Chesapeake Bay Watershed Land Use and Forest Land Conversion

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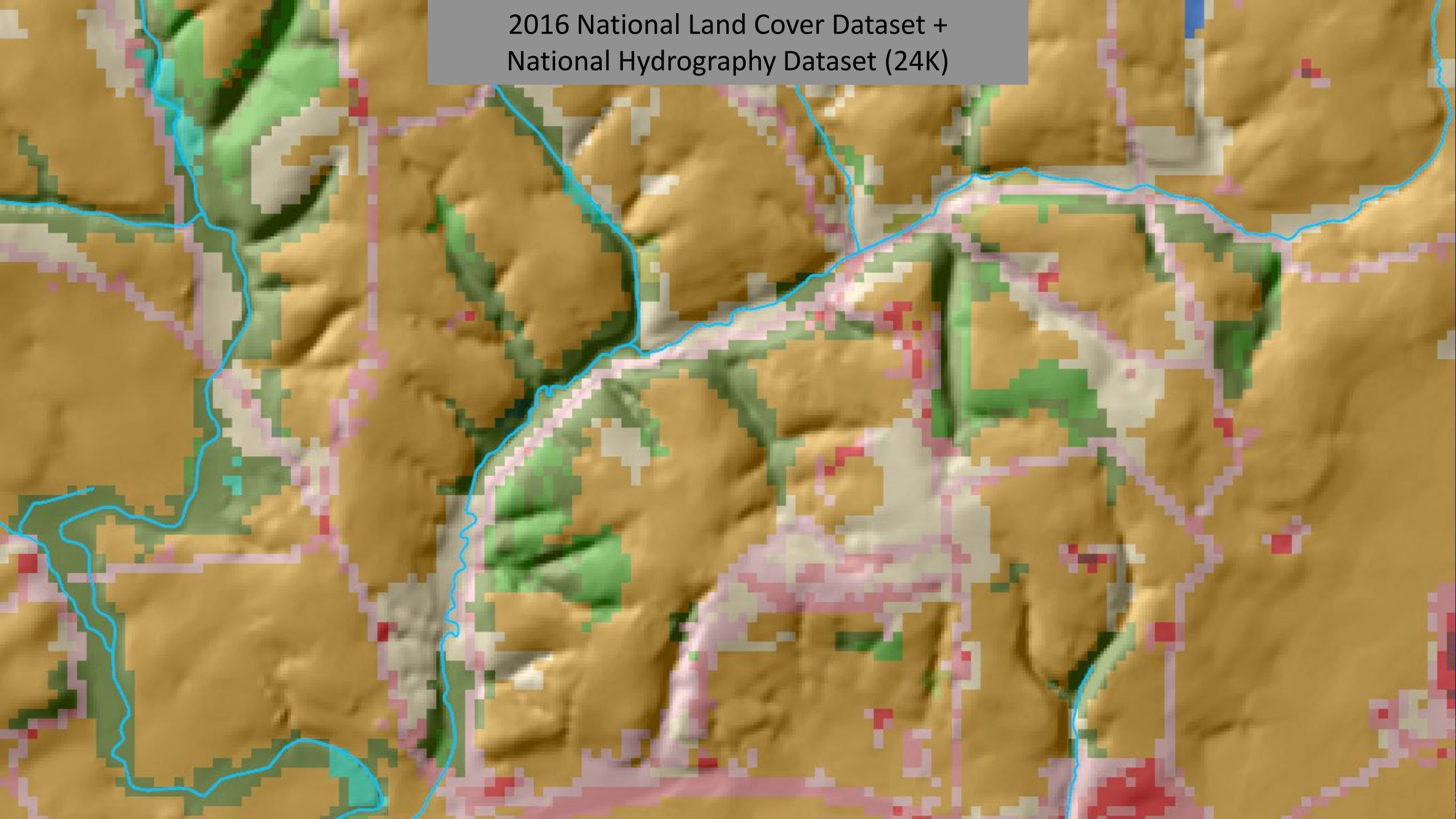
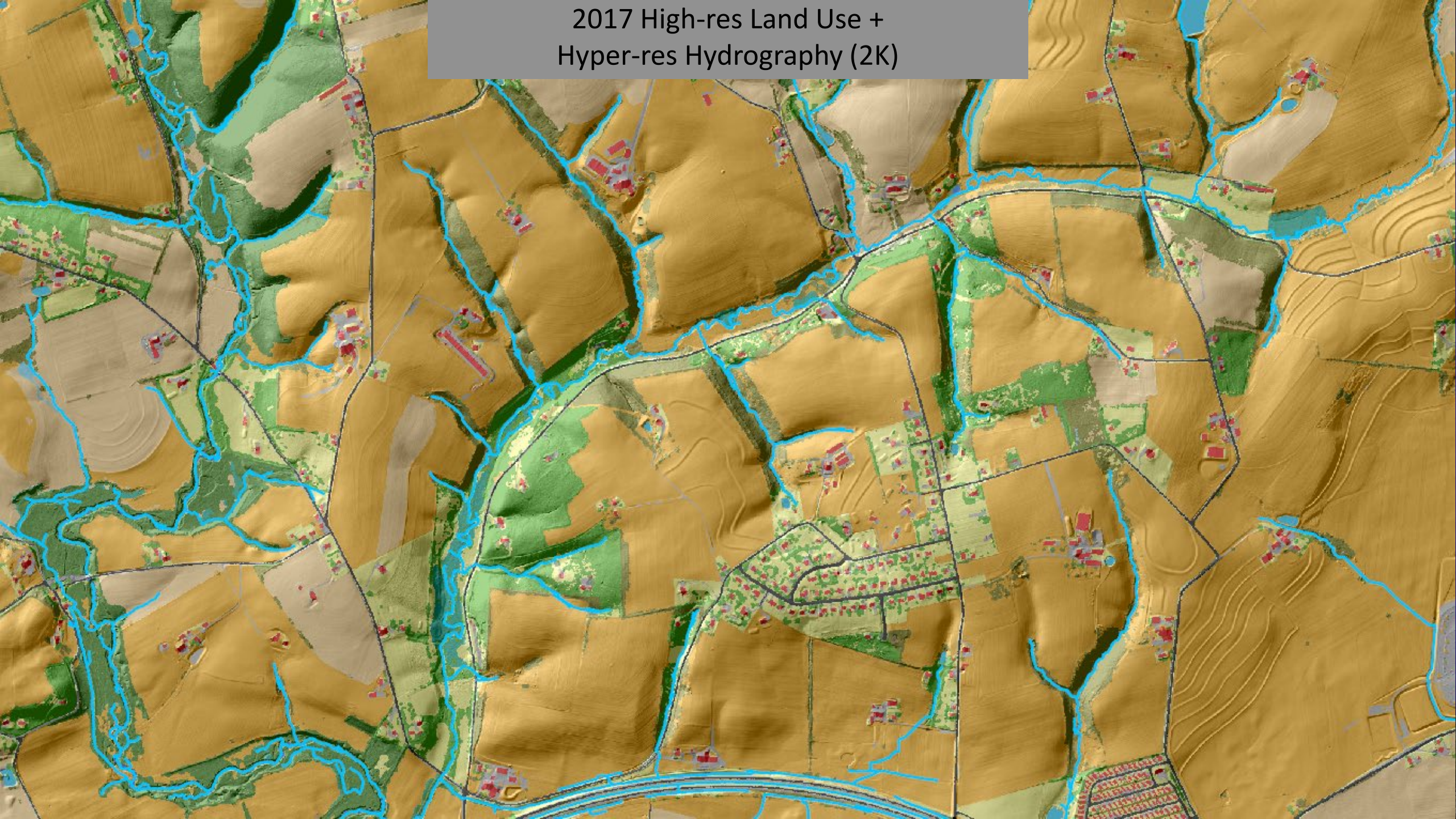
[3] University of Vermont's Spatial Analysis Laboratory

Citizens Advisory Committee Meeting
May 24-25, 2023
Harrisburg, Pennsylvania

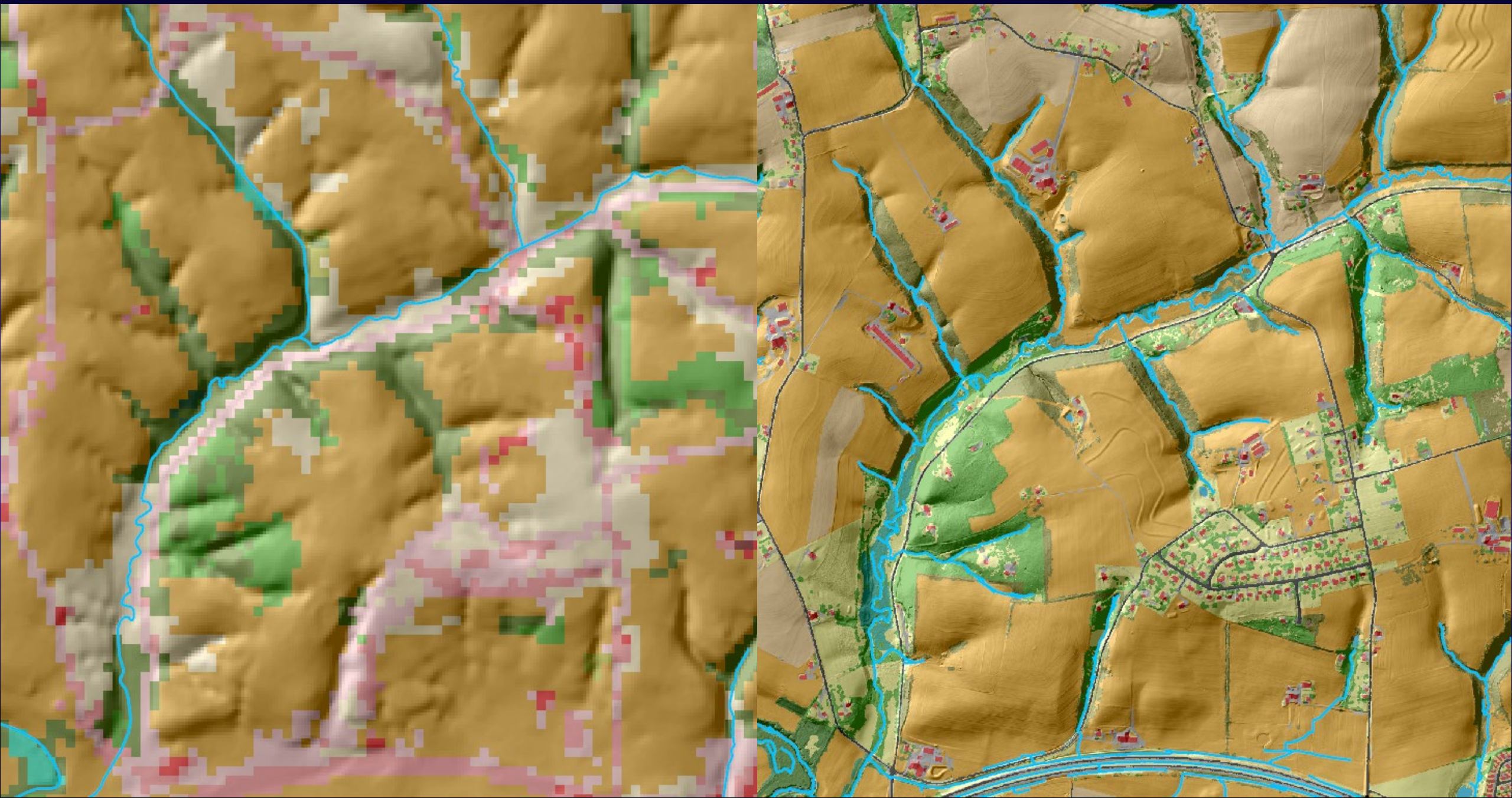
U.S. Department of the Interior
U.S. Geological Survey


2016 National Land Cover Dataset +
National Hydrography Dataset (24K)


2017 High-res Land Use +
Hyper-res Hydrography (2K)

30-meter Resolution

1-meter Resolution



What we've learned

High-resolution land cover, land use, and hydrography data representing every square meter of the Bay watershed are:

- **Foundational-** informing most CBP Outcomes managed by every Goal Implementation Team.
- **Authoritative-** providing a fully transparent, accurate, and verifiable representation of landscape conditions and change over time.
- **Transformative-** affecting the way we understand, interpret, and manage the landscape and mapped at the granularity (1-meter resolution) of individual/parcel-level decisions.

