APPENDIX A
ENGINEERING, DESIGN, AND COST ESTIMATES

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APPENDIX A
ENGINEERING, DESIGN, AND COST ESTIMATES

1.0. GENERAL

1.1 INTRODUCTION

The purpose of this Engineering, Design and Cost Estimates appendix is to document the engineering, design and cost estimates developed in support of the Willoughby Spit and Vicinity storm damage reduction study.

At the initiation of the study in FY 2007, the Norfolk District USACE prepared a Coastal Engineering Management Plan (CEMP) outlining its proposed plan of analyses for the study. The CEMP is provided in Attachment A-1. The Norfolk District utilized coastal expertise in the Philadelphia District to perform an Independent Technical Review (ITR) of the CEMP. The comments of the Philadelphia District's ITR are also provided in Attachment A-1. The Norfolk District, consulted with the Coastal Hydraulics Lab (CHL) of the Engineering Research & Development Center (ERDC) to address the ITR comments. This process formed the basis for Norfolk District's conduct of the coastal work accomplished in support of the study.

During the study period, the study area was impacted by a severe Northeaster in November 2009. This storm was the second most severe northeaster to impact the study area during the period of record from 1928. The storm was of such significance, that significant coastal work was redone so that the November 2009 northeaster could be fully incorporated into the analysis. A discussion of the November 2009 northeaster is included in the main report. The work presented in this appendix includes the November 2009 northeaster.

1.2 STUDY AREA

The study area includes 7.3 miles of shoreline along the southern shore of Chesapeake Bay in the city of Norfolk, Virginia, as shown on Plates A-1 and A-2. The location and orientation of the shoreline of the study area immediately inside of the mouth of the Chesapeake Bay near the Atlantic Ocean, as shown in Plate A-1, have made this area highly susceptible to erosion and damages associated with coastal storm activity.

2.0 WATER LEVELS

2.1 GENERAL

The most extensive and continuous data record available is for the Sewells Point, Hampton Roads, VA tide gage located just inside Hampton Roads Harbor and approximately 2 miles south of the western end of Willoughby Spit, as shown on Plate A-3. This record extends from August 1927 until the present and is considered representative of the tide history at Willoughby and vicinity for that time period.

According to National Oceanographic and Atmospheric Administration (NOAA), sea level rise (SLR) has averaged a relatively consistent 0.0145 feet per year for the Sewells Point tide gage. All tide levels in these analyses (tidal hydrographs, tide frequency, etc.) will be increased by 0.0145 feet per year from the year that the tide level was actually recorded until the year 2037, the mid-point of the planning period, to account for past and anticipated future increases in sea level.

The tides in the study area are semi-diurnal, with a mean tide range of 2.43 feet at the Sewells Point tide gage on Plate A-4.

2.2 DATUMS

The North American Vertical Datum of 1988 (NAVD 88) will be used for all elevations. Plate A-5 is a datum diagram for the project area.

3.0 TIDAL HYDROGRAPHS

Hourly stillwater elevations were obtained from the Sewells Point NOAA tide gage database for each of the actual storm events that were analyzed. The hourly tide heights for each of the storm events that were analyzed was increased by 0.0145 feet per year from when each of the storm events actually occurred until the mid-point of the planning period of 2037, to account for past and expected future increases in sea level rise.

Although many of the larger coastal studies (with project lengths as great as 83 miles) often synthesize additional storm surge hydrographs based on different tide ranges (spring, mean, and neap) and tide hydrograph phases (high, low, mean rising tide, and mean falling tide), thereby creating 12 different scenarios for each storm analyzed, it is not considered necessary for this particular study given the following:

(a) Any projects associated with this study are likely to have a relatively low initial and low annual investment cost, not warranting the type of refinement identified above.

(b) The mean tide range in the study area is only 2.43 feet, with the spring tide range of 2.95 feet (spring high tide only 0.26 feet greater than mean high tide).

(c) The new or full moon (spring tide) only coincides with perigee 3 to 4 times a year (less than 0.5% of the tide cycles in a year would be expected to have a spring tide occur coincident with the perigee) and the difference between the perigean spring tide and the normal tidal range for all areas of the coast is small (1 to 2 inches per NOAA website).

(d) For this study, all tidal elevations were increased approximately 0.4 feet to account for future sea level rise until the mid-point of the period of analysis. This adjustment alone is greater than the difference in the mean and spring high tide elevations.

(e) Northeasters, which comprise approximately 60% of the storms that will be analyzed in this analysis, typically have a duration of several days or more. Because of how these storms slowly spin up and slowly spin down and the fact that a tide cycle is only slightly more than 12 hours, it stands to reason that the actual peak of the storm will essentially coincide with a high tide.

(f) Although one would typically consider the timing of the landfall of a hurricane or tropical storm critical to the timing of the tide cycle, this has generally not been the case within the southern Chesapeake Bay region. The tropical system that adversely impacts the southern shoreline of the Chesapeake Bay generally makes landfall to the south of the area, in North Carolina, and passes over or to the west of the study area. The storm surge that is pushed ahead of the storm must then propagate through the mouth of the

Chesapeake Bay and is further influenced by the tropical system as it passes inland and over or west of the study area. The typical travel time from landfall to the south in North Carolina until the storm passes to the north of the study area is on the order of a tide cycle. During this entire time, the winds in the study area are onshore; thus, the maximum storm surge and wave heights are generally coincident and are of sufficient duration that they are also coincident with or very near the time of the predicted high tide. The August 1933 Hurricane and Hurricane Isabel are perfect examples of this, with the maximum surge occurring near the time of the predicted high tide.

Plates A-6 through A-9 provide the tidal hydrographs for the August 1933 and September 2003 hurricanes as well as the March 1962 and September 2009 northeasters.

4.0 FLOOD PROBABILITY - STILLWATER FREQUENCY ANALYSIS

A tidal frequency relationship was developed for the Hampton Roads, Sewells Point tide gage for the 1928 to 2010 period of record. The U.S. Army Corps of Engineers' Flood Frequency Analysis (FFA) Version 3.1 computer program, developed by the Corps of Engineers' Hydrologic Engineering Center (HEC) in accordance with the Hydrologic Subcommittee, Guidelines for Determining Flood Flow Frequency Bulletin 17-B, was utilized in developing the peak stage frequency based on the annual peaks that will have been adjusted for historic sea level rise. The partial duration adjustment was incorporated by plotting all independent tidal events that have been adjusted for sea level rise above elevation 4.0 feet NAVD 88.

Table A-1 shows the results of the annual peaks frequency analysis. Plates A-10 and A-11 show the annual peaks and annual peaks with partial duration stillwater frequency plots. The adopted stillwater frequency for the Willoughby, including partial duration, is shown in Table A-2.

Table A-1. FINAL RESULTS OF FREQUENCY CURVE FOR NORFOLK HARBOR (1)

Expected Computed	Exceedance probability	probability	Confidence limits 0.05 limit	0.95 limit
8.2	8.4	0.002	8.8	7.7
7.5	7.7	0.005	8.0	7.1
7.0	7.1	0.010	7.4	6.6
6.4	6.5	0.020	6.8	6.1
5.7	5.8	0.040	6.0	5.5
5.2	5.2	0.100	5.4	5.0
4.6	4.6	0.200	4.8	4.4
3.8	3.8	0.500	4.0	3.6
3.3	3.3	0.800	3.5	3.1
3.2	3.2	0.900	3.4	3.0
3.1	3.1	0.950	3.3	2.9
3.0	3.0	0.990	3.2	2.8

Frequency curve statistics		Statistics based on:	
Mean	4.02	Historic events	0
Standard deviation	0.85	High outliers	0
Computed skew	1.68	Low outliers	0
Generalized skew	-99.00	Zero or missing	0
Adopted skew	1.70	Systematic events	83

(1) All elevations are annual events in feet, NAVD.

Table A-2. ADOPTED FREQUENCY OF STILLWATER LEVELS

Exceedence Frequency	Stillwater frequency In feet, NAVD
0.5	4.1
0.2	4.6
0.1	5.2
0.05	5.7
0.02	6.5
0.01	7.1
0.005	7.6
0.002	8.4

5.0 STORM SELECTION AND PROBABILITY

To control study costs and reduce the study time without adversely impacting the results or findings of the study, it was decided to utilize existing data from the Flood Evaluation and Protection Study for Fort Monroe, Virginia that was prepared by the Norfolk District, U.S. Army Corps of Engineers in May 2005. As illustrated on Plate A-2, Fort Monroe is located approximately 2 miles northwest of the western end of Willoughby Spit on the western shoreline of the Chesapeake Bay.

A review of the tide data for the Sewells Point tide gage during the Fort Monroe study for the period 1928 to 2010 indicated that there were 42 storm events that, once adjusted for historic sea level rise, would have produced maximum stillwater levels of approximately +4.0 feet NAVD 88 or higher. The period of record was expanded to include events from 1928 to 2010 to include the November 2009 northeaster. These events included 12 tropical storm/hurricane type storm events and 30 northeaster (extra-tropical) type storm events and are provided in Table A-3.

Elevation +4.0 feet NAVD 88 also appears reasonable to use as a threshold value for the Willoughby Spit and Vicinity study below which inclusion of storms into the analysis would not influence the results of the study. This conclusion is based on the fact that the threshold value is only 2.8 feet higher than the mean higher high water level, is only slightly above the existing +3.5 feet NAVD berm elevation, and there is no infrastructure or damageable inventory bayward of the existing dune/structure locations.

To efficiently perform the required analyses during the Fort Monroe study, it was necessary to reduce the number of events that were analyzed. Thus, the data set was reviewed and seven tropical storms/hurricanes and eight northeasters were selected for analysis based on representative tidal hydrographs to effectively represent the range of storm intensities and durations that could be expected. During the Willoughby Spit and Vicinity study, this set of storms was increased to include the November 2009 Northeaster. The 16 selected storms are summarized in Table A-4.

Table A-3. 8638610, SEWELLS POINT, HAMPTON ROADS, VA
1928 - 2010 MAXIMUM STAGES ABOVE +4.0 FEET NAVD 88

HURRICANES				NORTHEASTERS			
Rank	Date	Name	Peak Stage (1)	Rank	Date	Name	Peak Stage (1)
1	8/23/1933	Aug '33	7.51	1	3/7/1962	Ash Wed.	6.29
2	9/18/2003	Isabel	6.37	2	11/12/2009		6.12
3	9/18/1936	Sep '36	6.17	3	4/11/1956		5.48
4	9/16/1933	Sep '33	5.61 (P)	4	4/27/1978		5.25
5	9/27/1956	Flossy	5.08 (P)	5	2/5/1998	Twin N.E.	5.13
6	9/12/1960	Donna	5.02	6	11/22/2006		5.06
7	9/19/1928	Sep '28	4.88	7	10/7/2006		4.95 (P)
8	9/13/1964	Dora	4.66	8	10/6/1957		4.76
9	9/16/1999	Floyd	4.50	9	10/5/1948		4.69
10	9/25/1992	Danielle	4.20	10	10/25/1982		4.68
11	8/28/1998	Ivan	4.09	11	1/28/1998	Twin N.E.	4.59 (P)
12	8/17/1986	Charley	4.04	12	12/19/2009		4.54 (P)
				13	11/4/1930		4.45
				14	10/21/1958		4.45
				15	7/3/1933		4.41 (P)
				16	1/24/1940		4.31
				17	10/21/1961		4.31 (P)
				18	4/13/1988		4.29
				19	10/14/1977		4.27
				20	9/25/2008		4.26
				21	1/1/1987		4.14
				22	2/6/2010		4.13
				23	8/30/1999		4.11 (P)
				24	10/19/1997		4.10
				25	12/5/1945		4.04
				26	10/12/1942		4.03
				27	1/17/1946		4.02
				28	2/11/1973		3.99
				29	1/25/2000		3.99
				30	10/31/1991		3.98

(1) Highest Peak Stages after adjustment for Historic Sea Level Rise of 0.0145 feet per year.
(P) Partial Duration, higher annual peak exists

Table A-4. 8638610, SEWELLS POINT, HAMPTON ROADS, VA
1928 - 2010 STORMS ANALYZED

HURRICANES				NORTHEASTER			
Storm	Date	Name	Peak Stage (1)	Storm	Date	Name	Peak Stage (1)
1	8/23/1933	Aug '33	7.51	1	3/7/1962	Ash Wed.	6.29
2	9/18/2003	Isabel	6.37	2	11/12/2009		6.12
3	9/18/1936	Sep '36	6.17	3	4/11/1956		5.48
4	9/16/1933	Sep '33	5.61 (P)	4	4/27/1978		5.25
5	9/12/1960	Donna	5.02	5	10/25/1982		4.68
6	9/16/1999	Floyd	4.50	6	10/21/1958		4.45
7	8/17/1986	Charley	4.04	7	10/14/1977		4.27
				8	1/1/1987		4.14
				9	10/31/1991		3.98

(1) Highest Peak Stages after adjustment for Historic Sea Level Rise of 0.0145 feet per year.
(P) Partial Duration, higher annual peak exists

6.0 WAVE DATA

Wave data, including wave heights, direction, and period, were developed for the Fort Monroe Flood Evaluation and Protection Study in 2004 to evaluate wave run-up and overtopping. The Corps of Engineers study team identified 5 locations, as shown on Plate A-12, immediately offshore of Fort Monroe that wave data would be generated by OCTI and used in the analysis. This wave data was developed under contract by Offshore & Coastal Technologies, Inc. (OCTI) for the seven historic hurricanes and eight northeasters that were evaluated in the study. The wave data were propagated to the area immediately offshore of Fort Monroe. As seen on Plates A-2 and A-3, this data is located approximately 2 miles northwest of the western end of Willoughby Spit and is considered representative of the waves that the Willoughby and vicinity study area would experience.

The waves were simulated in the Chesapeake Bay entrance using a time-varying directional spectral wave model referred to either as WAVAD or WISWAVE (Wave Information Study WAVE), and STWAVE (STeady State spectral WAVE), a steady-state model of the same type that was used for the nearshore areas. WISWAVE predicts directional spectra as well as integrated wave properties such as significant wave height, peak wave period, vector mean wave direction, and sea and swell components according to atmosphere wind inputs. STWAVE simulates wave transformation, including wave refraction and shoaling, over complex bathymetry; wave current interaction; local wave growth associated with wind input; and, depth- and steepness-induced wave breaking and diffraction.

A more detailed discussion of the wave study accomplished by OCTI, including model development and verification, is provided in Attachment A-2.

In the mid-2000s, a Nortek AWAC-AST wave gage was deployed offshore of the study area by the city of Norfolk. The AWAC (Acoustic Wave And Current) gage is a combination acoustic Doppler current profiler and directional wave gauge employing a unique Acoustic Surface Tracking (AST) vertical beam to measure the surface waves from a subsurface location. At the initiation of the study, it was felt the limited time the gage had been operational and the absence of significant storm events during this brief period that no additional wave data analysis was anticipated for the accomplishment of this study. However, the wave gauge was utilized to obtain data to model the November 2009 Northeaster. The location of the wave gauge is shown on Plate A-13.

7.0 REACH DELINEATION-ESTABLISHMENT OF REACHES

Norfolk District Corps of Engineers utilized profile data, hydrographic survey data, topograpghic survey data and aerial photographs in determining that 13 morphologically different areas exist along the 7.3 miles of shoreline. The reaches exhibit similar profile data and a constant orientation to the Chesapeake Bay. The reaches include five separate areas with existing breakwater structures, several different orientations of the shoreline, and a much shallower area on the west end of Willoughby Spit that extends onto the Willoughby Bank shoal. The 13 reaches are shown on Plate A-14.

8.0 PROFILE DATA

8.1 AVERAGE PROFILES PER REACH

Beach profiles have been developed within the study area over a considerable period by various interests and entities. These profiles were developed for various purposes and needs and were collected both intermittently in time (some following storm activity, some pre- and post-beachfill or construction of coastal structures such as breakwaters) and intermittently spatially (some extending to wading depth only, some extending considerably offshore, some only in isolated reaches of interest along the beach, etc.) In addition, some of this data is available electronically, but some of the data is only available in a hard copy format. Thus, the use of these profiles in developing morphologically representative beach profiles to represent existing conditions is somewhat questionable.

However, there are two beach profile surveys (September 2005 and March 2006) that were conducted by the city of Norfolk covering the entire 7.3 miles of study area. As shown in Figure 3, there are approximately 106 profiles spaced along the entire 7.3 miles of shoreline (interval varies from 250 to 1,500 feet) that extend well offshore (1,200 to 8,000 feet) to a depth of approximately 20 feet. Based on a review of the profile data, a closure depth of 14 was selected for use in this study. These two profile data sets were utilized during this feasibility study to develop morphologically representative beach profiles since they represent the best estimate of profile conditions that are expected to exist at the beginning of any storm in the future. The locations of the profiles are shown in Plate A-15.

The BMAP component of the Coastal Engineering Design and Analysis System (CEDAS) software developed by the Corps of Engineers' Coastal Hydraulics Laboratory (CHL) was utilized to first develop an average profile at each profile location and then these average profiles were grouped and averaged with adjacent and similar profiles to develop the representative profiles for each of the 13 reaches.

Subsequent to the initiation of this study, the area experienced the November 2009 Northeaster. Profile data was obtained in the fall of 2010 which was also analyzed to see if there were any significant changes in the profile data. Since the base condition essentially remained the same, the work based on the original set of average profiles was considered valid.

The original survey information was sufficient to perform beach/dune response modeling; however, economic damage assessment requires evaluation of damage potential landward of the first row of development. Therefore, the profiles were manually extended in a landward direction until the profile extended through the damage zone. These extensions were based on general characteristics of the topography as determined from topographic mapping.

8.2 IDEALIZED PROFILE DEVELOPMENT

The Beach-*fx* Users Manual contains the following discussion of the Simplified (Idealized) Profiles.

"Coastal process models need to use a detailed distance vs. elevation (X, Z) representation of the beach profile. The amount of data required for such a representation is not needed in an economic-engineering type model such as Beach-*fx* and so a simplified representation for the profile has been adopted. This simplified representation for the profile uses eight key features which include:

1. Dune Width;
2. Dune Height;
3. Dune Slope;
4. Foreshore Slope;
5. Upland Elevation;
6. Upland Width;
7. Berm Width; and
8. Berm Height.

The simplified Beach-*fx* Profile is represented schematically in Plate A-16 and the following assumptions apply:

1. A single dune;
2. A single berm (constant elevation); and
3. A representative (static) submerged profile.

Norfolk District Corps of Engineers utilized profile data, hydrographic survey data, topographic survey data and aerial photographs in determining the idealized profile appropriate for each reach. After the November 2009 northeaster, the idealized profiles were re-examined and found there was not significant change to the base condition previously determined. The location of the idealized profiles is shown on Plate A-17. An example of an average and idealized profile is shown in Plate A-18. The existing condition idealized profiles have dune crest elevations ranging from 5 to 12 feet, NAVD and berm widths ranging from 1-foot to 56 feet. The average dune elevation for the entire reach is less than 10 feet, NAVD while the average berm width is 20 feet.

The point where the upland and dune intersect was selected along the base of the existing dunes. If the project moves forward this “construction baseline” would need to be carefully reviewed to minimize any encroachments on private property while maintaining the integrity of the dune line.

9.0 SBEACH

The U.S. Army Corps of Engineers’ Storm-induced Beach Change Model (SBEACH) software developed by the Coastal Hydraulics Laboratory (CHL) was utilized to determine the short term beach profile response for each of the 16 modeled storms for the existing condition and each with project condition that will be analyzed. The existing condition is expected to represent future conditions in the base year 2012 as well as throughout the planning period based on the city’s past nourishment activities. The outputs from SBEACH will be utilized to populate the Storm Response Database for the Beach-*fx* modeling.

9.1 OVERVIEW OF SBEACH METHODOLOGY

SBEACH Version 4.03 in CEDAS was used in this analysis. SBEACH is a geomorphic-based two-dimensional model that simulates beach profile change, including the formation and movement of major morphologic features such as longshore bars, troughs, and berms under varying storm waves and water levels (Rosati et al., 1993). SBEACH has significant capabilities which make it useful for quantitative and qualitative investigation of short-term beach profile response to storms. However, since SBEACH is based on cross-shore processes, there are shortcomings when used in areas having significant longshore transport.

Input parameters include varying water levels as produced by storm surge and tide, varying wave heights and periods, and grain size in the fine-to-medium sand range. The initial beach profile can be input as either an idealized dune and berm configuration, or as a surveyed total profile configuration. SBEACH allows for variable cross-shore grid spacing, simulated water-level setup due to wind, advanced procedures for calculating the wave breaking index and breaker decay, and provides an estimation of dune overwash. Shoreward boundary conditions that may be specified include a vertical structure (that can fail due to either excessive scour or instability caused by wave action/water elevation) or a beach with a dune. Output results from SBEACH include calculated profiles, cross-shore parameters, and a report file.

9.1.1 Model Parameters. Various model parameters required to run SBEACH are input into the reach and storm configuration files. The reach configuration parameters include grid data, profile characteristics, beach data (including grain size), sediment transport parameters, and seawall or bulkhead data. The storm configuration file includes information on wave angle, height and period, water elevation, and other storm information.

9.1.2 Water Elevation. The water level is the most important or first-order forcing parameter controlling storm-induced beach profile change, normally exerting greater control over profile change during storms than either waves or wind. Water level consists of contributions from the tide, storm surge, wave- and wind-induced setup, and wave run-up; the latter three are computed within SBEACH. Input data in this case is tide and storm surge data. The combined time series of tide and surge is referred to as the hydrograph of total water level.

The shape of the hydrograph is characterized by its duration (time when erosive wave conditions and higher than normal water elevation occur) and by its peak elevation. Water level input data files for the sixteen storms modeled were developed and used.

9.1.3 Wave Height, Period, and Angle. Elevated water levels accompanying storms allow waves to attack portions of the profile that are out of equilibrium with wave action because the area of the beach is not normally inundated. Wave height and period are combined in an empirical equation within SBEACH to determine if the beach will erode or accrete for a time step. In beach erosion modeling, a storm is defined neither by the water level nor by the wave height or period alone; it is defined by the combination of these parameters that produces offshore transport. The SBEACH Version 4.03 allows for the input of random wave data, meaning waves with variable height, period, and direction or angle. Storm wave data for the fifteen historical/representative events used in this analysis were generated and or based on the wave hindcast described. Storm wave heights, as well as water levels, were based on hindcasted actual storm time series. The parameters for the November 2009 northeaster were obtained from wave gauge data.

9.1.4 Storm Parameters. The hindcast storm hydrograph, adjusted for sea-level rise, was used in the SBEACH modeling. Of the sixteen storm events modeled, nine are northeasters and seven are hurricanes. The set of northeasters includes the measured data from the November 2009 northeaster. The duration of hurricanes is generally less than the average duration of northeasters. Selected storm parameters of the sixteen modeled storms are listed in the following table.

Table A-5. STORM PARAMETERS

Storm Event	Event probability	Maximum stillwater level (1) (NAVD)	Duration wave > 2ft (hours)	Maximum wave height (feet)	Maximum period (sec)
		Hurricanes			
August 1933	0.005	7.51	42	9.65	14
September 2003 (Isabel)	0.024	6.37	43	8.50	14
September 1936	0.030	6.17	65	7.81	14
September 1933	0.060	5.61	71	8.96	20
September 1960 (Donna)	0.120	5.02	34	7.81	11
September 1999 (Floyd)	0.250	4.50	30	7.12	11
August 1986 (Charley)	0.500	4.04	17	5.51	11
		Northeasters			
March 1962 (Ash Wed)	0.026	6.29	95	4.59	14
November 2009	0.032	6.12	76	5.72	13
April 1956	0.070	5.48	51	4.36	14
April 1978	0.090	5.25	49	4.82	14
October 1982	0.190	4.68	70	7.81	14
October 1958	0.270	4.45	102	7.58	14
October 1977	0.340	4.27	29	3.44	11
January 1987	0.420	4.14	13	3.90	11
October 1991 (Halloween)	0.560	3.98	78	5.28	20

(1) Includes historic sea level rise through 2010.

9.2 SBEACH CALIBRATION

Calibration refers to the procedure of using SBEACH to reproduce the change in profile shape produced by an actual storm. The city of Norfolk has conducted a number of coastal studies on the Willoughby shoreline. The Corps of Engineers was able to take advantage of this work which included SBeach models for the study area that had been calibrated for smaller storms. The model coefficients from this work were used in the initial SBeach work accomplished in support of the study. This was considered appropriate since there were no existing pre and post profile data for the storms being modeled.

However, the city of Norfolk was able to provide both pre and post storm profiles for the November 2009 northeaster along with water level and wave data. Norfolk District utilized this data to replicate the November 2009 northeaster utilizing the model coefficients developed previously by the city and used in the earlier SBeach modeling. The results of the November 2009 calibration runs matched fairly well to the city's post storm profiles. Plate A-19 provides an example of the SBAECH modeling results.

9.3 SBEACH RUNS TO DEVELOP STORM RESPONSE DATABASE (SRD) INCLUDING SBEACH DATA GENERATOR DEVELOPMENT OF ALTERNATIVE PROFILES

The creation of the Storm Response Database (SRD) required for the Beach-*fx* modeling requires the running of SBeach simulations from the minimum profile to the maximum profile expected to be constructed. These results are then exported as an SRD which Beach-*fx* can utilize in it simulation runs. The only plans that were modeled were berm only plans and dune and berm plans. The following paragraphs discuss some of the features modeled for the Willoughby study.

In the Plan Formulation and Evaluation process, the beach nourishment alternative required optimization of the design parameters. In developing these parameters in the Shore Protection Manual, Coastal Engineering Tech Notes (CETN), the existing conditions in the study area and accepted coastal engineering practices were reviewed. Listed below are the boundary conditions utilized to construct a logical methodology to efficiently identify the optimum plan. The necessary design parameters for these plans include dune elevation and width, berm elevation and width, beach slope, and closure depth. The berm elevation, beach slope, and closure depth are affected by the prevailing natural processes and were based on the study area existing beach conditions.

9.3.1 Dune Elevation. Existing dunes in the Willoughby study area range from elevations 5 to 12 feet, NAVD. The study considered alternative dune crest elevations of 10, 12, and 14 feet, NAVD. These elevations were considered the minimum and maximum elevations reasonable for the study.

9.3.2 Dune Width. The minimum dune crest width considered appropriate for the Willoughby study area was 30 feet. Since the existing berm elevation will remain at elevation 3.5 feet, NAVD it was considered prudent to have a sizeable dune crest width capable of providing some protection when the existing berm is inundated during storm events. No dune crest widths wider than 30 feet were considered in the study.

9.3.3 Berm Elevation. Tides, waves, and beach slope determine the natural berm elevation. If the nourished berm is too high, scarping may occur; if too low, ponding of water and temporary flooding may occur when a ridge forms at the seaward edge. Design berm heights for each alternative have an elevation set at the natural berm crest elevation as determined by historical profiles. The average berm elevation is 3.5 feet, NAVD. It was determined that a constructible template that closely matches the prevailing natural berm height in the study area is the appropriate berm elevation for all design alternatives.

9.3.4 Berm Width. An interval between successive berm widths was chosen for modeling purposes. This interval is set wide enough to discern significant differences in costs and benefits between alternatives, but it is not so great that the NED Plan cannot be accurately determined. Additionally, due to the capability of the storm modeling methodology and effectiveness of the existing condition parameters, a 50-foot interval achieved the desired accuracy. Based on the Plan Formulation and Evaluation process analysis, the largest berm width considered was 150 feet. The smallest berm width, 50 feet, was determined in a similar manner.

9.3.5 Beach Slope. Beach slopes are the result of on-site wave climate and the characteristics of the beach material. In the idealized profiles, the existing foreshore slope was used. The SBeach Data Generator utilizes the same slope as the idealized profile in producing alternative profiles to model. During design, this will need to be confirmed with SBeach modeling for the recommended plan.

9.3.6 Closure Depth. A review of the profile data resulted in the closure depth being set at -14 feet, NAVD.

Plate A-20 provides an example template for a dune and berm alternative.

9.4 SUMMARY OF ALTERNATIVES

In the initial phases of the Plan Formulation process, various dune and beachfill plans were developed for analysis in Beach-*fx*. Based on the design parameters discussed above, dune crest elevations ranged from 10 to 14 feet, NAVD, while berm widths varied from 50 to 150 feet.

Utilizing the SBeach Data Generator, all potential dune and berm combinations were generated for each idealized profile so that the Storm Response Database could be developed. This set of profiles is not just the alternative plans being considered but is intended to model from the minimum to the maximum profile being considered. During the accomplishment of this effort, a balance had to be maintained between the desire to provide profiles and responses at small intervals and the time required to run the SBeach simulations create the SRD and run Beach-*fx* with the realization that this is an economic-engineering model utilizing idealized profiles. The parameters and their ranges and intervals are shown in the following table. The minimum dune elevation modeled was determined by the existing dune elevation from the idealized profile.

Table A-6. SBeach Profiles Analyzed for Storm Response Database

Reach	Dune Elevations Modeled	Dune Widths Modeled	Berm Widths Modeled	Total Profiles
1	6,8,10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	175
2	10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	105
3	10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	105
4	8,10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	140
5	10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	105
6	10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	105
7	10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	105
8	10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	105
9	12,14	10,15,20,25,30	0,25,50,75,100,125,150	70
10	12,14	10,15,20,25,30	0,25,50,75,100,125,150	70
11	10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	105
12	10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	105
13	10,12,14	10,15,20,25,30	0,25,50,75,100,125,150	105

9.5 WAVE MODIFICATIONS FOR EXISTING COASTAL STRUCTURES

There are five reaches that currently have some form of breakwater structure. SBeach cannot model a breakwater directly. The determination was made to utilize a reduction in the wave heights that was attributable to the breakwaters. The level of reduction was influenced by the size of the structures, the spacing of the structures, location of the structure, and the amount of the reach physically behind a structure. The reduction in wave heights was between 30 and 50 percent based on those considerations. These values seemed to correspond to the SBeach runs accomplished on the November 2009 northeaster.

10.0 HISTORIC EROSION RATES

Long-term trends that give rise to historical shoreline and beach planform changes can be determined using several methods. A common method to evaluate the long-term evolution of shorelines is to utilize the Army Corps of Engineers' GENEralized Model for SImulating Shoreline Change (GENESIS) software developed by the Coastal Hydraulics Laboratory (CHL).

At the present time, it is not anticipated that GENESIS modeling of the study area will be accomplished during this feasibility phase. The existing erosion rates and shoreline changes in the study area are well documented in previous reports and studies and are considered sufficient for this feasibility effort.

Depending on the recommended plan that is ultimately selected, GENESIS modeling may be required during the design phase to develop the final size, location, and orientation of breakwater structures (if included in the recommended plan) and/or to further detail any required renourishment activities (volumes and cycles).

Should it become necessary during the conduct of this feasibility study, or even during the design phase, to utilize GENESIS to evaluate long-term shoreline changes, the use of available data will be maximized to the extent possible to minimize the additional study costs and study time. Available data known at this time that could be used in any future GENESIS modeling includes several studies prepared for the city of Norfolk along short isolated reaches of the study area. These studies were prepared by the consulting firm Moffatt and Nichol in 2004 and 2005.

Present erosion rates determined by studies performed by Fleischer (1977), Byrne and Anderson (1977), and Rosen (1976) are reported to range from approximately 0.5 feet/year to 2.5 feet/year. For this report, an erosion rate of 1.3 feet/year was used for engineering design. This value represents an average long-term rate of retreat for Willoughby Spit since 1854.

11.0 PROBABILITY DATA FOR BEACH-*FX*

A key component of the Beach-*fx* simulations is the probability developed for the suite of storms provided. A total of 16 storms were modeled for this study but there were 42 storms during the period of analysis with water levels of 4.0 feet, NAVD or more. Separate seasonal (monthly) probabilities were computed for the hurricanes utilizing all 12 historic storms. Similarly all 30 historical northeasters were utilized to compute the seasonal (monthly) probabilities. These separate hurricane and northeaster seasonal probabilities were used in the Beach-*fx* modeling and are shown in the Attachment Beach-*fx* Description in Appendix B, Economics.

Beach-*fx* requires a separate and unique frequency relationship for hurricanes and northeasters. The combined stillwater frequency relationship developed for this study did not provide the required data. Norfolk District Corps of Engineers consulted with CHL to determine an appropriate way to develop the required frequency data. CHL provided preliminary results from storm surge modeling for the Federal Emergency Management Agency (FEMA) Region III that CHL is involved with. The following paragraphs describe the study.

FEMA Region III office is conducting a coastal analysis and mapping study to produce updated Digital Flood Insurance Rate Maps (DFIRMs) for coastal counties within Region III. The new coastal flood hazard analyses, initiated in the Fall of 2009, will utilize updated 1% annual chance stillwater elevations obtained from a comprehensive storm surge study being concurrently performed by FEMA Region III.

The storm surge study is one of the most extensive coastal storm surge analyses to date, encompassing coastal floodplains in three states and including the largest estuary in the U.S. Ultimately, the study will update the coastal storm surge elevations within the states of Virginia, Maryland, Delaware, and Pennsylvania including the Atlantic Ocean, Chesapeake Bay and its tributaries, and the Delaware Bay. This study differs from the storm surge mapping performed as part of Hurricane Evacuation Studies in that the resulting stillwater elevations are based on probability of occurrence as opposed to Hurricane Category events. The following table provides the storm surge frequency data from the storm surge model.

Table A-7. STORM SURGE FREQUENCY

Storm	25-YR	50-YR	100-YR	500-YR
Hurricanes	4.18	5.53	6.65	8.87
Northeasters	5.87	6.53	7.09	8.17
Combined	6.29	7.03	7.85	8.87

The relative probabilities used in the Beach-*fx* modeling were determined by normalizing all of the modeled hurricane probabilities to the August 1933 storm's frequency. Similarly, all of the modeled northeaster probabilities were normalized to the March 1962 storm's frequency.

These relative frequencies are shown in the Attachment Beach-*fx* Description in Appendix B, Economic Analysis.

12.0 BORROW SITE INVESTIGATIONS

The Norfolk District Corps of Engineers contracted with Alpine Ocean Seismic Survey to acquire 46 vibracore samples (Plate A-21) in the Lower Chesapeake Bay for this study. Three general areas of the investigation focused on Willoughby Bank, Middle Ground (south of Fisherman's Island) and between the Horseshoe and Tail of the Horseshoe. In addition to this sampling program, an extensive review of available information from sediment sampling was conducted dating back to the mid 1970's. Although samples near the Middle Ground contained several areas of compatible material, consultation with the project delivery team resulted in narrowing the borrow locations to Willoughby Banks, the Hampton borrow site and Thimble Shoal Auxiliary Channel.

12.1 WILLOUGHBY BANK

Six vibracores were obtained on Willoughby Bank (Dec. 2007) approximately 2 miles offshore of the western portion of the project site. As shown in the table below, most samples contained high percentages of silt and clay however there were some areas of compatible sands.

