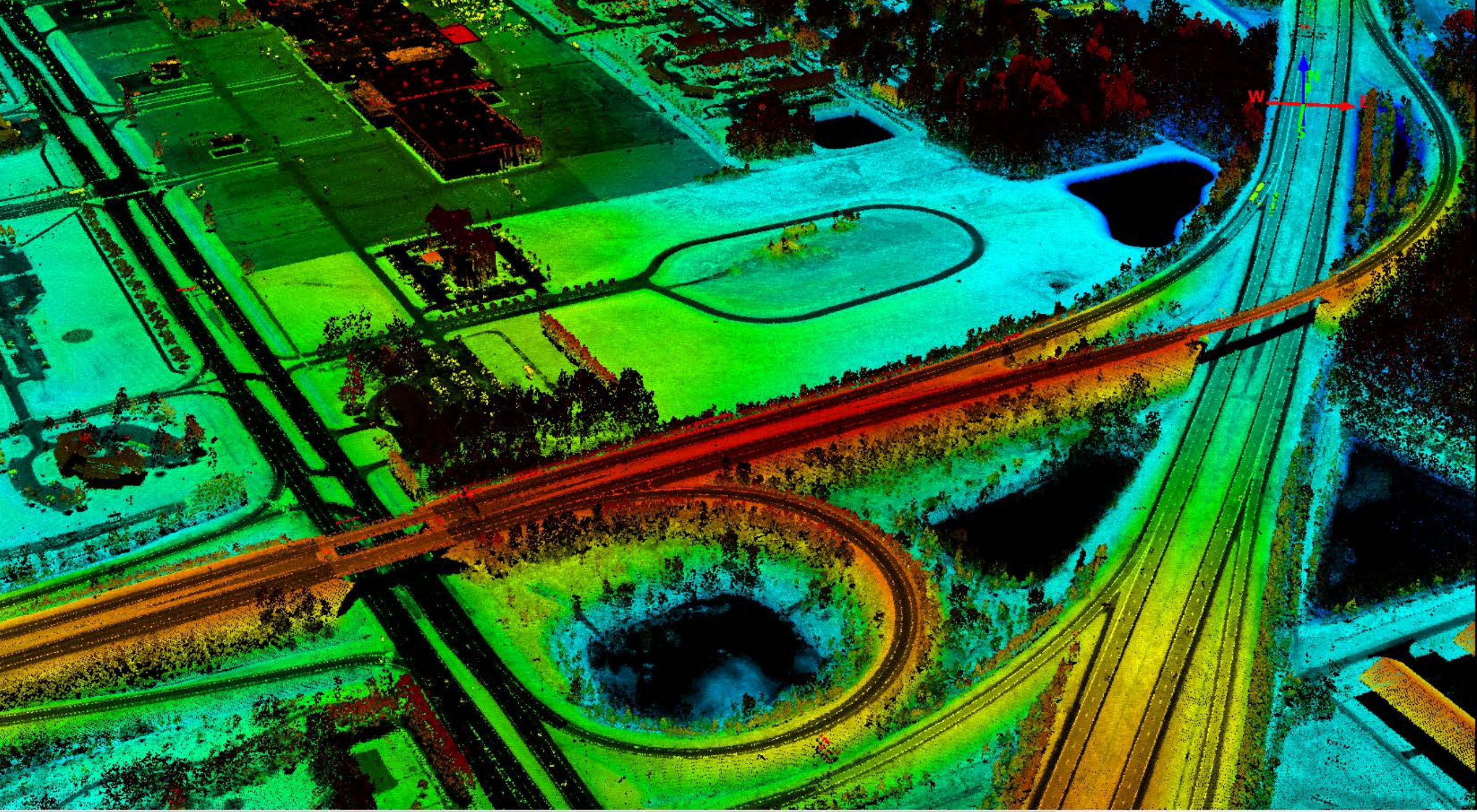
Image from: http://gisgeography.com/lidar-light-detection-and-ranging/

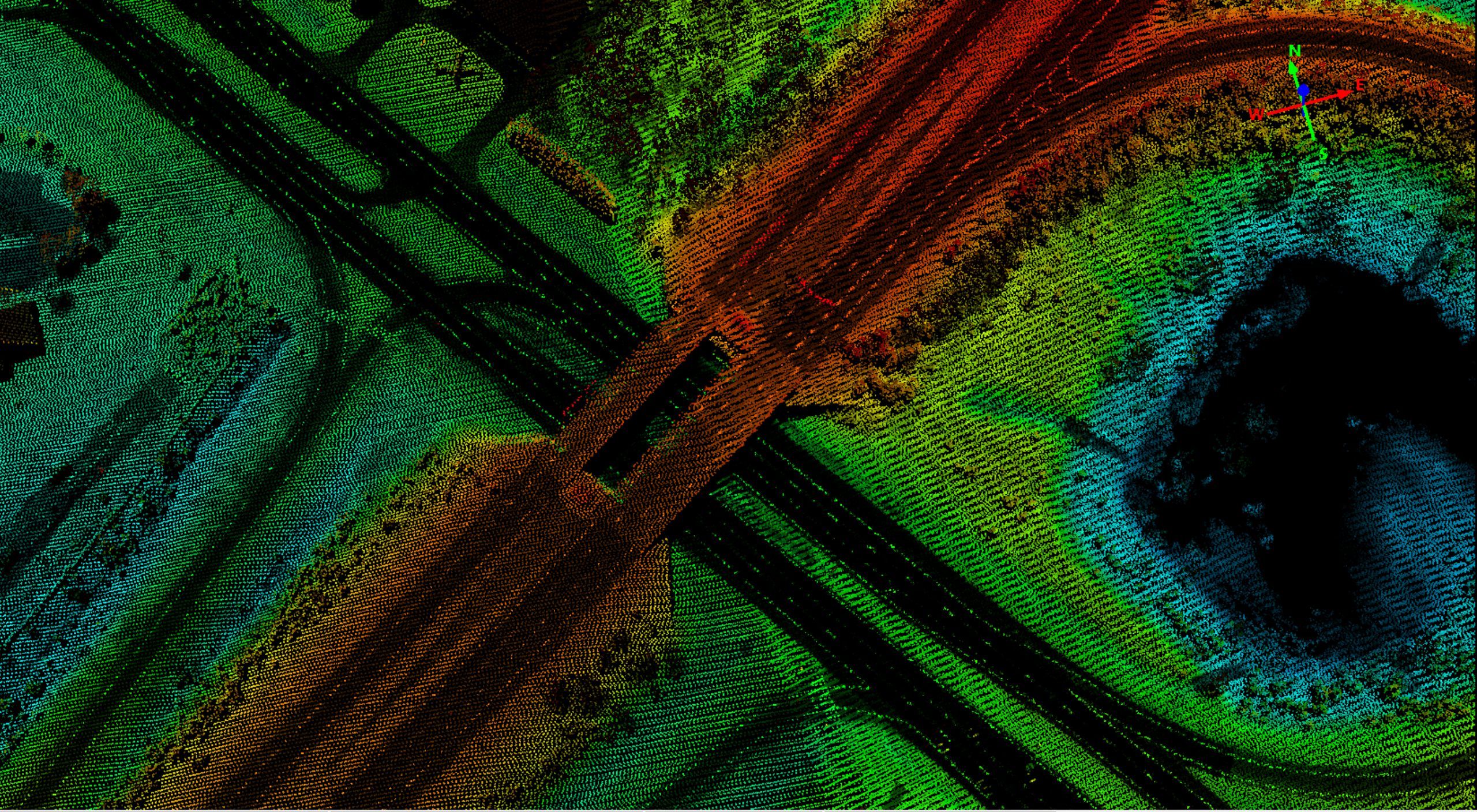
2014 Topographic (NIR) LiDAR

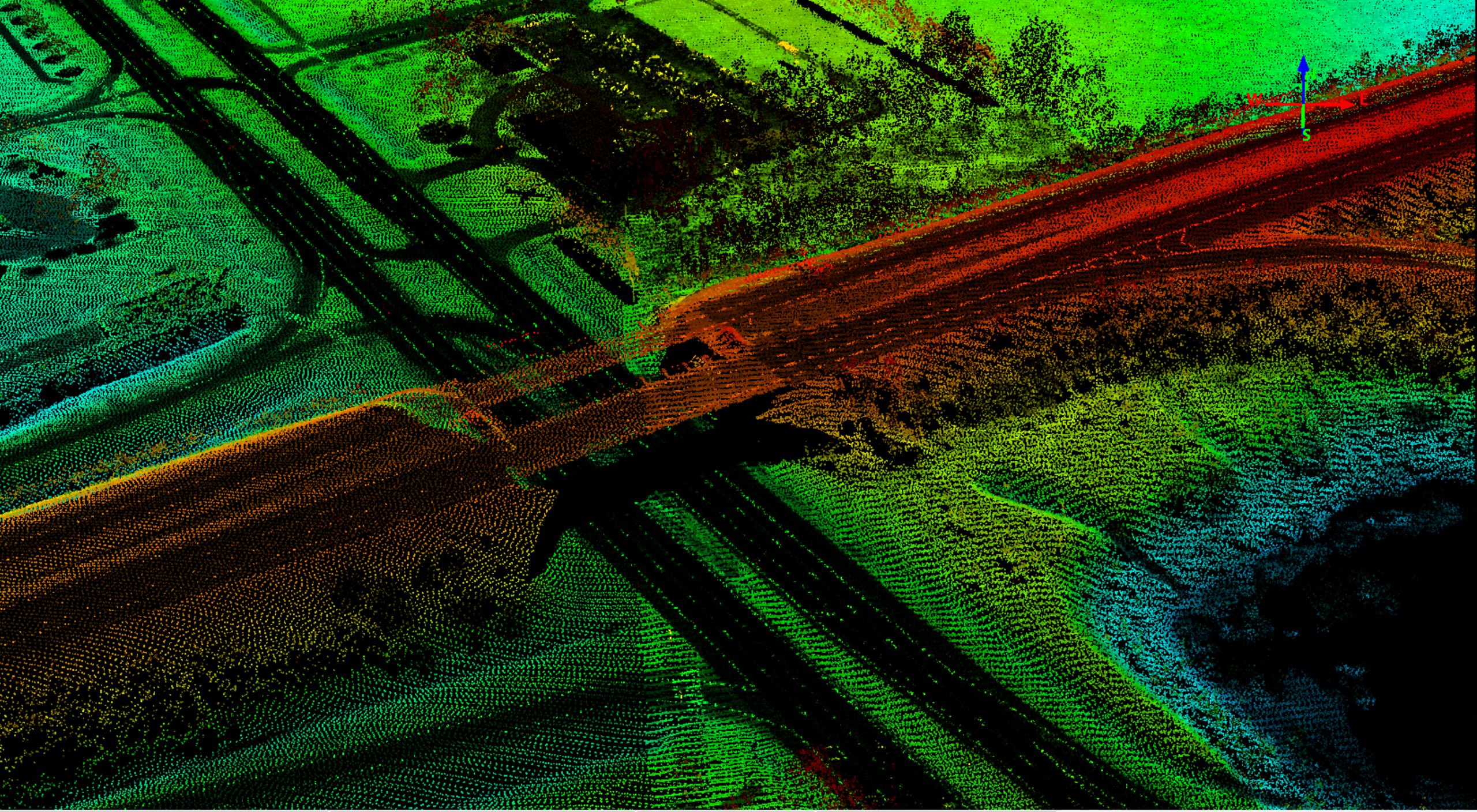
- Entire state of DE and part of MD (3000+ square miles)
- Funded through the Hurricane Sandy Supplemental Fund
  - USGS, DGS, DNREC, and DelDOT
- Quality Level 2 or better (>2 pts/m^2)
- December 2013 – April 2014
- Not tide coordinated
- Reported RMSEz open terrain: 6.3 cm
- Deliverables
  - classified point cloud
  - 1-m hydro-flattened DEM
  - intensity images
  - breaklines used for hydro-flattened

