Palm Beach County
Climate Vulnerability Assessment
Final Report


Jupiter Inlet, FL


Grassy Waters Preserve, FL


Pahokee Marina – Pahokee, FL

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TETRA TECH

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The Project Team would like to thank the following individuals for providing their input and expertise in this Climate Vulnerability Assessment Report:

Ali Bayat – Water Utilities, Director

Angela Matthews – Information System Services, GIS Support Specialist

Deb Drum – Environmental Resources Management, Director

Ed Chase – Intergovernmental Affairs, Director

Emily Hernandez – Information System Services, GIS Specialist

Eric McClellan – Facilities Development and Operations, Division Director

Gregg Weiss – Commissioner

Jennifer Cirillo – Parks and Recreation, Director

Jerri Clairday – Public Safety, LMS Coordinator

Kevin Fischer – Planning, Zoning, and Building, Special Projects Coordinator

Mack Bernard – Commissioner

Marci Woodward – Commissioner

Maria Marino – Vice Mayor

Maria Sachs – Mayor

Mary Blakeney – Public Safety, Emergency Management Division Director

Megan Houston – Office of Resilience, Director

Michael Barnett – Commissioner

Natalie Frendberg – Office of Resilience, Environmental Programs Supervisor

Patrick Rutter – Deputy County Administrator

Paul Linton – County Administration, Water Resources Manager

Regina Hagger – Information System Services, GIS Manager

Reginald Duren – Assistant County Administrator

Samuel Rajasekhar – Information System Services Contractor, GIS Analyst

Sara Baxter – Commissioner

Scott Marting – Risk Management, Director

Stephanie Sejnoha – Public Safety, Director

Stessy Cocerez – Office of Resilience, Resilience and Sustainability Analyst

Tammy Fields – Assistant County Administrator

Todd Bonlarron – Assistant County Administrator

Verdenia Baker – County Administrator

PROJECT STEERING COMMITTEE

Megan Houston – PBC, Office of Resilience, Director

Natalie Frendberg – PBC, Office of Resilience, Environmental Programs Supervisor

Paul Linton – PBC, County Administration, Water Resources Manager

Regina Hagger – PBC, Information System Services, GIS Manager

Deb Drum – PBC, Environmental Resources Management, Director

Jennifer Cirillo – PBC, Parks and Recreation, Director

Steve Carrier – PBC, Engineering, Assistant County Engineer

Ali Bayat – PBC, Water Utilities, Director

Eric McClellan – PBC, Facilities Development and Operations, Division Director

Kevin Fischer – PBC, Planning, Zoning, and Building, Principal Planner

Michael Fox – PBC, Planning, Zoning, and Building, Codes Product and Training Supervisor

Stephanie Sejnoha – PBC, Public Safety, Director

Mary Blakeney – PBC, Public Safety, Emergency Management Division Director

Jerri Clairday – PBC, Public Safety, LMS Coordinator

Ana Carolina Maran – South Florida Water Management District, Chief District Resiliency Officer

Keith Schriner – City of Belle Glade, Consultant

Leondrae Camel – City of South Bay, City Manager

Jongelene Adams – City of Pahokee, Deputy City Manager

PROJECT CONSULTANT TEAM

Tetra Tech, Inc.

Erin L. Deady, P.A.

Clearview Geographic, LLC

CMA Chen Moore & Associates

Brizaga, Inc.

SA Nelson & Associates

EXECUTIVE SUMMARY

Palm Beach County (also referred to herein as the "County" or "PBC") has undertaken a comprehensive effort to understand, evaluate, and address the challenges presented by a changing climate throughout the community. The County's Climate Vulnerability Assessment (CVA) ensures compliance with the state law (Section 380.093 Florida Statute [F.S.]), contributing to Florida's statewide data collection efforts and maintaining eligibility for infrastructure funding through the Resilient Florida Grant Program. This CVA was also funded by the Florida Department of Commerce Community Development Block Grant Mitigation Program, through the U.S. Department of Housing and Urban Development. The CVA analyzed various climate hazard scenarios for future planning horizons (2040, 2070, and 2100), identifying the most impacted geographic areas and vulnerable assets. Through strategic planning, adaptation evaluation, engineering, and community engagement, PBC has prioritized a resilient and sustainable future for the County. This CVA, compliant with Section 380.093, F.S. is based on best-available science and data, including geographic information system (GIS) database details, climate hazard mapping, critical asset evaluation, socioeconomic factors, and public outreach throughout the planning process. Findings from this CVA, form the foundation for the County's Resilience Action Plan, which outlines actions to increase the County's capacity to adapt to climate-based stressors, prioritize needs of the community, identify funding sources, and provide guidance on proactive responses to climate impacts.

This CVA includes a systematic process to identify the potential vulnerabilities of the community to adverse impacts from climate-related flood hazards. It incorporates scientific data from reputable sources such as the National Oceanic and Atmospheric Administration (NOAA) and the Federal Emergency Management Agency (FEMA), as well as input from residents, organizations, agencies, government entities, and businesses. Data collection for the project included transportation assets; critical infrastructure; community and emergency facilities; and natural, cultural, and historic resources as well as other supplemental information in existing studies relative to flood risk. Topographical and elevation data, hydrological data, future sea level rise and rainfall climatic projections, and asset data were among the specific attributes gathered about the community for the CVA. In total, over 7,500 assets were evaluated in this analysis including stormwater and wastewater infrastructure, communication towers, hospitals, pharmacies, police and fire stations, schools and universities, affordable housing, shelters, emergency and staging centers, parks, historic structures, airports, ports, and similar assets. Topographical and elevation data, hydrological data, climatic projections, and asset data were among the critical attributes gathered about the community for the CVA. While the GIS analyses and limited hydrologic hydraulic modeling provided in this assessment are sufficient to identify potential risk, the reader is directed to the Federal Emergency Management Agency's Flood Insurance Rate Maps and the South Florida Water Management District's Flood Protection Level of Service analyses for more definitive modeling.

Although the list may be more comprehensive to fully capture every risk to a community, the Climate Vulnerability Assessment focused on the ten key climate hazards listed below, each of which are discussed below:

- **Coastal Erosion** is the loss of land along shorelines due to wind, waves, and currents. This process threatens buildings, infrastructure, and natural habitats along the coast. It can also disrupt tourism, a key economic sector. As sea levels rise, erosion worsens, leaving coastal properties and adjacent upland areas more vulnerable to severe weather events.
- **Drought** occurs when there's a prolonged lack of rainfall, leading to water shortages that can disrupt daily life and agriculture. In PBC, drought increases wildfire risks, reduces crop yields, and can damage natural habitats. The depletion of water sources such as Lake Okeechobee exacerbates the threat, affecting public health and economic activities in agriculture and tourism.
- **Extreme Heat**, defined as temperatures exceeding average highs by 10°F or more, poses severe health risks, especially for vulnerable populations. Prolonged heat waves can cause heat-related illnesses and deaths, particularly among vulnerable populations like the elderly, low-income residents, and outdoor workers. In urban areas, the heat island effect compounds the problem, straining infrastructure, increasing energy demands, and disrupting public health and economic stability. Florida leads the nation in heat-related illnesses, highlighting the urgent need for community-focused interventions.
- **Wildfires** are uncontrolled fires that spread rapidly through vegetation, often ignited by lightning, human activity, or drought conditions. In PBC, wildfires pose a significant risk, particularly during dry periods, when they can devastate ecosystems, destroy homes, damage infrastructure, and severely impact air quality. The smoke from wildfires can also cause respiratory problems, especially for vulnerable populations. Wildfires are more likely during prolonged droughts and can lead to long-term environmental damage by altering landscapes and increasing erosion once vegetation is burned away. The County employs a Prescribed Fire Program to mitigate these risks, promoting healthier habitats and preventing uncontrolled wildfires.
- **Wind**, especially from hurricanes and tropical storms, is a major threat in Palm Beach County, causing widespread damage to infrastructure, homes, and vegetation. Strong winds from hurricanes can reach speeds exceeding 155 mph, leading to destruction of roofs, power lines, and trees. These winds can cause flying debris, dangerous conditions, and prolonged power outages. Hurricanes also push storm surges toward shorelines, exacerbating flooding and coastal erosion. Wind damage poses risks to public safety, disrupts critical services, and often leads to costly repairs and recovery efforts, particularly in areas with high-density development.
- **Sea level rise** is the gradual increase in the level of the world's oceans due to climate change. It poses a significant threat to coastal communities, ecosystems, and infrastructure. SLR leads to increased coastal flooding, shore erosion, natural habitat transition, and saltwater intrusion. Studies indicate that SLR could escalate saltwater and flood risks in Florida's coastal regions. The accelerated pace at which SLR is occurring has resulted in assets that

were considered safe for many years into the future now being classified as vulnerable in the near future.

- **Tidal flooding**, a consequence of rising sea levels, involves the recurrent inundation of low-lying areas by tidal waters during high tide events. As sea levels rise, this poses an increasing threat to County assets. Tidal flooding jeopardizes infrastructure integrity, including roads, bridges, and buildings. Additionally, saltwater intrusion accelerates corrosion of infrastructure components, impacting electrical systems and transportation networks. It also disrupts essential services like sewage systems and water treatment plants.
- **Storm surge** is the rise of seawater levels caused by intense sustained onshore winds and low atmospheric pressure during extreme weather events such as nor'easters and hurricanes. This poses a severe threat to PBC, particularly along coastlines and inland waterways. Storm surge results in rapid inundation of coastal areas and can cause extensive damage to infrastructure, homes, and critical facilities. It can cause extensive coastal erosion, compromising the stability of protective structures like rock revetments and seawalls. Moreover, saltwater intrusion into freshwater systems compromises natural habitats and water supplies, accelerating infrastructure deterioration.
- **Extreme rainfall** is the increased intensity and duration of precipitation events that often leads to severe flash-flooding in low-lying areas. This overwhelms stormwater management systems, causing widespread damage to infrastructure such as roads, bridges, buildings, homes, and businesses. Essential services and transportation networks are disrupted.
- **Compound flooding** occurs when multiple causes of flooding coincide simultaneously, such as tidal, storm surge, and rainfall-induced flooding, intensified by rising sea levels. This combination produces complex flood scenarios that inform this assessment. By addressing these various flooding-related climate hazards, the County aims to enhance its resilience to future challenges and ensure sustainable development.

The CVA, based on Section 380.093, F.S. requirements, incorporated critical municipal and regionally significant assets. Critical assets are public assets, networks, and essential systems crucial for the well-being of PBC. The following asset classes were evaluated for this CVA:

- **Transportation Assets and Evacuation Routes**: Airports, bridges, bus terminals, bus routes, boat ramps, major roadways, evacuation routes, port facilities, marinas, rail facilities, and railroad bridges.
- **Critical Infrastructure**: Wastewater conveyance structures and lift stations, potable water conveyance structures, stormwater drainage infrastructure and stormwater ponds, electric production and supply facilities, military installations, post offices, communications facilities, and disaster debris management sites.
- **Critical Community and Emergency Facilities**: Childcare facilities, schools, colleges, universities, assisted housing, community centers, emergency medical service facilities, fire stations, emergency management services, health care facilities, hospitals, law enforcement facilities, risk shelters, local government facilities, and state government facilities.

- **Natural, Cultural, and Historical Resources**: Dedicated to preserving and protecting natural areas and cultural/historical sites, including historic buildings and cemeteries, places of worship, and other historical and cultural assets, county parks, shorelines, surface waters, wetlands, and other terrestrial and aquatic natural areas.
- **Regionally Significant Assets**: Vital facilities serving beyond the County's jurisdiction, including water resource facilities, regional medical centers, transportation hubs, and utilities, crucial for regional resilience and response efforts, spanning neighboring communities and various geopolitical boundaries.

The CVA employed a sequential methods approach, first characterizing vulnerability as a function of exposure followed by sensitivity:

- **Exposure** refers to the presence of people, assets, and ecosystems in areas where they could be adversely affected by climate hazards. PBC's CVA assessed exposure levels to each climate hazard and identified the impact caused by each required climate hazard scenario for three planning horizons: 2040, 2070, and 2100. Once the assets at greatest risk (within flooding hot spots) were identified, a **sensitivity** analysis was performed to determine the degree to which a system, population, or resource is or might be affected by a climate hazard and the associated risk or consequence that would result if that climate hazard actually occurred. This step focused on identifying aggregations of critical assets in at risk flooding areas as depicted on exposure maps and designating those flooding hot spots. The results from this analysis also produced a list of prioritized critical assets impacted by flooding-related climate hazards.

Public and stakeholder engagement efforts throughout the project process were important to ensure the CVA efforts were communicated and that the CVA reflects the input received from the community. The public meetings and community surveys were aimed at two-way communication of science-based information to engage the public, community leaders, and subject matter experts and receive their feedback. Public stakeholders and steering committee members played a vital role in shaping the CVA by providing essential input and feedback. Various methods and multimedia tools were used to enhance community understanding and involvement and gain input into the planning process.

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** *Appendices have been omitted from this report due to security considerations.*

Acronyms and Abbreviations

°F	degrees Fahrenheit
CDC	Centers for Disease Control and Prevention
County	Palm Beach County
CVA	Climate Vulnerability Assessment
CVS	composite vulnerability score
DEM	digital elevation model
FDEP	Florida Department of Environmental Protection
FEMA	Federal Emergency Management Agency
FIS	flood insurance study
F.S.	Florida Statute
GIS	geographic information system
gSSURGO	Gridded Soil Survey Geographic Database
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HHD	Herbert Hoover Dike
HSG	Hydrologic Soil Group
HTF	high tide flooding
HUD	U.S. Department and of Housing and Urban Development
LAI	Location Affordability Index
LMI	Low to Moderate Income
LMS	Local Mitigation Strategy
MHHI	median household income
MHHW	mean higher high water
MHW	mean high water
MLW	mean low water
MLLW	mean lower low water
mph	miles per hour
MSL	mean sea level
NAVD 88	North American Vertical Datum 88
NH	NOAA high (sea level rise projection)
NI	NOAA intermediate (sea level rise projection)
NIH	NOAA intermediate-high (sea level rise projection)

NIL	NOAA intermediate-low (sea level rise projection)
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
OOR	Office of Resilience
PBC	Palm Beach County
RAP	Resilience Action Plan
SEFRCCC	Southeast Florida Regional Climate Change Compact
SFWMD	South Florida Water Management District
SLOSH	Sea, Lake, and Overland Surges from Hurricanes
SLR	sea level rise
SVI	Social Vulnerability Index
ULDC	Unified Land Development Code
USGS	U.S. Geological Survey
VA	Vulnerability Assessment
WUD	Water Utilities Department

Glossary

Adaptation (to climate change): The process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. Adaptive capacity is the ability to make these adjustments based on feedback loops.

Assets: People, resources, ecosystems, infrastructure, and the services they provide. Assets are the tangible and intangible things people or communities' value.

Bathtub Method / Model: The projected sea level rise at a point in time is added to the current water elevation and overlaid on the existing topography to identify potential future inundated areas.

Climate Change: The increasing changes in the measures of climate over a long period of time – including precipitation, temperature, and wind patterns.

Critical Assets/Infrastructure: Public assets, networks, and essential systems crucial for the well-being of Palm Beach County. Disruption or damage to critical infrastructure would lead to negative community, environmental, and/or economic consequences.

Composite Vulnerability Score: The comprehensive metric (derived from the risk assessment), integrating weighted components to offer a holistic measure of flood-related risk to County assets.

Days of Tidal Flooding: The number of days that the water level exceeds MHHW at (in this study) the Virginia Key Tide Guage, when that water level is adjusted for SLR.

Exposure: The presence of people, assets, and ecosystems in places where they could be adversely affected by hazards.

Flood Risk Index: The metric used to assess the current exposure to flood risks, ranking assets based on scores reflecting their level of impact from the various flood scenarios and employing a tiered system to identify those facing the highest risks to flooding-related climate hazards.

Flooding Hot Spot: A geographical region with heightened vulnerability to climate change impacts. Hot spots guide targeted adaptation and mitigation efforts.

Focus Areas: Municipalities selected by the County to serve as the focus of this assessment due to their potential environmental and social risk factors. These areas may lack infrastructure and preparedness to respond and recover from climate-related events. The focus areas for this assessment include Belle Glade, Pahokee, South Bay, and portions of unincorporated areas and municipalities containing County-owned assets.

Global Warming: The rise in global mean atmospheric temperatures due mainly to the increasing concentrations of greenhouse gases in the atmosphere.

Greenhouse Gas: Atmospheric gasses, such as carbon dioxide and methane, that trap heat and affect the earth's temperature.

Hazard: An event or condition that may cause injury, illness, or death to people or damage to assets or otherwise impede their normal function.

Hazard Mitigation: When used by the Federal Emergency Management Agency (FEMA), the actions taken to reduce loss of life and property by lessening the impact of near future disasters.

Hazus: A GIS-based software tool that applies engineering and scientific risk calculations to provide defensible damage and loss estimates.

Heat Island Effect: A phenomenon in which urban areas experienced heighted temperatures due to the lack of or removal of vegetation and materials that can absorb heat without heating quickly and addition of features made from materials that absorb and radiate heat quickly.

Horizon Index: The metric used to assess the immediacy of flooding impacts by categorizing planning horizons and utilizing a multiplier system to emphasize the criticality of near-term impacts.

Impacts: (Negative impacts in this discussion) Effects on natural and human systems that result from hazards. Evaluating potential impacts is a critical step in assessing vulnerability.

Infrastructure: Fundamental physical and organizational structures (man-man and natural) and facilities necessary for the functionality of a community.

King Tide: A non-scientific term describing an especially high tide caused by alignment of the gravitational pull between the sun and moon. A King Tide usually occurs three to four times a year.

Likelihood: The probability of an asset being impacted by a climate hazard based on its geographical position.

Mitigation (of climate change): A human intervention to reduce emissions or enhance the sequestration of greenhouse gases.

Planning Horizon: The projected conditions at a future date, in this study the planning horizons can include 2040, 2070, and 2100.

Projections: Potential future climate conditions calculated by computer-based models of the earth system. Projections are based on sets of assumptions about the future scenarios of human actions that may or may not be realized.

Raster: A spatial data format that represents geographic information and data through a grid of pixels, with each cell containing a value corresponding to a specific attribute.

Regionally Significant Assets: Vital facilities within the County that cater to a wider geographic scope, spanning neighboring communities, and may be but are not inherently under the County's ownership and maintenance.

Resilience: The capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from a disruption.

Risk: The potential total cost if something of value is damaged or lost, considered together with the likelihood of that loss occurring. Risk is often evaluated as the probability of a hazard occurring multiplied by the consequences that would result if it did happen.

Risk Assessment: The process of evaluating and prioritizing critical assets within hot spots by using a weighted system that combines three indexes—flood risk index, horizon index, and social index—to produce a comprehensive measure of flood related risk.

Scenarios: A set of assumptions about the future regarding the level and effectiveness of mitigation efforts and other physical processes, each with a level of uncertainty associated with it.

Sea Level Rise (Absolute Sea Level Rise): An increase in the height of the ocean surface above the center of the earth, without regard to whether nearby land is rising or falling.

Sensitivity: The degree to which a system, population, or resource is or might be affected by climate hazards.

Social Index: The metric used to assess flood vulnerability impacts on the County's inhabitants, focusing on vulnerable populations by evaluating socioeconomic status, minority status and language, housing composition and disability, and housing and transportation, to prioritize resource allocation and improve community resilience.

Socioeconomic Status: A combination of sociological and economic statistics, often measured as a combination of education, income/poverty level, and occupation.

Stillwater Elevations: The level of water in a body of water, such as a lake or river, under various conditions but not including wave action. This measurement is crucial in understanding water levels for purposes like flood prediction, navigation safety, and water resource management. It represents the height of the water surface when it is not affected by wind waves or tidal forces, providing a baseline for gauging water levels and their potential impacts.

Stressor: An external factor, such as a climate hazard, posing a threat to an asset.

Tidal Flooding: Defined in Subparagraphs 380.093(3)(d)1. and 380.093(3)(d)2., F.S. as “Depth of tidal flooding, including future high tide flooding. The threshold for tidal flooding is 2 feet above mean higher high water.”

Uncertainty: The inability to predict, with 100 percent accuracy, a particular outcome because future climate arises from the complexity of variables within the climate system, including human actions, and the ability of models to represent scenarios with absolute certainty, as well as the inability to predict the decisions that society will make.

Vulnerable Populations: Groups of individuals who are disproportionately at higher risk to impacts from community-wide hazards and threats. Vulnerable populations may include, but are not limited to: the elderly, youth, pregnant women, vulnerable occupational groups, persons with disabilities, persons with pre-existing or chronic medical conditions, and those with low income levels.

Vulnerability: The propensity or predisposition of assets (human, ecological, and man-made) to be adversely affected by hazards. Vulnerability encompasses the degree of exposure, sensitivity, risk, potential impacts, and adaptive capacity.

Vulnerability Assessment: A process for identifying who or what is impacted by climate change. It is the combination of exposure, sensitivity, and adaptive capacity.

24-Hour Rainfall: In this document, the 25-, 50-, 100-, 500-, and 1,000-year 24-hour rainfall. It is the amount of rainfall within a 24-hour period that has either a 4 percent (25-year), 2 percent (50-year), 1 percent (100-year), 0.2 percent (500-year), or a 0.1 percent (1,000-year) chance of occurring in any given year.

380.093(3), F.S.: A Florida statute passed in 2021, 380.093(3), F.S. pertains to vulnerability assessments related to flooding and sea level rise in the state of Florida. It requires the state compile a comprehensive statewide assessment of specific risks posed by flooding and sea level rise.

1.0 INTRODUCTION

1.1 Project Background

Palm Beach County (also referred to herein as the "County" or "PBC") has completed their Climate Vulnerability Assessment (CVA) to better understand and address the challenges a changing climate poses throughout the community. The County's CVA has been funded by both the Florida Department of Environmental Protections through the Resilient Florida Program (Grant 22PLN73) and by the Florida Department of Commerce Community Development Block Grant Mitigation Program (Grant MT026), through the U.S. Department of Housing and Urban Development (HUD).

This CVA is fully compliant with the new state law (Section 380.093 Florida Statute [F.S.]), contributing to the Florida Statewide Resilience Dataset, and ensures the County's eligibility for infrastructure funding through the Resilient Florida Grant Program.

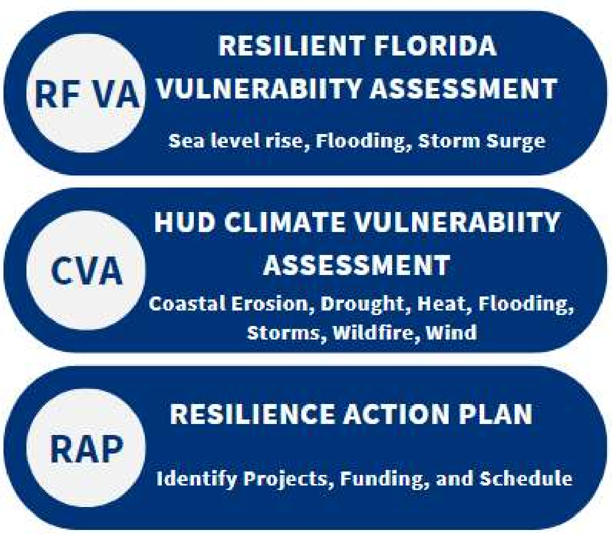


Figure 1-1. Climate Vulnerability Assessment Initiative

The County also received grant funding from the Florida Department of Commerce Community Development Block Grant Mitigation Program, on behalf of the U.S. Department of Housing and Urban Development (HUD), to complete a CVA and Resilience Action Plan (RAP). The HUD funded CVA components aimed to align with the Resilient Florida Grant Program's Section 380.093(3), Florida Statute requirements for conducting vulnerability assessments, but also incorporate additional climate related risks and to address socioeconomic factors in the evaluation process. The climate risks evaluated for HUD included coastal erosion, drought, extreme heat, inland flooding, wildfires, and wind, while the climate risks focused on for FDEP focused on flooding-related climate hazards including sea level rise, tidal flooding, storm surge, extreme rainfall, and compound flooding (Figure 1-1).

Through strategic planning, innovative engineering, and community engagement, the County is prioritizing a resilient and sustainable future for PBC. This countywide CVA relies on best-available science and data to examine the vulnerability of County assets to current and future climate hazards. The assessment included public outreach meetings and community engagement. Data collection efforts included local geographic information system (GIS) data supplied by PBC along with publicly available information. Inundation mapping and modeling and critical asset evaluation are summarized in this report.

Collaboration played a central role in this project, involving a diverse range of stakeholders, from elected officials to faith-based, health, education and other non-governmental organizations, ensuring both technical expertise and community insights were considered. Furthermore, the project emphasized social equity and climate justice throughout its development and execution.

Together, the CVA and the RAP will provide a roadmap for PBC to enhance its resilience through informed decision-making and community involvement. By addressing current and future challenges, these initiatives safeguard the County's quality of life, health, and assets against the impacts of climate change. The CVA will serve as the foundation for the RAP. The RAP will evaluate the County's needs and capacity to adapt and outline adaptation strategies and policy updates. It will provide County operations and County-wide community resilience targets, a strategy to achieve these targets, and a public engagement program that ensures social equity in evaluating, prioritizing, and implementing solutions. Each strategy will include key information such as estimated timelines, level of cost and effort required, proposed lead agency or organization, and social equity considerations. The RAP will examine current and future conditions that impact the sustainability and resilience of PBC and the community. Hazard mitigation efforts, emergency preparedness, land use planning, code and policy development, infrastructure investment, and public health policies and programs will be considered. Together, the work products will form the blueprint of the County's proactive planning to reduce or mitigate climate-related hazards countywide. The core project milestones are delineated in Figure 1-2.

Figure 1-2. Project Milestones

The CVA is a systematic process to understand the potential vulnerabilities of a community to adverse impacts of climate-related hazards. In the case of this CVA, it leverages scientific data pertaining to climate hazards, drawing from various technical sources such as the National Oceanic and Atmospheric Administration (NOAA) and the Federal Emergency Management Agency (FEMA). The scientific information gathered was combined with input from the County's residents and businesses to gain insights into the current and future challenges of the community and the relative importance they play. The assessment also examined critical assets of the County on an asset-by-asset level. The CVA was the first step in developing a comprehensive approach to adapt to, and mitigate, the effects of climate change and lays the foundation for informed decision-making and a resilient future.

1.2 Disclaimer

The PBC CVA uses publicly available data, asset data provided PBC, and standard practices and methodologies for evaluating flood hazards available at of the time of this study (June 2024). The CVA results are formulated using GIS modeling that projects water levels across the ground elevation of the study area but does not factor specific drainage pathways. The findings presented in this report are derived from data with varying degrees of uncertainty and underlying assumptions and should be viewed as indicators of relative risk across different areas of PBC. The analysis results provided in this report are intended to aid inquiries regarding asset vulnerability and provide basic planning level information.

Loss estimates, exposure analyses, and hazard-specific vulnerability evaluations rely on the best-available data and methodologies. Potential economic loss is based on the present value of the general building stock using the best available data. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following elements of the CVA process:

- Approximations and simplifications necessary to conduct such a study
- Incomplete or dated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- The amount of advance notice residents has to prepare for a specific hazard event
- Uncertainty of climate chance projections

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should only be used to understand relative risk. Over the long term, the County will collect additional data and update and refine existing inventories to assist in estimating potential losses.

1.3 Palm Beach County

1.3.1 Climate Change and Sea Level Rise

Globally, climate change poses an immense challenge marked by escalating temperatures, shifting weather patterns, and more frequent extreme weather occurrences. In PBC, these global shifts translate into specific regional impacts directly impacting the County’s environmental and socioeconomic framework. Given PBC’s geographical location, it faces distinct challenges exacerbated by climate change-induced impacts. The CVA primarily delves into comprehending these local ramifications, including the influence of climate pattern variations on the County’s natural ecosystems, urban infrastructure, and socioeconomic composition.

In the context of PBC, climate change introduces a complex array of challenges that necessitate thorough examination and proactive responses. With rising global temperatures, altered weather patterns, and increased frequency of extreme events, these changes create direct and indirect impacts across different areas in PBC, affecting various facets of the region’s environment, economy, and society. A prominent consequence is the rising sea levels, largely driven by thermal expansion of seawater and polar ice caps’ melting. As sea levels continue to increase, PBC’s coastal zones confront heightened risks, including coastal erosion, more frequent and severe flooding both seasonal and year-round, and compromised infrastructure. Some flooding challenges are compounded by low-lying topography within various areas of the County and its dependence on a resilient coastal economy, rendering it particularly susceptible to sea-level rise and other climate hazards.

Situated along the Atlantic Ocean, the eastern 1 to 2 miles of PBC's geographical location renders it vulnerable to sea-level rise effects. Moreover, the occurrences and severity of storms, including hurricanes and tropical cyclones, and subsequent coastal erosion, represent a significant threat to PBC's coastal regions. Elevated sea levels worsen the impact of storm surges, heightening the likelihood of severe inundation during such events. The County's coastal areas, characterized by shorelines and vital economic assets, face challenges anticipated to amplify in the future.

1.3.2 Physical Descriptors of the Area

1.3.2.1 Geographical Setting and Characteristics

PBC comprises roughly 2,500 square miles, 39 municipalities, over 1.5 million year-round residents (as of 2023), and 47 miles of beaches (Palm Beach County Planning Division 2023) (Figure 1-3). The County's geographic and social characteristics affect its vulnerability to natural hazards.

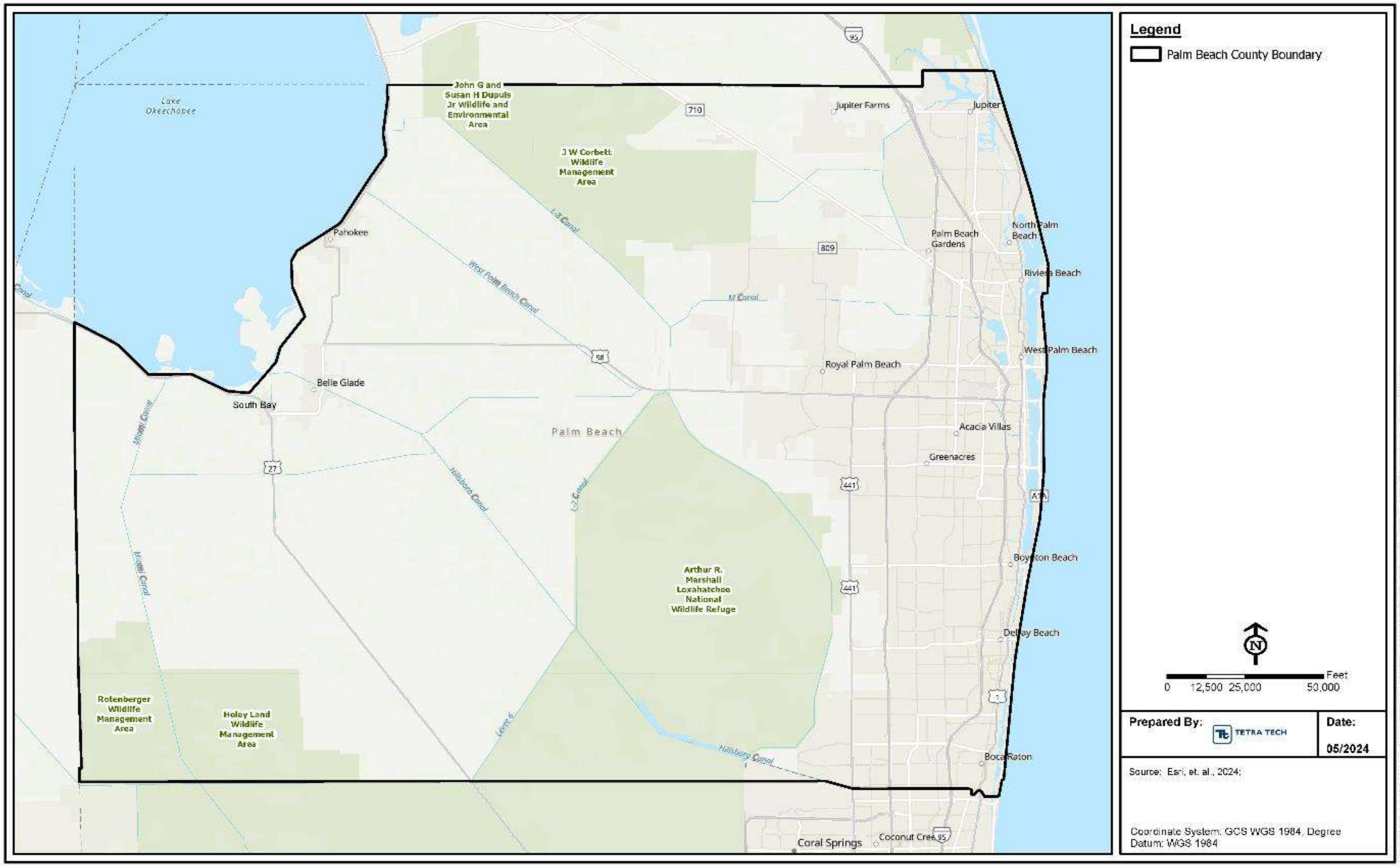


Figure 1-3. Palm Beach County Boundary

Portions of the County are generally higher in elevation than counties further south such as Broward and Miami Dade (Southeast Florida Regional Climate Change Compact Inundation Mapping and Vulnerability Assessment Work Group 2012) giving PBC more time and options for adapting to rising seas, coastal erosion, flooding, and storm surge. However, this higher elevation also makes the County a destination for future migration from southern displaced populations. Population growth and the associated increase in vulnerable populations is an important secondary climate stressor to consider in a localized CVA and RAP. Simultaneously, the County must continue to prioritize resilient affordable housing and provide resilient solutions for those most in need as they will be disproportionally impacted by the interruption of service, ability to work, and cost of repairs.

The County encompasses a variety of neighborhoods, business districts, recreational spaces, natural lands and essential infrastructure. Decades of development have reshaped its landscape, prompting the County to strive for a delicate equilibrium between future strategic development and preservation of open space. Positioned in an area prone to climate change and challenges related to SLR, the County faces significant challenges to alleviate or mitigate these impacts. This underscores the critical importance of proactive urban planning and robust infrastructure planning and maintenance to protect residents, assets, and resources.

1.3.2.2 Demographic Overview

Recent census data for PBC reveals a population exceeding 1.5 million residents, solidifying its status as one of Florida's largest counties by population (United States Census Bureau 2022). The County's demographic landscape is marked by rich diversity, with a significant portion of the population comprised of various ethnic and racial groups. The Hispanic or Latino population accounts for approximately 24 percent of the total population, while African Americans make up around 20 percent (United States Census Bureau 2022). Moreover, PBC possesses a wide range of age demographics, with a median age of around 45 years (United States Census Bureau 2022). The County's economy thrives across diverse sectors, including tourism, healthcare, finance, agriculture, and technology, offering ample opportunities for residents and businesses alike.

1.4 Resilience Initiatives in Palm Beach County

PBC has undertaken a proactive approach to addressing the challenges posed by a changing climate through its dedicated Office of Resilience (OOR). Tasked with improving the County's resilience to climate disruptions, the OOR plays a crucial role in ensuring that PBC remains a thriving community in the face of increasing climate risks. By focusing on the physical, social, and economic dimensions of resilience, the OOR works diligently to maintain essential services, foster economic opportunities, and create a sustainable environment for residents, businesses, and visitors alike. Through strategic planning and collaboration, the OOR strives to empower individuals and enterprises to adapt to climate change, while promoting sustainable practices that support long-term prosperity and well-being throughout PBC (Palm Beach County Office of Resilience 2023a).

In addition to its proactive initiatives, the OOR collaborates closely with local stakeholders to foster a shared understanding of climate vulnerability and preparedness. Through community engagement and outreach efforts, the OOR strives to enhance awareness and preparedness for climate-related risks among residents, businesses, and organizations throughout PBC. Moreover, the office is actively involved in developing tools and resources to assess climate vulnerability and support informed decision-making at the local level. By engaging with the housing and building community, OOR promotes the integration of resilience and sustainability principles into the planning and design of future development and capital projects countywide. This proactive approach ensures that infrastructure investments align with long-term resilience goals and contribute to the overall sustainability and livability of PBC (Palm Beach County Office of Resilience 2023a).

Furthermore, PBC has actively participated in regional initiatives aimed at addressing climate change challenges. Since 2010, the County has been a key member of the Southeast Florida Regional Climate Change Compact, along with Broward, Miami-Dade, and Monroe counties. This collaborative effort enables the sharing of best practices, resources, and strategies for climate resilience and mitigation across county lines. As part of this compact, PBC contributed to the development of the Regional Climate Action Plan, which provides a comprehensive framework for governments, resource management districts, and other organizations to implement climate adaptation and mitigation strategies effectively. Through its engagement in regional partnerships like the Compact, PBC demonstrates its commitment to a coordinated a holistic approach to climate resilience that transcends municipal boundaries and fosters regional cooperation (Palm Beach County Office of Resilience 2023a).

Moving forward, PBC remains committed to leading efforts to adapt to climate change, mitigate its impacts, and foster sustainable development. Recognizing the importance of engaging with community stakeholders, the County will continue its proactive approach to keeping residents, businesses, and visitors informed about the latest scientific findings regarding climate change. Moreover, the County will seek input from various stakeholders, including local governments, to ensure that adaptation and mitigation strategies are inclusive and representative of the diverse needs and priorities of the community. By promoting collaboration and maintaining open communication channels, PBC aims to harness collective knowledge and resources to address climate change challenges effectively and advocate for resilient and sustainable solutions (Palm Beach County Office of Resilience 2023a).

2.0 CLIMATE VULNERABILITY ASSESSMENT OVERVIEW

2.1 Project Goals and Objectives

The key primary goals and objectives of the CVA project are as follows:

- Model the exposure of County assets to the flood related climate-related hazards
- Determine the sensitivity and risk related to exposed assets
- Gather and incorporate public and stakeholder input
- Assign a vulnerability level to exposed County assets for prioritization
- Develop a range of adaptation strategies to protect and adapt vulnerable assets
- Incorporate results into future County planning initiatives and the RAP

The County's resulting CVA adheres to the Vulnerability Assessment (VA) requirements contained within Section 380.093(3), F.S. This CVA will support Florida's coordinated approach to address coastal and inland resiliency through the Statewide Flooding and Sea Level Rise Resilience Plan.

One of the key purposes of conducting a CVA consistent with Section 380.093, F.S. is the availability of funding for projects identified in the CVA. The County has already secured grant funding for capital projects through ranked projects in the Statewide Flooding and Sea Level Rise Resilience Plan. Those projects include:

- M-2 Bypass Project
- Australian Ave. Drainage Improvement Project
- Western Region Wastewater Treatment Facility Operations Building Replacement Project
- Wastewater Lift Station LS 0637 Hardening Project

To continue to be eligible for grant funding, the County must identify projects in a compliant CVA. The success in pursuing these funds has already led to $21,509,003 of grant funding to the County and the completion of this CVA enhances and continues those efforts by identifying additional adaptation projects for future funding cycles.

2.2 Steering Committee

PBC established a project steering committee of key collaborators, comprising representatives from diverse backgrounds and associations. The steering committee played a vital role in shaping the project by reviewing goals, offering input on study direction, identifying geographic context, guiding modeling methodologies, pinpointing available data and resources, providing specific asset information, and reviewing project findings. The 19-member steering committee represented various County departments including the Office of Resilience, Water Resources, Information System Services, Environmental Resources Management, Parks and Recreation, Water Utilities, Facilities Development and Operations, Planning, Zoning, and Building, and Public Safety.

An initial meeting was held on August 8, 2023, with attendees from the project steering committee as well as local government representatives from the City of Belle Glade, the City of Pahokee, and the

City of South Bay. The first meeting facilitated initial feedback through a prepared questionnaire and targeted prompts. Table 2-1 outlines the input received from the steering committee members and local government representatives regarding County assets. In addition to the asset data collected from PBC and publicly available sources, the assets identified by the project's steering committee were also evaluated.

Table 2-1. Palm Beach County Steering Committee and Local Government Identified Assets

	Transportation Assets and Evacuation Routes	Critical Infrastructure	Critical Community and Emergency Facilities	Natural, Cultural, and Historical Resources
City of Belle Glade	• Bridge to Torry Island • Belle Glade Municipal Airport • State Road 15 • State Road 80 • State Road 715	• (2) Sanitary sewer lift stations • Belle Glade Water Treatment Plant	• Lake Shore Civic Center • Shelters • Schools: Grove Elementary, Belle Glade Elementary, Pioneer Park Elementary, Lake Shore Middle, Glade View Elementary • Belle Glade Public Library • Senior centers • Hospitals • University of Florida Satellite Campus	• Torry Island & amenities: amphitheater, boat docks, boardwalks, seawalls, pavilion • Lawrence E Will Museum • Belle Glade Municipal Golf Club • Boys & Girls Club
City of Pahokee	• Pahokee Helipad	• *No additional assets identified*	• Schools: Pahokee Middle High School, Pahokee Elementary, Everglades Prep, Good Shepherd (church & school) • New Hope • Pahokee Juvenile Center • Emergency Operations Center • Pahokee Women's Club	• Martin Luther King Jr Memorial Park • Pahokee Campground • Old Pahokee High School • Pahokee Marina
City of South Bay	• US Highway 27	• *No additional assets identified*	• Senior Facilities • South Bay Elementary School • South Bay Correctional Facility	• Tanner Park • South Bay RV Park & Campground
Steering Committee	• FPL Distribution Center	• *No additional assets identified*	• *No additional assets identified*	• *No additional assets identified*

A second meeting was held on February 6, 2024, with attendance from steering committee members as well as local government representatives from the City of Belle Glade and the City of South Bay. The second steering committee meeting provided attendees with an overview of the preliminary CVA results, and the Project Team gathered further input from the steering committee related to the analysis methods and results.

2.3 Public Engagement

Community resilience refers to the ability of governments, individuals, organizations, institutions, and businesses to anticipate, respond to, endure, and recover from both immediate and prolonged pressures stemming from climate change effects such as rising sea levels, floods, extreme heat, drought, and heightened storm severity. To establish community resilience, it is essential to actively engage stakeholders when shaping planning efforts and determining adaptation strategies and infrastructure priorities. Without this inclusive approach, policies or projects may lack sufficient public backing that would be needed to implement policy recommendations over time, particularly amidst political or economic uncertainties.

Public involvement for the CVA was comprehensive with a focus on gathering feedback from community members. Information is provided to and received from members of the community through public meetings and a public survey. Public engagement and outreach efforts for this project were geared toward communicating science-based information that engages the public, community leaders, and subject matter experts, regardless of education and technical background. Utilizing various methods and multimedia tools collaboratively, the outreach initiatives aimed to enhance community understanding and involvement in the science and technical aspects behind the CVA and proposed projects. The approach to public engagement empowered the community to take informed actions in safeguarding their quality of life within the community.

Figure 2-1 outlines the public engagement approach utilized by the Project Team. The public engagement process was integral to the project's success, encompassing multiple phases to ensure comprehensive community involvement and support. The process began with meticulous planning for engagement events in various PBC locations, followed by listening to stakeholders' priorities and insights at these events. This initial phase was crucial in gathering and understanding the communities' perspectives and needs.

Public announcements and educational materials were widely distributed through various relevant websites, calendars, email lists, newsletters, local radio broadcasts, religious organizations, community organizations, and social media platforms. Community involvement played a pivotal role in identifying social, cultural, economic, and physical factors crucial to the project, ensuring that the CVA and adaptation efforts aligned with the community's needs. Public input and feedback were actively sought through public workshops, public surveys, comment cards, and engagement activities such as poster board prompts.

Figure 2-1. Palm Beach County Public Engagement Process

Next, the Project Team evaluated the information gathered from the community and coordinated efforts to integrate the input into the project. Presenting the climate hazards and adaptation strategies involved sharing information with the community about the risks and potential adaptation responses to the climate hazards within this project. Further coordination and validation involved various project refinements based on continued stakeholder input. Finally, documenting the engagement outcomes provided a transparent record of the community's contributions.

2.3.1 Stakeholder and Public Outreach Events

Three initial public community workshops were held in various locations within the County to gather input on potential hazards and assets to further include in the CVA. Three additional community workshops were held to share the preliminary CVA results with the community. The input gathered at these meetings was used to help the Project Team pinpoint critical assets prioritized by the community, define obtainable and measurable targets, and identify real concerns related to climate change. The public outreach events were hosted in various locations across the County, including events in the cities of Pahokee, Belle Glade, South Bay, and Unincorporated PBC. Table 2-2 outlines initial input gathered from the public regarding County assets. These publicly identified assets were evaluated in addition to the asset data collected from PBC as well as publicly available sources.

