2017

Resilient Volusia County

Prepared by the East Central Florida Regional Planning Council (ECFRPC) for Volusia County and our partners the River to Sea Transportation Planning Organization (R2CTPO), Florida Department of Transportation, UF Geoplan and the Florida Department of Environmental Protection

Volusia County
FLORIDA

East Central Florida Regional Planning Council
est. 1962

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Executive Summary

Flooding and storms have become more frequent across Florida's coastal communities due to changing climate and sea level rise. Local governments and residents are starting to see the beginning impacts sea level rise combined with storms will have on their community. The U.S. Army Corps of Engineers predicts sea level rise along Daytona Beach Shores to be between 0.82 feet to 5.15 feet by 2100. This, along with a 100-year storm, could mean devastation to coastal communities if appropriate planning and action is not taken early enough.

To build resiliency against flooding and sea level rise, the Volusia County Office of Emergency Management partnered with East Central Florida Regional Planning Council (ECFRPC), Florida Department of Transportation, the River to Sea Transportation Planning Organization, and UF Geoplan to assess impacts. Using the FDOT Sea Level Scenario Sketch Planning Tool along with FEMA's Hazus-MH software, impacts of sea level rise, combined with a 100-year-storm were modeled, along with hypothetical alterations of a historical hurricane under sea level rise scenarios.

Using these models and Volusia County data, critical assets such as shelters, airports, power plants, and other critical facilities were assessed to determine potential impacts during such a 100-year storm event with increased coastal flooding. Assessments also included evacuation routes and property impacts. Potential economic impacts were assessed in terms of property value and damage assessments using HAZUS. After analyzing the data Volusia can now begin to prepare for the future impacts of a 100- year storm as sea levels rise.

The study also looked at the different approaches Volusia can use to build resiliency including retreat, accommodate, and protect. Resources, along with recommendations for implementing new data and strategies, policies and information into existing plans throughout the county were discussed. Emphasis was placed on Emergency Preparedness, Land-Use, and Transportation. The data, resources and recommendations within this report should provide Volusia County with a solid foundation to guide conversations and coordination to determine the appropriate approach in each situation. It is important that coastal communities take steps like Volusia County to ensure resiliency.

Photo Courtesy of Volusia County

Acknowledgements

We would like to thank our grant and funding partners including the Florida Department of Environmental Protection – Coastal Partnership Initiative Grant, Volusia County, River to Sea TPO, Florida DOT, and UF Geoplan.

As part of this project, a **leadership team** was developed to oversee the project and model development. Thank you to those members of the leadership team for their time, insight and direction.

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To ensure review and vetting of the pilot project data inputs and outputs for the Sea Level Sketch Planning Tool, a team of **subject matter experts (SME)** was developed. SMEs were representative of County staff as well as staff from the various jurisdictions within Volusia County. Thank you for your time and input.

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Church	Nancy	Volusia County GIS
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Background

Volusia County Office of Emergency Management, in partnership with the East Central Florida Regional Planning Council, Florida Department of Transportation, the River to Sea Transportation Planning Organization, and UF Geoplan, received a Florida Department of Environmental Protection Coastal Partnership Initiative Grant to assess impacts sea level rise may have on the 100-year storm coastal flooding levels and extent. These modeling results were piloted through the Sea Level Scenario Sketch Planning Tool through a coordinated review, training and analysis process.

In an effort to develop appropriate data and analysis for decision making as well as coastal resiliency strategies for the County and provide quality review and input on a model for statewide utilization, the ECFRPC, Volusia County and partners, through this grant project:

1) Conducted a quality assurance review of model outputs;
2) Provided model training for local stakeholders;
3) Analyzed new impact areas resulting from 100-year storm coastal flooding (inclusive of storm surge) based on sea level rise projections resulting from the FDOT Sea Level Scenario Sketch Planning Tool;
4) Identified implementation strategies and educational materials to enhance community resiliency in all aspects for departments within Volusia County, its cities, as well as FDOT and the TPO.

As noted in the methodology section of this report, UF Geoplan Center team utilize d FEMA's Hazus-MH software for modeling 100-year flood hazard areas with the addition of sea level rise resulting from new climate effects. The project team provided a quality assurance review of these data utilizing various experts from county, regional and state agencies. As part of this process, UF and FDOT conducted a workshop in Volusia County to train local jurisdictions on the model and data. This aided in the review and understanding of the model data and helped to advance the integration of resiliency planning across the region.

Using the modeled data, the team analyzed impacts on critical assets such as shelters, evacuation routes, land uses, airports, transit facilities and other critical infrastructure necessary for economic and community resiliency. Analyzing the new flood impacts provides emergency management with the critical information to develop necessary response plans and continued collaboration between critical agencies.

The ECFRPC worked in conjunction with Florida Sea Grant, Deady Law, Stetson University and the City of Satellite Beach on a Sea Grant funded project, to take the results from the 2014-2015 DEP CPI funded to the next level in terms of site specific analysis and public outreach and education. This project utilized some of the outreach efforts of the Sea Grant project in the development of public education resources for Volusia County. This included the template for a series of flooding posters and the creation of a regional resiliency portal which was created in the spring of 2017. The planning of the portal occurred during this project timeframe and will aid in the dissemination of similar educational materials across the central Florida region.

Coastal Flooding/ Surge Modeling Methods

Sea level rise (SLR) is expected to exacerbate coastal flooding events, increasing the extent and depth of flooding as well as the intensity of damage from storms. For this project, researchers from the University of Florida GeoPlan Center looked at two methods for modeling future coastal flood risk under sea level rise scenarios using FEMA's Hazus-MH software. The goal of this modeling was to estimate the depth and extent of coastal flooding under future SLR conditions and assess those impacts to the transportation network. This document outlines the methods tested for the Volusia County pilot area, as part of the Resilient Volusia FDEP Coastal Partnership Initiative grant. The outputs do not include inland flood impacts from the St. Johns River. This modeling will need to be discussed further with UF Geoplan to determine feasibility and methodology to incorporate this information in the future.

Background: Hazus-MH - Multi-Hazard Loss Estimation Methodology

The Multi-Hazard Loss Estimation Methodology (Hazus-MH) is a standardized methodology created by the Federal Emergency Management Administration (FEMA) to estimate potential losses from earthquakes, hurricane winds, and floods. Hazus-MH contains multiple models for estimating losses from various hazards, including the Earthquake Model, the Flood Model, and the Hurricane Model.

The Flood Model is used to estimate riverine and coastal flood hazards and potential damage to buildings, infrastructure, and land use. The software models specific return intervals of flooding (such as the 100-year return interval or commonly referred to "100-year flood event" or "100-year storm") and damages resulting from those events. The Hurricane Wind Model is used to estimate hurricane winds and potential damage to buildings for the Atlantic and Gulf Coast regions and Hawaii. There is also an option to model the combined flood and wind hazards to produce hurricane-induced coastal surge. FEMA's Hazus-MH website: https://www.fema.gov/hazus

Method 1: Hazus-MH Coastal Flood Hazards Model: Analyzing 100-year storms-surge with SLR Scenarios

The first method to model potential future storm surge utilized the Coastal Flood Hazards component of the Hazus-MH Flood Model. This model follows FEMA's methodology for developing the Flood Insurance Rate Maps (FIRMs), where flood frequency and flood magnitude (or depth) are used to define flood hazard. The model relies on the 100-year Stillwater elevation (SWEL) and Stillwater depth (SWD) to identify the inland impacts of storm surge. Coastal flooding scenarios were run on the entire Atlantic coastline of Volusia County using the FEMA 100-year or 1% annual chance flood event as a baseline scenario. Nine scenarios of future SLR were then modeled by adding the SLR amounts to the coastal Stillwater elevations for the base 100-year storm.

The SLR scenarios used for these model runs are from the U.S. Army Corps of Engineers, and are consistent with the modeling and vulnerability analysis conducted by the East Central Florida Regional Planning Council for other counties and communities in the east central Florida region. In Table 1 (below), the SLR values are listed in feet, relative to mean sea level (MSL), and utilizing local sea level trend information from the Daytona Beach Shores tide station. At 2040, the range of projected SLR is

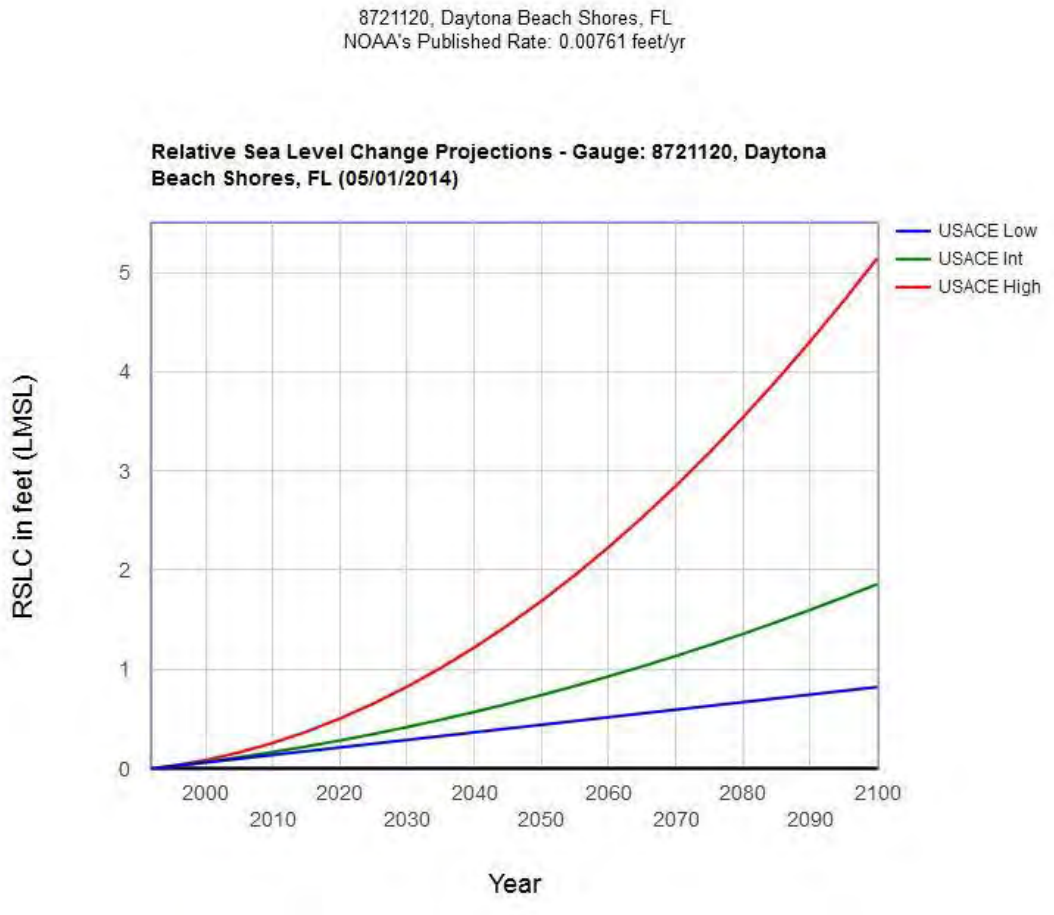
from 0.37-feet to 1.22-feet. At 2070, the range of projected SLR is 0.59-feet to 2.85-feet. At 2100, the range of projected SLR is from 0.82-feet to 5.15-feet. Table 2 below is a graph plotting the SLR values in Table 1.

Table 1: U.S. Army Corps of Engineers Sea Level Rise Projections in Feet, Daytona Beach Shores, FL

USACE SLR Projections
Feet of RSLR (relative to MSL)
Daytona Beach Shores, FL

	Low	Intermediate	High
2040	0.37 ft	0.57 ft	1.22 ft
2070	0.59 ft	1.14 ft	2.85 ft
2100	0.82 ft	1.86 ft	5.15 ft

Table 2: Relative Sea Level Change Projections, Daytona Beach Shores, FL, U.S. Army Corps of Engineers sea-level change calculator



The Hazus-MH software allows the user to enter the Stillwater elevations for different flooding event return rates (for example: 10% annual chance, 2% annual chance, 1% annual chance, 0.2% annual chance). SWELs for the 1% annual chance flood were obtained from the 2014 FEMA Flood Insurance

Study (FIS) for Volusia County. For Volusia County 2014 FIS, there are 49 coastal transects; each lists the 1% annual chance SWEL of 6.9 Feet NAVD88.

For each of the nine scenarios, the relative SLR amount was added to the Stillwater Elevation (SWEL), to represent a future SWEL. The Coastal Flood Hazard Model was then run with the future SWEL. A 5-meter Digital Elevation Model (DEM), compiled with Lidar data by the GeoPlan Center, was used for the modeling. The model outputs include depth grids of the 100-year storm surge which were then overlaid with data to analyze impacts under each of the nine scenarios.

The scenarios do not include inland flood impacts from the St. Johns River. This modeling will need to be discussed further with UF Geoplan to determine feasibility and methodology to incorporate this information in the future.

Method 2: HAZUS-MH Coastal Surge Model:

Modeling Historic Hurricanes plus SLR

The second method to model future storm surge also utilized FEMA's Hazus-MH, but a different model – the Coastal Surge Model. This model is a more recent addition to Hazus and couples storm surge and wave modeling functionality, using SLOSH for storm surge and SWAN for wave heights. The purpose of the model is to develop an overall estimate of combined coastal wind and flood losses for a single hurricane event. Previous Hazus-MH functionality allowed for wind-only or flood-only loss analysis.

The UF GeoPlan Center investigated this method as a way to model historic storms with the addition of SLR, to evaluate how SLR might change the extent and depth of flooding from a single storm event. For the Volusia County study area, a historic storm was selected from the available historical hurricanes in Hazus-MH Coastal Surge Model. One major limitation of the model is that only historical hurricanes of a Category 3 and higher are available, which greatly reduced the selection pool of hurricanes. Historically, there has been a low frequency of Category 3 or higher hurricanes making landfall along the Volusia County coastline. The closest historic hurricane available in the Hazus-MH hurricane model was Hurricane Dora, which made landfall near St. Augustine in 1964. The expected storm surge from this historic hurricane was low, because of the landfall location (considerably north of Volusia County) and the surge was not from the right front quadrant, where the greatest surge is typically expected.

First, the coastal surge model was run for Hurricane Dora to represent a baseline representation of historical storm surge. Next, increments of SLR were added to the initial water level when running the hurricane model to simulate the same hurricane making landfall from higher sea levels. Maps of storm surge from the resulting model runs are available for viewing in the beta map viewer. It is the project team's recommendation that the Coastal Surge Model needs more investigation and that another geographic area, which has historically experienced more direct hits from hurricanes, be modeled.

Hazus Caveats

The purpose of the Hazus-MH modeling was to estimate the extent and depth of coastal flooding under a future 100-year storm event including the sea revel rise conditions. While the Hazus-MH Flood Model uses a similar methodology for developing the Digital Flood Insurance Rate Maps (DFIRMs), the model results should not be confused with the 100-year floodplain maps, which delineate current flood risks. The base 100-year flood modeled with Hazus may differ with the 100-year coastal floodplain FIRM due to different elevation data inputs, flood model simplifications, and flood model enhancements:

- The elevation data used to create the DFIRMs may be different than what was used in Hazus. For the Hazus flood modeling for this project, the GeoPlan Center used a lidar-based Digital Elevation Model that was approximately 5.4-meter in horizontal resolution (cell size). Both the resolution of the elevation data and the resolution (or cell size) at which the models were processed have an impact on the resulting areas identified as flooded. Generally, the lower the cell size, the higher the accuracy of the output model results.
- The Hazus flood model is similar to the DFIRM methodology, but contains model simplifications that allow users to estimate flood hazards with less input and knowledge.
- Additionally, Hazus contains flood model enhancements that "extend and improve some aspects of FEMA's models, by incorporating more recent scientific developments" (FEMA, Multi-hazard Loss Estimation Methodology Flood Technical Manual, p. 4-77).

How the Hazus Outputs Can Be Used

The Hazus outputs can be used by emergency management staff, planning departments, floodplain managers, and resiliency planners for hazard identification, risk assessment. mitigation planning, and emergency preparedness. Rising sea levels are expected to increase the extent, depth, and frequency of coastal flooding. Hence, it is important to overlay the Hazus model results with other model results of current and future flood risk to get a more comprehensive picture of flood risk for an area. For example, these maps can be used in combination with current floodplain maps, current storm surge zones, and future sea level rise. Together, these overlays can estimate areas more prone to future flood risk, based on current flood risk and rising sea levels. These model results should not be used to determine regulatory floodplain areas or building-specific locations. While Hazus can estimate individual building losses, the results should be considered as an average for a group of similar buildings. These model results are estimates of future flood risk based on the best available elevation data, current Hazus flood models, and projections of sea level rise. The models should be updated in the future to reflect the best available elevation data and climate science.

Analysis Findings

Infrastructure and transportation facility data was collected from Volusia County, Florida Geographic Data Library (FGDL) and available ECFRPC datasets. Facilities that were assessed through this analysis include:

- Designated Evacuation Routes
- Parcel Infrastructure and Land Uses
- Shelters
- Transportation Facilities
- Public Works Facilities
- Emergency Management Centers
- Other Critical Facilities
- Other County/City Facilities

ALLOWABLE RISK AND LIFE SPAN SHOULD BE CONSIDERED WHEN PLANNING FOR SEA LEVEL RISE. RANGES BETWEEN SCENARIOS SHOULD BE EXAMINED BASED UPON PLANNING HORIZONS AND SPECIFIC FACILITY PLANNING

Each area was analyzed based on the based 100-year storm coastal flooding and each of the sea level rise scenarios low, intermediate and high, for the years 2040, 2070, and 2100. While the tables depict all the scenarios, concentration of discussion pertains mainly to the intermediate and high scenarios. This is due to the fact that the low scenario is based on historical sea level rise and does not incorporate changing conditions. Therefore, this run is primarily for comparison purposes only.

Land Area and Depth

The land area analysis examined the total acreage in Volusia and possible percentage of coastal flooding with a 100-year storm. Volusia County has many low-lying coastal areas making it susceptible to flooding events that can be intensified greatly by sea level rise. Without accounting for sea level rise, a 100-year coastal flood event would leave approximately 6.1% of Volusia flooded today. Table 3 below shows how much sea level rise will increase this extent of flooding. The intermediate scenario anticipates a 15% increase in coastal flood extent by 2070, impacting 7% of the county and a 24% increase by 2100. In the 2100 high scenario, almost 10% of Volusia will be vulnerable to flooding; an approximate 56% increase from the base 100-year storm coastal flood, while 34% of this increased coastal flooding may be recognized by the year 2070. The areas around Daytona Beach and Ormond Beach are also expected to see increased extents of coastal flooding, as well as the New Smyrna Beach area.

Assessing which areas are most susceptible to flooding and planning mitigation actions now can decrease future damage of flooding. If an area is known to flood, action should be taken to relocate critical infrastructure in the near future and also limit new development in the area. The pages that follow include depth maps depicting the modeled 100-year storm coastal flood areas and depth respective to each sea level rise scenario and year.

Table 3: Coastal Flood Extent Change by SLR Scenario and Year

Hazus-MH Coastal Flood Model Run	Total Acreage Flooded	Percent of Volusia Flooded	Percent Change
	55,738 acres	6.1%	
100-year + 2040 Low SLR	58,885 acres	6.4%	6%
100-year + 2070 Low SLR	60,153 acres	6.6%	8%
100-year + 2100 Low SLR	61,934 acres	6.8%	11%
100-year + 2040 Int SLR	60,153 acres	6.6%	8%
100-year + 2070 Int SLR	64,264 acres	7.0%	15%
100-year + 2100 Int SLR	69,314 acres	7.6%	24%
100-year + 2040 High SLR	64,810 acres	7.1%	16%
100-year + 2070 High SLR	74,463 acres	8.1%	34%
100-year + 2100 High SLR	87,004 acres	9.5%	56%

Due to the topography of the County, as higher levels of sea level were added to the base flood, not only did the extent of flooding increase, the depth of flooding increased in vulnerable areas. The modeling projects that by 2040, when using the intermediate to high scenario range, an increase of 3.5-4.17 feet (14.25-14.92 feet max depth) of flood depth above the 100-year stillwater elevation o can be expected; by 2070 an increase of 4.08-5.75 feet (14.83-16.50 feet max depth); and by 2100 an increase of 4.75-8.08 (14.75-18.83 feet max depth). Areas that may experience the greatest change in flood depth should be examined and stakeholders should consider potential changes to building codes, mitigation opportunities and other strategies to protect life and property as well as critical facilities and major transportation facilities that would be essential for evacuations and recovery. These facilities not only include governmental facilities but also businesses critical to community recovery such as food stores, electrical and water suppliers and others.

Flooded Home in Debary, FL

Photo Courtesy of Volusia County

Table 4: Coastal Flood Extent Change by SLR Scenario and Year

Hazus-MH Coastal Flood Model Run	Max Flood Depth (Inches)	Max Flood Depth (Feet)	Increase (feet)	RSLR Feet
	129	13.71		0
100-year + 2040 Low SLR	168	14.00	0.29	0.37
100-year + 2070 Low SLR	171	14.25	0.54	0.59
100-year + 2100 Low SLR	174	14.50	0.79	0.82
100-year + 2040 Int SLR	171	14.25	0.54	0.57
100-year + 2070 Int SLR	178	14.83	1.12	1.14
100-year + 2100 Int SLR	186	15.50	1.79	1.86
100-year + 2040 High SLR	179	14.92	1.21	1.22
100-year + 2070 High SLR	198	16.50	2.79	2.85
100-year + 2100 High SLR	226	18.83	5.12	5.15

