Phase 7 Land Use

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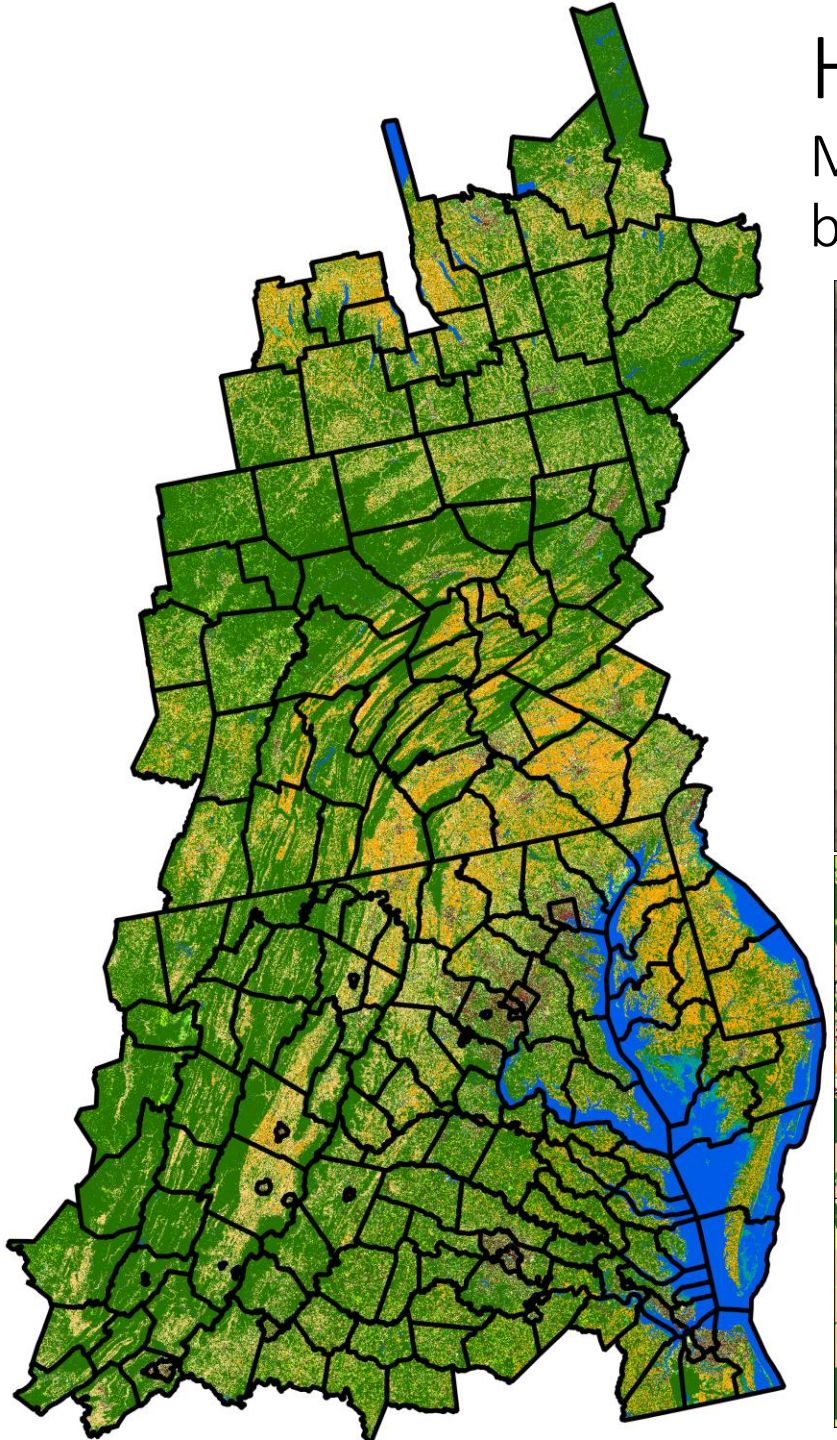
USGS, Lower Mississippi Gulf Water Science Center