Table 2-2. Palm Beach County Publicly Identified Assets

	Transportation Assets and Evacuation Routes	Critical Infrastructure	Critical Community and Emergency Facilities	Natural, Cultural, and Historical Resources
Belle Glade and South Bay July 2023	• Evacuation routes	• *No additional assets identified*	• Nursing homes: Glades Health Care Center, etc. • Local schools: Grove Elementary, Belle Glade Elementary, Pioneer Park Elementary, Lake Shore Middle, Glade View Elementary • Pioneer Park • Reverend Leon Camel, Jr. Park	• Lake Harbor
Unincorporated PBC August 2023	• *No additional assets identified*	• *No additional assets identified*	• *No additional assets identified*	• Agricultural land
Pahokee September 2023	• East Lake Village (streets)	• *No additional assets identified*	• Shelters: Lake Village, etc. • Pahokee Trailer Park • Schools: Pahokee Middle School, Pahokee Elementary School, Glades Academy Charter School, Pahokee High School • Senior facilities: Glades Health Care Center, etc. • Community centers • Padgett Island • Duncan Padgett Park • Paul Rardin Park	• Lake Okeechobee • The Old High School • Pahokee parks • Churches: St. Marys, Good Shepherd, Church of God, etc. • Pahokee Campground & Marina

The purpose of these public workshops was to allow the public to provide community-specific input on the results of the analyses as well as the methodologies and assumptions used in the analysis. During these meetings, the County conducted exercises to encourage public discussion and to solicit their feedback. Figure 2-2 through Figure 2-4 display examples of the results of the responses provided by participants during the public community workshops. See **Appendix G** for more details on the public workshop surveys and results.

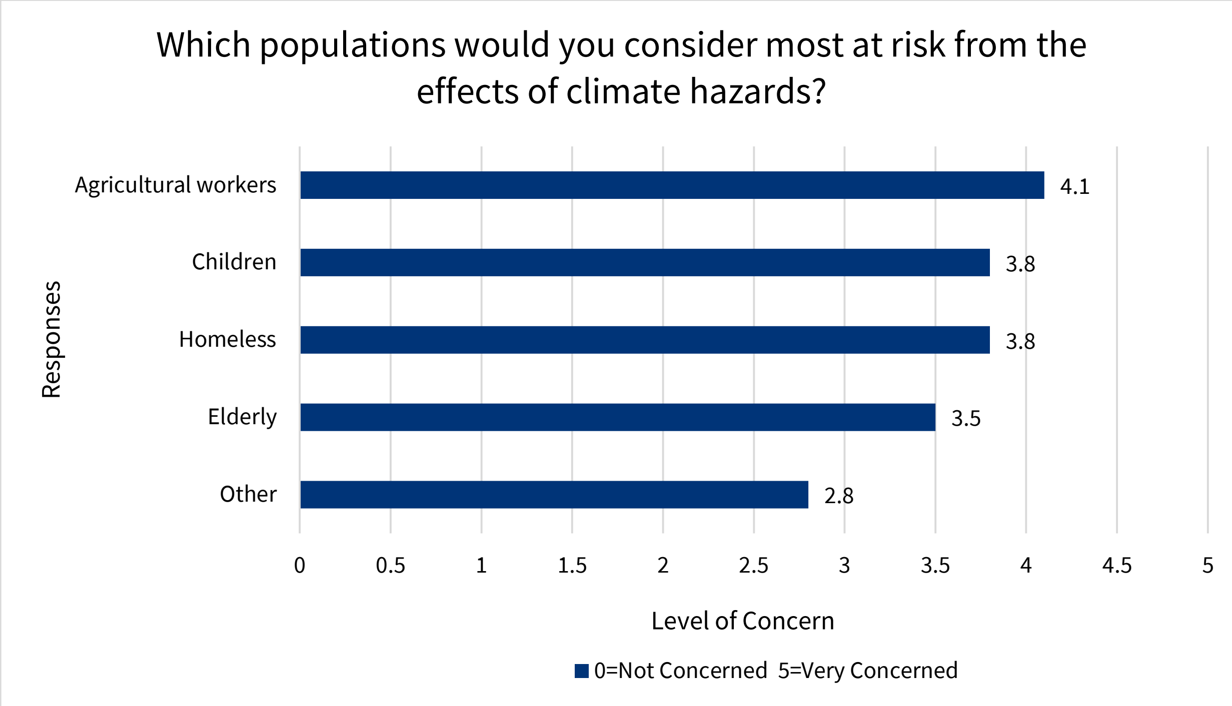


Figure 2-2. February 2024 Belle Glade Public Workshop Interactive Survey Question #1

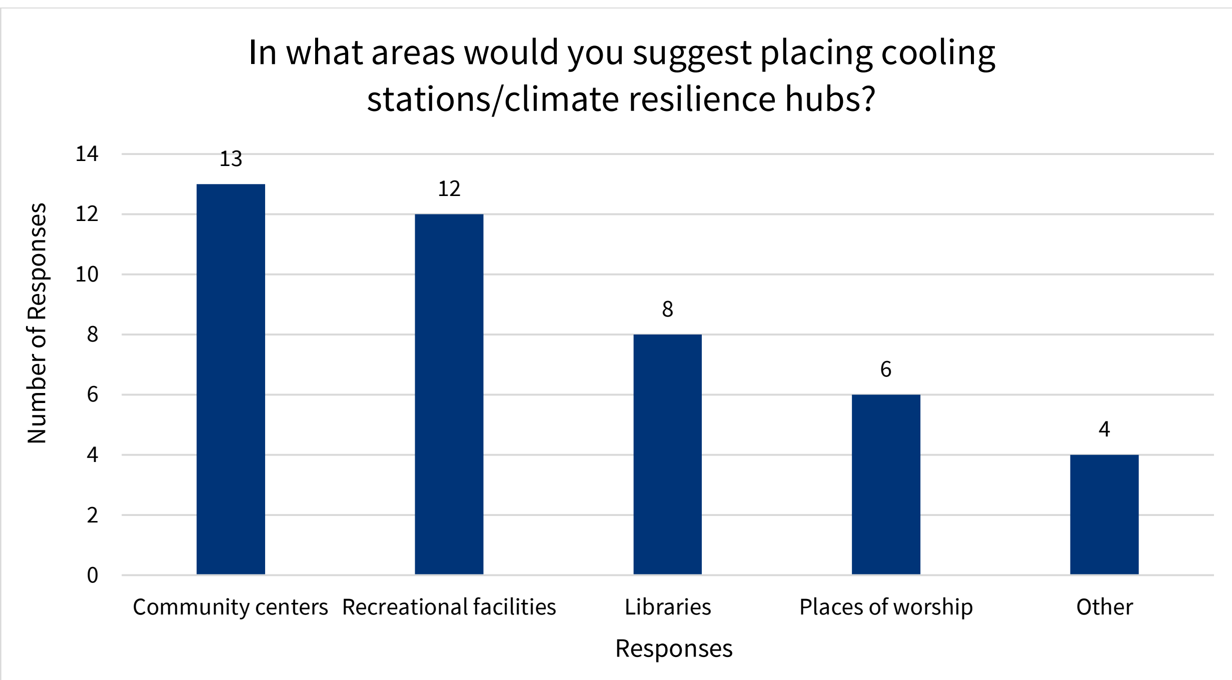


Figure 2-3. February 2024 West Palm Beach Public Workshop Interactive Survey Question #2

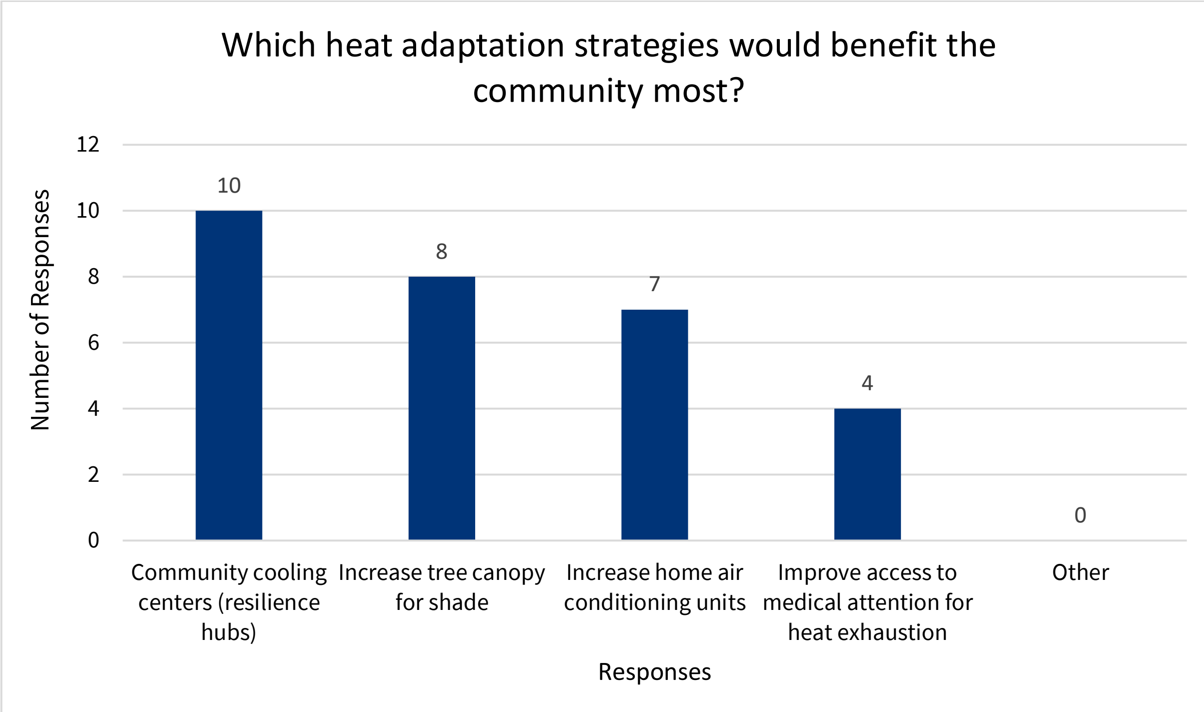


Figure 2-4. March 2024 Pahokee Public Workshop Interactive Survey Question #3

2.3.2 Climate Vulnerability Assessment Survey

In the project's early stages, a climate survey was formulated and distributed widely to serve as a mechanism for soliciting input from the public. Comprising a comprehensive set of questions, the survey encompassed various aspects, spanning from demographic details to insights on adaptation strategies. The CVA survey, featuring a total of 26 questions, was extensively promoted and made accessible throughout the project's entirety. Its availability ensured ample opportunity for community members to contribute their perspectives and insights, thereby enriching the CVA process with diverse viewpoints and informed responses. Approximately 245 responses were submitted for this survey over a period of availability from July 2023 to March 2024. Figure 2-5 through Figure 2-7 display results from various questions within the survey. See **Appendix G** for the complete CVA Survey and results (as of March 2024).

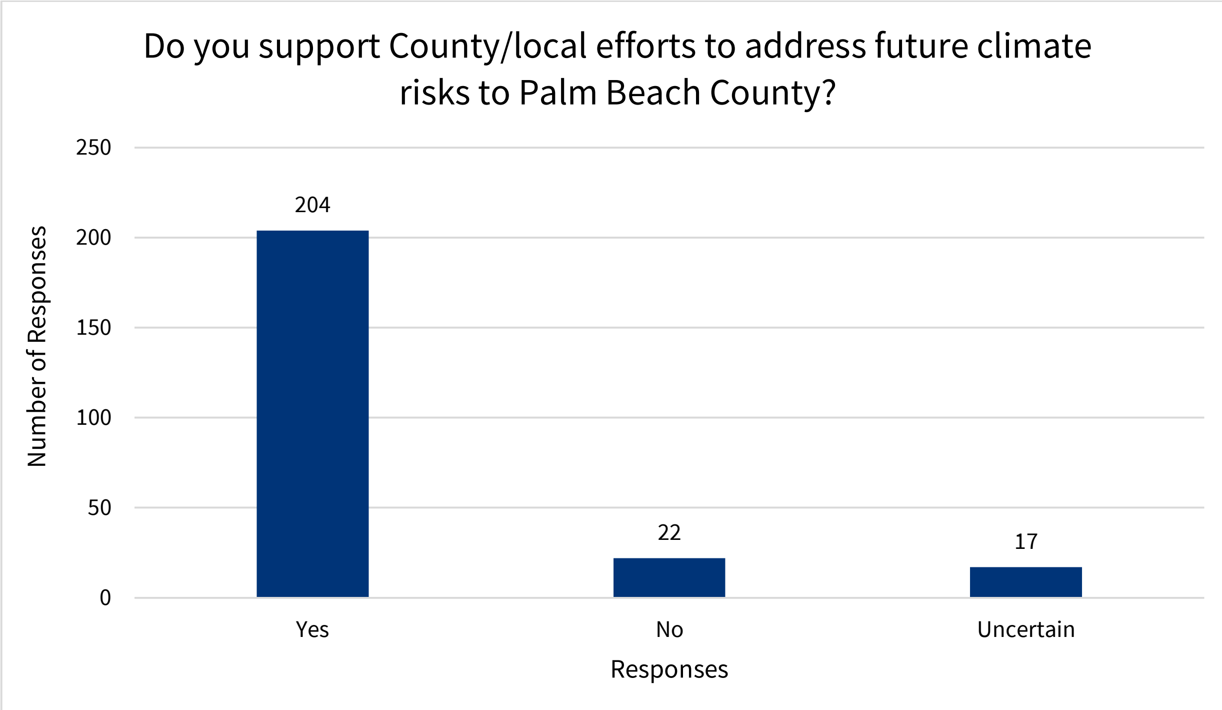


Figure 2-5. Public CVA Survey Results

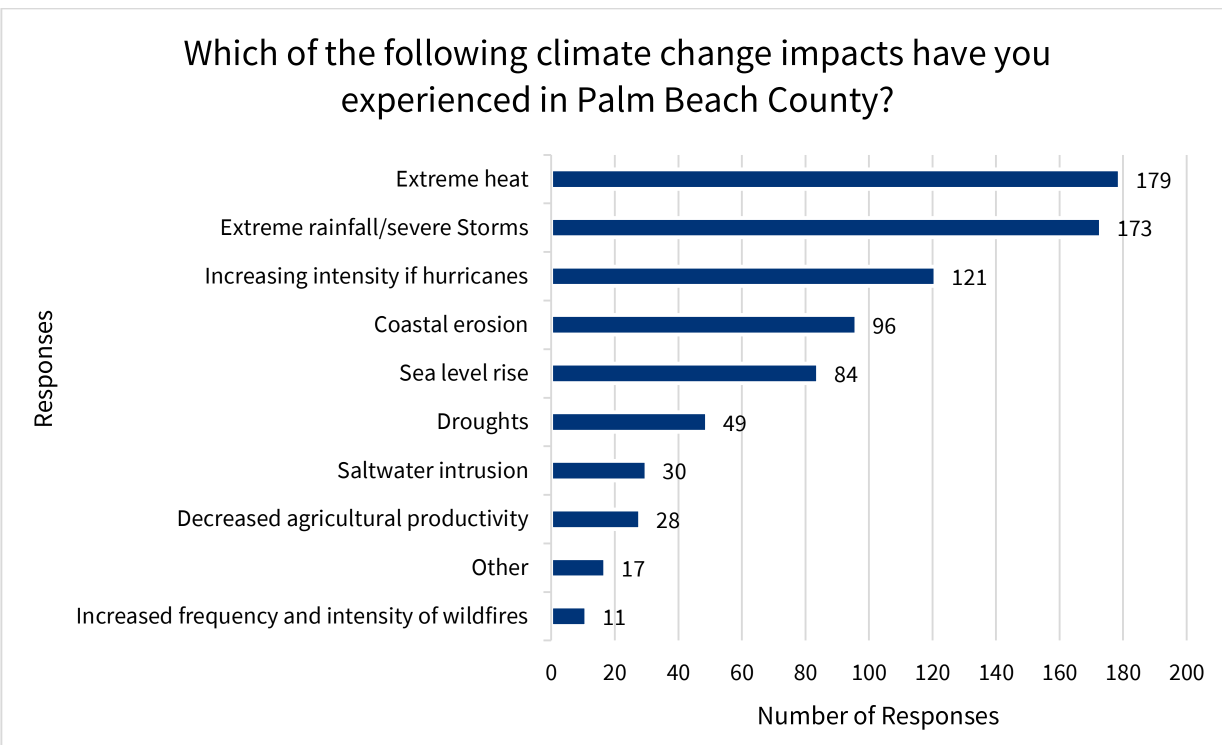


Figure 2-6. Public CVA Survey Results

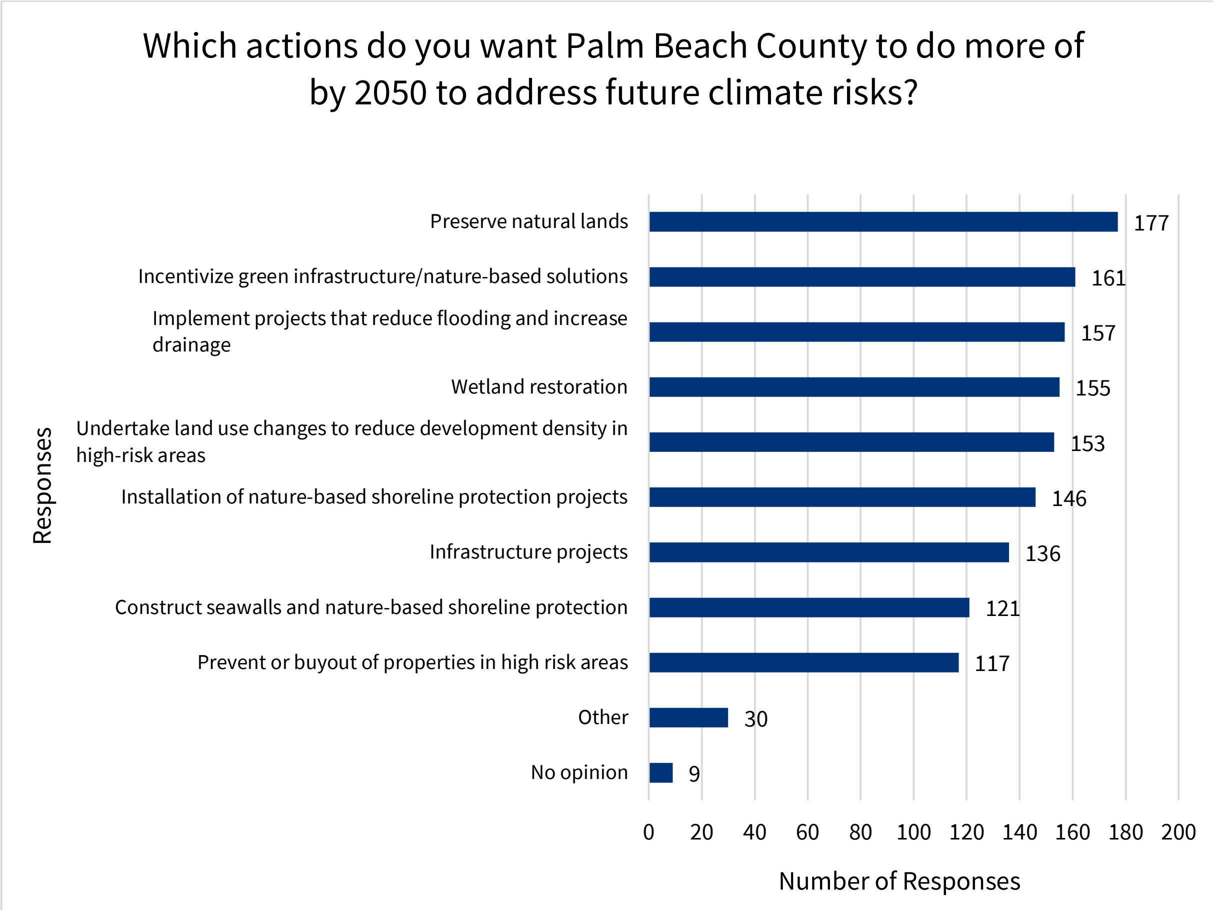


Figure 2-7. Public CVA Survey Results

3.0 CLIMATE HAZARDS

3.1 Climate Hazard Inventory

The County is committed to protect its future against various climate hazards such as tidal flooding, storm surge, extreme rainfall, coastal erosion, drought, wind, wildfire, extreme heat, and SLR (Figure 3-1). Through FDEP's and HUD's programs, the County is focusing its efforts on addressing these pressing issues. It should be noted that this is not an exhaustive list of all hazards that can potentially threaten PBC.

Figure 3-1. Climate Hazards

3.2 Climate Hazard Evaluation

The factors that influence each climate hazard's frequency, severity, and extent varies, and these factors are affected by projected climate change impacts. In recognition of these differences, the exposure and sensitivity methods are tailored to each climate-related hazard in the community. The following sections outline the framework and general process for exposure and sensitivity methods, and hazard-specific methods are detailed in corresponding results sections.

PBC conducted an evaluation of each climate hazard to better understand and communicate the potential magnitude, impact severity, and extent of the impact of each hazard. The climate hazards evaluated and selected for the CVA were based on an extensive review of available literature and detailed information, including historical weather data, climate projections, and other scientific data to better understand climate scenarios. The climate hazards include consideration of the potential impacts of extreme weather events and climate change on the site-specific operational viability of assets, infrastructure, and programs. These climate hazards can lead to impacts affecting PBC's critical facilities, infrastructure, public health, housing, economies, emergency response capabilities, transportation systems, and community resources. Both near-term climate impacts and long-term ramifications have been considered within this CVA.

3.3 Summary of Climate Hazards

3.3.1 Coastal Erosion

Coastal erosion is caused by wind, waves, and longshore currents and can negatively affect buildings, shoreline and infrastructure along the coast. Coastal erosion adversely affects the tourism industry. Coastal "hardening" measures such as seawalls or revetments may be installed, to protect man-made structures (such as houses and highways) which interrupt the natural retreat of beaches. However, these measures are likely to increase erosion rates. Coastal property losses have totaled about $500 million annually in the United States due to coastal erosion (U.S. Climate Resilience Toolkit 2021). PBC currently has 11 areas of eroded shoreline of varying degrees according to FDEP data sources.

PBC has a shoreline enhancement and restoration program that anticipates the significance of coastal erosion and takes proactive measures to protect the coastal areas. The Shoreline Enhancement Program promotes enhanced sand management approaches at inlets and implements projects for the eradication of non-native vegetation from sand dunes. Since 1989, the County has engaged in or overseen the creation of more than 22 miles of beach and dune restoration projects. Tourists, residents, and coastal property owners are among those who benefit from these projects. PBC has a 47-mile coastline (Palm Beach County Parks & Recreation n.d.), in which there are eight critically eroded areas (33.6 miles), two non-critically eroded areas (0.9 mile), and one critically eroded inlet shoreline area (0.8 mile) (FDEP 2021, Palm Beach County Public Safety Department 2020). Eroded shorelines can also leave adjacent upland areas vulnerable to other climate threats including severe weather (Palm Beach County Parks & Recreation n.d.).

3.3.2 Drought

A drought is an extended period of abnormally low precipitation that increases water demand that contributes to water supply shortages that affect everyday life. While droughts are a naturally occurring phenomena, they can contribute to various secondary impacts resulting from reduced agricultural productivity and increased wildfire risks, for example, and they can also incur public health and safety issues. Both climate and human-made factors influence the severity and geographic extent of a drought. For example, unusually low precipitation over several months or longer can create or worsen a water deficit in affected regions, but so too can a large influx of people to an area with limited water infrastructure or availability. The CVA focused on climate-driven droughts rather than human-driven factors.

Reduced availability of water, caused by drought, has several implications for PBC. Prolonged periods of drought can increase fire hazards, heighten public health hazards, contribute to agricultural disruptions, reduce water levels in environmental areas, increase wildlife and livestock mortality rates, and damage fish and wildlife habitats. Rising temperatures contributes to increased rate of soil moisture loss, resulting in a likely increase of in drought intensity (Runkle, et al. 2022). This could be further magnified by population growth and land-use changes regarding competition for water (Runkle, et al. 2022). Since 1990, there has been about one severe and widespread drought in Florida each decade (Florida State University n.d.a).

In PBC, Lake Okeechobee, the local watersheds, and underground freshwater aquifers are the main sources of water. When the normal water cycle is disrupted by drought, one of the potentially most damaging effects is substantial crop loss in the western agriculture areas of the County (Palm Beach County Public Safety Department 2020). Drought in the County is also linked to increased insect infestations, plant disease, and wind erosion. The frequency of wildfires also increases during extended droughts, which then leads to human and wildlife populations being at risk (Palm Beach County Public Safety Department 2020). The worst recorded drought within PBC occurred during the driest year on record for Florida, from October 1999 to May 2001. During that event, Lake Okeechobee dropped from an elevation of 18 feet National Geodetic Vertical Datum to an elevation of 9 feet National Geodetic Vertical Datum (Palm Beach County Public Safety Department 2020). A period of drought between 2010 and 2011 prompted irrigation restrictions resulting from depleted water sources. This had ripple effects within residential, commercial, and agricultural operations (Kwiatkowski 2011).

3.3.3 Extreme Heat

Extreme heat—weather that remains 10 degrees Fahrenheit (°F) or more above the average high temperature for a particular time and place—leads to the death of hundreds of Americans each year and can cause serious illness (EPA 2016, Palm Beach County Public Safety Department 2020). Globally, the annual average temperature has been increasing over the last 100 years and is expected to continue to increase through the end of the twenty-first century (EPA 2016). In Florida, the average temperature has increased 2°F since the beginning of the twentieth century (Runkle, et al. 2022). Extreme heat events are projected to become more frequent and severe, last longer, and cause more illnesses and deaths (EPA 2016). Florida's summer heat index is expected to experience the largest increase in the United States with an increase by 8°F to 15°F (Runkle, et al. 2022). The urban heat island effect further compounds this issue in many densely populated areas of the County with high amounts of impervious surface as compared to outlying areas. Urban areas comprise structures such as buildings, roads, and other infrastructure that absorb and re-emit the sun's heat. In contrast, vegetated and natural areas re-emit less heat and provide more shade (EPA 2023) reducing the heat island effect.

In PBC, between July 1938 and December 2016, there were 130 days with maximum temperatures above 95°F, of which 18 were above 97°F. It is predicted that the County will experience 157 days with a heat index above 100°F by late century (2070-2099) (Southeast Florida Regional Compact Climate Change n.d.). The highest temperature ever recorded at the Palm Beach International Airport weather station was at 101°F recorded on July 21, 1942 (Palm Beach County Public Safety Department 2020). It is anticipated that, even with reduced greenhouse gas emission levels, by the end of the century, the average temperature in Florida will increase by another 2°F. However, if emission levels remain consistent or become higher, the average temperature in Florida could increase by up to 8°F by the end of the century (Runkle, et al. 2022).

Extreme heat can have pronounced impacts on people who do not have access to consistent housing or shelter with air conditioning or others with sufficient cooling infrastructure. People who can also be affected by extreme heat include athletes, individuals with chronic medical conditions, infants and children, low-income households, adults over 65, and outdoor workers (Center for Disease Control and Prevention 2022). However, these groups sometimes lack representation at policymaking tables. Local organizations can often play a pivotal role in bridging these gaps through a community-led approach to addressing extreme heat in an equitable manner.

Florida leads the nation in heat-related illness. In 2019 for example, Florida led the nation with 6,800 heat-related hospitalizations. According to the Florida Department of Health, PBC has one of the highest rates of heat-related deaths among counties in Florida. In 2021, there were 5 heat-related deaths, 39 heat-related hospitalizations, and 242 heat-related emergency department visits during the summer months (Florida Department of Health 2022). While the County has a sheltering program, shelters have never been activated in response to extreme heat (Palm Beach County Public Safety Department 2020). In addition to heat-related health risks, there are also infrastructure and economic risks. Extreme heat can impact tourism, recreational activities, lead to other environmental impacts such as harmful algal blooms, reduce agricultural production, and can increase demand for energy and other utilities straining the systems that support building and cooling operations.

3.3.4 Sea Level Rise

As sea levels rise, the effect is not uniform around the globe, and recent studies indicate that South Florida will experience more rapid SLR than the overall average (Miami Herald 2024). SLR is influenced by ocean currents, wind, thermal expansion of water, and geologic uplift or subsidence. SLR poses a significant threat to coastal communities, ecosystems, and infrastructure and can be associated with increased coastal flooding, shore erosion, natural habitat transition, and saltwater intrusion. Numerous studies have determined that SLR will increase saltwater and flood risks in Florida's coastal regions. As local sea level rise continues to accelerate, it poses a mounting threat to County assets. The gradual encroachment of the salt water that surrounds the island will inundate and jeopardize the structural integrity of infrastructure such as roads, bridges, and buildings.

3.3.5 Tidal Flooding

Tidal flooding refers to the high tide impacts from rising sea levels, attributed to climate change, which often leads to the recurrent inundation of low-lying areas by tidal waters. Compared to the frequency 50 years ago, high tide flooding (HTF) now occurs 300 to 900 percent more frequently (NOAA 2022). Tidal flooding can occur during normal or extreme tide events. As sea levels continue to increase, this poses a mounting threat to County assets. The gradual encroachment of tidal waters jeopardizes the structural integrity of infrastructure such as roads, bridges, and buildings. This type of flooding has often been called "nuisance flooding" since it is disruptive but does not threaten human life directly. However, as sea levels continue to rise, this flooding is expected to be more than a nuisance. Moreover, the intrusion of saltwater into urban environments accelerates corrosion of infrastructure components, including electrical systems and transportation networks. Tidal flooding also impacts the functionality of essential services like sewage systems and water treatment plants. Sustained ponding from these events can also result in increased mosquito populations and the vector-borne diseases they carry.

3.3.6 Storm Surge Flooding

Storm surge is the rise of seawater levels due to intense sustained onshore winds combined with low atmospheric pressure. It can occur during extreme weather events such as nor'easters and hurricanes and often results in severe flooding, presenting a threat to the County. This impact is especially pronounced for its assets along coastlines on the open ocean and along tidally influenced inland waterways. Storm surge can lead to widespread and rapid inundation of coastal areas, causing extensive damage to infrastructure, homes, and critical facilities. Storm surge further threatens the shoreline as it accelerates coastal erosion on the Atlantic Ocean coast, reducing the protection afforded by a healthy beach and dune system, and can compromise the stability of other coastal protection structures such as rock revetments and seawalls. Additionally, surges can introduce saltwater into freshwater systems, posing risks to natural systems and water supplies and further accelerating the deterioration of infrastructure components.

3.3.7 Rainfall Induced Flooding

Extreme rainfall occurs when precipitation amounts experienced by a region are more intense and prolonged than typical. In low-lying areas, this phenomenon often results in severe flash-flooding, overwhelming stormwater management systems and leading to widespread damage to many types of infrastructure. The asset types that may be impacted can include roads, bridges, and buildings, as well as homes and businesses. Extreme rainfall can interrupt essential services and transportation networks. The project analyzes flooding that results from extreme rainfall events with volumes equal to the 25-, 50-, 100-, 500-, and 1,000-year events.

3.3.8 Wildfire

Wildfires, usually identified by dense smoke that fills an area for miles, are broken down into three classes: surface fire is the most common type of wildfire and burns along the floor of a forest, which is the layer of decaying matter covering the soil beneath forest trees, moving slowly damaging or killing trees in its path; ground fire, typically ignited by lightning, burns on or below the forest floor; and crown fires, which spread rapidly by wind (Palm Beach County Public Safety Department 2020). Florida experiences its peak number of wildfires from January to mid-June annually. In 2020, there were 2,381 wildfires in Florida with a total of 99,413 acres burned, attributing to Florida ranking as fifth in the nation for the number of wildfires. As droughts continue to intensify, it will likely trigger more wildfires in the future (Runkle, et al. 2022).

While many parts of PBC are urbanized, wildfires can still impact the County. In May 2022, PBC experienced an event in which two wildfires burned over 17,600 acres of land (Miller 2022). More recently, in April 2024, a brush fire burned approximately 10 acres of land in the Yamato Scrub Natural Area. Intense fires can damage ecosystems, disrupting plant and animal habitats. Following a wildfire, species may struggle or fail to adapt to their new landscape, altering biodiversity. Soil erosion resulting from a wildfire may alter water supply levels and quality. Potential health risks can arise from diminished air quality. Economic strains can also arise due to property and infrastructure damage and resource losses. To mitigate wildfires, PBC has a Prescribed Fire Program in which the Environmental Resources Management department employs a Burn Crew. A prescribed fire, or controlled burn, is a technique employed to provide the benefits of a natural fire. It involves setting small, controlled fires following a strategic timeline (Palm Beach County Environmental Resources Management n.d.). The benefits of a prescribed fire can include the following: healthier habitats, access to food and foraging areas for plants and animals, nutrient recycling into the earth, and the prevention of out-of-control wildfires (Palm Beach County Environmental Resources Management n.d.).

3.3.9 Wind

Hurricanes and tropical storms are of particular significance during the 6-month-long Atlantic hurricane season, June 1 through November 30, with the peak occurring between mid-August and late October (Florida State University n.d.d). The 2021 Florida Atlantic Hurricane Season ranked third among the state's most active season with a reported 21 tropical storms, 7 hurricanes, and 4 major hurricanes (Powell 2022). Since 1850, the entire Florida coastline has been impacted by at least one hurricane (Florida State University n.d.d). The Florida Atlantic University survey found that 68 percent of Floridians surveyed are moderately to extremely concerned about hurricanes worsening due to climate change (FAU Center for Environmental Studies 2023).

Impacts from hurricanes can include winds, storm surges, and flooding. Roofs, vegetation, and power lines are often damaged by hurricane winds occurring in the eye-wall of a hurricane. Hurricane winds can reach speeds more than 155 mph and often remain at strong levels due to Florida's generally flat terrain. Large hurricanes can produce winds reaching more than 150 miles out (Florida Gulf Coast University n.d.). As a hurricane moves onshore, water is pushed towards the shoreline, which is known as the storm surge. Storm surges can reach heights of 15 feet and create deadly waves and water levels. Worldwide, 90 percent of hurricane-related casualties are a result of drowning incidents within the storm surge or the associated flooding (Florida State University n.d.d). Slow-moving tropical storms have a direct correlation to higher flooding levels, as they produce larger amounts of rain. Slow-moving hurricane Jeanne of 1980 resulted in 23.38 inches of rainfall within in a 24-hour period (Florida State University n.d.d).

A Florida State University report, "Understanding Past, Present, and Future Tropical Cyclone Activity" presents an overview of the current state of science on the present and potential future relationship between climate change and hurricane activity. The report outlines hurricanes changing in the following manners (Carstens, Uejio and Wing 2022):

- Coastal flooding from storm surge is expected to increase regardless of changes in storm intensity due to future SLR (high confidence).
- There is agreement between theory and model projections that flooding rain associated with hurricanes will become more hazardous. It is more difficult to evaluate historical trends in hurricane rainfall, but a notable trend of slower-moving storms has recently emerged.
- While the mean intensity of hurricanes has not changed significantly in the past, warmer oceans raise the ceiling for intensity. A larger proportion of storms have reached major hurricane (Category 3 to 5) strength in recent years, along with an increase in rapid intensification events.
- The locations where hurricanes reach their peak intensity has shifted away from the equator poleward and toward the west, or closer to land in the Atlantic basin, with other regional changes in hurricane tracks observed. Theoretical explanations for this behavior are a topic of ongoing research.
- There is relatively low confidence in projections of future tropical cyclone frequency, and work is ongoing to understand what sets the global number of tropical cyclones each year.

Damage to buildings and homes, threats to infrastructure, undermining energy, water, and sewer systems, beach erosion, and damage to flood management structures have resulted from stronger hurricanes and tropical storms (Center for Climate and Energy Solutions 2023). Stronger hurricanes also pose a risk to public health and human lives. Problems with water supplies and power systems can cause waterborne illness, environmental contaminants, mosquito-borne illnesses, and can result in hospital closures. These risks are especially relevant in marginalized communities that have fewer resources with which to plan for and recover from hurricanes (Center for Climate and Energy Solutions 2023). In addition to direct damage to infrastructure, the potential for crop damage and economic disruption from hurricanes and tropical storms is also a significant threat to Florida. Taxpayers in the state are responsible for covering the costs associated with replacing or repairing damaged public infrastructure, often paying higher insurance rates to subsidize development in vulnerable locations (Young 2023). For example, Tropical Storm Mitch dropped approximately 10 inches of rain in some south Florida areas, which resulted in approximately $20 million in direct crop damage in PBC. However, the largest monetary loss was sustained by the sugar cane mills in the western part of PBC (Palm Beach County Public Safety Department 2020).

Florida is the most susceptible state to the impacts caused by hurricanes and tropical storms due to the frequency of storms, the length of the coastline, and the relatively low and flat ground elevations. Within PBC, the potential for property damage and human casualties has increased due to the sustained rapid development, most notably along the coastline (Palm Beach County Public Safety Department 2020). Since 1886, 57 hurricanes have passed within 125 miles of PBC, representing an average of one hurricane per 2 years (Palm Beach County Public Safety Department 2020).

3.4 Compound Flooding

Compound flooding occurs when multiple forms of flooding coincide simultaneously. Various combinations of tidal, storm surge, and rainfall-induced flooding, all occurring in addition to ever increasing sea levels, produced the compound flood modeling results that informed this assessment.

4.0 DATA COLLECTION AND ASSET INVENTORY

In an effort to assemble the most comprehensive database possible, information was sourced from multiple entities, including federal agencies like the Department of Homeland Security, NOAA, and FEMA; state bodies such as the FDEP, Florida Department of Transportation, and the Fish and Wildlife Conservation Commission; as well as local authorities such as the staff of PBC. The data gathered was then organized into four main categories that corollate to the required asset classes and was used to assess the vulnerability of assets within PBC to the various climate hazards.

4.1 Asset Classes

The asset data collection effort was divided into four main categories based on the statutorily defined asset classes: transportation assets and evacuation routes; critical infrastructure; critical community and emergency facilities; and natural, cultural, historical resources (Figure 4-1). An additional category was provided for supplemental information to enhance resilience planning.

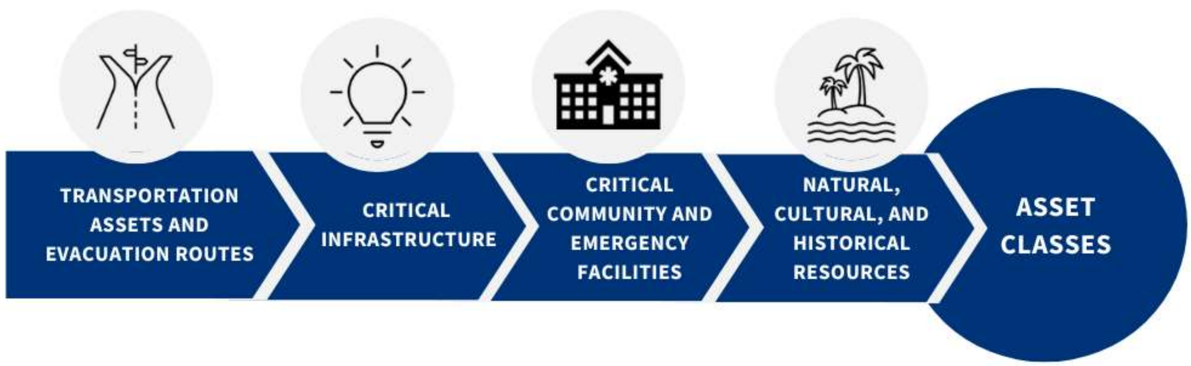


Figure 4-1. Asset Classes

4.1.1 Transportation Assets and Evacuation Routes

The Transportation Assets and Evacuation Routes asset class includes various transportation facilities that serve as key components of a community's infrastructure, such as airports, bridges, bus terminals, boat ramps, evacuation routes, port facilities, major roadways, marinas, rail facilities, and railroad bridges. The County includes a network of crucial transportation assets, serving as the arteries of connectivity. These assets are integral not only to daily routines but also to emergency response and evacuation efforts during climate-related incidents.

4.1.2 Critical Infrastructure

The Critical Infrastructure asset class focuses on the core facilities and systems that PBC relies on, including wastewater treatment facilities and lift stations, stormwater treatment facilities and pump stations, drinking water facilities, water utility conveyance systems, electric production and supply facilities, solid and hazardous waste facilities, military installations, communication facilities, and disaster debris management sites. These utilities are necessary for maintaining essential services, and their vulnerability to climate-related disruptions can have cascading effects on the community. Some are owned by the County and some are regionally owned.

4.1.3 Critical Community and Emergency Facilities

The Critical Community and Emergency Facilities asset class targets those facilities that support the County and help during emergencies, such as schools, colleges, universities, community centers, correctional facilities, disaster recovery centers, emergency medical service facilities, emergency operation centers, fire stations, healthcare facilities, hospitals, law enforcement facilities, local government facilities, logistical staging areas, affordable public housing, risk shelter inventory, and state government facilities.

Hospitals and healthcare establishments, typically not under the ownership and maintenance of the County, serve as lifelines during disaster response and recovery, particularly in the wake of severe weather occurrences. Ensuring their seamless operation is paramount for the community's welfare. Furthermore, they are mandated to undergo evaluations as per statutory requirements.

Likewise, emergency operational centers function as command centers for orchestrating emergency response endeavors. They are essential in disaster mitigation and necessitate sturdy infrastructure and connectivity to guarantee efficient responsiveness during climate-related emergencies.

4.1.4 Natural, Cultural, and Historical Resources

The Natural, Cultural, and Historical Resources asset class encompasses the preservation and protection of natural areas and cultural/historical sites. This category includes assets such as conservation lands, parks, shorelines, surface waters, wetlands, and historical and cultural assets. These resources provide a sense of place and uphold the County's heritage. Although conceptually different from the preceding three categories, they are equally important for the communities' well-being and necessitate safeguarding against the impacts of climate change.

The climate hazards explored can harm ecosystems, threaten wildlife, and damage cultural and historical sites; they include:

- Habitat destruction,
- Soil erosion,
- Physical damage to structures and facilities, or
- Inability to preserve historic or cultural sites.

Damage inflicted by climate hazards can affect the functionality and accessibility of these resources. Vulnerable communities may have an increased reliance on natural resources for their livelihoods or cultural identity. Many of the climate hazard-related impacts on this asset class can lead to losses that are difficult or impossible to reverse. As a result, mitigation measures are essential to protecting these assets.

4.2 Supplementary Information

The supplementary information category included data that might not be required under Section 380.093, F.S., but helped create a more detailed CVA. The supplementary information included flood analysis data such as FEMA's Flood Insurance Study and flood zones. Geomorphological features and socioeconomic environment data were also part of this supplementary category. Supplemental information is provided to enhance resilience planning, encompassing assets that may not be explicitly outlined in the statutory framework. This type of information will be valuable when the County conducts more detailed studies in the future.

4.3 Regionally Significant Assets

As outlined in Section 380.093, F.S., regionally significant assets denote vital facilities that cater to a wider geographic scope, spanning neighboring communities, and are not inherently under the County's ownership and maintenance. They do, however, serve the needs of communities across various geopolitical boundaries. These assets can include water resource facilities, regional medical centers, emergency operation centers, regional utilities, major transportation hubs, airports, and seaports. Recognizing and protecting these assets will improve regional resilience and response efforts.

Statutorily, these assets encompass Commercial and Strategic Intermodal System ports, spaceports, waterways, railroad crossings, railroads, rail terminals, rail bridges, bus terminals, evacuation routes, electric power plants, electric power transmission lines, dams, and drainage assets maintained by water management districts. Additionally, stormwater ponds, wastewater facilities, public water supply tanks, public water supply plants (non-federal), emergency medical services facilities, emergency operations centers, risk shelters for the general population, and risk shelters for those with special needs are deemed essential in fulfilling the infrastructure and safety requirements of multiple regions.

4.4 Baseline Asset Inventory Development

Based on the information gathered during the data collection phase of the project, a baseline inventory of all the County's assets was established and organized by asset class. A completed baseline asset inventory map series was made available to the Project Team for review and to document all assets collected during this project.

Drawing from input collected from the public, key stakeholders, and County staff members, the baseline inventory of all County assets underwent refinement to create a comprehensive inventory of "critical" assets. Critical assets include those deemed "of the greatest importance" to the County, which includes assets of economic significance and those facilitating access to healthcare facilities, serving as emergency evacuation routes, fostering social connectivity, bearing cultural significance, or upholding other fundamental values.

