Phase 7 Land Use

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USGS, Lower Mississippi Gulf Water Science Center

Modeling Work Group Quarterly Meeting

April 7, 2026

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

What is a summary unit?

The analysis units used in CAST (Chesapeake Assessment Scenario Tool)

- A combination of layers (has not yet been approved for Phase 7)

- Land-River segments (LRSEGs)
  - Land segments = county boundaries
  - River segments = 12-digit Hydrologic Unit Codes (HUCs)
  - Shoreline = tidal shoreline boundary
  - Climate boundaries = orographic regions
    - Along the Blue Ridge

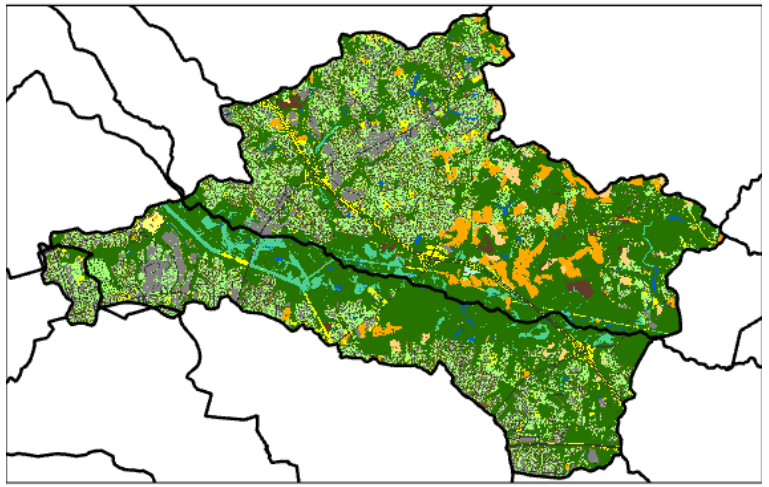
- Summary Units
  - LRSEGs
  - Municipal Separate Storm Sewer Systems (MS4s)
  - Federal Lands
  - Combined Sewer Overflows (CSOs)
  - 1:100k National Hydrography Dataset (NHD) Catchments

What Does “Land Use” Mean?

High-resolution LULC
56 classes

Mapped from aerial imagery, Light Detecting and Ranging (LiDAR), and ancillary data sources.

Phase 7 Rollup Land Use
17 classes



Reclassifies mapped LULC and summarizes as acres per class per summary unit to form the base land use for CAST.

CAST Land Use
51 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

Incorporates reported data (census of agriculture, state annually-reported forest harvest and construction acres, CSO separations) with the base land use acres. Produces acres of land use by summary unit in which BMPs are applied and loads are calculated.

LULC = Land Use/Land Cover
LRSEG = Land River Segment
CAST = Chesapeake Assessment Scenario Tool
BMP = Best Management Practice
CSO = Combined Sewer Overflows

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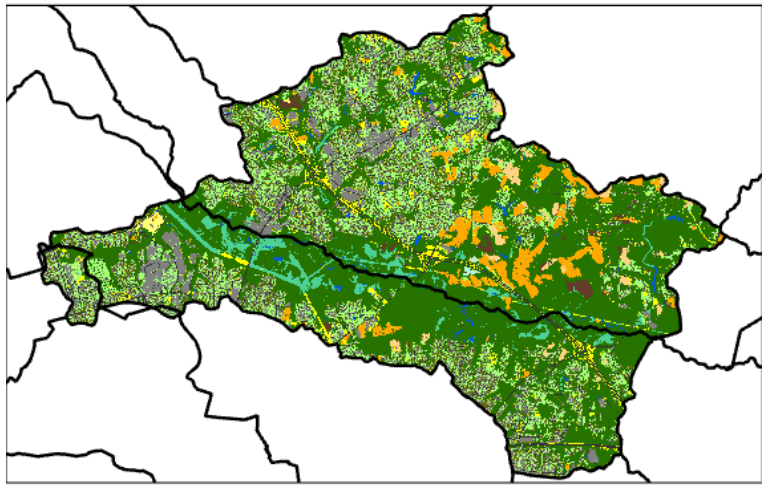

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High-resolution Land Use/Land Cover → Phase 7 Land Use

P7 Sector	HR Land Use/Land Cover	P7 Mapped Land Use	P7 CAST Land Uses/Sources
Agriculture	Cropland Barren Cropland Herbaceous Orchards and Vineyards Barren Orchards and Vineyards Herbaceous Orchards and Vineyards Shrubland	**Cropland**	Double Cropped Land Full Season Soybeans Silage with Manure Silage without Manure Small Grains and Grains Specialty Crop High Specialty Crop Low Grain with Manure Grain without Manure Other Agronomic Crops
	Pasture and Hay Barren Pasture and Hay Herbaceous	**Pasture and Hay**	Pasture / Pasture high Leguminous Hay Other Hay / Hay high Ag Open Space
	Extractive Impervious Other Impervious Structures	**Impervious Non-Roads**	Permitted Feeding Space Non-Permitted Feeding Space

P7 Sector	HR Land Use/Land Cover	P7 Mapped Land Use	P7 CAST Land Uses/Sources
Developed	Bare Developed Extractive Barren Natural Succession Barren (urban) Natural Succession Herbaceous (urban) Suspended Succession Barren Suspended Succession Herbaceous Suspended Succession Shrubland	**Compacted Pervious**	CSS Compacted Pervious MS4 Compacted Pervious Non-Regulated Compacted Pervious
	Roads	**Impervious Roads**	CSS Roads MS4 Roads Non-Regulated Roads
	Extractive Impervious Other Impervious Structures	**Impervious Non-Roads**	CSS Buildings and Other MS4 Buildings and Other Non-Regulated Buildings and Other
	Tree Canopy Over Other Impervious Tree Canopy Over Roads Tree Canopy Over Structures	**Tree Canopy over Impervious**	CSS Tree Canopy over Impervious MS4 Tree Canopy over Impervious Non-Regulated Tree Canopy over Impervious
	Tree Canopy Over Other Impervious Tree Canopy Over Roads Tree Canopy Over Structures	**Tree Canopy over Turf**	CSS Tree Canopy over Turf Grass MS4 Tree Canopy over Turf Grass Non-Regulated Tree Canopy over Turf Grass
	Turf Grass	**Turf Grass**	CSS Turf Grass MS4 Turf Grass Non-Regulated Turf Grass
	Barren lands developed in the future	**Construction**	CSS Construction Regulated Construction
	Solar Field Panel Arrays	**Solar Infrastructure**	CSS Solar Infrastructure MS4 Solar Infrastructure Non-Regulated Solar Infrastructure
	Solar Field Barren Solar Field Herbaceous Solar Field Shrubland	**Solar Pervious**	CSS Solar Pervious MS4 Solar Pervious Non-Regulated Solar Pervious

Bye-bye Mixed Open

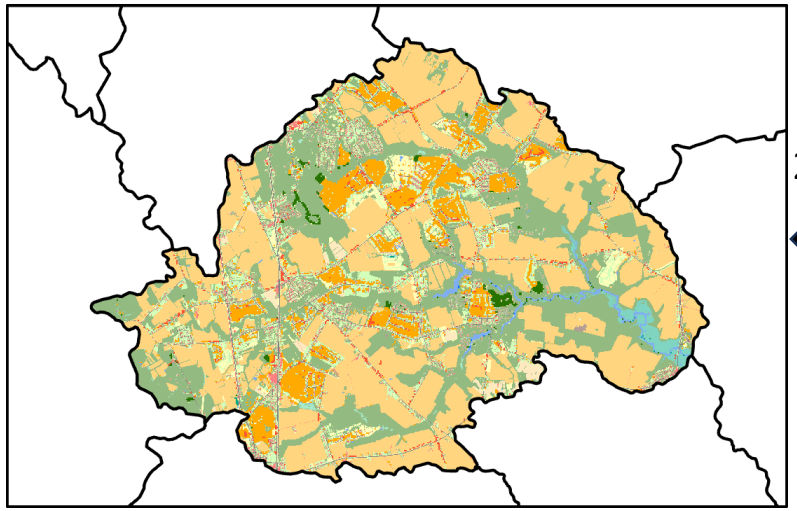
Phase 6 Mixed Open	Phase 7 Land Use
Bare Shore	Water
Bare Developed	Construction or Compacted Pervious
Extractive Barren	Construction or Compacted Pervious
Natural Succession Barren	Construction, Harvested Forest (rural areas), or Compacted Pervious (urban areas)
Natural Succession Herbaceous	Forest (rural areas) or Compacted Pervious (urban areas)
Natural Succession Shrubland	Forest
Suspended Succession Barren	Construction or Mixed open
Suspended Succession Herbaceous	Compacted Pervious
Suspended Succession Shrubland	Compacted Pervious
Solar Field Barren	Construction or Solar Pervious (loading like turf grass)
Solar Field Herbaceous	Solar Pervious (loading like turf grass)
Solar Field Shrubland	Solar Pervious (loading like turf grass)
Harvested Forest Barren	Construction or Harvested Forest
Harvested Forest Herbaceous	Harvested Forest

