CITY OF SEBASTIAN
HOME OF PELICAN ISLAND

Coastal Resiliency Plan

Resilience Plan Development

Prepared for:

City of Sebastian
1225 Main Street
Sebastian, FL 32958

Prepared by:

Kimley»Horn

Coastal Resiliency Plan – Resilience Plan Development

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1225 Main Street
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Prepared by:

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1 INTRODUCTION

Kimley-Horn was retained under Consultant Service Agreement (CSA) #1 with the City of Sebastian (the City) to provide professional services for the City to prepare a Coastal Resiliency Plan. In 2018, the City received funding through the Florida Department of Environmental Protection (FDEP) Program for Resilient Coastlines. This project is part of an effort by the City to build resilience into the City's Comprehensive Plan. To support the Comprehensive Plan Update, a vulnerability analysis of the City's critical infrastructure and social elements is required to evaluate coastal flooding. Specifically, this report provides a summary of the Vulnerability Assessment performed and the development of an Adaptation Action Plan.

2 BACKGROUND

The City is located in the Indian River Lagoon Basin on the east coast of Florida, bordered by the Indian River and the Saint Sebastian River, shown in Figure 1 below.

FIGURE 1: LOCATION MAP

The City is approximately 14.9 square miles with mixed urban and suburban areas populated by 25,174 (2017) residents. Elevations throughout the City range from 53 feet to 0 feet east to west, with a high ridge line along the Florida East Coast Railway running North-South through the City generally paralleling US 1. The City also maintains more than 10 miles of canal systems that eventually outfall into the Indian River.

3 RESILIENCE PLAN DEVELOPMENT

3.1 PROJECT KICKOFF

A kickoff meeting took place on October 30, 2018 with the City to discuss the objectives of the Coastal Resiliency Plan, flow of information, the project schedule, and existing datasets. Meeting notes were prepared and submitted to the City on November 2, 2018 and are included in Appendix A.

3.2 DATA COLLECTION AND REVIEW

Kimley-Horn reviewed the available GIS files, as-builts and other information provided by the City which included:

GIS Shapefiles

- City of Sebastian City Boundary
- City of Sebastian Future Land Use
- City of Sebastian Zoning
- City of Sebastian Common Resource Area
- City of Sebastian FEMA Zones
- Indian River County Parcels
- Indian River County Parks
- Indian River County Road Centerlines
- Indian River County Road Names
- Indian River County Evacuation Routes
- Indian River County FDOT Outfalls
- Indian River County Building Footprints
- Indian River County Government Facilities
- Indian River County Shelters
- Indian River County Lift Stations

As-Builts

- Indian River County Lift Stations
- City of Sebastian City Hall
- City of Sebastian Police Station

Miscellaneous Information

- City of Sebastian Stormwater Management Master Plan Update (2013)
- City of Sebastian Seawall Assessment (2015)
- Sebastian Municipal Airport Proposed Aircraft Hanger 'A'

- Sebastian Municipal Airport Proposed Aircraft Hanger 'B'
- Pelican Island Elementary School
- City of Sebastian Staff Testimonial Flooding Map

To further support the Coastal Resiliency Plan for the City, Kimley-Horn acquired and reviewed the following additional data:

- 2007 Indian River County Digital Elevation Model (DEM)
- National Oceanic and Atmospheric Administration (NOAA) monthly average water level reports for Station 8721604 Trident Pier, Port Canaveral, Florida
- NOAA and United States Army Corps (USACE) sea level rise projections
- University of Florida GeoPlan Center - Sea Level Scenario Sketch Planning Tool
- NOAA Coastal Flood Exposure Mapper
- Saint Johns River Water Management District (SJRWMD) Basis of Review Rainfall information
- Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) Maps revised and effective December 2012
- Treasure Coast Regional Planning Council (TCRPC) Storm Tide Atlas Indian River County
- VERTCON - North American Vertical Datum Conversion

3.3 INNUNDATION MAPPING

3.3.1 TIDE CONDITIONS AND PLANNING HORIZON (SEA LEVEL RISE)

Given the planning nature of this project, a Rapid Inundation Assessment Method was used to project flood risk. Rapid inundation technology works by routing water over the terrain using a simple set of rules based on how water levels respond to the topography (i.e. available information such as a Digital Elevation Model). Stormwater pipe infrastructure is not included in rapid inundation modeling. Applying the Rapid Inundation Assessment Method to this project has the following advantages:

- Provides an immediate appraisal of flood risk. The tool creates raster files which are imported into GIS and provides flood depths (click anywhere on the map to see flood depths).
- Enables the run of multiple scenarios (e.g. 2070 sea level rise, sea level rise with coupled rainfall) to identify vulnerable areas.
- Correlates results with other online tools such as the University of Florida's Sea Level Rise Sketch tool, NOAA Coastal Flood Exposure Mapper.

The 2007 DEM was used as a basis for the model and all elevations in the tool are based on the North American Vertical Datum of 1988 (NAVD 88). (*Topographic voids for new infrastructure or earthwork projects constructed after 2007 were not included in this analysis.*) The water elevation or boundary condition within the model was set at an elevation of 1.32 feet NAVD. This water elevation is based on the average Mean Higher High Water (MHHW) over ten years;

collected through NOAA historical water elevation data at the Trident Pier gauge (Station 8721604). The observed water levels can be seen in Figure 2.

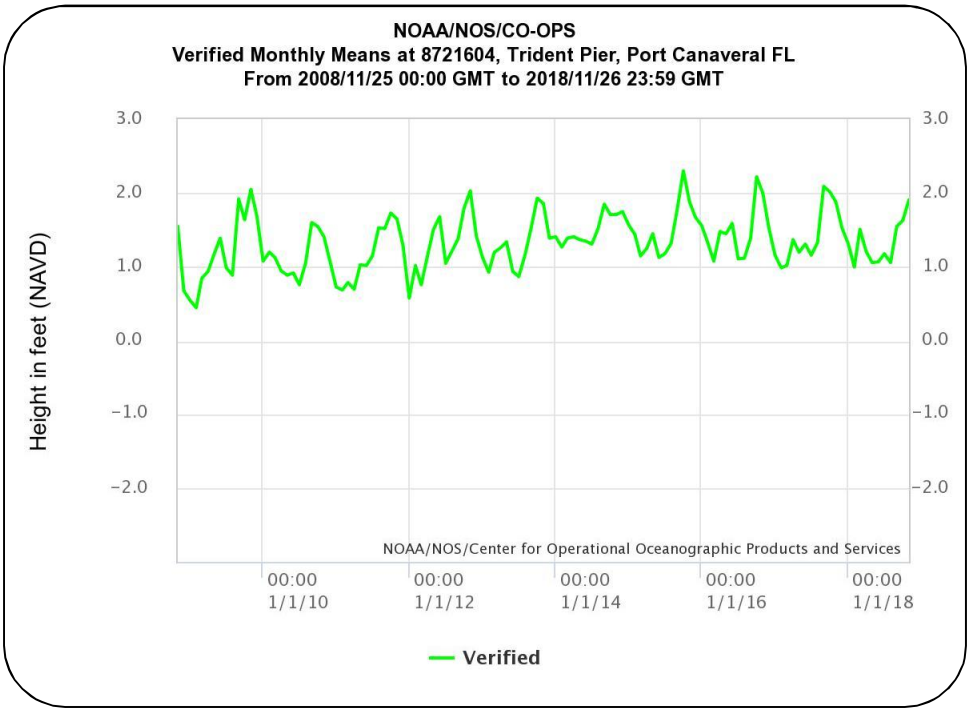

FIGURE 2: TRIDENT PIER (STATION 8721604) MHHW RECORDINGS

Information to assess coastal flooding was obtained from the nearest NOAA (2012) and USACE (2013) Sea Level Rise (SLR) Projections at the Daytona Beach Shores Gauge (Station 8721120), shown in Figure 3.

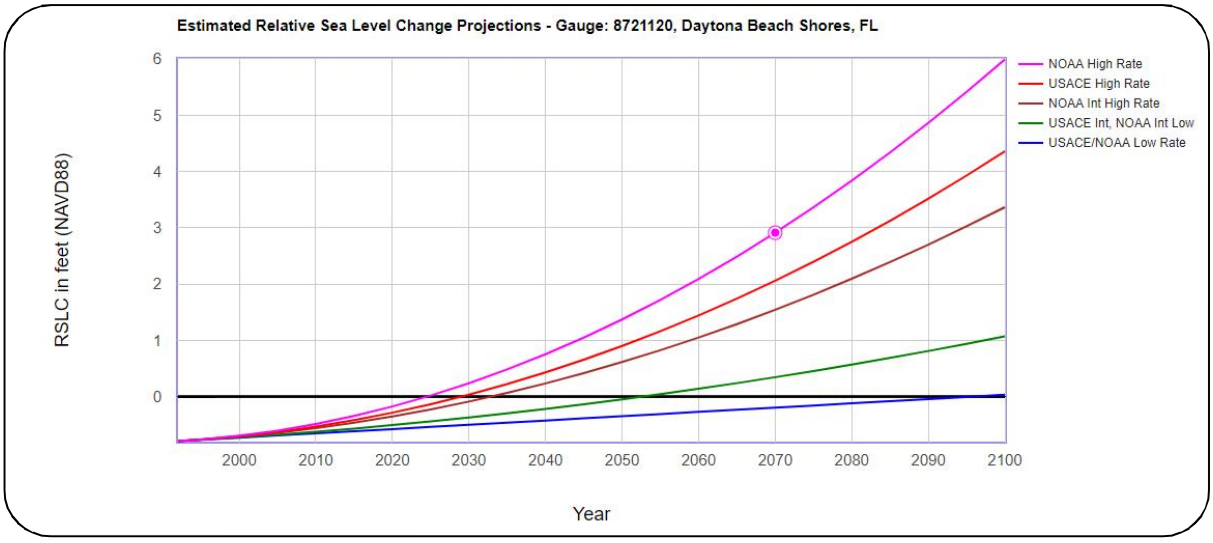

FIGURE 3: FUTURE SEA LEVEL RISE PROJECTIONS

When evaluating coastal flooding impacts, it is necessary to select a Planning Horizon (i.e. how far into the future) in which to protect the built and natural environments. Planning horizons are

based, in part, on the anticipated functional life expectancy of the facilities in various asset classes. Some common planning horizons that have been used by other localities' regional compacts and federal agencies within Florida (as well as other areas around the United States) are provided in Table 1.

TABLE 1: COMMON PLANNING HORIZONS

Common Planning Horizons	
Built Environment	Planning Horizon (express in years)
Critical infrastructure such as roads and pump stations	20-30
Private Structures (i.e. homes)	30
Commercial Buildings	50
Treatment Plants, Schools, Hospitals	60-80

** Some of these horizons have been used in Miami Dade (pump stations and treatment plants), Monroe County (roads) and FEMA programs (structures). *Note that the sections of Planning Horizons should be vetted where risks and costs are considered and are consistent with local ordinances and/or Comprehensive Plan Updates. The horizons provided here are for discussion purposes.*

At the kick-off meeting, the City requested to use a 50-year planning horizon. The 50-year horizon is consistent with the information in Table 1 and reasonable for the infrastructure of interest and associated societal exposure. The infrastructure evaluated included:

- City of Sebastian Government Facilities
- City of Sebastian Shelters
- City of Sebastian Lift Stations
- City of Sebastian Emergency Evacuation Routes
- City of Sebastian Streets

3.3.2 RAINFALL AND SURGE DATA

The 25-year and 100-year 24-hour rainfall events were simulated in the Rapid Inundation tool using the rainfall totals shown in Table 2 below. The Florida Modified Type II (SCS) rainfall distribution was used in the analysis and is consistent with SJRWMD's requirements for evaluating flood risk.

TABLE 2: RAPID INUNDATION RAINFALL INPUTS

Rainfall Event	Rainfall Total*
100-year/24-hour	12 inches
25-year/24-hour	9.5 inches

**Rainfall totals obtained by the SJRWMD isohyetal maps*

Category 1 and 3 hurricane events were modeled based on surge projections, shown in Table 3 below, from the Florida Division of Emergency Management and the Treasure Coast Regional Planning Council. It should be noted that the events modeled do not include wave propagation and wind speeds.

