Mapping Low-density Residential Development and Estimating # of Septic Systems

Peter Claggett, Fred Irani, Renee Thompson, and David Donato

June 17, 2013
Land Use Workgroup Meeting

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

Developed Land Uses – Phase 5.3.2

1. **Impervious developed**
   - Regulated (MS4, CSO)
   - Unregulated

2. **Pervious developed** (e.g., turf grass, landscaped areas)
   - Regulated (MS4, CSO)
   - Unregulated

3. **Construction**
   - 2.5 x annual change in impervious surface; or
   - acreage with an active E&S permit

Developed Land Uses – Phase 6

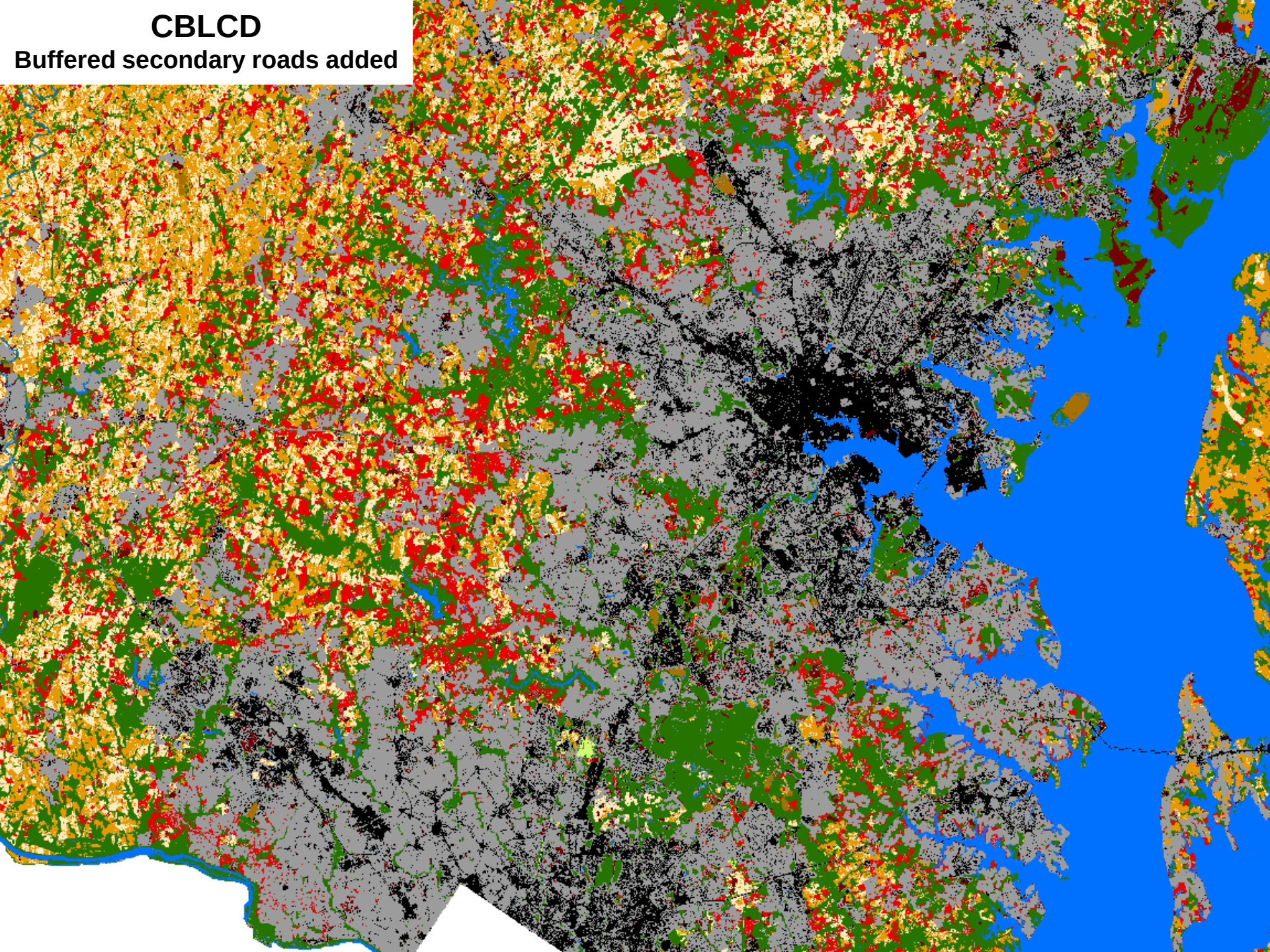
1. **Impervious developed**
    - Connected vs. Disconnected
        - Regulated vs. Unregulated
            - Rural, Low-density, Medium-density, High-density Residential, Mixed, Commercial/Industrial, Institutional
            - Urban Tree Canopy (over impervious surfaces)

2. Pervious developed (e.g., turf grass, landscaped areas)
    - Connected vs. Disconnected
        - Regulated vs. Unregulated
            - Open space, Low-density, Medium-density, High-density Residential, Mixed, Commercial/Industrial, Institutional
            - Low risk turf grass
            - High risk turf grass
            - Golf courses
            - Unfertilized turf, scrub/shrub, fallow developed
            - Residential woodlands

Developed Land Uses – Phase 6

3. **Roads**
    - Connected vs Disconnected
        - 1-lane, 2-lane, 4-6 lanes, 8+ lanes (to infer impervious area and size of medians and shoulders)
        - Dirt and gravel
    - Federal vs. state vs. other (to assign responsibility)
    - Traffic volume ranges (linked to dry atmospheric deposition)

4. **Construction** (requiring an E&S or other permit)
    - New development
    - Shale gas pads and associated infrastructure (tentative)


CBLCD
Buffered secondary roads added

Estimating Impervious Cover and Turf Grass in the Chesapeake Bay Watershed

Model Version	Impervious Surface (circa 2001/02)	Pervious Surface (circa 2001/02)
Phase 5.3.0 (land cover)	681,980	2,127,298
Phase 5.3.2 (land use)	1,207,346	3,143,388

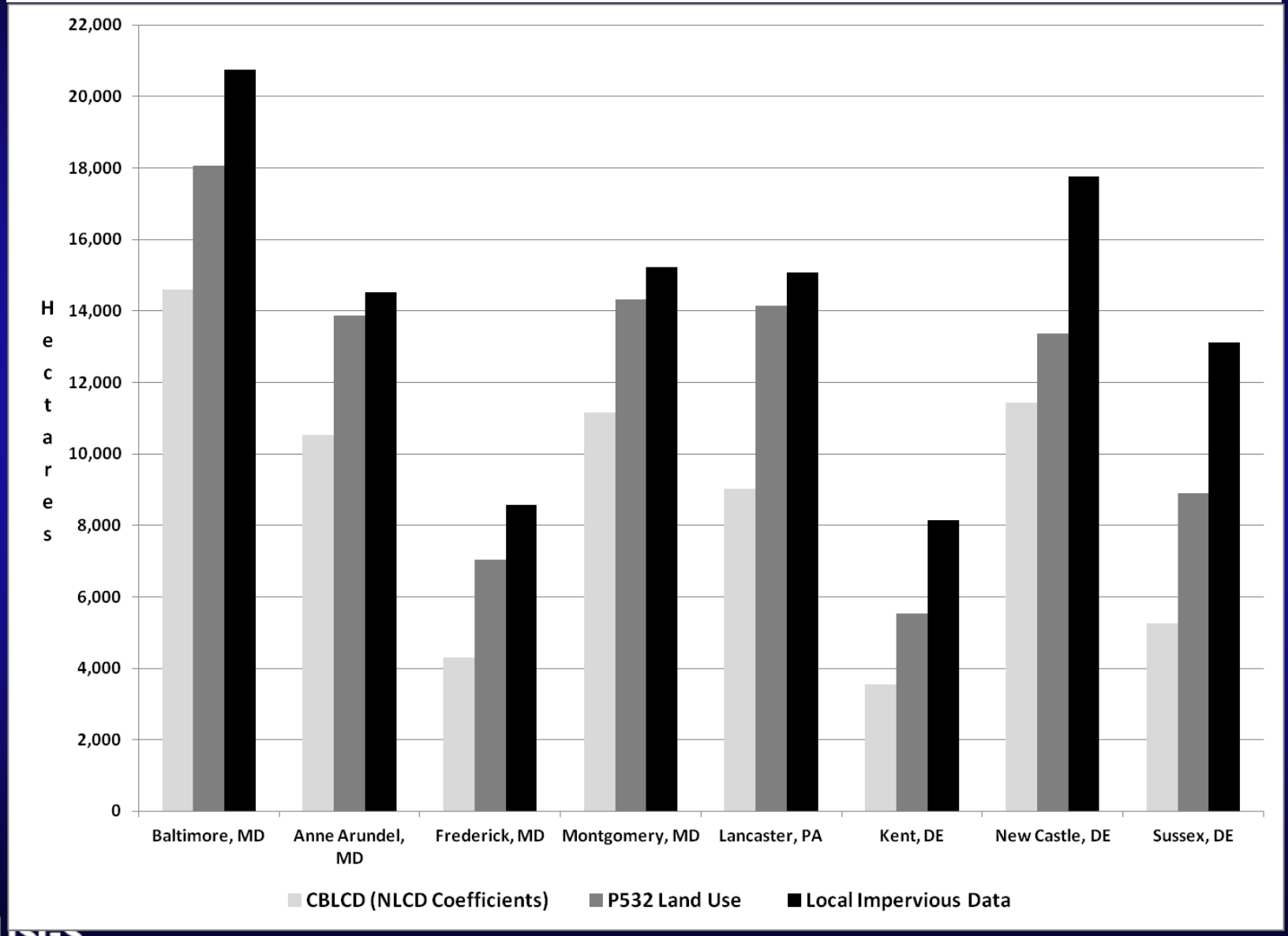
Source:

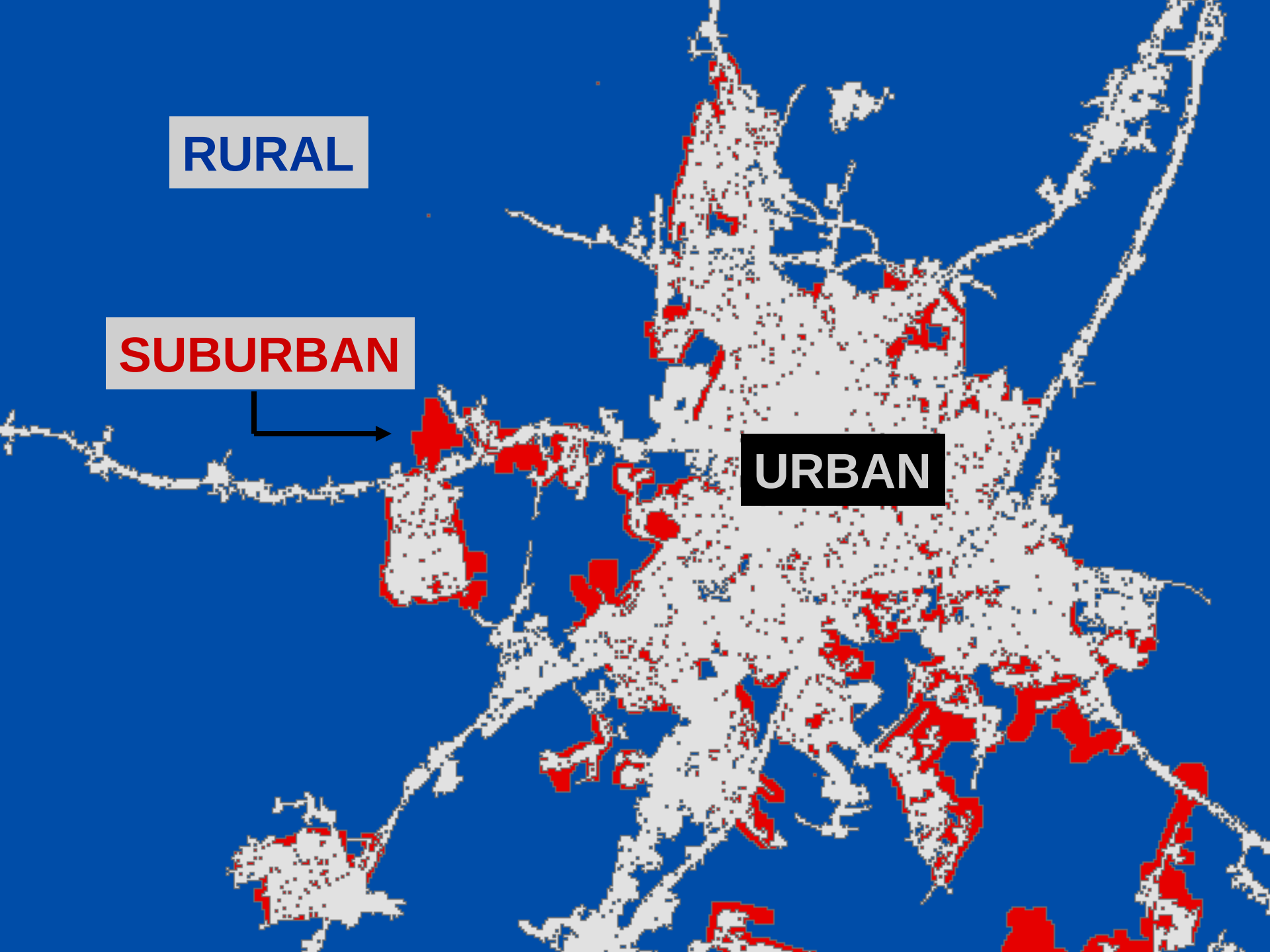
Claggett, et al., submitted. Estimating the Extent of Impervious Surfaces and Turf Grass Across Large Regions. *Journal of the American Water Resources Association*

