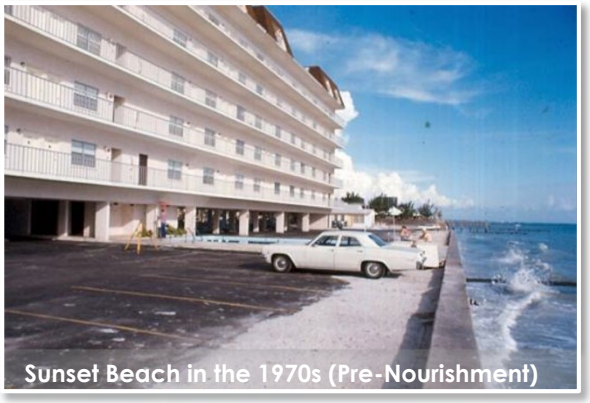
US Army Corps of Engineers ®
Jacksonville District

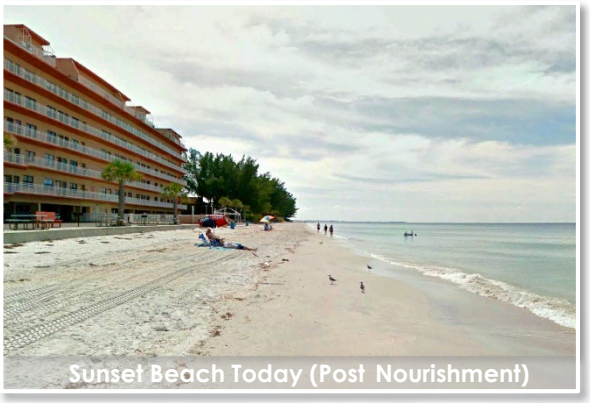
# PINELLAS COUNTY, FLORIDA
## COASTAL STORM RISK MANAGEMENT STUDY

### TREASURE ISLAND AND LONG KEY SEGMENTS

**Draft Integrated Feasibility Report and Environmental Assessment**

## APPENDIX B: ECONOMIC ANALYSIS


Sunset Beach in the 1970s (Pre-Nourishment)


Sunset Beach Today (Post Nourishment)

**August 2020**

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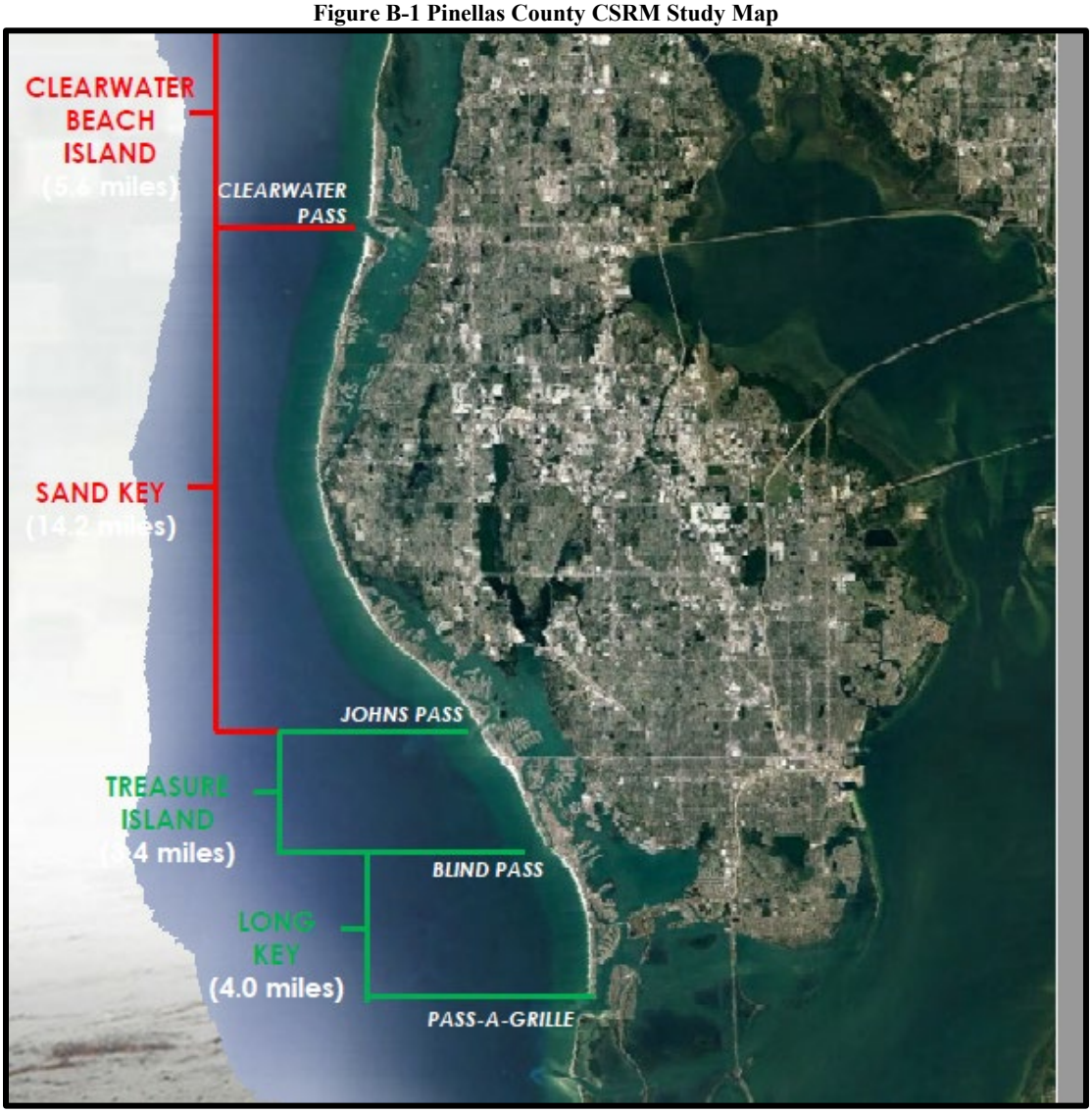
# 1 Introduction

This single purpose Coastal Storm Risk Management (CSRM) study will focus on the erosion problems and potential storm damage susceptibility of structures along two barrier islands, Treasure Island and Long Key, fronting the Gulf of Mexico in Pinellas County, Florida. This study was funded by the

Bipartisan Budget Act of 2018, Public Law 115-123 and the non-federal sponsor is Pinellas County, Florida.

As described in the main report, though the study authority allows the Corps of Engineers to study the entire Pinellas County shoreline, significant portions of the shoreline have not been included in the quantitative analysis due to either existing construction authority (Sand Key) or lack of Federal Interest. This document therefore focuses entirely on the two areas that were included in the quantitative analysis: Treasure Island and Long Key. For reference, Figure B-1 shows the full Pinellas County shoreline the different areas delineated.

**Figure B-1 Pinellas County CSRM Study Map**




## 1.1 Purpose of Report

The Pinellas County CSRM feasibility study is intended to investigate and evaluate the feasibility of implementing a Federal coastal storm risk management project over a 50 year period of analysis in the noted portions of the Pinellas County shoreline (Treasure Island and Long Key). The main feasibility report tells the overall story of the study and synthetizes information from engineering, plan formulation,

economics, environmental, and other disciplines. The purpose of this appendix is to tell the story of the economics investigation and resulting analysis, in the context of the larger feasibility study. The economic analysis described in this appendix was developed in accordance with ER-1105-2-100, using the Corps certified planning model for CSRM studies: Beach-fx. A detailed explanation of the qualitative rigor and the precise modeling efforts, from inputs to outputs, which gave rise to the recommended plan will be provided. The subsequent sections will cover the following topics:

- **Existing Conditions:** Items discussed include an assessment of socio-economic conditions, spatial organization of the study area, and an inventory of the coastal infrastructure within the study area.
- **Future Without-project Condition (FWOP):** The FWOP is a forecast of the economic conditions and structure values located within the project area that are subject to the risks associated with coastal processes and coastal storms. The FWOP is the basis for alternative comparison in order to obtain the benefits from any potential federal project.
- **Coastal Storm Risk Management (CSRM) Benefits:** This section will cover the methods and assumptions used to estimate the future without-project and future with-project condition using Beach-fx, while also accounting for risk and uncertainty. The FWOP will cover the distribution of the damages in the following dimensions:
    - Spatial (Where)
    - Categorization of structures (What)
    - Damage driving parameter (How)
    - Temporal (When)

Discussion of the future-with project condition (FWP) will address the management measures and alternative plans evaluated. In addition, a sensitivity analysis of how the alternatives perform under varying sea level change scenarios is provided.

**NED & Recommended Plan Selection and Performance:** This section addresses the quantitative analysis executed to determine which alternative maximizes NED and which alternative will be the recommended plan. A detailed description of the performance of the NED plan, including certified cost estimates, is provided with the same four dimensions described above in the CSRM section. The methodology underpinning the calculation of additional benefits provided by the project (i.e. land loss benefits, incidental recreation benefits) will be summarized as well.

## 1.2 Design of Document

Section 1 of this appendix provides an introduction, Section 2 provides a detailed description of the existing condition and overall modeling approach; Section 3 provides detailed summary of the future without project condition including information about the spatial and temporal distribution of estimated damages. Section 3 also provides a summary of the sea level change (SLC) analysis. Section 4 describes the future with project (FWP) condition as simulated in Beach-fx, as well as information about alternative comparison and evaluation. Section 5 describes the Recommended Plan in more detail, including benefits, refined costs, a benefit-cost ratio (BCR), net benefits, and information about project performance in the SLC scenarios. Section 5 also includes a brief conclusion.

# 2 Existing Conditions

This section of the appendix includes detailed information about the existing conditions in the study area, including socioeconomic conditions and the inventory of property potentially subject to storm damage. It

also includes information about the economic evaluation approach and how that approach utilizes existing data.

## 2.1 Study Area

As described in the main report, the study area includes 7.4 miles of Pinellas County shoreline between Florida Department of Environmental Protection (FDEP) range monuments (R) R-126 to R-166. R-monuments refer to Florida Department of Environmental Protection (FDEP) survey monuments used for geographic reference. The study area includes the following two barrier islands:

- Treasure Island: R-126 to R-143 (3.4 miles)
- Long Key: R-144 to R-166 (4.0 miles)

For planning purposes, these two islands are divided into seven reaches. Three are on Treasure Island: Sunshine Beach, Boca Ciega, and Sunset Beach. Four are on Long Key: Upham Beach, St Pete Beach North, St Pete Beach South, and Pass-a-Grille Beach. The planning reaches are delineated based on physical characteristics, socioeconomic characteristics, and construction history. It should be noted that background erosion rates vary considerably across the study area. Sunshine, Sunset, Upham, and Pass-a-Grille beaches are highly erosional, while the other study reaches are either stable or accretional. As a result of this variability, the erosional beaches have a Federal project construction history based on the existing Pinellas County authorities (set to expire).

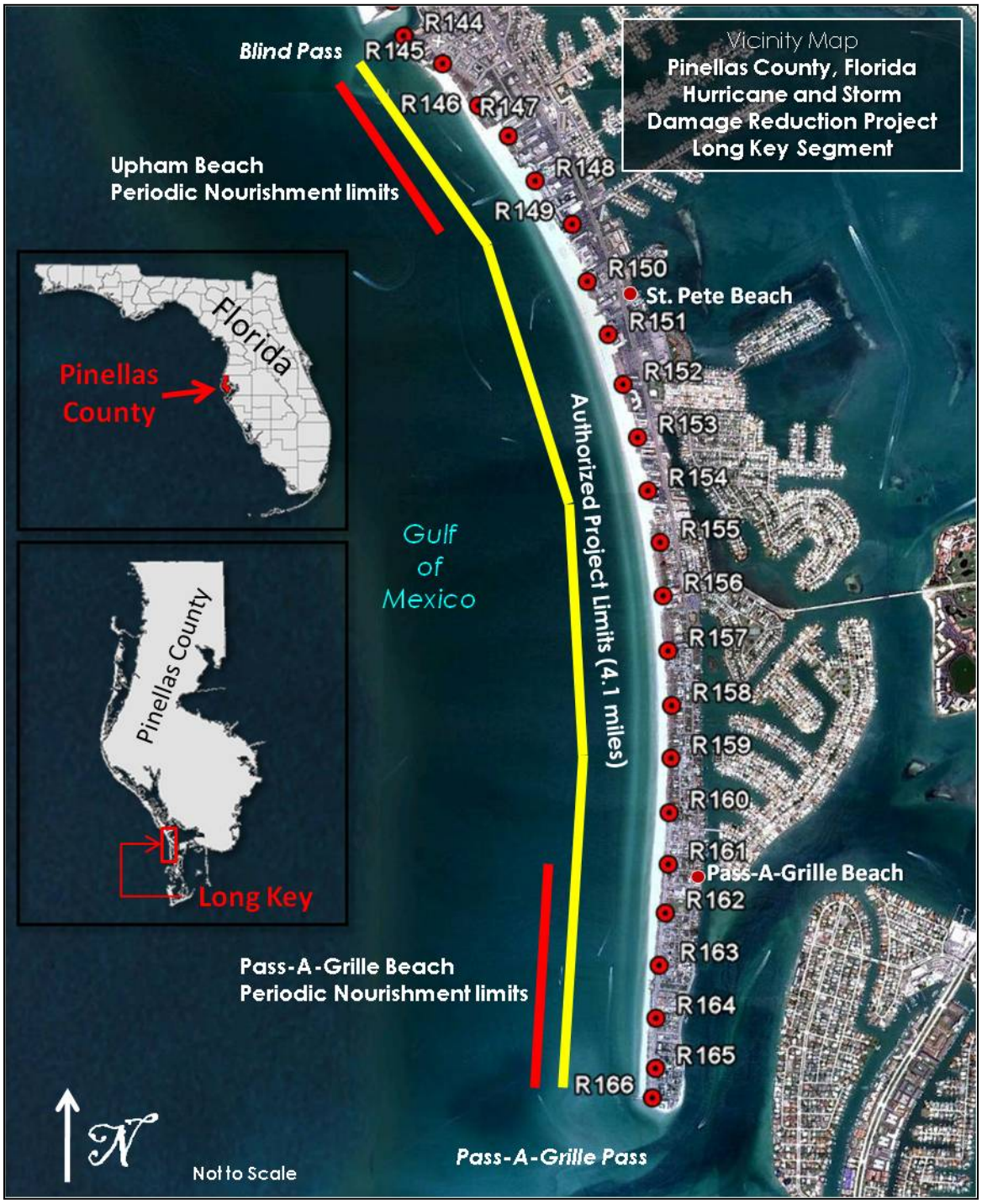
The boundaries of the Planning Reaches and the Florida Department of Environmental Protection (FDEP) R monuments are illustrated on Figure B-2. More detail about Treasure Island and Long Key, including the Florida Department of Environmental Protection (FDEP) R monuments, are illustrated in Figures B-3 and B-4, respectively. The existing Federal Beach Erosion Control (BEC) project limits are also shown on Figures B-3 and B-4 for reference. It should be noted however that the purpose of this report is to evaluate the feasibility of a new Federal project over a new 50 year period of analysis. The existing project is relevant in terms of understanding the history of the shoreline and the existing conditions. But, it is not relevant in terms of evaluating future alternatives

**Figure B-2 Pinellas County CSRM Study, Planning Reaches**

SAND KEY
JOHNS PASS
1 Sunshine Beach
TREASURE ISLAND
2 Boca Ciega
3 Sunset Beach
BLIND PASS
4 Upham Beach
5 St. Pete Beach North
LONG KEY
6 St. Pete Beach South
7 Pass-a-Grille Beach
PASS-A-GRILLE
PLANNING REACHES
1 Sunshine Beach
2 Boca Ciega
3 Sunset Beach
4 Upham Beach
5 St. Pete Beach North
6 St. Pete Beach South
7 Pass-a-Grille Beach

**Figure B-3 Treasure Island Map with FDEP R-monuments and existing project (for reference)**

**Figure B-4 Long Key Map with FDEP R-monuments and existing project (for reference)**




## 2.2 Socioeconomic Characteristics of Study Area

The study area falls within three Pinellas County census tracts (CTs). All Treasure Island reaches are contained within CT 279.01. Long Key reaches fall within CT 280.03 towards the northern end of the island and CT 280.02 towards the southern.

**Figure B-5 Study Area Census Tract Boundaries**

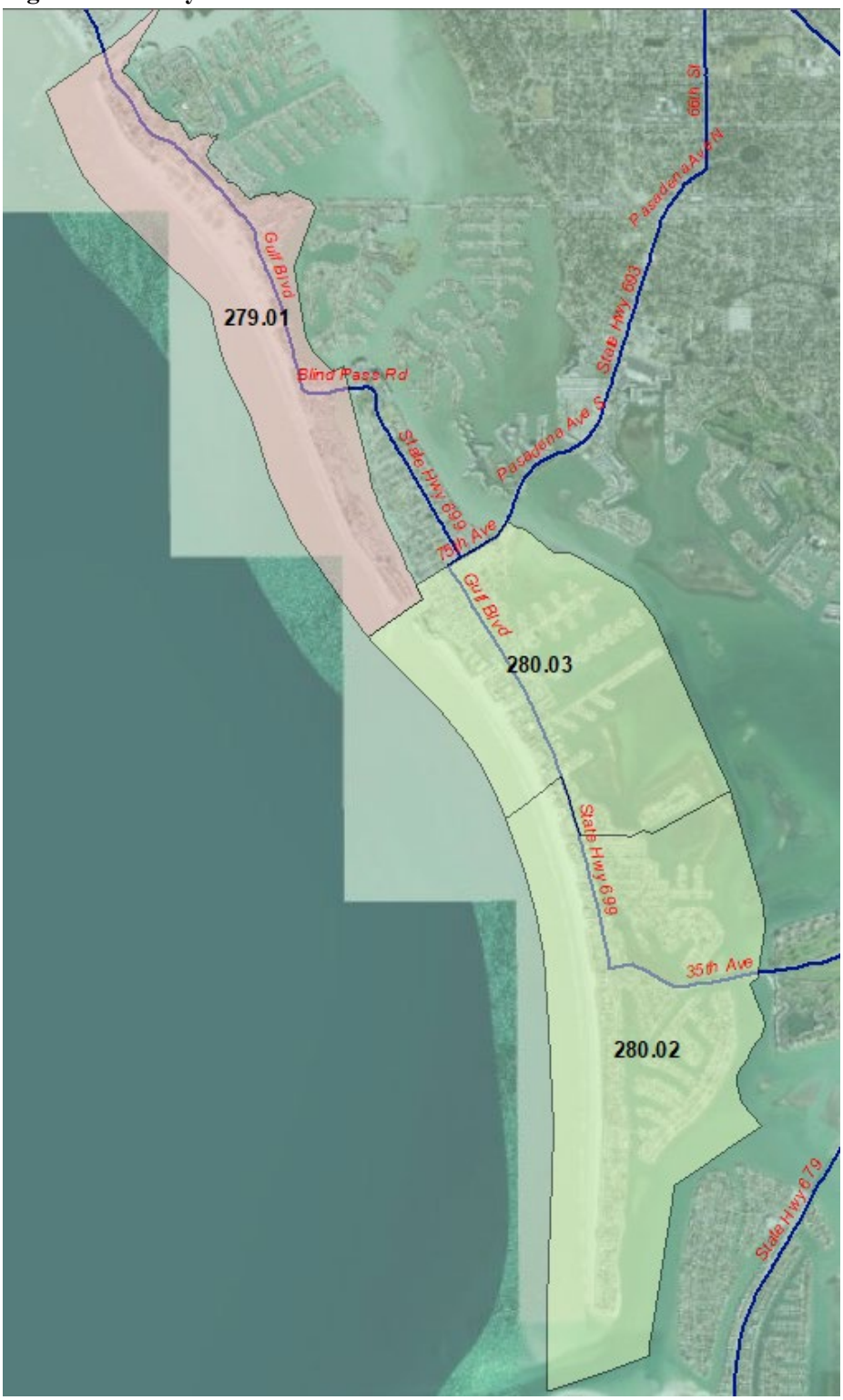


**Table B-1. Study Area 2018 Population and Household Data (2018 inflation-adjusted dollars)**

| | Census Tract 279.01 | Census Tract 280.02 | Census Tract 280.03 | Study Area |
|---|---|---|---|---|
| Residential Population | 2,358 | 3,954 | 3,375 | 9,687 |
| Households | 1,259 | 1,987 | 1,849 | 5,095 |
| Median HH Income | $72,725 | $97,278 | $59,414 | - |
| Mean HH Income | $102,818 | $126,702 | $89,568 | - |

The 2018 residential population for the study area amounted to 9,687 people spread between 5,095 households.