Joint Meeting: Urban Stormwater & and Wastewater Treatment Workgroups

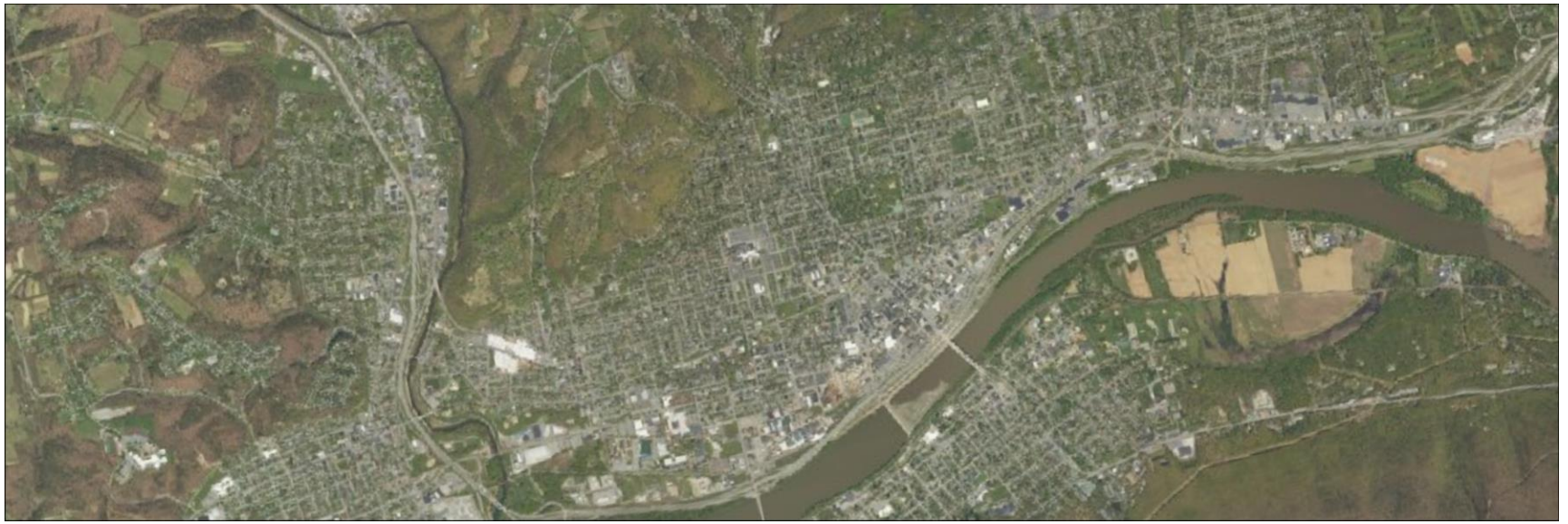
May 20, 2025

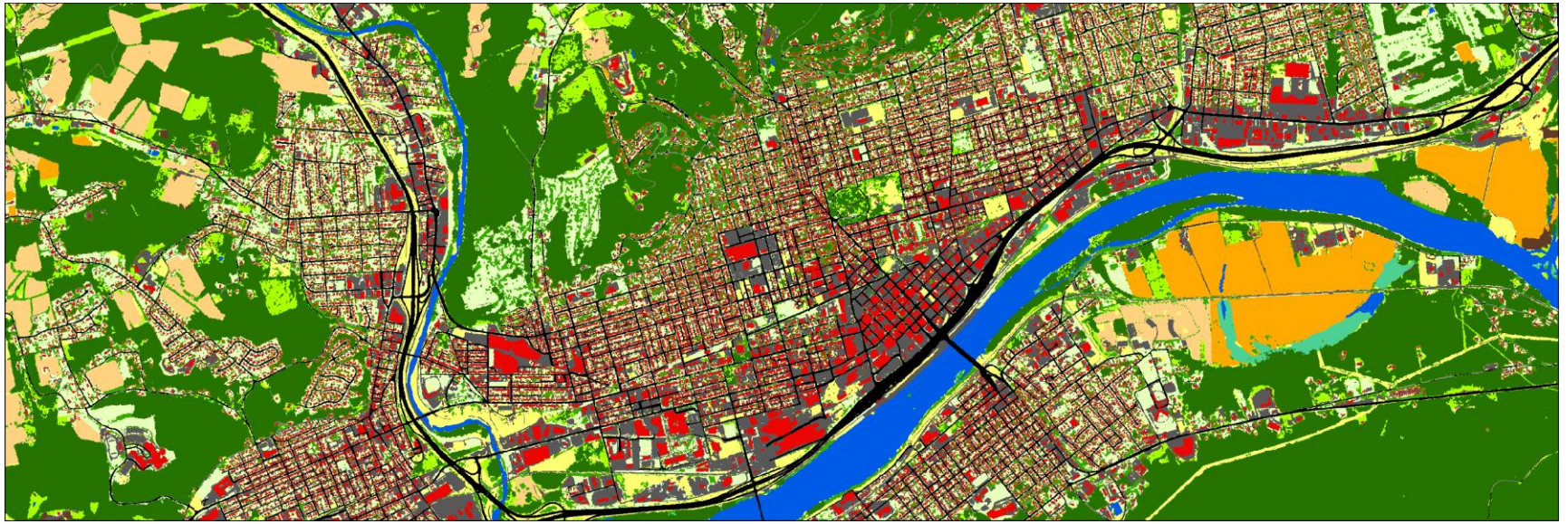
U.S. Department of the Interior
U.S. Geological Survey



High-Resolution Land Use/Land Cover (LULC)

Mapped data with high spatial and categorical resolutions that can be aggregated to different schemas and overlay geographies





What are the Accuracies to be Reported?

Static Land Cover

96% of the mapped region

Overall Accuracy*: 95%

Land Cover	Producer's*	User's*
Water	99%	98%
Herbaceous	94%	95%
Tree Canopy	97%	95%
Impervious	89%	91%
Barren	40%	63%

