TOWN OF OAK ISLAND, NC
BEACH MANAGEMENT PLAN

March 9, 2023

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Prepared For: Town of Oak Island, NC

Executive Summary

The Town of Oak Island (Town) has developed this Beach Management Plan utilizing the criteria established in 15A NCAC 07J.1200 to address a statewide policy change on how oceanfront development is regulated. The Coastal Resources Commission requires a review of this Beach Management Plan every five years for reapproval. The Town is currently preparing a separate multi-decadal Oak Island Beach and Inlet Management Plan (OIBIMP) which will develop a strategy to improve the level of storm protection provided to the citizens and visitors of Oak Island. The OIBIMP will allow the Town to regulate its oceanfront development. This Beach Management Plan is structured to address the plan elements as required by the State to obtain a State approved plan for the Town of Oak Island, which include:

- Review of Beach Fill Projects/Background
- Review of Design and Monitoring
- Review of Sediment Sources
- Review of Financial Plan
- Review of Public Comments

The Town of Oak Island has performed by itself or in cooperation with USACE several beach fill projects to manage their shoreline. The previous initiatives discussed herein include the following projects:

- Brunswick County Beaches Coastal Storm Damage Reduction (CSDR) 50-year project
- Wilmington Harbor Sand Management Plan
- 2001 Sea Turtle Habitat Restoration Project
- Lockwoods Folly Habitat Restoration Project
- FEMA Hurricane Matthew Emergency Dune Project
- Lockwoods Folly Inlet, AIWW Inlet Crossing
- 2020/2021 Beach Renourishment Project
- 2021/2022 Beach Renourishment Project

To support the development of the OIBIMP, the Town implemented the Oak Island Shoreline Mapping Program (OISMP) which assess current and historical beach conditions. The data collected from the OISMP has allowed the Town to move forward with an in-depth analysis of its beach sand volume needs over the next 30-years per State requirements. The OIBIMP has developed volumetric nourishment triggers to identify when nourishment events should occur. A project is expected to occur in 2024/2025 and future maintenance renourishment projects will take place every 6 years along the Oak Island Oceanfront. The total volume need over the next 30-years taking into consideration background erosion, storm induced erosion, potential seal level rise is approximately 16.2 Mcy. These projects implement dune planting to establish and maintain the vegetation on the entire dune system for the life of the plan.

The Town has also undertaken an extensive sediment sampling program to identify the native beach sediment characteristics and verify the compatibility and quantity of existing sediment sources adjacent to Oak Island. This effort determined the quantity and quality of potential sediment sources available to meet the design. Offshore sources consist of Frying Pan Shoals, which lies both within and outside of State waters), the Old and New ODMDS's, Lockwoods Folly

Inlet Complex, Jay Bird Shoals, and Yellow Banks. The total preliminary volume available within all available sources is approximately 99 Mcy

The Town of Oak Island has developed a financial plan to pay for and maintain this Beach Management Plan. The plan includes multiple funding streams which include the Accommodations Fund, Sand Tax Fund, and General Fund. The current funding on hand (with the $20M State grant) and streams available to the Town are adequate for the 2024/2025 Renourishment Project as well as providing and maintaining the design set by this plan.

The Town held a public information and comment session on October 4, 2022, where comments were recorded and have been included in Appendix D in accordance with 15A NCAC 07J 1201 (e). The Town has allowed for 5 months (October 2022 – March 2023) for comments to be submitted and consideration of this Beach Management Plan prior to submitting to Coastal Resources Commission. Comments are summarized in the attached spreadsheet in Appendix D from the Town Comment Session as well as additional comments to the draft copy of this Beach Management Plan. Comments requiring a modification to this Beach Management Plan have been incorporated into this document.

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1.0 PURPOSE

The Town of Oak Island has had a Pre-Project Vegetation Line, previously known as a Static Vegetation Line, in place for approximately 8.4 miles of the 9 miles of oceanfront beach since the Town's 2001 large-scale nourishment project. Pre-Project Vegetation Lines were added to the remainder of the Town's oceanfront shoreline as a result of subsequent nourishment events. Due to the fact that a Static Vegetation Line Exception (now known as a Beach Management Plan) was not available to the Town at the time due to the Town not having begun a beach nourishment/management plan at the time, on December 20, 2016, the Town received approval from the North Carolina Coastal Resources Commission (NCCRC) for a Development Line for the Town's oceanfront shoreline.

As of August 1, 2022, following a formal rulemaking process, the NCCRC eliminated the Development Line as one of its oceanfront management options for establishing the location of oceanfront development activities. With the elimination of the Development Line, and the lack of an approved Beach Management Plan, the Town of Oak Island is required to revert to setbacks based on the previously established Static Vegetation Line which is estimated to render as much as 82% of the Town's oceanfront lots unbuildable.

The Town of Oak Island is now well into the process of developing a 30-year Beach and Inlet Management plan (OIBIMP). The Town therefore considers the timing to be appropriate for the application to, and approval by, the NCCRC of a Beach Management Plan. This plan was developed utilizing the criteria established in 15A NCAC 07J.1200. Once approved, this plan will allow residents of the Town to utilize the first line of stable natural vegetation as the starting point for determining the oceanfront setback requirements as described in 15A NCAC 07H.0306, as opposed to the utilizing the Pre-Project Vegetation Line as the starting point for measuring such setbacks.

2.0 PROJECT BACKGROUND AND SUMMARY OF PREVIOUS PROJECTS

Several connections exist between the Town of Oak Island and previous shoreline maintenance initiatives conducted by other municipalities or the US Army Corps of Engineers (USACE). The connections link the Town either through direct management of the Oak Island shoreline or through the analysis of a potential borrow area viable for Oak Island. The previous initiatives discussed herein include the following projects:

- Brunswick County Beaches Coastal Storm Damage Reduction (CSDR) 50-year project
- Wilmington Harbor Sand Management Plan
- 2001 Sea Turtle Habitat Restoration Project
- Lockwoods Folly Habitat Restoration Project
- FEMA Hurricane Matthew Emergency Dune Project
- Lockwoods Folly Inlet, AIWW Inlet Crossing
- 2020/2021 Beach Renourishment Project
- 2021/2022 Beach Renourishment Project

2.1 Brunswick County Beaches CSDR

Congress authorized the Brunswick County Beaches CSDR (Coastal Storm Damage Reduction) project in 1966; however, in 1974 the USACE ceased development of the project due to insufficient local support. The original project covered all of the Brunswick County shoreline but in 1994 the USACE initiated a re-evaluation study (GRR) for a project covering Oak Island and Holden Beach (USACE, 2012). Construction of the project has not occurred to date due to federal funding limitations. The USACE conducted a significant amount of field investigations to identify a potential borrow site for the 50-year project. The USACE conducted feasibility level studies to classify the sediment characteristics within the following potential borrow sites:

- Frying Pan Shoals (FPS)
- Jay Bird Shoals
- Wilmington Harbor ODMDS
- Lockwoods Folly Inlet & AIWW Crossings
- Lockwoods Folly River
- Yellow Banks AIWW dredge material disposal site
- Tubbs Inlet
- Shallotte Inlet
- Offshore Ocean Isle, Holden Beach, & Oak Island.

The GRR identified Frying Pan Shoals as the most suitable borrow source for the 50-year project life. The USACE identified Jay Bird Shoals as an alternate site but prioritized Frying Pan Shoals due to its relative size, dynamic nature, and recharge capabilities (USACE, 2012). The USACE excluded some of the smaller sites such as Lockwoods Folly Inlet due to the limited material availability compared with the total project needs.

The GRR also provides a preferred design template of a 14 ft dune and 75 ft berm referenced as the 14/75 plan (USACE, 2012). The proposed dune would extend approximately 25 ft wide at elevation +14 (NGVD). The berm would extend 75 ft from the seaward toe of the dune at elevation +7 NGVD. The landward and seaward slope of the dune stands at a 5:1 and 10:1 ratio respectively. This template is shown below in Figure 2-1 referenced to North American Vertical Datum of 1988 (NAVD88).

At this time, it appears that the overall Brunswick County Beaches CSDR project has been stopped completely due to lack of funding and likely a low benefit/cost ratio. Individual towns have been applying for separate USACE CSRM (Coastal Storm Risk Management) projects as of late including the Town of Oak Island. To date, a USACE CSRM project for the Town of Oak Island has not been approved for study, but the Town continues to apply and has recently heard that it may be approved for study.

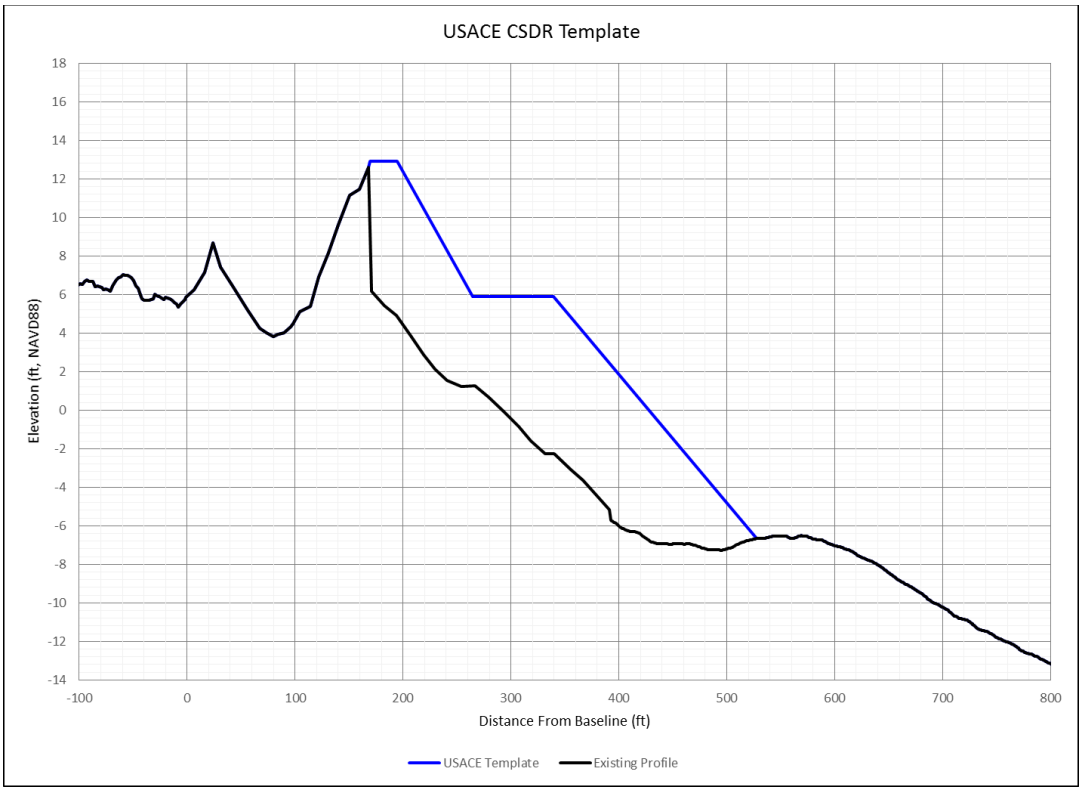

Figure 2-1: USACE CSDR Beach Nourishment Template

2.2 Wilmington Harbor Sand Management Plan

The sand management plan for Wilmington Harbor references the deepening project administered by the USACE in addition to periodic maintenance of the harbor entrance. The project allows placement of beneficial use material along the shorefront of Oak Island, Caswell Beach, and Bald Head Island. The USACE deepened Wilmington Harbor in 2001 and placed approximately 1.8 Mcy along the Oak Island shoreline. The USACE placed the material along the eastern and western portion of Oak Island. The 2001 Sea Turtle Habitat Restoration placed 2.65 Mcy of material along the central portion of Oak Island(see Section 2.3).

