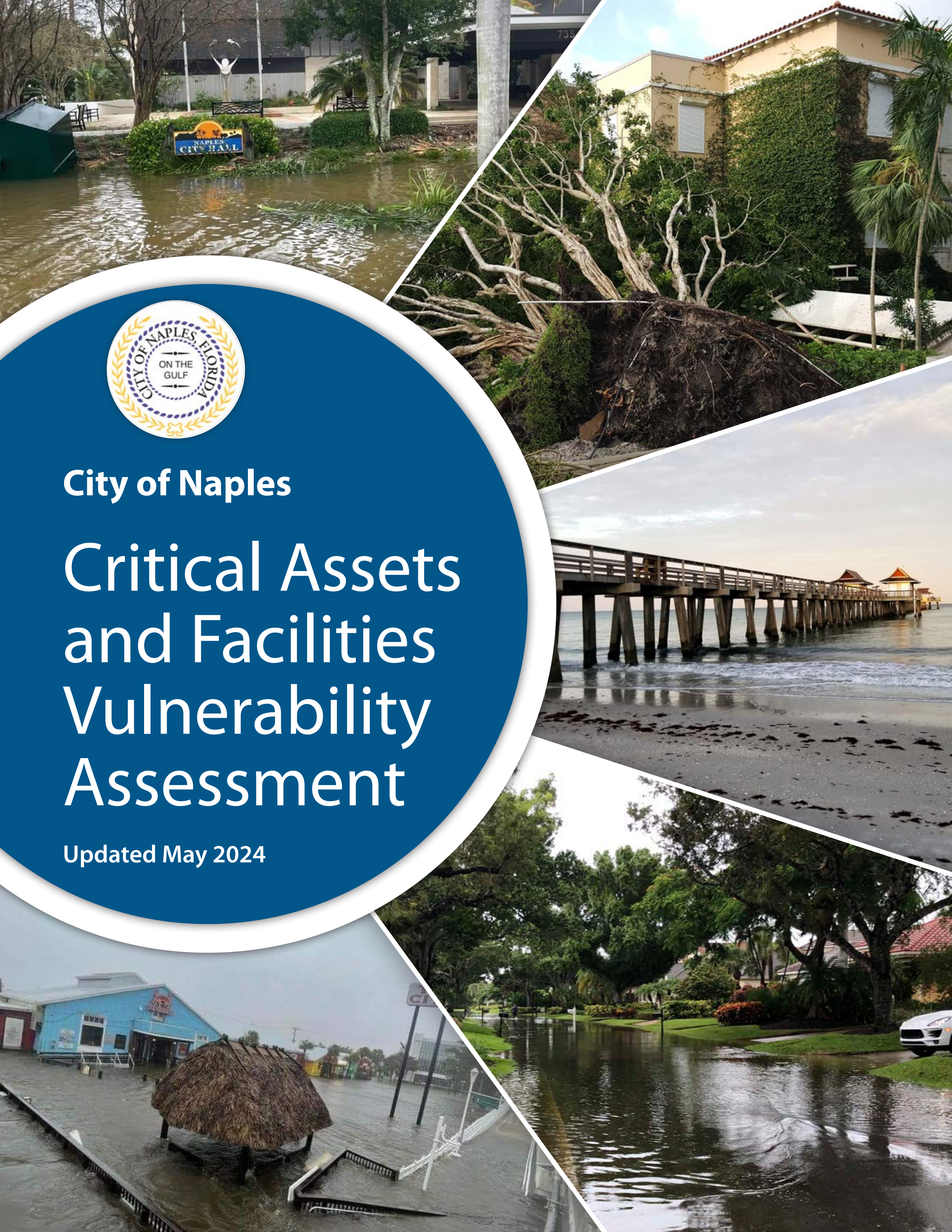

## City of Naples

# Critical Assets and Facilities Vulnerability Assessment

Updated May 2024

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# Acronyms

| | |
|---|---|
| ACUNE | Adaptation of Coastal Urban and Natural Ecosystems |
| AMO | Atlantic Multi-decadal Oscillation |
| ARFF | Aircraft Rescue and Firefighting |
| CMIP5 | Climate Model Intercomparison Project |
| CRA | Community Redevelopment Agency |
| °F | degrees Fahrenheit |
| ft | feet |
| GCMs | general circulation models |
| GHG | greenhouse gas emissions |
| GIS | Geographic Information System |
| IPCC | Intergovernmental Panel on Climate Change |
| km | kilometers |
| km2 | square kilometers |
| LiDAR | light detection and ranging |
| LOCA | Localized Constructed Analogs |
| MHHW | mean higher high water |
| mm | millimeter |
| NAVD88 | North American Vertical Datum of 1988 |
| NESDIS | National Environmental Satellite, Data, and Information Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NTDE | National Tidal Datum Epoch |
| ppm | parts per million |
| RCPs | representative concentration pathways |
| SLR | sea level rise |
| UHI | urban heat island |
| YR | year |

## Key Terms

**100-year flood (1 percent annual chance flood):** A flood event with a 1 percent chance of being equaled or exceeded in any given year.

**Adaptation:** Adjustment in natural or human systems in response to an actual or expected climatic stimulus.

**Adaptive capacity:** An asset's ability to adjust to accommodate future climate conditions.

**Asset:** City-owned built or natural infrastructure.

**Co-benefits:** Positive side effects of reducing greenhouse gas emissions or adapting an asset or system for potential climate change impacts.

**Compound Flooding:** The combined effect of two or more flood sources (e.g., rainfall and high tides) occurring simultaneously.

**Exposure:** The presence of people, livelihoods, ecosystems, infrastructure, or other assets in places that could be adversely affected.

**Flooding:** Temporary occurrence of water levels exceeding normally dry elevations; typically associated with an episodic event, such as a storm tide.

**Greenhouse Gases:** Gases that trap heat in the atmosphere, including carbon dioxide, methane, nitrous oxide, and fluorinated gases.

**Inundation:** The process of normally dry areas being submerged by daily high tides.

**King Tide:** Unusually large, but predictable tides that occur each year when the earth is particularly close to the moon and sun.

**Mean Higher High Water:** Average of the highest of two high tides occurring each day over the National Tidal Datum Epoch.

**National Tidal Datum Epoch (NTDE):** The NDTE is a specific 19-year period identified as the official time segment over which tide observations are taken and used to obtain mean values for tidal datums. The present NTDE is 1983 through 2001. This timeframe is deemed a full cycle, because the most significant tidal variations complete their cycles within 19 years.

**Representative Concentration Pathways:** Series of greenhouse gas concentration trajectories adopted by the Intergovernmental Panel of Climate Change to be used for consistent climate modeling and research.

**Resilience:** Degree to which a system or asset rebounds, recoups, or recovers from exposure to climate stressors.

**Risk:** Potential losses or impacts (consequences) that could occur if an asset or system is inoperable due to exposure to climate change.

**Sensitivity:** The degree to which an asset is directly or indirectly susceptible to exposure to climate change stressors.

**Storm Tide:** Temporary, short-term increase in sea level above predicted astronomical tide levels as a result of changes in atmospheric pressure, wind, and/or freshwater inflows.

**Stressor:** A chronic change in climatic conditions that places increased pressure on assets.

**Vulnerability:** The predisposition of an asset or system to be adversely affected by climate change. It is typically defined by a combination of exposure, sensitivity, and adaptive capacity.

# Acknowledgements

## Project Team

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AECOM

Cella, Molnar & Associates

Thank you to the City's Resiliency and Adaptation Working Group for providing insight on the City's assets and infrastructure and feedback on the vulnerability assessment process.

# 1

# Introduction

The City of Naples (City) is in the process of developing a Climate Adaptation Plan, which will document the City's proposed approach to address potential impacts posed by climate hazards. Once completed, the Climate Adaptation Plan will serve as a roadmap that will help prioritize adaptation strategies, land use decisions, and investments to protect the City's built and natural infrastructure.

The City is highly vulnerable to the effects of an evolving climate. Bordered by the Gulf of Mexico to the west, and intersected by the Naples Bay, Moorings Bay, and numerous canals, there are flood pathways to the City from many sides (Figure 1). With its predominately low-lying landscape that has been greatly altered by development over the past century, areas of the City already experience the effects of flooding from storm events and predictable tidal inundation during King Tide conditions. In addition to flooding, the City is already subject to frequent high temperature days during the summer season, which has cascading impacts to utility demands, use of City facilities, and the health of outdoor City employees. Like most communities, the City of Naples is tasked with balancing the demand for increasing development and protection of fragile environmental resources that attract residents and visitors to the area. Adding to the challenge is the threat that an evolving climate poses to existing development, ecological systems, and future planning efforts.

As a first step to the Climate Adaptation Plan, the City conducted a Critical Assets and Facilities Vulnerability Assessment (Assessment) to understand potential impacts to publicly-owned built and natural infrastructure and operations. Understanding a community's vulnerability is an essential first step for informing potential adaptation strategies that will protect infrastructure, ensure continuity of public services and safety, and increase long-term resilience of the City's vitality.

The Assessment draws from the best-available science to explore ways in which the City's assets are vulnerable to present and future hazards associated with climate change. Results of this step will inform the development of adaptation strategies to reduce long-term climate hazard impacts and risk.

Damages and emergency response following Hurricane Irma

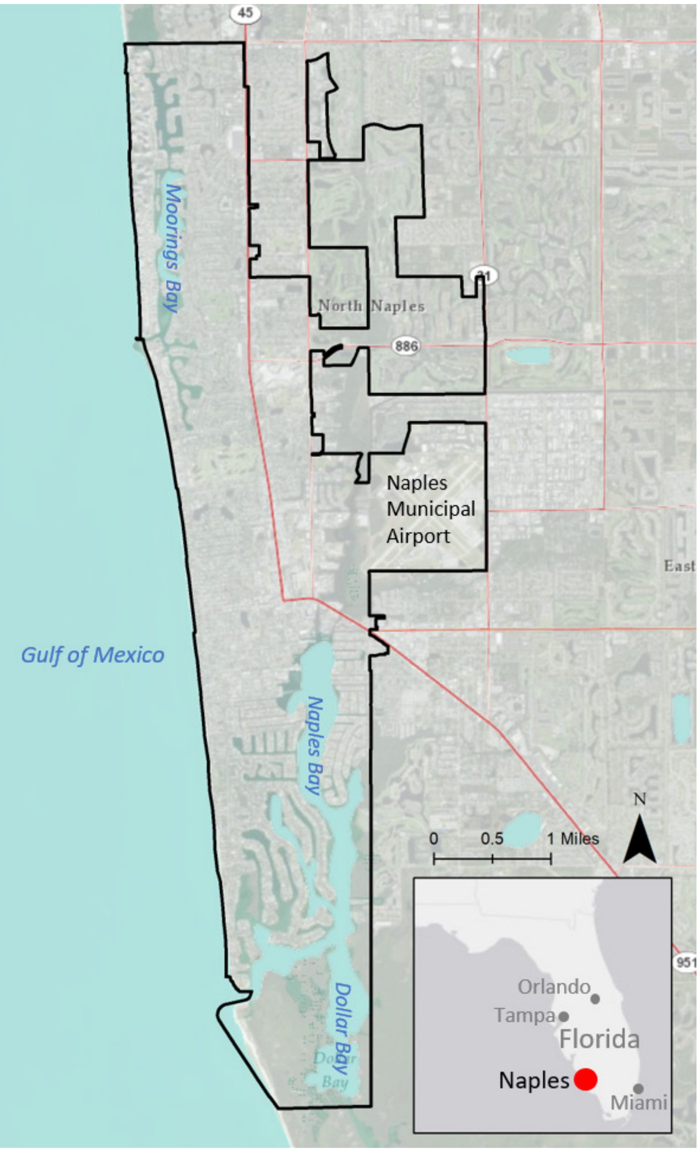


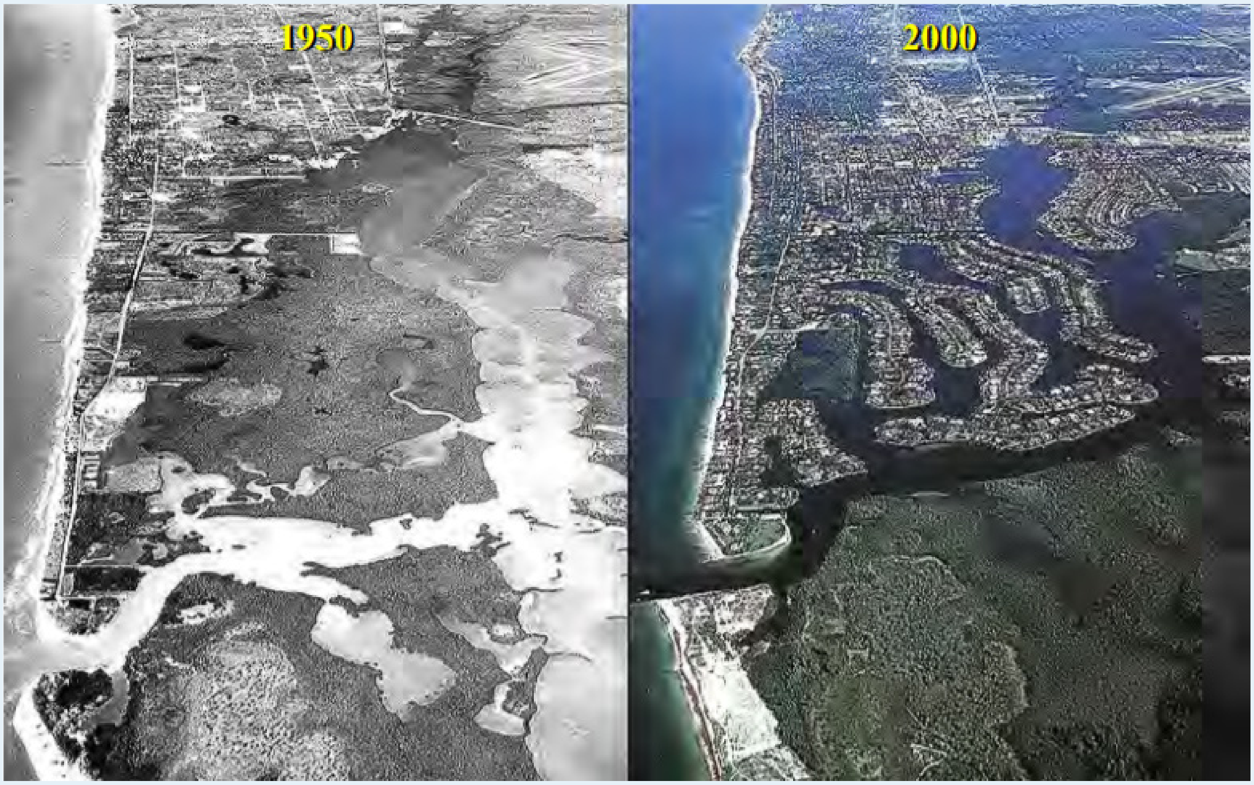
*Figure 1: Location of Naples, Florida Study Area*

> The City is already exposed to present-day flooding due to coincident large rain events and high tides, making it imperative to take steps to reduce risk.

Naples Pier at sunset

## A History of Change

Recognition of the landscape evolution that has occurred in our community helps frame our perspective of future possibilities. The City's shoreline and development patterns have changed dramatically over the past century. The 1930s saw the first dredging of Naples Bay, with the culmination of extensive dredge and fill developments that occurred in the 1950s and 1960s. Over 70 percent of the City's fringing mangroves and marshes, that once served as a sponge for excess stormwater and a buffer against coastal storms, have been converted to residential development (Schmid, 2006). As the City's population continues to grow in this dynamic setting, we can anticipate more transformations in the City's landscape in the decades ahead, including elevating the shoreline and buildings, future development, and land use changes. An evolving climate will be one of the factors of modification, but not the only driver.



Source: Schmid, 2006

## 1.1. Adaptation Planning Process

Adaptation planning for the City follows a three-phase process, summarized in Figure 2. The Assessment, occurring in Phase 1, defines the baseline and future climate conditions based on the best available science, and identifies potential vulnerabilities to infrastructure, residents, the economy, and the environment. This step serves as the foundation to inform subsequent phases focused on developing and implementing adaptation actions to address identified key vulnerabilities.

The climate adaptation planning process leveraged experiences and lessons learned from other cities and governmental entities throughout the country. The Assessment has been tailored to Naples' unique characteristics and needs by incorporating the City's own climate change experience.

At the onset of Phase 1, a central principle of the Assessment was the importance of augmenting the best-available climate science with input from the City and Airport Agency staff. Continuous insight from City staff was critical, because they are most familiar with the City's existing and planned public assets and operations and community values and have in-depth working knowledge of asset components most critical to maintain uninterrupted services. Representatives from each City Department and the Airport Authority joined to form the Climate Working Group, which met regularly throughout development and completion of the Assessment to provide data and information needs for the study, and ensure findings reflected the City's priorities and collective voice.

*Figure 2: Steps in the Adaptation Planning Process*

### Vulnerability Assessment Goals

The Climate Change Vulnerability Assessment report serves as the first step of the Climate Adaptation Plan, which will increase the City's resilience through collaborative planning and projects. The Vulnerability Assessment serves as the basis for the Climate Adaptation Plan through achieving the following goals:

**Map assets and future hazard scenarios:** Create an inventory of built and natural infrastructure at risk to future climate conditions

**Assess vulnerability:** Identify characteristics of assets that make them more/less susceptible to the impacts of climate change

**Build awareness:** Share findings of potential climate change impacts with the community to foster conversation and understanding around the topic

## 1.2. Organization of the Report

Chapters

1. **Introduction** – provides background and context of the Climate Adaptation Plan and Vulnerability Assessment.
2. **Climate Change Science Review** – provides an overview of historical and projected trends for key climate stressors affecting the City.
3. **Sea Level Rise Mapping Methodology** – describes the mapping process used to evaluate sea level rise inundation and coastal storm flooding, which are the greatest climate hazard for the City.
4. **Compound Flood Mapping Methodology** – describes the process used to evaluate compound flooding due to a combination of rainfall and sea level rise.
5. **Asset Inventory** – details the selection of built and natural assets considered in the City's Climate Change Vulnerability Assessment.
6. **Assessing Vulnerability** – describes the process used to assess the City's vulnerability to climate change and presents prioritized assets organized into vulnerability profiles for each City department and the Airport Authority.
7. **Conclusions and Next Steps** – summarizes key findings of the Assessment and considerations for climate change adaptation planning.

Appendices

A Provides the sea level rise inundation maps developed to support the Assessment.

B Provides the tidal flood day maps to evaluate the frequency of shoreline overtopping.

C Provides the Stormwater and compound flood maps to demonstrate potential exposure to future rainfall flooding.

Installation of Spartina grasses in the Cove Outfall area of Naples Bay (2019)

Inland flooding on Riviera Drive during a combined rain storm and high tide event (07/20/2019)

# 2

# Climate Change Science Review

This chapter provides a brief overview of the current global climate science to establish the scientific basis for evaluating climate impacts using the best, readily available, scientific information. It is followed by a discussion of historical and projected trends for key climate-related stressors affecting the City of Naples: sea level rise, coastal storms, temperature, and precipitation. Historical climate conditions provide context for understanding past trends of stressors and their observed impacts on local assets. Projected trends are provided to inform efforts to prepare for potential environmental changes and exacerbated impacts in the coming century. The data and information gathered for each climate stressor includes multiple planning time horizons (2040 and 2070), and a range of projections to account for uncertainty of future climate conditions.

## 2.1. Summary of the Science

The climate is a complex, interactive system consisting of the atmosphere, land surface, ice, water bodies, and biosphere (i.e., living organisms). It is typically thought of as "average weather," and is often characterized by long-term (e.g., greater than 30 years) variability of climate variables, such as temperature or precipitation. The climate system is continuously evolving due to changes in external factors (e.g., solar activity and volcanic eruptions) and human-induced changes to the atmosphere (e.g., greenhouse gas emissions [GHG])[1]. Over the last two centuries, combustion of fossil fuels and large-scale deforestation that has occurred since the Industrial Revolution has led to concentrations of GHGs that have been unprecedented in the last 800,000 years[2]. This change in the atmospheric composition has caused the global climate to exhibit rapid changes compared to the pace of natural variations observed throughout the Earth's history. Evidence of climate trend deviations is widespread, with scientifically documented increases in atmospheric and oceanic temperatures, melting glaciers, reduced ice sheets and snowpack, shifting rainfall patterns, intensification of storm events, and rising sea levels.

## 2.2. Modeling Climate Change

To project future climate conditions, scientists rely on numerical models, known as general circulation models (GCMs). These models incorporate the inter-related physical processes of the atmosphere, ocean, and land surface to simulate the response of climate systems to changing GHG and sulfate aerosol emissions. These models are based on well-established physical principles and have been demonstrated to reproduce observed changes of recent and past climates. Because the level of future emissions will be affected by population, economic development, environmental changes, technology, and policy decisions, the Intergovernmental Panel on Climate Change (IPCC) developed a range of possible future emission scenarios, based on a combination of these driving factors.

For the Fifth Assessment Report[i], published in 2013 and 2014 (AR5), IPCC updated the emission scenarios, called representative concentration pathways (RCPs), to reflect advances in modeling approaches and additional factors that could affect future climate

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[i] IPCC is currently in its Sixth Assessment Report (AR6) cycle, which reflects updated modeling and future climate projections that have occurred since the development of the Climate Vulnerability Assessment. A summary of the AR6 updates can be found on the IPCC website: https://www.ipcc.ch/report/sixth-assessment-report-cycle/.

### Difference Between Weather and Climate

Climate and weather are intertwined concepts. Weather is the day-to-day state of the atmosphere in terms of temperature, humidity, precipitation, cloudiness, wind, and atmospheric pressure. Climate is how the atmosphere behaves, and is often referred to as the average weather at a particular location over multi-decadal time scales (greater than 30 years). Statistical changes or trends in observed weather patterns are used to identify climate change.

A common confusion between climate and weather is the ability to project climate conditions decades into the future when weather cannot be forecasted more than 10 days in advance. The chaotic nature of weather makes it unpredictable beyond a couple of weeks. However, projecting long-term average changes due to variations in atmospheric composition or well-understood natural oscillations is much easier than pinpointing specific conditions for a particular day.

conditions[3]. For climate adaptation planning, RCP4.5 and RCP8.5 are the most commonly used scenarios. The scenario with higher global emissions, RCP8.5, is also referred to as a "business-as-usual" scenario and represents rapid economic growth with GHG concentrations exceeding 900 parts per million (ppm) by 2100. RCP4.5 represents a more moderate scenario, with GHG emissions rising until the year 2040, reaching a concentration of 550 ppm, followed by stabilization (Figure 3).

## Data Source for Naples Temperature and Precipitation Projections

To develop local projections for temperature and precipitation, downscaled climate model output was obtained from the online LOCA Viewer[ii, 4]. Future downscaled projections rely on 32 statistically downscaled climate models that are also used to inform the Fourth National Climate Assessment, a federal interagency effort to document future changes in the climate and associated impacts. Future conditions were obtained at the Collier County scale for a baseline historical period (1976-2005), mid-century (characterized by 2036-2065) and end-of-century (characterized by 2070-2099) planning time horizons for two future emission scenarios—RCP4.5 and RCP8.5.

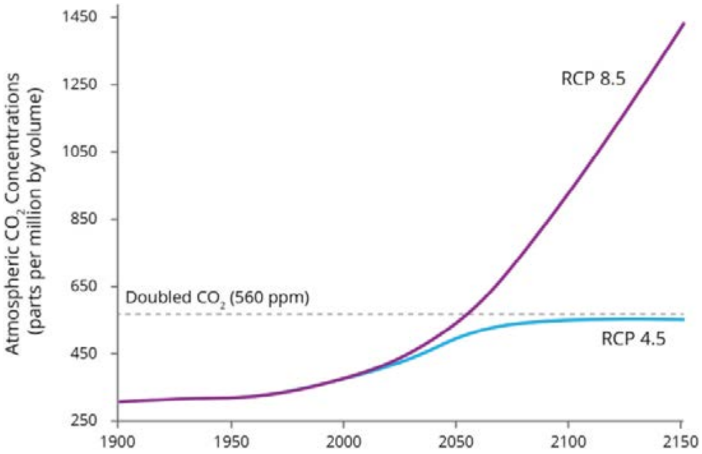
The following indicators for temperature and precipitation were selected to understand potential changes in average and extreme climate conditions:

### Temperature

- Average annual maximum temperature
- Nights above 75 degrees Fahrenheit
- Days equal to or above 95 degrees Fahrenheit

### Precipitation

- Average total annual precipitation
- Days per year with >4 inches of precipitation



Source: Modified from van Vuuren et al. (2011)

*Figure 3: Emission of Carbon Dioxide from RCP 4.5 and 8.5 Scenarios*

## 2.3. Temperature

Temperatures in Florida are strongly influenced by the Gulf of Mexico and Atlantic Ocean. As the state becomes more urbanized, temperatures are also increasingly influenced by the urban heat island (UHI) effect. This effect describes a metropolitan area that is significantly warmer than the surrounding rural area due to a large increase in dark surfaces, such as asphalt and roofs. These dark surfaces are more effective than the natural land at absorbing solar radiation and emitting heat[5].

Downscaled climate model simulations of future temperature conditions for the Naples area are presented in Table 1. Based on the RCP8.5 scenario, average annual maximum temperatures are projected to increase by 4 degrees Fahrenheit by mid-century, and 8 degrees Fahrenheit by end-of-century, relative to historical period observations (1976-2005) (Figure 4). Even greater changes are being observed and projected for nighttime temperatures. Naples currently experiences around 20 to 40 nights per year with temperature above 75 degrees Fahrenheit. Future climate models project the number of warm nights will increase by nearly 60 nights per year by mid-century and 100 nights per year by end-of-century based on the RCP scenarios (Figure 5).

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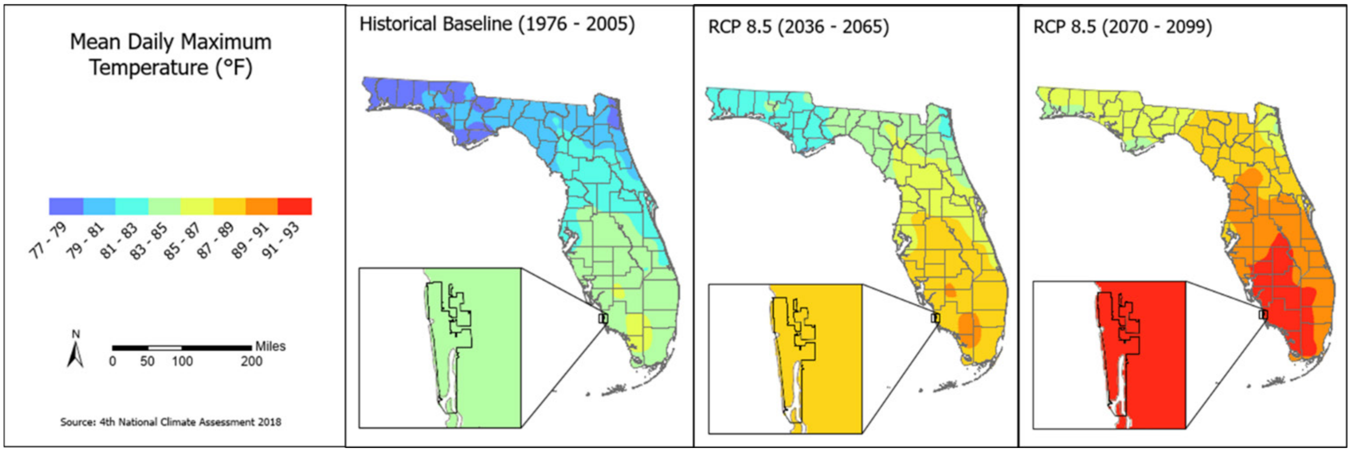
[ii] https://scenarios.globalchange.gov/loca-viewer/

Similar to trends in average conditions, extreme heat events, defined as days above 95 degrees Fahrenheit, are also increasing in frequency for Southwest Florida and Naples area. The area currently experiences fewer than 20 extreme heat days each year. However, this number is expected to increase by up to an additional 60 days at mid-century and an additional 120 days by end of the century (Figure 6).

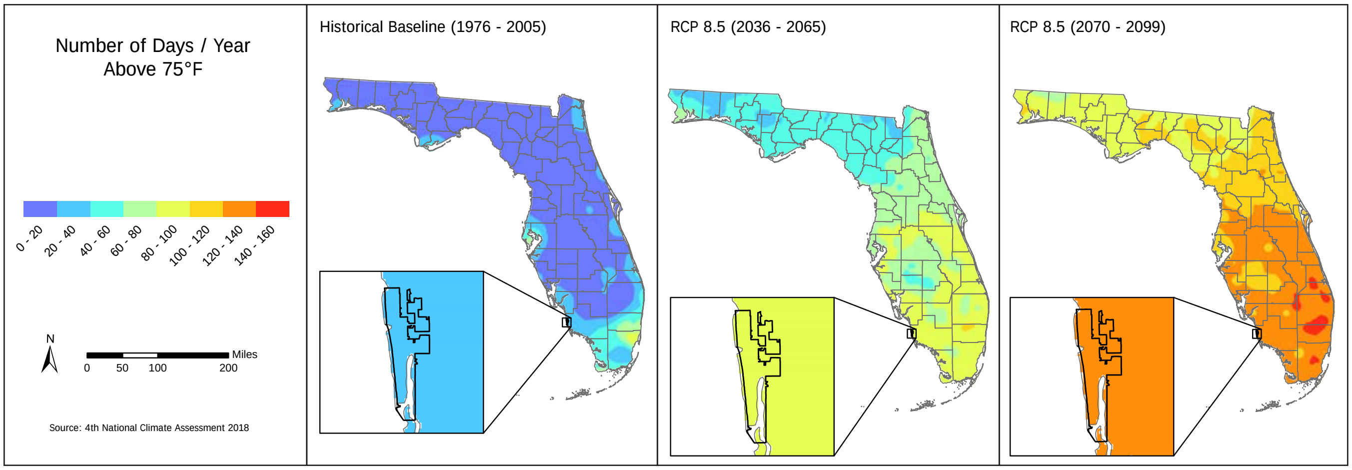
*Table 1: Summary of Temperature Projections for Naples*

| | Baseline (1970-2005) | RCP 4.5 (mid-century stabilization) | | RCP 8.5 (rapid economic growth) | |
|---|---|---|---|---|---|
| | | Mid-century (2036-2065) | End of Century (2070-2099) | Mid-century (2036-2065) | End of Century (2070-2099) |
| Average Annual Max Temp (°F) | 83 to 85 | +3 | +3 | +4 | +8 |
| Nights Above 75°F | 20 to 40 | +60 | +90 | +60 | +100 |
| Days Above 95°F | 0-20 | +50 | +70 | +60 | +120 |



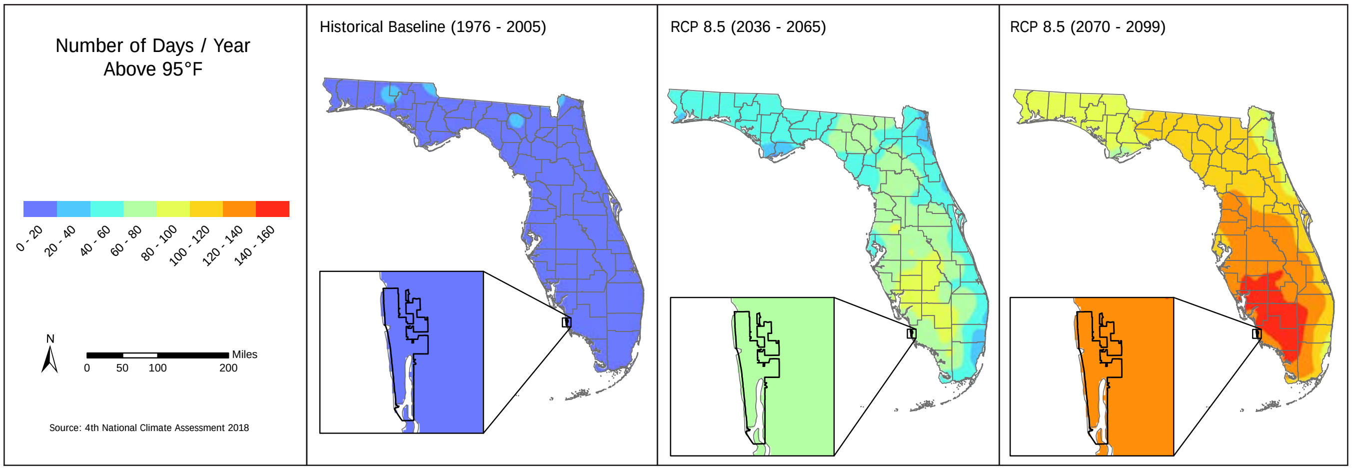
Source: 4th National Climate Assessment 2018

*Figure 4: Historical and Projected Changes in Mean Daily Maximum Temperature*



Source: 4th National Climate Assessment 2018

*Figure 5: Historical and Projected Changes in the Number of Warm Nights*


Number of Days / Year Above 95°F

Historical Baseline (1976 - 2005)

RCP 8.5 (2036 - 2065)

RCP 8.5 (2070 - 2099)

Source: 4th National Climate Assessment 2018

*Figure 6: Historical and Projected Changes in the Number of Extreme Heat Days*

## 2.4. Precipitation

Precipitation trends in Florida are primarily controlled by a combination of the amount of heat in the atmosphere, cloud cover, sea-breeze–related convection, and large-scale ocean-atmosphere phenomena such as the Atlantic Multi-decadal Oscillation (AMO) and El Niño Southern Oscillation[6]. The Florida wet season spans May through October, and the dry season occurs November through April. Although precipitation has been recorded over land areas in Florida for more than a century, interpreting trends has been difficult due to high spatial and temporal variability. For example, it can rain several inches in one neighborhood while being a sunny day in an adjacent area.

