Town of Duck
North Carolina

Town of Duck Shore Protection Project

Photograph obtained by Coastal Planning & Engineering of North Carolina, Inc. (July 7. 2017).

Beach Maintenance Plan

August 2017

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EXECUTIVE SUMMARY

The Town of Duck has initiated a shore protection project aimed at sustaining the beaches that support a significant portion of their local economy and maintaining the tax base of the Town. The project has and will continue to provide increased protection to the Town's economy and coastal development. Part of the project includes implementing a maintenance program to document construction achievements and project performance. Anticipated future costs have been estimated and are also included in the maintenance plan.

The Town successfully completed the initial construction of the Shore Protection Project in June 2017. Periodic maintenance or renourishment is included in the Town's maintenance plan for the Shore Protection Project. The renourishments are expected to occur on a 5 year cycle and will initially involve dredging of Borrow Area A offshore Kill Devil Hills and Nags Head. The Dept. of the Army and North Carolina Division of Coastal Management permits issued for the initial construction will require modifications to use Borrow Area A for future maintenance. Likewise, the Town will be required to obtain a new lease from the Bureau of Ocean Energy Management (BOEM) to use Borrow Area A for maintenance events. The Town has already made these agencies aware of their intentions to use Borrow Area A in the future. The estimated volume of material required for maintenance of the Duck project is 254,000 CY every five (5) years. Post-construction surveys of Borrow Area A show that sufficient sand is available for future maintenance.

Project monitoring has been implemented to track performance of the placed material and is used to update nourishment requirements. The initial baseline monitoring event is scheduled for fall 2017 following the completion of beach nourishment projects in Southern Shores, Kitty Hawk, and Kill Devil Hills. The maintenance plan may be updated throughout the monitoring phase to reflect any deviation from the current protocol. Surveys of the beach profiles have been designed and will be conducted to capture changes along the active profile of the beach both within the project area and adjacent to the project.

This Maintenance Plan serves as documentation that the Town of Duck's Shore Protection Project meets the criteria established by 44 CFR 206.226(j)(2). The Maintenance Plan has been developed in a way consistent with guidance provided by FEMA under Disaster Assistance Fact Sheet 9580.8. This Maintenance Plan will be updated regularly to reflect results of monitoring, construction of additional projects, maintenance events and changes in schedules.

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INTRODUCTION

The Town of Duck is focused on a long-term shoreline management program that will serve to sustain the beaches that support a significant portion of their local economy and maintains the tax base of the Town. In order to accomplish these stated goals, the Town has taken steps to maintain its oceanfront beach and dune to a configuration that 1) provides a reasonable level of storm damage reduction to public and private development, 2) mitigates long-term erosion that could threaten public and private development, recreational opportunities, and biological resources, and 3) maintains a healthy beach that supports valuable shorebird and sea turtle nesting habitat.

The Town of Duck completed an Erosion and Shoreline Management feasibility study in 2013, which evaluated potential management options for the oceanfront shoreline (CPE-NC, 2013). The recommendation of that feasibility study was a beach nourishment project along a portion of the Town's shoreline that was vulnerable to impacts of a design storm with wave and water level characteristics matching Hurricane Isabelle, which impacted the coast in 2003. The project was also designed to include 5 years of advanced nourishment to account for predicted background erosion of the project during the maintenance interval.

Initial construction of the beach nourishment project was completed in June, 2017. The project included placement of 1,323,409 cubic yards of beach compatible sand, which equates to an average fill density of 157.3 cy/lf, along 8,413 feet or approximately 1.6 miles. Sand was dredged from two offshore borrow sources. Following the construction of the project, the Town implemented a maintenance program to monitor the performance of the Shore Protection Project and determine when periodic renourishment is needed to maintain the goals of the project.

