LEE COUNTY, FLORIDA

SHORE PROTECTION PROJECT

GASPARILLA ISLAND SEGMENT

Final Integrated Section 934 Report and Environmental Assessment

APPENDIX C
Economics

May 2018

US Army Corps of Engineers
Jacksonville District

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Executive Summary

The Lee County Gasparilla Shore Protection Project consists of approximately 2.8 miles of shoreline along the southwestern coast of Florida. The project consists of periodic beach nourishment; it provides for initial construction and periodic renourishment at seven-year intervals along 2.8 miles of gulf shoreline. The design template is defined by a 20 foot extension of the project baseline, roughly the 1995 mean high water (MHW) line, at +5 FT. –MLW (3.75 FT-NAVD88).

The entirety of project is located in the city of Boca Grande, Florida. The project was authorized in 1976, and modified by the Water Resources Development Act (WRDA) of 2000. Authority was granted (in WRDA 2000) for initial construction and a ten year period of Federal participation. Initial construction was completed as a reimbursable project by the sponsor in 2007. A renourishment of the project was completed in 2013.

The Lee County Gasparilla 934 Report is intended to investigate the feasibility of extending the period of Federal participation in periodic nourishments to a full 50 years. This would add 40 years to the period of Federal participation in periodic nourishments, from 2016 through 2056. The purpose of this document is to describe the economic analysis of the 934 Report, including the future without project (FWOP) and future with project (FWP) conditions as simulated by the Corps certified model Beach-*fx*. It is intended to explain the approach, assumptions, and results of the economic analysis.

The economic analysis in this report confirms that continued Federal participation in the Lee County Gasparilla coastal storm risk management project is economically justified. In accordance with planning guidance and the stated purpose of a Section 934 report, an optimized version of the authorized project is the recommended plan. The optimized plan has positive net benefits and a benefit-cost-ratio above unity. The total project first cost (in FY18 dollars) is $35.771 million and the total investment cost is $35.771 million. At the current (FY18) water resources discount rate (2.75%), the average annual benefits are $1.375 million and the average annual costs are $941,000. The average annual net benefits of the recommend project are approximately $**434,000** and the benefit-cost ratio is **1.46.** As a result of the optimization of the authorized project, the recommended plan is defined as a 20 foot extension of the project baseline, roughly the 1995 MHW line, at +5 ft.-MLW (3.75 ft-NAVD88); a foreshore slope of 1V:15H transitioning to a nearshore slope of 1V:25H from MLW extending out to the intersection with the existing profile; a 60 foot advance/sacrificial berm accounts for an average periodic nourishment interval of 22 years; only two renourishments are expected throughout the remaining 40 year period of analysis

1 Introduction

The Lee County Gasparilla Shore Protection Project consists of approximately 2.8 miles of shoreline along the southwestern coast of Florida. The entirety of project is located in the city of Boca Grande, Florida. The project was authorized in 1976, and modified by the Water Resources Development Act (WRDA) of 2000. Authority was granted (in WRDA 2000) for initial construction and a ten year period of Federal participation. Initial construction was completed as a reimbursable project by the sponsor in 2007.

The authorized project provides for initial construction and periodic nourishment at seven-year intervals along 2.8 miles of gulf shoreline. The design template is defined by a 20 foot extension of the project baseline, roughly the 1995 mean high water (MHW) line, at +5 FT. –MLW (3.75 FT-NAVD88). **See Figure 1**.

Figure 1 Project Vicinity Map

1.1 Purpose of Report

The Lee County Gasparilla 934 Report is intended to investigate the feasibility of extending the period of Federal participation in periodic nourishments to a full 50 years. This would add 40 years to the period of Federal participation in periodic nourishments, from 2016 through 2056. The purpose of this document is to describe the economic analysis of the 934 Report, including the future without project (FWOP) and future with project (FWP) conditions as simulated by the Corps certified model Beach-*fx*. It is intended to explain the approach, assumptions, and results of the economic analysis.

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 rise (SLR) 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 SLR scenarios. Section 5 also has a brief conclusion. The appendix includes an attachment, *Addendum A*, which provides more information about the real estate assessment used in the Economics Appendix.

2 Existing Conditions

2.1 Beach-fx Economic Modeling Approach

Beach-*fx* was developed by the USACE Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi. 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. Beach-*fx* fully incorporates risk and uncertainty, and 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 damage incurred by the temporary loss of a given amount of shoreline as a direct result of waves, erosion, and inundation caused by a storm of a given magnitude and probability. Beach-fx is an event-driven life-cycle model that estimates damages and associated costs over a 50 year period of analysis based on storm probabilities, tidal cycle, tidal phase, beach morphology and many other factors. Damages or losses to developed shorelines include buildings, pools, patios, parking lots, roads, utilities, seawalls, revetments, bulkheads, replacement of lost backfill, etc. Beach-*fx* also provides the capability to estimate the costs of certain future measures undertaken by state and local organizations to protect coastal assets.

It should be noted that the future structure inventory and values are the same as the existing condition. This conservative approach neglects any increase in value due to future development. Due to the uncertainty involved in projections of future development, using the existing inventory is preferable and considered conservative for Florida where coastal development has historically increased in density and value.

The Lee County Gasparilla FWOP 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 Manual (August 2009); the manual is referenced throughout this document.

2.1.1 Model Reaches

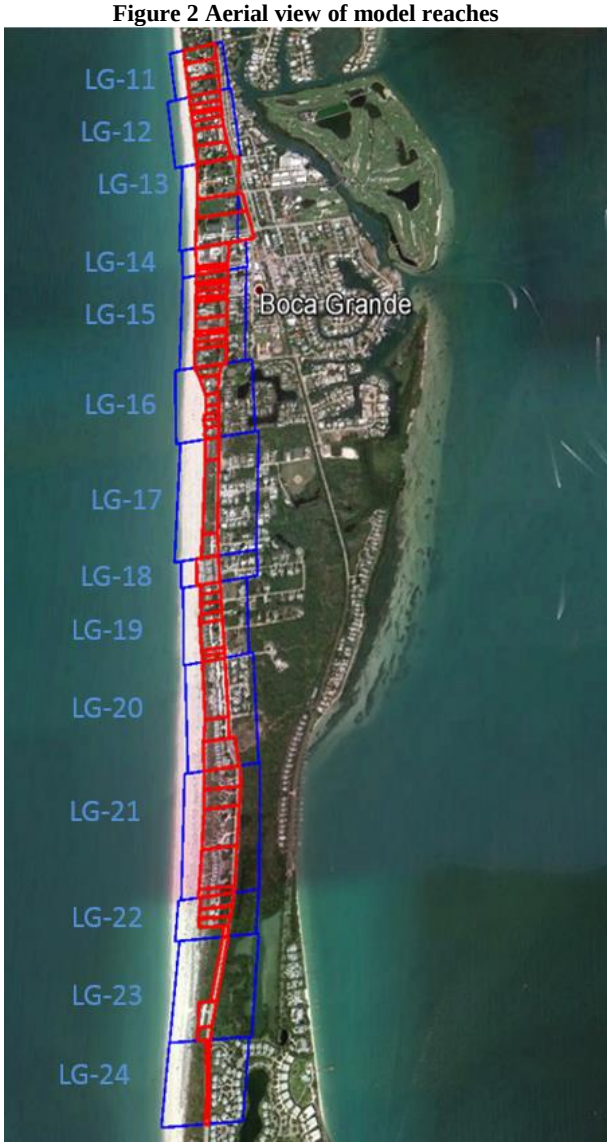
The broadest spatial category of socioeconomic inputs into Beach-*fx* is the model reach. There are 14 total reaches in the Gasparilla model, varying in length (parallel to the shoreline) from about 380 feet to about 1500 feet. They vary in width (perpendicular to the shoreline) from about 780 feet to 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 LG-11, the most southerly reach is LG-24. The extents of the study (both northerly and southerly) are based on the authorized project. Analysis of additional reaches beyond the current extent is beyond the scope of a 934 Report. 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. In this case, because the study is a Section 934 Report (rather than a feasibility study), multiple study reaches have not been developed. The project is already authorized; it is being analyzed as constructed-as a complete whole. The project may be modified somewhat (for example the recommend renourishment interval could change), but it has not been broken up into study reaches. Thus model reaches are the broadest spatial category in this study.

2.1.2 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. An Ariel view of the model reaches and lots is provided in **Figure 2**. Reaches are outlined in blue, lots are outlined in red.

Figure 2 Aerial view of model reaches



2.1.3 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. Real Estate professionals from the USACE Jacksonville district (SAJ) provided updated depreciated replacement costs for all of the damage elements in the summer of 2014. 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, bathhouses, pools, etc...) had zero contents value. An aerial view of a sample reach (R-15), with all lots and damage elements displayed, is shown in **Figure 3**.

Figure 3 Aerial view of R-15 with all lots and damage elements identified

2.2 Existing Condition Coastal Inventory

The Gasparilla study area has 282 individual damage elements, including 74 single family residential structures, 72 multifamily structures, 5 commercial/public structures, and numerous other structures including roads, dune walks, gazebos, parking lots, pools, and tennis courts. The public/commercial category includes some unique structures, such as Johann Fust Community Library and the Gasparilla Lighthouse. The total value of the existing inventory is estimated to be $222 million (including content values, but not including existing coastal armor such as seawalls and revetments). A summary of the damage elements (by type) is provided in **Table 1**. More information about the Gasparilla 934 Real Estate assessment is provided in Addendum A of this appendix.

Table 1: Distribution of Depreciated Replacement Value by Structure Type

Type	Description	Count	Structure Value	Contents Value	Total Value
COMM	Commercial/Public	5	$2,070,837	$975,437	$3,046,274
GARAGE	Garage	16	$765,000	$50,000	$815,000
GAZEBO	Gazebo	10	$102,000	$0	$102,000
LIGHTHOUSE	Gasparilla Lighthouse	1	$1,200,000	$600,000	$1,800,000
MFR1	Multi-family 1 Story	7	$6,392,576	$3,196,288	$9,588,864
MFR2	Multi-Family 2 Story	64	$48,083,986	$24,042,000	$72,125,986
MFR3	Multi-Family 3 Story	1	$320,843	$160,422	$481,265
PARKING	Parking Lot	6	$280,000	$0	$280,000
POOL	Pool	35	$420,000	$0	$420,000
ROAD	Road	55	$7,122,944	$0	$7,122,944
SFR1	Single Family Residence	74	$84,021,428	$42,010,716	$126,032,144
TENNIS	Tennis Court	5	$215,000	$0	$215,000
WALK	Dune Walkover	3	$34,500	$0	$34,500
Grand Total	**Total**	**282**	**$151,029,114**	**$71,034,863**	**$222,063,977**

*Individual road damage elements are delineated based on the lots; to avoid excessive length each road damage element longer than 600 feet was divided into two elements.

A summary of the damage elements by Reach is provided in **Table 2**. The northern reaches (LG11-12) are almost entirely residential; they consist of large, high value single family homes as well as pools, garages, and roads. The central reaches (LG13-20) are a mixture of single family homes, multifamily structures, some commercial structures (hotels) which include associated structures such as pools garages, tennis courts, and parking lots. The middle section of the project also includes a public park and the Gasparilla Lighthouse. The southern reaches (LG21-24) primarily consist of multi-family structures as well as a few single family homes and public park. The most southerly reach (LG24) has no damageable elements except for roads. The following sections briefly describe the individual damage elements categories.

Table 2: Structure Distribution by Reach

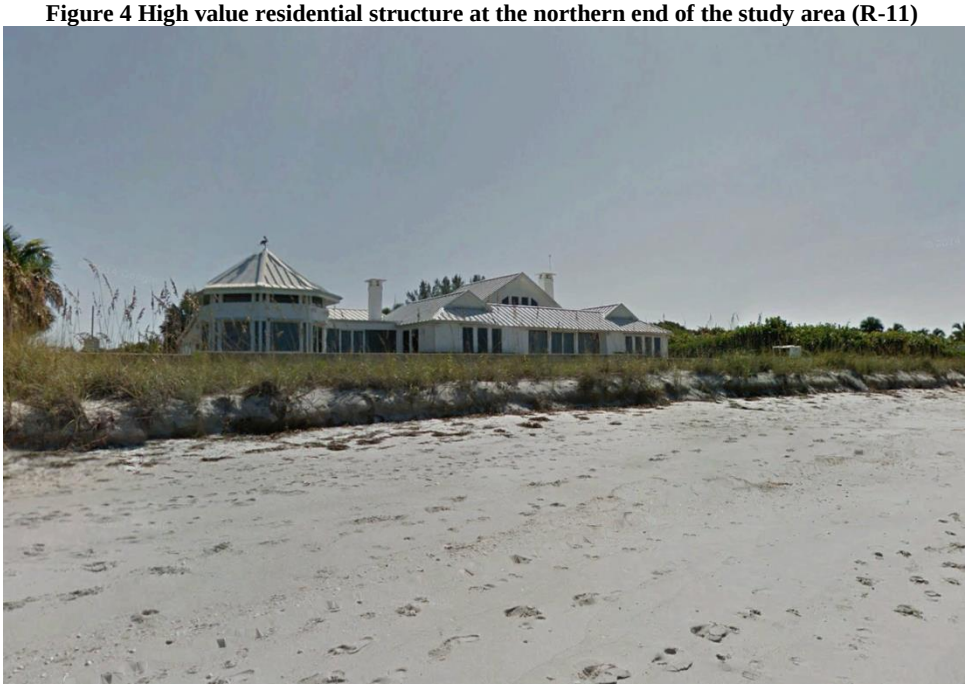
Reach	# of Structures	Structure Value	Contents Value	Total Value
LG-11	14	$7,604,452	$3,509,786	$11,114,238
LG-12	43	$28,115,844	$13,459,783	$41,575,627
LG-13	17	$12,192,404	$5,691,846	$17,884,250
LG-14	12	$5,951,985	$2,776,077	$8,728,062
LG-15	38	$27,597,011	$13,554,186	$41,151,197
LG-16	21	$9,480,154	$4,411,235	$13,891,389
LG-17	19	$3,386,736	$1,286,400	$4,673,136
LG-18	7	$1,222,912	$500,000	$1,722,912
LG-19	22	$17,145,106	$8,270,314	$25,415,420
LG-20	25	$6,311,080	$2,744,496	$9,055,576
LG-21	49	$26,876,582	$12,981,250	$39,857,832
LG-22	7	$3,958,564	$1,849,490	$5,808,054
LG-23	5	$706,428	$0	$706,428
LG-24	3	$479,856	$0	$479,856
Total	**282**	**$151,029,114**	**$71,034,863**	**$222,063,977**

*Individual road damage elements are delineated based on the lots; to avoid excessive length each road damage element longer than 600 feet was divided into two elements.