TABLE 3: RAPID INUNDATION SURGE HEIGHT INPUTS

Hurricane Event	Surge height*
Category 1	Up to 4 feet
Category 2	Up to 11 feet

**Surge Heights in Feet above NAVD88 obtained by the Indian River County Storm Tide Atlas*

3.3.3 INUNDATION SUMMARY

Based on the parameters described above the following events were simulated in the Rapid Inundation tool:

- 25-year/24-hour Event
- 100-year/24-hour Event
- 2070 Projected Sea Level Rise (High)
- 100-year/24-hour Event with 2070 Projected Sea Level Rise (High)
- Category 1 Surge Event
- Category 3 Surge Event

The 100-year/24-hour and 25-year/24-hour inundation extents were compared to the FEMA Flood Insurance Rate Maps (FIRM) and the results generally confirmed the results shown in the maps and study. The areas that appear to be inconsistent between the two maps are most likely due to drainage infrastructure not modeled either relieving areas of flood waters or introducing flood waters through conveyance to another. Additionally, some of the flood extents on the FIRM have a glass wall in the model which inhibits reasonable flood extents, for an example see figure 4 below (Glass walls in numerical modeling, is when storage is not adequately parameterized, the model will generate a fictitious vertical wall that artificially raises flood stage elevations. These walls typically occur at the stage/area relationship when either the highest elevation is breached or the corresponding storage is not accounted for resulting in a wall that inhibits floodplain projections). The coastal flooding impact extents produced by the sea level rise in the Rapid Inundation tool were compared to the University of Florida's Sea Level Sketch tool (https://sls.geoplan.ufl.edu/), and overall showed a good correlation with inundation extents. Likewise, the surge results for both Category 1 and 3 events compared favorably to results in NOAA's Coastal Flood Exposure Mapper. The City was able to see initial results of these inundation extent comparisons in a web meeting conducted on January 17, 2019.

The raster files containing flood depths for each event are provided as a separate attachment within a file geodatabase (GDB).

FIGURE 4: FEMA DFIRM – EXAMPLE GLASS WALL

3.4 VULNERABILITY ASSESSMENT

Assets exposed to flooding were evaluated through the development of a paired asset-threat matrix. A paired asset threat matrix essentially links an asset to multiple threats (i.e. sea level, rainfall, surge) and helps to identify which assets are vulnerable to flooding. Appendix B contains the asset-threat matrices prepared for this analysis. The approach taken to assess vulnerability involved a comparison of an inundation event versus a known elevation (all in NAVD datum). Known elevations were derived from either as built elevations provided by the City or the Digital Elevation Model at specific points. As built elevations were converted from NGVD 29 to NAVD 88 when necessary, if as-builts were already in the correct datum no conversion was needed. For the purposes of this study and where pertinent, assets were grouped into criticality classifications to prioritize needs for adaptations. Examples of these assets included Government Facilities and Lift Stations as shown below in Tables 4 and 5 respectively.

TABLE 4: GOVERNMENT FACILITIES CRITICALITY CLASSIFICATIONS

Government Facilities Criticality	Definition
HIGH	Impacts emergency or critical infrastructure needed during major events
MEDIUM	Impacts infrastructure where individuals may work or live
LOW	Impacts outdoor facilities

TABLE 5: LIFT STATIONS PRIORITY CLASSIFICATION

Lift Stations Priority*	Definition
HIGH	More than 3' of flood water - Impact to electrical equipment
MEDIUM	More than 2' of flood water - Possible impact to electrical equipment
LOW	Flood waters - Pumps will still remain in operation

**Lift stations have been classified by priority rather than criticality due to the unknown of station importance by the County. Classifications will be updated once it is confirmed how much of the population each station will serve.*

A summary of the vulnerabilities is provided in the following sections.

3.4.1 2070 SEA LEVEL RISE (NOAA HIGH)

The results from 2070 show limited impacts along the Eastern coast. From a topographic perspective the high ridge along the eastern shoreline is generally effective against sea level rise. (Since pipes were not included in the evaluation there may be landward impacts from direct outfalls where sea level rise is causing backwater impacts; the impacts from this standpoint are unknown given the limitations of this analysis. From the datasets provided there are two FDOT outfalls within City limits). There are impacts along the southern bank of the Sebastian River (notably at Donald MacDonald Park and Dale Wimbrow Park) most of the structures exposed to sea level rise are outside of the City limits with the exception of a few backyards off of Robin Lane. Since the 2070 NOAA High results showed limited exposure to the terrain, intermediate scenarios were not evaluated.

3.4.2 CITY STREETS AND EVACUATION ROUTES

The results for 2070 sea level rise show nominal impact to City maintained streets and Emergency Evacuation Routes (US Highway 1 and Sebastian Blvd.). However, the flood extents from the 25-year, 100-year and 100-year plus 2070 sea level rise events indicate flooding at various locations within the City. These locations generally match known areas of flooding provided by the City (See figure 5 below for areas identified by City Staff as “Severe Flood Areas – 4 to 6 inches” overlaid on the 25-year flood extents) and as discussed during a meeting on February 19, 2019 (See Appendix C). Given the limitations of the Rapid Inundation approach some locations where flooding is predicted may be over-estimating flood extents as drainage infrastructure is not included. Existing flooding levels of service for City-maintained roads were not provided or readily available. A review of the City’s land development code, indicated that new streets within the City must meet the following guidelines:

- the centerline profile of the roadway may not have flood waters exceed two inches above the lowest elevation during a 25-year/24-hour events:
- all bridges should be designed to pass the 100-year/72-hour storm.

No level of service issues along the evacuation routes were identified in the model or by City staff.

FIGURE 5: CITY OF SEBASTIAN 25-YEAR/24-HOUR FLOOD EXTENTS

3.4.3 FDOT OUTFALLS

Although pipes were not included in this analysis, landward impacts from sea level rise is a common problem for coastal communities due to the direct outfalls where sea level rise can cause backwater impacts. Two outfalls provided are within the City limits and could benefit from an inline check valve that inhibits tidal backflow and future sea level rise from inundating the City further inland given upstream pipe connectivity.

FIGURE 6: CITY OF SEBASTIAN - FDOT OUTFALLS

3.4.4 GOVERNMENT FACILITIES AND SHELTER

The government facilities owned by the City that are impacted by the generated inundation extents are low on the criticality scale since they are outdoor facilities; not critical during major events and not places where individuals reside or work. All buildings and/or shelters do not appear to be impacted by any events evaluated.

3.4.5 LIFT STATIONS

Multiple lift stations along the coastal area within the City limits appear to be exposed with more than 3 feet of flood waters during a Category 3 event causing station failure. These stations are not considered critical to the City because they do not serve more than fifty (50) residential units. These stations should still be prioritized as areas to increase resiliency within, but station failure will not impact a large number of citizens.

3.4.6 CANAL SYSTEM

During the meeting on February 19th, 2019 City staff indicated that meeting the appropriate level of service in the canal system has been an ongoing issue. Erosion along canal banks has impacted bulkheads and side slopes such that the systems are compromised and in need of repair. Additionally, many of the bulkheads are privately owned making repairs more difficult for coordination. The 2070 Sea Level Rise results do not show the canal system within the City to be exposed, this could be due to the limitations of no drainage conveyance systems modeled. Conversely, during the 25 and 100-year events, the canal systems appear to be completely filled with some areas overtopping impacting homes.

3.4.7 FUTURE LAND USE

Future land use overlaid by the 25 and 100-year events displays that the main issues appear to be in the future institutional and general commercial areas in the southern portion of the City limits. These areas at present are low lying and are vulnerable to flooding. If the City intends to develop these areas the ground elevation should be raised. When 2070 sea level rise is overlaid on the future land use map, future issues can be seen along the riverfront mixed use areas. The issues with sea level rise appear to mainly impact the dock areas as opposed to the further inland riverfront mixed use area.

3.4.8 SOCIETAL EXPOSURE

Due to our limitations on census block data, we were not able to overlay the rapid inundation results on demographic information. As such the NOAA Coastal Flood Exposure tool (https://coast.noaa.gov/digitalcoast/tools/flood-exposure.html) was used to generate maps to supplement this information, see Appendix D. More than 25% of the City is over the age of 65 making it more difficult for rapid evacuation. At 65 years of age and older it is also common to be retired, on a fixed income, potentially vulnerable due to lack of funds if a home needs to be repaired. As shown in the NOAA Coastal Flood Exposure Mapper the Categories 1 through 5 storms only affect a small portion of the City, but will cause need for evacuation and demographics may impact the warning time that the City will need to provide to residents.

4 VULNERABILITY SUMMARY

The results from our analysis indicate that a majority of the City's infrastructure does not appear to be at risk from sea level rise based on the current datasets for 2070 and only some infrastructure is at risk during major rain events based on the 25-year and 100-year inundation extents.

- Impacts to Government Facilities and shelters are not critical, it appears that inundation extents impacted outdoor facilities.
- Impacts to City streets exist throughout the City limits but may be over exaggerated due to the limits of this study, no drainage infrastructure accounted for.
- Impacts to evacuation routes are limited to small areas on Sebastian Boulevard, but appear to be contained on the road shoulder.
- Impacts to lift stations are concentrated near the coastal area of the City limits and flooding does not impact master lift stations serving more than fifty (50) residential units.

5 ADAPTATION ACTION PLAN

Based on the vulnerabilities identified and subsequent discussions with the City potential adaptation strategies were devised. The adaptation strategies were screened qualitatively using the following criteria:

- Ability to increase resilience
- Cost and benefits
- Community acceptance
- Environmental impacts
- Socio-economic impacts

A summary of the screening criteria is provided in the table below.

TABLE 6: POTENTIAL ADAPTATION STRATEGIES

Potential Adaptation Strategies	Ability to Increase Resilience	Cost and benefits	Community Acceptance	Environmental Impacts	Socio-economic impacts
Canal Bank Inspections	🟢	🔴	🟡	🟡	🟡
Define Street and Structure Level of Service	🟢	🟡	🟢	🟢	🟢
Retrofit Outfalls with Inline Check Valve	🟢	🟢	🟢	🟡	🟡
Update Comprehensive Plan	🟢	🟢	🟡	🟡	🟡
Update Stormwater Master Plan	🟡	🟢	🟢	🟡	🟢
Raise Lift Station Electrical Controls	🟢	🔴	🟢	🟡	🟡
*Level of value to the City: 🟢 = High 🟡 = Medium 🔴 = Low					

The table above summarize potential adaptations and their impacts within the community. In terms of assessing strategies to protect City assets we have generally categorized the adaptation strategies into two classifications, short term and long term. The short term actions or adaptations are those that can be implemented immediately, while long term actions will require more coordination and time.

Short Term Actions:

- Define existing street and structure flooding levels of service. Timeline approximately 6-12 months.
- Locate and map all City outfalls. It is recommended that the outfalls be retrofitted with an inline check valve to inhibit coastal flooding. Timeline approximately of 3 to 6 month and cost range between $5,000 to $20,000.
- Update the Comprehensive Plan Elements specific to Peril of Flood and this analysis. Timeline 2Q/3Q 2019.

Long Term Actions:

- Conduct a level 1 inspection of exposed and submerged canal bank/bulkheads structural elements within the City. The evaluation should include a determination of property rights associated with banks/bulkheads. For approximately 10 miles of diving banks/bulkheads a preliminary cost will range between $400,000 to $800,000 with an expected timeline of approximately 3 to 6 months. For an inspection of only exposed elements the timeline would be decreased to 1 to 3 months and cost between $100,000 to $300,000.
    - The discrepancy in costs can be attributed to the unknowns when diving within the canal, for example a wildlife specialist needing to be present. The evaluation of canals also depends on the bank and bulkhead structural materials, evaluations can require more time and analysis depending on the material as well as points of access.

- Update the 2018 Stormwater Master Plan – this would include a City-wide evaluation to update the numerical model with the latest datasets. If a new DEM is available, this is recommended to be incorporated and the model parameters revised accordingly. A detailed inventory of stormwater assets should be completed and can be accomplished by supplementing as-built information with drop down measurements and where necessary conventional surveying. The Rapid Inundation flood depths submitted as part of the attached geodatabase can be used to help target areas of where infrastructure exists or is required. The update of the model should include the development of a schema to enable a "plug and play" approach and increase the adaptive capacity for the City. (As conditions and parameters change in the future, an integrated schema will help streamline how the data is disseminated.) Floodplains should be developed based on latest regulatory requirements as well as identifying existing street and structure flooding level of service violations. Given the hydrology of the area, it is recommended that a pollutant load model be developed. Best Management Practices to address flooding level of service violations and water quality should be devised as part of the Master Plan update and include the impacts of future sea level rise and combined rain events. Based on the level of detail in the model, historical costs for stormwater masterplan updates for similar sized communities have ranged between $200,000 to $400,000. Typically, the more granular the model (i.e. local level) the higher the cost and if the City seeks to include coastal flooding evaluations, the higher range is reasonable. Timeline approximately 24 months.
- Liaise with the County to devise a consensus roadmap to harden (raise electrical controls) the pump-stations based on their criticalities. Timeline is dependent on Cities economic ability to raise multiple pump station controls at once, due to economic limitations the timeline could range from 2 months to multiple years.
- Discuss the potential of early warning notifications for elderly residents within the City.

Notes:

The costs presented above are preliminary/planning level costs; more detailed estimates should be completed for budgeting purposes. Costs provided herein are based on the information known to the Consultant at this time and represent only the Consultant's judgment as a design professional familiar with the construction industry. The Consultant cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from these costs.

