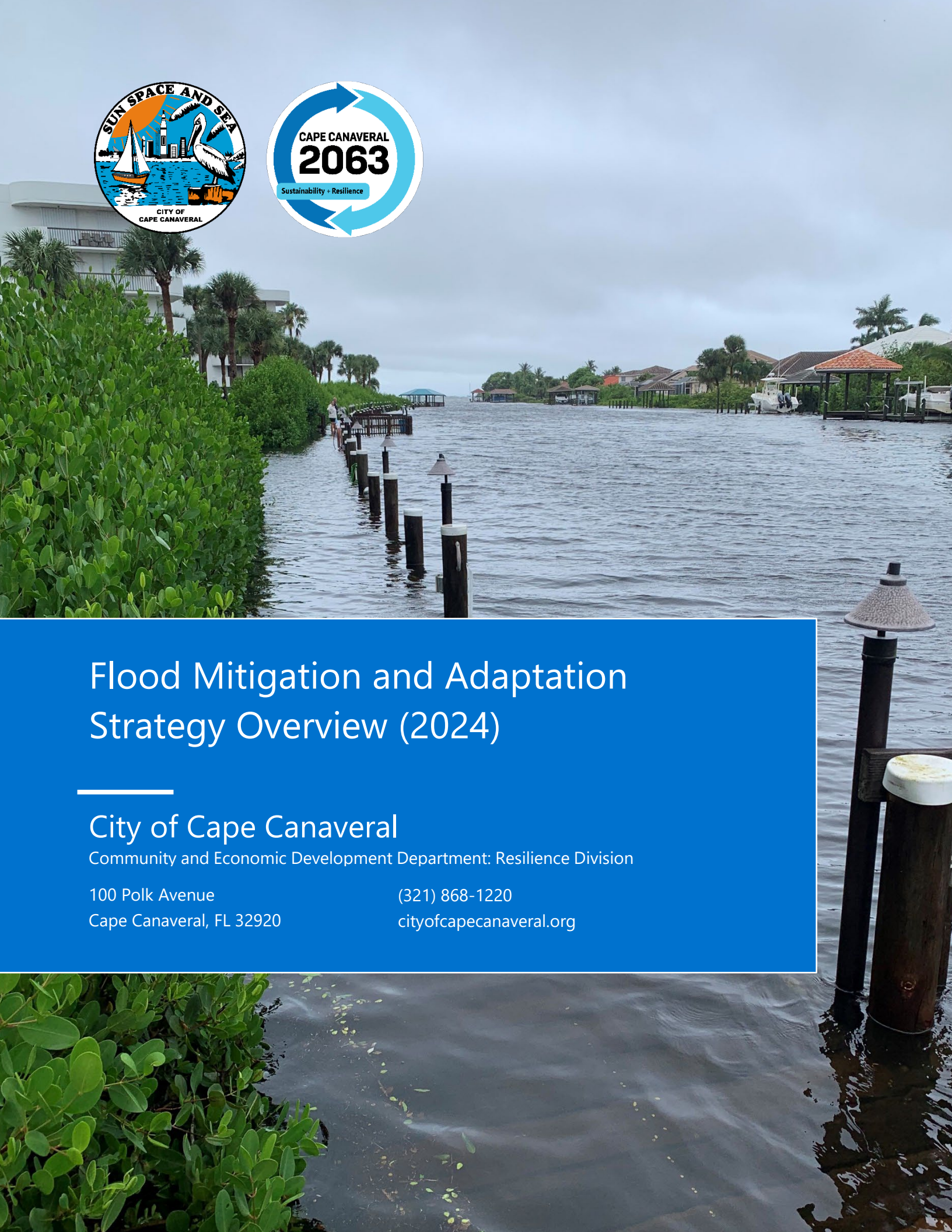

Flood Mitigation and Adaptation Strategy Overview (2024)

City of Cape Canaveral

Community and Economic Development Department: Resilience Division

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Executive Summary

As a barrier island community, the City of Cape Canaveral (City) faces numerous climate-related vulnerabilities, one of the most prominent and long-term being sea level rise. Sea level rise is caused primarily by two factors related to increasing global temperatures: melting terrestrial ice sheets and glaciers, and thermally expanding seawater. Across the United States (US), coastal cities are enacting forward-thinking policies, hardening infrastructure, and moving critical assets in order to deal with these rising tides. Inaction on this matter can lead to economic losses, property damage, and a loss of tax base.

Today, City Staff are developing short and long-term solutions to mitigate and adapt to sea level rise, as well as other flood threats such as storm surge and extreme rainfall events. Scientific observations point to an ever-accelerating rate of rise across the world's oceans over the next century. This will pose many complex social, economic, and environmental challenges to the City and the central Florida region. Acting together with local partners via a coordinated plan is key to the long-term livability and safety of the community.

This overview is intended to help highlight several of the City's most prominent strategies designed to mitigate the effects of sea level rise over the next two decades, per the 2021 Resiliency Action Plan. This report is broken down into three specific sections as related to flood mitigation and adaptation strategies for ease of reference:

1. Sea Level Rise Monitoring
2. Policy Updates
3. Infrastructure Upgrades

Projects statuses are defined as complete, in active development, design, construction, or conceptual at this time. This is a living document that will be updated annually as new information, data sets, and projects come about. For questions, please contact the City's Resilience Division at resiliencedivision@cityofcapecanaveral.org.

Figure 1. Banana River Park public dock in the aftermath of Hurricane Ian in 2022.

Sea Level Rise Background

According to data from the National Oceanic and Atmospheric Administration (NOAA), on average, global sea levels have risen 8-9 inches (21-24 centimeters) since 1880. In 2023, the National Aeronautics and Space Administration (NASA) released satellite data indicating that the average global sea level rose by 0.11 inches (0.27 centimeters) between 2021 and 2022. This is the equivalent of adding water from one million Olympic-size swimming pools to the ocean every day for a year. Since satellites began observing sea surface height in 1993, the average global sea level has risen by 3.89 inches (9.9 centimeters). The annual rate of rise – or how quickly sea level rise is happening – researchers expect to see has also increased from 0.08 inches (0.20 centimeters) per year in 1993 to 0.17 inches (0.44 centimeters) per year in 2022. Based on long-term satellite measurements, the projected rate of sea level rise will hit 0.26 inches (0.66 centimeters) per year by 2050.

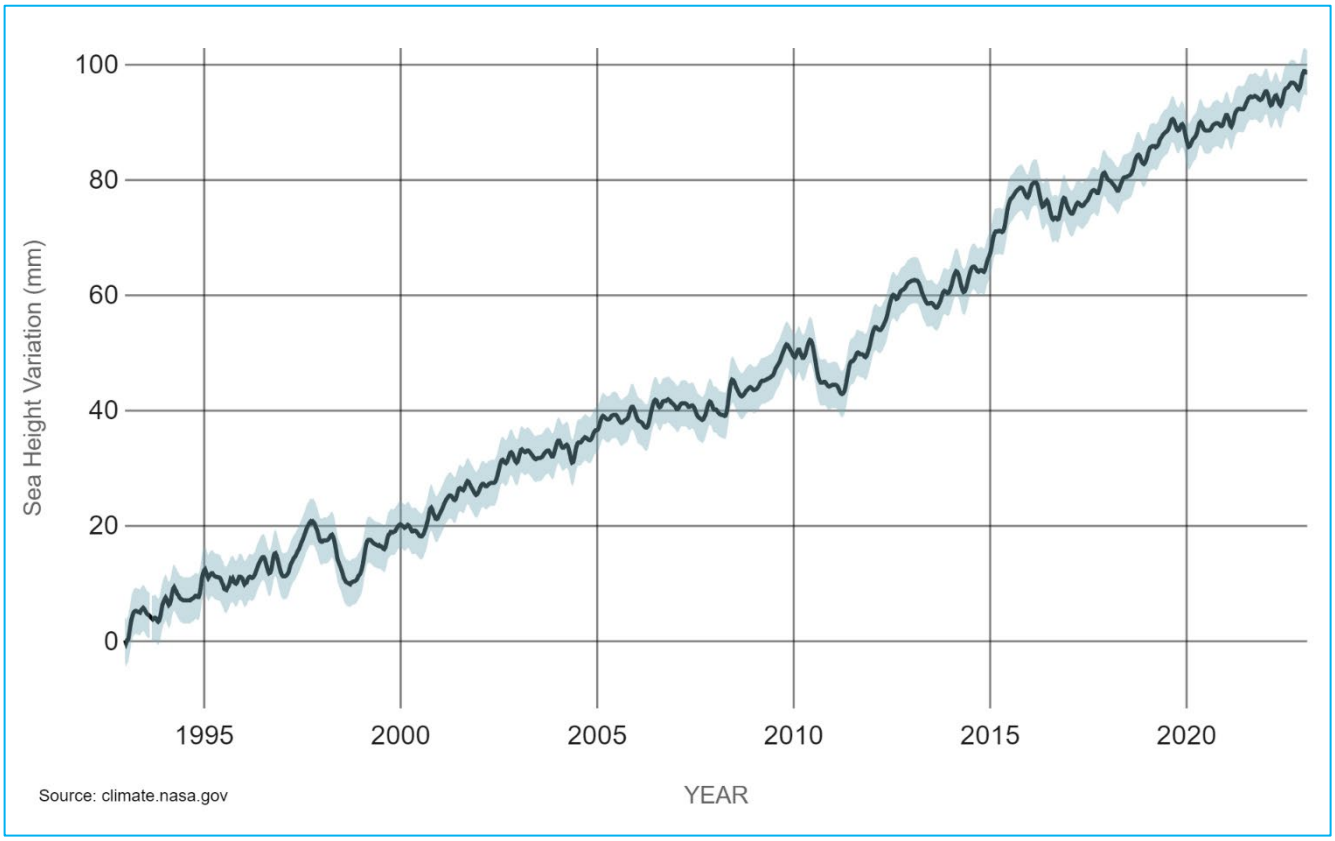
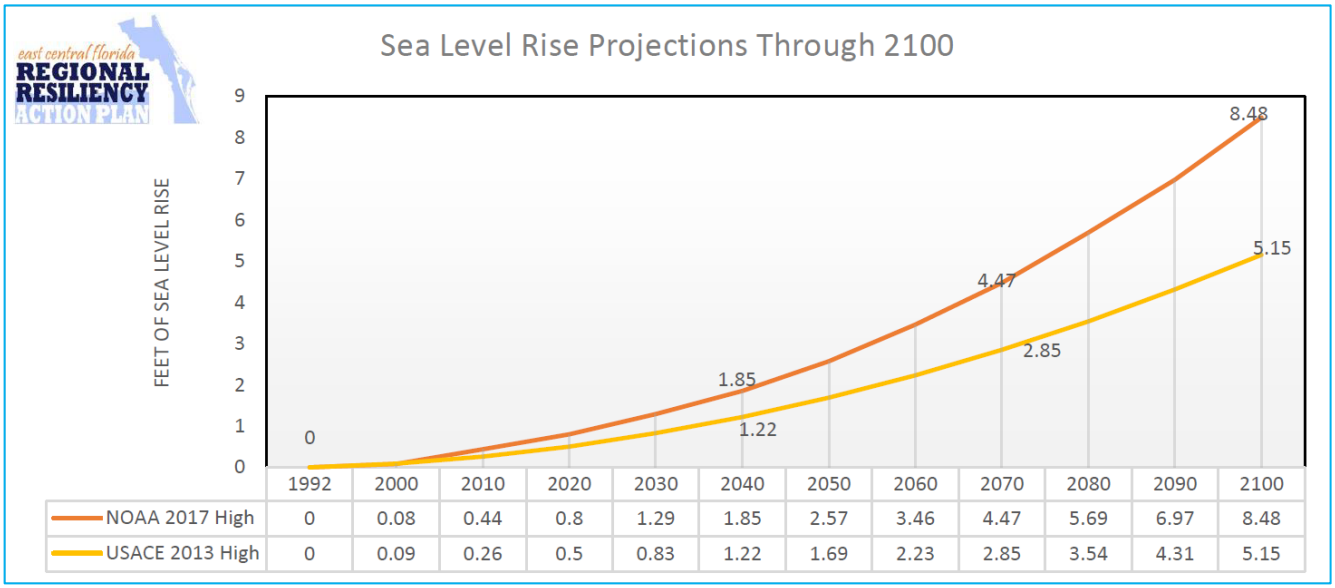


Figure 2. Global average sea level rise satellite-derived data observed between 1993 to present. Credit: NASA's Goddard Space Flight Center.

