Storm Resiliency and Infrastructure Development Review Committee

March 29, 2019

JEA

JACOBS

On December 15, 2017, CH2M HILL Engineers, Inc., became a wholly owned subsidiary of Jacobs Engineering Group Inc.

JEA's Resiliency Program Goals

- Understand Current and Future Severe Weather and Climate Risks
- Identify JEA Water, Wastewater, Reclaimed Water and Chilled Water System Vulnerabilities to Identified Risks
- Update Design and Construction Standards for Enhanced Reliability
- Develop Adaptation Strategies (System Enhancements/Upgrades)
- Develop Resiliency Plan as Roadmap to Implement Strategy
- Benchmark JEA System and Leverage Best Practices from other Industry Leading Utilities

JEA's Resiliency Program Activities

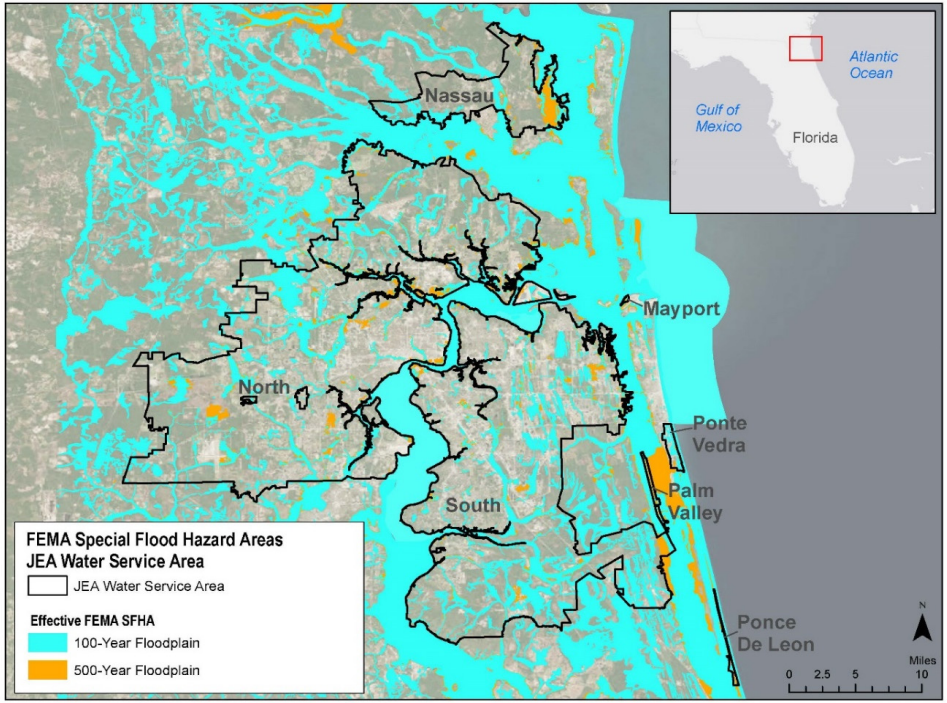
- Establish Future Extreme Weather Scenarios
- Perform Vulnerability Assessment and Risk Analysis of Select JEA Facilities
- Develop Mitigation and Adaptation Strategies
- Perform Economic Cost-Benefit Analysis
- Prioritize Strategies
- Update Design and Construction Standards
- Develop Resiliency Plan and Implementation Roadmap

JEA's Resiliency Program will Improve JEA's Readiness for an Uncertain Climate Future

- Mitigation/Adaptation for Extreme Weather and Climate Risks
  - » High Wind Events (and windborne debris)
  - » Extreme Tides (astronomical)
  - » Extreme Rainfall (intensity and volume)
  - » Storm Surge (tropical systems)
  - » Sea Level Rise (based on high likelihood scenarios across asset lifespans)
- Flexible and Forward Looking Design and Construction Standards
  - » Adaptive Capacity (retrofit flexibility)
  - » Facility Hardening (wet and dry floodproofing)
  - » System Redundancy (backup/alternate power, communications, pumping, etc.)

JEA Operates over 1,700 Facilities across a 4-County Region with nearly 500,000 Customer Accounts

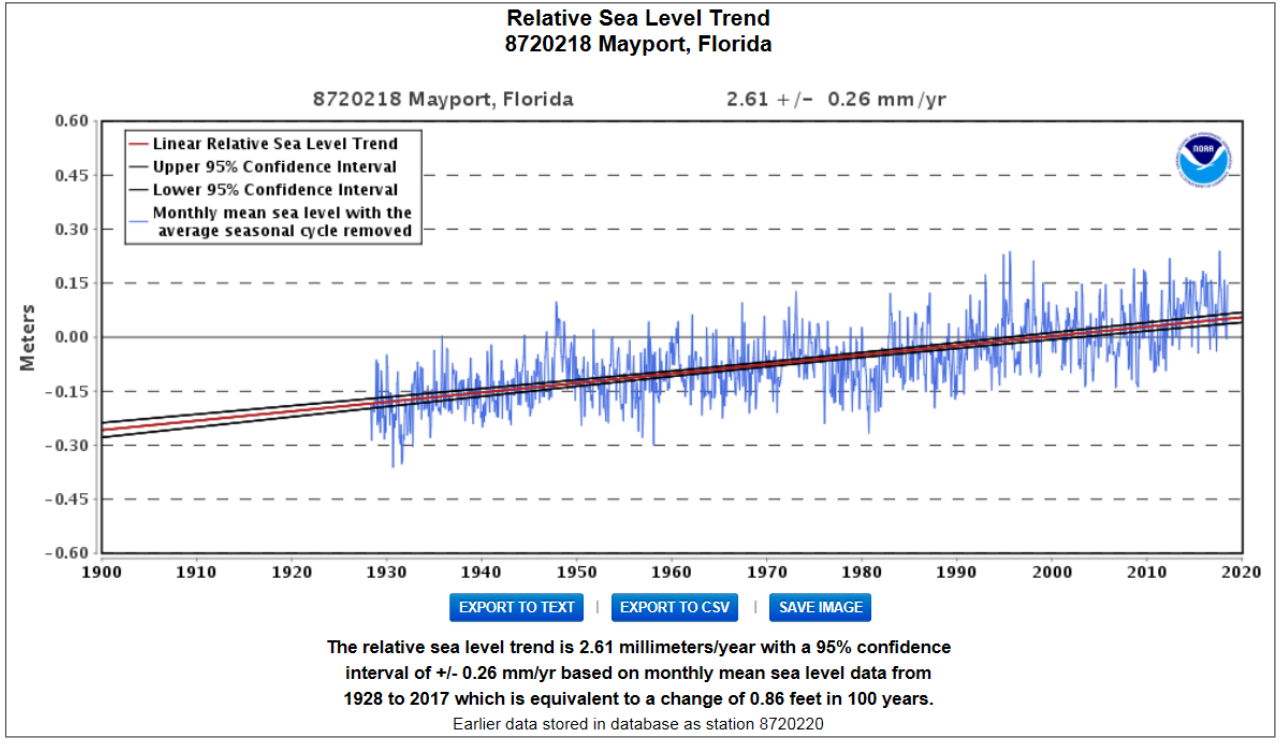
- Water Reclamation Facilities (WRFs) – 11
- Wastewater Pump Stations (WW PSs); Class 3 and 4 – 130
- Wastewater Pump Stations; Class 1 and 2 – 1,293
- Water Treatment Plants (WTPs) – 38
- Wells – 160 (including monitoring wells)
- Potable Water Booster Stations – 3
- Reclaimed Booster Stations – 3
- Chilled Water Plants – 4
- Water Intertie Stations – 3