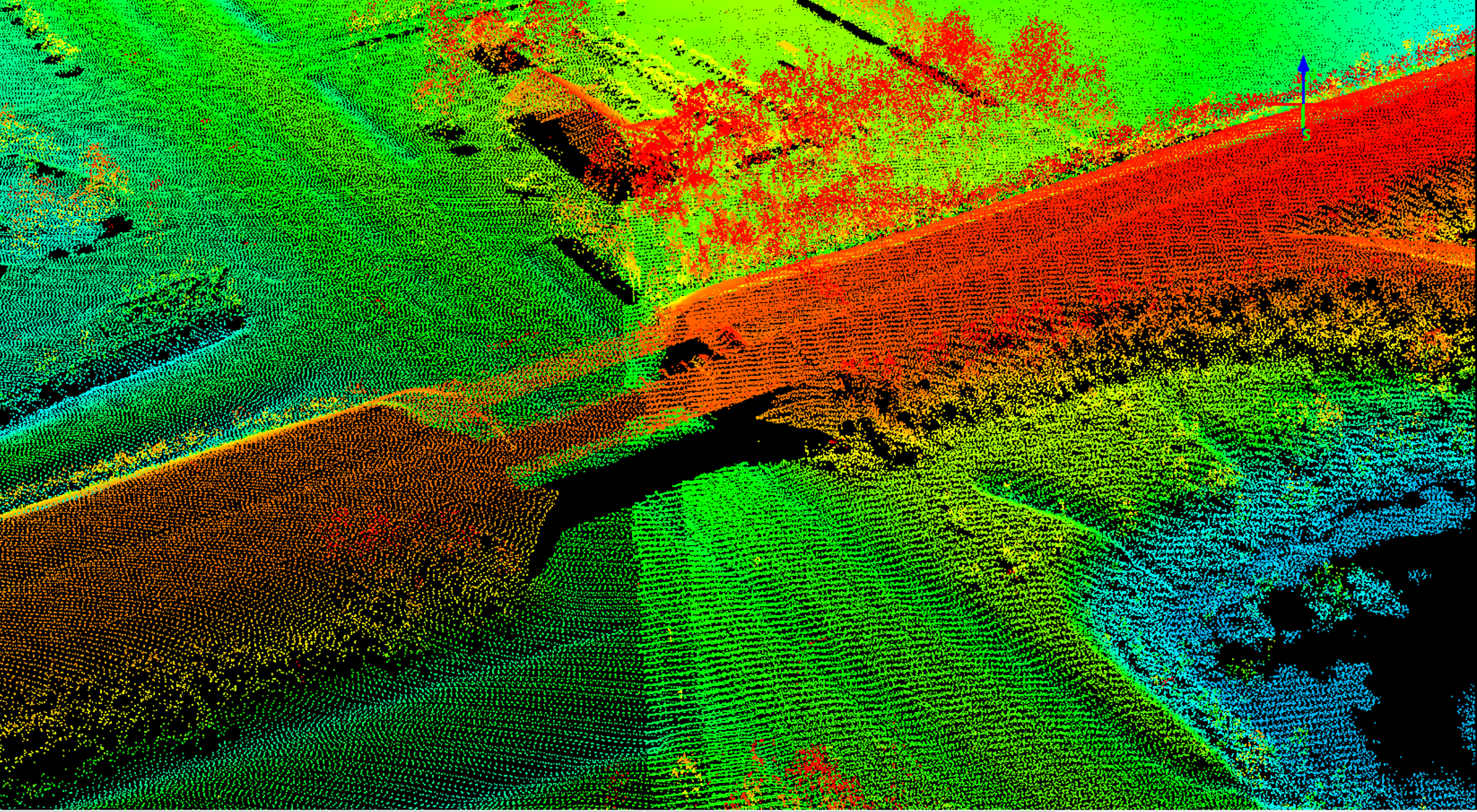
Topographic LiDAR Examples

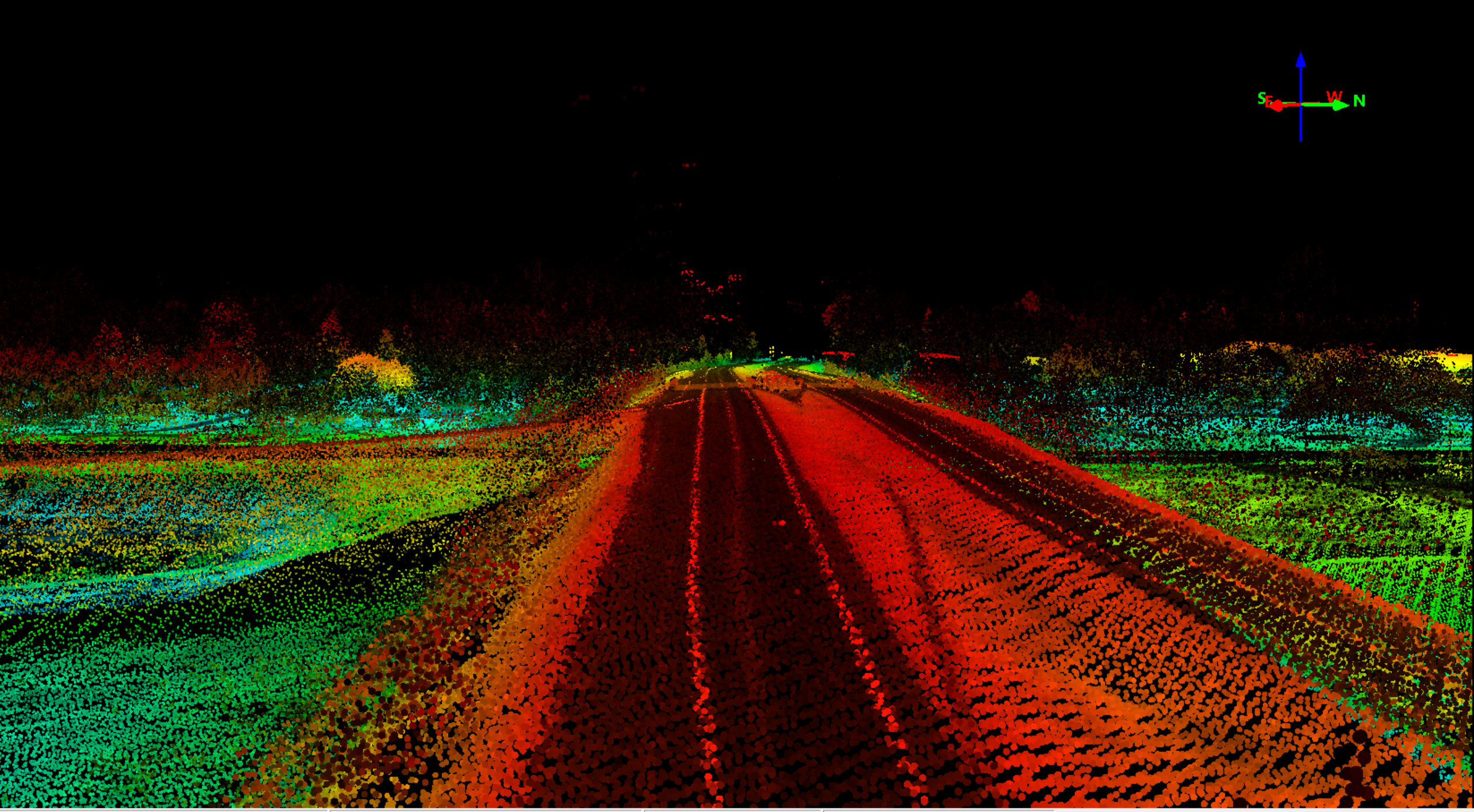

N
W
E
S

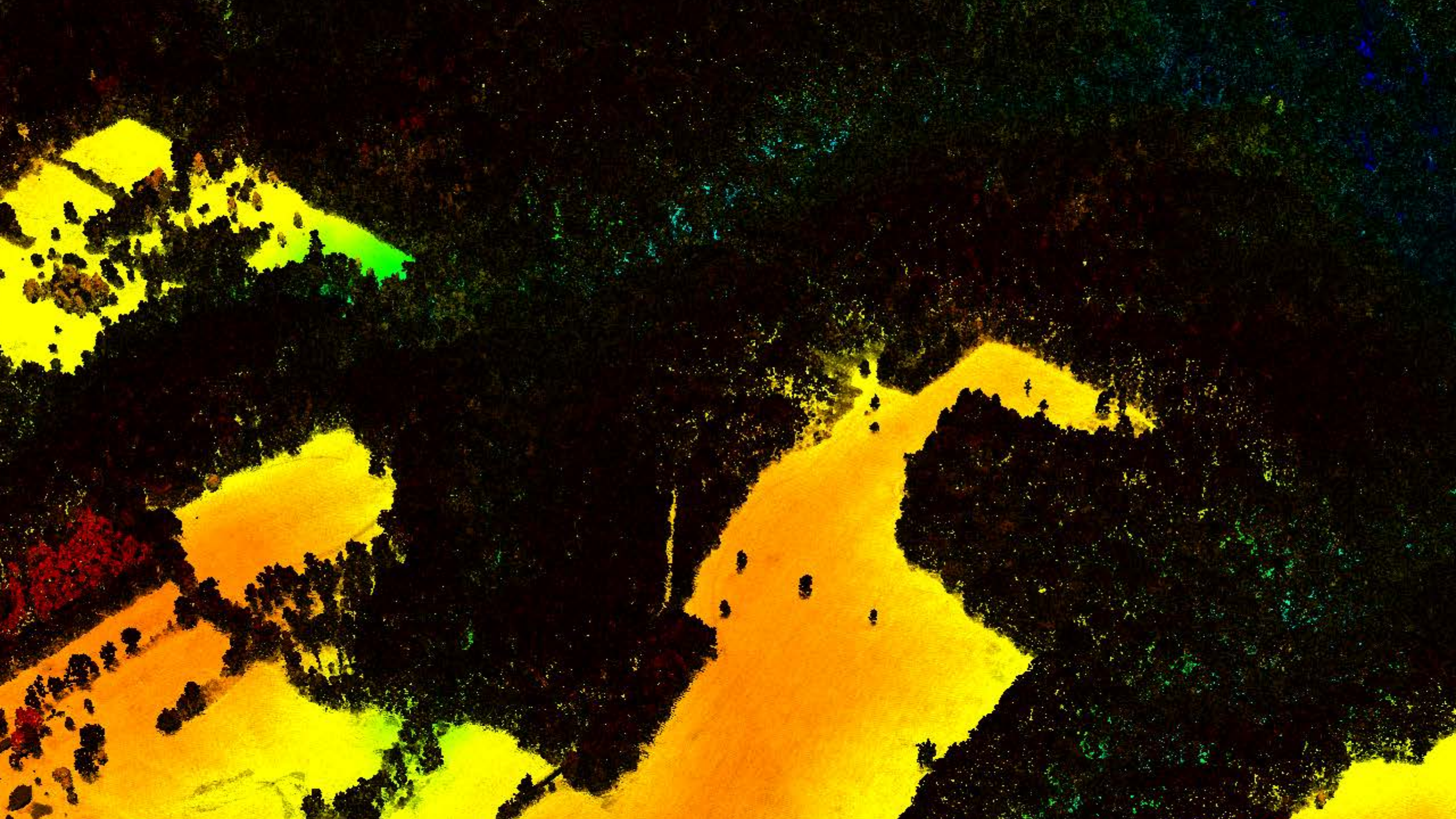

W
E

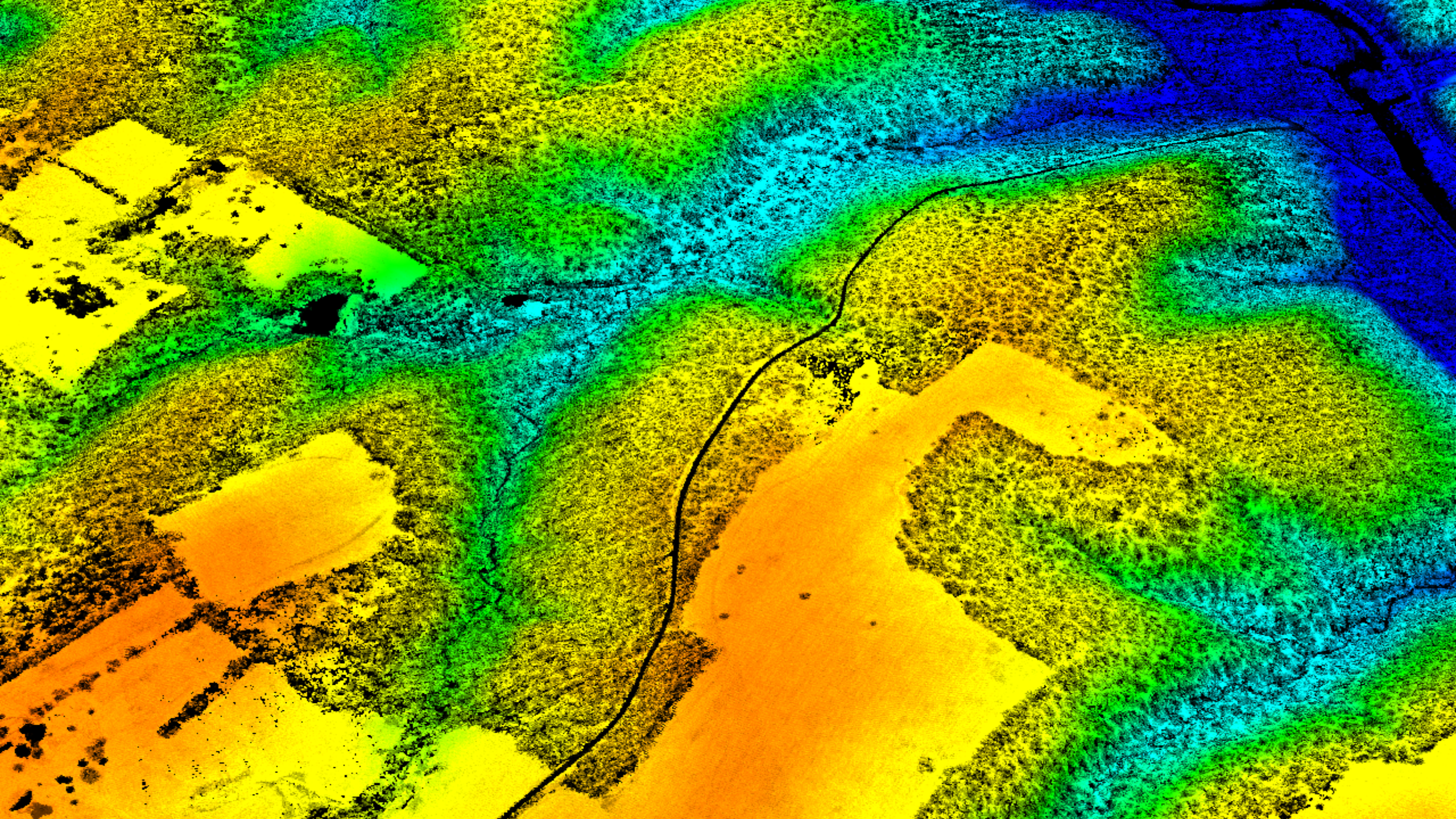

N
E
W
S


W
E
S


S


SE
W
N





Contours

- Production of 1-ft contours for the entire state
- Smoothing necessary to make cartographic contours
  - Focal statistics – uses a local neighborhood to compute the mean
    - 7x7 local neighborhood for cartographic contours
- Depression identification for cartographic purposes
- Indexing of contours (2-ft, 5-ft, 10-ft)
- Creation of manageable sized datasets for distribution