Chesapeake Bay 1-Meter Products for a 99,000 mi^2 Region

Land Cover (12-classes): 2013/14, 2017/18, 2021/22

Land Use (64-classes): 2013/14, 2017/18, 2021/22

Streams, ditches, and gullies (from LiDAR imagery)

- **Watershed only (white boundary)**

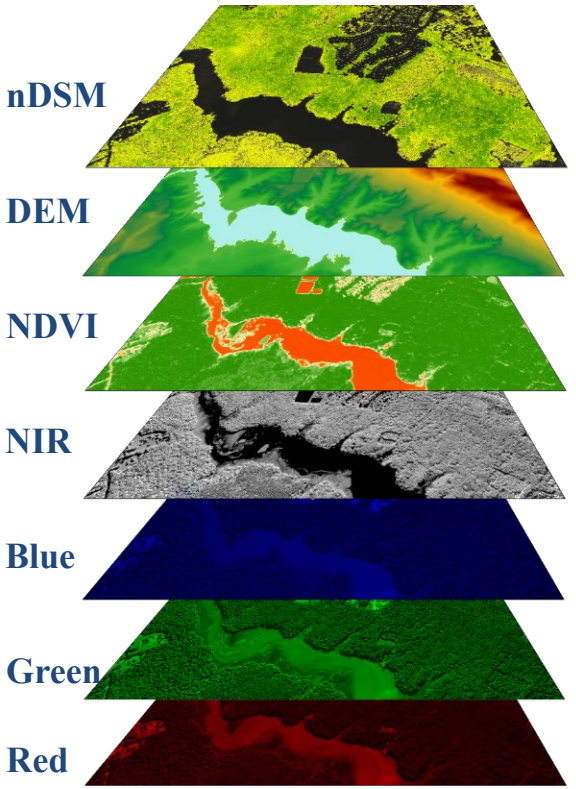
Stream channel and Floodplain Attributes (from FACET)

Remote Sensing

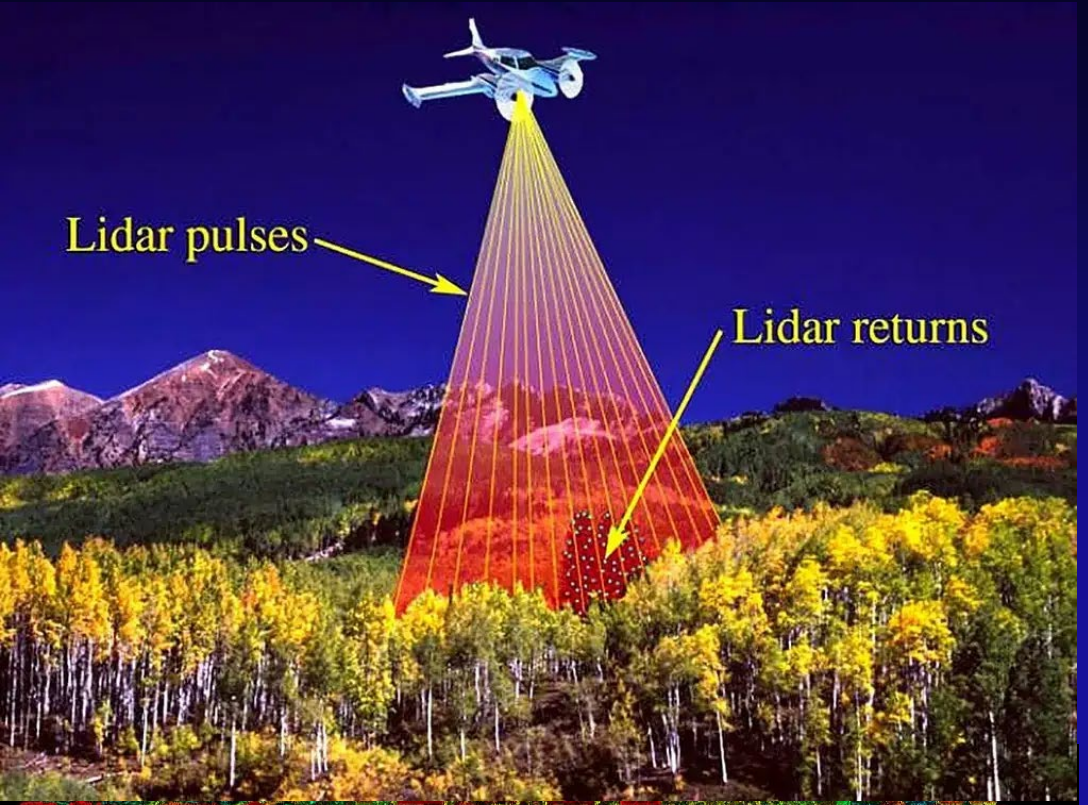
2013 NAIP

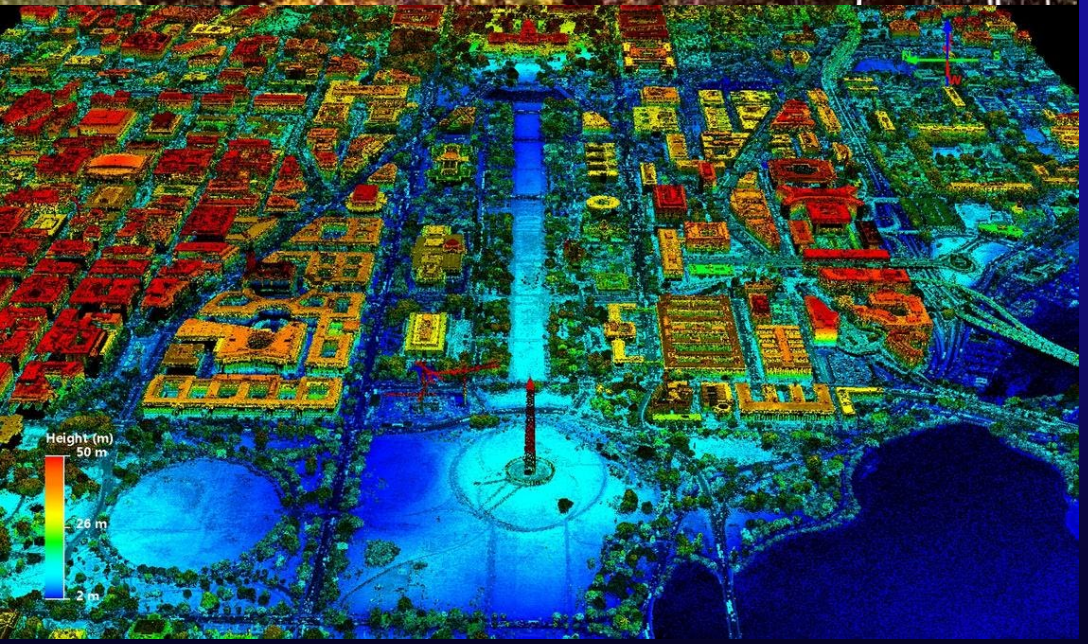
Ortho-imagery

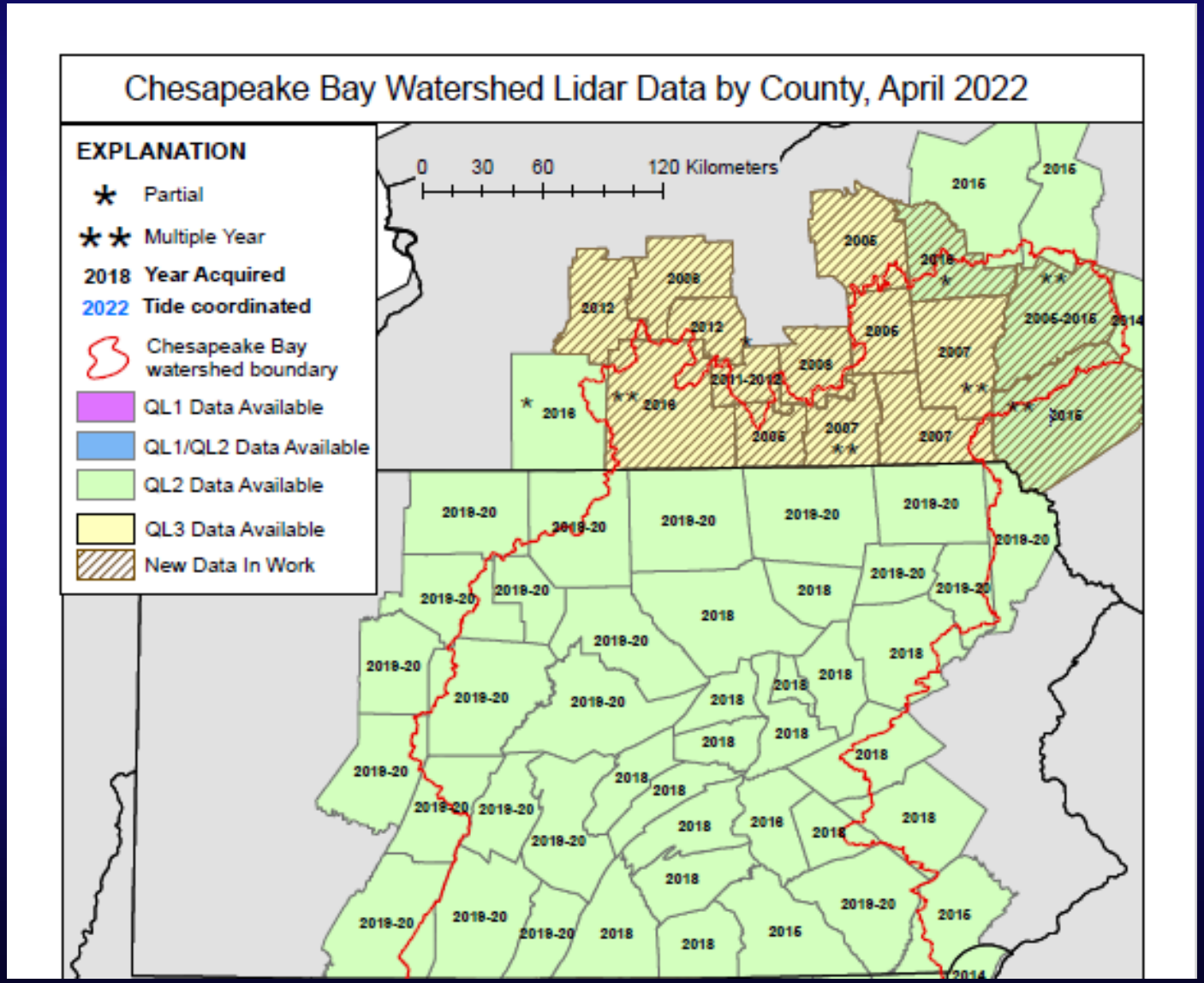
LiDAR



Light Detection And Ranging (LiDAR)