The Town of Oak Island receives sediment on the eastern quarter of their beaches from the maintenance dredging events of Wilmington Harbor Ocean Bar Channel at the mouth of the Cape Fear River. USACE maintains the authorized channel depths through maintenance dredging events typically every 3 years. The Sand Management Plan dictates that Bald Head Island receives the material for two (2) consecutive maintenance events then Caswell Beach/Oak Island will receive material from the third maintenance event, then the process repeats. This correlates to one (1) maintenance event placed on Caswell Beach/Oak Island every 9 years. The most recent maintenance event with placement on Caswell Beach/Oak Island occurred in 2018 and placed approximately 640,300 cy. The previous maintenance event which placed material on Caswell Beach/Oak Island occurred in 2009 and placed approximately 336,000 cy. Prior to the 2018 maintenance dredging event, the Town of Oak Island developed a Memorandum of Agreement (MOA) with the USACE which provides funding to place additional material further into Town limits. Figure 2-2 shows the approximate placement limits and quantities for the Wilmington Harbor initial deepening and maintenance events.

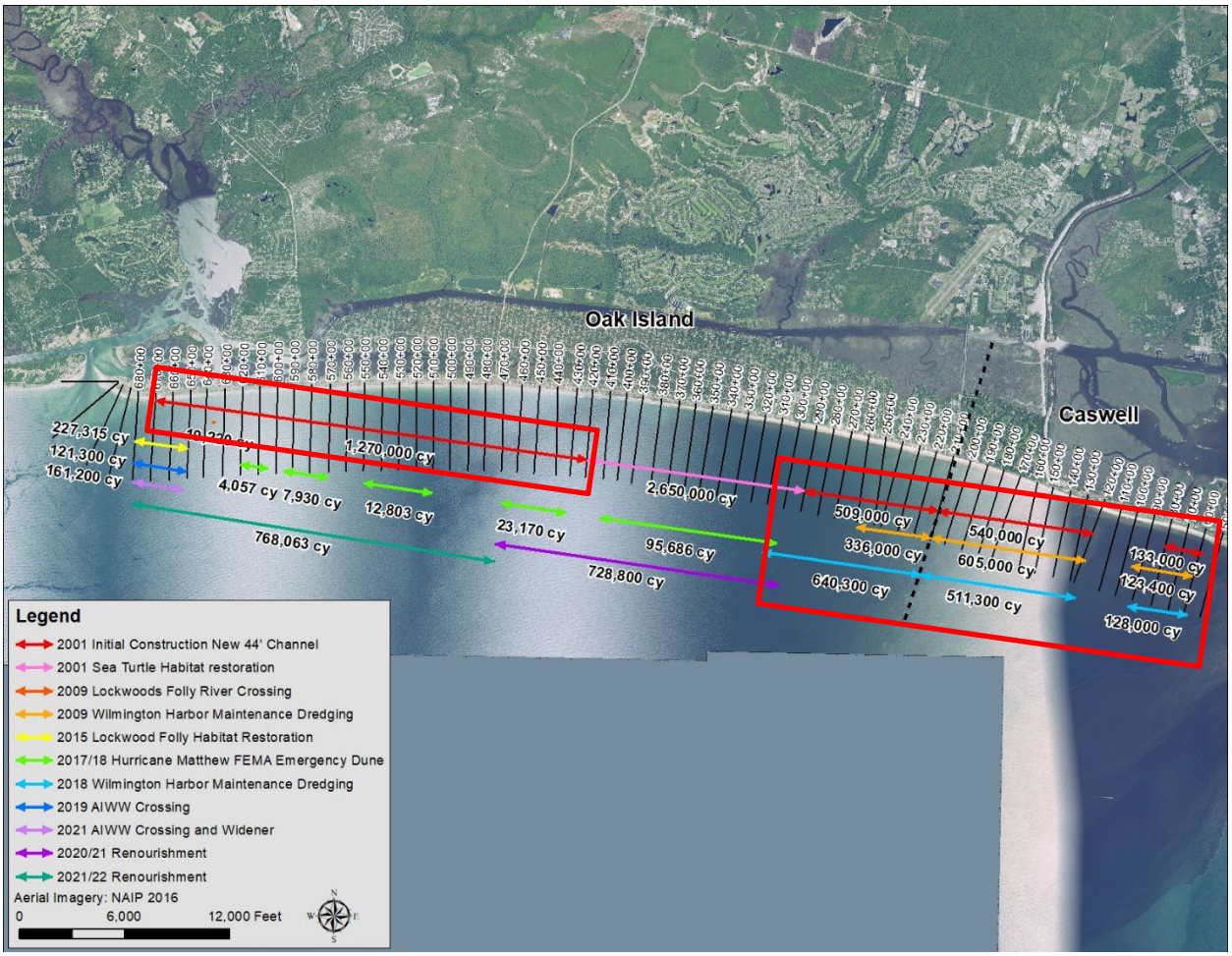

Figure 2-2: USACE Material Placement Quantities for Oak Island (2001 – 2018)

Although the east end of Oak Island benefits from the periodic Wilmington Harbor material placement, the project does not provide a design template to maximize the benefits. The USACE places the material along the shoreline close to the MHW contour (USACE, 2000). This typically entails the least cost method for sediment placement and only meets general design standards.

2.3 2001 Sea Turtle Habitat Restoration

The USACE also conducted a restoration project in 2001 along the central portion of Oak Island. The project placed approximately 2.65 Mcy from the Yellow Banks dredged material disposal site along the Oak Island shoreline (Offshore and Coastal Technologies, 2008). The Yellow Banks disposal site is located along the northern bank of the AIWW at approximately mid-island. The project addressed erosion impacts between East 26th Place to East 58th Street that were limiting suitable sea turtle habitat (USACE, 1999). The design template for the habitat restoration commenced with a 20 ft wide dune and then a berm extending approximately 70 ft at elevation +8 NGVD (+7 NAVD88), additional material was placed during the project as advanced fill. The dune crested at elevation +11 and maintained seaward and landward slopes of 1:5. Figure 2-3 shows the project limits of the habitat restoration project.

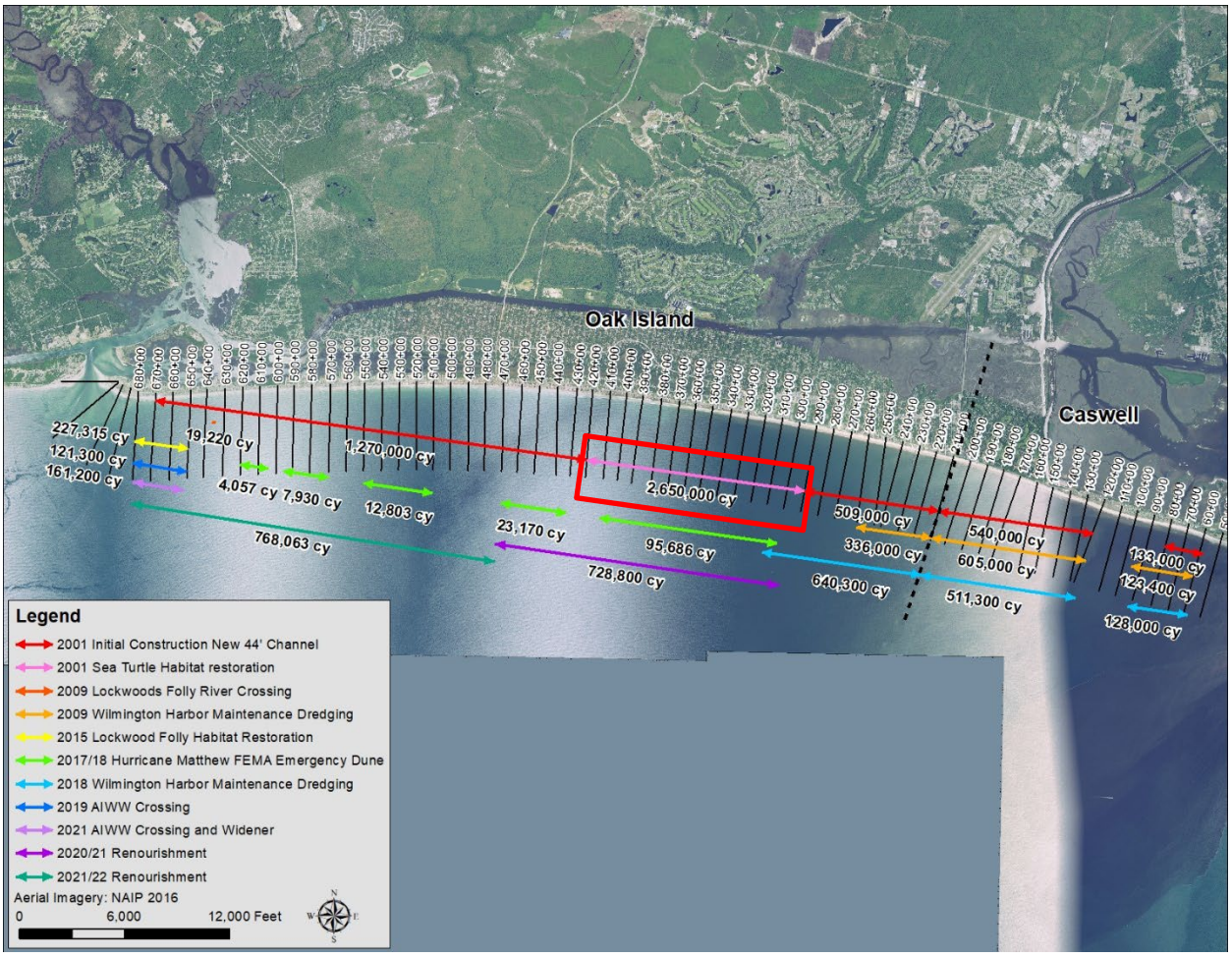

Figure 2-3: 2001 Sea Turtle Habitat Placement Extent

2.4 Lockwoods Folly Inlet, the AIWW crossing and Eastern Channel Navigation Initiatives

The USACE maintains the navigation channel within Lockwoods Folly Inlet and the AIWW through periodic dredging events. Maintenance of Lockwoods Folly Inlet typically consists of the outer bar or the interior channels and AIWW crossing. Beneficial use material placement generally occurs with the interior channel and AIWW maintenance while common practices for maintaining the outer bar include sidecast dredging or hopper dredging. The hopper dredging events may place excavated material within the nearshore region along the shoreline while sidescast events leave the material adjacent to the navigation channel. Maintenance of the interior channel and AIWW crossing occurs on an approximate 2-year schedule while maintenance of the outer bar may occur four times per year .

The USACE also carried out the Lockwoods Folly Inlet AIWW crossing project in the spring of 2019 (March). During the project approximately 121,300 cy of dredged shoal material from the AIWW inlet crossing was placed at the Oak Island – West End reach (Sta 650+00 – 680+00) with an average fill density of 40 cy/ft. The nourishment template consisted of a 75 feet berm with an elevation of +6.0 ft NAVD88. The most recent Lockwoods Folly Inlet AIWW crossing project was carried out in the spring of 2021 (March). During the project approximately 161,200 cy of

dredged shoal material from the AIWW inlet crossing was placed at the Oak Island – West End reach over 2,800 ft between Sta 652+00 – 680+00 with an average fill density of 57.5 cy/ft. The nourishment design template consisted of a 75 feet berm with an elevation of +6.0 ft NAVD88. The limits of both Projects are shown in Figure 2-4. Another project was just recently completed.

