LEE COUNTY, FLORIDA

SHORE PROTECTION PROJECT

GASPARILLA ISLAND SEGMENT

Final Integrated Section 934 Report and Environmental Assessment

APPENDIX A

Engineering

May 2018

US Army Corps of Engineers
Jacksonville District

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QUALITY CONTROL PLAN
Statement of Technical Review and Certification

Lee County, Gasparilla Island Segment
Coastal Flood Risk Management
Section 934 Study

Water Resources Engineering Branch
Engineering Division
U.S. Army Corps of Engineers
Jacksonville District

May 2016

STATEMENT OF TECHNICAL REVIEW AND CERTIFICATION

The Water Resources Engineering Branch has completed the project lifecycle analysis and associated shoreline morphology modeling of the Lee County, Gasparilla Island Segment Coastal Flood Risk Management Project. Notice is hereby given that technical review, that is appropriate to the level of risk and complexity inherent in the project, has been conducted as defined in the Quality Control Plan. During the technical quality review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included the review of: assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level obtained; and reasonableness of the result, including whether the product meets the customer's needs consistent with law and existing Corps policy. The quality review was conducted by appropriate team members, with all comments resulting from the review having been resolved. Products developed through an A-E Contractor have been verified to be in compliance with policies and procedures set forth for quality control, quality assurance and independent technical review (ITR).

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1 Background

The presently authorized Gasparilla Island Segment of the Lee County Coastal Storm Risk Management (CSRM) project consists of maintaining approximately 2.8 miles of beach between Lee County, Florida Department of Environmental Protection (FDEP) reference monument R-10.5 (R-11 plus a 1,200 foot long north extending taper) and R-24.5 (R-24 plus a 600 foot long south extending taper) (Figure A- 1). The project includes a 20 foot extension of the 1995 mean high water (MHW) baseline as established by the 2000 General Reevaluation Report (GRR) (USACE, 2000). The authorized fill allows for the 20 foot extension and provides additional material (540,000 cubic yards) to offset erosive losses for seven years between renourishments.

2 Purpose

The purpose of this report is to determine if a 40-year extension of Federal participation in the Gasparilla Island Segment of the Lee County authorized project is economically justified. Initial project construction occurred in 2006. The additional 40 years would therefore allow for continued maintenance of the existing project through 2056.

Section 934 analysis (see the Main Report for a complete discussion of Section 934 guidance) is a two-step process that consists of: (1) identification of current benefits of the existing project to determine if continued maintenance is economically justified and is consistent with current policies and (2) development of alternatives (size and timing) for nourishment to identify the most cost-effective nourishment scheme for the authorized project.

3 Natural Forces

3.1 Winds

Local winds are the primary means of generating the small-amplitude, short period waves that are an important mechanism of sand transport along the Florida shoreline. Lee County lies at about 26.7° degrees latitude, slightly south of the northern boundary of the tropical trade wind zone. Typical prevailing winds are from the east.

Wind data offshore of the project area is available from the USACE Wave Information Study (WIS) Program. WIS hindcast data are generated using the numerical hindcast model WISWAVE (Hubertz, 1992). WISWAVE is driven by wind fields overlaying a bathymetric grid. Model output includes significant wave height, peak and mean wave period, peak and mean wave direction, wind speed, and wind direction. In the Gulf of Mexico, the WIS hindcast database covers a 33-year period of record extending from 1980 to 2012.

There are 367 WIS stations along the Gulf of Mexico shoreline. WIS Station 73285 is representative of offshore wind and wave conditions for the project area. Table A- 1 provides a summary of wind data from WIS Station 73285, located at latitude 26.75, longitude -82.3 (about 2 miles west of the project area- Figure A- 2). This table contains a summary of average wind speeds and frequency of occurrence broken down into eight 45 degree angle-bands. This table indicates that annual average winds are predominantly from the east. The wind rose presented in Figure A- 3 provides a further breakdown of winds in the project area.

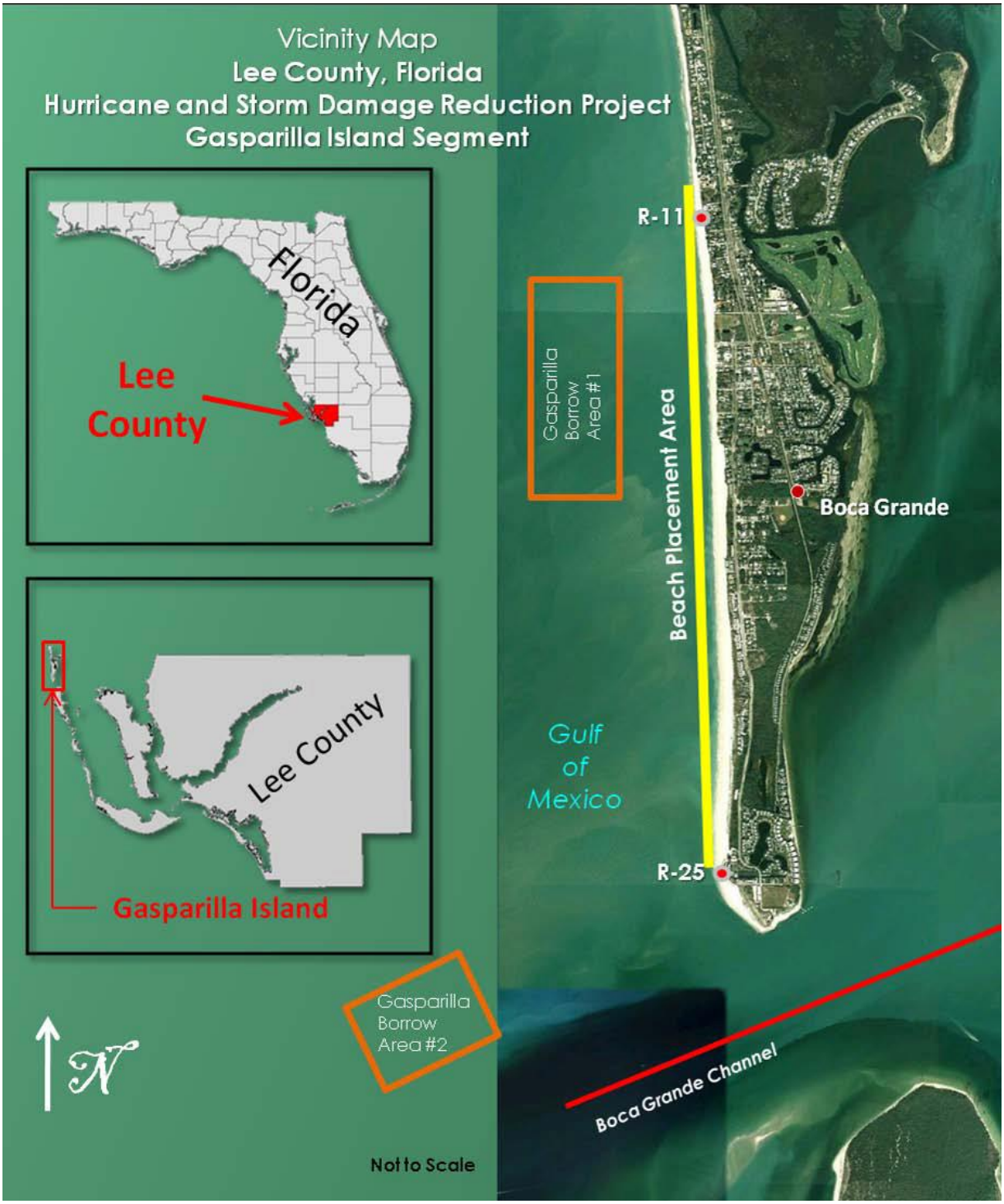

Figure A- 1. Project Site

Table A- 1. Average Wind Conditions

Wind Direction (from)	WIS Station #73285 (1980 – 2012)	
	Percentage Occurrence (%)	Average Wind Speed (mph)
North	11.4	15.0
Northeast	17.7	14.3
East	26.0	12.6
Southeast	17.0	11.6
South	9.4	11.3
Southwest	6.0	10.8
West	5.2	11.8
Northwest	7.3	14.4

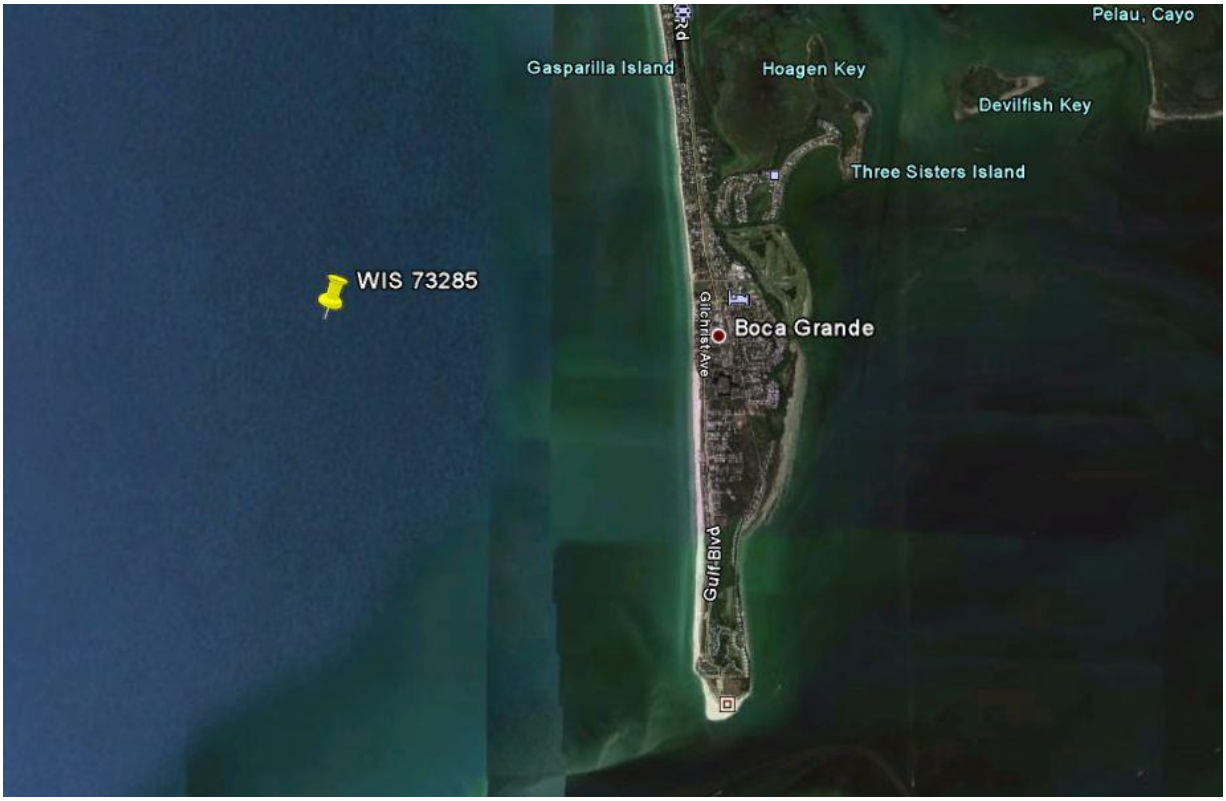

Figure A- 2. Location of WIS Station 73285

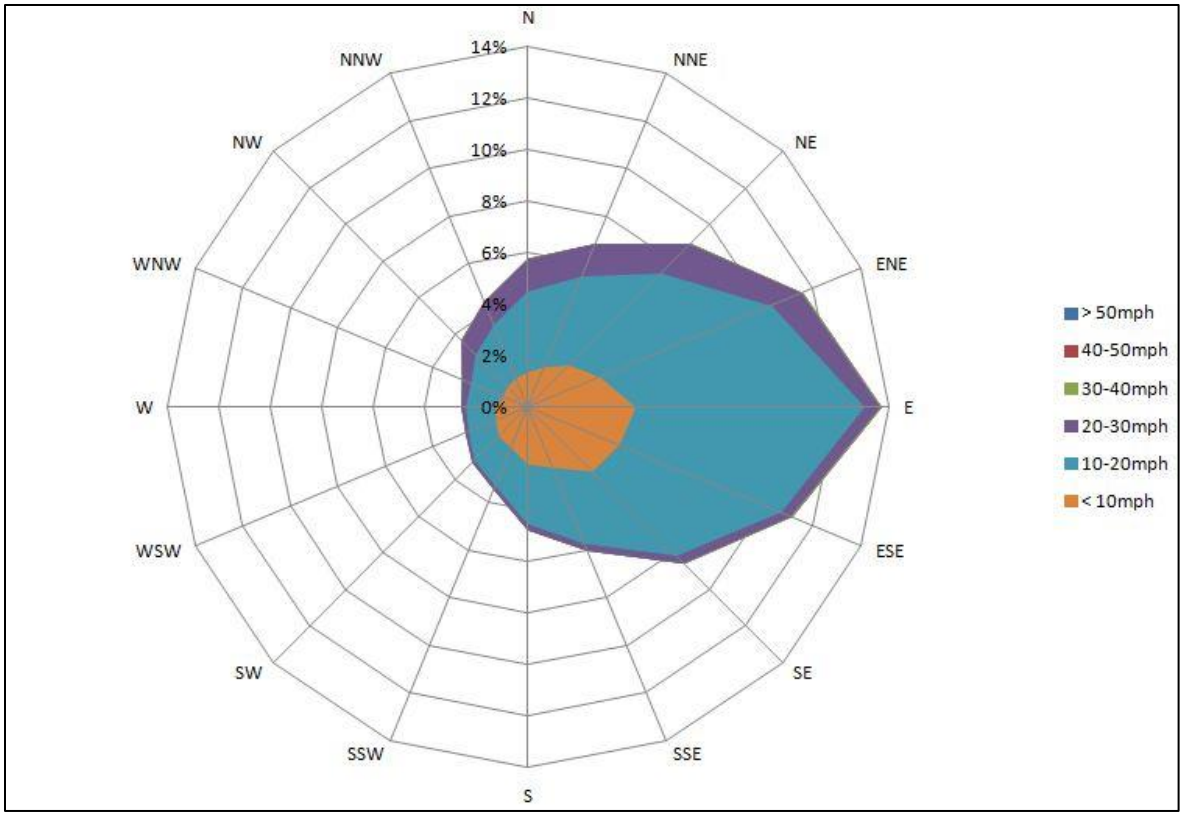

Figure A- 3. Wind Rose – WIS Station 73285

Wind conditions in Coastal Florida are seasonal. A further breakdown of the wind data provides a summary of the seasonal conditions (Table A- 2).

Between December and March, frontal weather patterns driven by cold Arctic air masses can extend as far as South Florida. These events (referred to as "Northeasters") generate winds that are predominantly from the northeast quadrant. However, in the vicinity of Gasparilla Island, these northeast winter winds are impacted by the Florida land mass and are predominantly veer to an easterly direction. While Northeasters often result in wave conditions that cause extensive beach erosion on the east coast of Florida, the west coast of Florida experiences little impact from these events.

During summer and fall months (June through November) tropical waves often develop into tropical storms and hurricanes, which can generate devastating winds, waves, and storm surge. These intense seasonal events will be discussed in greater detail under **Storm Effects** (page A-8). In the vicinity of Gasparilla Island, summer winds are predominantly from the east. In the fall, winds shift to the northeast.

In addition to storm winds, the project area also experiences daily breezes. These onshore and offshore winds result from differential heating of land and water masses and typically blow perpendicular to the shoreline. While these breezes play a significant role in local weather patterns, they are not an appreciable cause of sediment movement in the nearshore.

Table A- 2. Seasonal Wind Conditions

Month	WIS Station #73285 (1980 – 2012)	
	Average Wind Speed (mph)	Predominant Direction (from)
January	14.9	N
February	14.2	E
March	13.9	E
April	12.5	E
May	10.9	E
June	10.2	E
July	9.9	E
August	10.2	E
September	12.2	E
October	14.7	NE
November	15.7	NE
December	15.2	E

3.2 Waves

Energy dissipation that occurs as waves enter the nearshore zone and break is the principal method of sediment transport. Wave height and period, in combination with tides and storm surge, are the most important factors influencing the behavior of the shoreline. The Gasparilla Island study area is exposed predominantly to short period wind-waves with occasional exposure to longer period open-ocean storm swells (tropical storm events). However, the limited fetch of the Gulf of Mexico basin and relatively extensive shallow shelf fronting the island limits the size and associated period of significant storm waves.

Wave data for this report were obtained from the USACE WIS hindcast database for the Gulf of Mexico. As previously discussed, WIS station 73285 was selected for the study. Given the relatively shallow depth at this station (16.4 feet), and the smooth depth contours between the station and shoreline, wave conditions at 73285 are considered to be representative of nearshore wave conditions.

Table A- 3 summarizes the percentage of occurrence and average wave height of the WIS waves by direction. Average wave heights range from 0.5 feet to 1.4 feet, indicating a generally mild wave climate year round. Wave directions are generally from the northwest and southeast quadrants. This can be seen in greater detail in the wave rose presented in Figure A- 4. A seasonal breakdown of wave heights shows that higher wave heights are more frequent in the fall and winter months (October through February) and tend to originate from the northwest quadrant (Table A- 4). Spring and summer waves (March through September), are smaller and originate predominantly from the south to southeast.

Table A- 5 provides a seasonal breakdown of percent occurrence by wave period. From this table, it can be seen that short period, locally-generated wind waves are common throughout the year. The yellow highlighted values (in this case, entirely in the first row of the table) show the dominant wave period for each month. None of the dominant periods are greater than 4.0 seconds.

Table A- 3. Average Wave Heights (1980 to 2012)

Wave Direction (from)	WIS Station #73285 (1980-2012)	
	Percentage Occurrence (%)	Average Wave Height (ft)
North	3.1	1.4
Northeast	2.8	1.3
East	5.8	1.2
Southeast	12.5	0.7
South	24.8	0.5
Southwest	11.5	0.9
West	19.4	1.0
Northwest	20.2	0.8

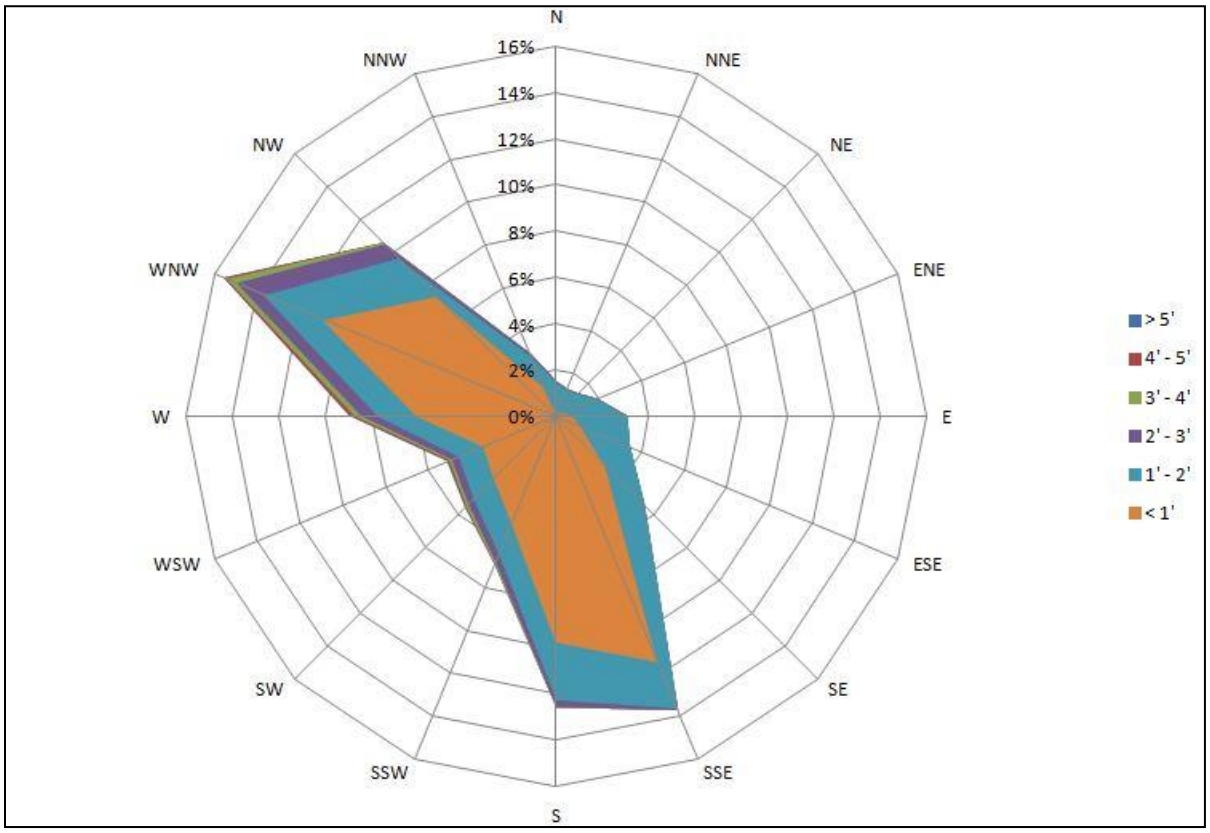

Figure A- 4. Wave Rose – WIS Station 73285

Table A- 4. Seasonal Wave Conditions

Month	WIS Station #73285 (1980-2012)	
	Average Wave Height (ft)	Predominant Direction (from)
January	1.1	NW
February	1.1	NW
March	1.1	S-SE
April	0.9	S-SE
May	0.6	S-SE
June	0.5	S-SE
July	0.5	S-SE
August	0.5	S-SE
September	0.6	S-SE
October	0.9	NW
November	1.0	NW
December	1.1	NW

Table A- 5. Wave Period – Percent Occurrence

Wave Period	Percent Occurrence by Wave Period Band											
(Sec)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
< 4.0	61.7	62.7	62.5	67.9	83.3	82.4	79.0	77.2	76.6	77.3	75.1	66.6
4.0 - 4.9	9.3	10.1	11.9	12.5	10.5	12.1	15.1	14.3	10.1	9.2	6.6	7.0
5.0 - 5.9	11.1	10.2	10.5	10.8	5.2	4.1	3.5	4.6	6.0	5.8	6.6	8.4
6.0 - 6.9	5.1	5.4	5.0	4.7	0.8	0.7	0.7	0.9	2.1	2.4	3.9	4.3
7.0 - 7.9	4.3	4.3	3.3	1.8	0.1	0.3	0.5	0.7	1.3	1.5	2.6	4.9
8.0 - 8.9	3.8	3.4	2.9	1.0	0.0	0.4	0.4	0.6	1.0	1.5	2.5	3.5
9.0 - 9.9	2.7	2.4	2.2	0.8	0.0	0.1	0.5	0.8	1.0	0.9	1.7	3.1
10.0 - 10.9	1.7	0.9	1.1	0.3	0.0	0.0	0.2	0.6	0.8	0.4	0.7	1.6
11.0 - 11.9	0.3	0.5	0.6	0.2	0.0	0.0	0.1	0.3	0.7	0.5	0.3	0.5
> 12.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.6	0.5	0.0	0.0

3.3 Tides and Currents

Astronomical tides are created by the gravitational pull of the moon and sun and are predictable in magnitude and timing. The National Oceanic and Atmospheric Administration (NOAA) regularly publishes tide tables for selected locations along the coastlines of the Unites States and selected locations around the world. These tables provide times of high and low tides, as well as predicted tidal amplitudes.

Tides in the project area are a mixture of diurnal and semi-diurnal types. There are no existing tide stations in the project area. Tidal datums were determined using the NOAA VDatum model. The model was verified using the two closest gulf-side gauges (Venice-8725858 and Naples-8725110). Resulting tidal datums are summarized in Table A- 6. The tide range (the difference between Mean High Water and Mean Low Water) is 1.33 feet in the project area.

Tidal currents in the vicinity of the project area occur at Boca Grande pass, the tidal inlet south of Gasparilla Island. Tidal currents at the inlet average approximately 2.2 knots, with ebb currents occasionally reaching maximum velocities of 3 to 4 knots (NOAA, 2015).

Table A- 6. Tidal Datums

Tidal Datum	Elevation (feet) Relative to NAVD88
Mean High Water (MHW)	0.08
North American Vertical Datum (NAVD88)	0.00
Mean Sea Level (MSL)	-0.57
Mean Low Water (MLW)	-1.25
Mean Lower Low Water (MLLW)	-1.69

Primary nearshore currents in the vicinity of Gasparilla Island are wave-induced longshore currents. These currents are driven by the transformation of obliquely incident waves in the nearshore. The magnitude of the longshore current is generally greatest in the region immediately landward of the point of depth induced wave breaking and is primarily a function of the local wind and wave climate. For Gasparilla Island, the main longshore current is from north to south. Additional contributions to nearshore currents at the southern end of Gasparilla Island are a result of tidal flows through Boca Grande Pass which can increase south-directed currents during flood tides or cause local reversals during ebb tides.

3.4 Storm Effects

The shoreline of Lee County is influenced by tropical systems during the summer and early fall. Unlike shorelines along the east coast of Florida, Gasparilla Island is not significantly influenced by northeaster storm activity which typically occurs in months between fall and early spring. However, during the late fall and winter, wave heights do increase slightly, predominantly coming from the northwest. Although hurricanes typically generate larger waves and storm surge, winter storms may have a greater impact on the shoreline because of longer duration and higher frequency.

During intense storm activity, the shoreline is expected to naturally modify its beach profile. Storms erode and transport sediment from the beach into the active zone of storm waves. Once caught in the waves, this sediment is carried along the shore and re-deposited farther down the beach, or is carried offshore and stored temporarily in submerged sand bars. Periodic and unpredictable hurricanes and coastal storms, with their intense breaking waves and elevated water levels, can change the width and elevation of beaches and accelerate erosion. After storms pass, gentle waves usually return sediment from the sand bars to the beach, which is restored gradually to its natural shape. While the beach profile typically recovers from storm energy as described, extreme storm events may cause sediment to leave the beach system entirely, sweeping it into inlets or far offshore into deep water where waves cannot return it to the beach. Therefore, a portion of shoreline recession due to intense storms may never fully recover.

Lee County is located in an area of significant storm activity. Figure A- 5 shows historic tracks of hurricanes and tropical storms from 1858 to 2010 as recorded by the National Hurricane Center (NHC).

These hurricane data are available from the National Oceanic and Atmospheric Administration (http://csc.noaa.gov/hurricanes/#). The shaded circle in the center of this figure indicates a 50-nautical mile radius drawn from the center of the study area and encompassing the entire Lee County shoreline. Based on NHC records, 15 hurricanes and 32 tropical storms have passed within this 50-mile radius over the 153-year period of record. The 50-mile radius was chosen for display purposes in Figure A- 5 because any tropical disturbance passing within this distance, even a weak tropical storm, would be likely to produce some damage along the shoreline. Stronger storms are capable of producing significant damage to the coastline from far greater distances.

In recent years, a number of named storms, passing within the 50 mile radius have significantly impacted the project area, including Bonnie (2010), Charley (2004), and Gabrielle (2001). Damages from these storms, as well as from more distant storms causing indirect impacts, included substantial erosion and damage from winds, waves, and elevated water levels.

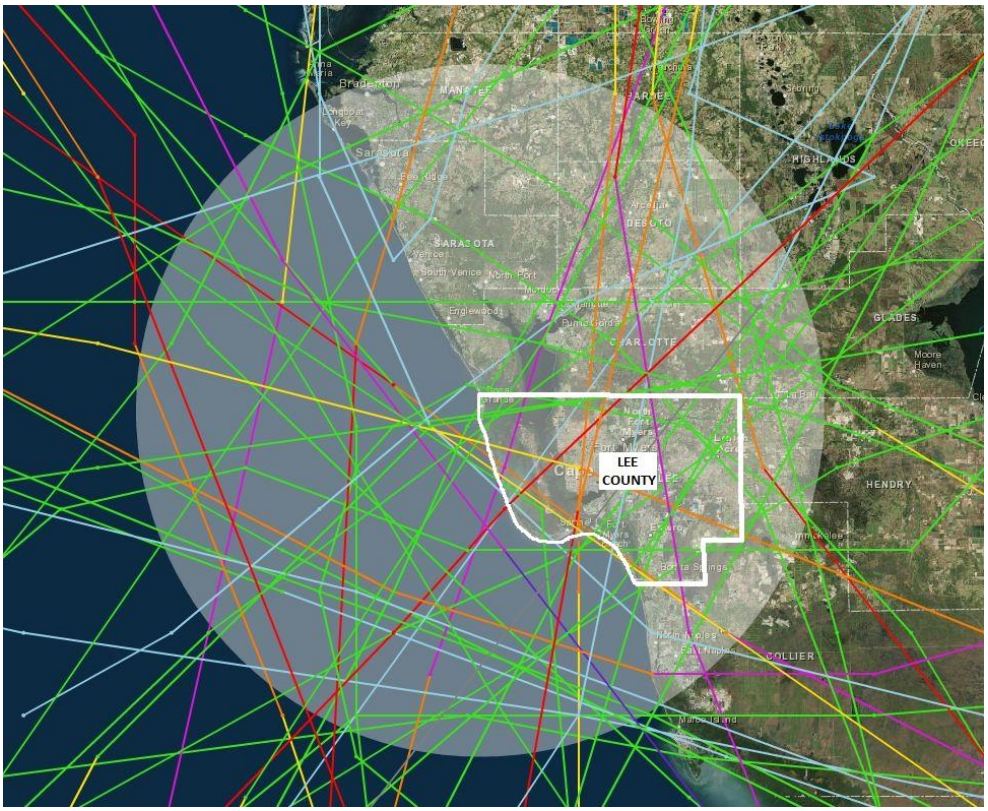

Figure A- 5. Historic storm tracks – Hurricanes and Tropical Storms (1858 – 2010, 50 mile radius)

3.5 Storm Surge

Storm surge is defined as the rise of the ocean surface above its astronomical tide level due to storm forces. Surges occur primarily as a result of atmospheric pressure gradients and surface stresses created by wind blowing over a water surface. Strong onshore winds pile up water near the shoreline, resulting in super-elevated water levels along the coastal region and inland waterways. In addition, the lower atmospheric pressure which accompanies storms also contributes to a rise in water surface elevation. Extremely high wind velocities coupled with low barometric pressures (such as those experienced in

tropical storms, hurricanes, and very strong northeasters) can produce very high, damaging water levels. In addition to wind speed, direction and duration, storm surge is also influenced by water depth, length of fetch (distance over water), and frictional characteristics of the nearshore sea bottom. An estimate of storm surge is required for the design of beach fill crest elevations. An increase in water depth may increase the potential for coastal flooding and allow larger storm waves to attack the shore.

The Lee County, Gasparilla Island study area is a relatively low, flat barrier island and is susceptible to overtopping from moderate to extreme storm surges. The Florida Division of Emergency Management provides storm tide zone maps for Florida coastlines (FDEM, 2010). Figure A- 6 shows the FDEM storm tide zone map for southern Gasparilla Island. An examination of this map shows that virtually the entire island would be inundated during even a severe tropical storm or Category 1 hurricane, should the storm make direct landfall at or near Gasparilla Island. The study area and dune system along the western shoreline would be inundated during a Category 2 land-falling hurricane. Note that the existing Federal project does not prevent flooding under these conditions.

Storm surge levels versus frequency of occurrence were obtained from data compiled by the University of Florida for the Florida Department of Transportation (FDOT, 2003). Table A- 7 provides peak storm surge heights by return period for Gasparilla Island. The storm surge elevations presented include the effects of astronomical high tide and wave setup.

3.6 Sea Level Rise

3.6.1 Relative Sea Level Rise

Relative sea level (RSL) refers to local elevation of the sea with respect to land, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. It is anticipated that sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future sea level change on design, construction, operation, and maintenance of coastal projects, the U.S. Army Corps of Engineers (USACE) has provided guidance in the form of an Engineering Regulation, ER 1110-2-8162 (USACE, 2013).

ER 1110-2-8162 provides both a methodology and a procedure for determining a range of sea level change estimates based on global sea level change rates, the local historic sea level change rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance, a Baseline (or "Low") estimate, which is based on historic sea level rise and represents the minimum expected sea level change, an Intermediate estimate (NRC Curve I), and a High estimate (NRC Curve III) representing the maximum expected sea level change. All three scenarios are based on the following eustatic sea level rise (sea level change due to glacial melting and thermal expansion of sea water) equation:

$$E(t) = 0.0017t + bt^2$$

Where E(t) is the eustatic sea level rise (in meters); t represents years, starting in 1992 (the midpoint of the current National Tidal Datum Epoch of 1983-2001), and b is a constant equal to 2.71E-5 (NRC Curve I), 7.00E-5 (NRC Curve II), and 1.13E-4 (NRC Curve III). This equation assumes a global mean sea level change rate of +1.7mm/year.

In order to estimate the eustatic sea level change over the life of the project, the eustatic sea level rise equation is modified as follows:

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b({t_2}^2 - {t_1}^2)$$

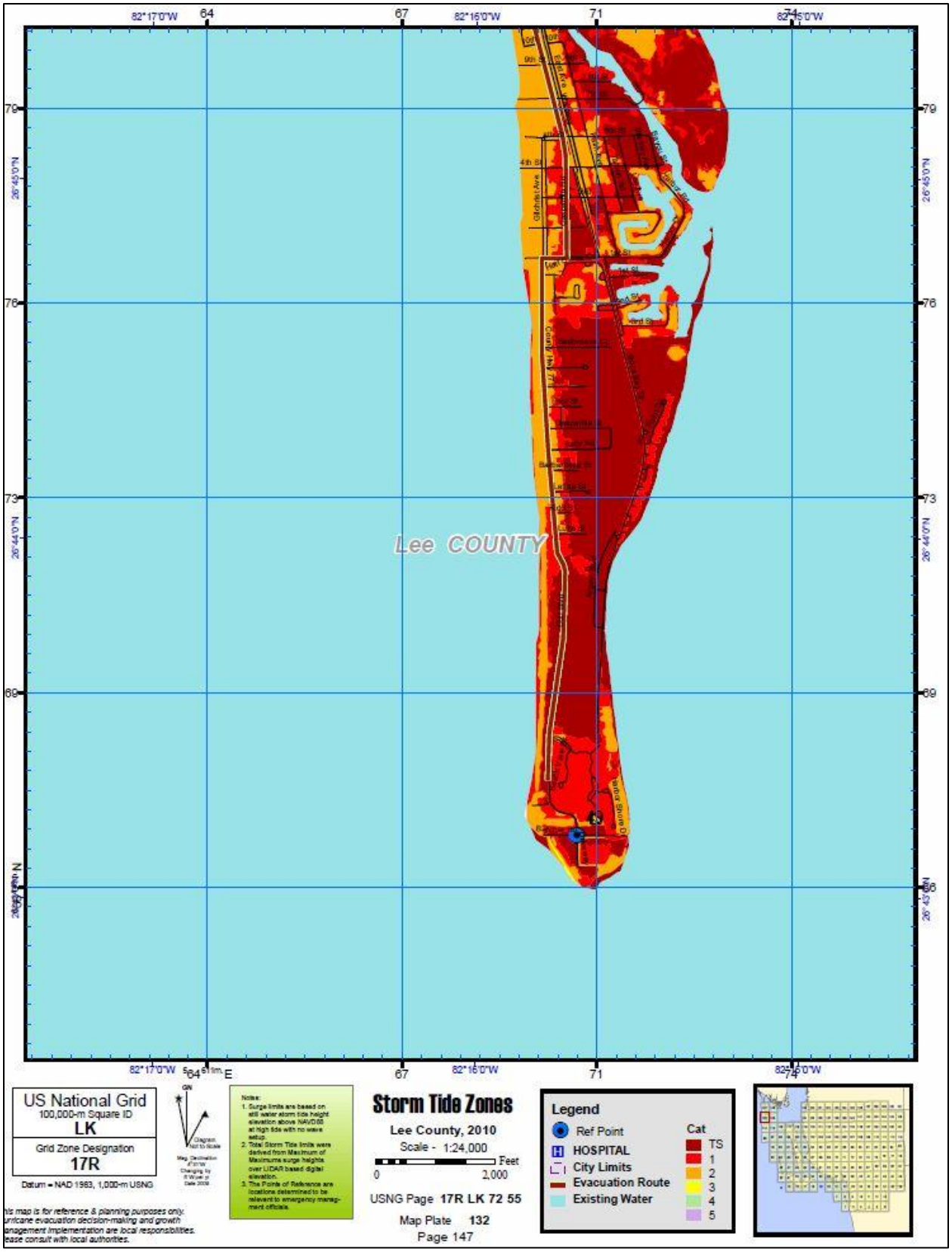

Figure A- 6. Storm Surge Zones, Lee County, Gasparilla Island, Florida, FDEM (2010).

Table A- 7. Storm Tide Elevations (FDOT Station 2001)

Return Period (Years)	Total Storm Tide Level (Feet, NAVD88)
500	15.4
100	12.5
50	10.7

Where t_1 is the time between the project's construction date and 1992 and t_2 is the time between the end of the project life and 1992. In order to estimate the required Baseline, Intermediate, and High Relative Sea Level (RSL) changes over the life of the project, the eustatic sea level rise equation is further modified to include site specific sea level change as follows:

$$RSL(t_2) - RSL(t_1) = (e+M)\,(t_2 - t_1) + b(t_2^2 - t_1^2)$$

Where $RSL(t_1)$ and $RSL(t_2)$ are the total RSL at times t_1 and t_2, and the quantity $(e + M)$ is the local sea level rise in mm/year. Local sea level rise accounts for the eustatic change (1.7mm/year; 0.0056 ft/year) as well as uplift, subsidence, and other effects and is generally available from the nearest tide gage with a tidal record of at least 40 years. The constant b is equal to 0.0 (Baseline), 2.71E-5 (Intermediate), and 1.13E-4 (High).

The Gasparilla Island project area is located approximately 25 miles from NOS gage #8725520 at Fort Myers, Florida. The historical sea level rise ("low" or "base" SLC scenario) rate taken from this gage was determined to be 2.4 mm/year (0.0079 ft/year) (http://www.corpsclimate.us/ccaceslcurves.cfm). Given a project base year of 2016 and 40 years remaining in the project life (project end date of 2056), the USACE corpsclimate website produced a table of sea level change rates for each of the three required scenarios. Figure A- 7 shows the sea level change rates relative to NAVD88 in two year increments, starting from the base year of 2016 and ending in 2056, the project end year. A graphic representation of the three levels of projected future sea level change for the life of the project is also provided. Average intermediate and high sea level rise rates were found to be 0.0157 ft/year and 0.0405 ft/year, respectively.

The local rate of vertical land movement is approximated by subtracting regional MSL trend from local MSL trend. The regional mean sea level trend is assumed equal to the eustatic mean sea level trend of 1.7 mm/year. Therefore at Gasparilla Island, there is approximately 0.70 mm/year of vertical change (vertical shift of approximately -0.70 mm/year).

