VULNERABILITY ASSESSMENT OF OSTDS TO SEA LEVEL RISE AND STORM SURGE TO DEVELOP ADAPTATION PLANS IN ST. AUGUSTINE, FL

PRESENTATION TO THE FSA WINTER CONFERENCE 2022

CITY OF ST. AUGUSTINE - JESSICA BEACH, P.E., CHIEF RESILIENCE OFFICER

UF CENTER FOR COASTAL SOLUTIONS - TRICIA KYZAR, PHD, RESEARCHER /PROJECT MANAGER

INTRODUCTION

- GRANT FUNDED PROJECT THROUGH FDEP'S FLORIDA RESILIENT COASTLINES PROGRAM (FRCP)
  - ✓ $75,000 FULLY FUNDED GRANT
- IN PARTNERSHIP WITH THE UNIVERSITY OF FLORIDA
  - ✓ DR. TRICIA KYZAR (FORMERLY PHD CANDIDATE - DEPT. OF URBAN AND REGIONAL PLANNING)
  - ✓ DR. EBAN BEAN, P.E., PRINCIPAL INVESTIGATOR - DEPT. OF AGRICULTURAL AND BIOLOGICAL ENGINEERING
- PROJECT DURATION – OCTOBER 2020 – JUNE 2021

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

CITY OF ST AUGUSTINE EST. 1565

