Simulating Future Development in the Chesapeake Bay Watershed

Modeling the Effects of Population, Employment, and Renewable Energy on Land Use Change

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U.S. Geological Survey

Clean Water Goal Team Meeting
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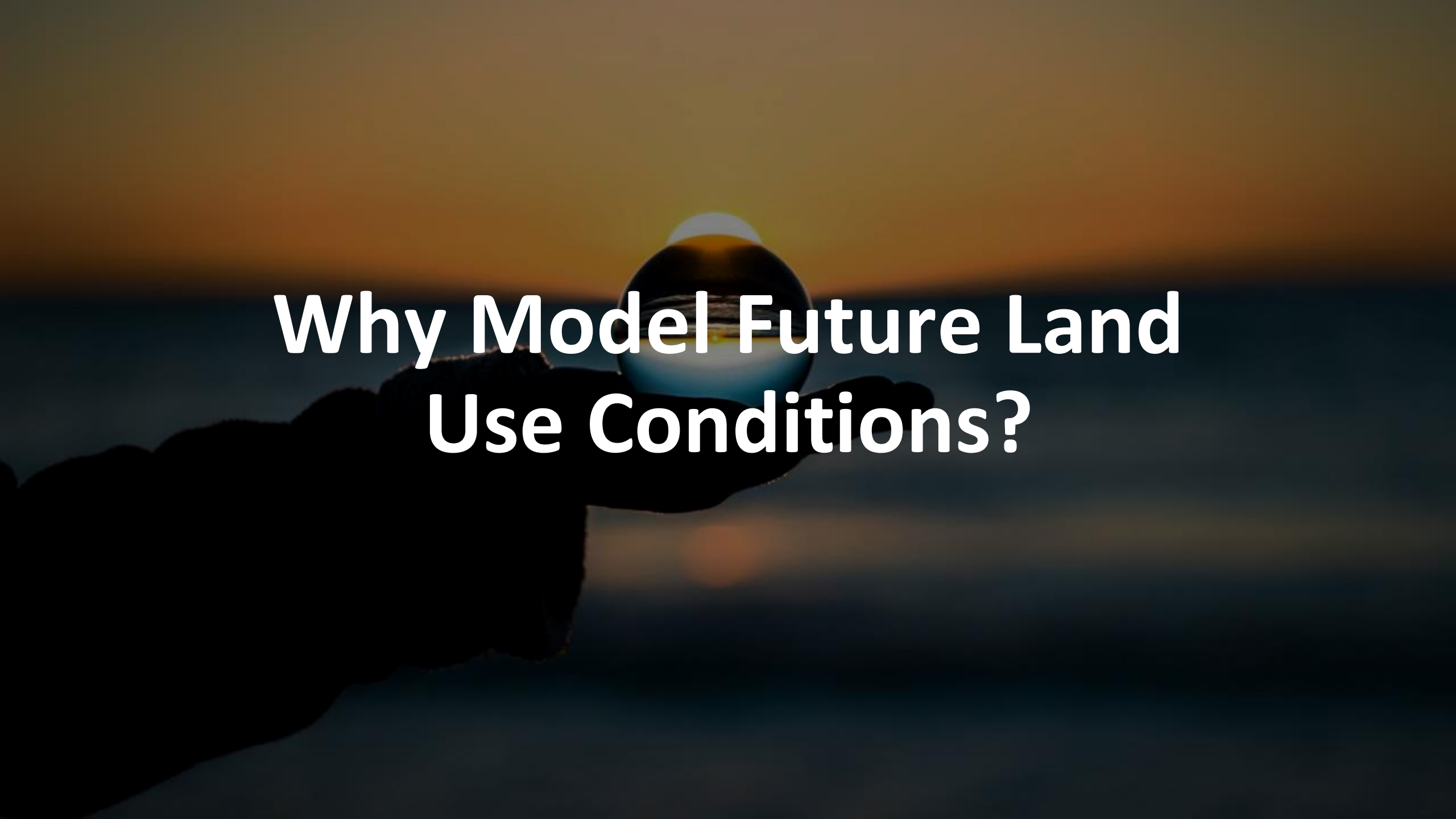
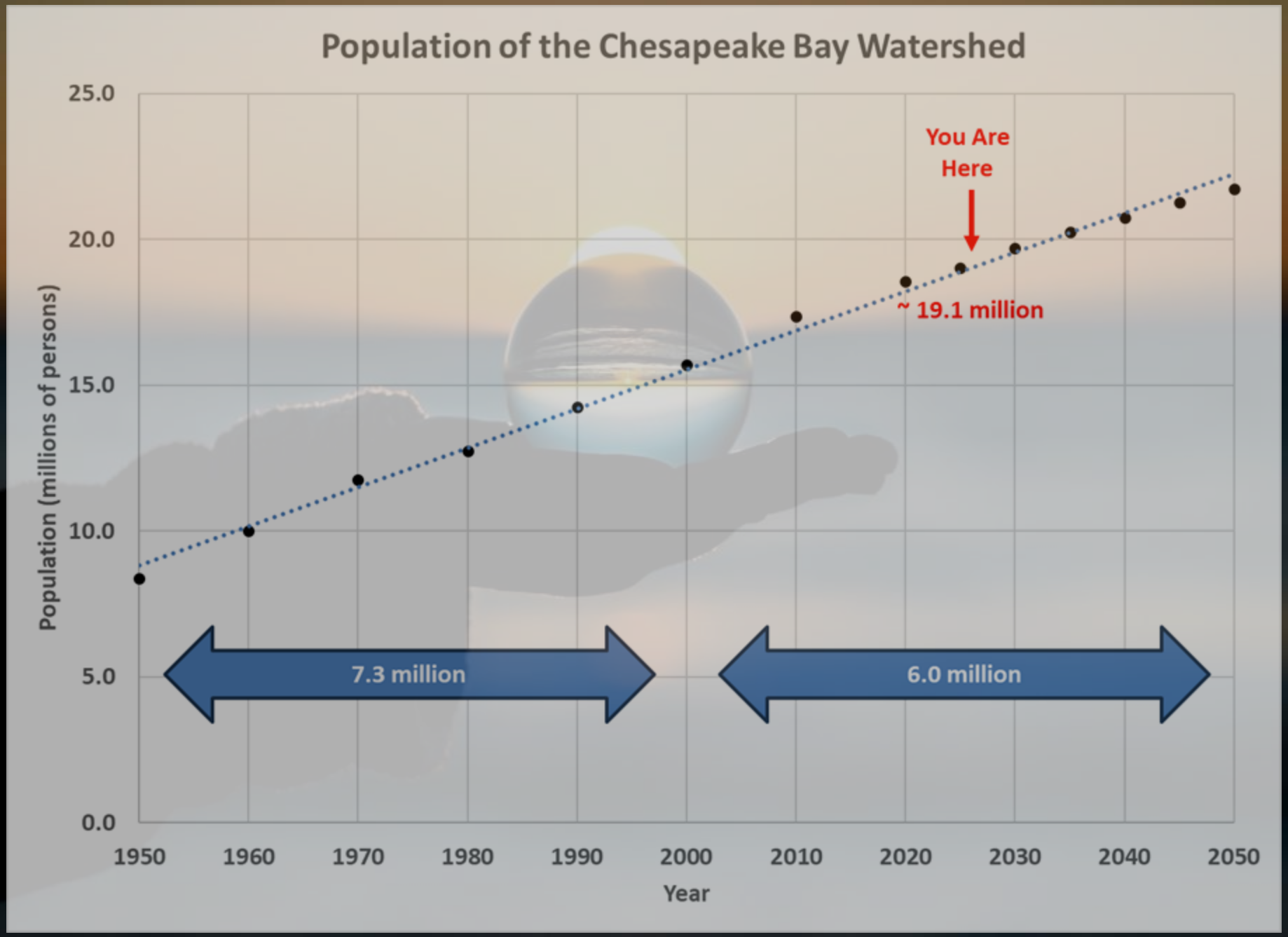
U.S. Department of the Interior
U.S. Geological Survey



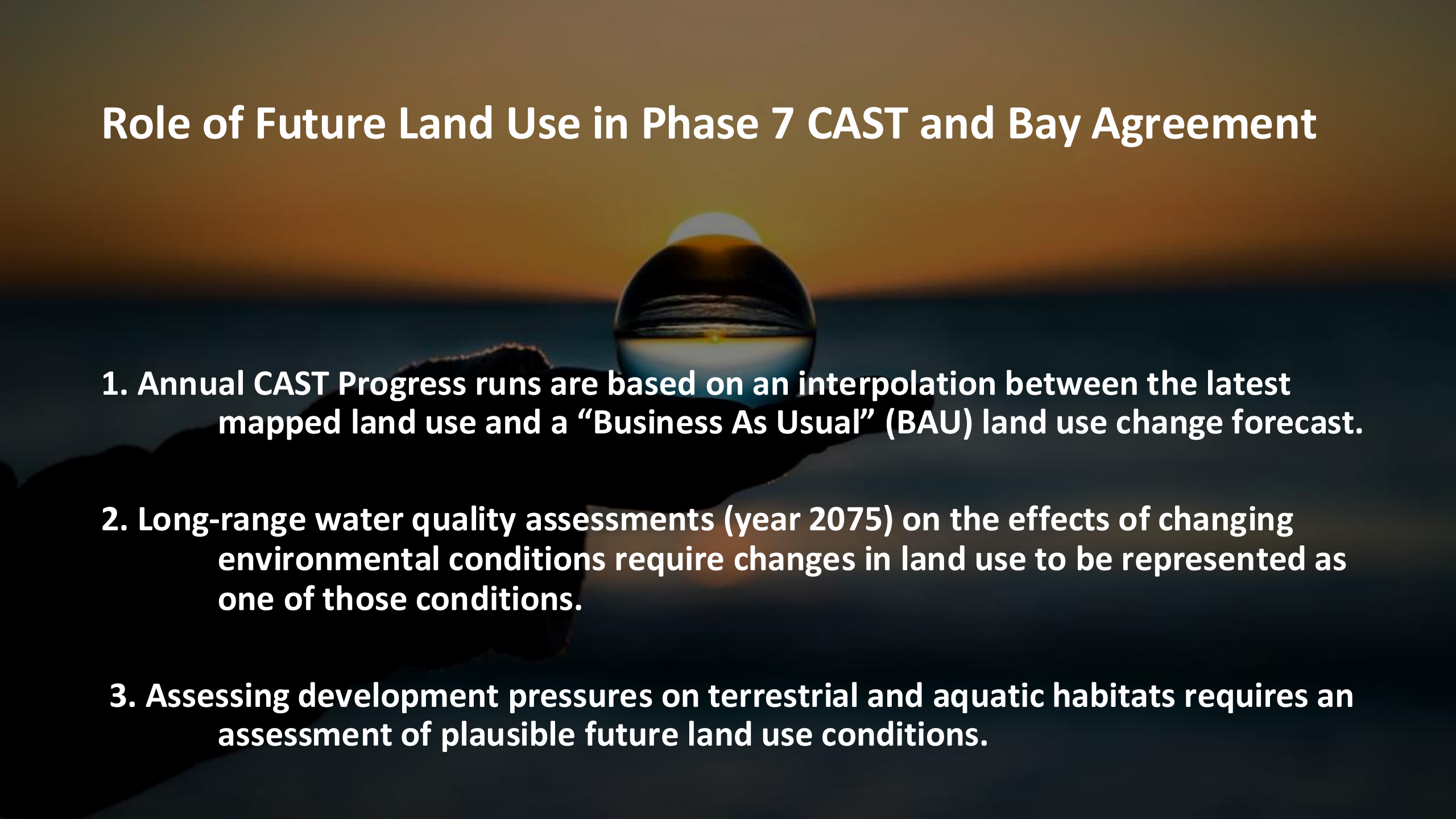
Why Model Future Land Use Conditions?