Documentation of the construction and subsequent monitoring events will be archived as evidence of the Town's commitment towards maintaining the Shore Protection Project. This information is required for eligibility under the Public Assistance (PA) program administered by FEMA. If the project is impacted by a presidentially declared disaster or emergency, justification that the maintenance plan has been implemented must be provided to receive federal aid. This stipulation is mandated by 44 CFR 206.226(j)(2), which states:

> *Work on an improved beach may be eligible under the following conditions:*
>
> *(i) The beach was constructed by the placement of sand (of proper grain size) to a designed elevation, width, and slope; and,*
>
> *(ii) A maintenance program involving periodic renourishment of sand must have been established and adhered to by the applicant.*

The amount of sand replacement eligible for FEMA funding is limited to the material volume lost as a result of the declared disaster or emergency. Pre- and post-storm profiles, when available, are used to determine the eligible volume of sand. If pre-storm profiles are not available, the estimated erosion from the design study and renourishment history can be used to determine a pre-storm condition. Surveys collected during the monitoring can also be used to determine the pre-storm condition.

This Maintenance Plan serves as documentation that the Town of Duck's Shore Protection Project meets the criteria established by 44 CFR 206.226(j)(2). The Maintenance Plan has been developed in a way consistent with guidance provided by FEMA under Disaster Assistance Fact Sheet 9580.8 issued October 2009, by Elizabeth Zimmerman (FEMA, 2009). The Maintenance Plan includes a description of the project design, construction activities to date, anticipated volume and cost for maintenance, schedule of maintenance and the monitoring protocols being employed by the Town of Duck. This Maintenance Plan will be updated regularly to reflect results of monitoring, construction of additional projects, maintenance events and changes in schedules.

CONSTRUCTION EVENTS

Beach Fill

The initial construction of the Town of Duck Shore Protection Project was completed in June 2017. The project included the construction of a dune and berm beach fill design along 7,913 feet of the Town of Duck Shoreline located just north of the US Army Corps of Engineer's Coastal and Hydraulics Laboratory Field Research Facility (FRF). In addition to the 7,913 ft. design fill section, the project also included a 500-foot long taper on the north end. In total, the project placed sand from baseline station 87+63 (128 Skimmer Way) to 171+75 (137 Spindrift Ln.). Figure 1 shows the extent of the project including the main fill construction template, the northern taper, and the construction baseline. Sand used to construct the project was dredged from two permitted offshore borrow areas using trailing suction hopper dredges (Figure 2).

The beach fill constructed in June 2017 included placement of 1,323,409 cy of beach compatible sand, which equates to an average fill density of 157.3 cy/lf, along 8,413 feet of beach (approximately 1.6 miles). The volume placed included both the volume necessary to construct the designed dune and berm as well as the volume needed for advanced fill. Advanced fill is the sacrificial portion of the fill required to protect the design section from anticipated sediment losses during the time between subsequent maintenance cycles. The volume of advanced fill needed was based on background erosion rates, anticipated diffusion losses and a five (5) year maintenance cycle. Ultimately, the performance of the beach fill dictates when constructed sections require maintenance, which is referred to as renourishment.

Dune Vegetation

The Town will plant American Beach Grass in the nourishment area along the crest of dune east to 3' from the east toe of the dune to include (single planting):

- One beach grass sprig (type 'cape') installed 8" deep on 18" centers, not to exceed 10 rows deep;
- Fertilize with 18-6-6 or 16-8-8 (400 lbs per acre broadcasted across top of planted beach grass)

Planting of American Beach Grass will occur between November and March annually with fertilization to occur no later than April 15th of any year.

