EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX E
BORROW AREA IMPACT ANALYSIS

BORROW AREA IMPACT ANALYSIS

FOR EDISTO BEACH, SC

Introduction

Edisto Island is located on the coast of South Carolina south of Charleston. The town of Edisto Beach is located on the southern tip of Edisto Island at the South Edisto River Inlet (Figure 1). The offshore area of Edisto Beach was investigated to identify sites that may be appropriate for use as borrow material source for beach nourishment at Edisto Beach. The estimated maximum total project volume is 3.4 Mcy needed for 50 years of nourishments.

Modifications of offshore bathymetry by removal of large quantities of sediment alter the local wave field, which in turn may modify the equilibrium planform of the leeward beach. These effects as well as the impact on sediment dynamics near the sediment removal area have become of concern as the extraction of offshore sediment for beach nourishment, construction materials, and other purposes has increased (Bender and Dean, 2003). The Coastal Modeling System CMS-WAVE was used to estimate wave transformation change in the study area and assess potential impacts along the Edisto Beach shorelines.

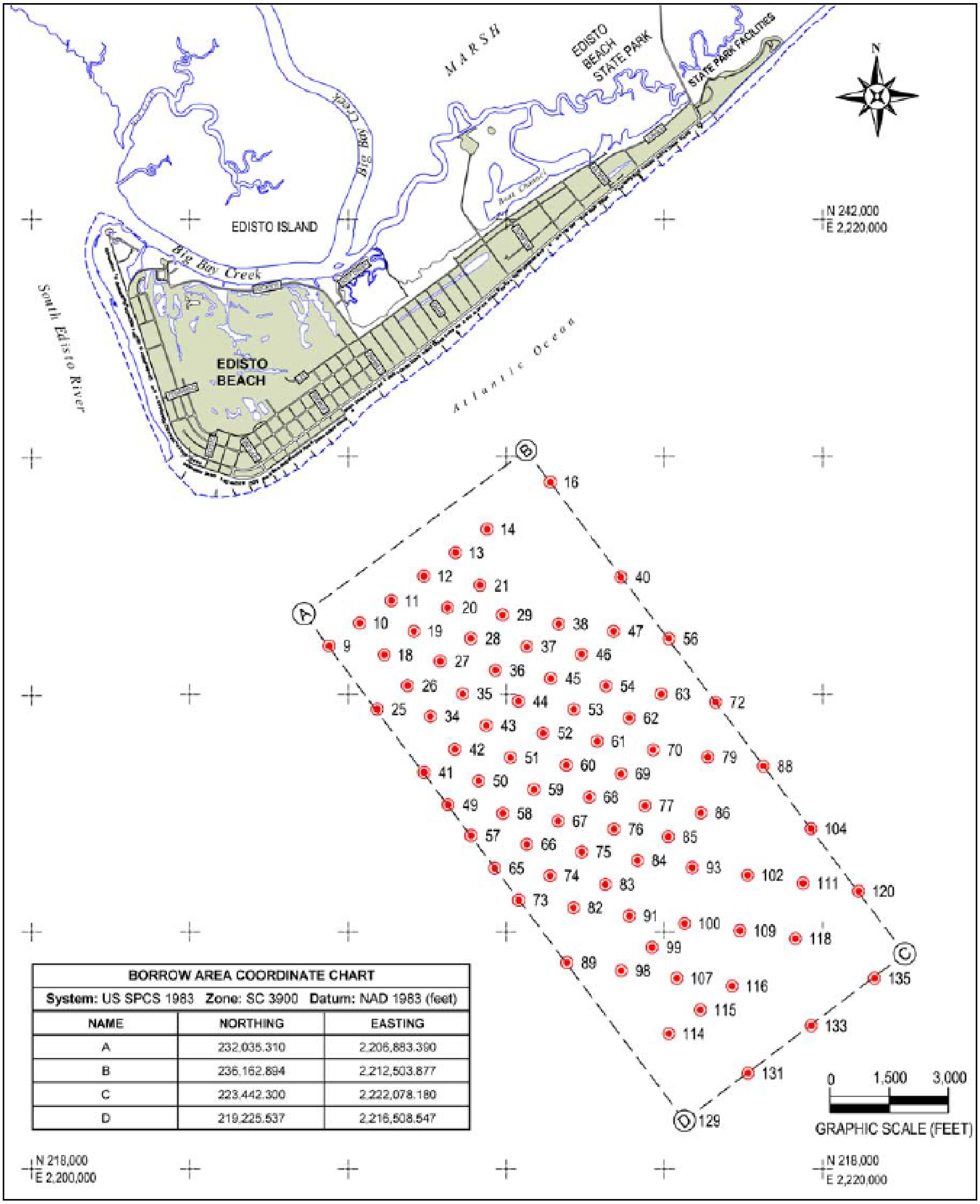
An initial investigation of the potential impacts of multiple borrow area scenario was conducted in 2009 for the 50-year project life for the Edisto Island Feasibility study (USACE, 2009). The present study is an update to the initial study and the same bathymetric and forcing wave data were adopted. The CMS-WAVE model grid and the synthesized forcing wave climate were modified. The impact of a final refined borrow area scenario was assessed with the modified wave model grid and synthesized forcing conditions.

Figure 1- Edisto Beach location map

Potential Borrow Area

USACE (2009) stated that the sand search area targeted the seaward shoal of South Edisto River Inlet at the southern end of Edisto Beach. The shoal is part of the ebb-tidal delta of St Helena Sound and is known to contain mixed sand and shell sediments (in some areas) that are similar to the native beach. The search area encompassed an area 7,000 ft by 16,000 ft (~4 square miles) paralleling the north side of the main channel of South Edisto River Inlet. Figure 2 shows the sand search area and the 77 borings obtained within the proposed borrow area (CSE 2008). The initial study (USACE, 2009) investigated seven borrow area scenarios. A revised borrow area A scenario is examined in this study.

There are some limits on the lateral and vertical extent of borrow material sites. Boreholes were used in identifying the vertical boundaries of the potential borrow sources. The composition and thickness of overburden should be examined and borrow areas should be identified based on depth of suitable material. Vertical buffers must be delineated between suitable and non suitable sediments, which cannot be included in the source's available volume. A one foot vertical buffer was adopted in this study. Lateral buffer areas around sensitive environmental or cultural resources, or around known obstructions, must also be excluded from the source's available volume. A 0.25 mile buffer was delineated on the north, west and east sides of the proposed borrow area. Two circular exclusion areas, of 1500 ft radius, were used to exclude two prehistoric sites found during cultural/hardbottom survey. Figure 3 shows the locations of boreholes offshore of Edisto Beach and the footprint of the proposed borrow area A. Also, the figure shows the three sides of the 0.25 mile (about 1300 ft) buffer around the borrow area and the two exclusion circular areas around the prehistoric sites. The potential borrow area covers about 1.0 square miles with potential dredging of about 7.2 Mcy of beach placement material. This amount is more than the estimated maximum total project volume of 3.393 Mcy needed for 50 years of nourishments. The geotechnical analysis describing the details of developing the borrow area limits are available in CSE (2008).



BORROW AREA COORDINATE CHART		
System: US SPCS 1983 Zone: SC 3900 Datum: NAD 1983 (feet)		
NAME	NORTHING	EASTING
A	232,035.310	2,206,883.390
B	236,162.894	2,212,503.877
C	223,442.300	2,222,078.180
D	219,225.537	2,216,508.547

Figure 2- Sand search grid over the shoals of South Edisto River Inlet

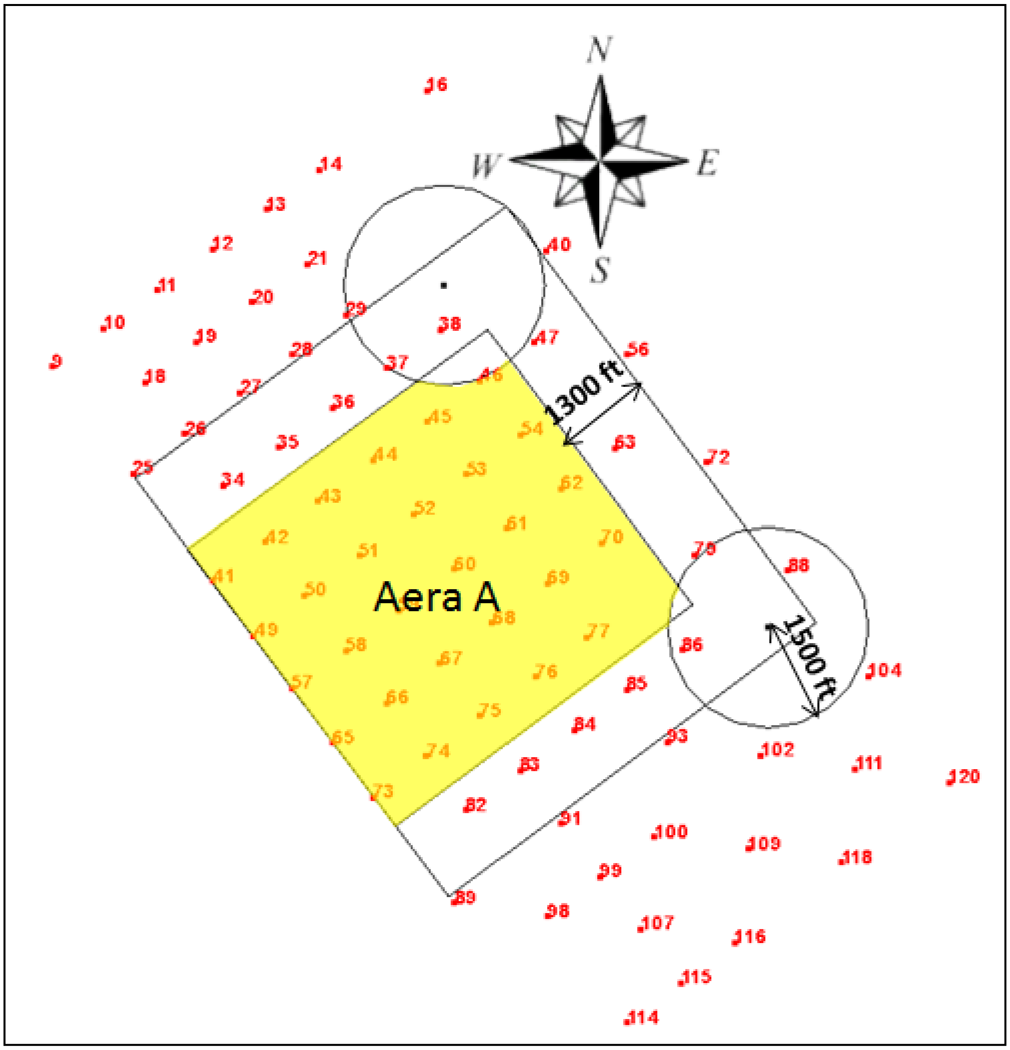


Figure 3- Proposed borrow area, lateral buffers and borehole locations

CMS-WAVE Grid

CMS-WAVE, previously called WABED (Wave-Action Balance Equation Diffraction), is a two dimensional (2D) spectral wave model formulated from a parabolic approximation equation (Mase et al. 2005a) with energy dissipation and diffraction terms. It simulates a steady-state spectral transformation of directional random waves co-existing with ambient currents in the coastal zone. The model operates on a coastal half-plane, implying waves can propagate only from the seaward boundary toward shore. It includes features such as wave generation, wave reflection, and bottom frictional dissipation (Lin et al., 2008).

CMS-WAVE model requires accurate bathymetry data to construct computational grid over which waves propagate and transform. The bathymetry used for the CMS-WAVE grid was the same data set used in the 2009 Edisto initial borrow area impact analysis (USACE, 2009). The data set is referenced to the horizontal UTM NAD83 Zone 17 in meters and to the vertical Mean Tidal Level (MTL) datum which represents the vertical datum of the model. Figure 4 shows the boundaries of the survey data sets.

