Point-Based Population Models: Making your data count!

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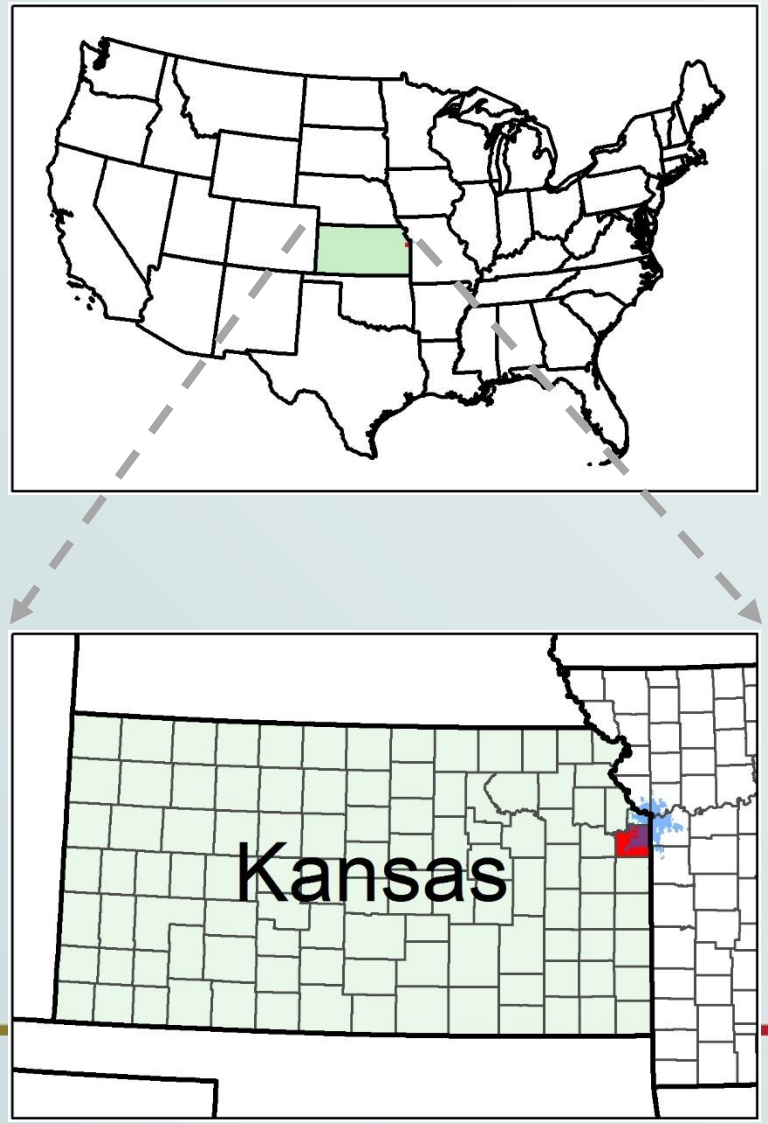
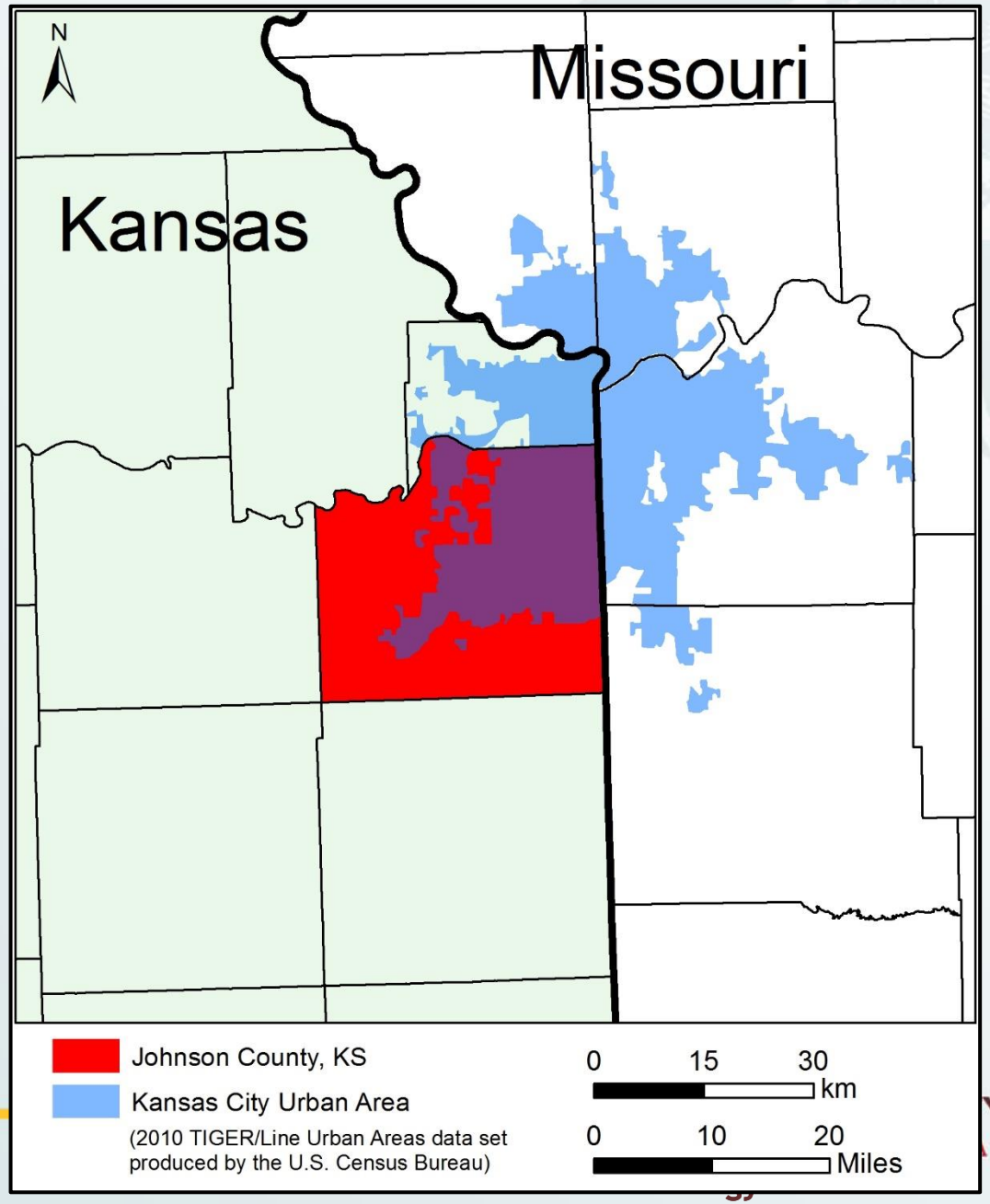
Abstract

- Join Johnson County, KS AIMS for a presentation on our point-based population models. In response to frequent requests for current or near-future population estimates in geographies not typically covered by Census Bureau datasets (such as school attendance zones or county commissioner districts) we have developed four distinct point-based population models over the past 20 years. These models effectively integrate local GIS data, including property centroid locations, address points, and land use codes, with Census Bureau data. Our approach allows for precise population estimation in any custom-defined area. This enhances both accuracy and adaptability in population estimation, making our models exceptionally valuable for local government planning and response initiatives.
- In my presentation, I will provide an overview of these models, highlighting the conceptual framework and input data unique to each. I will briefly discuss the model validation process and the challenges encountered