3.6.2 Beach Responses to Sea Level Change

This section evaluates how the sea level change scenarios outlined in the preceding section could affect future beach and shoreline behavior in the project area. The principal means by which sea level change would manifest itself on an open coast, sandy beach would be through changes to shoreline position and to beach volume. The following analyses are based on the assumption that sea level change would cause a change in the horizontal and vertical position of the beach profile. This phenomenon was first outlined by Per Bruun (1962). The theory states that an increase in water level causes the beach profile to shift upward and landward in response, in order to maintain an equilibrium shape. This shift causes both a shoreline change and a volumetric change as described herein.

Gasparilla Island
8725110, Naples, FL
NOAA's Published Rate: 0.00663 feet/yr
All values are expressed in feet relative to NAVD88

Year	USACE Low	USACE Int	USACE High
2016	-0.5	-0.4	-0.3
2018	-0.5	-0.4	-0.2
2020	-0.5	-0.4	-0.2
2022	-0.4	-0.4	-0.1
2024	-0.4	-0.3	-0.0
2026	-0.4	-0.3	0.0
2028	-0.4	-0.3	0.1
2030	-0.4	-0.3	0.1
2032	-0.4	-0.2	0.2
2034	-0.4	-0.2	0.3
2036	-0.3	-0.2	0.4
2038	-0.3	-0.1	0.4
2040	-0.3	-0.1	0.5
2042	-0.3	-0.1	0.6
2044	-0.3	-0.1	0.7
2046	-0.3	-0.0	0.8
2048	-0.3	0.0	0.9
2050	-0.3	0.0	1.0
2052	-0.2	0.1	1.1
2054	-0.2	0.1	1.2
2056	-0.2	0.1	1.3

Print Table

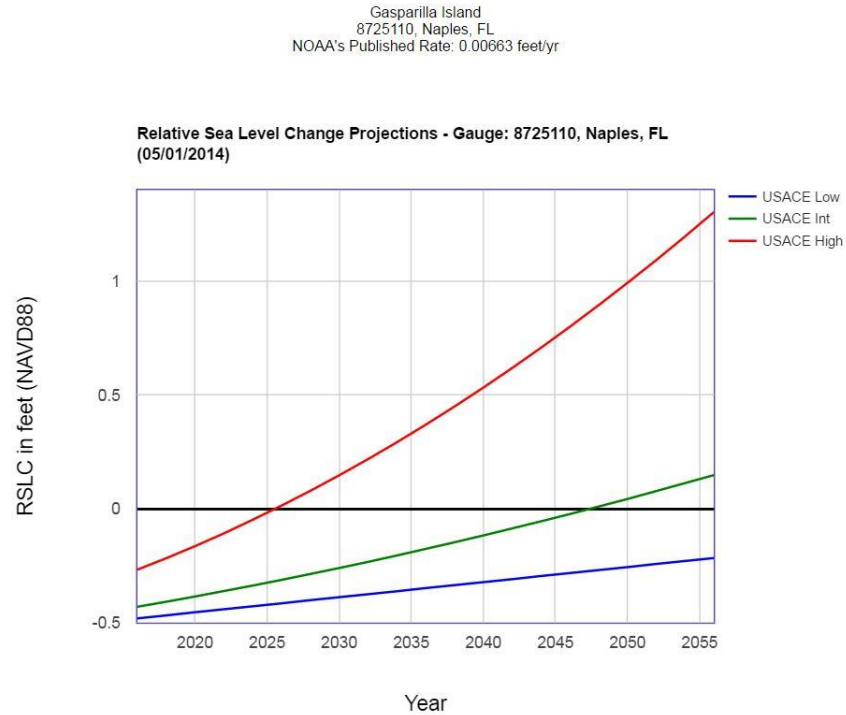

Figure A- 7. Relative Sea Level Change, Gasparilla Island (http://www.corpsclimate.us/ccaceslcurves.cfm)

3.6.2.1 Shoreline Change

Per Bruun (1962) proposed a formula for estimating the rate of shoreline recession based on the local rate of sea level change. This methodology also includes consideration of the local topography and bathymetry. Bruun's approach assumes that with a change in sea level, the beach profile will attempt to reestablish the same bottom depths relative to the surface of the sea that existed prior to sea level change. That is, the natural profile will be translated upward and shoreward to maintain equilibrium. If the longshore littoral transport in and out of a given shoreline is equal, then the quantity of material required to re-establish the nearshore slope must be derived from erosion of the shore. Shoreline recession, X, resulting from sea level change can be estimated using Bruun's Rule, defined as:

$$X = \frac{-SW_*}{(h_* + B)}$$

Where S is the rate of sea level change; B is the berm height (approximately +3.75 feet NAVD88); h_* is depth of closure (the depth beyond which there is no significant change over time in the shoreline profile; estimated to be approximately -15 feet NAVD88); and W_* is the width of the active profile (approximately 1,000 feet). Figure A- 8 provides the resulting shoreline recession versus year for each of the three sea level rise scenarios. Note that shoreline recession is plotted relative to existing conditions at the project start year (i.e. all curves begin at 0.0 relative to 2016).

The Bruun procedure is applicable to long straight sandy beaches with an uninterrupted supply of sand. Little is known about the rate at which profiles respond to changes in water level; therefore, this procedure should only be used for estimating long-term changes. The procedure is not a substitute for

the analysis for historical shoreline and profile changes when determining historic (baseline) conditions. However, if little or no historical data is available, then historical analysis may be supplemented by this method to provide an estimate of the long-term erosion rates attributable to sea level rise. The offshore contours in the project area are not entirely straight and parallel; however, Bruun's Rule does provide an estimate of the potential shoreline changes within the project area attributable to a projected change in sea level.

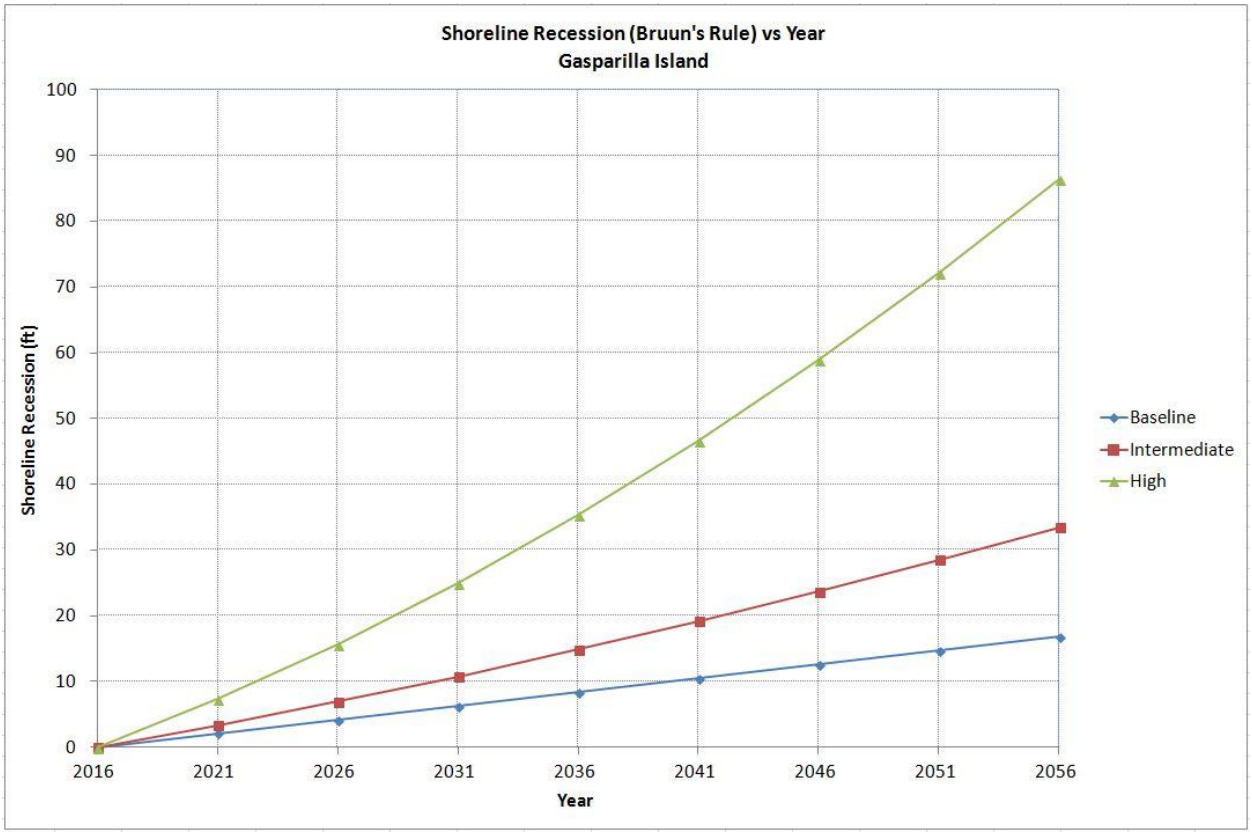

Figure A- 8. Shoreline Recession vs Year

3.6.2.2 Volumetric Change

Engineering Manual (EM) 1110-2-3301 (USACE, 1995) gives guidance on how to calculate beach volume based on berm height, depth of closure, and translation of the shoreline (in this case, shoreline recession). Assuming that as an unarmored beach erodes, it maintains approximately the same profile above the seaward limit of significant transport the volume can be determined as:

$$V = (B + h_*)X$$

Where B is the berm height, h_* is the depth of closure, and X is the horizontal translation of the profile. Figure A- 9 provides the resulting volume lost versus year for each of the three sea level rise scenarios. Note that volume change is plotted relative to existing conditions at the project start year (i.e. all curves begin at 0.0 relative to 2016).

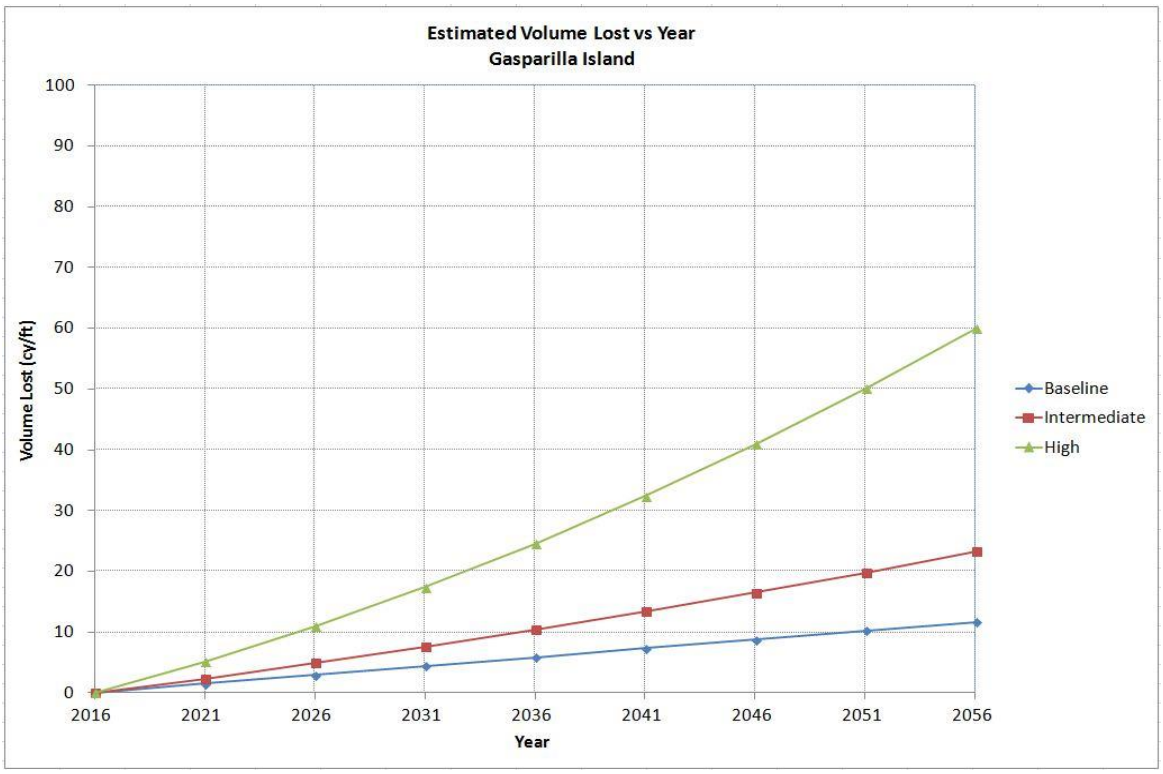

Figure A- 9. Estimated Volume Lost vs Year

3.7 Storm Tide and Back Bay Flooding

Upland elevations within the study area (Gulf side of the island) average approximately 5.5 ft-NAVD88. These uplands are fronted by a dune system with an average elevation of 9.0 ft-NAVD88 over a majority of the project area (R-11 to R-24). Elevations on the inland side of the island average approximately 4.0 ft-NAVD88. Although the Inland side of the island is not within the current study area, stakeholders should be aware of increased risk to infrastructure as sea level rises. Based on lidar topographic survey data, contoured over the barrier island between R-11 and R-24, key cross-island ground elevations were identified. Table A- 8 provides the key ground elevations according to R-monument and grouped by similar shoreline dimensions (see Engineering Appendix for details on profile groupings).

Representative profiles, taken in the vicinity of R-15, R-19, and R-24 are show in Figure A- 10 to Figure A- 12. Note that the topographic survey from which the profile was drawn are “bare earth” and do not illustrate vegetation or structures. Each profile shows the variability over the length of the project as well as across the width of the island.

The width of the island varies over the length of the project, from 0.7 miles at the north end of the project site to 0.3 miles at the south end. The inland side of the island is fronted by a combination of heavy vegetation and areas of development. In some regions, however, development extends from seaside to inland side.

Table A- 8. Key Elevations Along Cross-island Profiles

R-Monument	Ground Elevations (feet-NAVD88)			
	Average Dune Elevation	Roads	Gulf Side Structures	Inland Side Structures
R-11	10.0	5.0	7.0	5.0
R-12	10.0	5.0	7.0	3.5
R-13	9.0	5.0	6.5	3.0
R-14	9.0	5.0	8.0	4.5
R-15	9.0	5.0	8.0	4.0
R-16	8.5	5.5	7.0	4.5
R-17	8.0	5.5	7.0	4.0
R-18	7.5	5.5	7.0	4.0
R-19	7.5	5.5	5.5	4.0
R-20	9.0	5.0	5.0	3.5
R-21	9.0	4.0	4.0	4.0
R-22	9.0	4.0	4.0	3.0
R-23	10.0	4.0	3.5	6.0
R-24	10.0	4.0	3.5	6.0
Average for Study Area (R-11 to R-24)	9.0	4.9	5.9	4.2

A key question when assessing the vulnerability of the study area to SLC is when critical thresholds will be crossed. Throughout the study area, the dune crest height represents a critical threshold. The average dune height from Table A- 8 is 9.0 ft-NAVD88. Roads and other infrastructure are located at a lower elevations, approximately 3.0 to 8.0 ft-NAVD88. Since the dune lies between the ocean and infrastructure, the dune height will be the ocean side critical elevation.

The 50-year storm tide elevation for the study area has been determined to be +10.7 ft-NAVD88 (FDOT, 2003). As shown in Table A- 8, the average dune elevation for the project area is 9.0 ft-NAVD88. Therefore, regardless of sea level change rate, this area is already vulnerable to flooding due to storm surge. A 50-year storm tide would be expected to overtop the existing dune system by 1.7 feet.

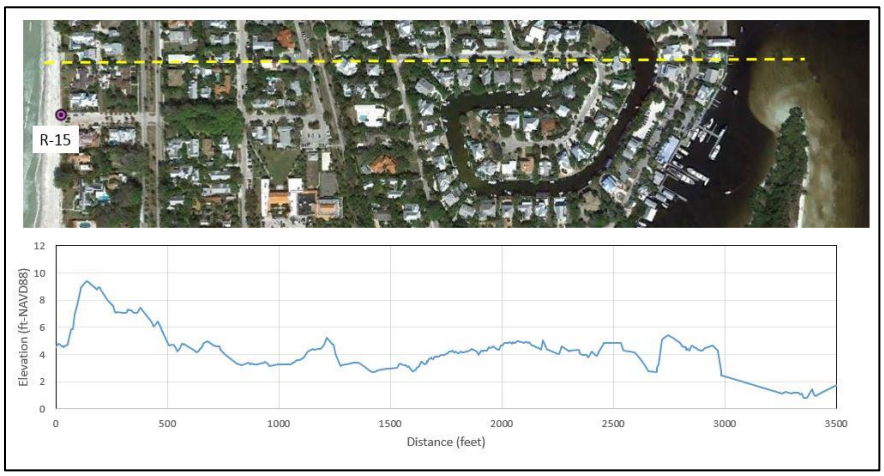

Figure A- 10. Cross-island Profile in the Vicinity of R-15

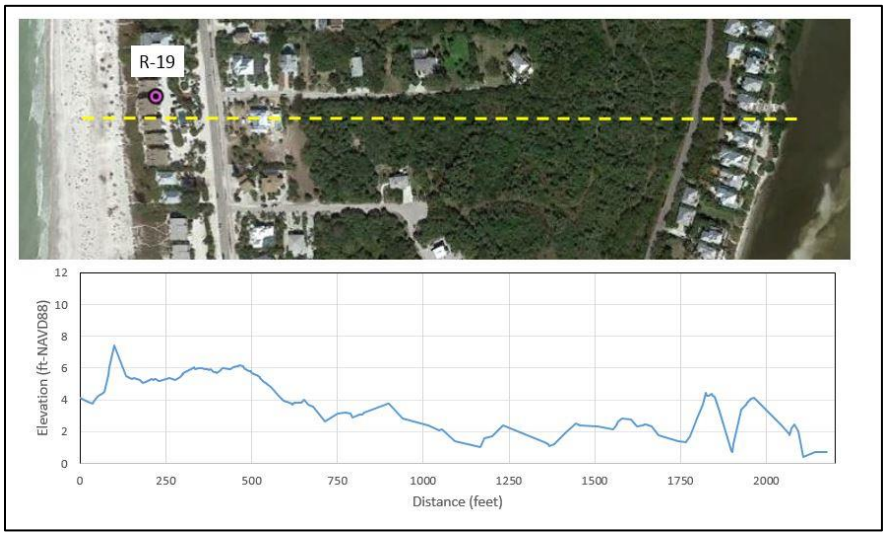

Figure A- 11. Cross-island Profile in the Vicinity of R-19

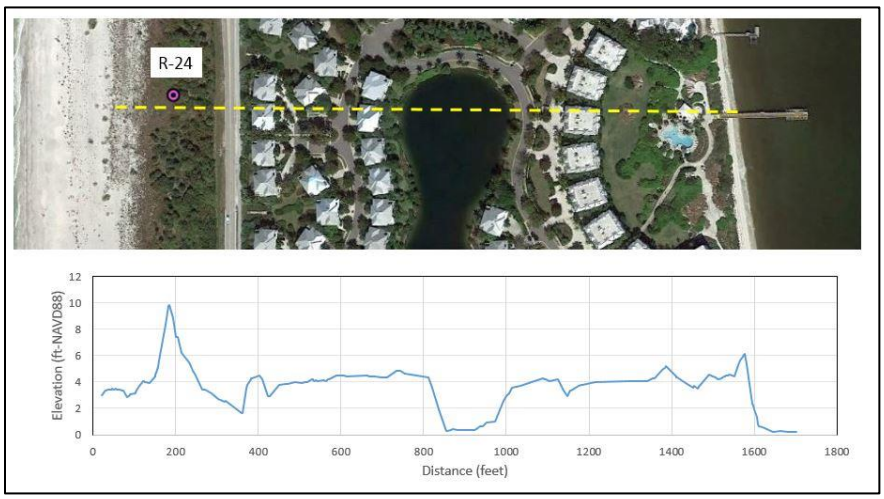

Figure A- 12. Cross-island Profile in the Vicinity of R-24

Traditionally, CSRM projects are designed to reduce impacts from erosion, waves, and inundation. However, it is clear that due to the overall elevation of Gasparilla Island and its proximity to the inlet (which allows for flooding from seaside, the inlet adjacent southern tip of the island, and the bay side) neither the existing authorized project nor any of the alternatives developed for this study prevent or significantly reduce inundation. In truth, there is no feasible alternative that can be developed within the scope of this study that would do so.

Although the existing authorized project and project alternatives cannot prevent or significantly reduce impacts due to storm tide inundation, they do prevent and reduce impacts due to both erosion and wave action. Damages due to erosion in particular are significantly reduced. Not only is Gasparilla Island susceptible to damages due to storm related erosion, the proximity of the island to the inlet creates chronic annual erosion along the shoreline within the project area. Both storm induced and annual erosion, as well as impacts due to wave action, are effectively addressed at Gasparilla. Analyses

discussed within the original authorizing document and those detailed in the current study clearly indicate Federal interest in maintaining a CSRM project at Gasparilla Island.

ETL 1100-2-1 recommends that systems related to, but existing outside, the study area should also be evaluated for vulnerability to SLC. The purpose of this is to bring attention to the vulnerability of the marsh side of the island for stakeholder knowledge. The southern end of Gasparilla Island has an average elevation that is lower than the ocean side dune system. Therefore, all systems located at the southern end of the island are presently just as vulnerable to storm tide flooding (regardless of sea level change rate) as the ocean side project area.

4 Historical Shoreline Change

Changes in mean high water (MHW) position provide a historical view of the behavior of the shoreline. Beach profiles are traditionally gathered by the FDEP, local sponsors, and USACE. Available beach surveys for Gasparilla Island go back as far as 1862 and the most recent surveys were completed in 2014. Because the Gasparilla Island portion of the Federal HSDR Project was initially completed in early 2007 and continues to be periodically renourished, surveys between 2007 and the present do not accurately reflect historical background erosion rates. Therefore, only MHW data collected prior to 2007 is included in the historical shoreline evolution analysis.

MHW shoreline positions were measured at each DNR survey monument location (also commonly referred to as FDEP R-monuments), for each survey, along the proper azimuth (265 degrees, measured clockwise from north). Resulting differences in MHW position from R-11 to R-24 are tabulated in Table A- 9.

In order to better interpret the shoreline change, the MHW position data was put into a graphical format (Figure A- 13). As seen in the figure, shoreline changes fluctuate significantly over time along the study area. While fluctuations are common, at Gasparilla Island there was no immediately recognizable historical trend at each survey monument.

Table A- 9. Mean High Water Shoreline Position Change

DNR Monument	MHW Shoreline Position Change in Feet											
	Before Federal Project											
	1860-1927	1927-1943	1943-1950	1950-1957	1957-1974	1974-1979	1979-1982	1982-1989	1989-2001	2001-2004	2004-2005	2005-2006
R-11	-251	-4			-70	17	-15	-24	8	-19		
R-12	-273	-17			-56	12	-21	-12	13	1		
R-13	-266	33			-103	11	19	-11	-7	-2		
R-14	-229	-12			-90	46	-29	-5	2	-3		
R-15	-275	-59	100	-107	-2	10	-11	-9	-10	8		
R-16	-238	-140	67	-98	-17	31	-22	-49	-9	-12		
R-17	-156	-198	94	-115	20	14	41	-54	-13	-24		
R-18	-178	-209	128	-151	-7	37	33	-46	3	-16		
R-19	-122	-185	53	-144	21	47	5	-39	33	-43	6	10
R-20	-117	-194	-32	-158	-21	13	27	-31	139	-91	-23	-18
R-21	-63	-177	-6	-194	-54	58	-34	20	123	-81	-45	17
R-22	-48	-178	-49	-147	-100	-8	16	20	110	-18	-48	31
R-23	-78	-156	-31	-156	-42	-22	-5	3	74	34	-26	18
R-24	-61	-229	6	-148	21	39	-48	-6	48	9	-7	63

In order to better identify underlying historical trends in the study area, MHW change rates were determined relative to the 2006 shoreline survey (Figure A- 14). Viewed relative to 2006, the shoreline trend becomes clearer. Between 1860 and 1950 the shoreline between R-11 and R-24 was erosional with the highest erosion rates occurring at the southern end of the project nearest the inlet (R-19 to R-24). From the 1957 survey, it can be seen that the southern end of shoreline stabilized, with stabilizing influences as far north as R-15. Surveys beginning in 1974 show a complete reversal of trend at the southern end of the study area. The region between R-18 to R-24 went from being moderately to significantly erosional to being moderately to significantly accretional. A review of the island's history revealed that in the 1940 -1950 timeframe, a large seawall and revetment was constructed in the vicinity of R-25. The seawall, which protrudes seaward to circle property at the southern end of the island, began to act in a groin-like fashion intercepting the north-south moving sediment and stabilizing what had previously been an erosional hotspot.

Because surveys taken prior to the 1970's reflect shoreline change rates that are no longer applicable due to the presence of the seawall at R-25, those surveys were not considered in determining rates representative of the project. Examination of the remaining surveys showed that some transition in the MHW trends was still occurring as late as 1974. Therefore, the range of shoreline data considered for establishing the historical (without project background) erosion rates was from 1979 to 2006. Table A- 10 provides the final historical MHW change rates. The north end of project is generally erosional, while the south end is accretional.

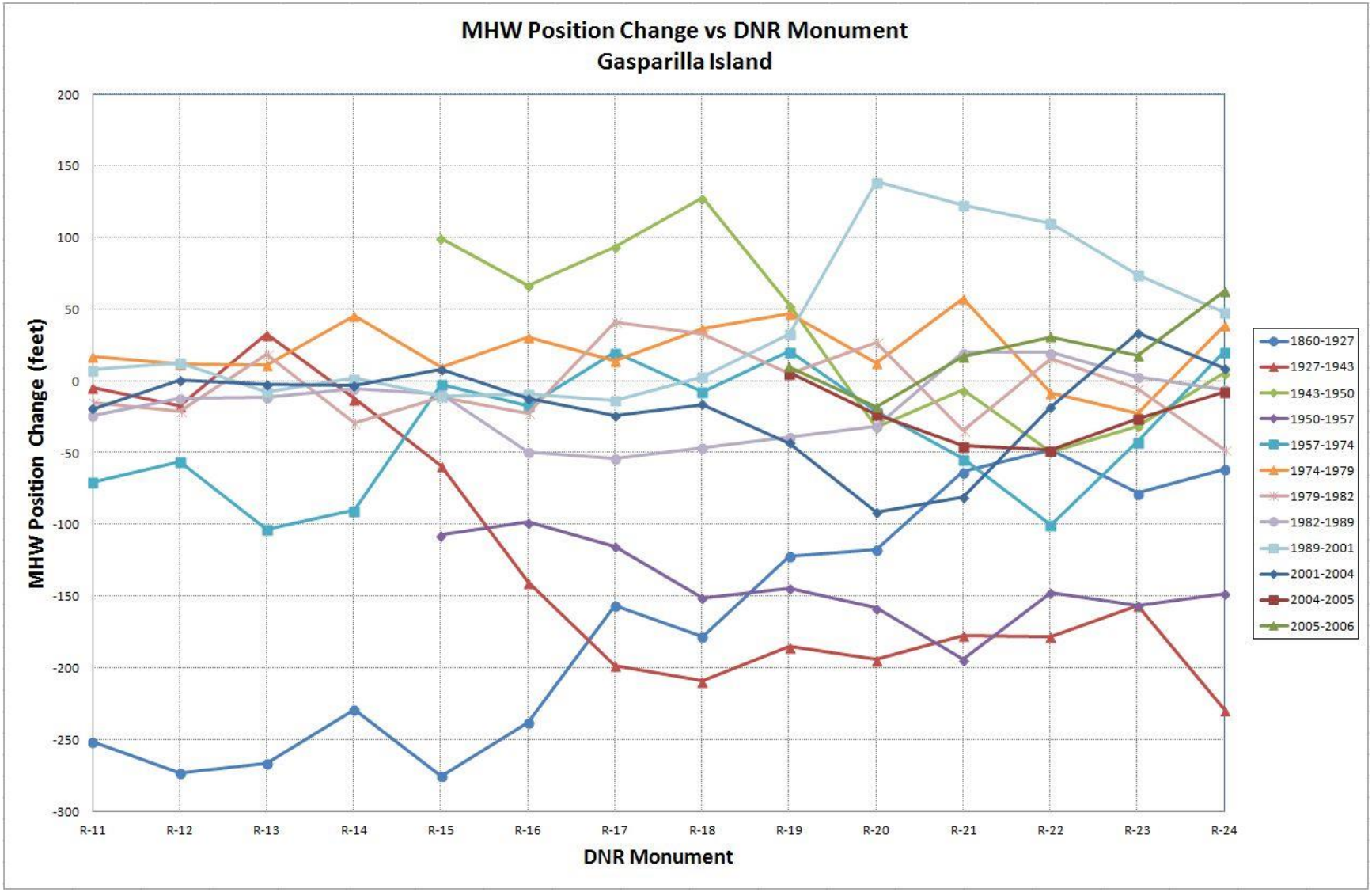

Figure A- 13. MHW Change (feet)

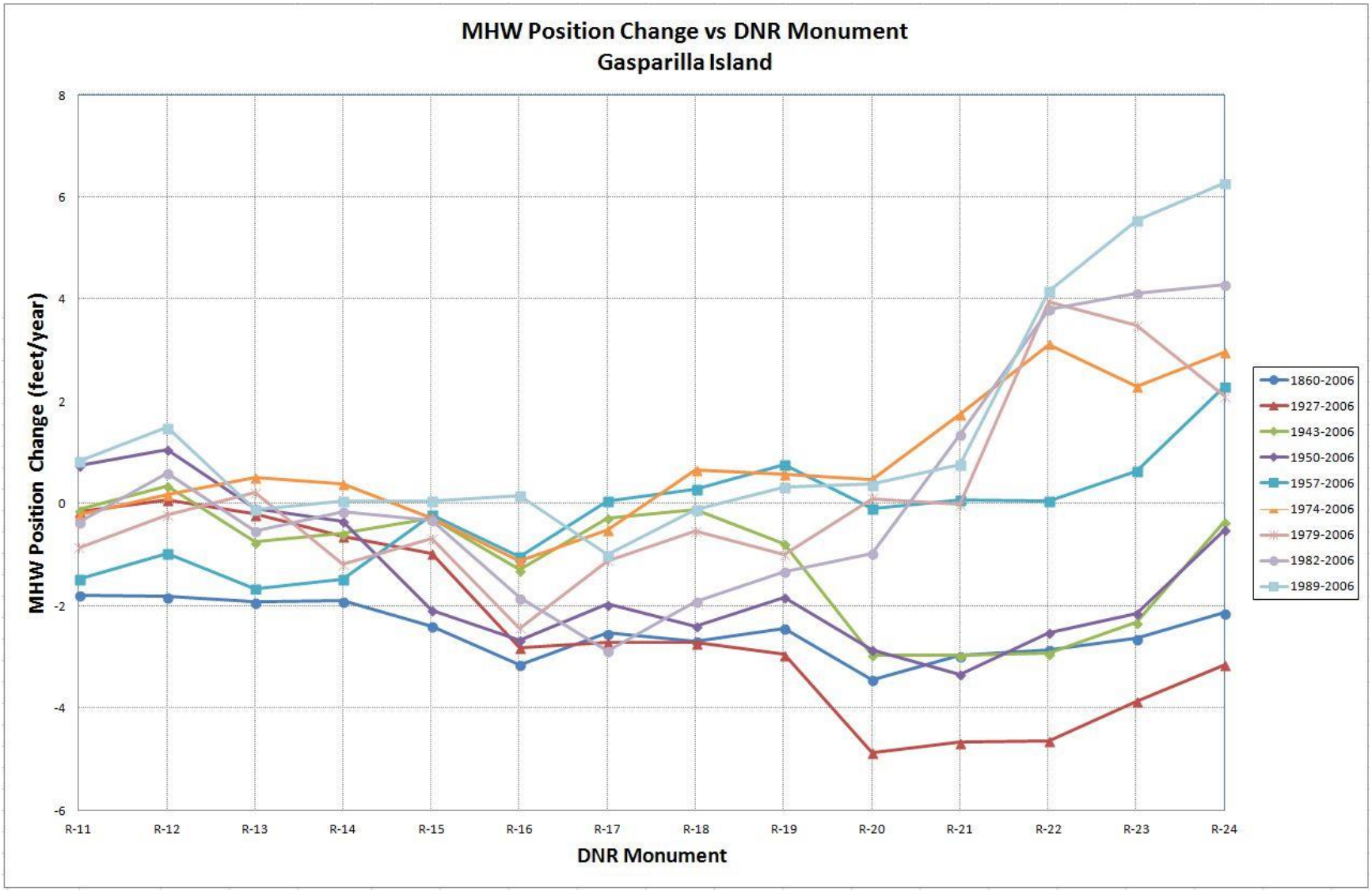

Figure A- 14. Summary of MHW Position Change Rate (feet/year)

Table A- 10. Annual Average Shoreline Rate of Change

Location (DNR Monument)	MHW Rate of Change (1979 – 2006) (feet/year)
R-11	-0.9
R-12	-0.2
R-13	0.2
R-14	-1.2
R-15	-0.7
R-16	-2.4
R-17	-1.1
R-18	-0.5
R-19	-1.0
R-20	0.1
R-21	0.0
R-22	4.0
R-23	3.5
R-24	2.1

4.1 Existing Shoreline Armor

Historically, the threat that shoreline erosion has posed to infrastructure has resulted in coastal armoring throughout a significant portion of the Gasparilla Island segment. Most of the existing shoreline armor within the project limits can be found in the northern portion of the segment from DNR Monument R-11 to just south of R-15. Additional armor can be found protecting a residential complex in the vicinity of R-18. Table A- 11 provides a summary of shoreline armor types throughout the Gasparilla Island segment. Locations can be seen graphically in Figure A- 15.

Table A- 11. Summary of Shoreline Armoring in Lee County, Gasparilla Island segment

Armor Type	Description	Vicinity	Length (feet)
1	12” thick concrete wall, rebar reinforced, 18”W x 12”T concrete cap, 36” wide scour “skirt”	R-11	495
2	12” thick concrete wall, rebar reinforced, no cap, 36” wide scour “skirt”	Between R-11 & R-12	1,598
3	12” thick concrete wall, rebar reinforced, 18”W x 24”T concrete cap, 36” wide scour “skirt”	Between R-13 & R-14	1,204
4	12” thick concrete wall, rebar reinforced, 18”W x 18”T concrete cap, 36” wide scour “skirt”	R-14	758
		R-15	61
		R-18	365
5	Concrete wall, 18” at top widening to 36” at bottom, 36” wide scour “skirt”	R-15	732

Figure A- 15. Armor Locations

5 Effects of Adjacent Features

5.1 Inlet Effects

Boca Grande Pass lies immediately to the south of Gasparilla Island and influences the project area. Tidal currents associated with the inlet impact littoral transport of sediment at the southern tip of Gasparilla Island, resulting in the deposition of nearshore sediments within the channel as well as within a system of shoals (flood and ebb). Section 2.2.2 of the main report contains additional information.

6 Beach-*fx* Life-Cycle Shore Protection Project Evolution Model

Federal participation in Hurricane and Storm Damage Reduction (HSDR) projects is based on a favorable economic justification in which the benefits of the project outweigh the costs. Determining the Benefit to Cost Ratio (BCR) requires both engineering (project performance and evolution) and planning (alternative analysis and economic justification) analyses. The interdependence of these functions has led to the development of the life-cycle simulation model Beach-*fx*. Beach-*fx* combines the evaluation of physical performance and economic benefits and costs of shore protection projects (Gravens et. al., 2007), particularly beach nourishment, to form the basis for determining the justification for Federal participation. This section describes the engineering aspects of the Beach-*fx* model.

6.1 Background & Theory

Beach-*fx* is an event-driven life-cycle model. USACE guidance (USACE, 2006) requires that flood damage reduction studies include risk and uncertainty. The Beach-*fx* model satisfies this requirement by fully incorporating risk and uncertainty throughout the modeling process (input, methodologies, and output). Over the project life-cycle, typically 50 years, the model estimates shoreline response to a series of historically based storm events. These plausible storms, the driving events, are randomly generated using a Monte Carlo simulation. The corresponding shoreline evolution includes not only erosion due to the storms, but also allows for storm recovery, post-storm emergency dune and/or shore construction, and planned nourishment events throughout the life of the project. Risk based damages to structures are estimated based on the shoreline response in combination with pre-determined storm damage functions for all structure types within the project area. Uncertainty is incorporated not only within the input data (storm occurrence and intensity, structural parameters, structure and contents valuations, and damage functions), but also in the applied methodologies (probabilistic seasonal storm generation and multiple iteration, life cycle analysis). Results from multiple iterations of the life cycle can be averaged or presented as a range of possible values.

The project site itself is represented by divisions of the shoreline referred to as “Reaches”. Because this term may also be used to describe segments of the shoreline to which project alternatives are applied, Beach-*fx* reaches will be referred to in this appendix as “Model reaches”. Model reaches are contiguous, morphologically homogenous areas that contain groupings of structures (residences, businesses, walkovers, roads, etc…), all of which are represented by Damage Elements (DEs). DEs are grouped within divisions referred to as Lots. Figure A- 16 shows a graphic depiction of the model setup. For further details about the specifics of Lot extents and DE grouping see the Economics Appendix.

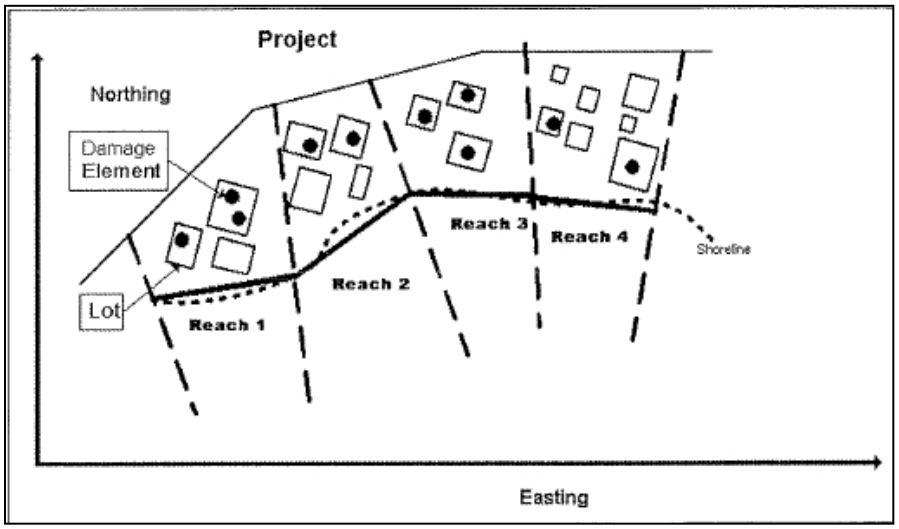

Figure A- 16. Beach-*fx* Model Setup Representation

Each model reach is associated with a representative beach profile that describes the cross-shore profile of the reach. While an effort is made to designate model reaches to include a single DNR monument (FDEP R-monument) from which historical survey data can be used to establish a representative profile for that reach, the positioning of the monument within each reach and the length of each reach are variable. Multiple model reaches may share the same representative beach profile and groupings of model reaches may represent a single design reach. For Gasparilla, the project area consists of a single design reach divided into 14 model reaches. Table A- 12 provides model reach identifiers as well as the FDEP R-monument that falls within the borders of each model reach.