High-resolution Land Use/Land Cover → Phase 7 Land Use

P7 Sector	HR Land Use/Land Cover	P7 Mapped Land Use	P7 CAST Land Uses/Sources
Natural	Forest Forested Other Riverine Wetlands Forest Riverine Wetlands Forested Other Terrene Wetlands Forest Terrene Wetlands Forested Other Natural Succession Herbaceous (rural) Natural Succession Shrubland	**Forest**	CSS Forest True Forest
	Harvested Forest Barren Harvested Forest Herbaceous Natural Succession Barren (rural)	**Harvested Forest**	CSS Harvested Forest Harvested Forest
	Riverine Wetlands Barren Riverine Wetlands Harvested Forest Riverine Wetlands Herbaceous Riverine Wetlands Shrubland	**Floodplain Wetlands**	Non-tidal Floodplain Wetland
	Terrene Wetlands Barren Terrene Wetlands Harvested Forest Terrene Wetlands Herbaceous Terrene Wetlands Shrubland	**Other Wetlands**	Headwater or Isolated Wetland
Water	Lakes and Reservoirs Riverine Ponds Streams and Rivers Terrene Ponds Bare shore	**Water**	Water

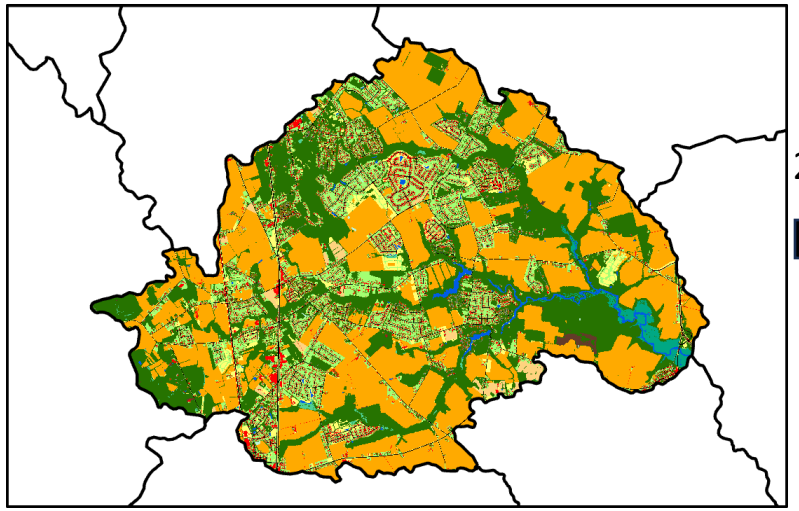
How do we assess land use over time?

Past Land Use (30m)
1985-2012



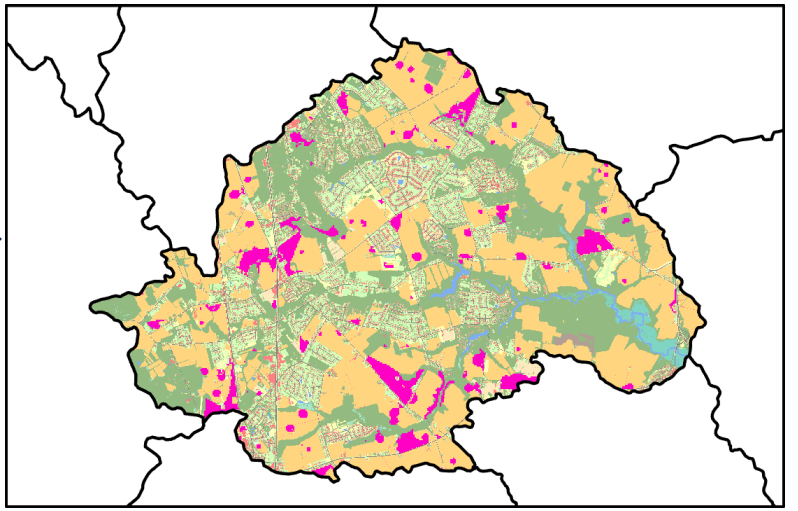
2013

Present Land Use (1m)
2013-2022



2022

Future Land Use (30m)
2023-2040 (2075)



Annual historic land use condition and trends by summary unit. NLCD detects and classifies change back through time with historical satellite imagery from Landsat at 30-meter resolution. The present is deconstructed where change is detected and summarized by summary unit.

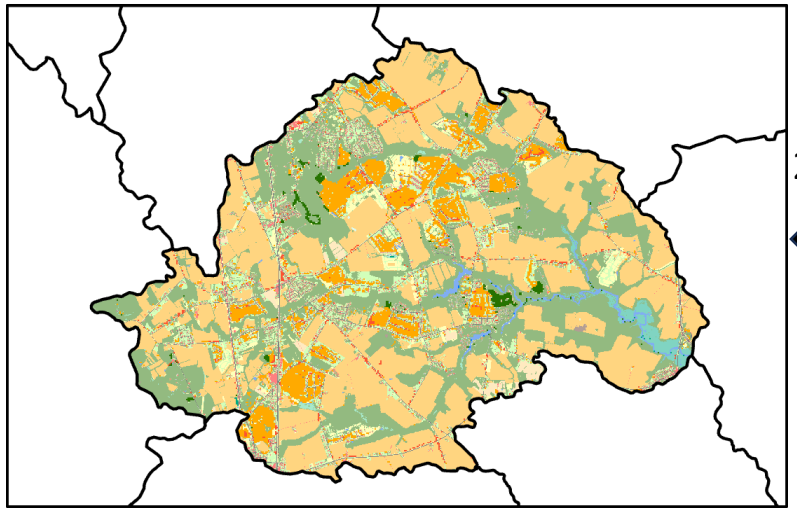
LULC = Land Use/Land Cover
LRSEG = Land River Segment
NLCD = National Land Cover Database

The land use conditions in the present, derived from the LULC at 1-meter resolution and by summary unit. Annualized from the mapped dates 2013/14, 2017/18, and 2021/22. Serves as the starting point for the back-cast and forecasts.

Future land use trends modeled with the Chesapeake Bay Land Change Model (CBLCM). Urban growth model that converts forest and farmland to development to allocate for population growth. Usually predicted in 5- or 10-year increments. Modeled at 30-meter resolution and summarizes land use by summary unit for modeled years.

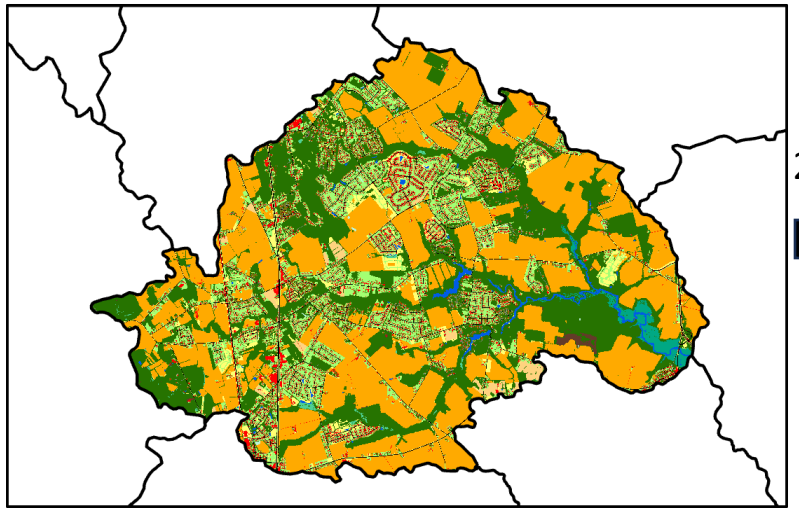
How do we assess land use over time?