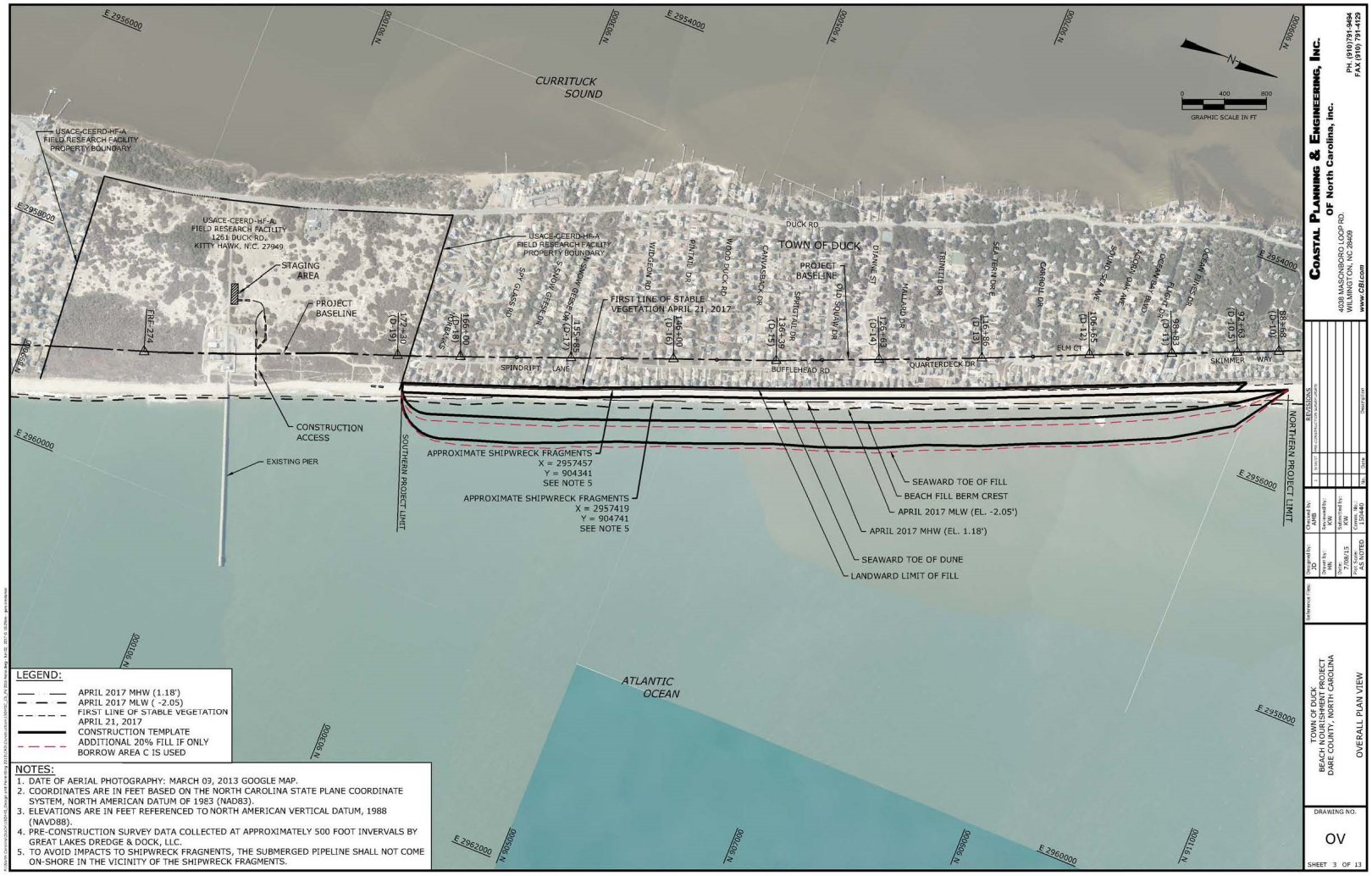

Figure 1. Map showing the extent of the project including the main fill construction template, the northern taper, and the construction baseline.