Flooding in Debary, FL. area

Photo Courtesy of Volusia County

Figure 1: 100-Year Storm Coastal Flood Depth 2040 Low

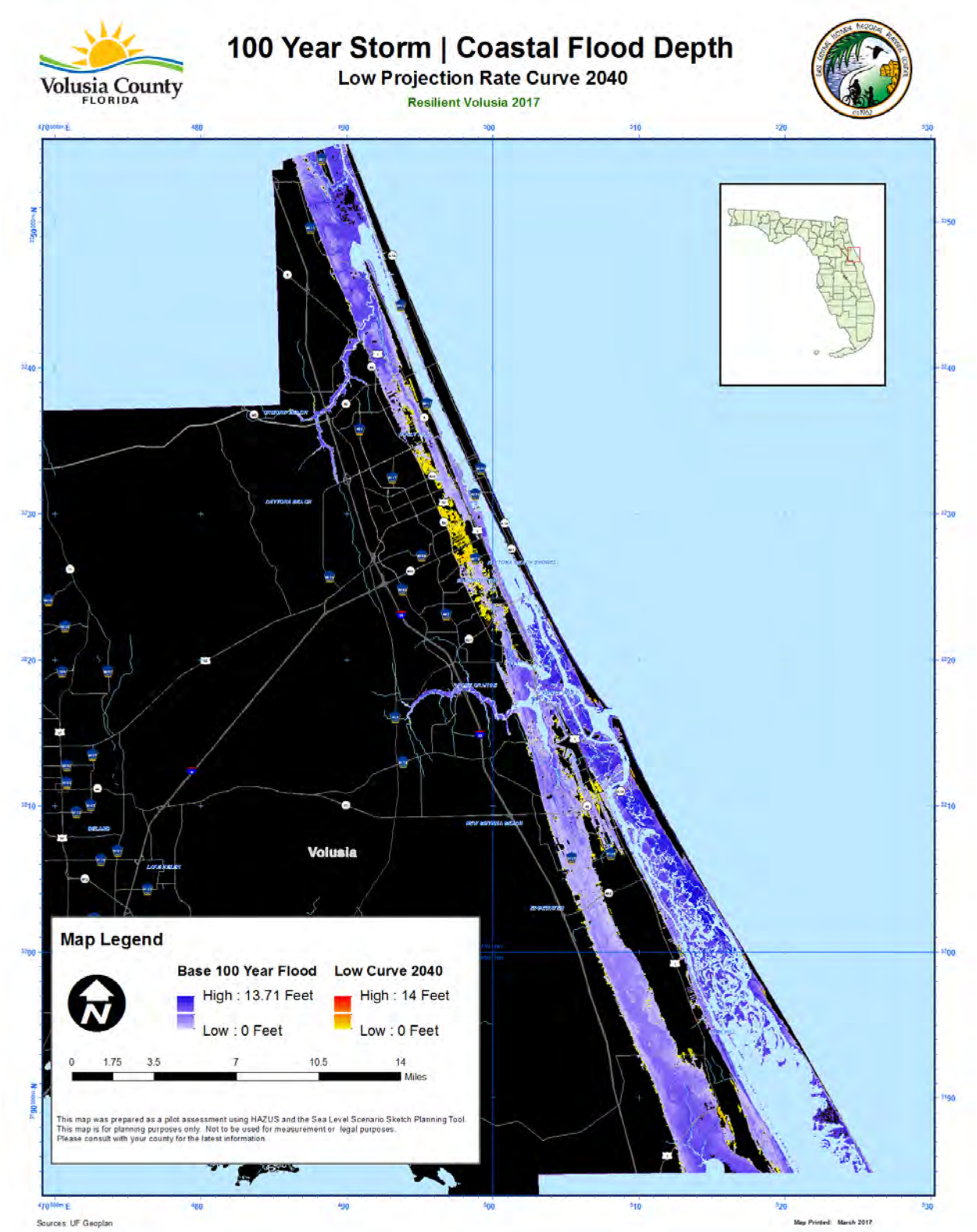


Figure 2: 100-Year Storm Coastal Flood Depth 2070 Low

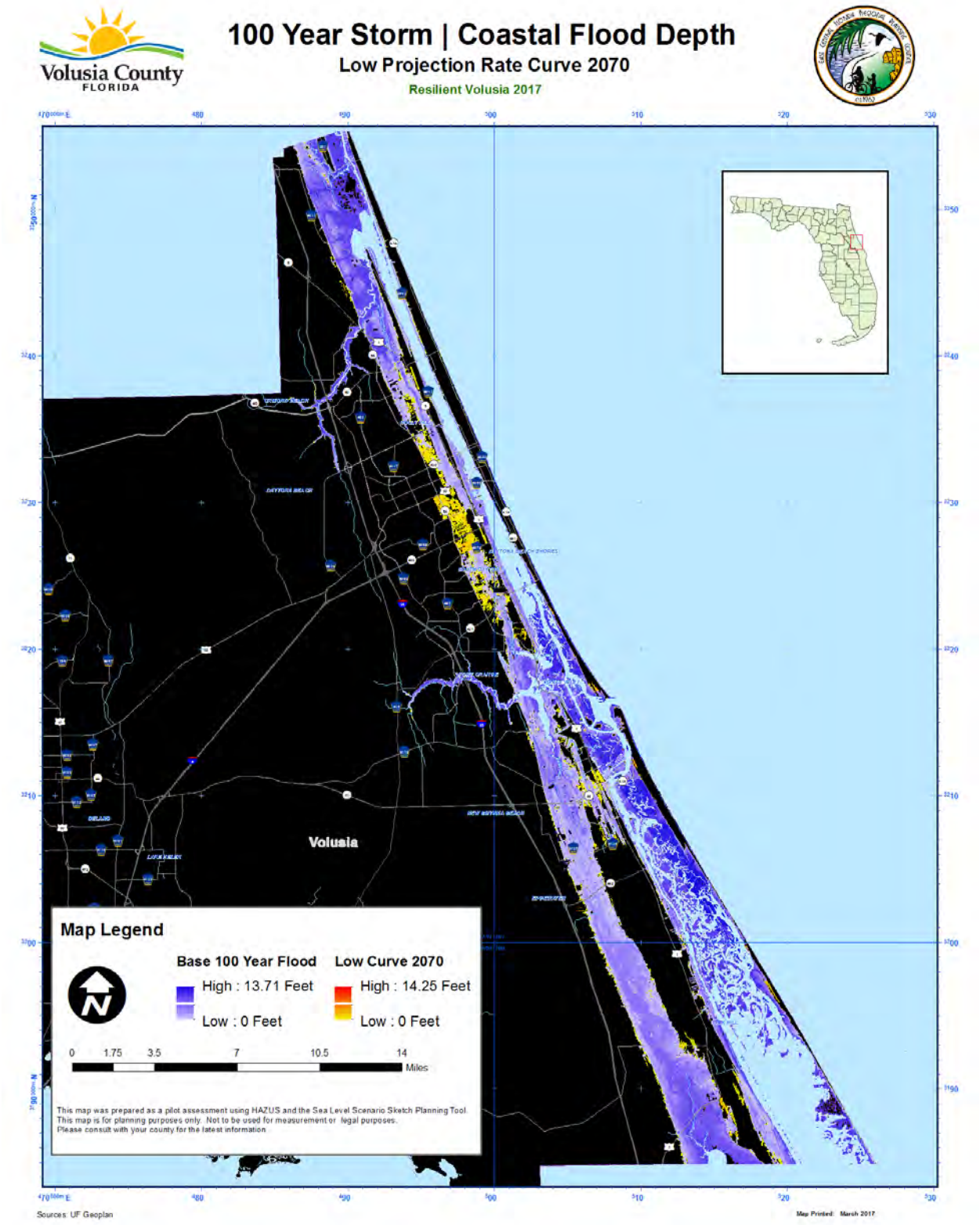


Figure 3: 100-Year Storm Coastal Flood Depth 2100 Low

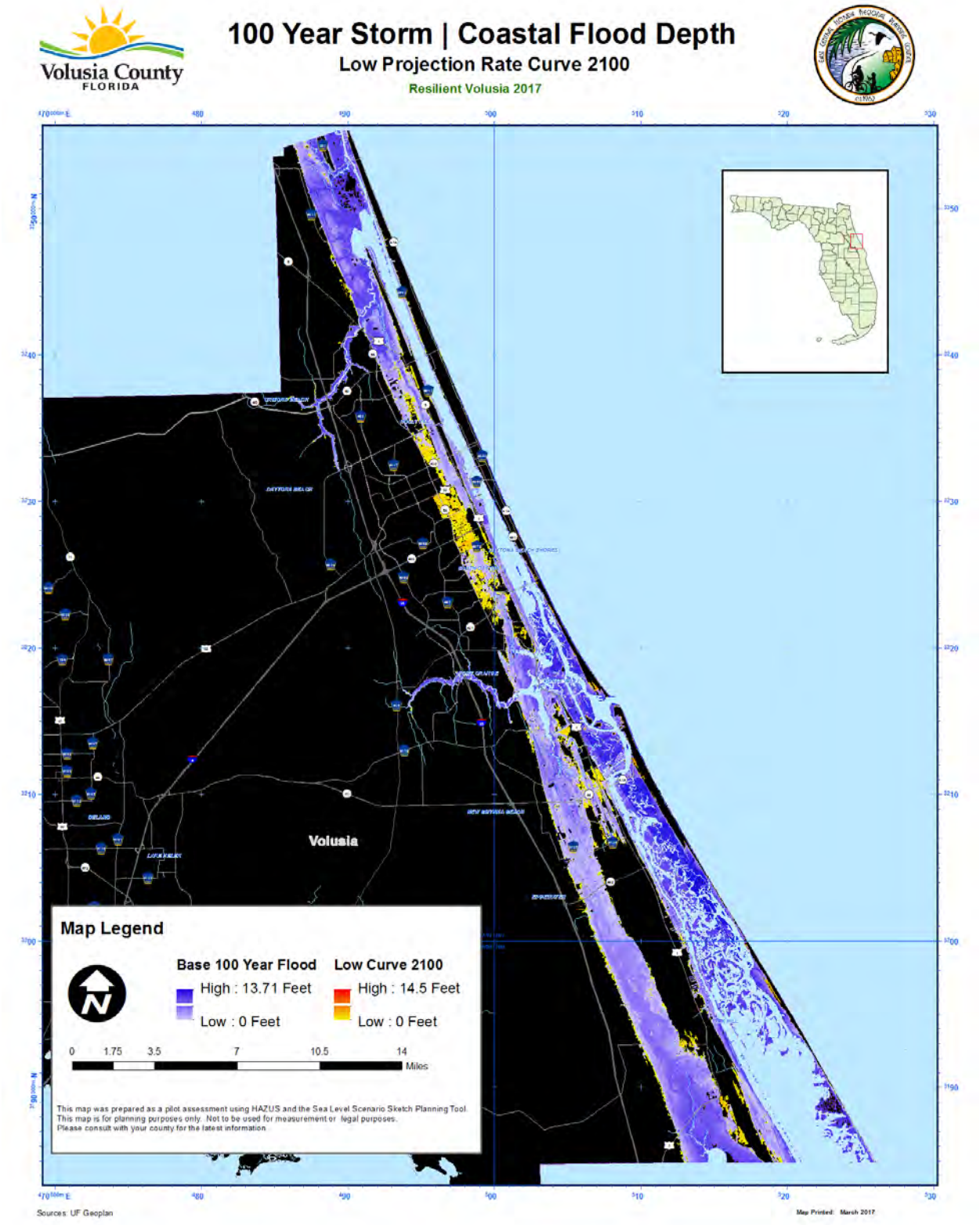


Figure 4: 100-Year Storm Coastal Flood Depth 2040 Intermediate

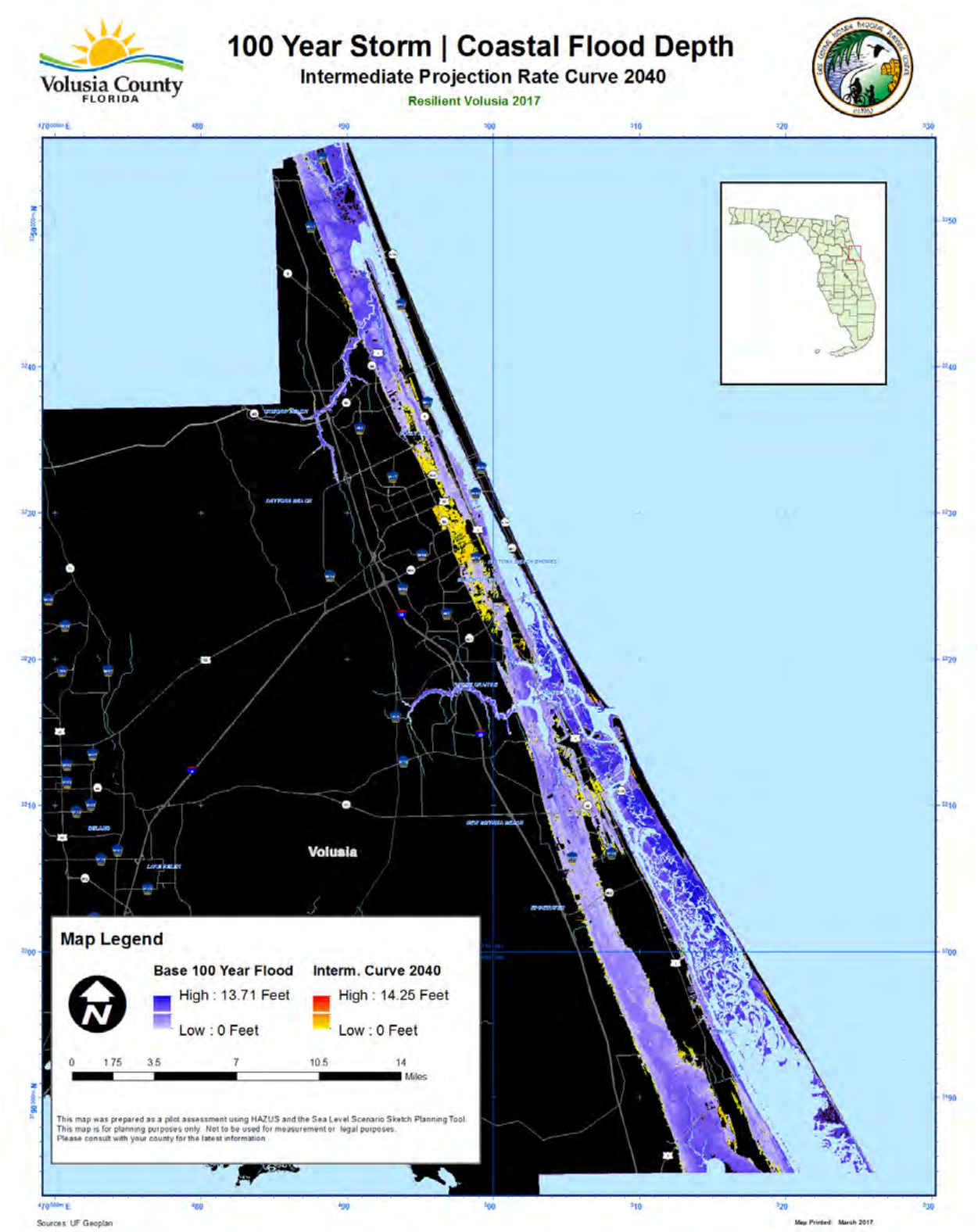


Figure 5: 100-Year Storm Coastal Flood Depth 2070 Intermediate

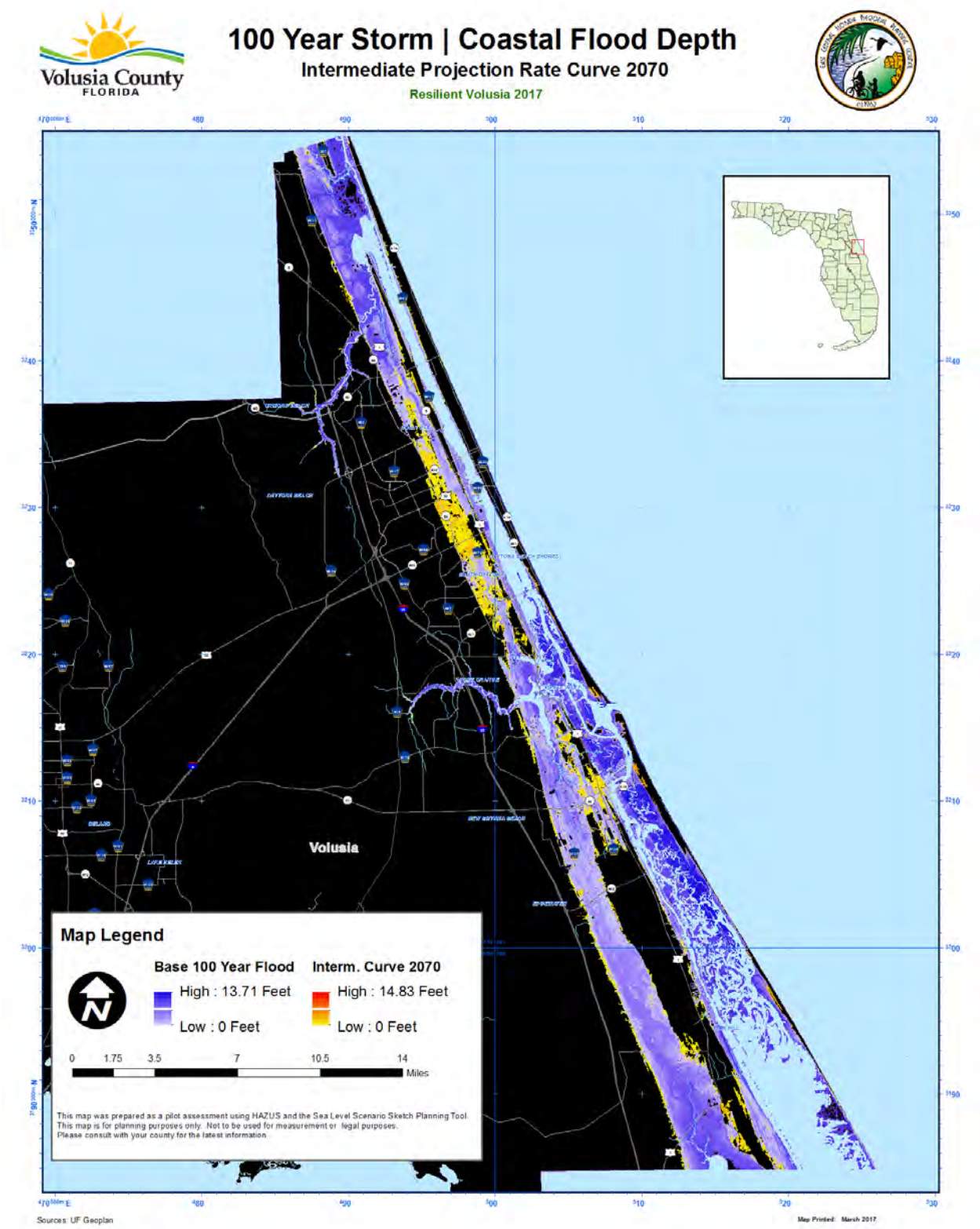


Figure 6: 100-Year Storm Coastal Flood Depth 2100 Intermediate

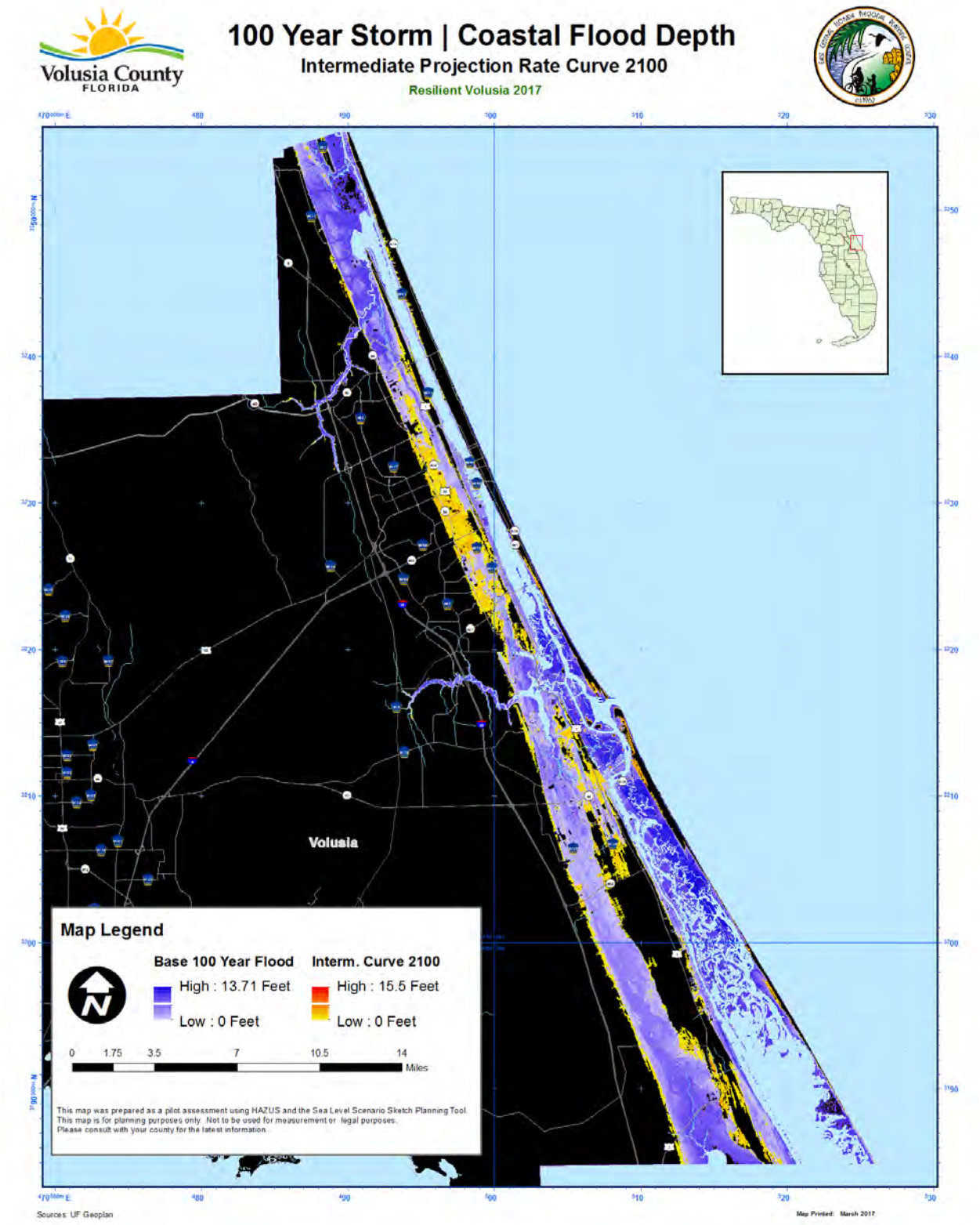


Figure 7: 100-Year Storm Coastal Flood Depth 2040 High

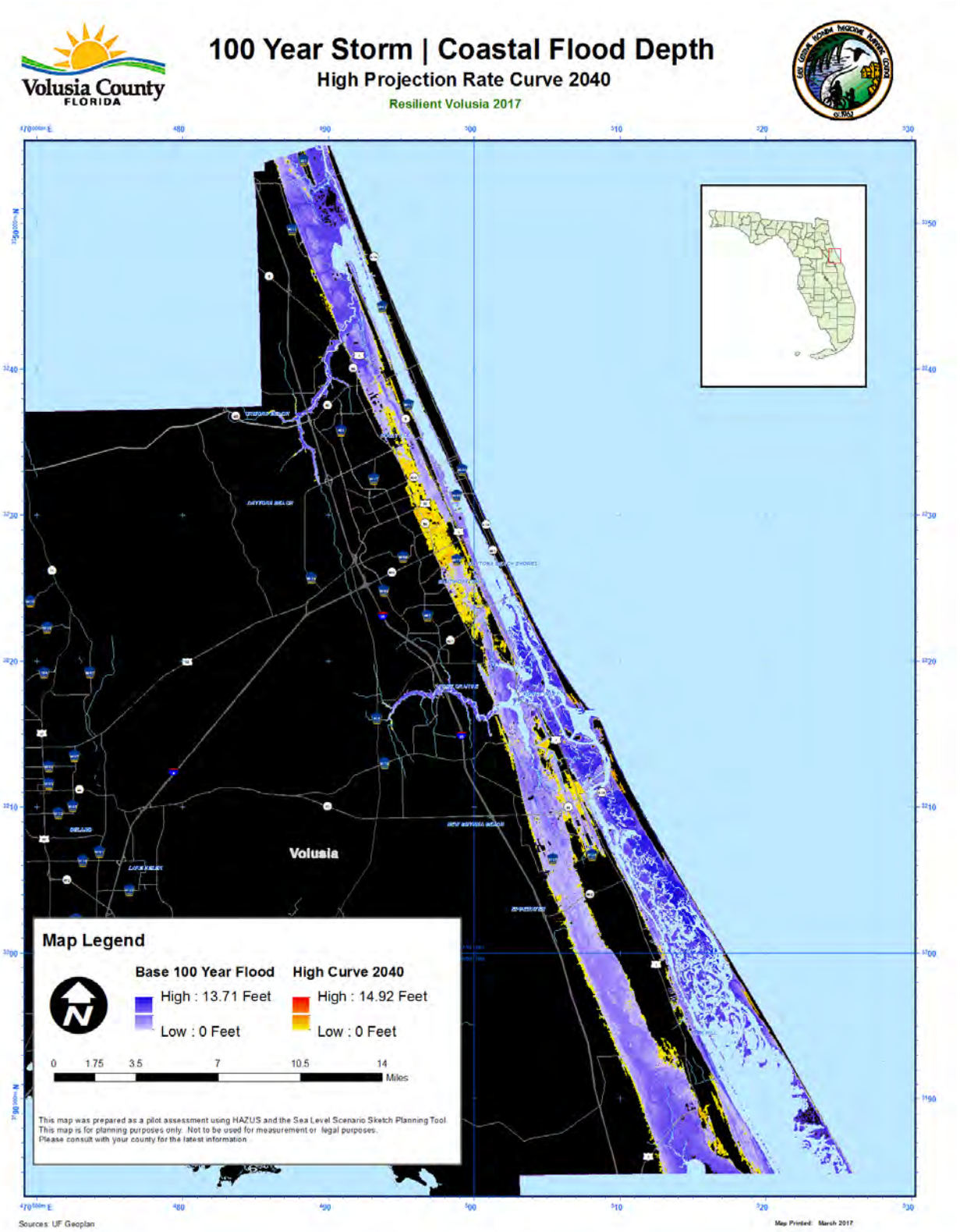


Figure 8: 100-Year Storm Coastal Flood Depth 2070 High

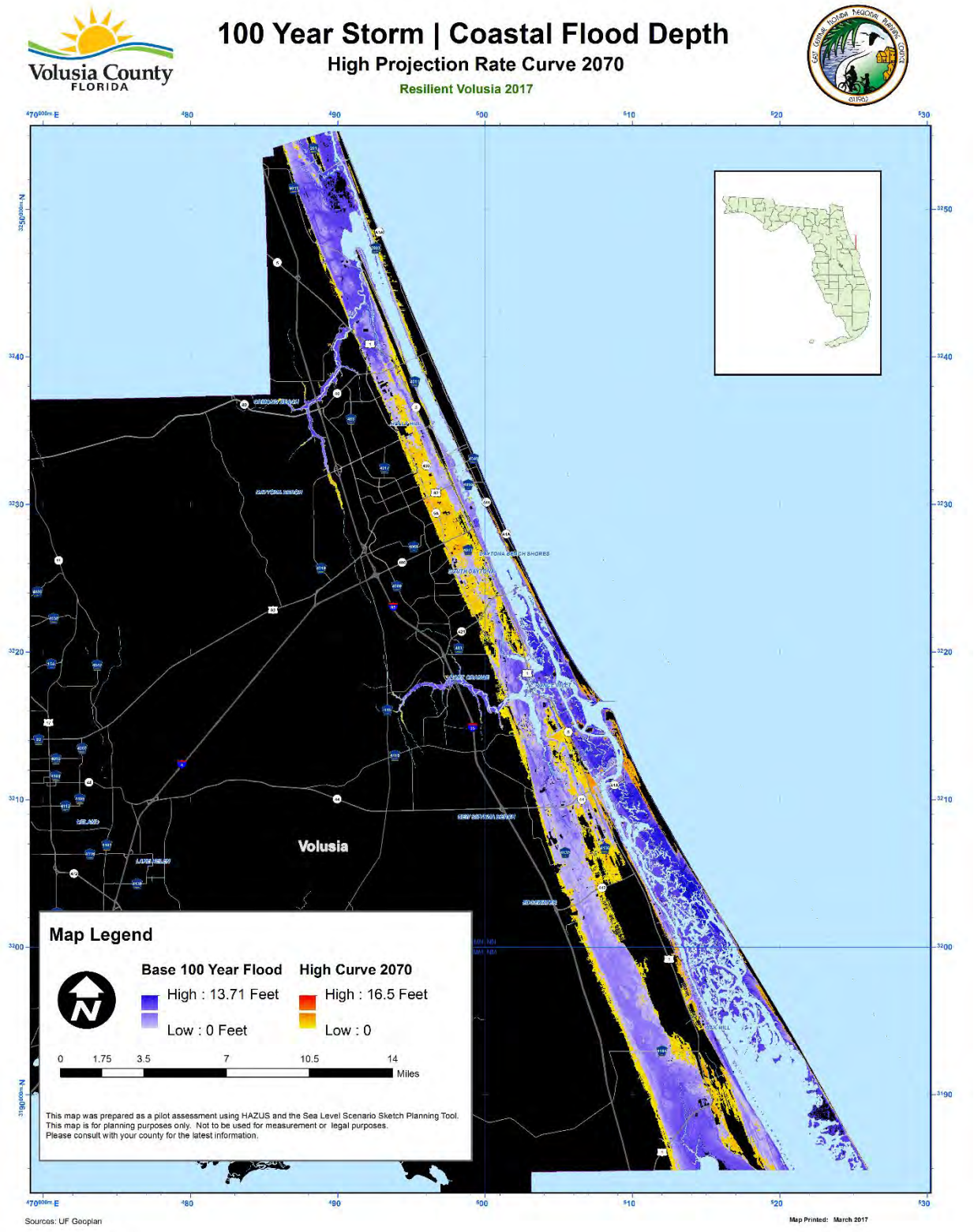
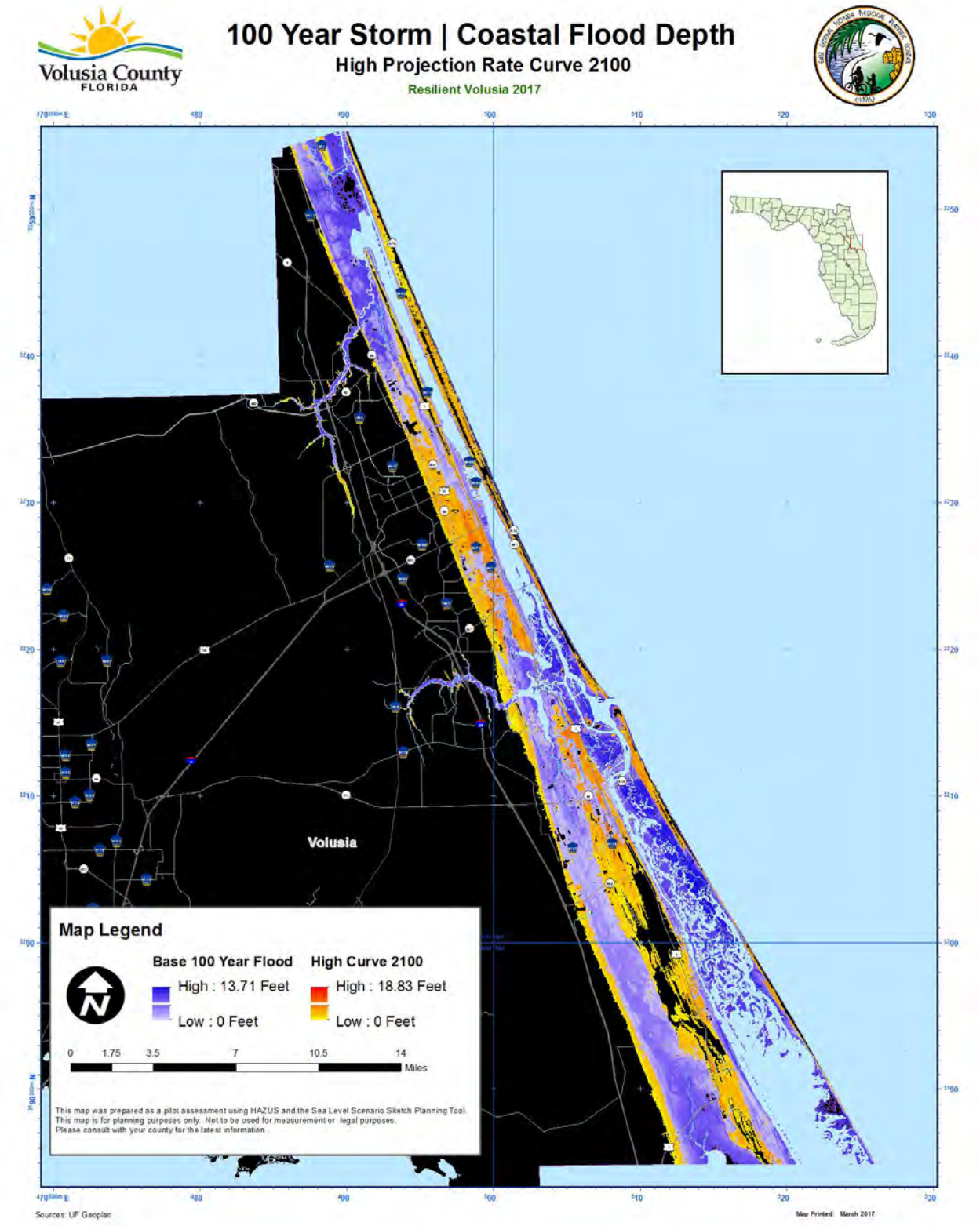


Figure 9: 100-Year Storm Coastal Flood Depth 2100 High



Land Use

Volusia County Property Appraiser data (2016) was used to assess the types of land uses and values that may be impacted by increased 100-year storm flood depths and extent as sea levels rise. While this land use and value information is a snapshot in time, it provides decision makers with important information as it pertains to the tax base and potential costs associated with repeated or isolated flooding. As sea levels rise and the 100-year storm flood depth and extent increases, the number of vulnerable properties increase between 31%-50% by 2040, 50%-91% by 2070 and 68%-154% by 2100 (comparing only intermediate and high scenarios). Due to the nature of the NOAA High Projection Rate Curve between 2070-2100, there is an 33% increase in properties vulnerable to coastal flooding from a 100-year storm event between 2070 and 2100 in the high curve and only an 11% increase in the intermediate curve. See table 7.

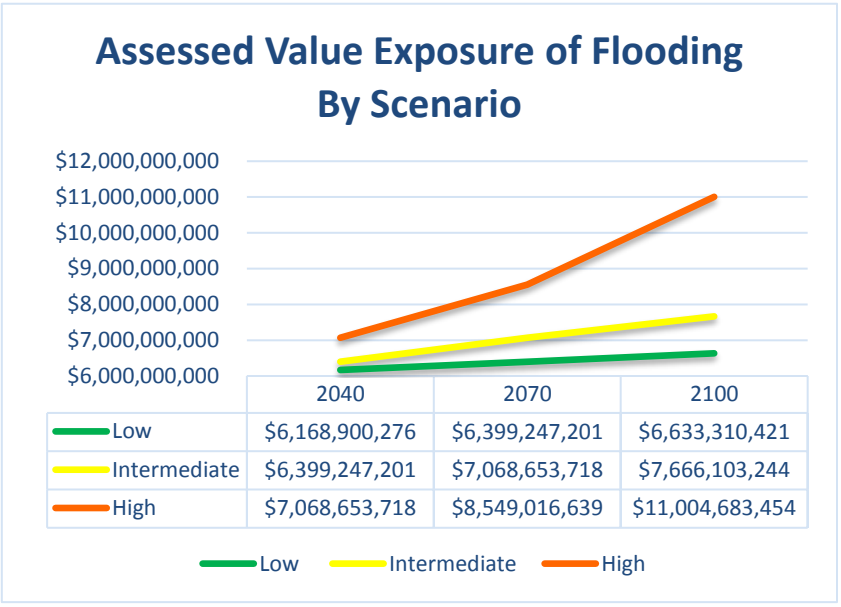
Throughout each scenario, the percentages of each land use type remained consistent. As would be expected from typical development along the Florida coast, residential parcels consistently comprised the overwhelming majority (89%-91%) of the vulnerable parcels in each scenario. Commercial, retail, and office land uses followed with approximately 6% of the parcels. Vacant lands (including rights of way, etc.) and agricultural lands make up approximately 1.2% of vulnerable parcels which could limit potential properties that could serve for mitigation purposes. Further proximity analysis of these properties to other vacant properties could serve to identify opportunities for flood mitigation and conservation priorities.

Table 5: Land Use Summary by Sea Level Rise Scenario

		Land Use Summary of Parcels Vulnerable to Coastal Flooding from 100-Year Storm Influenced by Sea Level Rise							
		Residential	Commercial and Office	Vacant/Other	Industrial	Institutional	Agriculture		
	Base	89.4%	5.9%	0.9%	2.0%	1.6%	0.2%	Base	
LOW	2040	89.2%	6.0%	0.9%	2.0%	1.6%	0.2%	2040	LOW
	2070	89.4%	5.9%	0.9%	2.0%	1.6%	0.2%	2070	
	2100	89.4%	6.0%	0.9%	1.9%	1.5%	0.2%	2100	
INTER	2040	89.4%	5.9%	0.9%	2.0%	1.6%	0.2%	2040	INTER
	2070	89.4%	6.0%	0.9%	1.9%	1.5%	0.2%	2070	
	2100	89.4%	6.1%	1.0%	1.9%	1.5%	0.2%	2100	
HIGH	2040	89.4%	6.0%	0.9%	1.9%	1.5%	0.2%	2040	HIGH
	2070	89.7%	6.0%	0.9%	1.9%	1.4%	0.2%	2070	
	2100	90.8%	5.5%	0.8%	1.5%	1.2%	0.2%	2100	

The financial exposure table includes all parcels, built and unimproved. Again, while this is a snapshot of value in 2016, these properties provide significant tax value to the county and cities while also serving as one of the biggest investments for residents. As the number of parcels vulnerable to coastal flooding by a 100-year storm increases through 2100, so does the total of impacted financial exposure. As more properties become vulnerable to flooding, the costlier the damage may be.

Table 6: Assessed Value Exposure of Coastal Flooding by Sea Level Rise Scenario



	2040	2070	2100
Low	$6,168,900,276	$6,399,247,201	$6,633,310,421
Intermediate	$6,399,247,201	$7,068,653,718	$7,666,103,244
High	$7,068,653,718	$8,549,016,639	$11,004,683,454

The table below illustrates financial exposure of parcels, vacant and improved, by land and building value, as well as assessed and taxable value. The high scenario, as would be expected, impacts the greatest number of properties and therefore has the highest financial exposure vulnerabilities. The cost associated with flood damage and exposure falls on both the owner and the government depending upon the use of the parcel and the potential loss of tax income when properties may no longer be "buildable" due to increased flooding, accessibility or other potential future regulations restricting building due to hazards. There will need to be discussion concerning potential tax loss and how to rectify this and/or utilize loss properties for mitigation, public access or other uses.

Table 7: Financial Exposure to Parcels Vulnerable to Coastal Flooding from 100 Year Storm by Sea Level Rise Scenario

		Financial Exposure to Parcels Vulnerable 100 Year Storm Influenced by Sea Level Rise						
		Vulnerable Parcels	Land Value	Building Value	Assessed Value	Taxable Value		
Base		25714	$ 2,291,705,045	$ 3,735,302,237	$ 5,399,873,825	$ 4,456,396,876	Base	
LOW	2040	31403	$ 2,521,819,535	$ 4,351,099,540	$ 6,168,900,276	$ 5,014,165,145	2040	LOW
	2070	33264	$ 2,596,192,164	$ 4,528,449,458	$ 6,399,247,201	$ 5,190,350,384	2070	
	2100	34875	$ 2,672,839,066	$ 4,708,938,658	$ 6,633,310,421	$ 5,396,415,701	2100	
INTER	2040	33264	$ 2,596,192,164	$ 4,528,449,458	$ 6,399,247,201	$ 5,190,350,384	2040	INTER
	2070	38100	$ 2,833,487,953	$ 5,027,695,416	$ 7,068,653,718	$ 5,761,449,737	2070	
	2100	42660	$ 3,045,717,868	$ 5,491,210,039	$ 7,666,103,244	$ 6,269,147,160	2100	
HIGH	2040	38100	$ 2,833,487,953	$ 5,027,695,416	$ 7,068,653,718	$ 5,761,449,737	2040	HIGH
	2070	48461	$ 3,372,370,874	$ 6,137,220,176	$ 8,549,016,639	$ 7,030,075,573	2070	
	2100	64507	$ 4,212,705,206	$ 8,102,058,541	$ 11,004,683,454	$ 9,074,512,864	2100	

An analysis of built parcels looked at the age of the building. As noted below, over 30% in all scenarios, consistently, were built pre-1970. This is important as these buildings may not have been upgraded to new codes associated with hurricane winds and flooding. Additionally, many of these properties may be in lower lying areas, approved prior to more stringent land use regulations. The percentages of build dates remained nearly constant throughout each scenario, give or take a percentage point, with approximately 40% of these property structures with a build date of between 1970 and 1989, and about 20% built after 1990. Further assessment of areas shown to be new vulnerable areas or projected to experience a large increase in flood depth should be considered as additional mitigation may be necessary if enhancements have not been made. Additional public outreach and education may also necessary to discuss future conditions and threats.

Table 8: Build Year Summary of Build Parcels Vulnerable to Coastal Flooding by Sea Level Rise Scenario

		Build-Year Summary of Built Parcels Vulnerable to Coastal Flooding from 100-Year Storm Influenced by Sea Level Rise							
		Vulnerable Built Parcels	Built Pre-1970	Built 1970-1979	Built 1980-1989	Built 1990-1999	Built 2000 and later		
	Base	25,687	33.8%	21.9%	20%	11.9%	12.5%	Base	
LOW	2040	31,051	35.1%	22.1%	20.0%	11.1%	11.8%	2040	LOW
LOW	2070	32,890	35.2%	22.4%	19.9%	11.0%	11.7%	2070	LOW
LOW	2100	34,484	35.5%	22.1%	20.1%	10.8%	11.6%	2100	LOW
INTER	2040	32,890	35.2%	22.2%	19.9%	11.0%	11.7%	2040	INTER
INTER	2070	37,677	36.5%	21.6%	19.9%	10.6%	11.4%	2070	INTER
INTER	2100	42,151	36.3%	21.2%	20.4%	10.7%	11.4%	2100	INTER
HIGH	2040	37,677	36.5%	21.6%	19.9%	10.6%	11.4%	2040	HIGH
HIGH	2070	47,909	36.2%	20.6%	21.5%	10.6%	11.1%	2070	HIGH
HIGH	2100	63,866	38.5%	19.0%	21.4%	10.2%	11.0%	2100	HIGH

HAZUS Damage Assessments

Photo Courtesy of Volusia County

The HAZUS model provides reports about potential damage estimates and assessments to various hazards. As part of this project, UF Geoplan created reports in HAZUS based upon the modeled scenarios of Sea Level Rise and its impacts on coastal flooding associated with a 100-year storm. The reports are based upon census tracks/blocks and associated data and are reported by scenario. The reports, in the Appendix of this report, examine "Direct Economic Losses for Buildings" which includes Capital Stock Losses (building loss, contents loss and inventory loss) and Income Losses (relocation loss, capital related loss, wage loss, rental income loss). This is a direct example of how the economic impact associated with increased flooding can affect the County and local jurisdictions.

The table below summaries the TOTAL LOSS modeled by HAZUS associated with each of the modeled scenarios.

Figure 10: HAZUZ Summarized Damage Model Results

		HAZUS Modeled Direct Damage Losses		HAZUS Modeled Building Damage by Square Foot			
		Total Loss	% increase from base flood	Total Square Feet	% increase from base flood		
	Base	3,616,739		60,177.71		Base	
LOW	2040	4,308,391	40%	72,450	30%	2040	LOW
	2070	4,537,170	46%	75,848	36%	2070	
	2100	4,959,795	58%	80,336	43%	2100	
INTER	2040	4,540,310	47%	75,910	36%	2040	INTER
	2070	5,528,863	74%	88,064	56%	2070	
	2100	6,917,100	112%	100,801	77%	2100	
HIGH	2040	5,685,504	78%	89,188	58%	2040	HIGH
	2070	9,092,645	172%	114,269	99%	2070	
	2100	16,163,145	368%	155,430	168%	2100	

All values are in thousands of dollars

Designated Evacuation Routes

This section includes an analysis of designated evacuation routes that may be impacted by rising seas and mass flooding events. Evacuation routes are extremely important for the safety of residents and visitors to Volusia County in the event of an emergency or evacuation. The table below lists vulnerable evacuation routes and the total miles estimated to be flooded in each scenario. One consideration to include is that the mileage in the table below is not a solid stretch of roadway vulnerable to flooding but rather segments of that specific roadway added together for total mileage. It is recommended Volusia County further analyze the location of these impacts to determine if larger stretches of the roadway may be mitigated due to the distance between potential impacts.

The evacuation route analysis of Volusia County estimates large impacts to State Highway/CR A1A, US Highway 1, along with sections of I-95. Along with this, we see impacts across state roads like SR 44 and SR 5A increasing steadily along with each scenario. The total number of miles impacted greatly increases under the high rate curve especially between 2070 and 2100 when the rate of sea level increase is highest. It is recommended Volusia begin to examine alternate evacuation routes as even under the low projection rate curve there will be at least 40 total miles of routes in Volusia potentially flooded. From the 2040 intermediate projection curve to the 2100 intermediate projection curve the total mileage of vulnerable roadways increases 34%, while under the high curve the total mileage of vulnerable roadway increases by 77%. With many residents living on the coast and having the potential of being trapped both at their homes or unable to return to their homes after a flood event, it is important Volusia begin to take action now as many will be at risk.

Roadway Flooding in Volusia County

Photos Courtesy of Volusia County

Table 9: Evacuation Routes Vulnerable to Coastal Flooding by Sea Level Rise Scenario

Evacuation Route	Miles of Evacuation Routes Vulnerable to Coastal Flooding from 100-Year Storm Influenced by Sea Level Rise*								
	Low			Intermediate			High		
	2040	2070	2100	2040	2070	2100	2040	2070	2100
CR 4019 (LPGA Blvd.)	1	1	1	1	1	1	1	1	2
CR A1A (Atlantic Ave./Turtlemound)	9	9	9	9	9	9	9	9	11
Interstate 95	4	4	4	4	4	4	4	4	4
S Peninsula Ave.	1	1	1	1	1	1	1	1	1
Flagler Ave.			<1			<1			<1
Silver Beach / Orange Ave.			<1			<1			<1
State Road 40	1	1	2	1	2	2	2	2	3
State Road 400			< 1	< 1	< 1	1	1	2	2
State Road 421	1	1	1	1	1	1	1	2	2
State Road 430	1	1	2	1	2	2	2	2	2
State Road 44	2	2	2	2	3	3	3	3	3
State Road 442								1	3
State Road 5A	2	2	2	2	4	9	4	10	12
State Highway A1A (Atlantic Ave/ Lytle Ave/Causeway)	2	2	2	2	2	2	2	2	8
US Highway 1	18	18	18	18	19	23	19	27	34
US Highway 92	2	2	2	2	2	2	2	2	3

** The mileage has only been estimated to a whole number due to data accuracy and alignment.*

Figure 11: Evacuation Routes Vulnerable to Coastal Flooding by Low Projection Rate Curve

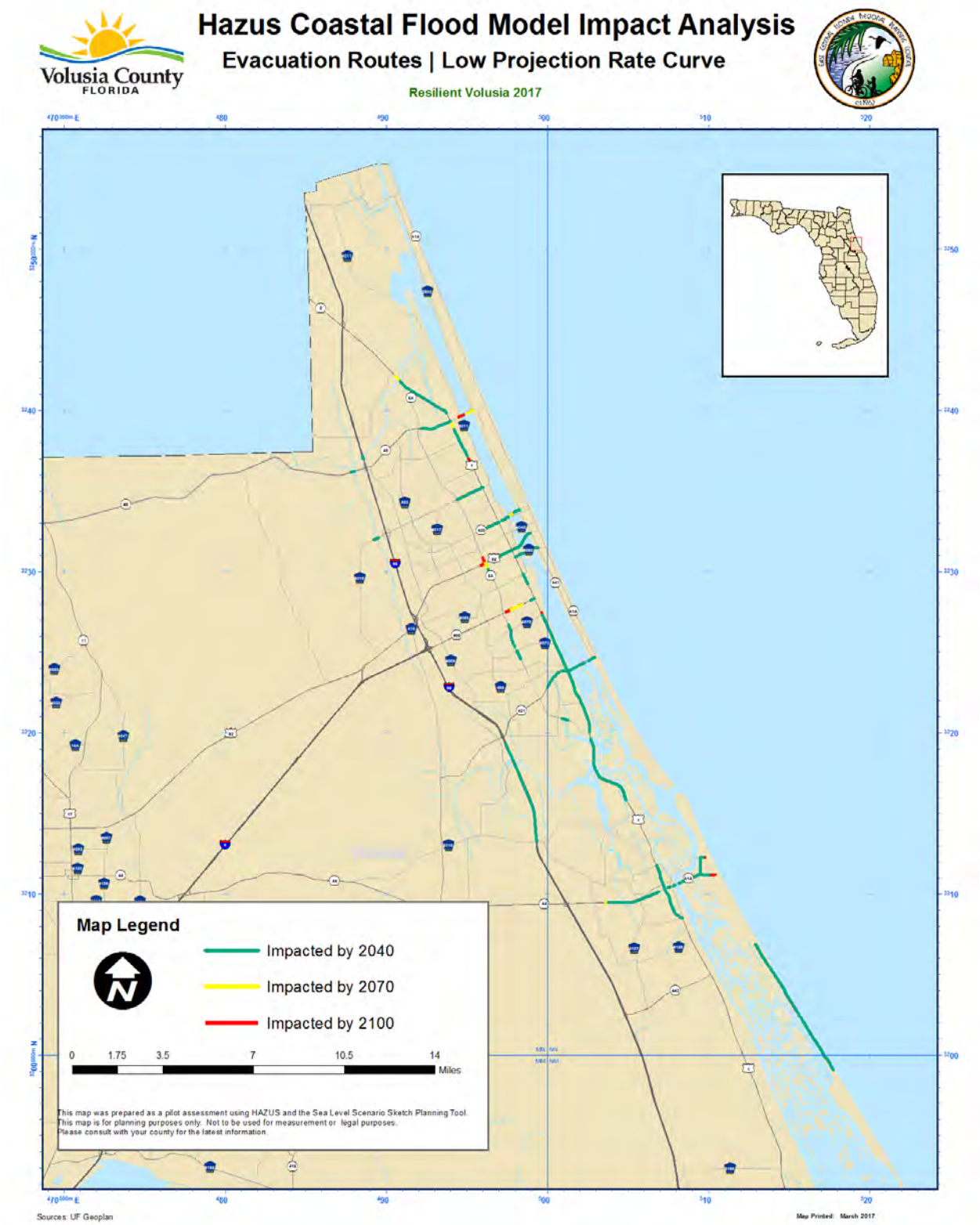


Figure 12: Evacuation Routes Vulnerable to Coastal Flooding by Intermediate Projection Rate Curve

