

# Level-Up Palm Beach

## Coastal Resilience Implementation Plan

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## EXECUTIVE SUMMARY

*Level-Up* is a concept unique to Palm Beach, aimed to build community coastal flood resilience. In this context, *resilience* means anticipating present and future flood risks, planning and implementing effective flood mitigation strategies, monitoring and adjusting over time in a changing climate, and with capacity to recover faster. *Level-Up* is about managing today's flood risk, which is substantial, as well as tomorrow's increasing flood risks with climate change, sea level rise, and storm intensification. *Level-Up* is the result of completing tasks included in the Town's 10-year Coastal Protection Program. This included the *Coastal Flood Vulnerability Assessment (CFVA)*<sup>1</sup> completed in 2019, and the *Implementation Plan* project producing this *Level-Up Palm Beach* document, strategy, and action plan.

Palm Beach already has a strong measure of coastal flood resilience. The geology and topography of the island have natural resilience, including a limestone foundation providing structural stability and topographic elevation not shared by other more traditional barrier island sand bars. The Town *Coastal Protection Program*, by definition, advances coastal flood resilience for the Town. The sand transfer plant, USACE collaboration to beneficially reuse clean beach-compatible dredged material, combined with robust beach and dune nourishment projects, strategic coastal structures, ecological protection and restoration, and related monitoring and adaptive management strategies all provide coastal flood protection and resilience. With investment in the Coastal Program, there are very few vulnerabilities along the Atlantic Ocean facing shoreline. The Town also has proactively built resilience into public works assets by flood-proofing and raising elements of critical infrastructure for stormwater management, wastewater treatment, and public safety.

Palm Beach assumed a leadership position in pursuing climate change planning for the Town. When the work was initiated proactively, the original anticipation was to focus on specific improvements for highest priority assets at risk of flooding, and to identify flooding pathways where targeted protections could intercept floodwaters at the source. When the *Implementation Plan* project was initiated, there also were limited state programs, policies, and funding sources available for advancing coastal flood resiliency. In this short period of time since the work began, there have been key evolutions. First, the systematic vulnerability along the Lake Worth shoreline was revealed. For this, there aren't targeted solutions; rather, there is a need for community-wide, and perhaps regional, response on public and private property. Second, the local and national focus on climate change planning and coastal resilience advanced rapidly. There is now a focused Resilient Florida state program, national focus on climate change planning and infrastructure, and significant opportunities for technical and financial support. *Level-Up Palm Beach* was formulated to address local needs, also recognizing the potential for larger-scale action and collaboration.

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<sup>1</sup> <https://www.townofpalmbeach.com/133/Coastal-Protection>

The basis for *Level-Up Palm Beach* is summarized in this document. The result will require substantial follow-on efforts, policy changes, stakeholder collaborations, and site-specific actions ranging from simply raising electrical boxes powering key infrastructure, and then perhaps through large-scale construction of a storm surge barrier at Lake Worth Inlet. Significant Town effort and leadership will be required.

Contents of the *Level-Up Palm Beach Implementation Plan* include specific components related to:

### **Town Facilities and Infrastructure**

- IDs specific assets and projects to advance short- and long-term coastal flood resilience.
- Short-term projects in some cases are already in the capital plan and present opportunities for refinements to implement immediately.
- Changes to design flood elevations (DFE) are suggested as the basis for design and for Town-wide policy changes to promote resilience.

### **Lake Worth Shoreline**

- Recognizing the primary source of coastal flood waters to Palm Beach is along Lake Worth, a series of policy changes are recommended for code of ordinance refinements to phase-in a higher level of protection over time. This includes bulkhead construction specifications, as well as maintenance and certification requirements.
- Concepts for neighborhood-scale protection along Lake Worth are presented.
- Recommendation to pursue feasibility of a Lake Worth Inlet storm surge barrier with the US Army Corps of Engineers and other stakeholders.
- Lake Worth water level monitoring program.

### **Floodplain Development**

- Given the tangible present-day flood risk, prevalence of assets in the extensive floodplains, and increasing future flood risk with climate change, a series of policy changes are recommended.
- Code of ordinance changes are proposed related to substantial improvements and damages, non-residential and residential building flood elevation requirements, building heights, and flood hazard areas.

### **Comprehensive Planning**

- Modifications are suggested for the Town Comprehensive Plan to integrate future coastal flood risk mitigation to provide clear and specific authority, commitment, and accountability for the Town to implement Level-Up Palm Beach.

- Specific Comprehensive Plan refinements are recommended for future land use, transportation, infrastructure, coastal management/conservation, intergovernmental coordination, and capital improvements.

Closing this document is the *Level-Up Implementation Plan*, consolidating the recommendations into tangible action items, including:

- Near- and medium-term actions are focused on the next 10 years, including frontloaded actions in years 1-2 to aggressively advance the program. Specific actions are categorized by theme (e.g., Town facilities and infrastructure) and sub-theme (e.g., Projects), and tabulate the specific recommended action, timeframe (years), and possible leading Town entity.
- Long-term actions and adaptation pathways also are presented, including key decision points in time. Adaptation pathways focus on the 2021 Initial Implementation Plan, as well as Post-2030 Scenarios with high adaptation rates and with or without a Lake Worth Inlet surge barrier.
- Elements of a monitoring program are outlined to measure and track key parameters to help inform Town decision-making along the adaptation pathways. Examples of monitoring metrics include observed water levels and sea level rise, change to FEMA base flood elevations, coastal flooding disasters and impacts, percent of facilities and properties adapted according to policy changes, status of Lake Worth Inlet surge barrier feasibility study, and potential for neighborhood-scale flood control systems.

From short-term, asset-specific actions and Town-wide policy changes, through collaboration with stakeholders on regional solutions, embracing *Level-Up Palm Beach* affords the Town to lead the way and make meaningful progress towards a resilient future.

## 1.0 INTRODUCTION

*Level-Up Palm Beach* is the Town of Palm Beach’s Implementation Plan to strengthen the community’s resilience to coastal flooding. In the context of this plan, resilience means the capacity of the community to:

- Anticipate future coastal flooding risks in a changing climate,
- Plan and implement effective coastal flood mitigation strategies,
- Monitor and adjust strategies to changes in coastal flood risk over time, and
- Recover faster and stronger from coastal flooding events.

### Box 1. A Strong Track-Record and Culture of Preparedness

The Town has taken many actions to reduce the impacts of storms and flooding on the community, including:

- Coastal flood modeling and vulnerability assessment
- Evacuation and emergency planning
- Coastal Protection Program beach and dune nourishment
- Building code enhancements
- Stormwater and wastewater infrastructure upgrades
- Utility undergrounding

*Level-Up* builds on the Town’s strong track-record and culture of preparedness by planning for a future with heightened coastal flooding risks due to climate change and associated sea level rise and storm intensification. Implementation of *Level-Up* will put Palm Beach at the forefront of communities working to secure a safer future for generations to come.

### The *Level-Up Implementation Plan* is:

- **Ambitious** – setting some of the highest standards adopted by coastal communities in Florida and nationally.
- **Inclusive** – involving both the public sector and private property owners and benefitting all members and areas of the Palm Beach community.
- **Phased** – prioritizing near-, medium-, and long-term actions based on evolving risks and the natural cycle of planning and capital renewal.
- **Layered** – identifying actions at multiple scales that reinforce flood protection and provide redundancy to safeguard from single-point failures.
- **Flexible** – anticipating multiple potential pathways for adaptation and building in capacity to adjust in the future in response to observed changes.
- **Cost-effective** – focusing on actions that provide a return on investment in the form of avoided damages and losses, reliability of public services, insurance cost savings, improved opportunities to secure matching funds, and preserved property value and tax base.

The term Level-Up is both figurative – as in raising the priority of coastal resilience planning, investment, and performance to a new and higher level – and literal – as in elevating shorelines, buildings, and other assets to adapt to higher levels of flood risk. Investment in resilient infrastructure will reduce future damage and long-term expenditures, allow for quicker return to normal operations after floods, improve the community, and generate return on infrastructure investment. Given rapid evolution of infrastructure improvements nationally, and implementation of programs focused on climate change planning and resilience in the State (e.g., Resilient Florida), Level-Up Palm Beach also positions the Town for financial support to help offset incremental cost of resilience measures.

### 1.1 Goal and Objectives

***The goal of Level-Up is to set Palm Beach on a path to achieve high standards of resilience to sea level rise, future storms, and related coastal flooding.***

*Level-Up Palm Beach* includes the following four themes and objectives:

 **Town Facilities and Infrastructure:**

Adapt Town assets to mitigate risks of damage and failure from future coastal flooding.

 **Lake Worth Shoreline:**

Mitigate neighborhood and Town-wide exposure to future coastal flooding, emanating primarily from the Lake Worth shoreline.

 **Floodplain Development:**

Improve the safety of buildings and their occupants from future coastal flooding.

 **Comprehensive Plan:**

Integrate future coastal flood risk mitigation with other Town planning, policy, and infrastructure funding priorities.

### 1.2 Background and Context

*Level-Up Palm Beach* builds on the findings of the 2019 ***Town of Palm Beach Coastal Flood Vulnerability Assessment (CFVA)*** to define specific priority actions for the Town to pursue. The CFVA is based on high resolution computer simulation technology developed for the Town, the ***Palm Beach Flood Risk Model (PB-FRM)***, which provides the probability of coastal flooding today, and in the future (~2055 time horizon) with Intermediate-High<sup>2</sup> sea level rise and more intense coastal storms.

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<sup>2</sup> PB-FRM utilized relative sea level rise projections from NOAA 2012 for 2050 Highest scenario, which is approximate to the NOAA 2017 Intermediate-High scenario for 2055.

**Box 2. The Coastal Flood Vulnerability Assessment and Palm Beach Flood Risk Model**

In 2019, the Town completed an assessment of its vulnerability to coastal flooding under present conditions and in a future scenario with higher sea levels and more intense storms. The *Coastal Flood Vulnerability Assessment (CVFA)* was focused on understanding future exposure to coastal flooding and the potential impact on Town-owned assets. The results included a series of Town-wide flood maps along with a ranking of assets based on their relative vulnerability. The CVFA report, figures, and tables are on the Town of Palm Beach Coastal Protection website: <https://www.townofpalmbeach.com/133/Coastal-Protection>

The CVFA relied on a probabilistic, dynamic model developed specifically for the Town of Palm Beach, based on an award-winning methodology described as “a gold standard for coastal resiliency work,” and “a blueprint that national and international agencies can mirror to better assess and design resiliency options”<sup>3</sup>. This **Palm Beach Flood Risk Model (PB-FRM)** is a physics-based coastal flood model developed to determine the probability of flooding based on hundreds to thousands of storm scenarios. The model outputs include the probabilities of inundation along with depth of flooding under present day conditions and a future scenario. The model also provides numerous other quantitative parameters, such as wave information, wind information, currents, and flooding times based on the passage of coastal storm events. An example map from the CVFA showing future flood risk and depths at specific recurrence interval levels is shown for the Mid-Town area below.

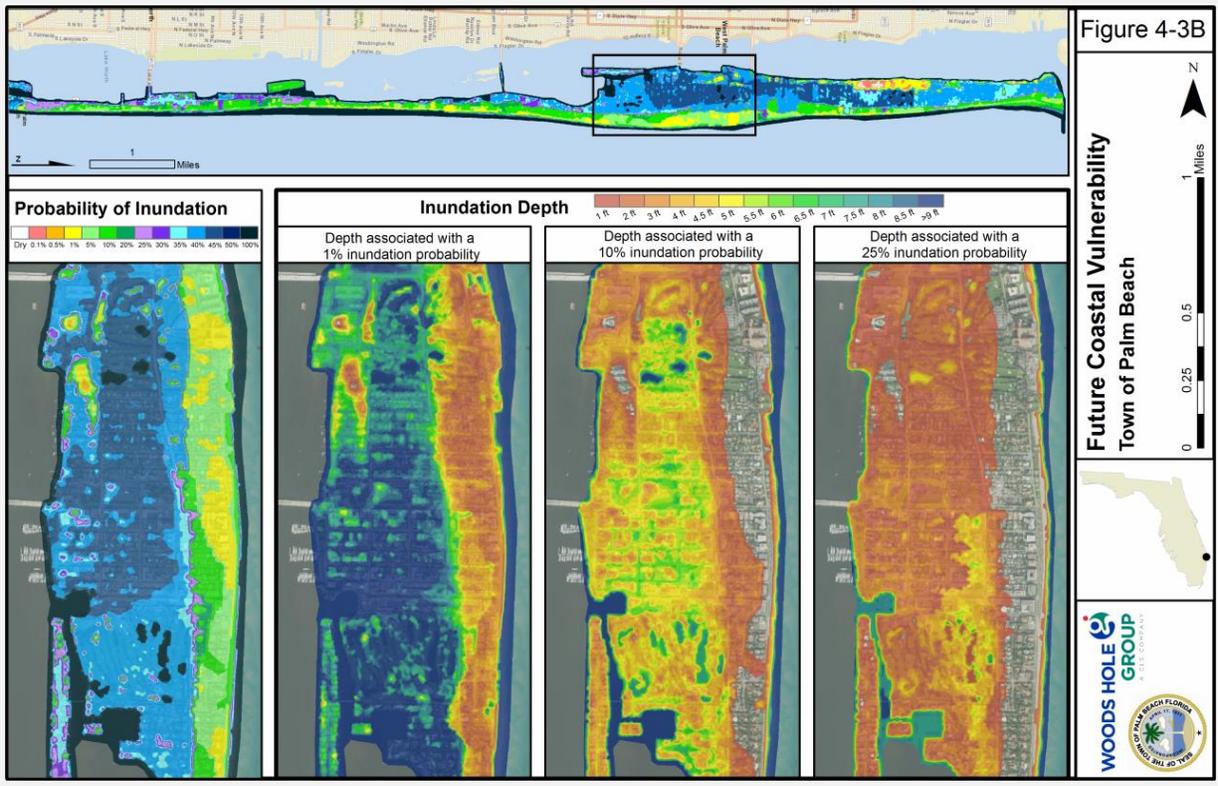


Figure 4-3B

<sup>3</sup> 2017 Federal Highway Administration Environmental Excellence Award letter.

The *CFVA* provides a comprehensive analysis of:

- The probability of coastal flooding across the island for present and future scenarios,
- Depth of flooding under a range of flood recurrence levels (100-year, 25-year, 10-year),
- Identification of over 2,200 Town-owned assets, including buildings, streets, parks, beach access ways, sewer pump/lift stations, stormwater basins and stormwater pumps,
- Assignment of standardized scores for each asset capturing their value to the community, and,
- Coastal Vulnerability Indices (CVIs), or risk scores, factoring in both the probability and consequence of flooding for each asset, considering both present and future scenarios.

This information positions Palm Beach to make informed, defensible, efficient, and effective decisions for managing risk to Town assets and the community from present and future flooding events. It enables the Town to identify sources of flooding and public assets at most risk now and in the future, determine which assets are most highly valued, and develop public works projects and policies to manage this risk. The strategies in *Level-Up Palm Beach* are fully informed by these results.

The PB-FRM simulations of coastal flooding show that the primary sources for present and future coastal flood risk emanate from the Lake Worth shoreline of the island, including diverse public and private property. This makes it complex to achieve community resilience, as there is no single independent Town-owned solution to manage flooding from Lake Worth. The *CFVA* also shows that many Town-owned critical assets are in the Lake Worth floodplain. Some of the most prevalent and highest risk assets are roads, including evacuation routes, and sewers that cannot be feasibly protected without addressing flood risks at the neighborhood or Town-wide scale. Although certain Town assets can be improved independently, community coastal flood resilience will depend on public/private cooperation, including forward-thinking policies and programs.

*Level-Up* provides a range of possible adaptations at different scales, such as:

- Individual assets (e.g., Town Hall; a Police or Fire Station),
- Categories of assets (e.g., all buildings; all sewer pump stations),
- Neighborhood-scale adaptations for areas where multiple infrastructure assets as well as homes, businesses, and institutions can be protected by independent flood control systems, and
- Town-wide (e.g., storm surge barrier at Lake Worth Inlet).

Level-Up also provides decision-making guidance and specific actions, policies, and projects, targeted to protect critical assets determined in the *CFVA* to be at risk from coastal flooding, as well as to protect property and public health, safety, and general welfare in Palm Beach. This plan serves a central role in translating the vulnerabilities and initial recommendations from the *CFVA* into an action plan that can be used directly to consider and weigh priorities, set the foundation for future engineering design and construction, create new policies, and plan future budgets. The

plan includes near- and medium-term recommendations the Town can implement independently to address reasonably foreseeable risks, and lays out a prospective plan for long-term projects and recommendations to build lasting resilience for the community.

*Level-Up* incorporates Adaptive Management measures, consistent with the Coastal Protection Program, to accommodate the uncertainty associated with the future increasing risk profiles. These include:

- Specific monitoring parameters and triggers are defined, which if exceeded indicate an increased risk that warrants direct action, recognizing the uncertainty with future climate change, sea level, storm intensity and associated risk.
- Flexible adaptation pathways are defined that map out alternative courses of action, triggers for decision-making on whether to stay the course or change course, and varied distribution of cost over time, serving as a tool for the Town to identify a cost-effective approach.
- Design guidelines are also provided that stress the importance of building in flexibility and modularity so that flood mitigation systems can be adjusted as necessary in the future. For example, new seawalls should be designed with additional structural capacity to support raising even higher in the future, if needed.

### 1.3 Enabling Legislation

The *Level-Up Implementation Plan* and its near-term recommendations are aligned with existing local legislation adopted by the community. The Coastal Management / Conservation Element of the ***Town of Palm Beach Comprehensive Plan (2017-2027)***, adopted by Town Council in Ordinance No. 9-2017, establishes an objective to increase the community's resiliency to climate change and coastal flooding, as well as several key policies (**Table 1**). The Implementation Plan and preceding vulnerability assessment were authorized as part of the Town of Palm Beach ***Comprehensive Coastal Management Program***, described in the *Comprehensive Plan*.

**Table 1 Key policies from the Town of Palm Beach Comprehensive Plan.**

<b>Objective 15</b>	The Town shall adopt and implement policies that increase community resiliency and protect property, infrastructure, and cultural and natural resources from the impacts of climate change, including sea level rise, changes in rainfall patterns, and extreme weather events.
<b>Policy 15.1</b>	The Town will continue to participate in the National Flood Insurance Program Community Rating System (CRS) and strive to maintain or improve its current CRS rating.
<b>Policy 15.2</b>	The Town will require that the impact of sea level rise be addressed in all Future Land Use Map amendments.
<b>Policy 15.10</b>	Continue to examine community-wide strategies to increase the resiliency of the Town to address future effects of coastal storms and climate change on the community.
<b>Policy 15.11</b>	The Town shall collaborate with Palm Beach County to increase regional resilience by sharing technical expertise, assessing local vulnerabilities, advancing agreed upon mitigation and adaptation strategies, and developing joint State and Federal legislation policies and programs.
<b>Policy 15.12</b>	The Town shall continue to utilize best practices and initiate mitigation strategies to reduce the risk of flooding in coastal areas that may results from high tide events, storm surge, flash floods, stormwater runoff, and the related impacts of sea level rise.

## 2.0 LEVEL-UP TOWN FACILITIES AND INFRASTRUCTURE

*The objective of **Level-Up Town Facilities and Infrastructure** is to adapt assets to mitigate risks of damage and failure from future coastal flooding.*

One key strategy for meeting that objective is to establish design standards for Town facilities that account for assets' increasing risk of flooding over time. An interim approach to setting forward-looking design flood elevations (DFEs) for Town assets is suggested, along with recommendations for updating PB-FRM to align with new State standards so that more site-specific DFEs can be defined for assets with a range of end-of-service time horizons.

As evidenced in the *CFVA*, many of the Town's assets are vulnerable to present and future coastal flooding. To adapt Town facilities and infrastructure cost-effectively and within funding constraints, it is necessary to prioritize assets to adapt in the near- versus medium- and long-term. Cost-effective prioritization must consider risk (i.e., likelihood, timing, and consequences of flooding) and integrate with other capital planning considerations (e.g., maintenance, rehabilitation, and replacement cycles). This chapter includes a section on the prioritization of Town assets.

A range of asset-level adaptation strategies can be applied to enable facilities to withstand higher future flood risks, including wet floodproofing (e.g., elevating equipment), dry floodproofing (keeping water out of buildings), perimeter flood protection, building elevation, and design and operational service recovery measures. Recommendations are provided to adapt specific facilities identified as near-term priorities. Finally, additional data needs are identified to guide medium- and long-term flood mitigation decision-making.

### 2.1 Design Flood Elevations

With the anticipated increased flood risk demonstrated by the PB-FRM, facilities and infrastructure expected to last for decades can no longer be designed based on historical data alone; design parameters must incorporate future increased risk projections. One key parameter, in the context of adapting the Town's vulnerable facilities, is the Design Flood Elevation (DFE). The DFE is the elevation, referenced to a specific vertical datum<sup>4</sup>, up to which design and operational strategies are applied to mitigate reasonably foreseeable flood risks.

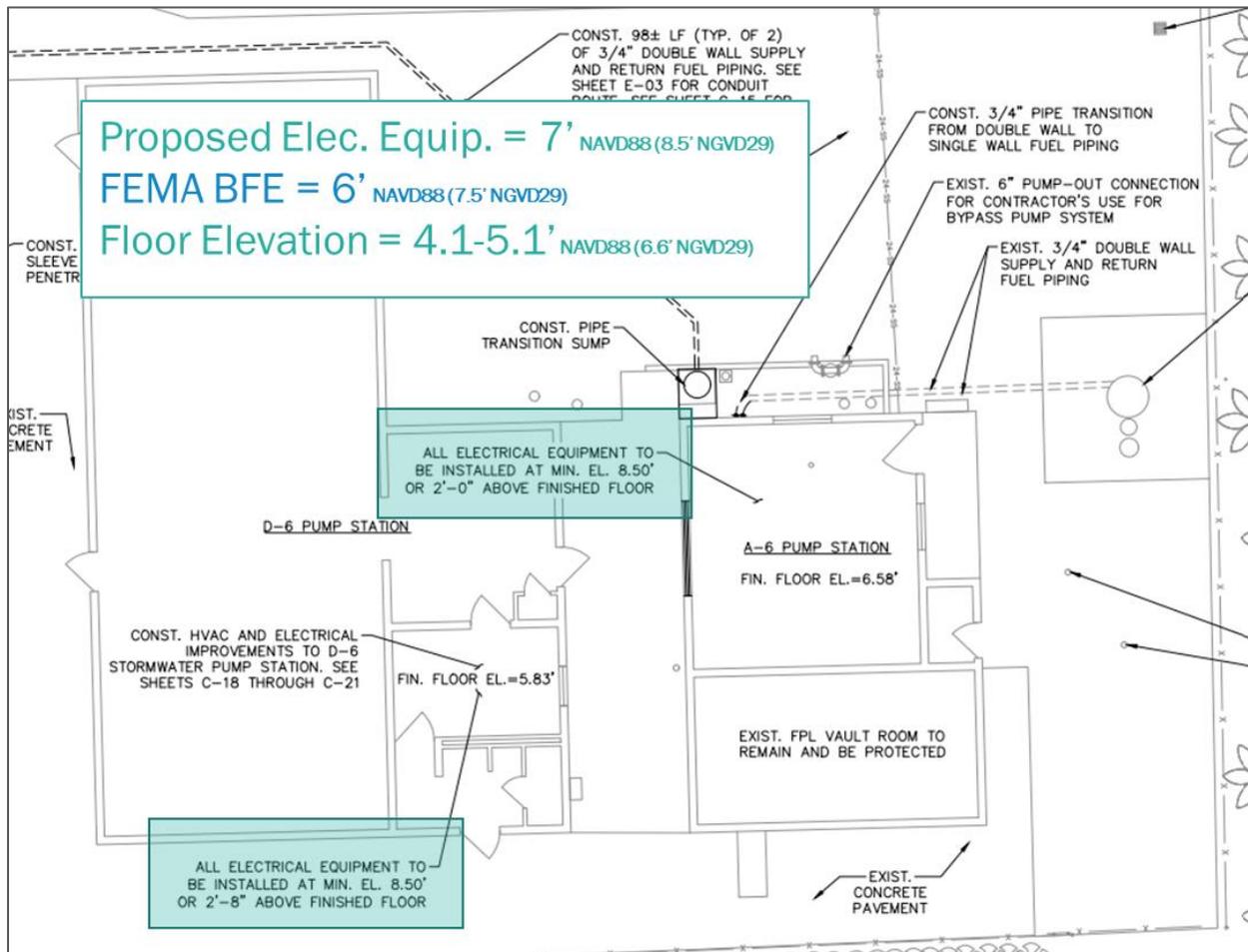
#### 2.1.1 Traditional DFE Calculation and Application

Traditionally, a DFE represents a reasonably foreseeable flood elevation under historically extreme conditions, plus a safety factor. Mandatory building codes and engineering standards generally stipulate the historical extreme as being equal to the 1% annual chance (100-year recurrence) flood level, or Base Flood Elevation (BFE), based on FEMA flood maps. FEMA flood maps only consider past events, and do not by definition account for future sea level rise or storm intensification. FEMA maps are designed to assess risk as basis for setting flood insurance premiums, but are often utilized by communities for other flood planning purposes. For instance,

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<sup>4</sup> Elevations in this report reference North American Vertical Datum of 1988 (NAVD88)

some communities manage flood risk by creating policies based on FEMA maps, flood elevations, and sometimes with an added factor of safety. One such factor of safety is often termed “freeboard.” Freeboard is an additional increment of height (generally 1, 2, or 3 ft) added as a safety factor to the BFE when calculating the DFE for an asset or project. The minimum freeboard required depends on how critical the asset is; the more critical the asset, the more freeboard is required. For example, the Town’s engineering design for upgrades to the D-6 stormwater pump station and A-6 wastewater pump station calls for all electrical equipment, including an emergency generator, to be installed at least 1 ft above the FEMA BFE (**Figure 1**).



**Figure 1** Final engineering design plans for upgrades to D-6 and A-6 pump stations, incorporating 1 ft of freeboard above FEMA BFE (color annotations added).

Owners vary in their tolerance for risk and may choose to apply DFEs that are higher than the mandatory minimums or to asset types not otherwise regulated. In some cases, owners may be able to obtain lower flood insurance costs for doing so. Application of DFEs does not eliminate risk. There will always be residual risk from a more extreme condition that cannot be reasonably foreseen, or the low probability of which can be tolerated, may occur. For instance, the 100-year storm that forms the basis for FEMA maps actually has a 1% chance of occurring in any given

year, even consecutive years. As communities have experienced, storms with conditions exceeding the 100-year event do occur; sometimes within multiple years. Understanding the range of risks is important for communities with infrastructure that has different levels of criticality. A recreational area does not require the same level of protection as a critical evacuation route, power supply, or stormwater management system. Having more sophisticated information about flood risk, including future flood risk is helpful; hence, implementation of the PB-FRM in Palm Beach.

The Town of Palm Beach has largely followed the traditional approach when determining DFEs for capital improvements to its facilities, while adding additional risk management measures where appropriate. Even when it has not been required to bring a facility up to code, the Town has for example raised sensitive equipment at its pump stations as part of planned upgrades. The Town has also included higher freeboard increments in the DFEs for more critical facilities, such as the Master Pump Station, which sends all of Palm Beach’s wastewater to the mainland for treatment. *Level-Up Palm Beach* takes these existing practices and capabilities, leverages the PB-FRM technology, and pushes them further to adapt to heightened future risks.