Table A-8. WILLOUGHBY BANK VIBRACORE DATA

Core Number	Sample	phi 84	phi 16	Mean phi	Sta. Dev.	Median	Depth Corrected
VC-30	Not tested	silt/clay					20.7
VC-31	Not tested	silt/clay					20.6
VC-32	Not tested	silt/clay					19.5
VC-33	0-4	3.95	3	3.48	0.48	3.4	17.2
	4-8.7	silt/clay					
	0-8.7	silt/clay					
VC-34	0-5	3.1	1.35	2.23	0.88	2.4	14.5
VC-35	Not tested	silt/clay					16.7

12.2 HAMPTON BORROW AREA

Offshore investigations in the Hampton borrow area were conducted in October 1999. The purpose of the investigation was to determine whether sediments of suitable grain size and sufficient volume exist within a reasonable distance to the Hampton-Buckroe Beach area. A total of 51 vibracores were obtained and graphical recordings were made of the penetration rates of the coring head into the sub-bottom for each successive foot of penetration. This assisted in determining the type of sediment material that was being cored in the event full recovery did not occur. Later, the vibracores sections were cut open longitudinally and the contents visually logged. Sediment samples were taken at specific horizons in the cores and composite samples representing the entire bulk samples were taken. This procedure was utilized to determine the composite characteristics are what a dredge intersects during excavation. Extracted samples were washed and sieved to determine the percent by weight of silt/clay content and the grain size distribution of the sands. The sediments were classified according to the Unified Soil Classification and Wentworth Classification System. Sampling results were found to contain fine to medium sand with varying amounts between 3 to 17 percent of silt/clay content.

Seventeen vibracores were obtained in the region designated borrow site A (Plate 21). The mean sand size was approximately 0.21 mm. An overfill ratio, Ra, of 1.26 was determined for this area. The area is estimated to have approximately 18 million cubic yards of material available for beach nourishment. This volume would be reduced to approximately 15 million cubic yards to avoid possible obstructions in the area.

Ten vibracores were performed in the region designated site B. The mean sand size was approximately 0.24 mm. An overfill ratio, Ra, of 1.2 was calculated for this site. The area is estimated to have approximately 11 million cubic yards of material available however to avoid sub-bottom obstructions, this volume would be reduced to 8 million cubic yards.

12.3 THIMBLE SHOAL AUXILIARY CHANNEL

Thirty-one vibracores were performed in the Thimble Shoal Channel during 1983, 1984, and 1985. In 1990, the Norfolk District Corps of Engineers performed an additional 55 and 60 vibracores in the Thimble Shoal Channel. These areas of suitable sand deposits correspond to station 11+00 to station 132+00 in the Thimble Shoal Auxiliary Channel. Station numbers refer to stations as identified on the Corps of Engineers hydrographic surveys published in the General Design Memorandum, Norfolk Harbor and Channels, Virginia Deepening Project, June 1986. Vibracores taken during the exploratory studies were sampled to generate a composite sample representing the entire dredge prism, including the allowed overdepth. Extracted samples were washed and sieved to determine the percent by weight of silt/clay content and the grain size distribution of the sands. Suitable beach-quality sand from Thimble Shoal Auxiliary Channel sediment ranged in mean size from 0.18 to 0.32 mm, and averaged 0.30 mm.

12.4 NATIVE BEACH GRAIN SIZE

Reports describe the sediments on the beach and nearshore at the western end of Willoughby Spit as having been derived and reworked from the 1984 beachfill project. The material was characterized by a mean diameter of 0.13 phi (0.9 mm) with broken shell hash comprising 50% of the larger size fraction and 10 to 15% of the finer size material. In May and September 1988, sediment samples were taken along the survey lines, at the top of the berm, high-tide mark, mid-tide mark, low-tide mark, -3.0, -6.0, -12.0, -15.0 (NGVD) and at the crest of the submarine bar. The mean sediment size for the study area was found to be 0.5 mm with a D (16) and D (84) of 0.81 mm and 0.18 mm, respectively. In June 1994, VIMS collected 53 samples along the entire beach profile at six locations along the western portion of project site. Mean grain sizes ranged from 0.5 to 2.2(phi) with an average of approximately 1 (phi) or 0.5 mm. In April 2004, Moffatt and Nichol analyzed samples in the Ocean View area and reports an average d 50 at mid-dune of 0.31 mm, mid-beach 0.39 mm and between high and low water of 0.45 mm. For the purposes of sand compatibility and overfill calculations, the mean grain size of the existing beach will be conservatively set at 0.6 mm.

12.5 BEACH NOURISHMENT OVERFILL

Once the volumes were determined for each of the berm widths discussed above, they were then multiplied by an adjusted overfill ratio. Overfill ratios calculated using ACES v 4.03 for each of the borrow areas.

The volumes of sand required to develop each berm width were increased, allowing for handling losses due to the dredging process and grain size compatibility. Table A-10 shows the required volumes, construction volumes (adjusted volumes), and modified volumes (or dredged volume). Prior to actual preparation of plans and specifications, it is recommended that dredging specialists of the Norfolk District Corps of Engineers be consulted to review and assist in determining what handling losses be assigned to each section of the channel. The handling losses should reflect the sediment characteristic and dredging equipment.

Table A-9. OVERFILL RATIOS

Willoughby Banks	Hampton Borrow Area	Thimble Shoal Channel
1.8	1.2	1.2

13.0 QUANTITY ESTIMATES & RENOURISHMENT VOLUMES FOR ALTERNATIVE & SELECTED PLANS

Beach-*fx* is able to generate both initial quantity estimates and renourishment estimates for each of the plans it is evaluating. Subsequent to Beach-*fx* determining the NED and Locally Preferred Plans, BMAP was utilized to obtain the initial quantity estimates required for each reach. This was considered as a check on the Beach-*fx* determination and provided a better basis for developing the project's cost estimates. The following table provides a comparison between the two methods.

Table A-10. INITIAL PLACEMENT VOLUMES - BEACH-*FX* and BMAP
Initial Placement Quantities (cubic yards)

Plan	Beach-*fx*	BMAP
Authorized Plan	1,062,000	1,218,000
NED Plan	2,843,000	2,702,400

The Economics Appendix provides information on the renourishment quantities estimated for the plans. The BMAP initial quantities were used for the final cost estimates.

14.0 COST ESTIMATES

Detailed cost estimates were developed for both the Authorized and NED plans. The following pages provide the Total Project Cost Summary and worksheets for each plan. A description of the assumptions used and the Mii (Corps of Engineers Cost Estimating Software) and CEDEP (Corps of Engineers Dredge Estimating Program) back-up for the cost estimates is included as Attachment C-3.

WILLOUGHBY SPIT AND VICINITY BEACH NOURISHMENT

FEBRUARY 19, 2013

INITIAL FILL

1. Authorized Plan – Hopper Dredging from Thimble Shoal Auxiliary Channel

Mob		$ 1,750,000	
Dredge	1,218,000 cy @ $10.27/cy	12,508,860	
Standby Cost		100,000	
Sub Total Construction Cost		$ 14,358,860	
Contingency	17.60%	2,527,159	$11.30/cy
Total Construction Cost		$ 16,886,019	
S&A Cost (5% of Construction Cost plus 5% Contingency)			
	5%	753,840	
Total Construction plus S&A Cost		$ 17,639,860	
PED Cost (5% of Construction Cost plus 5% Contingency)			
	5%	753,840	
TOTAL PROJECT COST		$ 18,393,700	15.10

2. NED Plan – Hopper Dredging from Thimble Shoal Auxiliary Channel

Mob		$ 2,500,000	
Dredge	2,702,400 cy @ $9.77 cy	26,402,448	
Standby Cost		100,000	
Sub Total Construction Cost		$ 29,002,448	
Contingency	17.80%	5,162,436	$10.75/cy
Total Construction Cost		$ 34,164,884	
S&A Cost (5% of Construction Cost plus 5% Contingency)			
	5%	1,522,629	
Total Construction plus S&A Cost		$ 35,687,512	
PED Cost (5% of Construction Cost plus 5% Contingency)			
	5%	1,522,629	
TOTAL PROJECT COST		$ 37,210,141	13.77

WILLOUGHBY SPIT AND VICINITY BEACH NOURISHMENT

FEBRUARY 19, 2013

RENOURISHMENT

1. Authorized Plan – Hopper Dredging from Thimble Shoal Auxiliary Channel

Mob		$ 800,000	
Dredge	445,100 cy @ $11.16/cy	4,967,316	
Standby Cost		100,000	
Sub Total Construction Cost		$ 5,867,316	
Contingency	17.10%	1,003,311	$12.28/cy
Total Construction Cost		$ 6,870,627	
S&A Cost (5% of Construction Cost plus 5% Contingency)			
	5%	308,034	
Total Construction plus S&A Cost		$ 7,178,661	
PED Cost (5% of Construction Cost plus 5% Contingency)			
	5%	308,034	
TOTAL PROJECT COST		$ 7,486,695	16.82

2. NED Plan – Hopper Dredging from Thimble Shoal Auxiliary Channel

Mob		$ 800,000	
Dredge	481,169 cy @ $11.16/cy	5,369,846	
Standby Cost		100,000	
Sub Total Construction Cost		$ 6,269,846	
Contingency	17.10%	1,072,144	$12.28/cy
Total Construction Cost		$ 7,341,990	
S&A Cost (5% of Construction Cost plus 5% Contingency)			
	5%	329,167	
Total Construction plus S&A Cost		$ 7,671,157	
PED Cost (5% of Construction Cost plus 5% Contingency)			
	5%	329,167	
TOTAL PROJECT COST		$ 8,000,324	16.63

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: Willoughby Spit and Vicinity
LOCATION: Norfolk, Virginia

DISTRICT: NOA Norfolk
POC: CHIEF, COST ENGINEERING

PREPARED: 2/15/2013
Gary Szymanski

This Estimate reflects the scope and schedule in report; General Reevaluation Report, Willoughby Spit & Vicinity, Norfolk, VA
NED PLAN-2.7 MCY

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2015 Effective Price Level Date: 1 OCT 14				Spent Thru: 1-Oct-12				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
17	BEACH REPLENISHMENT	$29,002	$5,162	17.8%	$34,165	3.3%	$29,967	$5,334	$35,301	$0		$30,238	$5,382	$35,621
	CONSTRUCTION ESTIMATE TOTALS:	$29,002	$5,162		$34,165	3.3%	$29,967	$5,334	$35,301	$0		$30,238	$5,382	$35,621
01	LANDS AND DAMAGES	$0	$0 -		$0	-	$0	$0	$0	$0		$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$1,450	$73	5%	$1,523	6.9%	$1,550	$77	$1,627	$0		$1,553	$78	$1,630
31	CONSTRUCTION MANAGEMENT	$1,450	$73	5%	$1,523	6.9%	$1,550	$77	$1,627	$0		$1,580	$79	$1,659
	PROJECT COST TOTALS:	$31,903	$5,307	16.6%	$37,210		$33,066	$5,489	$38,555	$0		$33,371	$5,539	$38,910

______________ CHIEF, COST ENGINEERING

______________ PROJECT MANAGER

______________ CHIEF, REAL ESTATE

______________ CHIEF, PLANNING AND POLICY

______________ CHIEF, WATER RESOURCES DIVISION

______________ CHIEF, ENGINEERING

______________ CHIEF, CONSTRUCTION

______________ CHIEF, ENGINEERING AND CONSTRUCTION

______________ CHIEF, PPMD

ESTIMATED FEDERAL COST:	65%	$25,292
ESTIMATED NON-FEDERAL COST:	35%	$13,619
ESTIMATED TOTAL PROJECT COST:		**$38,910**

2/19/2013

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: Willoughby Spit and Vicinity
LOCATION: Norfolk, Virginia

DISTRICT: NOA Norfolk
POC: CHIEF, COST ENGINEERING

PREPARED: 2/15/2013
Gary Szymanski

This Estimate reflects the scope and schedule in report; General Reevaluation Report, Willoughby Spit & Vicinity, Norfolk, VA
AUTHORIZED PLAN-1.2 MCY

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2015 Effective Price Level Date: 1 OCT 14								
WBS NUMBER *A*	Civil Works Feature & Sub-Feature Description *B*	COST ($K) *C*	CNTG ($K) *D*	CNTG (%) *E*	TOTAL ($K) *F*	ESC (%) *G*	COST ($K) *H*	CNTG ($K) *I*	TOTAL ($K) *J*	Spent Thru: 1-Oct-12 ($K) *K*	*L*	COST ($K) *M*	CNTG ($K) *N*	FULL ($K) *O*
17	BEACH REPLENISHMENT	$14,359	$2,527	17.6%	$16,886	3.3%	$14,836	$2,611	$17,448	$0		$14,971	$2,635	$17,606
	CONSTRUCTION ESTIMATE TOTALS:	$14,359	$2,527		$16,886	3.3%	$14,836	$2,611	$17,448	$0		$14,971	$2,635	$17,606
01	LANDS AND DAMAGES	$0	$0 -		$0	-	$0	$0	$0	$0		$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$718	$36	5%	$754	6.9%	$767	$38	$806	$0		$769	$38	$807
31	CONSTRUCTION MANAGEMENT	$718	$36	5%	$754	6.9%	$767	$38	$806	$0		$782	$39	$821
	PROJECT COST TOTALS:	$15,795	$2,599	16.5%	$18,394		$16,371	$2,688	**$19,059**	$0		$16,522	$2,712	$19,234

_______________ CHIEF, COST ENGINEERING

_______________ PROJECT MANAGER

_______________ CHIEF, REAL ESTATE

_______________ CHIEF, PLANNING AND POLICY

_______________ CHIEF, WATER RESOURCES DIVISION

_______________ CHIEF, ENGINEERING

_______________ CHIEF, CONSTRUCTION

_______________ CHIEF, ENGINEERING AND CONSTRUCTION

_______________ CHIEF, PPMD

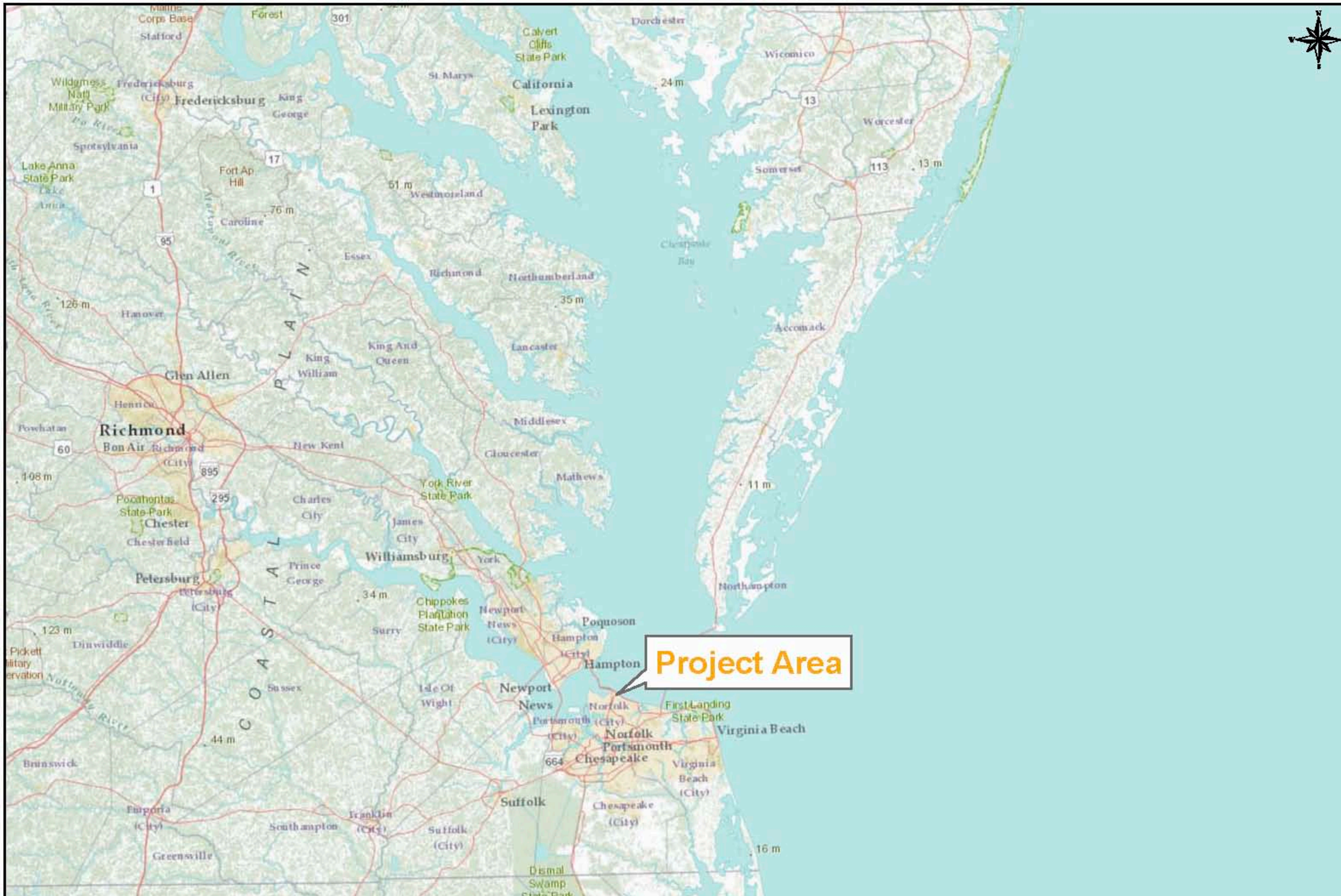
ESTIMATED FEDERAL COST:	**65%**	**$12,502**
ESTIMATED NON-FEDERAL COST:	**35%**	**$6,732**
ESTIMATED TOTAL PROJECT COST:		**$19,234**

2/19/2013

15.0 PROJECT MONITORING PLAN

A comprehensive monitoring program in accordance with USACE guidance (CEM Part V, Chapter 4 and CHETN II-35) is planned for the Willoughby Spit and Vicinity Project to assess and ensure project functionality throughout its design lifetime. This monitoring supports the design efforts for periodic renourishment. The cost for the annual monitoring is the responsibility of the local sponsor at the time of the monitoring. The monitoring costs will be credited to the local sponsor when a periodic nourishment is conducted making them ultimately cost shared in accordance with the cost sharing of the initial project construction. Estimated annual costs for beachfill monitoring are $250,000. The annual monitoring plan will consist of two beach profile surveys annually (one regularly scheduled for the end of the summer and the other to be utilized in response to storm events), aerial photos, existing wave gage data retrieval and an annual monitoring report. Beach profile surveys will allow assessment of anticipated beachfill performance and determination of renourishment volume and timing requirements. An aerial photographic record of the beach will further facilitate assessment of the beachfill performance. An annual monitoring report will be prepared that presents the data collected and the corresponding analysis of project performance, including recommendations on renourishment requirements.

Plate A-1



US Army Corps of Engineers
Norfolk District

Willoughby Spit & Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Project Location

January 2013

Projection:
Virginia State Plane
South Zone - NAD 83
U.S. Survey Feet

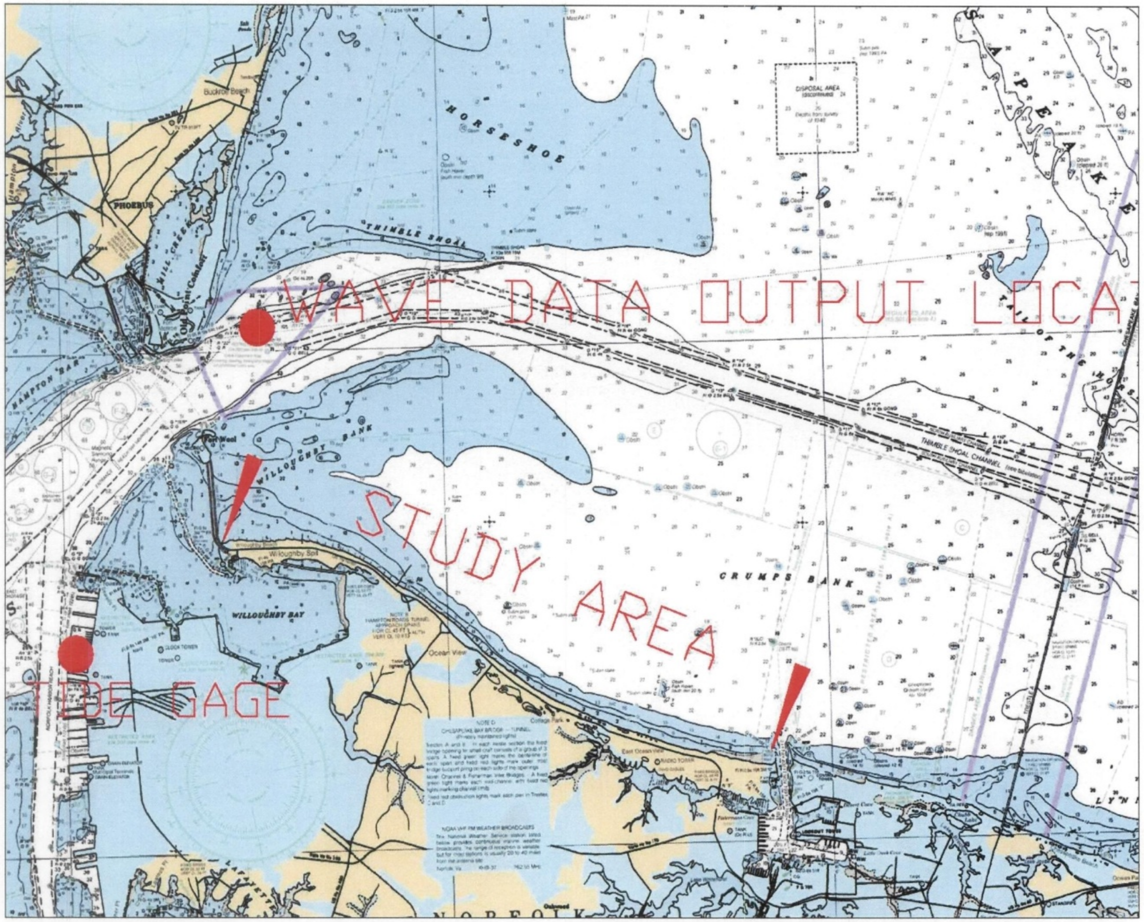
Base Map:
ESRI Online Bing Maps Road

Project Manager: Robert Pretlow
E-mail: robert.n.pretlow@usace.army.mil
Phone: (757) 201-7385
Fax: (757) 201-7036

Prepared by: Karin Dridge, Geospatial Section

Map File: SmallProjectOverviewMap.mxd
Map Date: 23 May 2012


Fort Monroe
Willoughby Spit
Little Creek
Inlet
US Army Corps
of Engineers
Norfolk District
Willoughby Spit & Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction
Study Area Map
January 2013
0 0.5 1 1.5 2
Miles
Projection:
Virginia State Plane
South Zone - NAD 83
U.S. Survey Feet
Base Map:
ESRI Online Bing Maps, Road
Project Manager: Robert Pretlow
E-mail: robert.n.pretlow@usace.army.mil
Phone: (757) 201-7385
Fax: (757) 201-7036
Prepared by: Karin Dridge, Geospatial Section
Map File: ProjectOverviewApr_12.mxd
Map Date: 27 Apr 2012



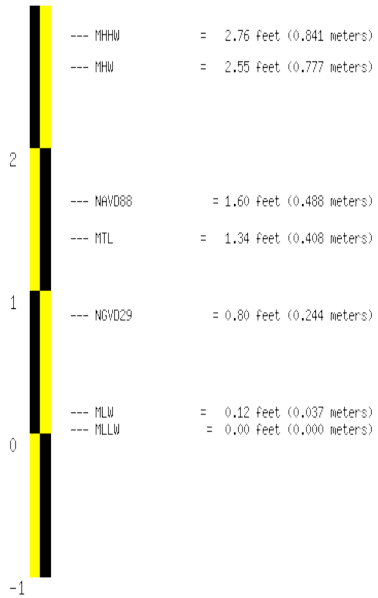
Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Tide Gage Location

January 2013
Norfolk District, Corps of Engineers

Date created
Wed Aug 2 10:37:39 EDT 2006

Elevation Information for PID = FX0093, VM = 511
Station_ID --- 8638610



The NAVD 88 and the NGVD 29 elevations related to MLLW were computed from Bench Mark, TIDAL 6 STA 97, at the station.

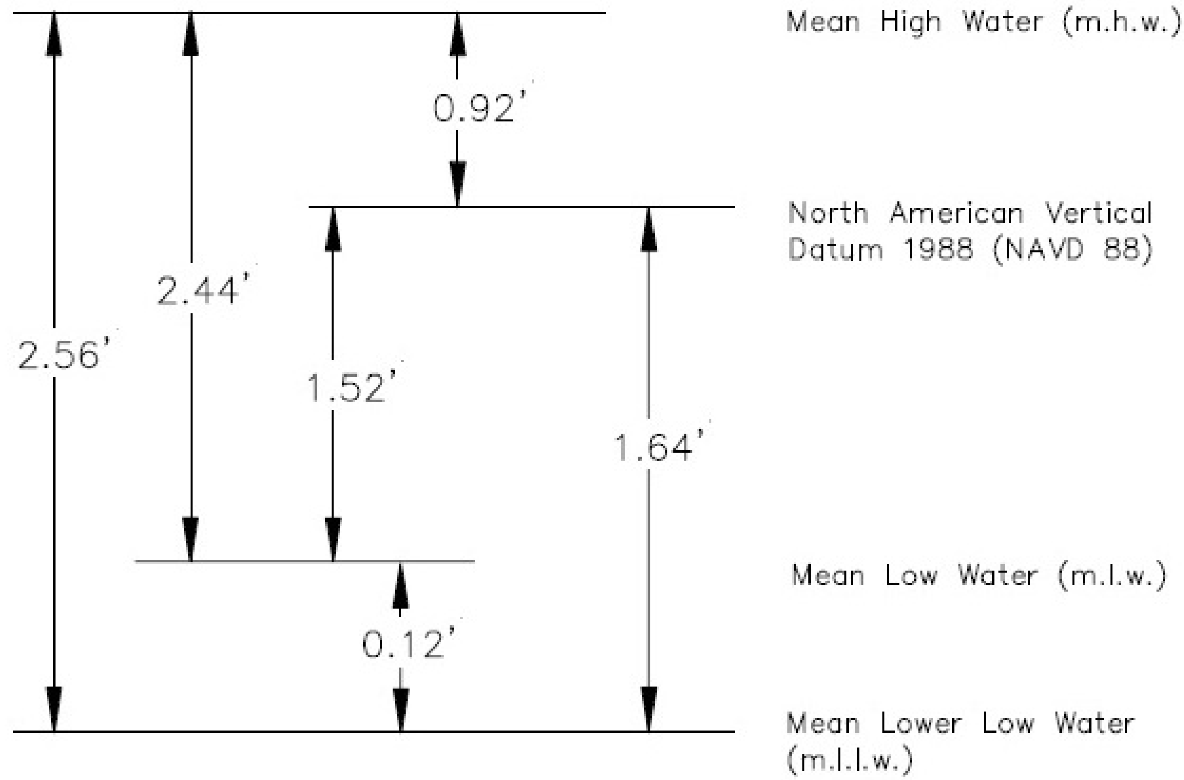
Displayed tidal datums are Mean Higher High Water(MHHW), Mean High Water (MHW), Mean Tide Level(MTL), Mean Low Water(MLW), and Mean Lower Low Water(MLLW) referenced on 1983-2001 Epoch

Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Sewell’s Point Datum Diagram

January 2013
Norfolk District, Corps of Engineers

Plate A-4



NOTES

1. Tidal datum determined at Old Point Comfort Hampton, Virginia from National Ocean Survey observations.

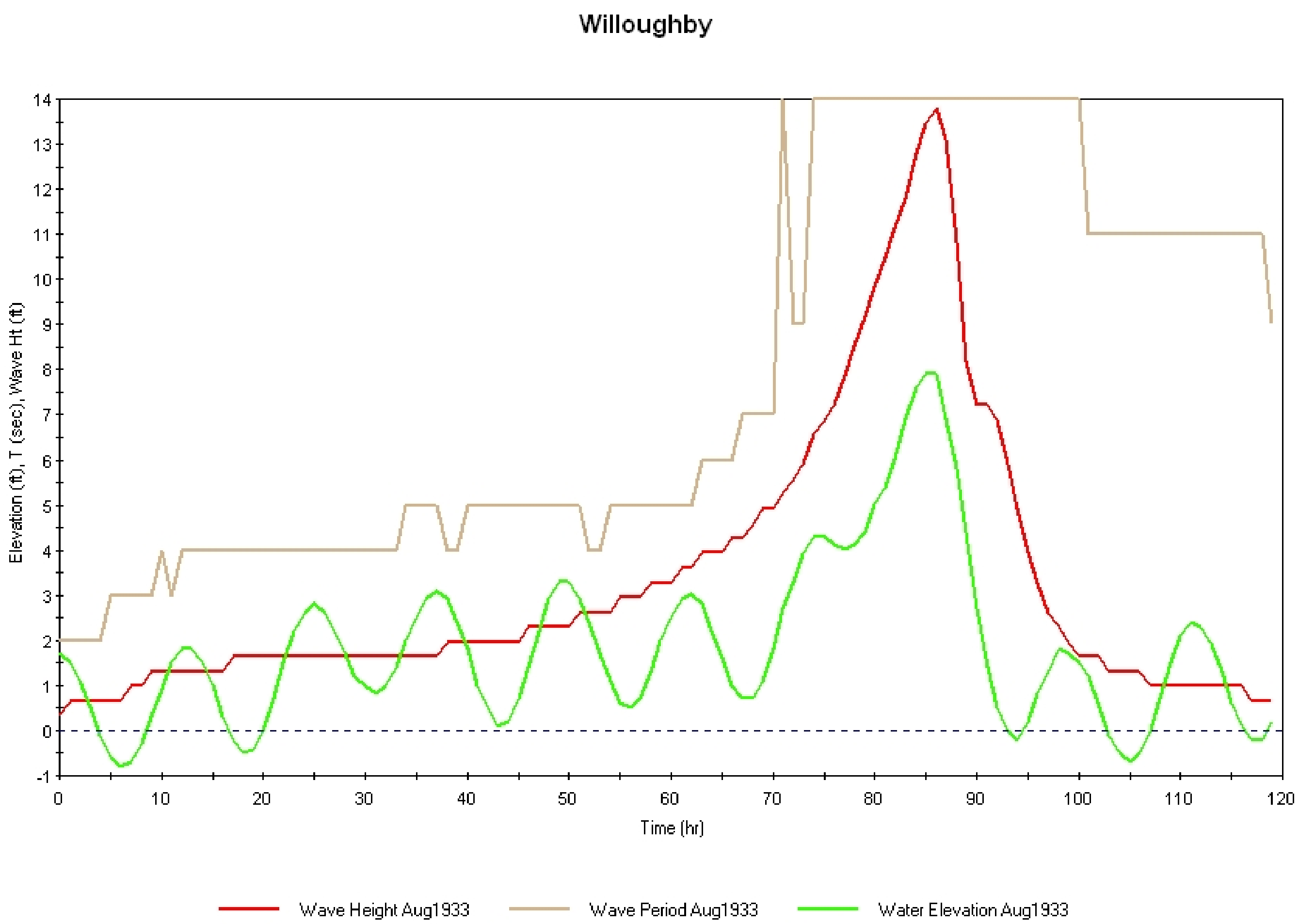
2. Fixed datum determined from leveling efforts in the United States, Canada, and/or Mexico by the National Geodetic Survey.