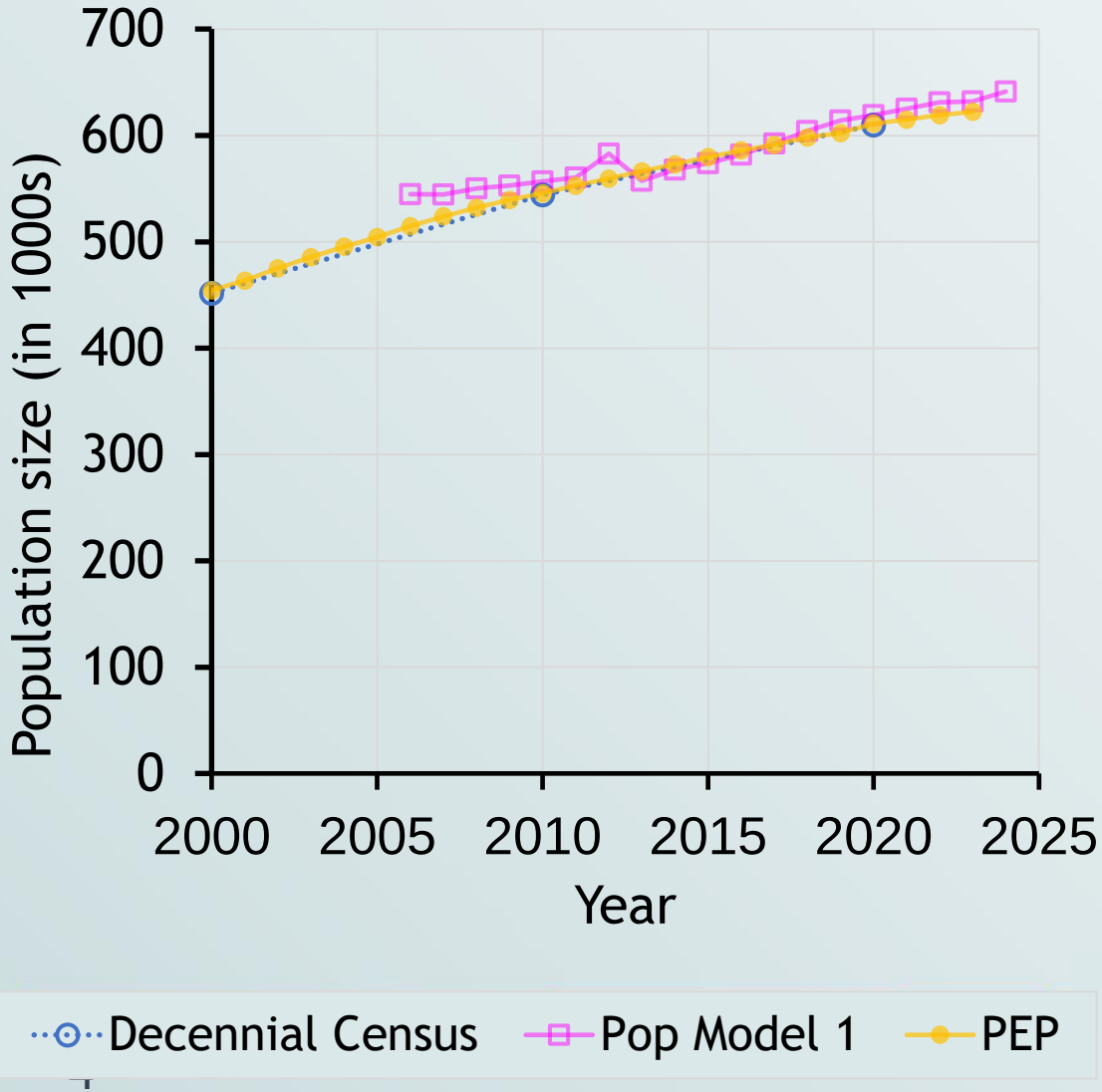
Johnson County, KS



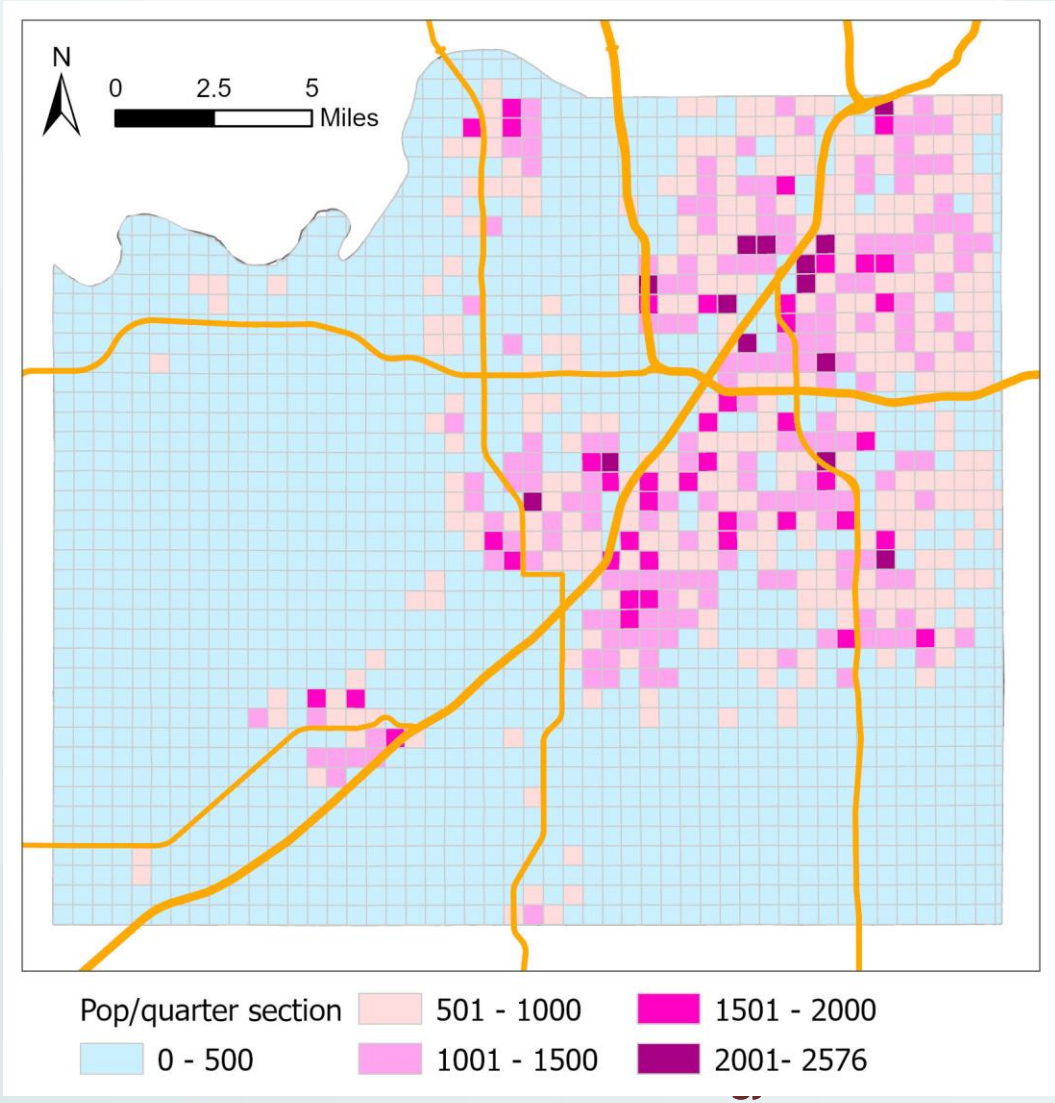


Johnson County Population

In Time



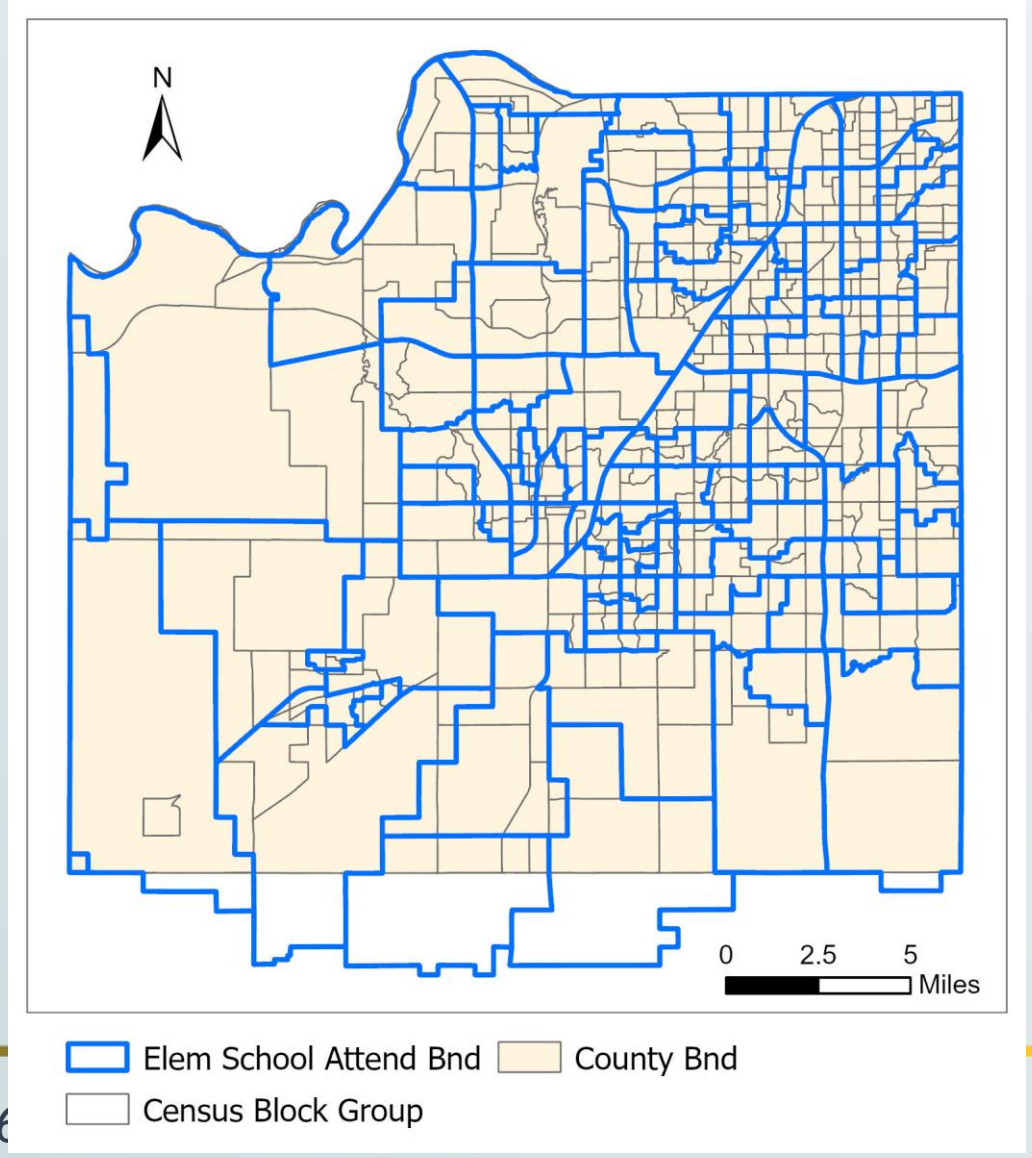
In Space on 2024-04-12 (Pop Model 1)