Past Land Use (30m)
1985-2012



2013

Present Land Use (1m)
2013-2022



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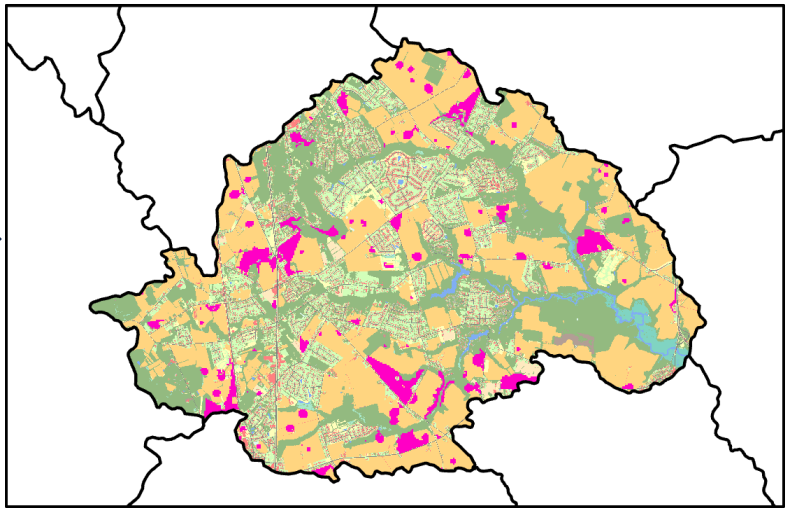
Future Land Use (30m)
2023-2040 (2075)



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Three distinct land use products that work together to provide a consistent classification of land use trends for the past, present and future

LULC = Land Use/Land Cover
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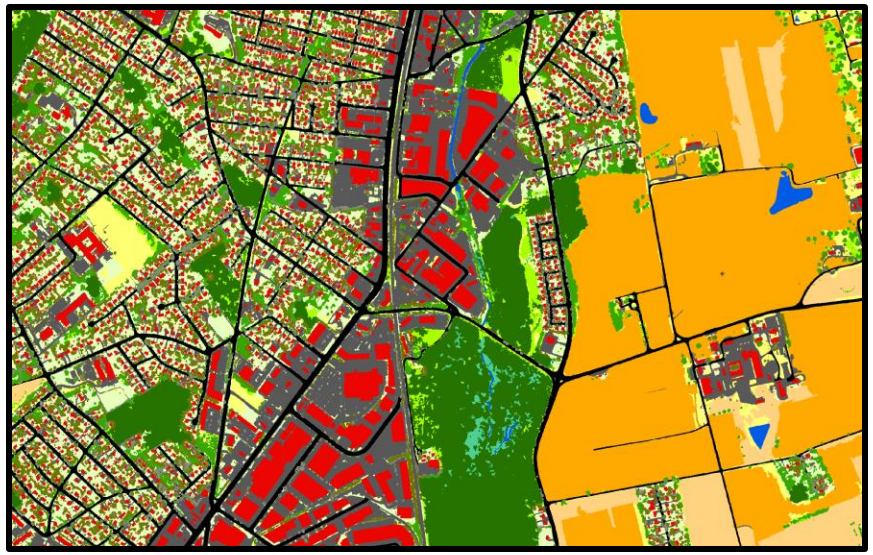
Data

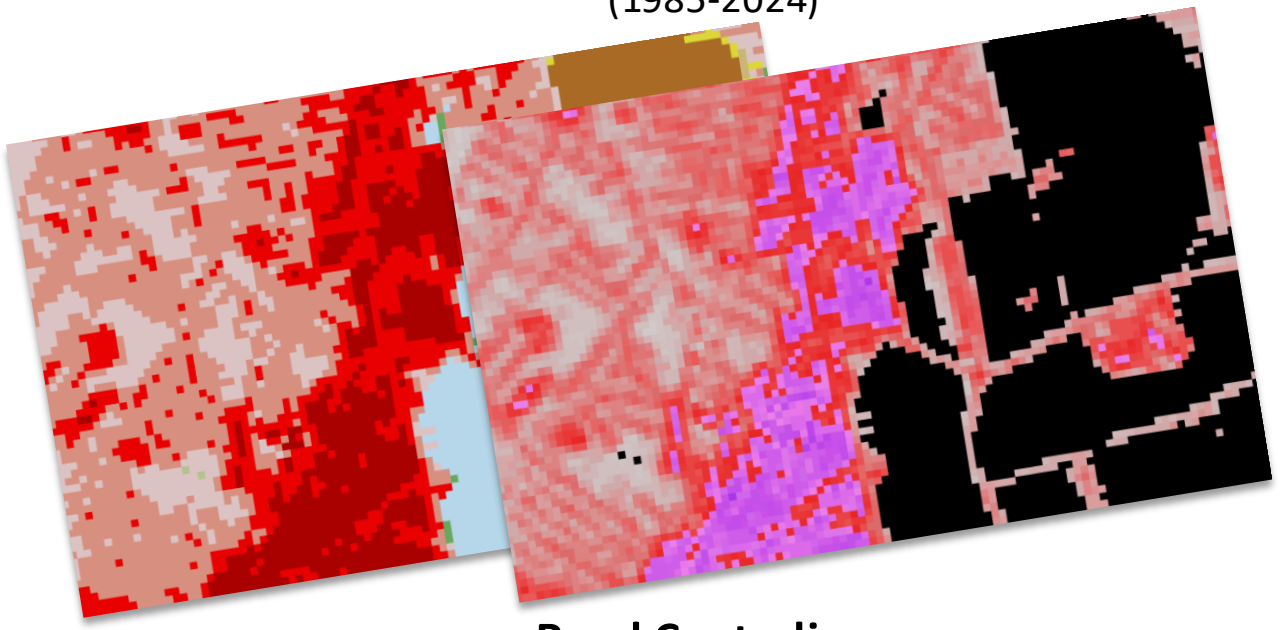
High-Resolution Land Use/Land Cover

Land Use
2013/14, 2017/18, 2021/22



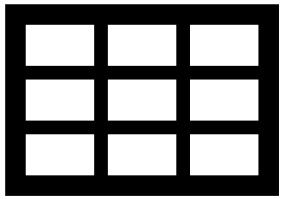
National Land Cover Database (NLCD)

Annual Land Cover and % Impervious
(1985-2024)