* Represents fuzzy (3x3-meter window) accuracy between 5 classes

Land Cover Change

4% of the mapped region

Overall Accuracy**: 86%

Producer's: 96%

User's: 77%

** Represents fuzzy (3x3-meter window) accuracy between change and no change

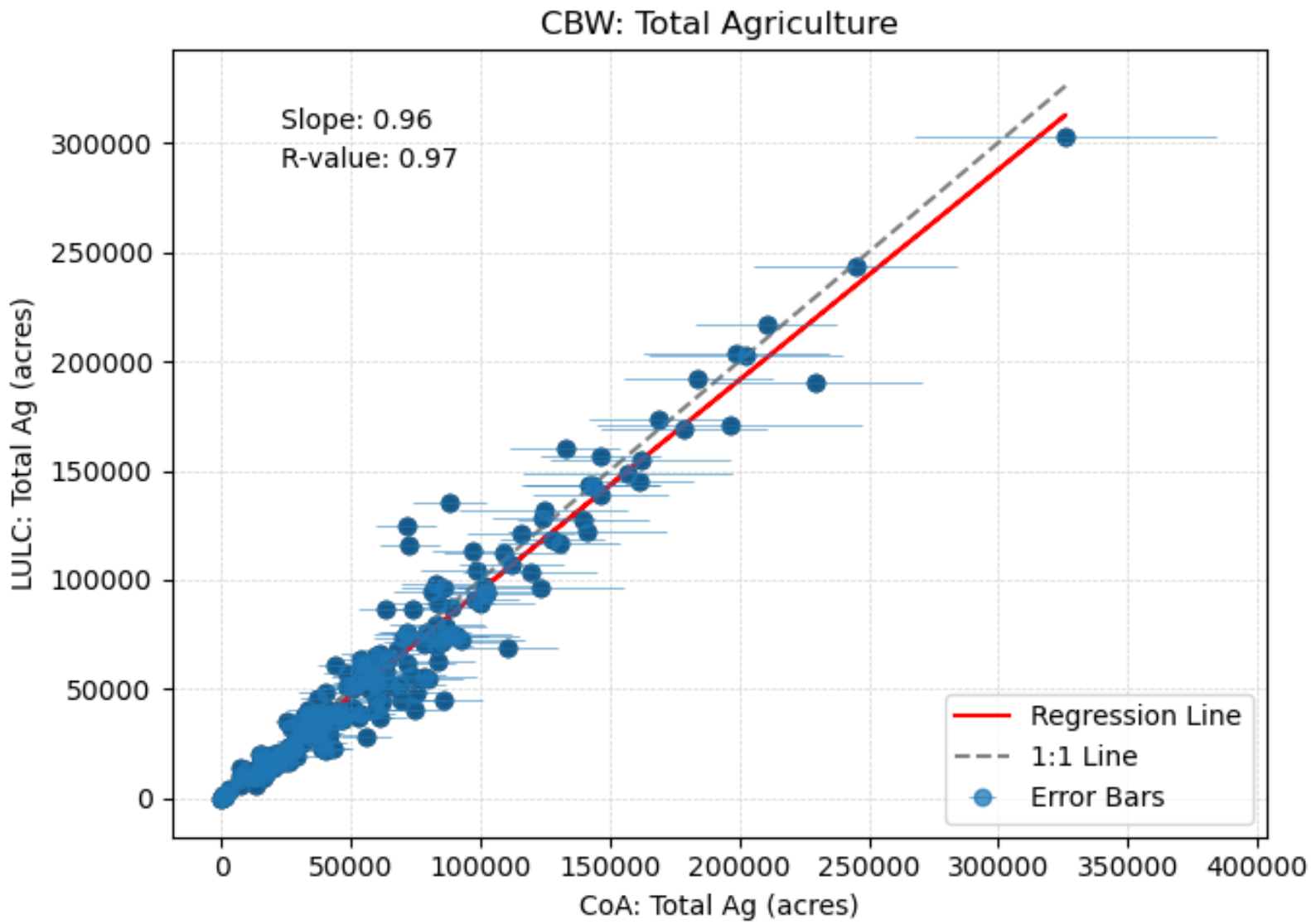
Water
Water

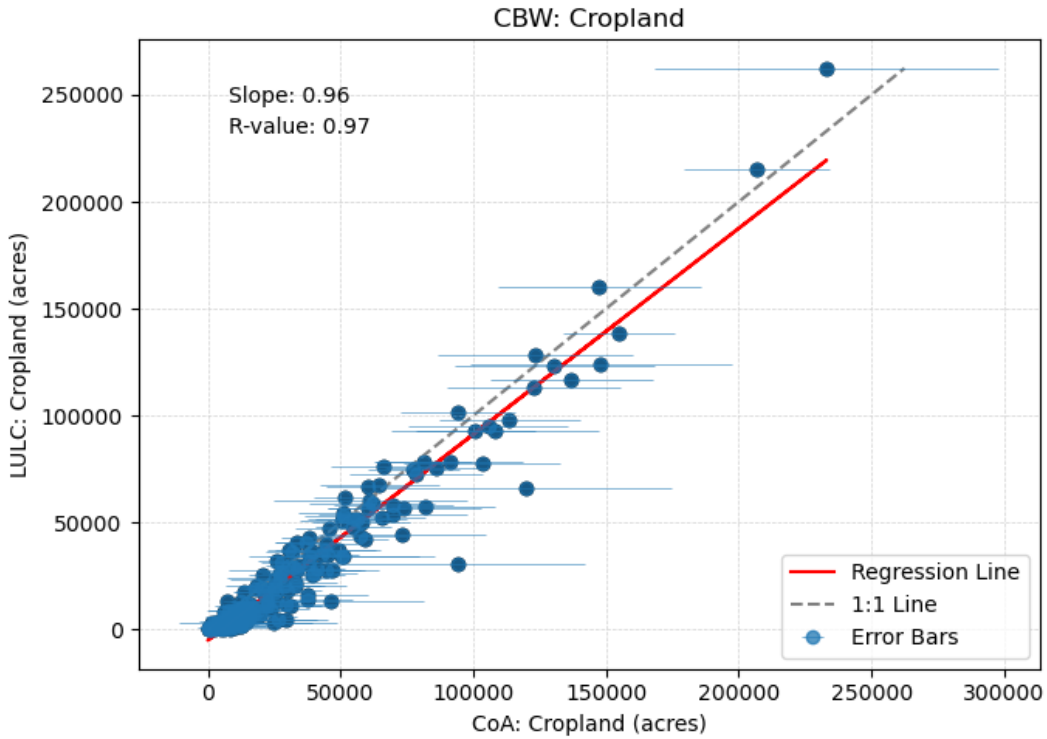
Herbaceous
Low Vegetation
Shrubland
Emergent Wetlands

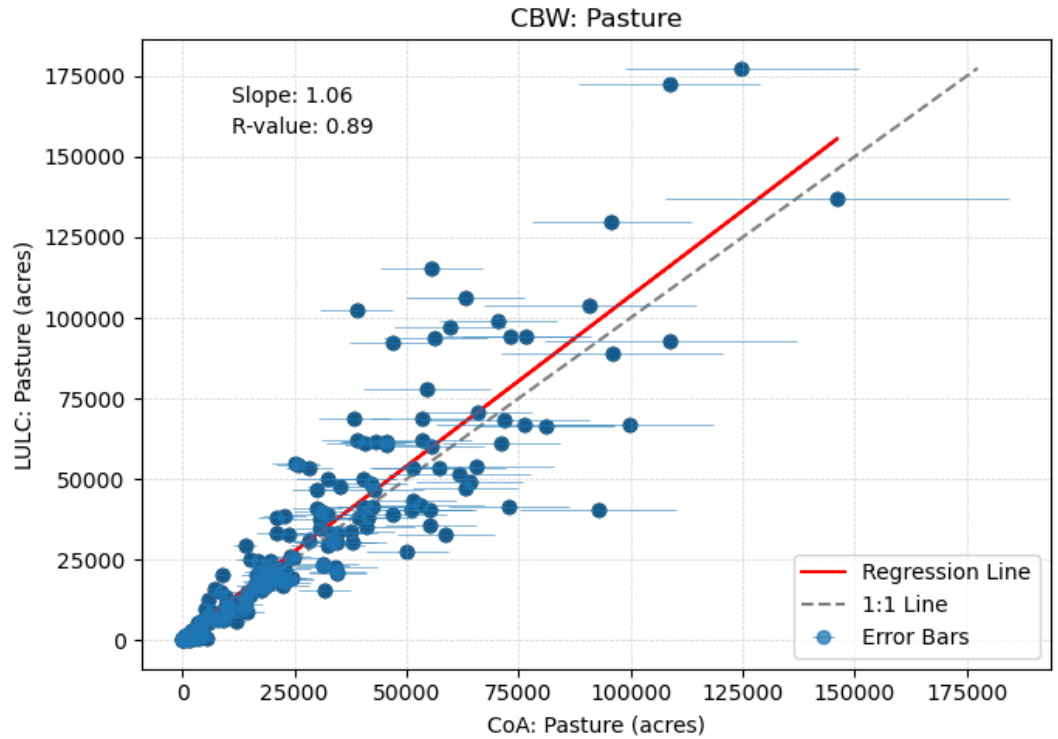
Tree Canopy
Tree Canopy
Tree Canopy over Structures
Tree Canopy over Other Impervious
Tree Canopy over Roads

Impervious
Structures
Other Impervious
Roads

Barren
Barren


CBW: Total Agriculture
Slope: 0.96
R-value: 0.97
LULC: Total Ag (acres)
CoA: Total Ag (acres)
0
50000
100000
150000
200000
250000
300000
350000
400000
Regression Line
1:1 Line
Error Bars

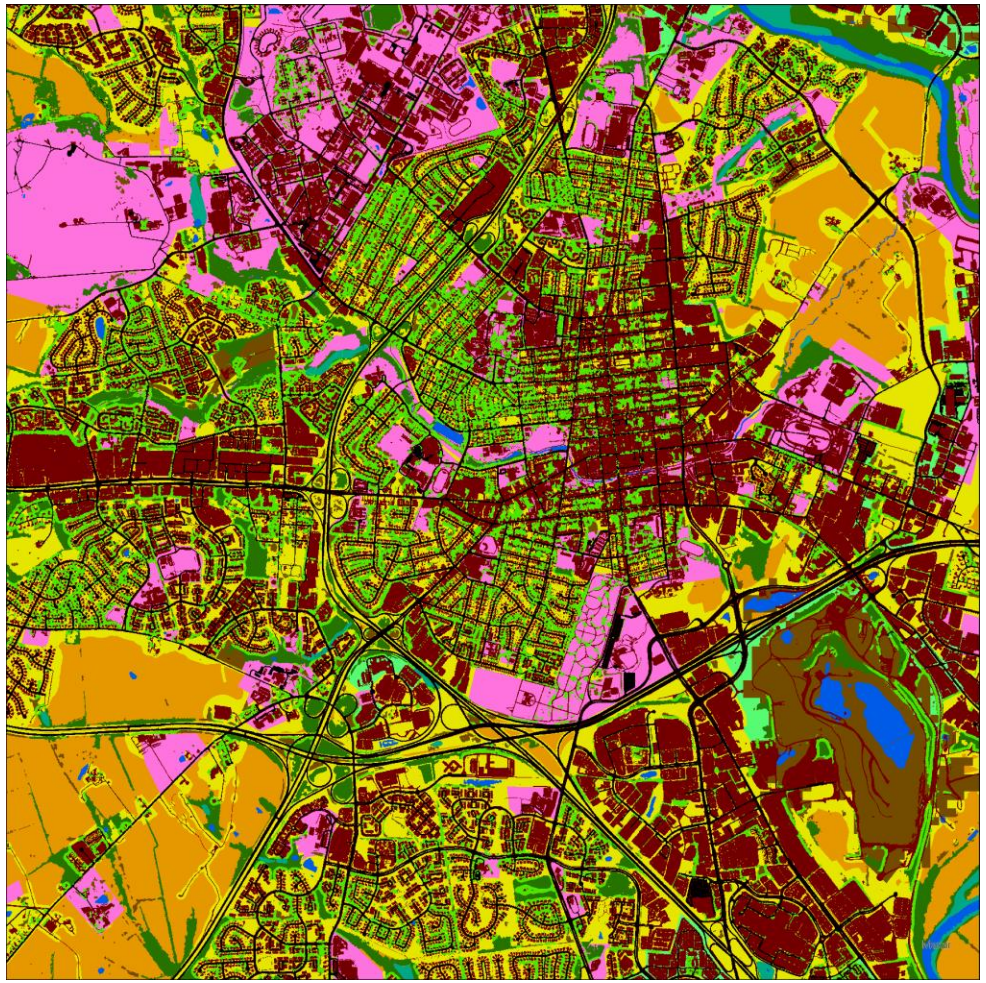

CBW: Cropland
Slope: 0.96
R-value: 0.97
LULC: Cropland (acres)
CoA: Cropland (acres)
Regression Line
1:1 Line
Error Bars
0
50000
100000
150000
200000
250000
300000


CBW: Pasture
Slope: 1.06
R-value: 0.89
LULC: Pasture (acres)
CoA: Pasture (acres)
Regression Line
1:1 Line
Error Bars
0
25000
50000
75000
100000
125000
150000
175000

How Has Land Use Improved Since Phase 6?