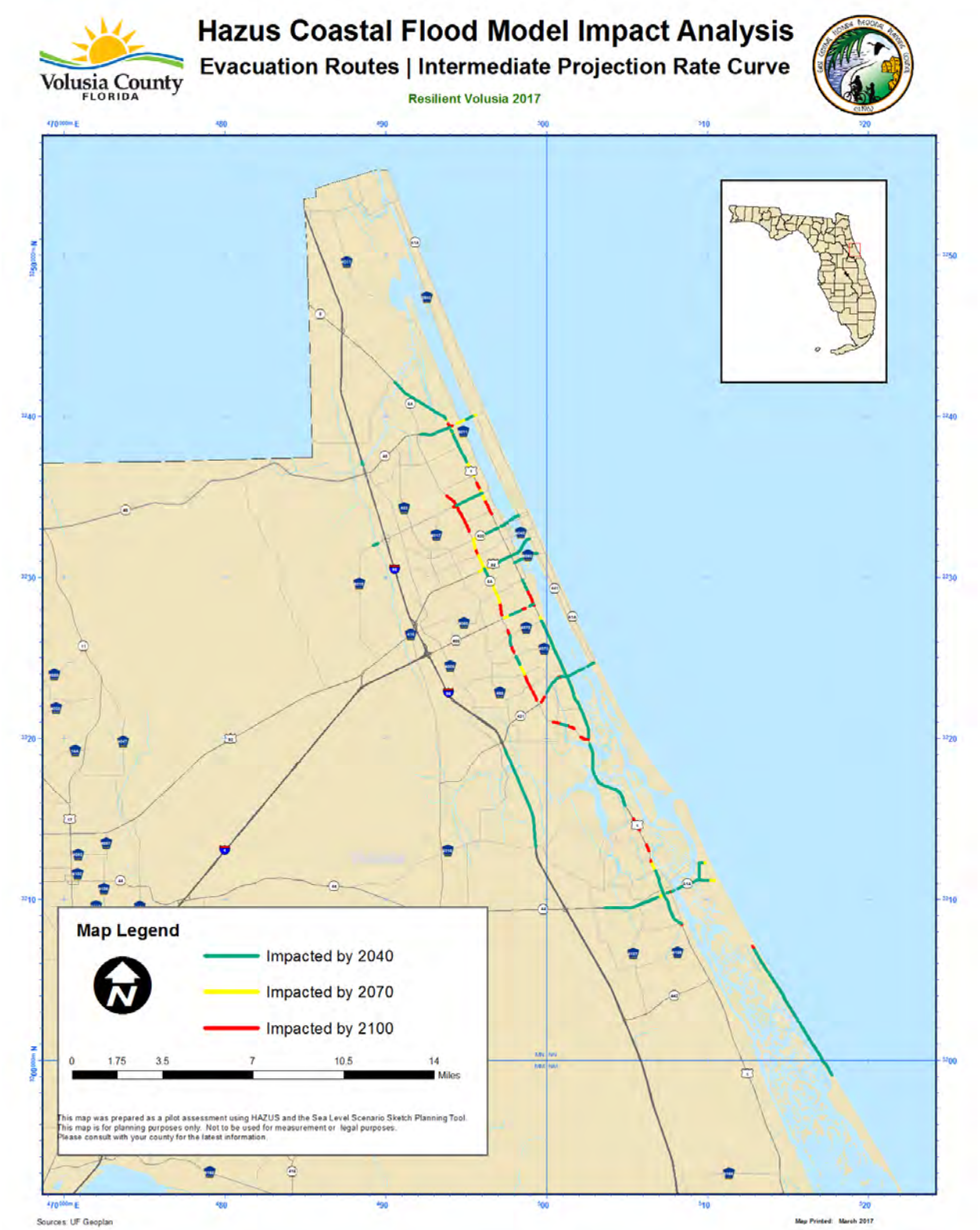
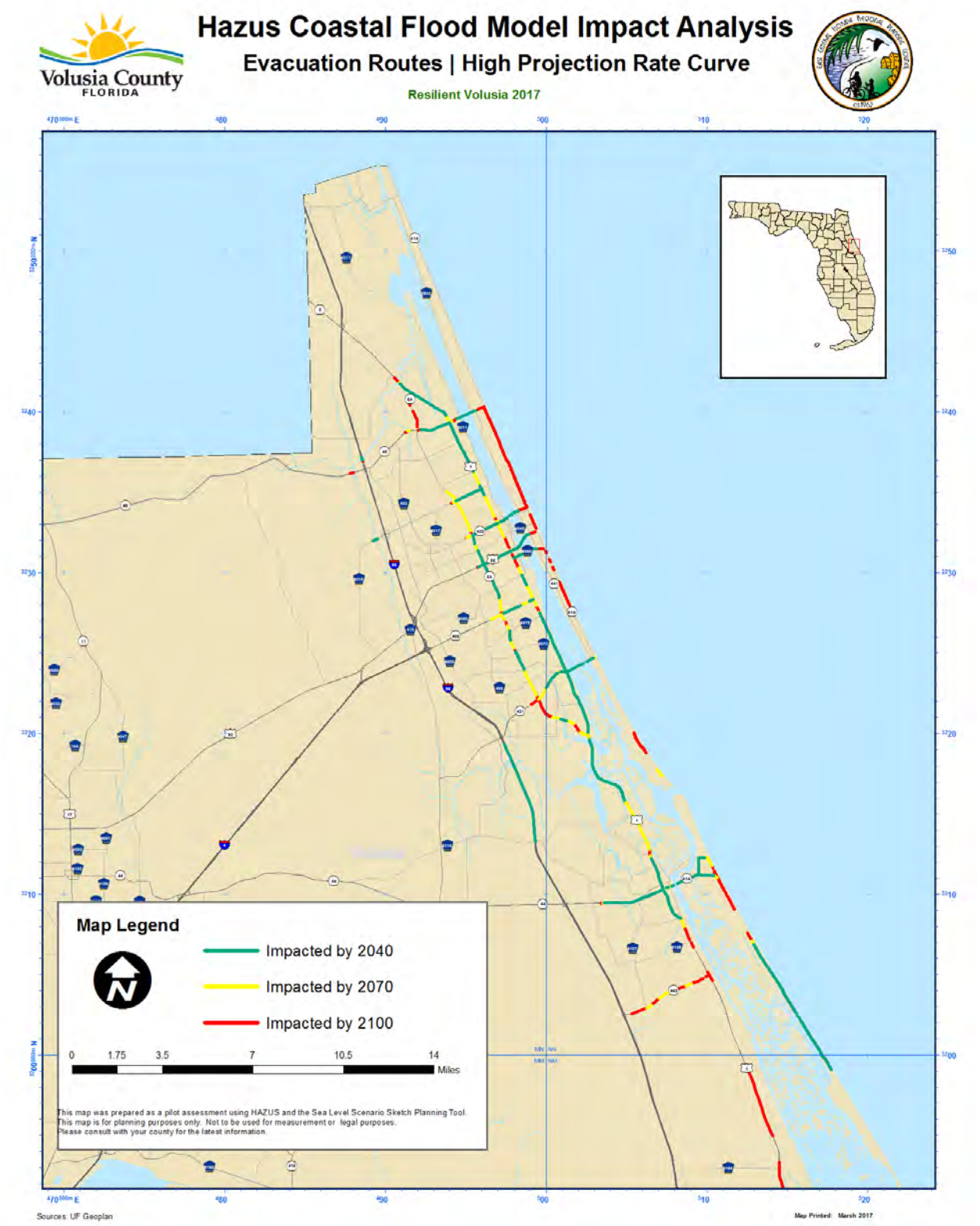


Figure 13: Evacuation Routes Vulnerable to Coastal Flooding by High Projection Rate Curve



Facilities

The impacts of coastal flooding can cause significant effects on the community both economically, environmentally and socially. Access issues due to flooded roadways, facility failure, and structural issues or flooding can take a beating on the facilities' fiscal position, prevent employees from earning income, and prevent some facilities from responding to community needs such as police and fire. For these reasons, it is important to address not only County and city facilities but also to educate the private sector concerning impacts and solutions. When considering adaptation strategies for facilities, consideration should be provided to life span of the facility, its purpose, and access to/from the facility due to flooding. *As noted by USACE 2014 publication, "The longer the life of engineered systems and their related socio-economic and ecological systems, the more important it becomes to evaluate, throughout the project life cycle, the sustainability and resiliency of these combined systems in the face of climate change effects."*[1] If a facility is not critical to the community during/after a storm, and access immediately after the storm is not needed, it may be deemed that some magnitude of flooding to the parcel may be acceptable. Therefore, it may be determined that only mitigation to some areas of the facility or property may be warranted to protect the facility itself. In other instances, flooding of any duration and magnitude may not be acceptable for facilities deemed critical to resiliency and recovery (i.e. wastewater treatment plants, shelters, fire/police stations, solid waste facilities). Therefore, additional analysis should be conducted such as onsite elevation data, flood risk assessment and analysis of access areas that may be vulnerable to flooding and time horizons. The most critical facilities, those likely to be impacted by 2040, should be considered a priority combined with facilities which are critical and, due to function and consequences, have a low risk tolerance.

A previous analysis conducted by the ECFRPC in 2015/2016 looked the available data concerning outfalls within the proximity of the Indian River Lagoon and Banana River in Volusia County. Since one of the main points of flooding vulnerability in coastal areas is aging stormwater infrastructure, further review and expansion of this data may be necessary to determine which outfalls may be susceptible to increased flood levels and potential failure. This is especially a concern in areas where stormwater pipes, most of which were built decades ago, drain directly into coastal water bodies. Sea-level rise makes such infrastructure more susceptible to flood risk.

Photo Courtesy of Volusia County

[1] USACE, 2014- http://www.publications.usace.army.mil/Portals/76/Publications/EngineerTechnicalLetters/ETL_1100-2-1.pdf

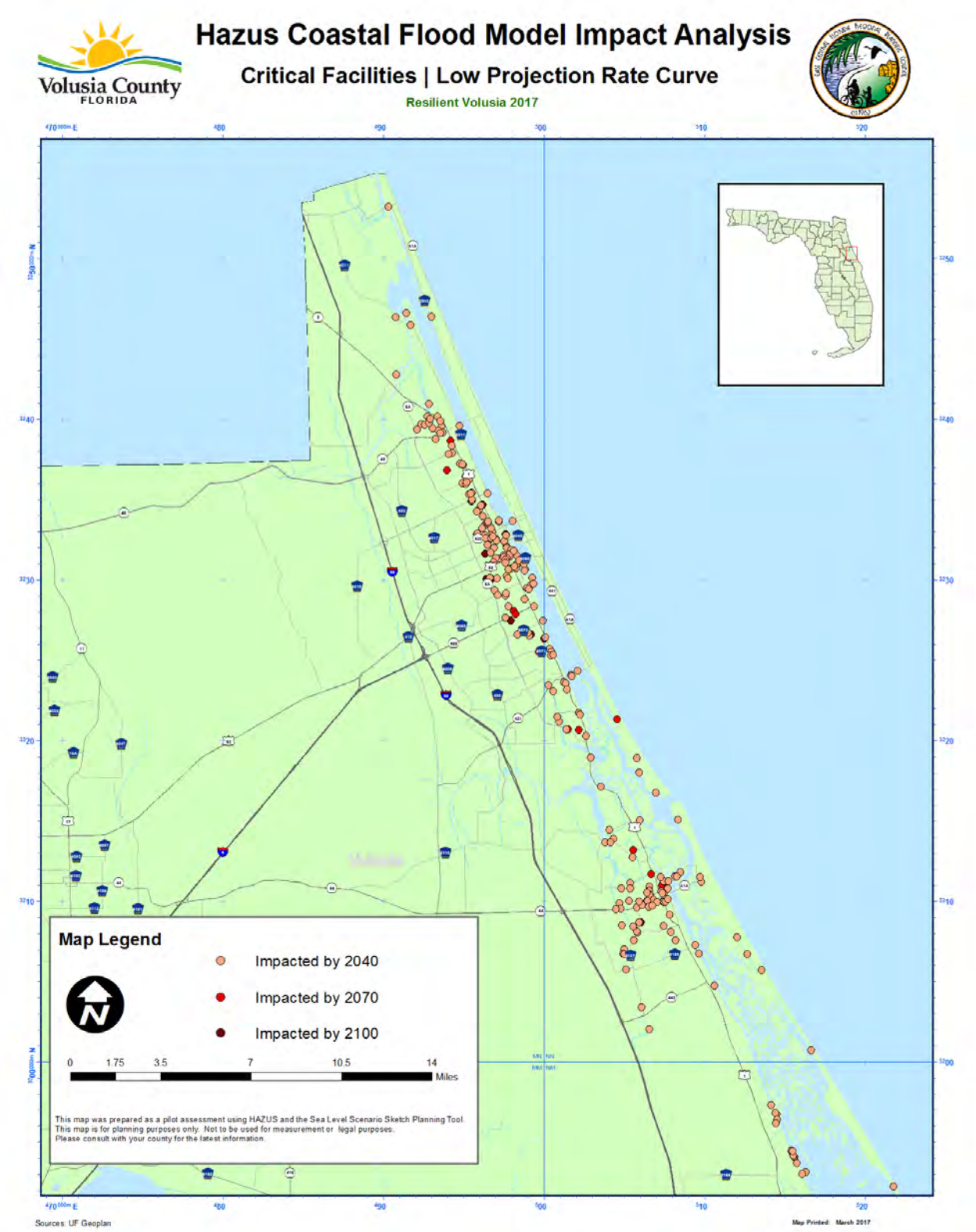
The facility analysis includes an assessment of fleet storage/barns and public work facilities, emergency management centers and other facilities that may be necessary for transportation or evacuation purposes such as airports, coast guard station, and transportation management centers. A complete list of facilities determined to be vulnerable to future 100-year flood levels can be found in the Appendix.

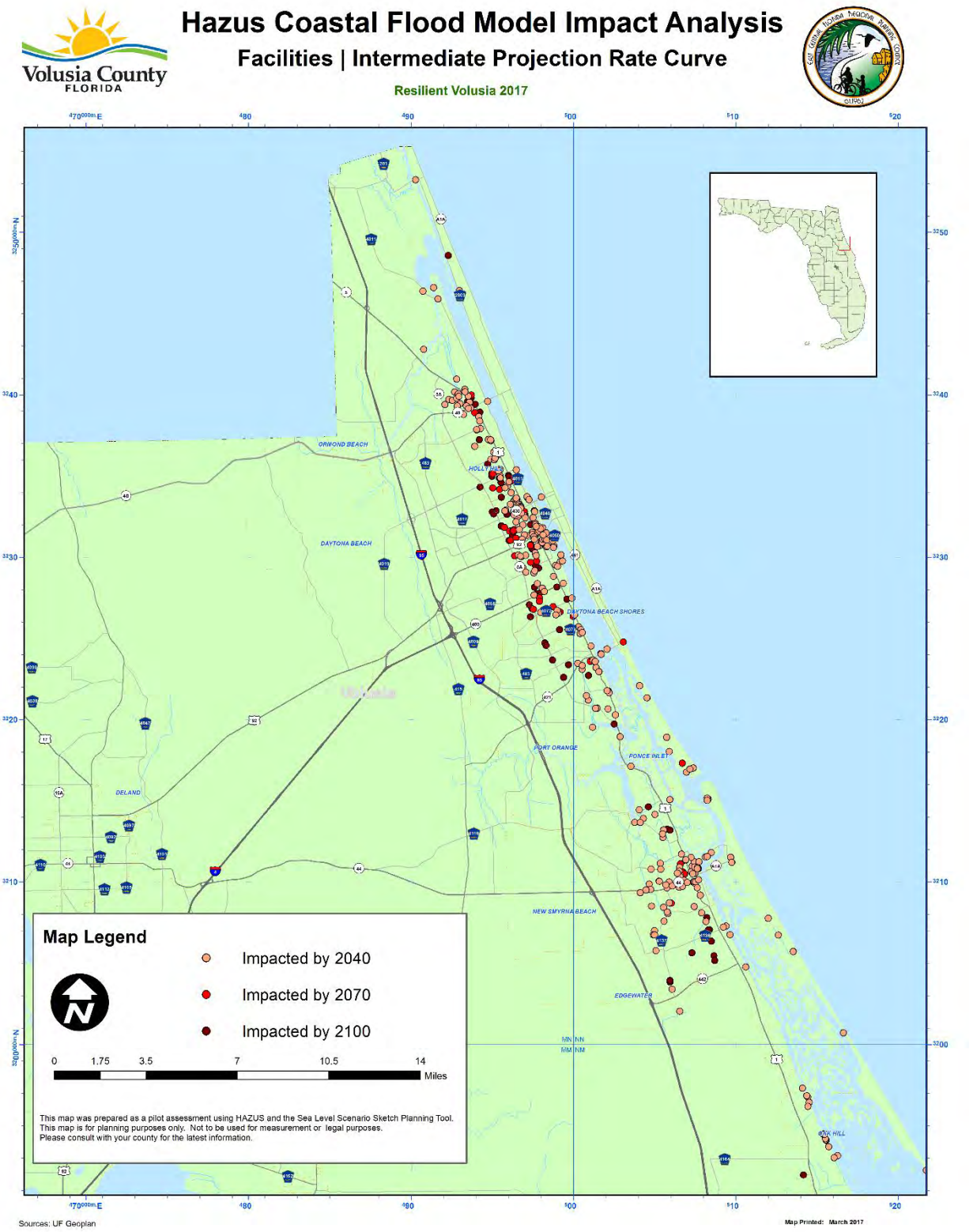
The table below list facility types, number of facilities and the scenario year they will likely be impacted by coastal flooding of a 100 – year storm. One major concern is the amount of hazardous materials facilities and wastewater and solid waste facilities that may be impacted in even the lower scenarios. It is important that these facilities are properly maintained and hazards mitigated as a failure could cause serious health and environmental issues. It may be beneficial to begin assessing facilities that may need to be relocated due to increasing frequent flooding impacts. However, some of these facilities may be small facilities with limited budgets. It is important to reach out to these businesses to discuss potential impacts to the facility and the potential of the company to conduct further analysis and risk assessment. Additionally, eight to thirteen fire stations are considered vulnerable under the high scenario, and three to ten law enforcement facilities. These assets are crucial in emergency responses and the stations that are predicted to be impacted should likely be assessed and possibly relocated or potentially elevated. The electric power plant located in New Smyrna off Lytle Ave. has been determined to be vulnerable by 2040 regardless of scenario, as well as some substations and lift stations. Finally, as future asset siting takes place, it is important that the responsible departments look at future conditions to ensure minimal risk.

Table 10: Facilities Vulnerable to Coastal Flooding by Sea Level Rise Scenario

Critical Facility Type*	Facilities Vulnerable to Coastal Flooding from 100-Year Storm Influenced by Sea Level Rise								
	Low			Intermediate			High		
	2040	2070	2100	2040	2070	2100	2040	2070	2100
Airports	2	2	3	2	3	3	3	3	5
Disaster Recovery Center			1		1	1	1	1	1
City Facilities (city hall, public works, community centers, etc.)	12	12	13	12	13	14	13	16	22
County Facilities	9	10	10	10	11	11	11	12	17
Electric Power Plant	1	1	1	1	1	1	1	1	1
Electric Substation	7	7	7	7	7	7	7	8	10
Emergency Operations Center/FOC									3
Fire Station	8	8	8	8	8	9	8	12	13
Hazardous Materials Facility	44	44	45	44	47	56	48	60	67
Law Enforcement	2	3	3	3	3	6	3	6	10
State Government Facility	3	3	4	3	4	4	4	4	4
Public Water Supply Plant	5	5	5	5	6	7	6	8	13
Public Works	4	4	5	4	5	5	5	6	9
Solid Waste Facility	8	8	8	8	8	10	8	13	15
Transportation Facilities	7	7	7	7	7	7	7	7	8
Wastewater Facility	8	8	8	8	8	10	8	13	15
Lift Stations	8	8	8	8	8	10	8	12	14

**some county/city facilities have been removed if they fell within another category. In general, some facilities may fall within more than one category due to function.*


Volusia County
FLORIDA
Hazus Coastal Flood Model Impact Analysis
Critical Facilities | Low Projection Rate Curve
Resilient Volusia 2017
Map Legend
Impacted by 2040
Impacted by 2070
Impacted by 2100
0 1.75 3.5 7 10.5 14
Miles
This map was prepared as a pilot assessment using HAZUS and the Sea Level Scenario Sketch Planning Tool.
This map is for planning purposes only. Not to be used for measurement or legal purposes.
Please consult with your county for the latest information.
Sources: UF Geoplan
Map Printed: March 2017


Volusia County
FLORIDA
Hazus Coastal Flood Model Impact Analysis
Facilities | Intermediate Projection Rate Curve
Resilient Volusia 2017
ORMOND BEACH
DAYTONA BEACH
DAYTONA BEACH SHORES
PORT ORANGE
PONCE INLET
DELAND
NEW SMYRNA BEACH
EDGEWATER
Map Legend
Impacted by 2040
Impacted by 2070
Impacted by 2100
0 1.75 3.5 7 10.5 14
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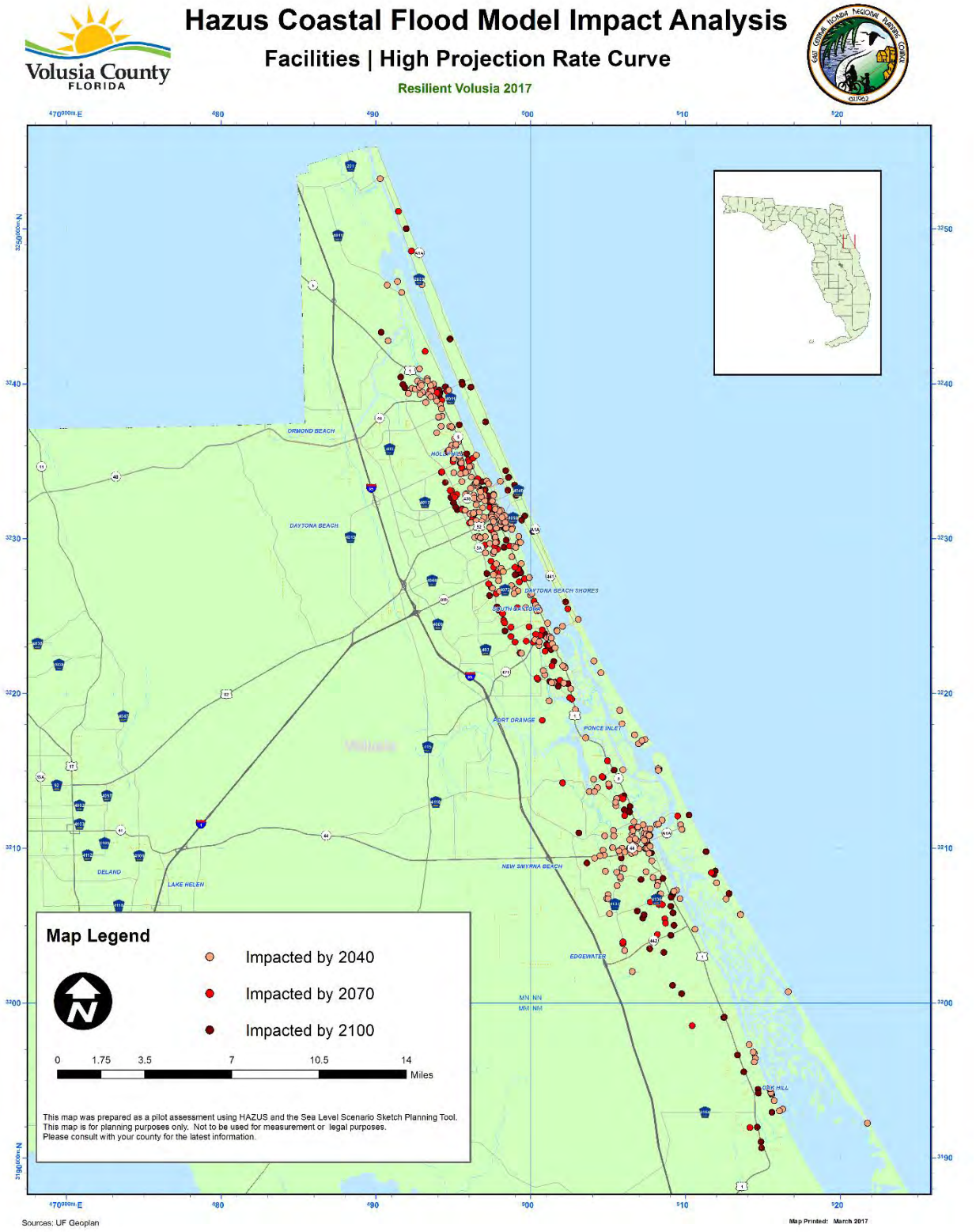
Volusia County
FLORIDA
Hazus Coastal Flood Model Impact Analysis
Facilities | High Projection Rate Curve
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ORMOND BEACH
DAYTONA BEACH
DAYTONA BEACH SHORES
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NEW SMYRNA BEACH
EDGEWATER
DELAND
LAKE HELEN
OAK HILL
Map Legend
Impacted by 2040
Impacted by 2070
Impacted by 2100
0 1.75 3.5 7 10.5 14
Miles
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Sources: UF Geoplan
Map Printed: March 2017

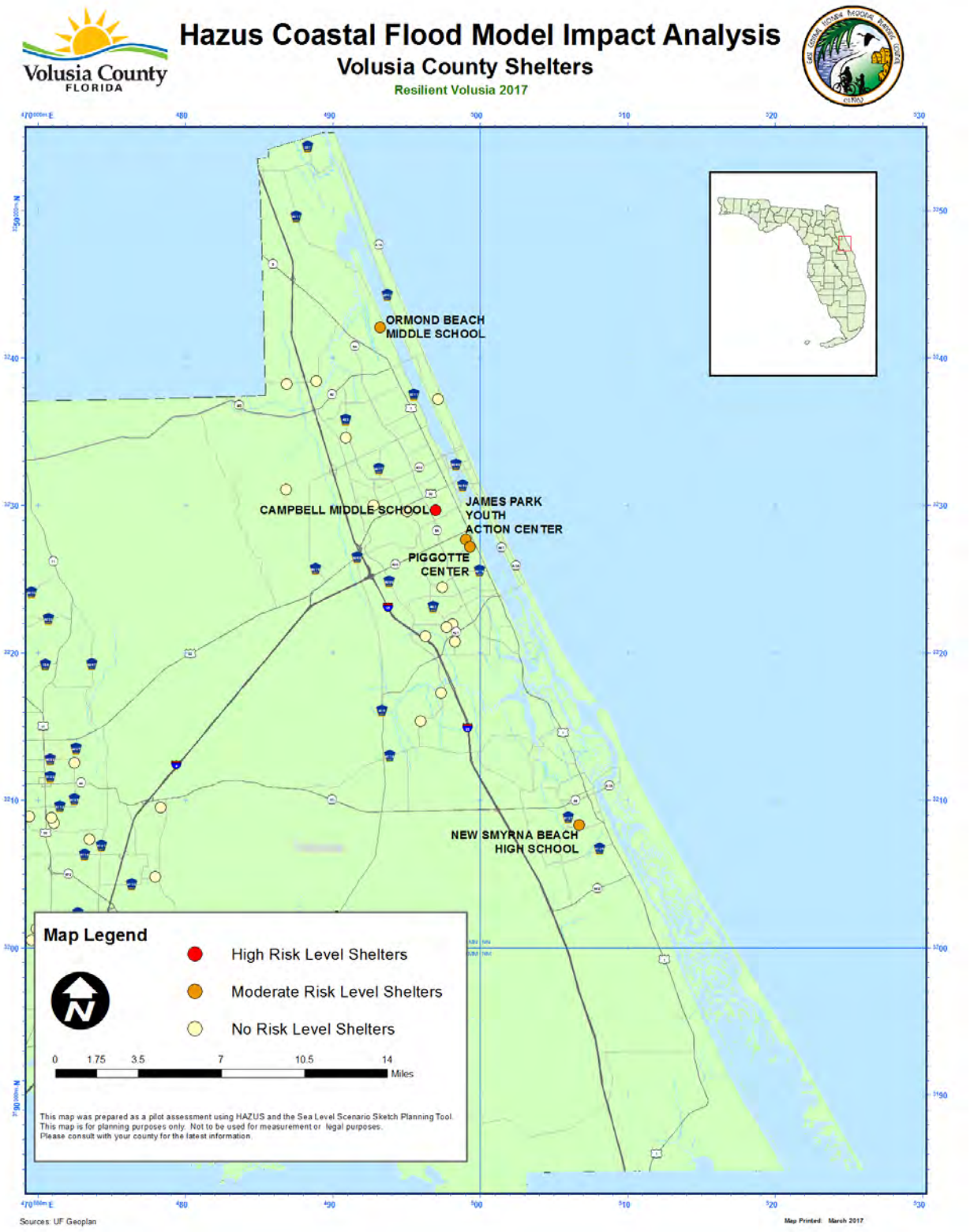
Shelters

Shelters provide safety accommodations during extreme weather to those in need. A shelter that is compromised by flooding, either the building itself or access routes, could put many people at extreme risk. Of the 44 shelters analyzed in Volusia, a total of five are considered vulnerable to coastal flooding from a 100-year storm event combined with sea level rise. Campbell Middle School is most at risk as it is likely to be flooded in each scenario except 2040 low. Campbell Middle School eventually will not be able to provide shelter and new accommodations should be found. In the 2100 high scenario, four more shelters are compromised, though the timeframe leads the priority of addressing Campbell MS over the other four shelters. No shelters in Volusia were compromised in the analysis of an historical hurricane event (DORA) combined with sea level rise. As to be ARC Compliant, shelters must not be located within a surge zone, this finding is a positive as all shelters are appropriately placed. This information on Hurricane Dora is found later in the report.

Table 11: Shelters Vulnerable to Coastal Flooding Sea Level Rise Scenario

Shelters	Shelters Vulnerable to Coastal Flooding from 100-Year Storm Influenced by Sea Level Rise								
	Low			Intermediate			High		
	2040	2070	2100	2040	2070	2100	2040	2070	2100
Campbell Middle School									
New Smyrna Beach High School									
James Park Youth Action Center									
Piggotte Center									
Ormond Beach Middle School									

Figure 14: Volusia County Shelters Vulnerable to Coastal Flooding



Hurricane Dora Analysis

UF Geoplan utilized historical data from Hurricane Dora and, as described in the methodology, incorporated sea level rise scenarios in the coastal flooding results. The HAZUS model findings anticipate that if sea level was higher during Hurricane Dora, the depth of the flooding would have increased from its base of 7.5 feet to 8.33-9.08 feet in the 2040 intermediate to high scenario. The same hurricane in 2100 scenarios was modeled to have depths between 9.58 – 13.58 feet. Table 12 below illustrates the model outputs of Hurricane Dora when sea level rise estimates are added. The extent change in flooding is minimal until about 2070 in the intermediate and high scenarios. These scenarios add a little over a foot to almost 3 feet to the base hurricane flood depth. Table 13 depicts the change in flood extent from Hurricane Dora in Volusia County if the various scenarios were applied. The base hurricane will leave 0.46% of Volusia flooded, while in the 2100 high scenario we see 2.43% of Volusia flooded, a 424% increase. The intermediate scenario will be excepted to have a 45% increase by 2070, impacting 0.67% of the County and 75% increase by 2100. The maps on the following pages illustrate the change in flood extent and depth by sea level rise scenario and year using Hurricane Dora data.

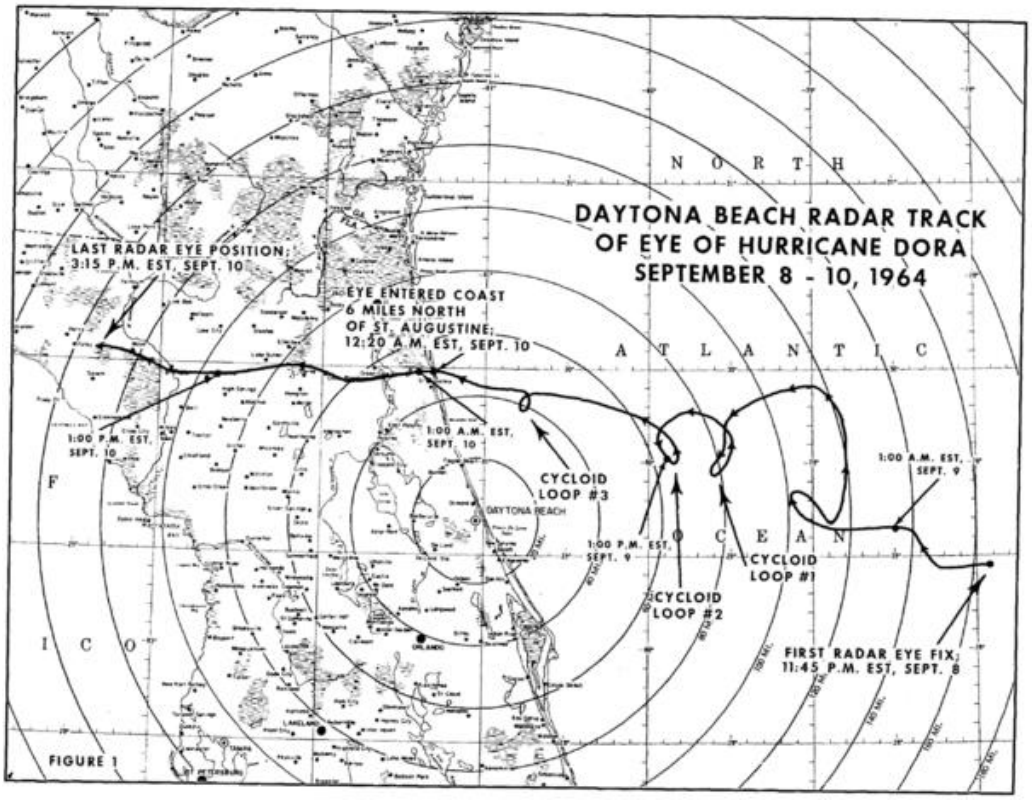


Image courtesy of United States Weather Bureau

Table 12: Hurricane Dora Coastal Flood Depth Model Results by Sea Level Rise Scenario

Hazus-MH Coastal Flood Model Run - Hurricane Dora	Max Flood Depth (Inches)	Max Flood Depth (Feet)	Percent Change	RSLR Feet
Hurricane Dora Base	93	7.75		0
Hurricane Dora + 2040 Low SLR	98.04	8.17	5%	0.37
Hurricane Dora + 2070 Low SLR	99.96	8.33	7%	0.59
Hurricane Dora + 2100 Low SLR	104.04	8.67	12%	0.82
Hurricane Dora + 2040 Int SLR	99.96	8.33	7%	0.57
Hurricane Dora + 2070 Int SLR	107.04	8.92	15%	1.14
Hurricane Dora + 2100 Int SLR	114.96	9.58	24%	1.86
Hurricane Dora + 2040 High SLR	108.96	9.08	17%	1.22
Hurricane Dora + 2070 High SLR	126.96	10.58	37%	2.85
Hurricane Dora + 2100 High SLR	162.96	13.58	75%	5.15

Table 13: Hurricane Dora Coastal Flood Extent Results by Sea Level Rise Scenario

Hazus-MH Coastal Flood Model Run – Hurricane Dora	Total Acreage Flooded	Percent of Volusia Flooded	Percent Change
Hurricane Dora Base	4,247 acres	0.46%	
Hurricane Dora + 2040 Low SLR	4,805 acres	0.52%	13%
Hurricane Dora + 2070 Low SLR	4,974 acres	0.54%	17%
Hurricane Dora + 2100 Low SLR	5,883 acres	0.64%	39%
Hurricane Dora + 2040 Int SLR	4,974 acres	0.54%	17%
Hurricane Dora + 2070 Int SLR	6,142 acres	0.67%	45%
Hurricane Dora + 2100 Int SLR	7,432 acres	0.81%	75%
Hurricane Dora + 2040 High SLR	6,225 acres	0.68%	47%
Hurricane Dora + 2070 High SLR	9,192 acres	1.00%	116%
Hurricane Dora + 2100 High SLR	22,256 acres	2.43%	424%