## 2.3 Beach-fx Economic Modeling Approach

Beach-fx was developed by the USACE Engineering Research and Development Center in Vicksburg, Mississippi. On April 1, 2009 the Model Certification Headquarters Panel certified the Beach-fx CSRM model based on recommendations from the Planning Center of Expertise (PCX) and in accordance with EC 1105-2-412 (Assuring Quality of Planning Models). The model was reviewed by the PCX for Coastal and Storm Damage and found to be appropriate for use in CSRM studies and is therefore the optimum model for use in the Pinellas County CSRM Study. The model links the predictive capability of coastal evolution modeling with project area infrastructure information, structure and content damage functions, and economic valuations to estimate the costs and total damages under various shore protection alternatives. The output generated from the model is then used to determine the benefits of each alternative. As an event-based Monte Carlo life-cycle simulation, Beach-fx fully incorporates risk and uncertainty. It is used to simulate future hurricane and storm damages at existing and future years and to compute accumulated present-worth damages and costs. Storm damage is defined as the ongoing monetary loss to contents and structures incurred as a direct result of waves, erosion, and inundation caused by a storm of a given magnitude and probability. The model also computes permanent shoreline reductions so that land-loss benefits can be derived exogenously. These damages and associated costs are calculated over a 50-year period of analysis based on storm probabilities, tidal cycle, tidal phase, beach morphology and many other factors. Beach-fx also provides the capability to estimate the costs of certain future measures undertaken by state and local organizations to protect coastal assets. Based on these attributes, Beach-fx is an ideal modeling tool for use in the Pinellas CSRM study.

Of course, the abovementioned computations require inputs from USACE personnel in order to function accurately. Data on historic storms, beach survey profiles, and private, commercial and public structures within the project area are used as these inputs. Refer to sections Error! Reference source not found. and Error! Reference source not found. for detailed information on key input data specific to Pinellas County.

The future structure inventory and values are the same as the existing condition. This conservative approach neglects any increase in value accrued from future development. Though Florida has historically experienced increases in density and value in real-dollar terms, using the existing inventory is considered preferable due to the uncertainty involved in projections of future development.

The FWOP damages are used as the base condition and potential project alternatives are measured against this base. The difference between FWOP and FWP damages will be used to determine primary CSRM benefits.

Once benefits for each of the project alternatives are calculated, they will be compared to the costs of implementing the alternative. Dividing the total benefits by the total costs of the alternative yields a benefit-to-cost ratio (BCR). This ratio must be greater than 1.0 (i.e. the benefits must be greater than the costs) in order for the alternative to be justified and implementable. The federally preferred plan, or NED,

is the plan that maximizes net benefits. Net benefits are determined by simply subtracting the cost of any given alternative from the benefits of that alternative ($Benefits - Costs = Net\ Benefits$).

The Pinellas County Beach-fx model has been developed in close collaboration with the SAJ Engineering Division. All coastal morphology inputs were developed by the SAJ engineering team (see engineering Appendix). This model has been built in accordance with the Beach-fx User's Manul; the manual is referenced throughout this document.

### 2.3.1 Model Reaches

The broadest spatial category of socioeconomic inputs into Beach-*fx* is the model reach. There are 40 total reaches in the model (18 and 22 in the respective Treasure Island and Long Key reach subsets), varying in length (parallel to the shoreline) from about 160 feet to about 1,991 feet. They vary in width (perpendicular to the shoreline) from about 2,340 to about 950 feet. The reach is a particularly important designation because Beach-fx outputs (damages) are reported by reach. The reaches give the results a spatial distribution. In this study, the reach numbers increase in a southern direction. The most northerly reach is R-126, the most southerly reach is R-165. The extents of the study (both northerly and southerly) are based on the existing authorized project. Also, the reach nomenclature has been retained from the engineering analysis, based in part of the FDEP R-monuments. It should be noted that the positioning of the monument within each reach and the length of each reach are variable. More information about the reaches is provided in the Engineering Appendix.

It should also be noted that many coastal studies have an even broader category, called "study reaches". These are general areas that have similar geomorphic and/or socioeconomic characteristics. For planning purposes study reaches can be considered separable elements. Also, study reaches can be fairly large. They may include many Beach-fx model reaches, thus the nomenclature can be somewhat confusing. Pinellas County study reaches are displayed in **Figures B-6 and B-7.**

**Figure B-6 Treasure Island Map with Beach-fx model reaches**

**Figure B-7 Long Key Map with Beach-fx model reaches**

### 2.3.2 Beach-fx Lots

Lots are simply an organizational container in the system for Damage Elements. A lot can be the entire size of the Reach or the size of an actual plot of land in the study area. They are built into the model as quadrilaterals encapsulated within model reaches and are used to transfer the effect of coastal morphology changes to the damage element. Lots are also the repositories for coastal armor costs, specifications, and failure threshold information. Within Beach-fx, armor is defined at the lot level.

### 2.3.3 Damage Elements

A Damage Element (DE) represents any structure where damages can be incurred. This could be a house, commercial property, deck, pool, walkover structure, etc. Damage Elements are members of a specified lot and are defined by a single, representative central point (X, Y coordinates).

Beach-*fx* handles economic considerations at the DE level. These considerations include extent of damage, cost to rebuild, and time to rebuild. Beach-*fx* uses pre-defined damage functions to calculate the extent of damage. For each damage element, the following information is input into Beach-fx:

- Geographical reference (northing and easting of center point)
- Alongshore length and cross-shore width
- Usage (e.g., single family, multi-family, commercial, walkover, pool, gazebo, tennis court, parking lot)
- Number of floors
- Construction type (e.g., wood frame, concrete, masonry)
- Foundation type (e.g., shallow piles, deep piles, slab)
- Armor type (e.g., seawall)
- Ground and/or first floor elevation
- Value of structure (replacement cost less depreciation)
- Value of contents

The geospatial location and footprint of the damage elements was verified using aerial photography in ArcMap. An uncertainty range of +/- 12.5% was assigned to these costs based on the real estate assessment, which concluded that 12.5% represents a reasonable range of uncertainty around the depreciated replacement values. The value of contents was assumed to be 50% of the structure value. Non-habitable structures (dune walks, etc...) had zero contents value. An aerial view of two example model reaches (R-157 and R-158), with all lots and damage elements displayed, is shown in **Figure B-8**.

**Figure B-8 Aerial view of R-157 in Long Key with all lots and damage elements identified**

## 2.4 Existing Condition Coastal Inventory

Information on the existing economic conditions along the Pinellas County coastline was collected for economic modeling purposes. The information on the coastal assets detailed in this section was collected from Pinellas County mapping resources, site visits, and contractors. Each parcel along the beach was identified as developed or undeveloped, with streets and parks noted.

The Beach-fx structure inventory was developed using Pinellas County property appraiser data, LIDAR ground elevation data, aerial imagery, and photographs/notes from site visits. The property appraiser data included information about each individual parcel in both Treasure Island and Long Key, which were then verified or modified based on pictures and site visit notes. The noted characteristics (usage, foundation type, construction type, number of floors etc.) were identified using this method, which were then used to assign the occupancy type and damage functions.

Estimation of flood damage using depth-damage relationships requires specification of the first floor elevation of floodplain structures. In this case, ground elevations were derived from 2015 LIDAR data.

Aerial photography was superimposed over a GIS shape file layer for the purpose of identifying the location and ground elevations of structures. Visual inspection (via site visit and supplemented with GoogleEarth Street View) was used to determine the foundation height above ground. The error implicit in using the LIDAR data to estimate the ground elevation of each of the structures is normally distributed with a mean of zero and a standard deviation of 0.5 feet. The standard deviation of 0.5 feet was used to represent the uncertainty surrounding the first floor elevation of the structures. These first floor elevations were compared with Florida's structure first floor elevation certificate database as available for a reasonableness test, which generated like results as available.

A summary of the coastal inventory is provided in **Table B-2**.

**Table B-2. Summary of Coastal Inventory**

| Damage Element Types | Treasure Island | Long Key | Total | % of Total |
|---|---|---|---|---|
| COM1 | 2 | 3 | 5 | 0.38% |
| COM8 | 7 | 13 | 20 | 1.53% |
| COM-HT-HR | 0 | 3 | 3 | 0.23% |
| COM-HT-MS | 60 | 31 | 91 | 6.97% |
| COM-SS | 17 | 12 | 29 | 2.22% |
| GROC | 1 | 1 | 2 | 0.15% |
| MFR1 | 110 | 260 | 370 | 28.33% |
| MFR2 | 52 | 25 | 77 | 5.90% |
| MFR3 | 154 | 170 | 324 | 24.81% |
| PUB-SS | 0 | 5 | 5 | 0.38% |
| ROAD | 72 | 75 | 147 | 11.26% |
| SFR1 | 43 | 27 | 70 | 5.36% |
| SFR2 | 62 | 21 | 83 | 6.36% |
| WALK | 27 | 53 | 80 | 6.13% |
| **Total** | **607** | **699** | **1306** | **100.00%** |

As shown in Table 1, the most common structure type across the study area are multi-family residential properties (one story, three story, and to a lesser extent two stories). The second most common type is roads; there a numerous road segments throughout the study area. Single family residences, dune walks, and high rise condominiums are also fairly common. All of the other categories are fairly sparse, with only a few structures at particular locations.

### 2.4.1 Structure & Contents Value

The economic value of the existing Treasure Island Segment structure inventory represents the depreciated replacement costs of damageable structures (i.e. damage elements) and their associated contents along the coastline. Real Estate professionals from the USACE SAJ district worked together with economists and planners to provide economic valuations for all of the 607 damageable structures and their contents. These

damage elements have an overall estimated value of $984.6M, with structure and content valuations of $672M and $312M respectively. Content values were established as a ratio to overall structure value. When applicable, content-to-structure ratios were based off the Institute for Water Resource (IWR) Report "Nonresidential Flood Depth-Damage Functions Derived from Expert Elicitation" (2013) for non-residential structures and a standard 50% for single-family residential structures.

For the purposes of USACE coastal storm risk reduction analysis, a structure's value is measured by its estimated depreciated replacement cost (replacement cost less depreciation). A structure's replacement cost is the cost of materially repairing/reconstructing that structure to its pre-damage event state. Structure depreciation accounts for variation in a structure's remaining useful life and deterioration that occurred prior to modelled damage events. Structure values are extracted from Pinellas County's property tax records to reflect most-current publicly-listed (as of September 2019) depreciated replacement value estimates. In Pinellas County, appraisers may reconcile any or all of three real estate value indication approaches (sales comparison, replacement cost, and income) into a final value based on the appropriateness, accuracy, and quantity of market information. The resulting reconciled value is known as the Just/Market value. The State of Florida requires that county real estate appraisals be within plus or minus (+/-) ten percent of Just/Market values for respective property classes. As replacement value constitutes a discontinuous sub-element of local appraisal methodology, an additional 2.5 percent (totaling [+/-] 12.5 percent) is added to this range of error and applied to the publicly-listed depreciated replacement values of each structure in the inventory. This triangular distribution, [+/-] 12.5 percent, is consistent with several other CSRM projects in Florida that have been approved in recent years, including the St. Lucie County Feasibility Study and the Lee County Gasparilla 934 Report.

The overall distribution of value by model reach is summarized in **Table B-3 and Table B-4**.

**Table B-3: Distribution of Structures & Structure Value by Model Reach: Treasure Island**

| Model Reach | Structure Value (FY20) | Content Value (FY20) | Total Value (FY20) | % Total Value |
|---|---|---|---|---|
| **R126** | $4,359,464 | $1,934,556 | $6,294,020 | 0.60% |
| **R127** | $67,831,361 | $33,437,462 | $101,268,823 | 10.30% |
| **R128** | $53,661,218 | $26,459,980 | $80,121,198 | 8.10% |
| **R129** | $4,997,857 | $2,265,376 | $7,263,233 | 0.70% |
| **R130** | $31,348,311 | $14,975,611 | $46,323,922 | 4.70% |
| **R131** | $42,241,927 | $15,865,252 | $58,107,179 | 5.90% |
| **R132** | $41,725,766 | $19,846,162 | $61,571,928 | 6.30% |
| **R133** | $51,240,828 | $24,827,646 | $76,068,474 | 7.70% |
| **R134** | $25,664,826 | $12,350,683 | $38,015,509 | 3.90% |
| **R135** | $34,021,514 | $16,725,275 | $50,746,789 | 5.20% |
| **R136** | $28,214,246 | $13,817,445 | $42,031,691 | 4.30% |
| **R137** | $8,010,223 | $3,655,411 | $11,665,634 | 1.20% |
| **R138** | $34,111,182 | $16,743,836 | $50,855,018 | 5.20% |
| **R139** | $32,361,511 | $16,092,087 | $48,453,598 | 4.90% |

| | | | | |
|---|---|---|---|---|
| **R140** | $32,590,680 | $15,871,436 | $48,462,116 | 4.90% |
| **R141** | $81,397,495 | $28,450,170 | $109,847,665 | 11.20% |
| **R142** | $61,185,457 | $30,276,368 | $91,461,825 | 9.30% |
| **R143** | $37,432,874 | $18,591,557 | $56,024,431 | 5.70% |
| **TOTAL** | $672,396,740 | $312,186,309 | $984,583,049 | 100.00% |

**Table B-4: Distribution of Structures & Structure Value by Model Reach: Long Key**

| Model Reach | Structure Value (FY20) | Contents Value (FY20) | Total Value | % of Total Value |
|---|---|---|---|---|
| **R144A** | $99,698,343 | $32,958,517 | $132,656,860 | 7.62% |
| **R144B** | $26,627,014 | $9,719,402 | $36,346,416 | 2.09% |
| **R144C** | $13,291,626 | $6,577,121 | $19,868,747 | 1.14% |
| **R145** | $47,916,659 | $23,625,076 | $71,541,734 | 4.11% |
| **R146** | $182,441,340 | $91,220,620 | $273,661,960 | 15.72% |
| **R147** | $38,698,475 | $17,879,767 | $56,578,242 | 3.25% |
| **R148** | $9,458,412 | $3,929,922 | $13,388,334 | 0.77% |
| **R149** | $215,567,905 | $105,778,672 | $321,346,577 | 18.46% |
| **R150** | $44,418,070 | $18,048,988 | $62,467,058 | 3.59% |
| **R151** | $113,928,397 | $55,383,259 | $169,311,655 | 9.73% |
| **R153** | $110,647,176 | $44,913,393 | $155,560,568 | 8.94% |
| **R155** | $35,308,303 | $17,146,887 | $52,455,189 | 3.01% |
| **R156** | $63,589,910 | $31,025,106 | $94,615,016 | 5.44% |
| **R157** | $56,069,586 | $27,674,274 | $83,743,859 | 4.81% |
| **R158** | $21,266,237 | $10,419,345 | $31,685,581 | 1.82% |
| **R159** | $30,737,438 | $15,321,970 | $46,059,407 | 2.65% |
| **R160** | $5,243,784 | $2,397,750 | $7,641,534 | 0.44% |
| **R161** | $10,763,320 | $5,047,511 | $15,810,830 | 0.91% |
| **R162** | $6,705,216 | $3,001,650 | $9,706,866 | 0.56% |
| **R163** | $10,858,727 | $4,934,531 | $15,793,258 | 0.91% |
| **R164** | $17,187,523 | $8,593,330 | $25,780,852 | 1.48% |
| **R165** | $32,023,851 | $12,533,269 | $44,557,120 | 2.56% |
| **Total** | **$1,192,447,309** | **$548,130,354** | **$1,740,577,662** | **100.00%** |

In Treasure Island, the value of distributed fairly evenly across all the model reaches, with a few exceptions. The lowest value model reaches are R126 and R129, both in the Sunrise Beach study reach. The highest value TI model reach is in R141, which is the Sunset Beach study reach. On Long Key, the highest value model reaches are R146 (Upham Beach) and R149 (St Pete North). Both these high value reaches have large high rise structures. It should be noted that the estimated damages (described in Section 3 of this Appendix) are no necessarily correlated with value. For example, while high rises

typically have enormous value, they are often designed to highly resilient to storm damage. At the other end of the spectrum, dune walks are very low value but tend to be highly vulnerable and so may present a higher proportion of damage than their total value might suggest.

A brief discussion of the different structure types, with a few examples, are provided in the below sections.

### 2.4.2 Multi-family Residential

As shown in Table 1, multi-family residential structures are the most prominent and common in the damage element inventory. Given the relatively large size and density of study area, this category represents both the largest number of structures and the greatest proportion of economic value. There is a considerable variability in the nature of the multi-family structures. They vary in terms of size, foundation type, condition, number of stories, etc. The category includes one story and two story rental properties as well as multi-story condominiums. Some of them are not elevated, but many have little or no damageable value on the first floor (just parking lots or parking garages). These individualized characteristics are captured in the Beach-fx model. A few examples are provided in the below photos.