4.5 GIS Data Acquisition

The CVA assessment relies on GIS-based modeling to predict future conditions. Even the best model will not produce reliable results if the data used to build it is incorrect or incomplete. Topographical data, hydrological data, climatic projections, asset data, and tidal data were among the critical datasets gathered and used to develop the models. Publicly available resources from reputable agencies such as the Department of Homeland Security, NOAA, FEMA, and other relevant organizations were reviewed to obtain the more relevant data. These sources provided data at regional and national scales, offering a foundation for the Asset Inventory and Exposure/Sensitivity Analysis. The data inventory compilation process involved the following:

- **Systematic Identification:** Utilizing GIS and remote sensing technologies that provide information to categorize critical assets.
- **Research and Data Collection:** Sourcing from federal, state, and local databases.
- **Validation and Cross-Referencing:** It should be noted that some data sources provided contradictory or repeated asset data, so it was important to review the resulting information thoroughly in order to organize it clearly for further analysis. Employing data quality assurance techniques to ensure the accuracy of information.
- **Collaborative Efforts:** Engaging with local authorities and subject matter experts for incorporating ground-truth data and local knowledge.

4.6 Data Gap Analysis: Gathering, Reviewing, and Updating Data

At the conclusion of the data acquisition phase of the project, a data gap analysis was produced. The data gap analysis report served as a qualitative assessment on the completeness, quality, and usefulness of the data provided to identify areas where data may be improved or acquired in the future. The data gap analysis conducted by the team identified several key challenges in data collection including insufficient geospatial data for specific assets; incomplete data on infrastructure, facilities, and resources; and discrepancies in terminology and inconsistencies in data coverage and metadata.

The Project Team used several strategies to fill as many data voids as practicable within the assessment timeline. Strategies included using additional data sources not previously considered such as satellite imagery for geospatial data; other government records for infrastructure and facilities data; conservation databases for natural, cultural, and historic resources data; and census data for socioeconomic data. It also included engaging with local authorities for updated and precise geospatial data, standardizing data collection methods and terminology, and enhancing collaboration with data providers for comprehensive coverage. The comprehensive data collection approach ensured an inclusive dataset to support the exposure models and provide reliable results about future conditions.

5.0 ASSESSMENT ANALYSES METHODOLOGY

The methodology utilized in this CVA applies to the County's top ranked assets, conforms to Section 380.093, F.S., and employs an array of data sources and modeling. The strategy delivers a review of the County's vulnerability to climate hazards.

Recognizing the constraints of this methodology is essential. While it offers a valuable foundational evaluation, it cannot replace detailed, site-specific investigations. Future studies incorporating engineering-grade hydrologic and hydraulic modeling are advised for a more nuanced understanding of localized flood risks.

5.1 Exposure Analysis

Exposure refers to the presence of people, assets, and ecosystems in places where they could be adversely affected by hazards (US Climate Resilience Toolkit 2023). PBC's CVA assessed its exposure levels to climate hazards including SLR, storm surge, extreme rainfall, high tide, and compound flooding, extreme heat, drought, wind, coastal erosion, and wildfire.

An exposure analysis was performed for PBC to identify the impact of climate hazards in the future years which can include 2040, 2070, and 2100. For flooding related climate hazards, the water surface depths (i.e., flood scenarios) used to identify and evaluate the assets' vulnerability included the following conditions in the target years: tidal flooding, current and future storm surge flooding, rainfall-induced flooding, and compound flooding. The flooding-related climate hazard analysis was conducted in accordance with the requirements of the state statute and the rules and guidelines of FDEP. The full Flooding Exposure Map Series is included as **Appendix A**.

5.1.1 Data Types and Methods

The quality and amount of data on physical exposure and relevant asset characteristics vary by hazard and asset type. Where possible, the CVA integrated spatial and quantitative data, supported by qualitative information on historical events and the County's natural environment. Literature reviews were conducted for various climate hazards to develop a broad understanding of how each hazard has historically affected the County and to what extent climate change will influence future event frequency and severity. For climate hazards lacking spatial extent data, the literature review evaluated the types of land, populations, and assets that are most likely to be exposed to the climate hazard. For hazards with spatial data, the level of analysis depended on the quality and quantity of available data. The CVA based loss estimations and vulnerability on the exposure levels of people, buildings, and infrastructure, allowing for a comprehensive analysis of the potential impacts of climate hazards on County assets. Figure 5-1 illustrates the stepwise mixed-methods approach to integrate these different types of information into the exposure analysis.

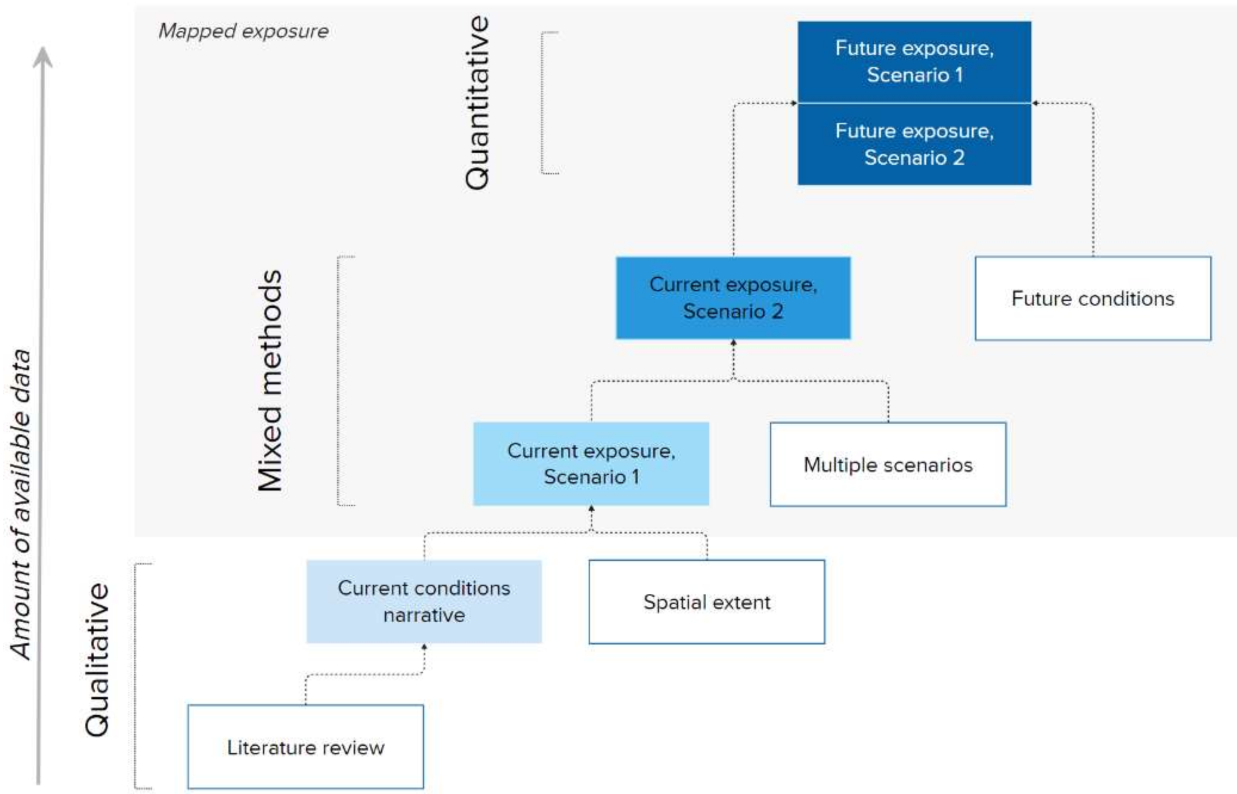


Figure 5-1. CVA Exposure Analysis Framework

5.1.2 Modeling Tools and Methodologies

The Project Team conducted the CVA by modeling multiple future climate scenarios within a spatial context. The goal of the assessment is to provide results that assist the County in making decisions to enhance resilience to the impacts of climate hazards. The climate scenarios analyzed represent conditions that can be reasonably expected to occur in the future.

The CVA aligns with the Resilient Florida guidelines and utilized GIS-based methods to assess PBC's assets with respect to the flood hazards identified. The modeling encompassed present-day conditions and can include planning horizons of scenarios for the years 2040, 2070, and 2100, incorporating assessments of 25-, 50-, 100-, 500-, and 1,000-year storm events. SLR scenarios included the 2017 NOAA intermediate-low (NIL) and intermediate-high (NIH) SLR projections as required by Section 380.093, F.S. at the time of the analysis.[1] To achieve the goal of accurate predictions of future conditions, a comprehensive strategy was employed, reviewing various data sources.
All analyses were conducted in the North American Vertical Datum of 1988 (NAVD 88).

[1] It should be noted that the sea level projections for use in Section 380.093, F.S. have been modified to include the 2022 NOAA Intermediate Low and Intermediate projections for all VAs initiated after July 2024. In the near term, the 2017 and 2022 sea level rise projections align with de minimis differences. For longer-term sea-level rise projections, the 2017 sea level rise projections are higher, meaning for out years 2070 and 2100, this CVA include more conservative sea level rise estimates. The County should be cognizant of this change for future updates relative to the CVA.

Table 5-1. Data Sources for Climate Hazards

Climate Hazard	Data Source
Days of Tidal Flooding	NOAA Virginia Key Tide Guage (with statistical analysis and bathtub modeling)
Current Rainfall	NOAA Atlas 14 (with HEC-RAS modeling)
Future Rainfall	NOAA Atlas 14 (with HEC-RAS modeling modified by SFWMD change factors and distribution rates)
Current and Future SLR	NOAA Virginia Key Tide Guage and NOAA 2017 SLR Projections (with bathtub modeling)
Future Storm Surge	National Aeronautics and Space Administration, NOAA, EPA, USGS, USACE (SLOSH and Hazus)
Current and Future Coastal Erosion	USGS Shoreline Regression Rates; Florida DEP
Historical and Future Drought	U.S. Climate Resilience Toolkit Climate Explorer, NOAA Climate Disaster Historical Context Data, PBC LMS, SFWMD Drought Report, SFWMD Environmental Report
100-year & 500-year Mean Return Period Wind/Hurricane	PBC Hazard Mitigation Plan, NOAA Saffir Simpson Hurricane Wind Scale, NOAA's Historical Hurricane Track dataset, and NOAA's Storm Prediction Center (Hazus v6.0)
Current and Future Extreme Heat	Trust for Public Land Urban Heat Island Severity Index and US Climate Resilience Toolkit Climate Explorer
Current Wildfire	U.S. Forest Service

The following sections on exposure and sensitivity are based on these analytics:

- **Future Sea Level Rise and High Tide Modeling:** The analysis used ArcGIS Pro and a methodology developed specifically for this purpose by NOAA. The NOAA VDATUM conversion tool normalizes data in various datums into a common mean higher high water (MHHW) datum. It is then possible to generate a digital elevation model that is relevant to MHHW. Using algorithms for tidal variability interpolation the model can then compute future high tide flood-water elevations and produce maps illustrating the tidal flooding threshold of 2 feet above MHHW as established in Subsection 380.093(3)(d)2. and Subsection 380.0937(1)(a), F.S. The results include the number of tidal flood days (days when water levels exceed the MHHW level) that is expected for each future scenario and planning time horizon in the map series titled "Days of Tidal Flooding" in **Appendix A**.
- **Storm Surge Analysis:** Using FEMA's storm surge data and Hazus-MH software, this analysis adjusts the historical storm surge data by the future SLR projections. The approach integrates these projections with the community's existing FEMA Flood Insurance Study data, offering a broad understanding of future storm surge impacts. Storm surge modeling was focused exclusively on coastal regions as this is where the primary impacts will occur.

  To ensure a holistic approach, a SLOSH model was also used to assess impacts under two scenarios: Category 1 and Category 5. The exposure analysis included land, population, and assets. The sensitivity analysis focused on population and assets.

- **Rainfall-Induced Flooding Evaluation:** Adhering to specific legislative requirements, this analysis employs the Hydrologic Engineering Center's River Analysis System (HEC-RAS) for rainfall simulation and runoff computation. It incorporates NOAA's Atlas 14 data, including the South Florida Water Management's (SFWMD) future rainfall change factors, to create baseline rainfall depth grids essential for a comprehensive evaluation of potential future rainfall-induced flooding (SFWMD 2022). The rainfall-induced flooding modeling excluded natural areas, focusing instead on urban and developed regions.

  An in depth modeling approach was conducted for PBC's western communities due to variations between eastern and western County rainfall rates. Rainfall-induced flooding for the western municipalities was examined using the SFWMD standard rainfall distribution for four 24-hour events, one 72-hour event, and NOAA Atlas 14 precipitation. Future rainfall precipitation change factors were derived from the SFWMD and USGS and applied appropriately. A HEC-RAS (Hydrologic Engineering Center – River Analysis System) rain-on-grid modeling approach used 2023 PBC Light Detection and Ranging (LiDAR) elevation data. The HEC-RAS model was developed to estimate depth of ponding due to heavy rainfall events. It did not evaluate riverine flooding or account for Lake Okeechobee bathymetry, inflow, outflow, or operations. Culverts and other stormwater infrastructure were not included in the model.
- **Compound Flooding Assessment:** This computation determines the compound effects of tidal, storm surge, and rainfall-induced flooding by overlaying depth grids from various scenarios. Compound flood modeling was focused exclusively on coastal regions as this is where the primary impacts will occur.
- **Coastal Erosion:** To help understand the geographic distribution of coastal erosion risk, data from the USGS National Shoreline Change short-term linear regression rates for Florida were utilized (USGS 2021). The costal erosion assessment focused on FDEP-identified critical erosion areas. To determine assets exposed to coastal erosion, the County's assets were overlaid with the hazard area. The analysis determined the extent (in miles) of shoreline affected by coastal erosion and qualitatively explored how this may affect citizens and assets. The evaluation utilized historical erosion rates to project future coastal erosion estimates in the County for the 2040 and 2070 time horizons. As a result, a designated impact zone was delineated, and an evaluation of its effects on assets was conducted. It is important to note that these modeling efforts and associated results do not account for any mitigation projects in place by the County.
- **Drought:** The drought hazard assessment consisted of a qualitative analysis, drawing upon a range of data sources. The analysis was based on data such as water supply and use, projected population growth estimates, historical losses due to drought, historical and future climate projections, and precipitation estimates. Historical data included regional plans and studies, as well as national sources. The analysis identified areas of high susceptibility to drought based on historical information and the potential effects of drought.
- **Extreme Heat:** The U.S. Climate Resilience Toolkit Climate Explorer was used to determine the average number of days per year that exceed 95°F in PBC. The extreme heat assessment

evaluates the change in the average annual number of 95°F days from the present day up to 2090 for two emissions scenarios developed by the Intergovernmental Panel on Climate Change: a low-emissions scenario referred to as RCP4.5, and a high-emissions scenario referred to as RCP8.5.

The extreme heat hazard analysis used heat island data collected by the Trust for Public Land's Climate Smart Cities Program to identify areas exposed to excessive heat. The heat island data set includes land cover type and tree canopy information. Populations and assets within the spatial extents identified were assessed using an area-weighted average, and rankings based on the heat island data were assigned. The analysis of extreme heat impacts allowed PBC to project future social impacts based on historical benchmarks.

- **Wind:** To create a comprehensive profile, the wind hazard analysis involved historical information from the PBC Hazard Mitigation Plan, hurricane windspeeds modeled in Hazus for different probabilities, and other sources. Two recurrence interval events were assessed: the 100-year event and the 500-year event using data from the NOAA Saffir Simpson Hurricane Wind scale. The Hazus model returned multiple interval events of varying degrees of impact. The CVA evaluated structural impacts on assets as costs associated with damage to structures, as well as short-term sheltering needs.
- **Wildfire:** The wildfire analysis leveraged data from the U.S. Forest Service Wildfire Hazard Potential to delineate wildfire hazard areas. GIS data was overlaid with the hazard area to estimate the value of buildings exposed to wildfire threats. Data from the Florida's Fish and Wildlife Conservation Commission's Florida Fire Occurrence (1994 to 2020) dataset provided historical context to this CVA.

Taken together, these components provide a data-driven approach to assess PBC's vulnerability to climate-induced changes. The methodology is crafted to not only meet statutory compliance standards, but also to provide actionable insight into the County's potential future climate scenarios.

5.1.2.1 Scenario Development and Assumptions for Evaluations/Modeling

North American Vertical Datum of 1988

All elevations referenced in and analyzed for this CVA are expressed in NAVD 88 values, the current official vertical datum for North America.

Modeled Storm Event

In the PBC area, FEMA has calculated the occurrence probability of various water elevations. Those elevations include astronomic tides as well as storm surge and wave setup, both of which developed during large tropical and extra-tropic storm events. NOAA and the SFWMD have also modeled the probability of rain events of a given magnitude occurring in any year.

These annual occurrences of water levels and precipitation are represented by storms of various return frequency, or percentage chance that a storm of a particular intensity will occur in any given year. When analyzing future flood impacts, it is important to layer SLR together with the modeled flood-water elevations to gain a true picture of expected water levels (FEMA 2016). This study focuses on impacts from the 25-, 50-, 100-, and 500-year events. A 1,000-year storm event was also modeled to represent the extreme rainfall that has been experienced in some areas of south Florida in recent years.

Table 5-2. Modeled Storm Events

Return Frequency (years)	% Chance of Occurrence in Any Year
25	4
50	2
100	1
500	0.2
1,000	0.1

Local Sea Level Rise Scenarios

The SLR scenarios included in the CVA include the 2017 NOAA Intermediate-Low Sea Level Rise Projection and the 2017 NOAA Intermediate-High Sea Level Rise Projection. These scenarios were the required scenarios when this CVA was initiated. As previously noted, legislation adopted by the Florida Legislature in 2024 will shift these required scenarios to the 2022 NOAA Intermediate Low and Intermediate scenarios. These new scenarios will apply to VAs initiated after July 1, 2024.

The benefit of evaluating a range of conditions is that the County can determine its tolerance of risk for any asset and develop an adaptation strategy decision matching that tolerance. In the future, the County can act upon data from this analysis that reflects a wider range of conditions. For assets, adaptation projects, and policy decisions where there is a higher criticality associated with that decision, the higher end of the projections and output should be considered in design and formulation. Where there is a higher tolerance for flood impact, the lower end of the projections could be considered. The range provides options needed for more place-based and flood impact decision-making.

Planning Horizons

The planning horizons for flood hazards in this assessment coincide with NOAA’s forecasting years: 2040, 2070, and 2100. While Subsection 380.093(3), F.S. only requires the 2040 and 2070 planning scenarios, currently, this CVA also includes the 2100 condition for an extended vision for adaptation response and long-term strategic planning.

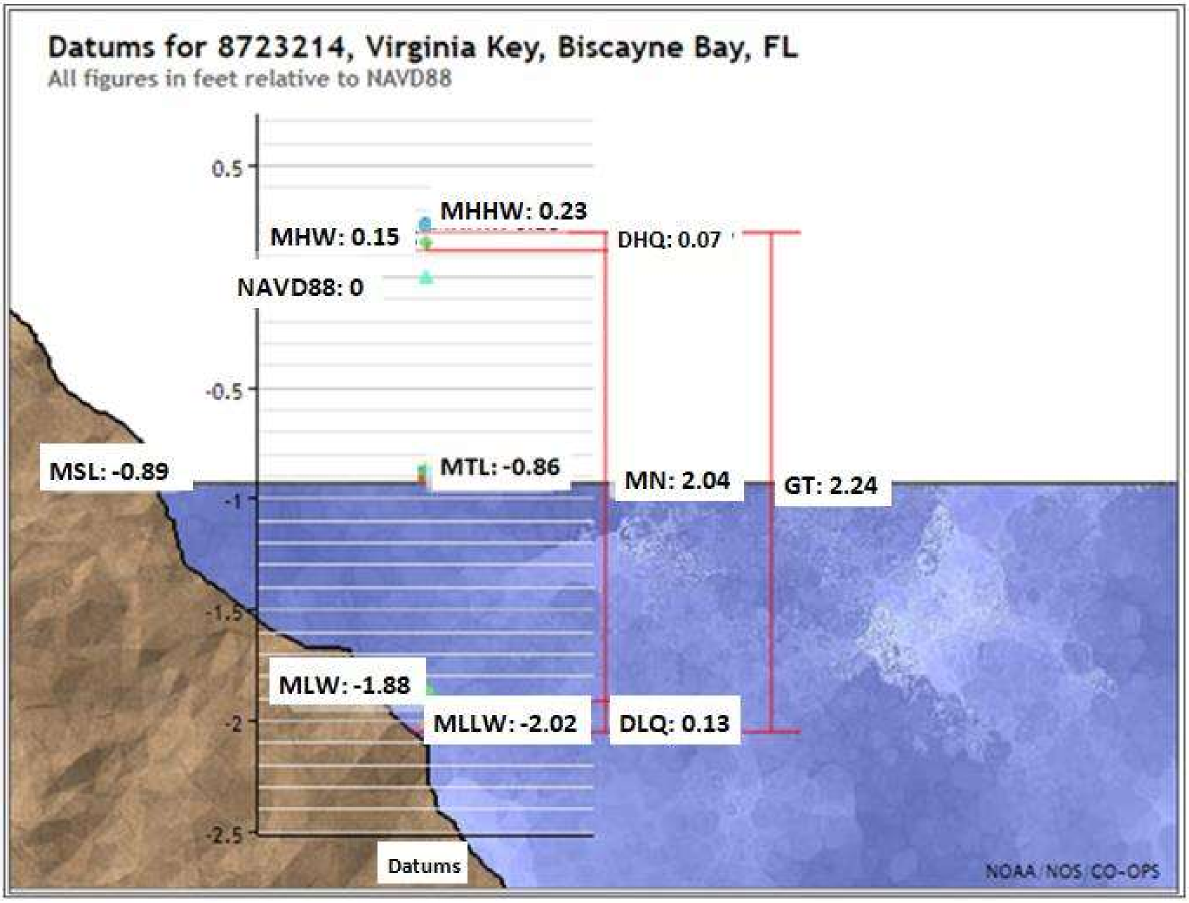
Sea Level Data Selection

The NOAA tide gauge selected for this study is located approximately 65 miles south at Virginia Key (Station ID 8723214). Installed in 1994, the tide gauge has supplied consistent data for three decades, providing a highly accurate record of water levels in the surrounding areas.

State statute provides multiple alternatives for using the tide records to determine SLR water elevations. One option includes interpolation between the two closest NOAA tide gauges, but another option provides that the higher of the two can be utilized if it has the higher mean sea level or an alternative gauge can be used with departmental approval. The highest mean sea level reported at the Virginia Key Tide Gauge is the greater of the two closest tide gauges. The benefits of using the

Virginia Key Tide Gauge are that it exhibits a higher mean sea level compared to other gauges in the region and it has an extensive and continuous tidal record. Utilizing this gauge for calculations provides the most conservative approach for this assessment and is explicitly contemplated in Section 380.093(3)(d)3.d. The datum chart below (Figure 5-2) provides a visual representation of various reference levels (datums) related to the NOAA Virginia Key Tide Gauge. These datums are standardized elevations used to serve as reference points for measuring various water levels. Each datum is related to specific tidal conditions and is used to predict tidal elevations for specific purposes such as navigation, and coastal and marine engineering. Below is a brief explanation of common datums on Figure 5-2:

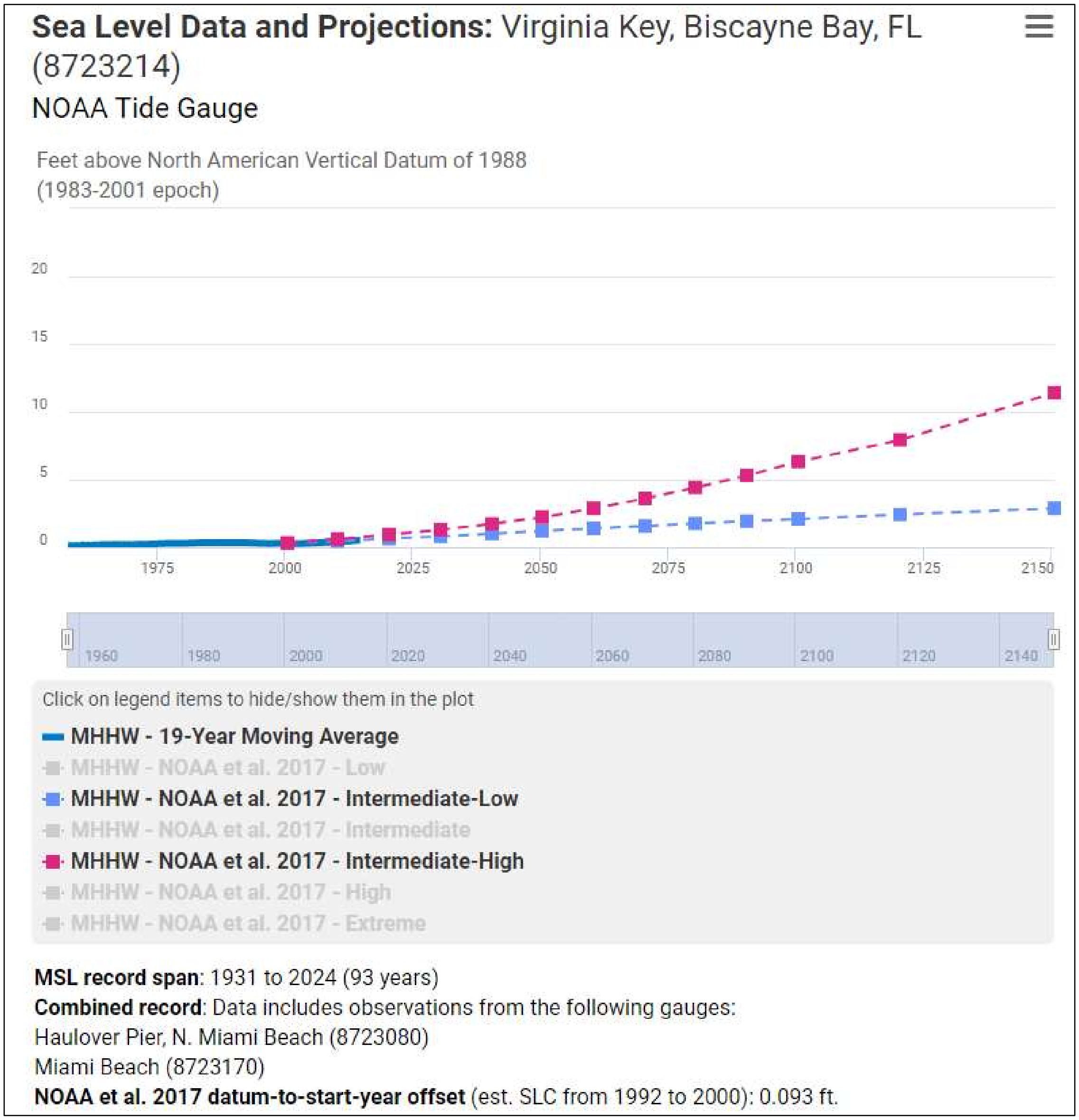
- **Mean Higher High Water (MHHW):** The average elevation of the highest high tides over a specific period. It is important for construction and development in coastal zones as it indicates the highest average water level that can be expected.
- **Mean High Water (MHW):** The average of all the high-water heights observed over the National Tidal Datum Epoch (usually a period of 19 years).
- **Mean Sea Level (MSL):** The average sea level. The mean level of the ocean's surface, calculated from hourly tidal heights measured over extended periods.
- **Mean Low Water (MLW) and Mean Lower Low Water (MLLW):** The average of the lowest tides and the lowest average tide recorded, respectively, often used for navigational purposes to ensure boats and ships do not run aground.



Source: NOAA n.d. (b)

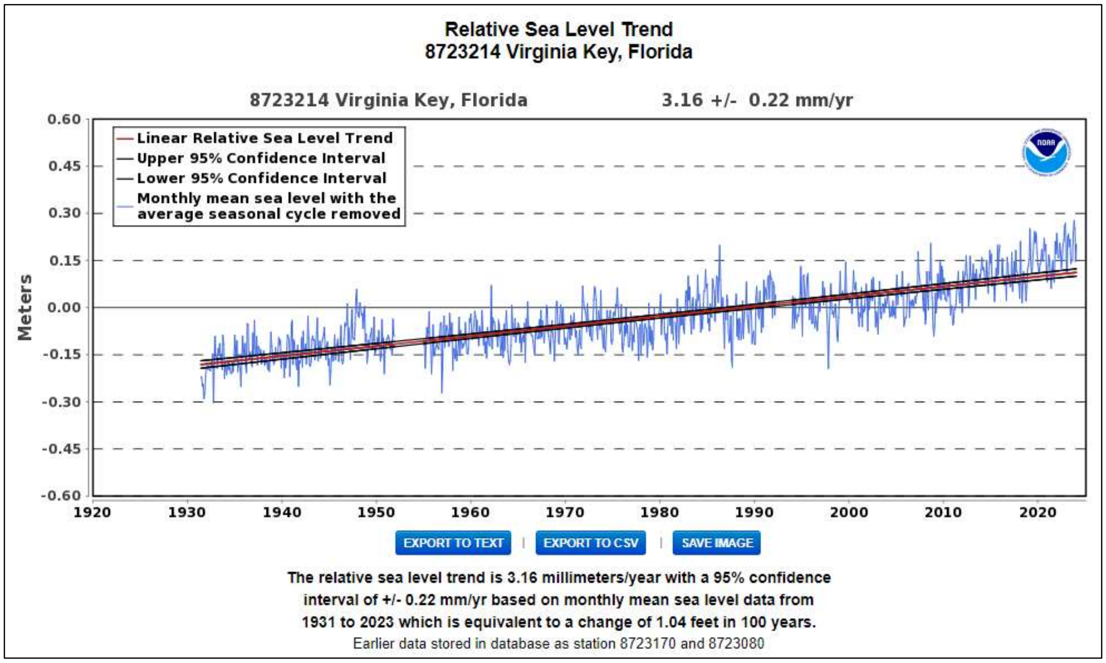
Figure 5-2. Datums for Virginia Key Tide Gauge

The USACE Sea Level Change Curve Calculator and Sea Level Analysis Tool (USACE n.d.) were utilized to calculate the SLR values required for NOAAs method for mapping SLR (NOAA 2017a) with the most recent digital elevation model and VDATUM derived tidal surfaces (NOAA n.d. (a)). The NOAA tide gauge, referenced as “Virginia Key, Biscayne Bay FL” (NOAA Gauge Station ID: 8723214, 2024) was selected for its proximity to the study area (Figure 5-3) along with the justification stated above. The Virginia Key Tide Gauge indicates a relative sea-level trend of 3.16 millimeters/year with a 95 percent confidence interval of +/- 0.22 mm/year based on data from 1931 to 2023 (Figure 5-4).



Source: USACE n.d.

Figure 5-3. Virginia Key Tide Gauge Sea Level Data (Measured) and Projections of Future Water Elevations

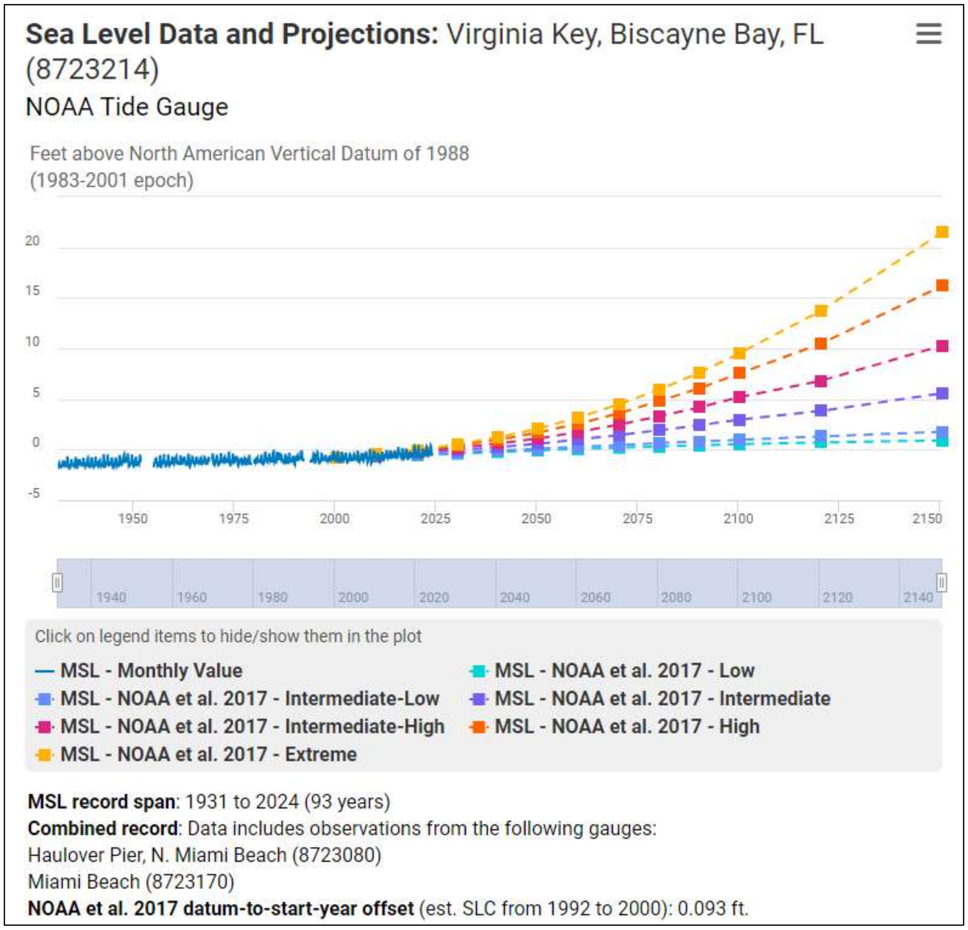


(3.16+/-0.22 mm/yr), equivalent to 1.04 ft in 100 years

Source: NOAA n.d. (b)

Figure 5-4. Sea Level Increase from 1931 to 2023

The plots above (Figure 5-3 and Figure 5-4) and below (Figure 5-5) describe the observed sea level and future projected increase in sea level within the region. Figure 5-5 provides the full suite of NOAA sea level projections. Modeling all of these projections would not be cost effective. The analysis here has been limited to NOAA intermediate low and intermediate high to comply with state statute requirements.



Source: NOAA n.d. (b)

Figure 5-5. Mean Sea Level Projections for Virginia Key

5.1.3 Climate Hazard Projections and Modeling Results

Exposure: Future High Tide

Using a planning-grade static coastal hydrology SLR modeling approach (NOAA 2017b) commonly known as a “Bathtub Model”, the assessment evaluated vulnerability to SLR inundation, leveraging future projections of SLR with an added 2 feet to account for high tide flooding as required by Subsection 380.093(3)(d)2., F.S.. The latest version of ArcGIS Pro was used to generate inundation results (Esri 2022). By following this modeling process, detailed future high tide flooding maps are generated that account for both regional and local variations in tidal flooding. These maps specifically identify areas with similar elevation that are not tidally connected according to the elevation surface but may still be vulnerable to flooding, especially if they connect to other tidal systems via stormwater conveyance or some other type of groundwater/surface water connection not captured within elevation data.

Table 5-3 shows the modeling results for PBC’s high tide flooding projections over the coming decades as sea levels rise. These projections serve as the foundation for the sea level aspects of the risk assessment, enabling the evaluation of potential consequences from multiple flood scenarios.

Table 5-3. Projected Future High Tide Water Elevations

Timeframe	NOAA Intermediate Low 2017 (feet NAVD 88)	NOAA Intermediate High 2017 (feet NAVD 88)
Present Day	2.33	2.62
2040	2.69	3.41
2070	3.25	5.28
2100	3.77	8.00

The future high tide model makes use of ArcGIS Pro and NOAA's methods to predict flooding (NOAA 2017a). It involves adjusting measurements for differences in sea level at various points and using algorithms to fill in gaps between these points. The modeling process utilized helps to accurately predict how high tides can rise, considering both current and future sea levels. By combining information on SLR with existing tide patterns, detailed maps that show where and how high tide flooding could happen in the future are generated. The results provide a clear picture of the risks of future high tide flooding.

The County's vulnerability to current and future flood risk, particularly concerning SLR, necessitates an examination of projections tailored specifically to this coastal city. The analysis of SLR projections and potential impacts are greatly enhanced by the incorporation of PBC-specific data and scenarios, especially those focused on the County's location along the coast. In PBC, as in many other coastal areas, the imminent threat of SLR has the potential to significantly impact communities, infrastructure, and environment.

Exposure: Depth of Tidal Flooding, Including Future High Tide Flooding

The following maps (Figure 5-6 and Figure 5-7) provide an overview showing which regions, infrastructure, and natural areas are at increased risk due to HTF in the present day and under future conditions based on the NIL and NIH SLR projections.

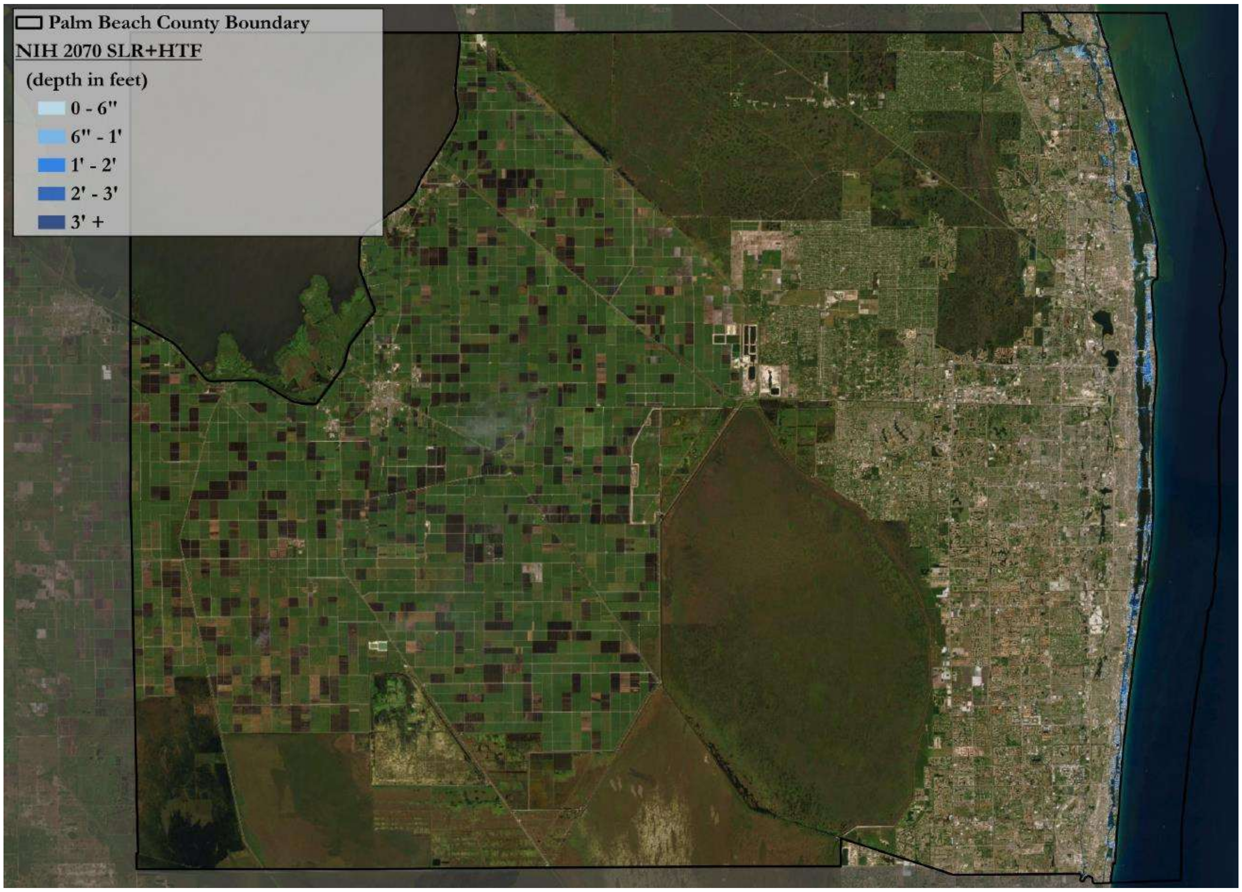


Figure 5-6. NIH 2070 SLR + HTF

Figure 5-7. NIH 2070 Days of Tidal Flooding

The assessment of tidal flooding is the basic element of comprehensive vulnerability evaluations aimed at understanding the impacts of SLR on coastal communities. The analysis of tidal elevations is conducted through the collection and examination of high and low tide data spanning at least 19 years, a period that encompasses the full Metonic cycle, from specific NOAA tide gauges, such as the Virginia Key Tide Gauge (Table 5-4). The objective is to extrapolate current high tide values from historical data, project them forward using the observed sea level trend, and then assess the potential frequency of increasing high tide elevations in the future. Section 380.093(3)(d)2.a. provides that to the extent practicable, the analysis should also geographically display the number of tidal flood days expected for each scenario and planning horizon. That representation is provided below.

Table 5-4. Statistical Analysis of Historical Tide Record (Feet NAVD 88)

1995-2013 (NAVD 88)	2004-2022 (NAVD 88)	Approximate Days Tide Reached This Height
1.64	2.02	1
1.40	1.80	5
1.29	1.60	10
1.18	1.45	15
1.09	1.35	20
0.97	1.23	30
0.89	1.14	40
0.76	0.98	50
0.57	0.79	100
0.26	0.47	≥150

Note: This table calculates the number of days where water elevations surpassed a “critical elevation”

The analysis utilized to develop Table 5-4 employed statistical methods to correlate historic tide records with observed days of tidal flooding. It reveals the changes in tide elevations over two distinct periods, 1995-2013 and 2004-2022, and associates these elevations with the observed frequency of tidal flooding events. A key observation is the trend of increasing tide elevations over time, indicating rising sea levels and, consequently, an increased risk of tidal flooding (Table 5-4). This trend is continued in the tidal projections contained in Table 5-5.

Table 5-5. Future Tidal Flooding Frequency (Feet NAVD 88)

2040-NIL	2070-NIL	2100-NIL	2040-NIH	2070-NIH	2100-NIH	Approximate # of Days Tide Will Reach This Height
2.33	2.99	3.51	3.15	5.29	8.05	1
2.13	2.77	3.29	2.87	5.02	7.75	5
1.97	2.55	3.16	2.73	4.81	7.54	10
1.83	2.38	3.03	2.60	4.61	7.40	15
1.72	2.28	2.93	2.49	4.49	7.30	20
1.60	2.17	2.80	2.35	4.36	7.17	30
1.50	2.08	2.71	2.25	4.25	7.07	40
1.35	1.93	2.57	2.09	4.11	6.88	50
1.16	1.74	2.37	1.88	3.89	6.61	100
0.84	1.40	2.04	1.53	3.47	6.08	≥150

Understanding the implications of these findings is crucial. The elevations for the two periods underscore not just the absolute rise in sea levels but also the increasing likelihood of flooding events.

The future projections shown in Table 5-5 show flooding trends continuing to increase in magnitude and frequency. They provide valuable insights for planning and adaptation strategies. For instance, the NIH scenario estimates that by 2040, HTF for 150 or more days out of the year will increase from 0.47 foot to 1.53 feet, escalating to 3.47 feet by 2070 and 6.08 feet by 2100. Viewed differently, in the 2040-NIL scenario, a tide stage of 2.33 feet is reached only one time per year, and 30 years later in the 2070-NIL scenario, a nearly equivalent tide stage of 2.38 feet is reached 20 times per year.

Maps displaying flooded conditions for PBC can be found in **Appendix A**. They identify which regions, infrastructure, and natural areas are at increased risk due to multiple days of tidal flooding.

Exposure: Storm Surge

Storm surge modeling uses FEMA's data and Hazus-MH software (FEMA 2022), adapted for future SLR. The approach integrates historical storm surge data from FEMA's Flood Insurance Study with projections of SLR, creating models of adjusted storm surge inundation. The models suggest how rising sea levels could intensify storm surge, which is essential for informed decision-making and mitigation development. Unlike SLR and tidal flooding, storm surge is a less permanent condition, but due to the force of fast-moving water and depth of flooding, it can be extremely destructive and debilitating to a community.

Stillwater elevations are used by FEMA to assess flood risks in coastal areas (Figure 5-8). Stillwater elevations represent the water level, including storm surge and tides, but not including any kind of wave action. FEMA calculates these levels for sectors of the coast, factoring in surge from storms with various return periods (FEMA 2005). Stillwater elevations across the coastal transects (Figure 5-9) identified within the FEMA October 2017 Palm Beach County Flood Insurance Study (FIS) were also averaged and adjusted by both NIL and NIH SLR. Baseline still water elevations for the various return interval coastal flood events (10-, 50-, 100-, and 500-year) were sourced from the 2017 Palm Beach County FIS (FEMA 2017).

