Predictions of Septic Effluent Transport to Charlotte Harbor Pre- and Post-Septic to Sewer Conversion for the Ackerman Subdivision

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November 19, 2019

Project Overview

- Objective: Predict the fate and transport of septic effluent from Ackerman subdivision, pre- and post-septic to sewer conversion.
- This involves the development of a numerical groundwater flow and nitrogen transport model of the Ackerman subdivision.
- The numerical model is based on and supported by data collected from a groundwater characterization and tracer study at El Jobean.

Study Site


El Jobean Field Site
2.2 miles
El Jobean
Tippecanoe Bay
Muddy Cove
Ackerman Model Boundary
Lake Worth Blvd
Ackerman Ave
Edgewater Dr
Flamingo Blvd
Collingswood Blvd
Deerfly Bay
Ohara Dr
Muddy Bay
Triple Lakes
Myakka Cutoff
Hog Island
Davis Blvd
776
Gillot Blvd
McCall Rd
771
Pineda Cir
Caspanilla Rd
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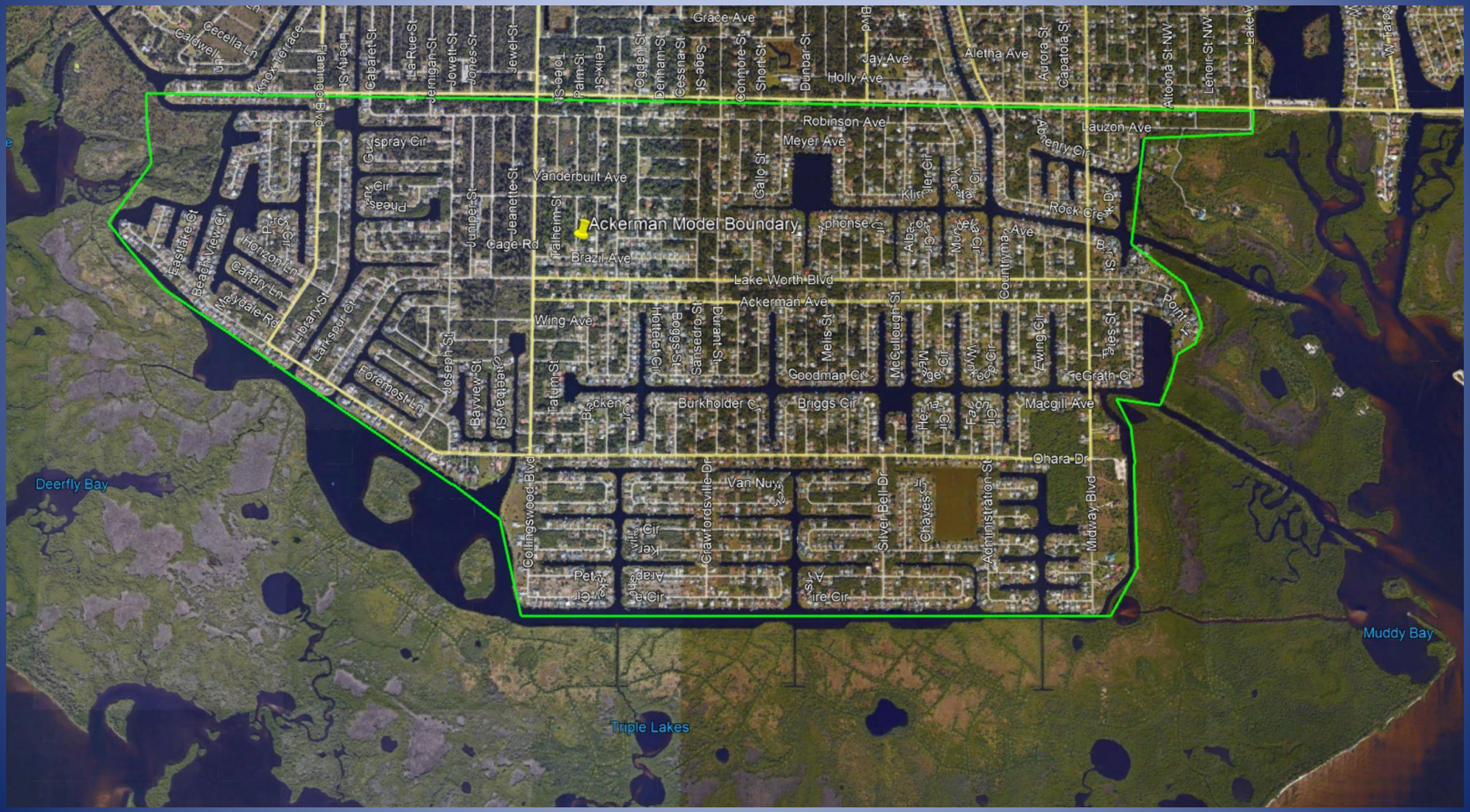
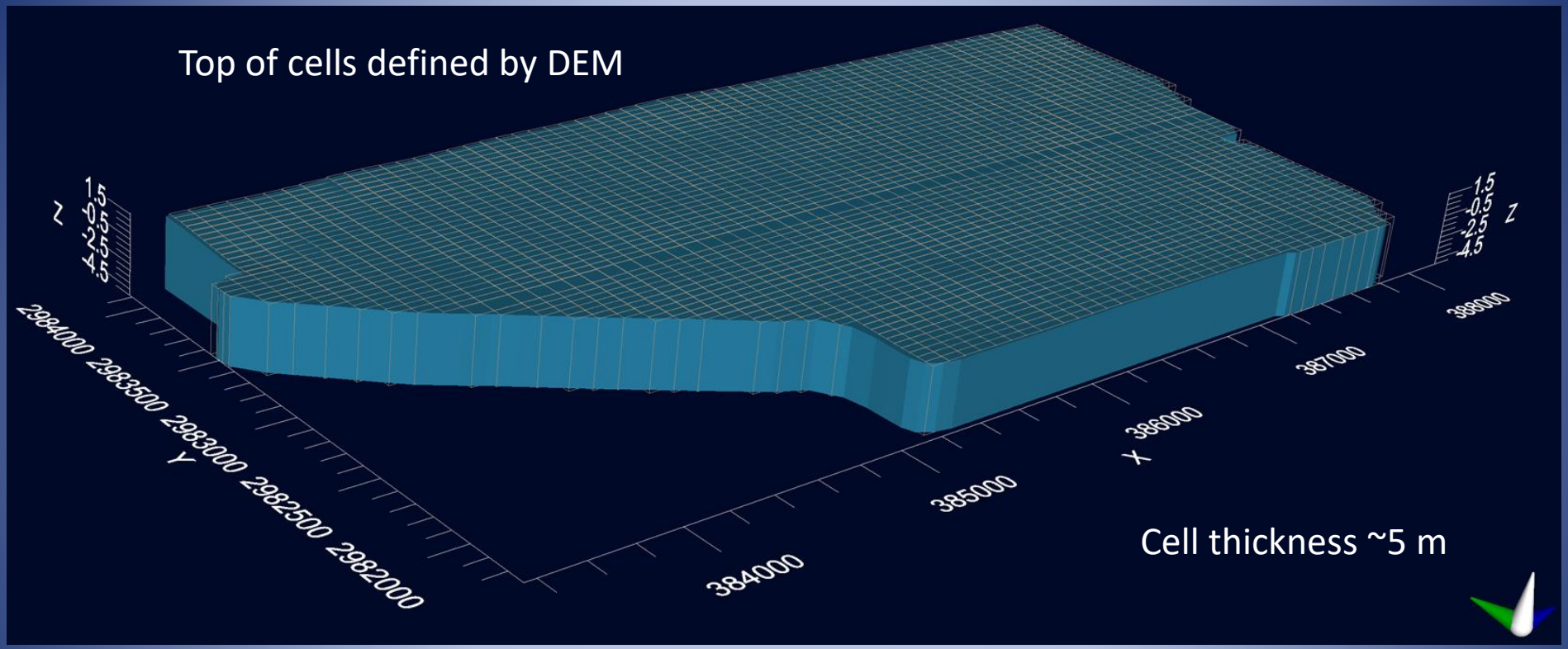
Google Earth