7x7 Focal Statistics smoothing used to produce cartographic contours

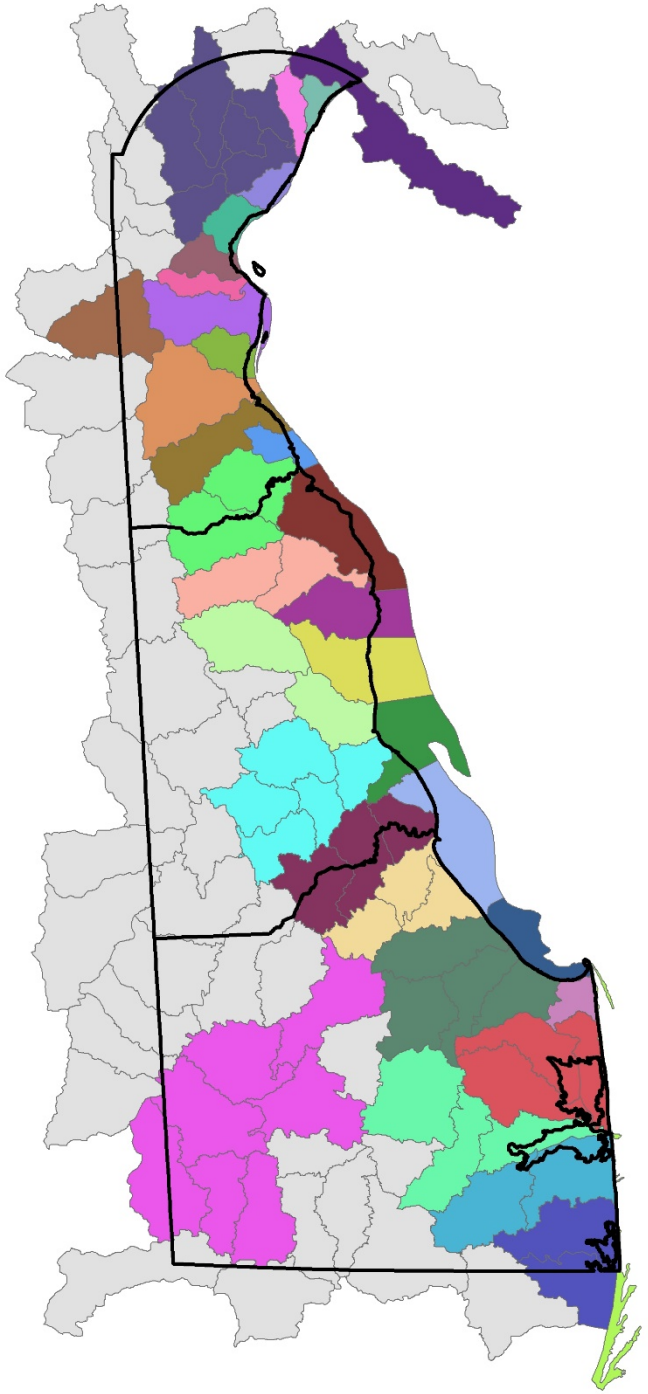
Coastal Inundation

- 2016 Delaware Sea Level Rise (SLR) Technical Committee
- Delaware Geological Survey
  - Coordinating for DNREC
- Review SLR research
  - update planning scenarios

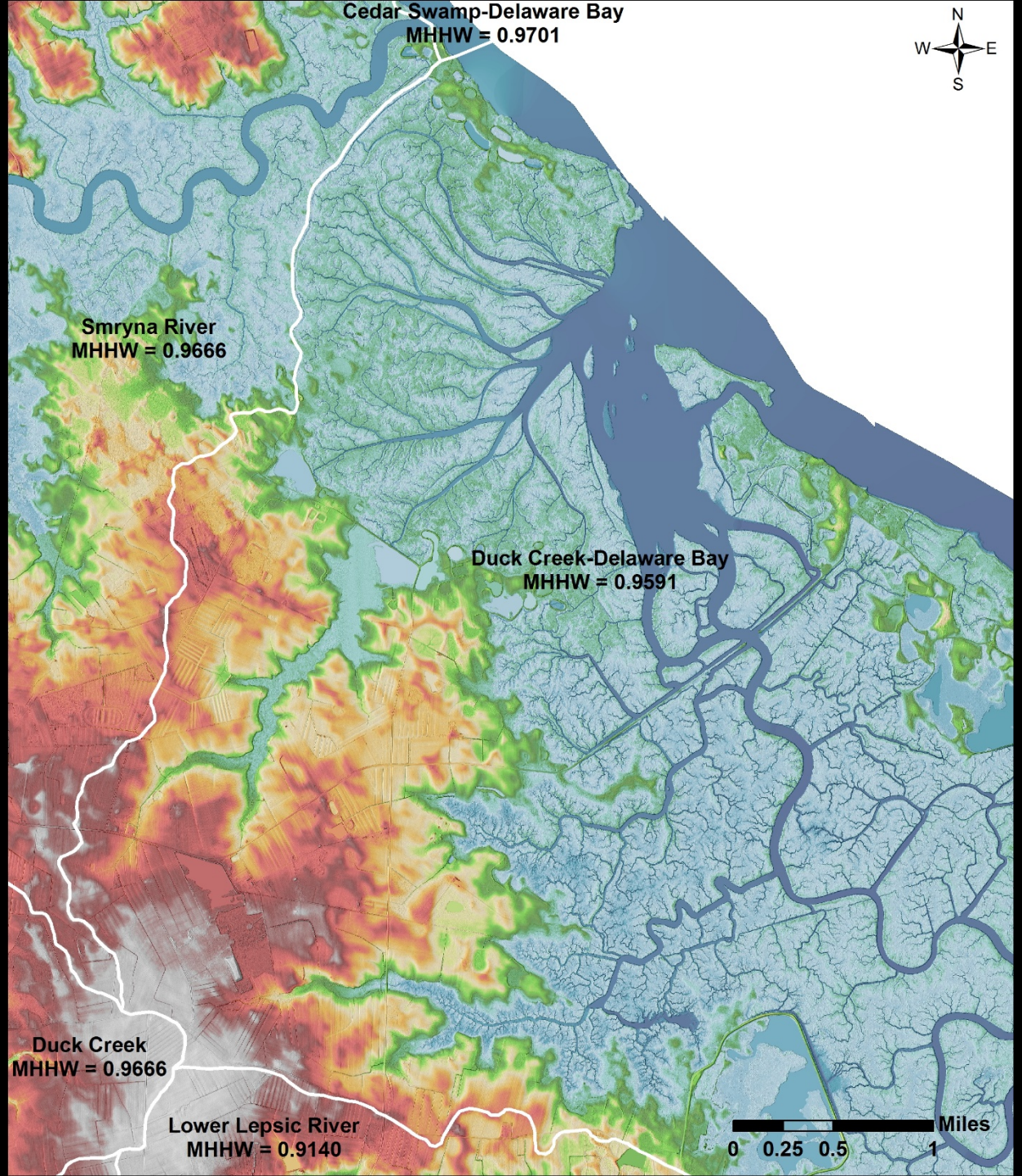
- Coastal inundation planning scenarios evaluated along side the SLR Review
  - Not tied to SLR scenarios but can be used to visualize potential SLR
  - Mean Higher-High Water (MHHW) to 7 ft above MHHW, in 1 foot increments
  - Advise long-range planning of infrastructure, facilities, land management, land-use, and capital spending

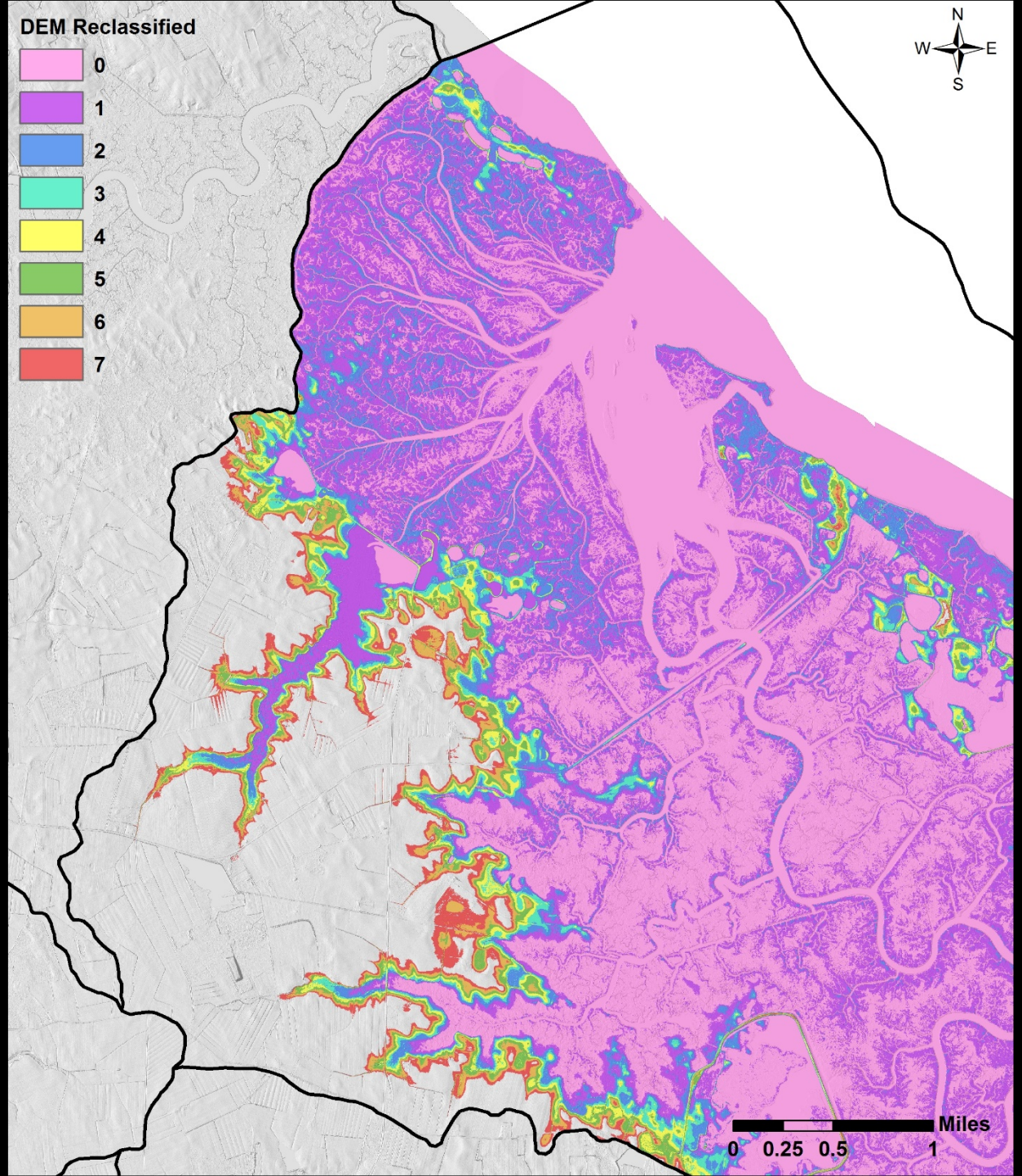
DELAWARE COASTAL PROGRAMS
DCMP

- Identify watersheds potential affected by coastal inundation (65 watersheds)
- Used NOAA's VDatum tool to determine MHHW at the mouth of each coastal watershed
- Grouped by MHHW – resulting in 35 watersheds for analysis