FLOOD INSURANCE STUDY

PALM BEACH COUNTY, FLORIDA
AND INCORPORATED AREAS

Community Name	Community Number	Community Name	Community Number
PALM BEACH COUNTY (UNINCORPORATED AREAS)	120192	LAKE WORTH, CITY OF	120213
ATLANTIS, CITY OF	120193	LANTANA, TOWN OF	120214
BELLE GLADE, CITY OF	120194	LOXAHATCHEE GROVES, TOWN OF	120309
BOCA RATON, CITY OF	120195	MANALAPAN, TOWN OF	120215
BOYNTON BEACH, CITY OF	120196	MANGONIA PARK, TOWN OF	120216
BRINY BREEZES, TOWN OF	120197	NORTH PALM BEACH, VILLAGE OF	120217
CLOUD LAKE, TOWN OF	120198	OCEAN RIDGE, TOWN OF	125134
DELRAY BEACH, CITY OF	125102	PAHOKEE, CITY OF	120219
GLEN RIDGE, TOWN OF	120200	PALM BEACH, TOWN OF	120220
GOLF, VILLAGE OF	120201	PALM BEACH GARDENS, CITY OF	120221
GREENACRES, CITY OF	120203	PALM BEACH SHORES, TOWN OF	125137
GULF STREAM, TOWN OF	125109	PALM SPRINGS, VILLAGE OF	120223
HAVERHILL, TOWN OF	120205	RIVIERA BEACH, CITY OF	125142
HIGHLAND BEACH, TOWN OF	125111	ROYAL PALM BEACH, VILLAGE OF	120225
HYPOLUXO, TOWN OF	120207	SOUTH BAY, CITY OF	120226
JUNO BEACH, TOWN OF	120208	SOUTH PALM BEACH, TOWN OF	120227
JUPITER, TOWN OF	125119	TEQUESTA, VILLAGE OF	120228
JUPITER INLET COLONY, TOWN OF	125120	WELLINGTON, VILLAGE OF	125157
LAKE CLARKE SHORES, TOWN OF	120211	WEST PALM BEACH, CITY OF	120229
LAKE PARK, TOWN OF	120212		

EFFECTIVE:
October 5, 2017

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
12099CV000A

Source: FEMA 2017

Figure 5-8. Palm Beach County FEMA Flood Insurance Study

Source: FEMA 2017

Figure 5-9. Palm Beach County Transect Location Map

Using the outputs from the Hazus-MH software, depth grids representing the maximum surge elevation (and corresponding flood depth) are created for a comparative overlay analysis with the critical asset inventory. Critical elevations utilized with the coastal floodplain module of Hazus-MH are provided in Table 5-6.

Table 5-6. Critical Elevations (Feet NAVD 88)/Stillwater Elevations

Planning Horizon	100 Year (feet)	500 Year (feet)
Present Day Average Stillwater	6.02	6.9
NIL 2040 Adjusted Average Stillwater	6.34	6.8
NIL 2070 Adjusted Average Stillwater	6.90	8.5
NIL 2100 Adjusted Average Stillwater	7.42	9.1
NIH 2040 Adjusted Average Stillwater	7.06	8.67
NIH 2070 Adjusted Average Stillwater	8.93	11.0
NIH 2100 Adjusted Average Stillwater	11.65	14.3

Exposure: Depth of Current and Future Storm Surge Flooding

Figure 5-10 and Figure 5-11 identify the areas at increased risk from the combined effects of storm surges and SLR, when viewing the 2040, 2070, and 2100 NIH SLR projections with 100-year (1.0 percent annual chance) and 500-year (0.2 percent annual chance) storms. In Figure 5-10 and Figure 5-11 below, the increased impact from storm surge can be seen from 2040 to 2070 when flooding from even the 100-year storm inundates most of the eastern area at a depth of 8 feet or more. Storm surge modeling was focused exclusively on coastal regions as this is where the primary impacts will occur.

Figure 5-10. NIH 2040 SLR + 100-Year Storm Surge

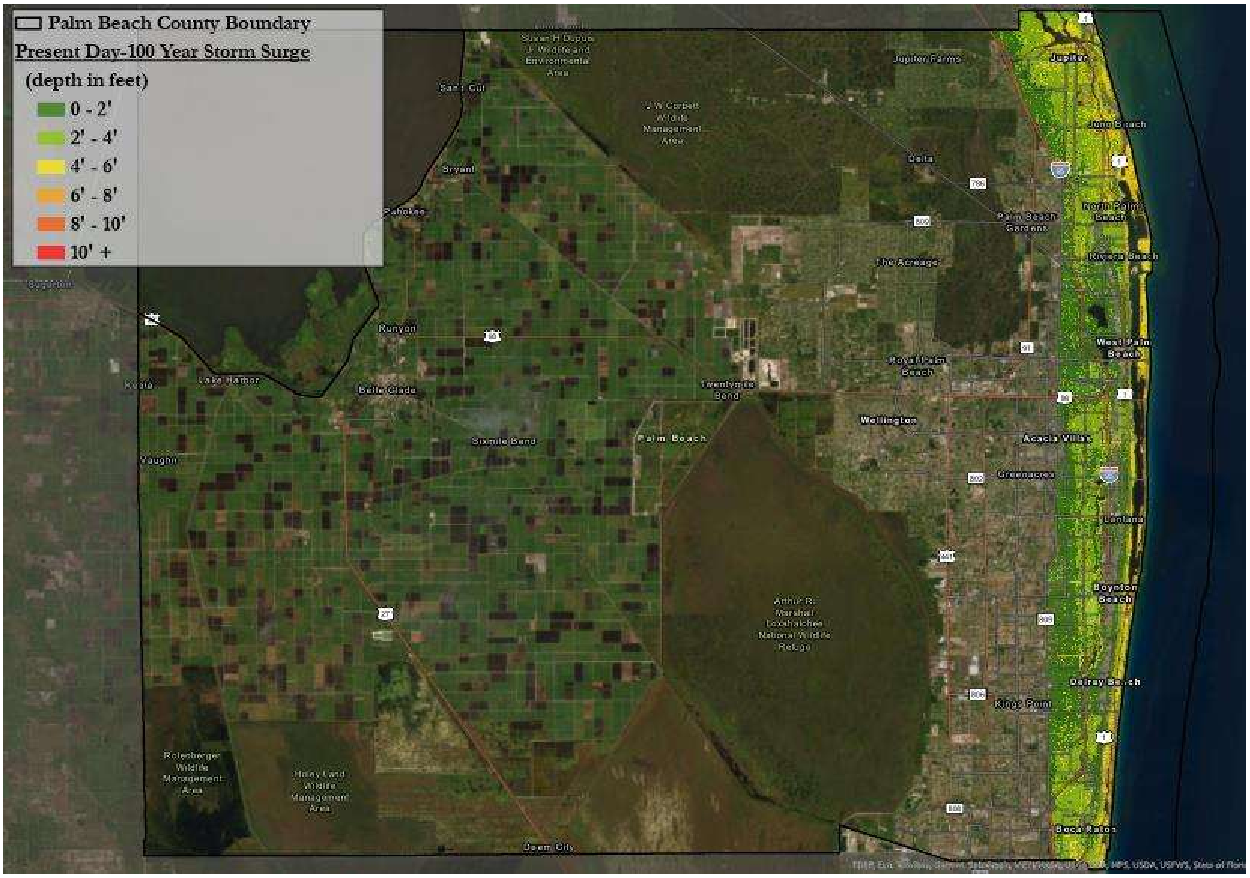


Figure 5-11. NIH 2070 SLR + 100-Year Storm Surge

To gather more holistic results, the storm surge climate hazard was also modeled using a SLOSH model. The SLOSH model was used to assess impacts under two scenarios: Category 1 and Category 5. The exposure analysis included land, population, and assets. The sensitivity analysis focused on population and assets.

Strong storms, including hurricanes and tropical cyclones, can result in greater tidal and wave action that pushes water further inland and above typical tide levels. For the purposes of this assessment, areas are exposed to storm surge if they intersect with the spatial extents of SLOSH Categories 1 and 5 storm surges. For reference, Hurricane Nicole in 2022 was a Category 1 storm, whereas Hurricanes Irma (2017), Dorian (2019), and Ian (2022) were Category 5.

The SLOSH Categories scenarios represent bracketing storm surge events, from least (Category 1) to most severe (Category 5). However, the SLOSH system's primary purpose is to identify areas that may require evacuation during certain events, rather than measure flood risks. FEMA products such as the Flood Insurance Rate Maps (FIRMs) are the primary source of information to evaluate flood risks as well as flood insurance rates. SLOSH was selected to represent storm surge due to its inclusion of parameters that consider atmospheric pressure, wind speed, and storm size that influence the degree of flooding during severe storm events (National Hurricane Center n.d.).

As shown in Table 5-7, during a Category 1 storm, less than 1 percent of PBC land area is expected to be affected by storm surge. No land area in the focus areas of Belle Glade, Pahokee, and South Bay were exposed and are excluded from the table. Affected areas lie along the County's coastline, where storm surge occurs. The western municipalities included in the focus areas (Belle Glade, Pahokee, and South Bay) were not affected by either scenario. Several coastal communities are expected to experience significant inundation during Category 5 events. For instance, nearly three-fourths of South Palm Beach's land area would be inundated, as well as more than half of Gulf Stream and Briny Breezes. Others, such as Boca Raton, may experience limited exposure during Category 1 events (approximately 95 acres or 0.4 percent of all acres), but significant exposure during a Category 5 (over 1,028 acres or over 5 percent of all acres).

Table 5-7. Land Exposure to Storm Surge in Palm Beach County

		Category 1				Category 5			
		Exposed Area (acres)			% of Total	Exposed Area (acres)			% of Total
	Jurisdiction	Low	Moderate	High		Low	Moderate	High	
Other Affected Areas	South Palm Beach	2	0	0	2%	43	11	1	74%
	Gulf Stream	87	0	0	16%	114	71	70	55%
	Briny Breezes	8	0	0	17%	7	14	4	54%
	Highland Beach	36	0	0	9%	143	42	28	48%
	Unincorporated Areas	1,077	2	0	<1%	2,233	467	1,049	1%
	Palm Beach County	2,478	12	0	<1%	11,172	2,980	1,966	1%

As shown in Table 5-8, population exposure to storm surge is limited to eastern coastal municipalities. Belle Glade, Pahokee, and South Bay are not expected to experience any population exposure under Category 1 or 5 scenarios, and these jurisdictions are excluded from the table. However, depending on the event magnitude and direction, these western municipalities could be impacted by storm features other than storm surge, such as strong winds or heavy rainfall, which are captured in other sections of the CVA.

In general, there is a significant growth in exposure between Category 1 and Category 5 events. For instance, as shown in Table 5-8, under a Category 1 scenario, just 2 percent of South Palm Beach residents are exposed to storm surge, whereas 75 percent will be during a Category 5 event. Similarly, in Boca Raton, there is limited population exposure during a Category 1 event (less than 0.5 percent exposed), but significant exposure during a Category 5 (approximately 6 percent).

Table 5-8. Population Exposure to Storm Surge in Palm Beach County

		Category 1				Category 5			
		Population			% of Total	Population			% of Total
	Jurisdiction	Low	Moderate	High		Low	Moderate	High	
Other Affected Areas	South Palm Beach	13	0	0	2%	317	84	9	75%
	Highland Beach	347	0	0	10%	1,238	408	274	58%
	Briny Breezes	54	0	0	17%	52	101	30	58%
	Ocean Ridge	103	0	0	8%	385	108	83	46%
	Unincorporated Areas	0	0	0	0%	6,421	1,295	1,982	2%
	Palm Beach County	5,928	72	0	<1%	46,669	10,879	4,879	4%

Asset exposure is limited to the eastern portion of the County. Areas exhibiting high rates of exposure tend to be smaller jurisdictions with only a few assets included in the asset inventory, such as in South Palm Beach. Overall, less than 1 percent of the County's assets are expected to be exposed to storm surge under Category 1 or 5 events.

Additionally, few miles of critical infrastructure and transportation assets are exposed to storm surge. No critical infrastructure miles are exposed; the only asset miles exposed based on the assessment are transportation miles, which include roads. Western municipalities, such as Belle Glade, Pahokee, and South Bay, are not expected to be exposed during either a Category 1 or 5 event. The County as a whole will likely have limited exposure as well, with less than percent exposed during a Category 1 event and less than 2 percent exposed during a Category 5 event.

Exposure: Rainfall Induced Flooding

The rainfall analysis within the CVA employs HEC-RAS software for rainfall simulation and runoff computation. Modeling efforts related to rainfall-induced flooding integrate NOAA's Atlas 14 data and SFWMD change factors to create baseline rainfall depth grids, aligning with legislative requirements to conduct such analyses (SFWMD 2022; NOAA 2023). The comprehensive modeling approach produces maps to help users understand and prepare for future flood risks. The rainfall-induced flood modeling approach meets and exceeds the statutory requirements for rainfall evaluation in VAs. In addition to modeling the 100-year and 500-year rainfall events required by statute, results from the present day 25-year, 50-year, and 1000-year rainfall models along with the future 25-year and 100-year rainfall event models were provided.

NOAA Atlas 14 provides high-quality data based on ongoing investigations of historical rainfall patterns across the United States. It offers site-specific rainfall distributions, which are essential for accurate hydrologic modeling. Compared to previous volumes, Atlas 14 estimates have longer periods of record and greater station density. NOAA Atlas 14 defines standard design rainfall distributions based on integrating high-intensity short duration events within longer, lower-intensity precipitation. These distributions are used in hydrologic models to estimate rainfall intensity for specified durations and annual exceedance probabilities (Figure 5-12). The NOAA Atlas 14 serves as a guideline to assess flood potential in watersheds and design stormwater infrastructure. The accuracy of rainfall data provided by NOAA Atlas 14 allows engineers and planners to make informed decisions when designing and managing infrastructure (NOAA 2023).

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.511** (0.411-0.643)	**0.586** (0.471-0.739)	**0.709** (0.568-0.896)	**0.810** (0.646-1.03)	**0.949** (0.732-1.24)	**1.06** (0.796-1.41)	**1.16** (0.849-1.59)	**1.27** (0.891-1.79)	**1.41** (0.954-2.06)	**1.52** (1.00-2.26)
10-min	**0.748** (0.602-0.942)	**0.858** (0.690-1.08)	**1.04** (0.832-1.31)	**1.19** (0.946-1.51)	**1.39** (1.07-1.82)	**1.55** (1.17-2.06)	**1.70** (1.24-2.33)	**1.86** (1.30-2.63)	**2.06** (1.40-3.01)	**2.22** (1.47-3.30)
15-min	**0.912** (0.734-1.15)	**1.05** (0.842-1.32)	**1.27** (1.02-1.60)	**1.45** (1.15-1.84)	**1.70** (1.31-2.22)	**1.88** (1.42-2.52)	**2.07** (1.52-2.84)	**2.26** (1.59-3.20)	**2.52** (1.70-3.67)	**2.71** (1.79-4.03)
30-min	**1.42** (1.14-1.79)	**1.62** (1.31-2.05)	**1.96** (1.57-2.48)	**2.24** (1.79-2.85)	**2.62** (2.02-3.44)	**2.92** (2.20-3.89)	**3.21** (2.34-4.40)	**3.51** (2.46-4.96)	**3.90** (2.64-5.69)	**4.19** (2.77-6.24)
60-min	**1.89** (1.52-2.38)	**2.12** (1.70-2.67)	**2.52** (2.02-3.18)	**2.87** (2.29-3.64)	**3.39** (2.64-4.50)	**3.82** (2.90-5.14)	**4.27** (3.14-5.91)	**4.75** (3.36-6.78)	**5.43** (3.69-7.98)	**5.97** (3.94-8.88)
2-hr	**2.35** (1.91-2.94)	**2.61** (2.11-3.26)	**3.07** (2.47-3.85)	**3.50** (2.80-4.42)	**4.16** (3.27-5.51)	**4.72** (3.62-6.34)	**5.33** (3.95-7.36)	**6.00** (4.27-8.54)	**6.96** (4.77-10.2)	**7.74** (5.15-11.5)
3-hr	**2.58** (2.10-3.22)	**2.84** (2.30-3.54)	**3.34** (2.70-4.18)	**3.83** (3.08-4.81)	**4.61** (3.65-6.13)	**5.30** (4.09-7.13)	**6.07** (4.53-8.39)	**6.93** (4.96-9.86)	**8.18** (5.64-12.0)	**9.22** (6.16-13.6)
6-hr	**2.95** (2.41-3.65)	**3.30** (2.70-4.09)	**3.99** (3.25-4.96)	**4.67** (3.78-5.84)	**5.78** (4.62-7.67)	**6.76** (5.25-9.06)	**7.85** (5.90-10.8)	**9.07** (6.55-12.9)	**10.9** (7.55-15.8)	**12.4** (8.31-18.1)
12-hr	**3.34** (2.74-4.10)	**3.90** (3.21-4.80)	**4.96** (4.06-6.12)	**5.96** (4.85-7.39)	**7.51** (6.02-9.88)	**8.85** (6.90-11.8)	**10.3** (7.78-14.1)	**11.9** (8.64-16.7)	**14.3** (9.95-20.6)	**16.2** (10.9-23.5)
24-hr	**3.97** (3.28-4.84)	**4.64** (3.83-5.66)	**5.89** (4.86-7.22)	**7.09** (5.81-8.73)	**8.96** (7.23-11.7)	**10.6** (8.31-14.0)	**12.4** (9.39-16.8)	**14.3** (10.5-20.0)	**17.2** (12.1-24.7)	**19.5** (13.3-28.2)
2-day	**4.94** (4.12-5.99)	**5.48** (4.55-6.64)	**6.58** (5.45-8.00)	**7.71** (6.36-9.43)	**9.60** (7.85-12.6)	**11.3** (8.98-14.9)	**13.3** (10.2-18.0)	**15.5** (11.4-21.5)	**18.7** (13.3-26.8)	**21.5** (14.7-30.8)
3-day	**5.51** (4.61-6.66)	**6.03** (5.03-7.28)	**7.11** (5.91-8.62)	**8.24** (6.82-10.0)	**10.1** (8.31-13.2)	**11.8** (9.44-15.6)	**13.8** (10.6-18.6)	**16.0** (11.9-22.2)	**19.3** (13.8-27.6)	**22.1** (15.2-31.6)
4-day	**5.97** (5.00-7.18)	**6.49** (5.43-7.82)	**7.58** (6.32-9.16)	**8.71** (7.22-10.6)	**10.6** (8.71-13.7)	**12.3** (9.83-16.1)	**14.3** (11.0-19.1)	**16.5** (12.2-22.8)	**19.7** (14.1-28.1)	**22.5** (15.5-32.1)
7-day	**7.17** (6.04-8.58)	**7.70** (6.48-9.22)	**8.79** (7.37-10.6)	**9.91** (8.26-12.0)	**11.8** (9.68-15.1)	**13.4** (10.8-17.4)	**15.3** (11.9-20.4)	**17.5** (13.0-23.9)	**20.6** (14.8-29.1)	**23.3** (16.2-33.0)
10-day	**8.19** (6.92-9.77)	**8.78** (7.41-10.5)	**9.96** (8.37-11.9)	**11.1** (9.30-13.4)	**13.0** (10.7-16.5)	**14.7** (11.8-18.9)	**16.5** (12.8-21.8)	**18.6** (13.9-25.4)	**21.7** (15.6-30.4)	**24.2** (16.9-34.2)
20-day	**11.0** (9.32-13.0)	**12.0** (10.2-14.2)	**13.7** (11.6-16.3)	**15.2** (12.8-18.2)	**17.4** (14.3-21.6)	**19.2** (15.4-24.2)	**21.1** (16.4-27.4)	**23.1** (17.2-30.9)	**25.8** (18.6-35.7)	**28.0** (19.6-39.4)
30-day	**13.4** (11.4-15.8)	**14.8** (12.6-17.4)	**17.0** (14.4-20.1)	**18.8** (15.9-22.4)	**21.4** (17.5-26.3)	**23.3** (18.7-29.2)	**25.3** (19.7-32.5)	**27.3** (20.4-36.2)	**29.9** (21.6-41.0)	**31.9** (22.5-44.7)
45-day	**16.7** (14.3-19.6)	**18.5** (15.8-21.7)	**21.3** (18.2-25.1)	**23.6** (20.0-27.9)	**26.6** (21.8-32.3)	**28.8** (23.1-35.7)	**30.9** (24.0-39.4)	**32.9** (24.7-43.4)	**35.5** (25.7-48.3)	**37.4** (26.4-52.1)
60-day	**19.7** (16.9-23.0)	**21.8** (18.7-25.5)	**25.0** (21.4-29.4)	**27.6** (23.5-32.6)	**31.0** (25.4-37.5)	**33.4** (26.9-41.2)	**35.7** (27.8-45.3)	**37.9** (28.4-49.6)	**40.5** (29.3-54.9)	**42.3** (30.0-58.8)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Figure 5-12. NOAA Atlas 14 Rainfall Time Series Table for Palm Beach County

To accurately capture the nuances of the terrain's elevation and slope, a model was constructed utilizing digital elevation models (DEMs). These DEMs serve as the basis for mapping and understanding the area's physical characteristics. The elevation data within these models are based upon the NAVD 88 datum. Figure 5-13 represents the outline of the two-dimensional DEM (Figure 5-14) area and the boundary condition lines used in conjunction with the DEM used as terrain inputs in the modeling environment.

Figure 5-13. LiDAR Data Extent and Boundary Condition Lines for Northern, Southern, Eastern, and Western Boundaries

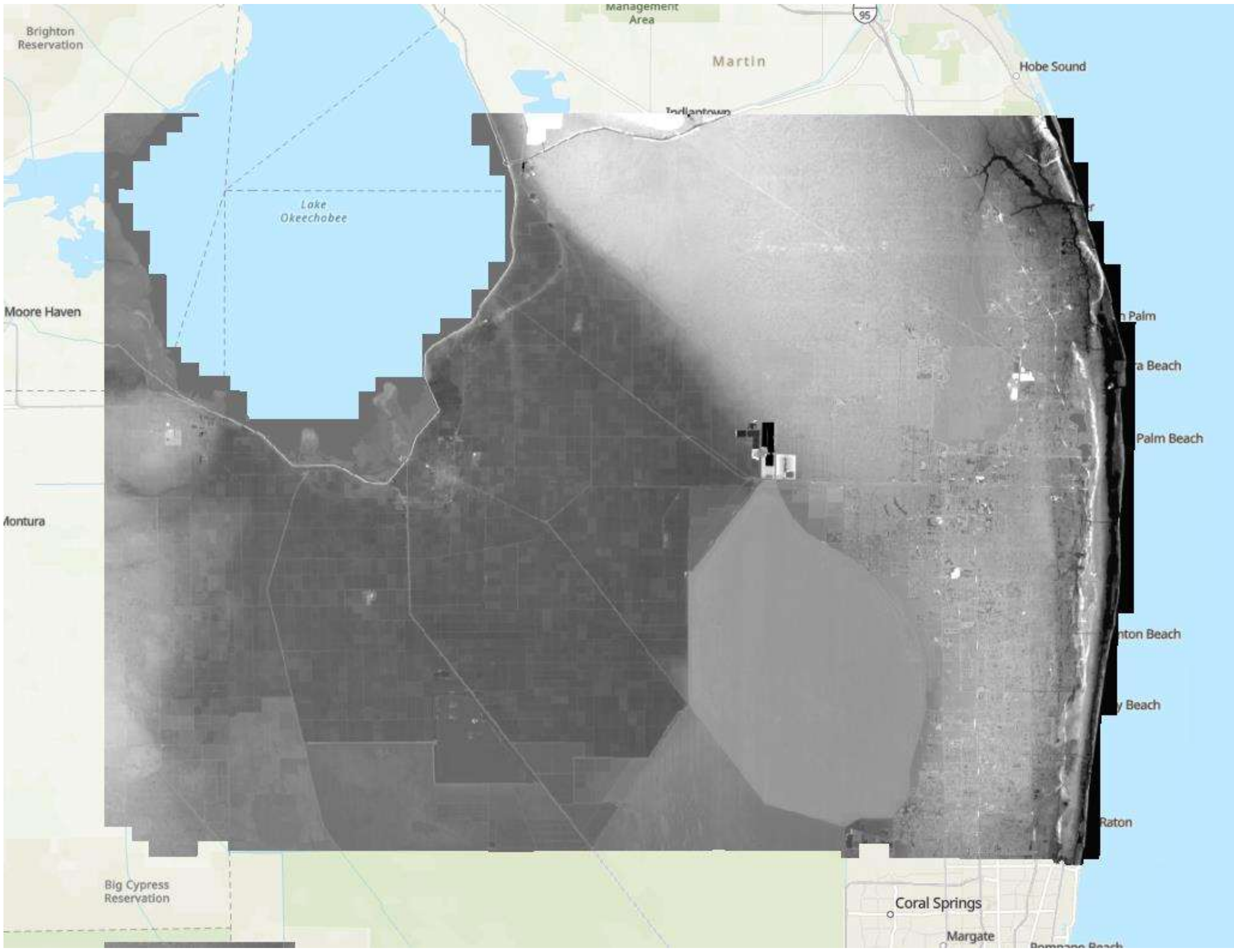


Figure 5-14. Palm Beach County Digital Elevation Model

The Precipitation Data files were generated using Intensity/Precipitation curves derived from the Florida Department of Transportation Drainage manual for 24-hour design storms. The design storms represent current (2023) rainfall patterns: 25-, 50-, 100-, 500-, and 1,000-year return interval 24-hour rainfall events, and the rainfall depths representing each 24-hour hypothetical storm event were taken from NOAA Atlas 14 annual maxima series to represent 2023 rainfall patterns (NOAA 2023). Future rainfall depths were computed using the current precipitation depths in Table 5-9 and deriving the intensity for the respective future conditions by using the SFWMD's change factors to arrive at the future-projected precipitation in Table 5-10 and Figure 5-15. The current and projected precipitation depths are then applied to the storm design criteria in Table 5-11 to arrive at a storm design that is suitable for varying present and future conditions.

Table 5-9. Precipitation in Inches for 24-Hour Storm Duration – Present Day

Year	Scenario	Precipitation (inches)
Present Day	25-Year	8.96
Present Day	50-Year	10.6
Present Day	100-Year	12.4
Present Day	500-Year	17.2
Present Day	1,000 Year	19.5

Table 5-10. Projected Precipitation in Inches for 24-Hour Storm Duration

Year	Scenario	Precipitation (inches)
2040	25-Year	10.04
2040	100-Year	13.89
2070	25-Year	10.93
2070	100-Year	15.13
2100	25-Year	12.01
2100	100-Year	16.62

Table 5-11. Rainfall Design Storm Criteria for Varying Storm Events

Design Storms					
T hours	I/P Total	25yr intensity	50yr Intensity	100yr Intensity	500yr Intensity
0	0	0	0	0	0
1	0.01	0.089	0.106	0.124	0.172
2	0.02	0.179	0.212	0.248	0.344
3	0.03	0.268	0.318	0.372	0.516
4	0.03	0.268	0.318	0.372	0.516
5	0.03	0.268	0.318	0.372	0.516
6	0.04	0.358	0.424	0.496	0.688
7	0.04	0.358	0.424	0.496	0.688
8	0.04	0.358	0.424	0.496	0.688
9	0.06	0.537	0.636	0.744	1.032
10	0.06	0.537	0.636	0.744	1.032
11	0.08	0.716	0.848	0.992	1.376
12	0.1	0.896	1.06	1.24	1.72
13	0.07	0.672	0.742	0.868	1.204
14	0.06	0.537	0.636	0.744	1.032
15	0.06	0.537	0.636	0.744	1.032
16	0.05	0.448	0.53	0.62	0.86
17	0.04	0.358	0.424	0.496	0.688
18	0.04	0.358	0.424	0.496	0.688
19	0.04	0.358	0.424	0.496	0.688
20	0.03	0.268	0.315	0.372	0.516

Design Storms					
T hours	I/P Total	25yr intensity	50yr Intensity	100yr Intensity	500yr Intensity
21	0.03	0.268	0.315	0.372	0.516
22	0.02	0.179	0.212	0.248	0.344
23	0.01	0.089	0.106	0.124	0.172
24	0	0	0	0	0

Source: FDOT n.d.

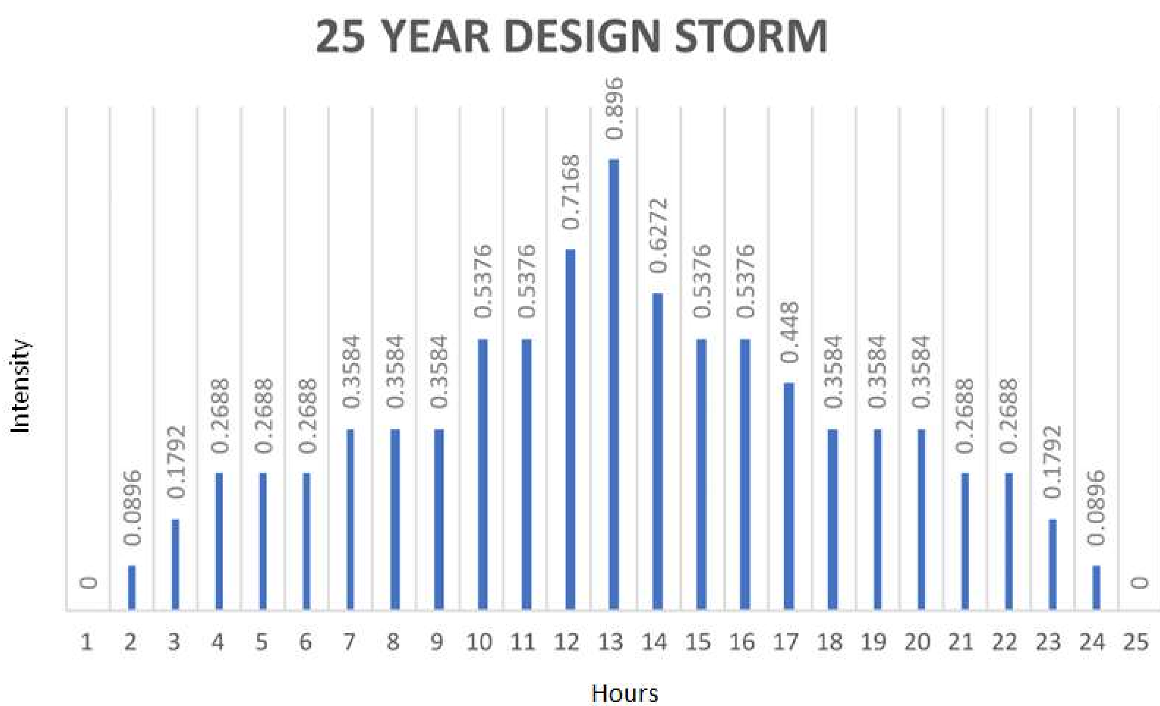


Figure 5-15. 25-year Design Storm Criteria for Palm Beach County

The infiltration method employed in this HEC-RAS model utilizes the Soil Conservation Service curve number method, designed to estimate direct runoff and infiltration rates from rainfall events. This approach is particularly suitable for varying soil conditions (Figure 5-16) and land use, offering a comprehensive understanding of how different terrains respond to precipitation.

The Soil Conservation Service curve number method is based on empirical data, correlating soil type, and land use to a curve number that represents the potential for runoff. This method simplifies the calculation of effective rainfall (precipitation that contributes to runoff) by considering the initial abstraction and potential maximum retention after runoff begins.

Manning's n roughness, a coefficient that represents the effect of surface roughness on flow resistance in open channel hydraulics, and percent impervious values were assigned to each USGS National Land Cover Database land cover category representing 2021 conditions (USGS 2023). Manning's n roughness ranges were taken from the HEC-RAS technical reference guide (USACE 2021).

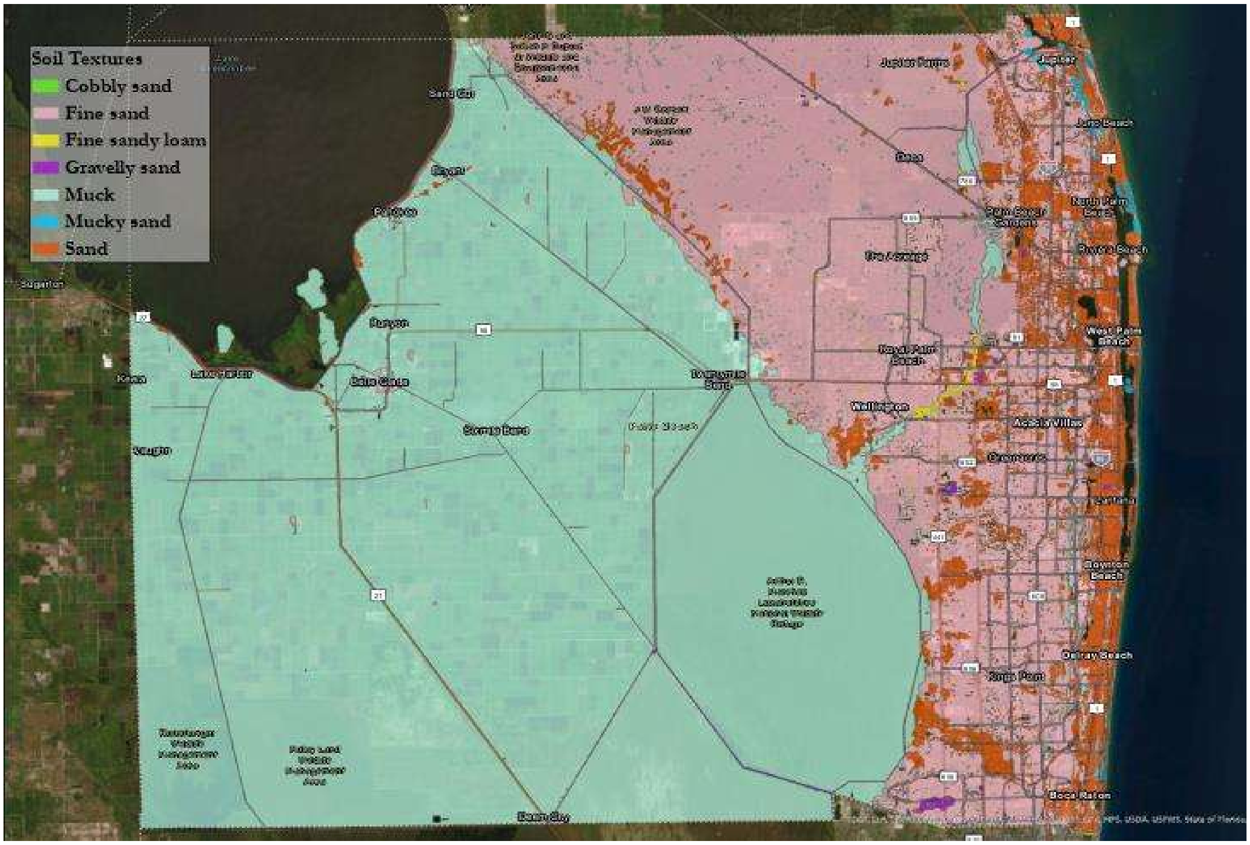


Figure 5-16. Palm Beach County Soil Texture Categories

Table 5-12 shows the land cover categories (Figure 5-17), Manning's n roughness (Table 5-12), percent impervious, and area within the modeled two-dimensional flow area.

Table 5-12. Land Cover Category Manning's N Roughness and Percent Impervious

ID	Name	Manning's n Range1/	Manning's n	Impervious %
31	Barren Land Rock-Sand-Clay	0.023-0.03	0.03	0
82	Cultivated Crops	0.02-0.05	0.05	0
24	Developed, High Intensity	0.12-0.20	0.15	80
22	Developed, Low Intensity	0.06-0.12	0.08	40
23	Developed, Medium Intensity	0.08-0.16	0.12	60
21	Developed, Open Space	0.03-0.05	0.035	0
95	Emergent Herbaceous Wetlands	0.05-0.085	0.07	75
42	Evergreen Forest	0.08-0.16	0.15	0
71	Grassland-Herbaceous	0.025-0.05	0.04	0
43	Mixed Forest	0.08-0.20	0.12	0
11	Open Water	0.025-0.05	0.035	100
81	Pasture-Hay	0.025-0.05	0.045	0
52	Shrub-Scrub	0.07-0.16	0.08	0
90	Woody Wetlands	0.045-0.15	0.10	50

1/ Ranges are from USACE Creating Land Cover, Manning's N Values, and % Impervious Layers (USACE 2021)

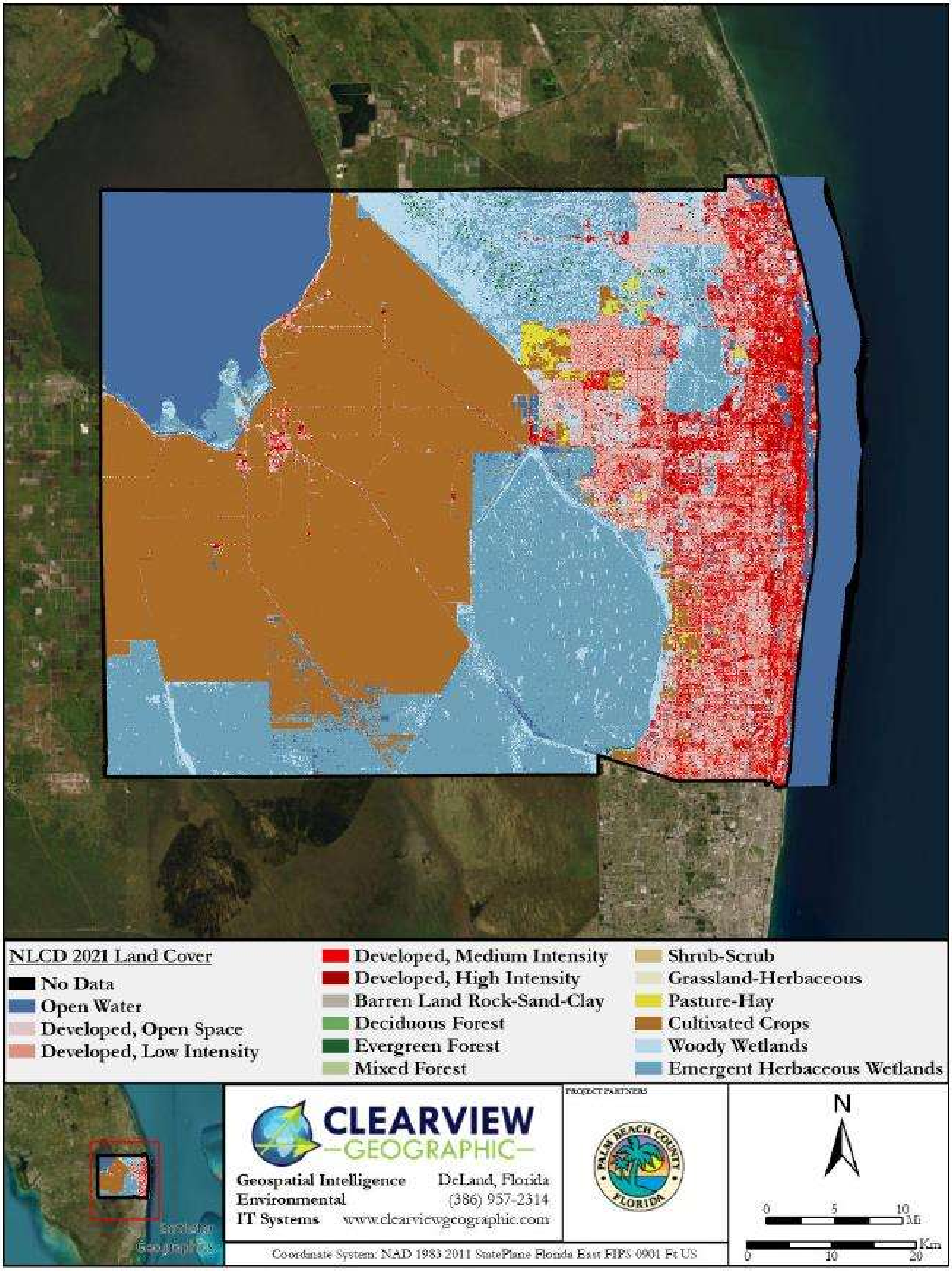


Figure 5-17. Palm Beach County Land Cover Categories

Table 5-13. Acre Area of Soil Textures

Soil Texture	Acres
Cobbly sand	2
Mucky sand	473
Fine sandy loam	1,635
Gravelly sand	6,605
Sand	78,714
Fine sand	388,423
Muck	770,315
Cobbly sand	2

The Gridded Soil Survey Geographic (gSSURGO) Database, provided by the U.S. Department of Agriculture-National Resource Conservation Service in 2023, provided the foundation for identifying both the soil texture and the Hydrologic Soil Groups (HSGs) of soils within the designated two-dimensional flow area. The gSSURGO soil map units reveal a diverse range of soil textures within the County.

A majority of the County's area is characterized by muck soils, as detailed in Table 5-13. Muck soils were described in the modeling as partially drained. Due to the shallow depth of their water table, muck soils have a limited ability to transmit water. Their high organic content places them in Group C or D, as they generally exhibit a lower infiltration rate and a greater capacity to retain water, which results in a higher potential for runoff (NRCS 2023).

Beyond muck, several other soil textures are present and warrant consideration:

- **Cobbly Sand:** This texture generally consists of sand mixed with larger, cobble-sized particles. It tends to have better drainage than finer sands due to the larger pore spaces between the cobbles. Cobbly sand is often placed in HSG A or B, reflecting its relatively high infiltration rates when not compacted.
- **Fine Sand:** Characterized by its fine particles, this soil texture offers high infiltration rates but can be prone to quick drying. Typically assigned to HSG A, fine sand areas may require careful water management to prevent rapid moisture loss, especially in arid conditions.
- **Fine Sandy Loam:** Fine sandy loam textures offer moderate drainage and are typically classified in HSG B. These soils balance water infiltration and retention, making them suitable for areas requiring a mix of drainage and moisture conservation, with a moderate runoff potential under typical conditions.
- **Gravelly Sand:** Gravelly sand textures are characterized by their excellent drainage and high permeability, often classified in HSG A. These soils are ideal for rapid water infiltration, significantly reducing the likelihood of surface runoff under normal conditions.
- **Mucky Sand:** Mucky sand textures have moderate drainage and are typically classified in HSG C or D due to their high organic content. These soils have a lower infiltration rate and higher water-holding capacity, leading to an increased potential for surface runoff under normal conditions.

- **Sand:** Simple sand textures are well-known for their excellent drainage and are commonly classified in HSG A. These soils are ideal for areas requiring rapid drainage and are less likely to support surface runoff under normal conditions.

These varied soil textures contribute to the hydrologic dynamics of the two-dimensional flow area. Understanding the distribution and characteristics of these soils helps in predicting water movement and managing flood risks effectively. The distinct properties of each soil type necessitate tailored approaches to land use planning, agricultural practices, and hydrological modeling to optimize water absorption, minimize erosion, and manage runoff.

These baseline depth grids are then adjusted by the SLR projection data based on NOAA's NIL and NIH projections for the respective timeframes and rainfall precipitation by the SFWMD's published change factors. These predict approximately 1.12 times more rain in 2040 than today (2024), 1.22 times more rain in 2070, and 1.34 times more rain in 2100. It should be noted that coastal communities are not required to include rainfall-induced flooding in their VAs per Section 380.093(3), F.S. However, non-coastal communities must perform a rainfall-induced flooding assessment. PBC has tidally connected and non-coastal areas, and the rainfall-induced flooding analysis is included to provide a comprehensive CVA over the entire area. Figure 5-18 through Figure 5-20 provide an overview showing which regions, infrastructure, and natural areas are at increased risk due to flooding because of extreme rainfall in the present day and under future conditions.