Model Domain



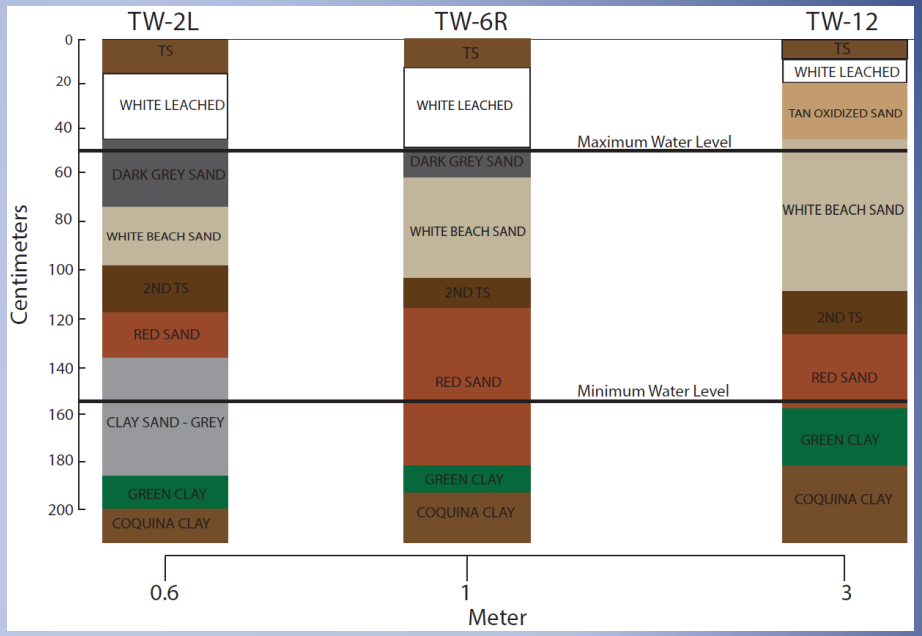
3D Model Domain

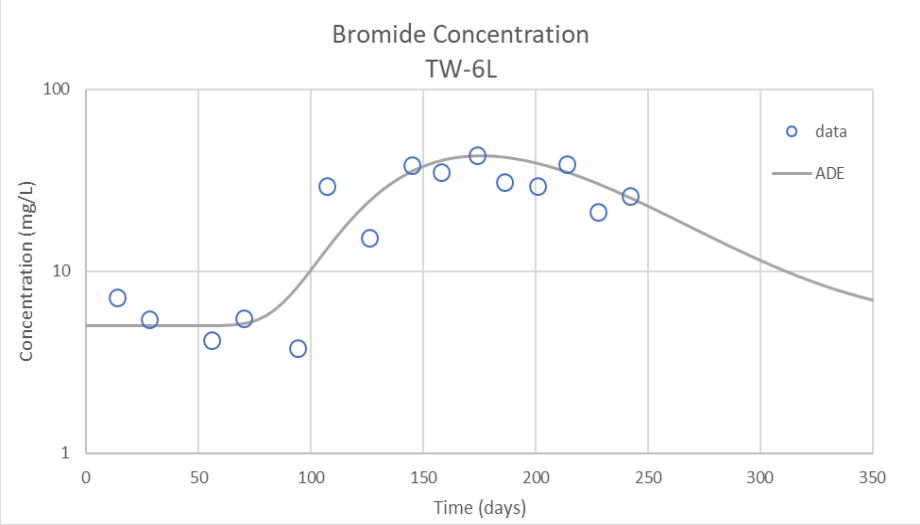


MODFLOW – USGS Modular Groundwater Flow Code
MODPATH – Traces Flow Pathlines
MT3DMS – Nitrogen (as nitrate) Transport

} Visual MODFLOW Interface

Supporting Data – El Jobean Site





Subsurface Geology – medium sand, underlain by clay

Hydraulic Conductivity/Permeability

Hydraulic Gradient (slope of water table)