Table A- 12. Model Reaches

Model Reaches	R-monuments
LG11	R-11
LG12	R-12
LG13	R-13
LG14	R-14
LG15	R-15
LG16	R-16
LG17	R-17
LG18	R-18
LG19	R-19
LG20	R-20
LG21	R-21
LG22	R-22
LG23	R-23
LG24	R-24

Implementation of the Beach-*fx* model relies on a combination of meteorology, coastal engineering, and economic analyses and is comprised of four basic elements:

- Meteorological driving forces
- Coastal morphology
- Economic evaluation
- Management measures

The subsequent discussion in this section addresses the basic aspects of implementing the Beach-*fx* model. For a more detailed description of theory, assumptions, data input/output, and model implementation, refer to Gravens et al. (2007), Males et al. (2007), and USACE (2009).

6.2 Meteorological Driving Forces

The predominant driving force for coastal morphology and associated damages within the Beach-*fx* model is the historically based set of storms that is applied to the life-cycle simulation. The predominant driving force for erosion, inundation, and wave damages on western coast of Florida is tropical storms (hurricanes) in the summer months. Extra-tropical storms are mild compared to east coast Northeasters and do not significantly impact morphological changes beyond their contribution to the background erosion rate. Derived from the historical wave and water level records, the plausible storm dataset is based on 36 tropical storms occurring between 1886 and 2001 and 49 extra-tropical storms identified from WIS data covering 1980 to 2012.

Because tropical storm events tend to be of limited duration, passing over a given site within a single portion of the tide cycle, it is assumed that any of the historical storms could have occurred during any combination of tidal phase and tidal range. Therefore, each of the 36 tropical storms surge hydrographs was combined with possible variations in the astronomical tide. This was achieved by combining the peak of each storm surge hydrograph with the astronomical tide at high tide, mean tide falling, low tide, and mean tide rising for each of three tidal ranges corresponding to the lower quartile, mean, and upper quartile tidal ranges. This resulted in 12 distinct combinations for each historically based tropical storm and a total of 432 tropical storm conditions in the plausible storm dataset.

In addition to the plausible storm dataset, the seasonality of the storms must also be specified. The desired storm seasons are based on the assumption that each plausible storm takes place within the season in which the original historical storm occurred. Probability is defined for each season through the Probability Parameter. The Probability Parameter is determined for each season and storm type by dividing the number of storms by the total number of years in the storm record. Four storm seasons were specified for Lee County (Table A- 13).

Table A- 13. Lee County Beach-*fx* Storm Seasons

Storm Season	Start Date	End Date	Probability Parameter
Extratrop Winter/Spring	Dec 1	Apr 31	0.00
Tropical Early Summer	May 1	Jul 31	0.07
Tropical Peak	Aug 1	Sep 30	0.13
Extratrop/Tropical	Oct 1	Nov 30	0.11

The combination of the plausible storm dataset and the specified storm season allows the Beach-*fx* model to randomly select from storms of the type that fall within the season currently being processed. For each storm selected, a random time within the season is chosen and assigned as the storm date.

The timing of the entire sequence of storms is governed by a pre-specified minimum storm arrival time. A minimum arrival time of 7 days was specified for Lee County. Based on this interval the model attempts to place subsequent storm events outside of a 14 day window surrounding the date of the previous storm (i.e. a minimum of 7 days prior to the storm event and a minimum of 7 days following the storm event). The model does allow the user to set different minimum arrival times for extra-tropical and tropical storms. Due to the probabilistic nature of the model the minimum arrival time may be overridden as warranted during the course of the life cycle analysis.

6.3 Coastal Morphology

The Beach-*fx* model estimates changes in coastal morphology through four primary mechanisms:

- Shoreline storm response
- Applied shoreline change
- Project-induced shoreline change
- Post-storm berm recovery

Combined, these mechanisms allow for the prediction of shoreline morphology for both with and without project conditions.

6.3.1 Shoreline Storm Response

Shoreline storm response is determined by applying the plausible storm set that drives the Beach-*fx* model to simplified beach profiles that represent the shoreline features of the project site. For this study, application of the storm set to the idealized profiles was accomplished with the SBEACH coastal processes response model (Larson and Kraus, 1989). SBEACH is a numerical model which simulates storm-induced beach change based on storm conditions, initial profiles, and shoreline characteristics such as beach slope and grain size. Output consists of post-storm beach profiles, maximum wave height and wave period information, and total water elevation including wave setup. Pre- and post-storm profiles, wave data, and water levels can be extracted from SBEACH and imported into the Beach-*fx* Shore Response Database (SRD). The SRD is a relational database used by the Beach-*fx* model to pre-store results of SBEACH simulations of all plausible storms impacting a pre-defined range of anticipated beach profile configurations.

6.3.1.1 Pre-Storm Representative Profiles

In order to develop the idealized SBEACH profiles from which the SRD was derived, it was necessary to first develop representative profiles for the project shoreline. The number of representative profiles developed for any given project depends on the natural variability of shoreline itself. Typically, historical profiles at each FDEP R-monument would be compared over time, aligned, and then averaged into a composite profile representative of the shoreline shape at that given R-monument location. Composite profiles would then be compared and separated into groupings according to the similarity between the following seven dimensions:

- Upland elevation
- Dune slope
- Dune height

- Dune width
- Berm height
- Berm width
- Foreshore slope

However, in a 934 study the future without project shoreline and the future with project shoreline represent two unrelated sets of physical characteristics. The future without project shoreline is the projected shoreline at the project base year assuming that no Federal project was ever constructed. The future with project shoreline is the projected shoreline at the project base year assuming that the Federal project was constructed and maintained as authorized. Therefore, the future without project and future with project are represented by two separate sets of representative profiles.

6.3.1.2 Future Without Project (FWOP) Profiles

The base year for the present study is 2016. In order to determine the condition of the project shoreline at the base year, historical pre-project surveys were studied. Three options were considered: (1) Begin with the pre-project shoreline (represented by the 2006 pre-project survey) and apply 10 years of erosion based on the historical MHW erosion rates, (2) Use an average historical pre-project shoreline, or (3) Adopt the most eroded pre-project shoreline from all reliable historical pre-project surveys. The first option was not considered practical at Gasparilla Island due to the presence of armor in the northern portion of the project (R-11 to R-15) and intermittent placement of dredge material in the southern portion of the project area. The second option was also not considered to be viable for the project area due to the intermittent fill events, which can influence the location of the MHW position for any given survey depending upon the date on which it was taken. The third option was considered to be the best, historically supported, representation of the eroded condition of the future base year shoreline. Reviewing historical MHW positions and aerial photographs indicated that the 2006 survey, taken prior to the original project placement, provided the most eroded pre-project shoreline.

Using the 2006 pre-project surveys, fourteen representative profiles were developed for the Gasparilla Island segment of Lee County (Figure A- 17 through Figure A- 30). Using the representative profiles, idealized profiles representing the major dimensions of the profile were defined. Table A- 14 provides dimensions for each of the idealized pre-storm Beach-*fx* profiles.