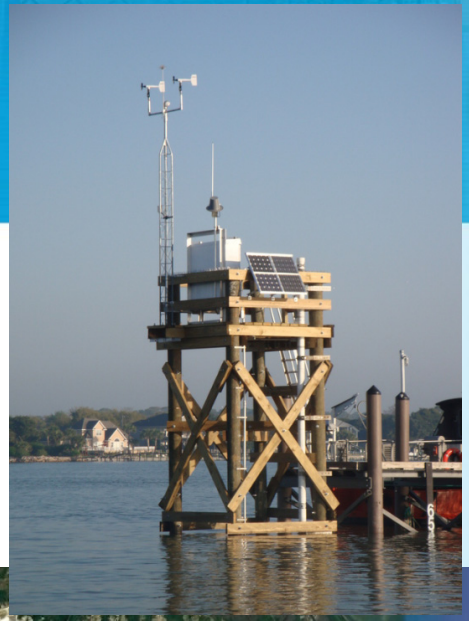


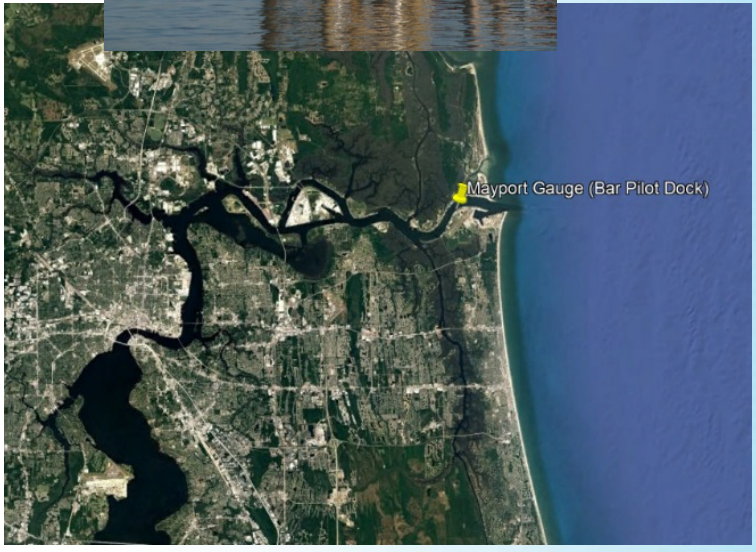
Sea Level Rise and Precipitation Projections, and Recommended Climate Scenarios

- Current and Projected Sea Level Rise Conditions for JEA's Service area
- Current and Projected Rainfall Intensity, Duration, and Frequency (IDF) Distributions
- Projections for Recommended Climate Scenarios for Flood Modeling:
  - » Bracket storm and sea level conditions range, based on range of factors:
    - Planning Time Horizons - Short, mid and long-term planning
    - Greenhouse Gas (GHG) scenarios: RCP8.5 and RCP6.0
    - Global Climate Model (GCM) summaries: 50% and 90% non-exceedance
  - » Identify probabilities to consider in defining current and future risk to JEA's assets