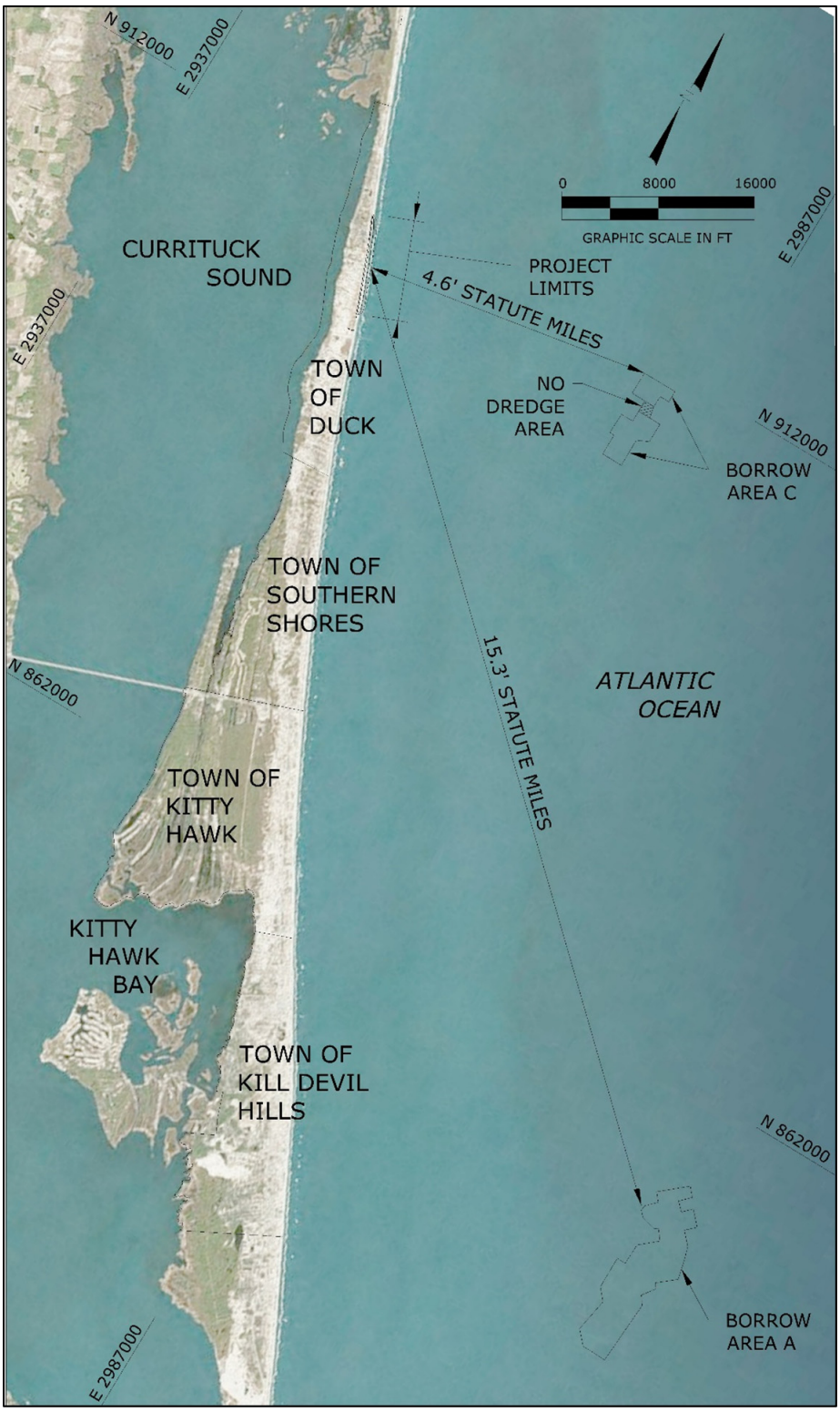

Figure 2. Map showing the location of offshore borrow areas used for the construction of the June 2017 Duck Shore Protection Project.

The Town will plant local Sea Oat stock in the nourishment area along the crest of the dune eastward to include:

- One sea oat sprigs installed a minimum of 8" deep staggered on 4' centers, not to exceed 3 rows deep;
- Fertilize each planting hole with one level teaspoon of time-release (18-6-12 Osmocote or similar type) fertilizer.

Planting of Sea Oats will occur between May and July yearly with fertilization to occur at planting.

All planted areas will be fertilized in the fall with 18-6-6 or 16-8-8 (400 lbs per acre broadcasted across top of planted beach grass). Fall fertilizer application shall be completed no later than October 30th yearly.

Sand Fencing
The Town will install 752 sections of sand fencing with a length of 10 ft. each. Sand fencing sections will be spaced 7-10' apart on a 45 degree angle along the eastern crest of the dune in the nourishment area. This fencing will be maintained and supplemented as needed on an annual basis.