National Agricultural Imagery Program (NAIP)

LULC 2013: First high-res model released in 2017, 16-17 classes



- Impervious Roads
- Impervious Non-Roads
- Tree Canopy over Impervious
- Tree Canopy over Turf
- Turf Grass
- Fractional (small)
- Fractional (medium)
- Fractional (large)
- Fractional (impervious)
- Forest
- Agriculture
- Barren
- Tidal Wetlands
- Floodplain Wetlands
- Other Wetlands
- Water

WorldView SOLUTIONS

University of Vermont Spatial Analysis Lab

USGS science for a changing world

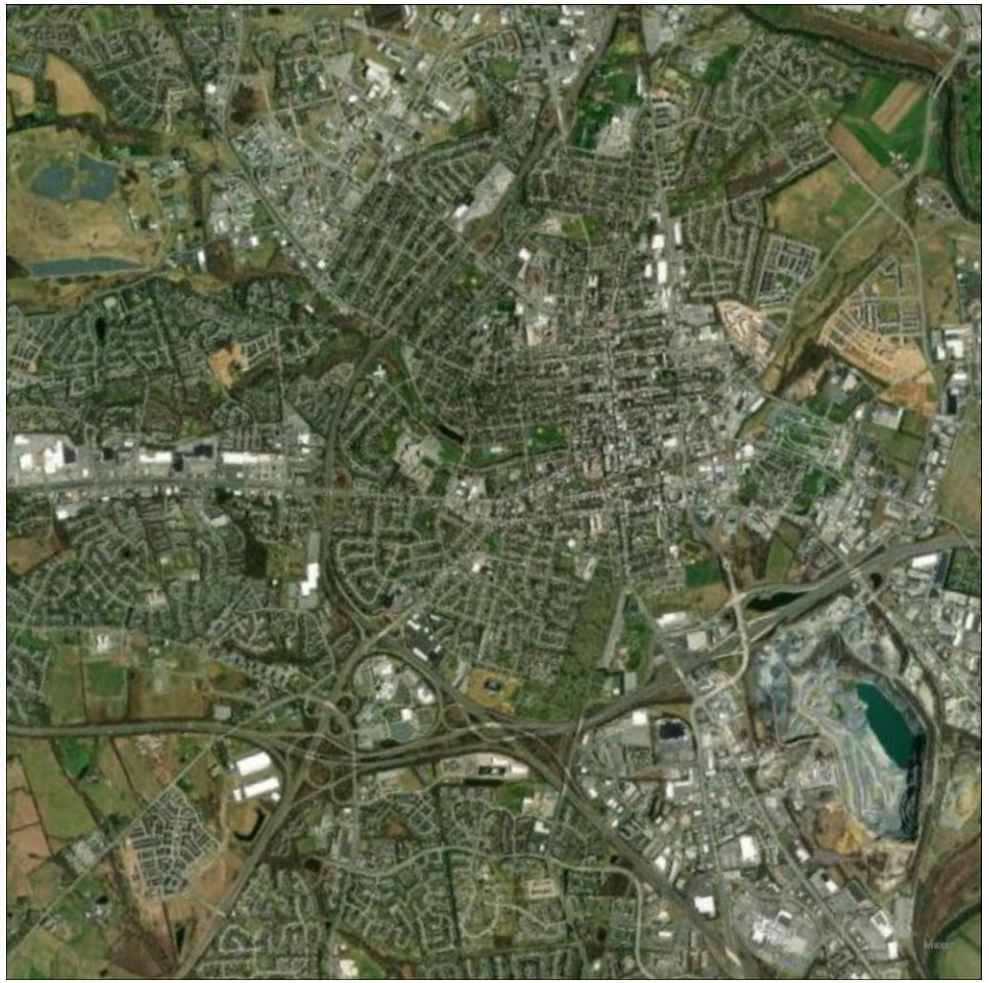
Chesapeake Conservancy

Chesapeake Bay Program
Science. Restoration. Partnership.

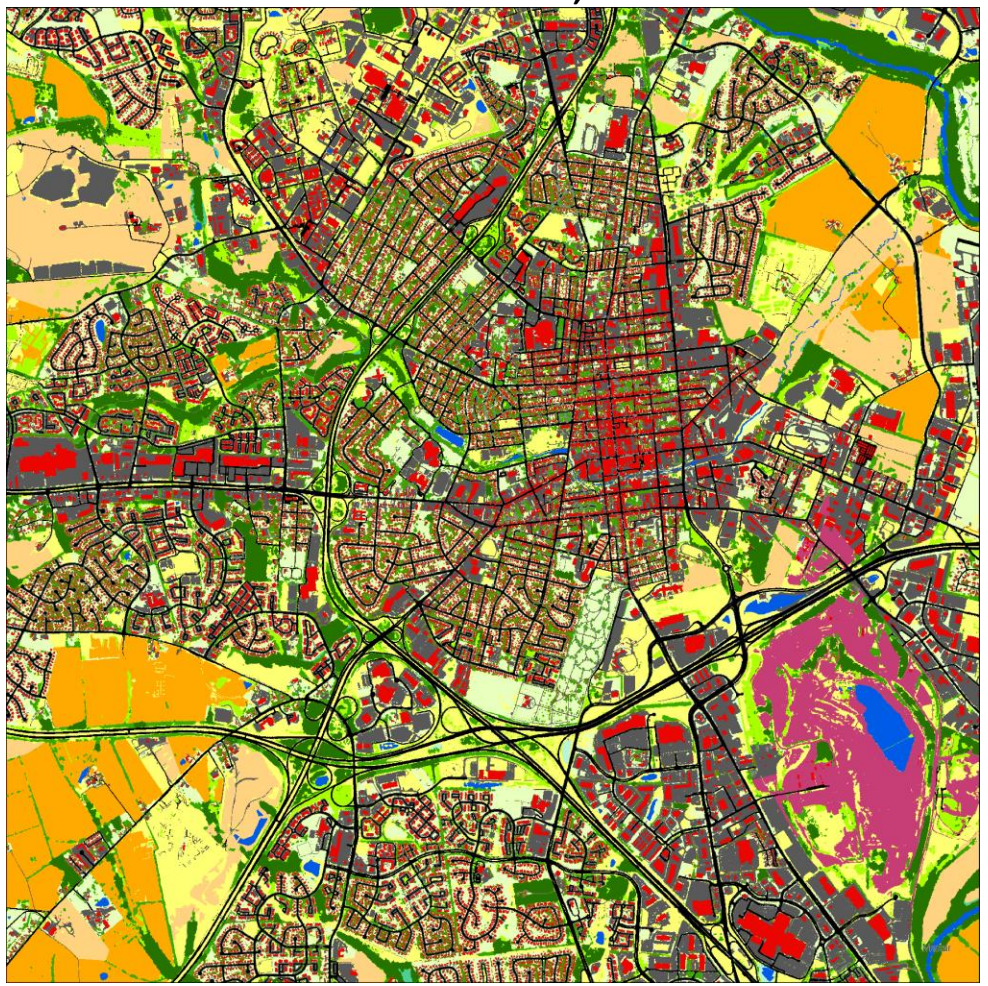
This version of the LULC was the first of its kind and was created for the development of the Phase 6 model.