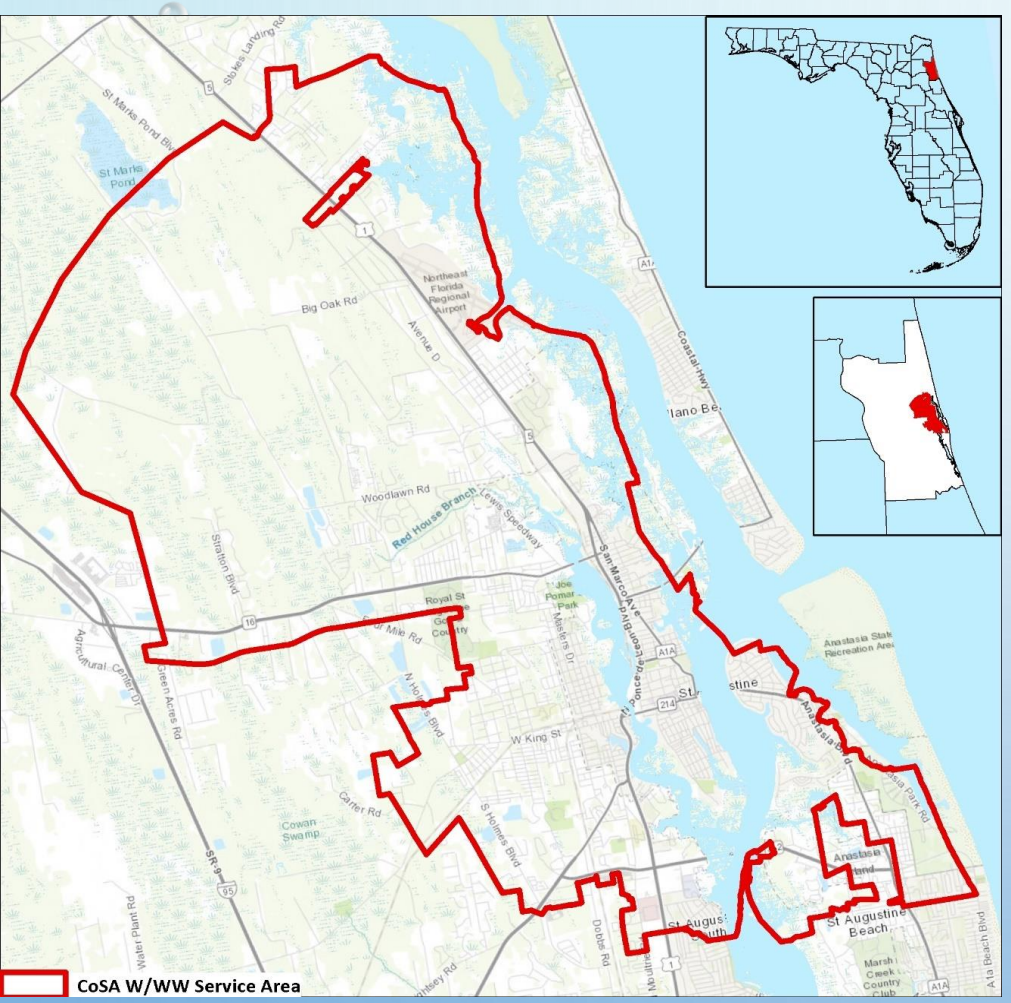
CCS CENTER FOR COASTAL SOLUTIONS UNIVERSITY OF FLORIDA

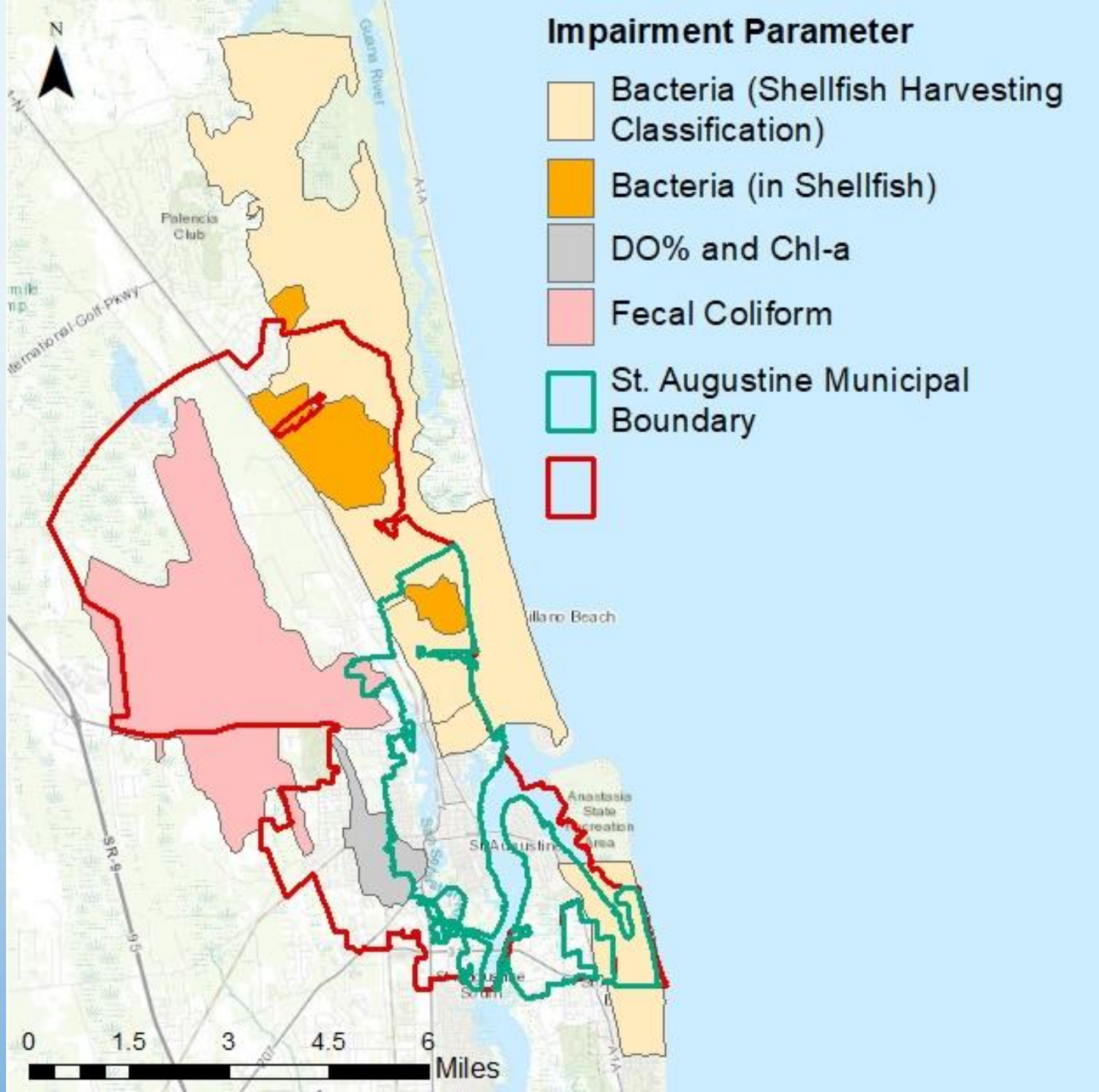
UF IFAS UNIVERSITY of FLORIDA

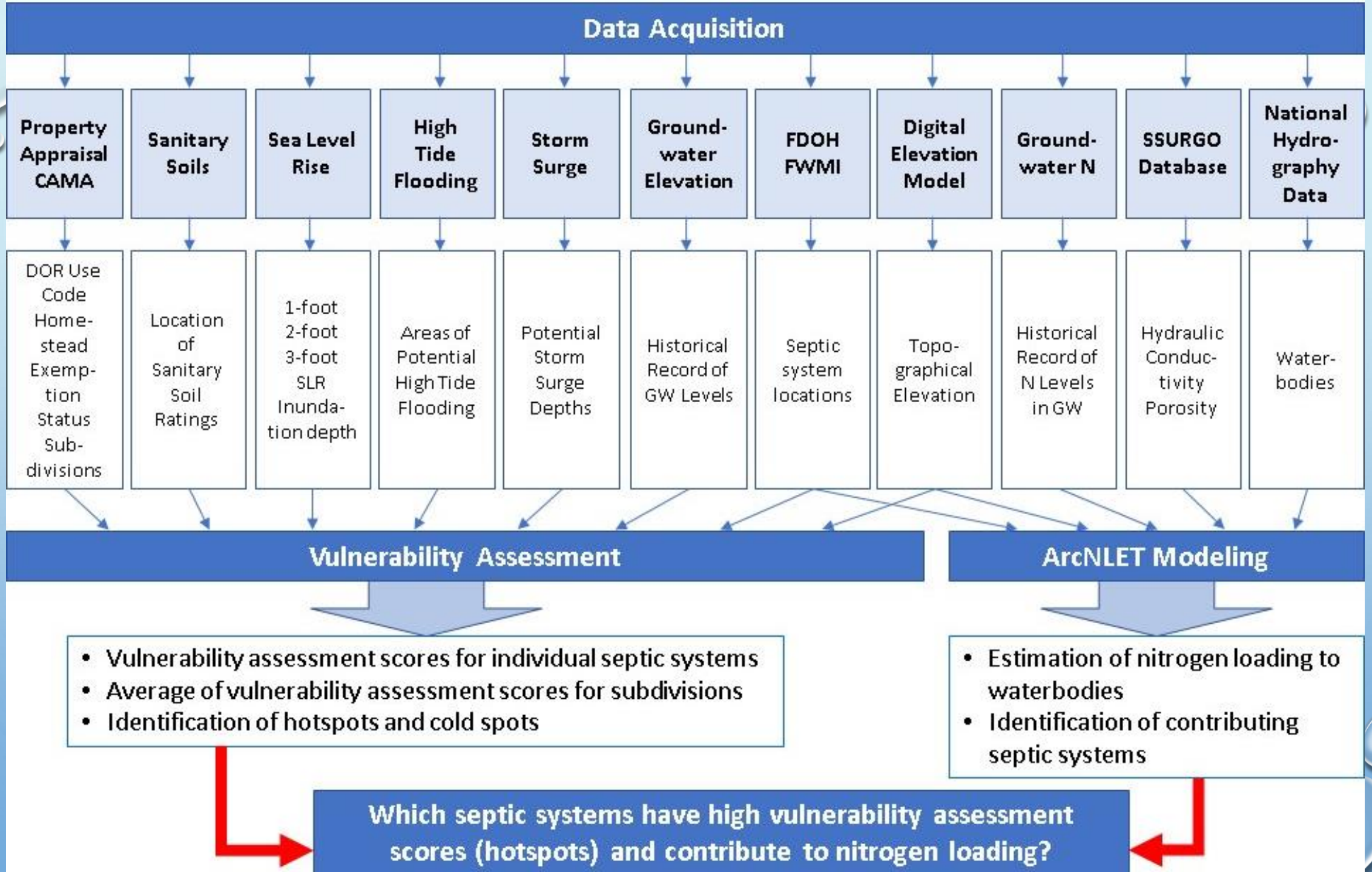
WHAT IS THE PROJECT?

- PROJECT TASKS
  - ✓ ASSESS THE VULNERABILITY OF IDENTIFIED ONSITE TREATMENT AND DISPOSAL SYSTEMS (OSTDS) TO MULTIPLE CLIMATE CHANGE RELATED PARAMETERS
  - ✓ CALCULATE NITROGEN EXPORTS UNDER CURRENT CONDITIONS USING ARCNLET
  - ✓ REPORT ON STATE OF WASTEWATER TREATMENT (WWT) TECHNOLOGIES
    - COSTS AND FUNDING OPPORTUNITIES
  - ✓ PRESENT FINDINGS TO THE PUBLIC
    - IDENTIFYING AREAS THAT ARE SUITABLE FOR STRATEGIC PLANNING INITIATIVES BECAUSE THEY ARE AT RISK OF SLR, STORM SURGE, ELEVATED GROUNDWATER TABLES AND/OR SOILS NOT SUITABLE FOR SEPTIC EFFLUENT PROCESSING