Funding
The project was funded through revenue derived from the Dare County Beach Nourishment Fund and the Town of Duck. The Town of Duck portion of the project was raised through a combination of General Fund appropriation and Municipal Service Districts (MSDs). In essence, the Town of Duck portion of the cost of the project was funded by a contribution from all of the taxpayers in Duck with additional funding provided by property owners in the project area, both oceanfront and non-oceanfront (MSDs).

MAINTENANCE

As-built surveys of the Duck Shore Protection Project were provided by the construction contractor, which represents conditions along each profile as sections of the project were constructed. The first post-construction survey of the project is scheduled to occur in fall 2017 following construction of beach nourishment projects currently underway in the Towns of Southern Shores, Kitty Hawk, and Kill Devil Hills. This survey will be compared to the pre-construction surveys conducted in April 2017, and will establish a baseline condition of the beach out to the depth of closure. The post-construction survey will be conducted along beach profiles at approximately 1,000 foot intervals. Figure 3 shows the location of these beach profiles. Starting in spring 2018, the Town will conduct annual monitoring surveys of the project, which will include beach profiles along the same 1,000 foot spaced beach profiles. These surveys will be conducted to assess the performance of the Shore Protection Project.

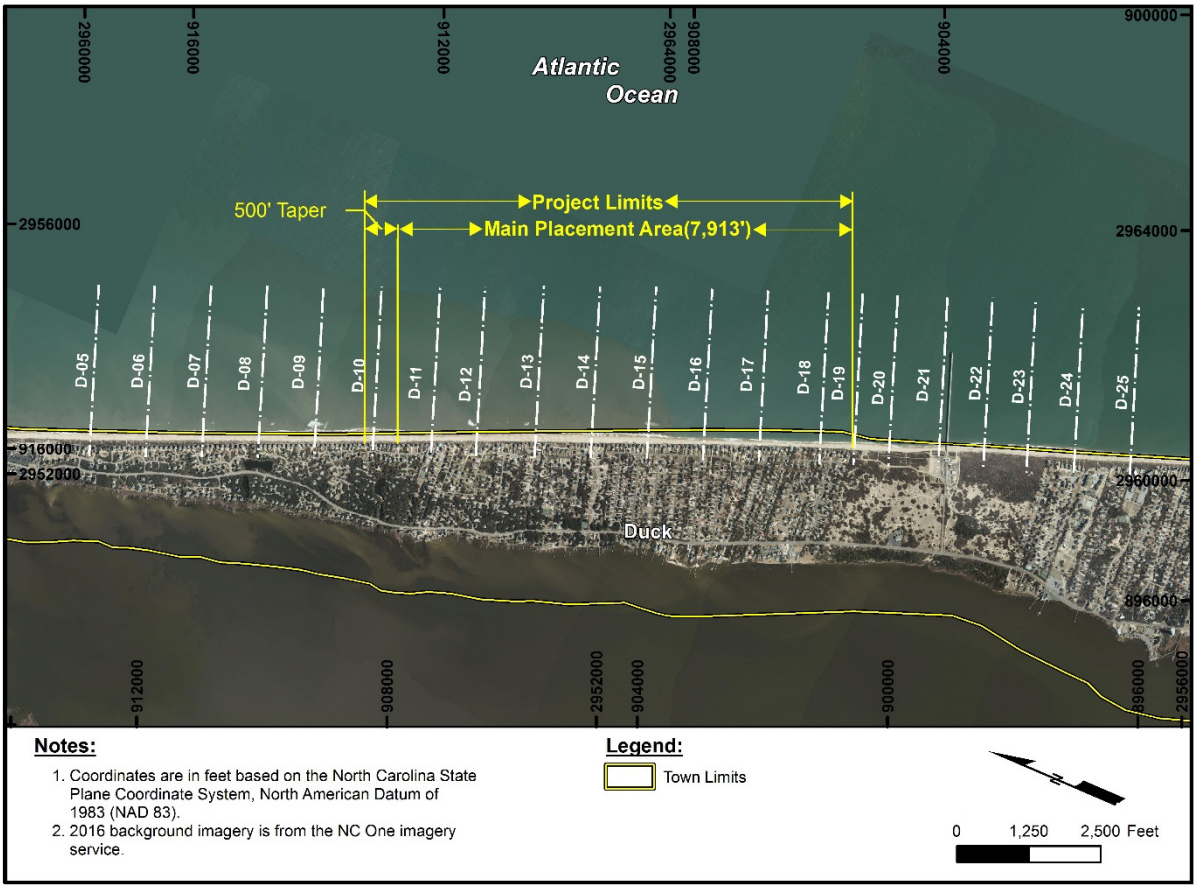

Figure 3. Map of Duck Shore Protection Project Monitoring Beach Profiles.

The Duck Shore Protection Project includes a 20 ft. wide dune at a height of 20.0 ft. NAVD, and a variable width berm at elevation +6.0 ft. NAVD. The project included five (5) years of advanced fill. As previously stated, the Town will conduct annual surveys to monitor the beach fill performance. Annual monitoring will assess the volume of sand in excess of the design that remains in place to determine the timing of, and volume needed for, subsequent beach renourishment. Construction of the June 2017 project used most of the sand available in the offshore borrow area located approximately 4.6 miles offshore of the Town of Duck project. However, sufficient sand is anticipated to be available in Borrow Area A, located offshore of Kill Devil Hills and Nags Head, to provide maintenance of the Duck Shore Protection Project.

RENOURISHMENT REQUIREMENTS