### **2.1.2 Future Flood Risk DFE Calculation and Application**

In the context of adapting to future coastal flood risks, the expected service life of the asset being improved is an important factor for the calculation of a DFE. Sea level will continue to rise over the coming decades; the flood risk in 20 years will be higher than today, and the flood risk in 50 years will be higher than in 20 years. Assets vary in their expected service lives and should ideally be designed to mitigate flood risks anticipated through their end-of-service lives. For example, an asset built today with a 20-year expected life should be designed to mitigate the increased flood risk expected over the next 20 years. It does not need to be designed for flood risks 50 years from now, as it will be replaced twice over 50 years and can be further adapted as needed each time it is replaced. This approach improves the cost-effectiveness of adaptation.

One implication of constructing a project today based on higher flood elevations 20 or 50 years from now is that for almost all an asset’s life it will be over-designed for the risks it is exposed to. For some types of assets, especially long-lived assets like seawalls or buildings, it may be more practical and cost-effective to only construct up to a more intermediate time horizon risk level today, but design- and build-in the capacity to fully build-out to that end-of-service risk level in the future. Examples of how this strategy is applied include designing a seawall foundation to accommodate raising the wall higher, or designing a pump station building with a higher ceiling so that interior equipment can be raised higher, as part of future rehabilitation projects. In each example, some of the costs of adapting to long-term risk levels can be delayed if projects are thoughtfully planned and designed.

The Town took this approach in the design and construction of capital improvements to the Town Marina. As part of the project, the old bulkhead is being replaced with a bulkhead that is 2.1 ft higher (**Figure 2**). The supporting foundation was designed and constructed in a way that will allow the Town to raise the bulkhead an additional 2 ft in the future, to accommodate future

flood risk revealed by PB-FRM, without having to rebuild the entire structure. This was specifically done to address changing risks from sea level rise over the seawall’s design life.



**Figure 2** Town Marina bulkhead designed to account for future sea level rise.

### ***2.1.3 Recommended DFEs for Town Facilities***

The gold standard approach to accounting for increased flood risk over time in DFEs is to incorporate sea level rise projections for future time horizons into a probabilistic, physics-based coastal flood risk model, such as PB-FRM, to generate future BFEs (1% annual chance water levels) for multiple end-of-service time horizons and then add freeboard, if desired, according to asset criticality. Modeling storms with higher sea level conditions ensures that interactive effects between sea level rise, storm surge, tides, and waves are included. Additionally, modeling could account for future storm intensification that would affect coastal flood risk – another likely impact of climate change particularly in the latter half of the century and with greater degrees of global warming. However, there is less scientific consensus on these effects and more uncertainty, so inclusion should be based on regional expert input, the user’s confidence that these effects will occur, and/or tolerance for risk.

### Box 3. Storm Intensification

In this report, the term “**storm intensification**” refers to an increase in the proportion of tropical cyclones (tropical depressions, tropical storms, and hurricanes) that are high category hurricanes, based on the hurricane surge index at landfall. PB-FRM includes a large, statistically robust set of synthetic tropical cyclones developed using peer-reviewed statistical methods for storm seeding<sup>5</sup>, historical climate inputs for the present day scenario, and 21<sup>st</sup> century projections from four global climate models for the future scenario. Comparing the present and future scenario storm sets, the future sets have a greater surge intensity.

The **Intergovernmental Panel on Climate Change (IPCC)** recently released The Physical Science Basis for the Sixth Assessment Report<sup>6</sup>. Relevant findings include:

- “It is *likely* that the global proportion of major (Category 3-5) tropical cyclone occurrence has increased over the last four decades and this cannot be explained entirely by natural variability.”
- “The proportion of intense tropical cyclones (categories 4-5) and peak wind speeds of the most intense tropical cyclones are projected to increase at the global scale with increasing global warming (*high confidence*).”
- Further, the regional fact sheet for North America states with “*medium confidence*” that “tropical cyclones (with higher precipitation) are expected to become more extreme” in the US East Coast region.

PB-FRM is the right type of computer model to develop future DFEs. It currently provides future BFEs for an Intermediate-High sea level rise scenario in 2055 and storm intensification based on four global climate models. However, for its full value as a basis for future DFEs to be realized, BFEs for additional end-of-service time horizons must also be modeled. The State of Florida in 2021 adopted into law specific sea level rise scenarios and time horizons for use in vulnerability assessments and consideration in the design of State-financed projects. Alignment of PB-FRM with these new standards codified after PB-FRM was completed will ensure that DFEs derived from PB-FRM are accepted as the basis of prioritization and design of projects the Town submits to State grant programs. Palm Beach is well-positioned to comply with these standards based on the progress already made proactively via the CVFA. Storm intensification is not yet part of the State’s new standards, and subject of ongoing investigation. In addition, analysis indicates that storm intensification has a significant effect on the future BFEs provided by PB-FRM, warranting further review with regional experts. An alternative interim approach to calculating DFEs is therefore recommended at this time. The current recommendation herein is based on traditional methods, informed by PB-FRM and other sources. PB-FRM results also can be applied on a site-

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<sup>5</sup> Emanuel, K., S. A. Ravela, E. A. Vivant and C.A. Risi. 2006. A Statistical-Deterministic Approach to Hurricane Risk Assessment. Bull. Amer. Meteor. Soc., 87, 299-314.

<sup>6</sup> IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. In Press.

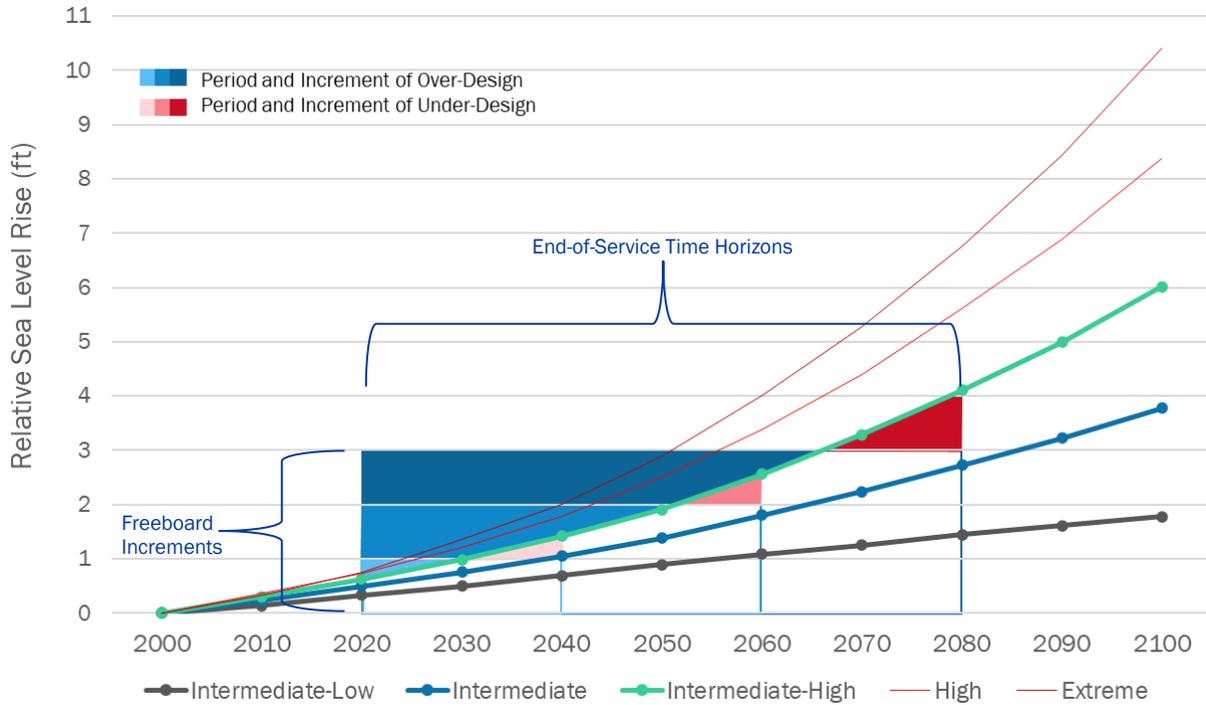
specific basis for assets and stakeholders with high criticality assets, low risk tolerance, and/or long service life. Once PB-FRM is updated to be consistent with the State standards, and some of the science around intensification evolves, the Town should consider updating the DFEs according to the PB-FRM results. The updated PB-FRM maps should also be made available for use by the public in the Town’s interactive GIS maps.

The recommended interim approach is to account for increased flood risk over time in the increment of freeboard added to present day FEMA BFEs. This approach is relatively straightforward to implement in the short-term, particularly in the context of making local policy updates. The freeboard added to the FEMA BFE is the amount of sea level rise, in feet, predicted for the asset’s end-of-service time horizon based on the “Intermediate-High” sea level rise scenario. To reduce complexity, three end-of-service time horizons are recommended, each spanning 20 years, with the freeboard increment based on the average sea level rise over the 20 years rounded to the nearest foot (**Table 2**). No additional freeboard is added based on criticality, as the sea level rise scenario is already on the more conservative side, but the Town could elect to add more freeboard for the most critical or longest-lived assets if desired based on risk tolerance.

**Table 2 Recommended interim Design Flood Elevations (DFEs) for Town facilities.**

End-of-Service Time Horizon	Design Flood Elevation	Typical Project/Asset Type
2021-2040	FEMA BFE + 1 ft	Maintenance; Electrical Panel
2041-2060	FEMA BFE + 2 ft	Rehabilitation; Emergency Generator, HVAC System, Pump, Deployable Flood Barriers
2061-2070	FEMA BFE + 3 ft	New Construction/Substantial Improvement; Building, Seawall

The effect of averaging over 20-year periods and rounding is that assets with end-of-service dates in the latter half of their DFE time horizon may be up to 0.5 to 1 ft under-designed for their final years of service if sea level rises according to the Intermediate-High scenario (**Figure 3**). If sea level rise follows an Intermediate scenario, as it is currently, they will not be under-designed.



**Figure 3 Interim DFE freeboard increments compared with Intermediate-High scenario relative sea level rise (NOAA 2017).**

This approach is like that used in many forward-looking industry and institutional design standards, including in Florida. The Southeast Florida Climate Change Compact, in its *2019 Unified Sea Level Rise Projection* guidance recommends applying the Intermediate-High sea level rise projections in the design of critical facilities and infrastructure. The DEP’s proposed Sea Level Impact Projection (SLIP) Study standards, effective in July 2022, require an evaluation of impacts in the 100-year flood (FEMA BFE) plus Intermediate-High sea level rise over the expected service life of a project or asset. State-financed projects in Palm Beach designed to the recommended interim DFEs, and subject to SLIP Study rules, will be able to demonstrate substantial resiliency from sea level rise impacts.

Woods Hole Group compared the interim DFE for assets with an end-of-life in 2055 (FEMA BFE + 2 ft) to representative probabilities of exceedance from PB-FRM’s future scenario results (Intermediate-High sea level rise in 2055 and storm intensification) and found that the interim DFE has a 2% to 5% annual probability of exceedance (20- to 50-year recurrence) according to PB-FRM, depending on where on the island the project is located. This suggests that, if the Town decides to include storm intensification in the updated PB-FRM scenarios, and base updated DFEs on PB-FRM results, different DFEs may be needed based on project location. The DFEs will likely need to be adjusted higher than indicated in **Table 2** to meet a standard 1% annual chance (100-year recurrence) level of protection at their end-of-service date.

## 2.2 Prioritization of Town Assets

The risk-based process used in the original 2019 *CFVA* to preliminarily identify and prioritize the Town assets for adaptation to future coastal flooding was refined in the development of the *Level-Up Implementation Plan*. Refinements were made based on a more detailed analysis of individual asset values, in some cases review of engineering drawings and onsite observations, and combined with probabilities of flooding from PB-FRM.

### 2.2.1 *CFVA Risk-Based Prioritization Method*

The *CFVA* developed a prioritized list of vulnerable Town facilities and infrastructure assets based on the value of assets and their probabilities of being exposed to coastal flooding. Asset value, criticality, or, conversely, consequence of failure was evaluated using the *CFVA* scoring criteria and input from the Town. Scoring criteria included:

- Potential impacts to public health and the environment
- Economic activities
- Public safety
- Cost of damage
- Area and duration of service loss.

Probability of flood exposure was estimated from the PB-FRM using geospatial analysis of present and future coastal flood maps compared with asset locations.

These two factors, probability and consequence, are the essential components of risk assessment – answering how likely it is that an asset will be exposed to flooding and how consequential it is if the asset is damaged or fails to function as a result of the flooding. By accounting for both factors, the *CFVA*'s risk-based approach sought to identify the highest priority Town assets for adaptation – those most likely and most consequential to be impacted by present and future coastal flooding. The prioritization process and results were further refined beyond what was presented in the 2019 *CFVA* to inform the Implementation Plan.

### 2.2.2 *Refinement of CFVA Asset Value Scores*

Individual asset values were further refined based on more detailed review of interdependencies between assets and systems. For example, review of wastewater and stormwater facility reports revealed that certain pump stations receive and pump out inflow from multiple upstream stations or from larger service areas than others. The area affected by failure of these more critical pump stations was larger than had previously been accounted for, and in some cases that meant that their importance for servicing commercial areas or public safety facilities were greater than originally rated in the 2019 *CFVA*. Additionally, some stormwater pump stations house backup power generators for nearby wastewater pump stations. The potential impacts to public health and the environment of those stormwater stations being flooded was therefore greater than had previously been rated. Asset values for specific criteria were adjusted higher according to these findings, resulting in higher risk scores for some assets.

### ***2.2.3 Refinement of CFVA Flood Probabilities***

Individual assets were also evaluated at a finer scale to account for factors that might mitigate their vulnerability to predicted flood levels. This included obtaining more specific data and plans cooperatively with Town staff. For example, the first floor of a critical facility (e.g., pump station) might already be elevated one or more feet above the surrounding grade, or the pumps in a below-grade pump station might be fully submersible, such that just a few inches of water around or in the facility would not cause substantial damage or a shutdown of services.

Readily available information, including topographic data, aerial images, street view map explorers, and facility reports were used to estimate the critical elevation at which each asset would be sensitive to damage from flooding. These critical elevations were then compared with present and future water elevation probabilities. Where appropriate, adjustments were made to the probability components of asset risk scores. Except for roadways, sewers, and parks, which do not generally have such nuanced sensitivities, this refinement process using the site-specific data tended to lower previously identified probabilities of flooding and resulting risk scores.

An even more detailed analysis was completed for a selection of facilities to inform specific adaptation recommendations. These included some of the highest risk assets based on the refined prioritization, and some assets already in the Town's 5-year capital improvements plan. Town staff collected the best available and most recent engineering drawings for a selection of facilities. In some cases, these drawings were more than 30 years old, and for certain assets, digitized records reflecting present conditions were not readily available. The drawings provided were reviewed in detail to determine what flood mitigation strategies could be implemented to adapt the facility to higher levels of coastal flooding. Specific recommendations for the assets at risk were developed to address vulnerabilities verified in this review.

In almost all cases, the review revealed that the critical elevations at which damage and failure would occur are, in fact, higher than estimated based on the probability refinement process described above. The Town has been proactive in the design, repair, and improvement of its facilities like pump stations, such that critical equipment is not generally installed below the FEMA 100-year flood elevation. Various adaptive modifications to older pump stations have been implemented to mitigate critical equipment vulnerabilities, including installing equipment on raised platforms (**Figure 4**) or wall-mounts, and selecting pumps that can be fully submersed without failing. As a result, probability of inundation and risk scores were lowered for the assets reviewed at this level of detail. Because not all assets were reviewed at this level of detail, and not all data are available at this time, additional data and guidance is needed to fully integrate risk-based priorities in the Town's capital planning.



**Figure 4** Renovated pump stations with critical equipment on raised interior platforms.

### 2.3 Recommended Near-Term Adaptations

The Town should focus near-term adaptation actions on critical facilities and infrastructure assets already in the 5-year capital investment plan. Specifically, flood risks to assets slated for replacement or upgrade should be mitigated up to the appropriate interim DFE, based on their end-of-life time horizon. If budgets are constrained such that the identified vulnerabilities of all assets cannot be mitigated in this timeframe, priority should be given to those with the highest risk score, including consideration of new survey and flood probability data available prior to design and construction. The risk-ranked asset list, including refined risk data and planned improvement year, is provided in **Table 3**.

**Table 3** Risk-based prioritization of assets in the 5-year capital plan.<sup>7</sup>

Asset	Probability (Present)	Probability (Future)	Asset Value	Risk Score (Present)	Planned Improvement Year
<b>G-7 WPS*</b>	10%	>20%	60	6.0	2021
<b>D-12 SPS (Building)</b>	5%	>20%	70	3.5	2022
<b>D-6 SPS (Building)</b>	5%	>20%	67	3.4	2025
<b>A-42 WPS*</b>	5%	>20%	60	3.0	2023
<b>E-6 WPS</b>	3%	20%	70	2.1	2022

<sup>7</sup> WPS stands for Wastewater Pump Station, and SPS stands for Stormwater Pump Station. Probability and risk score data for assets marked with an asterisk should be further verified, as engineering plans for planned capital improvements were not available for review at the time of this report.

Asset	Probability (Present)	Probability (Future)	Asset Value	Risk Score (Present)	Planned Improvement Year
E-5 WPS*	3%	20%	63	1.9	2022
A-43 WPS*	3%	>20%	60	1.8	2023
Town Hall*	2%	20%	73	1.5	2025
D-12 SPS (Wet Well)	2%	10%	70	1.4	2021
A-39 WPS*	2%	>20%	70	1.4	2023
D-17 SPS	2%	10%	57	1.1	2023-2024
Police*	1%	10%	80	0.8	2023/4
A-6 WPS	1%	10%	73	0.7	2021
Central Fire*	1%	10%	73	0.7	2022
D-8 SPS	1%	10%	63	0.6	2022
South Fire*	1%	10%	53	0.5	2022
S-2 WPS	0.5%	5%	90	0.5	2021-2025
North Fire*	0.5%	5%	70	0.4	2024-2025
A-5 WPS	1%	5%	60	0.3	2024

Incorporating resiliency retrofits within the scope of capital projects already planned is a cost-effective and pragmatic approach to implementation in the near-term. It reduces the additional effort and costs of designer selection, bidding, and contractor mobilization compared with implementing flood mitigation retrofits as standalone projects. It also avoids potential disruption of returning to modify recently implemented improvements. This approach creates opportunities for more integrated and holistic design solutions to multiple issues affecting an asset’s future performance, among which coastal flood risk is only one. For example, a stormwater pump replacement project implemented for maintenance reasons can not only consider strategies to prevent the new pumps or control systems from being damaged by exposure to higher flood levels, but also account for higher incoming rainfall and higher tidal conditions in receiving waters.

Recommended adaptation measures for assets in the Town’s current 5-year capital plan are provided in **Table 4**, along with their respective interim DFEs, prioritized from highest to lowest risk score. The recommended measures and interim DFEs are based on available documentation and assumptions regarding the scope and expected life of assets planned for replacement.

**Table 4 Recommended near-term adaptations and interim DFEs for Town facilities.<sup>8</sup>**

<b>Asset</b>	<b>Recommended Adaptation Measures</b>	<b>Interim DFE</b>
<b>G-7 WPS*</b>	Raise electrical/controls equipment to be replaced	FEMA BFE + 2 ft
<b>D-12 SPS (Building)</b>	Dry floodproof with deployable barriers, conduit sealant; evaluate/reinforce wall strength if needed; raise radiators and associated wall openings	FEMA BFE + 2.5 ft
<b>D-6 SPS (Building)</b>	Raise proposed main disconnect and existing 30KVA transformer	FEMA BFE + 2 ft
<b>A-42 WPS*</b>	Raise electrical/controls equipment to be replaced	FEMA BFE + 2 ft
<b>E-6 WPS</b>	Raise electrical/controls equipment to be replaced, raise or dry floodproof odor control enclosure	FEMA BFE + 2 ft
<b>E-5 WPS*</b>	Raise electrical/controls equipment to be replaced, new radiators and associated wall openings	FEMA BFE + 2 ft
<b>A-43 WPS*</b>	Raise electrical/controls equipment to be replaced	FEMA BFE + 2 ft
<b>Town Hall*</b>	Dry or wet floodproof	FEMA BFE + 2.5 ft
<b>D-12 SPS (Wet Well)</b>	Extend pump electrical gear wall, raise electrical panels, provide higher access if needed	FEMA BFE + 2.5 ft
<b>A-39 WPS*</b>	Raise electrical/controls equipment to be replaced	FEMA BFE + 2 ft
<b>D-17 SPS</b>	Raise electrical/controls equipment to be replaced	FEMA BFE + 2.5 ft
<b>Police*</b>	Dry or wet floodproof	FEMA BFE + 2.5 ft
<b>A-6 WPS</b>	Raise proposed equipment	FEMA BFE + 2.5 ft
<b>Central Fire*</b>	Dry or wet floodproof	FEMA BFE + 2.5 ft
<b>D-8 SPS</b>	Raise proposed air-cooled radiators, pump control panel	FEMA BFE + 2.5 ft
<b>South Fire*</b>	Dry or wet floodproof, or perimeter barrier	FEMA BFE + 2.5 ft
<b>S-2 WPS</b>	Dry or wet floodproof	FEMA BFE + 2.5 ft
<b>North Fire*</b>	Elevate building	FEMA BFE + 4 ft

<sup>8</sup> WPS stands for Wastewater Pump Station, and SPS stands for Stormwater Pump Station. Recommended measures and suggested interim DFEs for assets marked with an asterisk should be further verified, as engineering plans for planned capital improvements were not available for review at the time of this report.

## 2.4 Additional Data Needs and Decision-Making Guidance

The prioritization process for the remaining assets presently at risk from coastal flooding should be continued in the near-term, including on-the-ground survey of critical elevations to fill data gaps. This would produce consistent and comparable data forming the basis for refined flood probabilities. This would also be more efficient and effective than carrying out detailed engineering drawing reviews for all assets, given the large number of assets and variable availability and quality of engineering drawings.

In the near-term the PB-FRM and associated asset-specific probability of flooding estimates should also be updated to reflect sea level rise scenarios and time horizons recently adopted by the State of Florida. Signed into law in May 2021, Section 380.093 of the Florida Statutes entitled *Statewide Flooding and Sea Level Rise Resilience Plan* requires local vulnerability assessments to include, at a minimum, an evaluation of the impacts to critical assets from future high tide flooding and 100-year storm surge flooding in the 2040 and 2070 time horizons, based on the 2017 NOAA<sup>9</sup> “Intermediate-Low” and “Intermediate-High” sea level rise projections (**Table 5**).

**Table 5** Relative sea level rise projections for Palm Beach required by Florida Statutes.<sup>10</sup>

Sea Level Rise Scenario	Intermediate-Low	Intermediate-High
<b>2040</b>	0.7 ft	1.4 ft
<b>2070</b>	1.3 ft	3.3 ft

The PB-FRM future conditions scenario includes the 100-year storm surge and estimated sea level rise in 2055 (the midpoint year between 2040 and 2070) using an Intermediate-High scenario, but also including storm intensification not required by State law. Time horizon gaps and methodological differences with the law’s requirements must be addressed to achieve full compliance. A vulnerability assessment consistent with this law will be required for Palm Beach to be eligible for State grant funding of adaptation projects under the Resilient Florida Grant Program within the Department of Environmental Protection (DEP), which could provide up to \$100 million per year to municipalities and other eligible entities. The final risk scores should then be used to prioritize medium- and long-term investments in coastal flood protection of critical assets, and strategically considered among the other priorities driving Town department capital investment plans. Preliminary adaptation strategies for each asset can be further refined for medium- and long-term planning purposes.

<sup>9</sup> 2017 NOAA Technical Report National Ocean Service Center for Operational Oceanographic Products and Services (NOS CO-OPS) 083, Global and Regional Sea Level Rise Scenarios for the United States

<sup>10</sup> 2017 NOAA intermediate-low and intermediate-high relative sea level rise projections from the base year 2000, interpolated between Virginia Key (Miami) and Trident Pier (Cape Canaveral) tide gauges.

#### Box 4. Resilient Florida Grant Program

Florida Statute 390.093, signed into law in 2021, established the Resilient Florida Grant Program (Resilient Florida) within the Department of Environmental Protection (DEP). Grants can be used to fund the costs of the following eligible activities to address flooding (inland and coastal) and sea level rise:

- Comprehensive plan amendments
- Vulnerability assessments
- Plan, project, and policy development
- Critical asset adaptation projects (construction).

To be eligible for development and construction, projects must be identified in a vulnerability assessment meeting the standards set in the law.

The law also directs DEP to conduct a statewide vulnerability assessment and develop a statewide resilience plan, focused on flooding and sea level rise impacted critical assets (e.g., infrastructure, natural and historic resources), areas, and communities. The vulnerability assessment will fold-in findings from assessments carried out by municipalities, if they meet the standards set in the law. The resilience plan will include a list of prioritized projects submitted by municipalities and other eligible entities and recommended by DEP for funding under the Resilient Florida Grant Program, up to \$100 million annually and subject to appropriations. The list of projects will be updated annually and submitted to the Governor and Legislature. Proposals for the first round of funding are to be submitted by September 1, 2021.

Resilient Florida scales up an existing DEP Florida Resilient Coastlines Program grant initiative started in FY 2018-2019 with State and Federal funding support. Total grant funding delivered by this program was nearly \$6.5 million through FY 2020-2021. The Florida Resilient Coastlines Program has the following grant types, maximum grant award (per award), and eligible activities:

- Resilience Planning Grants (RPG) (maximum award up to \$75,000)
  - Comply with peril of flood statute
  - Vulnerability assessments
  - Adaptation and resilience plans
  - Regional collaboration efforts
- Resilience Implementation Grants (RIG) (maximum award up to \$500,000)
  - Nature-based erosion and flood control
  - Elevation of public structures
  - Projects in adaptation/resilience plans

Town facilities not in the current 5-year capital plan at present risk of flooding based on PB-FRM are listed by sector and ranked from high (top and left) to low (bottom and right) present risk score in **Table 6**. These should be considered preliminarily as medium-term targets for adaptation. Additional Town facilities at risk only in the PB-FRM future scenario with storm intensification are listed in **Table 7**.

**Table 6 Other Town assets at present risk of flooding based on PB-FRM.<sup>11</sup>**

Stormwater	Wastewater			Recreation
D-18*	E-15*	E-17*	G-1	Rec Center*
D-6*	E-50*	E-18*	A-7*	Par 3 Maintenance*
D-7*	E-9*	E-20*	E-1	Phipps North Restrooms*
D-14*	E-10*	E-22*	E-2	Chilean Ave Restrooms*
D-2*	E-12*	E-23*	E-13	Phipps South Restrooms*
D-4*	E-14*	A-41*	S-2	Par 3 ProShop*
D-9*	E-16*	E-19*	A-5*	Memorial Fountain*
D-16*	E-4*	E-3	E-24*	
D-17 (Generator)	E-7*	E-21*	E-25*	
D-10*	E-8*	E-38*	E-44*	
	E-11*	E-40*		

**Table 7 Town assets at future risk of flooding based on PB-FRM.<sup>12</sup>**

Wastewater			
G-9*	A-4 (Building)*	E-27*	A-4 (Wet Well)*

<sup>11</sup> Probability and risk score data for assets marked with an asterisk should be further verified, as engineering plans for planned capital improvements were not available for review at the time of this report.

<sup>12</sup> Probability and risk score data for assets marked with an asterisk should be further verified, as engineering plans for planned capital improvements were not available for review at the time of this report.