This rise in sea levels is exacerbating the risk of flooding to coastal communities such as Cape Canaveral: a barrier island community situated between the Atlantic Ocean and the Banana River Lagoon (BRL), part of the Indian River Lagoon (IRL) estuary. Short and long-term impacts of sea level rise that are compounding community risks include the potential for higher tropical cyclone-related storm surges, increased shoreline erosion, and the reduced drainage capacity of municipal stormwater systems. Scientific analysis conducted via the City's 2019 Vulnerability Assessment - a report that was prepared for the City, the Florida Department of Environmental Protection (FDEP), and NOAA by the East Central Florida Regional Planning Council (ECFRPC) - indicates that the City's greatest sea level rise-related impacts will be experienced along its western BRL-adjacent properties. A north-south oriented beachside dune ridge causes nearly all of the City's stormwater to flow and drain westward into the BRL, accentuating flood concerns in association with this watershed.

Prolonged periods of inundation are expected as early as the 2030s in several low-lying lagoon-adjacent areas, according to sea level rise projection curves from both the US Army Corps of Engineers (USACE) and NOAA. Timeframes analyzed within the Vulnerability Assessment include 2040, 2070, and 2100. Between the USACE's and NOAA's projection curves, it is estimated that the City could experience between 5.15 and 8.48 feet of sea level rise by the end of the twenty-first century.



	1992	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
NOAA 2017 High	0	0.08	0.44	0.8	1.29	1.85	2.57	3.46	4.47	5.69	6.97	8.48
USACE 2013 High	0	0.09	0.26	0.5	0.83	1.22	1.69	2.23	2.85	3.54	4.31	5.15

Figure 3. Sea level rise data as seen in the City's 2019 Vulnerability Assessment based on USACE (yellow) and NOAA (orange) projections.

However, analysis indicates that the City is likely already experiencing the impacts of sea level rise in the form of the municipal stormwater system's reduced drainage capacity due to lagoon outfall inundation and heightened groundwater elevations. This is due to a significant rise in the lagoon's average water levels in conjunction with sea level rise observed in the hydrologically connected Atlantic Ocean through the twentieth and into the early twenty-first century. It is important to note that sea levels can vary from region to region across the planet, as can rates of rise. Sea level rise planning should account for the global average as a baseline, but should also mirror a region's specific observed rate. In the case of Florida's east coast, the rate of sea level rise is higher than the global average.

A research team from the Stetson University Institute for Water and Environmental Resilience (IWER) assisted City Staff in measuring local water level data to showcase sea level rise in the Atlantic Ocean, collected by the NOAA operated Trident Pier tide gauge in Port Canaveral. Trident Pier's tide gauge was brought online in 1994. Data analysis from the gauge showed a trend of approximately 0.23 inches of rise per year (0.0193 feet per year; 5.8 millimeters per year), more than three times the twentieth century average extrapolated from global tide gauge records. When compared to the 1992 local mean sea level, Trident Pier data showed an average approximate rise of 0.5 feet, which is in line with the Vulnerability Assessment's NOAA projection curve. Historical sea level rise data was also reviewed by the research team at a NOAA tide gauge in Daytona Beach Shores, with a published trend equivalent to 0.091 inches per year (0.0076 feet per year), or approximately 9.1 inches over 100 years.

Within the BRL itself, the Stetson University researchers observed an average water level rise consistent with the nearby Atlantic at Trident Pier. Using available historical information derived from VDatum and nearby lagoon-based tide gauges, roughly 4.4-inch rise within the Brevard County section of the estuary between 1992-2013 has been observed. Extrapolating this trend outwards to 2022 increases the rise to 6.2 inches. An independent analysis conducted by researchers at the FDEP – working in conjunction with the City of Cocoa Beach (immediately south of Cape Canaveral) – indicates an average local water level rise in the BRL of about 2.64 inches in a 5-year period between 2017-2021 using data from a tide gauge located at the Cocoa Beach Public Works Department dock.

Figure 4. Street flooding on Fillmore Ave during a non-tropical heavy rain event.

This recorded water level rise within the BRL represents a clear and persistent challenge to City residents, infrastructure, and critical operations. Much of the City's stormwater infrastructure was designed and implemented predominantly between 1950 and 1980, when water levels were lower and less development was present. Observations by City Staff have shown that many of the municipal stormwater lagoon outfalls are regularly partially or fully inundated, and standing water can be present throughout the stormwater system even during "dry" atmospheric conditions. Today, these challenges necessitate an expansion of stormwater system capacity and the need for an ability to evacuate stormwater at faster rates to prevent flooding, as well as additional flood mitigation and adaptation measures to increase overall infrastructure readiness and resilience.

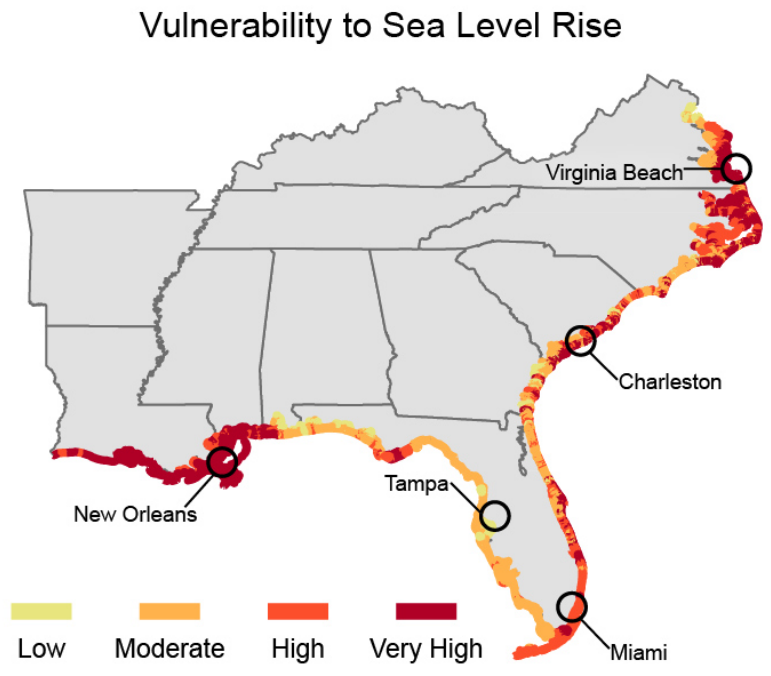


Figure 5. Map depicting sea level rise vulnerability along the US southeast coastline. Source: US Global Change Research Program

Appendix 1 shows USACE and NOAA sea level rise projection maps within the City's boundaries in more detail. These projections can also be viewed in the City's 2019 Vulnerability Assessment.

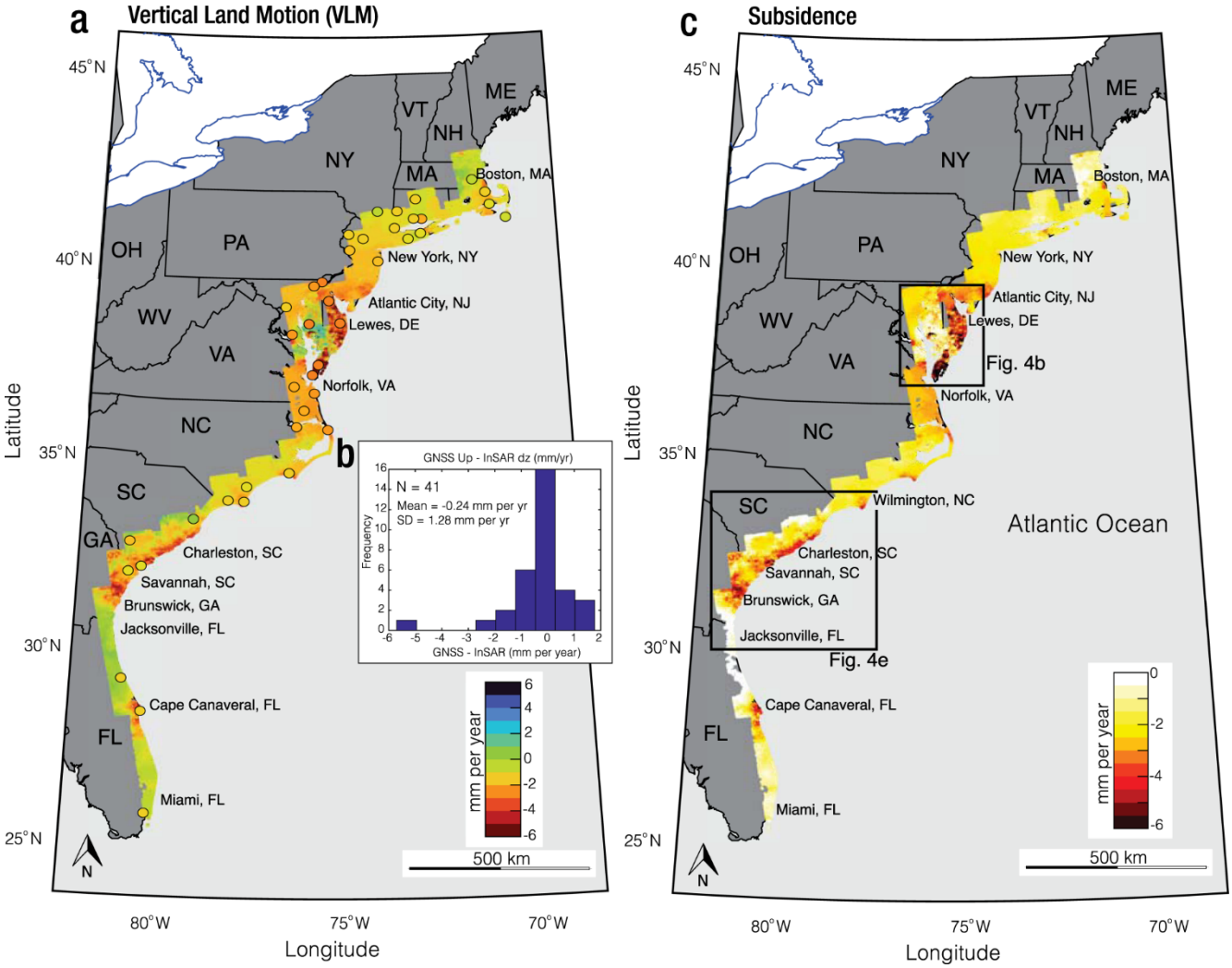


Figure 6. Geological data indicating ground subsidence along the US east coast.

Recent geological data also indicates that ground subsidence (i.e., sinking) is actively occurring along the east coast of the US and the Gulf of Mexico. Research published in the journal *Nature Communications* in April 2023 found that the Atlantic Coast is sinking by several millimeters per year on average. This phenomenon, observed directly by satellite instrumentation, has been mainly attributed to the pumping of groundwater. Once groundwater is removed, the ground above can sink as void space opens up. The full study can be found here: Hidden Vulnerability of US Atlantic Coast to Sea-Level Rise due to Vertical Land Motion.

The City's large amount of impervious surfaces, or surfaces such as asphalt and concrete that do not allow rainwater (i.e., stormwater) to drain into the soil, is an additional stressor causing urban flooding. LIDAR analysis by Stetson University's IWER indicate that some blocks of the City are nearly 80% paved, severely reducing the area in which stormwater can flow into the ground. This forces more runoff into the underground stormwater system, causing it to reach capacity more quickly and thereby reducing its efficiency to drain out of streets in a timely manner.

Sea Level Rise Monitoring

One of the first steps in sea level rise mitigation and adaptation is having reliable and consistent local monitoring. While many useful data sets exist that track sea level rise at regional and global scales, few exist at hyper-local levels for municipalities like Cape Canaveral. In 2020, City Staff began work with Stetson University's IWER and Florida Atlantic University (FAU) to install remote sensor sites across the community to better capture and analyze long-term weather and climate-related data in real-time, including water levels within the BRL.