3. Diagram not drawn to scale.

Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Datum Diagram

January 2013
Norfolk District, Corps of Engineers

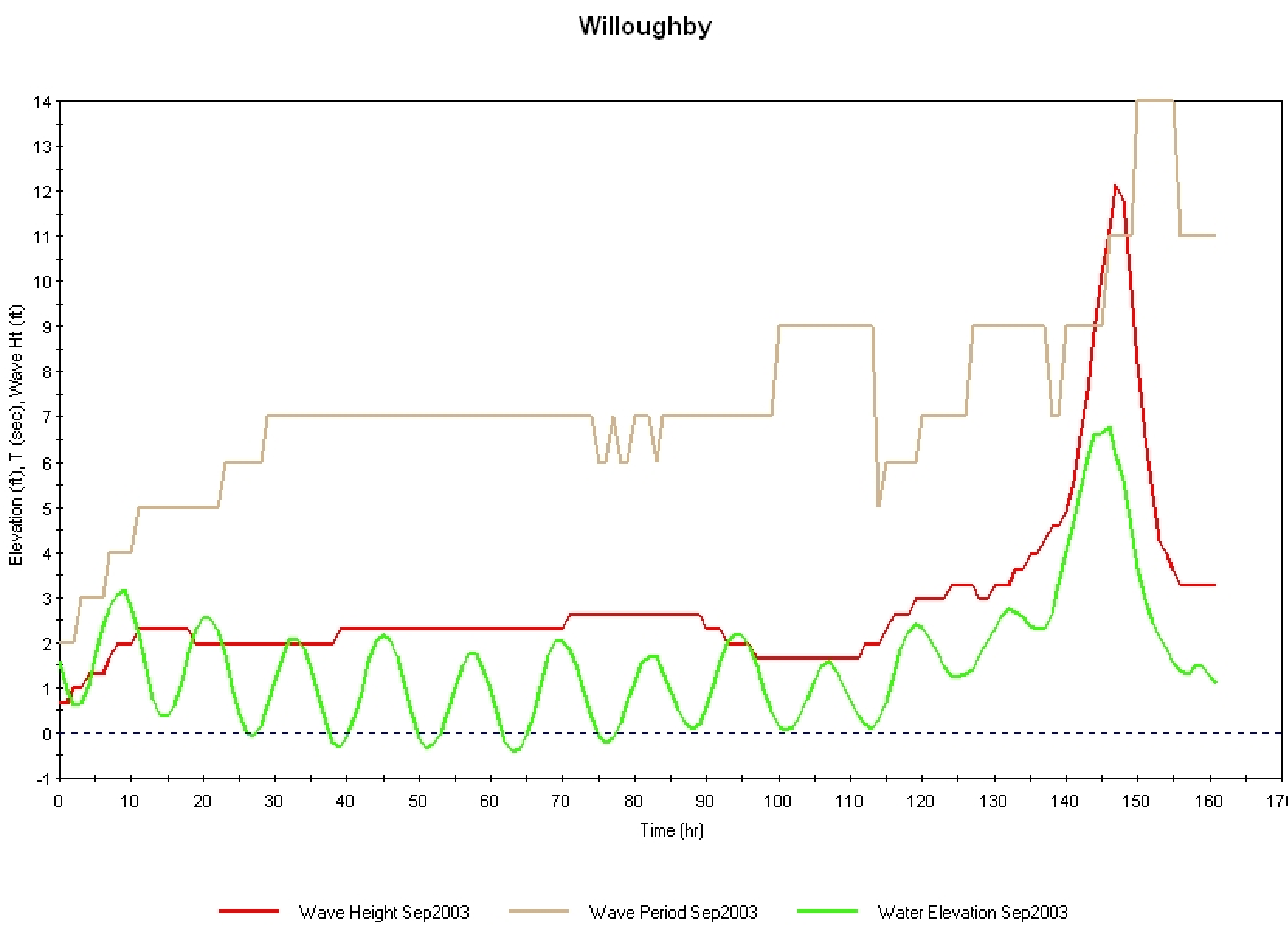


Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Wave Plot August 1933

January 2013

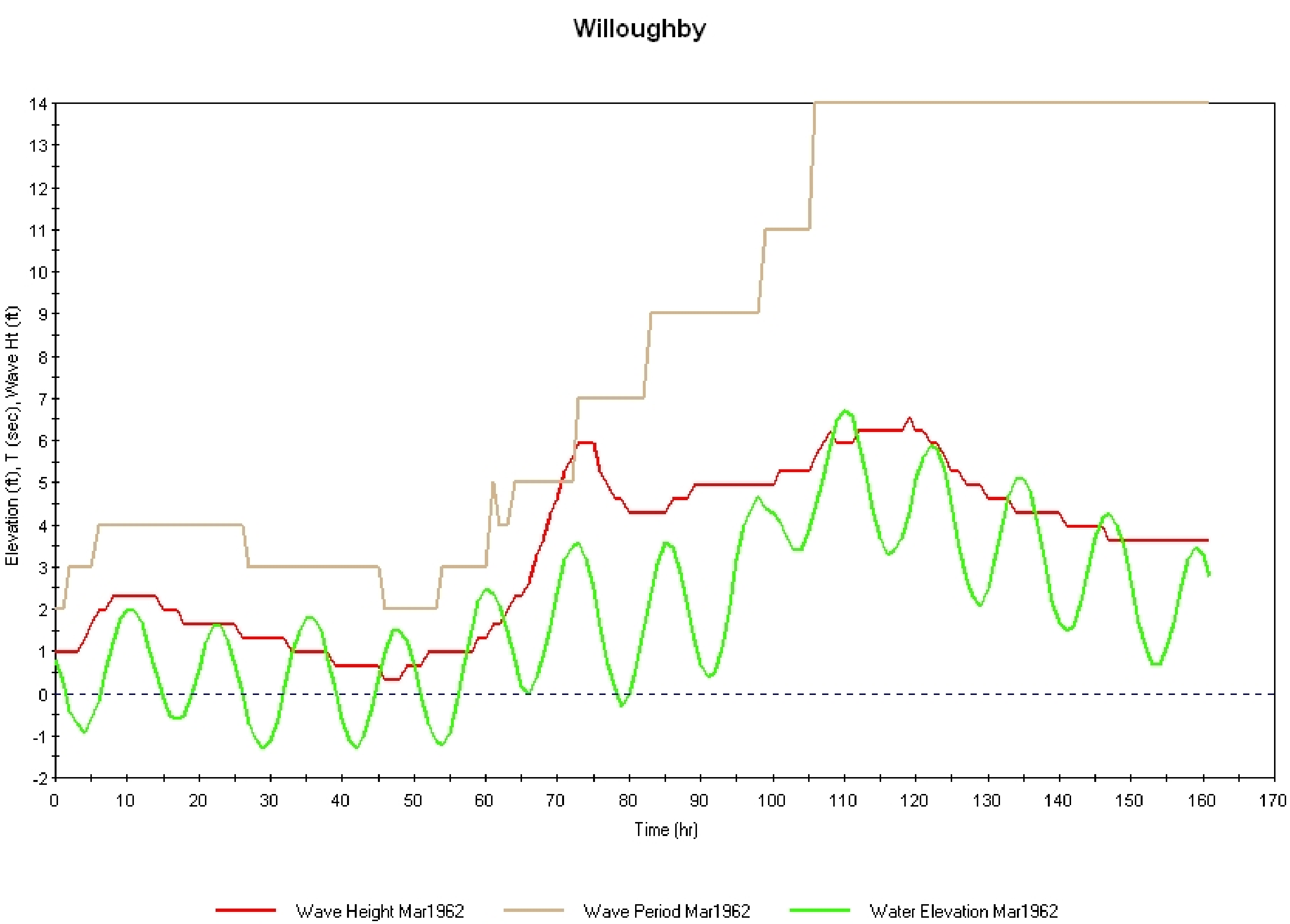
Norfolk District, Corps of Engineers



Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Wave Plot September 2003

January 2013
Norfolk District, Corps of Engineers



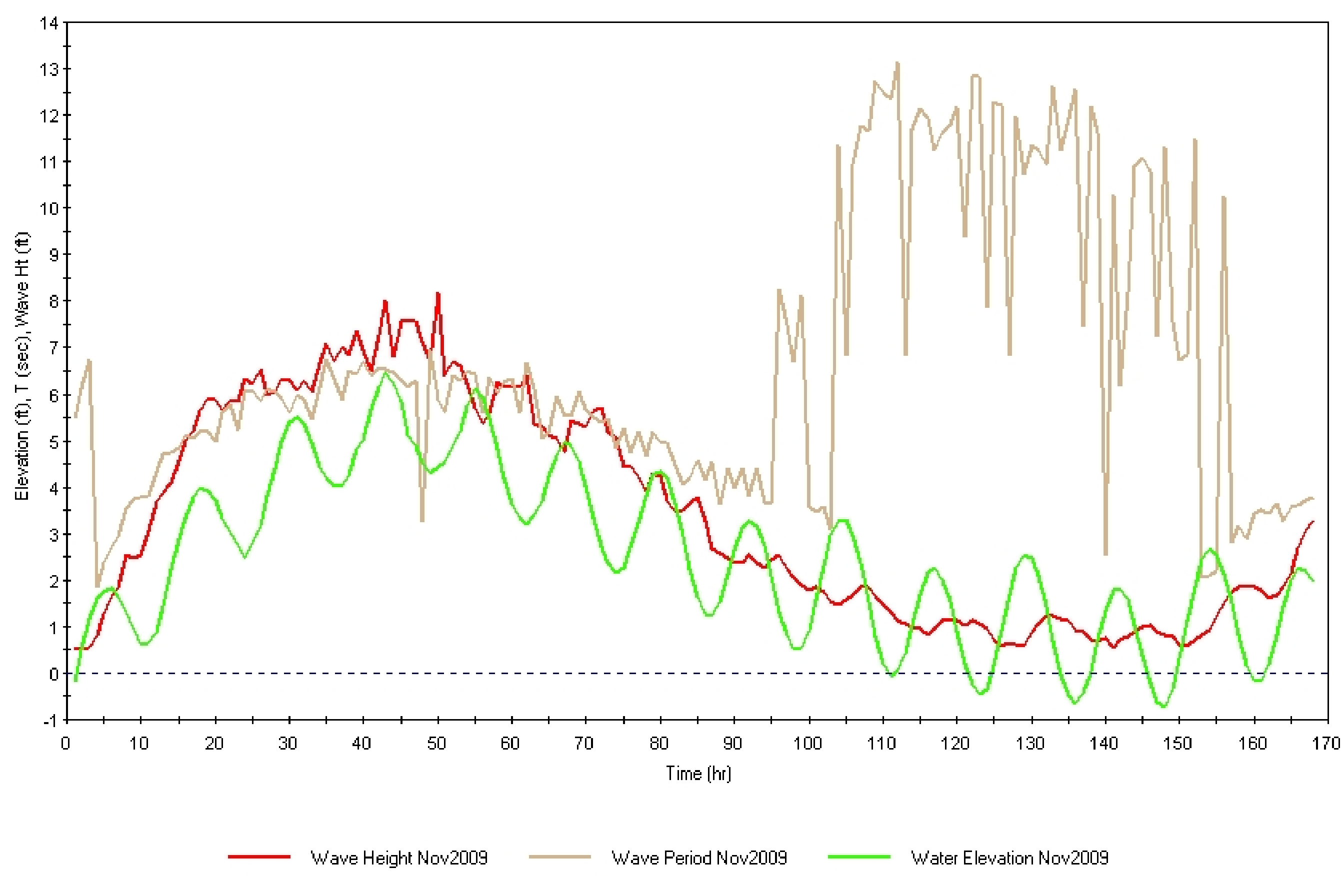
Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Wave Plot March 1962

January 2013
Norfolk District, Corps of Engineers

Plate A-8

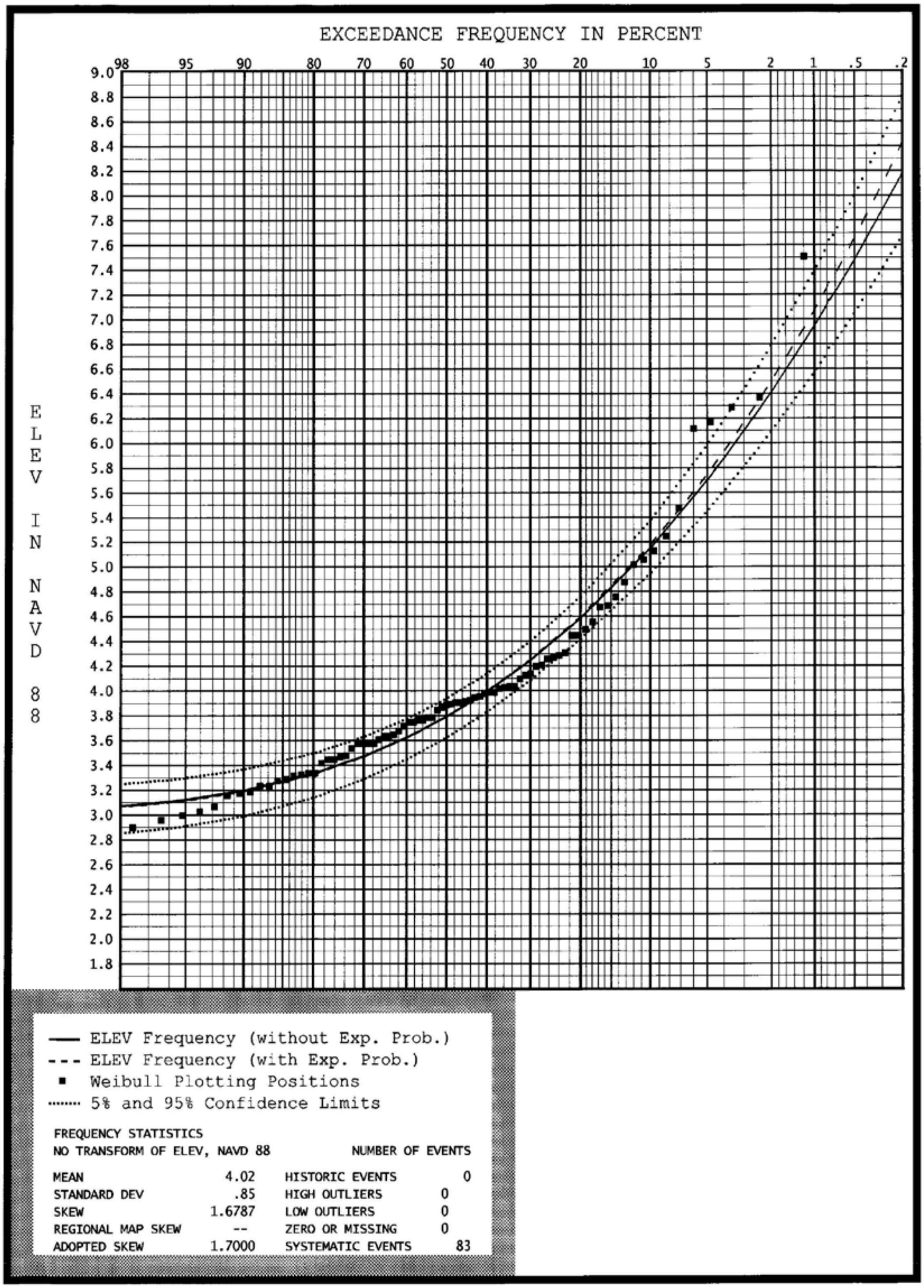
Willoughby



Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Wave Plot November 2009

January 2013
Norfolk District, Corps of Engineers



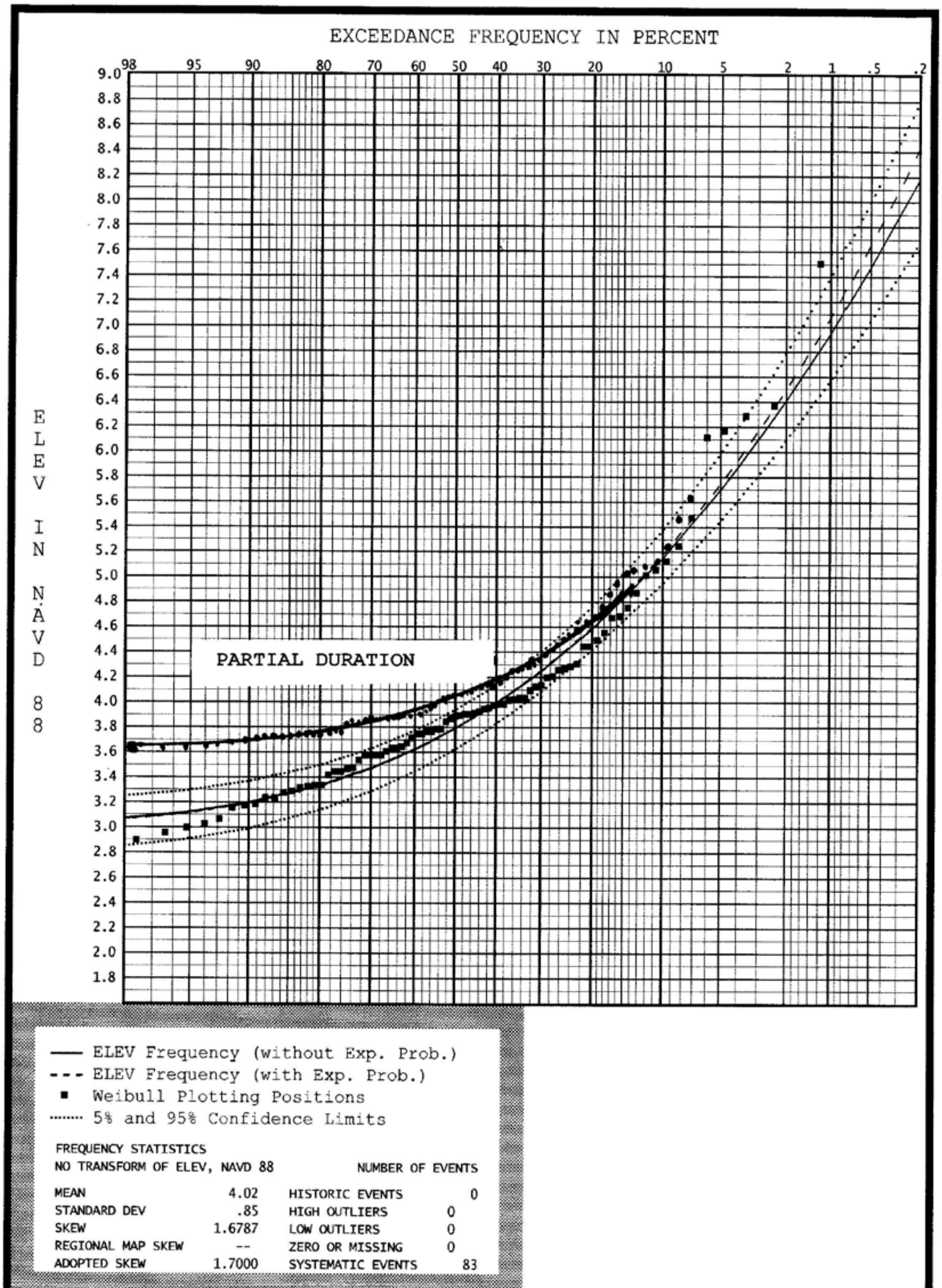
Willoughby Spit and Vicinity, Norfolk, Virginia

Hurricane and Storm Damage Reduction

Frequency Plot 1928- 2010 Annual Peaks

January 2013

Norfolk District, Corps of Engineers

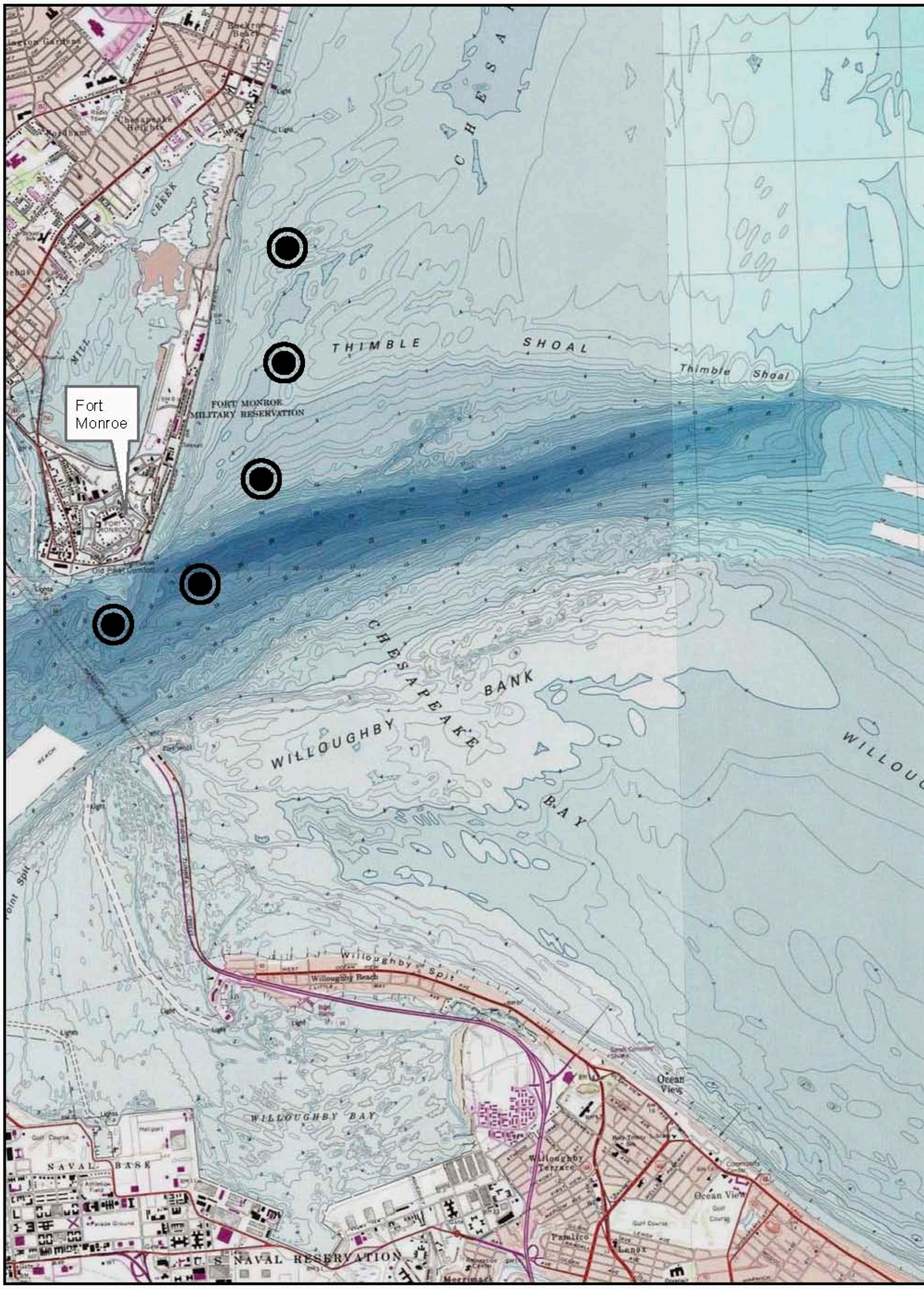


Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Frequency Plot 1929 – 2010 Partial Duration

January 2013
Norfolk District, Corps of Engineers

Plate A-11

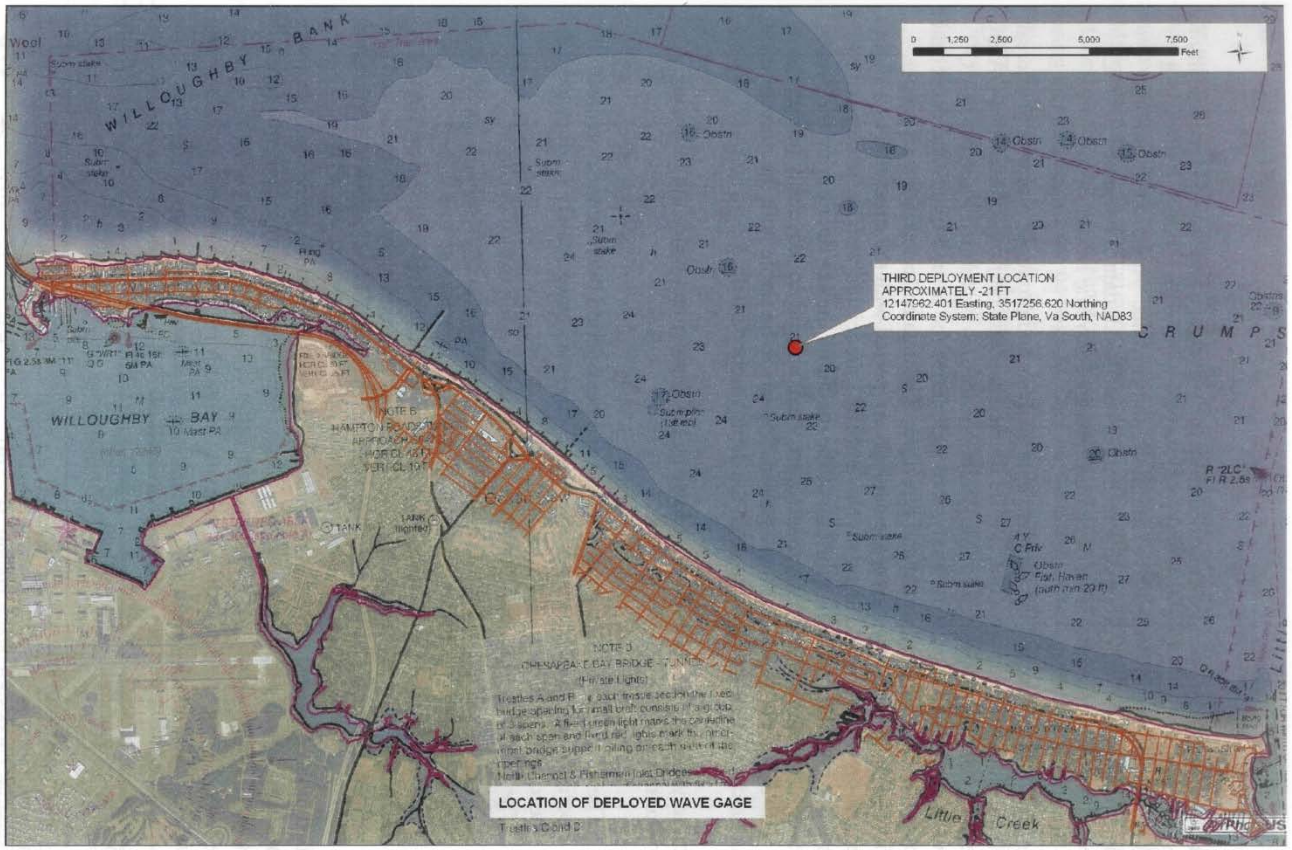


Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Wave Data Output Locations

January 2013
Norfolk District, Corps of Engineers

Plate A-12



Norfolk Wave Monitoring
Third Deployment September 6 – November 28, 2006

Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Wave Gage Deployment Location

January 2013
Norfolk District, Corps of Engineers

Plate A-13

US Army Corps of Engineers
Norfolk District

Study Reaches
Willoughby Spit & Vicinity
Coastal Storm Damage Reduction
Norfolk, VA

0 1,000 2,000 3,000 4,000 Feet

Legend

Reach Box

Projection:
Virginia State Plane
South Zone - NAD 83
U.S. Survey Feet

Base Image:
ESRI Online Bing Maps Aerial

Project Manager: Robert Pretlow
E-mail: robert.n.pretlow@usace.army.mil
Phone: (757) 201-7385
Fax: (757) 201-7036

Prepared by: Karin Dridge, Geospatial Section

Map File: HandHReaches.mxd
Map Date: 23 May 2012

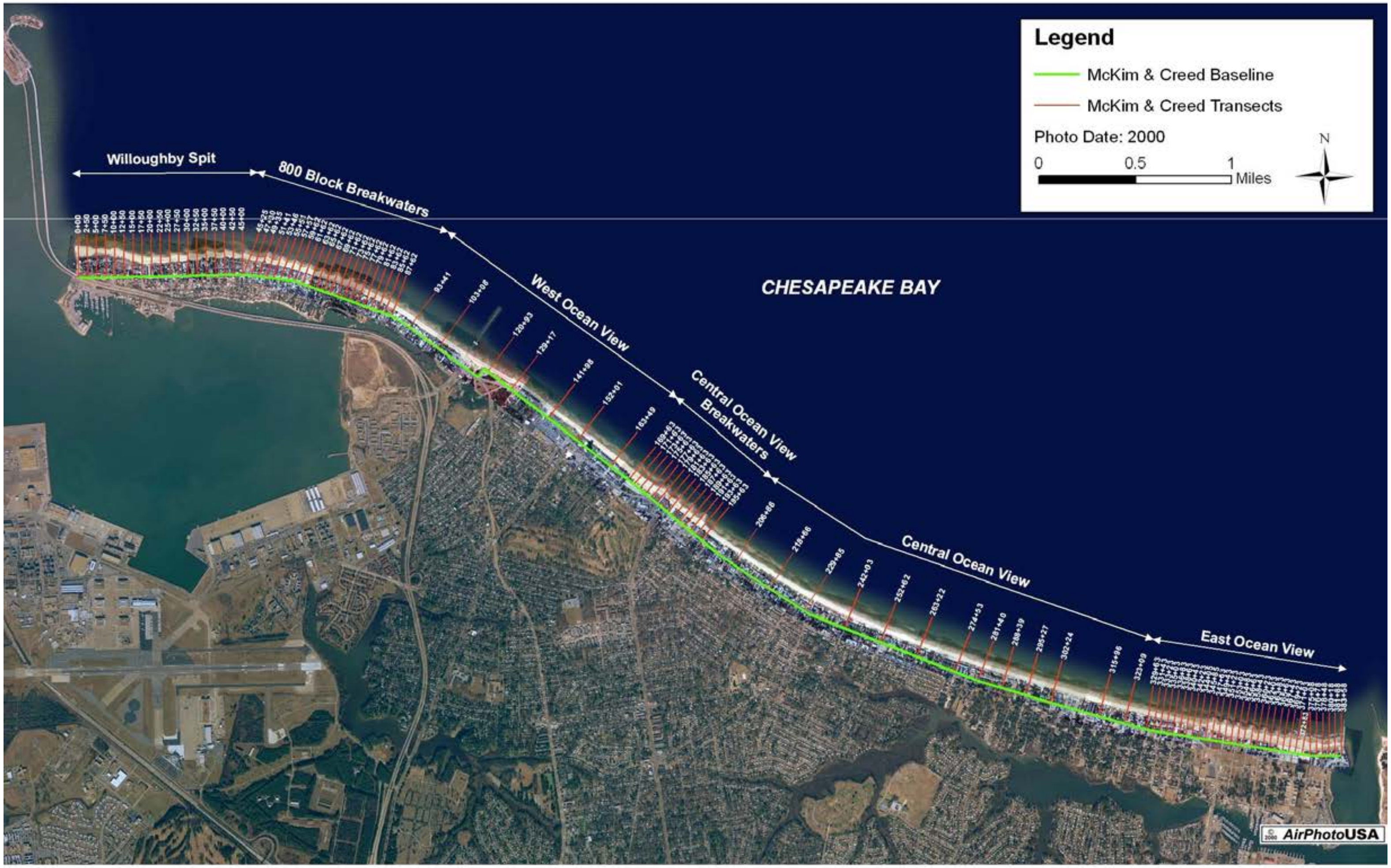
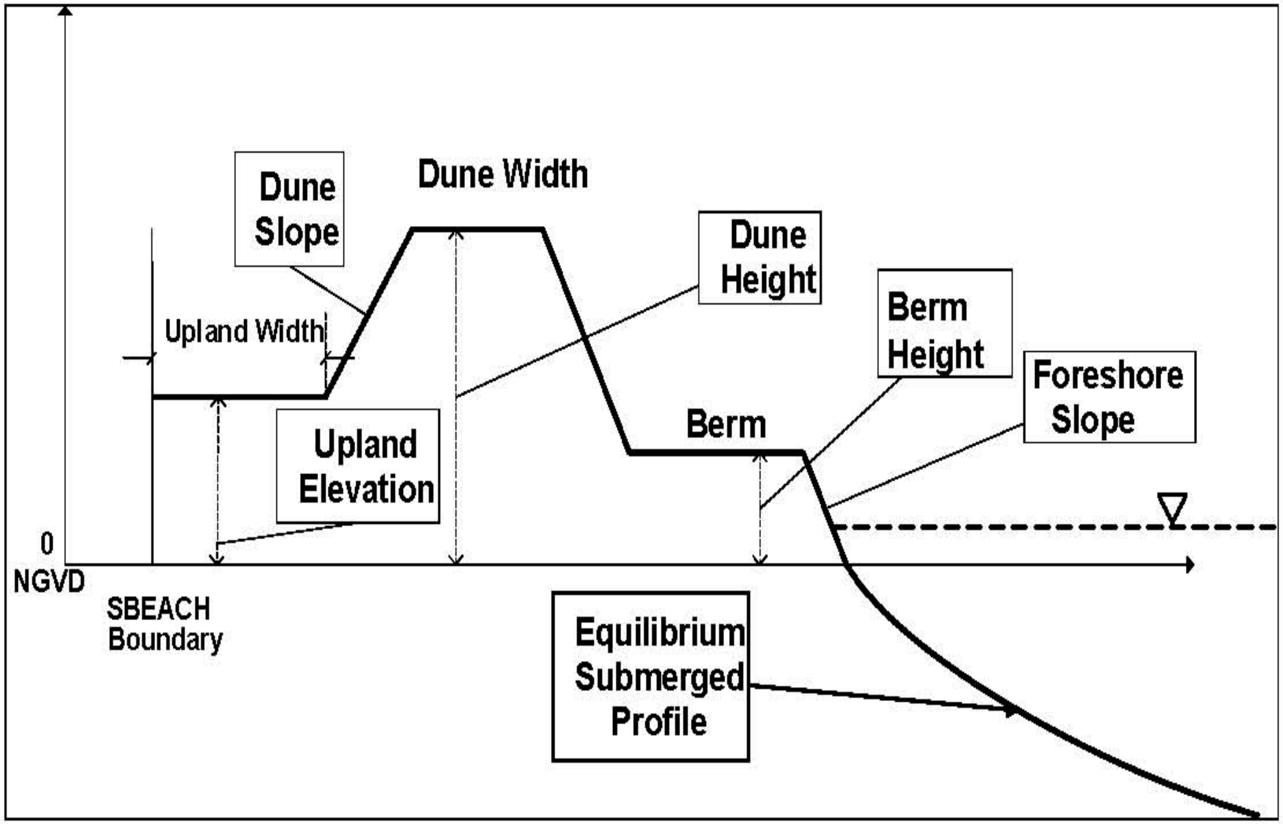


Figure 1. Survey Baseline and Transects

Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Profile Locations

January 2013
Norfolk District, Corps of Engineers



Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Idealized Profile Schematic

January 2013
Norfolk District, Corps of Engineers

Willoughby Spit & Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Idealized Profile Lines and Study Reach Boxes

January 2013

US Army Corps of Engineers
Norfolk District

0 1,000 2,000 3,000 4,000 Feet

Legend
Reach Profile
Reach Box

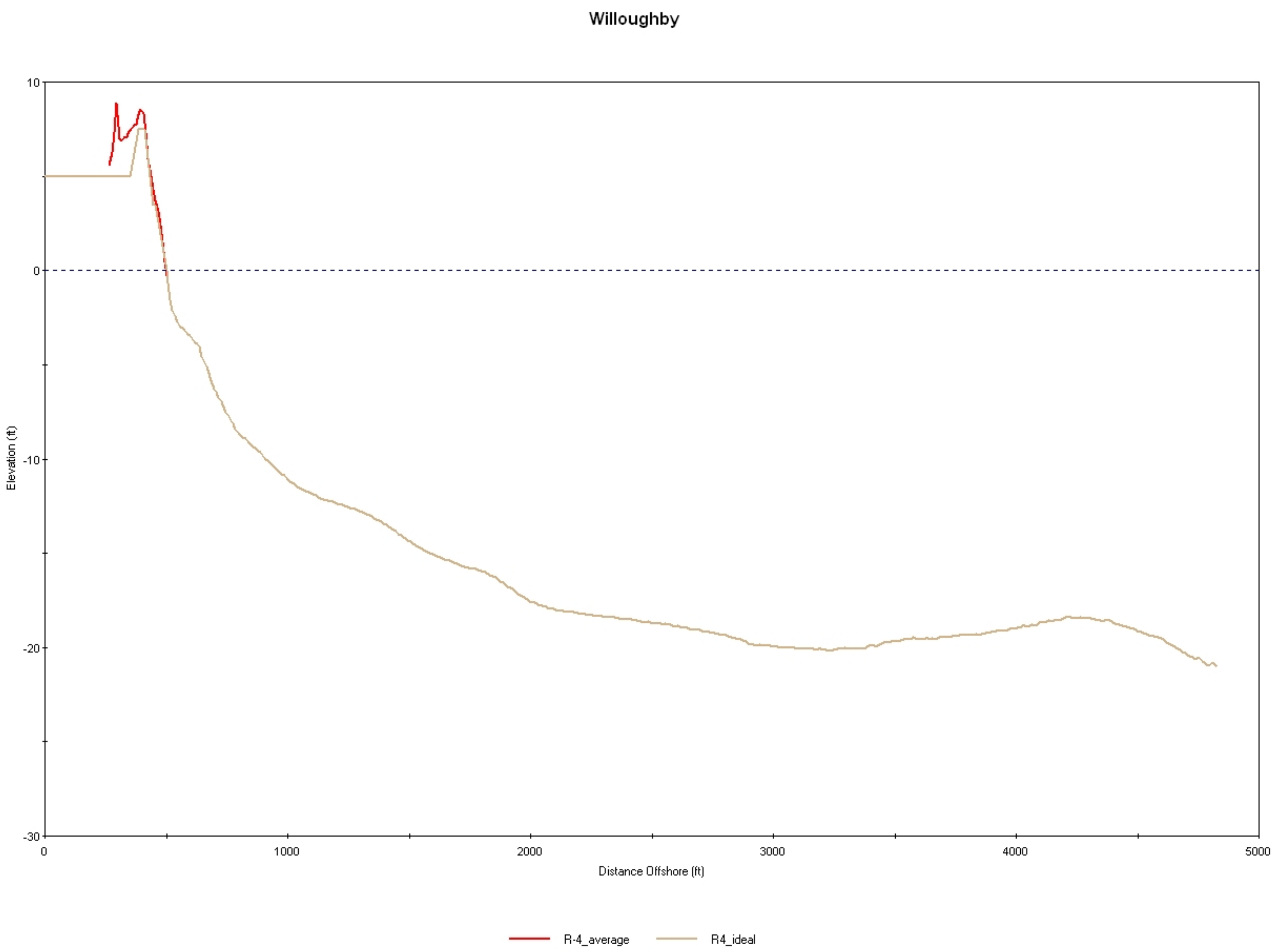
Projection:
Virginia State Plane
South Zone - NAD 83
U.S. Survey Feet

Base Image:
ESRI Online
Bing Maps Aerial

Project Manager: Robert Pretlow
E-mail: robert.n.pretlow@usace.army.mil
Phone: (757) 201-7385