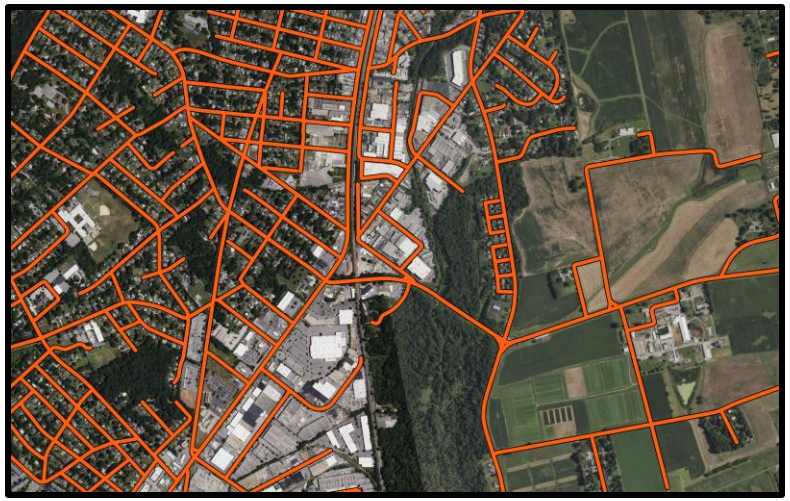


Parcel Boundaries

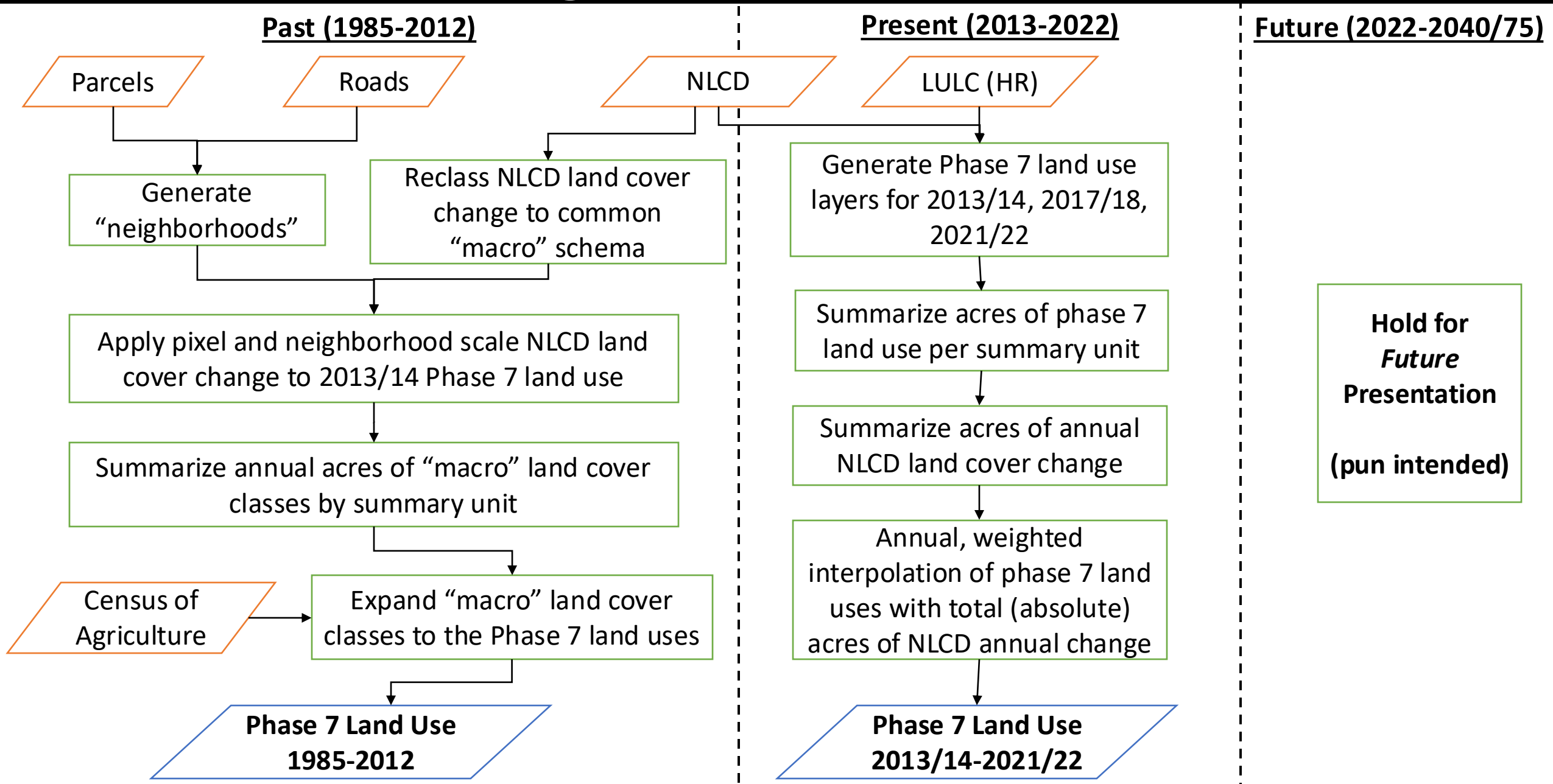
Census of Agriculture



Road Centerlines



High-Level Methods



High-Level Methods

Past (1985-2012)

Parcels

Roads

NLCD

Generate

Reclass NLCD land cover

More detailed back-cast methods available on Land Use Work Group site, under March Office Hours: LandUseTimeSeries_LUWG-Office-Hours_20260303.pdf

Census of Agriculture

Expand "macro" land cover classes to the Phase 7 land uses

Phase 7 Land Use 1985-2012

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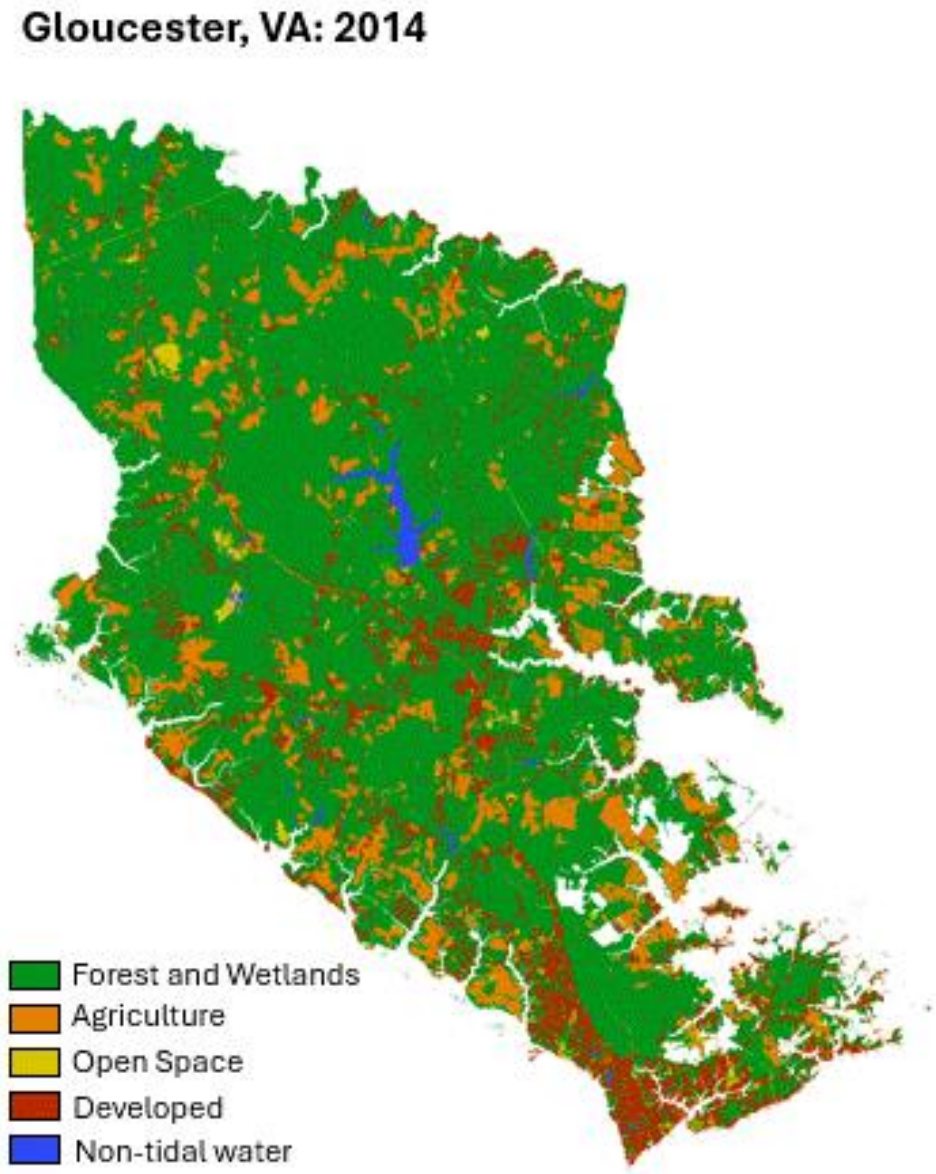


Review Process (https://gis.chesapeakebay.net/lulctrends/)

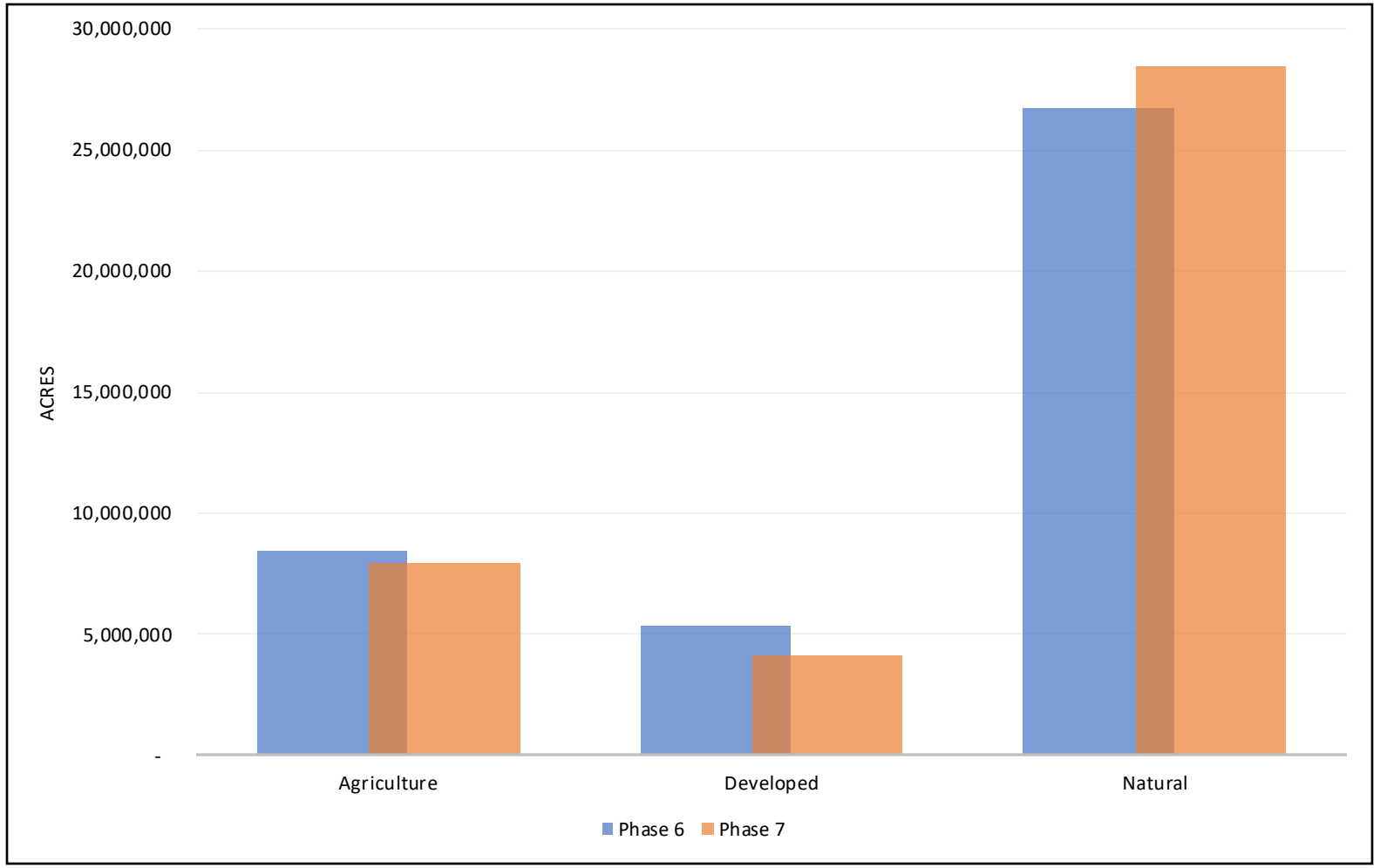
- The time series data (1985-2022) were sent for review to the Land Use Work Group, Agriculture Modeling Team, Urban Stormwater Work Group, and Forestry Workgroup.