Although still an area of active research, studies suggest that local average precipitation patterns may be changing in Florida. Analysis of long-term precipitation records (1950-2008) from 57 weather stations across the state indicate a delay in the onset of the wet season. A reduction in rainfall amounts was particularly evident for the month of May. This seasonal shift of the wet season may result in localized drought conditions, particularly when combined with high atmospheric temperatures[7].

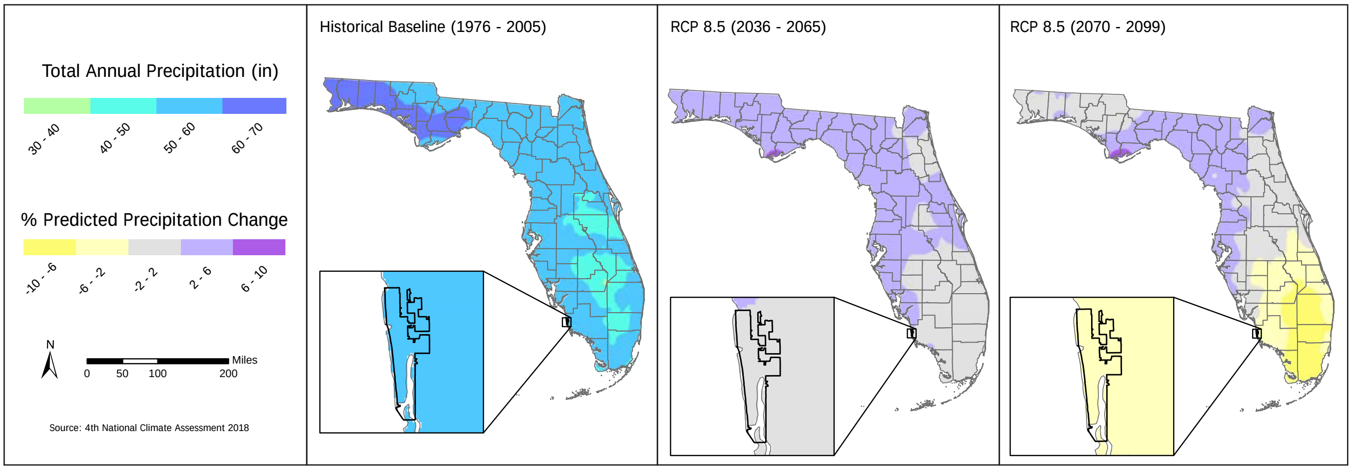
Projections of future precipitation are one of the least- certain aspects of climate models at the regional level. Models do not resolve many of the fine-scale and complex interactions that occur locally, particularly with projecting changes in large-scale circulation and the role in cloud formation and precipitation[8, 9]. Understanding the climate change effects on precipitation trends in Florida is particularly challenging, because it is also a transitional zone between eastern North America, which is projected to have increased annual rainfall amounts by the end of the century, and the Caribbean, which is projected to experience drier conditions than have been historically observed[10].

Downscaled climate model simulations of future precipitation conditions for the Naples area are presented in Table 2 and Figures 7 and 8 based on a business as usual scenario (RCP 8.5). In general, there was no strong trend identified for projections of average precipitation by mid-century. However, by end of the century, there may be an overall decrease in rainfall by up to six percent when compared to historical conditions.

Although models indicate negligible changes in the overall amount of annual precipitation, they project a possible increase in extreme rainfall and high intensity events. The number of days projected to experience greater than four inches of rainfall may increase by up to 20 percent by mid and end of century. However, this is a much lower increase in high-intensity rainfall than is projected for the rest of Florida, with most areas of the state projected to experience more than an 80 percent increase in extreme precipitation by end of century.

*Table 2: Summary of Precipitation Projections for Naples*

| | Baseline (1976-2005) | RCP 4.5 (mid-century stabilization) | | RCP 8.5 (rapid economic growth) | |
|---|---|---|---|---|---|
| | | 2036-2065 | 2070-2099 | 2036-2065 | 2070-2099 |
| Average Annual Precipitation (Inches) | 50 to 60 in | -5 to +5% | 0 to +5% | -2 to +2% | -6 to -2% |
| Days With >4 Inches of Rainfall | 0.25-0.50 in | +0 to +20% | +0 to +20% | +0 to +20% | +0 to +20% |

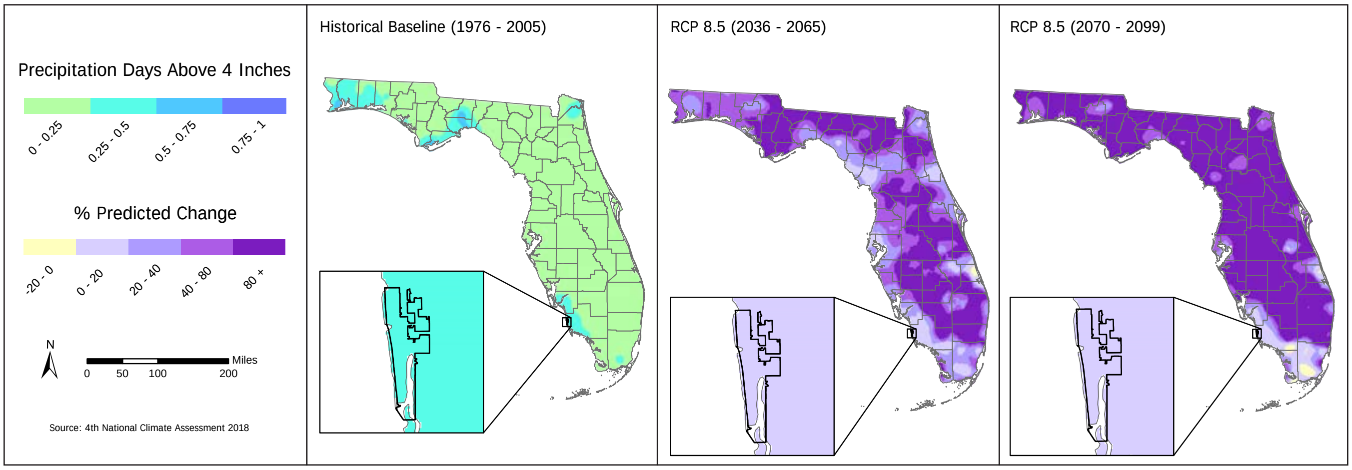

Historical Baseline (1976 - 2005)

RCP 8.5 (2036 - 2065)

RCP 8.5 (2070 - 2099)

Source: 4th National Climate Assessment 2018

*Figure 7: Historical and Projected Changes in Annual Precipitation*


Historical Baseline (1976 - 2005)

RCP 8.5 (2036 - 2065)

RCP 8.5 (2070 - 2099)

Source: 4th National Climate Assessment 2018

*Figure 8: Historical and Projected Changes in the Number of Days with >4 Inches of Precipitation*

## 2.5. Coastal Storms

Tropical storms and hurricanes are the leading cause of major flood damage in South Florida. Coastal storms in Florida typically develop in the summer months (June-November), but nearly 75 percent affect the state between August and October, when equatorial Atlantic Ocean and Gulf waters are the warmest[11]. Storm surge, an abnormal rise in water levels due to low atmospheric pressure and winds associated with an offshore tropical system, is the primary storm component responsible for large-scale flooding in low-lying coastal areas. Storm surge can reach 40 feet above average sea level for the strongest hurricanes[12]. The destructive power of storm surge, combined with large waves, can travel several miles inland on Florida's very low topography, damaging or destroying infrastructure, eroding beaches, and inundating coastal assets for up to several days.

Since the early 1980s, when high-resolution satellite data became available, there has been an increase in the intensity, frequency, and duration of Atlantic hurricanes[13, 14, 15]. Although hurricane development is influenced by multiple factors, studies suggest the recent increases in activity and storm intensity are linked to higher sea surface temperatures in the region[16] (CMIP5). End-of-century model projections suggest that although the overall number of storms may decrease in Florida, the possibility of storms rated as severe may increase. In particular, the strongest hurricanes (Category 4 and 5) are estimated to increase in frequency[17, 18].

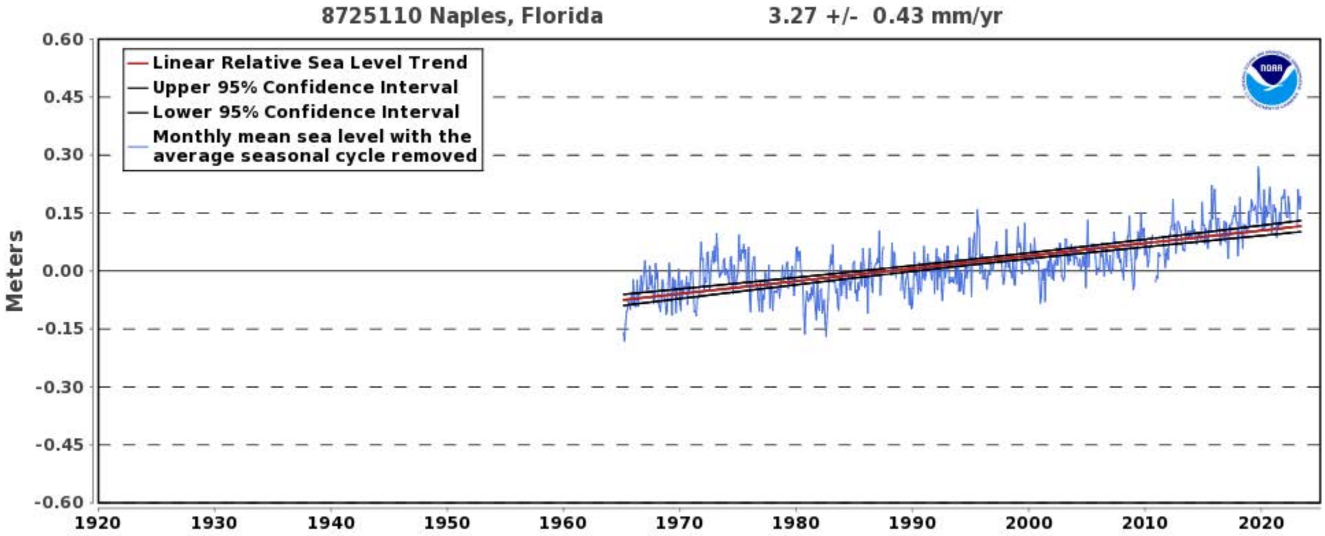
Regardless of change in the trends of coastal storms, sea level rise will yield large changes in the frequency and intensity of coastal flooding by elevating baseline water level conditions.

## 2.6. Sea Level Rise

Sea levels have been recorded locally by tide stations since the late 1800s, and globally by satellite altimetry since the early 1990s. Global sea level rise is driven by two primary factors: melting of land-based ice sheets (glaciers and continental ice sheets); and expansion of seawater as it warms (thermal expansion). During the 20th century, these two processes have caused global ocean levels to increase at an average rate of 0.07 inch per year (1.8 millimeters [mm] per year). Recent studies show that this rate has accelerated to 0.13 inch/year (3.3 mm/year) in the past 20 years, which is roughly twice the average rate of the preceding 80 years[19, 20].

Although these two factors increase global sea levels, the effects are not experienced uniformly. There is considerable spatial variability in the rate of sea level rise across the globe, because oceanic and atmospheric conditions can have a large influence on water distribution and uneven ocean conditions. Additionally, vertical land movement (i.e., subsidence or uplift) plays a large role in local sea level variability along shorelines.

Since the installation of the Naples tide station in the mid-1960s, local water levels have increased at a rate of 0.13 inch/year (3.21 mm/year), which equates to a 7-inch increase[21] (Figure 9). Recent observations also indicate that water levels in Southwest Florida are increasing at a faster rate than the global scale. Satellite altimetry data collected since 1993, shows that sea levels in the Gulf of Mexico region have accelerated to 0.17 inch/year (4.2 mm/year), which is 0.04 inch/year (1 mm/year) higher than global observations[22].



Source: NOAA Sea Level Rise Trends (Station #8725110)

*Figure 9: Observed Sea Level Measurements and Calculated Trend for Naples, FL*

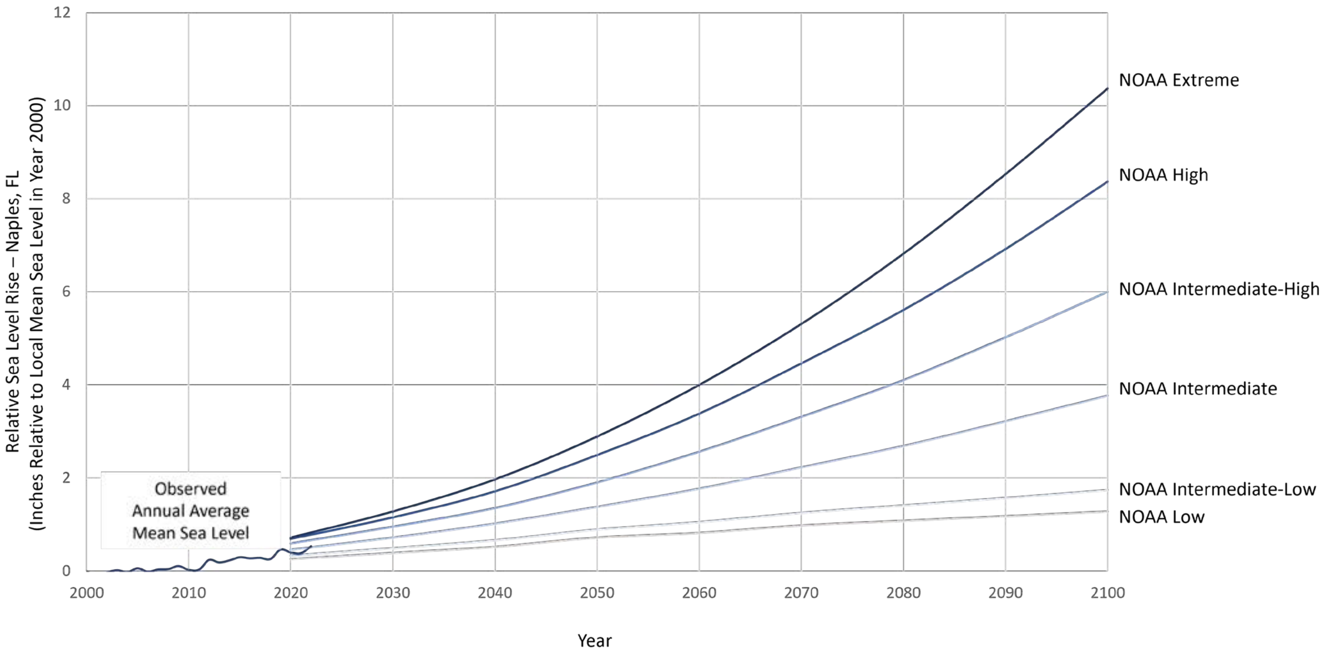


*Figure 10: Sea Level Rise Projections for Naples, FL*

In 2017, the National Oceanic and Atmospheric Administration (NOAA) released sea level rise projections in the report titled, Global and Regional Sea Level Rise Scenarios for the United States[23]. The report examines a wide range of plausible global and regional future water levels based on future climate conditions and ice sheet response. Based on these projections, sea levels at the City of Naples may be between 0.7 to 2.9 feet higher by 2050, and 1.3 to 10.4 feet higher by 2100 (Figure 10).

# 3

# Sea Level Rise Mapping Methodology

Sea level rise inundation maps are a valuable tool for evaluating the potential exposure of assets to future water level conditions. The maps are a useful means of evaluating the timing and extent of flooding that may be experienced based on projections of sea level rise. These maps also help to identify critical flooding thresholds where an entire area may be compromised.

The sections below describe the selection of sea level rise scenarios evaluated as a part of the City's Climate Vulnerability Assessment, leveraged sea level rise mapping layers, and mapping assumptions.

## 3.1. Sea Level Rise Scenario Selection

In accordance with the Resilient Florida Grant Program (s. 380.093, Florida Statute), sea level rise projections aligning with planning time horizons of 2040 and 2070 considering NOAA Intermediate Low and NOAA Intermediate High curves were selected to evaluate future flood impacts for City assets (Table 3).

*Table 3: Sea Level Rise Projections for Naples*

| Year | Int-Low | Int-High |
|---|---|---|
| Existing Conditions | 0 | 0 |
| 2040 | 0.4 | 1.1 |
| 2070 | 1.0 | 3.0 |

Note: Sea level rise projections have been adjusted to be relative to existing (2020) conditions using observed sea level trends from the Naples tide stations[24].

Future sea levels were evaluated under two tide conditions: 1) daily high tide; and 2) extreme storm tide. The water level evaluated for daily tidal inundation is the mean higher high water (MHHW) and represents the average of the higher of two high tides each day. The water level evaluated for the extreme storm tide is the 1-percent annual chance coastal storm, which is statistically derived water elevation that has a 1 percent chance of occurring in any given year and includes the effects of astronomical tides and storm conditions due to atmospheric pressure and metrological effects. This is a commonly used water design criteria for coastal development and flood protection.

## 3.2. Sea Level Rise Mapping

Development of the sea level rise maps relied on two primary data sources:

### Daily High Tide

A daily high tide water surface digital elevation model (DEM) was developed by adjusting a tidal surface grid of existing conditions mean higher high water (MHHW) elevations to account for future sea level rise projections. The existing conditions tidal surface grid was created by NOAA's Office of Coastal Management and represents spatially varying elevations of MHHW due to the interaction of local bathymetry, currents, and shoreline complexities.

The MHHW water surface DEM was used as input to the University of Florida's Sea Level Rise Sketch Planning Tool (SLR Sketch Planning Tool)[25] to create a geographical extent of future water surface elevations corresponding to the evaluated sea level scenarios.

### Extreme Storm Tide

Flood mapping layers for the 100-year storm tide were leveraged from the Adaptation of Coastal and Urban and Nature Ecosystems (ACUNE) tool[26] developed through a partnership of the University of Florida, Florida Gulf Coast University, University of Miami, and US Geological Survey, and the Institute of Regional Conservation. The tool considers a combination of climate, hurricane, coastal, and ecological models to produce probabilistic storm surge mapping layers representative of a 100-year coastal storm tide along the City's shoreline[27, 28, 29]. A significant advancement of the tool is its ability to account for storm intensification over time. By 2070, storm intensification increases the height of the 100-year storm tide by 5 to 11 feet.

Depths of inundation (MHHW) and flooding (100-year storm tide) due to the mapped water level conditions were created by subtracting a Collier County land surface DEM from the water surface DEMs[30]. The resultant flood hazard DEM provides both the inland extent and depth of inundation for all ground elevations that are below the coastal water level.

## Sea Level Rise Inundation Map Interpretation

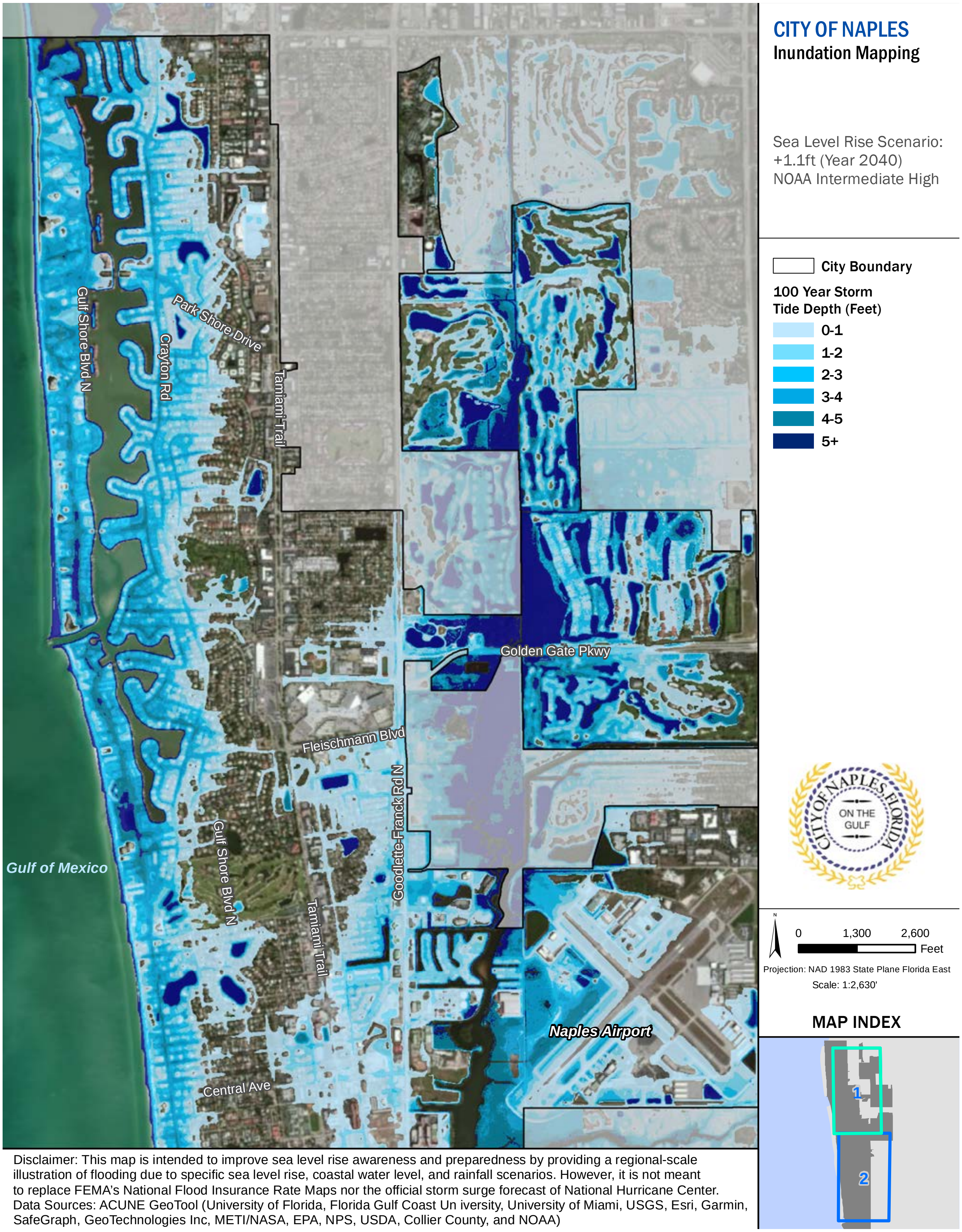
Maps were developed to help visualize areas of the City at risk to temporary flooding and permanent inundation. An example map panel is shown in Figures 11 and 12 for the +1.1-foot SLR NOAA Intermediate-High scenario at the year 2040. The legend along the right side of the map provides key information for interpreting the displayed data:

- Map Scenario –The sea level rise scenario shown on the map is indicated at the top of the legend.
- Water Level Conditions – This legend indicates the depth of MHHW inundation or the 100-year storm tide flooding. Light blue areas indicate shallow inundation and dark blue areas indicate deeper inundation. Green areas indicate the extent (but not depth) of hydraulically disconnected low-lying areas. These low-lying areas are included because it is possible that they may be connected through culverts, storm drains, or other features not captured in the DEM. Disconnected low-lying area may also experience impeded drainage or emergent groundwater flooding in the future due to sea level rise even if they are not directly inundated by overland marine floodwaters.
- City Boundary – The City's boundary is provided to provide a high level visual of potential areas of the City that may be exposed to sea level rise inundation.

The resulting output mapping layers were used as input for spatial analysis in the Geographic Information System (GIS) to estimate the exposure of City built and natural assets, including City-owned utilities, facilities, community assets, airport assets, and natural habitats. Sea level rise layers were overlaid on site feature locations to evaluate for overlap, indicating potential flood exposure.

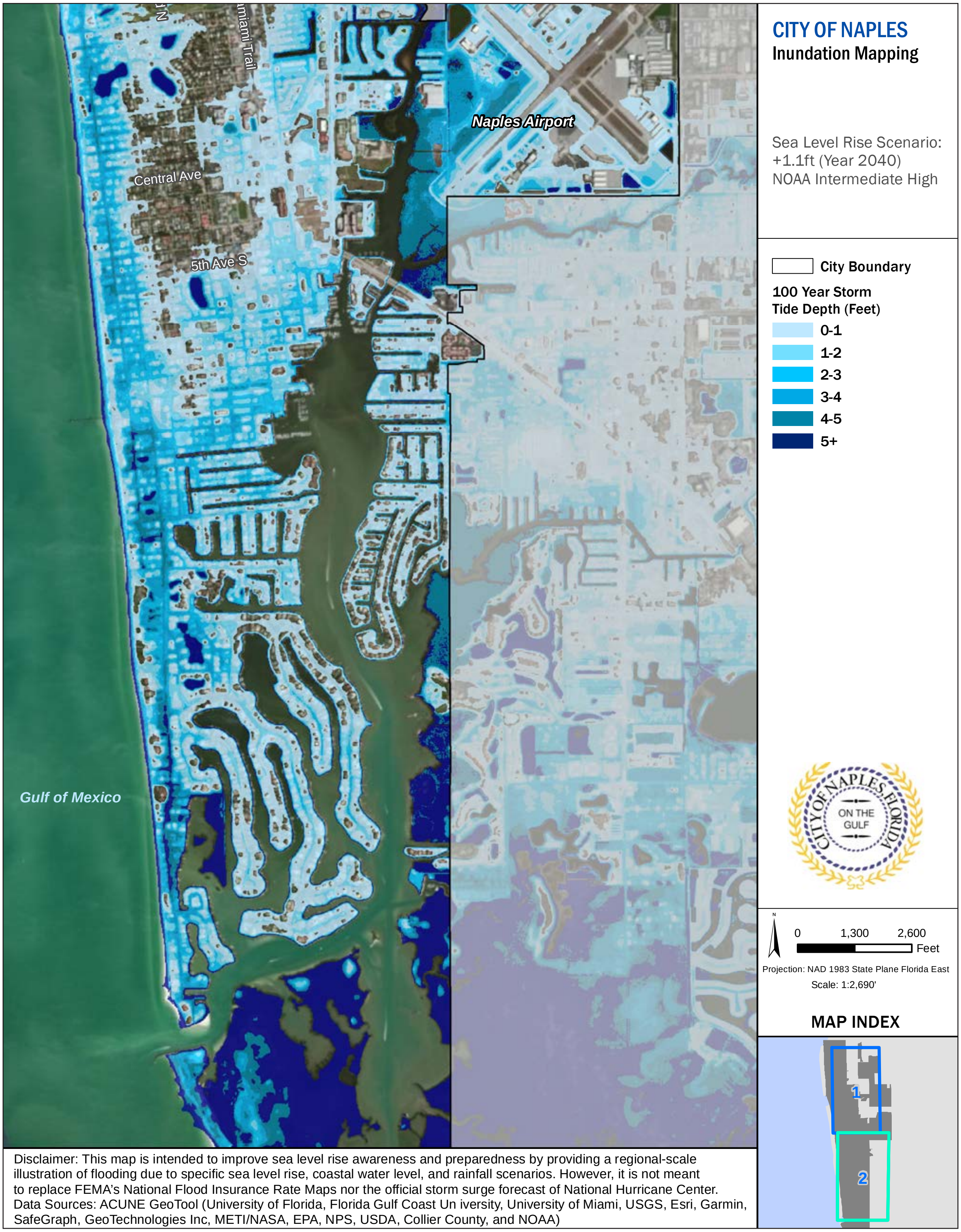
The full set up sea level rise maps are presented in Appendix A.

Coastal flooding at Tin City during Hurricane Ian (09/28/2022)



Disclaimer: This map is intended to improve sea level rise awareness and preparedness by providing a regional-scale illustration of flooding due to specific sea level rise, coastal water level, and rainfall scenarios. However, it is not meant to replace FEMA's National Flood Insurance Rate Maps nor the official storm surge forecast of National Hurricane Center. Data Sources: ACUNE GeoTool (University of Florida, Florida Gulf Coast Un iversity, University of Miami, USGS, Esri, Garmin, SafeGraph, GeoTechnologies Inc, METI/NASA, EPA, NPS, USDA, Collier County, and NOAA)

*Figure 11: Sea Level Rise Map Example (North Naples)*



Disclaimer: This map is intended to improve sea level rise awareness and preparedness by providing a regional-scale illustration of flooding due to specific sea level rise, coastal water level, and rainfall scenarios. However, it is not meant to replace FEMA's National Flood Insurance Rate Maps nor the official storm surge forecast of National Hurricane Center. Data Sources: ACUNE GeoTool (University of Florida, Florida Gulf Coast Un iversity, University of Miami, USGS, Esri, Garmin, SafeGraph, GeoTechnologies Inc, METI/NASA, EPA, NPS, USDA, Collier County, and NOAA)

*Figure 12: Sea Level Rise Map Example (South Naples)*

## 3.3. Tidal Flood Days

In addition to evaluating the timing and extent of coastal storm surge flooding and high tide inundation, the evaluation of the City's vulnerability to sea level rise considered the potential frequency of shoreline overtopping. For this evaluation, a shoreline was delineated using the topographic DEM and used to identify low-lying shoreline segments that could provide a flood pathway for inland areas of the City. The hourly time record of historical hourly tidal observations (March 1965 to September 2022) was downloaded for the Naples tide station (#8725110)[31] and adjusted to reflect present day (2020), 2040, and 2070 conditions, considering NOAA Intermediate Low and NOAA Intermediate High sea level rise projections. The adjusted time series was compared with the City's delineated shoreline to calculate the average annual number of days each coastline segment is projected to be exceeded for current and future conditions.