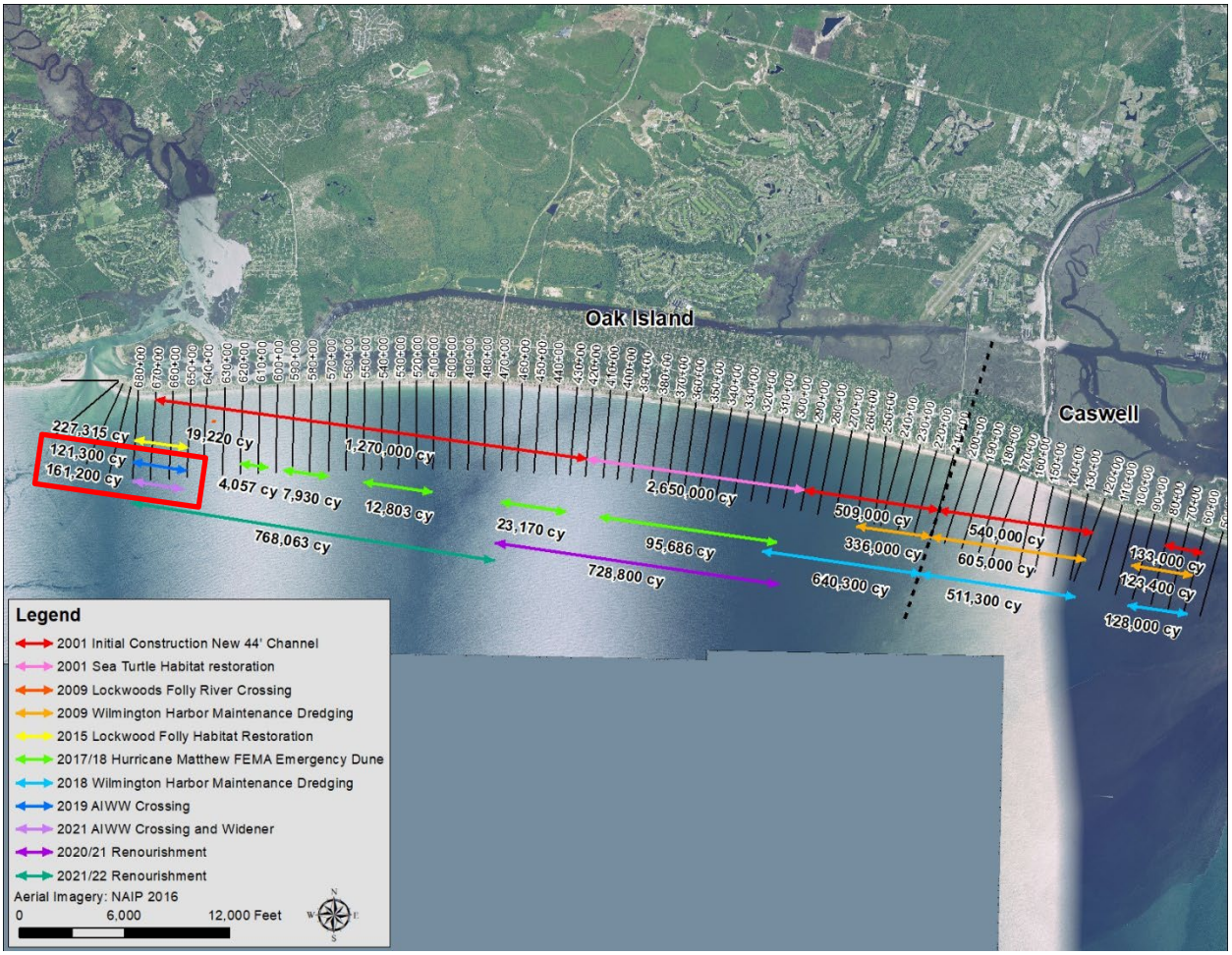

Figure 2-4: Lockwoods Folly Inlet AIWW Crossing and Bend Widener Projects

Along the west end of Oak Island, the Town has experienced an expanded need for shoreline stabilization and this tendency will increase if the current erosion patterns continue. The Town conducted the Lockwoods Folly Habitat Restoration Project which consisted of dredging Eastern Channel in spring 2015 to restore navigation depths. Non-compatible material was placed on a USACE disposal island (Horse Island). The project also placed approximately 227,315 cy of beach compatible material on the western end of Oak Island with an average fill density of approximately 85 cy/ft as shown in Figure 2-5: Lockwoods Folly Habitat Restoration Project. The beach placement provided a beneficial use of suitable material removed from Eastern Channel to help mitigate shoreline recession and erosion caused by recent storm events.

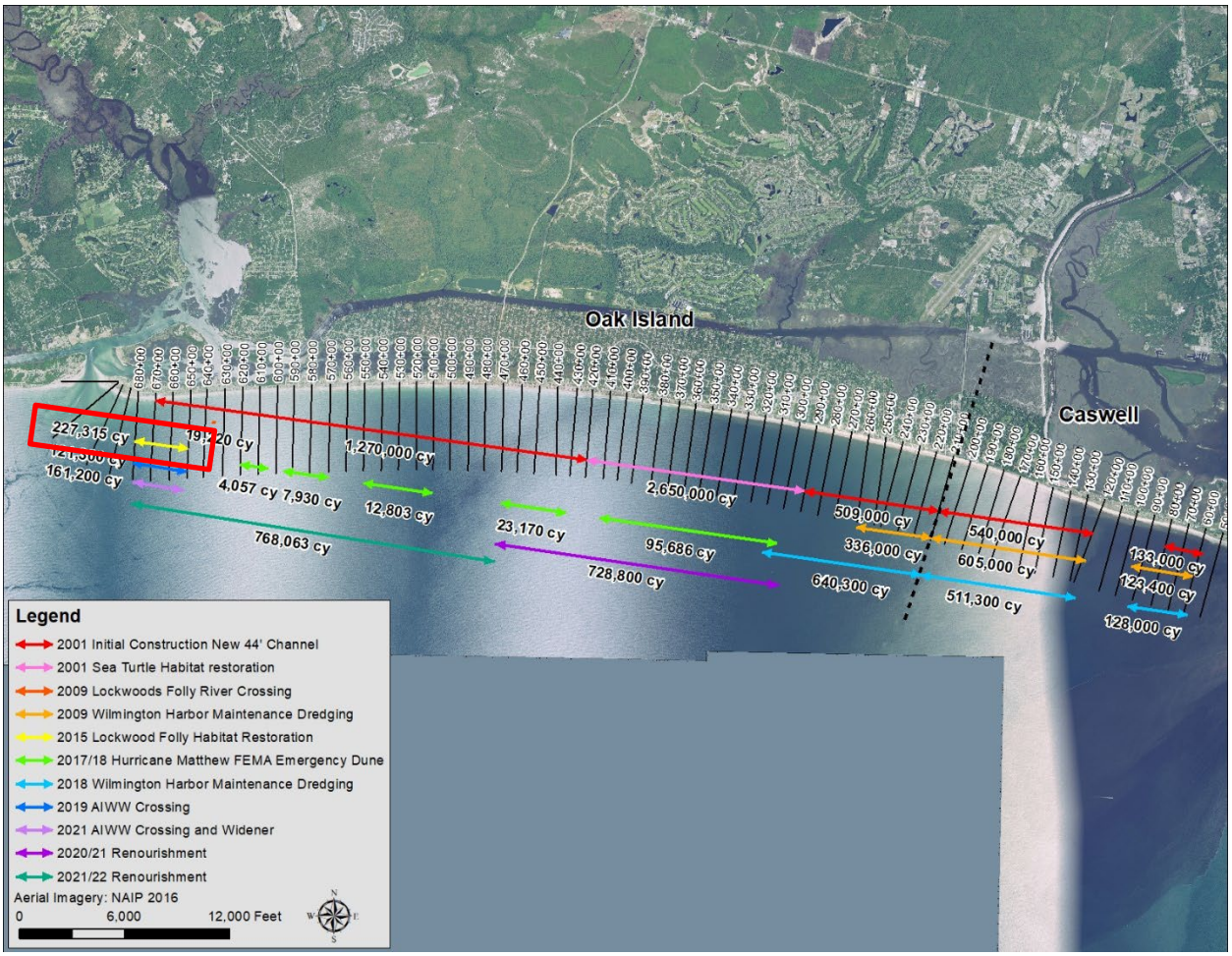

Figure 2-5: Lockwoods Folly Habitat Restoration Project

2.5 FEMA Hurricane Matthew Emergency Dune Project

In 2016, Hurricane Matthew impacted Oak Island causing significant dune loss across the oceanfront. Through the Robert T. Stafford Relief and Emergency Assistance Act, the Federal Emergency Management Agency (FEMA) approved reimbursement of up to 6 cy/ft above the 5-year flood elevation of +4.5 ft NAVD88. The dune restoration project placed approximately 143,646 cy (taken from an upland source) along 4.4 miles of shoreline. The dune template consisted of a 6-ft wide dune crest with 4H:1V slopes. The dune crest elevation varied between +8 and +11 ft NAVD88. Construction for the dune restoration initiated in spring 2017 with the placement of approximately 37,228 CY along 7,350 ft of the project's eastern limits. At the end of the April the construction was stopped due to the environmental moratorium window. When the construction reconvened in November 2017, the material placed during the spring 2017 required replacement due to erosion experienced between the spring and fall. The project was completed on March 5, 2018. Final placement extents and volumes are shown in Figure 2-6.