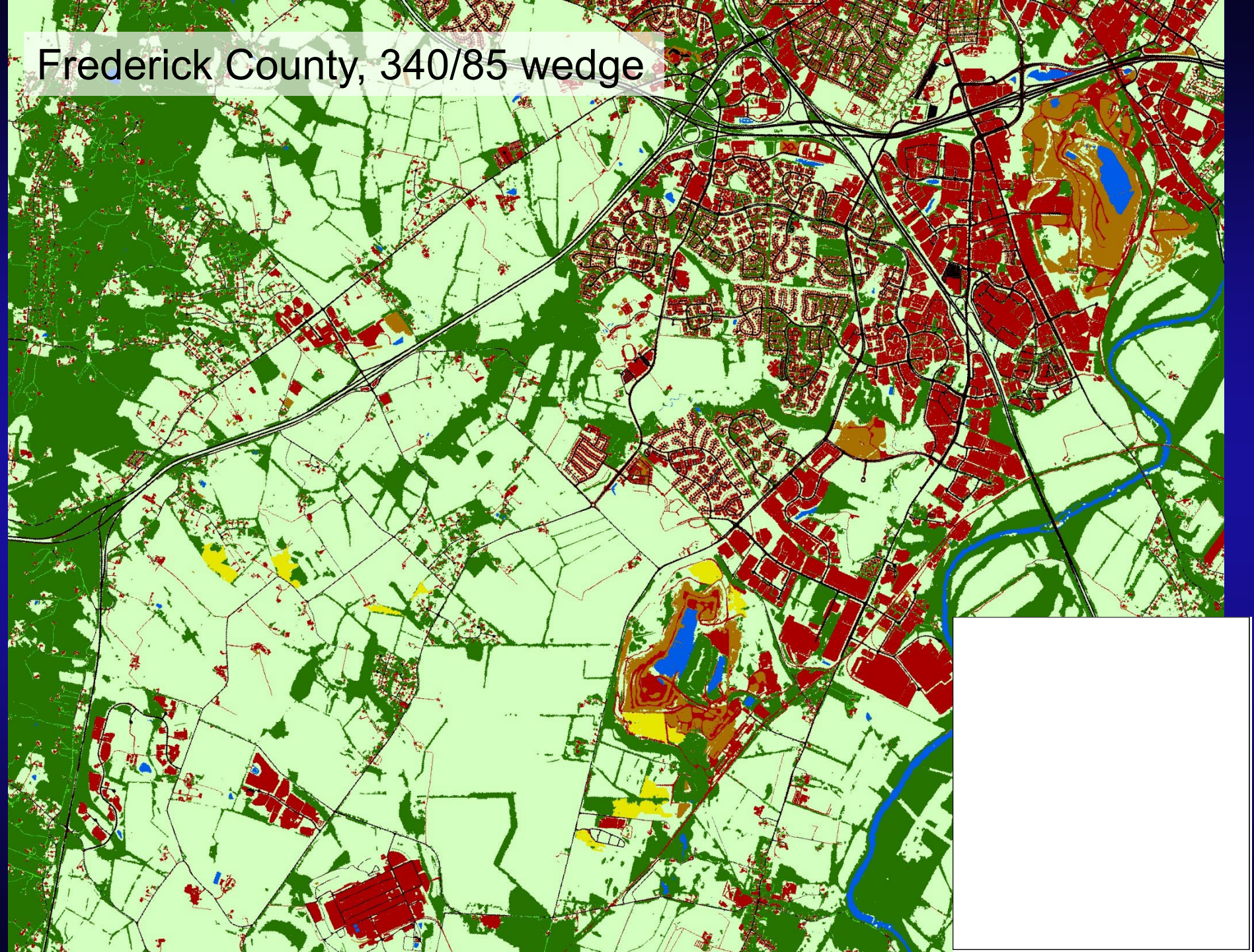




Frederick County, 340/85 wedge

USGS

Frederick County, 340/85 wedge



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Local land use and parcel data

- Low-density residential
- Recreation
- Agriculture
- Roads

High-resolution land cover data

- Impervious surfaces
- Tree canopy
- Low vegetation
- Water

CBP Land Uses

- Impervious-Roads
- Forests
- Turf Grass
- Natural Succession

USGS

Chesapeake Bay 1-meter Land Use/Cover Classification (64 classes)

Water and Water Margins (6)

- 10 Tidal Waters
- Lentic
  - 11 Lakes & Reservoirs
  - 12 Riverine Ponds
  - 13 Terrene Ponds
- Lotic
  - 14 Streams and Rivers (visible water)
- 15 Bare Shore

Development (18)

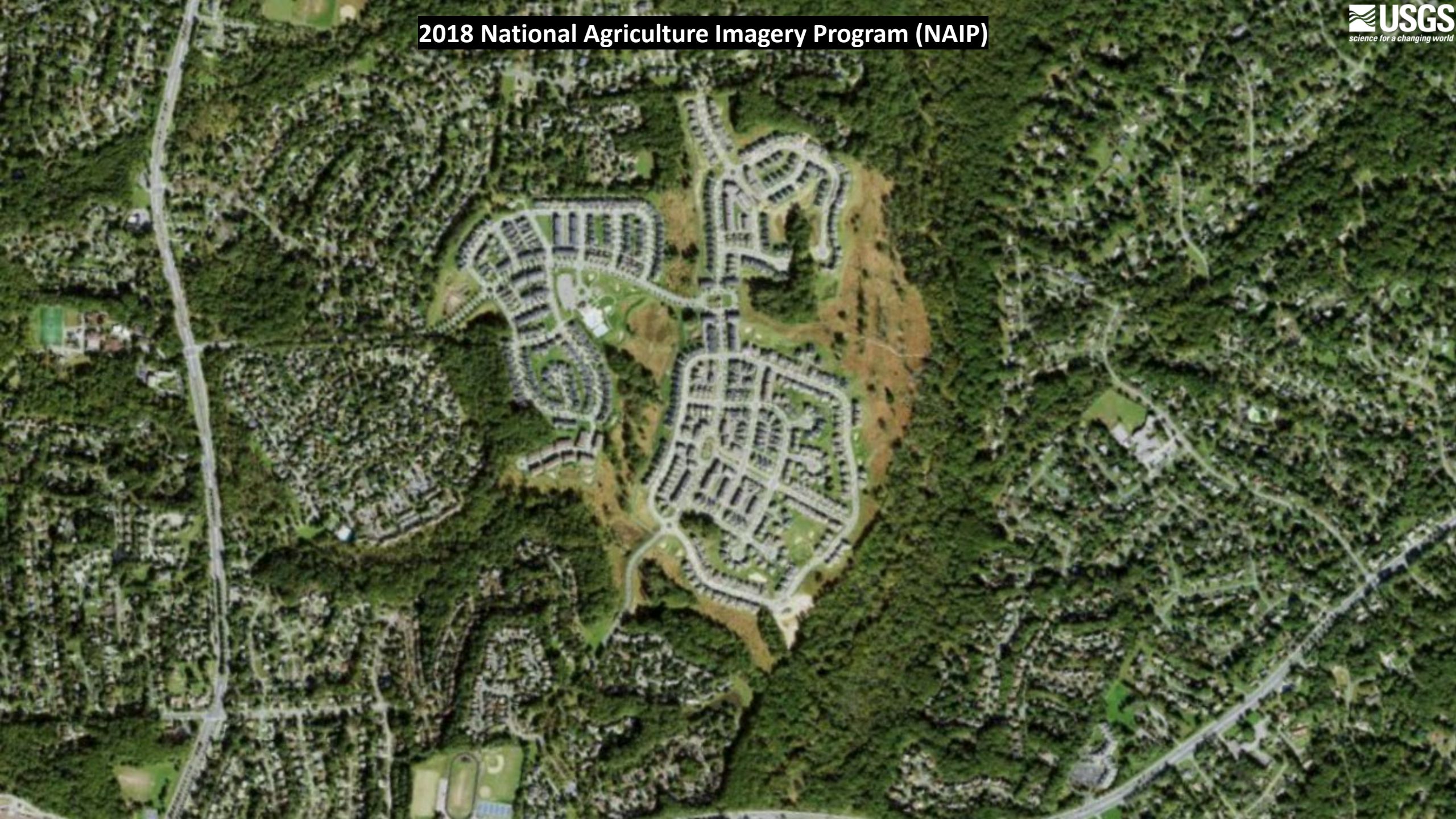
- Impervious
  - 20 Roads
  - 21 Structures
  - 22 Other Impervious (Parking lots, driveways)
  - 23 TC over Roads
  - 24 TC over Structures
  - 25 TC over Other Impervious
  - 31 Extractive Impervious
  - 32 Solar Field Panel Arrays
- Pervious
  - 26 Tree Canopy over Turf Grass
  - 27 Turf Grass
  - 28 Bare Developed
  - 30 Extractive Barren
  - 33 Solar Field Barren
  - 34 Solar Field Herbaceous
  - 35 Solar Field Shrubland
  - 36 Suspended Succession Barren
  - 37 Suspended Succession Herbaceous
  - 38 Suspended Succession Shrubland

Natural Lands (25)

- Tree Canopy
  - 40 Forest
  - 41 Tree Canopy, Other
- Open Space
  - 42 Natural Succession Barren
  - 43 Natural Succession Herbaceous
  - 44 Natural Succession Shrubland
  - 45 Harvested Forest Barren
  - 46 Harvested Forest Herbaceous
- Riverine Wetlands
  - 50 Riverine Wetlands Barren
  - 51 Riverine Wetlands Herbaceous
  - 52 Riverine Wetlands Shrubland
  - 53 Riverine Wetlands Tree Canopy
  - 54 Riverine Wetlands Forest
  - 55 Riverine Wetlands Harvested Forest
- Terrene Wetlands (isolated)
  - 60 Terrene Wetlands Barren
  - 61 Terrene Wetlands Herbaceous
  - 62 Terrene Wetlands Shrubland
  - 63 Terrene Wetlands Tree Canopy
  - 64 Terrene Wetlands Forest
  - 65 Terrene Wetlands Harvested Forest
- Tidal Wetlands
  - 70 Tidal Wetlands Barren
  - 71 Tidal Wetlands Herbaceous
  - 72 Tidal Wetlands Shrubland
  - 73 Tidal Wetlands Tree Canopy
  - 74 Tidal Wetlands Forest
  - 75 Tidal Wetlands Harvested Forest

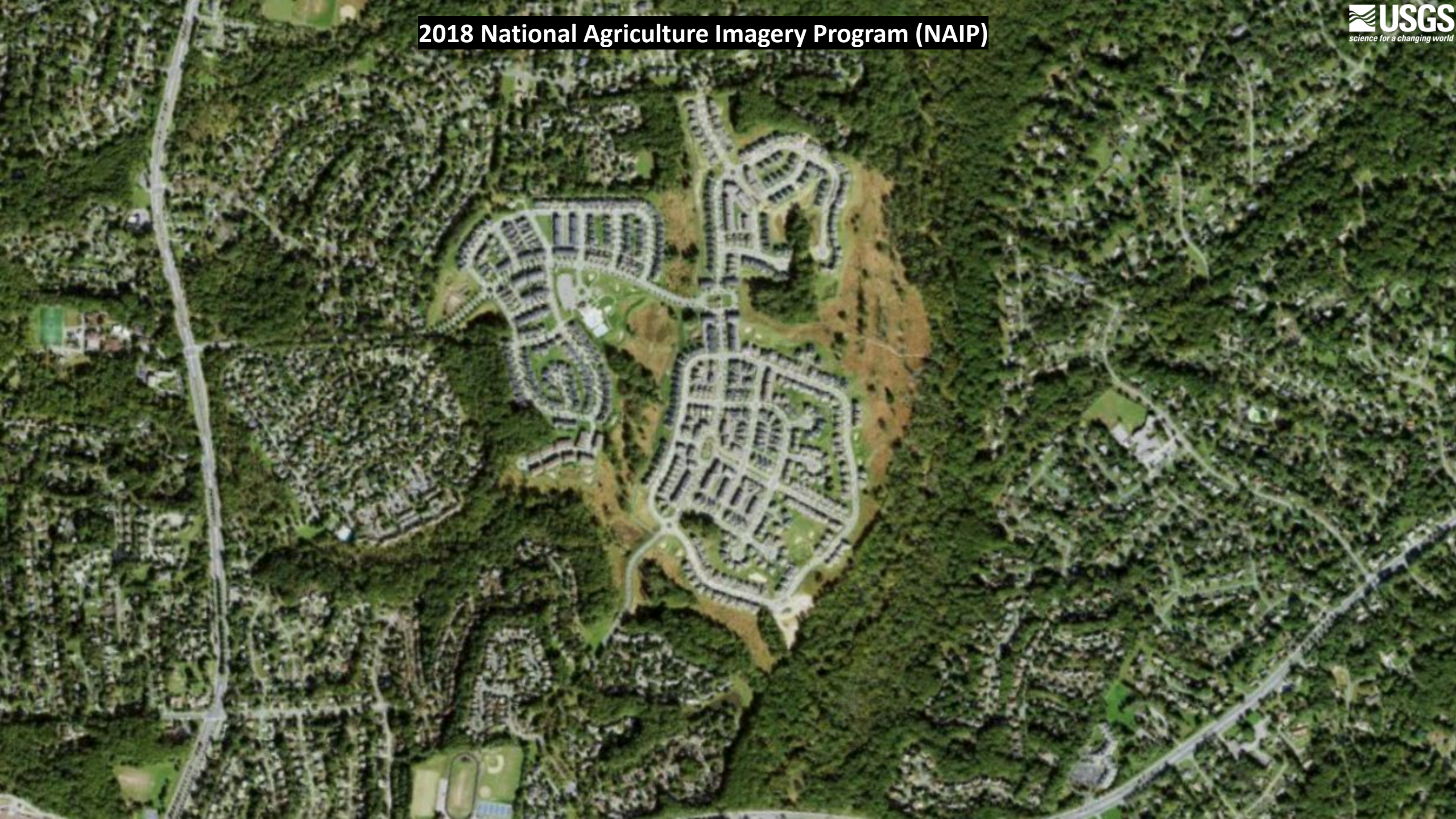
Agriculture (15)