Historical Trends in Sea Level Rise

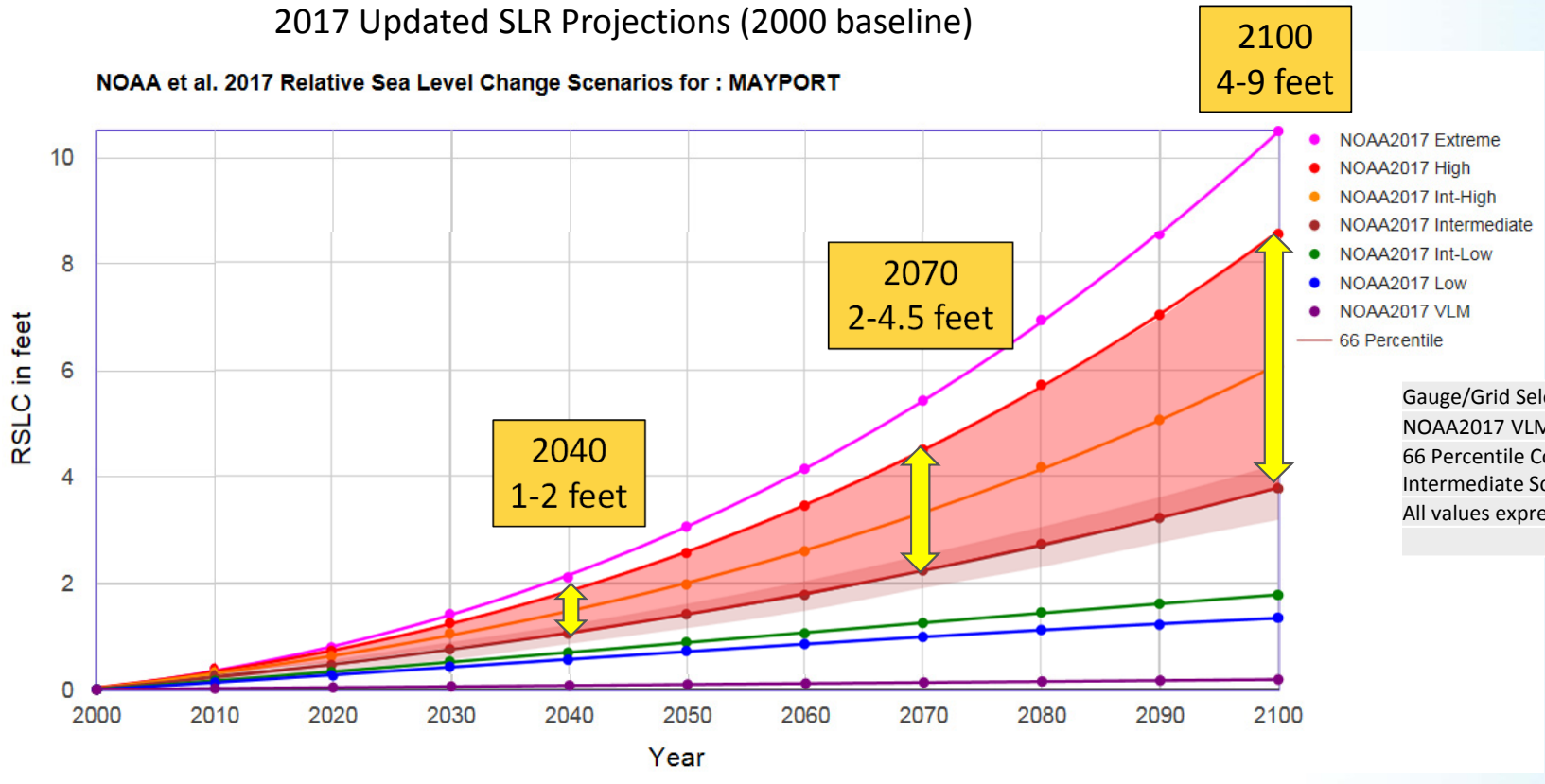






Sea Level Rise: Updated Projections

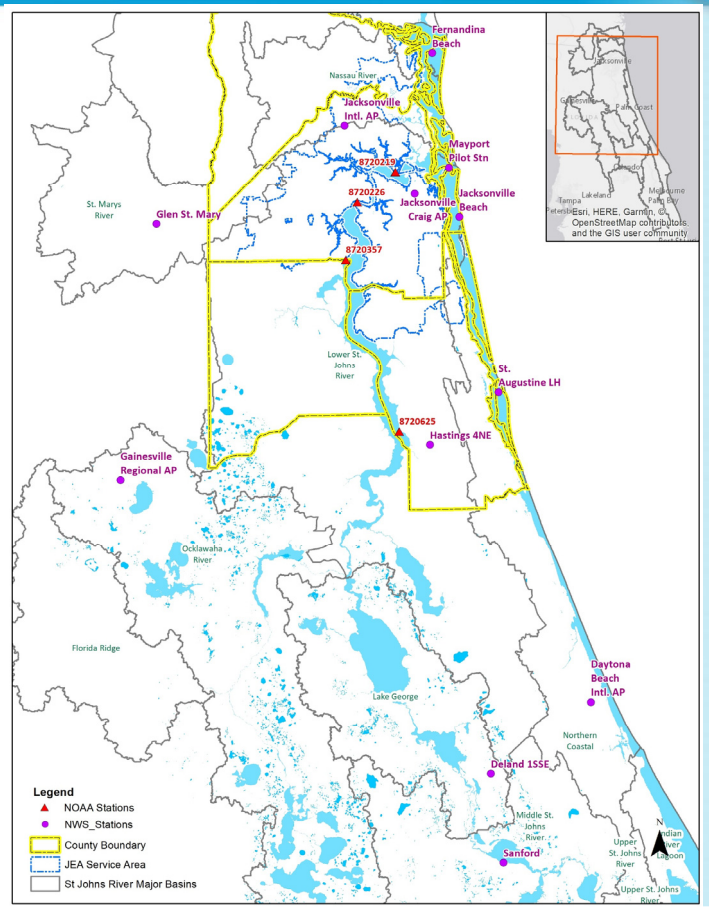
2017 Updated SLR Projections (2000 baseline)



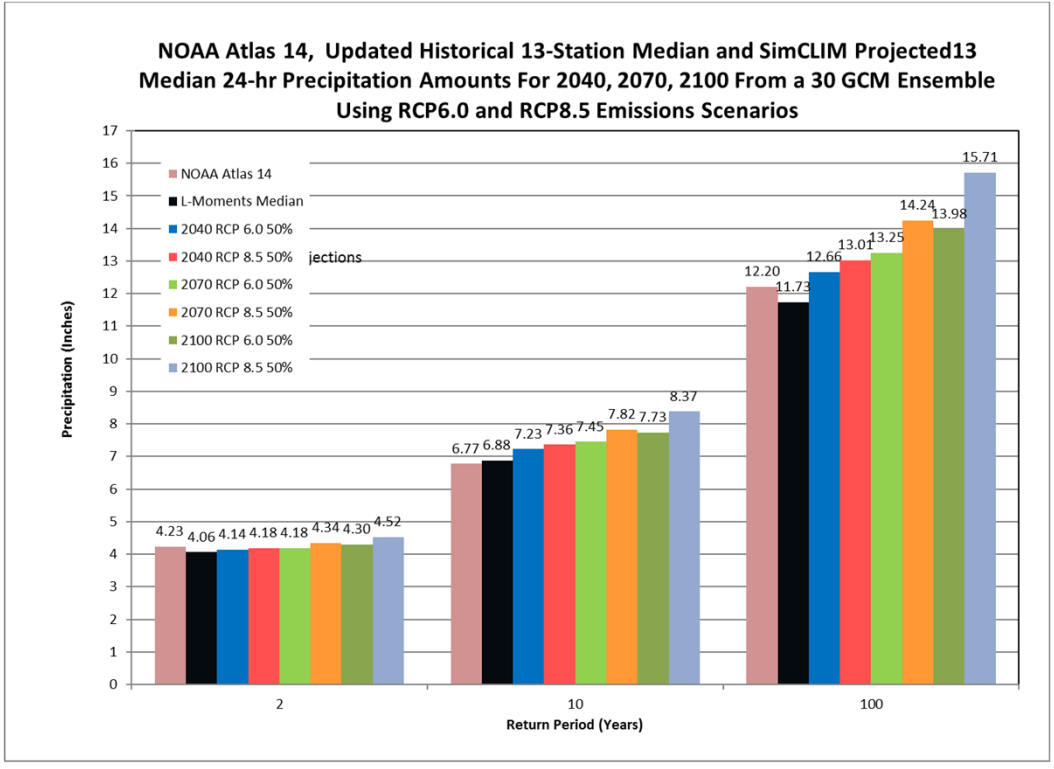
Gauge/Grid Selected: MAYPORT
NOAA2017 VLM: 0.00187 feet/year
66 Percentile Confidence Range for the Intermediate Scenario is shown
All values expressed in feet

