Potomac Aquifer Recharge Monitoring Laboratory (PARML): Report to Oversight Committee

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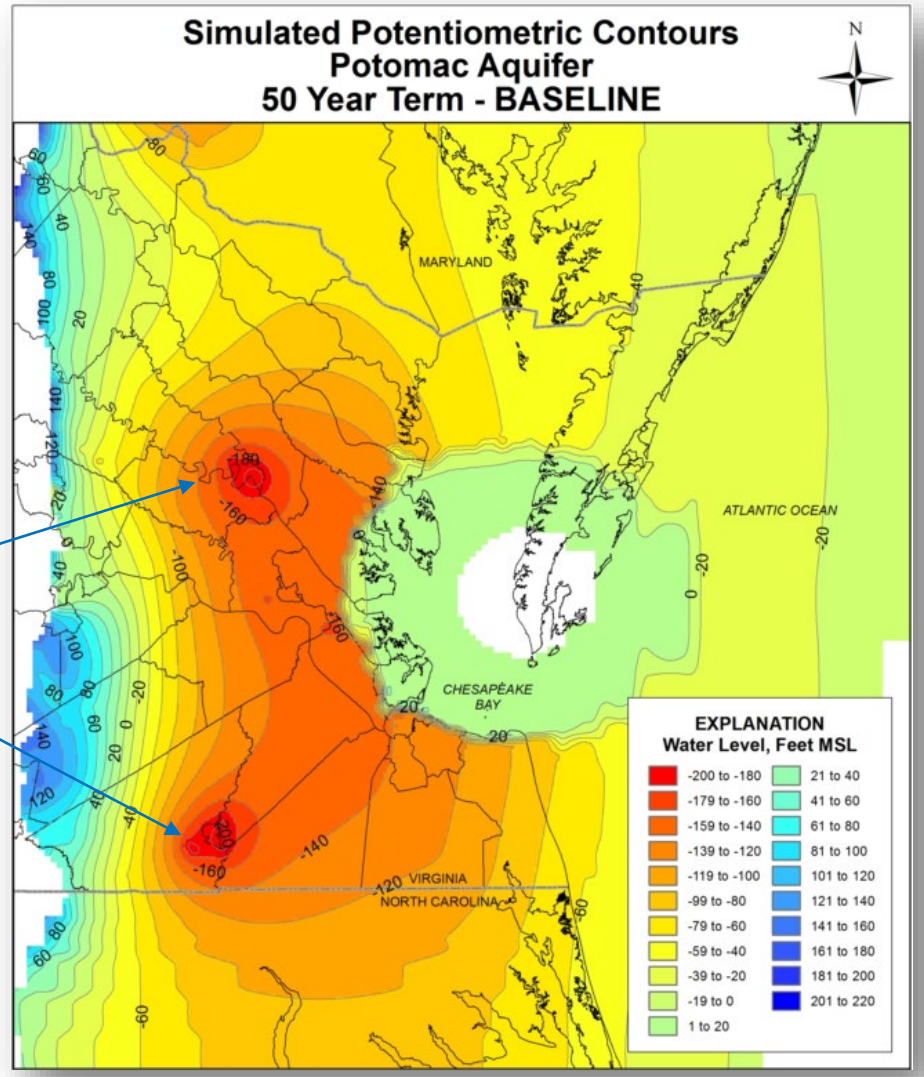
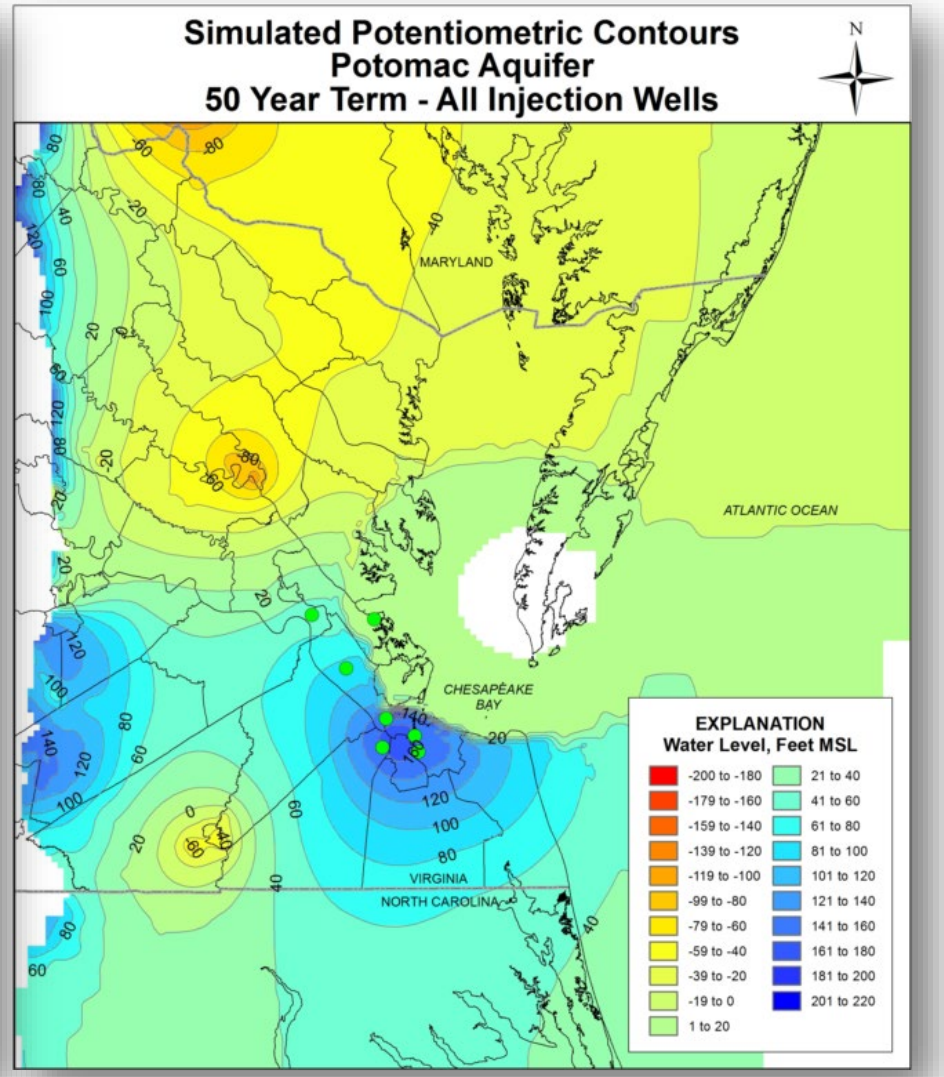
PARML Co-Director