### 3.0 LEVEL-UP LAKE WORTH SHORELINE

*The objective of **Level-Up Lake Worth Shoreline** is to mitigate neighborhood and Town-wide exposure to coastal flooding sourced from the Lake Worth Lagoon on the west side of the Palm Beach barrier island.*

Lake Worth presents the primary flood risk for the vast majority of Palm Beach’s present and future floodplains and the people, infrastructure, buildings, and open spaces therein. Although the majority of the Atlantic Ocean facing shoreline of Palm Beach is protected by higher land elevations, shore protection structures, and beach/dune nourishment from the Coastal Program, the lower existing shoreline elevation and infrastructure along Lake Worth Lagoon is not sufficient to mitigate present or future coastal flooding risks. This not only includes flood risk from coastal storms, but also high tide sunny day flooding.

Sunny day flooding occurs annually in low-lying sections of the Lake Trail. During King Tides, water in the lagoon reaches a higher level than the Lake Trail surface and seeps through bulkhead cracks or in some areas flows over the tops of lower elevation bulkheads (**Figure 5**). As sea level rises over the next 10-20 years, the tide levels currently causing nuisance flooding are projected to multiply in frequency and duration. King Tide levels are also projected to climb higher, extending areas and depths of flooding, and posing a greater threat in low-lying areas.



**Figure 5 King Tide flooding on the Lake Trail in 2018 and 2019.**

The Town’s exposure to more rare but severe storm-driven coastal flooding is clear based on the 2017 FEMA FIRMs, which indicate substantial present-day flood risk, as well as the 2019 CFVA present and future flood risk maps generated by Woods Hole Group from the Palm Beach Flood Risk Model (PB-FRM). The latter analysis considers combined influence of sea level rise and storm intensification, and illustrate the Lake Worth shoreline has an increasing likelihood of being flooded in the future by higher tides and storm surges, due to climate change. The dominant

source of flood water in these events is not from inland. Rather, the primary source of flood risk is from Atlantic Ocean storm surge entering the Lagoon through the Lake Worth Inlet. Inland precipitation runoff contributes to a degree, but the CFVA demonstrated coastal surge is the dominant contributor. Anecdotally, given the flood risk mapped by both FEMA and the present-day CFVA maps, it is fortunate the Town has not experienced a major coastal flooding event from Lake Worth in quite some time. According to the prevailing FEMA maps, and PB-FRM, substantial portions of Palm Beach have a 1% or more risk from coastal flooding derived from the Lake Worth shoreline in any given year (i.e., 100-year storm).

Infrastructure to mitigate flood risks from Lake Worth must be raised, strengthened, and created to address the substantial and increasing public risks from coastal flooding to Palm Beach. Although individual and/or groups of Town facilities and private development in the floodplain can be made more resilient by implementing recommendations presented elsewhere in this report, elevating and floodproofing buildings will not keep salt water off roads, trails, parks, or landscaping, or out of underground infrastructure. Controls are needed at the source of flooding to mitigate flood risk and build resilience. A storm surge barrier at the Lake Worth Inlet and possibly other inlets to the Intracoastal Waterway has the potential to provide Town-wide protection from coastal flooding in storm events, including protecting evacuation routes and sewers. However, even a storm surge barrier at the Inlet would not mitigate the risks of future high tide sunny day flooding, since navigation and commerce must be maintained at the inlets. Engineered and natural shoreline infrastructure must be adapted given their public purpose as a critical line of defense against future high tides, storm surges, or both.

The Town's role in advancing solutions to future coastal flooding from Lake Worth is crucial to safeguard the public health, safety, and general welfare. The Town owns very little shoreline infrastructure along Lake Worth – less than 6,000 linear ft of the nearly 90,000 linear ft (including developed islands). However, the Town can set and enforce consistent, higher construction, maintenance, and certification standards for private shoreline infrastructure through the Code of Ordinances. The Town can also increase its own flood mitigation capacity, building on the example of the Town Marina bulkhead, which was recently raised and made more adaptable to future sea level rise. In the future, whether for urgency, efficiency, or to leverage third-party public funding sources, the Town can also be empowered to provide neighborhood-scale coastal flood control systems. Finally, the Town can collaborate with neighbors and engage Federal and State partners to advocate for the study and funding of potential regional, Town-wide, and neighborhood-scale solutions. Specific recommendations to implement these strategies are provided in this section.

### 3.1 Bulkhead Construction Specifications

The Town should consider amending the *Code of Ordinances, Chapter 62, Article III. – Bulkheads and Pierheads on Lake Worth, Sec. 62-75. – Construction Specifications*. The amendments to consider would include modifications to existing specifications, and new specifications. Taken as a whole, these amendments would require new and substantially improved bulkheads on the Lake Worth shoreline to be built higher and stronger than those in existence today. Suggested

amendments also have creative aspects to help mitigate potential temporary aesthetic and functional impacts of staggered bulkhead heights that could otherwise result as individual sections of bulkhead are improved at different times under the existing private ownership and maintenance framework.

The following recommendations are suggested to modify existing specifications (**Table 8**):

- 1) **A consistent minimum top elevation** for bulkheads and seawalls along the Lake Worth shoreline should be specified for the purposes of flood mitigation, as it is for seawalls along the Atlantic Ocean (see Sec. 62-38). The Town should not be exempt from this requirement. The FEMA base flood elevation plus two feet of freeboard is recommended, aligning with State sea level rise projections for 2050 and present FEMA standards for flood control system certification. Additionally, the Town should require foundations to be designed with sufficient structural capacity to enable the top elevation to be raised an additional two feet without full reconstruction, should future monitoring and projections of water level align with State sea level rise projections for 2080. Once updated to align with new State standards, PB-FRM results for future time horizons should be compared with these freeboard increments, and the Town should consider whether adjustments to freeboard or geographic application are warranted.
- 2) **A standard permit application** setting minimum expectations for information to be submitted, should be specified, beyond the plan and profile currently required.
- 3) **Construction notification milestones** should be specified to facilitate timely inspection and to enforce quality workmanship for critical components of shoreline infrastructure.

The Town should also consider developing an online permit application and checklist to facilitate consistency and ease of review, along with a geospatial database and document management system for tracking permit application materials, top elevations, adjacent grades, lengths, waivers, and easements. The tracking system would help the Town administer maintenance and certification provisions recommended in the section that follows.

The recommended language included in **Table 8** is draft only and intended to inform a more deliberative redrafting process.

**Table 8 Higher standards for bulkhead construction on Lake Worth - modifications.**

Existing	Recommended
<p>(d) <i>Elevation of top.</i> The top of bulkheads or cutoff walls shall be governed by sound engineering recommendations, and the same shall be approved by the town engineer.</p> <p>...</p> <p>(k) <i>Profiles with application.</i> If in the construction of any structure covered in this section is made, such application must be accompanied by a profile taken along the line of the proposed structure, such profile to show the character of materials encountered to elevations of required penetrations.</p> <p>(l) <i>Plans.</i> All plans accompanying applications for structures covered in this section must be prepared by, or in collaboration with, a civil engineer licensed to practice in the state.</p> <p>...</p>	<p>(d) <i>Elevation of top.</i> The top of bulkheads or cutoff walls shall be at an elevation not lower than the base flood elevation plus two feet.<sup>13</sup> Foundations shall be designed with sufficient structural capacity to enable the top elevation to be raised an additional two feet without requiring full reconstruction.</p> <p>(k) <i>Permit applications.</i><sup>14</sup> [consolidating and expanding upon (k) and (l)] All permit applications shall include the following information:</p> <ol style="list-style-type: none"> <li>1) Engineering plans signed and sealed by a Professional Engineer licensed in the State of Florida.</li> <li>2) A Standard Penetration Test (SPT) soil boring report containing the required soil design parameters for the location of the proposed wall prepared by a geotechnical engineer licensed in the State of Florida. The location and required depth of the boring shall be determined by the geotechnical engineer. The depth of the boring shall be a minimum of five (5) feet lower than the deepest component of the proposed bulkhead wall.</li> <li>3) A soil boring profile signed and sealed by the geotechnical engineer.</li> <li>4) A plan view of the proposed bulkhead wall clearly indicating the location of the soil boring.</li> <li>5) A cross section of wall indicating the channel bottom elevation, the cap elevation and identifying the type, size, and location of wall components.</li> </ol>

<sup>13</sup> Alternatively, a lower top elevation could be set. North Palm Beach sets the minimum cap elevation for bulkheads in Lake Worth at 5 ft NAVD88 and the maximum cap elevation at the FEMA BFE, subject to approval by key staff. Fort Lauderdale sets the minimum seawall elevation for properties with a FEMA BFE of 4 ft NAVD88 at 3.9 ft NAVD88 and the maximum seawall elevation at 5 ft NAVD88 (FEMA BFE + 1 ft), and it strongly encourages “property owners choosing to construct seawalls at less than 5 ft NAVD88... to have foundations designed to accommodate a future seawall height extension up to a minimum elevation of 5 ft NAVD88.” Miami Beach sets a minimum elevation for seawalls at 5.7 ft NAVD88 (well below FEMA BFE in most parts of the City), with allowances for certain circumstances in which a minimum elevation of 4 ft NAVD88 is acceptable provided the structure is designed and constructed to accommodate a future extension to 5.7 ft NAVD88.

<sup>14</sup> Modified from North Palm Beach, FL Code of Ordinances

Existing	Recommended
<p>(n) <i>Inspection</i>. The town or authorized agent has the right at all times to inspect work being done under this section.</p> <p>...</p>	<ol style="list-style-type: none"> <li>6) Fundamental soil data from the soil boring used in the design including saturated and submerged unit soil weight, coefficient of active pressure, coefficient of passive pressure, friction angle (for cohesionless soils), and cohesion (for cohesive soils).</li> <li>7) Documentation demonstrating that concrete satisfies the requirements of ACI 318 Exposure Class C2.</li> <li>8) Plans demonstrating that exposed steel tie back anchor rods and other anchors shall be coated with a heavy-duty protective coating to prohibit corrosion.</li> <li>9) A copy of the pollution control plan required by the Florida Department of Environmental Protection (FDEP) permit depicting the location and types of pollution control mitigation measures. During the course of construction, the permittee shall be required to submit to the Town all reports required by the National Pollutant Discharge Elimination System (NPDES) permit prior to the Town's issuance of a certificate of occupancy.</li> </ol> <p>(n) Inspection. The town or authorized agent has the right at all times to inspect work being done under this section. The permittee shall notify the town at least forty-eight (48) hours prior to the following events to allow for inspection:</p> <ol style="list-style-type: none"> <li>1) the first installation of any structural support;</li> <li>2) the backfilling of structural supports, including any anchors or tie rods;</li> <li>3) the pouring of any cast-in-place construction; and</li> <li>4) the final cap pouring.</li> </ol>

The following recommendations are suggested to add new specifications (**Table 9**):

- 1) **Flood design requirements** should be specified to explicitly make engineers responsible for designing shoreline structures to prevent structural failure and potential backflow through stormwater outfalls under design storm conditions.
- 2) **Requirements for bulkhead caps** should be specified to mitigate potential negative aesthetic or functional impacts due to differences in adjoining shoreline structure heights from building to the higher top elevation recommended for adoption herein.
- 3) **Requirements to mitigate leakage** between adjoining bulkheads.

- 4) Requirements for adjacent grade elevations, relative to bulkhead or seawall top elevations, should be specified to mitigate potential impacts to accessibility and scenic vistas of Lake Worth from the Lake Trail (aligned with the intent of Sec. 134-1698) and private property.
- 5) A mechanism, proposed herein as a **system of temporary waivers and easements**, is needed to facilitate a smoothing of adjacent grades across property lines as adjoining shoreline structures are brought up to a consistent higher top elevation over time.

The recommended language included in **Table 9** is draft only, and is intended to inform a more deliberative redrafting process.

**Table 9 Higher standards for bulkhead construction on Lake Worth - additions.**

Recommended Additions
<p>(p) <i>Flood design requirements.</i><sup>15</sup> The design of bulkhead walls shall conform to recognized engineering standards and calculation methods for coastal flood mitigation, erosion control, and land retention structures and shall account for the following:</p> <ol style="list-style-type: none"> <li>1) A design flood equivalent to the base flood plus two feet;</li> <li>2) Load and resistance factors applicable for the engineering analysis and design of the wall;</li> <li>3) Differential hydrostatic pressure due to tides and stormwater runoff;</li> <li>4) Surcharge loads on the bulkhead wall;</li> <li>5) Potential erosion at the toe of the wall; and</li> <li>6) Backflow prevention for drainage outfalls, where applicable.</li> </ol> <p>(q) <i>Caps.</i><sup>16</sup> All bulkheads shall be capped with a continuous reinforced concrete cap. Caps placed at an elevation greater than the adjacent property shall provide a wall return of the same material and type as the bulkhead cap. All areas visible from adjacent property shall have a finished appearance equivalent to or better than painted concrete stucco.</p> <p>(r) <i>Adjoining bulkheads.</i><sup>17</sup> To the extent practicable, bulkheads shall be designed and constructed to adjoin immediately proximate bulkheads to close gaps and prevent trespass of tidal surface water.</p> <p>(s) <i>Elevation of adjacent grade.</i> For the purposes of this section, adjacent grade shall mean the area of land within a 15-foot<sup>18</sup> setback from the east face of the bulkhead wall, or, where the Lake Trail is present, between the east face of the bulkhead wall and the eastward limit of the</p>

<sup>15</sup> Modified from North Palm Beach, FL Code of Ordinances

<sup>16</sup> Modified from North Palm Beach, FL Code of Ordinances

<sup>17</sup> Modified from Miami Beach, FL Code of Ordinances

<sup>18</sup> Alternatively, a larger setback could be specified.

### Recommended Additions

Lake Trail right-of-way<sup>19</sup>. Except as provided in (u), adjacent grade shall be backfilled and graded to an elevation no lower than 30 inches below the proposed top of bulkhead elevation. Fill placed on the lot to comply with the requirements of this section shall be excluded from limitations and calculations of allowable fill imposed by other sections of this code.

(t) *Accessibility of adjacent grade.* The portions of adjacent grade within the Lake Trail right-of-way shall be graded as an accessible path of travel, as defined in the Florida Building Code.

(u) *Adjacent grade between adjoining properties.* The Town may grant a temporary waiver of the elevation of adjacent grade requirements in (s), following the process and conditions described in section (v) only for the minimum adjacent grade area required to:

- 1) maintain an accessible path of travel along the Lake Trail where transitioning to existing grade at adjoining side property lines or public ways; or
- 2) meet the existing grade of adjoining side property lines where the Lake Trail is not present and accessibility is not required.

(v) *Process and conditions for a temporary waiver of adjacent grade elevation requirements.* A coordination meeting will be held by the Town Engineer with the bulkhead or seawall owner and adjoining property owners prior to the issuance of any waivers to determine whether there are mutually agreeable alternatives to the granting of a waiver<sup>20</sup>. If no alternative is agreed, the Town Engineer may grant a separate temporary waiver with conditions to the bulkhead or seawall owner for each portion of adjacent grade that does not meet the requirements of (s). Each waiver shall expire 30 days<sup>21</sup> after the bulkhead or seawall on the adjoining property to which the subject adjacent grade is connected is reconstructed to meet the standards of this section. As a condition of granting a temporary waiver under this section, the Town shall require the bulkhead or seawall owner to provide the Town with a separate temporary easement over each portion of adjacent grade covered by a waiver. The term of each easement shall be set to expire no later than 30 days<sup>22</sup> after the issuance of a certificate of occupancy for the adjoining property's bulkhead to be replaced in the future. The temporary easement shall grant the Town the right to backfill, grade, pave, and landscape the subject adjacent grade to

<sup>19</sup> Alternatively, the limits could be set at the westward and eastward limits of the Lake Trail right-of-way.

<sup>20</sup> For example, an adjoining property owner may agree to extend the construction limits onto their property to enable a more desirable grading and vista outcome for both property owners.

<sup>21</sup> Alternatively, a longer or shorter period could be specified. The general idea is to put a time limit on the waiver so that either the Town or the bulkhead or seawall owner will be incentivized to coordinate a smoothing of grades and vistas once the adjoining project is under construction. If the waiver expires before the adjacent grade condition is corrected to comply with the vista requirement, penalties could start to accrue daily.

<sup>22</sup> Alternatively, a longer or shorter period could be specified. The term of the easement should coincide with the term of the waiver.

### Recommended Additions

bring it to an elevation no lower than 30 inches below the top of bulkhead elevation<sup>23</sup>. The Town Engineer<sup>24</sup> is authorized by this section to procure construction services and levy an assessment against the bulkhead or seawall owner for the backfilling, paving, and landscaping of adjacent grade over which such a temporary easement is held<sup>25</sup>. The terms of waivers and temporary easements granted under this section may be extended if agreed out of mutual convenience by the Town Engineer and property owner. The Town Engineer is hereby authorized to extend the terms of such waivers and easements on behalf of the Town for a period no longer than 90 days<sup>26</sup> beyond the initial terms. In no case shall the Town Engineer grant a temporary waiver to a bulkhead or seawall owner for the portion of adjacent grade where transitioning to an adjoining property where a bulkhead or seawall has already been constructed to the specifications of this section<sup>27</sup>.

### 3.2 Bulkhead Maintenance and Certification

The Town should consider amending the *Code of Ordinances, Chapter 62, Article III. – Bulkheads and Pierheads on Lake Worth, Sec. 62-77. – Maintenance and Certification of All Bulkheads and Seawalls*<sup>28</sup>. Shoreline owners' responsibilities for maintaining their shoreline infrastructure in the condition required to achieve high flood mitigation performance standards should be explicitly set forth in this section. In addition to establishing more robust maintenance standards, this section should define the conditions and procedures under which infrastructure condition must be assessed and deficient performance must be corrected to meet the standards and specifications. Together, these recommended amendments would be both proactive in facilitating a more rapid renewal of critical shoreline infrastructure, as well as reactive in requiring corrective action following future flooding events.

The recommended language suggested in **Table 10** is draft only, intended to inform a more deliberative redrafting process.

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<sup>23</sup> As noted above, fill placed on the lot to comply with the requirements of this section shall be excluded from limitations and calculations of allowable fill imposed by other sections of this code.

<sup>24</sup> Alternatively, another person or entity of authority could be specified. This same comment applies to other references to the Town Engineer's authorities herein.

<sup>25</sup> Because there could eventually be many of these conditions being corrected across the shoreline in the future, delegation of certain authorities reserved for Town Council or others would reduce administrative burden and maximize efficiency. This same comment applied to other delegation statements that follow.

<sup>26</sup> Alternatively, a longer or shorter period could be specified. The general concept is to provide some level of flexibility without allowing for perpetual extensions.

<sup>27</sup> In other words, if an adjoining property has already raised their seawall the outcome must be for the new project to meet the vista requirements, in order to facilitate the coordinated smoothing of the adjoining property's adjacent grade.

<sup>28</sup> While this section falls within *Article III*, pertaining to Lake Worth bulkheads, it may have been intended to apply to both *Article II – Bulkheads, Seawalls and Groins on Atlantic Ocean* and *Article III*.

**Table 10 Higher standards for bulkhead maintenance on Lake Worth.**

Existing	Recommended <sup>29</sup>
<p>All bulkheads and seawalls within the town shall be maintained in good condition to provide for the protection of upland and foreshore properties, limit wave overtopping, and be impervious without cracks or holes that would allow for the passage of sand. Failure to maintain a bulkhead or seawall in good condition shall be a violation of this section and subject to action before the town's code enforcement board. When cited by the town's code enforcement board a condition survey of any seawall or bulkhead prepared by a professional engineer licensed to practice in the state along with plans required to implement the engineer's recommendation to bring the structure into compliance shall be submitted to the town. Upon project completion, certification by a professional engineer licensed to practice in the state must be submitted to the town. Recertification of the seawall by a professional engineer licensed to practice in the state shall be required every 15 years from the date of the original certification.</p> <p>A condition survey of any seawall or bulkhead prepared by a professional engineer licensed to practice in the state along with plans required to implement the engineer's recommendation for repair or replacement shall be submitted to the town when a new building is proposed or when renovations exceeding 50 percent of the value of the primary structure are proposed. Upon project completion certification by a professional engineer licensed to practice in the state must be submitted to the town. Recertification of the seawall by a professional engineer</p>	<p>(a) All property owners must maintain their bulkheads and seawalls in good repair to provide for the protection of upland and foreshore properties. A bulkhead or seawall is presumed to be in disrepair if:</p> <ol style="list-style-type: none"> <li>1) it has cracks, holes, or other structural deficiencies that would allow for upland erosion through the bulkhead or seawall;</li> <li>2) allows unsafe, dangerous, or damaging wave overtopping; or</li> <li>3) allows tidal waters to flow through or over the bulkhead or seawall to adjacent properties or public right-of-way at levels below the minimum top elevation specified in Sec. 62-75.</li> </ol> <p>(b) Property owners failing to maintain their bulkheads or seawalls in good repair or failing to (re)certify them in accordance with the schedule set forth in (c) shall be in violation of this section and subject to action before the town's code enforcement board.</p> <ol style="list-style-type: none"> <li>1) Within sixty (60) days of receiving a citation from the town's code enforcement board, the owner of the property on which the bulkhead or seawall is constructed shall submit to town a condition survey of the structure prepared by a professional engineer licensed to practice in the state along with plans required to implement the engineer's recommendation to correct the disrepair shall be submitted to the town.</li> <li>2) The property owner shall complete the repair within seven hundred thirty (730) days<sup>30</sup> of receipt of citation.</li> <li>3) If the required repair meets the substantial repair threshold in (d), the</li> </ol>

<sup>29</sup> Modified from Fort Lauderdale, FL Code of Ordinances and Miami Beach, FL Code of Ordinances.

<sup>30</sup> Miami Beach allows 730 days to comply from the date of citation.

Existing	Recommended <sup>29</sup>
<p>licensed to practice in the state shall be required every 15 years from the date of the original certification.</p>	<p>property owner shall repair or replace the bulkhead or seawall to meet the minimum construction specifications in Sec. 62-75.</p> <p>4) Upon project completion, certification by a professional engineer licensed to practice in the state must be submitted to the town.</p> <p>c) Recertification of bulkheads and seawalls by a professional engineer licensed to practice in the state indicating that the structure is in a state of good repair shall be required every 10 years from the date of the original certification, or [date this ordinance is updated], whichever is later.</p> <p>(d) Bulkhead or seawall improvements constituting substantial repair at the time of permit application shall meet the construction specifications in Sec. 62-75 for the continuous bulkhead or seawall for the length of the property. For the purposes of this section, the substantial repair threshold shall mean:</p> <ol style="list-style-type: none"> <li>1) Any improvement to the bulkhead of more than twenty-five percent (25%)<sup>31</sup> of the length of the structure, including both the bulkhead and cap; or</li> <li>2) Any improvement to the bulkhead which results in an elevation change along more than twenty-five percent (25%)<sup>32</sup> of the length of the structure.</li> </ol> <p>(e) A condition survey of any seawall or bulkhead prepared by a professional engineer licensed to practice in the state, indicating that the structure is in compliance with the minimum construction specifications in Sec. 62-75 for the continuous bulkhead or seawall for the length of the property or with plans</p>

<sup>31</sup> Alternatively, a higher percent value could be specified.

<sup>32</sup> Alternatively, a higher percent value could be specified.

Existing	Recommended <sup>29</sup>
	<p>required to implement the engineer's recommendation for repair or replacement <b>to bring the structure into compliance</b>, shall be submitted to the town when new <b>construction or substantial improvement, as defined in Sec. 18-232</b>, to the primary structure are proposed.</p> <p>1) Upon project completion, certification by a professional engineer licensed to practice in the state must be submitted to the town.</p> <p>(d) Property owners with permeable erosion barriers such as rip rap, or a land/water interface of another nature on the Lake Worth shoreline shall maintain their land/water interface so as not to allow tidal waters to cross through or over their land/water interface to adjacent properties or public right-of-way at levels below the minimum top elevation specified in Sec. 62-75. Property owners failing to meet this maintenance <b>standard</b> shall be a violation of this section and subject to action before the town's code enforcement board.</p> <p>1) Within sixty (60) days of receiving a citation from the town's code enforcement board, <b>the owner of the property on which the violation occurred shall submit to town</b> a condition survey of the <b>land/water interface</b> prepared by a professional engineer licensed to practice in the state along with plans required to implement the engineer's recommendation to bring the <b>property</b> into compliance.<sup>33</sup></p> <p>2) The property owner shall complete the repair within seven hundred thirty (730) days of receipt of citation.</p>

<sup>33</sup> The Town could state an explicit preference for soft, natural, or nature-based coastal flood mitigation infrastructure on shorelines where no bulkheads or seawalls are present.

Strengthened maintenance and certification standards would give the Town the regulatory tools needed to incrementally correct deficiencies in coastal flood mitigation performance. Among the earliest sections of the shoreline to be affected by these changes would be areas that experience annual King Tide flooding along the Lake Trail (**Figure 6**).



**Figure 6 Annual King Tide flooding recurs at the same locations along the Lake Trail due to seepage through cracks in bulkheads and inadequate bulkhead height.**

### 3.3 Neighborhood-Scale Flood Control Systems

As demonstrated by the 2019 CVFA and PB-FRM simulations, the primary pathway for present-day and future Palm Beach flooding is via storm surge passing through Lake Worth Inlet and flooding over/through insufficient protection on the west side of the barrier island via the Lake Worth Lagoon. Virtually the entire Lake Worth shoreline must be transitioned to the higher standards proposed herein for the full benefits of strengthened construction specifications for private shoreline infrastructure to be realized, Town-wide. Strengthened maintenance and certification standards as proposed in *Level-Up Palm Beach* will increase the speed at which that transition is completed. Monitoring the effectiveness of these policies at speeding up the transition will be necessary. However, the transition may not happen fast enough, or there may be external factors, such as a major coastal flood, higher sea level rise rates, or the availability of significant public funding, that raise the urgency to complete the transition.

The Town may reasonably determine that the financing, design, construction, and/or maintenance of coastal flood control infrastructure is needed for public purposes, and would more efficiently and effectively be delivered systematically by the Town rather than incrementally by individual property owners. The Town could use its powers under the Florida Constitution, Article VIII, Section 2(b) and F.S. 166.021, 166.041, and 197.3236 and specified in the *Code of Ordinances, Chapter 90, Article II* to implement such improvements and services as are needed and recover the costs of implementation. It is beyond the scope of *Level-Up Palm Beach* to speculate on funding responsibility. Recognizing the community-wide benefits to building regional coastal flood resilience on Lake Worth can be analogous to the flood resilience build on the Atlantic Ocean associated with the Coastal Program, the Town’s past practice of

spreading the costs of beach and dune nourishment activities Town-wide could be followed to the extent feasible, since all property owners, businesses, and infrastructure benefit from making the community more resilient to coastal flooding.

To provide the flexibility for such action in the future, the Town should consider amending the *Code of Ordinances, Chapter 90, Article II, Division 5. – Municipal Services Special District* in the near-term. The Municipal Services entity charter should be amended to include “coastal flood control” in the list of services, facilities, programs, and local improvements the entity is authorized to provide<sup>34</sup>. The list appears in multiple sections within *Division 5* and would need to be modified in each instance. This change should be reflected in an amendment to the *Comprehensive Plan*.