How Has Land Use Improved Since Phase 6?

National Agricultural Imagery Program (NAIP)



LULC 2013: The third high-res model to be released in 2025, 56 classes



- Roads
- Structures
- Other Impervious
- Tree Canopy over Other Impervious
- Tree Canopy over Turf
- Turf Grass
- Pervious, Developed
- Cropland
- Pasture and Hay
- Extractive
- Forest
- Forested, Other
- Natural Succession
- Harvested Forest
- Tidal Wetlands, Non-forested
- Riverine Wetlands, Non-forested
- Terrene Wetlands, Non-forested
- Water

University of Vermont Spatial Analysis Lab

USGS science for a changing world

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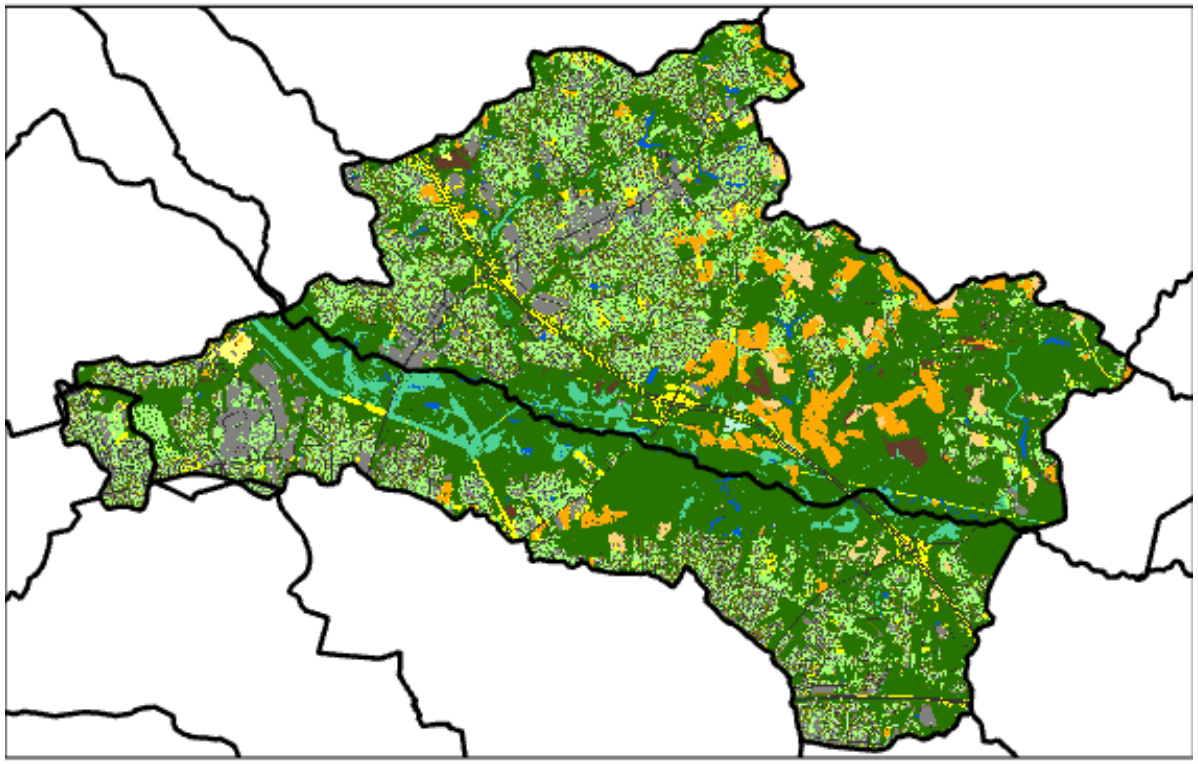
This version of LULC includes high-res LULC for three dates in time (2013/14, 2017/18, 2021/22) and change from 2013 to 2022. This product will be used in the development of the Phase 7 model.

What is the Phase 7 Aggregate Land Use?

Phase 7 Aggregate Land Use
*16 classes



The aggregated LULC schema that is summarized as acres by LRSEG and delivered to CAST to assess water quality

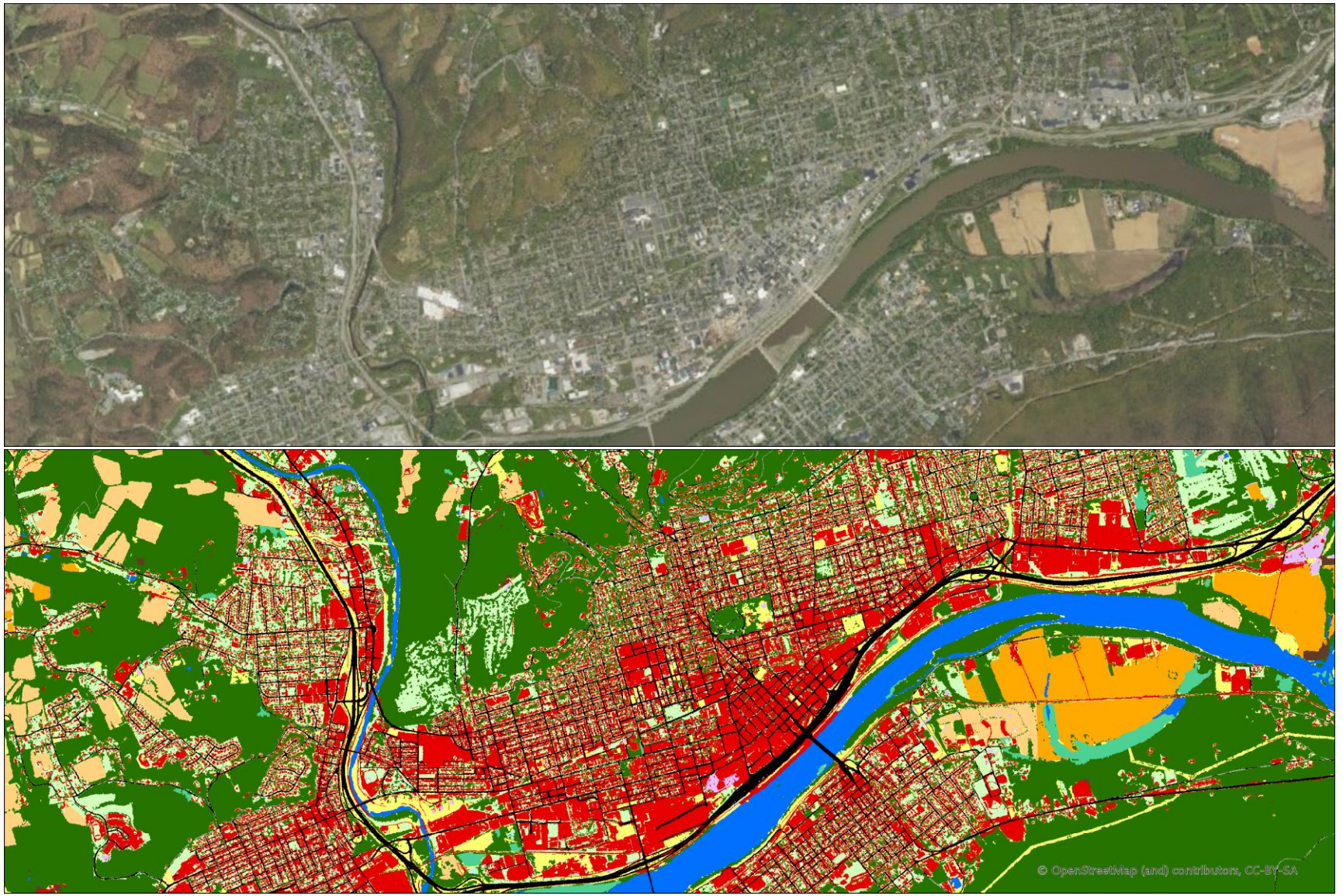
LULC = Land Use/Land Cover
LRSEG = Land River Segment
CAST = Chesapeake Assessment Scenario Tool
* Final classification schema for Phase 7 has not yet been approved.