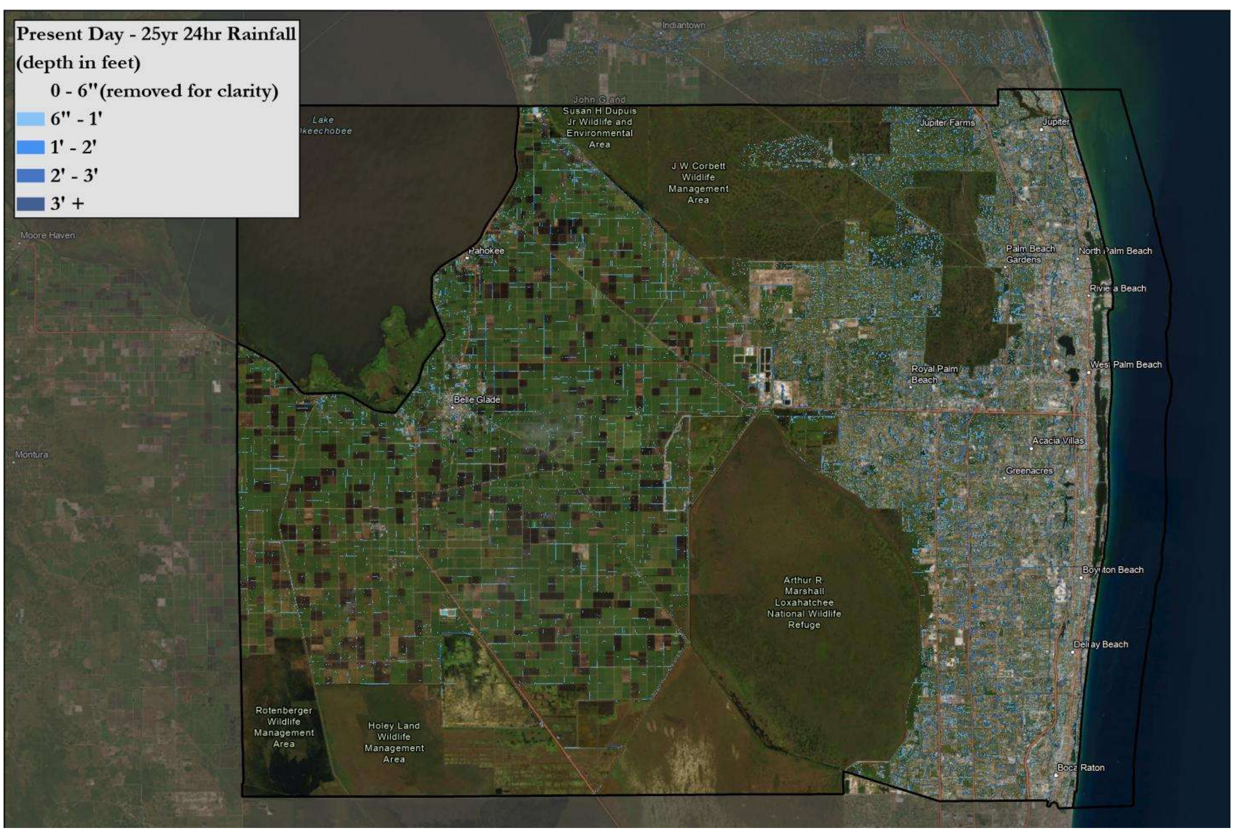


Figure 5-18. 25-Year 24 Hour Rainfall – Present Day

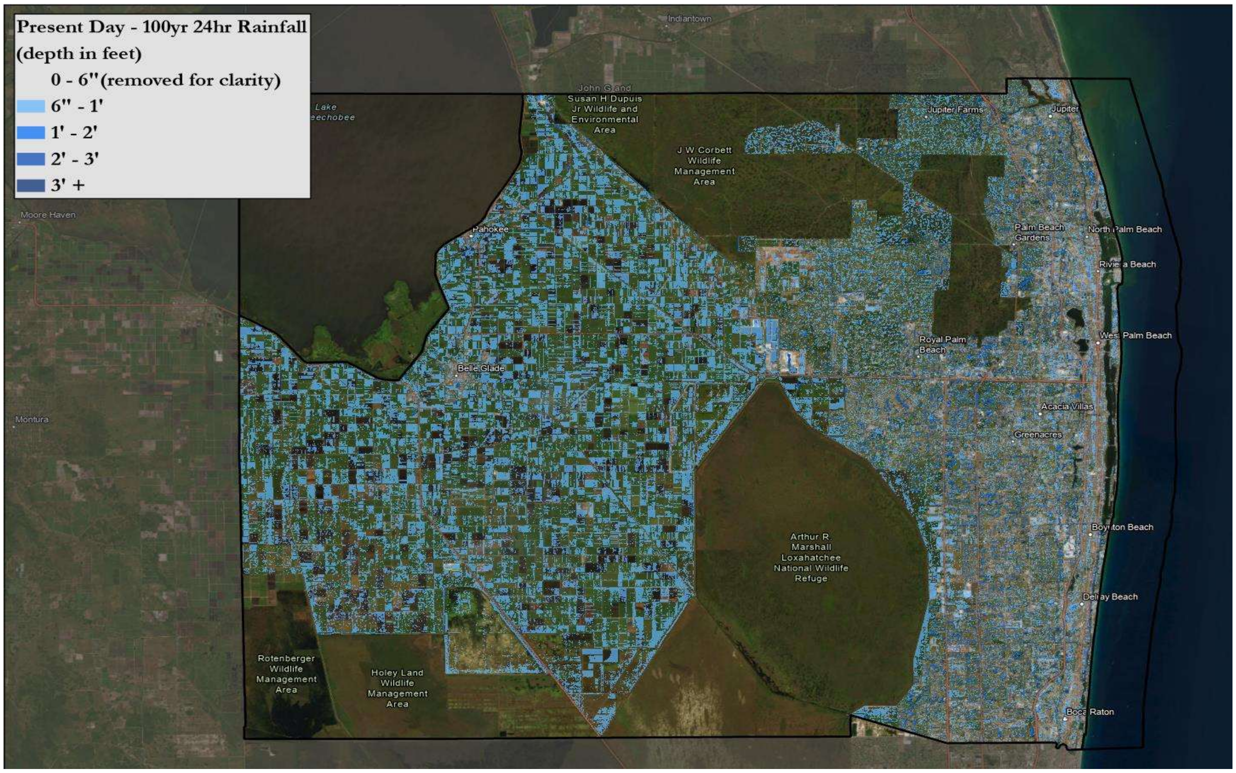


Figure 5-19. 100-Year 24 Hour Rainfall - Present Day

Figure 5-20. NIH 2070 SLR + 25-Year 24 Hour Rainfall

An in depth modeling approach was conducted for PBC's western communities due to variations between eastern and western County rainfall rates. Rainfall-induced flooding for the western municipalities was examined using the SFWMD standard rainfall distribution for four 24-hour events, one 72-hour event, and NOAA Atlas 14 precipitation. Future rainfall precipitation change factors were derived from the SFWMD and USGS and applied appropriately. A HEC-RAS (Hydrologic Engineering Center – River Analysis System) rain-on-grid modeling approach used 2023 PBC Light Detection and Ranging (LiDAR) elevation data. The HEC-RAS model was developed to estimate depth of ponding due to heavy rainfall events. It did not evaluate riverine flooding or account for Lake Okeechobee bathymetry, inflow, outflow, or operations. Culverts and other stormwater infrastructure were not included in the model.

The HEC-HMS (Hydrologic Engineering Center – Hydrologic Modeling System) model was used to develop the precipitation file for the HEC-RAS model. The HEC-HMS model was prepared to simulate nine design storms. Five design storms represent (2040) rainfall patterns: 500-, 100-, 50-, and 25-year return interval 24-hour rainfall events and the 100-year 72-hour rainfall event. Future (2070) rainfall depths were evaluated for the 100-, 50-, and 25-year return interval 24-hour design storm and the 100-year 72-hour design storm.

Rainfall depths representing each 24-hour and 72-hour hypothetical storm event were taken from NOAA Atlas 14 annual maximum series to represent 2023 rainfall patterns (NOAA 2023c). Zonal statistics were calculated for the 2D flow area from the Atlas 14 rasters and the mean rainfall depth was used. Future 2070 rainfall depths were computed using the current depths and the multiplier published in Technical Memorandum: Adoption of Future Extreme Rainfall Change Factors for Flood Resiliency Planning in South Florida (SFWMD 2022). Table 5-14 summarizes the data used for rainfall depths. Figure 5-21 through Figure 5-29 illustrate the current (2040) and future (2070) maximum 100-year 24-hour ponding depths within Belle Glade, Pahokee, and South Bay. Additionally, figures showing the difference in ponding depth between 2070 and 2040 rainfall estimates are also provided.

Table 5-14. Rainfall Depths for Hypothetical Storm Events in Western Palm Beach County

Hypothetical Storm Event	Current Atlas 14 Mean Rainfall Depth, inches[1/]	Change Factor[2/]	Future Computed Rainfall Depth, inches
500-year, 24-hour	14.8	—	—
100-year, 24-hour	10.9	1.21	13.2
100-year, 72-hour	12.3	1.20	14.8
50-year, 24-hour	9.4	1.20	11.3
25-year, 24-hour	8.0	1.17	9.4

For the purposes of this analysis, 24-hour rainfall volumes were selected to remain consistent with the Resilient Florida program guidance.

1/ NOAA, 2023c

2/ SFWMD 2022

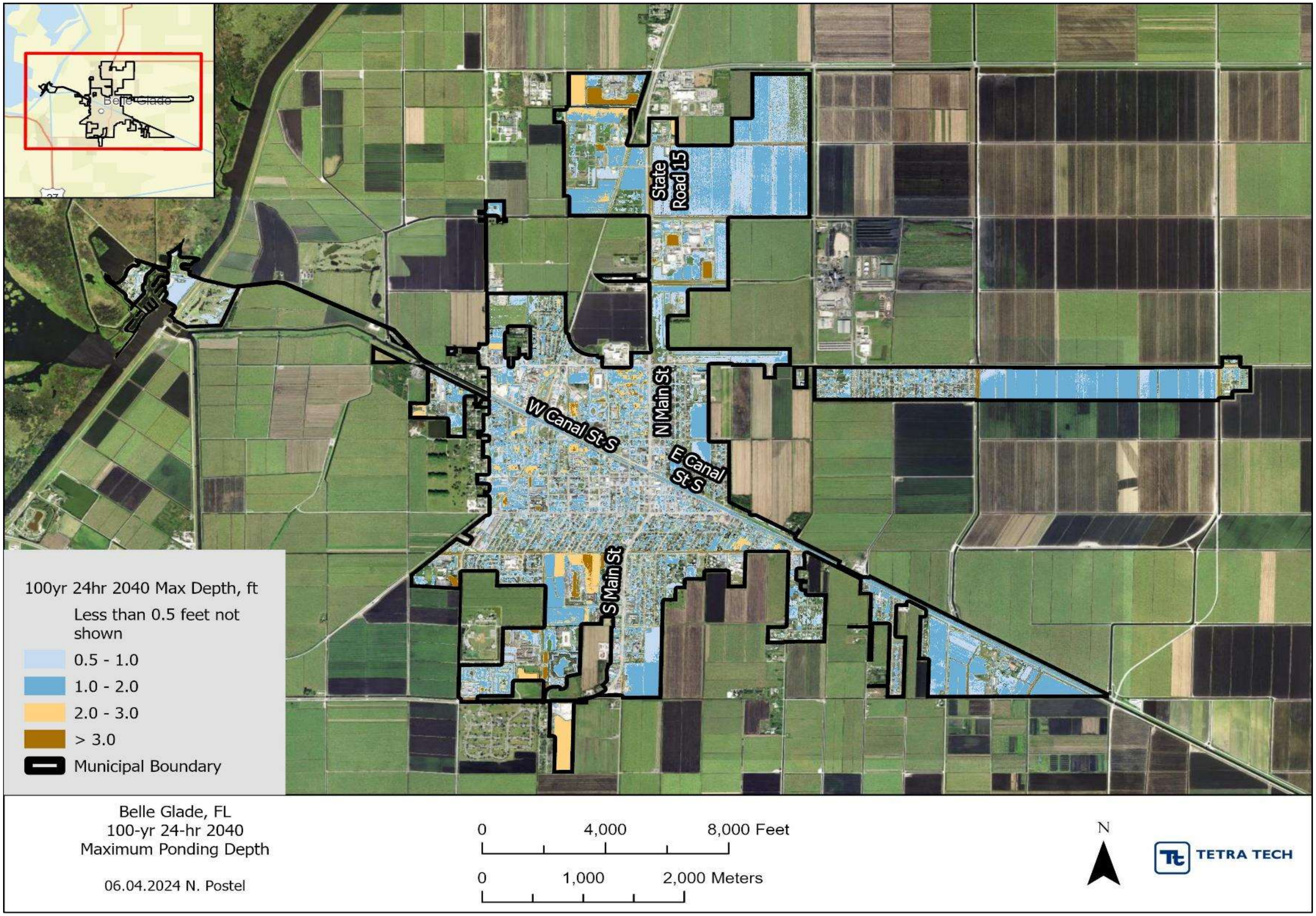


Figure 5-21. 100-Year 24-Hour 2040 Maximum Ponding Depth in Belle Glade, FL

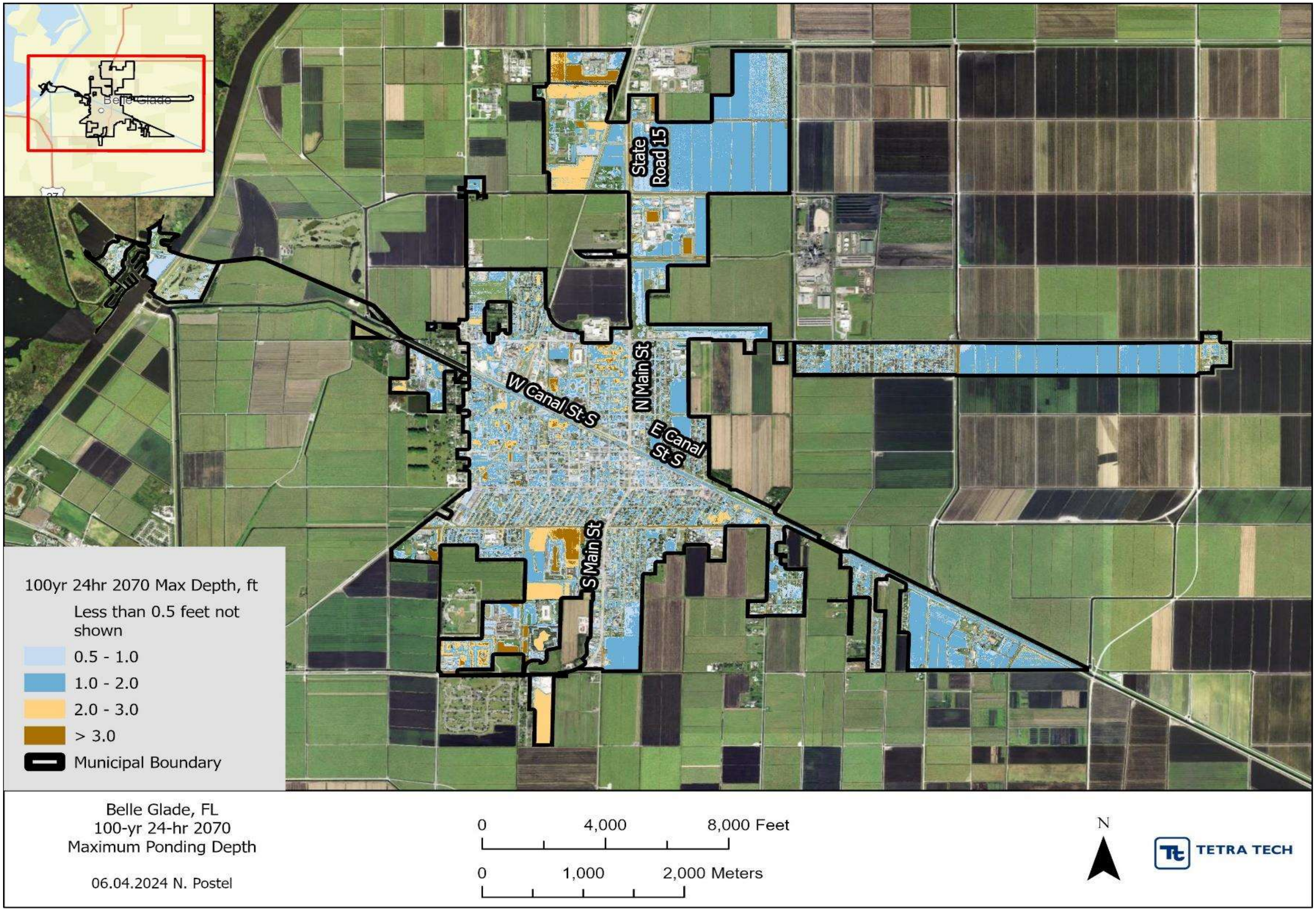


Figure 5-22. 100-Year 24-Hour 2070 Maximum Ponding Depth in Belle Glade, FL

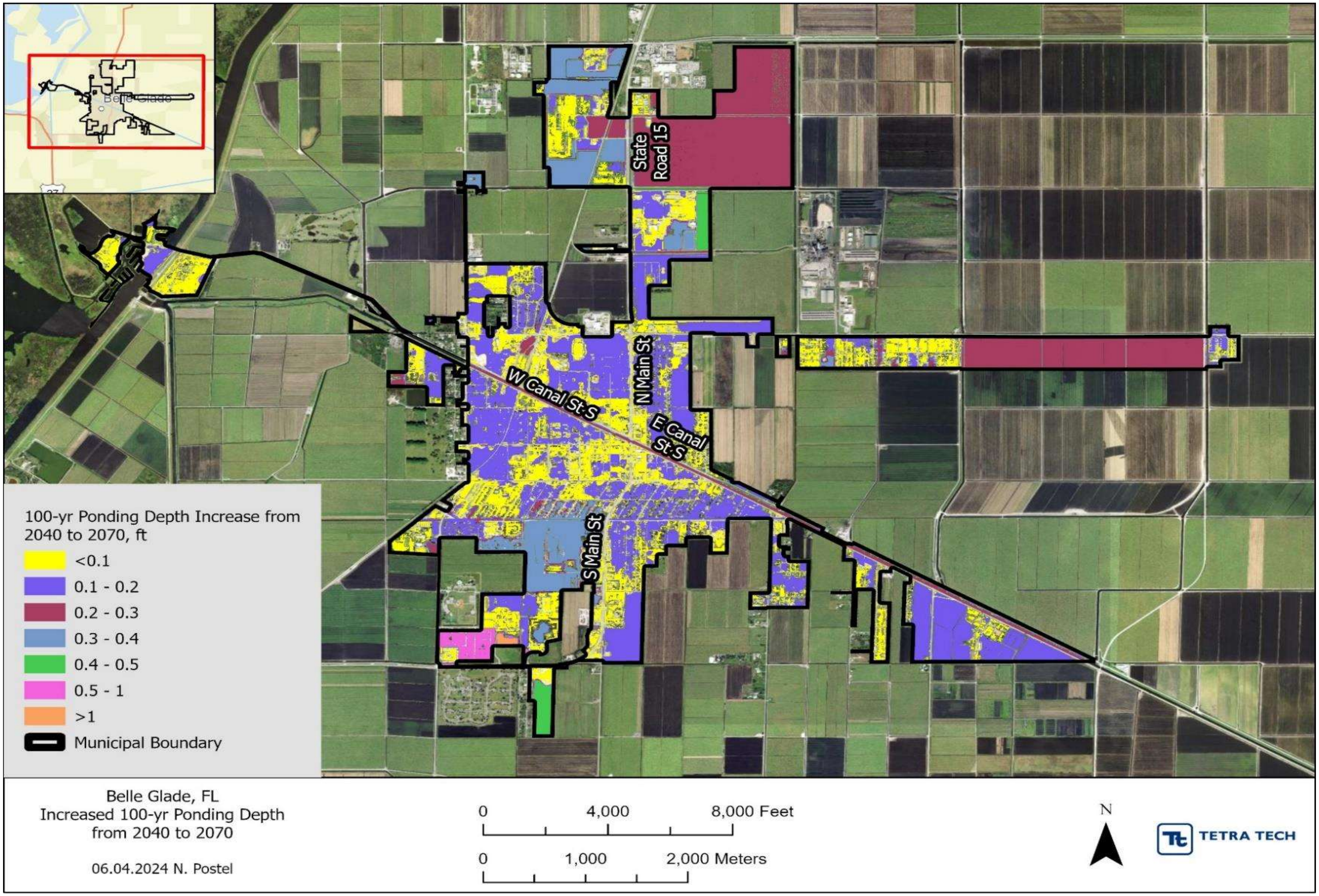


Figure 5-23. 100-Year 24-Hour Increased Ponding Depth from 2040 to 2070 in Belle Glade, FL

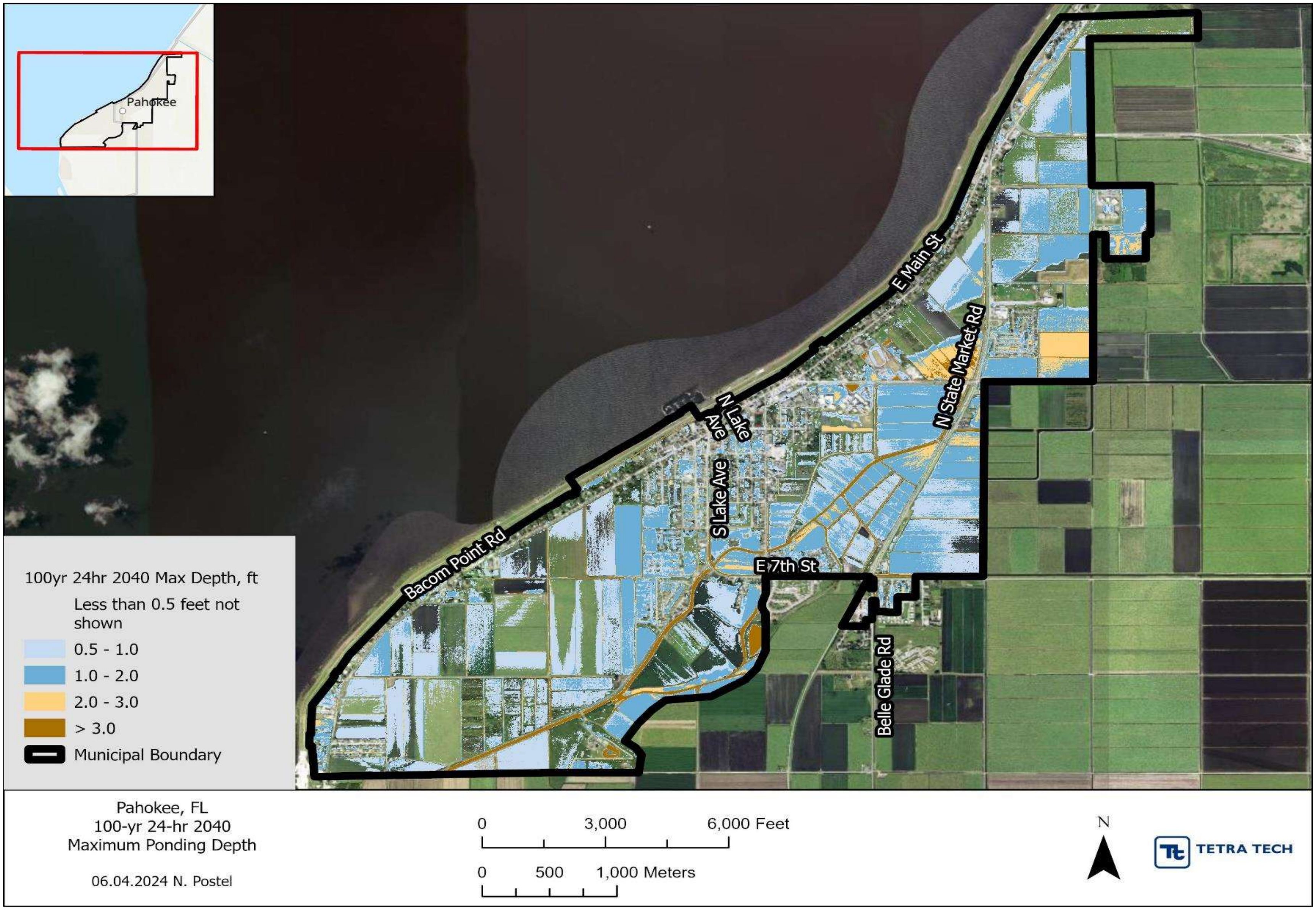


Figure 5-24. 100-Year 24-Hour 2040 Maximum Ponding Depth in Pahokee, FL

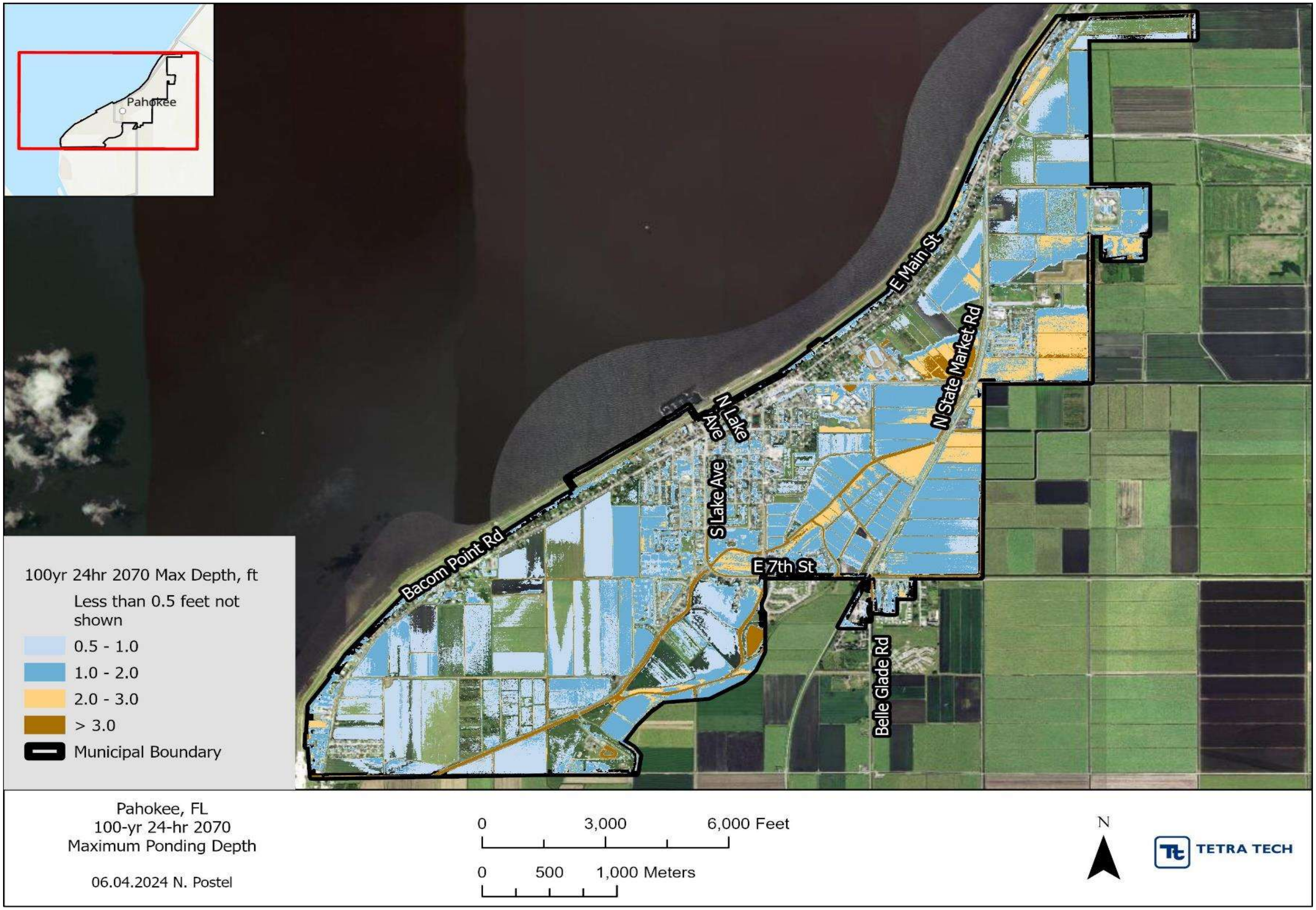


Figure 5-25. 100-Year 24-Hour 2070 Maximum Ponding Depth in Pahokee, FL

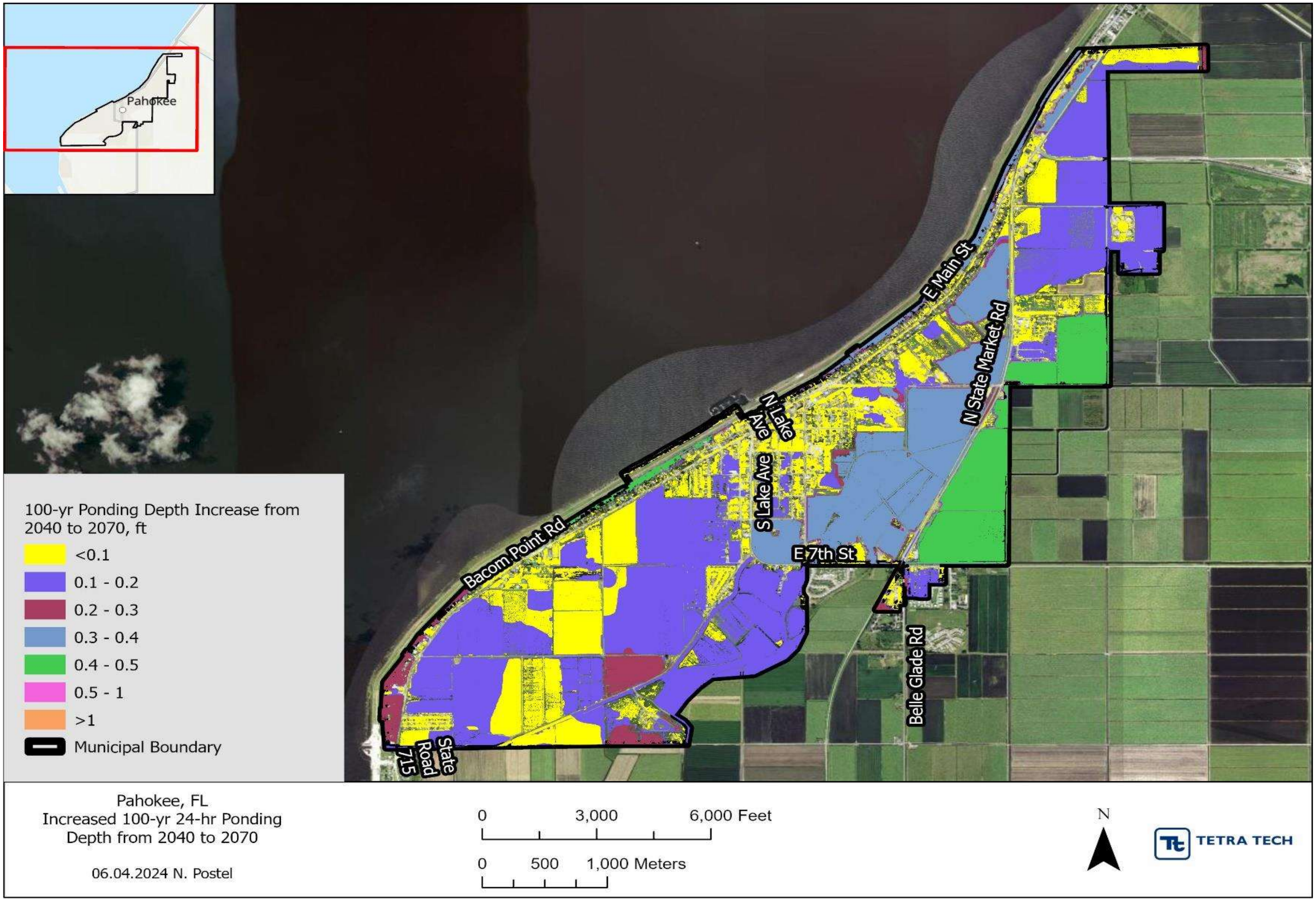


Figure 5-26. 100-Year 24-Hour Increased Ponding Depth from 2040 to 2070 in Pahokee, FL

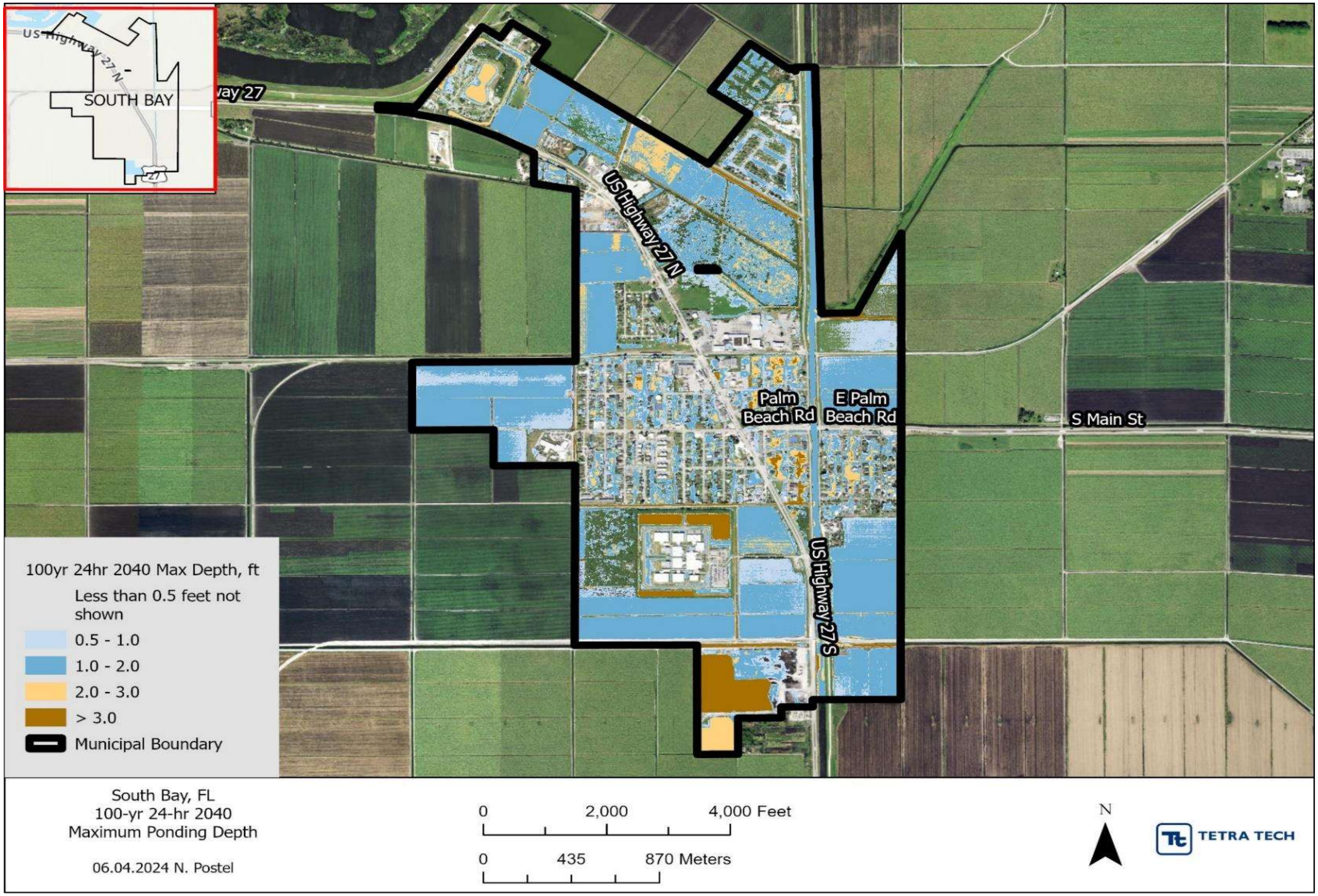


Figure 5-27. 100-Year 24-Hour 2040 Maximum Ponding Depth in South Bay, FL

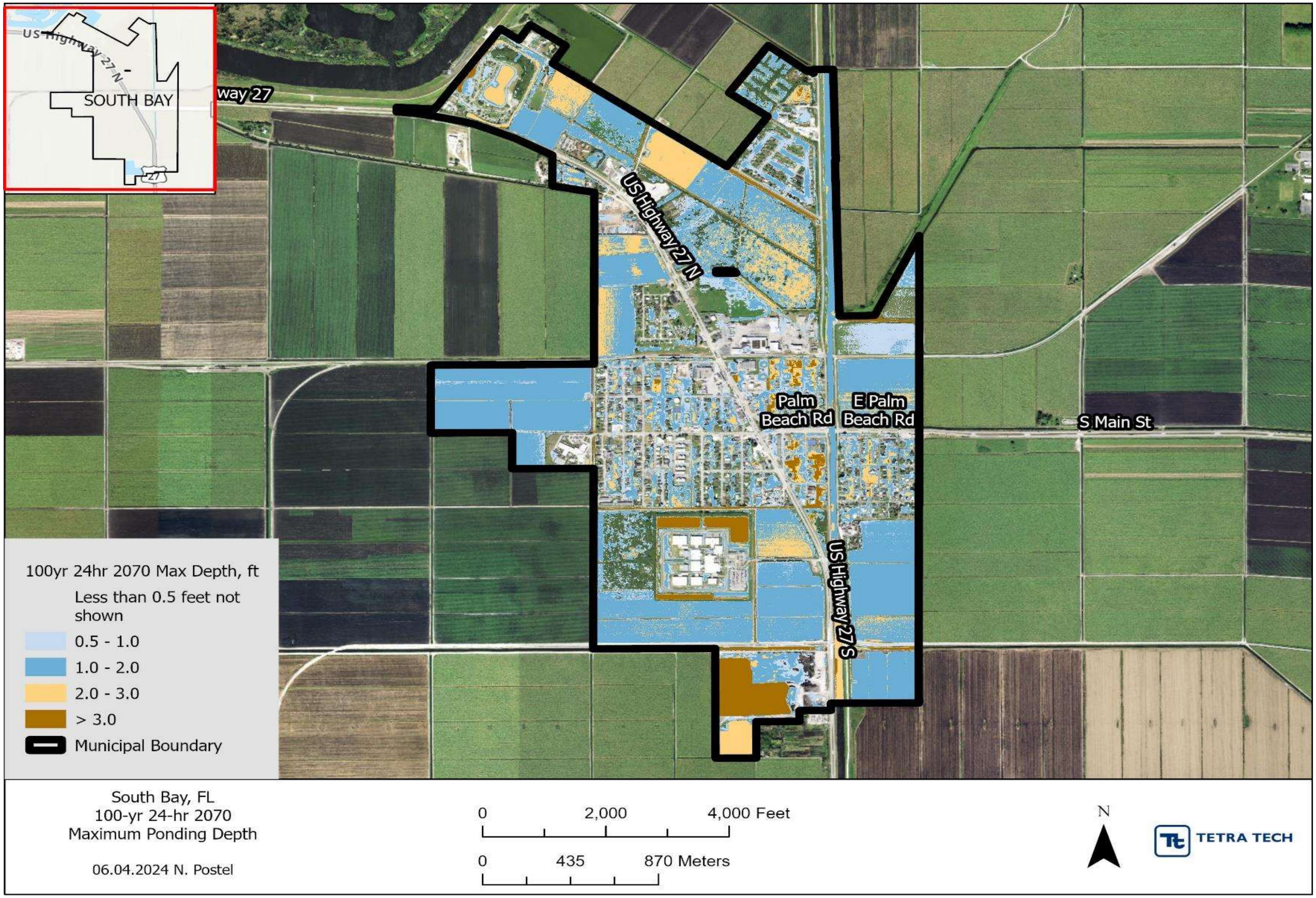


Figure 5-28. 100-Year 24-Hour 2070 Maximum Ponding Depth in South Bay, FL

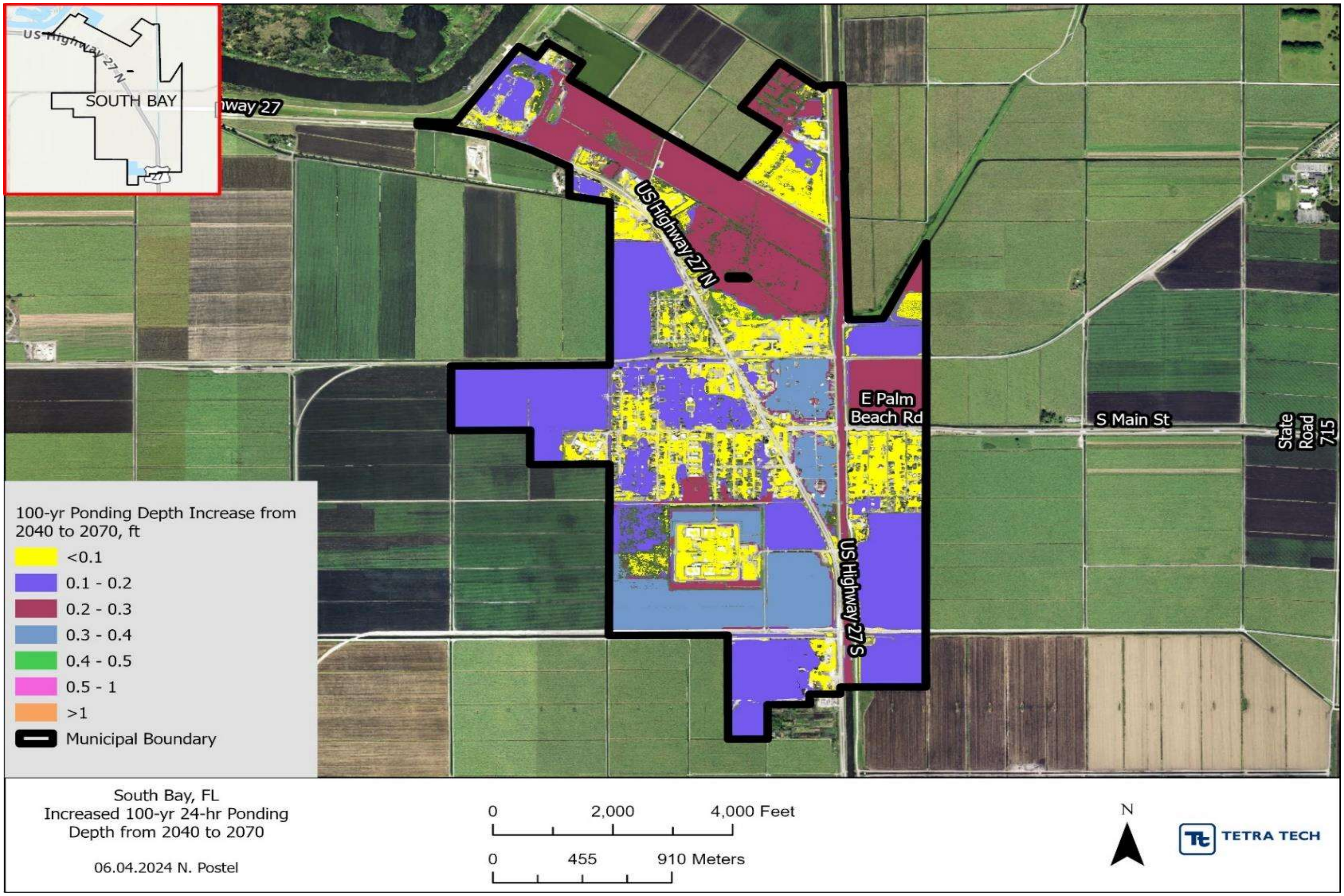


Figure 5-29. 100-Year 24-Hour Increased Ponding Depth from 2040 to 2070 in South Bay, FL

Inland flooding refers to flooding driven by rainfall that cannot be absorbed by the soil, transported by existing drainage systems or natural features. While PBC can experience rainfall anywhere, not all areas are equally vulnerable to inland flooding, due to variations in drainage capacities of physical and natural systems and existing waterbodies and streamflow patterns.

For the western community exposure analysis, areas are considered exposed to inland flooding if they are expected to experience maximum ponding depths of at least 1 inch during a rainfall event that has a 1-percent annual chance of occurring (i.e., 100-year event). The inland flood hazard applies only to Belle Glade, Pahokee, and South Bay. Areas are classified based on the depth of ponding the area can expect:

- Low refers to areas expected to experience between 1 and 6 inches of ponding.
- Moderate contains areas facing 6 to 18 inches of ponding.
- High areas are those expected to receive more than 18 inches of ponding.

Many areas in PBC have existing drainage capacity to handle up to 6 inches of rainfall. Therefore, areas that are considered Low (i.e., less than 6 inches of rainfall) may not experience inundation due to sufficient stormwater systems. In recognition of this, the inland flood exposure and sensitivity results focus on impacts to and changes in areas classified as Moderate or High exposure. Exposure is evaluated for present conditions (applicable to 2040) and for 2070.