Figure 15: Hurricane Dora 2040 Low

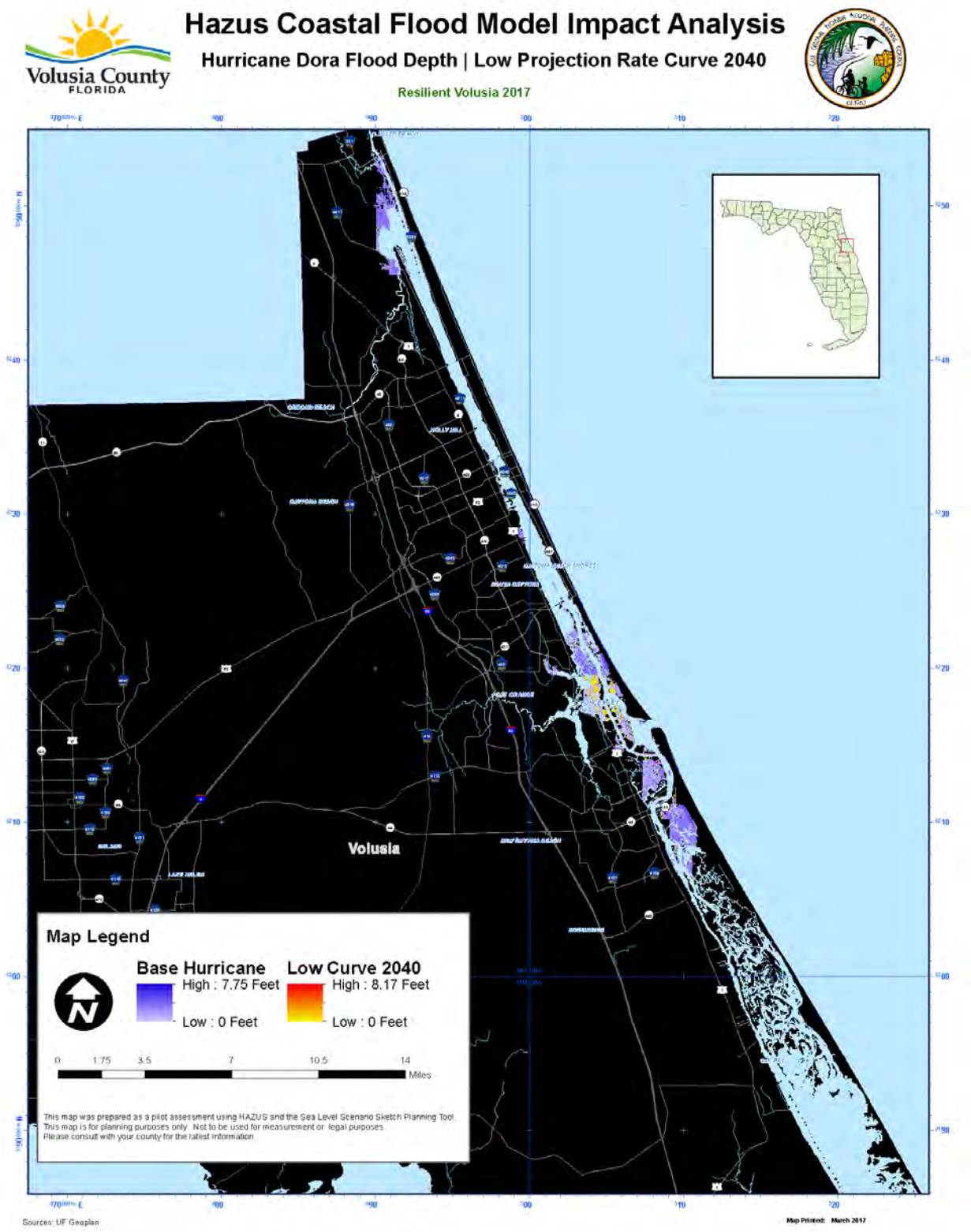


Figure 16: Hurricane Dora 2040 Intermediate

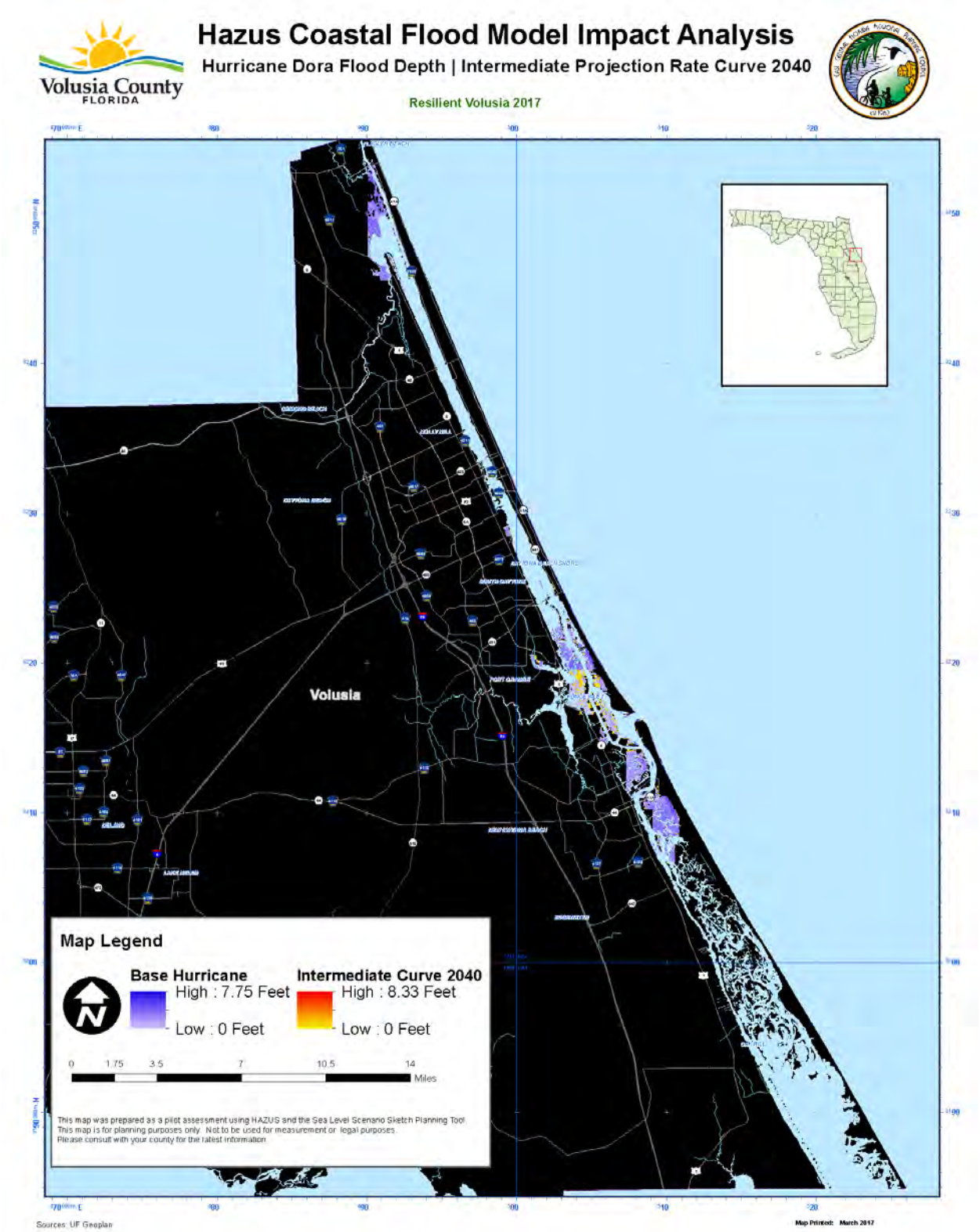


Figure 17: Hurricane Dora 2040 High

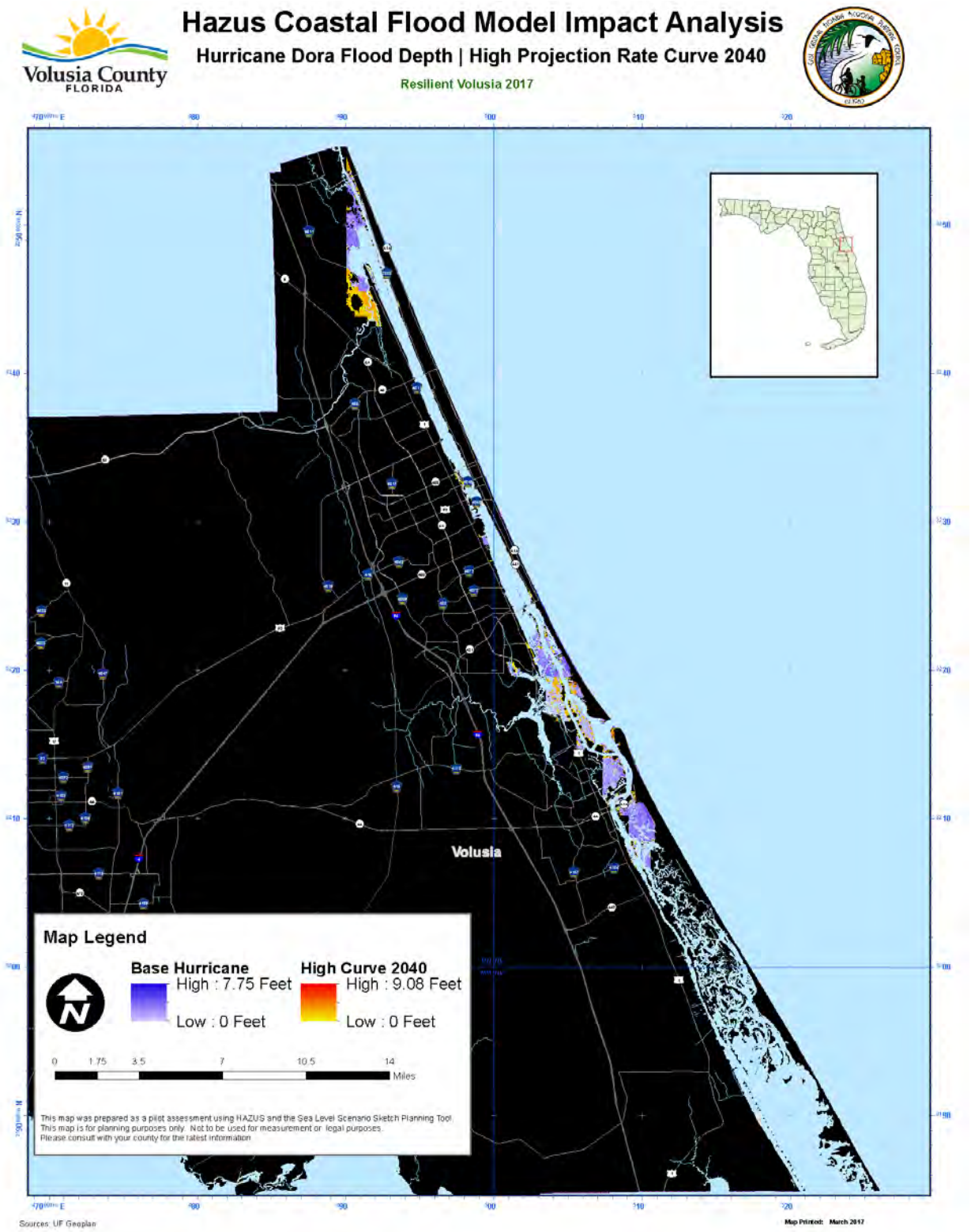


Figure 18: Hurricane Dora 2070 Low

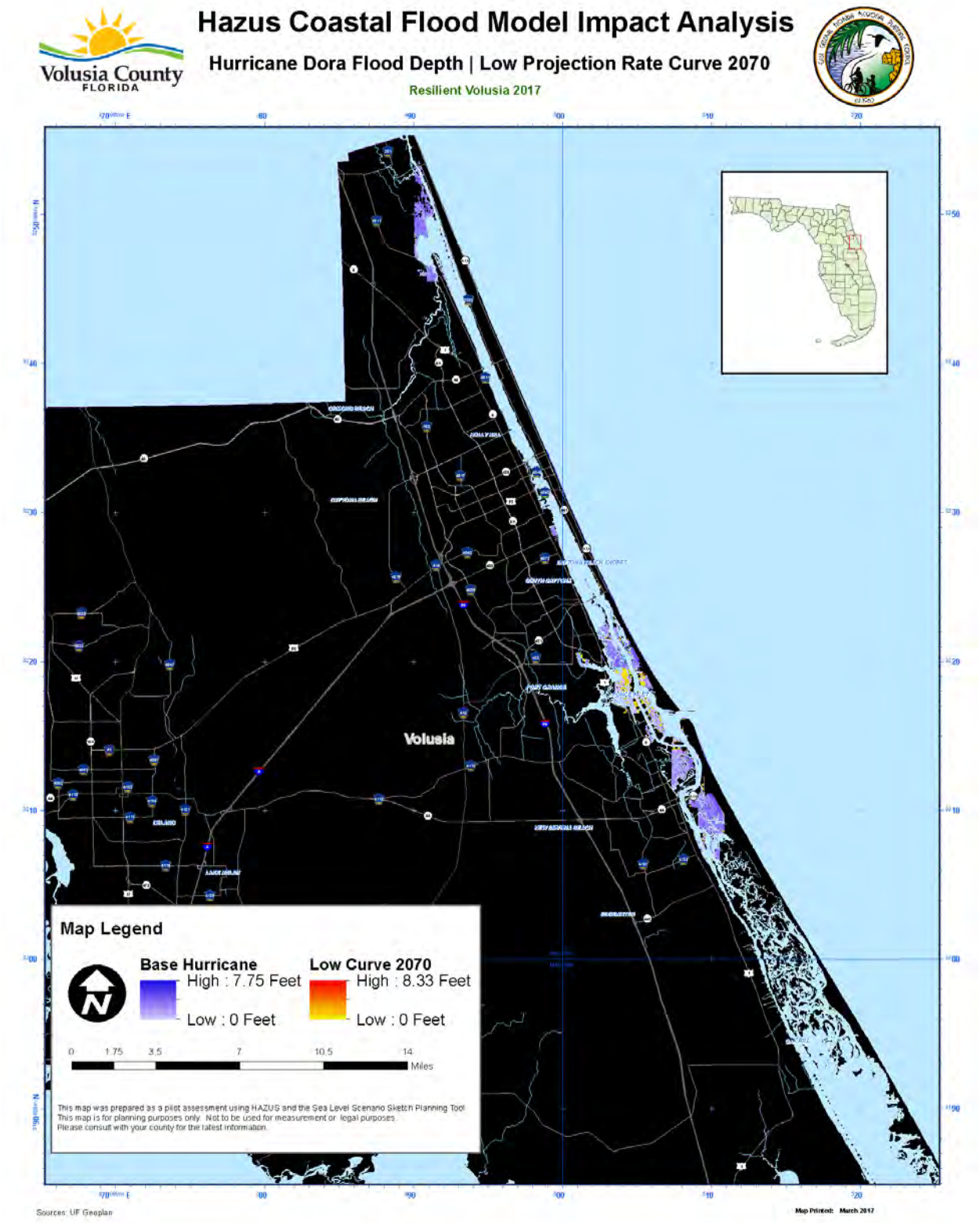


Figure 19: Hurricane Dora 2070 Intermediate

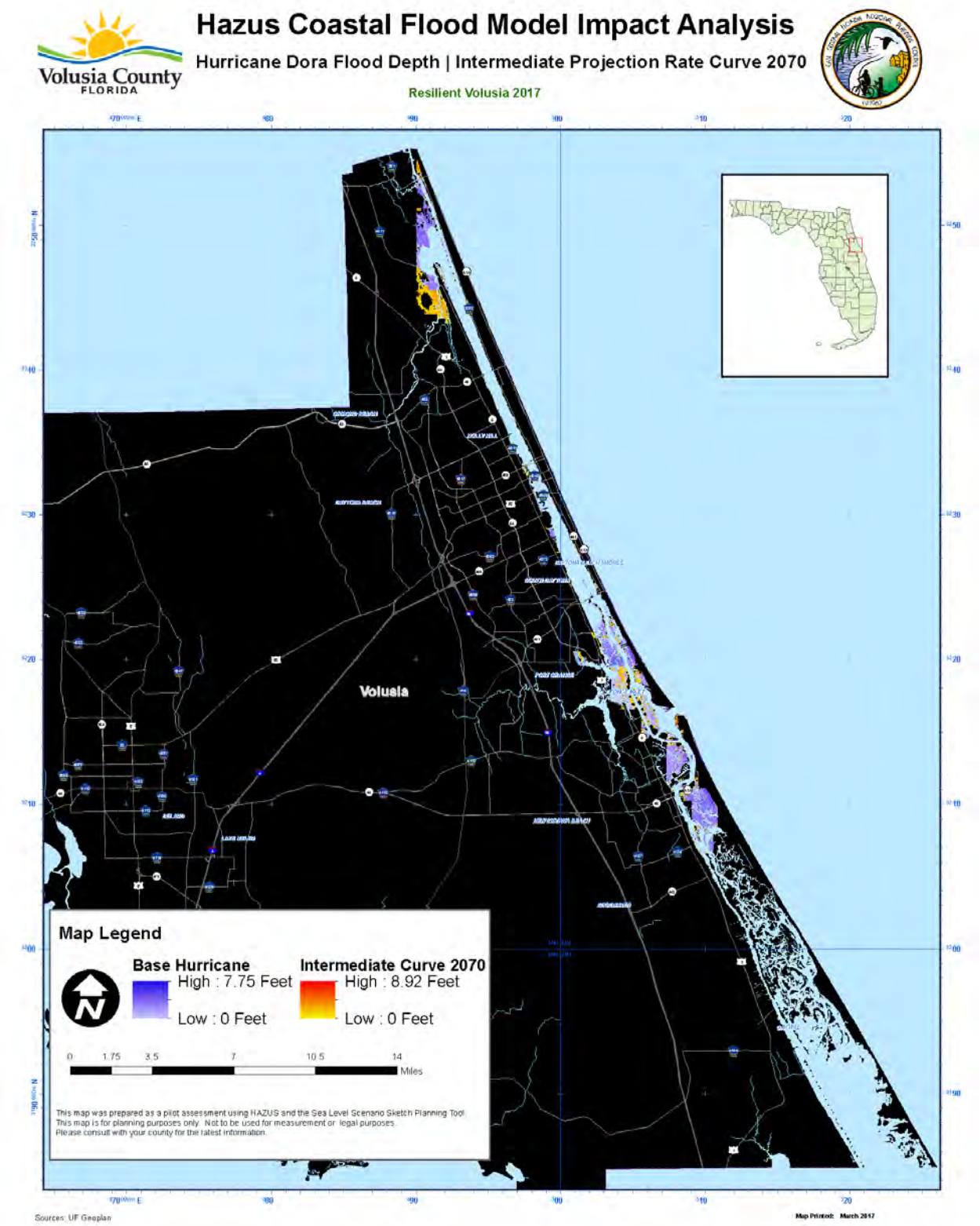


Figure 20: Hurricane Dora 2070 High

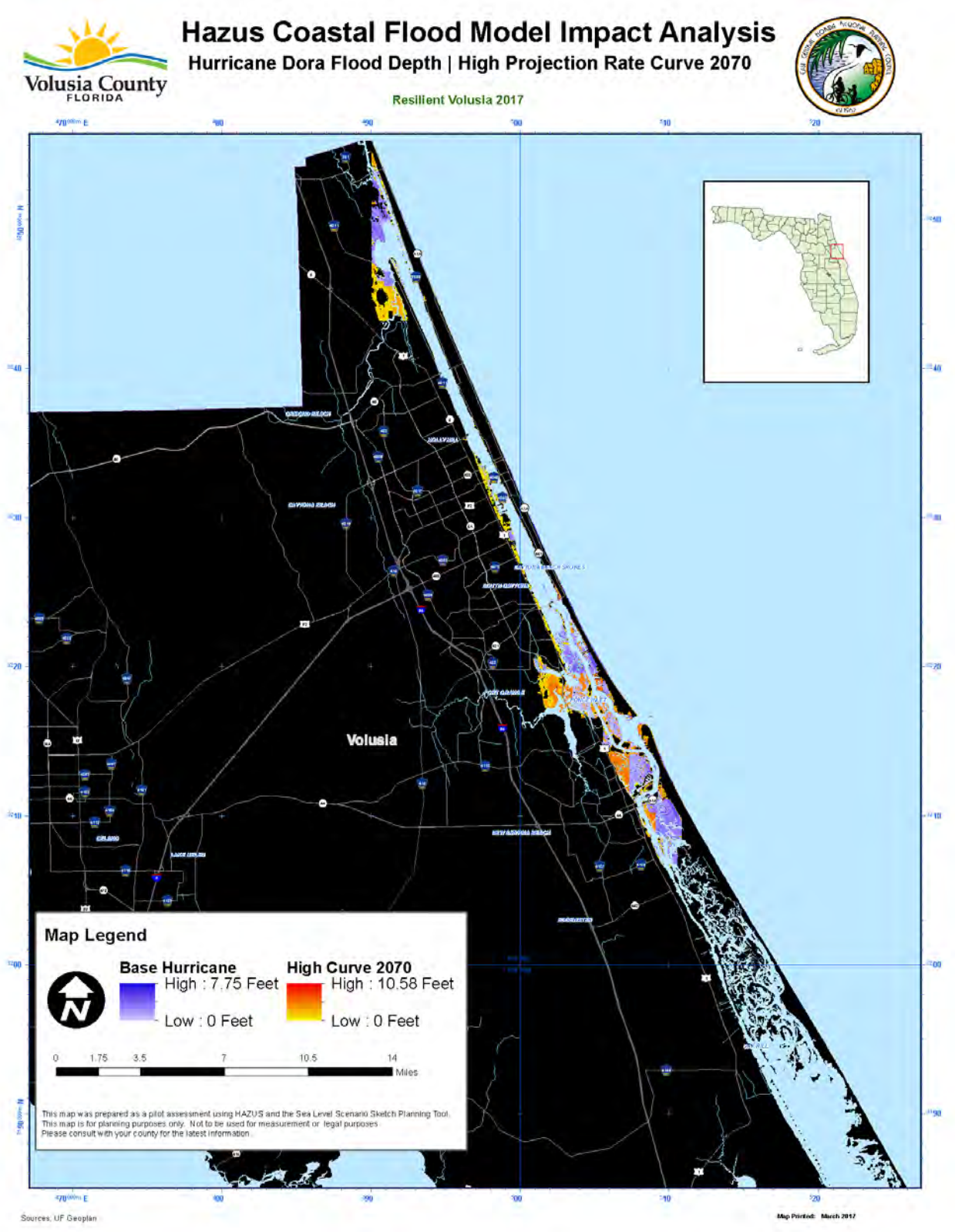


Figure 21: Hurricane Dora 2100 Low

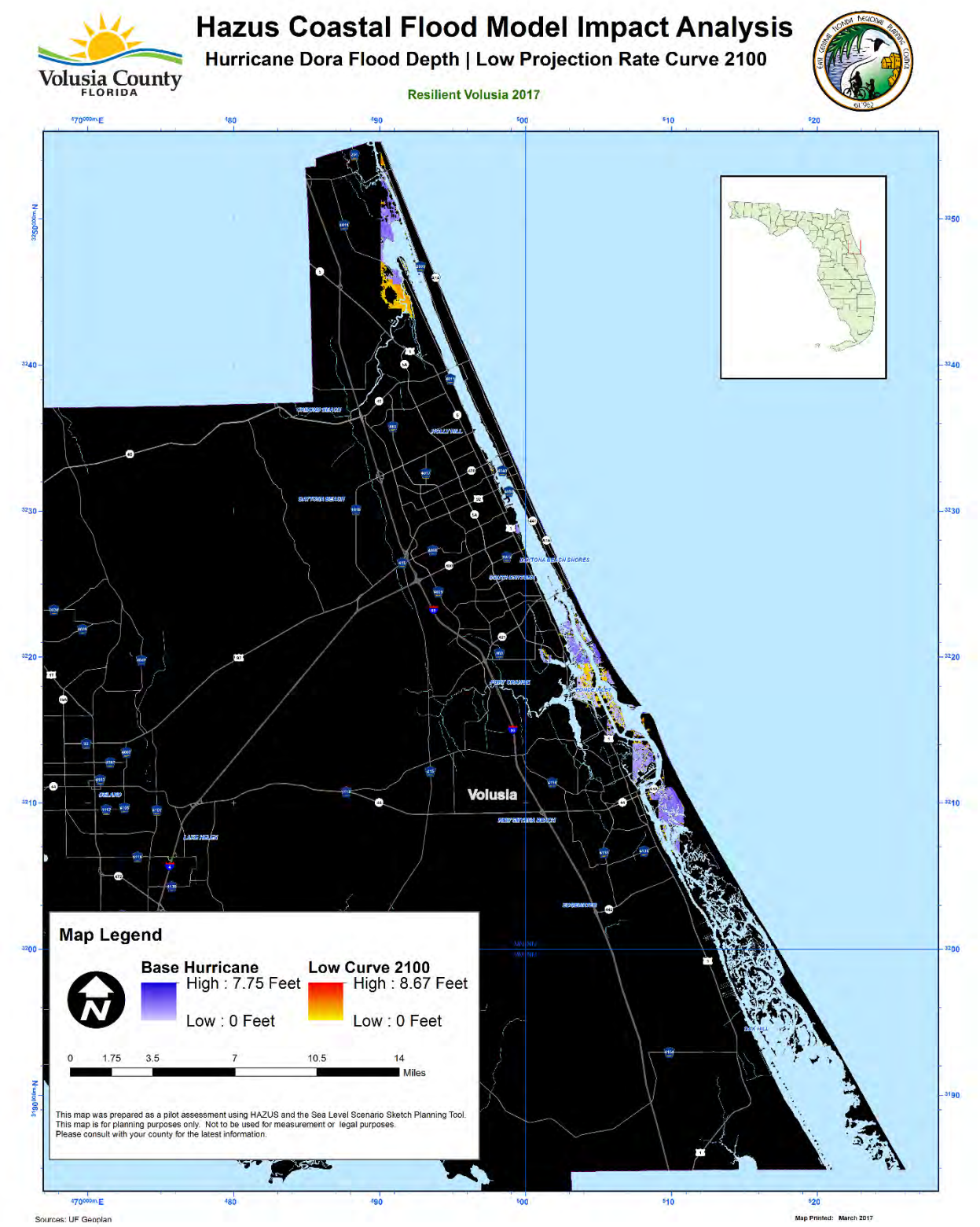


Figure 22: Hurricane Dora 2100 Intermediate

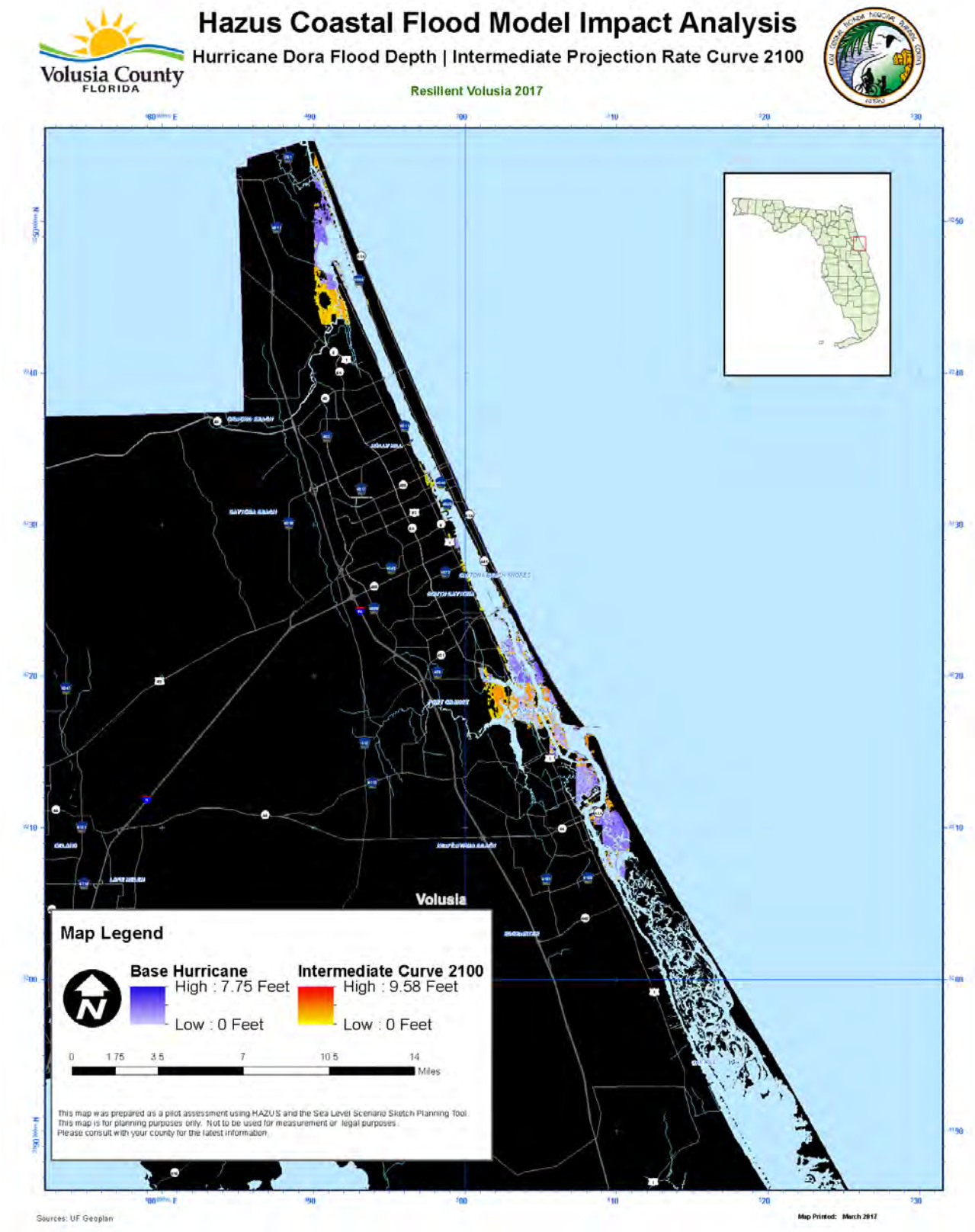
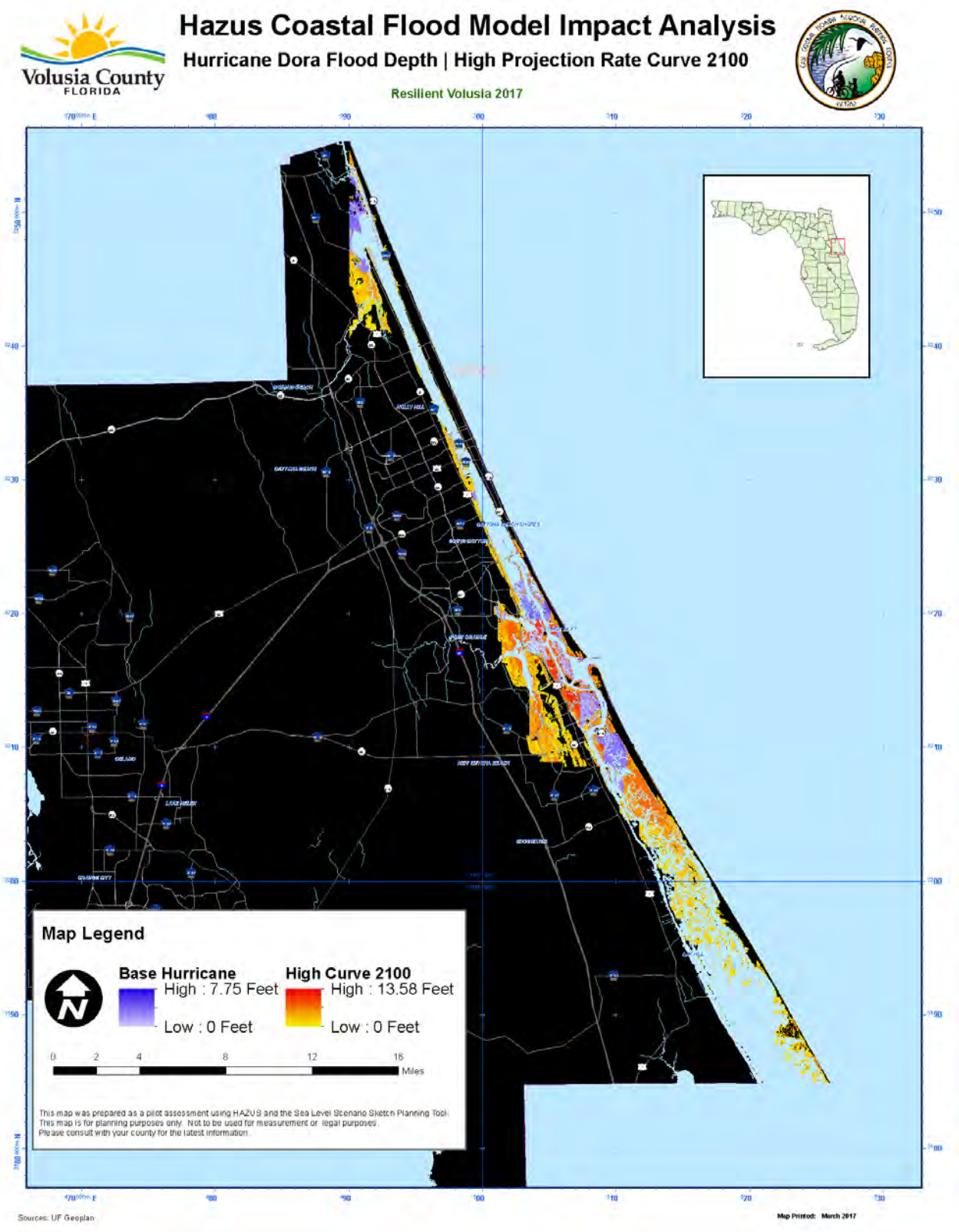


Figure 23: Hurricane Dora 2100 High



Considerations and Recommendations

There are typically three approaches when considering options in addressing vulnerabilities and risk in planning for sea level rise and incorporating strategies into various plans. [2]These three approaches are: **Accommodation, Protection, and Retreat.** Strategies and policies implemented typically fall within one of these three categories and depend on the extent and magnitude of vulnerability and risk, as well as location and purpose. Table 14 was provided by the USACE in Technical Letter 1100-21-1[3] to illustrate potential strategies that fall within each accommodation category. This is not meant to be an inclusive list of strategies but to be used as an illustration of some approaches and to be used as an aid in future discussions.

RETREAT: limits and discourages development in vulnerable areas and plans for relocation or removing existing structures already within the area.

ACCOMMODATION: continues development but requires new standards and regulations

PROTECTION: strategies that protect people, infrastructure and property from sea level rise impacts often implemented through engineering solutions.

Credit: Georgetown Climate, 2011

[2]Georgetown Climate, 2011 - http://www.georgetownclimate.org/files/report/Adaptation_Tool_Kit_SLR.pdf
[3] USACE, 2014-
http://www.publications.usace.army.mil/Portals/76/Publications/EngineerTechnicalLetters/ETL_1100-2-1.pdf

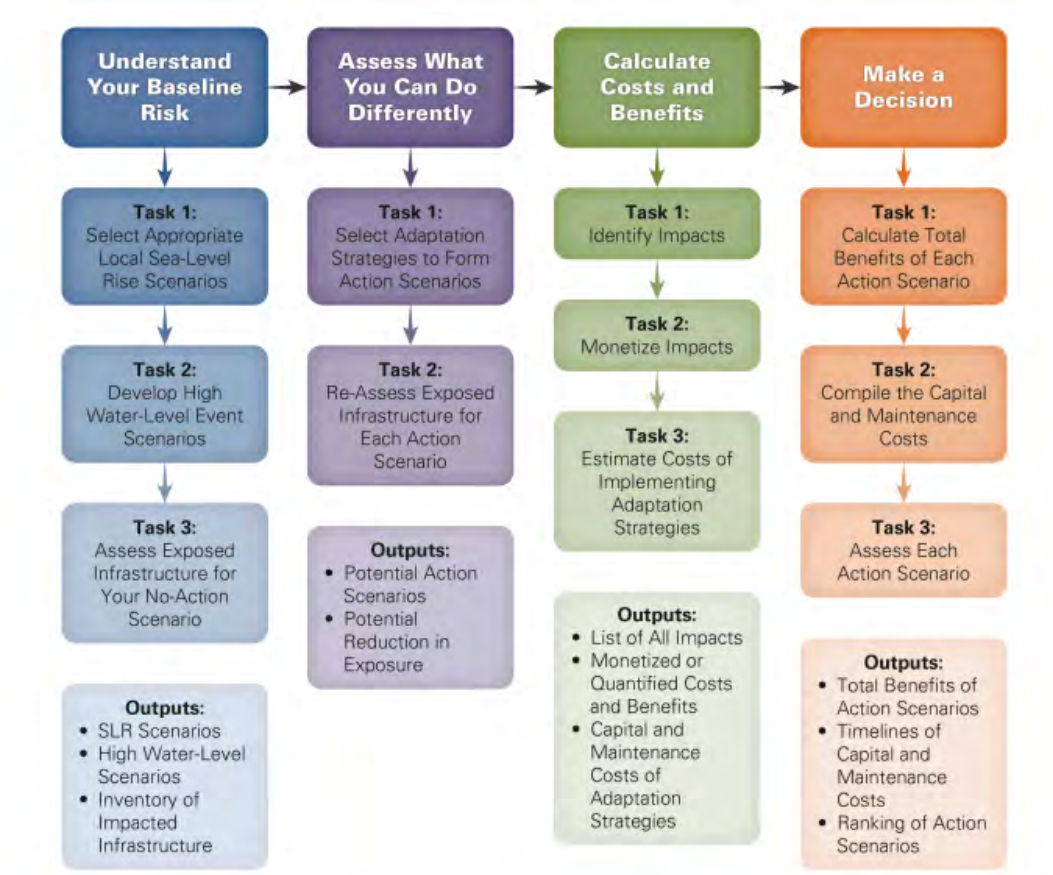
Table 14: Example Strategies by Adaptation Category USACE, 2014

Project Type	Protect	Accommodate	Retreat
Navigation	Upgrade and strengthen existing primary structures; Expand design footprint and cross section of existing structures, including raising for clearance and access; Add secondary structures; Add structures to protect backshore; Improve resilience of backshore facilities.	Upgrade drainage systems; Increase maintenance and dredging; Adjust channel location and dimensions; Modify operation windows; Floor proof interior infrastructure; Add sediment to shoreline or underwater morphology.	Relocate interior harbor infrastructure due to relative sea level rise or fall; Abandon harbor/port; Re-purpose project area.
Coastal Storm Damage Reduction	Upgrade and strengthen existing structures; Expand design footprint and cross section of existing structures; Add secondary structures Dune/beach construction.	Increase maintenance of shoreline protection features; Sediment management; Beach nourishment/vegetation; Upgrade drainage systems; Upgrade and modify infrastructure; Flood proof buildings; Implement building setbacks; Modify building codes.	Relocate buildings and infrastructure; Land-use planning and hazard mapping; Modify land use.
Flood Risk Reduction	Upgrade and strengthen existing structures; Expand design footprint and cross section of existing structures; Construct levees or implement flood proofing measures; Add secondary structures; Dune/beach construction.	Increase maintenance of flood risk protection features; Upgrade and modify infrastructure; Improve natural shoreline resilience (vegetation); Flood proof buildings; Implement building setbacks.	Relocate buildings and infrastructure; Land-use planning and hazard mapping; Modify land use.
Ecosystems	Construct drainage systems; Construct shoreline protection structures, dikes or cells; Construct tidal gates, install salt water intrusion barriers.	Accept changes to ecosystems; Sediment management; Change water extraction; Freshwater injection/diversion; Modify land use; Migrate landward.	Allow/facilitate habitat conversion; Forbid hard defenses; Ecosystem migration; Abandon ecosystem.