Prepared by: Karin Dridge, Geospatial Section

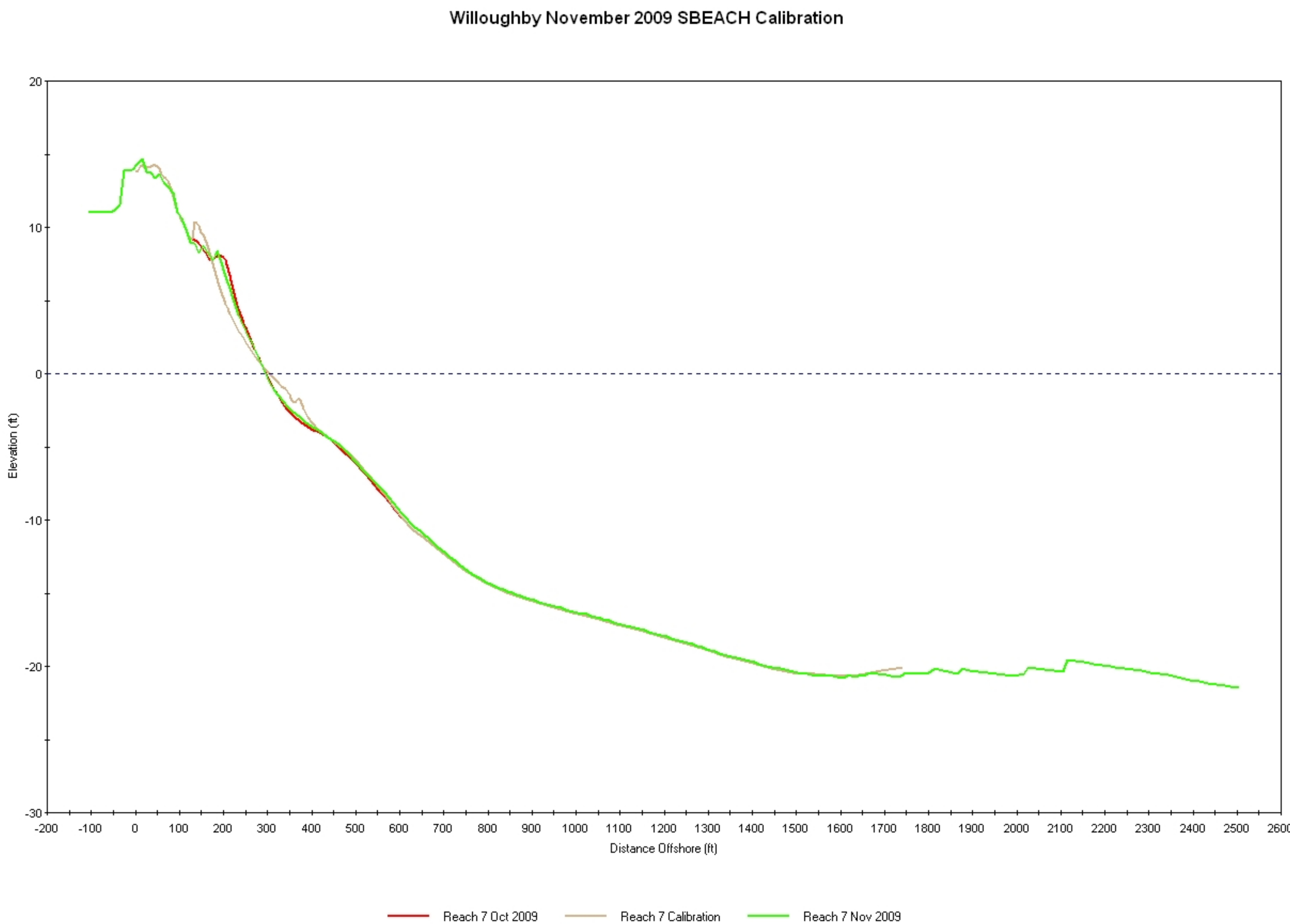
Map File: HandHReachesProfiles.mxd
Map Date: 30 July 2012



Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Average and Idealized Dune Profiles

January 2013
Norfolk District, Corps of Engineers



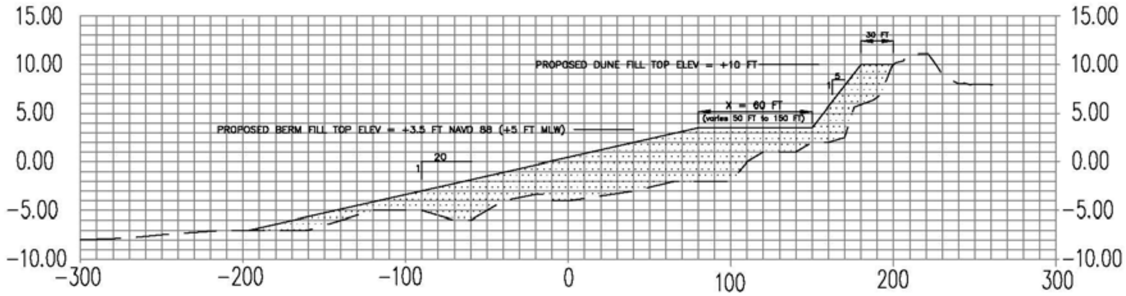
Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

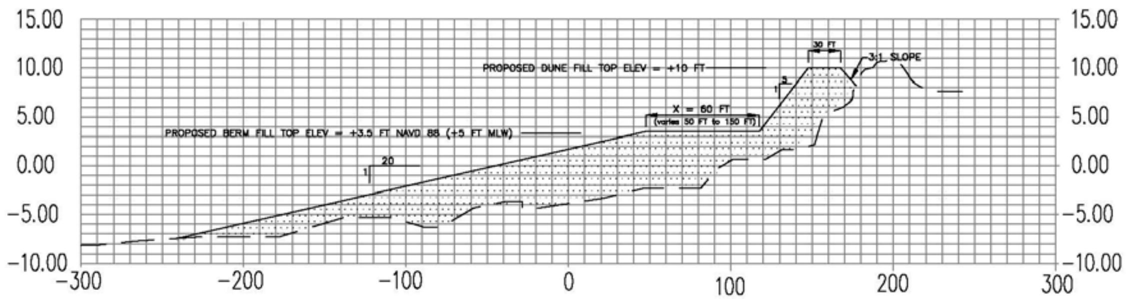
Willoughby SBEACH Calibration

January 2013
Norfolk District, Corps of Engineers

NOTE:

1. ENTIRE DUNE FACE TO BE STABILIZED WITH BEACH GRASS ON 1 to 1.5FT SPACING





TYPICAL CROSS SECTIONS

WILLOUGHBY SPIT
NORFOLK, VIRGINIA

HORIZONTAL SCALE 50 25 0 25 100 150
SCALE IN FEET

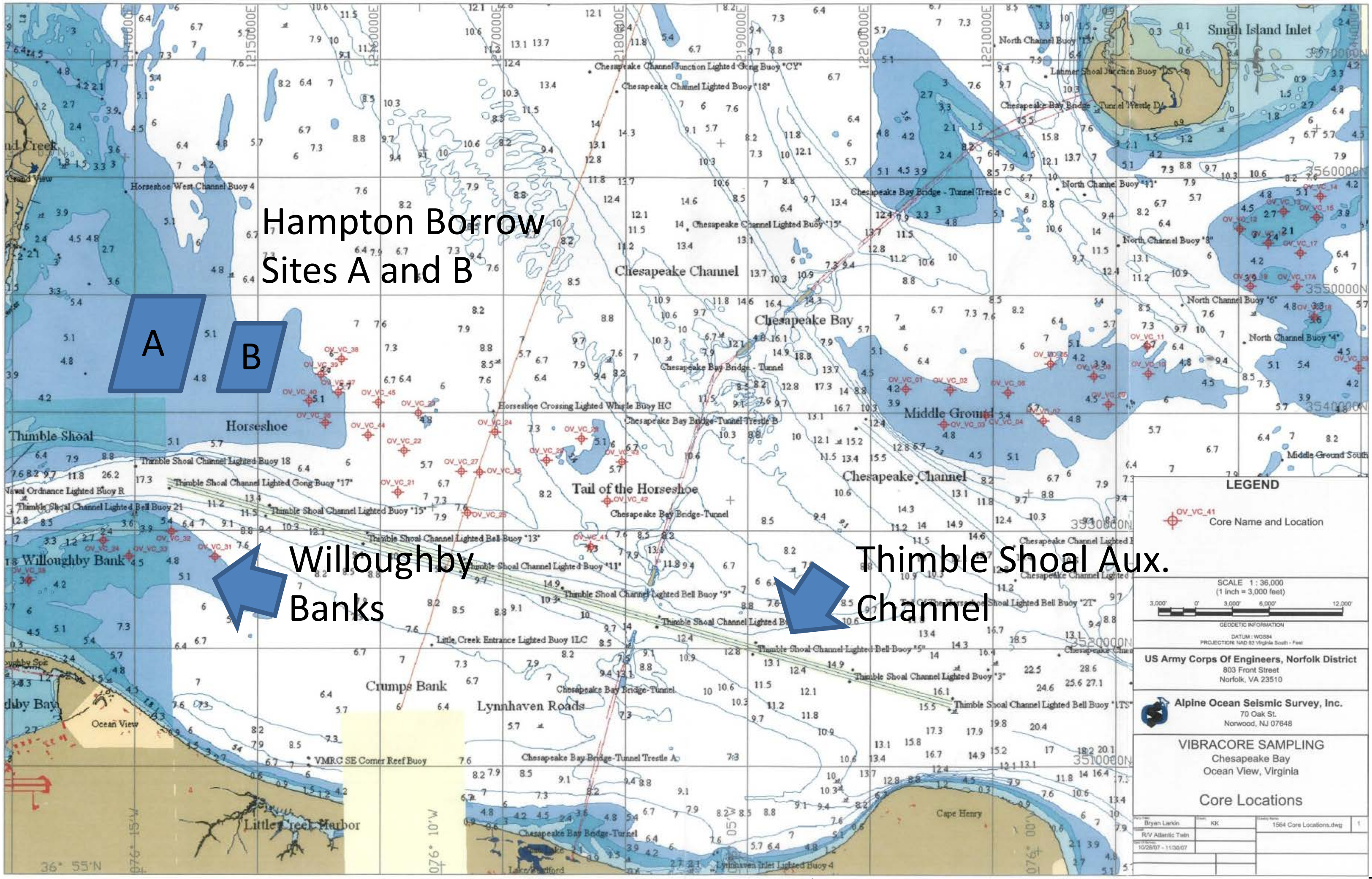
VERTICAL SCALE 10 5 0 10 20 30
SCALE IN FEET

US ARMY CORPS OF ENGINEERS NORFOLK DISTRICT

Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Cross Sections

January 2013
Norfolk District, Corps of Engineers



Willoughby Spit and Vicinity, Norfolk, Virginia
Hurricane and Storm Damage Reduction

Vibracore Locations

January 2013
Norfolk District, Corps of Engineers

Plate A-21

FEASIBILITY STUDY FOR WILLOUGHBY SPIT AND VICINITY, NORFOLK, VA HURRICANE AND STORM DAMAGE REDUCTION COASTAL ENGINEERING MANAGEMENT PLAN

GENERAL

The purpose of this Coastal Engineering Management Plan (CEMP) is to lay out a series of consistent, reasonable, and defensible coastal engineering analyses commensurate with the scope and complexity of the subject study. The results of these analyses will be utilized to populate the Shore Response Database (SRD) of the BEACH-fx model to evaluate and analyze the benefits and costs of alternative shoreline protection plans.

The recommended plan based on the September 2004 Reconnaissance Study included initial construction of a 60-foot wide berm at elevation +5.0 feet National Geodetic Vertical Datum (NGVD) (approximately equal to +4.2 North American Vertical Datum of 1988 {NAVD 88}). The total cost of the project was estimated at $18.5 million with periodic renourishment at an average annual cost of $1.0 million. Given the somewhat low level of risk associated with the relatively low level of investment and the somewhat limited study costs available, it is the intent of this CEMP to effectively utilize, to the extent reasonable and appropriate and without compromising the integrity of the study, existing available coastal engineering data and analyses.

The study area includes 7.3 miles of shoreline along the southern shore of Chesapeake Bay in the city of Norfolk, Virginia, as shown in Figure 1. The location and orientation of the shoreline of the study area immediately inside of the mouth of the Chesapeake Bay near the Atlantic Ocean, as shown in Figure 1, have made this area highly susceptible to erosion and damages associated with coastal storm activity.

The base year of the project has been selected as 2012, with a planning horizon of 50 years.

WATER LEVELS

The most extensive and continuous data record available is for the Sewells Point, Hampton Roads, VA tide gage located just inside Hampton Roads Harbor and approximately 2 miles south of the western end of Willoughby Spit, as shown in Figure 1. This record extends from August 1927 until the present and is considered representative of the tide history at Willoughby and vicinity for that time period.

According to National Oceanographic and Atmospheric Administration (NOAA), sea level rise has averaged a relatively consistent 0.0145 feet per year for the Sewells Point tide gage. All tide levels in these analyses (tidal hydrographs, tide frequency, etc.) will be increased by 0.0145 feet per year from the year that the tide level was actually recorded until the year 2037, the mid-point of the planning period, to account for past and anticipated future increases in sea level. The North American Vertical Datum of 1988 (NAVD 88) will be used for all elevations.

The tides in the study area are semi-diurnal, with a mean tide range of 2.43 feet at the Sewells Point tide gage (Figure 2).

TIDAL HYDROGRAPHS

Hourly still-water elevations will be obtained from the Sewells Point tide gage database for each of the actual storm events that will be analyzed. The hourly tide heights for each of the storm events that will be analyzed will be increased by 0.0145 feet per year from when each of the storm events actually occurred until the mid-point of the planning period of 2037, to account for past and expected future increases in sea level rise.

Although many of the larger coastal studies (with project lengths as great as 83 miles) often synthesize additional storm surge hydrographs based on different tide ranges (spring, mean, and neap) and tide hydrograph phases (high, low, mean rising tide, and mean falling tide), thereby creating 12 different scenarios for each storm analyzed, it is not considered necessary for this particular study given the following:

(a) Any projects associated with this study are likely to have a relatively low initial and low annual investment cost, not warranting the type of refinement identified above.

(b) The mean tide range in the study area is only 2.43 feet, with the spring tide range of 2.95 feet (spring high tide only 0.26 feet greater than mean high tide).

(c) The new or full moon (spring tide) only coincides with perigee 3 to 4 times a year (less than 0.5% of the tide cycles in a year would be expected to have a spring tide occur coincident with the perigee) and the difference between the perigean spring tide and the normal tidal range for all areas of the coast is small (1 to 2 inches per NOAA website).

(d) For this study, all tidal elevations will be increased approximately 0.5 feet to account for future sea level rise until the mid-point of the period of analysis. This adjustment alone is greater than the difference in the mean and spring high tide elevations.

(e) Northeasters, which comprise approximately 60% of the storms that will be analyzed in this analysis typically have a duration of several days or more. Because of how these storms slowly spin up and slowly spin down and the fact that a tide cycle is only slightly more than 12 hours, it stands to reason that the actual peak of the storm will essentially coincide with a high tide.

(f) Although one would typically consider the timing of the landfall of a hurricane or tropical storm critical to the timing of the tide cycle, this has generally not been the case within the southern Chesapeake Bay region. The tropical system that adversely impacts the southern shoreline of the Chesapeake Bay generally makes landfall to the south of the area, in North Carolina, and passes over or to the west of the study area. The storm surge that is pushed ahead of the storm must then propagate through the mouth of the Chesapeake Bay and is further influenced by the tropical system as it passes inland and over or west of the study area. The typical travel time from landfall to the south in North Carolina until the storm passes to the north of the study area is on the order of a tide cycle. During this entire time, the winds in the study area are onshore; thus, the maximum storm surge and wave heights are generally coincident and are of sufficient duration that they are also coincident with or very near the time of the predicted high tide. The August 1933 Hurricane and Hurricane Isabel are perfect examples of this, with the maximum surge occurring near the time of the predicted high tide.

(g) By aligning the tidal hydrographs with the wave heights as they actually occurred during the actual storm events, the pure randomness of the timing of the peak of the storm and the timing of the high tide is inherent.

FLOOD PROBABILITY

A tidal frequency relationship will be developed for the Hampton Roads, Sewells Point tide gage for the 1928 to 2005 period of record. The U.S. Army Corps of Engineers' Flood Frequency Analysis (FFA) Version 3.1 computer program developed by the Corps' Hydrologic Engineering Center (HEC) in accordance with the Hydrologic Subcommittee, Guidelines for Determining Flood Flow Frequency Bulletin 17-B, will be utilized in developing the peak stage frequency based on the annual peaks that will have been adjusted for sea level rise to the mid-point of the planning period. The partial duration adjustment will be incorporated by plotting all independent tidal events that have been adjusted for sea level rise above elevation 4.0 feet NAVD 88. The results of this analysis will then be increased by 0.46 feet (0.0145 feet per year from 2005 to the mid-point of the planning period in 2037) to account for future sea level rise.

STORM SELECTION

To control study costs and reduce the study time without adversely impacting the results or findings of the study, it is proposed to utilize existing data from the Flood Evaluation and Protection Study for Fort Monroe, Virginia that was prepared by the Norfolk District, U.S. Army Corps of Engineers in May 2005. As illustrated in Figure 1, Fort Monroe is located approximately 2 miles northwest of the western end of Willoughby Spit on the western shoreline of the Chesapeake Bay.

A review of the tide data for the Sewells Point tide gage during the Fort Monroe study for the period 1928 to 2003 indicated that there were 29 storm events that, once adjusted for sea level rise to 2003, would have produced maximum still-water levels of +4.0 feet NAVD 88 or higher. These events included 11 tropical storm/hurricane type storm events and 18 northeaster (extra-tropical) type storm events and are provided in Table 1.

Elevation +4.0 feet NAVD 88 also appears reasonable to use as a threshold value for the Willoughby Spit and Vicinity study below which inclusion of storms into the analysis would not influence the results of the study. This conclusion is based on the fact that the threshold value is only 2.8 feet higher than the mean higher high water level, is approximately equal to the existing +4.2 feet NAVD berm elevation, and there is no infrastructure or damageable inventory bayward of the existing dune/structure locations.

To efficiently perform the required analyses during the Fort Monroe study, it was necessary to reduce the number of events that were analyzed. Thus, the data set was reviewed and seven tropical storms/hurricanes and seven northeasters were selected for analysis based on representative tidal hydrographs to effectively represent the range of storm intensities and durations that could be expected.

In addition, a larger storm event (hypothetical variant) than any of those in the period of record was developed by utilizing the actual Hurricane Isabel track with the storm intensity increased by one category. The tidal still-water elevations for the hypothetical storm were increased to produce a peak tide two feet higher than actually occurred during Hurricane Isabel. This is consistent with a Category 1 to Category 2 Hurricane still-water level based on FEMA

Storm Surge modeling. The 15 selected storms are summarized in Table 2.

WAVE DATA

Wave data, including wave heights, direction, and period, were developed for the Fort Monroe Flood Evaluation and Protection Study to evaluate wave runup and overtopping. This wave data was developed under contract by Offshore & Coastal Technologies, Inc. (OCTI) for the eight hurricanes and seven northeasters that were evaluated in the study.

The waves were simulated in the Chesapeake Bay entrance using a time-varying directional spectral wave model referred to either as WAVAD or WISWAVE (Wave Information Study WAVE), and STWAVE (STeady State spectral WAVE), a steady-state model of the same type that was used for the nearshore areas. The wave data were propagated to the area immediately offshore of Fort Monroe. As seen on Figure 1, this data is located approximately 2 miles northwest of the western end of Willoughby Spit and is considered representative of the waves that the Willoughby and vicinity study area would experience.

Recently, a wave gage has been installed offshore of the study area. However, given the limited time the gage has been operational and the absence of significant storm events during this brief period, no additional wave data analysis is anticipated for the accomplishment of this study at this time.

PROFILE DATA

Beach profiles have been developed within the study area over a considerable period by various interests and entities. These profiles were developed for various purposes and needs and were collected both intermittently in time (some following storm activity, some pre- and some-post beach fill or construction of coastal structures such as breakwaters) and intermittently spatially (some extending to wading depth only, some extending considerably offshore, some only in isolated reaches of interest along the beach, etc.) In addition, some of this data is available electronically, but some of the data is only available in a hard copy format. Thus, the use of these profiles in developing morphologically representative beach profiles to represent existing conditions is somewhat questionable.

However, there are two recent beach profile surveys (September 2005 and March 2006) that have been conducted by the city of Norfolk that cover the entire 7.3 miles of study area. As shown in Figure 3, there are approximately 106 profiles spaced along the entire 7.3 miles of shoreline (interval varies from 250 to 1,500 feet) that extend well offshore (1,200 to 8,000 feet) to the closure depth of approximately 20 feet. These two profile data sets will be utilized during this feasibility study to develop morphologically representative beach profiles since they represent the best estimate of profile conditions that are expected to exist at the beginning of any storm in the future.

The BMAP component of the Coastal Engineering Design and Analysis System (CEDAS) software developed by the Corps of Engineers' Coastal Hydraulics Laboratory (CHL) will be utilized to first develop an average profile at each profile location and then these average profiles will be grouped and averaged with adjacent and similar profiles to develop the representative profiles for each morphologically different reach. At this time, prior to this analysis, it is estimated that 6 to 13 morphologically different areas exist along the 7.3 miles of shoreline. These include two separate areas with existing breakwater structures, several different orientations of the shoreline, and a much shallower area on the west end of Willoughby Spit that extends onto the Willoughby Bank shoal.

SBEACH

The U.S. Army Corps of Engineers' Storm-induced BEAch CHange Model (SBEACH) software developed by the Coastal Hydraulics Laboratory (CHL) will be utilized to determine the short term beach profile response for each of the 15 storms for the existing condition and each with project condition (nature and number yet to be identified) that will be analyzed. The existing condition is expected to represent future conditions in the Base Year of 2012 as well as throughout the planning period based on the City's past nourishment activities. The outputs from SBEACH will be utilized to populate BEACH-fx as intermittent noncyclic storm events that represent short-term mostly recoverable storm-induced processes.

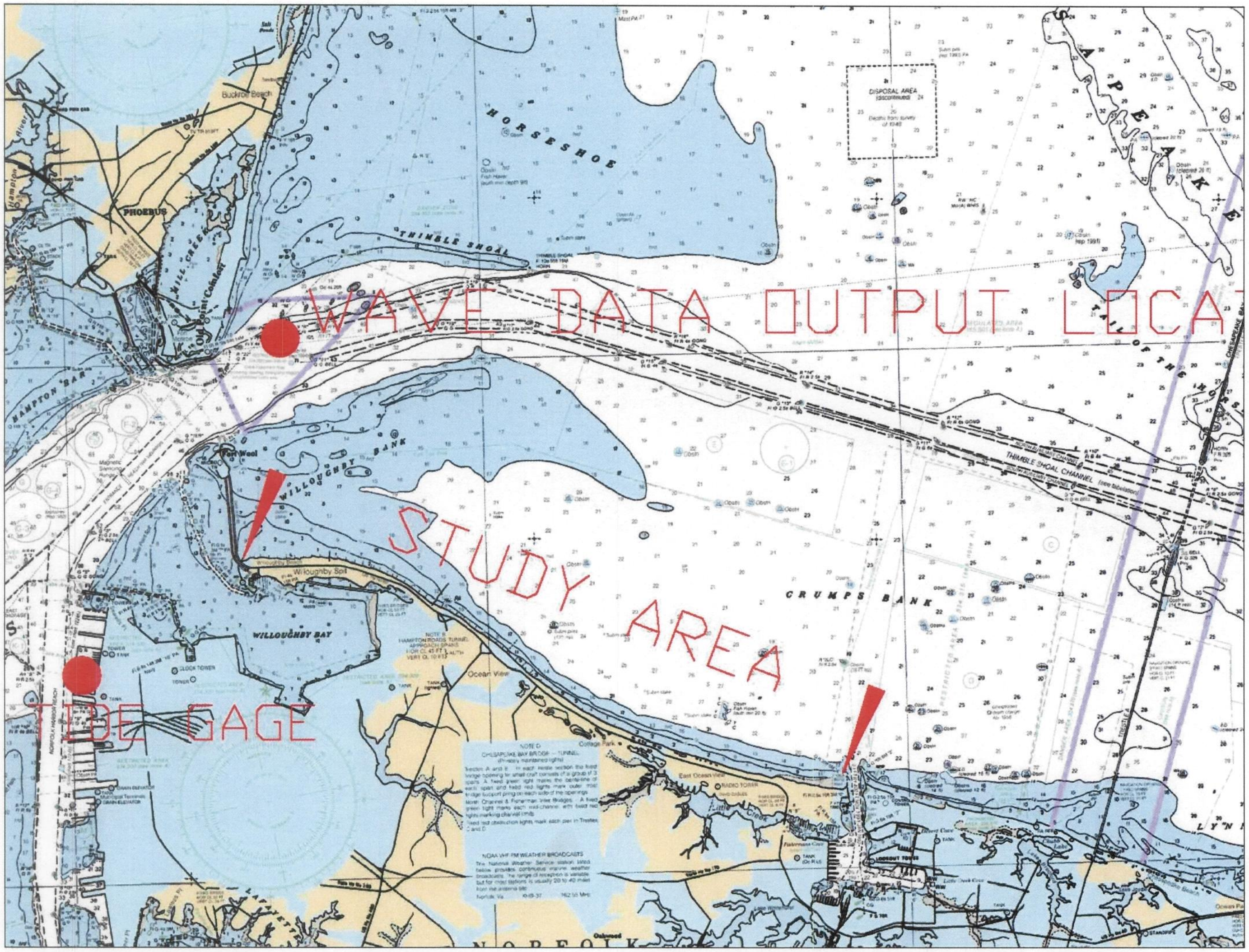
GENESIS

Long-term trends that give rise to historical shoreline and beach planform changes can be determined using several methods. A common method to evaluate the long-term evolution of shorelines is to utilize the U.S. Army Corps of Engineers' GENEralized Model for SImulating Shoreline Change (GENESIS) software developed by the Coastal Hydraulics Laboratory (CHL).

At the present time, it is not anticipated that GENESIS modeling of the study area will be accomplished during this feasibility phase. The existing erosion rates and shoreline changes in the study area are well documented in previous reports and studies and are considered sufficient for this feasibility effort.

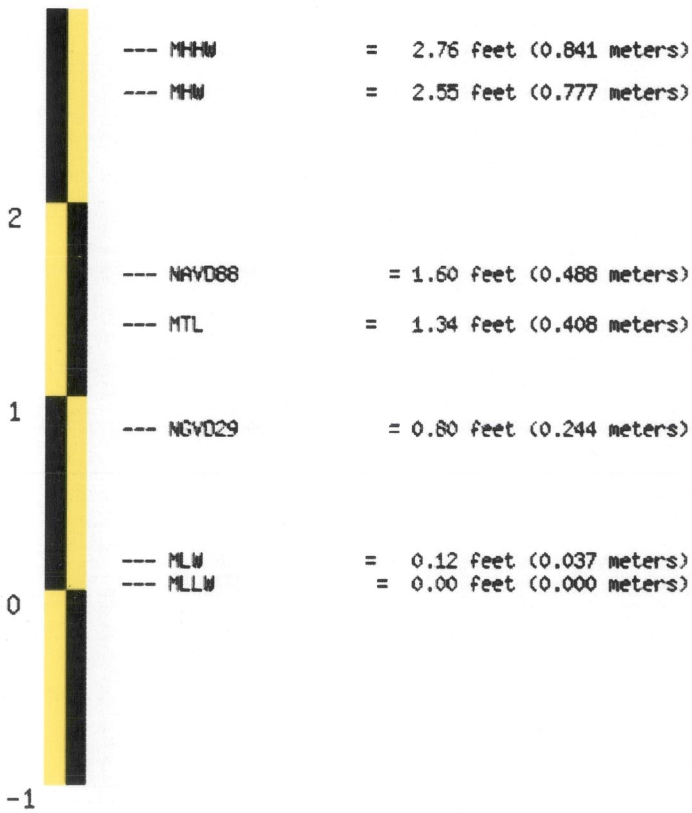
Depending on the recommended plan that is ultimately selected, GENESIS modeling may be required during the design phase to develop the final size, location, and orientation of breakwater structures (if included in the recommended plan) and/or to further detail any required renourishment activities (volumes and cycles).

Should it become necessary during the conduct of this feasibility study, or even during the design phase, to utilize GENESIS to evaluate long-term shoreline changes, the use of available data will be maximized to the extent possible to minimize the additional study costs and study time. Available data known at this time that could be used in any future GENESIS modeling includes several studies prepared for the City of Norfolk along short isolated reaches of the study area. These studies were prepared by the consulting firm Moffatt & Nichol in 2004 and 2005.


WAVE DATA OUTPUT LOCAT
STUDY AREA
TIDE GAGE
HORSESHOE
THIMBLE SHOAL
THIMBLE SHOAL CHANNEL
WILLOUGHBY BANK
WILLOUGHBY BAY
Willoughby Spit
CRUMPS BANK
DISPOSAL AREA
PHOEBUS
Buckroe Beach
Ocean View
NORFOLK

Date created
Wed Aug 2 10:37:39 EDT 2006

Elevation Information for PID = FX0093, VM = 511
Station_ID --- 8638610



The NAVD 88 and the NGVD 29 elevations related to MLLW were computed from Bench Mark, TIDAL 6 STA 97, at the station.

Displayed tidal datums are Mean Higher High Water(MHHW), Mean High Water (MHW), Mean Tide Level(MTL), Mean Low Water(MLW), and Mean Lower Low Water(MLLW) referenced on 1983-2001 Epoch

FIGURE 2. SEWELLS POINT DATUM DIAGRAM

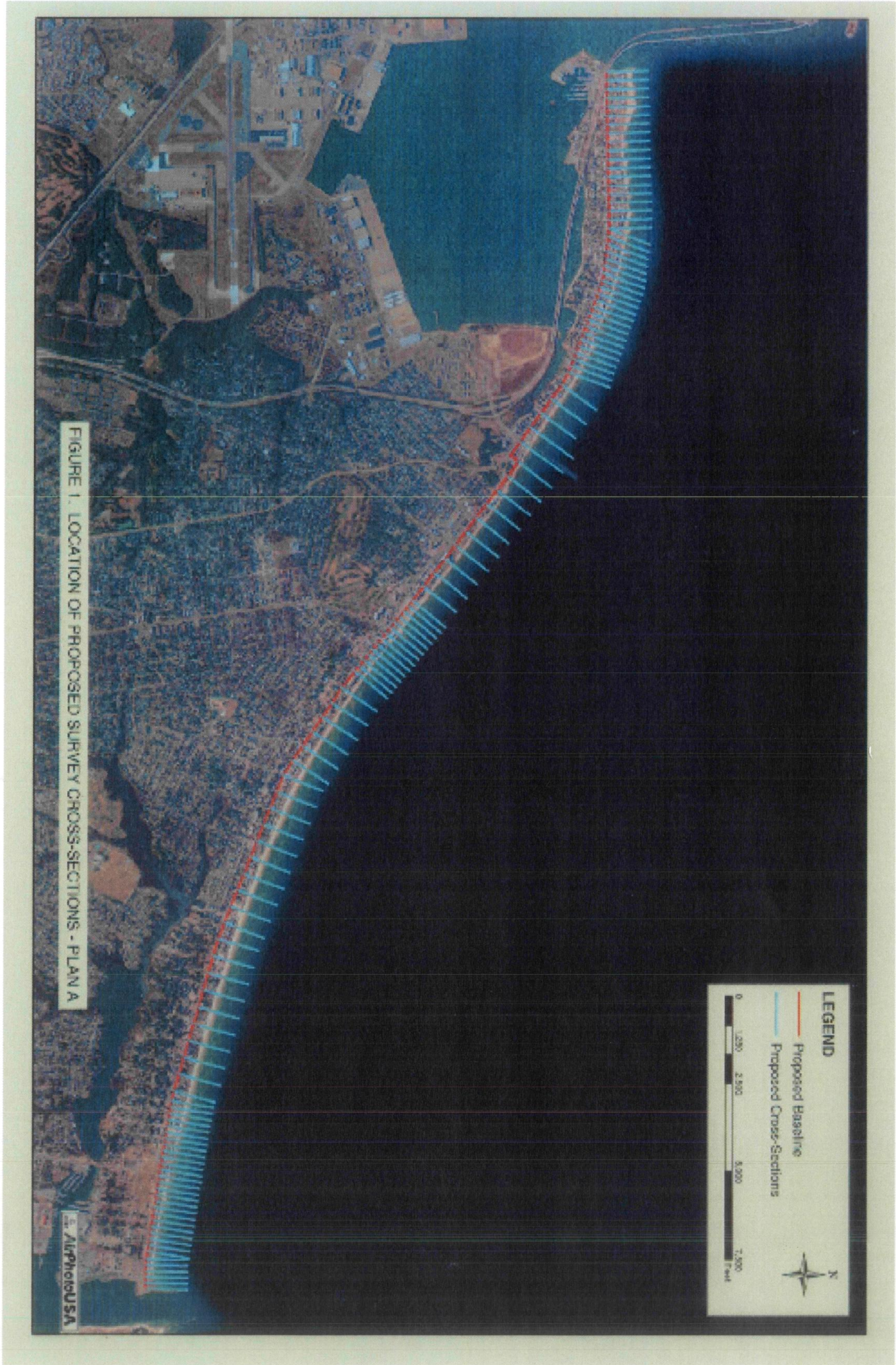


FIGURE 3. TRANSECT LOCATIONS

Table 1. 8638610 SEWELLS POINT, HAMPTON ROADS, VA
1928 - 2003 MAXIMUM STAGES ABOVE +4.0 FEET NAVD 88

HIGHEST PEAK STAGES IN FEET BASED ON NAVD 88 DATUM
AFTER ADJUSTMENT FOR SEA LEVEL RISE OF 0.0145 FEET PER YEAR

HURRICANES

Rank	Date	Name	Peak Stage
1	8/23/1933	Aug '33	7.41
2	9/18/2003	Isabel	6.26
3	9/18/1936	Sep '36	6.07
4	9/16/1933	Sep '33	5.51 (P)
5	9/27/1956	Flossy	4.98 (P)
6	9/12/1960	Donna	4.92
7	9/19/1928	Sep '28	4.78
8	9/13/1964	Dora	4.46
9	9/16/1999	Floyd	4.40
10	9/25/1992	Danielle	4.09
11	8/17/1986	Charley	3.94

NORTHEASTERS

Rank	Date	Name	Peak Stage
1	3/7/1962	Ash Wed.	6.19
2	4/11/1956		5.38
3	4/27/1978		5.15
4	2/5/1998	Twin N.E.	5.03
5	10/6/1957		4.66
6	10/5/1948		4.59
7	10/25/1982		4.58
8	1/28/1998	Twin N.E.	4.49 (P)
9	11/4/1930		4.35
10	10/21/1958		4.35
11	7/3/1933		4.31 (P)
12	1/24/1940		4.21
13	4/13/1988		4.19
14	10/14/1977		4.17
15	10/21/1961		4.10
16	1/1/1987		4.04
17	8/30/1999		4.03 (P)
18	10/19/1997		4.00

(P) = Partial Duration, higher annual peak exists

Table 2. 8638610 SEWELLS POINT, HAMPTON ROADS, VA
1928 - 2003 STORMS HINDCAST AND ANALYZED

HIGHEST PEAK STAGES IN FEET BASED ON NAVD 88 DATUM
AFTER ADJUSTMENT FOR SEA LEVEL RISE OF 0.0145 FEET PER YEAR

HURRICANES				NORTHEASTERS			
Rank	Date	Name	Peak Stage	Rank	Date	Name	Peak Stage
1	Isabel track, storm intensity increased 1 category						
2	8/23/1933	Aug '33	7.41	1	3/7/1962	Ash Wed.	6.19
3	9/18/2003	Isabel	6.26	2	4/11/1956		5.38
4	9/18/1936	Sep '36	6.07	3	4/27/1978		5.15
5	9/16/1933	Sep '33	5.51 (P)	4	10/25/1982		4.58
6	9/12/1960	Donna	4.92	5	10/21/1958		4.35
7	9/16/1999	Floyd	4.40	6	10/14/1977		4.17
8	8/17/1986	Charley	3.94	7	1/1/1987		4.04

(P) = Partial Duration, higher annual peak exists

15 November 2006

Independent Technical Review

"Feasibility Study for Willoughby Spit and Vicinity, Norfolk, VA
Hurricane and Storm Damage Reduction
Coastal Engineering Management Plan"

CENAO requested that CENAP-EC-DH perform a independent technical review (ITR) of the Coastal Engineering Management Plan (CEMP) for the Willoughby Spit hurricane and storm damage reduction feasibility study. The draft copy provided for review is dated 08 August 2006. ITR comments are provided herein.