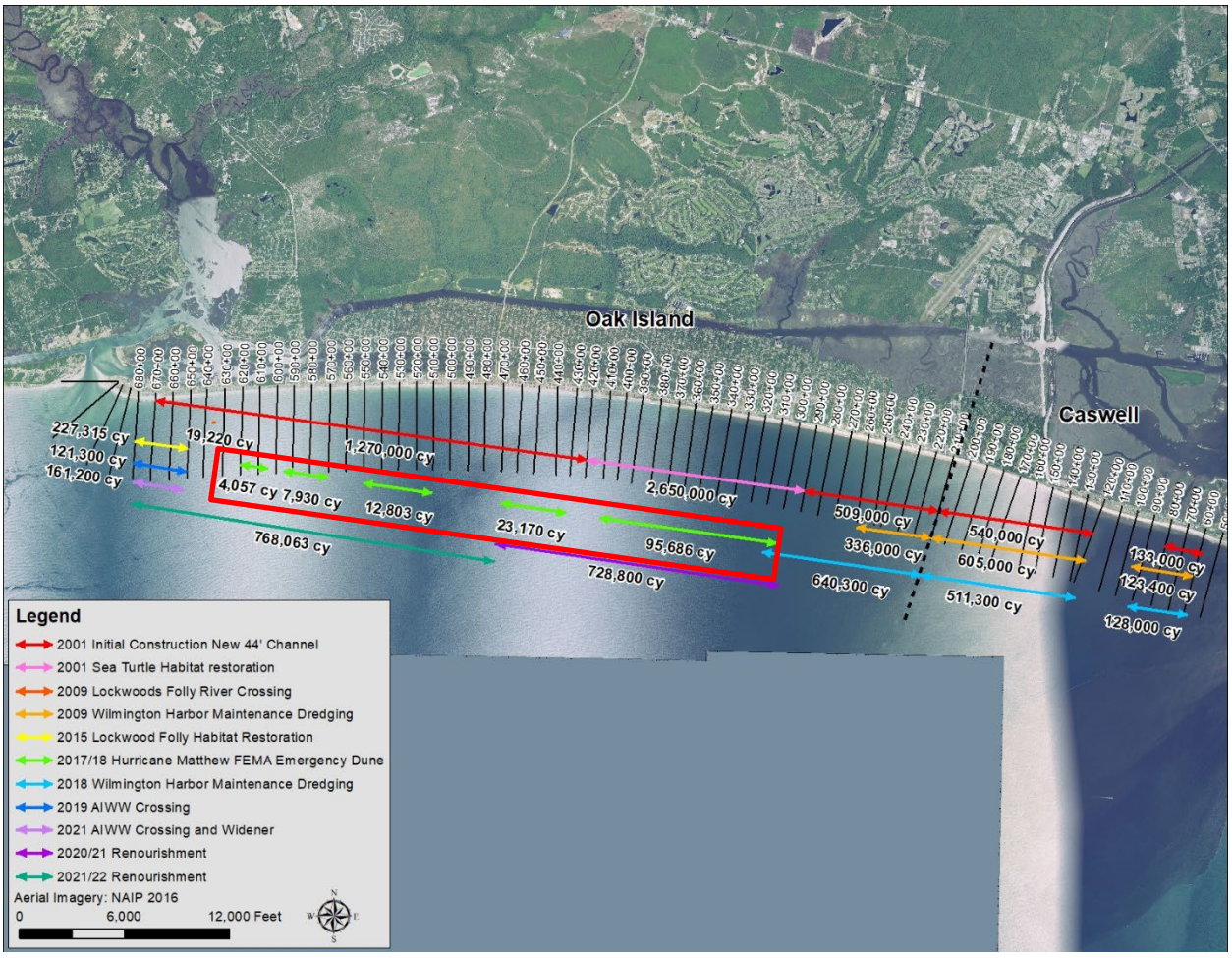

Figure 2-6: FEMA Hurricane Matthew Dune Placement Extent

2.6 2020/2021 Oak Island Renourishment Project

The Notice of Award for this project was issued on July 6, 2020. Project construction began on April 8, 2021 and was completed on May 22, 2021 (44 days). Jay Bird Shoals was the offshore borrow area utilized as shown in Figure 2-7. The project placed a total of approximately 729,000 cubic yards (cy) along 17,000 feet (ft) (approximately 3.2 miles) from SE 63rd Street to 3rd Place East. Figure 2-8 shows the beach fill extent for the project and Appendix A contains the construction plans and pre/post project surveys (see example in Figure 2-9).

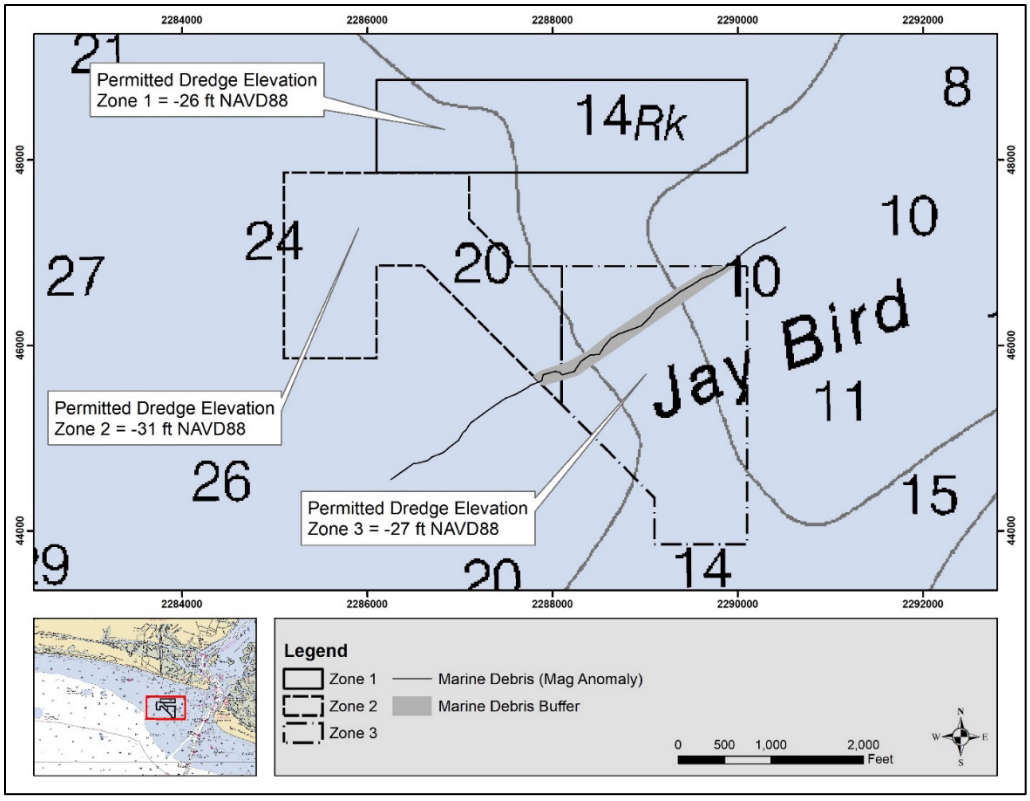

Figure 2-7: Jay Bird Shoals Borrow Area

Figure 2-8: 2020/2021 Oak Island Renourishment Project Beach Fill Extent (Construction from 4/8/21 to 5/22/21 from Sta. 300+00 to 470+00)

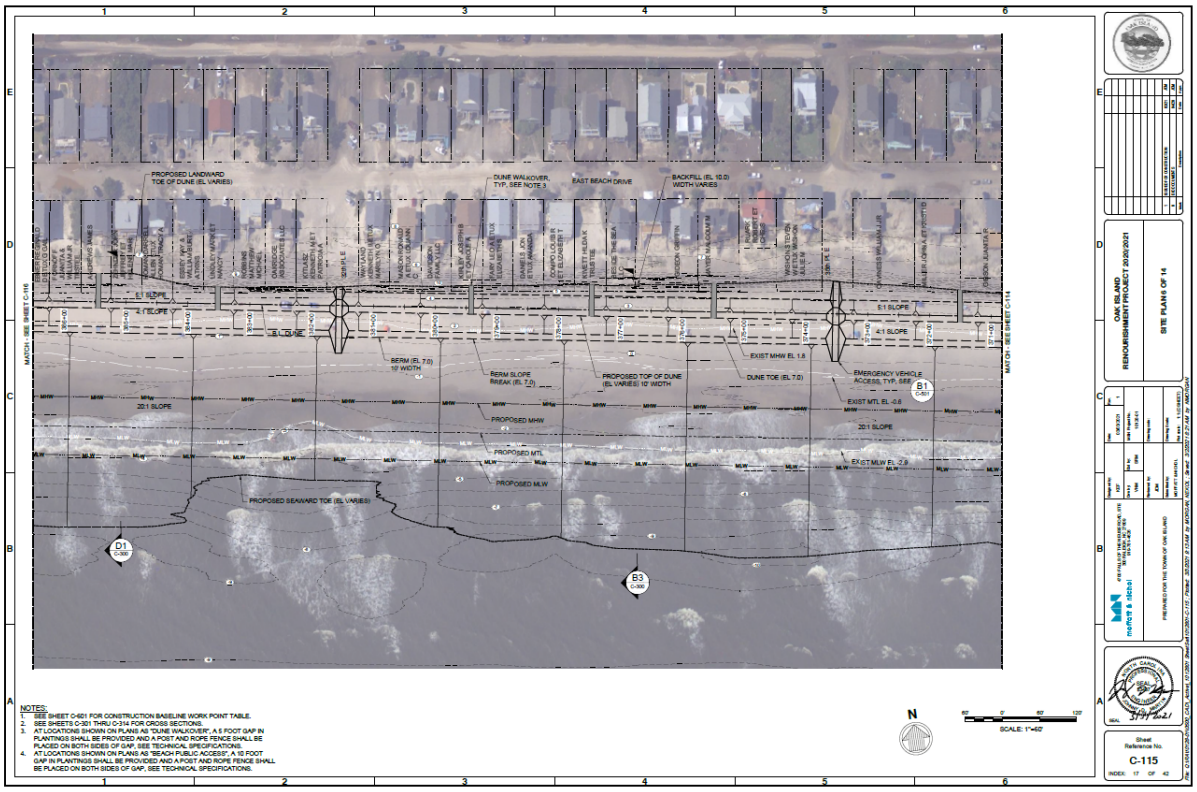

Figure 2-9: Example Plan View – 2020/2021 Oak Island Renourishment Project

The design template consisted of a dune designed to withstand a 25-year return period storm. The dune elevation ranged from 13.5 to 14.5 ft NAVD88 with a crest width of 10 ft. The front slope of the dune was 4 Horizontal:1 Vertical (H:V) and the back slope of the dune was 5H:1V. The front dune slope broke at elevation 7.0 ft NAVD88 and continued out on a 20H:1V slope until tie-in with existing grade. From Station 351+00 to Station 388+00 a 10 ft wide berm at elevation 7.0 ft NAVD88 was also included in the design to offset accretion experienced in other areas between project award (June 2020) and construction (April 2021) to ensure the contract quantity would still be placed. The typical section depicting the design without the berm is shown in Figure 2-10 and with the berm in Figure 2-11. Figure 2-12 and Figure 2-13 presents the before and after project conditions of Station 409+00 with no berm and Station 364+00 including a berm respectively.