To illustrate the findings geographically, the resulting number of average annual tidal flood days for each sea level scenario was categorized as low (<1 day per year), moderate (1 to 12 days per year), high (12 to 52 days per year), and very high (>52 days per year). This breakdown of the results allows a logical comparison of potential shoreline overtopping frequencies that include nuisance flood conditions (e.g., up to 1 day a month for low and moderate risk shoreline segments), to higher frequency and problematic flood conditions (e.g., up to 1 day per week for high risk shoreline segments, and more than 1 day per week for very high risk shoreline segments). An example map panel is shown in Figures 13 and 14 for the +1.1-foot SLR NOAA Intermediate-High scenario at the year 2040. The full set of tidal flood day maps are presented in Appendix B.

Under the NOAA Intermediate Low scenario, shoreline overtopping during high tide conditions first occurs by 2040 along low-lying areas of the shoreline in Naples Bay and the airport property. By 2070, short segments of shoreline in Moorings Bay are overtopped, but it is largely limited to low and moderate frequency of tidal flood days. At the 2070 planning time horizon, shoreline overtopping extends across Naples Bay with areas of high and very high frequency of tidal flood days occurring along the airport, Crayton Cove, and segments of the shoreline adjacent to the downtown area.

Under the NOAA Intermediate High scenario, shoreline overtopping is mostly concentrated within Naples Bay, with large segments of shoreline experiencing high and very high frequency of tidal flood days along the airport, Crayton Cove, and along the downtown waterfront. By 2070, most of the Naples shoreline is projected to experience a high and very high frequency of tidal flood days in Moorings Bay and Naples Bay.

Table 4 provides a tabulation of the average annual number of days per year the shoreline is projected to be exceeded or overtopped for a range of shoreline elevations across the City.

*Table 4: Number of High Tide Flood Days Per Year*

| | | | **Shoreline Elevations (ft, NAVD88)** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario** | **Year** | **SLR (ft)** | **2** | **2.25** | **2.5** | **2.75** | **3** | **3.25** | **3.5** | **3.75** | **4** | **4.25** | **4.5** | **4.75** | **5** | **5.25** | **5.5** | **5.75** | **6** |
| Existing Conditions | 2020 | 0.0 | 4 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Intermediate Low | 2040 | 0.4 | 26 | 8 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | 2070 | 1.0 | 167 | 92 | 40 | 13 | 4 | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Intermediate High | 2040 | 1.1 | 200 | 119 | 57 | 21 | 6 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| | 2070 | 3.0 | 365 | 365 | 365 | 363 | 359 | 344 | 308 | 246 | 167 | 92 | 40 | 13 | 4 | 1 | <1 | <1 | <1 |

| | | |
|---|---|---|
| Low | 🟨 | <1 day per year |
| Mod | 🟧 | <12 days per year |
| High | 🟧 | <52 days per year |
| Very High | 🟥 | >52 days per year (once a week or more) |

Flooding at Naples City Hall following Hurricane Ian.

Disclaimer: This map is intended to improve sea level rise awareness and preparedness by providing a regional-scale illustration of inundation and coastal flooding due to specific sea level rise and storm surge scenarios. However, it is not meant to replace FEMA's National Flood Insurance Rate Maps nor the official storm surge forecast of National Hurricane Center.
Data Sources: USGS; NOAA Center for Operational Oceanographic Products and Services; AECOM.

*Figure 13: Sea Level Rise Map Example (North Naples)*

Disclaimer: This map is intended to improve sea level rise awareness and preparedness by providing a regional-scale illustration of inundation and coastal flooding due to specific sea level rise and storm surge scenarios. However, it is not meant to replace FEMA's National Flood Insurance Rate Maps nor the official storm surge forecast of National Hurricane Center.
Data Sources: USGS; NOAA Center for Operational Oceanographic Products and Services; AECOM.

*Figure 14: High Tide Flood Days Map Example (South Naples)*

Seawall scour from Hurricane Ian

# 4

# Compound Flood Mapping Methodology

The vulnerability assessment includes an evaluation of the compounding effects posed by sea level rise and future rainfall-induced flooding of the City's assets. The sections below describe the approach to the stormwater model used to inform the assessment, modeled scenarios, and resulting maps of modeled flood extent.

## 4.1. Stormwater Modeling Approach

The stormwater model used for the compound flood analysis is ICPR4 by Streamline Technologies and utilizes the one-dimensional modeling approach. The model is set up at a high-level that does not model all the City's internal stormwater system network but instead only models the major connections between the subbasins that were delineated within the twelve basins laid out within the City of Naples 2018 Stormwater Master Plan Update[32]. Each subbasin was delineated to isolate separate stormwater networks and to model the major outfall pipes, weirs, and pumps that discharge out of each subbasin. The information used to identify the existing stormwater networks included information provided by the City of Naples such as as-builts and GIS data and included information from other studies and South Florida Water Management District permits. Where data gaps persisted in the model, an estimate of locations, elevations, and sizes of stormwater outfall conveyances was conducted through a review of aerial imagery and Light Detection and Ranging (LiDAR) datasets.

## 4.2. Stormwater Modeling Scenario Selection

The modeling scenarios for the compound flood model utilize a rainfall return period of 25 years for a 3-day storm event considering future rainfall projections. Tailwater conditions were also adjusted to consider sea level rise projections for 2040 and 2070 using NOAA Intermediate Low and NOAA Intermediate High scenarios. The 25-year 3-day storm rainfall amount of 11.8 inches was used to represent existing conditions, as referenced in the City of Naples 2018 Stormwater Master Plan Update[33]. The estimated future rainfall projection for both 2040 and 2070 was calculated as 14.2 inches, which reflects a 20% increase from existing conditions (Table 5). This increase is based on the upper range of future changes in local rainfall reported in the National Climate Assessment to represent both mid and end of century conditions. The existing conditions tailwater elevation reflects mean higher high water tidal datum, obtained from the Naples tide station[34] (NOAA #8725110). To understand how increasing sea levels may affect the drainage efficiency of the City's stormwater system, the tailwater condition of the model was adjusted to consider NOAA Intermediate Low and NOAA Intermediate High sea level projections, as indicated in Table 6.

*Table 5: Rainfall Projections for a 25-Year 3-Day Storm Event*

| Year | Rainfall (inches) |
|---|---|
| Existing Conditions (2020) | 11.8 |
| 2040 | 14.2 |
| 2070 | 14.2 |

*Table 6: Stormwater Model Tailwater Elevations*

| Year | NOAA Intermediate Low MHHW (ft, NAVD88) | NOAA Intermediate High MHHW (ft, NAVD88) |
|---|---|---|
| Existing Conditions (2020) | 0.9 | 0.9 |
| 2040 | 1.3 | 2.0 |
| 2070 | 1.9 | 3.9 |

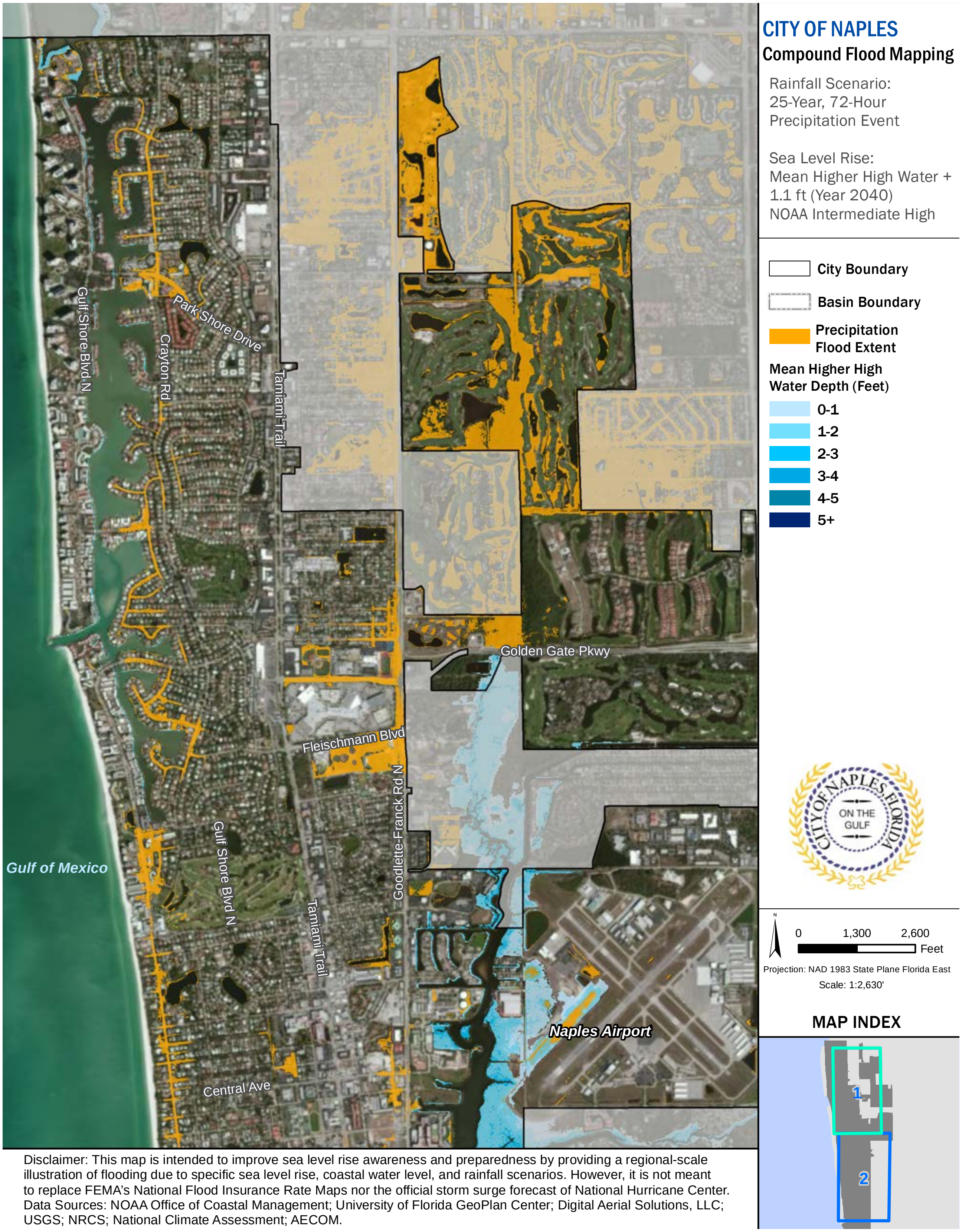
## 4.3. Compound Flood Mapping

Similar to the approach used for the sea level rise inundation maps described in Section 3, a set of compound flood maps was developed to help visualize areas of the City at risk to flooding due to a combination of precipitation and future high tide conditions. An example map panel is shown in Figures 15 and 16 for the +1.1-foot sea level rise NOAA Intermediate High scenario at the year 2040. The legend along the right side of the map provides key information for interpreting the displayed data:

- Map Scenario –The rainfall and modeled sea level tailwater scenario shown on the map is indicated at the top of the legend.
- Flood Extent – This legend indicates the depth of MHHW inundation. Light blue areas indicate shallow inundation and dark blue areas indicate deeper inundation. Orange areas indicate the extent (but not depth) of potential compound flooding resulting from precipitation that is unable to efficiently drain due to elevated coastal high tide conditions.
- City Boundary – The City's boundary provides a high level visual of potential areas of the City that may be exposed to sea level rise inundation.
- Basin Boundary – The City's flood basin boundaries are provided to illustrate the basins with the greatest amount of compound flooding.

The resulting mapping layers were used as input for spatial analysis in GIS to estimate the exposure of City built and natural assets, including City-owned utilities, facilities, community assets, airport assets, and natural habitats. Precipitation flood layers were overlaid on site feature locations to evaluate for overlap, indicating potential flood exposure.

The full set up compound flood maps are presented in Appendix C.



CITY OF NAPLES
Compound Flood Mapping

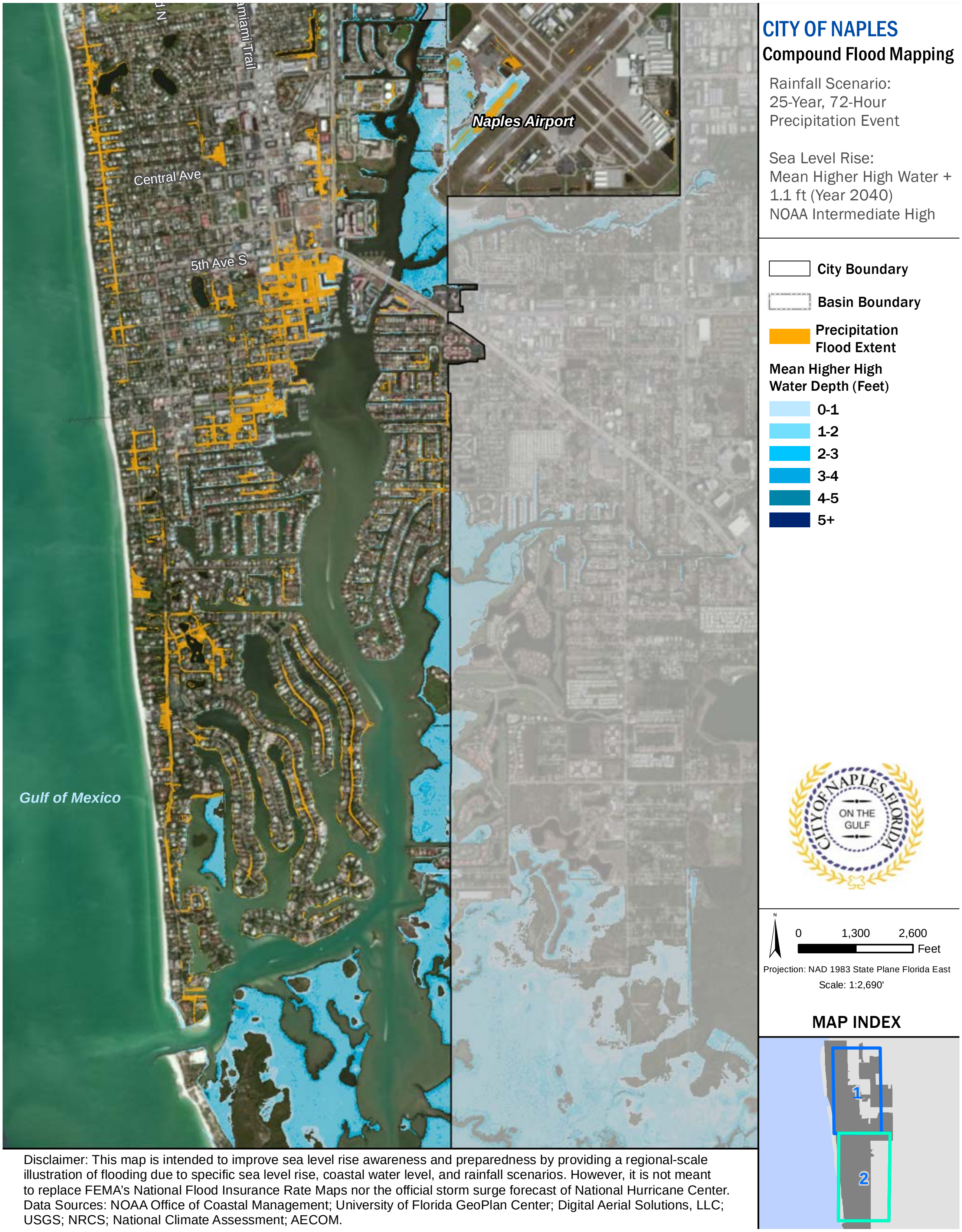
Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
1.1 ft (Year 2040)
NOAA Intermediate High

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

Disclaimer: This map is intended to improve sea level rise awareness and preparedness by providing a regional-scale illustration of flooding due to specific sea level rise, coastal water level, and rainfall scenarios. However, it is not meant to replace FEMA's National Flood Insurance Rate Maps nor the official storm surge forecast of National Hurricane Center.
Data Sources: NOAA Office of Coastal Management; University of Florida GeoPlan Center; Digital Aerial Solutions, LLC; USGS; NRCS; National Climate Assessment; AECOM.

*Figure 15: Compound Flood Map Example (North Naples)*



Disclaimer: This map is intended to improve sea level rise awareness and preparedness by providing a regional-scale illustration of flooding due to specific sea level rise, coastal water level, and rainfall scenarios. However, it is not meant to replace FEMA's National Flood Insurance Rate Maps nor the official storm surge forecast of National Hurricane Center. Data Sources: NOAA Office of Coastal Management; University of Florida GeoPlan Center; Digital Aerial Solutions, LLC; USGS; NRCS; National Climate Assessment; AECOM.

*Figure 16: Compound Flood Map Example (South Naples)*

Oyster Reef Restoration Project in Naples Bay, 2019

# 5

# Asset Inventory

This chapter describes the development of a comprehensive inventory of built and natural assets within the City of Naples. Included assets were selected based on their significance to the City's operations and provided services. All assets included as a part of the inventory were evaluated for vulnerability to climate change impacts.

The following pages describe the development and organization of the City's assets that were considered in the vulnerability assessment.

An inventory was developed to identify and organize the publicly owned assets and services to assess the City's vulnerability to climate change. It is not possible, or necessary to evaluate the climate vulnerability of all individual assets within the City's jurisdictional boundary. Therefore, assets included in the inventory list will be prioritized for evaluation of potential climate change impacts and protection through the development of adaptation strategies. Inventoried assets will be evaluated for exposure to climate change, sensitivity, and adaptive capacity during the vulnerability assessment, discussed in Chapter 6.

The inventory was developed using extensive City-maintained geospatial data for asset locations, as well as through review and discussions with AECOM, the City and Airport Authority staff. The inventory is organized by high level asset categories described in Table 7 to align with critical assets outlined in the Resilient Florida grant program (s. 380.093, Florida Statute).

*Table 7: Inventory of City and Airport assets included in the Assessment*

| Category | Asset Subcategory | Asset |
|---|---|---|
| Transportation Assets and Evacuation Routes | Streets | Streets |
| Transportation Assets and Evacuation Routes | Streets | Evacuation Routes |
| Transportation Assets and Evacuation Routes | Streets | Traffic Cabinets |
| Transportation Assets and Evacuation Routes | Marinas | City Dock – includes dock facilities, parking lot, and fueling station |
| Transportation Assets and Evacuation Routes | Naples Airport | Runways/Taxiways |
| Transportation Assets and Evacuation Routes | Naples Airport | Terminals |
| Transportation Assets and Evacuation Routes | Naples Airport | Airport-Owned Buildings |
| Transportation Assets and Evacuation Routes | Naples Airport | Tenant-Owned Buildings |
| Transportation Assets and Evacuation Routes | Naples Airport | Airfield Electrical Vault |
| Transportation Assets and Evacuation Routes | Naples Airport | Air Traffic Control Tower |
| Transportation Assets and Evacuation Routes | Naples Airport | Airport Parking |
| Transportation Assets and Evacuation Routes | Naples Airport | Aircraft Rescue and Firefighting |
| Transportation Assets and Evacuation Routes | Naples Airport | Generators |
| Critical Infrastructure | Utilities | City of Naples Wastewater Treatment Facility |
| Critical Infrastructure | Utilities | Wastewater Pump Stations |
| Critical Infrastructure | Utilities | Sewer Manholes |
| Critical Infrastructure | Utilities | Electrical Substations |
| Critical Infrastructure | Utilities | Water Treatment Plant |
| Critical Infrastructure | Utilities | Potable Water Pump Stations |
| Critical Infrastructure | Utilities | Potable Water Wells |
| Critical Infrastructure | Stormwater | Stormwater Ponds |
| Critical Infrastructure | Stormwater | Stormwater Inlets |
| Critical Infrastructure | Stormwater | Stormwater Pump Stations |
| Critical Infrastructure | Stormwater | Stormwater Outfalls |
| Critical Community and Emergency Facilities | Police | Naples Police Department -includes SWAT armored vehicle, Crime Scene Investigation Vehicle, two police motorcycles, Mobile Command Post/ RV, marked and unmarked police vehicles |

*Table 7: Inventory of City and Airport assets included in the Assessment (continued)*

| Category | Asset Subcategory | Asset |
|---|---|---|
| Critical Community and Emergency Facilities | Police | Two Police Water Vessels – located at Walker's Marina |
| Critical Community and Emergency Facilities | Fire Stations | Fire-Rescue Administration and Station #1 – includes Engine 1, Ladder 1, Rescue 1 |
| Critical Community and Emergency Facilities | Fire Stations | Fire Station #2 – includes Engine 2, Tower 2, Rescue 2, and Reserve Engines 1 and 2 |
| Critical Community and Emergency Facilities | Local Government Facilities | City Hall |
| Critical Community and Emergency Facilities | Local Government Facilities | Community Development Building – includes Building & Zoning, Planning, Technological Services, Streets, and Stormwater Offices |
| Critical Community and Emergency Facilities | Local Government Facilities | Community Services Building |
| Critical Community and Emergency Facilities | Local Government Facilities | River Park Community Center |
| Critical Community and Emergency Facilities | Local Government Facilities | Utility Administration Building |
| Critical Community and Emergency Facilities | Local Government Facilities | Utilities Maintenance/Wastewater Collections Buildings |
| Critical Community and Emergency Facilities | Local Government Facilities | Solid Waste Recycle Transfer Building |
| Critical Community and Emergency Facilities | Schools | Poinciana Elementary School |
| Critical Community and Emergency Facilities | Schools | Sea Gate Elementary School |
| Critical Community and Emergency Facilities | Schools | Vineyards Elementary School |
| Critical Community and Emergency Facilities | Schools | Gulfview Middle School |
| Critical Community and Emergency Facilities | Schools | Naples High School |
| Critical Community and Emergency Facilities | Schools | St Ann Catholic School |
| Critical Community and Emergency Facilities | Colleges and Universities | Florida Gulf Coast University Branch |
| Critical Community and Emergency Facilities | Hospitals and Urgent Care Centers | Tyrone Medina Walk-in Clinic/Naples Medical Center |
| Critical Community and Emergency Facilities | Hospitals and Urgent Care Centers | Advanced Medical Urgent Care Center |

*Table 7: Inventory of City and Airport assets included in the Assessment (continued)*

| Category | Asset Subcategory | Asset |
|---|---|---|
| Critical Community and Emergency Facilities | Hospitals and Urgent Care Centers | Well-Being Medical Center |
| Critical Community and Emergency Facilities | Hospitals and Urgent Care Centers | Collier Urgent Care |
| Critical Community and Emergency Facilities | Affordable Public Housing Areas | George Washington Carver Apartments |
| Critical Community and Emergency Facilities | Affordable Public Housing Areas | Community Redevelopment Area |
| Critical Community and Emergency Facilities | Economic Centers | Fifth Avenue District |
| Natural, Cultural, and Historical Resources | Natural Resources | Oyster Reefs and Restoration Sites 1-3 |
| Natural, Cultural, and Historical Resources | Natural Resources | Naples Beaches/Dunes |
| Natural, Cultural, and Historical Resources | Natural Resources | Seagrass, Wetlands, and Mangrove Areas |
| Natural, Cultural, and Historical Resources | Parks | Cambier Park |
| Natural, Cultural, and Historical Resources | Parks | Charlie C. Anthony Park |
| Natural, Cultural, and Historical Resources | Parks | Fleischmann Park |
| Natural, Cultural, and Historical Resources | Parks | Naples Dog Park |
| Natural, Cultural, and Historical Resources | Parks | Edge Johnny Nocera Skate Park |
| Natural, Cultural, and Historical Resources | Parks | Arthur L. Allen Tennis Center |
| Natural, Cultural, and Historical Resources | Parks | Baker Park |
| Natural, Cultural, and Historical Resources | Parks | Lowdermilk Park |
| Natural, Cultural, and Historical Resources | Parks | Naples Preserve |
| Natural, Cultural, and Historical Resources | Parks | Naples Pier |
| Natural, Cultural, and Historical Resources | Parks | Naples Landing |
| Natural, Cultural, and Historical Resources | Parks | Parks and Maintenance Facility |
| Natural, Cultural, and Historical Resources | Historic Areas | Historic District |

# 6

# Assessing Vulnerability

Vulnerability assessments help determine which of the City's physical assets and services will potentially be impacted by future climate change conditions. This assessment also provides information about the potential timing, extent, and consequence of climate hazard impacts. Overall, the process serves as a prioritization exercise for identifying the City assets that are the most at risk from climate change and informing the development of strategies to integrate climate considerations into City planning, design, and operations. The sections below describe the approach for assessing the relative vulnerability and prioritization of City assets and describe key susceptibilities identified for each City department and the Airport Authority.

## 6.1. Climate Change Hazards

As the accumulation of GHGs in the atmosphere continues to exert a large-scale influence on natural variations of climate stressors, these climate changes will interact with human systems, which are currently based on a narrow range of historical and existing climate conditions. Once climate stressors begin to negatively impact human health, livelihoods, the economy, valued ecosystems, infrastructure, and environmental resources, they transform to climate hazards that are associated with a range of physical and social impacts. For the purposes of the Assessment, hazards are defined as the potential occurrence of a climate-related natural event, trend, or physical impact that may cause loss of life, injury, or health impacts, and damage or loss to property, infrastructure, ecosystems, or environmental resources[35]. Climate hazards are complex and often the result of the interaction between multiple climate stressors. For example, a flood hazard experienced in a low-lying coastal community may be attributed to the compounding effects of increases in extreme precipitation, intensifying coastal storms, and sea level rise. Figure 17 shows the relationship between the primary climate stressors discussed above and the resulting climate hazards that are evaluated in the Assessment.

The Assessment evaluates climate hazards to the City's built and natural assets and operations. Two climate hazards, directly influenced by the climate stressors described in Chapter 2, were identified as having increasing impacts to the City: flooding and heat.

A description of how hazard impacts to City assets are evaluated is described in the following sections.

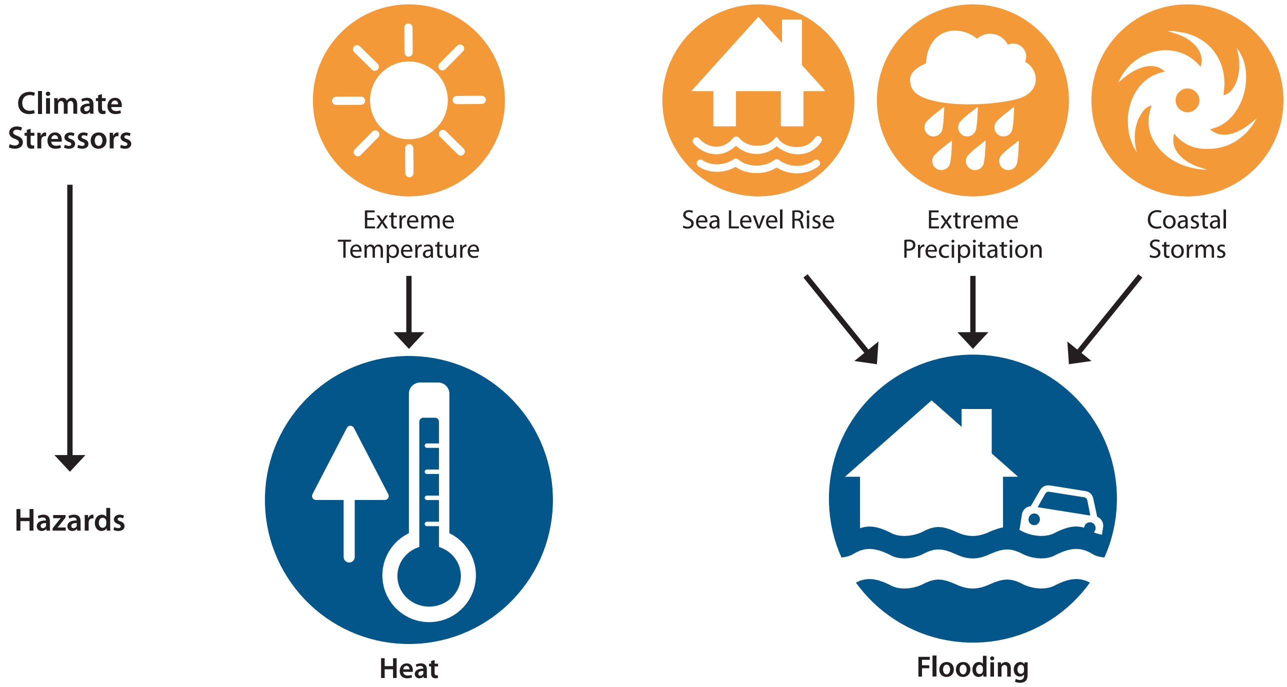


*Figure 17: Relationship between climate stressors and hazards*

## 6.2. Methodology and Approach

A vulnerability assessment helps determine which physical assets and City operations will potentially be impacted by future climate conditions. It also provides information about the potential timing, extent, and consequence of impacts. Overall, the process, illustrated in Figure 18, serves as a prioritization exercise to identify City assets and infrastructure most at risk from climate change and informs the development of strategies to integrate climate change adaptation into City planning, design, and operations.

Based on the recommendations from the Florida Department of Environmental Protection's Florida Adaptation Planning Guidebook, vulnerability is expressed in terms of exposure and sensitivity (Figure 18):

- **Exposure** – the timing and extent to which an asset or system is introduced to the climate hazard
- **Sensitivity** – the degree to which the physical condition and functionality of an asset, population, or system is affected by climate hazard exposure

Although exposure can be a good indicator of an asset's susceptibility to climate change impacts, evaluating sensitivity provides valuable information on the degree to which an asset would be impaired once exposed. Assets are considered most vulnerable if they are exposed to a climate hazard and have high sensitivity.

For assets identified as vulnerable, a high-level risk assessment was also completed by analyzing the potential consequences that could occur due to exposure to climate hazards. Understanding the consequences of inaction is useful in prioritizing assets for potential adaptation planning. Consequences are evaluated from the following perspectives:

- **Environmental** – potential effects to the surrounding natural environment due to damages or impacts to individual assets or operations
- **Social** – potential impacts to the local community, health/safety, provision of social services, and/or culture
- **Economic** – workforce disruption, loss of real estate, impacts on tourism or significant industries, asset damage/loss

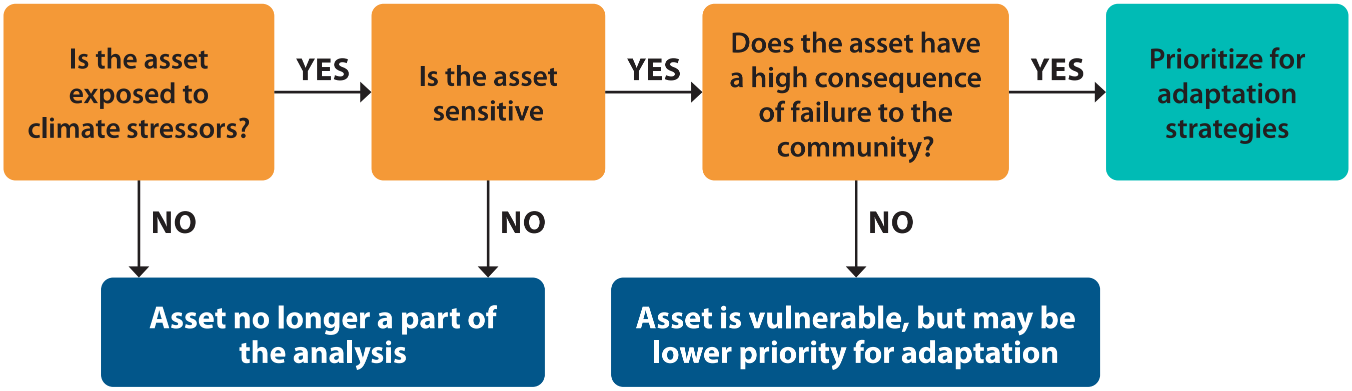


*Figure 18: Vulnerability and risk assessment steps*

The following sections provide additional details for the methodology for each step of the vulnerability assessment. The results of the analysis have been summarized in vulnerability profiles (Section 6.3), which were created for each asset category, and used as the basis for establishing priorities for future climate adaptation planning.

