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FLORIDA SHORE & BEACH PRESERVATION ASSOCIATION
A League of Cities and Counties on Beach and Coastal Issues

Pilot Study: FL Adaptation Planning

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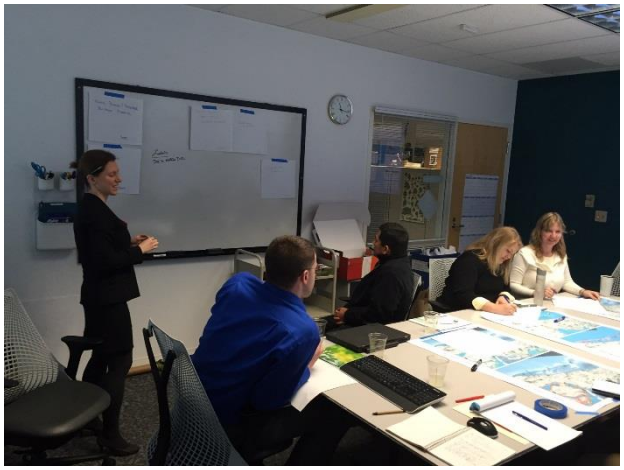
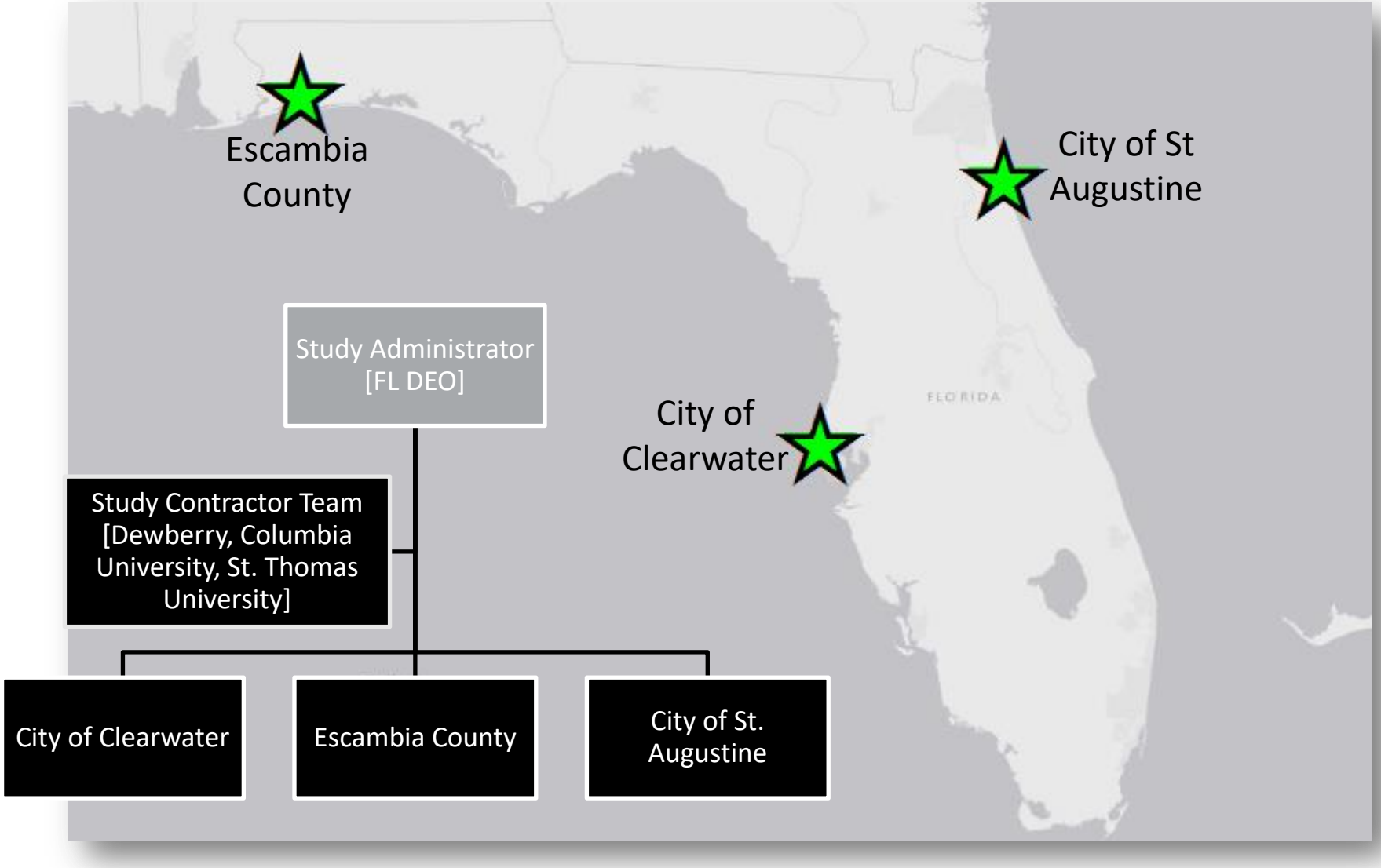
60th Florida Beach and Shore Preservation Association Annual Conference
September 28, 2017



Sea Level Rise Adaptation – Technical Assistance Pilot Project Vulnerability and Planning Support

This publication was funded in part, through a grant agreement from the Florida Department of Environmental Protection, Florida Coastal Management Program, by a grant provided by the Office for Coastal Management under the Coastal Zone Management Act of 1972, as amended, National Oceanic and Atmospheric Administration Award No. NA15NOS4190217. The views, statements, findings, conclusions and recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the State of Florida, NOAA or any of their sub-agencies.

Project Team Overview

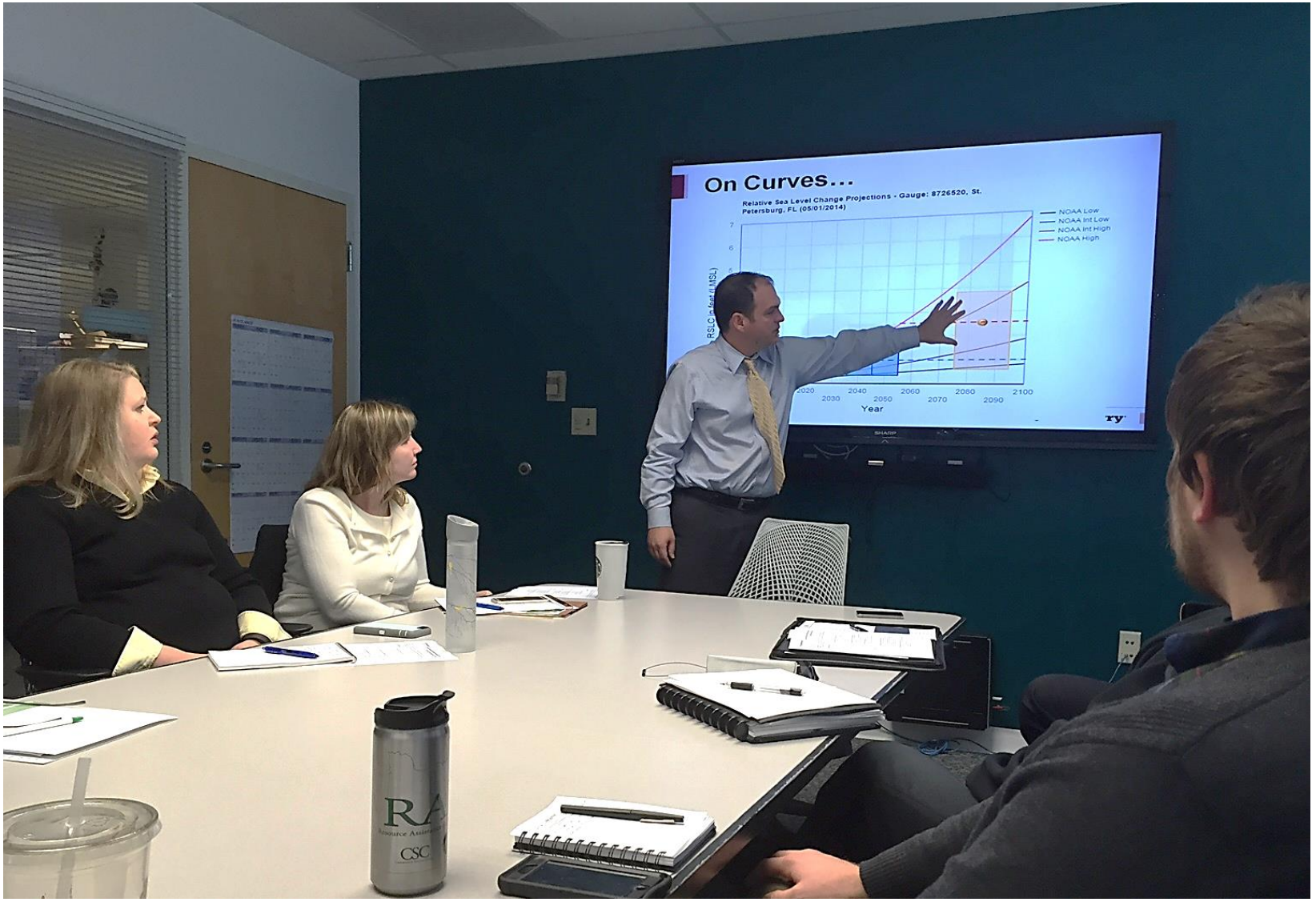


Study Tasks Overview

Task 1. Vulnerability/Risk Assessment	• Future condition scenarios • Hazard data development • Overlay of hazard data on natural/built assets • Summary of impacts (cartographic, tabular, narrative)
Task 2. Adaptation Planning	• Review of existing programs/policies • Prioritize Task 1 findings • Qualitative and/or quantitative evaluation • Recommendations