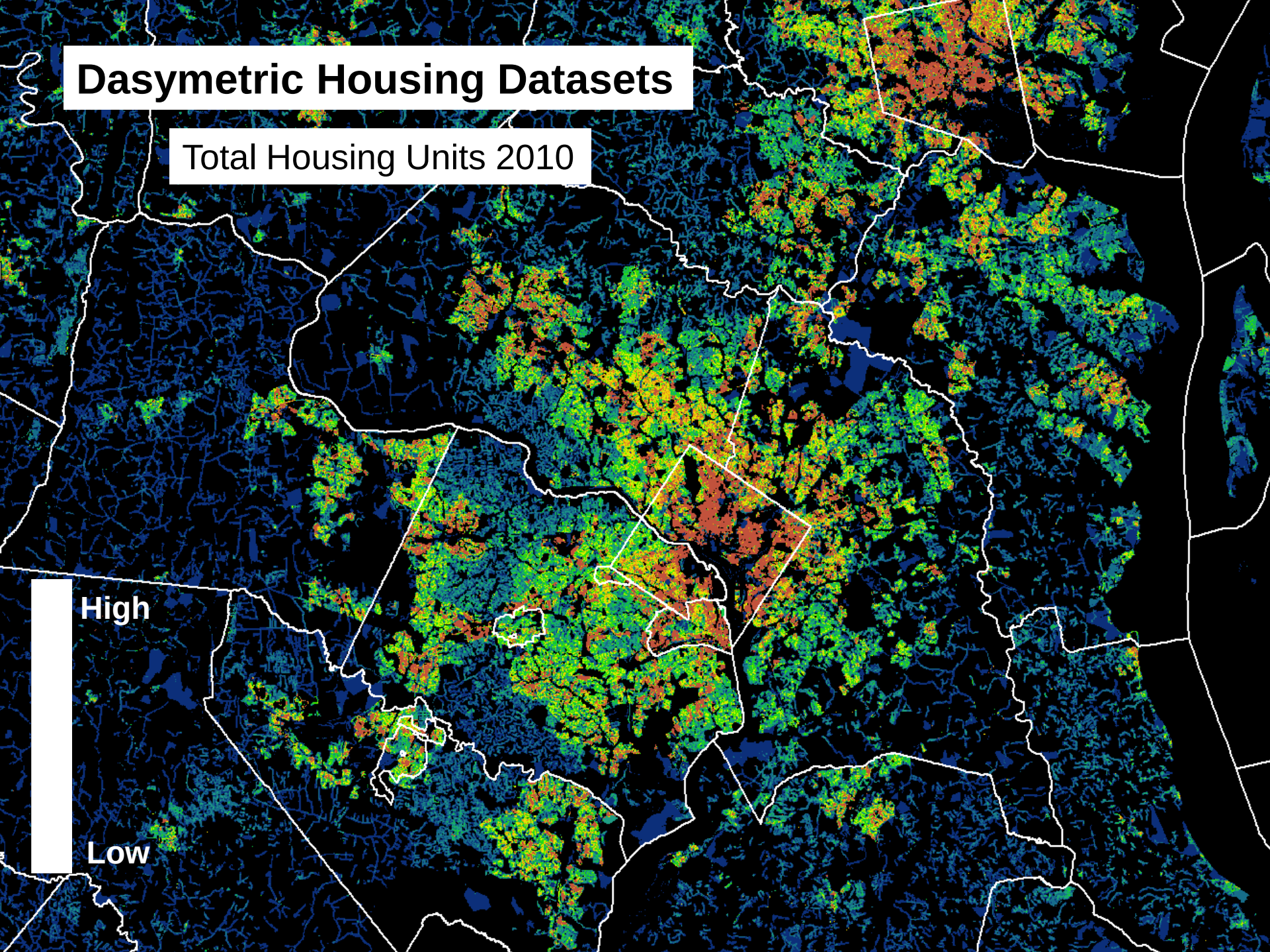
USGS

County-level Impervious Surface Estimates

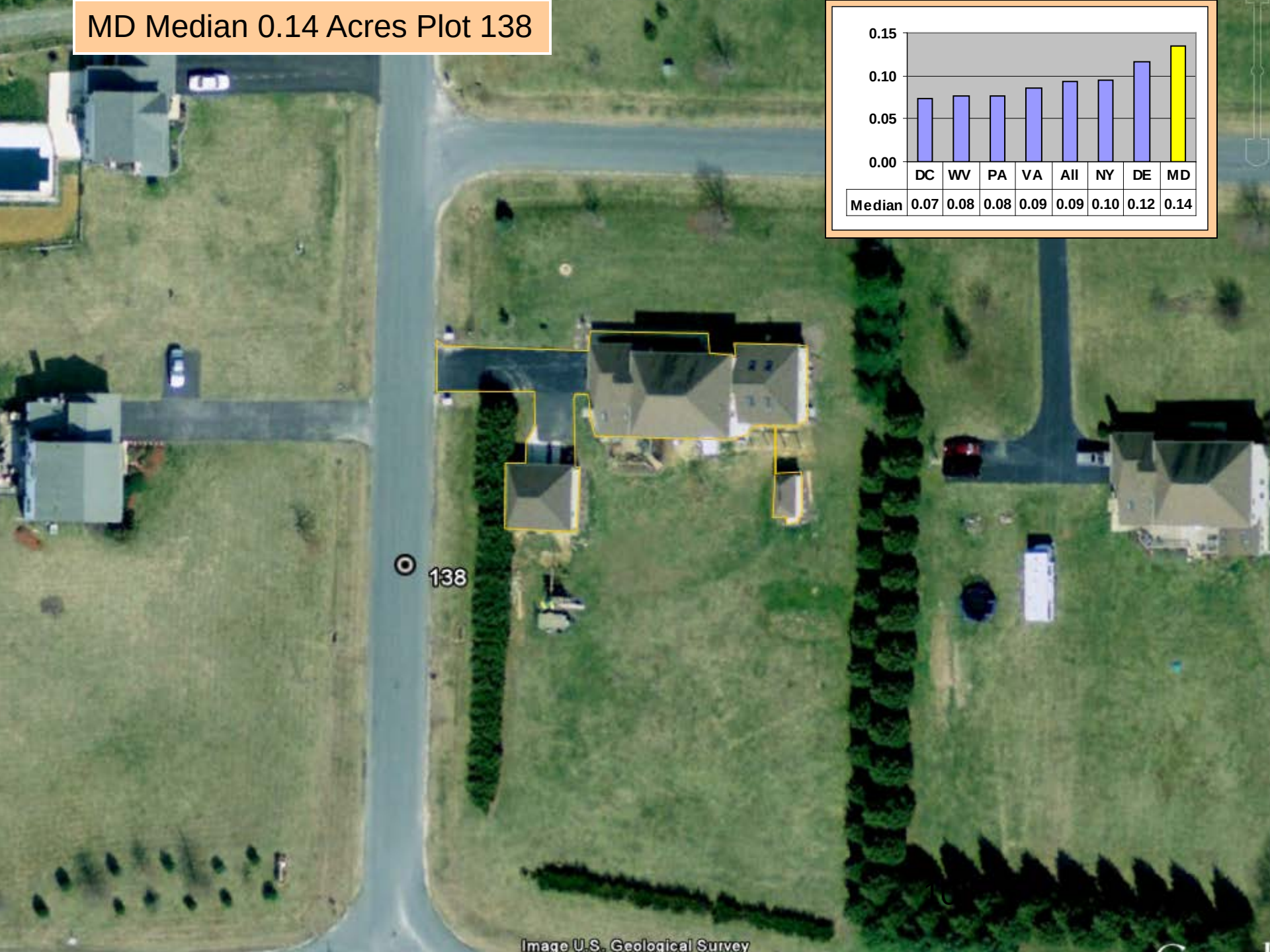
Landsat (Phase 5.3.0), Modeled (Phase 5.3.2), and Local Data