To date, Staff have overseen the installation of seven individual remote sensor sites at the following locations:

1. City of Cape Canaveral Community Center (C5) rooftop
    - Weather station – FAU owned/operated
2. Cape Canaveral City Hall rooftop
    - Weather station – City owned/operated
3. Center Street Park stormwater outfall
    - Water level gauge – Stetson University owned/operated
4. Water Reclamation Facility
    - Weather station – City owned/operated
5. Canaveral Ditch
    - Water level gauge – Stetson University owned/operated
6. Veterans Memorial Park
    a. Weather station – FAU owned/operated
7. Banana River Park public dock
    - Weather station/water level gauge – FAU owned/operated

Figure 7. C5 weather station being installed by an FAU student.

Data from each of these remote sensor sites is publicly accessible via the internet or by request. Researchers and City Staff utilize the nearby Trident Pier NOAA tide gauge's (Station ID: 8721604) publicly accessible readings to determine sea level rise beachside in the Atlantic Ocean.

Every piece of data obtained can lead to valuable insights into improving new municipal construction, creating relevant policy updates, and providing accurate information to residents. Even small changes in sea levels can have major impacts. For example, a general average used in regards to sea level rise and its impact on beach erosion holds that for every inch of sea level rise observed, 100 inches of beach is lost without remediation.

Policy Updates

Staff continues to develop several policy updates intended to help the City mitigate and adapt to sea level rise. Several of the most high-profile, policy-related initiatives are outlined below.

2019 Vulnerability Assessment and 2023 Update:

In early 2023, the City was awarded a $225,000 grant from the FDEP to update its 2019 Vulnerability Assessment. This will be a critically important endeavor – which will be done in conjunction with the ECFRPC – as it will allow Staff to update storm surge and sea level rise projections, evaluate the latest in resilience strategies, better determine best management practices in terms of climate-readiness, and provide eligibility for new state funding opportunities that the City previously would not have had access to.

This grant comes as part of a larger announcement made on February 13, 2023, in which the FDEP awarded over $28 million to develop and update county and municipal comprehensive vulnerability assessments across the state due to increasing instances of flooding and ongoing sea level rise. According to the FDEP, the 128 planning grants will result in 222 total local government vulnerability assessments. Communities with updated vulnerability assessments will be eligible for future iterations of the Statewide Flooding and Sea Level Rise Resilience Plan, which proposes funding for resilience and adaptation projects across the state on a ranked basis.

Cape Canaveral was one of the first municipalities in Brevard County to complete a vulnerability assessment in response to climate-related challenges. Staff, alongside the ECFRPC, completed the first iteration of the City's vulnerability assessment in August 2019 when its results were unanimously accepted by City Councilmembers. The report employs several models developed by the USACE and NOAA to project sea level rise scenarios and respective impacts on the City out to 2040, 2070, and 2100. Models considered vulnerabilities from the effect of sea level rise on storm surge, shallow coastal flooding, the 100-year floodplain, and the 500-year floodplain. Current federal and state data sets and requirements have necessitated assessments to incorporate updated forecast models, information, and resilience planning techniques.

2021 Resiliency Action Plan:

The City's 2019 Vulnerability Assessment directly led to the writing and adoption of its Resiliency Action Plan in June 2021, which details 56 actionable items (called Preparedness Targets) planned across a 30-year timeframe that are broken into "current" or "ongoing" implementation periods: 5 years (2025); 15 years (2035); and 30 years (2050). The Preparedness Targets are organized into eight (8) Action Categories, including one specifically meant to address sea level rise and flooding. Targets in this section are:

- Preparedness Target #50:
  - Build at least three (3) new stormwater parks where appropriate and necessary to manage flooding and continue to implement subterranean exfiltration systems as needed for increased storage capacity. (15)
- Preparedness Target #51:

        - Pursue a partnership with Brevard County to build a stormwater park with associated amenities such a perimeter walking trail, benches and water fountains at Cherie Down Park after conveyance of ownership. (15)
    - Preparedness Target #52:
        - Implement appropriate semi-permanent flood defenses at City facilities for protecting open access points such as doorways and garage doors to replace sandbags. (15)
    - Preparedness Target #53:
        - Dredge and strengthen the Central/Canaveral Ditch to improve erosion control and increase capacity while creating shoreline stabilization and improved stormwater management. (30)
    - Preparedness Target #54:
        - Work with FDOT and the SCTPO to redevelop SR A1A in order to reduce flood risks posed by minimum SLR projections (USACE 5.15 feet by 2100) depicted in the City's Vulnerability Assessment. (30)
    - Preparedness Target #55:
        - Research and implement climate-resilient engineering solutions such as wave attenuation devices, sea walls and berms in conjunction with green infrastructure around the perimeter of the City's Water Reclamation Facility. (30)
    - Preparedness Target #56:
        - Complete a City-wide stormwater outfall sea level rise threat assessment and explore solutions that reduce the threat of flooding due to storm surge events and sea level rise that could cause stormwater backups. (30)

The document and its Preparedness Targets will be reviewed every five years by Staff to ensure plan compliance and measure success.

2024 Comprehensive Plan Updates:

Staff is currently undertaking a complete review and revision of the City's Comprehensive Plan (comp plan). Of particular interest is the comp plan's Coastal Management and Future Land Use Elements and the addition of "Peril of Flood" language, which must be integrated, completed, and approved by 2024 per state regulations (Senate Bill 1094). Draft changes to the aforementioned elements will be provided to the City's Planning and Zoning Board for comment prior to final review by Council. Upon adoption by Council, Staff will submit the updates to the Florida Department of Economic Opportunity.

The City's Comprehensive Plan is an all-encompassing document that dictates policy direction. State-mandated Peril of Flood language calls for Florida municipalities to become more resilient to short and long-term flood issues such as tropical cyclones and sea level rise. One such directive is that cities must establish Adaptation Action Areas (AAA). AAAs are regions within a municipality deemed of particular concern in regards to flooding. Per the mandatory Peril of Flood language in the comp plan, sites within AAAs may be required to implement increased mitigation and protective measures against flooding for all new development and redevelopment. Currently, the proposed AAA – internally referred to as an Enhanced Resilience Area (ERA) – is set within the northwest section of the City, shown in Appendix 2, and was selected due to its high socioeconomic output, immediate vulnerability to storm surge from low hurricane categories, flood potential surrounding SR A1A, poor soil conditions, and long-term vulnerability to even minimal sea level rise.

Additional relevant policies being researched and reviewed include the integration of low impact development (LID) and green stormwater infrastructure (GSI) practices, increased base flood elevations for new structures, and the expanded use of permeable pavement.

Figure 8. Street flooding at the intersection of Poinsetta Ave. and Tyler Ave. after a non-tropical heavy rain event.

Infrastructure Updates

To date, the City has implemented a series of high-level infrastructure projects that mitigate the effects of current and future flood-related events. This list is not comprehensive, and showcases the more expansive and impactful projects that build resilience and adaptability, and contribute to general quality of life in the community. Staff will review and evaluate this project list each year, and provide updates as needed with each annual release of this report.

1) Thurm Blvd. Improvements
Project Status: Design
Project Construction Start Date: Sometime in 2024
Estimated Project Completion Date: 2025
Project Intent: Flood mitigation and adaptation, pedestrian safety, stormwater runoff treatment, critical facility accessibility

Thurm Blvd. is a highly flood prone two-lane roadway that runs through the northwest quadrant of the City, providing the only access to the City's Wastewater Reclaim Facility (WRF), a municipal park, and residential developments.

The project proposes to transform Thurm into a streetscape, offering improved multi-modal enhancements and stormwater management, including 8-foot wide pedways and 6-foot-wide sidewalks, pedestrian benches, repaving, curb and gutter, striped bicycle lanes, solar-powered LED roadway lighting, and Florida-native vegetation "islands".

2) Long Point Preserve

Project Status: Conceptual

Project Construction Start Date: TBD

Estimated Project Completion Date: TBD

Project Intent: Flood mitigation and adaptation, storm surge protection, habitat preservation and expansion

The area known as "Long Point" is a 7.88-acre City-owned, lagoon-front conservation property located off Long Point Rd. In 2019, the City restored a number of vegetative areas on the property, which is extremely low lying and has mosquito canals. According to various storm surge and sea level rise projections, Long Point is one of the most vulnerable parcels of land within the City in regards to flooding. The property was set to host an elevated board walk and kayak dock as part of the Long Point Park project, with an awarded FIND Waterways Assistance Program grant of $327,400 (50/50 match); these plans were however removed from the City's budget by Council in 2022.

It is recommended that Long Point remain an undeveloped parcel and be reclassified as Long Point Preserve. The thick vegetative buffer currently mitigates storm surge and wave energy for surrounding residential areas, a valuable ecosystem service that will only continue to grow. Future project concepts may be explored when funding is available if deemed appropriate and feasible.

Figure 9. The proposed Long Point Preserve highlighted in red.

3) Shoreline Improvements

Project Status: Conceptual/Design

Project Construction Start Date: NA

Estimated Project Completion Date: 2026 – 2028

Project Intent: 2021 Resiliency Action Plan: Preparedness Target #55, flood mitigation and adaption, erosion control, protection of critical City infrastructure

Staff are currently investigating several areas along the City's BRL shoreline where long-term improvements can be made to reduce the impacts of storm surge, wave energy, and erosion. The City owns several thousand feet of shoreline, most of which consist of park lands. However, the City's highly critical WRF is also located adjacent to the BRL in a vulnerable geographic location that makes it susceptible to erosion and storm surge. This is due to the long fetch present at this particular location and the poor soil conditions on which the WRF was built in the 1960s. This vulnerability has been noted by both storm surge computer modeling and onsite observations from past storm events such as 2017's Hurricane Irma where sections of the shoreline collapsed into the lagoon. No critical infrastructure was lost and no sewage spills occurred due to these particular collapses because they happened in empty sections of the property.

Staff is investigating living shoreline concepts for the City's parks that would include the planting of Florida-native species such as red mangroves and sand cordgrasses, as well as wave attenuation devices– essentially in-water barriers designed to reduce wave energy. Banana River Park and Center Street Park suffered moderate erosion during 2022's Hurricane Ian, specifically in areas that were not vegetated. Living shorelines will serve to significantly reduce wave energy and could even help to recruit sediment to build out depleted sections of shoreline.

Since 2021, City Staff have been actively engaged with officials from the USACE as part of the agency's Section 14 Emergency Streambank Protection Program to one day see a comprehensive enhancement and hardening of the WRF's shoreline in order to better handle increasing instances of climate-related vulnerabilities. In early 2023, the WRF was officially placed on the USACE's national list of threatened shorelines host to critical infrastructure, allowing it to take part in the Section 14 Emergency Streambank Protection Program.

The first step of this program is for the USACE to conduct a survey of the WRF's existing shoreline and a subsequent design study recommending what can be done to harden its resilience. This survey and design work is expected to begin in FY 2023-2024. The USACE will pay for up to $100,000 in study/design costs; any expenditures after this point are split on a 50%-50% basis. The USACE indicated to City Staff that due to rising inflationary prices, the final study/design costs could reach $200,000. This informed Staff's decision to add a $50,000 budget contingency line item for this specific endeavor. Moving forward, Staff wants as complete of a picture as possible for what future enhancements can be made and the current extent of the shoreline's erosion issues. It is likely that proposed enhancements will involve some type of hybrid green/gray infrastructure design. This study/design is expected to be completed sometime in late 2024.

Should the City accept this survey and design work, the next phase of the project would involve construction. Funding for construction would be completed via a 65% (USACE)-35% (City) cost share, which would ultimately need to be budgeted and approved by Council. If allowed to commence, construction would be completed in 3 – 5 years according to the USACE. This is a far quicker pace then would be possible if the City were undertaking the project alone, as well as less expensive given the cost sharing.

Proper investment in the WRF's shoreline has been calculated to be less costly over the long-term when compared to the costs of infrastructure and socioeconomic damages incurred by a loss of the plant's services to the community. It is the single most important piece of infrastructure that the City owns, maintains, and operates.

Figure 10. The WRF's Oxidation Ditch is located adjacent to the BRL.