Vulnerability Assessment

SLR Scenarios



SLR Scenarios – Model Projections

- NOAA low scenario
  - continuation of historical observations
- NOAA Intermediate-Low scenario
  - upper end of the IPCC Fourth Assessment Report
- NOAA Intermediate-High scenario
  - upper end of semi-empirical methods
- The NOAA High scenario
  - potential change with maximum possible glacier and ice sheet loss by the end of the century.
- Chose to look at
  - Short-term (2045)
  - Long-term (2085)

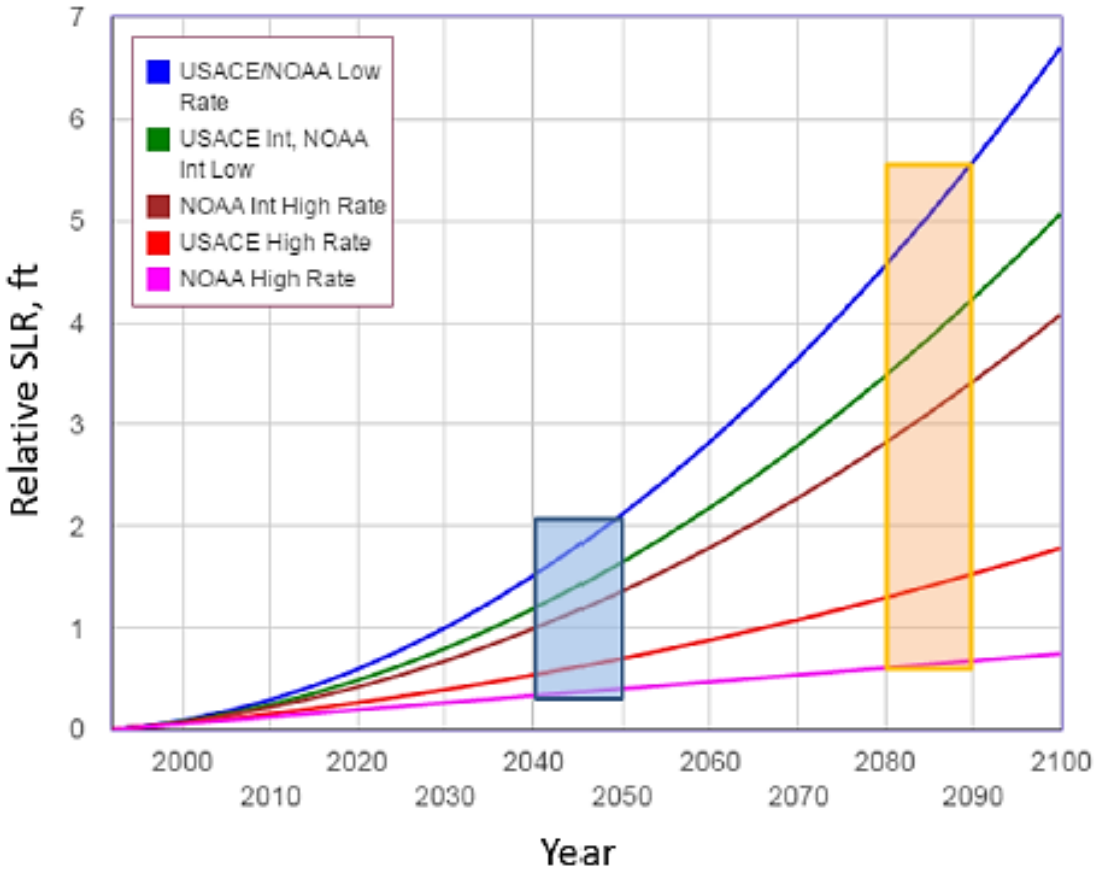


Figure 2. NOAA relative SLR curve for Gauge 8729840, Pensacola, FL (source: USACE Sea-Level Change Curve Calculator).

SLR Scenarios - Clearwater

- From the NOAA Technical Report OAR CPO-1, Global Sea Level Rise Scenarios for the United States National Climate Assessment, Dec 2012.
- Design meeting established a preference for representative short-, moderate- and long-term values with the short-term value providing a "no regrets" planning elevation

Time Horizon	Low	Intermediate-Low	Intermediate High	High	Average Value	Representative Value
Short-term (2040s)	0.41	0.66	1.21	1.85	1.03	**1**
Moderate-term (2070s)	0.64	1.25	2.61	4.16	2.17	**2**
Long-term (2090s)	0.80	1.74	3.83	6.22	3.14	**3**

SLR Scenarios – Escambia

Table 2. SLR projections extracted from the USACE and NOAA SLR curves and rounded to the nearest tenth of foot. Results in the report will reference the relative scenario for each time horizon.

Time Horizon	USACE Low	USACE Intermediate	USACE High	NOAA High
Short-term (2045)	0.4	0.6	1.4	1.8
Long-term (2085)	0.6	1.4	3.9	5.1
Report Reference:	Low	Medium	High	Highest

SLR Scenarios – St Augustine

- From the NOAA Technical Report OAR CPO-1, Global Sea Level Rise Scenarios for the United States National Climate Assessment, Dec 2012.

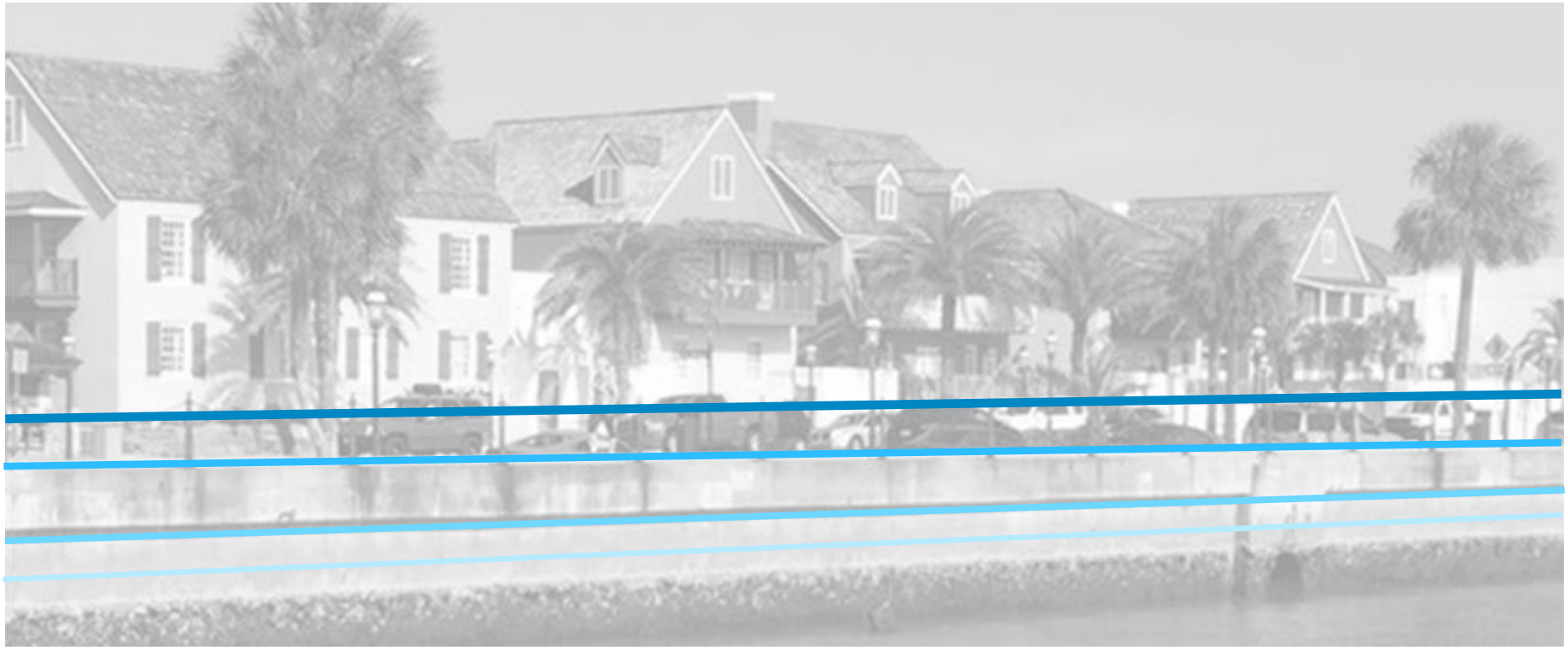
Time Horizon	Low	Intermediate Low	Intermediate High	High
Short-term (2045)	0.4	0.7	1.2	1.9
Long-term (2085)	0.7	1.5	3.2	5.2