ST. AUGUSTINE

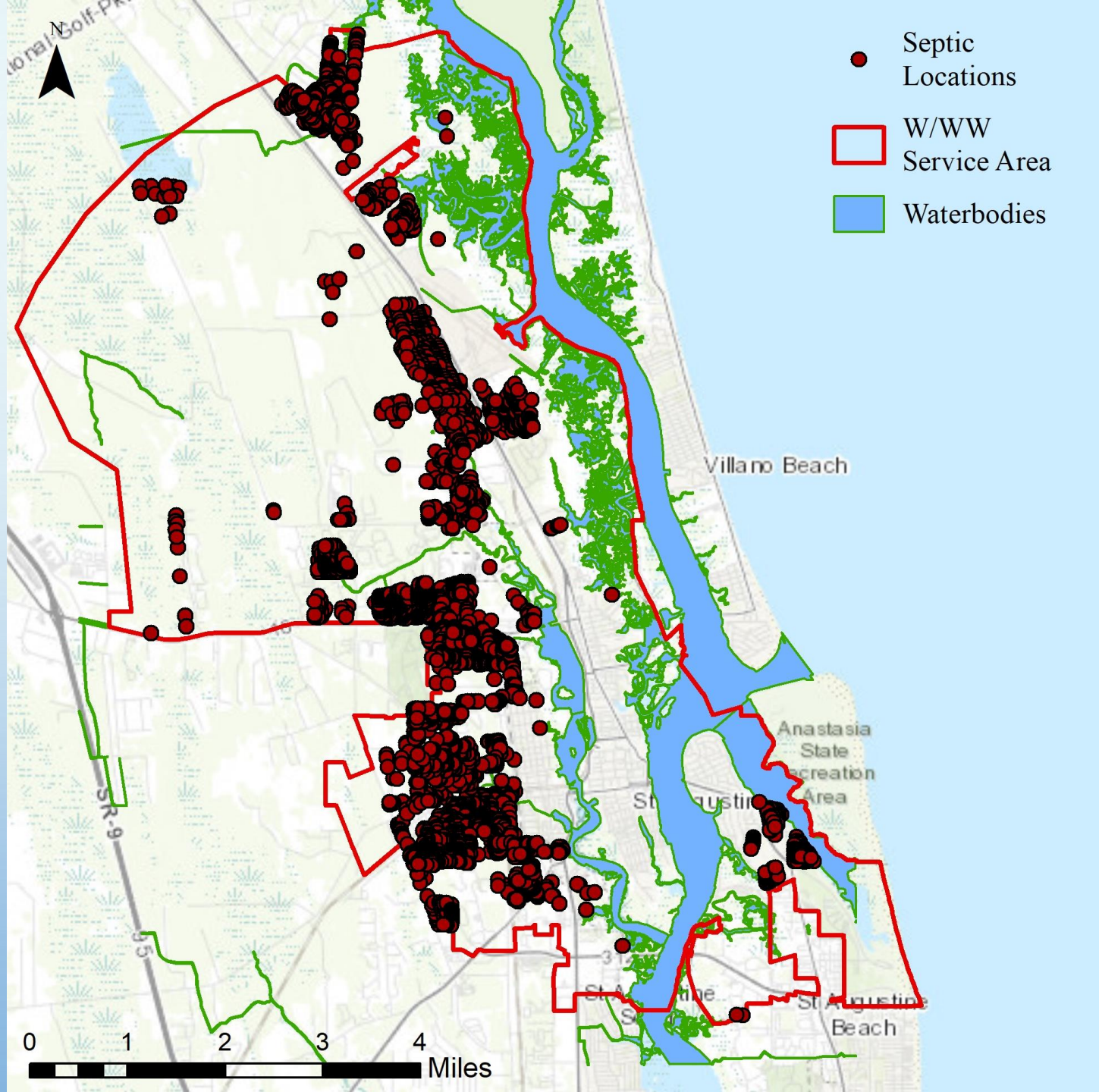





Data Acquisition
Property Appraisal CAMA
Sanitary Soils
Sea Level Rise
High Tide Flooding
Storm Surge
Ground-water Elevation
FDOH FWMI
Digital Elevation Model
Ground-water N
SSURGO Database
National Hydro-graphy Data
DOR Use Code Home-stead Exemp-tion Status Sub-divisions
Location of Sanitary Soil Ratings
1-foot 2-foot 3-foot SLR Inunda-tion depth
Areas of Potential High Tide Flooding
Potential Storm Surge Depths
Historical Record of GW Levels
Septic system locations
Topo-graphical Elevation
Historical Record of N Levels in GW
Hydraulic Conduc-tivity Porosity
Water-bodies
Vulnerability Assessment
ArcNLET Modeling
• Vulnerability assessment scores for individual septic systems
• Average of vulnerability assessment scores for subdivisions
• Identification of hotspots and cold spots
• Estimation of nitrogen loading to waterbodies
• Identification of contributing septic systems
Which septic systems have high vulnerability assessment scores (hotspots) and contribute to nitrogen loading?

SOURCE LOCATIONS

- 2,938 SEPTIC SYSTEMS



VULNERABILITY ASSESSMENT

- MULTI-CRITERIA AND WEIGHTED

$$\text{vulnerability}_s = \sum_p^n \left(R_{p1} \times I_{p1}\right) + \left(R_{p2} \times I_{p2}\right) + \left(R_{p3} \times I_{p3}\right) \ldots + \cdots \left(R_{px} \times I_{px}\right)$$

- WHERE:
  - s = THE SEPTIC SYSTEM FOR WHICH THE VULNERABILITY IS BEING CALCULATED
  - R = THE RISK RATING OF PARAMETER X
  - I = THE IMPORTANCE RATING OF PARAMETER X
  - P = THE PARAMETER BEING CALCULATED

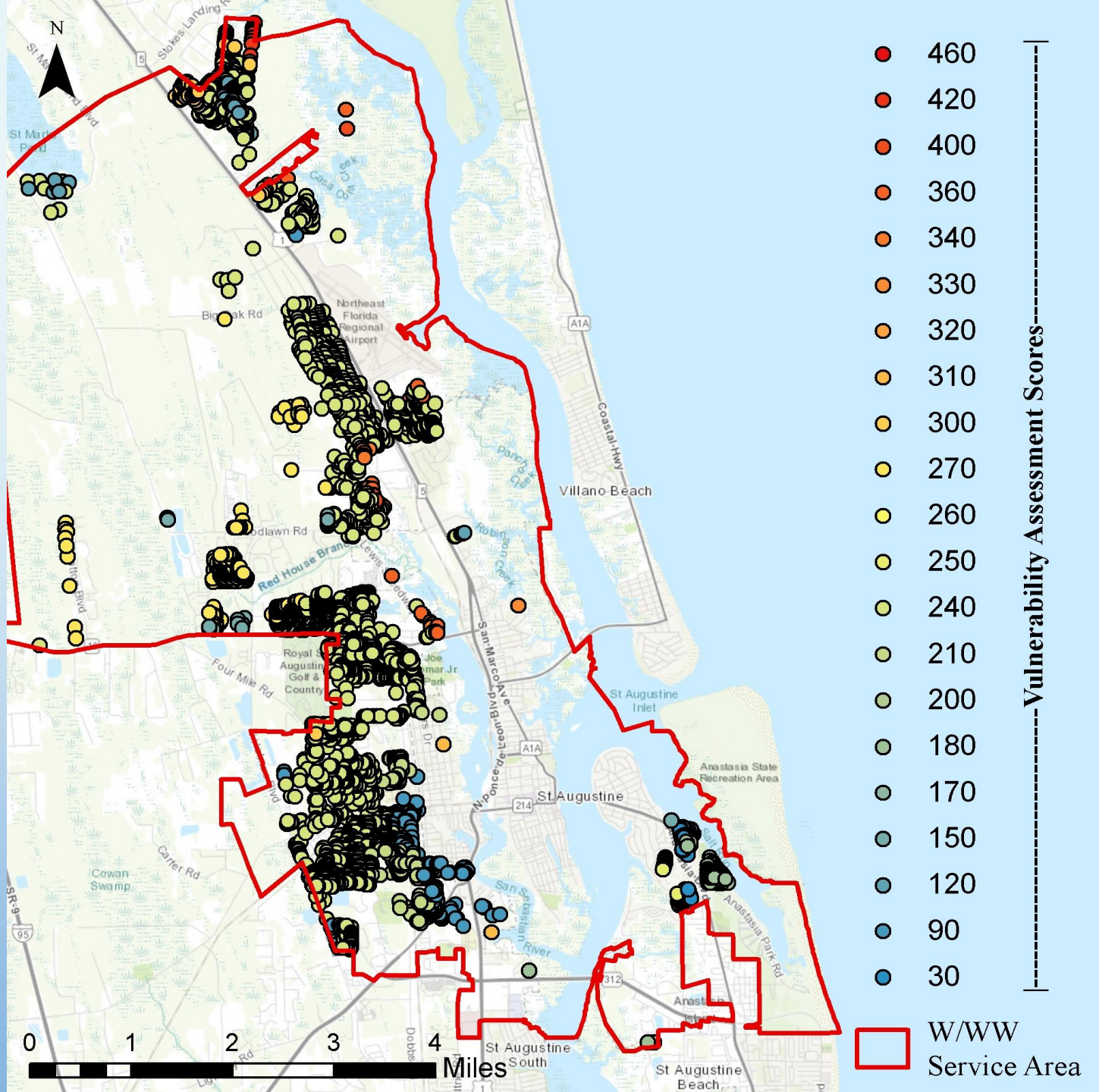
RISK RATING VALUES AND WEIGHTS

Risk Parameter	Low – 1	2	Medium - 3	4	High - 5	Weight
Storm Surge (Hurricane) & Elevation (ft.)	Cat 1 & > 10 ft.		Cat1 & 7-10 ft.		Cat 1 & < 7 ft.	20%
Soils	Slightly Limited		Moderately Limited		Severely Limited	30%
Rise in Groundwater (in./yr)	1.5 in./yr	2.1 in./yr	2.7 in./yr	3.3 in./yr	3.8 in./yr	30%
Sea-level rise scenario (ft.)	3 ft.		2 ft.		1 ft.	20%