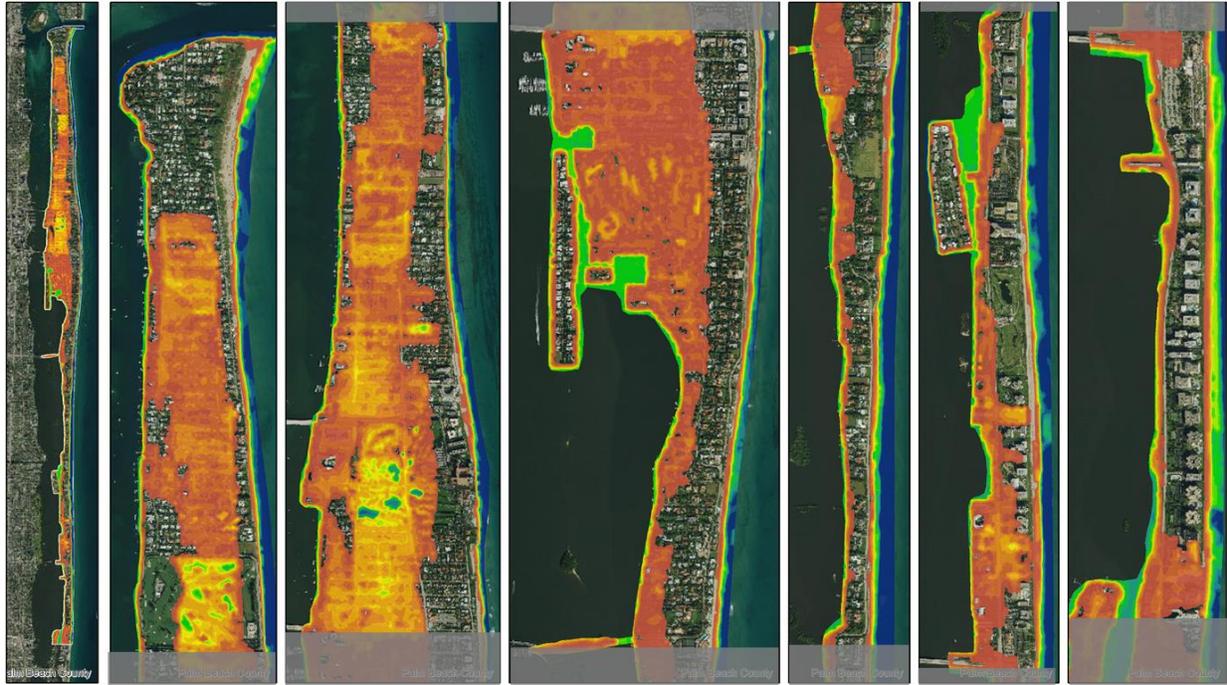
Significant planning would then be needed to translate new authority into construction-ready projects. Stakeholders would need to be engaged, funding sources identified and secured, legal agreements reached, engineering and design completed, and permits obtained. Due to capacity limitations, coastal flood control systems could be segmented into smaller, independently effective units (“neighborhood-scale”), allowing them to be prioritized, funded, and built over time.

To inform a phasing and prioritization process, *Level-Up Palm Beach* includes a preliminary assessment to identify potential alignments for independently effective flood control systems. The assessment considered readily available geospatial information on flood risk from PB-FRM, topography, land use, shoreline conditions, and property ownership.

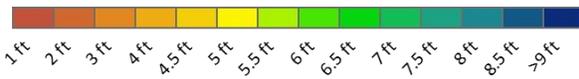
Flood exposure and depth maps from PB-FRM were reviewed, starting with higher probability scenarios. The 10% annual chance (10-year recurrence) flood depth map is shown in **Figure 7**. This map illustrates there are limited opportunities to implement small flood control systems that could be independently effective at mitigating even a 10-year flood due to the long, low-lying shoreline and expansive, interconnected floodplain. As a result, the potential for larger neighborhood-scale units were explored.

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<sup>34</sup> Alternatively, the Town could create a new Division within Article II, creating a Coastal Flood Control Special District or similar. Punta Gorda, FL established two special districts with specific powers to maintain seawalls for public benefit (see Code of Ordinances, Chapter 6. – Vessels, Docks and Waterways, Articles 3 through 5). Monroe County recently approved a special district ordinance establishing a new municipal service benefits unit that will be used for implementing and funding coastal resiliency infrastructure projects (see Ordinance No. 002-2021). This also could have a community-wide approach, similar to past practices at Palm Beach, such as the Coastal Program.

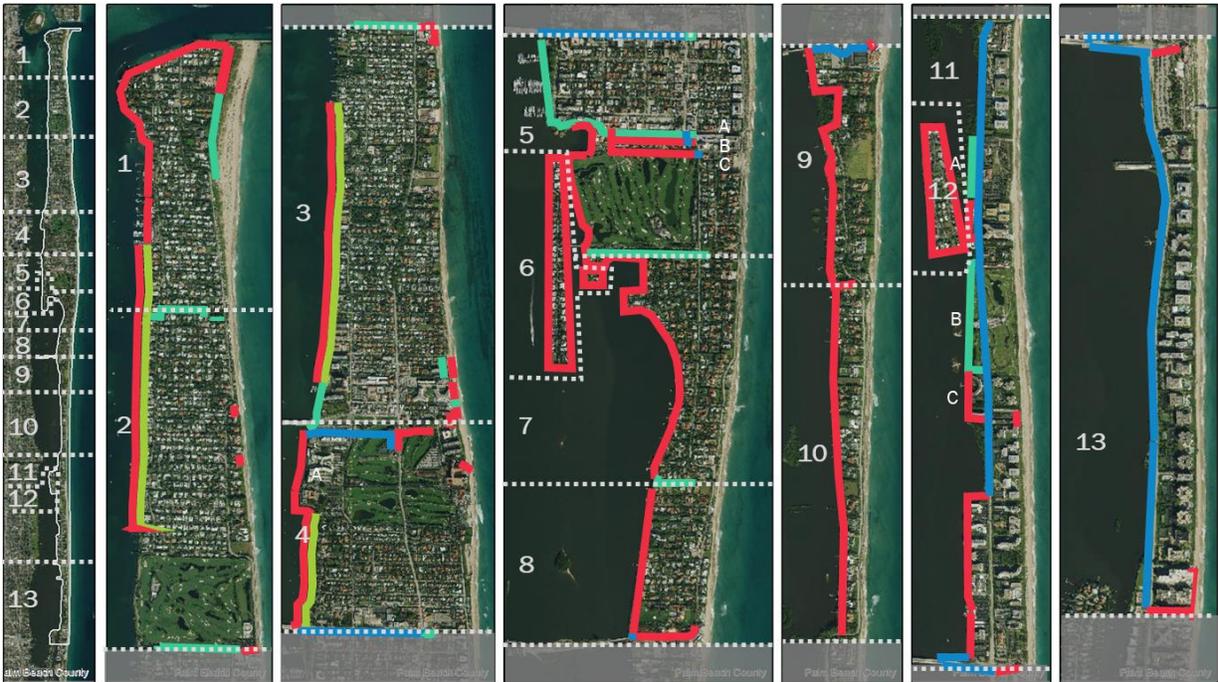


**Present 10-Year Flood Depth**



**Figure 7 Present day 10% annual chance (10-year recurrence) flood depth.**

As many as thirteen potential neighborhood-scale units were identified at a conceptual level (Figure 8). These units are not yet developed at the level of specificity required for boundary delineation or design, and costs have not been developed. Each of these areas could conceptually be served by an independently effective flood control system, effective up to an interim DFE of FEMA BFE + 2 ft. Once updated to align with new State standards, PB-FRM results for future time horizons should be compared with the interim DFE, and the Town should consider whether the time horizon and level of risk reduction provided are adequate.



**Ownership**

- Town
- ROW Easement
- Private
- State

**Figure 8** Potential neighborhood-scale flood control units and system alignments. These “flood control units” are not intended to align with the traditional Coastal Program shoreline “Reaches.”

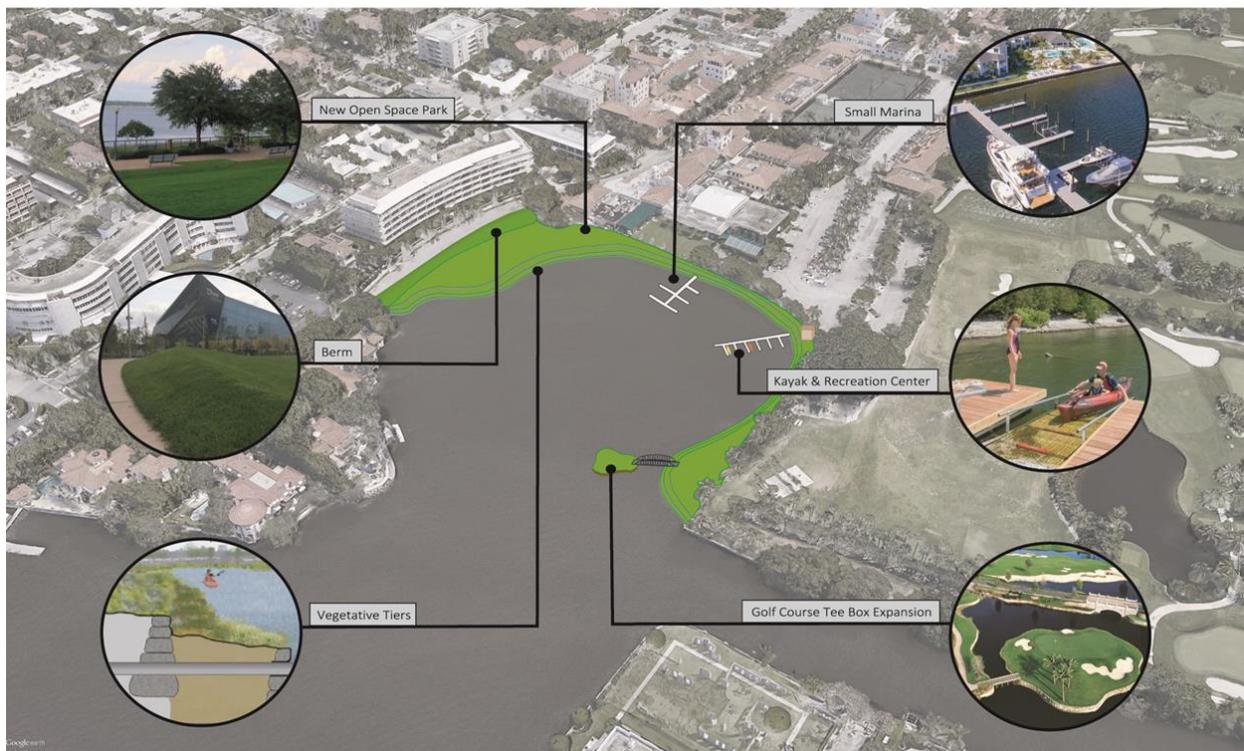
The form of flood control infrastructure to be implemented along these alignments would be determined through the design process. Based on preliminary analysis:

- **Raising bulkheads and adjacent grades** along the Lake Worth shoreline, on a neighborhood-scale, would be the primary strategy (**Figure 2**). This would also address recurring tidal flooding on the Lake Trail and other low-lying areas.
- **Natural and nature-based strategies**, such as living shorelines and vegetated berms, or hybrid strategies, combining natural features and hard structures like revetments and bulkheads, could be implemented on Lake Worth’s more natural shorelines, such as along golf courses (i.e., Everglades, Par 3) and A1A south of Sloans Curve (**Figure 9**).
- **Vegetated berms or deployable and permanent flood walls**, which could be screened by vegetation or enhanced for aesthetics or functionality<sup>35</sup>, would tie back to high ground on

<sup>35</sup> See “Resist Toolkit” from Hudson River Rebuild by Design project, available online at: <https://www.nj.gov/dep/floodresilience/docs/rbd-fs/feasibility-report-appendices-k.pdf>

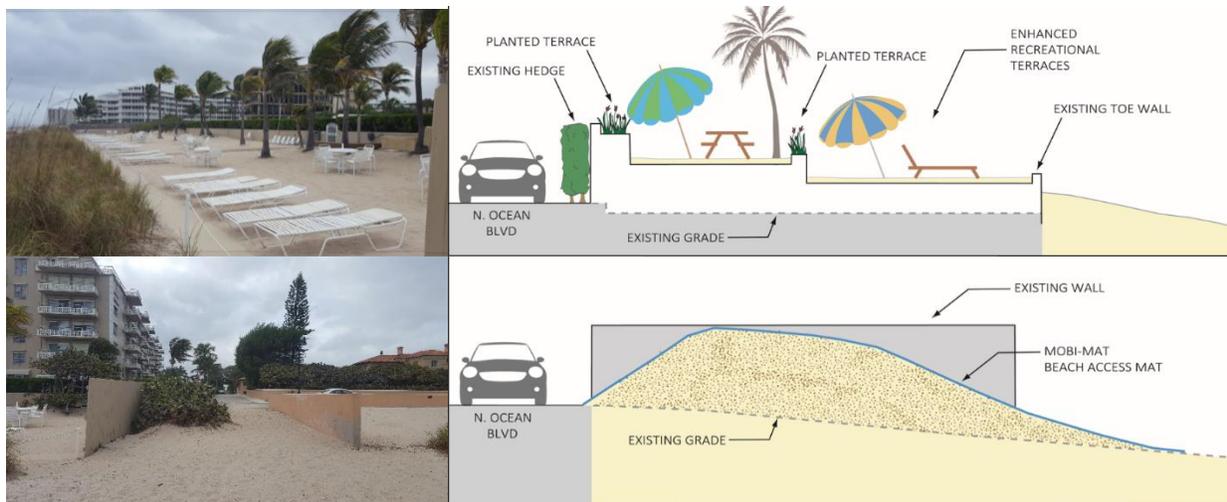
the natural coastal ridge, aligning with Town and State transportation rights-of-way, and **flood gates** at intersections<sup>36</sup>.

- Limited interventions would be required along particularly low-lying areas on the Atlantic shoreline, including:
  - **Additional dune enhancements** along Reach 1 fronting lower natural landward topography.
  - **Adapted beach access facilities** (Figure 10 is of a public beach access facility, but there are also private facilities like at The Beach Club that require adaptation).
  - **Raising seawalls or oceanfront yards** on a few private properties.



**Figure 9** Conceptual coastal flood control strategies at the Everglades Club.

<sup>36</sup> See East Side Coastal Resiliency Project flood gate renderings, available online at: <https://www1.nyc.gov/site/escr/about/resiliency-and-flood-protection.page>



**Figure 10** Conceptual strategy at Root Trail passive recreation area (top) and public beach access way (bottom).

Town-owned sections of the Lake Worth shoreline where coastal flood control system components may be needed include:

- **Unit 3:** ~500 linear ft at Bradley Park
- **Unit 5:** Town Marina, which is already adapted
- **Unit 11:** ~1,300 linear ft across A1A from Phipps Ocean Park, and ~2,300 linear ft at Par 3 Golf Course
- **Various:** stormwater pump station discharge locations

Town-owned sections of the Atlantic Ocean shoreline where coastal flood control system components may be needed include:

- **Unit 1:** Primary dune enhancement at Reach 1 (partly private)
- **Unit 3:** Root Trail beach access/recreation area
- **Unit 3:** Sunset beach access

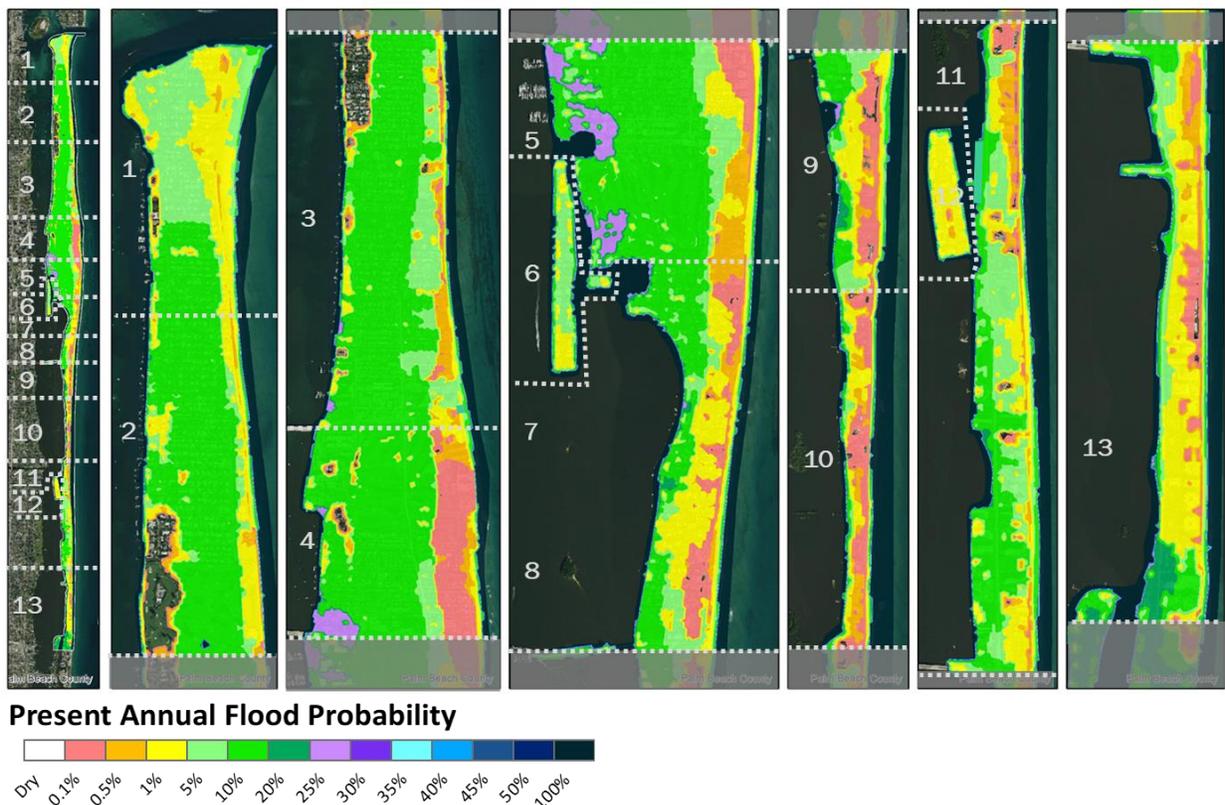
In all the conceptual alignments, local improvements would need to be sited on private property (e.g., raising bulkheads and seawalls). In most areas, some improvements (generally tie-back flood walls, berms, and flood gates) would need to be sited on Town and State transportation rights-of-way. The independent effectiveness of these systems depends on tying back from the shoreline to higher ground located around the natural coastal ridge of the island, including flood gates that would temporarily close across evacuation routes<sup>37</sup>.

Because of the long, low-lying condition of the Lake Worth shoreline, several units could be combined into larger units served by longer flood control systems with fewer across-road

<sup>37</sup> Operational protocols would hold off such closures for as long as possible, until flooding was imminent.

closures, if so desired. However, a benefit of designing flood control systems at smaller units of independent effectiveness, from a resiliency perspective, is that no single point of failure would affect the entire system. Neighborhood-scale units also could be more manageable for phased implementation depending upon interest, level, priorities, and consequences of flood damage.

Prioritization criteria should be developed to inform phasing and at a minimum consider the risks mitigated in terms of relative physical flood exposure (tide only, annual probability, extent, depth), impacts to public assets (Town critical facilities and infrastructure, regionally significant assets), population (number, social vulnerability), and cost-effectiveness (benefits compared with costs). Based on PB-FRM flood risk maps for present day (**Figure 11**), Units 5 and 4 have relatively higher annual probability of flooding than other parts of Town, followed by Units 3 and 2 (in that order). Units 5, 4, and 3 are also most vulnerable to King Tide flooding under future sea level rise scenarios. Units 3 and 2 (in that order) have the most linear feet of roadway and gravity sewer at risk of flooding, followed by Units 1 and 4. Unit 5 has by far the largest number of Town-owned facilities, followed by Units 11, 7, and 3 (in that order). Other information valuable for prioritization, such as population, benefits, and costs, could be collected through the storm surge barrier feasibility study discussed in the following section.



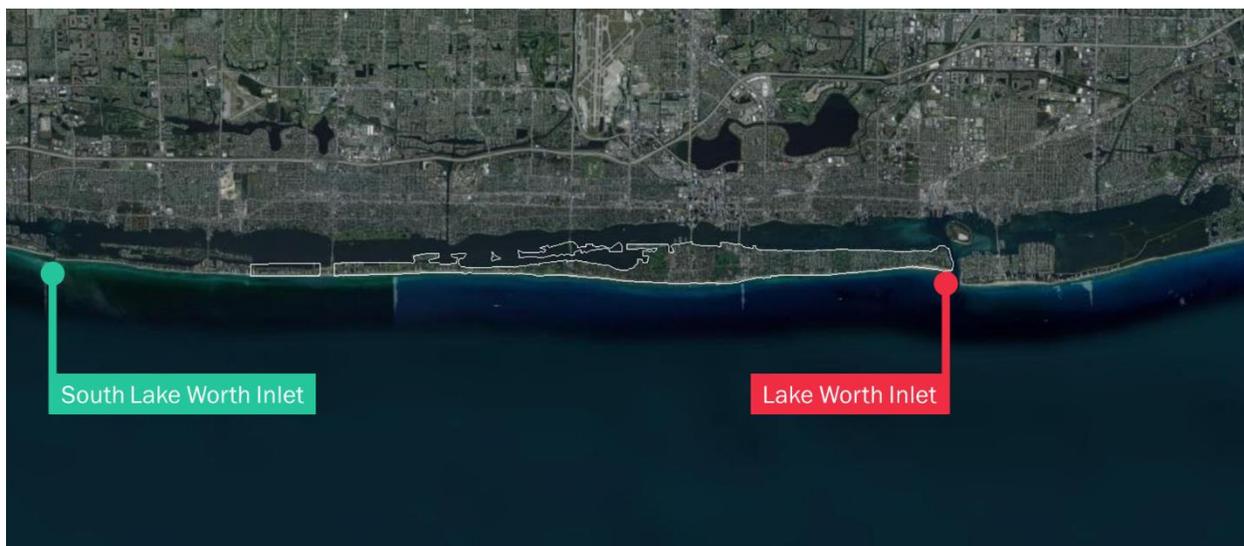
**Figure 11 Present annual probability of flooding and potential coastal flood control units.**

To better inform medium-term planning of potential flood control system alignments, the Town should conduct a high-resolution survey of shoreline infrastructure in the near-term, particularly

along Lake Worth. Top elevations of shoreline structures, adjacent grades, and condition ratings should be collected. This information would also be extremely valuable in the near-term for incorporation with updated PB-FRM simulations, administration of bulkhead and seawall maintenance and certification, and the storm surge barrier feasibility study.

### 3.4 Storm Surge Barrier Feasibility Study

Palm Beach’s present exposure to widespread coastal flooding is primarily from the Lake Worth shoreline due to flood waters derived from Atlantic Ocean storm surge passing through the Lake Worth Inlet during an extreme event (**Figure 12**). The probability of such an event is increasing due to sea level rise and potentially storm intensification. Strong consideration should be directed towards evaluating the feasibility and effectiveness of a surge barrier at the Inlet that can be closed in advance of forecasted storm surge to prevent surge from entering Lake Worth. The surge barrier would remain open, except for regular operations and maintenance, during normal weather and minor storms to maintain navigation and commerce<sup>38</sup>.



**Figure 12** Location of inlets to the Lake Worth Lagoon from the Atlantic Ocean.

A surge barrier designed to mitigate future coastal flood levels over its service life has the potential to generate significant benefits for Palm Beach, neighboring communities, critical infrastructure of regional importance, and environmental resources.

Potential benefits include but are not limited to:

- Avoided deaths, injuries, and mental stress;
- Avoided damage and loss (property, infrastructure, income, economic);
- Avoided costs of community lifelines disruption;
- Avoided response and recovery costs;

<sup>38</sup> Lake Worth water levels would still be affected by sea level rise and minor storm surge.

- Avoided environmental impacts (debris, pollutants, untreated sewage);
- Avoided flood insurance costs; and
- Avoided adaptation costs.

This would be a major infrastructure undertaking requiring significant planning, management, technical resources, political will, and funding. It would also involve a large and multi-jurisdictional group of stakeholders, including Palm Beach County, neighboring communities, Port of Palm Beach, South Florida Water Management District (SFWMD), and State and Federal agencies, and would of course be of interest to potentially affected property owners, the public, and the media. The entity to lead the study and potential implementation of such a project would need to have a high level of institutional capacity and experience carrying out initiatives of a similar nature.

The US Army Corps of Engineers (USACE) has constructed storm surge barriers elsewhere, including New Orleans, LA, New Bedford, MA, Stamford, CT, and Providence, RI. USACE also is conducting numerous Coastal Storm Risk Management (CSRM) Feasibility Studies, including in Miami-Dade County, Collier County, and New Jersey, in which they are evaluating the feasibility of storm surge barriers at inlets. A CSRM study evaluates the engineering feasibility, costs, benefits, and environmental impacts of various alternatives to mitigate coastal flood risks in a project area, including structural measures (e.g., surge barriers, bulkheads, flood walls and gates, beach and dune nourishment), non-structural measures (e.g., elevating buildings, floodproofing, acquisitions), and natural and nature-based features (e.g., artificial reefs, living shorelines). A cost-effective plan is tentatively selected from the alternatives evaluated, further reviewed for feasibility, and refined to maximize net benefits. USACE then finalizes its recommendation and submits it to Congress for consideration. The Federal share of funding to carry out the study and to implement study recommendations are each subject to Congressional authorization and appropriation.

The timeline to obtain a study, complete the study, and then move through phases of implementation, including obtaining funding for each, is long. The feasibility study alone can take up to 3 years to complete. The Town should therefore take the following steps in the near-term towards obtaining a CSRM feasibility study:

- Use PB-FRM to conduct a preliminary evaluation of coastal flood mitigation effectiveness of a surge barrier at the Lake Worth Inlet. Based on modeling results, it may be necessary to evaluate additional measures, such as surge barriers at other inlets or other structural measures at lower-lying sections of the Atlantic Ocean coast. Pre-evaluation is not required to submit a proposal for a feasibility study. However, the results of this evaluation would be valuable for outreach, engagement, and proposal development activities recommended below.
- Conduct regional outreach and coordination with USACE, FDEP, FDOT, Palm Beach County, neighboring municipalities, the Port, and SFWMD to introduce the concept for the feasibility study, identify interests and concerns, and discuss potential roles. Iterative

outreach may be needed to reach agreement on project boundaries and critical scope elements, identify the non-Federal Project Sponsor, and determine the roles of project partners (e.g., proposal development, cost-sharing for the study, providing letters of support).

- Engage Federal and State elected officials to raise awareness of the intent to propose a feasibility study and potential benefits for their constituents, seek guidance to maximize funding opportunities, and request support through the legislative process for authorization and appropriations.
- Support the submittal of a feasibility study proposal by the Project Sponsor (which may be the Town) to USACE for inclusion in their annual *Report to Congress on Future Water Resources Development*<sup>39</sup> and to Federal elected officials. Members of Congress can insert authorization for the feasibility study directly in legislation, including Water Resources Development Act or disaster bills.
- Advocate with elected officials for feasibility study Federal authorization and appropriations and State grant support for non-Federal cost-sharing.

The cost of a CSRSM study is typically around \$3 million, which can be at 50-100% Federally funded, depending on Congressional authorizations and appropriations. State grant funding, for example from the Resilient Florida Grant Program, should be sought for non-Federal cost-share. Non-Federal funding is required for expanded study scopes (50-100%), implementation projects (35%), implementation of additional features not included in the USACE recommendation (100%), and operations and maintenance (100%). Based on a screening-level 50% confidence interval parametric cost equation used in the New Jersey Back Bays CSRSM feasibility study, a screening-level order-of-magnitude conceptual construction cost (project first cost) for a surge barrier sized to fit the Lake Worth Inlet based on approximate measurements is \$700 million including a 37% contingency. This does not include any additional structural measures that may be required for effectiveness. Operations, maintenance, repair, replacement, and rehabilitation costs are also not included in this estimate.