As shown in Table 5-15, approximately half of the land area in Belle Glade, Pahokee, and South Bay is currently expected to experience at least 6 inches of ponding. By 2070, these figures will grow to over 60 percent in Pahokee and South Bay and to 80 percent in Belle Glade. Overall, Belle Glade is expected to experience the greatest increase in land area exposed to ponding depths greater than 6 inches, with 5 percent.

Table 5-15. Land Exposure to Inland Flooding in Palm Beach County

Jurisdiction	Total Land Area (acres)	Present (and 2040) Area Exposed (acres)			2070 Area Exposed (acres)			Moderate and High % Change
		Low	Moderate	High	Low	Moderate	High	
Belle Glade	917	683	1,584	564	646	1,502	829	5%
Pahokee	3,194	722	1,177	410	581	1,223	602	4%
South Bay	1,383	169	430	262	162	363	371	4%

As shown in Table 5-16, over 40 percent of Belle Glade's population is exposed to Moderate and High inland flooding. By 2070, the number of people exposed will be 45 percent. In South Bay, more than half of residents are currently exposed, and this figure will be 54 percent by 2070. Pahokee is expected to experience the largest increase of the municipalities studied. Currently, just over 50 percent of residents are exposed to Moderate and High inland flooding, but by 2070, nearly 60 percent will be, an increase to 65 percent.

Table 5-16. Population Exposure to Inland Flood in Palm Beach County

Jurisdiction	Present (and 2040) Population Low	Present (and 2040) Population Moderate	Present (and 2040) Population High	Present (and 2040) Moderate/ High % of Total	2070 Population Low	2070 Population Moderate	2070 Population High	2070 Moderate/ High % of Total	Moderate/ High % Change
Belle Glade	2,133	2,973	1,375	41%	2,197	3,111	1,741	45%	7%
Pahokee	795	1,313	365	50%	642	1,358	579	58%	4%
South Bay	148	390	224	51%	145	318	329	54%	4%

As shown in Table 5-17, between now and 2070, the share of asset sites in Belle Glade exposed to inland flooding will increase by 7 percentage points. In particular, the number of critical community and emergency facilities is expected to increase by nearly 10 additional assets. In Pahokee, approximately 2 out of every 10 assets is exposed; by 2070, it will grow to 1 in 4. Of studied municipalities, South Bay has the fewest exposed, but the largest increase by 2070. Under present conditions, about 3 percent of assets are exposed to inland flooding, whereas by 2070, nearly 30 percent will be exposed.

Table 5-17. Asset Sites Moderate and High Exposure to Inland Flooding in Palm Beach County

Jurisdiction	Present (and 2040) Number of Assets: Critical Community and Emergency Facilities	Critical Infrastructure	Natural, Cultural, and Historic Resources	Transportation Assets	% of Total	2070 Number of Assets: Critical Community and Emergency Facilities	Critical Infrastructure	Natural, Cultural, and Historic Resources	Transportation Assets	% of Total
Belle Glade	7	6	7	0	13%	9	7	7	0	15%
Pahokee	5	1	0	0	4%	6	1	0	0	5%
South Bay	1	3	3	0	13%	2	3	4	0	17%

As shown in Table 5-18, less than 1 mile of transportation assets is exposed in Belle Glade, Pahokee, and South Bay under current scenarios; both Pahokee and South Bay have less than 1 mile exposed in future scenarios, and Belle Glade will have approximately 1 mile. Belle Glade contains the most critical infrastructure miles exposed for present and 2070 scenarios. Between now and 2070, asset miles exposed to inland flooding in Belle Glade will grow from 46 to 51 percent. In Pahokee, that figure will increase modestly from 32 to 35 percent; and in South Bay, from 35 to 38 percent.

Table 5-18. Asset Miles Moderate and High Exposure to Inland Flooding in Palm Beach County

Jurisdiction	Present (and 2040)			2070		
	Exposed Assets (miles)		% of Total	Exposed Assets (miles)		% of Total
	Critical Infrastructure	Transportation		Critical Infrastructure	Transportation	
Belle Glade	77	<1	46%	84	1	51%
Pahokee	23	<1	32%	25	<1	35%
South Bay	14	<1	35%	15	<1	38%

Exposure: Compound Modeling

The compound modeling within the CVA focuses on assessing the combined impacts of various flooding scenarios (see results within Table 5-19 and Figure 5-30). Modeling efforts combine HTF, storm surge, and rainfall-induced flooding. The methodology involves overlaying depth grids from each scenario to identify the aggregate flood heights. Exposure to compound flooding modeling is designed to provide a comprehensive understanding of the potential cumulative impacts of different flooding events occurring simultaneously, aiding in effective planning and mitigation strategies. It is important to note that the influence of fluvial (riverine floods from Lake Okeechobee) or groundwater floods (infiltration and inflow) is excluded from this study. This modeling does not simulate the hydrologic interactions between these events or the stormwater management system's effect on flooded conditions. In circumstances where this more precise information is required, complex engineering-based models should be considered.

SLR inundation modifies the "coastline" with a net landward movement of that tidal interface boundary. Stormwater drains may lose their functionality as sea level rises and be unable to drain water that accumulates during rains storms. Storm surge impacts are large but temporary in nature, caused by the force of storm pushing water onto the terrain. The devastation caused by storm surge is typically a combination of extreme, transient flooding and the power of extreme water currents pushing the water inland. When two or more of these events coincide, which is occurring with increasing frequency, the results can be devastating.

Table 5-19. NOAA Intermediate Low and High Compound Flood Scenario Water Rise Impacts

Sea Level Rise Scenario	Surge Scenario	Rainfall Scenario	Combined Water Rise (ft)
NIL Present Day	100 Year	25 Year 24 Hour	8.49
NIL Present Day	100 Year	100 Year 24 Hour	8.81
NIL Present Day	500 Year	25 Year 24 Hour	10.16
NIL Present Day	500 Year	100 Year 24 Hour	10.36
NIH Present Day	100 Year	25 Year 24 Hour	8.78
NIH Present Day	100 Year	100 Year 24 Hour	9.10
NIH Present Day	500 Year	25 Year 24 Hour	10.33
NIH Present Day	500 Year	100 Year 24 Hour	10.65
NIL 2040	100 Year	25 Year 24 Hour	9.96
NIL 2040	100 Year	100 Year 24 Hour	10.37
NIL 2040	500 Year	25 Year 24 Hour	10.42

Sea Level Rise Scenario	Surge Scenario	Rainfall Scenario	Combined Water Rise (ft)
NIL 2040	500 Year	100 Year 24 Hour	10.83
NIH 2040	100 Year	25 Year 24 Hour	11.40
NIH 2040	100 Year	100 Year 24 Hour	11.81
NIH 2040	500 Year	25 Year 24 Hour	13.04
NIH 2040	500 Year	100 Year 24 Hour	13.45
NIL 2070	100 Year	25 Year 24 Hour	11.08
NIL 2070	100 Year	100 Year 24 Hour	11.49
NIL 2070	500 Year	25 Year 24 Hour	12.68
NIL 2070	500 Year	100 Year 24 Hour	13.13
NIH 2070	100 Year	25 Year 24 Hour	15.14
NIH 2070	100 Year	100 Year 24 Hour	15.55
NIH 2070	500 Year	25 Year 24 Hour	17.21
NIH 2070	500 Year	100 Year 24 Hour	17.62
NIL 2100	100 Year	25 Year 24 Hour	12.12
NIL 2100	100 Year	100 Year 24 Hour	12.53
NIL 2100	500 Year	25 Year 24 Hour	13.80
NIL 2100	500 Year	100 Year 24 Hour	14.21
NIH 2100	100 Year	25 Year 24 Hour	20.57
NIH 2100	100 Year	100 Year 24 Hour	20.99
NIH 2100	500 Year	25 Year 24 Hour	23.23
NIH 2100	500 Year	100 Year 24 Hour	23.64

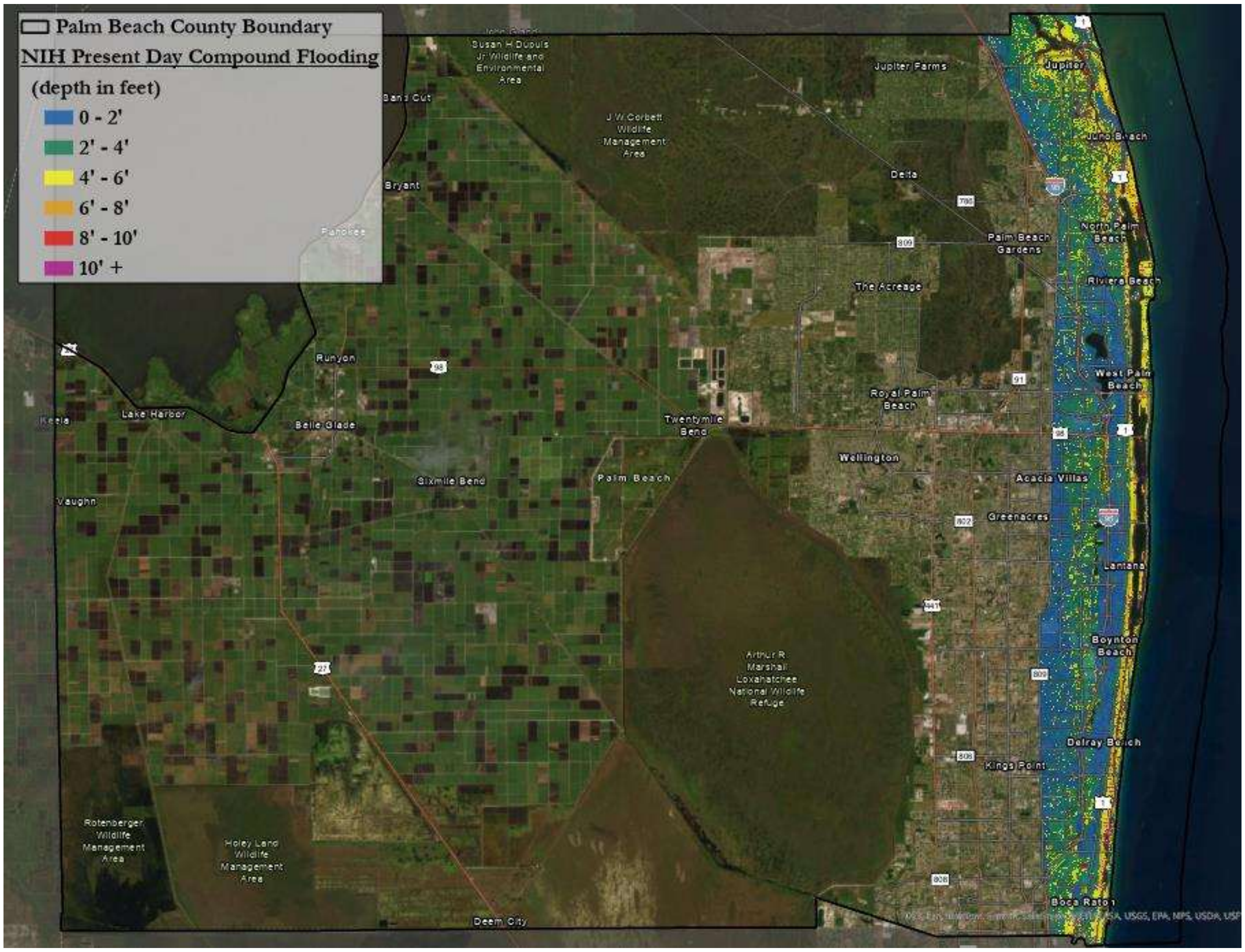
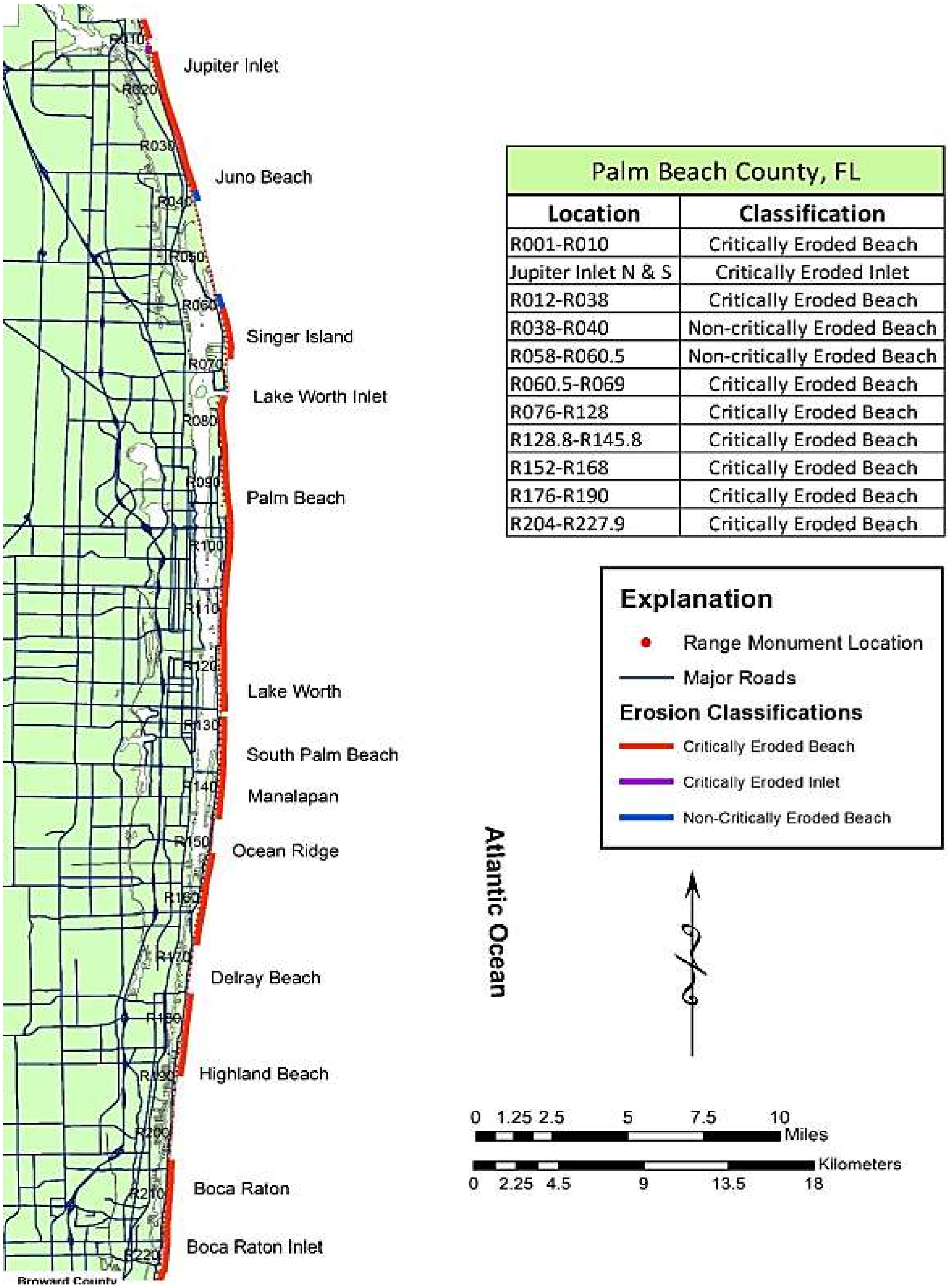


Figure 5-30. Present Day SLR + 100-Year Storm Surge + 25-Year Rainfall

Exposure: Coastal Erosion

Coastal erosion occurs when wind or waves are strong enough to physically move sediment and sand to and from sites. PBC's CVA for coastal erosion assesses exposure only for land areas that are located along the Atlantic Ocean. Affected areas were localized along the County's shoreline, and associated maps (Figure 5-31 and Figure 5-32) provide enlarged representations of these areas to better visualize results. The analyses evaluated potential erosion rates on regularly spaced locations. In Figure 5-32, the estimated erosion by the year 2040 is displayed in orange and the estimate of erosion by 2070 in shown in yellow. Actual erosion will be continuous and irregular.

Present-day exposure to coastal erosion was initially determined by identifying Coastal Critical Erosion Areas as defined by FDEP staff engineers who evaluate coastlines and erosion severity. The purpose of these areas is to document areas of likely increase and identify areas of the greatest need. In PBC, FDEP identified 11 Coastal Critical Erosion Areas, as shown in Figure 5-31. Cumulatively, these areas represent 35.3 miles of coastline, or approximately 75 percent of the County's coast (FDEP 2023). Many of these areas contain private development and recreational interests in PBC, which could be susceptible to damage due to erosion. Some areas have existing beach replenishment and protective structures that can help mitigate erosion rate. Coastlines with such projects include areas in Jupiter Inlet, (R001-R010), the Towns of Jupiter and Juno Beach (R13-R38), Riviera Beach (R61-R67), the Town of Palm Beach (R076-R128, R128.8-R145.8), the Town of Ocean Ridge (R152-R159), South Lake Worth Inlet (R152-168), Delray Beach (R176-R190), and the City of Boca Raton (R204-R227.9) (FDEP 2023).



Palm Beach County, FL	
Location	**Classification**
R001-R010	Critically Eroded Beach
Jupiter Inlet N & S	Critically Eroded Inlet
R012-R038	Critically Eroded Beach
R038-R040	Non-critically Eroded Beach
R058-R060.5	Non-critically Eroded Beach
R060.5-R069	Critically Eroded Beach
R076-R128	Critically Eroded Beach
R128.8-R145.8	Critically Eroded Beach
R152-R168	Critically Eroded Beach
R176-R190	Critically Eroded Beach
R204-R227.9	Critically Eroded Beach

Source: FDEP 2023

Figure 5-31. Critically Eroded Shorelines in Palm Beach County

Figure 5-32. Coastal Erosion Exposure near Jupiter, Palm Beach County

To estimate future exposure, the coastal erosion assessment used USGS National Shoreline Change short-term linear regression rates for Florida. The USGS rates indicate observed changes in the shoreline position, in meters, between the 1970s and 2018, including accretion. The coastal erosion assessment applied these rates to Coastal Critical Erosion Areas (excluding areas exhibiting accretion) to estimate areas affected by coastal erosion for 2040 and 2070. The coastal erosion modeling approach assumes a constant rate, without the impact from severe coastal storms or development of protective structures that could influence erosion patterns and rates. Based on these limitations, the data and maps associated with the coastal erosion hazard should be used as a reference and for planning purposes only.

None of the focus areas (i.e., Belle Glade, Pahokee, and South Bay) contain coastal areas, so these areas are considered not exposed to coastal erosion. As summarized in Table 5-20, areas expected to face additional exposure to erosion are concentrated around the Palm Beach barrier islands and along the shores of Jupiter. In unincorporated areas alone, the number of acres exposed to erosion will grow by 2 acres by 2040 and an additional 14 acres by 2070. Throughout the County, 5 additional acres will be exposed to erosion by 2040. By 2070, an additional 45 acres are expected to be exposed to erosion.

Table 5-20. 2040 and 2070 Change in Land Exposure to Coastal Erosion in Palm Beach County

	Jurisdiction	Change in Area Exposed (acres)	
		2040	2070
Focus Areas	Belle Glade	0.0	0.0
	Pahokee	0.0	0.0
	South Bay	0.0	0.0
Other Affected Areas	Unincorporated Areas	2.4	14.4
	Manalapan	1.0	9.6
	Palm Beach	0.6	8.0
	Jupiter	0.9	4.7
	Tequesta	0.4	2.9

The exposure analysis for coastal erosion evaluated population and assets, but due to the limited geographic extent of the Coastal Critical Erosion Areas and shoreline data, no assets are considered exposed under either the 2040 scenario or the 2070 scenario and less than 0.1 percent of all residents in the County are considered exposed. As previously noted, the predicted risk does not include the risk from severe storms. Figure 5-32 and Figure 5-33 display two areas exhibiting higher exposure compared to the rest of the County: Jupiter and Manalapan. It is important to note that the projected areas of erosion displayed in Figure 5-32 and Figure 5-33 are modeled projections and should be interpreted as potential outcomes without the implementation of mitigation strategies. Actual conditions may vary based on current and future protective measures as well as environmental factors.

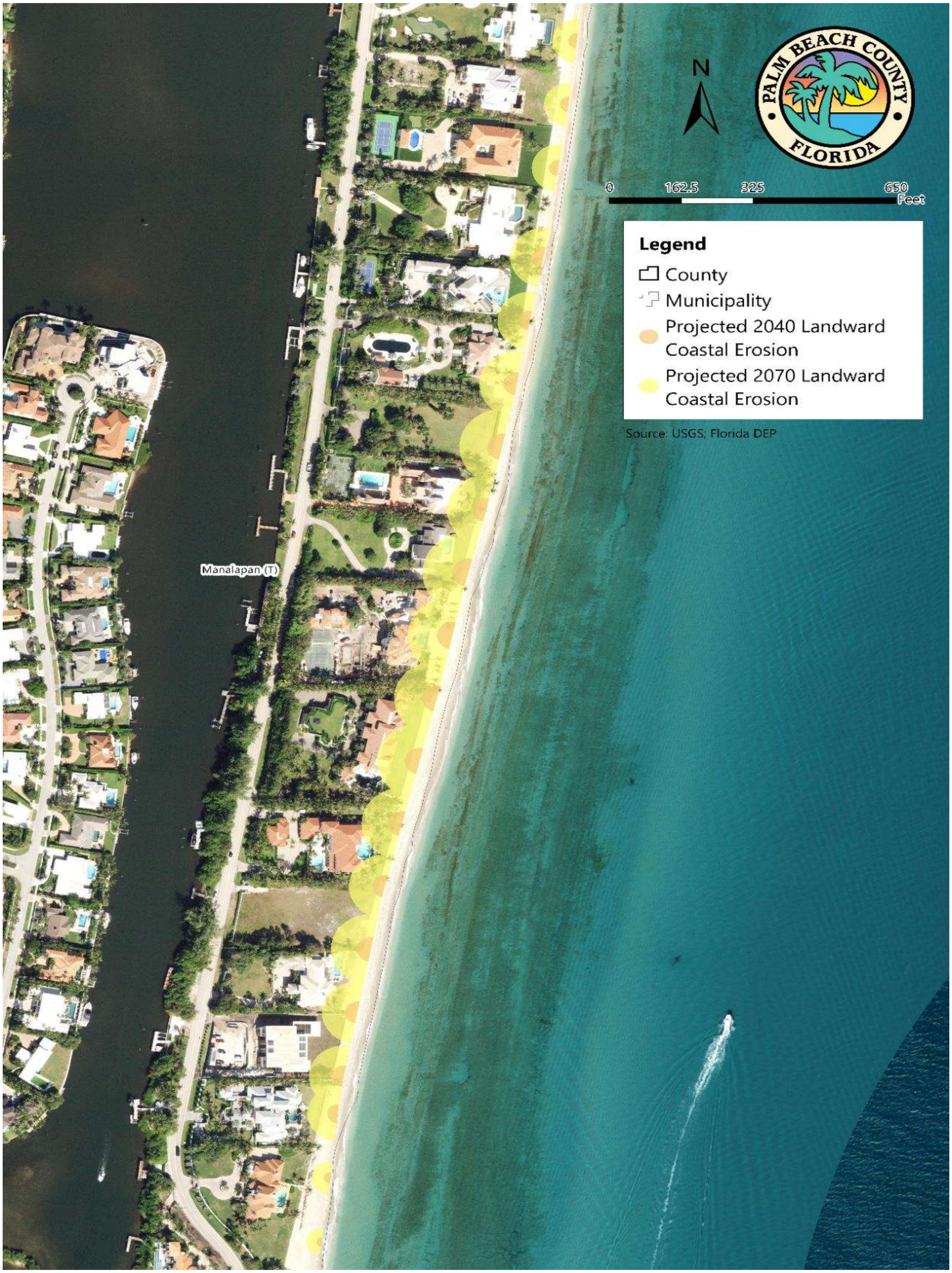


Figure 5-33. Coastal Erosion Exposure near Manalapan, Palm Beach County

Exposure: Drought

Like most of Florida, PBC has a climate that is more humid and wetter than the rest of the country. Historically, the County has received an average of 50 to 60 inches of rain every year (Palm Beach County 2024). Geographically, coastal areas of the County tend to receive more precipitation than the central and western regions, which can be partially attributed to coastal storms (SFWMD 2021). How much precipitation the region receives can depend on reoccurring continental climate patterns, such as El Niño tropical storm activity and cold fronts. Seasonally, PBC receives the most precipitation between June and September (see Figure 5-34).

Source: NOAA National Centers for Environmental Information 2023

Figure 5-34. Average Monthly Precipitation at West Palm Beach International Airport Weather Station in Palm Beach County (1991-2020)

PBC regularly experiences dry days and periods. Between 1961 and 1990, the County saw an annual average of 169 days with precipitation less than 0.01 inch, also called "dry days" (NOAA 2023b). During periods of drought, that number can be much higher.

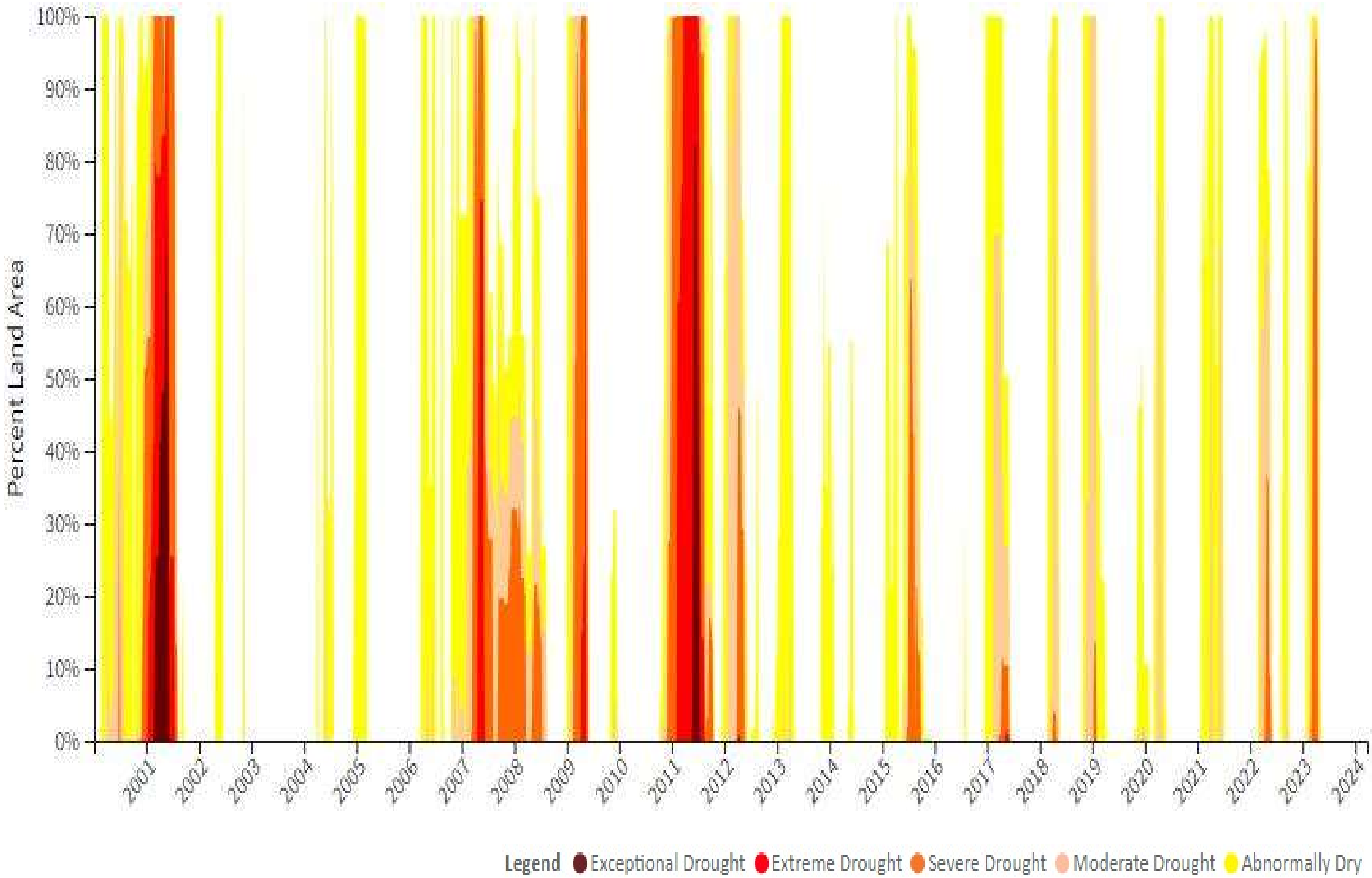
For instance, in 2000, PBC recorded 190 dry days when Florida was experiencing one of its most severe droughts at that time. The 2000 to 2001 drought resulted in an approximate 17-inch rainfall deficit over Lake Okeechobee, one of the County's primary water sources. During that time, water levels in Lake Okeechobee dropped by nearly 9 feet, hitting the lowest water level yet recorded (roughly 9 feet, National Geodetic Vertical Datum [NGVD]) (SFWMD 2002). At the drought's peak, more than 70 percent of PBC's land area recorded significantly drier soils and less water availability in streams and lakes than seasonal averages, as shown by the "Exceptional Drought" classification in Figure 5-35. The 2000 to 2001 drought produced conditions that have a one-percent annual chance of occurring, equating it to a "100-year drought." Table 5-21 lists other significant historical droughts that have affected the County.

Table 5-21. Historical Drought Event Summaries

Drought Event	Approximate Rainfall Deficit in SFWMD	Lake Okeechobee Water Level Decrease
1980 to 1982[a]	20 inches	7.7 feet NGVD
1988 to 1989[a]	21 inches	4.9 feet NGVD
1990[a]	9 inches	1.8 feet NGVD
2000 to 2001[b]	17 inches[1/]	7.5 feet NGVD
2006 to 2007[c]	12 inches	4.6 feet NGVD

Drought Event	Approximate Rainfall Deficit in SFWMD	Lake Okeechobee Water Level Decrease
2011[d]	14 inches	3 feet NGVD

Sources: a. Palm Beach County 2024; b. SFWMD 2002; c. SFWMD 2008; d. SFWMD 2011
1/ The 2000 to 2001 rainfall deficit shown represents the rainfall deficit for only the Lake Okeechobee rain area within SFWMD.



Source: NOAA 2024

Figure 5-35. Palm Beach County Drought Conditions (2000-2023)

Droughts generally affect broad regions with drier than normal conditions. For the drought assessment, it is assumed the entire County is equally exposed to drought. The impacts of drought can be difficult to measure because it affects many different elements of the economy and PBC receives water supply from Lake Okeechobee. For instance, public water supply utilities have lost revenue because they pumped less water or resorted to alternative water sources that had higher production costs (SFWMD 2002). Industries that rely on ecological health—such as agriculture, landscaping, recreation, and tourism—have experienced significant, but unquantified, financial impacts. For instance, the SFWMD, the agency charged with managing the County's water resources, spent nearly $10 million in unbudgeted funds on drought-related expenditures in response to the 2000 to 2001 drought (SFWMD 2002).

Exposure: Extreme Heat

All PBC is exposed to extreme heat, but certain topographies and development patterns increase the likelihood of urban heat islands. An urban heat island is an urbanized area, such as those with more buildings and impervious surfaces that experiences higher temperatures than less developed areas with more vegetation. These highly developed areas effectively become isolated areas (i.e., "islands") of temperatures that are several degrees hotter than other areas.

As maximum and minimum temperatures rise, so does the possibility of extreme heat events and urban heat islands. By 2040 and 2070, these patterns in PBC are expected to intensify due to climate change. As shown in Table 5-22, the County has historically experienced a handful of days each year in which maximum temperatures exceed 95°F. By 2040, PBC is expected to experience 5 to 7 weeks of days exceeding this threshold; by 2070, it could experience 9 to 16 weeks of days exceeding 95°F. These days likely will not be experienced consecutively, but combined with rising average minimum temperatures, this increase elevates the potential chance for extreme heat events and urban heat islands to form.

To evaluate exposure to extreme heat, the heat assessment identified areas in the County that have historically experienced urban heat island effects. Using the Trust for Public Land's Urban Heat Island Severity Index, the extreme heat assessment categorized exposure from low to high based on the heat anomaly, meaning, the difference between recorded temperature at a specific location (i.e., a 30-square-meter [323-square-foot] area) and the mean temperature for its encompassing municipality or region. Areas that recorded temperatures equal to or below the mean temperature are considered not exposed to extreme heat. Exposed areas are ranked from low to high exposure to represent smaller to higher anomalies between localized and regional recorded temperatures.

The distribution of these areas around the County is shown in Figure 5-36. The sum of these areas approximates the total land area exposed to extreme heat in PBC.

Table 5-22. Average Annual Days with Maximum Temperature Greater than 95°F in Palm Beach County

	Decade	Average Number of Days per Year
Observed	1950	1.65
	1960	1.01
	1970	0.42
	1980	4.11

	Decade	Average Number of Days per Year	
	1990	3	
	2000[2/]	1.45	
		Low[1/]	*High*[1/]
Projected	2010[2/]	11.18	11.28
	2020[2/]	18.99	19.39
	2030	26.28	31.79
	2040	35.37	51.44
	2050	46.28	71.95
	2060	54.32	93.44
	2070	61.94	112.64
	2080	65.22	127.95
	2090	65.44	146.3

Source: NOAA 2023b

1/ Low scenario refers to RCP4.5. High scenario refers to RCP8.5.

2/ The NOAA Climate Explorer provides the observed number of annual days with a maximum temperature greater than 95° for the years 1950 to 2013; the decadal observation for the years 2010 to 2019 is not shown in this table due to this data limitation. Projected temperatures for 2010 and 2020 were developed based on modeled data and do not reflect actual observations, which are not yet captured in the NOAA Climate Explorer.

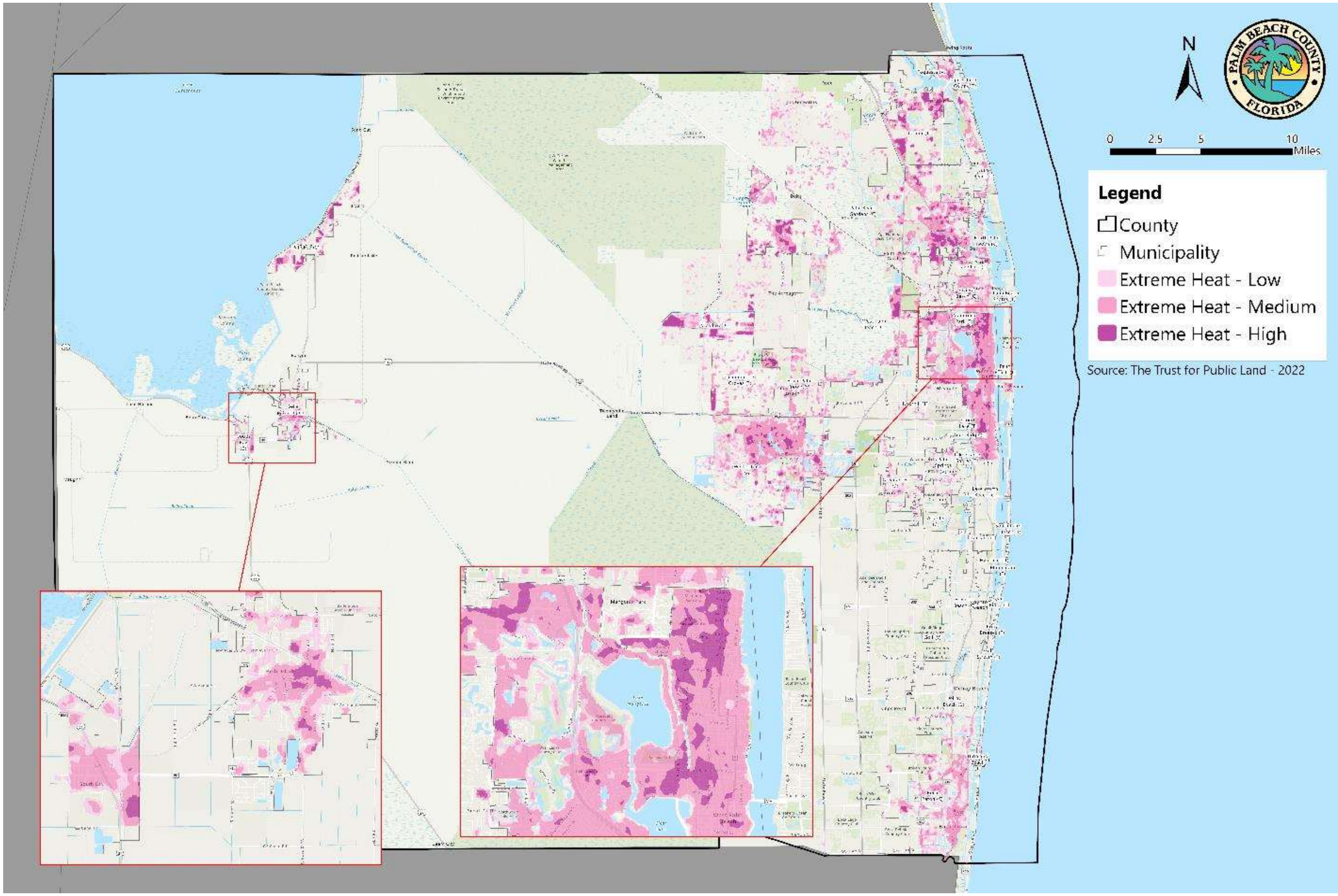


Figure 5-36. Extreme Heat Exposure in Palm Beach County

As shown in Table 5-23, roughly 67,000 acres of the County is considered exposed to extreme heat, representing 4.4 percent of the total land area. Nearly half of South Bay's area is exposed to extreme heat, but most of that is ranked as Low or Moderate. More than a third of West Palm Beach's land area is exposed to extreme heat, and of those exposed areas, nearly 2,000 acres exhibit High exposure.

Table 5-23. Land Exposure to Extreme Heat in Palm Beach County

	Jurisdiction	Exposed Area (acres)			% of Total
		Low	Moderate	High	
Focus Areas	Belle Glade	535	508	110	25%
	Pahokee	338	408	352	34%
	South Bay	259	366	36	48%
Other Affected Areas	Westlake	789	795	658	54%
	Wellington	4,141	5,599	805	37%
	Riviera Beach	1,054	1,129	67	36%
	West Palm Beach	2,462	9,015	1,891	36%
	Unincorporated Areas	3,944	1,253	194	<1%
	Palm Beach County	26,324	33,565	7,357	4%

As shown in Table 5-24, about 20 percent of residents in PBC (almost 300,000 people) are exposed to extreme heat. Roughly 30 percent of exposed residents (more than 87,000 people) reside in West Palm Beach. Most municipalities with significant exposure (at least 40 percent) are among the County's most densely developed and populated communities. Urban heat islands tend to affect the most densely populated portions of PBC, due to the development patterns that make it more likely for such islands to form.

Table 5-24. Population Exposure to Extreme Heat in Palm Beach County

	Jurisdiction	Population			% Total
		Low	Moderate	High	
Focus Areas	Belle Glade	2,230	3,313	1,162	63%
	Pahokee	319	359	269	28%
	South Bay	227	337	22	49%
Other Affected Areas	West Palm Beach	11,153	61,630	14,526	72%
	Wellington	8,834	23,068	4,699	61%
	Palm Beach Gardens	7,762	14,389	6,171	47%
	Riviera Beach	7,015	8,788	230	46%
	Unincorporated Areas	9,168	2,768	280	2%
	Palm Beach County	95,571	164,707	37,717	20%

As shown in Table 5-25, a third of PBC's asset sites are exposed to extreme heat. A third of these sites are in West Palm Beach, where more than 80 percent of all assets are exposed to extreme heat. West Palm Beach has nearly half of all natural, cultural, and historic assets in the County exposed to extreme heat and roughly 45 of all exposed transportation assets. South Bay has over three-quarters of its assets exposed to extreme heat; however, South Bay is a smaller community and has far fewer such assets than West Palm Beach.

Table 5-25. Asset Site Exposure to Extreme Heat in Palm Beach County

	Jurisdiction	Number of Asset Sites				% of Total
		Critical Community and Emergency Facilities	Critical Infrastructure	Natural, Cultural, and Historic Resources	Transportation Assets	
Focus Areas	Belle Glade	40	19	11	3	47%
	Pahokee	15	4	4	0	16%
	South Bay	19	14	5	2	75%
Other Affected Areas	West Palm Beach	296	181	493	40	83%
	Wellington	85	17	42	5	80%
	Palm Beach Gardens	108	47	37	7	76%
	Riviera Beach	86	23	47	24	52%
	Unincorporated Areas	28	8	15	0	2%
	Palm Beach County	1,116	484	875	94	34%

As shown in Table 5-26, more than 10 percent of the County's asset miles—referring to roads, pipelines, waterways, and other asset systems that cannot be identified as a single site—are exposed to extreme heat. About half of all the transportation miles exposed are in West Palm Beach or Boca Raton.

Table 5-26. Asset Miles Exposed to Extreme Heat in Palm Beach County

	Jurisdiction	Exposed Assets (miles)		% of Total
		Critical Infrastructure	Transportation	
Focus Areas	Belle Glade	68.3	3.4	43%
	Pahokee	5.8	0.9	9%
	South Bay	27.3	5.1	82%
Other Affected Areas	Tequesta	0	2.1	78%
	West Palm Beach	19.5	60.3	71%
	Juno Beach	0	4.5	60%
	North Palm Beach	0	4.6	52%
	Unincorporated Areas	46.8	2.1	1%
	Palm Beach County	391.3	209.2	11%

Exposure: Wind

Facing the Atlantic Ocean, PBC is exposed to strong winds associated with tropical cyclones, hurricanes, and tornados. Over the past several decades, the exposure to wind hazards has increased in PBC, primarily due to increased population and development along the low-lying coastline. Most of this development occurred during the 1970s and 1980s, coinciding with a time of few hurricanes or strong coastal storms affecting PBC (Palm Beach County 2024). By the early 1990s, however, the County had experienced two major hurricanes—Hurricane Hugo in 1989 and Hurricane Andrew in

1992—that instilled new urgency to the need for mitigation and preparedness for the region. Among one of the most destructive and costly hurricanes to affect the country, Hurricane Andrew incurred losses of roughly $25 billion at the time; in 2022 dollars, this figure equates to more than $56 billion (National Hurricane Center 1993).

More recently, Hurricane Irma in 2017 incurred significant wind damage in affected areas. At its peak, Hurricane Irma was classified as a Category 5 cyclone and reached winds of 185 mph (Palm Beach County 2024). In PBC, sustained wind gusts were recorded between 50 and 70 mph; at the Palm Beach International Airport, a peak of 91 mph was recorded (NCEI 2024). The storm required more than 17,000 residents to evacuate to county shelters and left nearly 75 percent of residents (more than 566,000) without power. In total, Hurricane Irma produced roughly $300 million in damage in the County.

Wind occurs when there is a difference in atmospheric pressure, often connected to temperature. Trends in wind velocities and the frequency of intense events can be influenced by climate patterns, such as El Niño. Facing warmer summer and winter temperatures, PBC may experience more frequent and intense storms (i.e., Categories 3 to 5), and thus, strong winds in the coming decades (Palm Beach County Office of Resilience 2023b).

Exposure: Wildfire

Historically, wildfires—both prescribed and unplanned—have occurred throughout PBC. In the three western municipalities in the identified focus areas, each has recorded burned acres multiple times over the past several decades, as shown in Table 5-27. To evaluate exposure to wildfire, the assessment uses the U.S. Wildfire Hazard Potential dataset to identify areas with vulnerable vegetations and topographies and historical incidents of wildfires. The wildfire assessment categorized exposure into three tiers—Low, Moderate, and High—as shown on Figure 5-37.