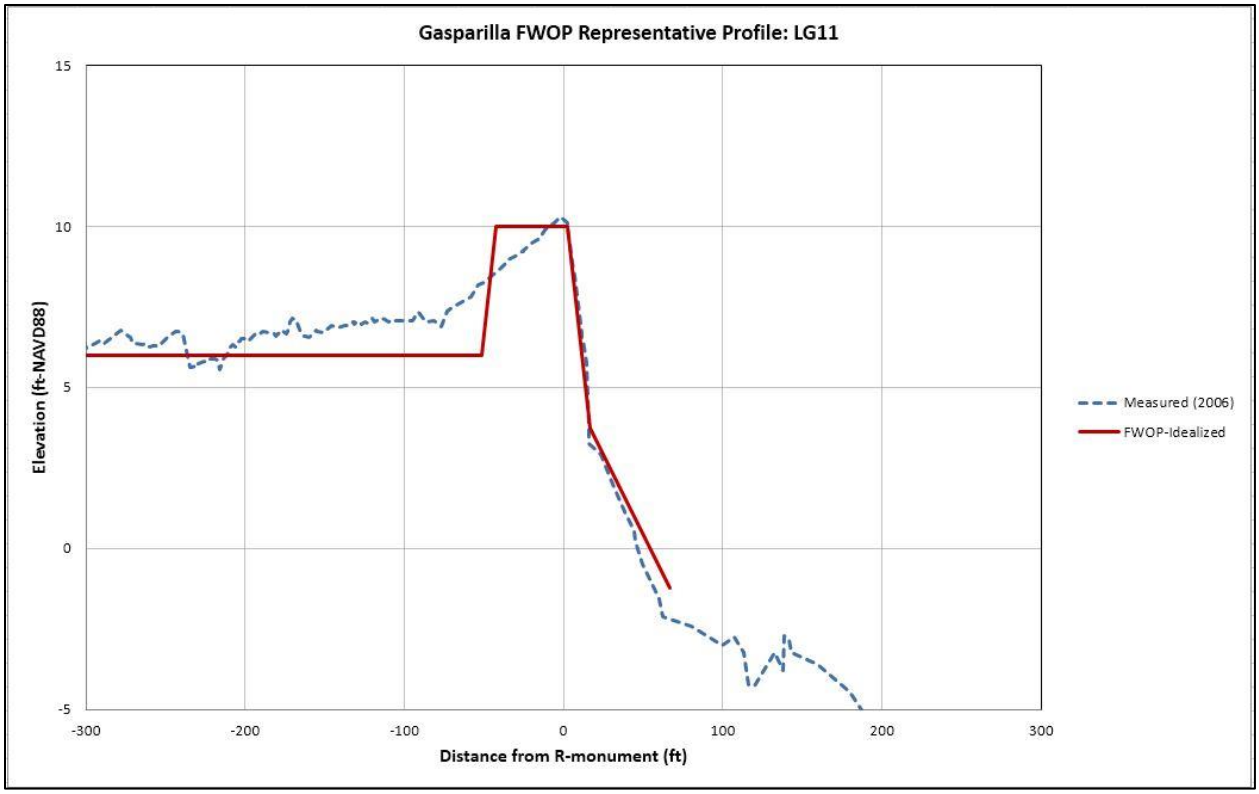

Figure A- 17. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-11

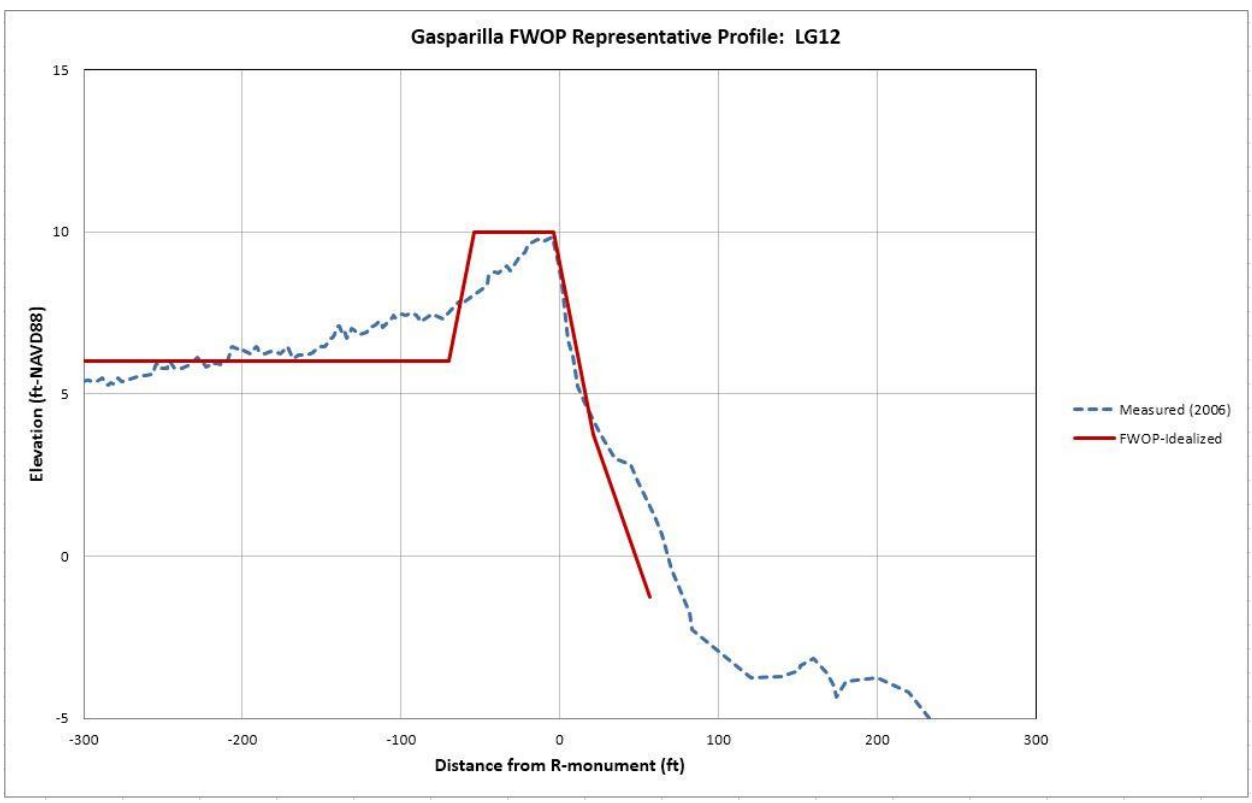

Figure A- 18. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-12

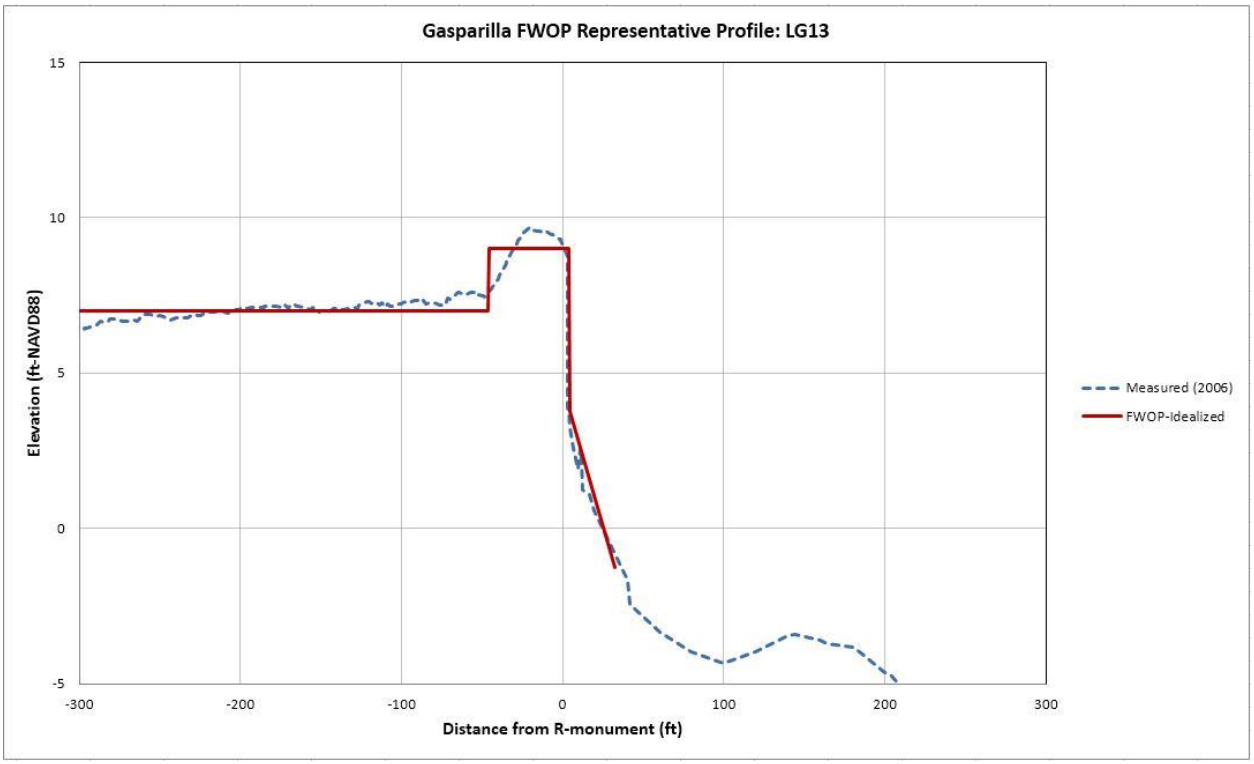

Figure A- 19. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-13

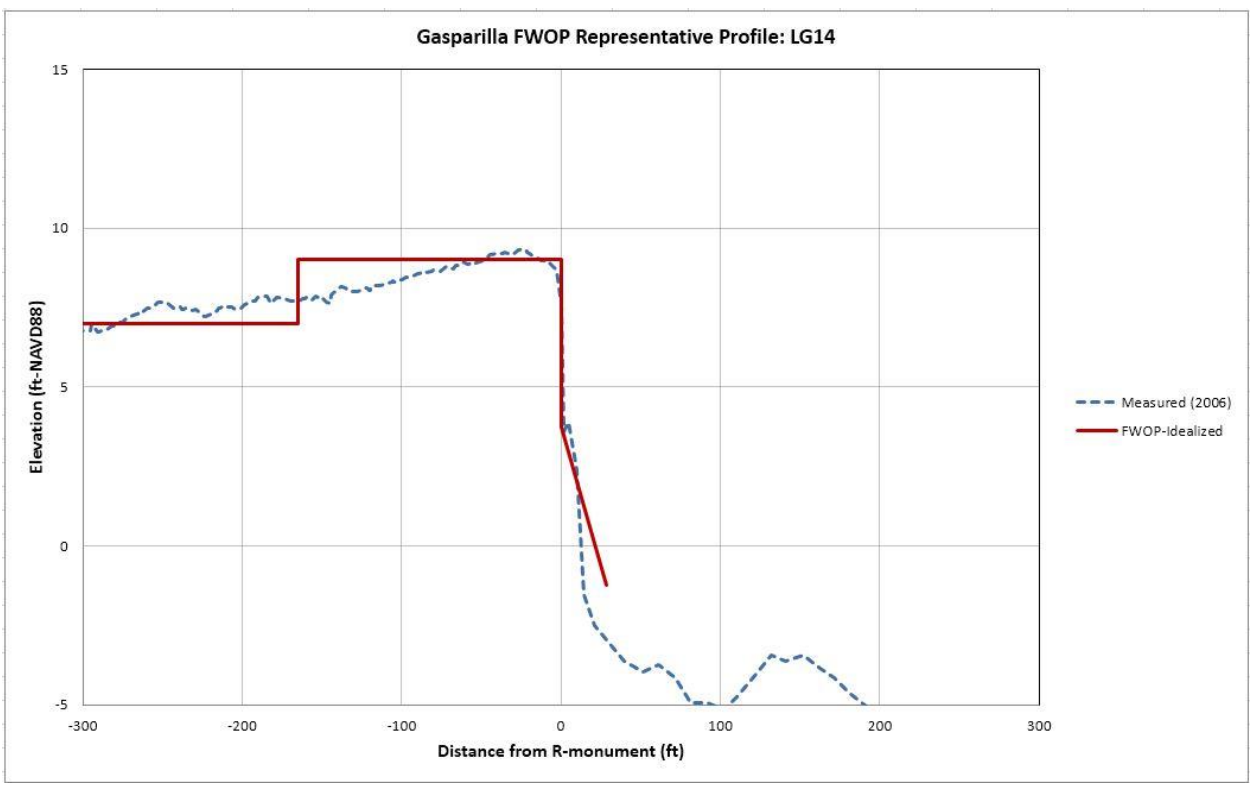

Figure A- 20. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-14

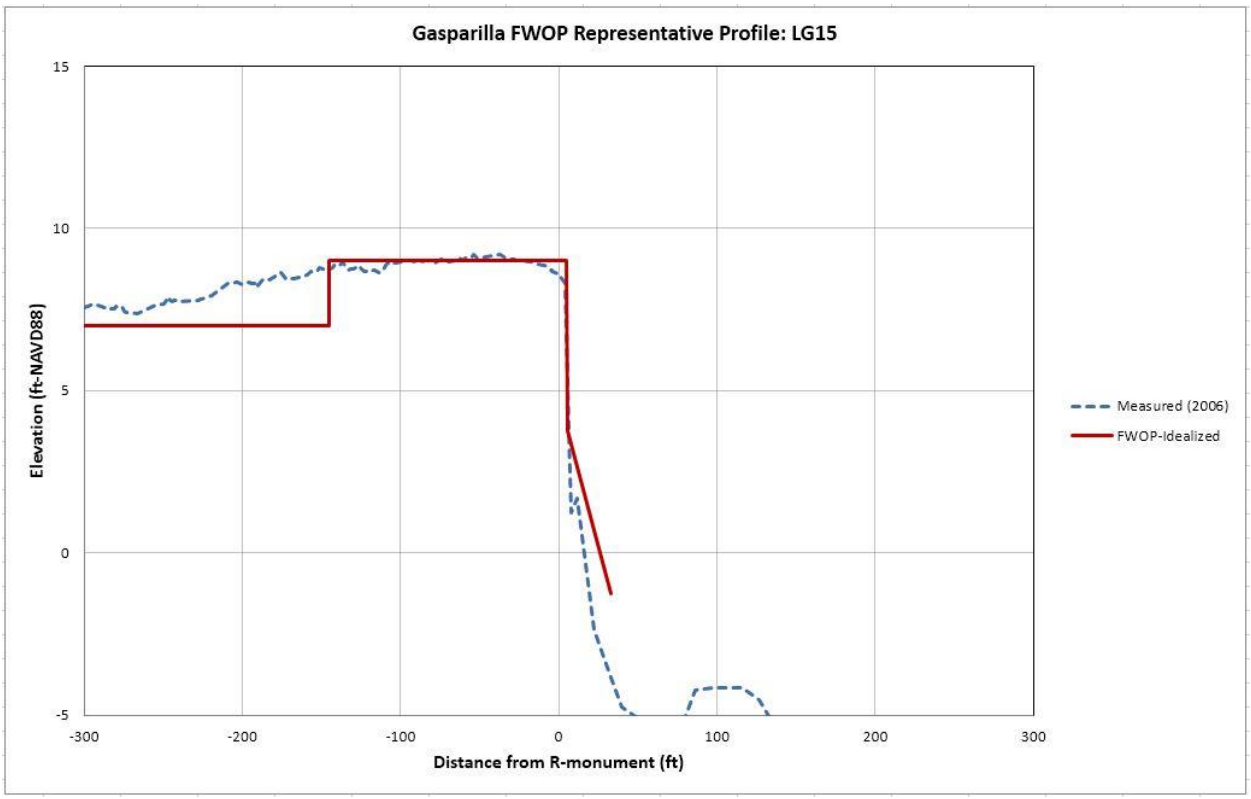

Figure A- 21. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-15

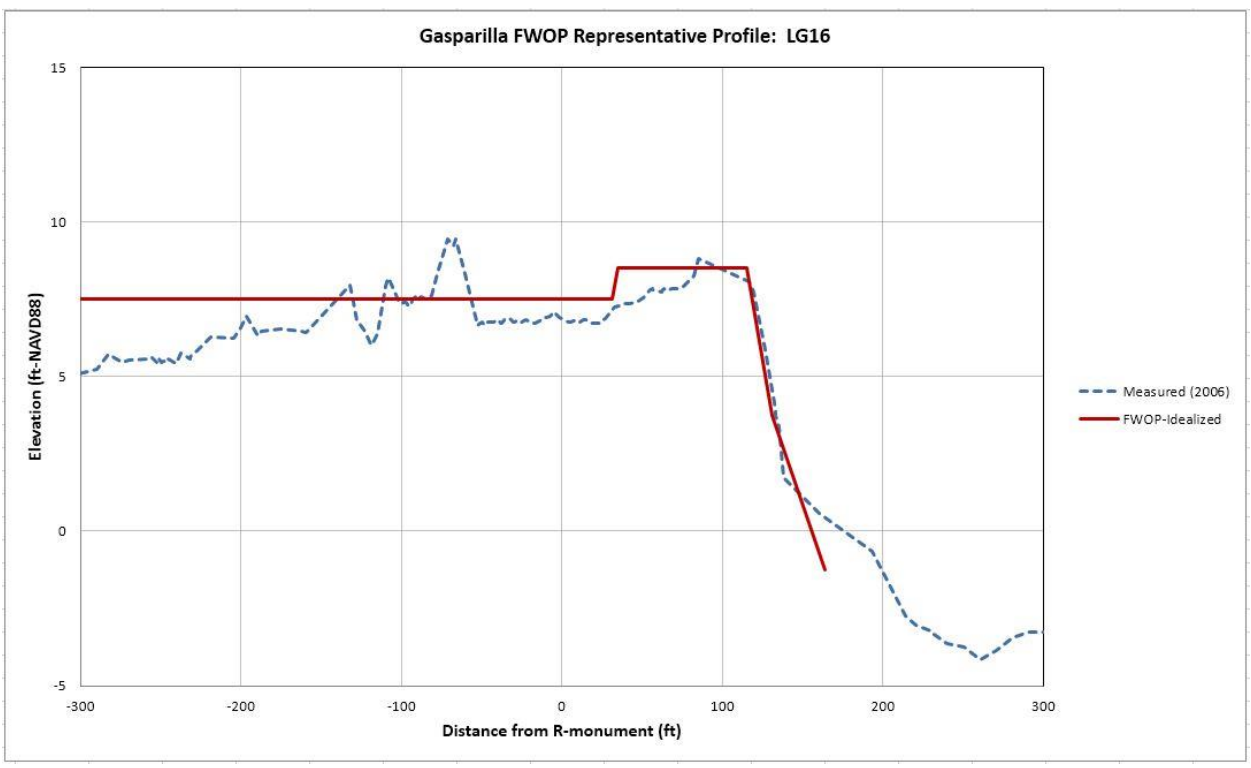

Figure A- 22. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-16

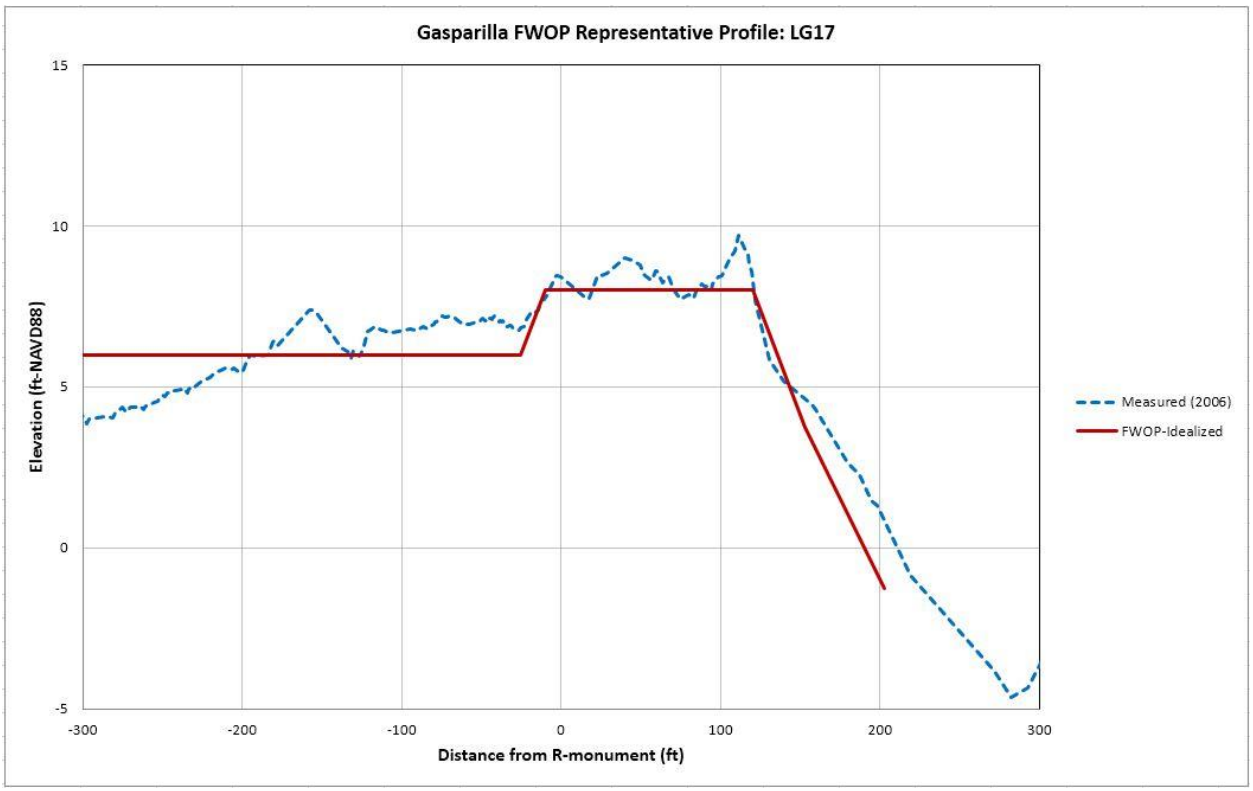

Figure A- 23. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-17

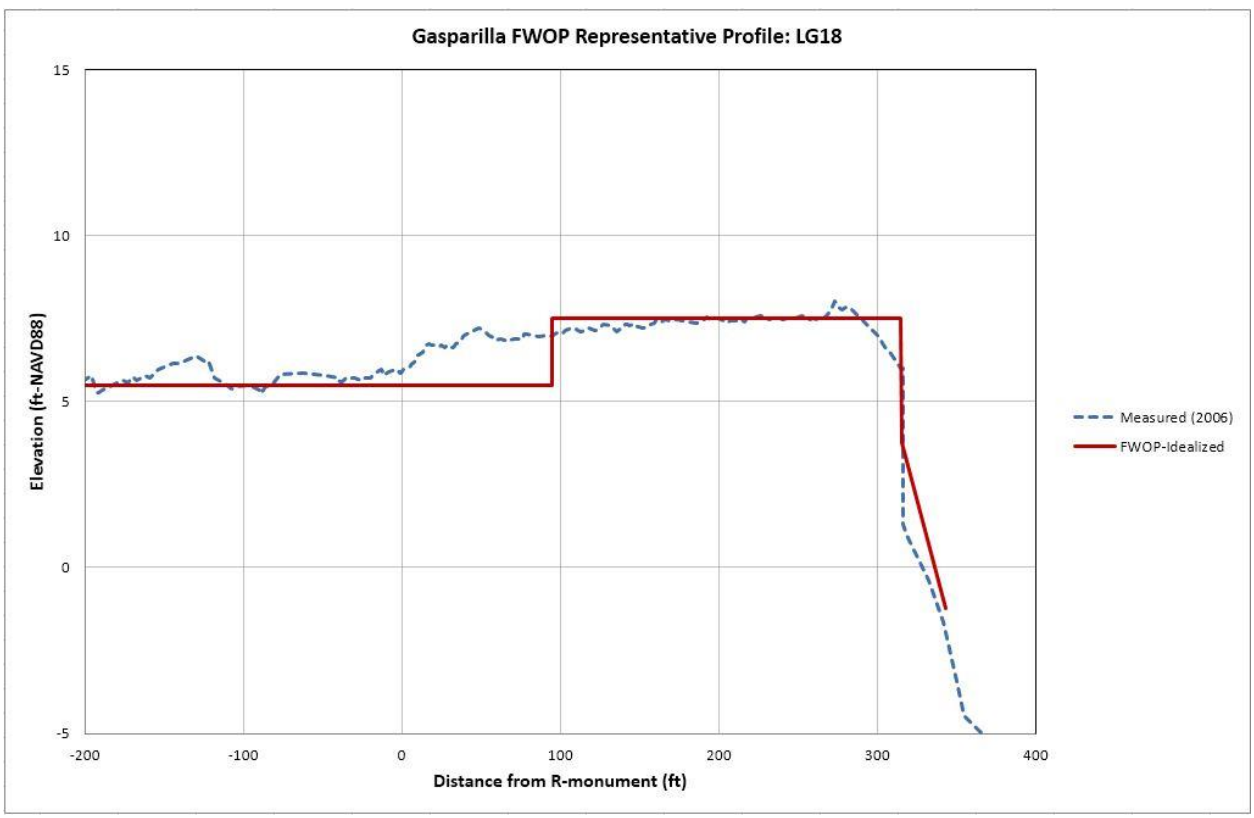

Figure A- 24. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-18

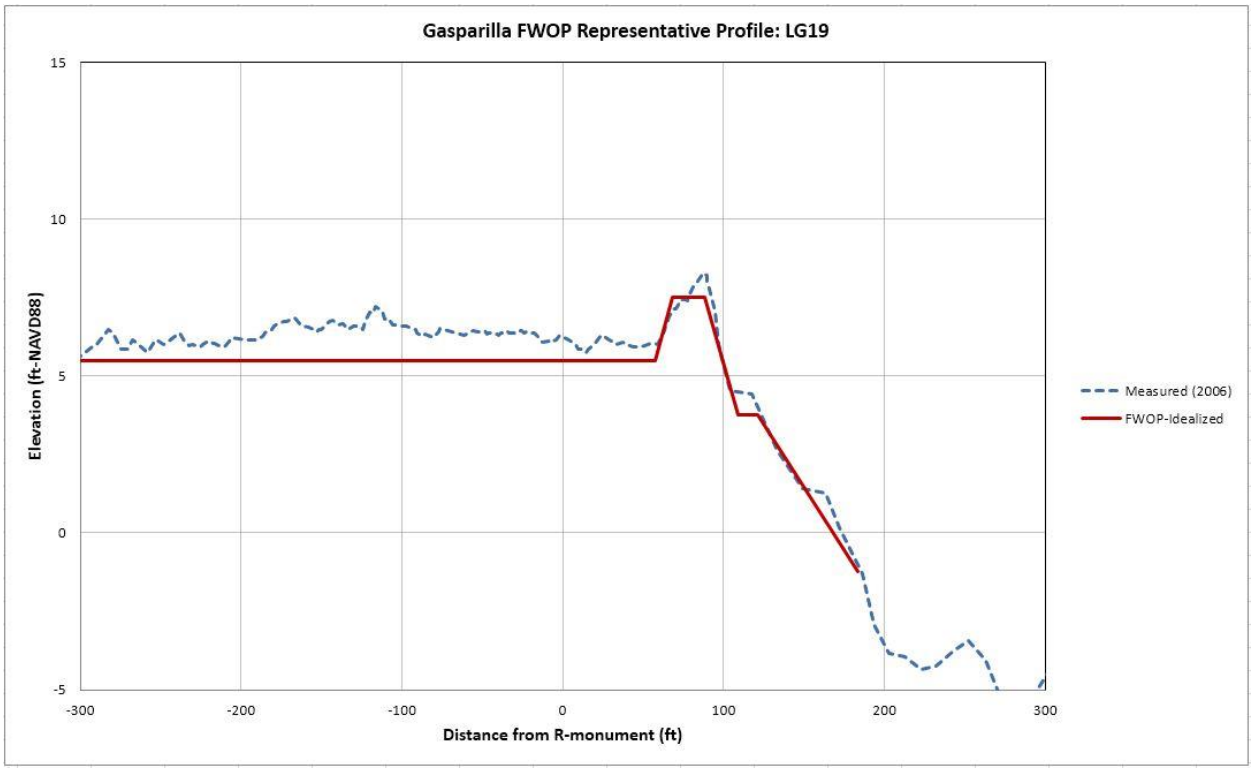

Figure A- 25. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-19

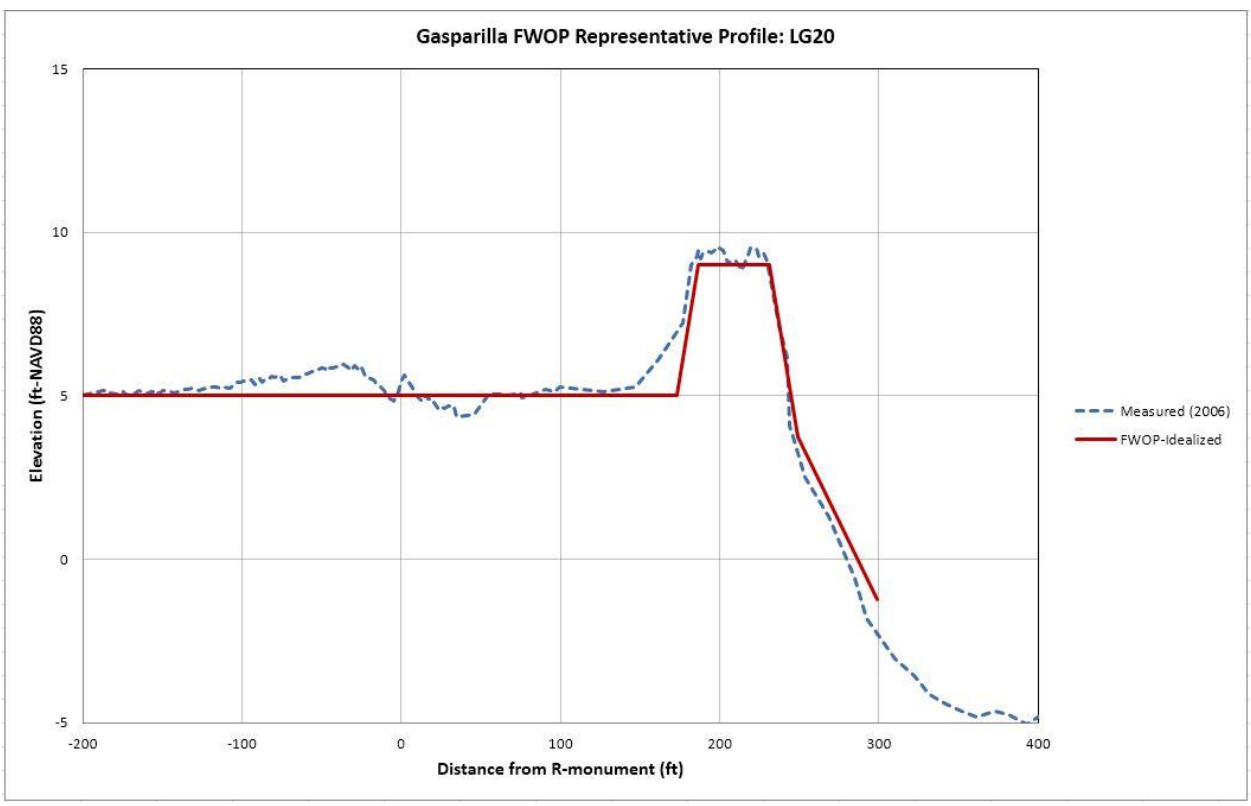

Figure A- 26. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-20

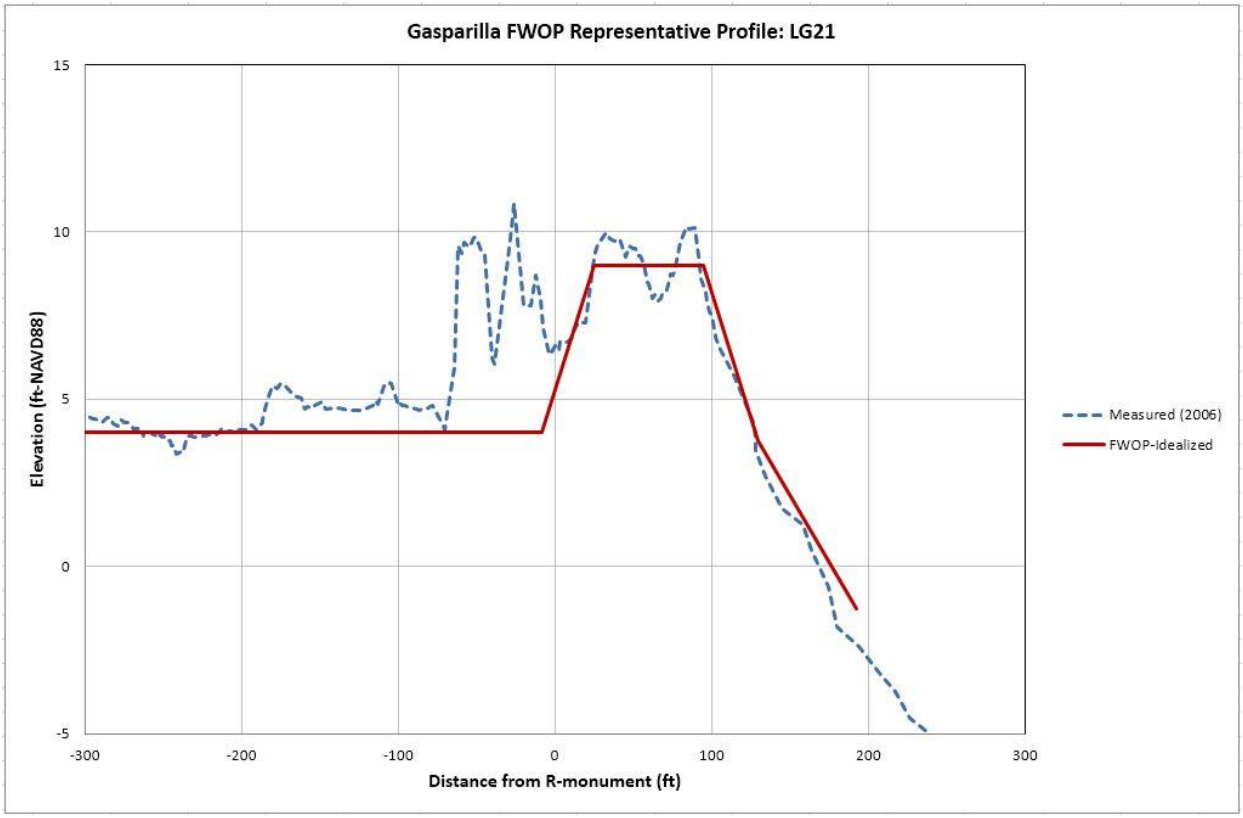

Figure A- 27. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-21

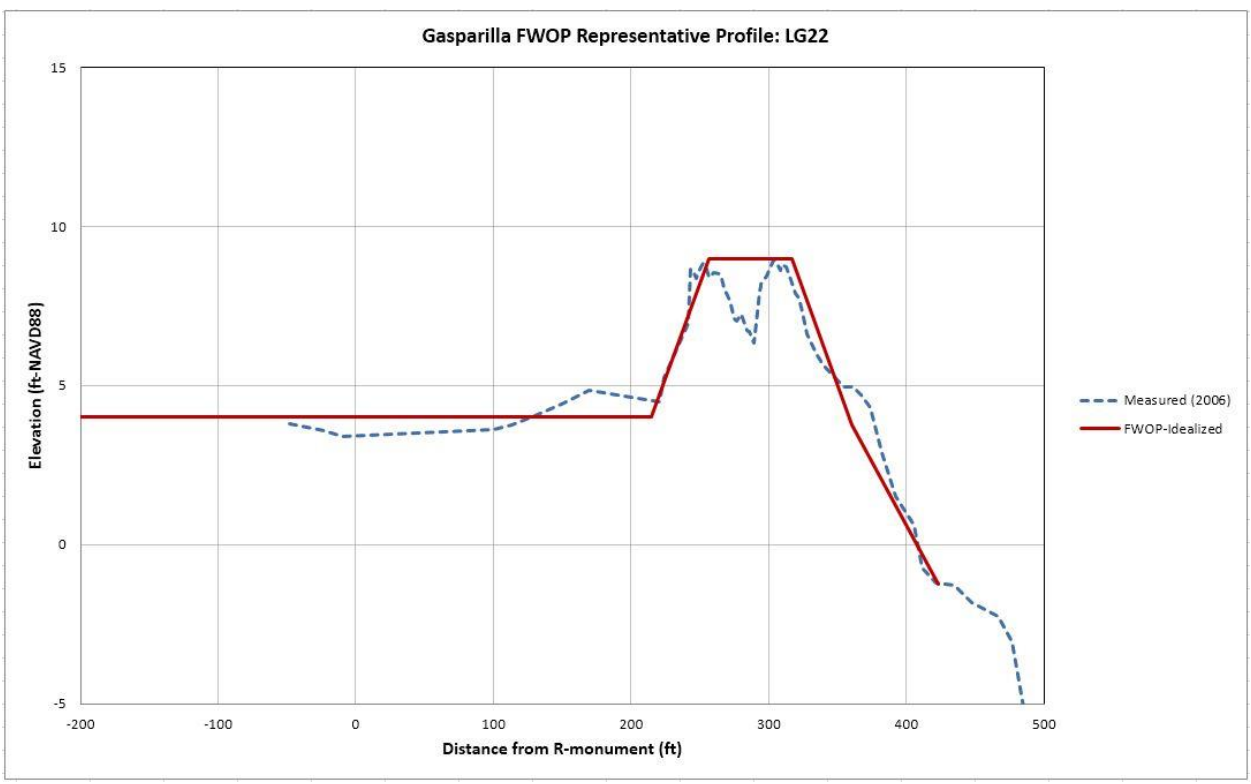

Figure A- 28. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-22

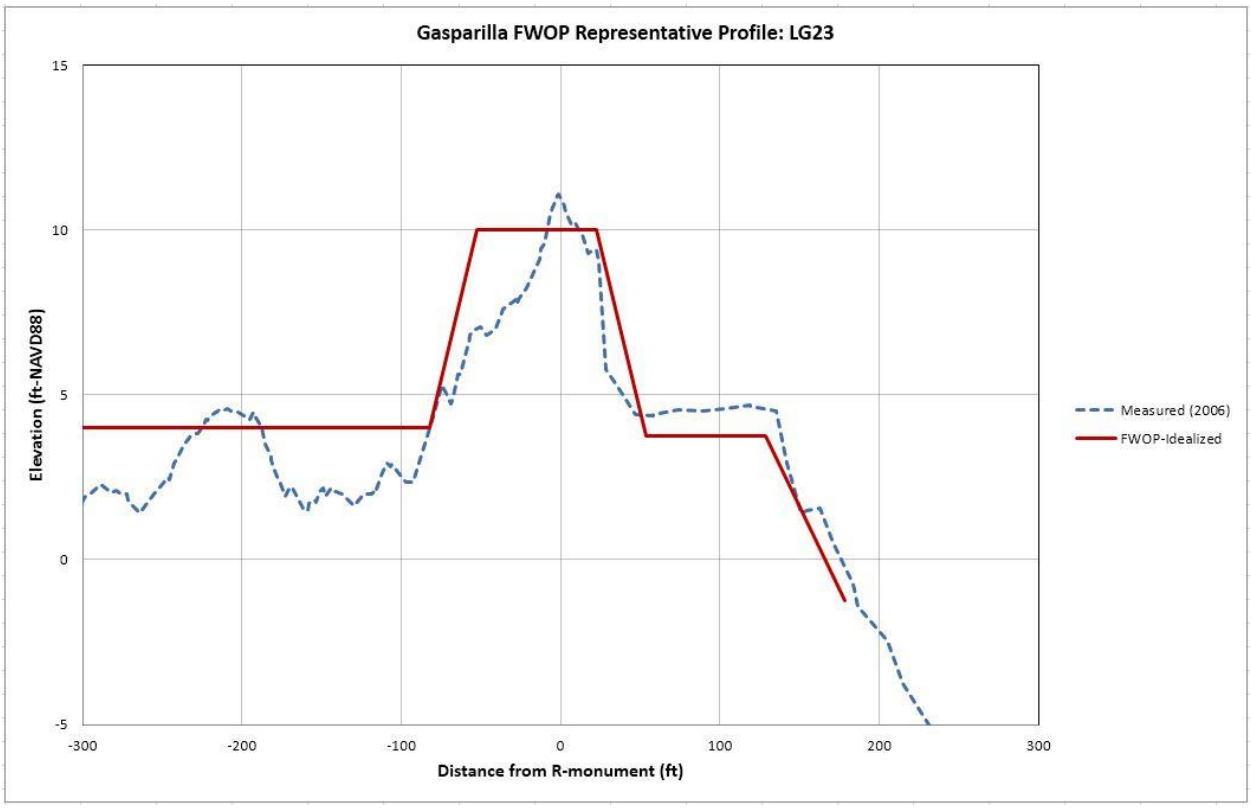

Figure A- 29. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-23

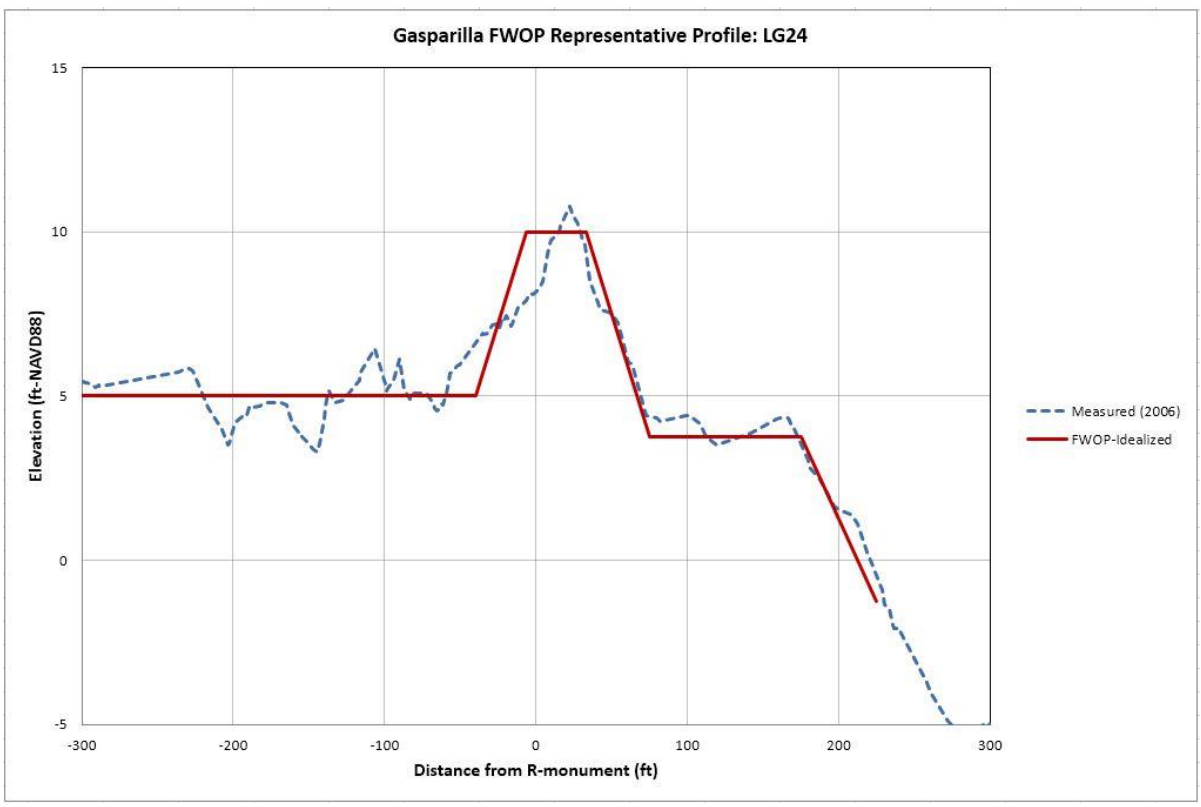

Figure A- 30. Measured (2006) and Idealized (Beach-*fx*) Profiles: Model Reach LG-24

Table A- 14. Dimensions of Idealized Pre-Storm Representative Profiles (FWOP)

Profile	R-monuments Represented	Upland Elevation (ft-NAVD88)	Dune Height (ft-NAVD88)	Dune Width (ft)	Berm Elevation (ft-NAVD88)	Berm Width (ft)
LG11	R-11	6	10	45	3.75	0
LG12	R-12	6	10	50	3.75	0
LG13	R-13	7	9	50	3.75	0
LG14	R-14	7	9	165	3.75	0
LG15	R-15	7	9	150	3.75	0
LG16	R-16	7.5	8.5	80	3.75	0
LG17	R-17	6	8	130	3.75	0
LG18	R-18	5.5	7.5	220	3.75	0
LG19	R-19	5.5	7.5	20	3.75	12
LG20	R-20	5	9	45	3.75	0
LG21	R-21	4	9	70	3.75	0
LG22	R-22	4	9	60	3.75	0
LG23	R-23	4	10	75	3.75	75
LG24	R-24	5	10	40	3.75	90

6.3.1.3 Future With-Project (FWP) Profiles

As with the FWOP scenario, the base year of the FWP portion of the analysis is 2016 and the condition of the project shoreline must reflect expected 2016 shoreline dimensions. In 2013 the project was renourished. Because the 2013 post-fill surveys showed that the fill dimensions varied from the authorized template, it was determined that the post-fill shoreline could not be used as the basis for a 2016 FWP shoreline representative of the authorized project. Instead, the authorized project (GRR) template was assigned as the "2013 shoreline". The FWP 2016 shoreline was than developed by applying three years of erosion to this template. Table A- 15 provides dimensions for each of the idealized representative FWP Beach-*fx* profiles. Note that low storm activity between 2013 and 2016 combined with shoreline armor (in the northern project) prevented erosion damages to the dune.

Table A- 15. Dimensions of Idealized FWP Pre-Storm Representative Profiles)

Profile	R-monuments Represented	Upland Elevation (ft-NAVD88)	Dune Height (ft-NAVD88)	Dune Width (ft)	Berm Elevation (ft-NAVD88)	Berm Width (ft)
LG11	R-11	6	10	45	3.75	100
LG12	R-12	6	10	50	3.75	206
LG13	R-13	7	9	50	3.75	56
LG14	R-14	7	9	165	3.75	33
LG15	R-15	7	9	150	3.75	75
LG16	R-16	7.5	8.5	80	3.75	305
LG17	R-17	6	8	130	3.75	195
LG18	R-18	5.5	7.5	220	3.75	79
LG19	R-19	5.5	7.5	20	3.75	92
LG20	R-20	5	9	45	3.75	141
LG21	R-21	4	9	70	3.75	126
LG22	R-22	4	9	60	3.75	170
LG23	R-23	4	10	75	3.75	194
LG24	R-24	5	10	40	3.75	165

In accordance with 934 guidance, the FWP analysis consists primarily of determining if the authorized design template is still economically justified. According to the original authorization, the design template is defined as a 20 foot extension of the 2000 GRR project baseline (roughly the 1995 MHW line) at +5 ft-MLW (3.75 ft-NAVD88). Figure A- 31 to Figure A- 44 show the GRR baseline, 20 foot extension of the GRR Baseline, FWOP profile, and the idealized 2016 FWP profiles (as defined in Table A-15). Note that for Beach-*fx*, the FWOP and FWP must share the same upland elevation, berm elevation, and dune and foreshore slopes.

6.3.1.4 SBEACH Methodology

SBEACH simulates beach profile changes that result from varying storm waves and water levels. These beach profile changes include the formation and movement of major morphological features such as longshore bars, troughs, and berms. SBEACH is a two-dimensional model that considers only cross-shore sediment transport. The model assumes that simulated profile changes are produced only by cross-shore processes. Longshore wave, current, and sediment transport processes are not included.

SBEACH is an empirically based numerical model, which was formulated using both field data and the results of large-scale physical model tests. Input data required by SBEACH describes the storm being simulated and the beach of interest. Basic requirements include time histories of wave height, wave period, water elevation, beach profile surveys, and median sediment grain size.

SBEACH simulations are based on six basic assumptions:

- Waves and water levels are the major causes of sand transport and profile change
- Cross-shore sand transport takes place primarily in the surf zone
- The amount of material eroded must equal the amount deposited (conservation of mass)
- Relatively uniform sediment grain size throughout the profile,
- The shoreline is straight and longshore effects are negligible
- Linear wave theory is applicable everywhere along the profile without shallow-water wave approximations

Once applied, SBEACH allows for variable cross shore grid spacing, wave refraction, randomization of input waves conditions, and water level setup due to wind. Output data consists of a final calculated profile at the end of the simulation, maximum wave heights, maximum total water elevations plus setup, maximum water depth, volume change, and a record of various coastal processes that may occur at any time-step during the simulation (accretion, erosion, over-wash, boundary-limited run-up, and/or inundation).