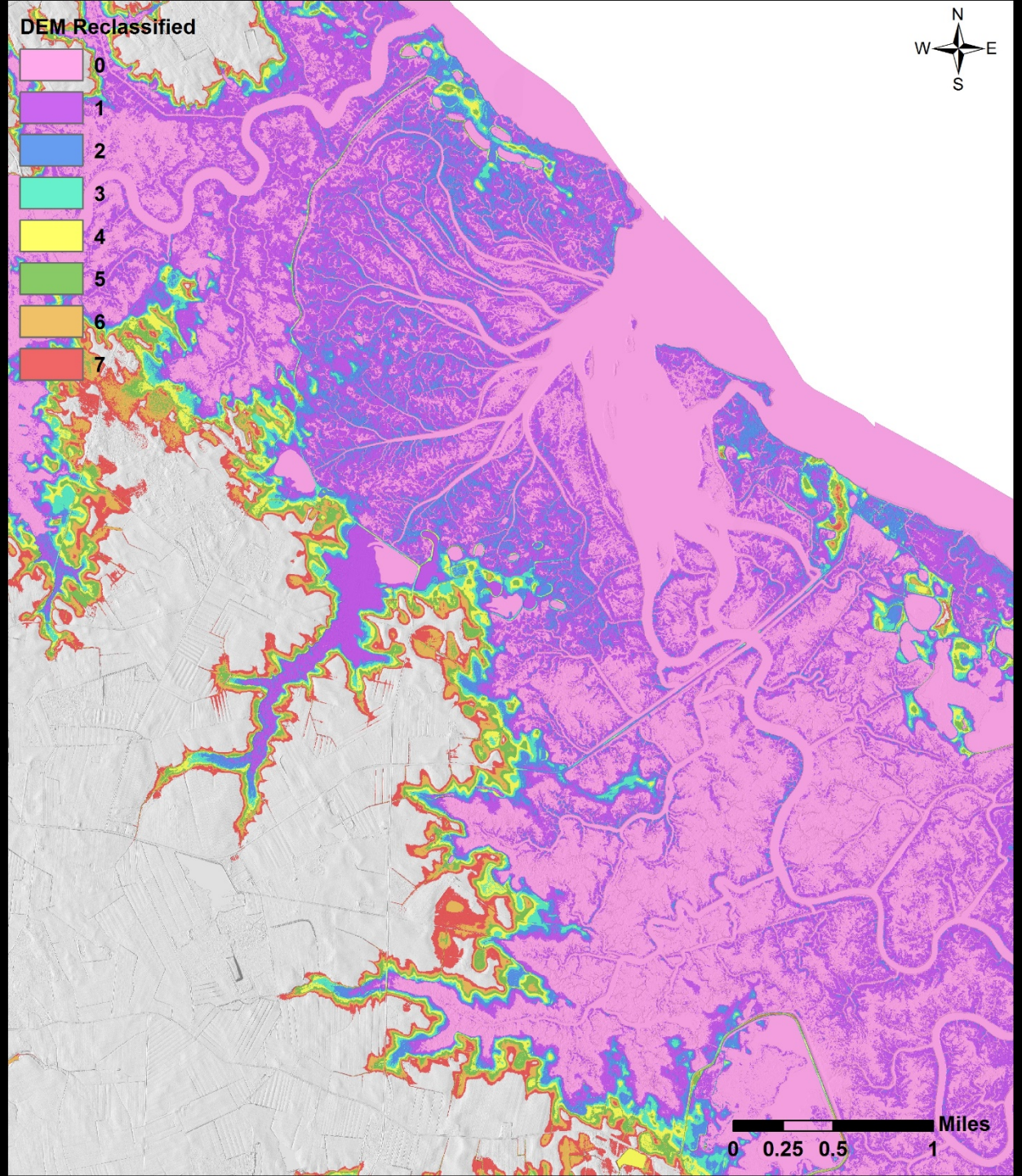


Start with hydro-flattened DEM with a few manual corrections




DEM Reclassified
0
1
2
3
4
5
6
7
N
W
E
S
Miles
0
0.25
0.5
1

Merged DEM

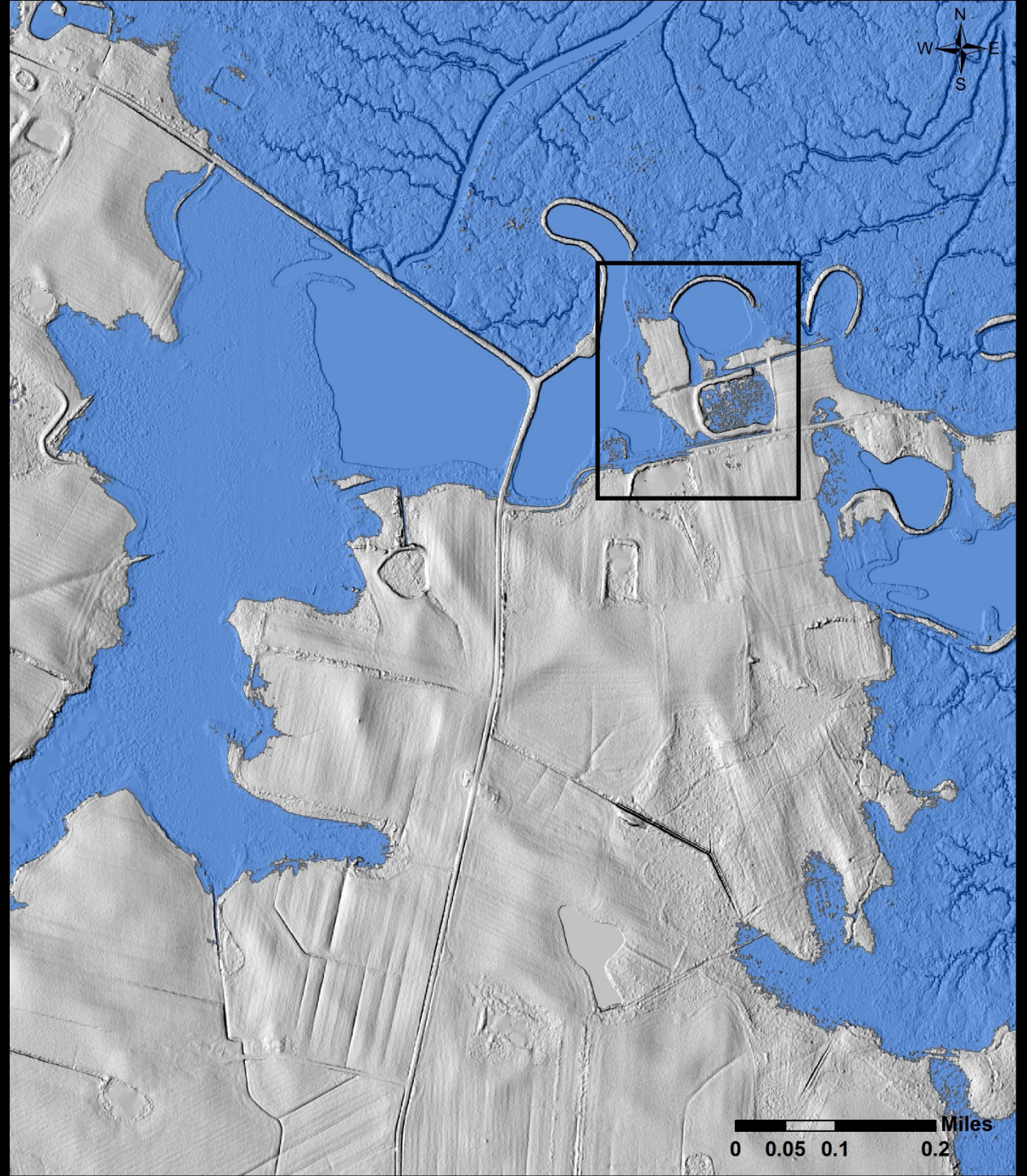


Inundation Scenario:

2ft

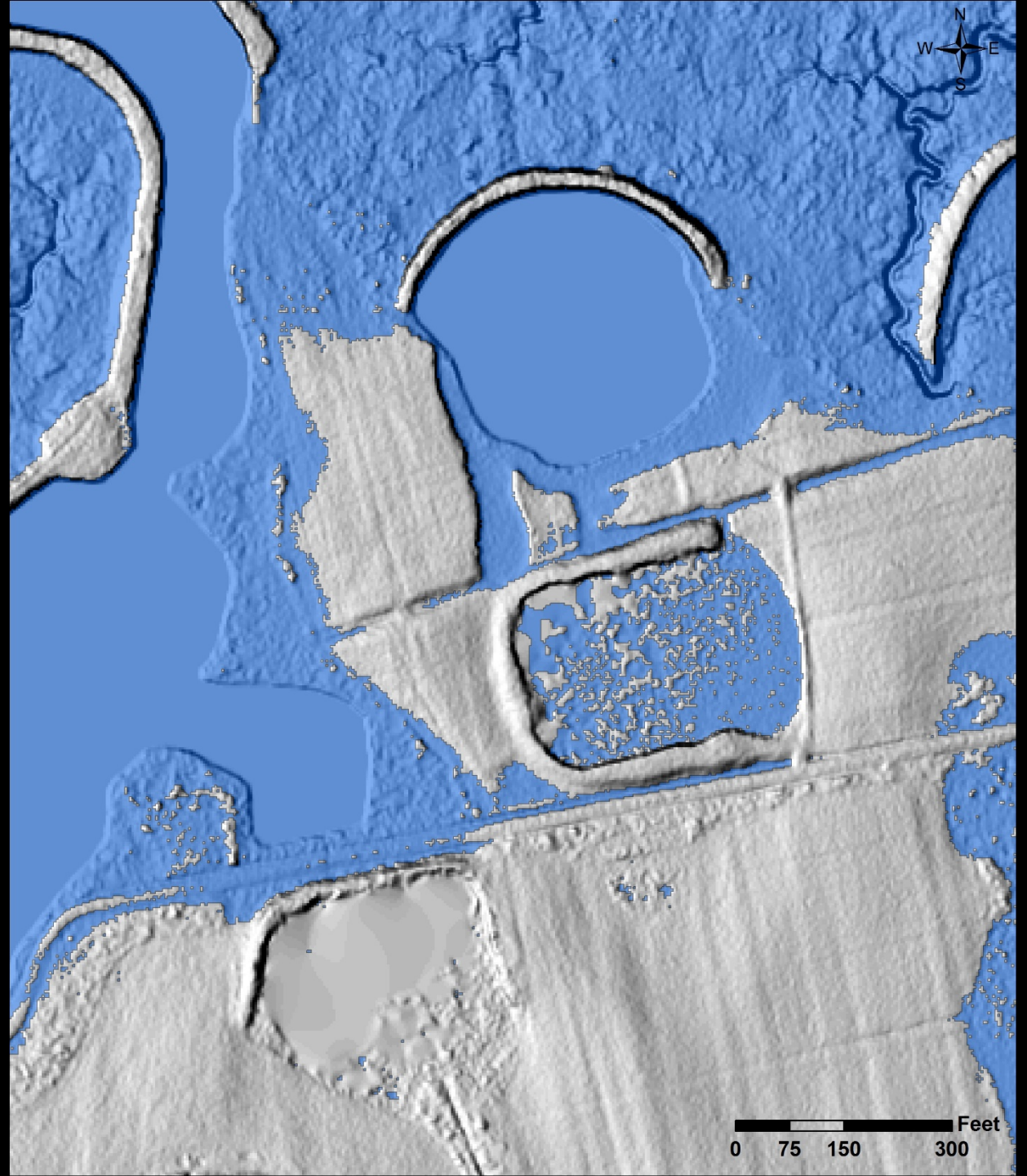
Inundation Scenario:

2ft



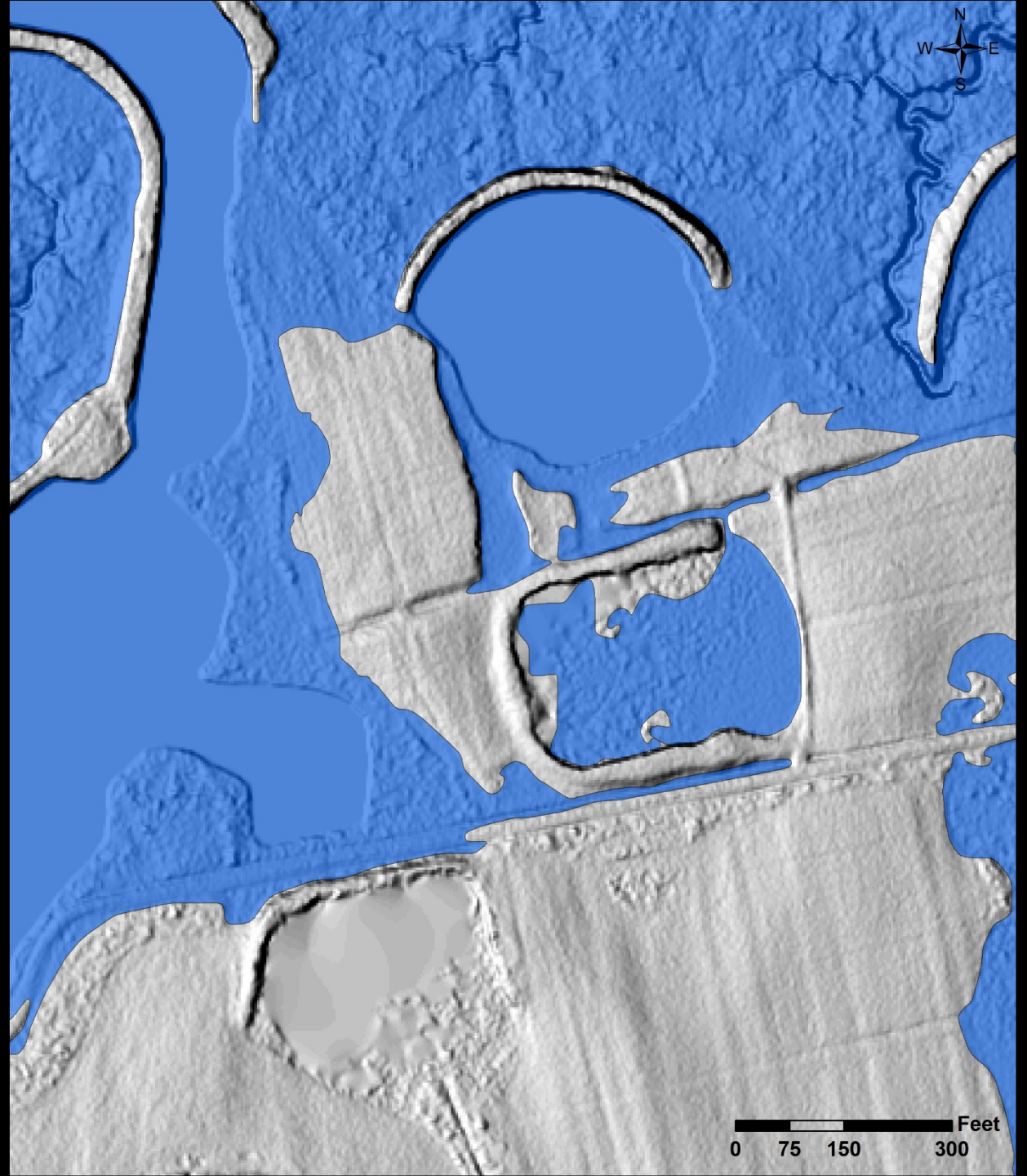
Inundation Scenario:

2ft



Inundation Scenario:

2ft

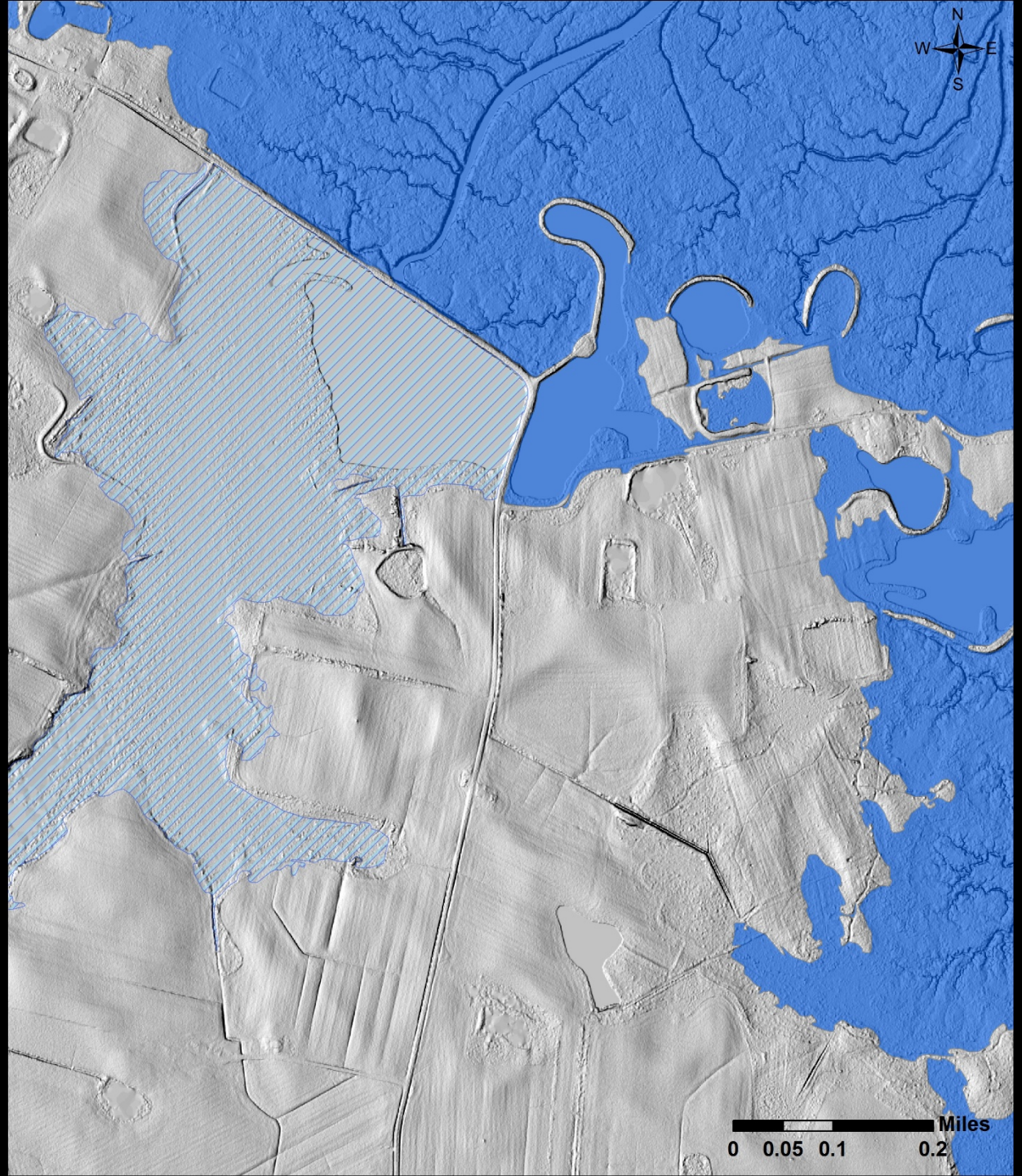


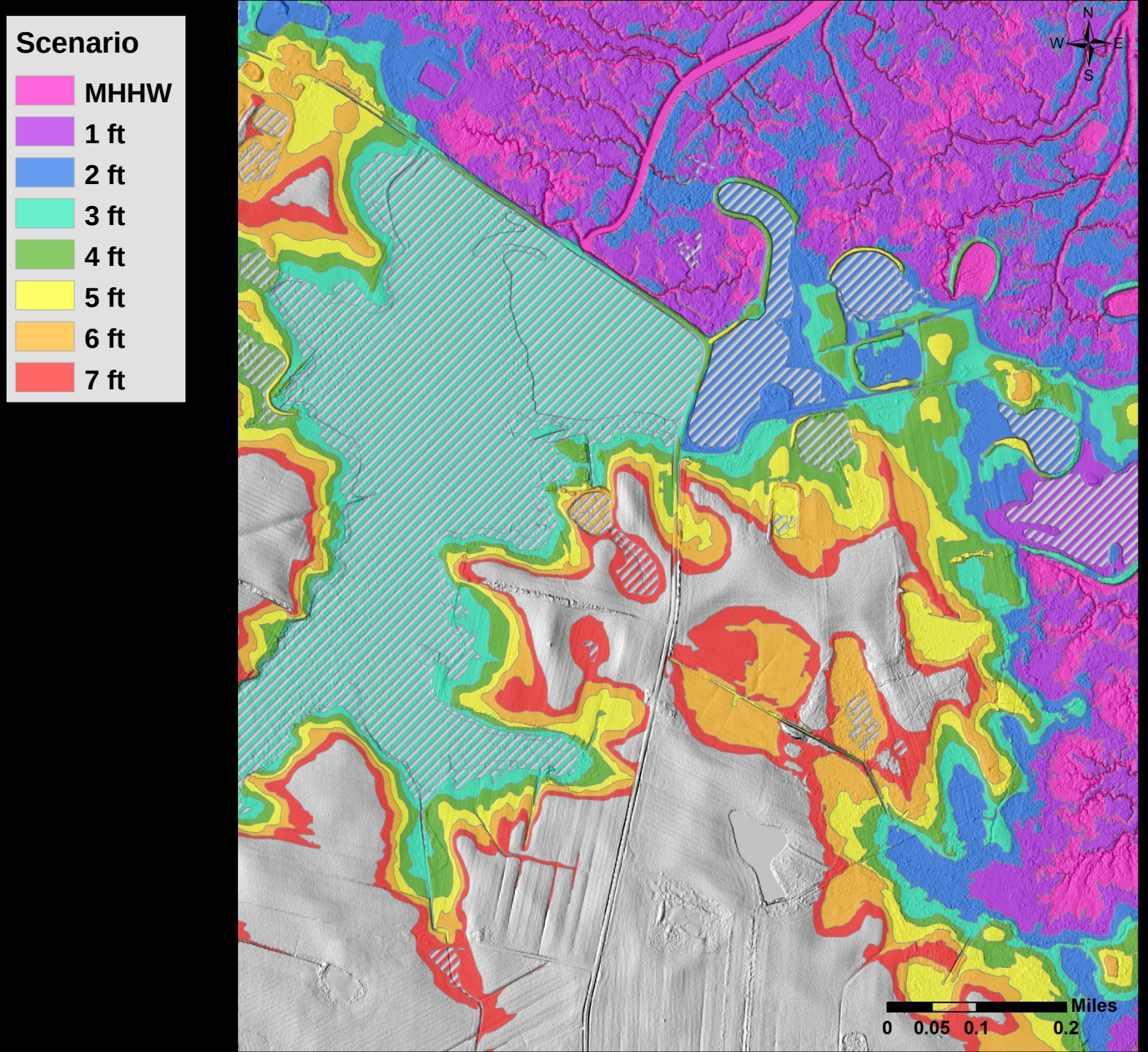
Inundation Scenario:

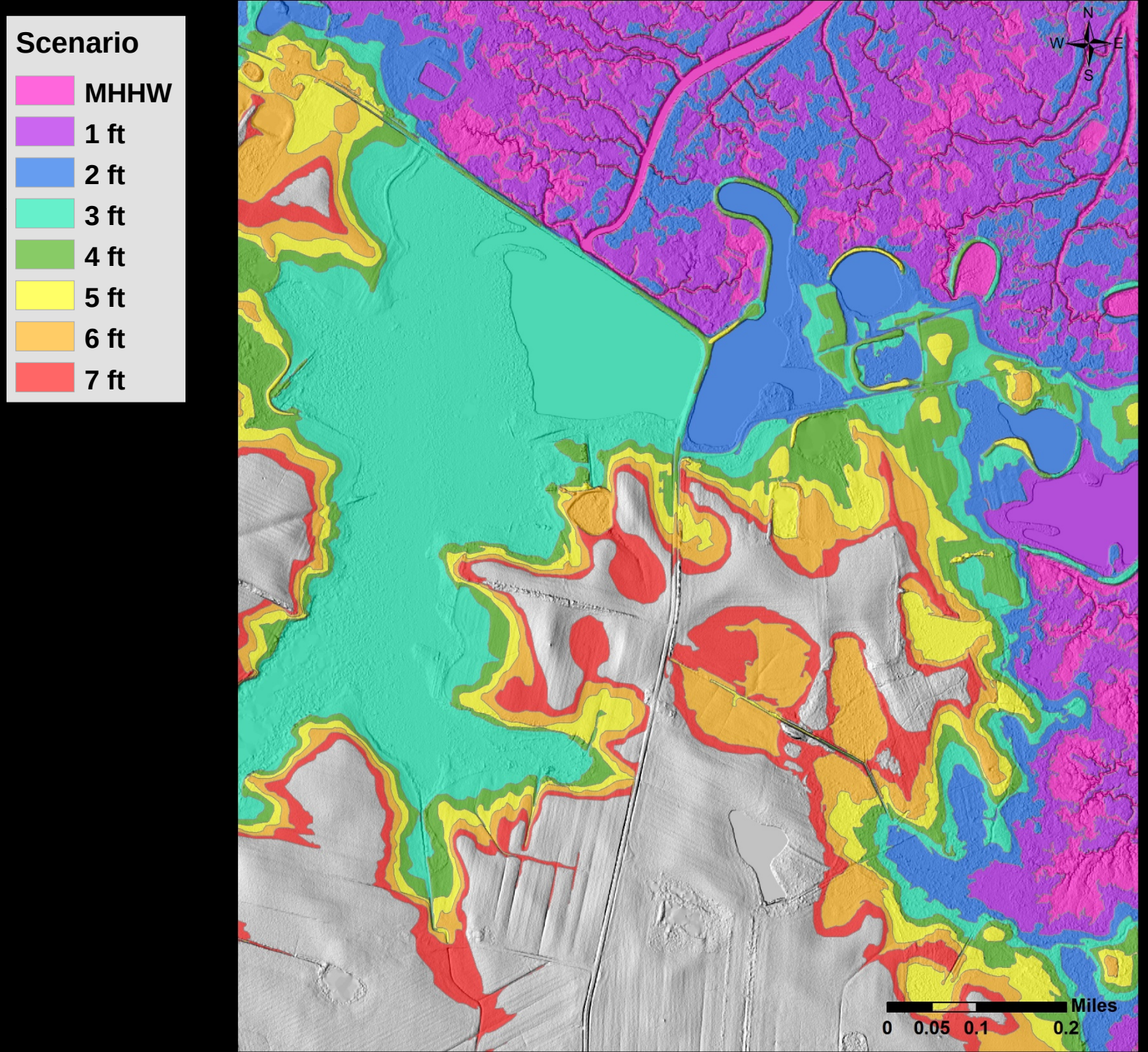
2ft

Inundation Scenario:

2ft

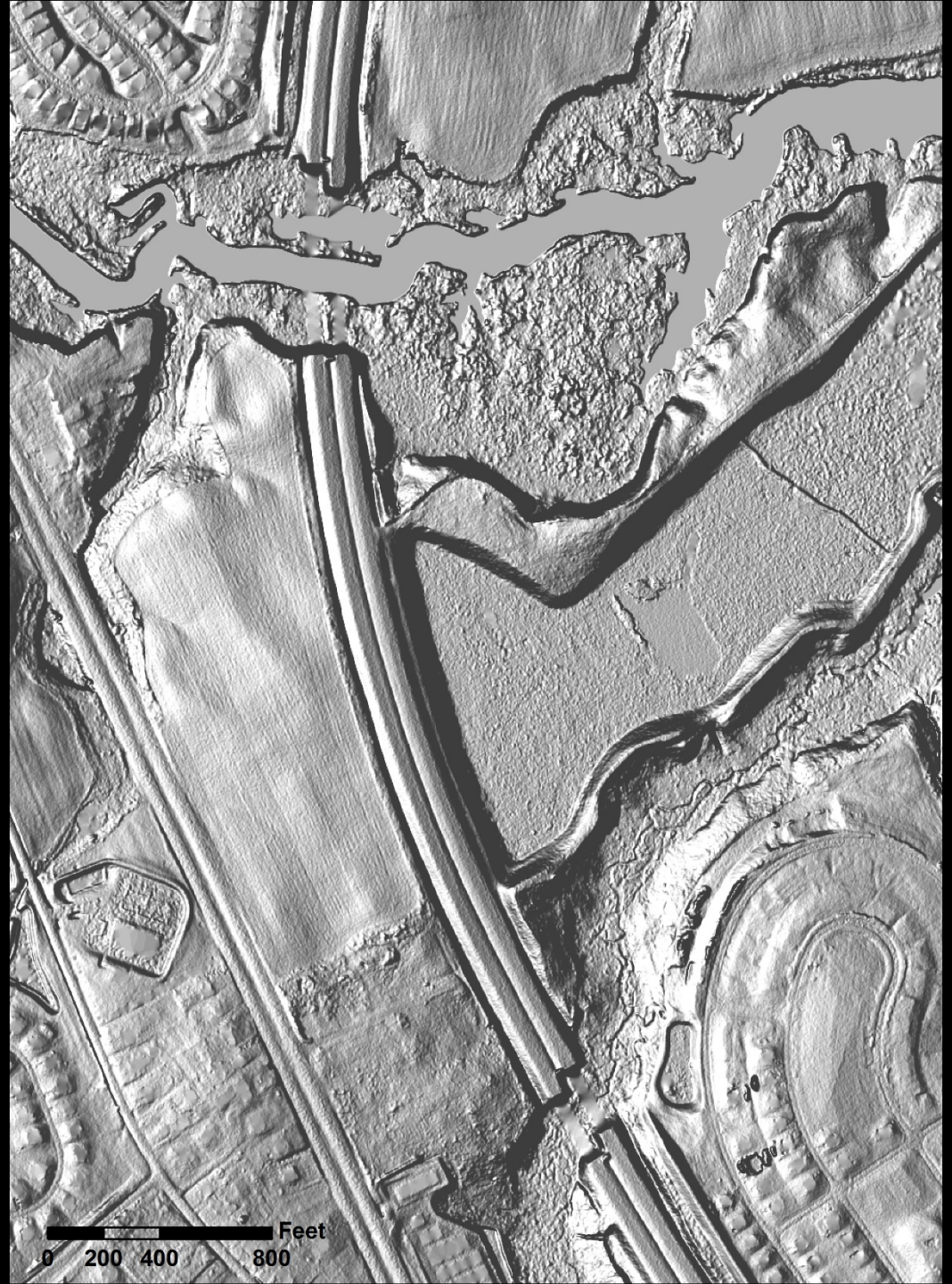


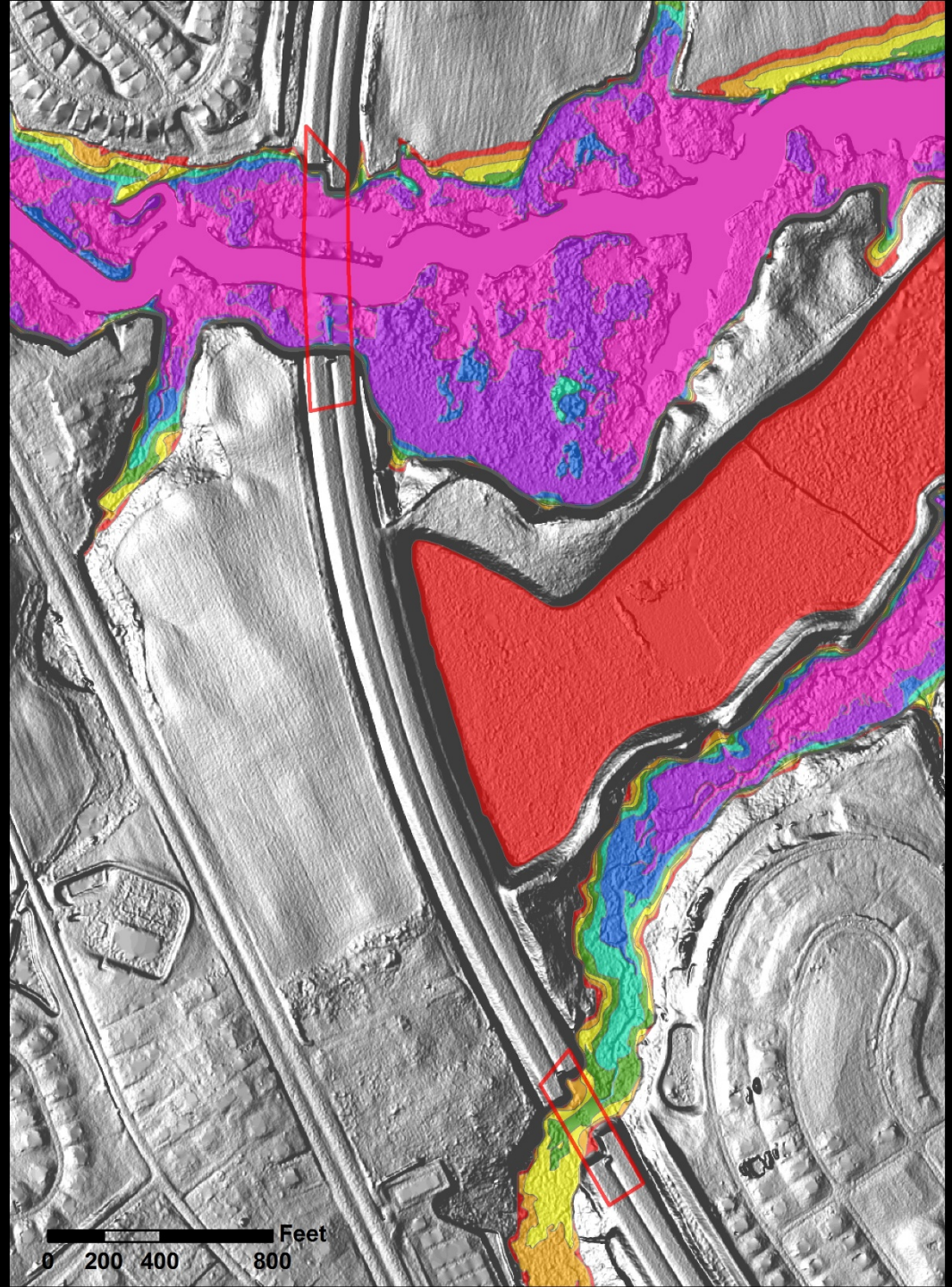

Scenario
MHHW
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft
7 ft
N
W
E
S
Miles
0
0.05
0.1
0.2

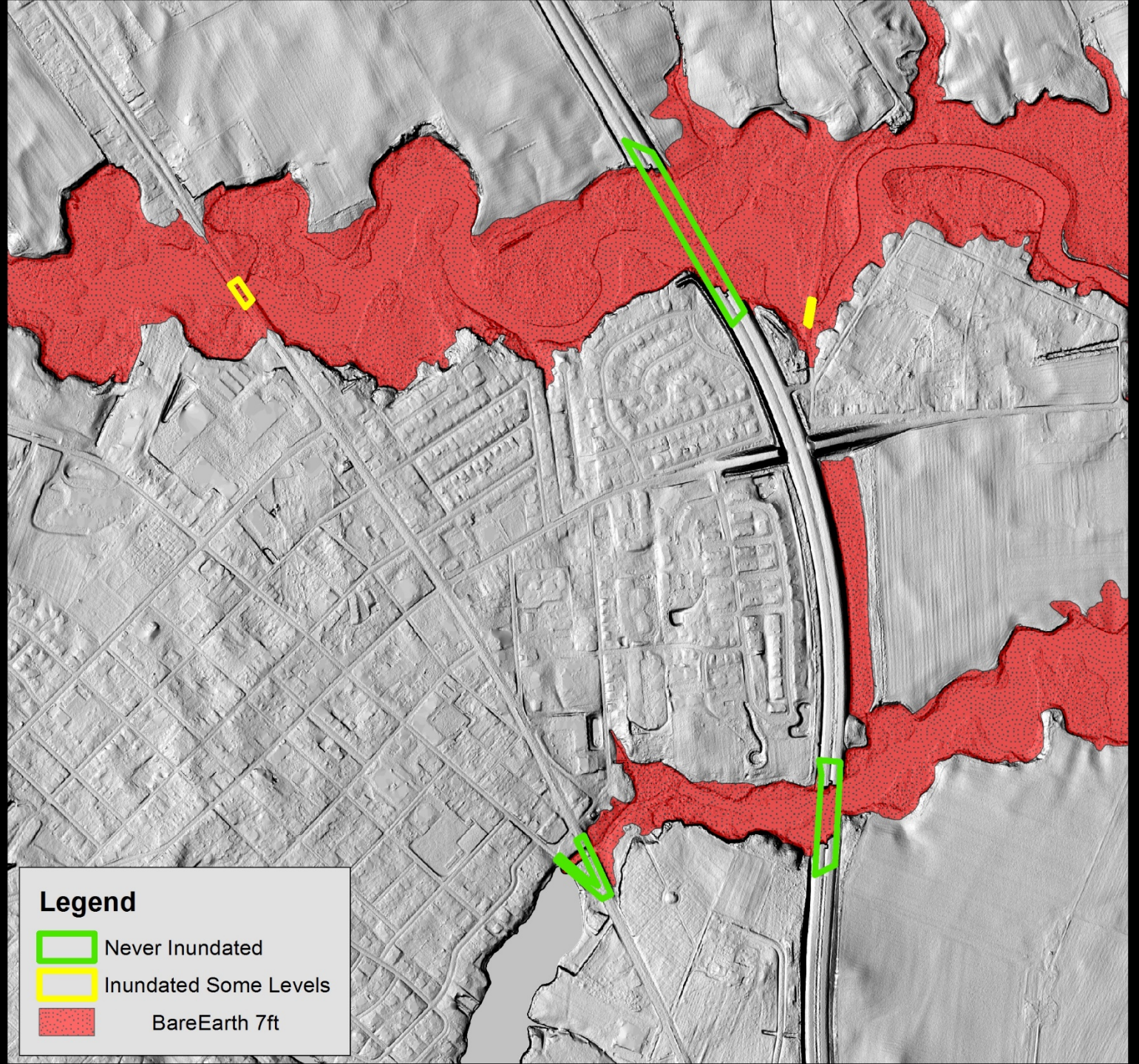

Scenario
MHHW
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft
7 ft
N
W
E
S
Miles
0
0.05
0.1
0.2

