

Preliminary Predictive Simulation of Land Use Change Impacts on Groundwater Recharge West of Billings, Montana



Kurt Zeiler
MT AWRA
October 9, 2025



West Billings GWIP Project

This copy is for your personal, non-commercial use only. Distribution and use of this material are governed by our Subscriber Agreement and by copyright law. For non-personal use or to order multiple copies, please contact Dow Jones Reprints at 1-800-843-0008 or visit www.djreprints.com.

<https://www.wsj.com/articles/montana-boomtown-jumps-to-no-1-on-wsj-realtor-com-housing-market-index-11626773400>

WSJ NEWS EXCLUSIVE

Montana Boomtown Jumps to No. 1 on WSJ/Realtor.com Housing Market Index

Rankings show how the housing boom has ignited homebuying in smaller to midsize cities around the U.S.

By *Nicole Friedman* [Follow](#) | *Photographs by Louise Johns for The Wall Street Journal*

July 20, 2021 5:30 am ET

Billings, Mont., is the new No. 1 on The Wall Street Journal/Realtor.com Emerging Housing Markets Index, boosted by its affordability and appeal to remote workers.

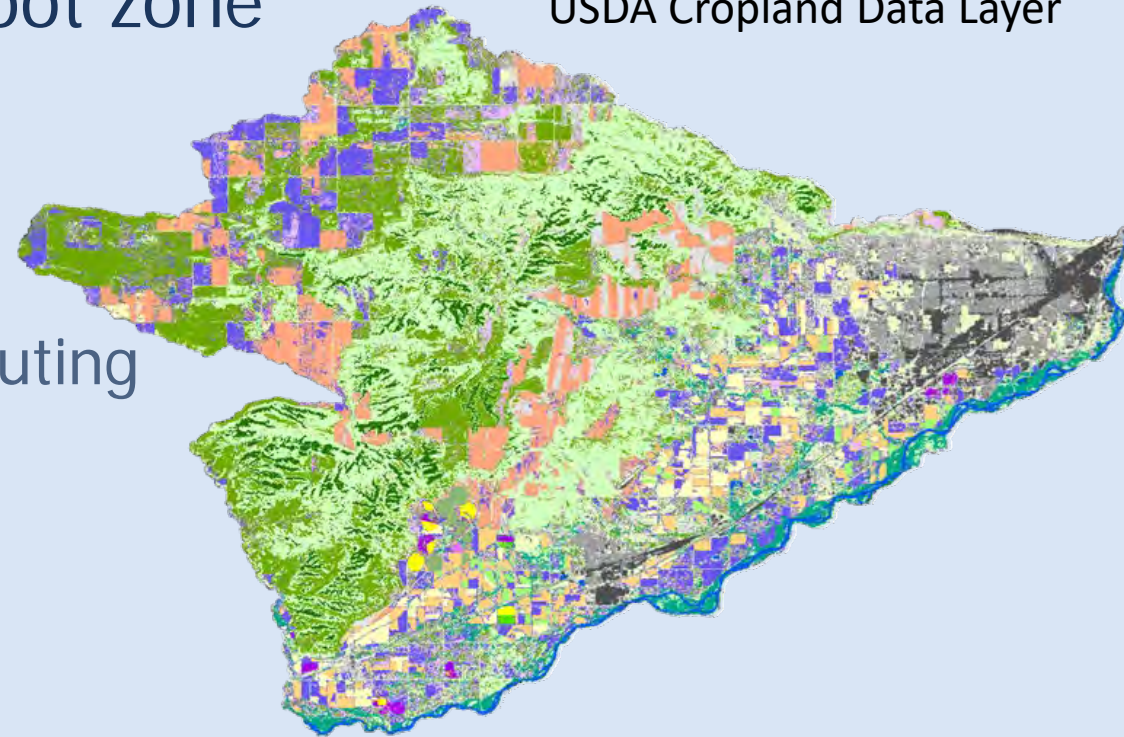
The index reflects how the housing boom has ignited homebuying activity in smaller to midsize cities around the U.S. The top 20 cities in the ranking have an average population size of just over 300,000.