MULTI-CRITERIA VULNERABILITY ASSESSMENT / INDICATOR BASED VULNERABILITY ASSESSMENT

VULNERABILITY ASSESSMENT

- HIGH SCORES = MORE VULNERABLE
- LOW SCORES = LESS VULNERABLE

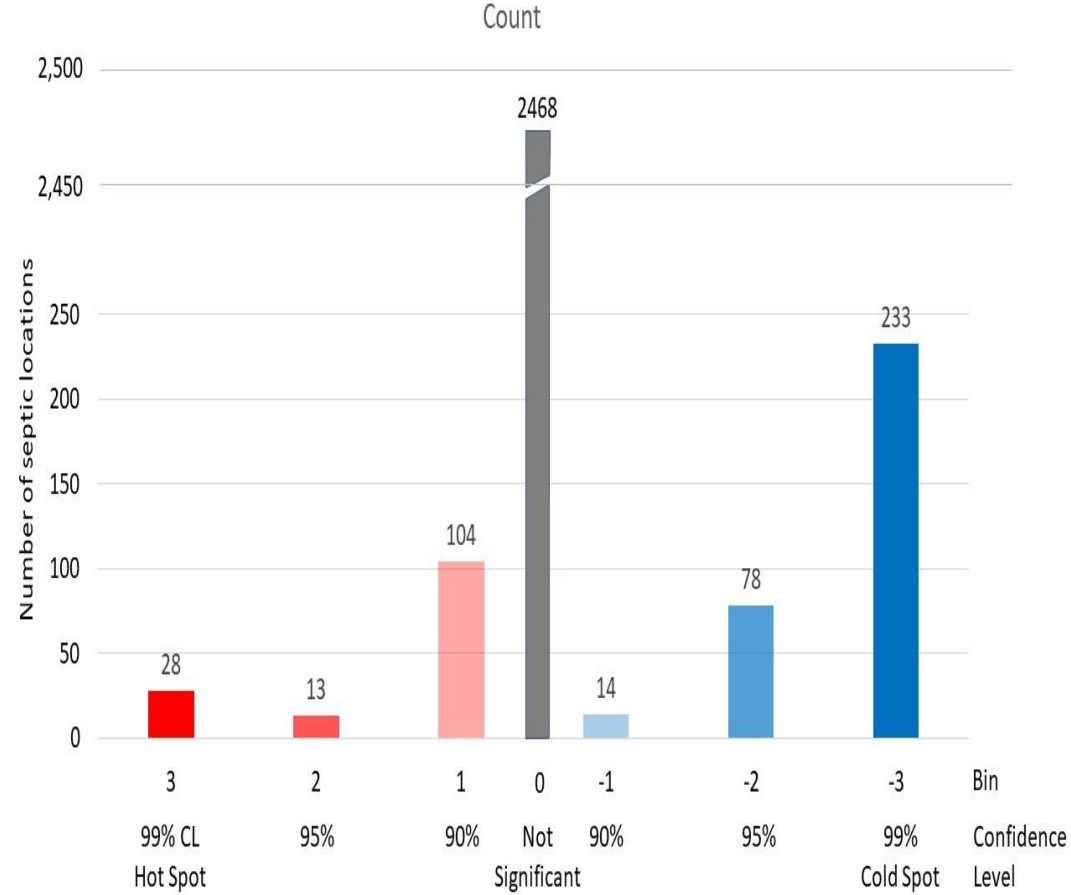


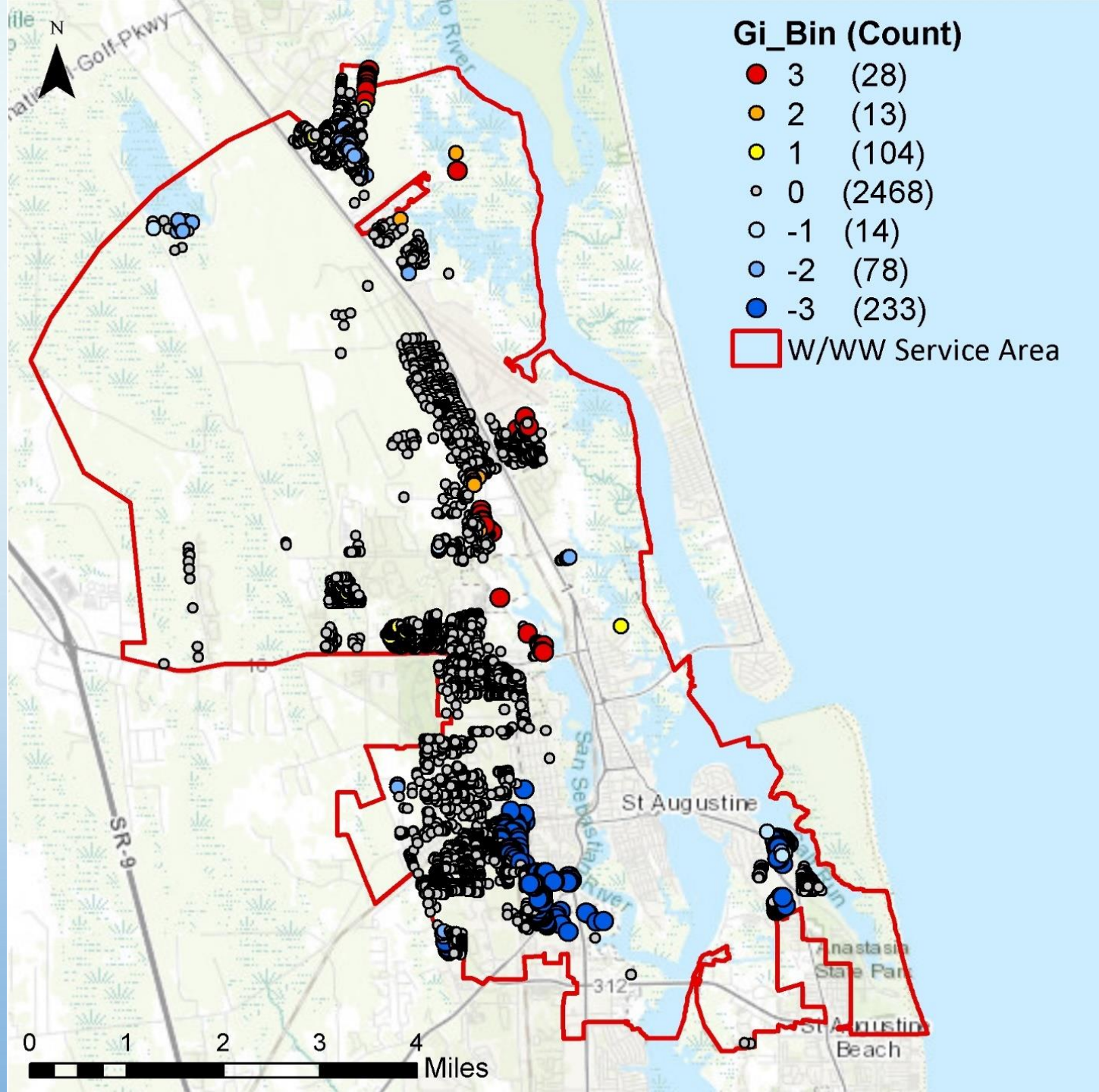
HOTSPOT ANALYSIS

- ESRI'S HOTSPOT ANALYSIS TOOL
  - CALCULATES THE STATISTICAL SIGNIFICANCE OF THE CLUSTERING OF HIGH AND LOW VALUES
  - HIGH VALUES ARE HOT SPOTS
    - HIGH Z-VALUE AND LOW P-VALUE, CLUSTERING IS STATISTICALLY SIGNIFICANT
  - LOW VALUES ARE COLD SPOTS
    - LOW Z-VALUE AND LOW P-VALUE, CLUSTERING IS STATISTICALLY SIGNIFICANT
  - RESULTS ARE 'BIN'D IN CONFIDENCE INTERVALS