Large-scale ecosystem restoration and infrastructure projects take decades to accomplish.

Over decades, population growth coupled with changes in technology, transportation, energy production, and the environment may significantly alter the landscape, challenging assumptions behind today's restoration strategies and decisions.


Population of the Chesapeake Bay Watershed
25.0
20.0
15.0
10.0
5.0
0.0
Population (millions of persons)
You Are Here
~ 19.1 million
7.3 million
6.0 million
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
Year

Role of Future Land Use in Phase 7 CAST and Bay Agreement



1. Annual CAST Progress runs are based on an interpolation between the latest mapped land use and a “Business As Usual” (BAU) land use change forecast.

2. Long-range water quality assessments (year 2075) on the effects of changing environmental conditions require changes in land use to be represented as one of those conditions.

3. Assessing development pressures on terrestrial and aquatic habitats requires an assessment of plausible future land use conditions.

Review role for CBP Workgroups & Goal Teams

LUWG: Review and recommend 2040 "Business As Usual" (BAU) scenario.

- understand model assumptions, data, and methodology
- recommend analyses, adjustments, and alternative future scenarios

USWG: Review and recommend forecast of solar fields for the 2040 BAU scenario

- understand model assumptions, data, and methodology
- recommend analyses, adjustments, and alternative future scenarios

CWGT: Understand and approve 2040 BAU scenario.

Review Schedule

August 6th Post run #2 results

August 12th Office Hours – discuss run #2, share draft solar results for Virginia

August 27th LUWG review

September 9th Post run #3 results (aka "Final version" including solar)

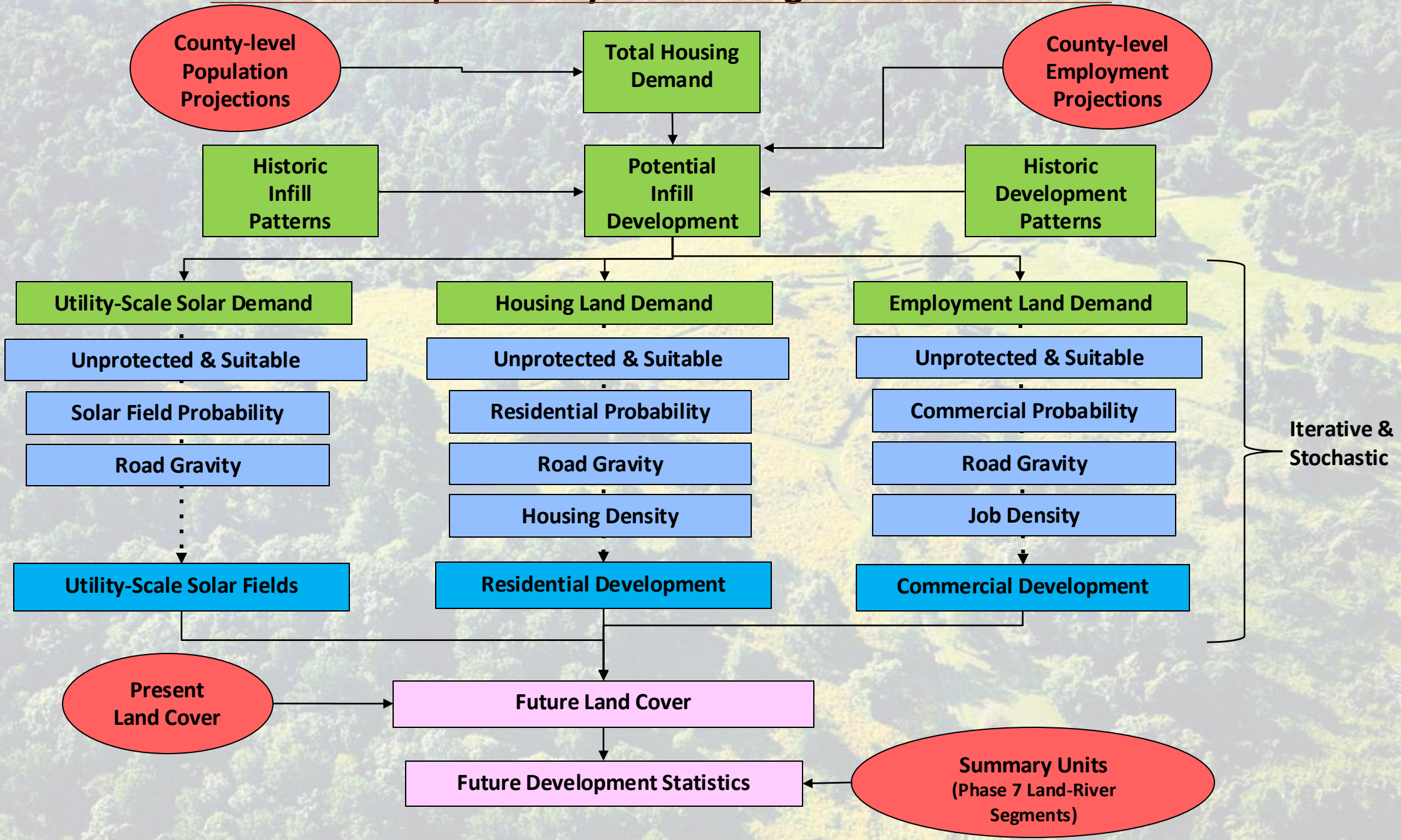
September 16th Office Hours – discuss run #3 (fatal flaw check)

September 23rd Joint LUWG/USWG review

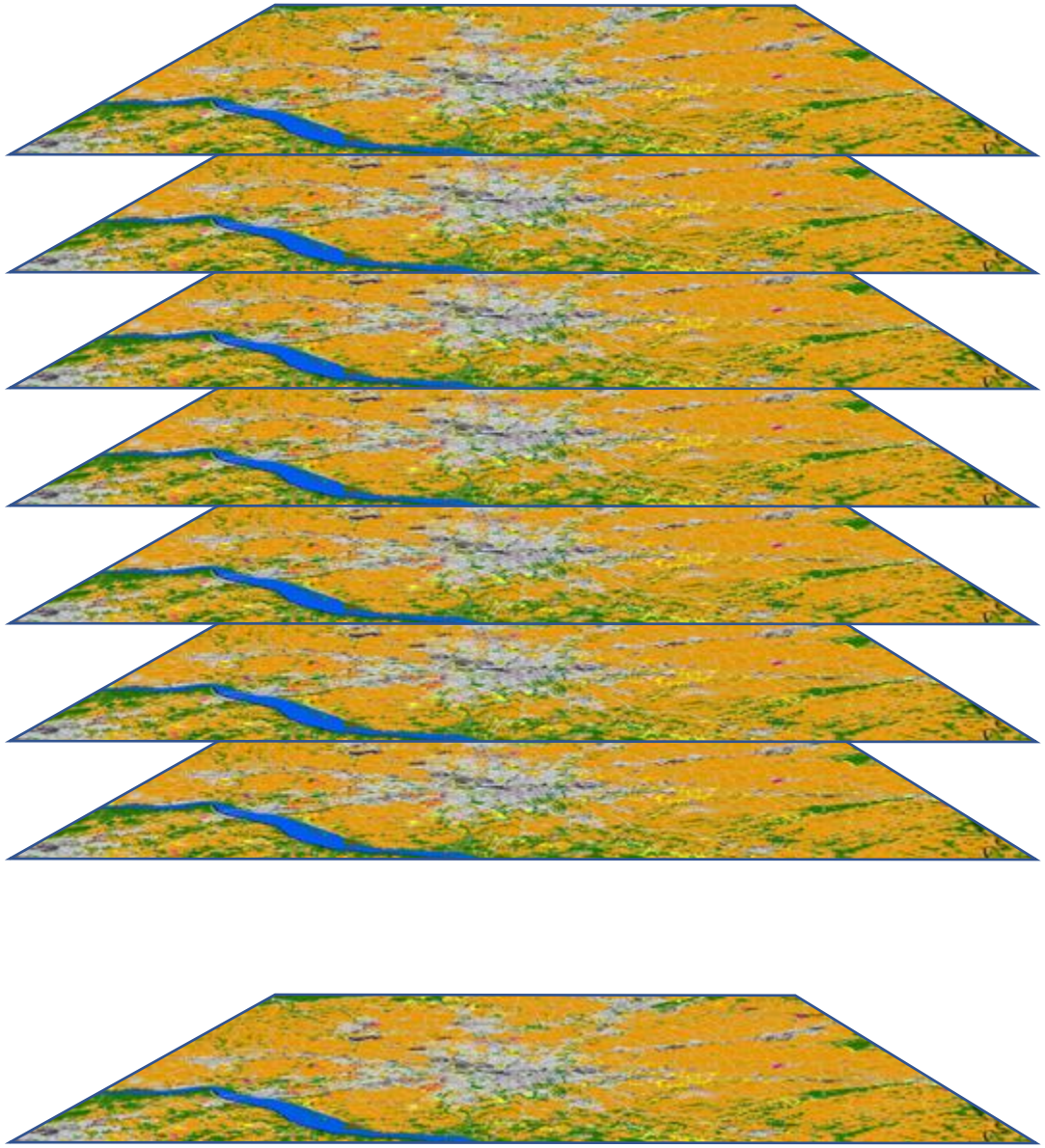
- recommend BAU scenario specifications and results for approval