June 27, 2022

Modeled Potomac Aquifer water levels with and without SWIFT

Pumping Centers





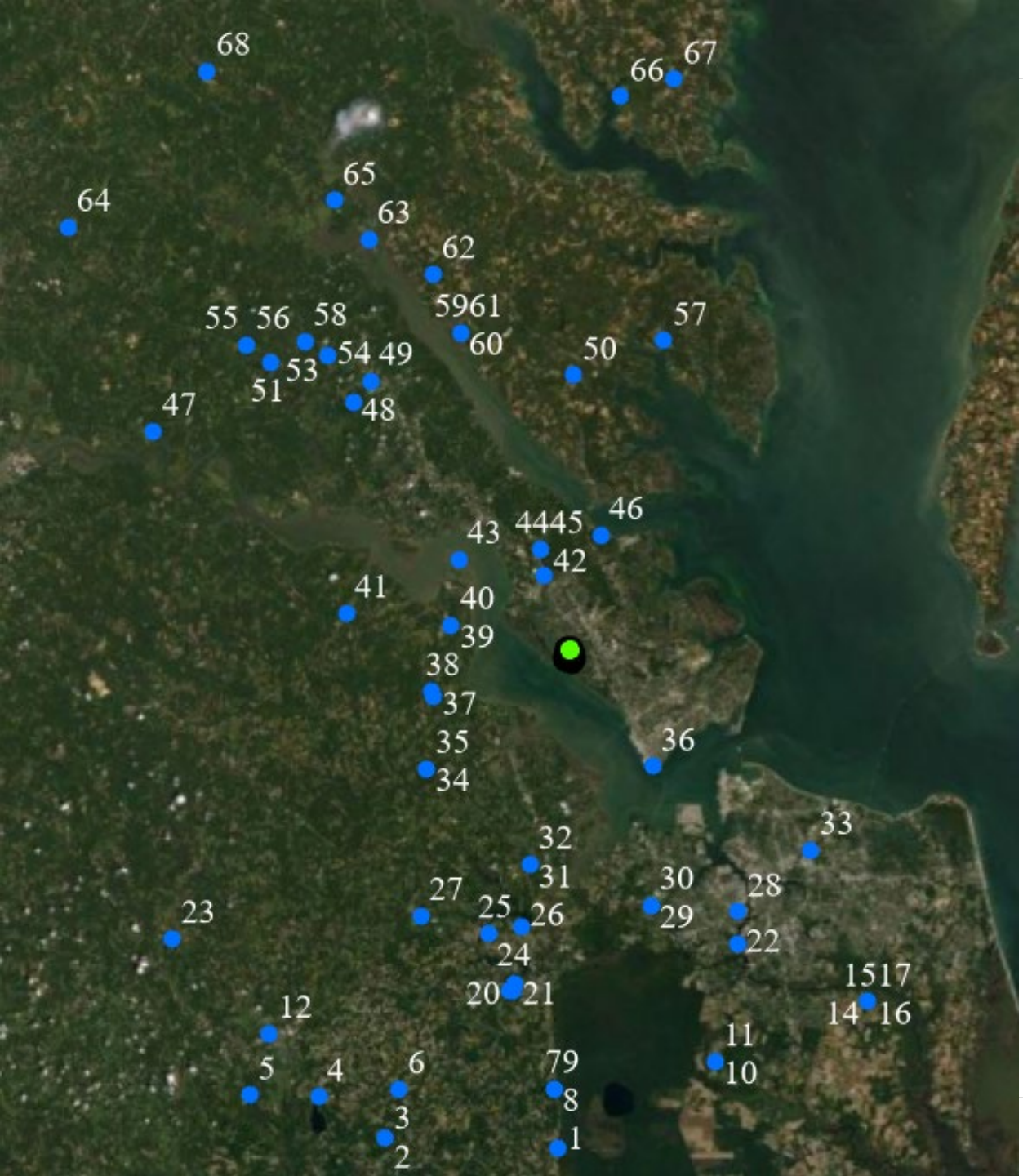
Problem Statement: Groundwater models needed for local-scale analysis of SWIFT projects

- Modeling Objectives (SWIFT sites):
  - What are the expected water level changes in the vicinity of James River?
  - Where to monitor water levels to document impacts?
- One limitation of the Regional Model: *Computational grid was not designed to address modeling objectives*
- Greater resolution in proximity to each SWIFT site requires finer-scale numerical grids

Objectives and Approach

Go/No Go

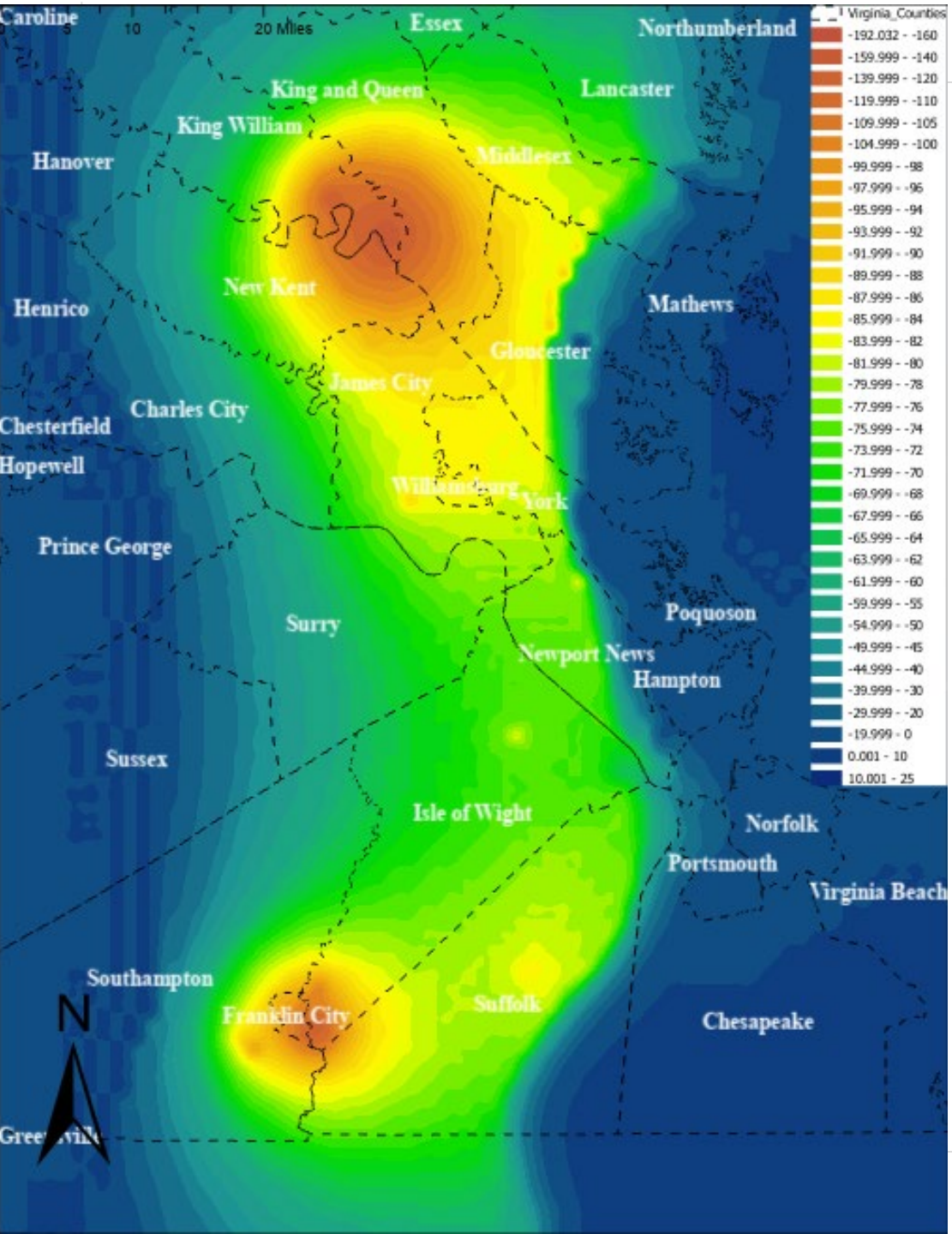
Groundwater Modeling of Managed Aquifer Recharge at the Regional and Local Scale
Andrew Frazier, MS Thesis (2022)



