PINELLAS COUNTY

SEA LEVEL RISE & STORM SURGE

VULNERABILITY ASSESSMENT EXECUTIVE SUMMARY

DECEMBER 2022

PREPARED BY

WITH SUPPORT FROM

Contents

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Cover image: Aerial view of St. Petersburg coastline town during morning sunrise, Florida

St. Pete beach and resorts, St. Petersburg, Florida

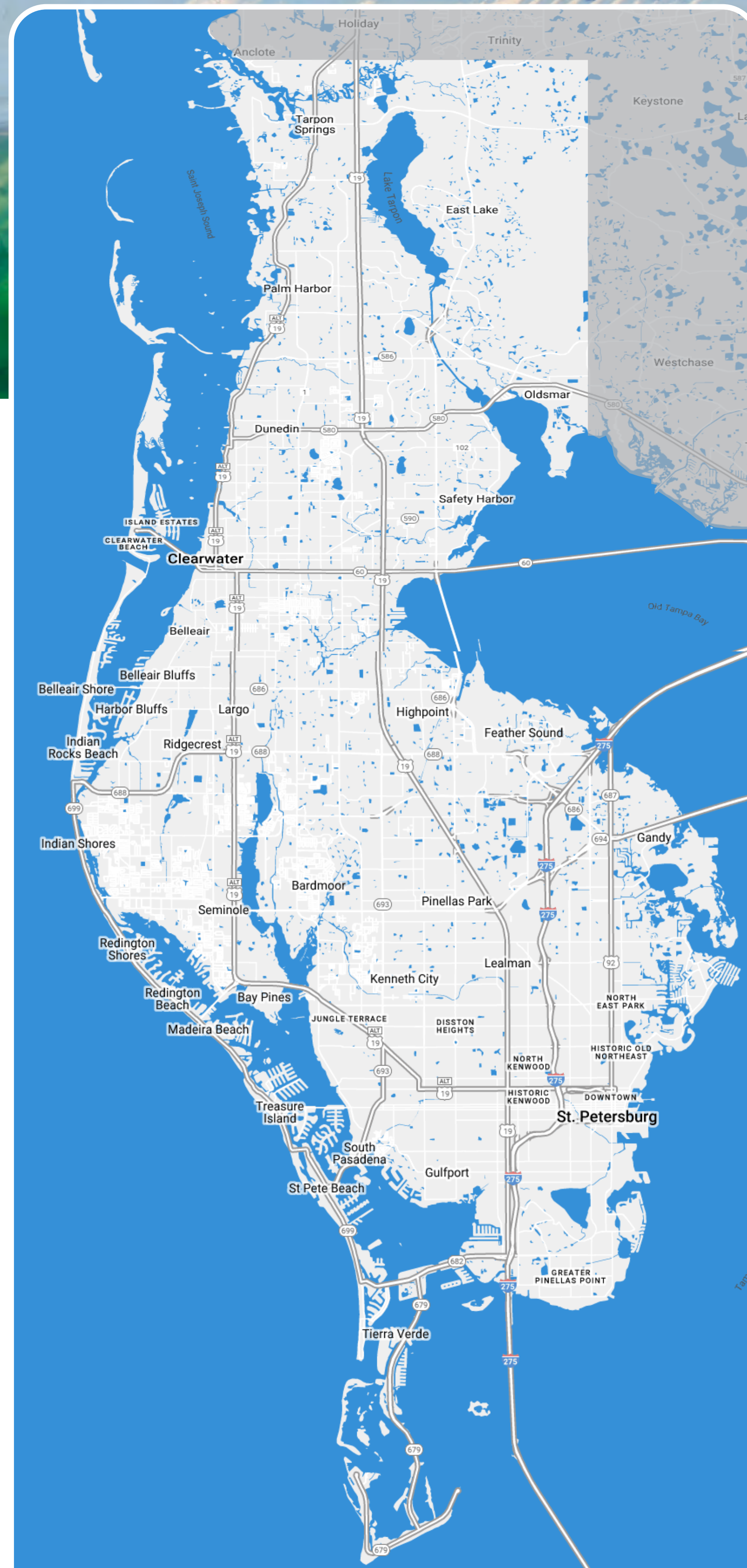
Introduction

Pinellas County, Florida is one of the most environmentally friendly and economically viable coastal communities in the country—defined, in part, by its position on the west coast of Florida between Tampa Bay and the Gulf of Mexico.

This unique geographic and culturally diverse location contains thirty-five miles of coastal beaches and approximately 590 miles of coastline. It is a community of close to one million people, and growing, that lives near and with the sea.

Pinellas County is a low-lying peninsula within a peninsula. Increasing risks from rising sea levels and storm surge require consideration of the potential consequences to the County, its municipalities and communities, and infrastructure. To better understand these changing conditions and risks, and to prioritize mitigation and adaptation strategies, the County applied for funding to assess flooding risks in detail. The County was awarded grant funding from the RESTORE Act Direct Component program, which was combined with County funds, to finance the Pinellas County Sea Level Rise and Storm Surge Vulnerability Assessment. The key foundational questions addressed in this study included the following:

- How can we gather foundational infrastructure and modeling data to inform County decisions?
- What is the timing associated with climate impacts and environmental changes?
- When can impacts be expected or worsen throughout the County and where should action be taken?
- What types of costs to the County can be anticipated from the impacts of sea level rise and storm surge conditions?
- How should investment decisions be made while taking future conditions into consideration?



Pinellas County and the Participating Jurisdictions

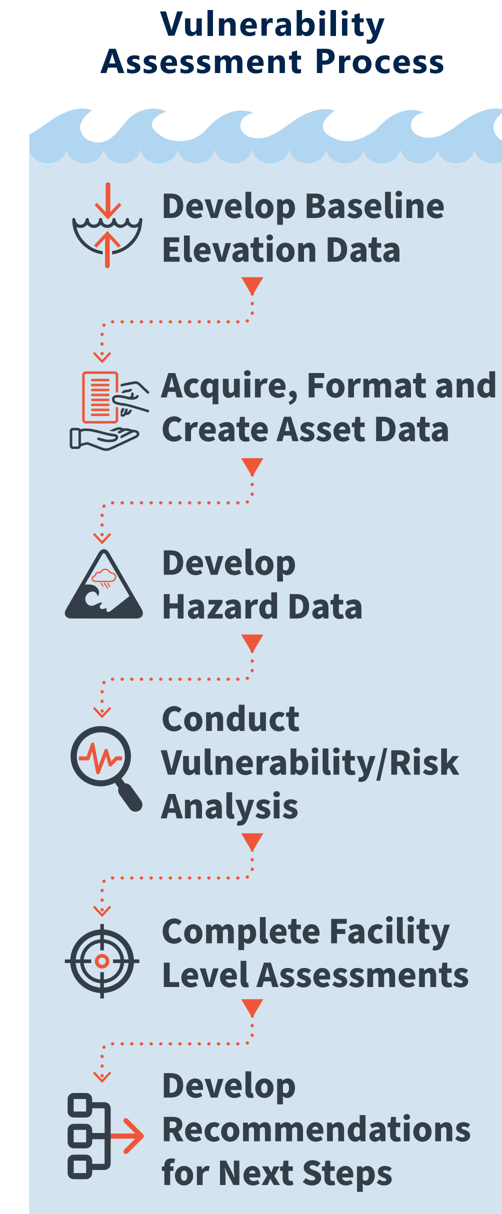
Researching these questions formed the foundation of the project. The assessment provides the County with a sound basis of data and technical information to define flooding threats and vulnerabilities, and specific actions to take to ensure the long-term viability of local communities. Overall research in the project involved identifying uncertainties associated with sea level rise and storm surge as well as helping direct and prioritize the most feasible adaptation and mitigation actions for specific critical infrastructure (see table on page 9).

Underlying analysis within the assessment required considering the consequences of exceeding the original design of critical infrastructure assets, particularly where water levels reach higher elevations than what was intended in the original design. This occurrence is anticipated to be more frequent with sea level rise, and currently, consideration of inundation exceedance is not widely implemented as an element of traditional engineering practices.

Overall, the Vulnerability Assessment included the following:

- Developed data for countywide critical infrastructure assets, noting elevations of concern where impacts from flooding may take place;
- Generated sea level rise flooding models for future tidal conditions, noting locations that are projected to either be fully inundated or frequently flooded during varying tidal events;
- Generated storm surge model data that presents probable future flooding conditions for projected sea level rise conditions;
- Conducted a facility-level analysis of flood risks and economic impacts to critical infrastructure, such as roadways and wastewater treatment facilities, noting potential costs to the County under future conditions; and,
- Developed planning and mitigation actions to prepare for future conditions.

This assessment provided the County with the groundwork to continue enhancing resiliency as a community. The study generated cause-and-effect data that can be used to communicate concerns to the diverse stakeholders that comprise Pinellas County. The Vulnerability Assessment also contributes information to and directly supports goals and initiatives within the County's Sustainability and Resiliency Action Plan (SRAP).



Skyline of St. Petersburg, Florida from the Pier

St. Petersburg, Florida, Downtown city skyline at twilight on the bay.

Building the Risk Framework for the County

Developing and applying a resilience framework in Pinellas County required the development and assembly of multiple data products to analyze the cause-and-effect relationship of sea level rise and storm surge on County infrastructure.

Defining the Parameters of Flooding

Flooding in the County is influenced by two fundamental factors that are driving increasing risks of inundation: higher prevalence of nuisance tidal events (high tide, king tide, etc.), and increasing risk from storm surge events associated with higher water levels. This study was conducted to analyze these two main conditions to support a framework for strategic decision-making.

The analysis of tidal conditions included calculating five tidal flooding frequencies as well as the maximum elevation anticipated for tidal events throughout the year. This range of data was created in part to enable effective County decision-making at the first instance of future tidal impacts.

Conceptual Diagram

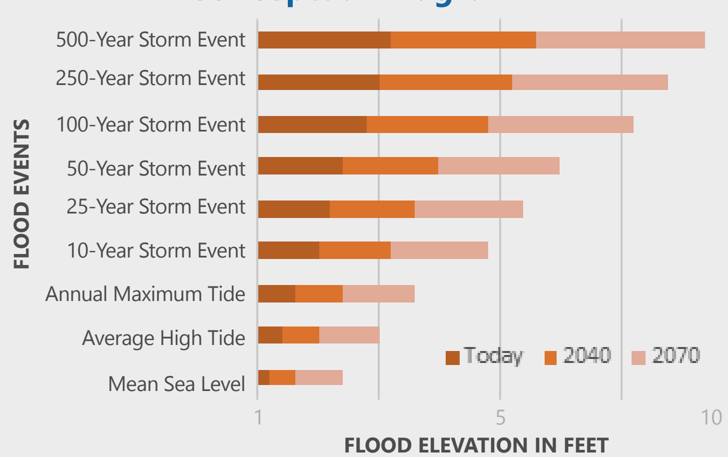


Figure 1: Water Elevations for Tidal/Storm Events—with sea level rise. Conceptual

The assessment of current and future storm surge conditions relied largely on the process established by the Federal Emergency Management Agency (FEMA) to determine the flood zones, which involves determining storm surge levels for estimated storm recurrence. A 500-year storm event describes a storm that has a one in 500 chance of being equaled or exceeded in a given year. Thus, a 500-year storm has a .2 percent probability of occurring in a given year. The 250-year, 100-year, 50-year, 25-year and 10-year storms have a .4 percent probability, 1 percent probability, 2 percent probability, 4 percent probability, 10 percent probability, respectively of occurring in a given year. As such, the University of Florida's coastal engineering department developed storm surge data that represented water elevations and depth over the landscape for various storm probabilities, while also including water depth associated with future sea level rise projections.