September 28th Clean Water Goal Team review and approval

Chesapeake Bay Land Change Model v7



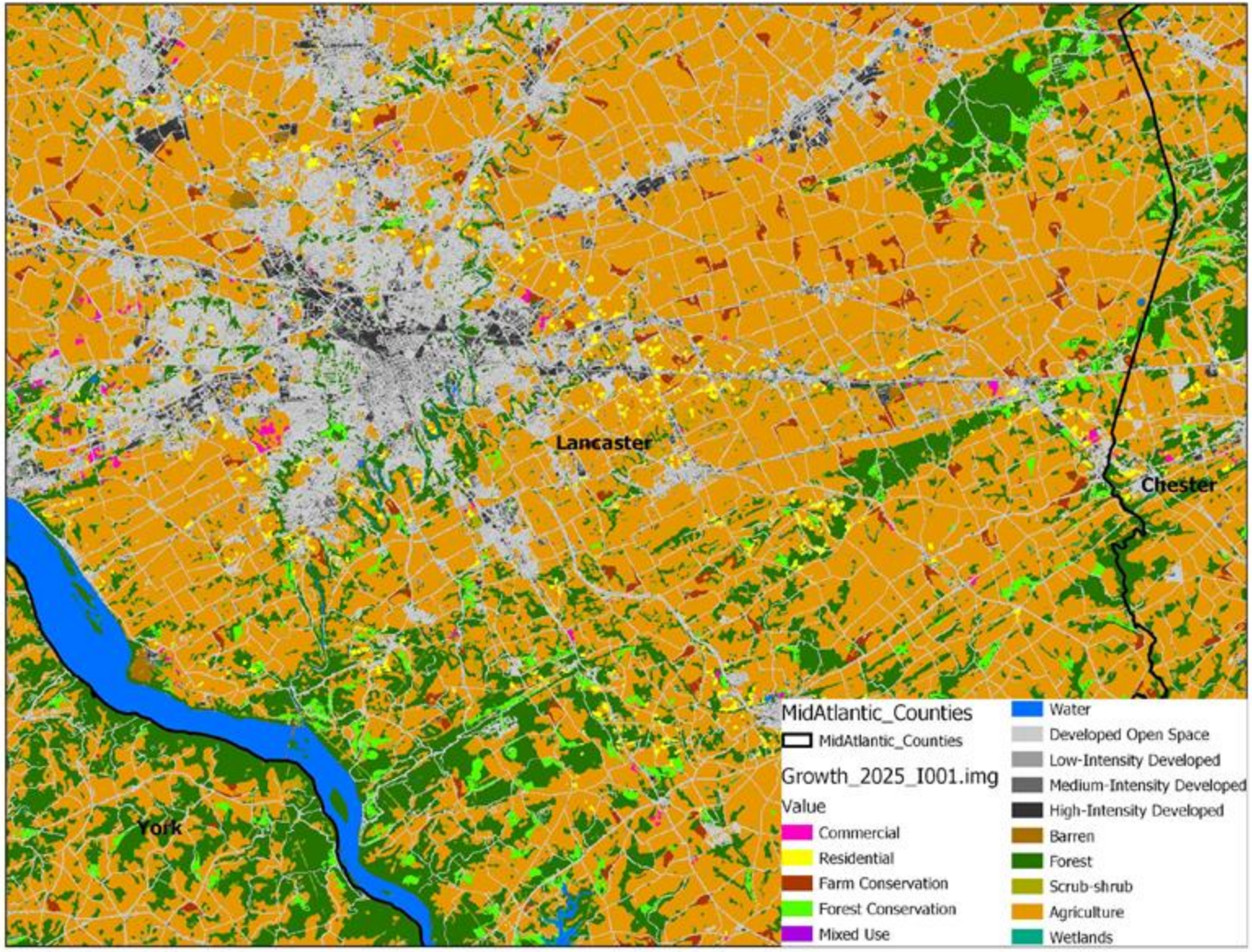
Multiple Stochastic Iterations

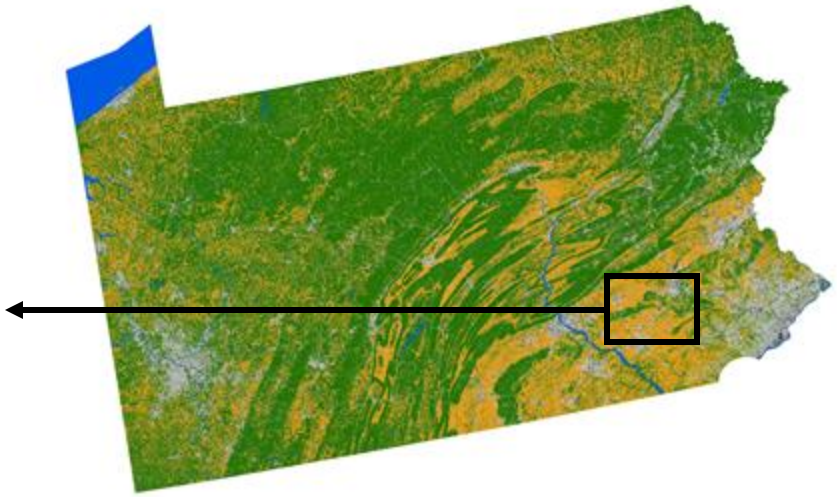


Every county is simulated 101 times for each scenario and target year, i.e., 2040.

Average of simulations by summary unit = **future development**

Relative Standard Deviation = **estimate of uncertainty**

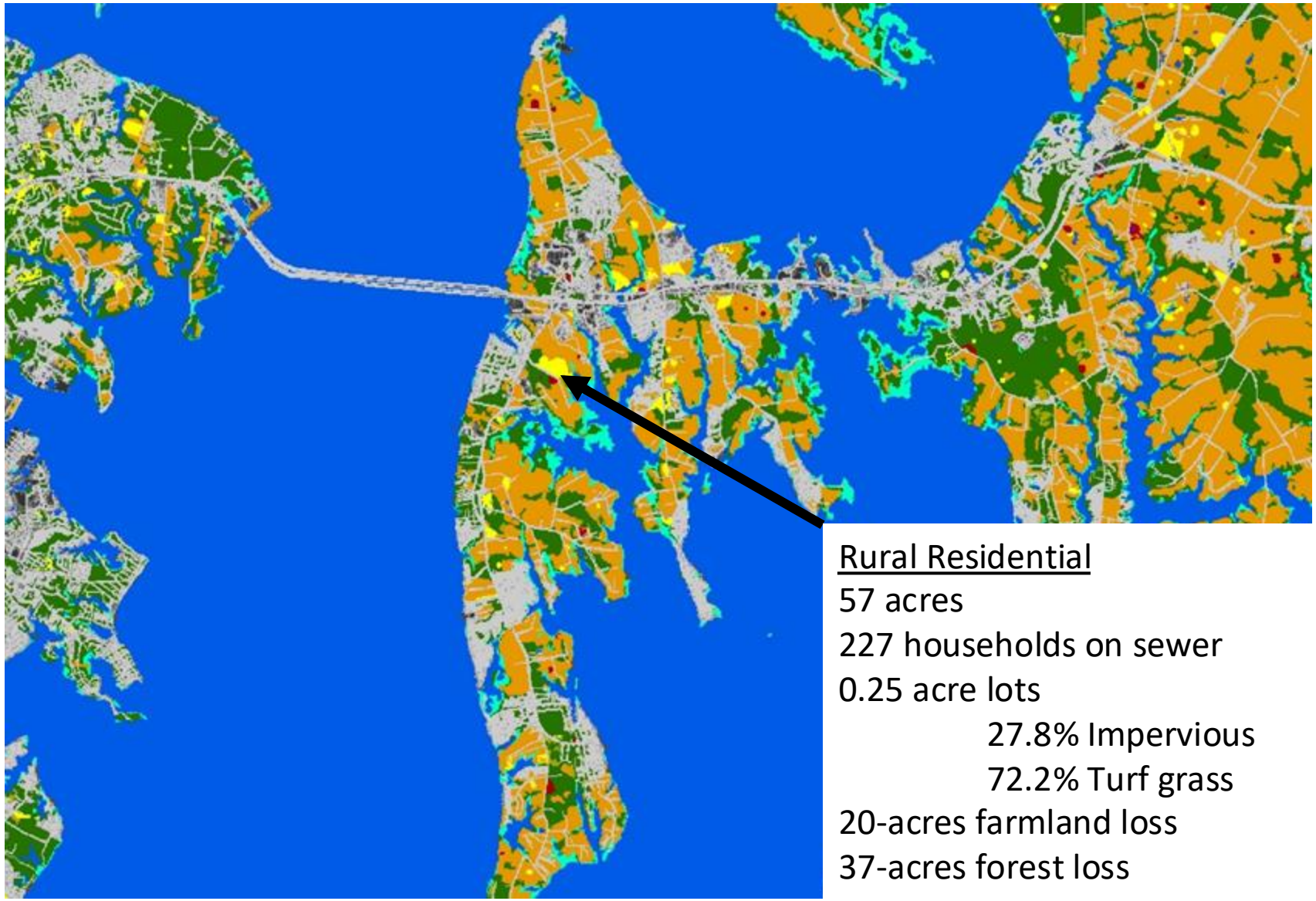




Simulated year 2025 residential, commercial, and mixed-use development and farm and forest land conservation in southeastern Pennsylvania, USA.