2.2.1 Single Family Residential

Single family residential structures can be found throughout the study area, though they are most dense in the northerly reaches. Some of these homes are high value structures exceeding $1 million in depreciated replacement values. Single family homes represent the largest category of total economic value (more than $126 million). A few examples of single family homes in the study area are presented in **Figures 4 and 5.**

Figure 4 High value residential structure at the northern end of the study area (R-11)



Property near 15th Street West, Boca Grande FL

Figure 5 Residential structures in Reach 16

Property near 132 Gulf Blvd, Boca Grande FL

2.2.2 Multi-Family Residential

Multi-family residential structures (primarily condominiums) are found in the central and southern reaches of the study area. These structures are diverse in terms of value and type of construction. Some, though not all, are highly elevated (two feet or more) above the ground. First floor elevation data were provided by the non-federal sponsor (elevation surveys have been conducted throughout the study area as part of permit applications to ensure compliance with building codes on the island). These survey data (organized by property and by permit) were provided by the sponsor to the PDT. A few examples of multi-family in the study area are presented in **Figures 6 and 7.**

Figure 6 Multi-family residential structure (MFR2) in Reach 18

Property near 32 Gulf Blvd, Boca Grande FL

Figure 7 Multi-family residential structure (MFR2) in Reach 19

Property near 411 Gulf Blvd, Boca Grande FL

2.2.3 Commercial / Public Structures

Several hotel/resort complexes can be found in the central part of the study area. These complexes are generally high value and are not elevated. In addition to resorts, public structures include a real estate office and public library. An example of a commercial property is presented in **Figure 8.**

Figure 8 Commercial Property in Reach 16

130 Gulf Blvd, Boca Grande FL

2.2.4 Roads

All lots in the study have at least one road damage element, typically located near the landward edge of the lot. The roads are defined a linear damage element in Beach-fx. In cases where the lot is more than 600 feet in length, the road was divided up into two distinct damage elements. 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.

2.2.5 Other Structures

Other structures include the DECKS, GARAGE, GAZEBO, PARKINGLOT, POOL, TENNIS, and WALK damage element types. These structures are rarely protected by coastal armor, are built for outdoor use, tend to be closer to the shoreline, and tend to be less costly to rebuild. As a result, these damage elements are hit by the damage driving parameters more often, and rebuilt with a greater frequency. These damage elements are not subject to content damage. In addition to the structure types listed above, there is one lighthouse in the study area. This is a high value structure of unique historic and cultural value (see Figure 9).

Figure 9 Gasparilla Lighthouse

2.2.6 Armor

Most of the lots in the study have existing coastal armor, which vary considerably in value and construction type. A map of the armor locations is provided in Figure 10. Pictures of existing armor are provided in Figures 11 and 12.

Figure 10 Map of Existing Armor in the Study Area

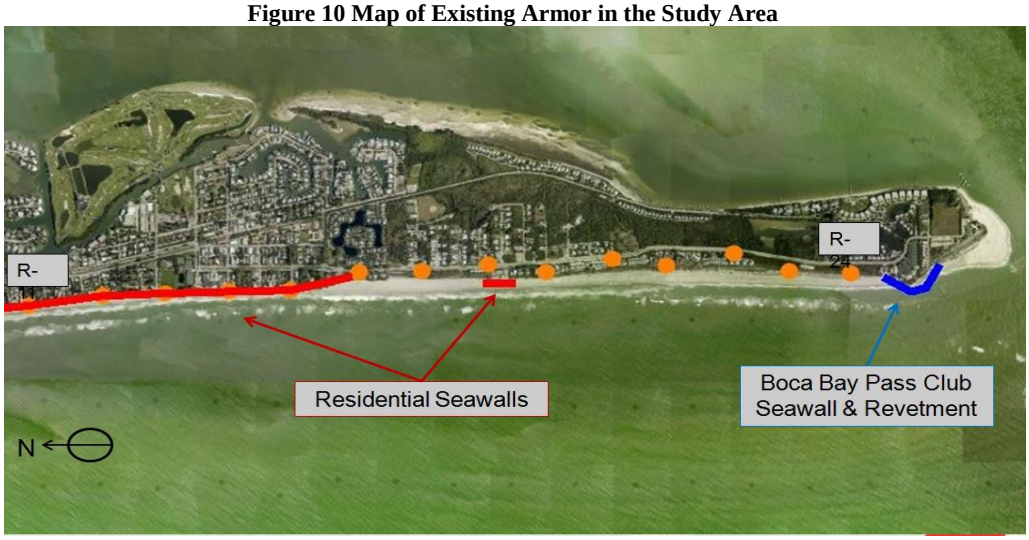


Figure 11 Existing Seawall near Banyon Street

Figure 12 Existing Seawall near 4th Street

3 Future Without Project Condition (FWOP)

This section documents the future without project condition in detail, including modeling assumptions and results.

3.1 FWOP Economic Model Assumptions

3.1.1 Period of Analysis and Discount Rate

As noted in Section 1, a 934 Report is different from feasibility study. Rather than evaluate the feasibility of a new authorization and 50 year period of participation, a 934 Report investigates the feasibility of extending the period Federal participation in an existing, authorized project to 50 years. In this case, the period of analysis is 40 years- 2016 to 2056. Each model simulation (Beach-*fx* iteration) analyses the full 40 year period. Also, the present value of damages were calculated using the FY16 water resources discount rate (3.125%). It should be noted that, though the FWOP analysis (and alternative comparison) were completed at the FY16 rate, the costs and benefits associated with the recommended plan (presented later in this appendix and in the executive summary) were recalculated using the FY18 discount rate (2.75%).

3.1.2 Content Values

Estimating content values is an important part of developing the structure inventory. Typically, content-to-structure value ratios (CSRVs) are used to define content value as a percentage of the depreciated structure value. In this case, a ratio of 0.50 has been applied to all structures in the study. Given the lack an appropriate empirical study about content values in south Florida, this is a conservative, reasonable assumption that is consistent with ER 1105-2-100. Other coastal studies throughout the country have concluded that CSVRs are often higher than 50%. Therefore, this assumption is conservative. It should be noted that there were a few exceptions to the 0.50 ratio assumption, because there are a number of structures that typically do not have

valuable contents. Gazebos, Dunewalks, and pools are examples of structures for which the CSVR was assumed to be zero. The 50% assumption was applied to the lighthouse, which could be either an overestimate or an underestimate of actual content values for that unique structure. However, given that damage to the lighthouse represents less than 1% of total FWOP damage, further research about this is not a prudent use of study resources.

3.1.3 Structure Rebuild Assumptions

The number of rebuilds specifies the maximum number of times a class of damage elements (SFR1, MFR1, etc.) can be rebuilt. This assumption is important, because it effectively creates a cap after which structure and content damages cannot be incurred. In this study, most of the damage element classes are assumed to have a maximum number of rebuilds of once every four years (10 total rebuilds per simulation). The one exception is dune walks, which are often damaged in storms and may be rebuilt more frequently. Therefore, the total number of rebuilds per simulation is 80 (twice per year).

3.1.4 Structure Condemnation Assumptions

It should be noted that most of the structure classes in this study are considered condemnable. Once it is condemned, a damage element cannot be rebuilt. The ratio of post-storm structure value divided by initial structure value below which will result in the structure being marked as condemned, provided that the Damage Element Type is also marked as condemnable. The following language from p. 41 of the Beach-fx User's Manual has been copied to provide additional clarification:

> "For example, if a condemnation ratio of 0.7 is specified for single-family residential (SFR1), structures and SFR1 Damage Element Types are marked as condemnable structures then, a SFR1 Damage Element will be marked as condemned, if a storm produces damages that exceed 30 percent of the initially specified structure value."

In this case the condemnation ratio was set at 0.5, meaning that if more than 50% of a structure's value is lost in a single storm, it will not be rebuilt.

3.1.5 Armor Assumptions

Most of the lots in the Gasparilla model are armored in the existing condition. Those lots that are not armored are assumed to be armorable in the future. Based on correspondence with the non-federal sponsor, it is believed that landowners would seek permits from the state of Florida to erect armor if erosion (at some future time) was directly threatening the lot. Also, some unarmored lots have no damageable elements except for roads. In this cases, it is believed that the Florida Department of Transportation would attempt to armor the lots before the road itself was damaged.

Because armor is a major part of the existing coastal inventory, the armor assumptions are critically important to the analysis. 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). A summary of the existing armor is provided in **Table 3**. The modeling assumptions used in this analysis are summarized in **Table 4**; they were developed as a collaborative effort between SAJ economics, coastal engineering, and cost engineering. Pictures and notes about the armor were taken on a site visit in the summer of 2014.

Table 3: Gasparilla Existing Armor

Armor	Armor	Length	Description	Top	Bottom	Height
Structure	Type			Elevation	Elevation	
(N to S)		(ft)		(ft-NAVD)	(ft-NAVD)	(ft)
1	1	495	12" thick concrete wall, rebar reinforced, 18" wide, 12" tall concrete cap, fronted by a riprap scour protection "skirt"	7	-6.15	13.15
2	2	1598	12" thick concrete wall, rebar reinforced,no cap, 36" concrete scour protection "skirt"	7	-6.15	13.15
3	3	1204	12" thick concrete wall, rebar reinforced, 18" wide, 24" tall concrete cap	8	-6.15	14.15
4	4	758	12" thick concrete wall, rebar reinforced, 18" wide, 18" tall concrete cap	8	-6.15	14.15
5	5	239	Concrete wall, 18" at top widening to 36" at bottom, fronted by a 36" concrete scour protection "skirt"	8	-6.15	14.15
6	5	493	Concrete wall, 18" at top widening to 36" at bottom, fronted by a 36" concrete scour protection "skirt"	8	-6.15	14.15
7	4	61	12" thick concrete wall, rebar reinforced, 18" wide, 18" tall concrete cap	8	-6.15	14.15
8	6	365	Likely the same as Armor #7, but buried	6.5	-6.15	12.65

Table 4: Coastal Armor Modeling Assumptions

		Failure thresholds (feet NAVD)			Cost	
Armor Type	Distance Trigger	Erosion	Flood	Wave	Mobilization	Cost per foot
1	0	10	8	7	$158,000	$1,057
2	0	10	8	7	$409,000	$939
3	0	N/A	9	8	$321,000	$1,003
4	0	N/A	9	8	$218,000	$1,028
5	0	N/A	9	8	$152,000	$1,448
6	0	N/A	9	8	$152,000	$1,034
7	0	11	9	8	$61,000	$2,000
8	0	9.5	7.5	6.5	$128,000	$1,129

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." In this case, the armor was assumed to fail when the vertical erosion exceeded the existing top elevation by three feet or more. However, some of the armor centrally located in the study area consists of sturdy, deeply built seawalls that are constructed out of reinforced concrete. It is highly unlikely that these seawalls would fail from typical coastal erosion alone. Thus, the failure threshold for erosion alone was set very high (30 vertical feet) for armor types 3-6. These elements of armor still could fail due to flooding or wave attack associated with hurricanes and/or major storm surge. Mobilization costs and costs per linear foot were provided by the SAJ cost engineering branch.

3.1.6 Other Assumptions

In order to achieve stable results, the FWOP was simulated over 100 iterations. A number of other important modeling assumptions are noted below:

- **Storm Suite:** Only large storms were included in the storm suite. Smaller extra-tropical were not included, as they are not expected to make a significant difference.
- **Back Bay Flooding:** In this study back bay flooding was not simulated. Based on historical experience, it is not expected that back flooding would be significant in this area.
- **Planned Nourishment:** As this is the FWOP condition, no planned nourishments were assumed.
- **Emergency Nourishment:** Though FCCE nourishments have occurred in the past, they were simulated in this study. The purpose of the FWOP analysis is to simulate a future without Federal participation.
- **Armor Construction Length:** Length was measured in feet as the parallel to shore lot length, measured in GIS (with the aid of aerial photography).
- **Seed Value:** The Beach-fx manual recommends using a large prime number as a simulation seed value. In this case, the number 1545863 was used.

3.2 Beach-fx FWOP Simulation Results

Over 100 iterations the future without project condition damages range between $28.6 and $407.4 M in present value dollars. Descriptive statistics on the FWOP model results are as follows:

Mean: $184,665,000
Standard deviation: $110,456,000
Median*: $175,944,000

*Beach-fx model results are reported to the dollar; here they have been rounded to the nearest thousand.

The standard deviation is less than the mean, suggesting that the results are relatively stable. It should be noted though there still is considerable variability in the model results. The minimum iteration showed $27.68 million in FWOP damage, while the maximum showed in damage $407.128 million in damage. Model stability is discussed in more detail in Section 3.2.6. A breakdown of the type of damage is provided in **Table 5**.

Table 5: Present Value Damages by Category

Structure	$114,942,000
Contents	$53,309,000
Armor	$16,412,795
Total	**$184,665,000**

*Computed at FY16 discount rate (3.125%); results have been rounded to the nearest thousand.

3.2.1 Structure and Content Damages

Structure damages refer to economic losses resulting from the structures situated along the coastline being exposed to wave attack, inundation, and erosion damages. In the Gasparilla FWOP condition, structure damages (about $115 million in present value damages) account for approximately 62% of the total FWOP damages.

Content damages refer to the material items housed within the aforementioned structures (usually air conditioned and enclosed) that are potentially subject to damage. In the Gasparilla FWOP condition, content damages (about $53 million in present value damages) account for approximately 29% of the total FWOP damages. A summary of structure and content damages (by damage element type) is provided in **Table 6**. Please note that armor damages are not included in this table.