Table 5-27. Acres Burned 1994 to 2020

Jurisdiction	Total Acres Burned	Year of Last Burn	% of Total
Belle Glade	600	2020	13%
Pahokee	692	2020	22%
South Bay	208	2020	15%

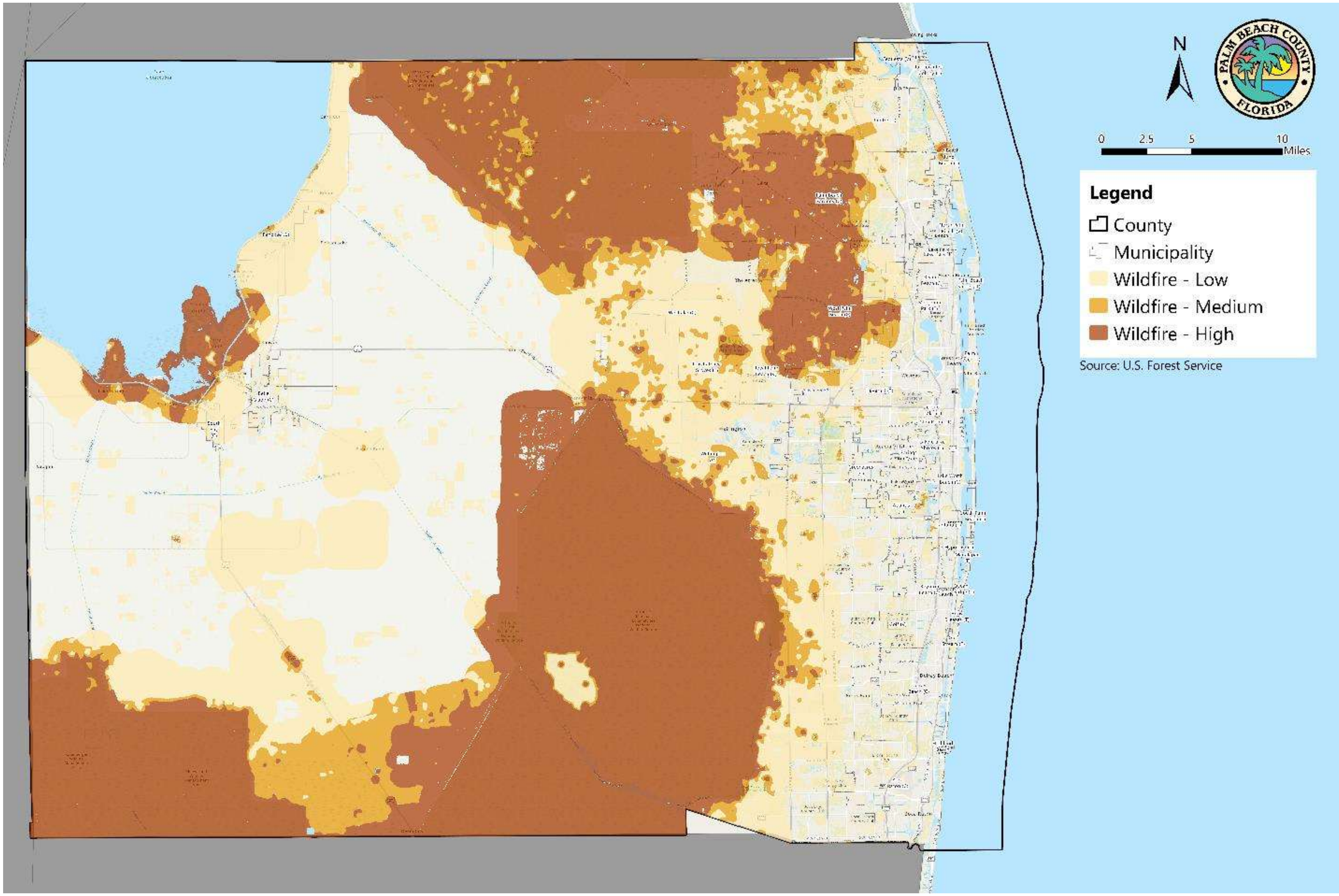


Figure 5-37. Wildfire Exposure in Palm Beach County

As shown in Table 5-28, more than half of all acres in PBC are exposed to wildfires. Several geographically small communities, like Pahokee and South Bay, have nearly all their land area exposed to wildfire. In the assessment focus areas, most of this exposed land is classified as "Low."

Table 5-28. Land Exposure to Wildfire in Palm Beach County

	Jurisdiction	Exposed Area (acres)			% of Total
		Low	Moderate	High	
Focus Areas	Belle Glade	1,284	48	60	31%
	Pahokee	3,079	100	12	100%
	South Bay	1,325	8	0	96%
Other Affected Areas	Loxahatchee Groves	5,505	2,286	156	100%
	Westlake	4,062	63	0	100%
	Palm Beach Gardens	5,544	4,811	20,747	82%
	Wellington	14,862	5,759	2,862	81%
	Unincorporated Areas	215,417	79,397	425,161	55%
	Palm Beach County	280,267	98,432	468,572	56%

As shown in Table 5-29, more than 550,000 PBC residents —roughly four out of every 10 residents—are exposed to wildfires. Approximately 60 percent of all exposed residents (over 320,000) reside in unincorporated PBC. Small communities that exhibit total land exposure to wildfires for this assessment likewise show total population exposure. These trends, however, are likely due to how wildfires are defined and the assessment process as it is applied to smaller geographic areas.

Table 5-29. Population Exposure to Wildfire in Palm Beach County

	Jurisdiction	Population			% of Total
		Low	Moderate	High	
Focus Areas	Belle Glade	2,112	9	8	20%
	Pahokee	3,249	106	9	100%
	South Bay	1,164	4	0	98%
Other Affected Areas	Loxahatchee Groves	3,207	1,308	93	100%
	Westlake	901	20	0	100%
	Royal Palm Beach	19,892	3,253	4,958	72%
	Golf	551	0	0	63%
	Unincorporated Areas	264,811	35,900	21,746	48%
	Palm Beach County	447,507	68,314	49,449	38%

As shown in Table 5-30, nearly 30 percent of PBC's asset sites are exposed to wildfires. Natural, cultural, and historic resources make up the largest group of assets that face wildfire exposure. Proportionally, however, the asset type with the highest exposure is transportation, with nearly one-third of assets exposed. Like land and population exposure, several smaller municipalities, such as Pahokee and South Bay, have all of their assets exposed to wildfire.

As shown in Table 5-31, nearly half of the County's miles of roads, pipelines, waterways, and other asset types are exposed to wildfires. Most of these miles exposed for both critical infrastructure and transportation asset types are in unincorporated areas. In areas with a high share of land exposure, there is likewise a high share of total asset miles exposed.

Table 5-30. Asset Sites Exposed to Wildfires in Palm Beach County

	Jurisdiction	Number of Assets				Total Exposed
		Critical Community and Emergency Facilities	Critical Infrastructure	Natural, Cultural, and Historic Resources	Transportation Assets	
Focus Areas	Belle Glade	8	10	9	6	21%
	Pahokee	70	19	49	3	100%
	South Bay	24	20	7	2	100%
Other Affected Areas	Loxahatchee Groves	9	9	5	0	100%
	Westlake	13	4	0	0	100%
	Royal Palm Beach	49	13	44	6	67%
	Wellington	44	19	25	2	48%
	Unincorporated Areas	282	308	213	172	41%
	Palm Beach County	663	562	565	255	27%

Table 5-31. Asset Miles Exposed to Wildfire in Palm Beach County

	Jurisdiction	Exposed Assets (miles)		Total Exposed
		Critical Infrastructure	Transportation	
Focus Areas	Belle Glade	32.6	1.9	21%
	Pahokee	65.2	7.5	100%
	South Bay	32.7	6.8	100%
Other Affected Areas	Tequesta	19.4	0	100%
	Juno Beach	4.4	0	100%
	Westlake	220.5	0.4	71%
	Jupiter	0.0	39.6	56%
	Unincorporated Areas	1,795.2	257.3	51%
	Palm Beach County	2,263.7	385.1	48%

5.2 Sensitivity Analysis

Sensitivity refers to the degree to which a system, population, or resource is or might be affected by climate hazards. In conjunction with the exposure analysis, a sensitivity analysis was performed on critical assets examining all flooding scenarios. The sensitivity analysis helps prioritize resilience adaptation efforts based on the level and way various SLR projections affect critical assets within key geographic areas in PBC. Two slightly different approaches were taken to determine sensitivity of flooding-related climate hazards (sea level rise, high tide flooding, storm surge, rainfall, and compound flooding) and non-flooding related climate hazards (drought, coastal erosion, extreme heat, wind, and wildfire).

5.2.1 Asset Sensitivity to Flooding-Related Climate Hazards

An overall composite index score was developed to prioritize each asset by combining exposure, vulnerability, and sensitivity to impacts. The composite index scoring system identifies the County's most vulnerable assets and prioritizes them for adaptation responses.

The flooding-related asset prioritization was accomplished using the following process (also depicted in Figure 5-38):

- **Establish flooding hot spots** based on concentrations of assets impacted by flood hazards, stakeholder input, a comprehensive flood scenario review, and a baseline asset and critical asset review.
- **Conduct an assessment of risk** for critical assets located within the flooding hot spots based on scores from flood risk (flood risk index), immediacy of impact (horizon index), and social vulnerability (social index).
- **Calculate a composite vulnerability score (CVS)** for each asset based on the risk assessment scoring.
- Prioritize critical assets based on CVS scores.

Figure 5-38. Palm Beach County Four-step Sensitivity Analysis Process.

By assigning priorities to these assets, decision-makers can allocate resources effectively, focusing on the most vulnerable assets while also maintaining a holistic approach to enhancing overall community resilience against climate-induced flooding and SLR. The Flooding Hot Spot Map Series, including the results of the sensitivity analysis, are provided as **Appendix C**.

5.2.1.1 Flooding Hot Spots

The first step in the sensitivity analysis is the identification of high-risk flooding areas by designating them as flooding hot spots. The methodology for identifying geographic flooding hot spots consisted of reviewing concentrations of critical assets (Table 5-32) and planning horizons, analyzing exposure to flood risks, collecting stakeholder input, and prioritizing geographic areas by immediacy of impacts (Figure 5-39). These flooding hot spots contain a mix of government facilities, commerce areas, critical transportation hubs, and residential neighborhoods and are often exposed to multiple flood scenarios.

Table 5-32. Critical Assets within Flooding Hot Spots

Asset Category	Asset Type	Quantity
Transportation Assets and Evacuation Routes	Airport	1
	Boat Ramps	8
	Rail Facility	1
	Bus Station	1
	Bus Routes	19
	Bridges	47
	Streets	4,990
	Evacuation Routes	13
Critical Infrastructure	Emergency Activation Sites	21
	Military Facilities	2
	Disaster Debris Management Sites	1
	Electrical Substations	11
	Sewer Stations	168
	Potable Water Facilities	3
	Production Wells	10
	Well Field Zones	304
	Petroleum Terminals	4
	Microwave Service Towers	26
	Cellular Tower	6
	Land Mobile Broadcast Tower	5
Critical Community and Emergency Facilities	Local Government Facilities	34
	College/Universities	3
	Libraries	6
	Schools	70
	Fire Stations	18
	National Shelter System	12

Asset Category	Asset Type	Quantity
	Law Enforcements Facilities	12
	Non-Emergency Medical	12
	Emergency Services	1
	Hospitals	1
	Public Health Department	1
	Public Housing Development	1
	Public Low-Income Housing	9
	Mobile Home Parks	28
	Assisted Living Facilities	22
Natural, Cultural, and Historic Resources	Conservation Land	2
	Parks	75
	Historic Assets	503

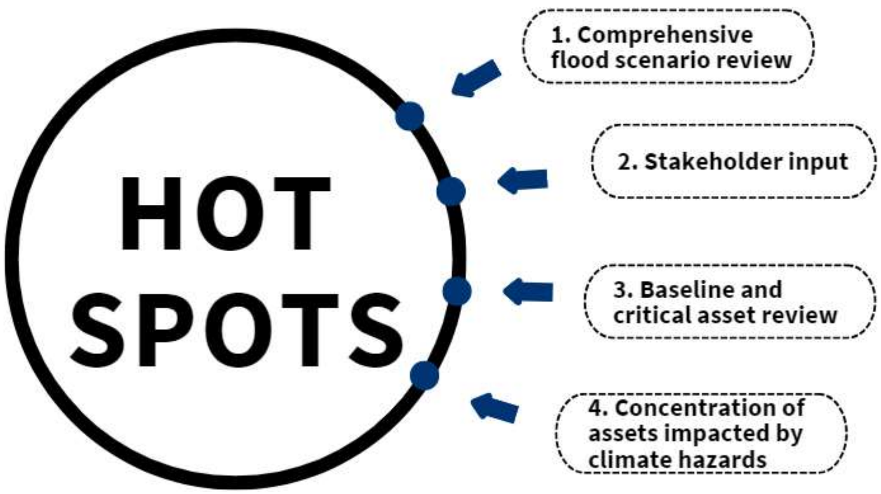


Figure 5-39. Flooding Hot Spot Formulation Methodology

While the impacts of flooding can be experienced throughout PBC, the County has designated 25 flooding hot spots. These areas represent geographic regions of increased flooding vulnerability with a concentration of critical assets as determined by the exposure and sensitivity analyses. The map (Figure 5-40) is color coded to reflect the type of flood risk and the approximate year that area will be impacted by that flood risk. The summary table (Table 5-33) shows each flooding hot spot breakdown, which flood scenarios impact that flooding hot spot, and the scenario year the impact occurs. While all assets within a flooding hot spot may experience the impacts of flooding, the degree of vulnerability varies for each asset. These areas served as the primary focus points for PBC's tailored adaptation efforts. Resources can be focused where multiple risks intersect, identifying highly vulnerable assets and creating an adaptation plan that is prioritized by geographic area and immediate need with input from residents. The approach employed ensured that County initiatives were not only rooted in data-backed analysis, but also resonated with priorities of the community it serves.

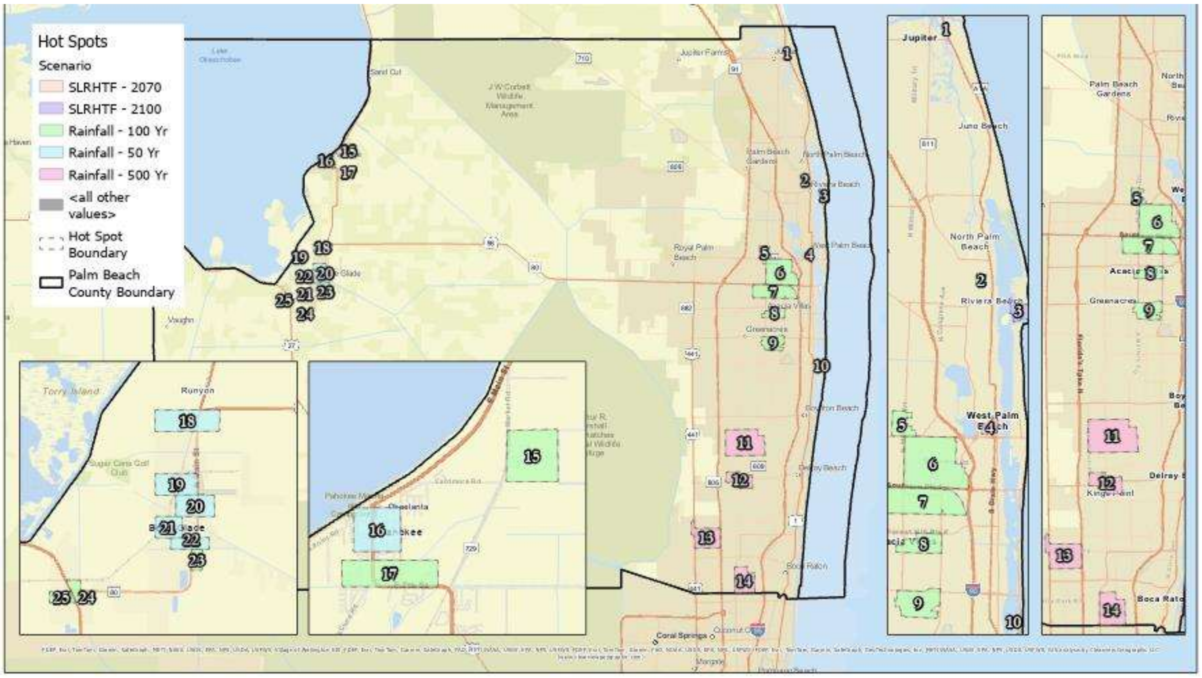


Figure 5-40. Palm Beach County Flooding Hot Spot Map

Table 5-33. Timing or Magnitude of Flood Scenarios Impacting Flooding Hot Spots

Flooding Hot Spot Number	Sea Level Rise + HTF	Rainfall	Storm Surge
1	2100	Present Day-100 Year 24 Hour *(Minimal Impact)*	100-Year Surge
2	*No Impact*	Present Day-100 Year 24 Hour	100-Year Surge
3	2100	Present Day-100 Year 24 Hour	100-Year Surge
4	*No Impact*	Present Day-500 Year 24 Hour	100-Year Surge
5	*No Impact*	Present Day-100 Year 24 Hour	100-Year Surge
6	*No Impact*	Present Day-100 Year 24 Hour	100-Year Surge
7	*No Impact*	Present Day-100 Year 24 Hour	100-Year Surge
8	*No Impact*	Present Day-100 Year 24 Hour	100-Year Surge
9	*No Impact*	Present Day-100 Year 24 Hour	100-Year Surge
10	2070	Present Day-500 Year 24 Hour	100-Year Surge
11	*No Impact*	Present Day-500 Year 24 Hour	500-Year Surge
12	*No Impact*	Present Day-500 Year 24 Hour	500-Year Surge
13	*No Impact*	Present Day-500 Year 24 Hour	500-Year Surge
14	*No Impact*	Present Day-500 Year 24 Hour	100-Year Surge
15	*No Impact*	Present Day-100 Year 24 Hour	*No Impact*
16	*No Impact*	Present Day-50 Year 24 Hour	*No Impact*
17	*No Impact*	Present Day-100 Year 24 Hour	*No Impact*

Flooding Hot Spot Number	Sea Level Rise + HTF	Rainfall	Storm Surge
18	*No Impact*	Present Day-50 Year 24 Hour	*No Impact*
19	*No Impact*	Present Day-50 Year 24 Hour	*No Impact*
20	*No Impact*	Present Day-50 Year 24 Hour	*No Impact*
21	*No Impact*	Present Day-50 Year 24 Hour	*No Impact*
22	*No Impact*	Present Day-50 Year 24 Hour	*No Impact*
23	*No Impact*	Present Day-100 Year 24 Hour	*No Impact*
24	*No Impact*	Present Day-100 Year 24 Hour	*No Impact*
25	*No Impact*	Present Day-100 Year 24 Hour	*No Impact*

Table 5-34 defines the flood thresholds used to assign rankings of no, low, medium, high, and very high for flood depths in the GIS modeling. These exposure thresholds can be used to assess the impact of future flooding levels on community assets. The level of exposure represents the sensitivity of the asset. High sensitivity denoted the most vital critical assets that are at risk with any inundation level above zero inches and general critical assets that are at risk with greater than 1-foot inundation. Moderate sensitivity applied to general critical assets facing inundation levels exceeding 6 inches. Low sensitivity encompassed critical asset types at risk when exposed to inundation levels beyond 6 inches. Critical assets with no exposure detected by modeling were placed within the no sensitivity categorization class. These thresholds are critical for understanding the specific flood risks that PBC faces, allowing for targeted measures to be implemented in areas predicted to be most affected by flooding.

Table 5-34. Exposure Ranking Using Flooding Thresholds

Flood Depth (feet)	Exposure Ranking	Description
0	No Exposure	No flooding detected. Areas with no impact from sea level rise or flooding.
>0 to 0.5	Low Exposure	Minor flooding. Shallow inundation typically causing minimal impact.
>0.5 to 1	Medium Exposure	Moderate flooding. Likely to impact structures and disrupt daily life.
>1 to 3	High Exposure	Significant flooding. Serious degree of inundation causing damage and major disruptions.
>3	Very High Exposure	Severe flooding. Extensive inundation posing critical threats and causing extensive damage.

Table 5-34 outlines PBC’s determined exposure levels for this project. These ranking levels serve as a crucial foundation for the risk assessment, enabling evaluation of the potential consequences of rising sea levels and overall flooding impact in PBC’s specific context.

5.2.1.2 Flood Hazard Risk Assessment

The second phase of the sensitivity analysis involved conducting a risk assessment. During this stage, an evaluation and prioritization system was developed to assess the County’s critical assets within flooding hot spots. The risk assessment comprises the following three indexes:

- Flood risk index

- Horizon index
- Social index

Each index evaluates distinct aspects of risk and vulnerability and is assigned a specific weight for evaluation and scoring. These indexes collectively contribute to a final metric known as the CVS, which provides a comprehensive measure of flood-related risk by integrating these three weighted components.

Flood Risk Index

PBC assets were ranked based on their Flood Risk Index scores, using a tiered system to identify those facing the highest risks (Table 5-35). It considers all the aspects of flooding and assigns a weight to each one. Rain and SLR, considered the most likely flooding combination resulting in pervasive impacts, was given the most weight followed by SLR alone and the combination of rainfall, SLR, and storm surge.

Table 5-35. Flood Risk Metric Weighting

Metric	Weight
Rain and Sea Level Rise Combo	0.35
Sea Level Rise Impact	0.25
Rain, Sea Level Rise, and Storm Surge	0.15
Number of Times Asset is Exposed	0.10
Average Flood Depth	0.10
Average Flood Depth Percentile Rank	0.05
Total	**1.00**

Horizon Index

The planning horizons for this CVA are categorized into near-term (approximately zero to 20 years), mid-term (approximately 20 to 50 years), and long-term (approximately 50 to 100 years). The Horizon Index reflects this temporal segmentation, using a multiplier system to emphasize the criticality of impacts in the near term (Figure 5-41). Information regarding the expected timeframe when flooding is expected to become problematic is important in making informed decisions about near-term planning, adaptation measures, and risk management. It also serves as a guide for prioritizing investments in infrastructure and formulating policy responses to the challenges posed by SLR and climate change.

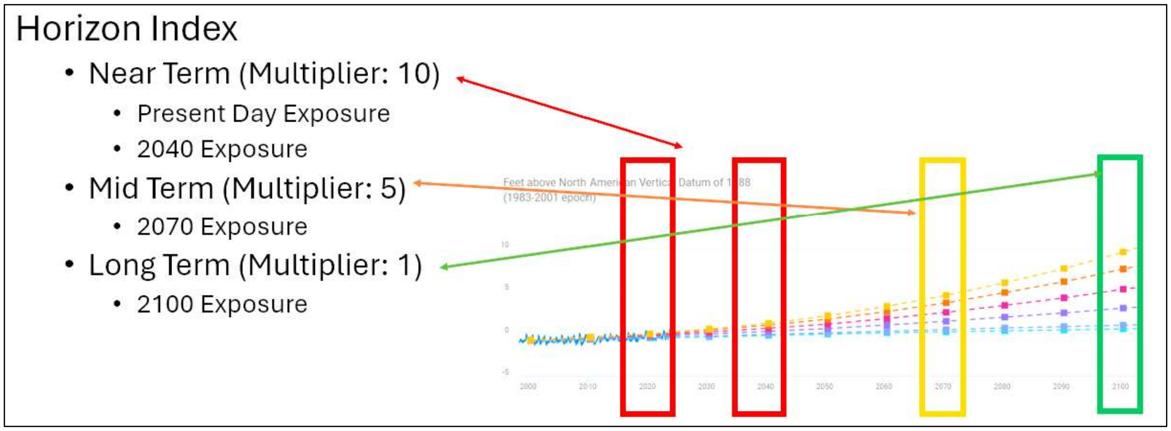
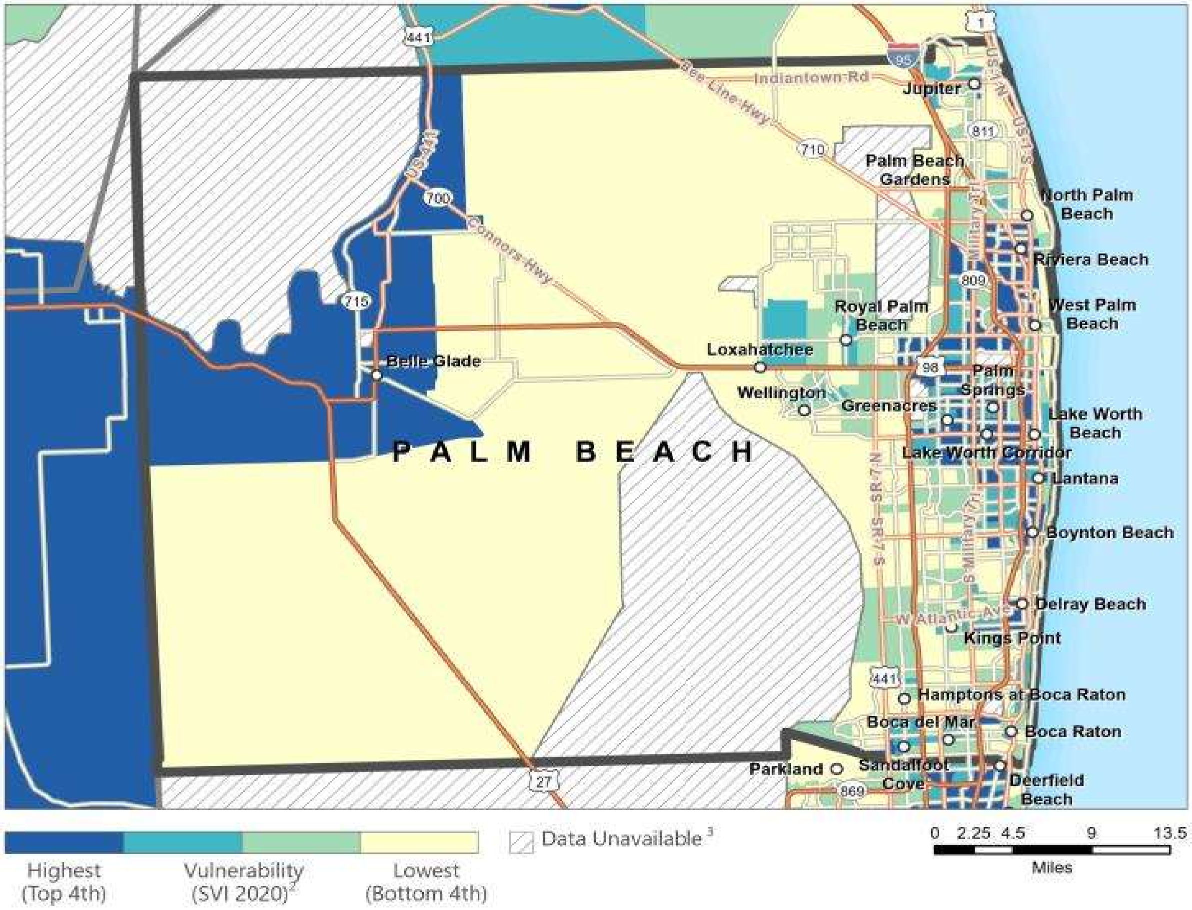


Figure 5-41. Planning Horizon Prioritization

Social Index

Social Index offers an assessment aimed at equitable consideration of flood vulnerability impact on the County's inhabitants, with purposeful inclusion of vulnerable populations. Individuals with limited resources or access to essential services warrant additional focus, necessitating targeted allocation of resources. Tailoring effective flood mitigation strategies specifically for these groups is imperative.

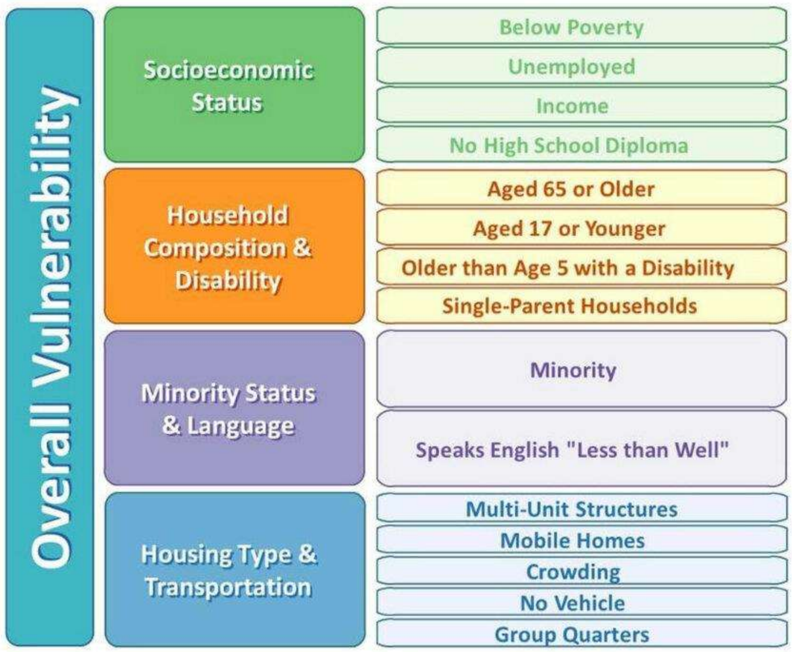
Socioeconomic disparities play a pivotal role in shaping a community's resilience to climate change. The social index offers an assessment aimed at acknowledging and addressing the impact of flood vulnerability on the County's inhabitants, specifically including vulnerable populations. Vulnerable populations, as identified by the most recent (2020) Social Vulnerability Index (SVI) from the Centers for Disease Control and Prevention (CDC), face heightened risks due to factors like poverty, limited access to transportation, and overcrowded housing (CDC 2020). Figure 5-42 displays the SVI levels for PBC. The SVI offers a comprehensive assessment across four critical domains—socioeconomic status, minority status and language, housing composition and disability, and housing and transportation—providing valuable insights for emergency preparedness, resource allocation, shelter provision, and evacuation planning amidst SLR and potential flooding scenarios.



Source: CDC 2020

Figure 5-42. CDC SVI Palm Beach County Map

As reflected in Figure 5-43, the analysis of the County's social vulnerability using the 2020 CDC's SVI utilizes U.S. Census data to analyze the social vulnerability of every census tract. Each census tract is ranked on 15 social factors including poverty, lack of vehicle access, and crowded housing, and groups them info four related themes to create an average score between zero to 100 percent (CDC 2020). In the CDC SVI, values range from 0.25 to 1.00, with higher values indicating greater vulnerability, and are assigned multipliers from 1 to 4. It assesses aspects like socioeconomic status, household composition and disability, minority status and language, and housing and transportation.



Source: CDC 2020

Figure 5-43. CDC's SVI Index Metrics

The U.S. Department and of Housing and Urban Development (HUD), with the help of the Department of Transportation, launched the Location Affordability Index (LAI), which identifies areas based on cost estimates of housing and transportation for eight different household profiles (Table 5-36) (HUD 2019). HUD LAI data was also used to compute metrics for the Social Index. The HUD LAI considers housing affordability in various household profiles, ranging from median-income families to dual-professional families, in relation to the median household income (MHHI) for a given area. Similar to the CDC index, values assigned to each profile range from 0.25 to 1.00, with associated multipliers from 1 to 4.

Table 5-36. HUD Location Affordability Index Household Income Profiles

Household Profile	Median Household Income for a Given Area (MHHI)
1. Median-Income Family	MHHI
2. Very Low-Income Individual	National Poverty Line
3. Working Individual	50% of MHHI
4. Single Professional	135% of MHHI
5. Retired Couple	80% of MHHI
6. Single-Parent Family	50% of MHHI
7. Moderate-Income Family	80% of MHHI
8. Dual-Professional Family	150% of MHHI

Source: HUD 2019

The LAI presents advanced insights into housing and transportation costs, which are critical for flood risk planning and enhancing climate resilience. The HUD LAI data also includes considerations of auto ownership, housing expenses, and transit usage, providing a nuanced understanding of affordability challenges faced by residents (HUD 2019). It underscores the interconnectedness of socioeconomic status and disaster vulnerability, emphasizing the need for targeted approaches in resilience planning and support.

Within the Social Index, the CDC SVI metrics were assigned a weight of 0.6 while the HUD LAI metrics were assigned a weight of 0.4. By combining these factors, the Social Index creates a weighted sum that helps identify and prioritize intervention areas where people may be more affected by socioeconomic and housing-related challenges. This tool is particularly useful for policy makers and planners to direct resources and efforts to improve the resilience and support of communities that are most at risk.

Flood Hazard Composite Vulnerability Score

Each of the components described above assesses different aspects of flood-related risk and vulnerability and is assigned a specific weight to determine the CVS.

1. **Horizon Index:** This metric measures the potential future impact of flooding, considering the planning horizon or the timeframe within which the impacts are expected. The Horizon Index score is given a weight of 0.5, This weight reflects the importance of long-term flood risk projections in overall risk assessment but focusing on the immediacy of near-term impacts.
2. **Flood Risk Index:** This metric evaluates the current exposure to flood risks, including the frequency and depth of potential flooding events. The Flood Index score has a weight of 0.3, suggesting that immediate flood risks are also a significant factor in the overall assessment but less so than long-term projections.
3. **Social Index:** This metric assesses socioeconomic considerations such as income, disability, minority, and socioeconomic status by utilizing data from the CDC Social Vulnerability Index and HUD's Location Affordability Index. The Social Index score has a weight of 0.2, recognizing the heightened risk encountered by a community's most vulnerable members.

The resulting CVS score offers a holistic measure of flood-related risk by combining these weighted components. It can guide decision-making in urban planning, emergency preparedness, resource allocation, and other critical areas of public policy and infrastructure development. The CVS is an essential tool in the toolkit, allowing various risk factors to be overlaid and identify where they converge to create heightened risk profiles. It is not just a measure but a strategic guide to direct efforts effectively. By factoring in both the likelihood and potential severity of flood events, as well as the social dimensions of vulnerability, the CVS serves as a robust tool for the prioritizing actions in and investments to mitigate flood risks.

5.2.1.3 Flood-Related Critical Asset Prioritization

The third step within the flood-related sensitivity analysis is to apply the evaluation system described above to analyze and prioritize critical assets in the County for adaptation measures. The assets prioritized were limited to those located within flooding hot spot areas. This methodology is outlined in Figure 5-44. PBC's critical assets were prioritized by applying the CVS described above.

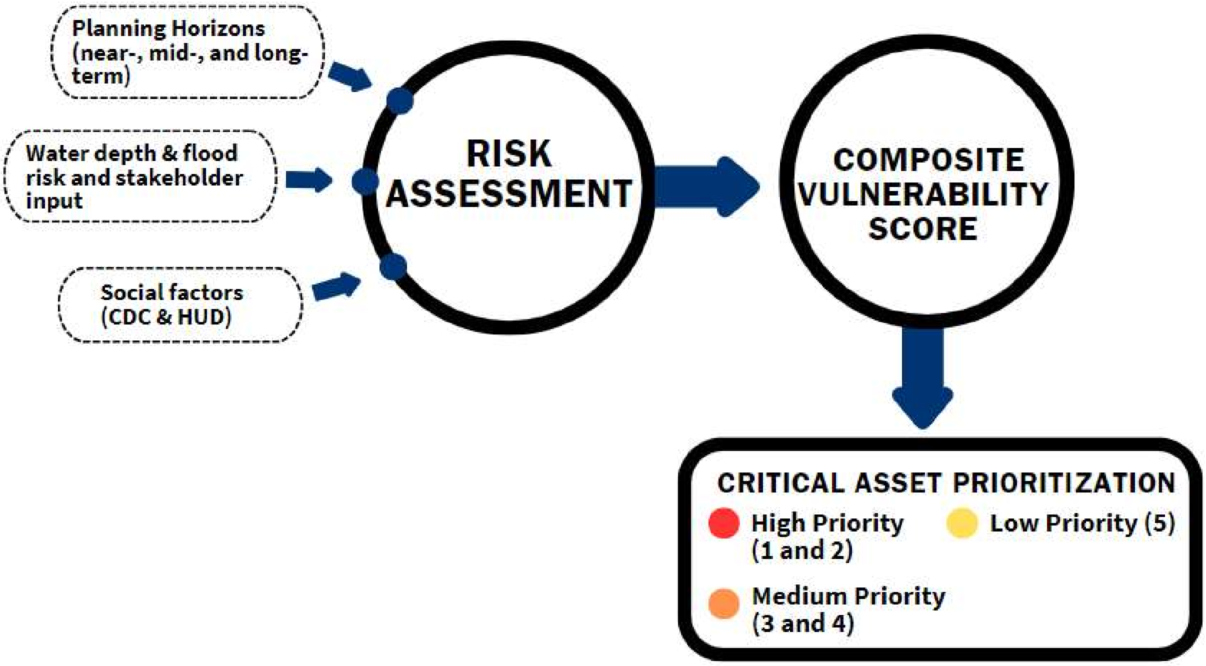


Figure 5-44. Critical Asset Prioritization Methodology

Employing the index described above, the analysis assigned a priority of 1 through 5, or not prioritized, ranking based on the indexed score. Table 5-37 provides the index thresholds used to assign the priorities.

Table 5-37. Composite Risk Assessment Scores and Prioritization

Risk Assessment Score Threshold	Assigned Priority
Top 5% Highest Values	1 (High)
5-10%	2 (High)
10-15%	3 (Moderate)
15-25%	4 (Moderate)
25-50%	5 (Low)
Below 50%/Median Value - Not Prioritized	0 (Low)

5.2.1.4 Flooding Hot Spot Prioritization

Risk is the result of combining the probability or relative likelihood of a climate hazard occurring with the magnitude of its impact. To assign a priority to the various high-risk areas and align with Resilient Florida Grant criteria, the analysis results were then re-ordered by the overall risk determination. The ranking was assigned by considering the percentages of land area inundated and the number of critical assets affected in each of the identified flooding hot spots, as described in Figure 5-45. As an example, a hot spot in the less-than-25-percent land area and the 50-to-75-percent asset categories would rank higher than one with 25 to 50 percent land area but less than 25 percent assets. The methodology for scoring sensitivity (risk assessment, CVS, and critical asset prioritization) of assets is shown in Table 5-38.

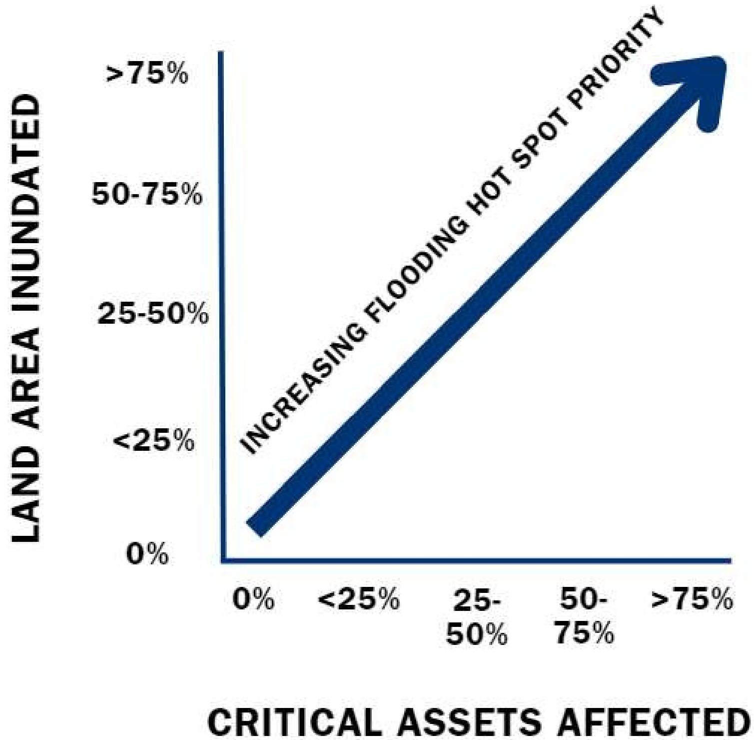


Figure 5-45. Flooding Hot Spot Ranking

Table 5-38. Flood Related Sensitivity Analysis Scoring Methodology

Risk Assessment			Composite Vulnerability Score	Critical Asset Prioritization
Horizon Index (weight 0.5)	**Flood Risk Index[1/] (weight 0.3)**	**Social Index[2/] (weight 0.2)**		
High Risk – Near Term (Present day and 2040 Exposure)	**High Risk** – Rainfall and SLR Combo	**High Risk** – Groups with high overall vulnerability to social factors (e.g., income, socioeconomic status, disability, minority, etc.)	**High** – Top 5% - 10% of highest risk assessment values	**High** – Priority 1 & 2
Moderate Risk – Mid Term (2070 Exposure)	**Moderate Risk** – SLR	**Moderate Risk** – Groups with moderate overall vulnerability to social factors (e.g., income, socioeconomic status, disability, minority, etc.)	**Moderate** – 10%-25% of risk assessment values	**Moderate** – Priority 3 & 4
Low Risk – Long Term (2100 Exposure)	**Low Risk** – Rainfall, SLR, and Storm Surge combo	**Low Risk** – Groups with low overall vulnerability to social factors (e.g., income, socioeconomic status, disability, minority, etc.)	**Low** – 25%-0% of risk assessment values	**Low** – Priority 5 & 0

1/ This index also considers the number of times an asset is exposed to a flood scenario, the average flood depth across all scenarios, and the average flood depth percentile rank across all assets.
2/ Based on data derived from the CDC SVI and HUDs Location Affordability Index.

5.2.2 Asset Sensitivity to Non-Flooding Related Climate Hazards

The quality and amount of data on physical sensitivity and asset characteristics vary by hazard and asset type. Where possible, the sensitivity analysis leveraged quantitative data to calculate expected structural damage, measured in dollars. For hazards with future-condition scenarios available, the change in structural damage was calculated to illustrate the potential increase in sensitivity due to climate change. A meeting with key personnel was held to review the outcomes of the sensitivity analysis, facilitating input on selected impact scores. Figure 5-46 illustrates the sensitivity analysis' overall approach and integration of qualitative and quantitative information.

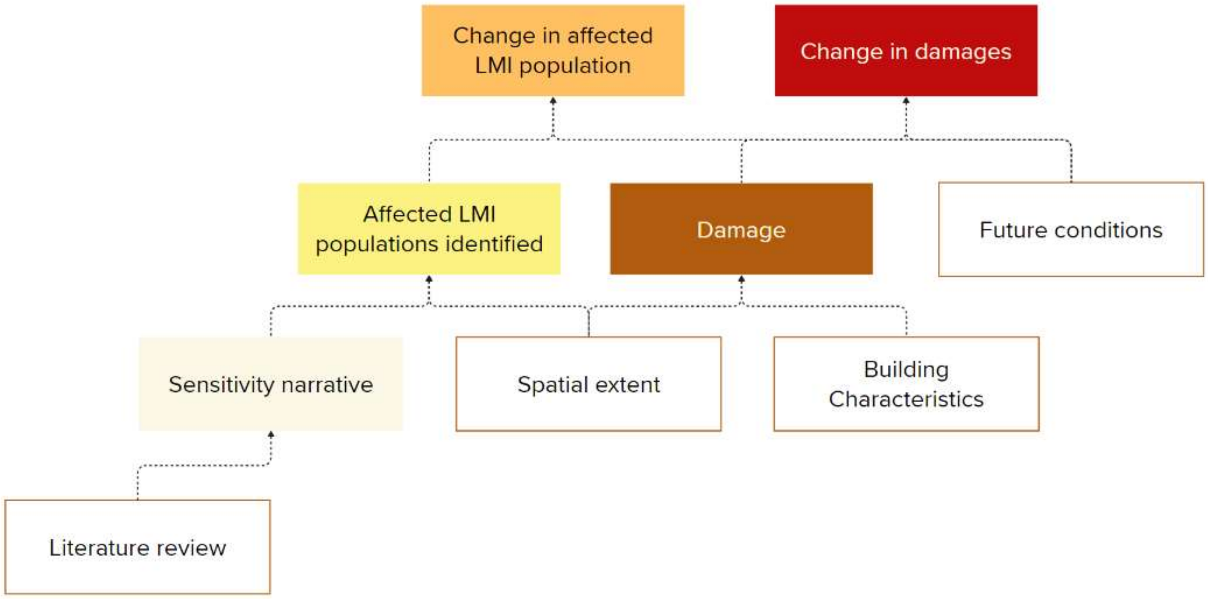


Figure 5-46. Non-Flooding Related Sensitivity Analysis Framework

5.2.2.1 Determining Sensitivity

A population's sensitivity to adverse impacts depends on demographic characteristics such as income, age, or preexisting health conditions. For some populations, these adverse impacts may be disproportionate compared to the larger population or may be more likely to trigger cascading events, such as economic hardship or temporary displacement that can have increased impacts on socially vulnerable populations. If affected by a hazard, these populations may struggle to recover due to limited income to pay for home repairs or alternative shelter, inability to commute or work, or limited access to healthcare and medical services.

To identify sensitive populations, the sensitivity analysis leveraged the HUD LMI data, which is available at the Census Block Group level. Block Groups with higher shares of LMI populations may experience more severe impacts than those with lower shares. Individuals or households are considered LMI if their household income is no more than 80 percent of the median income for the county. For hazards with spatial data, sensitivity was evaluated by determining what share of a Block Group's LMI households are exposed.