Phase 7 Land Use Roll-Up

The aggregated LULC schema that is summarized as acres by LRSEG and delivered to CAST to assess water quality

Proposed 16-classes for Phase 7 Water Quality Modeling

- Impervious Roads
- Impervious Non-Roads
- Tree Canopy over Impervious
- Tree Canopy over Turf
- Turf Grass
- Compacted Pervious
- Solar Infrastructure
- Solar Pervious
- Construction
- Cropland
- Pasture and Hay
- Forest
- Harvested Forest
- Riverine Wetlands, Non-forested
- Terrene Wetlands, Non-forested
- Water



Why is the Phase 7 Aggregation Important?
Loading Implications

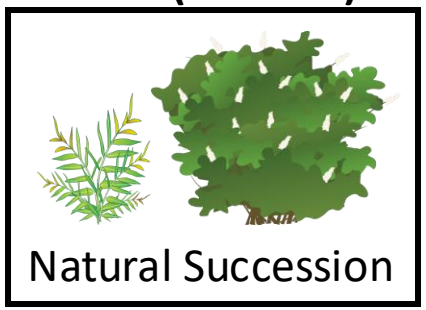
- Each land use has unique sediment, Nitrogen, and Phosphorus loading rates
  - Moving acres from one class to another results in a change in loads

Simplified Example

Changing the roll-up changes loads

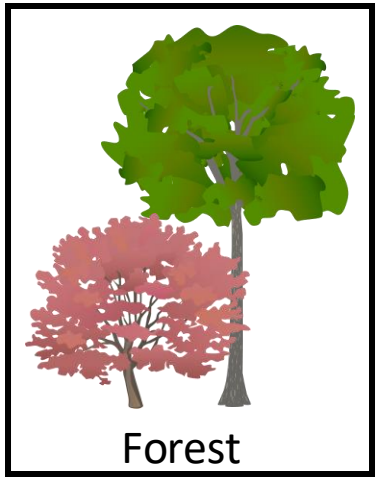
Phase 6 Roll-Up

LULC (56-class)



100-acres

Phase 7 Roll-Up



Nitrogen (N) and Phosphorus (P) Loads

N: 2.45 lbs/acre/year * 100-acres = 245 lbs/year

P: 0.43 lbs/acre/year * 100-acres = 43 lbs/year

Nitrogen (N) and Phosphorus (P) Loads)

N: 1.68 lbs/acre/year * 100-acres = 168 lbs/year

P: 0.08 lbs/acre/year * 100-acres = 8 lbs/year

Summary: How are the Land Use Products Related?

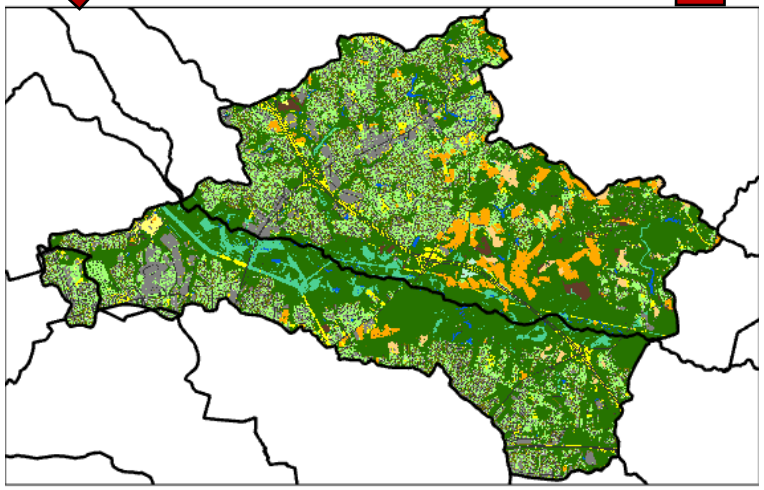
Aggregate LULC to Phase 7 classes

Summarize acres per class by LRSEG
Incorporate state-reported timber harvest and construction, CSOs, and Census of Agriculture

High-resolution LULC
56 classes

Mapped data with high spatial (1-meter) and categorical (56-class) resolutions that can be aggregated) to different schemas and summarized by any overlay geography to meet the needs of a variety of projects

Phase 7 Aggregate Land Use
*16 classes



The aggregated LULC to the Phase 7 schema for assessing water quality.

CAST Land Use
49* classes
(or load sources)

County	LRSEG	Land Use	Acres
ABC	1	Grass	100
ABC	2	CSS Roads	200
ABC	3	Pasture	50
DEF	4	Septic	35
DEF	5	True Forest	500

Table of acres per load source (or land use) by land-river segment (counties x watersheds) in which BMPs are applied and loads are calculated.

CSO = Combined Sewer Overflows
* Final classification schema for Phase 7 has not yet been approved.