Figure 1 conceptually represents this modeling framework, which identifies the various flood measures that were used in this study. The full envelope of risks associated with flooding from sea level rise and storm surge were represented. Overall, this conceptual diagram demonstrates how sea level rise will affect increased flood levels in the future.

Measures of Risk and Consequence

An integrated data collection process was undertaken to collect spatial data that represented assets within the County, including both County-owned as well as those maintained by local jurisdictions. Asset locations were collected, and through coordination with County staff, the County identified water depths at each of these assets that would result in an impact to its overall function. This data set was developed to represent that each particular asset faces different levels of risk depending on specific depths of inundation. These asset-specific inundation depths, and the associated risks, can significantly aid in prioritizing vulnerable assets for mitigation and adaptation to current-day and future hazards.

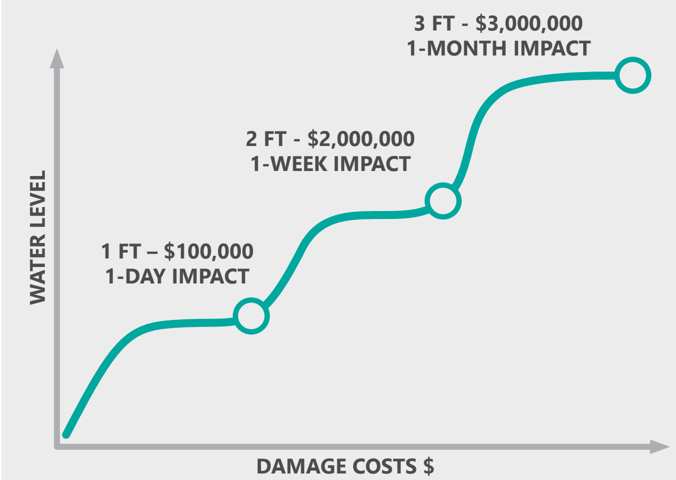


Figure 2: Representative Damage and Disruption Cost to Assets as a Function of Water Level

Figure 2 represents how this data source can be applied, showing how various water levels at a County-owned asset can trigger differing levels of consequences. This is critical information that should be included in any risk assessment framework applied to support decision-making. Of particular importance is that assessment of costs extend beyond initial repairs to the asset. These costs should comprehensively capture the broader impacts that could be faced by County residents, businesses, tourists, and other stakeholders.

Calculating Risk

Storm recurrence intervals are an estimate of storm flooding probabilities

Risks were quantified by collecting information on probability and consequence. The basic equation is risk = probability x consequence. This is the type of approach is applied by FEMA and the US Army Corps of Engineers, as well as many other agencies and emergency management entities.

A simplified version of a calculation to describe an event would be:

A 10-year return period storm (10% change of occurring) would result in $1M in damages. So, at an annual value, the calculation would be – 10% x $1M or $100,000.

The process for calculating cumulative risk (risks to an asset for all consequence levels) or present value risk (the value of all predicted risks over a defined future period) are additional calculations undertaken to determine dollar values of risks and are not presented here as they introduce increased complexities. However, these calculations follow the same general framework presented here.

This methodology was used to consider risks to aid in decision-making and as the key calculation to determine cost-effective design strategies for facility-level assessments. Going forward, the County could expand upon this countywide assessment to support investment priorities or ensure that capital investments are better informed through a holistic consideration of risk.

Sand Key, Clearwater, Florida

Scenic view of tropical and sunny Clearwater, Florida

Considering Flood Risk Hazards in Pinellas County

Sea levels are rising and subsequently storm surge is becoming more severe. These trends are expected to continue into the future, posing a risk to properties and communities in the County. This section describes these hazards in greater detail.

Sea Level Rise & Tidal Flooding

According to the National Oceanic and Atmospheric Administration (NOAA), sea level rise is caused by three key factors: thermal expansion, water runoff and glacial ice melt. Rising average global temperatures are resulting in warmer worldwide ocean temperatures, causing thermal expansion in oceans. Glaciers are melting alongside ice sheets, particularly in the Antarctic and Greenland, contributing to rising sea levels. These factors are depicted in Figure 3.

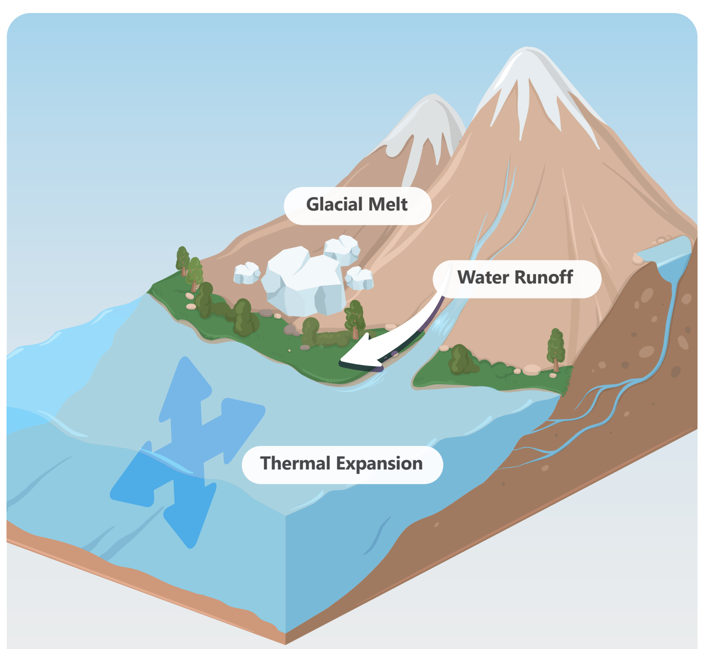


Figure 3: Causes of Sea Level Rise

The County has been experiencing the effects of sea level rise for decades. The Tampa Bay Climate Science Advisory Panel (CSAP) reports that since 1946, the water levels in Tampa Bay have increased 7.8 inches at the St. Petersburg tide gauge, which equates to roughly an inch of sea level rise per decade.

Sea levels will continue to rise, resulting in more frequent "sunny day" tidal flooding impacts within low-lying communities. The estimated rate of future change in sea levels is largely dependent on the rate and level of warming worldwide. The CSAP panel set values for sea level rise to be used by local partners to conduct their regional sea level rise, storm surge, and vulnerability assessments.[1]

Following the sea level rise recommendations from the CSAP, the selected regional sea level rise estimates are depicted in Figure 4. These sea level rise values were applied to this project to understand potential impacts to County infrastructure, resources, and assets.

Sea level rise curves are representations of changing conditions and are estimated based on research into each of the contributing elements. Because these curves are dynamic, they are updated regularly based on new findings. For the County, and for decision-making purposes, it is best to focus primarily on the timing of change, and how that change should be integrated into its processes. Of particular importance are near-term sea level rise projections; one foot of sea level rise is anticipated sometime between 2020-2050, while two feet of rise is projected between 2040-2090, and three feet between 2060 to beyond 2100, as shown in Figure 4 and Table 1.

1 http://www.tbrpc.org/wp-content/uploads/2019/05/CSAP_SLR_Recommendation_2019.pdf

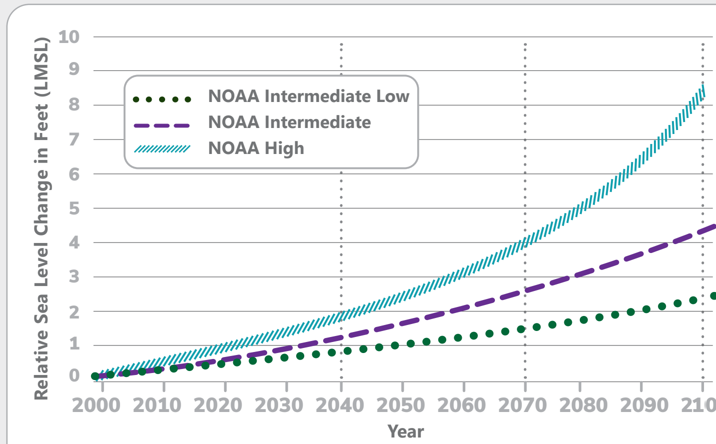


Figure 4: Selected Sea Level Rise Projections

Table 1: Data Analysis Parameters

Horizon Analysis Years	2018	2040	2070	2100	
NOAA Sea Level Rise Scenarios (Highs to 2100)	Current	1.9 Feet	3.9 Feet	8.5 Feet	
Tidal Flooding Frequencies	1,185 hours per year (Mean Higher Water)	528 hours per year (Mean Higher Water)	250 Hours Per Year	50 Hours Per Year	1 Hour Per Year
Storm Surge Return Periods	25 Year	50 Year	100 Year	250 Year	500 Year

Storm Surge

While sea level rise is an inundation concern, storm surge is likely to occur and threaten damage during storm events. Storm surge occurs when winds push ocean waters toward the shoreline during storm events. With higher sea levels, storm surge risk is anticipated to worsen due to greater depth of water being pushed toward the shoreline. Additionally, surge is projected to extend further inland due to the amount of water being pushed shoreward, shown in Figure 5.