During the design of the Duck Shore Protection Project, CPE-NC conducted an analysis of background erosion losses and diffusion losses to determine the volume of advanced fill to include in the project design. Based on these analyses, the design included 234,000 cy of advanced fill (CPE-NC, 2015). More recent analysis conducted by CPE-NC for the Town of Duck and Dare County to determine future re-nourishment costs assumed a renourishment volume of 254,000 cy.

This volume assumes an average fill density of 30 cy/ft. CPE-NC has estimated that the cost to conduct maintenance of the Duck Shore Protection project in 2023 would be $4,559,000, assuming renourishment occurred simultaneously with the Kitty Hawk and Kill Devil Hills renourishment projects and that the mobilization and demobilization costs were allocated based on the percentage of the total renourishment volumes. Additionally, this cost estimate is based on construction cost to place 254,000 cy of sand. This cost does not reflect engineering or environmental permitting costs for the maintenance event.

During the permitting of the Duck Shore Protection Project, CPE-NC conducted a comprehensive marine sand search and borrow area design (CPE-NC, 2015A). Two borrow sites, referred to as Borrow Area A and C, were designed during the investigation (Figure 2). Borrow Area A is located on the Outer Continental Shelf (OCS) between 5.0 and 6.5 miles offshore of the Towns of Kill Devil Hills and Nags Head in water depths between 50 and 60 ft. (NAVD88). The borrow area covers 1,173 acres and initially contained approximately 16,335,000 cy of sand. The mean grain size of the sand was found to be 0.36 mm with a sorting value of 0.90. The sand in the borrow area was characterized as fine to medium grained quartz sand with trace silt, shell hash, and shell fragments. The average wet Munsell color value was determined to be 5 and dry color value 6. The borrow area was broken up into 6 different cuts with cut depths ranging from -58.5 to -68.0 ft. NAVD88.

Proposed Borrow Area C is located on the Outer Continental Shelf between 4.1 and 5.2 miles offshore of the Town of Duck in water depths between 55 and 65 ft. (NAVD88) (Figure 2). The proposed borrow area covers 354 acres and initially contained approximately 1,905,000 cy of sand. The mean grain size of the sand was found to be 0.28 mm with a sorting value of 1.09. The sand in the borrow area was characterized as fine grained quartz sand with trace silt, shell hash, and shell fragments. The average wet Munsell color value was determined to be 5 and dry color value 6. The borrow area was broken up into 5 different cuts with cut depths ranging from -61.0 to -65.0 ft. NAVD88.