RURAL
SUBURBAN
URBAN

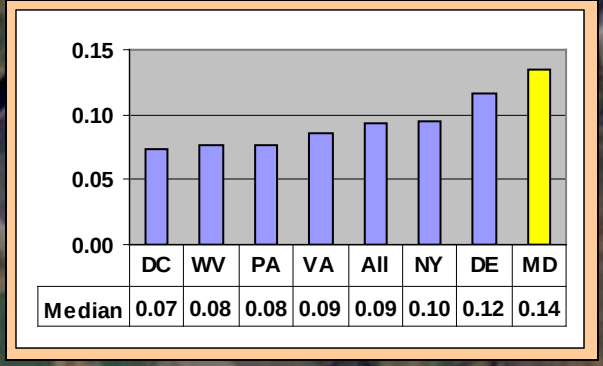

Dasymetric Housing Datasets
Total Housing Units 2010
High
Low

MD Median 0.14 Acres Plot 138



	DC	WV	PA	VA	All	NY	DE	MD
Median	0.07	0.08	0.08	0.09	0.09	0.10	0.12	0.14

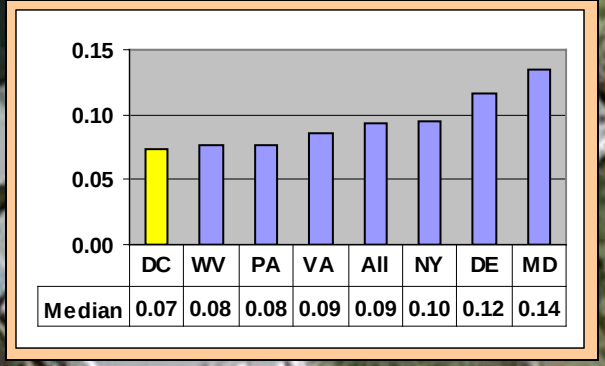
MD Median 0.14 Plot 110



	DC	WV	PA	VA	All	NY	DE	MD
Median	0.07	0.08	0.08	0.09	0.09	0.10	0.12	0.14

110

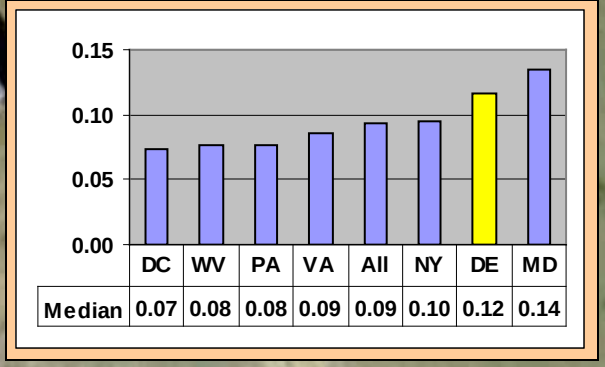
DC Median 0.07 Acres Plot 5



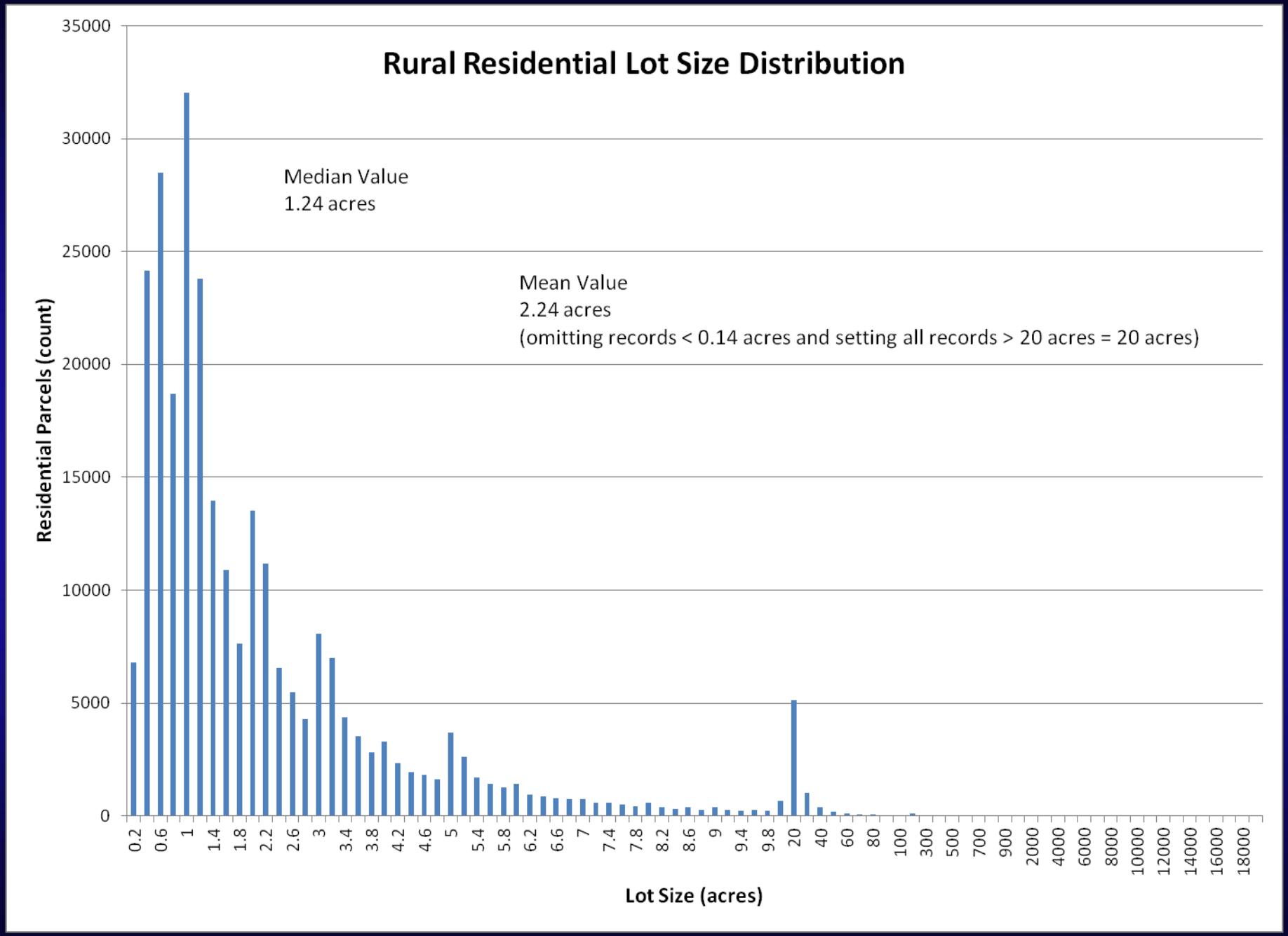
	DC	WV	PA	VA	All	NY	DE	MD
Median	0.07	0.08	0.08	0.09	0.09	0.10	0.12	0.14

5

DE Median 0.12 Acres Plot 53



	DC	WV	PA	VA	All	NY	DE	MD
Median	0.07	0.08	0.08	0.09	0.09	0.10	0.12	0.14


Rural Residential Lot Size Distribution
Median Value
1.24 acres
Mean Value
2.24 acres
(omitting records < 0.14 acres and setting all records > 20 acres = 20 acres)
Residential Parcels (count)
35000
30000
25000
20000
15000
10000
5000
0
0.2
0.6
1
1.4
1.8
2.2
2.6
3
3.4
3.8
4.2
4.6
5
5.4
5.8
6.2
6.6
7
7.4
7.8
8.2
8.6
9
9.4
9.8
20
40
60
80
100
300
500
700
900
2000
4000
6000
8000
10000
12000
14000
16000
18000
Lot Size (acres)

Suburban & Rural Impervious Coefficients (acres)

Median	Suburban	Rural
DC	0.073	0.177
DE	0.116	0.149
MD	0.135	0.177
NY	0.095	0.113
PA	0.077	0.148
VA	0.085	0.150
WV	0.076	0.109

USGS

Urban Impervious Coefficients (% per pixel per county)

NLCD Impervious Coefficients (County Ranges)

Developed Land Cover Classes	County Min	County Mean	County Max
Developed Open Space	2.1 %	6.6%	19.2%
Low-intensity Developed	11.4%	19.3%	37.1%
Medium-intensity Developed	32.4%	43.4%	68.7%
High-intensity Developed	53.0%	66.9%	90.8%

Due to potential error at the low-end of the range, the coefficients are not allowed to be less than the 1st quartile value in range of county coefficients for each state.

USGS

Measuring Impervious Surface Associated with Roads

Road Type	% of Rd Miles	Literature Range	Sample Range	Sample Mean	Selected Width
2-lanes (2-way)	88.8%	22 – 36	13 – 50	23- 25	22 (rural) 26 (urban)
4-6 lanes (2-way)	2.4%	42 – 84	26 – 104	72	26, 36, and 72
8 + lanes (2-way) (controlled access)	2.9%	116 - 120	70 - 222	120	116

Within the Bay watershed, there are 372,461 acres of impervious surfaces associated with rural roads composing about 31% of all impervious surfaces. Eighty-nine percent of the roads have 2 lanes and most likely range from 22’ – 26’ resulting in an impervious surface range of +/- 70,000 acres in the Bay watershed.

Note: Lane width= 10’ - 12’. Shoulder width= 2’ - 12’ (2 – 6 lanes) or 10’ – 12’ (controlled access highway).

This analysis does not take into account sidewalks or parking lanes.

USGS

P532 Turf Grass Acres in Maryland = 947,984 acres
NASS Estimate = 1,134,000 acres

Why the difference?

1. P532 does not capture turf grass associated road right-of-ways, and isolated commercial, industrial, and institutional establishments.
2. Turf Industry estimate is used to substantiate the economic importance of the industry. Therefore, it probably represents the upper bounds of the probable extent of turf grass.

Turfgrass areas used and maintained in Maryland, 2005

Sector	Turf Acres	Percent of Turf Acres	New Turf Established	Cost of Establishing New Turf	Average Cost per Acre to Establish New Turf
	- acres -	*- percent -*	*- acres -*	*- dollars -*	*- dollars -*
Airports	5,000	0.4	----	----	
Cemeteries	4,200	0.4	130	361,000	2,777
Religious Facilities	9,400	0.8	250	581,000	2,324
Parks and Athletic Fields	21,800	1.9	320	3,275,000	10,234
Golf Courses	16,400	1.4	310	2,105,000	6,790
County Government	78,200	6.9	480	3,914,000	8,154
State Highways	9,000	0.8	650	1,570,000	2,415
Apartments	7,500	0.7	200	765,000	3,825
Lawn Care	[1]		[1]	[1]	
Sod Farms	8,000	0.7	[2]	[2]	
Single Family Homes	936,900	82.6	28,190	73,112,000	2,594
Schools	38,400	3.4	360	3,481,000	9,669
Total	1,134,800		30,890	89,164,000	2,887