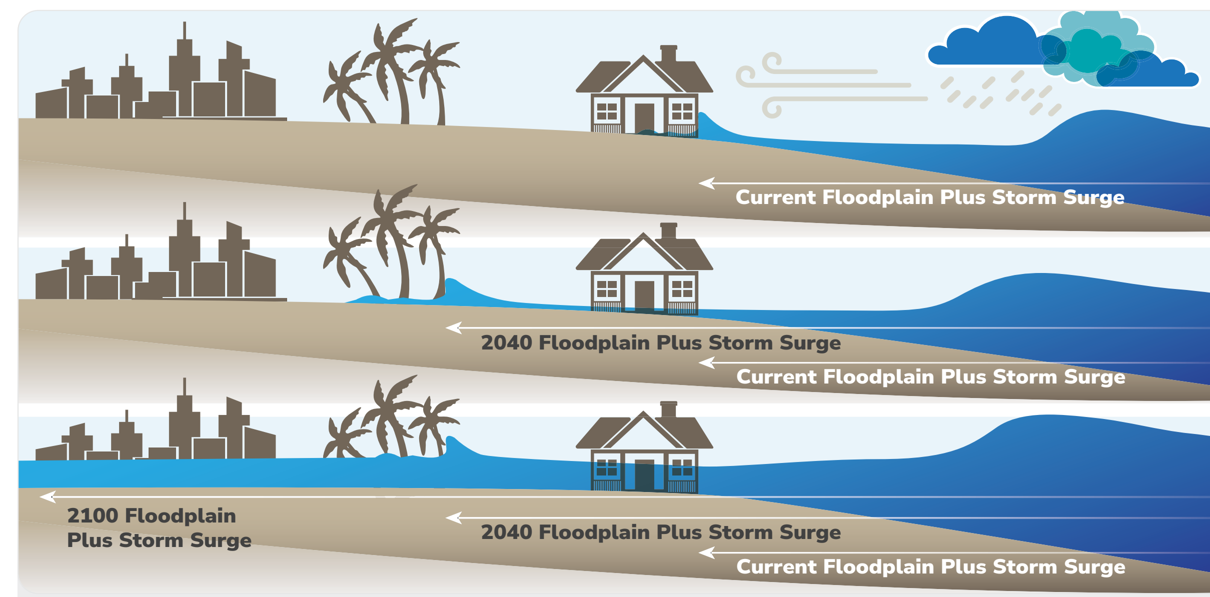


Figure 5: Storm Surge Example

Infrastructure Assets Considered

Table 2 summarizes the assets that were collected and considered in the risk assessment.

Table 2: Assets considered in the risk assessment.

CATEGORY	ASSET NAME
Airports	Airport Facility Building Footprints
	Airport Facility Footprints*
	Airport Facility Taxiways/Runways
Electricity	Power Plant Facility Building Footprints*
	Power Plant Facility Footprints
	Substation Facility Footprints*
Natural Gas	Gate Stations
	Meter Settings
	Regulator Stations
	Service Facility Building Footprints
	Service Facility Footprints*
Potable Water	Pump Station Facility Building Footprints
	Pump Station Facility Footprints*
	Treatment Facility Building Footprints
	Treatment Facility Footprints*
	Water Storage Tank Facility Building Footprints
	Water Storage Tank Facility Footprints*
	Wellheads
Railway	Rail Centerlines
Roads	ITS Cabinets
	Road Centerlines
Stormwater	Stormwater Discharges
Wastewater	Lift Stations
	Major Outfalls
	Manholes
	Treatment Facility Building Footprints
	Treatment Facility Footprints*

* Facility footprints represent surface area covered by a grouping of assets within the same facility.

Current and Future Risk in Pinellas County

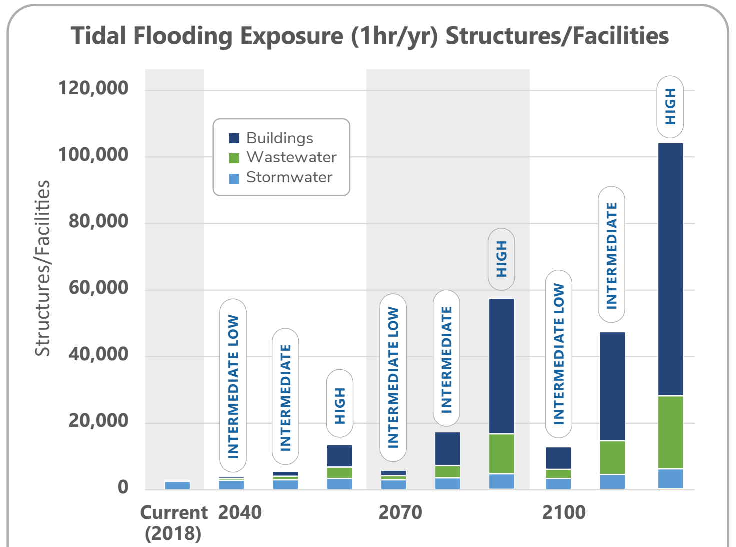
St. Pete Beach, Florida

Countywide Exposure

Using the available sea level rise scenarios, the County assessed future exposure of critical infrastructure assets to tidal and storm surge flooding for four different time periods: 2018 (current conditions), 2040, 2070, and 2100. A summary is provided in Figure 6, which also demonstrates that the exposure and risk to County infrastructure and communities will increase over time.

The tidal flooding at the Intermediate sea level rise scenario for one hour per year (maximum tide), is presented on Figure 7. Figure 8 presents a storm surge map that depicts the extent of the storm surge inundation for today through 2100 at the Intermediate sea level rise scenario. Not depicted in this map is the change in depth of flooding over time, which increases into the future for many of the coastal areas.

St. Pete Beach, Florida



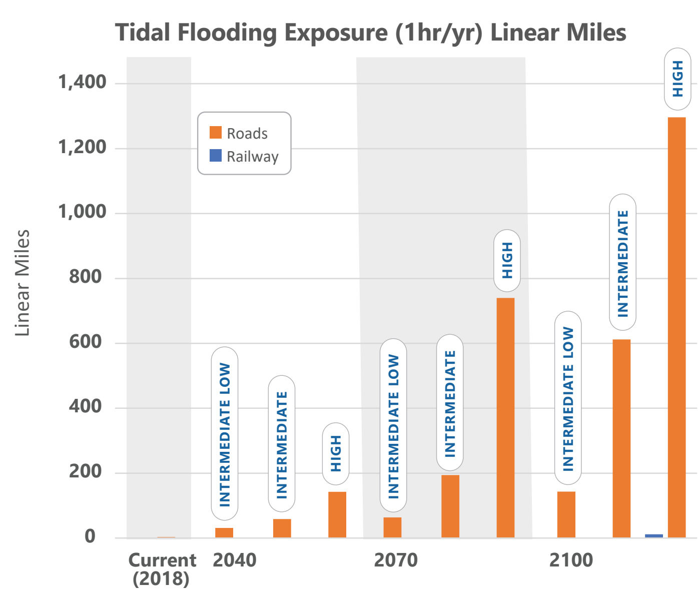


Figure 6: Example summary of countywide asset exposure to tidal flooding over time