The CMS-WAVE grid was delineated such as to include Edisto Beach, anticipated offshore borrow areas and the offshore Wave Information Studies (WIS) 63356 station. The grid boundaries should be located away from the study area, to eliminate boundary effects, and should ensure accurate development and propagation of the modeled parameters. Therefore, the Western wave grid boundary, used in the initial wave impact analysis, was extended to include more of the St Helena Sound area. Accordingly, the Edisto Beach and the proposed borrow area were centered within the alongshore extent of the model grid. The grid extends about 37.5 km along the shoreline and 30.3 km offshore (Figure 5). The offshore grid boundary includes WIS station 63356. The computational grid was constructed with 433818 cells and with resolution of 80 m in the offshore area. The resolution was increased to 40 m in the nearshore area and in the offshore proposed borrow site vicinity to adequately resolve wave energy propagation in the area. The grid origin was selected such as to resolve the details of the proposed borrow area. Also, the previous initial grid orientation was modified from 127.5 to 126.6 deg (counterclockwise from East) to match the orientation of the revised proposed borrow area. The modified orientation, location and resolution of the grid were designed to optimize the accuracy of the anticipated dredged borrow volume (Figure 6). The bathymetry of the CMS-WAVE grid was obtained by interpolating the scatter survey data to the grid cells as shown in Figure 7.

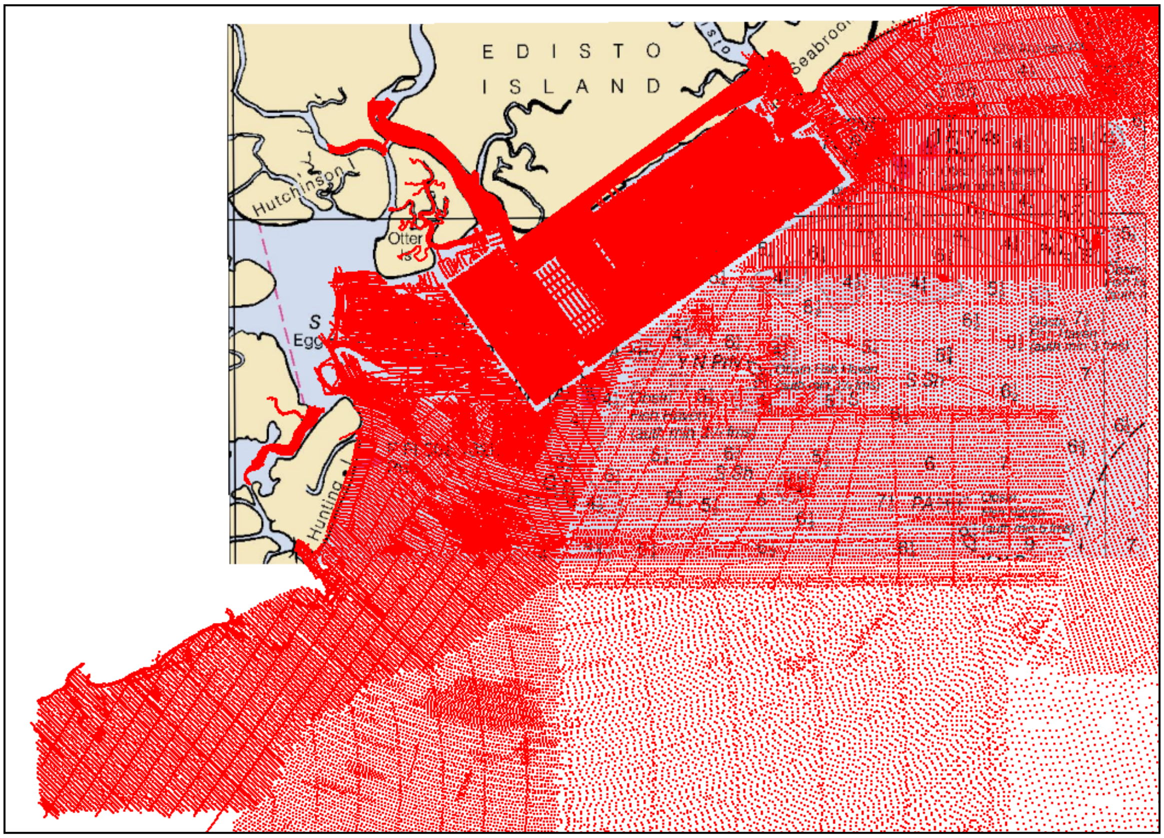


Figure 4- Scatter data coverage

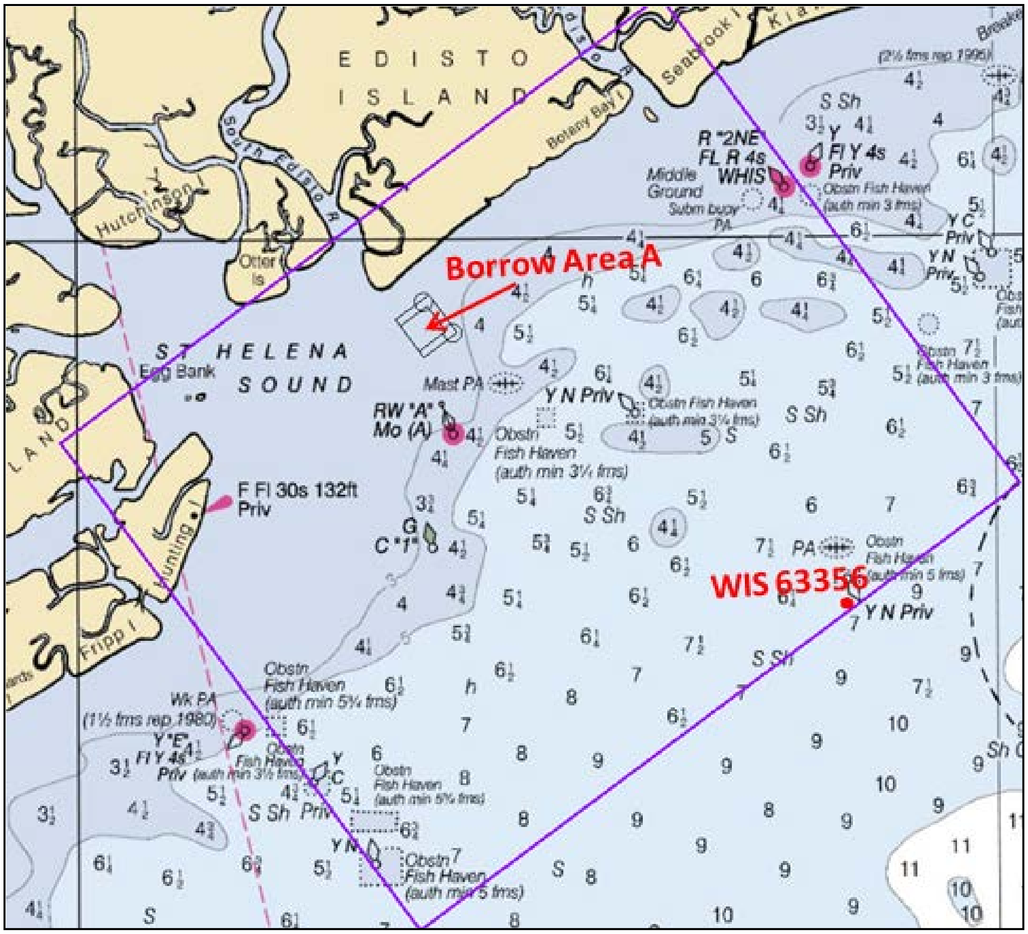


Figure 5- Extent of CMS-WAVE grid

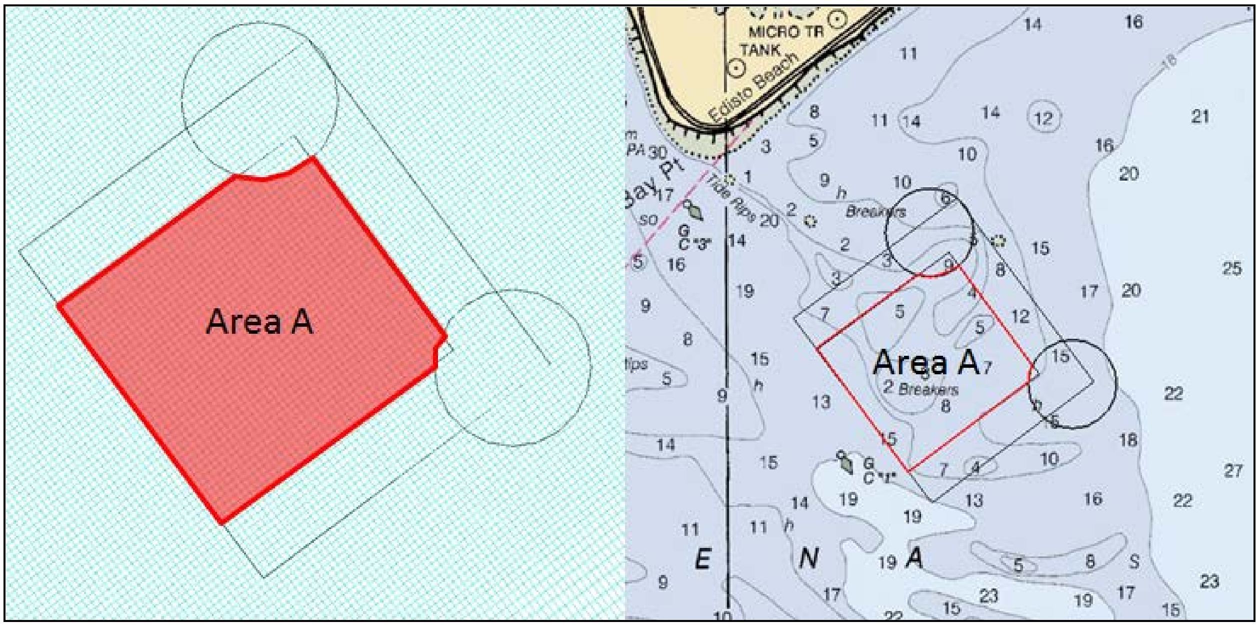


Figure 6- CMS-WAVE grid details within borrow area A

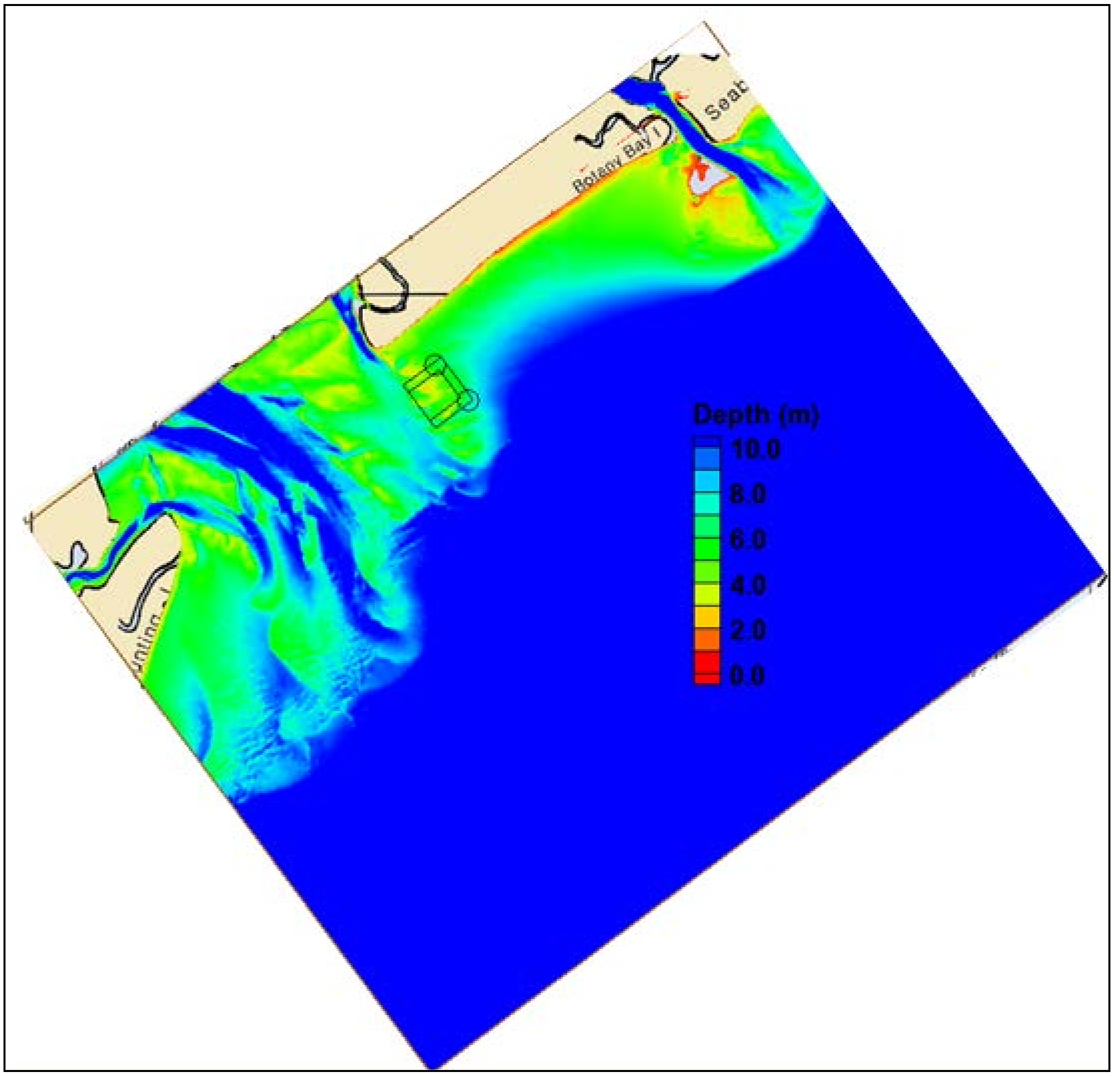


Figure 7- CMS-WAVE grid bathymetry

CMS-WAVE Forcing Conditions

CMS-WAVE was forced with directional wave spectra at the offshore grid boundary. The offshore wave climate provides representative wave boundary conditions. The model was not forced with wind or current fields which are optional.