Proposed Aggregation of High-Res LULC for Phase 7

1. **Impervious, Roads**
   - Roads
2. **Impervious, Non-Roads**
   - Structures
   - Other Impervious (Parking lots, driveways)
   - Extractive Impervious
3. **Tree Canopy Over Impervious**
   - TC over Roads
   - TC over Structures
   - TC over Other Impervious
4. **Turf Grass**
   - Turf Grass
5. **Tree Canopy over Turf Grass**
   - Tree Canopy over Turf Grass
6. **Solar Infrastructure**
   - Solar Field Panel Arrays
7. **Solar Pervious**
   - Solar Field Herbaceous
   - Solar Field Shrubland
8. **Compacted Pervious**
   - Extractive Barren
   - Suspended Succession Barren
   - Suspended Succession Herbaceous
   - Suspended Succession Shrubland
   - Natural Succession Herbaceous (urban areas)
9. **Construction**
   - Bare Developed (Urban areas)
   - Solar Field Barren
   - Natural Succession Barren (Urban areas and adjacent to impervious change)
   - Cropland Barren (Urban areas and adjacent to impervious change)
   - Reported Data from States
10. **Forest**
    - Forest
    - Forested, Other
    - Natural Succession Herbaceous (rural areas)
    - Natural Succession Shrubland
    - Riverine Wetlands Tree Canopy
    - Riverine Wetlands Forest
    - Terrene Wetlands Tree Canopy
    - Terrene Wetlands Forest
11. **Harvested Forest**
    - Harvested Forest Barren
    - Harvested Forest Herbaceous
    - Natural Succession Barren (Rural areas)
    - Reported Data from States
12. **Wetlands, Riverine Non-forested**
    - Riverine Wetlands Barren
    - Riverine Wetlands Herbaceous
    - Riverine Wetlands Shrubland
    - Riverine Wetlands Harvested Forest
13. **Wetlands, Terrene Non-forested**
    - Terrene Wetlands Barren
    - Terrene Wetlands Herbaceous
    - Terrene Wetlands Shrubland
    - Terrene Wetlands Harvested Forest
14. **Cropland**
    - Cropland Barren
    - Cropland Herbaceous
    - Orchards and Vineyards Barren
    - Orchards and Vineyards Herbaceous
    - Orchards and Vineyards Shrubland
15. **Pasture and Hay**
    - Pasture and Hay Barren
    - Pasture and Hay Herbaceous
16. **Water**
    - Lakes & Reservoirs
    - Riverine Ponds
    - Terrene Ponds
    - Streams and Rivers (visible water)
    - Bare Shore- adjacent to lakes

Blue = LULC 56-class schema
White = Phase 7 Rollup schema

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Blue = LULC 56-class schema
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8. **Compacted Pervious**
   - Extractive Barren
   - Suspended Succession Barren
   - Suspended Succession Herbaceous
   - Suspended Succession Shrubland
   - Natural Succession Herbaceous (urban areas)

Classes in white represent proposed schema that the LULC will be summarized as acres by LRSEG and delivered to CAST

and adjacent

Cropland Barren (Urban areas and adjacent to

Classes in blue in what is actually mapped in the LULC

10. **F**
    - Forested, Other
    - Natural Succession Herbaceous (rural areas)
    - Natural Succession Shrubland
    - Riverine Wetlands Tree Canopy
    - Riverine Wetlands Forest
    - Terrene Wetlands Tree Canopy
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    - Orchards and Vineyards Herbaceous
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16. **Water**
    - Lakes & Reservoirs
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    - Terrene Ponds
    - Streams and Rivers (visible water)
    - Bare Shore- adjacent to lakes

Phase 7 Construction

Option 1: Reported by states

- Permitted (E&S) disturbed area per year per county or HUC12;
- Allocated from HUC12 or county to land-river segments in proportion to mapped developed area;
- Subtracted from mapped developed area (?) in each land-river segment.

Option 2: Mapped by CBPO

- X * (estimated annual change in impervious surfaces in each land-river segment) in non-mapped years;
- Mapped construction = bare construction + (natural succession barren & cropland barren in urban areas) acres for mapping years;
- Subtracted from mapped developed area in each land-river segment.

Phase 7 Construction - considerations

Why map construction?

- Exposed and disturbed soil is prone to erosion and contributes nutrients and sediment to streams even when permitted with Erosion and Sediment Control BMPs.
- Average noBMP loading rates (lbs./acre/yr.): 21.7 TN, 3.5 TP, and 8025 SED
- Average WIP loading rates (lbs./acre/yr.): 19.4 TN, 3.5 TP, and 2337 SED

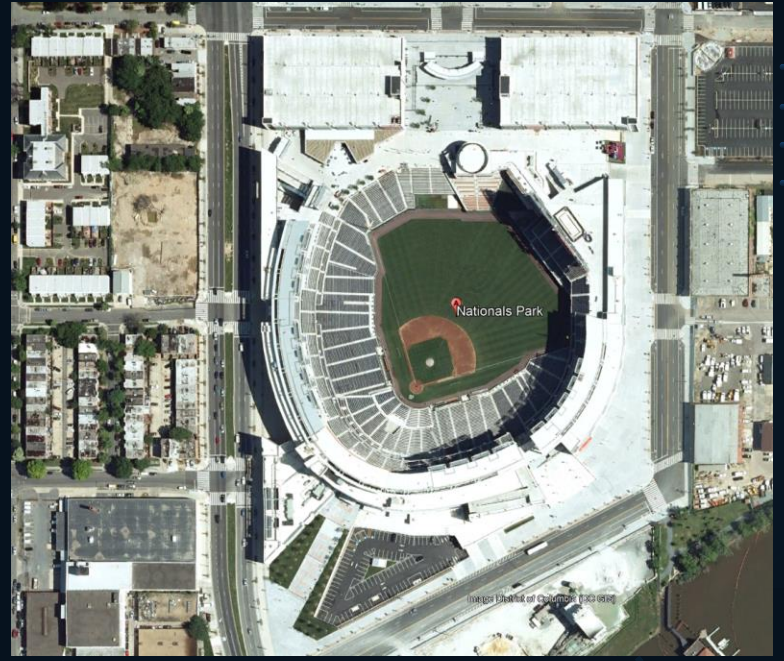
Difference between reported and mapped construction

- Reported construction represents permitted disturbed areas multiplied by an implementation/compliance rate, potentially averaged over multiple years and may not reflect actual disturbed areas.
- Mapped construction represents bare ground areas that are presumed to be associated with the land development process but may include lands unvegetated for other reasons.