Land Change Model Outputs: Summary Statistics

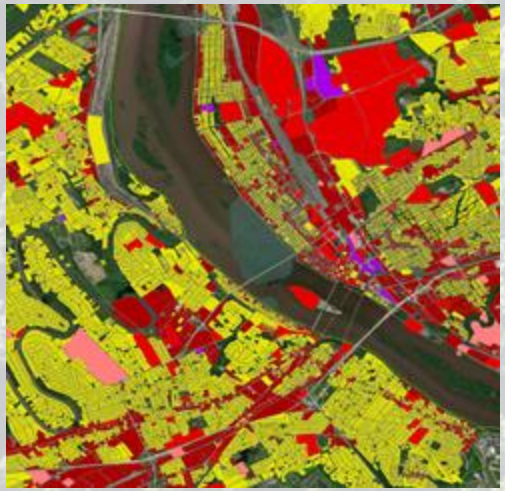
- Impervious surface and turf grass expansion
- Forest conversion to development
- Farmland conversion to development
- Future population on sewer and septic

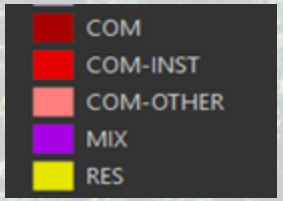


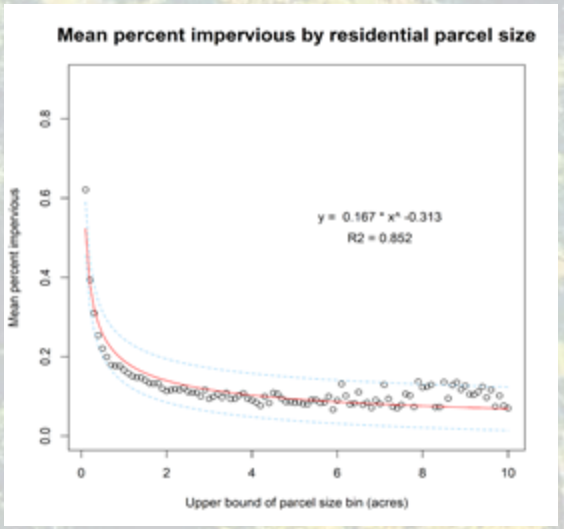
<u>Rural Residential</u>
57 acres
227 households on sewer
0.25 acre lots
27.8% Impervious
72.2% Turf grass
20-acres farmland loss
37-acres forest loss

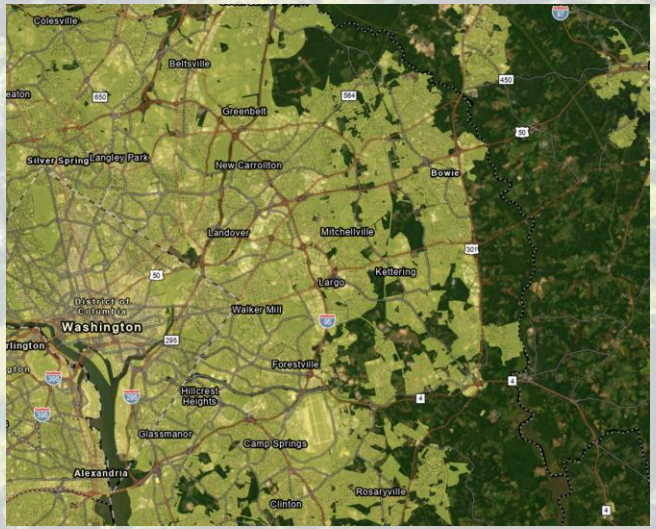
CBLCM Version 7: Parameterization with High-resolution Data

- P7 Land Use 2013/14 and 2021/22
- State-specific, parcel-level impervious surface coefficients
- Consistent definition of residential and commercial areas by parcel
- Parcel-level sewer and septic mapping





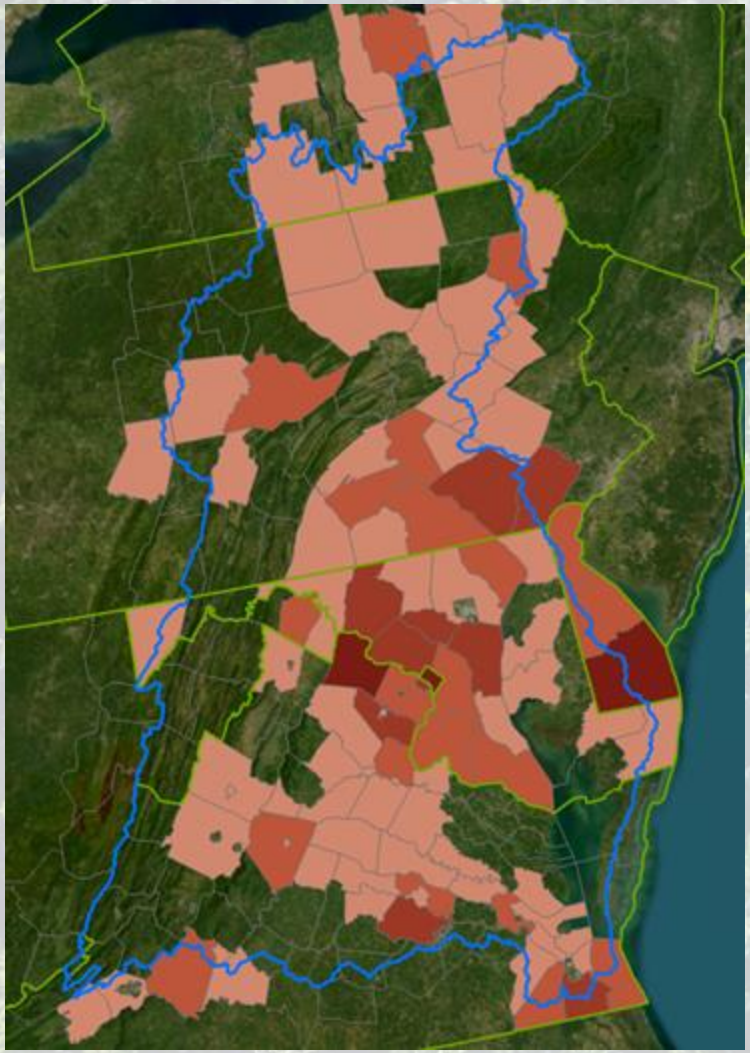




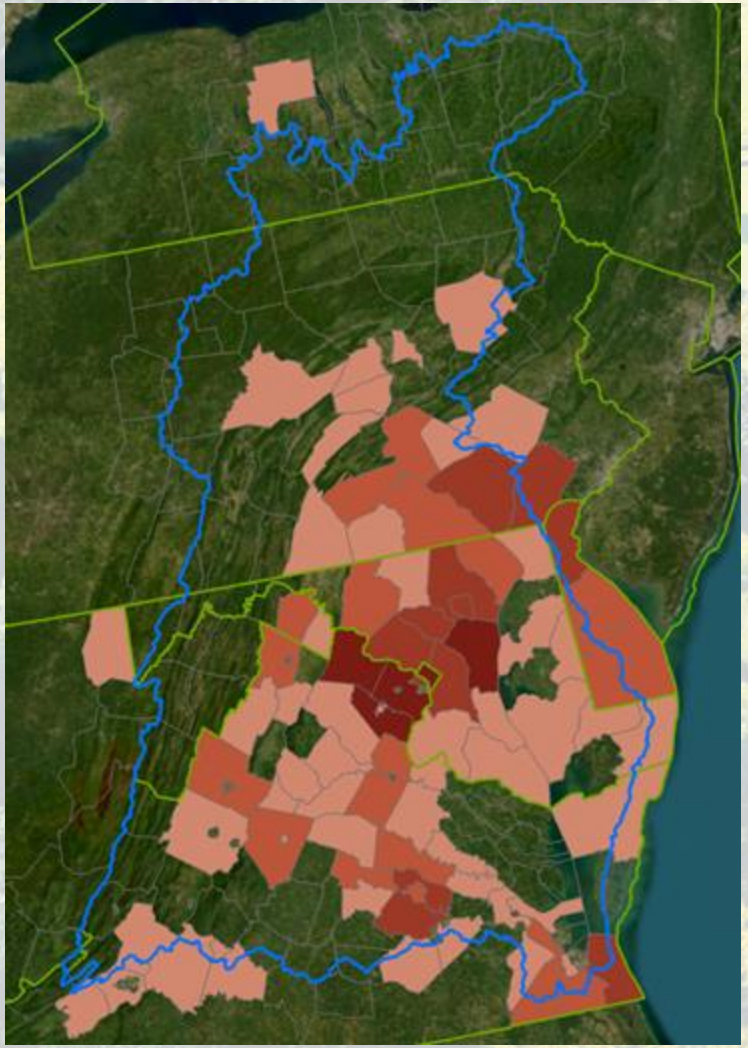
This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.