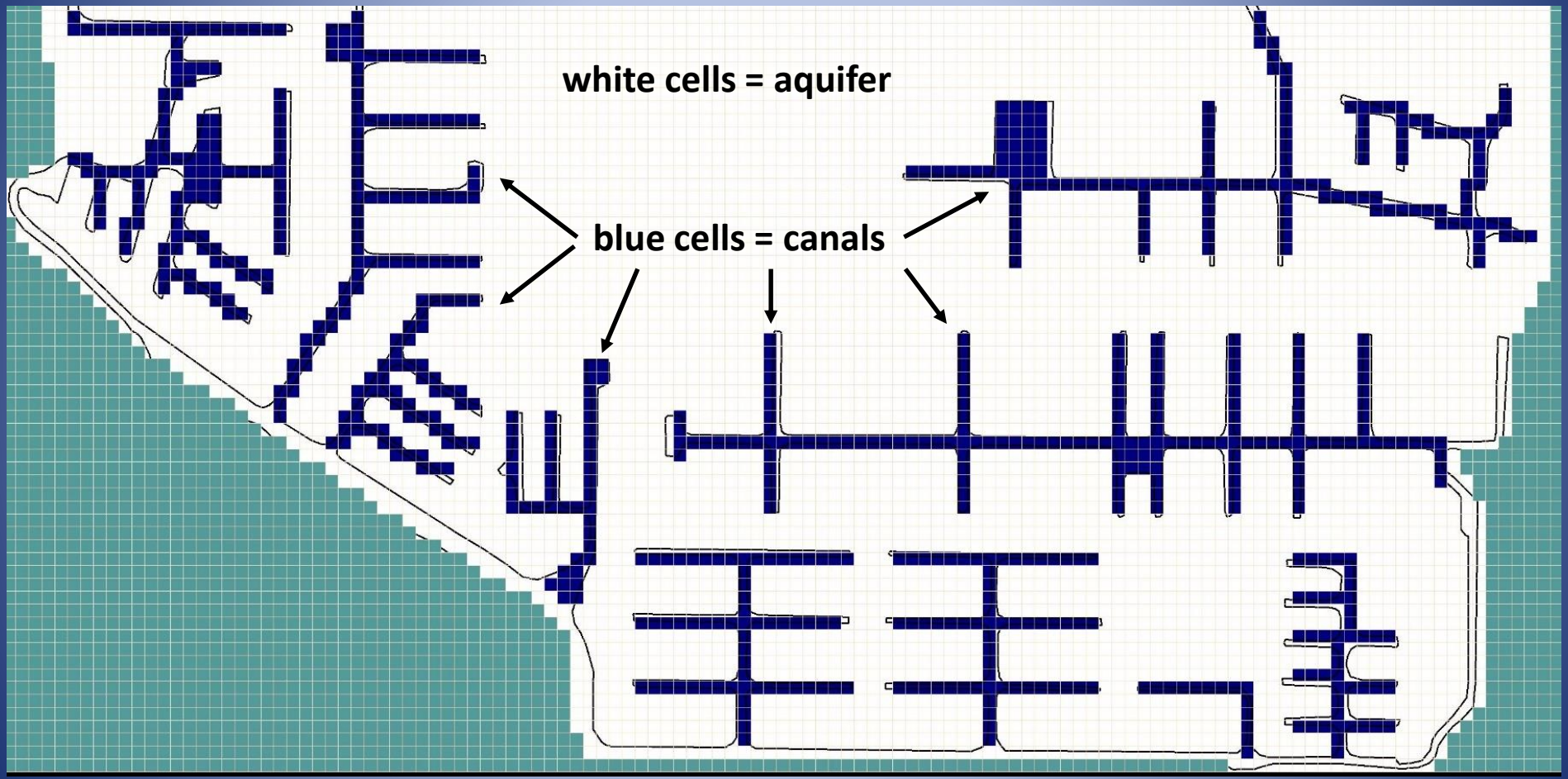
Velocity and Plume Spreading

Seasonal Water Table Fluctuations

Supporting Data – Other

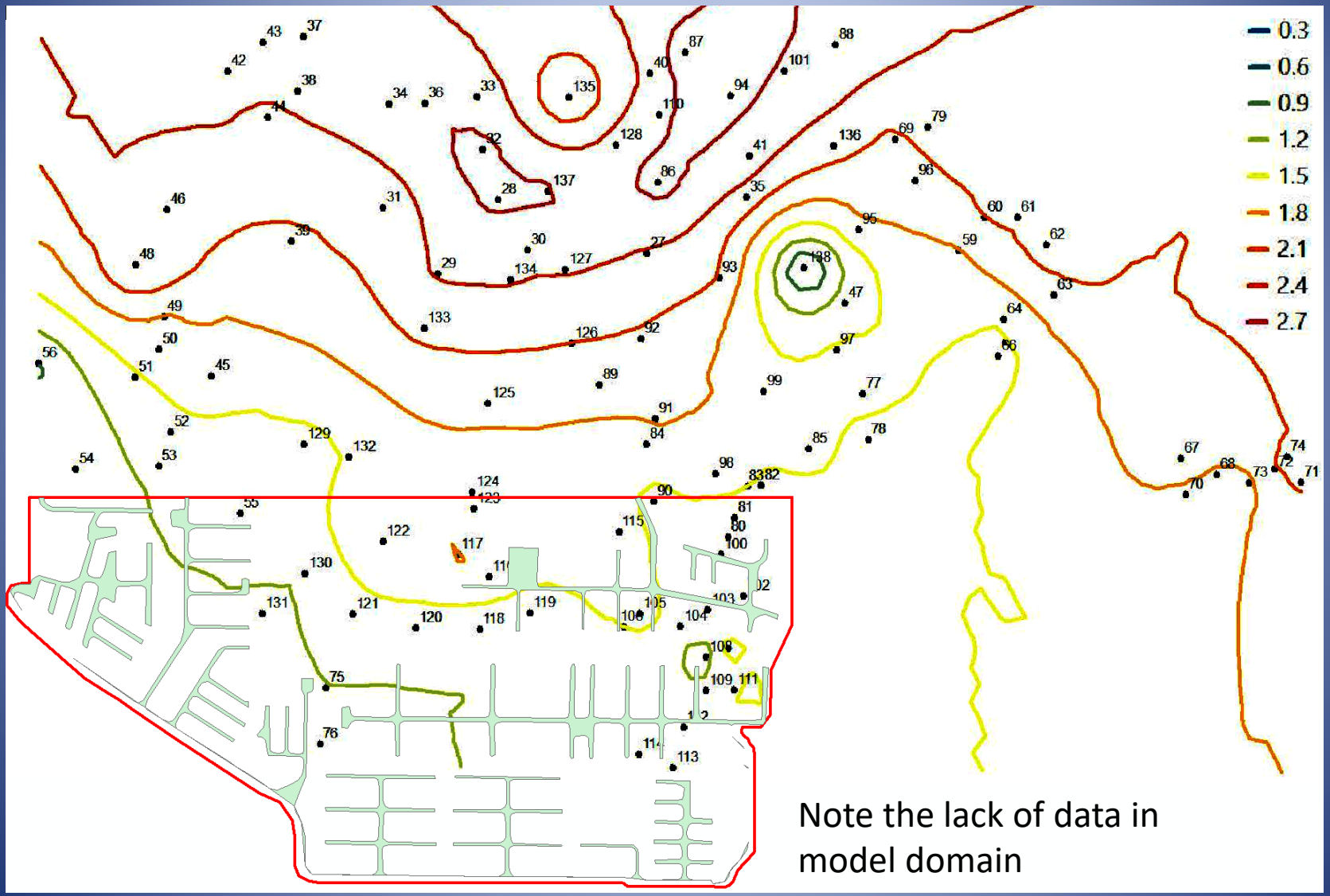
- Digital Elevation Map (DEM) from USGS National Map to assign land surface elevations
- Net recharge to the water table: ppt – ET from Southwest Florida Water Management District from 1994 – 2005 (7 in/yr average)
- Charlotte County Utilities Department (CCUD) shape file for canal configuration within model domain, water levels in Ackerman area
- CCUD shape files to delineate Ackerman into 5 distinct zones for simulation of septic fluid and nitrogen
- Septic fluid and nitrogen mass loading for septic systems according to Lift Station 23 O'Hara data from CCUD