- Sector comparisons (i.e. Developed, Natural, Agriculture) at the watershed-portion of county scale were made available via a web viewer. County-specific review documents were made available, highlighting comparisons with phase 6 as well as validation data where it was available. The full Phase 7 land uses by Land River Segment were also provided for review.

- Two items were identified for correction. These corrections are not reflected in the results section of this presentation, but will have a minimum effect at the sector-scale.

Comparison of CBW 2013/14 Sector Area Between Phase 6 and Phase 7

- Both Phase 6 and Phase 7 rely on 2013/14 high-resolution land use/land cover as the starting point for the past land use
- Phase 6 used the first ever high-resolution representation of land use in the region, where Phase 7 utilizes the third attempt of mapping the same time-period. In addition, Phase 6 utilized a "true-up" method which averaged agricultural acres from the map with the Census of Agriculture.
- Differences in the representation of 2013/14 conditions will be seen in the total sector acres of the time series since 2013/14 is used as the starting point.



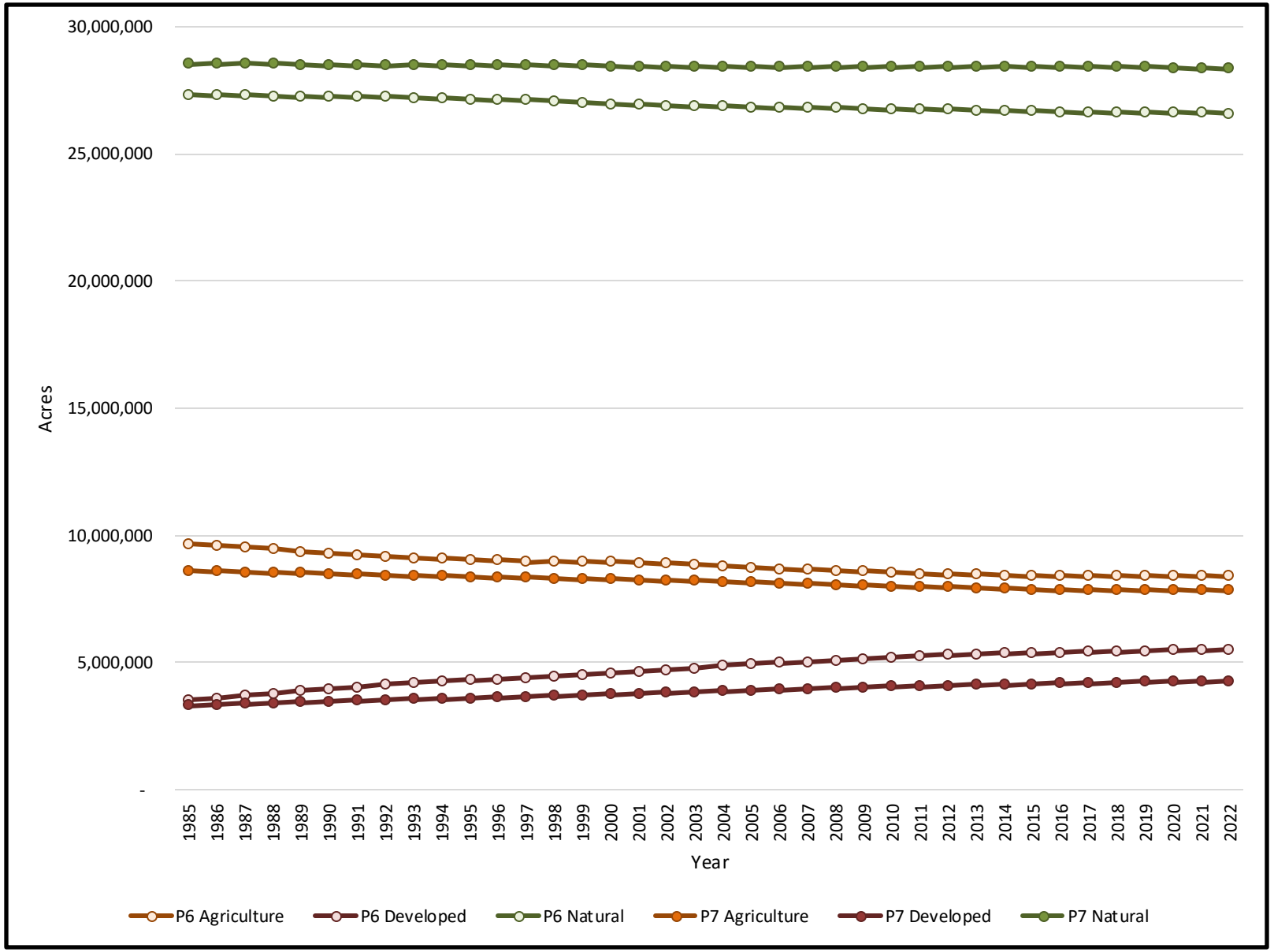
Phase 7 has…

- More natural lands
- Less agricultural lands
- Less developed lands

Why?

- Improved mapping of herbaceous lands (e.g. harvested forest mapped as agriculture in phase 6, open space and other features being misclassified as turf grass)
- The removal of the "true-up" process that averaged the mapped acres with the Census of Agriculture (inflated P6 ag numbers in most cases)