Non-Federal partners can also independently fund and carry out a feasibility study for submission to USACE and transmission to Congress, but the study process and recommendations are subject to USACE compliance and technical reviews, and the findings of those reviews will also be transmitted to Congress. USACE may also provide planning or design recommendations or set construction conditions. State funding for the study could be sought through the Resilient Florida Grant Program if Congress does not authorize and appropriate funding for the study in a reasonable timeframe.

In partnering with USACE, with the goal of eventually obtaining Federal funding for construction, the Town would relinquish significant control over the solutions recommended for Federal funding. USACE has specific legal, regulatory, and policy constraints intended to minimize the

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<sup>39</sup> The deadline for proposals to be included in the 2022 Report to Congress is August 30, 2021.

cost and maximize the benefits to the Federal government for major civil works projects. Sometimes recommend solutions consistent with Federal standards may not align with other community goals or individual private property owner interests. If the Town and other funding partners are willing and able to cover the cost of enhancements (aesthetic, environmental, climate resilience, or otherwise) to what the USACE recommends, these conflicts can be mitigated.

### 3.5 Lake Worth Water Level Monitoring

A recent and long-term continuous record of water levels in the Lake Worth Lagoon is not presently available to the Town for coastal resilience planning, design, and management purposes. The only active NOAA tide gauge is located at Lake Worth Pier (Atlantic Ocean), with data going back to 2010. Data from Lake Worth Pier do not directly reflect water levels experienced within the Lagoon during King Tides or storm surge events, nor do they account for differences between the north, middle, and south regions of the island.

The Town would benefit from monitoring Lake Worth water levels to support short- and long-term interests. In the short-term, water level measurements will help document local events, such as measuring relationship between coastal storm surge and propagation to Lake Worth, understanding influence of precipitation events on Lake Worth, and recording actual local water levels corresponding to high tide “sunny day” floods. For any event resulting in bulkhead overtopping and Palm Beach flooding, it will be beneficial to have corresponding local water level information to use as the basis for administration of maintenance and certification standards. Long-term water level measurements will be useful to document local tidal datums and changes in sea level, which may trigger the need for changes in coastal resilience strategies (see Sections 6.1.1 Applications to Grant Program

We recommend the Town apply for funding through the Resilient Florida and FEMA Hazard Mitigation Program grant funding on an annual basis for priority projects identified for near-term implementation. The first round of Resilient Florida funding was opened for application in 2021. The Town submitted the projects listed in **Table 25** for funding to multiple grant programs, and decisions are pending.

**Table 25 Projects submitted to Resilient Florida and other grant programs in 2021.**

Project	Grant Request	Town Match*	Design Year	Construct Year
<b>D-12 Pump Station (Dry Floodproofing)</b>	\$80,000 (All additional costs)	\$830,000 (91% match) (Already programmed)	2022	2023
<b>A-5 Lift Station (Equipment Elevation)</b>	\$33,000 (All additional costs)	\$1,000,000 (97% match) (Already programmed)	2023	2024
<b>D-8 Pump Station / E-5 Lift Station</b>	\$90,000	\$1,246,196 (93% match) (Already programmed)	2022	2023

<b>(Equipment Elevation)</b>	(All additional costs)			
<b>D-17 Pump Station (Equipment Elevation)</b>	\$300,000 (All additional costs)	\$460,000 (60% match) (Already programmed)	2022	2023
<b>Coastal Flood Vulnerability Assessment Update and Priority Planning</b>	\$105,000 (50% of cost)	\$105,000 (50% match) (New commitment)	2022	N/A
<b>Total</b>	<b>\$608,000</b>	<b>\$3,641,196 (86% match)</b> <b>(\$105,000 in new cost)</b>		

## 6.2 Long-Term Adaptation Pathways and 6.3 Monitoring).

A water level measurement program must be carefully designed and implemented. Selection of site(s), instrumentation, mounting apparatus, and proper installation require specific protocols to ensure data reliability and accuracy. A commitment to an operations and maintenance plan also is essential to inspect, clean, and repair equipment, including provision for rapid response in the event of damage including vandalism. Water level measurements are only meaningful when related to a specific datum, requiring surveying the equipment to a high degree of precision compared to established approved benchmarks.

NOAA is a preeminent source of water level measurements in the USA and worldwide. The NOAA Physical Oceanographic Real Time System (PORTS®) program<sup>40</sup> provides near real-time accurate water level measurements for the primary purpose of navigation safety and efficiency, serves short-term purposes such as search and rescue, and also builds long-term data sets for environmental and engineering purposes. PORTS® systems exist for Miami<sup>41</sup> and Jacksonville<sup>42</sup> where Woods Hole Group designed, installed, and continues to operate and maintain the system in partnership with Jacksonville Marine Transportation Exchange, and now under contract directly to NOAA. NOAA also has the National Water Level Observation Network (NWLON)<sup>43</sup> and the Vertical Datum Transformation (VDatum)<sup>44</sup> programs specifically designed to monitor water levels and establish vertical datums for the USA. Woods Hole Group is currently supporting VDatum under contract to NOAA to support measurements at 48 locations throughout the southeast, including in Florida.

Given the proximity of Palm Beach to the Port, the federal channel at Lake Worth Inlet, and the various commercial and governmental interests in having accurate water level information, it is

<sup>40</sup> <https://tidesandcurrents.noaa.gov/ports.html>

<sup>41</sup> <https://tidesandcurrents.noaa.gov/ports/index.html?port=mi>

<sup>42</sup> <https://tidesandcurrents.noaa.gov/ports/index.html?port=jx>

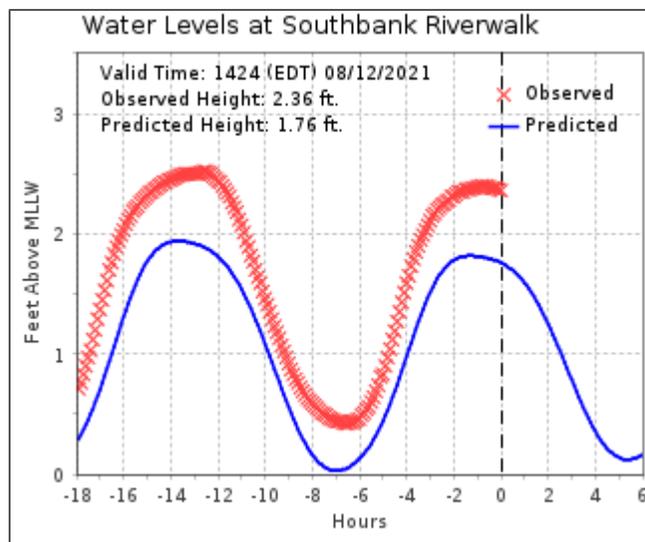
<sup>43</sup> <https://tidesandcurrents.noaa.gov/nwlon.html>

<sup>44</sup> <https://vdatum.noaa.gov/>

possible for the Town or other partners to collaborate with NOAA on local water level measurements, including technical assistance and possibly including equipment installation, operations, and maintenance. We recommend specifically contacting the Center for Operational Oceanographic Products and Services (CO-OPS) stakeholder services branch to explore options. An example of a robust NWLON water level monitoring station part of Jacksonville, FL PORTS® is illustrated by **Figure 13**. Data also are available to view in near real-time via website, telephone, text, and other means. A sample data output is shown by **Figure 14**, with observations in red x and predicted waters level in blue line. The notable differences vary in time and reveal the benefit of site-specific data.



**Figure 13** Example NOAA NWLON water level monitoring station part of Jacksonville PORTS®



**Figure 14** Example water level data from Southbank Riverwalk of Jacksonville PORTS®. Data are available in near real-time, and indicate differences between predicted water level (blue line) and local observations (red x).

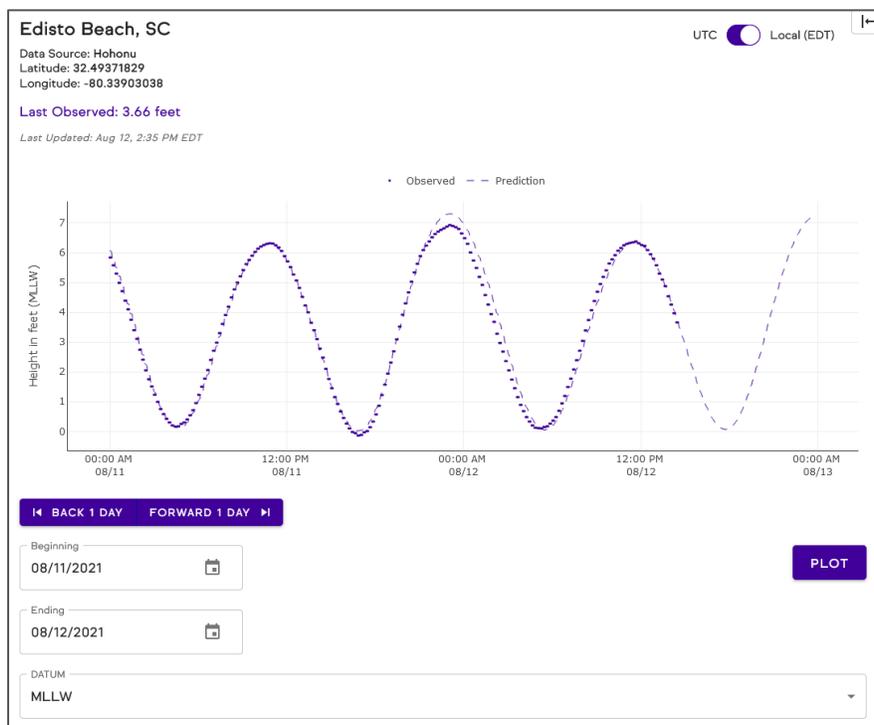
Alternative technologies for collecting water level measurements are evolving rapidly. While NOAA programs are focused on providing the most reliable measurements for high profile applications, such as safe and efficient navigation, and using infrastructure and technologies to withstand rigorous environmental conditions, including extreme storms, other applications may not require this level of investment. There also is growing interest to have higher density of water level measurements over space. Depending upon site-specific needs and consequences, other technologies exist to collect such measurements. This include self-recording submerged pressure gauges through above water radar techniques. An example of an emerging technology from a company called Hohonu<sup>45</sup> is shown by **Figure 15** where a system is installed in the Cape Cod Canal, and **Figure 16** illustrates the latest data from a system in South Carolina. Woods Hole Group has extensive experience with this equipment, increasingly proving reliable and affordable. A recommendation of Level-Up Lake Worth Shoreline is to make plans for a water level monitoring program for Palm Beach. The starting point for a plan would be to pursue:

- NOAA grade station perhaps together with Port of Palm Beach to capture water levels in Lake Worth at the north end of the island.
- Alternative measurement technology (like Hohonu) perhaps near the Rte. 704 and Rte. 802 bridges to characterize Lake Worth water level near the central and southern regions.

<sup>45</sup> <https://www.hohonu.io/>



**Figure 15** Example Hohonu water level station installation in Cape Cod Canal.



**Figure 16** Example water level data from a Hohonu water level station near Edisto Beach, SC. Data are available from various sources in near real-time, and indicate differences between predicted water level (purple dots) and local observations (purple dashes).

#### 4.0 LEVEL-UP FLOODPLAIN DEVELOPMENT

*The objective of **Level-Up Floodplain Development** is to improve the safety of buildings and their occupants from future coastal flooding.*

Whereas *Level-Up Lake Worth Shoreline* is aimed at mitigating flood pathways from the Lagoon to Palm Beach, which would reduce upland areas at risk of flooding (i.e., the floodplain), the *Level-Up Floodplain Development* recommendations are focused on mitigating risk to the actual assets in the floodplain assuming flood pathways and risk remain. The full extent of *Level-Up Lake Worth Shoreline* combined with *Level-Up Floodplain Development* together would result in redundant levels of flood mitigation and coastal resilience. These two *Level-Up* components are not mutually exclusive, and would be refined depending on actual progress made (see Sections 6.1.1 Applications to Grant Program

We recommend the Town apply for funding through the Resilient Florida and FEMA Hazard Mitigation Program grant funding on an annual basis for priority projects identified for near-term implementation. The first round of Resilient Florida funding was opened for application in 2021. The Town submitted the projects listed in **Table 25** for funding to multiple grant programs, and decisions are pending.

**Table 25** Projects submitted to Resilient Florida and other grant programs in 2021.

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<b>D-17 Pump Station (Equipment Elevation)</b>	\$300,000 (All additional costs)	\$460,000 (60% match) (Already programmed)	2022	2023
<b>Coastal Flood Vulnerability Assessment Update and Priority Planning</b>	\$105,000 (50% of cost)	\$105,000 (50% match) (New commitment)	2022	N/A
<b>Total</b>	<b>\$608,000</b>	<b>\$3,641,196 (86% match)</b>		

		(\$105,000 in new cost)		
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6.2 Long-Term Adaptation Pathways and 6.3 Monitoring).

The Town of Palm Beach is densely developed within the regulatory floodplain, defined by the FEMA 100-year flood zone, and historically experiences high losses from flooding. In August 2017, the Town of Palm Beach adopted *Comprehensive Plan* amendments (2017-2027) and flood-related amendments to the Code of Ordinances.

#### Box 6. Existing Floodplain Development at Risk

- Most Palm Beach residences, businesses, roads, and public infrastructure and facilities are located within the regulatory floodplain.
- Palm Beach has the most flood insurance losses and loss payments of any local jurisdiction in the County in aggregate since 1978.<sup>46</sup>
- Palm Beach has the most repetitive loss properties and repetitive loss payments in the County, accounting for almost a third of each.<sup>47</sup>
- The total flood insurance in force in Palm Beach is nearly \$2 billion.<sup>48</sup>
- Palm Beach has the 4<sup>th</sup> most flood insurance policies, 2<sup>nd</sup> most total flood insurance premiums, and 3<sup>rd</sup> most total flood-insured value in-force of all incorporated jurisdictions in Palm Beach County.<sup>49</sup>

The adequacy of adopted policies and regulations for their intended purpose – mitigating risks to floodplain development beyond the minimum State standards – has been weakened by significant changes in coastal flood risk information and regulations in the past few years. The combination of historical vulnerabilities, recent changes in regulations, and anticipated future impacts of climate change warrant consideration of policies to further strengthen the resilience of development in the regulatory floodplain to protect property and safeguard the public health, safety, and general welfare.

#### Box 7. New Flood Risk Information and Regulations

- Future coastal flood risk maps prepared by Woods Hole Group as part of the 2019 *Coastal Flood Vulnerability Assessment (CFVA)* show that, with ~1.5 ft of relative sea level rise and future storm intensification based on global climate change models, the present day 100-year flood elevation and floodplain could be statistically more akin to the 5- to 10-year flood elevation and floodplain later in this century.

<sup>46</sup> Palm Beach County Local Mitigation Strategy 2020, Appendix H: Flood Loss Data since 1978 as of 11/30/2017

<sup>47</sup> Palm Beach County Local Mitigation Strategy 2020, Appendix H: FEMA RLP Data by jurisdiction as of 11/30/2017

<sup>48</sup> Town of Palm Beach 2019 Annual Flood Report

<sup>49</sup> Palm Beach County Local Mitigation Strategy 2020, Appendix H: Flood Policy Data as of 11/30/2017

- The updated 2020 Florida Building Code (FBC) – Residential 7th Edition came into force on January 1, 2021, and the new flood-resistant construction standards are in several instances higher than those set in the Town of Palm Beach’s technical amendments to the FBC – Residential 6<sup>th</sup> Edition, adopted in 2017.
- A new Florida Statute (s. 161.551) was signed into law in 2020, effective July 1, 2021, that will require a Sea Level Impact Projection (SLIP) study for any major structures proposed to be constructed by a public entity in the “coastal building zone” (within which the entirety of Palm Beach is located) with State funding. The Florida Department of Environmental Protection (DEP) is in the process of adopting final rules for implementing the law, effective July 1, 2022. The results of the proactive CVFA conducted by Palm Beach can be efficiently adapted to address this new FDEP requirement.

#### 4.1 Substantial Improvement and Substantial Damage

The Town should consider amending the *Code of Ordinances, Chapter 18, Article IV, Division 1, Sec. 18-232 – Definitions*. The Town should consider a more stringent definition of *substantial improvement* and *substantial damage*, over a longer cumulative period and at a lower percent of market value threshold, to increase the speed at which existing buildings are brought into compliance with higher standards for flood-resistant construction (See **Table 11** for recommended amendments). This is because of the high and increasing coastal flood risks in the Town of Palm Beach. The Floodplain Administrator’s duties and administrative procedures should be amended as well, as needed, to align with changes in these definitions. Any amendments to the FBC should be coordinated with the Florida Division of Emergency Management (DEM) before first reading.

**Table 11 Higher standards for substantial improvement and substantial damage.**

Existing	Recommended
<p><i>Substantial improvement.</i> Any combination of repair, reconstruction, rehabilitation, addition, or other improvement of a building or structure taking place during a one-year period, the cumulative cost of which equals or exceeds 50 percent of the market value of the building or structure before the improvement or repair is started. For each building or structure, the one-year period begins on the date of the first permit issued for improvement or repair of that building or structure subsequent to (see Note). If the structure has incurred "substantial damage," any repairs are considered substantial improvement regardless of the actual repair work performed...</p>	<p><i>Substantial improvement.</i> [<i>For the purposes of determining compliance with the flood provisions of this code,</i>] Any combination of repair, reconstruction, rehabilitation, addition, or other improvement of a building or structure taking place during a <b>10</b>-year period<sup>50</sup>, the cumulative cost of which equals or exceeds <b>25</b> percent<sup>51</sup> of the market value of the building or structure before the improvement or repair is started. For each building or structure, the one-year period begins on the date of the first permit issued for improvement or repair of that building or structure subsequent to (see Note). If the structure has incurred "substantial damage," any repairs are considered substantial improvement regardless of the actual repair work performed...</p>
<p>(FBC 7<sup>th</sup> Ed.) <i>Substantial damage.</i> Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.</p>	<p><i>Substantial damage.</i> [<i>For the purposes of determining compliance with the flood provisions of this code,</i>] Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed <b>25</b> percent of the market value of the structure before the damage occurred.</p>

Supporting information:

- The replacement rate for single-family residential units was approximately 1.8% in 2011-2016.<sup>52</sup> At this rate, excluding substantial improvements, it would hypothetically take approximately 275 years for all single-family units to be brought up to current code through replacement.

<sup>50</sup> Alternatively, the Town could adopt a 5-year period and earn half as many additional CRS credit points.

<sup>51</sup> The Town could adopt any percentage lower than 50% and earn the same number of CRS credit points. Alternatively, the Town could base substantial improvement determinations based on a threshold of more than 25% of the building's lowest floor square footage, for less CRS credit points.

<sup>52</sup> Town of Palm Beach Comprehensive Plan 2017.

- Under the current definitions, the costs of flood damage in a single year may be less likely to meet 50% of the structure’s market value than in other communities because Palm Beach housing market values are very high compared to construction costs. This local market condition may weaken the intended effect of the NFIP substantial improvement rule to hasten compliance with current flood-resistant construction standards, perpetuating the vulnerability of existing structures to future flood damage and loss.
- Only nine of the 90 repetitive loss structures (i.e., two or more \$1,000+ loss claims in a 10-year period) in Palm Beach in 2017, had cumulative building loss payouts over the preceding 10 years of 50% or more of the building value, and only 18 had payouts of greater 25% or more.<sup>53</sup>
- The recommended amendments would earn the Town additional CRS credit points.
- There are eight communities in Florida with substantial improvement and substantial damage thresholds less than 50%, including Royal Palm in Palm Beach County. Fernandina Beach has the lowest threshold, at 30%, but they do not account for costs cumulatively. Cutler Bay has the next lowest threshold, at 44%, with costs cumulative over a five-year period.

#### 4.2 Non-Residential Building Flood Elevation Requirements

The Town should consider amending the *Code of Ordinances, Chapter 18, Article IV, Division 2, Sec. 18-244. - Amendments*, to add an amendment to Florida Building Code – Buildings. Higher elevation requirements for non-residential structures and non-residential areas of mixed-use structures should be set than the minimum requirements in the 2020 FBC 7<sup>th</sup> Edition – Buildings, because of the high and increasing coastal flood risks in the Town of Palm Beach (See **Table 12** for recommended amendments). Once updated to align with new State standards, PB-FRM results for future time horizons should be compared with the freeboard recommended in **Table 12**, and the Town should consider whether adjustments to freeboard or geographic application are warranted. Any amendments to the FBC should be coordinated with the Florida DEM before first reading.

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<sup>53</sup> Palm Beach County Local Mitigation Strategy 2020, Appendix H: FEMA FLP Data by jurisdiction as of 11/30/2017

**Table 12 Higher standards for Buildings elevation requirements.**

Existing	Recommended
(FBC 7 <sup>th</sup> Ed.) 1612.4 Design and construction. The design and construction of buildings and structures located in flood hazard areas, including coastal high hazard areas and Coastal A Zones, shall be in accordance with Chapter 5 of ASCE 7 and with ASCE 24.	The following sections of the Florida Building Code – Buildings are hereby amended as follows:
1612.4.1 Modification of ASCE 24. ...	1612.4.3 Modifications of ASCE 24 – Elevation Requirements. Table 2-1, Table 4-1, Table 5-1, Table 6-1, and Table 7-1 shall be modified as follows:
1612.4.2 Modification of ASCE 24 9.6 Pools. ...	1. The minimum elevation requirements for Flood Design Class 2, Flood Design Class 3, and Flood Design Class 4 buildings and structures shall be to or above the base flood elevation plus three (3) feet. <sup>54, 55</sup>

Supporting information:

- Non-residential buildings within the floodplains of Palm Beach include Town Hall, public safety facilities, wastewater and stormwater pump stations, schools, public and private recreational facilities, grocery stores, restaurants, and retail, among many others. The coastal flood resilience of Palm Beach residents depends on the rapid recovery of these types of facilities and the services they provide.
- The recommended amendment would apply to new construction and substantial improvements to Town facilities.
- The recommended amendment would earn the Town additional CRS credit points and earn complying flood insurance policyholders lower premiums.
- Amendments to elevation requirements for Flood Design Class 2 buildings should be consistent with amendments to the FBC – Residential recommended elsewhere herein.

### 4.3 Residential Flood Elevation Requirements

The Town should consider amending the *Code of Ordinances, Chapter 18, Article IV, Division 2, Sec. 18-244, R322.2.1. and R322.3.2. – Elevation Requirements*. Higher elevation requirements for residential structures should be set than the minimum requirements in the 2020 FBC 7<sup>th</sup>

<sup>54</sup> Modified from Fernandina Beach, FL Code of Ordinances.

<sup>55</sup> Alternatively, the Town could set lower elevation requirements for Class 2 structures (e.g., BFE + 1.5 or 2 ft). Sixty-three Florida municipalities or counties have adopted BFE + 1.5 ft or higher elevation requirements, 48 of those have adopted BFE + 2 ft or higher (including West Palm Beach, Gulf Stream, and Cloud Lake in Palm Beach County), and 10 of those have adopted BFE + 3 ft.

Edition - Residential because of the high and increasing coastal flood risks in the Town of Palm Beach (see **Table 13** for recommended amendments). Other technical amendments under Sec. 18-244 should be reviewed and amended, as needed, to eliminate redundancies and inconsistencies with the 7<sup>th</sup> Edition. Once updated to align with new State standards, PB-FRM results for future time horizons should be compared with the freeboard recommended in **Table 13**, and the Town should consider whether adjustments to freeboard or geographic application are warranted. Any amendments to the FBC should be coordinated with the Florida DEM before first reading.

**Table 13 Higher standards for Residential elevation requirements.**

Section and Parameter	Palm Beach Code of Ordinances	7 <sup>th</sup> Edition FBC	Recommended Future Technical Amendment <sup>56</sup>
<b>R322.2.1 Elevation requirements</b>			
Lowest floor - in flood hazard areas not designated as Coastal A Zones	BFE + 6 inches	BFE + 1 foot	BFE + 3 feet
Lowest floor - in Coastal A Zones	BFE + 1 foot	BFE + 1 foot	BFE + 3 feet
Lowest floor (including basement) – in areas of shallow flooding (AO Zones)	At least as high above the highest adjacent grade as the depth number specified in feet on the FIRM + 6 inches, or at least 2.5 feet if a depth number is not specified	Height above highest adjacent grade of not less than the depth number specified in feet on the FIRM + 1 foot, or not less than 3 feet if a depth number is not specified	<i>Recommend deleting as there are presently no AO Zones in Palm Beach</i>
Basement floors that are below grade on all sides	To or above the BFE + 6 inches	To or above BFE + 1 foot	To or above BFE + 3 feet
<b>R322.3.2 Elevation requirements</b>			
Lowest horizontal structural members supporting the lowest floor (with certain exceptions) - in coastal high-hazard areas and Coastal A Zones	BFE + 6 inches	BFE + 1 foot	BFE + 3 feet

Supporting information:

- The Town has previously demonstrated intent that residential development in Palm Beach should be required to meet higher elevation requirements than the minimums set

<sup>56</sup> Alternatively, the Town could set lower elevation requirements to BFE + 2 ft, or not less than 4 ft if depth number is not specified.

by the FBC – Residential 6<sup>th</sup> Edition, as codified in August 2017 technical amendments to the Code of Ordinances.

- The minimum elevation requirements in the updated 2020 FBC – Residential 7th Edition are in several instances higher than those set in the Town of Palm Beach’s technical amendments to the 6<sup>th</sup> Edition.
- The recommended amendments would earn the Town additional CRS credit points and earn complying flood insurance policyholders lower premiums.
- Amendments to elevation requirements for the FBC – Residential should be consistent with amendments to the FBC – Buildings for Flood Design Class 2 buildings recommended elsewhere herein.
- The Town is modifying residential zoning to limit the height of fill that can be used to meet minimum elevation requirements to half the distance from the crown of road to first habitable floor level. The intent is to mitigate stormwater runoff impacts to neighboring properties.

#### 4.4 Building Heights

The Town should consider amending the *Code of Ordinances, Chapter 31, Article 1, Sec. 134-2. – Definitions*. Building height within flood hazard areas should be defined in reference to the minimum flood elevation to mitigate the potential adverse incentives not to redevelop or make substantial improvements because of higher elevation requirements proposed herein. The zero datum for the purposes of calculating building height for new construction and substantial improvements should be defined in all districts to include the term “**or the minimum flood elevation as defined in Sec. 134-2 of the code.**” A definition for the term “minimum flood elevation” should be added to this section to clarify that it includes the base flood elevation plus freeboard heights required in Chapter 18 as applied to flood hazard areas defined in Chapter 50. A potential definition is, “**the minimum elevation requirements defined in Chapter 18 for new construction or substantial improvements, applicable within flood hazard areas defined in Chapter 50.**” This term should be consistently used and referenced across the building height definitions, throughout Section 134 and, if needed, in Chapter 50.