Wave data used to determine the offshore wave conditions was obtained from the WIS Station 63356 located at Latitude of 32.333° N and Longitude of 80.083° W in 13 m depth. The WIS project produces a high quality online database of hindcast nearshore wave conditions from 1980-1999. The hindcast wave conditions were produced using the latest updated version of the numerical ocean wave generation and propagation model WISWAVE along with wind fields produced by Oceanweather Inc. All Atlantic WIS products, prior to 11/15/2011 (hourly interval), dependent on the parabolic fit wave period, and the wave direction contained errors that were corrected during 2012 (http://wis.usace.army.mil/fix_ATL.shtml). The present study adopted the updated 3-hour interval corrected WIS data.

Figure 8 shows the wave rose diagram of wave height versus wave direction percent occurrence at WIS station 63356 during 1980-1999. The figure shows that waves come mainly from the South East quadrant. Table 1 shows the percent occurrence of heights and periods of all directions at WIS station 63356. It can be seen from the table that wave heights generally range between 0.5-4 m and wave periods range between 5 -10 sec. Also the WIS station mean-maximum summary table (http://wis.usace.army.mil/products.html?staid=63356&lat=32.33300&lon=-80.08300&dep=13), which states the maximum monthly wave height and period during the 20 years of hindcast, was examined. The maximum wave height and period were 8.23 m and 16.01 s respectively. From these statistics, a set of discrete conditions were selected for simulations. The wave height range was defined at 0.5-m intervals from 0.0 m to 2.0 m and at 2 m interval to 10.0 m. The wave period range was 0 to 16 sec at a 3 sec interval. The wave directions were incremented every 22.5 deg. Significant wave height, wave period and vector mean wave direction (degrees clockwise from True north) were adopted in the analysis.

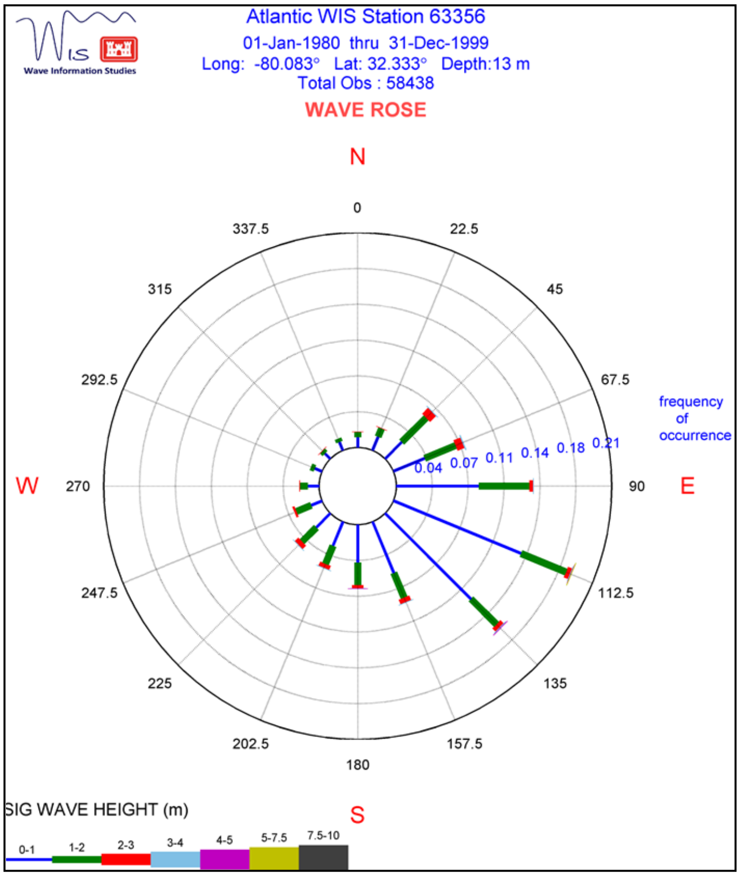
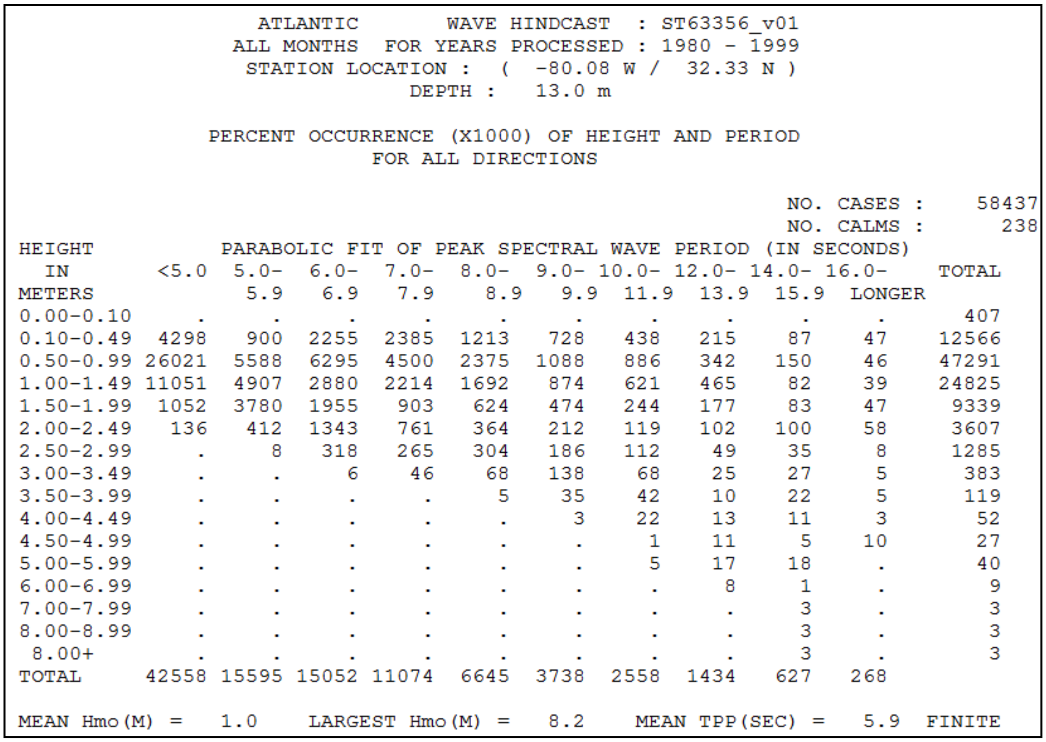


Figure 8- Waverose diagram at WIS station 63356

Table 1- Percent occurrence of wave heights and periods of all directions at WIS station 63356



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                   ATLANTIC       WAVE HINDCAST  : ST63356_v01
                 ALL MONTHS  FOR YEARS PROCESSED : 1980 - 1999
                  STATION LOCATION :  (  -80.08 W /  32.33 N )
                               DEPTH :   13.0 m

                PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD
                             FOR ALL DIRECTIONS

                                                              NO. CASES :    58437
                                                              NO. CALMS :      238
HEIGHT          PARABOLIC FIT OF PEAK SPECTRAL WAVE PERIOD (IN SECONDS)
  IN       <5.0  5.0-  6.0-  7.0-  8.0-  9.0- 10.0- 12.0- 14.0- 16.0-     TOTAL
METERS            5.9   6.9   7.9   8.9   9.9  11.9  13.9  15.9  LONGER
0.00-0.10     .     .     .     .     .     .     .     .     .     .       407
0.10-0.49  4298   900  2255  2385  1213   728   438   215    87    47     12566
0.50-0.99 26021  5588  6295  4500  2375  1088   886   342   150    46     47291
1.00-1.49 11051  4907  2880  2214  1692   874   621   465    82    39     24825
1.50-1.99  1052  3780  1955   903   624   474   244   177    83    47      9339
2.00-2.49   136   412  1343   761   364   212   119   102   100    58      3607
2.50-2.99     .     8   318   265   304   186   112    49    35     8      1285
3.00-3.49     .     .     6    46    68   138    68    25    27     5       383
3.50-3.99     .     .     .     .     5    35    42    10    22     5       119
4.00-4.49     .     .     .     .     .     3    22    13    11     3        52
4.50-4.99     .     .     .     .     .     .     1    11     5    10        27
5.00-5.99     .     .     .     .     .     .     5    17    18     .        40
6.00-6.99     .     .     .     .     .     .     .     8     1     .         9
7.00-7.99     .     .     .     .     .     .     .     .     3     .         3
8.00-8.99     .     .     .     .     .     .     .     .     3     .         3
 8.00+        .     .     .     .     .     .     .     .     3     .         3
TOTAL     42558 15595 15052 11074  6645  3738  2558  1434   627   268

MEAN Hmo(M) =   1.0    LARGEST Hmo(M) =   8.2    MEAN TPP(SEC) =   5.9  FINITE
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The regional shore line adopted in the study is approximately oriented at 53.4 deg clockwise from North as shown in Figure 9. Statistics were performed for onshore wave direction bands only (67.5 deg-225.5 deg) and other waves were considered as directed offshore and were not considered in the analysis. The wave data was analyzed between 67.5 deg and 225.5 deg directions in 22.5-deg bins.

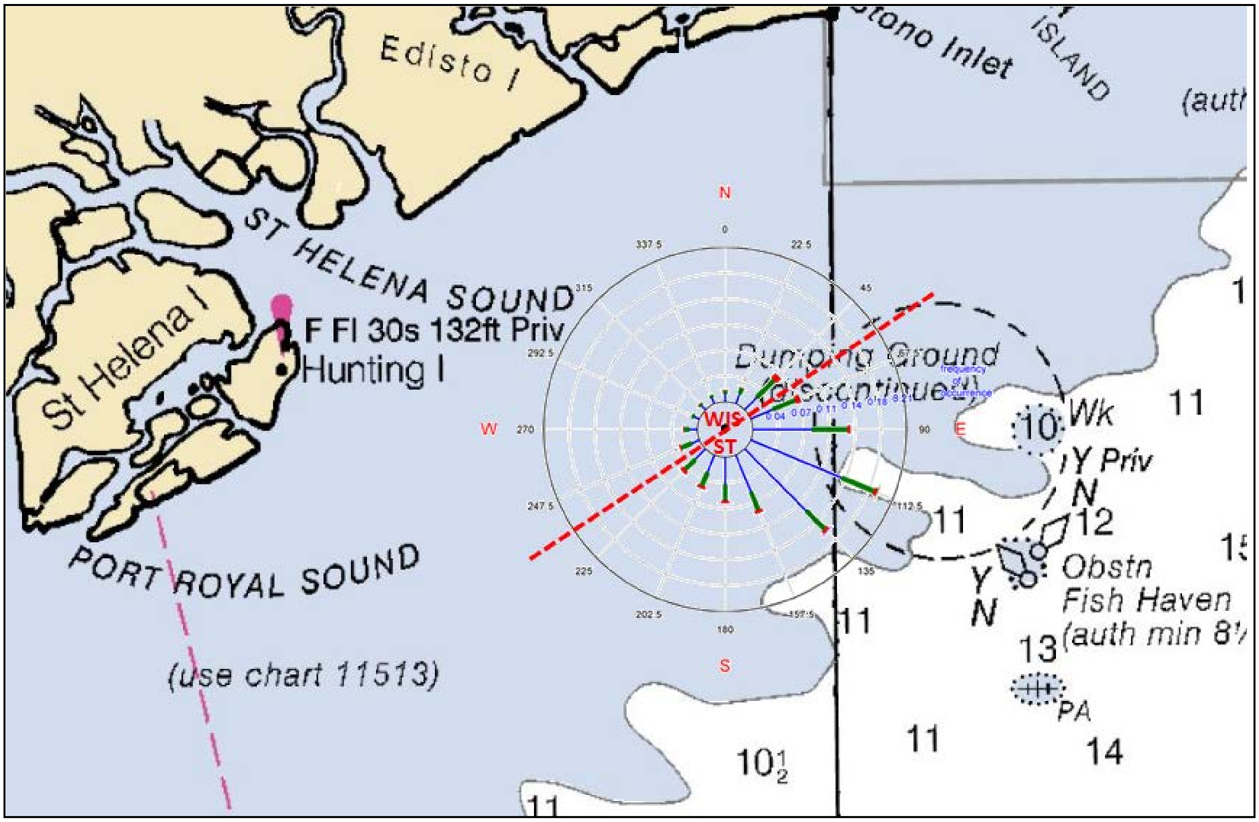

Figure 9- Orientation of regional shoreline and onshore wave bands

The 20 years hindcast record was used to develop a binned approach based on joint probability of wave direction, period and height. MATLAB routine was used to calculate the joint probability of wave direction, period and height. Table 2 shows the selected direction-period-height bins used to synthesize the wave climate. The total number of occurrences from the selected bins was 43781 which represent about 75% of the total waves (58437) at WIS station 63356.