Table 6: PV Structure and Content Damages by Damage Element Type (not including armor)

Type	Description	PV Structure Damage	PV Content Damage	PV Total Damage	% of total damage
COMM	Commercial /Public	$1,796,070	$664,510	$2,460,580	1.46%
GARAGE	Garage	$571,276	$27,856	$599,131	0.36%
GAZEBO	Gazebo or pavilion	$570,117	$0	$570,117	0.34%
LIGHTHO USE	Gasparilla Lighthouse	$595,404	$287,786	$883,190	0.52%
MFR1	Multi-family, one story	$6,294,717	$3,147,358	$9,442,075	5.61%
MFR2	Multi-family, two story	$33,631,986	$15,085,475	$48,717,462	28.96%
MFR3	Multi-family, three story	$280,699	$140,350	$421,049	0.25%
PARKING	Parking Lot	$245,523	$0	$245,523	0.15%
POOL	Pool	$321,114	$0	$321,114	0.19%
ROAD	Road	$4,661,364	$0	$4,661,364	2.77%
SFR1	Single Family Home	$65,790,960	$33,955,897	$99,746,857	59.28%
TENNIS	Tennis court	$105,343	$0	$105,343	0.06%
WALK	Dune walk	$77,915	$0	$77,915	0.05%
Grand Total		**$114,942,487**	**$53,309,231**	**$168,251,719**	**100.00%**

The two largest categories of damage by far are single family homes and multi-family residences. This makes sense, because those categories constitute the largest accumulation of economic value in the study area. Other than those two categories, the only notable sources of damage were road damage (2.77% of the total) and commercial property damage (1.46%). All other categories received less than 1% of total damage.

3.2.2 Armor Damages

Beach-*fx* provides the capability to estimate the costs incurred from measures likely to be taken to protect coastal assets and or prevent erosion in the study area. Armor "damage" is a broad category that includes direct damage to existing armor, and the costs associated with erecting new armor. In the Gasparilla FWOP condition, armor damage (about $16 million in present value damage) accounts for approximately 9% of the total FWOP damages.

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:

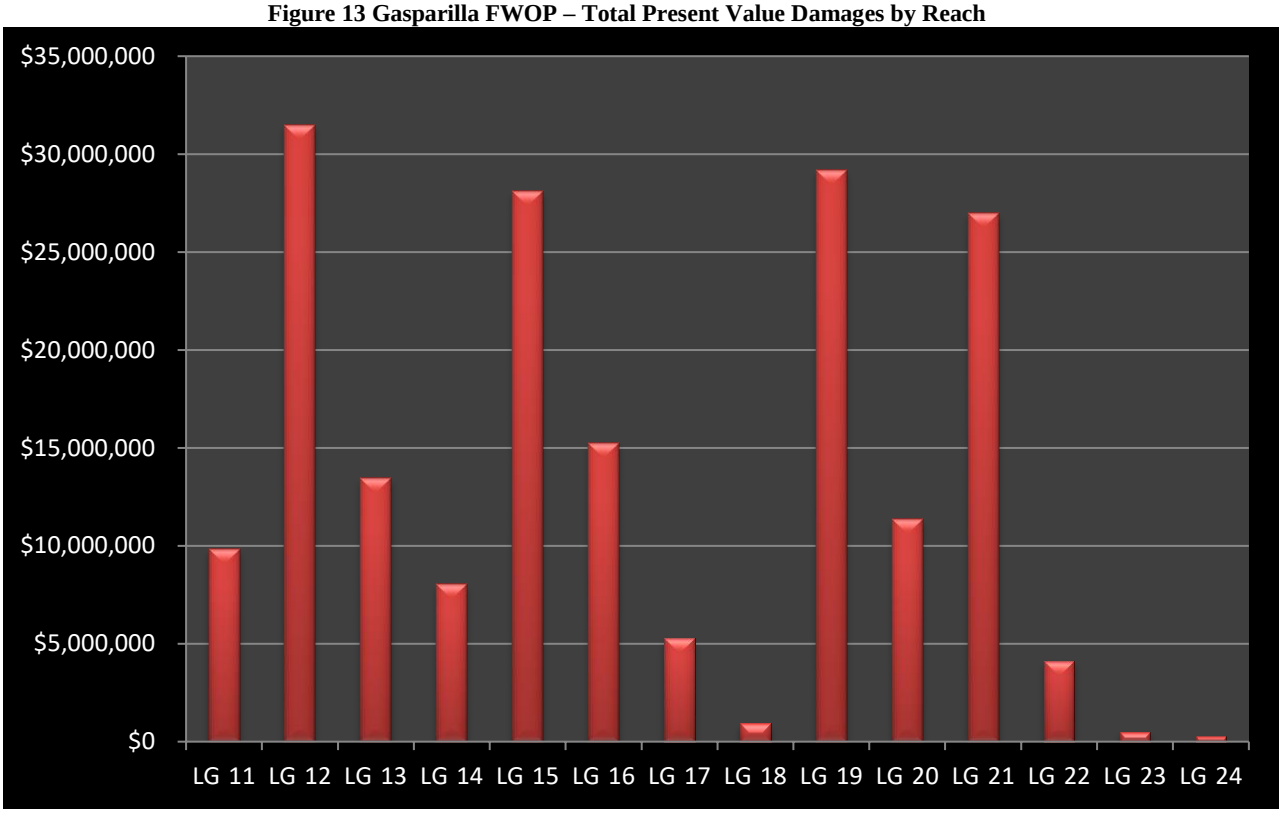
- Density and amount of development
- Typical size and value of structures
- Typical distance between structures and mean-high water
- Size, shape and location of the dunes and coastal morphology
- Rate of erosion for each reach
- Amount and type of coastal armoring present
- Timing that property owners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

A spatial summary of the Gasparilla FWOP damages is presented in **Table 7** and **Figure 13**.

Table 7: Present Value Damages by Reach

Reach	PV Structure Damage	PV Contents Damage	Armor Damage	PV Total Damage
LG-11	$6,393,591	$3,062,717	$346,144	$9,802,452
LG-12	$20,863,242	$9,863,246	$753,527	$31,480,014
LG-13	$8,823,770	$4,343,363	$280,356	$13,447,488
LG-14	$6,351,933	$1,653,309	$11,802	$8,017,044
LG-15	$18,475,034	$9,597,404	$13,427	$28,085,865
LG-16	$9,399,663	$4,322,441	$1,533,215	$15,255,319
LG-17	$2,038,099	$568,581	$2,679,299	$5,285,980
LG-18	$693,835	$218,796	$0	$912,631
LG-19	$17,857,701	$8,686,121	$2,639,845	$29,183,667
LG-20	$5,458,016	$2,375,003	$3,512,945	$11,345,965
LG-21	$15,521,523	$7,495,285	$3,946,533	$26,963,341
LG-22	$2,393,841	$1,122,965	$609,194	$4,126,001
LG-23	$401,915	$0	$86,508	$488,423
LG-24	$270,324	$0	$0	$270,324
Total	**$114,942,487**	**$53,309,231**	**$16,412,795**	**$184,664,514**

Figure 13 Gasparilla FWOP – Total Present Value Damages by Reach



The reach with the largest proportion of total damage was LG-12 ($31.5 M in PV damages). Reach 12 is densely developed with high value residential proprieties, including several homes with value exceeding $1 million, as well as numerous pools, garages, and roads. With $41.6 million in existing damageable value, it is the model reach with most economic value in the existing condition.

Other reaches with relatively high damage were LG-15 ($28.1 M), LG-19 ($29.1 M) and LG-21 ($26.9 M). LG-15 is similar to LG-12. It contains a number of very high value residential properties that are relatively close to the shoreline. With $41.1 million in damageable value, it is the model reach with the second most economic value in the existing condition.

LG-19 and LG-21 are somewhat different. LG-19 contains seven single family homes, as well as the *Sea Grape Colony* rental complex (six individual housing units). Both the homes and the rental units experience damage in the FWOP condition, and in LG-19 Beach-fx also triggers new armor construction. As noted in Section 4.3, construction costs associated with new armor are considered part of the overall "armor damage" in the FWOP condition. This is why the armor damage reported in LG-19 ($2.6 million) is higher than in most other reaches.

This is similar to LG-21. New armor construction is why the reported armor damage ($3.9 million) is relatively high. LG-21 is also the location of *Boca Grande Shores*, which includes 20 rental homes, and the *Turtleback Colony* condominium complex. Both complexes receive structure and content damage in the FWOP condition.

The reaches with the least damage were LG-23 and LG-24 (about $1.4 million and $0 in present value damages, respectively). This makes sense because both reaches have a have large undeveloped lots and

very few damageable structures. Reach 23 has one public park and a few roads. Reach 24 has no damageable structures, except for roads.

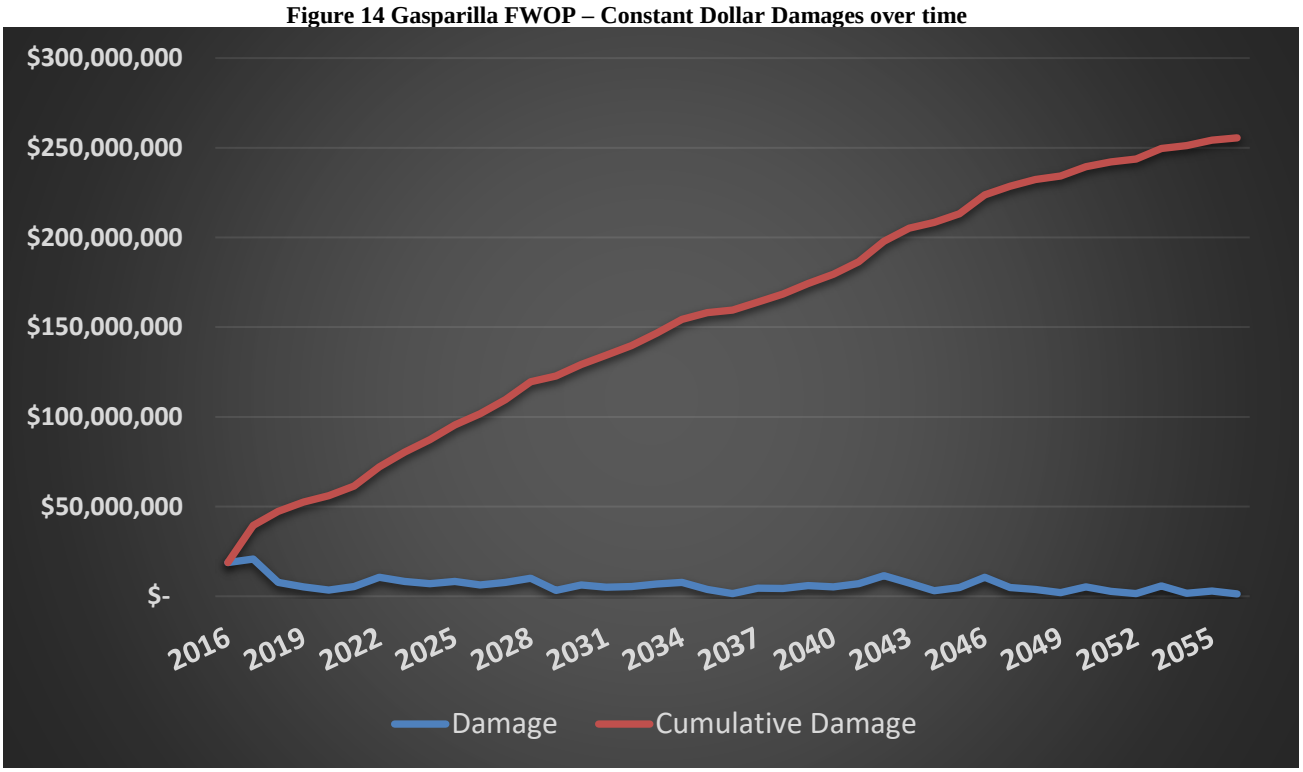
As previously explained, armor damages include both damage to existing armor and the costs associated with construction of new armor in unarmored reaches. In lots with existing armor, erosion damage to structures and contents is prevented throughout the simulation (unless the armor fails). However, even in armored lots, structures are vulnerable to inundation and wave attack from major storms. Storm surge can sometimes inflict damage behind seawalls even if the armor itself does not fail.

3.2.4 Temporal Distribution of Damages

The temporal distribution of damages is fairly consistent over time. There is some variation throughout the life cycle of the simulation, but not dramatic spikes or troughs in the damages. Over time, the damages tend to decrease because new armor construction is triggered on unarmored lots. Once a lot has armor, it is less vulnerable to damage. The armor cost for new armor is reported in the model outputs based on the simulation year in which the model is built.

The distribution of constant dollar damages is summarized in Figure 14. It should be noted that the Beach-*fx* simulation reported damages for earlier years, but the base year for the study is 2016. The simulation begins in 2006 (the year of initial construction).

Figure 14 Gasparilla FWOP – Constant Dollar Damages over time



3.2.5 FWOP Damages by Damage Driving Parameter

Within the beach-fx model environment, damage to structures and contents can be caused by three different damage driving parameters: flooding (inundation), wave attack, and erosion. The results of damage to structures and contents are broken out by parameter in **Table 8**.