Objective 1

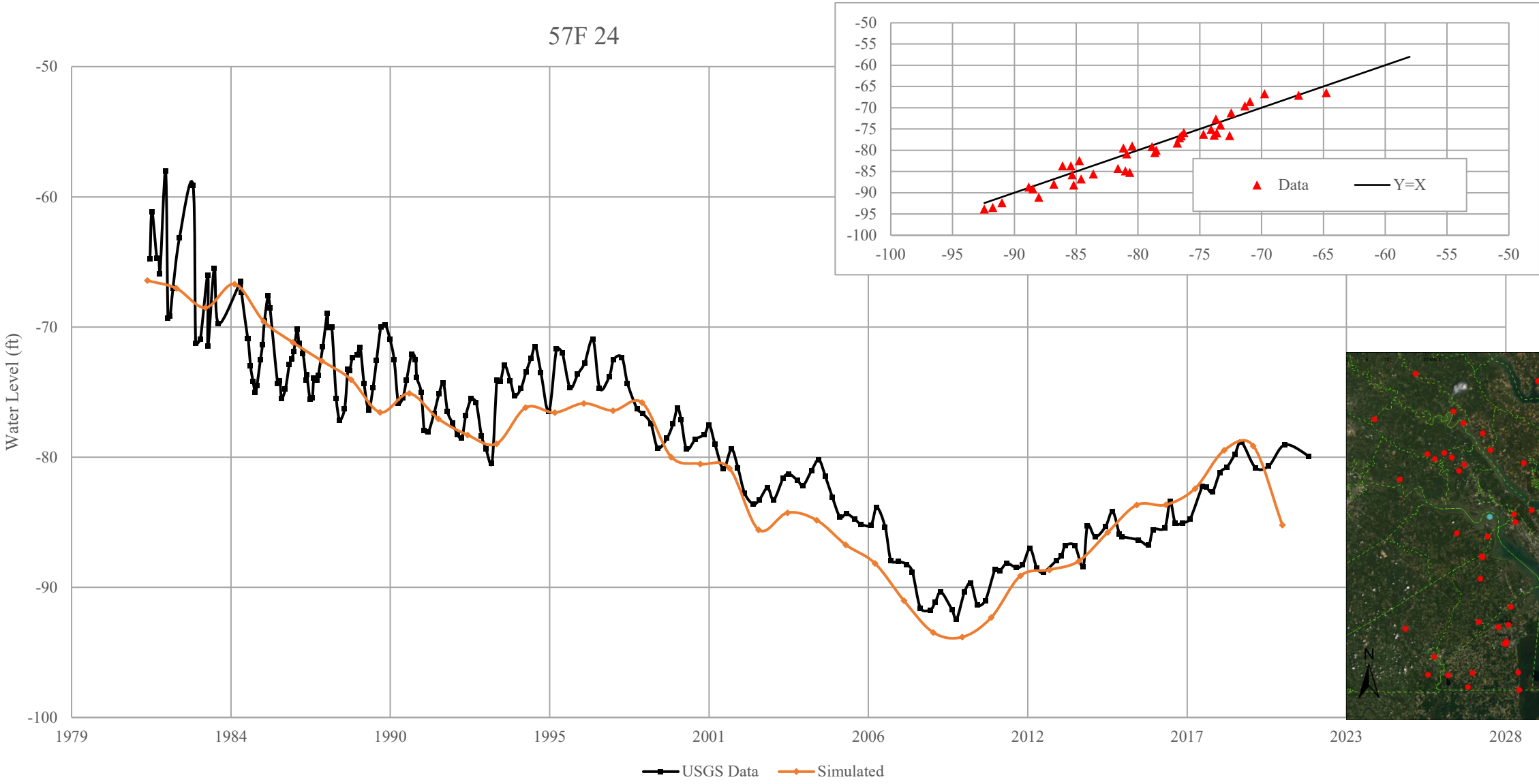
Regional Model Validation

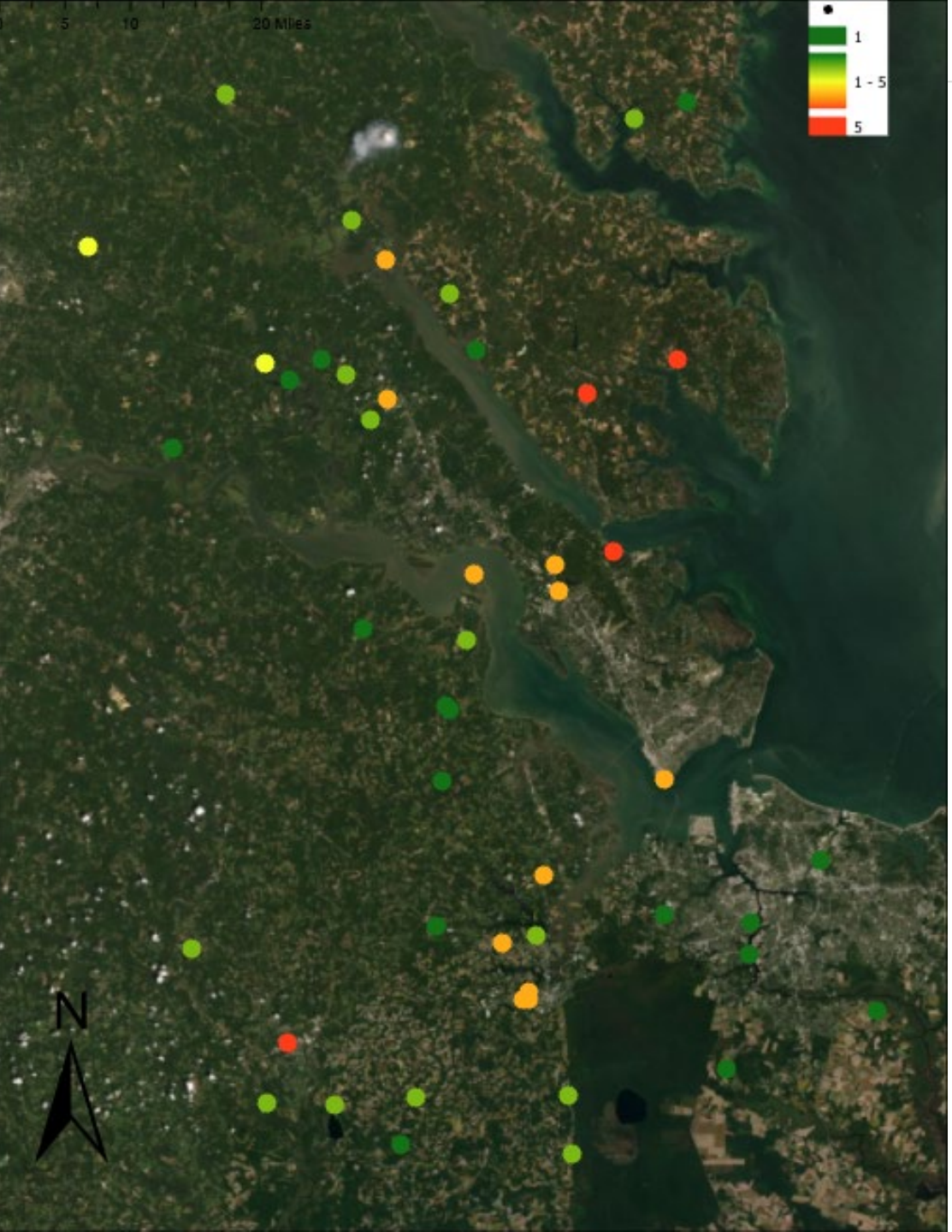
- Data: USGS water level data from PAS wells located within 50 mi of the James River SWIFT site



2020 Simulated Head

- Last output from observed data
- Statistical Analysis
  - Pearson's Coefficient of Determination
  - Nash-Sutcliffe Efficiency
  - Percent Bias
  - Visual Comparison


57F 24
Water Level (ft)
-50
-60
-70
-80
-90
-100
1979
1984
1990
1995
2001
2006
2012
2017
2023
2028
USGS Data
Simulated
Data
Y=X
N