Supporting information:

- Sec. 134-2 defines building height in relation to “minimum flood elevations” or similar terms in only the following areas:
  - R-B districts
  - R-B lots abutting Lake Trail
  - All other lots abutting Lake Trail
  - Lots located in the west side of South Ocean Blvd between Via Agape and Sloan’s Curve in the R-AA district and having a natural ground level lower than that of the roadway on which the lots front
  - Lots east of the State of Florida Coastal Construction Control Line

- Lots abutting low streets
- The following terms are used in Sec. 134-2 building height definitions in relation to flooding:
  - “minimum flood elevation”
  - “minimum flood elevation as defined in chapter 50” Note: Chapter 50 does not define this term.
  - “minimum bottom of grade beam elevation as established by the Florida Building Code plus two feet”
  - “minimum floodplain elevation as established in chapter 50 of this Code”
- To illustrate the effects of the recommended changes, consider as an example that under current zoning, a two story building located in an R-C district (medium density residential) has a maximum building height of 23.5 ft, measured from the maximum crown of road elevation abutting the lot (zero datum). If the highest crown of road is at elevation 4 ft NAVD88, the top of the building could be no higher than 27.5 ft NAVD88 (4 ft + 23.5 ft). If the FEMA BFE is 6 ft NAVD88, then under current code the building’s first floor could be no lower than 7 ft NAVD88 (BFE + 1 ft). The habitable portion of the building height would therefore be 20.5 ft. (27.5 ft – 7 ft). If only the recommended changes to minimum flood elevations (FEMA BFE + 3 ft) were adopted, the habitable portion of building height would reduce by 2 ft to 18.5 ft (27.5 – FEMA BFE of 6 ft – 3 ft freeboard). However, if in addition the zero datum is changed to equal the minimum flood elevation instead of the maximum crown of road, the height of habitable space intended by the zoning at 23.5 ft could be preserved. The building’s first floor would need to be at 9 ft NAVD88 (FEMA BFE + 3 ft) and the top of the building could be as high as 32.5 ft NAVD88 (32.5 ft – 9 ft = 23.5 ft).

#### 4.5 Flood Hazard Areas

The Town should consider amending the *Code of Ordinances, Chapter 50, Article II, Division 2, Sec. 50-38. – Submission of Additional Data to Establish Flood Hazard Areas*. The flood hazard areas within which floodplain management regulations and flood-resistant construction standards of the FBC, as amended, apply in Town should be expanded to include areas lower than the base flood elevation plus the minimum freeboard height adopted in Chapter 18 elevation requirements (see **Table 14** for recommended amendments). This is because of the high and increasing coastal flood risks in the Town of Palm Beach. This will require that new development and substantial improvements meet a consistent minimum standard of flood-resistance, regardless of whether they are located within the present FEMA 100-year floodplain boundary or, just beyond it. Development not within current flood plains may be within the potential future floodplain considering greater than 100-year floods could occur, as well as projected sea level rise and climate change. Once updated to align with new State standards, PB-FRM results for future time horizons could be used as an alternative reference in the ordinance for identifying flood hazard areas.

It is also critical that Chapter 50 be reviewed to identify where the FBC is referenced and amended to also reference Chapter 18 amendments to the FBC (e.g., “This chapter is intended

to be administered and enforced in conjunction with the Florida Building Code, **as amended in Chapter 18.**”). Without this cross-reference there is an increased likelihood that both Town staff and proponents of developments will not be empowered and fail to address the higher standards amendments to the FBC contained in Chapter 18.

**Table 14 Higher standards for establishing flood hazard areas.**

Existing	Recommended
<p>To establish flood hazard areas and base flood elevations, pursuant to division 5 of this article the floodplain administrator may require submission of additional data. Where field surveyed topography prepared by a Florida licensed professional surveyor or digital topography accepted by the community indicates that ground elevations:</p> <p>(2) Are below the closest applicable base flood elevation, even in areas not delineated as a special flood hazard area on a FIRM, the area shall be considered as flood hazard area and subject to the requirements of this chapter and, as applicable, the requirements of the Florida Building Code.</p> <p>(3) Are above the closest applicable base flood elevation, the area shall be regulated as special flood hazard area unless the applicant obtains a Letter of Map Change that removes the area from the special flood hazard area.</p>	<p>To establish flood hazard areas and <b>minimum</b> flood elevations, pursuant to division 5 of this article the floodplain administrator may require submission of additional data. Where field surveyed topography prepared by a Florida licensed professional surveyor or digital topography accepted by the community indicates that ground elevations:</p> <p>(2) Are below the closest applicable base flood elevation <b>plus three (3) feet<sup>57</sup></b>, even in areas not delineated as a special flood hazard area on a FIRM, the area shall be considered as flood hazard area and subject to the requirements of this chapter and, as applicable, the requirements of <b>Chapter 18.</b></p> <p>(3) Are above the closest applicable base flood elevation, the area shall be regulated as special flood hazard area unless the applicant obtains a Letter of Map Change that removes the area from the special flood hazard area.</p>

Supporting information:

- Limiting the application of strengthened elevation requirements to the present FEMA 100-year floodplain would lead to undesirable edge effects and disparities in flood mitigation around the floodplain boundary line. For instance, the significant increment of freeboard recommended herein would by definition imply a larger adjacent floodplain boundary. The PB-FRM and CFVA indicate larger future floodplain as well in changing

<sup>57</sup> The freeboard height referenced should be the same as is adopted in Sec. 18-244 elevation requirements. As alternatives to the recommended 3 feet freeboard height, this section could reference varying freeboard heights by Flood Design Class in ASCE 24 or reference a lower freeboard height (e.g., + 2 ft).

climate. A potential outcome of limiting areas where strengthened elevations are applied would be that, in some locations, new structures just on or inside the existing floodplain boundary would be made resistant to flood levels up to 3 feet higher than neighboring structures located just outside the boundary.

- Expanding the area of special flood hazards, particularly if the adjusted area is mapped, can increase CRS credit points across a range of activities.
- Complying flood insurance policyholders located outside the FEMA 100-year floodplain would earn lower premiums.

## 5.0 LEVEL-UP COMPREHENSIVE PLANNING

*The objective of **Level-Up Comprehensive Planning** is to integrate future coastal flood risk mitigation with other Town planning, policy, and infrastructure funding priorities.*

The *Town of Palm Beach Comprehensive Plan (2017-2027)* lays out the community's existing conditions; anticipated issues; and goals, objectives, and policies to guide future development and municipal administration. The *Comprehensive Plan* was thoroughly reviewed as part of this coastal resilience implementation planning effort to identify potential gaps to fill, supplemental information or actions to provide, and conflicts between the *Comprehensive Plan* and *Level-Up* recommendations.

Recommendations are provided in the following sections to update or expand Executive Summaries and modify or add specific Goals, Objectives, and Policies under each Element of the *Comprehensive Plan*. Recommendations are repeated across relevant Elements, which may appear redundant, but follows an existing, intentional practice used in the *Comprehensive Plan* to reinforce intent and ensure coordination. These changes, if adopted partially or in full, would provide more clear and specific authority, commitment, and accountability for the Town to implement *Level-Up* recommendations over the near- to medium-term.

### 5.1 Future Land Use Element

The Town should consider amending the **Future Land Use Element** of the *Comprehensive Plan* to integrate the findings and recommendations from *Level-Up Lake Worth Shoreline* and *Level-Up Town Floodplain Development*.

The **Executive Summary** should be updated and expanded in the following sections:

- The **Provision of Public Services** section should be expanded to include a discussion of Coastal Flood Control services. See recommended updates to the *Infrastructure Element* section of the *Comprehensive Plan* for additional guidance.
- The **Development of Coastal and Flood-Prone Areas** section should be expanded to address present and future coastal flood risk. There is currently no discussion of the significant present coastal flood exposure, or the increasing future risks due to sea level rise and potential storm intensification. See recommended updates to the *Coastal Management/Conservation Element* section of the *Comprehensive Plan*, as well as introductory section in *Level-Up Floodplain Development*, for additional guidance. The concept of Adaptation Action Areas should also be introduced as an overarching policy tool for addressing coastal flood risks.

Recommended changes to consider for *Future Land Use Element* Objectives and Policies are provided in **Table 15**.

**Table 15 Recommended changes to Future Land Use Element Objectives and Policies.**<sup>58</sup>

<b><i>Future Land Use Element</i></b>	The purpose of the Future Land Use Element is to designate future land use patterns as reflected in the goals, objectives, and policies of the other Comprehensive Plan Elements.
<b><i>Goal 1</i></b>	To maintain the Town's unique identity and its high quality of life through the efficient distribution of compatible land uses.
<b><i>Objective 2</i></b>	Maintain the character of the Town as a predominantly residential community having only the type and amount of businesses and other support services necessary to meet the needs of Town residents.
<b><i>Policy 2.1.1</i></b>	Where essential services are indicated as an appropriate use, essential services shall include public utility facilities related to water supply, telephone (excluding wireless telecommunication facilities), cable television, gas, electrical distribution systems and town-owned services such as sanitary sewer, stormwater drainage, <i>coastal flood control</i> , and solid waste collection and disposal systems, including any necessary appurtenant structures serving the Town.
<b><i>Objective 3</i></b>	Development order or permits for <i>new construction or substantial improvement</i> shall be issued for construction in the <i>flood hazard area (as defined in the Town of Palm Beach Code of Ordinances Ch. 50)</i> , <i>coastal high hazard area</i> , or <i>Lake Worth shoreline</i> only if they meet the <i>flood-resistant construction requirements of the Florida Building Code, as amended by the Town of Palm Beach Code of Ordinances (Ch. 18)</i> ; <i>comply with the Town's Floodplain Management Ordinance</i> ; and, <i>as applicable to parcels abutting Lake Worth, meet the bulkhead and seawall construction, maintenance, and certification requirements in the Town of Palm Beach Code of Ordinances (Ch. 62)</i> .
<b><i>Policy 3.1</i></b>	Prior to the issuance of a development order or permit, the Town shall make and record the following determinations: <ul style="list-style-type: none"> <li>a. The proposed <i>new construction or substantial improvement</i> meets or exceeds <i>the flood-resistant construction requirements of the Florida Building Code, as amended by the Town of Palm Beach Code of Ordinances (Ch. 18)</i></li> <li>b. <i>The proposed new construction or substantial improvement complies with the Town's Floodplain Management Ordinance (Palm Beach Code of Ordinances Ch. 50)</i>.</li> <li>c. <i>(If applicable) All bulkheads or seawalls of the parcel abutting Lake Worth on which the proposed new construction or substantial improvement is located comply with the construction, maintenance, and certification requirements in the Town of Palm Beach Code of Ordinances (Ch. 62)</i>.</li> </ul>

<sup>58</sup> Text of recommended changes or additions is italicized and bright green.

<p><b>Objective 5</b></p>	<p>Development orders and permits for new development or redevelopment, or building permits for developments that have been issued development orders prior to the adoption of the Comprehensive Plan, shall be issued only if public facilities and services necessary to meet the Town's adopted level of service standards are available concurrent with the impacts of the development.</p>
<p><b>Policy 5.2</b></p>	<p>In order to ensure the availability of public facilities and services necessary to support development concurrent with its impacts, prior to the issuance of a development order or permit, the Town shall make and record the following determinations:</p> <ul style="list-style-type: none"> <li>a. Flooding will not occur during a one-year storm for systems served by pumping stations or during a three-year storm for systems with gravity outfalls, and the minor flooding associated with a five-year storm shall be carried off within sixty minutes. <i>(Consider referencing a specific data source, storm duration, and precipitation depth: “during a 2-year, 1-hour storm based on NOAA Atlas 14 Upper 90% Confidence Interval precipitation depth”)</i></li> <li>b. Negative impacts of stormwater discharge upon water quality in Lake Worth are ameliorated by the retention of the first two inches of rainfall prior to discharge into the Town system; or, the post-development runoff does not exceed predevelopment runoff for a three-year one-hour storm, whichever is greater; <i>(Consider referencing a specific data source and precipitation depth: “for a 3-year, 1-hour storm based on NOAA Atlas 14 Upper 90% Confidence Interval precipitation depth”)</i></li> <li>...</li> <li>k. <i>Coastal flood waters will not substantially damage critical Town-owned facilities during a 100-year flood accounting for projected Intermediate-High sea level rise over the service life of the assets.</i></li> <li>l. <i>Coastal flood waters will not pass through or over coastal flood control structures, constructed or permitted by the Town, during a 100-year flood accounting for projected Intermediate-High sea level rise over the service life of the structures.</i><sup>59</sup></li> </ul>
<p><b>Objective 8</b></p>	<p>The Town shall protect its natural resources. The measurement of this objective is the extent to which natural resources are preserved and the degree to which the following policies are implemented.</p>
<p><b>Policy 8.4</b></p>	<p>The Town shall require that all new development and redevelopment on the Atlantic shore restore dunes, where restoration potential exists and is necessary, as determined by the Town and FDEP. <i>Primary dune restoration to a higher crest elevation and sediment volume is a high priority along Reach 1 for coastal flood control.</i></p>

<sup>59</sup> This Level of Service standard should only be applied to improvements made after the adoption of seawall/bulkhead standards recommended in *Level-Up Lake Worth Shoreline*.

<b>Policy 8.6</b>	No development or redevelopment shall occur on or over submerged land other than docks, essential services or parks owned and operated by the Town. <i>Coastal flood control is considered an essential service.</i>
<b>Objective 13</b>	Public access shall be maintained to all recreational facilities, including recreational and commercial working waterfronts as defined in F.S. 342.07, under the jurisdiction of the Town of Palm Beach.
<b>Policy 13.4</b>	In evaluating applications for marinas or marina siting all of the following shall be addressed: land use compatibility; availability of upland support services; existing protective status or ownership; <i>adequacy of coastal flood control infrastructure</i> ; hurricane contingency planning; protection of water quality; water depth; environmental disruptions and mitigation actions; availability for public use; and, economic need and feasibility. The criteria shall be reviewed by the Planning Department on an annual basis and updated as necessary.
<b>Objective 14</b>	The Town shall adopt and implement policies that increase community resiliency and protect property, infrastructure, and cultural and natural resources from the impacts of climate change, including sea level rise, changes in rainfall patterns, and extreme weather events.
<b>Objective 14.1</b>	<i>The Town shall adopt one or more ordinances designating and mapping Adaptation Action Areas within Town that experience coastal flooding due to extreme high tides and storm surge, and that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure and adaptation planning<sup>60</sup>. A map of Adaptation Action Areas shall be included in the Comprehensive Plan. Adaptation Action Area 1 shall be designated as encompassing all lands within the municipal boundaries of the Town of Palm Beach designated as evacuation zones for storm surge.<sup>61</sup></i>

## 5.2 Transportation Element

The Town should consider amending the **Transportation Element** of the *Comprehensive Plan* to integrate the findings and recommendations from *Level-Up Town Facilities and Infrastructure* and *Level-Up Lake Worth Shoreline*.

The **Executive Summary** should be updated and expanded in the following sections:

- The **Regionally Significant Roadways** and **Existing System Deficiencies** sections should be expanded to identify coastal flooding risks to transportation infrastructure based on

<sup>60</sup> This language aligns with the Adaptation Action Area definition in F.S. 163.3164.

<sup>61</sup> Adaptation Action Area 1 could alternatively be designated based on updated PB-FRM results meeting State standards, or areas within flood hazard areas as recommended herein to be redefined in the Code of Ordinances. Other embedded Adaptation Action Areas could be designated in the future, for example areas requiring improvements to implement a storm surge barrier at the Lake Worth Inlet, specific neighborhood-scale flood control system service areas, or as identified through future technical or public planning process.

the updated future coastal flooding scenarios recommended in *Level-Up Town Facilities and Infrastructure*. Narrative should also describe the challenges of mitigating these risks due to significant constraints and limited feasibility of independent adaptation strategies (e.g., difficulty of raising roads due to narrow rights-of-way, high density of driveways, limited setbacks, runoff redirection to abutting properties).

- A discussion of adaptation strategies affecting transportation rights-of-way should also be included. *Level-Up Lake Worth Shoreline* contains recommendations that the Town Municipal Services entity be authorized to provide coastal flood control services and begin planning for potential neighborhood-scale flood control systems. Based on the preliminary evaluation of potential alignments for such systems, the need to site certain coastal flood control infrastructure within Town and State rights-of-way was identified. Such infrastructure may include raised bulkheads and seawalls, living shorelines, vegetated berms, floodwalls, and flood gate closures. These systems may be necessary to mitigate coastal flood risks to local and regionally significant transportation infrastructure because most roadways cannot be independently adapted, more stringent private shoreline infrastructure policies may take a long time to affect change, and a surge barrier at the Lake Worth Inlet may not be feasible. A map should be included identifying potential future neighborhood-scale flood control system locations within transportation rights-of-way based on the preliminary analysis included in *Level-Up Lake Worth Shoreline*.

Recommended changes to consider for *Transportation Element* Objectives and Policies are provided in **Table 16**.

**Table 16 Recommended changes to Transportation Element Objectives and Policies.**<sup>62</sup>

<b><i>Transportation Element</i></b>	The purpose of the Town's Transportation Element is to provide the framework for establishing its desired transportation system; and, in particular, to plan for its future motorized and non-motorized traffic circulation needs.
<b><i>Goal</i></b>	Maximize the existing street transportation system to foster a safe, efficient and convenient transportation system, coordinated with the other governmental agencies, for all existing and future land uses.
<b><i>Objective 1</i></b>	The Town shall continue to correct traffic operational deficiencies and undertake other needed measures, identified in this Element, that are necessary to the provision of a safe, convenient, and energy efficient, multimodal transportation system, including providing for protection of existing and future rights-of-way from building encroachment. Design of the multimodal transportation system will be done to ensure the safety of not only motorists, but also the safety of cyclists and pedestrians, particularly where they interact with motorists.

<sup>62</sup> Text of recommended changes or additions is italicized and bright green.

<b>Policy 1.4</b>	<i>The Town will evaluate future needs for space within the Town and State transportation rights-of-way for siting of coastal flood control system infrastructure.</i>
<b>Objective 3</b>	Coordinate the Town's transportation planning efforts with the plans and programs of the Metropolitan Planning Organization and the Florida Department of Transportation's Adopted 5-Year Work Program, and take into consideration public transportation, bicycle and pedestrian ways, <i>and coastal flood control infrastructure</i> , in future transportation planning.
<b>Policy 3.7</b>	<i>The Town will coordinate with the MPO, FDOT, Palm Beach County, the City of West Palm Beach, and the Town of South Palm Beach on plans and funding to mitigate future coastal flood risks to regionally significant roadways.</i>

### 5.3 Infrastructure Element

The Town should consider amending the **Infrastructure Element** of the *Comprehensive Plan* to integrate the findings and recommendations from *Level-Up Town Facilities and Infrastructure* and *Level-Up Lake Worth Shoreline*.

The **Executive Summary** should be updated and expanded in the following sections:

- The **Sanitary Sewer Services** and **Drainage** sections should be expanded to include a summary of wastewater and stormwater assets vulnerable to present and future coastal flooding and identify the need for asset mitigation measures. This would be informed by, or identify the need for, updated flood probability and critical elevation survey data recommended in *Level-Up Town Facilities and Infrastructure*.
- The **Drainage** section should also be updated to identify the need for updated stormwater modeling, level of service performance expectations, and development standards incorporating climate change projections for future precipitation and tidal boundary conditions.
- A new **Coastal Flood Control** section should be added. It is critical that coastal flood control be added to the charter of the Municipal Services entity in coordination with this addition to the *Comprehensive Plan*. The Town should consider adding Level of Service standards for coastal flood control. This section should highlight actions the Town has taken or plans to undertake to enhance coastal flood control infrastructure, including adopted recommendations in *Level-Up Lake Worth Shoreline* (i.e., private infrastructure standards, Town-owned infrastructure adaptation, enabling and planning for municipal flood control services, and surge barrier feasibility study). The results of, or need for, the recommended Lake Worth shoreline infrastructure top elevation survey and condition assessment should be summarized, including priorities identified based on the results and ongoing Town planning. If available, existing shoreline infrastructure elevations, conditions, and/or ownership should be shown in a map in the *Comprehensive Plan*.

Recommended changes to consider for *Infrastructure Element* Goals, Objectives, and Policies are provided in **Table 17**.

**Table 17** Recommended changes to Infrastructure Element Goals, Objectives, and Policies.<sup>63</sup>

<b>Infrastructure Element</b>	The purpose of the Infrastructure Element is to provide for necessary public facilities and services related to future land use projections. It includes plans for sanitary sewer, solid waste, potable water, <i>coastal flood control</i> , and drainage facilities.
<b>Goal 1</b>	Maintain adequate levels of utility services for existing and future populations, and maximize utilization of existing investment and facilities.
<b>Objective 1</b>	The Town shall assure that all existing and future residents, and businesses in the Town, will have access to sanitary sewer facilities; maximize the use of existing collection and treatment facilities; and, meet future needs through continuation of its Sanitary Sewer Rehabilitation Program. The measurement of this objective is whether or not sanitary sewer facilities are available to all users, and the extent to which the following policies are implemented.
<b>Policy 1.3</b>	<i>The Town shall incorporate the funding of improvements in its Capital Improvements Element to mitigate identified vulnerabilities from future coastal flooding in the design, repair, and rehabilitation of sanitary sewer pump stations.</i>
<b>Objective 7</b>	The Town shall maximize its existing drainage facilities by correcting drainage problems in Town and explore methods of improving the quality of stormwater discharge. The measurement of this objective is the extent to which identified drainage problems are corrected, and the degree to which the following policies are implemented.
<b>Policy 7.6</b>	<i>The Town shall incorporate funding in its Capital Improvements Element to mitigate identified vulnerabilities from future coastal flooding in the design, repair, and rehabilitation of drainage pump stations.</i>
<b>Policy 7.7</b>	<i>The Town will evaluate the need for updated stormwater system modeling, level of service performance expectations, and development standards incorporating climate change projections for future precipitation and tidal boundary conditions.</i>
<b>Objective 8</b>	Development orders and permits for new development or redevelopment shall be issued only if the proposed project meets the Town's adopted level of service standards, or if needed expansion of facilities is coordinated with future development.

<sup>63</sup> Text of recommended changes or additions is italicized and bright green, except that red is used where background colors are bright green or teal.

<p><b>Policy 8.1</b></p>	<p>The Town shall establish the following level of service standards:</p> <ol style="list-style-type: none"> <li>1. Flooding will not occur during a one-year storm for systems served by pumping stations, or during a three-year storm for systems with gravity outfalls; and, the minor flooding associated with a five-year storm shall be carried off within sixty minutes. <i>(Consider referencing a specific data source, storm duration, and precipitation depth: “during a 2-year, 1-hour storm based on NOAA Atlas 14 Upper 90% Confidence Interval precipitation depth”)</i></li> <li>2. Negative impacts of stormwater discharge upon water quality in Lake Worth are ameliorated by the retention of the first two inches of rainfall prior to discharge into the Town system, or the post-development runoff does not exceed predevelopment runoff for a three-year one-hour storm, whichever is greater. <i>(Consider referencing a specific data source and precipitation depth: “for a 3-year, 1-hour storm based on NOAA Atlas 14 Upper 90% Confidence Interval precipitation depth”)</i></li> </ol>
<p><b>Objective 12<sup>64</sup></b></p>	<p><i>The Town shall initiate planning, enact policies, coordinate with partners, develop projects, and identify funding to mitigate neighborhood and Town-wide exposure to future coastal flooding. The measurement of this objective is the degree to which the following policies are implemented</i></p>
<p><b>Policy 12.1</b></p>	<p><i>The Town shall establish the following level of service standards:</i></p> <ol style="list-style-type: none"> <li>m. <i>Coastal flood waters will not substantially damage critical Town-owned facilities during a 100-year flood accounting for projected Intermediate-High sea level rise over the lifetime of the assets.</i></li> <li>n. <i>Coastal flood waters will not pass through or over coastal flood control structures, constructed or permitted by the Town, during a 100-year flood accounting for projected Intermediate-High sea level rise over the lifetime of the structures.</i><sup>65</sup></li> </ol>

<sup>64</sup> A subsection on Aquifer Recharge currently follows Objective 11. The Aquifer Recharge subsection contains a separate unnumbered Goal, Objective 12, and related Policies. These should be renumbered following the recommended addition of a new Objective 12 related to Coastal Flood Control.

<sup>65</sup> This Level of Service standard should only be applied to improvements made after the adoption of seawall/bulkhead standards recommended in *Level-Up Lake Worth Shoreline*.

<p><b>Policy 12.2</b></p>	<ol style="list-style-type: none"> <li>1. <i>The Town shall survey shoreline infrastructure top elevations, adjacent grades, and conditions along Lake Worth.</i></li> <li>2. <i>The Town shall revise and strengthen bulkhead construction specifications in the Code of Ordinances.</i></li> <li>3. <i>Revise and strengthen bulkhead maintenance and certification standards in the Code of Ordinances.</i></li> <li>4. <i>The Town shall create an online seawall/bulkhead permit application system.</i></li> <li>5. <i>The Town shall create and maintain a geospatial database and document management system for tracking bulkhead/seawall permit application materials, top elevations, adjacent grades, lengths, substantial improvements, certifications, waivers, and easements.</i></li> <li>6. <i>The Town shall carry out technical, planning, coordination, advocacy, and grant-seeking activities to study the feasibility, environmental impacts, and cost-effectiveness of a storm surge barrier at the Lake Worth Inlet and other alternatives for Town-wide and neighborhood-scale coastal storm risk management.</i></li> </ol>
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#### 5.4 Coastal Management/Conservation Element

The Town should consider amending the ***Coastal Management/Conservation Element*** of the *Comprehensive Plan* to integrate the findings and recommendations from *Level-Up Town Facilities and Infrastructure* and *Level-Up Lake Worth Shoreline*.

The ***Executive Summary*** should be updated and expanded in the following sections:

- The ***Floodplains*** section should be significantly expanded to summarize the general methods and findings from the PB-FRM simulations, including future conditions recommended to be updated according to State standards in *Level-Up Town Facilities and Infrastructure*. The summary should highlight that Palm Beach’s exposure to coastal flooding largely emanates from Lake Worth and the Inlet. The projected impacts of sea level rise on sunny day high tide flooding exposure, and of sea level rise and storm surge on more catastrophic flood exposure, should also be documented. The Floodplain map (V-2) should also be updated to correct a reversed coloring error for the 100-year flood zone. The future 1% annual chance flood extent and elevation maps produced using PB-FRM should be added as Future Coastal Flood Hazard Areas maps, noting the specific sea level rise increment in feet, scenario (2017 NOAA Intermediate-High) and time horizon associated with each.
- The ***Comprehensive Coastal Management Plan*** (CCMP) section should be expanded to explain the genesis and development of the CFVA and *Level-Up* Implementation Plan. It should also summarize the main goals, themes, and objectives of *Level-Up*. The following recommendations within the CCMP scope should also be integrated alongside related narrative:

- *CFVA* enhancements needed:
  - Updating PB-FRM sea level rise scenarios and time horizons to align with recently adopted State standards.
  - Carrying out a survey of Lake Worth shoreline infrastructure top elevations and conditions and integrating that data in the PB-FRM digital elevation model.
  - Carrying out a survey of critical elevations for Town facilities and updating asset risk scores based on the new PB-FRM and critical elevation data.
  - Including the Sand Transfer Plant in the final vulnerability assessment.
- Coastal flood mitigation improvements needed along the Atlantic Ocean:
  - Increasing the primary dune crest elevation and volume along Reach 1. There is significant sand volume available in Reach 1, but the primary dune and landward topography is low relative to the rest of the barrier island's coastal ridge.
  - Adapting the Root Trail and Sunset Ave public access facilities to also function as coastal flood control structures.
- Water level monitoring:
  - Creating a Lake Worth water level monitoring program to track the short-term coastal flooding events and long-term sea level rise.
- The ***Remedies for Existing Pollution*** section should be updated to note that, while major coastal floods have not occurred, the potential remains for future coastal floods to cause debris, untreated sewage, sediment, and other pollutants to runoff into Lake Worth with the recession of floodwaters and affect water quality and natural resources.
- The ***Infrastructure and Natural Disaster Planning*** section should be updated to focus primarily on discussions surrounding the Coastal High Hazard Area, Coastal Construction Control Line, and evacuation and emergency management plans and systems. By implementing strategies to mitigate future coastal flooding of upland developed areas, the Town would also be mitigating potential future water pollution.
- A new ***Adaptation Action Areas*** section should be added designating and mapping Adaptation Action Areas within Town experiencing coastal flooding due to extreme high tides and storm surge, and vulnerable to related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure and adaptation planning. Within Adaptation Action Areas (AAAs), in accordance with F.S. 163.3164(1) and F.S. 163.3177(6)(g)(10), local governments may consider policies within the *Coastal Management/Conservation Element* to improve resilience to coastal flooding resulting from high-tide events, storm surge, flash floods, stormwater runoff, and related impacts of sea-level rise. Implementation projects located within AAAs earn additional points in the Resilient Florida Grant Program's project scoring criteria. AAAs the Town wishes to designate must be mapped and included in the *Comprehensive Plan*. There is significant flexibility in how the Town defines the boundaries of these areas, but the Town should

consider starting by designating all areas within the storm surge evacuation zone<sup>66</sup> (i.e., the entire Town) as Adaptation Action Area 1 (AAA1). This section should describe the AAA1 boundary, provide a rationale for why this area was designated, and identify the recommendations from *Level-Up* that will be applied within AAA1. A schedule should also be provided for regular monitoring and reporting of implementation progress and key metrics that may affect decision-making (see Section 6.3 Monitoring for more detail).