Table 8: PV Damages by Damage Driving Parameter

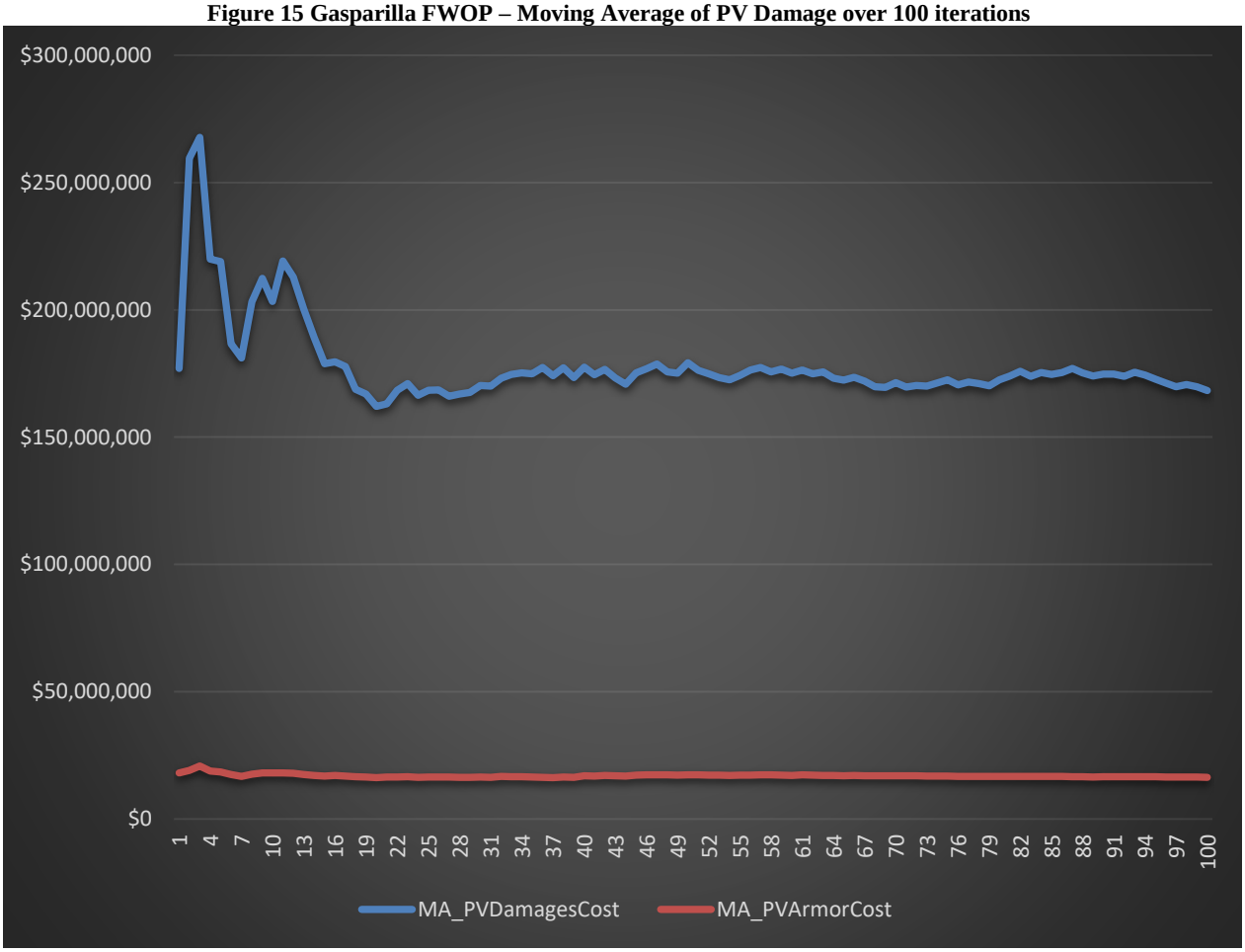
Damage Driver	PV Damage	% of Total
Flood (Inundation) Damage	$53,885,394	32%
Wave Damage	$102,150,396	61%
Erosion Damage	$12,215,927	7%
Total	**$168,251,718**	**100%**

Typically, in Florida, the vast majority of damage is caused by erosion. Gasparilla is somewhat unique in that only 7% of the total damage is caused by erosion. This is largely because the coastline of the study area is heavily armored. Armor in Beach-*fx* prevents erosion damage. Erosion damage can still occur *after* armor fails, but the extent of existing armor drastically reduces the total proportion of erosion damage. However, within Beach-*fx* armor does not have any effect on wave or inundation damage. Gasparilla is unique; the combination of heavy armor and relatively low dunes make the coastal inventory particularly susceptible to wave and inundation damage.

3.2.6 Model Stability

One issue facing any Beach-fx study concerns the appropriate number of iterations (each representing a life cycle simulation). In order to determine the ideal number of iterations, the modeler must find a balance between results stability and a reasonable simulation time. Typically, the results become more stable with more iterations. However, simulation time increases with more iterations, as does the size and complexity of the output files. In this case, 100 iterations represents a good balance. As noted in Section 3.2 of this report, the standard deviation of damage throughout all the iterations (about $110 million) is less than the mean (about $185 million), suggesting that the results are relatively stable. The moving average of total PV damage is summarized in **Figure 15**, which visually illustrates the stability over the time. As indicated by the chart, additional model runs would be unlikely to significantly increase the overall stability of the model.

Figure 15 Gasparilla FWOP – Moving Average of PV Damage over 100 iterations



3.2.7 FWOP Damages in alternative Sea Level Rise (SLR) scenarios

The FWOP condition was modeled for three sea level rise (SLR) scenarios. ER 1165-2-211 provides both a methodology and a procedure for determining a range of sea level rise estimates based on the local historic sea level rise rate, the construction (base) year of the project, and the design life of the project. The Beach-*fx* results presented above refer to the baseline scenario, which is based on the historic erosion rate. The results associated with the other two SLR scenarios are presented here.

Table 9: Simulated FWOP damages in the Sea Level Rise scenarios

	SLR1 (Baseline)	SLR2 (Intermediate)	SLR3 (High)
Structure Damage	$114,942,487	$117,123,720	$121,536,574
Content Damage	$53,309,231	$54,306,088	$56,269,049
Armor Damage	$16,412,795	$16,304,026	$15,617,246
Total PV Damage	**$184,664,513**	**$187,733,834**	**$193,422,868**

The results are interesting; though the total damages are (as expected) higher in the accelerated SLR scenarios, they are not higher by a significant magnitude. Damage in the high scenario (SLR3) is only about 5% greater than the baseline scenario. This result is also probably due to the high degree of armoring in the existing condition (as well as the classification of unarmored lots as "armorable in the

future”). Within Beach-fx, coastal armor will prevent the higher the erosion damages that are typically associated with accelerated SLR scenarios.

3.3 Beach-fx FWOP Simulation Conclusion

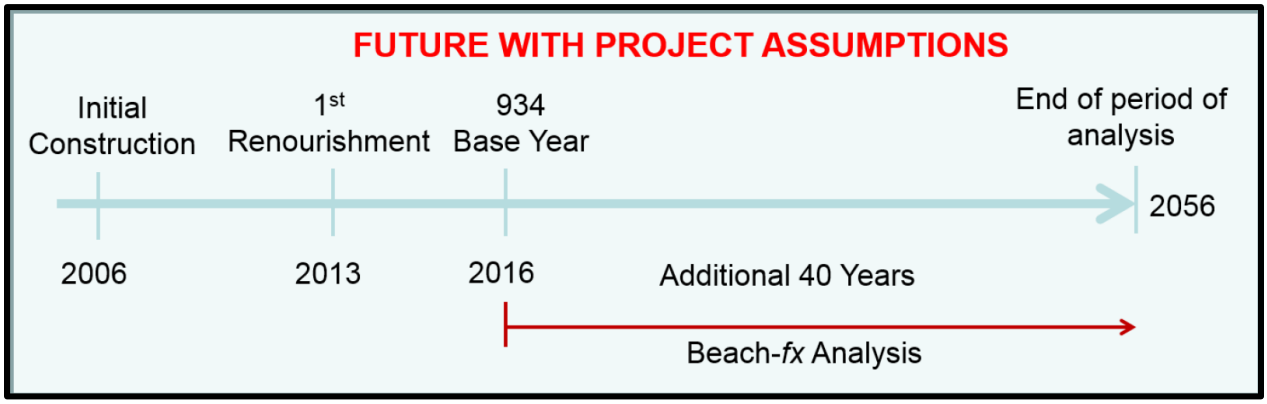
The future without project condition simulated here suggests that the study area may be subject to considerable storm damage throughout the period of analysis. In particular, there are five important conclusions:

- Most of the FWOP damage is attributable to direct damage to structures, though content and armor damage are also significant.
- The damages vary considerably over space (different reaches have significantly different types and magnitudes of damage).
- The damages are fairly consistent over time.
- Unlike some coastal areas in Florida, most the damage is not caused by erosion. Due to the combination of heavy armoring throughout much of the study area and low elevation dunes, most of the damage is caused by inundation and wave attack.
- Damages increase slightly in the accelerated Sea Level Rise scenarios

4 Future With Project (FWP) Conditions

As noted in Section 1.1, the purpose of the 934 Report is to investigate and evaluate the feasibility of extending the period of Federal participation for the authorized project to a full 50 years. In this case, a full 50 years would add 40 years to the period of analysis, from 2016 through 2056. See below figure for a summary of the timeline in the with project conditions.

Figure 16 Gasparilla Project Timeline



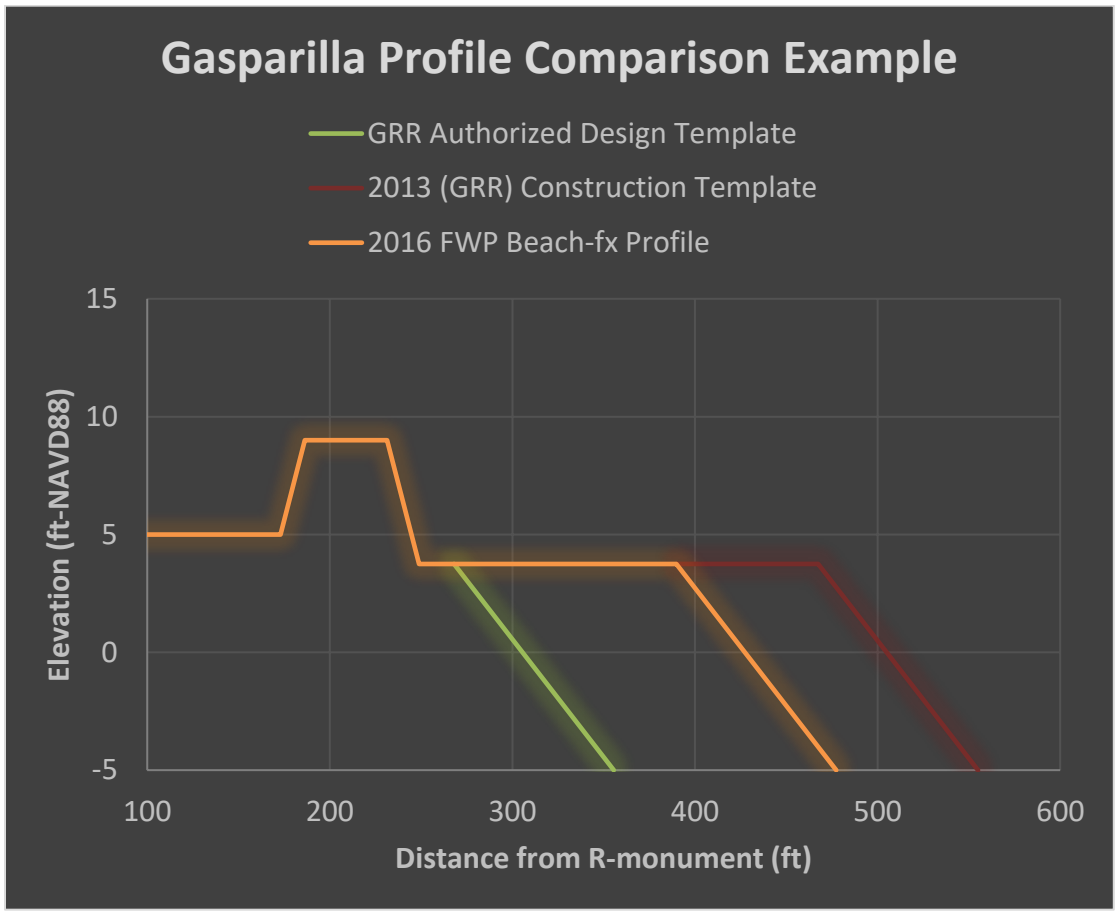
In order to evaluate the additional 40 years of Federal participation, a future with project (FWP) condition must be developed in Beach-fx to compare to the FWOP. The purpose of this section is to describe the methods, assumptions, and results of the FWP modeling effort.

4.1 Existing Federal Project

As noted above and in Section 1, the Gasparilla project was constructed in 2006 and renourished in 2013. The authorized project provides for initial construction and periodic nourishment at

seven-year intervals along 2.8 miles of gulf shoreline. The project is defined as a 20 foot extension of the project baseline and a 60 foot advance/sacrificial berm. Figure 17 shows a generalized cross section view of the project, including the relative shoreline position of the design template, the actual construction template in 2013, and the current shoreline position (as of 2016). Due in part to advance fill built into the 2013 renourishment project, the current shoreline is actually wider than the GRR design template.

Figure 17 Gasparilla Project Profle Comparison



4.2 Optimization of Federal Project

The purpose of the 934 Report is to evaluate the feasibility of continued Federal participation throughout an additional 40 years of analysis (2016-2056). Unlike a full feasibility study, a full suite of potential alternatives has not been considered. However, planning guidance does have a provision for optimization of the Federal project, including a modification of the renourishment interval to make it more efficient. Therefore, in order to optimize the project, different FWP conditions were developed within Beach-fx. Specifically, a whole range of different advance berm widths were simulated: 20 feet to 100 feet (in ten foot increments). Of these widths, the 60 foot project is most similar to the existing authorized project. Other FWP nourishment specifications, all of the modeling assumptions and parameters are the same in the FWP condition

as they were in the FWOP condition. It should be noted that the alternative comparison is based on screening level mobilization and placement cost estimates. These estimates should be considered "rough order of magnitude" costs (ROM costs).

4.3 Alternative Comparison and Evaluation

Ultimately eight different variations of the authorized project were simulated in Beach-fx. The results of this analysis are summarized below. It should be noted that the initial assessment of FWOP damages were computed at FY16 discount rate (3.125%). Then the alternative screening comparison presented below was updated using the FY17 discount rate (2.875%).