Comparison of CBW Trends Between Phase 6 and Phase 7



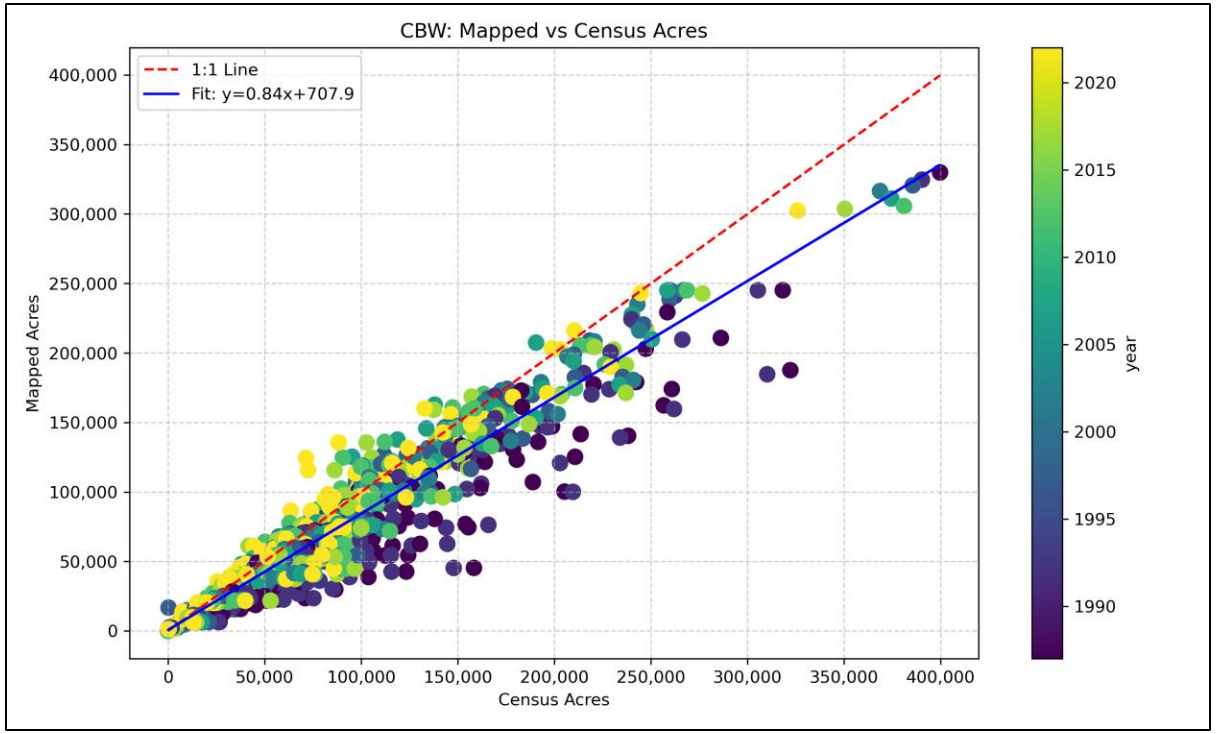
Phase 7 has…

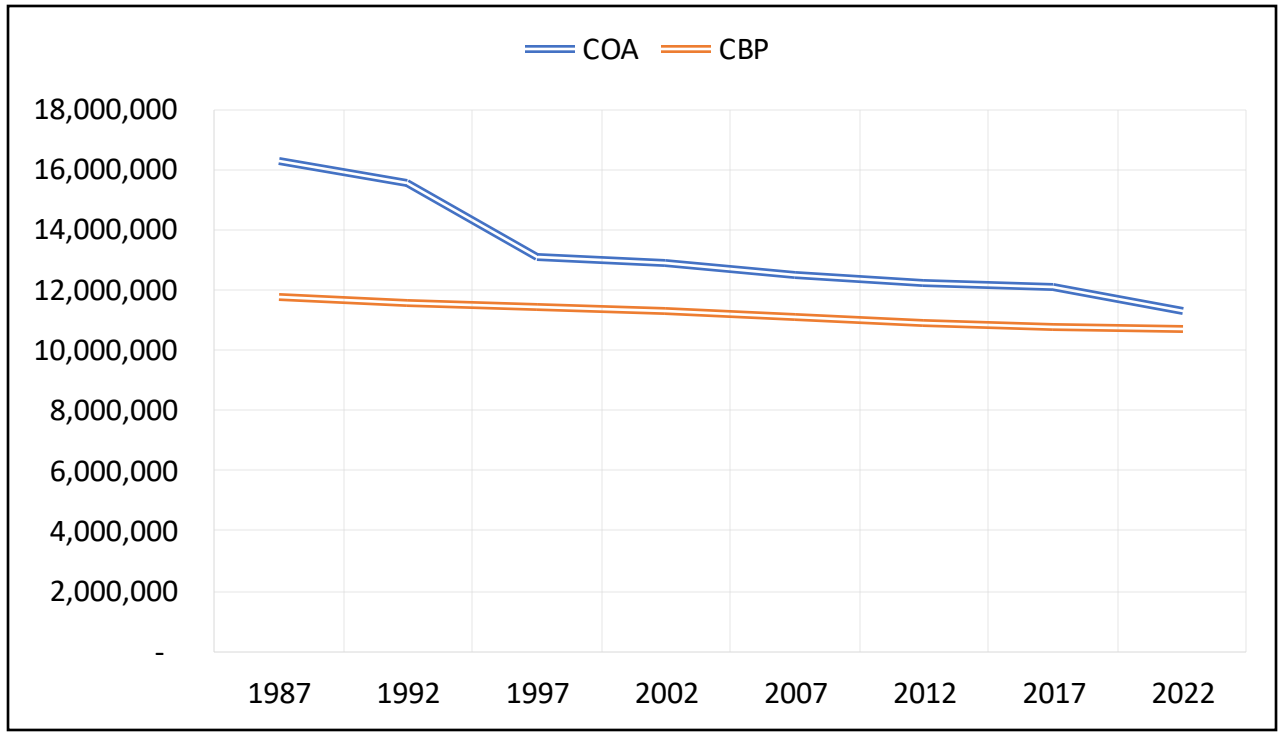
- Smoother trends
- Smaller amount of change (i.e. P6 and P7 have almost same amount of development in 1985, but P6 shows over 1.2 million acres more development in 2022)

Why?

- Phase 7 relied on annual, remotely sensed products that weren't available for Phase 6
- Phase 7 doesn't rely on reported acres in the ag census, which affected all sectors in phase 6