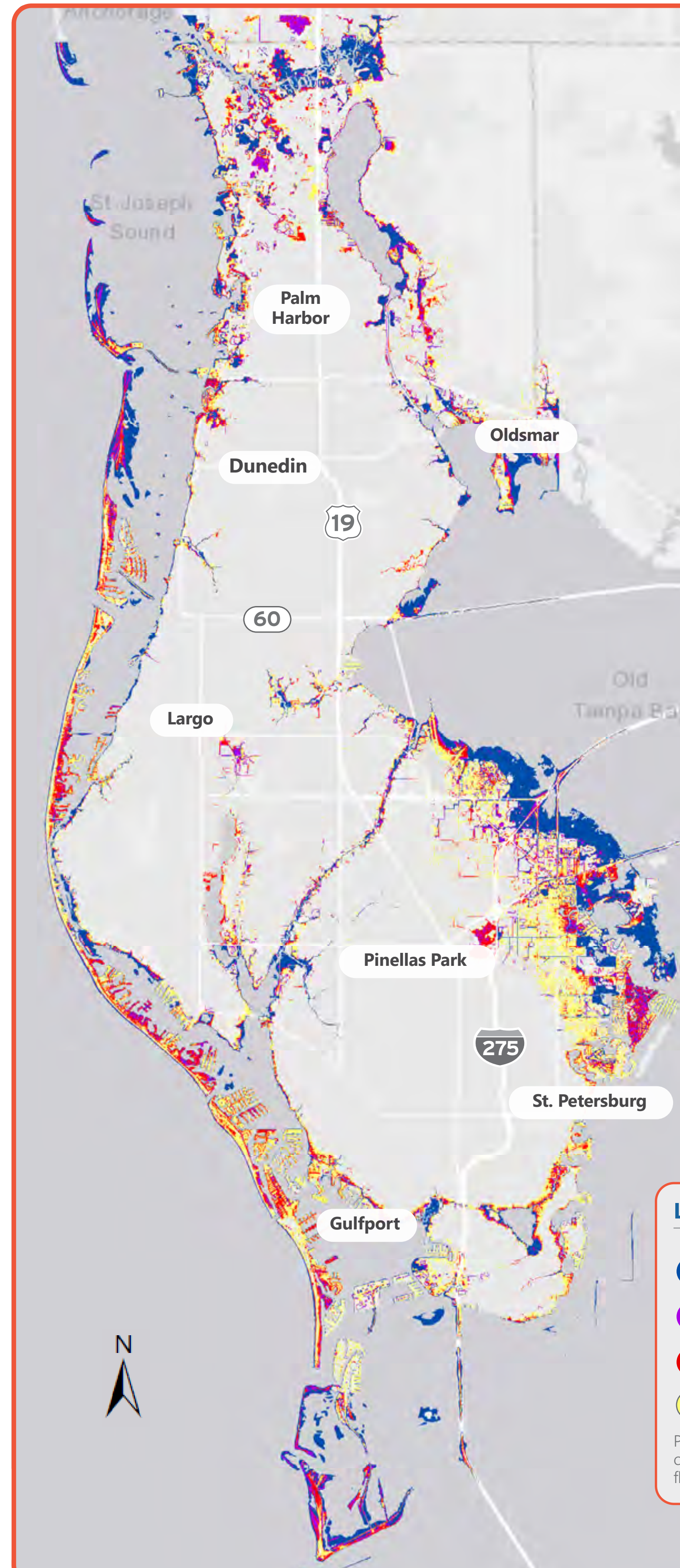


Figure 7: Potential Tidal Inundation Areas

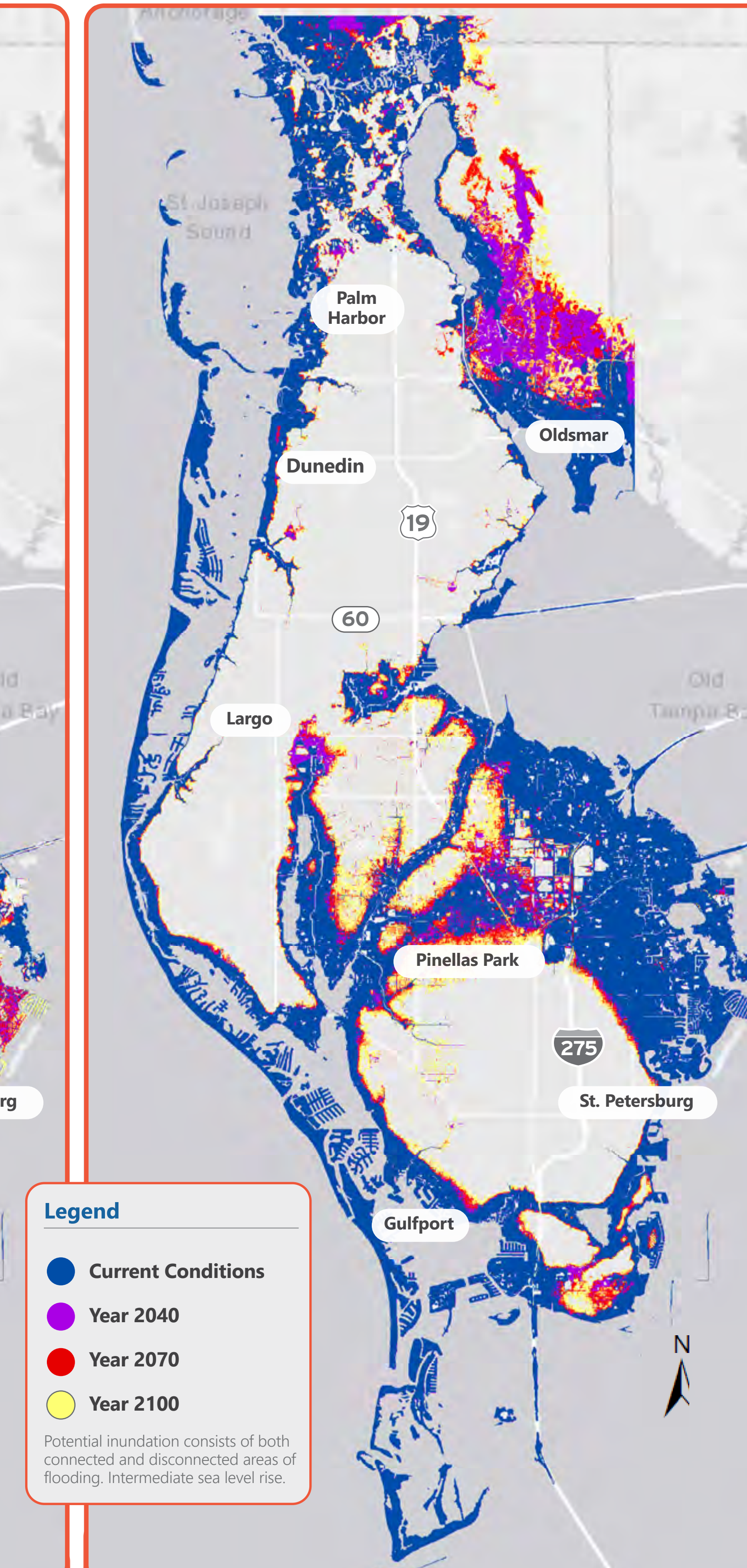


Figure 8: Potential Storm Surge Inundation Areas

Change in Exposure Over Time – Gateway District

To highlight the change in exposure and risk to County infrastructure and buildings over time with sea level rise, it is helpful to zoom in on a specific area of the county. The set of maps on this page outline varying concerns specific to risks for the Gateway District. The following maps present:

- Figure 9a depicts tidal frequencies and storm surge return periods for 2018 and 2100 in a single area. This juxtaposition shows how flooding from different storm events will change over time.
- Figure 9b depicts depth of flooding at Gateway District buildings in the flood area.
- Figure 9c depicts storm surge water depths for a 100-year storm event in 2040 and tidal flooding showing water depth for the highest annual tide event.

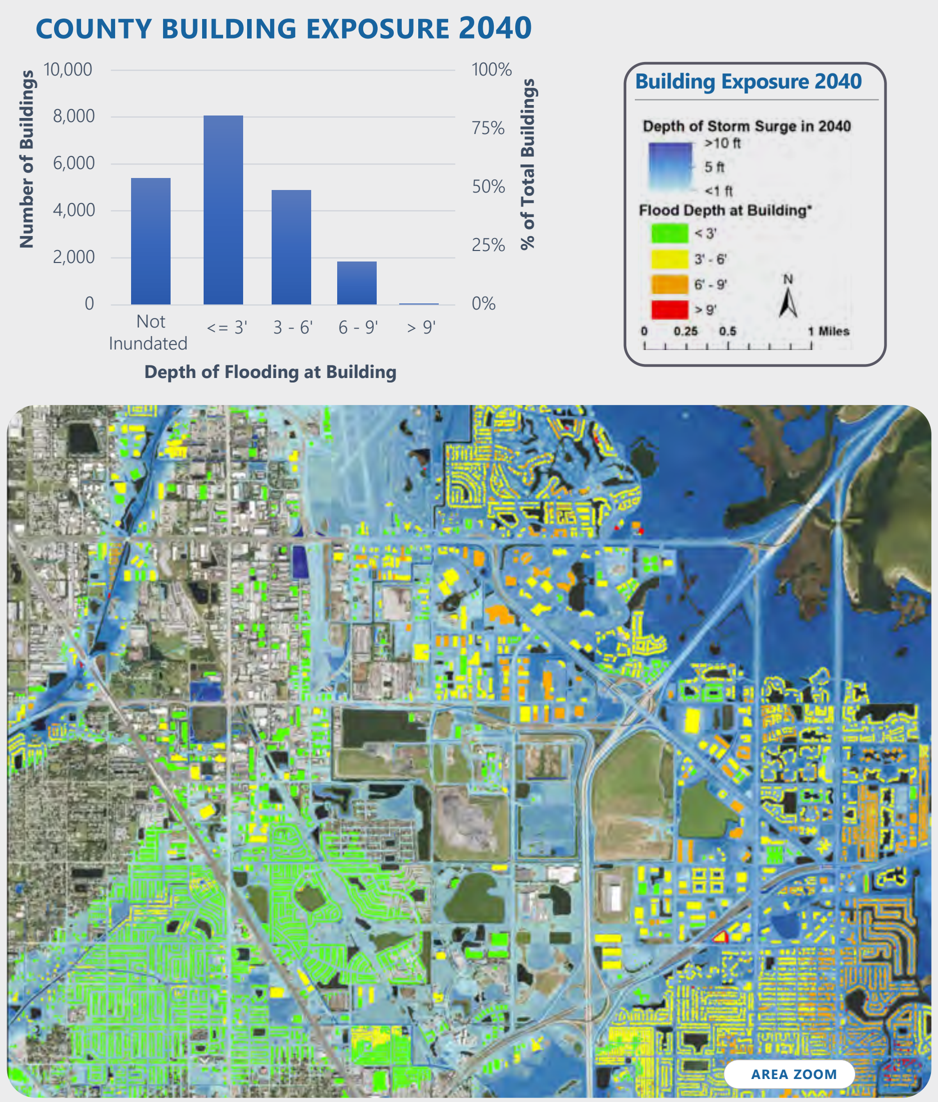


Figure 9b: Gateway District Example – A summary of exposure and risk to County Buildings.

The anticipated levels of flooding associated with varying conditions for years 2040 and 2100 depicted here can provide the County with baseline data with which to target investments or develop policies that provide for the long-term resiliency of this vital area of the county.

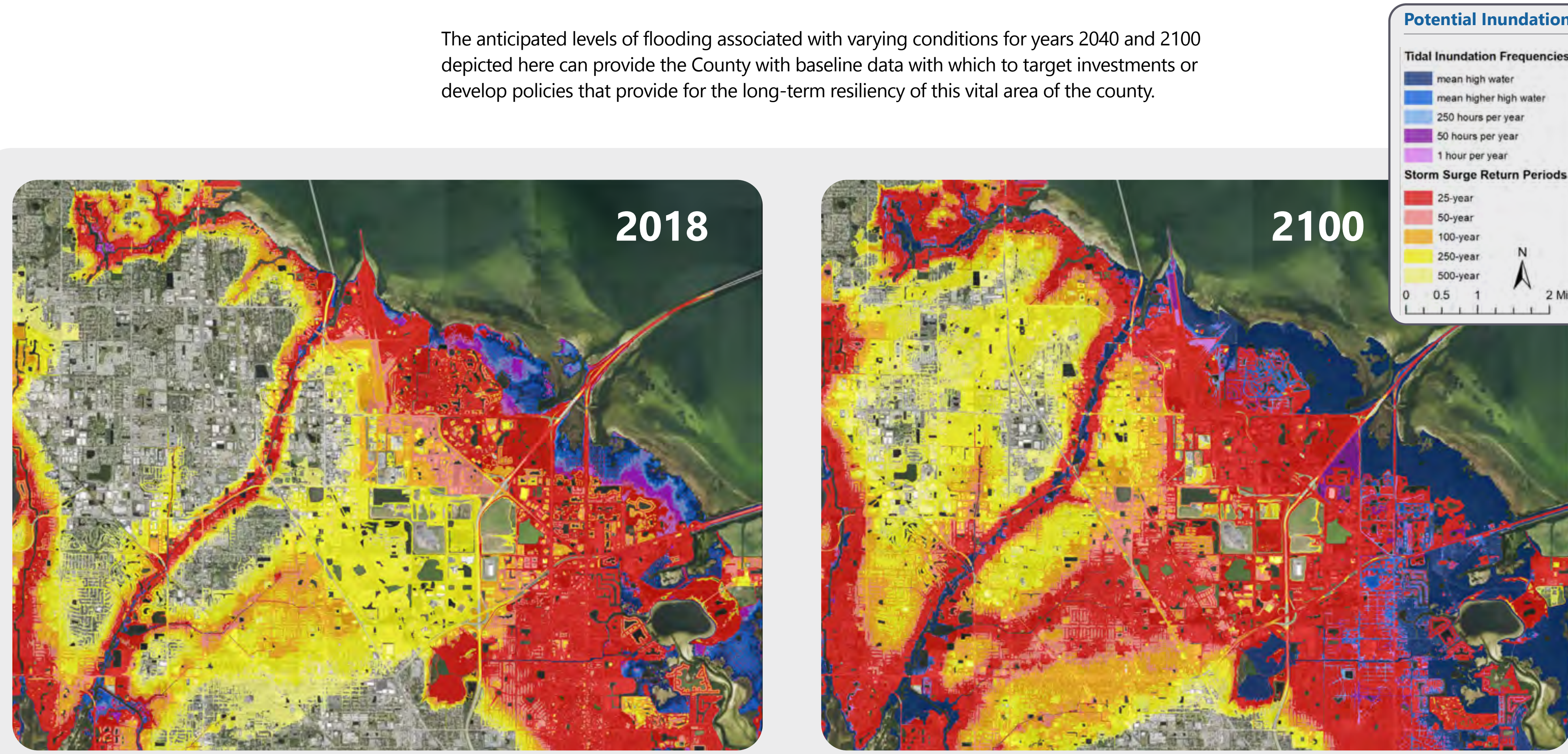


Figure 9a: Gateway District Example – tidal frequencies and storm surge return periods dipicting change in exposure over time.

