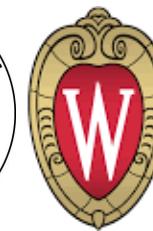
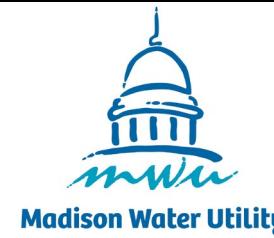


# Hydraulic Analysis of Water Infrastructure Projects for Anticipated Urban Expansion

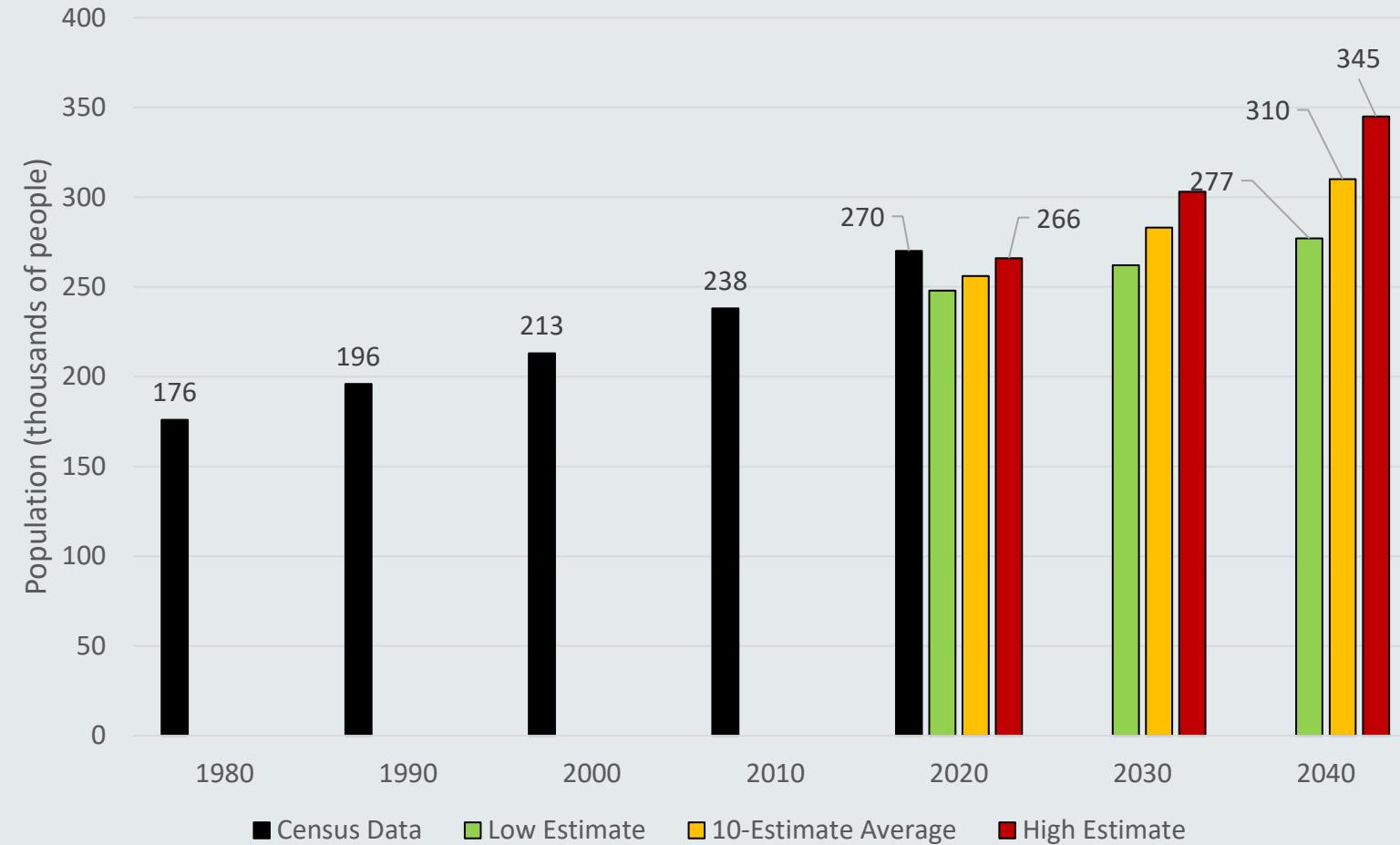
Cooperative Research between MWU and UW-Madison