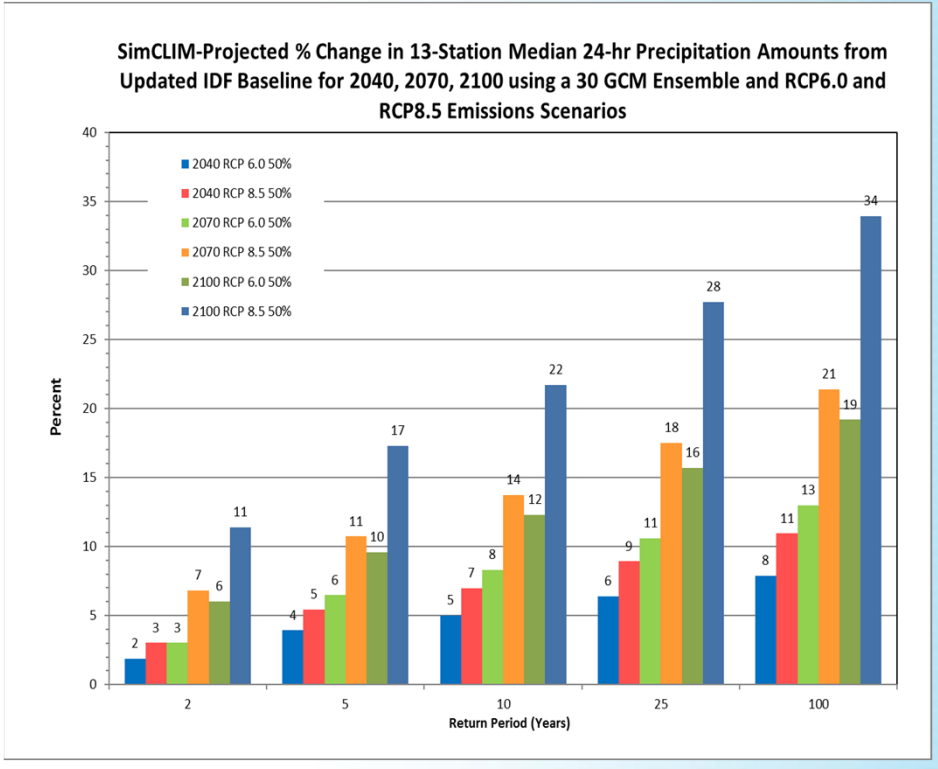
Rainfall Analysis and IDF Projections

- Historical Rainfall Data
  - » Daily precipitation from National Weather Service Cooperative Weather Observer.
  - » 13 stations identified in the JEA project area with up to 126 years of data.
- Data and Process Validation
  - » Data validated with NOAA Atlas 14 through 2010.
  - » Additional data through 2017 added to the updated IDF analysis.
- Future Projections
  - » RCP 6.0 and 8.5 emissions scenarios.
  - » 2040, 2070, 2100
  - » Ensemble of 30 general circulation models.
- IDF Curve Development using SimCLIM
  - » Return period/event frequency.



SimCLIM Preliminary IDF Projection Results
Median of Global Climate Model Projection Ensemble





Eight Scenarios were Selected through Scenario Planning

Scenario planning was applied with flood model to bracket levels of climate risk for cost-benefit analysis, and align to asset management planning.

Scenario Description		Scenarios (R/S = Rain/Surge, with SLR; R = Rain only, with SLR)							
		1	2	3	4	5	6	7	8
Rainfall	SLR Projections	Rainfall and/or SLR, with Storm Surge (R/S = Rain/Surge, with SLR; R = Rain only, without storm surge or SLR)							
RCP6.0 50% non-exceedance	NOAA 2017: Intermediate	R/S		R/S		R/S			
RCP8.5 50% non-exceedance	NOAA 2017: High		R/S		R/S		R/S	R/S	R/Astronomical Tide
Target Year									
2040		✓	✓			✓			
2070				✓	✓		✓	✓	✓
Return Period of Surge Event (year)									
25-year (current rain: 8.8”)						✓	✓		
100-year (current rain: 12.3”)		✓	✓	✓	✓				✓
500-year (current rain: 16.6”)								✓	
Scenario Summary									
Rainfall 24-hour Total (inches)		13.21	13.69	13.94	14.99	9.34	10.36	21.54	14.99
MHHW (2000: 1.96 feet NAVD88)		3.01	3.76	4.19	6.45	3.01	6.45	6.45	N/A
SLR (feet)		1.05	1.8	2.23	4.49	1.05	4.49	4.49	4.49

Flood Modeling Methodology Development

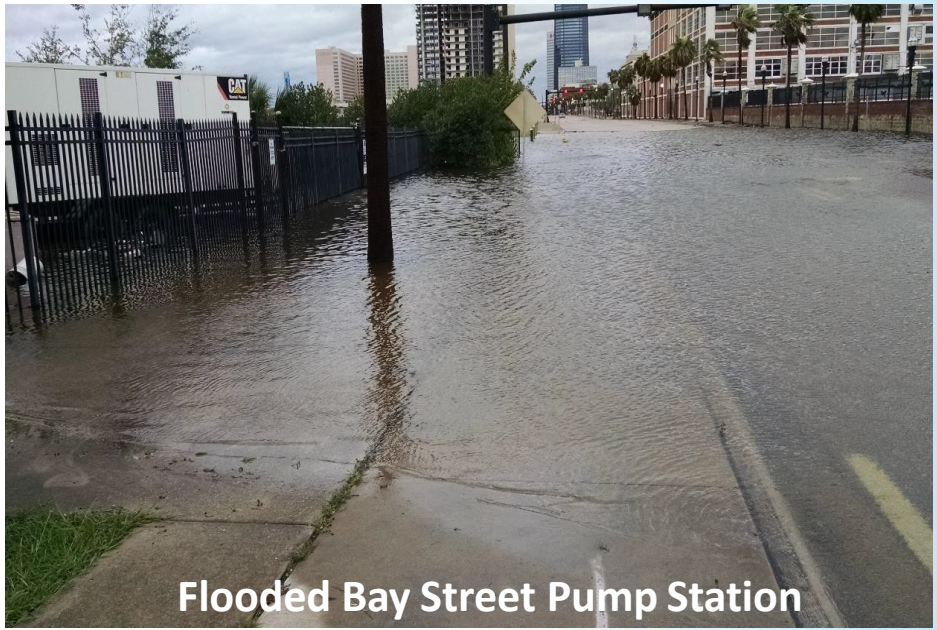
- Model Calibration/Validation to Current Conditions:
  - » Hurricane Irma
  - » FEMA 100-year and 500-year elevations at selected transects
  - » FEMA 100-year and 500-year flood maps
- Model Results for 8 Climate Scenarios
  - » Comparison of extent of 100- and 500-year floodplain
  - » Depth of flooding at select JEA facilities

Hurricane Irma Flooding

Source: www.s.w-x.co/wu/jax-flooding-sheriff-9.11.17

Flood Modeling Methodology Development

- Scenario Modeling and Model Calibration using monitoring station data from JEA, COJ, County, NOAA, and USGS, where available:
  - » Rainfall analysis
  - » Sea level rise analysis
  - » Coastal surge analysis
  - » St. Johns River surge analysis
  - » Inland flooding analysis



Source: JEA

Surge Modeling Performed of Historical Hurricane Events (used as base set)