Chesapeake Bay Region Observed Growth 2010 - 2020

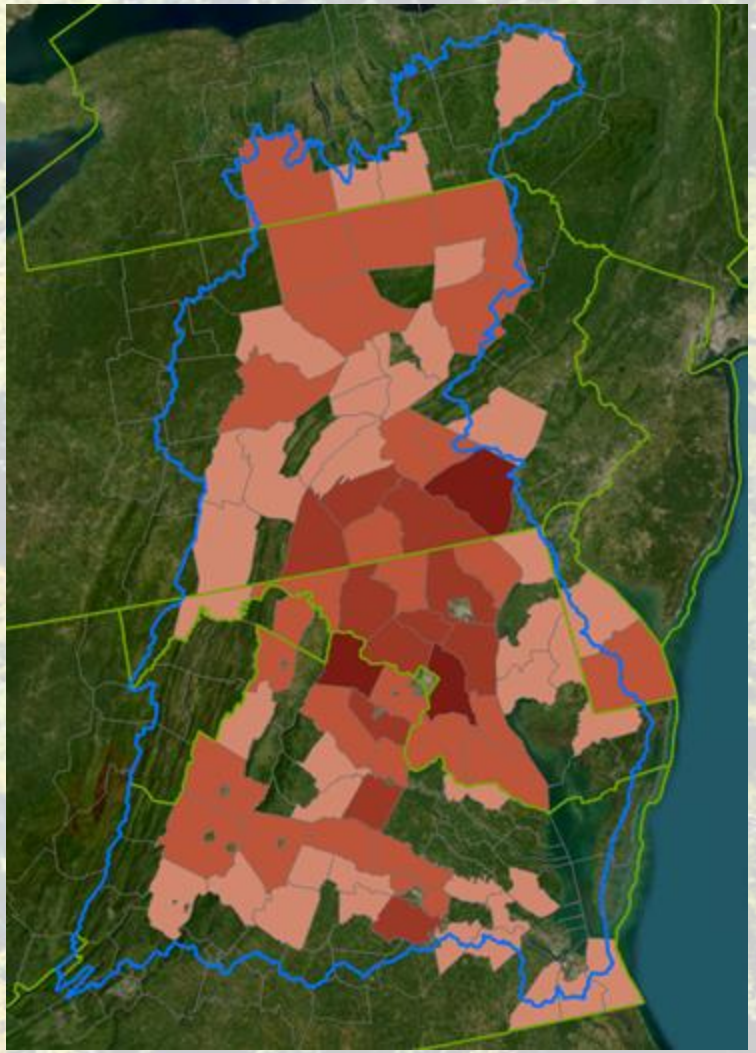
Housing Growth: 0.41 million



Job Growth: 1.09 million

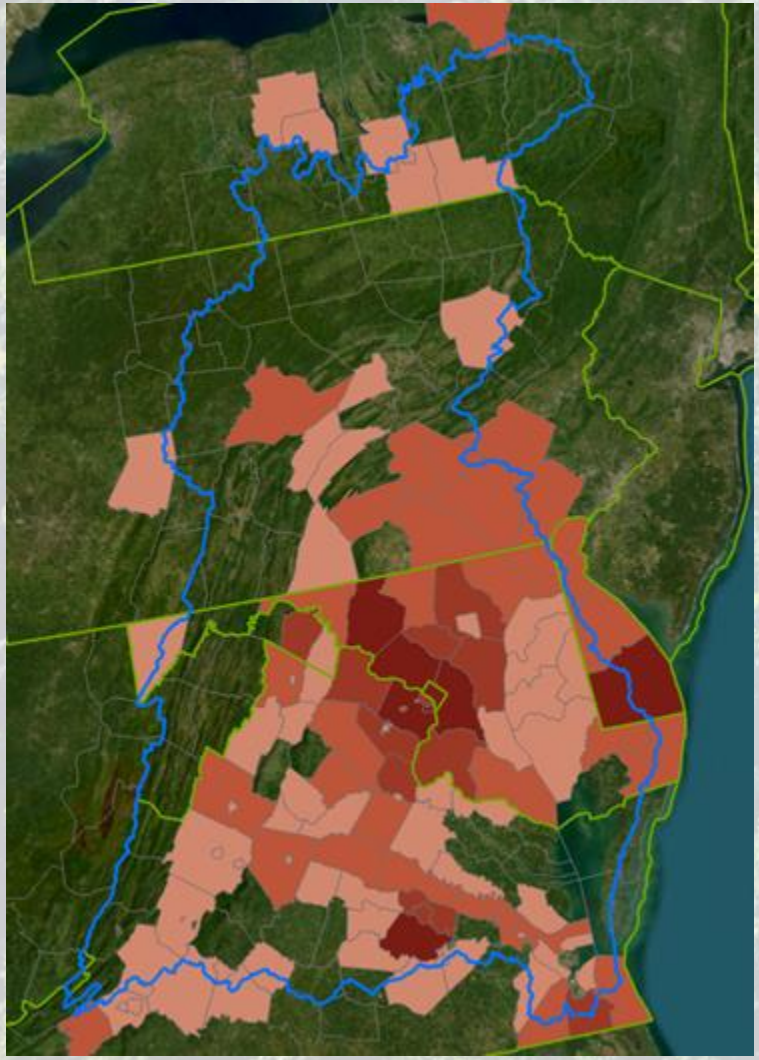


Observed Growth: 172,802 acres

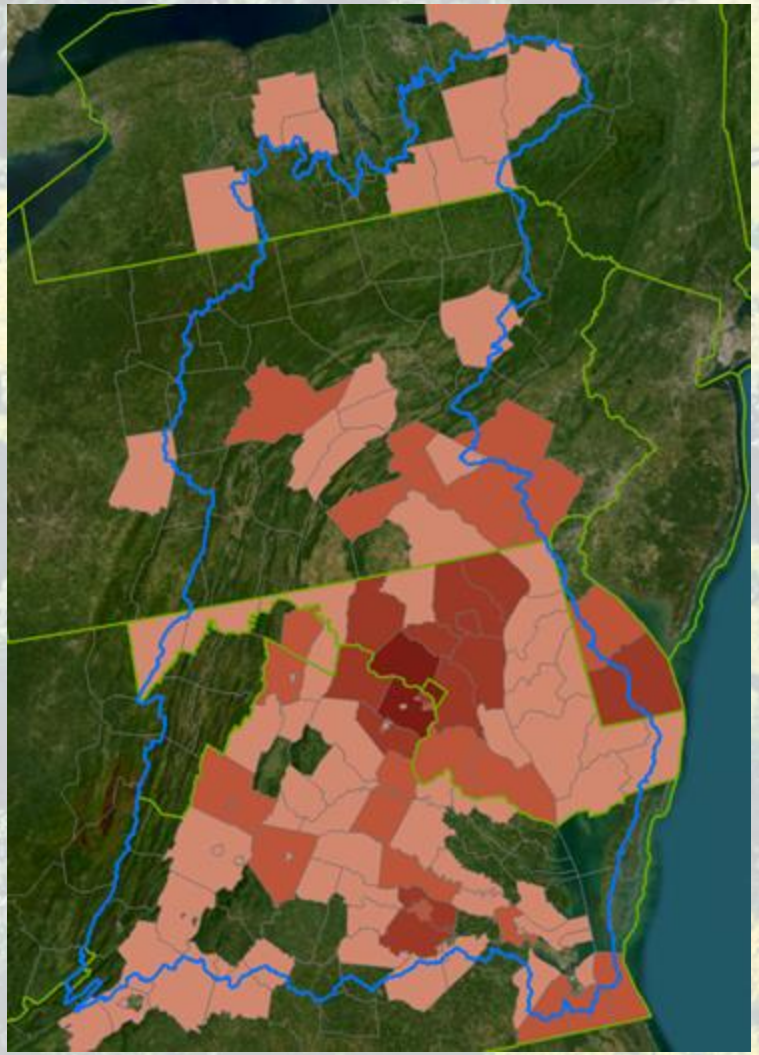


Chesapeake Bay Region Future Growth
2020 - 2050

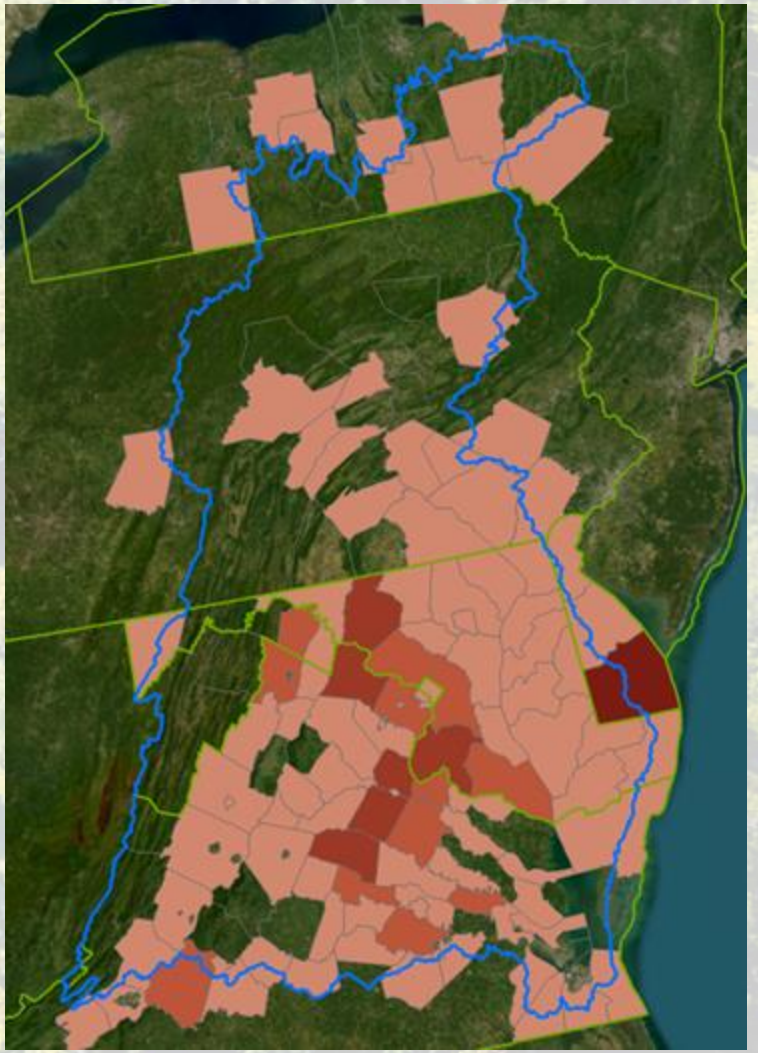
Additional Housing: 1.99 million



Additional Jobs: 2.73 million