- Design meeting and work plan established a step-wise assessment using half-foot (0.5 ft) increments from 0 to 5 ft.

Short-term (2045) SLR Estimates

Low	Intermediate Low	Intermediate High	High
0.4 Feet	0.7 Feet	1.2 Feet	1.9 Feet

Long-term (2085) SLR Estimates



Low	Intermediate Low	Intermediate High	High
0.7 Feet	1.5 Feet	3.2 Feet	5.2 Feet

Time Horizons for Planning

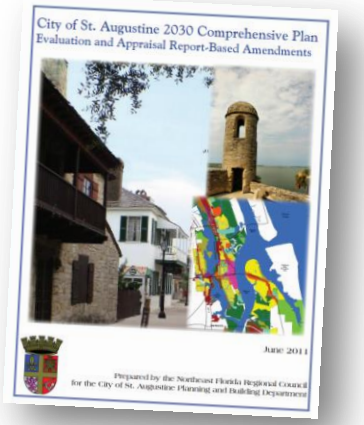
Life Cycle Alignment	Time Horizon/ Time Period	Relevance	Use
Municipal Planning	20-40 years 2035-2055	Comprehensive Plan & Outcomes Short end of Commercial and Utility life-cycles	Vulnerability assessment Key planning value Basis for evaluation of all adaptation strategies
Critical Infrastructure/ Long-term awareness	50-80 years 2065-2085	Utility Infrastructure life-cycles Transportation infrastructure lifecycles Residential structure lifecycles	Secondary vulnerability assessment to provide insight into long-term risk Basis for long-term infrastructure decisions Evaluate cost-effectiveness of additional protection for adaptable resilience strategies

Timing of Increments

- Table indicates earliest year scenario can occur based on level of SLR curve:
  - NOAA low scenario - represents a continuation of historical observations;
  - NOAA Intermediate-Low scenario, based primarily on based on the upper end of the IPCC Fourth Assessment Report;
  - NOAA Intermediate-High scenario, based on the upper end of global projections modeled by semi-empirical methods; and
  - The NOAA High scenario, based on a estimation of potential change with maximum possible glacier and ice sheet loss by the end of the century.

Sea Level Rise	NOAA Low	NOAA Intermediate Low	NOAA Intermediate High	NOAA High
Feet	Year	Year	Year	Year
0.50	2050	2035	2020	2015
1.00	>2100	2060	2040	2030
1.50	>2100	2085	2050s	2040s
2.00	>2100	>2100	2060s	2040s
2.50	>2100	>2100	2070s	2050s
3.00	>2100	>2100	2080s	2060s
3.50	>2100	>2100	2090	2070s
4.00	>2100	>2100	2090s	2070s

Align Scenarios with Planning, Lifecycles…



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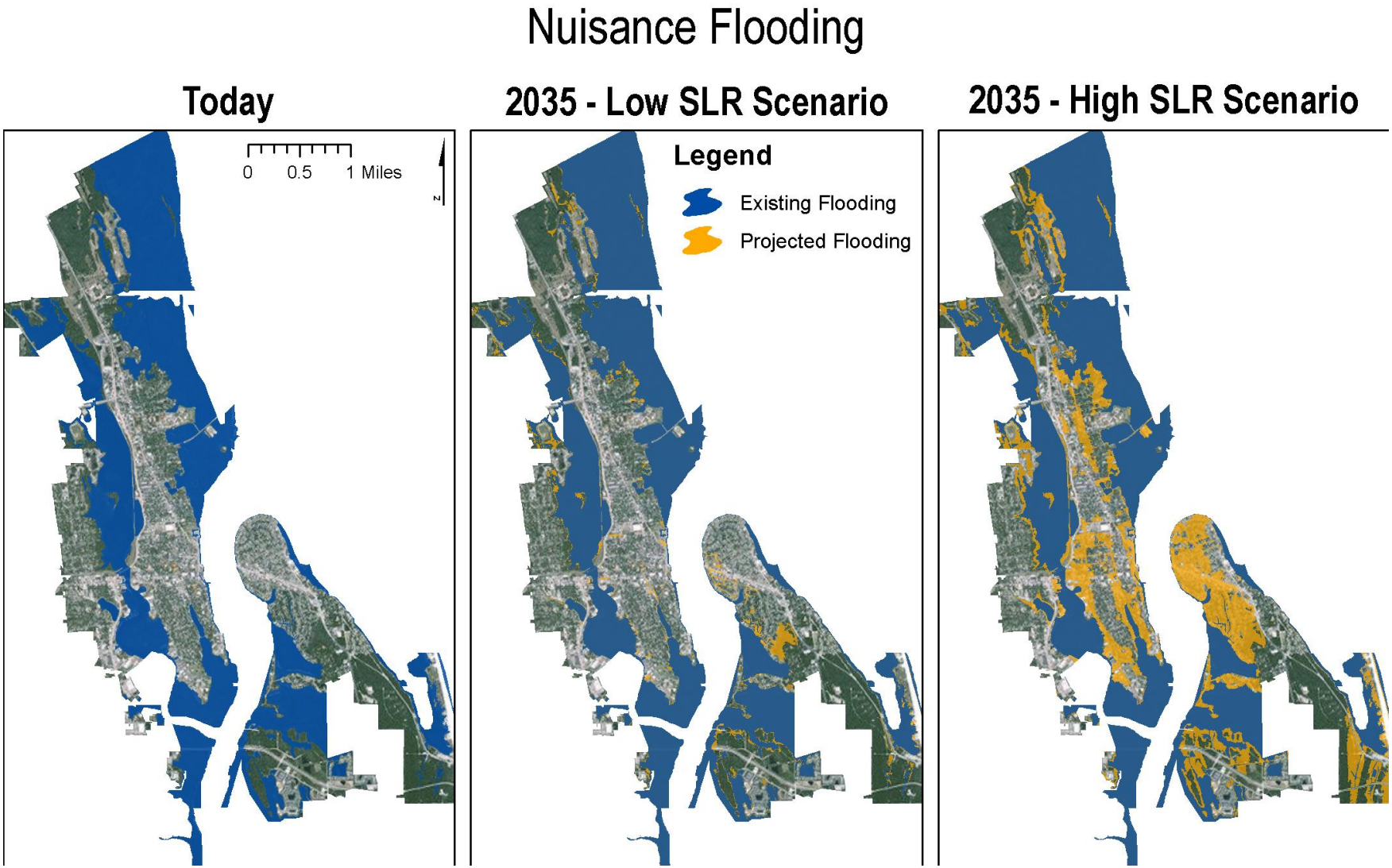
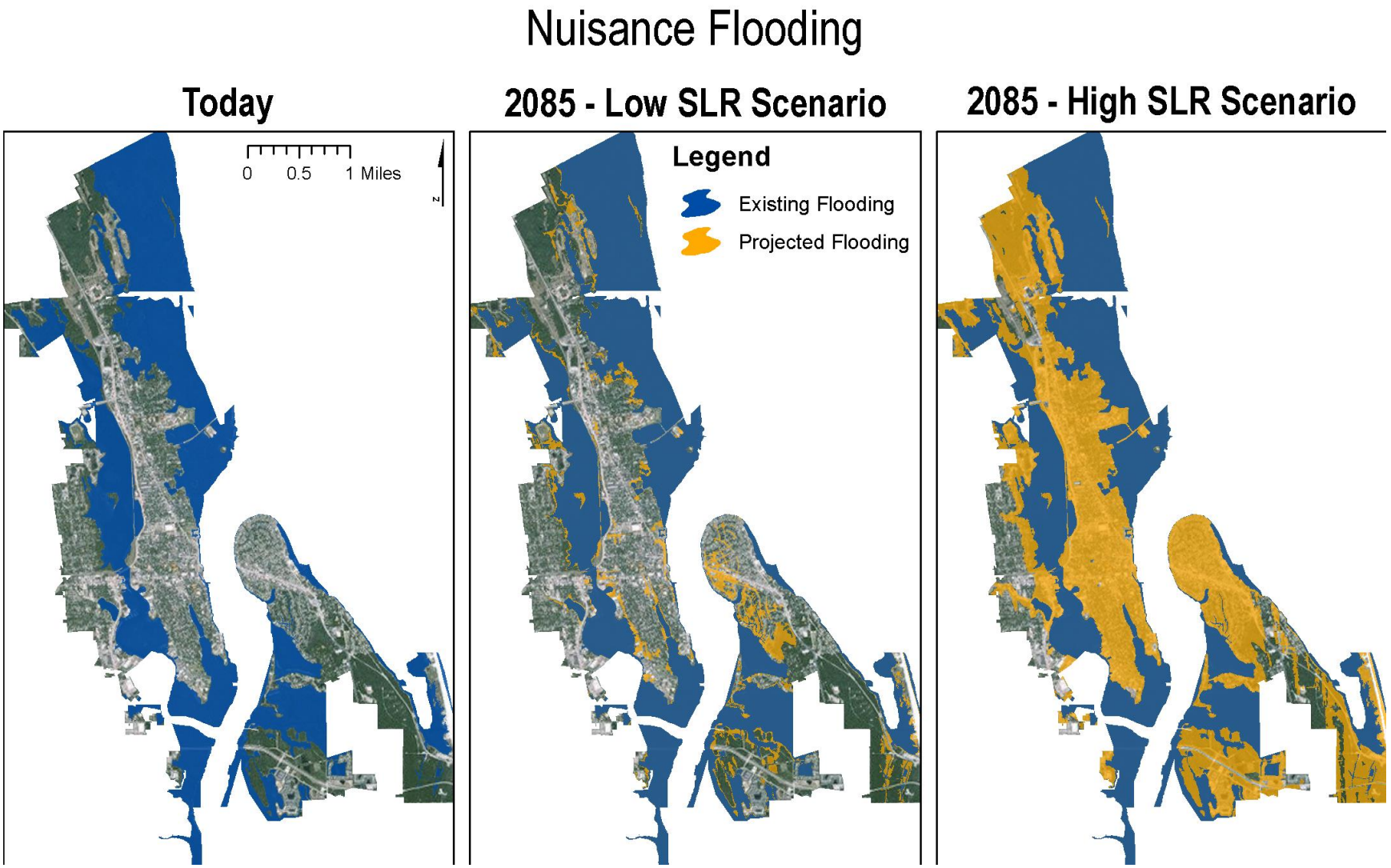
SLR Mapping – Changes to Nuisance Flooding (2035)