Table 10: Alternative comparison using screening level costs

Alternative (Berm Width)	Total # of Beach-fx Iterations	Iterations with at least one Renourishment	Total number of simulated nourishment events over 100 iterations	Average number of nourishment events per iteration	Avg Renourishment Interval (Years)	Avg Total Project Vol (CY)	FWOP iteration.csv AAEQ Damages ($)	FWP iteration.csv Avg AAEQ Damages ($)	% Damage Reduction	Avg AAEQ Total Damage Reduction Project Benefits	Alternative iteration.csv AAEQ Costs ($)	BCR	AAEQ Net Benefits
20' Berm	100	99	832	8.32	5	1,734,257	$8,060,893	$6,754,099	16%	$1,306,793	$1,142,678	1.14	$164,116
30' Berm	100	99	394	3.94	10	994,205	$8,060,893	$6,796,379	16%	$1,264,514	$512,456	2.47	$752,058
40' Berm	100	82	259	2.59	15	848,827	$8,060,893	$6,908,098	14%	$1,152,795	$309,460	3.73	$843,334
50' Berm	100	69	200	2.00	20	776,990	$8,060,893	$6,975,289	13%	$1,085,604	$217,312	5.00	$868,292
60' Berm	**100**	**63**	**179**	**1.79**	**22**	**783,729**	**$8,060,893**	**$6,968,008**	**14%**	**$1,092,885**	**$183,419**	**5.96**	**$909,465**
70' Berm	100	54	164	1.64	24	870,569	$8,060,893	$7,032,619	13%	$1,028,274	$123,435	8.33	$904,838
80' Berm	100	42	145	1.45	28	892,467	$8,060,893	$7,018,163	13%	$1,042,730	$141,971	7.34	$900,759
100' Berm	100	33	134	1.34	30	1,065,612	$8,060,893	$7,067,960	12%	$992,932	$109,785	9.04	$883,148

***Average Annual Costs and Benefits computed at the FY17 water resourced discount rate (2.875%).**

Of the alternatives analyzed, all of them appear to be economically justified. It is interesting to note that all the alternatives are only partially effective at preventing damage. Generally berm alternatives (like the authorized project) are effective at preventing or reducing both erosion and armor damage; they are typically not effective at preventing wave or flood damages. In fact, every simulated alternative prevents less than 20% of total damage. However, because both costs and benefits are relatively low, all of the plans are economically justified. As shown in the table, the 60 foot berm in the version of the project that maximizes net benefits. Therefore, it is the recommended plan.

It should be noted that, compared to the 60 foot plan, the 70 foot plan has similar net benefits and a slightly lower average annual cost. This is largely because the cost comparison provided in Table 10 is based on an average over 100 Beach-fx iterations. In both simulations, each of these plans had a number of iterations in which only a single renourishment was triggered. This occurrence (only one renourishment) was slightly more likely with the 70 foot alternative, thus the average annual cost was slightly lower. However, if a fully refined cost estimate (rather than ROM cost) was developed for the 70 foot alternative, it would be assumed that two full nourishments would be needed over the remaining period of analysis (which is the most likely

scenario). Therefore, with fully refined costs, the total cost of this alternative would be higher than the 60 foot alternative.

Also, the 60 plan is consistent with the authorized project footprint. If a larger plan was selected, additional environmental mitigation would be required, which would significantly increase the cost of the project. For alternatives that are 60 feet or less, no additional mitigation is required. For these reasons, the 60 foot alternative remains the NED Plan.

However, though the 60 foot berm is the most similar alternative to the authorized project, the estimated renourishment interval is much less frequent than the authorized interval. This is because Beach-fx only initiates a nourishment event when it is needed; the triggers in the model are based on the condition and position of the shoreline (see engineering appendix for more information). Because, as of 2016, the Gasparilla shoreline is in a relatively good condition, only two renourishment events (on average) are triggered in the simulation.

Another interesting result is the relationship between benefits and project size. Typically, in CSRM (coastal storm risk management) projects larger alternatives generate more benefits (though not necessarily more net benefits). In this case, the largest benefits are actually observed with the smaller projects. In fact, the highest benefits are predicted for the smallest alternative (the 20 foot alternative). This slightly counterintuitive result is due to the nature of FWOP damage (primarily wave attack and inundation associated storm surge rather than consistent erosion over time) as well the way renourishments are triggered in the model. With the smaller projects, renourishment events are triggered much more frequently than with the larger projects. In the 20 foot alterative FWP simulation, any potentially damaging storm is likely to trigger a renourishment. However, in the larger alternatives, some storms are large enough to cause damage without actually inducing enough erosion throughout the study area to trigger a renourishment event. Some individual reaches may be highly eroded, but the overall volume threshold is not enough to trigger a resnousihsment. Thus, some of the smaller alternatives actually generate more benefits.

Of course, these smaller alternatives are much more costly to maintain due to the significantly shorter renoruishment intervals. Therefore, even though total estimated benefits are higher with some of the smaller projects, net benefits are maximized with the 60 foot alternative.

4.3.1 The Four P&G Accounts

Planning Guidance, including the Federal *Principles and Guidelines* (P&Gs) as well as ER-1105-2-100, define four accounts to be considered in the evaluation of alternative plans:

- National Economic Development (NED): measures the change in national economic value
- Environmental Quality (EQ): measures significant effects on environmental resources
- Regional Economic Development (RED): measures local and regional economic impacts
- Other Social Effects (OSE): measures other, intangible but important considerations including factors that affect the well-being and happiness of people affected by the project.

Throughout this 934 Report the economic analysis focuses on the NED account. The primary benefits of the project (damage reduction) are NED benefits, as are the incidental recreation benefits (discussed in Section 5.4.3). However, the other three accounts should also be considered in alternative evaluation and plan selection. In this case, there are few significant differences in those three accounts between the various alternatives. The specifics of each account are discussed briefly below.

Environmental Quality (EQ): Generally, coastal storm damage reduction projects that consist of sand placement on a beach have mixed environmental effects. The long-term effects are usually quite positive; they include an increase in habitat for various species. However, there may be some adverse short-term effects, because mobilization and construction can disrupt existing habitat. In this case, the 60 foot alternative represents an important threshold for the EQ account. Anything larger than a 60 foot berm would require additional environmental mitigation. In at least one important respect, the recommended plan is the best option from the EQ perspective. It represents the largest increase in habitat without creating the need for more mitigation. Also, other storm damage reduction alternatives that were not evaluated quantitatively (seawalls, groins, etc.) would almost certainly have much more significant negative impacts than sand placement.

Regional Economic Development (RED): The Regional economic development (RED) account registers changes in the distribution of regional economic activity that results from each alternative plan. This account measures sub-national economic impacts, such as local employment effects and municipal and/or county tax revenue. Because this project is so important to the economy of Gasparilla Island and Lee County, all of the alternatives generate significant RED benefits relative to the No Action Plan. The project helps support both local business and local tax revenues. As noted in the Economics Appendix, the total visitation to the project area was approximately 138,000 in 2016. Quantifying these RED impacts is beyond the scope of a 934 Report, but they clearly are important. There are few, if any, meaningful RED differences between the different alternatives. As long as the project continues to be sustained through periodic nourishment, visitation and tourism to Gasparilla Island is expected to continue. The dimensions of the recommended plan are not expected to have a significant impact on tourism or visitation.

Other Social Effects (OSE): As described in IWR publication 2013-R-02, the OSE account includes other considerations, such as: Health and Safety, Social Vulnerability and Resilience, Economic Vitality, Identity, and Social Connectedness. Leisure and Recreation are also listed as OSE criteria. In this case, the OSE account is similar to the RED account in the sense that all the alternatives have OSE benefits compared to the No Action Plan. The beaches are a huge part of the identity and social fabric of Gasparilla Island. The project helps retain that identity. The project also helps provide resilience and retain recreation opportunities. Like the RED account, there are no meaningful differences between the different alternatives, with the possible exception of the renourishment interval. Construction events can be temporarily disruptive to local residents. Therefore, some of the smaller alternatives that would require more renourishments (i.e., the 20 foot plan, which on average requires a nourishment every five years) may be less

appealing from an OSE perspective. This is not a major concern for the Recommended Plan, which only has two expected renourishments over 40 years.

4.4 Uncertainty in the Alternative Analysis

As described in in ER 1105-2-101, *Risk Analysis in Flood Damage Reduction Studies*, economic analysis results in planning studies should be presented in a risk based format. The Beach-fx results described in **Table 10** reflect average values over 100 iteration simulations. But average results, while useful in providing a broad picture, do not tell the entire story. Different alternatives may have very different distributions of benefits even if average benefits are similar. Presenting results in a risk-based format assists decision makers in selecting the best alternative.

In accordance with, ER 1105-2-101, **Table 11** shows all the alternatives in a risk based format. Based on the Beach-fx results, the net benefits are displayed in percentiles.

Table 11: Alternative comparison presented in a risk based format

				AAEQ Net Benefits Percentiles				
Alternative	**Total StructureValue**	**Total ContentValue**	**Avg AAEQ Net Benefits**	**5%**	**25%**	**50%**	**75%**	**95%**
FWOP	$151,029,114	$71,034,863	$0	$0	$0	$0	$0	$0
20 foot berm	$151,029,114	$71,034,863	$220,648	($566,650)	$551,369	$793,155	$816,205	$821,957
30 foot berm	$151,029,114	$71,034,863	$780,530	($196,425)	($283,380)	$691,009	$1,536,473	$1,782,620
40 foot berm	$151,029,114	$71,034,863	$865,813	($85,150)	($139,660)	$895,181	$1,197,498	$1,604,088
50 foot berm	$151,029,114	$71,034,863	$881,576	($84,355)	$27,392	$857,892	$1,222,098	$1,585,889
60 foot berm	$151,029,114	$71,034,863	$1,111,162	($76,878)	$30,470	$1,149,428	$1,695,151	$1,785,023
70 foot berm	$151,029,114	$71,034,863	$1,108,298	($76,878)	$16,773	$1,242,508	$1,577,843	$1,784,501
80 foot berm	$151,029,114	$71,034,863	$921,753	($85,122)	$81,298	$1,137,997	$1,221,341	$1,359,903
90 foot berm	$151,029,114	$71,034,863	$889,892	($189,161)	$89,798	$1,064,556	$1,076,114	$1,426,190
100 foot berm	$151,029,114	$71,034,863	$890,640	($85,122)	$247,272	$1,030,988	$1,130,940	$1,382,870

Several conclusions can be drawn from this comparison. First, when presented in a risk based format, the analysis appears to confirm that the 60 foot plan optimizes net benefits. Generally, at almost every percentile, the net benefits are highest in the 60 foot berm alternative. There are some exceptions to this, particularly with the larger alternatives. For example, at the 50th percentile the 70 foot alternative has higher net benefits, and at the 95th percentile both the 90 foot and 100 foot alternatives have higher net benefits. But, as noted in Section 3, any project beyond the authorized footprint (60 foot berm extension) would require additional mitigation and so would have higher costs (and lower net benefits) than this screening comparison would suggest.

Secondly, the 60 foot alternative appears to minimize the risk that the project would not be economically justified. At the fifth percentile, all the alternatives have negative net benefits. However, these benefits are minimized in the 60 foot and 70 foot alternatives. Also, at the 25th percentile some of the smaller projects are not economically justified, while the 60 foot advance berm alternative has positive net benefits.

Finally, this analysis indicates that the overall magnitude of benefits are reasonable in the sense that they are relatively small compared to the total value of property subject to damage. In the 60 foot alternative, average annual net benefits are less than 1% of the total value subject to damage (including content values). This suggests that the annual benefits are not unreasonably high.

For all of these reasons, the 60 foot advance berm alternative should be the recommended plan.

5 Recommended Plan

As noted in Section 4.3, the recommended plan is a modified version of the authorized project extended through a full 50 year period of analysis (2056). As a result of the optimization of the authorized project, the recommended plan is defined as a 20 foot extension of the project baseline, roughly the 1995 MHW line, at +5 ft.-MLW (3.75 ft-NAVD88); a foreshore slope of 1V:15H transitioning to a nearshore slope of 1V:25H from MLW extending out to the intersection with the existing profile; a 60 foot advance/sacrificial berm accounts for an average periodic nourishment interval of 22 years; only two renourishments are expected throughout the remaining 40 year period of analysis. (The first renourishment is expected to occur less than 22 years from now, because some erosion has already occurred since the last renourishment).

The model does not predict that renourishment is necessary until approximately 2029. As a result, only two renourishments are expected throughout the remaining 40 year period of analysis. Beach-fx analysis suggests that this modified version of the project would be the most efficient plan and have the greatest net benefits. The purpose of this section of the report is to describe the recommended plan in more detail, including refined costs, net benefits, and project performance.

The alternative screening comparison in Table 10 was computed using the FY17 discount rate (2.875%). Then, the fully developed costs and benefits associated with the Recommended Plan (presented later in this appendix, as well as in the Section 3.6 of the main report) were recalculated at the FY18 rate (2.75%).

5.1 Uncertainty associated with the Recommended Plan

Traditionally in coastal storm risk management projects the costs, benefits, net benefits, and BCRs are based on an average over all model simulations. In this case, the TSP summary presented in the Executive Summary of the Main Report and this Economics Appendix are based on average values over 100 model iterations. However, in accordance with ER 1105-2-101, planning studies should include a probabilistic approach to net benefits analysis.

Because it consists of Monte Carlo simulations, Beach-fx is a useful tool for examining the uncertainty associated with the recommended plan. The 100 iterations used in this study provide important information about the risk that the recommended plan would not actually result in a good investment decision (i.e., BCR <1). When using screening level costs, all 100 of the FWP iterations indicate that the project would be economically justified. However, comparing the benefits to the certified cost

estimate provides a more conservative and realistic picture of the variability and the risk. A graphical display of this comparison is provided in **Figure 18**. A tabular display is provided in **Table 12**. It should be noted that the costs and benefits in this risk assessment have been computed at the FY17 discount rate (2.875%), and that the benefits summarized here do not include recreation benefits.