Timelines identified above are for implementation and do not account for procurement.

APPENDIX A:
KICK-OFF MEETING NOTES

From: Klepper, Kelley
Sent: Friday, November 2, 2018 10:59 AM
To: Lisa Frazier <LFrazier@CityofSebastian.org>
Cc: Niforatos, Chris <Chris.Niforatos@kimley-horn.com>; Battles, Sara (Green) <Sara.Battles@kimley-horn.com>; DiMaria, Philip <Philip.DiMaria@kimley-horn.com>
Subject: Kick-off Meeting

Lisa

I know you made a copy of my meeting notes; however, we wanted to also provide you with the following information.

- Meeting started at approximately 9:00 am with introductions from those present

- KH gave a short overview on resiliency and discussed the main goals of the project

- The City is focused on addressing resiliency for Critical Infrastructure. Among the assets to be included in the vulnerability analysis (City will provide as-builts for pertinent facilities*):
    - Schools*
    - City hall*
    - Evacuation routes
    - Cell towers and communications facilities
    - Police Department*
    - Fire Department*
    - Shelters*
    - Airport
    - Public Works building* and facility
    - Master Lift Stations (Shape file of locations and as-builts to be provided by County)

- City currently has a CRS rating of 7
- City has stormwater utility in place. Non-ad-valorem assessment contained in TRIM notice. SWU was started ~ 2013 and recently updated (2017/18 ~ $5 increase in ERU)
- City Stormwater Masterplan requires an update.
- City is keen on Green Infrastructure but at present only requires it on new commercial businesses
- City does not have any highwater mark data or flooding testimonials spatially available. Institutional knowledge resides with City staff
    - City noted significant flooding during Hurricane Fay ~ 2009. Stormwater facilities were effective conveying flood-waters.
- FIRMs were published in 2004 with an update in 2013. Preliminary Coastal Flood Plains have been provided though not officially published. A portion of the City is still under evaluation and was not included in 2013 update.
- City initiated a seawall engineering assessment in 20015
- City does have some of its outfalls mapped. (KH mentioned quick hit at mapping all of them and retrofitting them with tide control valves.)
- City agreed to evaluate Critical infrastructure at a 50 yr planning horizon (i.e. 2070). Roads are typically evaluated at a 20-30 year horizon as are lift stations.
- Comprehensive Plan has not been updated in some time. With Peril of Flood Act made sense to simultaneously update comp plan and perform vulnerability analysis
- KH provided a copy of the resilience presentation slides to the City.

- Schedule to complete the project is by June 2019
- Meeting adjourned at ~ 11:00

Action items:

- City to provide datasets as described above and in scope of work to Kimley Horn
  - Philip to work with Kim directly
- City via the County will obtain shapefile and as-builts of County master lift stations located within the City

Sincerely,

Kelley

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Kelley Klepper, AICP
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APPENDIX B:
ASSET-THREAT MATRICES

ASSET-THREAT MATRICES
GOVERNMENT FACILITIES

MAJOR_CAT	NAME	OWNER	CATEGORIES	2070 SEA LEVEL RISE	2070 SEA LEVEL RISE + 100 YEAR	25 YEAR/24HOUR	100YEAR/24HOUR	CAT 1	CAT 3	FIRM ELEVATION	DEM ELEVATION	CRITICALITY
LOCAL GOVERNMENT	SEBASTIAN CITY HALL	CITY OF SEBASTIAN	GOVERNMENT BUILDING	0	0	0	0	0	0	0	23.54170036	
LAW ENFORCEMENT	CITY OF SEBASTIAN POLICE DEPARTMENT	CITY OF SEBASTIAN	LAW ENFORCEMENT	0	0	0	0	0	0	0	22.27039909	
CITY PARK	EASY STREET PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	21.9	22.34569931	
CITY PARK	HARDEE PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	20.89999962	
CITY PARK	RIVERVIEW PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	11.02000046	0	6.329810143	LOW
BOAT RAMP	CAPTAIN ROBERT HARDEE BOAT LAUNCH	CITY OF SEBASTIAN	BOAT RAMP	3.812999964	5.893000126	0	0	3.990999937	11.01399994	7	1.821529864	LOW
BOAT RAMP	SEBASTIAN YACHT CLUB	CITY OF SEBASTIAN	BOAT RAMP	3.803999901	5.893000126	0	0	3.987999916	11.01900005	7	3.020329952	LOW
CITY PARK	SCHUMANN LAKE PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	24.0048008	
CITY PARK	BARBER STREET SPORTS COMPLEX	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	21.13439941	
CITY PARK	SEBASTIAN BARK PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	21.11400032	21.07799911	21.11499977	0	0	18	19.8654995	LOW
CITY PARK	STORMWATER PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	20.86429977	
CITY PARK	SEBASTIAN SKATE PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	22.25769997	
CITY PARK	SCHUMANN LAKE PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	23.07259941	
CITY PARK	PERIWINKLE PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	19.12899971	
CITY PARK	AIRPORT PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	21.86969948	
CITY PARK	BLOSSOM STREET PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	18.7241993	
CITY PARK	BRYANT COURT PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	19.95199966	19.95299911	19.95199966	0	0	0	19.48590088	
CITY PARK	COMMUNITY CENTER	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	15.08460045	
CITY PARK	FILBERT STREET PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	21.45949936	
CITY PARK	FRIENDSHIP PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	24.38710022	
CITY PARK	GARDEN CLUB PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	21.73870087	
CITY PARK	GEORGE STREET PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	20.27400017	20.27400017	20.27499962	0	0	0	20.14909935	
CITY PARK	HISTORICAL PARK	CITY OF SEBASTIAN	PUBLIC PARK	0	0	0	0	0	0	0	13.60589981	

CRITICALITY	Definition
HIGH	Impacts emergency or critical infrastructure needed during major events
MEDIUM	Impacts infrastructure where individuals may work or live
LOW	Impacts outdoor facilities

ASSET-THREAT MATRICES
LIFT STATIONS

FID	Owner	InstallYea	LS_NUMBER	ERUs SERVED	Elevation	2070 SEA LEVEL RISE	2070 SEA LEVEL RISE + 100 YEAR	25 YEAR/24HOUR	100YEAR/24HOUR	CAT 1	CAT 3	DEM ELEVATION	PRIORITY
0	IRC	2005	1298	189	20.76000022	0	0	0	0	0	0	19.43029976	
1	PVT	2013			0	0	0	0	0	0	0	23.18880081	
2	PVT	2015	3223		23.73	0	0	0	0	0	0	22.7682991	
3	IRC	2016			24.01	0	0	0	0	0	0	23.52960014	
4	PVT	2016	3277		18.64	0	0	0	0	0	0	18.42550087	
5	IRC	1981	1194	197	22.79999923	0	0	0	0	0	0	21.57859993	
6	IRC	1972	1197		23	0	0	0	0	0	0	21.88019943	
7	PVT	2016			22.48	0	21.72400093	21.72299957	21.71899986	0	0	11.80729961	
8	PVT	2014			23.88	0	0	0	0	0	0	20.79700089	
9	PVT	2017			28.08	0	0	0	0	0	0	25.47310066	
10	IRC	0			0	0	0	0	0	0	11.01099968	9.622150421	LOW
11	PVT	2016			24.42	0	0	0	0	0	0	23.45339966	
12	PVT	2008			11.15	0	0	0	0	0	11.02000046	9.886599541	
13	PVT	2013			0	0	0	0	0	0	0	16.85230064	
14	PVT	0			0	0	21.74399948	21.74399948	21.73900032	0	0	21.41699982	
15	PVT	0			0	3.803999001	5.888999938	3.151000023	3.151000023	3.987999916	11.01900005	3.118900061	HIGH
16	IRC	1996	1213	23	9.02999973	0	0	0	0	0	11.01599979	7.113729954	MEDIUM
17	PVT	1991	416		8.970000267	0	0	0	0	0	11.01299953	7.739960194	MEDIUM
18	IRC	1997	1211	71	26.14999961	0	0	0	0	0	0	24.67169952	
19	PVT	0			11.14000034	0	0	0	0	0	11.02099991	8.933329582	
20	PVT	0			29.39999961	0	0	0	0	0	0	28.08889961	
21	IRC	1994	1201	97	0	0	0	0	0	0	11.01200008	6.252240181	HIGH
22	PVT	0			8	0	5.893000126	0	0	0	11.01500034	3.840749979	HIGH
23	IRC	1990	1166	49	23.09000015	0	21.29400063	21.29500008	21.29400063	0	0	21.2343998	
24	IRC	1994	1187	48	24.38	0	0	0	0	0	0	22.98509979	
25	IRC	1994	1185	87	0	0	0	0	0	0	0	20.46100044	
26	IRC	1992	1199	18	0	0	21.91500092	21.91600037	21.91699982	0	0	20.79380035	LOW
27	IRC	1996	1200		25.62	0	0	0	0	0	0	23.85930061	
28	PVT	2009			0	0	21.64500046	21.64500046	21.6439991	0	0	20.85820007	
29	PVT	2005			22.54000091	0	0	0	0	0	0	21.22769928	
30	PVT	2010			20.75	0	0	0	0	0	0	19.87750053	
31	PVT	1995			0	0	0	0	0	0	0	21.25830078	
32	PVT	2004			0	0	0	0	0	0	0	24.35519981	
33	PVT	1998			0	0	0	0	0	0	0	21.9503994	
34	PVT	0			0	0	0	0	0	0	0	21.47170067	
35	IRC	0			0	0	22.60499954	22.60499954	22.60400009	0	0	22.26619911	
36	IRC	0			0	0	22.60199928	22.60199928	22.60199928	0	0	22.25160027	
37	IRC	0			0	0	22.60199928	22.60199928	22.60199928	0	0	21.96240044	
38	IRC	0			0	0	0	0	0	0	0	23.20269966	
39	IRC	1981	1195	117	22.5	0	0	0	0	0	0	20.8879967	
40	IRC	1981	1196	1	22.5	0	0	0	0	0	0	21.93659973	
41	IRC	1981	1193	177	22.79999923	0	21.81299973	21.81299973	21.81299973	0	0	21.62809944	
42	PVT	0			7.65000009	0	0	0	0	0	11.01099968	6.940629959	HIGH
43	PVT	2011			0	0	0	0	0	0	11.02099991	8.394510269	HIGH
44	PVT	0			25.5	0	0	0	0	0	0	24.63080025	
45	PVT	2004			26.54000091	0	0	0	0	0	0	22.33909988	
46	IRC	2005	1168	82	22.32999992	0	0	0	0	0	0	20.79630089	
47	IRC	2005	1296	24	11.93999958	0	0	0	0	0	11.03499985	9.99944973	
48	IRC	2002	1260	37	25.57999992	0	0	0	0	0	0	23.69079971	
49	IRC	2004	1270	234	13.10999965	0	13.05500031	13.05599976	13.05599976	0	0	12.53820038	
50	IRC	2006	1314	137	17.53000068	0	0	0	0	0	0	16.6427002	
51	IRC	2005	1285	101	25.17000007	0	0	0	0	0	0	23.77129936	
52	PVT	0			27.54999923	0	0	0	0	0	0	25.81819916	
53	PVT	0			0	0	0	0	0	0	11.02200031	5.605110168	HIGH
54	PVT	0			23.37999916	0	0	0	0	0	0	23.23469925	
55	IRC	2005	1299	193	25.04000091	0	0	0	0	0	0	23.16349983	
56	PVT	0			26.54000091	0	0	0	0	0	0	24.92029953	
57	PVT	0			25.5	0	0	0	0	0	0	24.59230042	
58	IRC	1985	1202	94	23.95	0	0	0	0	0	0	24.07099996	
59	IRC	1985	1163	506	22	0	19.84399986	19.84300041	19.84399986	0	0	19.35560036	
60	PVT	0			32.06999969	0	0	0	0	0	0	30.19529915	
61	IRC	2002	1216	194	20.44000053	0	0	0	0	0	0	19.10810089	
62	IRC	1999	1212	114	20.09000015	0	0	0	0	0	0	18.52549934	
63	PVT	0			9.39999961	0	0	0	0	0	11.02099991	7.038440228	LOW
64	PVT	0			9.53999996	0	0	0	0	0	11.02200031	6.571090221	LOW
65	PVT	0			0	0	6.413000107	6.413000107	6.409999847	0	11.01299953	5.752679825	HIGH
66	PVT	2009			0	0	0	0	0	0	11.01399994	9.920450211	LOW
67	PVT	2010			0	0	0	0	0	0	0	23.01009941	
68	PVT	2010			0	0	21.72400093	21.72299957	21.71899986	0	0	11.80000019	
69	IRC	2001	1206	25	13.29	0	0	0	0	0	0	11.51840019	
70	PVT	2005			0	0	0	0	0	0	0	27.52059937	
71	PVT	1989			24.95	0	0	0	0	0	0	23.80990028	
72	PVT	2011			0	0	0	0	0	0	0	28.81209946	
73	PVT	1998			0	0	0	0	0	0	0	24.60610008	
74	IRC	2004	1198	21	23.22999954	0	0	0	0	0	0	21.61650085	
75	PVT	0			30.5	0	0	0	0	0	0	29.54680061	
76	PVT	0			8.5	0	0	0	0	0	11.01099968	8.550359726	MEDIUM
77	PVT	0			11.30000019	0	0	0	0	0	11.01200008	9.061450005	
78	PVT	0			31.06999969	0	0	0	0	0	0	29.18650055	
79	PVT	0			0	0	0	0	0	0	0	12.57740021	
80	IRC	2005	1286	198	24.54999923	0	0	0	0	0	0	22.92910004	
81	PVT	2005			0	0	0	0	0	0	0	22.66720009	
82	PVT	1999			0	0	0	0	0	0	0	21.49360085	
83	PVT	0			0	0	7.913000107	7.913000107	7.913000107	0	11.01299953	7.824550152	HIGH
84	PVT	0			0	0	21.71699905	21.71800041	21.71299934	0	0	21.57439995	
85	PVT	0			0	0	0	0	0	0	0	23.21980095	
86	IRC	1980	1192	148	26.5	0	0	0	0	0	0	26.24250031	
87	PVT	0			0	0	0	0	0	0	0	21.91189957	
88	PVT	0			0	0	0	0	0	0	0	22.66539955	
89	PVT	2001	PVT		0	0	0	0	0	0	0	16.51759911	
90	PVT	0			20.67000007	0	0	0	0	0	0	20.35619926	
91	PVT	0			25.31999969	0	0	0	0	0	0	23.64259911	
92	IRC	2001	1191	200	22.94000053	0	0	0	0	0	0	21.00180054	
93	PVT	2005			0	0	0	0	0	0	0	16.87739944	
94	PVT	2002			0	0	5.893000126	0	0	0	11.01099968	4.942550182	HIGH
95	PVT	0			9.5	0	0	0	0	0	11.02000046	8.274350166	LOW
96	IRC	2006	1047	49	0	0	20.30400085	20.30400085	20.30400085	0	0	19.22100067	LOW
97	PVT	0			0	0	28.76600075	28.76600075	28.76600075	0	0	28.61240005	
98	PVT	0			11.96000003	0	0	0	0	0	11.01799965	9.935819626	
99	IRC	1981	1263		0	0	0	0	0	0	0	21.55340004	
100	PVT	0			0	0	0	0	0	0	0	23.27459908	
101	IRC	2006	1048	50	22.19	0	19.87999916	19.87899971	19.87899971	0	0	19.86680031	
102	PVT	0			0	0	0	0	0	0	11.01200008	6.802370071	HIGH
103	PVT	0			0	0	0	0	0	0	11.01200008	6.178110123	HIGH
104	PVT	0			0	0	5.893000126	0	0	0	11.01099968	5.146210194	HIGH