SLR Mapping – Changes to Nuisance Flooding (2085)



Key Tipping Points

Focus Area	SLR Increase	Metrics of Note
Land Area Inundated	2.0 Feet	• Amount of inundated areas by MHHW begins to accelerate at this point • Majority of downtown and North Davis Shores becomes inundated
Road Network	2.0 Feet	• Percentage of road network impacted accelerates (may be due to design standards around similar elevations) • Nuisance flood event could impact ~40% of network
Bridges	• 0.5 Feet • 1.5 Feet • 2.0 Feet	• At 0.5 feet of SLR, nuisance flood event could start reducing the number of passable bridges • At 1.5 feet. nuisance flood impacts could transition 4 bridges from passable to non-functioning • At 2 feet SLR, MHHW could impact bridge approaches
Buildings	• 1.5 Feet • 2.5 Feet	• Nuisance flood impacts 3 times as many buildings as currently vulnerable • 25 times as many buildings inundated from MHHW as currently vulnerable
Historic District	• 1.0 Foot • 2.5 Feet	• At one foot of SLR, nuisance impacts to the district rise rapidly • At 2.5 feet, MHHW impacts to the district accelerate
Archeological Resources	No particular tipping points of note	• Most cemeteries show little vulnerability to even high SLR changes for MHHW. However, many are already vulnerable to existing nuisance and 1% flood events. • Archeological zones are fairly insulated from low SLR increases to MHHW, but can change dramatically once a threshold elevation is reached.

Shoreline Response

Shoreline Response - Process

Shoreline Response

Review historical changes → **Consider past coastal management activities** → **Estimate future shoreline positions**

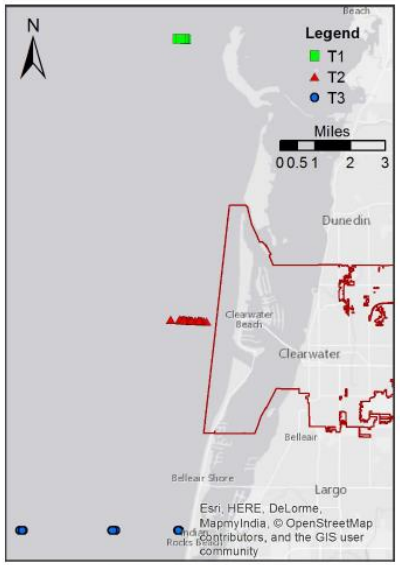


Figure A-2. Location of USACE Depth of Closure transects.

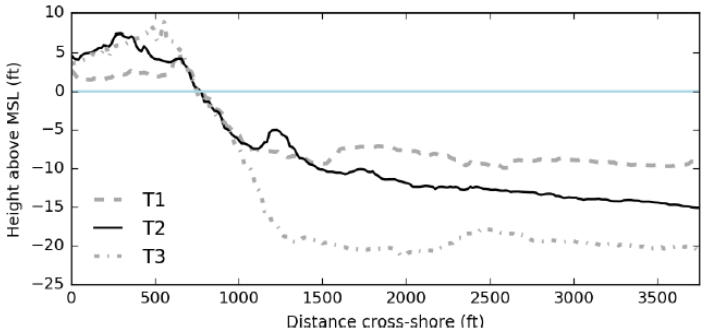
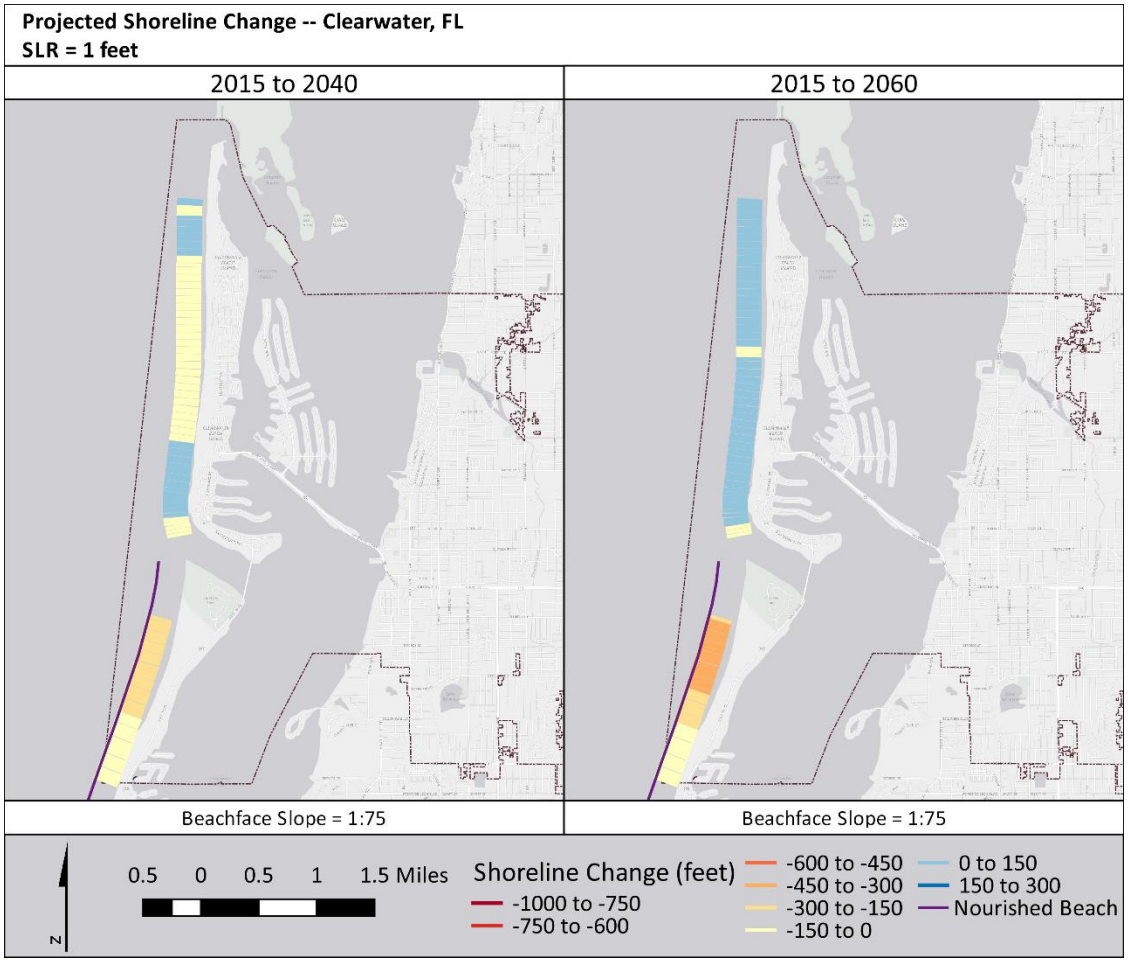


Figure A-3. Cross-shore transects extracted from available digital elevation model.