Table 2- Selected wave bins

Bin	**Wave Direction (deg, from North)**	**Wave Period (sec)**	**Significant Wave Height (ft)**
1	67.5 – 90.0	3.0 - 6.0	0.00 - 0.50
2	90.0 - 112.5	6.0 - 9.0	0.50 - 1.00
3	112.5 – 135.0	9.0 - 12.0	1.00 - 1.50
4	135.0 - 157.5	12.0 - 15.0	1.50 - 2.00
5	157.5 - 180.0	15.0 - 18.0	2.00 - 4.00
6	180.0 - 202.5		4.00 - 6.00
7	202.5 - 225.0		6.00 - 8.00

The frequency of occurrence of all possible height-period-direction combinations was estimated. The number of populated wave bin combinations listed in table 2 is 178. For each wave bin, representative wave conditions with percent of occurrence more than 0.5 were selected to represent the normal or the most commonly occurring conditions in the wave climate for this study. Accordingly, 35 wave conditions with total percent of occurrence of about 60 were selected to represent the prevailing wave climate in the study area (Table 3). The Mean-Max summary table for WIS station 63356 was used to extract severe wave conditions. Two wave conditions with extreme wave height and period values were selected to represent storm conditions as shown in Table 3. Wave condition 36 occurred during September 1999 which represents Hurricane Floyd. Wave condition 37 occurred during September 1996 which represents Hurricane Fran. The selected extreme wave conditions had rare occurrences during the hindcast period of 20 years and consequently the percent of occurrence for the two extreme conditions was negligible and is not listed in the table.

Table 3- Representative wave conditions at WIS station 63356

Wave Condition	Wave Direction (deg, from North)	Wave Period (sec)	Wave Height (m)	Percent of Occurrence
1	123.75	4.5	0.75	5.79
2	123.75	7.7	0.75	4.91
3	101.25	4.5	0.75	4.09
4	101.25	7.5	0.75	3.60
5	146.25	4.5	0.75	3.18
6	123.75	7.5	0.25	3.04
7	168.75	4.5	0.75	2.83
8	78.75	4.5	0.75	2.42
9	191.25	4.5	0.75	2.23
10	146.25	7.5	0.75	2.16
11	101.25	7.5	1.25	2.07
12	213.75	4.5	0.75	1.84
13	101.25	4.5	1.25	1.73
14	78.75	4.5	1.25	1.61
15	123.75	4.5	1.25	1.50
16	101.25	7.5	0.25	1.39
17	123.75	7.5	1.25	1.36
18	191.25	4.5	1.25	1.12
19	146.25	4.5	1.25	1.10
20	146.25	7.5	0.25	1.08
21	168.75	4.5	1.25	1.07
22	213.75	4.5	1.25	1.04
23	123.75	4.5	0.25	0.93
24	78.75	7.5	0.75	0.92

25	146.25	7.5	1.25	0.86
26	168.75	7.5	0.75	0.76
27	78.75	7.5	1.25	0.74
28	101.25	10.5	0.75	0.68
29	101.25	7.5	1.75	0.68
30	168.75	4.5	0.25	0.61
31	78.75	4.5	0.25	0.60
32	123.75	7.5	1.75	0.58
33	168.75	7.5	1.25	0.54
34	146.25	4.5	0.25	0.52
35	78.75	4.5	1.75	0.51
36	128	15.47	8.23	Hurricane Floyd
37	120	14.24	5.62	Hurricane Fran

The Surface-Water Modeling System (SMS) (Zundel, 2005) includes the capability to generate incident spectra using a TMA one dimensional shallow-water spectral shape (named for the three data sets used to develop the spectrum: TEXEL storm, MARSEN, and ARSLOE) (Bouws et al. 1985) and a $\cos^{nn}\alpha$. . To generate a TMA spectrum, the following parameters must be specified: peak wave period (*Tp*), wave height, water depth, and a spectral peakedness parameter (γ). The directional distribution of the spectrum is specified with a mean direction and a directional spreading coefficient (*nn*). The energy in the frequency spectrum is spread proportional to $\cos^{nn}(\alpha-\alpha_m)$, where α is direction of the spectral component and α_m is the mean wave direction (Smith et al, 2001). For each of the selected 37 wave conditions, TMA wave spectra were implemented by SMS software.

Figure 10 shows an isopach map of the deposit to determine the volume of the proposed borrow materials. An isopach map is a contour map showing the thickness of a deposit between two physical or arbitrary boundaries. In this case, the upper boundary of the deposit is defined by the surface of the sea bottom and can be delineated by bathymetric data. The lower boundary is the borehole depth which is created by interpolating the scatter borehole data to a uniform grid with a resolution of 20 m. The removal depth is to follow the borehole surface created from the borehole scatter data set. The dredged borrow area provides an estimated volume of 7.2 Mcy of beach placement material.

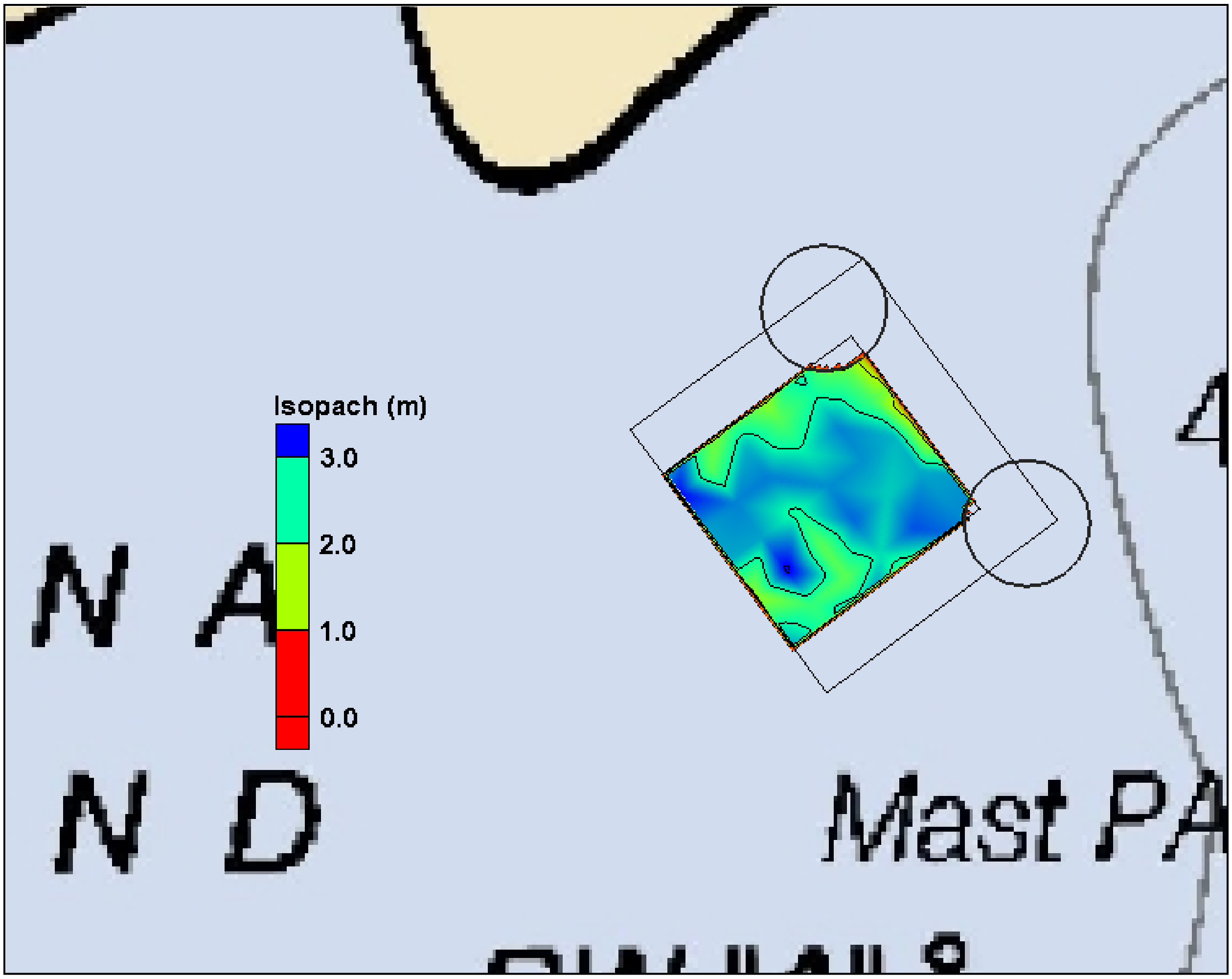

Figure 10- Borrow area isopach

The existing grid bathymetry was modified to incorporate the proposed dredged depths. Figure 11 shows the modified bathymetry of the CMS-WAVE grid at the proposed borrow sites. Therefore the only difference between the before- and the after-dredge CMS-WAVE grids was within the borrow area boxes shown in the figure.