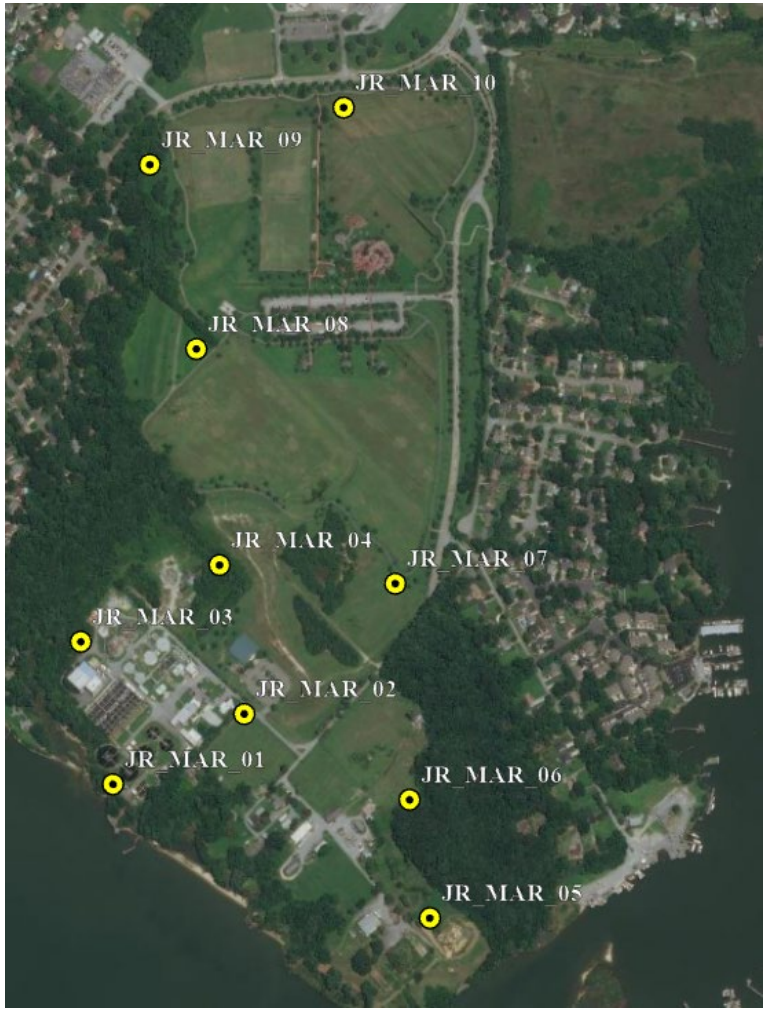
Validation Summary

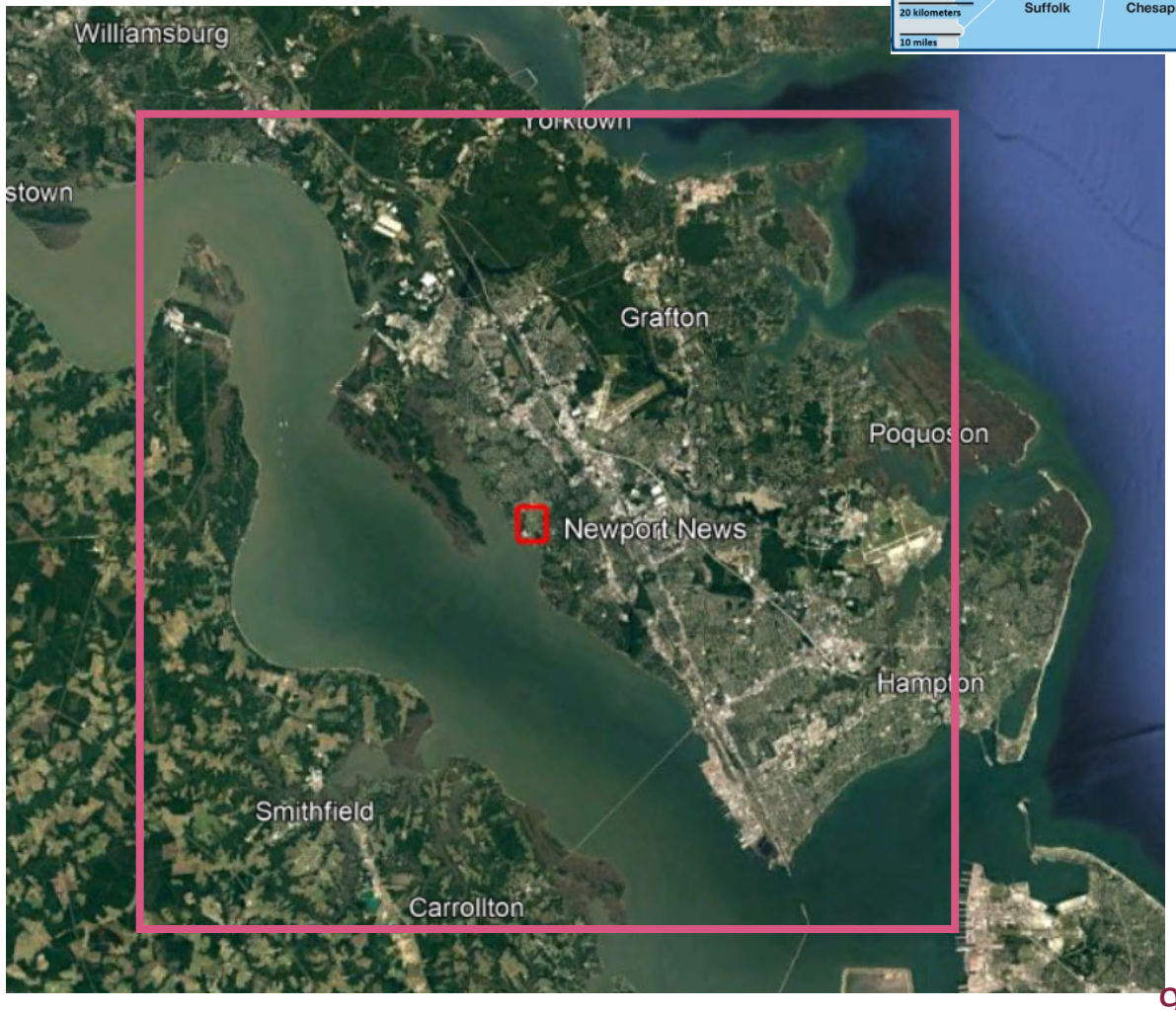
- 94% of comparisons acceptable
- Limited to 50 mi from JR SWIFT site

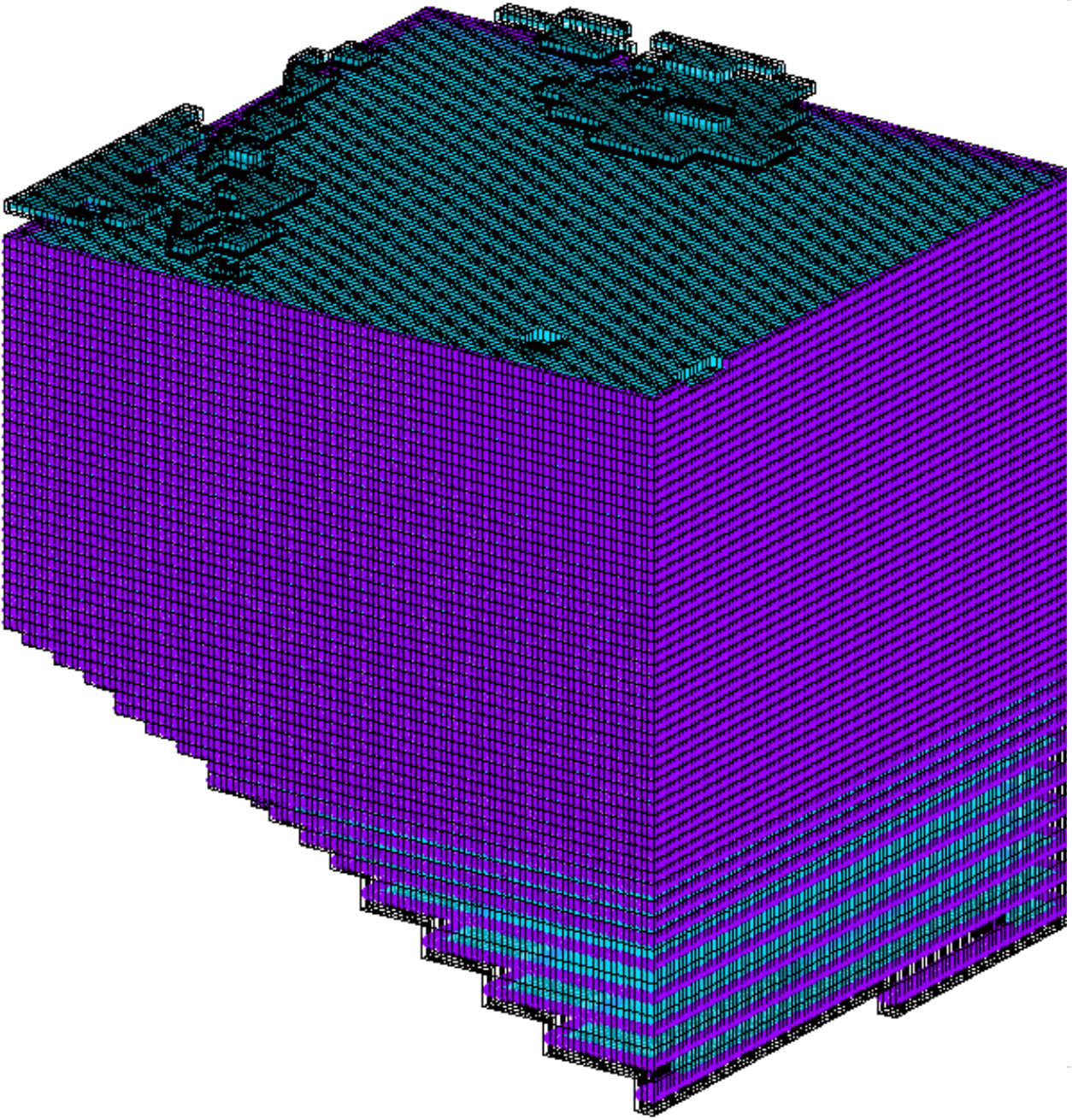
Data Issue	Number	Percent
None (1)	27	40%
Trend Fit (2)	21	31%
Cyclic Data (3)	3	4%
Fluctuating Data (4)	13	19%
Poor Fit (5)	4	6%