	Cold Spot						Hot Spot
CI	99%	95%	90%	0	90%	95%	99%
Bin	-3	-2	-1	0	1	2	3

HOT SPOT ANALYSIS

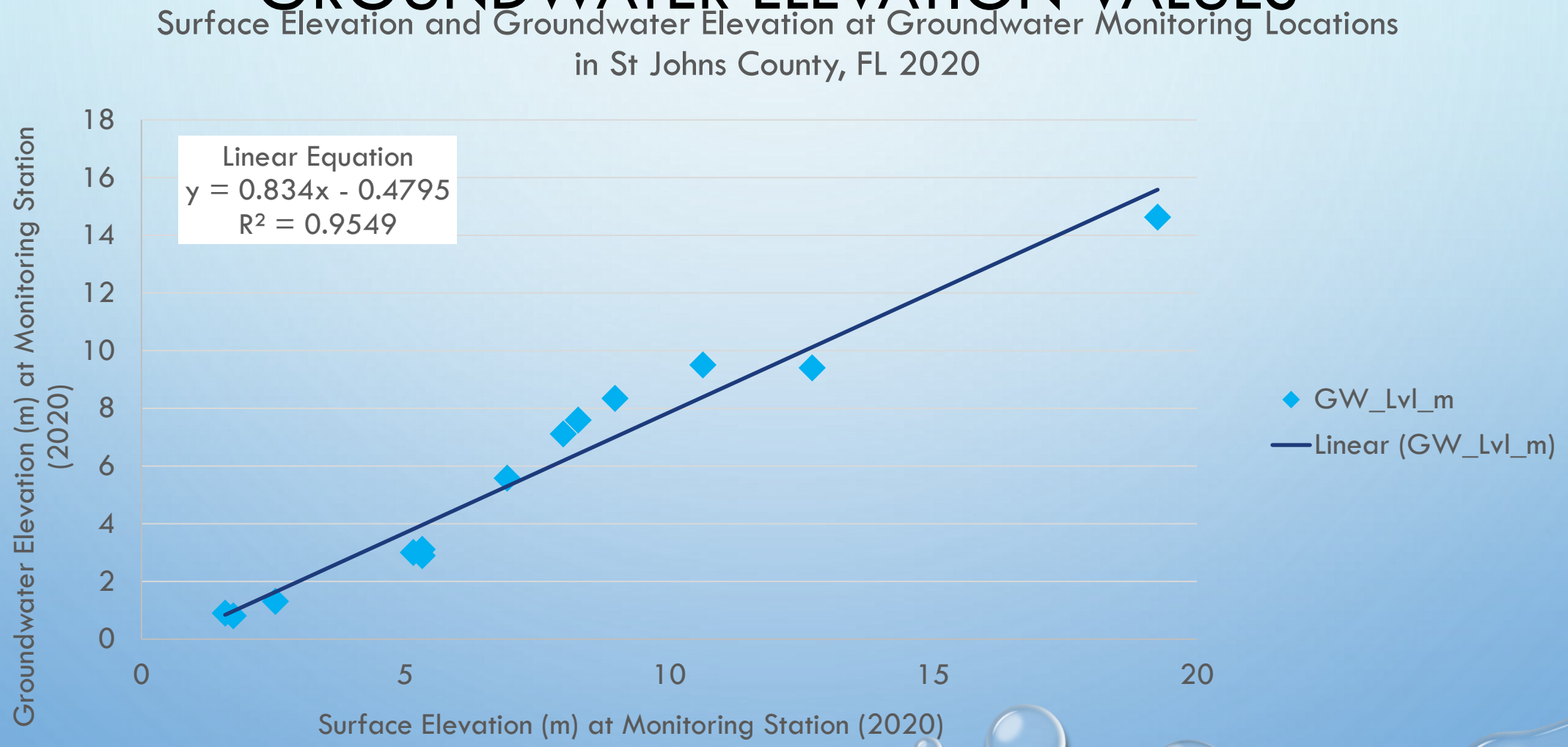




GROUNDWATER LEVELS

- OBTAINED FROM SJRWMD
- 11-YEAR CONTINUOUS DAILY RECORDING AT 15 STATIONS (PLUS 1 STATION WITH 2020 DATA) ACROSS ST JOHNS COUNTY
  - ONLY 2 IN STUDY AREA
- USED ANNUAL AVERAGES TO CALCULATE RATE OF CHANGE (SLOPE) TO IDENTIFY IF GROUNDWATER LEVELS WERE RISING.
  - ALL WERE RISING
  - USED IDW INTERPOLATION TO CREATE A RASTER OF RISE VALUES ACROSS STUDY AREA
  - ZONAL STATISTICS, MEAN, TO PARCEL ZONE
- GROUNDWATER ELEVATION VALUES
  - CREATED SCATTER PLOT OF SURFACE ELEVATION AT STATION (X-AXIS) AND GROUNDWATER LEVEL AT STATION (Y-AXIS)
  - USED LINEAR EQUATION TO CREATE A GROUNDWATER ELEVATION RASTER