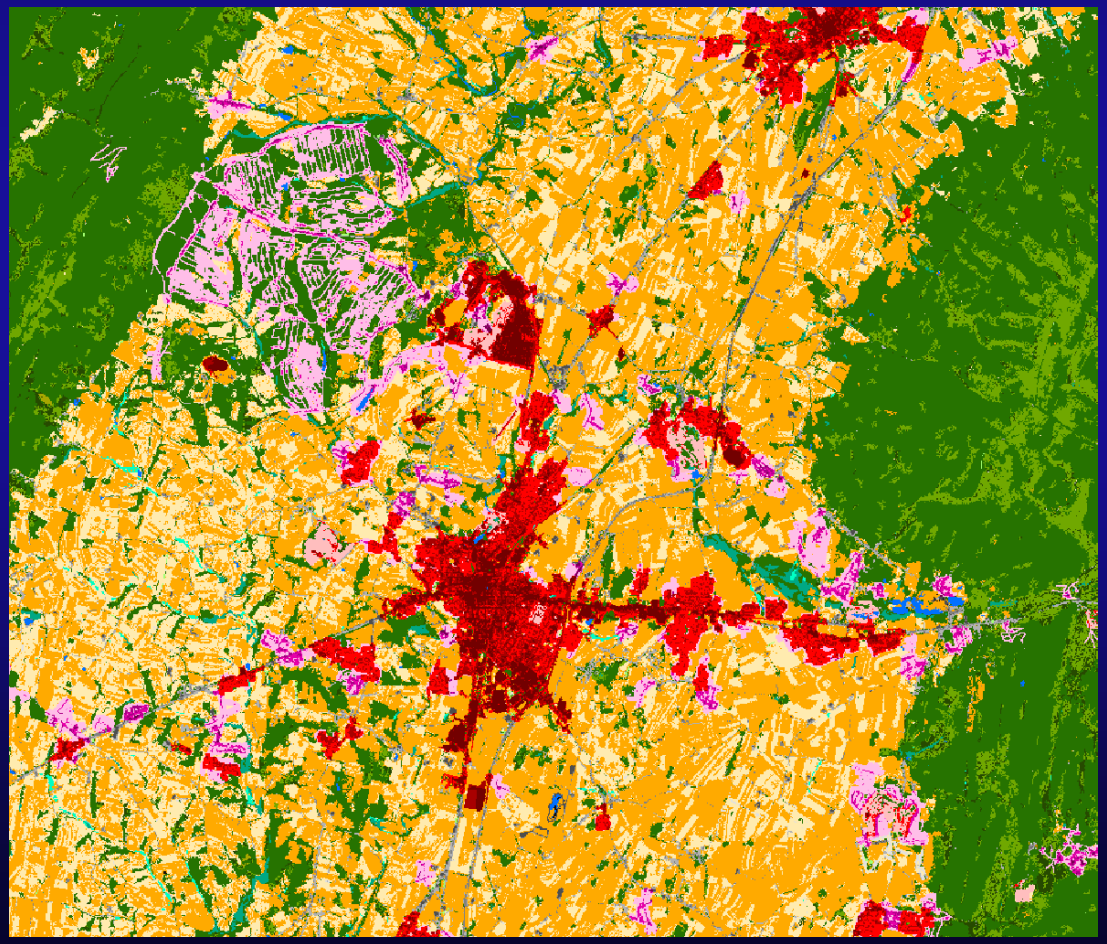
[1] Maryland Department of Natural Resources, 2006.
[2] USDA, National Agricultural Statistics Service, Maryland Field Office, 2006.

USGS

Capturing low density residential development improved accuracy of agricultural classes

P530 2006 Farmland Acres in Maryland	=	2,116,531 acres
P532 2006 Farmland Acres in Maryland	=	1,639,198 acres
USDA 2007 Ag Census	=	1,558,546 acres