James River SWIFT Site

- 10 recharge wells
- 2 MGD capacity each
- Operational in 2025





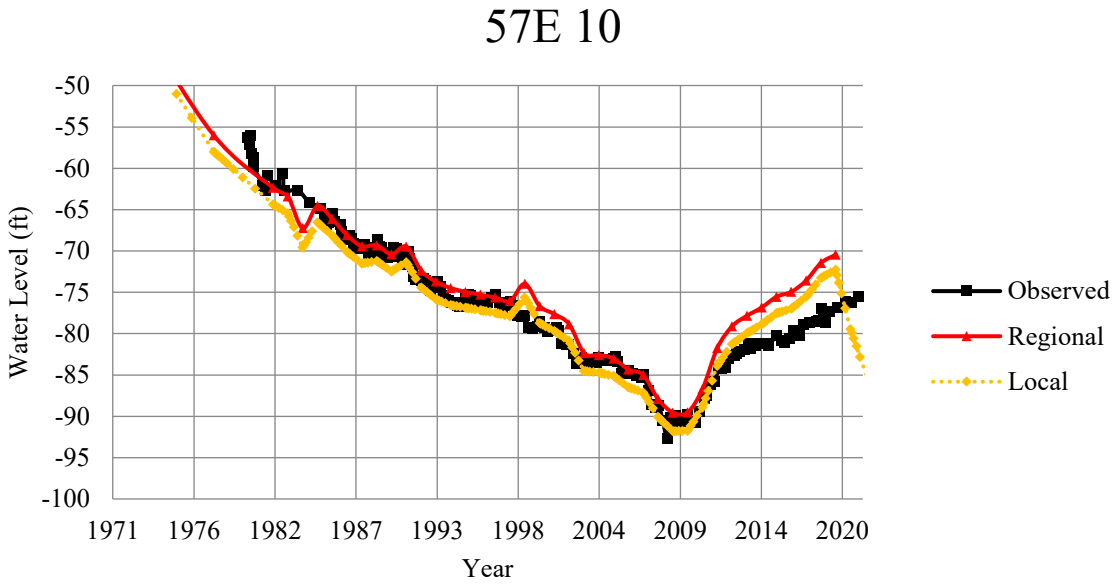


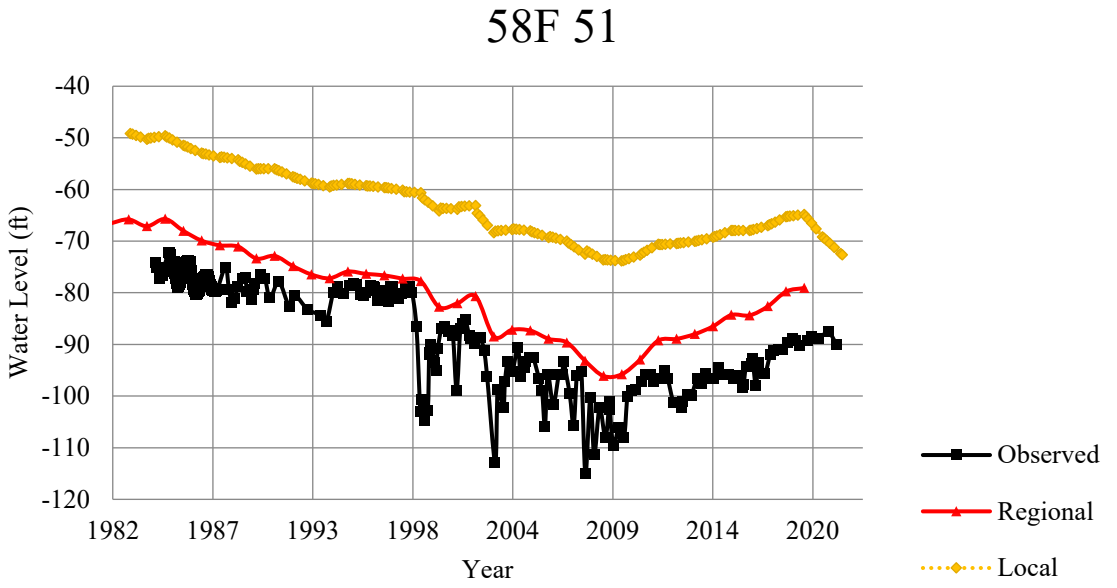
Local Model Grid

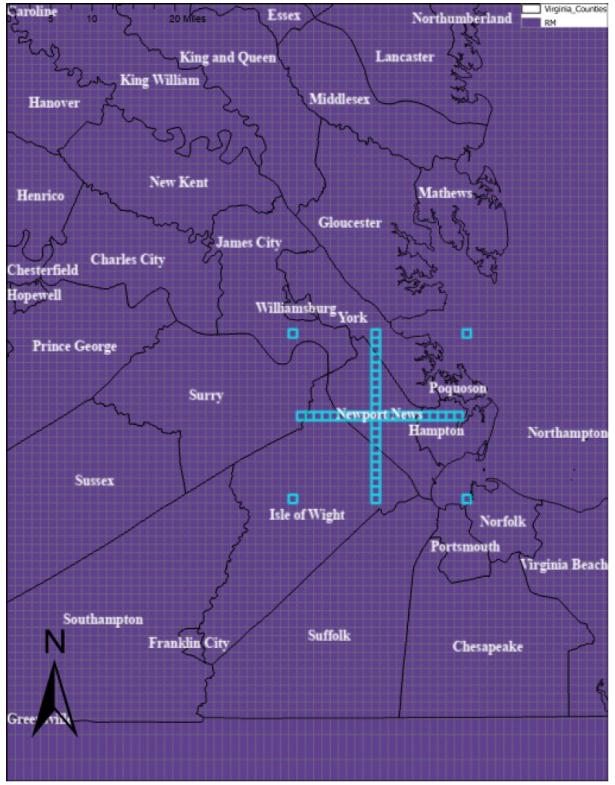
- 60 Layers
- 106 Rows
- 101 Columns

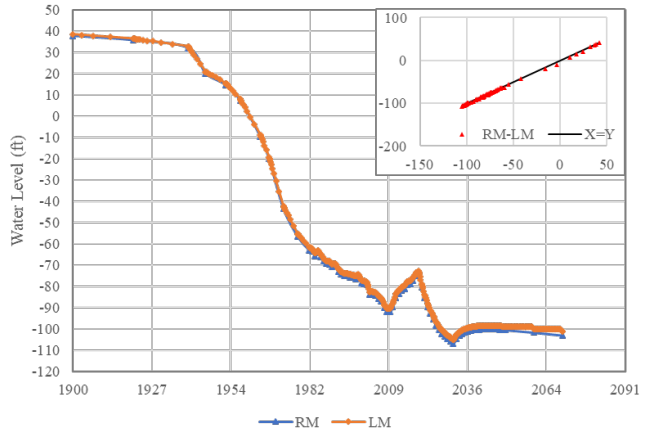
Scenario 1: 0%

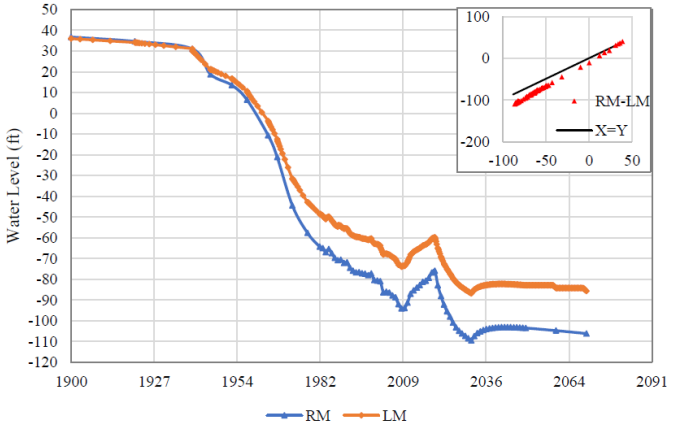
- Regional model to local model comparison
- Comparison to observed data
- Baseline for other scenarios



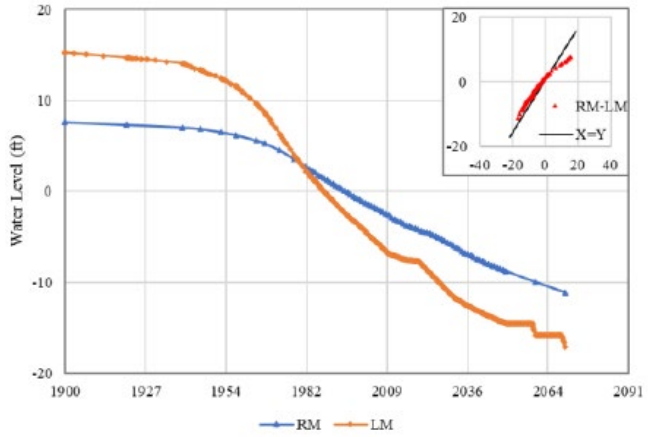