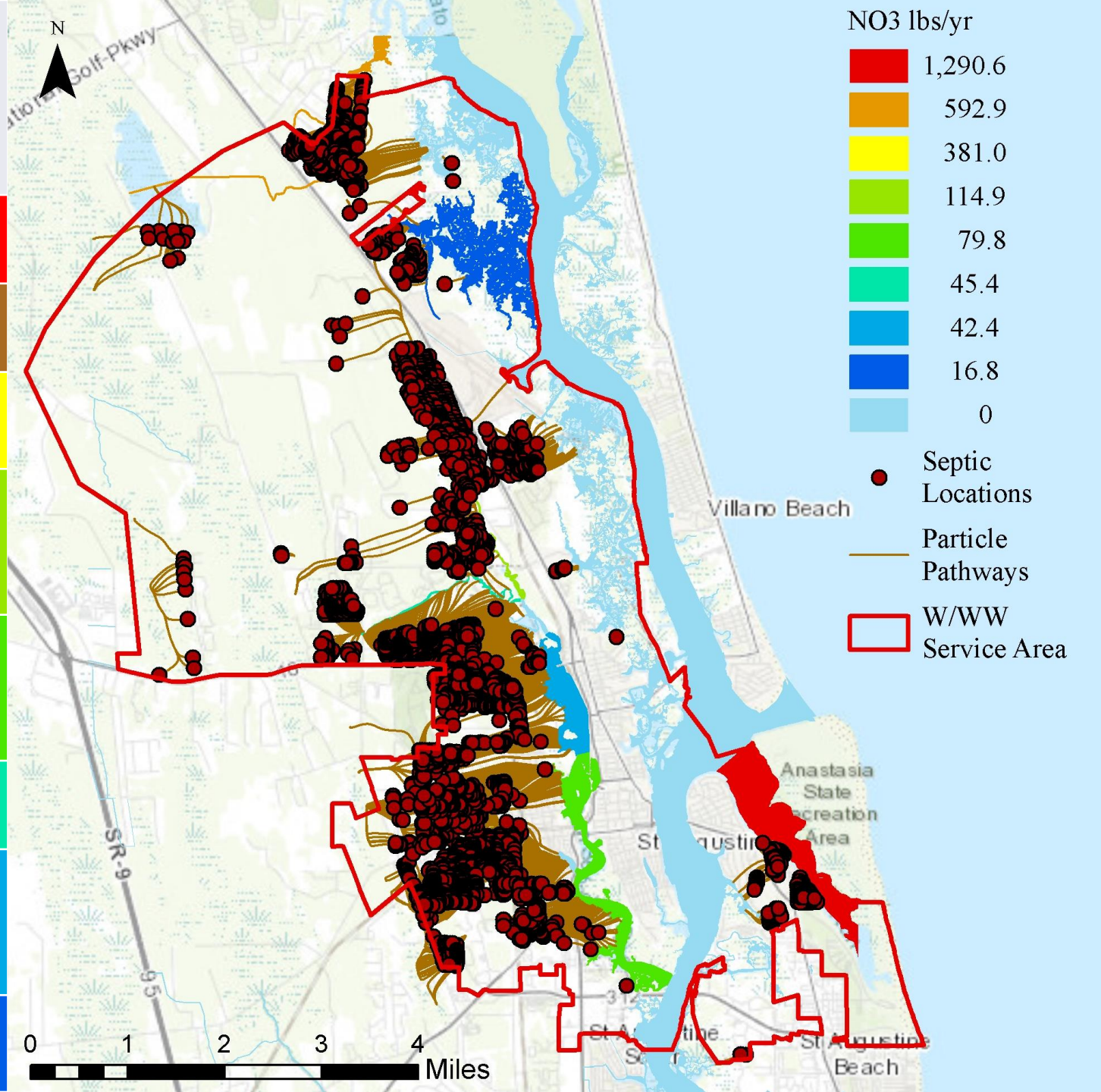
GROUNDWATER ELEVATION VALUES



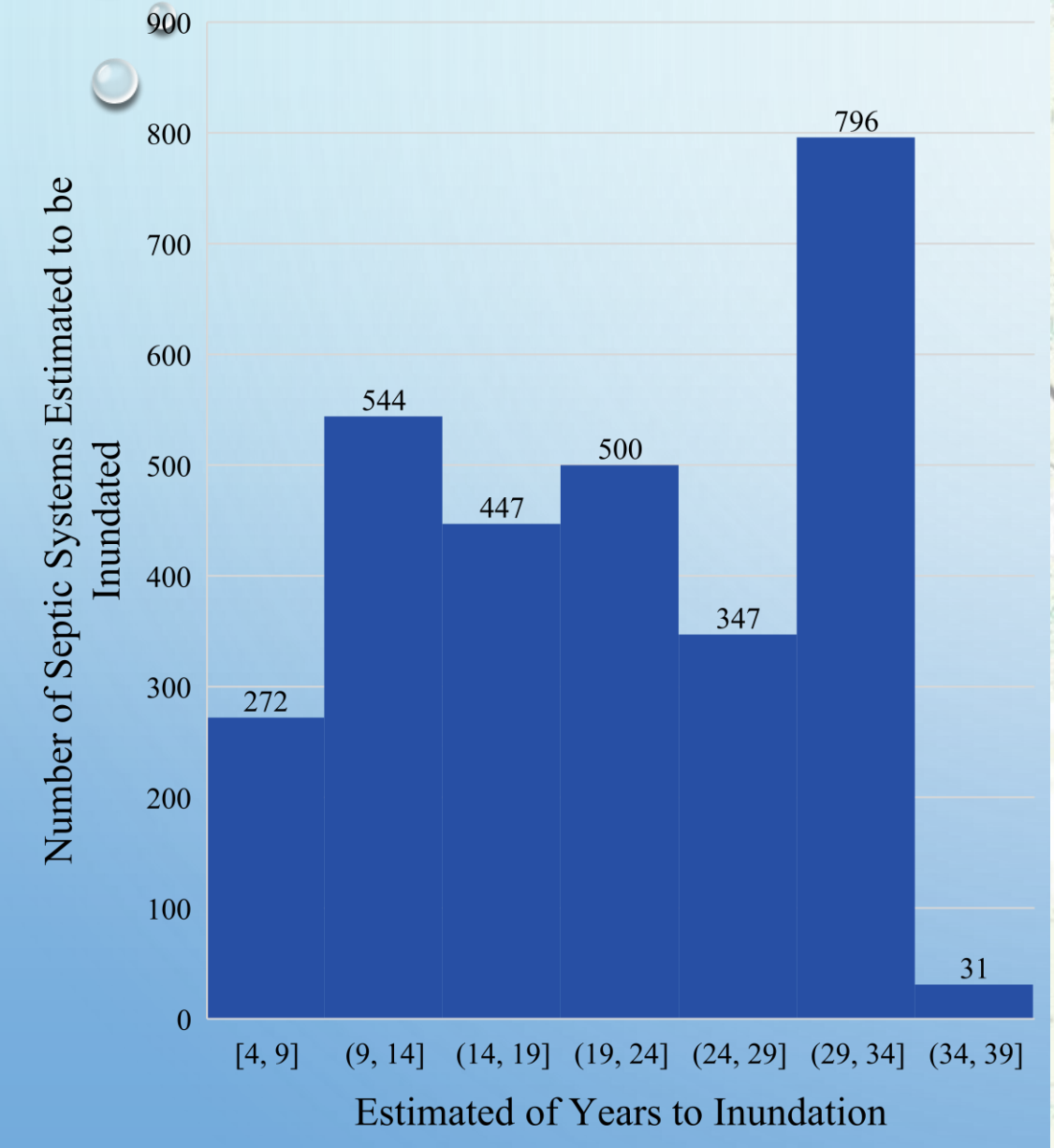
ARCNLET MODELING

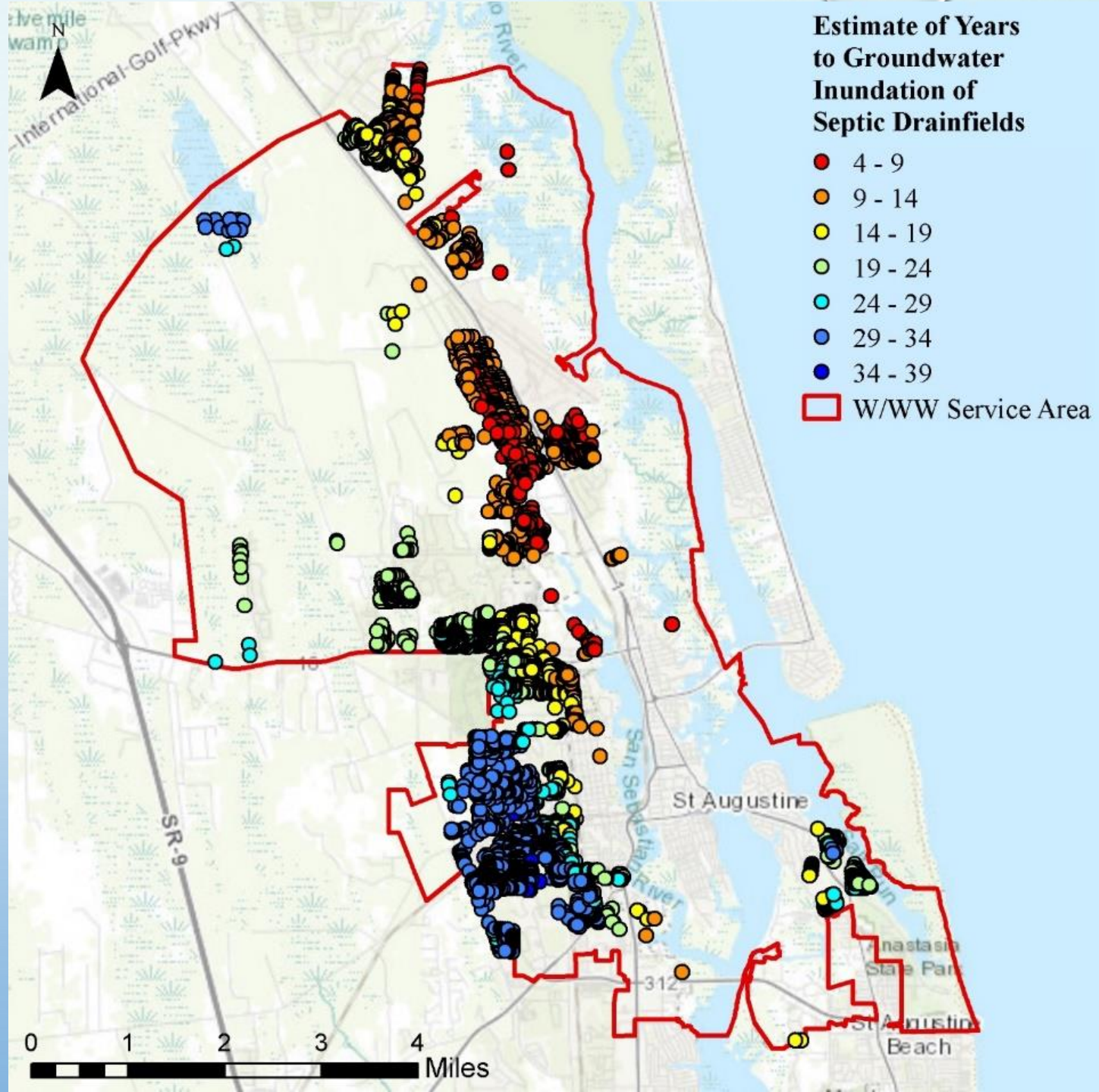
- A TOOL USED IN ARCGIS DESKTOP SOFTWARE
- ESTIMATES NITROGEN OUTPUTS TO WATERBODIES FROM SOURCE LOCATIONS (OSTDS)
- INPUT DATA: DEM, HYDRAULIC CONDUCTIVITY, POROSITY, WATERBODIES, SOURCE LOCATIONS
- DEVELOPS A GROUNDWATER FLOW MODEL TO ESTIMATE NITRATE PLUMES AND LOAD ESTIMATES
  - PROJECT USED A SMOOTHING FACTOR OF 50, ALL OTHER DEFAULT SETTINGS
  - NO_3 ONLY