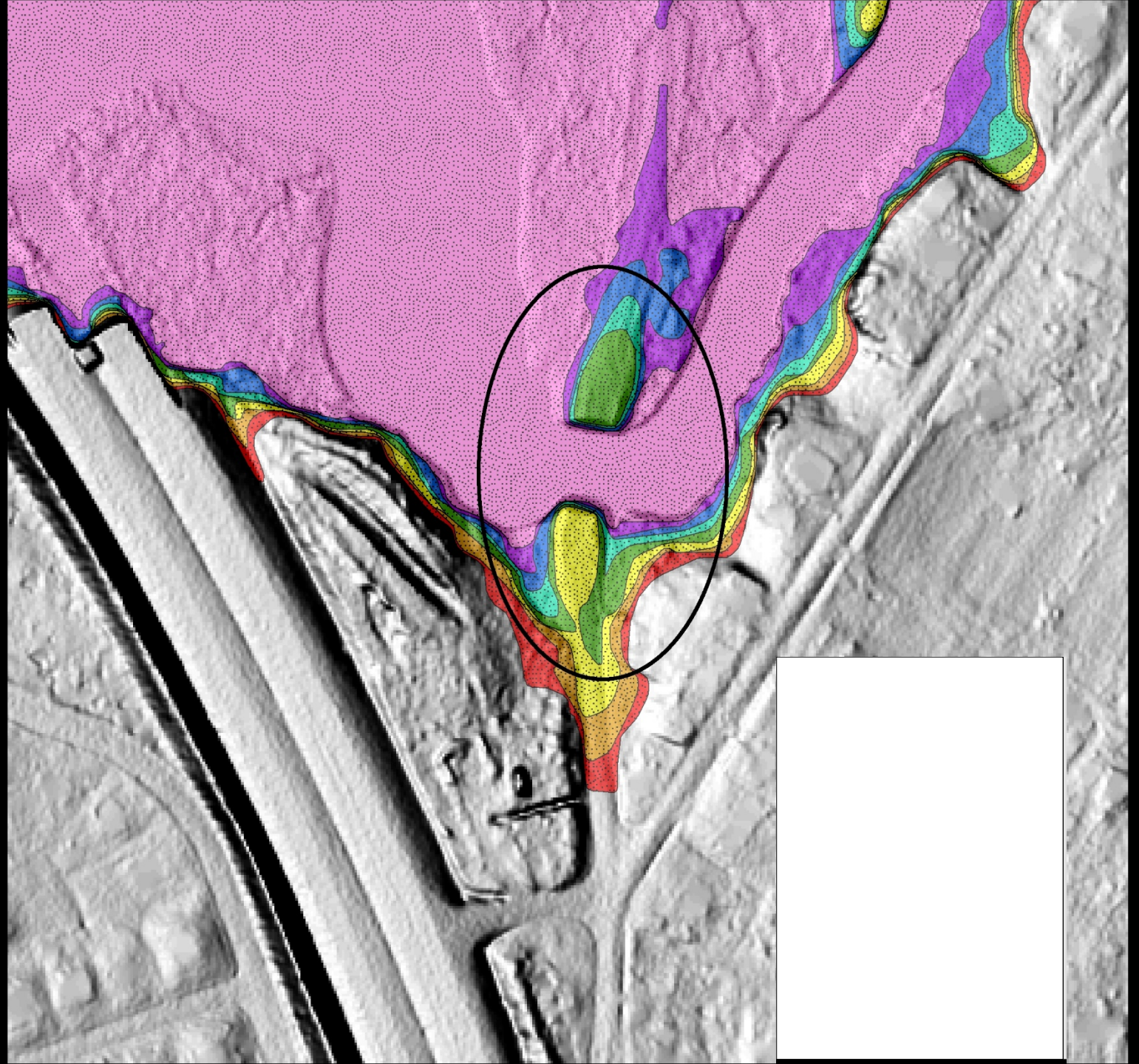
Elevated Roadways

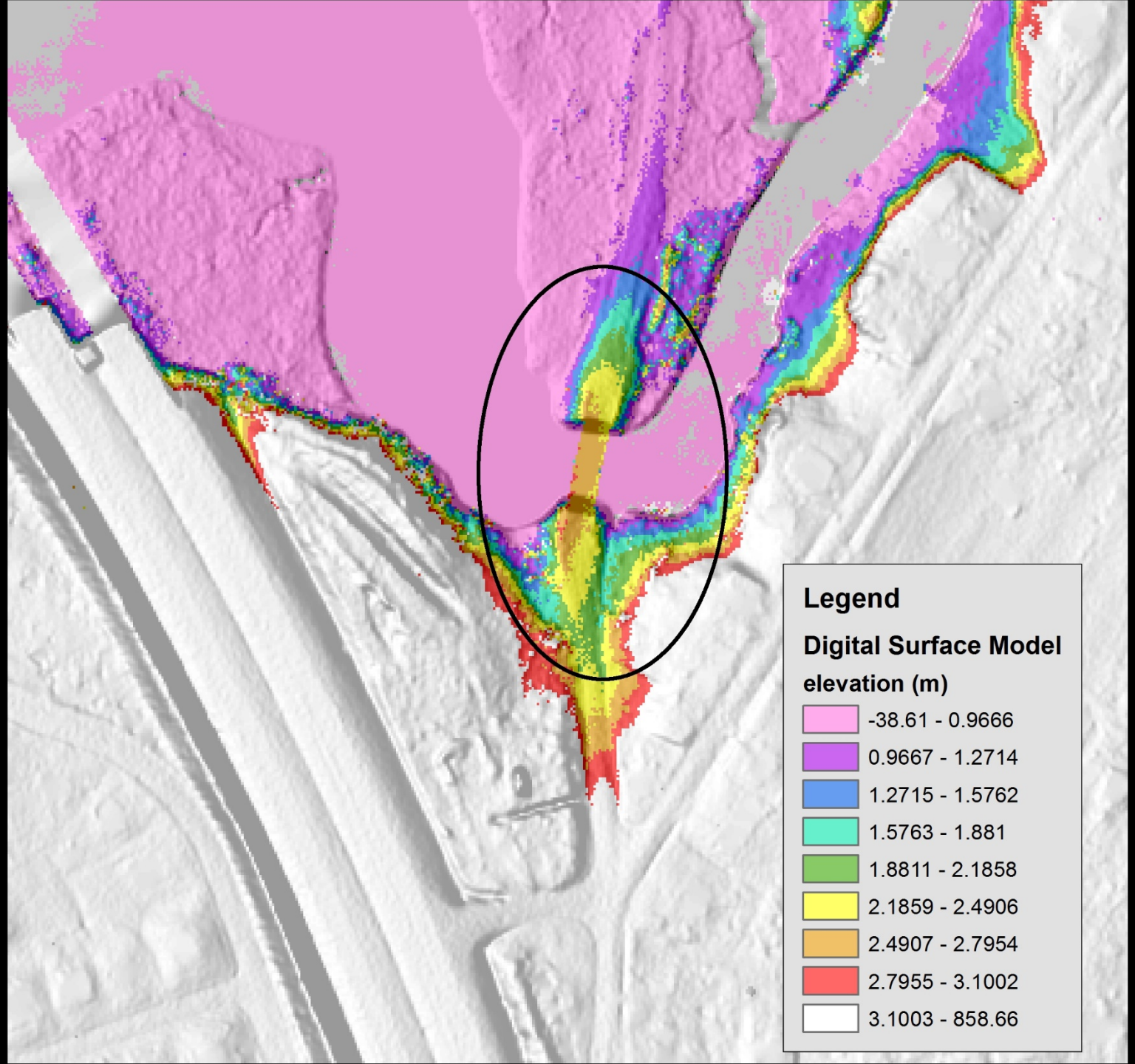
- Elevated Roadways often removed from Bare Earth DEM
- Important to know how these roadways affected by coastal inundation
- Manually adjust inundation maps

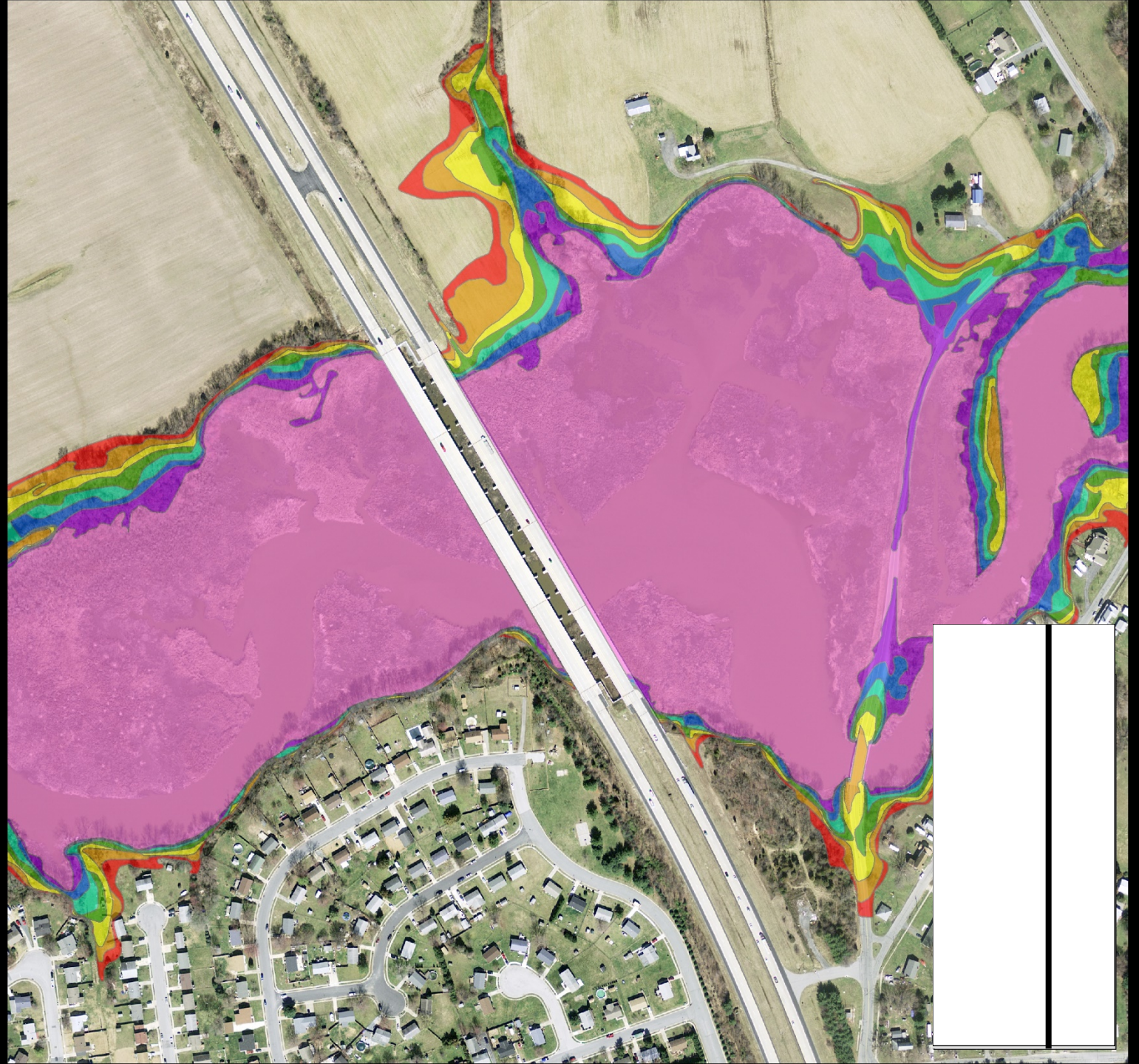



Scenario
MHHW
1 ft
2 ft
3 ft
4 ft
5 ft
6 ft
7 ft
Feet
0 200 400 800

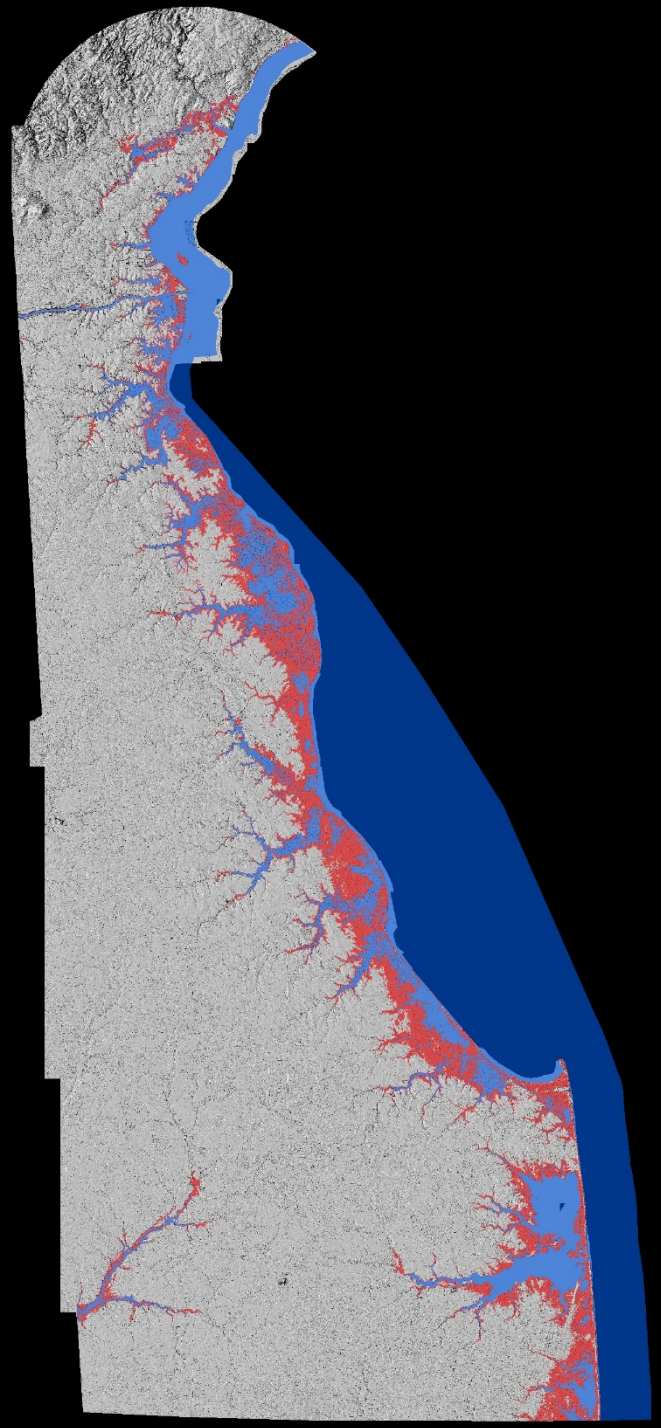

Legend
Never Inundated
Inundated Some Levels
BareEarth 7ft




Legend
Digital Surface Model
elevation (m)
-38.61 - 0.9666
0.9667 - 1.2714
1.2715 - 1.5762
1.5763 - 1.881
1.8811 - 2.1858
2.1859 - 2.4906
2.4907 - 2.7954
2.7955 - 3.1002
3.1003 - 858.66



MHHW and 7-ft Inundation Scenarios



Coastal Inundation Final Products

- Geodatabase layers include surfaces from Mean Higher-High Water (MHHW) to 7 feet above MHHW, in 1-foot increments
- Bare earth bathtub-model coastal inundation mapping
- Coastal inundation mapping with elevated roadways and bridges accounted for

Please Note!