GENERAL COMMENTS

Overall, the document is well written and provides a concise summary of coastal engineering analyses to be performed in support of the economic benefit and cost evaluation of alternative hurricane and storm damage reduction plans. Analysis tools and techniques proposed for use in the study are technically sound and are consistent with policy requirements. In general, the proposed level of detail in the analyses is commensurate with the scope of the study. The intent to use existing data to the extent practicable is appropriate, and the existing available data described in the CEMP should suffice to adequately represent morphological conditions in the project area and coastal processes controlling hurricane and storm response and shoreline change. Specific comments that follow are referenced by section.

SPECIFIC COMMENTS

Water Levels: Sea level rise is accounted for by adjusting all tide measurements to the midpoint of the planning period (2037). This is presumably done to provide a single representative future sea level condition which avoids the complexity of accounting for temporal changes in sea level over the period of the analysis. Implications are that storm elevations will be overestimated early in the life cycle and underestimated late in the life cycle. As a result of this simplifying assumption, the impact of a maximum storm surge combined with the sea level that would otherwise be predicted to occur near the end of the 50 year planning period will not be represented in the analysis.

The intent of this comment is not to imply that the approach is flawed or requires modification. However, rationale for applying this simplified assumption should be presented and implications should be discussed briefly in the CEMP to better clarify the influence of sea level rise in the analysis.

Tidal Hydrographs: Several points are presented as to why analysis of varied tide ranges and phases is considered unnecessary in developing storm hydrographs for the study. Point (a) implies that the economic scale of the project does not warrant such a level of detail. The statement is somewhat subjective, and one could argue that a 7-mile project with estimated initial construction cost of $18 million and average annual cost of $1 million is not a "relatively low" investment cost. Such cost figures are representative of many shore protection projects along the nation's coasts that are considered substantial investments in hurricane and storm damage reduction. Whether or not varied tide ranges and phases are considered necessary should be dictated primarily by technical factors. Points (b) and (c) demonstrate that varying the tide range would be expected to have minimal influence on study results due to the small difference in mean, spring, and perigean spring tide ranges relative to storm surges that occur at the project site. This should be the primary focus of the discussion rather than tying the analysis to investment cost. The concern is that an investment cost argument could set a precedent for precluding analysis of tide ranges and phases for other similar-scale projects in cases where such influences may be more critical to storm response.

Point (d) suggests that tide range variation is unimportant because the difference in tide ranges is less than the amount of sea-level rise applied in the analysis. However the two parameters are on the same order of magnitude in comparison to storm surge elevations. One could argue that if sea level rise warrants consideration, then tide range variation does as well. It is suggested that point (d) be deleted because, though factual, it does little to support the argument that tide ranges need not be considered.

Point (e) is effective in explaining why tide phase need not be considered as a first order parameter influencing peak storm water level for northeasters with long duration. However, the discussion in point (f) seems to apply only to hurricanes that follow the "general" track of landfall in North Carolina and passing to the west of the study area. What about hurricanes that could potentially track just to the east of the study area and pass up through the Chesapeake Bay? In such a case, tide phase could have a significant influence on peak storm surge values at the project site. Lessons of Katrina show that a "worst case" scenario may not necessarily align with historical storm tracks. Sensitivity analyses should be considered to assess significance of tide phase for hurricanes of different tracks.

Point (g) argues that randomness of the timing of peak of the storm and timing of the high tide is inherently reflected in the historical record. While this is true, the historical record does not necessarily reflect the full range of randomness in timing that could occur between peak storm surge and high tide for future events. Suggest deleting this point as it seems to add little support for not considering tide phase variation.

Flood Probability: No Comments

Storm Selection: It is the reviewer's understanding that the BeachFx life cycle approach relies on using all historical events above the specified threshold (+4 ft NAVD peak water level elevation, in this case) within the selected historical record. Table 1 indicates that 11 tropical storms and 18 northeasters were above the threshold in the 1928-2003 record, but Table 2 lists only 8 tropical storms and 7 northeasters as representative of the range of storm intensities and durations to be expected. It appears that the storms identified in Table 2 were developed for a frequency-based approach rather than life cycle-based approach. Applicability of a subset of storms from the historical record should be confirmed with BeachFx developers (Mark Gravens, ERDC) prior to commencing the study. Additionally, appropriate assignment of probability to the hypothetical variant developed from Hurricane Isabel should be checked with BeachFx developers.

Wave Data: No Comments

Profile Data: Concur that morphologic reaches are best characterized using the September 2005 and March 2006 surveys. Historical long-line beach profiles that pre-date the September 2005 and March 2006 surveys should be examined together with the later surveys to evaluate depth of closure for use in developing design templates for beachfill alternatives.

SBEACH: No Comments

GENESIS: No Comments

Storm Wave Modeling
Fort Monroe, Virginia

Offshore & Coastal Technologies, Inc.

22 November 2004

Model Setup

The waves in the Chesapeake Bay entrance were simulated using WAVAD (called WISWAVE within the Corps of Engineers), a time-varying directional spectral wave model and STWAVE, a steady-state model of the same type used for nearshore areas (Resio and Perrie, 1989; Hubertz, 1992). Storm simulations were performed using a series of nested finite difference grids which increased in resolution toward the project site. The project site is Fort Monroe on the western shore of the southern end of the Chesapeake Bay.

The basis for model bathymetry was NOAA Navigation Charts, with the finest resolution obtained for local model bathymetry from NOAA Navigation Chart 12221 and 12245. Chart depths were deepened to a water level of +1.0m above MSL. The approach of using successively finer grids assures that open ocean conditions and Chesapeake Bay conditions are properly generated and transformed to the site, while resolving local details of the wave transformations across the continental shelf, the Chesapeake Bay and locally in the entrance to the bay. The model's nesting capability allows boundary conditions to be written by a coarser grid for propagation into the next successively finer grid. The finest grid resolution was selected to be approximately 1 nautical mile to achieve tolerable model execution times while resolving local shoal and channel features, as well as shoreline positions locally. Model grids had the following coverage and resolutions:

Grid	Coverage	Latitude Range (degrees)		Longitude Range (degrees)		Resolution (degrees)
1	North Atlantic Ocean	20.00N	45.00N	80.00W	50.00W	1.00
2	Western Atlantic Ocean/Shelf	35.75N	38.25N	76.25W	74.75W	0.25
3	Continental Shelf and Southern Chesapeake Bay	36.41N	38.50N	76.50W	75.66W	0.083
4	Extreme Southern Chesapeake Bay and Entrance	36.91N	37.09N	76.34W	76.08W	0.0166

The purpose of the WAVAD simulations is to provide storm data for use in coastal modeling and design. So the WAVAD model was used to simulate a series of extreme storms. WAVAD was chosen because of the seamless ability to propagate directional wave spectra from offshore to the site of interest while including a 360-degree range of wave directions (as opposed to half-plane models).

To verify and enhance the results of the WAVAD simulations at the output locations of interest, the model STWAVE was also redundantly applied to the area included in Grid 4 (above). The model resolution was increased to 50m. Separate simulations were performed using the surface wind and boundary spectra to drive the model in two orientations: eastern boundary to drive the model (waves from the Atlantic Ocean), and from the northern boundary to drive the model (waves from the Chesapeake Bay)

Storm Events and Wind Field Development

The storm events that were modeled were specified by the Norfolk District (presumably based on peak water level stage in the area) were as follows:

HURRICANES					NORTHEASTERS			
Rank	Date	Name	Peak Stage (ft)		Rank	Date	Name	Peak Stage (ft)
1	Isabel track, storm intensity increased 1 category				1	Halloween storm recentered to the southwest		
2	8/23/1933	Aug '33	7.41		2	3/7/1962	Ash Wed.	6.19
3	9/18/2003	Isabel	6.26		3	4/11/1956		5.38
4	9/18/1936	Sep '36	6.07		4	4/27/1978		5.15
5	9/16/1933	Sep '33	5.51		5	10/25/1982		4.58
6	9/12/1960	Donna	4.92		6	10/21/1958		4.35
7	9/16/1999	Floyd	4.40		7	10/14/1977		4.17
8	8/17/1986	Charley	3.94		8	1/1/1987		4.04

Tropical wind velocity fields, 10-m above the water surface for tropical storm events were developed using PBL, a tropical cyclone model (Thompson and Cardone, 1996). PBL describes the vortex pressure field using existing historical information on storm track, scale radius of the storm radial pressure profile, and other parameters.

Storm tracks and initial estimates of intensity of an historical North Atlantic basin tropical storm to be analyzed are taken, with some modification, from the NOAA Tropical Prediction Center's database (Jarvinen et al., 1984). Surface winds generated from PBL are then imported into a graphical interface at 6-hourly intervals and evaluated against available surface data and aircraft reconnaissance wind observations adjusted to the surface as described by

Powell and Black (1989). This process is iterated until a solution for the surface wind fields that is most consistent with all of the available data is achieved. The final wind field is this best fit model solution.

Wind fields, 10-m above the water surface, for extratropical storm events were developed using IKOA. The benefits of IKOA enhancement to the performance of ocean response modeling over wind fields produced by strictly automated methods for extratropical storms are well established (e.g., Cardone *et al.*, 1995). The IKOA starts from a first-guess background wind field and then proceeds to assimilate observations of surface winds from ships, buoys, coastal stations, and remote sensing sources. If available, background winds were taken from the AES40 hindcast (Swail and Cox, 1999).

Wind fields were reported at a grid spacing of 0.0625° latitude by 0.0625° longitude (about 7 km) and 0.625° latitude by 0.833° longitude, for tropical and extratropical events respectively. Temporal resolution for tropical and extratropical events was 30 minutes and 3 hours, respectively.

Model Validation

The wave model performance was examined for two of the specified storms: the January, 1987, northeaster and for the September, 2003, hurricane Isabel. Depths from the charts were deepened to a water level of +1.0m above MSL, to reflect a storm tide that was elevated but not overly conservative. The comparisons, illustrated in the figures below, indicate the model reliably reproduces measurements at NOAA's Chesapeake Light wave measurement station. That gauge is nondirectional; however, the wave height comparisons appear excellent.

The model performance was also examined inside the Chesapeake Bay mouth at two locations monitored in the late 1980's and early 1990's by the Virginia Institute of Marine Sciences. Part of the VIMS deployment overlapped three hindcasted storms that were not part of the project storm set listed above but were made available to validate the model. One events in March 1993 was measured and reported by Boon and Hepworth (1993) and one event in March 1994 was measured and reported by Boon and Hepworth (1994). The measurement locations in 1993 were 37 deg 2.4 min N, 76 deg 12.5 min W (here called BOON1) and 36 deg 58.4 min N, 76 deg 2.4 min W (here called BOON2). The measurement location in 1994 was 37 deg 2.6 min N, 76 deg 11.6 deg W (here called BOON3). The results are shown in the table below. The results indicate that the proper amount of wave energy is reaching the measurement sites in the model without adjusting the wind input and/or the bathymetry.

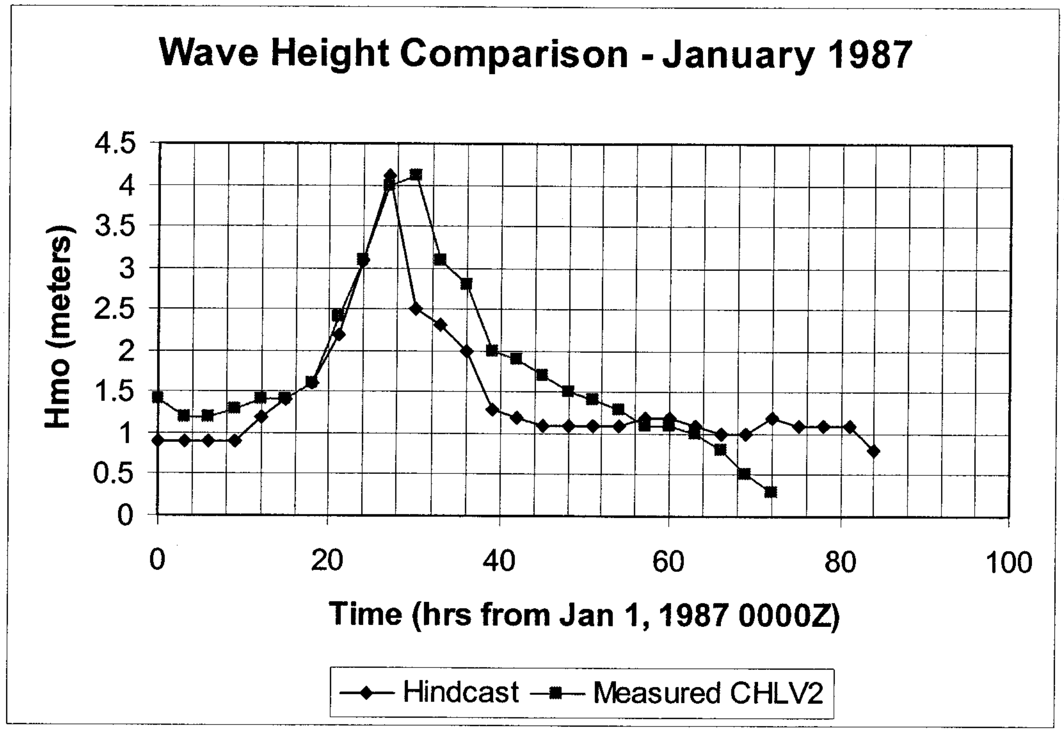


Figure 1. Comparison of wave model to measurements for an extreme northeaster storm.

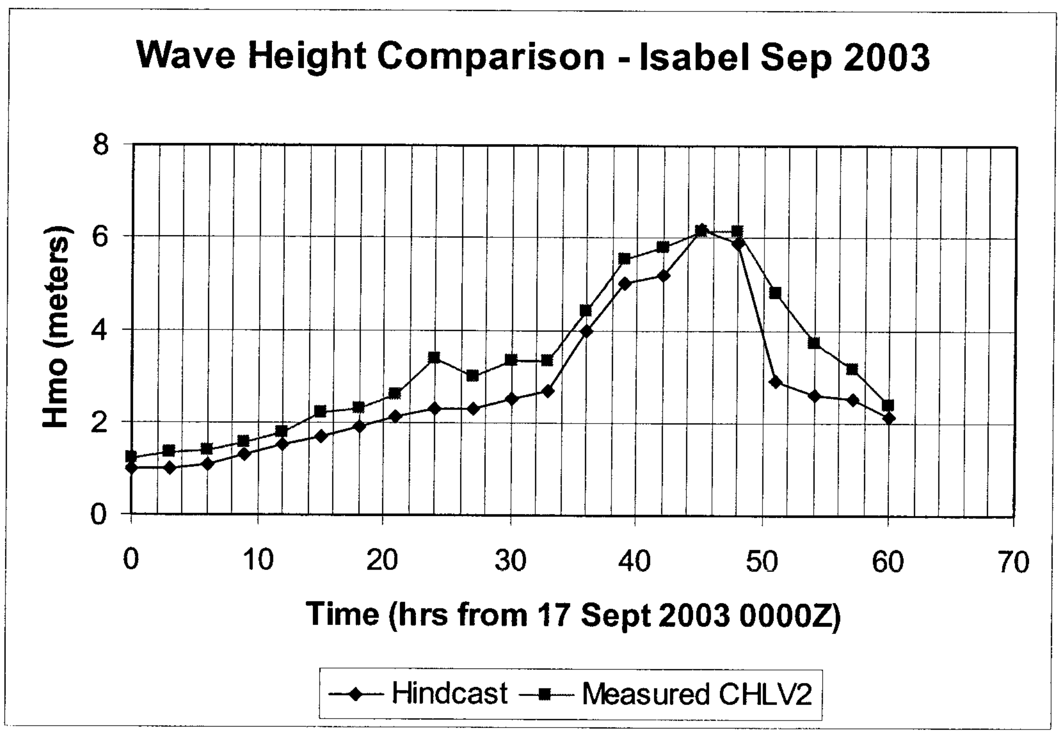


Figure 2. Comparison of wave model to measurements for an extreme hurricane.

Event	CHLV2 Hmo (m)	Model Hmo (m)	VIMS	Peak Measured Hmo (m)	Peak Measured Tp (s)	Peak Measured Dp (deg)	Modeled Hmo (m)	Modeled Tp (s)	Modeled Dp (deg)
3/3/1993	2.8	2.6	BOON1	1.2	5	180	1.0	3	160
3/3/1993	2.8	2.6	BOON2	1.2	7	185	1.0	3	149
3/4/1994	4.1	3.9	BOON3	2.5	11	150	2.4	8	147

Output Locations and Data Provided

The Norfolk District requested that wave model output be provided at five locations that were indicated on a digital navigation chart. Scaling those locations from the chart yielded the following coordinates:

Location	Longitude	Latitude
1	76 deg 17.0 min	37 deg 1.5 min
2	76 deg 17.0 min	37 deg 1.0 min
3	76 deg 17.0 min	37 deg 0.5 min
4	76 deg 17.5 min	37 deg 0.0 min
5	76 deg 18.5 min	36 deg 59.5 min

Output for each storm are provided in ASCII files with the suffix *.blk, because they contain the bulk parameters from the wave model. The ASCII text files can be imported into Excel or any text editor. The format is as follows:

```
OCTI 3091219 3091912 36.992 -76.309  <-- File header: beginning date
YYMMDDHH, ending date, latitude, longitude

For each time increment (hour) through the storm file:

3091219 0.2 2 270 <-- YYMMDDHH, Hmo(m), Tp (s), Wave direction (deg)..

Hmo is the zero-moment wave height in meters, Tp is the peak wave
period taken from the peak of the directional spectrum in seconds.
Wave direction is the direction from which waves arrive, clockwise from
north.  So, waves from 90 degrees are coming from the east.  All times
are GMT.
```

The wind field for Hurricane Isabel was intensified by 1 category number. During landfall, the maximum 1-hr wind was 64 knots (from 1818-1900Z). The 64 knots translates to an 80 kt 1-min wind. For 1-min winds, category 1 is 64-82 kts and category 2 is 83-95 kts. The ratio within the category is the net wind speed divided by the category range, (80-64)/(82-64)or 16/18=x/12, where X=10.7 (+83) 1-min, which then translates to 74.96 1-hour. The ratio of 74.96/64 is 1.171. The factor 1.171 was multiplied to winds > 35 kts at all time steps. To smooth evenly, 1.086 was multiplied for winds 30-35 kts at all time steps. This yields an 11 knot increase at the center at landfall and 8-10 knots at the Bay entrance.

A careful assessment of the Halloween storm to determine what might be the most severe condition for the Chesapeake Bay entrance yielded a shift in the wind field of 5 degrees to the west. Because of the large size of the storm and the complex features within the storm, the direction and magnitude of the shift required to create the most severe wave condition at the Bay entrance would require many storm simulations and an iterative adjustment to the wind fields. Because of the scope of this project, the adjustment was based on the opinion of an expert meteorologist with a careful review of the storm structure and wind fields that occurred during the storm time period.

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Willoughby Spit Beach Nourishment, Norfolk, Virginia

Norfolk District, US Army Corps of Engineers

February 2013

Introduction: Willoughby Spit and Vicinity: The Willoughby Spit and Vicinity project area is located entirely within the City of Norfolk and consists of 7.3 miles of southern Chesapeake Bay extending east from the tip of Willoughby Spit near the Hampton Roads Bridge-Tunnel to the Federal navigation project at Little Creek Inlet. Planning documents conclude that the threat of coastal storm damage is a major problem along the project area shoreline and recommend the construction and periodic nourishment of a protective beach berm. The current plan is to build a berm and dune system to protect the beachfront.

Project Description: See main report for background. This general Reevaluation Report includes a plan which will improve hurricane and storm damage along Willoughby Spit. Primarily the plan includes nourishing the beach along the 7.3 mile shoreline. The project also includes construction of several small beach dunes.

Basis of Estimate: The General Reevaluation Report summarizes the exact extent of beach nourishment and the location of the potential borrow site.

Cost Estimate: The cost estimate basis is primarily from CEDEP (Corps of engineers Dredge Estimating Program) estimates. The derivation of the final sand quantities is from BMAP. Beach FX volume calculations provided a check for the BMAP volumes. The potential borrow source for sand is the Thimble Shoal Channel. The Thimble Shoals borrow area is about 10.4 statute miles one-way from an average pump-out location at Willoughby Beach. The hopper dredge will anchor approximately ¼ of a mile offshore and hook up to a stationary Scott's Buoy. The dredge will pump sand directly onto the beach through a pipeline system. There will be approximately 5 different setups of the buoy along the shoreline. Dozers will spread sand on the beach. Other land-based equipment will move the pipeline on the beach to each new pumpout location. The most expensive cost in the project is the cost to deliver sand to the beach using a hopper dredge. One or more hoppers will operate 24 hours a day to bring sand to the beach. The variables in CEDEP include: markups, dredge area, dredge volume, material type, haul distance, haul speed, pumpout rate, time efficiency, additional equipment such as a Scott's Buoy, and fuel price.

Cost Estimate Summaries: The Mii estimate is the main summary estimate for the entire job. The CEDEP estimate feeds into the Mii estimate as line items for dredge mobilization and unit costs for dredging. The Mii estimate develops and adds the cost to spread sand on the beach. The Prime contractor for the entire job is the Dredging Contractor. The Mii estimate shows the Dredging Contractor as Prime-Dredging. Spreading sand on the beach is also done by the Prime, but the

Contractor title is Prime-Land. In the CEDEP estimates the Dredging Contractor is the Prime Contractor.

Estimate Contractor Markups Setup: The Mii estimate includes a Dredge Contractor for Dredging. The same Dredge Contractor also spreads sand on the beach after the pipeline delivers the sand to the beach. The CEDEP estimate includes prime markups for overhead, profit, and bond. CEDEP costs imported into the Mii estimate do not include additional Mii markups, to keep from marking up the dredging twice. The land-based activity in the Mii estimate includes prime markups: overhead, profit, and bond.

Estimate Contractor Markup percentages: The Prime-Dredging contractor has the following markups: Overhead-15%, Profit-10%, and Bond-1%. The Prime-Land contractor has the markups: Overhead-12%, Home Office Overhead-2%, Profit-10%, and Bond-1%.

Equipment Database: The latest Equipment database for Region II is in the estimate. The basis of revisions to the Region II Equipment database is current rates and factors such as fuel cost, Virginia sales tax, etc. The Equipment rates are similar to rates seen in this area for earthmoving contracts. The Equipment database can be updated to include universal type rates for the entire project estimate. There are some references to the Region II Equipment database as “MidEast”. This is not the foreign Mideast but the MidEast which includes the states of Virginia, Maryland, Delaware, West Virginia, Ohio, and several others.

Labor Database: The latest labor database is in the estimate. The dredging labor database basis is the latest Davis-Bacon schedule for Virginia. The labor database for land-based activities is at or above Davis-Bacon rates for Norfolk, Virginia. Most contractors pay more than Davis-Bacon rates in order to keep experienced and employees. In general the higher rates are closer to the Davis-Bacon rates. The “Payroll, Tax and Insurance” percentage rates are for Virginia and the Contractor Class is “Excavation-rock/earth NOC”.

Site access: Access to the site is not difficult. The PDT expects full cooperation from the local sponsor to reach the beach from land and sea.

Construction Window: Mobilization and preparatory work on the beach cannot start prior to 1 November. Dredging can start 1 December and must be complete by 31 Mar. This is because of the tourist season and turtle monitoring.

Escalation: Escalation has not been applied. Current pricing information has been used to prepare the estimate in 2013 dollars.

Project Schedule

PED -Prior Work-Aug 12;
Estimate Completion Date -Aug 12;
PED-Economics Study Start-Sep 12 ;
Cost Basis of Estimate-Oct 12 ;
Contract Bid Opening-Sep 14 ;
FY of Construction Start-Oct 14 ;
Contract Award-Oct-14 ;
PED Complete-Dec-14 ;
Construction Start-Dec 14;
Construction Midpoint-May 15 ;
Construction End-Sep 15

TPCS-Total Project Cost Summary: The TPCS is the single page spreadsheet that shows the costs through completion of the project. The Federal cost share for this project is 65% and the Non-Federal share is 35%. The basis of the TPCS is the sample spreadsheet supplied by Walla-Walla district. The TPCS spreadsheet model is from Walla-Walla's non-Cap example. The spreadsheet embeds CWCCIS escalation rates for CWBS Feature Codes 02 through 20. For Feature Code 30-Planning, Engineering, and Design and Feature Code 31-Construction Management escalation rates are from EC 11-2-202 Corps of Eng Civil Works Direct Program-Program Direct Guidance-FY14.

Contingencies and Risk Analysis: Norfolk District (NAO) performed an Abbreviated Risk Analysis (ARA) for the Initial Fill for the Authorized Plan and the NED plan. NAO also performed the ARA for the Periodic Renourishment of the Authorized and NED plans. The contingency for the Initial Fill for the Authorized plan was 17.6% and for the NED plan was 17.8%. The periodic Renourishment contingencies were 17.1%. Backup for the risk development is a separate attachment.

Project Acquisition: This project will be advertised as a large business competitive job. We expect two to four bidders for this job.

Uncertainties: Dredging is a competitive and unpredictable business. Mob-demob costs have increased at a high rate over the last five years. The basis of the mob cost in this estimate is primarily historical cost records in the Virginia/North Carolina region and in general along the East Coast. Dredging companies are busier than ever. This means a dredging company may have several jobs at the same time. They may have to use several dredges to complete their jobs on time.

Willoughby Renourishment Rev Cost Est FEB 2013

Estimated by	
Designed by	Norfolk District
Prepared by	mkh
Preparation Date	6/20/2012
Effective Date of Pricing	10/1/2012
Estimated Construction Time	Days

Date	Author	Note
2/19/2013	mh	Willoughby Spit Beach Nourishment
2/19/2013		Norfolk, Virginia Norfolk District, US Army Corps of Engineers; February 2013
2/19/2013		Introduction: Willoughby Spit and Vicinity: The Willoughby Spit and Vicinity project area is located entirely within the City of Norfolk and consists of 7.3 miles of southern Chesapeake Bay extending east from the tip of Willoughby Spit near the Hampton Roads Bridge-Tunnel to the Federal navigation project at Little Creek Inlet. Planning documents conclude that the threat of coastal storm damage is a major problem along the project area shoreline and recommend the construction and periodic nourishment of a protective beach berm. The current plan is to build a berm and dune system to protect the beachfront.
2/20/2013		Project Description: See main report for background. This general Reevaluation Report includes a plan which will improve hurricane and storm damage along Willoughby Spit. Primarily the plan includes nourishing the beach along the 7.3 mile shoreline. The project also includes construction of several small beach dunes.
2/20/2013		Basis of Estimate: The General Reevaluation Report summarizes the exact extent of beach nourishment and the location of the potential borrow site.
2/20/2013		Cost Estimate: The cost estimate basis is primarily from CEDEP (Corps of engineers Dredge Estimating Program) estimates. The derivation of the final sand quantities is from BMAP. Beach FX volume calculations provided a check for the BMAP volumes. The potential borrow source for sand is the Thimble Shoal Channel. The Thimble Shoals borrow area is about 10.4 statute miles one-way from an average pump-out location at Willoughby Beach. The hopper dredge will anchor approximately ¼ of a mile offshore and hook up to a stationary Scott's Buoy. The dredge will pump sand directly onto the beach through a pipeline system. There will be approximately 5 different setups of the buoy along the shoreline. Dozers will spread sand on the beach. Other land-based equipment will move the pipeline on the beach to each new pumpout location. The most expensive cost in the project is the cost to deliver sand to the beach using a hopper dredge. One or more hoppers will operate 24 hours a day to bring sand to the beach. The variables in CEDEP include: markups, dredge area, dredge volume, material type, haul distance, haul speed, pumpout rate, time efficiency, additional equipment such as a Scott's Buoy, and fuel price.
2/20/2013		Cost Estimate Summaries: The Mii estimate is the main summary estimate for the entire job. The CEDEP estimate feeds into the Mii estimate as line items for dredge mobilization and unit costs for dredging. The Mii estimate develops and adds the cost to spread sand on the beach. The Prime contractor for the entire job is the Dredging Contractor. The Mii estimate shows the Dredging Contractor as Prime-Dredging. Spreading sand on the beach is also done by the Prime, but the Contractor title is Prime-Land. In the CEDEP estimates the Dredging Contractor is the Prime Contractor.
2/20/2013		Estimate Contractor Markups Setup: The Mii estimate includes a Dredge Contractor for Dredging. The same Dredge Contractor also spreads sand on the beach after the pipeline delivers the sand to the beach. The CEDEP estimate includes prime markups for overhead, profit, and bond. CEDEP costs imported into the Mii estimate do not include additional Mii markups, to keep from marking up the dredging twice. The land-based activity in the Mii estimate includes prime markups: overhead, profit, and bond.
2/20/2013		Estimate Contractor Markup percentages: The Prime-Dredging contractor has the following markups: Overhead-15%, Profit-10%, and Bond-1%. The Prime-Land contractor has the markups: Overhead-12%, Home Office Overhead-2%, Profit-10%, and Bond-1%.
2/20/2013		Equipment Database: The latest Equipment database for Region II is in the estimate. The basis of revisions to the Region II Equipment database is current rates and factors such as fuel cost, Virginia sales tax, etc. The Equipment rates are similar to rates seen in this area for earthmoving contracts. The Equipment database can be updated to include universal type rates for the entire project estimate. There are some references to the Region II Equipment database as "MidEast". This is not the foreign Mideast but the MidEast which includes the states of Virginia, Maryland, Delaware, West Virginia, Ohio, and several others
2/20/2013		Labor Database: The latest labor database is in the estimate. The dredging labor database basis is the latest Davis-Bacon schedule for Virginia. The labor database for land-based activities is at or above Davis-Bacon rates for Norfolk, Virginia. Most contractors pay more than Davis-Bacon rates in order to keep experienced and employees. In general the higher rates are closer to the Davis-Bacon rates. The "Payroll, Tax and Insurance" percentage rates are for Virginia and the Contractor Class is "Excavation-rock/earth NOC".
2/20/2013		Site access: Access to the site is not difficult. The PDT expects full cooperation from the local sponsor to reach the beach from land and sea.
2/20/2013		Construction Window: Mobilization and preparatory work on the beach cannot start prior to 1 November. Dredging can start 1 December and must be complete by 31 Mar. This is because of the tourist season and turtle monitoring.