Scenario	Parameters (ft)			Result
	B	*h*	*L*	*Slope*
T1 - Low	4.5	7.0	400	**34.8**
T1 - High	4.5	9.0	760	**56.3**
T2 - Low	4.0	12.0	1350	**84.4**
T2 - High	4.0	14.5	2600	**140.5**
T3 - Low	8.0	12.0	500	**25.0**
T3 - High	8.0	20.0	800	**28.6**
Weighted Avg.	5.1	12.6	1295	**73.0**

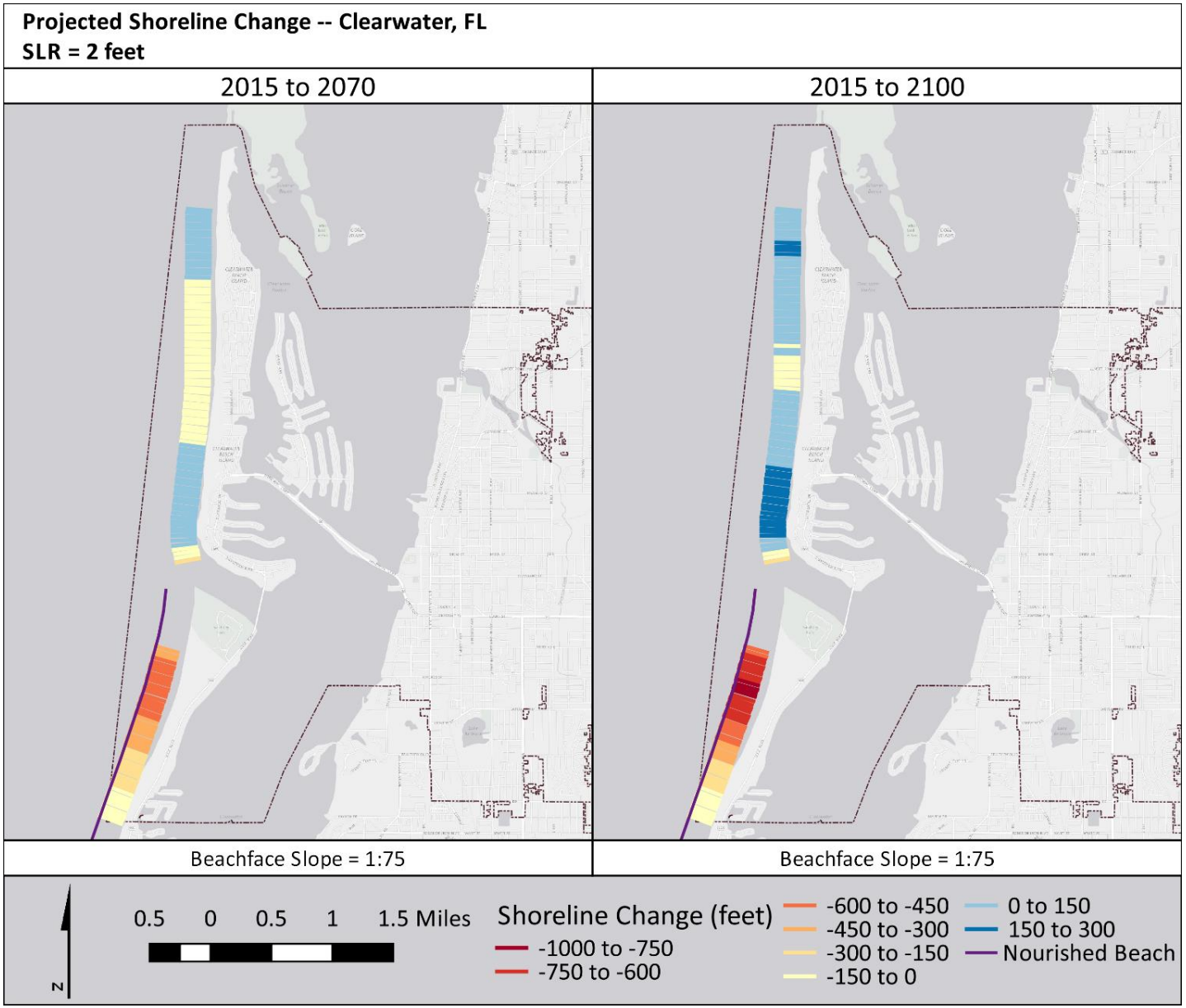
Shoreline Response +1 ft.



Shoreline Response

- The northern shores have been accretionary in the near past
- In the south, there is a trend toward erosion
- Ongoing coastal processes (i.e. accretion) may counter SLR trends somewhat

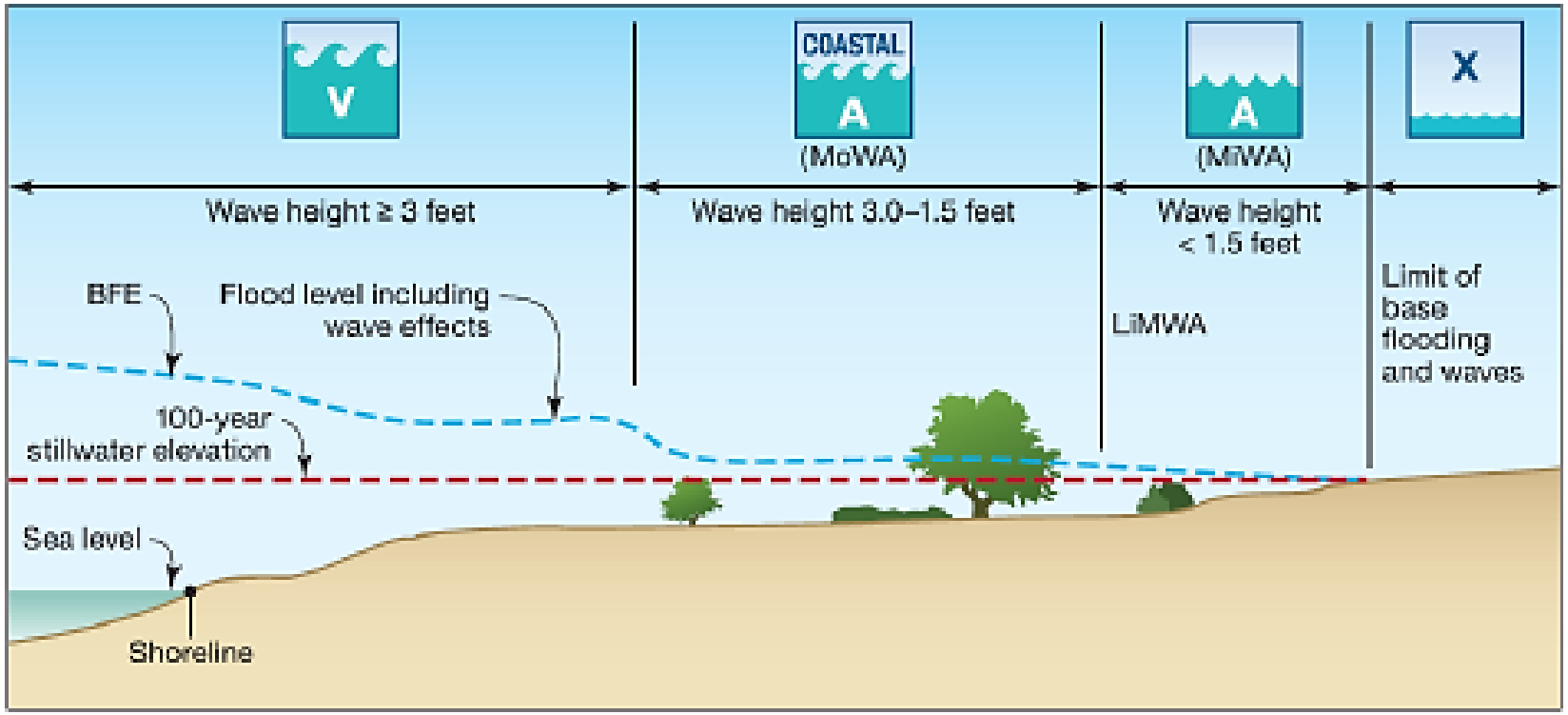
Shoreline Response +2 ft.