Model Domain and Canal System



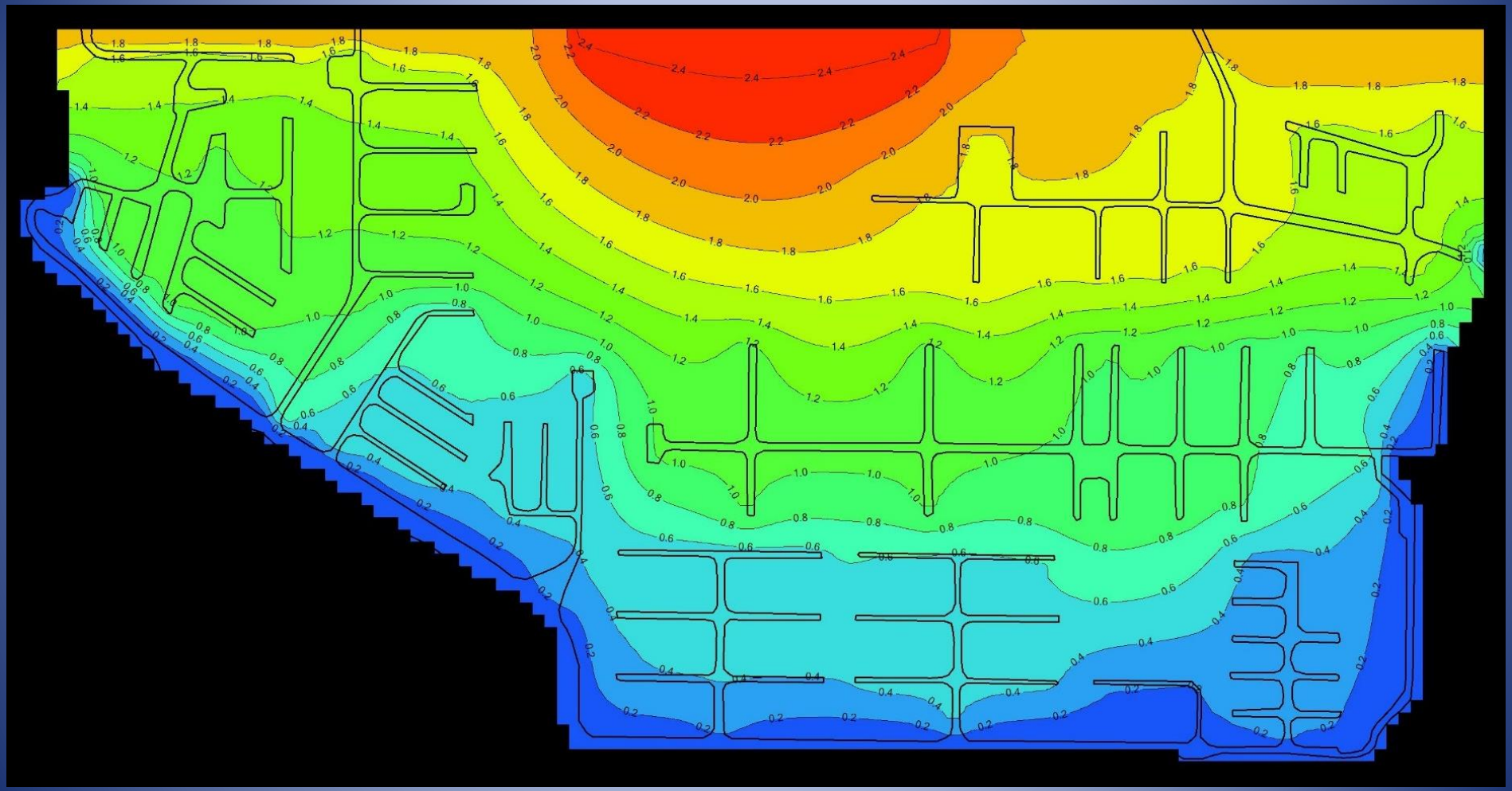
Boundary conditions allow for flow to exit along canals bounding model domain, set to sea level.