Jaxon Hoffmann, E.I.T.  
Harrington Group



**DEPARTMENT OF  
Civil and  
Environmental Engineering**

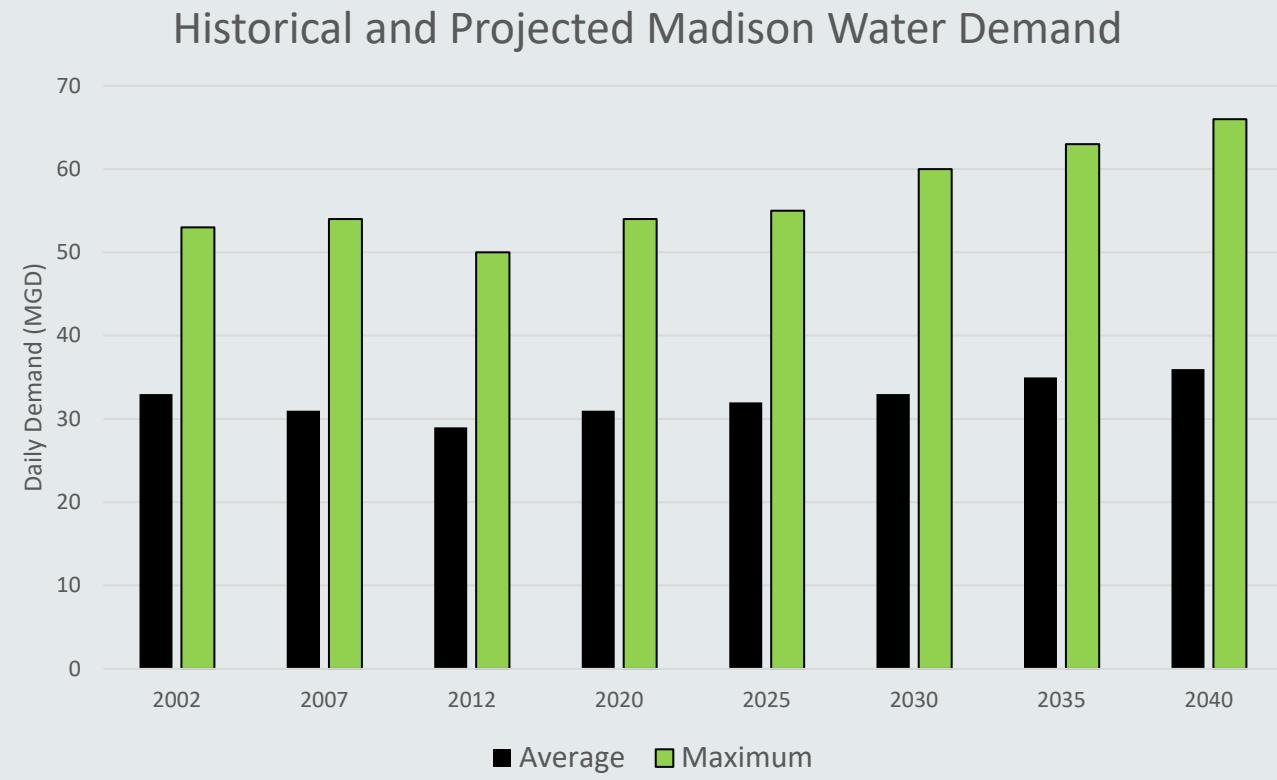
# Madison Population Projections



Source: 2019 Madison Water Utility Water System Master Plan

# Madison Water and Power Usage

- In 2022, MWU
  - Consumed over 19.7 million kWh of electricity (*Reams 2023*)
  - Made up 41% of the City of Madison's power consumption, per City sources
  - Emitted 13,824 Tons CO<sub>2</sub>e



Source: 2019 Madison Water Utility Water System Master Plan

# Objective Statement

- MWU has completed analyses (2020 Master Plan) that anticipate additional need for water supply on Madison's west side.
- Addressing this need would involve additional energy consumption to either source new water or move existing water.

# Approach

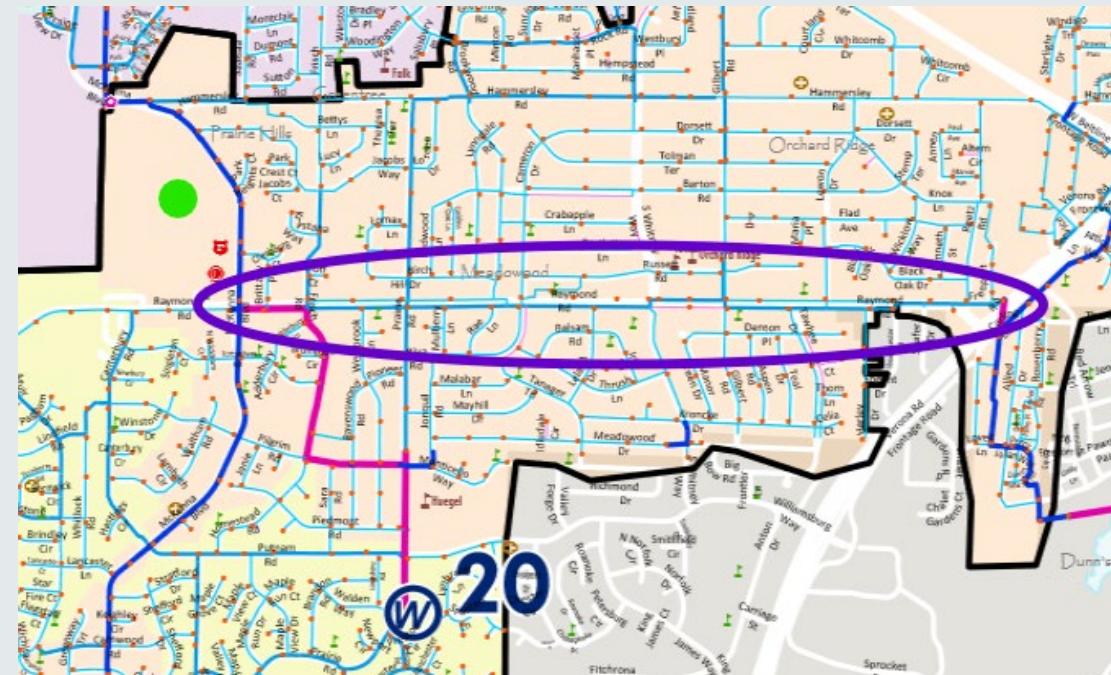
- This study examined several water system modification options from the 2020 Master Plan and assesses their system-wide implications as they relate to energy usage, hydraulics, and water quality.
- MWU's current water model was leveraged to describe the above metrics and to begin establishing business case evaluations related to this expected supply need.