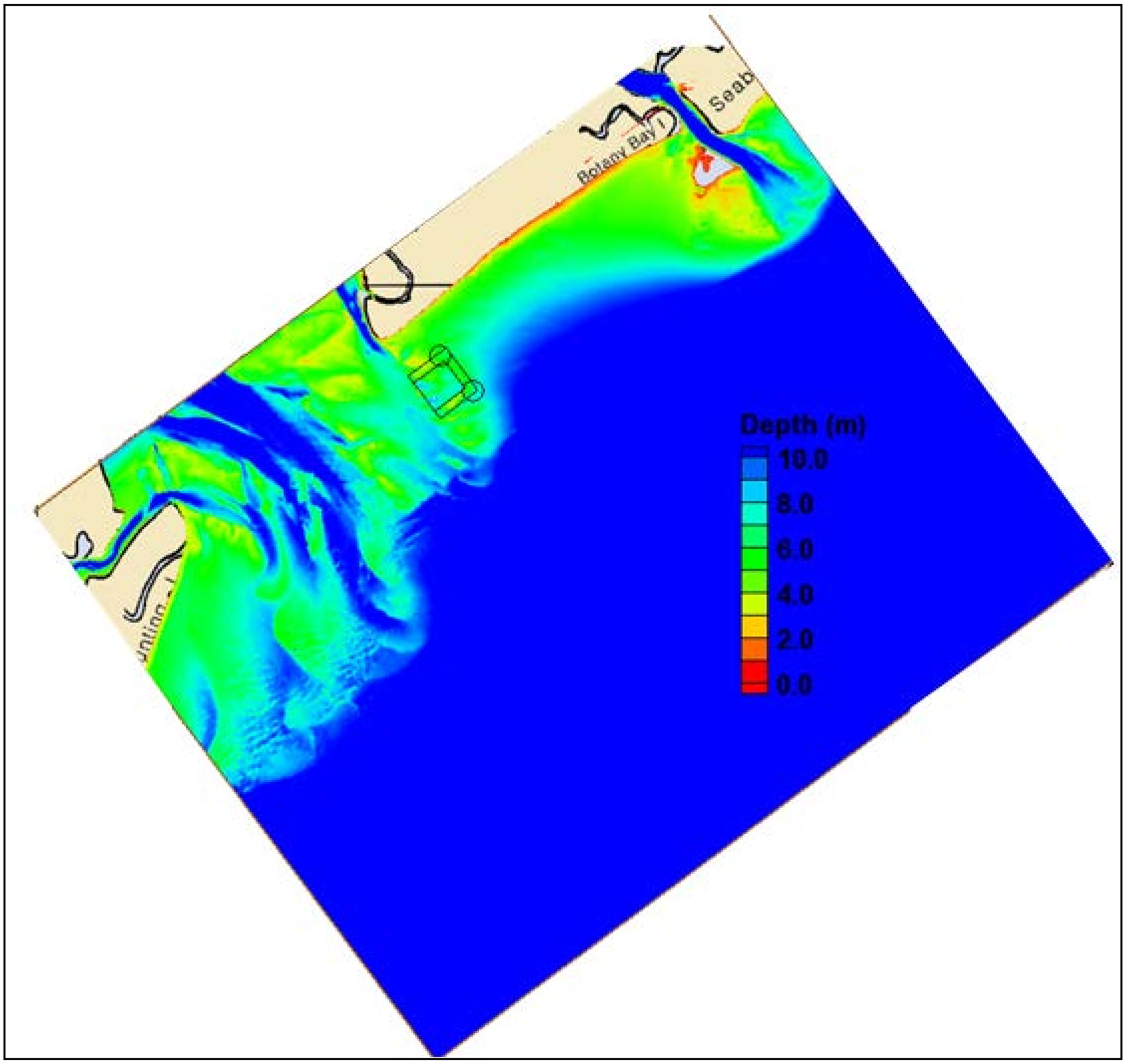

Figure 11- CMS-WAVE grid bathymetry after excavating the proposed borrow area

Wave Model Simulations

CMS-WAVE model simulations were conducted with and without the borrow area excavation to investigate the potential for adverse effects of mining on the wave climate along Edisto Beach shorelines. CMS-WAVE simulations for the synthesized 37 wave conditions were conducted for the existing and after dredging the borrow area grids to investigate the impact of dredging on wave climate in the study area.

This analysis was conducted based upon the assumption of fully excavating the entire borrow area. This extreme borrow area removal is a highly unlikely scenario because the total estimated volume requirements of the project are approximately 3.4 Mcy whereas the simulated excavated volume is approximately 7.2 Mcy. Furthermore, excavation of the borrow area is scheduled to take place periodically over the nourishment project life of 50 years. Therefore, the investigated scenario represents a worst case condition.

When wave angles deviate by about 60 deg or more from perpendicular to the seaward boundary, such model-induced energy losses are usually significant (Thompson, et. al., 1999). Wave conditions within Bin 1 and 7 deviate by 64.75 deg and 70.25 deg from perpendicular to the seaward boundary but since only qualitative comparison of wave height is being investigated in this study, Bin 1 and 7 cases were not rerun with rotated grids.

Wave conditions 1 thru 5 represent about 21.5% of the modeled wave climate with wave height of 0.75 m and South East wave direction. Figure 12 shows the difference in wave height due to excavating the proposed borrow area for wave condition 1 which can be considered representative of the most prevailing wave climate in the area with percent of occurrence of 5.79. The wave height difference was estimated by subtracting the existing wave height values from the excavated borrow area wave height values. The positive wave height difference (cool colors) indicates wave height increase and the negative wave height difference (warm colors) indicates wave height decrease. The arrows in the figure represent the existing wave direction. The figure shows that dredging the borrow areas has minimal change on the wave climate with maximum wave height change of less than 10 cm in the borrow area vicinity. The change in wave height, due to the borrow area excavation, for the 35 prevailing wave conditions was examined and the maximum increase of wave height was about 25 cm within the offshore borrow area vicinity except for wave conditions 29 and 32. The maximum increase of wave height for wave conditions 29 and 32 was about 50 cm and 60 cm respectively within the borrow area. Figure 13 shows the difference in wave height, due to excavating the proposed borrow area, for wave condition 29 with input wave height of 1.75 m, wave period of 7.5 s and wave direction of 101.25 deg. Figure 14 shows the difference in wave height, due to excavating the proposed borrow areas, for wave condition 32 with wave height of 1.75 m, wave period of 7.5 s and wave direction of 123.75 deg. The percent of occurrence of wave conditions 29 and 32 is 0.68 and 0.58 respectively.

Figures 15 and 16 depict wave height change of more than 5 cm in front of the Edisto Beach shorelines. Figure 15 shows that the impact zone of the borrow area significantly increased due to the increase in the wave period (wave conditions 15 and 17). The figures show that the wave height increase never exceeded 25 cm within the nearshore area between the Edisto Beach shorelines and the borrow area. Also, the figures show the shift in the impact zone due to the variations in the spectral wave approach. In addition, the change in wave height was confined within the borrow area and in the nearshore area in front of Edisto Beach and did not extend to the West toward St. Helena Sound or to the East toward Edisto State Park Beach.

Figures 17 and 18 show the wave height change due to excavating the proposed borrow area for wave cases 36 (Hurricane Floyd) and 37 (Hurricane Fran) which represent extreme weather conditions during the 20 years with very rare occurrences. Inclusion of the water level is important for the extreme wave events because otherwise dissipation from depth-induced wave breaking would be overestimated. Therefore, the wave data might be overestimated since surge values were not included in the analysis. Wave transformation was governed by refraction and breaking in the nearshore shallow area in front of the shorelines. Cross-shore transport impact due to storm is not included in this study.

Figure 19 shows the wave height change at six points in the local vicinity of the borrow area for the prevailing wave conditions (1 thru 35). It can be seen from the figure that the maximum wave height increase within the offshore borrow area was approximately 25 cm except for wave conditions 29 and 32. The maximum observed wave height increase in the borrow area vicinity was about 1.8 m and 2.1 m for wave conditions 36 and 37 respectively. Most of the wave height increase in the proximity of the borrow site occurred along the South Eastern and North Western boundaries of the borrow area, mainly due to wave energy focusing at the borrow areas boundaries.

CMS-WAVE estimated the breaker index at each cell of the grid. Grid cells with active breaking are specified with an index of 1 and nonbreaking cells are specified with an index of 0 (Smith et al., 2001). A Transect was delineated, in front of Edisto Beach shorelines, just seaward of the breaker index of 1 for each cell. Figure 20 shows the change in wave height, before and after dredging the proposed borrow area, along the Transect in front of Edisto Beach. The figure indicates a maximum wave height increase of approximately 10 cm along Edisto Beach shorelines. Also, Figure 18 shows the cumulative average wave height difference along the Transect (excluding the two extreme wave conditions).The cumulative maximum average wave height increase was negligible (about 2 cm) along Edisto Beach shorelines. Figure 21 shows the change in wave direction along the Transect with maximum change of about 4 deg. The maximum change in wave height and direction occurred in front of Edisto Beach, between distances 1000 m and 4000 m along the Transect, due to its proximity to the borrow area site.

The four wave transformation processes associated with offshore bathymetric changes due to borrow pits can include wave refraction, diffraction, reflection and dissipation (Tang, 2002).The nearshore bathymetry has significant limiting effect on the amount of wave energy that reaches the shoreline from a given direction (USACE, 2008). Even during extreme wave events, wave heights were small along the Edisto Beach shoreline. This is mainly due to wave dissipation at the nearshore shallow bathymetry in front of the shorelines which provides sheltering to Edisto beach (Figure 22).