PRIORITY	Definition
HIGH	More than 3' of flood water - Impact to electrical equipment
MEDIUM	More than 2' of flood water - Possible impact to electrical equipment
LOW	Flood waters - Pumps will still remain in operation

APPENDIX C:
PROGRESS MEETING PRESENTATION

City of Sebastian – Coastal Resiliency Plan

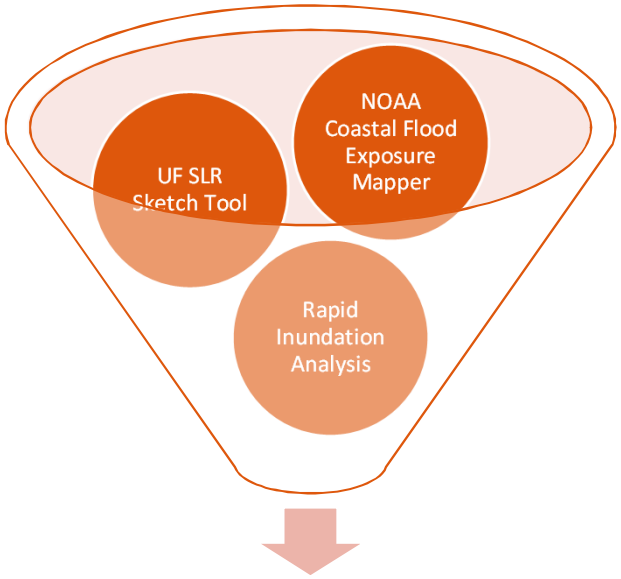
PROGRESS MEETING

FEBRUARY 19, 2019

Agenda

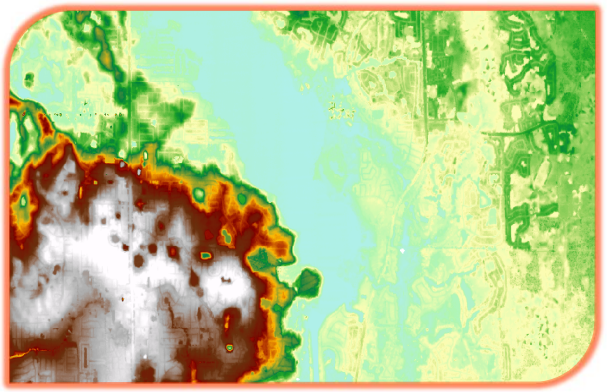
- Introductions
- Flood Analysis
  - Inundation Extents
  - Facility Overlays
  - Asset Matrix
- Next Steps

Analysis

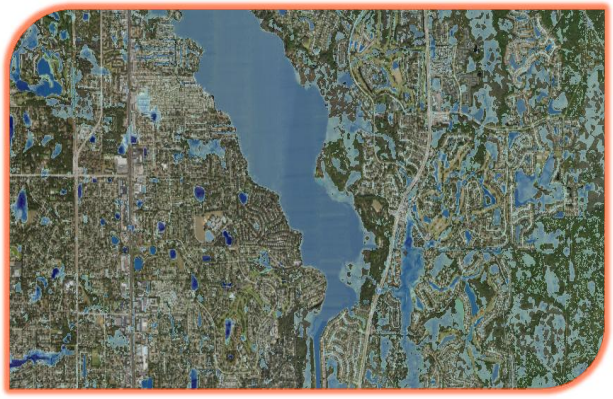


Actionable Strategies

Rapid Inundation Analysis



DEM



Flood Extents

- Run multiple events in one day
- Combine SLR with varying rainfall events
- Aids in knowledge transfer

Rapid Inundation Analysis

- Inundation Extents Analyzed
  - 100 Year
  - 25 Year
  - 2070 SLR (NOAA High)
  - 2070 SLR (NOAA High) + 100 YR
  - CAT 1 Storm Surge
  - CAT 3 Storm Surge

Rainfall Depths

100 Year Event

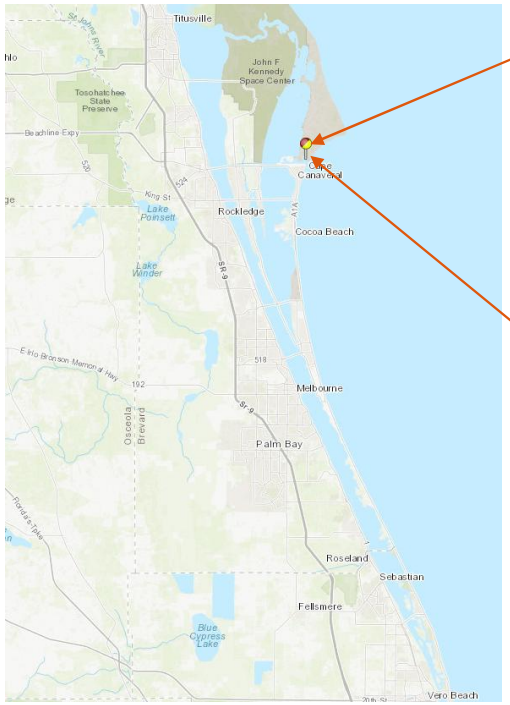
12 inches/24 hours

25 Year Event

9.5 inches/24 hours

Data Sources: SJRWMD

Tidal Information



Average MHHW taken from 2008 to 2018 (10 years) = 1.32 (NAVD)

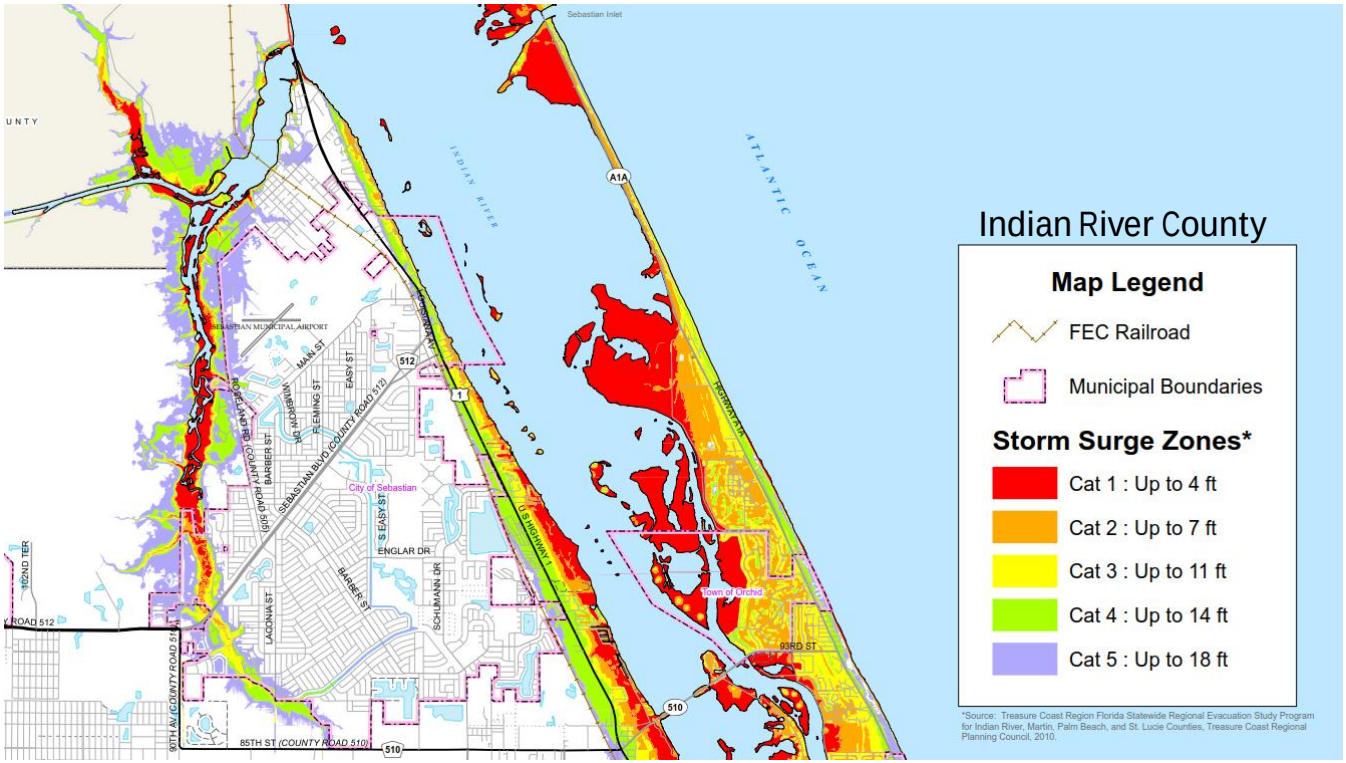
Data Source: NOAA, Station 8721604 Port Canaveral, FL

2070 SLR (NOAA High)

UF Sketch planning tool:

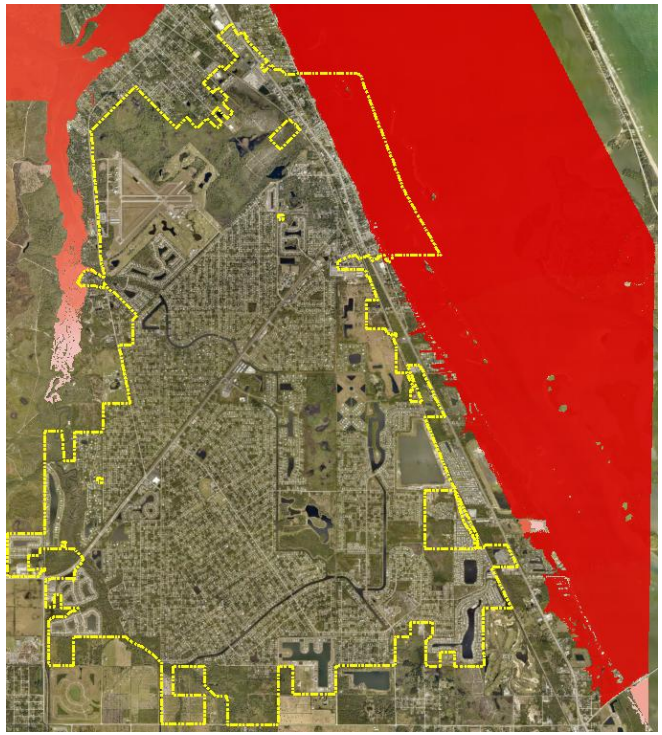
2070 SLR

Indian River County Surge Map

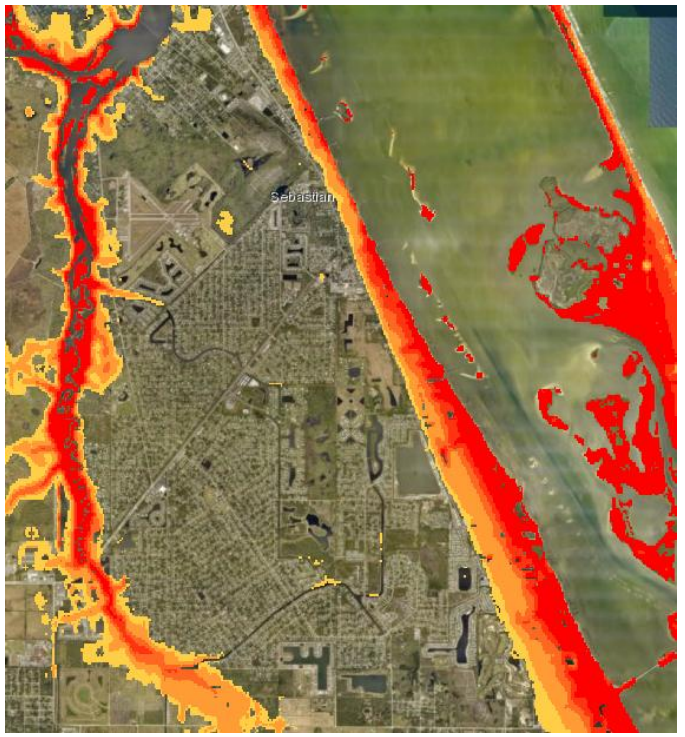


City of Sebastian – Category 1 Surge

RI tool CAT 1:



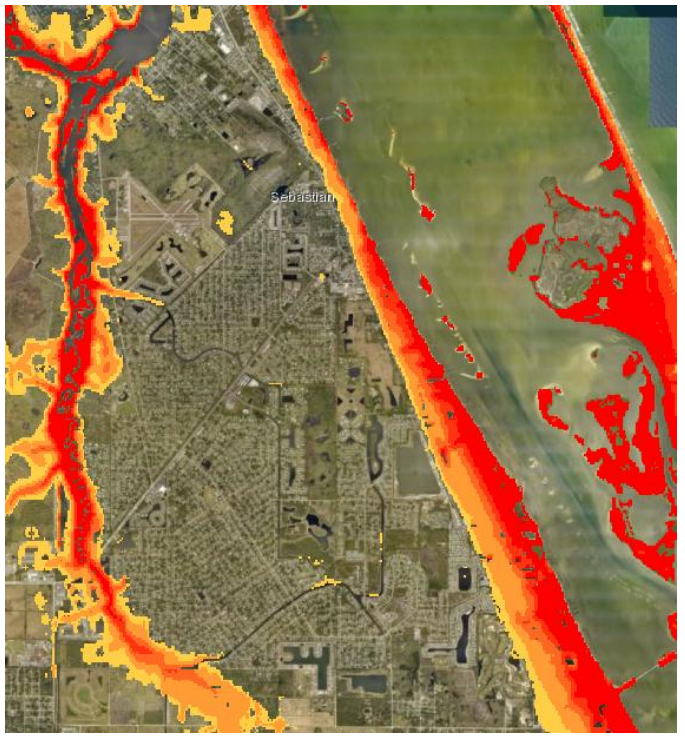
NOAA Coastal Exposure Map CAT 1 (Bright Red):



City of Sebastian – Category 3 Surge

RI tool CAT 3:

NOAA Coastal Exposure Map CAT 3 (Light Orange):

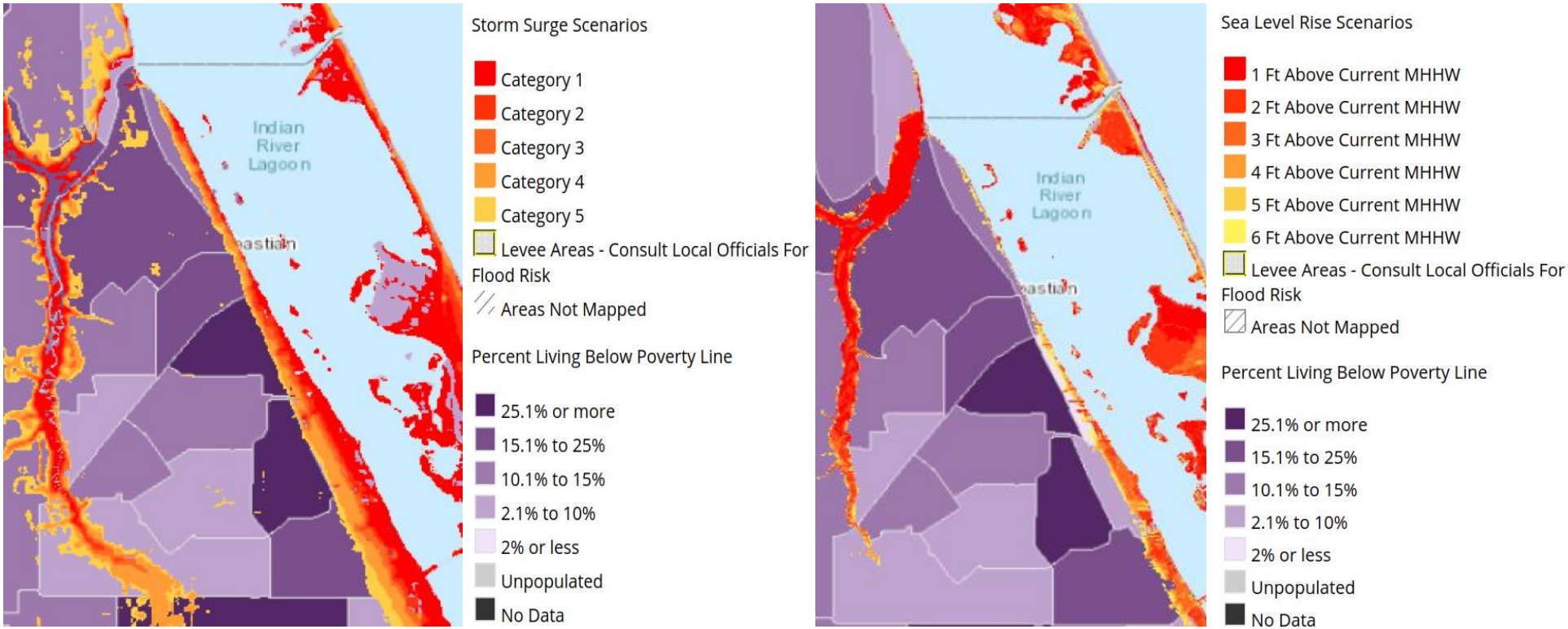


Exposure VS. Vulnerability

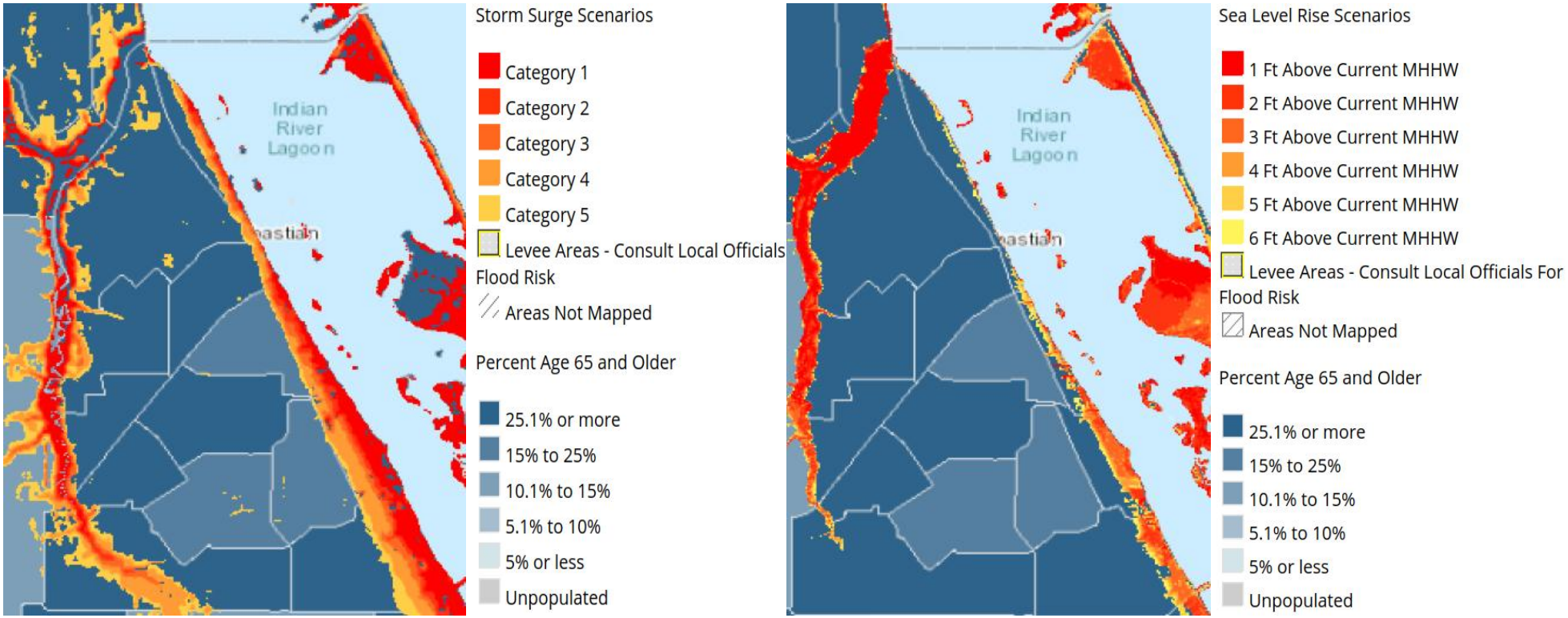
Asset Analysis

- Asset Elevations
  - DEM (point) Elevation as FFE if no other information is available
  - As Builts
  - Lift Station As-Builts
- Government Facilities Criticality
  - High – Impacts emergency or critical infrastructure needed during major events
  - Medium – Impacts infrastructure where individuals may work or live
  - Low – Impacts outdoor facilities
- Lift Stations Priority
  - High – More than 3’ of flood water – Impact to electrical equipment
  - Medium – More than 2’ of flood water – Possible impact to electrical equipment
  - Low – Under 2’ of flood water – Pumps will still remain in operation