- Users should be aware that the LiDAR data upon which these maps are based represents the land surface as it was when data was collected in Winter 2013-2014 may not be representative of current conditions
- Areas where considerable change to the land surface is known to have occurred included the following: Prime Hook, Dikes near New Castle
- Users should also be familiar with LiDAR data collection accuracy, errors, and systematic biases
- It should also be noted that these maps are based on a bathtub model which assumes a constant water surface throughout each watershed

Coastal Inundation Products

- Available on FirstMap: https://firstmap.delaware.gov/arcgis/rest/services/Environmental/

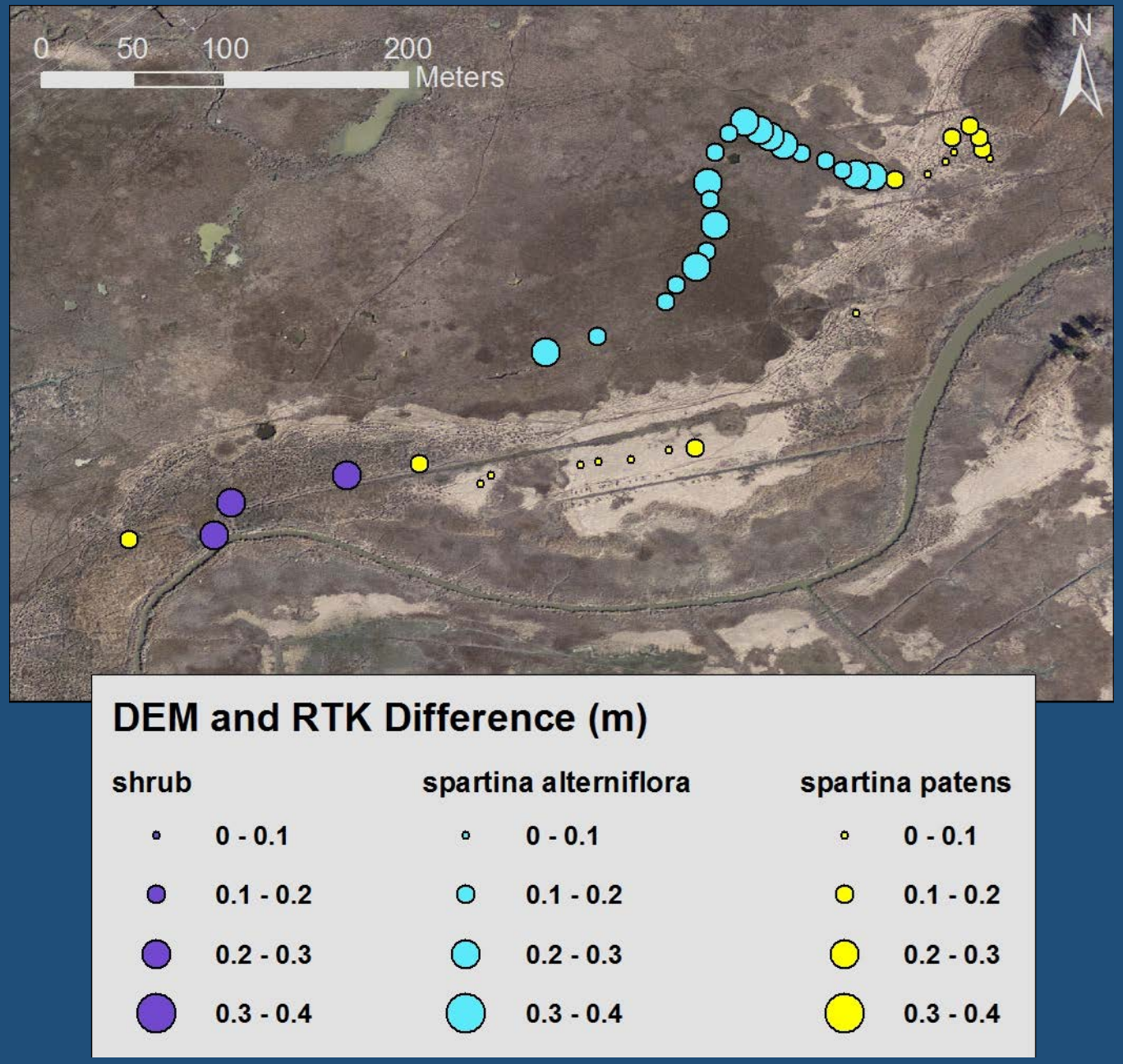
Comparison With Other Flooding Maps

- FIRM – FEMA
  - Hydrodynamic model
  - Regulatory products
- FRAM – 100 year FIRM + 3ft sea-level rise
  - Hydrodynamic model + bathtub model
  - Screening level took for state agency planning
- 2016 Coastal Inundation
  - Bathtub Model

- Projections not Predictions
- Advise long-range planning of infrastructure, facilities, land management, land-use, and capital spending

Marsh LiDAR Corrections

- Large LiDAR biases in areas of dense vegetation
- St. Jones and Blackbird Creek
- RTK measurements of marsh platform to determine bias in LiDAR data
- Creating bias-corrected DEM



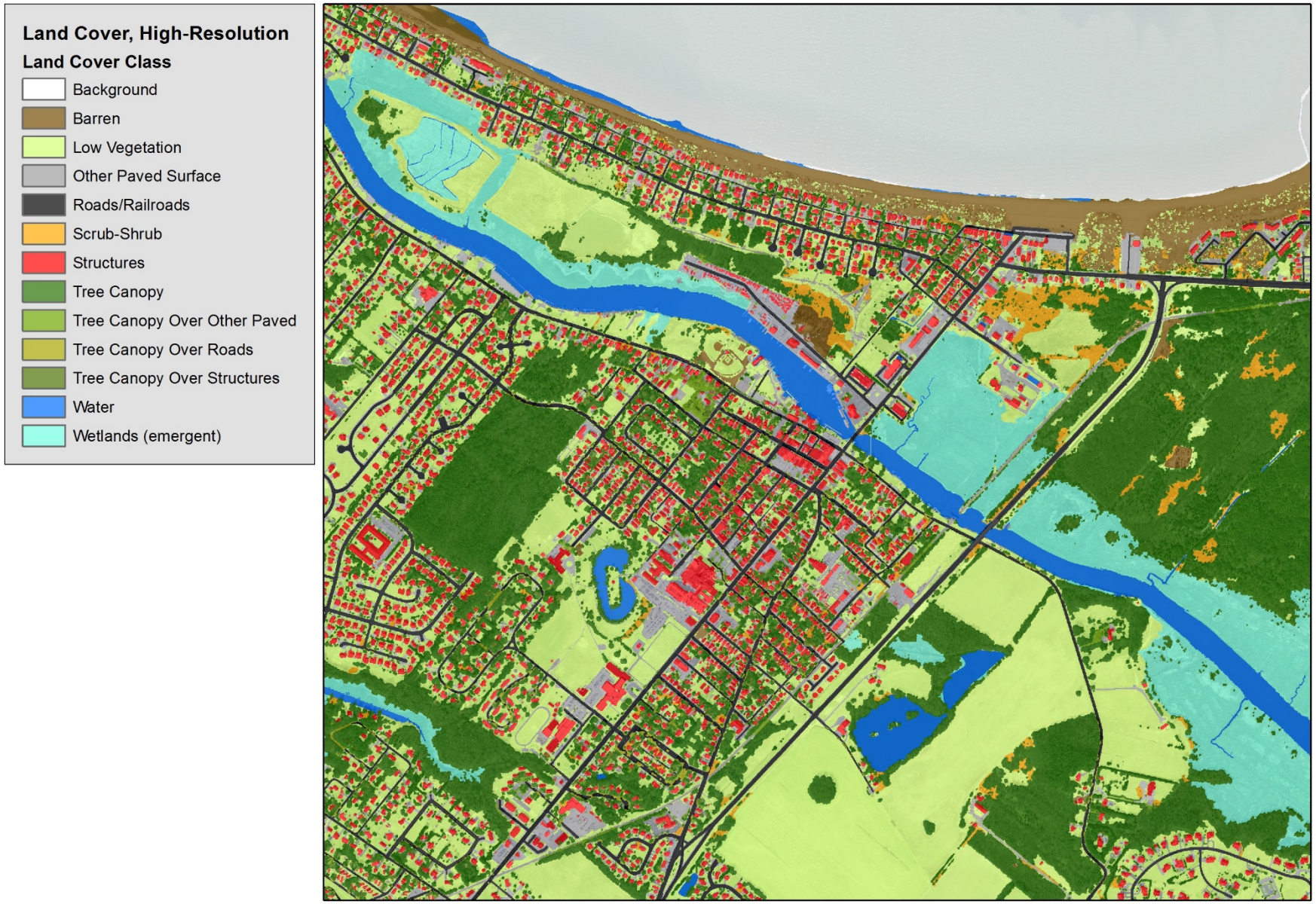
Delaware Department of Natural Resources and Environmental Control

Delaware Coastal Programs DCMP

Sea Grant Delaware

High-Resolution Land Cover

- 1-m Land Cover dataset for all of Delaware based on 2014 LiDAR data and 2012/2013 imagery
- **University of Vermont Spatial Analysis Lab - Jarlath O'Neil-Dunne**
- http://letters-sal.blogspot.com/2016/03/delaware-high-resolution-land-cover.html
- Classes
  - 0 - Background
  - 1 - Water
  - 2 - Emergent Wetlands
  - 3 - Tree Canopy
  - 4 - Scrub/Shrub
  - 5 - Low Vegetation
  - 6 - Barren
  - 7 - Structures
  - 8 - Other Paved Surfaces
  - 9 - Roads/Railroads
  - 10 - Tree Canopy over Structures
  - 11 - Tree Canopy over Other Paved Surfaces
  - 12 - Tree Canopy over Roads


Land Cover, High-Resolution
Land Cover Class
Background
Barren
Low Vegetation
Other Paved Surface
Roads/Railroads
Scrub-Shrub
Structures
Tree Canopy
Tree Canopy Over Other Paved
Tree Canopy Over Roads
Tree Canopy Over Structures
Water
Wetlands (emergent)


Land Cover, High-Resolution
Land Cover Class
Background
Barren
Low Vegetation
Other Paved Surface
Roads/Railroads
Scrub-Shrub
Structures
Tree Canopy
Tree Canopy Over Other Paved
Tree Canopy Over Roads
Tree Canopy Over Structures
Water
Wetlands (emergent)

StreamStats

- StreamStats is a USGS web application that provides estimates of drainage-basin boundaries, basin characteristics, and streamflow statistics at gaged and ungaged locations
- StreamStats used for engineering design purposes and numerous other water resource planning and management applications
- Current project to update StreamStats
  - DGS - GIS data based on recent LiDAR data
  - USGS - peak-flow frequency relations for DE watersheds

DelDOT

USGS
science for a changing world

StreamStats

- Use the 2014 statewide LiDAR data to create a hydrologically-enforced DEM for the entire state of Delaware
- Hydro-enforecment includes the modification of the DEM to allow for downslope flow in areas where the bare-earth DEM includes artificial impoundments such as culverts and bridges
- The hydro-enforced DEM will be used to extract updated stream networks and watershed boundaries
- This stream network will be checked for accuracy and geometric connectivity
- Create GIS files for the update of the Delaware USGS StreamStats application

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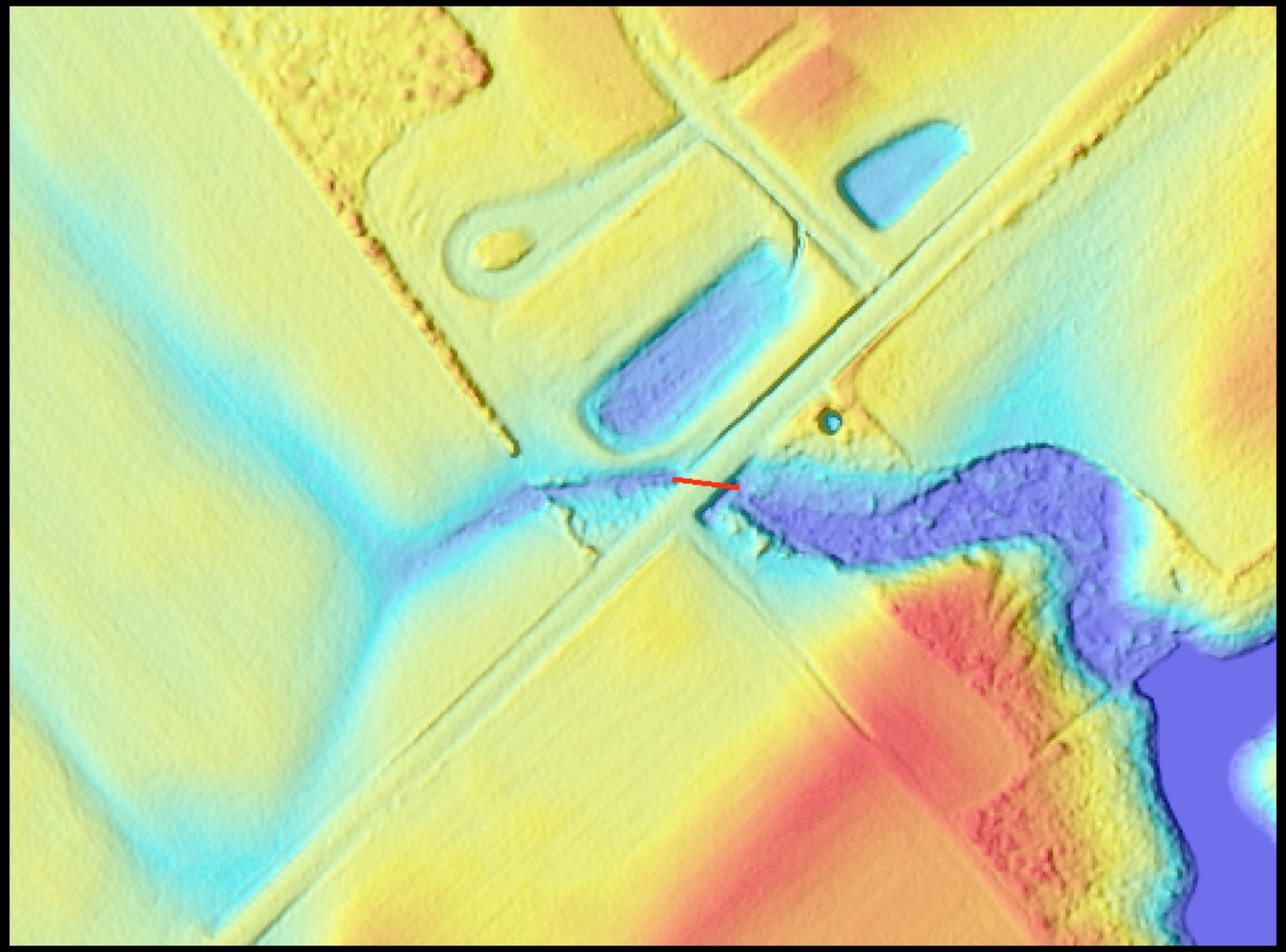
Hydro-enforcement



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Questions?

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