- Results greater differences towards model center
- Cells diverge from regional model after reaching modeled crater



Objective 3

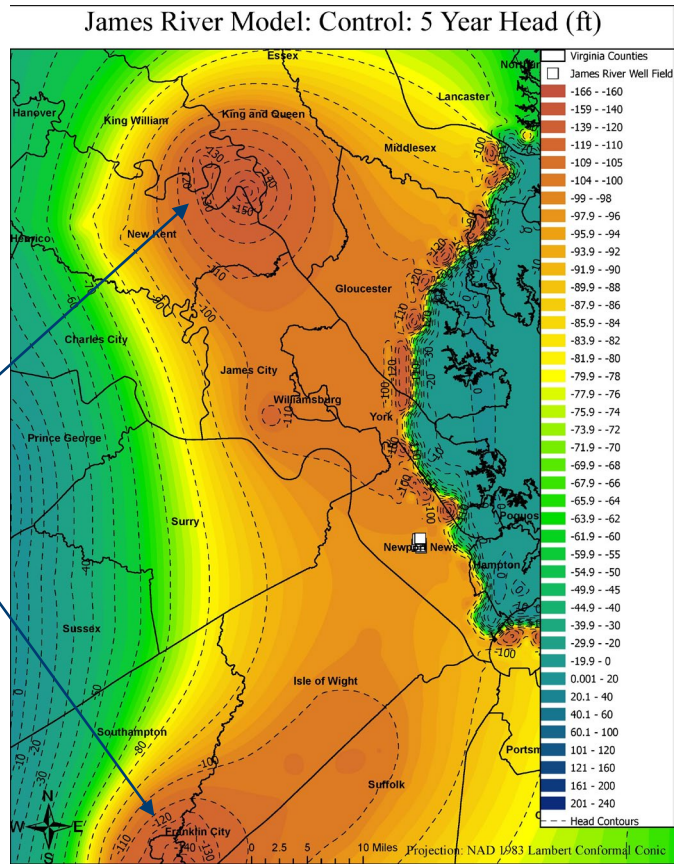
Model Scenarios

- Four scenarios
- Conservative capacity
- Flow divided evenly between 10 wells
- Run at regional and local scale

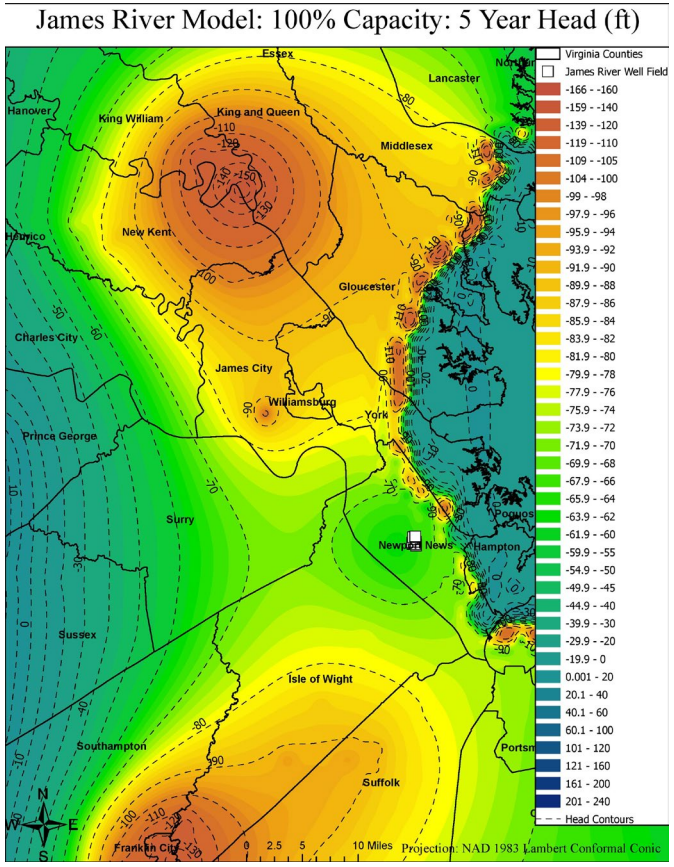
	Total Flow Rate Q (MGD)	Flow Rate per Well (cfd)	% of Capacity
Scenario 1	0	0	0
Scenario 2	8	106,944	50
Scenario 3	12	160,417	75
Scenario 4	16	213,889	100