## Exposure

The exposure analysis informs the timing and extent of projected climate change impacts to City assets. Flood exposure was evaluated for the initial timing that assets are projected to be introduced to each contributing flood component (daily high tide, coastal storm, and precipitation) for existing and future sea level conditions. Using a GIS overlay, inventoried assets were compared with flood hazard extends for existing, 2040, and 2070 planning horizons to identify their timing of exposure. Assets that were projected to be exposed to flooding were also evaluated for sensitivity and consequence of exposure. Assets not projected to be exposed to flood hazards were not considered vulnerable and were not removed from the analysis.

For the heat hazard, it is anticipated that all City assets will be exposed to average temperatures and extreme heat events simultaneously over the coming decades. Therefore, spatial variability of heat exposure was not assessed for the assets. However, sensitivity and the consequence of exposure to heat is discussed by asset type in the following sections.

## Sensitivity

Assets that are exposed to climate hazards were analyzed for sensitivity, which is the degree to which an asset is affected by its exposure to a hazard. For example, an asset is considered sensitive to flood waters if its function or construction materials can be impaired or damaged from being wet (e.g., electrical structures are damaged more readily from water contact than roadways and are, therefore, more sensitive).

For each asset, sensitivity was assessed qualitatively based on a set of considerations unique to each asset category. The following characteristics would affect an asset's sensitivity to climate change hazards:

- **Flooding (high tide, coastal storm, and precipitation)**
    - **Electrical equipment** *(flooding or inundation of electrical equipment may lead to operation malfunction or damage to the asset)*
    - **Corrosive material** *(subsurface structures required for the conveyance of water, sewer, natural gas, and electrical utilities may be made of materials that could corrode prematurely if exposed to saltwater).*
    - **Susceptible to increased frequency, duration, or depth of saltwater inundation** *(some assets and/or habitats have a narrow tolerance of water depth changes and may experience damage or complete loss of function).*
    - **Susceptible to erosion/scour events** *(flood event may cause erosion/scour under the asset).*
    - **Buildings** *(some buildings house equipment on lower floors that could be damaged if exposed to flooding).*
    - **Elevation (***some assets are elevated above the adjacent ground elevation, making them less sensitive to floodwaters, but access could potentially be impacted).*
- **Extreme Heat**
    - **Electrical equipment** *(temperatures may exceed the designed threshold).*
    - **Asphalt** *(material is more likely to experience shoving, or ripple across a pavement surface, during extreme heat events)*
    - **Narrow tolerance for temperatures** *(many species have a narrow tolerance for temperature variations)*
    - **Made of dark colored material (***more sensitive due to increased heat gain)*

The Climate Working Group evaluated how susceptible their assets would be to potential exposure to flooding and extreme heat hazards, based on their expertise and the presence of asset characteristics that increase their sensitivity to climate change. Each asset was assigned a qualitative rating ranging from 'not sensitive' to 'high sensitivity' as defined in Table 8.

*Table 8: Climate Change Hazard Sensitivity Scoring*

| Rating | Definition |
|---|---|
| Not Sensitive | No impact on asset functionality |
| Low Sensitivity | Short-term, minor, or reversible damage to asset or functionality |
| Moderate Sensitivity | Significant, but reversible damage to asset functionality |
| High Sensitivity | Irreversible damage to asset and permanent loss of function |

## Consequence

Consequence considers the magnitude of the impact that may occur if the asset is damaged or inoperable due to climate hazard exposure. As many of the City's assets and operations are interconnected, it is also likely that there will be cascading or cumulative consequences that threaten the City's economy, health and well-being, and natural environment.

By understanding the cascading nature of the impacts of climate change, we will be better able to plan, adapt, and manage risks. For each asset, the consequence was assessed qualitatively based on the following set of considerations:

- **Potential economic impacts**
  - **Asset damage** *(electrical or mechanical systems may be damaged).*
  - **Operation disruptions** *(some assets may cause lost revenue due to facility limitations or closure, loss of access via primary roadway, or loss of critical infrastructure).*
  - **Loss of tourism opportunities** *(tourism and seasonal residence may decline due to climate stressors affecting the region's high quality of life).*
  - **Increase in maintenance (***financial burden may increase the City budget due to increased maintenance required for exacerbated stress placed on asset or system).*
- **Potential social impacts**
  - **Loss of jobs** *(inability to access place of employment could have direct and indirect negative consequences for working families).*
  - **Life safety assets** *(such as fire stations, police stations, and roadways that connect to life safety structures or are the only access points for personnel are more sensitive because they need to function 24/7).*
  - **Public health effects** *(observable impacts to the well-being of residents, work force, and tourists with regard to stress, discomfort [extreme heat], water quality, disease, etc.).*
  - **Cultural and historical (***loss of historical communities or cultural assets that define the City's identity).*
- **Potential environmental impacts**
  - **Conversion or loss of habitat** *(existing habitats may face deterioration or complete loss due to inundation or extreme heat events).*
  - **Reduction in water quality** *(flooding could cause coastal waters to be exposed to hazardous materials and other chemicals/oils from land surfaces).*
  - **Harm to local wildlife (***impacts on native or endangered species or species of interest).*

Using their technical expertise, the Working Group used the definitions in Table 9 to assign a qualitative rating ranging from 'low consequence' to 'high consequence' to represent the consequences of damage or loss associated with each asset for each of the three consequence categories (economic, social, and environmental).

*Table 9: Climate Change Hazard Consequence Scoring*

| Rating | Definition |
|---|---|
| Low Consequence | Negligible impacts (e.g., inconvenient or temporary effects) |
| Moderate Consequence | Localized impacts resulting in loss or setback of asset or system |
| High Consequence | Extensive or permanent loss of services and impacts to community likely |

## 6.3. Prioritization of Assets for Adaptation Planning

Assets were prioritized for adaptation considering a combination of their exposure and sensitivity to climate hazards as well as their consequence of asset damage or loss of service. This approach is demonstrated conceptually in Figure 19. Assets that are exposed with a high sensitivity and high consequence were considered a priority for adaptation actions to enhance the City's resilience to climate change.

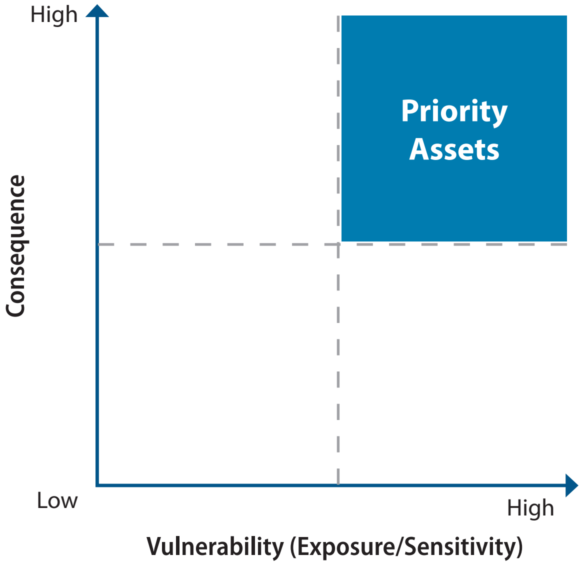


*Figure 19: Prioritization of Assets Conceptual Diagram*

## 6.4. Vulnerability Profiles

The results of the Assessment have been summarized in the following vulnerability profiles, which have been organized by each critical asset category. Assets identified as having a high sensitivity and high consequence through the mid-century planning horizon (year 2040) will be used as the basis for establishing priorities for future climate change adaptation planning.

## Transportation Assets and Evacuation Routes Vulnerability Profile

### Asset Overview

Intersection of 5th Ave S and 3rd St S

The City's transportation network includes over 200 miles of street and road networks that links residents and visitors with community facilities, services, jobs, recreational sites, and neighborhoods throughout the area. It also provides an evacuation route for approaching storm events or other emergencies. In addition to streets, 42 traffic cabinets (which house signal controllers and electronics) were evaluated for their vulnerability to climate change hazards.

The City also hosts the Naples Airport, a general aviation airport that provides domestic access between the City, Marco Island, and the Everglades. The Airport property includes a variety of assets for maintaining operations, including terminals, runways/taxiways, parking areas, navigational aids, car rental facilities, and corporate and non-aviation businesses.

The City Dock provides access to water vessels with 84 slips on floating docks. The site also includes fueling services and public restrooms.

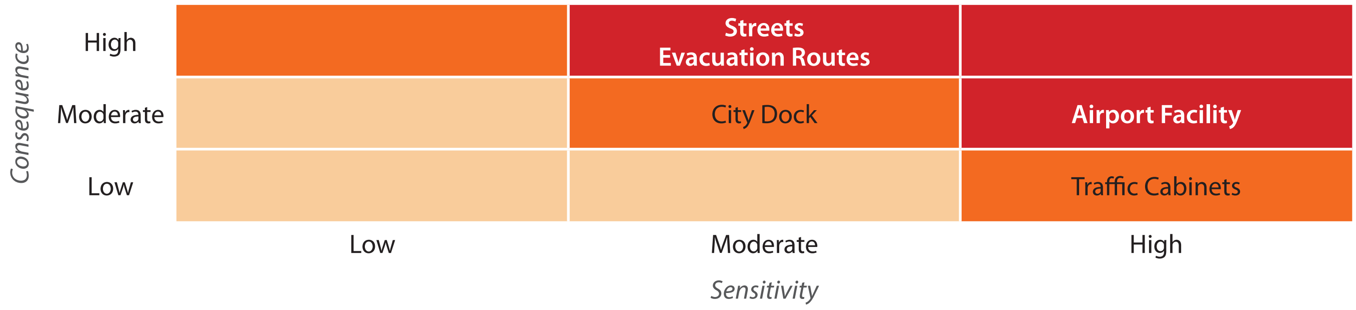
### Flooding (high tide, coastal storm, and precipitation)

| | Sensitivity | Consequence |
|---|---|---|
| **Streets and Evacuation Routes** | Streets and evacuation routes have low to moderate sensitivity to temporary flooding. Movement on roads can quickly resume once water from a flood event of a few inches has receded.<br>Sensitivity of roadways increases to moderate to high during high-velocity flows, repeated, or long-term flooding, which can cause the degradation of roadway and subsurface materials, increasing the need for maintenance and repair. | • Flooded streets can impede or restrict access to large areas of homes and businesses, affect first responders' ability to respond to emergencies, and prevent City staff from performing regular duties.<br>• Flooded streets can create large-scale traffic congestion, prevent the movement of goods/supplies to the City, and impact the quality of everyday life. |
| **Traffic Cabinets** | Traffic cabinets and lighting systems are highly sensitive to flooding because they contain equipment components that may require repair or complete replacement once exposed to floodwaters. | • Damage to traffic cabinets may affect traffic signal operability, affecting travel times and roadway safety across the City. |

|  | Sensitivity | Consequence |
|---|---|---|
| **Naples Airport** | Airports are highly sensitive to flooding. Runways, taxiways, and adjacent navigational aids contain electric light fixtures that may be obstructed or damaged if exposed to flood waters.<br>Standing water on runways and/or taxiways may prevent aircraft from landing or taking off. The Airport also relies as a network of ancillary infrastructure, including an electrical vault, fuel facilities, and buildings that are susceptible to damage from flood exposure. | • Rising sea levels may displace wildlife toward dry areas of the airport, impacting flight operations.<br>• Temporary flooding of the airport runways/taxiways, facilities, fuel facilities, and the electrical vault will cause travel delays, travel re-routing, potential cancellations, an increased need for maintenance and repairs.<br>• Flooding of airport parking lots may limit the capacity of available parking, affecting the passenger travel experience and employee access. |
| **City Dock** | The City Dock is moderately sensitive to flooding. Although it contains electrical components that may be damaged if they are exposed to saltwater, it is a floating structure that reduces its susceptibility to damage from changing water levels. | • Dock facilities include diesel and gasoline stations that could be exposed to the surrounding waterways, if flooded.<br>• Temporary storm flooding will limit the use of the City Dock by residents and visitors.<br>• Long-term inundation will result in a loss of use, affecting outdoor recreation options and water access to the City. |

## Summary of Key Flood Vulnerabilities

Results of the flood hazard vulnerability assessment for transportation assets are summarized below. Roadways, evacuation routes, and airport facilities were identified as highly vulnerable to future flood hazards.



|  |  |  |  |  |
|---|---|---|---|---|
| *Consequence* | High |  | **Streets<br>Evacuation Routes** |  |
|  | Moderate |  | City Dock | **Airport Facility** |
|  | Low |  |  | Traffic Cabinets |
|  |  | Low | Moderate | High |
|  |  |  | *Sensitivity* |  |

**EXPOSURE**

| Asset | Stressor | 2020 | 2040 NOAA Intermediate Low | 2040 NOAA Intermediate High | 2070 NOAA Intermediate Low | 2070 NOAA Intermediate High |
|---|---|---|---|---|---|---|
| Streets | High Tide | ✓<br>2 miles | ✓<br>4 miles | ✓<br>6 miles | ✓<br>5 miles | ✓<br>31 miles |
| Streets | Coastal Storm | ✓<br>59 miles | ✓<br>105 miles | ✓<br>131 miles | ✓<br>160 miles | ✓<br>160 miles |
| Streets | Compound Flood | ✓<br>89 miles | ✓<br>88 miles | ✓<br>92 miles | ✓<br>92 miles | ✓<br>106 miles |
| Evacuation Routes | High Tide | - | ✓<br>(<1 miles) | ✓<br>(<1 miles) | ✓<br>(<1 miles) | ✓<br>(<1 miles) |
| Evacuation Routes | Coastal Storm | ✓<br>(<1 miles) | ✓<br>(<1 miles) | ✓<br>(2 miles) | ✓<br>(6 miles) | ✓<br>(6 miles) |
| Evacuation Routes | Compound Flood | ✓<br>(<1 miles) | ✓<br>(<1 miles) | ✓<br>(<1 miles) | ✓<br>(<1 miles) | ✓<br>(<1 miles) |
| Traffic Cabinets | High Tide | - | - | - | - | ✓<br>(5 cabinets) |
| Traffic Cabinets | Coastal Storm | ✓<br>(6 cabinets) | ✓<br>(21 cabinets) | ✓<br>(26 cabinets) | ✓<br>(42 cabinets) | ✓<br>(42 cabinets) |
| Traffic Cabinets | Compound Flood | ✓<br>(8 cabinets) | ✓<br>(10 cabinets) | ✓<br>(11 cabinets) | ✓<br>(11 cabinets) | ✓<br>(14 cabinets) |
| Naples Airport | High Tide | - | - | ✓ | ✓ | ✓ |
| Naples Airport | Coastal Storm | ✓ | ✓ | ✓ | ✓ | ✓ |
| Naples Airport | Compound Flood | ✓ | ✓ | ✓ | ✓ | ✓ |
| City Dock | High Tide | - | ✓ | ✓ | ✓ | ✓ |
| City Dock | Coastal Storm | ✓ | ✓ | ✓ | ✓ | ✓ |
| City Dock | Compound Flood | - | ✓ | ✓ | ✓ | ✓ |

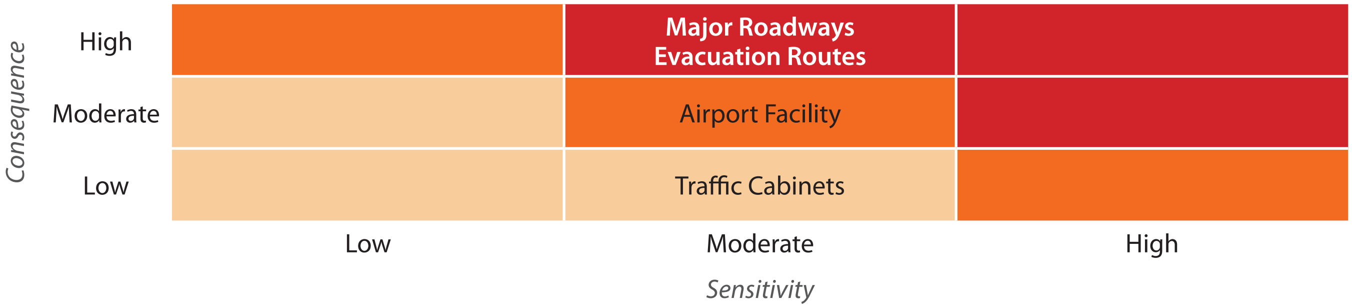
## Extreme Heat

| | Sensitivity | Consequence |
|---|---|---|
| **Streets and Evacuation Routes** | Road materials are moderately sensitive to repeated and prolonged periods of extreme heat. Asphalt roadways may soften, deform, crack, or split due to heat exposure.<br>Concrete roadways and sidewalks are also sensitive to prolonged periods of extreme heat because of thermal expansion. | • Extreme heat days may increase maintenance and repair demands for transportation infrastructure. Under existing conditions, the City already experiences sidewalk heave where expansion joints are insufficient to mitigate extreme heat conditions. As extreme heat conditions become exacerbated or prolonged in the future, it could increase the need for more frequent and extensive sidewalk replacement activities.<br>• Extreme heat days may also affect commuting habits of City residents and visitors, which could have cascading impacts on roadway infrastructure. For example, if temperatures are uncomfortably warm, commuters may choose to avoid walking or cycling, thereby increasing the number of drivers and required road maintenance due to elevated road use over time. |
| **Traffic Cabinets** | Traffic cabinets are moderately sensitive to temperature. They are dependent on electricity, which may be interrupted during power outages or "brownouts" that may occur on extreme heat days should the power grid become overloaded.<br>Extreme heat days may also shorten the lifespan of electrical equipment in the cabinets, which are designed to operate optimally within a specified temperature range. | • Damage to traffic cabinets may affect traffic signal operability, affecting travel times and roadway safety near affected cabinets. |

| | Sensitivity | Consequence |
|---|---|---|
| **Naples Airport** | Runways and taxiways are moderately sensitive to repeated long periods of extreme heat. Asphalt runways may experience pavement distress when surface temperatures exceed 100 °F.<br>Elevated air temperatures can reduce the ability to transmit power and "brown-outs" or power outages may occur due to an overloaded electrical grid. Therefore, any utility assets dependent on an uninterrupted power supply are sensitive to extreme heat days.<br>Extreme heat days can also affect the performance and longevity of exposed electrical equipment, which is designed to operate within a specified temperature range. | • Power outages at the airport may result in operational delays or closures.<br>• Extreme heat days may reduce the lifespan of electrical components and increase the maintenance schedule.<br>• An increase in average temperatures and extreme heat days will cause an overall increase in the airport's energy consumption.<br>• In addition to the airport's physical assets, extreme heat days can create an occupational hazard for outdoor personnel working at the airport. |
| **City Dock** | The City Dock is not sensitive to extreme heat. | Not applicable |

## Summary of Key Heat Vulnerabilities

Results of the heat hazard vulnerability assessment for transportation assets are summarized below. Roadways and evacuation routes were identified as highly vulnerable to future heat hazards.



| | Low | Moderate | High |
|---|---|---|---|
| High | | **Major Roadways**<br>**Evacuation Routes** | |
| Moderate | | Airport Facility | |
| Low | | Traffic Cabinets | |

# Critical Infrastructure Vulnerability Profile

## Asset Overview

Naples Wastewater Treatment Plant

The City is responsible for the protection of public welfare and providing basic services for residents and visitors. To accomplish this goal, the City owns and/or manages a combination of utility infrastructure for water production and distribution, wastewater collection and treatment, and solid waste collection. Supporting the utility systems and operations are administration and equipment services buildings.

The City owns and maintains a stormwater network designed to collect and convey excess floodwater from low-lying areas across the city and discharge it through outfalls to stormwater detention ponds, canals, bays, and ultimately, the Gulf of Mexico during wet weather events.

For the Assessment, physical assets from each sector of utilities (wastewater, water, solid waste, electrical, and administration) and stormwater (pump stations, outfalls, inlets, and retention ponds) were evaluated for their vulnerability to climate change hazards.

## Flooding (high tide, coastal storm, and precipitation)

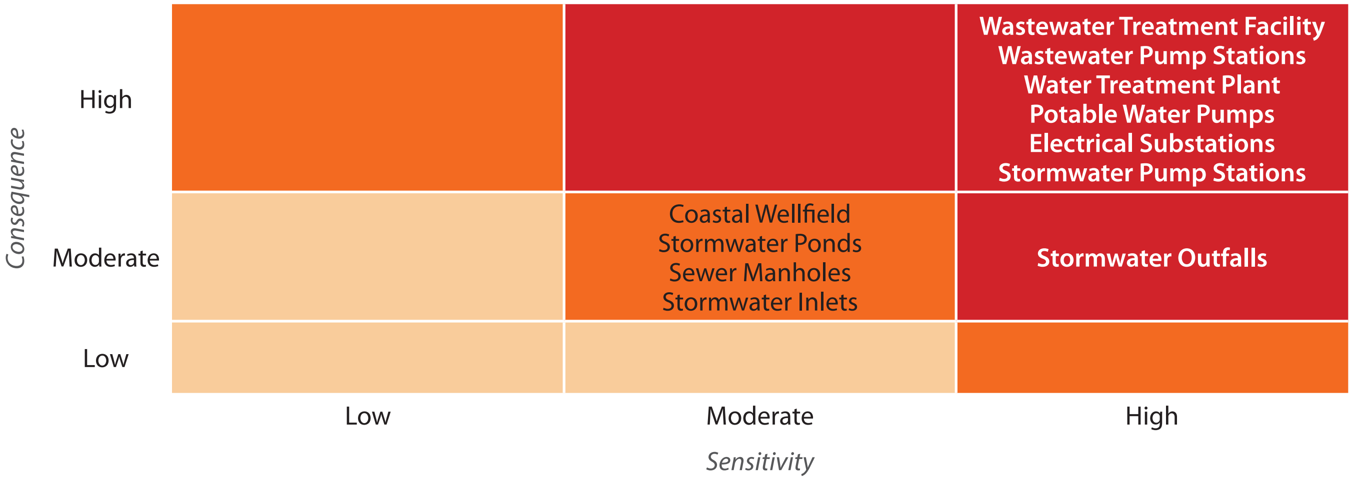
| | Sensitivity | Consequence |
|---|---|---|
| **Wastewater Assets** | Wastewater treatment plants are highly sensitive to flooding because they are complex facilities with many electrical and mechanical components that are susceptible to flood damage. Pump stations are also highly sensitive due to electrical components that may fail or require replacement once exposed. Inflow of excess floodwaters through surface manholes into the wastewater pipe network is another key sensitivity of the system because it can cause the capacity of the treatment plant to be exceeded and compromise the wastewater biological treatment process due to sensitivities to salinity concentrations. | • Wastewater treatment is a critical service provided by the City and failure of wastewater assets can create sewage backups and overflows, affecting the water quality of adjacent waterways and the health of surrounding ecosystems and causing water-borne pathogens to spread and affect the health of the community. |

|  | Sensitivity | Consequence |
|---|---|---|
| **Water Assets** | Exposed wells at the coastal wellfield have moderate to low sensitivity to flooding. Operation of the wells is dependent on the functionality of adjacent electrical controls, which may be damaged if exposed to flooding. Wells are equipped with seals to prevent surface flood water from entering the well casings. The wells may also be sensitive to saltwater intrusion due to sea level rise over time. They are currently being monitored for signs of aquifer exposure with no evidence found to date. Water treatment plants and pumps are highly sensitive to flooding due to the presence of numerous mechanical and electrical components that could be damaged if exposed to water. | • The loss of the water treatment plant will affect potable water supplies to the City.<br>• The loss of water pump stations will affect water pressure throughout the City.<br>• The loss of the coastal wellfield due to contamination from surface water or saltwater intrusion will not immediately affect the City's water supply, because this is not the primary wellfield |
| **Electrical Substations** | The substations are highly sensitive to flood exposure, which may cause equipment failure and an inability to convey power to the City. | • The loss of electrical substations could have cascading impacts, such as sewer overflows into adjacent waterways, affecting water quality; however, the City has backup generators for the majority of the pump stations and water and wastewater treatment plants. |

| | Sensitivity | Consequence |
|---|---|---|
| **Stormwater Assets** | Stormwater retention ponds are moderately sensitive to flooding. Although they are designed to be exposed to excess stormwater, if water levels in the ponds exceed the design capacity, the ponds will overtop, and flood waters could affect adjacent areas. Outfalls and storm inlets are not structurally susceptible to flood damage; however, their functionality is highly sensitive. Most of the stormwater system is gravity drained, with outfalls being the lowest point of discharge. Outfall functionality is limited during any flooding event when receiving waterbody levels are higher than outfall elevations. Flooded inlets that are overwhelmed beyond their design capacity will not drain runoff efficiently. | • The loss of pond functionality will allow excess stormwater, along with sediment and surface contaminants, to flow into the adjacent water bodies and properties.<br>• The loss of any stormwater assets may cause increased flood damage, affect access and the ability of City staff to perform routine tasks, impact recreational opportunities, and influence the overall quality of everyday life for residents and visitors.<br>• The loss of the stormwater system's functionality will have cascading impacts on the City's economy, including negatively-affected property values, causing damage to public and private infrastructure, and impacting the City's tourism industry and residential appeal. |

## Summary of Key Flood Vulnerabilities

Results of the flood hazard vulnerability assessment for critical infrastructure assets are summarized below. Complex utility assets with electrical and mechanical components were generally prioritized as highly vulnerable to future flood hazards.



| Consequence | Low | Moderate | High |
|---|---|---|---|
| High | | | **Wastewater Treatment Facility<br>Wastewater Pump Stations<br>Water Treatment Plant<br>Potable Water Pumps<br>Electrical Substations<br>Stormwater Pump Stations** |
| Moderate | | Coastal Wellfield<br>Stormwater Ponds<br>Sewer Manholes<br>Stormwater Inlets | **Stormwater Outfalls** |
| Low | | | |

*Sensitivity*

**EXPOSURE**

| Asset | Stressor | 2020 | 2040 NOAA Intermediate Low | 2040 NOAA Intermediate High | 2070 NOAA Intermediate Low | 2070 NOAA Intermediate High |
|---|---|---|---|---|---|---|
| City Wastewater Treatment Plant | High Tide | - | - | - | - | ✓ |
| City Wastewater Treatment Plant | Coastal Storm | ✓ | ✓ | ✓ | ✓ | ✓ |
| City Wastewater Treatment Plant | Compound Flood | ✓ | ✓ | ✓ | ✓ | ✓ |
| Wastewater Facilities | High Tide | - | - | - | - | - |
| Wastewater Facilities | Coastal Storm | - | - | ✓ (1 facility) | ✓ (3 facilities) | ✓ (3 facilities) |
| Wastewater Facilities | Compound Flood | - | - | - | - | - |
| Wastewater pump stations | High Tide | - | - | - | - | ✓ (21 stations) |
| Wastewater pump stations | Coastal Storm | ✓ (37 stations) | ✓ (102 stations) | ✓ (145 stations) | ✓ (261 stations) | ✓ (261 stations) |
| Wastewater pump stations | Compound Flood | ✓ (40 stations) | ✓ (56 stations) | ✓ (61 stations) | ✓ (59 stations) | ✓ (77 stations) |
| Wastewater Manholes | High Tide | ✓ (3 manholes) | ✓ (6 manholes) | ✓ (16 manholes) | ✓ (15 manholes) | ✓ (334 manholes) |
| Wastewater Manholes | Coastal Storm | ✓ (849 manholes) | ✓ (1969 manholes) | ✓ (2674 manholes) | ✓ (4170 manholes) | ✓ (4172 manholes) |
| Wastewater Manholes | Compound Flood | ✓ (1075 manholes) | ✓ (1376 manholes) | ✓ (1436 manholes) | ✓ (1427 manholes) | ✓ (1696 manholes) |
| Electrical Substations | High Tide | - | - | - | - | - |

**EXPOSURE**

| Asset | Stressor | 2020 | 2040 NOAA Intermediate Low | 2040 NOAA Intermediate High | 2070 NOAA Intermediate Low | 2070 NOAA Intermediate High |
|---|---|---|---|---|---|---|
| Electrical Substations | Coastal Storm | - | ✓ (1 substation) | ✓ (1 substation) | ✓ (3 substations) | ✓ (3 substations) |
| Electrical Substations | Compound Flood | - | - | - | - | - |
| Water Treatment Plant | High Tide | - | - | - | - | - |
| Water Treatment Plant | Coastal Storm | - | ✓ | ✓ | ✓ | ✓ |
| Water Treatment Plant | Compound Flood | - | - | - | - | ✓ |
| Potable Water Pump Stations | High Tide | - | - | - | - | - |
| Potable Water Pump Stations | Coastal Storm | ✓ (1 station) | ✓ (1 station) | ✓ (1 station) | ✓ (2 stations) | ✓ (2 stations) |
| Potable Water Pump Stations | Compound Flood | - | - | - | - | - |
| Potable Water Wells | High Tide | - | - | ✓ (1 well) | - | ✓ (1 well) |
| Potable Water Wells | Coastal Storm | ✓ (7 wells) | ✓ (13 wells) | ✓ (21 wells) | ✓ (71 wells) | ✓ (71 wells) |
| Potable Water Wells | Compound Flood | ✓ (20 wells) | ✓ (21 wells) | ✓ (21 wells) | ✓ (21 wells) | ✓ (21 wells) |
| Stormwater Pump Stations | High Tide | - | - | - | - | - |
| Stormwater Pump Stations | Coastal Storm | - | ✓ (2 stations) | ✓ (3 stations) | ✓ (3 stations) | ✓ (3 stations) |
| Stormwater Pump Stations | Compound Flood | - | ✓ (1 station) | ✓ (1 station) | ✓ (1 station) | ✓ (3 stations) |

**EXPOSURE**

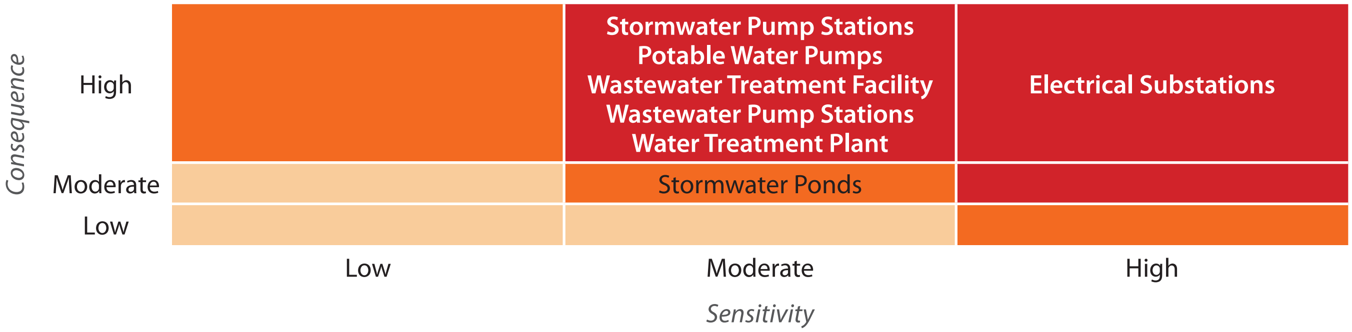
| Asset | Stressor | 2020 | 2040 NOAA Intermediate Low | 2040 NOAA Intermediate High | 2070 NOAA Intermediate Low | 2070 NOAA Intermediate High |
|---|---|---|---|---|---|---|
| Stormwater Discharge | High Tide | ✓ (24 outfalls) | ✓ (30 outfalls) | ✓ (47 outfalls) | ✓ (46 outfalls) | ✓ (139 outfalls) |
| Stormwater Discharge | Coastal Storm | ✓ (250 outfalls) | ✓ (436 outfalls) | ✓ (651 outfalls) | ✓ (806 outfalls) | ✓ (810 outfalls) |
| Stormwater Discharge | Compound Flood | ✓ (341outfalls) | ✓ (373 outfalls) | ✓ (403 outfalls) | ✓ (399 outfalls) | ✓ (515 outfalls) |
| Stormwater Ponds | High Tide | ✓ (9 ponds) | ✓ (9 ponds) | ✓ (9 ponds) | ✓ (9 ponds) | ✓ (29 ponds) |
| Stormwater Ponds | Coastal Storm | ✓ (21 ponds) | ✓ (98 ponds) | ✓ (69 ponds) | ✓ (147 ponds) | ✓ (147 ponds) |
| Stormwater Ponds | Compound Flood | ✓ (89 ponds) | ✓ (96 ponds) | ✓ (99 ponds) | ✓ (99 ponds) | ✓ (109 ponds) |
| Stormwater Inlets | High Tide | - | ✓ (18 inlets) | ✓ (31 inlets) | ✓ (29 inlets) | ✓ (630 inlets) |
| Stormwater Inlets | Coastal Storm | ✓ (1171 inlets) | ✓ (2488 inlets) | ✓ (3322 inlets) | ✓ (4624 inlets) | ✓ (4624 inlets) |
| Stormwater Inlets | Compound Flood | ✓ (1891 inlets) | ✓ (2179 inlets) | ✓ (2265 inlets) | ✓ (2249 inlets) | ✓ (2679 inlets) |

## Extreme Heat

| | Sensitivity | Consequence |
|---|---|---|
| **Utility Assets** | Elevated air temperatures can reduce the ability to transmit power and excess demand on the electrical grid may result in "brown-outs" or power outages. Therefore, any utility assets that are dependent on an uninterrupted power supply are sensitive to extreme heat days.<br>Extreme heat days can also affect the performance and longevity of exposed electrical equipment, which is designed to operate within a specified temperature threshold. | • If the wastewater system fails due to regional electrical outages, sewer pumps and the treatment plant may be disrupted, and there may be sewage backups and overflows, affecting the water quality of adjacent waterways and the health of surrounding ecosystems as well as causing water-borne pathogens to spread and affect the health of the community.<br>• Extreme heat days may also cause an increase in odor impacts from the wastewater treatment plant.<br>• Extreme heat days may lower the lifespan of utility electrical components and may increase the maintenance schedule.<br>• An increase in average temperatures and extreme heat days will cause an overall increase in the City's energy consumption. |
| **Stormwater Assets** | Pump stations, which are dependent on an uninterrupted power supply, are sensitive to extreme heat days. The performance and longevity of exposed electrical equipment in the pump stations can also be affected. Stormwater ponds are also sensitive to heat because algae growth increases when temperatures are higher. | • The loss of pump station functionality due to power outages may cause inland flooding of public and private property.<br>• Increased algae growth in stormwater retention ponds can affect the health of the ponds, many of which are located in public areas and private neighborhoods throughout the City.<br>• In addition to impacts to the City's physical assets, extreme heat days will also create an occupational hazard for the outdoor staff that maintain the stormwater system.<br>• Extreme heat days may lower the lifespan of pump station electrical components and may increase the maintenance schedule. |

## Summary of Key Heat Vulnerabilities

Results of the heat hazard vulnerability assessment for critical infrastructure assets are summarized below. In general, utility assets are highly vulnerable to extreme heat conditions because of their dependence on uninterrupted power supply for operations.



| | Low | Moderate | High |
|---|---|---|---|
| High | | **Stormwater Pump Stations<br>Potable Water Pumps<br>Wastewater Treatment Facility<br>Wastewater Pump Stations<br>Water Treatment Plant** | **Electrical Substations** |
| Moderate | | Stormwater Ponds | |
| Low | | | |

Storm damage at Lowdermilk Beach Park after Hurricane Ian

# Critical Community and Emergency Facilities Vulnerability Profile

## Asset Overview

River Park Community Services Center

The City operates numerous community service facilities for conducting city business and maintaining public programs. Four buildings, including City Hall, the Community Development Building, the Community Services Building, and the River Park Community Services Center, were evaluated for potential climate change impacts.