4) Wetland Buffer Zone

Project Status: NA

Project Construction Start Date: NA

Estimated Project Completion Date: NA

Project Intent: Flood mitigation and adaptation, storm surge protection, habitat preservation and expansion

A 19.30-acre area of wetlands resides in the City's extreme northwest corner between SR A1A and the BRL, maintained by the Canaveral Port Authority that is leased from the City that is set to expire in the early 2040s. This area is considered the second most vulnerable parcel in the City when it comes to flooding due to its low elevation. It is proposed that this parcel remain wholly undeveloped, continuing to serve as a vegetated buffer to protect SR A1A from storm surge and wave energy.

Figure 11. Wetland buffer zone.

5) Center Streets Pump Station/Tidal Valve

Project Status: Moving into Construction Phase
Project Construction Start Date: Q4 2023
Estimated Project Completion Date: Q3 2024
Project Intent: 2021 Resiliency Action Plan: Preparedness Target #56, flood mitigation and adaptation

In 2023, the City was awarded a $467,500 grant from the FDEP to help construct a permanent pump station to alleviate urban flooding; the first in the City's history. Since 2020, utilizing its newly established remote sensor network of weather stations and water level gauges, staff have observed six significant and disruptive flood events, particularly within an area of the City known as the Center Street Drainage Basin. This is a highly urbanized area of the community that is mostly residential and contains high amounts of impervious surfaces, leading to an increased strain on the capacity of underground stormwater infrastructure. This area's stormwater runoff drains to a single outfall on the BRL at the west end of Center Street Park. Today, this outfall is often partially or fully submerged within the lagoon, which can cause - especially during storm surge events from tropical cyclones - backflow and a subsequent reduction in the efficiency of stormwater flow out of the system.

To combat this, the City is set to implement two specific mitigation strategies to increase flow out of the existing stormwater system in the Center Street Drainage Basin and prevent backflow situations. The first measure will be the construction of a permanent diesel-powered pump station on Center Street that will, in emergency flood situations, automatically begin forcing excess runoff out of the drainage basin's stormwater system and safely into the lagoon. The second measure will see the installation of a tidal valve on the Center Street Drainage Basin's stormwater outfall that will close during emergency storm events to prevent lagoon water from back flowing into the stormwater system. The pump station will pump water around the closed tidal valve to keep flow moving efficiently. Once a severe flow situation has subsided, the tidal valve will reopen and the pump station will shut itself down. Since the pump is diesel-powered, it will be able to remain active even during power outage situations. It will only turn itself on during flood situations, remaining silent at all other times so as not to create excess noise. It will also be built within a sound attenuated enclosure.

The pump will have a targeted flow rate between 6,000 and 6,200 gallons per minute operated on an automatic level control system and connected to the City's lift station SCADA system for monitoring and operation.

Grant funding from the FDEP will specifically go towards the construction of the pump station, which will cover about half the cost of its construction. The grant's funding became available to the City on October 1, 2023, at which point the project will commenced. American Rescue Plan Act (ARPA) funding will supply the remaining project costs. As a whole, the project is expected to be completed in Summer 2024 and was a prominent recommendation made within a 2022 study of the Center Street Drainage Basin conducted by the engineering firm Mead & Hunt.

6) Center Street Stormwater Reserve

Project Status: Conceptual

Project Construction Start Date: NA

Estimated Project Completion Date: NA

Project Intent: 2021 Resiliency Action Plan: Preparedness Target #50, flood mitigation and adaptation, stormwater runoff treatment

Staff is continuously seeking to increase the stormwater holding capacity within the Center Street Drainage Basin where chronic flood issues exist. Retention ponds within the City have traditionally been difficult to build due to a lack of appropriate space. However, Staff have been working with a developer who has acquired property along the north and south sides of Center Street. This developer intends to build a mixed-use project. They have indicated that they do not have any plans for developing the property on the south side of the street, which today is a large parking area with nearly 100% impervious cover about one acre in size.

Staff and the developer have discussed the City's interest in the property to build a stormwater retention pond, which is at the end of the Center Street Drainage Basin's conveyance system. This pond could act as a reserve and hold additional stormwater, easing the strain on the Center Street Drainage Basin's system. The pond could also be used to treat stormwater before it enters into the BRL.

At the January 16, 2024, City Council meeting, Council unanimously approved Ordinance No. 10-2023 on its second and final reading, creating a Mixed-Use (MXU) Future Land Use Category in the City's Comprehensive Plan, which will ultimately allow this project to move forward upon completion of the appropriate approval process. Staff will apply for appropriate grants in order to fund the design and construction of the proposed stormwater retention pond.

Figure 12. Proposed stormwater retention pond on Center Street.

7) West Central Blvd. Improvements

Project Status: Complete
Project Construction Start Date: 2021
Project Completion Date: 2022
Project Intent: Flood mitigation and adaptation, pedestrian safety, stormwater runoff treatment

In 2022, construction was completed on the redevelopment of West Central Blvd. between SR A1A and the intersection of Thurm Blvd. and Puerto Del Rio Dr. Prior to the project, West Central Blvd. chronically flooded during heavy rain events. Improvements made to the road included resurfacing, new underground stormwater piping, enhanced Florida-native vegetation "islands", and multi-modal amenities such a pedway and bicycle lanes. The road was also raised nine to 12 inches above its original height. Since the project's completion, flooding has not been observed or reported on this specific section of West Central Blvd.

8) Environmental Innovation Corridor

Project Status: Conceptual
Project Construction Start Date: NA
Estimated Project Completion Date: NA
Project Intent: Flood mitigation and adaptation, storm surge protection, stormwater runoff treatment, habitat preservation and expansion

In 2021, funding from NOAA's Sea Grant College Program and Office of Coastal Management allowed the City to partner with a team of experts from Florida Sea Grant, Stetson University, and the ECFRPC to identify current and future flood risks within the community. These collaborative efforts led to the identification of two key undeveloped parcels that are ideal for creating an "Environmental Innovation Corridor" within the City. Development of such a corridor would provide stormwater parks, flood resilience, improved water quality, and enhance the overall quality of life for residents, workers, and visitors, while also serving as a model for others to emulate.

The development of the Environmental Innovation Corridor concept would include passive recreational amenities in a natural preserve setting. Importantly, the development would include the construction of stormwater retention systems capable of pre-treating stormwater runoff, before it gets to the lagoon. This will have an immediate, direct, and positive ecological impact on water quality discharges to the BRL by the natural removal of harmful phosphorus and nitrogen while also adding capacity to the City's existing stormwater system.

One parcel is about 10 acres in size and straddles the Canaveral Ditch west of SR A1A between Thurm Blvd. and Columbia Dr. The other is about seven acres in size and is located between the Canaveral Ditch and North Atlantic Ave., with its entire north end bordering West Central Blvd. Both sites are currently privately-owned. Direct acquisition is not feasible at this time due to the high cost of property acquisition. Staff are actively investigating alternative funding means for acquisition.

The City will need to take ownership of these parcels in order to apply for grant funds for their development. Once ownership of the parcels is established, the properties would be re-zoned to a City-owned conservation classification in perpetuity.

At the 2022 Strategic Planning Retreat, City Council directed Staff to begin the formal process of developing the Environmental Innovation Corridor concept into a reality in order to uphold and expand upon four critical community-wide priorities also determined by City Council at past meetings:

1. Conserving and enhancing remaining green spaces and coastal wetlands within the City.
2. Utilizing remaining green spaces and coastal wetlands for passive eco-tourism, education, and outreach by providing areas to conduct scientific monitoring of ecosystems, restoration projects, and environmental stewardship in conjunction with local schools, universities, and research organizations.
3. Improving the health and wellbeing of the Indian River Lagoon.
4. Maintaining remaining green spaces and coastal wetlands in order to mitigate impacts from storm surge and intense rainfall events that can lead to widespread community flooding, as well as sea level rise.

Long Point Preserve would also be a component of this concept given its proximity to the BRL and its recently restored habitat, as well as its ability to serve as a vegetative buffer to reduce storm surge.

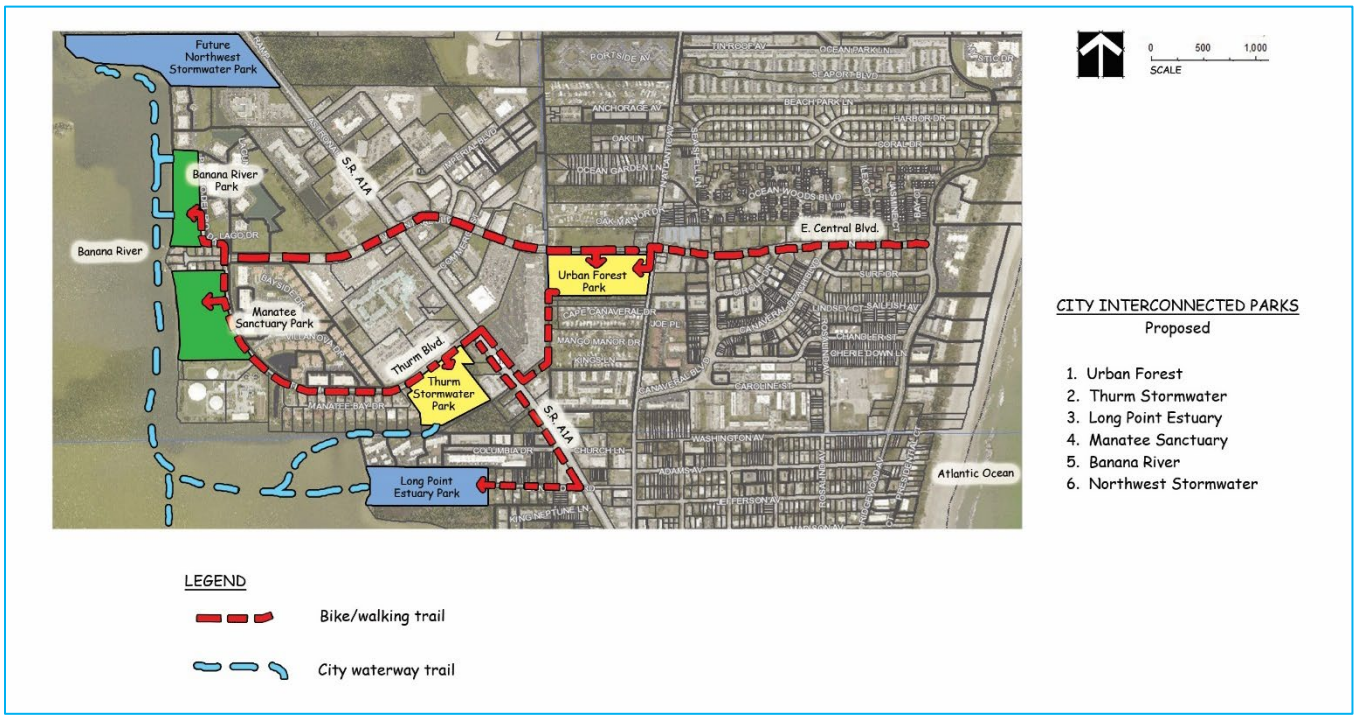


Figure 13. Environmental Innovation Corridor overview.

9) Canaveral Ditch Pump Station/Tidal Valve
Project Status: Research and Development
Project Construction Start Date: NA
Estimated Project Completion Date: NA
Project Intent: 2021 Resiliency Action Plan: Preparedness Target #53, flood mitigation and adaptation

As was the case for the Center Street Drainage Basin, an additional engineering study is being conducted by Mead and Hunt reviewing the current effectiveness of the Canaveral Drainage Basin. This basin helps to drain a large portion of the City's northern area along the Canaveral Ditch, and has been historically prone to flood events from both heavy rainfall and storm surge. The Canaveral Ditch is a narrow waterway that begins at the City's northernmost border with Port Canaveral, runs due south under West Central Blvd., and then curves southwest under SR A1A before exiting out into the BRL at the Treasure Island Club condominium complex. This ditch is the only waterway of its kind within the City.

Staff have observed - both visually and through water level gauge data - rapid rises in water throughout the length of the ditch, as well as backflow situations during tropical cyclone events in which a wind-driven storm surge has pushed water up the ditch from the BRL, raising its level and preventing efficient stormwater flow out of the Canaveral Drainage Basin.

This second Mead and Hunt engineering study, which was commissioned in 2022, is expected to be finalized in 2024. Preliminary discussions with the study's engineering team have yielded similar recommendations to that of the Center Street Drainage Basin study – namely a pump station.