Date	Author	Note
2/20/2013		Escalation: Escalation has not been applied. Current pricing information has been used to prepare the estimate in 2013 dollars.
2/20/2013		PED -Prior Work-Aug 12; Estimate Completion Date -Aug 12; PED-Economics Study Start-Sep 12 ; Cost Basis of Estimate-Oct 12 ; Contract Bid Opening-Sep 14 ; FY of Construction Start-Oct 14 ; Contract Award-Oct-14 ; PED Complete-Dec-14 ; Construction Start-Dec 14; Construction Midpoint-May 15 ; Construction End-Sep 15
2/20/2013		TPCS-Total Project Cost Summary: The TPCS is the single page spreadsheet that shows the costs through completion of the project. The Federal cost share for this project is 65% and the Non-Federal share is 35%. The basis of the TPCS is the sample spreadsheet supplied by Walla-Walla district. The TPCS spreadsheet model is from Walla-Walla's non-Cap example. The spreadsheet embeds CWCCIS escalation rates for CWBS Feature Codes 02 through 20. For Feature Code 30-Planning, Engineering, and Design and Feature Code 31-Construction Management escalation rates are from EC 11-2-202 Corps of Eng Civil Works Direct Program-Program Direct Guidance-FY14.
2/20/2013		Contingencies and Risk Analysis: Norfolk District (NAO) performed an Abbreviated Risk Analysis (ARA) for the Initial Fill for the Authorized Plan and the NED plan. NAO also performed the ARA for the Periodic Renourishment of the Authorized and NED plans. The contingency for the Initial Fill for the Authorized plan was 17.6% and for the NED plan was 17.8%. The periodic Renourishment contingencies were 17.1%. Backup for the risk development is a separate attachment.
2/20/2013		Project Acquisition: This project will be advertised as a large business competitive job. We expect two to four bidders for this job.
2/20/2013		Uncertainties: Dredging is a competitive and unpredictable business. Mob-demob costs have increased at a high rate over the last five years. The basis of the mob cost in this estimate is primarily historical cost records in the Virginia/North Carolina region and in general along the East Coast. Dredging companies are busier than ever. This means a dredging company may have several jobs at the same time. They may have to use several dredges to complete their jobs on time.
2/20/2013		New Project Note

Description	Quantity	UOM	ContractCost	Escalation	Contingency	SIOH	MiscOwner	ProjectCost
Project Cost Summary Report			**55,505,444**	**0**	**0**	**0**	**0**	**55,505,444**
Initial Fill	**1.00**	**EA**	*43,368,240.65* **43,368,241**	**0**	**0**	**0**	**0**	*43,368,240.65* **43,368,241**
17 BEACH REPLENISHMENT (Authorized Project)	**1.00**	**EA**	*14,364,081.61* **14,364,082**	**0**	**0**	**0**	**0**	*14,364,081.61* **14,364,082**
1700 Beach Replenishment	**1.00**	**EA**	*14,364,081.61* **14,364,082**	**0**	**0**	**0**	**0**	*14,364,081.61* **14,364,082**
170001 Mob demob	**2.00**	**EA**	*875,000.12* **1,750,000**	**0**	**0**	**0**	**0**	*875,000.12* **1,750,000**
170017 Hopper Dredging	**1,218,000.00**	**CY**	*10.27* **12,514,081**	**0**	**0**	**0**	**0**	*10.27* **12,514,081**
170099 Associated General Items	**1.00**	**EA**	*100,000.00* **100,000**	**0**	**0**	**0**	**0**	*100,000.00* **100,000**
17 BEACH REPLENISHMENT (NED Plan)	**1.00**	**EA**	*29,004,159.03* **29,004,159**	**0**	**0**	**0**	**0**	*29,004,159.03* **29,004,159**
1700 Beach Replenishment	**1.00**	**EA**	*29,004,159.03* **29,004,159**	**0**	**0**	**0**	**0**	*29,004,159.03* **29,004,159**
170001 Mob demob	**1.00**	**EA**	*2,500,000.25* **2,500,000**	**0**	**0**	**0**	**0**	*2,500,000.25* **2,500,000**
170017 Hopper Dredging	**2,702,400.00**	**CY**	*9.77* **26,404,159**	**0**	**0**	**0**	**0**	*9.77* **26,404,159**
170099 Associated General Items	**1.00**	**EA**	*100,000.00* **100,000**	**0**	**0**	**0**	**0**	*100,000.00* **100,000**
Periodic Renourishment (after initial fill)	**1.00**	**EA**	*12,137,203.37* **12,137,203**	**0**	**0**	**0**	**0**	*12,137,203.37* **12,137,203**
17 BEACH REPLENISHMENT (Periodic Renourish Authorized Project)	**1.00**	**EA**	*5,865,171.38* **5,865,171**	**0**	**0**	**0**	**0**	*5,865,171.38* **5,865,171**
1700 Beach Replenishment	**1.00**	**EA**	*5,865,171.38* **5,865,171**	**0**	**0**	**0**	**0**	*5,865,171.38* **5,865,171**
170001 Mob demob	**1.00**	**EA**	*800,000.02* **800,000**	**0**	**0**	**0**	**0**	*800,000.02* **800,000**
170017 Hopper Dredging	**445,100.00**	**CY**	*11.16* **4,965,171**	**0**	**0**	**0**	**0**	*11.16* **4,965,171**

Description	Quantity	UOM	ContractCost	Escalation	Contingency	SIOH	MiscOwner	ProjectCost
170099 Associated General Items	**1.00**	**EA**	*100,000.00* **100,000**	**0**	**0**	**0**	**0**	*100,000.00* **100,000**
17 BEACH REPLENISHMENT (Periodic Renourish NED PLan)	**1.00**	**EA**	*6,272,031.99* **6,272,032**	**0**	**0**	**0**	**0**	*6,272,031.99* **6,272,032**
1700 Beach Replenishment	**1.00**	**EA**	*6,272,031.99* **6,272,032**	**0**	**0**	**0**	**0**	*6,272,031.99* **6,272,032**
170001 Mob demob	**1.00**	**EA**	*800,000.02* **800,000**	**0**	**0**	**0**	**0**	*800,000.02* **800,000**
170017 Hopper Dredging	**481,169.00**	**CY**	*11.16* **5,372,032**	**0**	**0**	**0**	**0**	*11.16* **5,372,032**
170099 Associated General Items	**1.00**	**EA**	*100,000.00* **100,000**	**0**	**0**	**0**	**0**	*100,000.00* **100,000**

Description	Quantity	UOM	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
Contract Cost Summary Report			**53,151,534**	**0**	**8,743,886**	**2,353,910**	**55,505,444**
			41,570,919.92		*6,676,367.02*		*43,368,240.65*
Initial Fill	**1.00**	**EA**	**41,570,920**	**0**	**6,676,367**	**1,797,321**	**43,368,241**
			13,786,372.60		*2,145,970.60*		*14,364,081.61*
17 BEACH REPLENISHMENT (Authorized Project)	**1.00**	**EA**	**13,786,373**	**0**	**2,145,971**	**577,709**	**14,364,082**
			13,786,372.60		*2,145,970.60*		*14,364,081.61*
1700 Beach Replenishment	**1.00**	**EA**	**13,786,373**	**0**	**2,145,971**	**577,709**	**14,364,082**
			872,170.81		*10,509.81*		*875,000.12*
170001 Mob demob	**2.00**	**EA**	**1,744,342**	**0**	**21,020**	**5,659**	**1,750,000**
			1,718,408.00		*0.00*		*1,718,408.00*
Dredging Mob	**1.00**	**EA**	**1,718,408**	**0**	**0**	**0**	**1,718,408**
			12,921.61		*12,921.61*		*16,400.20*
Land Equip Mob	**1.00**	**EA**	**12,922**	**0**	**12,922**	**3,479**	**16,400**
			13,012.01		*8,098.01*		*15,192.04*
Other	**1.00**	**EA**	**13,012**	**0**	**8,098**	**2,180**	**15,192**
			9.80		*1.74*		*10.27*
170017 Hopper Dredging	**1,218,000.00**	**CY**	**11,942,031**	**0**	**2,124,951**	**572,050**	**12,514,081**
			9.80		*1.74*		*10.27*
17001702 Site Work-Dredging	**1,218,000.00**	**CY**	**11,942,031**	**0**	**2,124,951**	**572,050**	**12,514,081**
			100,000.00		*0.00*		*100,000.00*
170099 Associated General Items	**1.00**	**EA**	**100,000**	**0**	**0**	**0**	**100,000**
			100,000.00		*0.00*		*100,000.00*
COR-directed Standby Time	**1.00**	**EA**	**100,000**	**0**	**0**	**0**	**100,000**
			27,784,547.32		*4,530,396.42*		*29,004,159.03*
17 BEACH REPLENISHMENT (NED Plan)	**1.00**	**EA**	**27,784,547**	**0**	**4,530,396**	**1,219,612**	**29,004,159**
			27,784,547.32		*4,530,396.42*		*29,004,159.03*
1700 Beach Replenishment	**1.00**	**EA**	**27,784,547**	**0**	**4,530,396**	**1,219,612**	**29,004,159**
			2,490,193.88		*36,426.98*		*2,500,000.25*
170001 Mob demob	**1.00**	**EA**	**2,490,194**	**0**	**36,427**	**9,806**	**2,500,000**
			2,448,852.90		*0.00*		*2,448,852.90*
Dredging Mob	**1.00**	**EA**	**2,448,853**	**0**	**0**	**0**	**2,448,853**
			25,843.23		*25,843.23*		*32,800.39*
Land Equip Mob	**1.00**	**EA**	**25,843**	**0**	**25,843**	**6,957**	**32,800**

Description	Quantity	UOM	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
			15,497.75		*10,583.75*		*18,346.96*
Other	**1.00**	**EA**	**15,498**	**0**	**10,584**	**2,849**	**18,347**
			9.32		*1.66*		*9.77*
170017 Hopper Dredging	**2,702,400.00**	**CY**	**25,194,353**	**0**	**4,493,969**	**1,209,805**	**26,404,159**
			9.32		*1.66*		*9.77*
17001702 Site Work-Dredging	**2,702,400.00**	**CY**	**25,194,353**	**0**	**4,493,969**	**1,209,805**	**26,404,159**
			100,000.00		*0.00*		*100,000.00*
170099 Associated General Items	**1.00**	**EA**	**100,000**	**0**	**0**	**0**	**100,000**
			100,000.00		*0.00*		*100,000.00*
COR-directed Standby Time	**1.00**	**EA**	**100,000**	**0**	**0**	**0**	**100,000**
			11,580,614.02		*2,067,519.01*		*12,137,203.37*
Periodic Renourishment (after initial fill)	**1.00**	**EA**	**11,580,614**	**0**	**2,067,519**	**556,589**	**12,137,203**
			5,598,008.36		*992,409.62*		*5,865,171.38*
17 BEACH REPLENISHMENT (Periodic Renourish Authorized Project)	**1.00**	**EA**	**5,598,008**	**0**	**992,410**	**267,163**	**5,865,171**
			5,598,008.36		*992,409.62*		*5,865,171.38*
1700 Beach Replenishment	**1.00**	**EA**	**5,598,008**	**0**	**992,410**	**267,163**	**5,865,171**
			795,781.60		*15,669.86*		*800,000.02*
170001 Mob demob	**1.00**	**EA**	**795,782**	**0**	**15,670**	**4,218**	**800,000**
			770,624.43		*0.00*		*770,624.43*
Dredging Mob	**1.00**	**EA**	**770,624**	**0**	**0**	**0**	**770,624**
			12,921.61		*12,921.61*		*16,400.20*
Land Equip Mob	**1.00**	**EA**	**12,922**	**0**	**12,922**	**3,479**	**16,400**
			12,235.55		*2,748.24*		*12,975.40*
Other	**1.00**	**EA**	**12,236**	**0**	**2,748**	**740**	**12,975**
			10.56		*2.19*		*11.16*
170017 Hopper Dredging	**445,100.00**	**CY**	**4,702,227**	**0**	**976,740**	**262,945**	**4,965,171**
			10.56		*2.19*		*11.16*
17001702 Site Work-Dredging	**445,100.00**	**CY**	**4,702,227**	**0**	**976,740**	**262,945**	**4,965,171**
			100,000.00		*0.00*		*100,000.00*
170099 Associated General Items	**1.00**	**EA**	**100,000**	**0**	**0**	**0**	**100,000**
			100,000.00		*0.00*		*100,000.00*
COR-directed Standby Time	**1.00**	**EA**	**100,000**	**0**	**0**	**0**	**100,000**
			5,982,605.66		*1,075,109.39*		*6,272,031.99*

Description	Quantity	UOM	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
17 BEACH REPLENISHMENT (Periodic Renourish NED PLan)	**1.00**	**EA**	**5,982,606**	**0**	**1,075,109**	**289,426**	**6,272,032**
			5,982,605.66		*1,075,109.39*		*6,272,031.99*
1700 Beach Replenishment	**1.00**	**EA**	**5,982,606**	**0**	**1,075,109**	**289,426**	**6,272,032**
			795,781.60		*15,669.86*		*800,000.02*
170001 Mob demob	**1.00**	**EA**	**795,782**	**0**	**15,670**	**4,218**	**800,000**
			770,624.43		*0.00*		*770,624.43*
Dredging Mob	**1.00**	**EA**	**770,624**	**0**	**0**	**0**	**770,624**
			12,921.61		*12,921.61*		*16,400.20*
Land Equip Mob	**1.00**	**EA**	**12,922**	**0**	**12,922**	**3,479**	**16,400**
			12,235.55		*2,748.24*		*12,975.40*
Other	**1.00**	**EA**	**12,236**	**0**	**2,748**	**740**	**12,975**
			10.57		*2.20*		*11.16*
170017 Hopper Dredging	**481,169.00**	**CY**	**5,086,824**	**0**	**1,059,440**	**285,208**	**5,372,032**
			10.57		*2.20*		*11.16*
17001702 Site Work-Dredging	**481,169.00**	**CY**	**5,086,824**	**0**	**1,059,440**	**285,208**	**5,372,032**
			100,000.00		*0.00*		*100,000.00*
170099 Associated General Items	**1.00**	**EA**	**100,000**	**0**	**0**	**0**	**100,000**
			100,000.00		*0.00*		*100,000.00*
COR-directed Standby Time	**1.00**	**EA**	**100,000**	**0**	**0**	**0**	**100,000**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
Project Direct Costs Report			**3,859,241**	**4,892,741**	**20,706**	**44,378,845**	**53,151,534**
			2,966,720.83	*3,709,121.19*	*10,353.00*	*34,884,724.90*	*41,570,919.92*
Initial Fill	**1.00**	**EA**	**2,966,721**	**3,709,121**	**10,353**	**34,884,725**	**41,570,920**
			915,246.31	*1,230,461.78*	*5,176.50*	*11,635,488.00*	*13,786,372.60*
17 BEACH REPLENISHMENT (Authorized Project)	**1.00**	**EA**	**915,246**	**1,230,462**	**5,177**	**11,635,488**	**13,786,373**
			915,246.31	*1,230,461.78*	*5,176.50*	*11,635,488.00*	*13,786,372.60*
1700 Beach Replenishment	**1.00**	**EA**	**915,246**	**1,230,462**	**5,177**	**11,635,488**	**13,786,373**
			5,176.38	*5,202.18*	*2,588.25*	*859,204.00*	*872,170.81*
170001 Mob demob	**2.00**	**EA**	**10,353**	**10,404**	**5,177**	**1,718,408**	**1,744,342**
			0.00	*0.00*	*0.00*	*1,718,408.00*	*1,718,408.00*
Dredging Mob	**1.00**	**EA**	**0**	**0**	**0**	**1,718,408**	**1,718,408**
			0.00	*0.00*	*0.00*	*859,204.00*	*859,204.00*
USR Mob demob	2.00	EA	0	0	0	1,718,408	1,718,408
(Note: from CEDEP file (Willoughby Beach-Thmbl Shl CEDEP Auth Plan Feb 13.xls))							
			2,517.26	*10,404.36*	*0.00*	*0.00*	*12,921.61*
Land Equip Mob	**1.00**	**EA**	**2,517**	**10,404**	**0**	**0**	**12,922**
(Note: Mob/Demob of equipment associated with beach placement. Mobilization: Assume 1-ea D-6 dozer; 1-ea D-7 dozer; 1-ea Front-End Loader; 2-ea Lite set (1 tow will carry both) . 8 hr/ ea mob x 4 ea pieces of equip = 32 hours. DeMobilization: Assume 1-ea D-6 dozer; 1-ea D-7 dozer; 1-ea Front-End Loader; 2-ea Lite set . 8 hr/ ea mob x 4 ea pieces of equip = 32 hours. Total hours = 64 hours)							
			0.00	*7.69*	*0.00*	*0.00*	*7.69*
EP T45XX014 TRUCK TRAILER, LOWBOY, 35 TON, 3 AXLE (ADD TOWING TRUCK)	64.00	HR	0	492	0	0	492
			0.00	*55.99*	*0.00*	*0.00*	*55.99*
MAP T50XX030 TRUCK, HIGHWAY, 70,000 LBS GVW, 2 AXLE, 6X6 (CHASSIS ONLY-ADD OPTIONS)	64.00	HR	0	3,583	0	0	3,583
			39.33	*0.00*	*0.00*	*0.00*	*39.33*
RSM X-TRKDVRHV Outside Truck Drivers, Heavy	64.00	HR	2,517	0	0	0	2,517
			0.00	*118.15*	*0.00*	*0.00*	*118.15*
EP T15CA011 TRACTOR, CRAWLER (DOZER), 165 HP, LOW GROUND PRESSURE, W/5.09 CY SEMI-U BLADE (ADD ATTACHMENTS)	16.00	HR	0	1,890	0	0	1,890
(Note: D-6 LGP)							
			0.00	*136.10*	*0.00*	*0.00*	*136.10*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	16.00	HR	0	2,178	0	0	2,178
(Note: D-7 LGP)							
			0.00	*110.68*	*0.00*	*0.00*	*110.68*
GEN L40Z4420 LOADER, FRONT END, WHEEL, ARTICULATED, 5.50 CY (4.2 M3) BUCKET, 4X4	16.00	HR	0	1,771	0	0	1,771
			0.00	*6.38*	*0.00*	*0.00*	*6.38*
EP L20AB022 6/1000W, W/8 KW GEN, TRLR MTD, ELECTRIC MAST WINCH	16.00	HR	0	102	0	0	102
(Note: 127 day x 14 hr /day = approx 1778 hr)							
			0.00	*24.25*	*0.00*	*0.00*	*24.25*
EP T50GM005 TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	16.00	HR	0	388	0	0	388
			7,835.51	*0.00*	*5,176.50*	*0.00*	*13,012.01*
Other	**1.00**	**EA**	**7,836**	**0**	**5,177**	**0**	**13,012**
			2,485.74	*0.00*	*262.50*	*0.00*	*2,748.24*
Safety Fence	**1.00**	**EA**	**2,486**	**0**	**263**	**0**	**2,748**
			0.00	*0.00*	*0.53*	*0.00*	*0.53*
RSM 015626500600 Safety Fencing material only	500.00	LF	0	0	263	0	263
			0.06	*0.00*	*0.00*	*0.00*	*0.06*
RSM 015626500610 Safety Fencing remove and reinstall existing fence	38,600.00	LF	2,486	0	0	0	2,486
			5,349.77	*0.00*	*4,914.00*	*0.00*	*10,263.77*
Construction Surveying/Staking	**1.00**	**EA**	**5,350**	**0**	**4,914**	**0**	**10,264**
			34.97	*0.00*	*0.00*	*0.00*	*34.97*
FOP FC-SURYR Surveyors - 3-man team	153.00	HR	5,350	0	0	0	5,350
(Note: Gradelines spaced every 100'; stake out every 25' for 100' wide berm (extended for survey sake). Survey crew can do 20 lines per day which is 2000' per day for a berm of 100'. 200,000 SF/DAY = 4.59 acres/ 8 hours per day = 0.57 acres per hour production Crew survey output estimated at approximately .57 acres per hour. 89 acres = 51 hours. 3-man team = 3 ea x 51 hr = 153 hours)							
			0.00	*0.00*	*63.00*	*0.00*	*63.00*
USR Grade Stakes, Steel Pipe	78.00	EA	0	0	4,914	0	4,914
(Note: 25 per pack, $60/pack quoted from www.surveysupplyinc.com; Assume gradeline of stakes every 100', spaced 25' apart; 38,544'/ 100' = 386 lines; 100' wide berm/ 25' spacing = 5 stakes per line; 386 * 5 = 1930 stakes / 25 stakes per pack = 78 packs.)							
			0.74	*1.00*	*0.00*	*8.06*	*9.80*
170017 Hopper Dredging	**1,218,000.00**	**CY**	**904,894**	**1,220,057**	**0**	**9,817,080**	**11,942,031**
			0.74	*1.00*	*0.00*	*8.06*	*9.80*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
17001702 Site Work-Dredging	**1,218,000.00**	**CY**	**904,894**	**1,220,057**	**0**	**9,817,080**	**11,942,031**
			0.00	*0.00*	*0.00*	*8.06*	*8.06*
Dredging	**1,218,000.00**	**CY**	**0**	**0**	**0**	**9,817,080**	**9,817,080**
(Note: Costs from CEDEP estimate.)							
			0.00	*0.00*	*0.00*	*8.06*	*8.06*
USR Dredging (from CEDEP Estimate)	1,218,000.00	CY	0	0	0	9,817,080	9,817,080
(Note: The borrow source is Thmible Shoals Channel. The sailing distance is 10.37 miles. CEDEP file (Willoughby Beach-Thmbl Shl CEDEP Auth Plan Feb 13.xls))							
			0.74	*0.99*	*0.00*	*0.00*	*1.73*
Beach Placement	**1,150,000.00**	**CY**	**848,816**	**1,141,417**	**0**	**0**	**1,990,233**
(Note: Current total dredge yardage = 1,218,000 CY. Dune work = 68,000 ; 1,218,000 - 68,000 = 1,150,000 CY for Normal Beach Placement Duration based on CEDEP Pay Production. Basis is 140.7 days using one crew.)							
			0.00	*118.15*	*0.00*	*0.00*	*118.15*
EP T15CA011 TRACTOR, CRAWLER (DOZER), 165 HP, LOW GROUND PRESSURE, W/5.09 CY SEMI-U BLADE (ADD ATTACHMENTS)	3,377.00	HR	0	398,994	0	0	398,994
(Note: D-6 LGP)							
			0.00	*136.10*	*0.00*	*0.00*	*136.10*
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	3,377.00	HR	0	459,614	0	0	459,614
(Note: D-7 LGP)							
			0.00	*110.68*	*0.00*	*0.00*	*110.68*
GEN L40Z4420 LOADER, FRONT END, WHEEL, ARTICULATED, 5.50 CY (4.2 M3) BUCKET, 4X4 (Assume used 1/2 time or 0.5 ea)	1,688.50	HR	0	186,882	0	0	186,882
			0.00	*24.25*	*0.00*	*0.00*	*24.25*
EP T50GM005 TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	3,377.00	HR	0	81,881	0	0	81,881
			0.00	*6.38*	*0.00*	*0.00*	*6.38*
EP L20AB022 6/1000W, W/8 KW GEN, TRLR MTD, ELECTRIC MAST WINCH (141 days x 15.6 hrs/day =2200 hrs)	2,200.00	HR	0	14,045	0	0	14,045
			60.68	*0.00*	*0.00*	*0.00*	*60.68*
RSM X-EQOPRHVY Outside Equip. Operators, Heavy (Group1) 2.5-ea	8,442.50	HR	512,298	0	0	0	512,298
			39.33	*0.00*	*0.00*	*0.00*	*39.33*
RSM X-EQOPROIL Outside Equip. Oilers 1-ea	3,377.00	HR	132,825	0	0	0	132,825
			28.99	*0.00*	*0.00*	*0.00*	*28.99*
RSM X-LABORER Outside Laborers, (Semi-Skilled) 1-ea	3,377.00	HR	97,909	0	0	0	97,909

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
			47.65	*0.00*	*0.00*	*0.00*	*47.65*
MIL X-ELECTRN Outside Electricians for Lights (141 days x 15.6 hrs/day =2220 hrs)	2,220.00	HR	105,785	0	0	0	105,785
			0.82	*1.16*	*0.00*	*0.00*	*1.98*
Dune Construction	**68,000.00**	**CY**	**56,077**	**78,640**	**0**	**0**	**134,718**
(Note: Dune work = 68,000 cy out of 1,218,000 cy (total yardage) Duration based on CEDEP Pay Production. Basis is 8.3 days using one crew. Dune construction volume is only 5.6% of the total volume of sand placement.)							
			0.00	*118.15*	*0.00*	*0.00*	*118.15*
EP T15CA011 TRACTOR, CRAWLER (DOZER), 165 HP, LOW GROUND PRESSURE, W/5.09 CY SEMI-U BLADE (ADD ATTACHMENTS)	200.00	HR	0	23,630	0	0	23,630
(Note: D-6 LGP)							
			0.00	*136.10*	*0.00*	*0.00*	*136.10*
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	200.00	HR	0	27,220	0	0	27,220
(Note: D-7 LGP)							
			0.00	*110.68*	*0.00*	*0.00*	*110.68*
GEN L40Z4420 LOADER, FRONT END, WHEEL, ARTICULATED, 5.50 CY (4.2 M3) BUCKET, 4X4 (Assume used full time or 1.0 ea)	200.00	HR	0	22,136	0	0	22,136
			0.00	*24.25*	*0.00*	*0.00*	*24.25*
EP T50GM005 TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	200.00	HR	0	4,849	0	0	4,849
			0.00	*6.38*	*0.00*	*0.00*	*6.38*
EP L20AB022 6/1000W, W/8 KW GEN, TRLR MTD, ELECTRIC MAST WINCH	126.00	HR	0	804	0	0	804
(Note: 9 day x 14 hr /day = 126 hr)							
			60.68	*0.00*	*0.00*	*0.00*	*60.68*
RSM X-EQOPRHVY Outside Equip. Operators, Heavy (Group1) 3-ea	600.00	HR	36,408	0	0	0	36,408
			39.33	*0.00*	*0.00*	*0.00*	*39.33*
RSM X-EQOPROIL Outside Equip. Oilers	200.00	HR	7,866	0	0	0	7,866
			28.99	*0.00*	*0.00*	*0.00*	*28.99*
RSM X-LABORER Outside Laborers, (Semi-Skilled)	200.00	HR	5,799	0	0	0	5,799
			47.65	*0.00*	*0.00*	*0.00*	*47.65*
MIL X-ELECTRN Outside Electricians for Lights	126.00	HR	6,004	0	0	0	6,004
(Note: 9 day x 14 hr /day = 126 hr)							

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
170099 Associated General Items	**1.00**	**EA**	**0**	**0**	**0**	**100,000**	**100,000**
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
COR-directed Standby Time	**1.00**	**EA**	**0**	**0**	**0**	**100,000**	**100,000**
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
USR COR-directed Standby Time, Dredge operations	1.00	DAY	0	0	0	100,000	100,000
(Note: Cost takens from recent bid results.)							
			2,051,474.52	*2,478,659.40*	*5,176.50*	*23,249,236.90*	*27,784,547.32*
17 BEACH REPLENISHMENT (NED Plan)	**1.00**	**EA**	**2,051,475**	**2,478,659**	**5,177**	**23,249,237**	**27,784,547**
			2,051,474.52	*2,478,659.40*	*5,176.50*	*23,249,236.90*	*27,784,547.32*
1700 Beach Replenishment	**1.00**	**EA**	**2,051,475**	**2,478,659**	**5,177**	**23,249,237**	**27,784,547**
			15,355.77	*20,808.71*	*5,176.50*	*2,448,852.90*	*2,490,193.88*
170001 Mob demob	**1.00**	**EA**	**15,356**	**20,809**	**5,177**	**2,448,853**	**2,490,194**
			0.00	*0.00*	*0.00*	*2,448,852.90*	*2,448,852.90*
Dredging Mob	**1.00**	**EA**	**0**	**0**	**0**	**2,448,853**	**2,448,853**
			0.00	*0.00*	*0.00*	*816,284.30*	*816,284.30*
USR Mob demob	3.00	EA	0	0	0	2,448,853	2,448,853
(Note: Assume there will be three mobs. More dredges may be needed, because of the greater volume of work for the NED Plan. Cost taken from CEDEP file (Willoughby Beach-Thmbl Shl CEDEP NED Plan Feb 13.xls).)							
			5,034.52	*20,808.71*	*0.00*	*0.00*	*25,843.23*
Land Equip Mob	**1.00**	**EA**	**5,035**	**20,809**	**0**	**0**	**25,843**
(Note: Mob/Demob of equipment associated with beach placement. Mobilization: Assume 1-ea D-6 dozer; 1-ea D-7 dozer; 1-ea Front-End Loader; 2-ea Lite set (1 tow will carry both) . 8 hr/ ea mob x 4 ea pieces of equip = 32 hours. DeMobilization: Assume 1-ea D-6 dozer; 1-ea D-7 dozer; 1-ea Front-End Loader; 2-ea Lite set . 8 hr/ ea mob x 4 ea pieces of equip = 32 hours. Total hours = 64 hours Double this for two crews.)							
			0.00	*7.69*	*0.00*	*0.00*	*7.69*
EP T45XX014 TRUCK TRAILER, LOWBOY, 35 TON, 3 AXLE (ADD TOWING TRUCK)	128.00	HR	0	984	0	0	984
			0.00	*55.99*	*0.00*	*0.00*	*55.99*
MAP T50XX030 TRUCK, HIGHWAY, 70,000 LBS GVW, 2 AXLE, 6X6 (CHASSIS ONLY-ADD OPTIONS)	128.00	HR	0	7,166	0	0	7,166
			39.33	*0.00*	*0.00*	*0.00*	*39.33*
RSM X-TRKDVRHV Outside Truck Drivers, Heavy	128.00	HR	5,035	0	0	0	5,035
			0.00	*118.15*	*0.00*	*0.00*	*118.15*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
EP T15CA011 TRACTOR, CRAWLER (DOZER), 165 HP, LOW GROUND PRESSURE, W/5.09 CY SEMI-U BLADE (ADD ATTACHMENTS)	32.00	HR	0	3,781	0	0	3,781
(Note: D-6 LGP)							
			0.00	*136.10*	*0.00*	*0.00*	*136.10*
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	32.00	HR	0	4,355	0	0	4,355
(Note: D-7 LGP)							
			0.00	*110.68*	*0.00*	*0.00*	*110.68*
GEN L40Z4420 LOADER, FRONT END, WHEEL, ARTICULATED, 5.50 CY (4.2 M3) BUCKET, 4X4	32.00	HR	0	3,542	0	0	3,542
			0.00	*6.38*	*0.00*	*0.00*	*6.38*
EP L20AB022 6/1000W, W/8 KW GEN, TRLR MTD, ELECTRIC MAST WINCH	32.00	HR	0	204	0	0	204
(Note: 127 day x 14 hr /day = approx 1778 hr)							
			0.00	*24.25*	*0.00*	*0.00*	*24.25*
EP T50GM005 TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	32.00	HR	0	776	0	0	776
			10,321.25	*0.00*	*5,176.50*	*0.00*	*15,497.75*
Other	**1.00**	**EA**	**10,321**	**0**	**5,177**	**0**	**15,498**
			4,971.48	*0.00*	*262.50*	*0.00*	*5,233.98*
Safety Fence	**1.00**	**EA**	**4,971**	**0**	**263**	**0**	**5,234**
			0.00	*0.00*	*0.00*	*0.00*	*0.00*
RSM 312513101120 Erosion control, silt fence, polypropylene, 3' high, includes 7.5' posts	0.00	LF	0	0	0	0	0
			0.00	*0.00*	*0.00*	*0.00*	*0.00*
RSM 312513101100 Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	0.00	LF	0	0	0	0	0
			0.00	*0.00*	*0.00*	*0.00*	*0.00*
USR 023707001001* Erosion control, safety fence, polypropylene, 3' high, ideal conditions	0.00	LF	0	0	0	0	0
			0.00	*0.00*	*0.53*	*0.00*	*0.53*
RSM 015626500600 Safety Fencing material only	500.00	LF	0	0	263	0	263
			0.13	*0.00*	*0.00*	*0.00*	*0.13*
RSM 015626500610 Safety Fencing remove and reinstall existing fence	38,600.00	LF	4,971	0	0	0	4,971
			5,349.77	*0.00*	*4,914.00*	*0.00*	*10,263.77*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
Construction Surveying/Staking	**1.00**	**EA**	**5,350**	**0**	**4,914**	**0**	**10,264**
			34.97	*0.00*	*0.00*	*0.00*	*34.97*
FOP FC-SURYR Surveyors - 3-man team	153.00	HR	5,350	0	0	0	5,350
(Note: Gradelines spaced every 100'; stake out every 25' for 100' wide berm (extended for survey sake). Survey crew can do 20 lines per day which is 2000' per day for a berm of 100'. 200,000 SF/DAY = 4.59 acres/ 8 hours per day = 0.57 acres per hour production. Crew survey output estimated at approximately 0.57 acres per hour. 89 acres = 51 hours. 3-man team = 3 ea x 51 hr = 153 hours)							
			0.00	*0.00*	*63.00*	*0.00*	*63.00*
USR Grade Stakes, Steel Pipe	78.00	EA	0	0	4,914	0	4,914
(Note: 25 per pack, $60/pack quoted from www.surveysupplyinc.com; Assume gradeline of stakes every 100', spaced 25' apart; 38,544'/ 100' = 386 lines; 100' wide berm/ 25' spacing = 5 stakes per line; 386 * 5 = 1930 stakes / 25 stakes per pack = 78 packs.)							
			0.75	*0.91*	*0.00*	*7.66*	*9.32*
170017 Hopper Dredging	**2,702,400.00**	**CY**	**2,036,119**	**2,457,851**	**0**	**20,700,384**	**25,194,353**
			0.75	*0.91*	*0.00*	*7.66*	*9.32*
17001702 Site Work-Dredging	**2,702,400.00**	**CY**	**2,036,119**	**2,457,851**	**0**	**20,700,384**	**25,194,353**
			0.00	*0.00*	*0.00*	*7.66*	*7.66*
Dredging	**2,702,400.00**	**CY**	**0**	**0**	**0**	**20,700,384**	**20,700,384**
(Note: Costs from CEDEP estimate.)							
			0.00	*0.00*	*0.00*	*7.66*	*7.66*
USR Dredging (from CEDEP Estimate)	2,702,400.00	CY	0	0	0	20,700,384	20,700,384
(Note: Assume efficiency increase with the greater volume than the Authorized plan. Cost taken from CEDEP file (Willoughby Beach-Thmbl Shl CEDEP NED Plan Feb 13.xls).)							
			0.75	*0.91*	*0.00*	*0.00*	*1.66*
Beach Placement	**2,702,400.00**	**CY**	**2,036,119**	**2,457,851**	**0**	**0**	**4,493,969**
(Note: Current total dredge yardage = 2,702,400 CY for Normal Beach Placement Duration based on CEDEP Pay Production. Basis is 303 days using one crew (or 151.5 days using 2 crews))							
			0.00	*118.15*	*0.00*	*0.00*	*118.15*
EP T15CA011 TRACTOR, CRAWLER (DOZER), 165 HP, LOW GROUND PRESSURE, W/5.09 CY SEMI-U BLADE (ADD ATTACHMENTS)	7,272.00	HR	0	859,191	0	0	859,191
(Note: D-6 LGP)							
			0.00	*136.10*	*0.00*	*0.00*	*136.10*
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	7,272.00	HR	0	989,729	0	0	989,729
(Note: D-7 LGP)							