A key role of the City is to create a safe and secure environment for residents, businesses, and visitors. The City operates police and fire facilities and assets to serve the area, including two fire stations, a police station, and a police water vessel storage area. These were evaluated in the Assessment for potential climate change impacts that could affect their ability to respond to emergencies.

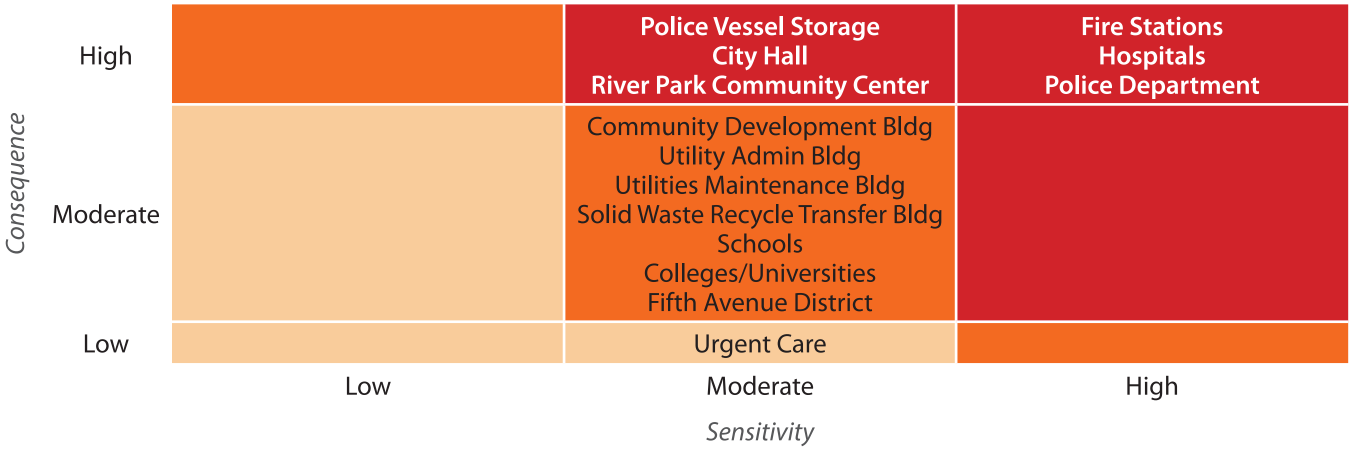
## Flooding (high tide, coastal storm, and precipitation)

| | Sensitivity | Consequence |
|---|---|---|
| **Police** | The Police Department building and water vessel storage area are moderately sensitive to flooding. Both contain electrical equipment and assets located on the first floor, which may experience minor damage, if exposed. However, long-term inundation is likely to cause extensive damage to the building.<br>Flooding of the water vessel storage area may also cause damage to police watercraft and/or prevent access to watercraft during emergencies. | • The loss of police facilities and assets could result in delays in response time and dangers to public health and safety.<br>• By protecting the local community, public safety facilities provide value to the local economy. If emergency responses are delayed or impaired, recovery costs could increase and local communities in the region could endure long-term economic consequences. |
| **Fire** | Fire stations have a high sensitivity to flooding. Although the living quarters of the station are generally constructed to be elevated above the floodplain, the station bays are generally lower to allow access of the apparatuses, which can cause damage to equipment.<br>The ability of fire apparatuses to respond is sensitive to standing water in the apparatus bay. | • The loss of fire facilities and assets could result in delays in response time and dangers to public health and safety.<br>• By protecting the local community, public safety facilities provide value to the local economy. If emergency responses are delayed or impaired, recovery costs could increase and local communities in the region could endure long-term economic consequences. |

|  | Sensitivity | Consequence |
|---|---|---|
| **Local Government Facilities** | Facilities are moderately sensitive to flood exposure. Buildings contain electrical equipment and other assets that may be damaged if exposed to flooding. Flooding may also limit access to building entrances and limited use of the facility. | - A loss of community service facilities may delay City operations because many of these buildings are the primary location for public meetings, permitting, records, and other administrative purposes.<br>- The loss of community service facilities could also have economic impacts on the City, because many of the buildings are the primary location for conducting City business. The loss of access to the buildings may also cause a workforce disruption for City employees. |
| **Buildings** | Other community buildings, such as colleges and community centers, are moderately sensitive to flood exposure. Depending on flood depths, the first floor could experience structural, electrical, and material damage.<br>Hospitals have a high sensitivity to flooding. The first floor may experience material and electrical damage, and due to safety standards, the building may need to be evaluated to determine the ability to reopen the facility. Equipment and instrumentation located on the first floor may also be damaged. | - Flood exposure of buildings may cause damage and the need for costly repairs to structural, electrical, or mechanical components.<br>- Flood damage of the River Park Community Center may disproportionately affect the City's disadvantaged populations that rely on its hosted services and programs.<br>- Damage to hospitals can result in a delay of essential healthcare services to the community, and require costly and extensive cleanup of medical facilities. |

## Summary of Key Flood Vulnerabilities

Results of the flood hazard vulnerability assessment for critical community and emergency assets are summarized below. City Hall as well as most emergency facilities were identified as highly vulnerable to future flood hazards.



|  | Low | Moderate | High |
|---|---|---|---|
| High |  | **Police Vessel Storage**<br>**City Hall**<br>**River Park Community Center** | **Fire Stations**<br>**Hospitals**<br>**Police Department** |
| Moderate |  | Community Development Bldg<br>Utility Admin Bldg<br>Utilities Maintenance Bldg<br>Solid Waste Recycle Transfer Bldg<br>Schools<br>Colleges/Universities<br>Fifth Avenue District |  |
| Low |  | Urgent Care |  |

*Consequence*

*Sensitivity*

## EXPOSURE

| Asset | Stressor | 2020 | 2040 NOAA Intermediate Low | 2040 NOAA Intermediate High | 2070 NOAA Intermediate Low | 2070 NOAA Intermediate High |
|---|---|---|---|---|---|---|
| Police Stations | High Tide | - | - | - | - | - |
| Police Stations | Coastal Storm | - | - | - | ✓<br>( 2 locations) | ✓<br>( 2 locations) |
| Police Stations | Compound Flood | - | - | - | - | - |
| Fire Stations | High Tide | - | - | - | - | - |
| Fire Stations | Coastal Storm | - | ✓<br>(1 station) | ✓<br>(1 station) | ✓<br>(3 stations) | ✓<br>(3 stations) |
| Fire Stations | Compound Flood | - | - | - | - | - |
| Local Government Facilities | High Tide | - | - | - | - | - |
| Local Government Facilities | Coastal Storm | - | ✓<br>(2 facilities) | ✓<br>(4 facilities) | ✓<br>(13 facilities) | ✓<br>(13 facilities) |
| Local Government Facilities | Compound Flood | ✓<br>(1 facility) | ✓<br>(2 facilities) | ✓<br>(2 facilities) | ✓<br>(2 facilities) | ✓<br>(2 facilities) |
| Schools | High Tide | - | - | - | - | - |
| Schools | Coastal Storm | - | ✓<br>(1 school) | ✓<br>(1 school) | ✓<br>(6 schools) | ✓<br>(6 schools) |
| Schools | Compound Flood | - | ✓<br>(1 school) | ✓<br>(1 school) | ✓<br>(1 school) | ✓<br>(1 school) |
| Colleges and Universities | High Tide | - | - | - | - | - |
| Colleges and Universities | Coastal Storm | - | - | ✓ | ✓ | ✓ |

**EXPOSURE**

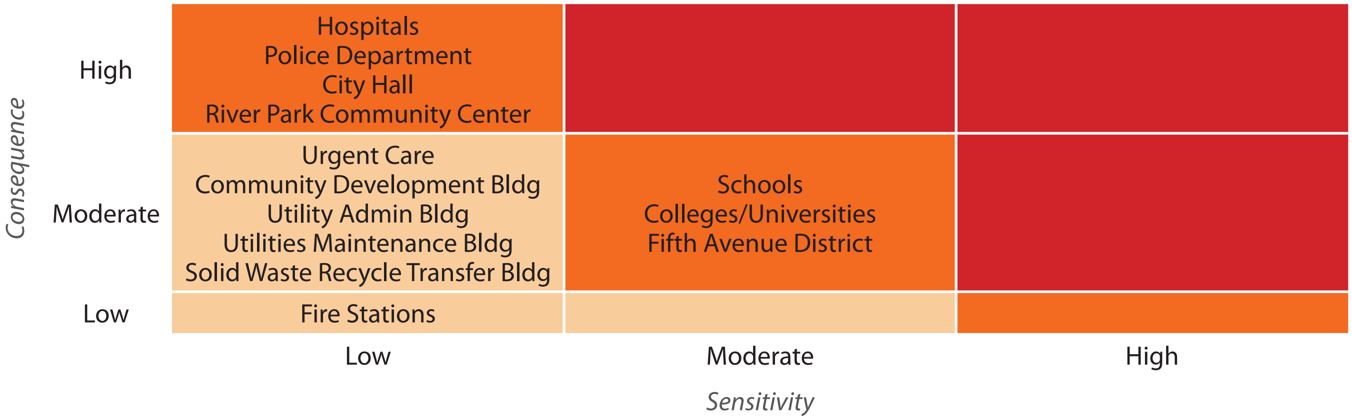
| Asset | Stressor | 2020 | 2040 NOAA Intermediate Low | 2040 NOAA Intermediate High | 2070 NOAA Intermediate Low | 2070 NOAA Intermediate High |
|---|---|---|---|---|---|---|
| Colleges and Universities | Compound Flood | - | - | - | - | - |
| Hospitals and Urgent Care Centers | High Tide | - | - | - | - | - |
| Hospitals and Urgent Care Centers | Coastal Storm | - | ✓ (1 center) | ✓ (1 center) | ✓ (5 centers) | ✓ (5 centers) |
| Hospitals and Urgent Care Centers | Compound Flood | - | - | - | - | - |
| Affordable Public Housing Areas | High Tide | ✓ | ✓ | ✓ | ✓ | ✓ |
| Affordable Public Housing Areas | Coastal Storm | ✓ | ✓ | ✓ | ✓ | ✓ |
| Affordable Public Housing Areas | Compound Flood | ✓ | ✓ | ✓ | ✓ | ✓ |
| Economic Centers | High Tide | - | - | - | - | ✓ |
| Economic Centers | Coastal Storm | ✓ | ✓ | ✓ | ✓ | ✓ |
| Economic Centers | Compound Flood | ✓ | ✓ | ✓ | ✓ | ✓ |
| Community Centers | High Tide | - | - | - | - | - |
| Community Centers | Coastal Storm | - | - | ✓ | ✓ | ✓ |
| Community Centers | Compound Flood | - | - | - | - | - |

## Extreme Heat

| | Sensitivity | Consequence |
|---|---|---|
| **Police and Fire** | Police facilities and fire stations have a low sensitivity to extreme heat days.<br>An increasing amount of energy will be required to cool buildings as average temperatures increase. | • Extreme heat days will create an occupational hazard for outdoor public safety personnel. Exposure to extreme heat can cause various adverse health effects, ranging from the aggravation of minor conditions such as general discomfort, heat cramps, and respiratory difficulties, to increased chances of heat stroke.<br>• Extreme heat may increase the number of calls from the public to first responders or repair services regarding heat-related injuries or electrical/mechanical equipment failure due to overheating.<br>• An increase in emergency responses to public-related heat injuries may increase wear and tear on fire apparatuses, increasing maintenance and fuel costs. |
| **Local Government Facilities and Buildings** | Local government facilities have a low sensitivity to extreme heat days. An increasing amount of energy will be required to cool buildings during as average temperatures increase.<br>Elevated air temperatures also reduce the ability to transmit power, and power outages may occur due to an overloaded electrical grid. | • The temporary closure of community service facilities due to power outages on extreme heat days may delay City operations because many of these buildings are the primary location for public meetings, permitting, records, and other administrative purposes.<br>• An increase in average temperatures and extreme heat days will cause an overall increase in the City's energy consumption to cool buildings. |

## Summary of Key Heat Vulnerabilities

Results of the heat hazard vulnerability assessment for critical community and emergency assets are summarized below. In general, facilities have a moderate to low vulnerability to extreme heat hazards.



| Consequence | | | |
|---|---|---|---|
| High | Hospitals<br>Police Department<br>City Hall<br>River Park Community Center | | |
| Moderate | Urgent Care<br>Community Development Bldg<br>Utility Admin Bldg<br>Utilities Maintenance Bldg<br>Solid Waste Recycle Transfer Bldg | Schools<br>Colleges/Universities<br>Fifth Avenue District | |
| Low | Fire Stations | | |
| | Low | Moderate | High |
| | | *Sensitivity* | |

# Natural, Cultural, and Historical Resources Vulnerability Profile

## Asset Overview

Naples Beach

In addition to physical infrastructure, the City supports, protects, and restores a variety of natural systems. Most of the City's natural areas are located adjacent to or in water bodies, including wetlands, oyster reefs, mangroves, beaches, and dunes, nearshore hardbottom areas, and seagrass beds. Each of these resources were evaluated in the Assessment for potential climate change impacts.

To promote health and wellness, the City provides residents and visitors with a network of parks throughout the City. To ensure that recreational opportunities are available for future generations, the City's parks and associated recreational facilities were also evaluated for their vulnerability to climate change hazards.

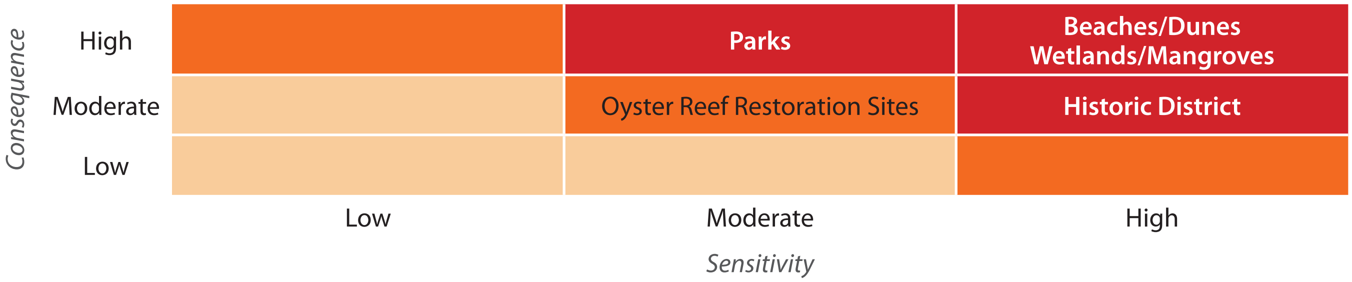
## Flooding (high tide, coastal storm, and precipitation)

| | Sensitivity | Consequence |
|---|---|---|
| **Natural Resources** | The City's natural resources are sensitive to changes in water elevations, even during temporary storm events.<br>Many plant and animal species located in the City's natural areas are dependent on existing habitats and have a narrow tolerance for changing conditions.<br>Oyster reef restoration areas have been designed for sea level rise and can survive in subtidal conditions temporarily. This lowers their sensitivity to flooding and inundation. | • Degraded or damaged beaches could result in a loss of gopher tortoise, sea turtle, and shorebird nesting and feeding habitat. Beach and dune erosion would damage dune grasses. Water quality could be negatively impacted due to resuspension of sand bacteria into the water column.<br>• Inundation may cause a complete loss of mangroves, resulting in a habitat loss for other organisms (e.g., shorebirds, mammals, fish nurseries, etc.). Mangrove habitat loss would affect local water quality, eliminate a large local carbon sink and reduce shoreline protection from storm events.<br>• Impacts to natural resources may affect local recreational opportunities such as the fishing tourism industry, birding, kayaking, etc. This could have cascading impacts, causing a loss of jobs.<br>• Water quality may also be affected, increasing the occurrence of water-borne diseases. |

| | Sensitivity | Consequence |
|---|---|---|
| **Parks** | Most of the City's parks have a low to moderate sensitivity to flooding. Most of the parks contain multi-use facilities (e.g., bocce courts, playgrounds, greenspace, fields, tennis courts, etc.) that may experience minor damage if exposed to temporary flood events.<br>Some parks (e.g., Cambier, Baker, and Lowdermilk) also have shelters or buildings that may have electrical components on the ground floor, which are likely to be more sensitive to flood damage.<br>Vegetation throughout the parks may also be sensitive to repeated flooding or long-term inundation. | • Dock facilities include diesel and gasoline stations that could be exposed to the surrounding waterways, if flooded.<br>• Park vegetation may be damaged or destroyed by exposure to repeated saltwater flooding or long-term inundation.<br>• Temporary storm flooding will limit the use of parks, associated facilities, the dock, and the pier by residents and visitors. Long-term inundation will result in a loss of use, affecting outdoor recreation options and access to iconic areas of the City.<br>• Many of the City's parks and recreation facilities are a large tourist draw for the area (e.g., the Pier, City Dock, Lowdermilk Park, etc.). The loss of the facilities may affect the local economy.<br>• Flood damage to the parks may require post-storm cleanup and damage repair, and the replanting of damaged vegetation. |
| **Historic District and Buildings** | The City's Historic District and buildings are highly sensitive to flooding. Historic buildings are often constructed with lower first flood elevations that increase their potential exposure to flooding. They are also often designed using materials and architecture styles that are difficult to replicate, if damaged. | • Damage to the City's Historic District and buildings can negatively affect the City's character.<br>• Many of the City's historic buildings host local business owners and event spaces. Damage to these facilities could affect small businesses. |

## Summary of Key Flood Vulnerabilities

Results of the flood hazard vulnerability assessment for natural, cultural, and historical assets are summarized below. Due to their proximity to water and low elevations, most evaluated resources are highly vulnerable to flooding.



| | | | | |
|---|---|---|---|---|
| *Consequence* | High | | Parks | Beaches/Dunes<br>Wetlands/Mangroves |
| | Moderate | | Oyster Reef Restoration Sites | Historic District |
| | Low | | | |
| | | Low | Moderate | High |
| | | | *Sensitivity* | |

## Extreme Heat

| | Sensitivity | Consequence |
|---|---|---|
| **Natural Resources** | Oyster reefs, beach/dune habitat communities (i.e., vegetation, birds, turtles, etc.), wetlands, seagrass beds, and the nearshore hardbottom are highly sensitive to changes in temperature.<br>Increased temperatures may also increase evaporation rates, which can create hypersaline conditions that many species are also sensitive to.<br>Mangroves are sensitive to large temperature fluctuations and hypersaline conditions but can survive in a wider range of conditions than the other habitats evaluated. | • The loss of oyster reefs and restoration sites will cause a shift in the reef community, including a shift in predators, due to a change in temperature and dissolved oxygen.<br>• Elevated temperatures will cause a shift in vegetation and animal community structure on beaches and dunes. Potential consequences include impacts to sea turtle gestation, lack of food and shade for gopher tortoises, and impacts to shorebirds and chicks, which are not able to regulate their temperature.<br>• Impacts to mangroves due to extreme heat, temperature fluctuations or increased salinity could cause loss of habitat for other organisms (e.g., shorebirds, mammals, fish nurseries, etc.), affect local water quality, and cause the loss of a large local carbon sink and shoreline protection from storm events.<br>• Increases in the number of visitors to the beach and other waterways may lead to increased pressure on the environment (e.g., trampling dune vegetation, increased garbage, etc.).<br>• Decreased water quality may increase the occurrence of water-borne diseases.<br>• Beach sand bacteria have higher growth rates during elevated temperatures, which may affect human health.<br>• The City may also see increased costs for habitat and water quality management, monitoring, and mitigation. |

| | Sensitivity | Consequence |
|---|---|---|
| **Parks** | Although the park infrastructure has a low sensitivity to extreme heat, park vegetation may be affected, requiring increased irrigation.<br>Several parks (e.g., Cambier, Baker, and Lowdermilk) also have buildings that rely on electricity, which may be affected by power outages during extreme heat days. | • Vegetation and wildlife throughout parks may be affected by extreme heat events.<br>• Park visitation may be affected, with parks with limited shade experiencing a decline in users. Conversely, parks with abundant shade or access to water may experience a surge in use during extreme heat days.<br>• An increase in average temperatures and extreme heat days will cause an overall |

**EXPOSURE**

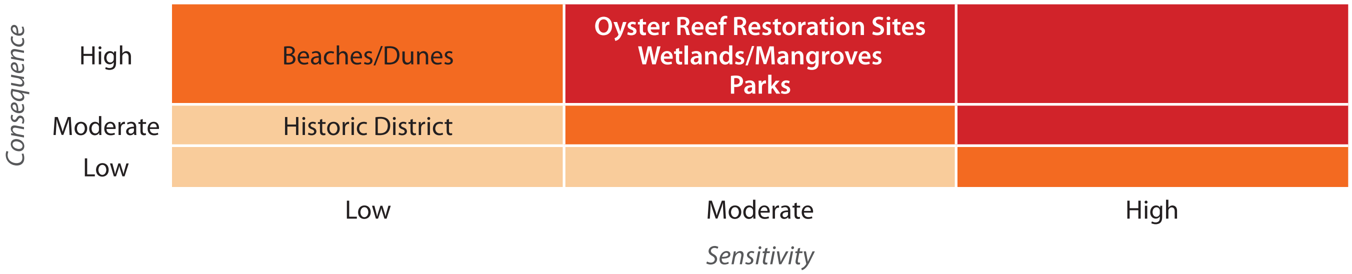
| Asset | Stressor | 2020 | 2040 NOAA Intermediate Low | 2040 NOAA Intermediate High | 2070 NOAA Intermediate Low | 2070 NOAA Intermediate High |
|---|---|---|---|---|---|---|
| Oyster Reefs and Restoration Sites 1-3 | High Tide | ✓ | ✓ | ✓ | ✓ | ✓ |
| Oyster Reefs and Restoration Sites 1-3 | Coastal Storm | ✓ | ✓ | ✓ | ✓ | ✓ |
| Oyster Reefs and Restoration Sites 1-3 | Compound Flood | ✓ | ✓ | ✓ | ✓ | ✓ |
| Beaches and Dunes | High Tide | ✓ | ✓ | ✓ | ✓ | ✓ |
| Beaches and Dunes | Coastal Storm | ✓ | ✓ | ✓ | ✓ | ✓ |
| Beaches and Dunes | Compound Flood | ✓ | ✓ | ✓ | ✓ | ✓ |
| Seagrass, Wetlands, and Mangroves | High Tide | ✓ | ✓ | ✓ | ✓ | ✓ |
| Seagrass, Wetlands, and Mangroves | Coastal Storm | ✓ | ✓ | ✓ | ✓ | ✓ |
| Seagrass, Wetlands, and Mangroves | Compound Flood | ✓ | ✓ | ✓ | ✓ | ✓ |

**EXPOSURE**

| Asset | Stressor | 2020 | 2040 NOAA Intermediate Low | 2040 NOAA Intermediate High | 2070 NOAA Intermediate Low | 2070 NOAA Intermediate High |
|---|---|---|---|---|---|---|
| Coastal Access | High Tide | - | - | ✓<br>(1 access point) | ✓<br>(1 access point) | ✓<br>(1 access point) |
| Coastal Access | Coastal Storm | ✓<br>(29 access points) | ✓<br>(41 access points) | ✓<br>(41 access points) | ✓<br>(41 access points) | ✓<br>(41 access points) |
| Coastal Access | Compound Flood | ✓<br>(2 access points) | ✓<br>(2 access points) | ✓<br>(2 access points) | ✓<br>(2 access points) | ✓<br>(3 access points) |
| Parks | High Tide | ✓<br>(3 parks) | ✓<br>(3 parks) | ✓<br>(3 parks) | ✓<br>(3 parks) | ✓<br>(4 parks) |
| Parks | Coastal Storm | ✓<br>(6 parks) | ✓<br>(9 parks) | ✓<br>(9 parks) | ✓<br>(9 parks) | ✓<br>(9 parks) |
| Parks | Compound Flood | ✓<br>(8 parks) | ✓<br>(8 parks) | ✓<br>(8 parks) | ✓<br>(8 parks) | ✓<br>(8 parks) |
| Historic District | High Tide | - | - | - | - | - |
| Historic District | Coastal Storm | ✓ | ✓ | ✓ | ✓ | ✓ |
| Historic District | Compound Flood | ✓ | ✓ | ✓ | ✓ | ✓ |
| Historic Buildings | High Tide | - | - | - | - | - |
| Historic Buildings | Coastal Storm | ✓<br>(48 buildings) | ✓<br>(60 buildings) | ✓<br>(61 buildings) | ✓<br>(61buildings) | ✓<br>(61 buildings) |
| Historic Buildings | Compound Flood | ✓<br>(42 buildings) | ✓<br>(45 buildings) | ✓<br>(45 buildings) | ✓<br>(45 buildings) | ✓<br>(50 buildings) |

## Summary of Key Heat Vulnerabilities

Results of the heat hazard vulnerability assessment for natural, cultural, and historical assets are summarized below. Oyster Reef Restoration Sites, Wetlands/Mangroves, and Parks were identified as highly vulnerable to future heat hazards. In general, natural resources are highly vulnerable to extreme heat conditions because they are highly sensitive to changes in air and water temperature and have a limited ability to adapt to changing conditions.



| *Consequence* | Low | Moderate | High |
|---|---|---|---|
| High | Beaches/Dunes | Oyster Reef Restoration Sites<br>Wetlands/Mangroves<br>Parks | |
| Moderate | Historic District | | |
| Low | | | |

*Sensitivity*

Crayton Rd & Harbour Dr intersection following Hurricane Irma

# 7

# Conclusions and Next Steps

The citywide Assessment identified public built and natural infrastructure at risk from each climate hazard (flooding and extreme heat) by applying a prioritization process to identify the timing and extent of each hazard's exposure, describe the City assets' sensitivity to hazards, and identify potential consequences for the City's people, ecosystems, infrastructure, and economy. The project team collected and mapped information provided by City departments that own, operate, and maintain the City's assets and held meetings with the City's Resiliency and Adaptation Working Group (Working Group) throughout the project to determine how the assets may be affected by climate change. Based on this information, each asset was given a vulnerability rating to prioritize the timing of intervention and inform strategies to provide a consistent level of protection over time.

## Key Findings of the Assessment:

- **The City is Already Vulnerable Under Existing Conditions:** Although the Assessment focused on understanding future changes in hazard exposure, the City already experiences periods of extreme heat and rainfall/coastal flooding due to a combined influence of concurrent sea level rise, coastal storm surge, and heavy rainfall conditions. Without improvements, projected changes in the climate may increase the frequency and magnitude of hazard exposure for the City's residents, infrastructure, and natural areas.

- **Decline or Loss of Shoreline, Parks, and Natural Areas:** Open space, parks, and natural areas add to the City's quality of life and generate economic activity through increased tourism and appeal for seasonal residents. Many of these areas are vulnerable to changes in future climate conditions and face being narrowed or eventually being "squeezed out" by rising sea levels or highly stressed by an increase in average temperatures and extreme heat days. Natural and open space areas provide unique recreational opportunities that cannot be easily replaced once lost.

- **Local and Regional Transportation Impacts:** Local and regional street infrastructure connects residents, workers, and tourists to locations throughout the City and the greater Southwest Florida region. Flood impacts on the street network pose severe impacts on emergency response, access to neighborhoods and businesses, and the overall vitality of the City. To maintain uninterrupted access, the City will need to consider the climate's influence on future flood risk in roadway design and coordinate with state, regional, and federal transportation partners to protect and enhance the transportation network.