Future Wave Hazard Modeling

Escambia Example

Future Wave Hazard Modeling



Limit of Moderate Wave Action (LiMWA) - which is the inland limit of the area expected to receive 1.5-foot or greater breaking waves during the 1-percent-annual-chance flood event

Limit of Moderate Wave Action (LiMWA)

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes *Zone X*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
	E 18.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	8 Coastal Transect

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by the Florida Department of Transportation (FDOT). This information was derived from digital orthophotography at a 0.5-foot resolution dated 2016.

LIMIT OF MODERATE WAVE ACTION: Zone AE has been divided by a Limit of Moderate Wave Action (LiMWA). The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between Zone VE and the LiMWA (or between the shoreline and the LiMWA for areas where Zone VE is not identified) will be similar to, but less severe than, those in Zone VE.

Limit of Moderate Wave Action (LiMWA)

SCALE

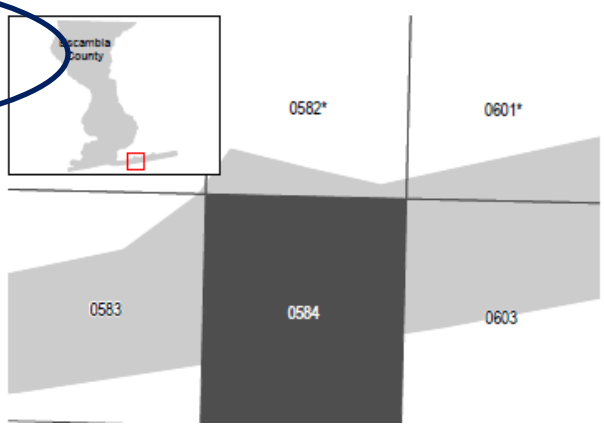
Map Projection:
HARN State Plane Lambert Conformal Conic, Florida North Zone (FIPS Zone 0903);
North American Datum 1983 HARN; Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

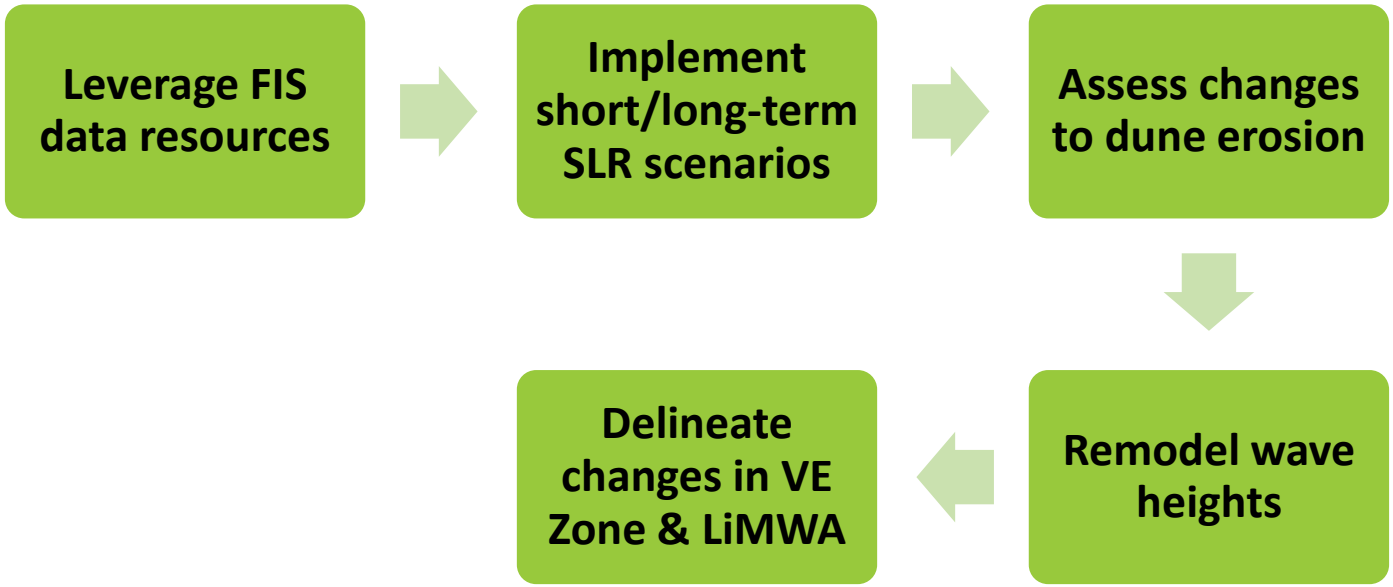
0 500 1,000 2,000 Feet

0 125 250 500 Meters

PANEL LOCATOR



Future Wave Hazard Modeling



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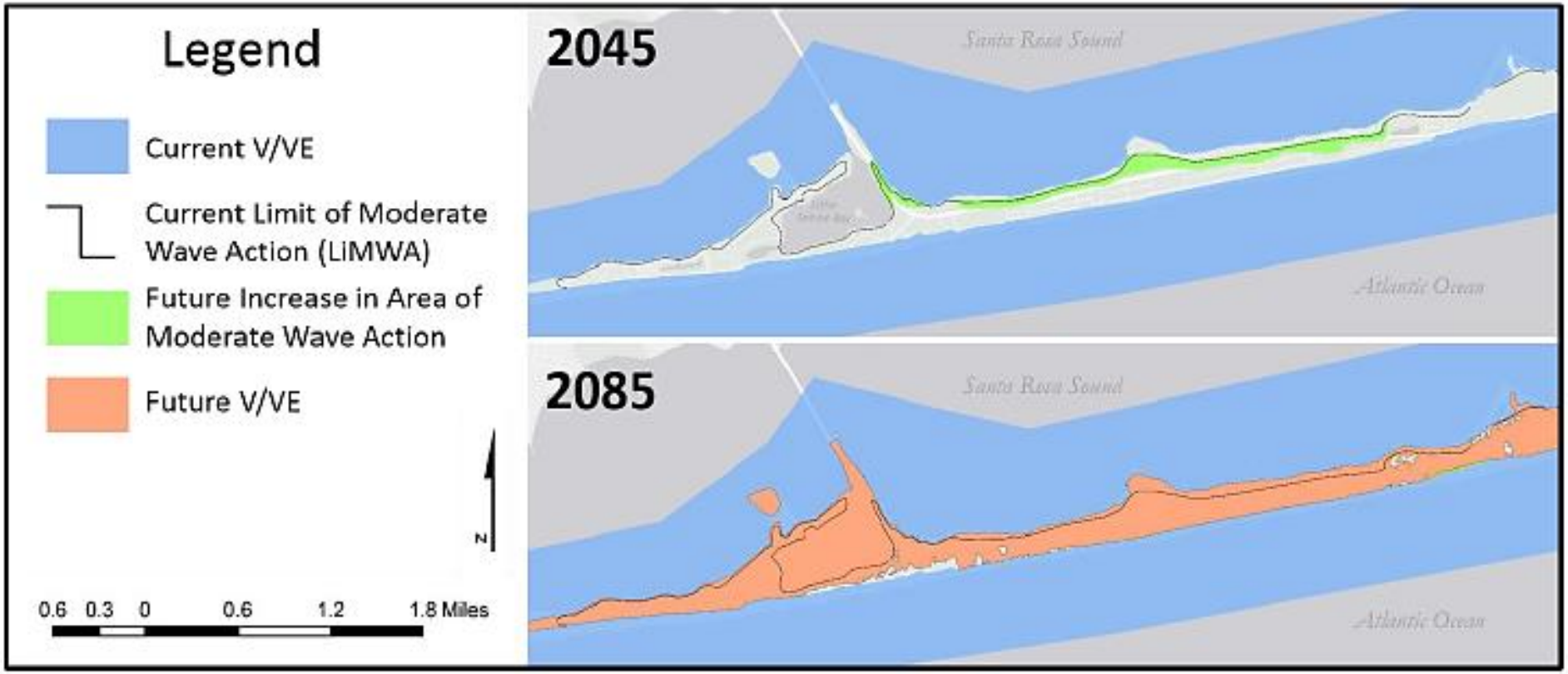


Figure 24. Changes in the VE and LiMWA along western Santa Rosa Island and Pensacola Beach area for the short- the long-term time horizons. Changes depict response to wave hazards to the Medium SLR scenario. Note that the floodplain is not shown to more clearly illustrate changes to the wave hazard zones.