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
			0.00	*110.68*	*0.00*	*0.00*	*110.68*
GEN L40Z4420 LOADER, FRONT END, WHEEL, ARTICULATED, 5.50 CY (4.2 M3) BUCKET, 4X4 (0.5 ea)	3,636.00	HR	0	402,431	0	0	402,431
			0.00	*24.25*	*0.00*	*0.00*	*24.25*
EP T50GM005 TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	7,272.00	HR	0	176,322	0	0	176,322
			0.00	*6.38*	*0.00*	*0.00*	*6.38*
EP L20AB022 6/1000W, W/8 KW GEN, TRLR MTD, ELECTRIC MAST WINCH (303 days x 15.6 hrs/day = 4727 hrs)	4,727.00	HR	0	30,178	0	0	30,178
			60.68	*0.00*	*0.00*	*0.00*	*60.68*
RSM X-EQOPRHVY Outside Equip. Operators, Heavy (Group1) 2.5-ea	18,180.00	HR	1,103,177	0	0	0	1,103,177
			39.33	*0.00*	*0.00*	*0.00*	*39.33*
RSM X-EQOPROIL Outside Equip. Oilers 1-ea	7,272.00	HR	286,023	0	0	0	286,023
			28.99	*0.00*	*0.00*	*0.00*	*28.99*
RSM X-LABORER Outside Laborers, (Semi-Skilled) 2-ea	14,544.00	HR	421,674	0	0	0	421,674
			47.65	*0.00*	*0.00*	*0.00*	*47.65*
MIL X-ELECTRN Outside Electricians for Lights (303 days x 15.6 hrs/day = 4727 hrs)	4,727.00	HR	225,245	0	0	0	225,245
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
170099 Associated General Items	**1.00**	**EA**	**0**	**0**	**0**	**100,000**	**100,000**
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
COR-directed Standby Time	**1.00**	**EA**	**0**	**0**	**0**	**100,000**	**100,000**
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
USR COR-directed Standby Time, Dredge operations	1.00	DAY	0	0	0	100,000	100,000
(Note: Cost takens from recent bid results.)							
			892,520.42	*1,183,620.21*	*10,353.00*	*9,494,120.39*	*11,580,614.02*
Periodic Renourishment (after initial fill)	**1.00**	**EA**	**892,520**	**1,183,620**	**10,353**	**9,494,120**	**11,580,614**
			428,509.99	*568,210.43*	*5,176.50*	*4,596,111.43*	*5,598,008.36*
17 BEACH REPLENISHMENT (Periodic Renourish Authorized Project)	**1.00**	**EA**	**428,510**	**568,210**	**5,177**	**4,596,111**	**5,598,008**
			428,509.99	*568,210.43*	*5,176.50*	*4,596,111.43*	*5,598,008.36*
1700 Beach Replenishment	**1.00**	**EA**	**428,510**	**568,210**	**5,177**	**4,596,111**	**5,598,008**
			9,576.31	*10,404.36*	*5,176.50*	*770,624.43*	*795,781.60*
170001 Mob demob	**1.00**	**EA**	**9,576**	**10,404**	**5,177**	**770,624**	**795,782**
			0.00	*0.00*	*0.00*	*770,624.43*	*770,624.43*
Dredging Mob	**1.00**	**EA**	**0**	**0**	**0**	**770,624**	**770,624**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
USR Mob demob	1.00	LS	0	0	0	770,624	770,624
			2,517.26	*10,404.36*	*0.00*	*0.00*	*12,921.61*
Land Equip Mob	**1.00**	**EA**	**2,517**	**10,404**	**0**	**0**	**12,922**
(Note: Mob/Demob of equipment associated with beach placement. Mobilization: Assume 1-ea D-6 dozer; 1-ea D-7 dozer; 1-ea Front-End Loader; 2-ea Lite set (1 tow will carry both) . 8 hr/ ea mob x 4 ea pieces of equip = 32 hours. DeMobilization: Assume 1-ea D-6 dozer; 1-ea D-7 dozer; 1-ea Front-End Loader; 2-ea Lite set . 8 hr/ ea mob x 4 ea pieces of equip = 32 hours. Total hours = 64 hours)							
			0.00	*7.69*	*0.00*	*0.00*	*7.69*
EP T45XX014 TRUCK TRAILER, LOWBOY, 35 TON, 3 AXLE (ADD TOWING TRUCK)	64.00	HR	0	492	0	0	492
			0.00	*55.99*	*0.00*	*0.00*	*55.99*
MAP T50XX030 TRUCK, HIGHWAY, 70,000 LBS GVW, 2 AXLE, 6X6 (CHASSIS ONLY-ADD OPTIONS)	64.00	HR	0	3,583	0	0	3,583
			39.33	*0.00*	*0.00*	*0.00*	*39.33*
RSM X-TRKDVRHV Outside Truck Drivers, Heavy	64.00	HR	2,517	0	0	0	2,517
			0.00	*118.15*	*0.00*	*0.00*	*118.15*
EP T15CA011 TRACTOR, CRAWLER (DOZER), 165 HP, LOW GROUND PRESSURE, W/5.09 CY SEMI-U BLADE (ADD ATTACHMENTS)	16.00	HR	0	1,890	0	0	1,890
(Note: D-6 LGP)							
			0.00	*136.10*	*0.00*	*0.00*	*136.10*
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	16.00	HR	0	2,178	0	0	2,178
(Note: D-7 LGP)							
			0.00	*110.68*	*0.00*	*0.00*	*110.68*
GEN L40Z4420 LOADER, FRONT END, WHEEL, ARTICULATED, 5.50 CY (4.2 M3) BUCKET, 4X4	16.00	HR	0	1,771	0	0	1,771
			0.00	*6.38*	*0.00*	*0.00*	*6.38*
EP L20AB022 6/1000W, W/8 KW GEN, TRLR MTD, ELECTRIC MAST WINCH	16.00	HR	0	102	0	0	102
(Note: 127 day x 14 hr /day = approx 1778 hr)							
			0.00	*24.25*	*0.00*	*0.00*	*24.25*
EP T50GM005 TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	16.00	HR	0	388	0	0	388
			7,059.05	*0.00*	*5,176.50*	*0.00*	*12,235.55*
Other	**1.00**	**EA**	**7,059**	**0**	**5,177**	**0**	**12,236**

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
			2,485.74	*0.00*	*262.50*	*0.00*	*2,748.24*
Safety Fence	**1.00**	**EA**	**2,486**	**0**	**263**	**0**	**2,748**
			0.00	*0.00*	*0.53*	*0.00*	*0.53*
RSM 015626500600 Safety Fencing material only	500.00	LF	0	0	263	0	263
			0.06	*0.00*	*0.00*	*0.00*	*0.06*
RSM 015626500610 Safety Fencing remove and reinstall existing fence	38,600.00	LF	2,486	0	0	0	2,486
			4,573.31	*0.00*	*4,914.00*	*0.00*	*9,487.31*
Construction Surveying/Staking	**1.00**	**EA**	**4,573**	**0**	**4,914**	**0**	**9,487**
			29.89	*0.00*	*0.00*	*0.00*	*29.89*
FOP FC-SURYR Surveyors - 3-man team	153.00	HR	4,573	0	0	0	4,573
(Note: Gradelines spaced every 100'; stake out every 25' for 100' wide berm (extended for survey sake). Survey crew can do 20 lines per day which is 2000' per day for a berm of 100'. 200,000 SF/DAY = 4.59 acres/ 8 hours per day = 0.57 acres per hour production Crew survey output estimated at approximately .57 acres per hour. 89 acres = 51 hours. 3-man team = 3 ea x 51 hr = 153 hours)							
			0.00	*0.00*	*63.00*	*0.00*	*63.00*
USR Grade Stakes, Steel Pipe	78.00	EA	0	0	4,914	0	4,914
(Note: 25 per pack, $60/pack quoted from www.surveysupplyinc.com; Assume gradeline of stakes every 100', spaced 25' apart; 38,544'/ 100' = 386 lines; 100' wide berm/ 25' spacing = 5 stakes per line; 386 * 5 = 1930 stakes / 25 stakes per pack = 78 packs.)							
			0.94	*1.25*	*0.00*	*8.37*	*10.56*
170017 Hopper Dredging	**445,100.00**	**CY**	**418,934**	**557,806**	**0**	**3,725,487**	**4,702,227**
			0.94	*1.25*	*0.00*	*8.37*	*10.56*
17001702 Site Work-Dredging	**445,100.00**	**CY**	**418,934**	**557,806**	**0**	**3,725,487**	**4,702,227**
			0.00	*0.00*	*0.00*	*8.37*	*8.37*
Dredging	**445,100.00**	**CY**	**0**	**0**	**0**	**3,725,487**	**3,725,487**
			0.00	*0.00*	*0.00*	*8.37*	*8.37*
USR Dredging from CEDEP Estimate	445,100.00	CY	0	0	0	3,725,487	3,725,487
			0.94	*1.25*	*0.00*	*0.00*	*2.19*
Beach Placement	**445,100.00**	**CY**	**418,934**	**557,806**	**0**	**0**	**976,740**
(Note: Current total dredge yardage = 445,100 CY for Normal Beach Placement Duration based on CEDEP Pay Production. Basis is 59 days using one crew.)							
			0.00	*118.15*	*0.00*	*0.00*	*118.15*
EP T15CA011 TRACTOR, CRAWLER (DOZER), 165 HP, LOW GROUND PRESSURE, W/5.09 CY SEMI-U BLADE (ADD ATTACHMENTS)	1,416.00	HR	0	167,301	0	0	167,301
(Note: D-6 LGP)							
			0.00	*136.10*	*0.00*	*0.00*	*136.10*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	1,416.00	HR	0	192,719	0	0	192,719
(Note: D-7 LGP)							
			0.00	*110.68*	*0.00*	*0.00*	*110.68*
GEN L40Z4420 LOADER, FRONT END, WHEEL, ARTICULATED, 5.50 CY (4.2 M3) BUCKET, 4X4 (1- ea)	1,416.00	HR	0	156,722	0	0	156,722
			0.00	*24.25*	*0.00*	*0.00*	*24.25*
EP T50GM005 TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	1,416.00	HR	0	34,333	0	0	34,333
			0.00	*6.38*	*0.00*	*0.00*	*6.38*
EP L20AB022 6/1000W, W/8 KW GEN, TRLR MTD, ELECTRIC MAST WINCH (59 days x 15.6 hrs/day = 921 hrs)	921.00	HR	0	5,880	0	0	5,880
			60.68	*0.00*	*0.00*	*0.00*	*60.68*
RSM X-EQOPRHVY Outside Equip. Operators, Heavy (Group1) 3-ea	4,248.00	HR	257,772	0	0	0	257,772
			39.33	*0.00*	*0.00*	*0.00*	*39.33*
RSM X-EQOPROIL Outside Equip. Oilers 1-ea	1,416.00	HR	55,694	0	0	0	55,694
			28.99	*0.00*	*0.00*	*0.00*	*28.99*
RSM X-LABORER Outside Laborers, (Semi-Skilled) 1.5-ea	2,124.00	HR	61,581	0	0	0	61,581
			47.65	*0.00*	*0.00*	*0.00*	*47.65*
MIL X-ELECTRN Outside Electricians for Lights (59 days x 15.6 hrs/day = 921 hrs)	921.00	HR	43,886	0	0	0	43,886
			0.00	*850.00*	*0.00*	*0.00*	*850.00*
USR Misc Tools	1.00	EA	0	850	0	0	850
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
170099 Associated General Items	**1.00**	**EA**	**0**	**0**	**0**	**100,000**	**100,000**
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
COR-directed Standby Time	**1.00**	**EA**	**0**	**0**	**0**	**100,000**	**100,000**
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
USR COR-directed Standby Time, Dredge operations	1.00	DAY	0	0	0	100,000	100,000
(Note: Cost takens from recent bid results.)							
			464,010.43	*615,409.77*	*5,176.50*	*4,898,008.96*	*5,982,605.66*
17 BEACH REPLENISHMENT (Periodic Renourish NED PLan)	**1.00**	**EA**	**464,010**	**615,410**	**5,177**	**4,898,009**	**5,982,606**
			464,010.43	*615,409.77*	*5,176.50*	*4,898,008.96*	*5,982,605.66*
1700 Beach Replenishment	**1.00**	**EA**	**464,010**	**615,410**	**5,177**	**4,898,009**	**5,982,606**
			9,576.31	*10,404.36*	*5,176.50*	*770,624.43*	*795,781.60*

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
170001 Mob demob	**1.00**	**EA**	**9,576**	**10,404**	**5,177**	**770,624**	**795,782**
			0.00	*0.00*	*0.00*	*770,624.43*	*770,624.43*
Dredging Mob	**1.00**	**EA**	**0**	**0**	**0**	**770,624**	**770,624**
USR Mob demob	1.00	LS	0	0	0	770,624	770,624
			2,517.26	*10,404.36*	*0.00*	*0.00*	*12,921.61*
Land Equip Mob	**1.00**	**EA**	**2,517**	**10,404**	**0**	**0**	**12,922**
(Note: Mob/Demob of equipment associated with beach placement. Mobilization: Assume 1-ea D-6 dozer; 1-ea D-7 dozer; 1-ea Front-End Loader; 2-ea Lite set (1 tow will carry both) . 8 hr/ ea mob x 4 ea pieces of equip = 32 hours. DeMobilization: Assume 1-ea D-6 dozer; 1-ea D-7 dozer; 1-ea Front-End Loader; 2-ea Lite set . 8 hr/ ea mob x 4 ea pieces of equip = 32 hours. Total hours = 64 hours)							
			0.00	*7.69*	*0.00*	*0.00*	*7.69*
EP T45XX014 TRUCK TRAILER, LOWBOY, 35 TON, 3 AXLE (ADD TOWING TRUCK)	64.00	HR	0	492	0	0	492
			0.00	*55.99*	*0.00*	*0.00*	*55.99*
MAP T50XX030 TRUCK, HIGHWAY, 70,000 LBS GVW, 2 AXLE, 6X6 (CHASSIS ONLY-ADD OPTIONS)	64.00	HR	0	3,583	0	0	3,583
			39.33	*0.00*	*0.00*	*0.00*	*39.33*
RSM X-TRKDVRHV Outside Truck Drivers, Heavy	64.00	HR	2,517	0	0	0	2,517
			0.00	*118.15*	*0.00*	*0.00*	*118.15*
EP T15CA011 TRACTOR, CRAWLER (DOZER), 165 HP, LOW GROUND PRESSURE, W/5.09 CY SEMI-U BLADE (ADD ATTACHMENTS)	16.00	HR	0	1,890	0	0	1,890
(Note: D-6 LGP)							
			0.00	*136.10*	*0.00*	*0.00*	*136.10*
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	16.00	HR	0	2,178	0	0	2,178
(Note: D-7 LGP)							
			0.00	*110.68*	*0.00*	*0.00*	*110.68*
GEN L40Z4420 LOADER, FRONT END, WHEEL, ARTICULATED, 5.50 CY (4.2 M3) BUCKET, 4X4	16.00	HR	0	1,771	0	0	1,771
			0.00	*6.38*	*0.00*	*0.00*	*6.38*
EP L20AB022 6/1000W, W/8 KW GEN, TRLR MTD, ELECTRIC MAST WINCH	16.00	HR	0	102	0	0	102
(Note: 127 day x 14 hr /day = approx 1778 hr)							
			0.00	*24.25*	*0.00*	*0.00*	*24.25*
EP T50GM005 TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	16.00	HR	0	388	0	0	388

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
			7,059.05	*0.00*	*5,176.50*	*0.00*	*12,235.55*
Other	**1.00**	**EA**	**7,059**	**0**	**5,177**	**0**	**12,236**
			2,485.74	*0.00*	*262.50*	*0.00*	*2,748.24*
Safety Fence	**1.00**	**EA**	**2,486**	**0**	**263**	**0**	**2,748**
			0.00	*0.00*	*0.53*	*0.00*	*0.53*
RSM 015626500600 Safety Fencing material only	500.00	LF	0	0	263	0	263
			0.06	*0.00*	*0.00*	*0.00*	*0.06*
RSM 015626500610 Safety Fencing remove and reinstall existing fence	38,600.00	LF	2,486	0	0	0	2,486
			4,573.31	*0.00*	*4,914.00*	*0.00*	*9,487.31*
Construction Surveying/Staking	**1.00**	**EA**	**4,573**	**0**	**4,914**	**0**	**9,487**
			29.89	*0.00*	*0.00*	*0.00*	*29.89*
FOP FC-SURYR Surveyors - 3-man team	153.00	HR	4,573	0	0	0	4,573
(Note: Gradelines spaced every 100'; stake out every 25' for 100' wide berm (extended for survey sake). Survey crew can do 20 lines per day which is 2000' per day for a berm of 100'. 200,000 SF/DAY = 4.59 acres/ 8 hours per day = 0.57 acres per hour production Crew survey output estimated at approximately .57 acres per hour. 89 acres = 51 hours. 3-man team = 3 ea x 51 hr = 153 hours)							
			0.00	*0.00*	*63.00*	*0.00*	*63.00*
USR Grade Stakes, Steel Pipe	78.00	EA	0	0	4,914	0	4,914
(Note: 25 per pack, $60/pack quoted from www.surveysupplyinc.com; Assume gradeline of stakes every 100', spaced 25' apart; 38,544'/ 100' = 386 lines; 100' wide berm/ 25' spacing = 5 stakes per line; 386 * 5 = 1930 stakes / 25 stakes per pack = 78 packs.)							
			0.94	*1.26*	*0.00*	*8.37*	*10.57*
170017 Hopper Dredging	**481,169.00**	**CY**	**454,434**	**605,005**	**0**	**4,027,385**	**5,086,824**
			0.94	*1.26*	*0.00*	*8.37*	*10.57*
17001702 Site Work-Dredging	**481,169.00**	**CY**	**454,434**	**605,005**	**0**	**4,027,385**	**5,086,824**
			0.00	*0.00*	*0.00*	*8.37*	*8.37*
Dredging	**481,169.00**	**CY**	**0**	**0**	**0**	**4,027,385**	**4,027,385**
			0.00	*0.00*	*0.00*	*8.37*	*8.37*
USR Dredging from CEDEP Estimate	481,169.00	CY	0	0	0	4,027,385	4,027,385
			0.94	*1.26*	*0.00*	*0.00*	*2.20*
Beach Placement	**481,169.00**	**CY**	**454,434**	**605,005**	**0**	**0**	**1,059,440**
(Note: Current total dredge yardage = 481,169 CY for Normal Beach Placement Duration based on CEDEP Pay Production. Basis is 64 days using one crew.)							
			0.00	*118.15*	*0.00*	*0.00*	*118.15*
EP T15CA011 TRACTOR, CRAWLER (DOZER), 165 HP, LOW GROUND PRESSURE, W/5.09 CY SEMI-U BLADE (ADD ATTACHMENTS)	1,536.00	HR	0	181,479	0	0	181,479

Description	Quantity	UOM	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectCost
(Note: D-6 LGP)							
			0.00	*136.10*	*0.00*	*0.00*	*136.10*
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	1,536.00	HR	0	209,052	0	0	209,052
(Note: D-7 LGP)							
			0.00	*110.68*	*0.00*	*0.00*	*110.68*
GEN L40Z4420 LOADER, FRONT END, WHEEL, ARTICULATED, 5.50 CY (4.2 M3) BUCKET, 4X4 (1 ea)	1,536.00	HR	0	170,004	0	0	170,004
			0.00	*24.25*	*0.00*	*0.00*	*24.25*
EP T50GM005 TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	1,536.00	HR	0	37,243	0	0	37,243
			0.00	*6.38*	*0.00*	*0.00*	*6.38*
EP L20AB022 6/1000W, W/8 KW GEN, TRLR MTD, ELECTRIC MAST WINCH (64 days x 15.6 hrs/day = 999 hrs)	999.00	HR	0	6,378	0	0	6,378
			60.68	*0.00*	*0.00*	*0.00*	*60.68*
RSM X-EQOPRHVY Outside Equip. Operators, Heavy (Group1) 3-ea	4,608.00	HR	279,617	0	0	0	279,617
			39.33	*0.00*	*0.00*	*0.00*	*39.33*
RSM X-EQOPROIL Outside Equip. Oilers 1-ea	1,536.00	HR	60,414	0	0	0	60,414
			28.99	*0.00*	*0.00*	*0.00*	*28.99*
RSM X-LABORER Outside Laborers, (Semi-Skilled) 1.5-ea	2,304.00	HR	66,800	0	0	0	66,800
			47.65	*0.00*	*0.00*	*0.00*	*47.65*
MIL X-ELECTRN Outside Electricians for Lights (64 days x 15.6 hrs/day = 999 hrs)	999.00	HR	47,603	0	0	0	47,603
			0.00	*850.00*	*0.00*	*0.00*	*850.00*
USR Misc Tools	1.00	EA	0	850	0	0	850
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
170099 Associated General Items	**1.00**	**EA**	**0**	**0**	**0**	**100,000**	**100,000**
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
COR-directed Standby Time	**1.00**	**EA**	**0**	**0**	**0**	**100,000**	**100,000**
			0.00	*0.00*	*0.00*	*100,000.00*	*100,000.00*
USR COR-directed Standby Time, Dredge operations	1.00	DAY	0	0	0	100,000	100,000
(Note: Cost takens from recent bid results.)							

MOB & DEMOB COST:		$816,284		BID QUANTITY		2,702,400	C.Y.
				UNIT COST...		$7.66	PER C.Y.
		Willoughby Spit Initial Fill-NED Plan		EXCAV. COST.		$20,700,384	
CHECKLIST FOR INPUT DATA.				TIME........		9.9	MONTHS

PG 1 OF 12: PROJECT TITLES			|	PG 7 & 8 OF 12: PLANT OWN. & OPER.			
PROJECT	-	Willoughby Spit Initial Fill-NED Plan	|	DREDGE SELECTED	-	GENERIC MEDIUM	
LOCATION	-	Norfolk, VA	|	DREDGE ACQUIS COST	-	$16,600,000	
INVIT #	-	0	|	DREDGE CAPITAL IMPROV	-	10%	
DATE OF EST.	-	Jan 2013	|	PROPULSION TUG	-	self prop.	/mo
EST. BY	-	mh	|	SURVEY VESSEL	-	$11,000	/mo
MOB. BID ITEM #	-	1	|	BOOSTER	-	$250,000	/mo
EXCAV. BID ITEM #	-	2	|	CRANE BARGE	-	$0	/mo
			|	TENDER TUG	-	$0	/mo
PG 2 OF 12: TYPE OF EST & IND COSTS			|	OTHER MARINE	-	$0	/mo
TYPE OF EST.	-	Planning Estimate	|	SHORE EQUIP	-	$0	/mo
CONTRACTOR'S O.H.	-	15.0%	|				
CONTRACTOR'S PROFIT	-	10.0%	|	PG 9 OF 12: OTHER ADJUSTMENTS			
CONTRACTOR'S BOND	-	1.0%	|	SPECIAL COST/MO (1ST)	-	$0	Permits
			|	SP COST/MO (2ND-14TH)	-	$0	From Sheet D\3
PG 3 OF 12: EXCAVATION QTY'S			|	SPECIAL COST LS (1ST)	-	$1,000	Mooring-Scotts Buoy
DREDGING AREA	-	7,800,000 sf	|	SP COST LS (2ND-14TH)	-	$0	From Sheet E
REQ'D EXCAVATION	-	2,702,400 cyds	|				
PAY OVERDEPTH	-	0 cyds	|				
CONTRACT AMOUNT	-	2,702,400 cyds	|	PG 10 OF 12: LOCAL AREA FACTORS			
NOT DREDGED	-	0 cyds	|	PRESENT YEAR	-	2012	
NET PAY	-	2,702,400 cyds	|	ECONOMIC INDEX	-	8230	
NONPAY YARDAGE	-	0 cyds	|	LAF	-	1.02	
GROSS YARDAGE	-	2,702,400 cyds	|	INTEREST RATE	-	2.000%	/yr
NONPAY HEIGHT	-	0.0 ft overdig	|	TIME PERIOD	-	January 01 to June 30 2011	
TOTAL BANK HEIGHT	-	9.4 ft	|	PIPELINE AVAILABILITY	-	9	mos/yr
			|	BUCKET AVAILABILITY	-	10	mos/yr
PG 4, 5 & 6 OF 12: PRODUCTION			|	HOPPER AVAILABILITY	-	10	mos/yr
TYPE OF MATERIAL	-	2% MUD	|	FUEL PRICE	-	$4.50	/gal
	-	98% SAND	|				
	-	0% GRAVEL	|	PG 11 OF 12: DREDGE OPER ADJ FACTORS			
HOPPER CAPACITY	-	3,800 cyds	|	PUMP LOAD FACTOR	-	50%	
EFF. HOPPER CAP.	-	2,000 cyds	|	RPR & MAINT. ADJ	-	1.00	
DRDGE RATE (ALL HEADS)	-	1,270 cy/hr	|	JET PUMP USEAGE	-	100%	
ACT. DRAGHDS USED	-	2 ea	|				
DRDGE RATE USED	-	1,270 cy/hr	|	PG 12 OF 12: TRAVEL & PROVISIONS			
TURNS/CYCLE	-	2 ea	|	FREQ PD TRAVEL	-	28	days
MIN. PER TURN	-	1 min	|	RT TRAVEL COST	-	$400	
DISPOSAL DIST	-	10.37 mi	|	GOVT. PERSONNEL	-	3	ea
TRVL SPD TO DISP	-	10.5 mph	|	PROVISIONS & SUPP	-	$15	/man
TRVL SPD FROM DISP	-	12.0 mph	|				
DUMP/CONNECT TIME	-	20 min	|				
PUMPOUT RATE	-	2200 cy/hr	|	LOADS PER DAY	-	4.5	
PIPELINE USED	-	5900 lf	|	PRODUCTION	-	426	gross cy per hour
CLEANUP	-	0% More Time	|	OPERATING TIME	-	641	hours per month
% EFF WORK TIME	-	87.8%	|	GROSS PRODUCTION	-	273,066	cy per month
			|	PAY PRODUCTION	-	272,970	pay cy per month

A DESCRIPTION AND QUANTITY SUMMARY

1	PROJECT	Willoughby Spit Initial Fill-Auth Plan	DATE OF ESTIMATE	Jan 2013
2	LOCATION	Norfolk, VA	INVIT. OR CONTR. NO.	0
3	ESTIMATED BY	mh	CHECKED BY	0
4	TYPE OF DREDGE	3800 CYD HOPPER DREDGE	TYPE OF ESTIMATE	Planning Estimate

5 DESCRIPTION OF WORK

Feasibility Study

Authorized Plan

Borrow area is at Thimble Shoals Auxiliary Channel. Midpoint of borrow to beach midpoint

thru Scotts buoy is 10.37 miles. Pumpout included. Beach fill spread is from another estimate.

6 EXCAVATION

				REMARKS
A. REQUIRED		800,000	CY	3,500,000 s.f. of Dredging Area
B. PAY OVERDEPTH	+	418,000	CY	
C. MAX. PAY YARDAGE	=	1,218,000	CY	(YARDAGE USED ON BID FORM)
D. O.D. NOT DREDGED	-	0	CY	
E. NET PAY YARDAGE	=	1,218,000	CY	(YARDAGE USED TO FIGURE UNIT PRICE PER C.Y.)
F. NON-PAY YARDAGE	+	0	CY	0.0 ft overdig
G. GROSS YARDAGE	=	1,218,000	CY	(YARDAGE USED TO FIGURE PRODUCTION TIME & COST)

B DREDGING COST BID ITEM # 2

					REMARKS
1	GROSS YARDAGE		1,218,000	CY	FROM SHEET A, ITEM 6 G.
2	PRODUCTION RATE	/	249,210	CY/MO	FROM SHEET C, ITEM 9.
3	DREDGING TIME	=	4.89	MONTHS	1,218,000 Net Pay CY ÷ 4.89 MO = 249,210 Pay CY/MO
4	TOTAL MONTHLY COST	x	$1,570,369		FROM SHEET D
	SUBTOTAL............=		$7,679,105		
5	FIXED COSTS	+	$1,000		FROM SHEET E
	SUBTOTAL..............=		$7,680,105		
6	OVERHEAD 15.0%	+	$1,152,016		
	SUBTOTAL............=		$8,832,121		
7	PROFIT 10.0%	+	$883,212		
	SUBTOTAL..............=		$9,715,333		
8	BOND 1.0%	+	$97,153		
9	GROSS PRODUCTION COS	=	$9,812,486		
10	NET PAY YARDAGE	/	1,218,000	CY	FROM SHEET A, ITEM 6 E.
11	UNIT COST	=	$8.06	/CY	
12	MAX PAY YARDAGE	x	1,218,000	CY	FROM SHEET A, ITEM 6 C.
13	DREDGING COST	=	$9,817,080		

C MONTHLY PRODUCTION SUMMARY BID ITEM # 2

					REMARKS
1	AVERAGE UNADJUSTED CYCLE TIME		282	min/load	SEE SHEET C \ 1, ITEM 3.
2	CLEANUP FACTOR	/	1.00		0% ADDITIONAL DREDGING TIME (100% / 10%)
3	AVERAGE CYCLE TIME	=	282	min/load	
4	CONVERSION TO HOURS		60	min/hr	
5	AVERAGE CYCLE TIME	/	282	min/load	THIS SHEET, ITEM 3.
6	EFFECTIVE HOPPER CAPACITY	x	2,000	cy/load	
7	GROSS PRODUCTION	=	426	CY/HR	

					REMARKS
8	OPERATING TIME:				
	A. TIME EFFICIENCY		80.2%		% OF EFFECTIVE WORKING TIME
	B. MAX DREDGE TIME	x	730	HRS/MO	
	C. OPERATING TIME	=	585	HRS/MO	
9	PRODUCTION RATE	=	249,210	CY/MO	426 CY/HR x 585 HRS/MO
10	LOADS PER DAY		4.1		(1440 MIN/DAY ÷ 282 MIN/LOAD) X 80.2% EWT
11	PROJECT DURATION		4.89	MONTHS	

C \ 1 — PRODUCTION WORK SHEET — CYCLE TIME — BID ITEM # 2

1 DREDGE USED:

A. DESCRIPTION OF DREDGE		3800 CYD HOPPER DREDGE	
B. EFFECTIVE HOPPER CAPACITY		2,000 cy/load	
			REMARKS
2 TIME PER AVERAGE LOAD CYCLE:			
A. EXCAVATING		94 min	(2,000 cy ÷ 1,270 cy/hr) x 60 min/hr.
B. TURNING	+	2 min	2 turns at 1 minutes per turn.
C. TO DISPOSAL OR MOORING	+	59 min	(10.4 miles ÷ 10.5 mph) x 60 min/hr.
D. DUMPING OR CONNECT TO PIPELINE	+	20 min	TYPE OF DISPOSAL----> PUMPOUT
E. PUMPOUT THROUGH PIPELINE	+	55 min	(2,000 cy ÷ 2,200 cy/hr) x 60 min/hr.
F. FROM DISPOSAL OR MOORING	+	52 min	(10.4 miles ÷ 12.0 mph) x 60 min/hr.
3 AVERAGE UNADJUSTED CYCLE TIME	=	282 min/load	

D MONTHLY COST SUMMARY BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

				REMARKS
1 LABOR COSTS		$359,145	/MO	FROM SHEET D \ 1
2 EQUIPMENT				
A. DREDGE	+	$943,271	/MO	FROM SHEET D \ 2
PROPULSION TUG	+	self prop.	/MO	
B. CREW/SURVEY VESSEL	+	$11,000	/MO	
C. BOOSTER	+	$250,000	/MO	
D. CRANE BARGE	+	$0	/MO	
E. TENDER TUG	+	$0	/MO	
F. OTHER MARINE	+	$0	/MO	
G. SHORE EQUIPMENT	+	$0	/MO	
3 TRAVEL EXPENSE	+	$6,953	/MO	(30.42 dys/mo / 28 dys x $400 rt x 16 ea)
4 OTHER MONTHLY COSTS	+	$0	/MO	FROM SHEET D \ 3
5 TOTAL MONTHLY COST	=	$1,570,369		

D \ 1 LABOR COSTS BID ITEM # 2

Last Update...Jan 13

DREDGE SIZE: 3800 CYD HOPPER DREDGE

		Social Security Tax	7.65%
		Employ. Liability Tax	6.90%
Overtime %	28.00%	Workers comp.	10.00%
Vacation & Holiday %	8.64%	Unemployment tax	6.20%
	--------------		--------------
COMPOSITE..................	36.64%	COMPOSITE.....................	30.75%

EA	CREW	BASIC HRLY WAGE		O.T. VACATION & HOLIDAY 36.64% AMOUNT		SUB-TOTAL AMOUNT		TAXES INSUR 30.75% AMOUNT		SUB-TOTAL AMOUNT		FRINGE BENEFITS $7.44 AMOUNT		HRLY COST AMOUNT		HOURS PER MONTH		MONTHLY COST
	Dredgecrew...																	
1	CAPTAIN	56.27	+	20.62	=	76.89	+	23.64	=	100.53	+	7.44	=	107.97	x	365	=	$39,409
1	CHIEF ENG	52.70	+	19.31	=	72.01	+	22.14	=	94.15	+	7.44	=	101.59	x	365	=	$37,080
1	ENGINEER	33.90	+	12.42	=	46.32	+	14.24	=	60.56	+	7.44	=	68.00	x	365	=	$24,820
1	MATE	35.20	+	12.90	=	48.10	+	14.79	=	62.89	+	7.44	=	70.33	x	365	=	$25,670
2	DRAGTENDER	23.85	+	8.74	=	32.59	+	10.02	=	42.61	+	7.44	=	50.05	x	730	=	$36,537
2	WATCH AB	34.50	+	12.64	=	47.14	+	14.50	=	61.64	+	7.44	=	69.08	x	730	=	$50,428
1	COOK	21.45	+	7.86	=	29.31	+	9.01	=	38.32	+	7.44	=	45.76	x	365	=	$16,702
1	STEWARD	28.12	+	10.30	=	38.42	+	11.81	=	50.23	+	7.44	=	57.67	x	365	=	$21,050
2	SEAMAN AB	26.91	+	9.86	=	36.77	+	11.31	=	48.08	+	7.44	=	55.52	x	730	=	$40,530
1	AB WIPER	30.05	+	11.01	=	41.06	+	12.63	=	53.69	+	7.44	=	61.13	x	365	=	$22,312
1	LAUNCHMAN	24.02	+	8.80	=	32.82	+	10.09	=	42.91	+	7.44	=	50.35	x	365	=	$18,378
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	7.44	=	7.44	x	0	=	$0
14	Crew on Dredge									TOTAL DREDGE MONTHLY LABOR COST =								$332,916
	Shorecrew...																	
0	SUPERINT	23.02	+	8.43	=	31.45	+	9.67	=	41.12	+	7.44	=	48.56	x	0	=	$0
0	DUMP FOREMN	23.02	+	8.43	=	31.45	+	9.67	=	41.12	+	7.44	=	48.56	x	0	=	$0
0	EQUIP OPER	22.75	+	8.34	=	31.09	+	9.56	=	40.65	+	7.44	=	48.09	x	0	=	$0
2	SHOREMAN	15.95	+	5.84	=	21.79	+	6.70	=	28.49	+	7.44	=	35.93	x	730	=	$26,229
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	7.44	=	7.44	x	0	=	$0
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	7.44	=	7.44	x	0	=	$0
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	7.44	=	7.44	x	0	=	$0

16 Total Crew TOTAL MONTHLY LABOR COST = $359,145

(Average Gross Wage = $61.50 per manhour)

D \ 2 — DREDGE OWNERSHIP & OPERATING COST SUMMARY — BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

		RATES			MOB/DEMOB RATES	
1. OWNERSHIP COSTS:						
Ownership Elements	$	139,720	/MO	$	139,720	/MO
Facilities Capitol Cost of Money (FCCM)	$	16,726	/MO	$	16,726	/MO
TOTAL	= $	156,446	/MO	$	156,446	/MO
2. OPERATING COSTS:						
Fuel	$	767.60	/HR	$	793.80	/HR
Lubricants	$	22.40	/HR	$	22.40	/HR
Repairs and Maintenance	$	376.00	/HR			
Pump and Pipe Wear & Repairs	$	163.80	/HR			
Provisions and Supplies	$	14.80	/HR	$	11.88	/HR
SUBTOTAL	= $	1,345	/HR	$	828	/HR
Effective Working Time = (730 HRS/MO x 80.2% EWT)	x	585	HRS/MO			
Calendar Time per Month (Mob/Demob uses Calendar Time)				x	730	HRS/MO
TOTAL	= $	786,825	/MO	$	604,440	/MO
3. TOTAL OWNERSHIP & OPERATING COSTS:						
Total Ownership Costs	$	156,446	/MO	$	156,446	/MO
Total Operating Costs	$	786,825	/MO	$	604,440	/MO
TOTAL	= $	943,271	/MO	$	760,886	/MO

D \ 2A DREDGE OWNERSHIP COSTS BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

ACQUISITION COST (A):	$	16,600,000
CAPITAL IMPROVEMENTS (I) @ 10% OF (A):	$	1,660,000
(A + I)	$	18,260,000

COST OF MONEY (FULL RATE):	2.000%	USE MONTHS PER YEAR (UMPY):	10 months
DISCOUNTED MONEY RATE:	1.600%	MARINE INSURANCE (MI):	1.50%
SALVAGE VALUE FACTOR (S):	10%	TAXES (TA):	1.00%
ECONOMIC LIFE (N):	20 yrs	LAYUP (LU):	$47,000 per layup month
YEAR COMMISSIONED:	1981	YARD COST (Y):	$6,000 per month

CALCULATIONS

1. OWNERSHIP ELEMENTS:

A. DEPRECIATION = (A+I)*[1-S]/N = ($18,260,000) x [1 - 10%] / 20 yrs	= $	821,700	/YR
B. MARINE INSURANCE = MI(A+I) = 1.50% x ($18,260,000)	= $	273,900	/YR
C. TAXES = TA(A+I) = 1.00% x ($18,260,000)	= $	182,600	/YR
E. LAYUP = (LU)(12-1-UMPY) = ($47,000 per mo) x (12 mo/yr - 1 mo - 10 mo)	= $	47,000	/YR
F. YARD = 12(Y) = 12 mo x ($6,000 per mo)	= $	72,000	/YR
G. YEARLY OWNERSHIP = (Sum of Items 1.a. thru 1.f.)	= $	1,397,200	/YR
H. MONTHLY OWNERSHIP = (yrly Ownership / UMPY) = ($1,397,200 / 10 mo)	= $	139,720	/MO

2. FACILITIES CAPITAL COST OF MONEY (FCCM):

A. YEARLY FCCM = (A+I)[(N-1)(1+S)+2] x Discounted Money Rate / 2N

= ($18,260,000) [(20 yrs - 1)(1 + 10%) + 2] x (1.60%) / [(2)(20 yrs)] = $ 167,262 /YR

B. MONTHLY FCCM = (yrly FCCM / UMPY) = ($167,262 / 10 mo) = $ 16,726 /MO

D \ 2B OPERATING COSTS - FUEL BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

1 FUEL

A. TABLE A. FUEL CONSUMPTION FACTORS:

	FUEL FACTOR (GAL/BHP-HR)					
		Propulsion		Pumps		Aux & Misc
Type of Work	%	factor	%	factor	%	factor
Excavating	45	0.024	50	0.027	30	0.016
Haul and Return	80	0.042	0	0.000	25	0.013
Pumpout	0	0.000	80	0.042	25	0.013
Non-Effective	0	0.000	0	0.000	25	0.013

B. POWER REQUIREMENTS FOR FUEL CONSUMPTION FOR THE DREDGE (From Database):

	SUMMARY OF RATED HP (1)		TOTAL REQUIRED HP (2)
DESCRIPTION	ELECTRIC	DIESEL	DIESEL
Propulsion	0	3,500	3,500
Dredge Pump(s)	0	1,700	1,700
Jet Pump	0	565	565
Pumpout Pump(s)	0	1,700	1,700
Auxillary & Misc	1,375	565	2,265

(1). Rated hp is the output power of drive engines or motors or equivalent hp of other misc electrical loads.