Anticipated Impact to Regional Groundwater Levels

Pumping Centers

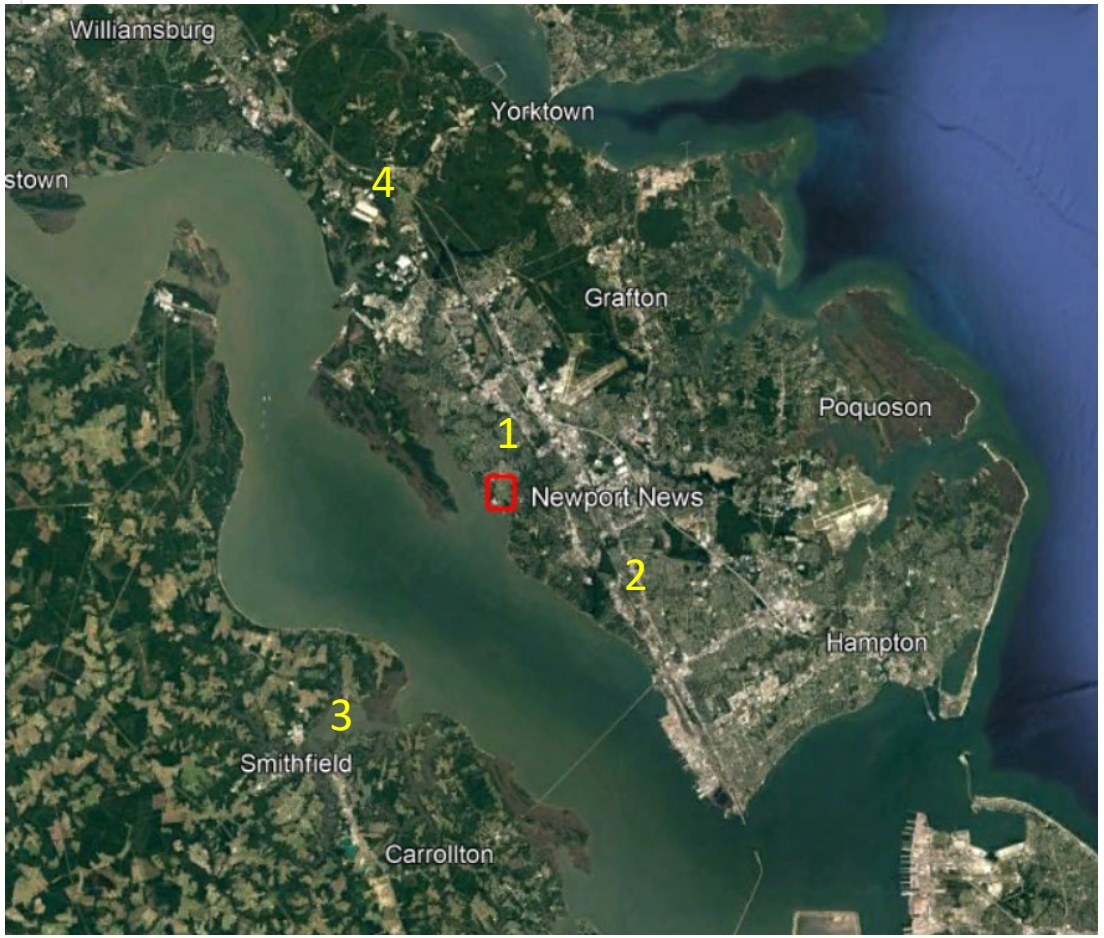


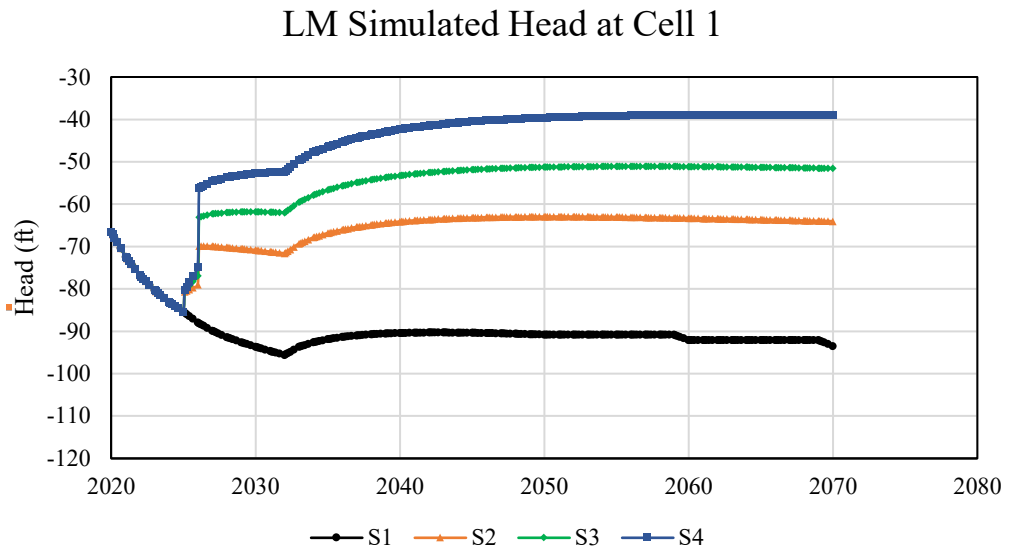
Control Scenario: No Managed Aquifer Recharge

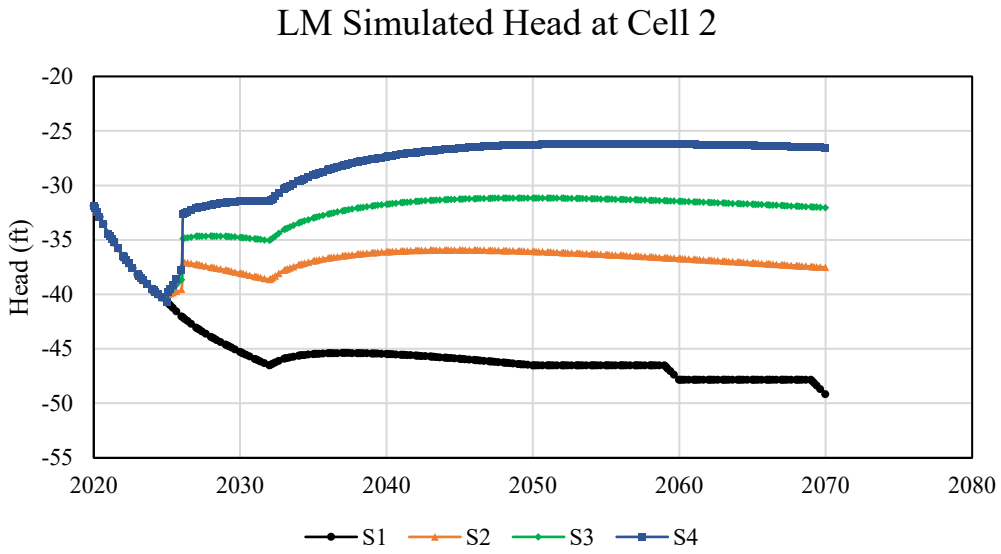


MAR Scenario (16 MGD)