Water Levels - CCUD

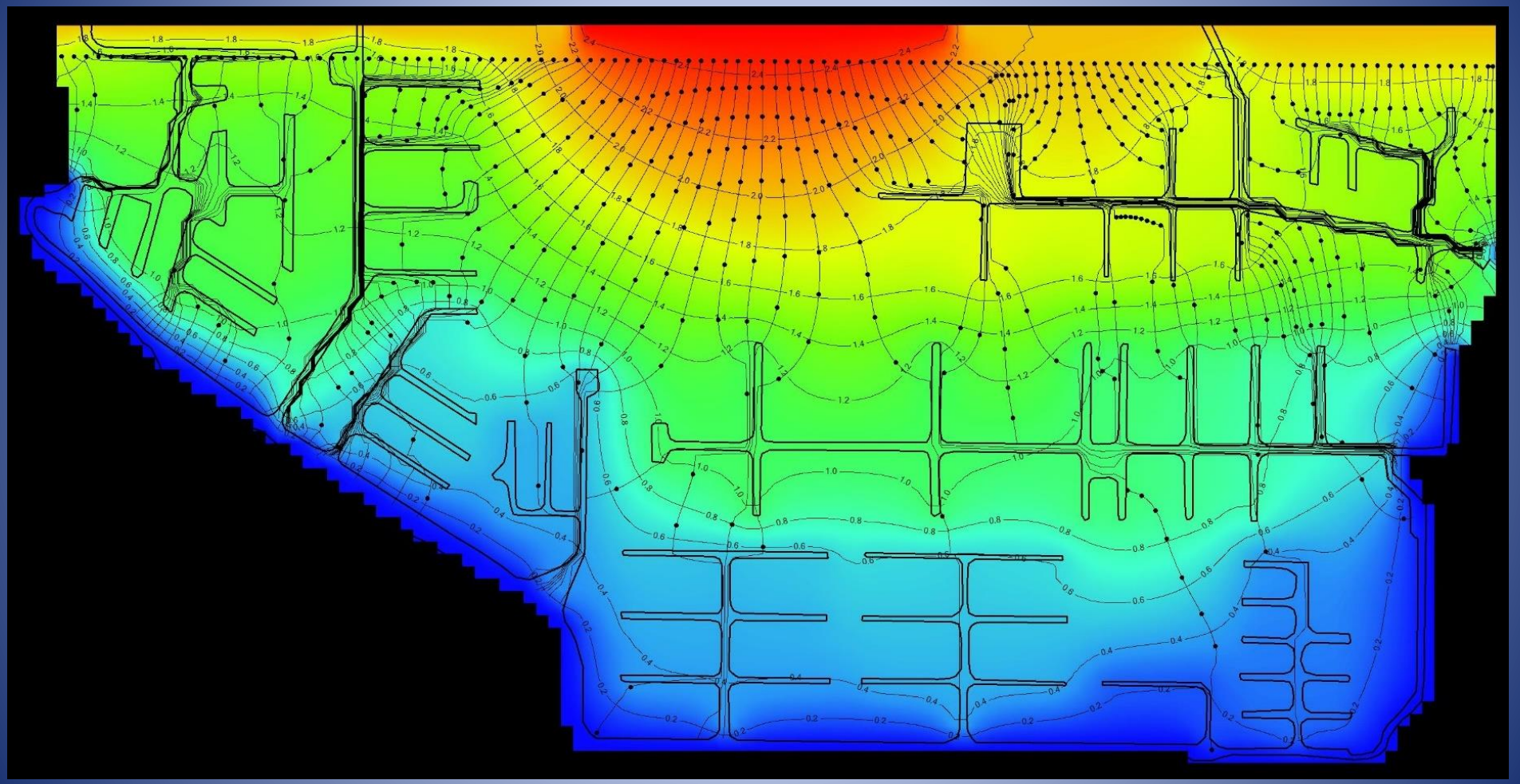


Flow Model Results

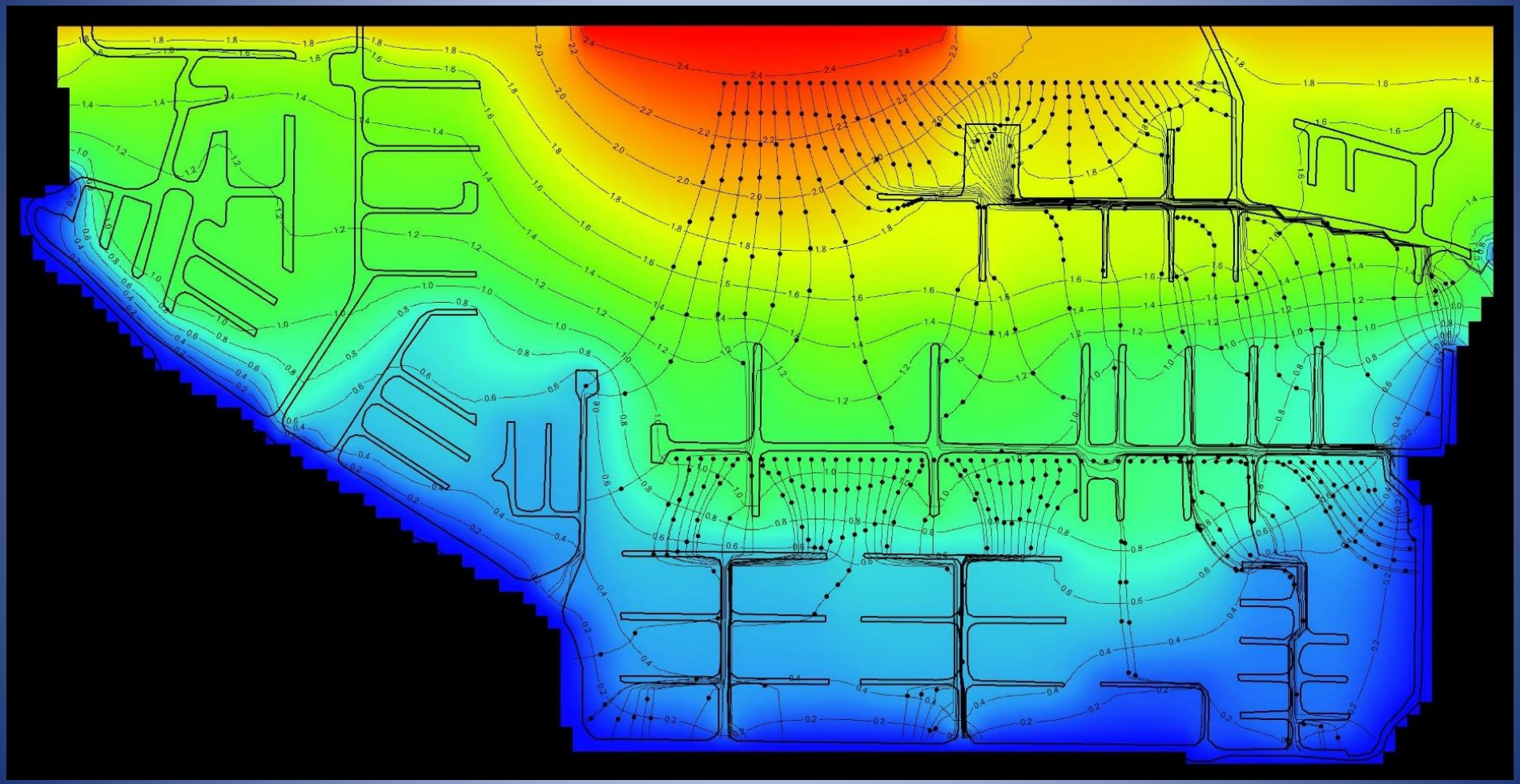
Water Table Profile – Base Case Model