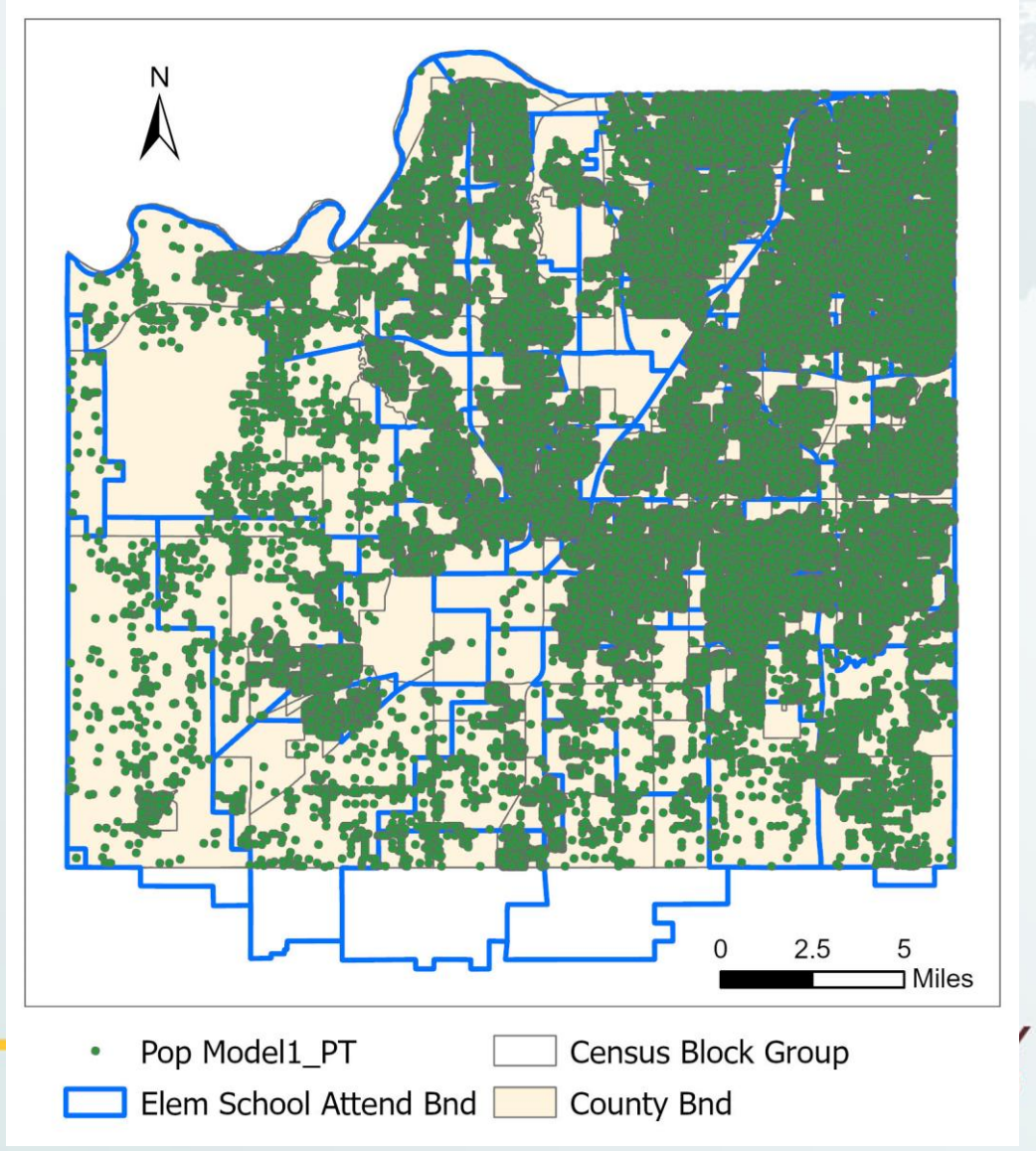


Why a point-based population model?

- A population model is quite simply a bunch of points on a map, and each point is attributed with an estimate of the number of occupants at that location. So, for instance, the model would have a point at each single-family residence and an estimate of 2.5 occupants (for example) at each point.
- By drawing a circle, polygon, or some other shape on a map, we can simply add up the number of occupants at the points within that shape and, voila, that is your population estimate.

Why a point-based population model?





Why not just rely on estimates from the Census Bureau?

- Spatial – not limited to standard census geography
  – Watersheds, School districts, Subdivisions, etc.
- Temporal – can estimate at any time and/or predict
- Delay – census often a year delayed

Make your local data count!

What are the model inputs?

- Local data
  - Property, address, permit
  - land use, dwelling units, permit type, floodplains
- Census Bureau data
  - Average Household Size (AHS) and vacancy rate (VR)
  - Implemented 2021 ACS
    - update every year instead of every 10 years

Overview of our Models

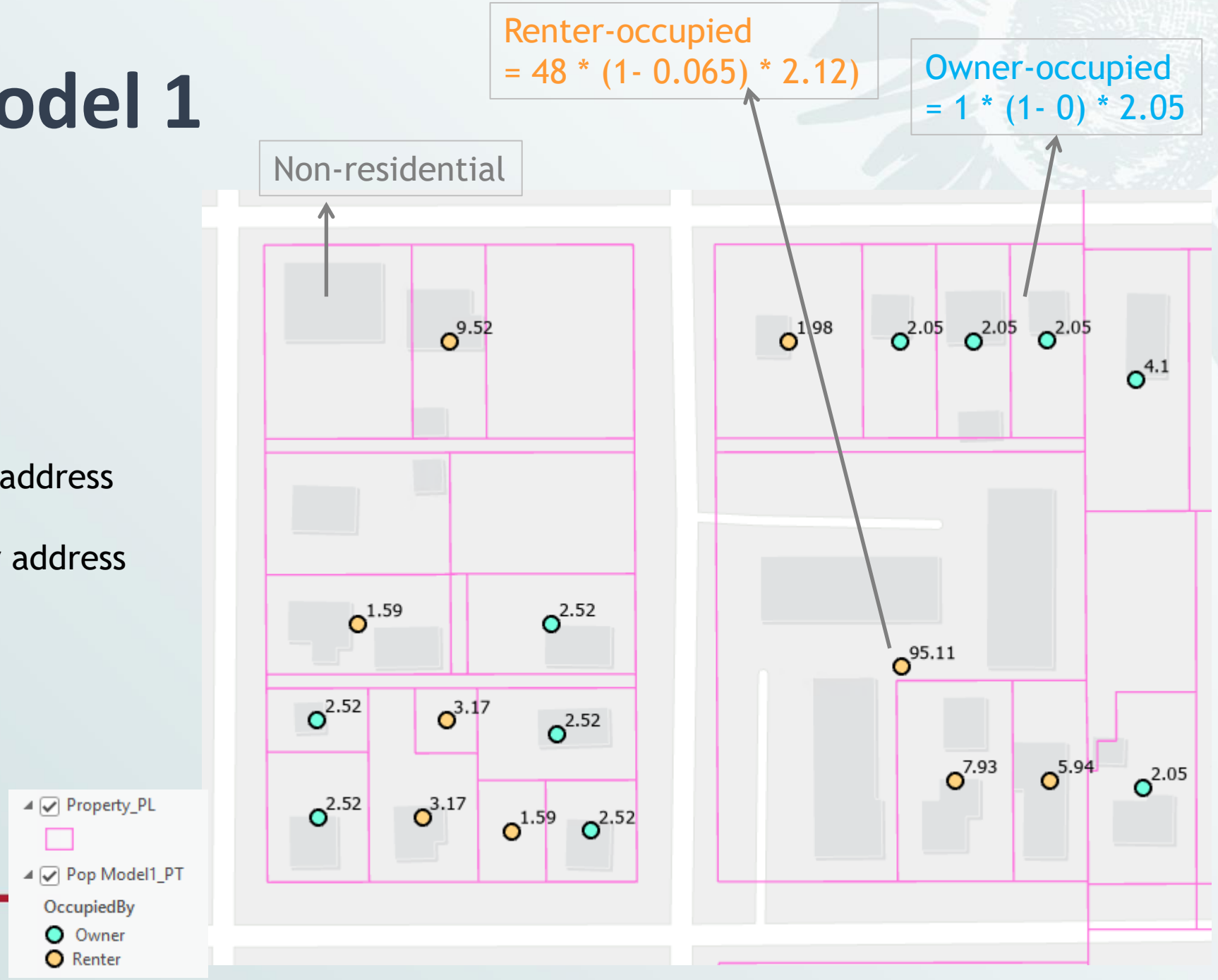
- **Model One** provides a cautious, but very reliable, estimate of current population. It relies heavily on County Land Record data.
- **Model Two** is used when an informed, forward-looking projection is needed. It can be better than a simple extrapolation of past estimates since that assumes growth occurs as it always has (and in areas it historically has). Model Two uses the County's address dataset to inform where growth is most likely.
- **Model Three** is best applied when the user already has a census count for a particular area, as it simply adds on to that base number using residential building permit data that has occurred since the count.
- **Model Four** facilitates estimates of "ultimate" population for an area, when development is complete and full build-out has taken place.