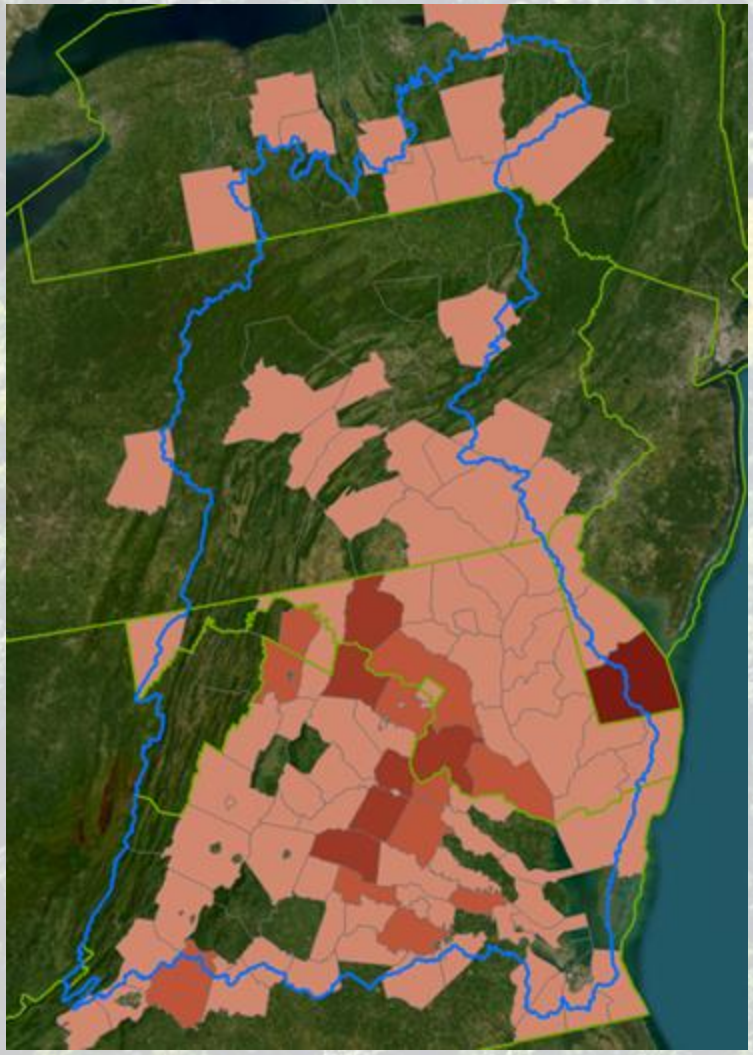


Simulated Growth: 317,822 acres



Chesapeake Bay Region Future Land Use 2020 - 2050

Simulated Growth: 317,822 acres



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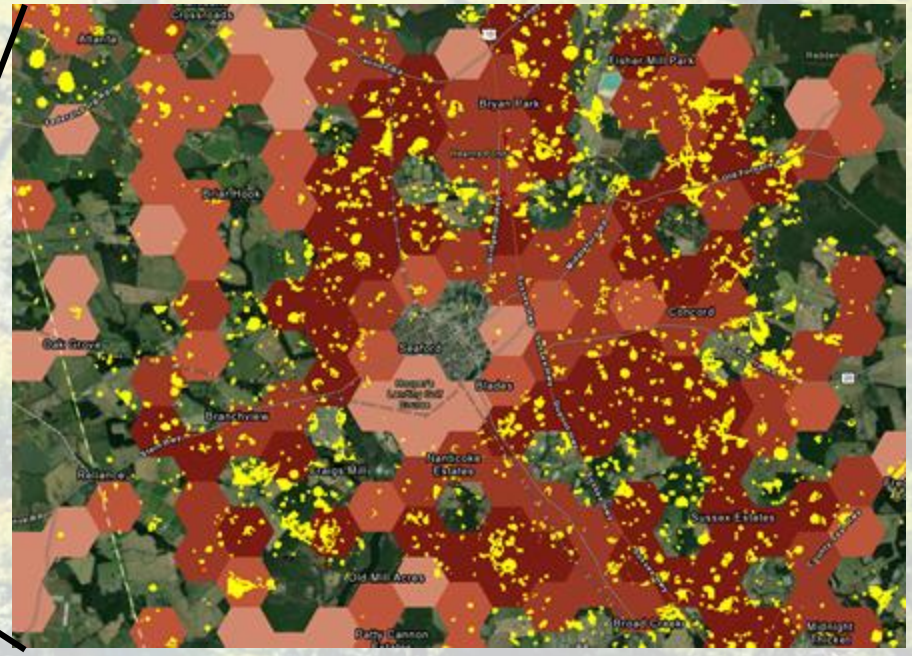
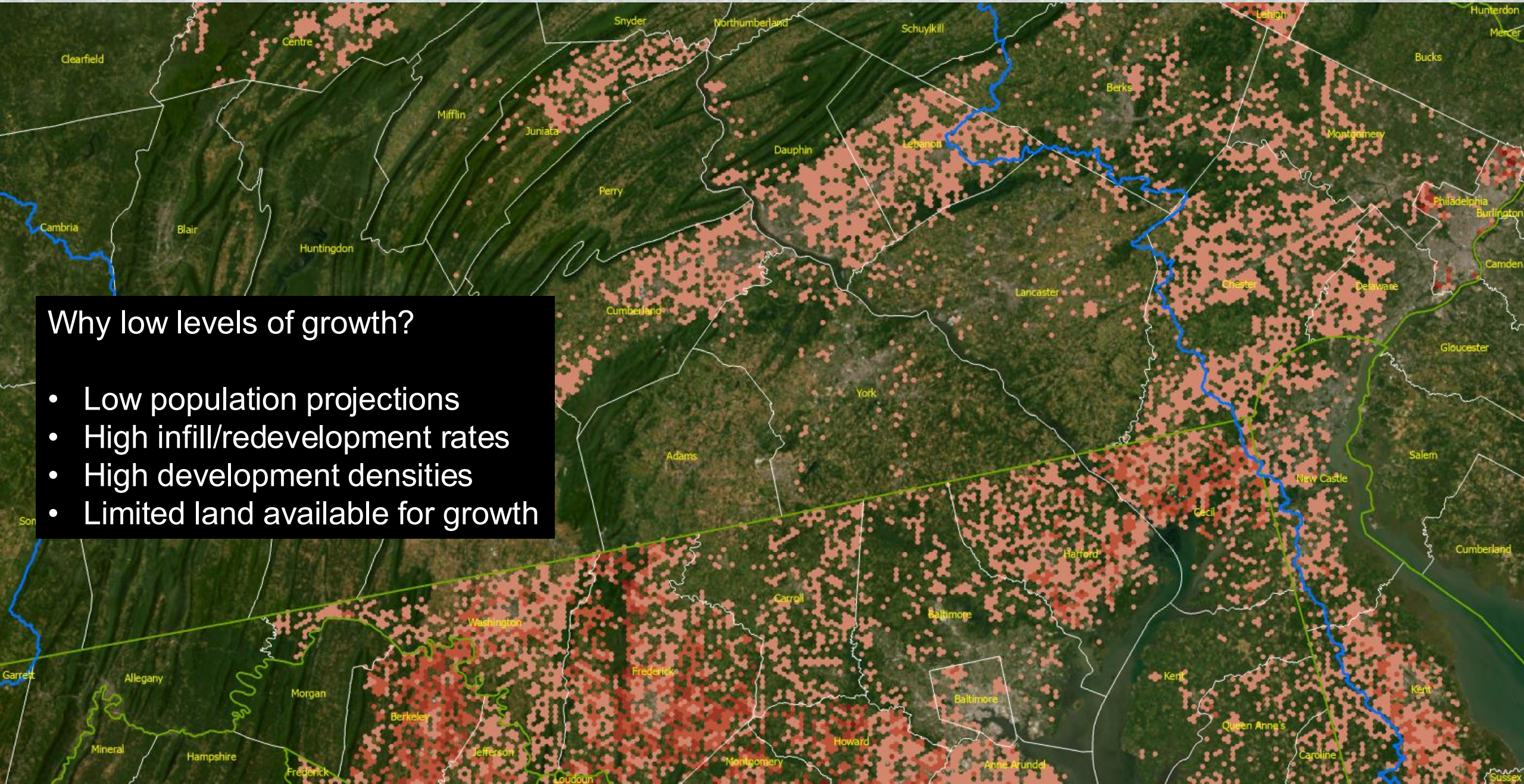


Seaford, DE

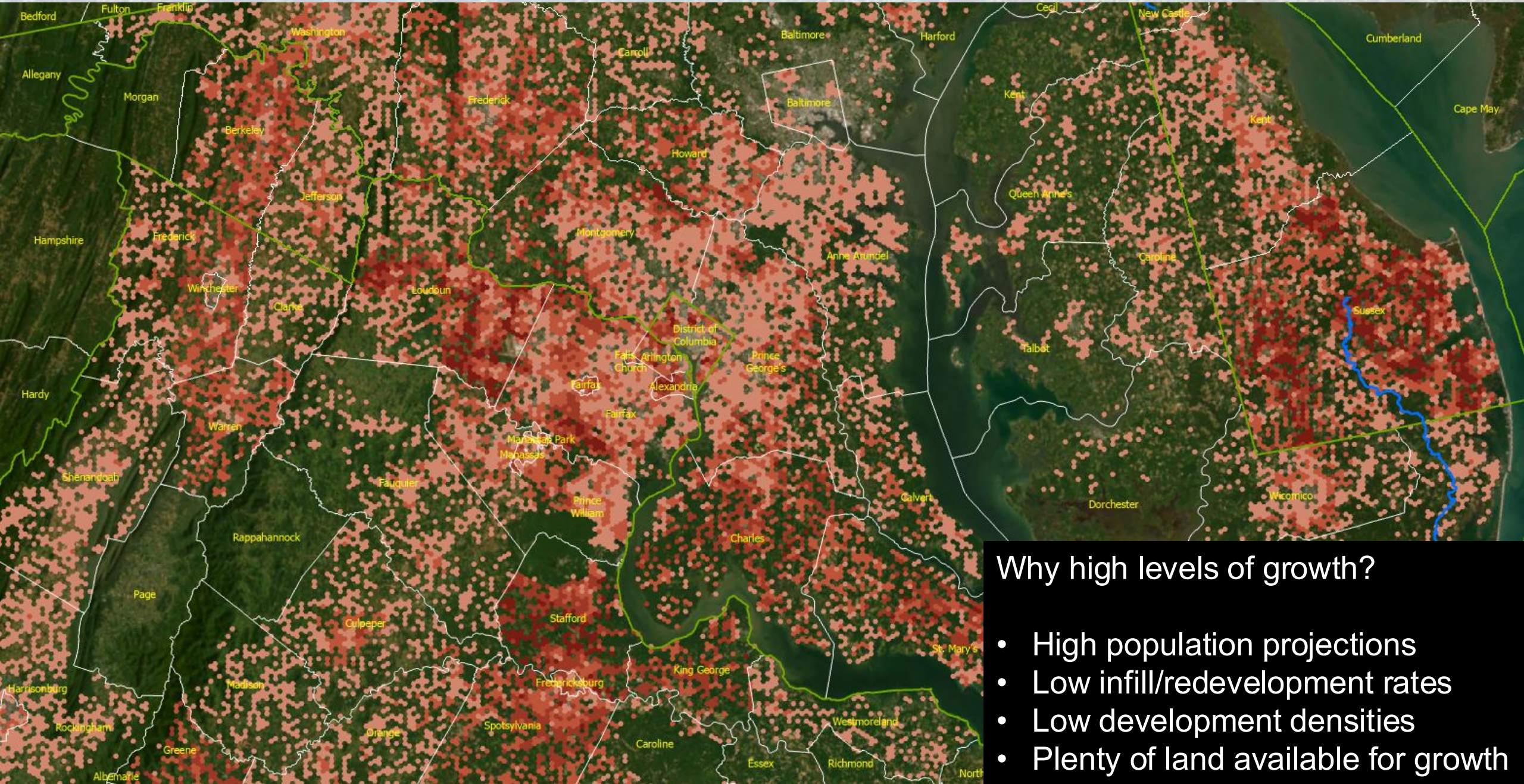
2050 Development: Northern Maryland and Southeastern Pennsylvania



Why low levels of growth?