- Productive Lands
  - 80 Cropland Barren
  - 81 Cropland Herbaceous
  - 82 Orchards and Vineyards Barren
  - 83 Orchards and Vineyards Herbaceous
  - 84 Orchards and Vineyards Shrubland
  - 85 Pasture Barren
  - 86 Pasture Herbaceous
  - 87 Hay Barren
  - 88 Hay Herbaceous
- Agricultural Facilities
  - 90 Agricultural Structures
  - 91 Animal Operation Impervious
  - 92 Animal Operation Barren
  - 93 Animal Operation Herbaceous
  - 94 TC over Agricultural Structure
  - 95 TC over Animal Operation Impervious


2018 National Agriculture Imagery Program (NAIP)
USGS
science for a changing world


2018 Land Use
USGS
Science for a changing world
Riparian Zone
FACET Streams (1:100k)
GenLandUse
Water
Impervious Roads
Impervious Structures
Impervious, Other
Tree Canopy over Impervious
Turf Grass
Pervious Developed, Other
Tree Canopy over Turf Grass
Forest
Tree Canopy, Other
Harvested Forest
Natural Succession
Cropland
Pasture/Hay
Extractive
Wetlands, Tidal Non-forested
Wetlands, Riverine Non-forested
Wetlands, Terrene Non-forested


2012 Google Earth Imagery
USGS
science for a changing world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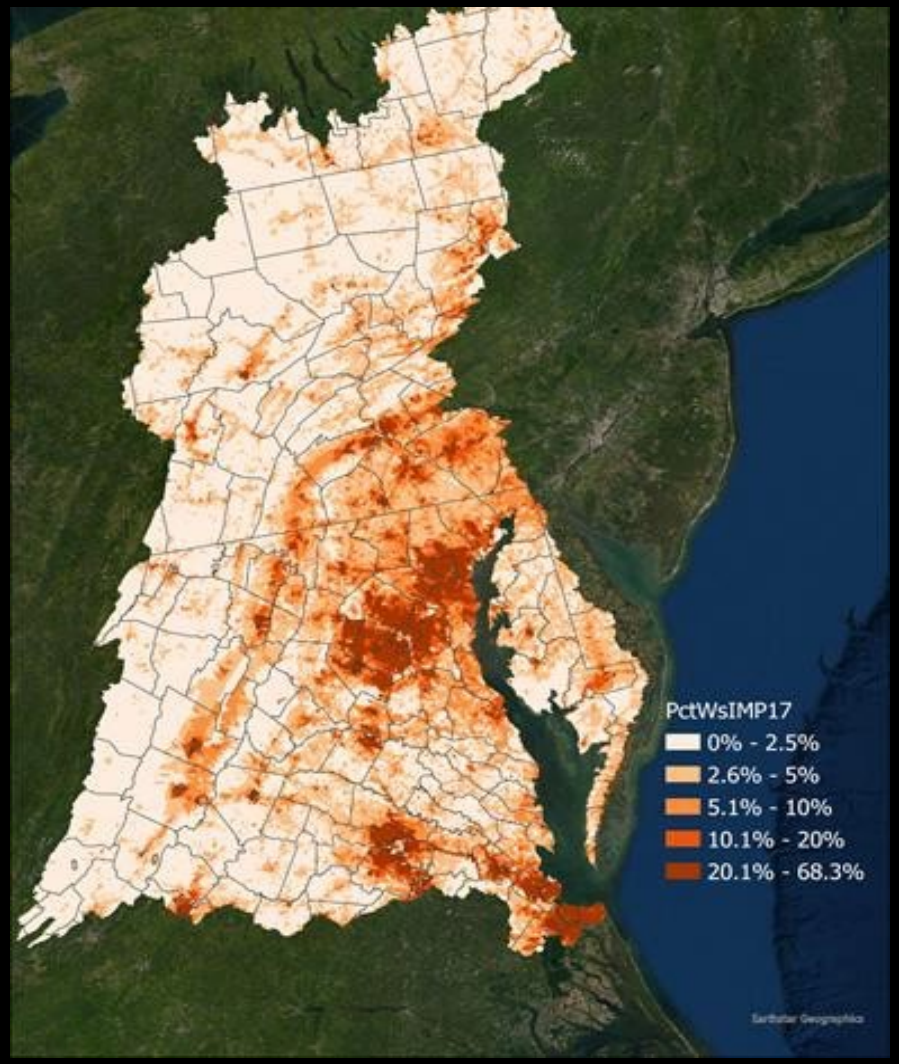
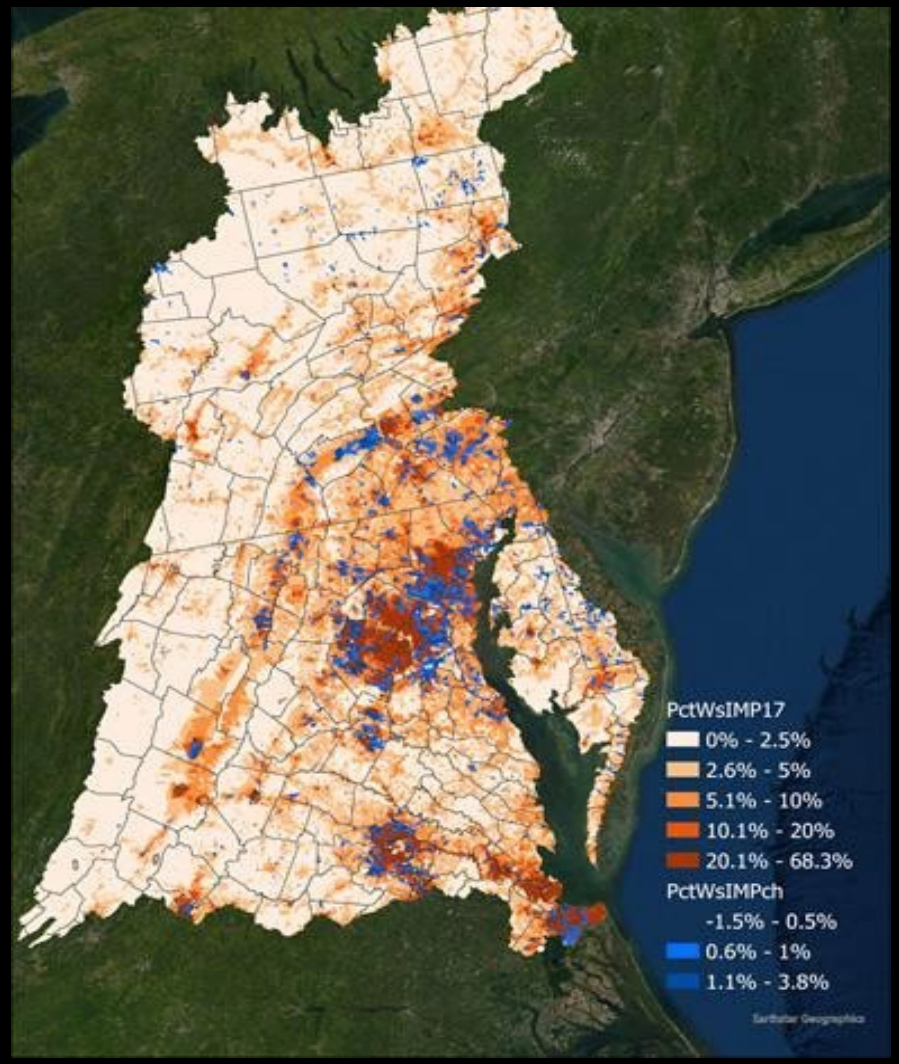
Impervious Cover and Change