# Examined Alternatives

- Selected based on...
  - Location on West Side
  - Variety in Cost
  - Variety in Performance

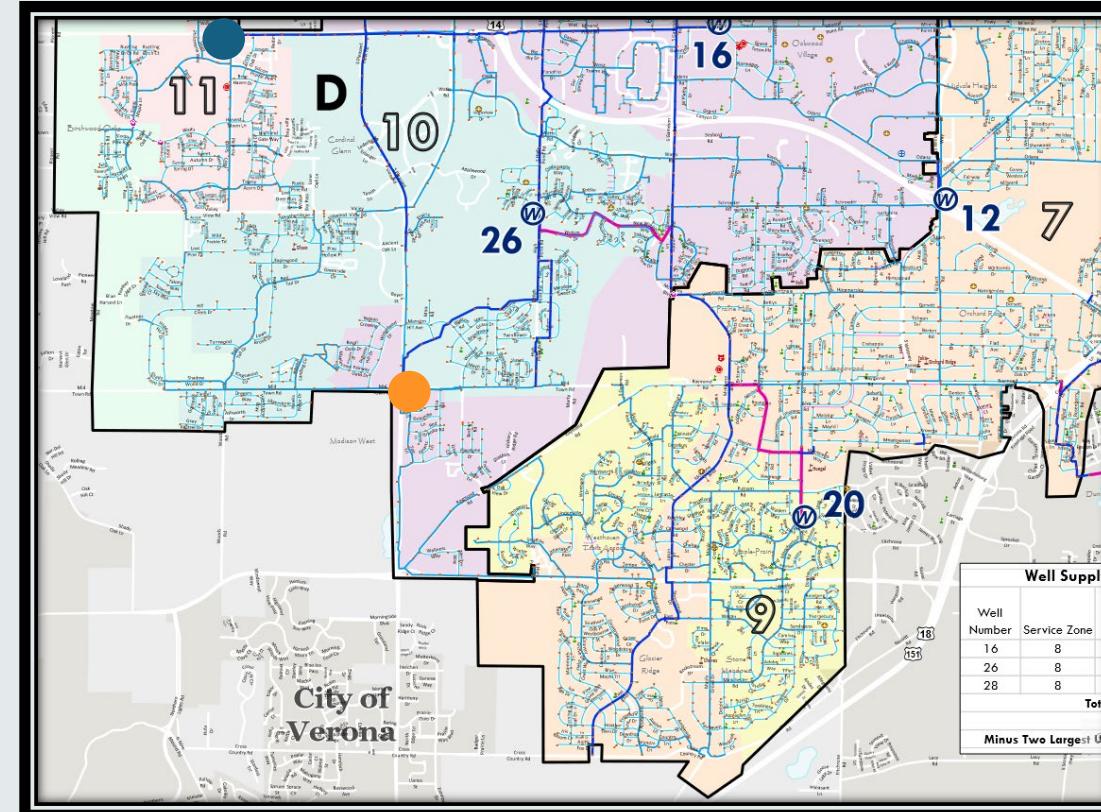
# Alternatives: Transmission

- Transmission: Change Distribution of Existing Supply
  - **TW-08**: New Booster Station near Elver Park
  - **TW-11**: Replace and Upgrade Raymond Road Piping



# Alternatives: Supply

- Supply: Introduce New Sources of Water
  - **SW-01**: New Unit Well at Mineral Point Rd. and South Point Rd.
  - **SW-03**: New Unit Well at Pleasant View Rd. and Mid Town Rd.