USGS SWB2 Model – Recharge Estimates

- Modified Thornthwaite-Mather soil-water-balance accounting approach
- Estimates distribution and timing of *net infiltration* downward out of the root zone
- Inputs
 - Climate
 - Soils
 - Land surface flow direction – runoff routing
 - Land use/land cover & characteristics

USDA Cropland Data Layer

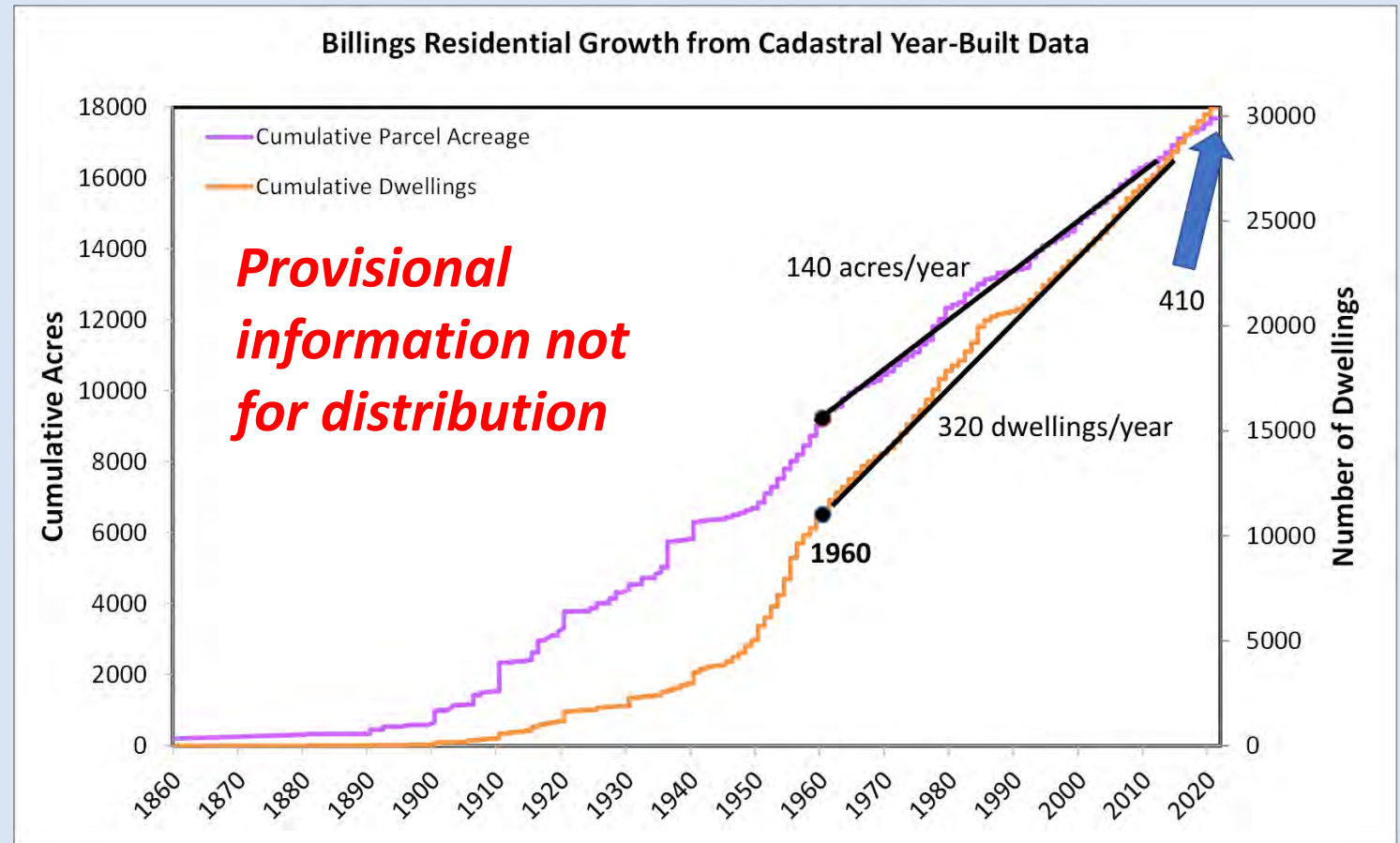


Potential Predictive Scenarios – Land Use

- Recharge changes in response to land use changes
 - Development at 60-year rate (~320 housing units/yr)
 - Development at accelerated (2021) rate (~410 units/yr)