P 5.3.0



Chambersburg, PA

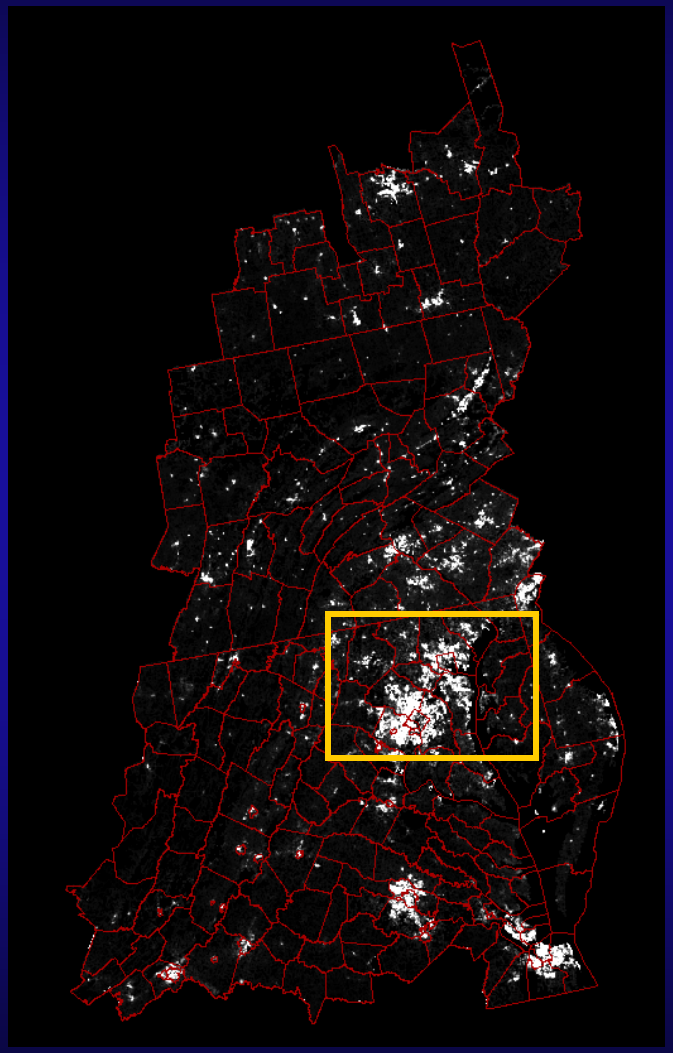
USGS

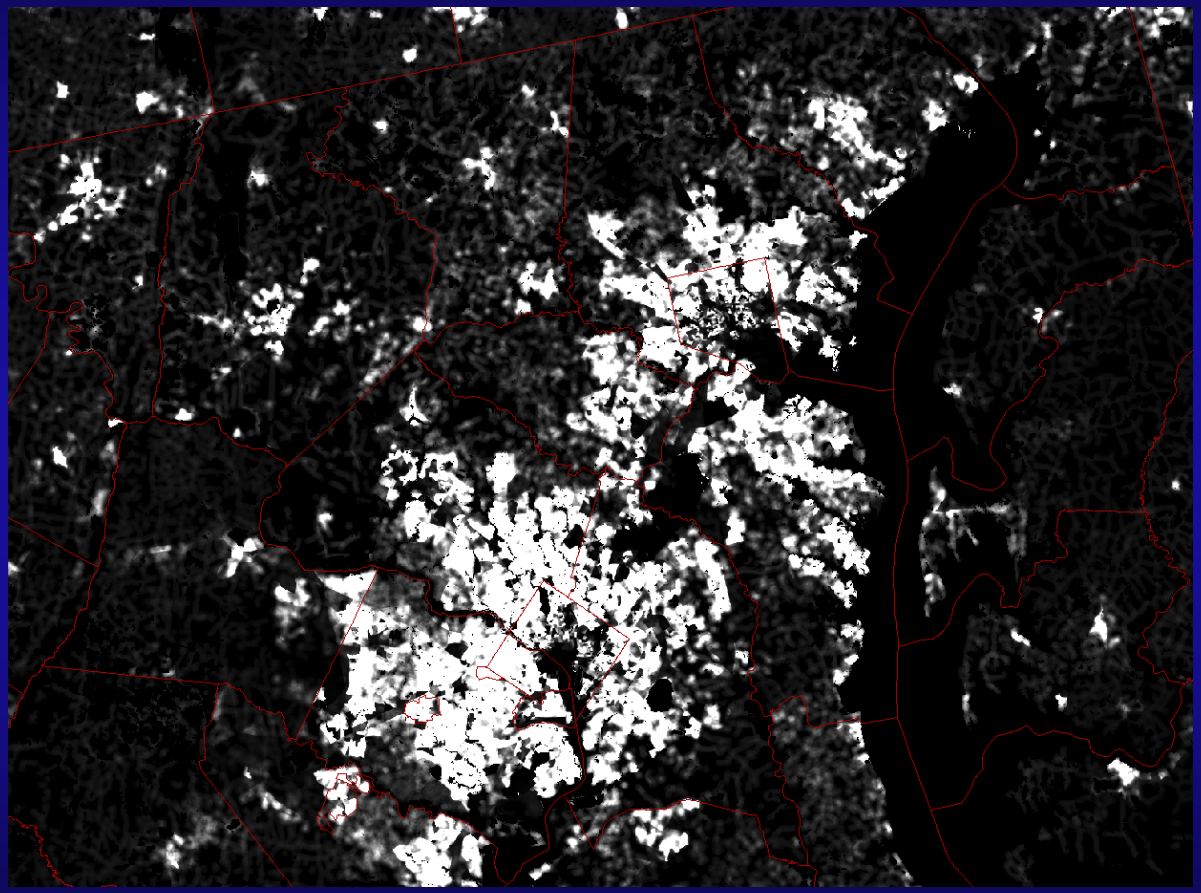
Tetra Tech 2009 Survey of WWTPs

- 403 major WWTPs in Bay watershed surveyed
- 257 facilities (~ 64%) responded
- Additional data collected in 2008 from:
  - Maryland Department of Planning
  - Delaware Counties (all)
  - Washington Council of Governments
  - Virginia: Albemarle, Arlington, Henrico, Loudoun, and Rockingham Counties and James City, Newport News City, Virginia Beach and Richmond City.
  - Pennsylvania: Perry, Dauphin, Lancaster, Lycoming, and Cumberland Counties.
  - New York: Broome County.

USGS

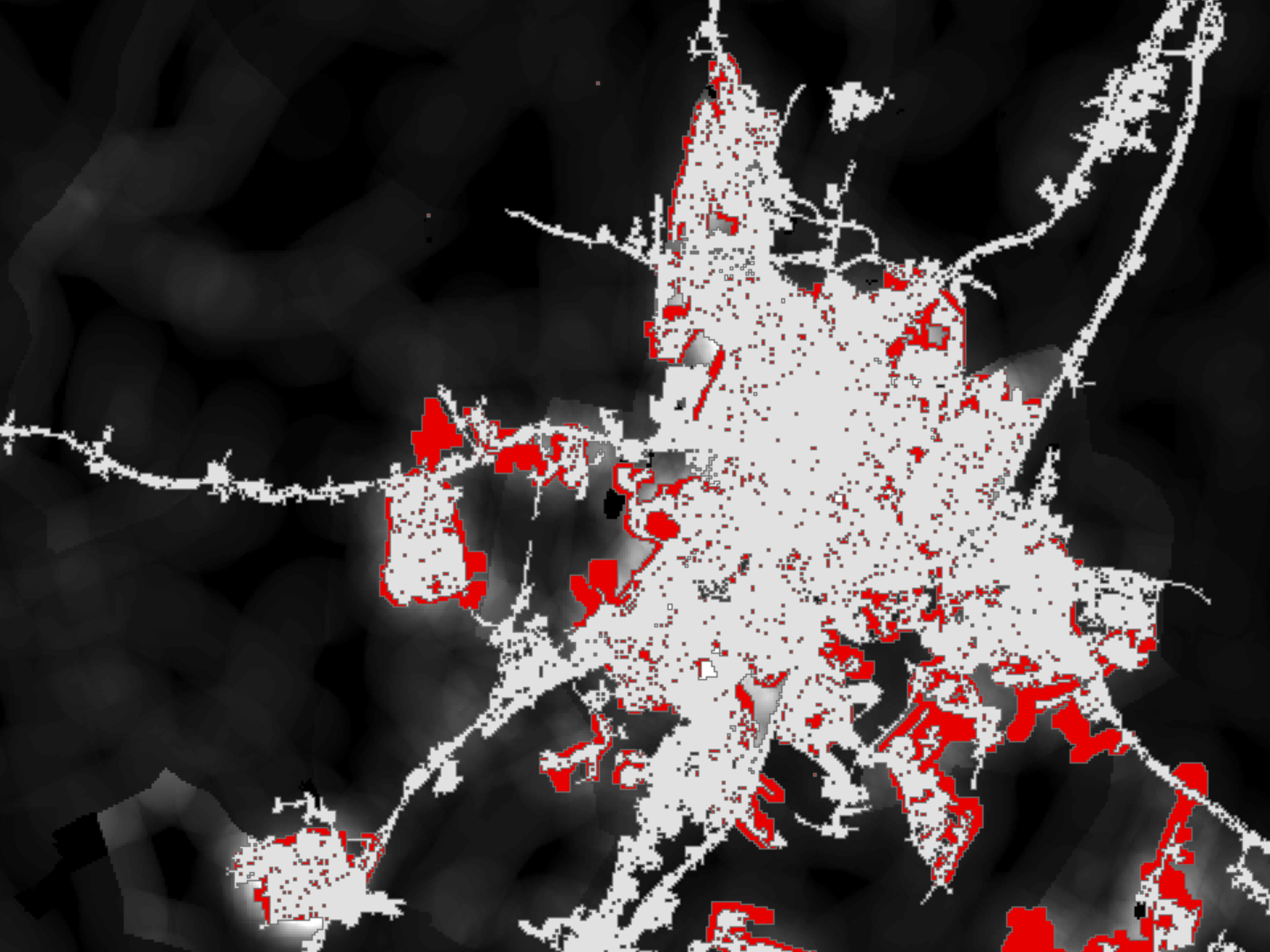
Dasymetric Mapping of Single-detached Housing Units