NOAA Societal Exposure



NOAA Societal Exposure



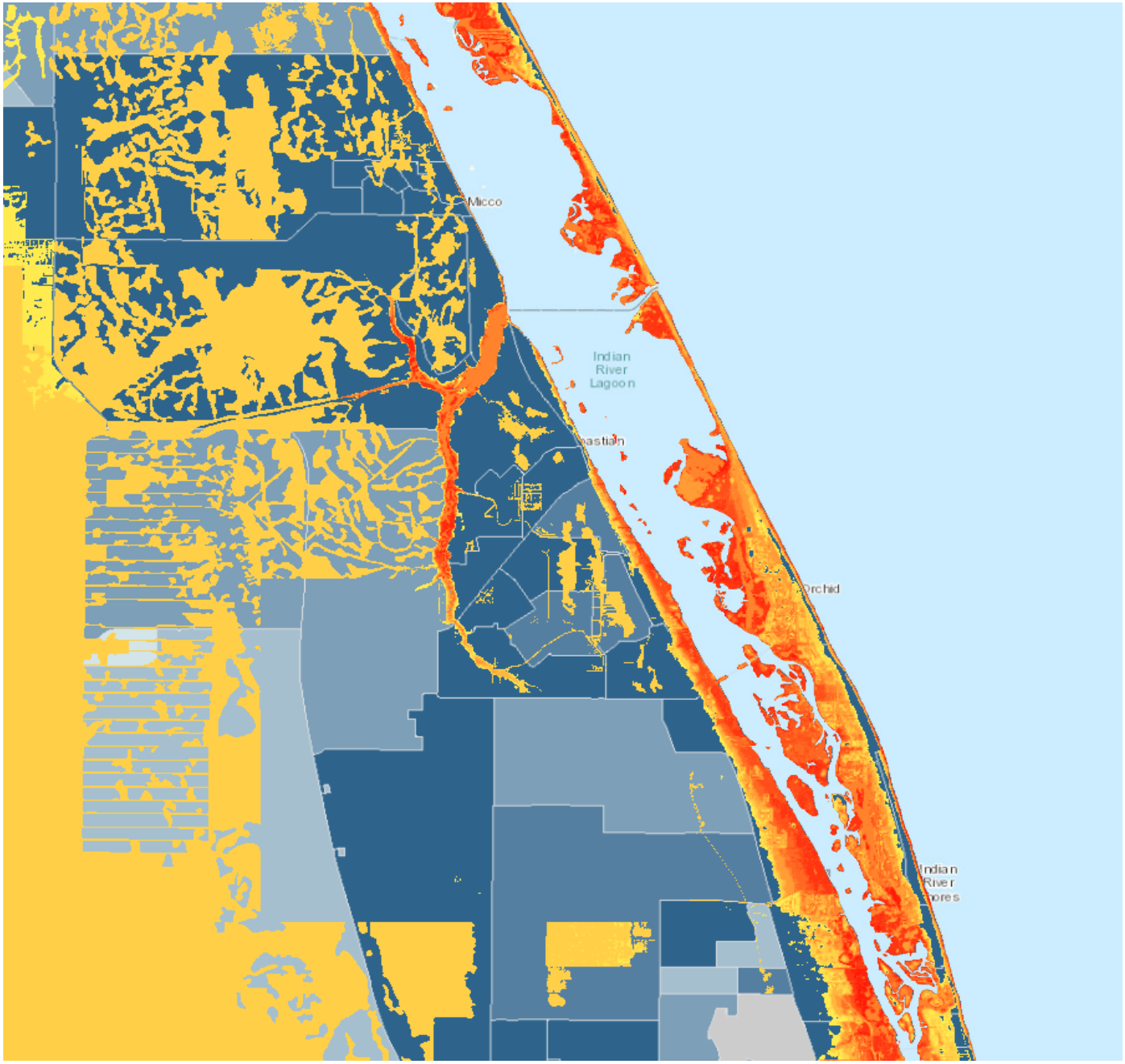
Next Steps

- ❑ Submit Vulnerability Matrix – Flood Analysis
- ❑ Identify Master Pump Stations for criticality identification
- ❑ Submit Model Result Geodatabase (GDB)
- ❑ Submit Coastal Resiliency Plan Technical Memo
- ❑ Comprehensive Plan – Evaluation and Opportunity Assessment
- ❑ Comprehensive Plan – Resiliency Amendments

Potential Adaptation Strategies

- Update Stormwater Master Plan
- Update Comprehensive Plan Elements

APPENDIX D:
NOAA COASTAL FLOOD EXPOSURE MAPS



Societal Exposure | Elderly

Flood Hazard Composite

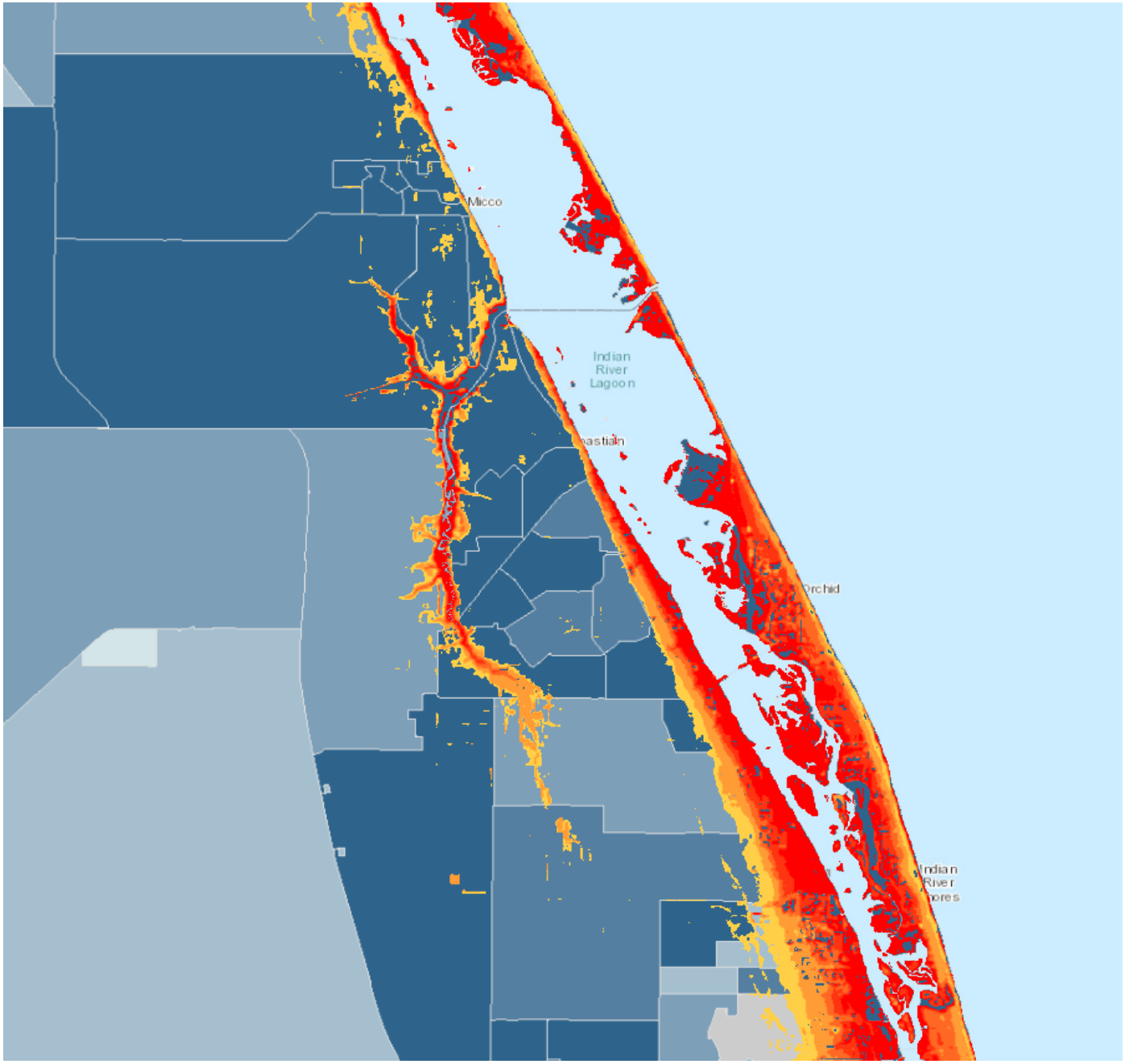
- 1 Hazard Zone
- 2 Hazard Zones
- 3 Hazard Zones
- 4 Hazard Zones
- 5 Hazard Zones
- 6 Hazard Zones
- 7 Hazard Zones
- 8 Hazard Zones
- 9 Hazard Zones
- 10 Hazard Zones
- 11 Hazard Zones
- Areas Not Mapped

Percent Age 65 and Older

- 25.1% or more
- 15% to 25%
- 10.1% to 15%
- 5.1% to 10%
- 5% or less
- Unpopulated

https://go.usa.gov/xEqBe

Coastal Flood **Exposure Mapper**



Societal Exposure | Elderly

Storm Surge Scenarios

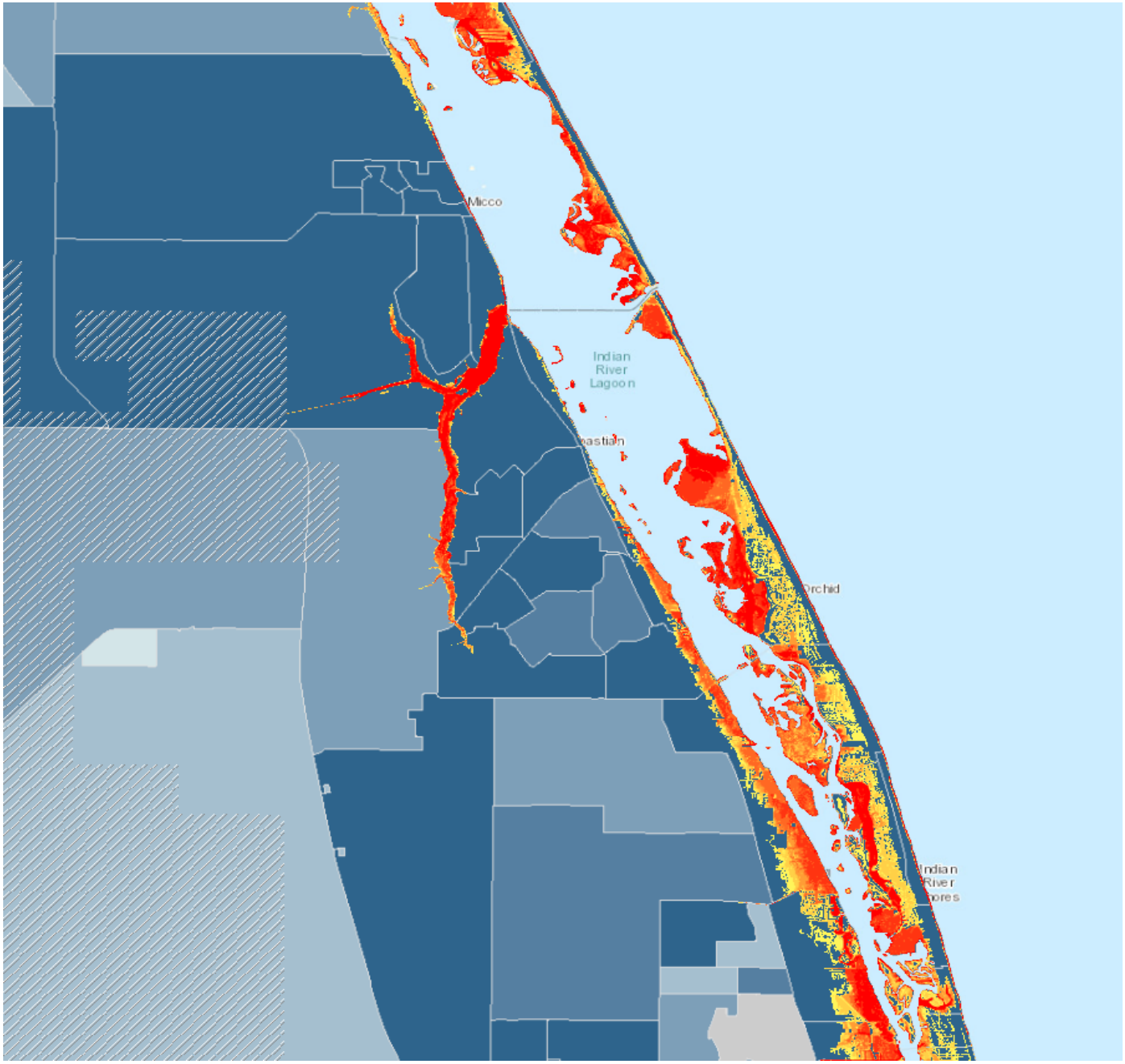
- Category 1
- Category 2
- Category 3
- Category 4
- Category 5
- Levee Areas - Consult Local Officials For Flood Risk
- Areas Not Mapped