- **Impacts of Extreme Heat on Health:** Negative health impacts due to extreme heat are well understood and can include direct loss of life, increases in respiratory and cardiovascular disease, and challenges to mental health. Increasing temperatures can also contribute to air pollution levels and vector-borne diseases. While everyone is vulnerable during extreme heat days, some members of the population, including older adults, children, low-income residents, those with preexisting conditions, and outdoor workers are particularly susceptible to heat impacts on their health. Similar to human health, the well-being of many of the City's natural habitats is also at risk. Many natural areas are limited to a narrow range of conditions for survival and are easily stressed when temperatures exceed their normal conditions.

- **Development and Revitalization of Waterfront Neighborhoods:** The City's key development and revitalization neighborhoods, such as the Community Redevelopment Agency and the River Park Neighborhood, are in close proximity to the shoreline and are vulnerable to future flooding. These neighborhoods already have planned or approved developments that will revitalize formerly undeveloped or economically declining areas of the City, providing new housing, new business space, or enhanced cultural richness. These areas represent an opportunity for incorporate area-scale flood adaptation strategies in their planning and design to protect entire neighborhoods of the City.

## Considerations for Adaptation Planning

As the City advances its adaptation planning efforts, below are considerations to guide adaptation planning and promote effective, efficient, inclusive, and appropriate actions.

- Engage the community in the process to ensure that strategies meet local needs and build public support for each action.
- Consider vulnerable neighborhoods or revitalization areas that already have disproportionate risk and will be most impacted by future climate hazards.
- Incorporate nature-based solutions, where appropriate, to improve the City's environment and recreational opportunities.
- Create an adaptable decision-making framework for when to implement strategies based on identified triggers that consider evolving climate, environmental, and political conditions.
- In addition to strategies that adapt physical infrastructure to accommodate future conditions, consider actions that will create policies for managing City operations and create opportunities to learn more about climate change impacts on the City. Together, they will form a comprehensive strategy for climate resilience.
- Prioritize strategies that consider cross-departmental collaboration and provide area-scale protection to maximize public investment.
- Identify potential funding sources and regional collaborators that support the successful implementation of selected strategies.

## Conclusion

The City of Naples is committed to working to adapt to the challenges of climate change and is aware that sea level rise, coastal storms, precipitation, and extreme heat will continue to affect public assets, including streets, public safety services, stormwater and utility networks, parks and facilities, and natural resources. This vulnerability assessment serves as the essential foundation for understanding key areas of the City that may be susceptible to changing climate conditions and may require adaptation actions to achieve urban resilience through the coming century. It will also inform the development of a Citywide Critical Assets and Facilities Adaptation Plan that outlines adaptation strategies, positions for potential funding that will support the outlined strategies and provides a framework for incorporating climate change considerations into existing and future projects, policies, and operating procedures that will protect public assets from future climate hazards.

Beach vegetation damage from Hurricane Ian

# Appendix A

Provides the sea level rise inundation maps developed to support the Assessment.

- **High Tide Flooding**
- **Storm Tide Flooding**

# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+ 0ft (Year 2020)
Existing Conditions

□ **City Boundary**

**Mean Higher High Water Depth (Feet)**

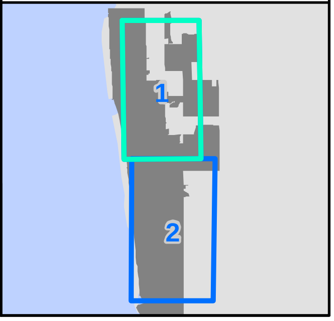
- ■ 0-1
- ■ 1-2
- ■ 2-3
- ■ 3-4
- ■ 4-5
- ■ 5+

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

### MAP INDEX



Disclaimer: This map is intended to improve sea level rise awareness and preparedness by providing a regional-scale illustration of inundation and coastal flooding due to specific sea level rise and storm surge scenarios. However, it is not meant to replace FEMA's National Flood Insurance Rate Maps nor the official storm surge forecast of National Hurricane Center.
Data Sources: NOAA Office of Coastal Management; University of Florida GeoPlan Center; Digital Aerial Solutions, LLC; USGS; NRCS.

# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+ 0ft (Year 2020)
Existing Conditions

▭ **City Boundary**

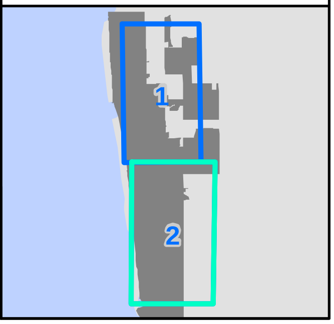
**Mean Higher High Water Depth (Feet)**

- 🟦 0-1
- 🟦 1-2
- 🟦 2-3
- 🟦 3-4
- 🟦 4-5
- 🟦 5+

N
0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

## MAP INDEX



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# CITY OF NAPLES

## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+0.4ft (Year 2040)
NOAA Intermediate Low

☐ **City Boundary**

**Mean Higher High Water Depth (Feet)**

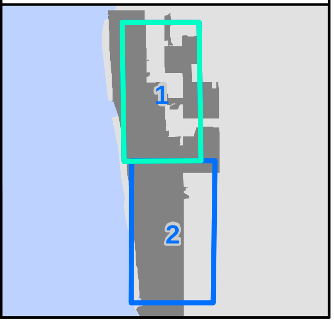
- 🟦 0-1
- 🟦 1-2
- 🟦 2-3
- 🟦 3-4
- 🟦 4-5
- 🟦 5+

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

## MAP INDEX



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# CITY OF NAPLES

## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+0.4ft (Year 2040)
NOAA Intermediate Low

☐ **City Boundary**

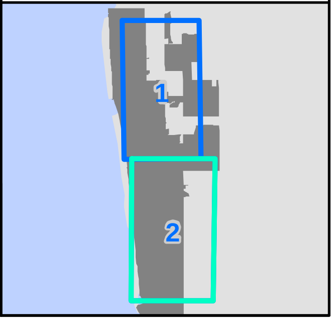
**Mean Higher High Water Depth (Feet)**

🟦 **0-1**
🟦 **1-2**
🟦 **2-3**
🟦 **3-4**
🟦 **4-5**
🟦 **5+**

N
0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

**MAP INDEX**



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# CITY OF NAPLES

## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+1.1ft (Year 2040)
NOAA Intermediate High

▭ **City Boundary**

**Mean Higher High Water Depth (Feet)**

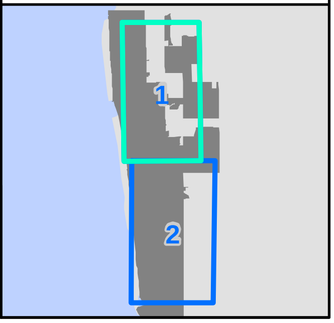
- ■ **0-1**
- ■ **1-2**
- ■ **2-3**
- ■ **3-4**
- ■ **4-5**
- ■ **5+**

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

## MAP INDEX



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# CITY OF NAPLES

## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+1.1ft (Year 2040)
NOAA Intermediate High

☐ **City Boundary**

**Mean Higher High Water Depth (Feet)**

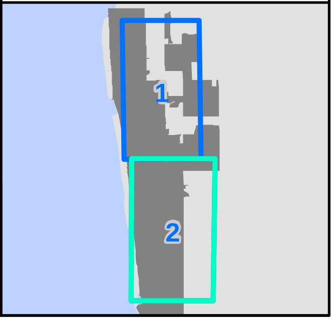
- ■ 0-1
- ■ 1-2
- ■ 2-3
- ■ 3-4
- ■ 4-5
- ■ 5+

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

**MAP INDEX**



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# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+1.0ft (Year 2070)
NOAA Intermediate Low

☐ **City Boundary**

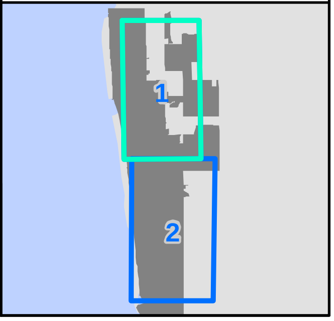
**Mean Higher High Water Depth (Feet)**

| | |
|---|---|
| ■ | 0-1 |
| ■ | 1-2 |
| ■ | 2-3 |
| ■ | 3-4 |
| ■ | 4-5 |
| ■ | 5+ |

N
0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

## MAP INDEX



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Data Sources: NOAA Office of Coastal Management; University of Florida GeoPlan Center; Digital Aerial Solutions, LLC; USGS; NRCS.

# CITY OF NAPLES

## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+1.0ft (Year 2070)
NOAA Intermediate Low

▭ City Boundary

**Mean Higher High Water Depth (Feet)**

- ■ 0-1
- ■ 1-2
- ■ 2-3
- ■ 3-4
- ■ 4-5
- ■ 5+

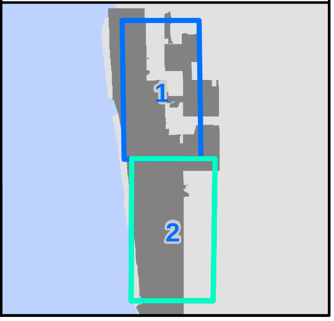
N

0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East

Scale: 1:2,690'

**MAP INDEX**



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# CITY OF NAPLES

## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+3.0ft (Year 2070)
NOAA Intermediate High

▭ **City Boundary**

**Mean Higher High Water Depth (Feet)**

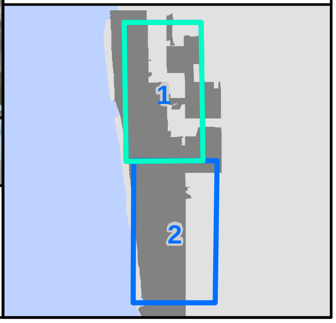
- 🟦 0-1
- 🟦 1-2
- 🟦 2-3
- 🟦 3-4
- 🟦 4-5
- 🟦 5+

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

**MAP INDEX**



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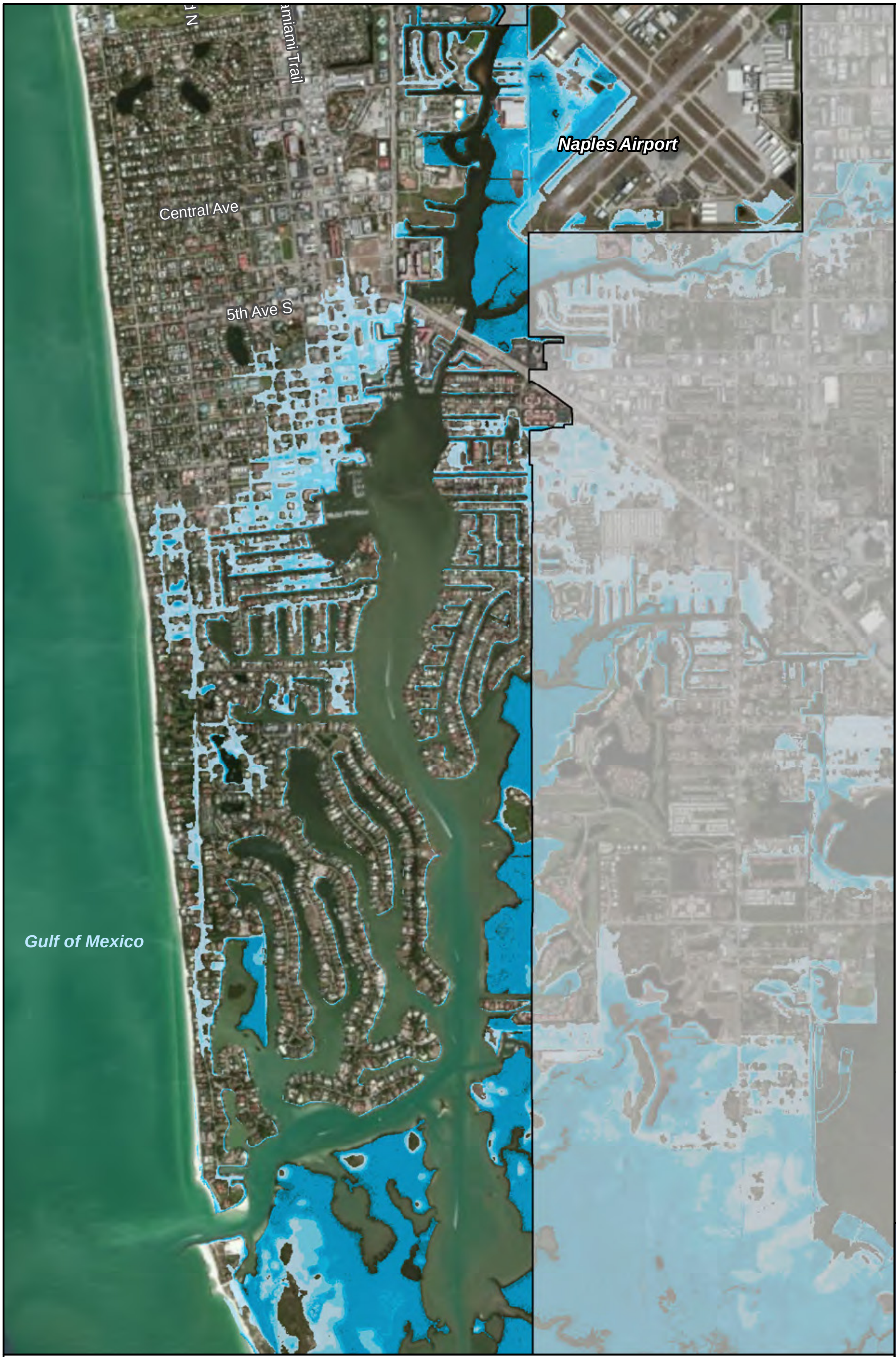
# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
Mean Higher High Water
+3.0ft (Year 2070)
NOAA Intermediate High



☐ **City Boundary**

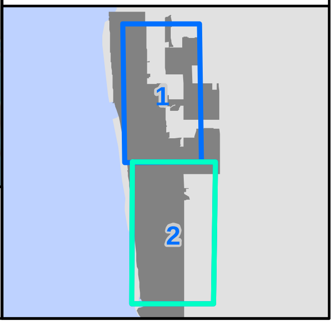
**Mean Higher High Water Depth (Feet)**

- ▨ 0-1
- ▨ 1-2
- ▨ 2-3
- ▨ 3-4
- ▨ 4-5
- ▨ 5+

N
0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

## MAP INDEX



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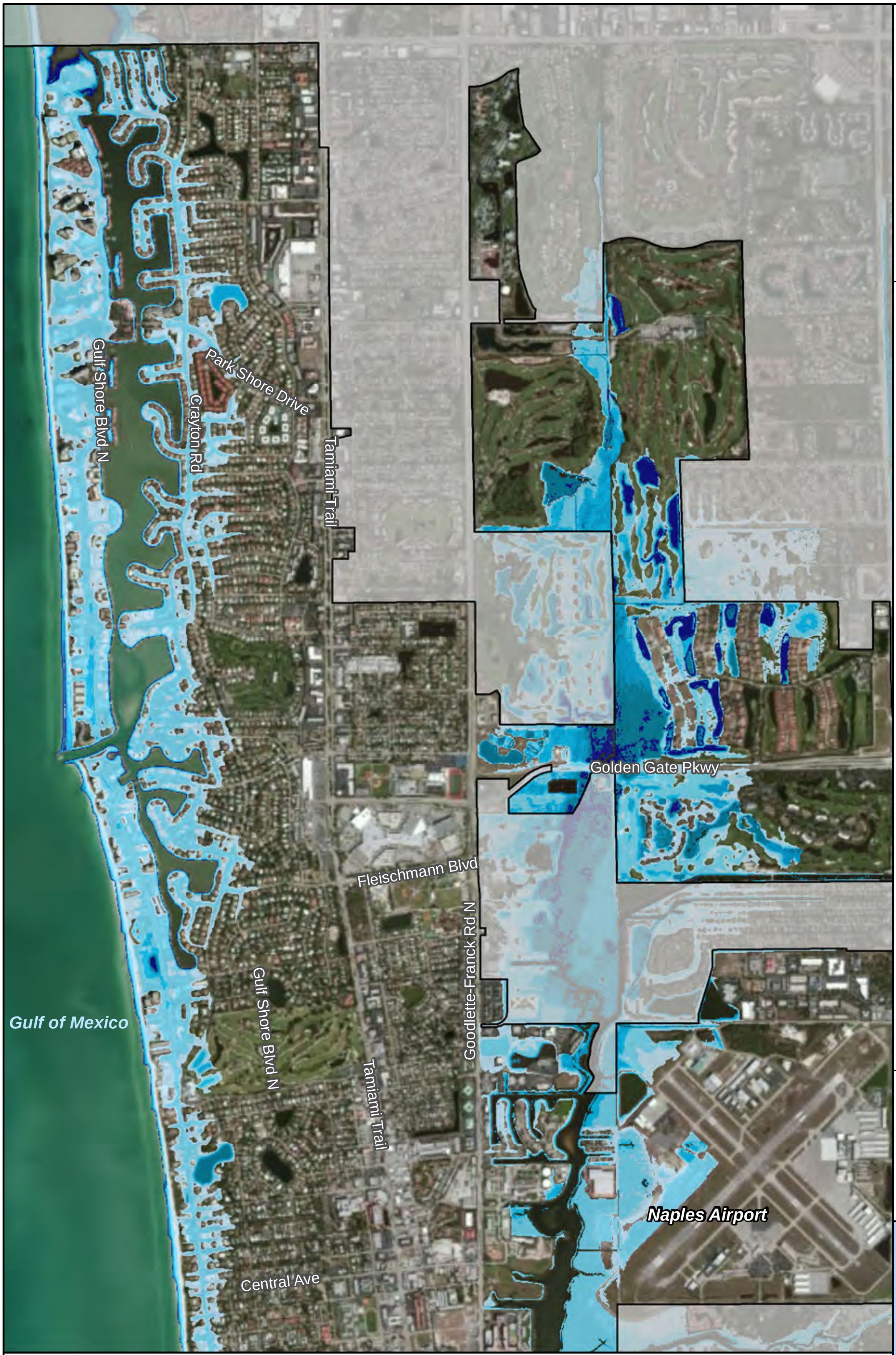


# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
100-year Storm Tide
+0ft (Year 2020)
Existing Conditions

☐ **City Boundary**

**100 Year Storm Tide Depth (Feet)**

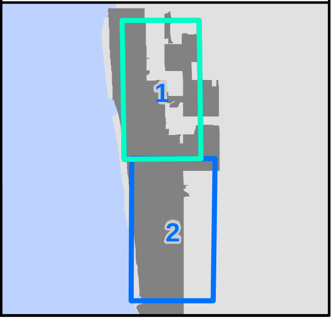
- ■ 0-1
- ■ 1-2
- ■ 2-3
- ■ 3-4
- ■ 4-5
- ■ 5+

N

0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

**MAP INDEX**



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# CITY OF NAPLES

## Inundation Mapping

Sea Level Rise Scenario:
100-year Storm Tide
+0ft (Year 2020)
Existing Conditions

▭ **City Boundary**

**100 Year Storm Tide Depth (Feet)**

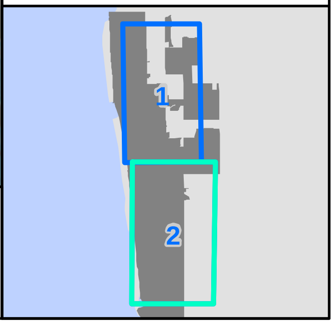
- ■ **0-1**
- ■ **1-2**
- ■ **2-3**
- ■ **3-4**
- ■ **4-5**
- ■ **5+**

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

## MAP INDEX



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# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
100-year Storm Tide
+0.4ft (Year 2040)
NOAA Intermediate Low

☐ **City Boundary**

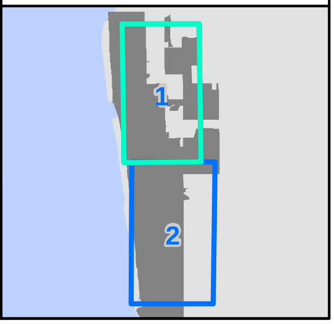
**100 Year Storm Tide Depth (Feet)**

- ▨ 0-1
- ▨ 1-2
- ▨ 2-3
- ▨ 3-4
- ▨ 4-5
- ▨ 5+

N
0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

## MAP INDEX



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# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
100-year Storm Tide
+0.4ft (Year 2040)
NOAA Intermediate Low

☐ **City Boundary**

**100 Year Storm**
**Tide Depth (Feet)**

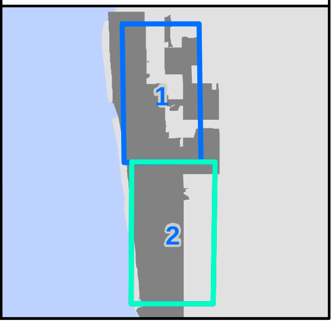
| | |
|---|---|
| 🟦 | **0-1** |
| 🟦 | **1-2** |
| 🟦 | **2-3** |
| 🟦 | **3-4** |
| 🟦 | **4-5** |
| 🟦 | **5+** |

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

**MAP INDEX**



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# CITY OF NAPLES

## Inundation Mapping

Sea Level Rise Scenario:
100-Year Storm Tide
+1.1ft (Year 2040)
NOAA Intermediate High

☐ **City Boundary**

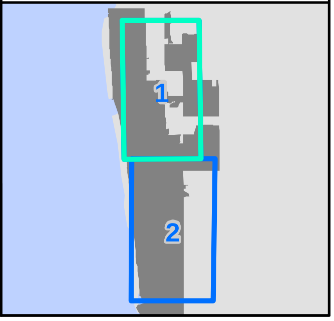
**100 Year Storm Tide Depth (Feet)**

- 0-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

N
0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

**MAP INDEX**



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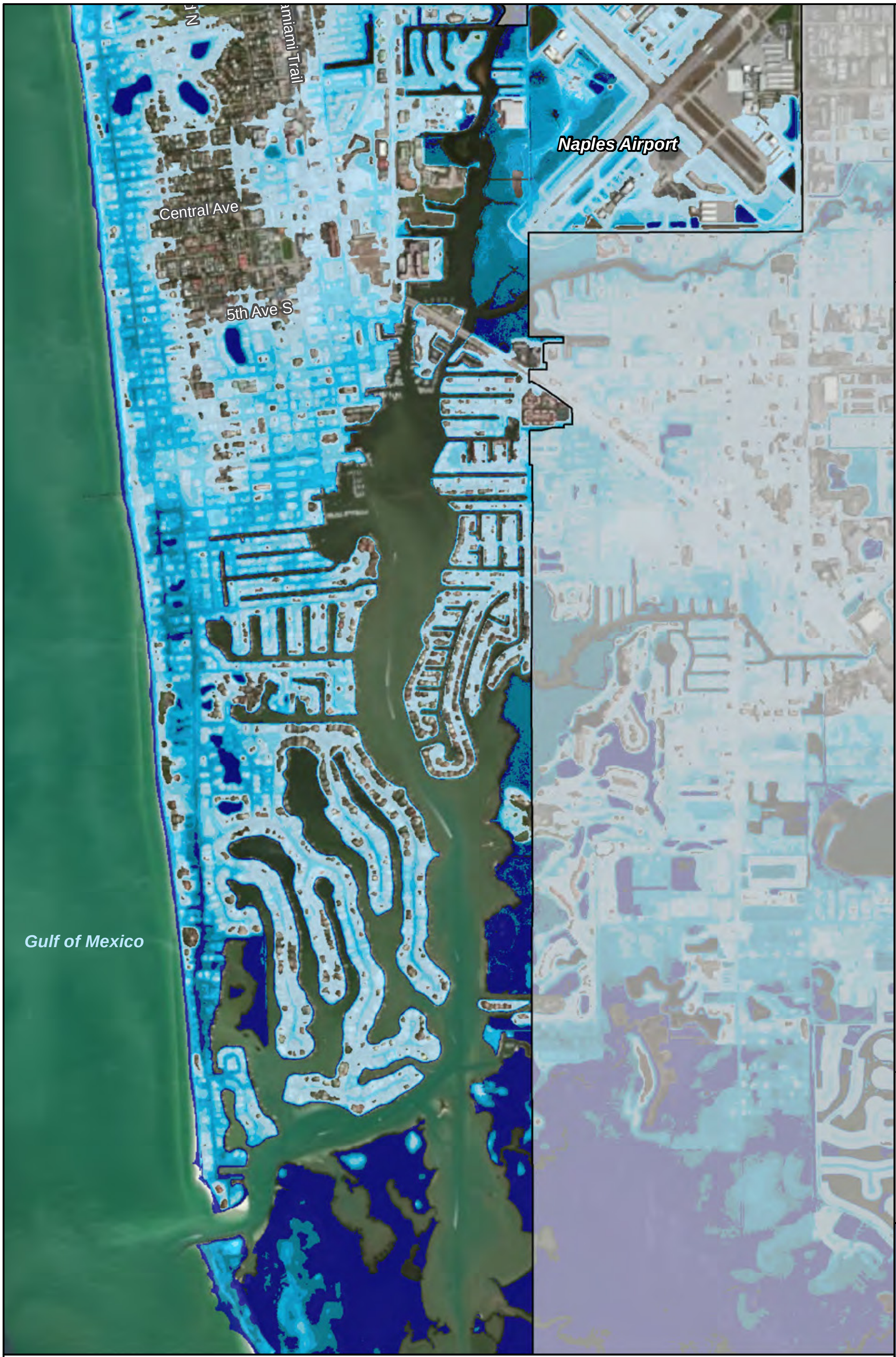


# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
100-Year Storm Tide
+1.1ft (Year 2040)
NOAA Intermediate High

☐ **City Boundary**

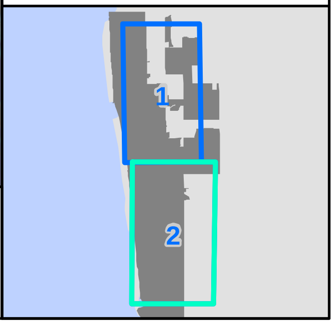
**100 Year Storm
Tide Depth (Feet)**

- 🟦 0-1
- 🟦 1-2
- 🟦 2-3
- 🟦 3-4
- 🟦 4-5
- 🟦 5+

N
0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

## MAP INDEX



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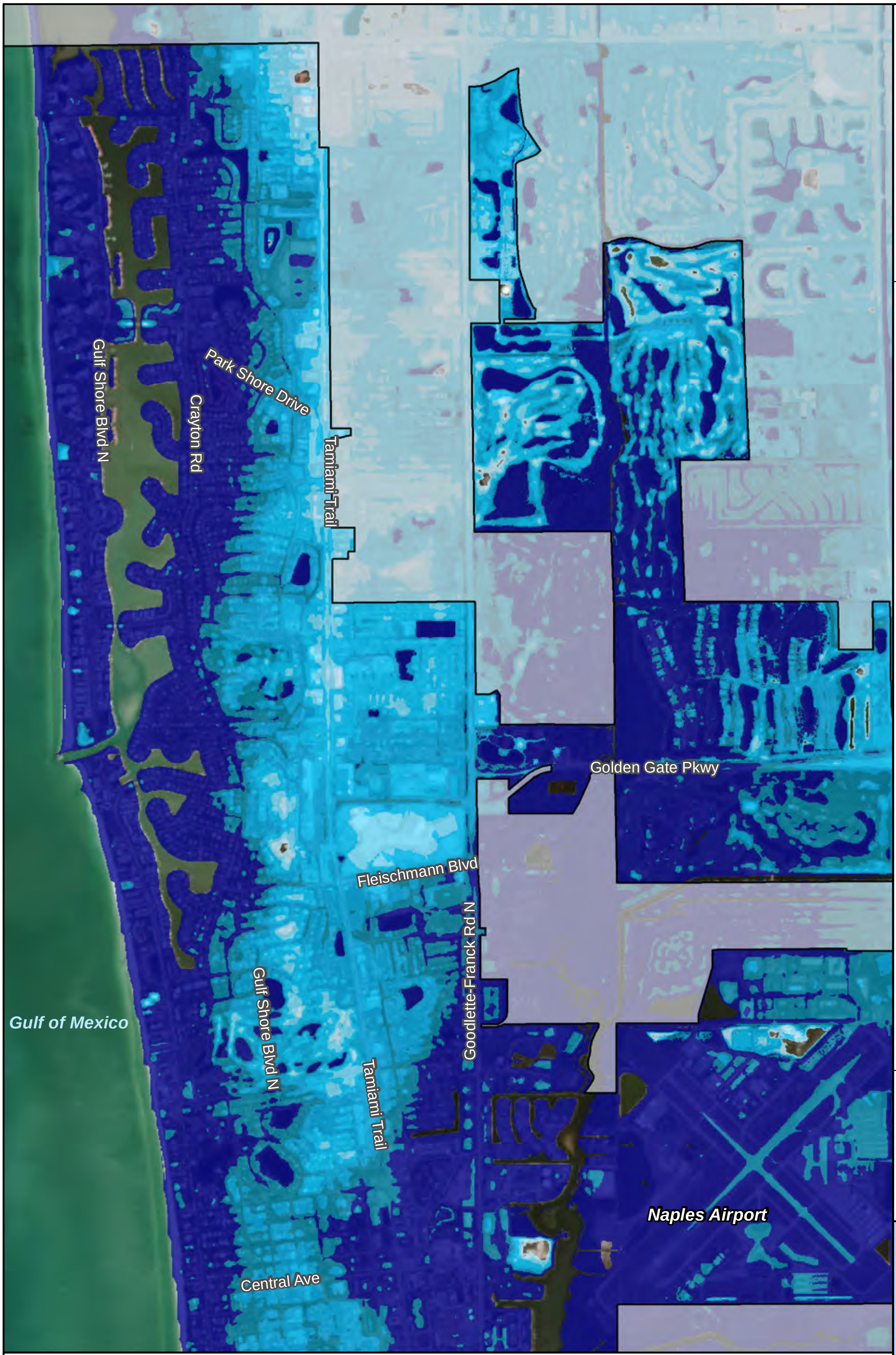


# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
100-Year Storm Tide
+1.0ft (Year 2070)
NOAA Intermediate Low

☐ **City Boundary**

**100 Year Storm Tide Depth (Feet)**

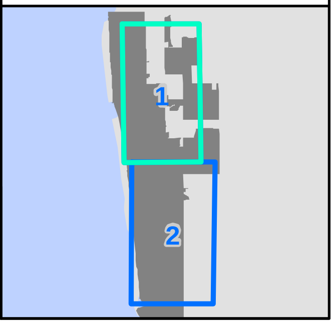
- ■ 0-1
- ■ 1-2
- ■ 2-3
- ■ 3-4
- ■ 4-5
- ■ 5+