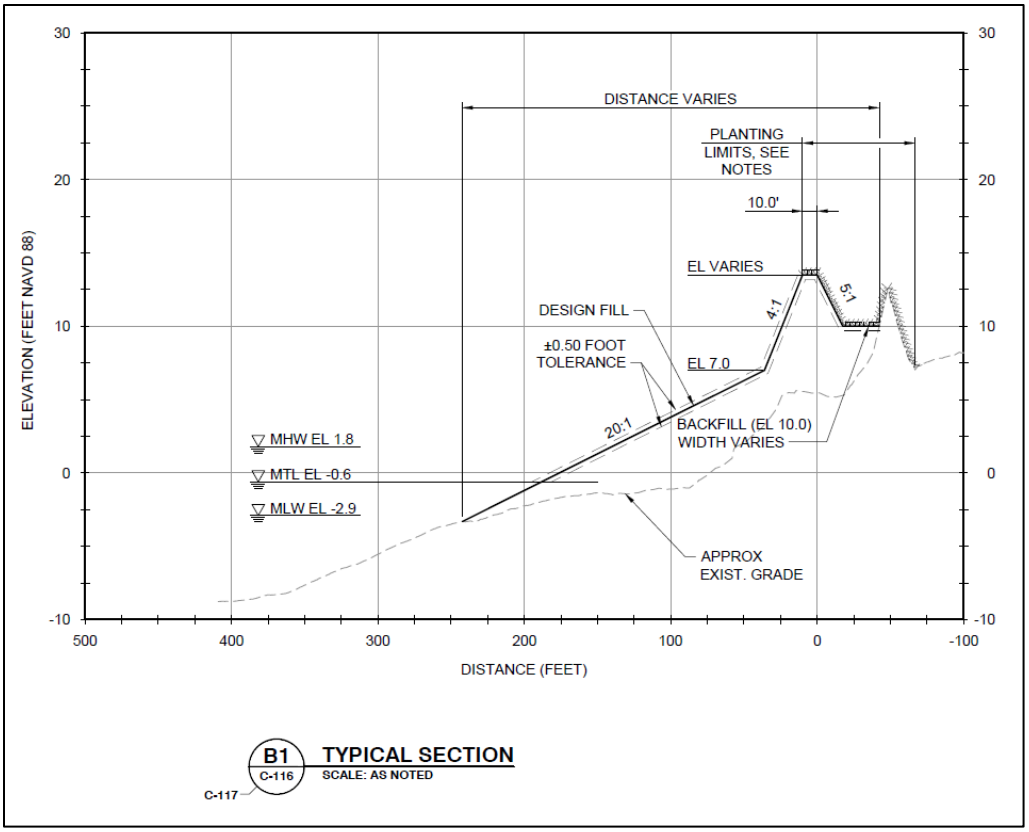

Figure 2-10: Beach Fill Typical Cross Section – No Berm

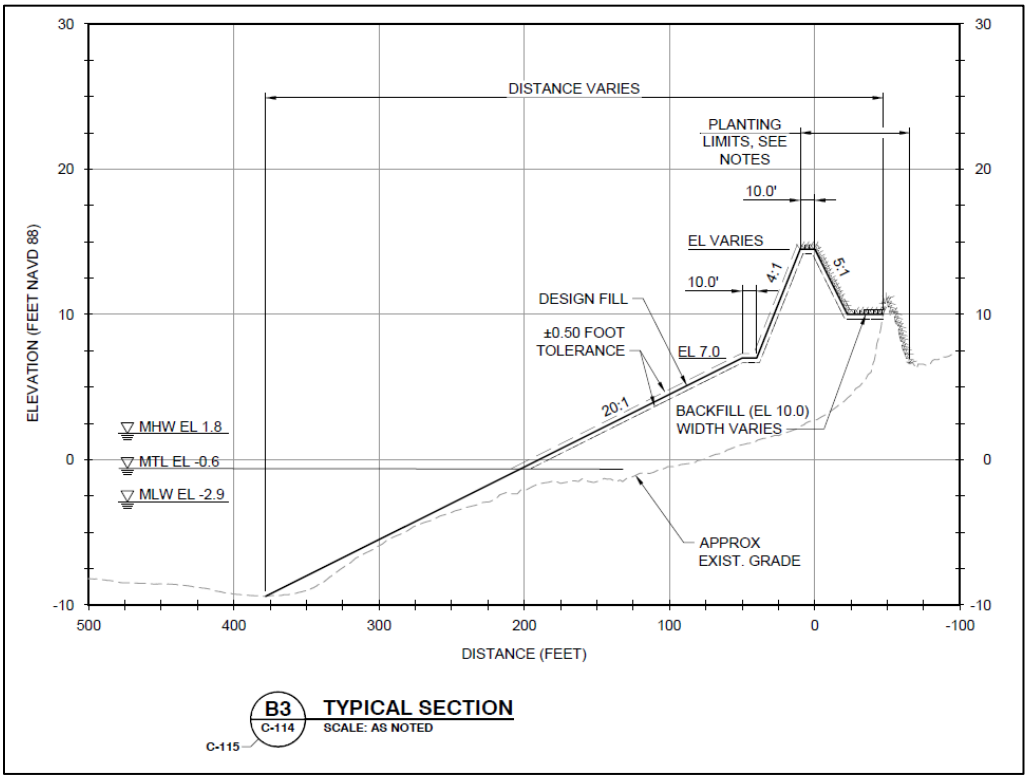

Figure 2-11: Beach Fill Typical Cross Section – With Berm

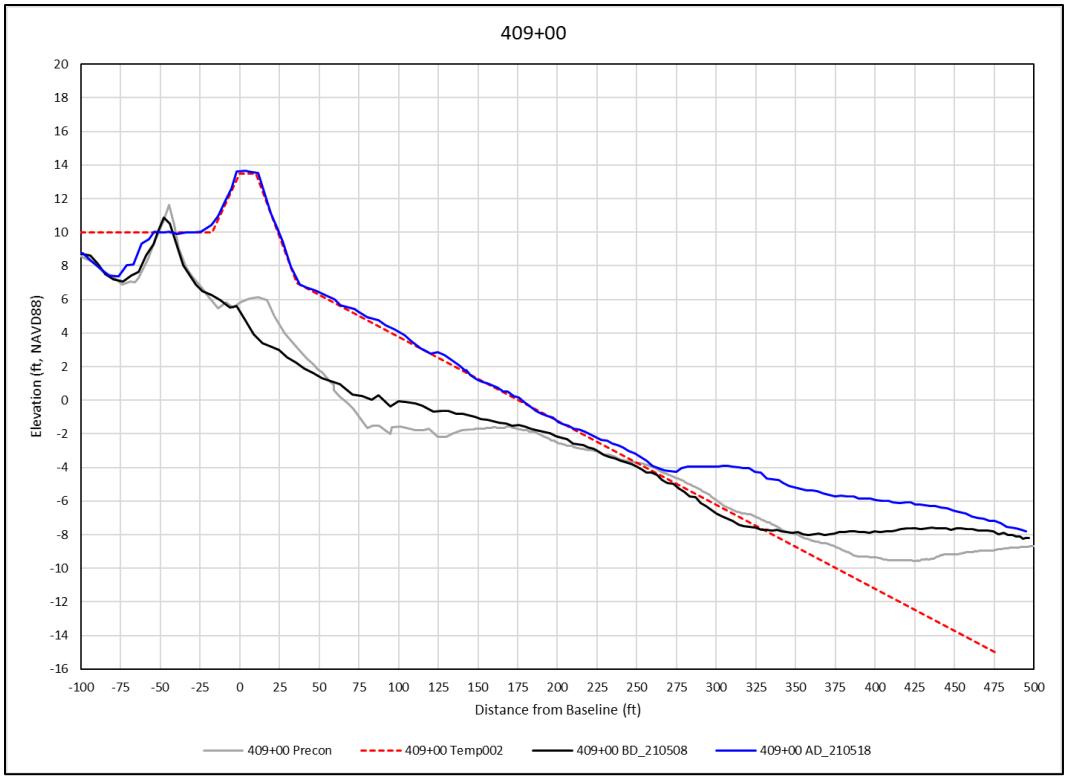

Figure 2-12: Profile Station 409+00 No Berm Pre- and Post-Nourishment Example

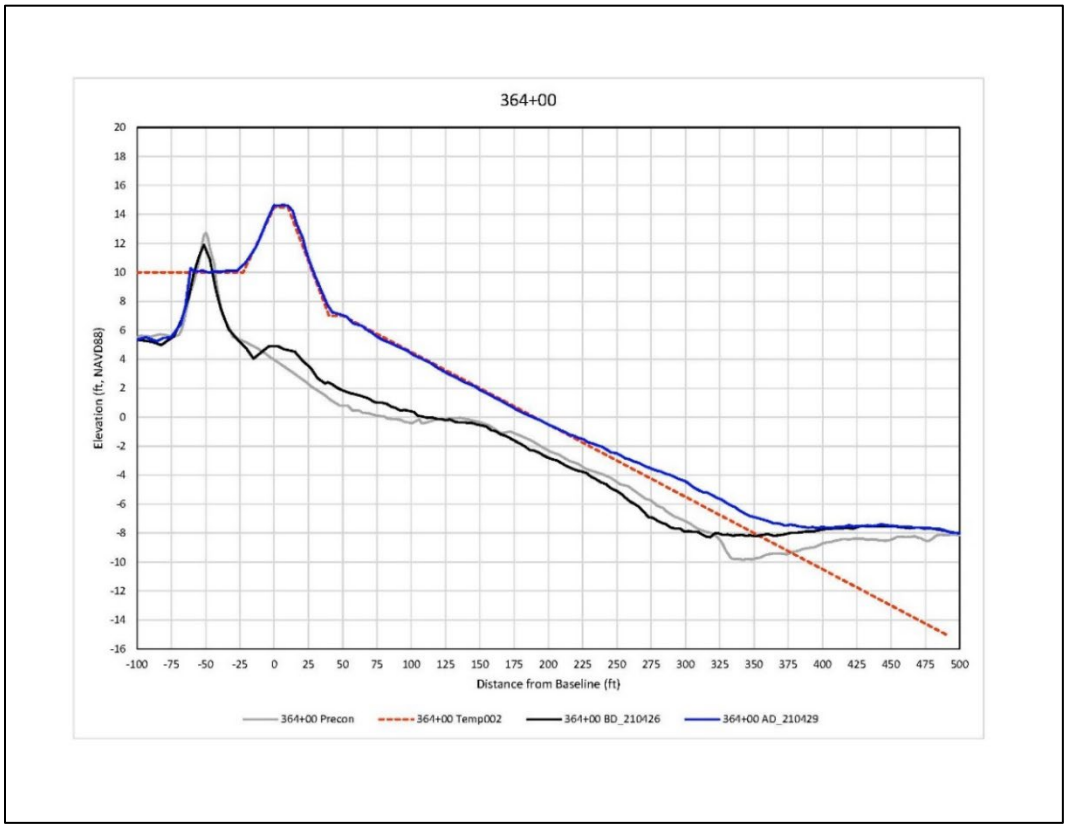

Figure 2-13: Profile Station 364+00 With Berm Pre- and Post-Nourishment Example

Dune Planting

Originally the project was awarded to include 66,200 square yards of dune grass planting however an additional 51,000 square yards was added for a total of 117,200 square yards. Planting began on June 9, 2021 and was completed on June 24, 2021. Planting occurred on the crest of dune and down the backslope of the constructed dune and emergency dune as seen in Figure 2-14. The distribution of plants throughout the project was 75% Sea Oats (*Uniola paniculata*) and 20-25% Bitter Panicum (*Panicum amarum*) with 5% Seashore Elder (*Iva imbricata*).

Figure 2-14: Recently planted section of dune (M&N photo 6/15/21)

A final walkthrough was conducted on June 29, 2021 to observe the project for escarpments and the completion of planting. No escarpments were noted, and the success of planting (80% surviving) was evaluated 90 days after planting.

Continued monitoring of the planted vegetation will be performed by the Town for establishment and potential need to supplement additional vegetation for the propagation of the vegetation seaward in an effort to establish a new vegetation line that will be considered stable and natural.

Project Cost and Funding

The final construction cost of the project, excluding engineering, was $14,777,946.15. The project was funded partly by the Federal Emergency Management Agency (FEMA) Hurricane Matthew claim of approximately $8M. Additional grant money to extend the scope of the project was received from the Hurricane Florence Disaster Recovery Fund Coastal Storm Damage Mitigation of approximately $3.2M. The Town paid for the remaining portion of the project ($3.6M).

2.7 2021/2022 Oak Island Renourishment Project

The Notice of Award for this project was issued on October 4, 2021. Project construction began on February 20, 2022 and was completed on April 20, 2022 (59 days) b. The project design consisted of approximately 765,000 cubic yards (cy) to be placed along 21,500 feet (ft) of shoreline (approximately 4.1 miles) from 3rd Place East to the west end parking lot as shown in Figure 2-15. The construction plans detailing the placement extents, cross-sections, and borrow areas are shown in Appendix B with an example shown in Figure 2-16.

Figure 2-15: 2021/2022 Oak Island Renourishment Project Beach Fill Extent (Sta 465+00 to Sta 680+00)

Figure 2-16: Example Plan View – 2021/2022 Oak Island Renourishment Project

Jay Bird Shoals and Central Reach, shown in Figure 2-17, were the authorized offshore borrow areas. However, all but a few loads were dredged from Jay Bird Shoals due to sediment compatibility concerns in Central Reach.