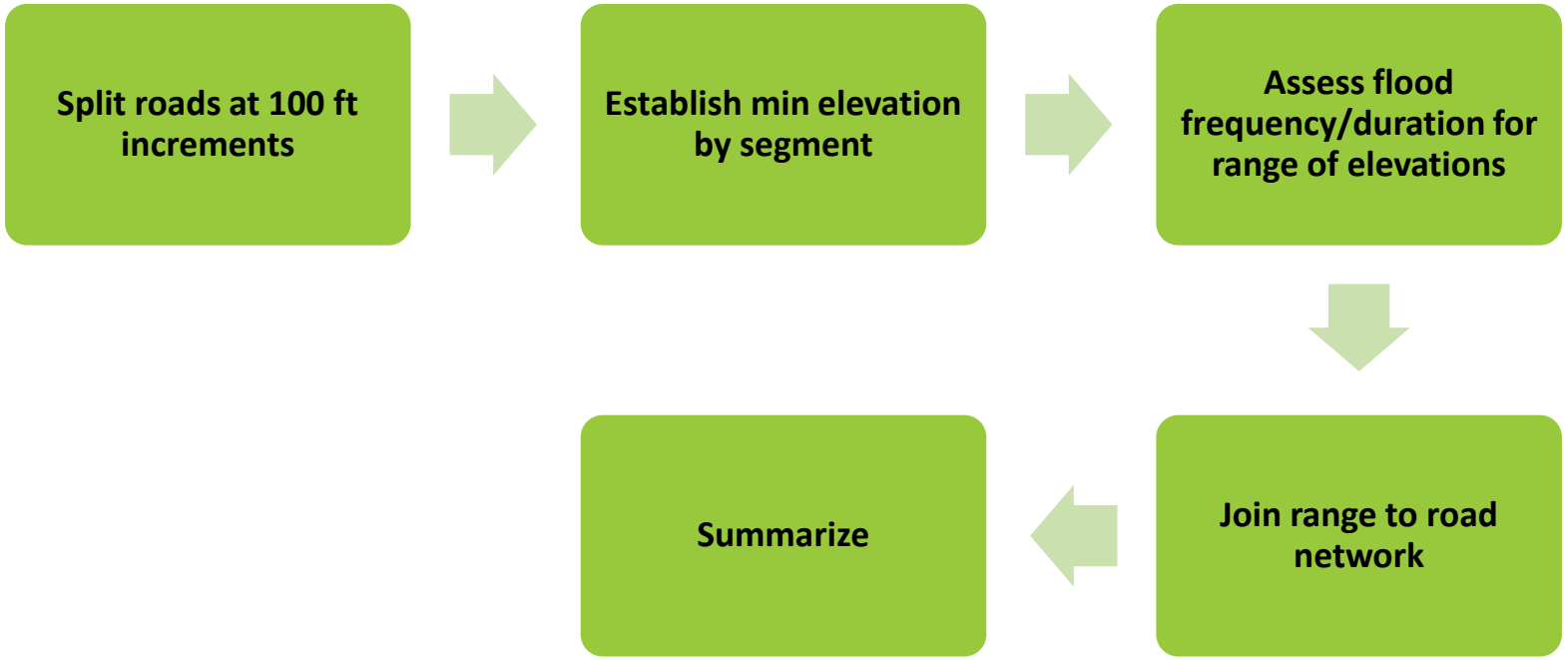
Road Inundation (Mileage and Duration)

St Augustine Example

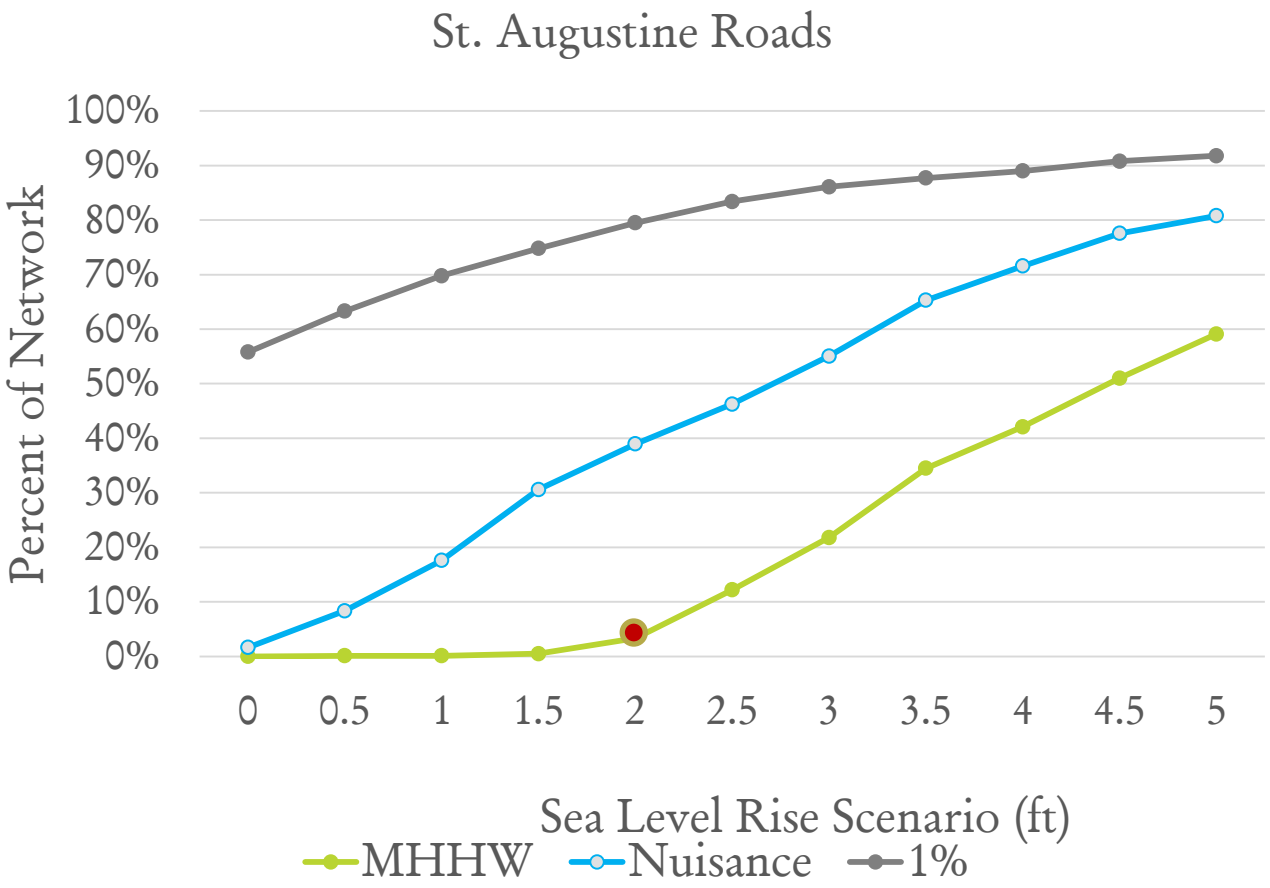
Road Inundation Approach

- Overview:
  - Segment roads into small, discreet segments with assigned elevations
  - Apply NOAA coastal inundation tool to assess the anticipated number and duration for count and duration of instances where water levels will exceed road elevations by segment with each SLR scenario.