Population Model 1

Local data: Parcel polygons
- → polygon centroids
- Residential parcels
  - # Dwelling units (DU)
- Tenure
  - Owner-occupied:
    - Site address = owner address
  - Renter-occupied:
    - Site address != owner address

Census Bureau data
- Average household size (AHS)
- Vacancy Rate (VR)

Occupants = DU * (1 – VR) * AHS



Population Model 2

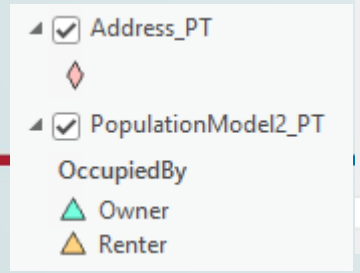
Local data: Address points (AddPnt)

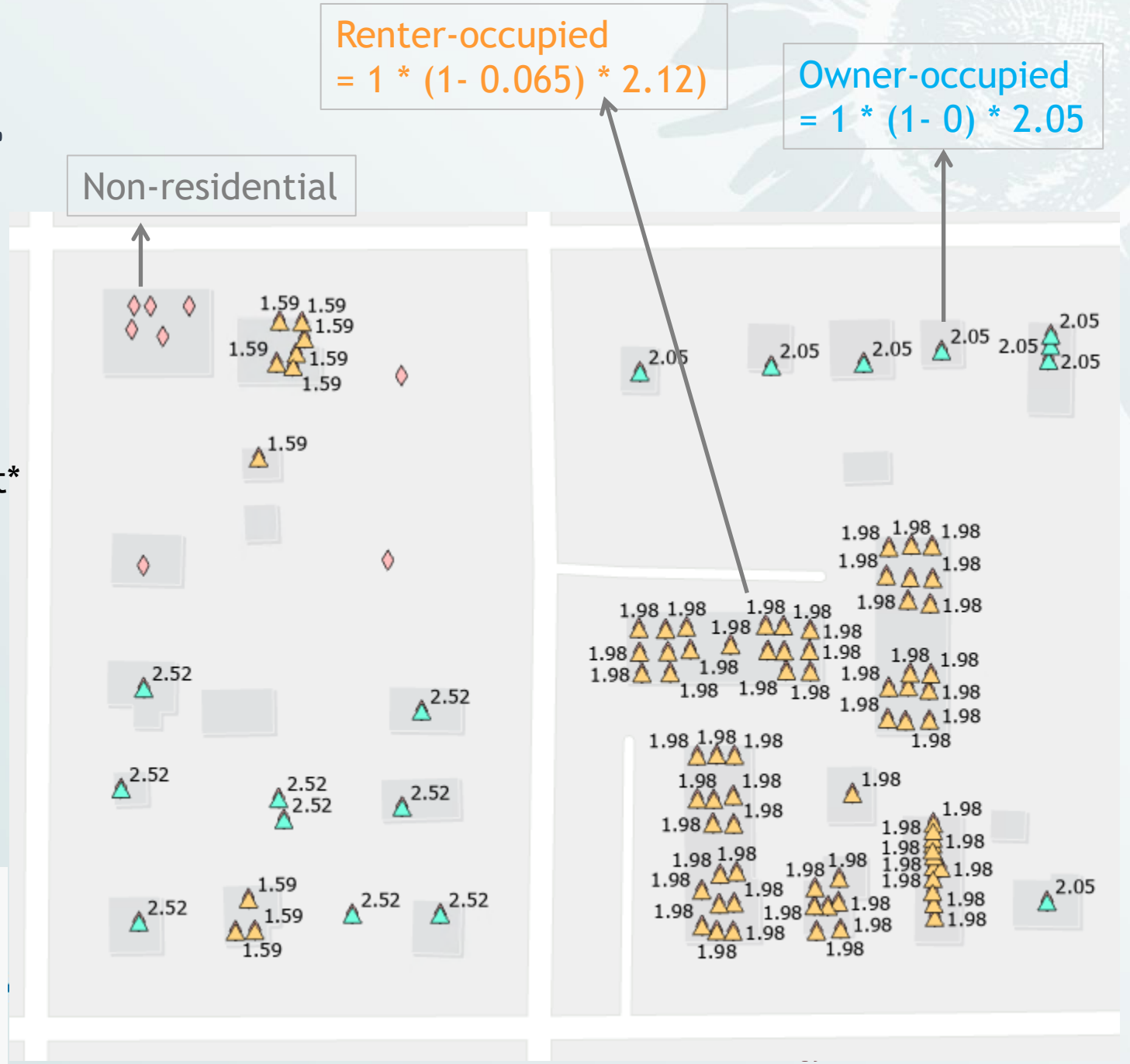
- Residential addresses
  - 1 AddPnt = 1 household
- Tenure
  - Owner-occupied
    - SnglFamRes, TwoFamRes, AgVacant*
  - Renter-occupied
    - MultFamRes

Census Bureau data

- Average household size (AHS)
- Vacancy Rate (VR)

Occupants = AddPnt * (1 – VR) * AHS





Population Model 3

Projects population growth since 2010

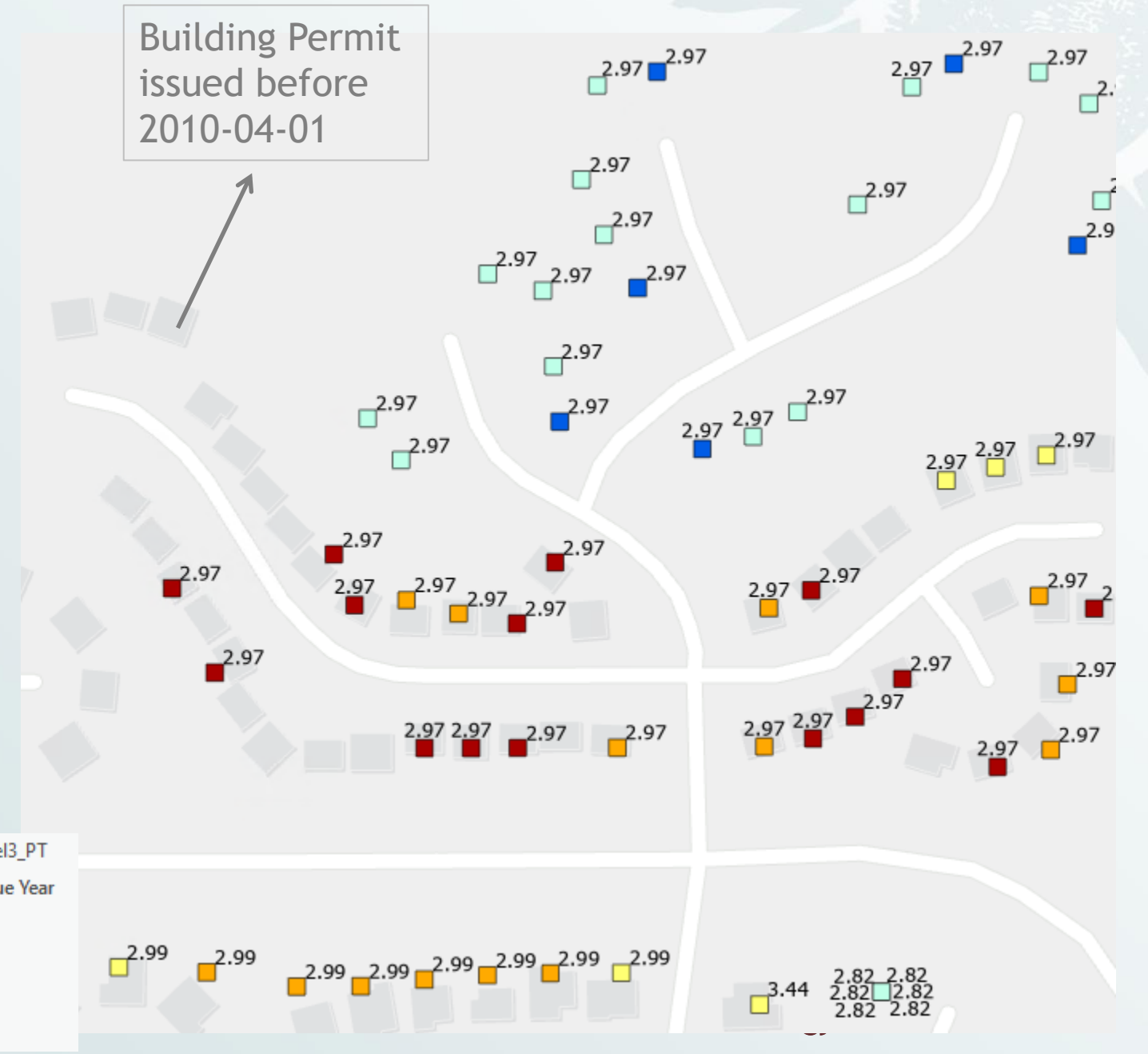
Local data: Building permits (BP)