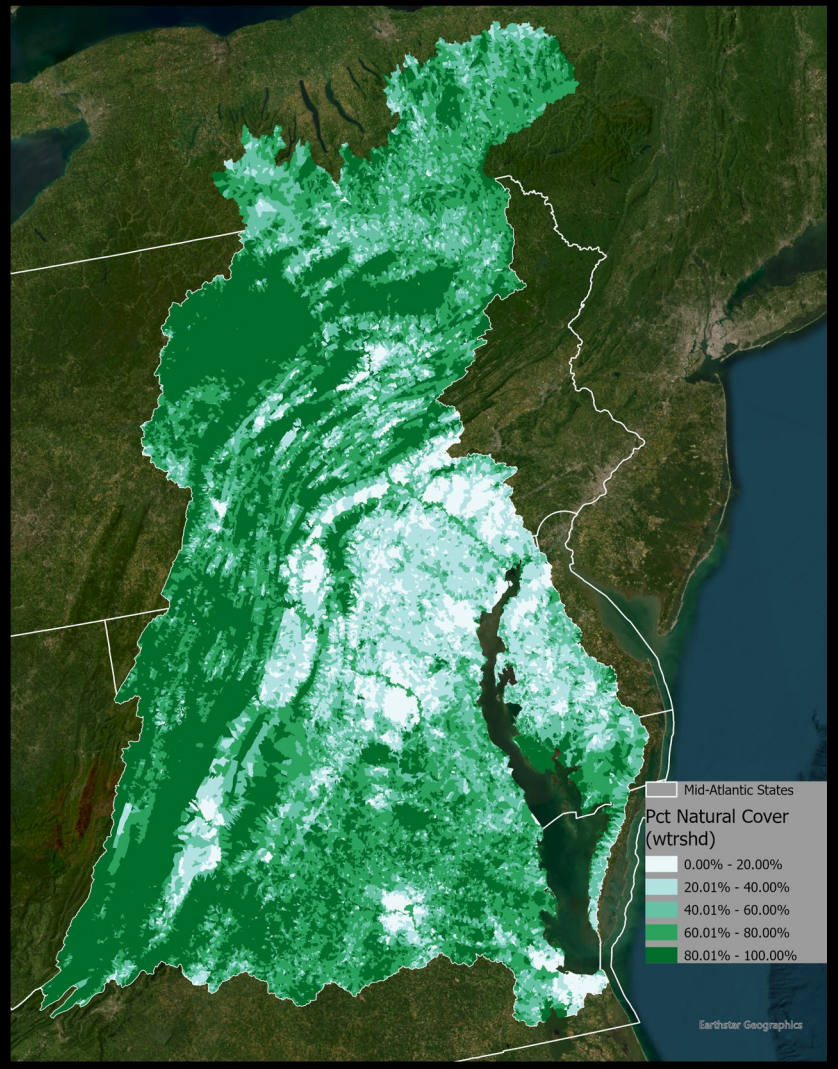


Impervious Cover, 2017/18

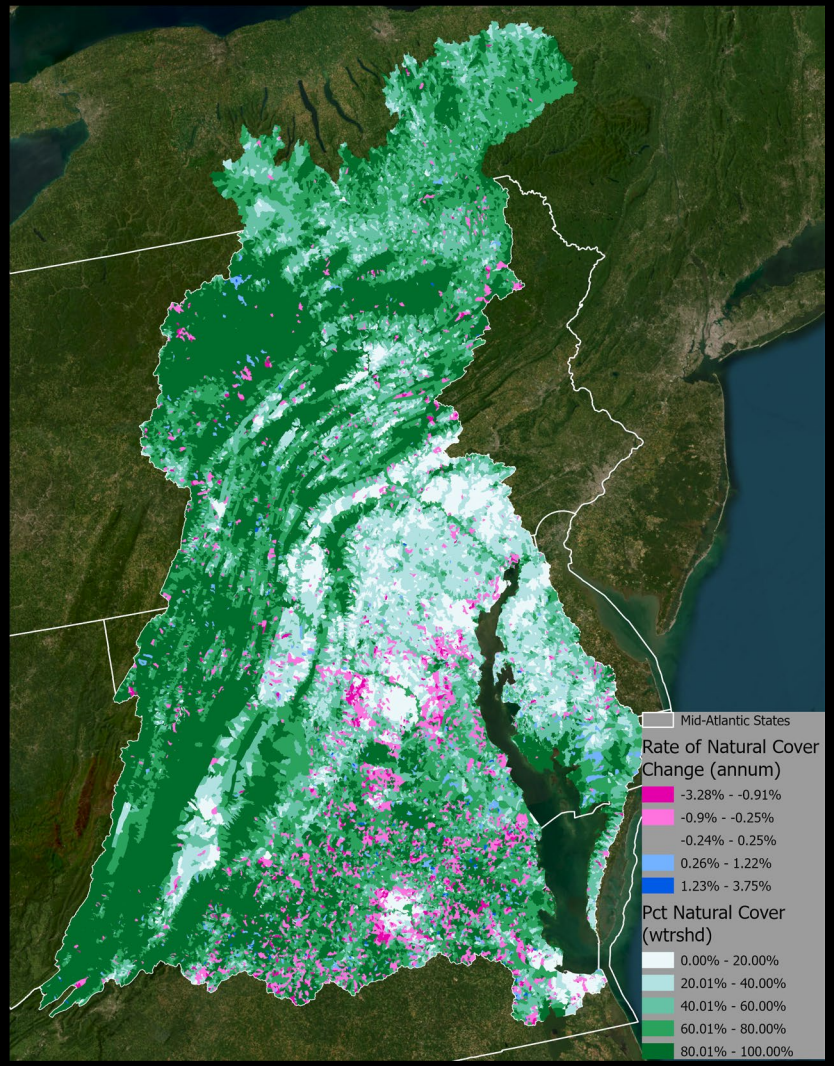


Impervious Cover Change, 2013/14 - 2017/18

Natural Cover and Change

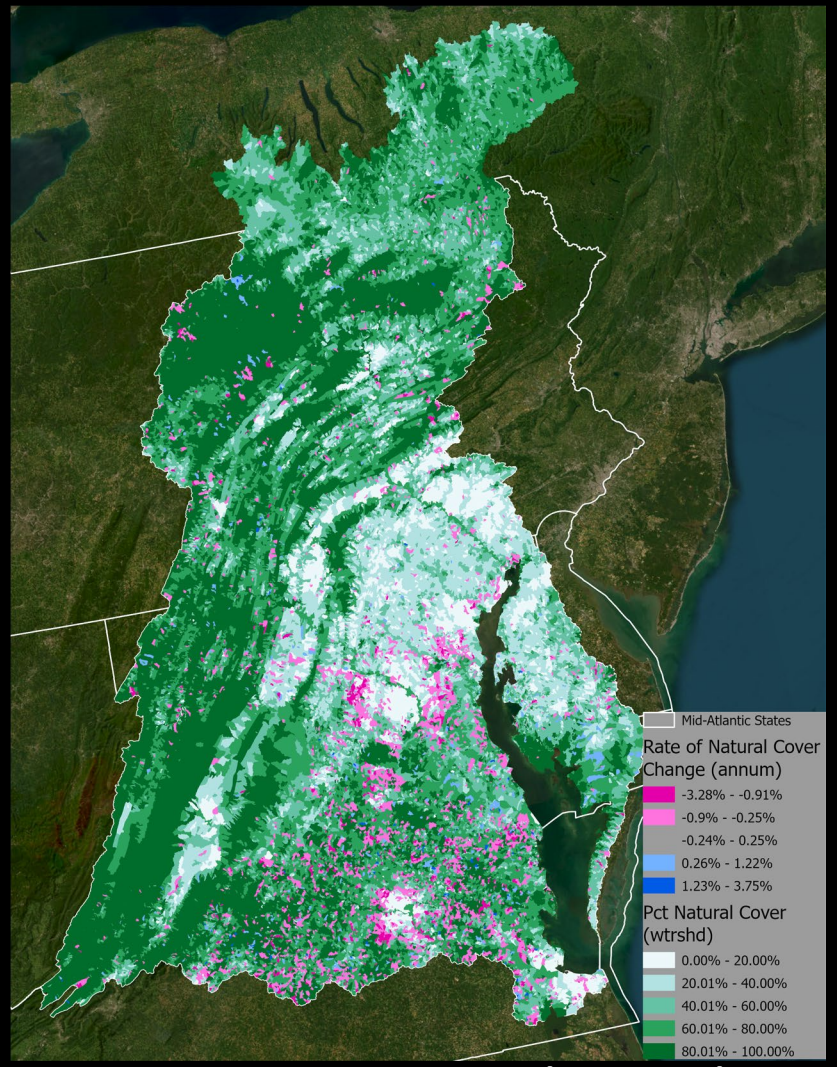


Natural Cover, 2017/18



Natural Cover Change, 2013/14 - 2017/18

Natural Land Cover Change Statistics for the Bay Watershed



Natural Cover Change, 2013/14 - 2017/18

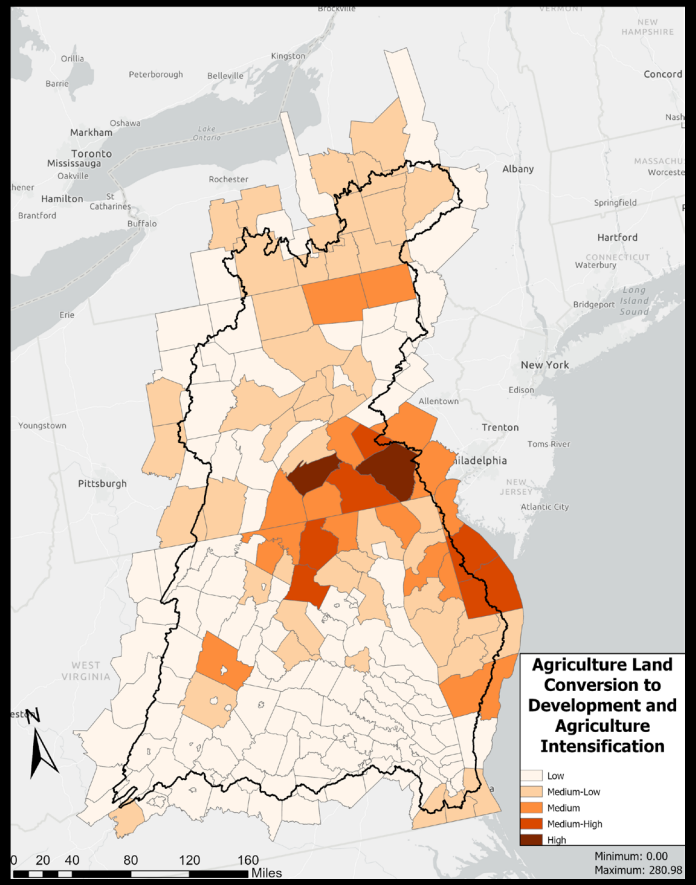
From 2013/14 to 2017/18, a net amount of 64,000 acres of natural lands were cleared for development. A net amount of 6,000 acres of natural lands were cleared for agriculture and 5,000 acres cleared for mining.

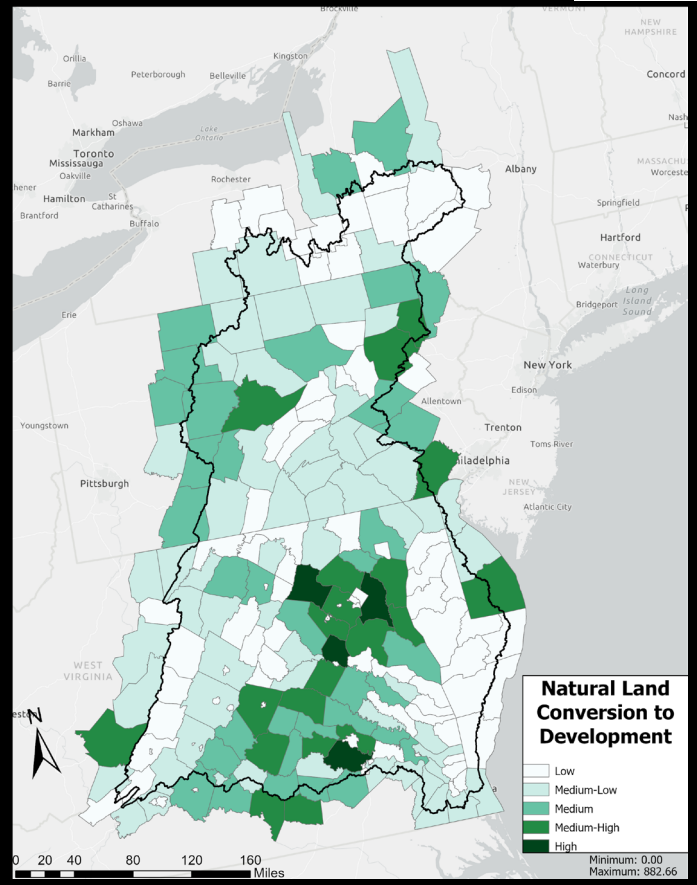
For reference, a net amount of 38,000 acres of agricultural lands were converted to development.

Ratios of Natural to Productive Land Conversion

Ratio of Natural Lands (Forest and Wetlands) to Productive Lands (Cropland and Pasture) Converted to Development from 2013/14 to 2017/18