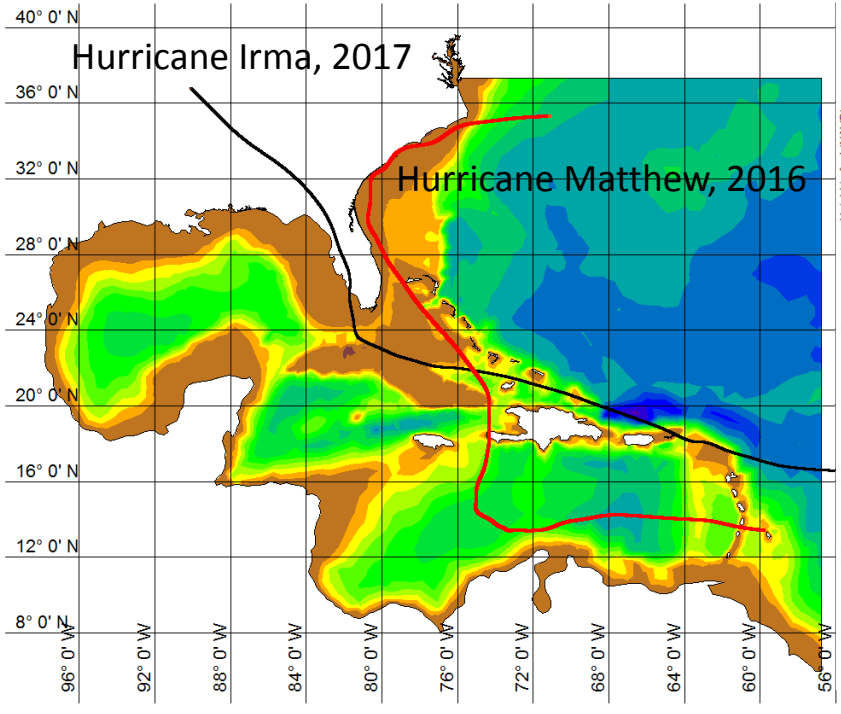
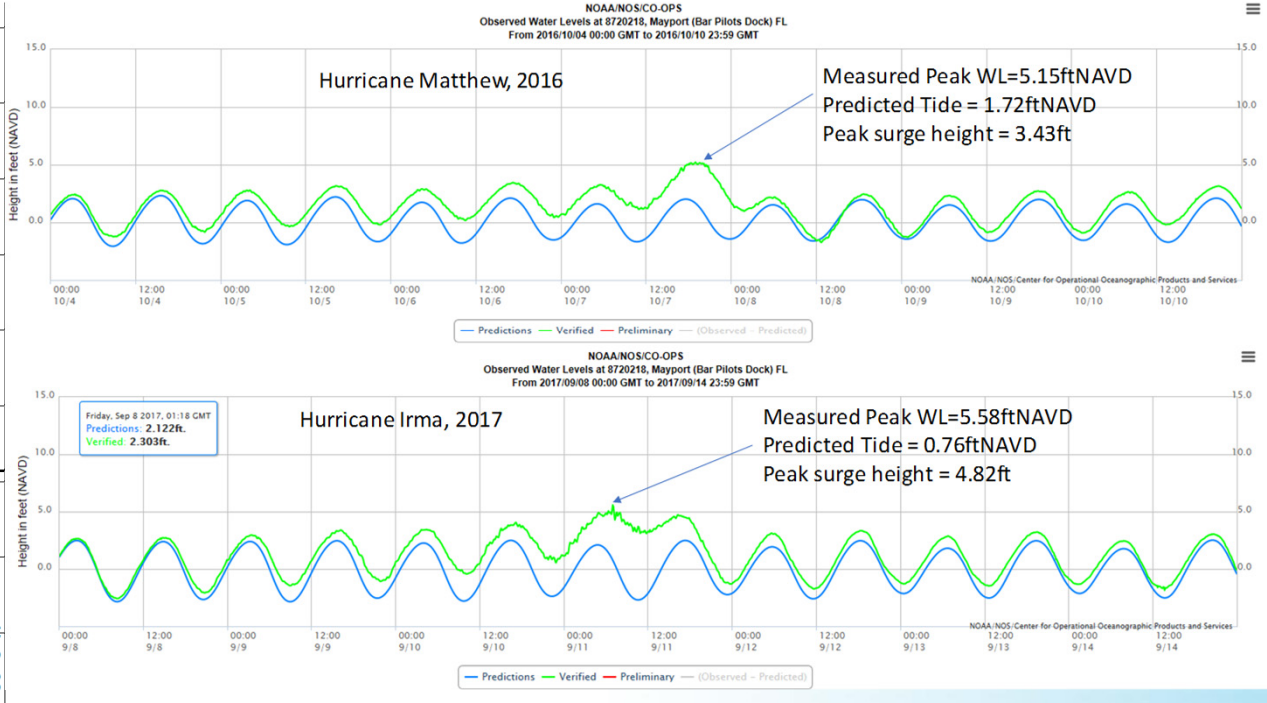


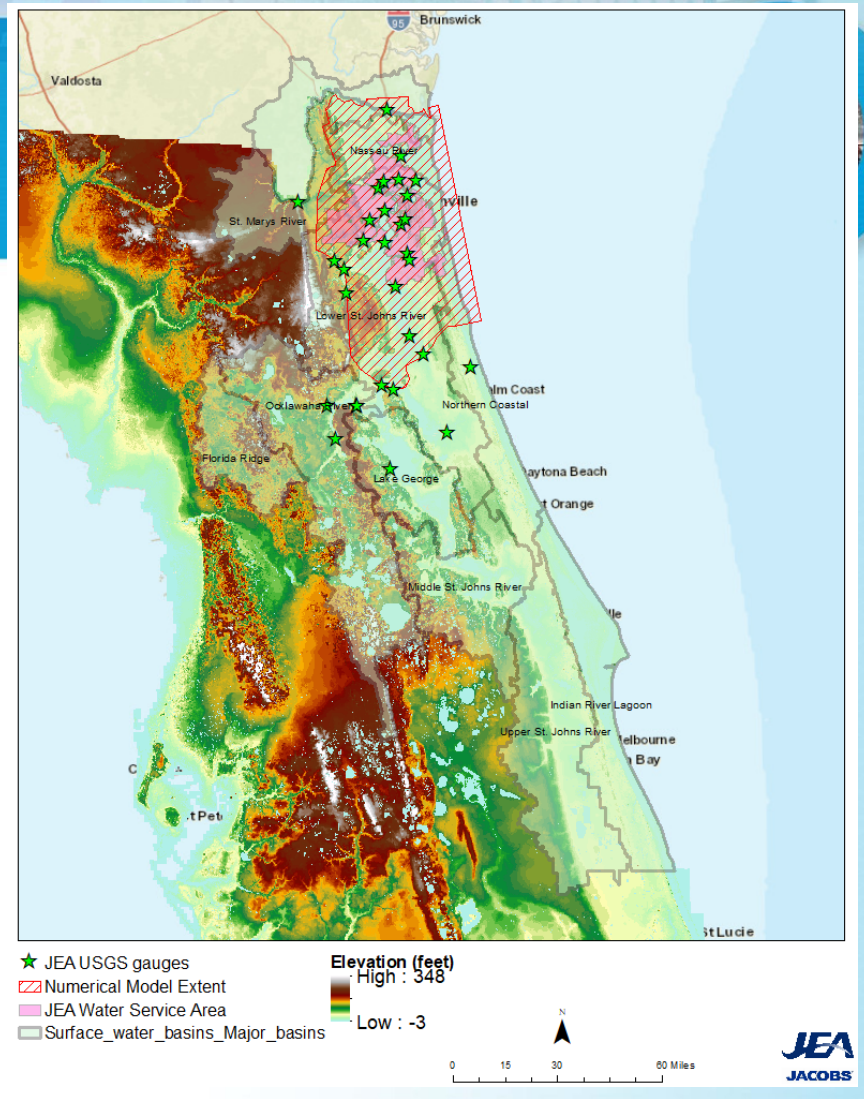
Image: Bathymetry of Gulf of Mexico, Caribbean and Eastern Atlantic, with Hurricane Matthew and Irma tracks.