Source: USACE, 2014

As discussed in various areas of this report, risk, probability and cost should be considered when assessing adaptation strategies. NOAA developed a report entitled *"What Will Adaptation Cost? An Economic Framework for Coastal Community Infrastructure"* in June 2013[4]. It provides a framework for communities to evaluate adaptation options for addressing resiliency. It walks through the frame work and provides meaningful appendixes that address adaptation strategies, tools and strategies for monetizing impacts and also provides relevant case studies including their methodology and findings. This report will help the various departments and agencies in Volusia County during "next steps" in developing a framework and action plan for the County. The figure below outlines the framework as presented in the NOAA report.

Figure 24: Framework Presented by NOAA for Making Informed Decisions



Source: NOAA, 2013 – https://coast.noaa.gov/data/digitalcoast/pdf/adaptation-report.pdf

Numerous other resources exist to help planners, engineers, decision makers and others develop plans, strategies and educate the public in addressing resiliency. A list of resources and tools are found in the appendix of this report. The sections that follow provide considerations as they pertain to various types of plans and potential avenues and recommendations for updating these plans.

[4] NOAA, 2013 – https://coast.noaa.gov/data/digitalcoast/pdf/adaptation-report.pdf

Emergency Preparedness

Numerous plans exist providing Volusia County Emergency Management with strategies, policies and goals for addressing both natural and manmade hazards. Some of these plans such as the Local Mitigation Strategy Plan (LMS) and the Floodplain Management Plan (FMP) may be enhanced to include sea level rise and increased duration and extent of flooding from storms as well as increased frequency of flooding events.

The Volusia County Local Mitigation Strategy Plan is a multi-hazard and multi-jurisdictional strategy plan that establishes the broad community vision and guiding principles for reducing hazard risk and further proposes specific mitigation actions to eliminate or reduce identified vulnerabilities. The plan was updated in 2015 and has been prepared in coordination with FEMA Region IV and the Florida Division of Emergency Management to ensure that the Plan meets all applicable DMA 2000 and state requirements. During this update, the LMS working group included, for the first time, sea level rise as a hazard for consideration and provided recognition that some hazards such as storm surge and flooding may be impacted by changes in climate over time. At the time of the report, a preliminary analysis for 1, 3, and 5 feet of sea level rise was conducted. Additional linkages between hazards should be further incorporated into the LMS, and a more extensive "sea level rise" hazard section should be developed and also include the concepts of increased frequent flooding and the expansion of the 100-year storm and associated depth. As noted later in this report, since the LMS is a multi-jurisdictional plan, it will be important for the County to assess and track policies and projects of local governments that address sea level rise.

Photo Credit: FEMA NFIP- CRS Coordinators Manual,2013

Since this time, the County, the ECFRPC and county partners have been working to assess sea level rise impacts on infrastructure and hazards such as flooding. To this end, this report, as well as findings and recommendations from other efforts in the County, should be integrated into the LMS and FMP. This section will provide recommendations to integration within the LMS to not only plan and prepare for the hazards associated with sea level rise, but to also go above and beyond FEMA's National Flood Insurance Program requirements, utilizing the latest Community Rating System (CRS) Coordinator's Manual for guidance to help lower Community Rating System scores for the County and participating municipalities. Also, new DFRIM maps for Volusia County are planned to be adopted in fall of 2017. The adoption of new DFIRMs provides a logical opportunity for the County to update appropriate plans.

The Community Rating System (CRS) is a national program developed by the Federal Emergency Management Agency (FEMA). The 2017 CRS Coordinator's Manual provides information on credits and credit criteria for community activities and programs are beyond the minimum requirements for participation in FEMA's National Flood Insurance Program. The Coordinator's Manual is available in Adobe pdf format at the FEMA NFIP website.[5] *At the time of the final review of this document, the NFIP Manual was updated on May 4, 2017 and expires on March 31, 2020. Review of new components of the manual is recommended.*

The CRS Manual, the Federal Emergency Management Agency (FEMA) document which establishes the details for the Community Rating System, provides a series of nineteen activities that local governments may undertake to accomplish the various goals. Communities receive credit to earn a rating of 1-10, the lower the number, the better the rating. As a result of the rating obtained from local government implementation of the activities outlined in the CRS Manual, owners of property in the participating community pay lower flood insurance premiums.

By conducting various GIS analysis, map development and assessment of sea level rise impacts, the County may utilize some of these activities for CRS credits. Also, as other forms of outreach, education and projects/policies are developed throughout the County, additional credits may also be available. It will be important to ensure appropriate criteria are met to obtain CRS credits.

In the appendix, there is table of the changes in the CRS Coordinators' 2017 manual. One change in the watershed master plan credit description is the option for coastal communities to study the 2100 impact of sea level rise in lieu-of a hydrologic/hydraulic analysis of watersheds. Also section 116.c. – Future conditions and Impacts of Climate Change discusses how the manual provides credits for these considerations. Below is information taken from this section to provide an overview of the future conditions credit[6]:

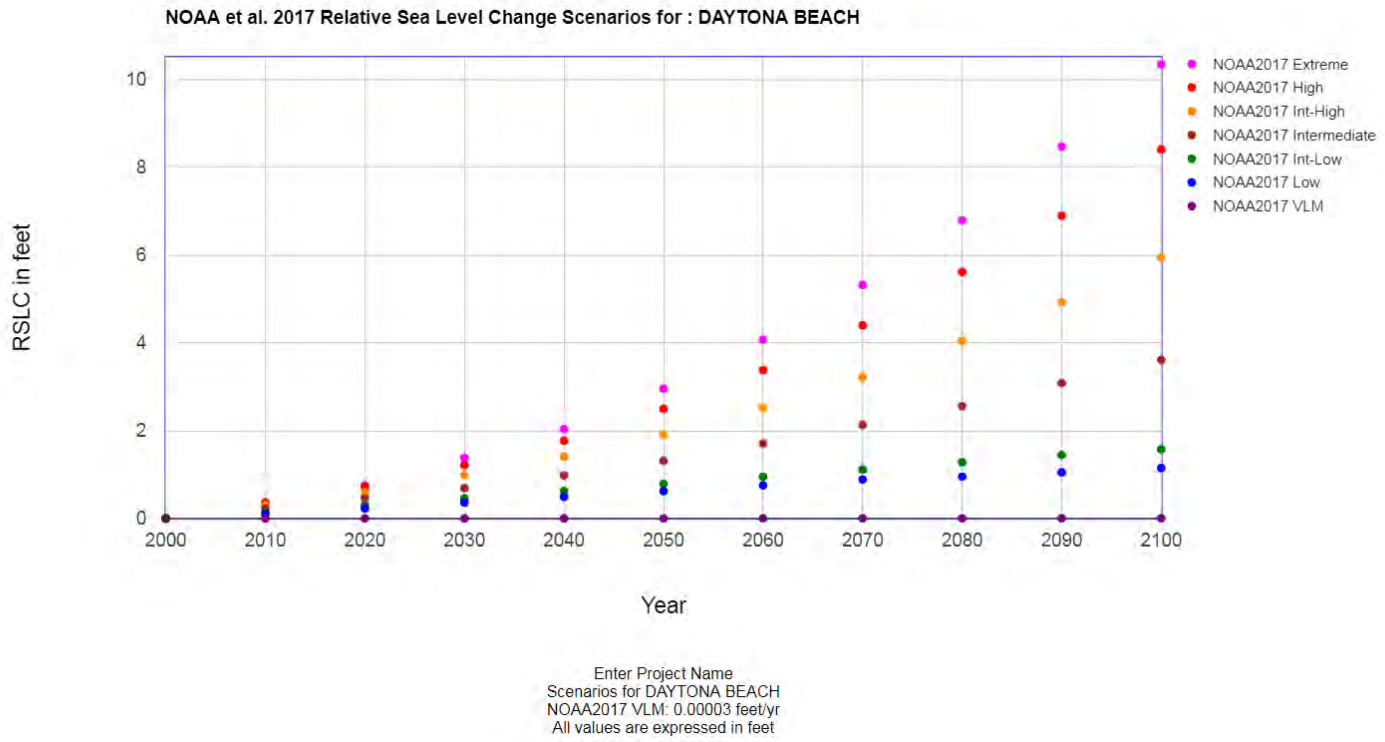
- Credit is provided in Section 322.c for communities that provide information about areas (not mapped on the FIRM) that are predicted to be susceptible to flooding in the future because of climate change or sea level rise.
- To become a Class 4 or better community, a community must (among other criteria) demonstrate that it has programs that minimize increases in future flooding.
- To achieve CRS Class 1, a community must receive credit for using regulatory flood elevations in the V and coastal A Zones that reflect future conditions, including sea level rise.
- Credit is provided in Section 342.d when prospective buyers of a property are advised of the potential for flooding due to climate changes and/or sea level rise.
- Credit is provided in Section 412.d when the community's regulatory map is based on future-conditions hydrology, including sea level rise.
- Credit is provided in Section 432.k when a community accounts for sea level rise in managing its coastal A Zones.
- Credit is provided in Section 452.a if a community's stormwater program regulates runoff from future development.

[5] FEMA - https://www.fema.gov/media-library/assets/documents/8768
[6] FEMA - https://www.fema.gov/media-library-data/1493905477815-d794671adeed5beab6a6304d8ba0b207/633300_2017_CRS_Coordinators_Manual_508.pdf

- Credit is provided in Section 452.b for a community whose watershed master plan manages future peak flows so that they do not exceed present values.
- Credit is provided in Section 452.b for a coastal community whose watershed master plan addresses the impact of sea level rise.
- Credit is provided in Section 512.a, Steps 4 and 5, for flood hazard assessment and problem analysis that address areas likely to flood and flood problems that are likely to get worse in the future, including (1) changes in floodplain development and demographics, (2) development in the watershed, and (3) climate change or sea level rise.

According to the guidance on the sea level rise projections that are to be used for the purpose of CRS credit can be found in Section 404, " The NOAA "intermediate-high" projection for 2100, as included in the report Global Sea Level Rise Scenarios for the United States National Climate Assessment (National Oceanic and Atmospheric Administration, 2012, https://scenarios.globalchange.gov/sites/default/files/NOAA_SLR_r3_0.pdf), is the minimum projection that must be used for CRS purposes. Communities may use other projections provided that they are equal to or greater to NOAA's "intermediate-high" projection for 2100." Note that NOAA updated its curves (as seen below) in 2017 and CRS references the previous report, which places the NOAA 2012 Intermediate-High Rate curve at a lower rate than the USACE high rate curve used in this report.

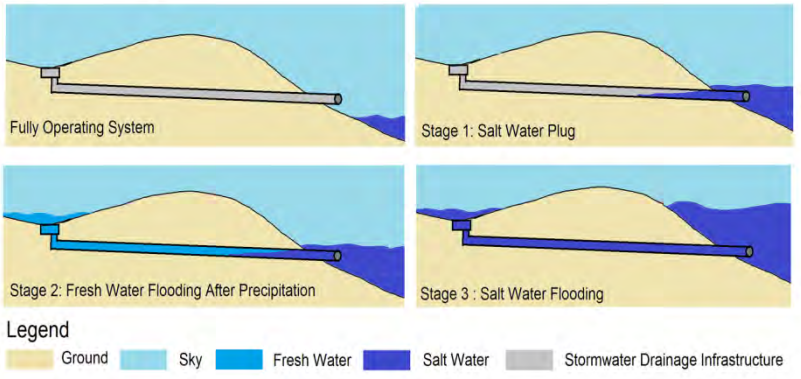
Figure 25: NOAA Relative Sea Level Changes for Daytona Beach



As one of the first signs of flooding issues is the failure of the stormwater system through backups or ponds over capacity. An important process of assessing outfalls and stormwater ponds, especially those in current and anticipated flood prone areas should be a priority to help mitigate future impacts of increased coastal flooding. This is especially a concern in areas where stormwater pipes drain directly into coastal water bodies. Sea-level rise makes such infrastructure more susceptible to flood risk. A previous analysis conducted by the ECFRPC in 2015/2016 looked the available data concerning outfalls within the proximity of the Indian River Lagoon and Banana River in Volusia County. Further review and expansion of this data may be necessary to determine which outfalls, though not expected to be inundated, may be susceptible to increased coastal flooding levels. The assessment and potential restructured maintenance or other mitigation efforts may not only help reduce risk during a 100-year storm but may minimize impacts from frequent flooding events, which are expected to increase in frequency as sea level rises. Assessments of stormwater infrastructure are also potential CRS credit activities. Again, care would be needed to ensure the efforts meet the criteria required for credits. Regardless, maintaining an effective and resilient stormwater system that is able to function as flooding increases and sea levels rise, is essential for a resilient community.

Additionally, green infrastructure should be emphasized in the LMS, local comprehensive plans, and long-range transportation, among others, to mitigate flooding issues. Green Infrastructure can be utilized for recreational open space while providing stormwater solutions, stormwater parks can be developed as part of larger developments or even transportation projects. Projects are context sensitive with scale, design and multi-function purposes differing between rural, suburban and urban landscapes. Restoration of natural and living shorelines should be a priority throughout the County to help provide buffers to storm surge, especially during a 100-year storm or hurricane. The Volusia LMS should include tracking green infrastructure policies and projects as flooding mitigation projects. It is also important to educate public about green infrastructure, low impact development and living shorelines as options on private property to reduce flooding and erosion impacts, and increase their understanding of all the benefits natural infrastructure. These projects and policies may be eligible for CRS credits.

Figure 26: Stages of Stormwater Infrastructure Failure Due to Sea level Rise



Graphic Credit: Dr. Jason Evans, Emily Neiderman, Stetson University

Table 15 on the following page is an excerpt from the NOAA 2013 document entitled "*What Will Adaptation Cost? An Economic Framework for Coastal Community Infrastructure"* and includes various strategies that minimize impacts associated for coastal flooding. It would be advantageous for the LMS working group to review these strategies to determine the applicability and feasibility of the implementation of some of the strategies identified, or additional strategies determined by the LMS working group or in other reports and best management practices. As noted in the Volusia LMS, it is a living document, therefore, it will be important to ensure tracking of local jurisdictional policies and strategies that are implemented as locals begin addressing impacts of sea level rise.

The Gulf of Mexico Alliance (GOMA) resiliency team developed a Resilience Index for coastal communities to self-assess a community's resiliency after a disaster. The index looks at critical infrastructure and facilities, transportation, community plans/agreements, mitigation measures, business plans and social systems. While the assessment is self-guided GOMA has trained facilitators to assist through the process. This tool may be used by the County and jurisdictions to provide an assessment of some gaps that should be addressed to increase resiliency to natural disasters and determine the community's ability to reach and maintain an acceptable level of functioning after a disaster. GOMA and UF/IFAS Extension Services are available as resources to assist in completing the index as well as other areas of technical assistance. Numerous grants and funding opportunities are also located on their website. http://www.gulfofmexicoalliance.org/

Photo Courtesy of Volusia County

Table 15: NOAA Documented Adaptation Strategies

Adaptation Strategy	How This Adaptation Strategy Changes the Impacts of Coastal Flooding
Managed Retreat Policies	
Transfer of development rights (TDR)	Encourages future development to be located out of harm's way.
Purchase of development rights (PDR)	Encourages future development to be located out of harm's way.
Rolling easements	May discourage future development from being located in harm's way. Can lead to removal of existing development from harm's way as shorelines move inland.
Fee-simple acquisition (buyout)	Prevents new development from being located in harm's way and/or removes development currently in harm's way.
Infrastructure relocation	Relocates the infrastructure out of harm's way.
Tidal Management	
Storm-surge barriers	Prevents higher water from traveling through inlets or into estuaries up to a certain water-level increase.
Engineered Barriers	
Levees and dikes	Prevents flooding up to a certain water-level increase.
Sea walls	Prevents flooding up to a certain water-level increase.
Beach nourishment	Prevents flooding up to a certain water-level increase.
Sandbagging	Prevents flooding up to a certain water-level increase.
Infrastructure Modification/Design	
Elevated development	Reduces the damage caused by flooding by raising the infrastructure above ground level.
Flood-proofing infrastructure	Reduces the damage caused by flooding.
Floating development	Prevents flooding to structure as the development rises with the water.
Floodable development	Prevents structural damage up to a certain height. May contain some water which can prevent flooding of other assets.
Movable buildings	Allows for relocating the infrastructure out of harm's way.
Drainage systems	Manages flood water to reduce damage.
Development fees in vulnerable areas	Can be used to pay for flood mitigation measures and may encourage future development to be located out of harm's way.
Green Infrastructure	
Wetlands	Absorb water to reduce the overall water-level increase, and dissipate wave and storm surge energy.
Mangroves	Reduce the wave power, typically resulting in a smaller storm surge and a slightly lower water-level increase.
Oyster and coral reefs	Reduce the wave power, typically resulting in a smaller storm surge and a slightly lower water-level increase.
Living dunes	Prevent flooding up to a certain water-level increase.
Barrier island restoration	Reduces the wave power, typically resulting in a smaller storm surge and a slightly lower water-level increase.

[7]

[7] NOAA Coast Service Center (2013) What Will Adaptation Cost? An Economic Framework for Coastal Community Infrastructure https://coast.noaa.gov/data/digitalcoast/pdf/adaptation-report.pdf

Land Use Planning

Currently (2017), the Volusia County comprehensive plan does not directly address sea level rise in any detail. The only mention of "sea level rise" is addressed in Chapter *11.4.1.21 Volusia County should continue to monitor sea level rise science to determine how sea level rise will affect the County. Based on pertinent data, the County will act accordingly.*

However, in other sections of Chapter 11 (Coastal Element), language addresses:

- the minimization of flooding and storm damage to evacuation routes - *11.5.1.4 Future roadway improvements shall minimize the impact of flooding and storm damage on evacuation route facilities;*
- relocation of County-owned infrastructure - *11.5.3.8 If feasible, and where State funds are anticipated to be needed, County-owned infrastructure presently within the Coastal High Hazard Area shall be relocated outside of said area when repairing/replacing the infrastructure. If relocation of the infrastructure is deemed by the County to not be feasible, any reconstruction or repair of the infrastructure necessitating State funds shall be designed so as to minimize potential damage (i.e., wind and/or flooding) from hurricanes or other storms.*
- Future siting of public buildings outside hazard areas - *11.7.7 Public Buildings. Ensure through capital improvement planning and site selection that public buildings meet the needs of population growth and are located outside of areas susceptible to damage from storms or flooding.*
- School facility siting outside hazard areas - *11.7.7.2 Encourage the School Board to locate future school facilities outside of areas susceptible to hurricane storm damage or areas prone to flooding, or as consistent with Chapter 235, Florida Statutes regarding flood plain and school building requirements.*
- Future siting of law enforcement and fire stations - *11.7.7.6 Locate new fire and law enforcement facilities outside of the areas susceptible to hurricane storm damage or flooding where feasible.*
- Parameters for new sea walls - *New seawalls shall only be allowed in an emergency situation to protect health, safety, principal buildings, public infrastructure, or to fill in small gaps (size of gaps will be consistent with FDEP definition of a gap) between existing seawalls. The construction of new seawalls shall be consistent with Policies 11.4.1.5, 11.4.1.6, and 11.4.1.7. Also, new seawalls must receive proper permits from the County and the FDEP prior to construction.*
- Dunes associated with sea walls - *11.4.1.6 A dune system shall be developed and vegetated with suitable materials to bury all new, and/or reconstruction or replacement seawalls within the County*

The Future Land Use Chapter of the comprehensive plan does not address sea level rise but in many areas the language addresses flooding:

- *1.1.1.3 - Regulate areas subject to seasonal and periodic flooding and provide for drainage and stormwater management;*
- *1.2.2.7 Structures shall be discouraged within the 100-year flood plain; however, if located therein, they shall be constructed to minimize the amount of additional fill, thereby reducing the potential for flood damage to the structure, supporting facilities, and adjacent property, consistent with the Flood Hazard Management section of the Land Development Code.*

- *1.2.2.11 Proposals for development within designated riverine floodways shall be approved by the County only if it can be demonstrated to the satisfaction of Volusia County that any encroachment into the floodway will not result in any increase in flood levels during the occurrence of discharge. If approved, the development must be consistent with the environmental performance standards from the Conservation Element*
- *FG 2.4 Resource Based Open Space.*

Other sections of the comprehensive plan that address flooding and standards to address or mitigate for flooding include the Capital Improvement Element, Drainage Sub-Element, and Conservation. The County has much of the base language in the comprehensive plan to address some items related to current conditions. The language may need to be expanded to include future conditions in order to continue its effort towards resiliency as conditions change.

In 2011, the Georgetown Climate Center developed a document titled "Adaptation Tool Kit – Sea Level Rise and Coastal Land Use". This is just one of the various documents and tools available to local governments in assessing strategies and processes to adapt to sea level rise. This particular tool kit focuses on land uses. As noted in the report, comprehensive plans are the "first step" governments can take to incorporate adaptive strategies. These policies and strategies would then lead to amendments of other ordinances such as overlays, zoning, building codes, subdivision codes, capital improvement plans, and others. The following pages include a synopsis of sea level rise adaptive tools taken from the Georgetown Climate Report to provide an overview of the various components, plans and regulations within land use planning that can be assessed for adaptation measures and policies.
(http://www.georgetownclimate.org/files/report/Adaptation_Tool_Kit_SLR.pdf)

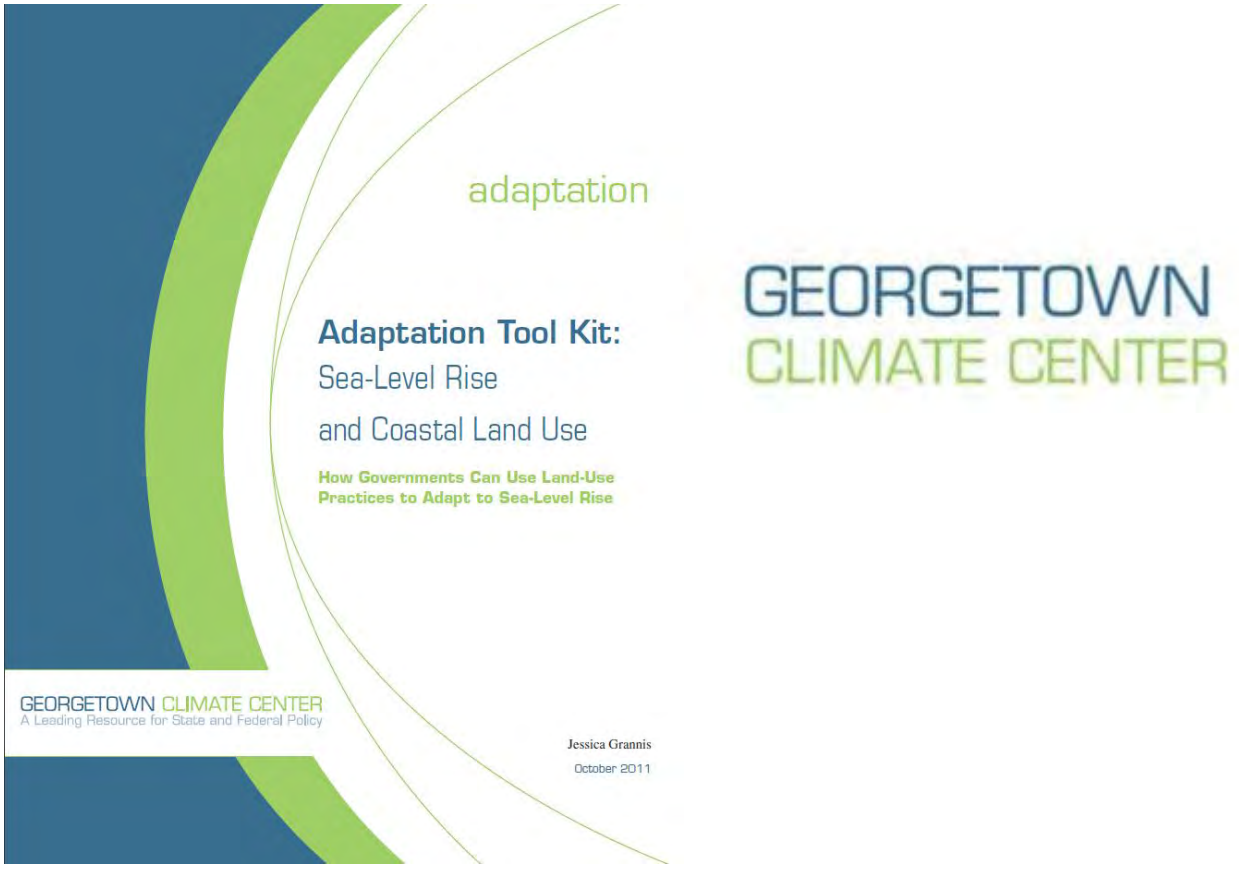


Figure 27: Synopsis of Sea Level Rise Adaptation Tools (excerpt from Georgetown Climate Center Adaptation Tool Kit)

Tool Number	Adaptation Measure	Description	Implementation to Address SLR
PLANNING TOOLS			
1	**Comprehensive Plans**	Provide the long-range planning tool used to guide future development in a community.	Considering SLR in comprehensive plans is the first step by which local governments can begin to incorporate adaptive strategies into their communities' land-use decision-making framework. Studies and evidence used to amend comprehensive plans can serve as the evidentiary support needed to amend zoning ordinances.
REGULATORY TOOLS			
2	**Zoning and Overlay Zones**	Provide the legal framework that governs the use and development of land in a community. Zoning maps divide the community into different districts based upon the types of uses that are permitted (e.g., residential, commercial, or industrial). Then, within each zone the ordinance specifies the design requirements that govern development (e.g., setbacks, building heights, building densities). Overlay zones superimpose additional regulations on an existing zone based upon special characteristics of that zone (e.g., floodplains and historic districts).	As a necessary predicate to implementing most land-use tools, local governments will need to amend their zoning ordinances to designate areas that are vulnerable to impacts and to impose special regulations on those areas. Special regulations could prohibit or limit expansion or major renovation to existing structures and rebuilding of damaged structures. Governments could create zones based upon their adaptation goals (protection, accommodation, retreat, or preservation).
3	**Floodplain Regulations**	As a requirement to participate in the National Flood Insurance Program (NFIP), local governments must impose minimum regulation on development in floodplains (generally delineated as the 100-year floodplain). Typically structures in these areas must be constructed to minimize flood damage (e.g., elevated).	Governments could impose additional restrictions on development in floodplains above NFIP minimum standards. Governments could impose use restrictions in the 100-year floodplain (e.g., limit permitted uses to low-density, large-lot residential, agricultural, or recreational uses). Governments could also begin to impose design requirements in the 500-year floodplain (e.g., requirements that structures be elevated).
4	**Building Codes and Resilient Design**	Establish requirements for building construction to maximize protection from flooding (e.g., elevation and construction techniques and materials).	Governments can extend building code regulations to properties in the 500-year floodplain and require that new structures be designed to be more resilient to flood impacts. Governments can require that structures in the 100-year coastal floodplain be further elevated or strengthened to account for increased coastal flooding from SLR over the life of the structure.

Source: Georgetown Climate Center, 2011

Tool Number	Adaptation Measure	Description	Implementation to Address SLR
5	**Setbacks/Buffers**	Require that development be set back a distance from a baseline, typically a shoreline feature (e.g., high water mark, bluff crest, or vegetative line). Require landowners to leave, in their natural state, portions of property that support natural and beneficial functions (such as wetlands that prevent runoff and flooding).	Governments could establish or increase mandatory setbacks from the coast, establish setbacks based upon projected shoreline position using calculations of increased flood and/or erosion rates, or create a tiered setback system permitting smaller structures with less of a setback and requiring greater setbacks for larger development. Governments could require that development adjacent to the shore leave buffers to provide natural protection to development while allowing for upland migration of beaches and wetlands.
6	**Conditional Development and Exactions**	Impose special conditions as a condition of a development permit. Conditions can be designed to mitigate the impacts of development, and can take the form of impact fees, land-use restrictions, and dedications of lands for public purposes.	Governments can use conditions to restrict landowners' rights to build hard coastal protection, require removal of structures that come to be inundated as the shoreline recedes, require dedication of coastal buffers, require impact fees to pay for emergency response costs or to mitigate impacts from coastal armoring, or require that structures have greater levels of flood protection.
7	**Rebuilding Restrictions**	Limit a property owner's ability to rebuild structures destroyed by natural hazards, such as flooding.	Governments can limit when and how structures are rebuilt by prohibiting reconstruction, requiring that structures be rebuilt using resilient design techniques, or conditioning redevelopment on a landowner's agreement not to armor in the future.
8	**Subdivision and Cluster Development**	Require the concentration of development in desirable areas using subdivision ordinances. These programs allow developers to increase densities in specified areas in exchange for the developer's agreement to designate open space.	Governments could encourage concentration of development in upland areas and require dedication of vulnerable areas as open-space and flood buffers.
9	**Hard-Armoring Permits**	Use permitting processes to regulate the construction of hard-engineered structures that provide flood and erosion control.	It may be necessary to harden the coast where there is considerable existing development or critical infrastructure. However, governments can limit hard armoring along vulnerable coastlines with sensitive ecosystems, require that the armoring be constructed to protect against storm surge combined with increased sea levels, and require mitigation where armoring is permitted.
10	**Soft-Armoring Permits**	Facilitate "soft" coastal protection projects that replenish or mimic natural buffers, such as beach nourishment, living shorelines, or wetlands restoration.	Governments could create permitting programs to require the use of soft-armoring techniques where feasible in order to lessen environmental impacts of shoreline armoring.
11	**Rolling Coastal Management/ Rolling Easement Statutes**	Combine different land-use regulations that serve to ensure that coastal development does not impede the natural inland migration of coastal resources.	Rolling coastal management statutes can limit new development in at-risk coastal areas, limit or prohibit the construction of hard-coastal armoring, require removal of structures that come to encroach on public lands due to erosion, and require real estate disclosures.

Tool Number	Adaptation Measure	Description	Implementation to Address SLR
SPENDING TOOLS			
12	**Capital Improvement Programs (CIPs)**	Guide future investments in public infrastructure based upon projections of the community's growth.	Governments can use CIPs to site new infrastructure out of harm's way, discontinue maintenance and repair of infrastructure that is repetitively damaged, or relocate or retrofit existing infrastructure to be more resilient to SLR.
13	**Acquisitions and Buyout Programs**	Acquire property at risk from flooding or other hazards. Structures are typically demolished and the property is restored. Undeveloped lands are conserved as open space, public parks, or for natural resources.	Governments could extend floodplain buyout programs to properties threatened from SLR and could prioritize for acquisition vulnerable properties with high natural resource value. Governments could prioritize for acquisition lands with potential to serve as flood buffers for existing development and potential to serve as corridors for migrating beaches and wetlands.
14	**Conservation Easements**	Provide a flexible mechanism by which public entities can preserve land in its natural state while allowing land to remain in private ownership. Landowners grant an easement agreeing to restrict development of the land often for compensation or tax benefits.	Governments could prioritize acquisition of easements on properties vulnerable to SLR and acquire conservation easements to ensure preservation of lands that could serve as flood buffers, habitat, or migration corridors.
15	**Rolling Conservation Easements**	Adapt conservation easements to provide a rolling boundary that is designed to preserve the ability of the shoreline to migrate inland.	Rolling easements could be used to purchase any rights that landowner may have to construct coastal armoring and to require owners to remove structures that become threatened by rising seas and erosion while allowing for some upland development of the property.
TAX AND MARKET-BASED TOOLS			
16	**Tax incentives**	Encourage preferred development patterns and can take the form of preferential assessment programs, tax abatements, and tax credits.	Governments can encourage conservation of vulnerable properties by taxing properties at a lower rate based upon its restricted "use value;" encourage relocation or retrofit of flood-prone properties by providing a one-time tax credit; or encourage upland infill development by providing tax credits or streamlined permitting.
17	**Transfer Development Rights**	Restrict development in one area ("sending area") and allow for the transfer of development rights to another area more appropriate for intense use ("receiving area").	Governments could restrict development in vulnerable areas and allow for transfer of development rights to upland parcels where development will be out of harm's way.
18	**Real Estate Disclosures**	Require sellers of real estate to disclose certain property defects to prospective buyers prior to close.	Governments can compile and disseminate information about a property's vulnerability to SLR, or require sellers to disclose if a property is located in an area vulnerable to SLR.

Specific to Florida, recent legislation has provided direct opportunities for planners to incorporate resiliency planning into local comprehensive plans. **Adaptation Action Areas (AAA)** were adopted into statute in 2011, through the Community Planning Act. AAAs are voluntary and help local governments adapt to coastal flooding through their comprehensive plan, by using best practices in areas such as sustainable development, green infrastructure, water management, natural resources, and post disaster redevelopment. The Florida Department of Economic Opportunity created a report entitled "Adaptation Action Areas: A Planning Guidebook for Florida's Local Governments". The report provides a process to help guide local governments in integrating Adaptation Action Areas into various planning and operational documents and procedures. The guidebook includes a "broad process for engaging community stakeholders, identifying vulnerability, developing planning tools, adopting policies, and implementing strategies." [8] Also included are local lessons learned as AAAs will not be identical across jurisdictional lines. What may work in one community may not be suitable for another. It is important re to remember that the main purpose of an AAA, according to Section 163.3164 (1) of Florida State Statute is to prioritize funding for infrastructure and adaptation planning.

> *"Adaptation Action Area" or "Adaptation Area" is an optional designation in the coastal management element of a local government's comprehensive plan which identifies one or more areas that experience coastal flooding due to extreme high tides and storm surge, and that are vulnerable to the related impacts of rising sea levels* ***for the purpose of prioritizing funding for infrastructure needs and adaptation planning****. Section 163.3164(1), Florida Statute*

In 2015, Florida Senate passed SB 1095/House passed HJ 803 resulting in the **Peril of Flood Act**, approved by the Governor (https://www.flsenate.gov/Session/Bill/2015/1094/?Tab=BillHistory). The act specifies requirements for jurisdictions required to have a coastal management element in their comprehensive plan. The Act requires the coastal management redevelopment element to:

1) Include development and redevelopment principles, strategies, and engineering solutions that reduce flood risk in coastal areas which results from high-tide events, storm surge, flash floods, storm water runoff, and the related impacts of sea level rise.
2) Encourage the use of best practices development and redevelopment principles, strategies and engineering solutions that will result in the removal of coastal real property from flood zone designations established by FEMA.
3) Identify site development techniques and best practices that may reduce losses due to flooding and claims made under flood insurance policies issued in this state.

[8] Florida Department of Economic Opportunity, 2015 - http://www.floridajobs.org/docs/default-source/2015-community-development/community-planning/crdp/aaaguidebook2015.pdf?sfvrsn=2

4) Be consistent with, or more stringent from, the flood-resistant construction requirements in the Florida Building Code and applicable flood plain management regulations set forth in 44 C.F.R part 60.
5) Require that any construction activities seaward of the coastal construction control lines established pursuant to s. 161.053 be consistent with chapter 161.
6) Encourage local governments to participate in the FMA CRS program to achieve flood insurance premium discounts for residents.

As of March 2017, only 6 jurisdictions in Florida adopted Peril Flood language in their comprehensive plan, none of which are in Volusia County. These jurisdictions include: St. Petersburg, Treasure Island, Madeira Beach, South Pasadena, Miami Beach, and Tampa.

When the County and municipalities adopt Peril Flood and develop AAA, where appropriate, staff should evaluate and incorporate these concepts, strategies, and principles into other plans including:

- Capital Improvement Plans
- Resiliency Plans
- Sustainability Plans
- Emergency Management Plans
- Local Mitigation Strategy
- Stormwater Master Plans
- Park and Trail Plans/Conservation Plans
- Transportation Plans
- Strategic Plans
- Land Development Regulations
- Agreements with utility and infrastructure providers
- Agreements with Public Health Providers
- Other local government agreements
- Other government plans and procedures

Understanding only where inundation will occur, combined with increased periodic flooding, only gives one piece to the story. Sea level rise will create a new landscape in Volusia County through ecosystem changes and migrations. As ecosystems change and move, wetlands migrate and new systems develop, connectivity between ecosystems, conservation lands and uplands will need to be re-examined. Current development plans may hinder migration of wetlands and the natural progression of ecosystem connectivity. Examining anticipated ecosystem migration, compared to existing and future land use and current conservation plans is critical in determining adaptation strategies, land use decisions, and policy development.