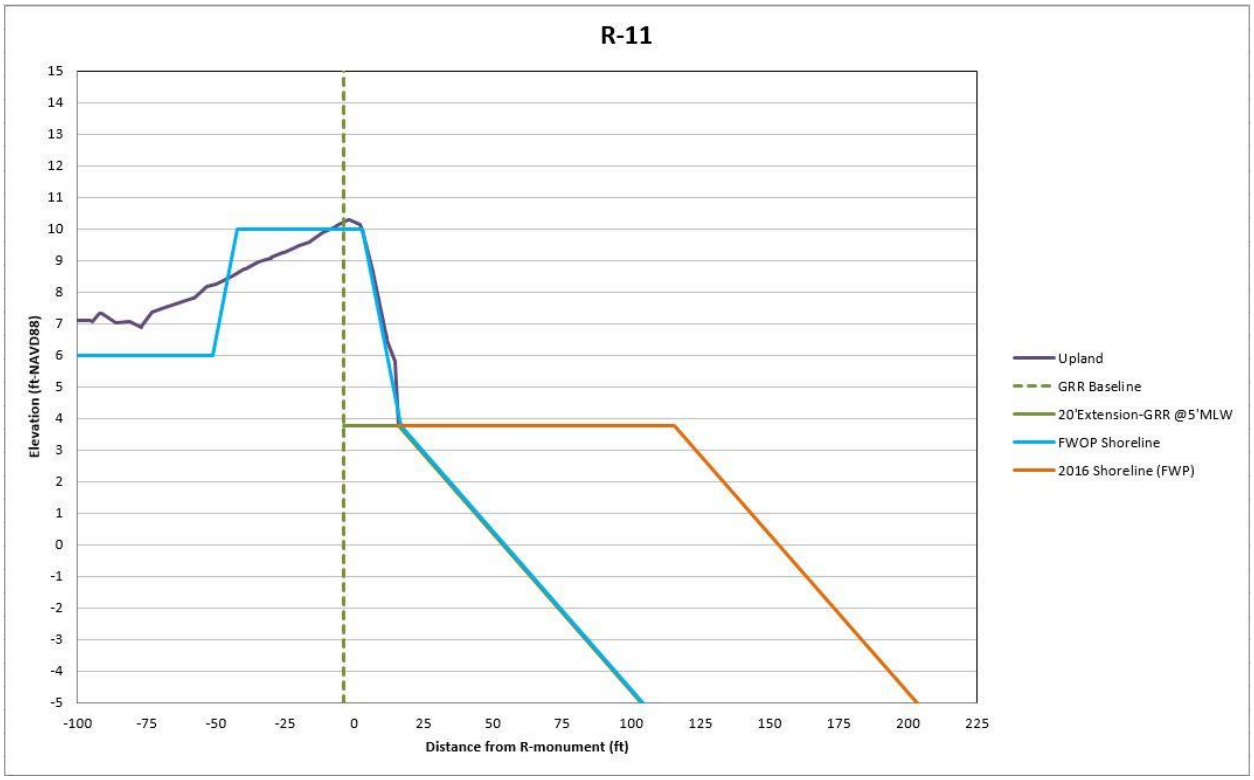

Figure A- 31. Projected 2016 Idealized Profile: Model Reach LG11

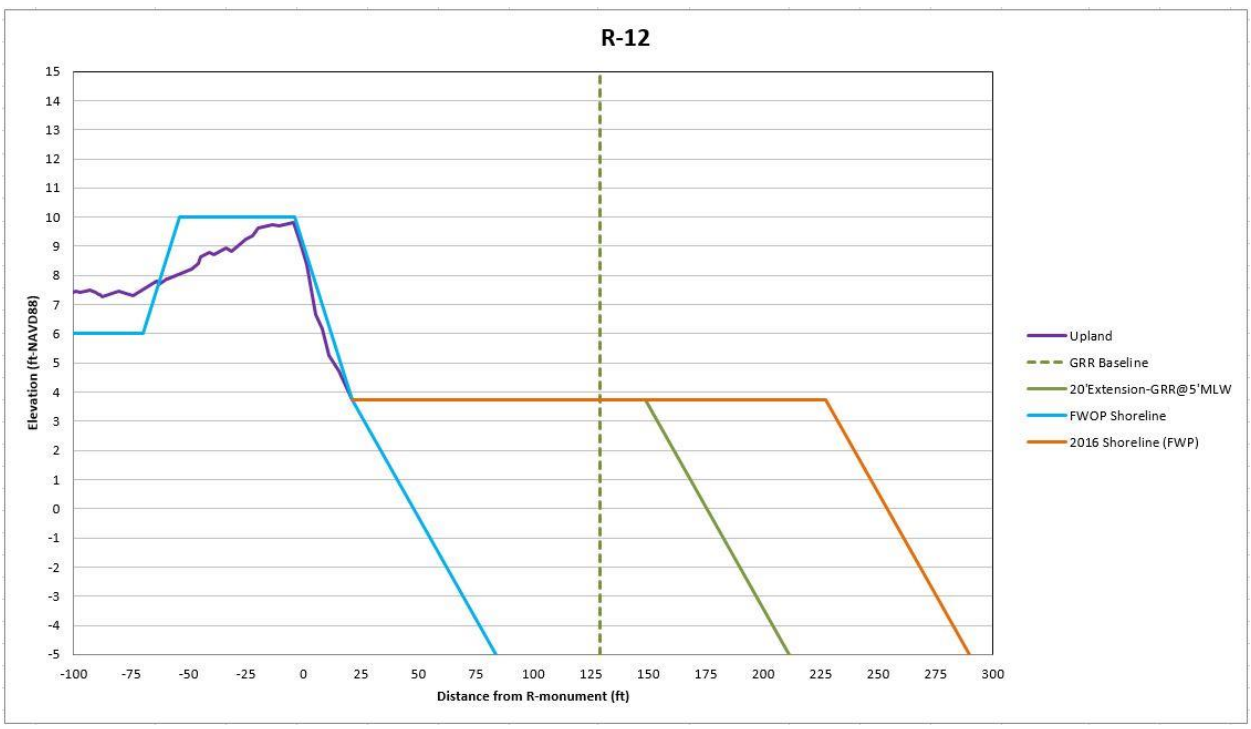

Figure A- 32. Projected 2016 Idealized Profile: Model Reach LG12

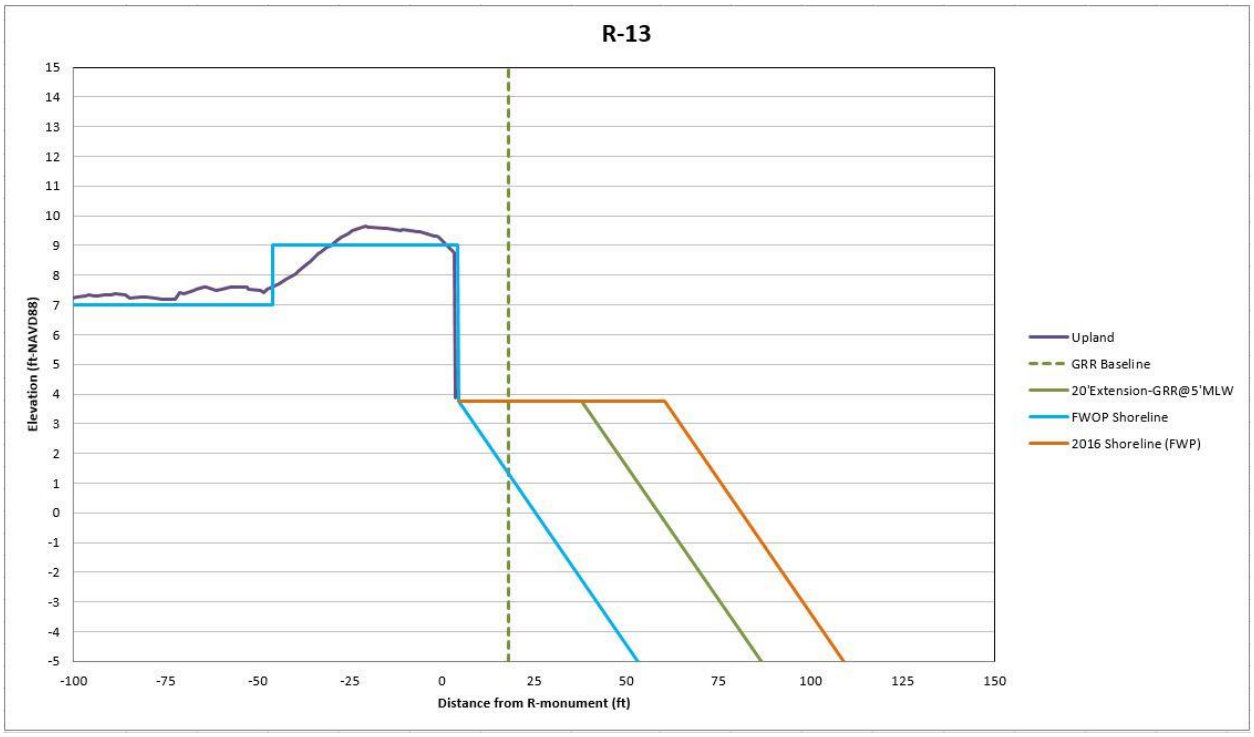

Figure A- 33. Projected 2016 Idealized Profile: Model Reach LG13

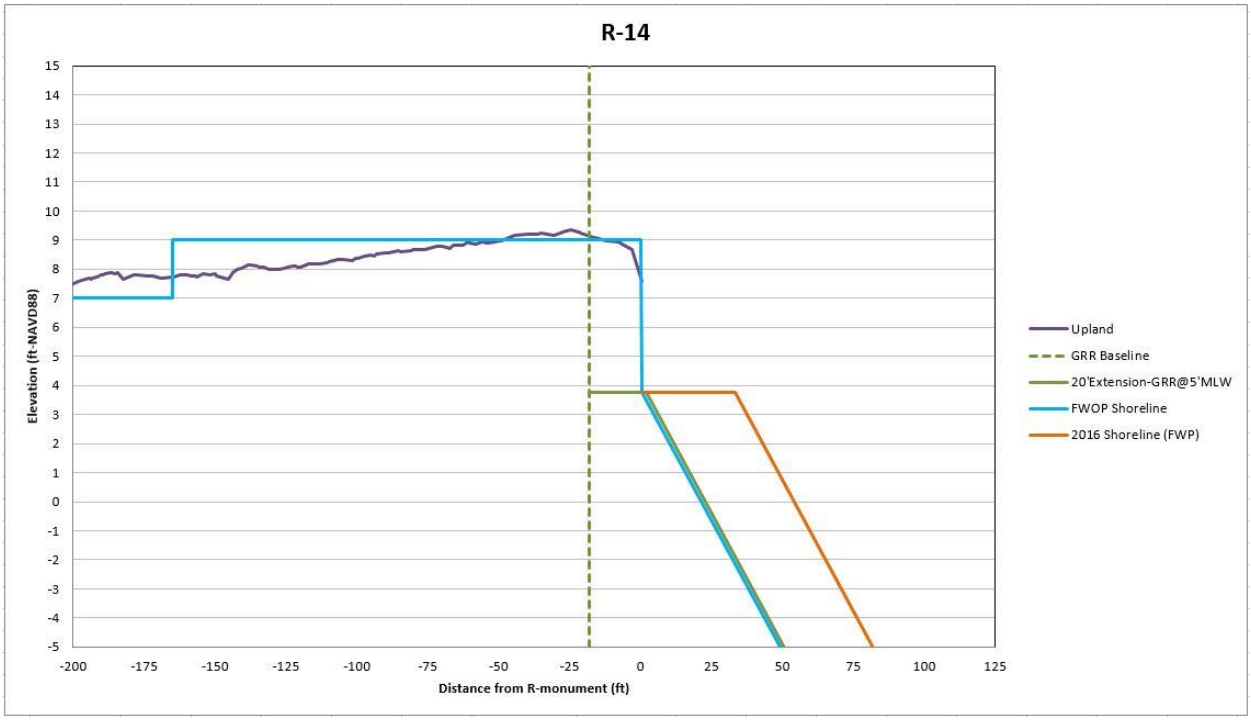

Figure A- 34. Projected 2016 Idealized Profile: Model Reach LG14

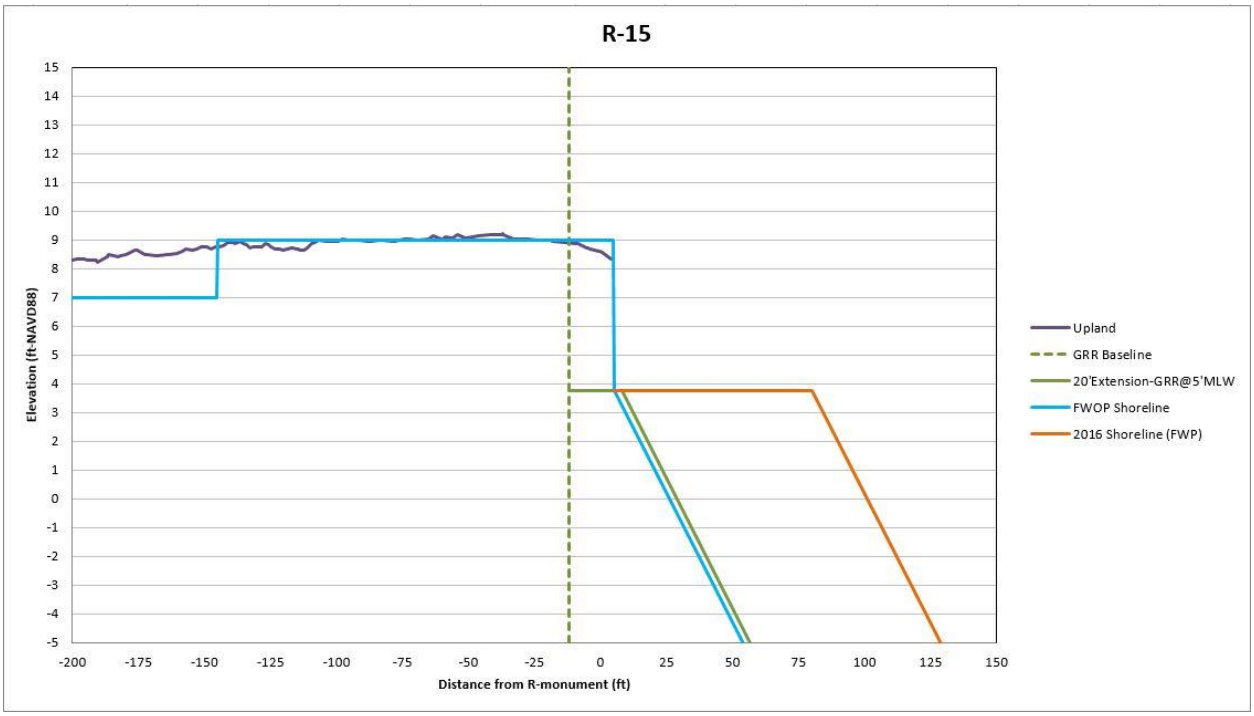

Figure A- 35. Projected 2016 Idealized Profile: Model Reach LG15

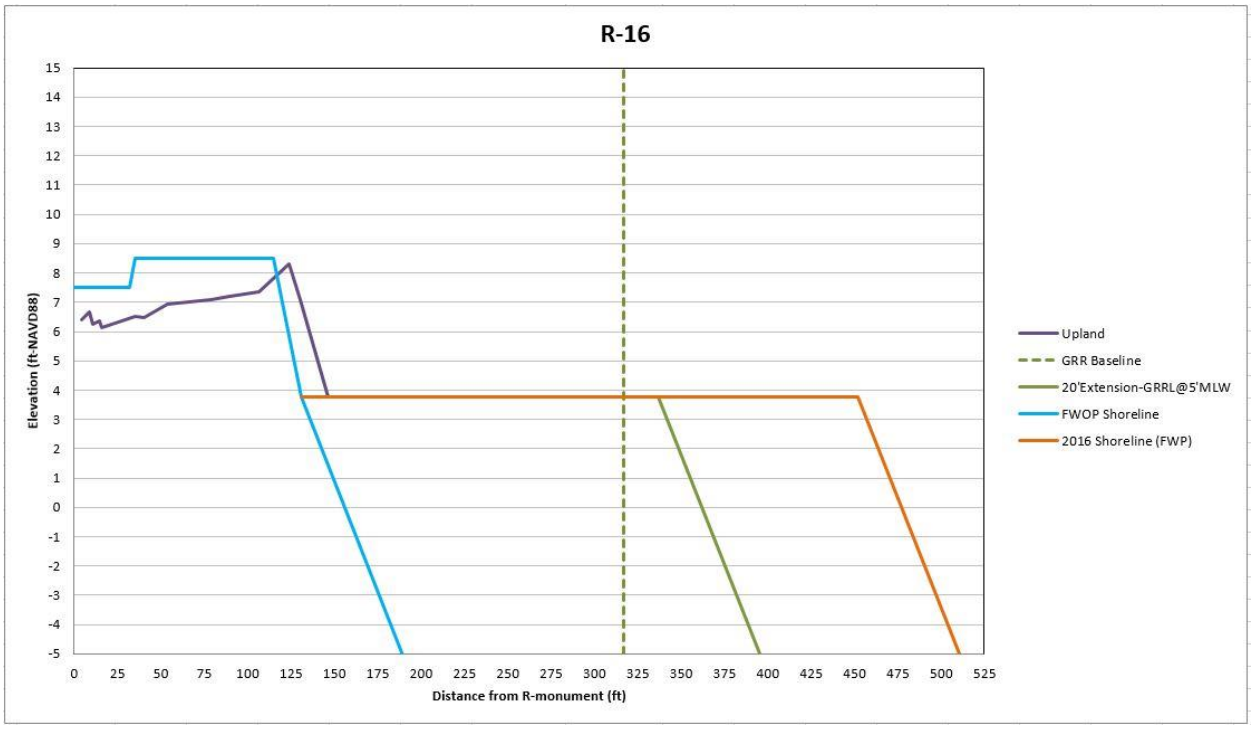

Figure A- 36. Projected 2016 Idealized Profile: Model Reach LG16

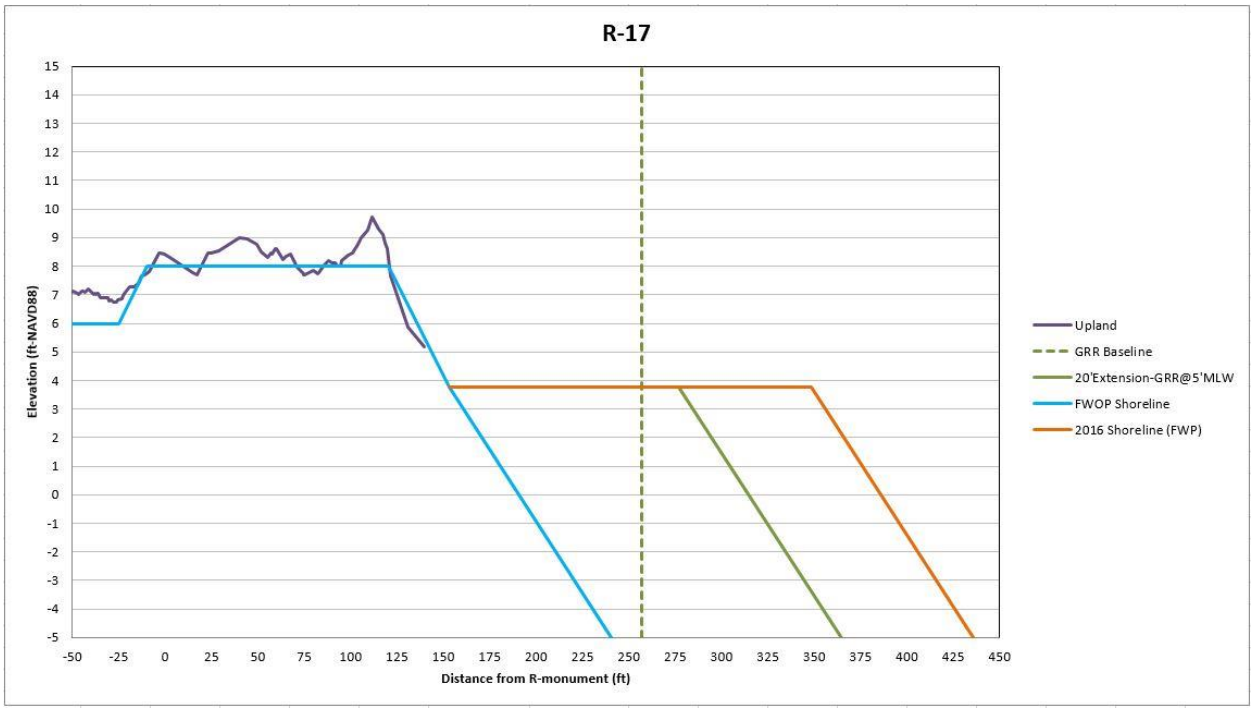

Figure A- 37. Projected 2016 Idealized Profile: Model Reach LG17

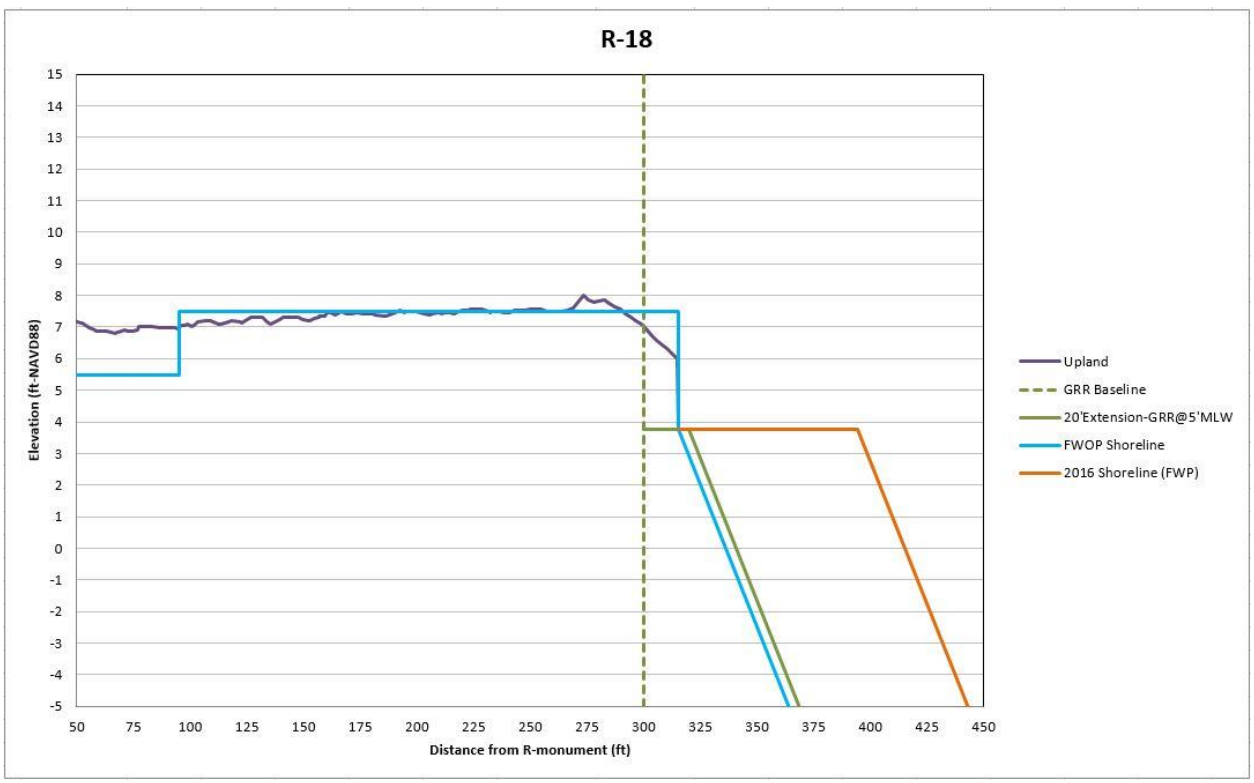

Figure A- 38. Projected 2016 Idealized Profile: Model Reach LG18

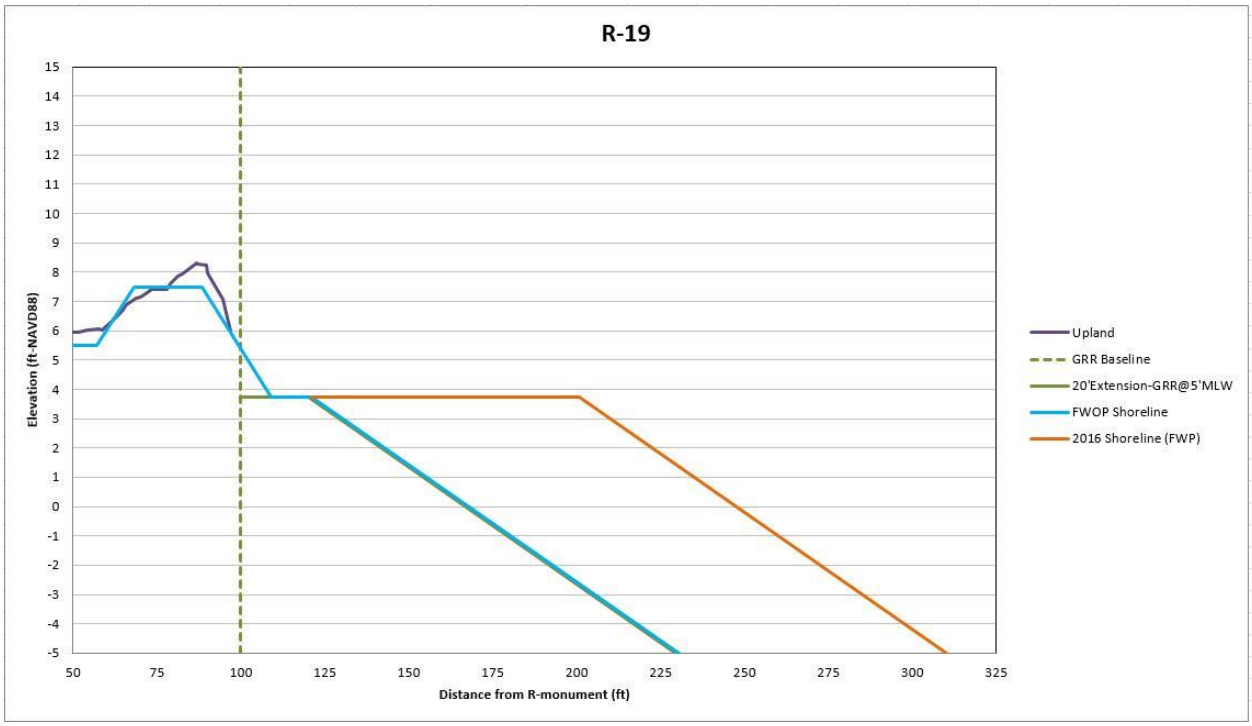

Figure A- 39. Projected 2016 Idealized Profile: Model Reach LG19

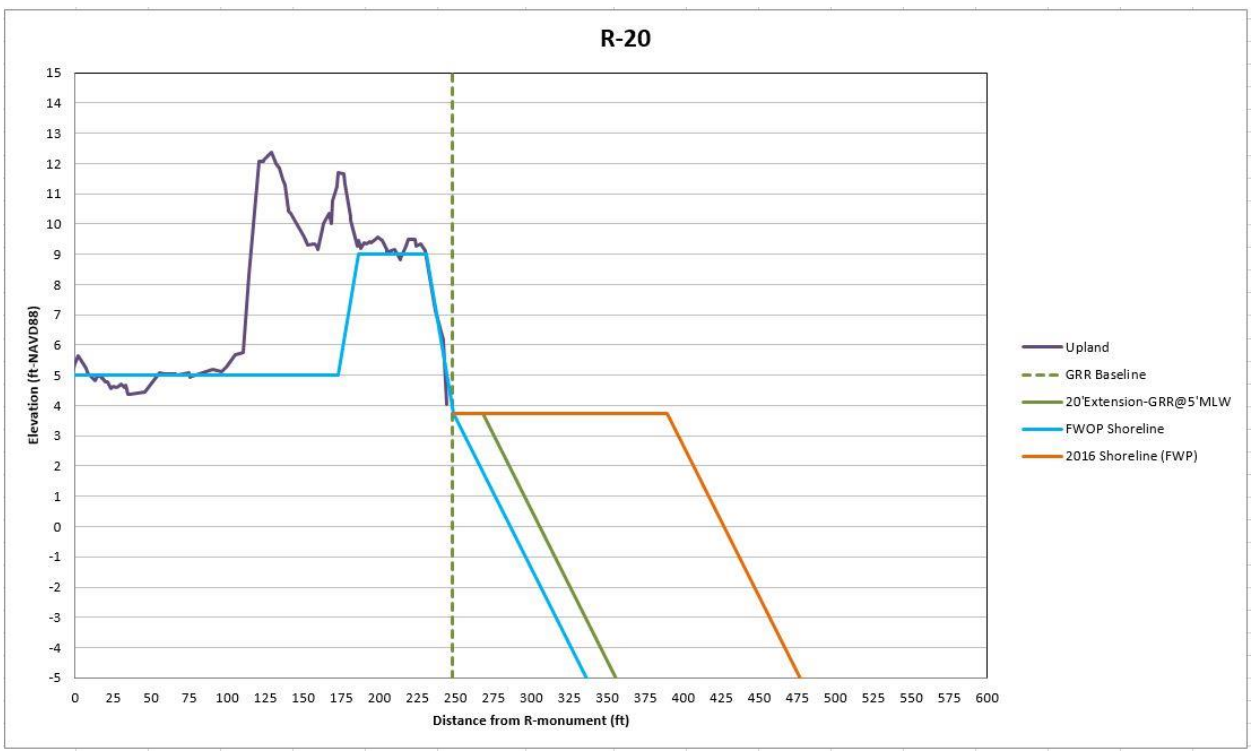

Figure A- 40. Projected 2016 Idealized Profile: Model Reach LG20

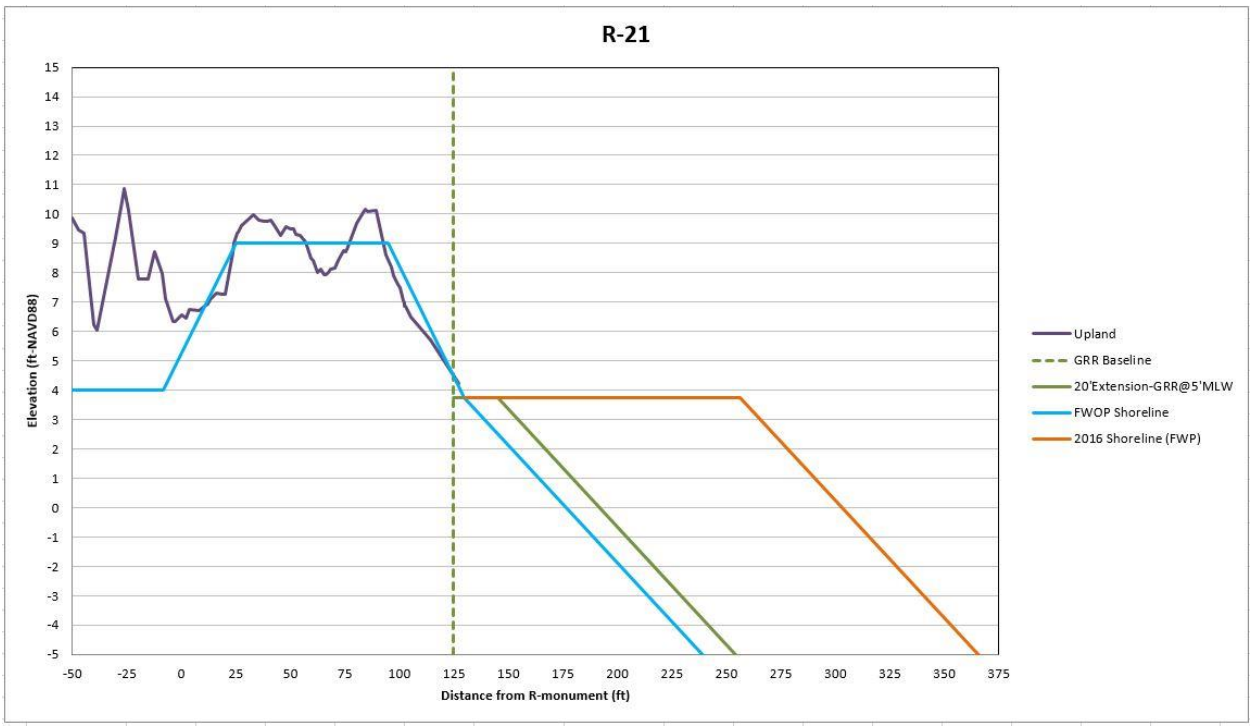

Figure A- 41. Projected 2016 Idealized Profile: Model Reach LG21

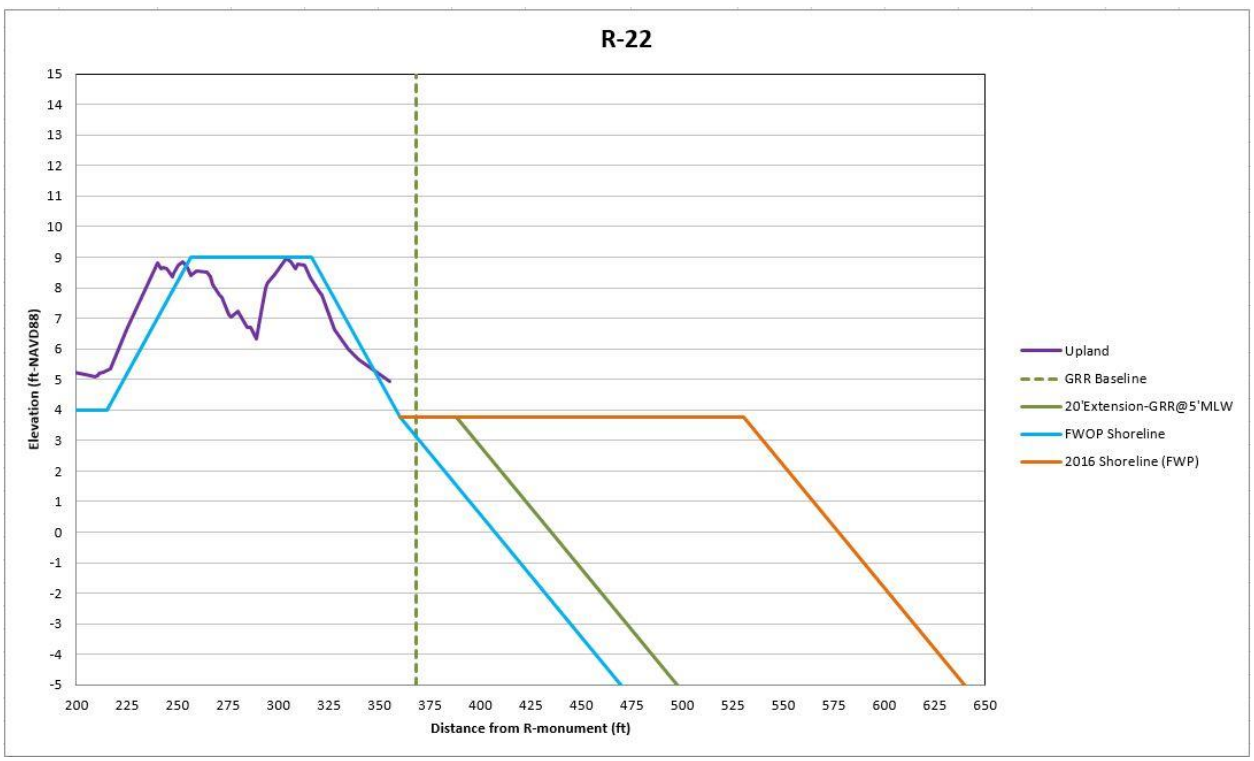

Figure A- 42. Projected 2016 Idealized Profile: Model Reach LG22

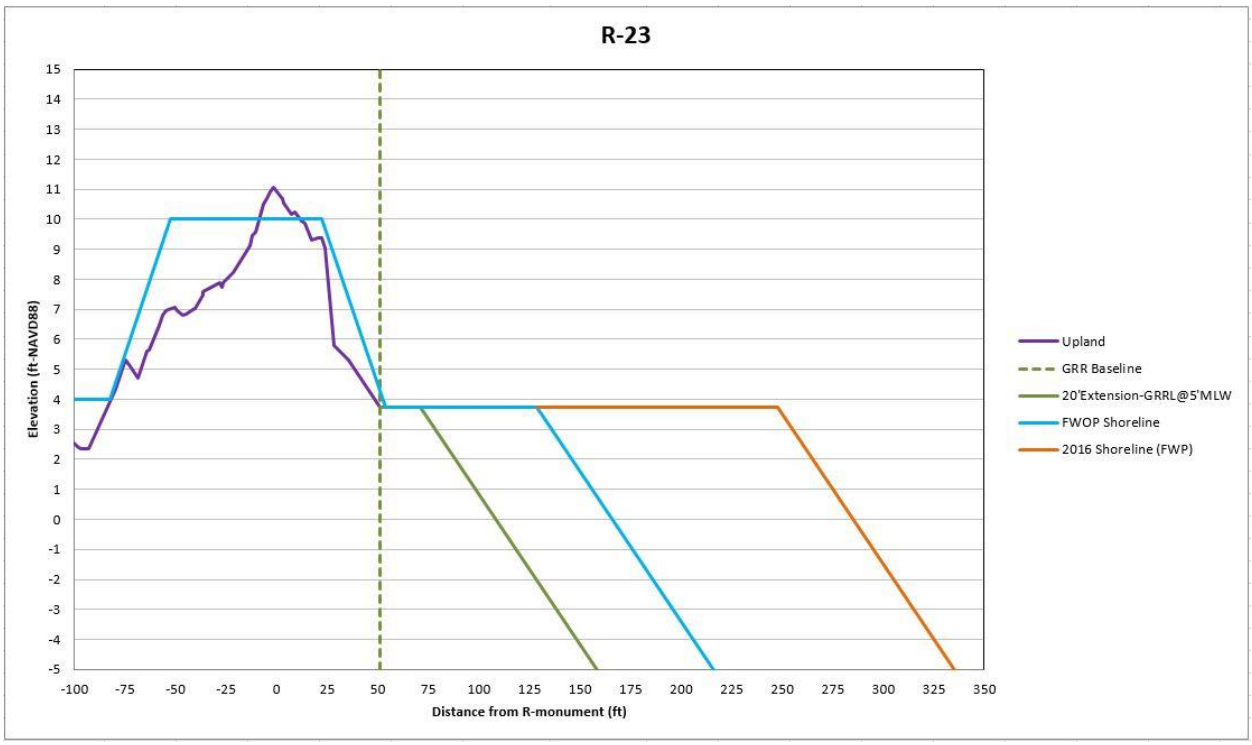

Figure A- 43. Projected 2016 Idealized Profile: Model Reach LG23

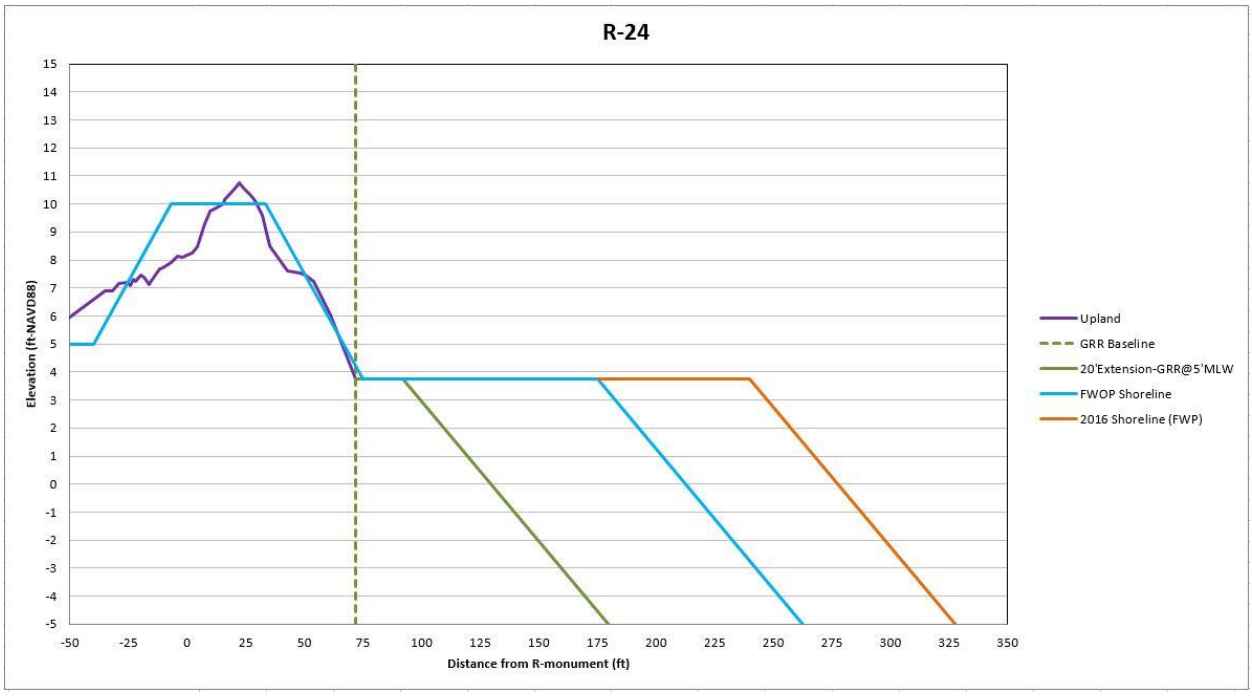

Figure A- 44. Projected 2016 Idealized Profile: Model Reach LG24

6.3.1.5 SBEACH Calibration and Verification

Calibration of the SBEACH model was performed using wave height, wave period, and water level information from Tropical Storm Barry (2007) (Figure A- 45). Calibration of the model is required to ensure that the SBEACH model is tuned to provide realistic shore responses that are representative of the specific project location.

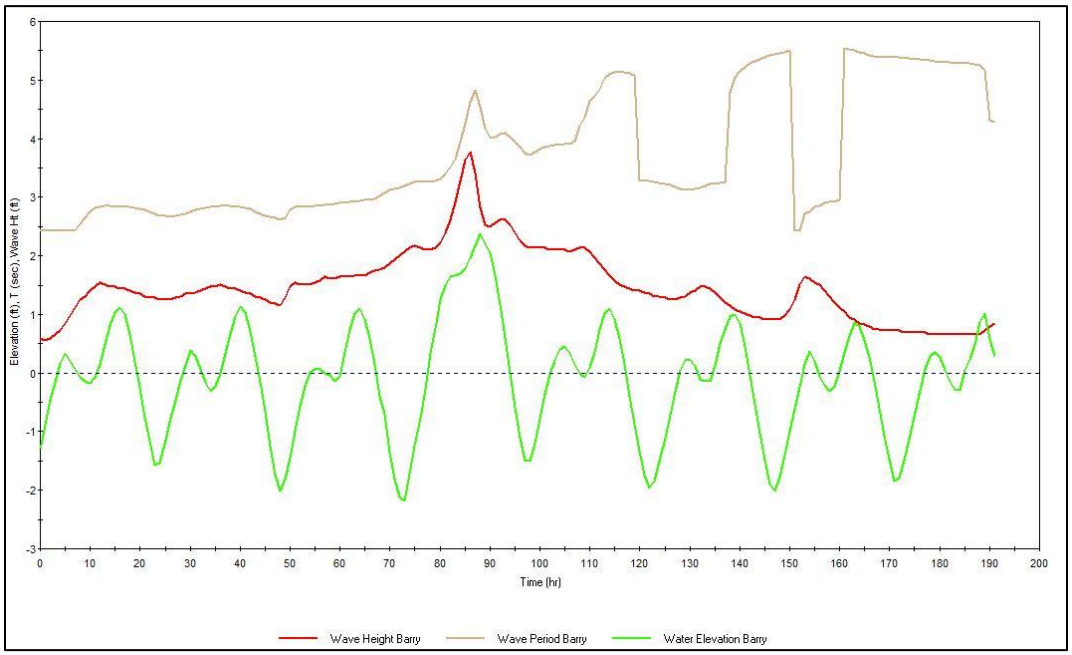

Figure A- 45. Tropical Storm Barry Wave and Water Level Data for SBEACH Calibration

Pre- and post-storm shoreline profiles were obtained from FDEP. Using the pre-storm profiles, SBEACH was then run with a range of values for an array of calibration parameters. Table A- 16 provides the relevant beach characteristic and sediment transport calibration parameters as well as their final calibrated values. Calibration parameters were verified using wave height, wave period, and water level information from Tropical Storm Fay (2008). For a detailed discussion of the SBEACH calibration and verification analysis see Sub-Appendix A-1: SBEACH Calibration and Verification.

Table A- 16. SBEACH Calibrated Beach Characteristic and Sediment Transport Parameters

Beach Characteristic		Sediment Transport	
Parameter	**Calibrated Value**	**Parameter**	**Calibrated Value**
Landward Surf Zone Depth	1.0 ft	Transport Rate Coefficient	2.5e-06 (m4/N)
Effective Grain Size	0.32 mm	Overwash Transport Parameter	0.0
		Coefficient for Slope-Dependent Term	0.003
Maximum Slope Prior to Avalanching	15	Transport Rate Decay Coefficient Multiplier	0.5
		Water Temperature	25degC

6.3.1.6 SBEACH Simulations

Calibrated Gasparilla Island SBEACH simulations were run for each of the existing, future without project, and with project idealized profiles in combination with each of the tropical and extra-tropical storms in the plausible storm database. This resulted in individual storm response profiles. From these profiles, changes in the key profile dimensions were extracted and stored in the Gasparilla Beach-*fx* SRD.

6.3.2 Applied Shoreline Change

The applied shoreline change rate (in feet per year) is a Beach-*fx* morphology parameter specified at each of the model reaches. It is a calibrated parameter that, combined with the storm-induced change generated internally by the Beach-*fx* model, returns the historical shoreline change rate for that location.

The target shoreline change rate is an erosion or accretion rate derived from the MHW rate of change determined at each R-monument location (see Section 4: Historical Shoreline Change). Although the MHW rate of change represents the historical behavior of the project shoreline, when it is calculated at single point locations, such as R-monuments, there is a high degree of variability between consecutive locations. This variability results in a similar variability in the Beach-*fx* results, specifically in project costs and predicted damages. Because this does not reflect actual shoreline behavior and leads to inconsistencies between adjacent economic reaches, the target shoreline change rate is determined by averaging adjacent MHW change rates to allow for smoother transitions along the length of the project shoreline. Figure A- 46 shows the smoothed target shoreline change rates along with the original MHW shoreline change rates from which they were derived.

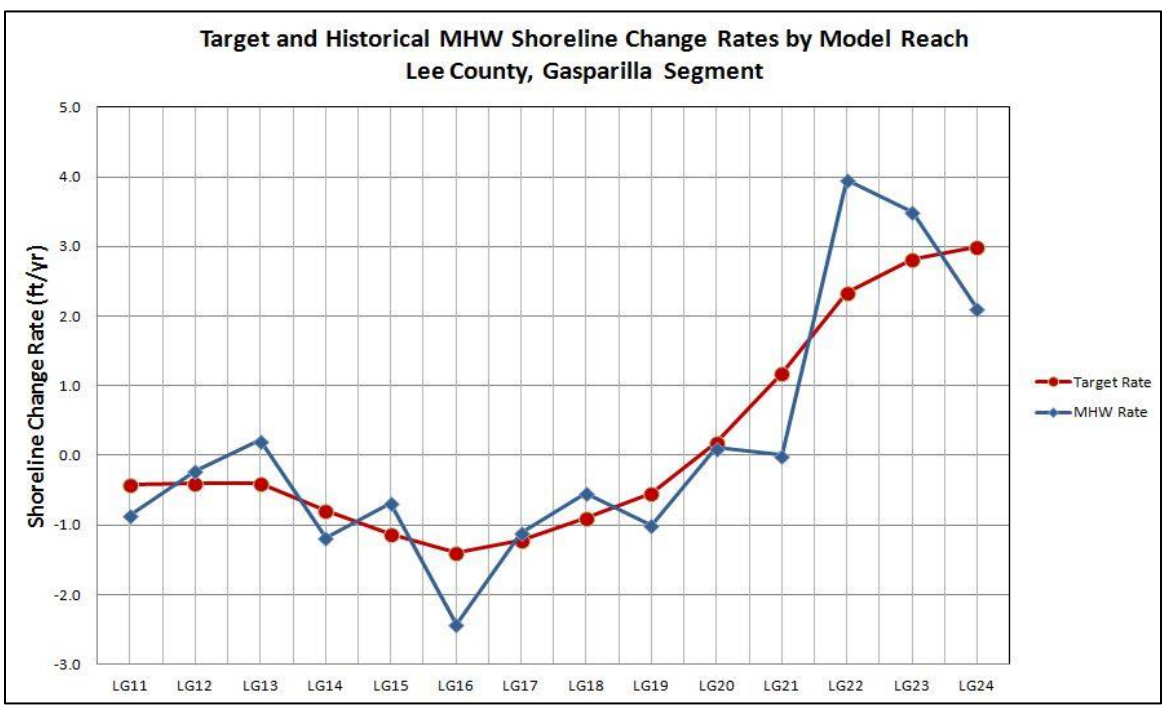

Figure A- 46. Target and Historical MHW Shoreline Change Rates

During Beach-*fx* calibration, applied erosion rates were adjusted for each model reach and the Beach-*fx* model was run for hundreds of iterations over the 50-year project life cycle. Calibration is achieved when the rate of shoreline change, averaged over hundreds of life cycle simulations, is equal to the target shoreline change rate.

Engineering Manual EM 1110-2-3301 Design of Beach Fills (USACE, 1995) provides guidance on the selection of shoreline change models. Four acceptable alternatives are discussed:

- GENESIS – One-dimensional model (PC based)
- Dean and Yoo (1992) – One line analytical model (spreadsheet/calculator based)
- Multi-contour 3D – Three dimensional model with variable profile and longshore capabilities (PC based)
- Fully 3D Model – Three dimensional model that calculate waves and currents in addition to sediment transport (PC based)

Of the alternatives, the one line analytical model is simplest to apply, but produces valid planform diffusion estimates for variable fill widths and lengths. It should be noted that the governing equation within the GENESIS and GenCade models is a one line analytical solution.

6.3.2.1 One Line Analytical Model

While Dean and Yoo provides the basic governing formulations for assessing shoreline change rates, it does not specify a discrete analytical solution. These governing formulations, based on the conservation of sand combined with sediment transport, have existed for several decades. In that time, many analytical solutions have been developed to solve them. Because the analytical solution presented by Larson et al. (1987) is the closest in formulation to the GENESIS model traditionally used in more complex USACE applications, it was selected as the one-line model for use with the Gasparilla Island project.

Governing Equations

As presented by Dean and Yoo, shoreline response can be derived from the following governing equations:

(1) Conservation of Sand (one dimensional form)

$$\frac{\partial y}{\partial t} + \frac{1}{(h_* + B)}\frac{\partial Q}{\partial x} = 0$$

Where

y = cross-shore distance
t = time
h_* = depth of closure
B = berm elevation
Q = long shore sediment transport
x = long-shore distance

(2) Sediment Transport (one dimensional form)

$$I = KP_{ls}$$

Where

I = immersed weight sediment transport rate (a function of Q)
K = non-dimensional sediment transport proportionality factory
P_{ls} = long shore energy flux factor (a function of the breaking wave climate)

6.3.2.2 One Line Analytical Solution

Based on the governing formulations, a number of analytical solutions are possible. The solution derived by Larson et al. was selected based on compatibilities to the derivation of the one line model on which GENESIS and GenCade are formulated.

Larson et al.

The analytical solution for shoreline evolution derived by Larson et al. can be described by:

$$y(x,t) = \frac{1}{2} y_o \left[erf\left(\frac{a-x}{2\sqrt{\varepsilon t}}\right) + erf\left(\frac{a+x}{2\sqrt{\varepsilon t}}\right) \right]$$

Where

a = one half of the length of the fill
y_o = original cross-shore width of the fill
x = long-shore distance (where *x* = 0 is the center point of the fill)
t = time (where *t* = 0 is initial placement)
ε = diffusion coefficient

The diffusion coefficient is defined as:

$$\varepsilon = \frac{2Q}{(h_* + B)}$$

Where *Q* can be computed using the CERC equation, given as:

$$Q = \frac{KH_b^{\frac{5}{2}}\sqrt{\frac{g}{\lambda}}\sin(2\theta)}{16(s-1)(1-p)}$$

Where

K = non-dimensional sediment transport proportionality factory (see Section 6.3.2.3.3: Non-dimensional Sediment Transport Coefficient, *K*)
H_b = breaker height (see Section 6.3.2.3.1: Breaker Wave Height)
g = acceleration due to gravity
λ = breaking wave height proportionality factor

θ = angle of wave approach
s = specific gravity of sediment
p = porosity of sediment

6.3.2.3 Input Parameters

6.3.2.3.1 Breaker Wave Height

The breaker wave height is an estimate of the height of waves as they arrive and break on a given beach. As wave trains are composed of irregular waves with heights and periods that are variable in both time and space, it is necessary to develop a single breaker height H_b that represents the wave energy present at the shoreline due to the wave climate of the project area. Methodologies for estimating H_b have been developed, generally from laboratory or observed data, since the 1940's. There are many formulations available. One of the most commonly accepted methods of estimating H_b is based on deep-water wave characteristics (USACE, 1984). It is expressed as:

$$\frac{H_b}{H'_o} = \frac{1}{3.3(\frac{H'_o}{L_o})^{\frac{1}{3}}}$$

Where

H'_o = unrefracted deep-water wave height
L_o = deep-water wave period

For the Gasparilla project, the representative deep-water wave height for the estimate was determined using hindcast wave data from WIS station #73285. A percent occurrence breakdown of deep-water waves by height and period indicates that the majority of waves have deep-water wave heights of less than 1.0 feet and periods of less than 5 seconds. The average deep water wave height and wave period was found to be 0.8 feet and 4.3 seconds, respectively. Applying these averages, the representative value of H_b was estimated to be 1.2 feet.

6.3.2.3.2 Wave Angle

The representative direction of wave approach, θ, was taken to be the average dominant wave direction of all waves in the WIS dataset. This was accomplished by taking the average WIS wave direction for all waves regardless of wave height or periods. The average deep-water wave direction was found to be 135°, measured clockwise from 0° due north (45 ° relative to shore normal). The deep water wave direction was then transformed using Snell's Law into a nearshore representative wave direction. Snell's Law is given as:

$$Sin(\theta_n) = \frac{C_n}{C_o} Sin(\theta_o)$$

Where

θo = representative deep-water wave direction (45° relative to shore normal)
C_o = deep water wave celerity defined by:

$$C_o = \frac{gT}{2\pi}$$

Where g = 32.2 ft/sec^2 and T= average wave period (4.3 seconds)

C_n = nearshore wave celerity defined by

$$C_n = \sqrt{gh}$$

Where h = nearshore depth (taken to be depth of closure = -15 feet)

Applying Snell's Law for the described parameters, the direction of wave approach was determined to remain consistent with the deepwater wave angle at 45° counter-clockwise relative to shore normal.

6.3.2.3.3 Non-dimensional Sediment Transport Coefficient, K

The sediment transport coefficient *K* can be highly variable. It is dependent on sediment characteristics, properties of the suspension medium, and local wave climate. Small changes in any of the environmental or sediment factors can have a significant impact on the value of *K*. This can be problematic as many of these factors vary in both time and space. Most recommended values of K in literature and guidance are based on field measurements and can vary widely.

Given its variability, *K*, can be set initially based on known or generally accepted parameter values, and then fine-tuned using measured or historical data for the project site. GENESIS applications are calibrated in just this manner, where *K* is adjusted to maximize replication of observed shoreline changes and longshore sediment transport rates. A similar principle can be used in application of the one-line model.

6.3.2.4 Calibration

In order to apply a one-line model to Gasparilla, it is necessary to calibrate the model using available data. In the case of Gasparilla, best available data are measured post-fill erosion rates collected from annual monitoring reports. This data from the previous fill event can be used to calibrate the model by determining the optimum value of K. The model can then be applied to renourishment templates of different dimension.

Table A- 17 provides dimensions for the existing Gasparilla project. Table A- 18 provides the average post-project recession rates as measured between 2006 and 2013. Measurements were taken at fourteen FDEP R-monuments, R-11 to R-24. A combination of seawalls, inlet effects, and the stabilizing presence of a seaward protruding revetment south of the project result in erosion rates that vary along the length of project and are inconsistent over time.

Table A- 17. Existing Gasparilla Project Dimensions

Initial Fill Width*	Y_o	180 feet
Fill Length	l	2.8 miles
Depth of Closure	h	15 ft-NAVD88
Berm Elevation	B	3.75 ft-NAVD88
*Due to overfill during initial construction, the fill width for the calibration is greater than the authorized template		

Table A- 18. Measured Average Annual Shoreline Change

R-monument	Average Annual Post-Nourishment Shoreline Change (feet)
R-11	-18.0
R-12	-19.0
R-13	-25.0
R-14	-27.3
R-15	-24.8
R-16	-5.8
R-17	-6.3
R-18	-12.2
R-19	-16.7
R-20	-15.3
R-21	-15.8
R-22	-17.0
R-23	-19.2
R-24	-21.5

In order to calibrate the one-line model to give representative planform rates for a range of project alternatives, an average representative measured value for the current (measured) project was required. Due to the extensive presence of armor in the northern portion of the project, the project length was divided into two segments for calibration: the armored northern segment (R-11 to R-15) and the unarmored southern segment (R-16 to R-24). The average post-fill erosion rate in the northern portion of the project was found to be -23 feet per year and the average erosion rate in the southern portion was -14 feet per year. Each of these rates applied to the original initial fill width of 180 feet.

The one-line model is not generally applicable to armored shorelines. Therefore calibration focused on the southern portion of the project. Due to the seaward protruding revetment south of the project, which acts to stabilize the southern end of the fill, R-23 and R-24 were also omitted from the comparison. While comparisons of calculated and measured erosion rates were made at all monument locations, the focus of the calibration was on the segment between R-16 and R-22.

Adjusting the K value in increments and calculating the absolute difference between the calculated and measured erosion rates at each R-monument allowed the optimum K parameter to be determined. Table A- 19 shows absolute difference values for K parameters 2.0 through 3.8 (by increments of 0.2). The modeled values vary the most (+/- 8 to 10 feet per year) from measured values in the north segment of the project. This is consistent with the presence of armor. The match, as expected, is closer

in the southern segment, averaging approximately +/- 4 feet per year. From R-16 to R-12, K=2.8 gives the best fit to the average measured value by +/- 3.08 feet per year.

No model currently exists that can fully define planform rates for a shoreline that is influenced by both armor and inlet effects. Therefore, the rates computed using the "best fit" calibrated one-line model are the closest approximation to measured and predicted erosion rates for such a complex project area as Gasparilla.