Percent Age 65 and Older

- 25.1% or more
- 15% to 25%
- 10.1% to 15%
- 5.1% to 10%
- 5% or less
- Unpopulated

https://go.usa.gov/xEqBz

Coastal Flood **Exposure Mapper**



Societal Exposure | Elderly

Sea Level Rise Scenarios

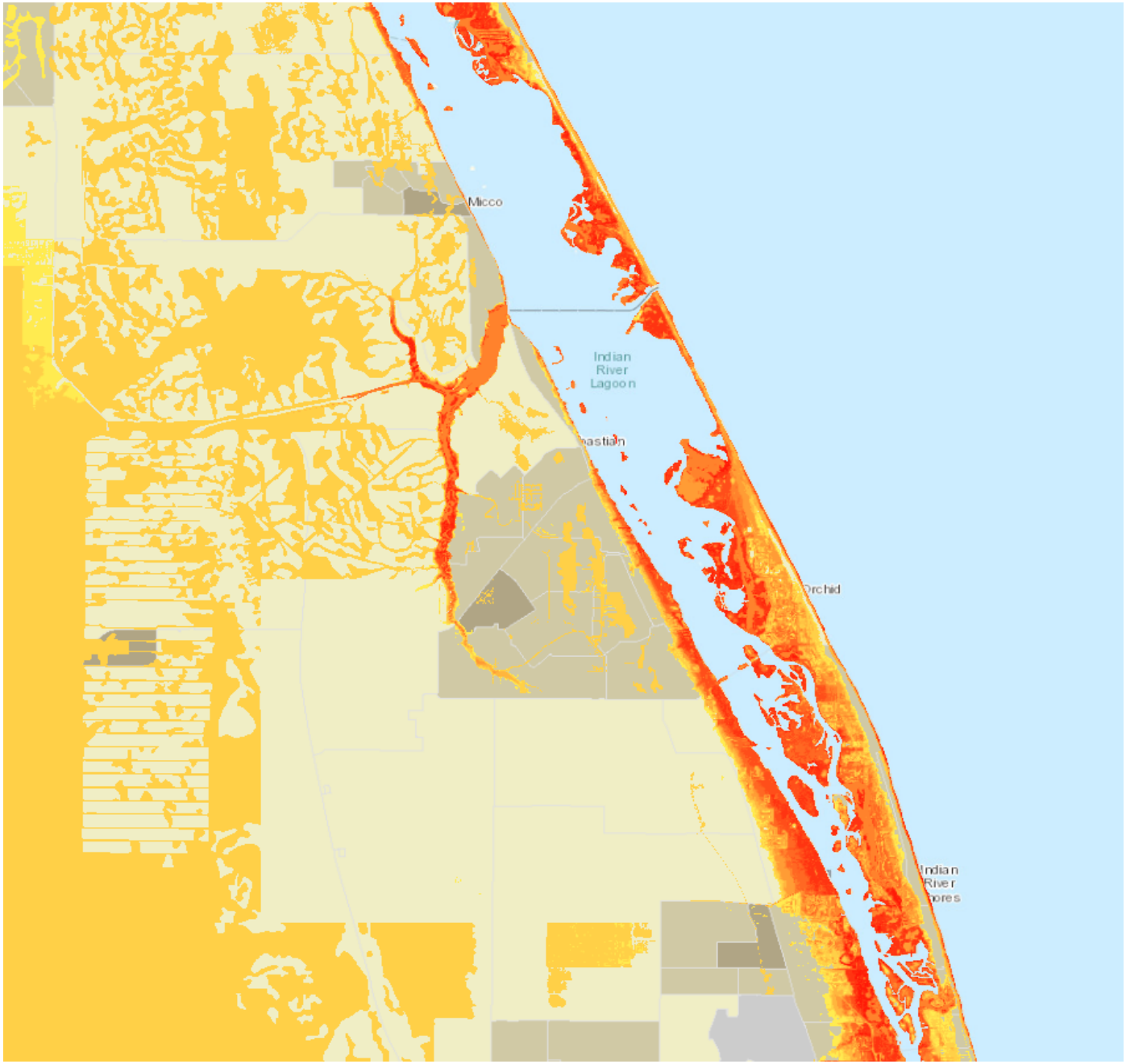
- 1 Ft Above Current MHHW
- 2 Ft Above Current MHHW
- 3 Ft Above Current MHHW
- 4 Ft Above Current MHHW
- 5 Ft Above Current MHHW
- 6 Ft Above Current MHHW
- Levee Areas - Consult Local Officials For Flood Risk
- Areas Not Mapped

Percent Age 65 and Older

- 25.1% or more
- 15% to 25%
- 10.1% to 15%
- 5.1% to 10%
- 5% or less
- Unpopulated

https://go.usa.gov/xEqBJ

Coastal Flood **Exposure Mapper**



Societal Exposure | Population Density

Flood Hazard Composite

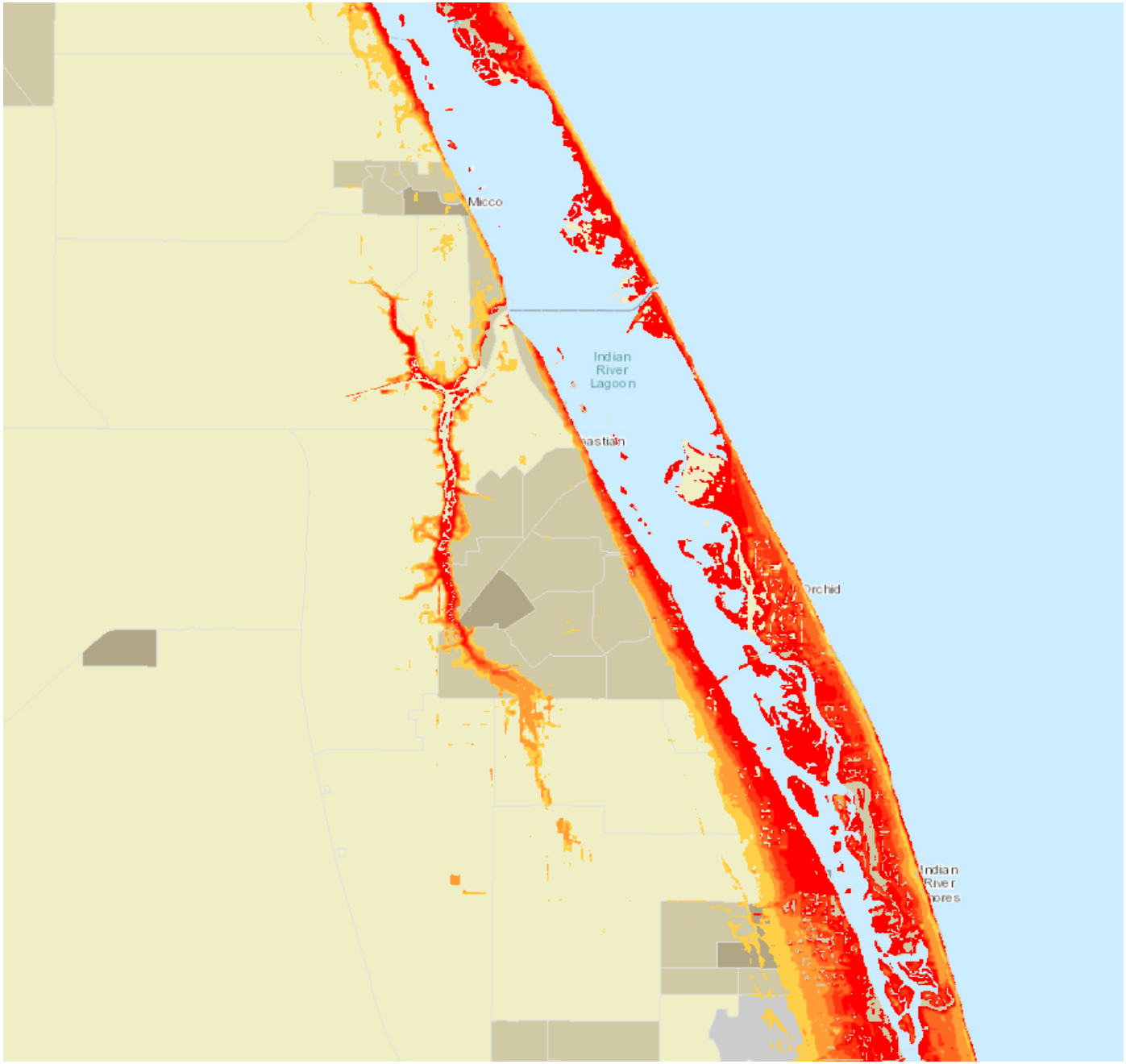
- 1 Hazard Zone
- 2 Hazard Zones
- 3 Hazard Zones
- 4 Hazard Zones
- 5 Hazard Zones
- 6 Hazard Zones
- 7 Hazard Zones
- 8 Hazard Zones
- 9 Hazard Zones
- 10 Hazard Zones
- 11 Hazard Zones
- Areas Not Mapped

People per Square Mile

- 45,001 or more people
- 15,001 to 45,000 people
- 7,501 to 15,000 people
- 2,501 to 7,500 people
- 501 to 2,500 people
- 500 people or less
- Unpopulated

View Online

Coastal Flood **Exposure Mapper**



Societal Exposure | Population Density

Storm Surge Scenarios

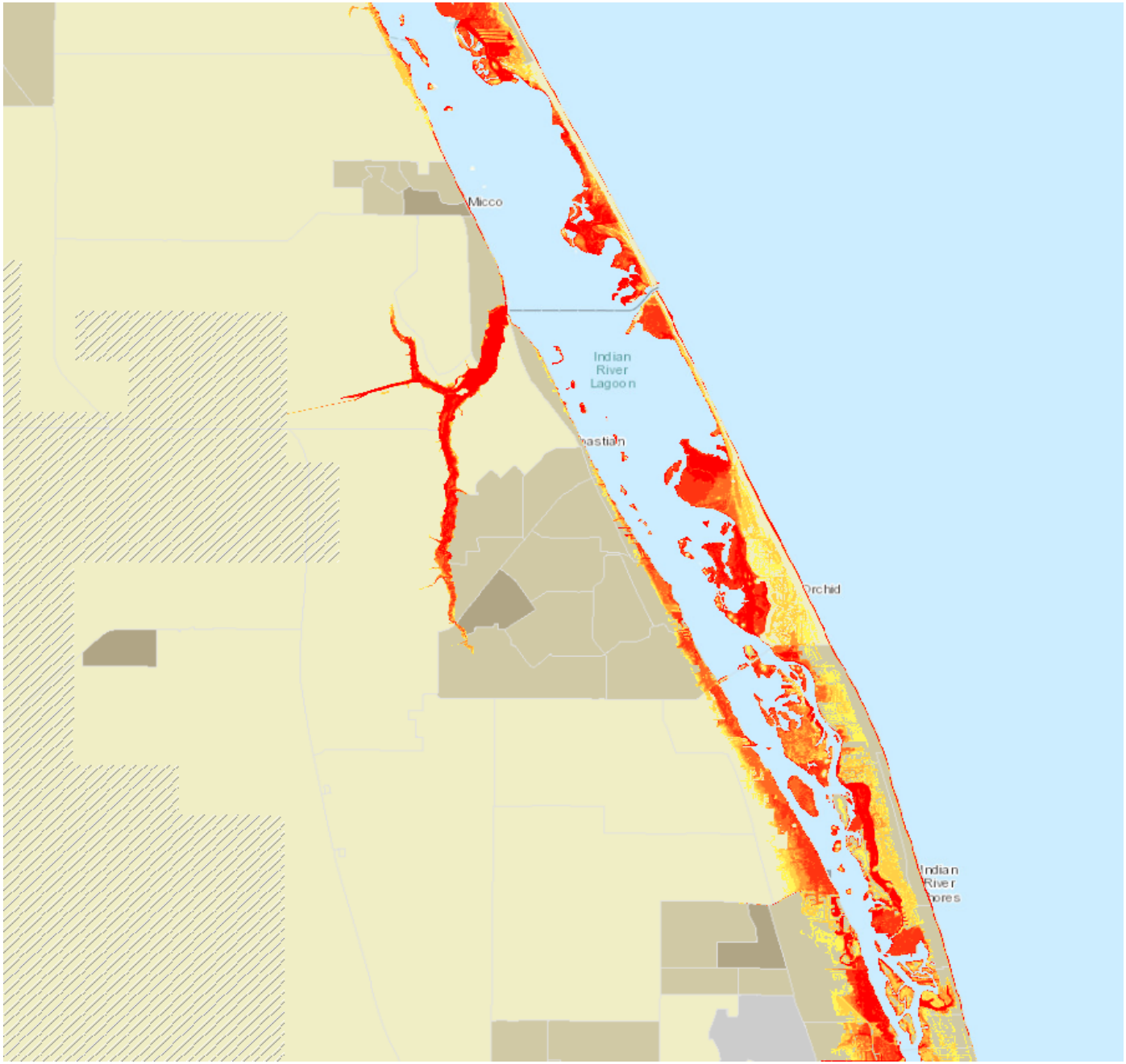
- Category 1
- Category 2
- Category 3
- Category 4
- Category 5
- Levee Areas - Consult Local Officials For Flood Risk
- Areas Not Mapped