Natural Succession Barren

2005

2006

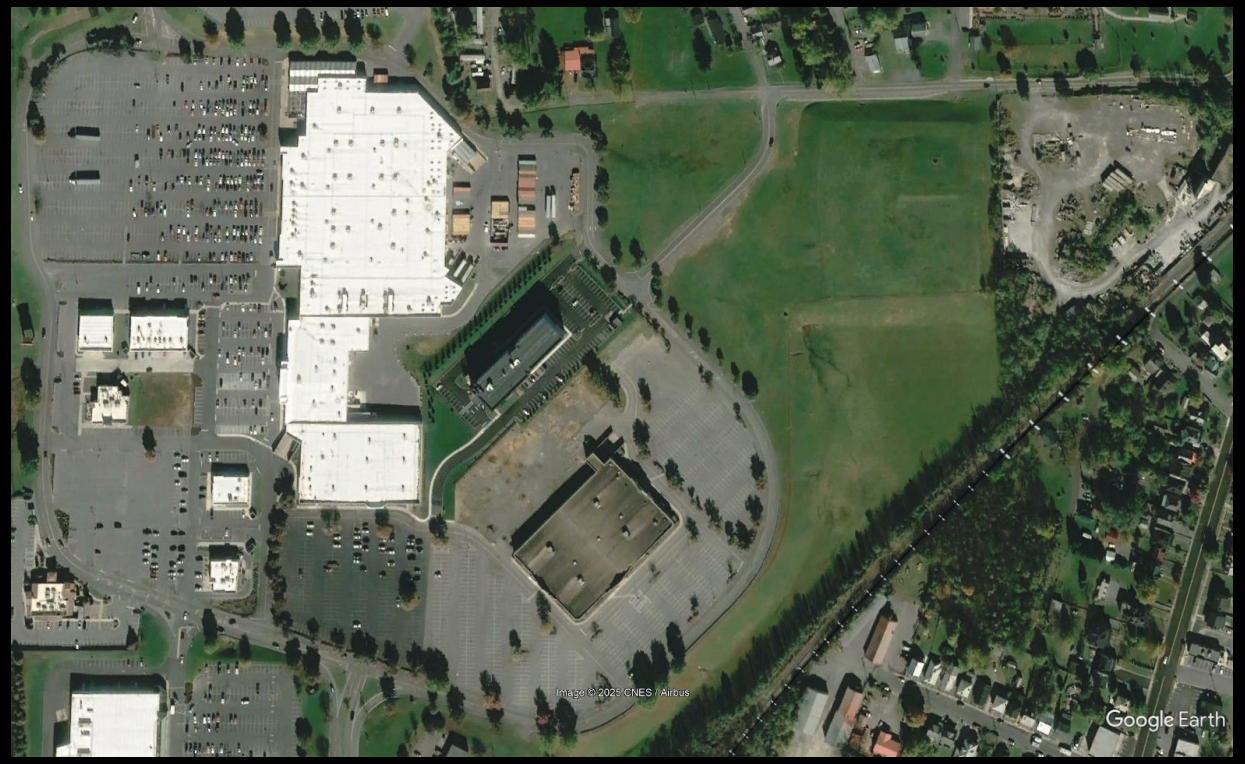


2008

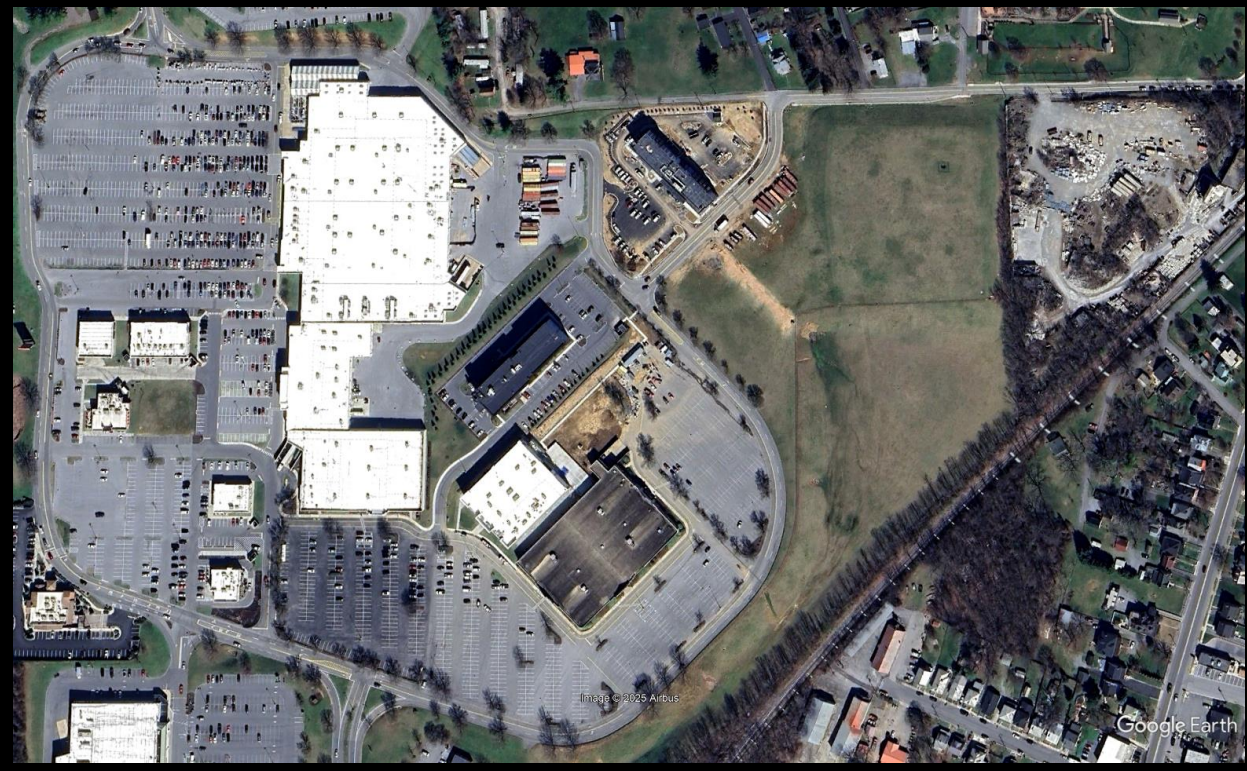
Bare Developed

Construction Permit, Berkeley County, WV

11/2020



3/2024



Construction Permit, Berkeley County, WV

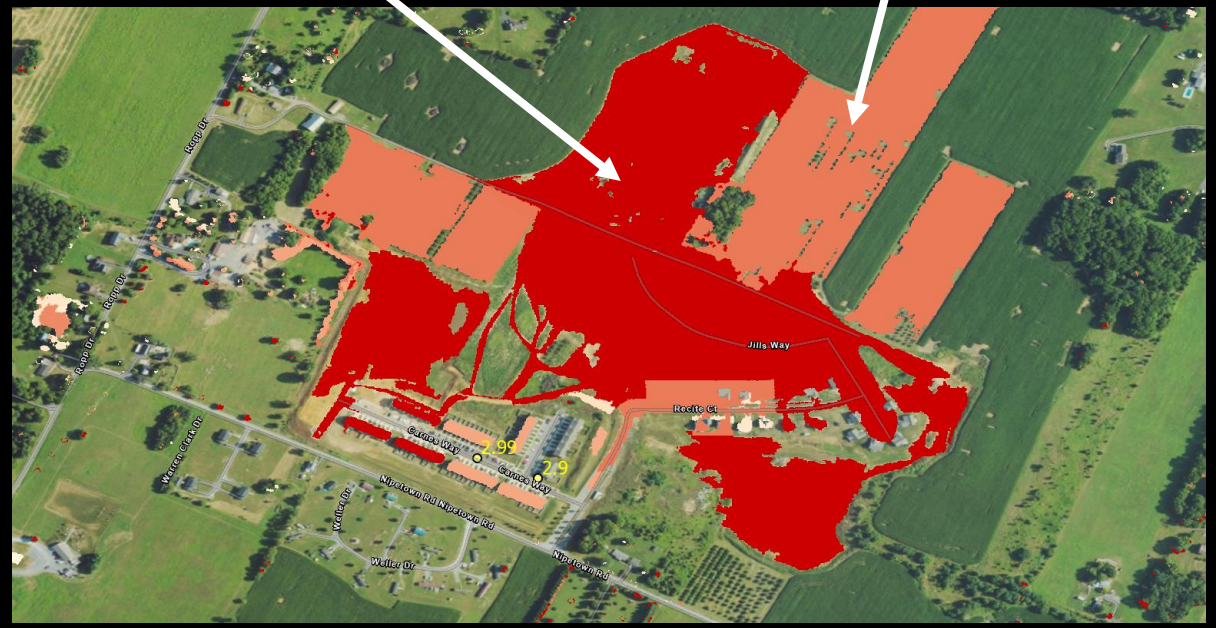
Change from 2018 - 2022

Construction Permit, Berkeley County, WV

Change from 2018 - 2022

Cropland Herbaceous
To
Cropland Barren

Natural Succession Herbaceous
To
Natural Succession Shrubland



Next Steps

Compare additional remotely-sensed high-res barren land with spatially-explicit construction data reported by the jurisdictions.

Further refine mapping of areas under construction vs areas that are maintained in a barren state.

Consider changes to loading rates for the Phase 7 “compacted pervious” class (permanently barren areas).

Consider changes to loading rates for construction associated with infill and redevelopment vs greenfield development.

Questions?

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