Finally, the Volusia County Sustainability Action Plan (2014) provides many actions the County and cities can address in an effort to become more resilient. The plan addresses the protection of groundwater and surface water bodies through many strategies identified in this report (living shore lines, low impact

development, conservation corridors). The plan addresses green building and creating a sustainable tourism industry. Many of the strategies addressed in the plan will need some forward movement and buy-in from the businesses in order to ensure their sustainability as conditions change. The plan also addresses sea level rise in the following actions:

- incorporate of potential sea level rise scenarios into land acquisition, public infrastructure, and land development decisions to ensure the ability to adapt to changing conditions
- incorporate of changing climate conditions into hazard mitigation planning efforts.
- Encourage coastal cities to adopt adaptive design strategies, which could include coastal setbacks, density restrictions, and rolling easements.
- Encourage the restoration of tidal wetlands and salt marshes, as they are considered one of the most valuable ecosystems for the sequestration of carbon"

Many of the actions of the plan feeds into various adaptation strategies. For example, the plan supports and incentivizes green building practices: "Areas that may experience the greatest change in flood depth should be examined and stakeholders should consider potential changes to building codes, mitigation opportunities and other strategies to protect life and property as well as critical facilities and major transportation facilities that would be essential for evacuations and recovery." The priority of restoring wetlands and marshes can be implemented through an analysis of wetland and habitat migration to reassess priority acquisition and protection areas. In fact, the plan discusses the importance of green space as it relates to resiliency. "Additionally, a review of conservation areas, planned acquisition and other open space through the lens of resiliency may open opportunities for ecosystem migration, provide green infrastructure for stormwater mitigation, and provide social and economic benefits while protection life and property." Ecosystem services are important for sustainability and resiliency as they serve various functions including:

- Carbon sequestration
- Economic benefits of living shoreline projects
- Absorb the impact of storm surge and serve as buffer to development

Photo Courtesy of Volusia County

St. Johns River, Natural Stormwater Mitigation but also source of flooding

Transportation Planning

Many of the resources and strategies presented previously can easily be incorporated into transportation planning. The main plan for transportation planners is the Long-Range Transportation Plan (LRTP). This plan, as the comprehensive plan and emergency management plans, should incorporate scenarios and sea level rise ranges on which to base planning and decision making. The River to Sea TPO has already conducted a preliminary assessment on vulnerable transportation infrastructure using the same sea level rise scenarios within this report. The findings of that report should be combined with those of this analysis to develop areas of priority. Policies and procedures for incorporating those priority areas and sea level rise into studies associated with new roadways or improvements should be incorporated into the long-range transportation plan. Some considerations should include roadways that may not be susceptible to sea level rise but may be subsequently undercut with erosion due to rising seas and increased wave action; roadways near stormwater ponds that are already over capacity during storms or are within the areas anticipated to be inundated or within potential new flood areas; bridge run ups should be further analyzed to determine impacts as these areas are sometimes difficult to model using lidar/DEM data, additionally, bridge span above water levels should also be assessed. Green infrastructure is a concept that should be considered for projects within current or anticipated flood areas. These projects can help mitigation future flood impacts and provide numerous environmental and social benefits.

One of the necessary steps in order to build the consensus around these new policies and procedures is to engage the elected officials and staff who are working to make decisions and implement the strategies. The River to Sea TPO is off to a great start in building consensus and educating stakeholders, implementers and decisions makers. The Annual Meeting of the TPO held early in 2017 focused on sea level rise, stormwater impacts and how to plan for the vulnerabilities and legal issues that may arise as the counties address rising seas.

Funding for roadway improvements are often tied to federal standards and requirements. It will be important to make sure policies, procedures and plans of the FDOT, TPO and County are in line with the requirements of the federal agencies to ensure compliance to receive funding. Contractors should also be aware of new standards and processes to ensure timely deliverables that address the needs associated with new procedures and engineering solutions required under funding agencies. Reviewing the funding regulations and updating plans and procedures is an important next step for the TPO, FDOT and County.

The Federal Highway Administration has been hosting a number of webinar series addressing resiliency in transportation. These webinars are still available and cover topics including:

- Pilot Projects
- How to assess assets and vulnerabilities to sea level rise and storm surge
- Green infrastructure for transportation resiliency
- Overview of tools including the Vulnerability Assessment Scoring Tool (VAST)
- Engineering Roads and Assets to be resilient to climate change
- And many others

The webinars can be viewed at the following link;

https://www.fhwa.dot.gov/environment/sustainability/resilience/webinars/index.cfm

Conclusion

All county and city planning areas are intertwined and strategies incorporated in any area will have either benefits or consequences, including economic implications, in other realms. For example, impacts on transportation facilities also have economic and social impacts. It is important for Volusia County to continue its cross departmental, agency and jurisdictional conversations. As noted below, there are a number of "first steps" that various departments and agencies should undertake in an effort to become more resilient. The establishment of a working group may be beneficial for to ensure continued discussion and review of strategies and goals being implemented across the County, cities and agencies to determine potential impacts as well as opportunities. The group could help in the development of an action plan and establish priorities and policy development for various stakeholders. While some jurisdictions may or may not be ready to address sea level rise, it will be important to include all stakeholders at the table. Actions taken in one jurisdiction may have varying degrees of impacts on neighboring communities. Also, it will provide an opportunity for cross collaboration and sharing of ideas and lessons learned. The stakeholder group should include representation from local, regional and state transportation departments/agencies, county and municipal public works, emergency preparedness, land use planning/growth management, natural resources, the Indian River Lagoon Council, St. Johns River Water Management District, floodplain managers, tourism/economic development councils, the Florida East Coast Railway (FEC), utility providers (water/wastewater/energy), and other groups identified through the process. Subcommittees and smaller, subject area meetings may be necessary as the working group progresses in order to make best use of time and collaboration efforts.

Volusia County should consider the implementation of Adaptation Action Areas in the comprehensive plan to identify, plan for and strategize funding for vulnerable infrastructure projects. Consideration should also include Florida SB 1094, "An Act relating to the peril of flood" which incorporates sea level rise as a flood risk when addressing development and redevelopment principles. Further analysis of the stormwater system including outfalls and stormwater ponds should be conducted to assist in the prioritizing of infrastructure improvements or mitigation projects. The Volusia County LMS should further enhance its commitment to address sea level rise and the increase for potential flooding and track member jurisdictions' policies in order to apply for CRS Credits, as well as the actions of the TPO. The County should closely follow the upcoming NFIP structure discussions. Finally, the TPO should begin to implement strategies and procedures into their various plans including the long-range transportation plan and the prioritization process. The County and municipalities should be at the table with the TPO during these discussions so that similar strategies and planning criteria may be incorporated into the planning for local and county roadways. Additionally, a review of conservation areas, planned acquisition and other open space through the lens of resiliency may open opportunities for ecosystem migration, provide green infrastructure for stormwater mitigation, and provide social and economic benefits while protection life and property. A large undertaking of understanding risk and probability associated with future conditions is also a recognized next step for county departments. As mentioned in this report, mitigation efforts, retrofits, relocation and other strategies may need to be assessed upon

cost benefit, risk analysis to aid in the decision-making process. This may be necessary for large scale, costly projects.

The Volusia County Sustainability Plan offers a good frame work to help guide some work to address resiliency within the County. The Sustainability Plan offers the opportunity to further assess how impacts of coastal flooding and sea level rise can have impacts on the economy, society, and environment if steps are not taken as a community in its entirety to plan for and address these impacts and be a sustainable and resilient county. To further this plan, as the County, agencies and jurisdictions begin to assess adaptation strategies to address sea level rise hazards and increased flooding, the stakeholders should consider the development of a Resiliency Action Plan to prioritize actions by departments and agencies and develop strategies for implementation and public engagement. Having such a plan can also help to leverage future grant funding. To broaden this plan, and provide the regional approach many funders such as NOAA are requiring, the County should consider a partnership with Brevard County, FDOT D5, the TPOs, Port Canaveral and the various federal installations along the coast.

It is important to remember the ever-changing science behind sea level rise. During the writing of this report, NOAA 2017 scenarios were released representing the latest science synthesis, and in general these scenarios are higher than the previous NOAA scenarios. While the differences are less pronounced in the near term (next few decades), there are significant differences out towards 2100. Also, as the CRS program just released their new manual in May of 2017 with a requirement to use at a minimum the NOAA intermediate high projection (2012) for future conditions. While analysis to date has considered the USACE, the USACE high projection rate curve is higher than the 2012 NOAA intermediate-high rate curve. It is recommended to work towards adoption of the USACE High projection rate curve as that complies with the 2017 CRS. This will also allow time to see how the 2017 NOAA rate curves as addressed over the next few years.

As the County and agencies discuss the adoption of a projection curve, it is important to remember that, no matter which scenarios one might choose, it is important to think about risk tolerance for different types of assets to determine the appropriate curve for planning. The County may ultimately choose a range between curves, such as High and Intermediate based on risk and type of infrastructure.

Photo Courtesy of Volusia County

Resources Cited

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Acronyms	
AAA	Adaptation Action Areas
CBP	Custom and Border Protection
CPI	FDEP Coastal Partnership Initiative
CRS	Community Rating System
DEM	Digital Elevation Model
ECFRPC	East Central Florida Regional Planning Council
FDEM	Florida Department of Emergency Management
FDEO	Florida Department of Economic Opportunity
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEC	Florida East Coast Railway
FEMA	Federal Emergency Management Administration
FHWA	Federal Highway Administration
FIS	Flood Insurance Study
FMP	Floodplain Management Plan
FPZA	Florida Planning and Zoning Association
GIS	Geographical Information Systems
GOMA	Gulf of Mexico Alliance
Hazus-MS	Multi-Hazard Loss Estimation Methodology
IFAS	University of Florida's Institute of Food and Agricultural Sciences
Lidar	Light Detection and Ranging
LLC	Limited Liability Corporation
LMS	Local Mitigation Strategy
LRTP	Long Range Transportation Plan
MHP	Mobile Home Park
MSL	Mean Sea Level
N.S.B.	New Smyrna Beach
NASA	National Aeronautics and Space Administration
NAVD88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NOAA	National Oceanographic and Atmospheric Administration
POFA	Peril of Flood Act
R2CTPO	River to Sea Transportation Planning Organization
RSLR	Relative to Mean Sea Level Rise
SLR	Sea Level Rise
SME	Subject Matter Experts
SWD	Stillwater Depth
SWEL	Stillwater Elevation
TPO	Transportation Planning Organization
USACE	United States Army Corps of Engineers
WWTF	Waste Water Treatment Plant

RESILIENT VOLUSIA APPENDIX

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Appendix A – Quality Assurance Findings Summary

Appendix B – Vulnerable Critical Facilities

Appendix C – Vulnerable Hazardous Facilities

Appendix D – Vulnerable Major Roadways

Appendix E – Hazus Damage Assessment - Volusia

Appendix F – Resources

Appendix G – Preliminary Flagler County Extent and Depth Assessment

Appendix H – Public Poster

Appendix I - List of Changes in the CRS Manual

APPENDIX A

Quality Assurance Findings Summary

QUALITY ASSURANCE FINDINGS SUMMARY

Coordination

To ensure review and vetting of the pilot project data inputs and outputs for the Sea Level Sketch Planning Tool, a team of subject matter experts (SME) from Volusia County was developed. The purpose of the team was to review the data to help determine model accuracy and identify any issues with the base data as well as provide comments and suggestions for the model interface. The team consisted of traffic engineers, planners, floodplain managers, sustainability managers, emergency management planners, and additional members of the Volusia Local Mitigation Strategy team. SMEs were representative of County staff as well as staff from the various jurisdictions within Volusia County. A table of the team members is found below.

Last	First	Agency
Church	Nancy	Volusia County GIS
Clark	Wayne	Port Orange
Coslow	Randy	Edgewater
Dewees	Brenda	Edgewater
Dillard	John	South Daytona
Dixon	Kimberly	Daytona Beach
Fegley	Kyle	New Smyrna Beach
Goodison	Crystal	UF Geoplan
Harris	Stephan	River to Sea TPO
Hiatt	Fred	Daytona Beach Shores
Hill	Al	Volusia County GIS
Jackson	Susan	Volusia Growth Management
Joulani	Aref	Ponce Inlet
King	Amye	New Smyrna Beach
Lahue	Larry	Volusia County Emergency Management
Lear	Darren	Edgewater
Locke	Katrina	Volusia County Environmental Management
Martin	Michelle	Daytona Beach
Nelson	Jim	Daytona Beach
Ponitz	Shannon	Daytona Beach
Reiding	Dana	FDOT
Roberts	Larry	Port Orange
Smith	Dennis	FDOT
Sussman	Andrew	DEM
Weedo	Becky	Ormond Beach
Winslett	Melissa	Volusia County Traffic Engineering

During the process, SMEs were contacted via email to provide some background to the project, discuss the training workshop and their role in the review process. Then on September 29th, 2016, a webinar was held to provide more in-depth discussion on the FDEP Coastal Partnership Initiative (CPI) grant, background on the Sea Level Scenario Sketch Planning Tool and current pilot work (100-year storm surge plus SLR and historic storm plus SLR) and the agenda for the training workshop including their role as SME to review and provide feedback on the tool and outputs. The second conference call was in a webinar format and lead by Crystal Goodison of the UF Geoplan Center. The webinar provided more in-depth review of the tool and the kind of feedback and review that the team was looking for. Agendas for the conference calls are located at the end of this appendix.

Training

The training workshop, "Coastal Resiliency Tools Buffet", was held on October 26, 2016 at that Volusia County Emergency Operations Center in Daytona Beach. This workshop was a combined effort to train attendees on the Sea Level Scenario Sketch Planning Tool and NOAA Digital Coast Tools (a training that was required as part of another statewide project). The workshop had over 30 attendees from both Volusia and Brevard Counties and allowed for hands on training. Not only did SMEs provide feedback during the training, but all other attendees also provided varying amounts of feedback concerning applicability and usability of the tool, potential adjustments of colors, layouts and information, as well as other items. An agenda of the workshop is found at the end of this appendix.

The following feedback and comments were collected during workshop at Volusia EOC conducted on October 26, 2016:

- Inconsistencies and incorrect information listed in the FDOT RCI Roads Database. Examples include:
    - Airport Blvd/ Williamson in Volusia County has been 4-laned. RCI database still says 2 lanes.
    - Oceanshore Blvd – listed incorrectly as International Speedway
    - These naming errors seem to be associated with odd segmentation in the database. Some segments are not represented solely by straight lines, but a straight line with a 90 degree turn onto an adjacent roadway. In these cases, two roads (which are actually intersecting) would share the same name. We may need to look at some alternative road layers for analyzing road impacts, but the choices are slim for statewide, publicly available data.
    - The ECFRPC has notified the FDOT of RCI database issues.
- Being able to change the symbology on the map would help visualization and comparison of scenarios. With so much data and so many scenarios, it's hard to see with some of the layers effectively. Would be good if users had the option to change the symbology on their own.
- More Tool tips needed to orient and help the users. Especially on the Swipe tool (hard to know which layer is swiping away).

- Error on basemap print – the resulting file shows a different basemap than what was selected on map viewer.
- Some map functions do not work in IE.
- Attribute Table
    - Would be good if user could select a set of records from the attribute table.
    - Would like the attribute table to have a spatial filter based on map extent

Review

Subject matter experts were also provided a document via email to use to provide comments and attach screen shots. The following pages include the feedback forms from the SMEs and responses from UF Geoplan noted in red.

Comments and Findings 1

Williamson flooding should be diminished for all scenarios to a reach from Anita Street to Cherokee Lane.

It appears that the road may have been widened after the Lidar data was collected (2006). The Lidar seems to show only the southbound lanes of the roadway. See attached pic. CG

Comments and Findings 2

Spruce Creek Road should be shown inundated for all high scenarios from Hewitt Drive to Wiltshire Blvd.

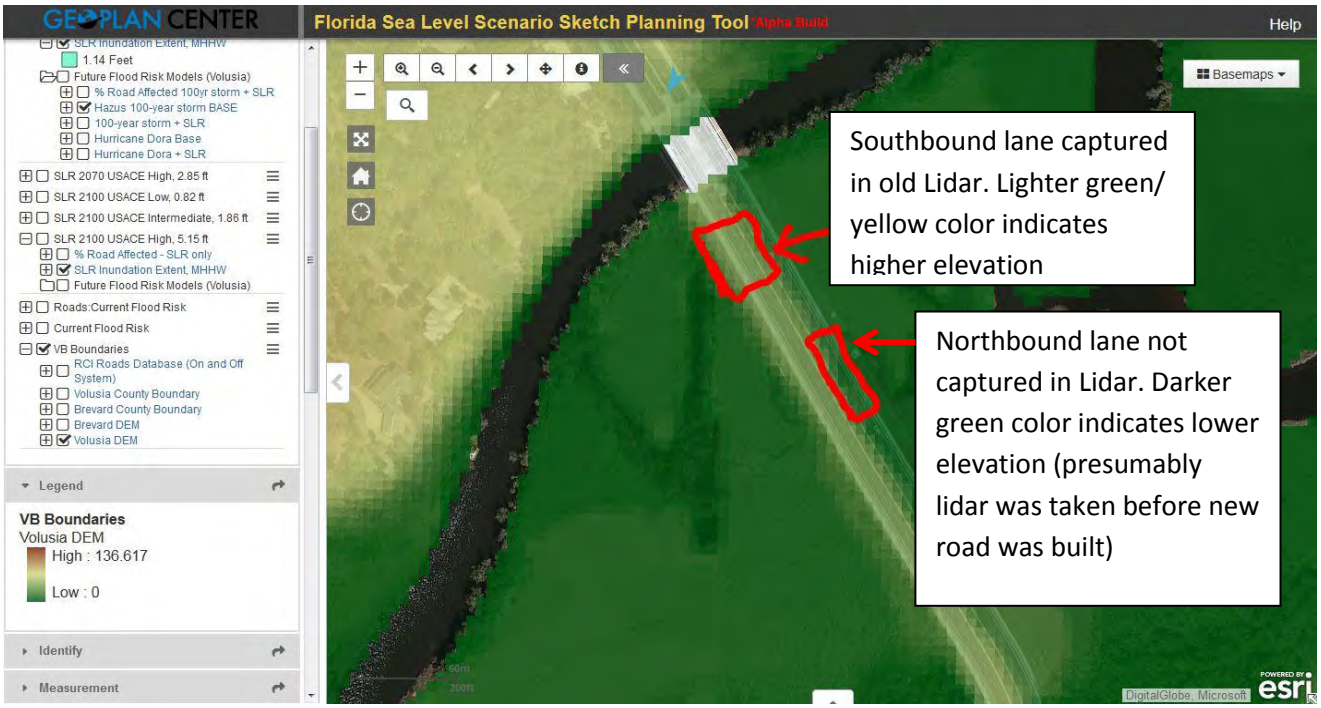
Seems that the flood model is not pushing water far enough West, because of a ridge of higher elevation located east of Spruce Creek Rd. The 100-year storm model + 2100 High Scenario SLR is the only scenario that pushes water over the road. See attached pics. CG

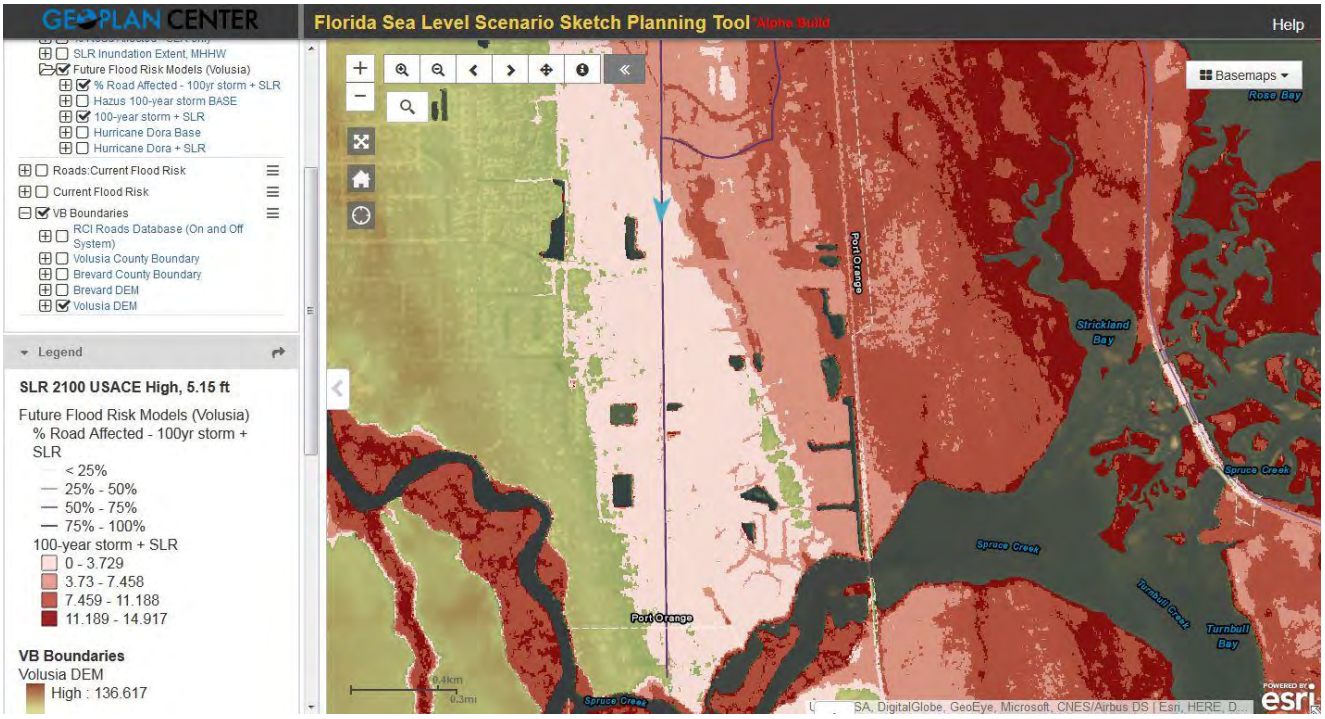
Comments and Findings 3

More information is needed from the Design Builder of I-95 to determine if the Spruce Creek Crossing is high enough to accommodate any of the scenarios.

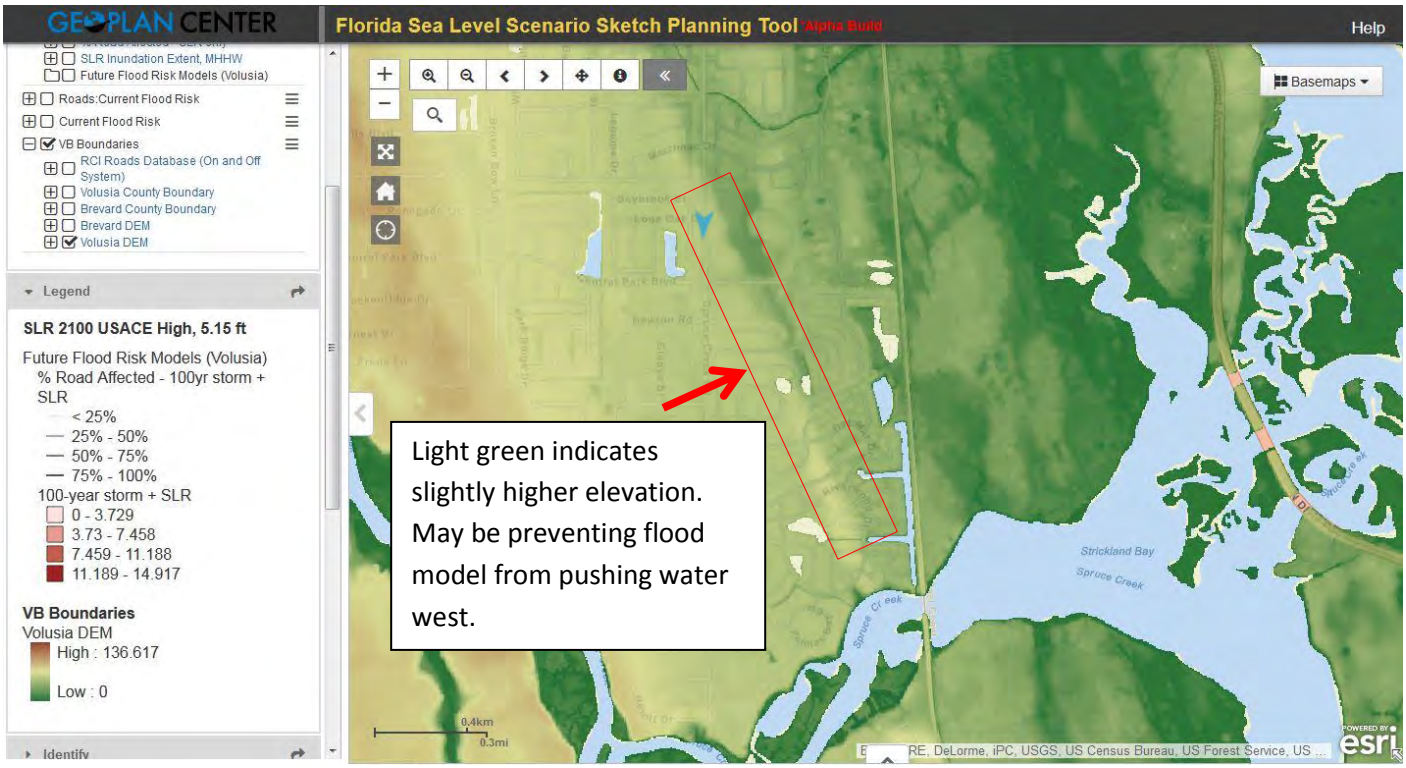
Roadway elevations should be taken for crossing and floodplains. CG

S. Williamson Blvd





Spruce Creek – Elevation



Comments and Findings 4

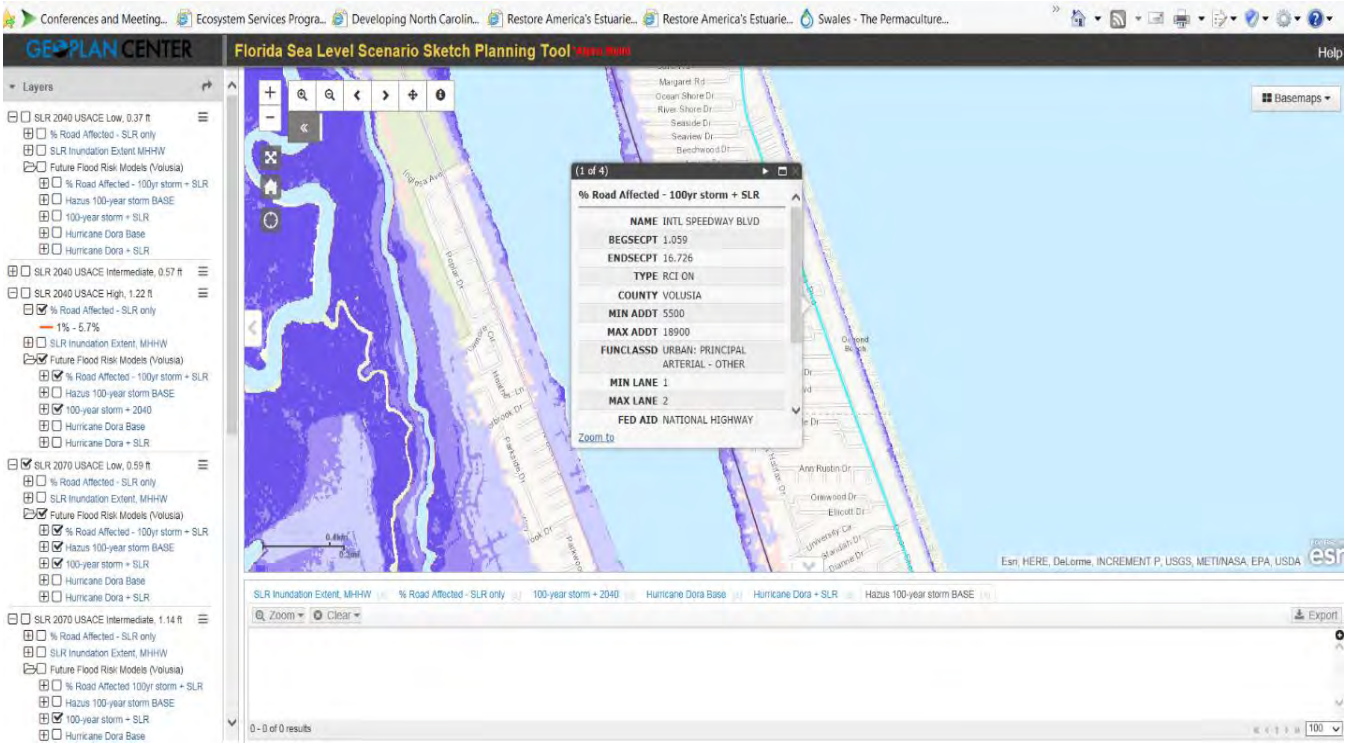
General comments from using the tool:

This may be because the map is in beta, I had problems getting the layers, legend and other items on the left of the screen to load. Had to open and close the link a few times before I had access to the layers.

Yes, some general bugginess and the map is not fully supported in Internet Explorer (which was the only option on some of the EOC laptops).

Comments and Findings 5

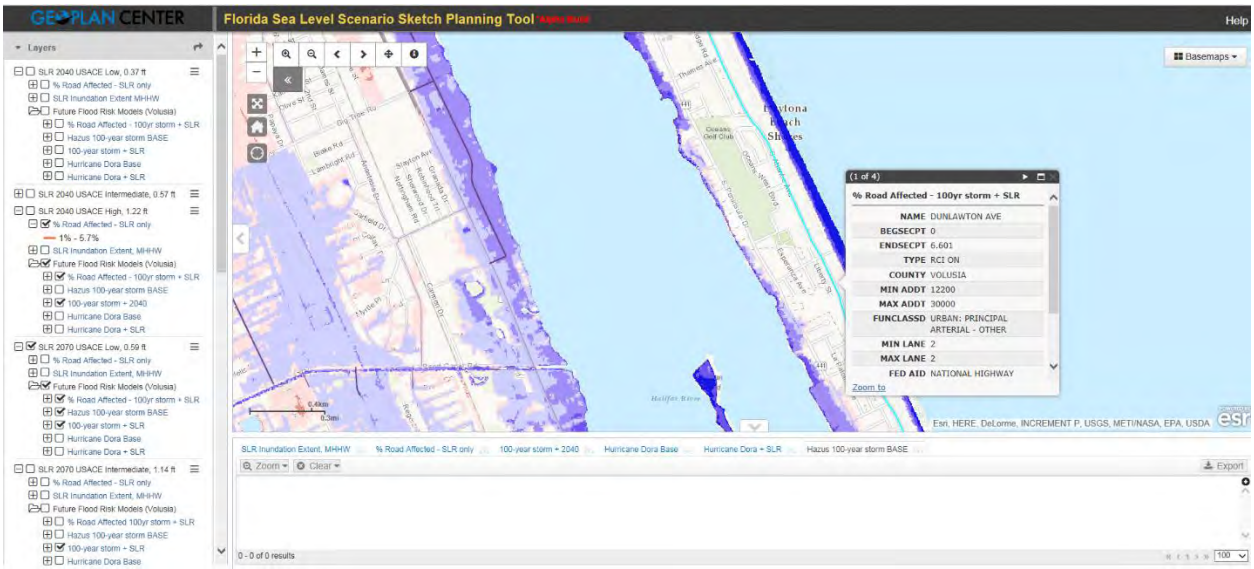
I looked at Ocean Shore Blvd for flooding and noticed when I was pulling up the information for % road affected the road labelling wasn't correct, the same for S. Atlantic Ave (screen shots attached).



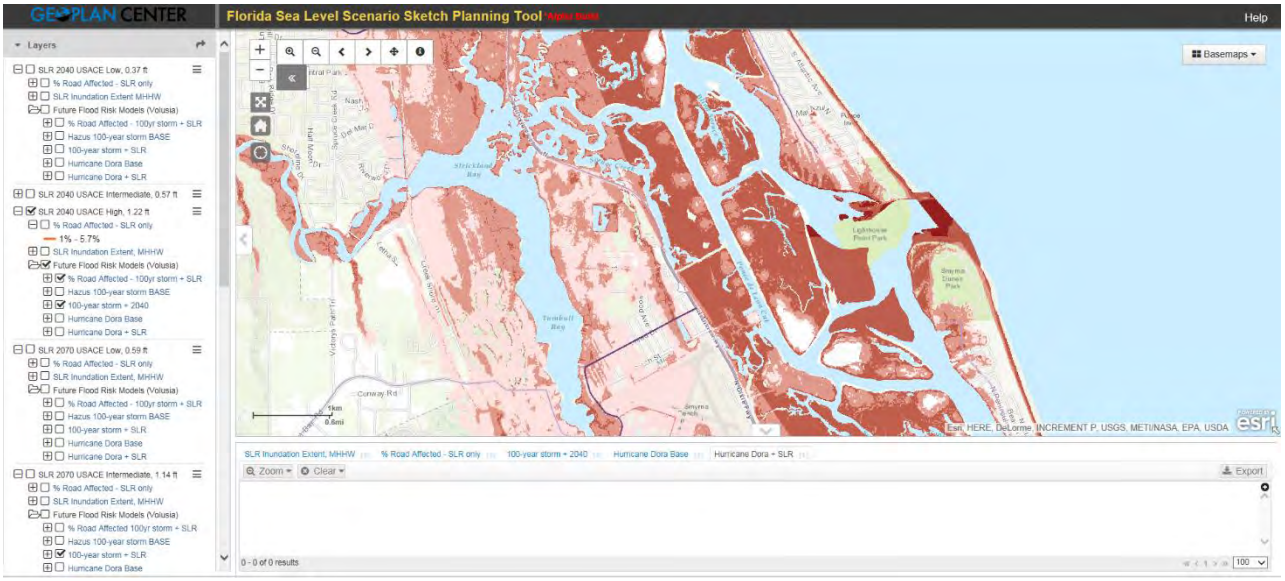
Mis-naming noted. Source of error is the FDOT RCI roads database. For some reason, the roadway segment includes a small portion of International Speedway Blvd (at the southern end of the segment). CG

Mis-naming – noted. Source of error is the FDOT RCI roads database. Similar issue as above (a small portion of Dunlawton Ave is included with S Atlantic Ave. CG

Comments and Findings 6



Some of the area identified as Lighthouse Point Park is actually a sand bar in Ponce Inlet. When I have the 100 year flood layer on (using different scenarios) the shading extends across Ponce Inlet (screen shot attached). When I have the 100 year flood layer on (using different scenarios) the shading extends across the inlet.



The sand bar showing up as Lighthouse Point Park is an issue with the Esri basemap (which we don't create). If you change the basemap to Satellite or Hybrid, it still labels it as the park, but it's obvious that it's a sand bar!

As far as the 100 year flood layer extending across the inlet – we've made a note of it and will find a better water layer to mask out the ocean.

Resilient Volusia FDEP CPI - Subject Matter Expert Call

Thursday, September 29, 2016

3:30pm – 4:00pm

Meeting Information:

Dial +1 (646) 749-3122

Access Code: 660-242-813

Agenda:

1) Overview of FDEP Coastal Partnership Initiative (CPI) grant & October 26 Workshop (Tara)
2) Quick background on Sea Level Scenario Sketch Planning Tool (Crystal)
3) Discuss current pilot work (coastal flood/ surge modeling) (Crystal)
    a) 100-year storm surge plus SLR
    b) Historic Storm plus SLR
4) Agenda for workshop – (Crystal/ Tara)
    a) Morning portion – Sketch Planning Tool (Crystal)
        i) Overall Tool training on all components
        ii) Review new model outputs for FDEP CPI - focus on Volusia. What to look for.
        iii) "Homework": Review and send any feedback to Tara by Nov. 4
    b) Afternoon portion – NOAA Tools/ focus on Brevard/ Vulnerability Assessment (Tara)

Image courtesy of NASA

East Central Florida Regional Planning Council (ECFRPC), Tampa Bay Regional Planning Council, & UF Geoplan Center

invite you to the:

COASTAL RESILIENCY TOOLS BUFFET

WEDNESDAY OCTOBER 26TH 2016
9:00 AM – 4:30 PM

Volusia County EOC
3825 Tiger Bay Road
Daytona Beach, FL

How will sea level rise affect my community in the coming decades? How can we inform and lead our communities to reduce exposure and build resiliency?

To find out, join us for the ***Coastal Resiliency Tools Buffet***, an opportunity to get in-person guidance and useful tips on how to use emerging adaptation tools to conduct vulnerability assessments, and then get hands on experience conducting one on your own!

WORKSHOP GOALS:

1. In-depth training for Sea Level Scenario Sketch Planning Tool and NOAA Coastal Flood Exposure Mapper
2. Introduce various NOAA adaptation assessment tools for visualizing vulnerability and enhancing preparedness
3. Gain understanding of basic sea level rise concepts and the U.S. Army Corps of Engineers methods for projecting SLR.
4. Provide overview on vulnerability assessments
5. Conduct local vulnerability assessments in small groups using tools
6. Review strategies for addressing impacts from sea-level rise

Who should attend? Anyone working in local government or government agencies will benefit from this workshop!

THE TOOLS:

CanVis – NOAA
CanVis modifies imagery to show potential inundation scenarios. It is intended to elicit higher levels of stakeholder engagement and to communicate risks.

Sea Level Rise (SLR) Viewer – NOAA
The SLR Viewer offers an online interactive map display of various SLR scenarios overlaid with data that allows for scoping, inventory, assessments and analysis.

Coastal Flood Exposure Mapper – NOAA
The Exposure Mapper helps start community discussions about flood hazard impacts with maps that show the exposure of people, places, and natural resources.

Sketch Planning Tool – UF GeoPlan Center
The Sea Level Scenario Sketch Planning Tool is a planning tool for preliminary assessment of vulnerable transportation infrastructure due to sea level change. The tool includes an online visualizer, GIS data, and software to promote stakeholder engagement, scoping, inventory, assessment, and analysis of transportation facilities potentially impacted by sea-level rise.

AICP Credits Pending/Confirmed for 6 CECs for CFM

Register by September 30th
https://www.surveymonkey.com/r/toolsbuffet

Space is limited
For additional details contact Tara McGue tara@ecfrpc.org

Coastal Resiliency Tools Buffet
October 26, 2016
Volusia County Office of Emergency Management
3825 Tiger Bay Rd. #102
Daytona Beach, FL 32124
Time 9 am – 4:30 pm

BACKGROUND

This training is part of a series of statewide coordinated efforts to promote the use of coastal flood hazard assessment tools. The Trainers and Tools: Building Coastal Flood Hazard Resiliency in Florida's Regional Planning Council Communities Grant, funded by the National Oceanographic and Atmospheric Administration (NOAA) and the Florida Department of Environmental Protection (DEP), brings together the Florida Department of Economic Opportunity (DEO) and Florida's Regional Planning Councils to create regional Vulnerability Assessments and conduct a series of trainings.