- Residential BP
  - 1 BP = 1 household
- Tenure
  - Owner-occupied
    - Single Family, Duplex
  - Renter-occupied
    - Triplex, Fourplex

Census Bureau data

- Average household size (AHS)
- Vacancy Rate (VR)

Occupants = BP * (1 – VR) * AHS



Population Model 4

Projects MAX growth potential beyond current population (= Pop model 1)

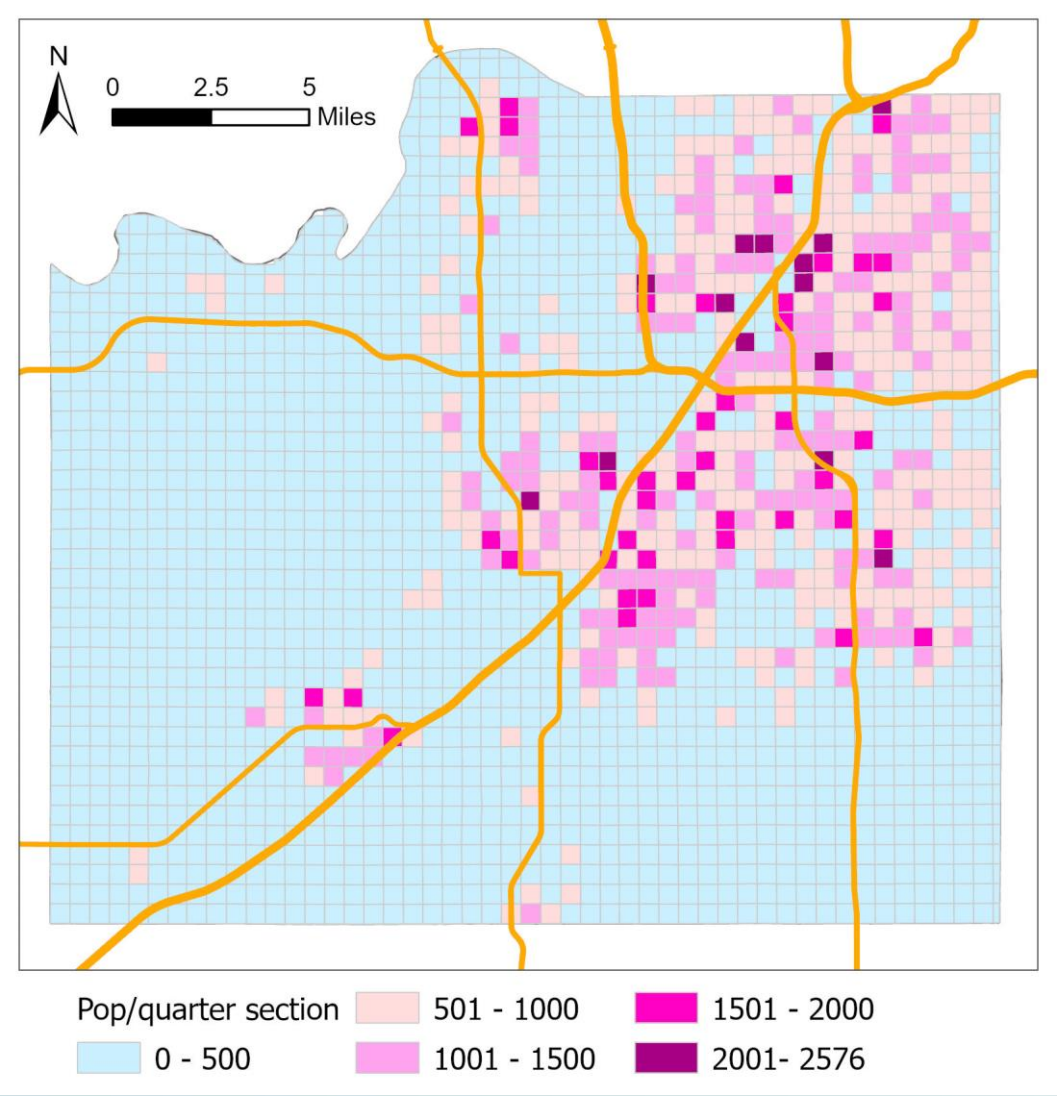
Local data: Parcel polygons

- Developable parcel centroids

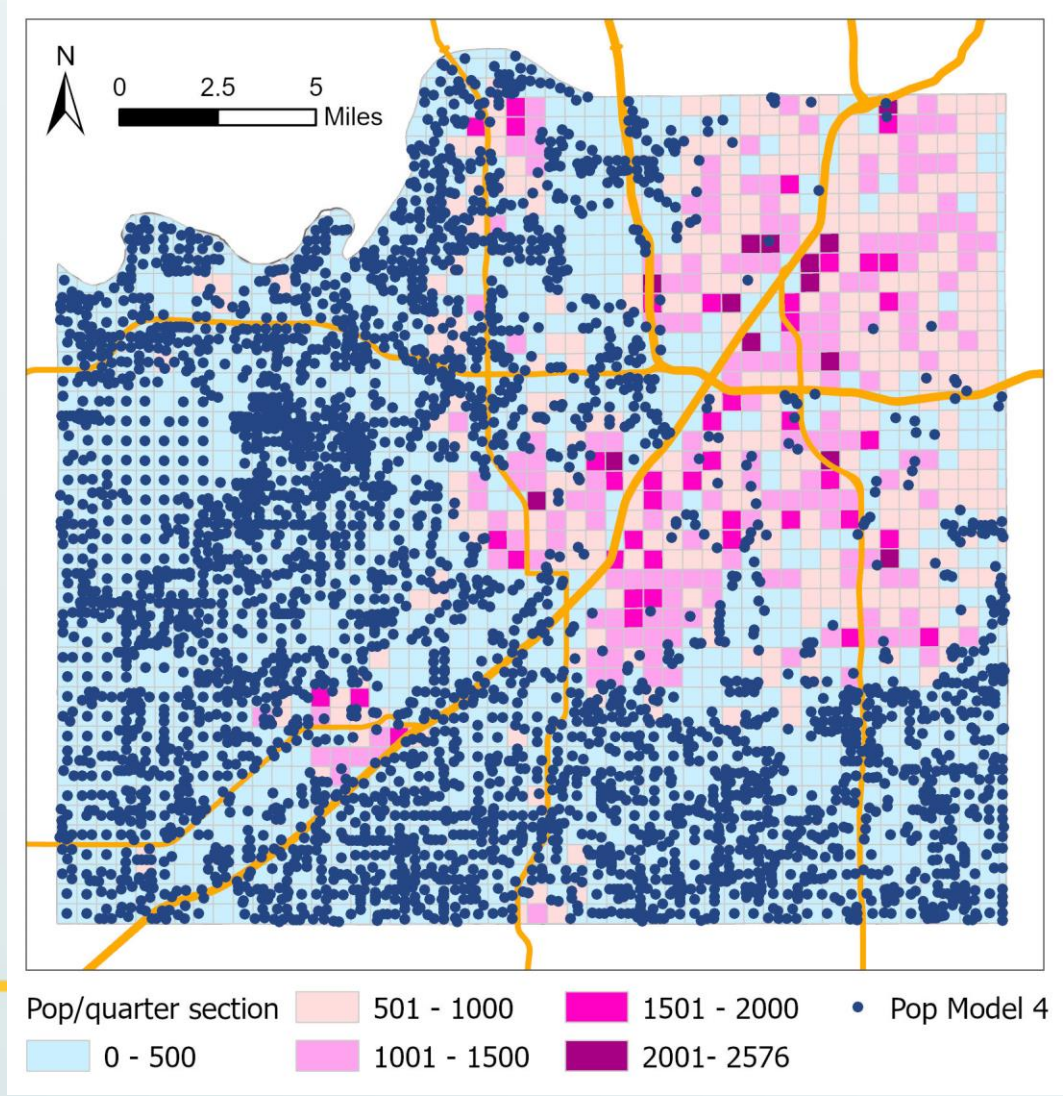
Occupants = AcresNotInFEMAZoneA * AvgUnitsPerAcre * AvgHouseholdSize