DRAFT

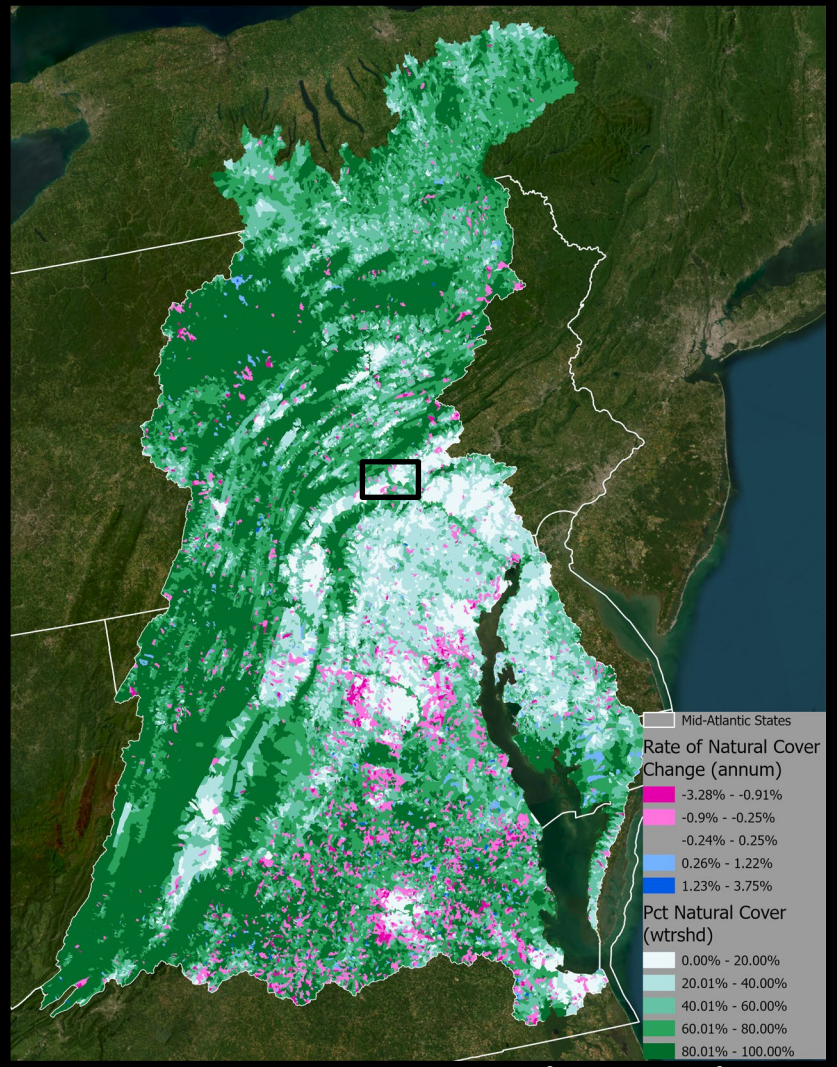




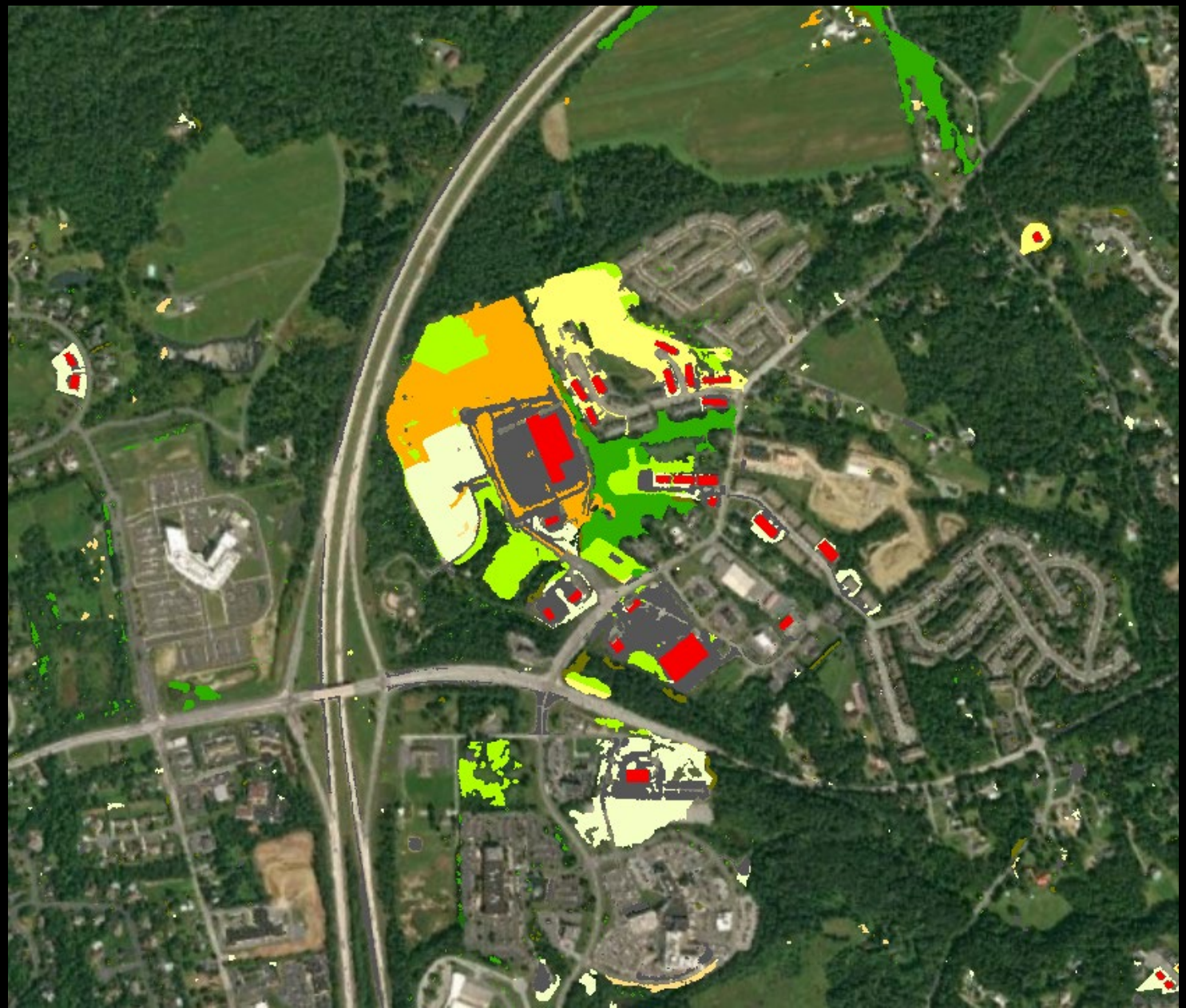
State	Ratio
DE	0.67 : 1
DC	n/a
MD	2.63 : 1
NY	1.5 : 1
PA	1.8 : 1
VA	5.28 : 1
WV	3.43 : 1

Example interpretation: for every acre of productive land converted to development in Virginia, 5.3 acres of natural land were converted.

Natural Land Cover Change Statistics for the Bay Watershed



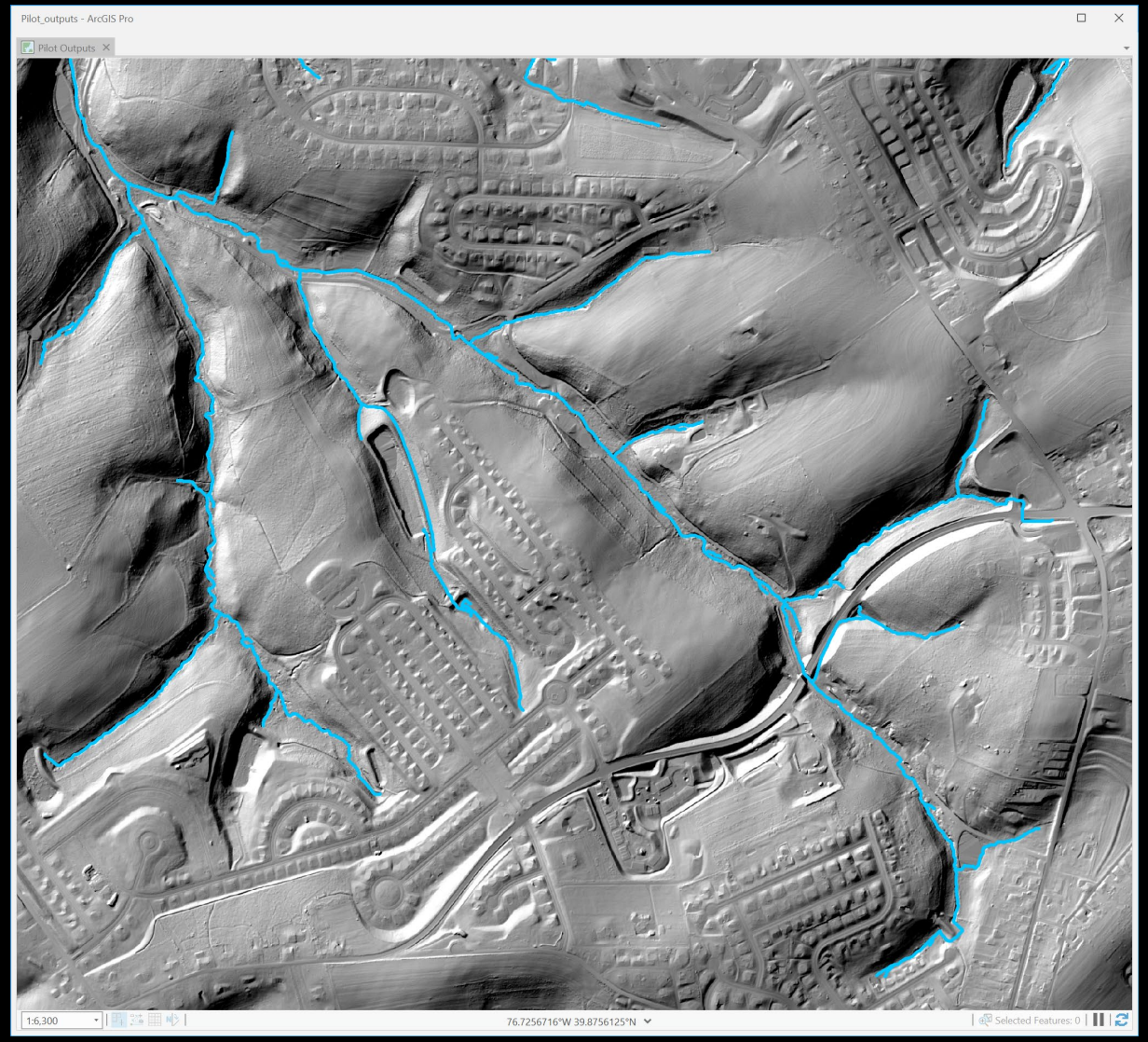
Natural Cover Change, 2013/14 - 2017/18



Hyper-Resolution* Hydrography

1. Lidar elevation
2. Valley-scale geomorphons
3. Channel-scale geomorphons
4. Extract valley network
5. Extract channels using valley network
6. QAQC channel skeleton
7. Connect stream network

Attributed with bank-height ratio, channel width, floodplain width, entrenchment ratio