OBJECTIVES

- Enhance understanding of coastal vulnerability in the region by training local professionals on coastal flood hazard tools
- Provide technical assistance to local governments to utilize coastal flooding assessment tools and vulnerability assessment techniques to inform and lead constituents in coastal adaptation.

TOOLS

- Geoplan Sea Level Scenario Sketch Planning Tool
- NOAA Sea Level Rise Viewer
- NOAA Coastal Flood Exposure Mapper
- NOAA CanVis

AGENDA

8:45 AM Registration

9:00 AM Introductions and Training Objectives

9:30 AM Sea Level Scenario Sketch Planning Tool Training

10:30 AM Break Out – Group Activity - Sea Level Scenario Sketch Planning Tool Exercise

12 Noon Lunch **(Bring your own lunch or Sub Shop Pre-Order Available – please bring cash)**

1 PM NOAA Resiliency Tool Overview and Coastal Flood Exposure Tool Training

2PM Vulnerability Assessment Overview and Break Out Activity – Vulnerability Assessment Activity

4 PM Wrap up and final discussions

Resiliency Tools Buffet Registration								
Last Name	First Name	Email address	What jurisdiction/department or agency do you represent?	Phone Number	Signature	Ordered Sub	Sub Paid	SME
Abeels	Holly	habeels@ufl.edu	University of Florida IFAS Extension/Brevard County/Florida Sea Grant	321-633-1702 x235				
Arnel	Vanessa	vanessa.arnal@brevardfl.gov	Brevard County	321-633-2016 x52904		X		
Bostel	Steven	steven.bostel@brevardfl.gov	Space Coast TPO	321-690-6890		Y	X	new
Britton	Keith	keith.j.britton@nasa.gov	NASA	321-867-1955				
Cechowski	Michelle	michelle@ecfrpc.org	ECFRPC	407-262-7772				
Church	Nancy	nchurch@volusia.org	Volusia County IT/GIS	386-736-5973, ext 12474				X
Corwin	Todd	todd.corwin@mlbfl.org	Melbourne	31-608-7506		X		
Coslow	Randy	rcoslow@cityofedgewater.org	City of Edgewater - Environmental Services Department	386-424-2400, ext. 4007			NEW X	X
Defoe-Surprenant	Brenda	brenda.defoe@gmail.com	City of Cape Canaveral	321-868-1240				

Resiliency Tools Buffet Registration

Last Name	First Name	Email address	What jurisdiction/department or agency do you represent?	Phone Number	Signature	Ordered Sub	Sub Paid
DiFabio	Robin	robin.difabio@brevardfl.gov	Brevard County Planning & Development	(321) 633-2069 ext 56363		X	✓
Dixon	Kimberly	dixonk@codb.us	Daytona Beach	386-671-8807		X	
Flynn	Marshall	marsh@tbrpc.org	Tampa Bay RPC	727 570-5151		X	
Goodison	Crystal	goody@ufl.edu	UF Geoplan	352-392-4836		X	✓
Harris	Stephan	sharris@r2ctpo.org	River to Sea TPO	386-736-5927 x15850		X	✓
Hart	Jane	jane.hart@brevardfl.gov	Brevard County Natural Resources Management	321-633-2016		X	
Hill	Al	ahill@volusia.org	Volusia County IT/GIS	386 736 5973 x13470			
Kamm	Bob	bob.kamm@brevardfl.gov	Space Coast TPO	321-690-6890		X	
King	Amye	aking@cityofnsb.com	City of New Smyrna Beach	386-41-02830		X	

SME

X

X

X

X

Resiliency Tools Buffet Registration							
Last Name	**First Name**	**Email address**	**What jurisdiction/department or agency do you represent?**	**Phone Number**	**Signature**	**Ordered Sub**	**Sub Paid**
Kraum	Sarah	sarah.kraum@brevardfl.gov	Space Coast TPO	321-690-6890	Sarah	No	
Lahue	Larry	llahue@volusia.org	Volusia Emergency Management	386-254-1500, ext. 11315		NO	
Lieberman	Cynthia	cindy.lieberman@brevardfl.gov	Brevard County Natural Resources - Watershed Dept.	321-633-2016		X	
Locke	Katrina	klocke@volusia.org	Volusia County	386-736-5927		No	
Martin	Michelle	martinm@codb.us	City of Daytona Beach / Public Works	321-633-2016	Michelle M	X	
McCue	Tara	tara@ecfrpc.org	East Central FL Regional Planning Council	407-262-7772, ext. 327		X	
Milch	Fred	fmilch@ecfrpc.org	ECFRPC	407-245-0300		X	
Nelson	Jim	nelsonj@codb.us	Daytona Beach	386-671-8613	Jim Nels		
Pierre-jean	Reggie		Geoplan			X	

SME

new

X

X

X

X

Resiliency Tools Buffet Registration							
Last Name	**First Name**	**Email address**	**What jurisdiction/department or agency do you represent?**	**Phone Number**	**Signature**	**Ordered Sub**	**Sub Paid**
Propst	Terri	tpropst@volusia.org	Volusia County Coastal Division	386 248-8072 Ext 23		X	
Ratliff	Jeff	j.ratliff@cityofcapecanaveral.org	City of Cape Canaveral	321-868-1240, ext. 404		X	✓
Rembert	Anne	anne.rembert@brevardcounty.us	Planning & Development GIS	321-633-2060		X	✓
Rogers	John	bamboojohn@hotmail.com	Transition Towns Muller Interest	321-412-1570			
schelble	chip	chip.schelble@flhealth.gov	FL Department of Health	386 274-0700			
Smith	Dennis	dennis.smith@dot.state.fl.us	Florida DOT	352-678-9792			
Smith	PJ	pjsmith@ecfrpc.org	East Central FL Regional Planning Council	407-2645-0300, ext. 312		X	
Spratt	Robbyn	robbyn.spratt@brevardfl.gov	Brevard County Natural Resources Mgmt. Dept.	321-633-2016		X	
Sterk	Erin	erin.sterk@brevardfl.gov	Brevard County Planning & Public Works	321-633-2070, ext. 52640		X	

Sm ?

X

Resiliency Tools Buffet Registration							
Last Name	**First Name**	**Email address**	**What jurisdiction/department or agency do you represent?**	**Phone Number**	**Signature**	**Ordered Sub**	**Sub Paid**
Stockham	John	jstockham@volusia.org	County of Volusia, Planning and Development Services	363-943-7059, ext. 12617		X	✓
Stonor	Honor	hstoner@stetson.edu	ECFRPC	6783333835		X	
Surprenant	Joshua	j.surprenant@cityofcapecanaveral.org	City of Cape Canaveral	321 868 1240 321-633-2016			
Weedo	Becky	weedo@ormondbeach.org	City of Ormond Beach	386-676-3342		X	✓
Weitlich	Derrick	derrick.weitlich@noaa.gov	National Weather Service - Melbourne, FL	321-255-0212		X	
Winsett	Melissa	mwinsett@volusia.org	Volusia County Traffic Engineeing	386-226-0422			
Young	Jay	jyoung9508@cfl.rr.com	Volusia County Planning and Land Development Regulation Commission	386-253-9449			
Pearce	Matthew	Matthew.pierce@dot.state.fl.us	CLMS FDOT	386.943.5549			

SME

X

X

Resiliency Tools Buffet Registration							
Last Name	First Name	Email address	What jurisdiction/department or agency do you represent?	Phone Number	Signature	Ordered Sub	Sub Paid
Disher	Mike	mdisher@volusia.org	Volusia County Growth Mgmt.	(386) 736-5959 x12043			new X
Harris	Stephan	sharris rdc					
mcgrath	Scott	smcgrath@Daytonafl.gov	Daytona	386-878-8624			

APPENDIX B

List of Vulnerable Critical Facilities

CRITICAL FACILITIES

FACILITY NAME	TYPE OF FACILITY
AIRPORT USED AUTO PARTS SALVAGE YD	SOLID WASTE FACILITY
BABE JAMES COMMUNITY CENTER	COMMUNITY CENTER
Balduf Concrete	WASTEWATER FACILITY
Barrier Island Sub	LIFT STATION
CEMEX Cnstrct Mtrls FL LLC- New Smyrna Beach Ready Mix Plant	WASTEWATER FACILITY
CEMEX Construct Mtrls FL LLC - Ormond Beach Ready Mix Plant	WASTEWATER FACILITY
CEMEX Construction Materials FL LLC- Daytona Ready Mix Plant	WASTEWATER FACILITY
CHAPS RESTAURANT	PUBLIC WATER SUPPLY - PLANT
CITY OF HOLLY HILL	PUBLIC WATER SUPPLY - PLANT
CITY OF HOLLY HILL-SITE #1 DEBRIS STAGING AREA	SOLID WASTE FACILITY
CLOER & SONS INC.	SOLID WASTE FACILITY
COLE CONSTRUCTION CO.	SOLID WASTE FACILITY
DAYTONA	ELECTRIC SUBSTATION
DAYTONA BEACH CIVIL / COURT SERVICES UNIT	LAW ENFORCEMENT
DAYTONA BEACH FD ST 1	FIRE STATION
DAYTONA BEACH FD ST 1 (DAYTONA BCH FIRE DEPT)	EMERGENCY MEDICAL SERVICE
DAYTONA BEACH FD ST 2	FIRE STATION
DAYTONA BEACH FD ST 5	FIRE STATION
DAYTONA BEACH POLICE DEPT BEACHSIDE PRECINCT	LAW ENFORCEMENT
Daytona Beach, City of - Bethune Point WWTF	WASTEWATER FACILITY
DRIVERS LICENSE OFFICE	STATE GOVERNMENT FACILITY
EDGEWATER	ELECTRIC SUBSTATION
EDGEWATER LANDFILL	SOLID WASTE FACILITY
EDGEWATER POLICE DEPT	LAW ENFORCEMENT
EDGEWATER TRANSFER STATION	SOLID WASTE FACILITY
EDGEWATER YMCA	COMMUNITY CENTER
Edgewater, City Of	WASTEWATER FACILITY
El Dorado	WASTEWATER FACILITY
ELDORADO ESTATES	PUBLIC WATER SUPPLY - PLANT
EVAC AMBULANCE SERVICE	EMERGENCY MEDICAL SERVICE
F.B.I. DAYTONA BEACH RESIDENT OFFICE	LAW ENFORCEMENT
FIFTH DISTRICT COURT OF APPEAL	STATE GOVERNMENT FACILITY
Fishermans Cove	LIFT STATION
FLEMING	ELECTRIC SUBSTATION
Florida Rock-Edgewater	WASTEWATER FACILITY
Hacienda Sub	LIFT STATION
HALCRESS MHP	PUBLIC WATER SUPPLY - PLANT
HALIFAX WRECKING COMPANY, INC	SOLID WASTE FACILITY

FACILITY NAME	TYPE OF FACILITY
HHB/D BTRY 1-265th ADA (ARMED FORCES RESERVE CENTER)	STATE GOVERNMENT FACILITY
HOLLY HILL	ELECTRIC SUBSTATION
Holly Hill, City Of	WASTEWATER FACILITY
JACKSON HOLE R.V. -FISH CAMP, INC.	PUBLIC WATER SUPPLY - PLANT
JAMES PARK YOUTH ACTIVITY CENTER	COMMUNITY CENTER
KINGSTON SHORES	PUBLIC WATER SUPPLY - PLANT
Kingston Shores WWTF	WASTEWATER FACILITY
KLENK C & D	SOLID WASTE FACILITY
LAGOON BAIT & TACKLE	PUBLIC WATER SUPPLY - PLANT
Lighthouse Cove Marina	LIFT STATION
MADISON	ELECTRIC SUBSTATION
MAGNOLIA VILLAGE	PUBLIC WATER SUPPLY - PLANT
Magnolia Village WWTF	WASTEWATER FACILITY
MASSAIR FLIGHT SVC INC AMB	EMERGENCY MEDICAL SERVICE
MASSEY RANCH AIRPARK	AIRPORT
MOSQUITO LAGOON/ LEFILS FISH CAMP	PUBLIC WATER SUPPLY - PLANT
NEW SMYRNA BCH TRANSFER STATION	SOLID WASTE FACILITY
NEW SMYRNA BEACH AIRPORT LANDFILL	SOLID WASTE FACILITY
NEW SMYRNA BEACH FD ST 50	FIRE STATION
NEW SMYRNA BEACH FD ST 50 (NEW SMYRNA BCH FIRE DEPT)	EMERGENCY MEDICAL SERVICE
NEW SMYRNA BEACH FD ST 52	FIRE STATION
NEW SMYRNA BEACH FD ST 53	FIRE STATION
NEW SMYRNA BEACH MUNICIPAL AIRPORT	AIRPORT
NOEL'S MOBILE HOME PARK	PUBLIC WATER SUPPLY - PLANT
ORMOND	ELECTRIC SUBSTATION
ORMOND BEACH	PUBLIC WATER SUPPLY - PLANT
ORMOND BEACH FD ST 93	FIRE STATION
ORMOND BEACH POLICE DEPT	LAW ENFORCEMENT
ORMOND BEACH TRANSFER STATION	SOLID WASTE FACILITY
Ormond Beach WWTF	WASTEWATER FACILITY
PARA EXCAVATING	SOLID WASTE FACILITY
Pelican Dunes Sub.	LIFT STATION
Peninsula Winds	LIFT STATION
Phase 2A (Future)	LIFT STATION
PIGGOTTE COMMUNITY CENTER	COMMUNITY CENTER
PONCE INLET FIRE RESCUE ST 78	FIRE STATION
PONCE INLET FIRE RESCUE ST 78 (PONCE INLET FIRE RESCUE)	EMERGENCY MEDICAL SERVICE
PONCE INLET POLICE DEPT	LAW ENFORCEMENT
PORT ORANGE	ELECTRIC SUBSTATION
PORT ORANGE FIRE RESCUE ST 71	FIRE STATION
PORT ORANGE FIRE RESCUE ST 71 (DEPT FIRE/RESC-RIDGEWOOD)	EMERGENCY MEDICAL SERVICE
PORT ORANGE FIRE RESCUE ST 72	FIRE STATION

FACILITY NAME	TYPE OF FACILITY
PORT ORANGE FIRE RESCUE ST 72 (DEPT FIRE/RESC-TRAILWOOD)	EMERGENCY MEDICAL SERVICE
Port Orange WWTF	WASTEWATER FACILITY
QUICK TIRE	SOLID WASTE FACILITY
RETI CO. INC.	SOLID WASTE FACILITY
RICHMOND PROPERTY	SOLID WASTE FACILITY
River Breeze Park	LIFT STATION
RIVERWOOD PARK CAMPGROUND	PUBLIC WATER SUPPLY - PLANT
S. E. Master	LIFT STATION
Sandpiper Ridge Sub.	LIFT STATION
S JAMES FOXMAN JUSTICE CENTER	LAW ENFORCEMENT
Seabridge WWTF	WASTEWATER FACILITY
SICA HALL COMMUNITY CENTER	COMMUNITY CENTER
SMITH STREET	ELECTRIC POWER PLANT
SMYRNA	ELECTRIC SUBSTATION
SOUTH BEACH ST 21	FIRE STATION
SOUTH DAYTONA	ELECTRIC SUBSTATION
SOUTH DAYTONA FD ST 98	FIRE STATION
SOUTH DAYTONA FD ST 98 (S DAYTONA FIRE DEPT 1ST RESP)	EMERGENCY MEDICAL SERVICE
SOUTH DAYTONA POLICE DEPT	LAW ENFORCEMENT
Sparks Concrete	WASTEWATER FACILITY
SUGAR MILL RUINS TRAVEL PARK	PUBLIC WATER SUPPLY - PLANT
Sugar Mill Ruins Travel Park WWTF	WASTEWATER FACILITY
SUNSHINE PARK MALL	DISASTER RECOVERY CENTER
SWFP Charles	LIFT STATION
SWFP Coleman	LIFT STATION
SWFP Douglas	LIFT STATION
SWFP Lewis	LIFT STATION
Tarmac - Daytona Beach CBP	WASTEWATER FACILITY
Tarmac - Edgewater CBP	WASTEWATER FACILITY
TURNBULL ST 23	FIRE STATION
Ormond	ELECTRIC SUBSTATION
VCUD - NE Barn - Equipment & Truck Wash Recycle System	WASTEWATER FACILITY
VCUD - Southeast Barn Equipment & Truck Wash Recycle System	WASTEWATER FACILITY
VOLUSIA COUNTY COUTHOUSE ANNEX	LOCAL GOVERNMENT FACILITY
VOLUSIA COUNTY SHERIFF DISTRICT 3	LAW ENFORCEMENT
VOLUSIA COUNTY SHERIFF DISTRICT 5 / CIVIL N.S.B.	LAW ENFORCEMENT

APPENDIX C

List of Vulnerable Hazardous Material Facilities

HAZARDOUS MATERIALS FACILITIES

HAZARDOUS MATERIALS FACILITIES	
812320 - HOLLY HILL	LANE CONSTRUCTION - EDGEWATER (Lane Construction Edgewater)
812779 - ORMOND BEACH	LEVEL 3 COMMUNICATIONS - DAYTONA BEACH - DYBHFLGY
AIRPORT SUBSTATION	LEVEL 3 COMMUNICATIONS - DAYTONA BEACH - DYBHFLMN
AMERIGAS PROPANE - HOLLY HILL	LEVEL 3 COMMUNICATIONS - HOLLY HILL - HLHLFL02
AUTO PLUS DAYTONA	LIFT STATION 60
BELLSOUTH - 33846	MCI- DAYDFL (VZB- FLDAYDFL)
BELLSOUTH - 33850	MCI- DYAWFL (VZB- FLDYAWFL)
BELLSOUTH - 33888	METRA ELECTRONICS CORPORATION
BERT FISH MEDICAL CENTER	MHC OPERATING LP DBA MARALAGO CAY
CEMEX - DAYTONA READY MIX AND BLOCK	MOMENTIVE PERFORMANCE MATERIALS USA
CEMEX - NEW SMYRNA BEACH READY MIX	NATIONAL GUARD - DAYTONA BEACH AFRC
CEMEX - ORMOND BEACH READY MIX	NEW CINGULAR WIRELESS PCS, LLC - B016 DAYTONA - USID64907
CENTURYLINK QCC- DAYTONA BEACH	PRODUCT QUEST MFG, LLC
CITY OF DAYTONA BEACH - BETHUNE POINT WWTP	R J DOUGHERTY ASSOCIATES
CITY OF DAYTONA BEACH - HALIFAX HARBOR MARINA	REDDY ICE-NEW SMYRNA BEACH
CITY OF DAYTONA BEACH - PUBLIC WORKS COMPLEX	RITCHEY CADILLAC BUICK GMC
CITY OF HOLLY HILL	RYDER TRANSPORTATION SERVICES - 0178A
CITY OF ORMOND BEACH - FLEET OPERATIONS	S C P DISTRIBUTORS LLC - # 73
CITY OF ORMOND BEACH - WTP	SCHOOLWAY SUBSTATION
CITY OF ORMOND BEACH - WWTP	SMITH STREET GENERATION
CITY OF PORT ORANGE - PORT ORANGE	SMITH STREET PUMP STATION
CITY OF PORT ORANGE - WWTP	SOUTH BEACH PUMP STATION
COMMERCIAL CHEMICAL PRODUCTS - HOLLY HILL	SOUTHEASTERN CHEMICAL INDUSTRIES
CUNNINGHAM OIL---7028	SPRINT - DAYTONA BEACH, FL POP
DAYTONA STATE COLLEGE - NEWS JOURNAL CENTER	SWOOPE GENERATION
DECHLORINATION BUILDING AT RIVER OUTFALL	TARMAC AMERICA - DAYTONA RMC
DECORATIVE ELECTRO COATINGS	TARMAC AMERICA - EDGEWATER RMC
FAA DAB ATCT	TRADEMARK METAL RECYCLING - HOLY HILL
FIELD STREET GENERATION	U.S. COAST GUARD STATION (Station Ponce De Leon Inlet)
FIELD STREET SUBSTATION	VOLUSIA COUNTY MOSQUITO CONTROL
FLORIDA EAST COAST RAILWAY- NEW SMYRNA BEACH	VOLUSIA COUNTY TRANSIT / VOTRAN
FLORIDA POWER AND LIGHT - ORMOND SERVICE	INTERSTATE BATTERY SYSTEM OF DAYTONA

HAZARDOUS MATERIALS FACILITIES	
CENTER/FLEMING SUBSTATION	
FLORIDA PUBLIC UTILITIES - TUSCANNA	LANE CONSTRUCTION - EDGEWATER (Lane Construction Edgewater)
GORMAN - HOLLY HILL	LEVEL 3 COMMUNICATIONS - DAYTONA BEACH - DYBHFLGY
INLET HARBOR RESTAURANT MARINA AND GIFT SHOP	LEVEL 3 COMMUNICATIONS - DAYTONA BEACH - DYBHFLMN
INTERSTATE BATTERY SYSTEM OF DAYTONA	LEVEL 3 COMMUNICATIONS - HOLLY HILL - HLHLFL02
LANE CONSTRUCTION - EDGEWATER (Lane Construction Edgewater)	LIFT STATION 60
LEVEL 3 COMMUNICATIONS - DAYTONA BEACH - DYBHFLGY	MCI- DAYDFL (VZB- FLDAYDFL)
LEVEL 3 COMMUNICATIONS - DAYTONA BEACH - DYBHFLMN	MCI- DYAWFL (VZB- FLDYAWFL)
TARMAC AMERICA - DAYTONA RMC	METRA ELECTRONICS CORPORATION
TARMAC AMERICA - EDGEWATER RMC	MHC OPERATING LP DBA MARALAGO CAY
TRADEMARK METAL RECYCLING - HOLY HILL	MOMENTIVE PERFORMANCE MATERIALS USA
U.S. COAST GUARD STATION (Station Ponce De Leon Inlet)	NATIONAL GUARD - DAYTONA BEACH AFRC
VOLUSIA COUNTY MOSQUITO CONTROL	NEW CINGULAR WIRELESS PCS, LLC - B016 DAYTONA - USID64907
VOLUSIA COUNTY TRANSIT / VOTRAN	PRODUCT QUEST MFG, LLC
INTERSTATE BATTERY SYSTEM OF DAYTONA	R J DOUGHERTY ASSOCIATES
SMITH STREET PUMP STATION	REDDY ICE-NEW SMYRNA BEACH
SOUTH BEACH PUMP STATION	RITCHEY CADILLAC BUICK GMC
SOUTHEASTERN CHEMICAL INDUSTRIES	RYDER TRANSPORTATION SERVICES - 0178A
SPRINT - DAYTONA BEACH, FL POP	S C P DISTRIBUTORS LLC - # 73
SWOOPE GENERATION	SCHOOLWAY SUBSTATION
SMITH STREET PUMP STATION	SMITH STREET GENERATION

APPENDIX D

List of Vulnerable Major Roadways

MAJOR ROADWAYS

Major Roadway Name
BEVILLE RD/SR 400
DUNLAWTON AV/ SR 421
DUNLAWTON BLVD
E GRANADA BLVD
E INTL SPEEDWAY BLVD/ US 92
E ORANGE AV
FLAGLER AV
I-95
LPGA BLVD
LYTLE AV/ SR 44
MASON AV/ SR 430
N ATLANTIC AV
N DIXIE FREEWAY
N NOVA RD
N RIDGEWOOD AV (US 1)
N US 1
N YONGE ST
NOVA RD/ SR 5A
ORANGE AV
RIDGEWOOD AV (US 1)
S ATLANTIC AV
S CAUSEWAY
S DIXIE FREEWAY (US 1)
S NOVA RD
S PENINSULA AV
S RIDGEWOOD AV (US 1)
S US 1
S YONGE ST
SEABREEZE BLVD
SILVER BEACH AV
SR A1A
W GRANADA BLVD
W INDIAN RIVER BLVD/ SR 442
W INTL SPEEDWAY BLVD

APPENDIX E

Hazus Damage Assessment Reports

Damage Assessment Reports generated by HAZUS based on scenario runs. The scenario is located at the bottom of the report.

Building Damage By General Occupancy

June 05, 2017

All values are in thousands of square feet

		Square Footage Distribution by Damage Percent Range						
	Total Square Footage	None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Religion	834.86	78.97	261.93	493.96	0.00	0.00	0.00	0.00
Agriculture	209.60	17.87	63.83	85.49	22.83	15.43	4.05	0.10
Government	185.01	12.65	87.41	84.63	0.33	0.00	0.00	0.00
Residential	46,300.08	14,126.64	1,715.35	10,650.41	6,073.05	2,811.00	2,046.04	8,877.60
Industrial	3,129.66	106.97	639.66	1,294.65	453.89	390.47	171.76	72.26
Commercial	9,344.07	458.04	2,756.04	4,507.08	1,143.57	342.16	136.51	0.65
Education	174.42	11.09	134.97	28.36	0.00	0.00	0.00	0.00
Total	**60,177.71**	**14,812.23**	**5,659.19**	**17,144.58**	**7,693.68**	**3,559.07**	**2,358.36**	**8,950.60**
Total	**60,177.71**	**14,812.23**	**5,659.19**	**17,144.58**	**7,693.68**	**3,559.07**	**2,358.36**	**8,950.60**
Scenario Total	**60,177.71**	**14,812.23**	**5,659.19**	**17,144.58**	**7,693.68**	**3,559.07**	**2,358.36**	**8,950.60**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Direct Economic Losses for Buildings

CR version: 11.5.12

June 05, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	1,805,464	1,760,598	36,547	10.40	2,876	3,342	5,567	1,345	3,615,739
Total	**1,805,464**	**1,760,598**	**36,547**	**10.40**	**2,876**	**3,342**	**5,567**	**1,345**	**3,615,739**
Scenario Total	**1,805,464**	**1,760,598**	**36,547**	**10.40**	**2,876**	**3,342**	**5,567**	**1,345**	**3,615,739**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volu_20170605
Scenario: base
Return Period: 100

Building Damage By General Occupancy

February 01, 2017

All values are in thousands of square feet

		Square Footage Distribution by Damage Percent Range						
	Total Square Footage	None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Religion	1,394.63	131.42	452.94	809.69	0.58	0.00	0.00	0.00
Agriculture	323.36	33.40	92.08	116.39	47.10	15.82	15.87	2.71
Government	348.54	22.48	196.25	127.87	1.77	0.17	0.00	0.00
Residential	68,404.64	19,974.70	1,999.27	15,260.74	9,235.29	4,360.60	3,359.74	14,214.30
Industrial	4,371.56	139.27	457.72	1,958.92	680.83	683.11	315.13	136.59
Commercial	14,001.38	595.88	3,732.37	6,858.42	1,693.04	829.01	279.79	12.86
Education	344.21	22.69	274.05	44.62	2.85	0.00	0.00	0.00
Total	**89,188.32**	**20,919.83**	**7,204.67**	**25,176.66**	**11,661.46**	**5,888.71**	**3,970.53**	**14,366.47**
Total	**89,188.32**	**20,919.83**	**7,204.67**	**25,176.66**	**11,661.46**	**5,888.71**	**3,970.53**	**14,366.47**
Scenario Total	**89,188.32**	**20,919.83**	**7,204.67**	**25,176.66**	**11,661.46**	**5,888.71**	**3,970.53**	**14,366.47**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Direct Economic Losses for Buildings

CR version: 11.5.12

February 01, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	2,823,622	2,780,361	58,972	13.70	4,629	5,314	10,635	1,971	5,685,504
Total	**2,823,622**	**2,780,361**	**58,972**	**13.70**	**4,629**	**5,314**	**10,635**	**1,971**	**5,685,504**
Scenario Total	**2,823,622**	**2,780,361**	**58,972**	**13.70**	**4,629**	**5,314**	**10,635**	**1,971**	**5,685,504**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2040high
Return Period: 100

Building Damage By General Occupancy

February 01, 2017

All values are in thousands of square feet

	Total Square Footage	Square Footage Distribution by Damage Percent Range						
		None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Religion	1,134.48	132.58	380.82	621.00	0.08	0.00	0.00	0.00
Agriculture	270.26	29.49	81.12	100.56	33.61	18.61	5.86	1.01
Government	274.16	29.01	137.43	106.14	1.57	0.00	0.00	0.00
Residential	58,207.84	18,350.92	2,061.64	12,970.17	7,699.21	3,571.26	2,438.36	11,116.29
Industrial	3,857.34	149.08	559.95	1,746.06	525.78	549.60	225.56	101.31
Commercial	11,914.59	611.20	3,499.83	5,620.22	1,457.93	504.37	218.40	2.64
Education	251.42	16.55	198.11	36.36	0.41	0.00	0.00	0.00
Total	**75,910.09**	**19,318.84**	**6,918.89**	**21,200.52**	**9,718.58**	**4,643.84**	**2,888.18**	**11,221.24**
Total	**75,910.09**	**19,318.84**	**6,918.89**	**21,200.52**	**9,718.58**	**4,643.84**	**2,888.18**	**11,221.24**
Scenario Total	**75,910.09**	**19,318.84**	**6,918.89**	**21,200.52**	**9,718.58**	**4,643.84**	**2,888.18**	**11,221.24**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2040mod
Return Period: 100

Direct Economic Losses for Buildings

CR version: 11.5.12

February 01, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	2,252,492	2,222,931	47,186	11.50	3,691	4,336	8,048	1,626	4,540,310
Total	**2,252,492**	**2,222,931**	**47,186**	**11.50**	**3,691**	**4,336**	**8,048**	**1,626**	**4,540,310**
Scenario Total	**2,252,492**	**2,222,931**	**47,186**	**11.50**	**3,691**	**4,336**	**8,048**	**1,626**	**4,540,310**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2040mod
Return Period: 100

Building Damage By General Occupancy

January 31, 2017

All values are in thousands of square feet

	Total Square Footage	Square Footage Distribution by Damage Percent Range						
		None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Religion	1,082.43	127.37	363.67	591.32	0.06	0.00	0.00	0.00
Agriculture	259.66	27.02	77.48	97.84	30.71	18.35	7.73	0.53
Government	258.86	25.08	130.16	102.51	1.12	0.00	0.00	0.00
Residential	55,605.10	17,414.93	2,063.49	12,538.44	7,351.13	3,403.67	2,326.16	10,507.28
Industrial	3,702.67	134.62	600.34	1,643.26	497.43	523.29	207.56	96.18
Commercial	11,306.49	592.91	3,321.20	5,321.45	1,423.88	441.86	204.22	0.98
Education	234.60	16.23	182.69	35.68	0.00	0.00	0.00	0.00
Total	**72,449.82**	**18,338.16**	**6,739.04**	**20,330.50**	**9,304.32**	**4,387.17**	**2,745.66**	**10,604.96**
Total	**72,449.82**	**18,338.16**	**6,739.04**	**20,330.50**	**9,304.32**	**4,387.17**	**2,745.66**	**10,604.96**
Scenario Total	**72,449.82**	**18,338.16**	**6,739.04**	**20,330.50**	**9,304.32**	**4,387.17**	**2,745.66**	**10,604.96**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Direct Economic Losses for Buildings

CR version: 11.5.12

January 31, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	2,140,136	2,106,949	44,547	11.30	3,504	4,076	7,598	1,581	4,308,391
Total	**2,140,136**	**2,106,949**	**44,547**	**11.30**	**3,504**	**4,076**	**7,598**	**1,581**	**4,308,391**
Scenario Total	**2,140,136**	**2,106,949**	**44,547**	**11.30**	**3,504**	**4,076**	**7,598**	**1,581**	**4,308,391**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2040low
Return Period: 100

Building Damage By General Occupancy

February 01, 2017

All values are in thousands of square feet

	Total Square Footage	Square Footage Distribution by Damage Percent Range						
		None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Religion	1,737.16	111.08	280.73	1,336.78	7.10	1.30	0.17	0.00
Agriculture	408.31	38.95	61.84	147.72	83.49	36.81	18.94	20.56
Government	459.51	9.62	188.49	246.64	13.05	1.52	0.17	0.01
Residential	87,681.86	17,820.40	1,719.57	17,920.24	12,520.50	6,660.59	5,847.43	25,193.13
Industrial	5,310.74	149.95	273.42	1,768.49	1,236.39	850.07	699.05	333.37
Commercial	18,194.46	638.85	2,938.07	9,004.30	2,938.27	1,904.79	707.91	62.28
Education	476.77	13.88	378.66	72.29	10.27	1.67	0.00	0.00
Total	**114,268.81**	**18,782.73**	**5,840.78**	**30,496.46**	**16,809.07**	**9,456.75**	**7,273.66**	**25,609.36**
Total	**114,268.81**	**18,782.73**	**5,840.78**	**30,496.46**	**16,809.07**	**9,456.75**	**7,273.66**	**25,609.36**
Scenario Total	**114,268.81**	**18,782.73**	**5,840.78**	**30,496.46**	**16,809.07**	**9,456.75**	**7,273.66**	**25,609.36**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2070high
Return Period: 100

Direct Economic Losses for Buildings

CR version: 11.5.12

February 01, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	4,578,954	4,393,895	88,617	19.80	6,478	7,257	14,784	2,660	9,092,645
Total	**4,578,954**	**4,393,895**	**88,617**	**19.80**	**6,478**	**7,257**	**14,784**	**2,660**	**9,092,645**
Scenario Total	**4,578,954**	**4,393,895**	**88,617**	**19.80**	**6,478**	**7,257**	**14,784**	**2,660**	**9,092,645**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2070high
Return Period: 100

Building Damage By General Occupancy

February 01, 2017

All values are in thousands of square feet

	Total Square Footage	Square Footage Distribution by Damage Percent Range						
		None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Religion	1,363.07	137.83	449.13	775.85	0.26	0.00	0.00	0.00
Agriculture	318.88	34.72	91.93	114.41	44.45	15.62	15.25	2.50
Government	341.60	24.67	189.44	125.64	1.70	0.16	0.00	0.00
Residential	67,540.91	20,126.32	2,048.18	15,122.30	8,959.92	4,311.76	3,239.73	13,732.71
Industrial	4,325.33	146.68	467.84	1,941.58	670.51	665.69	301.28	131.75
Commercial	13,837.00	628.58	3,749.07	6,727.77	1,669.75	782.19	268.65	10.99
Education	336.96	26.19	264.73	43.54	2.50	0.00	0.00	0.00
Total	**88,063.76**	**21,124.99**	**7,260.32**	**24,851.09**	**11,349.09**	**5,775.41**	**3,824.91**	**13,877.95**
Total	**88,063.76**	**21,124.99**	**7,260.32**	**24,851.09**	**11,349.09**	**5,775.41**	**3,824.91**	**13,877.95**
Scenario Total	**88,063.76**	**21,124.99**	**7,260.32**	**24,851.09**	**11,349.09**	**5,775.41**	**3,824.91**	**13,877.95**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2070mod
Return Period: 100

Direct Economic Losses for Buildings

CR version: 11.5.12

February 01, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	2,743,632	2,705,509	57,632	13.30	4,542	5,228	10,392	1,928	5,528,863
Total	**2,743,632**	**2,705,509**	**57,632**	**13.30**	**4,542**	**5,228**	**10,392**	**1,928**	**5,528,863**
Scenario Total	**2,743,632**	**2,705,509**	**57,632**	**13.30**	**4,542**	**5,228**	**10,392**	**1,928**	**5,528,863**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2070mod
Return Period: 100

Building Damage By General Occupancy

February 01, 2017

All values are in thousands of square feet

	Total Square Footage	Square Footage Distribution by Damage Percent Range						
		None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Religion	1,135.41	132.90	380.95	621.48	0.08	0.00	0.00	0.00
Agriculture	270.22	29.46	81.10	100.38	33.74	18.65	5.85	1.04
Government	274.15	28.98	137.42	106.16	1.58	0.00	0.00	0.00
Residential	58,145.89	18,330.97	2,056.87	12,950.64	7,692.64	3,568.36	2,437.33	11,109.07
Industrial	3,857.32	148.92	559.78	1,746.18	525.88	549.42	225.67	101.47
Commercial	11,913.56	610.43	3,499.61	5,619.10	1,456.89	505.85	218.30	3.39
Education	251.43	16.55	198.05	36.42	0.41	0.00	0.00	0.00
Total	**75,847.98**	**19,298.22**	**6,913.79**	**21,180.35**	**9,711.21**	**4,642.29**	**2,887.15**	**11,214.96**
Total	**75,847.98**	**19,298.22**	**6,913.79**	**21,180.35**	**9,711.21**	**4,642.29**	**2,887.15**	**11,214.96**
Scenario Total	**75,847.98**	**19,298.22**	**6,913.79**	**21,180.35**	**9,711.21**	**4,642.29**	**2,887.15**	**11,214.96**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2070low
Return Period: 100

Direct Economic Losses for Buildings

CR version: 11.5.12

February 01, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	2,250,397	2,221,886	47,193	11.50	3,685	4,334	8,050	1,625	4,537,170
Total	**2,250,397**	**2,221,886**	**47,193**	**11.50**	**3,685**	**4,334**	**8,050**	**1,625**	**4,537,170**
Scenario Total	**2,250,397**	**2,221,886**	**47,193**	**11.50**	**3,685**	**4,334**	**8,050**	**1,625**	**4,537,170**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2070low
Return Period: 100