(2). Total required hp is the rated bhp of engines when the type of power is diesel, or the rated bhp of generator engines providing the power when the type of power is electric.

D \ 2C OPERATING COSTS - FUEL BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

1. FUEL (CONT.)

C. FUEL USE DURING DREDGING: F U E L U S E C O N S U M P T I O N S U M M A R Y

DESCRIPTION	EXCAVATING	TURNING, SAILING & DISPOSAL	PUMPOUT	TOTAL NON-EFFECTIVE TIME	TOTALS	JET @ 100% OF EXCAV TIME
Cycle Time In Min.	94	133	55	70	352	94
% Of Total Cycle Time	26.7%	37.8%	15.6%	19.9%	100.0%	26.7%
FUEL CONSUMPTION IN GAL/HR (1)						
Propulsion	22.4	55.6	0.0		78.0	
Pumps (2 dragheads used)	12.3	0.0	11.1		23.4	4.1
Auxillary & Misc.	9.7	11.1	4.6	5.9	31.3	
Subtotals:	44.4	66.7	15.7	5.9	132.7	4.1

Average Hourly Fuel Consumption (Effective and Non-Effective Time): 136.8 GAL/HR

Historical Fuel Consumption DATA Not Available or Not Used........

Average Hourly Fuel Cost @ $4.50 per gallon = $ 615.60 /HR

FUEL RATE (Adjusted to Effective Time Basis: $615.60 / 80.2%) = $ 767.60 /HR

D. DURING MOB & DEMOB OPERATION:

Propulsion = (Propulsion hp x Propulsion factor during sailing) = 147.0 GAL/HR

Aux. & Misc. = (Aux. & Misc. hp x Aux. & Misc. factor during Mob & Demob) = 29.4 GAL/HR

Average Hourly Fuel Consumption (During Mob & Demob): 176.4 GAL/HR

FUEL RATE (Average Hourly Fuel Cost @ $4.50 per gallon) = $ 793.80 /HR

NOTES: (1). Computations = (% of Total Cycle Time) x (Fuel Factor from Table A.) x (Horsepower).

D \ 2D OPERATING COSTS - LUBRICANTS BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

Base Price Level (Cost in Tables B & C)	1988
Base Index (EP 1110-1-8, App E, EK 105)	3920
Current Price Level (Cost in Tables B & C)	2012
Current Index (EP 1110-1-8, App E, EK 105)	8230

TABLE B. LUBRICANTS, REPAIRS AND MAINTENANCE.

TOTAL INSTALLED HP OF DREDGE	LUBE $/HR (1)	REPAIRS & MAINTENANCE $/HR (2)
0 - 3999 HP	$9.20	$229.00
4000 - 4999 HP	$11.90	$256.00
5000 - 5999 HP	$14.50	$283.00
6000 - 6999 HP	$17.10	$317.00
7000 - 7999 HP	$19.70	$346.00
8000 - 8999 HP	$22.40	$376.00
9000 - 9999 HP	$25.00	$405.00
10000 - 10999 HP	$27.60	$435.00
11000 - 11999 HP	$30.20	$464.00
12000 - 12999 HP	$32.90	$493.00
13000 - 13999 HP	$35.50	$523.00
14000 - 14999 HP	$38.10	$554.00
15000 - 15999 HP	$40.70	$579.00
16000 - 16999 HP	$43.40	$613.00
17000 - 17999 HP	$46.00	$642.00

(1) LUBRICANTS Includes materials only.

(2) Includes all repairs and maintenance to all components except pumps and discharge piping for pumpout, including parts, labor, small tools, equipment and drydocking.

2 LUBRICANTS (From Table B.)

TOTAL INSTALLED POWER = 8,000 HP $ 22.40 /HR

3 REPAIRS AND MAINTENANCE (From Table B.)

TOTAL INSTALLED POWER = 8,000 HP $ 376.00 /HR

D \ 2E OPERATING COSTS - PUMP & PIPELINE BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

	DREDGED QUANTITIES:			PUMPOUT QUANTITIES:
TYPE	%	TOTAL CY	%	TOTAL CY
Mud:	2%	24,360	100%	24,360
Sand:	98%	1,193,640	100%	1,193,640
Gravel:	0%	0	100%	0
Combined:	100%	1,218,000	100%	1,218,000

TABLE C. COST DATA FOR PUMP & PIPE WEAR AND REPAIRS

PUMP WEAR COST / CY OF MATERIAL PUMPED

DISCHARGE DIAM.	MUD	SAND	GRAVEL
16	$0.019	$0.059	$0.168
18	$0.021	$0.067	$0.191
20	$0.023	$0.078	$0.214
24	$0.029	$0.094	$0.260
28	$0.034	$0.113	$0.304
34	$0.042	$0.141	$0.374

PUMPOUT PIPE WEAR COST PER (CY PUMPED x LF OF PUMPOUT PIPE)

DISCHARGE DIAM.	MUD	SAND	GRAVEL
12	$0.000042	$0.000055	$0.000084
14	$0.000038	$0.000048	$0.000073
16	$0.000031	$0.000042	$0.000065
18	$0.000029	$0.000038	$0.000057
22	$0.000025	$0.000034	$0.000050
27	$0.000023	$0.000029	$0.000044
30	$0.000021	$0.000023	$0.000038

D \ 2F OPERATING COSTS - PUMP & PIPELINE BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

4 PUMP AND PIPE WEAR AND REPAIRS

DESCRIPTION	TOTAL WEAR AND REPAIRS COST		
	MUD	SAND	GRAVEL
PUMP SIZE: 24"			
QUANTITY DREDGED (CY)	24,360 CY	1,193,640 CY	0 CY
% PUMPOUT	100%	100%	100%
PUMPS: (From Table C.)			
Dredge Pumps	$ 706	$ 112,202	$ 0
Pumpout Pumps	$ 706	$ 112,202	$ 0
SUBTOTALS: PUMPS -	1,413	224,404	$ 0
TOTAL PUMP WEAR..			$ 225,817
DISCHARGE PIPES:			
Pumpout Line Length	5,900 LF	5,900 LF	5,900 LF
Pipe Wear Cost	$ 3,593	$ 239,444	$ 0
SUBTOTALS: DISCHARGE PIPES -	$ 3,593	$ 239,444	$ 0
TOTAL PIPE WEAR..			$ 243,037

TOTAL COST FOR PUMP AND PIPE WEAR AND REPAIF $ 468,854 TOTAL

AVERAGE COST PER CY EXCAVATED: $ 0.38 /CY

TOTAL COST/HR = TOTAL WEAR COST/(TOTAL JOB EFFECTIVE HRS) =
= $468,854 / (4.89 mo x 730 hrs/mo x 80.2% EWT) = $ 163.80 /HR

5 PROVISIONS & SUPPLIES

ACTUAL CREW = 16 EA

GOVERNMENT PERSONNEL ON DREDGE = 3 EA

TOTAL PROVISIONS @ ($15.00/ MAN-DAY x 19 ea) / 24 HRS/DAY = $ 11.88 /HR

PROV & SUPPL RATE (Adjusted to Effective Time Basis: $11.88 / 80.2%) = $ 14.80 /HR

D \ 2G DREDGE INFO FROM DATABASE BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

Name Of Plant - - - - - - - - - ->	GENERIC MEDIUM	
Acquistion Cost - - - - - - - - ->	$16,600,000	
Capital Improvements - - - - - - ->	10%	Added Cost
Year Commisioned - - - - - - - - ->	1981	
Economic Life - - - - - - - - - ->	20	years
Salvage Factor - - - - - - - - - ->	0.10	
Propulsion Tug Needed ? - - - - ->	NO	
Propulsion Tug Cost - - - - - - ->	self prop.	
Marine Insurance - - - - - - - - ->	1.5	%
Taxes - - - - - - - - - - - - - ->	1	%
Layup Cost - - - - - - - - - - - ->	$47,000	/mo
Yard Cost - - - - - - - - - - - ->	$6,000	/mo
Water Volume of Hopper - - - - - ->	3,800	cy
Max. Safe Load (Sand) - - - - - ->	2,500	cy
Mud Capacity of Hopper - - - - - ->	1,140	cy
Sand Capacity of Hopper - - - - ->	1,900	cy
Gravel Capacity of Hopper - - - ->	1,520	cy
Mud Production Rate - - - - - - ->	2,100	cy/hr
Sand Production Rate - - - - - - ->	1,260	cy/hr
Gravel Production Rate - - - - - ->	420	cy/hr
# Of Dragheads Available - - - - ->	2	
Suction Pipe Diam. - - - - - - - ->	27	inches
Discharge Pipe Diam. - - - - - - ->	24	inches
Min. Digging Depth - - - - - - - ->	14	ft
Max. Digging Depth - - - - - - - ->	70	ft
Draft Loaded - - - - - - - - - - ->	19.4	ft
Speed Loaded (mph) - - - - - - ->	11.5	(10.0 knots)
Speed Light (mph) - - - - - - ->	12.7	(11.0 knots)
Pumpout Available - - - - - - - ->	YES	
Pumpout Pipe Diam. - - - - - - - ->	24	inches
Max. Pumpout Length - - - - - - ->	6,000	lf
Pumpout Rate - - - - - - - - - - ->	1,800	cy/hr
Total Installed Horsepower - - - ->	8,000	
Propulsion Horsepower - - - - - ->	3500	(Diesel)
Dredge Pump Horsepower - - - - - ->	1700	(Diesel)
Pumpout Horsepower - - - - - - - ->	1700	(Diesel)
Jet Pump Horsepower - - - - - - ->	565	(Diesel)
Auxiliary Engine Horsepower - - ->	1375	(Electric)
Auxiliary Engine Horsepower - - ->	565	(Diesel)
Main Generator Horsepower - - - ->	1700	(Diesel)
Survey Vessel Cost - - - - - - - ->	$0	/mo
Pumpout Booster Cost - - - - - - ->	$100,000	/mo
Crane Barge Cost - - - - - - - - ->	$7,000	/mo
Tender Tug Cost - - - - - - - - ->	$0	/mo
Crew Size - - - - - - - - - - - ->	14	

D \ 3 OTHER MONTHLY COSTS BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

#	Item		Cost	REMARKS
1	Permits		$0 /MO	
2	>	+	$0 /MO	
3	>	+	$0 /MO	
4	>	+	$0 /MO	
5	>	+	$0 /MO	
6	>	+	$0 /MO	
7	>	+	$0 /MO	
8	>	+	$0 /MO	
9	>	+	$0 /MO	
10	>	+	$0 /MO	
11	>	+	$0 /MO	
12	>	+	$0 /MO	
13	>	+	$0 /MO	
14	>	+	$0 /MO	
15	TOTAL OTHER MONTHLY COSTS	=	$0 /MO	

E FIXED COSTS BID ITEM # 2

DREDGE SIZE: 3800 CYD HOPPER DREDGE

				REMARKS
1	Mooring-Scotts Buoy		$1,000	
2	>	+	$0	
3	>	+	$0	
4	>	+	$0	
5	>	+	$0	
6	>	+	$0	
7	>	+	$0	
8	>	+	$0	
9	>	+	$0	
10	>	+	$0	
11	>	+	$0	
12	>	+	$0	
13	>	+	$0	
14	>	+	$0	
15	FIXED COSTS	=	$1,000	

M MOB & DEMOB BID ITEM # 1

DREDGE SIZE: 3800 CYD HOPPER DREDGE

	MOBILIZATION			DEMOBILIZATION		
	# DAYS	$/DAY	TOTAL	# DAYS	$/DAY	TOTAL
1. PREPARE DREDGE FOR TRANSFER	1 x	$45,399 =	$45,399	1 x	$45,399 =	$45,399
2. TRANSFER ALL PLANT 1100 MILES (mob) / 400 MILES (demob) @ 155 miles/day =	7.1 x	$45,399 =	$322,333	2.6 x	$45,399 =	$118,037
3. PERMANENT PERSONNEL & MISC.	L.S.	=	$14,272	L.S.	=	$14,272
4. PREPARE DREDGE AFTER TRANSFER	1 x	$45,399 =	$45,399	1 x	$45,399 =	$45,399
5. OTHER	misc	=	$11,978	cleanup	=	$10,000
	SUBTOTAL MOBILIZATION		$439,381	SUBTOTAL DEMOBILIZATION		$233,107

				REMARKS
6. SUBTOTAL MOBILIZATION & DEMOBILIZATION		=	$672,488	
7. OVERHEAD	15.0%	+	$100,873	
	SUBTOTAL.................=		$773,361	
8. PROFIT	10.0%	+	$77,336	
	SUBTOTAL....................=		$850,697	
9. BOND	1.0%	+	$8,507	

10. TOTAL MOBILIZATION & DEMOBILIZATION = $859,204

M \ 1 MOBIL MONTHLY COST SUMMARY BID ITEM # 1

DREDGE SIZE: 3800 CYD HOPPER DREDGE

				REMARKS
1 LABOR COSTS		$359,145	/MO	FROM SHEET D \ 1
2 EQUIPMENT				
A. DREDGE	+	$760,886	/MO	FROM SHEET D \ 2
PROPULSION TUG	+	self prop.	/MO	
B. CREW/SURVEY VESSEL	+	$11,000	/MO	
C. BOOSTER	+	$250,000	/MO	
D. CRANE BARGE	+	$0	/MO	
E. TENDER TUG	+	$0	/MO	
F. OTHER MARINE	+	$0	/MO	
G. SHORE EQUIPMENT	+	$0	/MO	
3 TOTAL MONTHLY RATE	=	$1,381,031	/MO	
4 CONVERSION TO DAILY RATE	/	30.42	dys/mo	
5 DAILY RATE	=	$45,399	/day	

PERMANENT PERSONNEL & MISC.

				MOBILIZATION	DEMOBILIZATION
16 men @	8 hrs/day @	$61.50 per hour @ 1 DAY		$7,872	$7,872
Travel Expenses	$400 per man			$6,400	$6,400
			TOTAL	$14,272	$14,272

MOB & DEMOB COST:	$859,204		BID QUANTITY		1,218,000	C.Y.
			UNIT COST...		$8.06	PER C.Y.
	Willoughby Spit Initial Fill-Auth Plan		EXCAV. COST.		$9,817,080	
CHECKLIST FOR INPUT DATA.			TIME........		4.89	MONTHS

PG 1 OF 12: PROJECT TITLES			
PROJECT	-	Willoughby Spit Initial Fill-Auth Plan	
LOCATION	-	Norfolk, VA	
INVIT #	-	0	
DATE OF EST.	-	Jan 2013	
EST. BY	-	mh	
MOB. BID ITEM #	-	1	
EXCAV. BID ITEM #	-	2	
PG 2 OF 12: TYPE OF EST & IND COSTS			
TYPE OF EST.	-	Planning Estimate	
CONTRACTOR'S O.H.	-	15.0%	
CONTRACTOR'S PROFIT	-	10.0%	
CONTRACTOR'S BOND	-	1.0%	
PG 3 OF 12: EXCAVATION QTY'S			
DREDGING AREA	-	3,500,000	sf
REQ'D EXCAVATION	-	800,000	cyds
PAY OVERDEPTH	-	418,000	cyds
CONTRACT AMOUNT	-	1,218,000	cyds
NOT DREDGED	-	0	cyds
NET PAY	-	1,218,000	cyds
NONPAY YARDAGE	-	0	cyds
GROSS YARDAGE	-	1,218,000	cyds
NONPAY HEIGHT	-	0.0	ft overdig
TOTAL BANK HEIGHT	-	9.4	ft
PG 4, 5 & 6 OF 12: PRODUCTION			
TYPE OF MATERIAL	-	2%	MUD
	-	98%	SAND
	-	0%	GRAVEL
HOPPER CAPACITY	-	3,800	cyds
EFF. HOPPER CAP.	-	2,000	cyds
DRDGE RATE (ALL HEADS)	-	1,270	cy/hr
ACT. DRAGHDS USED	-	2	ea
DRDGE RATE USED	-	1,270	cy/hr
TURNS/CYCLE	-	2	ea
MIN. PER TURN	-	1	min
DISPOSAL DIST	-	10.37	mi
TRVL SPD TO DISP	-	10.5	mph
TRVL SPD FROM DISP	-	12.0	mph
DUMP/CONNECT TIME	-	20	min
PUMPOUT RATE	-	2200	cy/hr
PIPELINE USED	-	5900	lf
CLEANUP	-	0%	More Time
% EFF WORK TIME	-	80.2%	

PG 7 & 8 OF 12: PLANT OWN. & OPER.			
DREDGE SELECTED	-	GENERIC MEDIUM	
DREDGE ACQUIS COST	-	$16,600,000	
DREDGE CAPITAL IMPROV	-	10%	
PROPULSION TUG	-	self prop.	/mo
SURVEY VESSEL	-	$11,000	/mo
BOOSTER	-	$250,000	/mo
CRANE BARGE	-	$0	/mo
TENDER TUG	-	$0	/mo
OTHER MARINE	-	$0	/mo
SHORE EQUIP	-	$0	/mo
PG 9 OF 12: OTHER ADJUSTMENTS			
SPECIAL COST/MO (1ST)	-	$0	Permits
SP COST/MO (2ND-14TH)	-	$0	From Sheet D\3
SPECIAL COST LS (1ST)	-	$1,000	Mooring-Scotts Buoy
SP COST LS (2ND-14TH)	-	$0	From Sheet E
PG 10 OF 12: LOCAL AREA FACTORS			
PRESENT YEAR	-	2012	
ECONOMIC INDEX	-	8230	
LAF	-	1.02	
INTEREST RATE	-	2.000%	/yr
TIME PERIOD	-	January 01 to June 30 2011	
PIPELINE AVAILABILITY	-	9	mos/yr
BUCKET AVAILABILITY	-	10	mos/yr
HOPPER AVAILABILITY	-	10	mos/yr
FUEL PRICE	-	$4.50	/gal
PG 11 OF 12: DREDGE OPER ADJ FACTORS			
PUMP LOAD FACTOR	-	50%	
RPR & MAINT. ADJ	-	1.00	
JET PUMP USEAGE	-	100%	
PG 12 OF 12: TRAVEL & PROVISIONS			
FREQ PD TRAVEL	-	28	days
RT TRAVEL COST	-	$400	
GOVT. PERSONNEL	-	3	ea
PROVISIONS & SUPP	-	$15	/man
LOADS PER DAY	-	4.1	
PRODUCTION	-	426	gross cy per hour
OPERATING TIME	-	585	hours per month
GROSS PRODUCTION	-	249,210	cy per month
PAY PRODUCTION	-	249,080	pay cy per month

Abbreviated Risk Analysis

Project (less than $40M): **WILLOUGHBY SPIT & VICINITY (GRR-Auth Plan)**
Project Development Stage: **Feasibility (Recommended Plan)**
Risk Category: **Low Risk: Simple Project-No Life Safety**

Total Construction Contract Cost = $ 14,358,860

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ -		15.00%	$ -	$ -
1	17 BEACH REPLENISHMENT	Mobilization	$ 1,750,000		12.21%	$ 213,719	$ 1,963,718.99
2	17 BEACH REPLENISHMENT	Dredging	$ 9,817,080		20.56%	$ 2,018,672	$ 11,835,751.57
3	17 BEACH REPLENISHMENT	Beach Placement	$ 2,691,780		10.62%	$ 285,745	$ 2,977,525.34
4	17 BEACH REPLENISHMENT				0.00%	$ -	$ -
5	17 BEACH REPLENISHMENT				0.00%	$ -	$ -
6	17 BEACH REPLENISHMENT				0.00%	$ -	$ -
7	17 BEACH REPLENISHMENT				0.00%	$ -	$ -
8	17 BEACH REPLENISHMENT				0.00%	$ -	$ -
9	17 BEACH REPLENISHMENT				0.00%	$ -	$ -
10	17 BEACH REPLENISHMENT				0.00%	$ -	$ -
11	17 BEACH REPLENISHMENT				0.00%	$ -	$ -
12		**Remaining Construction Items**	**$ 100,000**	*0.7%*	5.00%	$ 5,000	$ 105,000.00
13	30 PLANNING, ENGINEERING, AND DESIGN	**Planning, Engineering, & Design**	$ 717,943		5.00%	$ 35,897	$ 753,840.15
14	31 CONSTRUCTION MANAGEMENT	**Construction Management**	$ 717,943		5.00%	$ 35,897	$ 753,840.15

Totals	Contract Cost	% Contingency	$ Contingency	Total
Real Estate	$ -	0.00%	$ -	$ -
Total Construction Estimate	$ 14,358,860	17.57%	$ 2,523,136	$ 16,881,996
Total Planning, Engineering & Design	$ 717,943	5.00%	$ 35,897	$ 753,840
Total Construction Management	$ 717,943	5.00%	$ 35,897	$ 753,840
Total	$ 15,794,746		$ 2,594,930	$ 18,389,676

WILLOUGHBY SPIT & VICINITY (GRR-Auth Plan)
Feasibility (Recommended Plan)
Abbreviated Risk Analysis

Potential Risk Areas

Typical Risk Elements	Mobilization	Dredging	Beach Placement	0	0	0	0	0	0	0	0	Remaining Construction Item	Planning, Engineering, & Design	Construction Management
Project Scope Growth	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Acquisition Strategy	2	2	1	-	-	-	-	-	-	-	-	-	-	-
Construction Elements	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Quantities for Current Scope	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Specialty Fabrication or Equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cost Estimate Assumptions	-	-	-	-	-	-	-	-	-	-	-	-	-	-
External Project Risks	2	3	1	-	-	-	-	-	-	-	-	-	-	-

Abbreviated Risk Analysis

WILLOUGHBY SPIT & VICINITY (GRR-Auth Plan)
Feasibility (Recommended Plan)

Meeting Date: 19-Dec-12

PDT Members
Note: PDT involvement is commensurate with project size and involvement.

Project Management:	Robert Pretlow
Planner:	NAME
Study Manager:	Rachel Haug
Contracting:	Tracy Hughes
Real Estate:	Lanny Pricer / David Parson
Relocations:	NAME
OTHER:	NAME
Engineering & Design:	NAME
Technical Lead:	Mark Hudgins
Geotech:	NAME
Hydrology:	Owen Reece
Civil:	NAME
Structural:	NAME
Mechanical:	NAME
Electrical:	NAME
Cost Engineering:	Gary Szymanski
Construction:	NAME
Operations:	Tom Friberg
OTHER:	Michael Hall (Cost Eng)
OTHER:	NAME
OTHER:	NAME
OTHER:	NAME
OTHER:	NAME
OTHER:	NAME
OTHER:	NAME
OTHER:	NAME

WILLOUGHBY SPIT & VICINITY (GRR-Auth Plan)
Feasibility (Recommended Plan)
Abbreviated Risk Analysis

Meeting Date: ########

Risk Level

Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Possible	0	1	2	3	4
Unlikely	0	0	1	2	3
	Negligible	Marginal	Significant	Critical	Crisis

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope Growth							
					Max Potential Cost Growth		40%
PS-1	Mobilization	• Potential for scope growth, added features and quantities?	• Potential for scope growth, added features and quantities?	A large increase in the size of the project will add additional mobilization costs to this job. However it is unlikely that the project size will increase enough to require extra dredges.	Unlikely	Marginal	0
PS-2	Dredging	• Investigations sufficient to support design assumptions?	• Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions?	The current scope could possibly grow but any increase requires a corresponding increase in funds available to do the work, which is not very likely at this time. The potential exists for borrow sands to not meet project requirements for quality beach fill. The team considered potential borrow outside of the borrow limits. The team considered this a low risk since the area had been used for prior beach fill.	Possible	Marginal	1
PS-3	Beach Placement	• Potential for scope growth, added features and quantities?	• Potential for scope growth, added features and quantities?	The current scope could possibly grow but any increase requires a corresponding increase in funds available to do the work, which is not very likely at this time.	Possible	Negligible	0
PS-4	0	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-5	0	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-6	0	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-7	0	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-8	0	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-9	0	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-10	0	• Project accomplish intent?			Unlikely	Negligible	0
PS-11	0	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-12	Remaining Construction Items	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-13	Planning, Engineering, & Design	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-14	Construction Management	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Acquisition Strategy							
						Max Potential Cost Growth	30%
AS-1	Mobilization	• Limited bid competition anticipated?	• Contracting plan firmly established? • Limited bid competition anticipated?	Plant Availability/ Adequate Competition: Contracts that include dredging component are subject to poor competition depending on dredging work at other port areas. This risk has affected bid prices in the past and is a considerable risk element.	Possible	Significant	2
AS-2	Dredging	• Contracting plan firmly established?	• Limited bid competition anticipated? • Contracting plan firmly established?	Plant Availability/ Adequate Competition: Contracts that include dredging component are subject to poor competition depending on dredging work at other port areas. This risk has affected bid prices in the past and is a considerable risk element.	Possible	Significant	2
AS-3	Beach Placement	• Contracting plan firmly established?	• Contracting plan firmly established?	Plant Availability/ Adequate Competition: Contracts that include dredging component are subject to poor competition depending on dredging work at other port areas. This risk has affected bid prices in the past and is a considerable risk element.	Possible	Marginal	1
AS-4	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-5	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-6	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-7	0	• Contracting plan firmly established?			Unlikely	Marginal	0
AS-8	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-9	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-10	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-11	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-12	Remaining Construction Items	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-13	Planning, Engineering, & Design	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-14	Construction Management	• Contracting plan firmly established?			Unlikely	Negligible	0

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Construction Elements							
						Max Potential Cost Growth	15%
CE-1	Mobilization	• Special mobilization?	• Special mobilization?	Endangered Species; turtles, sturgeon, etc.: These risks are real in the Chesapeake Bay. The PDT has experience in dealing with these species and has tailored the project to specific time windows and operational restrictions.	Possible	Negligible	0
CE-2	Dredging	• Special equipment or subcontractors needed?	• Accelerated schedule or harsh weather schedule? • Special equipment or subcontractors needed?	There is a specified construction window for this job. The Dredging work feature is the feature that is most affected by a Construction work window. Endangered Species; turtles, sturgeon, etc.: These risks are real in the Chesapeake Bay. The PDT has experience in dealing with these species and has tailored the project to specific time windows and operational restrictions.	Possible	Marginal	1
CE-3	Beach Placement	• Unique construction methods?	• Potential for construction modification and claims? • Unique construction methods?	Endangered Species; turtles, sturgeon, etc.: These risks are real in the Chesapeake Bay. The PDT has experience in dealing with these species and has tailored the project to specific time windows and operational restrictions.	Unlikely	Negligible	0
CE-4	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-5	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-6	0	• Special equipment or subcontractors needed?			Unlikely	Negligible	0
CE-7	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-8	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-9	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-10	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-11	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-12	Remaining Construction Items	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-13	Planning, Engineering, & Design	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-14	Construction Management	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Quantities for Current Scope							
						Max Potential Cost Growth	20%
Q-1	Mobilization	• Level of confidence based on design and assumptions?	• Level of confidence based on design and assumptions?	The Mobilization is a set quantity. There is little liklihood that the contractor will not have item covered in his bid price. Any subsequent or unschedule mobs will most likely be in the contractor's bid price. There is little risk here.	Unlikely	Marginal	0
Q-2	Dredging	• Level of confidence based on design and assumptions?	• Sufficient investigations to develop quantities? • Level of confidence based on design and assumptions?	Differing Site Conditions: The PDT recognized this as a dynamic area. A known risk, the PDT considered this a low risk.	Possible	Marginal	1
Q-3	Beach Placement	• Sufficient investigations to develop quantities?	• Sufficient investigations to develop quantities?	Differing Site Conditions: The PDT recognized this as a dynamic area. A known risk, the PDT considered this a low risk.	Possible	Marginal	1
Q-4	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-5	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-6	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-7	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-8	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-9	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-10	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-11	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-12	Remaining Construction Items	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-13	Planning, Engineering, & Design	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-14	Construction Management	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Specialty Fabrication or Equipment							
						Max Potential Cost Growth	50%
FE-1	Mobilization	• Risk of specialty equipment functioning first time? Test?	• Ability to reasonably transport? • Risk of specialty equipment functioning first time? Test?	There is little risk for cost increase of specialy equipment during mobilization .	Unlikely	Negligible	0
FE-2	Dredging	• Confidence in contractor's ability to install?	• Risk of specialty equipment functioning first time? Test? • Confidence in contractor's ability to install?	All specialty euqipment for this item is part of the hopper dredge and other accessories such as a pump-out buoy.	Unlikely	Marginal	0
FE-3	Beach Placement	• Unusual parts, material or equipment manufactured or installed?	• Unusual parts, material or equipment manufactured or installed?	Equipment for spreading sand is standard and readily available.	Unlikely	Negligible	0
FE-4	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-5	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-6	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-7	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-8	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-9	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-10	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-11	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-12	Remaining Construction Items	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-13	Planning, Engineering, & Design	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-14	Construction Management	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Cost Estimate Assumptions							
						Max Potential Cost Growth	25%
CT-1	Mobilization	• Lack confidence on critical cost items?	• Site accessibility, transport delays, congestion? • Lack confidence on critical cost items?	There are not alot of cost variables for mobilization except when there are multiple mobs. This factor is already in the estimate.	Possible	Negligible	0
CT-2	Dredging	• Site accessibility, transport delays, congestion?	• Lack confidence on critical cost items? • Site accessibility, transport delays, congestion?	Dredging assumptions are not out of the oridinary. There are no special risks here.	Possible	Negligible	0
CT-3	Beach Placement	• Site accessibility, transport delays, congestion?	• Lack confidence on critical cost items? • Site accessibility, transport delays, congestion?	Beach placement is a normal operation for this job without any special risks.	Unlikely	Negligible	0
CT-4	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-5	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-6	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-7	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-8	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-9	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-10	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-11	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-12	Remaining Construction Items	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-13	Planning, Engineering, & Design	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-14	Construction Management	• Reliability and number of key quotes?			Unlikely	Negligible	0

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
External Project Risks							
					Max Potential Cost Growth		20%
EX-1	Mobilization	• Potential for market volatility impacting competition, pricing?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	Fuel Prices: Fuel prices are volatile and our practice is to use conservative values in our estimates. The team still considered this a risk, but the impacts were mitigated by the borrow site location and substantial marine presence in the area. Local Sponsor funding: Always a risk, but direct impacts to the project cost are in escalation until funds are made available. The sponsor is committed to the project. Plant Availability/ Adequate Competition: Contracts that include dredging component are subject to poor competition depending on dredging work at other port areas. This risk has affected bid prices in the past and can be a considerable risk element. Major Weather Event: The project site is substantially impacted by flooding during major storm events. The team considered likely impacts of a weather event during construction. Public Beach Access is not directly related to mobilization except for a few pieces of equipment. Contact with Unexploded ordinance (UXO) is not part of mobilization. Differing Site Conditions will also not affect mobilization.	Likely	Marginal	2
EX-2	Dredging	• Potential for market volatility impacting competition, pricing?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	Sand Availability outside the Borrow Area: The potential exists for borrow sands to not meet project requirements for quality beach fill. The team considered potential borrow areas outside of the proposed borrow limits. The team considered this a low risk since the area had been used for prior beach fill. Fuel Prices: Fuel prices are volatile and our practice is to use conservative values in our estimates. The team still considered this a risk, but the impacts were mitigated by the borrow site location and substantial marine presence in the area. Local Sponsor funding: Always a risk, but direct impacts to the project cost are in escalation until funds are made available. The sponsor is committed to the project. Plant Availability/ Adequate Competition: Contracts that include dredging component are subject to poor competition depending on dredging work at other port areas. This risk has affected bid prices in the past and is a considerable risk element. Major Weather Event: The project site is substantially impacted by flooding during major storm events. The team considered likely impacts of a weather event during construction. Public Beach Access: this is mostly an external risk related to the public's ability to use the completed project. The risk is moderate to low. Unexploded ordinance (UXO): Given the history of this area, it is likely that some UXO or other similar debris will be encountered during operations. The risk is considered moderate. PDT Turnover in Personnel: This risk element is highly likely and has even been experienced by the PDT. The nature of the project insures that adequate team knowledge will remain with the effort. Differing Site Conditions: The PDT recognized this as a dynamic area. A known risk, the PDT considered this a low risk.	Likely	Significant	3
EX-3	Beach Placement	• Unanticipated inflations in fuel, key materials?	• Potential for severe adverse weather? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing? • Unanticipated inflations in fuel, key materials?	Fuel Prices: Fuel prices are volatile and our practice is to use conservative values in our estimates. The team still considered this a risk, but the impacts were mitigated by the borrow site location and substantial marine presence in the area. Local Sponsor funding: Always a risk, but direct impacts to the project cost are in escalation until funds are made available. The sponsor is committed to the project. Major Weather Event: The project site is substantially impacted by flooding during major storm events. The team considered likely impacts of a weather event during construction. Public Beach Access: this is mostly an external risk related to the public's ability to use the completed project. The risk is moderate to low. Unexploded ordinance (UXO): Given the history of this area, it is likely that some UXO or other similar debris will be encountered during operations. The risk is considered moderate. Differing Site Conditions: The PDT recognized this as a dynamic area. A known risk, the PDT considered this part of the External Project Risk a low risk.	Possible	Marginal	1
EX-4	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-5	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-6	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-7	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-8	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-9	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-10	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-11	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-12	Remaining Construction Items	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-13	Planning, Engineering, & Design	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-14	Construction Management	• Potential for severe adverse weather?			Unlikely	Negligible	0