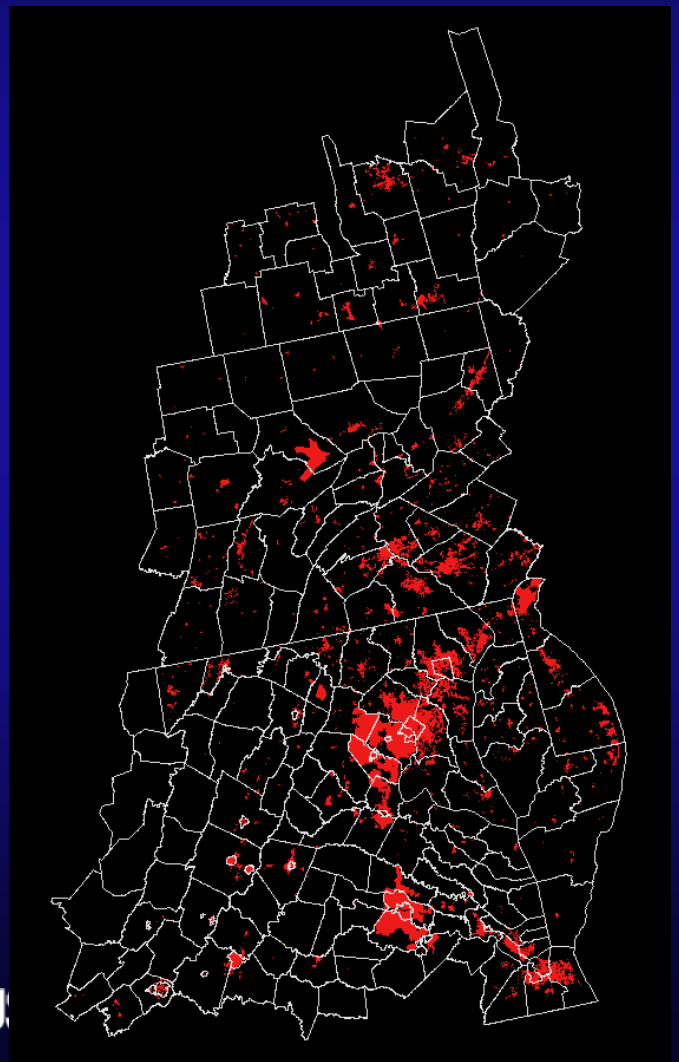
USGS

Correlation with Census Block data at Modeling Segment Scale = 0.80



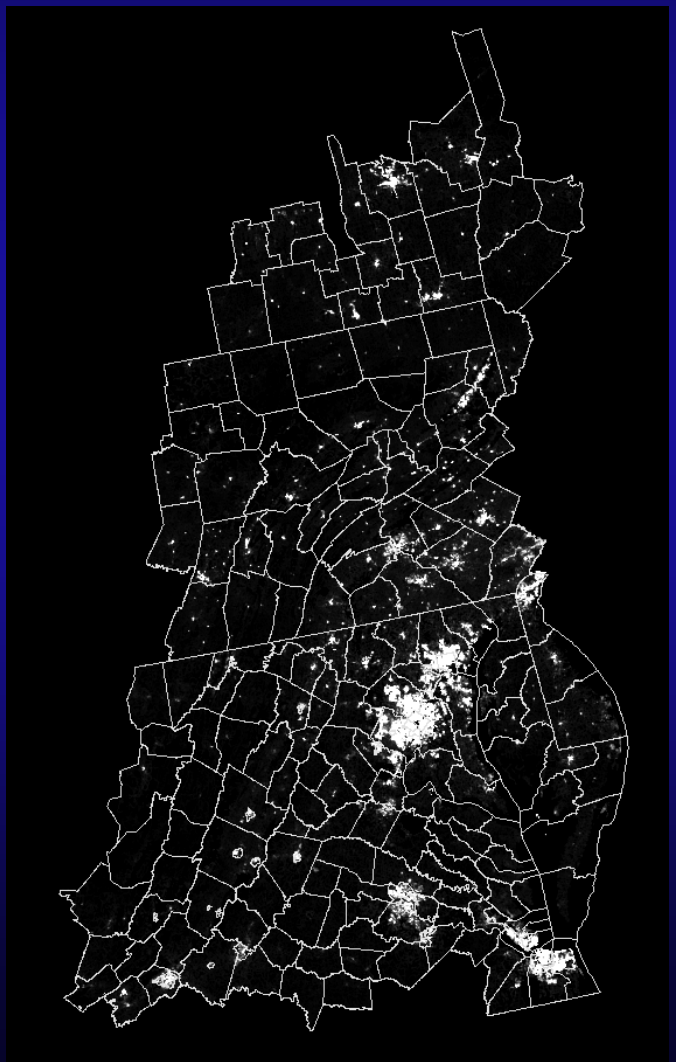
Estimating Population on Sewer

Sewer Service Areas

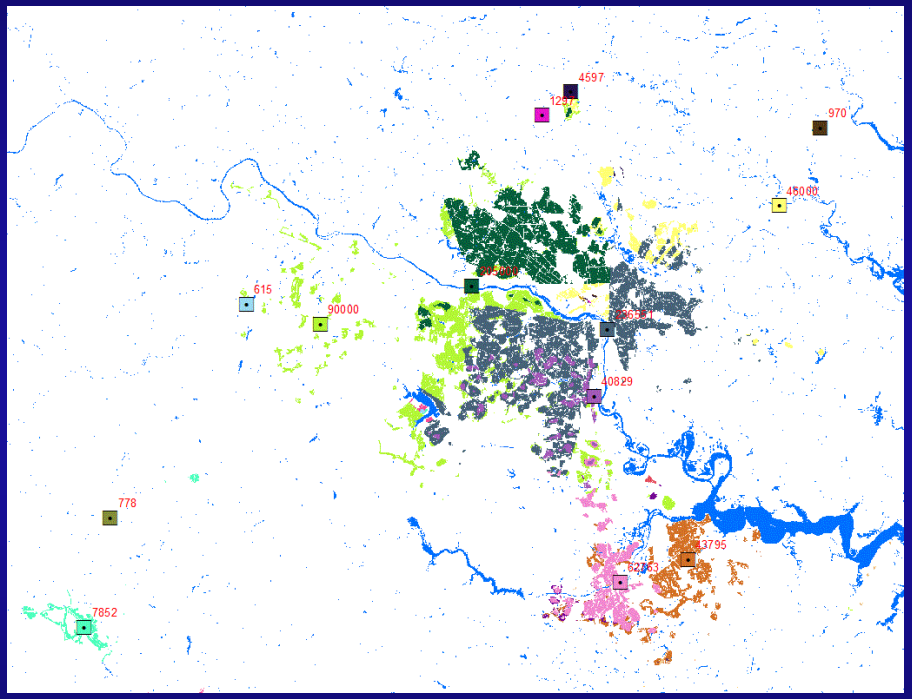


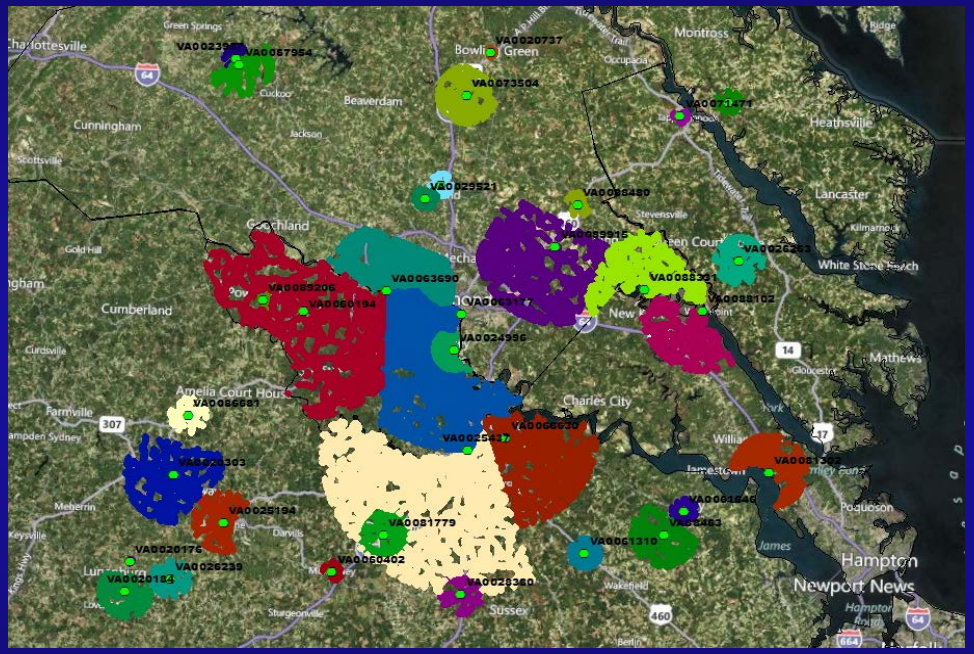
+

Population Distribution (yr. 2000)



Alternative Mapping Techniques for Delineating Sewer Service Areas (Richmond, VA)