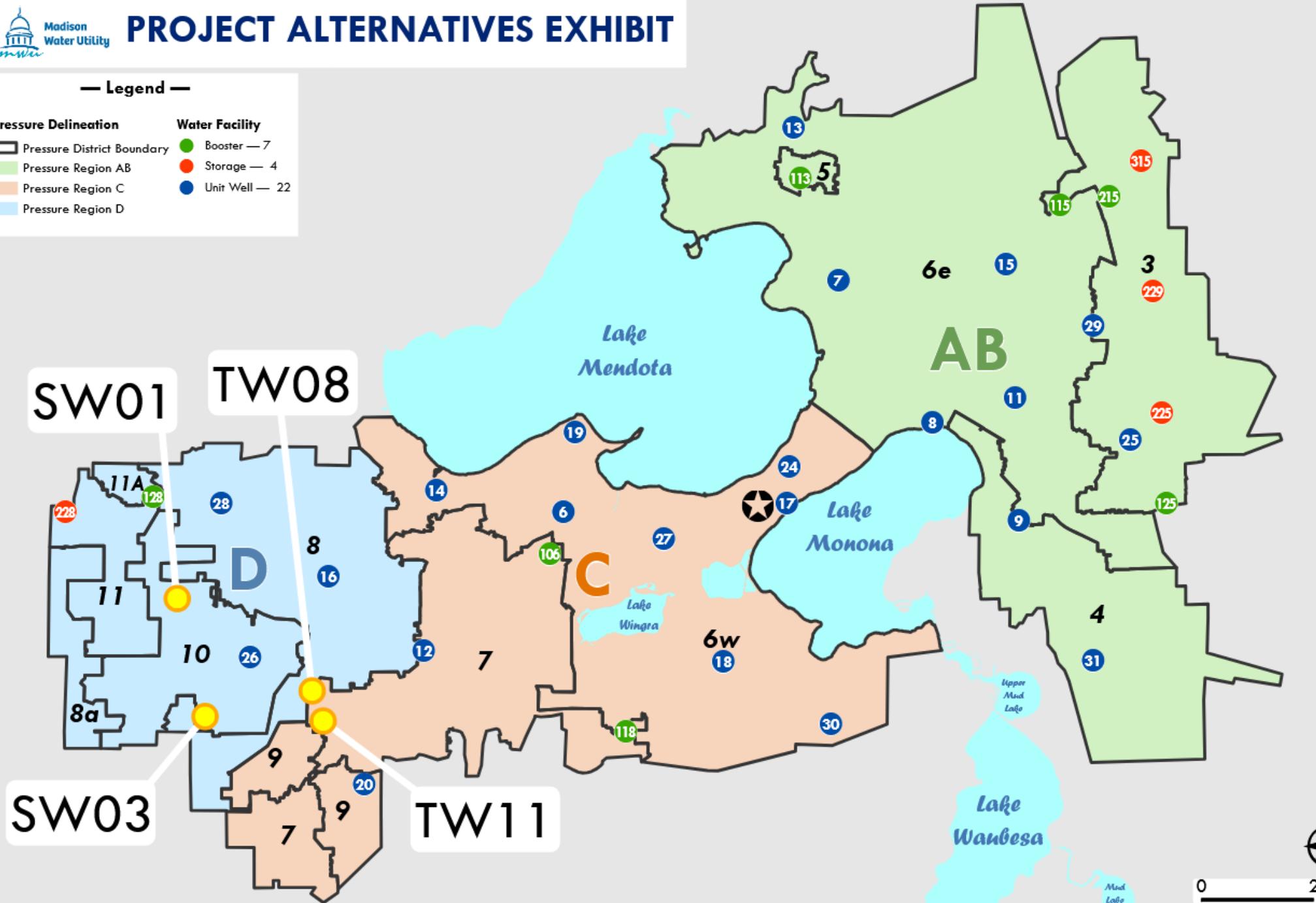




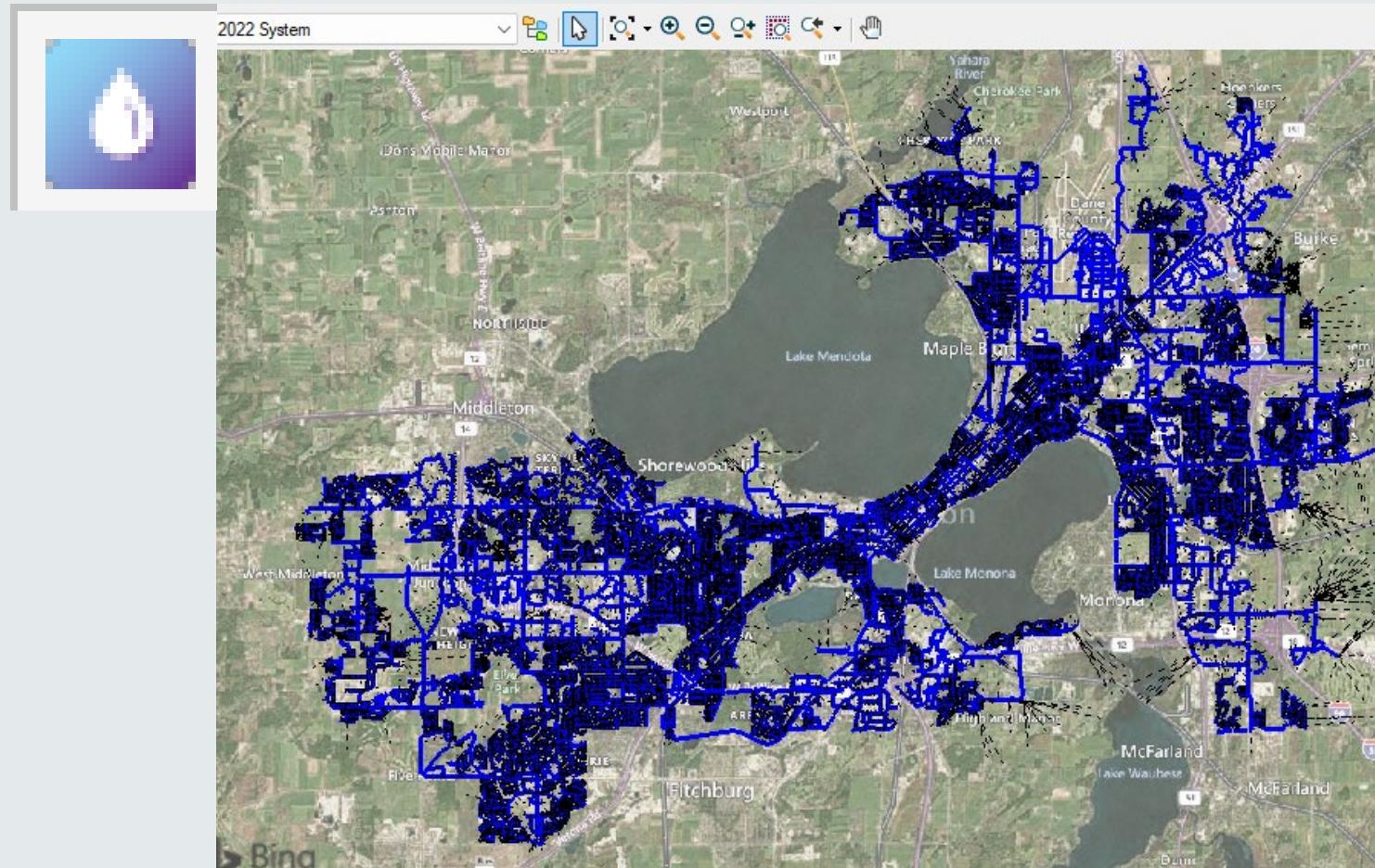
# PROJECT ALTERNATIVES EXHIBIT

## — Legend —

Pressure Delineation	
Pressure District Boundary	Water Facility
Pressure Region AB	Booster — 7
Pressure Region C	Storage — 4
Pressure Region D	Unit Well — 22



# Hydraulic Model: Bentley OpenFlows WaterCAD



# Hydraulic Model: Inputs and Outputs

- Inputs:

- Pipes, Nodes, Hydrants, and Associated Metadata
- Pumps and Pump Curves
- SCADA (Supervisory Control and Data Acquisition) Demand Data