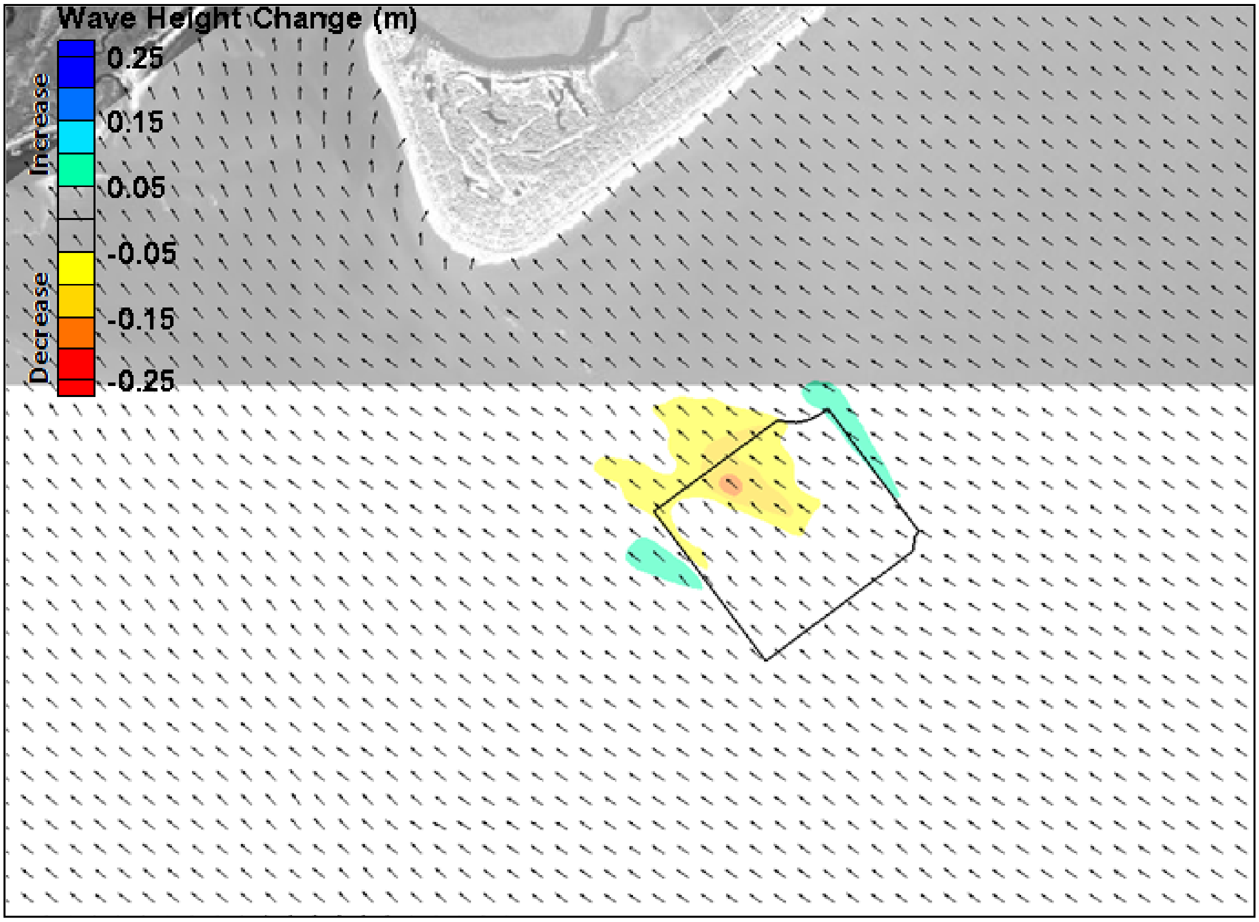

Figure 12- Wave height change for wave condition 1

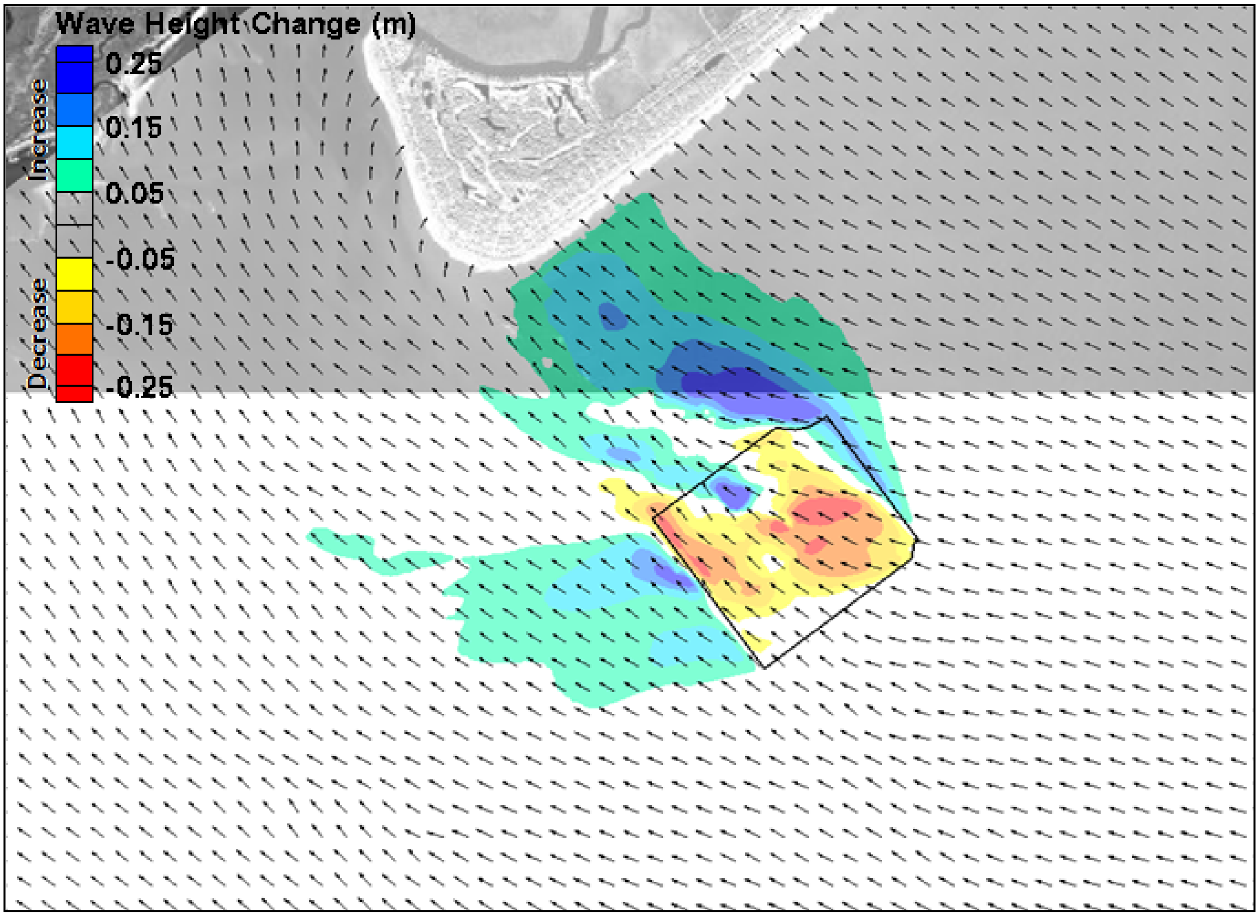

Figure 13- Wave height change for wave condition 29

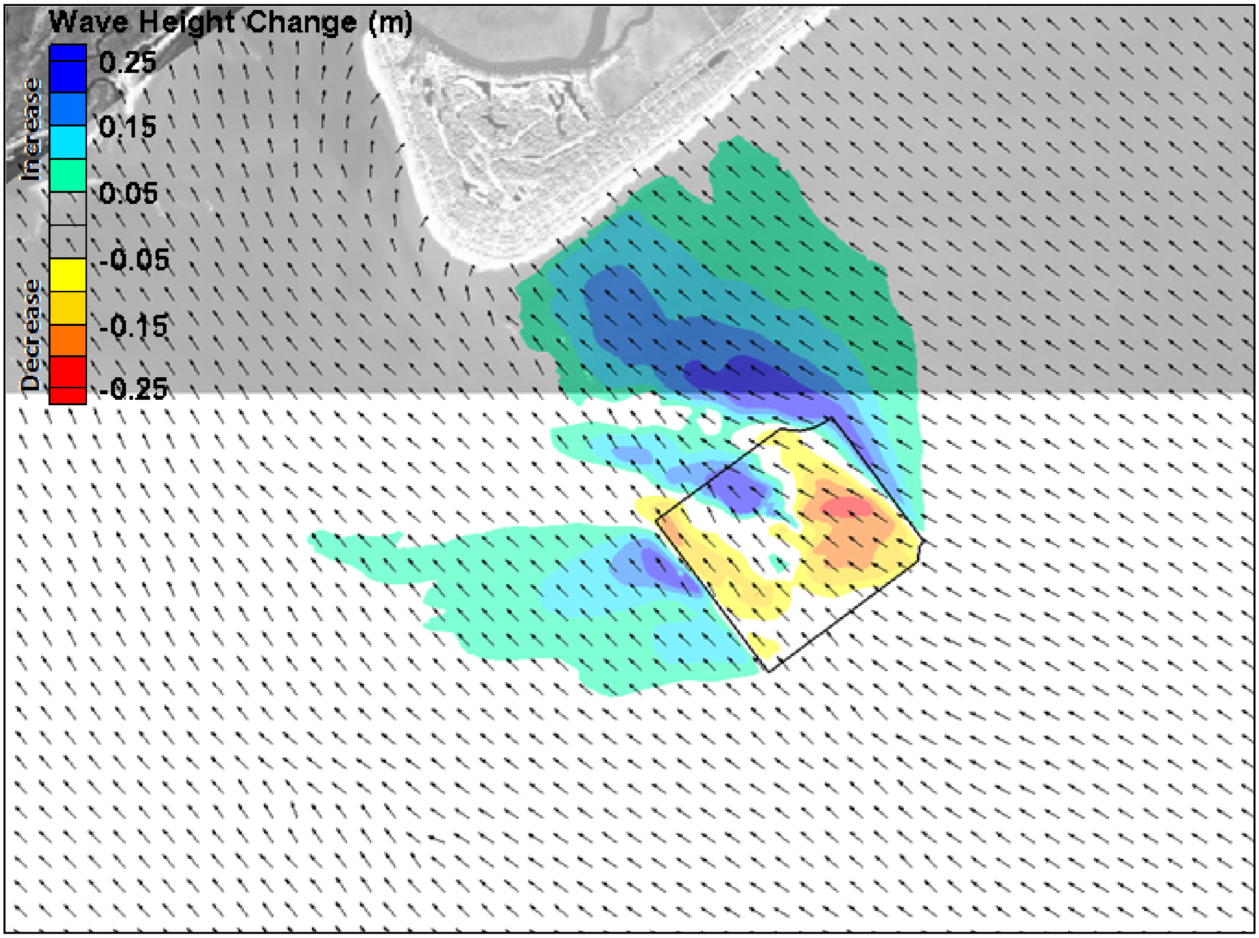

Figure 14- Wave height change for wave condition 32

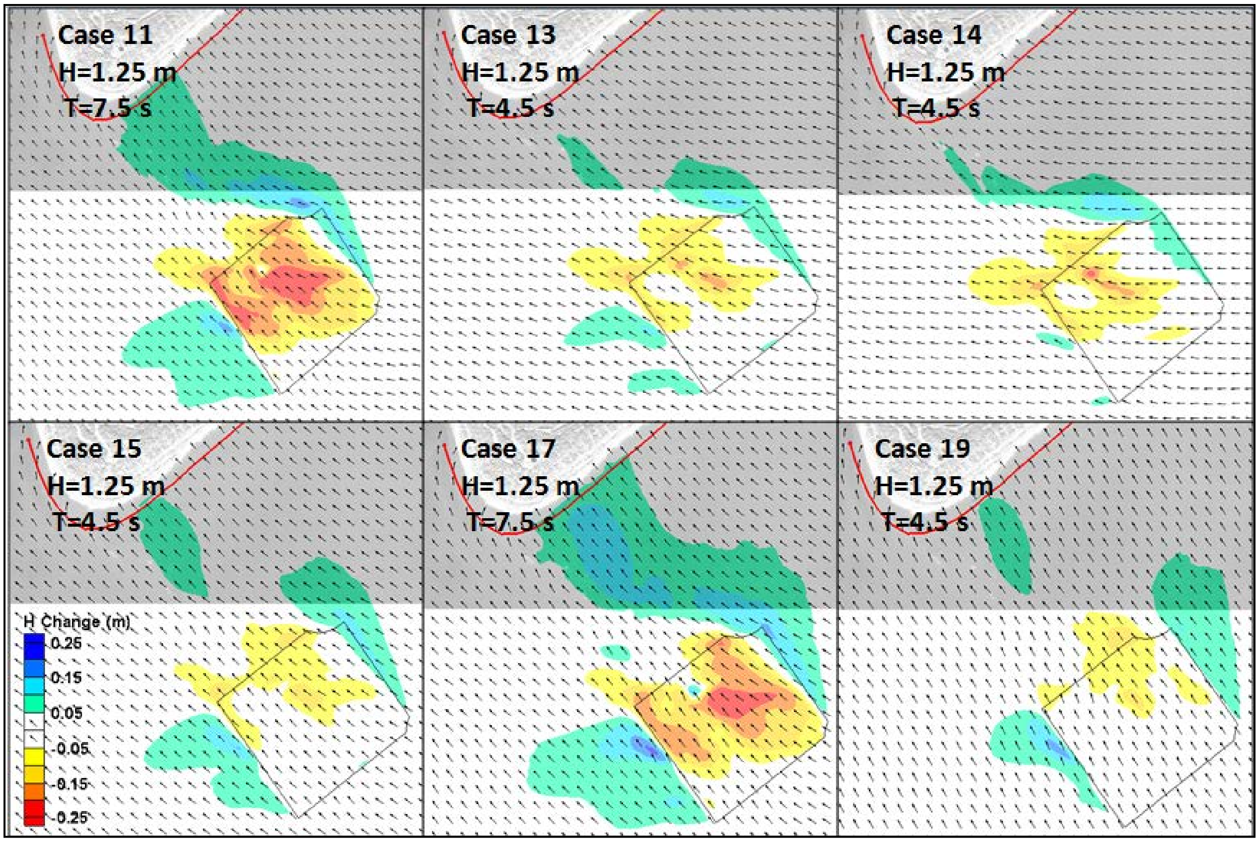

Figure 15- Wave height change for wave condition 11, 13, 14, 15, 17 and 19

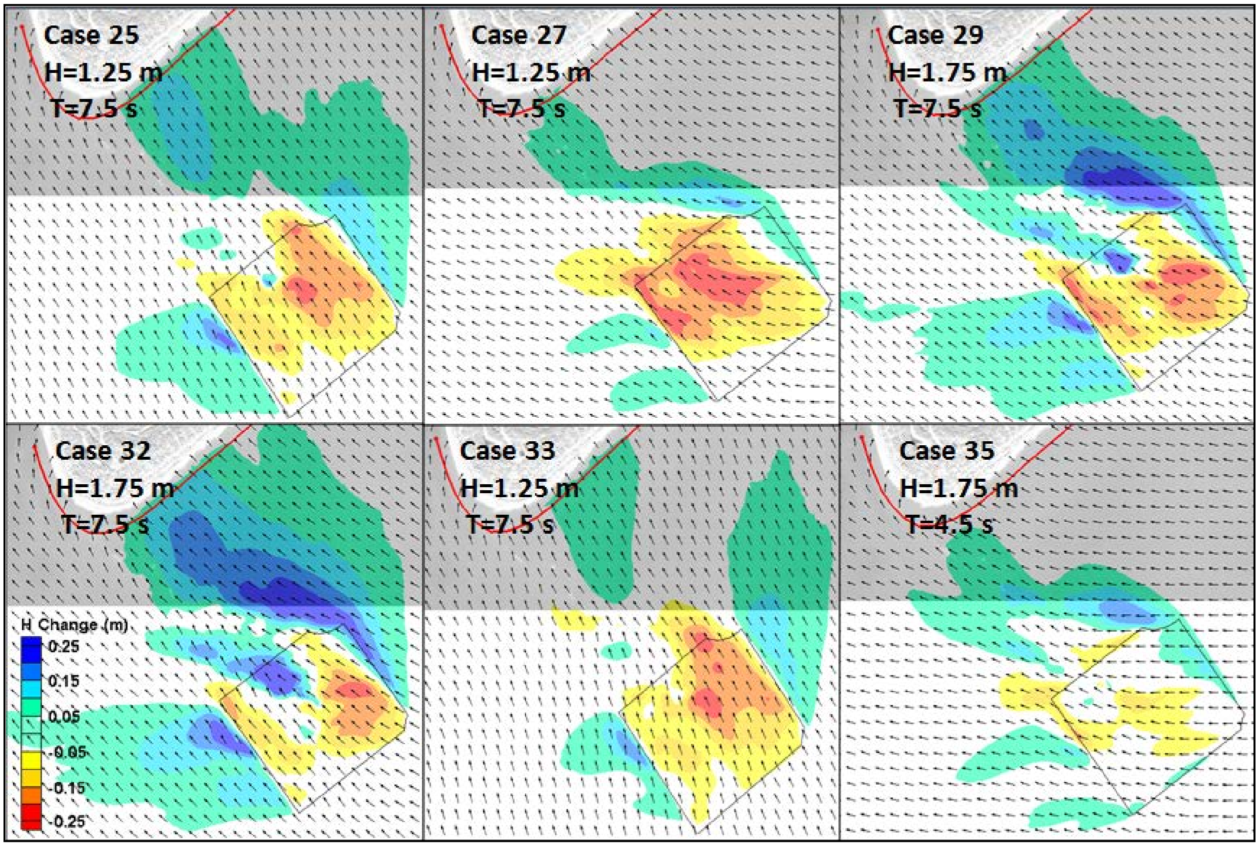

Figure 16- Wave height change for wave condition 25, 27, 29, 32, 33 and 35

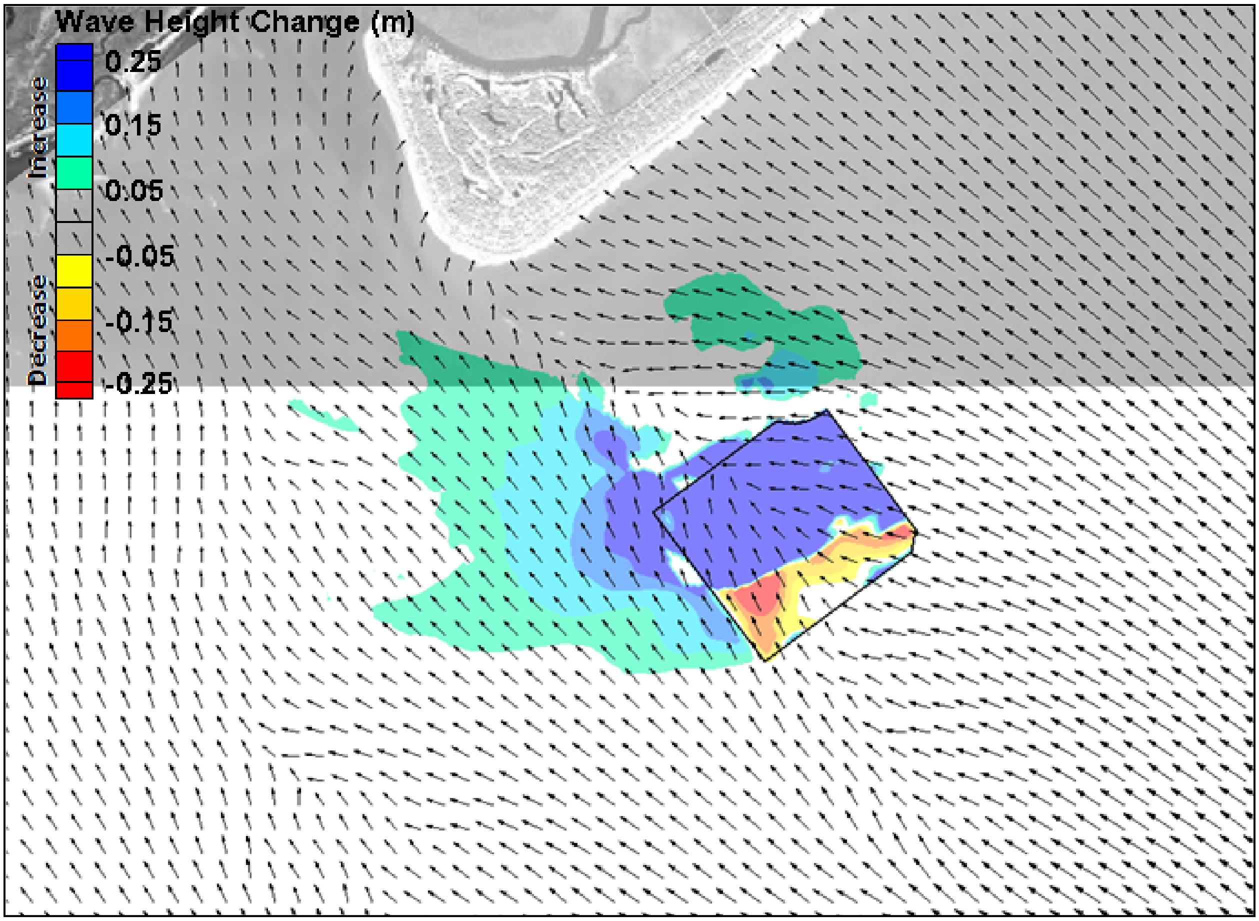

Figure 17- Wave height change for wave condition 36

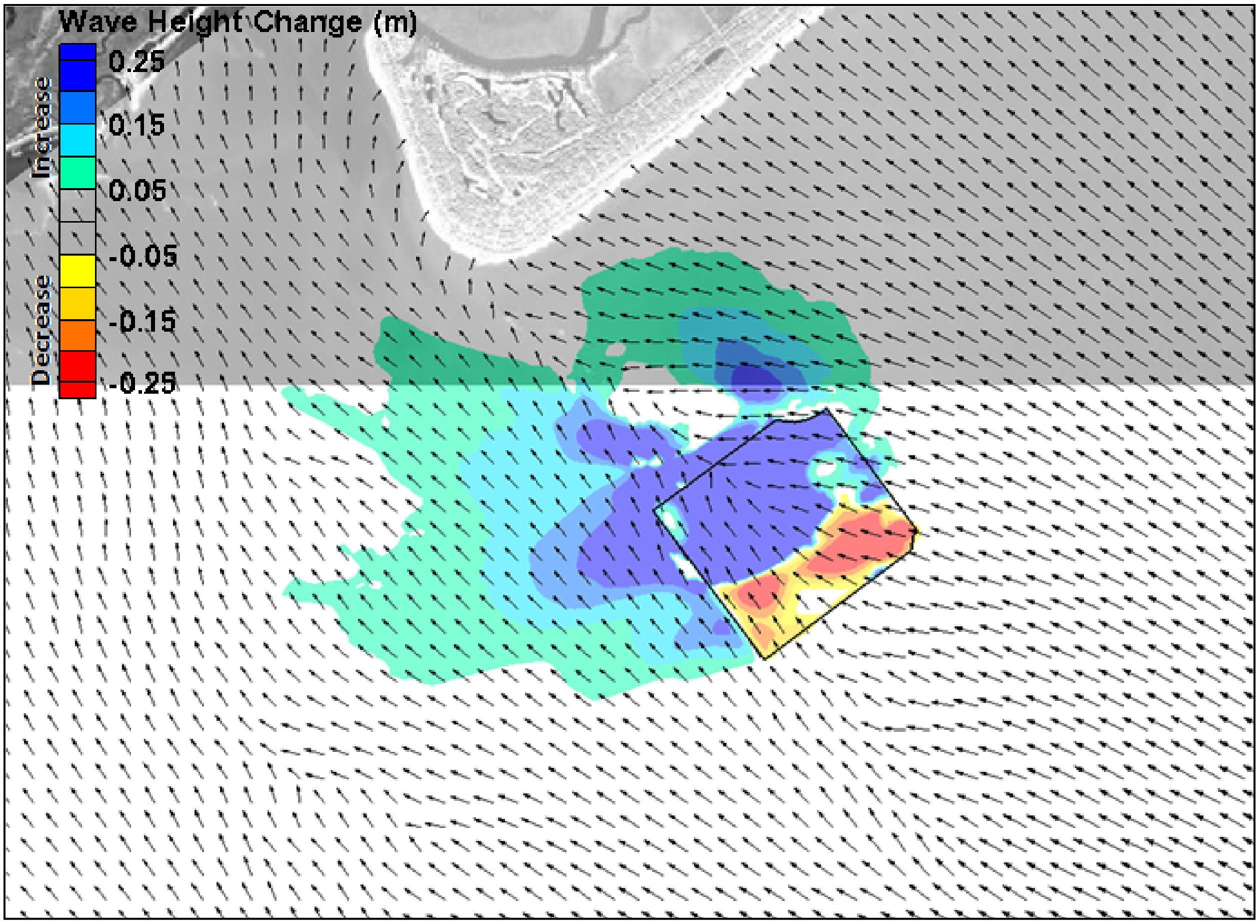

Figure 18- Wave height change for wave condition 37

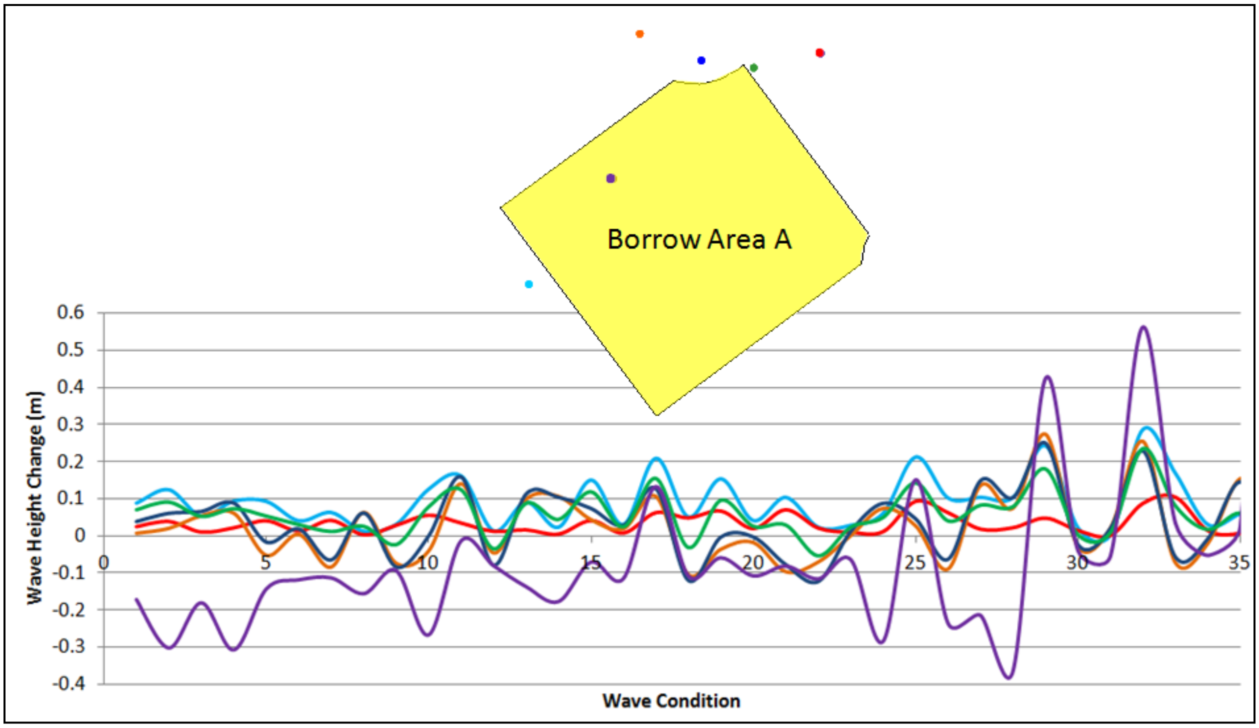

Figure 19-Wave height change at points within the borrow areas vicinity

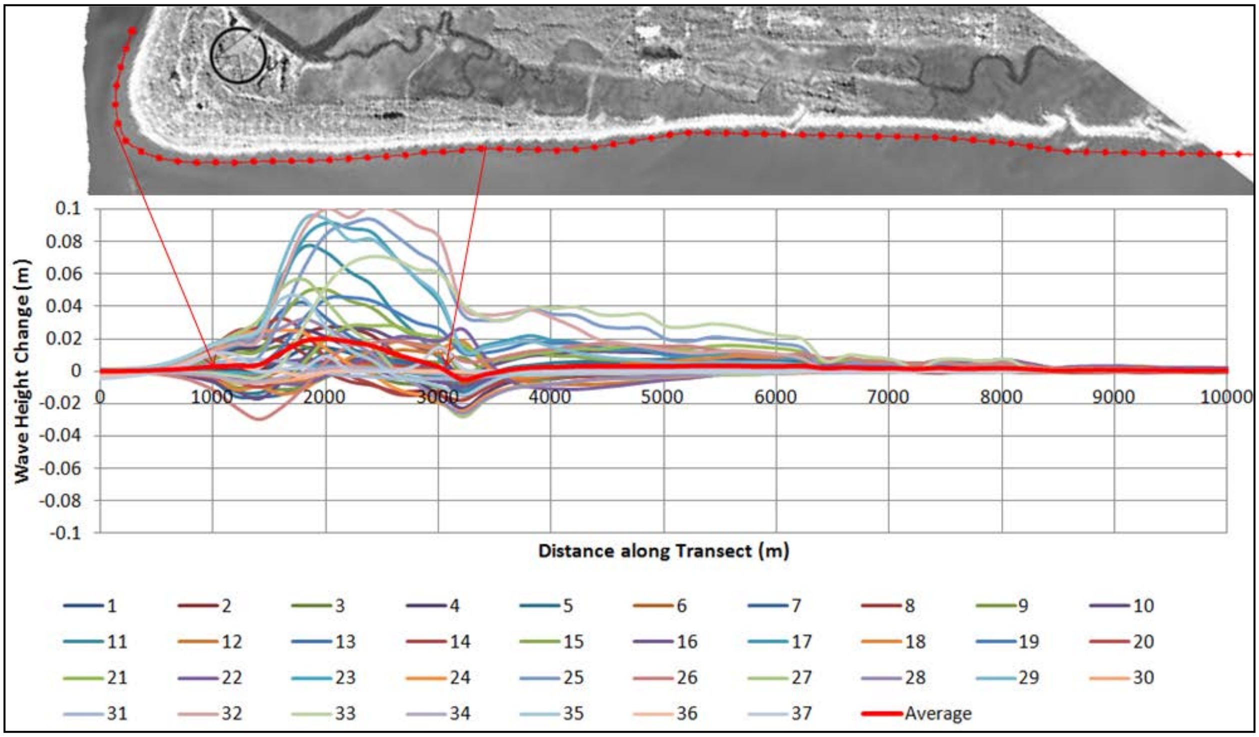

Figure 20-Wave height change along Edisto Beach Transect

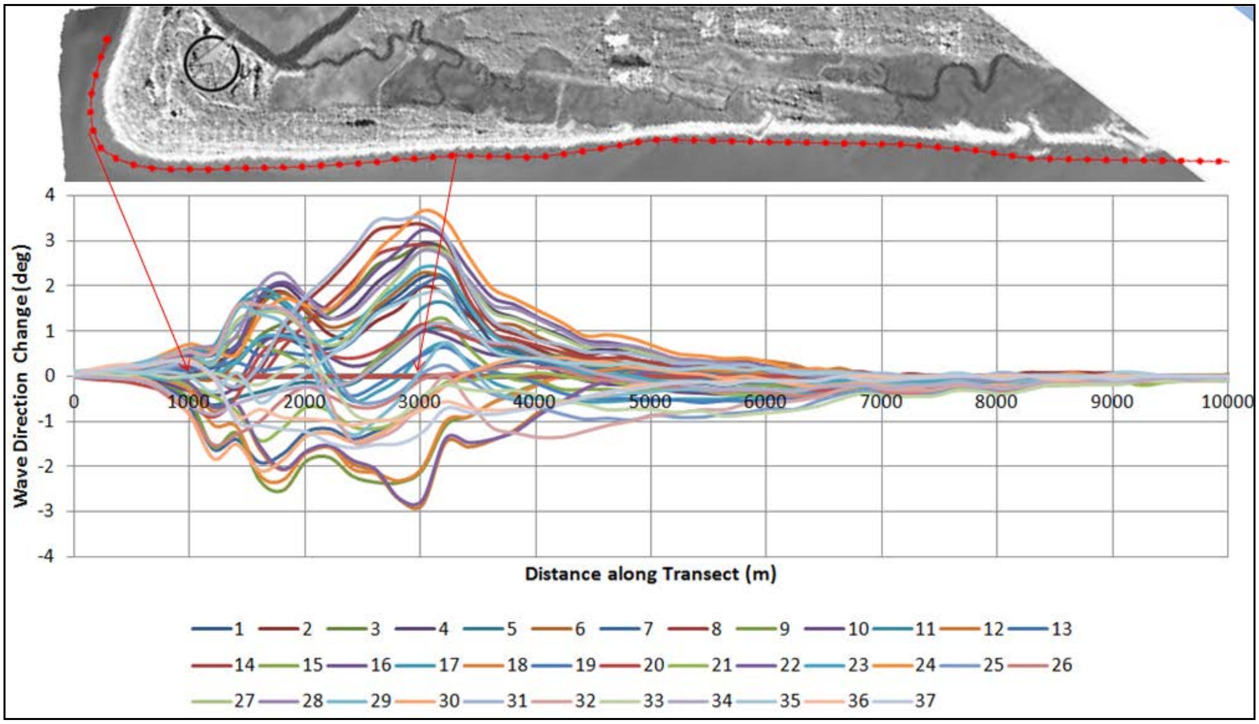

Figure 21-Wave direction change along Edisto Beach Transect

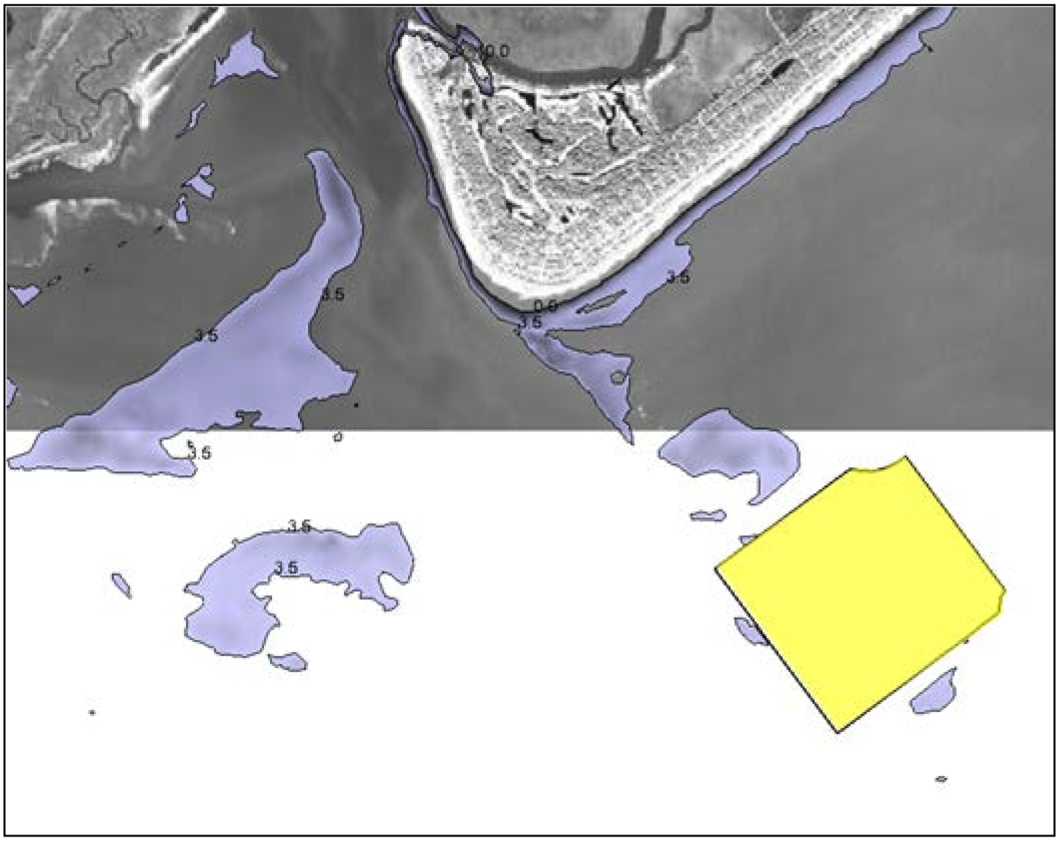

Figure 22-Shoal areas (3.5 m, MTL) in front of Edisto shorelines

Significance of Borrow Area Impacts

The changes in wave height and direction generated at the borrow site may produce corresponding changes in breaking wave height and direction along a broad shadow zone at the shoreline. In turn, changes in breaking wave conditions may potentially alter predicted longshore transport patterns, creating areas of increased erosion or accretion (Olsen, 2007).

USACE (2007) stated that for borrow site studies in Alabama (Byrnes et al., 1999) and New Jersey (Byrnes et al., 2000), the significance of borrow site impacts were evaluated relative to potential error estimates associated with wave height and direction (Rosati and Kraus, 1991). It was concluded that if percent changes in longshore sediment transport caused by offshore sand mining were less than the percent error determined for wave height/direction estimates, the impact was insignificant (Kelley et al., 2001).