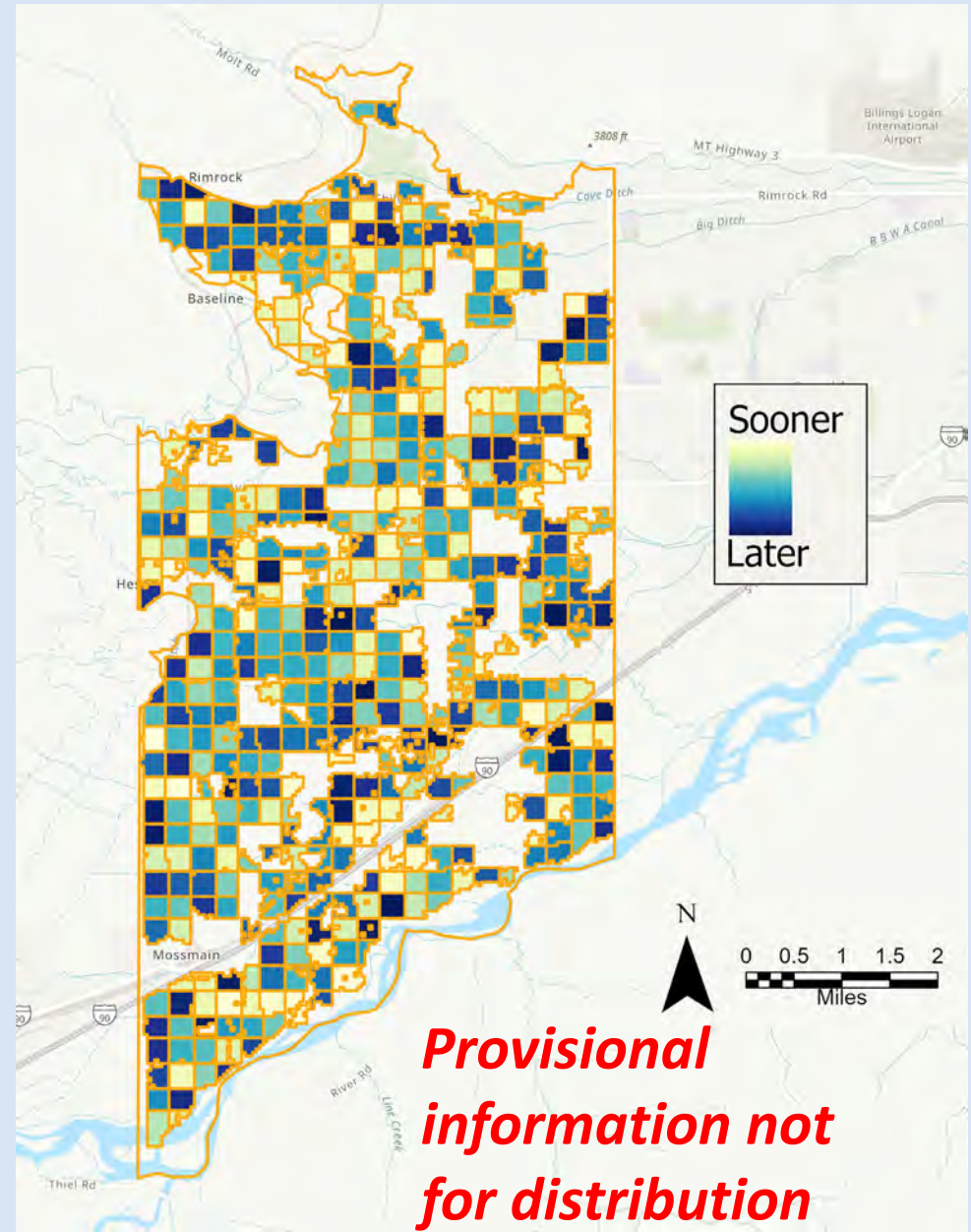
- Other inputs

- Soils and runoff flow direction are static
- Climate – replay cycles of 2008-2023 Daymet datasets