Figure 18 Recommended Plan BCR variation over 100 iterations

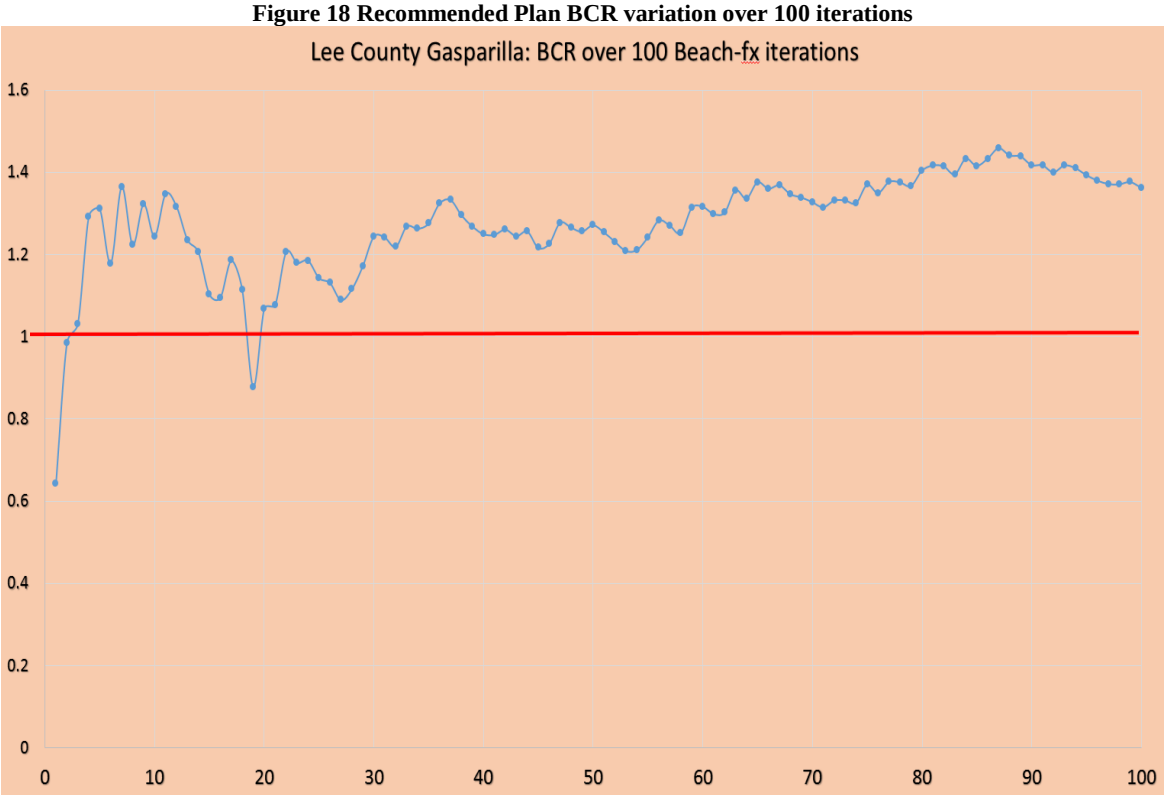


Table 12: BCR for Recommended Plan over 100 iterations (not including Recreation benefits)

Iteration	AAEQ Benefits	AAEQ Costs	BCR
1	$515,627	$802,053	0.642883605
2	$789,804	$802,053	0.984727881
3	$827,261	$802,053	1.031430143
4	$1,036,971	$802,053	1.292896231
5	$1,051,238	$802,053	1.310684205
6	$945,377	$802,053	1.178696475
7	$1,094,806	$802,053	1.365005037
8	$981,161	$802,053	1.22331225
9	$1,060,927	$802,053	1.322764128
10	$997,887	$802,053	1.244165873
11	$1,080,561	$802,053	1.347244277
12	$1,056,287	$802,053	1.31697982
13	$991,316	$802,053	1.23597336
14	$966,997	$802,053	1.205652643
15	$885,052	$802,053	1.103482967

16	$878,300	$802,053	1.095064728
	$950,978	$802,053	1.185680424
18	$893,124	$802,053	1.113547699
	$704,652	$802,053	0.878560074
20	$856,635	$802,053	1.068053668
	$864,198	$802,053	1.077482032
22	$967,046	$802,053	1.205713613
	$946,448	$802,053	1.180031481
24	$950,768	$802,053	1.185417603
	$916,656	$802,053	1.142887424
26	$907,318	$802,053	1.131244091
	$873,944	$802,053	1.089633661
28	$895,011	$802,053	1.11589981
	$940,208	$802,053	1.1722515
30	$997,354	$802,053	1.243501994
	$995,536	$802,053	1.241235548
32	$977,424	$802,053	1.218653205
	$1,017,196	$802,053	1.268240504
34	$1,012,909	$802,053	1.2628955
	$1,023,049	$802,053	1.275538168
36	$1,061,982	$802,053	1.324080259
	$1,068,942	$802,053	1.332758049
38	$1,038,938	$802,053	1.295348389
	$1,017,107	$802,053	1.268130019
40	$1,002,470	$802,053	1.249880151
	$1,000,983	$802,053	1.248025752
42	$1,011,430	$802,053	1.261052018
	$998,192	$802,053	1.244545884
44	$1,007,617	$802,053	1.256297093
	$975,709	$802,053	1.216514906
46	$983,438	$802,053	1.226151749
	$1,024,679	$802,053	1.277570169
48	$1,015,051	$802,053	1.265566216
	$1,007,195	$802,053	1.255771434
50	$1,019,757	$802,053	1.271433246
	$1,005,807	$802,053	1.254040335
52	$987,441	$802,053	1.231142237
	$969,509	$802,053	1.20878446
54	$971,372	$802,053	1.211106916
	$996,169	$802,053	1.242024331
56	$1,028,913	$802,053	1.282849572
	$1,019,011	$802,053	1.270503018
58	$1,004,054	$802,053	1.251855316

	$1,053,349	$802,053	1.313315618
60	$1,055,859	$802,053	1.316445735
	$1,041,664	$802,053	1.298747338
62	$1,044,338	$802,053	1.302081423
	$1,087,865	$802,053	1.356350898
64	$1,071,817	$802,053	1.336342108
	$1,103,624	$802,053	1.375998597
66	$1,090,868	$802,053	1.360094864
	$1,097,699	$802,053	1.368612391
68	$1,080,133	$802,053	1.346710361
69	$1,074,003	$802,053	1.339067717
70	$1,064,798	$802,053	1.327590925
	$1,054,638	$802,053	1.314922753
72	$1,067,890	$802,053	1.331446102
	$1,068,102	$802,053	1.331709918
74	$1,062,916	$802,053	1.325244378
	$1,098,682	$802,053	1.369836992
76	$1,082,474	$802,053	1.349629855
	$1,104,258	$802,053	1.376789058
78	$1,103,413	$802,053	1.375735721
	$1,096,214	$802,053	1.366760822
80	$1,125,934	$802,053	1.403814718
	$1,136,323	$802,053	1.41676775
82	$1,134,362	$802,053	1.41432388
	$1,118,900	$802,053	1.395045727
84	$1,149,381	$802,053	1.433049049
	$1,135,307	$802,053	1.415501362
86	$1,149,601	$802,053	1.433323292
	$1,169,880	$802,053	1.458606768
88	$1,155,791	$802,053	1.441041417
	$1,153,904	$802,053	1.438688478
90	$1,136,956	$802,053	1.417556926
	$1,136,702	$802,053	1.417240167
92	$1,122,771	$802,053	1.399871947
	$1,136,463	$802,053	1.416943196
94	$1,131,013	$802,053	1.410147267
	$1,117,485	$802,053	1.393280437
96	$1,106,956	$802,053	1.380153358
	$1,100,183	$802,053	1.371709411
98	$1,099,438	$802,053	1.370780055
	$1,104,043	$802,053	1.376520937
100	$1,092,885	$802,053	1.362609602

This analysis suggests a relatively high degree of confidence that the recommended plan would be economically justified over the remaining 40 years of Federal participation. The BCR varies from a minimum of 0.64 to a maximum of 1.46. However, the BCR is greater than unity in 97 of 100 iterations.

Residual Risk

ER 1105-2-101 also indicates that it important to consider the residual risk. In this case, residual risk implies two related things: 1.) the risk of project failure 2.) the damages that would occur even if the project is implemented. The first type of residual risk is not particularly relevant for this type of project. Unlike a dam or a levee, a project "failure" would not increase risk to people or property in the project area. It just might fail to protect them to the extent predicted. While a levee or dam failure can result in significant (or massive) induced flooding, the failure of a berm extension project does not induce damage. However, the second type of residual risk is very relevant to this project. As noted in both this Economics Appendix and the Main 934 Report, none of the alternatives are effective at preventing a majority of the expected future damage. The FWOP damage prevented varies from 13% to 16% over the different alternatives. All the alternatives are economically justified, but much of the damages that are expected to accrue over the next 40 years will not be prevented by the project. In the FWOP Beach-fx analysis, the total Present Value of damage varies from a minimum of $29.2 million to a maximum of $398.9 million. In the FWP condition, the total Present Value of damage varies from a minimum of $28.6 million to a maximum of $381.1 million. The potential for residual damage, even after the project is implemented, is significant. However, the project is still a good investment because the benefits exceed the costs.

5.2 Project Performance in the SLR scenarios

As noted in Section 4, Corps guidance requires the analysis of three sea level scenarios. Therefore, it is important to consider the performance of the selected plan in these scenarios. For the 60 foot project, the SLR Beach-fx analysis results are summarized in the below table (**Table 13**). The BCRs reported in the table only reflect primary benefits (i.e., recreation benefits are not included).

Table 13: Project Performance of the Recommended Plan

	SLR1	SLR2	SLR3
AAEQ FWOP Damage	$7,990,995	$8,253,874	$8,875,602
AAEQ FWP Damage	$6,897,247	$7,022,595	$7,125,171
AAEQ Benefits	$1,093,748	$1,231,279	$1,750,431
AAEQ Cost	$909,414	$1,445,969	$2,355,383
AAEQ Net Benefits	**$184,334**	**($214,690)**	**($604,953)**
BCR	**1.20**	**0.85**	**0.74**

*Annual Costs and Benefits computed at the FY18 water resources discount rate (2.75%).

It should be noted that, though the Beach-fx model itself used screening level costs, this SLR comparison has been updated to reflect more refined costs for mobilization/demobilization and placement costs. A fully developed cost (i.e., certified) estimate has been developed for the SLR1 scenario (as described in Section 5.3), but has not been developed for the other scenarios. However, using more refined Mob/demob and placement cost provides a reasonable proxy for what the costs and net benefits would look like in the accelerated SLR scenarios.

Interestingly, though the FWOP damages increase in the accelerated SLR scenarios, the benefits also increase. Based on screening level costs, the project is economically justified in all three scenarios (net benefits are positive and BCRs are above 1.0). But, as noted in Table 13, when using more refined costs the project does *not* appear to be justified on primary benefits alone in the accelerated SLR scenarios. This is because costs increase more significantly than benefits in these scenarios. It should be noted that if incidental recreation benefits are included (as described in Section 5.4.3), the project would be justified in the Intermediate scenario (SLR2). Therefore, it is reasonable to conclude that the recommended plan would be resilient and adaptable if an intermediate level of accelerated sea level rise actually occurs during the 40 year remaining period of analysis. However, if high levels of accelerated sea level rise are observed, the project will need to be reevaluated.

5.3 Refined Costs of the Recommended Plan

After a plan is selected, a fully refined cost estimate is developed. The alternative comparison used screening level costs, which should be considered rough order of magnitude estimates. The fully refined cost estimate includes a number of other costs, including PED, construction management, and a cost contingency. As a result of these factors, the fully developed cost of the recommended plan is much higher than the screening level estimate. Table 14 summarizes the refined costs. The estimates assumes two renourishment events: 2028 and 2042. Given the relatively good condition of the existing shoreline, Beach-fx did not trigger a renourishment event until (on average) 2028. Beach-fx did not trigger a second renourishment event until (on average) 2042. More information about the cost estimate is provided in the cost appendix.

Table 14: Refined Project Costs for the Recommended Plan (FY18 Price Level)

Construction Cost (mobilization and placement)	**$21,802,000**
Lands and Damages	$428,000
Preconstruction, Engineering, and Design (PED)	$5,849,000
Construction Management	$311,000
Subtotal	**$28,390,000**
Contingency	26.00%
Total Project Cost	**$35,771,000**

*Costs reflect the grand total for both renourishment events

5.3.1 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 Gasparilla, the annual OMRR&R cost is estimated to be $32,000 per year.

5.3.2 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.

It should be noted that, in this case, interest during construction (IDC) is not applicable because the project has already been constructed and is already generating benefits. The total economic cost of the recommended plan is summarized in the below table.

Table 15: Economic Costs of the Recommended Plan (FY18 Price Level)

Total Cost	**$35,771,000**
Interest During Construction (IDC)	$0
Total Investment Cost	$35,771,000
Present Value of Investment Cost	$21,896,971
AAEQ* of Investment Cost	$909,414
Annual OMRR&R	$32,000
Total AAEQ* Cost	**$941,414**

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

Also, as noted in Table 15, the annual economic cost of a project includes operations, maintenance, repair, replacement, and rehabilitation (OMRR&R). These are fully non-Federal costs that ensure continued project function over time. They include certain types of environmental monitoring, beach tilling, sign and parking maintenance, and local mitigation requirements.

5.4 Benefits of the Recommended Plan

5.4.1 Storm Damage Reduction Benefits

As noted in Section 4.3, the recommended plan prevents about 14% of the without project damages. This reduction is the source of primary project benefits. The benefits are summarized in **Table 16**.

Table 16: Storm Damage Reduction Benefits of the Recommended Plan

PV FWOP Damages	**$192,407,975**
PV FWP Damages	$166,072,602
PV Damage Reduction Benefits	**$26,335,372**
AAEQ Damage Reduction Benefits	$1,093,748

*Annual damages and benefits amortized using the FY18 discount rate (2.75%)

5.4.2 Land Loss Benefits

Typically, in CSRM studies, prevention of land loss is also part of the primary project benefits. These benefits arise from preventing permanent loss of the upland (areas landward of the existing dune). Upland has economic value, as it is the location of current and future development (residential, commercial, etc). Beach-fx estimates net shoreline changes over time, including changes to the upland width. However, in this case all lots are defined as currently armored or amorable in the future. The armor prevents erosion damage to the upland in both the FWOP and FWP conditions. Therefore, land loss benefits do not apply in this study.

5.4.3 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 Gasparilla project area. Therefore, the travel cost method is not applicable.