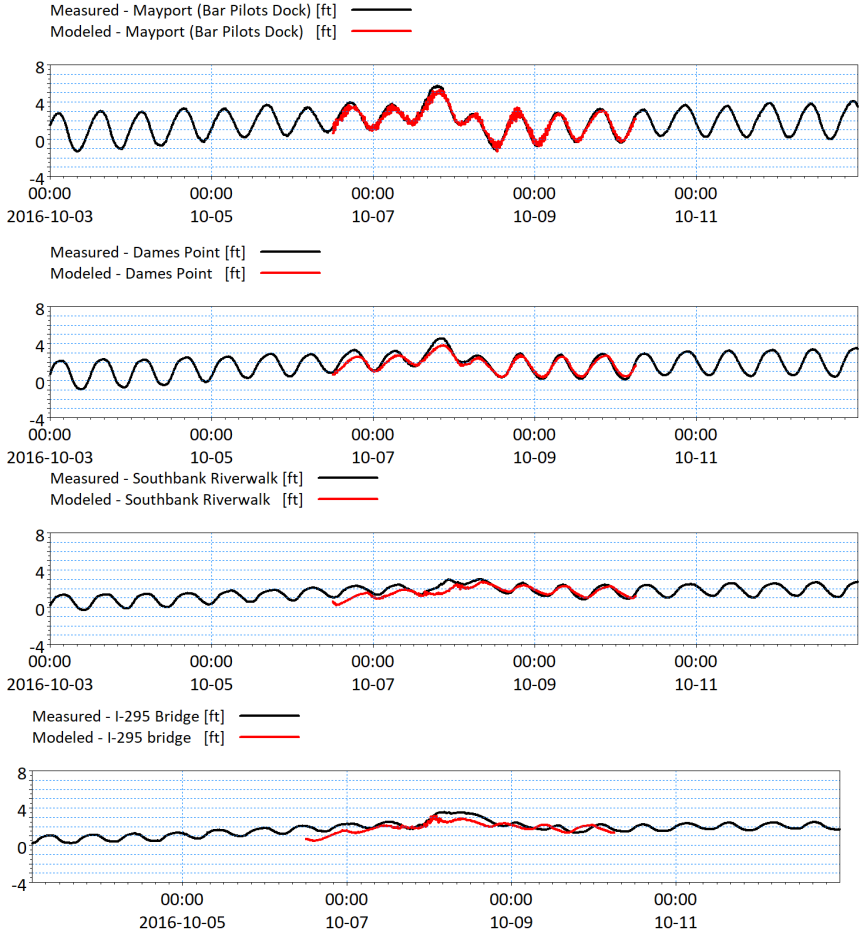
Note: "Predicted Tide" refers to NOAA prediction of astronomical tide based on harmonic analysis of measured water level data, without meteorological disturbances such as surge.

Inland Flood Modeling Performed

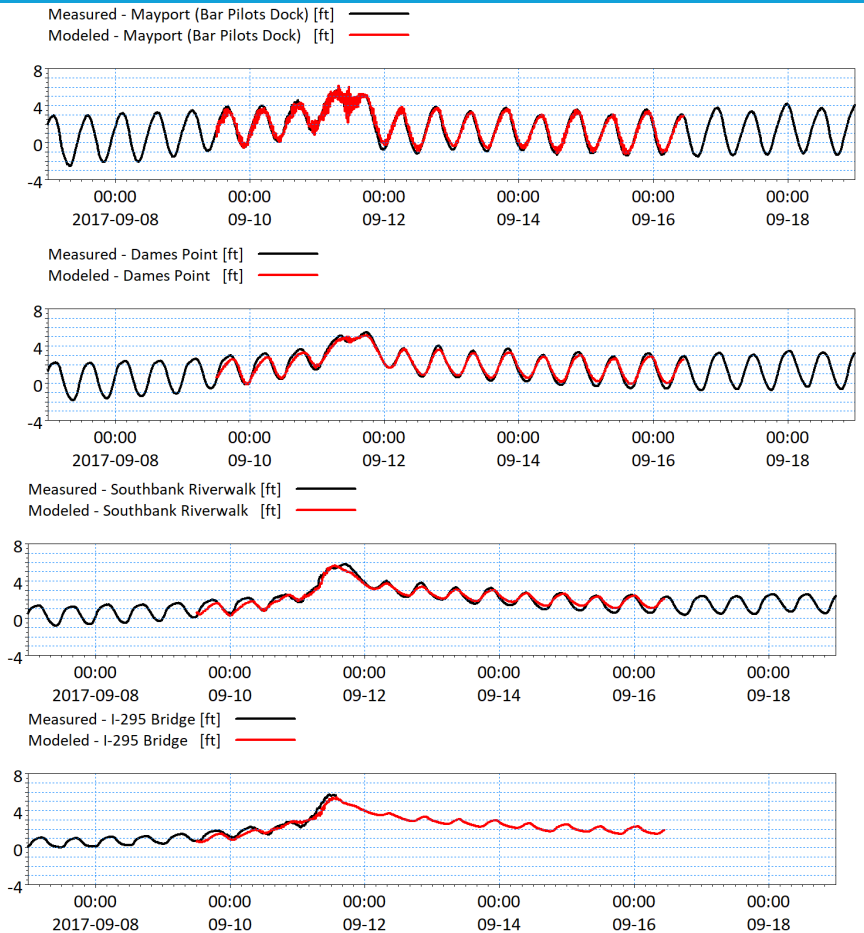
- Hydrologic Inputs
  - » Rainfall – NCDC rain gauge data from Hurricanes Irma and Matthew for calibration
- Hydraulic Inputs
  - » DEM and target flexible mesh (-3 to 348 feet elevation)
  - » Land use characteristics – defining surface flow parameters
  - » Boundary conditions
    - – Storm surge boundary from coastal modeling
    - – Flow boundary from upstream using USGS gauge flow data
  - » **No subsurface stormwater infrastructure is included in the model**