Although its exact recommended location has not been determined, a permanent pump station will likely be considered somewhere along the length of the ditch to help evacuate water out of it to the south towards the BRL. Given the required large size of such a pump station, a possible suitable site would be at the headwall where the ditch passes under West Central Blvd. North of this location the ditch is briefly channelized underground. This channelization can lead to a reduction in flow, serving as a choke point. A pump would help move water out of the ditch's northern section while a series of tidal valves or flood gates would close at the outfall pipes on the southside of the headwall to prevent backflow.

10) Canaveral City Park Stormwater Exfiltration System

Project Status: Complete

Project Construction Start Date: 2016

Project Completion Date: Q4 2016

Project Intent: 2014 Stormwater Management Plan recommendation, flood prevention, and nutrient pollution reduction

Figure 14. Stormwater exfiltration system under construction at Canaveral City Park in 2016.

Traditional methods of capturing, retaining, and treating stormwater onsite such as in a large pond are impractical within the City due to its highly urbanized nature. Runoff must be captured and allowed to enter back into the soil onsite with minimal to no contact with the City's existing stormwater drainage system in order to increase capacity on the system as a whole. To save space and allow for direct infiltration of stormwater, the City began utilizing underground stormwater exfiltration systems; the largest example of which is under Canaveral City Park.

The project, which was completed in 2016, included the installation of 4,000 stormwater chambers beneath Canaveral City Park that can collectively capture approximately 931,000 gallons of stormwater. Once inside these chambers, stormwater is allowed to percolate down into the underlying soil where it is naturally filtered. The contributing area of treatment is equivalent to 30.3 acres. The chambers are specifically located beneath the little league field and across the open green space that spans the south facade of the C5.

In 2019, the underground system was modified to be able to accept excess reclaim water from the City's WRF so as to reduce the number of direct discharges into the BRL. If conditions are correct, reclaim water can be transferred directly from the plant to the exfiltration system where it will gradually flow down into the porous soil below and be filtered. To date, this system has helped divert well over 100 million gallons of reclaim water from the lagoon.

Similar - yet smaller - systems are also present at other City-owned properties including beneath the parking lot of City Hall and Canaveral Fire Rescue Station #53. Other locations currently being scoped to accommodate additional exfiltration systems include the Nancy Hanson Recreation Complex as part of the Civic Hub Project and throughout the Presidential Streets as part of the Presidential Streets Master Plan.

11) Civic Hub Stormwater Exfiltration System

Project Status: Conceptual

Project Construction Start Date: Sometime in 2025

Estimated Project Completion Date: Sometime in 2027

Project Intent: Flood mitigation and adaptation, pedestrian safety, improved universal design-based amenities

The Civic Hub is a project that is expected to see the redevelopment and enhancement of the Nancy Hanson Recreational Complex and areas to the immediate north of the complex running between SR A1A, Taylor Ave., Poinsetta Ave., the CAPE Center and the Brevard County Sheriff's Office Cape Canaveral Precinct Building. Before aboveground improvements are made, the City intends to utilize the project as an opportunity to significantly increase the stormwater holding capacity of the Center Street Drainage Basin.

Staff is investigating the feasibility of installing underground concrete stormwater vaults in areas where impervious ground cover is already present to capture, hold, and treat stormwater runoff. Preliminary scoping has yielded a cumulative system holding capacity of well over one million gallons of stormwater in a relatively small geographic footprint. These vaults are modular in design and could be engineered to withstand the weight of overhead foot and vehicle traffic. Staff is also investigating the possibility of utilizing the system to hold excess reclaim water in order to continue reducing direct discharges to the BRL.

Figure 15. Example rendering of underground stormwater vaults.

12) Sea Oat Plantings

Project Status: Ongoing Implementation
Project Construction Start Date: 2005
Estimated Project Completion Date: Ongoing
Project Intent: 2021 Resiliency Action Plan: Preparedness Target #11, dune stabilization and recruitment, storm surge and coastal flood protection, habitat preservation, sea level rise mitigation

Sea oats are a perennial grass native to the beaches of the US southeast anywhere from Texas to Virginia. As they grow, the roots of the plants will burrow down several feet and form complex webs, which act to stabilize sand dunes and hold them in place. Above ground, the sea oats' long wispy reeds serve to catch wind blow sand, often leading to a buildup of material at the base of the plants. Over time, this build up will cause the sand dunes to increase in height. This height increase adds to the overall resilience of the beach by allowing it to be able to stop higher tides and storm surges from overtopping the dunes.

In 2023, City Staff and volunteers planted 18,528 sea oats to help support and enhance the natural dune line. Since 2005, the City has planted over 176,000 (see historical data below) sea oats beachside. According to the City's 2021 Resiliency Action Plan, Preparedness Target #11, the City is to plant over 220,000 sea oats beachside by 2036. At the current rate of plantings, the City will meet this target well ahead of schedule.

- 2005: 2,950 sea oats planted
- 2006: 9,600 sea oats planted
- 2007: 9,600 sea oats planted
- 2008: 5,000 sea oats planted
- 2009: 7,500 sea oats planted
- 2010: 7,500 sea oats planted
- 2011: 8,000 sea oats planted
- 2012: 7,200 sea oats planted
- 2013: 7,200 sea oats planted
- 2014: 7,700 sea oats planted
- 2015: 7,700 sea oats planted
- 2016: 7,200 sea oats planted
- 2017: 7,200 sea oats planted
- 2018: 7,200 sea oats planted
- 2019: 10,000 sea oats planted
- 2020: 10,000 sea oats planted
- 2021: 20,000 sea oats planted
- 2022: 19,000 sea oats planted
- 2023: 18,528 sea oats planted

Beach renourishment, which is the practice of placing dredged sand back onto the beach, is a vital strategy in mitigating the effects of beach erosion caused slowly overtime by constant wave action and sea level rise or via the passage of tropical cyclones. Brevard County and the USACE are the primary governmental entities responsible for conducting beach renourishment operations. It is advised that the City continue supporting local beach renourishment efforts as without it the City's oceanfront properties could be at serious risk of collapse without a

wide beach to reduce wave energy and suppress high tides. The last beach renourishment project in Cape Canaveral was completed in 2019.

Figure 16. Here, a City resident plants sea oats beachside.

13) Presidential Streets Master Plan

Project Status: Moving into Design Phase
Project Start Date: 2021
Estimated Project Completion Date: 2045 – 2050
Project Intent: Flood mitigation and adaptation, improved safety, stormwater runoff treatment

At the 2021 Strategic Planning Retreat, City Council endorsed the preparation of the Presidential Streets Master Plan (Plan), which calls for the systematic redevelopment of each Presidential Street via a design process involving community input, updated environmental, demographic and traffic analysis, and incorporating the latest in future-ready resilient infrastructure. In Summer 2021, the City engaged the planning and design firm Kimley-Horn and Associates (KHA) to develop, research, and draft the desired Plan. At the December 20, 2022, Regular City Council meeting, Council enthusiastically and unanimously accepted the finalized Plan and its various recommendations.

The Plan is a high-level policy document that forwards infrastructure themed planning recommendations to be implemented as funds are available. It is intended to provide long range guidance for Staff and councilmembers, with recommendations intended to be implemented across the Study Area. Implementation of the Plan will likely be one of the most impactful initiatives ever undertaken by the City and represents an approximate 25-year financial commitment to the redevelopment of the Study Area.

The Study Area of the Plan is approximately 256 acres, including approximately 13.16 miles of roadway extending from SR A1A eastward to the dune line and from Washington Ave. southward to Johnson Ave. The Study Area has a population of 2,836, which is approximately 28% of the City's total population. It also includes 1,674 households with an average household size of 1.69 and a median age of 54.3 years old. The majority of housing in the Study Area is rental (58.7%) versus owned (41.3%). Several streets within the Study Area experience chronic flood issues during heavy rain events that will be addressed through the course of this Plan's implementation.

The vision for the Plan is to ultimately create a Study Area-specific destination that includes the concept of Complete Streets, improved stormwater management, safer pedestrian access, more efficient traffic management, and enhanced resilience against weather and climate-related hazards such as extreme flooding and heat waves. The key elements of the Plan supporting this vision include the following:

- Strong sense of place
- Equitable, environmentally sustainable community
- Connected, efficient multi-modal transportation

This Plan builds upon local momentum to implement several initiatives and projects between now and 2035 that involve improving the overall sustainability and resilience of the City's existing infrastructure codified by past City documents such as, and perhaps mostly influentially, the 2021 Resiliency Action Plan, 2019 Vulnerability Assessment, 2017 Pedestrian and Bicycle Mobility Master Plan, and the 2012 Community Redevelopment Plan.

The project's intent is to create a framework that identifies planning recommendations that can be implemented and constructed as funds become available for capital improvements and as opportunities arise within the market for investment and redevelopment. This Plan is also intended to create a design concept framework for future above ground improvements in the Presidential Streets such as rain gardens, bicycle-related infrastructure, solar-powered street lighting, etc.; and also addresses underground improvements to stormwater and utilities systems

in conjunction with the streetscape improvements. One-waying some or all of the Study Area's street system is being explored as well via a separate one-way specific study that is also being conducted by KHA. One-waying certain streets could allow for a reduction in impervious surface cover and more space for stormwater infiltration.

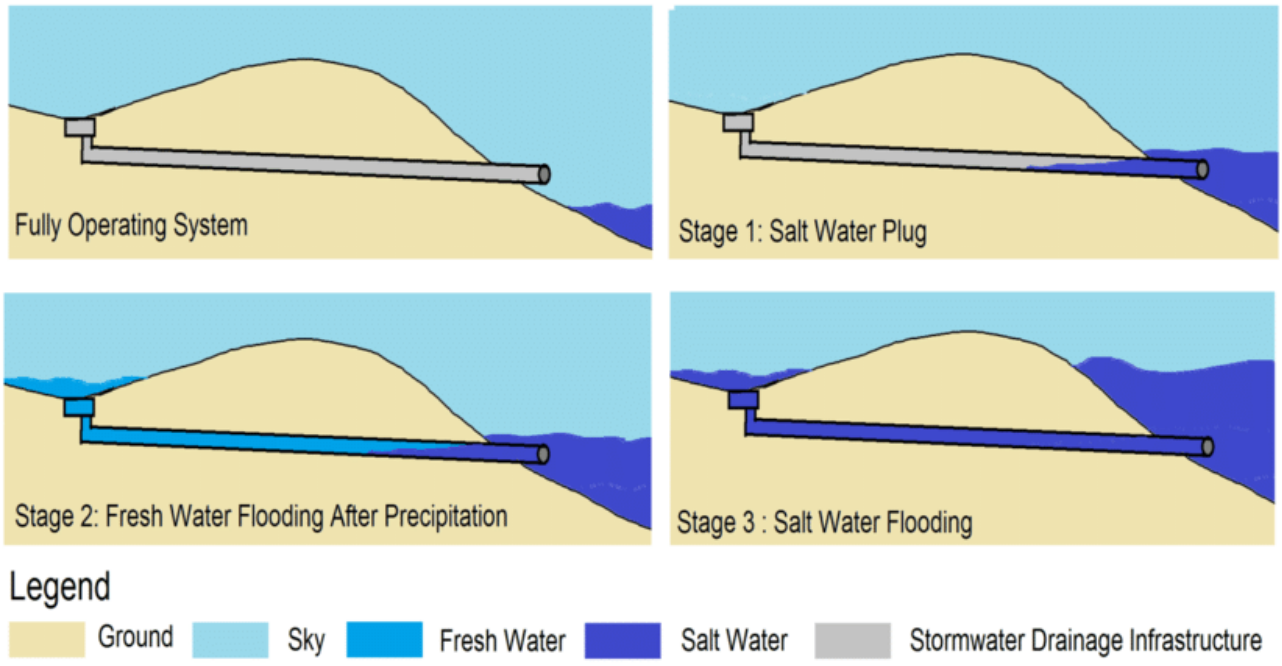


Figure 17. Diagram showcasing how sea level rise can inhibit the ability of stormwater drainage systems to efficiently remove water from the built environment to watersheds by creating backflow and blockage situations.