Kraus and Rosati (1991) stated that the uncertainty in the longshore transport rate (Q) is defined as:

Uncertainty in Q = Q (wave direction uncertainty + 2.5 wave height uncertainty)

The uncertainty in wave height is greatly amplified compared to the uncertainty in wave angle.

CPE (2007) stated that the error margin of wave direction in the Gulf of Mexico is approximately 10 deg and the root-mean-square difference between WIS hindcast wave height and the measured wave height is 1.2 feet. The largest changes due to excavating borrow area 11 (Panama City Beaches Restoration Project) was 1 foot and 9 deg. Modifications to the wave refraction patterns due to excavation of borrow area 11 were considered minor because the changes to wave height and wave direction were lower than the WIS marginal values. The Gulf of Mexico WIS accuracy values (10 deg and 1.2 ft) are conservative estimate for the WIS Atlantic stations accuracy values (personal communications, Dr. Robert Jensen, ERDC). In this study, the potential longshore transport was not calculated and the change in wave height and direction was used to assess the significance of the borrow area impact. The maximum change of wave height and direction along Edisto Beach shorelines,10 cm and 4 deg, is less than the WIS Atlantic stations accuracy values which indicates that the borrow area impact can be considered insignificant. Olsen (2007) used the Atlantic WIS data to study the impact of borrow area on local wave climate for Bald Head Island NC. The maximum change in wave height of 9 cm along Bald Head Island shoreline was considered insignificant.

Conclusions

CMS-WAVE was used to estimate wave transformation change along Edisto Beach shorelines due to the excavation of proposed borrow area for 50 year nourishment project. WIS station 63356 was used to synthesize the offshore wave climate. Thirty seven simulations were conducted to assess the impact of dredging the borrow areas on wave climate in the study area.