However, even though the Gasparilla 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 is already occurring. Thus, in the 934 Report, 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 #18-03, *Unit Day Values for Recreation, FY 2018*, are presented in **Table 17**. 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 17: 2018 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	$4.05	$5.82	$28.35	$16.45
10	$4.81	$6.58	$29.11	$17.47
20	$5.32	$7.09	$29.62	$18.73
30	$6.08	$7.85	$30.38	$20.25
40	$7.59	$8.61	$31.14	$21.52
50	$8.61	$9.37	$34.17	$24.30
60	$9.37	$10.38	$17.21	$26.83
70	$9.87	$10.89	$29.49	$32.40
80	$10.89	$11.64	$42.53	$37.72
90	$11.64	$11.90	$45.57	$43.04
100	$12.15	$12.15	$48.10	$48.10

The recreation Point Values assigned to the Gasparilla vary by year. They are summarized in **Table 18.**

Table 18: Total Unit Day Point Scores applied to the Gasparilla project area

Year	Without Project	With Project	Increased Point Values With Project
2016	64	64	0
2026	55	64	9
2036	47	64	17
2046	39	64	25
2056	27	64	37

The point assignments are based on qualitative criteria; they depend on best professional judgment (i.e. "judgment criteria"). In this case the scores were developed in close collaboration with the Non-federal sponsor (Lee County) during a site visit and project meeting conducted on Gasparilla Island in March of 2016. The differences in the assigned point scores vary for each category depending on the relevant recreation facilities. The following list briefly explains the logic behind the judgment criteria applied to the Lee County Gasparilla study area.

- **Recreation Experience:** Beaches in the Gasparilla 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 Gasparilla beaches 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 6, which corresponds to "several opportunities within one hour of travel time; none within 30 minutes." Compared to many Florida beaches, Gasparilla Island is somewhat isolated. The nearest publically accessible beaches are on Manasota Key and Little Gasparilla Island; due to a limited number of bridges, each of these is more than 30 minutes away from the project area. Initially this point score does not change between the FWOP and FWP because the proposed project would have no effect on the availability of other recreation opportunities. However, in the FWOP, the availability of recreation on and within Gasparilla Island itself would be negatively affected. Therefore, in the FWOP, the score declines slightly (to a score of four) by the end of the period of analysis. Four is still in the same general judgment factor category, but it indicates a slight decline in quality.
- **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. By 2056, 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 Gasparilla Island is considered a vacation destination. 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 2016 for the FWOP and FWP condition. A summary of the assigned scores in 2056 are summarized in the below table.

Table 19: Unit Day Values Point Score

Criteria	Point Scale	Unit Day Point Value - Without Project	Unit Day Point Value - With Project
Recreation Experience	0-30	11	21
Availability of Opportunity	0-18	4	6
Carrying Capacity	0-14	3	11
Accessibility	0-18	6	12
Environmental Quality	0-20	3	14
	Total	27	64

It should be noted that the deterioration in recreation quality would not occur instantly in the without project condition. Rather, it will be a gradual change over time. Therefore, the changes in point scores have been applied gradually over time. A summary comparison of the total point score, in both the with and without project condition, is provided in **Table 20**. As shown in the table, the scores were assumed to be the same in 2016. By the end of the period analysis, there is a significant difference between the two conditions.

Table 20: Changes to Assigned Unity Day Value Point Score over time

Year	Total Score: Without Project	Total Score: With Project	Increased Point Values With Project
2016	64	64	0
2026	55	64	9
2036	47	64	17
2046	39	64	25
2056	27	64	37

After assigning point scores and dollar values, these values must be assigned to expected recreation visits over the life the project. The following sections describe how visitation projections were developed.

Visitation Projections

First, a baseline count of beach visitation was developed for the existing condition. In order to develop a baseline, different categories of visitation were defined. In the Gasparilla project area, recreation visitation can occur from five different sources, visitors from: the state park, private residences, rental houses, the hotel, and beach condos in the project area. A baseline visitation number must be developed for each of these categories of visitation. As described below, some adjustments have been made to account for the fact that, due to bad weather and other factors, visitors to Gasparilla Island will not be able to visit the beach every day. Also, it should be noted that the visitation numbers described below are at least somewhat conservative because they do not take into account direct boat visitors. Some Lee County residents will take their small watercraft directly to Gasparilla beaches, but no data are available for this category.

State Park

The most recent visitation data available is for Gasparilla Island State Park is from the FY15 fiscal year- a year in which 482,166 individual users visited the state park. Correspondence with the non-Federal Sponsor indicates that essentially all visitors to the park visit the beach at least once during their visit. However, it cannot be assumed that all of these people visited the beach *inside* the project area. Most of the state park parking spaces are actually located to the south of the project area itself. Of approximately 200 parking spots near the beach, only 40 of them (20%) are located within the project area. Therefore, the baseline visitation from the park is assumed to be 96,433 (or 20% of total park visitation).

Private Residences

There are 46 private, single family homes in the project area. Residents of these homes can be expected to recreate on Gasparilla beaches throughout the life of the project. Based on 2010 Census data, the average household size in Lee County is 2.59 people per household. This would suggest that the number of people in this category capable of using the beach is approximately 119 people per day (or 43,486 per year). However, it is not reasonable to assume that individual residents would use the beach every day. So, for the baseline number, a conservative estimate might be two beach visits per week per resident. This amounts to 104 beach visits for each resident per year, or 12,391 total user events per year in this category.

Rental Houses

There are 18 rental homes in the project area. If the above assumption is used (2.59 people per household), the total number of beach visitors could be as many as 47 per day, or 17,017 per year. However, correspondence with the Sponsor suggests that beach use on Gasparilla Island is highly seasonal. Only seven months (October through April) are highly active for short term visitors. This translates to about 210 beach visits for each rental home visitor per year. Also, it is unlikely that every rental house is completely booked for every single day in the busy season, though they are a popular type of lodging for out-of-town guests. A conservative assumption might be that, at any given time, 80% the houses are occupied. And even of the houses that are occupied, visitors to those rental houses cannot be expected to visit the beach every day. In the busy season, a reasonable assumption might be that five out every seven days represents a “breach day”. Taking into account the seasonality of visitation, the 80% occupancy adjustment, and the five day adjustment, it is estimated that the project area has 5,221 total user events per year in this category. (There are actually two separate groups of rental homes- Sea Oats and Boca Grande Shores; the same logic applies to both and 5,221 reflect the sum them together).

Condos

A similar logic applies to the condominiums in the study area- specifically the Turtleback Colony. The colony has ten individual condo units. If, during the busy season (210 days per year), each has an average visitation of 2.59 people per day with a 80% occupancy adjustment and five day per week “good beach day” adjustment, then the total number of beach visits would be 2,901 per year in this category.

Hotel

One hotel, *The Gasparilla Inn and Beach Club*, is located in the project area. This hotel has 66 rooms. During the busy season, it is expected that the hotel is near capacity (90% of rooms are occupied). If the hotel has an average occupancy of two people per room, and five days per week are “good beach days”, then the total expected visitation would be 16,632 in this category. All of

the above categories contribute to the overall visitation estimate; the following table (**Table 21**) shows of breakout of the baseline visitation numbers.

Table 21: Baseline Visitation Summary

Recreation Source	Baseline Visitation
State Park	96,433
Private Residences	16,680
Condos	2,901
Rental Houses - Sea Oats	1,740
Rental Houses-BGS	3,481
Hotel	16,632
Total	**137,867**

Recreation Growth over time

After establishing a baseline, growth in visitation must be projected over time. Data collected by the Gasparilla Bridge authority provides a good basis for determining long term trends in visitation to the island. The Gasparilla Bridge is the only way to access the island; all vehicles going to the island are captured in the bridge authority data (see **Table 22**). Therefore, traffic count data from the bridge represents a reasonable proxy for trends in beach visitation over time.

Table 22: Gasparilla Traffic data over time

Calendar Year	Total Traffic count over bridge
2005	835,380
2006	856,438
2007	904,766
2008	904,179
2009	868,693
2010	839,396
2011	839,396
2012	839,711
2013	851,284
2014	917,299
2015	990,157

The total traffic count has increased over time, though the increase has not been consistent. The count actually declined between 2008 and 2011- years that correspond with the national recession. Growth has been steady and significant since 2012. For expected future growth, these ten years of data provide a reasonable basis for projecting into the future. Overall, between 2005 and 2015, the total traffic count increased by about 18.5%. This growth rate has been applied, in ten year increments, to the baseline visitation numbers as an "expected case" scenario. However, in order to provide a reasonable range of potential future growth scenarios, a high and low growth scenario were developed as well. The high scenario is based on the relatively high growth period of 2010-2015 (17.96% growth over five years).

The low scenario is based on the relatively slow growth period of 2005-2010 that included the worst years of the recession (0.06% growth over five years). Also, a zero growth scenario was created as well where the baseline visitation estimate does not change over time. All four scenarios are depicted graphically in **Figure 19**.

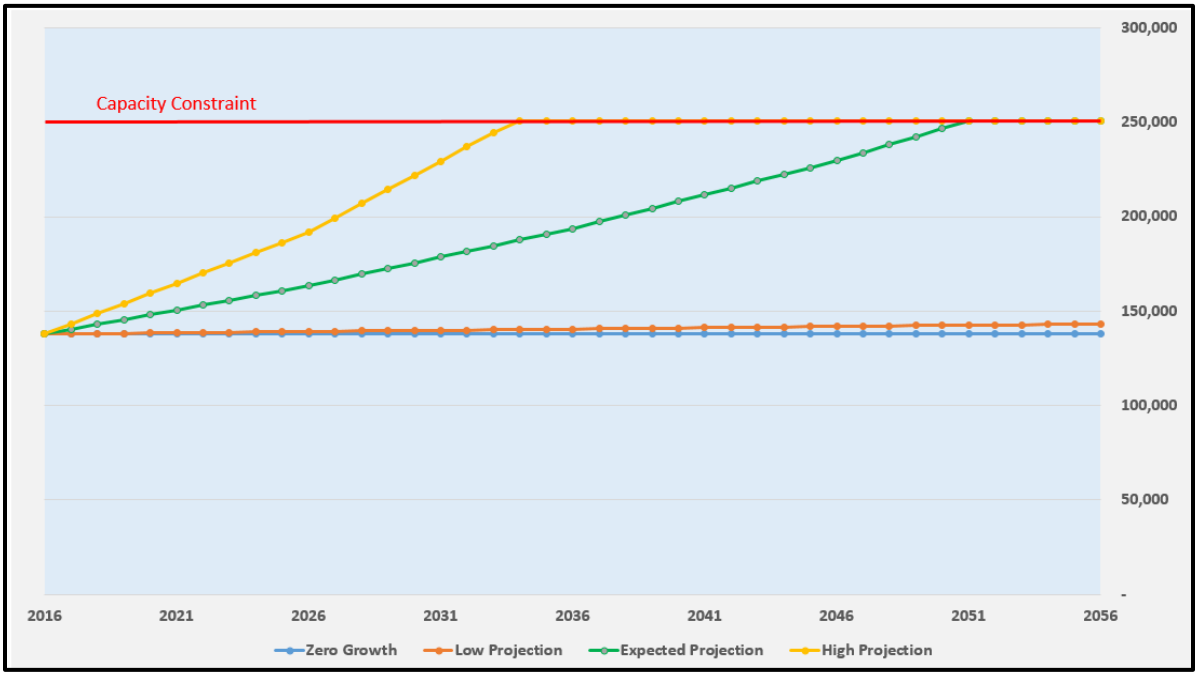
Capacity constraints

Though traffic data provide a reasonable proxy for growth over time, it is possible that growth in beach visitation will actually reach a capacity limit, after which further growth would not be possible. In order to account for this, a separate capacity constraint was developed for each category of beach visitation. The maximum capacity was determined by ignoring some of the restrictions assumed in the baseline estimate (seasonality, occupancy limits, etc.). For example, in the state park, only 40 parking spaces are available in the project area. If up to two vehicles could utilize each parking space per day (over 365 days a year), and each vehicle could have up to 4 four occupants, than the total maximum capacity of state park visitation would be 175,200 individual visits per year (compared to 96,433 in the baseline). A similar method was used for all the other categories. For example, if there are, on average, about 260 "good beach days" per year (five per week), then the total maximum possible capacity for the private residence category would be 47,840. A summary of maximum capacity by category is provided in **Table 23**. A graphical depiction of the four scenarios is provided in **Figure 19**.

Table 23: Maximum Recreation Capacity

Recreation Source	Maximum Capacity
State Park	124,800
Private Residences	47,840
Condos	3,626
Rental Houses - Sea Oats	6,240
Rental Houses-BGS	12,480
Hotel	55,440
Total	**250,426**

Figure 19: Recreation Projections over time (Constrained)



The total recreation capacity of the project area is 329,519. Neither the zero growth nor low projection scenario ever reach this threshold. However, the expected case and high growth scenarios do eventually reach this threshold. The constrained expected case scenario is used to compute benefits.

Recreation Benefits

After assigning point values and determining visitation over time, recreation benefits can be calculated. The constrained, expected case scenario will be used in the NED analysis (see **Table 24**). In this scenario, the total PV of recreation benefits is approximately $6.76 million, or $280,778 in average annual benefits. These recreation benefits will be added as incidental benefits to the TSP. The other scenarios are retained as part of a sensitivity analysis.

Table 24: PV and AAEQ Recreation Benefits

	Zero Growth	Low Projection	Expected Projection	High Projection
Unconstrained Projection				
PV benefits	$4,212,910	$4,323,459	$6,760,592	$8,895,489
AAEQ Benefits	$174,969	$179,560	$280,778	$369,443
Constrained Projection				
PV benefits	$4,212,910	$4,323,459	**$6,760,592**	$8,601,545
AAEQ Benefits	$174,969	$179,560	**$280,778**	$357,235

*Benefits calculated at the FY18 discount rate (2.75%) over a 40 year period of analysis.

5.5 BCR and Net Benefits of the Recommended Plan

The net benefits of the recommended plan incorporate both the costs and benefits of the project. The below table (**Table 25**) provides a summary. Average Annual costs and benefits have been computed at FY18 price levels and at the FY18 water resources discount rate (2.75%). The BCR and net benefits at the OMB discount rate (7%) are summarized in **Table 26**.