14) Veterans Memorial Park "Smart" Rain Garden

Project Status: Under Construction
Project Construction Start Date: October 1, 2023
Estimated Project Completion Date: September 30, 2024
Project Intent: Flood mitigation, habitat expansion, beautification, stormwater runoff treatment, community outreach and education

In 2022, the City and Stetson University received a $50,000 "Stage 1" planning grant from the National Science Foundation (NSF) to implement community-driven, nature-based infrastructure in order to mitigate flooding in the City and improve local water quality in the BRL. Such nature-based infrastructure would utilize LID practices, which refers to systems that incorporate or mimic natural processes that result in the infiltration, evapotranspiration, and use of stormwater to reduce impacts on surrounding watersheds. Between November 2022 and February 2023, three community workshops were held to gather resident feedback and ideas regarding practical LID solutions that could be implemented within the City. The feedback obtained in these three sessions helped to inform the application of a "Stage 2" NSF grant worth up to $1 million in funding for infrastructure implementation. The application/project proposal for the "Stage 2" NSF grant was submitted in March 2023, with a notice of funding award announced on September 21, 2023, and made available starting October 1, 2023.

Based on the feedback from workshop attendees and prior surveys, the Staff project team applied for grant funding to enhance and beautify an existing dry retention pond into a "smart" rain garden located in the southwest corner of Veterans Memorial Park – located adjacent to the intersection of Taylor Ave. and Orange Ave. – which is already set to see a revitalization through the course of 2024 via a separate project.

To make this project eligible and feasible for NSF grant funding, it needed to be "shovel-ready", meaning a planning and design effort must have been previously completed. For this planning and design work, Staff reached out to KHA, who is already designing the Veterans Memorial Park enhancement project and who also served as a grant partner for the "Stage 2" NSF grant submittal. A network of remote sensors will be placed throughout the rain garden that will digitally monitor nutrient inputs and local atmospheric conditions, hence the project's identification as being a "smart" rain garden.

Per the NSF's "Stage 2" grant requirements, the project must be completed within twelve months of funding being available, allowing for a project timeline from start to finish of October 1, 2023, to September 30, 2024. Due to this accelerated timeline, Staff began design work as soon as possible so that the project was "shovel-ready" if and when grant funding was awarded to the City, allowing for certainty that the rain garden could be completed within the allotted twelve months. Physical construction on the rain garden officially began on January 9, 2024.

This rain garden – also known as a bioswale – will be able to hold more stormwater runoff and have better nutrient treatment capabilities due to its enlarged size and diversification of Florida-native and Florida-friendly plants throughout than what the current dry retention pond can do. Rocks will also be added for soil stabilization and erosion control. Staff believes this project could not only serve the community with the tangible benefits of flood mitigation and nutrient reductions but also serve as a pilot program that can allow for proper LID-based training and best management practices relating to "green infrastructure". This rain garden concept can be scaled and replicated at other stormwater-critical and vulnerable areas of the City and within the Presidential Streets, following in line with recommendations set forth within the Presidential Streets Master Plan.

Of the $1 million applied for, the City is directly receiving $525,000, with the remaining amount going to grant partners for their own project-related work, equipment, and staffing.

A list of benefits of this LID-based rain garden area would consist of the following:

- Less hydrological stress on the Center Street Drainage Basin
- Reduce the chances of urban flooding in the area
- TMDL credits through the FDEP
- Mitigate stormwater runoff out of the Banana River Lagoon
- Improved local water quality
- Beautification of the surrounding area of the updated Veterans Memorial Park
- Educational opportunities
- Scientific monitoring opportunities with university partners
- Continuing to lead by example as a model coastal municipality

This project is believed to be the largest grant-related collaborative effort ever undertaken by the City. Grant partners on this initiative include:

1. City of Cape Canaveral
2. Stetson University's Institute for Water and Environmental Resilience
3. Kimley-Horn Associates
4. Marine Resources Council
5. Brevard Zoo
6. St. Johns River Water Management District
7. Ferguson Waterworks
8. Riverside Conservancy
9. Florida Sea Grant/UF/IFAS
10. East Central Florida Regional Planning Council
11. Indian River Lagoon National Estuary Program
12. National Science Foundation
13. Florida Atlantic University
14. Embry-Riddle Aeronautical University
15. Florida Institute of Technology

15) C5 Flood Barriers

Project Status: Active implementation
Project Start Date: January 1, 2024
Estimated Project Completion Date: Q2 2024
Project Intent: Flood mitigation and adaptation, resiliency enhancement, improving continuity of operations

Within the FY 23-24 budget (specifically within the Community Redevelopment Agency's (CRA) budget), Council authorized a line item of$55,000 for the installation of semi-permanent flood barriers for deployment at the C5 should a flood situation be predicted. Creating traditional sandbags can be extremely labor intensive and time consuming to produce, especially when considering the time constraints usually associated with preparing for hazardous situations. In order to expedite the pace of flood-related preparations, Staff will be acquiring flood barriers that can be rapidly deployed by relatively few personnel at the C5, a building that is steadily being enhanced with various upgrades to become the City's first dedicated Resilience Hub. As defined by the Urban Sustainability Directors Network, Resilience Hubs are community-serving facilities augmented to: (1) support residents and (2) coordinate resource distribution and services before, during, and after a natural hazard event.

Figure 18. Example of a water inflated temporary dam system.

Staff is exploring several variations of flood barriers, including movable metal gates that span across doorways, plastic dams that can span doorways and facades, and tube structures that can be filled with water to create a dam that can be erected around entire structures. Project completion is expected by the start of the 2024 hurricane season.

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Appendices 1 – 5

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Appendix 1: Sea Level Rise Projection Maps

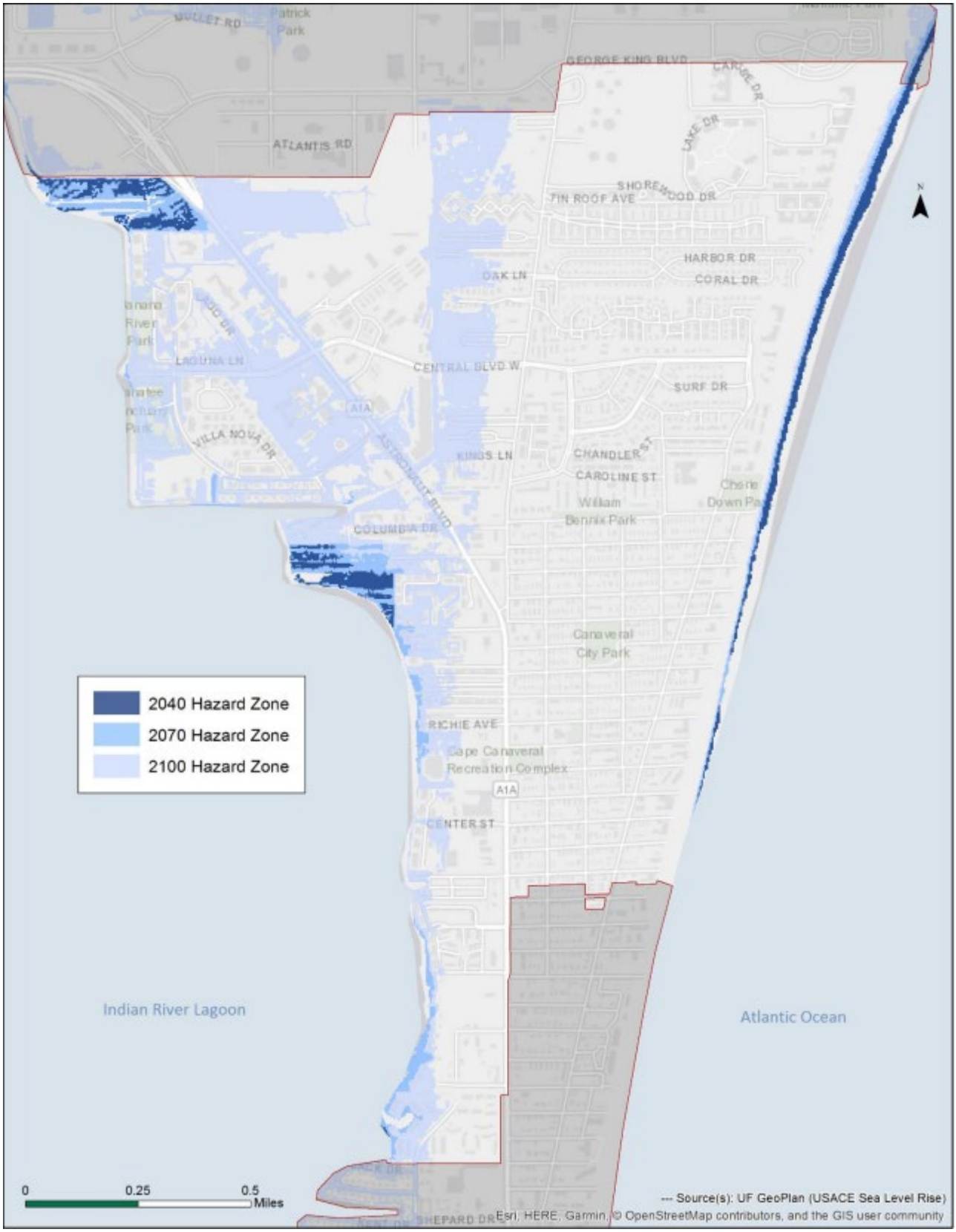

Figure 19. USACE City sea level rise projections, 2040 – 2100.

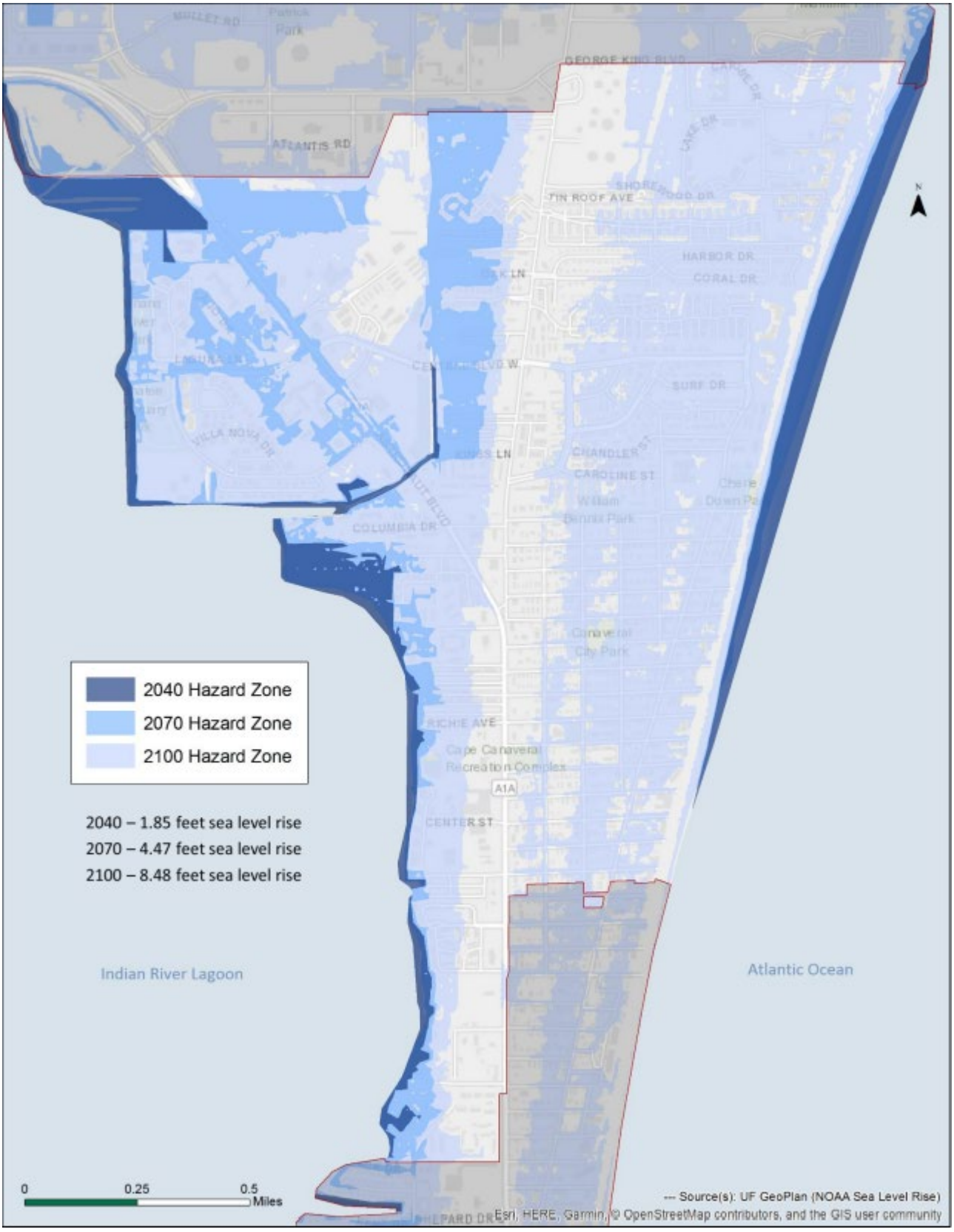

Figure 20. NOAA City sea level rise projections, 2040 – 2100.