Maximum wave height increase of about 10 cm was observed along Edisto Beach shorelines for the thirty seven wave conditions. Even during extreme weather conditions, maximum wave height increase due to the borrow area excavation was small along Edisto Beach shoreline. The cumulative average wave height increase was also negligible. The maximum change in wave direction along Edisto Beach shorelines was about 4 deg.

The change in wave height was mainly localized within the borrow area and in the nearshore area in front of Edisto Beach and did not extend to the West toward St. Helena Sound or to the East toward Edisto State Park Beach. Maximum increase of wave height of less than 25 cm was observed in the offshore borrow areas vicinity for wave conditions 1 thru 35 except wave conditions 29 and 32. Maximum wave height increase, of about 2.0 m, occurred in the borrow area vicinity only during storms. During a storm event, waves are large even without modifications caused by dredging.

Predicted changes in longshore sediment transport rates resulting from offshore sand mining are expected to have minimal impact along the shoreline. Although changes during storm conditions illustrated greater variation within the borrow area, the relative impacts along the shorelines were similar to non-storm conditions. This is mainly due to dissipating wave energy at the nearshore shallow bathymetry.

This analysis was conducted based upon the assumption of fully excavating the entire borrow area. This extreme borrow area removal is an unlikely scenario because the excavation of the borrow areas is scheduled to take place periodically during the nourishment project life of 50 years. Furthermore, the simulated volume of material excavated from the borrow area is more than twice the estimated volume needed for the beach nourishment project. Therefore, the investigated scenario represents a worst case condition. USACE (2009) stated that the total time for the borrow area to fully recover was estimated at 1.75 years. This recovery rate is expected to farther mitigate the impact of the borrow area mining on Edisto Beach shorelines.

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