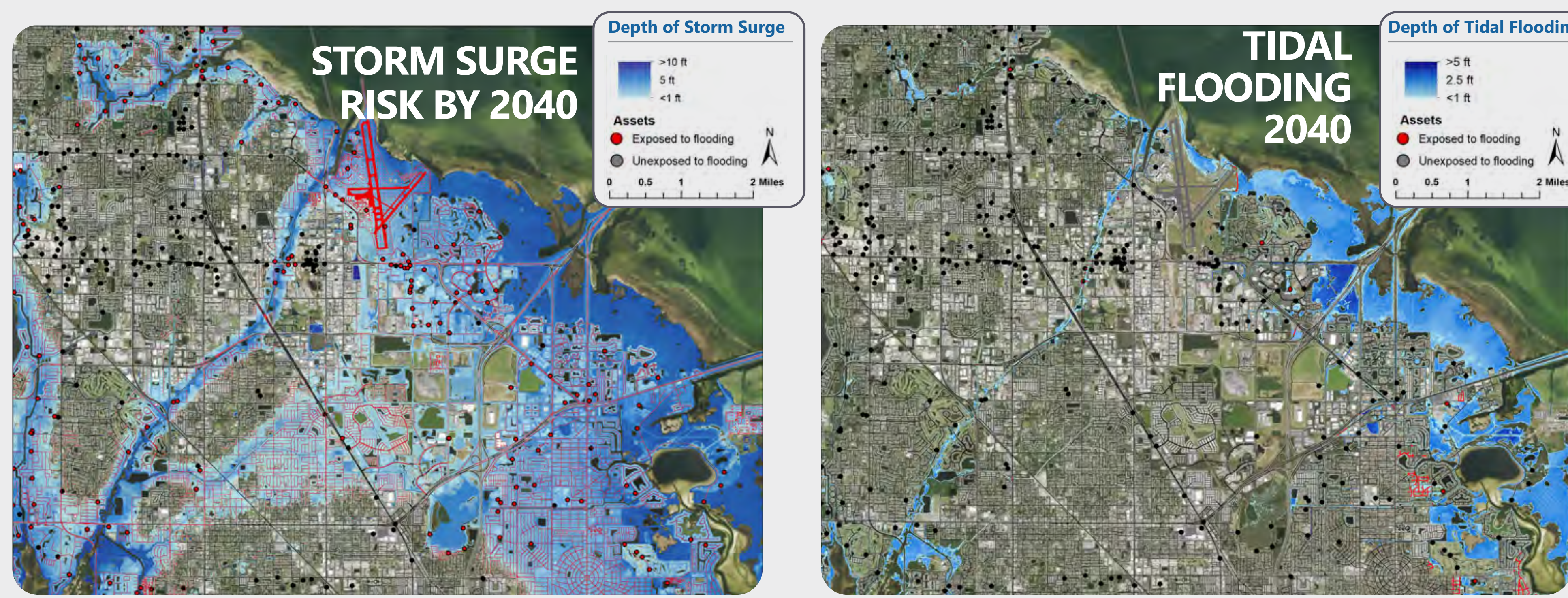
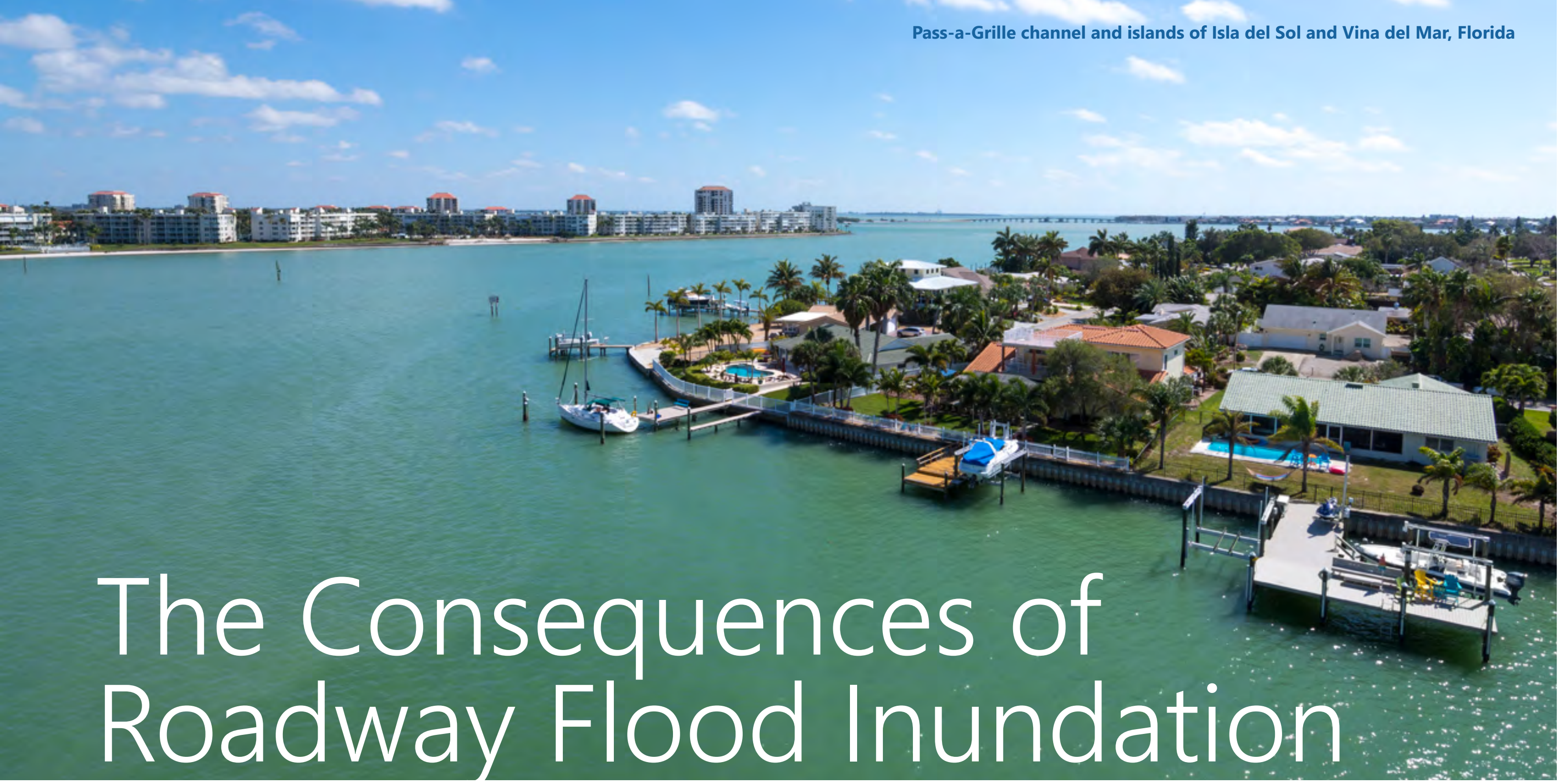


Figure 9c: Gateway District Example – Depth of tidal and storm surge inundation in 2040



The Consequences of Roadway Flood Inundation

Sea level rise and storm surge will impose costs on the County through damage to coastal and inland infrastructure due to increased stormwater flooding and floodplain inundation. For roadways, rising sea levels will inundate and erode pavement foundations, reduce surface drainage, reduce the effectiveness of stormwater systems—and, over time, fully inundate some sections of county roadways requiring elevation or realignment. Storm surge has the potential to damage embankments, scour pavement surfaces or erode the pavement base.

Methods are needed that reflect these concerns and consider the costs of increasing coastal risks, enabling targeted investments and making the case on funding requirements through local funding strategies or federal grant applications. For this project, the County selected priority roadway segments to utilize a methodology that aims to quantify and capture future cost implications due to flooding impacts. This effort combined the risk-based approach outlined earlier in this report with additional research on potential effects on roadway infrastructure and assembled information on reconstruction costs associated with certain impacts.

A theoretical model was developed for this assessment with Pinellas County Public Works staff and representatives from the Florida Department of Transportation. It models costs that may increase over time with increasing sea levels, and was developed as GIS and database code. Figure 10 depicts this model framework. The analysis was performed on 36 roadway sites, which were identified to exhibit risks due to their low-lying location near the shoreline.

Results of this analysis for the Intermediate sea level rise scenario for the period from 2018 to 2040 (approximately 1.5 feet of sea level rise) identify a few compelling concerns as depicted in Figure 11:

- Four of the segments analyzed—Whitcomb Blvd, Venetian Blvd NE, Dodecanese Blvd and East Maritana Drive—are shown to be inundated during the daily high tide by 2040—requiring capital investment to elevate or realign them to keep them clear for travel.
- The top three roadways reflecting the highest potential costs to the County for repair include Gulf Boulevard, Pinellas Bayway South, and Park Street North.
- When combined with possible costs (from detours) the top costs include U.S. Route 19-Alternate, Memorial Causeway and Pinellas Bayway South.

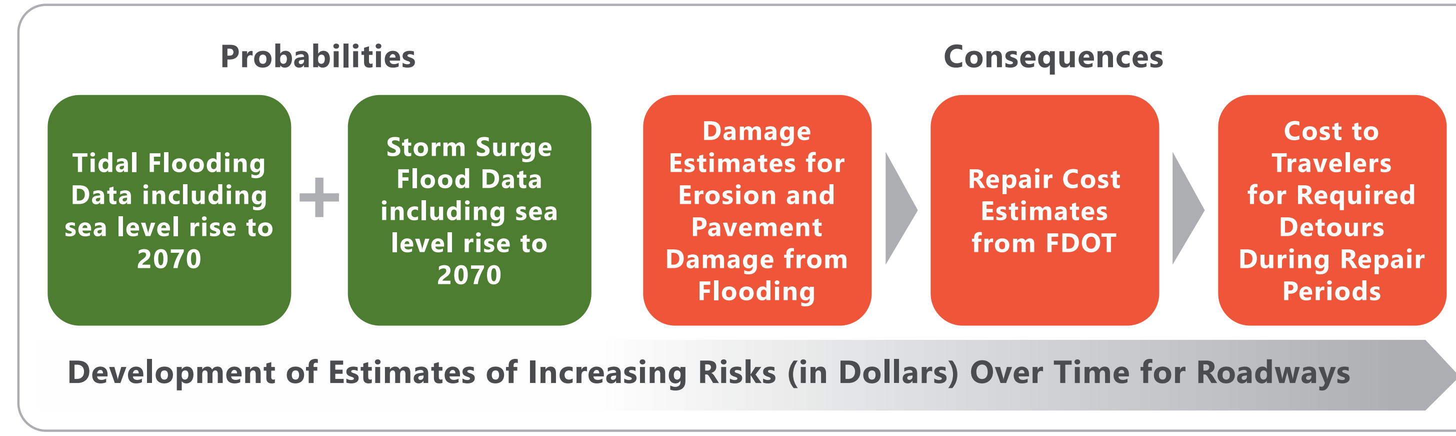


Figure 10: Pilot Infrastructure Cost Model Framework

Figure 10 depicts a model framework that provides an example for how the effects of sea level rise and storm surge may impact County infrastructure and travelers. Further refinements and development could help the county in programming of resilience funds, or in identifying additional potential costs to the county that will need to be taken up by leadership to determine the best actions to address this concern.