Table A- 19. Absolute Difference - Measured vs Calculated Shoreline Change Rates

R-Mon	Absolute Difference Between Measured and Calculated Shoreline Change Rates (feet/year)									
	K=2.0	K=2.2	K=2.4	K=2.6	K=2.8	K=3.0	K=3.2	K=3.4	K=3.6	K=3.8
R-11	12	12	12	13	13	13	13	13	14	14
R-12	3	3	4	5	5	6	6	6	7	7
R-13	9	8	7	6	6	5	5	4	4	3
R-14	16	15	14	13	12	12	11	10	10	9
R-15	16	15	14	13	12	12	11	10	10	9
R-16	1	2	3	4	5	5	6	7	7	8
R-17	0	1	2	3	3	4	5	6	6	7
R-18	5	5	4	3	2	1	1	0	1	1
R-19	9	8	7	6	6	5	4	3	3	2
R-20	5	5	4	3	2	1	1	0	1	1
R-21	3	2	1	1	0	1	1	2	3	3
R-22	1	2	2	3	4	4	5	5	6	6
R-23	4	5	5	6	6	6	7	7	8	8
R-24	8	9	9	9	9	10	10	10	10	10
Averages:										
North (R-11 to R-15)	11	11	10	10	10	9	9	9	9	8
South (R-16 to R-24)	4	4	4	4	4	4	4	4	5	5
R-16 to R-22	3.59	3.44	3.30	3.17	3.08	3.16	3.23	3.30	3.72	4.14

6.3.2.4.1 Shoreline Change Rates

Table A- 20 provides the final parameters for determining shoreline change rates for Gasparilla

Table A- 20. Final Parameters for Determining Shoreline Change

Shoreline Change Key Input Parameters		
Breaker height	H_b	1.2 feet
Angle of wave approach	θ	45°
Optimized sediment transport proportionality factory	K	2.8
Breaking wave height proportionality factor	λ	0.78
Specific gravity of sediment (quartz sand)	s	2.65
Porosity of sediment (quartz sand)	p	0.4

Figure A- 47 shows the annual post-nourishment shoreline change rates (planform rates) from Larson et al. Because the Larson et al. model is the closest in formulation to the GENESIS model traditionally used in more complex applications, it is considered to be an appropriate one-line model for use with the Gasparilla project.

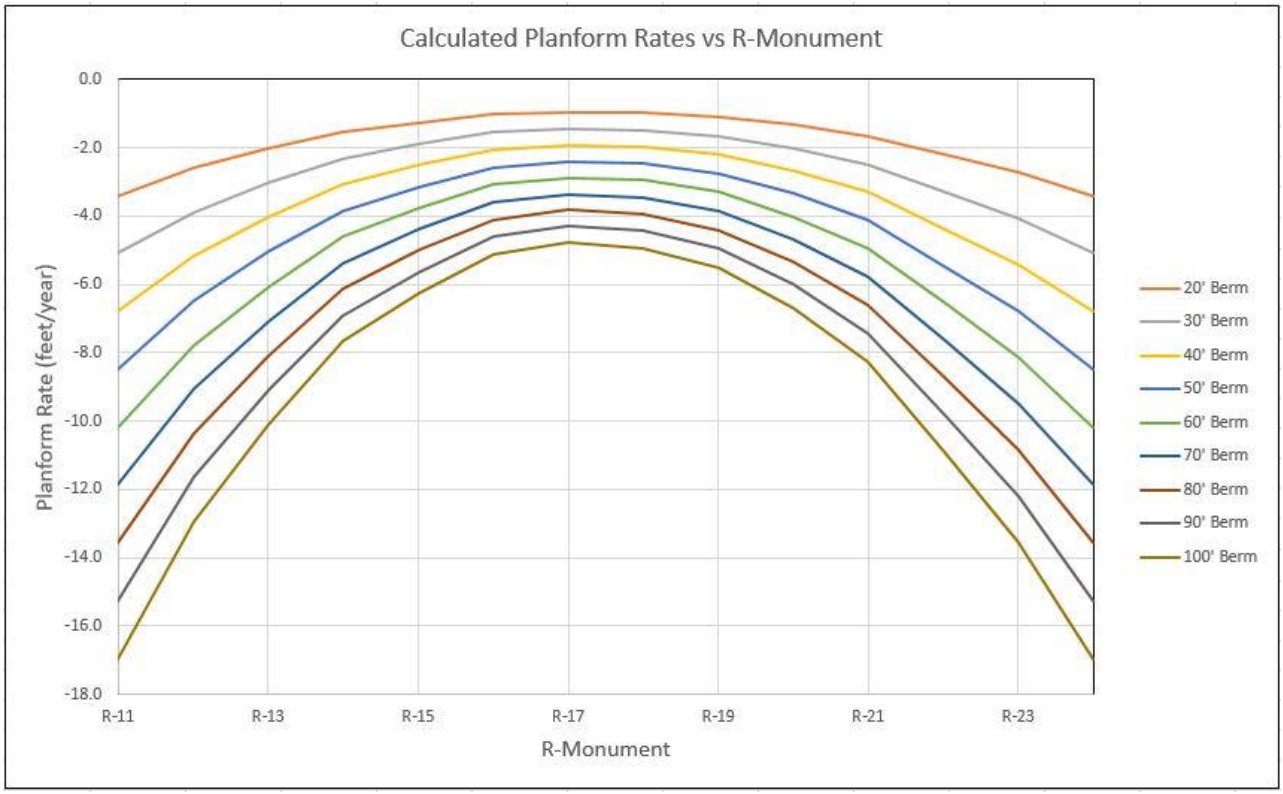

Figure A- 47. Calculated Planform Rates from Larson et al.

6.3.3 Performance

The project induced shoreline change rates calculated using the one-line model do not take into account the improved performance of beach nourishments projects that comes with project maturation. That is, theory and beach nourishment experience has shown that dispersion losses at a beach nourishment project tend to decrease with the number of project nourishments. Neither does Beach-*fx* factor in this phenomena. In order to prevent underestimating project performance and benefits, early Beach-*fx* users from within the coastal engineering community of practice determined that based on the behavior of previous storm damage reduction projects along the coasts of Florida, it can be assumed for the sake of this study that there will be a 20% reduction in shoreline change rates following each consecutive renourishment cycle.

6.3.4 Post Storm Berm Recovery

Post storm recovery of eroded berm width after passage of a major storm is a recognized process. Although present coastal engineering practice has not yet developed a predictive method for estimating this process, it is an important element of post-storm beach morphology. Within Beach-*fx*, post-storm recovery of the berm is represented in a procedure in which the user specifies the percentage of the estimated berm width loss during the storm that will be recovered over a given recovery interval. It is important to note that the percentage itself is not a "stand alone" parameter that is simply applied during the post storm morphology computations. The percentage of berm recovery is estimated prior

to model calibration and becomes a tunable calibration parameter to ensure model convergence (when the model reproduces the target erosion rates as discussed in Section 6.3.2 Applied Shoreline Change).

Based on recommendations by the model developer regarding Florida shorelines, review of available historical FDEP profiles that would qualify as pre- and post- storm, and successful model calibration a recovery percentage of 90% over a recovery interval of 21 days was determined to be appropriate for Lee County.

6.4 Economic Evaluation

The Beach-*fx* model analyzes the economics of shore protection projects based on the probabilistic nature of storm associated damages to structures in the project area. Damages are treated as a function of structure location and construction, the intensity and timing of the storms, and the degree of protection that is provided by the natural or constructed beach. Within the model, damages are attributed to three mechanisms:

- Erosion (through structural failure or undermining of the foundation)
- Flooding (through structure inundation levels)
- Waves (though the force of impact)

Although wind may also cause shoreline damage, shore protection projects are not designed to mitigate for impacts due to wind. Therefore, the Beach-*fx* model does not include this mechanism.

Damages are calculated for each model reach, lot, and damage element following each storm that occurs during the model run. Erosion, water level, and maximum wave height profiles are determined for each individual storm from the lookup values in the previously stored SRD. These values are then used to calculate the damage driving parameters (erosion depth, inundation level, and wave height) for each damage element.

The relationship between the value of the damage driving parameter and the percent damage incurred from it is defined in a user-specified "damage function". Two damage functions are specified for each damage element, one to address the structure and the other to address its contents. Damages due to erosion, inundation, and wave attack are determined from the damage functions and then used to calculate a combined damage impact that reduces the value of the damage element. The total of all FWOP damages is the economic loss that can be mitigated by the shore protection project.

A thorough discussion of the economic methodology and processes of Beach-*fx* can be found in the **Economics Appendix.**

6.5 Management Measures

Shoreline management measures that are provided for in the Beach-*fx* model are emergency nourishment and planned nourishment.

6.5.1 Emergency Nourishment

Emergency nourishments are generally limited beach fill projects conducted by local governments in response to storm damage. The Gasparilla Segment of Lee County does not have a consistent history of emergency nourishment in response to storm related erosion. Therefore, no emergency management measure was included in the Gasparilla Beach-*fx* analysis.

6.5.2 Planned Nourishment

Planned nourishments are handled by the Beach-*fx* model as periodic events based on nourishment templates, triggers, and nourishment cycles. Nourishment templates are specified at the model reach level and include all relevant information such as order of fill, dimensions, placement rates, unit costs, and borrow-to-placement ratios. Planned nourishments occur when user defined nourishment triggers are exceeded and a mobilization threshold volume is met. At a pre-set interval, all model reaches which have been identified for planned nourishment are examined. In reaches where one of the nourishment threshold triggers is exceeded, the required volume to restore the design template is computed. If the summation of individual model reach level volumes exceeds the mobilization threshold volume established by the user, then nourishment is triggered and all model reaches identified for planned nourishment are restored to the nourishment template.

6.5.3 Nourishment Templates

For Gasparilla, the Beach-fx nourishment template must reflect the existing federally authorized design template as well as the sacrificial volume that is traditionally referred to as "Advance Fill". Based upon the project authorization, the design template consists of a 20 foot extension of the GRR project baseline at +5 ft-MLW (+3.75 ft-NAVD88). The authorized advance fill of 540,000 cubic yards was necessary to maintain project dimensions over the seven-year renourishment interval. This volume is approximately equivalent to the "60'" nourishment Beach-*fx* template. Table A- 21 provides the authorized berm dimensions (20 foot seaward of the GRR baseline) as well as the total renourishment template berm dimensions for a number of "advance fill" alternatives. Note that a 20 foot extension of the GRR project baseline is not necessarily equivalent to a 20 foot authorized berm width. Extending 20 feet seaward of the baseline produces authorized berm widths ranging from 0 feet to 206 feet measured from the toe of the dune.

It is the purpose of the 934 analysis to determine if the authorized design template (20 foot extension of the GRR baseline) plus the "advance fill" volume currently being placed (equivalent of the 60' nourishment template) remains economically justified. However, should the existing project no longer be justified due to changing environmental conditions, "advance fill" volumes can be optimized (under 934 Guidance). Therefore, additional "advance fill" volumes were also evaluated in case such optimization would be required. Each Gasparilla nourishment template reflects the 20 foot extension of the GRR baseline (authorized design template) plus a variable volume of advance fill.

Table A- 21 summarizes the fill alternatives, including the authorized berm width and the total template berm width that comprise each of the alternative templates.

Table A- 21. Nourishment Templates

Beach-fx Reach	Authorized Berm Width (feet)	Renourishment Template (Relative to Authorized Berm Width)								
		20' Berm (feet)	30' Berm (feet)	40' Berm (feet)	50' Berm (feet)	60' Berm (feet)	70' Berm (feet)	80' Berm (feet)	90' Berm (feet)	100' Berm (feet)
LG11	0	20	30	40	50	60	70	80	90	100
LG12	128	148	158	168	178	188	198	208	218	228
LG13	34	54	64	74	84	94	104	114	124	134
LG14	2	22	32	42	52	62	72	82	92	102
LG15	3	23	33	43	53	63	73	83	93	103
LG16	206	226	236	246	256	266	276	286	296	306
LG17	124	144	154	164	174	184	194	204	214	224
LG18	5	25	35	45	55	65	75	85	95	105
LG19	11	31	41	51	61	71	81	91	101	111
LG20	19	39	49	59	69	79	89	99	109	119
LG21	15	35	45	55	65	75	85	95	105	115
LG22	28	48	58	68	78	88	98	108	118	128
LG23	17	37	47	57	67	77	87	97	107	117
LG24	17	37	47	57	67	77	87	97	107	117

6.5.3.1 Nourishment Distance Triggers and Mobilization Threshold

Beach-*fx* planned nourishment templates have three nourishment distance triggers (1) berm width, (2) dune width, and (3) dune height. Each distance trigger is a fractional amount of the corresponding nourishment template dimension. When the template dimensions fall below the fraction specified by the trigger, a need for renourishment is indicated. For any project template, the berm width trigger can be set such that a minimum berm width (what has been traditionally referred to as a "design berm") can be maintained, allowing the remainder of the template to act as sacrificial fill (traditional "advance fill"). The Gasparilla study alternatives each included a single maintained berm option (20 foot extension of the GRR baseline) and variable amounts of sacrificial fill. Because the width of the berm governs the alternatives, the dune width and dune height triggers were set to allow minimal erosion of the dune itself. For all cases that include a berm, the dune width and dune height triggers were set to 0.99 (1% loss of width allowed) and 0.90 (10% loss of height allowed), respectively.

The mobilization threshold (minimum nourishment volume required to trigger a nourishment cycle) was set to be approximately the volume of the sacrificial portion of the nourishment template. This ensures that both the berm width trigger and mobilization threshold act together to maintain the desired "design berm" for each alternative. Distance Triggers and Mobilization thresholds for the Gasparilla project alternatives are presented in greater detail under Section 6.6: **Beach-fx Project Alternatives**.

6.6 Beach-*fx* Project Alternatives

In order to fully evaluate the authorized as well as optimized alternative protective beach templates for Gasparilla, nine alternatives were developed by combining the design reaches and nourishment templates discussed previously (Table A- 21). Additionally, for each template the authorized ("design") berm width (as described in the previous section) was ensured through a combination of distance triggers and volume threshold values. Table A- 22 provides each of the project alternatives as well as corresponding berm distance triggers and volume thresholds. As discussed previously, dune width and dune height distance triggers were set to 0.99 and 0.90, respectively for all alternatives.

Table A- 22. Beach-*fx* Berm Distance Triggers and Threshold Volumes

Alternative Template	Volume Threshold (cubic yards)	Distance Trigger (Berm) Required to Maintain Authorized Design Berm													
		LG11	LG12	LG13	LG14	LG15	LG16	LG17	LG18	LG19	LG20	LG21	LG22	LG23	LG24
20' Berm	200,000	0.00	0.86	0.63	0.09	0.13	0.91	0.86	0.20	0.35	0.49	0.43	0.58	0.46	0.46
30' Berm	300,000	0.00	0.81	0.53	0.06	0.09	0.87	0.81	0.14	0.27	0.39	0.33	0.48	0.36	0.36
40' Berm	400,000	0.00	0.76	0.46	0.05	0.07	0.84	0.76	0.11	0.22	0.32	0.27	0.41	0.30	0.30
50' Berm	500,000	0.00	0.72	0.40	0.04	0.06	0.80	0.71	0.09	0.18	0.28	0.23	0.36	0.25	0.25
60' Berm	600,000	0.00	0.68	0.36	0.03	0.05	0.77	0.67	0.08	0.15	0.24	0.20	0.32	0.22	0.22
70' Berm	700,000	0.00	0.65	0.33	0.03	0.04	0.75	0.64	0.07	0.14	0.21	0.18	0.29	0.20	0.20
80' Berm	800,000	0.00	0.62	0.30	0.02	0.04	0.72	0.61	0.06	0.12	0.19	0.16	0.26	0.18	0.18
90' Berm	900,000	0.00	0.59	0.27	0.02	0.03	0.70	0.58	0.05	0.11	0.17	0.14	0.24	0.16	0.16
100' Berm	1,000,000	0.00	0.56	0.25	0.02	0.03	0.67	0.55	0.05	0.10	0.16	0.13	0.22	0.15	0.15

6.7 Recommendation

Beach-*fx* modeling and economic analysis determined that the existing project is economically justified based on current guidelines and policies and that the "60' Berm" template is the most economical alternative for the optimized sacrificial fill (see the Economics Appendix).

6.8 Value Engineering

A Value Management Plan (VMP) has been prepared in order to document this study's compliance with Value Engineering regulations. The VMP documents concurrence of the VE strategy of "No Further Action" for the Gasparilla Island 934 Report. The VMP can be found in Sub-Appendix A-2: Value Engineering.

7 Design Criteria

Based on analysis and modeling efforts documented in the 2000 GRR, the present authorized plan for the Lee County Gasparilla Island Segment was formulated. Updated modeling and economic analysis have confirmed that the present authorized plan is still justified with a sacrificial fill volume equivalent that the authorized GRR fill template. A detailed description of the plan is presented in the following sections.

7.1 Project Length

The authorized project consists of 2.8 miles of shoreline along the south end of Gasparilla Island. The southern limit of the beachfill is located at FDEP monument R-24. A 600 foot taper then connects the fill with the existing southern shoreline. The northern limit is defined as FDEP monument R-11. A 1,200 foot taper section connects the fill to the existing northern shoreline.

7.2 Project Baseline

The project consists of a 20 foot extension of the project baseline as established by the 2000 General Reevaluation Report (GRR). The baseline over most of the project is coincident with the 1995 MHW shoreline. However, within the region from R-15 to R-17 an extension of the project baseline was incorporated in the design based on modeled results. This extension, required to straighten a deficit in the shoreline position, consisted of 5 feet at R-15, 84 feet at R-16, and 14 feet at R-17. Table A- 23 defines the location of the established project baseline relative to R-monument.

7.3 Berm Elevation

Based on the existing natural berm elevation, the authorized design berm was placed at +5 ft-MLW (+3.75 ft-NAVD88).

Table A- 23. Project Baseline Relative to R-monument

R-monument	Distance Relative to R-monument (ft)
R-11	-4
R-12	+129
R-13	+18
R-14	-18
R-15	-12
R-16	+317
R-17	+257
R-18	+300
R-19	+100
R-20	+248
R-21	+125
R-22	+368
R-23	+51
R-24	+72

7.4 Berm Widths

Based on modeling and economic analysis described in the 2000 GRR, the authorized fill consists of a 20 foot extension of the project baseline while providing additional material (traditionally referred to as "Advance Fill") to offset erosive losses over an estimated (based on the 2000 GRR analyses) seven years between renourishments. Note that the 20 foot extension of the baseline does not translate into a 20 foot berm width. Due to the layout of the shoreline and dune system, the authorized extension of the baseline results in actual berms widths ranging from 0 (R-11) to 200+ feet (R-16). These variable berm widths can be seen in Figure A- 31 to Figure A- 44 (Section 6.3.1.3: **Future With-Project (FWP) Profiles**)

7.5 Beach Slopes

For Gasparilla Island, the native beach slope was estimated as 1 (vertical) on 15 (horizontal) above MLW and 1 on 25 below MLW. The construction slope is assumed to be 1 on 10. Based on these dimensions,

the 60' Berm alternative will have the same project footprint as presented in the 2000 GRR (Figure A- 48 to Figure A- 52)

7.6 Project Volumes and Renourishment Interval

Shoreline response modeling and economic analyses detailed in the 2000 GRR resulted in an authorized template that consisted of a 20 foot extension of the specified project baseline. It was estimated that initial construction would require approximately 790,000 cubic yards, followed by an additional 540,000 cubic yards of renourishment at seven year intervals.

As part of the current 934 study, shoreline response modeling and economic analyses was updated to current practices, including the application of the Beach-*fx*. While the dimensions of the authorized design template (20 foot extension of the project baseline) remained constant as required for 934 compliance, project volumes and renourishment requirements estimated using current risk based methodologies differed from original 2000 GRR estimates.

Table A- 24 provides Beach-*fx* project volumes and renourishment intervals for the authorized project for each of the three sea level change scenarios. Note that while the average renourishment volume increases from approximately 540,000 cubic yards to approximately 617,000 cubic yards, the average expected renourishment interval increases from seven years to 22 years.

Table A- 24. Beach-*fx* Project Volumes and Renourishment Interval: Authorized Project

Project Volumes (Over 100 Beach-fx Life-cycle Iterations)				
Sea level change Case	Volume Description	Initial Fill Volume (cubic yards)	Renourishment Interval (years)	Average Volume per Interval (cubic yards)
Base	Min - Max	596,700 – 699,600	15 – 29	601,700 – 676,700
	Average	624,500	22	617,200
Intermediate	Min - Max	597,100 – 727,200	14 – 28	606,100 – 754,700
	Average	633,500	21	665,600
High	Min - Max	598,400 – 726,800	10 - 26	605,100 – 781,200
	Average	643,100	18	655,400

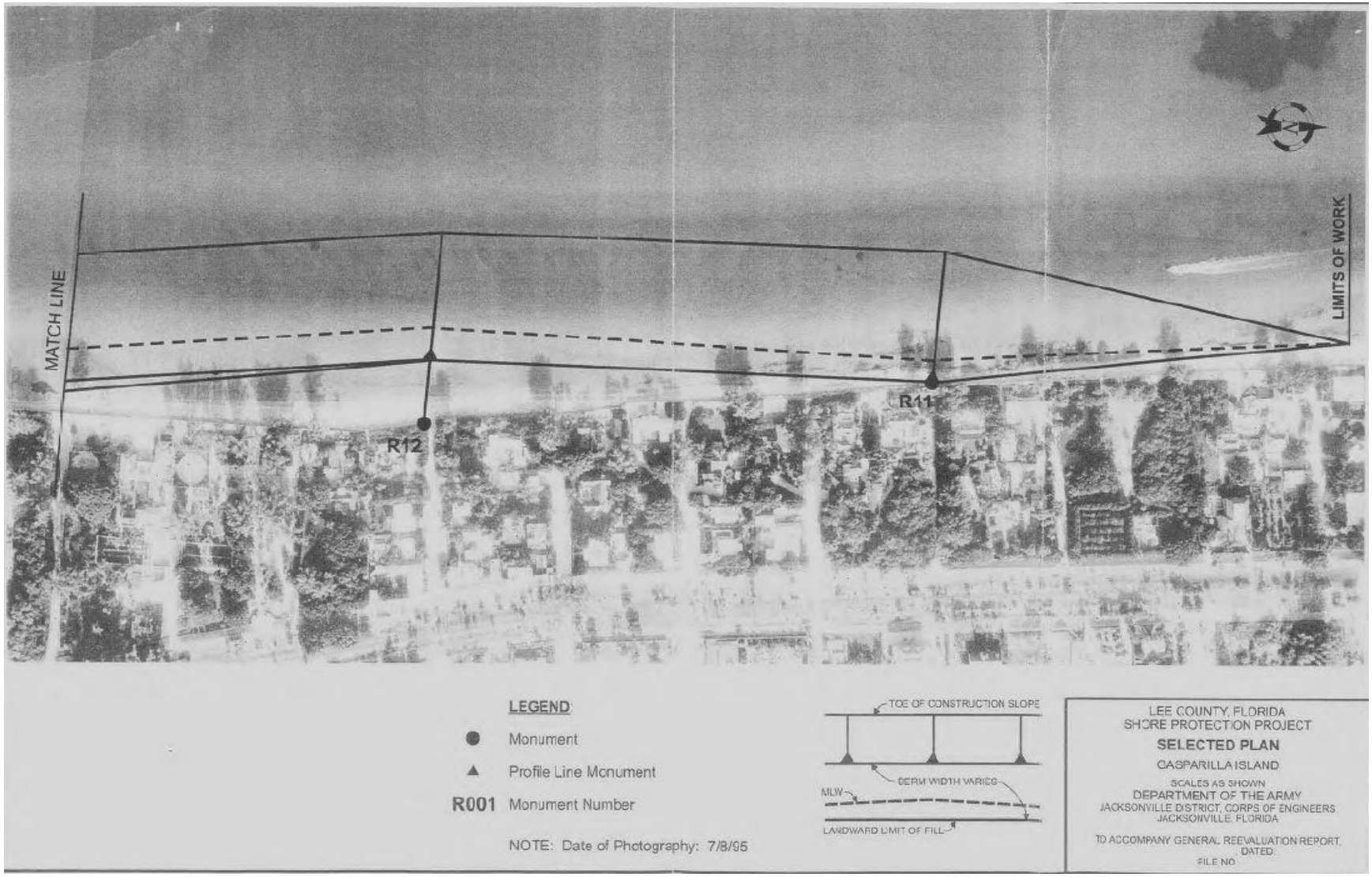

Figure A- 48. Project Footprint (R-11 to R-12)

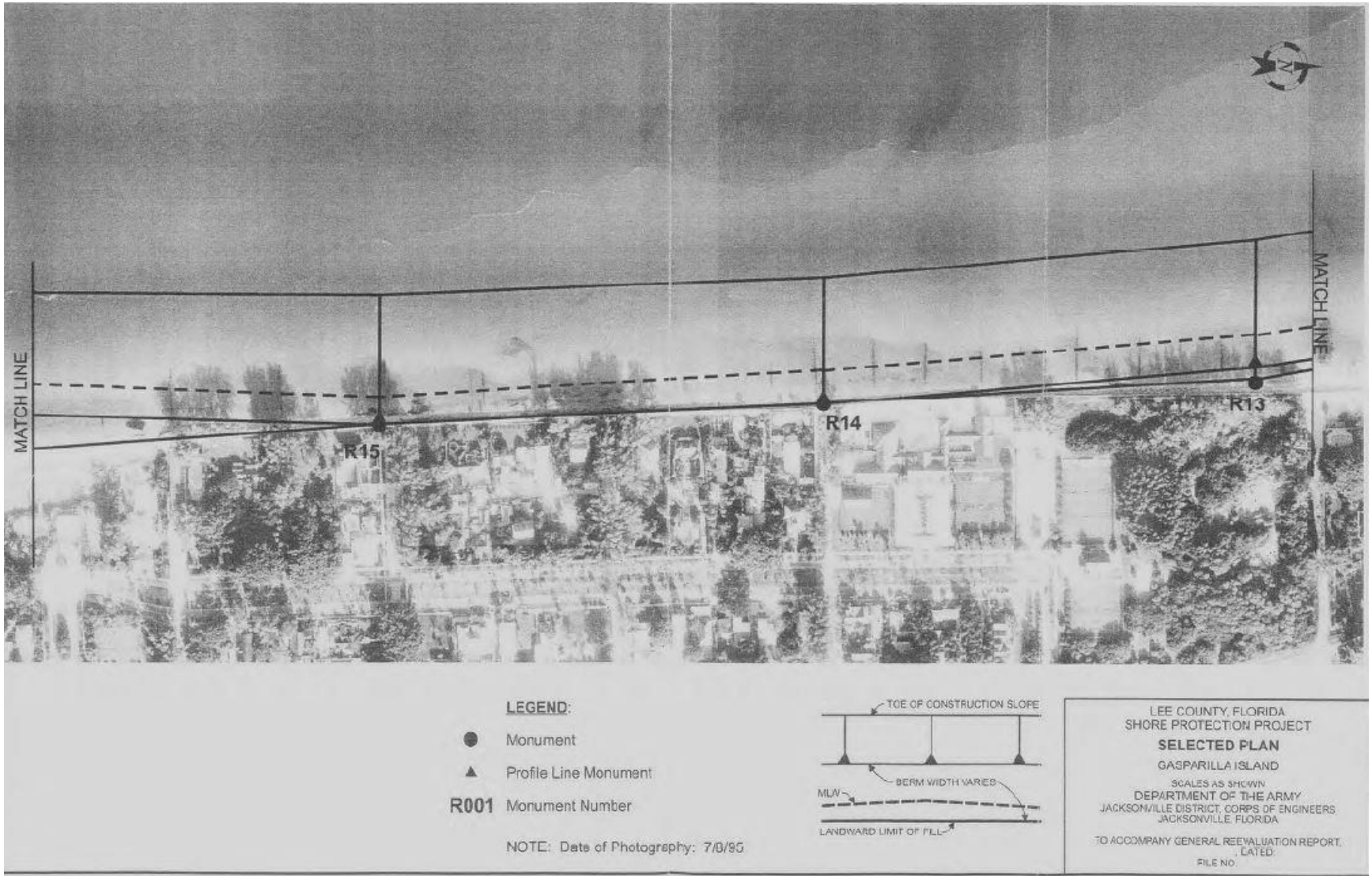

Figure A- 49. Project Footprint (R-13 to R-15)

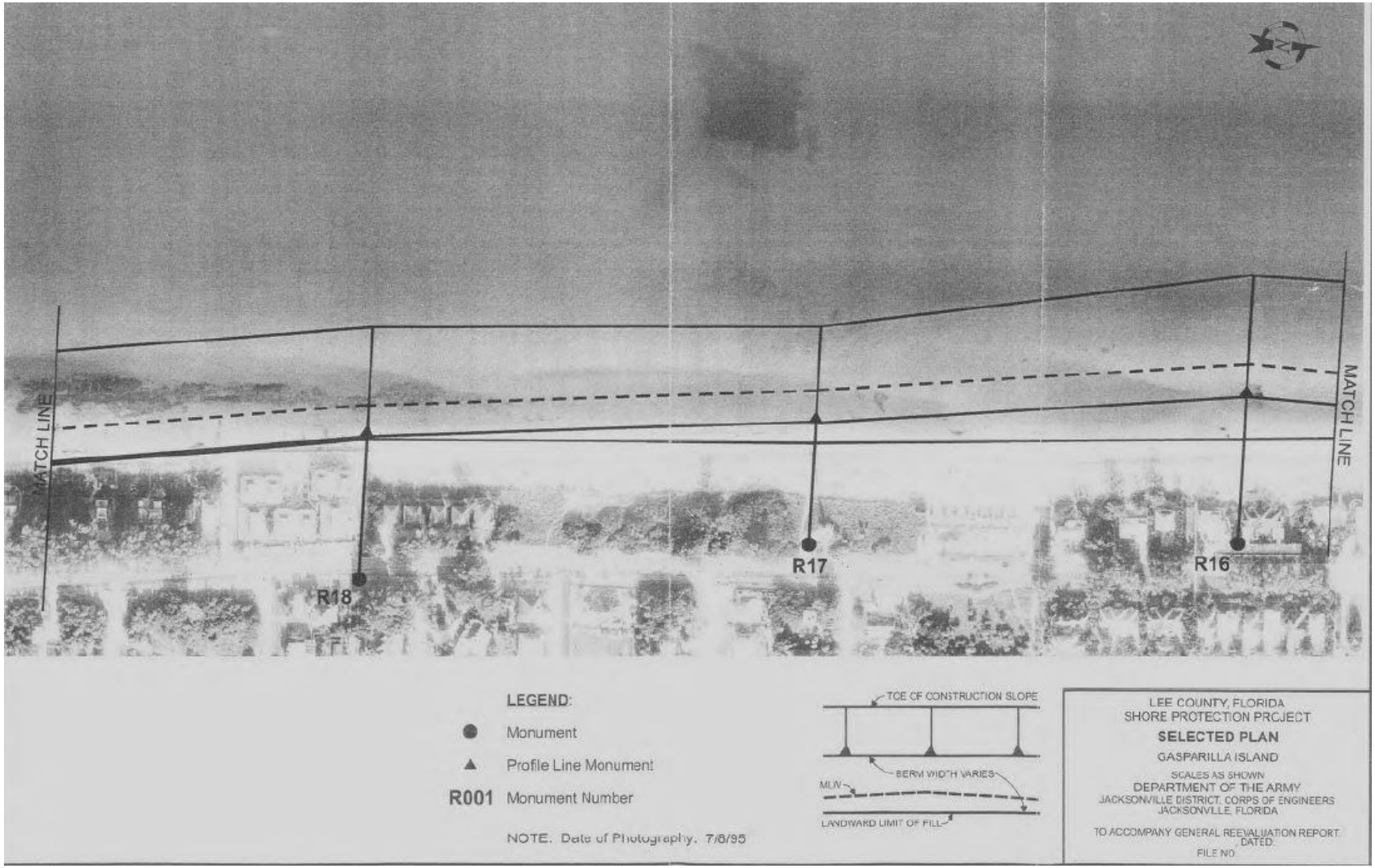

Figure A- 50. Project Footprint (R-16 to R-18)

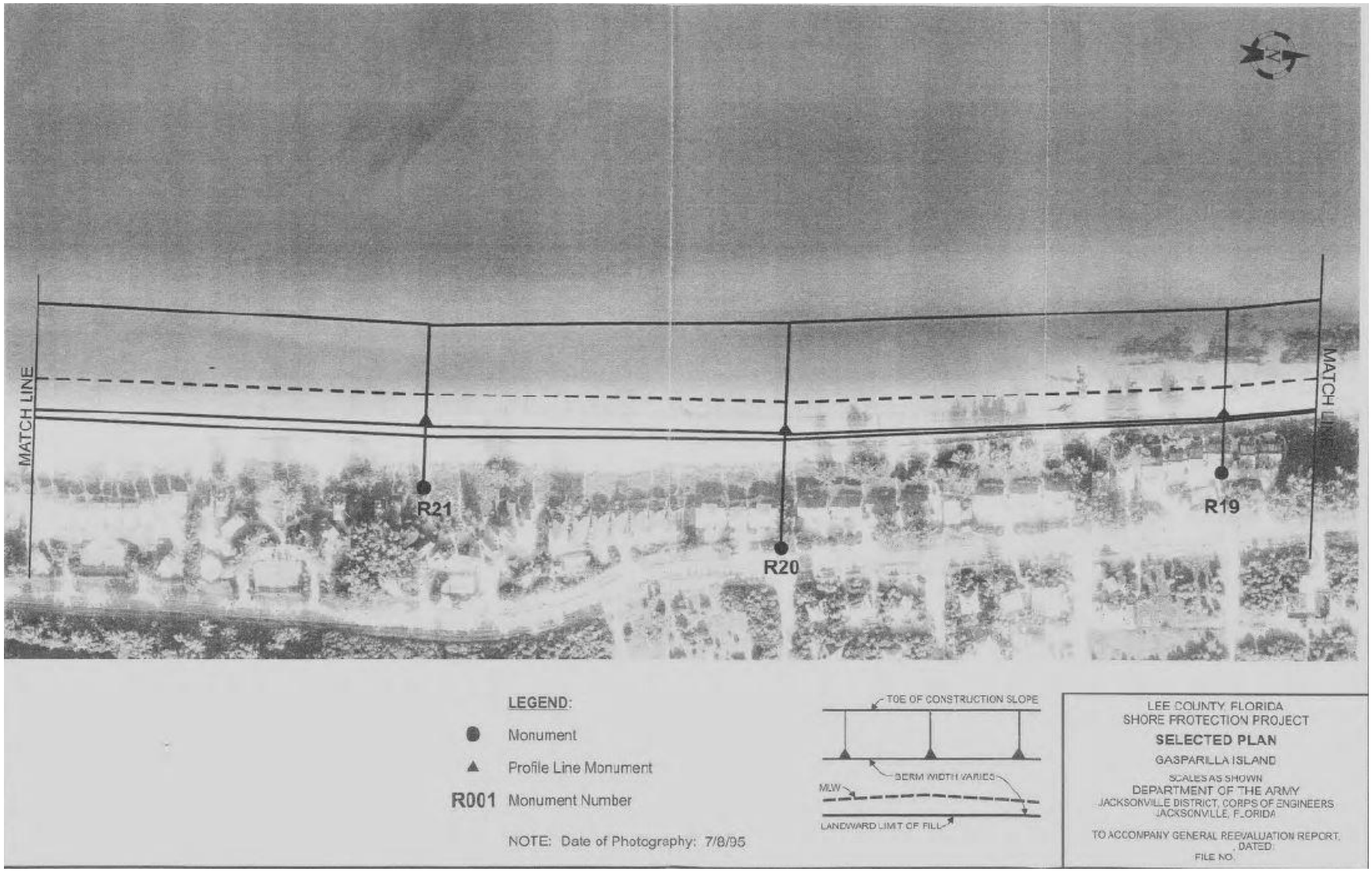

Figure A- 51. Project Footprint (R-19 to R-21)

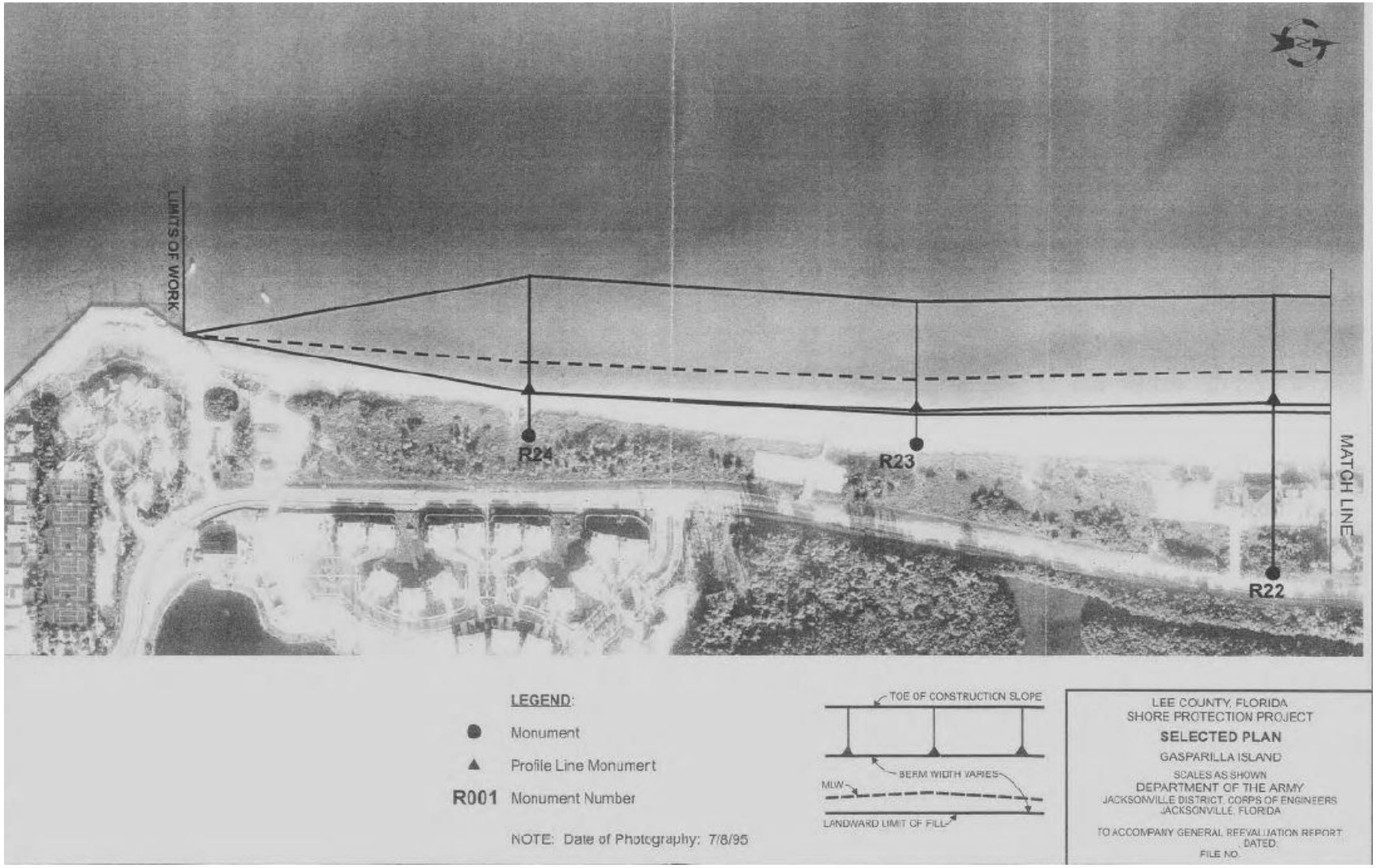

Figure A- 52. Project Footprint (R-22 to R-24)

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Sub-Appendix A-1

Lee County, Gasparilla Island, Section 934

SBEACH Calibration and Verification

Lee County, Gasparilla Island, Section 934

SBEACH Calibration and Verification

Project Site

The Lee County, Gasparilla Island Hurricane Storm Damage Reduction (HSDR) Project is located at the southern end of Gasparilla Island at the northern end of Lee County, Florida between R-monuments R-11 and R-24 (Figure 1).