**Figure B-9. Sunset Beach Dune Condo; landside view**

**Figure B-10. Sunset Villas at 12000 Gulf Boulevard; oceanside view**

### 2.4.3 Single Family Residential (SFR)

Single family residential structures can be found throughout the study area; they represent the second largest category of damage elements. The SFR structures include both one and two story houses at various locations on both Treasure Island and Long Key. A few examples of single family homes in the study area are presented in **Figures 4 and 5.**

### 2.4.4 Commercial Structures

The third largest category is commercial structures, the vast majority of which are high rise hotels. Several hotel/resort complexes throughout the study area. These complexes are generally high value and are not elevated. Example of a commercial property is presented in **Figure 11.**

**Figure B-11. High Rise Hotel on Upham Beach**

### 2.4.5 Roads

Numerous road segments are found throughout the study area, including some that are quite close to the shoreline. The roads are defined as a linear damage element in Beach-fx, and considered only vulnerable to erosion damage (not flood damage or wave attack). Depreciated replacement values for roads were provided by the Florida Department of Transportation (FDOT) based on previous coastal road projects. The costs are defined on a per liner foot basis.

### 2.4.6 Other Structures

Other structures in the damage element inventory include dune walks and public structures. There are only a few public structures, but dune walks represent about 6% of the total number of damage elements (80 in total). Though relatively low value compared to most other structure types (and not possessing any content value), their close proximity to the shoreline make them particularly vulnerable to storm damage. Also, unlike residential or commercial properties, they are unlikely to be to be protected by seawalls or other elements of coastal armor. Therefore, dune walk damage is an important part of the economic story.

### 2.4.7 Armor

Armor costs, specifications, and failure threshold information is defined at the lot level in Beach-fx. Some of the lots in the study area have existing coastal armor, which vary considerably in value, construction type, and construction date. The study area shoreline that is not currently armored has been categorized as either armorable in the future or not armorable (**Figures B12 and B13)**. This categorization is based on the assumed likelihood that armor would or would not be constructed by local interests should property be threatened in the future by coastal processes.

**Figure B-12. Coastal Armor in Northern Treasure Island; adjacent to John's Pass**

**Figure B-13: Upham Beach shorefront on Long Key in April 2012.**

**Figure B-14. Revetment at Southern extent of Long Key**

# 3 Future Without Project Condition (FWOP)

This section of the Appendix documents the future without project condition in detail, including Beach-fx modeling assumptions and results.

## 3.1 Economic Model Assumptions

Beach-fx accuracy is not only dependent upon inputs but also requires a meticulous level of thought be given to the parameters (i.e. assumptions) under which the model is bound. This section describes some key assumptions specific to the Pinellas CSRM study and the resulting consequences.

### 3.2.1 Timeframe and Discount Rate

- **Start Year:** The year in which the simulation begins is 2027. This year determines the starting shoreline position which will be impacted by standard erosion and storm forces throughout the period of analysis. It is also the starting point for the sea level change (SLC) projections.
- **Base Year:** The year in which the benefits of a constructed federal project would be expected to begin accruing is 2028.
- **Period of Analysis:** 50 years, from 2028 to 2077.
- **Discount Rate:** 2.75% FY2020 Federal Water Resources Discount Rate
- **Iterations:** Beach-fx was run using 100 iterations. The moving average of FWOP damages stabilized by this point and was thus determined an adequate number of iterations. Figures 15 and 16 demonstrates the model stabilizing since the moving average does not vary by more than three percent after the 26th iteration in Treasure Island, and the 37$^{th}$ iteration in Long Key.

**Figure B-15: Model Stabilization: Treasure Island**

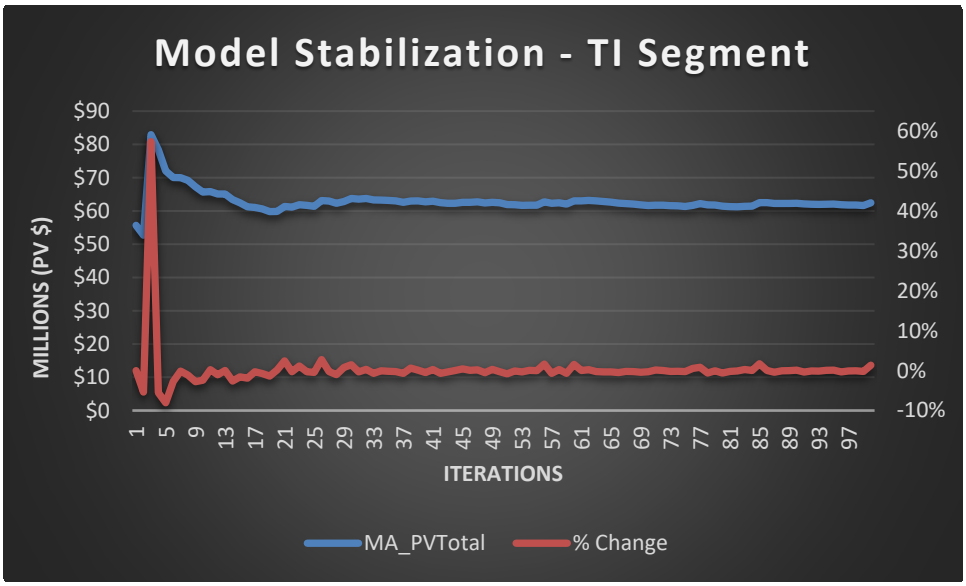
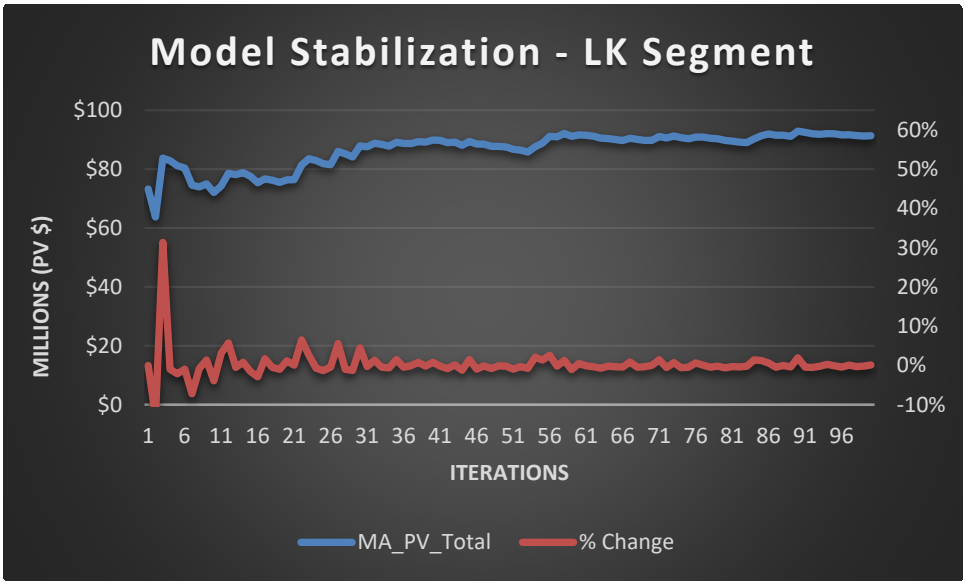



**Figure B-16: Model Stabilization: Long Key**




### 3.2.2 Rebuilding

The rebuilding parameter within Beach-fx allows the economic modelers to restrict the amount of monetary investment allocated to structural repair for any specific building type in order to most accurately reflect real-world behavior. Rebuilding does not refer to a total rebuild event (i.e. 100% of structure value), but rather a repair event (i.e. some non-zero percent of value intended to restore the structure). Allowing for an unlimited amount of rebuilding in the period of analysis may be unrealistic for a CSRM study and can potentially overstate damages in the FWOP. However, issuing emergency permits for rebuilding on lots meeting a minimal setback restriction is generally the rule, not the exception in

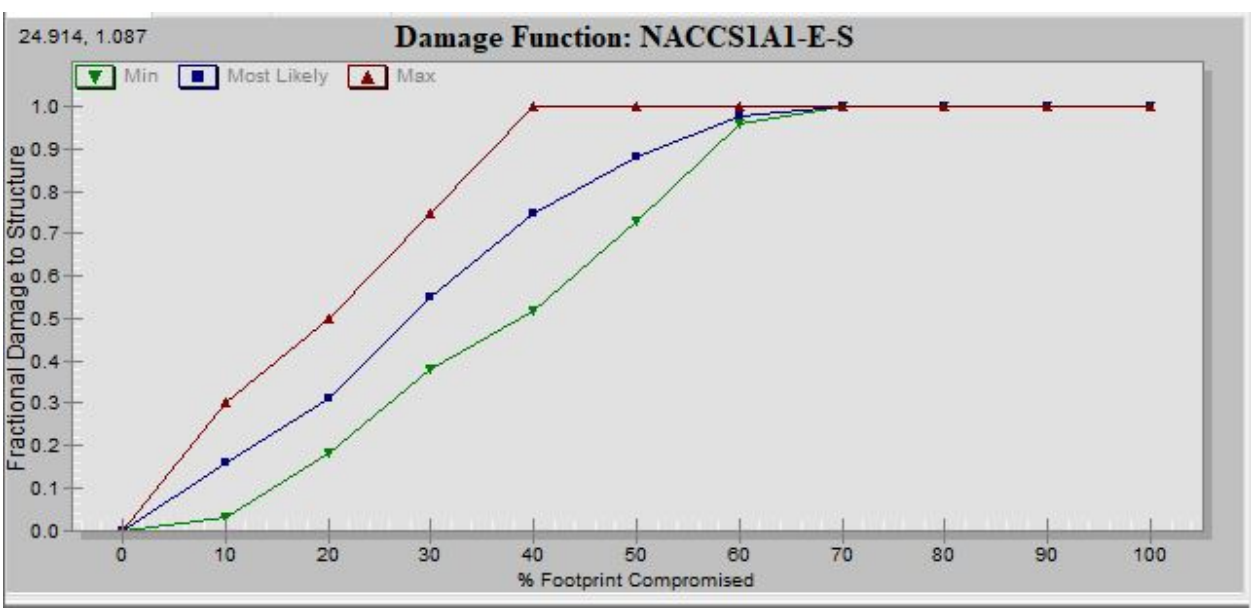
Florida. Common practice and historical evidence also show that rebuilding lost structures, provided setback restrictions are met, occurs frequently[1]. Additionally, county records dating back to 1994 demonstrate that there have been no known rejections to rebuilding requests. As a result, the number of rebuilds within the model has been set to allow for one repair/rebuild event per year for the majority of assets in the inventory.

There is also a control feature that allows an individual damage element to become condemned once 50% of the original structure value has been damaged at which point the damage element undergoes a "time to rebuild" period where no additional damages can accrue. These assumptions will continue to prevent overestimation of the FWOP damages while allowing for realistic rebuilding to occur.

### 1.1.3 Damage Functions

Damage functions are used within the model to determine the extent of storm-induced damages attributable to any specific combination of damage element type, foundation type, and construction type. There are a total of six types of damage function which include erosion damages, inundation damages, and wave damages for both contents and structure. The functions are completely user-definable within the model and transfer damages to the individual damage elements. Damage is determined as a percentage of overall structure or content value using a triangular distribution (minimum, most likely, maximum). The range of percentage points used for the damage is determined by parameters dependent upon which function is being triggered. For erosion it is dependent upon the extent to which the structure's footprint has been compromised and inundation and wave-attack are dependent upon storm-surge heights in excess of first-floor elevation. An example diagram of how these damage functions operate is provided by Figure B-17.

**Figure B-17: Example Damage Function**




[1] Reference Florida Office of General Counsel order 12-1453 and 12-1264 as examples.

For the vast majority of aforementioned combinations within this study the damage functions used were those developed by the "Physical Depth Damage Function Summary Report" (January 2015) within the greater North Atlantic Coast Comprehensive Study (NACCS) . For the majority of non-residential assets in the inventory the Institute for Water Resources (IWR) "Nonresidential Flood Depth-Damage Functions Derived from Expert Elicitation" was used. Though this particular study is being conducted on a county within the South Atlantic Coastal Division, the NACCS curves were determined to be acceptable since the various structure types, foundation types, and construction materials utilized in the North-Atlantic are virtually the same as those within the South-Atlantic Region. For example, a single-family residence on a pile foundation, which is common and frequently required by code in the state of Florida, will become damaged by erosion or wave attack in much the same manner as a similar single-family residence on pile foundation in the state of Virginia.

### 1.1.4 Coastal Armoring Assumptions

Beach-fx allows for assumptions surrounding coastal armoring (e.g. breakwaters, seawalls) as well. A user can define the different types of armoring applied to individual damage elements as well as a distance trigger, applied at the lot level, which will prompt construction of said armor. Strict environmental permitting is required by the Florida Department of Environmental Protection with regards to armoring. Individual property owners seeking to build armor must first receive a permit and there are various guidelines to the permitting process covered under FDEP rule 62B-33.0051. Not least is the rule which indicates the armoring must have a high level of engineering design: "Coastal armoring structures shall be designed for the anticipated runup [sic], overtopping, erosion, scour, and water loads of the design storm event. Design procedures are available in the latest edition of the Department of the Army Corps of Engineers' Coastal Engineering Manual (EM 1110-2-1100), or other similar professionally recognized publications."

The assumptions used in the analysis are based on a combination of site visit observation, previous, observation of coastal armor in other areas, and engineering/planning judgment. Existing elements of armor were described in the model based on their observed characteristics. Potential future elements of armor generally fell into two categories: vinyl sheetpile walls (assumed to go up in front of lots with smaller residential properties such as SFR1, MFR1, etc.) and concrete seawalls reinforced with rebar (assumed to go up in front of high rise condos and hotels.) The specific assumptions pertaining to each of these is largely based on work done in previous studies that assessed existing armor, particularly the Palm Beach County Jupiter Carlin 934 Report and the Lee County Gasparilla 934 Report (both approved by HQ in recent years). Other studies and observations throughout Florida suggest that when a massive structure, like a high rise, is directly threatened by erosion, the owner will usually make a major investment in armor, such as a concrete seawall.

In particular, the failure thresholds and the armor construction distance triggers are very important. In the case of the distance triggers, the Beach-fx lots have be drawn such that the seaward edge of the lot is located where armor would reasonably be constructed. In the case of failure thresholds, the assumed threshold depends on the type of armor and the relevant damage driver (erosion, inundation, or wave attack).

According to the Beach-fx User's Guide, the erosion failure threshold is defined as "the magnitude of vertical erosion (feet) at the cross-shore location of the armor unit that will cause the armor to fail." The

wave attack failure threshold is based on the vertical elevation of the armor. A storm surge reaching the crest of a seawall could cause it fail, as the wave attack damage driving parameter is intended to capture the energy in the waves. Sustained wave attack at this stage would during a hurricane would be expected to weaken and eventually fail a seawall. The inundation failure threshold is also based on a vertical elevation. However, water depth alone at that same stage (equal to the crest of the seawall) would not necessarily be enough to fail the seawall. Additional depth above that stage would be needed to undermine it. So, the inundation failure threshold was set to the crest elevation +1 foot (for vinyl) and +2 feet (for reinforced concrete).

In addition the information and assumptions described above, Beach-fx parameters pertaining to armor that will be summarized in this section include:

- **Combined Armor Construction Length.** Sum of the parallel shore distance (ft) of all lots in the applicable subset, representing the maximum possible non-repetitive armor construction length for the study area.
- **Armor Construction Cost Per Foot.** Estimated cost of armor construction per foot of armor length.
- **Armor Construction Mobilization Cost**. All costs associated with armor construction not included in the Armor Construction Cost Per Foot specification (e.g., engineering and design, equipment rental, backfill material, etc.).

The Treasure Island Beach-fx model contains 45 lots designated armorable in the future and 35 lots designated already armored **(Figure B-18)**. Respective input parameter summaries by planning reach for the Treasure Island armorable in the future and already armored subsets are presented in **Table B-5 and B-6.**

**Figure B-18. Treasure Island Armor Status by Lot**

**Table B-5: Treasure Island Summary Armorable in the Future Lot Parameters by Planning Reach**

| | Sunshine Beach | Boca Ciega | Sunset Beach |
|---|---|---|---|
| Combined Armor Construction Length (ft) | 3,128 | 6,958 | 7,516 |
| MAX Lot Armor Construction Moblization Cost ($FY20 ) | $597,259 | $597,259 | $597,259 |
| MIN Lot Armor Construction Moblization Cost ($FY20) | $43,470 | $43,470 | $43,470 |
| MAX Lot Armor Construction Cost per foot ($FY20) | $3,466 | $3,466 | $3,466 |
| MIN Lot Armor Construction Cost per foot ($FY20) | $502 | $502 | $502 |

**Table B-6: Treasure Island Summary Already Armored Lot Parameters by Planning Reach**

| | Sunshine Beach | Boca Ciega | Sunset Beach |
|---|---|---|---|
| Combined Armor Construction Length (ft) | 2,274 | 5,853 | 4,448 |
| MAX Lot Armor Construction Moblization Cost ($FY20 ) | $43,470 | $43,470 | $43,470 |
| MIN Lot Armor Construction Moblization Cost ($FY20) | - | - | - |
| MAX Lot Armor Construction Cost per foot ($FY20) | $502 | $502 | $502 |
| MIN Lot Armor Construction Cost per foot ($FY20) | - | - | - |

The Long Key Beach-fx model contains 60 lots designated armorable in the future and 13 lots designated already armored **(Figure B-20)**. Respective input parameter summaries by planning reach for the Treasure Island armorable in the future and already armored subsets are presented in **Table B-7** and **B-8**.