Recommended changes to consider for *Coastal Management/Conservation Element* Objectives and Policies are provided in **Table 18**.

**Table 18 Recommended changes to Coastal Management/Conservation Element Objectives and Policies.**<sup>67</sup>

<b>Coastal Management/Conservation Element</b>	The purposes of this Element are to plan for and, where appropriate, restrict development activities where such activities would damage or destroy coastal resources; to protect human life; to limit public expenditures in areas subject to destruction by natural disaster; and to promote the conservation, use, and protection of natural resources.
<b>Goal</b>	Preserve, protect and enhance the natural and historic resources of the town, and limit public expenditures in areas subject to destruction by natural disasters, while ensuring maximum enjoyment and minimum exposure of human life in the coastal zone.
<b>Objective 4</b>	Protect and restore wetland habitat and estuarine water quality in the Town, thereby protecting fisheries and marine habitat. The measurement of this objective is the extent to which wetland habitat and estuarine quality are protected, and the degree to which the following policies are implemented.
<b>Policy 4.3</b>	<i>Mitigate the negative impacts of coastal flooding runoff upon water quality in Lake Worth by establishing that coastal flood waters will not pass through or over coastal flood control structures, constructed or permitted by the Town, during a 100-year flood accounting for projected Intermediate-High sea level rise over the lifetime of the structures.</i> <sup>68</sup>
<b>Policy 4.4</b> <sup>69</sup>	<i>The Town shall continue to prohibit the use of septic tanks.</i>
<b>Objective 5</b>	The Town shall protect and restore its beaches and dunes. The measurement of this objective is the extent to which beaches and shores are protected and restored, and the degree to which the following policies are implemented.

<sup>66</sup> F.S. 163.3177(6)(g)(10) specifically calls out storm surge evacuation zones as an example criteria for AAA designation.

<sup>67</sup> Text of recommended changes or additions is italicized and bright green.

<sup>68</sup> This Level of Service standard should only be applied to improvements made after the adoption of seawall/bulkhead standards recommended in *Level-Up* Lake Worth Shoreline.

<sup>69</sup> Moved from existing Objective 15, Policy 15.4

<b>Policy 5.3</b>	The Town shall require that all new development and redevelopment on the Atlantic shore restore dunes, where restoration potential exists and is necessary, as determined by the Town and FDEP. <i>Primary dune restoration to a higher crest elevation and sediment volume along Reach 1 is a high priority for coastal flood control.</i>
<b>Objective 8</b>	The Town will provide and maintain existing public access to beach areas which have been nourished at public expense, publicly-owned beachfront parks, and the Municipal Docks on Lake Worth. The measurability of this objective is the extent to which public access is provided and maintained, and the degree to which the following policies are implemented
<b>Policy 8.6</b>	The Town will adapt public access facilities to also function as coastal flood control structures.
<b>Objective 15<sup>70</sup></b>	<i>The Town shall adopt and implement policies that limit development and public expenditure within the Coastal High Hazard Area (CHHA).</i>
<b>Policy 15.1</b>	Publicly funded facilities that subsidize development will not be built in the Coastal High Hazard Area. However, this limitation does not apply to such facilities necessary to serve projects approved under prior development orders but not yet built, or to such facilities necessary to maintain adequate levels of public facilities and services to existing residents. Nor does it apply to publicly funded projects associated with providing beach restoration, public access, recreation, resource restoration, or the rehabilitation, maintenance or construction of shore protection structures such as groins, revetments or seawalls.
<b>Policy 15.2</b>	The Town shall not expand utility systems or public services that would be necessitated by increased development within the Coastal High Hazard Area.
<b>Policy 15.3</b>	The Town will coordinate with, and will rely on, the Florida Department of Environmental Protection to enforce building limitations seaward of the Coastal Construction Control Line.
<b>Policy 15.4<sup>71</sup></b>	<i>The Town will mitigate hazards within the Coastal High Hazard Area through enforcement of building code requirements and other restrictions.</i>
<b>Policy 15.5<sup>72</sup></b>	The Town will limit residential development within the Coastal High Hazard Area.
<b>Policy 15.6<sup>73</sup></b>	The Town will limit public building and infrastructure in the CHHA.
<b>Policy 15.7<sup>74</sup></b>	Town-funded public facilities shall not be built in the coastal high hazard area, except for purposes of public safety and/or access, enhancement of water-related activities or significant resource protection.

<sup>70</sup> Objective 15 should be modified to disaggregate CHHA-related Policies from those dealing with climate change impacts.

<sup>71</sup> Changed number from existing Policy 15.5 and modified to disaggregate CHHA-related provisions.

<sup>72</sup> Changed numbering from existing Policy 15.6.

<sup>73</sup> Changed numbering from existing Policy 15.7.

<sup>74</sup> Changed numbering from existing Policy 15.8.

<b>Policy 15.8<sup>75</sup></b>	The Town will not permit density increases in the CHHA for redevelopment and new development unless such requests are consistent with this Comprehensive Plan.
<b>Objective 16<sup>76</sup></b>	The Town shall adopt and implement policies that increase community resiliency and protect property, infrastructure, and cultural and natural resources from the impacts of climate change, including sea level rise, changes in rainfall patterns, and extreme weather events.
<b>Policy 16.1<sup>77</sup></b>	The Town will continue to participate in the National Flood Insurance Program Community Rating System (CRS) and strive to maintain or improve its current CRS rating.
<b>Policy 16.2<sup>78</sup></b>	The Town will continue to enforce its building code and drainage requirements.
<b>Policy 16.3<sup>79</sup></b>	The Town will mitigate hazards through building practices and implementation of FEMA requirements, stormwater retention requirements, and other restrictions.
<b>Policy 16.3</b>	<i>The Town will update its existing Coastal Flood Vulnerability Assessment and underlying coastal flood risk model and stormwater flood model, to the extent practicable, to comply with State vulnerability assessment requirements in Section 380.093 of the Florida Statutes to meet eligibility requirements for Resilient Florida Grant Program implementation funding.</i>
<b>Policy 16.4</b>	<i>The Town shall create a Lake Worth water level monitoring program.</i>
<b>Policy 16.5</b>	<i>The Town shall adopt one or more ordinances designating and mapping Adaptation Action Areas within Town that experience coastal flooding due to extreme high tides and storm surge, and that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure and adaptation planning<sup>80</sup>. Adaptation Action Areas shall be included in the Future Land Use Map of the Town. Adaptation Action Area 1 shall be designated as encompassing all lands within the municipal boundaries of the Town of Palm Beach that are designated as evacuation zones for storm surge.<sup>81</sup></i>

<sup>75</sup> Changed numbering from existing Policy 15.9.

<sup>76</sup> Changed numbering from existing Objective 15 to disaggregate CHHA-related Policies from those dealing with climate change impacts on flooding.

<sup>77</sup> Changed numbering from existing Policy 15.1.

<sup>78</sup> Changed numbering from existing Policy 15.3 and modified to disaggregate CHHA-related provisions.

<sup>79</sup> Changed numbering from existing Policy 15.5 and modified to disaggregate CHHA-related provisions.

<sup>80</sup> This language aligns with the Adaptation Action Area definition in F.S. 163.3164.

<sup>81</sup> Adaptation Action Area 1 could alternatively be designated based on updated PB-FRM results meeting State standards, or areas within flood hazard areas as recommended herein to be redefined in the Code of Ordinances. Other embedded Adaptation Action Areas could be designated in the future, for example areas requiring improvements to implement a storm surge barrier at the Lake Worth Inlet, specific neighborhood-scale flood control system service areas, or as identified through future technical or public planning process.

<p><b>Policy 16.6</b></p>	<p><i>For the purposes of improving resilience to coastal flooding resulting from high-tide events, storm surge, flash floods, stormwater runoff, and related impacts of sea level rise<sup>82</sup> in Adaptation Action Area 1, the Town will:</i></p> <ol style="list-style-type: none"> <li><i>7. Survey critical elevations of Town facilities for use in adaptation prioritization.</i></li> <li><i>8. Survey shoreline infrastructure top elevations and conditions along Lake Worth for use in flood risk modeling, adaptation prioritization, and code enforcement.</i></li> <li><i>9. Revise and strengthen bulkhead construction specifications in the Code of Ordinances.</i></li> <li><i>10. Revise and strengthen bulkhead maintenance and certification standards in the Code of Ordinances.</i></li> <li><i>11. Create an online seawall/bulkhead permit application system.</i></li> <li><i>12. Create and maintain a geospatial database and document management system for tracking bulkhead/seawall permit application materials, top elevations, adjacent grades, lengths, substantial improvements, certifications, waivers, and easements.</i></li> <li><i>13. Amend the charter of the Municipal Services entity to include coastal flood control services.</i></li> <li><i>14. Establish level of service standards for coastal flood control infrastructure and mitigation of Town asset coastal flood vulnerabilities.</i></li> <li><i>15. Carry out technical, planning, coordination, advocacy, and grant-seeking activities to study the feasibility, environmental impacts, and cost-effectiveness of a storm surge barrier at the Lake Worth Inlet and other alternatives for Town-wide and neighborhood-scale coastal flood control.</i></li> <li><i>16. Adopt amendments to the Florida Building Code through the Code of Ordinances, establishing higher standards for substantial improvement and substantial damage definitions and minimum elevation requirements for residential and non-residential structures.</i></li> <li><i>17. Revise and expand the definition in the Code of Ordinances of flood hazard areas within which floodplain management and flood-resistant construction standards apply.</i></li> <li><i>18. Report on implementation progress and key metrics every other year, with a comprehensive report every ten years.</i></li> </ol>
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### 5.5 Intergovernmental Coordination Element

The Town should consider amending the **Intergovernmental Coordination Element** of the *Comprehensive Plan* to integrate the findings and recommendations from *Level-Up Lake Worth Shoreline*.

<sup>82</sup> This language aligns with the stated purpose of Adaptation Action Areas in F.S. 163.3177(6)(g)(10).

The *Executive Summary* should be updated and expanded in the following sections:

- The *Analysis* sections should be expanded to identify the need for coordination among governmental stakeholders on strategies and funding to mitigate future coastal flood risks emanating from the Lake Worth Inlet and shoreline.
- The *Transportation Element* section should also be expanded to identify the need for coordination on strategies and funding to mitigate future coastal flood risks to regionally significant roadways from sea level rise and coastal storms, including the potential siting of coastal flood control infrastructure within transportation rights-of-way.
- The *Infrastructure Element* section should be updated to identify the need for coordination on strategies and funding for coastal flood risk mitigation, such as a storm surge barrier at the Lake Worth Inlet, neighborhood-scale coastal flood control systems, and Town facility and infrastructure adaptations.
- The *Coastal Management/Conservation Element* section should be updated to identify the need for coordination on State funding for vulnerability assessment updates to meet State standards; and strategies, State and Federal funding, and regulatory coordination for implementation of Adaptation Action Area 1 Policies, primary dune enhancement activities in Reach 1 of the CCMP, and adaptation of public access facilities to also function as flood control structures.
- The *Capital Improvements* section should be updated to identify the need for coordination in seeking State and Federal support for a U.S. Army Corps of Engineers Coastal Storm Risk Management Feasibility Study for Lake Worth, including an evaluation of a storm surge barrier at the Lake Worth Inlet; State funding support for Town facility and infrastructure adaptations; and State funding support and regulatory coordination for neighborhood-scale flood control systems.

In addition, the *Intergovernmental Coordination Matrix* should be updated to include Lake Worth Coastal Flood Mitigation in the list of program work tasks and USACE in the list of governmental entities.

Recommended changes to consider for *Intergovernmental Coordination Element* Goals, Objectives, and Policies are provided in **Table 19**.

**Table 19 Recommended changes to Intergovernmental Coordination Element Goals, Objectives, and Policies.<sup>83</sup>**

<b><i>Intergovernmental Coordination Element</i></b>	The purpose of this Element is to identify and resolve incompatible aspects of proposed comprehensive plans of local governments, and to determine and respond to the needs for coordination processes and procedures with adjacent local governments and regional and state agencies.
<b><i>Goal 1</i></b>	An effective government which utilizes intergovernmental coordination to maximize efficiency in providing services and facilities; to reduce duplication of effort; and, to solve common problems.
<b><i>Objective 1.2</i></b>	In order to ensure coordination mechanisms to address impacts of developments proposed in and adjacent to the Town that may affect adjacent local governments, the Town will continue to participate on various intergovernmental advisory committees, boards, commissions or groups serving the Town.
<b><i>Policy 1.2.7</i></b>	<p>Issues of regional and state significance shall be coordinated with the Treasure Coast Regional Planning Council, the South Florida Water Management District, and/or State agencies having jurisdictional authority. Issues to be pursued include but are not limited to the following:</p> <p>...</p> <p><i>k. Strategies and funding to mitigate coastal flood risks from sea level rise and coastal storms along the Lake Worth and Atlantic Ocean shorelines.</i></p>
<b><i>Goal 3</i></b>	It is the goal of the Town of Palm Beach to work with Federal, State, County, and adjacent municipalities or agencies to protect and restore the existing coastal dune system and beaches along the City's beachfront, establish standards to minimize impacts resulting from beach erosion, <i>and mitigate future coastal flood risks along the Lake Worth shoreline.</i>
<b><i>Objective 3.2</i></b>	The Town will coordinate with appropriate agencies to address future coastal flood risks along the Lake Worth shoreline caused by sea level rise and extreme weather events, resulting in significant exposure of highly developed and populated areas and critical infrastructure.

<sup>83</sup> Text of recommended changes or additions is italicized and bright green, except that red is used where background colors are bright green or teal.

<p><b>Policy 3.2.1</b></p>	<p><i>Seek State and Federal support for a U.S. Army Corps of Engineers Coastal Storm Risk Management Feasibility Study for Lake Worth, including an evaluation of a storm surge barrier at the Lake Worth Inlet.</i></p> <p><i>a. Conduct outreach to USACE, FDEP, FDOT, Palm Beach County, neighboring municipalities, Port of Palm Beach, and SFWMD.</i></p> <p><i>b. Conduct outreach to Federal and State elected officials.</i></p> <p><i>c. Support the Project Sponsor (which may be the Town) in submitting a feasibility study proposal to USACE and to Federal elected officials</i></p> <p><i>d. Engage elected officials to advocate for Federal authorization and appropriations and State grant support for non-Federal cost-sharing.</i></p>
<p><b>Policy 3.2.2</b></p>	<p><i>Coordinate with the MPO, FDOT, Palm Beach County, the City of West Palm Beach, and the Town of South Palm Beach on plans and funding to mitigate future coastal flood risks to regionally significant roadways, including the potential siting of neighborhood-scale or Town-wide coastal flood control infrastructure within transportation rights-of-way.</i></p>

## 5.6 Capital Improvements Element

The Town should consider amending the **Capital Improvements Element** of the *Comprehensive Plan* to integrate the findings and recommendations from *Level-Up Town Facilities and Infrastructure* and *Level-Up Lake Worth Shoreline*.

The **Executive Summary** should be updated and expanded in the following section:

- The **Capital Improvement Program Project Descriptions** section should be updated, including by adding costs of implementing coastal flood mitigation improvements identified as near-term priorities in *Level-Up Town Facilities and Infrastructure* to identified project budgets. If the Town is to be responsible for a portion of the non-Federal cost-share for the USACE Coastal Storm Risk Management Feasibility Study for Lake Worth, the project should be identified and costs provided. If the Town plans to implement elements of neighborhood-scale flood control systems, including on Town-owned properties, such projects and costs should be identified.

Recommended changes to consider for *Capital Improvements Element* Objectives and Policies are provided in **Table 20** through **Table 24**.

**Table 20 Recommended changes to Capital Improvements Element Objectives and Policies.<sup>84</sup>**

<p><b>Capital Improvements Element</b></p>	<p>The purpose of this Element is to evaluate the need for public facilities, as identified in the other Plan Elements; to estimate the cost of improvements for which the Town of Palm Beach has fiscal responsibility; to analyze the Town's fiscal capability to finance and construct such improvements; and to adopt financial policies to guide funding and construction of capital improvements when required, based on needs identified in the other Plan Elements.</p>
<p><b>Goal</b></p>	<p>The Town shall, using sound fiscal policies, provide adequate services and facilities in a timely and efficient manner.</p>
<p><b>Objective 3</b></p>	<p>The Town shall coordinate its land use decisions and fiscal resources with its schedule of capital improvements identified as necessary to maintain the Town's adopted Level of Service (LOS) standards and meet existing and future facility needs. These capital improvements and facility improvements shall have first priority for allocation of the Town's fiscal resources available for capital expenditures.</p>
<p><b>Policy 3.1</b></p>	<p>The Town shall utilize the following Level of Service standards, found in other elements of the Town's Comprehensive Plan, for public facilities in the Town.</p> <p>3.1a Stormwater Discharge or Runoff --</p> <p>1) Flooding will not occur during a one-year storm for systems served by pumping stations or during a three-year storm for systems with gravity outfalls, and, the minor flooding associated with a five-year storm would be carried off within sixty minutes. <i>(Consider referencing a specific data source, storm duration, and precipitation depth: “during a 2-year, 1-hour storm based on NOAA Atlas 14 Upper 90% Confidence Interval precipitation depth”)</i></p> <p>2) Negative impacts of stormwater discharge upon water quality in Lake Worth are ameliorated by the retention of the first two inches of rainfall prior to discharge into the Town system; or the post-development runoff does not exceed predevelopment runoff for a three-year one-hour storm, whichever is greater. <i>(Consider referencing a specific data source and precipitation depth: “for a 3-year, 1-hour storm based on NOAA Atlas 14 Upper 90% Confidence Interval precipitation depth”)</i></p> <p>...</p> <p><b>3.1g Coastal Flood Control –</b></p> <p><i>1) Coastal flood waters will not substantially damage critical Town-owned facilities during a 100-year flood accounting for projected Intermediate-High sea level rise over the service life of the assets.</i></p>

<sup>84</sup> Text of recommended changes or additions is italicized and bright green, except that red is used where background colors are bright green or teal.

	<p><i>2) Coastal flood waters will pass through or over coastal flood control structures, constructed or permitted by the Town, during a 100-year flood accounting for projected Intermediate-High sea level rise over the service life of the structures.</i></p>
<p><b>Objective</b></p>	<p>The Town shall include in its Schedule of Capital Improvements (SCI) all capital improvements needed within the five-year period covered by its CIP, including replacement of sanitary sewer infrastructure recognized as obsolete or worn-out and improvements needed to eliminate recognized deficiencies in its drainage system <i>and coastal flood control infrastructure</i>, as identified in the Comprehensive Plan.</p>

## 6.0 IMPLEMENTATION PLAN

The *Level-Up Implementation Plan* consolidates the detailed analysis and recommendations to guide tangible actions and management of the program over time. It consists of:

- **Near- and Medium-Term Implementation Plan:** a matrix and proposed phasing of actions through the end of the 2020s.
- **Long-Term Adaptation Pathways:** a flexible framework with decision points and series of scenarios for anticipating and adapting to changing conditions in 2030 and following decades.
- **Monitoring:** a summary of relevant metrics and methods for the Town to track, informing future adaptive management and decision-making.

### 6.1 Near- and Medium-Term Implementation Plan

This section summarizes and organizes near- and medium-term actions identified in *Level-Up Palm Beach* into an *Implementation Plan*. Recommended actions under each of the four *Level-Up* themes are consolidated in tables. Actions are listed by sub-theme along with the recommended implementation timeframe and candidate lead Town entities.

Recommended timeframes are based on the rational sequencing of interdependent actions, estimated time to complete actions, and considering capacity to manage concurrent actions. Timeframes are intentionally aggressive given the significant existing flood risks and urgency for action. However, timeframes may be extended due to capacity constraints, changed external conditions, or other Town strategic considerations.

Candidate lead Town entities include Public Works (PW), Planning, Zoning, and Building (PZB), Information Technology (IT), Town Manager (TM), Town Council (TC), and Mayor (M). Lead entities listed would be expected to engage other departments, boards and commissions, and other relevant partners and stakeholders (including the public) as appropriate for implementation of the recommended actions.

**Table 21 Level-Up Town Facilities and Infrastructure implementation matrix**

Town Facilities and Infrastructure						
Sub-Theme	Recommended Action	Timeframe (Years)				Lead Town Entities
		1-2	3-5	6-10	10+	
Policy	Adopt interim DFEs for Town facilities and infrastructure	■				PW
	Consider revising interim DFEs based on PB-FRM updates	■	■			PW
Projects	Incorporate adaptation measures in existing 5-year capital plan projects	■	■			PW, TM
	Incorporate future flood risk in selection, design, and budget of projects for future 5-year capital plans	■	■	■	■	PW, TM
Prioritization	Conduct survey of critical elevations for Town facilities	■				PW
	Update PB-FRM to align with State standards	■				PW
	Revise probability of flooding data and risk scores for Town assets	■				PW
Public Communication	Add updated PB-FRM maps to Town GIS for public use	■	■			PZB, IT

**Table 22 Level-Up Lake Worth Shoreline implementation matrix**

Lake Worth Shoreline						
Sub-Theme	Recommended Action	Timeframe (Years)				Lead Town Entities
		1-2	3-5	6-10	10+	
Administration	Create online seawall/bulkhead applications					PW, PZB, IT
	Create and maintain geospatial database and document management system for tracking bulkhead/seawall application materials, top elevation, adjacent grade, length, substantial improvements, certification, waivers, and easements					PW, PZB, IT
Code of Ordinances	Revise and strengthen bulkhead construction specifications (Code of Ordinances)					PW, PZB, TM, TC
	Revise and strengthen bulkhead maintenance and certification standards (Code of Ordinances)					PW, PZB, TM, TC
	Consider revising interim DFEs based on updated PB-FRM results					PW, PZB, TM, TC
Neighborhood-Scale Flood Control Systems	Add “coastal flood control” to Municipal Services entity charter (Code of Ordinances)					PW, TM, TC
	Survey seawall top elevations, adjacent grades, and conditions					PW
	Develop prioritization criteria and collect required data					PW, PZB, TM, TC
	Plan priority flood control system(s)					PW, PZB, TM, TC
	Implement priority flood control systems					PW, TM
Storm Surge Barrier Feasibility Study	Carry out preliminary model-based evaluation of storm surge barrier effectiveness (optional)					PW
	Conduct outreach to USACE, FDEP, FDOT, Palm Beach County, neighboring					PW, TM, TC, M

	municipalities, Port, and SFWMD for CSRSM study					
	Conduct outreach to Federal elected officials for CSRSM study					PW, TM, TC, M
	Develop and submit a proposal to USACE for CSRSM study					PW, TM, TC, M
	Engage Federal elected officials for Congressional authorization and appropriations for CSRSM study					PW, TM, TC, M
	Collaborate with USACE and partners to carry out CSRSM study					PW, TM, TC, M
	Engage State and Federal elected officials and agency leadership for funding to implement CSRSM study recommendations					PW, TM, TC, M
Lake Worth Water Level Monitoring	Create a water level monitoring plan					
	Implement water level monitoring plan (phased)					

**Table 23 Level-Up Floodplain Development implementation matrix**

Floodplain Development						
Sub-Theme	Recommended Action	Timeframe (Years)				Lead Town Entities
		1-2	3-5	6-10	10+	
Code of Ordinances	Revise and strengthen substantial improvement and substantial damage definitions and administrative procedures					PZB, TM, TC
	Adopt higher non-residential building elevation requirements					PZB, TM, TC
	Revise and strengthen residential building elevation requirements					PZB, TM, TC
	Revise building height definitions					PZB, TM, TC
	Revise and expand flood hazard area boundaries where floodplain management and building standards apply					PZB, TM, TC
	Coordinate proposed amendments to Florida Building Code with FDEM					PZB, TM, M

**Table 24 Level-Up Comprehensive Planning implementation matrix**

Comprehensive Planning						
Sub-Theme	Recommended Action	Timeframe (Years)				Lead Town Entities
		1-2	3-5	6-10	10+	
Comprehensive Plan	Prepare draft Comprehensive Plan amendment, hold public hearings, intergovernmental review, and adopt final amendment by ordinance					PZB, TM, TC
	Implement adopted policies and monitor progress					PZB, TM, TC

### 6.1.1 Applications to Grant Program

We recommend the Town apply for funding through the Resilient Florida and FEMA Hazard Mitigation Program grant funding on an annual basis for priority projects identified for near-term implementation. The first round of Resilient Florida funding was opened for application in 2021. The Town submitted the projects listed in **Table 25** for funding to multiple grant programs, and decisions are pending.

**Table 25** Projects submitted to Resilient Florida and other grant programs in 2021.

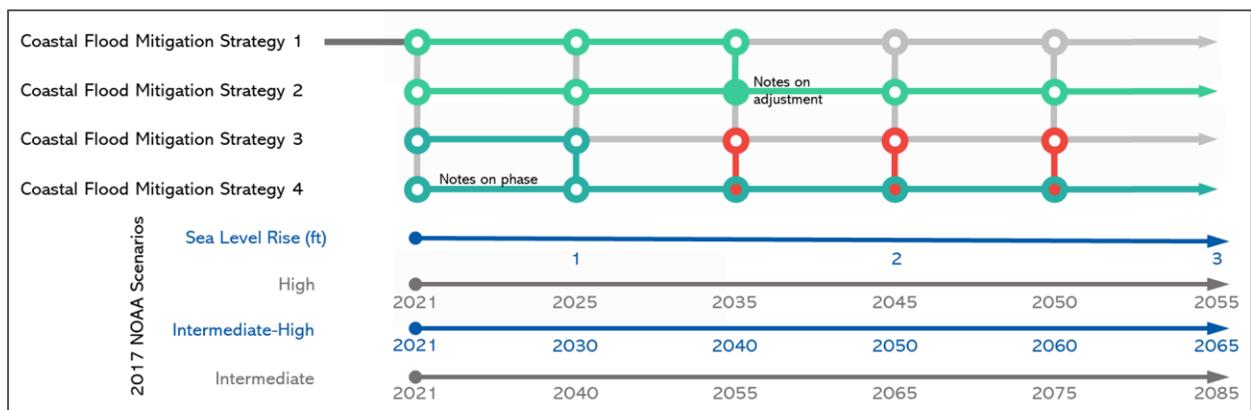
Project	Grant Request	Town Match*	Design Year	Construct Year
<b>D-12 Pump Station (Dry Floodproofing)</b>	\$80,000 (All additional costs)	\$830,000 (91% match) (Already programmed)	2022	2023
<b>A-5 Lift Station (Equipment Elevation)</b>	\$33,000 (All additional costs)	\$1,000,000 (97% match) (Already programmed)	2023	2024
<b>D-8 Pump Station / E-5 Lift Station (Equipment Elevation)</b>	\$90,000 (All additional costs)	\$1,246,196 (93% match) (Already programmed)	2022	2023
<b>D-17 Pump Station (Equipment Elevation)</b>	\$300,000 (All additional costs)	\$460,000 (60% match) (Already programmed)	2022	2023
<b>Coastal Flood Vulnerability Assessment Update and Priority Planning</b>	\$105,000 (50% of cost)	\$105,000 (50% match) (New commitment)	2022	N/A
<b>Total</b>	<b>\$608,000</b>	<b>\$3,641,196 (86% match)</b> <b>(\$105,000 in new cost)</b>		

## 6.2 Long-Term Adaptation Pathways

This section presents a manageable number of clearly defined long-term adaptation pathways, providing decision guidance for the Town to adapt how it manages *Level-Up Palm Beach* over time in response to changing conditions. Adaptive implementation pathways recognize the uncertain future. To make a future decision based on what is predicted today essentially requires that what we predict today will come true. Based on the probabilistic results for Palm Beach in the *CFVA*, we know a range of future flood risk scenarios are possible at different probabilities. For this reason, there is a need for the Implementation Plan to make a commitment in the short-term, but allow for a change in course, acceleration, or pull back over the long-term future if, based on what is learned, experienced, or measured in the interim, proves a need for a different action. This method is based on a variety of work, including Dynamic Adaptive Policy Pathways (DAPP), first online April 5, 2019 by Haasnoot, Warren and Kwakkel. In taking this approach that accounts for future uncertainty and monitoring into its decision-making process, the Town of Palm Beach is being proactive in planning responsible infrastructure investments. Make plans best on best available information today, then adapt in the future based on clear guidelines.