- Low population projections
- High infill/redevelopment rates
- High development densities
- Limited land available for growth

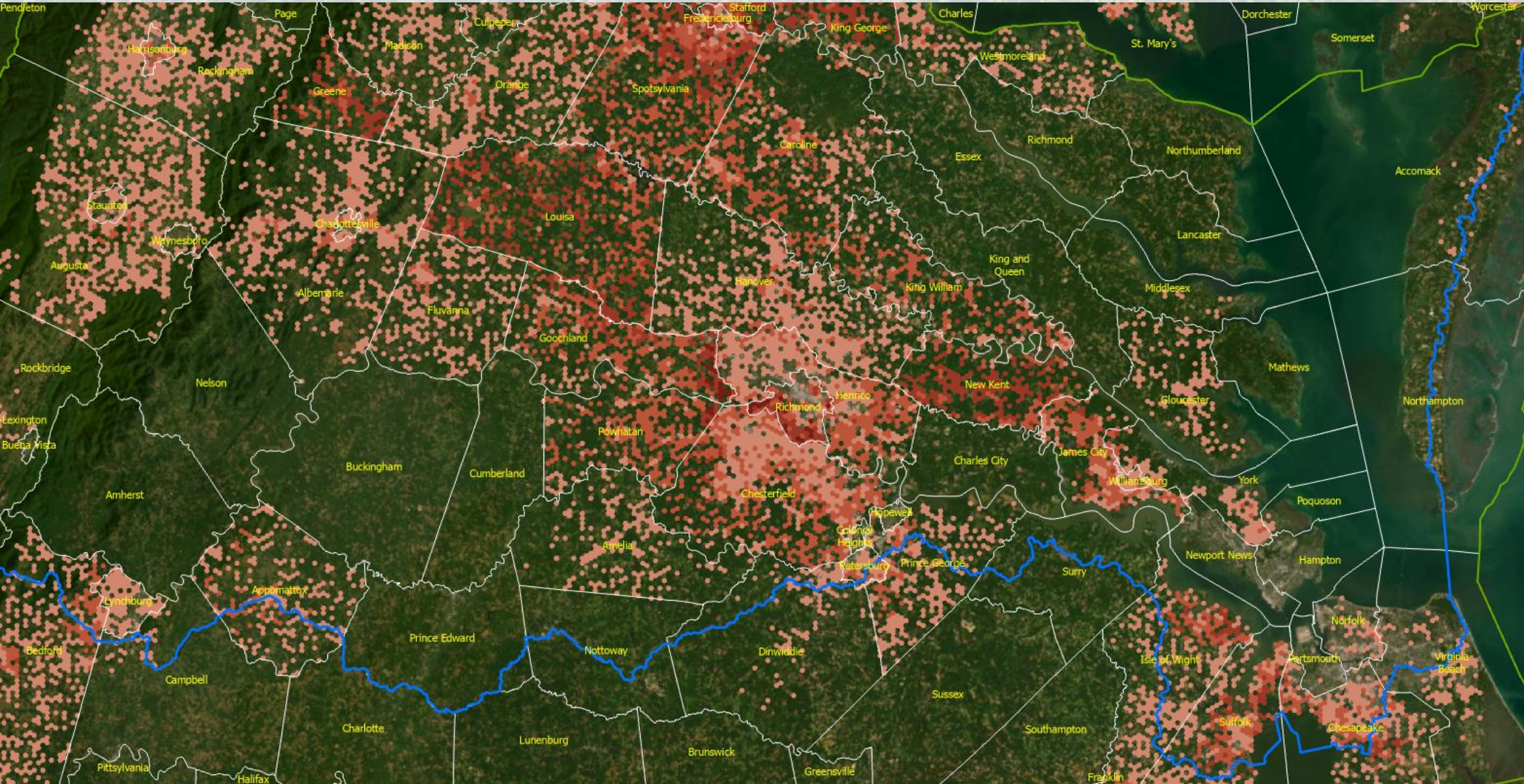
2050 Development: Northern Virginia and Central Maryland



Why high levels of growth?

- High population projections
- Low infill/redevelopment rates
- Low development densities
- Plenty of land available for growth

2050 Development: Southern and Central Virginia



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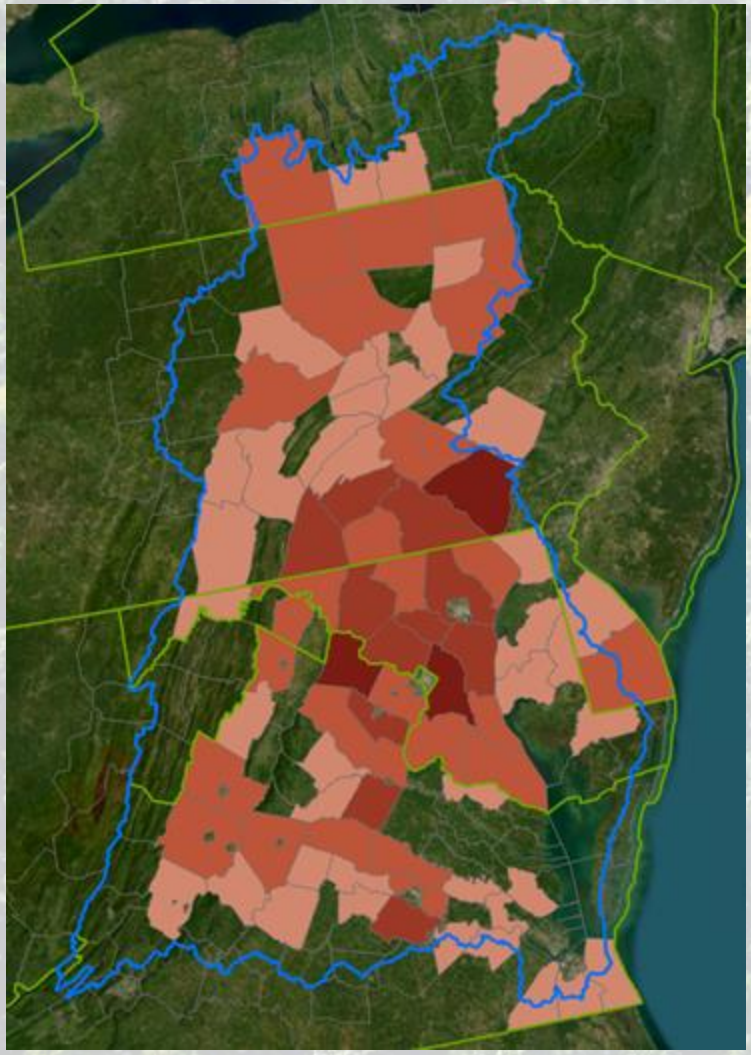

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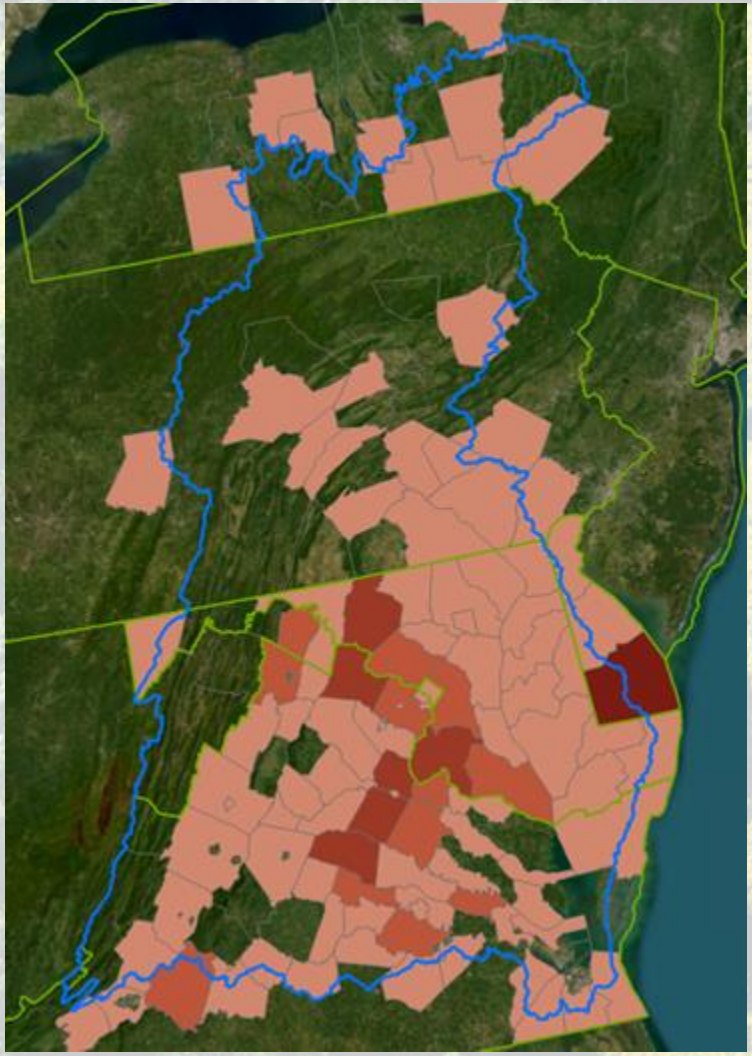
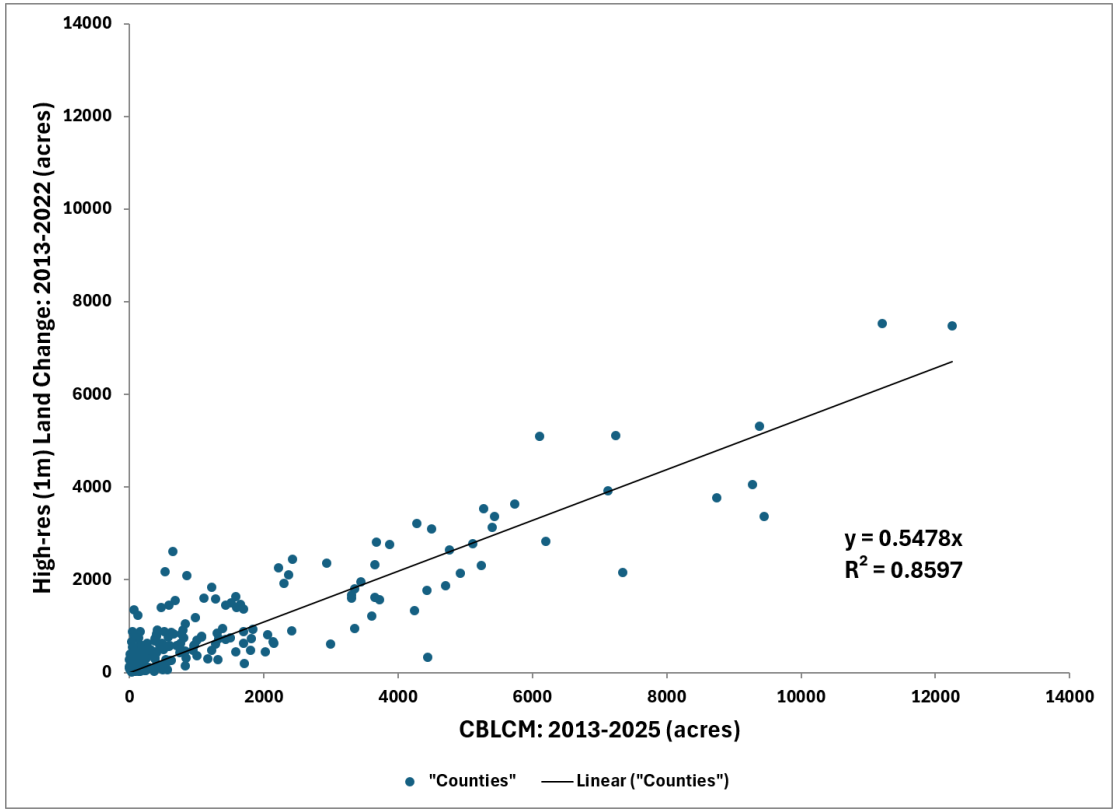