Appendix 2: Proposed ERA Boundary

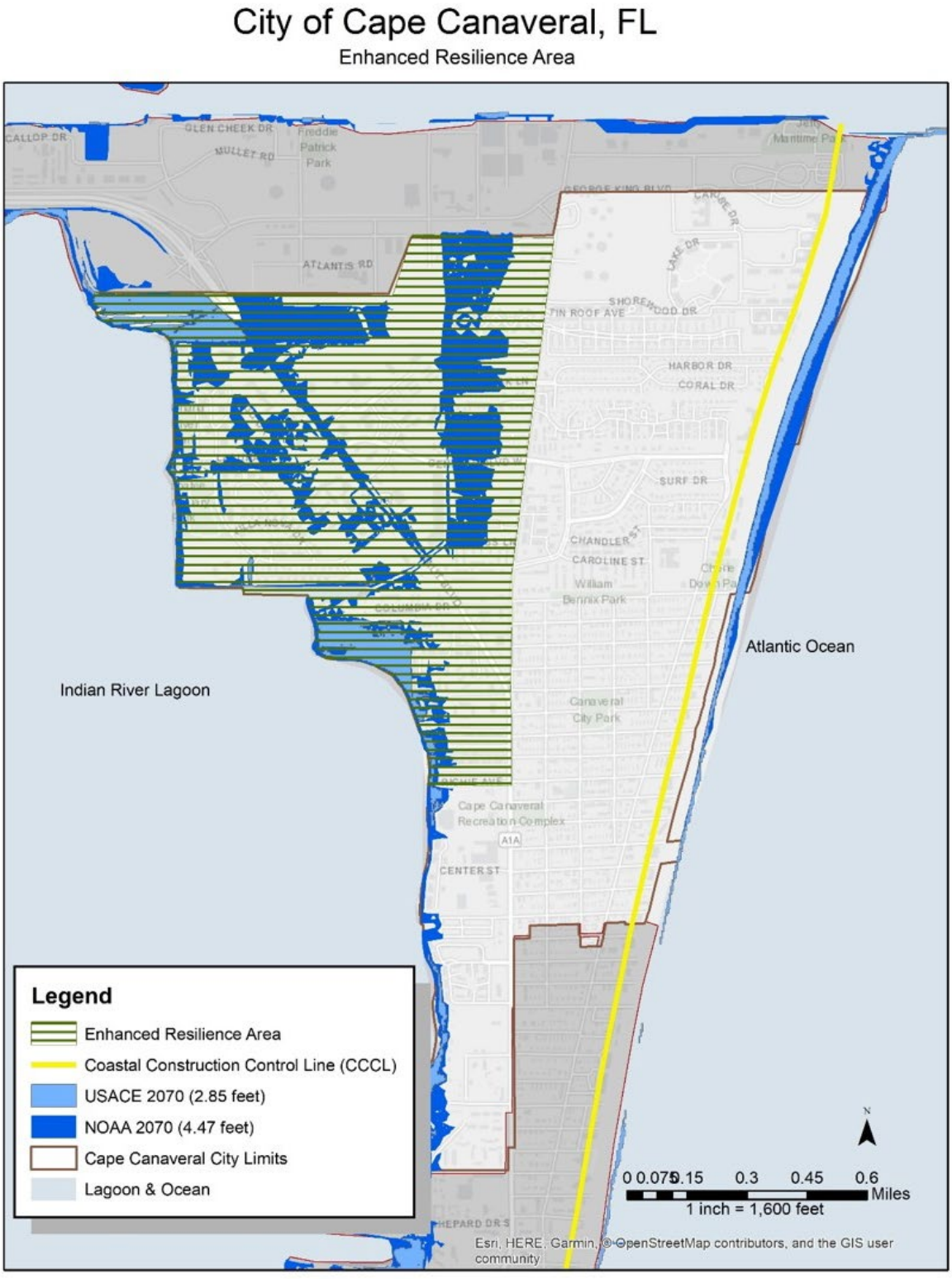

Figure 21. Proposed ERA boundaries.

Appendix 3: City Projects Map

City of Cape Canaveral Flood Mitigation and Adaptation Infrastructure Map

- Project implementation timeframe: (2020 – 2050)

Appendix 4: Current Storm Surge Maps

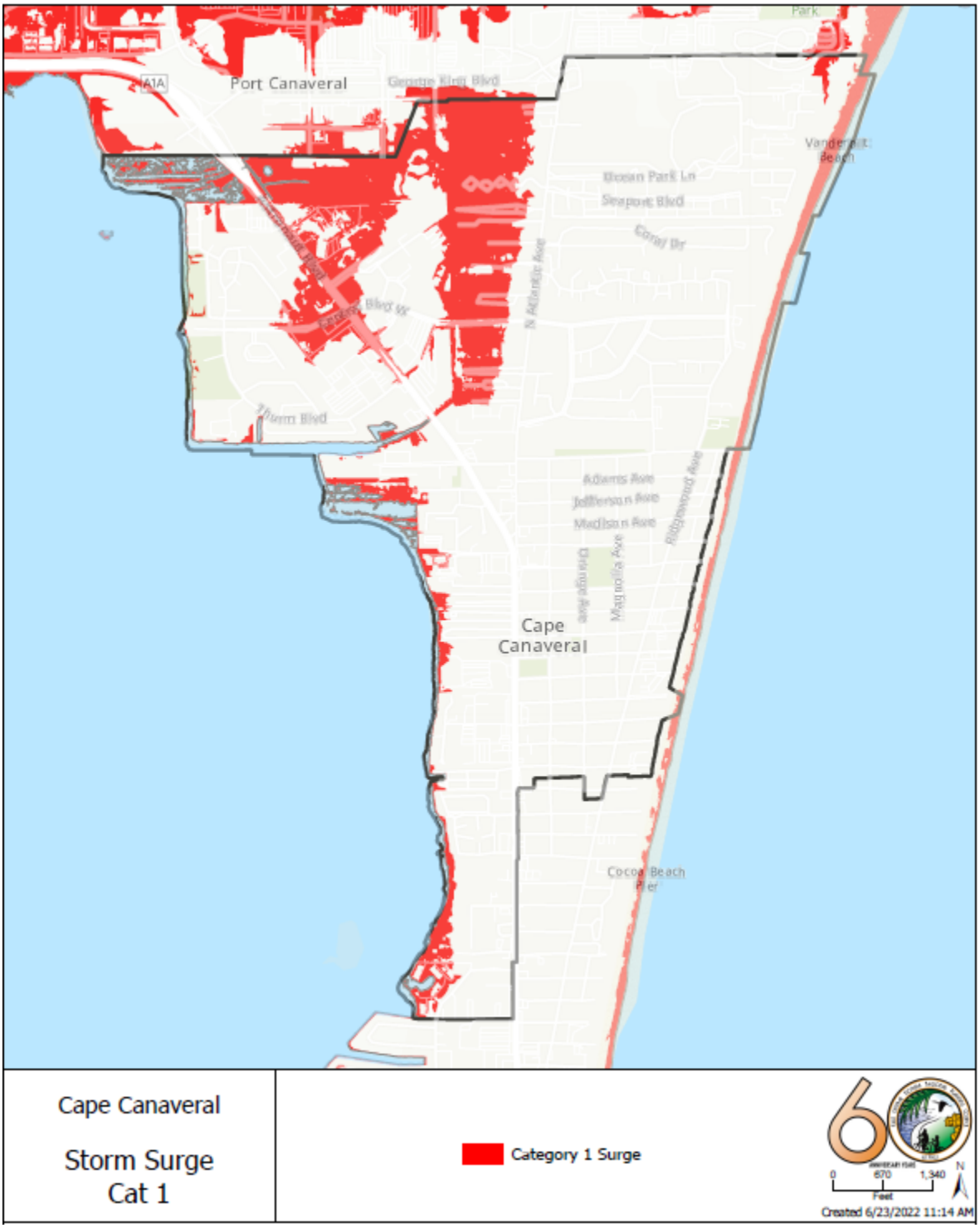

Figure 22. Projected category 1 hurricane storm surge protentional.

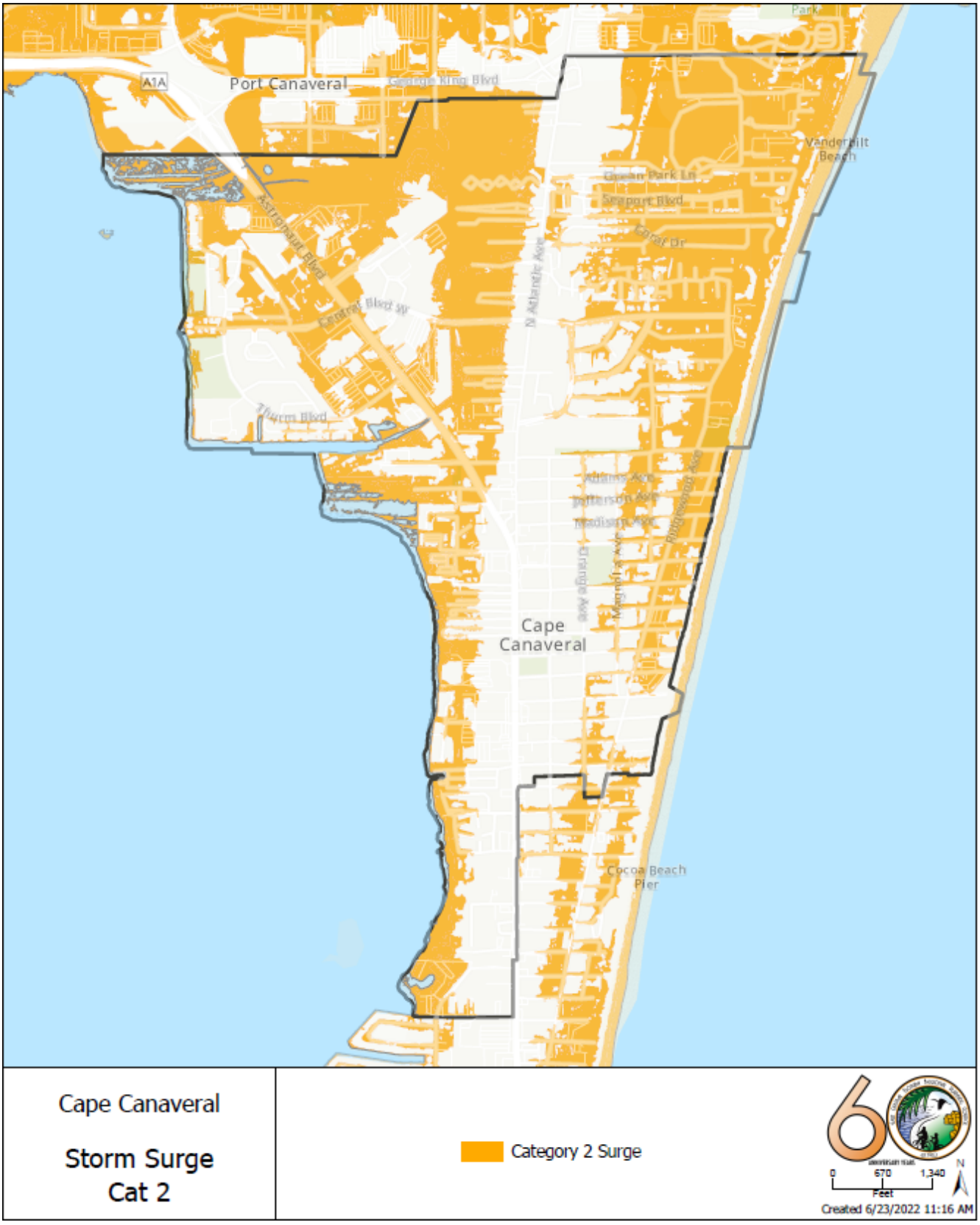

Figure 23. Projected category 2 hurricane storm surge protentional.