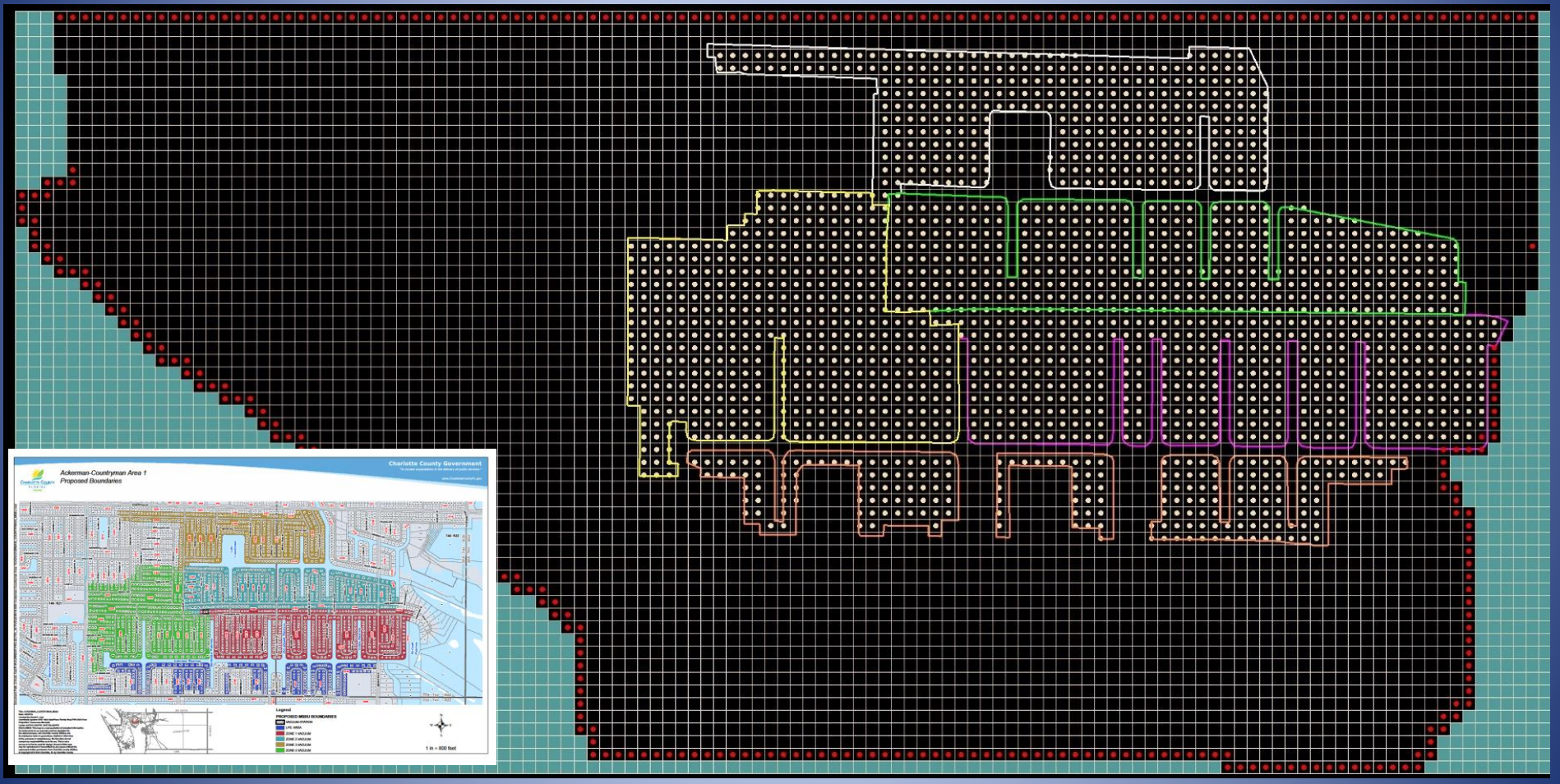
MODPATH – Pathlines (Upper Line Source)



MODPATH – Pathlines (Ackerman Line Sources)