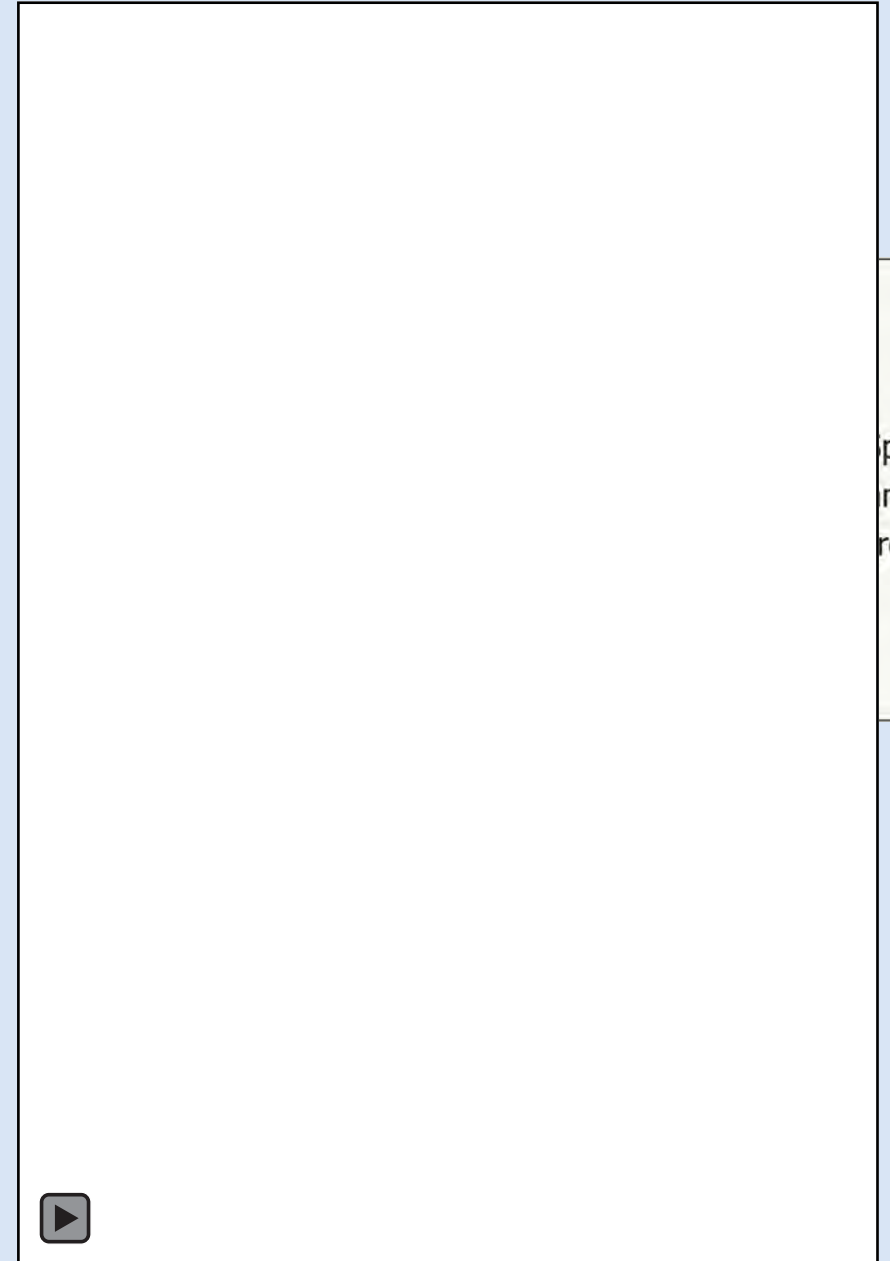
Land Use Change – Pseudo-Random Distribution Method

- Start with western study area
- PLSS 2nd division (quarter-quarter sections) – approximately 40 ac
- Determine lands that could be converted to residential use
- Reduce to developable blocks
- Order through time w/ pseudo-random number generator code



Land Use Change – Pseudo-Random Distribution Method

- Development has generally occurred as producers retire or decide to sell
- Fill in developable areas in order through time at the different rates
- Assume percentages of development intensity
 - High intensity (0.2 ac parcels) – 35%
 - Medium intensity (0.5 ac parcels) – 55%
 - Low intensity (1.0 ac parcels) – 10%
- 50 Years – 2026 through 2075