**Figure B-20. Long Key Armor Status by Lot**

**Table B-7: Long Key Summary Armorable in the Future Lot Parameters by Planning Reach**

| | Upham Beach | St. Pete Beach North | Sunset Beach | Pass-a-Grille Beach |
|---|---|---|---|---|
| Combined Armor Construction Length (ft) | - | 2,648 | 8,318 | 5,341 |
| MAX Lot Armor Construction Moblization Cost ($FY20 ) | - | $597,259 | $597,259 | $61,000 |
| MIN Lot Armor Construction Moblization Cost ($FY20) | - | - | $43,470 | $43,470 |
| MAX Lot Armor Construction Cost per foot ($FY20) | - | $3,466 | $3,466 | $2,000 |
| MIN Lot Armor Construction Cost per foot ($FY20) | - | - | $502 | $502 |

**Table B-8: Long Key Summary Already Armored Lot Parameters by Planning Reach**

| | Upham Beach | St. Pete Beach North | Sunset Beach | Pass-a-Grille Beach |
|---|---|---|---|---|
| Combined Armor Construction Length (ft) | 1,727 | 4,801 | - | - |
| MAX Lot Armor Construction Moblization Cost ($FY20 ) | $597,259 | $597,259 | - | - |
| MIN Lot Armor Construction Moblization Cost ($FY20) | - | $61,000 | - | - |
| MAX Lot Armor Construction Cost per foot ($FY20) | $3,466 | $3,466 | - | - |
| MIN Lot Armor Construction Cost per foot ($FY20) | - | $2,000 | - | - |

## 3.2 Beach-fx FWOP Simulation Results

Over 100 iterations the future without project condition damages in Treasure Island range between $57.6 and $247.9 M in present value dollars (or about $2.1 M and $10.2 M, respectively, in average annual dollars). The future without project condition damages in Long Key range between $45.2 and $215.3 M in present value dollars (or about $1.7 M and $8.0 M, respectively, in average annual dollars).

### 3.2.1 Structure and Content Damages

All references to estimated FWOP damages are those from the high SLC scenario[2] unless otherwise noted. Descriptive statistics on the damages per the FWOP model results are as follows:

**Table B-9: FWOP Summary of Descriptive Statistics in AAEQ dollars**

| | Treasure Island | Long Key |
|---|---|---|
| **Mean** | $4,110,637 | $3,606,878 |
| **Median** | $3,830,697 | $3,202,266 |
| **Standard Deviation** | $1,355,111 | $1,371,270 |

*Descriptive statistic based on Present Value damage estimates from Beach-fx, annualized at the 2020 water resources discount rate: 2.75%

As seen in Table B-9, for Treasure Island and Long Key the standard deviation is much lower than mean, which indicates relatively low variability and volatility in the FWOP damage estimates in the study area throughout the 100 iterations. This lack of volatility is due to the fact that lots are constructing armor frequently and consistently in the FWOP resulting in limited long-term erosion damages. However, the structures beyond the armoring are still susceptible to high storm surge and wave action resulting from hurricanes and tropical storms.

[2] Refer to the Main Section of this report for rationale on using the high sea level change scenario

Pursuant to estimating FWOP damages and associated costs for the study area in Pinellas County Treasure Island, Beach-fx was used to estimate damages and costs in the following categories:

- Structure Damage: Economic losses resulting from the structures situated along the coastline being exposed to wave attack, inundation, and erosion damages. Structure damages account for % of the damages for the FWOP.
- Contents Damage: The material items housed within the structures (usually air-conditioned and enclosed) that are potentially subject to damage. Content damages are % of the total damages.
- Armor Damages: Sometimes called "armor cost", this category refers both to damage accruing to existing elements of coastal armor, or the cost associated with the building of new (non-Federal) armor due to erosion cutting into the lots. This is not to be confused with potential structural measures that could be part of a Federal project and may be evaluated as such.

A summary of these three categories is presented below.

**Table B-10. Summary of FWOP Damages by category**

| AAEQ | Treasure Island | Long Key | Total |
|---|---|---|---|
| Structure Damage | $2,309,000 | $2,072,000 | $4,380,000 |
| Contents Damage | $1,178,000 | $944,000 | $2,122,000 |
| Armor Damage | $624,000 | $592,000 | $1,215,000 |
| **Total** | **$4,111,000** | **$3,608,000** | **$7,717,000** |

### 3.2.2 Damage Distribution by Structure Category – Treasure Island Segment

This section addresses what is being damaged in the FWOP by structure category. The coastal inventory was categorized as delineated by multi-family residential, single-family residential, commercial, hotels and public access structures. Further delineation was done within the model on the number of stories each structure has as this plays a role in the value at risk and is used in the various damage function assignments. **Table B-11 and B-12** provide greater detail on the type of structures within each category as well as the composition of the FWOP damages within those categories. The distribution of the damages by category is as follows:

As shown in the above table, Treasure Island damages skew toward multi-family residential properties with three stories or less. This is not surprising, as multi-family residential properties are large proportion of the total value subject to damage in Treasure Island. Also, the three story or less structures tend to be somewhat older and more vulnerable (due to construction type and foundation type) than the high rise properties. The second largest category of damage is armor cost; this is also not surprising given that most of the Beach-fx lots in Treasure Island are classified as either currently armored or armorable in the future. High rise properties (both hotels and condos) make up a smaller, but still significant proportion of the damage.

**Table B-11. Distribution of Damages by Damage Category: Treasure Island**

| Asset Type | FWOP Damages (AAEQ) | Percent Total |
|---|---|---|
| Armor Cost | $623,793 | 15% |
| Multi-Family Residential (1 Story) | $665,345 | 16% |
| Multi-Family Residential (2 Story) | $771,353 | 19% |
| Multi-Family Residential (3-9 Story) | $986,138 | 24% |
| Single-Family Residential (1 Story) | $285,993 | 7% |
| Single-Family Residential (2 Story) | $235,589 | 6% |
| Multi-Story Hotel | $428,375 | 10% |
| Dune Walk | $69,344 | 2% |
| Commercial | $43,047 | 1% |
| Road | $1,660 | 0% |
| ***Total*** | ***$4,110,637*** | **100%** |

As shown in the above table, Treasure Island damages skew toward multi-family residential properties with three stories or less. This is not surprising, as multi-family residential properties are large proportion of the total value subject to damage in Treasure Island. Also, the three story or less structures tend to be somewhat older and more vulnerable (due to construction type and foundation type) than the high rise properties. The second largest category of damage is armor cost; this is also not surprising given that most of the Beach-fx lots in Treasure Island are classified as either currently armored or armorable in the future. High rise properties (both hotels and condos) make up a smaller, but still significant proportion of the damage.

**Table B-12. Distribution of Damages by Damage Category: Long Key**

| Asset Type | FWOP Damages (AAEQ) | Percent Total |
|---|---|---|
| Armor Cost | $602,952 | 17% |
| Multi-Family Residential (1 Story) | $255,802 | 7% |
| Multi-Family Residential (2 Story) | $125,252 | 3% |
| Multi-Family Residential (3-9 Story) | $1,430,050 | 40% |
| Single-Family Residential (1 Story) | $23,047 | 1% |
| Single-Family Residential (2 Story) | $73,934 | 2% |
| Multi-Story Hotel | $908,135 | 25% |
| Dune Walk | $82,386 | 2% |
| Commercial | $30,620 | 1% |
| Road | $55,531 | 2% |
| ***Total*** | ***$3,608,000*** | **100%** |

### 3.2.3 Spatial Distribution of Damages

There is a great deal of variability in the amount of damages amongst the Beach-fx reaches. This is explained by the large number of variables, all of which the Beach-*fx* model takes into account. Examples of variation between the reaches result from the following:

- Density and amount of development
- Typical size and value of structures
- Typical distance between structures and mean-high water
- Size, shape and location of the dunes and coastal morphology
- Rate of erosion for each reach
- Amount and type of coastal armoring present
- Timing that property owners construct coastal armoring in the future.

The Treasure Island segment was divided into three different economic/planning reaches based on the FWOP damage estimates as well as based on where the previously authorized project most frequently placed material in the periodic nourishments. It should be noted that Planning Reaches are distinct from Beach-fx model reaches. While model reaches are used to organize input data, planning reaches are larger and are intended to identify potentially separable elements from a plan formulation standpoint. While each planning reach can be considered a constructible increment on its own, the same cannot be said for individual model reaches. In this study, Planning Reach 1 refers to the northern most extent of Treasure Island, also known as Sunshine Beach, and has been historically filled during periodic nourishments. Planning Reach 2 consists of the middle portion of Treasure Island (i.e., Boca Ciega) where historically there has been no fill. Planning Reach 3 is the southernmost portion of Treasure Island, also known as Sunset beach, and has received historic fill. The Planning reaches in Long Key also follow the Planning Reaches described earlier in this document as well as the main report: Upham Beach, St Peter Beach North, St Pete Beach North, and Pass-a-Grille beach. A spatial summary of the FWOP damages by Study Reach is presented in Figure 1.

FWOP damages really spike in the southern portion of the Treasure Island shoreline (Sunset Beach). With a length of approximately 5,700 feet, this economic reach contains model reaches R138-R143 and accounts for 69% of total damages and armor costs. The middle section, or Boca Ciega, which consists of model reaches R129-R137 measuring an approximate length of 8,800 feet, has a relatively healthy shoreline throughout the FWOP and as a result records an estimated 10% of damages. And finally Sunshine Beach, with a length of approximately 2,800 feet records the final 21% of damages and armor costs. The spatial distribution of damages is intuitive based on the fact that historic fill has primarily been needed on the north and south ends of Treasure Island. In Long Key the story of the damages is somewhat similar: relatively high damage in northern and southern reaches (due primarily to higher background erosion rates). The lowest damages are observed in St Peter Beach South, which makes sense because this area has very low background erosion rates.

**Figure B-21: FWOP Damages by Economic Reach (AAEQ)**

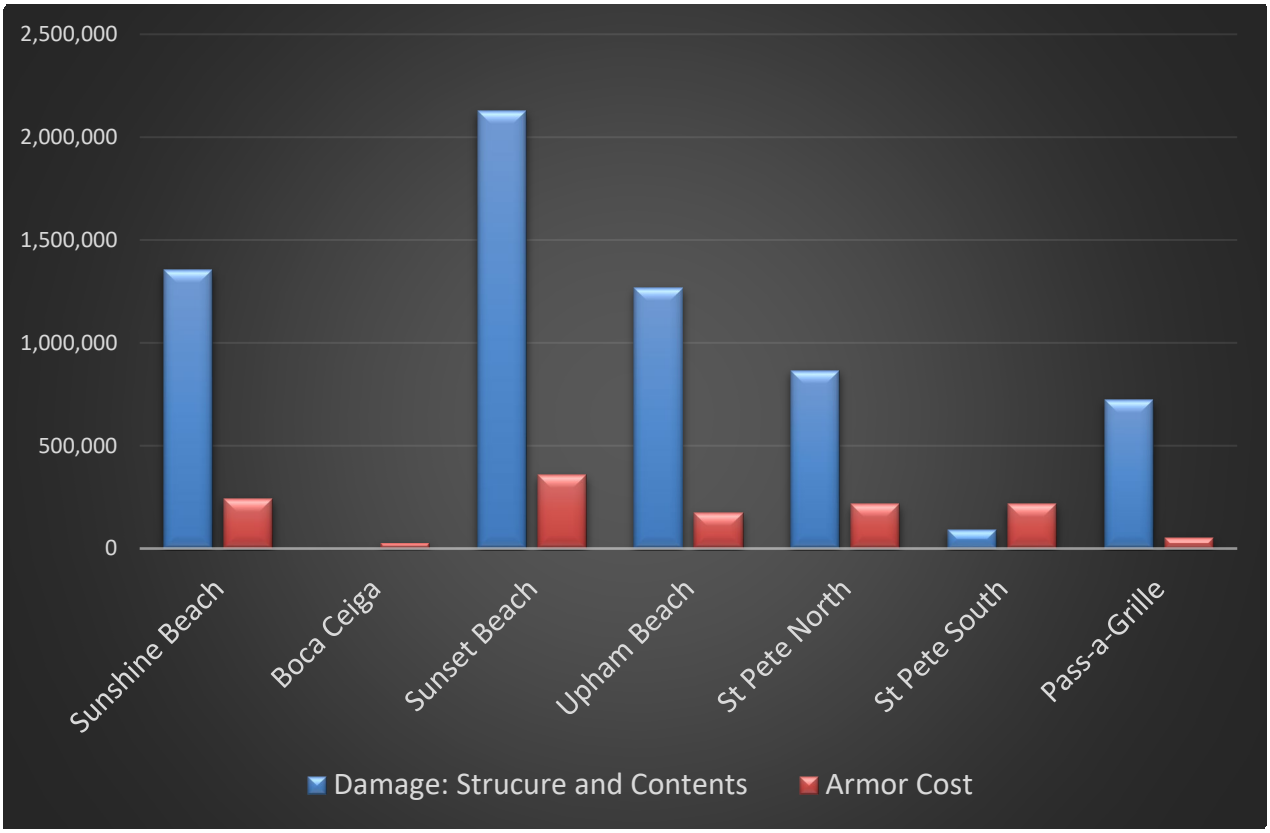
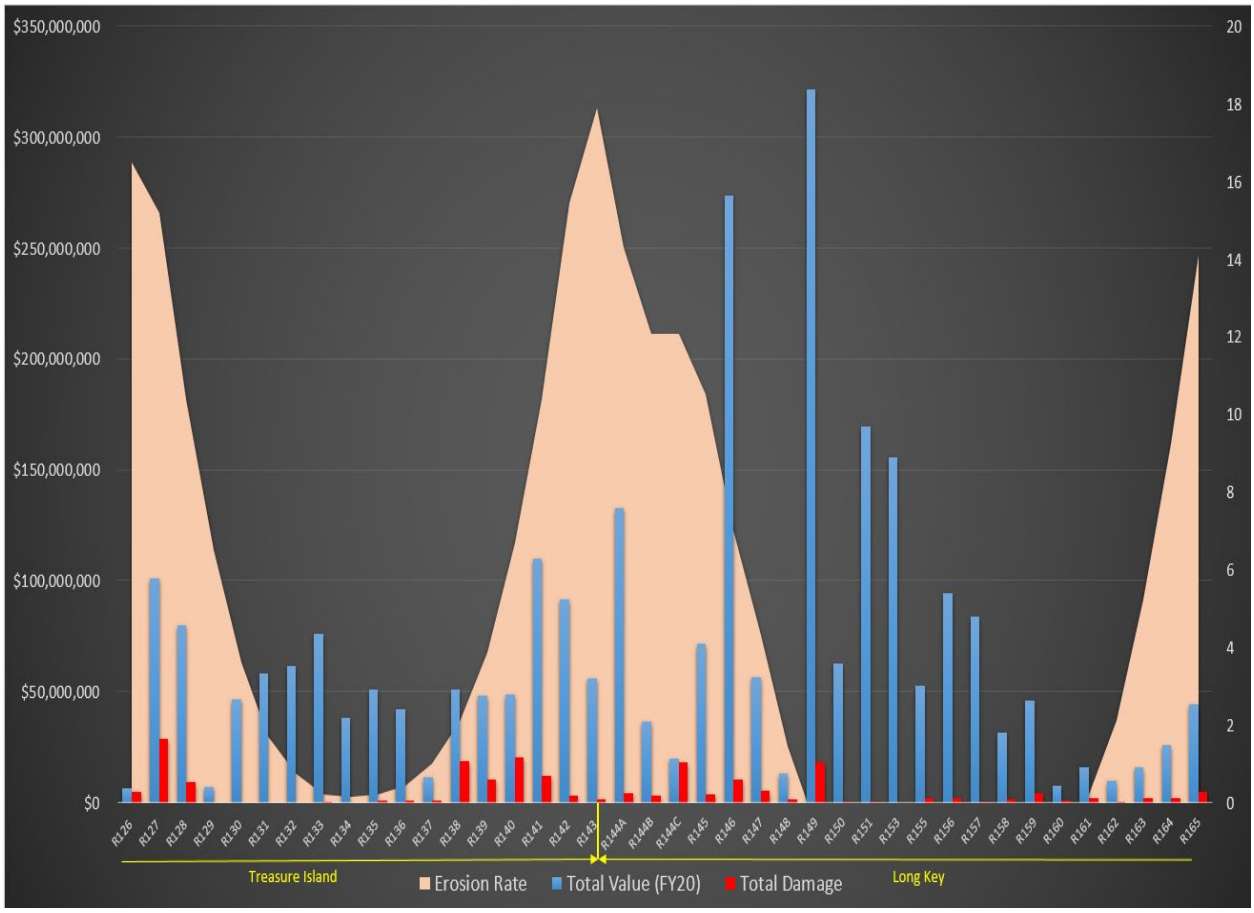


**Figure B-22. Summary of Value, PV Damages, and Background Erosion Rate by model Reach**



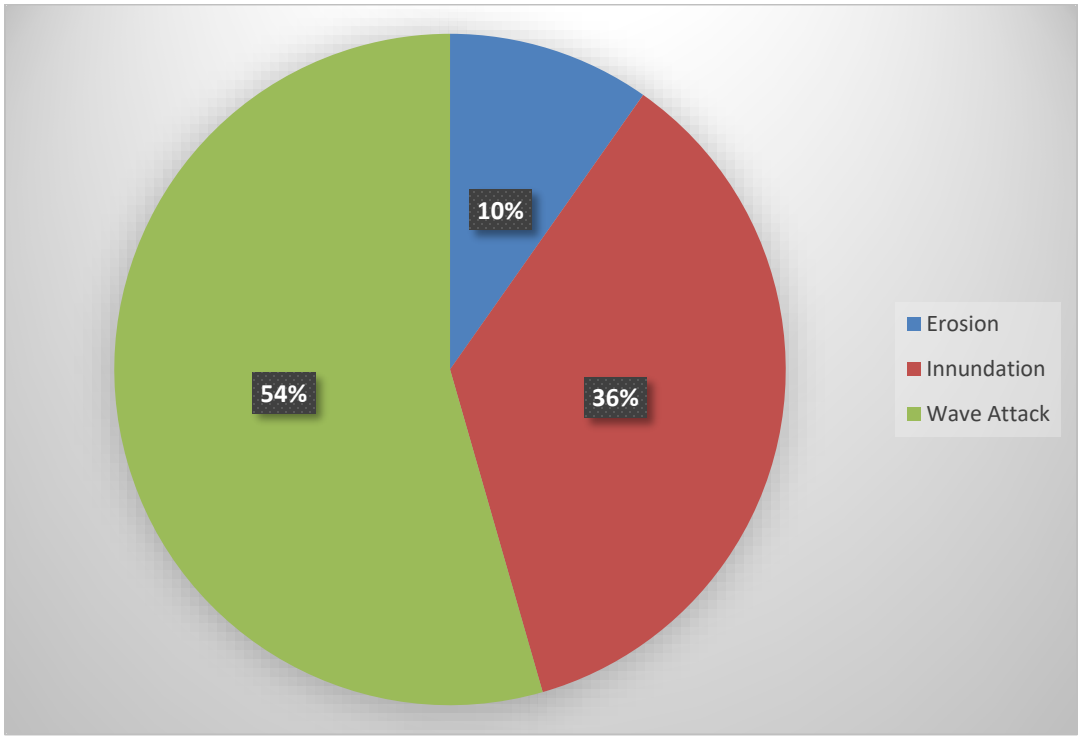

### 3.2.4 Distribution of Damage by Damage Driving Parameter (Structures and Contents)

As previously described in this Appendix and elsewhere in the feasibility report, Beach-fx estimates coastal damage associated with three different parameters: erosion, inundation, and wave attack. A breakdown of the Pinellas County FWOP results s provided below in **Table B-13** and Figure B-22.