People per Square Mile

- 45,001 or more people
- 15,001 to 45,000 people
- 7,501 to 15,000 people
- 2,501 to 7,500 people
- 501 to 2,500 people
- 500 people or less
- Unpopulated

https://go.usa.gov/xEqBt

Coastal Flood **Exposure Mapper**



Societal Exposure | Population Density

Sea Level Rise Scenarios

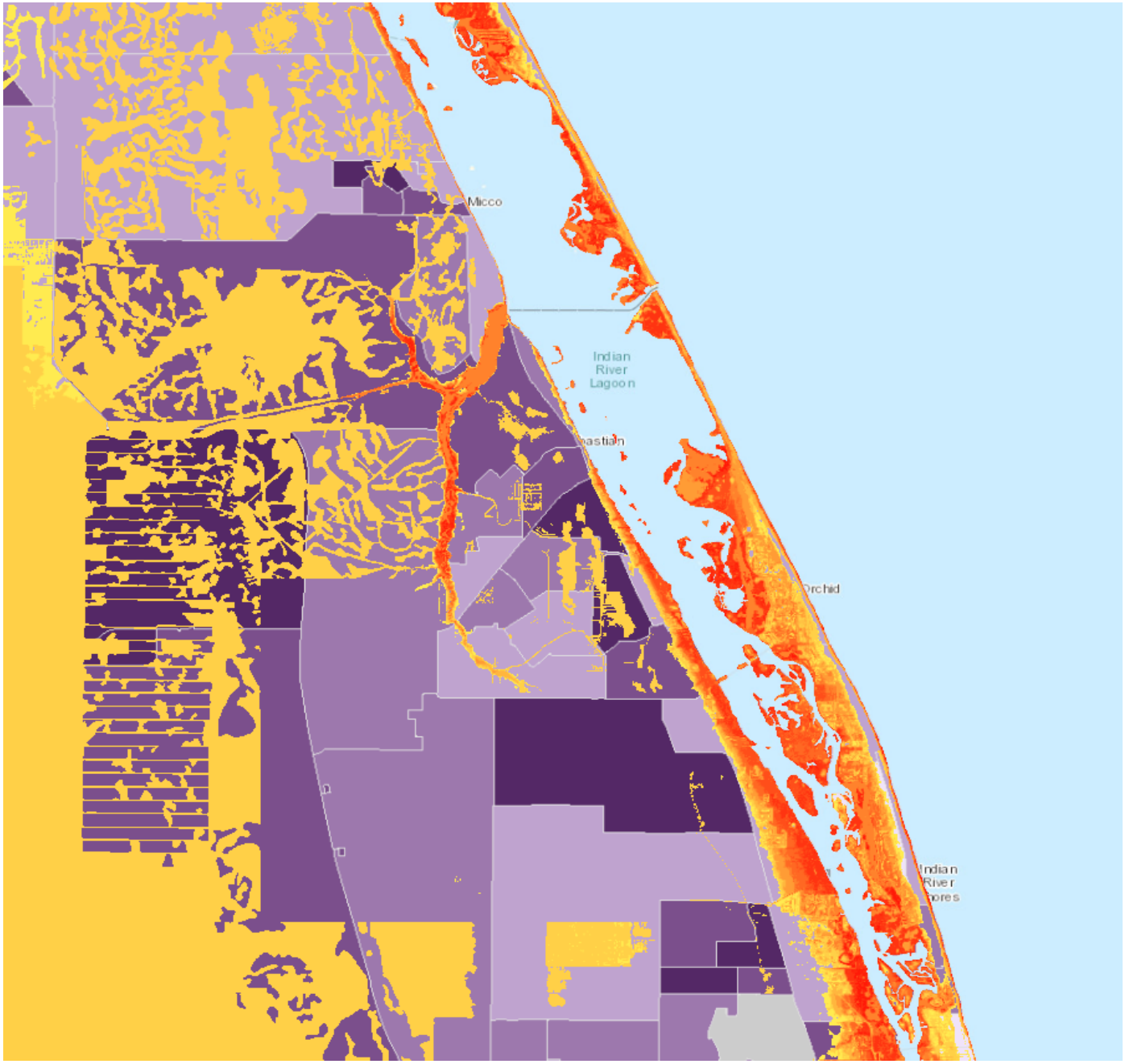
- 1 Ft Above Current MHHW
- 2 Ft Above Current MHHW
- 3 Ft Above Current MHHW
- 4 Ft Above Current MHHW
- 5 Ft Above Current MHHW
- 6 Ft Above Current MHHW
- Levee Areas - Consult Local Officials For Flood Risk
- Areas Not Mapped

People per Square Mile

- 45,001 or more people
- 15,001 to 45,000 people
- 7,501 to 15,000 people
- 2,501 to 7,500 people
- 501 to 2,500 people
- 500 people or less
- Unpopulated

https://go.usa.gov/xEqBu

Coastal Flood **Exposure Mapper**



Societal Exposure | Poverty

Flood Hazard Composite

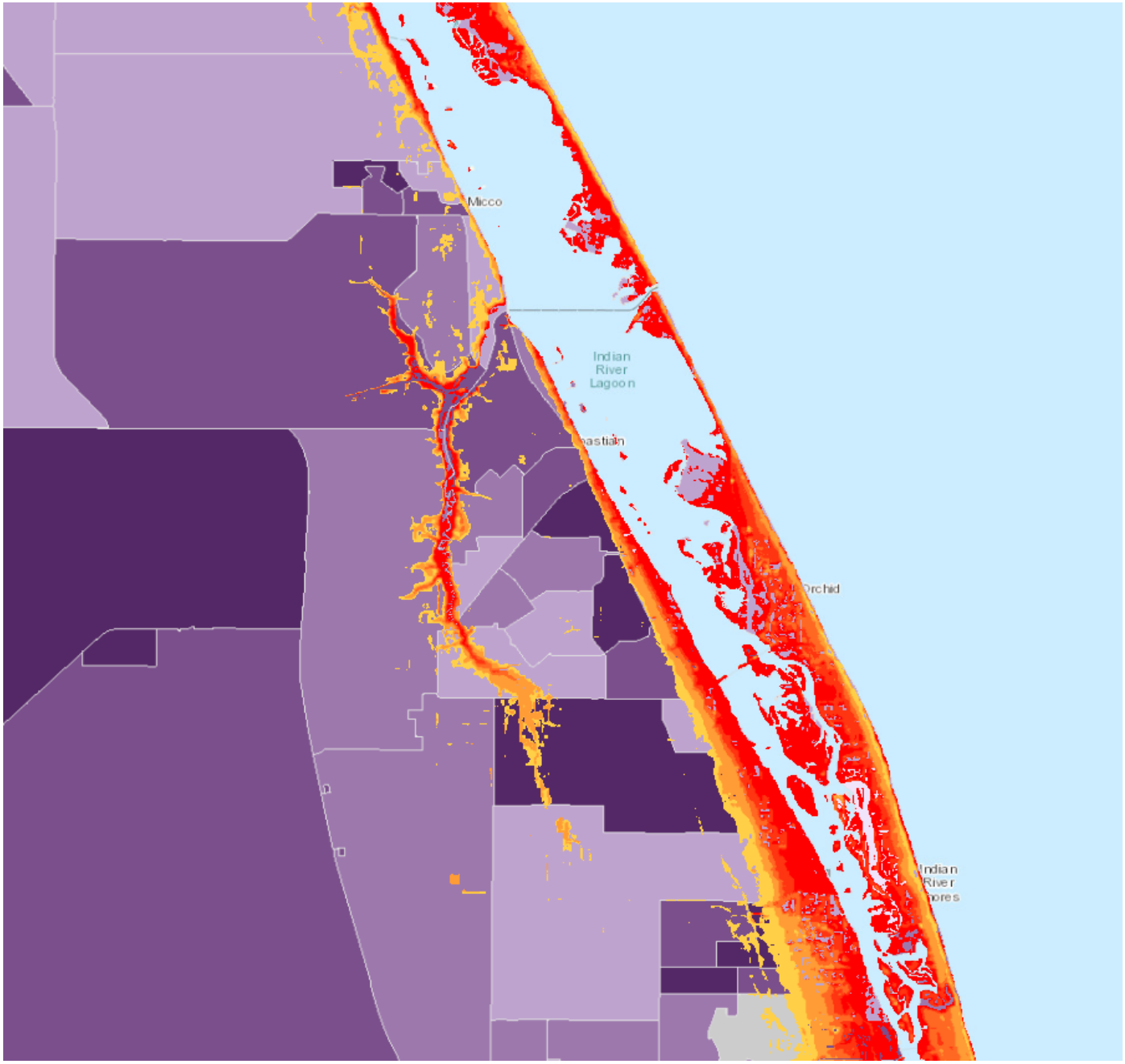
- 1 Hazard Zone
- 2 Hazard Zones
- 3 Hazard Zones
- 4 Hazard Zones
- 5 Hazard Zones
- 6 Hazard Zones
- 7 Hazard Zones
- 8 Hazard Zones
- 9 Hazard Zones
- 10 Hazard Zones
- 11 Hazard Zones
- Areas Not Mapped

Percent Living Below Poverty Line

- 25.1% or more
- 15.1% to 25%
- 10.1% to 15%
- 2.1% to 10%
- 2% or less
- Unpopulated
- No Data

https://go.usa.gov/xEqBM

Coastal Flood **Exposure Mapper**



Societal Exposure | Poverty

Storm Surge Scenarios

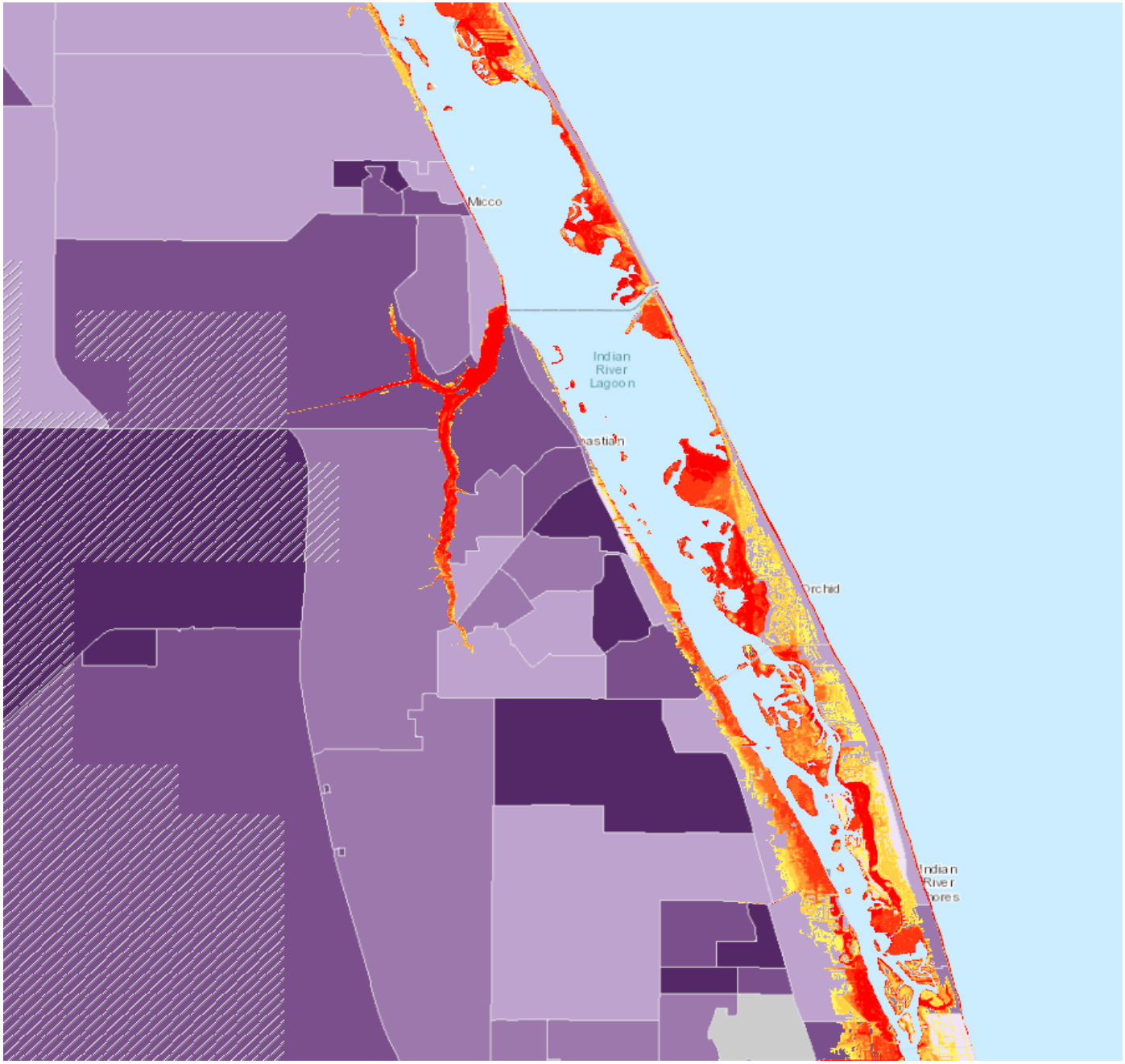
- Category 1
- Category 2
- Category 3
- Category 4
- Category 5
- Levee Areas - Consult Local Officials For Flood Risk
- Areas Not Mapped

Percent Living Below Poverty Line

- 25.1% or more
- 15.1% to 25%
- 10.1% to 15%
- 2.1% to 10%
- 2% or less
- Unpopulated
- No Data

View Online

Coastal Flood **Exposure Mapper**



Societal Exposure | Poverty

Sea Level Rise Scenarios

- 1 Ft Above Current MHHW
- 2 Ft Above Current MHHW
- 3 Ft Above Current MHHW
- 4 Ft Above Current MHHW
- 5 Ft Above Current MHHW
- 6 Ft Above Current MHHW
- Levee Areas - Consult Local Officials For Flood Risk
- Areas Not Mapped

Percent Living Below Poverty Line

- 25.1% or more
- 15.1% to 25%
- 10.1% to 15%
- 2.1% to 10%
- 2% or less
- Unpopulated
- No Data

View Online

Coastal Flood **Exposure Mapper**