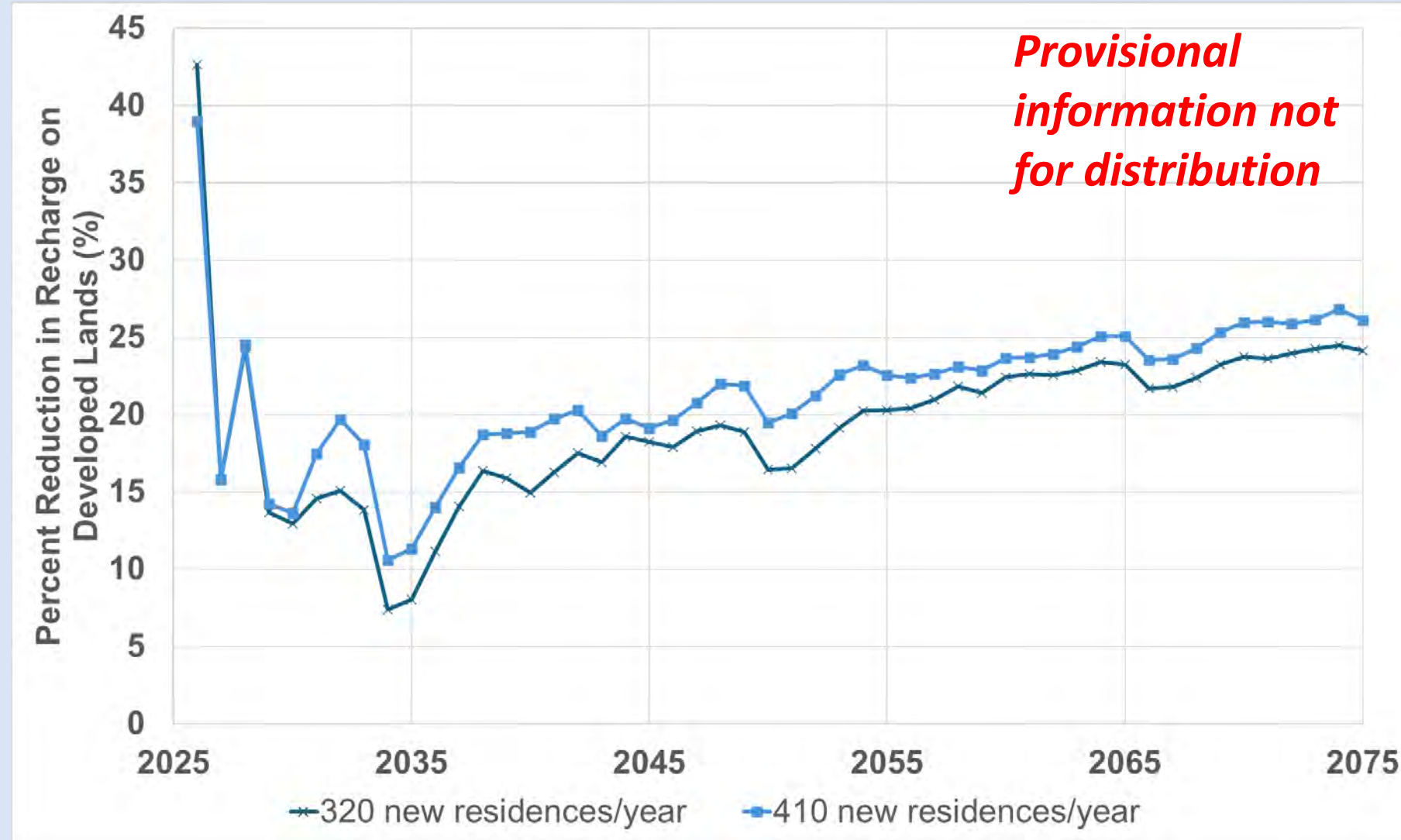


pace
nd
rest



Predicted Percentage Reduction in Recharge on Developed Lands

- Initially large percent reduction, then less reduction
- Later steady increase in the percentage reduction