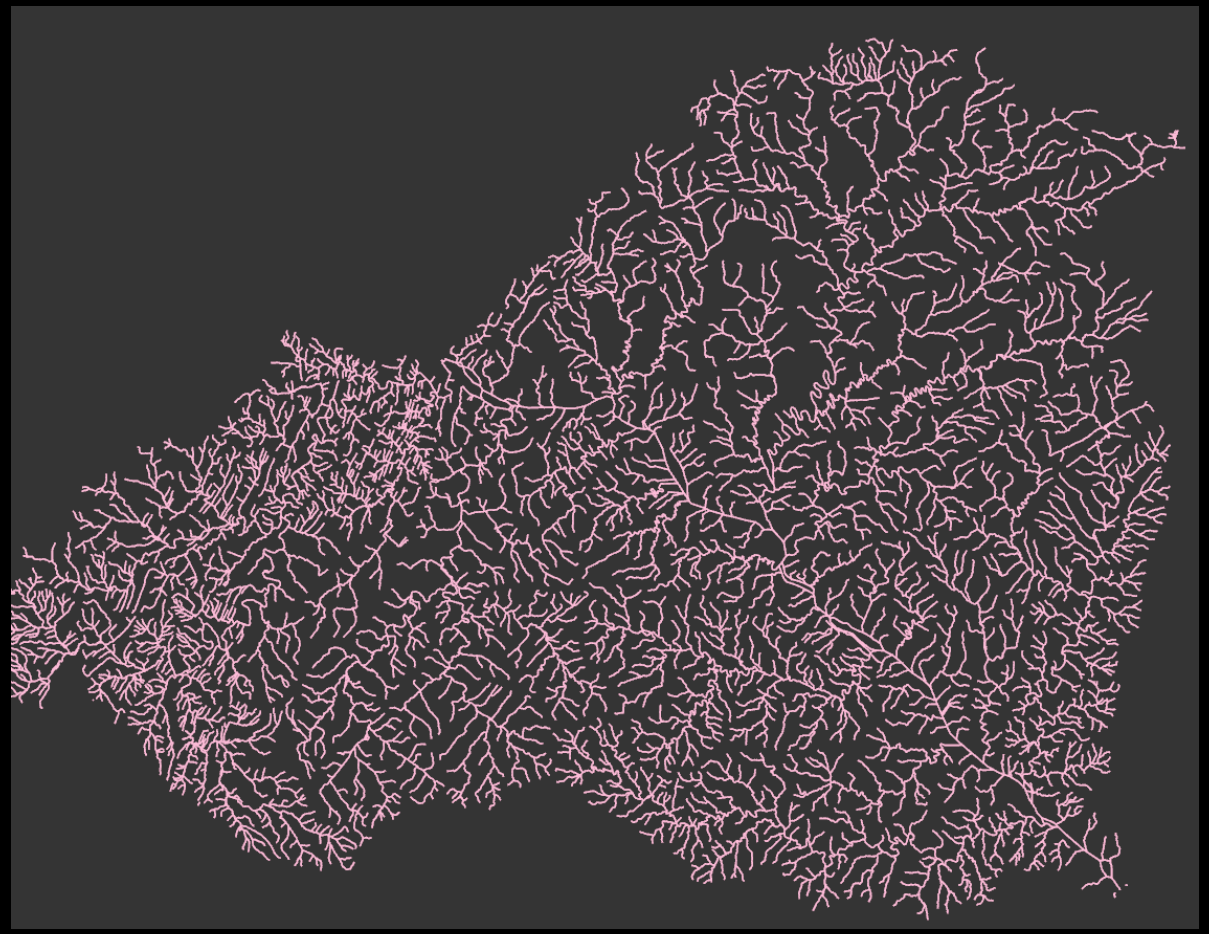


* 1-meter raster, 1:2000 scale

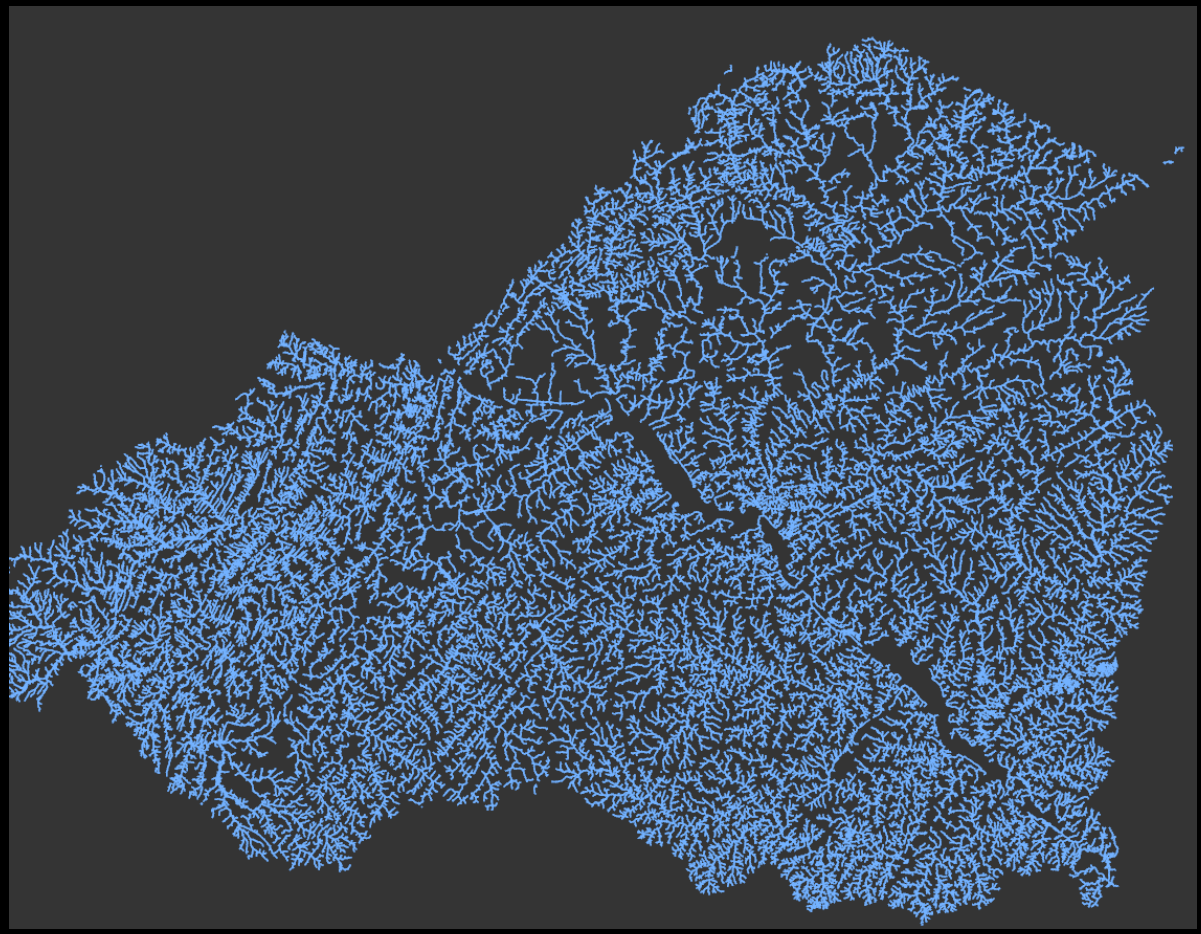
New Hyper-res Streams (1:2000 scale)

Lower Susquehanna Example

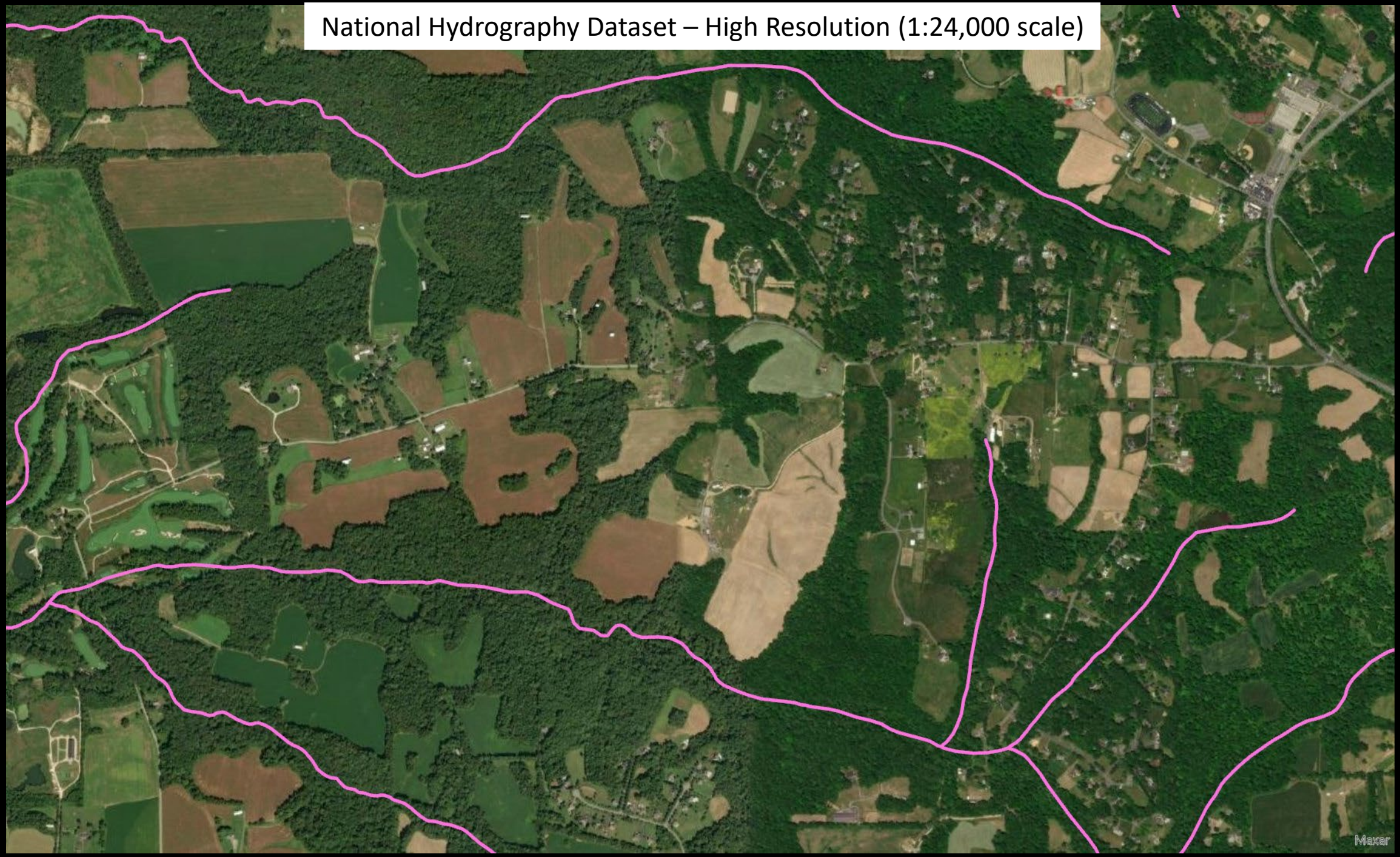
National Hydrography Dataset, 1:24,000
6,923.6 km