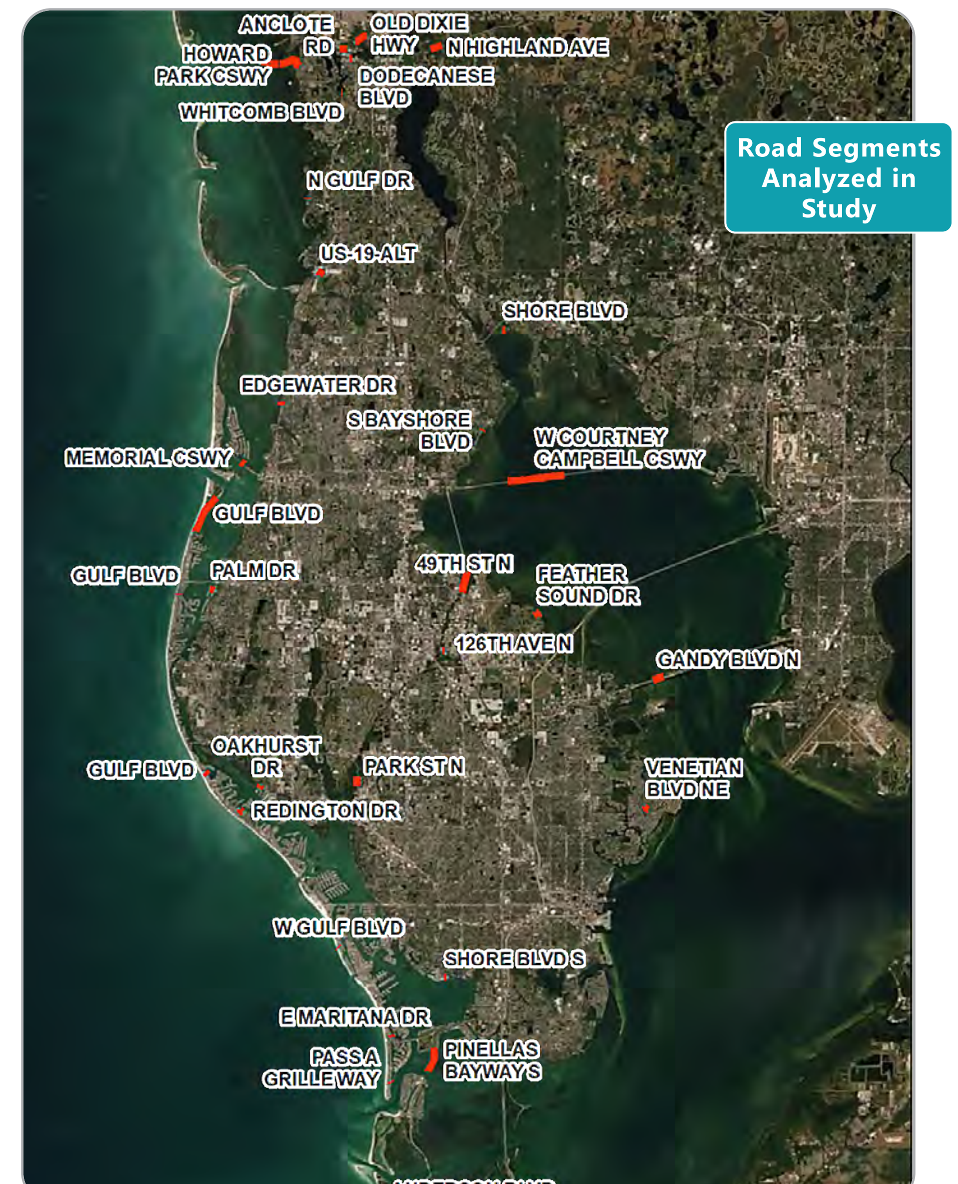


Figure 11: Roadway Segments Studied

Moving Toward Effective Decisions

Intracoastal waterway in the Island Estates community, Clearwater, Florida

St. Pete beach and resorts, St. Petersburg, Florida

Through a comprehensive analysis of sea level rise and storm surge risk with the climate projections, this study supports continued prosperity in the County by informing strategic capital investments and decision-making. At a countywide level, the results of the analysis pinpoint particular areas of the County that are of greater risk of flood exposure and impacts over time. Further, the data assembled for the study can be used to make decisions to support project level design and adaptation strategies.

Future degrees of sea level rise are variable and this reality creates complications when considering upcoming or needed investments near the shoreline. Historical engineering practices designed infrastructure such as stormwater management infrastructure based upon historical storm data (i.e, a 50-year storm event) and did not account for future increases in storm frequencies and durations, sea level rise, and storm surge. This approach of only reviewing and incorporating past events no longer provides a logical basis for decisions given what is currently understood about sea level rise; methods used within this study help the County look forward.

There has also been recognition that some design policies have been insufficient in their ability to withstand extreme weather events. Infrastructure damage and losses, as a result of natural disasters in Florida (as well as nationwide) over the past few decades, have been devastating, costly, and reactive in approach instead of preventative. This intensifies the impact of major events on communities by amplifying the time and costs required to recover and rebuild, cumulatively incurring significant adverse consequences both immediately after an event as well as longer-term negative impacts.

These challenges have given rise to methods that facilitate more comprehensive design when considering sea level rise or extreme weather events. The methods are scenario-based, allowing for exploration of the benefits and risks of various investment levels throughout an asset's lifecycle. This enables proactive investment during design of a mitigation or adaptation strategy. These approaches help address common concerns with investing in resiliency and capital improvement projects including:

- If I design for a lower level of sea level rise, and a higher level is realized, what type of impacts can I anticipate on my investment in later years?
- What type of impacts would be expected for the asset users in terms of loss of service if impacted?
- If I design to the highest level of sea level rise, how much would that cost in comparison to a traditional design?
- How do we assess the consequences to the asset of concern from conditions that exceed the design criteria applied?
- Given all these uncertainties, how can I proceed and make smart investments that are cost effective?

The Federal Highway Administration spent a decade developing processes to help provide answers to these questions. They developed and publicized a step-by-step methodology that nests within existing project development processes and supports better and more effective decisions. The Adaptation Decision-making Assessment Process (ADAP) is a tool for planners and designers to account for climate-related hazards now and into the future in the design of civil works projects (FHWA, 2019).[1] ADAP is a risk-based tool meant to aid decision-makers in assessing and determining which project alternative(s) is most practical and effective.

Figure 12 presents these considerations graphically for an asset on the shoreline. Considering the latest sea level rise projections, to what elevation should a coastal bridge be built? How can we consider the consequences of design when considering sea level rise scenarios?

Figure 13 highlights a key analysis consideration for decision-making, supporting a recommendation that all assessments consider cumulative risks, rather than single event risks, to present a robust decision framework.

1 Federal Highway Administration. 2019. Adaptation Decision-Making Assessment Process (ADAP). May 10. Accessed November 27, 2019.