- Diurnal Demand Curves
  - One for each Pressure Zone
  - 2040 and 2035 curves projected using MWU Master Plan data

- Outputs:

- Flow and Storage Data
  - Analyzed water level stability in six head-setting reservoirs.
- Energy Data
  - Used to calculate energy intensity and greenhouse gas intensity.



**2040 Demand cannot be met by the MWU  
System as it is currently designed.**

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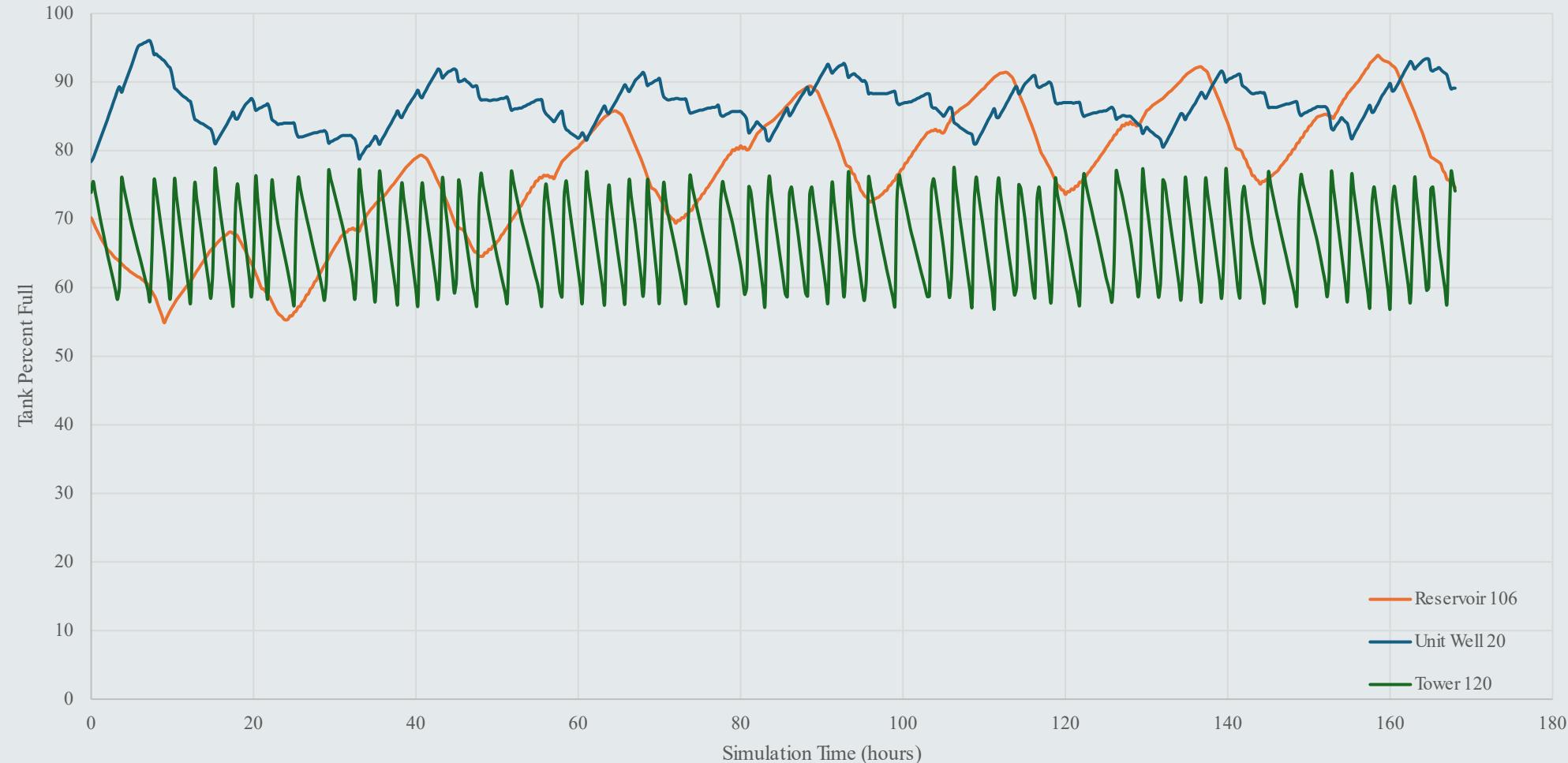
# Current System Findings