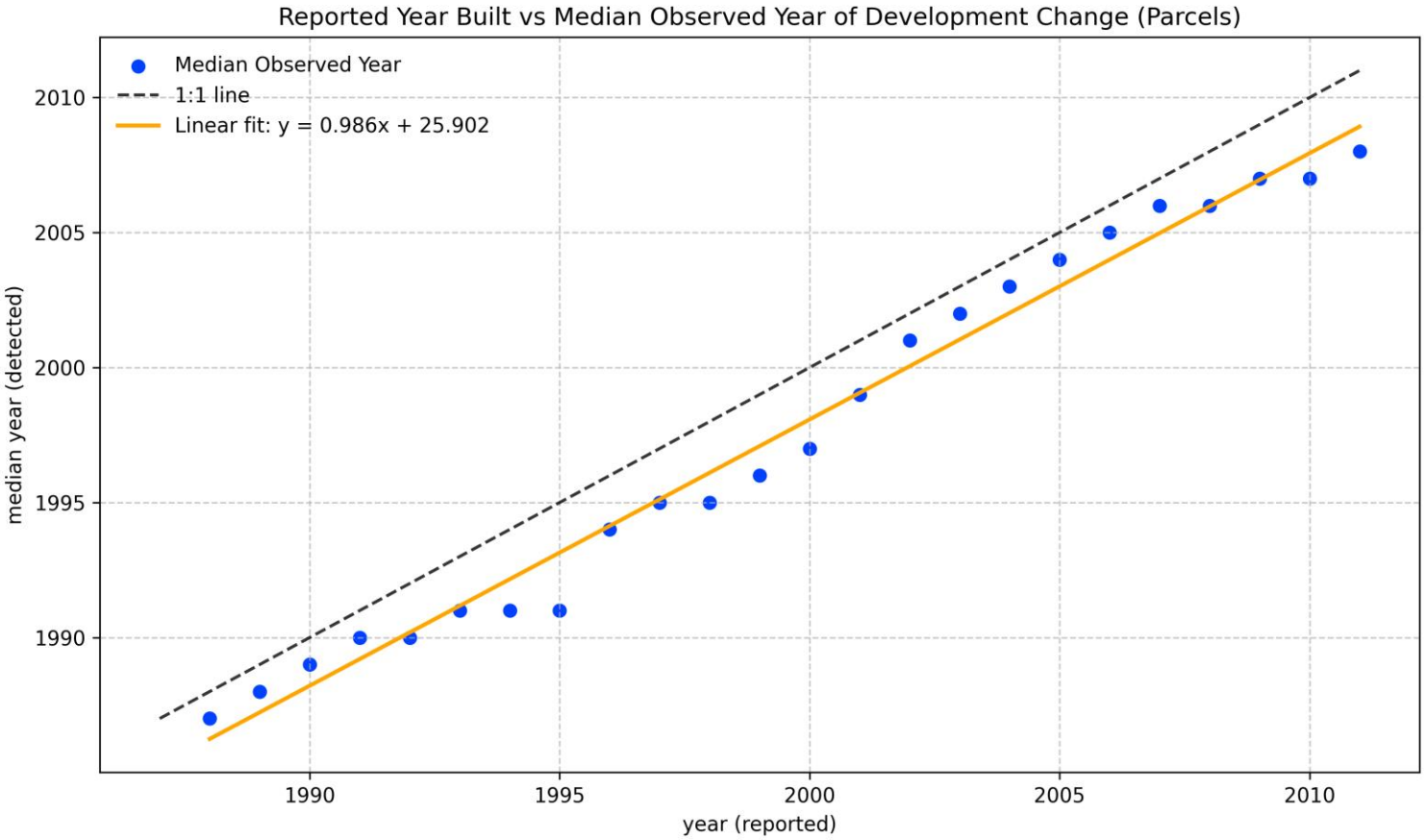
Phase 7: Agriculture Validation



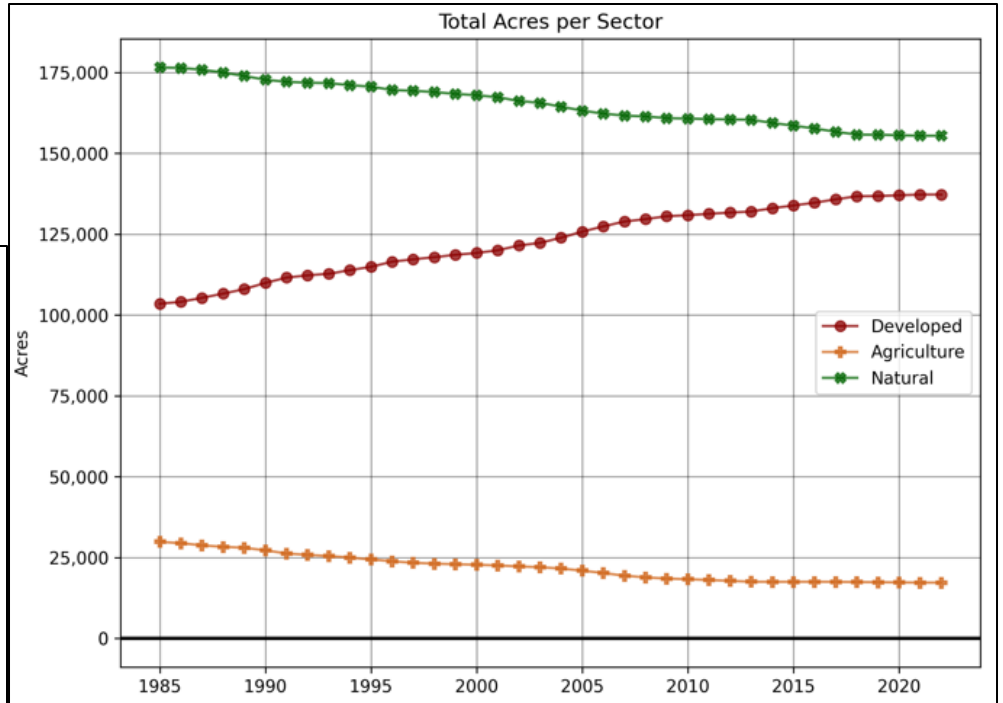


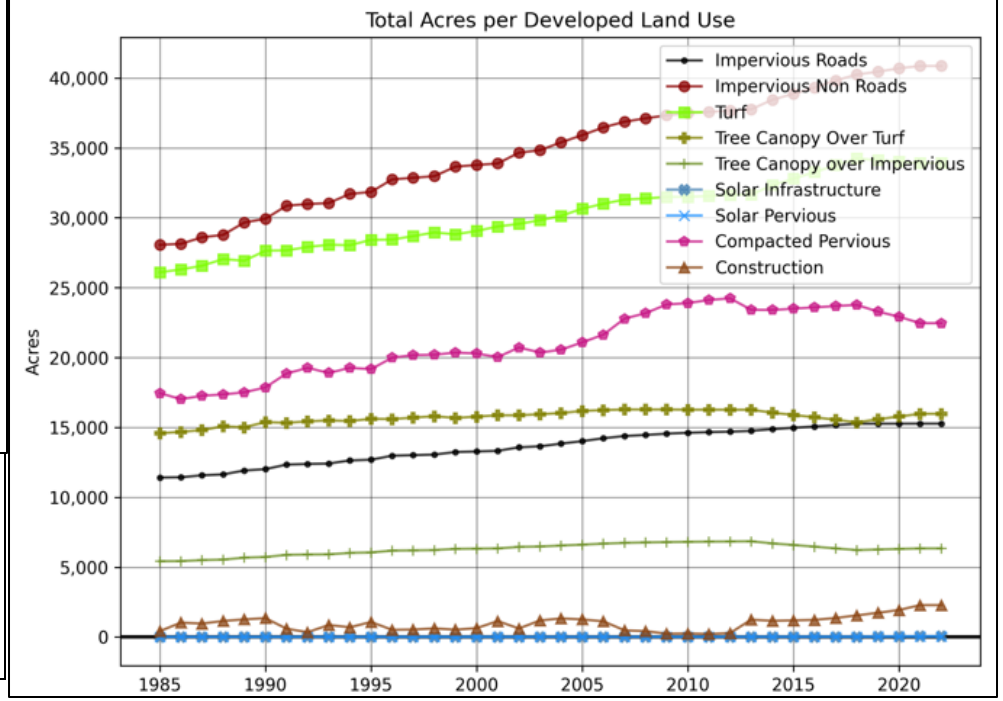
Phase 7 Development Trends

Prince George's County, MD



For counties with enough parcel data attributed with "year built" during the observed period, plots comparing the median year of mapped development change per reported year is produced. **Validation is at a much finer scale than the model. If this comparison is reasonable, we can assume the model-scale trends will be too.**





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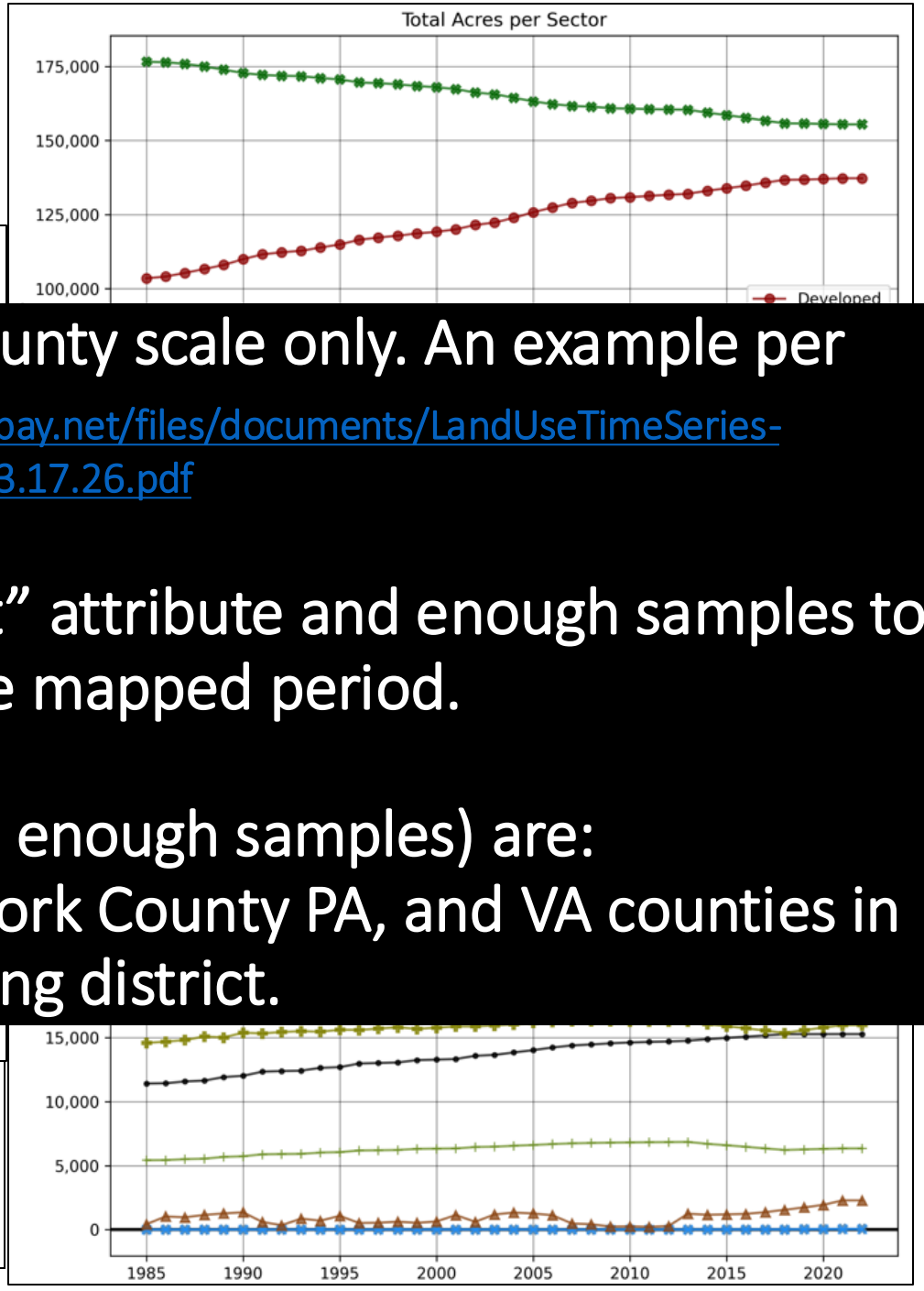
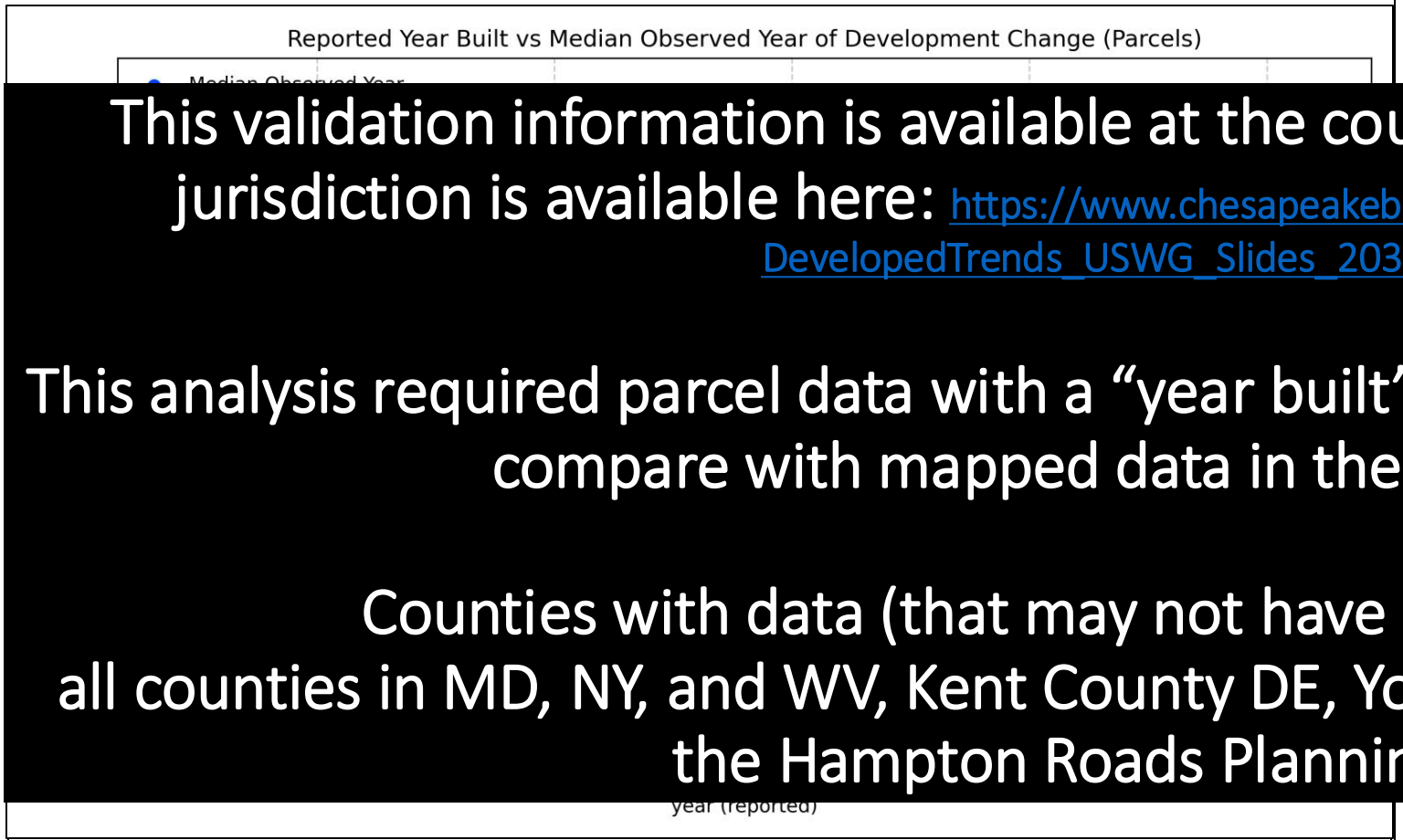