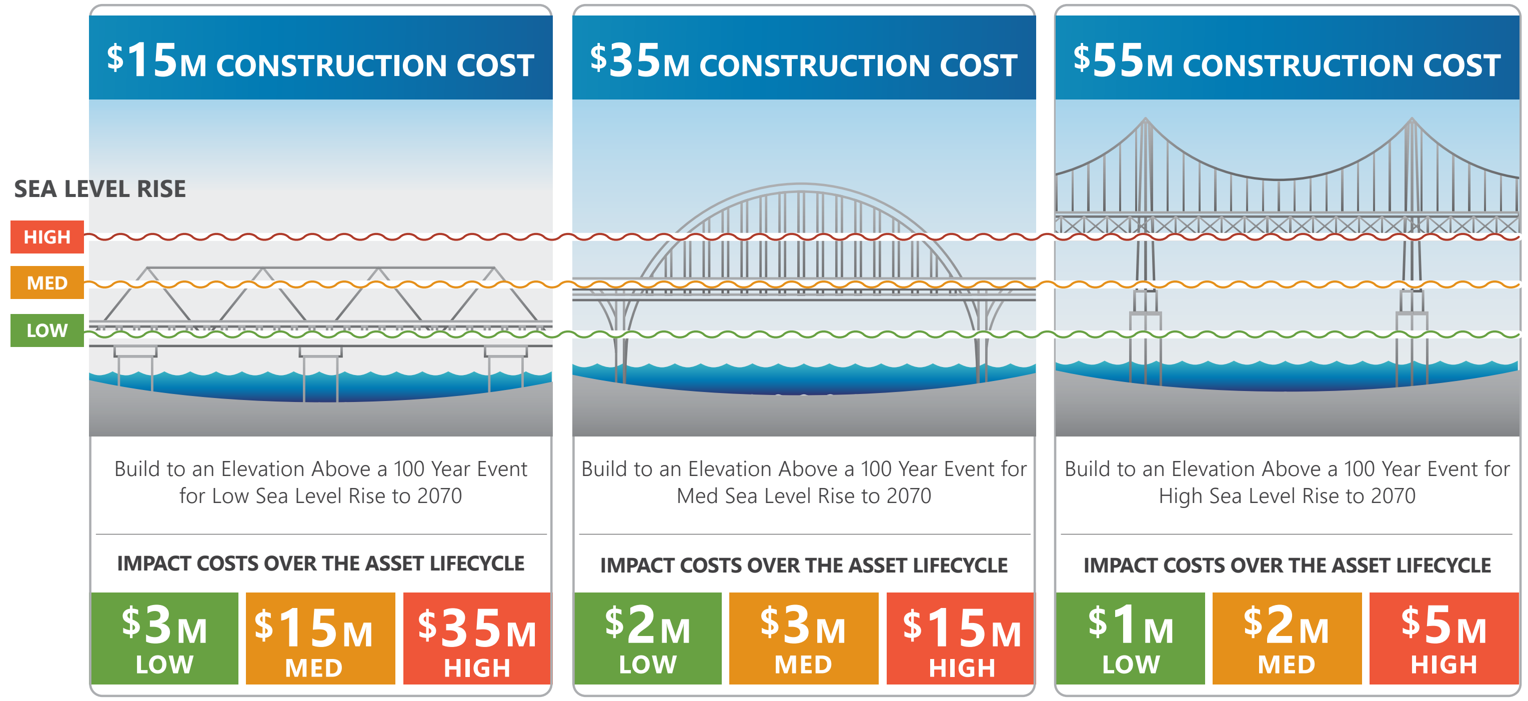


Figure 12: ADAP decision-making conceptual framework

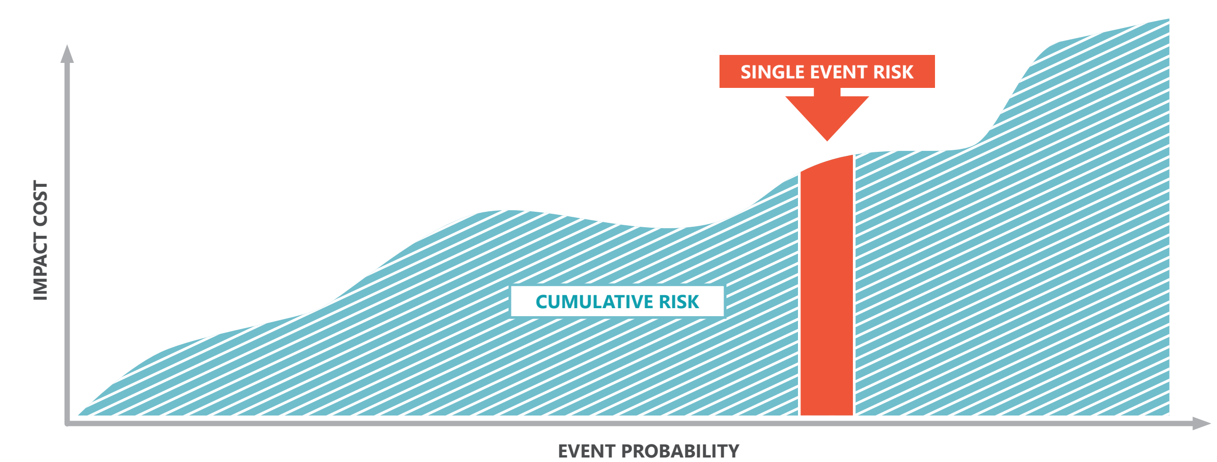
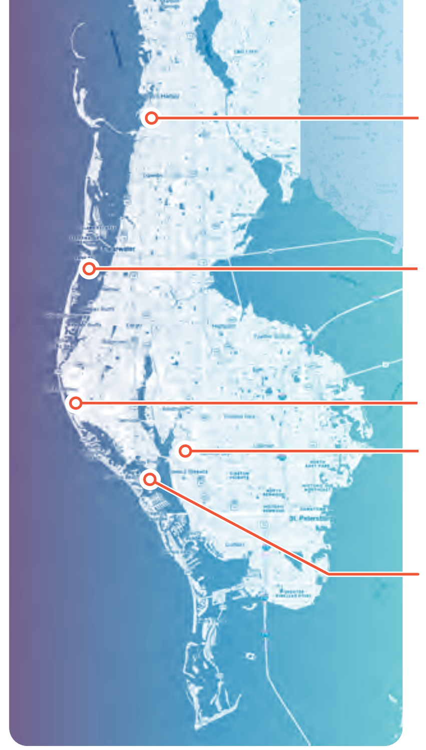


Figure 13: Single Value vs Cumulative Risk Quantification

Facility-level Assessments

In this study, the County applied ADAP to understand how future conditions might impact five different County facilities, including: a segment of U.S. Route 19-Alternate in Ozona, a segment of Gulf Boulevard on Sand Key, Wastewater Lift Station 163 in Madeira Beach, South Cross Bayou Advanced Water Reclamation Facility, and the Hamlin Boulevard Storm Drain.

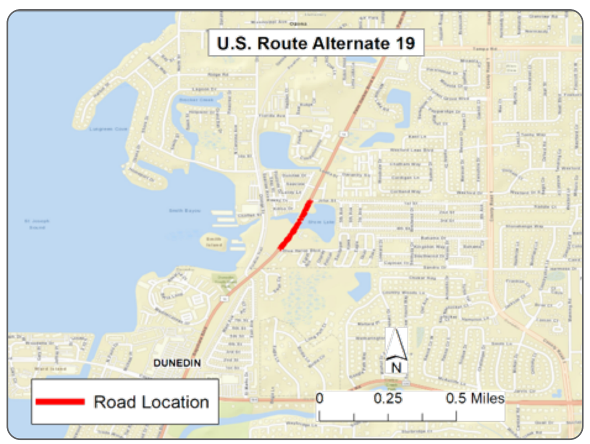
For each assessment, tidal flooding and storm surge were considered and, in several instances, future assessment of the risks and impacts of future precipitation-based flooding will be needed to further inform the analyses. The results of each of the five facility-level assessments are summarized in Table 3.

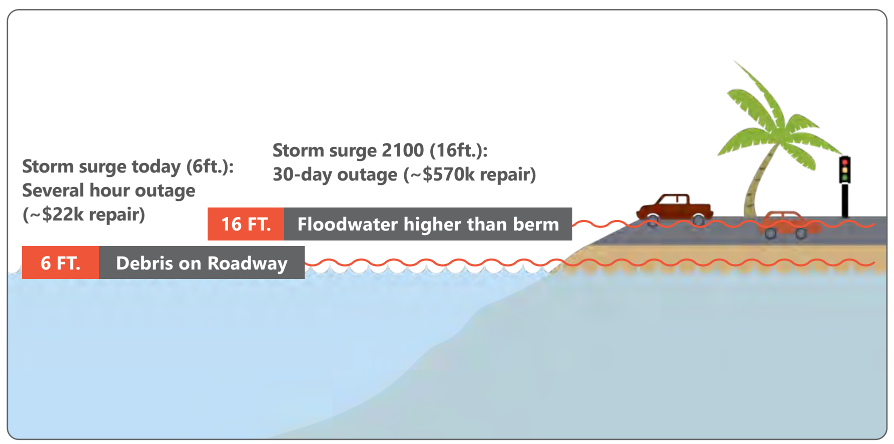


Locations of assets analyzed

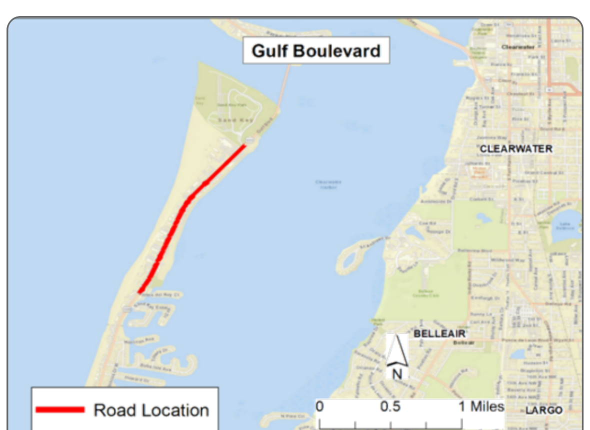
Table 3: ADAP reports

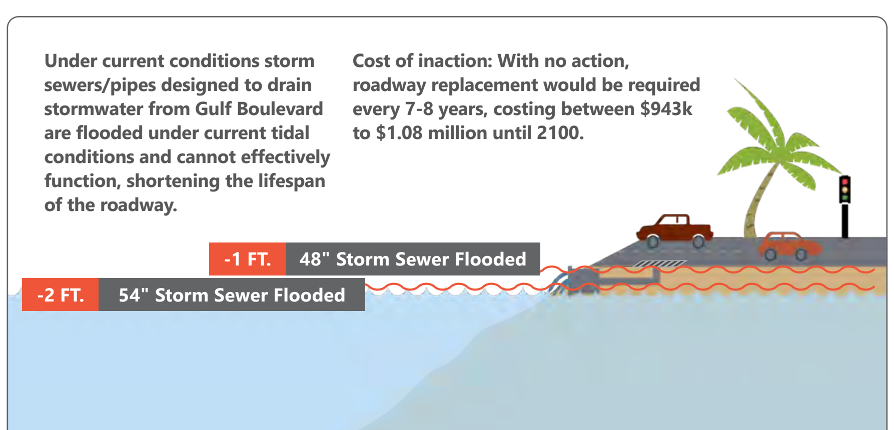
	KEY STRESSOR	ASSESSMENT FOCUS	KEY FINDINGS	KEY RECOMMENDATIONS
U.S. Route Alt. 19	Storm surge	Flooding of roadway segment	Roadway at risk of flooding under today's conditions	Elevate roadway Conduct additional analyses



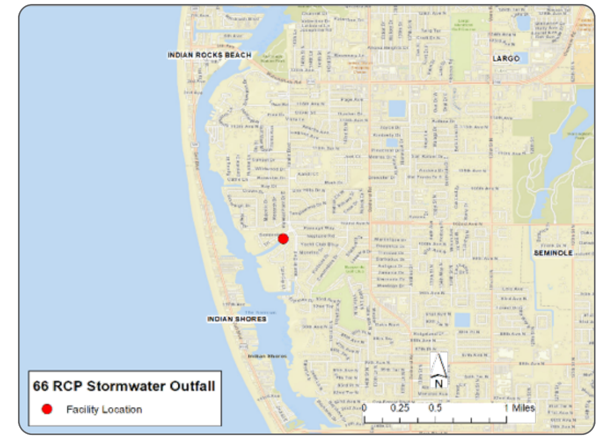


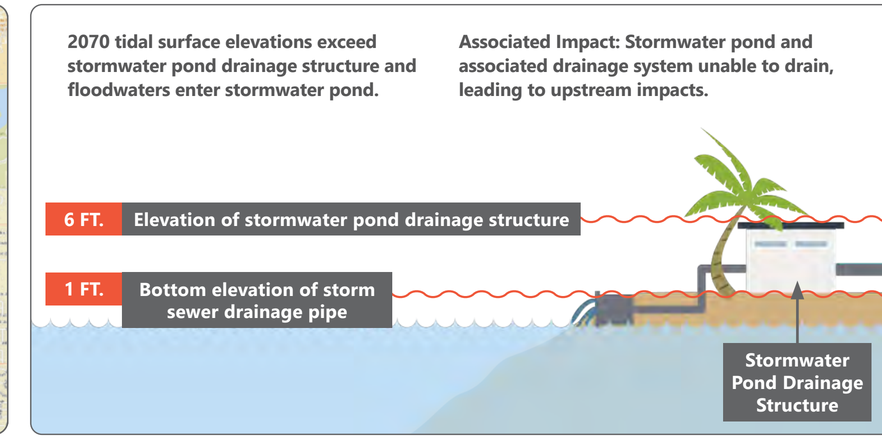
	KEY STRESSOR	ASSESSMENT FOCUS	KEY FINDINGS	KEY RECOMMENDATIONS
Gulf Boulevard	Tidal flooding	Capacity of roadway drainage network over time	Roadway drainage system at risk of tidal impacts today	Implement stormwater pump