Background

Lee County, Gasparilla Island was originally authorized after completion of a 1999 General Re-evaluation Report (GRR). As part of the GRR, a complete SBEACH analysis, including calibration and verification was conducted. For the present Section 934 evaluation, it was determined that the SBEACH calibration parameters from the GRR would be assessed to determine if they still represented processes within the project area. The recalibration, resulting in the resetting of several parameters, was confirmed with model verification runs. Both the recalibration and verification used updated (post-GRR) storm data sets.

Calibration/Verification Storms

Four storms effecting the project area were identified for possible application to the calibration (and verification) of the SBEACH model: Tropical Storm Gabrielle (September 2001), Hurricane Charley (August 2004), Tropical Storm Barry (May 2007), and Tropical Storm Fay (August 2008). Due to the availability of pre- and post-storm profiles as well as measured water level data, Tropical Storm Barry and Tropical Storm Fay were selected for model calibration and verification, respectively.

SBEACH Calibration

Pre-storm and Post-storm Profiles

For the verification phase of the analysis, pre-storm and post-storm shoreline data were obtained from USACE post-fill surveys. The pre-storm survey was conducted in April 2007 soon after completion of the 2007 renourishment of the project. The post-storm survey was conducted in May 2008, approximately 1-year following renourishment. Tropical Storm Barry impacted the area in May of 2007.

Due to the fact that Tropical Storm Barry occurred soon after renourishment, it is possible that a comparison of pre-storm and post-storm profiles reflected not only natural background and storm induced erosion, but also stabilization losses as the profiles equilibrated from the construction template. However, an examination of post-construction and several years of monitoring surveys showed little difference in profile slope and overall shape. It was therefore concluded that the

April 2007 profiles were similar enough in shape to an equilibrated profile that they could be used, in conjunction with the May 2008 profiles, for SBEACH verification.

Storm Inputs

The SBEACH calibration storm data set contains wave and water level information ranging from May 30, 2007 to June 6, 2007.

Wave Height and Period

Offshore wave data were obtained from the USACE Wave Information Studies (WIS) database. This database contains wave hindcasts generated using the numerical hindcast model WISWAVE (Hubertz, 1992). Model output for the Gulf of Mexico extends from 1980 to 2012 and includes significant wave height and wave period information among other wave components. Wave heights and wave periods were obtained from WIS station 73285, located at 26.75^{o} N, -82.3^{o} W, approximately 2 miles due west of Gasparilla Island.

Due to the proximity of the selected WIS station to shore, the relatively shallow water depth at the station (16.4 feet), and the virtually flat topography between the station and the seaward end of the pre- and post-storm profiles, it was determined that the WIS wave information could be used directly in the SBEACH model as nearshore wave conditions without transformation.

Figure 2 and Figure 3 show wave height and wave period information from May 30, 2007 to June 6, 2007. Wave data are provided in 1 hour increments.

Wave Direction

Wave angle was set to 0 degrees for the SBEACH analysis.

Water Elevation

Water level information was obtained from the National Data Buoy Center (NDBC) at COMPS (University of South Florida) station BGCF1 (Big Carlos Pass), located approximately 30 miles southeast of Gasparilla Island. Situated in the mouth of the inlet at Big Carlos Pass, this is the nearest station to the project site with open ocean exposure that contains a historical water level record.

Figure 4 shows water level values from May 30, 2007 to June 6, 2007. Water level data in each case are provided in 1 hour increments.

Wind Data

Wind speed and wind direction were assigned values of 0.0 for the SBEACH analysis.

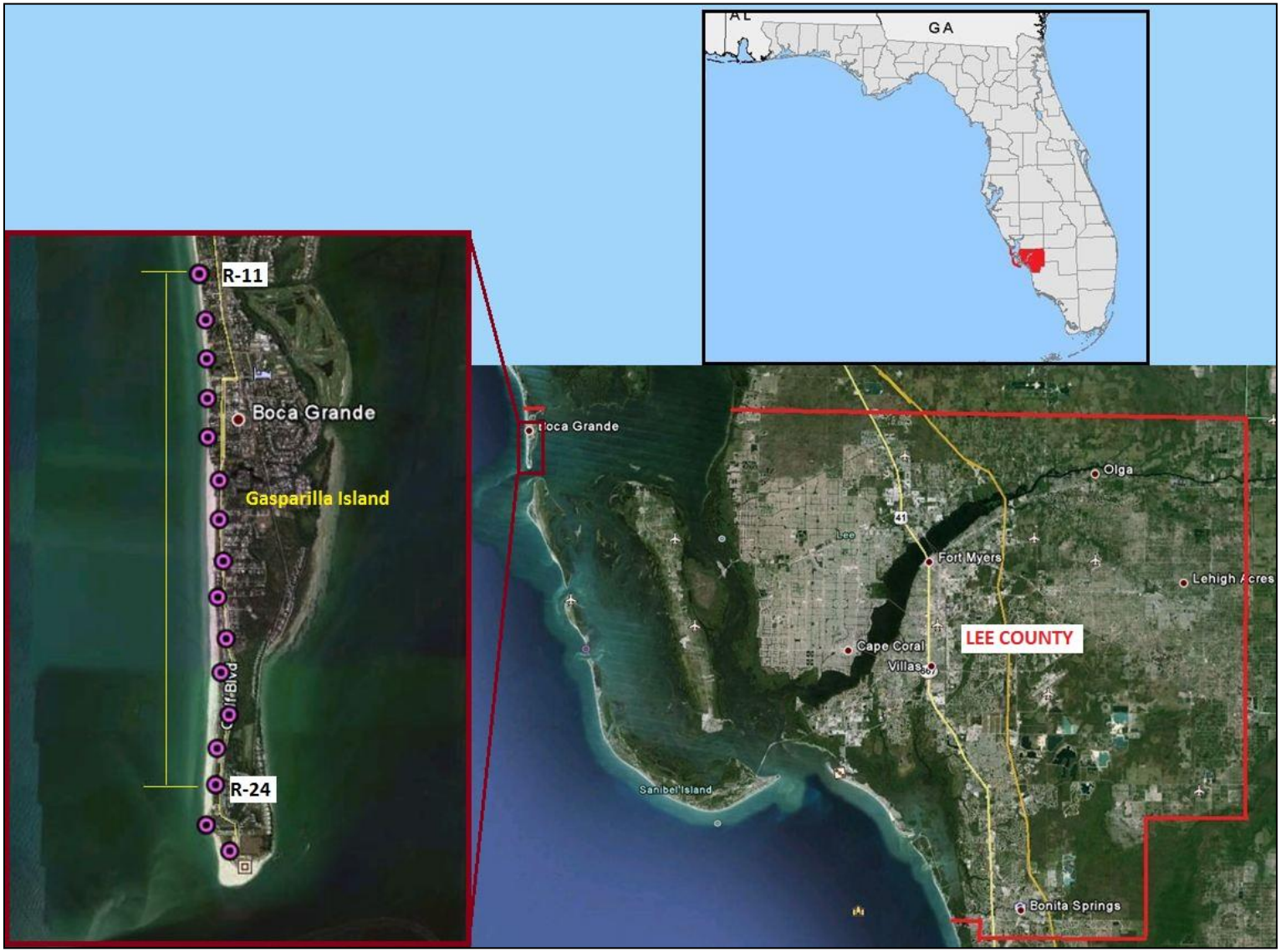

Figure 1. Project Site

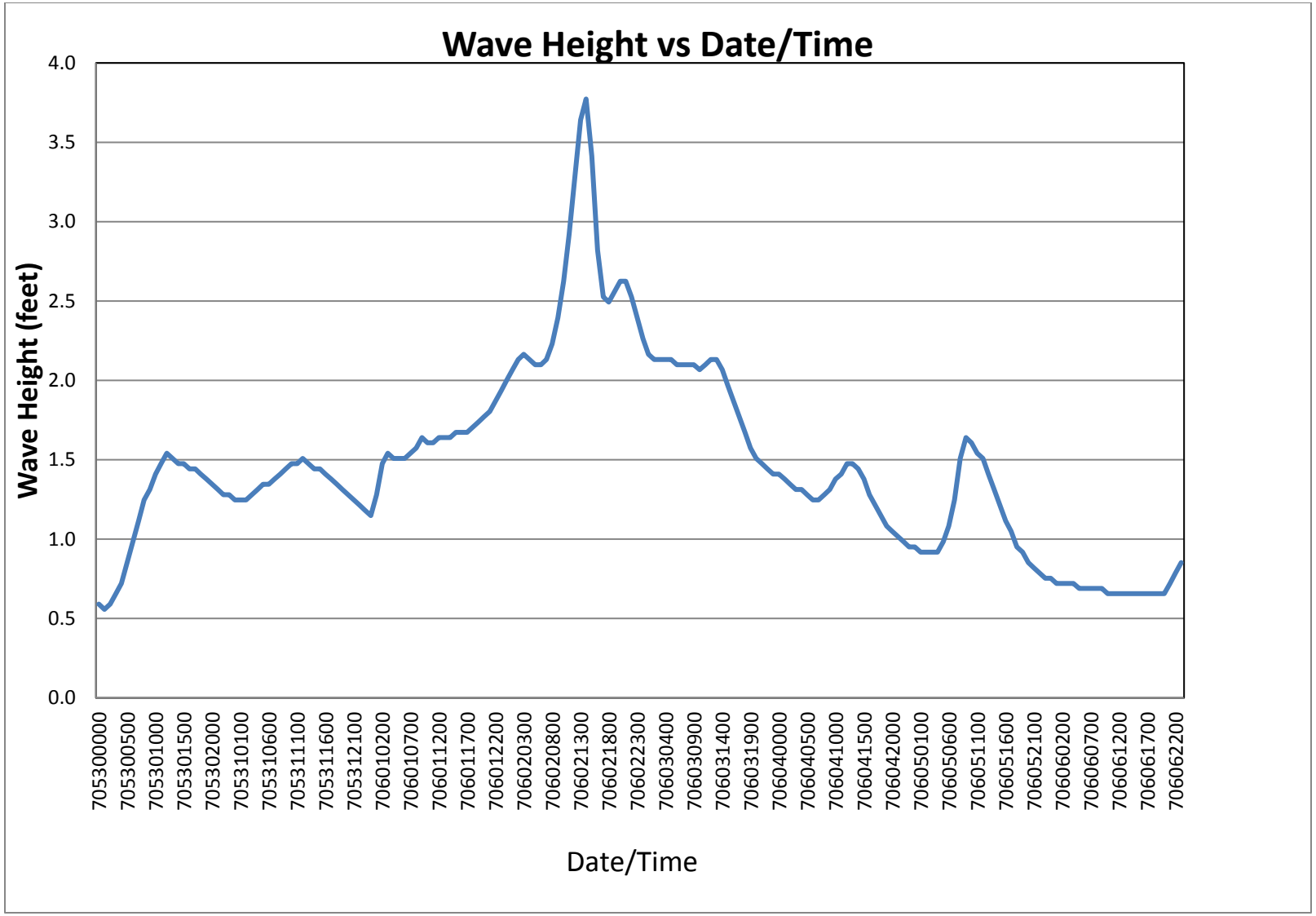

Figure 2. Wave Heights (May 30, 2007 to June 6, 2007)

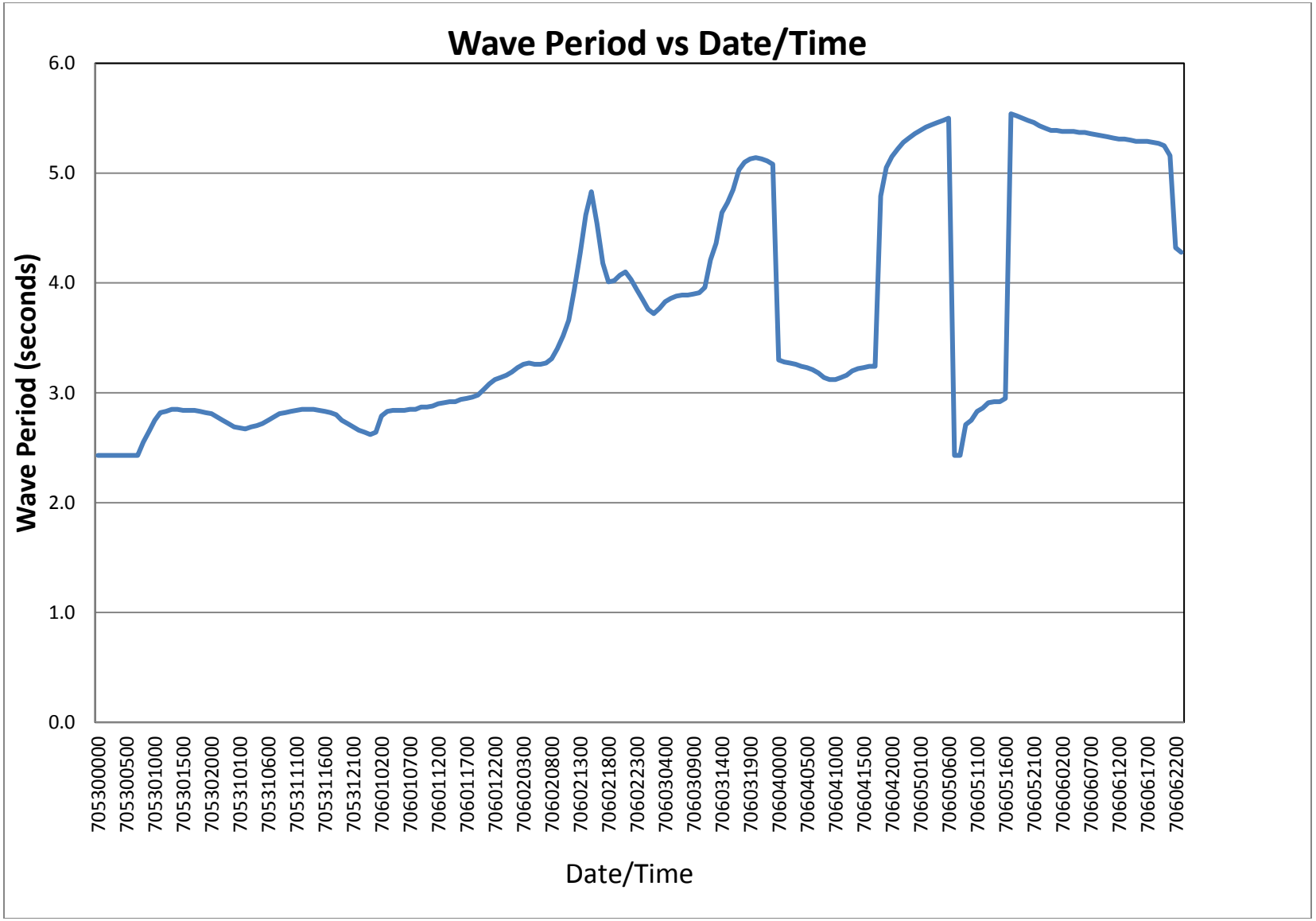

Figure 3. Wave Periods (May 30, 2007 to June 6, 2007)

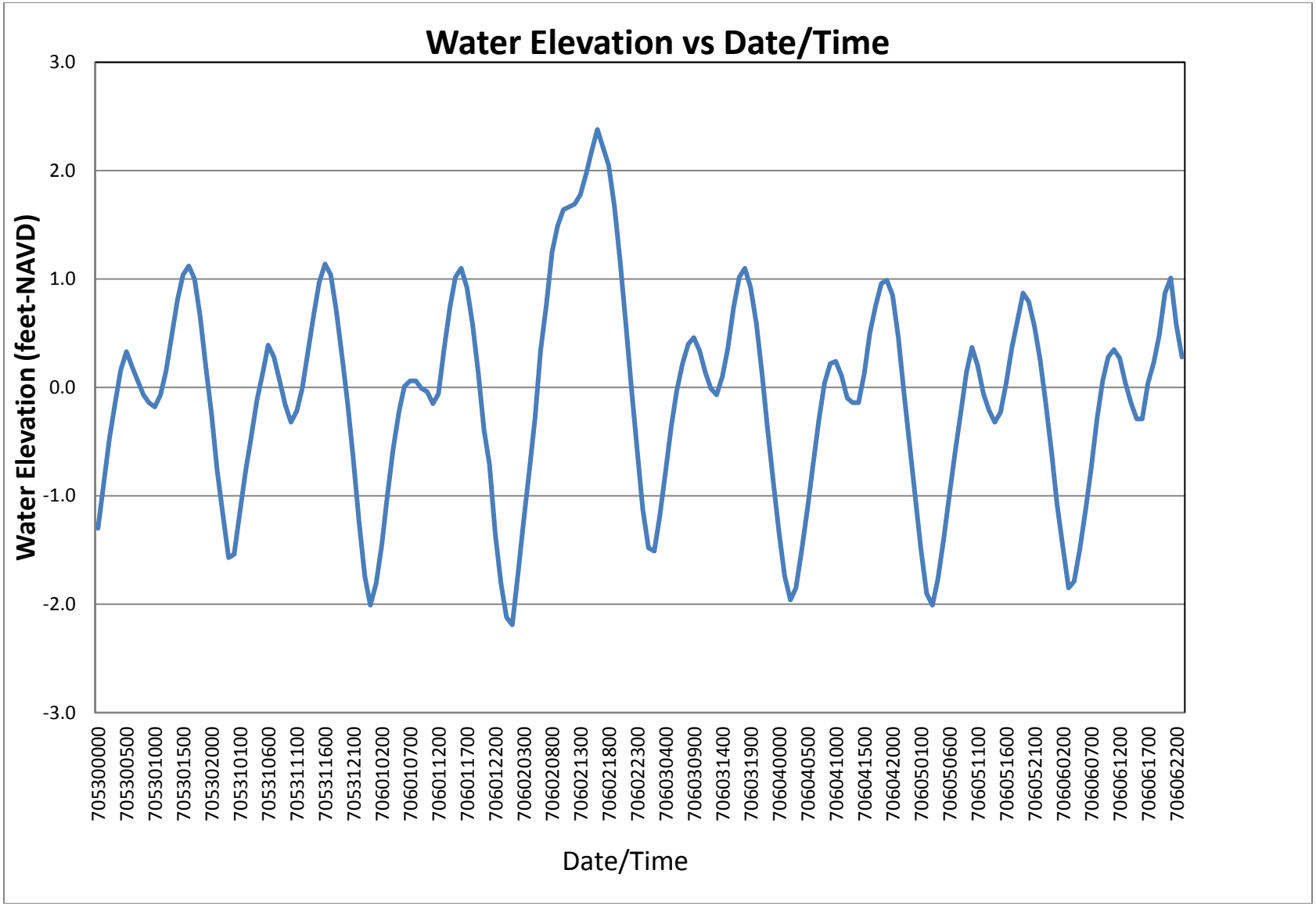

Figure 4. Water Levels (May 30, 2007 to June 6, 2007)

SBEACH Calibration Parameters and Results

The 1999 Lee County, Gasparilla Island GRR provided most of the original SBEACH calibration parameters. However, a number of key parameters were not documented (maximum slope prior to avalanching, overwash transport parameter, and water temperature). Using the original GRR values as a starting point, calibration runs were conducted until remaining parameter values leading to the best fit between final (modeled post-storm) profiles and measured (USACE surveyed post-storm) profiles were identified. Calibration also included evaluation of the original GRR values to determine if they were still applicable. The only change between GRR and final calibration parameters was a 0.001 reduction in the coefficient for slope dependency.

Table 1 provides both the original and the calibration parameters which provided the best fit to measured data in the present study.

Table 1. SBEACH Calibration Parameters for "Best Fit"

Calibration	Landward Surfzone	Grain Size (mm)	Max Slope	Transport Coefficient (m^4/N)	Overwash Transport Param	Coeff. Slope Depend. (m^2/S)	Transport Decay	Water Temp
1999 GRR	1	0.32	---	2.50E-06	---	0.004	0.50	---
2014 Section 934	1	0.32	15	2.50E-06	0.001	0.003	0.50	25

Comparison between final (modeled post-storm) profiles and surveyed (measured) post-storm profiles influenced by Tropical Storm Barry, indicated that the northern profiles (R-11 through R-17) lost material at a rate that could not be duplicated by the SBEACH model. Given the good agreement between modeled and measured profiles in the central and southern region of the project, it was concluded that the northern portion of the project was experiencing end losses that the model could not account for. Due to protruding armor in the proximity of R-25 south of the project, the southern profiles do not experience the same accelerated end losses.

Figure 5 to Figure 9 show calibration results for Hurricane Charley at R-18 through R-22, respectivley.

SBEACH Verification

Pre-storm and Post-storm Profiles

For the verification phase of the analysis, pre-storm and post-storm shoreline data were obtained from USACE post-fill surveys. The pre-storm survey was conducted in May 2008 approximately 1 year after completion of the 2007 renourishment of the project. The post-storm survey was conducted in August 2009, approximately 2 years following renourishment. Tropical Storm Fay impacted the area in August 2008.

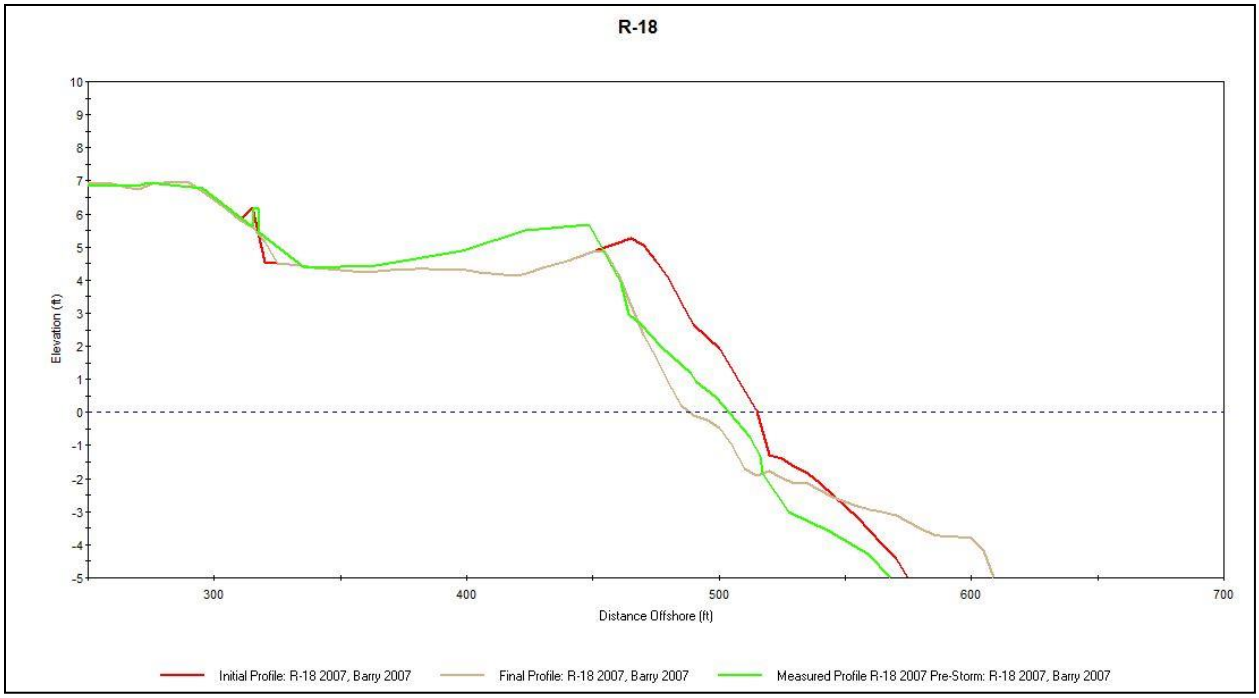

Figure 5. SBEACH Calibration Run (TS Barry), R-18 (Dune to Waterline)

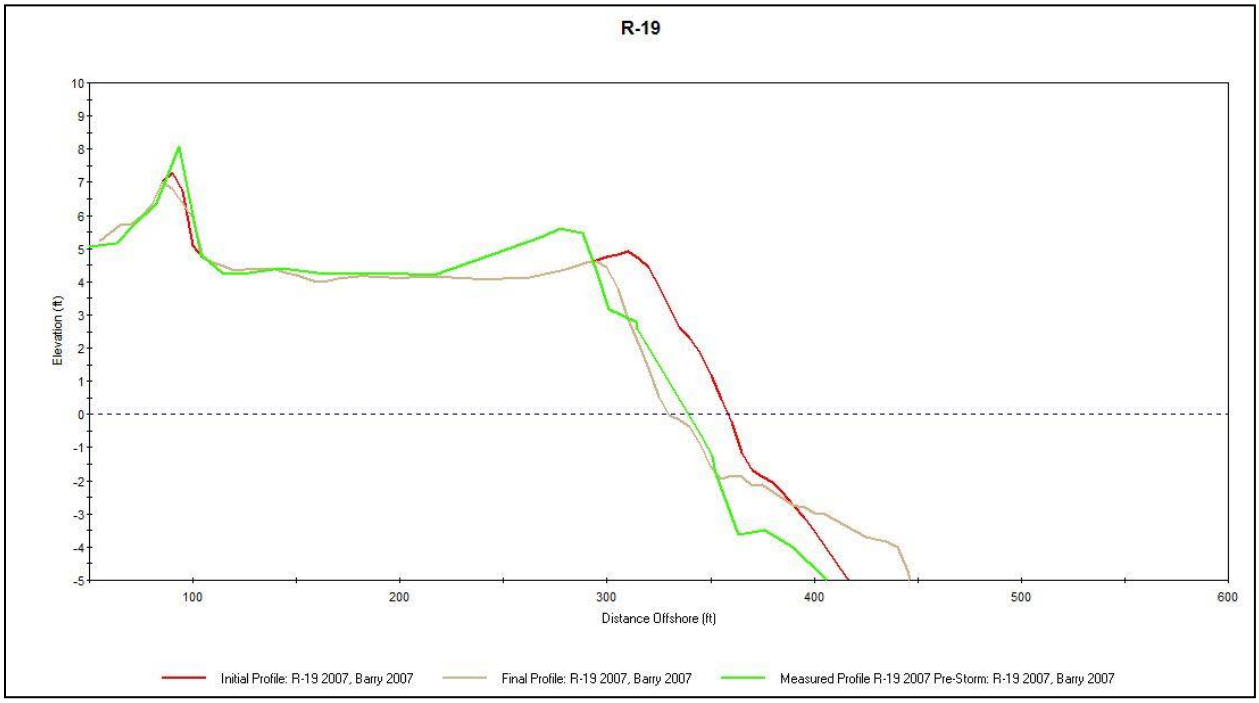

Figure 6. SBEACH Calibration Run (TS Barry), R-19 (Dune to Waterline)

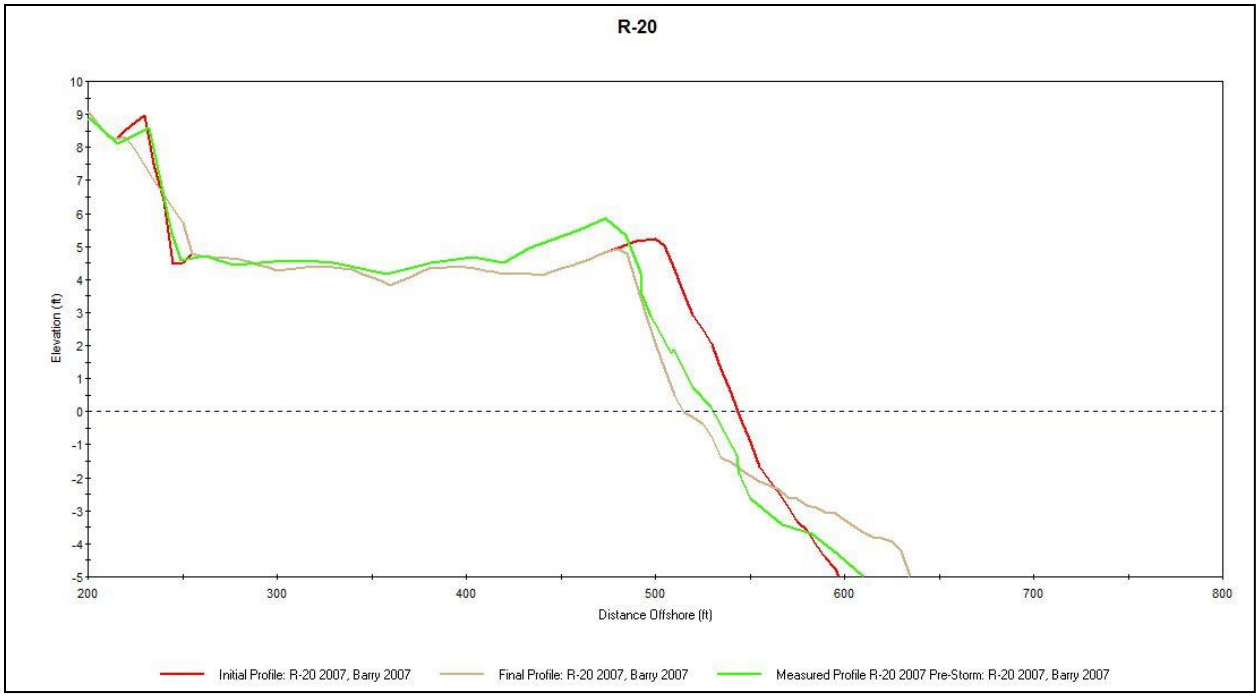

Figure 7. SBEACH Calibration Run (TS Barry), R-20 (Dune to Waterline)

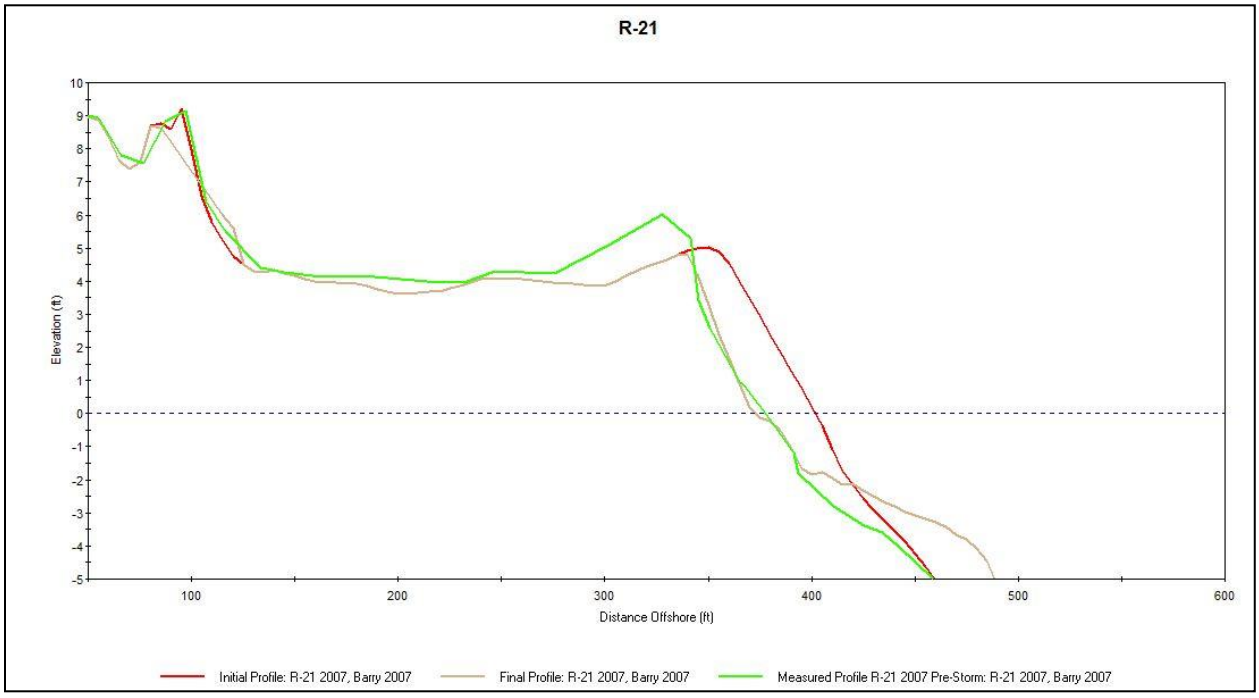

Figure 8. SBEACH Calibration Run (TS Barry), R-21 (Dune to Waterline)

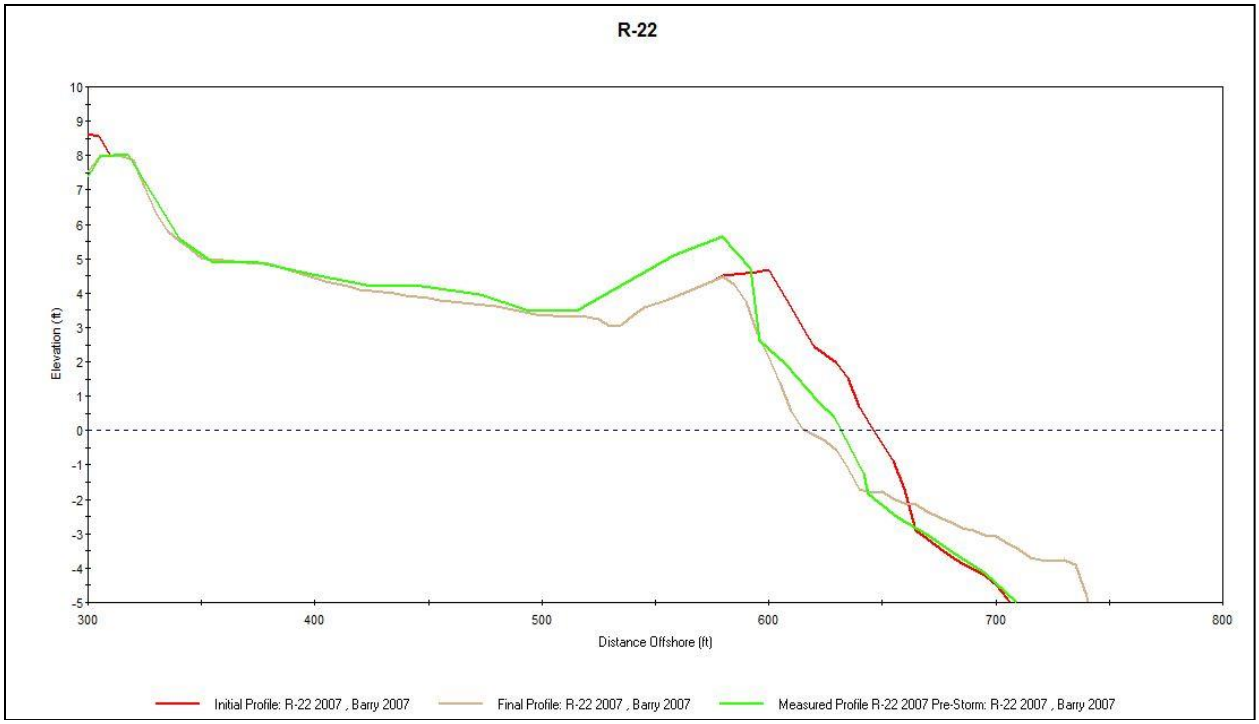

Figure 9. SBEACH Calibration Run (TS Barry), R-22 (Dune to Waterline)

Storm Inputs

The SBEACH verification storm data set contains wave and water level information ranging from August 1, 2008 to September 7, 2008. Due to high wave activity (likely to impact shoreline evolution) that occurred for an extended period of time surrounding the timeframe of Tropical Storm Fay, SBEACH storm inputs covered a substantial period both before and after landfall.

Wave Height and Period

Offshore wave data were obtained from the USACE WIS database. As with the SBEACH calibration inputs, wave data was obtained from WIS station 73285.

Figure 10 and Figure 11 show wave height and wave period information from August 1, 2008 to September 7 2008. Wave data are provided in 1 hour increments.

Wave Direction

Wave angle was set to 0deg for the SBEACH analysis.

Water Elevation

Water level information was obtained from the NDBC at COMPS station. Situated in the mouth of the inlet at Big Carlos Pass, this is the nearest station to the project site with open ocean exposure that contains a historical water level record.

Figure 12 shows water level values from August 1, 2008 to September 7, 2008. Although from the same gage as data used during calibration, water level data for Tropical Storm Fay are provided in six minute increments (rather than 1 hour increments).

Wind Data

Wind speed and wind direction were assigned values of 0.0 for the SBEACH analysis

SBEACH Verification Parameters and Results

Verification runs were made using the 2008/2009 pre- and post-storm USACE survey data sets. SBEACH parameters were defined as those obtained during the calibration phase of the analysis (Table 1).

Comparison between final (modeled post-storm) profiles and surveyed (measured) post-storm profiles influenced by Tropical Storm Fay, showed that as previously encountered in the 2007/2008 profiles processes beyond storm erosion were occurring in the project area. While the northern portion of the project provided a good match between modeled and measured post-storm profiles during verification runs profiles at the southern end (R-21 to R-24) showed accretion. Due to the protruding armor acting as a stabilizer at R-25, this is not unexpected. Given that end losses were expected to slow as the project shoreline equilibrated, the good agreement between modeled and measured results between R-11 and R-20 is considered to be suitable verification of the SBEACH model and the established calibration parameters.