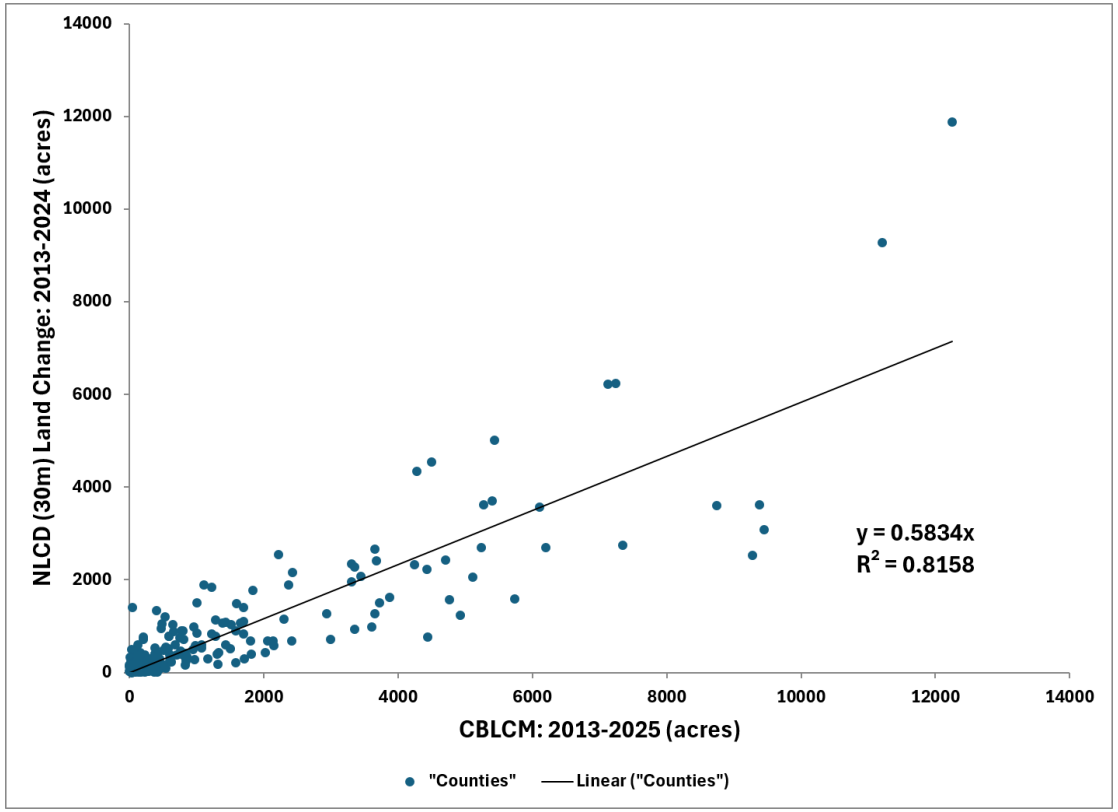
Annual Rate of Growth (acres)

State	Observed	Simulated
DC	(2)	53
DE	1,233	1,686
MD	3,176	3,703
NY	1,518	394
PA	5,774	721
VA	8,805	8,926
WV	1,286	407

Model Validation

Original (CBLCM v3a) Phase 6 Forecast to 2025





CBLCM v3a forecast ~50% more growth than observed in the high-res and NLCD land change datasets over similar periods
CBLCM v3a overestimated growth mostly in high-growth counties (e.g., Spotsylvania, Sussex, Loudon, Anne Arundel)

Why the current model is less likely to overestimate growth to the same degree:

- Current population projections based on the 2020 Census are lower than those available mid-2010's*
- Residential and commercial infill rates are 19% and 25% higher respectively, in CBLCM v7 compared to CBLCM v3a.
- Residential densities are 2x higher and commercial densities are 4x higher

* The current projected change in population from 2020-2040 for Lancaster, PA is 50% lower than it was in the mid-2010's.

Outstanding CBLCM Updates

1. **Refine model inputs**
   - Develop separate residential, commercial, and solar suitability layers
   - Exclude forecasted Traffic Analysis Zone housing and employment “no growth” areas from residential and commercial suitability respectively
   - Update solar probability layer with data from 2023-2026
   - Simulate utility-scale solar field growth
   - Incorporate planned/proposed data centers

2. **Verify and validate model outputs**
   - Compare infill/redevelopment estimates derived from MD and DE parcel data with CBLCM estimates.
   - Compare observed and simulated growth relative to distance to roads and urban areas.
   - Compare observed vs simulated patterns of growth at different spatial scales: 0.1 km2, 1 km2, 10 km2.

250,000 acres of new Utility-Scale Solar by 2040 (statewide totals)

Jurisdiction	Total
DE	3,302
DC	303
MD	12,412
NY	80,855
PA	31,092
VA	116,749
WV	9,228

Data Sources: Solar Energy Industry Association, PJM Long-Term Load Forecast, Pitt, et al., 2025, Virginia DEQ Renewable Energy Permits, U.S. Solar Photovoltaic Database, CBP High-resolution Land Use/Land Cover

CBLCM Review Resources

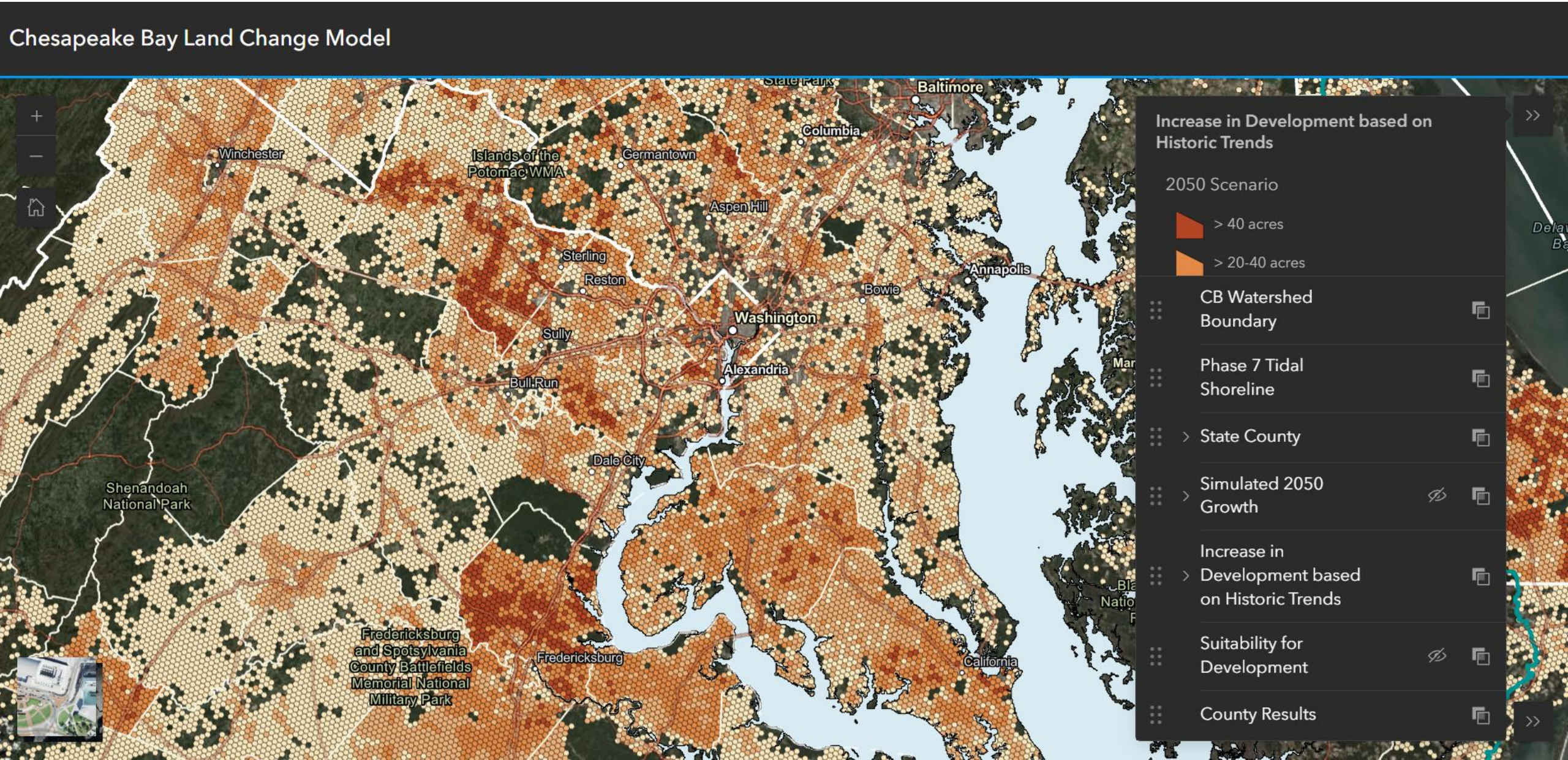
CBLCM Frequently Asked Questions (a must read): available on CWGT 7/27 meeting page

CBLCM Output Viewer: https://gis.chesapeakebay.net/cblcm/

Peer-reviewed Journal Article:
https://onlinelibrary.wiley.com/doi/10.1111/1752-1688.13131
available for free on CWGT 7/27 meeting page

Project Lead: pclaggett@usgs.gov , 410-490-1202

Review of Model Results

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