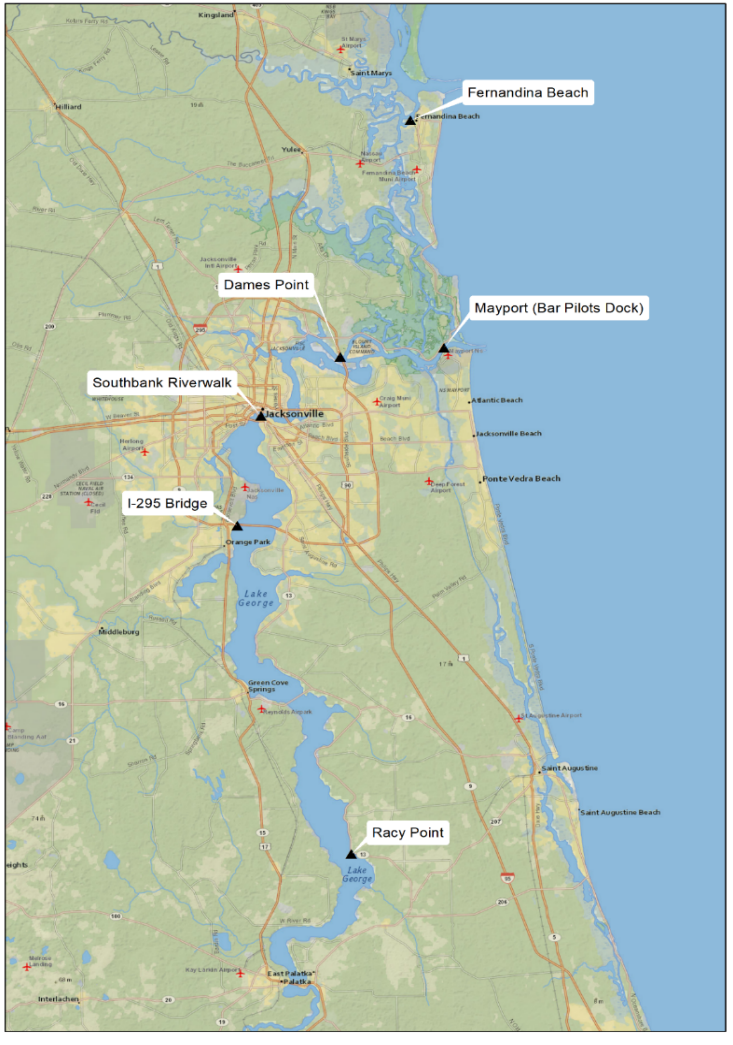


Calibration – Historical Event: Hurricane Matthew



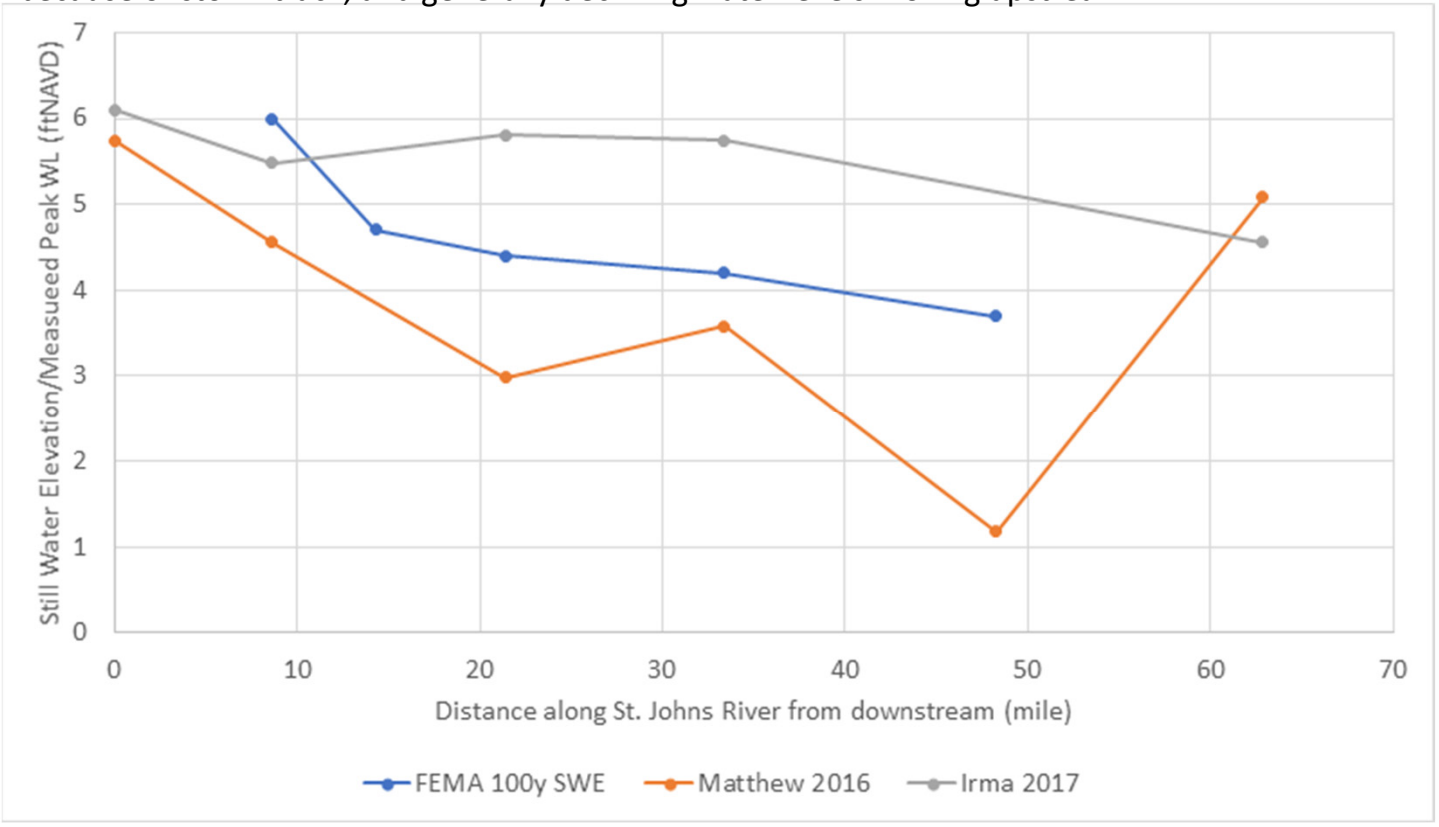
Validation – Historical Event: Hurricane Irma