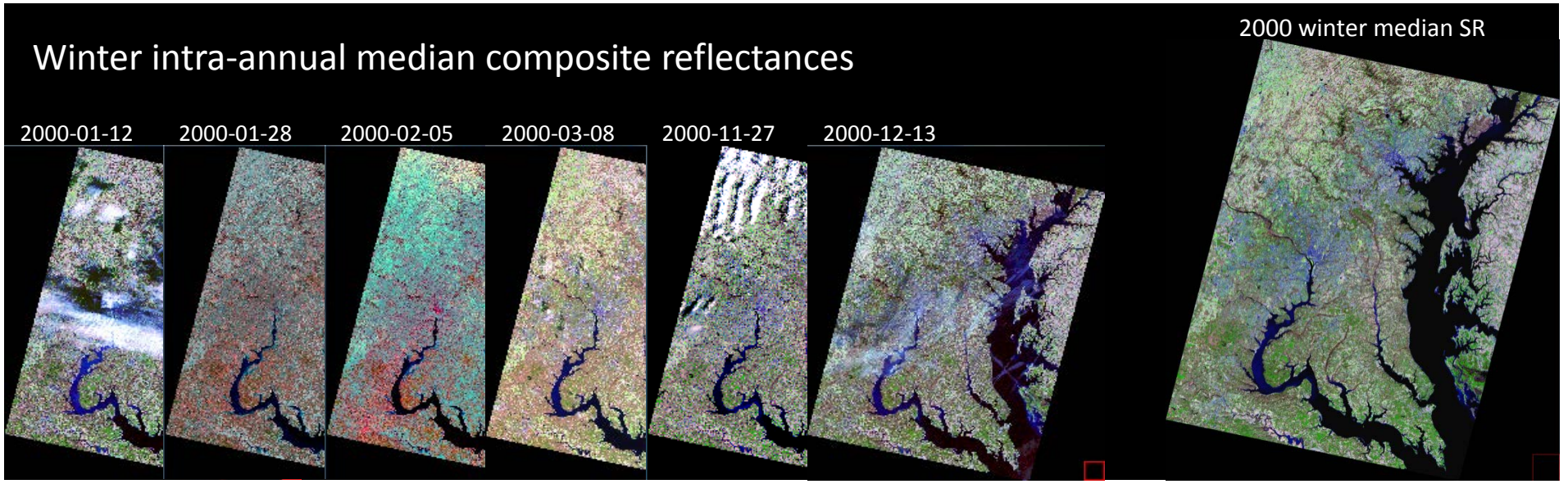
USGS

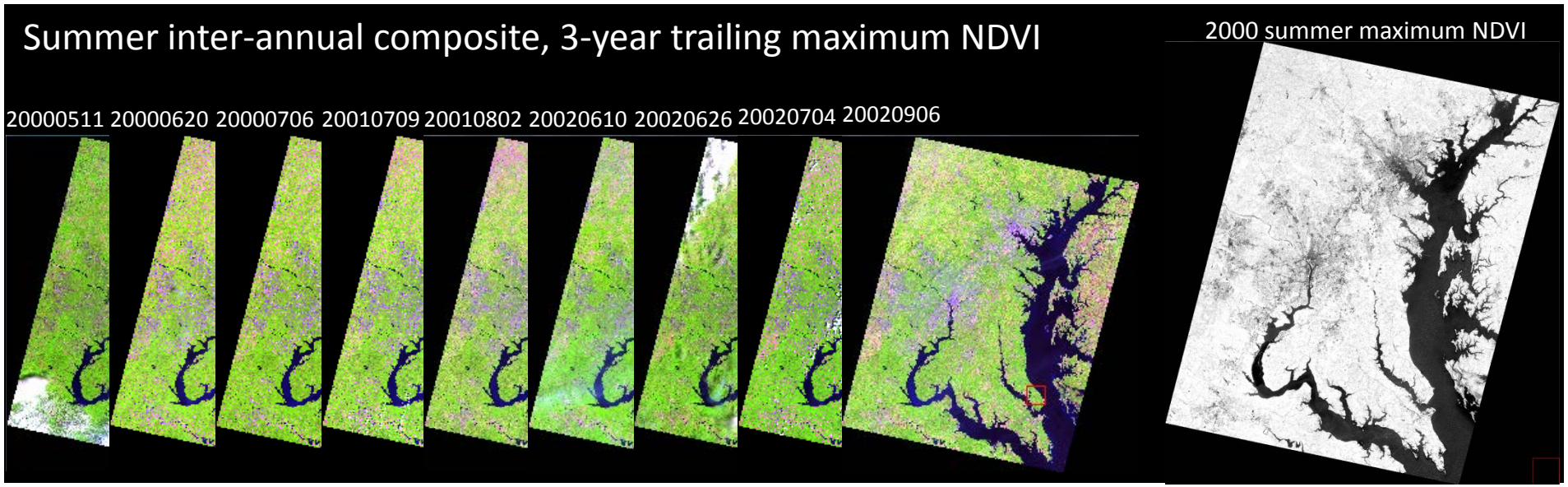
Phase 6 Possibilities

- Incorporate local land use and sewer service area data where provided.
- Estimate impervious surfaces at annual intervals using improved Landsat classifications
- Refine sample estimates of suburban and rural impervious surface.
- Refine estimates of rural lot sizes
- Refine turf grass estimates with fractional tree canopy
- Re-survey sewer service providers to map sewer service areas and to associate area served with each plant.
- Explore use of groundwater well and health department information to map septic systems.

USGS

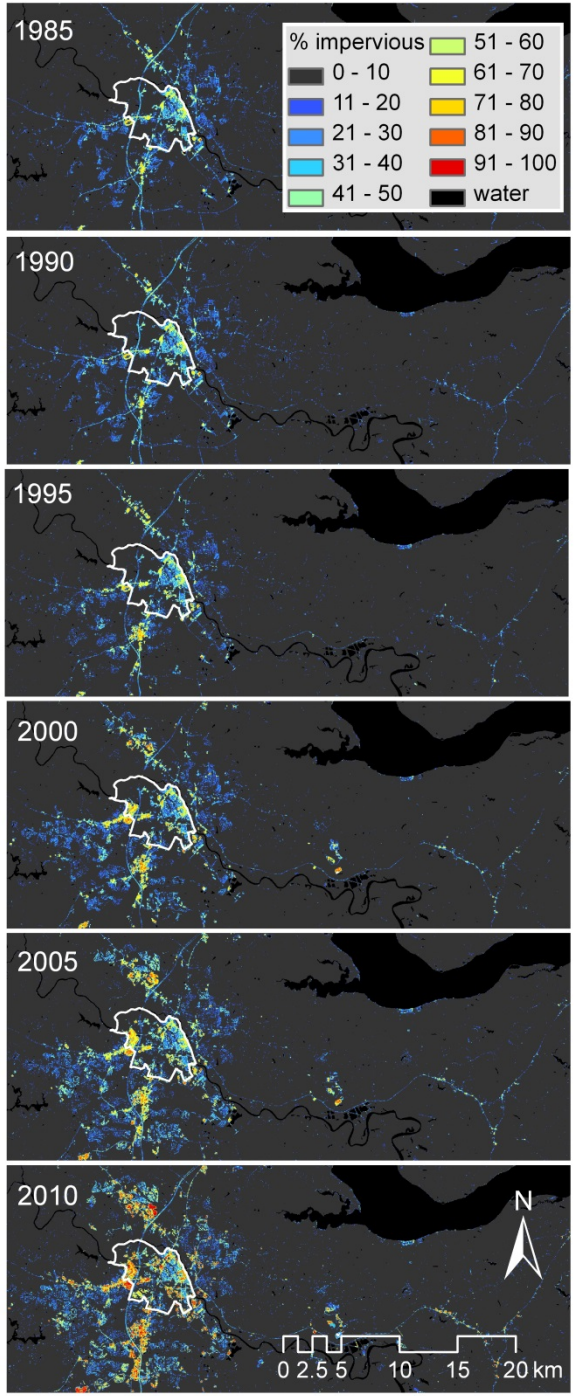
High-density Landsat compositing





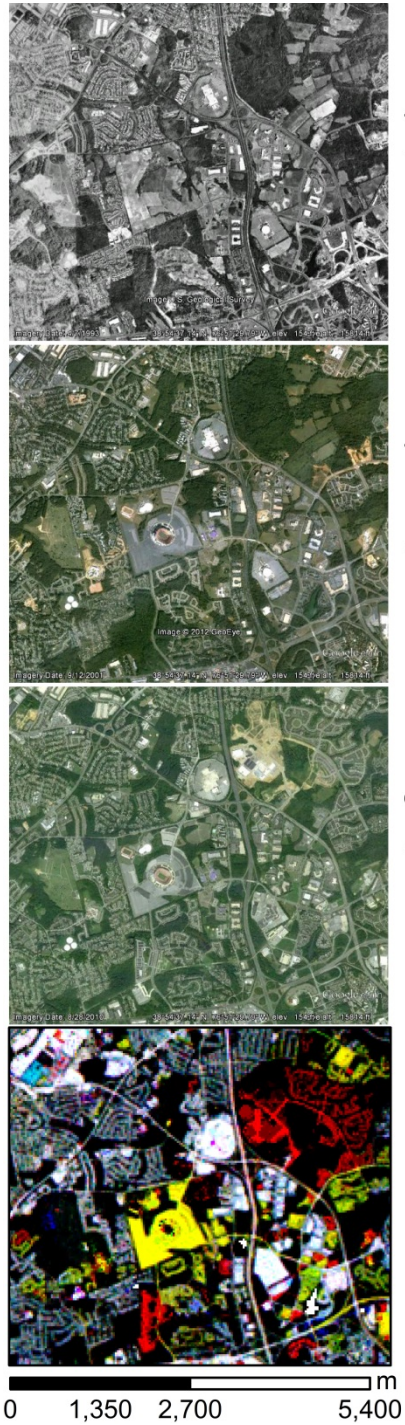
Growth of Fredericksburg, VA

- Clear patterns of urbanization
- Most growth outside municipal boundary



Development around the Verizon Center

- Parcel-level development evident
  - Cleanly demarcated buildings, office parks, and subdivisions



Contact Information:

Peter Claggett
Research Geographer
U.S. Geological Survey
410-267-5771
pclaggett@usgs.gov

USGS