This validation information is available at the county scale only. An example per jurisdiction is available here: https://www.chesapeakebay.net/files/documents/LandUseTimeSeries-DevelopedTrends_USWG_Slides_203.17.26.pdf

This analysis required parcel data with a "year built" attribute and enough samples to compare with mapped data in the mapped period.

Counties with data (that may not have enough samples) are:
all counties in MD, NY, and WV, Kent County DE, York County PA, and VA counties in the Hampton Roads Planning district.

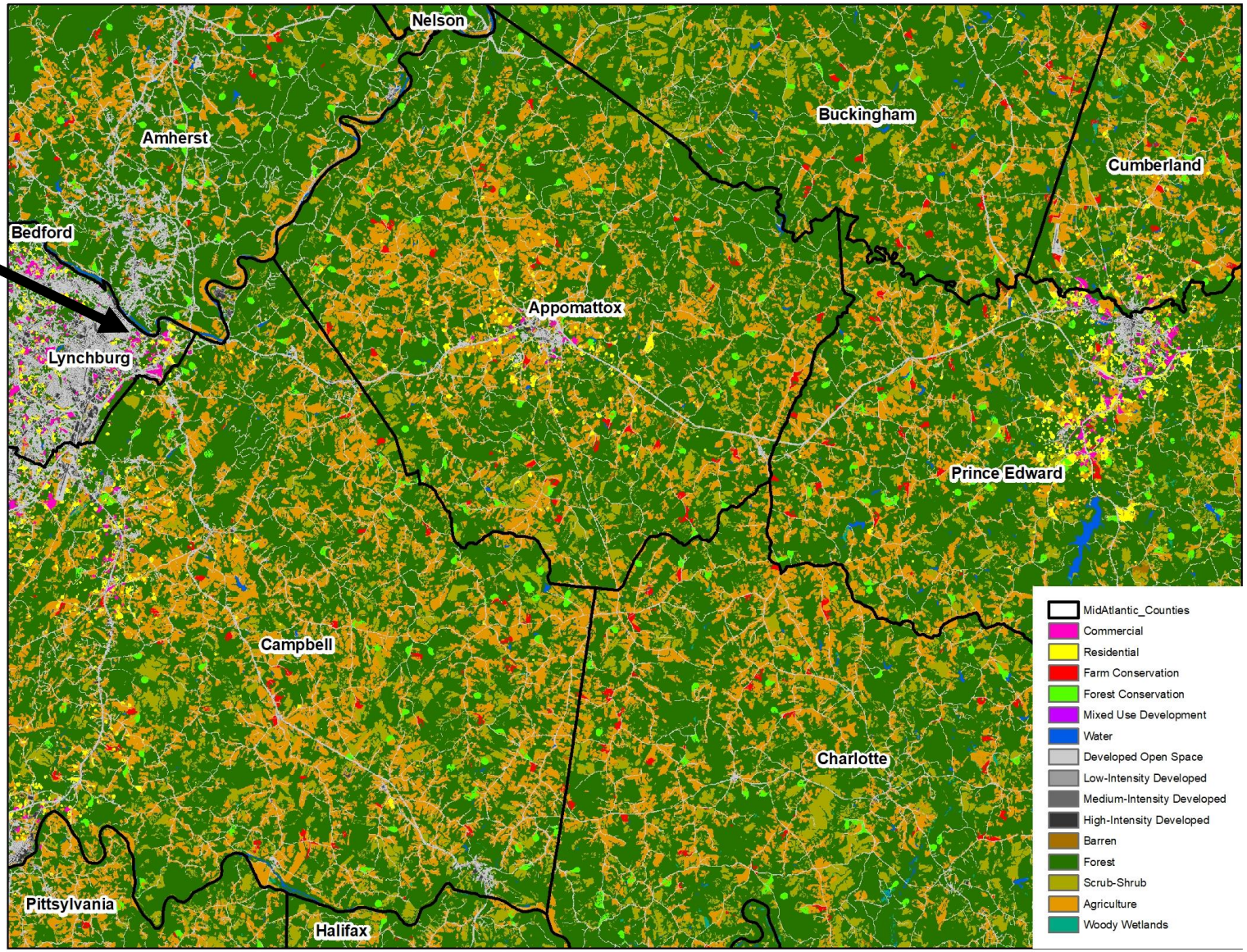
For counties with enough parcel data attributed with "year built" during the observed period, plots comparing the median year of mapped development change per reported year is produced. **Validation is at a much finer scale than the model. If this comparison is reasonable, we can assume the model-scale trends will be too.**

Looking to the Future: Chesapeake Bay Land Change Model v7 Outputs

Commercial and Residential Growth

- Residential and commercial growth
- Future land conservation
- Future utility-scale solar

- Impervious surface and turf grass expansion
- Forest conversion to development
- Farmland conversion to development
- Future population on sewer and septic



Looking to the Future: Planned Future Scenarios (5 - 10 yr. increments)

1. **Validation**
   - Development over the 2000's forecasted to 2020
   - Due August 2026

2. **P7 Trend** (*aka "Business as Usual")*
   - Development from 2013/14 to 2021/22 forecasted through 2040 and 2075
   - Including moderate estimate of utility-scale sol
   - ar
   - Due October 2026

3. **High Energy**
   - Continued expansion of data centers with >=50% of energy from renewable sources through the year 2040.

4. **Custom State WIP scenarios?**

Questions?

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