Population Model 4

Pop Model 1



Pop Model 4 points overlaying on top of Pop Model 1



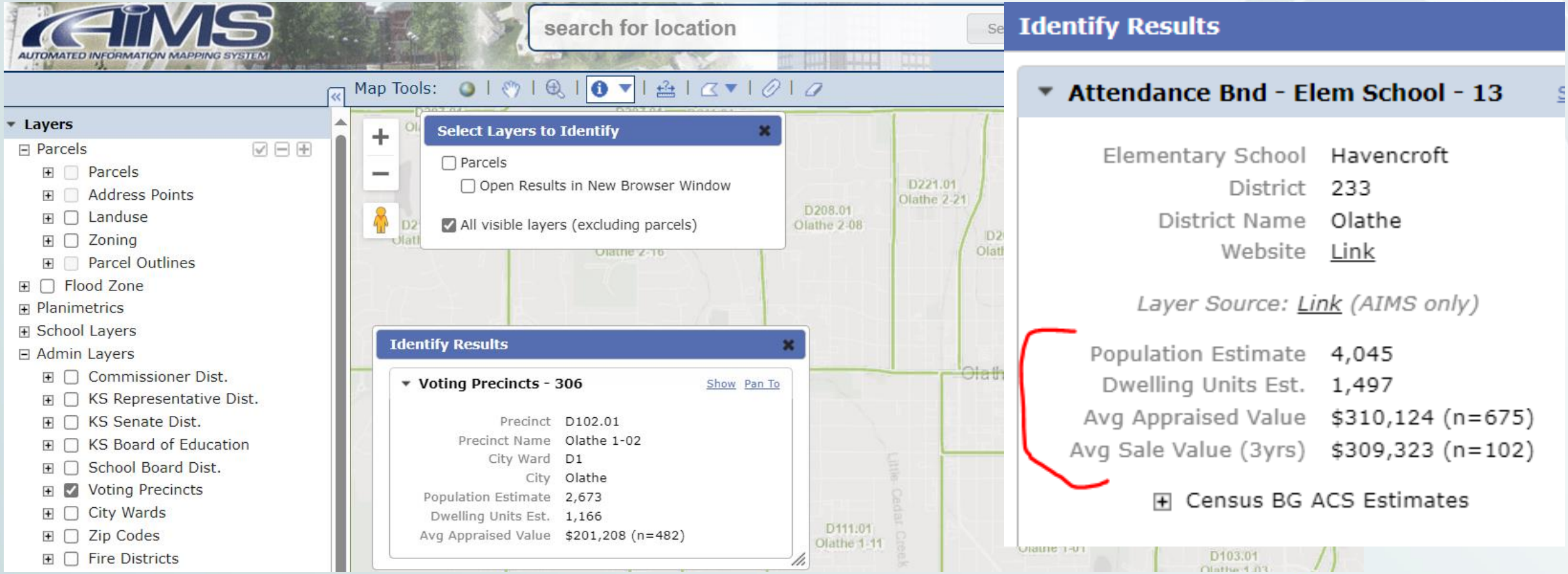
How do we use them?

- Redistricting (Board of County commissioner, school districts, etc)
- Wastewater capacity planning – model 4
- Facility planning (libraries, fire, ambulance, etc)
- Emergency and disaster response
  - Tornado scenario app
  - Hazmat exercises

How do we use them (continued)?

- Public use – model 1 and 2
  - Standard Admin boundaries
  - Advanced layers – Economic development
  - Any shape - available on our website for any self created geography.

Standard Admin Boundaries - precalculated



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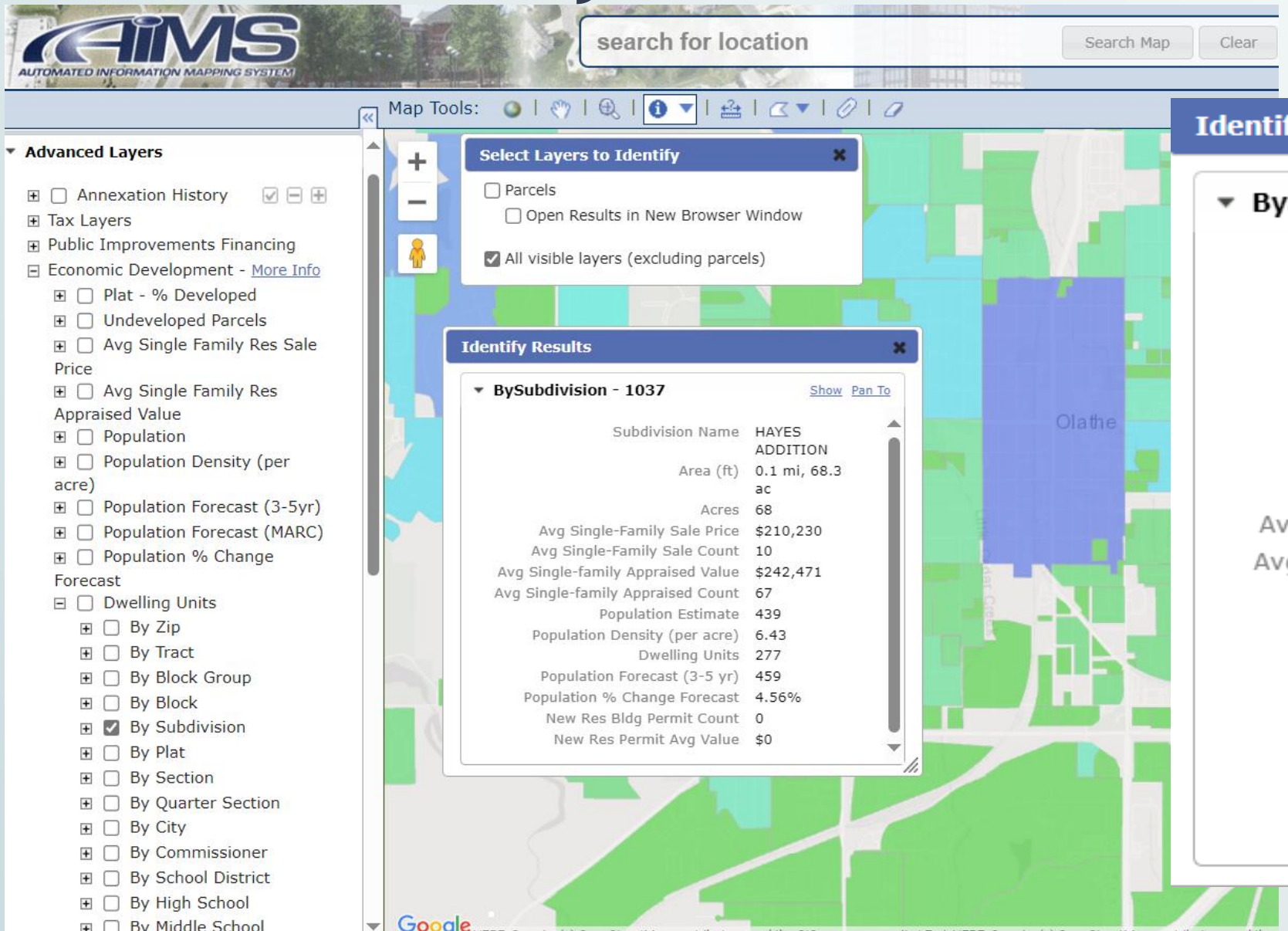
Advanced Layers - Economic Development