Water Body ID	Waterbody Name	OSTDS Plumes to Reach Waterbody	Mass Output Load (lbs/yr)
10	Salt Run	46	1,290.60
12	Stokes Creek	51	592.88
2	Oyster Creek (within Evergreen Cemetery)	29	380.97
5	San Sebastian River north of Red House Branch	4	114.86
8	San Sebastian River from ~Bernard St to Matanzas River	11	79.80
4	Red House Branch	5	45.44
7	San Sebastian River from ~Bella Vista Blvd to ~Bernard St	2	42.38
13	Wetland/Marsh areas off Casa Cola Creek	2	16.78



Estimate of Years to Inundation of Septic Drainfields by Rising Groundwater Elevations





KEY TAKEAWAYS FROM THIS PROJECT

- RISING GROUNDWATER IS THE CURRENT GREATEST THREAT IN THIS STUDY AREA
  - THE VALUES USED TO ESTIMATE GROUNDWATER RISE NEED TO BE VALIDATED WITH MORE MONITORING LOCATIONS (A PROJECT IS IN DEVELOPMENT TO DO THIS)
- VULNERABILITY ASSESSMENT PROVIDED CRITICAL NEW INFORMATION THAT REVEALED THREATS TO SOME LOCATIONS FROM STORM SURGE, HIGH TIDE FLOODING AND SEA LEVEL RISE
- ARCNLET MODELING PROVIDED CRITICAL NEW INFORMATION THAT REVEALED ESTIMATED NITROGEN EXPORTS BASED ON CURRENT CONDITIONS

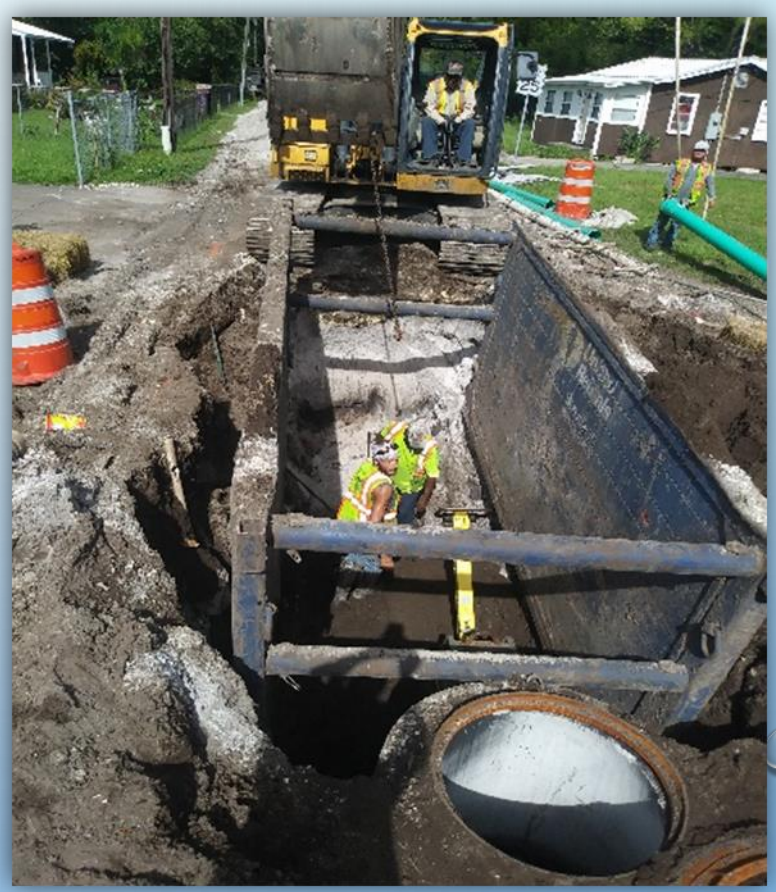
HOW HAVE THE RESULTS BEEN USED?

- REINFORCES THE EXISTING PROGRAM THAT THE CITY HAS FOR SEPTIC TO SEWER CONVERSIONS
  - MAINLY FOCUSED IN WEST AUGUSTINE BUT PROJECT IDENTIFIED OTHER AREAS THAT WE NEED TO EVALUATE
- AWARENESS OF THE WATER QUALITY IMPACTS AND FUTURE CHALLENGES FOR SEPTIC TANKS
- ACCELERATED A MASTER PLAN/EVALUATION FOR LIGHTHOUSE PARK NEIGHBORHOOD TO CONVERT FROM SEPTIC TO SEWER
- APPLIED FOR (AND RECEIVED) ADDITIONAL FUNDING TO BETTER ASCERTAIN GROUNDWATER MONITORING IMPACTS TO OUR AREA TO INFLUENCE PLANNING, DESIGN AND PROJECTS
- NEED FOR LOCAL COLLABORATION WITH THE COUNTY (UTILITY SERVICE AREA VS. CITY LIMITS)
- IDENTIFY FUNDING NEEDS FOR FUTURE PROJECTS FOCUSED ON THESE EFFORTS

HOW HAVE THE RESULTS BEEN USED?

WEST AUGUSTINE GRAVITY SEWER IMPROVEMENTS

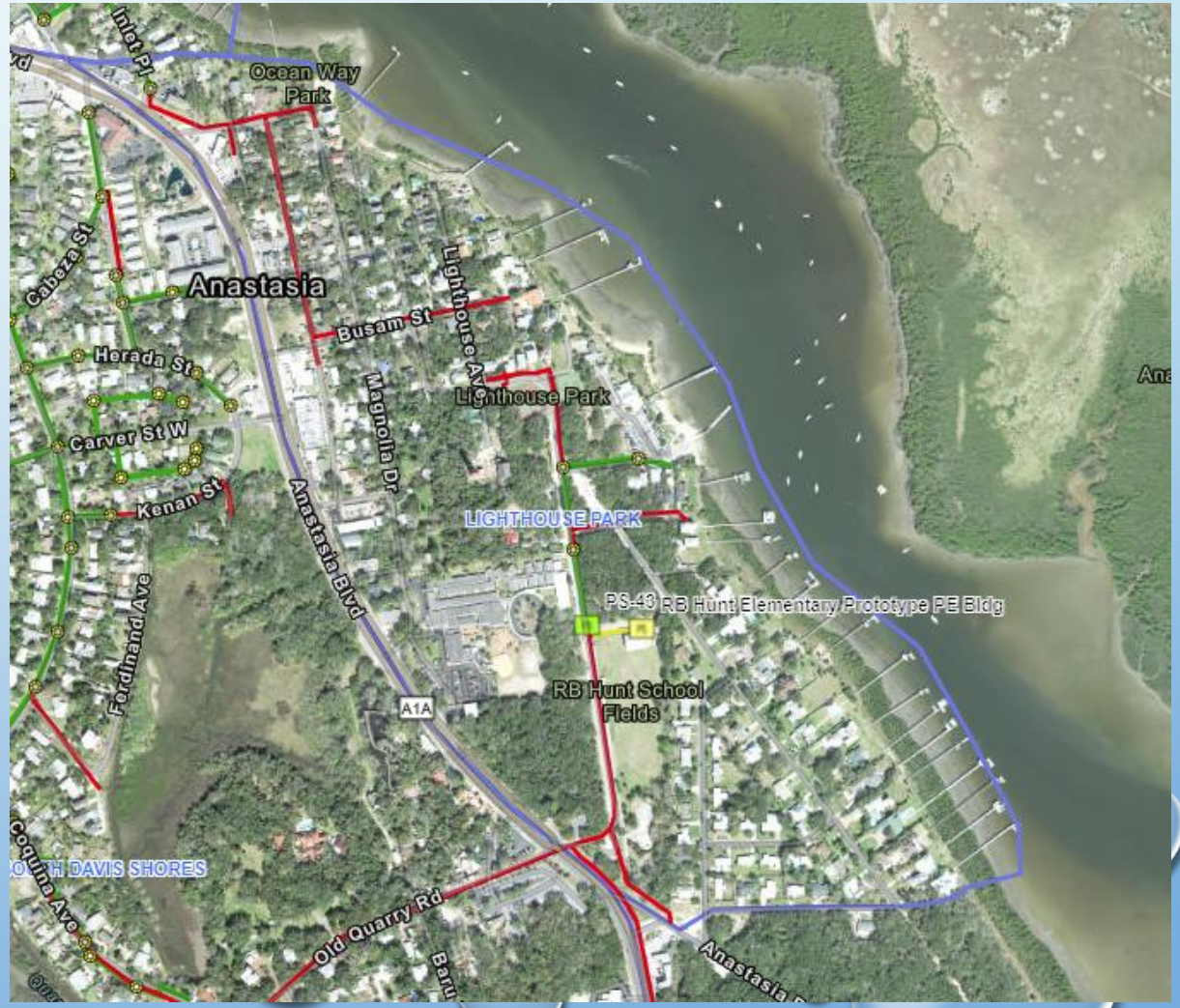
- WEST AUGUSTINE SEWER MASTER PLAN
  - IN DESIGN
- WEST 3RD STREET SEWER EXTENSION – VOLUSIA TO KNOWLTON ST
  - DESIGN COMPLETE
  - ELIMINATES 20 RESIDENTIAL SEPTIC TANKS
- SEPTIC-TO-SEWER PROGRAM
  - ABANDONED 57 SEPTIC SYSTEMS TO DATE
- PEARL STREET GRAVITY SEWER
  - IN DESIGN - EXPANDING GRAVITY SEWER FROM EXISTING LIFT STATION