Building Damage By General Occupancy

February 14, 2017

All values are in thousands of square feet

		Square Footage Distribution by Damage Percent Range						
	Total Square Footage	None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Religion	2,264.32	191.28	101.78	1,727.19	209.03	12.59	17.00	5.44
Agriculture	544.17	46.41	45.26	95.62	112.70	79.10	78.94	86.15
Government	532.20	8.28	26.19	340.20	63.93	74.12	10.70	8.78
Residential	121,275.83	16,057.59	1,298.20	14,272.25	16,403.70	11,496.97	12,561.46	49,185.67
Industrial	6,551.77	238.48	77.17	630.11	1,240.80	1,689.77	1,327.87	1,347.57
Commercial	23,619.45	1,434.03	1,029.09	7,251.81	5,429.70	3,685.72	3,386.08	1,403.01
Education	642.32	40.15	273.20	242.67	62.64	16.17	6.40	1.10
Total	**155,430.06**	**18,016.22**	**2,850.89**	**24,559.85**	**23,522.50**	**17,054.45**	**17,388.45**	**52,037.71**
Total	**155,430.06**	**18,016.22**	**2,850.89**	**24,559.85**	**23,522.50**	**17,054.45**	**17,388.45**	**52,037.71**
Scenario Total	**155,430.06**	**18,016.22**	**2,850.89**	**24,559.85**	**23,522.50**	**17,054.45**	**17,388.45**	**52,037.71**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Direct Economic Losses for Buildings

CR version: 11.5.12

February 14, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	8,423,726	7,551,826	138,459	31.40	10,946	11,587	22,111	4,490	16,163,145
Total	**8,423,726**	**7,551,826**	**138,459**	**31.40**	**10,946**	**11,587**	**22,111**	**4,490**	**16,163,145**
Scenario Total	**8,423,726**	**7,551,826**	**138,459**	**31.40**	**10,946**	**11,587**	**22,111**	**4,490**	**16,163,145**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia_2
Scenario: 2100high
Return Period: 100

Building Damage By General Occupancy

February 02, 2017

All values are in thousands of square feet

	Total Square Footage	Square Footage Distribution by Damage Percent Range						
		None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Religion	1,561.68	122.65	446.38	989.40	3.17	0.08	0.00	0.00
Agriculture	368.25	39.49	89.42	131.82	64.65	18.45	17.98	6.44
Government	419.34	18.22	240.72	151.09	9.01	0.29	0.00	0.00
Residential	77,181.70	20,503.43	1,799.72	16,610.60	10,781.50	5,526.30	4,286.95	17,673.20
Industrial	4,819.41	144.27	366.26	1,994.48	913.07	790.23	424.98	186.12
Commercial	16,034.32	663.87	3,591.70	8,017.01	2,024.33	1,351.38	365.44	20.59
Education	416.23	16.82	337.98	56.17	5.26	0.00	0.00	0.00
Total	**100,800.94**	**21,508.75**	**6,872.18**	**27,950.58**	**13,800.98**	**7,686.74**	**5,095.35**	**17,886.36**
Total	**100,800.94**	**21,508.75**	**6,872.18**	**27,950.58**	**13,800.98**	**7,686.74**	**5,095.35**	**17,886.36**
Scenario Total	**100,800.94**	**21,508.75**	**6,872.18**	**27,950.58**	**13,800.98**	**7,686.74**	**5,095.35**	**17,886.36**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2100mod
Return Period: 100

Direct Economic Losses for Buildings

CR version: 11.5.12

February 02, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	3,441,727	3,377,433	71,284	15.60	5,376	6,152	12,883	2,245	6,917,100
Total	**3,441,727**	**3,377,433**	**71,284**	**15.60**	**5,376**	**6,152**	**12,883**	**2,245**	**6,917,100**
Scenario Total	**3,441,727**	**3,377,433**	**71,284**	**15.60**	**5,376**	**6,152**	**12,883**	**2,245**	**6,917,100**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2100mod
Return Period: 100

Building Damage By General Occupancy

February 02, 2017

All values are in thousands of square feet

	Total Square Footage	Square Footage Distribution by Damage Percent Range						
		None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Volusia								
Agriculture	288.24	29.26	85.10	105.43	38.20	14.52	13.58	2.15
Commercial	12,616.51	572.40	3,549.27	6,085.79	1,513.12	649.64	238.64	7.65
Education	273.73	16.51	218.45	37.82	0.95	0.00	0.00	0.00
Government	299.44	19.56	163.27	114.98	1.63	0.01	0.00	0.00
Industrial	4,045.68	133.34	529.55	1,821.21	585.13	606.59	254.32	115.55
Religion	1,209.40	121.09	404.24	683.92	0.15	0.00	0.00	0.00
Residential	61,602.49	18,605.18	2,066.77	13,773.19	8,218.54	3,760.14	2,932.61	12,246.07
Total	**80,335.49**	**19,497.33**	**7,016.66**	**22,622.33**	**10,357.71**	**5,030.90**	**3,439.14**	**12,371.41**
Total	**80,335.49**	**19,497.33**	**7,016.66**	**22,622.33**	**10,357.71**	**5,030.90**	**3,439.14**	**12,371.41**
Scenario Total	**80,335.49**	**19,497.33**	**7,016.66**	**22,622.33**	**10,357.71**	**5,030.90**	**3,439.14**	**12,371.41**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2100low
Return Period: 100

Direct Economic Losses for Buildings

CR version: 11.5.12

February 02, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				
	Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
Florida									
Volusia	2,462,289	2,426,247	51,676	12.30	4,096	4,734	8,966	1,787	4,959,795
Total	**2,462,289**	**2,426,247**	**51,676**	**12.30**	**4,096**	**4,734**	**8,966**	**1,787**	**4,959,795**
Scenario Total	**2,462,289**	**2,426,247**	**51,676**	**12.30**	**4,096**	**4,734**	**8,966**	**1,787**	**4,959,795**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region: volusia
Scenario: 2100low
Return Period: 100

APPENDIX F

Resources

RESOURCES

There are numerous resources and tools available to communities for assessing impacts and solutions to changing climate and coastal mechanisms. Below are just some of the resources identified.

Adaptation Clearinghouse – Florida SB 1094: "An Act relating to the peril of flood"
Description of senate bill that includes sea level rise now as flood risk that must be managed
http://www.adaptationclearinghouse.org/resources/florida-sb-1094-e-an-act-relating-to-the-peril-of-flood-e.html

Climate Central – Summary of Sea Level Rise and Coastal Flood Risk of Volusia
Information about sea level rise and climate change impacts for Volusia County
http://riskfinder.climatecentral.org/api/reports/county/volusia-county.fl.us/fast-look

Coastal Resiliency
A program led by The Nature Conservancy to examine nature's role in reducing coastal flood risk. The program consists of an approach, a web mapping tool, and a network of practitioners around the world supporting hazard mitigation and climate adaptation planning.
http://coastalresilience.org/

Delaware Department of Natural Resources and Environmental Control – Adapting to Sea Level Rise
Report from Delaware about mitigation planning for their coastal communities
http://www.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/FinalAdaptationPlanasPublished.pdf

Federal Highway Administration – Office of Planning, Environment and Realty
Includes webinars across the US planning for climate resiliency and such
https://www.fhwa.dot.gov/environment/sustainability/resilience/webinars/index.cfm

FEMA - Hazard Mitigation Planning Resources Website
Includes mitigation resources for specific states and grant information
https://www.fema.gov/hazard-mitigation-planning-resources

FEMA- Integrating Hazard Mitigation Into Local Planning: Case Studies and Tools for Community Officials
Gives specific examples of how to integrate mitigation into a local community
https://www.fema.gov/media-library/assets/documents/31372?id=7130

Florida Department of Economic Opportunity- Adaptation Action Area Guild Book, 2015
Report from Broward County and City of Ft. Lauderdale about adapting for sea level rise and climate change
http://www.floridajobs.org/docs/default-source/2015-community-development/community-planning/crdp/aaaguidebook2015.pdf?sfvrsn=2

Florida Department of Economic Opportunity – Adaptation Planning for Coastal Flooding and Sea Level Rise
Describes basic adaptation planning, along with links to reports about specific adaptation practices
http://www.floridajobs.org/community-planning-and-development/programs/community-planning-table-of-contents/adaptation-planning

Georgetown Climate Center – A Leading Resource for State and Federal Policy
http://www.georgetownclimate.org/

Mississippi-Alabama Sea Grant Consortium - A Community Self-Assessment – Understanding How Prepared Your Community Is For a Disaster
Self-Assessment guide for community leaders to use to predict how they will respond to a disaster.
http://masgc.org/assets/uploads/publications/662/coastal_community_resilience_index.pdf

Naturally Resilient Communities - Explore over 50 solutions and case studies that can help your community become a Naturally Resilient Community.
http://nrcsolutions.org/

NOAA Digital Coast
NOAA-sponsored website is focused on helping communities address coastal issues and has become one of the most-used resources in the coastal management community.
https://coast.noaa.gov/digitalcoast/

Planning for Sea Level Rise in Matanzas Basin – University of Florida, National Estuarine Research
Report for Matanzas Basin and how sea level rise will impact the local ecosystem and steps to take to prevent
https://planningmatanzas.files.wordpress.com/2012/06/planning-for-sea-level-rise-in-the-matanzas-basin1.pdf

Southeast Florida Regional Compact Climate Change – Regional Climate Action Plan
Report across Southeast Florida for climate change impacts and the action coastal communities are taking
https://southeastfloridaclimatecompact.files.wordpress.com/2014/05/regional-climate-action-plan-final-ada-compliant.pdf

UF Geoplan Sea Level Scenario Sketch Planning Tool
A planning tool for preliminary assessment of vulnerable transportation infrastructure due to sea level change
https://sls.geoplan.ufl.edu/

U.S DOT Federal Highway Administration (2017). Office of Planning, Environment, & Realty – Sustainability Website
Information and webinars focused on transportation facility resiliency
https://www.fhwa.dot.gov/environment/sustainability/resilience/webinars/index.cfm

APPENDIX G

Preliminary Flagler County Assessment

FLAGLER COUNTY

Due to the topography of Flagler County, as higher levels of sea level were added to the base flood, not only did the extent of flooding increase, the depth of flooding increased in vulnerable areas. Compared to the base 100 year coastal flood extent, a 0.5m rise in sea level will impact an additional 2,072 acres, while a 1m rise will impact approximately 6800 more acres or 43% more area. The modeling projects an increase of 2.59 feet of maximum flood levels (18.59-inch max. flood depth) with a 0.5M rise in sea level with a 1m rise causing an increase of 5.11-foot in maximum flooding levels to 21.11 feet.

Change in Impacted Flood Area

Hazus-MH Coastal Flood Model Run	Total Acreage Flooded	Percent of Flagler Flooded	Percent Change
Base 100-year	15,744 acres	4.3%	
100-year + 0.5M SLR	17,816 acres	4.9%	13%
100-year + 1.0M SLR	22,588 acres	6.2%	43%

Change in Impacted Flood Depth

Hazus-MH Coastal Flood Model Run	Max Flood Depth (Inches)	Max Flood Depth (Feet)	Increase (feet)
Base 100-year	192	16.00	
100-year + 0.5M SLR	223	18.59	2.59
100-year + 1.0M SLR	253	21.11	5.11

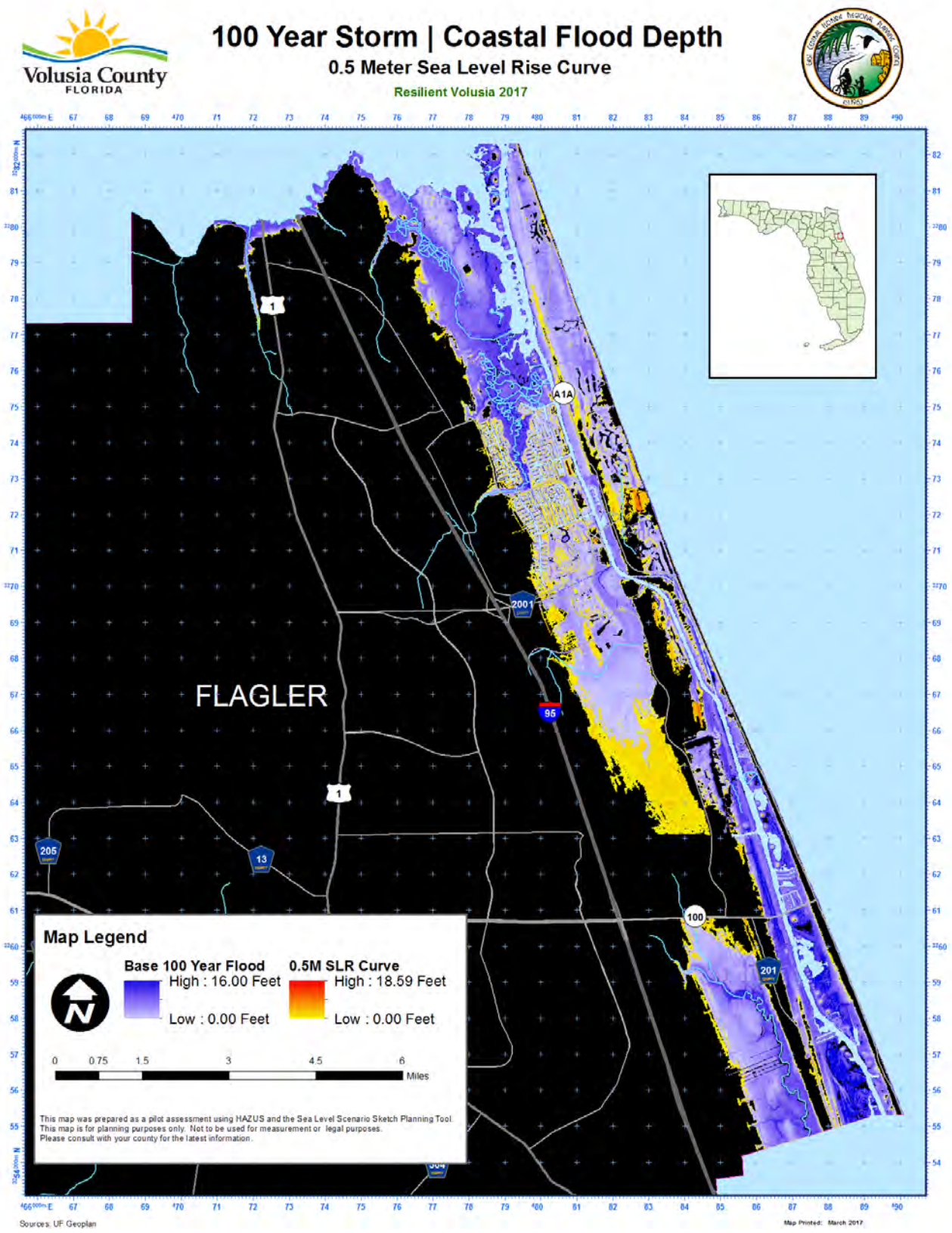
As shown in the maps below, a 0.5 meter rise in sea level increases flooding extent into the open space area of Graham Swamp as well as the residential areas around Palm Harbor Parkway and Hammock Dunes/Beach area. There is also shown to be a projected increase in coastal flooding from the 100-year storm between Palk Coast Parkway and Graham Swamp. It appears that the Lehigh Trail keeps the flooding from crossing south towards E. Moody Blvd (Highway 100) with a 0.5 meter rise. However, according to the HAZUS model, a 1m rise in sea level will push the coastal flooding from a 100-year storm over the trail, to Mood Blvd., connecting the flooding between the north and south. The extent of flooding grows in the area east of Fox Cut, along the western areas of Hammock Dunes/Beach.

Areas that may experience the greatest change in flood depth should be examined and stakeholders should consider potential changes to building codes, mitigation opportunities and other strategies to protect life and property as well as critical facilities and major transportation facilities that would be essential for evacuations and recovery. These facilities not only include governmental facilities but also businesses critical to community recovery such as food stores, electrical and water suppliers and others.

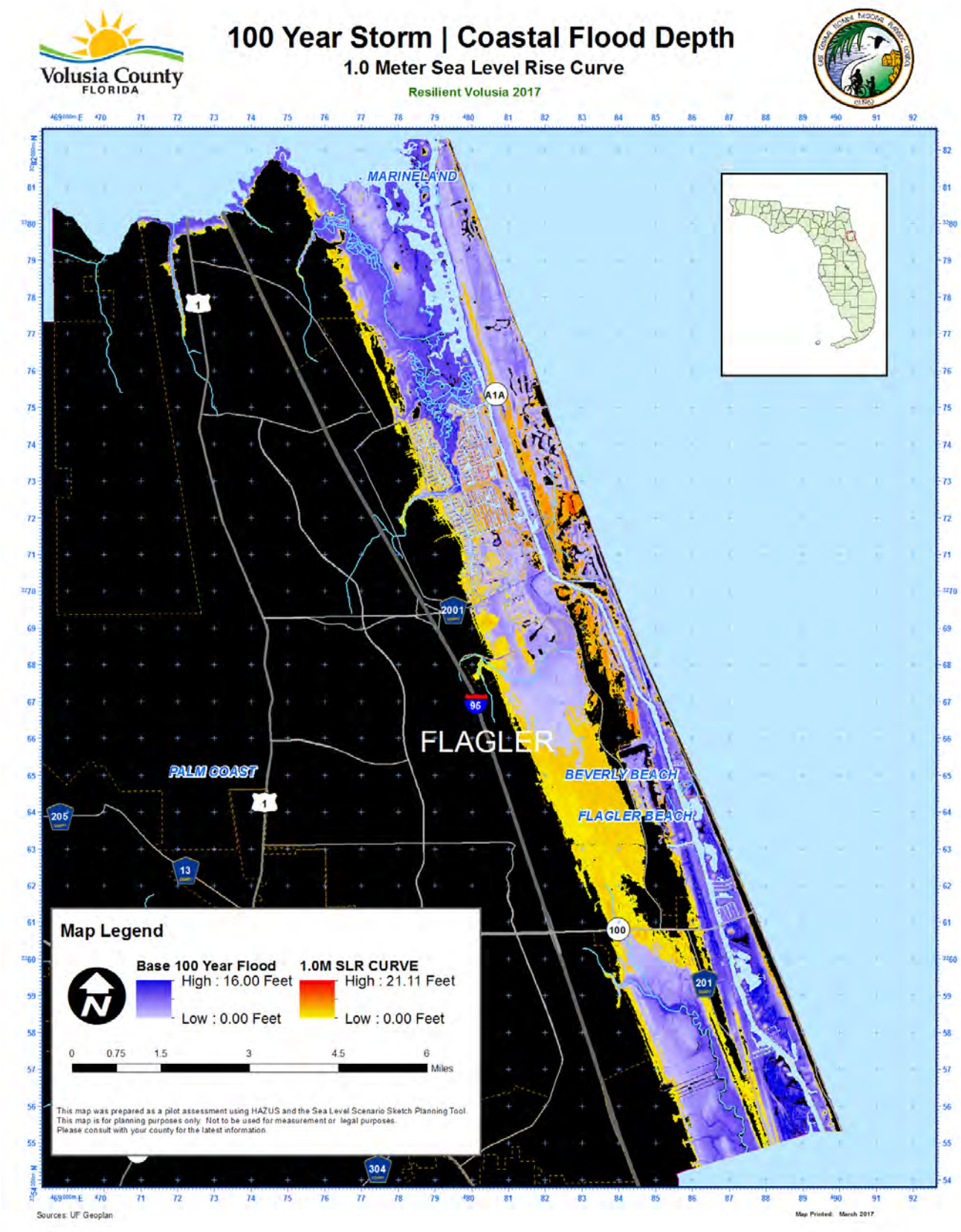
An analysis was completed to assess impacts on major roadways. Under the 0.5 M scenario, most of the roadways experience flooding on less than one mile of roadway, except for State Highway A1A, which is expected to have flooding on over 5 miles of roadway. Some roadways remained below one mile of impacted roadway with 1 M of sea level rise combined with the 100 Year Coastal Flood, while others increased by over a mile. Again, the State Highway is the most vulnerable with over 6 miles of impacted roadway. It is important to remember that these numbers to not represent a constant section of roadway but may be numerous smaller areas of the roadway.

Impacted Major Roadways

Road Name	0.5 M Sea Level Rise	1 M Sea Level Rise	Evacuation Route
Colbert Ln	<1 Mile	2.0	NO
County Hwy 201	1.5	1.9	NO
Farmsworth	<1 Mile	<1 Mile	NO
Florida Pkwy Dr	<1 Mile	1.7	NO
Forest Grove Dr	<1 Mile	1.7	NO
Hammock Dunes Pkwy	<1 Mile	<1 Mile	YES
I 95	<1 Mile	<1 Mile	YES
Moody Blvd	<1 Mile	<1 Mile	YES
Oceanshore Blvd	<1 Mile	2.6	YES
Palm Coast Pkwy	2.5	3.0	YES
Palm Harbor	1.5	2.2	NO
State Hwy 5	<1 Mile	<1 Mile	YES
State Hwy A1A	5.1	6.4	YES
Surfview Dr	<1 Mile	<1 Mile	YES


Volusia County
FLORIDA
100 Year Storm | Coastal Flood Depth
0.5 Meter Sea Level Rise Curve
Resilient Volusia 2017
FLAGLER
1
A1A
2001
95
205
13
100
201
Map Legend
Base 100 Year Flood
High : 16.00 Feet
Low : 0.00 Feet
0.5M SLR Curve
High : 18.59 Feet
Low : 0.00 Feet
0 0.75 1.5 3 4.5 6
Miles
This map was prepared as a pilot assessment using HAZUS and the Sea Level Scenario Sketch Planning Tool.
This map is for planning purposes only. Not to be used for measurement or legal purposes.
Please consult with your county for the latest information.
Sources: UF Geoplan
Map Printed: March 2017

APPENDIX G


Volusia County
FLORIDA
100 Year Storm | Coastal Flood Depth
1.0 Meter Sea Level Rise Curve
Resilient Volusia 2017
MARINELAND
A1A
FLAGLER
PALM COAST
BEVERLY BEACH
FLAGLER BEACH
1
2001
95
205
13
100
201
304
Map Legend
Base 100 Year Flood
High : 16.00 Feet
Low : 0.00 Feet
1.0M SLR CURVE
High : 21.11 Feet
Low : 0.00 Feet
0 0.75 1.5 3 4.5 6
Miles
This map was prepared as a pilot assessment using HAZUS and the Sea Level Scenario Sketch Planning Tool.
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Sources: UF Geoplan
Map Printed: March 2017

APPENDIX G

APPENDIX H

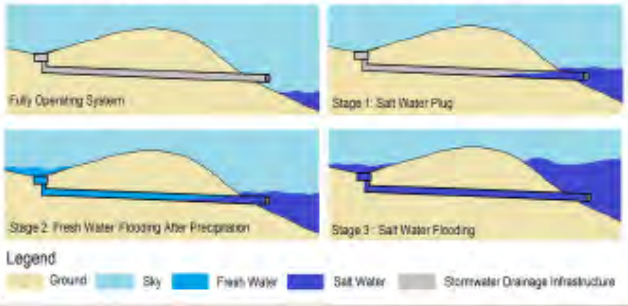
Public Poster

The template for this poster is available. Contact the ECFRPC.

Sea Level Rise Impacts To Stormwater

Why Stormwater?

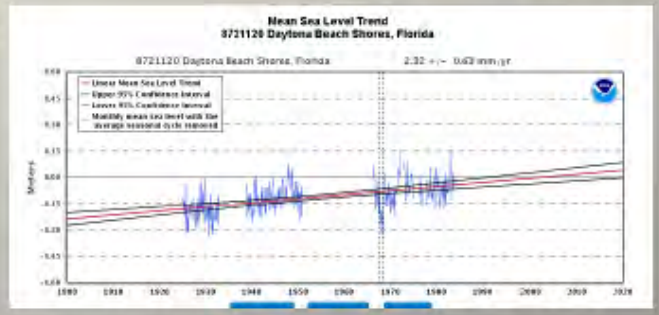
Figure 1: Stages of Stormwater Infrastructure Failure due to Sea Level Rise



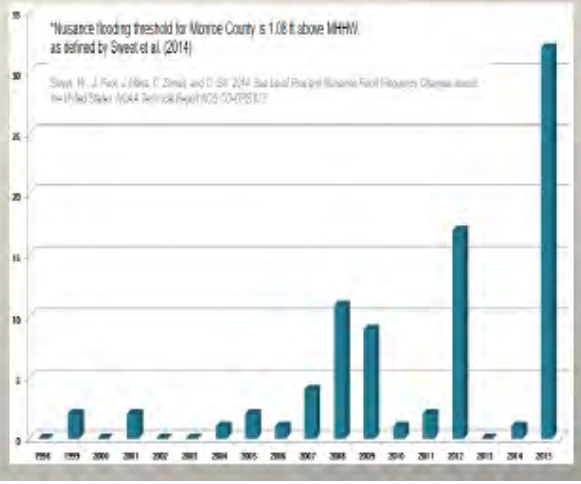
One of the main points of flooding vulnerability in coastal areas is aging stormwater infrastructure. This is especially a concern in areas where stormwater pipes, most of which were built decades ago, drain directly into coastal water bodies. Sea-level rise makes such infrastructure more susceptible to flood risk.

Many municipalities along the Indian River Lagoon have stormwater pipe systems that may be highly impacted by sea-level rise.

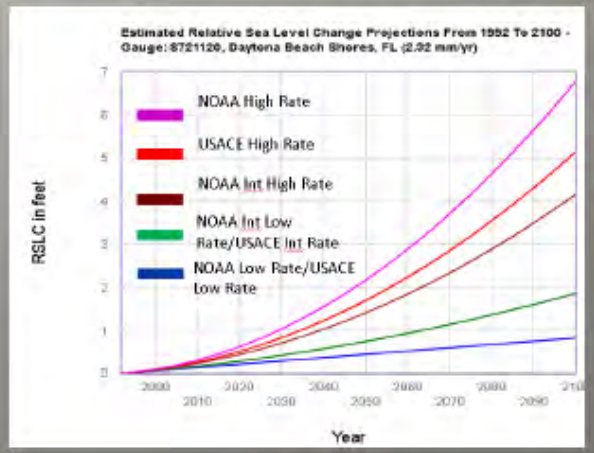
Mean Sea Level Trend



Nuisance Floods Per Year, Vaca Key



Sea Level Rise Projections to Year 2100



APPENDIX I

List of Changes in the 2017 CRS Coordinator's Manual
Source: NFIP/CRS

List of Changes in the 2017 CRS Coordinator's Manual

April 2017

Notes: The following list of changes does not include corrections and small clarifications made within the 2017 Manual.

Vertical lines are provided in the margins of the 2017 Manual to indicate changes. In most instances, vertical lines in the margins of the Manual are not provided for corrections and small clarifications.

Credit Description	2013 Sub-Section	2013 Element	2013 Maximum Credit	2017 Sub-Section	2017 Element	2017 Maximum Credit*	Change
Section 210 - Class 9 Prerequisites	211a			211a			Clarification. 510, 512 Floodplain Management Plans, full credit for Step 5.c. required
Section 210 - Class 6 Prerequisites	211b			211b			No change
Section 210 - Class 4 Prerequisites	211.c			211.c			Change in FRB credit requirement. At least 1 foot of freeboard required throughout SFHA, including unnumbered zones
Section 210 - Class 4 Prerequisites	211.c			211.c			No change for WMP prerequisite, however change made in 450 to address the nature of watersheds in coastal municipalities; clarified that 1 foot of freeboard is required throughout SFHA and not just 100 points
Section 210 - Class 4 Prerequisites	211.c			211.c			Clarifications on 600 Series-related prerequisites
Section 210 - Class 4 Prerequisites	211.d			211.d			(4)(b)(i) for BFEs removed since required for Class 4 freeboard prerequisite
Section 230 - State-based Credit	231.d			231.d			Changed from Uniform Minimum Credit (UMC) to State-based Credit
310 (Elevation Certificates)	**310**	**c310**	**116**		**c310**	**116**	Better explanation of permit list and provide sample spreadsheet; explain diagrams 1A and 1B, clearer on "up to 38 points"
320 (Map Information Service)	**320**	**c320**	**90**		**c320**	**90**	Removed requirement to publicize the available of elevation certificate; better description of the requirement to "volunteer" information to the inquirer
330 (Outreach Projects)	**330**	**c330**	**350**		**c330**	**350**	
Activity Description	331.a			331.a			People potential impacted a levee, dam or special flood-related hazard included as a "priority audiences" for OP and FRP. Revised Table 330-1. New example to be added to highlight credit for high water mark signs/campaigns
Program for public information (PPI)	332.c	PPI	%	332.c	PPI	%	Communities with PPI may select any additional 4 messages of their choosing. Clarifications for updating PPIs.
350 (Flood Protection Information)	**350**	**c350**	**125**		**c350**	**125**	Credit criterion (4) deleted. Redundant credit in WEB2 eliminated and moved to WEB1.
370 (Flood Insurance Promotion)	**370**	**c370**	**110**		**c370**	**110**	Clarification on when insurance data must be reassessed. Dropped requirement for a lender to participate on committee; one insurance agent still required.
Section 403 (Impact Adjustment Maps)	403.b	maps		403.b	maps		Large open bodies of water and federal/tribal lands are removed from area of the SFHA and Activity 420 and 430 credit areas

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Credit Description	2013 Sub-Section	2013 Element	2013 Maximum Credit	2017 Sub-Section	2017 Element	2017 Maximum Credit*	Change
410 (Floodplain Mapping)	**410**	**c410**	**802**		**c410**	**850**	
New study	412.a	NS	290	412.a	NS	350	More credit available; points moved from retired CTP credit
Leverage for non-FEMA cost sharing (multiplier)	412.b	LEV	%	412.b	LEV	%	All leverage credit still available
State review bonus	412.c	SR	60	412.c	SR	60	20% bonus applied after impact adjustment
Higher study standards	412.d	HSS	160	412.d	HSS	200	More credit available; points moved from retired CTP credit; mapping of freeboard added as HSS: better topography and mapping of 500-year floodplain no longer credited under HSS
Floodway standard	412.e	FWS	110	412.e	FWS	140	More credit available; points moved from retired CTP credit
	412.f			412.f	MCE	50	Moved from Supplement; credit for mapping of coastal erosion
	412.f			412.f	MTS	50	Moved from Supplement; mapping of tsunami hazard areas
Special hazards credit	412.f	MAPSH	50	412.f	MAPSH	100	Credit for mapping inland hazards moved to Activities 420 and 430; credit for mapping coastal and tsunami hazards increased to 100 points (MCE=50 and MTS=50)
Signing a CTP	412.g	CTP1	20				CTP1 credit retired; points moved to NS, HHS and FWS
CTP bonus for NS credit	412.g	CTP2	112				CTP2 credit retired; points moved to NS, HHS and FWS
420 (Open Space Preservation)	**420**	**c420**	**2,020**		**c420**	**2870**	Point increase due to special flood-related hazard credit being included in the 2017 Manual
Preserved open space	422.a	OSP	1,450	422.a	OSP	1450	Better documentation guidance provided
Natural functions open space	422.c	NFOS	350	422.c	NFOS	350	Move NFOF5 credit to NFOS1. the outreach in NFOS5 will still be credited in 330 - under topic 6.
Sites include public information/education	422.c	NFOS5	20				NFOS5 credit for public information/education retired and moved to NFOS1, to allow for better credit
Natural functions open space for natural or restored sites	422.c	NFOS1	170	422.c	NFOS1	190	Credit for natural functions open space including public information/education materials
Special hazards open space	422.d	SHOS	50	422.d	SHOS	150	Moved from Supplements and credit increased
Coastal erosion open space	422.d			422.e	CEOS	750	Moved from Supplements
Land development criteria/open space incentives	422.e	OSI	250	422.f	OSI	250	OSI regulations must apply to development and redevelopment

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Credit Description	2013 Sub-Section	2013 Element	2013 Maximum Credit	2017 Sub-Section	2017 Element	2017 Maximum Credit*	Change
430 (Higher Regulatory Standards)	**430**	**c430**	**2,042**		**c430**	**2042**	Clarification that maximum impact adjustment for the activity cannot exceed 1.5 (area regulated divided by area of the SFHA)
Development limitations (fill & buildings)	432.a	DL	1,330	432.a	DL	1330	Clarified that maximum credit for all DL elements is provided when the community prohibits LOMR-Fs
Enclosure limitations	432.g	ENL	240	432.g	ENL	390	CAZ2 credit retired and credit added to ENL (150 points); clarified "and/or" terminology for credit
Building code	432.h	BC	100	432.h	BC	100	Address adoption of both IRC and IBC
Coastal A Zone regulations	432.k	CAZ	650	432.k	CAZ	500	CAZ credit instead of CAZ1 and CAZ2; 150 points of CAZ2 credit moved to ENL
Buildings prohibited in SHR areas	432.x			432.l	SHDL2	100	Moved from Supplements
Ice jam regulations	432.x			432.l	IJR	50	Moved from Supplements
Closed basin lake regulations	432.x			432.l	CBR	80	Moved from Supplements
Mudflow hazard regulations	432.x			432.l	MFR	35	Moved from Supplements
Land subsidence regulations	432.x			432.l	SUR	80	Moved from Supplements
Uncertain flow path regulations	432.x			432.l	UFR1	80	Moved from Supplements
Moveable stream bed regulations	432.x			432.l	UFR2	80	Moved from Supplements
Tsunami special hazards regulations	432.y			432.m	TSR	50	Moved from Supplements
Coastal erosion hazard regulation	432.z			432.n	CER	400	Moved from Supplements
440 (Flood Data Maintenance)	**440**	**c440**	**222**		**c440**	**222**	Erosion data maintenance moved from Supplements
450 (Stormwater Management)	**450**	**c450**	**755**		**c450**	**755**	Emphasis on future development including redevelopment
Watershed master plan	452.b	WMP	315	452.b	WMP	315	Option added for coastal communities to study the 2100 impact of sea level rise in-lieu-of a hydrologic/hydraulic analysis of watersheds; WMP plans no longer have to include discussion or recommendations for stormwater regulations, however communities must still receive SMR credit for all storms up to the 25-year event
Erosion and sedimentation control	452.c	ESC	40	452.c	ESC	40	
Water quality regulations	452.d	WQ	20	452.d	WQ	20	
500 Series	500						
AW-501	501			501			Included with CC-RL form
Rep. Loss Properties	502			502			Change in RL Categories: A = 0 RLs, B = 1-49 RLs, C = 50 or more RLs (unmitigated); Category C communities must receive full credit for Step 5.c. of FMP or received RLAA credit for all RL areas (Class 9 prerequisite)
510 (Floodplain Management Planning)	**510**	**c510**	**622**		**c510**	**622**	Added emphasis on Class 9 RL prerequisite
530 (Flood Protection)	**532**	**c530**	**1,600**	**532**	**c530**	**1600**	Option 1 impact adjustment revised to incorporate the flood protection technique used; Option 2 impact adjustment must be used when buildings were previously built at or above the BFE at the time of construction

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Credit Description	2013 Sub-Section	2013 Element	2013 Maximum Credit	2017 Sub-Section	2017 Element	2017 Maximum Credit*	Change
540 (Drainage System Maintenance)	**540**	**c540**	**570**		**c540**	**570**	Credit calculation change due to CDR being removed as a prerequisite for PSM, CIP and SDR
Channel debris removal	542.a	CDR	200	542.a	CDR	200	Emphasis added on credit for natural systems; impact adjustment can be based on the percentage of a community's system that is inspected annually (Note that credit for underground systems was NOT included in previous Manuals and therefore there is not changes in the CDR discussion in the 2017 Manual. Coastal communities were offered underground system credit as a program implementation decision. Reciprocal credit was not offered to riverine communities.)
Problem site maintenance	542.b	PSM	50	542.b	PSM	50	CDR credit no longer a prerequisite for PSM credit (all communities eligible)
Capital improvements program	542.c	CIP	70	542.c	CIP	70	CDR credit no longer a prerequisite for CIP credit (all communities eligible)
Stream dumping regulations	542.d	SDR	30	542.d	SDR	30	CDR credit is still a prerequisite for SDR credit
Storage basin maintenance	542.e	SBM	120	542.e	SBM	120	
Erosion protection maintenance	542.f	EPM	100				EPM credit retired; beach nourishment no longer credited
610 (Flood Warning and Response)	**610**	**c610**	**395**		**c610**	**395**	Clarification on Activity prerequisites and the types of plans that can be recognized for credit
Flood threat recognition system	612.a	FTR	75	612.a	FTR	75	
Emergency warning dissemination	612.b	EWD	75	612.b	EWD	75	Redistribution of subelement credit based on CRS Task Force input
Flood response operations plan	612.c	FRO	115	612.c	FRO	115	Redistribution of subelement credit based on CRS Task Force input
620 (Levees)	**620**	**c620**	**235**		**c620**	**235**	Clarification on Activity prerequisites
630 (Dams)	**630**	**c630**	**160**		**c630**	**160**	Clarification on Activity prerequisites
Appendices							
Appendix A - Acronyms							Updated
Appendix B - NFIP							Updated
Appendix C - CRS Publications							Updated
Appendix E - Certifications							CC-213, CC-230 and CC-RL updated
Appendix D - History							Updated
Appendix F - EHPs							No changes
Index							Updated

* Increases in maximum credit for a CRS activity are due to the credit for special flood-related hazards being added to the Coordinator's Manual.

Resilient Volusia County

2017