N

0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

## MAP INDEX



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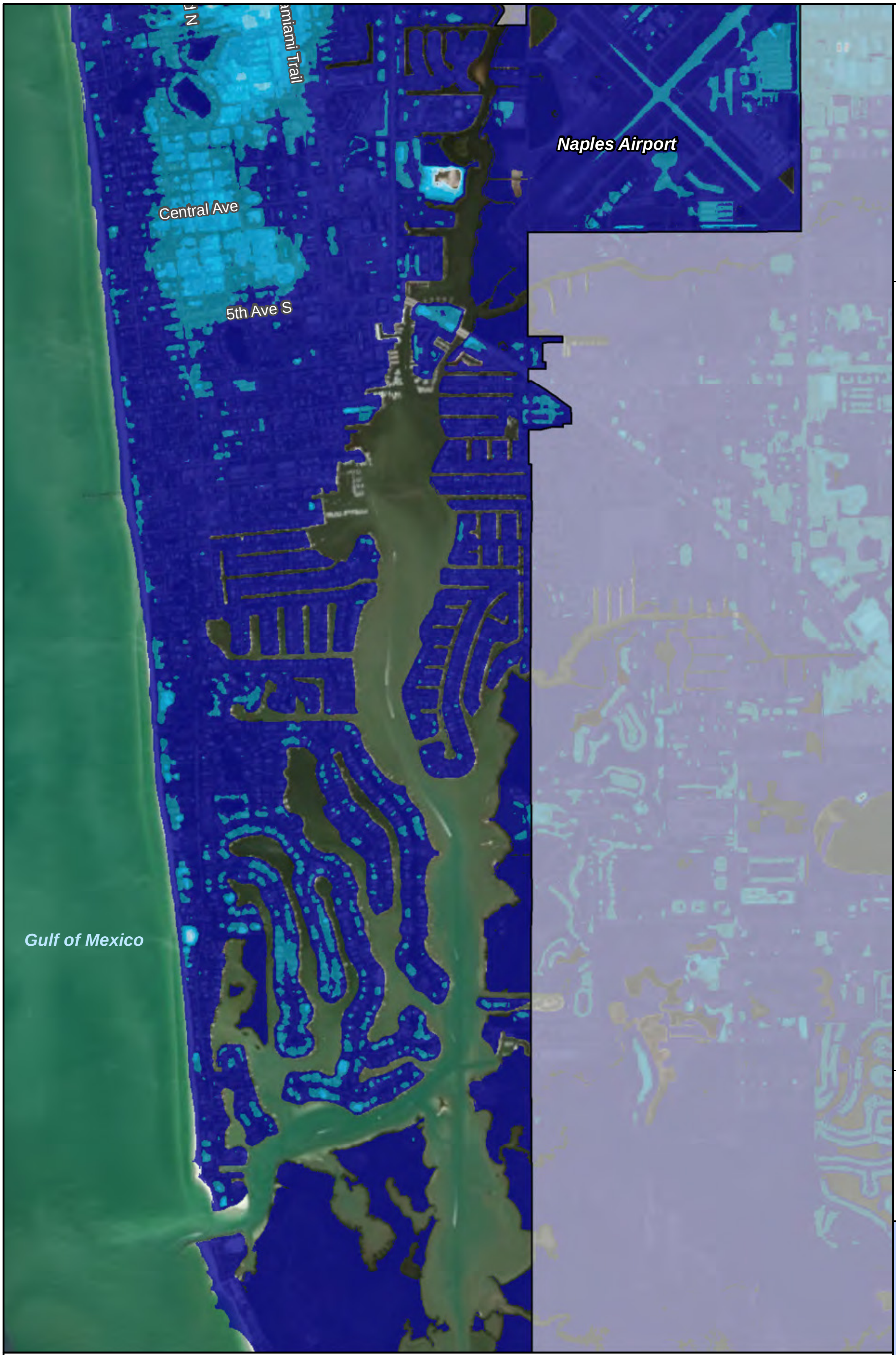

# CITY OF NAPLES

## Inundation Mapping

Sea Level Rise Scenario:
100-Year Storm Tide
+1.0ft (Year 2070)
NOAA Intermediate Low

▭ **City Boundary**

**100 Year Storm Tide Depth (Feet)**

- 🟦 **0-1**
- 🟦 **1-2**
- 🟦 **2-3**
- 🟦 **3-4**
- 🟦 **4-5**
- 🟦 **5+**

N

0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

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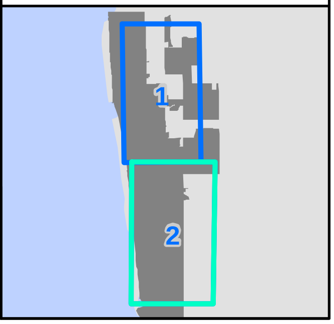

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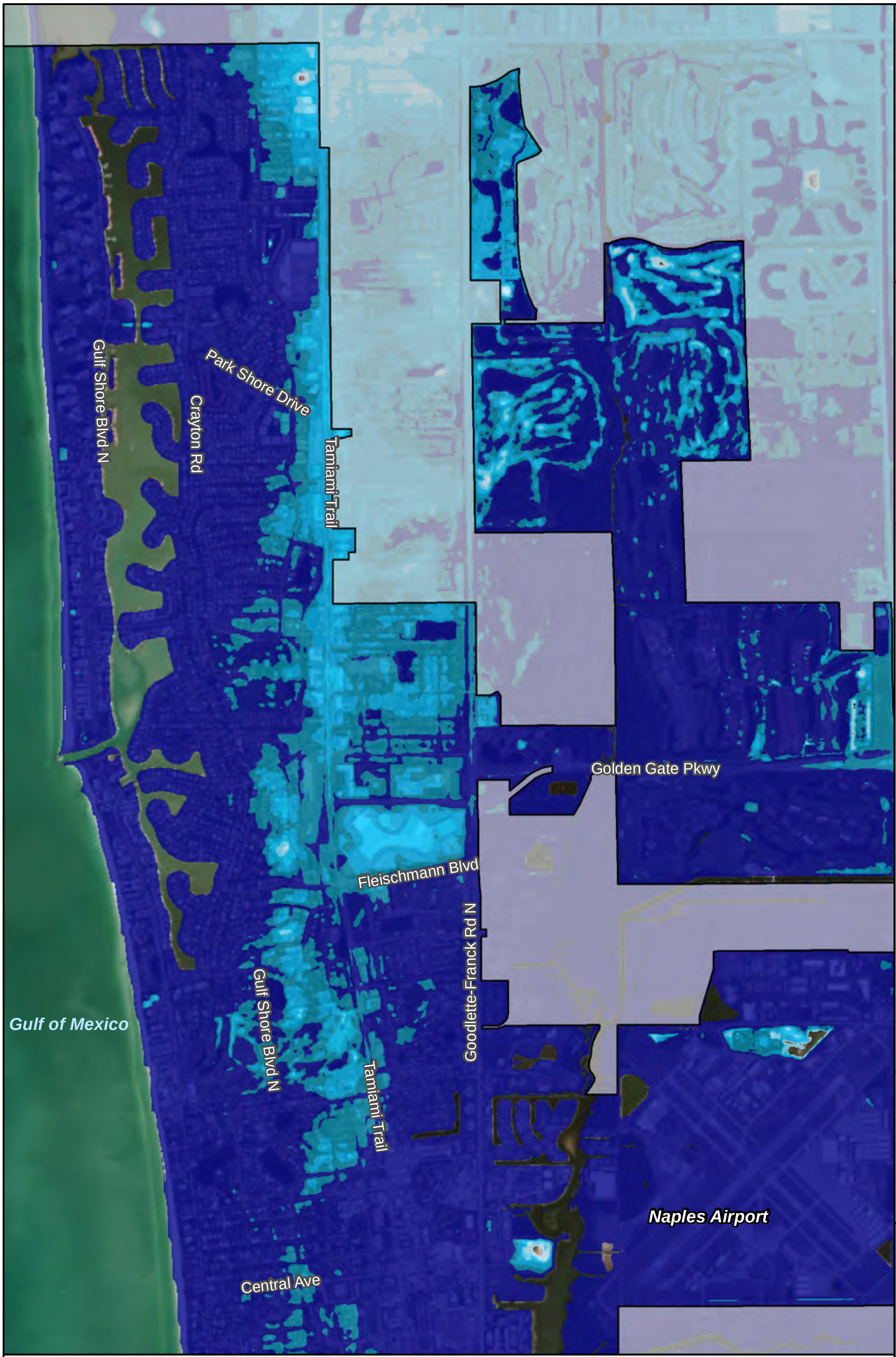
# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
100-Year Storm Tide
+3.0ft (Year 2070)
NOAA Intermediate High



☐ City Boundary

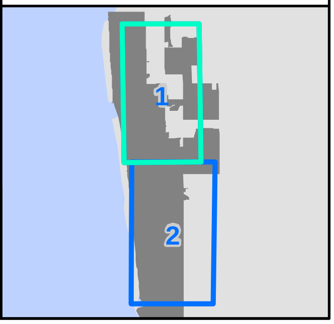
**100 Year Storm Tide Depth (Feet)**

- ■ 0-1
- ■ 1-2
- ■ 2-3
- ■ 3-4
- ■ 4-5
- ■ 5+

N
0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

## MAP INDEX



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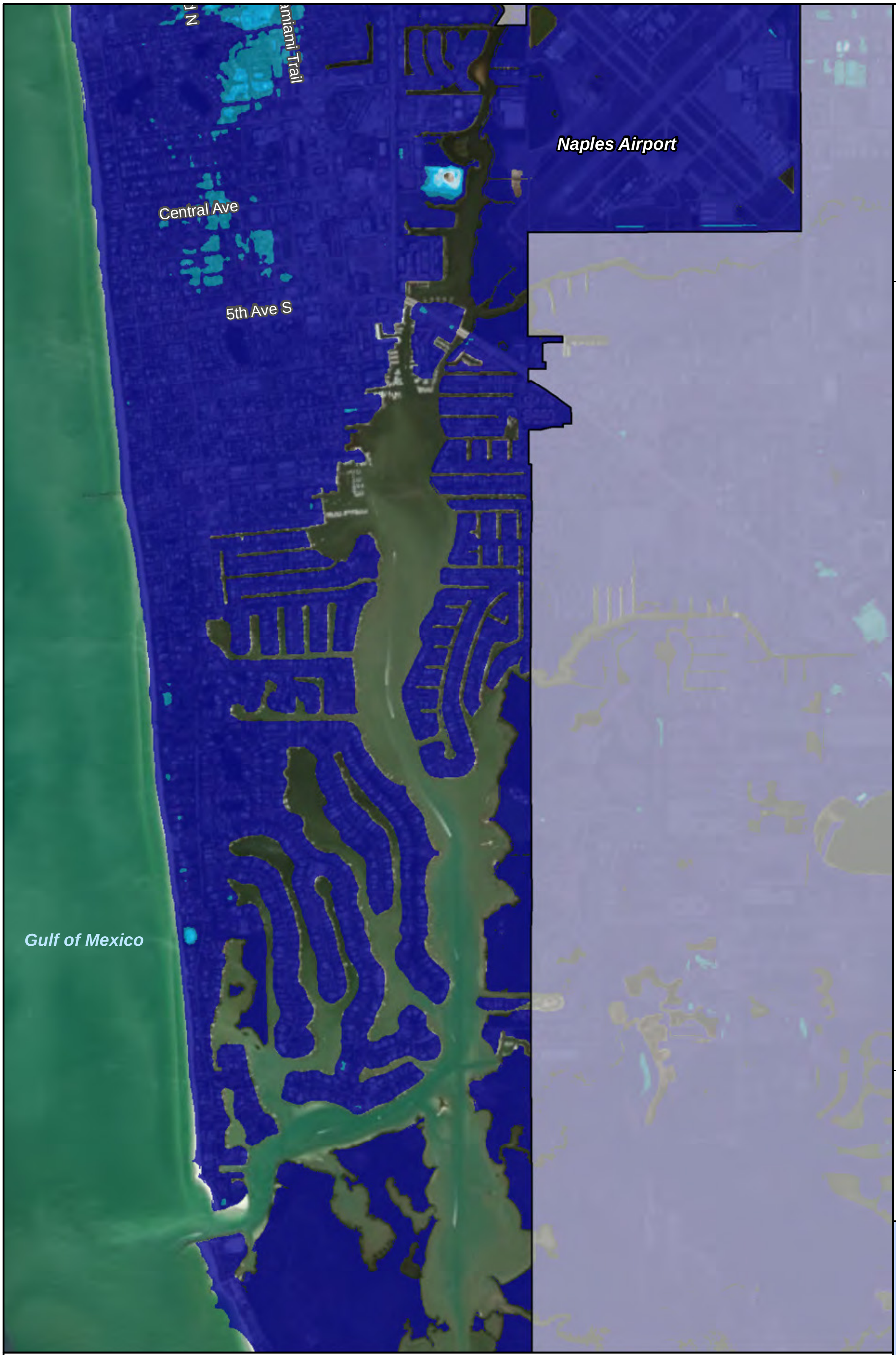


# CITY OF NAPLES
## Inundation Mapping

Sea Level Rise Scenario:
100-Year Storm Tide
+3.0ft (Year 2070)
NOAA Intermediate High

☐ **City Boundary**

**100 Year Storm Tide Depth (Feet)**

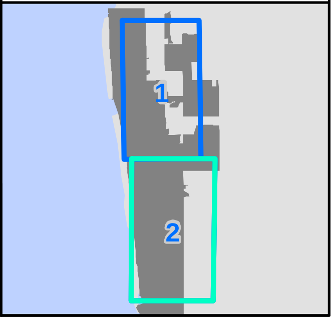
- 🟦 0-1
- 🟦 1-2
- 🟦 2-3
- 🟦 3-4
- 🟦 4-5
- 🟦 5+

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

## MAP INDEX



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# Appendix B

Provides the tidal flood day maps to evaluate the frequency of shoreline overtopping.

# CITY OF NAPLES

## Tidal Flood Days

Sea Level Rise Scenario:
Year 2020 (+0ft SLR)
Existing Conditions

**Tidal Flood Day Risk**

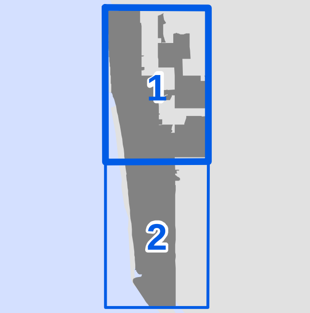
— **Low: <1 Day**
— **Moderate: 1-12 Days**
— **High: 12-52 Days**
— **Very High: >52 Days**

▭ **City Boundary**

N
0 750 1,500 3,000
Feet

Projection: NAD 1983 State Plane Florida East

**MAP INDEX**



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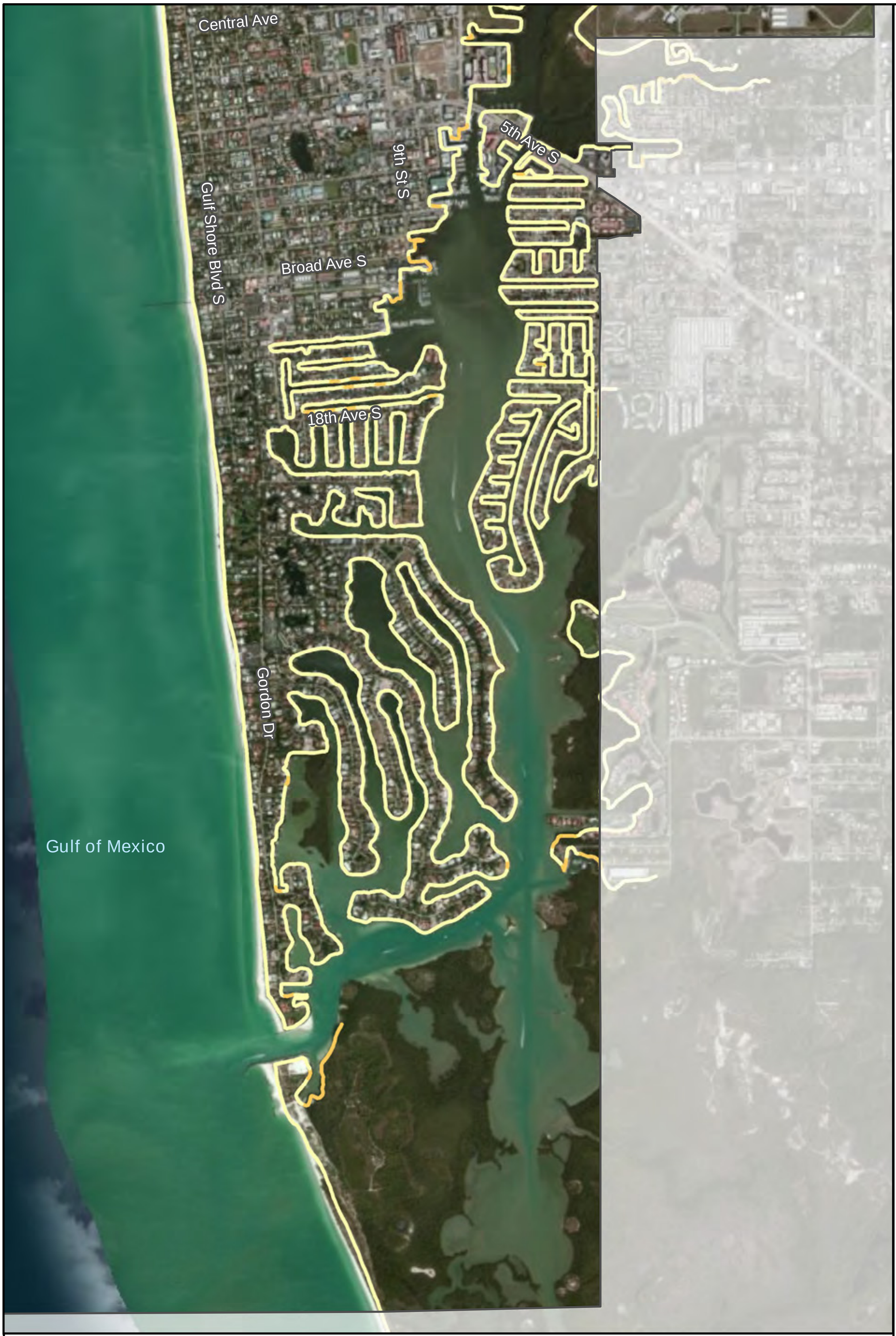


# CITY OF NAPLES

## Tidal Flood Days

Sea Level Rise Scenario:
Year 2020 (+0ft SLR)
Existing Conditions

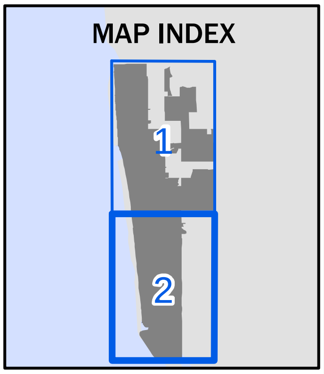
**Tidal Flood Day Risk**

- **Low: <1 Day**
- **Moderate: 1-12 Days**
- **High: 12-52 Days**
- **Very High: >52 Days**

▭ **City Boundary**

0 750 1,500 3,000 Feet

Projection: NAD 1983 State Plane Florida East



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# CITY OF NAPLES

## Tidal Flood Days

Sea Level Rise Scenario:
Year 2040 (+0.4ft SLR)
NOAA Int-Low Scenario

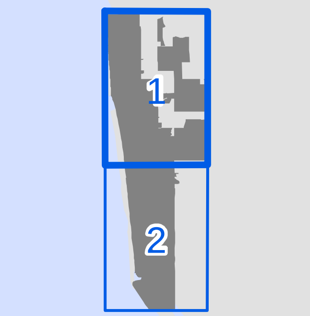
**Tidal Flood Day Risk**

- ▬ **Low: <1 Day**
- ▬ **Moderate: 1-12 Days**
- ▬ **High: 12-52 Days**
- ▬ **Very High: >52 Days**

▭ **City Boundary**

Projection: NAD 1983 State Plane Florida East

## MAP INDEX



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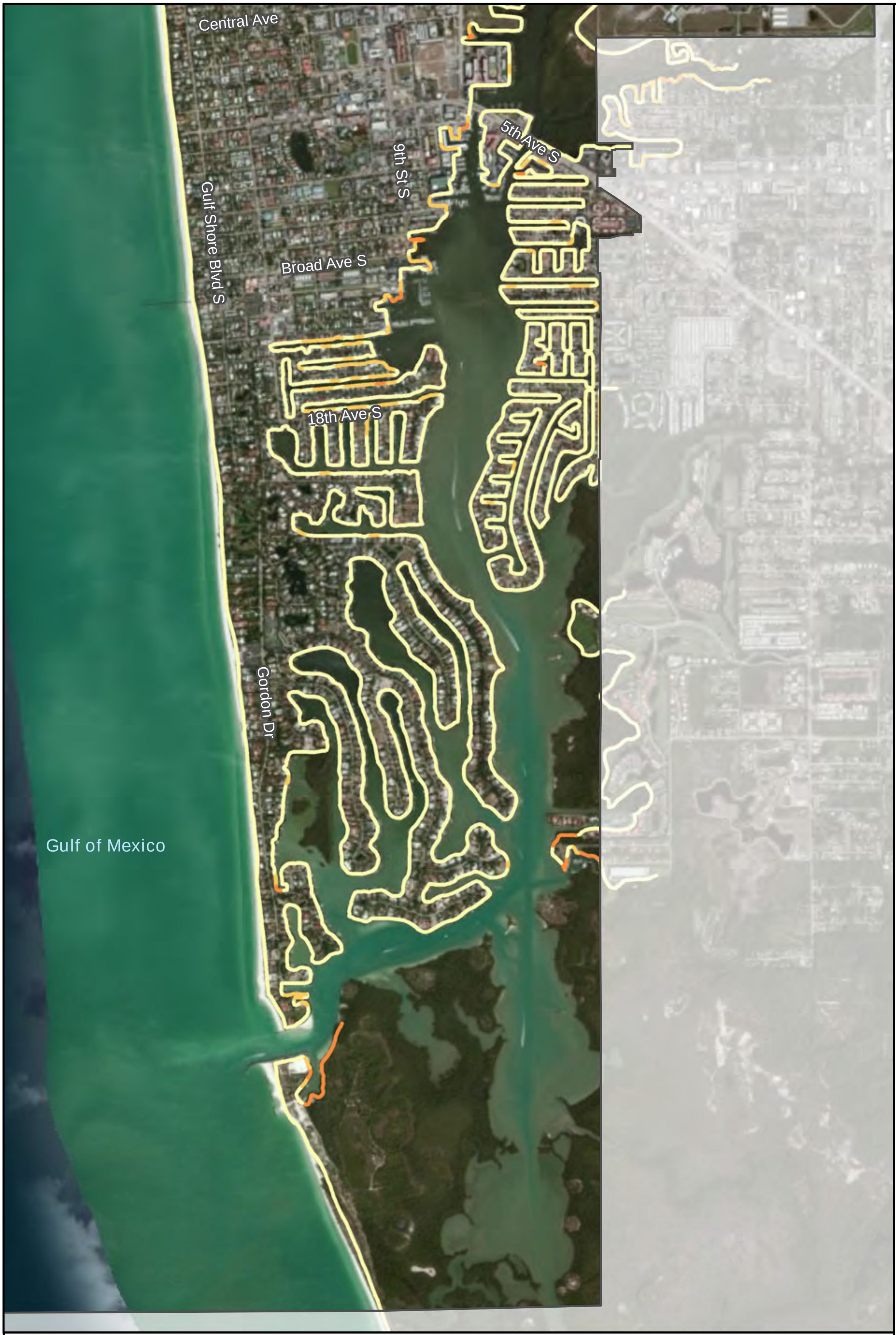
# CITY OF NAPLES
## Tidal Flood Days

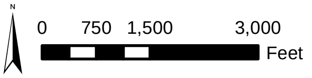
Sea Level Rise Scenario:
Year 2040 (+0.4ft SLR)
NOAA Int-Low Scenario



**Tidal Flood Day Risk**

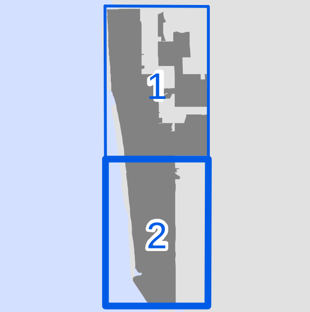
- — **Low: <1 Day**
- — **Moderate: 1-12 Days**
- — **High: 12-52 Days**
- — **Very High: >52 Days**

☐ **City Boundary**



Projection: NAD 1983 State Plane Florida East

**MAP INDEX**



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# CITY OF NAPLES

## Tidal Flood Days

Sea Level Rise Scenario:
Year 2070 (+1.0ft SLR)
NOAA Int-Low Scenario

**Tidal Flood Day Risk**

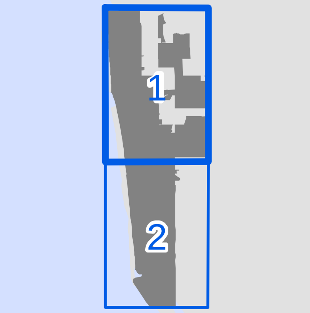
- Low: <1 Day
- Moderate: 1-12 Days
- High: 12-52 Days
- Very High: >52 Days

☐ City Boundary

N
0 750 1,500 3,000
Feet

Projection: NAD 1983 State Plane Florida East

MAP INDEX



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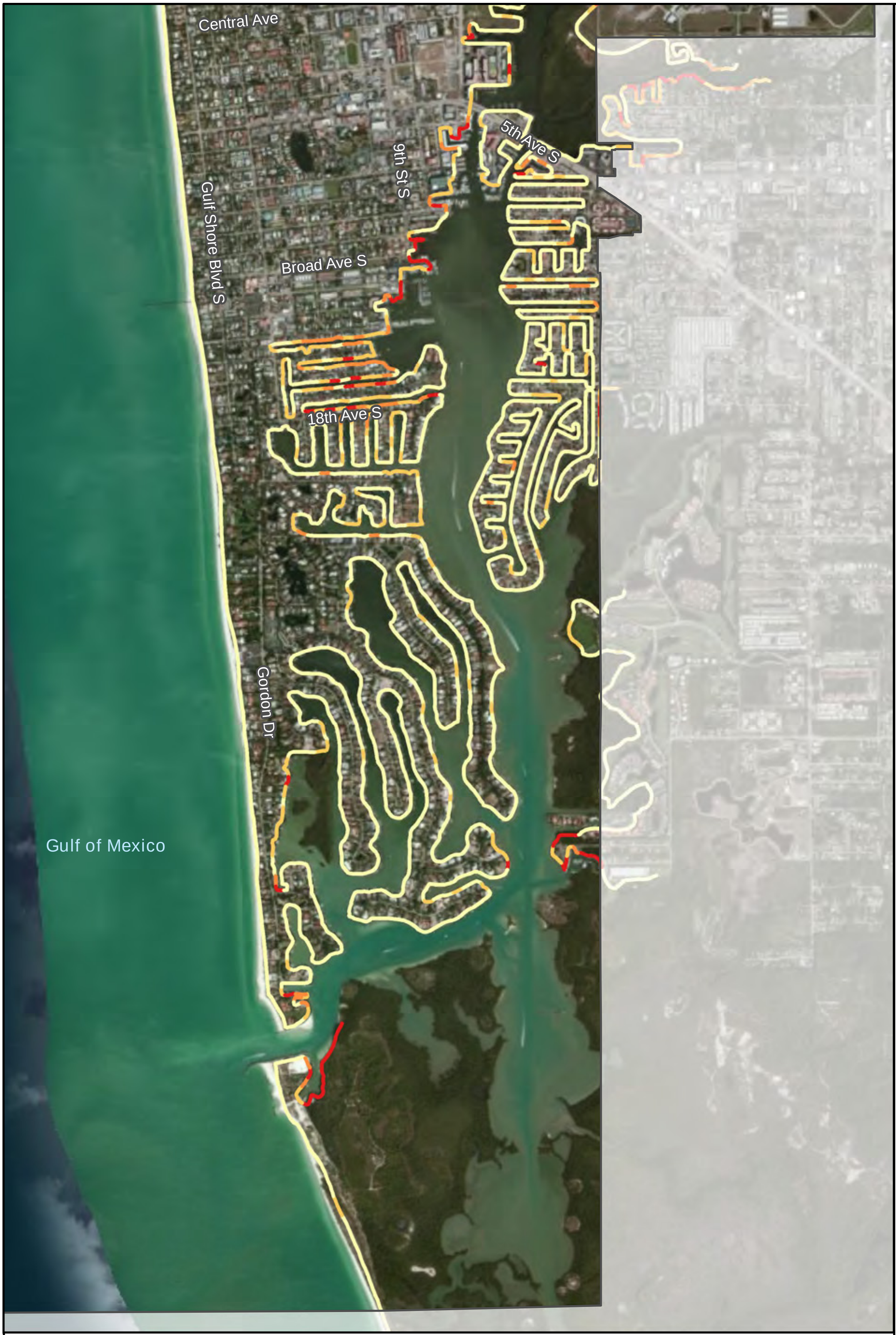


# CITY OF NAPLES

## Tidal Flood Days

Sea Level Rise Scenario:
Year 2070 (+1.0ft SLR)
NOAA Int-Low Scenario

**Tidal Flood Day Risk**

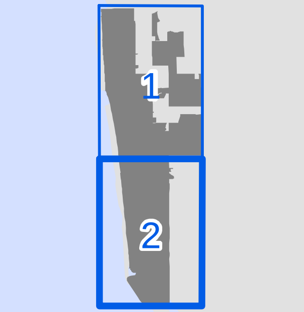
- **Low: <1 Day**
- **Moderate: 1-12 Days**
- **High: 12-52 Days**
- **Very High: >52 Days**

▭ **City Boundary**

N
0 750 1,500 3,000
Feet

Projection: NAD 1983 State Plane Florida East

**MAP INDEX**



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Data Sources: USGS; NOAA Center for Operational Oceanographic Products and Services; AECOM.