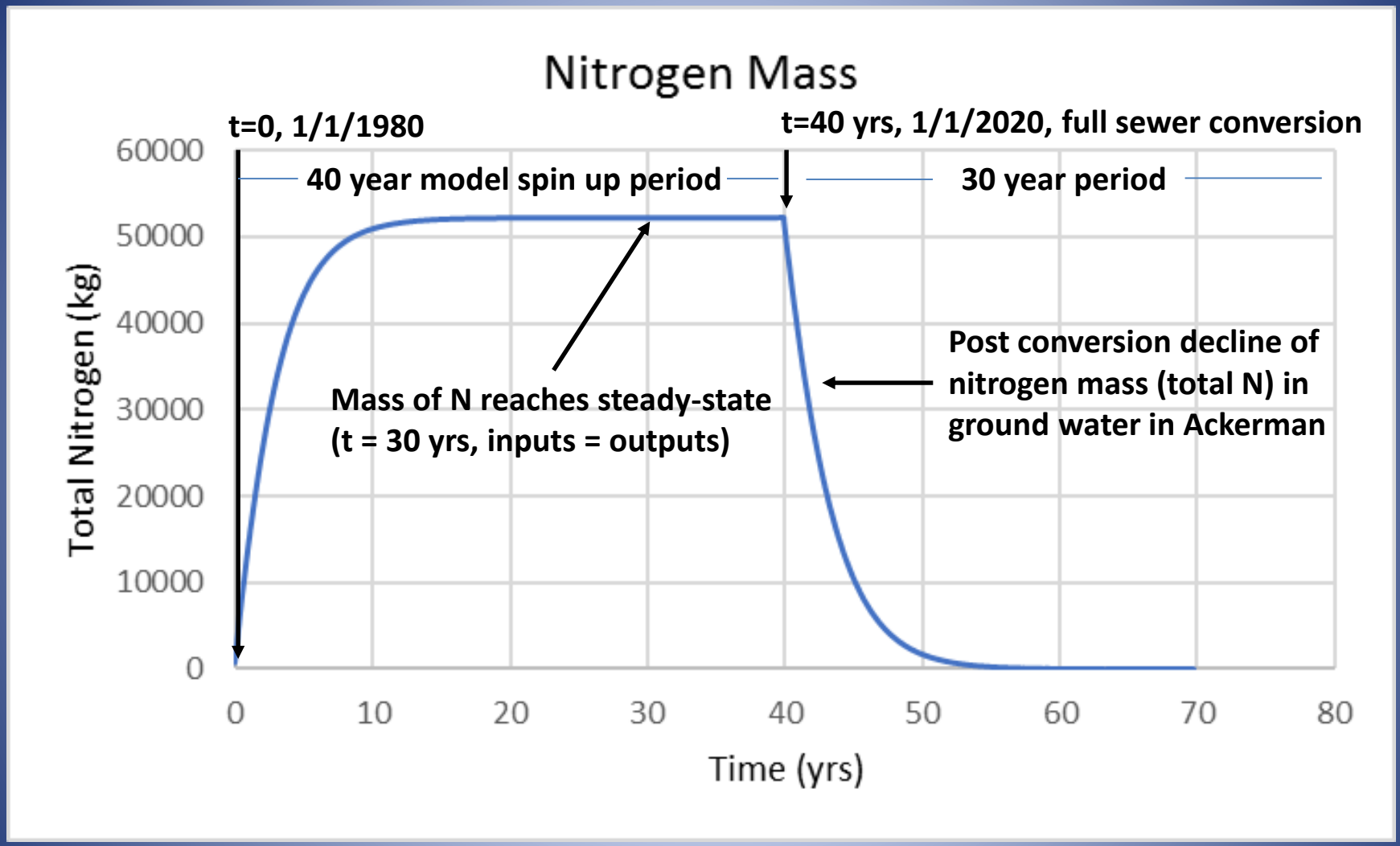


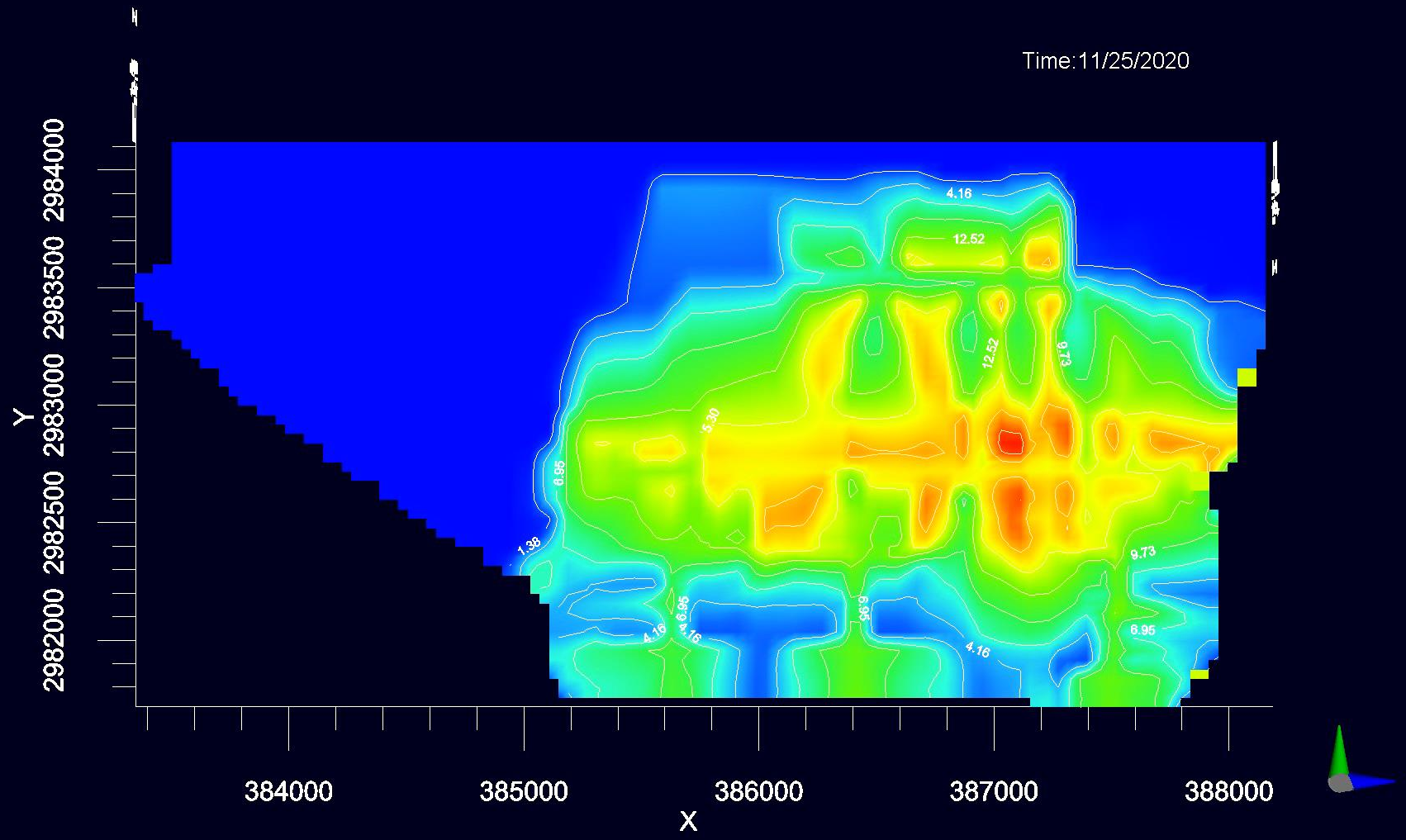
Ackerman Zones – Septic Loading



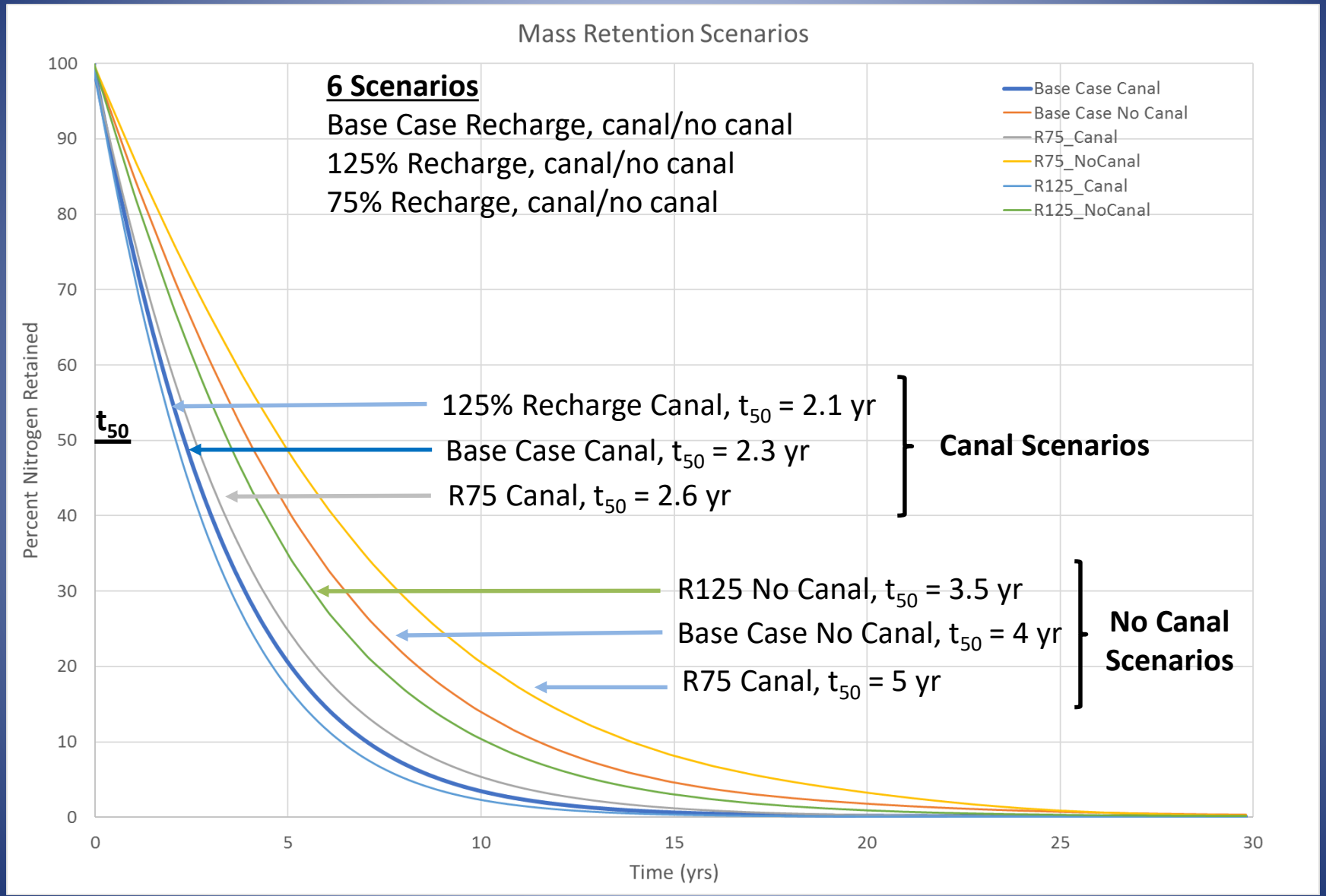
Each zone is applied a water and nitrogen flux based on the number of active lots (septic)