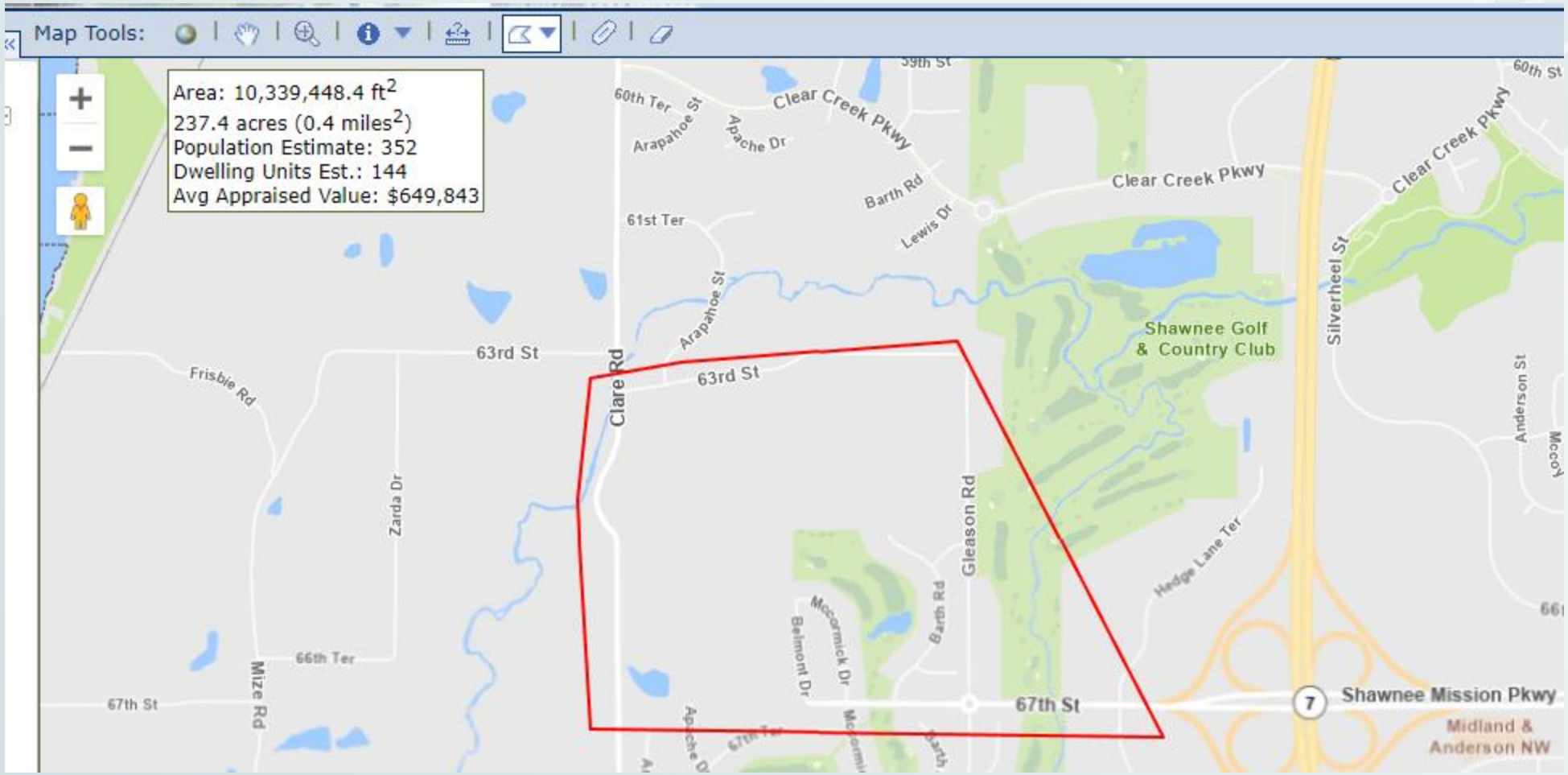


Identify Results

BySubdivision - 1037 Show Pan To

Subdivision Name HAYES ADDITION
Area (ft) 0.1 mi, 68.3 ac
Acres 68
Avg Single-Family Sale Price $210,230
Avg Single-Family Sale Count 10
Avg Single-family Appraised Value $242,471
Avg Single-family Appraised Count 67
Population Estimate 439
Population Density (per acre) 6.43
Dwelling Units 277
Population Forecast (3-5 yr) 459
Population % Change Forecast 4.56%
New Res Bldg Permit Count 0
New Res Permit Avg Value $0

Custom Shape - on the fly calculation



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Model validation process

- Compare our population estimates to Census Bureau's dataset
  - On 2022-07-01
  - County, and 27 minor civil divisions (i.e., cities or townships)

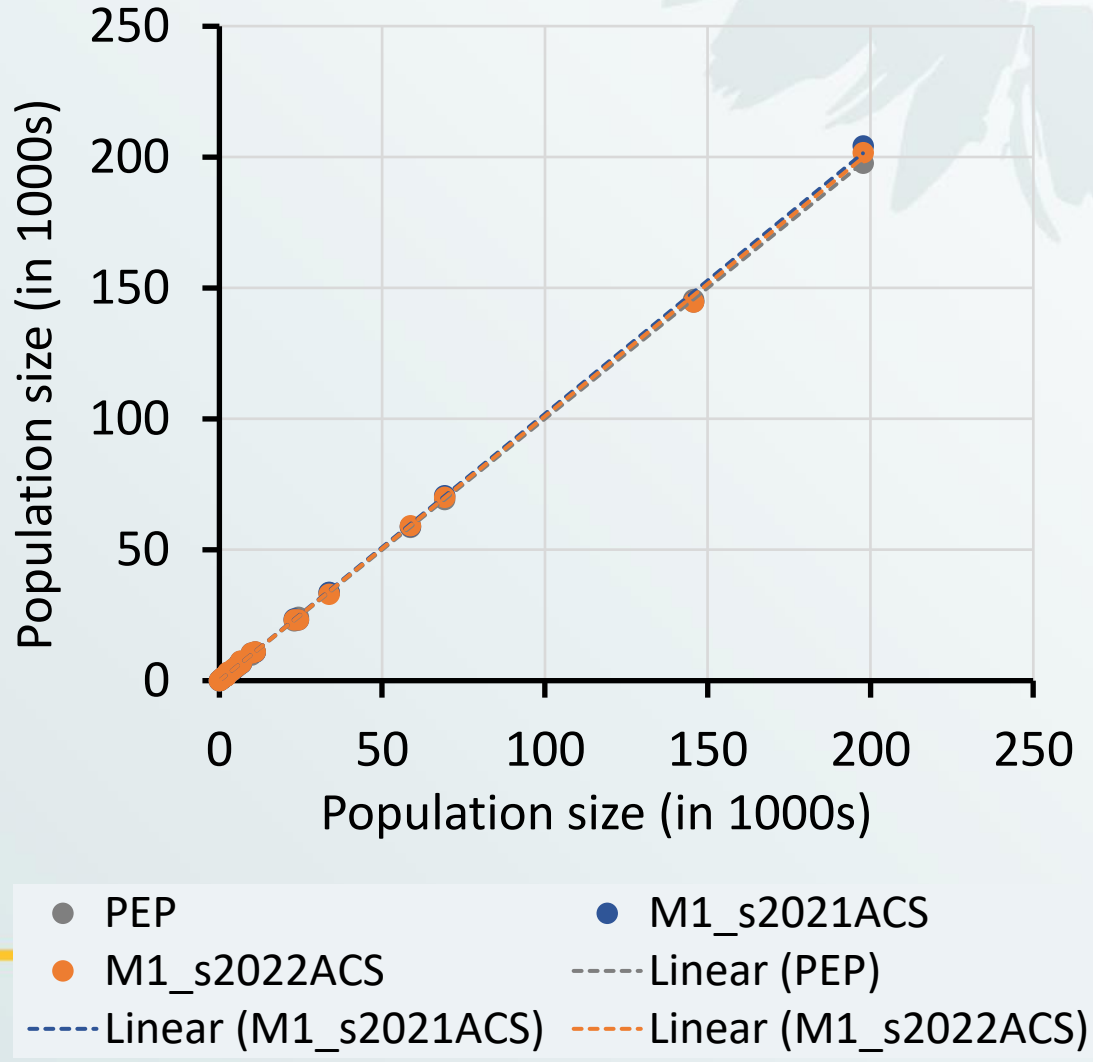
  - Census Bureau: Population Estimate Program (PEP) estimates
  - Our population Model 1
    - 2 sources of Average Household Size and Vacancy Rate
      - 2021 ACS 5 year
      - 2022 ACS 5 year
    - All local data are the same

Population estimates on 2022-07-01

County, & 3 largest cities

	PEP	M1_ s2021ACS	M1_ s2022ACS
Johnson County	619,195	629,626	625,666
Overland Park	197,726	204,311	201,707
Olathe	145,616	144,809	144,629
Shawnee	69,198	70,716	70,083