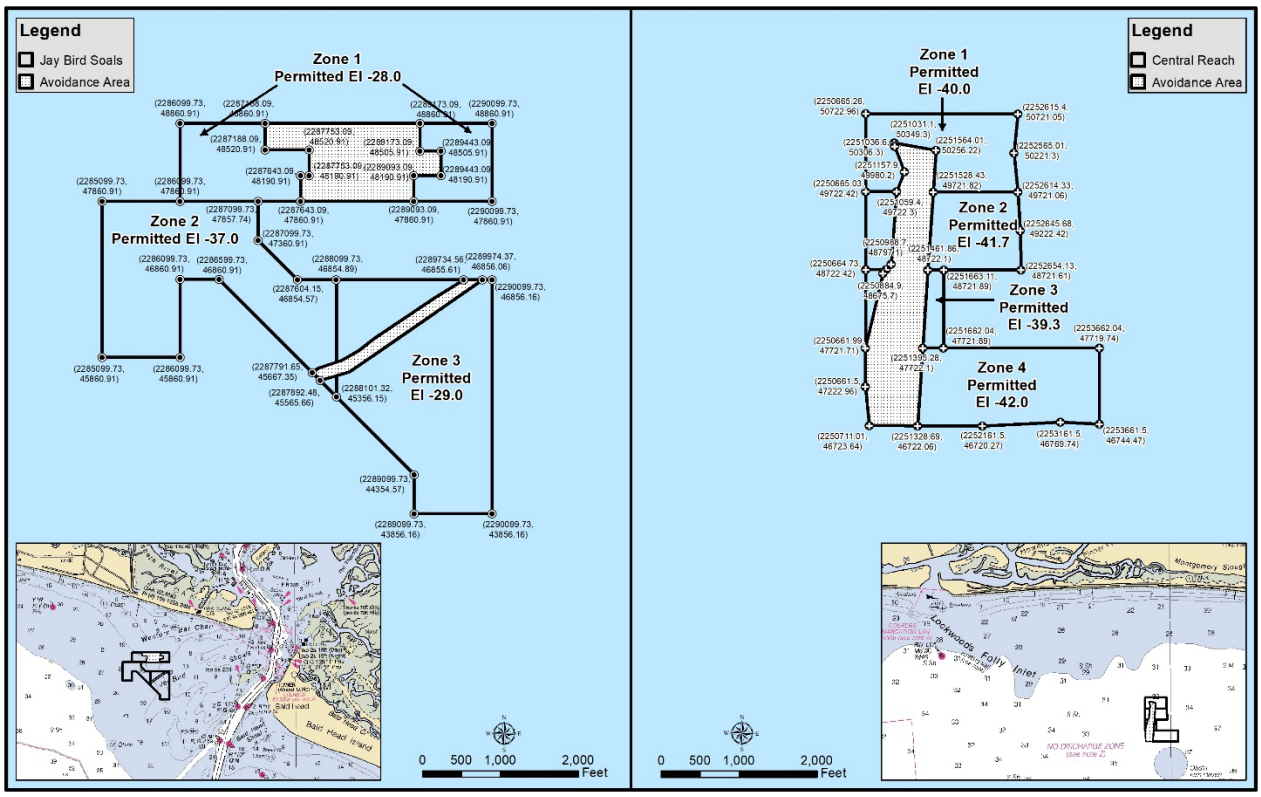

Figure 2-17: Jay Bird Shoals and Central Reach Borrow Areas

The design template consisted of four typical cross-sections which varied based on two dune tie-in configurations and the presence or absence of a berm. Figure 2-18 shows the two typical dune tie-in configurations without a berm and Figure 2-19 shows the two typical dune tie-in configurations with a berm. The design template consisted of a dune designed to withstand a 25-year return period storm. The dune elevation ranged from 13.0 to 15.5 ft NAVD88 with a crest width of 10 ft in most locations. However, due to existing grade some locations featured a direct horizontal tie-in to existing ground with varying dune crest width. The front slope of the dune was 4 Horizontal:1 Vertical (H:V) and the back slope of the dune, where applicable, was 5H:1V. The front dune slope broke at elevation 7.0 ft NAVD88 and continued out on a 20H:1V slope until tie in with existing grade from approximately Sta 465+00 to Sta 620+00. From Station 621+00 to Station 677+00 a variable width berm ranging from 60 ft to 65 ft at elevation 7.0 ft NAVD88 was also included in the design to account for accelerated erosion historically experienced on the west end of Oak Island. Figure 2-20 and Figure 2-21 presents the before and after project conditions of Station 620+00 with no berm and Station 650+00 including a berm respectively.