It should be noted that SBEACH was not able to replicate the post-storm "piling" of sand into a dune like feature at the seaward end of the berm. An examination of pre- and post-storm profiles shows that sand eroded from the berm and foreshore is moving offshore where it is trapped by the offshore bar. This is the typical of a shoreline exposed to storm waves. It is unclear if the excess sand piled on the berm is related to storm response or if it occurred at another time between surveys. As Beach-fx allows for only flat representation of berms, the inability of SBEACH to replicate the piling of sand on the dune (if storm related) is not relevant. The ability of the SBEACH model to adequately replicate the retreat and slope of the foreshore is suitable for application to Beach-fx.

Verification results, showing the modeled (final) post-storm profiles and measured (USACE survey) post-storm profiles for R-11, R-13, R-15, R-17, R-19, and R-20 are provided in Figure 13 to Figure 18.

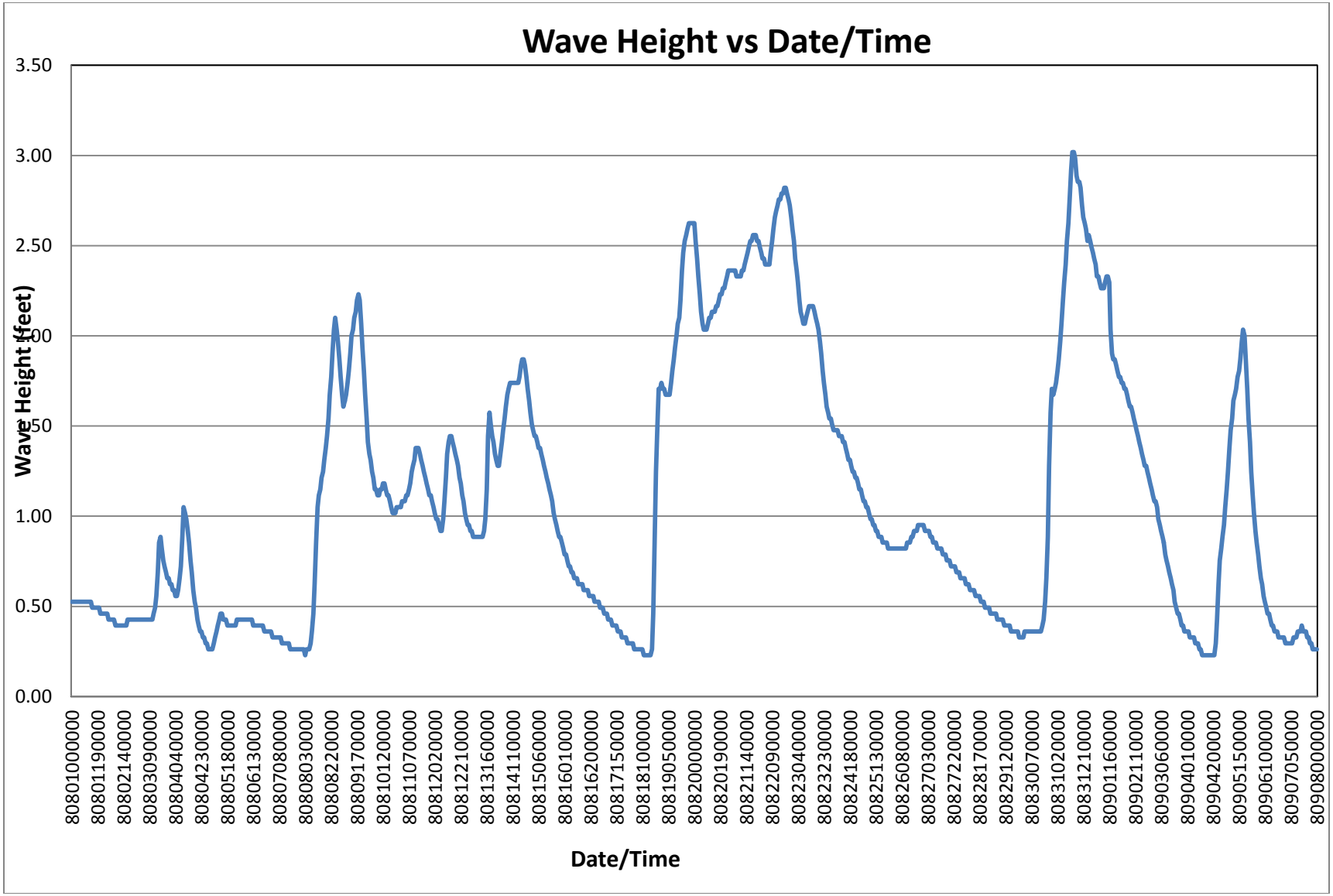

Figure 10. Wave Heights (August 1, 2008 to September 7, 2008)

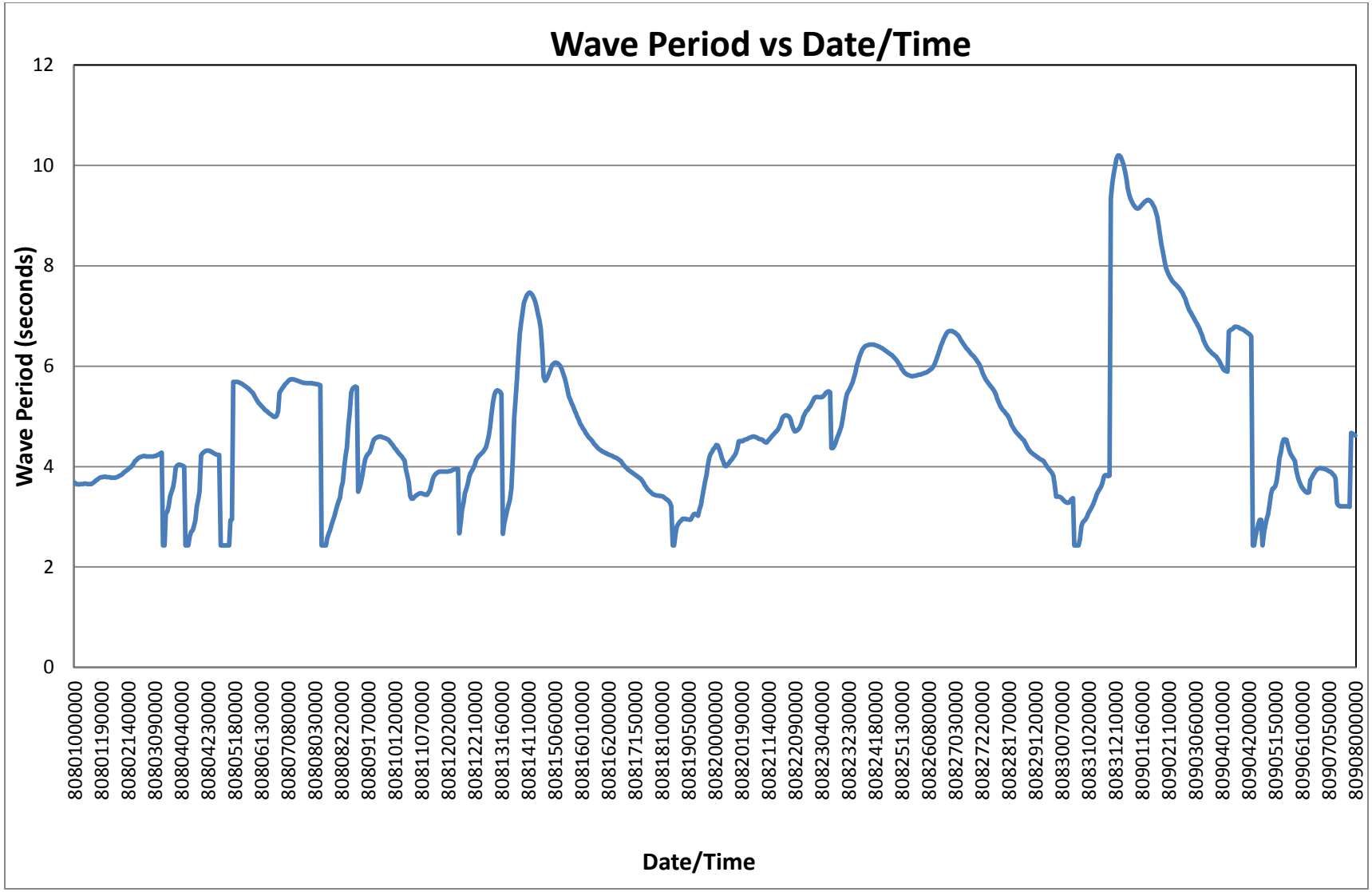

Figure 11. Wave Periods (August 1, 2008 to September 7, 2008)

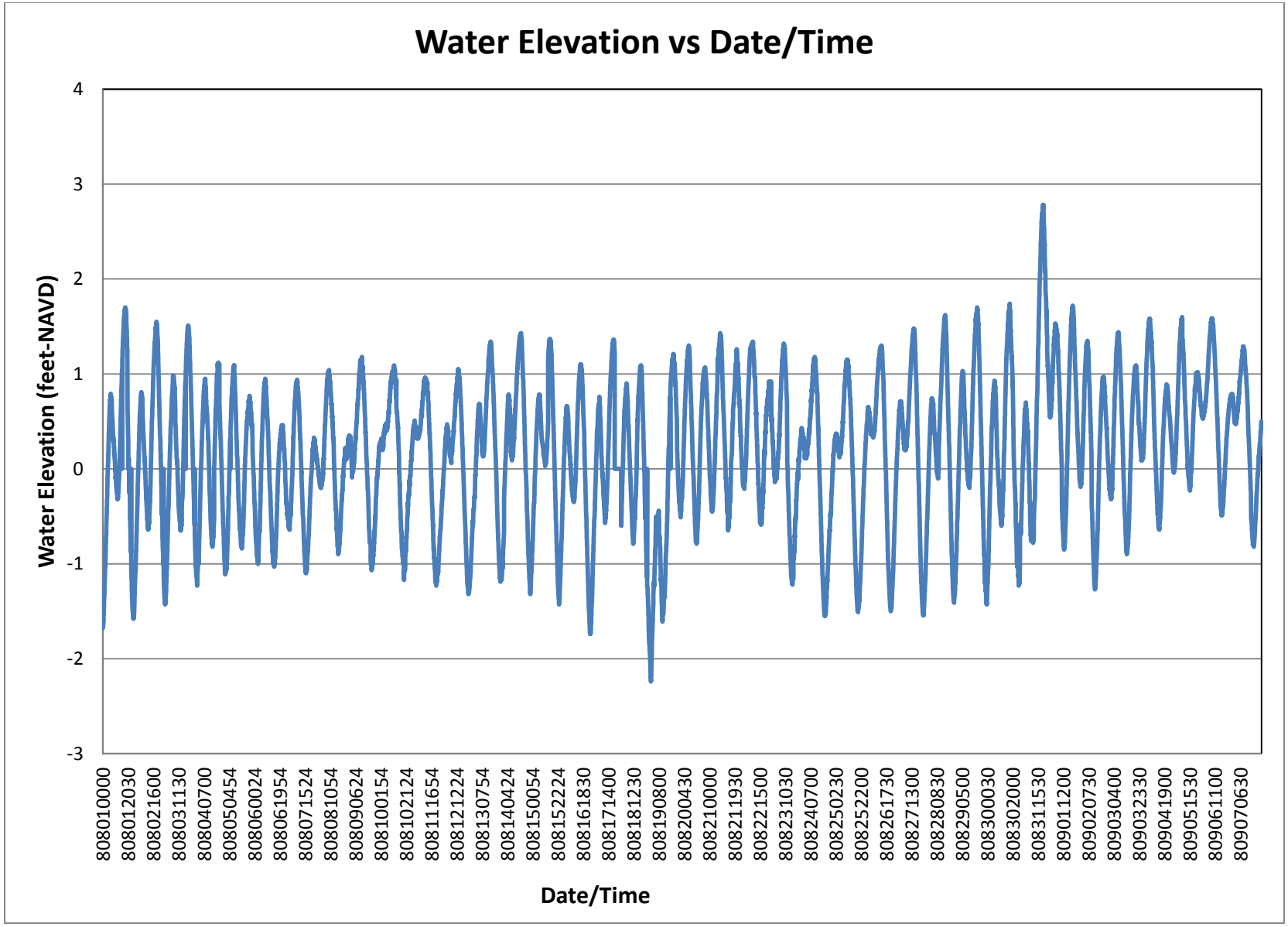

Figure 12. Water Levels (August 1, 2008 to September 7, 2008)

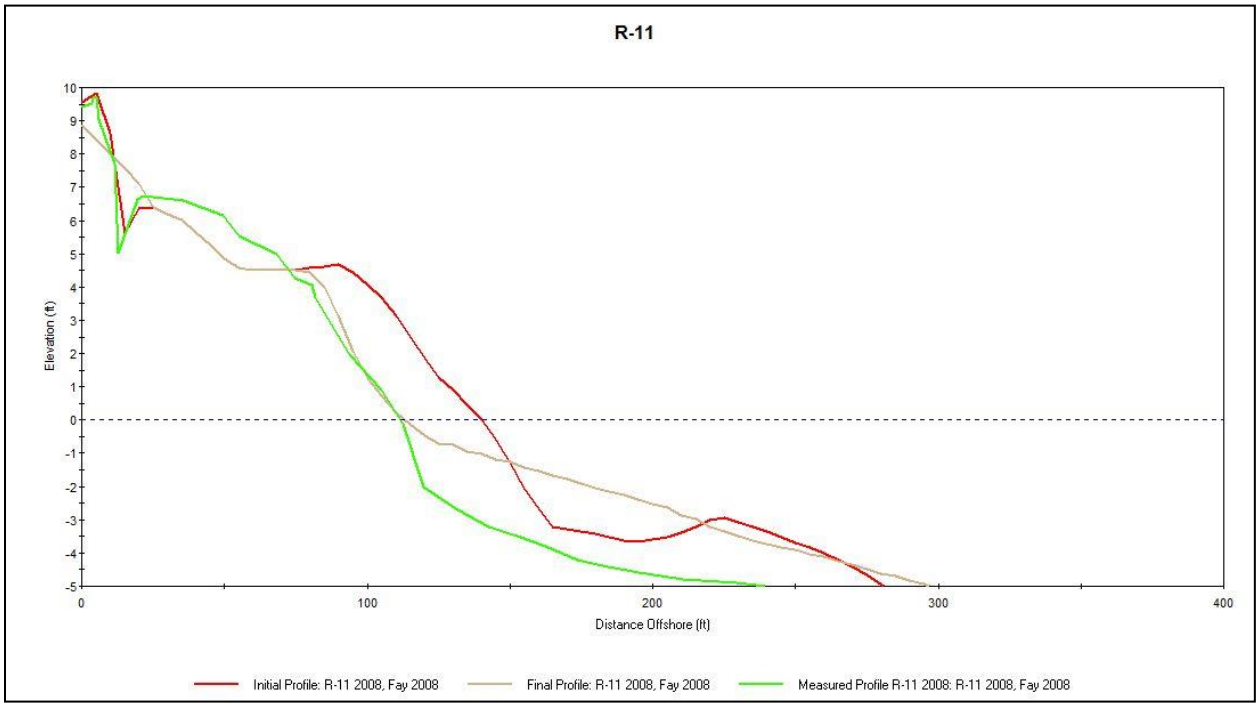

Figure 13. SBEACH Verification Run (TS Fay), R-11

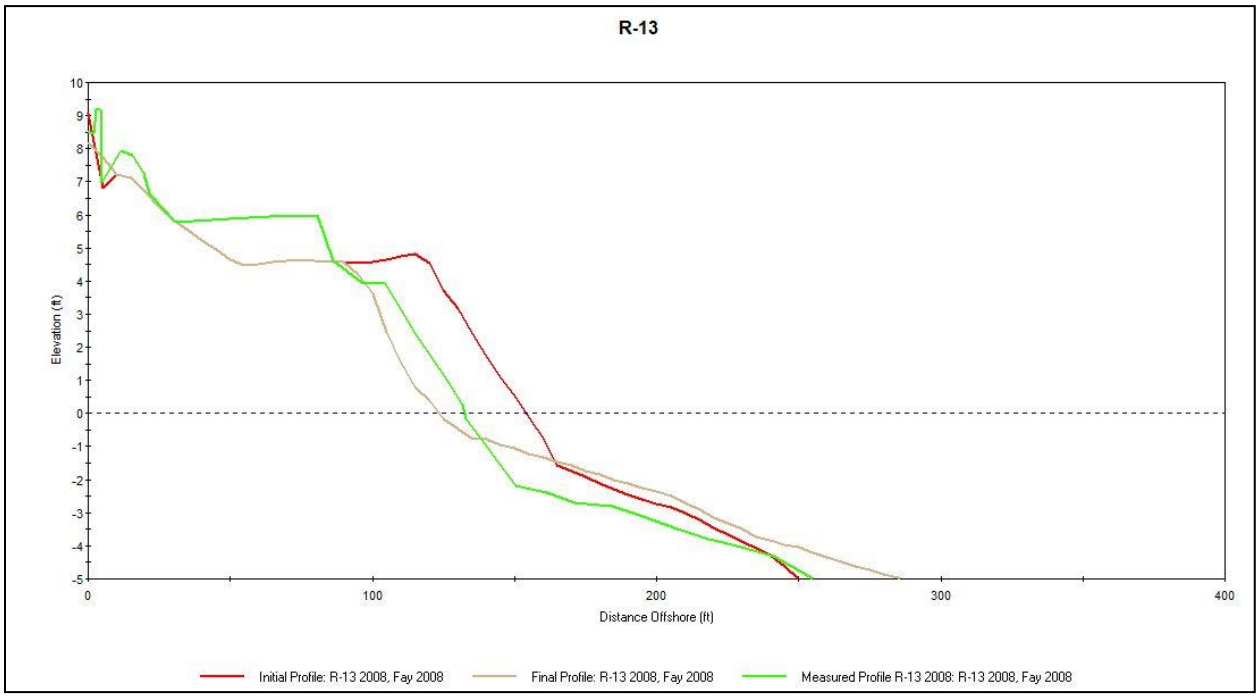

Figure 14. SBEACH Verification Run (TS Fay), R-13

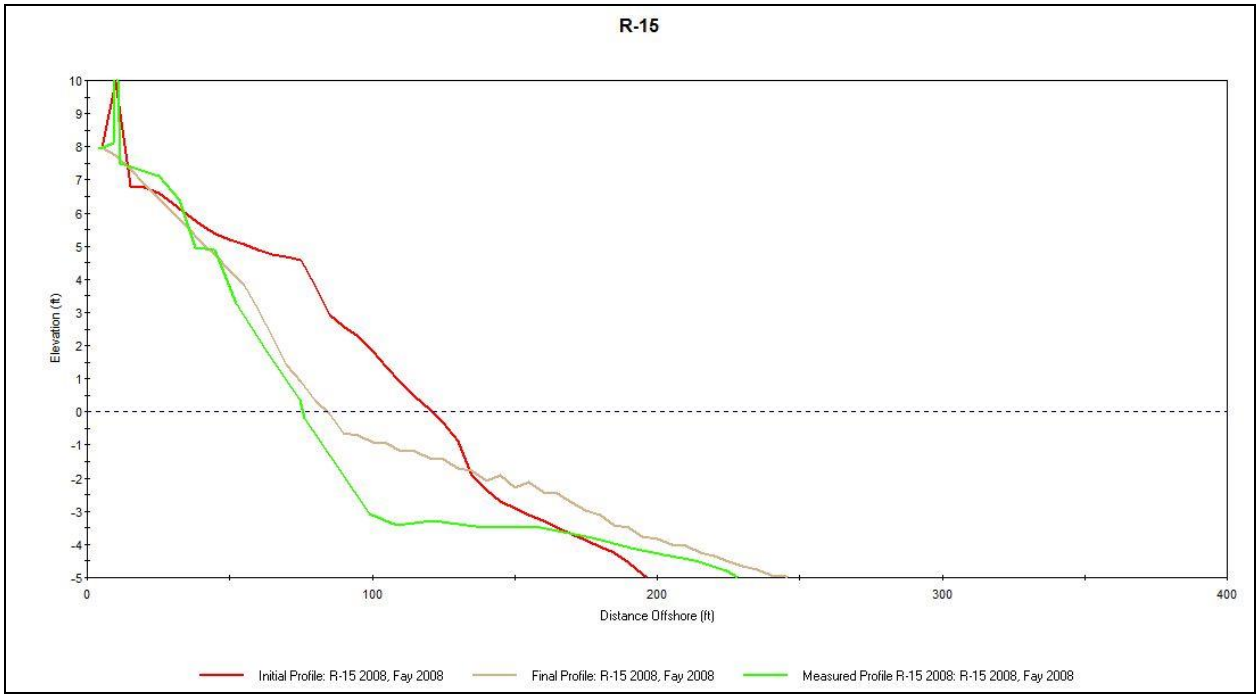

Figure 15. SBEACH Verification Run (TS Fay), R-15

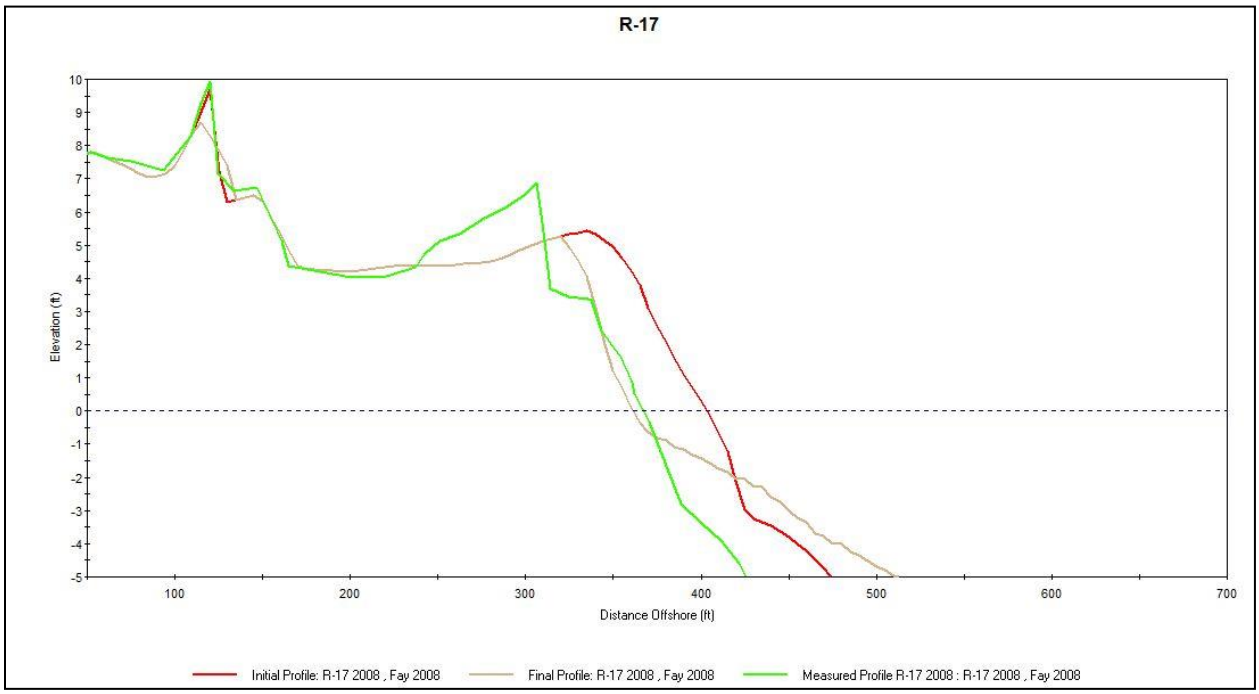

Figure 16. SBEACH Verification Run (TS Fay), R-17

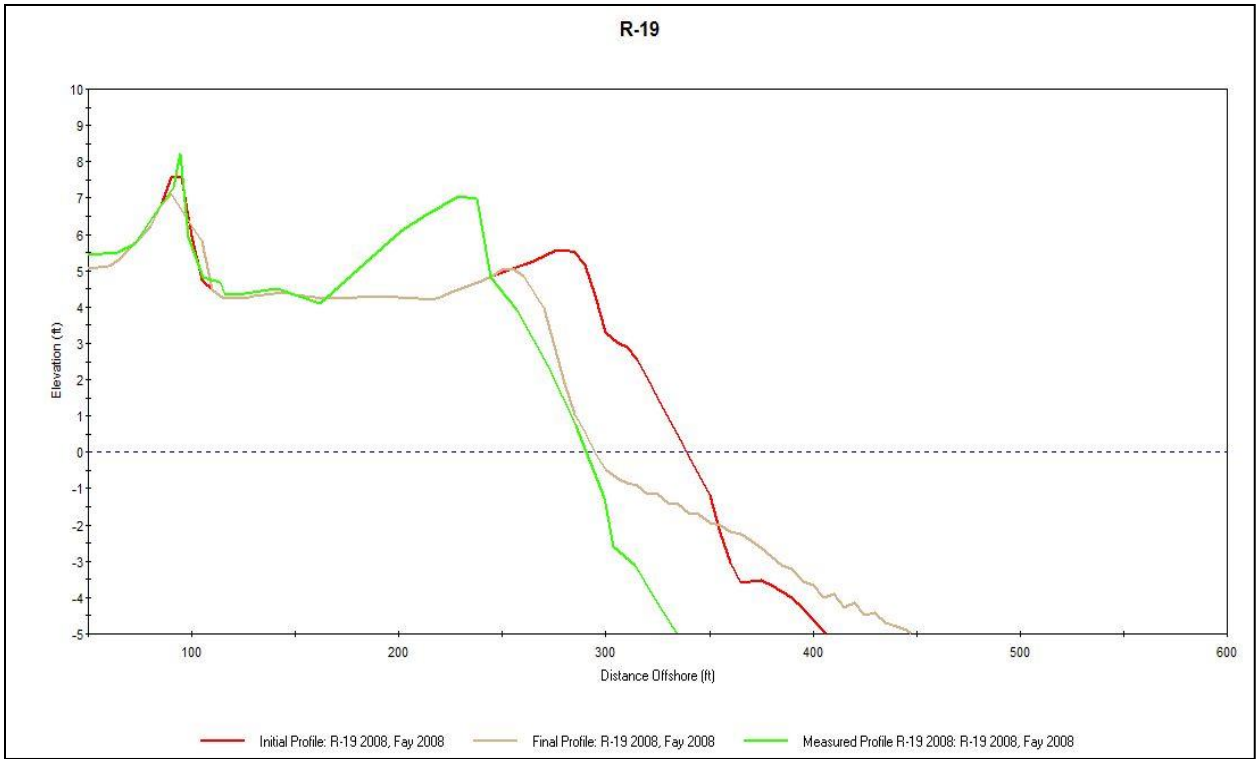

Figure 17. SBEACH Verification Run (TS Fay), R-19

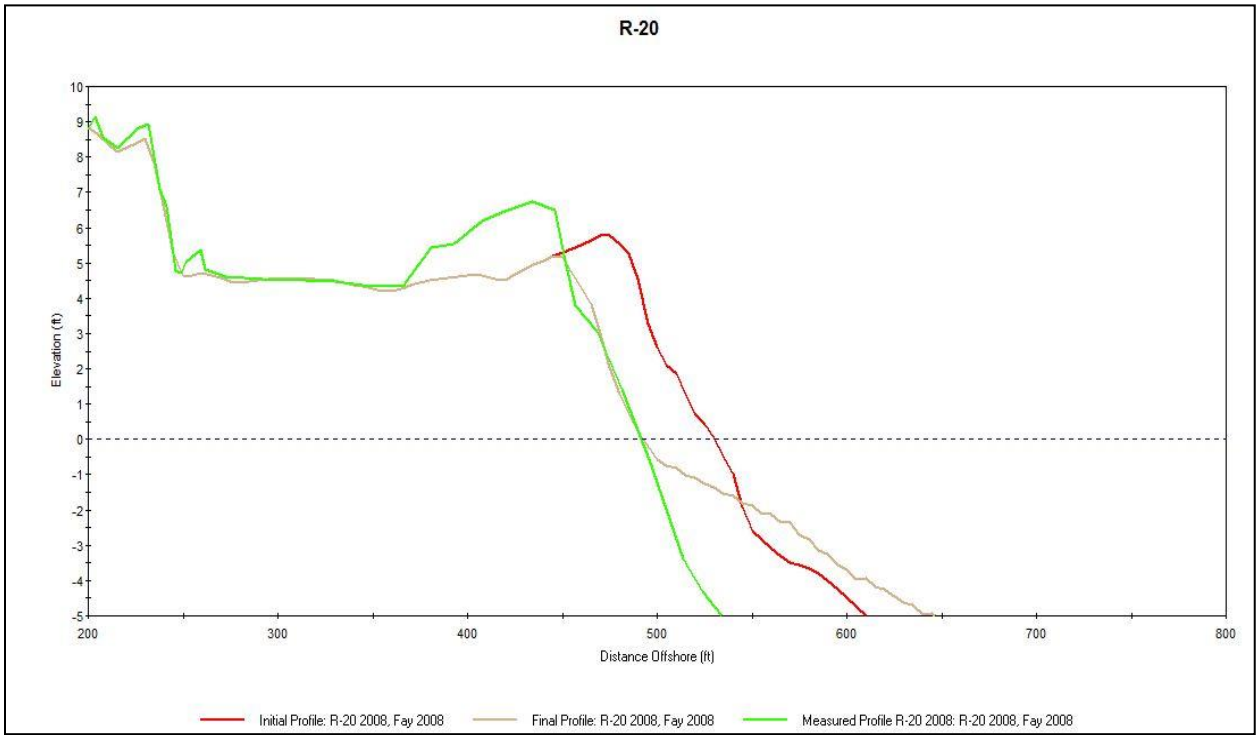

Figure 18. SBEACH Verification Run (TS Fay), R-20

Conclusions

Based on reasonably good matches between pre-storm and post-storm profiles during the 2007 storm event calibration runs as well as good agreement between pre-storm and post-storm profiles for the 2008 storm event verification runs, it can be concluded that the SBEACH parameters determined during model calibration are acceptable for production model runs associated with the Lee County, Gasparilla Island HSDR Project.

References

Hubertz, J. A., 1992. "User's Guide to the Wave Information Studies (WIS) Wave Model, version 2.0," WIS Report 27, U.S. Army Engineer Waterways Experiment Station, Vicksburg , MS.

Sub-Appendix A-2

Lee County, Gasparilla Island, Section 934

Value Engineering

Value Management Plan

(PMBP REF8023G)

Civil Works: ☑		**Agency:**	USACE
Military: ☐	**Project/Procurement Amount Cost =** $53,000,000	**District:**	SAJ
P2#:	113085	**Date:**	2/6/2017
PN:		**Filled Out By:**	Autumn Ziegler, PE, AVS
Project Title:	Shore Protection Project, Lee County, FL, Gasparilla Island, Section 934 Report	**Project Manager:**	Laurel Reichold

Goal: (Statement of overall goal of VM/E effort)

The Value Management Plan (VMP) is being prepared in compliance with ER-11-1-321, Change 1 dated Jan 2011. The VMP will document compliance with Value Engineering regulations by determining the best strategy based on the complexity and cost of the project.

Objective: (Specific items of accomplishment that the VM/E effort will achieve as specific to the project)

The purpose of this Value Management Plan is to document concurrence with the selected VE strategy of "No Further Action" for the Gasparilla Island 934 Report.

Execution - VE Strategy & Level of Effort: (Document Decisions from Sections I & II)

Selected VE Strategy: (Select Only One Strategy)

Design Agent VE Compliance ☐ **Date of Compliance:**

No Further Action ☑ **Reason:** The purpose of the 934 report is to provide the basis for extension of Federal cost sharing during the remaining years of the 50-year period of Federal participation.

Low Opportunity - VMP Only ☐
Low Opportunity - Bridge ☐
Low Opportunity - Scan ☐

Value Planning (Level 1) ☐
Abbreviated Study (Level 2) ☐
Standard Study (Level 3) ☐
Problem Resolution (Level 4) ☐
Programmatic (Level 5) ☐
Enterprise (Level 6) ☐

VE Activity Preliminary Schedule	
Overall VE Start (ML285, CW285, CW192)	
VE Activity Start	
VE Activity Finish	
Overall VE Finish (ML290, CW290, CW195)	

Level of Effort:
Single Effort ☐
Multiple Efforts ☐

VE Team:
Independent ☐
Integrated ☐
Blended ☐

Value Engineering Budget:

Cost Category	Cost	Remarks
VEO Labor	$2,000	VEO Labor for VMP Preparation and Coordination
Independent VE Team Member Labor		Labor for Non-CESAJ VE Team Members
In-House VE Team Labor		Labor for CESAJ In-House VE Team Members
A-E Services Contract		Budget is an estimate. Actual contract cost to be determined.
Contracting		Fee for CESAJ Contracting to Award and Close-out Task Order
VEO Travel		For projects requiring site visits
Total Budget	$2,000	

REICHOLD.LAUREL.P.1368127384 Digitally signed by REICHOLD.LAUREL.P.1368127384 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=REICHOLD.LAUREL.P.1368127384 Date: 2017.02.07 11:13:24 -05'00'

Signature & Date of Project Manager (Required)

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Signature & Date of VEO (Required)

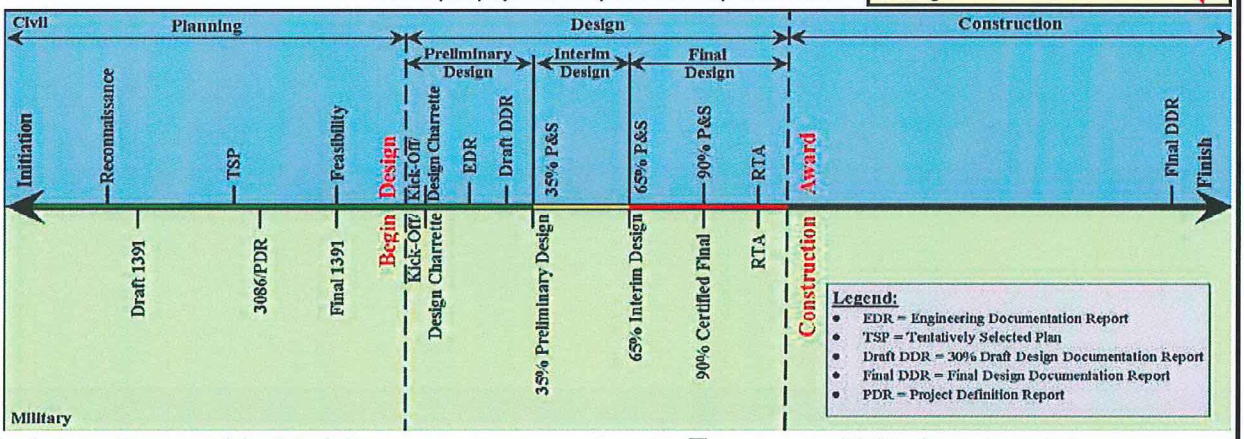
Screening Tool

P2#: 113085	**Date:** 2/6/2017
PN:	**Filled Out By:** Autumn Ziegler, PE, AVS
Project Title: Shore Protection Project, Lee County, FL, Gasparilla Island, Section 934 Report	**Project Manager:** Laurel Reichold

I. Initial Screening Process

Project Cost $ $53,000,000

Where is your project currently on the delivery time line below? Planning



A) Is the Project/Procurement federally funded?	Yes ☑	No ☐	If No, document as No Further Action.
B) Is the Corps the design agent?	Yes ☑	No ☐	If No, document design agent compliance.
C) Has a programmatic study been previously executed within the last 3 years? Allowed before 35% Design only. (Determines if a Bridge Strategy is an option)	Yes ☐	No ☑	If Yes, can select Bridge Strategy as long as design is below 35%.
D) Could this be a part of a programmatic study? (Automatically determines Programmatic Strategy)	Yes ☐	No ☑	If Yes, select Programmatic Strategy.
E) Are there at least 5 similar studies within the last 3-5 years in the same region? Allowed before 35% Design only . Applicable to projects in the $2-$10M range with MSC approval; projects over $10M require HQ Ch. OVE approval (Determines if Scan Strategy is an option)	Yes ☐	No ☑	If Yes, can select Scan Strategy as long as design is below 35%. If opportunity to change exists outside of past studies, do not select Yes.
F) Is the project/program/procurement over $10M?	Yes ☑	No ☐	If Yes, proceed to Strategy Screening Process in Section II below.
G) Is there a program specific screening tool?	Yes ☐	No ☑	If Yes and not pre-flagged as low opportunity, proceed to program specific screening tool.

II. VE Strategy Screening Process (work with PDT)

A) Project Specific			
1) Disciplines Involved	Couple (≤2) ☐	Few (2-4) ☑	Several (>4) ☐
2) Scope – Simple/Complex	Simple ☑	Moderate ☐	Complex ☐
3) New/Renovate/Addition	New ☑	Addition ☐	Renovation ☐
4) Unique or Standard Type Design	Unique ☐	Repetitive ☑	
5) Constraints	Minimal ☑	Moderate ☐	Significant ☐
6) Single Phase/Multi-Phase	Single ☐	Multiple ☑	
7) Single Facility/Multiple Facility	Single ☑	Multiple ☐	
8) Status of Design	Early ☑	35% ☐	65% or later ☐
B) Stakeholders			
1) Level of PDT Experience	Limited ☐	Substantial ☑	Unknown ☐
2) Applicability of Team Experience	Applicable ☑	N/A ☐	Unknown ☐
3) Design Provided by Others	Yes ☐	No ☑	
C) Risk/Opportunity			
1) Confidence in Budget Estimate	Low ☐	Moderate ☐	High ☑
2) Adequacy of Schedule – Design & Construction	Adequate ☐	Moderate ☑	Tight ☐
3) Technical Risk – Design & Construction	Low ☑	Moderate ☐	High ☐
4) Opportunity for Beneficial Change	Low ☑	Moderate ☐	High ☐
Complexity Judgment - Assess complexity of overall circumstances (A-C)	Low ◉	Moderate ○	High ○

See Page 3 for Complexity Narrative and Explanation of Selected VE Strategy.

Screening Tool - Narrative

P2#: 113085	**Date:** 2/6/2017
PN:	**Filled Out By:** Autumn Ziegler, PE, AVS
Project Title: Shore Protection Project, Lee County, FL, Gasparilla Island, Section 934 Report	**Project Manager:** Laurel Reichold

Narrative: (Selected VE Strategy / Complexity)

The Lee County, Gasparilla Island, Florida, Hurricane and Storm Damage Reduction (HSDR) Project is an existing authorized project. A Section 934 Report is being prepared to seek extension of Federal participation of the existing authority for future nourishment within the existing authorized design template. The Section 934 Report will include no new plan formulation or design changes to the authorized project. Therefore, the selected VE strategy for the 934 Report is "No Further Action". If there are future construction contracts for the Project, the need for value analysis will be determined on a contract-by-contract basis with separate value management plans prepared as applicable.