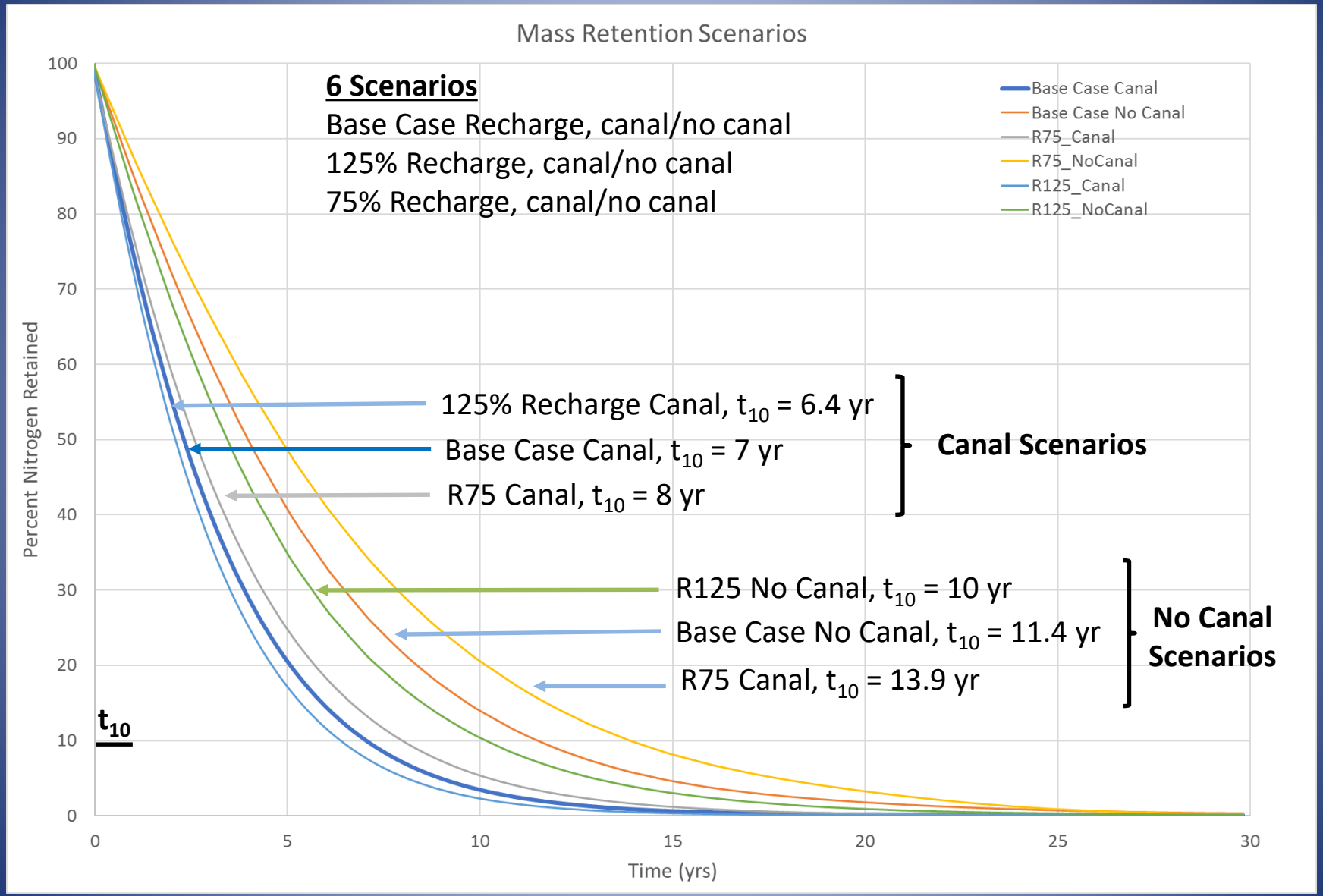
Nitrogen Transport Model Results


Nitrogen Mass
t=0, 1/1/1980
t=40 yrs, 1/1/2020, full sewer conversion
40 year model spin up period
30 year period
Mass of N reaches steady-state
(t = 30 yrs, inputs = outputs)
Post conversion decline of
nitrogen mass (total N) in
ground water in Ackerman
Total Nitrogen (kg)
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
Time (yrs)



Note focused transport through canal system


Mass Retention Scenarios
6 Scenarios
Base Case Recharge, canal/no canal
125% Recharge, canal/no canal
75% Recharge, canal/no canal
Base Case Canal
Base Case No Canal
R75_Canal
R75_NoCanal
R125_Canal
R125_NoCanal
Percent Nitrogen Retained
Time (yrs)
t50
125% Recharge Canal, t50 = 2.1 yr
Base Case Canal, t50 = 2.3 yr
R75 Canal, t50 = 2.6 yr
Canal Scenarios
R125 No Canal, t50 = 3.5 yr
Base Case No Canal, t50 = 4 yr
R75 Canal, t50 = 5 yr
No Canal Scenarios


Mass Retention Scenarios
6 Scenarios
Base Case Recharge, canal/no canal
125% Recharge, canal/no canal
75% Recharge, canal/no canal
Base Case Canal
Base Case No Canal
R75_Canal
R75_NoCanal
R125_Canal
R125_NoCanal
125% Recharge Canal, t10 = 6.4 yr
Base Case Canal, t10 = 7 yr
R75 Canal, t10 = 8 yr
Canal Scenarios
R125 No Canal, t10 = 10 yr
Base Case No Canal, t10 = 11.4 yr
R75 Canal, t10 = 13.9 yr
No Canal Scenarios
t10
Percent Nitrogen Retained
Time (yrs)
0
10
20
30
40
50
60
70
80
90
100
0
5
10
15
20
25
30

Summary and Conclusions

- All scenarios show that sewer conversion will have significant reductions in Nitrogen to the harbor – modeling results indicate that a 50% reduction in nitrogen mass within the ground water will occur in 2-5 years.

- Residual nitrogen will likely stay in the aquifer at least on the scale of a decade, if not longer.

Additional Work and Model Limitations

- The modeling results are preliminary.
- Collection of water levels within model domain will likely influence some of the model parameters and upper boundary, that can, in turn, modify the time scales of the results presented.
- Nitrogen speciation and transport is quite complex, the model assumes all nitrogen is nitrate that undergoes no natural attenuation.