In short, for the major strategies to address risk in the long-term future, a clear set of decision pathways is identified guided by observations over time, and based on consideration of cost savings. A simple example is for the Town Marina bulkhead. One could achieve the end objective of protecting against the prediction for 2100 by designing today for the predicted worst-case condition. However, this would be extremely conservative and costly today. Instead, the project was designed presently for a moderate future condition that provides improved protection today, and with likelihood to provide lasting protection in the future at less than present day cost. At the same time, the bulkhead under construction today was designed in a way that it can be enhanced in the future if observations prove a more severe climate case evolves. The future enhancement would then achieve the protection goal, but at less cost than rebuilding the project again. This type of rationale is applied overall to the Implementation Plan.

A series of adaptation pathways figures, like **Figure 17**, are presented herein. While these figures can seem overwhelming at first, once understood, they can be a valuable decision tool for Town policy makers.



**Figure 17** Example adaptation pathway figure.

The main capital-intensive strategies from *Level-Up* are listed on the top left, with their respective pathways to the right of each. Moving left-to-right along a pathway for a particular strategy, at key time steps there are “transfer stations”, depicted as circles. These transfer stations represent decision points and opportunities to adjust a strategy (e.g., strengthen or relax standards) or shift to a different strategy (i.e., move up or down along one of the vertical paths when a change in approach is decided upon due to changed conditions).

Guiding each of the scenarios is a prevailing principle that the Town should work towards having a first and second line of defense from coastal flooding, recognizing that the first line of defense can fail unexpectedly – a lesson most notably learned from levee failures during Hurricane Katrina. For example, if a surge barrier at the Lake Worth Inlet is constructed (first line of defense), the Town can choose whether to continue either building shoreline flood mitigation infrastructure or adapting individual buildings and facilities as its second line of defense, but it need not continue both in addition to a surge barrier. These strategies could both still be

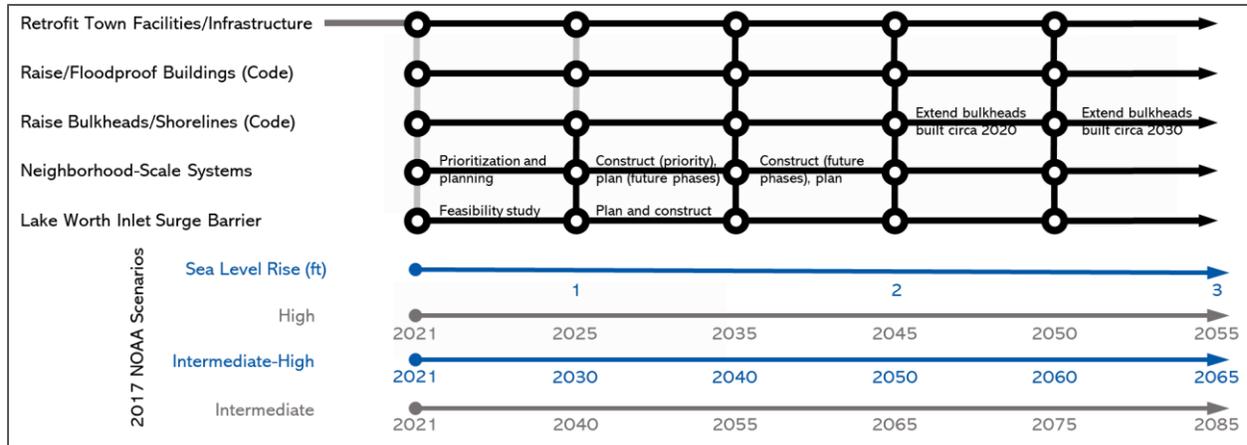
continued; however, the costs of doing so are unlikely to be financially justified if a surge barrier is constructed.

Transition points (circles) and sections of each pathway (lines) are coded in each figure with dark green, light green, red, or light gray color. **Dark green** indicates a strategy intended to function as the **first line of defense** in a two-layered coastal flood mitigation system. **Light green** indicates the **second line of defense**. **Red** is reserved for indicating a potential **alternative strategy** exists to supplant the first line of defense. **Light gray** indicates a given strategy is **discontinued** (for horizontal paths), or there is **no transition pathway** between strategies (for vertical paths). Where implementation of a given strategy would affect the adjustment or discontinuance of another strategy, the transition points of the affected strategy will have an inner circle colored based on the affecting strategy's color.

Finally, at the bottom of each figure are four threshold lines. The top line (blue) is the cumulative amount of **sea level rise** in feet, measured from the year 2000 baseline. The bottom three lines indicate at approximately what **outyear** the amount of sea level rise in the top line is expected to occur given a High, **Intermediate-High** (blue), or Intermediate sea level rise scenario, based on the 2017 NOAA projections. The top line, indicating the cumulative amount of sea level rise in feet, can be compared to actual measured water levels over time to determine which scenario best reflects the observed sea level rise trajectory, and design flood elevations for implementation adjusted accordingly (see Section 6.3 Monitoring for more). For the purposes of the discussions below, all timeframes will be discussed in relation to the State-standard 2017 NOAA Intermediate-High sea level rise scenario (i.e., "2030" corresponds with the time horizon in which 1 ft of sea level rise is projected compared with the year 2000 baseline).

### **6.2.1 2021 - Initial Implementation Plan**

The Initial Implementation Plan (starting in 2021) described in this report is an all-of-the-above strategy through 2030. It advances multiple potential layers of risk reduction over the 2020s and potentially beyond, involving both significant public and private effort (**Figure 18**). Because of uncertainties in which strategies will ultimately become first and second lines of defense, all pathways and transition points are colored in black. While this strategy will result in some economic inefficiencies and require significant upfront effort by the Town, it also preserves the ability to act on all options over the long-term without delay. This is critical because there is significant existing coastal flood risk and urgency to adapt, and there are significant uncertainties about how conditions may change by 2030 and beyond.

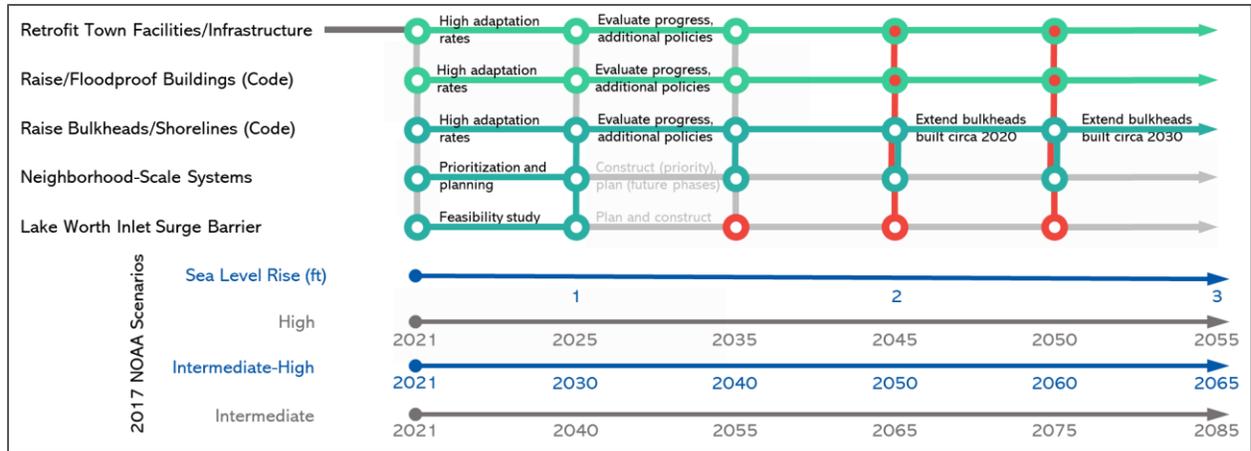


**Figure 18 2021 Adaptation Pathway – Initial Implementation Plan.**

**6.2.3 Post-2030 Scenario – High Adaptation Rates**

By 2030, it may become apparent that the Town and private property owners have rapidly adapted their assets to future flood risks, driven by *Level-Up* actions implemented over the prior decade and strong economic conditions. Rapid adaptation could also occur in response to a coastal flooding disaster in Palm Beach – an ever-present risk – helped along by a combination of available capital from flood insurance claims and State and Federal aid, the Town’s strengthened building standards, and changes in property owners’ risk perceptions.

With significant adaptation of a two-layered coastal flood resilience system (shorelines and buildings/facilities), the Town may have limited incentive to advance costly and challenging public-led strategies such as neighborhood-scale coastal flood control systems or a Lake Worth Inlet surge barrier. Instead, the Town could double-down on a private model of advancing coastal resilience, while ensuring the resilience of Town assets (**Figure 19**). Through continued monitoring over the following decades, the Town would be alerted when there is a need to implement additional policies, like further lowering the threshold for substantial improvements/damages, increasing enforcement, or creating incentives to maintain high rates of adaptation. If additional policies prove insufficient, the Town could change course in future decades towards implementing public-led strategies. If eventually a surge barrier is constructed, it would supplant needs for raised bulkheads as the first line of defense (then the second line of defense), and the Town could discontinue adaptation of Town assets and higher floodplain development standards.



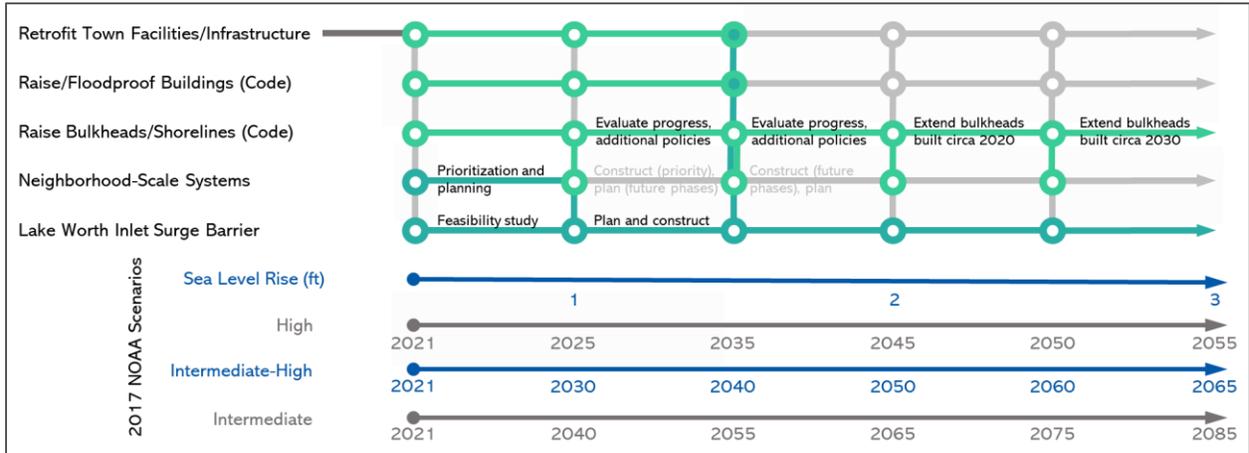
**Figure 19 Post-2030 Adaptation Pathway – high adaptation rates.**

**6.2.4 Post-2030 Scenarios – Surge Barrier**

If advocacy efforts by the Town and its regional partners are successful in obtaining rapid authorization and appropriations, by 2030, the U.S. Army Corps of Engineers (USACE) Coastal Storm Risk Management (CSRМ) Feasibility Study for Lake Wort should be completed. A positive outcome for the Town and region would be if a storm surge barrier at the Lake Worth Inlet is found to be feasible and cost-effective with acceptable and mitigatable environmental impacts. With a positive recommendation by USACE to Congress, and rapid Congressional authorization and appropriations, construction could be complete by around 2040. The Town would have a strong incentive to advance a surge barrier strategy, particularly if adaptation rates for Town assets, private buildings, and/or private bulkheads/shorelines are not high. At least two potential implementation pathways extend from this scenario.

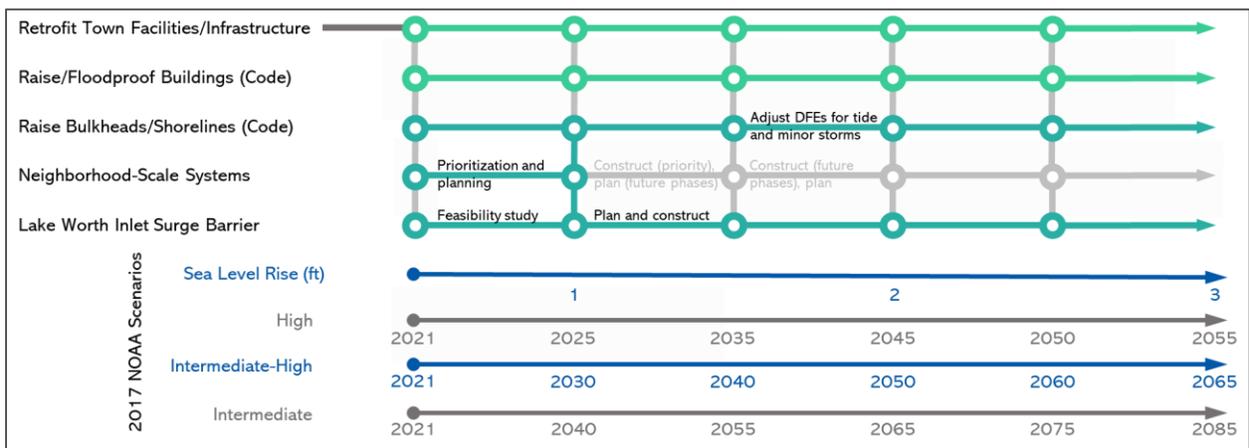
Starting around 2040, the Town could discontinue adapting Town facilities and infrastructure and the higher building standards set in Level-Up Floodplain Development, choosing instead to focus on building its second line of defense at the shoreline (**Figure 20**). The significant risk mitigation provided by the surge barrier would give the Town time to phase in full replacement of private and public shoreline infrastructure along Lake Worth. The Town would need to continue monitoring the effectiveness of bulkhead/seawall construction, maintenance, and certification standards, and, if adaptation rates are low, consider additional policies needed to induce a higher

rate. The Town would still retain the flexibility to advance neighborhood-scale coastal flood control systems if required to expedite completion of the second layer of defense.



**Figure 20 Post-2030 Adaptation Pathway – surge barrier and private bulkheads/shorelines.**

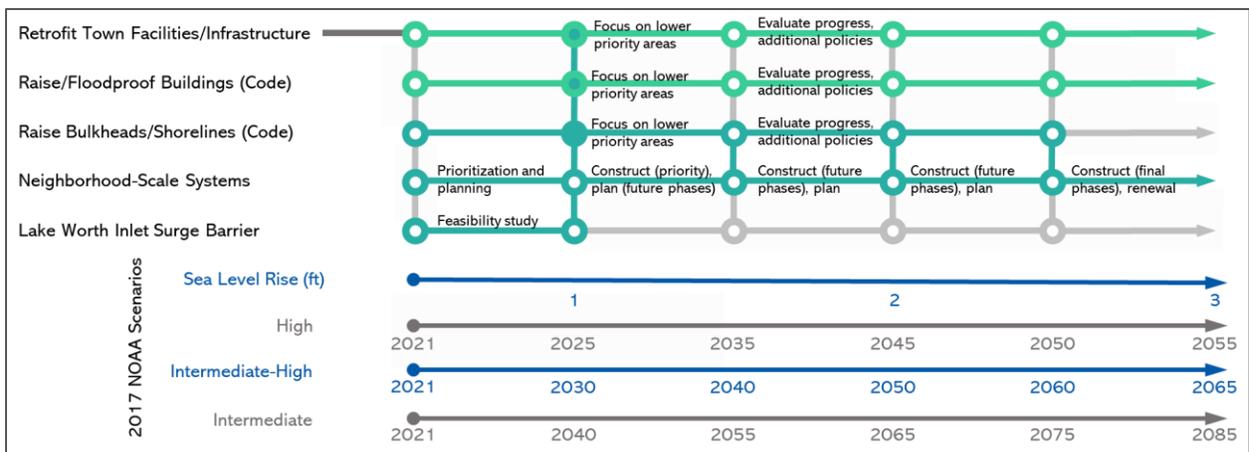
Alternatively, the Town could continue adapting Town assets and requiring higher standards for floodplain development, while lowering the Design Flood Elevation (DFE) for bulkheads and seawalls only to mitigate future annual high tides and smaller storms (**Figure 21**). As discussed elsewhere in this report, the surge barrier would remain open during normal weather, so low-lying areas of Palm Beach would remain vulnerable to sea level rise and coastal flooding during high tides and minor storms. The Town would need to continue monitoring the effectiveness of Town asset mitigation efforts and floodplain development standards, and, if adaptation rates are low, consider additional policies needed to affect more rapid improvement of assets. The incentive for pursuing this pathway would be to limit the height of bulkhead/shoreline raising, affording the community a closer vertical connection to the waters of Lake Worth.



**Figure 21 Post-2030 Adaptation Pathway – surge barrier, high tide protection, and buildings/facilities adaptation.**

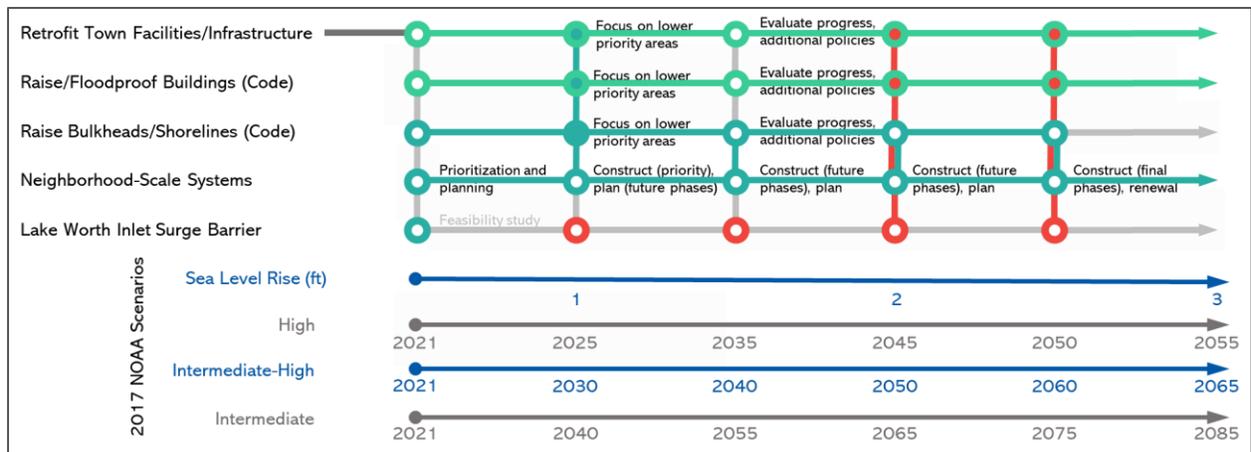
**6.2.5 Post-2030 Scenarios – No Surge Barrier**

If, in its CSRSM Feasibility Study findings, the USACE does not recommend a Lake Worth Inlet surge barrier (**Figure 22**), or advocacy efforts are not successful to obtain such a study (**Figure 23**), by 2030 the Town should transition its efforts towards implementing neighborhood-scale coastal flood control systems as the primary line of defense. These systems would likely need to be implemented in phases over multiple decades based on prioritization criteria established by the Town. Because of this phased implementation, the Town could modify how it prioritizes Town assets for adaptation, and regulates and enforces higher standards for floodplain development and bulkheads/shorelines. Absent a surge barrier, renewed community focus can be directed toward raising adaptation rates in geographic areas that are lower-priority and later-phased in the program for neighborhood-scale flood control systems. Bulkhead/shoreline elevation should continue alongside the development of neighborhood-scale systems until such time that all are adapted. As in the other scenarios, the Town should monitor adaptation rates and consider additional policies as needed. The Town would have a strong incentive to advance this strategy, particularly if actual adaptation rates for improving Town assets, private buildings, and/or private bulkheads/shorelines are not effective enough to effect meaningful change.



**Figure 22 Post-2030 Adaptation Pathway – surge barrier not recommended, neighborhood-scale systems, building/facilities adaptation.**

If a CSRSM Feasibility Study is not authorized, funded, or otherwise carried out with non-Federal funding and management, the implementation pathway is largely the same as that described above, except the option would remain open to continue to advocate for or independently carry out the feasibility study in the decades following 2030 (**Figure 23**). If, in a future time horizon, the feasibility study is carried out and a surge barrier is constructed, the Town could discontinue adapting Town assets and requiring higher standards for floodplain development, given that a second line of defense (neighborhood-scale flood control systems, in this scenario) will have been advanced and continued.



**Figure 23 Post-2030 Adaptation Pathway – no feasibility study, neighborhood-scale systems, building/facilities adaptation.**

### 6.3 Monitoring

To inform adaptive management decisions, the Town would need to monitor conditions and periodically assess whether certain thresholds are reached for a change in actions to be considered. A full stocktaking is recommended every 10 years, with an interim status reports every 2 years. The following metrics are recommended for monitoring:

- Observed sea level rise.** Annual mean sea level (MSL), mean higher high water (MHHW), and maximum water level should be monitored based on tide gauge measurements and compared with baseline and projected values. The Town could use publicly available data from the Lake Worth Pier NOAA Tide Gauge (#8722670). However, it is recommended that the Town consider installing several lower-cost tide gauges along the Lake Worth shoreline to better account for local conditions<sup>85</sup>. Depending on whether observed sea level rise is on track, higher, or lower than projected in the State-standard 2017 NOAA Intermediate-High scenario, design flood elevation (DFE) standards set in the Code of Ordinances may need to be updated (**Table 26**).
- FEMA base flood elevations (BFEs).** FEMA updates its Flood Insurance Rate Maps (FIRMs) and BFEs occasionally to account for observed water level data. Although FEMA has no current mandate to consider sea level rise, a future FEMA restudy should at least account for observed sea level rise at the time of the FIRM updates. The Town will be aware of changes to FIRMs and BFEs as they happen. Depending on whether FEMA increases its BFEs to account for observed sea level rise, or not, DFE standards may also need to be

<sup>85</sup> The tide gauge data could also strengthen the Town’s administration of maintenance and certification standards recommended in Level-Up Lake Worth Shoreline, which require private remedial actions when water levels exceeds the tops of existing shoreline structures and flows to abutting properties and public rights-of-way. This data would supplement on-the-ground observations and reports.

updated (Table 26) to ensure recommendations herein are not redundant with future FEMA BFE revisions.

**Table 26 Triggers and thresholds for adapting Design Flood Elevations (DFEs).**

2030 Observed Sea Level Rise <sup>86</sup>	2030 FEMA Base Flood Elevations (BFEs)	2030 Adaptive Responses
Intermediate-High sea level rise: <ul style="list-style-type: none"> <li>MSL = 0.0 ft NAVD88 +/- 0.3 ft</li> <li>MHHW = 1.5 ft NAVD88 +/- 0.3 ft</li> <li>Maximum Water Level = 3.2 ft NAVD88 +/- 0.3 ft</li> </ul>	FEMA raises BFEs by + 1 ft	Maintain existing DFE formulas
	FEMA does not raise BFEs	Consider increasing DFEs by +1 ft
Intermediate sea level rise: <ul style="list-style-type: none"> <li>MSL &lt; -0.7 ft NAVD88</li> <li>MHHW &lt; 1.2 ft NAVD88</li> <li>Maximum Water Level &lt; 2.9 ft NAVD88</li> </ul>	FEMA raises BFEs by + 1 ft	Consider lowering DFEs by -1 ft
	FEMA does not raise BFEs	Maintain existing DFE formulas
High sea level rise: <ul style="list-style-type: none"> <li>MSL &gt; 0.3 ft NAVD88</li> <li>MHHW &gt; 1.8 ft NAVD88</li> <li>Maximum Water Level &gt; 3.5 ft NAVD88</li> </ul>	FEMA raises BFEs by + 1 ft	Consider increasing DFEs by +1 ft
	FEMA does not raise BFEs	Consider increasing DFEs by +2 ft

- Coastal flooding disasters.** Extreme events such as tropical storms, hurricanes, and extratropical storms, combined with sea level rise, are likely at some point to cause significant local damages, trigger local regulations under which private property owners must adapt their assets, and create significant funding opportunities for local coastal flood mitigation improvements. The Town should continue to monitor Federal disaster declarations and State and Federal legislation regarding disaster and hazard mitigation aid.
- Percent of Town-owned facilities, private buildings, and Lake Worth shoreline adapted.** The Town should monitor the efficacy of the higher standards recommended by *Level-Up Town Facilities and Infrastructure*, *Floodplain Development*, and *Lake Worth Shoreline* toward actually hastening adaptation of assets to higher future flood levels. Depending on whether facilities, shorelines, and/or buildings are rapidly or slowly adapted, the stringency of recommended standards (e.g., substantial improvement/damage thresholds) may need to be adjusted. Low rates of adaptation may raise the urgency of public-led interventions, like neighborhood-scale systems, or warrant consideration of

<sup>86</sup> Scenarios are based on 2017 NOAA projections. Metrics are annual, as measured at Lake Worth Pier NOAA Tide Gauge #8722670.

additional policies and incentives for private property owners. High rates may lessen the need for more intensive public-led interventions. It may also be useful to monitor these metrics geographically, for example based on the neighborhood-scale flood control units in *Level-Up Lake Worth Shoreline*.

- **Coastal Storm Risk Management (CSRM) Feasibility Study.** A surge barrier would have meaningful influence on overall long-term planning. The status, findings, and recommendations of the suggested CSRM Feasibility Study, involving the U.S. Army Corps, could have significant cascading effects on how other *Level-Up* strategies are implemented going forward. Metrics should include whether or not a feasibility study has been authorized/funded/completed, whether it recommends a storm surge barrier (or neighborhood-scale coastal flood control systems) to Congress for funding and implementation, and when construction is scheduled for completion.
- **Neighborhood-scale coastal flood control systems.** The Town should monitor the progress of prioritization and planning for neighborhood-scale systems. The extent to which prioritization criteria have been adopted, areas prioritized, and priority projects planned (i.e., stakeholder engagement conducted, designed, funding identified, permitted) will inform how the Town modifies other strategies, should construction be advanced.