**Table B-13. FWOP Damage by Damage Driving Parameter**.

| | Treasure Island | Long Key |
|---|---|---|
| Erosion | 2% | 21% |
| Innundation | 39% | 31% |
| Wave Attack | 59% | 48% |

**Figure B-22. Overall Damages by Damage Driving Parameter**




Erosion is a major driver of risk within the Treasure Island segment of Pinellas County. However, the assumption of future armoring minimizes estimated dollar damages to the asset inventory caused by erosion itself. Erosion is the primary driver for armor costs (see section 3.2.1 below for details on armor costs) but only makes up approximately 10% of direct damages to the asset inventory. Across the study area as whole, the primary damages to the asset inventory occur from flooding (36%) and wave attack (56%). Due to way armor is simulated in Beach-fx, armor prevents erosion damage but does not prevent either flooding or wave attack damage to structures and contents. Given that most of the lots are classified as either currently armored or amorable in the future, these results make sense.

This information was used as a primary indicator for potential nourishment templates during plan formulation since a high level of damages occurring from flooding and wave attack lends itself to a larger and wider dune feature.

### 3.2.5 Temporal Distribution of Damages: Structures and Contents

In addition to understanding the spatial distribution of damages, in it important to understand how and why damages vary over time. A temporal summary of FWOP damage is presented in Figures 3 and 4.

In Treasure Island damages remain relatively low in the first 3-5 years of the period of analysis while there is still some sand remaining in the system. After erosion has taken its toll on the northern and southern ends of the study area damages become increasingly high and erratic, demonstrating the increased vulnerability of the study area to storm impacts. **Figure 23** demonstrates this effect graphically.

**Figure 23 Present-Value Damages Over Time by Economic Reach: Treasure Island**

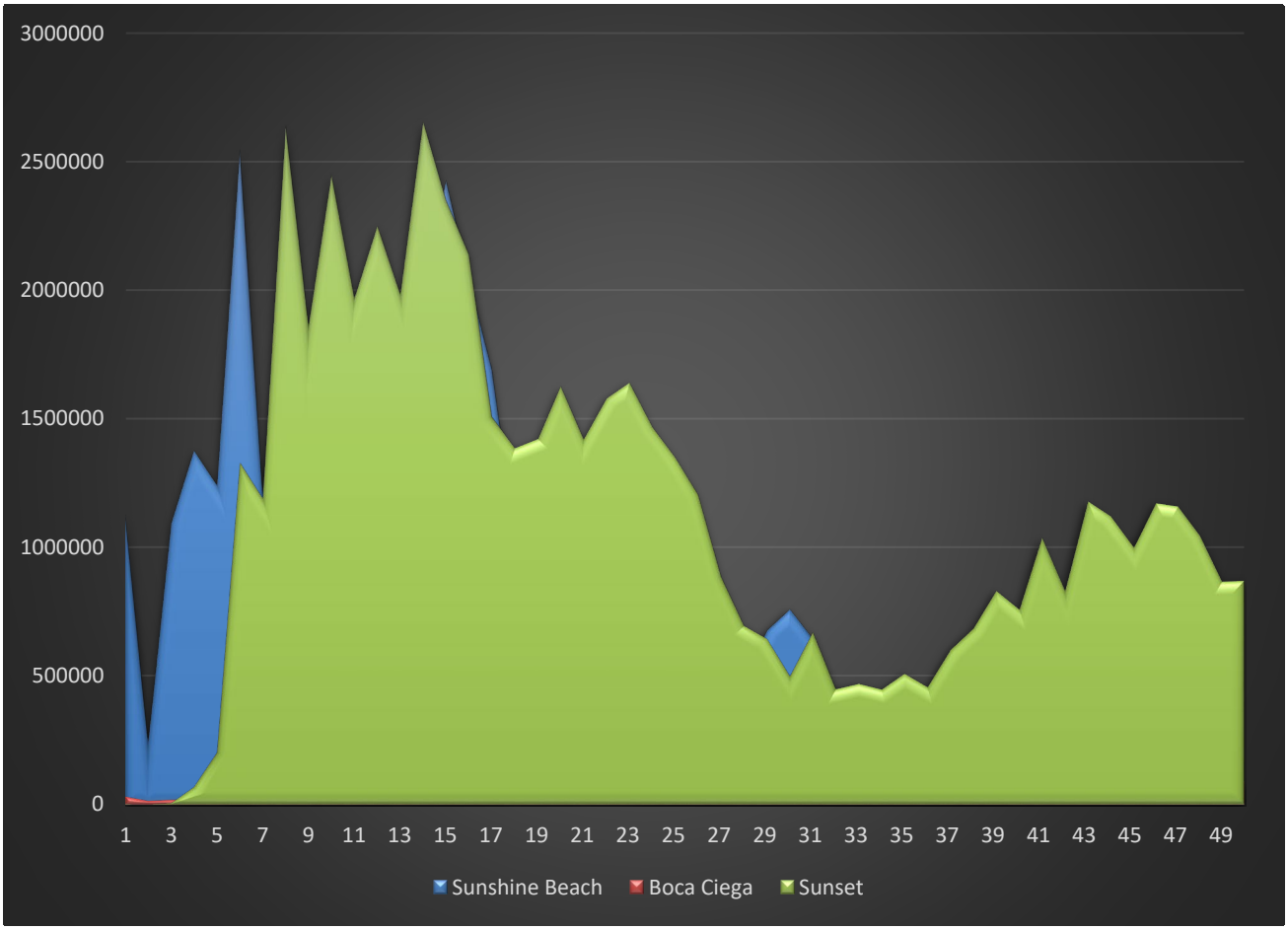
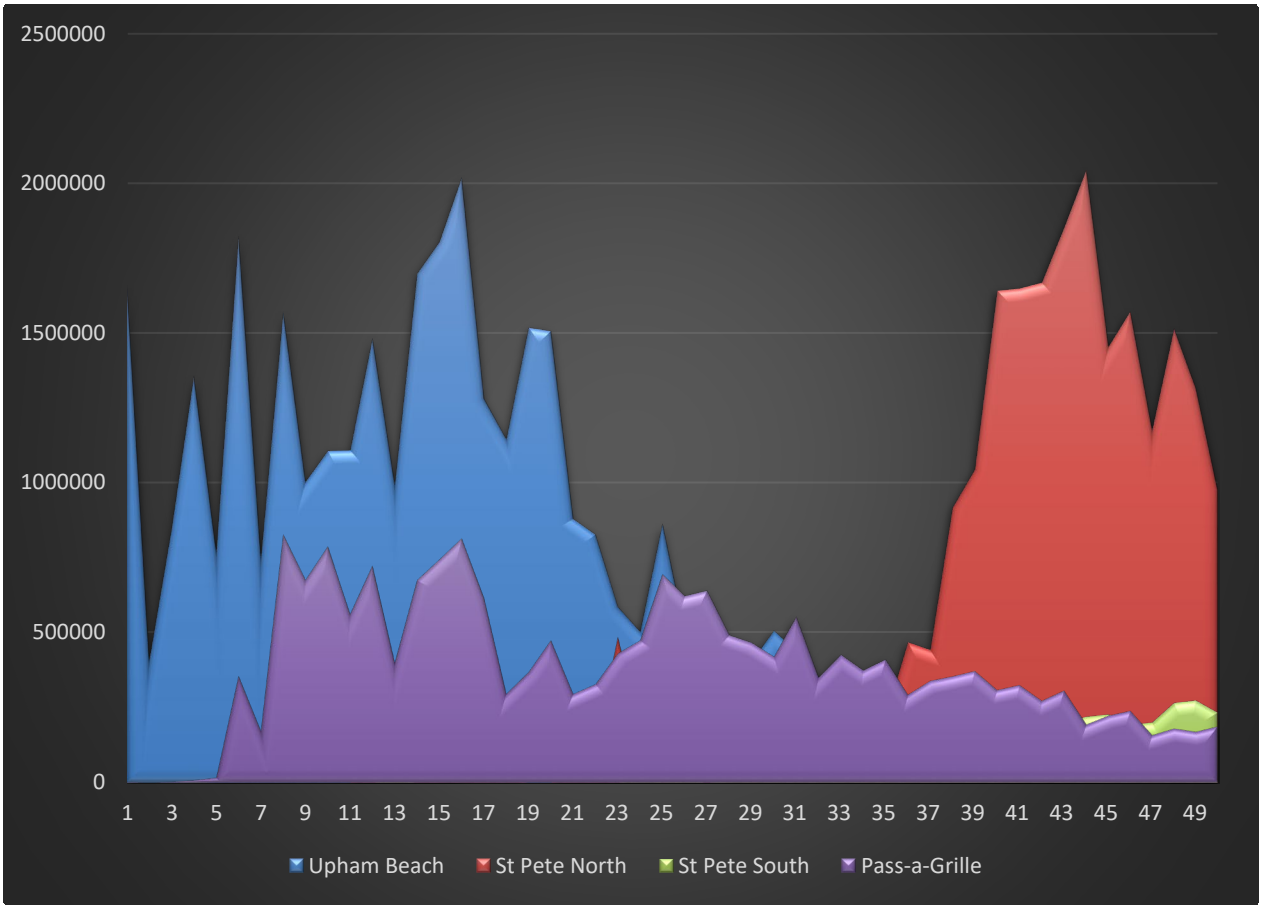


**Figure 24 Present-Value Damages Over Time by Economic Reach: Long Key**




The temporal distribution of damages in Long Key is somewhat different. The two planning reaches that accumulate the most damage: Upham and Pass-a-Grille, do receive some damage early in the simulation (years one through ten). Pass-a-Grille actually receives most of its damage early, rather than late in the simulation, probably due to new armor construction preventing erosion damages in later years. Both Upham Beach and St Pete North experience a significant spike in damage very late in the simulation, likely due the heavily eroded state of the shoreline in those years. St Pete South receives minimal damage throughout the simulation.

### 3.2.1 Temporal Distribution of Damages: Armor Cost

Armor construction for lots that are marked as armorable in the future will be triggered once erosion has reached the seaward-most vertex of the lot polygon. Therefore, all initial construction of armor is caused by erosion. Once a lot is armored, whether from the start of the analysis or triggered by erosion to be constructed at a later date, said armor is susceptible to failure by the same damage driving parameters that threaten the coastal infrastructure (i.e. erosion, wave, flood). The failure thresholds are measured by the vertical depth of erosion at the point of the armor in feet below the ground surface (i.e. undermining) and the height of flood waters and wave crests relative to the vertical datum. In the Treasure Island segment of the study area there is some existing armor but the majority of lots are currently unarmored but are assumed to be armored in the future. As a result, armor construction is triggered relatively quickly on the north and south ends of the project so Economic Reaches 1 and 3 incur the majority of armor costs in the

first five years of the period of analysis (refer to Figure B-25). The same is not true of the middle segment of Treasure Island. Though the average number of lots triggering an armor build and the average length (linear feet) of construction are similar, the fact that the average point in time in the simulation in which this armoring is incurred is well into the future means a much lower average cost due to discounting (see for the details on year armor is constructed).

Armor failure is infrequent for each of the Reaches. The most frequent failure occurs in Sunshine Beach but a single lot failure is only recorded in a little over half of the iterations.

**Figure B-25: Armor Construction Cost By Year: Treasure Island**

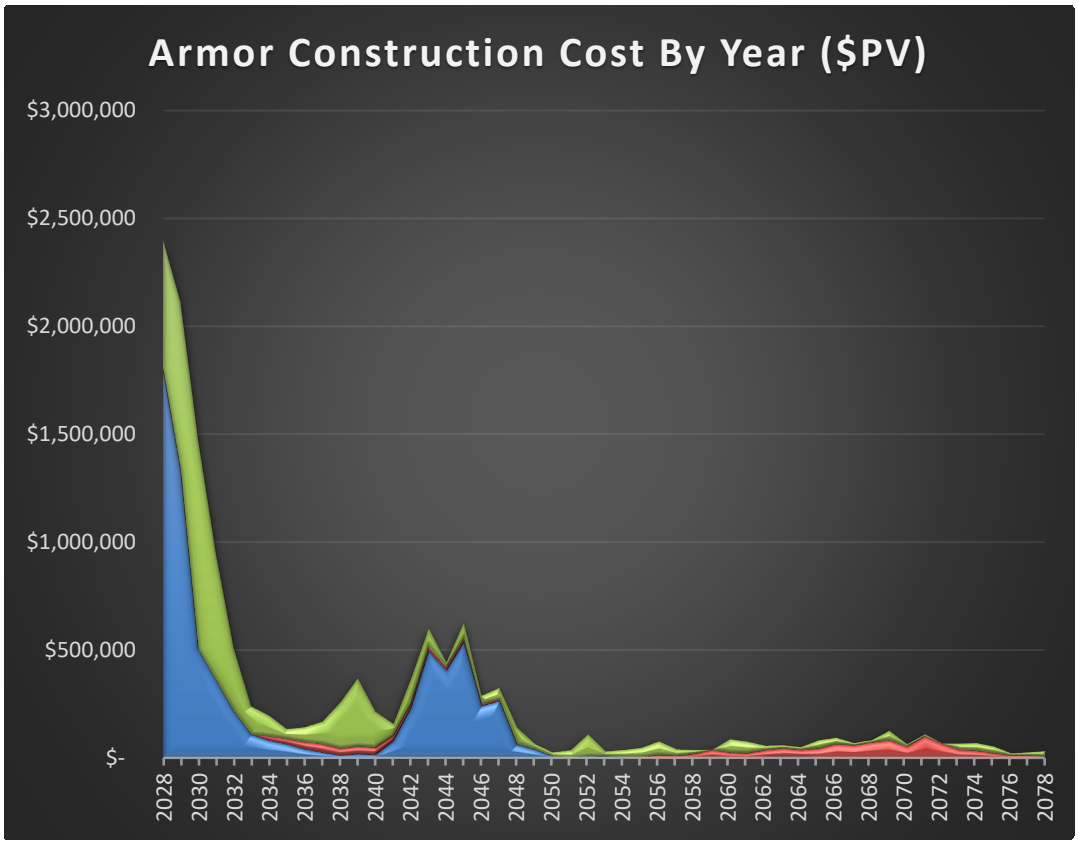
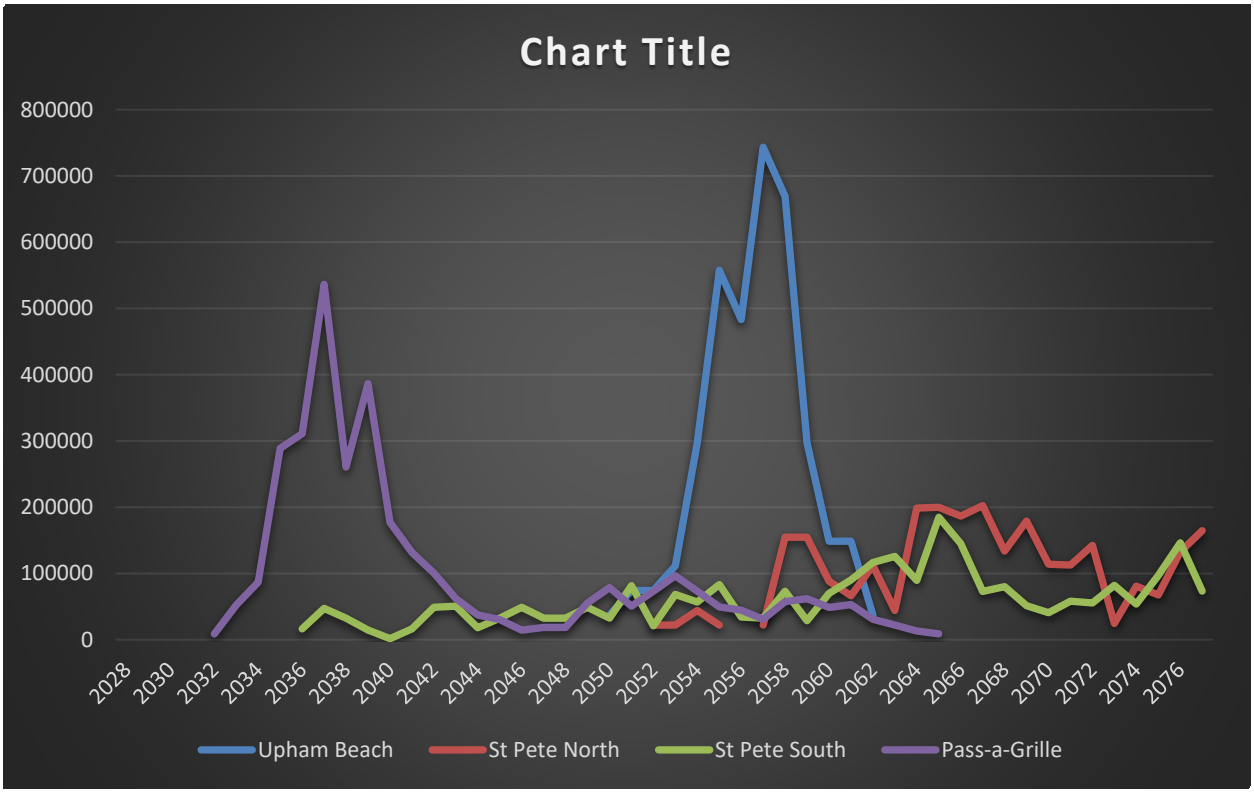