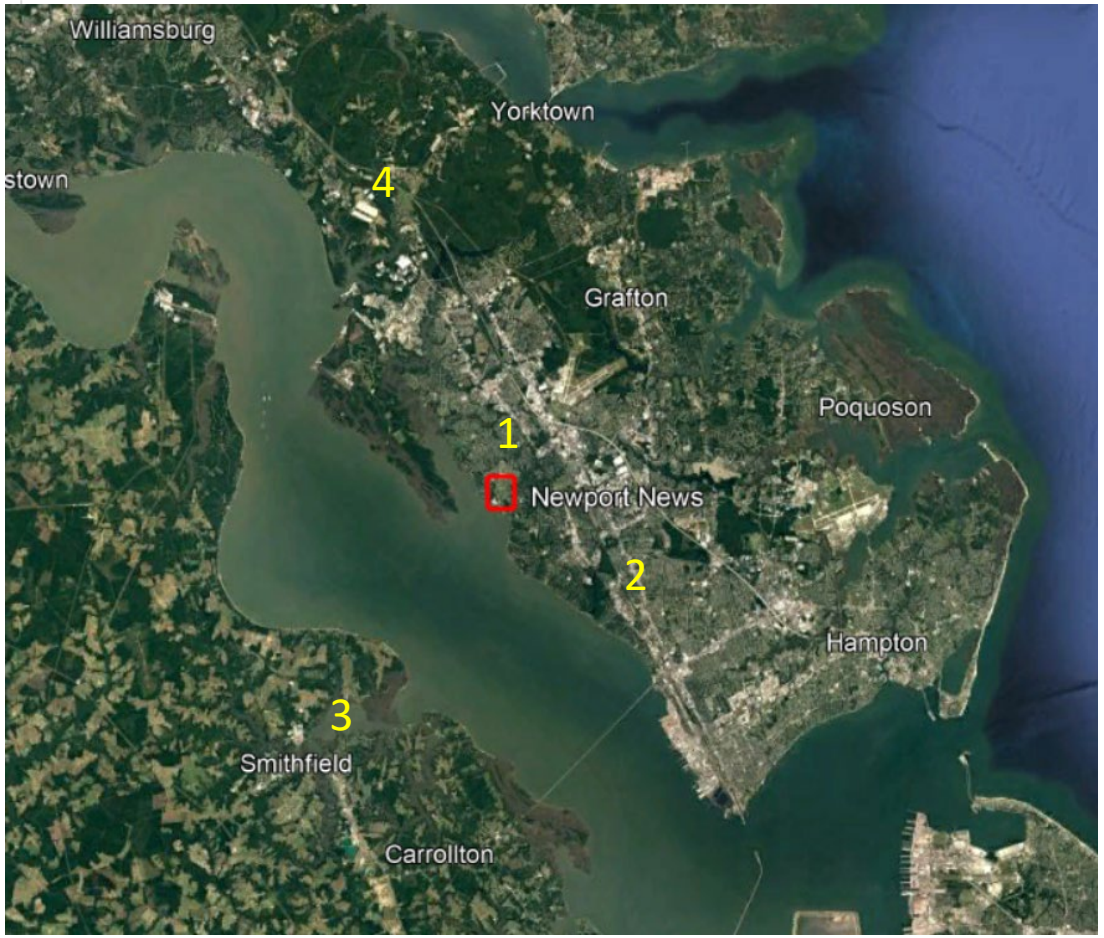
Anticipated Change in Water Levels

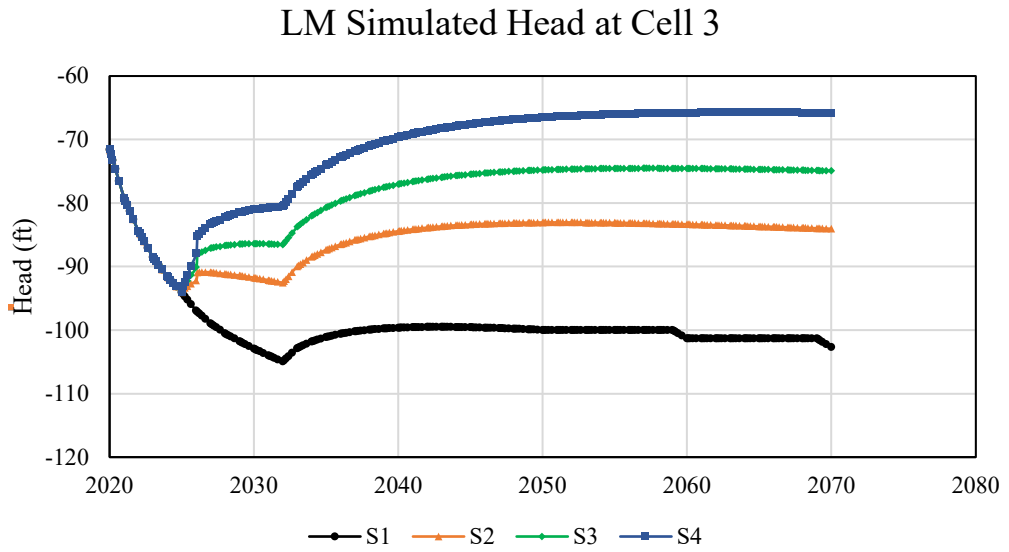


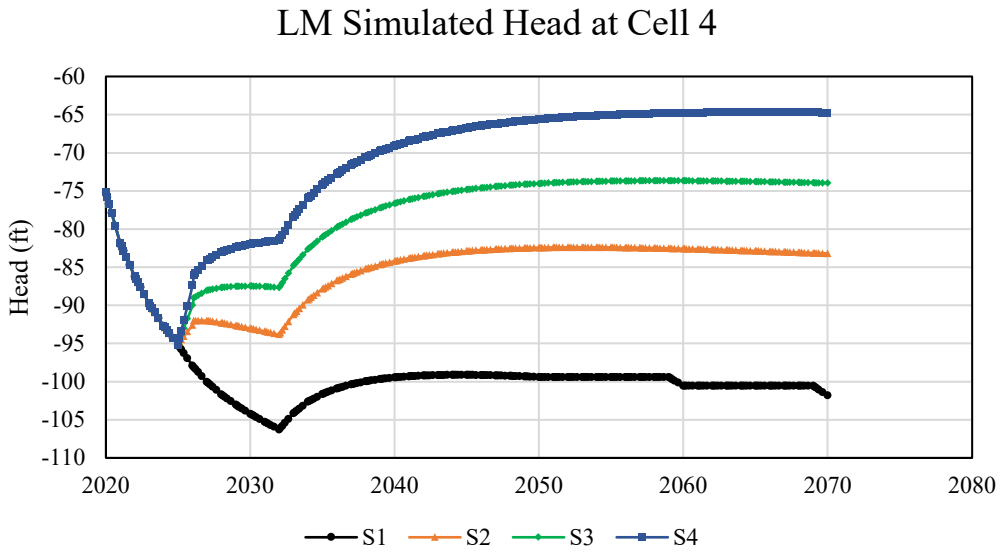




Anticipated Change in Water Levels





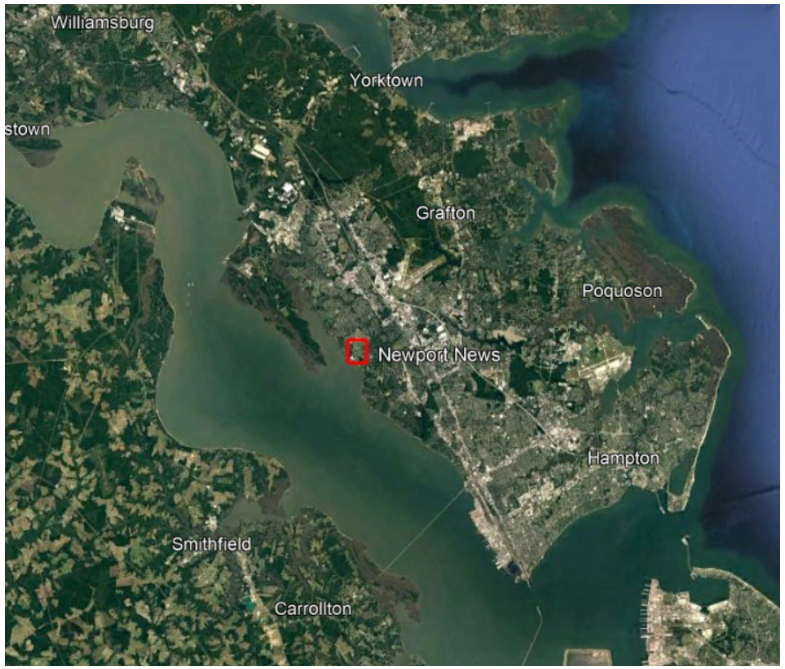


Outcomes

VALIDATE REGIONAL MODEL → DEVELOP LOCAL MODEL → MODEL SCENARIOS

$h(x, y, t)$

- Modeling Objectives:
  - What are the expected water level changes in the vicinity of James River?
  - Where to monitor water levels to document impacts?



GW Monitoring: James River

- Local data monitoring by PARML in collaboration with HRSD
  - Instrumentation and data acquisition systems
  - Data monitoring and management