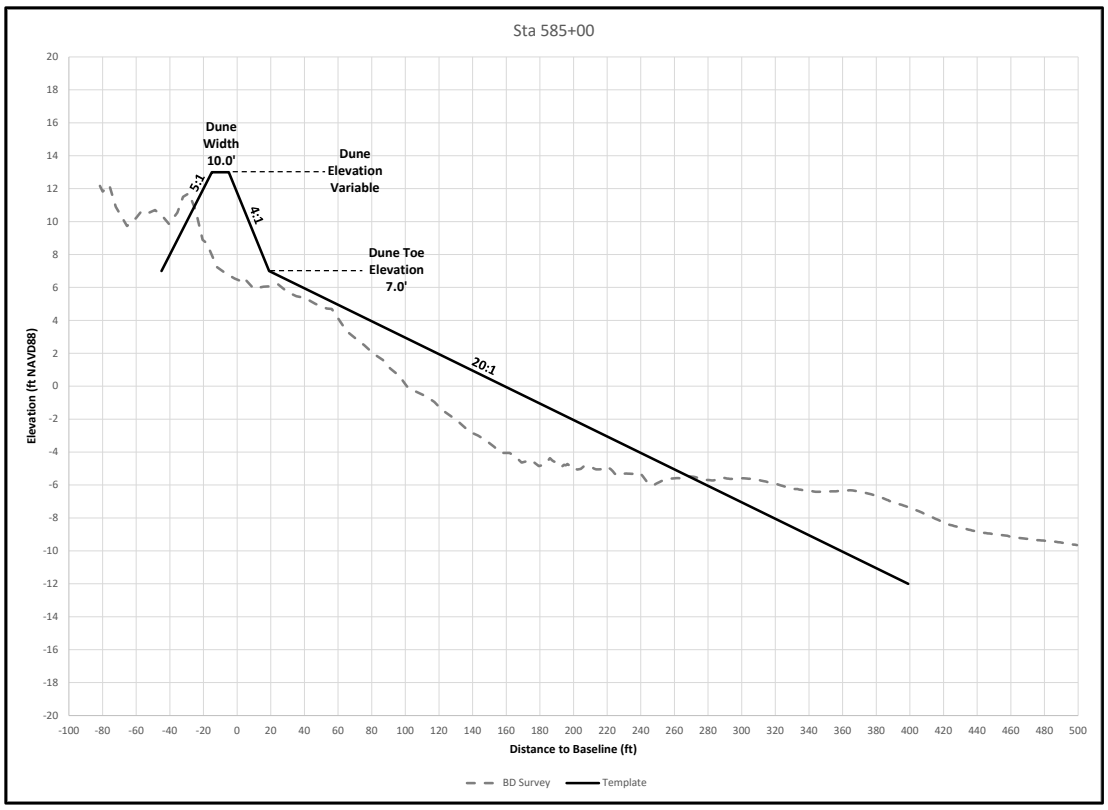

Figure 2-18: Beach Fill Typical Cross Section – No Berm

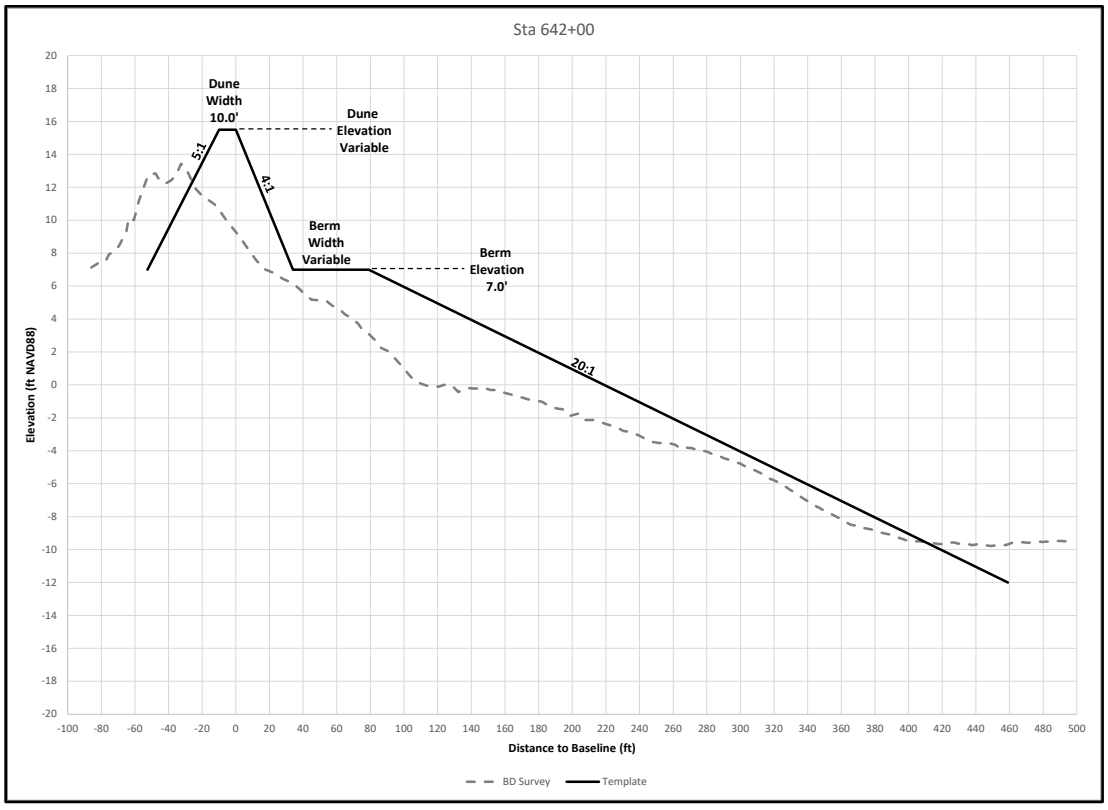

Figure 2-19: Beach Fill Typical Cross Section – With Berm

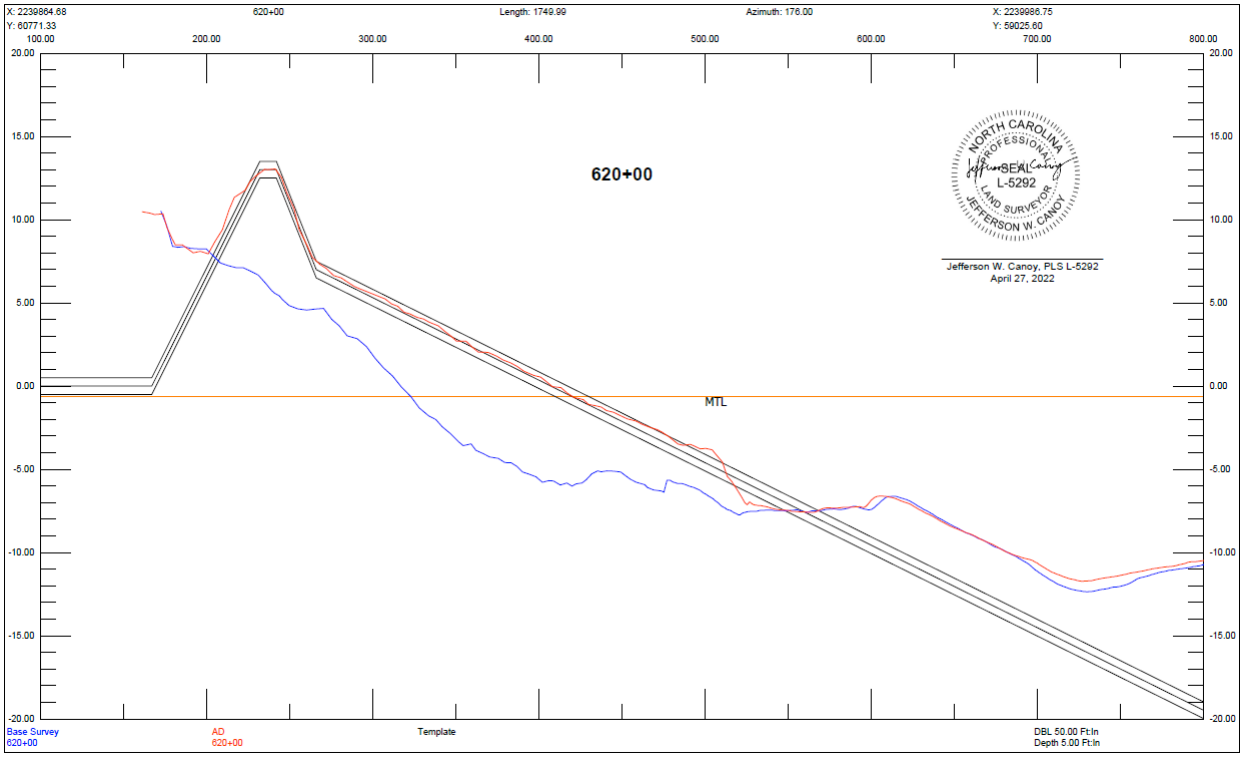

Figure 2-20: Profile Station 620+00 No Berm Pre- and Post-Nourishment Example

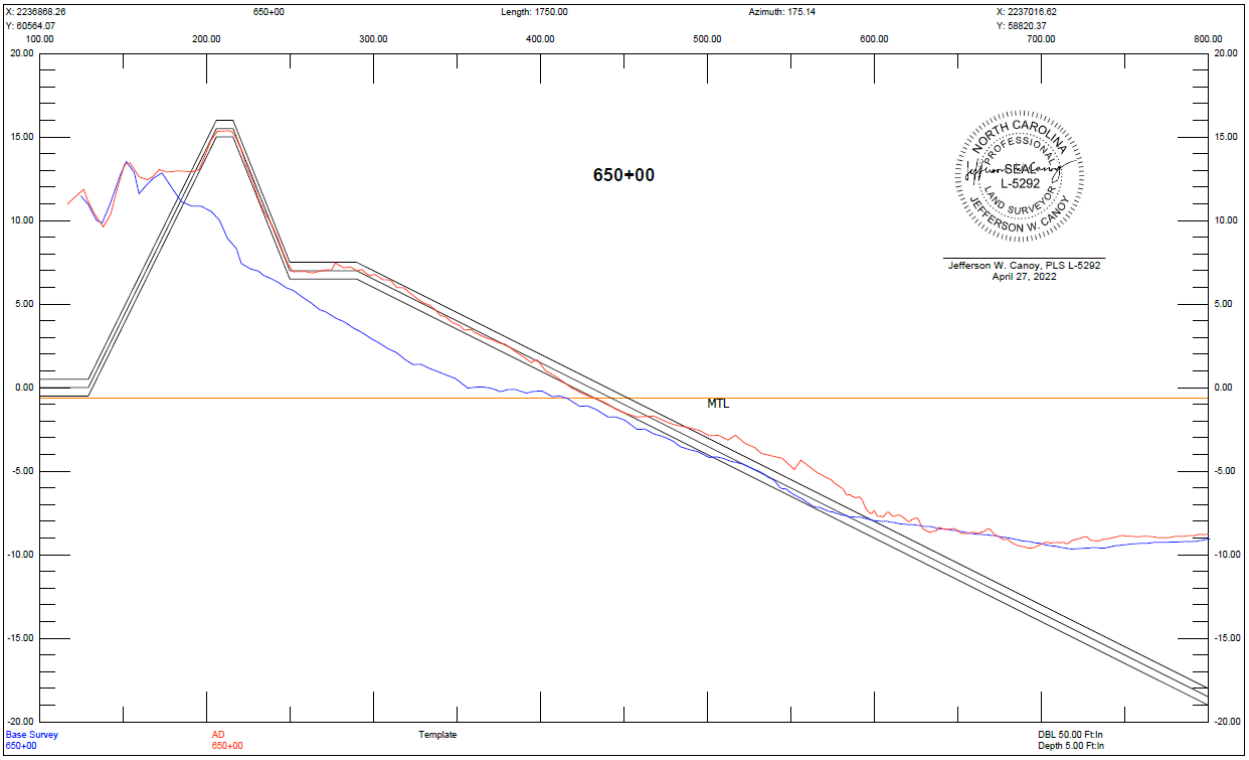

Figure 2-21: Profile Station 650+00 With Berm Pre- and Post-Nourishment Example

Dune Planting

The Town separately contracted a contractor to grow and plant 275,000 plants along the crest and landward slope of the dune as shown in Figure 2-22. Dune planting began on May 23, 2022 and was completed on July 25, 2022. All plants grown and installed were Sea Oats and were installed with 24 inch spacing. The contractor completed initial planting in the project area on June 29, 2022. Due to dry weather, the contractor immediately returned to replant several areas that did not survive the initial planting effort, finishing on July 25, 2022. Upon project completion, approximately 245,200 plants were installed, 44,400 of which were replacement plants for those that did not survive the dry weather during initial planting. The contractor utilized UTV's and small trailers to haul equipment (plants, hoses, tools, coolers, markers) with blue lay flat hose for water. Guidance by the permitting agencies concerning equipment restrictions and coordination regarding turtle monitoring were followed. An 80% plant survival rate after 90 days will be established, and the contractor will re-plant any areas that do not meet this criteria. Figure 2-23 presents an example of the dune planting.

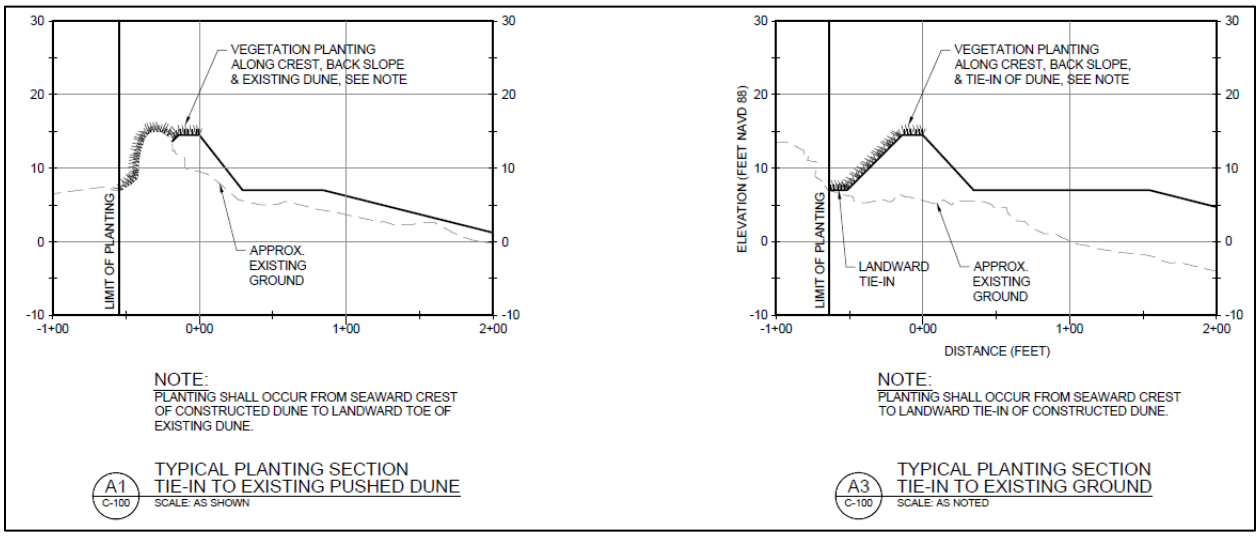

Figure 2-22: Dune Planting Typical Section

Figure 2-23: Recently planted section of dune (M&N photo 7/25/22)

Continued monitoring of the planted vegetation will be performed by the Town for establishment and potential need to supplement additional vegetation for the propagation of the vegetation seaward in an effort to establish a new vegetation line that will be considered stable and natural.

Project Cost and Funding

The final construction cost of the project, excluding engineering, was $17,648,935.15. The project was funded partly by the Federal Emergency Management Agency (FEMA) Hurricane Matthew claim of approximately $7.6M. Additional grant money to extend the scope of the project was received from the Hurricane Florence Disaster Recovery Fund Coastal Storm Damage Mitigation of approximately $1.3M. The Town paid for the remaining portion of the project ($8.7M).

3.0 OAK ISLAND SHORELINE MAPPING (MONITORING) PROGRAM

The Oak Island Shoreline Mapping Program (OISMP) was initiated in 2015 to assess current and historical beach conditions and to assist in the formulation of beach management strategies in the OIBIMP. In addition, surveying is to be performed after large storm events to assess storm induced shoreline and volume change. This monitoring plan will remain in place throughout the life of this Beach Management Plan. Historical surveys collected since 2015 occurred on a yearly basis with some samples taken post-hurricane events to monitor beach profile. Table 3-1 provides such historical data including date obtained and purpose for survey.

Table 3-1: Oak Island historical survey data collection time frame and type of survey completed.

Location	Date	Survey Type
Oak Island	7/18/2014	Annual
Oak Island	10/16/2015	Annual
Oak Island	7/25/2016	Annual
Oak Island	10/20/2016	Post-Storm (Hurricane Matthew)
Oak Island	8/17/2017	Annual
Oak Island	9/6/2018	Annual
Oak Island	10/17/2018	Post-Storm (Hurricane Florence)
Oak Island	6/18/2019	Annual
Oak Island	9/11/2019	Post-Storm (Hurricane Dorian)
Oak Island	6/26/2020	Annual
Oak Island	8/12/2020	Post-Storm (Hurricane Isaias)
Oak Island	3/24/2021	Annual
Oak Island	10/8/2021	Post-Storm (Hurricane Ian)
Oak Island	5/26/2022	Annual

The existing transect lines and origins established by the USACE were used to collect elevation and positioning data. Additional inlet and quality control transects were developed and added in 2016 to better track sand movement and provide an approximate 1,000 ft spacing across Oak Island. In July 2016, the first survey was conducted to include both the additional transects and the previously established transect lines. In 2018 additional transects were added at 200 ft spacing from Station 650+00 through 680+00. This area is known locally as a 'hotspot' for erosion, and the additional transects were added to help track and understand this sand loss. Figure 3-1 shows the location of current survey lines and origins applied for surveying and the monitoring reach extents. Please note the western divide between Oak Island – East and Oak Island – Central Reaches will be moved west by one transect (between 420+00 and 430+00) for this Beach Management Plan and future monitoring efforts will reflect this update.

Figure 3-1: Oak Island Survey Line Locations and Reaches

The mapping program utilized survey data collected on a yearly basis to compute the shoreline location change at +1.8 ft NAVD88 which is designated as the Mean High Water (MHW) elevation. Volume changes are also calculated above +1.8 ft NAVD88 (MHW), -5 ft NAVD88 (wading depth), -12 ft NAVD88 (outer bar), -20 ft NAVD88, and -25 ft NAVD88. The last three elevations of -12 ft NAVD88, -20 ft NAVD88 and -25 ft NAVD88 were selected to bracket the expected depth of closure (DOC), the limiting elevation where significant changes in profile shape occur. Figure 3-2 presents a graphical display of the various elevations for which volume change calculations were made.