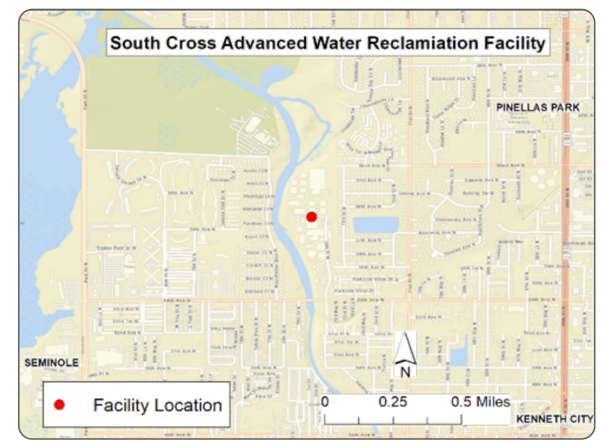


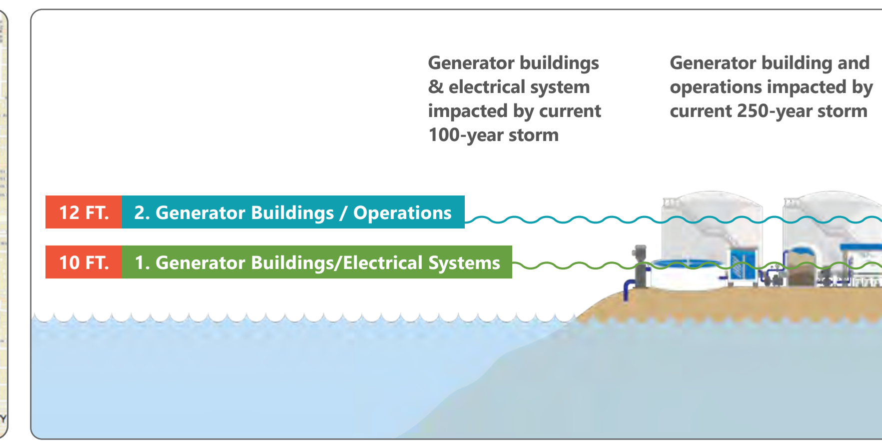
	KEY STRESSOR	ASSESSMENT FOCUS	KEY FINDINGS	KEY RECOMMENDATIONS
Hamlin Boulevard Storm drain	Tidal flooding	Impact to the stormwater drainage system due to flooding caused by tidal fluctuation.	Storm drain function impacted in 2070 under high sea level rise scenario	Consider raising the stormwater pond drainage structure



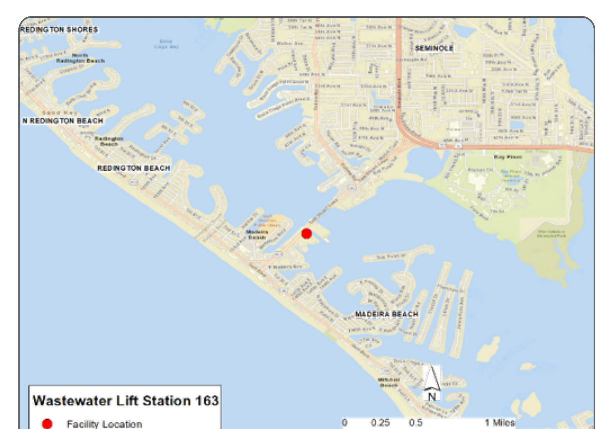


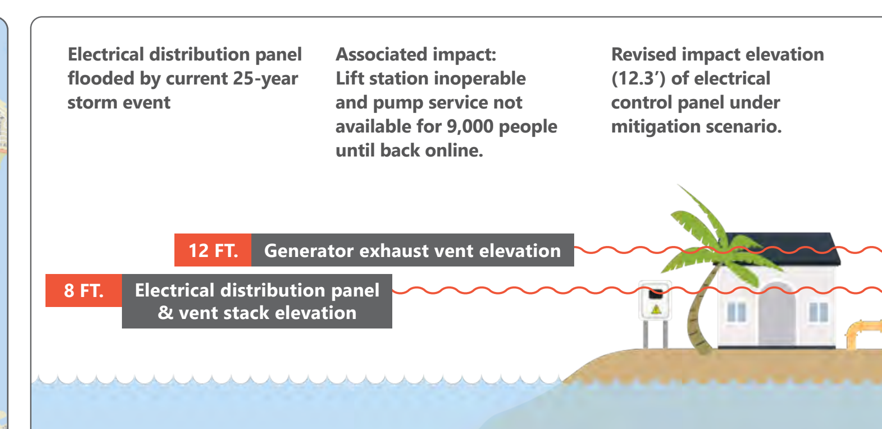
	KEY STRESSOR	ASSESSMENT FOCUS	KEY FINDINGS	KEY RECOMMENDATIONS
South Cross Bayou Advanced Water Reclamation Facility	Storm surge	Potential for seawater to impact the essential buildings of the wastewater treatment process.	Wastewater treatment facility at risk of storm surge impacts under current conditions. Impacts to electrical systems and generators would impact operations	Action needs to be taken in near term. Further vet adaptation alternatives.





	KEY STRESSOR	ASSESSMENT FOCUS	KEY FINDINGS	KEY RECOMMENDATIONS
Wastewater Lift Station 163	Storm surge	Flooding of key infrastructure at the site and identifying strategies to improve the capacity of the system to resume service following a storm event.	Key equipment flooded by current 25-year storm event	Elevate electrical distribution panel in the near term





Conclusion and Next Steps

Aerial view of southern Pinellas County during sunrise. Florida

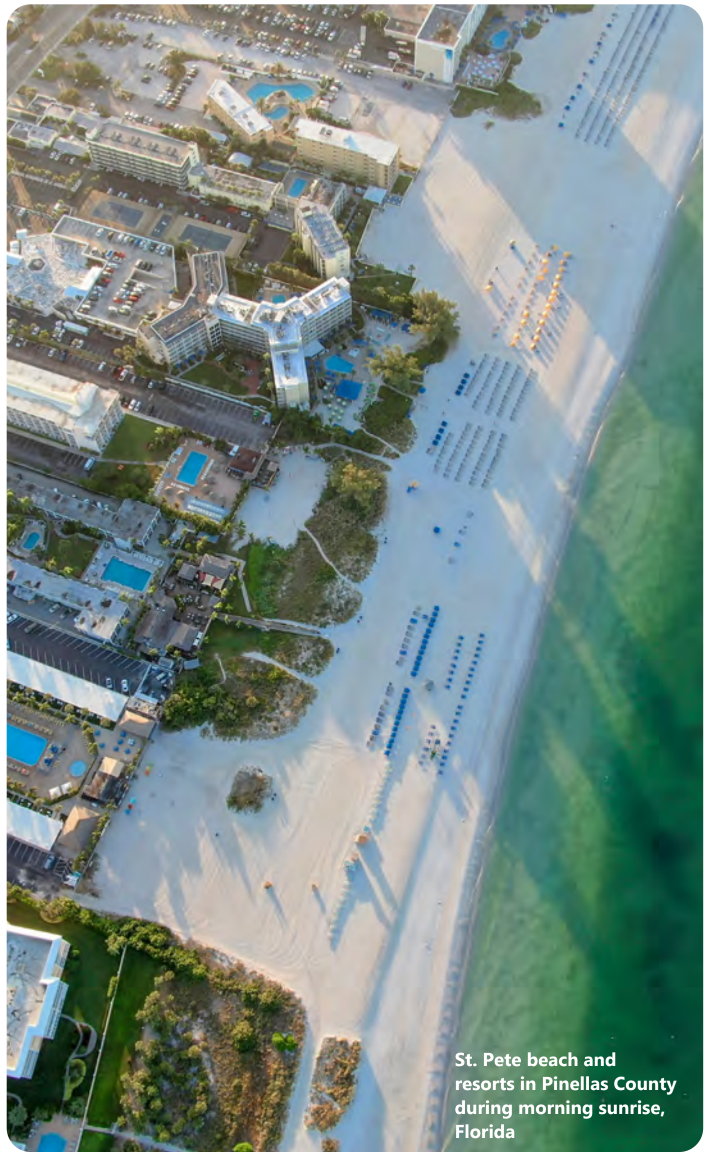
Facilitating Strategic and Cost-effective Decision-making Amidst a Changing Climate

Through this study, Pinellas County has developed data that empowers innovative prioritization for these complex, multi-faceted resiliency challenges, encompassing a wide range of planning, programming, and stakeholder needs. Defining sea level rise and storm surge impacts as a decision-making factor rather than as an abstract future concern allows County officials to be strategic in their policies and proactive in their investments, ensuring the long-term viability of the infrastructure, the communities, and the economy of the county. With this framework, the County can execute specific mitigation and adaptation strategies and investments to best respond to the increasing flood risks imposed by sea level rise.

With this information, the County has the preliminary elements to utilize a sophisticated GIS-based decision-support tool. This tool can help the County to:

- Identify areas of concern countywide;
- Provide data on long-term inundation risks;
- Estimate costs to the County of sea level rise and storm surge; and
- Inform effective capital investments.

The data provided to the County from this assessment supplies the information to support such decision-making, but also reflects some responsibility on behalf of landowners, developers, businesses, residents, and government agencies that provide services in areas now identified as being at risk. Sea level rise and storm surge concerns are no longer an uncertainty but must be considered in both public and private decision-making strategies.



St. Pete beach and resorts in Pinellas County during morning sunrise, Florida

Equipped with this information, the County can appropriately respond to and prepare for these concerns. The specific series of actions should include:

Additional assessments:

- Assess anticipated precipitation change and groundwater rise.
- Develop projected temperature change, and determine the risks posed to County infrastructure and communities.

Data communication:

- Develop a countywide data inventory for all public and private assets.
- Create an online data portal that enables interested parties within the County to have access to data specific to their property or neighborhood.

Quantify Risk:

- Further define and quantify risk; identify areas of the county most exposed to the risks.
- Quantify potential future damage to countywide assets to direct the priorities and target investments to address the at-risk assets.

Plan and Fund:

- Develop a countywide risk plan identifying policies intended as guidance for addressing concerns from multiple perspectives—including economic, environmental, community, social/equity concerns, and other views or needs from any other relevant stakeholders.
- Estimate near-term capital needs above and beyond annual maintenance and capital programs.
- Develop a capital investment design guide that outlines the use of scenario-based decision-making, and that uses the data generated by this study to inform the scenario assessments.
- Pursue additional resilience grant funding from available state and federal sources. These grant funding opportunities include those funded by the state of Florida, from the Resilient Florida Program, by FEMA and the U.S. Department of Urban Housing and Development (HUD). In addition, such information resources would be invaluable in taking advantage of new resilience-oriented funding sources that become available.

Aerial view of Pinellas County coastline town during morning sunrise, Florida

Pinellas County

PINELLAS COUNTY

SEA LEVEL RISE & STORM SURGE

VULNERABILITY ASSESSMENT
EXECUTIVE SUMMARY

www.pinellas.gov/projects/vulnerability-assessment

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