- Pressure Zones 6w, 7, and 9 have enough supply to meet demand until at least 2040.
- Pressure Zone 8 is expected to meet 2040 demand if Unit Well 12 is converted to a Zone 8 well.
- Pressure Zones 10 and 11 do not have enough supply to meet demand in 2040.

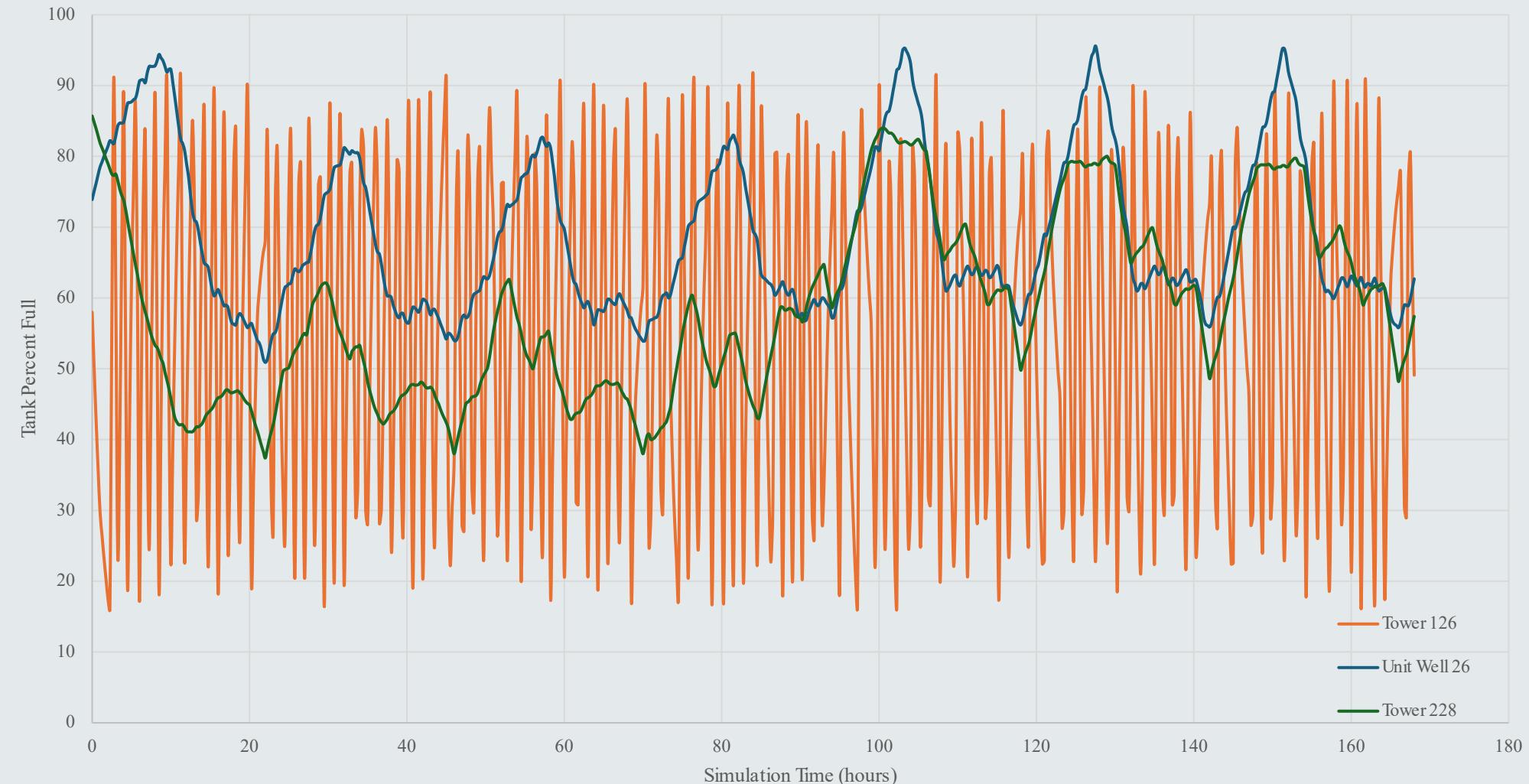
# Transmission Alternatives

- TW-08 meets 2040 demand in Zone 8.
- TW-11 only meets 2040 Zone 8 demand if Unit Well 12 is converted to a Zone 8 well.
- Neither alternative meets 2040 demand in Zones 10 or 11.