The U.S. Army Corps of Engineers and North Carolina Division of Coastal Management issued permits for the Town of Duck to use this borrow area for the initial construction of the Duck Shore Protection Project. Furthermore, since the borrow site is located in Outer Continental Shelf (OCS) waters, the Town was required to obtain a lease from the Bureau of Ocean Energy Management (BOEM) to use the sand in the permitted borrow site. The majority of the sand available in Borrow Areas C was used in the construction of the Duck project in 2017. Therefore, this borrow area is unlikely to provide sand for future maintenance events. However, a sufficient volume of sand is still present within the permitted dimensions of Borrow Area A to provide sand for future maintenance events.

MONITORING PROTOCOL

A monitoring plan has been developed and is being implemented for the Duck Shore Protection Project. Topographic and hydrographic surveys of the beach profiles will be conducted to monitor

project performance and potential impacts. The beach profile surveys include the fill area and adjacent shoreline within a minimum distance of 5,000 feet.

Beach profile surveys will be conducted along the constructed project on an annual basis to monitor the performance of the project. Supplemental beach profile surveys may also be required following significant storm events. Reports for each monitoring event will be archived by the Town. The reports will contain volumetric and shoreline change calculations to describe how the project is performing. Erosion rates and shoreline change rates along the beach will be documented throughout the monitoring process. The monitoring results will also be used to identify erosion 'hot spots' and to estimate sediment needs for future maintenance events.

CONCLUSION

The Town of Duck has initiated a shore protection project aimed at sustaining the beaches that support a significant portion of their local economy and maintaining the tax base of the Town. The project has and will continue to provide increased protection to the Town's economy and coastal development. Part of the project includes implementing a maintenance program to document construction achievements and project performance. Anticipated future costs have been estimated and are also included in the maintenance plan.

The Town successfully completed the initial construction of the Shore Protection Project in June 2017. Periodic maintenance or renourishment is included in the Town's maintenance plan for the Shore Protection Project. The renourishments are expected to occur on a 5 year cycle and will initially involve dredging of Borrow Area A offshore Kill Devil Hills and Nags Head. The Dept. of the Army and North Carolina Division of Coastal Management permits issued for the initial construction will require modifications to use Borrow Area A for future maintenance. Likewise, the Town will be required to obtain a new lease from BOEM to use Borrow Area A for maintenance events. The Town has already made these agencies aware of their intentions to use Borrow Area A in the future. The estimated volume of material required for maintenance of the Duck project is 254,000 CY every five (5) years. Post-construction surveys of Borrow Area A show that sufficient sand is available for future maintenance.

Project monitoring has been implemented to track performance of the placed material and is used to update nourishment requirements. The initial baseline monitoring event is scheduled for fall 2017 following the completion of beach nourishment projects in Southern Shores, Kitty Hawk, and Kill Devil Hills. The maintenance plan may be updated throughout the monitoring phase to reflect any deviation from the current protocol. Surveys of the beach profiles have been designed, and will be conducted, to capture changes along the active profile of the beach both within the project area and adjacent to the project.

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9580.8. This Maintenance Plan will be updated regularly to reflect results of monitoring, construction of additional projects, maintenance events and changes in schedules.

REFERENCES

CPE-NC (2013) Erosion and Shoreline Management Feasibility Study. Prepared For: The Town of Duck, North Carolina, 48 pgs.

CPE-NC (2015 A) Comprehensive Marine Sand Search and Borrow Area Design Report. Prepared For: The Towns of Duck Kitty Hawk and Kill Devil Hills, North Carolina, 49 pgs.

CPE-NC (2015 B) Town of Duck Erosion and Shoreline Management Design Report. Prepared For: The Town of Duck, North Carolina, 96 pgs.

FEMA (2009) Disaster Assistance Fact Sheet DAP9580.8 Eligible Sand Replacement on Public Beaches. From: Elizabeth A. Zimmerman, Assistant Administrator, Disaster Assistance Directorate, 4 pgs.