HOW HAVE THE RESULTS BEEN USED?

LIGHTHOUSE PARK GRAVITY SEWER IMPROVEMENTS

- IDENTIFIED IN THE STUDY AS A TOP CONTRIBUTOR OF NITROGEN TO SURFACE WATERS (CLASS II WATERBODY FOR SHELLFISH HARVESTING – SALT RUN
- MASTER PLAN ACCELERATED TO BRING GRAVITY SEWER TO THE NEIGHBORHOOD
- PROJECT WILL ELIMINATE EXISTING AND FUTURE OSTDS SYSTEMS AND RESIDENTIAL GRINDER PUMP CONNECTIONS TO EXISTING FORCE MAIN



HOW HAVE THE RESULTS BEEN USED?

GROUNDWATER MONITORING NETWORK – GRANT FUNDING THROUGH RESILIENT FLORIDA

- APPLIED FOR FUNDING IN 2021, AWARDED $201,903
- INSTALL A MONITORING NETWORK, UP TO 60 LOCATIONS
- COLLECT DATA TO BETTER PREDICT THE IMPACTS TO CRITICAL INFRASTRUCTURE DUE TO SEA LEVEL RISE (MEASURE RATES OF CHANGE IN CURRENT SHALLOW GROUNDWATER ELEVATIONS AND WATER QUALITY)
- IMPLICATIONS FOR IRRIGATION, BURIED UTILITIES, ROADS AND OTHER CRITICAL INFRASTRUCTURE STABILITY, DESIGN AND EFFECTIVENESS OF STORMWATER SYSTEMS
- BETTER UNDERSTAND THE THREAT TO ARCHAEOLOGICAL AND HISTORICAL ASSETS

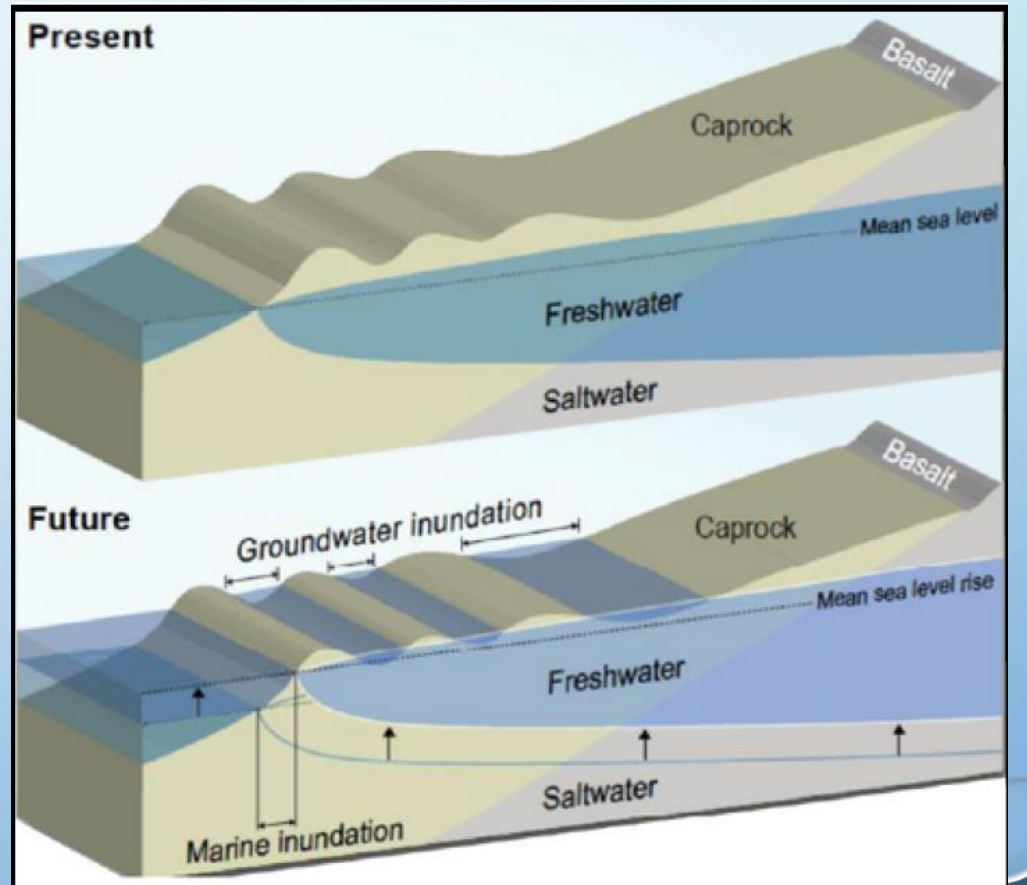


Figure 19. Conceptual diagram of groundwater inundation, obtained from Rotzoll and Fletcher (2012).

ADAPTING THIS TO YOUR AREA

- WHAT WE WOULD LIKE TO DO DIFFERENTLY
  - PANHANDLE FLORIDA
- WHAT IS PARTICULAR ABOUT YOUR AREA
- USING A DIFFERENT VULNERABILITY ASSESSMENT FORMULA

IN SUMMARY

- PLANNING LEVEL TOOL TO HELP IDENTIFIY AREAS TO TARGET UPGRADES TO EXISTING SEPTIC SYSTEMS
- NEED FOR LOCAL COLLABORATION WITH THE COUNTY (UTILITY SERVICE AREA VS. CITY LIMITS)
- TARGET VARIOUS FUNDING OPTIONS IDENTIFIED TO ASSIST WITH THE UPGRADES
- MAKE THIS INFORMATION PUBLICALY AVAILABLE
  - ✓STORYMAP: HTTPS://ARCG.IS/0KIDFV
  - ✓SUBMIT PUBLIC COMMENTS AND INPUT TO STORMWATER@CITYSTAUG.COM
  - ✓STUDY AND OTHER RESILIENCY INFORMATION AVAILABLE AT HTTPS://WWW.CITYSTAUG.COM/RESILIENCY

QUESTIONS AND DISCUSSION

Jessica Beach, P.E.
Chief Resilience Officer
City of St. Augustine
jbeach@citystaug.com

Tricia Kyzar, Ph.D.
Researcher/Project Manager
UF Center for Coastal Solutions
tkyzar@ufl.edu

Dr. Eban Bean
Assistant Professor
Agricultural and Biological Engineering
University of Florida
ezbean@ufl.edu

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https://floridadep.gov/rcp/florida-resilient-coastlines-program