Road Infrastructure Process



Vulnerability Assessment - Results



Street Flooding

- Possible tipping point for MHHW around 2 ft.
- At 1.5 ft., 30% of the road network is affected by nuisance flooding
- At 3 ft., over 50% of the road network is affected by nuisance flooding

Vulnerability Assessment - Results

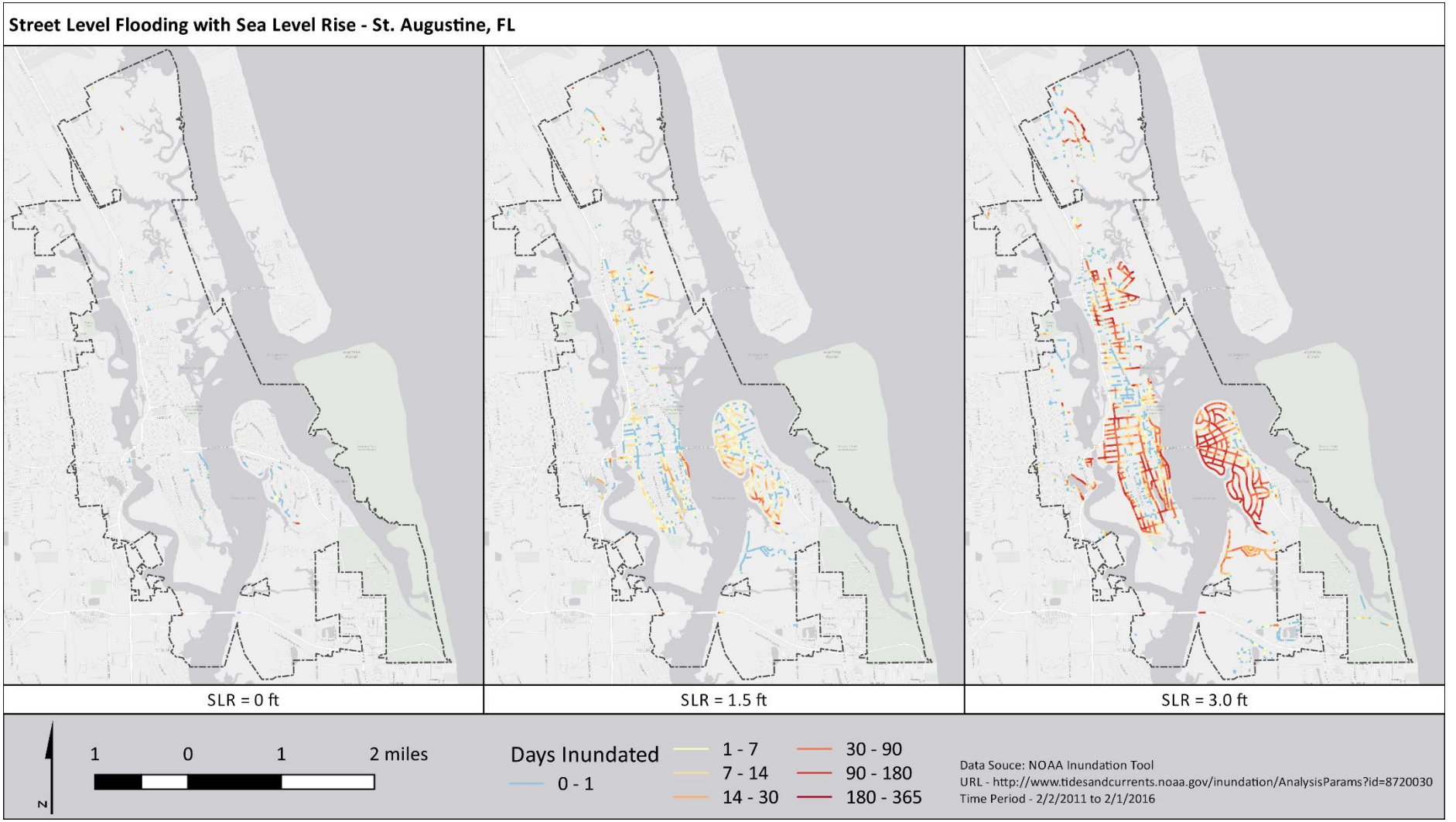
Street Flooding

Table 8. Mileage and percentage of road network affected by nuisance flood level for each SLR increment.

SLR Scenario, ft	Flood Elevation, ft NAVD88	Length of Road Affected, mi	Percent of Network
0	3.75	1.64	2%
0.5	4.25	8.41	8%
1	4.75	17.74	18%
1.5	5.25	30.82	31%
2	5.75	39.22	38%
2.5	6.25	46.60	46%
3	6.75	55.47	55%
3.5	7.25	65.77	65%
4	7.75	72.10	72%
4.5	8.25	78.12	78%
5	8.75	81.38	81%

Nuisance Flood Event

Vulnerability Assessment- Results



Task 2. Adaptation Planning

Adaptation Discussions

Clearwater Example

Issue Area	Specific Issues Identified	Potential Responses Discussed
Stormwater Management	7	8
Flood Insurance and Freeboard	5	4
Coastal Management	1	1
Wastewater Management	2	3
Roads and Bridges	2	2
Disaster Recovery	3	3
Justifying Adaptation Measures	2	2

Adaptation Discussions

Coastal management	- Residents and commercial property owners generally rely on hard armoring and current restrictions limit sea wall heights	➔ Participants agreed that it would be difficult to persuade anyone to replace sea walls with living shorelines, espcially mangroves; any such replacement would likely go forward in a large area rather than parcel-by-parcel; Conservation easements could facilitate a transition from hard armoring
Disaster recovery	- SB 1094 requires adoption of redevelopment component in coastal management plan element; it also authorizes localities to adopt long-term time horizons for all manner of planning decisions	➔ This requirement presents an opportunity for Clearwater to designate locations, developments, or projects as subject to redevelopment restrictions, and to conform those restrictions to expectations about the future viability of various uses
	- Many beachfront structures are single-story structures built on slabs; mobile home parks are situated in areas identified as extremely vulnerable to flooding (nuisance and storm-related)	➔ Participants discussed possibility of presenting strict redevelopment limits as a bet—"if you win, none of this will happen and the restrictions won't matter; if you lose, then down-zoning is appropriate"

Florida Community Resiliency Initiative Pilot Project

Adaptation Plan

for Clearwater, Florida

May 2017

CONTENTS

Changes to 2017 CRS Manual

More about What's New

- The CRS has always credited mapping and regulations that account for future conditions and for sea level rise. The 2017 *Coordinator's Manual* establishes a sea level rise standard for crediting communities that assess and manage the changes anticipated from changing sea levels. The CRS has chosen to require, at a minimum, that communities use the "intermediate-high" projection for 2100, from the report *Global Sea Level Rise Scenarios for the U.S. National Climate Assessment*. This report was published by the National Oceanic and Atmospheric Administration's Climate Program Office in collaboration with 10 federal and academic science institutions.

  The U.S. Army Corps of Engineers' website offers a Sea-Level Change Curve Calculator that communities can use for purposes of CRS credit. Website links and instructions for determining the sea level rise for a community will be available on www.CRSresources.org and on www.FEMA.gov.

- Coastal communities are being provided with more options for watershed management planning credit (WMP) under Activity 450 (Stormwater Management). Credit will be available for watershed plans that assess the impacts of climate change and sea level rise on the local drainage system. This allows a coastal community that has a non-traditional watershed (no natural or constructed channels) but is nonetheless threatened by flooding because of a rise in sea level to receive credit for evaluating its sea-level-related flood problems without a "model" of the watershed.

  This addition reflects the fact that increasing numbers of communities are taking action to mitigate the effects of a changing climate and rising sea levels, and that federal initiatives like that of the Corps and NOAA (see previous bullet) have made such actions feasible. Assessing the impact of sea level rise also provides another option for coastal communities to meet the Class 4 prerequisite of demonstrating that they have "taken appropriate steps to eliminate or minimize future flood losses."

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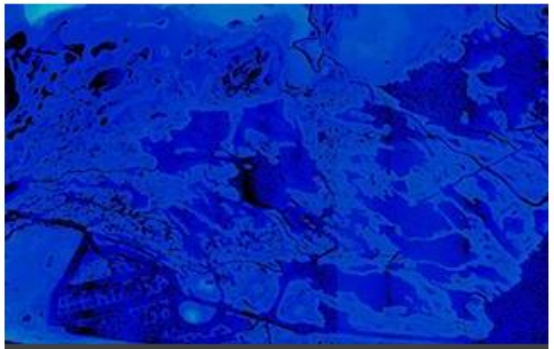
Climate Change | Markets | Regions | SEARCH PORTFOLIO

North Carolina Sea Level Rise Management Study | North Carolina
Preventing Loss to Coastal Communities

Platte River Recovery Implementation Program | Platte River Basin, Nebraska, Colorado, and Wyoming
Adapting Water Management to Climate Changes

Ecological Effects of Sea Level Rise in the Gulf Coast | Gulf of Mexico
Protecting Our Shorelines



NOAA Sea Level Rise Viewer 2 | Nationwide
Protecting Our Coasts

West Creek Flood Response Plan | Douglas County, CO
Using Climate Knowledge to Prevent Flooding

Colorado Flood Threat Bulletin | Colorado
Preparing Communities for Flash Floods