The CVA uses quantitative and qualitative data to comprehensively characterize PBC's vulnerability to climate-related hazards. Figure 5-47 illustrates the CVA's overall framework.

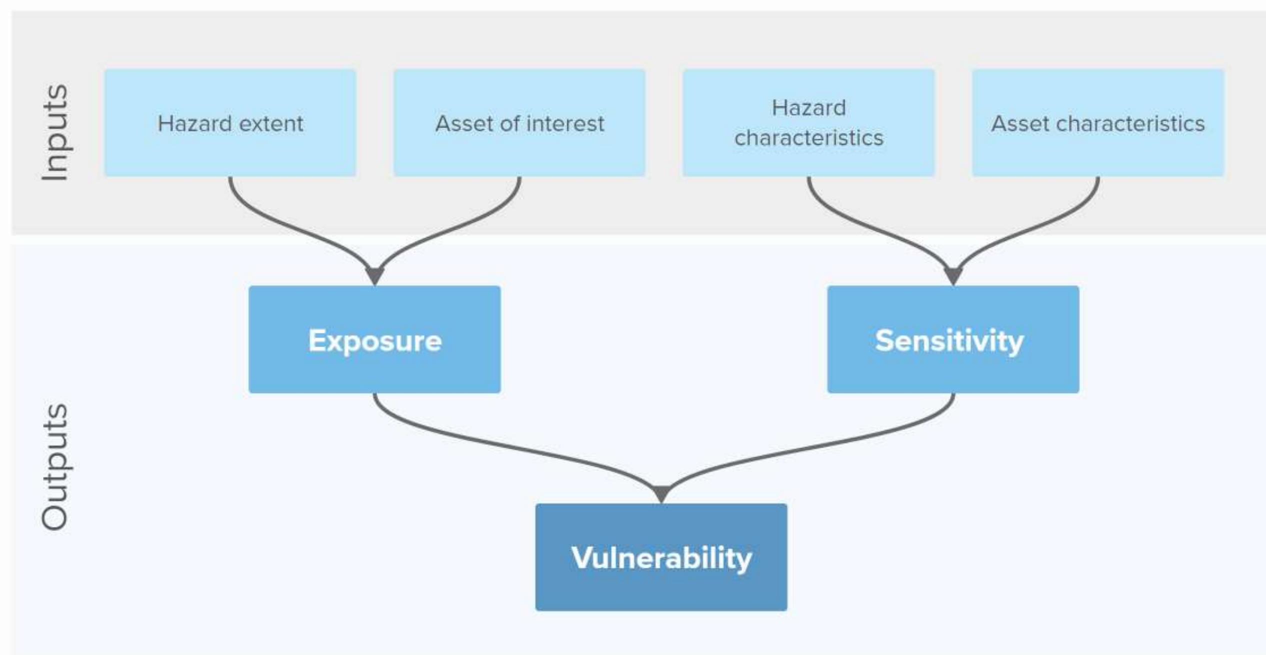


Figure 5-47. Climate Vulnerability Assessment Approach Framework

These exposure analysis focus areas for the non-flooding related climate hazards served as the primary targets for the project's in-depth analysis and assessment of vulnerability to climate hazards. The assessment focus areas include Belle Glade, Pahokee, South Bay and portions of unincorporated areas and municipalities containing County-owned assets. These areas may possess environmental risk factors, as well as social factors that would put these communities at a higher risk due to a lack of infrastructure and/or preparedness to respond and recover from climate threat related events. The approach allowed for a detailed examination of the challenges faced by different communities within PBC, enabling the development of tailored adaptation strategies and resilience measures to address specific needs and vulnerabilities.

Sensitivity: Coastal Erosion

PBC is already mitigating coastal erosion through beach replenishment, dune restoration, and other activities. However, the potential for coastal erosion to injure or harm residents or communities also depends on the capability of residents to prepare for, mitigate, and recover from associated events.

A person's sensitivity to coastal erosion can also depend on not just where they live, but in what type of housing. For instance, if a family rents their home, they may have little control over whether mitigation efforts are implemented to the property. Similarly, individuals who live in public housing may be residing in structures that were built before resilient design standards were in place or the full extent of erosion's impact was known. Manufactured housing is located where the ground has been stabilized to ensure a sufficient anchoring system to serve as the unit's foundation (FEMA 2009). If the area is vulnerable to erosion, occupants may face an elevated risk of potential damage to their unit.

For the purposes of the coastal erosion assessment, sensitivity to adverse impacts is considered by determining the extent to which populations meeting HUD's LMI requirements are exposed to coastal erosion. Due to the limited geographic extent of the Critical Coastal Erosion Areas and shoreline data, less than 0.1 percent of the LMI population is considered exposed to coastal erosion under both 2040 and 2070 scenarios.

Sensitivity: Drought

All PBC will continue to be exposed to droughts in the future, and drought events may be more severe and prolonged than in the past due to climate change. By mid- to late-century, the County is expected to receive roughly the same amount of annual precipitation as it does today, but it will be distributed throughout the year more evenly than historically experienced (NOAA 2023b). The region may experience drier wet seasons (April to September) and wetter dry seasons (October to March), effectively lessening PBC's existing seasonal trends (Table 5-39).

Table 5-39. Observed and Projected Average Monthly Precipitation (inches) for Palm Beach County

		Jan	Feb	Mar / Apr / May / Jun	Jul	Aug	Sep	Oct	Nov		Dec		
				Wet Season									
Observed		2.0	2.2	2.9	2.7	4.7	7.7	6.7	7.1	7.2	5.2	2.4	1.9
2050	*Low*[1/]	2.4	2.3	2.9	2.4	4.8	7.7	5.7	6.6	7.0	5.9	2.7	2.0
	High[1/]	2.2	2.3	3.0	2.4	4.6	7.4	5.9	6.3	7.1	6.1	2.7	1.9
2075	*Low*[1/]	2.3	2.3	2.9	2.7	4.8	7.4	5.8	6.4	6.9	6.1	2.8	2.0
	High[1/]	2.3	2.4	2.8	2.3	4.4	7.1	5.2	5.8	6.8	6.1	2.9	2.1

Source: NOAA 2023b

1/ Low refers to RCP4.5 scenario. High refers to RCP8.5 scenario.

Between 1950 and 2013, PBC received a monthly average of 5.9 inches of rainfall during its wet season and just under 3 inches per month during its dry season (NOAA 2023b). By 2050, the County could experience a decrease in precipitation of 2.5 to 4.1 percent during its wet seasons, and an increase of 1.8 to 2.2 percent during its dry season. By 2075, wet season precipitation totals may dip by 3.6 to 10 percent compared to historical average; with dry season precipitation increasing between 3.2 and 3.9 percent.

As temperatures rise, the rate of soil moisture loss will accelerate, meaning the minimal increase in annual rainfall and shift in the dry season is unlikely to lessen the impacts of increased temperatures (NOAA 2022). Overall, PBC is expected to experience higher temperatures year-round and particularly during the wet season (see Table 5-40). Between 1950 and 2013, PBC had an average wet-season high temperature of 88.4°F (NOAA 2023b). By 2050, the average temperature between April and September may increase by 3.9 to 5.0 percent over historical averages. By 2075, average temperatures during these months could be 4.9 to 7.5 percent higher than those observed between 1950 and 2013. During the wet seasons, these rising temperatures, combined with less precipitation, may lead to drier conditions in the region, elevating the possibility of drought.

Table 5-40. Observed and Projected Average Maximum Monthly Temperatures for Palm Beach County

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				Wet Season								
Observed	75	76	80	83	87	89	91	91	89	85	80	76

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2050	*Low*[1/]	78	79	83	87	90	93	94	94	93	89	84	79
	High[1/]	78	80	84	88	91	94	95	95	94	90	85	80
2075	*Low*[1/]	78	80	84	88	91	94	95	95	94	90	84	80
	High[1/]	80	82	86	90	93	96	97	98	96	92	86	82

Source: NOAA 2023b

1/ Low refers to RCP4.5 scenario. High refers to RCP8.5 scenario.

Sensitivity: Extreme Heat

Extreme heat events can affect anyone, but some individuals are more susceptible to harmful or even deadly impacts. Households with limited incomes may face challenges accessing medical care or health resources during extreme heat events. Some individuals may depend on jobs that require manual labor or do not provide paid leave, making them less likely to miss work if facing health issues due to extreme heat.

An individual's susceptibility to extreme heat impacts is also influenced by their housing conditions. For instance, public housing units tend to be older, making them more likely to inefficient insulation and/or poor ventilation. Residents may rely on in-unit air conditioners to keep cool, but if the unit cannot maintain a cooler temperature, they may still face increased temperatures and even health risks; moreover, the types of individuals who rely on public housing may also experience additional demographic factors, such as age or access to healthcare, that compound these risks. (Gabbe and Pierce 2020). Multi-family buildings also tend to be in more urbanized areas that have less tree canopy and a higher share of paved surfaces, elevating the risk for potential urban heat islands to form (Pierce, Gabbe and Rosser 2022). People that reside in manufactured housing may lack air conditioning or, even if they do, struggle to keep their units cool, depending on building's materials and insulation efficiencies (Bernard and Proano 2022).

As shown in Table 5-41, the LMI population exposed to extreme heat makes up about 9 percent of the County's total population. In Belle Glade, approximately 5,200 residents that are considered LMI are exposed to extreme heat. Those residents represent nearly half of Belle Glade's total population. With the exception of West Palm Beach, the percentage of the LMI population exposed to extreme heat tends to be greater than the percentage of the general population exposed.

Table 5-41. LMI Population Sensitivity to Extreme Heat in Palm Beach County

	Jurisdiction	LMI Population			% of LMI Population	% of Total Population
		Low	Moderate	High		
Focus Areas	Belle Glade	1,836	2,530	859	64%	49%
	Pahokee	243	309	223	34%	23%
	South Bay	69	100	9	50%	15%
Other Affected Areas	West Palm Beach	4,576	31,729	8,419	76%	37%
	Riviera Beach	4,234	5,569	184	53%	29%
	Mangonia Park	139	125	25	27%	19%
	Tequesta	491	398	76	54%	17%
	Unincorporated Areas	3.603	1,004	138	2%	1%

	Jurisdiction	LMI Population			% of LMI Population	% of Total Population
		Low	Moderate	High		
	Palm Beach County	38,418	73,649	18,808	21%	9%

Sensitivity: Rainfall Induced Flooding

Households with limited incomes may lack the capital needed for mitigation projects that would protect their property from inland flooding. For instance, just one inch of flooding can cause $26,000 in damage and lead to mold or other health concerns (NLIHC & PAHRC 2021). They also may rent their home rather than owning and therefore have limited control over improvements to the structure. These residents may have more challenges in mitigating inland flooding.

Additionally, individuals that live in public housing or manufactured units may face an increased risk of experiencing property damage. Public housing units tend to be older, meaning they were built before resilient design standards were implemented or the long-term risks due to flooding and changing conditions were fully understood. Similarly, people that live in manufactured housing may be more sensitive to harm from inland flooding, depending on building materials used and the age of their home. Moreover, manufactured housing should be sited on places where the ground has been stabilized to ensure a sufficient anchoring system to serve as the unit's foundation (FEMA 2009). If this foundation fails or increasing flood waters changes the site's stability, occupants may face increased risks of property damage or other harm.

In the three municipalities studied for inland flooding, many LMI residents face moderate or high inland flooding (Table 5-42). By 2070, approximately half of all three municipalities' LMI residents will be exposed to serious inland flooding. In Belle Glade, exposed LMI residents in 2070 will represent more than a third of the total population. In Pahokee, all residents meet the LMI criteria, so the percentage of LMI population exposed is the same as the percentage of the jurisdiction's total population exposed. Under current scenarios, more than half of the LMI population in South Bay is exposed to moderate or high inland flooding; by 2070, an additional 3 percent of LMI residents will face serious inland flooding exposure.

Table 5-42. LMI Population Sensitivity to Inland Flooding in Palm Beach County

Jurisdiction	Present (and 2040)				2070			
	LMI Population		% of LMI	% of Total	LMI Population		% of LMI	% of Total
	Moderate	High	Population	Population	Moderate	High	Population	Population
Belle Glade	2,300	990	40%	31%	2,426	1,250	45%	34%
Pahokee	875	189	47%	47%	977	288	56%	56%
South Bay	113	69	51%	15%	93	99	54%	16%

Sensitivity: Storm Surge

Households with limited incomes may lack the capital needed for mitigation projects that would protect their property from storm surge. They also may rent their home rather than owning and therefore have limited control over improvements to the structure. For those that live in public housing or manufactured, residents may face elevated sensitivity due to a building's age and construction materials. If their unit is damaged during a storm surge event, this could lead to compounding health impacts, such as if mold develops or they must temporarily shelter elsewhere due to the unit's conditions. Additionally, manufactured housing is typically built on land that has been stabilized to provide a strong anchoring system as the unit's foundation (FEMA 2009). However, if the area is affected by storm surge, depending on the velocity and volume of water, these anchoring systems could be weakened or damaged, increasing the risk for potential damage.

Due to the limited geographic extent of the SLOSH Categories 1 and 5 storm surges, less than 0.1 percent of the LMI population is considered exposed to storm surge under both scenarios.

Sensitivity: Wind

Many PBC residents are exposed to the impacts of strong wind events, but some are more vulnerable to adverse impacts. Public housing units tend to be older, making them more likely to have been built before more resilient design standards were introduced. Additionally, individuals that rely on public housing likely have limited incomes or underlying conditions, such as a physical disability or chronic illness, that makes it challenging for them to evacuate or find temporary shelter (NLIHC & PAHRC 2021). Similarly, occupants of manufactured housing can face elevated sensitivity to adverse impacts, especially if they live in an older unit. For example, Hurricane Andrew caused such severe damage to manufactured homes that the federal requirements for manufactured housing were overhauled to prevent future impacts (FEMA 2009). Manufactured housing is required to be able to withstand certain wind conditions, such as speed and pressure, through the federal design requirements, including the strength of its anchoring system.

Some may require short-term shelter (see Table 5-43), as was required during Hurricane Irma and similar storms. During a 100-year event (i.e., 1 percent annual probability), 21 percent of PBC residents will be required to evacuate to shelter. Due to differences in the hurricane tracks used for the 100- and 500-year event simulations, fewer individuals are required to shelter during a 500-year event (i.e., 0.2 percent annual probability), despite the likely greater severity. To minimize misinterpretation of these results, this analysis focuses on impacts to the focus areas and unincorporated areas.

Much of the risk due to wind events is concentrated in the more heavily developed portions of the County, especially those exposed to the Atlantic Ocean. Compared to these areas, the assessment focus areas exhibit less sensitivity. Approximately 2 percent and 7 percent of residents in unincorporated areas will be required to shelter during 100- and 500-year wind events, respectively.

Table 5-43. Population Sensitivity to Wind in Palm Beach County

	Jurisdiction	100-Year		500-Year	
		Population Requiring Short-Term Shelter	% of Total	Population Requiring Short-Term Shelter	% of Total
Focus Areas	Belle Glade	79	<1%	60	<1%
	Pahokee	14	<1%	84	3%
	South Bay	32	3%	13	1%
	Unincorporated Areas	12,945	2%	44,342	7%

Communities with large LMI populations, such as Belle Glade, may experience heightened sensitivity. LMI populations may have limited capital to mitigate their properties from high wind impacts, such as through landscaping or tree trimming. They may be unable to pay for repairs incurred from these events, especially if they rent their home and have limited control over physical changes to the structure.

Wind produces significant debris that can be cost- and time-intensive for municipalities to remove before beginning to repair and recover after a hazard event. Due to differences in the hurricane tracks used for the 100- and 500-year event simulations, some jurisdictions are estimated to experience less damage if impacted by the 500-year storm, despite the likely greater severity. To minimize misinterpretation of these results, this analysis focuses on impacts to the focus areas and unincorporated areas.

For instance, a 100-year wind event is expected to cause nearly $2.4 million in damage to the County's assets in unincorporated areas (see Table 5-44). The unincorporated areas exhibit the highest sensitivity to high wind events, with over 5 percent of the total estimated damage.

Table 5-44. Asset Sensitivity to Wind in Palm Beach County

		100-Year		500-Year	
	Jurisdiction	Asset Damage (Replacement Cost Value)	% of Total	Asset Damage (Replacement Cost Value)	% of Total
Focus Areas	Belle Glade	$44,411,580	4%	$42,114,557	4%
	Pahokee	$11,253,166	2%	$41,868,272	9%
	South Bay	$4,543,889	6%	$2,524,942	3%
	Unincorporated Areas	$2,399,742,600	5%	$6,624,813,634	15%

A 500-year wind event is expected to incur over $6.6 million in asset damage throughout the unincorporated areas in the County. IAs previously noted, some municipalities exhibit lower damage during a 500-year event than the 100-year event, due to the different hurricane tracks used for modeling each scenario.

Sensitivity: Wildfire

Wildfires can cause significant property damage, as well as resulting in lingering environmental health issues. For individuals with limited access to capital or resources, these impacts can affect their ability to access safe housing and working conditions. Households with limited incomes may face challenges accessing medical care or health resources following a wildfire, especially if there are longer term impacts, such as poor air quality. Additionally, LMI populations may have limited capital to mitigate their properties to reduce their risk to wildfires, such as through landscaping. They may be unable to pay for repairs incurred from these events, especially if they rent their home and have limited control over physical changes to the structure.

Where one lives influences sensitivity to wildfire as much as what type of unit one occupies. Public housing units tend to be older, making them more likely to pre-date resilient building standards, such as siting and ventilation requirements. For example, approximately 22 percent of all federally assisted housing units are in the wildland-urban interface areas, which refers to transition areas between those containing wildfire fuel (i.e., vegetation) and developed areas (NLIHC & PAHRC 2021). Additionally, individuals that rely on public housing may have limited incomes or underlying conditions, such as a physical disability or chronic illness, that makes it challenging to evacuate or find temporary shelter during a wildfire (NLIHC & PAHRC 2021). Similarly, manufactured housing units are more likely to be exposed to wildfires due to where they are sited, in addition to the materials used for their construction (Pierce, Gabbe and Rosser 2022). Depending on where their unit is located, residents may also experience difficulties evacuating if they live in isolated or rural locations.

As shown in Table 5-45, about one-third of the County's total LMI population is exposed to wildfires. In small communities, nearly all the LMI populations are expected to be exposed, such as in Pahokee, South Bay, and West Palm Beach. In Pahokee and West Palm Beach, the LMI populations exposed to wildfires represent about two-thirds of each municipality's total population. Overall, LMI populations in PBC face lower exposure to wildfires than the general population.

Table 5-45. LMI Population Exposure to Wildfire in Palm Beach County

	Jurisdiction	Population			% of LMI	% of Total
		Low	Moderate	High	Population	Population
Focus Areas	Belle Glade	1,583	5	4	19%	15%
	Pahokee	2,129	113	16	100%	67%
	South Bay	345	2	0	98%	29%
Other Affected Areas	Westlake	607	7	0	100%	66%
	Haverhill	692	0	0	39%	30%
	Loxahatchee Groves	793	381	29	100%	26%
	Royal Palm Beach	6,517	854	1,152	69%	22%
	Unincorporated Areas	94,875	12,192	6,638	41%	17%
	Palm Beach County	160,281	21,441	14,207	32%	13%

6.0 SUMMARY AND ANALYSIS OF RESULTS

Intuitively, the coastal communities are identified as areas that will likely be tidally affected, generally areas east of Interstate 95. The coastal focus of the analysis includes HTF, SLR, and storm surge impacts. The 2040 High Tide Flooding exposure map series shows flooding that is concentrated along waterfront areas. This would change by the year 2070 when high-tide water encroaches further inland into communities near or adjacent to open waterways. By the year 2100, the flooding would encroach inland to a greater extent.

During a Category 1 storm, less than 1 percent of PBC land area is expected to be affected by storm surge. Affected areas lie along the County's coastline, where storm surge occurs. The western municipalities included in the focus areas (Belle Glade, Pahokee, and South Bay) were not affected by storm surge scenarios. Several coastal communities are expected to experience significant inundation during Category 5 events. For instance, nearly three-fourths of South Palm Beach's land area would be inundated, as well as more than half of Gulf Stream and Briny Breezes.

While SLR impacts also become progressively more severe, the flooded areas contain a lower number of the assets that are the focus of this analysis. The exceptions to this are the Burt Reynolds Park area in Jupiter, Palm Beach Shores, and South Palm Beach/Manalapan where boat ramps, town halls, police stations, and a fire station are potentially impacted by SLR in either 2070 or 2100.

The potential for rain-driven flooding is not limited to one sector. Modeling for extreme rain events of varying intensity and duration was completed for all areas within the County, and results showed rain-induced flooding in low-lying areas dispersed throughout the County. Focused hydrologic and hydraulic modeling was completed for the western communities to highlight portions of the cities that are more prone to rainfall-driven flooding. Results are presented in the County's HUD CVA.

Within the analysis, over 7,000 assets owned or maintained by the County were analyzed. Of these, 526 critical assets vulnerable to flooding were identified within 25 flooding hot spot areas throughout the County, and have been prioritized for consideration of adaptation measures. Communities within these flooding hot spot areas are listed in Table 6-1. The asset types contained in these flooding hot spots include pump stations, roads, fire stations, emergency facilities, healthcare facilities, assisted living facilities, community support buildings, schools, historic structures, and similar resources. Specific assets vulnerable to flooding include facilities such as PBC Fire Rescue Station #55, Westgate Community Center, PBC Water Utilities Department (WUD) Western Region North Wastewater Treatment Facility, PBC WUD Western Region Wastewater Treatment Facility, PBC Water Treatment Plant #11, and others. These specific assets serve critical functions in PBC and flooding events can lead to significant operational disruptions, potential environmental hazards, public health risks, and costly damage to infrastructure. A full list of prioritized assets occurring within the flooding hot spots is included in **Appendix D**. Ensuring the resilience of PBC's critical assets is vital for the continued provision of safe public services in the County.

Table 6-1. Communities within Flooding Hot Spots

Communities with Critical or Regional Assets	Hot Spot
Atlantis	9
Belle Glade	18 through 23
Boca Raton	13 and 14
Boynton Beach	11
Cloud Lake	6 and 7
Delray Beach	11
Glenridge	6 and 7
Golf	11
Greenacres	9
Haverhill	6 and 7
Jupiter	1
Lake Clarke Shores	7
Lake Park	2
Lake Worth	10
Lantana	10
Manalapan	10
Pahokee	15, 16, and 17
Palm Beach	10
Palm Beach Shores	3
Palm Springs	7, 8, and 9
Riviera Beach	2 and 3
South Bay	24 and 25
South Palm Beach	10
Unincorporated Palm Beach County	12 and 13
West Palm Beach	4, 5, 6, and 7

6.1 Flooding Implications

SLR, HTF, and tidal inundation are flood indicators used in the context of climate change and its impact on coastal and low-lying areas. However, they refer to slightly different phenomena:

- **SLR** is a gradual increase in the average level of the world's oceans. It can intensify coastal erosion; increase the risk of coastal flooding; result in saltwater intrusion; and lead to the loss of habitat for plants, animals, and even humans.
- **HTF**, sometimes referred to as "nuisance flooding" or "sunny day flooding," occurs when, absent of storms or rainfall, tides reach 2 feet above the current MHHW (the FDEP threshold) and may begin to flood onto streets or other areas that are historically dry. While often associated with specific high tide events, HTF is becoming more frequent with SLR and it provides a glimpse into the future when these water levels will be increasingly common disrupting daily life by flooding roads, overwhelming drainage systems, and damaging property.

- **90 Days of Tidal Inundation** refers to a specific metric used to assess the areas experiencing a persistent impact from SLR and HTF. In this analysis, 90 days or one-fourth of a year has been chosen as a benchmark to highlight areas that are currently, or will at some point in the future, experience flooding from tidal impact. It helps in planning and preparing for increased flooding events, identifying vulnerable infrastructure, and implementing adaptation strategies.

Table 6-2 focuses on two key elements of tidal flooding analysis (flood indicators): 1) SLR/HTF, which is an inundation scenario capturing the extent of levels tied to the average of the highest of the high tides (MH or MHHW), and 2) Days of Tidal Flooding, which incorporates a duration component. Land inundation represents the physical area (in acres) that will be submerged by each type of flood impact. Viewing the two indicators together, Table 6-2 below provides a snapshot of the tide range that will impact the landscape of Palm Beach County under the 2040, 2070, and 2100 planning horizon.

Table 6-2. Future Land Inundation from Flood Indicators

Projection (Year)	NIL SLR + HTF (acres)	NIL 90 days of Tidal Inundation (acres)	NIH SLR + HTF (acres)	NIH 90 Days of Tidal Inundation (acres)
2040	1,091	266	1,889	8,379
2070	1,644	8,350	5,642	9,258
2100	2,336	8,539	13,771	14,194

Note: Data in this table is based on SLR and tide extent 90 days of the year.

PBC is a partner in the Southeast Florida Regional Climate Change Compact (SEFRCCC). The SEFRCCC has developed and adopted the 2019 Regionally Unified Sea Level Rise Projections for Southeast Florida. The Unified Sea Level Rise projection for Southeast Florida, updated in 2019, projects the anticipated range of sea level rise for the region from 2000 to 2120. The projection can be used to estimate future potential sea level elevations in Southeast Florida and the relative change in sea level from today to a point in the future. The projection is intended to inform adaptation strategies and policies and is offered to ensure that all major infrastructure projects throughout the Southeast Florida region have the same basis for design and construction relative to future sea level. To relate both the Section 380.093 statutorily required scenario requirements and those of the SEFCCC, a summary chart (Table 6-3) and exposure map series (**Appendix B**) have been created to indicate the inches of projected sea level rise.

Table 6-3. Key West Tide Gauge Sea Level Rise Projections Comparison (Inches)

Projection (Year)	NIL (2017) 1/	IPCC Median/SEF RCCC 2019 2/	NIL (2022) 3/	NI (2022) 4/	NIH (2017) SEFRCCC 2019 5/	NIH (2022) 6/	NH (2017) 7/
2000	0	0	0	0	0	0	0
2020	4	5	4	4	7	4	8
2040	8	10	9	10	17	11	21
2070	15	21	17	22	40	31	54
2100	21	33	26	44	74	64	103

1/ Consistent with Section 380.093, F.S. at the time of project launch.

2/ 2019 SEFRCCC Unified SLR Low projections for 2040, 2070, & 2120 (Appendix B exposure map series is limited to 2100).

3/ NIL and consistent with new Section 380.093(3), F.S. requirements adopted 2024.

4/ 2022 NI is consistent with new Section 380.093(3), F.S. requirements adopted 2024.

5/ Consistent with Section 380.093, F.S. at the time of project launch and is the same projection as 2019 SEFRCCC Unified SLR Upper Unified SLR projections for 2040, 2070, & 2120.

6/ Modeling Memo recommended this prior to adoption of new sea level rise projections in 2024.

7/ 2019 SEFRCCC Unified SLR Low projections for the NOAA High curve as the upper boundary for medium and long-term use (beyond 2070 so modeled for the 2100 condition).

Note: SEFRCCC Unified SLR Scenarios

Section 380.093 Scenarios

New (2024) Section 380.093 Scenarios

Exposure Map Series (**Appendix B**)

6.2 Critical Assets Prioritized by Asset Class

By identifying various flooding hot spots of vulnerability, each with unique assets and inherent risks, appropriate adaptation strategies can be developed for assets in five critical domains: 1) transportation infrastructure; 2) critical infrastructure; 3) critical community and emergency facilities; 4) the preservation of natural, cultural, and historical resources; and 5) regionally significant assets.

Within these high-risk areas, further in-depth analysis of the assets was conducted to determine the potential impacts to County functions if the assets were compromised by flooding. This final step guarantees the accurate identification of the most flood vulnerable areas and assets in PBC, providing a foundation for the development of targeted mitigation and adaptation strategies. The full list of prioritized critical assets impacted by flooding is included as **Appendix D**.

Numerous adaptation strategies will be evaluated in the RAP for the prioritized critical assets including, but not limited to, the following:

- Acquisition/Relocation/Demolition
- Stormwater Drainage Improvements
- Outfall Improvements
- Collection Systems/Pumping Stations
- Bulkheading/Tide Check Valve Projects
- Coastal Revetment
- Bank and Soil Stabilization
- Roadway Elevation
- Wind Retrofit
- Post-disaster Code Enforcement

- Safe Room Construction
- Green Infrastructure
- Wet and Dry Floodproofing
- Nature Based Solutions

6.3 Transportation Assets and Evacuation Routes

The roadway system in PBC serves many purposes: connecting neighborhoods and business centers, serving as evacuation routes, providing main routes to hospitals, and allowing efficient movement for emergency vehicles.

An investigation of the flooding hot spot areas and coordination with the Steering Committee identified the following priority road segments under control of the County that are at risk of flooding. Table 6-4 showcases a range of noteworthy transportation assets in PBC.

Adaptation strategies for roadways and evacuation routes include:

- Increasing the road crowns,
- Raising road elevations,
- Additional roadside ditches and swales to increase flood protection,
- Temporary pumps for emergency events, and
- Protective walls and other hardening structures.

Table 6-4. Palm Beach County Transportation Assets

[redacted]

The PBC Engineering and Public Works Department is responsible for all County-maintained roadways and right of ways including 3,500 lane miles of paved roads. PBC is also responsible for eight bridges over the Intracoastal Waterway and also maintains various types of fixed structures including interstate and highway overpasses, canal crossings, pedestrian bridges, golf course underpasses, and stormwater control structures. Ensuring resilience for roadways in PBC involves a multi-faceted approach focusing on infrastructure durability, environmental considerations, and effective planning to ensure roadways remain safe and functional under future climate risks.

6.4 Critical Infrastructure

This category includes public assets, networks, and essential systems that were identified within the 25 flooding hot spot areas. These are assets that are critical to maintain the County's functionality. Included in this category are lift stations, stormwater treatment facilities and pump stations, electric production and supply facilities, microwave service towers, cellular towers, and similar assets. The critical infrastructure assets are affected by all flood scenarios evaluated in the exposure analysis including SLR, high tide flooding, rainfall, storm surge, and compound flooding. Table 6-5 showcases a range of noteworthy transportation assets in PBC.

Table 6-5. Palm Beach County Critical Infrastructure

[redacted]

6.5 Critical Community and Emergency Facilities

This category includes educational and community centers, emergency operation centers, relief centers, fire stations, hospitals, law enforcement facilities, local government facilities, affordable public housing, and similar facilities. In all cases, the loss of service from these assets would be catastrophic to the community, and all such facilities within the flooding hot spot areas were identified and prioritized. Table 6-6 showcases a range of noteworthy critical community and emergency assets in PBC.

Table 6-6. Palm Beach County Critical Community and Emergency Facilities

[redacted]

6.6 Natural, Cultural, and Historical Resources

This category includes assets such as conservation lands, parks, shorelines, surface waters, wetlands, and historical and cultural assets. These resources provide a sense of place and uphold the County's heritage. PBC's natural resources play a vital role in its identity, characterized by its diverse ecosystems and landscapes. These resources reflect the County's natural heritage, contributing to the County's aesthetic appeal and serving vital ecological functions. They provide habitat for wildlife species, from nesting sea turtles to migratory birds. Additionally, these ecosystems can act as natural buffers, offering mitigation against climate-related flood hazards such as flooding. Moreover, PBC's natural areas offer abundant recreational opportunities for residents and visitors alike. As stewards of these invaluable resources, PBC is committed to preserving and protecting its natural heritage for future generations to enjoy. The County's rich history is a cornerstone of its identity, reflected in its diverse array of historic structures and architecture. The County's historic resources serve as a testament to PBC's growth, character, heritage, and pride. Historical resources serve as tangible links to the people and events that have shaped PBC into the County it is today. The County acknowledges the threat that flood hazards pose to its historical resources. Climate change, with its associated risks such as SLR and increased flooding, poses a substantial challenge to the preservation of the County's historical assets. A number of PBC's historical resources are at risk due to the flood hazards analyzed within this report. Table 6-7 showcases a range of noteworthy natural, cultural, and historical resources in PBC.

Table 6-7. Palm Beach County Natural, Cultural, and Historical Resources

[redacted]

6.7 Regionally Significant Assets

Regionally significant assets are crucial facilities that serve a broad geographic area, extending beyond individual communities and not typically owned or maintained by the County. These assets cater to the needs of various communities across different geopolitical boundaries and include water resource facilities, regional medical centers, emergency operation centers, regional utilities, major transportation hubs, airports, and seaports. Recognizing and safeguarding these assets enhances regional resilience and response capabilities.

Statutorily, these assets include Commercial and Strategic Intermodal System ports, spaceports, waterways, railroad crossings, railroads, rail terminals, rail bridges, bus terminals, evacuation routes, electric power plants, electric power transmission lines, dams, and drainage systems managed by water management districts. Additionally, essential facilities such as stormwater ponds, wastewater treatment plants, public water supply tanks, public water supply facilities (excluding federal ones), emergency medical services centers, emergency operations centers, general population risk shelters, and special needs risk shelters are crucial for meeting the infrastructure and safety needs of multiple regions. Table 6-8 showcases a range of noteworthy regionally significant assets in PBC.

Table 6-8. Palm Beach County Regionally Significant Assets

[redacted]

7.0 POLICY IMPLICATIONS

Policy, Land Use, and Development

When conducting a CVA, an immense amount of data and analysis is generated, but a key component is what the community does with that information. A primary way that a community can make better decisions based on the outcomes of a CVA is through their budget, infrastructure design, and land use and development policies. Each of these examples is discussed in this section.

Budget Implications

This CVA can help the County target investments into priority areas through focusing on the flooding hot spots identified in this document. The flooding hot spots show current and increasing flood risk based on the type of flooding. For flooding hot spots that are tidally influenced, shoreline defense measures such as living shorelines, or controlling other tidal impacts through backflow prevention on stormwater outfalls, can be strategies to help alleviate that type of tidal flood impact. These types of strategies can help protect the critical assets identified in those hot spots as well as the property and business owners relying on those assets for their day-to-day quality of life. For flooding hot spots where rainfall is the primary driver of current and future flood risk, generally, these areas already align with known flood-prone areas and will be reflected in any updated, more advanced hydrological modeling which could serve as a further check and balance on stormwater improvement priorities. Prioritizing investments in these areas can maintain or improve stormwater levels of service defined with the County's Comprehensive Plan and Code, and again assist in targeting investments to the areas that will be impacted the soonest. These strategies of prioritization would essentially take place in the County's capital improvements and budgeting processes.

Infrastructure Design

When designing infrastructure in the County, there are two basic concepts: the actual design of a project, and the level of service it provides. A couple of examples in the County's Code and Comprehensive Plan are provided to demonstrate this concept and how this CVA can help shape those policies based on its outcomes.

Stormwater

In the Unified Land Development Code (ULDC), the County design standards requirements for stormwater management systems are contained within Article 11 of the ULDC and are generally related to Secondary Stormwater Systems as follows:

- Secondary facilities for each residential, commercial, and industrial development exempt from SFWMD permitting pursuant to Chapter 40E-4, F.A.C., except an individual residential lot containing not more than two dwelling units, shall be designed and constructed on site, or otherwise be provided through authorized connection to off-site secondary facilities, so as to limit the discharge rate at the point of legal positive outfall to not more than the peak runoff rate produced by the site under pre-development conditions for both the 3-year, 1-hour, and the 25-year, 72-hour rainfall events, and either:

- Detain the greater of the first 1 inch of runoff or the total runoff from the 3-year, 1-hour rainfall event; or
- Retain the initial portion of runoff in an amount equal to one-half of that required to be detained.

In the County's 2024 Comprehensive Plan, the level of service for drainage is as follows in the Stormwater Management Sub-Element:

Levels of Protection Standards

- As established in this Sub-Element, these standards represent degrees of protection provided for various development features expressed in terms of storm events to be accommodated by the applicable drainage facilities. As a result, these standards are levels of protection to be provided at development design of on-site stormwater management facilities, and do not constitute levels of service standards to be provided by off-site (public) conveyance facilities. They include site performance standards used as minimum design requirements for tertiary drainage systems (see Policy 1.1-a, Table 1); and minimum requirements for on-site secondary drainage systems for discharge control and treatment of stormwater runoff, based on criteria of the agency having jurisdiction over the receiving waters (see Policies 1.1-b and 1.1-c).
- Policy 1.1-b: The level of protection provided by on-site secondary drainage systems for discharge control shall not exceed the discharge limit established by the agency having jurisdiction over the receiving water at the point of outfall. If not otherwise specified, post-development peak discharge shall not exceed the pre-development peak rate based on the 25-year, 3-day storm.
- Policy 1.1-c: The level of protection provided by on-site secondary drainage facilities for treatment of stormwater runoff shall be, as a minimum, the volume and duration of required retention or detention as specified by SFWMD criteria.

The existing development level of service for a 25-year, 3-day design storm may be a very low level of service, but it should be recognized that much of the land area where growth, development, and redevelopment is occurring is located within municipal boundaries subject to independent policies of those areas. That said, there are opportunities to improve this level of service through new capital projects or larger redevelopment projects on a case-by-case basis. The results of the CVA indicate potentially higher volume rainfall events (1.16 times more rainfall in 2040 than present day and 1.21 times more rainfall in 2070). A recommendation may be to reevaluate these adopted level of service standards in the Comprehensive Plan based on the information in this CVA.

Land Use / Land Development

Land use and land development policies generally control how and where projects are developed. There is, however, the potential to address new development to determine if improvements in level of service delivery for stormwater and flooding are possible. It should be noted, however, that redevelopment opportunities also exist to make improvements. Recommended policies that the County should examine in relation to increasing flood risk include the following:

- Adhering to the County's Flood Damage Prevention Ordinance in Article 18 of the ULDC. Key provisions may include enhanced freeboard in certain areas of the County or for substantial improvements.
- Requiring enhanced pervious surfaces in the landscaping requirements (Article 7 of the ULDFC).
- Facilitating uniform shoreline design standards that harmonize concepts of seawall heights, promoting living or hybrid shorelines in key locations, and tying useful life of shoreline improvements to future flood risk.

7.1 Integration of Results into Palm Beach County's Local Mitigation Strategy

Coordination with the PBC Local Mitigation Strategy (LMS) also played a crucial role in determining the priority of the analysis. Section 1 of the current version of the Local Mitigation Strategy 2024 draft document identifies hazards or areas of concern developed by the Local Mitigation Strategy Working Group (Palm Beach County 2024). Those include the following areas:

- Loss of life
- Loss of property
- Community sustainability
- Health/medical needs
- Sheltering
- Adverse impacts on natural resources (e.g., beaches, water quality)
- Damage to public infrastructure (e.g., roads, water systems, sewer systems, and stormwater systems)
- Economic disruption
- Fiscal impact
- Recurring damage
- Redevelopment/reconstruction
- Development practices/land use
- Intergovernmental coordination
- Public participation
- Repetitive flood-loss properties
- Historical structures

The County's CVA and RAP are a pivotal component that integrates with and supports the objectives of PBC's LMS. It is intended to summarize vulnerabilities and support the ongoing efforts included in the County's LMS for reducing the community's vulnerability to identified natural, technological, and human caused hazards. The RAP will provide foundational data for comprehensive mitigation planning, aiding in cost-effective project identification and prioritization, securing funding strategies and recommendations, and aligning with state and federal guidelines. It will offer insights into the County's vulnerabilities to specific hazards, including their likelihood, magnitude, and potential impacts on critical assets, infrastructure, and communities. Furthermore, the CVA and RAP can contribute to the LMS Prioritized Project List of mitigation projects, allowing for future funding eligibility and efficient resource allocation. This contribution will ensure that the County focuses on its most pressing hazards. The results from the CVA and RAP will also provide the LMS' working group and sub-committees with essential data to make informed data-driven decisions surrounding mitigation and policy making. Both the LMS and RAP place a strong emphasis on public engagement and awareness. By leveraging the insights and findings from the CVA and RAP, the LMS will be well-equipped to strengthen community resilience.

8.0 RECOMMENDATIONS

The overarching objectives of this CVA revolve around the comprehensive acquisition of data and the evaluation of threats posed by climate hazards. The results of this analysis will inform the formulation of the RAP. PBC's CVA revealed the County's potential susceptibilities to the adverse impacts of climate threats. These hazards include coastal erosion, drought, extreme heat, inland flooding, storm surge, wind, and wildfire. Present day and future climate hazard scenarios alongside County assets were mapped to determine risk. Then characteristics were identified to determine vulnerability levels to the climate hazards.

The following items, organized by hazard, should be considered to enhance the overall understanding of climate related risks and inform future planning efforts for the County:

All Hazards

- Create an updated user-defined general building stock and critical facilities dataset using up-to-date parcels, footprints, and values from the RSMeans Data (cost data software) inventory.
- Use updated and current demographic data.
- Using assessor data, include updated occupancy class attributes in general building stock and critical facilities.

Extreme Temperatures

- Track extreme temperature data for injuries, deaths, shelter needs, agricultural losses, and other impacts to determine distributions of most at-risk areas.
- Future land development data from the County may be utilized and explored through a qualitative analysis.

Flood

- The general building stock inventory and critical facilities can be updated to include attributes regarding first floor elevation and foundation type (pier, slab on grade, etc.) to enhance loss estimates.
- As more current FEMA floodplain data becomes available (i.e., Digital Flood Insurance Rate Maps), update the exposure analysis and generate a more detailed flood depth grid that can be integrated into the current Hazus version.
- Conduct a Hazus loss analysis for more frequent flood events (e.g., 10- and 50-year flood events).
- Conduct a repetitive loss area analysis.
- Continue to expand and update urban flood areas to further inform mitigation.

Storm Surge

- The general building stock inventory and critical facilities can be updated to include attributes regarding protection against strong winds, such as hurricane straps, to enhance loss estimates.

Wildfire

- General building stock inventory and critical facilities can be updated to include attributes such as roofing material or fire detection equipment or integrating distance to fuels as another measure of vulnerability.

9.0 CONCLUSION

The overarching objectives of this CVA revolve around the comprehensive acquisition of data and the evaluation of the timing and impact from climate hazards. Critical assets throughout the County were identified and ranked for criticality based upon flooding impacts (**Appendix D**). Flooding inundation was mapped (**Appendix A**) across the County and regions with clusters of critical assets identified as flooding hot spots and labeled sequentially according to geographic location and timing of impact (**Appendix C**). Modeling of multiple climate scenarios was conducted, both individually and in combinations. These hazards include storm surge, tidal flooding, rainfall-induced flooding, SLR, wildfire, coastal erosion, extreme heat, drought, wind, and compound flooding. Present day and future climate hazard scenarios alongside County assets were mapped in many scenarios to determine risk. Characteristics were then identified to determine vulnerability levels to the climate hazards. Throughout the process, community engagement and education fostered an awareness and understanding of the relevant topics. PBC's CVA revealed the County's potential susceptibilities to the adverse impacts of climate hazards.

The assessment should be used to guide land use regulations, building codes, land development policies, emergency response strategies, and asset adaptation projects, and inform various justice, equity, diversity, and inclusion initiatives associated with climate resilience adaptation planning (CDC 2022). Integration of these components into the resilience framework of the RAP will result in an equitable and inclusive adaptation response, particularly addressing the needs of those disproportionately affected by climate risks. These justice, equity, diversity, and inclusion initiatives are integral to the adaptation strategy, ensuring that climate resilience adaptation planning not only protects physical assets, but also supports the social fabric of the community. The information provided by this assessment allows decision makers to implement measures that reduce vulnerability and mitigate future harms in a staged manner. The CVA also aims to facilitate collaboration between communities surrounding the long-term goals of sustainable coastal management and environmental conservation. The project process, guided by science, community engagement, and expert input, lays the groundwork for a resilient County.

Palm Beach County Resilience Action Plan

The County will use the results of the CVA to develop a County-wide RAP. The RAP will serve as an implementation roadmap for climate adaptation and mitigation strategies. The RAP will provide a comprehensive framework for increasing the County's capacity to adapt to climate change impacts, prioritizing needs, and outlining strategies, land use decisions, and investments based on the vulnerabilities identified in the CVA. Specifically addressing threats highlighted in the CVA, the RAP will set out a series of adaptation goals and actions. These initiatives will be developed with input from County staff and the community, ensuring alignment with the needs and priorities of PBC residents. Decision matrices will standardize future analysis and responses, facilitating efficient decision-making. The RAP will include a list of specific and implementable prioritized projects, along with analyses of funding options and policy recommendations. These projects aim to enhance the adaptive capacity of County assets, reducing exposure to costly disruptions and repairs while allowing the community to recover more swiftly from flood-related climate events. Together, the CVA and RAP ensure a cohesive approach to long-term resilience planning for PBC.

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