Table 25: Economic Summary of the Recommended Plan (FY18 Price Level)

Total Cost	$35,771,000
Interest During Construction (IDC)*	$0
Total Investment Cost	$35,771,000
Present Value of Investment Cost	$21,897,000
AAEQ of Investment Cost	$909,000
Annual OMRR&R	$32,000
Total AAEQ Cost	**$941,000**
PV Damage Reduction Benefits	$26,335,000
PV Land Loss Benefits	$0
PV Recreation Benefits	$6,761,000
PV Total Benefits	$33,096,000
AAEQ Total Benefits	$1,375,000
AAEQ Net Benefits	**$434,000**
Benefit-Cost Ratio (BCR)	**1.46**

*Because the project has already been constructed, there is no interest during construction; IDC is zero for continuing construction of projects that are already generating benefits.

Table 26: Economic Summary of the Recommended Plan at 7%

Total Cost	**$35,771,000**
Interest During Construction (IDC)*	$0
Total Investment Cost	$35,771,000
Present Value of Investment Cost	$11,295,000
AAEQ of Investment Cost	$847,000
Annual OMRR&R	$36,000
Total AAEQ Cost	**$883,000**
PV Damage Reduction Benefits	$11,162,000
PV Land Loss Benefits	$0
PV Recreation Benefits	$2,171,000
PV Total Benefits	$13,333,000
AAEQ Total Benefits	**$1,000,000**
AAEQ Net Benefits	**$117,000**
Benefit-Cost Ratio (BCR)	**1.13**

5.6 Conclusion and Recommendations

The economic analysis in this report confirms that continued Federal participation in the Lee County Gasparilla coastal storm risk management project is economically justified. In accordance with planning guidance and the stated purpose of a Section 934 report, an optimized version of the authorized project is the recommended plan. The optimized plan has positive net benefits and a benefit-cost-ratio above unity. The plan is very similar to the constructed project, though the recommended renourishment interval is less frequent (approximately once every 22 years).

6 Addendum A: Real Estate Report

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Lee County Boca Grande Beach Restoration

Estimated Depreciated Replacement Costs of Damage Elements

Prepared by Appraisal Branch

US Army Corps of Engineers ®
Jacksonville District

Purpose of the Analysis:
The purpose of this analysis is to evaluate and estimate the depreciated replacement costs associated with selected real estate structures directly abutting the Gulf of Mexico in Lee County Florida. This analysis represents a planning level estimate and is restricted to use by the client, the U.S. Army Corps of Engineers. Reference is made to the U.S. Army Corps of Engineers Circular (EC) 405-1-4 Chapter 4, Section III-Planning, dated 30 December 2003. Paragraph 4-19 (b) Use of Cost Estimates. Cost estimates are generally utilized as an initial cost projection for one or more alternative(s) presented in the Reconnaissance Report or Project Study plan (PSP). These cost estimates should document and note the information available or relied upon for this stage of planning. Cost estimates prepared under this paragraph are not authorized to be incorporated or utilized in any approval decision document, project authorization, or funding documents, except for CAP projects.

Intended Use and Intended User:
The intended use of this report is to assist the U.S. Army Corps of Engineers in the planning process to estimate the depreciated replacement costs associated with the damage elements vulnerable to a coastal storm. The cost estimates cited are subject to the limiting conditions and assumptions included herein. There is no other intended use. The intended user in this assignment is the U.S. Army Corps of Engineers; there are no other known intended users of this cost estimate.

Effective Date of the Report:
The effective date of the report is April 24, 2014. The last physical date of viewing the project area was from April 21 through April 24, 2014. The date the report was prepared is June 5, 2014.

Legal Descriptions:
No legal descriptions have been provided. Valuation premises, presented in this report, are based upon maps provided by the engineering department of the U.S. Army Corps of Engineers.

Real Property Interests:
The property rights analyzed in this report are those of fee simple interests. Fee simple estate is defined as an absolute right or interest in real property without limitations to any particular class of heirs or restrictions, but subject to the limitations of eminent domain, escheat, police power, and taxation.

Scope of Work:
The scope of work includes, but is not limited to, the degree of property viewing or identification, the extent of data research into physical or economic factors affecting cost, and the type and extent of analysis applied to arrive at depreciation estimates or conclusions. This analysis is an estimate of depreciated replacement costs for building improvements, selected by the project manager, that have a potential risk of damage from a coastal storm surge. The estimated project depreciated replacement costs are relevant from the end of 2014 through 2015. Project area maps provided by the USACE engineering department are based on 2012 Lee County Property Appraiser valuation roll. Additional information was obtained by interviews with; personnel from the Lee County Property Appraisers Office, agents' active in the management of the condominiums and hotels, as well as realtors active with sales of oceanfront properties. These interviews influenced and/or validated final estimated costs per square foot.

The project corridors the Lee County coast encompassing major beachfront improvements from Range Monument 10 at 19th Street beach access south to Boca Grande Pass Range Monument 26. The corridor is limited in depth by parcels with structures that are beachfront. The range monuments are shown on Coastal Construction Control Lines (CCCL) maps, and are a statewide network of survey monumentation used by DEP to provide a quick reference between a coastal property and its proximity to the R-monument. The project area and structures have been physically inspected from public rights of way to the extent possible. We have also relied to a significant extent on physical description information provided by the Lee County Property Appraisers Office. Improvements in this corridor ranged from single family and multi-family residences to commercial retail/service establishments. The cost estimates are subject to the limiting conditions and assumptions included herein. Replacement Cost unit price was estimated utilizing Marshall & Swift valuation service, a nationally recognized construction cost reporting service. This guide is used to help determine the construction costs of different types of residential and commercial and special use properties. Based on the published (public records) physical characteristics, validated by a personal viewing of the structure, a replacement cost new is estimated. Depreciation was estimated from the observed condition and compared to prevailing market conditions for validity. Replacement Cost New, less depreciation, results in a depreciated replacement cost estimate. Other determining factors evaluated in reference to real estate costs included, but not limited to: coastal construction control line (CCCL), applicable land use restrictions, zoning, construction constraints, set back requirements, and the development approval process. Additional data sources include, but are not limited to: the appraiser's files, Loop Net market data reporting service, and interviews with property managers.

Conclusions of Analysis:
The square foot replacement costs are averages of final costs including architects' fees, sales taxes, permit fees, insurance during construction, contractors' overhead and profit. Current and local cost multipliers have been utilized. Physical characteristics, actual age and size are based on public records and field measurements; condition and effective age based on field observation.

Reference is made to the addenda for the spreadsheets depicting cost estimate calculations.

This analysis involves two primary building categories: residential and commercial.

The residential analysis included both single family and multi-family improvements. These improvements ranged from single story, ranch style homes to multi-story, low rise buildings. Single family residences come in many architectural styles and mixtures of styles. However, for those structures within the same quality category, cost will not vary significantly. Thus, the modern, the rustic, the ranch, and the one story conventional house are all variations on the same theme, as are the Cape Cod, the split-level, and the almost infinite number of other variations. The single story, ranch style homes were categorized into four classes: fair, average, good, and excellent. Condominium is a form of ownership and not a type of construction, and the multiple residence costs are valid for this type of construction. Multiple residence structures are categorized into three categories; Good, Average and Fair. Row houses, flats, garden apartments, duplexes, triplexes, etc., are examples of low-rise multiple residences. Low-rise buildings are not adjusted for number of stories or elevators. Estimated depreciated replacement costs for the residential category is as follows:

Single Family ..... $92,120,651 rounded to $92,120,000.
Condominiums ..... $59,276,569 rounded to $59,280,000.

Commercial improvements included: hotels/motels, free standing restaurants, multi tenant retail buildings, nightclubs, and bars. Institutional improvements included Lighthouses, historic buildings, museums, libraries, restrooms, county parking lots and gift shops. Estimated depreciated replacement costs for the Commercial and institutional categories are:

Commercial ..... $8,927,959 rounded to $9,000,000.
Institutional ..... $2,260,385 rounded to $2,260,000.

Total Depreciated Replacement Cost estimate for the Lee County Shore protection project is estimated at:..... $162,660,000

General Assumptions and Limiting Conditions:

- Reference is made to the U.S. Army Corps of Engineers Circular (EC) 405- 1-4 Chapter 4 Section III- Planning, dated 30 December 2003. Paragraph 4-19, (b) Use of Cost Estimates. Cost estimates are generally utilized as an initial cost projection for one or more alternative(s) presented in the Reconnaissance Report or Project Study plan (PSP). These cost estimates should document and note the information available or relied upon for this stage of planning. Value conclusions prepared under this paragraph are not authorized to be incorporated or utilized in any approval decision document, project authorization, or funding documents, except for CAP projects.
- Cost Estimates shall be as complete and descriptive as possible, but there is no requirement for owner contact, and the appraiser may rely on tax records, previous analyses and appraisals, cursory inspections, or other suitable information for descriptions of improvements, as detailed inspections are not practical. This report is a cost estimate for the Army Corps of Engineers, its use is restricted to the Corps, and the function of the report is for planning purposes of projects that may take several years for commencement or for screening out alternatives in plan formulation. While as descriptive of the project as possible, the real estate market is dynamic, and the estimated values may increase or decrease during the planning and contracting phase. Because the function of the report is for planning purposes, the appraiser may select the estimated cost of acquisition from the higher or lower end of the market indication range. That selection may be subjective, based on the appraiser's geographical competency, experience, or knowledge of that particular market place.
- Cost estimate premises, presented in this report are based upon maps and plans as provided by the engineering department of the U.S. Army Corps of Engineers and, for planning purposes, are believed to reflect the current state of the subject project as portrayed.
- No opinion is expressed for matters legal in nature, nor is any opinion rendered herein as to title, which is assumed good and merchantable. The subject properties are assumed "free and clear" of all liens and encumbrances, unless specifically enumerated herein, and under responsible ownership and management as of the appraisal date.
- It is assumed there is full compliance with all local, state, and national environmental regulations and laws, unless noncompliance is stated and defined in the appraisal report.
- Possession of this report, or a copy thereof, does not carry with it the right of publication. Any use, for any purpose, by any person other than the party to whom addressed, without the written consent of the appraiser, is unauthorized. This report is prepared for the sole use of the U.S. Army Corps of Engineers. Acceptance and/or use of this cost estimate constitutes acceptance of the foregoing Assumptions and Limiting Conditions.

General Assumptions and Limiting Conditions (Continued):

- Data for the subject properties and comparable sales are based on information obtained from the County Property Appraiser's office for the county in which the property is located. This data is assumed correct. The report and cost estimates are subject to change if this data is revealed different from previously disclosed.
- *ENVIRONMENTAL DISCLOSURE:* A review of the available environmental assessments for this area did not indicate any findings of significant impact. The cost estimates in this report are based on the assumption that the property is not negatively affected by the existence of hazardous substances or detrimental environmental conditions. While viewing the properties, the appraiser observed above ground refueling tanks, maintenance being performed on mechanical equipment, and rehabilitation work on the utilities and streets. Operations appeared normal and hazard free; however, there is the potential for contamination that could adversely affect cost estimates. Tests and environmental inspections made by a qualified hazardous substance and environmental expert could reveal the existence of hazardous materials and environmental conditions, unknown to the appraiser, on or around the properties that would negatively affect cost estimates. The appraiser hereby reserves the right to alter, amend, revise, or rescind any of the cost estimates based upon any subsequent environmental impact studies, research, or investigation.
- No liability is assumed for the soundness of structures, equipment, or soil conditions, and unless stated in this report, all are considered to be adequate. No responsibility is assumed for such conditions or for arranging for engineering studies that may be required to discover them.
- The information furnished by others is believed to be reliable. Any maps, drawings, sketches, plot plans, or other illustrative materials in this report are included only to assist the reader in visualizing the properties.
- The distribution, if any, of the total valuation in this report between land and improvements applies only under the stated program of utilization. The separate allocations for land and buildings must not be used in conjunction with any other assignment and are invalid if so used.

Project Photographs

Southern beachfront of project

Project Photographs

Southern end of seawall

Project Photographs

View of seawall deterioration

Project Photographs

View of seawall Rehab

Project Photographs

Boca Bay Clubhouse

Project Photographs

801 Belcher Road

Project Photographs

801 Belcher Road

Project Photographs

Boca Grande Lighthouse Museum and Visitors Center

Project Photographs

Boca Grande Lighthouse Museum and Visitors Center

Project Photographs

Historic Cisterns

Project Photographs

Port Boca Grande Lighthouse

Project Photographs

Park Shade House

Project Photographs

Historic Boca Grande Church

Project Photographs

Belcher Road Single Family Properties

Project Photographs

County Park Restrooms

Project Photographs

South Beach Bar and Grille
Beachside

Project Photographs

Entry to South Beach Bar and Grille

Project Photographs

Gulf Front Single Family Homes

Project Photographs

Island House Condominiums

Project Photographs

Woodwind Condominiums

Project Photographs

Boca Grande Shores Condominium

Project Photographs

Turtleback Colony Condominium

Project Photographs

Gulf Dunes Condominium

Project Photographs

Sundown Colony Condominium

Project Photographs

Seagrape Colony Condominium

Project Photographs

Single Family- 370 Gulf Blvd.

Project Photographs

Single Family- 356 Gulf Blvd.

Project Photographs

Single Family – 350 Gulf Blvd.

Project Photographs

Single Family – 344 Gulf Blvd.

Project Photographs

Boca Grande Beach Club Condominium

Project Photographs

Lighthouse Condominium

Project Photographs

Gasparilla Island Light (AKA Boca Grande Light Rear Range)

Project Photographs

Gasparilla Island Park Restrooms

Project Photographs

Gasparilla Island Park Shade houses

Project Photographs

Single Family – 174 Gulf Blvd.

Project Photographs

Single Family – 160 Gulf Blvd.

Project Photographs

Single Family – 150 Gulf Blvd.

Project Photographs

Single Family – 138 Gulf Blvd.

Project Photographs

Single Family – 134 Gulf Blvd.

Project Photographs

Boca Bay Clubhouse

Project Photographs

Single Family – 100 Gulf Blvd

Project Photographs

Single Family – 100 Gulf Blvd.

Project Photographs

Single Family – 400 4th Street West

Project Photographs

Gasparilla Inn Beach Clubhouse