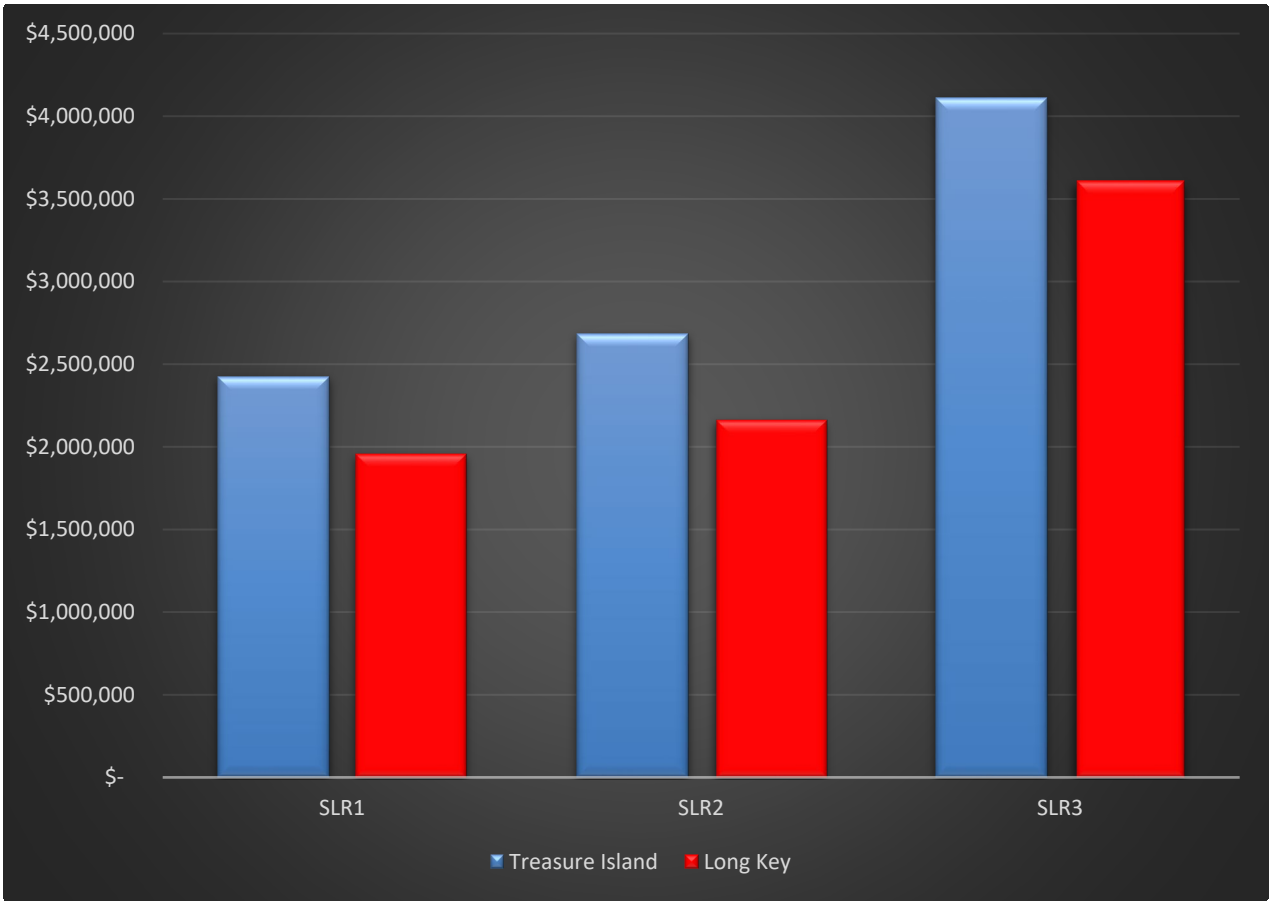
**Figure B-26: Armor Construction Cost By Year: Long Key**




### 3.2.2 FWOP Damages in alternative Sea Level Change (SLC) scenarios

Evaluating sea level change (SLC) is a vital component in the planning process to ensure alternatives are selected based on risk-informed analysis. To incorporate risk into the analysis the FWOP must be run assuming three distinct future rates of SLC. EC 1165-2-211 provides both a methodology and a procedure for determining a range of SLC estimates based on the local historic rate, the construction (base) year of the project, and the design life of the project. In Pinellas County, the average baseline (SLC1), intermediate (SLC2) and high (SLC3) rates were found to be 0.00774 feet/year, 0.0163 feet/year, and 0.0439 feet/year, respectively. The Beach-fx results that were presented above refer strictly to SLC3. The results comparing the SLC scenarios are presented here. Figure B-27 provides an overall summary of damages in each SLC scenario.

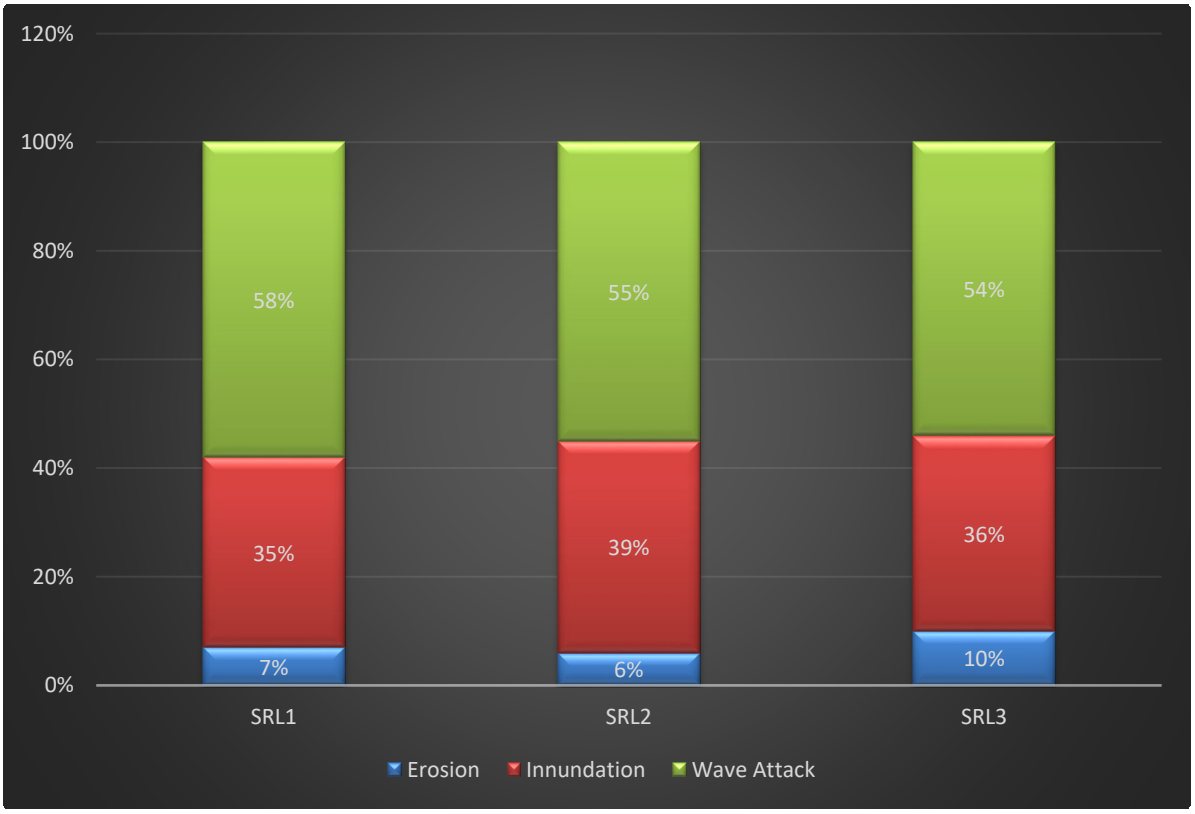
**Figure B-27: Total Damages by SLC Scenario ($ AAEQ)**




The SLC results are intuitive in the sense that one would expect damages to be positively correlated with water levels (i.e. as water levels increase throughout the period of analysis so do damages). What is important to note, however, is the magnitude of the effect. Damages barely diverge between SLC1 and SLC2, but begin to rapidly increase when analyzing the high SLC scenario.

Another important item to note in terms of plan formulation and risk-informed decision making is what drives the damages in each scenario. Across the three scenarios the trend is similar with erosion accounting for 10% or less of damages and wave attack accounting for the majority of damages. This is important since the recommended plan should reduce risk in all three scenarios and in this case with the damage driving parameters being similar the proposed alternative that works best in the face of all three should be similar, perhaps only diverging in magnitude but not type. Figure B-28 displays the changing trend in how damages are occurring. In formulating a plan, reducing risk from wave and inundation should be the focus. Therefore, dune enhancements may be more effective than berm enhancements (due to the fact that berm focused projects tends to be most effective at reducing erosion damage).

**Figure B-28: Percent of Total Damages by Driver in the SLC Scenarios**




### 3.2.3 FWOP Condition Conclusion

- Damages to the asset inventory are largely driven by wave and inundation in all SLC scenarios.
- The overwhelming majority of the damage is structural in nature. Multi-Family structures account for the majority of structure and content damages. A small but significant proportion of the damage is associated with Armor costs.
- Coastal storm risk is heavily concentrated in the Planning reaches which represent the termini of the two islands: Sunrise Beach, Sunset Beach, Upham Beach and Pass-a-Grille Beach. Risk in the southern terminus of Treasure Island (Sunset Beach) and the northern terminus of Long Key (Upham Beach). The risk of damage is especially pronounced when looking through the lens of SLC and the potential impacts if the SLC3 scenario were to be realized. The middle reaches of each island have less damage, particularly Boca Ciega on Treasure Island and St Pete Beach on Long Key, where the estimated damages are minimal.
- The coastal armoring assumption prevents most of the erosion damages that could potentially occur to the asset inventory, but this armoring is estimated to come at a large cost (23% of total damages) and a potential project that avoids or defers this cost could be potentially beneficial.

# 4 Future With Project (FWP) Conditions

This section of the appendix tells the story behind the evaluation and comparison of the Pinellas County CSRM study alternatives. A description of the alternatives, their performance in terms of benefits and costs, and the methods used for screening are provided in the sub-sections that follow.

### 4.1.1 Management Measures

Management measures were selected to accomplish at least one of the planning objectives for the Pinellas study. Both nonstructural and structural measures were identified. The following is a summary of the management measures considered:

- **Structural Measures:**
  - Beach Nourishment
  - Groins
  - Submerged Artificial Reefs
  - Dunes and Vegetation
- **Non-structural Measures:**
  - No Action
  - Condemnation and Land Acquisition

Only two management measures were carried forward to the modeling phase of study: Dune and Vegetation and Beach Nourishment. More information about the preliminary management measure screening process is provided in the Main Report. The two measures carried forward are described below.

**Dunes and Vegetation:** This measure would include placement of beach compatible material, from either upland or offshore sources, into an extension of the existing dune feature. Vegetation would be planted after initial placement of the dune material. Preliminary engineering design work concluded that the most feasible plan for dunes and vegetation would be extending the existing dune by up to an estimated 10' NAVD88 as well as combinations of dune extension seaward.

**Beach Nourishment:** This measure includes initial construction of a beach fill and future periodic nourishments at regular intervals. Periodic nourishment of the beach would be undertaken to maintain the erosion control features within design dimensions. There were several combinations of project dimensions initially considered for beach nourishment. Through various rounds of alternatives a final array of alternatives was selected and it was concluded that it was unlikely that any berm feature would be economically justifiable beyond an estimated 100' extension of the existing profile.

### 4.1.2 Alternative Development – Treasure Island

An alternative plan is a set of one or more management measures functioning in tandem to address project-area objectives. An alternative plan can be constituted by different measures in different planning reaches (and/or the No Action Plan is some reaches). Due to the possibility of different measures being implemented in different reaches, numerous distinct alternatives are possible. Though the team only carried forward two management measures there were a total of over 50 alternatives for initial modeling (25 iterations screening runs) resulting from combinations of dune width extensions, dune height extensions, berm extensions, placement only in Reach 3, and fixed interval options. During the modeling process it became clear that net-benefits were being maximized when the nourishment interval was approximately 6-8 years and with a dune width and dune height extension. Limited berm width extensions appeared viable. As a result, only 5 alternatives were carried into the final array as follows:

- S TI E DWDH 0 6INT – This alternative was placement in only Economic Reach 3, the southern end, as denoted by the preceding "S" in the alternative name. The TI indicates the placement occurring in Treasure Island. The dune width extension is approximately 20' with a dune height extension to approximately 10' NAVD88. The interval for this alternative was fixed at 6 years as is denoted by the "6INT".
- S TI E DWDH 30 6INT – This alternative is the same as S TI E DWDH 0 6INT described above but the 30 in place of the 0 indicates a 30' berm extension.
- TI E DWDH 0 6INT – This alternative is the same as the first bullet point alternative but it also includes placement of the same exact dimensions in Economic Reach 1.
- S TI E DH 100 8INT – 100' berm extension in Economic Reach 3 with no dune width adjustment and a dune height at approximately 10' NAVD88. The nourishment interval was fixed at 8.
- TI Ends 60 – No adjustment to the dune at all with a 60' berm extension in both Economic Reach 1 and Economic Reach 3. The nourishment interval was not fixed with this alternative and naturally produced an average nourishment interval of 7.4 years.

For more detailed review of template designs of the final array please refer to the **Engineering Appendix (APPENDIX A)** of this report.

### 4.1.3 Alternative Development – Long Key

A similar process was used to narrow down the management measures in Long Key to as reasonable final array of alternatives. The screening process was signed to capture a wide range of different potential projects, including a few that were similar to the current authorized project. A summary of all the screening level alternatives for both islands is provided below:

| Primary Template Dimensions | | | Treasure Island | Long Key | Alternative |
|---|---|---|---|---|---|
| Berm Width (ft) | Dune Elevation (ft-NAVD88) | Dune Width (ft) | Alternative ID | Alternative ID | Description |
| Berm Only | | | | | |
| 20 | Existing | Existing | TI_Ends_20ft | LK_Ends_20ft | 20ft Berm at Ends |
| 30 | Existing | Existing | TI_Ends_30ft | LK_Ends_30ft | 30ft Berm at Ends |
| 40 | Existing | Existing | TI_Ends_40ft | LK_Ends_40ft | 40ft Berm at Ends |
| 50 | Existing | Existing | TI_Ends_50ft | LK_Ends_50ft | 50ft Berm at Ends |
| 60 | Existing | Existing | TI_Ends_60ft | LK_Ends_60ft | 60ft Berm at Ends |
| 70 | Existing | Existing | TI_Ends_70ft | LK_Ends_70ft | 70ft Berm at Ends |
| 80 | Existing | Existing | TI_Ends_80ft | LK_Ends_80ft | 80ft Berm at Ends |
| 90 | Existing | Existing | TI_Ends_90ft | LK_Ends_90ft | 90ft Berm at Ends |
| 100 | Existing | Existing | TI_Ends_100ft | LK_Ends_100ft | 100ft Berm at Ends |
| 110 | Existing | Existing | TI_Ends_110ft | LK_Ends_110ft | 110ft Berm at Ends |
| 120 | Existing | Existing | TI_Ends_120ft | LK_Ends_120ft | 120ft Berm at Ends |
| 130 | Existing | Existing | TI_Ends_130ft | LK_Ends_130ft | 130ft Berm at Ends |
| Dune Raising | | | | | |
| 0 | 10 | Existing | TI_Ends_DH_0ft | LK_Ends_DH_0ft | 0ft Berm at Ends + Added 10ft Dune Height Addition |
| 30 | 10 | Existing | TI_Ends_DH_30ft | LK_Ends_DH_30ft | 30ft Berm at Ends + Added 10ft Dune Height Addition |
| 100 | 10 | Existing | TI_E_DH_100ft | LK_E_DH_100ft | 100ft Berm + 10ft Dune Height |
| Dune Widening | | | | | |
| 0 | Existing | Existing + 20 | TI_Ends_DW_0ft | LK_Ends_DW_0ft | 0ft Berm at Ends + 20ft Dune Width Extension |
| 30 | Existing | Existing + 20 | TI_Ends_DW_30ft | LK_Ends_DW_30ft | 30ft Berm at Ends + 10ft Dune Width Extension |
| 100 | Existing | Existing + 20 | TI_E_DW_100ft | LK_E_DW_100ft | 100ft Berm + Added 20ft Dune Width |
| Dune Raising + Widening | | | | | |
| 0 | 10 | Existing + 20 | TI_E_DWDH_0ft | LK_E_DWDH_0ft | 0ft Berm at Ends + Added 20ft Dune Width + 10ft Dune Height |
| 30 | 10 | Existing + 20 | TI_E_DWDH_30ft | LK_E_DWDH_30ft | 30ft Berm at Ends + Added 20ft Dune Width + 10ft Dune Height |
| 100 | 10 | Existing + 20 | TI_E_DWDH_100ft | LK_E_DWDH_100ft | 100ft Berm +10ft Dune Height +Added 20ft Dune Width |

Similar to Treasure Island, screening runs indicated that the most promising alternatives primarily consisted of dune enhancements in one or both of the Planning Reaches on Long Key with the highest

estimated damages: Upham Beach and Pass-a-Grille. Similar to Treasure Island alternatives with the middle section of the island included have lower net benefits because the FWOP damages are lower in those areas. Including St Pete Beach South; including of this segment would lead to significantly higher cost but virtually no additional benefits. In general, dunes seems to be more effective than berms in terms of damage reduction. This is not surprising, given the fact that most of the damages are driving by inundation and wave attack rather than erosion (berm extensions are usually only effective at preventing or reducing erosion, as well as reduction in armor cost). In Long Key one alternative with a large berm was carried forward into the Final Array because it performed relatively well. The Long Key alternatives carried into the final array were as follows:

- LK E DWDH 0 6INT – This alternative was placement in both The Upham and Pass-a-Grille Segments. The dune width extension is approximately 20' with a dune height extension to approximately 10' NAVD88. The interval for this alternative was fixed at 6 years as is denoted by the "6INT". The E denotes "Ends only", as in the ends of Long Key.
- LK U DWDH 0 6INT – This alternative was placement in just the Upham Beach segment. The dune width extension is approximately 20' with a dune height extension to approximately 10' NAVD88. The interval for this alternative was fixed at 6 years as is denoted by the "6INT". The U denotes "Upham Only".
- LK U DWDH 30 6INT – This alternative is the same as LK U DWDH 6INT described above but the 30 in place of the 0 indicates a 30' berm extension.
- LK U DWDH 30 6INT – This alternative indicates placement just in Upham beach. The dune width extension is approximately 20' and a berm extension of approximately 100'. This alternative is somewhat unique among the relatively high performing alternatives in that it does not include a dune height extension but does include a large berm.
- LK E DWDH 30 6INT – This alternative is the same as LK U DWDH 30 6INT described above, but with both Upham and Pass-a-Grille included

### 4.1.4 Alternative Comparison

All of the alternatives described above were modeled in Beach-fx using full (100 iteration) life-cycle simulations in order to calculate benefits and costs. Additionally, land-loss benefits were added to the total project benefits for each of the alternatives. For a full discussion on how land-loss benefits were calculated please refer below to section Error! Reference source not found.. The results of these simulations, which were used to estimate the NED plan, are presented in **Table B-41 (for Treasure Island) and Table B-15 (for Long Key)**. All values are in FY20 price level and converted to average annual equivalent terms (AAEQ). The alternative with the highest BCR and net-benefits is S_TI_E_DWDH_0FT_6INT making it the NED Plan. Model optimizations to the final array are currently underway and as a result the NED plan as estimated to-date and in its current form may not be the recommended plan. However the recommended plan is estimated to be very similar to the alternatives outlined below with maximum dimensions of dune width extension of approximately 20', a maximum dune height of approximately 10' NAVD88, and a maximum berm extension of approximately 100'. It is important to note that, during the evaluation of the final array, costs for OMRR&R and IDC had not yet been calculated and are therefore only added to the recommended plan during the cost certification process and will be included along with the modeling optimizations.