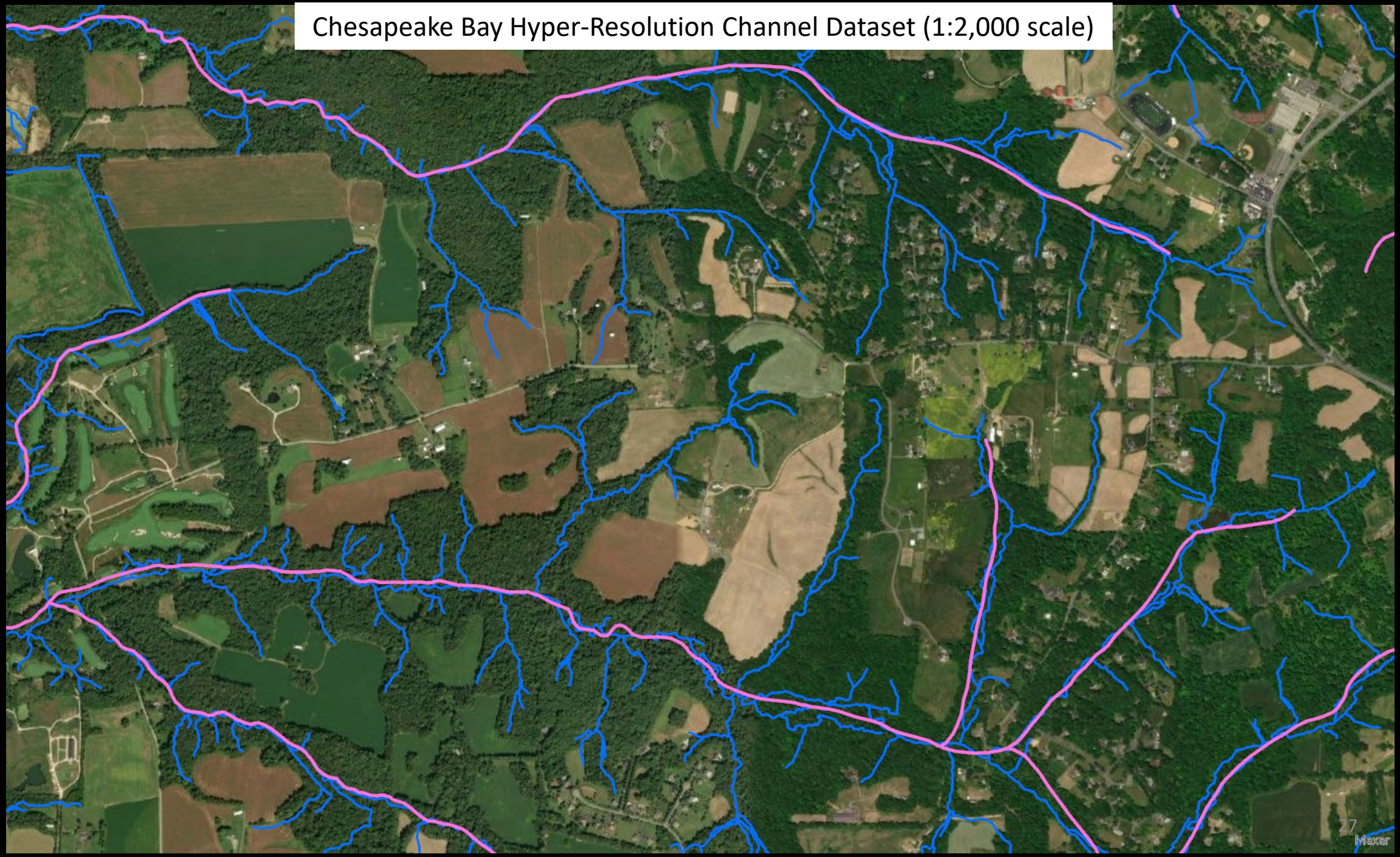


CBP Hyper-Resolution Streams, 1:2000
16,784.6 km

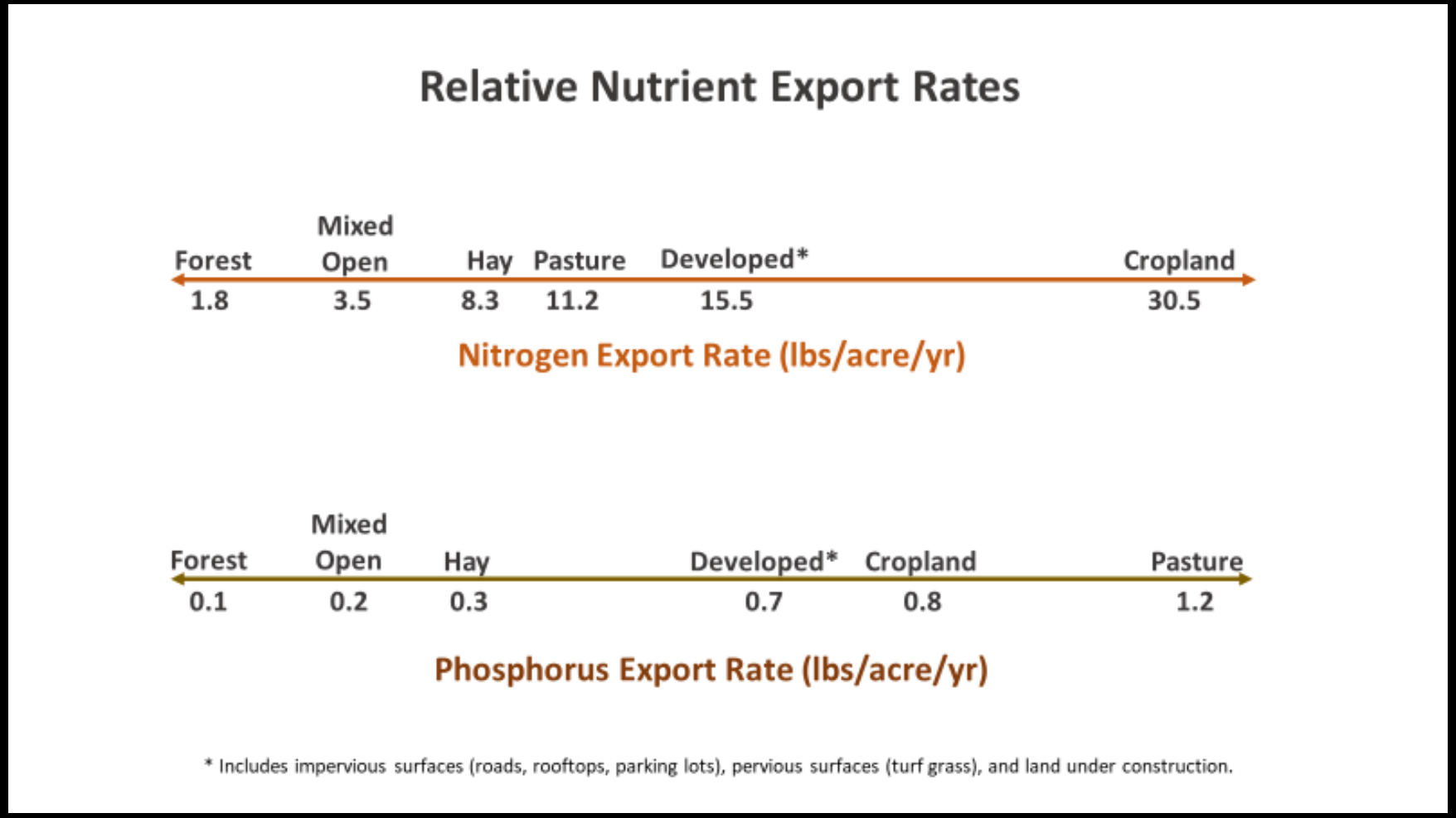


National Hydrography Dataset – High Resolution (1:24,000 scale)




Chesapeake Bay Hyper-Resolution Channel Dataset (1:2,000 scale)

Impacts of forest conversion on water quality



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ECOSYSTEM BENEFITS

Get information about the complementary benefits to BMP implementation.

Watershed Health

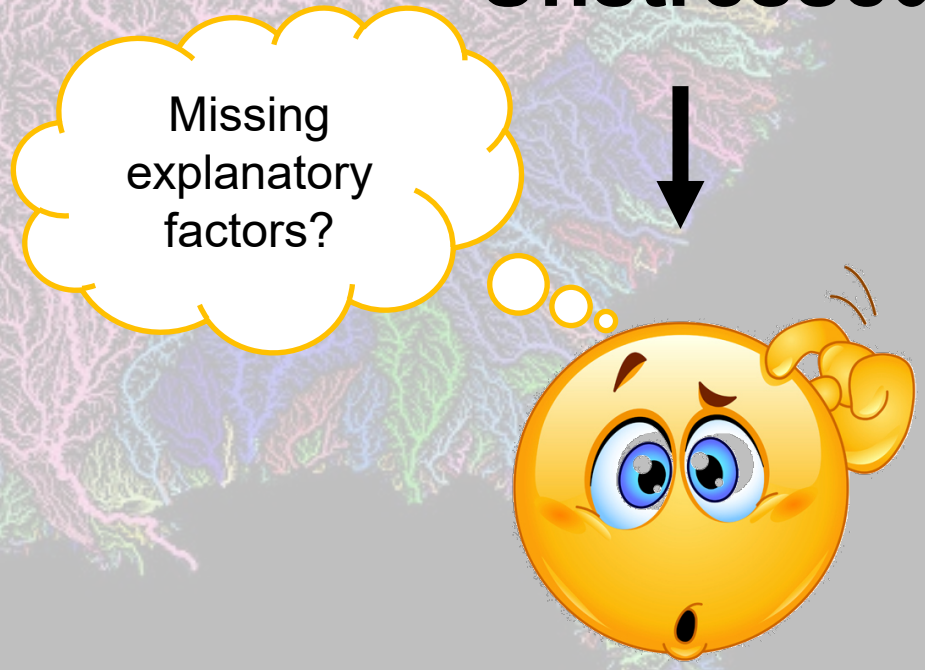
Diagnostic Measures

Healthy ⟷ Unhealthy

\+ +

Watershed Characteristics

Stressed ⟷ Unstressed



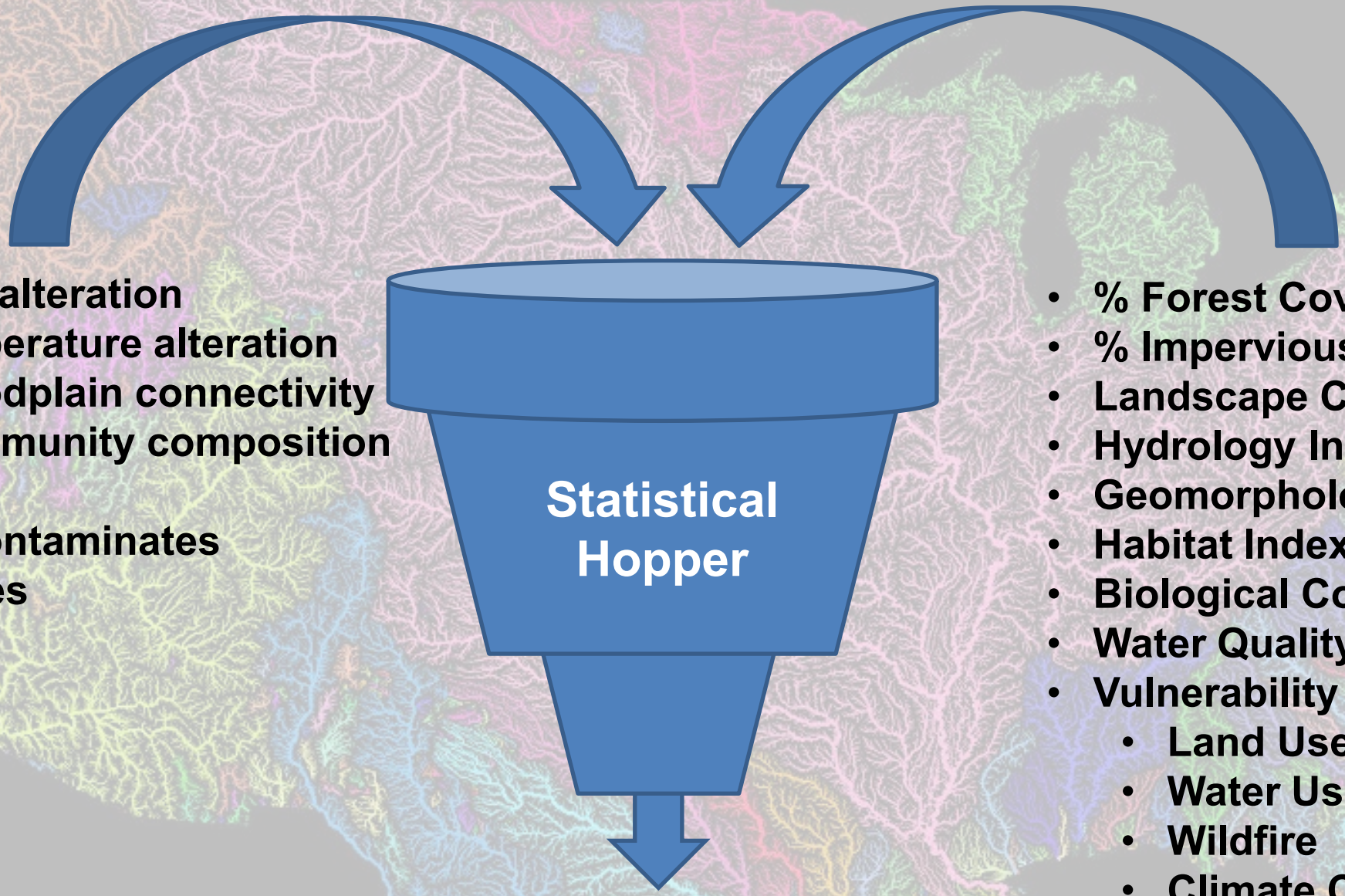
Stream (Watershed) Health

Diagnostic Measures

- Stream flow
- Stream temperature
- Stream incision / floodplain connectivity
- Aquatic community composition
- Toxics
- Disease
- Nutrients
- Sediment

Watershed Characteristics

- Population density
- Impervious cover (%)
- Tree cover (%)
- Hydric soils (%)
- Road x stream crossing density
- Probability of land conversion



- Stream flow alteration
- Stream temperature alteration
- Stream / floodplain connectivity
- Aquatic community composition
- Toxics
- Emerging contaminates
- Fish Diseases
- Bacteria
- Nutrients
- Sediment

Diagnostic Measures of Stream Health

- % Forest Cover
- % Impervious Cover
- Landscape Condition Index
- Hydrology Index
- Geomorphology Index
- Habitat Index
- Biological Condition Index
- Water Quality Index
- Vulnerability Indices
  - Land Use Change
  - Water Use
  - Wildfire
  - Climate Change

Watershed Characteristics (metrics and indices)

Indicators of Watershed Health

Watershed Health Assessment Framework and Example Metrics

Bold: New metrics developed for this assessment

Watershed Health Index and Sub-Indices

The EPA Preliminary Healthy Watersheds Assessment method was used to calculate sub-indices and a watershed health indicator for each catchment in the Chesapeake Bay Watershed. Before combining into sub-indices, values were converted to a 0 to 1 scale, where 1 = the maximum value and other values were computed as the original value divided by the maximum. Positive metrics (i.e., those such as Percent Forest, with values expected to be higher in healthy watersheds) were not further transformed, but negative metrics (i.e.,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