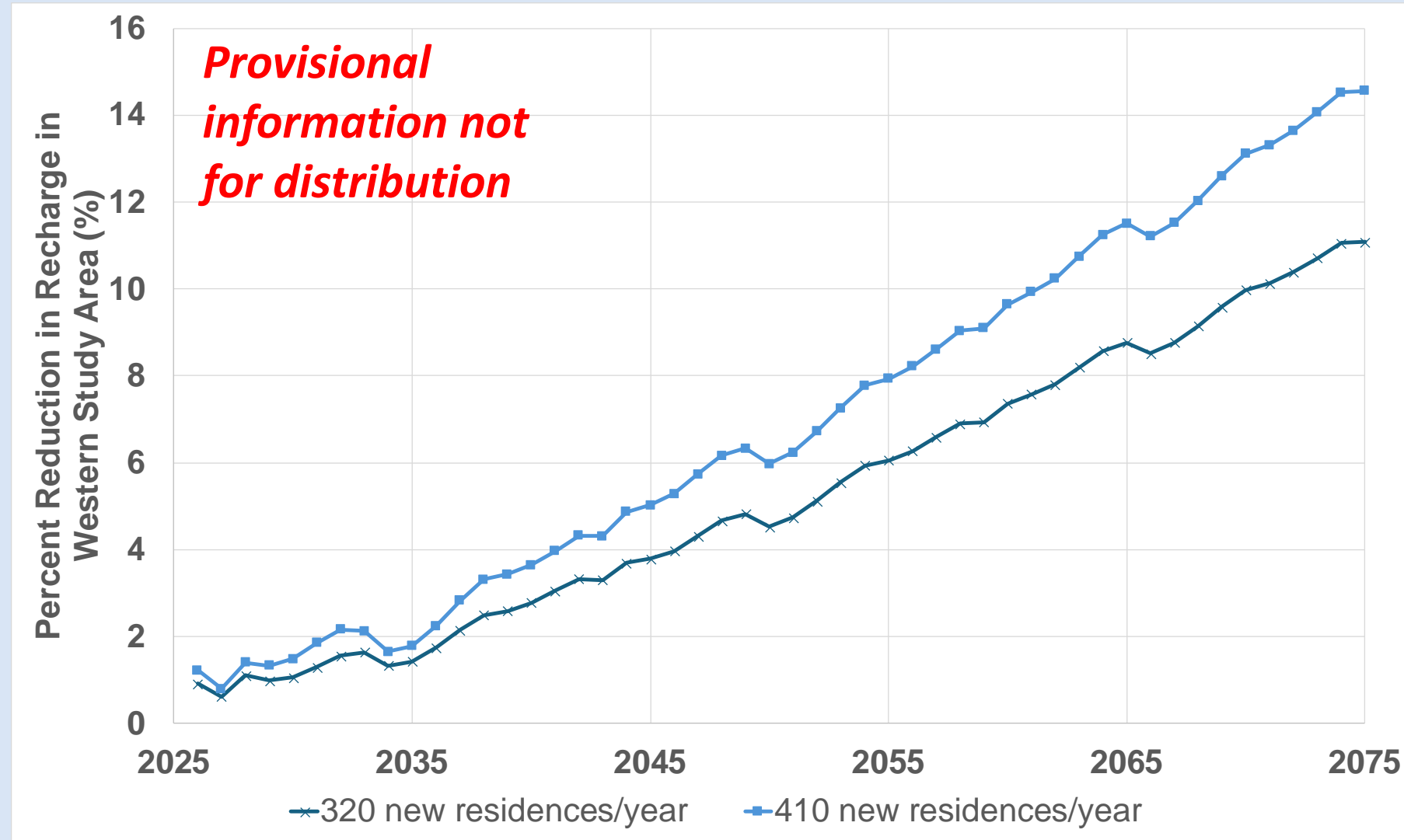


Compared to no additional residential development



Predicted Percentage Reduction in Recharge West Study Area

- Initially small percentages, but then linear increase
- Can see 16-year cycle for meteorology inputs



Compared to no additional residential development



Conclusions and Next Steps

- Refine approach – discussions with stakeholders
 - Pseudo-random lends itself to a probabilistic analysis
 - Test different assumptions of growth rates and mixes of parcel sizes
 - East to west focused development?
 - Remove floodplain parcels?
 - Target irrigated parcels?
- Incorporate drought scenarios
- Managed aquifer recharge mitigation scenario(s)
- Questions or suggestions?