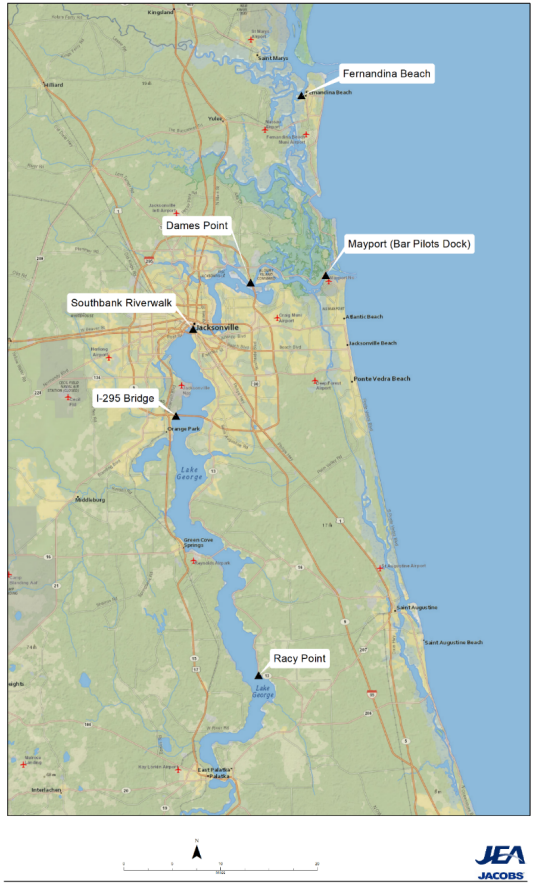




Longitudinal Profiles for FEMA SWE and Hurricanes Irma and Matthew

Longitudinal profiles for FEMA SWE and Hurricanes Irma and Matthew show complex hydrodynamics because of storm track, and generally declining water levels moving upstream.





100-year Storm: Base Scenario versus Scenario 1

2040, Rain (lower emissions – RCP6.0), SLR (NOAA intermediate), and Storm Surge

Facilities in Floodplain

All JEA Facilities:

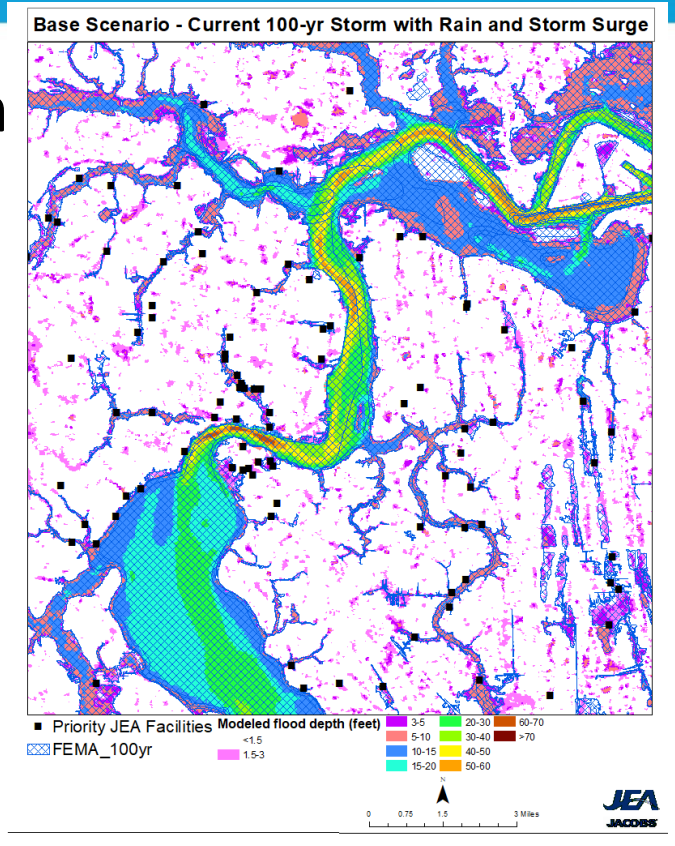
Current: 210 (12.6%)

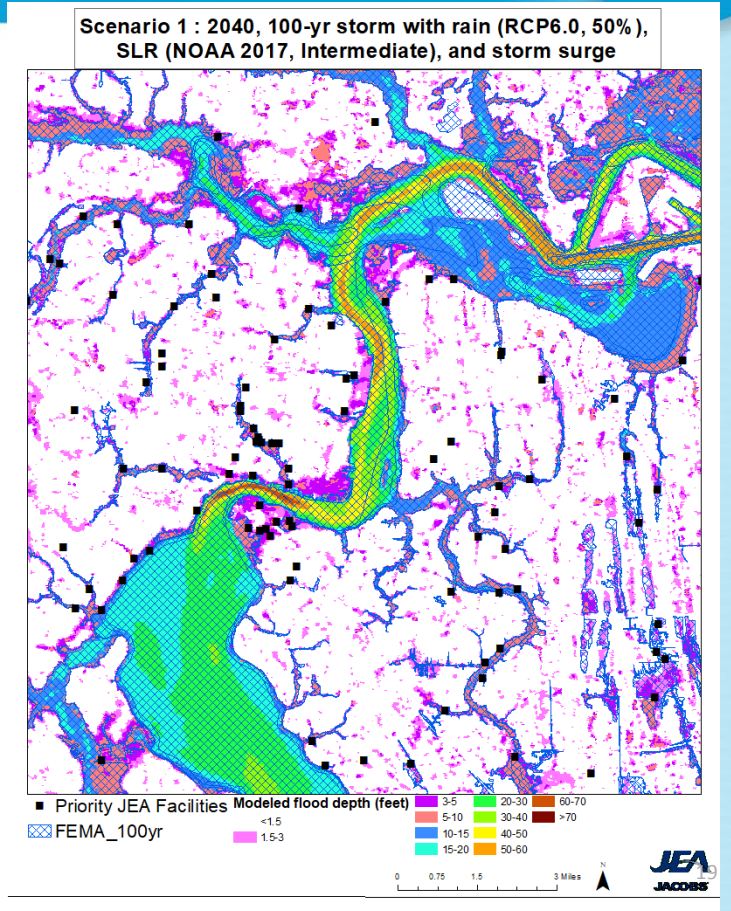
Scenario 1: 288 (16.9%)

Priority JEA Facilities:

Current: 90 (50%)

Scenario 1: 91 (50%)





Process for Identifying and Prioritizing JEA's Critical Facilities

- Create Facility-Level Service Area Boundaries in GIS for JEA's Wastewater Lift Stations and Drinking Water Facilities
- JEA Facility-Level Service Area Boundaries used to Identify Critical Facilities Served by each Lift Station
- Data used for JEA Facility Prioritization and Further Analysis as part of the Vulnerability Assessment
- Facility Criticality based on
  - » Critical customers served (hospital, EOC, first responders)
  - » Facility lists from Duval, St. Johns, Clay and Nassau Counties.
- JEA facility flow characteristics
- Dependent/linked systems
  - » Repump stations
  - » Booster stations

Vulnerability Assessment – JEA Facility Criticality and Prioritization for Site Visits

- Identify and Prioritize JEA Facilities with the Highest Flood Risk
- Perform Site Visits (completed) to Facilities Identified; Obtain Data and Perform Further Vulnerability and Risk Analyses
  - » Visited over 170 JEA facilities
  - » Compiled site data in comprehensive database
- Better Understand Facilities most Vulnerable to Severe Weather Impacts and Climate-related Hazards:
  - » Compare asset elevations (e.g. pumps, motors, electrical panels) to modeled flood elevations

Questions and Answers