**Table B-14: AAEQ Damages for Final Array of Alternatives (AAEQ $), Treasure Island**

| Alternative Name | Average Volume | Avg AAEQ Cost | Avg FWP Damage (AAEQ $) | FWOP Damage (AAEQ $) | Damage Reduction Benefits (AAEQ $) | Avg Land Loss Benefits (AAEQ $) | Avg Total Benefits (AAEQ $) | Net-Benefits (AAEQ $) | BCR |
|---|---|---|---|---|---|---|---|---|---|
| S_TI_E_DWDH_0ft_6INT | 446,000 | 1,505,000 | 778,000 | 4,111,000 | 3,332,000 | $12,000 | $3,344,000 | $1,839,000 | 2.22 |
| S_TI_E_DWDH_30ft_6INT | 483,000 | 1,954,000 | 965,000 | 4,111,000 | 3,146,000 | $10,000 | $3,156,000 | $1,202,000 | 1.62 |
| S_TI_E_DH_100ft_8INT | 411,000 | 2,132,000 | 760,000 | 4,111,000 | 3,351,000 | $10,000 | $3,361,000 | $1,229,000 | 1.58 |
| TI_E_DWDH_0ft_6INT | 409,000 | 2,665,000 | 728,000 | 4,111,000 | 3,383,000 | $22,000 | $3,405,000 | $740,000 | 1.28 |
| TI_Ends_60ft | 486,000 | 2,895,000 | 641,000 | 4,111,000 | 3,470,000 | $22,000 | $3,492,000 | $597,000 | 1.21 |

**Table B-15: AAEQ Damages for Final Array of Alternatives (AAEQ $), Long Key**

| Alternative Name | Average Volume | Avg AAEQ Cost | Avg FWP Damage (AAEQ $) | FWOP Damage (AAEQ $) | Damage Reduction Benefits (AAEQ $) | Avg Land Loss Benefits (AAEQ $) | Avg Total Benefits (AAEQ $) | Net-Benefits (AAEQ $) | BCR |
|---|---|---|---|---|---|---|---|---|---|
| LK_E_DWDH_0ft_6INT | 382,000 | $1,473,000 | $2,474,000 | $3,607,000 | $1,132,000 | $26,000 | $1,158,000 | ($315,000) | 0.79 |
| LK_U_DWDH_0ft_6INT | 483,000 | $870,000 | $3,114,000 | $3,607,000 | $493,000 | $16,000 | $509,000 | ($361,000) | 0.59 |
| LK_U_DWDH_30ft_6INT | 411,000 | $960,000 | $3,362,000 | $3,607,000 | $245,000 | $16,000 | $261,000 | ($699,000) | 0.27 |
| LK_U_DW_100ft_6INT | 409,000 | $1,849,000 | $3,217,000 | $3,607,000 | $390,000 | $14,000 | $404,000 | ($1,445,000) | 0.22 |
| LK_E_DWDH_30ft_6INT | 486,000 | $1,627,000 | $2,452,000 | $3,607,000 | $1,155,000 | $24,000 | $1,179,000 | ($448,000) | 0.72 |

In both Treasure Island and Long Key, the alternative that maximizes net benefits is a dune width and height expansion with minimal berm extension (DWDH_0ft). This alternatives prevents much of the FWOP damage at minimal cost. Other variations of a breach project involve similar benefits, but at a higher cost. In the case of Treasure Island, the optimum Plan only includes Sunset Beach, while in Long Key it includes both Upham Beach and Pass-a-Grille. A similar plan but with a 30 foot berm extension (DWDH_30ft) included preforms relatively well on both islands. It should be noted that overall project performance appears to be much better in Treasure Island than in Long Key. Though none of the Long Key alternatives appear to be incrementally justified based on primary (i.e., storm damage reduction) benefits alone, it is possible that at least a few of them could be justified with incidental recreation benefits added in (discussed later in this report).

Based on the most current modeling results (as described above) and the best available information at this time, the NED Plan appears to be the **DWDH_0ft** Alternative in Sunset, Upham, and Pass-a-Grille beaches. The following sections of this Appendix provide more information about this NED Plan. However, it should be noted that because the plan is still being optimized (in terms of both volume and interval), and because the Beach-fx model is being refined, there is still some uncertainty about the precise specifications of the proposed project. It seems fairly certain that a dune enhancement will be part of the Recommended Plan, but the exact size, location, volume, and renourishment interval will be refined between the draft and final feasibility report. Also, there is considerable uncertainty regarding a potential berm extension. Therefore, the tentatively selected plan (TSP) is described in broad terms using flexible language in the main report. The remaining sections of this appendix focus on the DWDH_0ft alternative.

# 5 Tentatively Selected Plan (TSP)

Based on the most current modeling results (as described above) and the best available information at this time, the NED Plan appears to be the **DWDH_0ft** Alternative in Sunset, Upham, and Pass-a-Grille beaches. The following sections of this Appendix provide more information about this NED Plan. However, it should be noted that because the plan is still being optimized (in terms of both volume and interval), and because the Beach-fx model is being refined, there is still some uncertainty about the precise specifications of the proposed project. It seems fairly certain that a dune enhancement will be part of the Recommended Plan, but the exact size, location, volume, and resnourishment interval will be refined between the draft and final feasibility report. Also, there is considerable uncertainty regarding a potential berm extension. Therefore, the tentatively selected plan (TSP) is described in broad terms using flexible language in the main report. The remaining sections of this appendix focus on the DWDH_0ft alternative.

### 5.1.1 Performance of NED/Recommended Plan in the SLC Scenarios[3]

An important question when evaluating a final array of alternatives is performance under different SLC scenarios. For the NED plan identified using the SLC3 scenario the net-benefits using primary benefits (i.e. without recreation benefits added) are negative under the SLC2 and SLC1 scenario. This result is due to the fact that the benefit base (i.e. FWOP damages) is much smaller in the SLC1 and SLC2 but the costs of maintaining the template are higher. See the tables for details on the NED plan in the three SLC scenarios. Additionally, it is important to know if the NED plan would still be the NED plan under each scenario and for both segments that is indeed the case. It is also the case in Long Key. Though the combined project described below does not appear to be economically justified in the High SLC scenario based on primary benefits, it will be justified (in all three scenarios) when incidental Recreation benefits are included.

**Table B-16: FWOP and Recommended Plan Damages in SLC Scenarios – Combined**

| SLR Scenario | Alternative Name | Avg AAEQ Cost | Avg FWP Damage (AAEQ $) | Avg FWOP Damage (AAEQ $) | Damage Reduction Benefits (AAEQ $) | Avg Land Loss Benefits (AAEQ $) | Avg Total Benefits (AAEQ $) | Net-Benefits (AAEQ $) | BCR |
|---|---|---|---|---|---|---|---|---|---|
| **SLR1** | S_TI_E_DWDH_0ft_6INT and LK_E_DWDH_0ft_6INT | $2,978,000 | $1,931,000 | $4,918,000 | $2,987,000 | $86,000 | $3,073,000 | $95,000 | 1.03 |
| **SLR2** | S_TI_E_DWDH_0ft_6INT and LK_E_DWDH_0ft_6INT | $3,132,000 | $2,070,000 | $5,134,000 | $3,064,000 | $140,000 | $3,204,000 | $72,000 | 1.02 |
| **SLR3** | S_TI_E_DWDH_0ft_6INT and LK_E_DWDH_0ft_6INT | $4,289,000 | $3,589,000 | $7,718,000 | $4,129,000 | $38,000 | $4,167,000 | -$122,000 | 0.97 |

### 5.1.2 Risk and Uncertainty with the NED Plan

With any modeling effort utilizing a monte-carlo life-cycle approach there is uncertainty inherent in the results. The benefit of a monte-carlo simulation is that a range of inputs (e.g. first-floor elevation, structure value, content value) are modeled and an average obtained over many iterations. This section will discuss the results on an iteration-by-iteration basis for the NED plan to attempt to quantify the uncertainty with the NED plan net-benefits. It is important to note that this analysis only takes into consideration net-benefits of storm-damage reduction and does not consider land loss or recreation benefits.

Figure b-29 displays the frequency distribution of net-benefits across all iterations in each of the SLC scenarios. This figure demonstrates the relatively high risk of the NED being economically unjustified. The results in the SLC1 and SLC2 scenarios are skewed negatively whereas SLC3 is skewed positively. For SLC1 and SLC2 roughly one-half of all iterations are mildly net-negative and around 10% are largely net-negative. For SLC3 over half of the iterations yielded net-benefits in excess of $1,000,000 AAEQ. Table B-17 demonstrates the percentage of iterations in which net-benefits were negative or positive in each of the SLC scenarios. It should be noted that this analysis is based on preliminary cost data used directly in the Beach-fx analysis. More refined costs, with regard to the TSP, are discussed later in this appendix.

**Figure B-29 Net-Benefit Frequency Distribution Based on 100 Iterations**

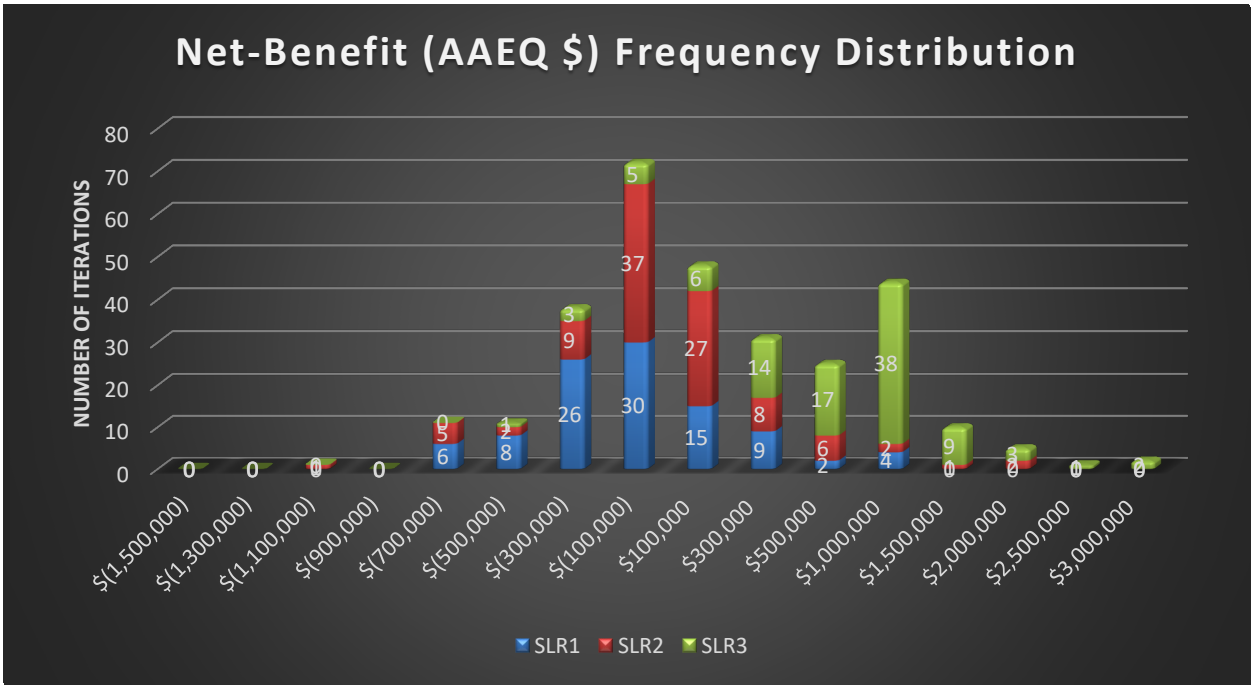



**Table B-17 Percentage of Iterations with Negative or Positive Net-Benefits**

| | *SLC1* | *SLC2* | *SLC3* |
|---|---|---|---|
| **% of Iterations with Negative Net-Benefits** | 70% | 54% | 9% |
| **% of Iterations with Positive Net-Benefits** | 30% | 46% | 91% |

One important item that Beach-Fx does not allow uncertainty around are the planned nourishment costs. Currently the assumption is that Treasure Island nourishments will always coincide and share the mobilization cost equally with Long Key segment. If this were not to be the case the mobilization cost would double, further jeopardizing economic justification. Additionally the unit cost assumes that only the passes would need to be utilized and that material from Egmont Shoal would not be required. These assumptions will be further analyzed during the NED plan optimization and costs will be adjusted pending that optimization.

## 5.2 Cost of the Recommended Plan

One a TSP is selected, the preliminary cost estimate can be refined. In this case, a more detailed estimated cost for the TSP is approximately $211 M over the 50 year period of analysis. This includes initial construction in 2028 and seven renourishment events over 50 years. More information about the cost estimate is provided in the Cost Appendix.

### 5.2.1 OMRR&R Costs of the Project

In addition to PED and construction management, the annual economic cost of a project includes costs associated with periodic operations, maintenance, repair, replacement, and rehabilitation of the project (OMRR&R). The OMRR&R costs are fully non-Federal, they are considered part of the overall economic cost of the project. For coastal projects, these costs include items like long term environmental monitoring, escarpment removal, dune vegetation, and maintenance of features required for public access. In the case of the proposed Pinellas County project, the annual OMRR&R cost is estimated to be $30,000 per year.

### 5.2.2 Economic Cost of the Recommended Plan

The Economic cost of the project must also account for the time value of money. Per planning guidance, the costs and benefits of the NED Plan should be compared in average annual equivalent (AAEQ) terms.

**Table B-18 Summary of TSP Costs**

| | |
|---|---|
| **Total First Cost of Project** | **$211,089,000** |
| **Interest During Construction** | $52,536 |
| **Total Economic Cost** | $211,141,536 |
| **Present Value Cost** | $115,802,263 |
| **AAEQ* Cost** | $4,289,422 |

*Annual costs computed at the FY18 discount rate (2.75%)

## 5.3 Benefits of the Recommended Plan

### 5.3.1 Storm Damage Reduction Benefits

As described elsewhere in this report, direct damage reduction benefits refer to reduced damages to structures, contents, and armor as estimated by Beach-fx. The TSP prevents about 50% of the total FWOP damage, for 2.856 in annual benefits. A more detailed breakdown is provided in Table B-19.

**Table B-19 Summary of TSP Direct Damage Reduction Benefits**

| | Treasure Island | Long Key | Total |
|---|---|---|---|
| AAEQ FWOP Damages | $4,111,000 | $3,607,000 | $7,718,000 |
| AAEQ FWP Damages | $1,115,000 | $2,474,000 | $3,589,000 |
| AAEQ Damage Reduction Benefits | $2,996,000 | $1,132,000 | $4,128,000 |

### 5.3.2 Land Loss Benefits

In outlining the process and procedures to be used in the evaluation of CSRM projects, ER-1105-2-100 details the inclusion of land loss due to erosion, stating that such damages should be computed as the market value of the average annual area expected to be lost. Prevention of land loss is a component of primary benefits and is computed based on output data from Beach-fx. Land loss benefits must be added

to the structure and content benefits as computed by Beach-fx to obtain the total CSRM benefits of the project.

Following the guidance provided, two key pieces of information are needed to calculate land loss benefits of a CSRM project: (1) the square-footage of the land lost each year and (2) the market value of land in the project footprint.

In the case of Pinellas County Treasure Island Segment, annual reduction of upland width across all Beach-fx study reaches was obtained from the Beach-fx *LandLoss.csv* FWOP and FWP output files based on modeled changes to the shoreline. ER 1165-2-130 does not allow land loss benefits be claimed for beach areas subject to temporary shoreline recessions. Thus, changes in upland width rather than changes in berm width are used as the appropriate measure of land loss.

For Beach-fx model reaches located within the study area the basis of the annual changes in upland width calculation for the FWOP is the width in each reach in the model start year (2027) and the width of each subsequent year until armoring is triggered. Once a reach has armoring triggered upland width changes are no longer calculated. The same calculation is then done for each alternative and the comparison of upland width change from the FWOP and FWP in a given year results in the *cumulative* loss of land for that specific model reach. However, for the purpose of calculating land loss benefits, the *annual* loss of width is needed. This is obtained by taking the cumulative change in width in a given year and subtracting from it from the cumulative change in width from the previous year. This calculation results in the yearly incremental change in upland width for a given reach.

Using the annual decrease in width for a specific reach and the corresponding length of shoreline eligible for land-loss benefits, the total annual square-footage of land lost is obtained on a reach-by-reach basis and then summed across all study reaches for a given project year.

As the second component of the land-loss benefits calculation, ER 1105-2-100 instructs that nearshore land values be used to estimate the value of land lost. Currently the value being used per square-foot is $90 and is based on previous CSRM studies of nearby Florida coastline. This value will be updated during the optimization modeling.

Using the analysis technique described, the total present value of land-loss benefits over the 50 year period of analysis for the NED plan is estimated at $38,000 in average annual equivalent (AAEQ) terms. This is a relatively low number and is a function of the fact that armor construction in the FWOP prevents the majority of loss of land and therefore precludes the ability of a project to preserve lost upland. This estimate ($38,000 in annual benefits) represents the most likely estimate of land loss benefits. But, in accordance with Principles of Risk Informed Planning (PRIP), a range of land loss benefits is currently being developed based in variability in the Beach-fx outputs (particularly the *Land Loss* csv file).

### 5.3.3 Incidental Recreation Benefits

According to ER-1105-2-100, incidental recreation benefits can be calculated in CSRM studies. Recreation benefits are not to be used in plan formulation, but they can constitute up to 50% of total project benefits needed for economic justification.

For coastal storm risk management feasibility studies, recreation benefits are sometimes calculated using the travel cost method (TCM). The basis for this method is the concept that by increasing the carrying capacity of a particular recreation resource, a project may reduce the travel time (and travel cost) associated with recreation visits. In this case, preliminary investigations concluded that there is no excess demand for recreation in the proposed project area. Therefore, the travel cost method is not applicable.

However, even though the proposed Pinellas project does not necessarily increase the *availability* or *quantity* of recreation in the project area, there may be some benefits associated with increasing the *quality* of recreation that would occur in the Future Without-Project Condition. Thus, recreation benefits have been calculated using the Unit Day Value (UDV) method, as described in EGM 09-03 and in Appendix E of ER 1105-2-100.