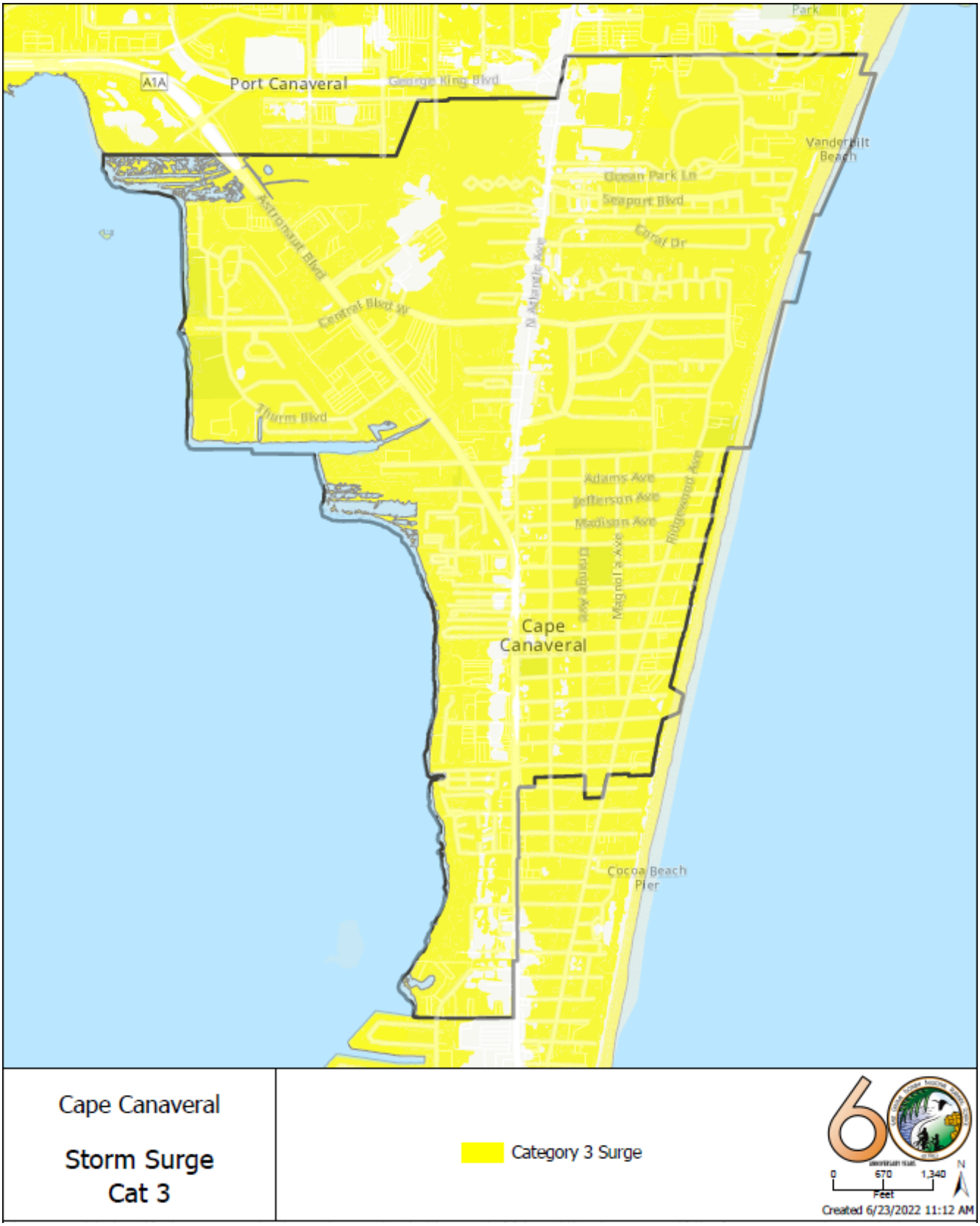

Figure 24. Projected category 3 hurricane storm surge protentional.

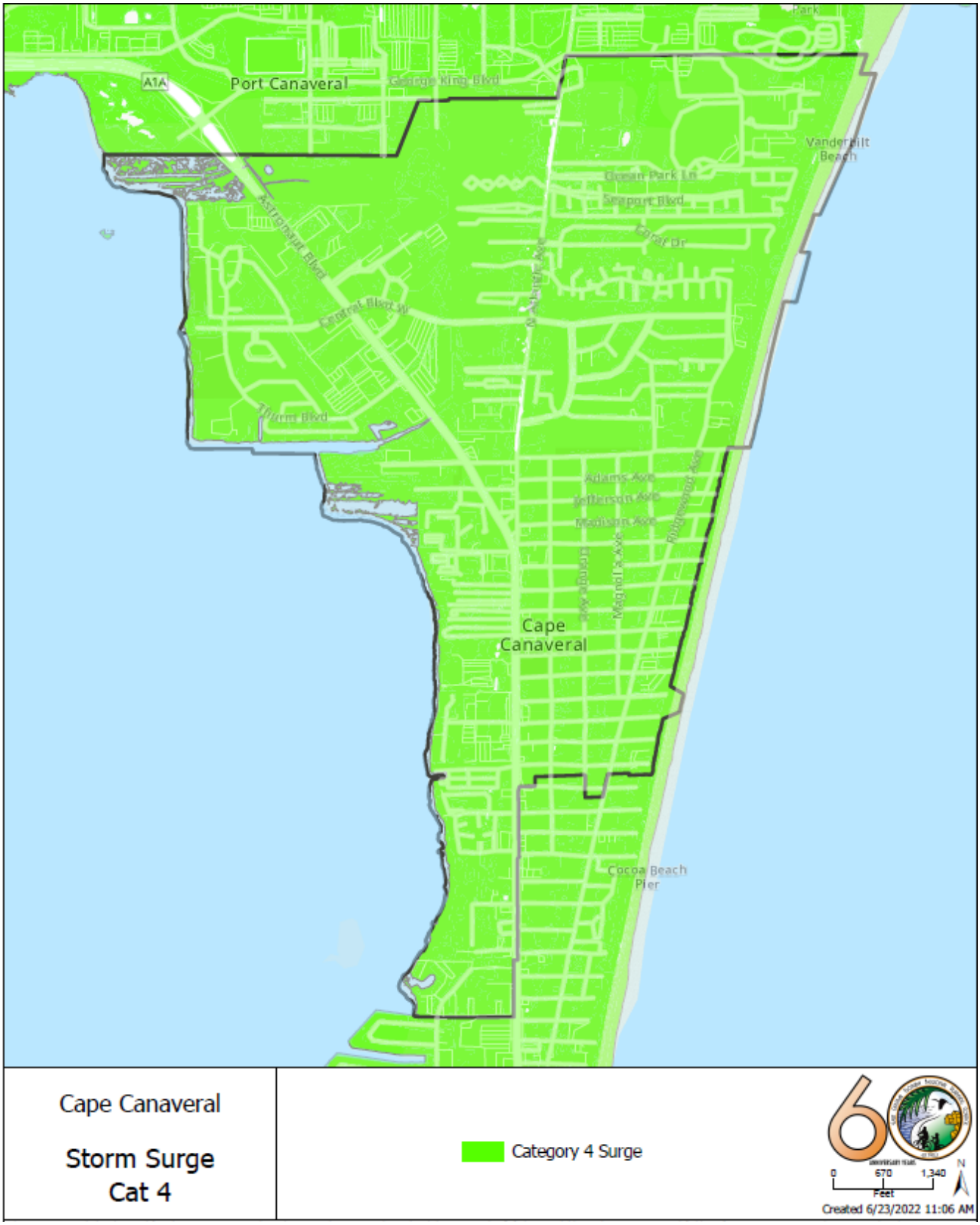

Figure 25. Projected category 4 hurricane storm surge protentional.

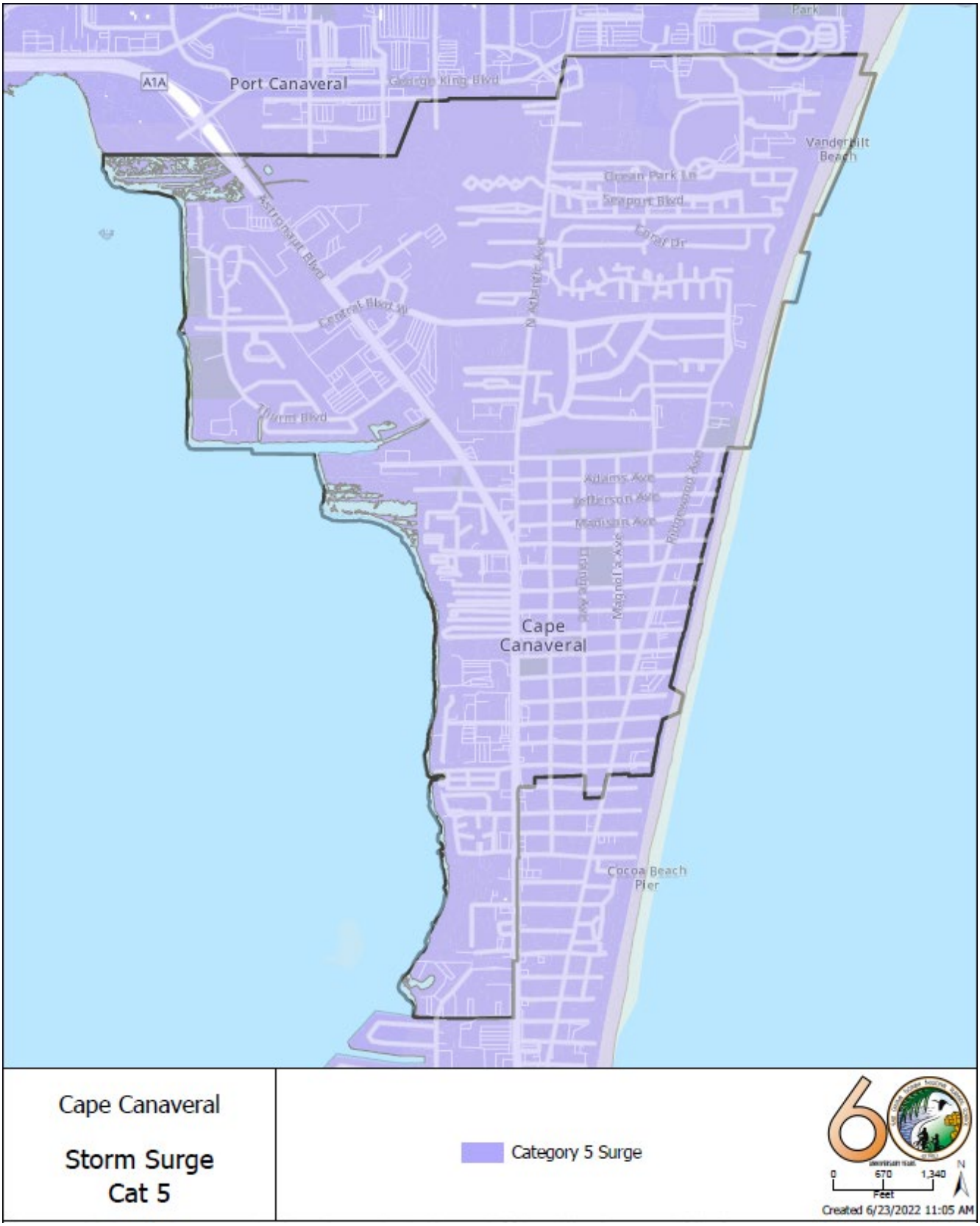

Figure 26. Projected category 5 hurricane storm surge protentional.

Appendix 5: Trident Pier Sea Level Rise Observations