# CITY OF NAPLES

## Tidal Flood Days

Sea Level Rise Scenario:
Year 2040 (+1.1ft SLR)
NOAA Int-High Scenario

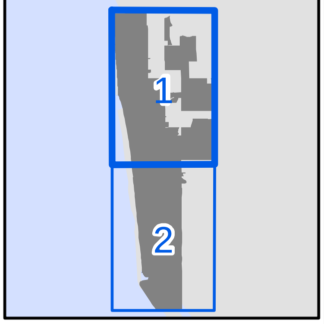
**Tidal Flood Day Risk**

| | |
|---|---|
| 🟨 | **Low: <1 Day** |
| 🟧 | **Moderate: 1-12 Days** |
| 🟧 | **High: 12-52 Days** |
| 🟥 | **Very High: >52 Days** |
| ▭ | **City Boundary** |

N
0 750 1,500 3,000
Feet

Projection: NAD 1983 State Plane Florida East

**MAP INDEX**



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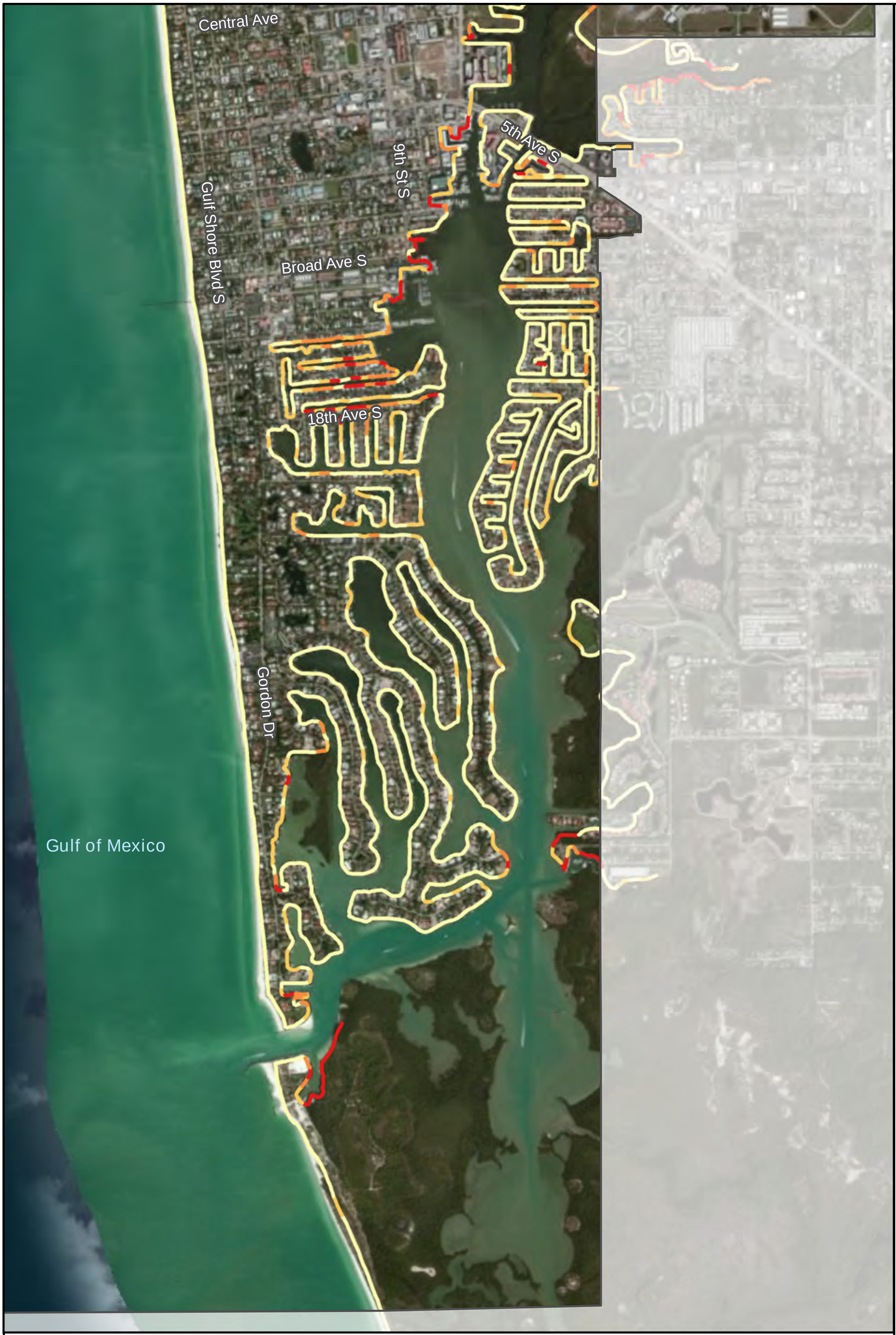


# CITY OF NAPLES

## Tidal Flood Days

Sea Level Rise Scenario:
Year 2040 (+1.1ft SLR)
NOAA Int-High Scenario

**Tidal Flood Day Risk**

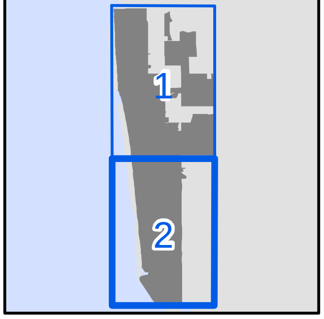
- **Low: <1 Day**
- **Moderate: 1-12 Days**
- **High: 12-52 Days**
- **Very High: >52 Days**

☐ **City Boundary**

N
0 750 1,500 3,000
Feet

Projection: NAD 1983 State Plane Florida East

### MAP INDEX



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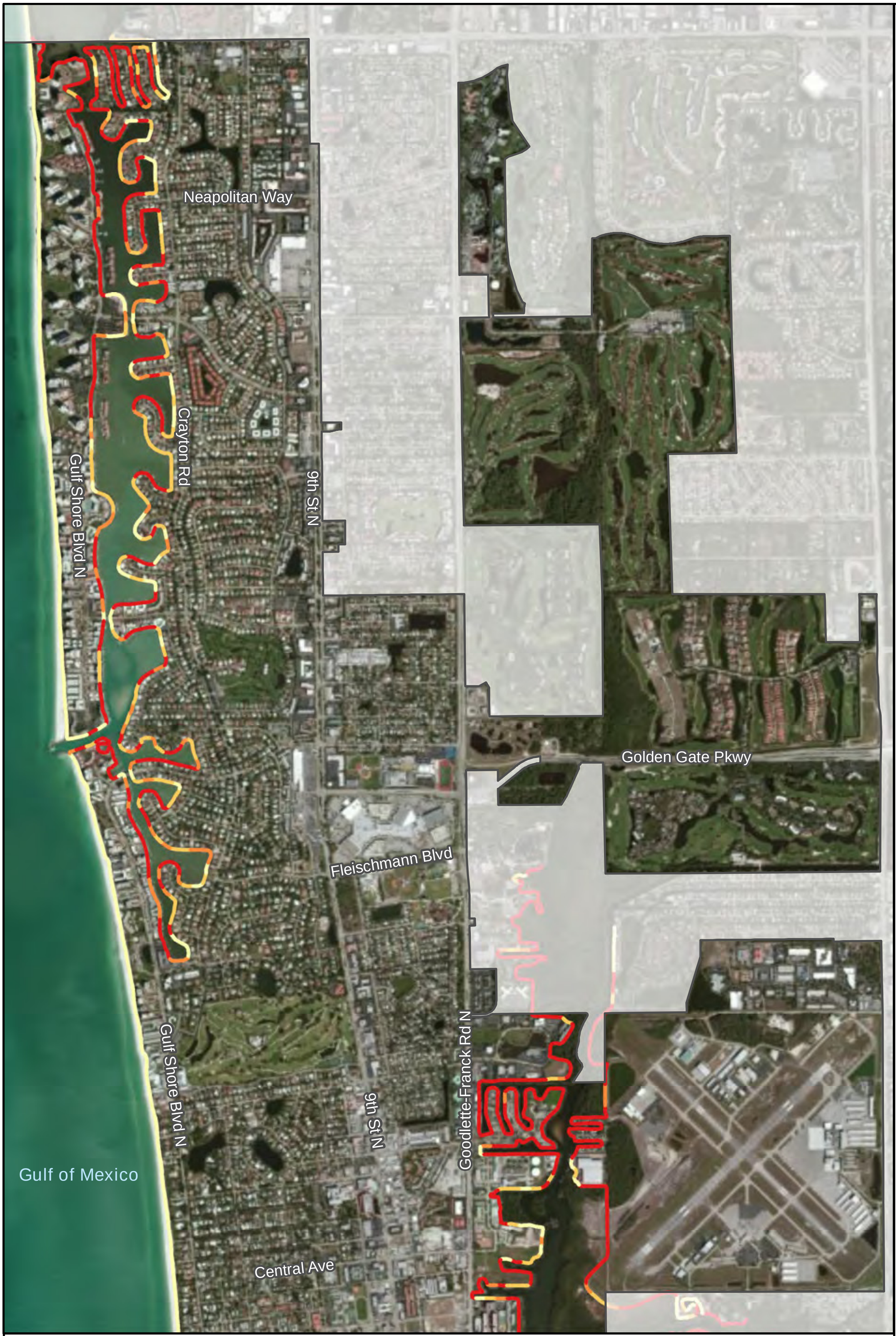


# CITY OF NAPLES

## Tidal Flood Days

Sea Level Rise Scenario:
Year 2070 (+3.0ft SLR)
NOAA Int-High Scenario

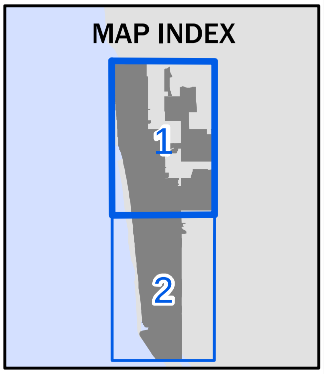
**Tidal Flood Day Risk**

- **Low: <1 Day**
- **Moderate: 1-12 Days**
- **High: 12-52 Days**
- **Very High: >52 Days**

☐ **City Boundary**

0 750 1,500 3,000
Feet

Projection: NAD 1983 State Plane Florida East



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# CITY OF NAPLES

## Tidal Flood Days

Sea Level Rise Scenario:
Year 2070 (+3.0ft SLR)
NOAA Int-High Scenario

**Tidal Flood Day Risk**

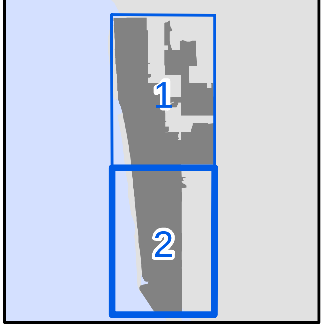
- **Low: <1 Day**
- **Moderate: 1-12 Days**
- **High: 12-52 Days**
- **Very High: >52 Days**

☐ **City Boundary**

N
0 750 1,500 3,000
Feet

Projection: NAD 1983 State Plane Florida East

### MAP INDEX



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# Appendix C

Provides the Stormwater and compound flood maps to demonstrate potential exposure to future rainfall flooding.

# CITY OF NAPLES

## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
0ft (Year 2020)
NOAA Existing Conditions

☐ **City Boundary**

🟧 **Precipitation Flood Extent**

**Mean Higher High Water Depth (Feet)**

- ■ 0-1
- ■ 1-2
- ■ 2-3
- ■ 3-4
- ■ 4-5
- ■ 5+

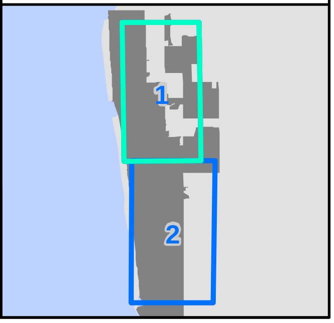
N

0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East

Scale: 1:2,630'

## MAP INDEX



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# CITY OF NAPLES
## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
0ft (Year 2020)
NOAA Existing Conditions

□ **City Boundary**

🟧 **Precipitation Flood Extent**

**Mean Higher High Water Depth (Feet)**

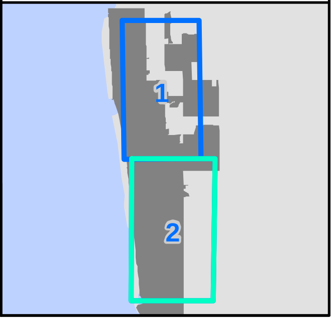
- 🟦 **0-1**
- 🟦 **1-2**
- 🟦 **2-3**
- 🟦 **3-4**
- 🟦 **4-5**
- 🟦 **5+**

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

**MAP INDEX**



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# CITY OF NAPLES

## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
0.4ft (Year 2040)
NOAA Intermediate Low

| | |
|---|---|
| □ | **City Boundary** |
| 🟧 | **Precipitation Flood Extent** |

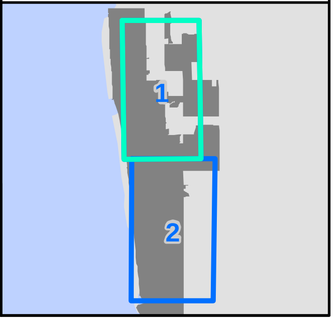
**Mean Higher High Water Depth (Feet)**

| | |
|---|---|
| 🟦 | 0-1 |
| 🟦 | 1-2 |
| 🟦 | 2-3 |
| 🟦 | 3-4 |
| 🟦 | 4-5 |
| 🟦 | 5+ |

N
0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

## MAP INDEX



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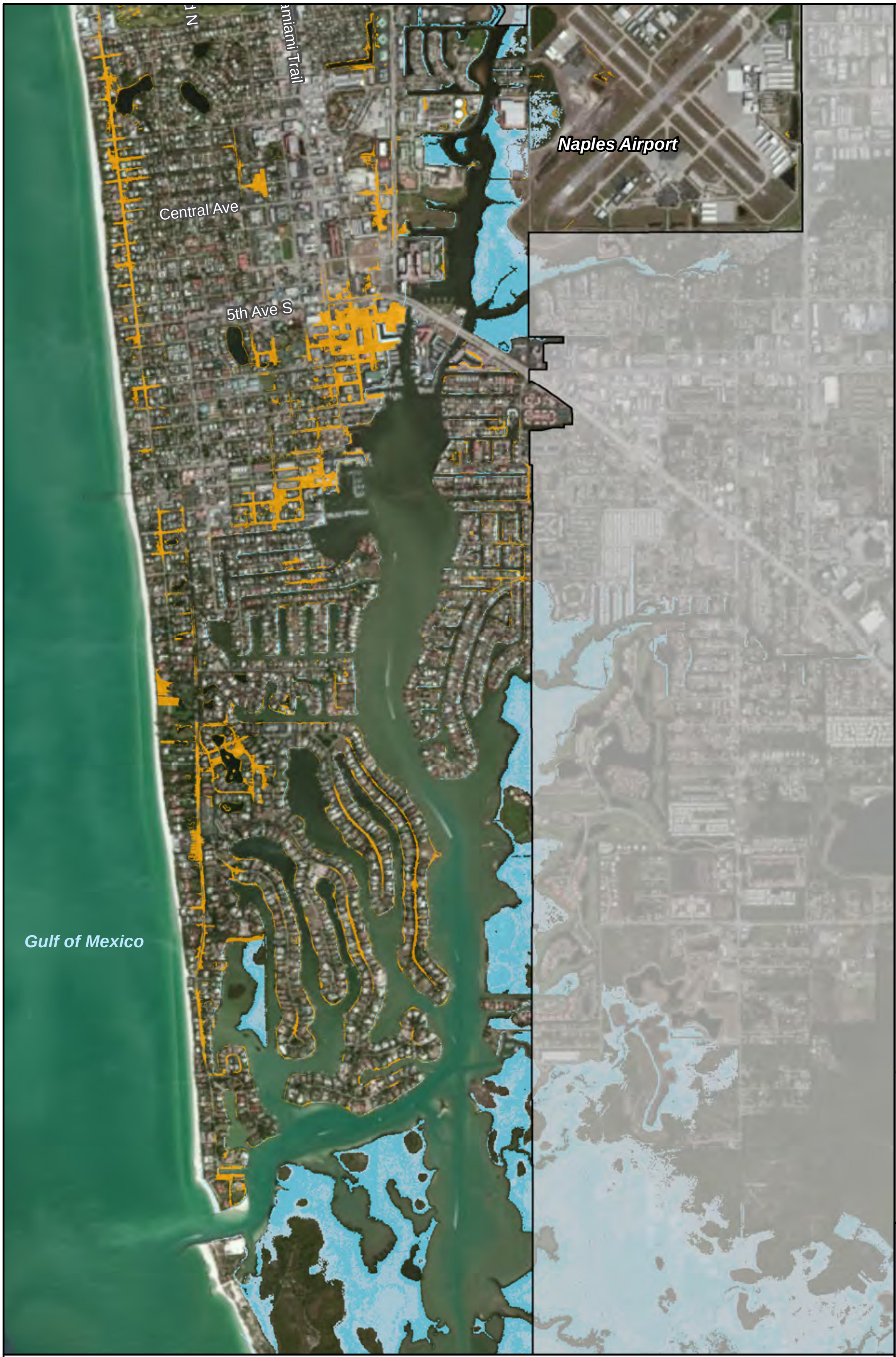
# CITY OF NAPLES

## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
0.4ft (Year 2040)
NOAA Intermediate Low



| | |
|---|---|
| ☐ | **City Boundary** |
| 🟧 | **Precipitation Flood Extent** |

**Mean Higher High Water Depth (Feet)**

| | |
|---|---|
| 🟦 | 0-1 |
| 🟦 | 1-2 |
| 🟦 | 2-3 |
| 🟦 | 3-4 |
| 🟦 | 4-5 |
| 🟦 | 5+ |

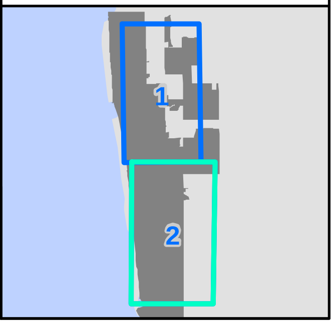
N

0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East

Scale: 1:2,690'

### MAP INDEX



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# CITY OF NAPLES

## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
1.1 ft (Year 2040)
NOAA Intermediate High

☐ **City Boundary**

🟧 **Precipitation Flood Extent**

**Mean Higher High Water Depth (Feet)**

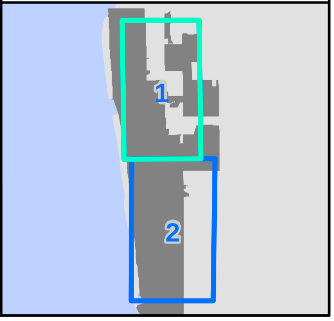
- 0-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East

Scale: 1:2,630'

## MAP INDEX



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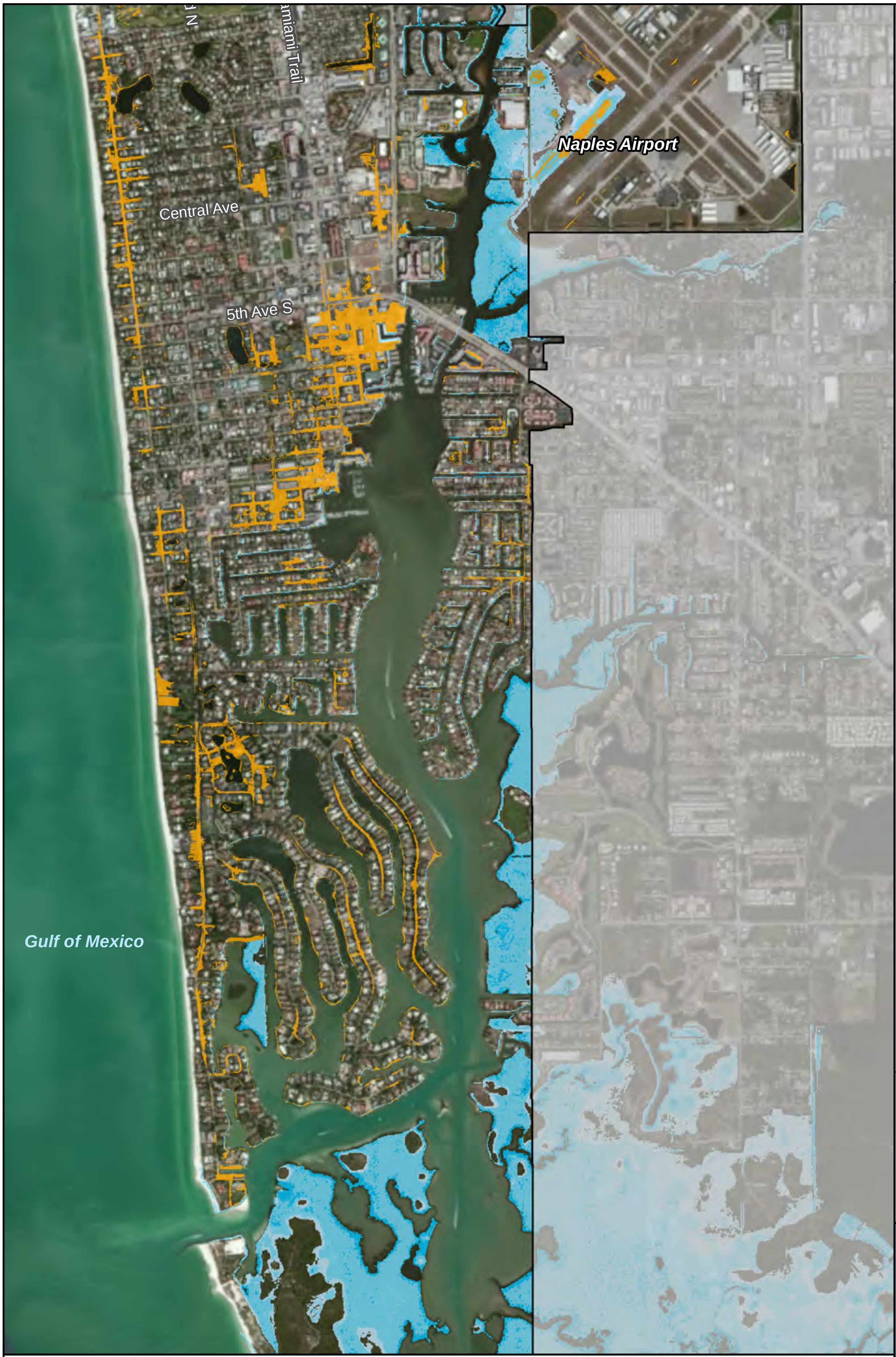
# CITY OF NAPLES

## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
1.1 ft (Year 2040)
NOAA Intermediate High



| | |
|---|---|
| ☐ | **City Boundary** |
| 🟧 | **Precipitation Flood Extent** |

**Mean Higher High Water Depth (Feet)**

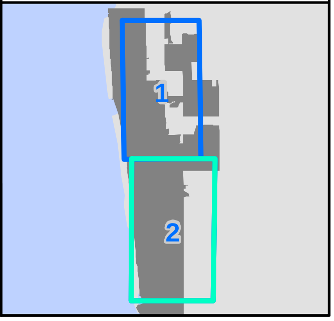
| | |
|---|---|
| ▨ | 0-1 |
| ▨ | 1-2 |
| ▨ | 2-3 |
| ▨ | 3-4 |
| ▨ | 4-5 |
| ■ | 5+ |

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,690'

## MAP INDEX



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# CITY OF NAPLES

## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
1.0ft (Year 2070)
NOAA Intermediate Low

☐ **City Boundary**

🟧 **Precipitation Flood Extent**

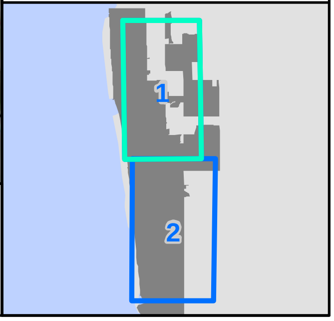
**Mean Higher High Water Depth (Feet)**

- 0-1
- 1-2
- 2-3
- 3-4
- 4-5
- 5+

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

### MAP INDEX



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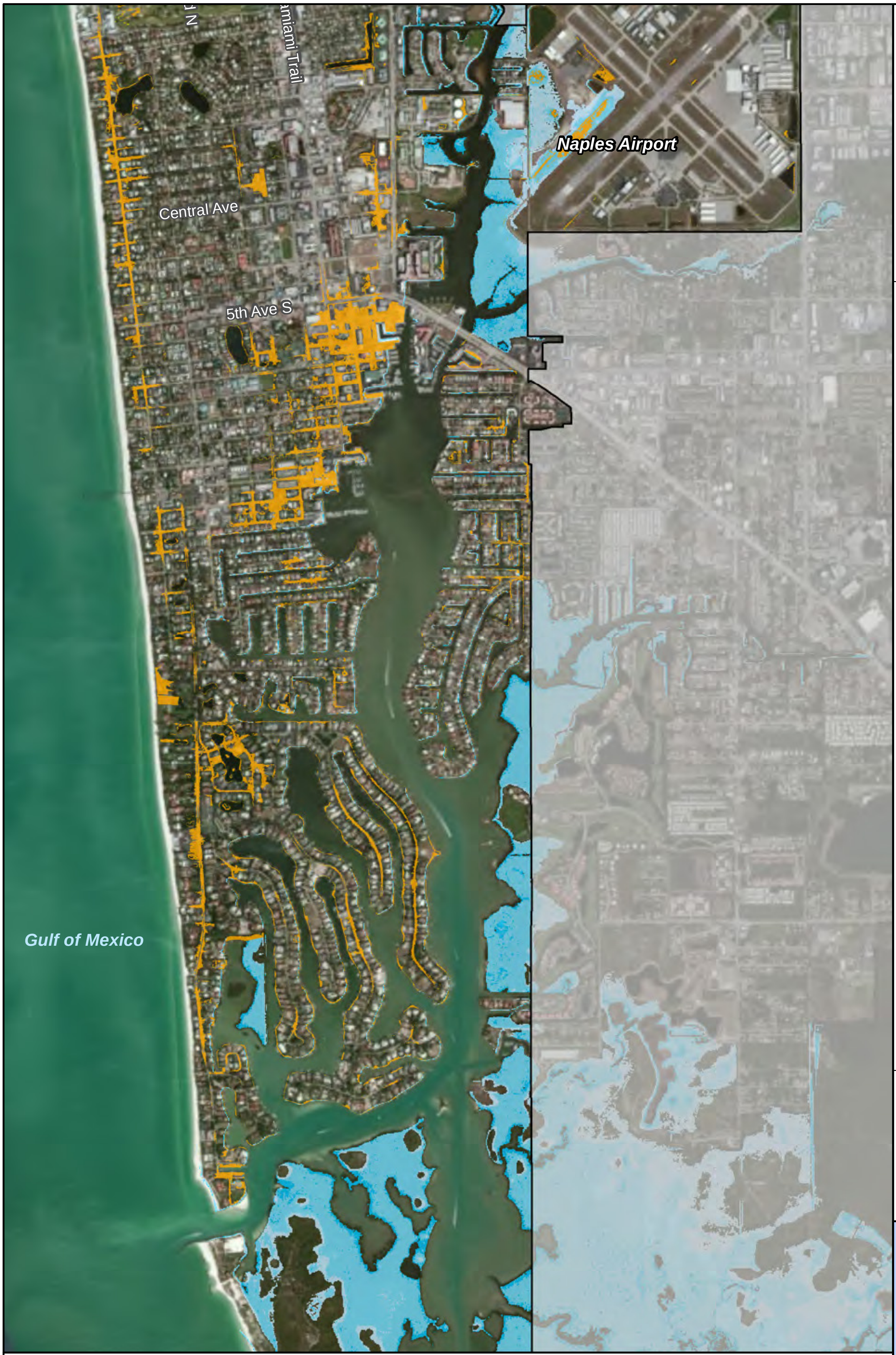

# CITY OF NAPLES

## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
1.0ft (Year 2070)
NOAA Intermediate Low

▭ **City Boundary**

🟧 **Precipitation Flood Extent**

**Mean Higher High Water Depth (Feet)**

- 🟦 0-1
- 🟦 1-2
- 🟦 2-3
- 🟦 3-4
- 🟦 4-5
- 🟦 5+

0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East

Scale: 1:2,690'

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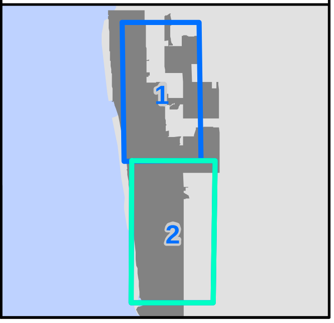

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# CITY OF NAPLES

## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
3.0ft (Year 2070)
NOAA Intermediate High

☐ **City Boundary**

🟧 **Precipitation Flood Extent**

**Mean Higher High Water Depth (Feet)**

- 🟦 0-1
- 🟦 1-2
- 🟦 2-3
- 🟦 3-4
- 🟦 4-5
- 🟦 5+

N

0 1,300 2,600
Feet

Projection: NAD 1983 State Plane Florida East
Scale: 1:2,630'

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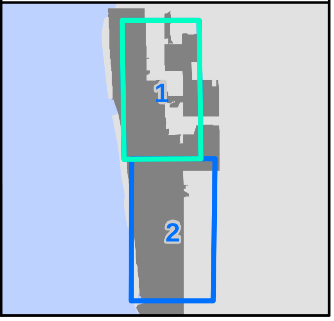

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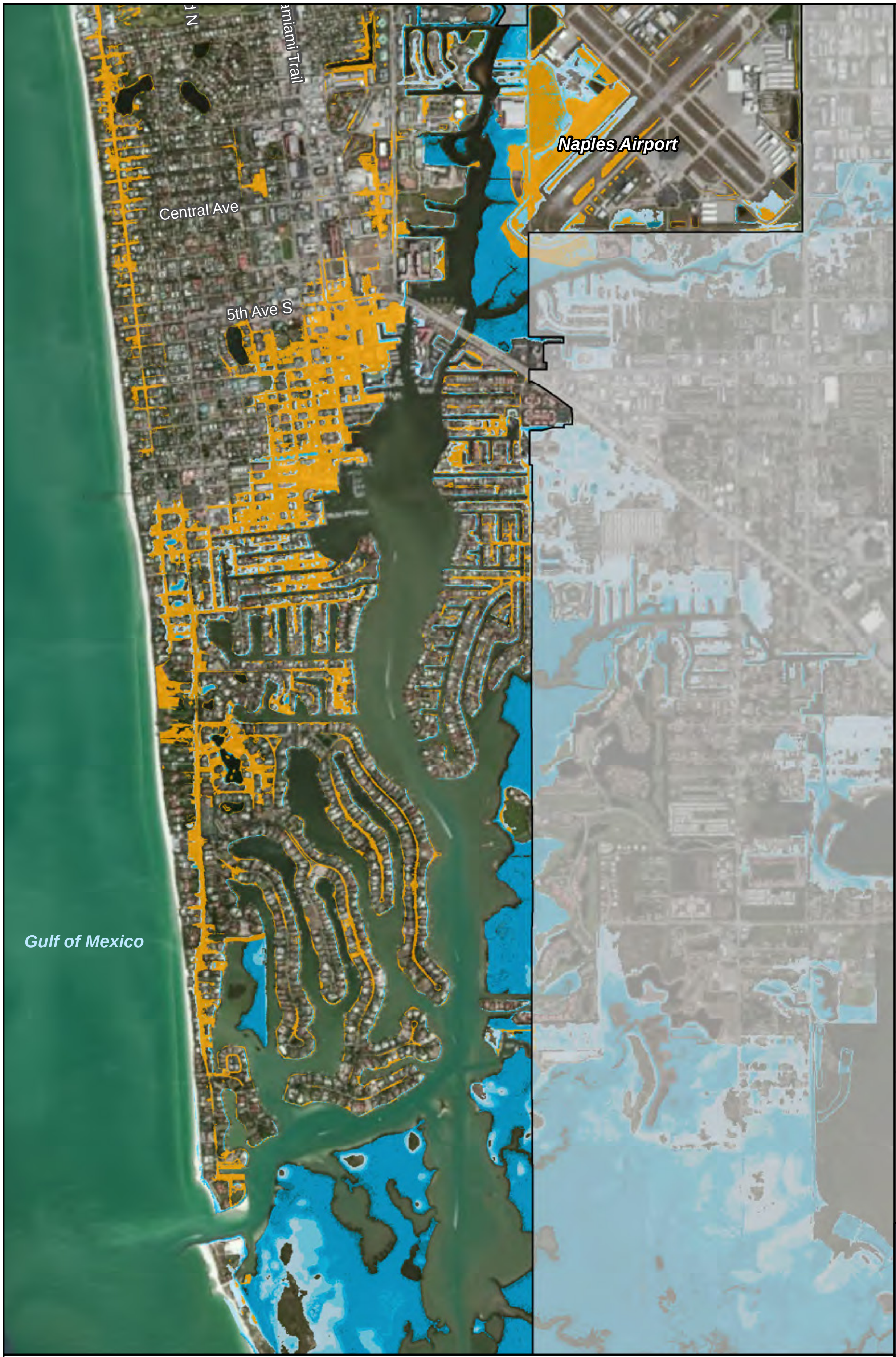

# CITY OF NAPLES

## Compound Flood Mapping

Rainfall Scenario:
25-Year, 72-Hour
Precipitation Event

Sea Level Rise:
Mean Higher High Water +
3.0ft (Year 2070)
NOAA Intermediate High

▭ **City Boundary**

🟧 **Precipitation Flood Extent**

**Mean Higher High Water Depth (Feet)**

- ■ 0-1
- ■ 1-2
- ■ 2-3
- ■ 3-4
- ■ 4-5
- ■ 5+

N

0 1,300 2,600 Feet

Projection: NAD 1983 State Plane Florida East

Scale: 1:2,690'

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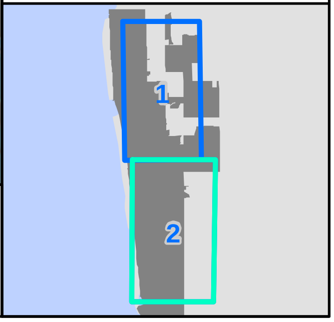

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