The Unit Day Value method estimates a user's willingness to pay for a given recreational opportunity (i.e. a dollar amount the recreational experience would be worth to them were they required to pay). This value is estimated via a series of criteria applied to the various recreational facilities and opportunities provided by the project; criteria gauging the overall quality of the experience, availability, carrying capacity, accessibility, and environmental factors. Each criterion can be assigned a score selected from one-of-five possible ranges which represents rating from low to high. These point values are summed together and applied a dollar day value based on the current UDV guidance. The current unit day values, provided by USACE Economic Guidance Memo #20-03, *Unit Day Values for Recreation*, *FY 2020*, are presented in **Table B-20**. Linear interpolation was used to estimate the dollar value of point scores between. So, for example, a point score of 2 in General Recreation corresponds with a dollar value of $4.20.

**Table B-20 - 2020 Unit Day Values for Recreation**

| Point Values | General Recreation Values (1) | General Fishing and Hunting Values (1) | Specialized Fishing and Hunting Values (2) | Specialized Recreation Values other than Fishing and Hunting (2) |
|---|---|---|---|---|
| 0 | $4.21 | $6.06 | $27.33 | $15.86 |
| 10 | $5.00 | $6.85 | $28.07 | $16.84 |
| 20 | $5.53 | $7.37 | $28.55 | $18.06 |
| 30 | $6.32 | $8.16 | $29.29 | $19.52 |
| 40 | $7.90 | $8.85 | $30.02 | $20.74 |
| 50 | $8.95 | $9.74 | $32.95 | $23.43 |
| 60 | $9.74 | $10.80 | $35.87 | $25.87 |
| 70 | $10.27 | $11.32 | $38.07 | $31.24 |
| 80 | $11.32 | $12.11 | $41.00 | $36.36 |
| 90 | $12.11 | $12.38 | $43.93 | $41.49 |
| 100 | $12.64 | $12.64 | $46.37 | $46.37 |

The recreation Point Values assigned to the Pinellas County proposed project area vary by year. In the FWP condition, they are assumed to stay the same the same as in the FWOP, because the project will maintain the dune and a small recreational berm (the FWOP and FWP are the same in the base year, 2028). However, in the FWOP, as erosion affects both islands over time, the quality of recreation gradually declines. The sum of assigned point scores in different categories are summarized in **Table B-21.**

**Table B-21: Total Unit Day Point Scores applied to the Pinellas County project area**

| Year | Without Project | With Project | Increased Point Values With Project |
|---|---|---|---|
| 2028 | 60 | 60 | 0 |
| 2038 | 55 | 60 | 5 |
| 2048 | 47 | 60 | 13 |
| 2058 | 39 | 60 | 21 |
| 2068 | 27 | 60 | 33 |

The point assignments are based on qualitative criteria; they depend on best professional judgment (i.e. "judgment criteria" as described in EGM 20-03).

- **Recreation Experience:** Beaches in Pinellas County project area were assigned a point score of 21 in the FWOP, which corresponds to "several general recreation activities; more than one high quality activity." The beaches on Treasure Island offer visitors the opportunity to experience several general activities, including swimming, surfing, and walking along the beach. As for high quality activities, the beaches on the island are a premier destination for wildlife viewing (specifically turtle nesting) and shell collecting. Initially, the value in the FWP is also assigned a 21 because the FWOP and the FWP conditions are identical until the next nourishment event. However, the assigned value for the FWOP declines throughout the project life as degradation of quality is anticipated. By the end of Federal participation, the score has declined to an 11. This scores indicates that general recreation activities are still possible, but with a lower overall quality. In the FWP condition, the existing quality (score 21) is maintained through the remaining 40 years of Federal participation. This difference over time is the source of recreation benefits.
- **Availability of Opportunity:** The project area beaches were assigned a point score of 1, which corresponds to "several opportunities within one hour of travel time; few within 30 minutes." The beaches in the study area have numerous substitutes available nearby, including other recreational beaches on both Treasure Island and Long Key that are not included in the proposed project area. The availability score does no change between the FWOP and FWP conditions, or over time.
- **Carrying Capacity:** In both the FWOP and FWP the carrying capacity was initially assigned a point score of 11, indicating "optimum facilities" to conduct recreation activities. Throughout the project area there are numerous public parking and access points, relatively wide beaches, and supporting facilities such as public restroom, dune walks, and gazeboes. Given these conditions, "optimum" seems like a reasonable category (better than "adequate", but less than "ultimate"). In the FWP condition this score remains the same over time. However, in the FWOP, the carrying capacity is expected to decline significantly as erosion occurs to the berm and dune and as parking lots and dune walks are damaged. By 2068, the project has been assigned a score of 3, which corresponds to "basic facilities."
- **Accessibility:** Initially, both the FWOP and FWP conditions were assigned a score of 11, which corresponds to "good access, good roads to site, fair access, and good roads within site." Again, the FWP score does not change over time in this category. In the FWOP, beaches in the project would gradually become less accessible for recreation over time. Though significant road damage is not expected to occur, armored potions of the project will become less accessible. Currently, in some of the armored beaches, the beach available for recreation is relatively narrow at high tide. In the future, erosion and rising sea levels will likely make the beach even narrower, and could make it disappear entirely at high tide. The roads will continue to be good, but accessibility *within* the site will decline. Therefore, the assigned score declines gradually through the period of analysis. By 2056 it has been assigned a 6, a score that corresponds to "limited access within site." 6 is the maximum score for that

particular judgment category (the maximum was assigned because the roads should still be in good condition).

- **Environmental Quality:** In the existing condition, this category was assigned a score of 14, which corresponds to "high aesthetic quality." The beaches within the project area currently in a generally good condition, and both Treasure Island and Long Key are considered a vacation destinations. The FWP condition score does not change over time. Over time, in the FWOP, the aesthetic quality of the project area beaches are expected to deteriorate somewhat as damages are inflicted on coastal structures (including dune walks) and existing armor. By 2056, the score assigned to Environmental Quality was reduced to 3, which corresponds with "average aesthetic quality; factors exist that lower quality to a minor degree."

As noted above, all scores are the same in the base year (2028) for the FWOP and FWP condition.

**Visitation Projections**

County level recreation data in dictates that approximately 9 million visitors recreate on Pinellas County beaches per year. This number is based on a five year moving average (2015-2019) and includes visitors from other parts of Florida, other states, and foreign tourists, as well as visits from local residents within the County. Visitation numbers in 2020 are expected to be much lower, but that should be considered an outlier given the pandemic. In general, Pinellas County is a major destination for beach recreation.

However, only a portion of the beach recreation visitation in Pinellas County occurs in the proposed project area. Most of the beach visitors to the county go to either Sand Key or Clearwater Beach, which are not part of the project. Based on analysis of publicly available parking spaces throughout the county, it is estimated that 28.3% of total Pinellas County beach recreation occurs on beaches that would benefit from directly from this project (i.e., Sunset Beach, Upham Beach, and Pass-a-Grille). This translates to 2,547,000 visitors per year that could benefit from the project (in terms of improved recreational quality). However, though more than 2 million visitors year could experience recreational benefits from the proposed project, USACE policy limits the potential number of visitors that can be assumed in a UDV analysis to 750,000 per year. This cap (750,000) must be applied to the Pinellas recreation analysis.

**Benefits**

Based on the UDV point scores and capped visitation numbers described above, the total annual recreation benefits of the project are estimated to be $1,128,000. It should be noted that uncertainty in the assumptions results also pertains to the Recreation benefits. Therefore, a range of recreation benefits is currently being developed to account for this uncertainty as it pertains to the TSP.

## 5.4 BCR and Net Benefits of the TSP

The net benefits of the recommended plan incorporate both the costs and benefits of the project. The below table (**Table B-22**) provides a summary. Average Annual costs and benefits have been computed at FY20 price levels and at the FY20 water resources discount rate (2.75%).

**Table B-22. Pinellas County Economic Summary of the TSP**

| | |
|---|---|
| Total First Cost of Project | $211,089,000 |
| Interest During Construction | $52,536 |
| Total Economic Cost | $211,141,536 |
| Present Value Cost | $115,802,263 |
| AAEQ* Cost | $4,289,422 |
| Annual OMRR&R | $30,000 |
| **Total AAEQ* Cost** | **$4,319,422** |
| | |
| | |
| AAEQ Damage Reduction Benefits | $4,128,018 |
| AAEQ Land Loss Benefits | $38,000 |
| AAEQ Recreation Benefits | $1,128,000 |
| **AAEQ Total Benefits** | $5,294,018 |
| | |
| **AAEQ Net Benefits** | **$974,596** |
| **Benefit-Cost Ratio (BCR)** | **1.23** |

As shown in the table, when all benefits are included (damage reduction, land loss, and incidental recreation benefits), the TSP is estimated to generate about $975 in annual net benefits, with a BCR of 1.23.

## 5.5 Uncertainty in Net Benefits based on Refined Costs

As previously explained, the Monte-Carlo simulation capability within Beach-fx allows the user to account for uncertainty based in variability in the model results. Each Beach-fx iteration represents a distinct life cycle, with its own simulated storms and unique estimated damages. The distribution of damages and benefits (over the various iterations) can be compared to estimated costs, which provides a picture of uncertainty with regard to net benefits. The previous discussion of uncertainty was based on preliminary, rough-order-of-magnitude costs. This discussion of unceratinay in the net befeits (with regard to the TSP), is based on more refined costs as deceibed in the Cost Appendix.

While uncertainty in the benefits is based on variability in the Beach-fx outputs, uncertainty in the costs is accounted for in the cost-schedule risk assessment and is represented by the contingency (30%, in this case). Generally greater uncertainty leads to a higher contingency.

An analysis of the net benefits generated by the Pinellas TSP indicates some risk that the costs ultimately could exceed the benefits (i.e., BCR <1). A visual depiction of the benefits (by iteration) relative to cost is provided in Figures 30 and 31.

**Figure 31. Benefits by Beach-fx Iteration, compared to estimated costs**

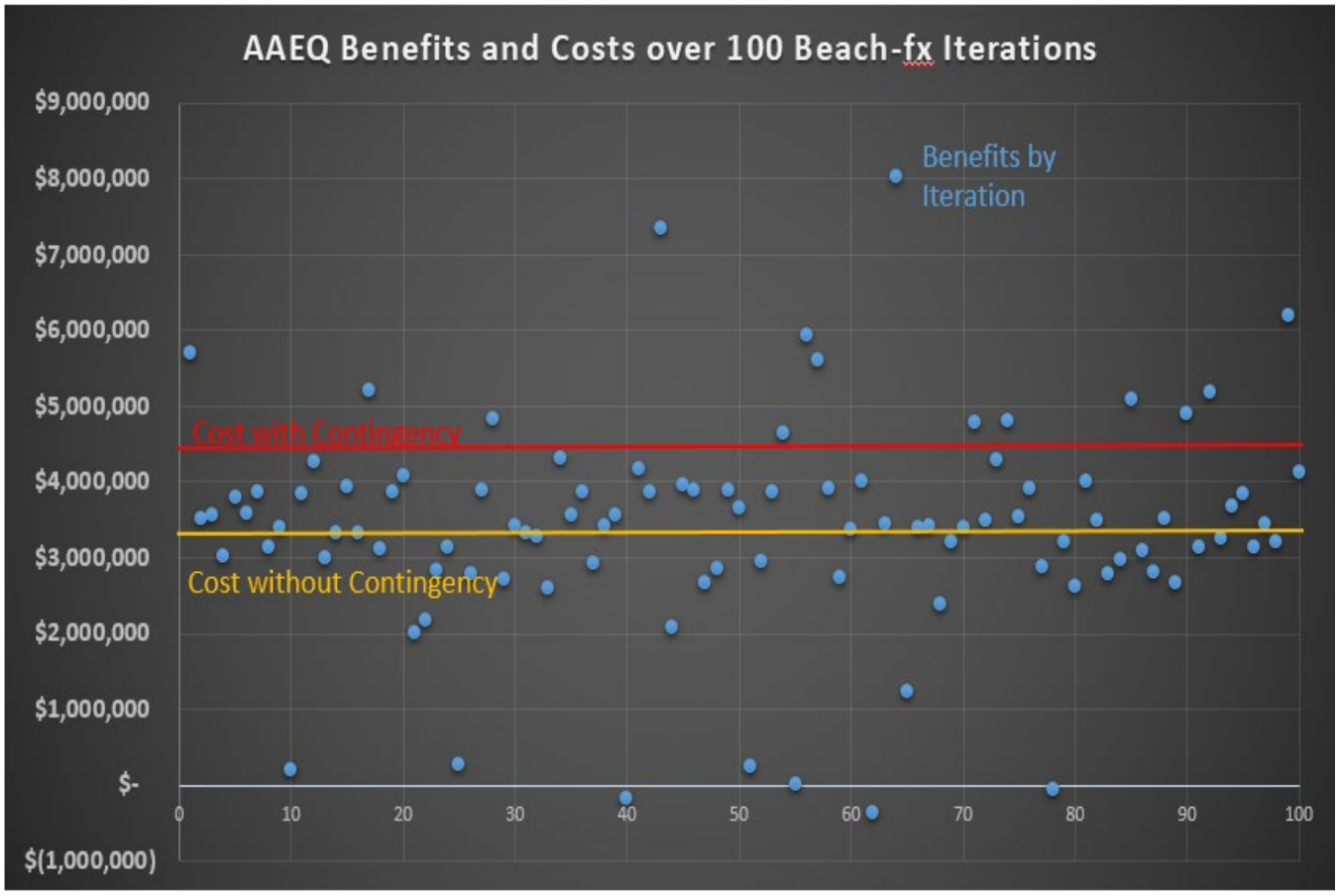
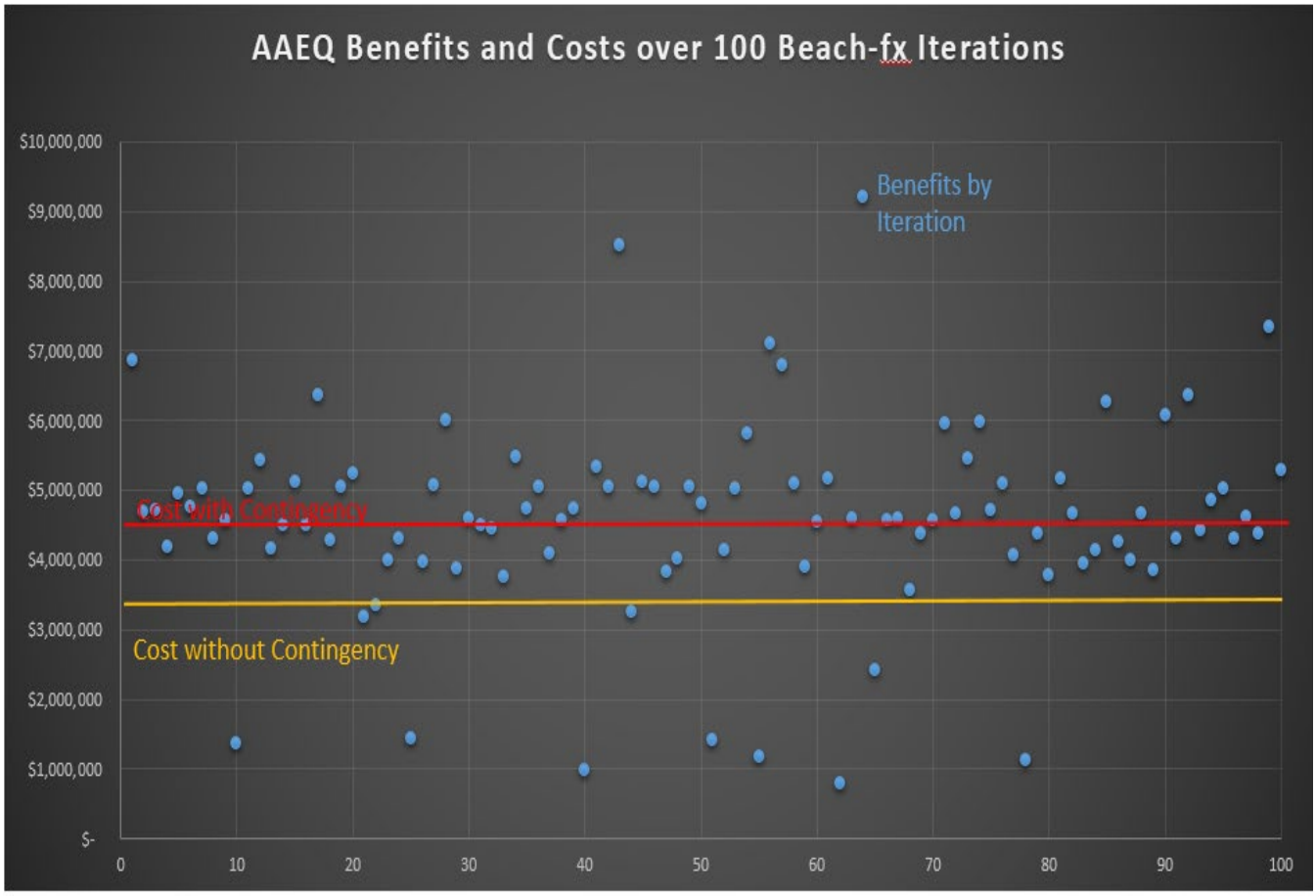


**Figure 32. Benefits by Beach-fx Iteration, with Land Loss and Recreation benefits added, compared to estimated costs**




In terms of direct damage reduction benefits (structures, contents, and armor) it is actually more likely that costs would exceed benefits. However, when all the benefits are included (recreation and land loss), there is 90% probability (90 out of 100 iterations) that benefits will exceed non-contingency costs and 64% probability that it will exceed costs when including contingency. So, while there is some risk that the project will not ultimately generate positive net benefits over the 50 year period of analysis, it is more likely it that will. It should be noted that these charts are based on the High SLC scenario; project performance with regard to net benefits is slightly better in the other scenarios. Also, further optimization of the TSP is expected to increase net benefits somewhat during development of the final report.

## 5.6 Conclusion and Recommendations

The economic analysis in this report indicates that a Federal CSRM project along the Pinellas County shoreline, on Treasure Island and Long Key, would be economically justified. In accordance with ER-1105-2-100 and other planning guidance, the existing conditions have been characterized, a reasonable future without project condition has been developed, and alternatives have been evaluated. Based, on those evaluations, the tentatively selected plan (TSP) calls for a dune enhancement project on both islands.

The optimized plan has positive net benefits and a benefit-cost-ratio above unity. The details of the TSP are subject to change because both the Beach-fx model and the plan itself are still being refined, including further optimization of the volumes and renoruishment intervals.