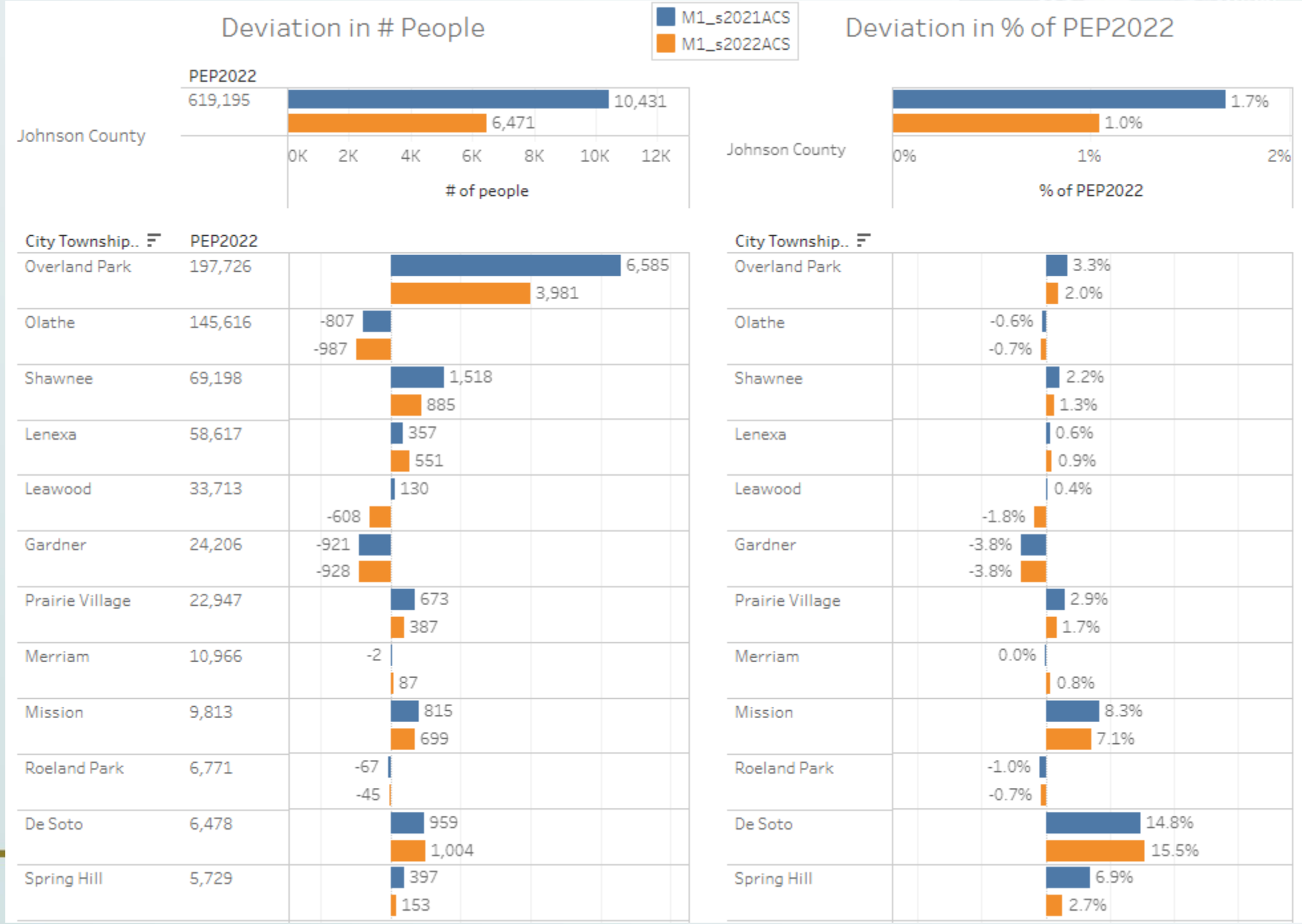
All 27 cities/townships



Population estimates on 2022-07-01

Difference:

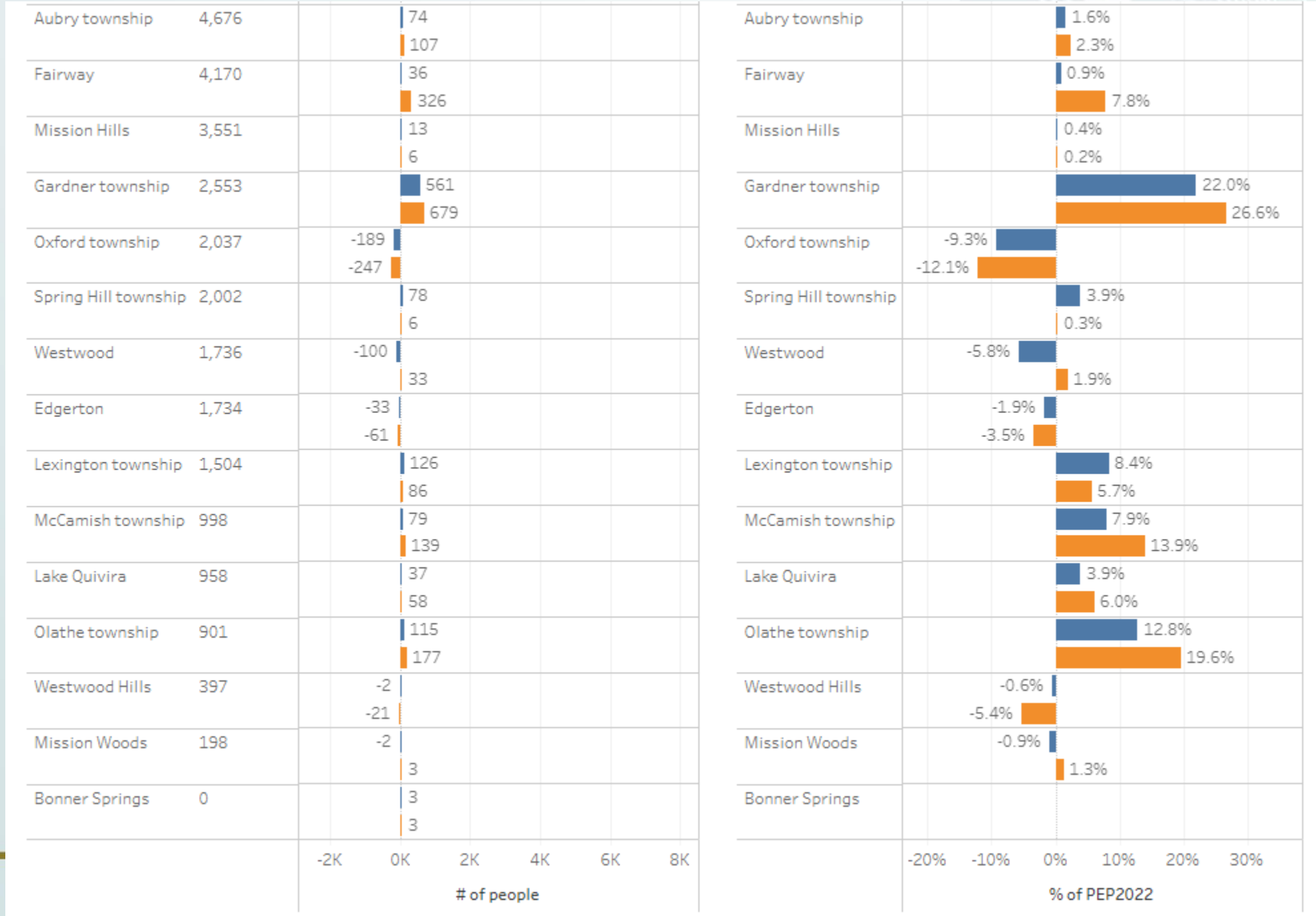
- M1_s2021ACS – PEP
- M1_s2022ACS - PEP



Population estimates on 2022-07-01

Difference:

- M1_s2021ACS – PEP
- M1_s2022ACS - PEP



Challenges/Limitations

- Challenges:
  - Ensuring you keep data sources up to date
  - Explaining why it is different than census
  - Always ways to improve it – how much time to invest?
- Limitations:
  - It is a residential model
    - NOT a daytime model of where people are (i.e. Work)
    - NOT an “event” model (i.e., where people are for events (e.g., Fri night football game, Sunday AM church, Parade))

Recent/Upcoming improvements

- Implement 2022 ACS 5 year
- Improve Group quarter occupants
  - Use local data that can be acquired regularly rather than only update every 10 years
- Situs/owner address improvements/corrections
- Working on model 3 and 4 updates to bring to current
- Appraiser Working Tax Year (LBCS, Dwelling Units)
- ACS 2023 – Dec?

Summary

- With some simple local data and basic Census data you can create models of your own.
  - Parcel centroid and dwelling units (Appraiser)
  - or address points (filtered to residential)
  - Census Avg household size for your county
- Recommend archiving on key census dates

Questions?

- AIMS Website: https://aims.jocogov.org/
- About AIMS Storymap: https://arcg.is/1mKivb0
- Mapper – mapper@jocogov.org

- Shannon Porter – GIS Manager – Shannon.porter@jocogov.org
- Jin Yao – Senior Data Analyst – Jin.yao@jocogov.org