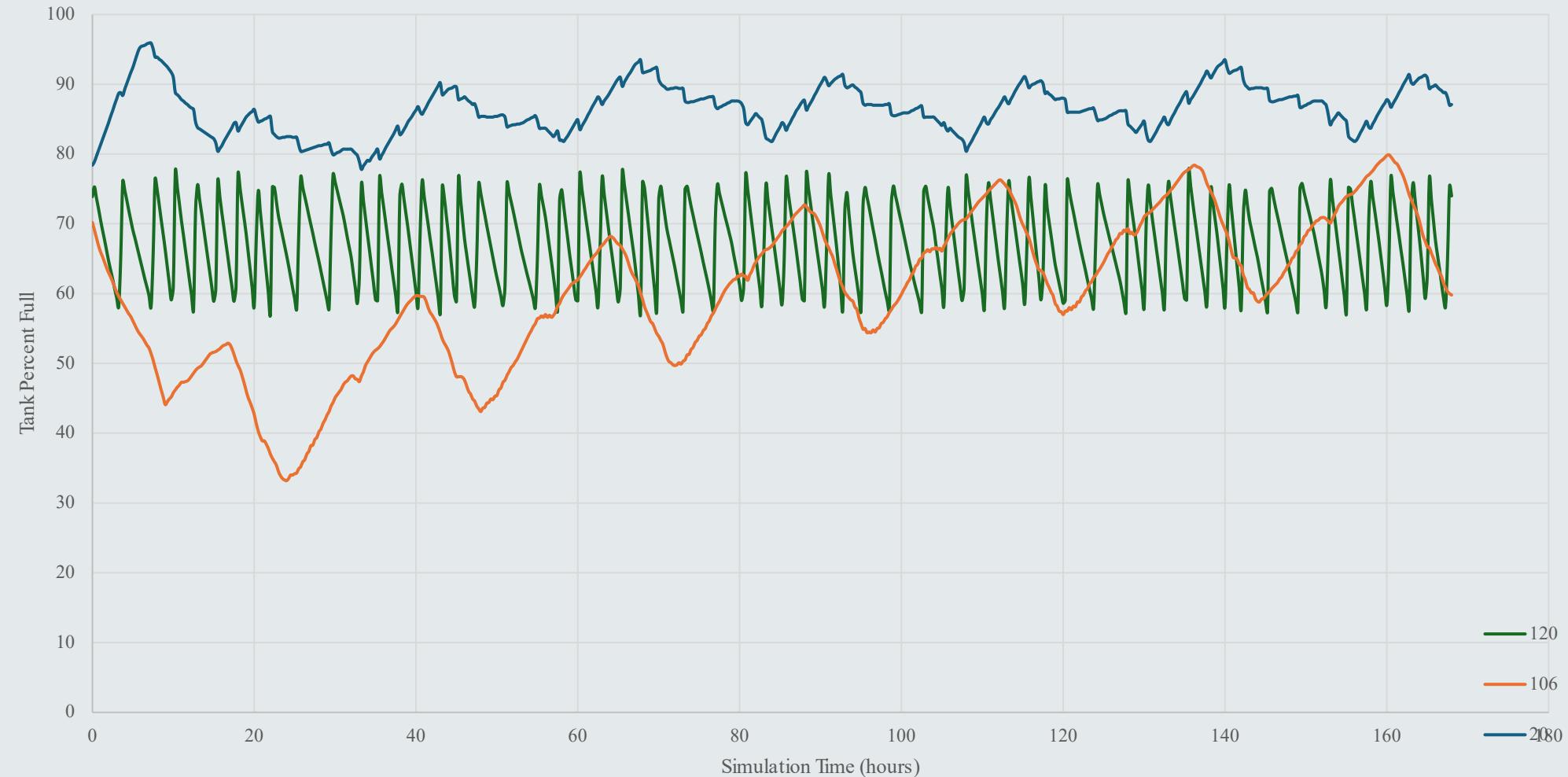
# Well SW-01: 2040 Region C Demand



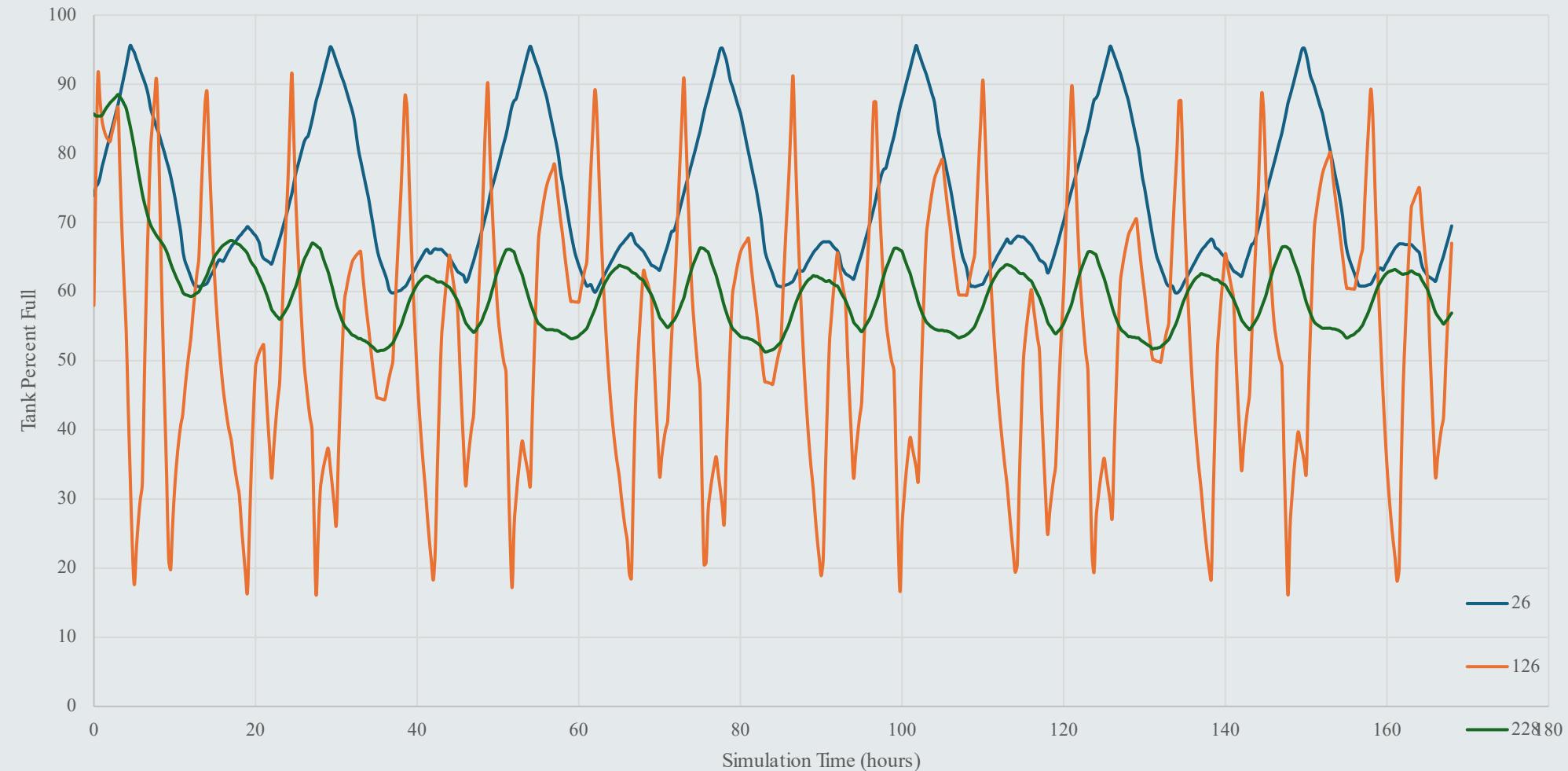
# Well SW-01: 2040 Region D Demand



# Well SW-03: 2040 Region C Demand



# Well SW-03: 2040 Region D Demand



# Economic and Energy Analysis

Alternative	Capital Cost	Year	Scaled Energy Intensity (kWh/MG)	Scaled Emissions (lb CO <sub>2</sub> e/MG)
Current	None	2022	2180 (observed value)	2990
Current	None	2040		Does Not Meet Water Demand
TW-08	\$4.1M	1040		Does Not Meet Water Demand
TW-08	\$4.1M	2035	2070	2830
TW-11	\$4.1M	2040		Does Not Meet Water Demand
TW-11	\$4.1M	2035	2280	3120
SW-01	\$12.0M*	2040	2210	3040
SW-03	\$13.4M*	2040	2340	3200

\*Note: Capital Cost does not include land purchase.

# Conclusions

- As it currently exists, the MWU system will be able to keep up with the projected increase in demand on the City of Madison's west side until approximately **2030**. Around that time, Unit Well 12 may need to serve as a dedicated PZ 8 facility.
- Projects TW-08 and TW-11 could meet the increasing west side demand until approximately **2035**. Project TW-11 would also require Unit Well 12 to serve as a dedicated PZ 8 facility to achieve this.
- Completing either of projects SW-01 or SW-03 would enable MWU's system to meet anticipated west side water demands through at least **2040**.
- Given the modeling estimate uncertainties (margins of error) for energy usage, there is no significant difference between the facility project alternatives in terms of energy usage or greenhouse gas intensity.

# Questions?

## Acknowledgements

- Dr. Greg Harrington
- Madison Water Utility
  - Krishna Kumar, General Manager
- MWU Engineering Division
  - Pete Holmgren, Joe Grande, Joe Demorett, Shayne Santi
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  - Jadon Basilevac
- Short Elliott Hendrickson Inc. Madison Office
  - Chad Katzenberger, PE
  - Heather Schumacher, PE
- City of Madison Office of Sustainability
- WRE Group



## Sources:

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<https://www.cityofmadison.com/water/about/water-infrastructure-management-plans>
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<https://www.cityofmadison.com/sustainability/energy/renewable-energy>
- *Bentley WaterCAD User Documentation*
- *Whitman, Brian E. et al. Computer Applications in Hydraulic Engineering (9<sup>th</sup> Ed.) Bentley Institute Press, 2021.*
- *Google Earth*