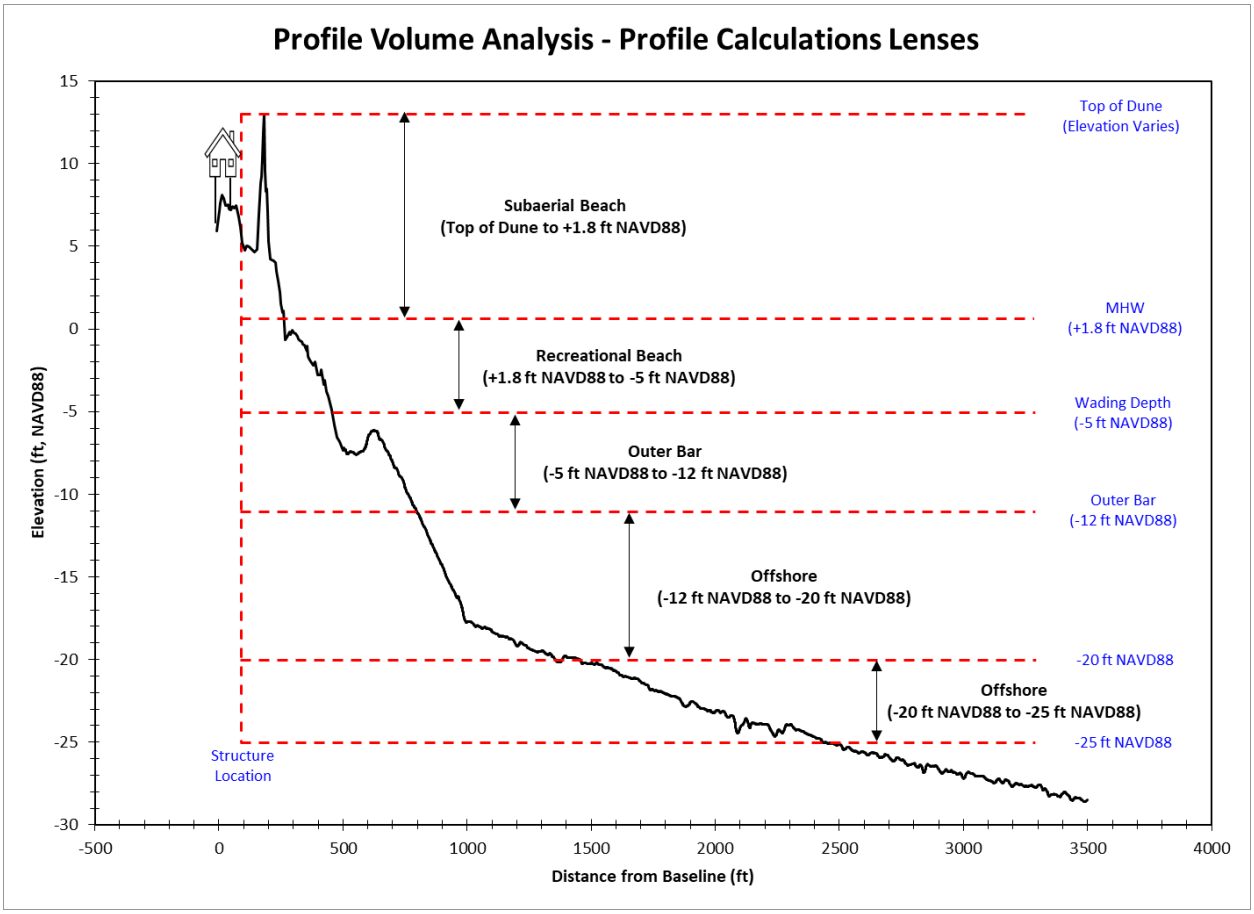

Figure 3-2: Profile Volume Calculation Lenses

4.0 OAK ISLAND BEACH AND INLET MANAGEMENT PLAN

4.1 Design

The OIBIMP intends to provide long-term shoreline stabilization and equivalent level of protection along the 9 mile oceanfront. A programmatic Environmental Impact Statement (EIS) is being prepared and will apply to nourishment operations throughout the next 30 years. As part of the EIS, an engineering report is being prepared to provide insight into the future sand needs and availability. The EIS will also require an alternatives analysis, in which a preferred alternative will be identified which is expected to be a combination of beach renourishment, dune planting and inlet management. A combination of analytical analysis, as well as cross-shore and longshore modeling was used to determine historical loss rates (both background erosion and storm erosion), volumetric requirements and triggers, and anticipated nourishment cycles necessary to provide equal protection to all portions of the Town's oceanfront.

Through the Storm Induced Beach Change (SBEACH) modeling, it was determined that a 10-year to 25-year return period storm level of protection (LoP) for the entire island was feasible given the current state of the beach after the recent projects, both from a construction/sand availability standpoint, as well as the Town's financial position. Therefore, the island was divided into various reaches based on similar profile characteristics. The SBEACH modeling was used to determine

the volume of material required to protect infrastructure in each reach from 10-year to 25-year storm events. This volume was calculated between the representative structure line the -12 ft NAVD88 contour and varied slightly across the oceanfront based on existing dune configurations. Table 4-1 shows the calculated 10- year and 25-year triggers for the LoP for the various monitoring reaches of Oak Island and Figure 4-1 shows the location of this trigger volume. This volume is what provides protection to Town infrastructure by being the portion of the beach that absorbs wave energy and minimizes wave and surge overtopping. The Town of Oak Island will initiate nourishment actions as these triggers are approached or reached. Based on discussions with the Town, this Beach Management Plan will maintain the 10-year LoP.

Table 4-1: Beach and Inlet Management Plan Nourishment Triggers

Reach	10-year Level of Protection Trigger Volume (cy/ft)	25-year Level of Protection Trigger Volume (cy/ft)
Oak Island-East End 210+–0 - 290+00 (Eastern Town Limits – SE 63rd St)	307	315
Oak Island-East 300+–0 - 420+00 (SE 63rd St – 16th Pl East)	257	283
Oak Island-Central 430+–0 - 500+00 (16th Pl East – 10th Pl West)	235	244
Oak Island-West 510+–0 - 590+00 (10th Pl West – 42nd Pl West)	231	242
Oak Island-West End 600+–0 - 680+00 (42nd Pl West – West End Parking Lot)	238	249

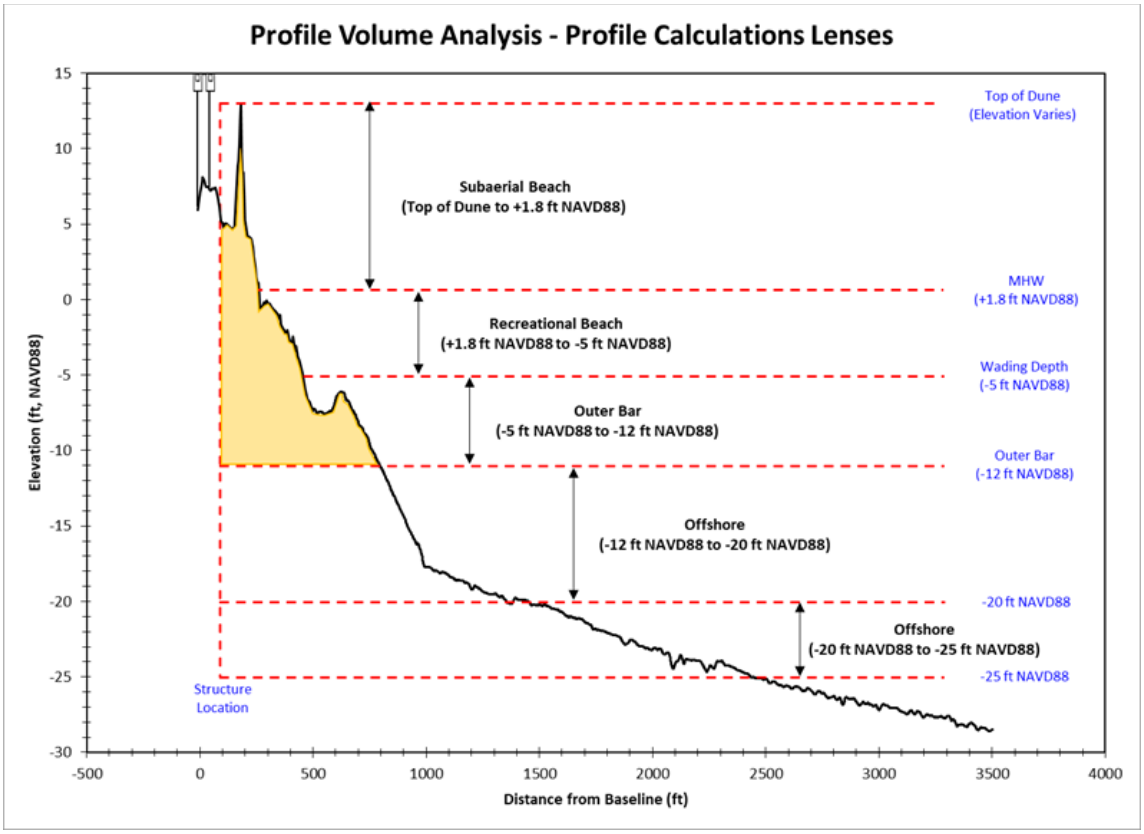

Figure 4-1: Trigger Volume Calculation

In order to develop a more accurate basis of volume loss and ultimately sediment needs over the next 30 years for continued maintenance, an analysis of historical volume losses since 2014 was performed to capture and statistically quantify the variability inherent within the existing data. After some investigation, it was determined that the Crystal Ball software (a Microsoft Excel Add-in program) would best meet this need.

Crystal Ball allows the user to specify a distribution (normal, Gumbel, Ln Pearson III, etc.) for each assumption (in our case – unit volume change for each transect). Any equation in Excel that references an assumption, then becomes a forecast (in our case – volume change per transect/per reach/subreach of beach – depending on the length studied). Through using a Monte Carlo simulation running for hundreds of thousands of trials, the distribution of the forecasts can then be modeled and determined. Therefore, the user can end up with results such as the 50% or 75% probability that the volume change for a given transect will not exceed say 2,000 cy/yr or 3,500 cy/yr respectively. These individual results can then be added over various reaches of beach to study localized erosion/deposition patterns as well as overall volume needs on an annual and longer-term basis. Utilizing this tool gives the user increased confidence in predictions and allows for more informed decision making.

Table 4-2 summarizes the Crystal Ball analyses for the management reaches and subreaches included within the OIBIMP. Results were tabulated for 0 – 100% probability for each study reach.

Table 4-2: Crystal Ball Analysis Result Table for Annual Volume Change

Reach	Reach Length (ft)	+1.8 ft Annual Loss 50% (cy)	+1.8 ft Annual Loss 75% (cy)	-5 ft Annual Loss 50% (cy)	-5 ft Annual Loss 75% (cy)	-12 ft Annual Loss 50% (cy)	-12 ft Annual Loss 75% (cy)	-20 ft Annual Loss 50% (cy)	-20 ft Annual Loss 75% (cy)	-25 ft Annual Loss 50% (cy)	-25 ft Annual Loss 75% (cy)
East End - A (210+00-230+00)	2,500	-12,430	-20,665	-21,167	-33,282	-17,627	-25,967	-12,791	-20,770	-10,920	-34,226
East End - B (240+00-270+00)	4,000	-17,475	-26,920	-30,017	-43,689	-20,330	-33,454	-9,108	-20,418	-2,320	-31,374
East End - C (280+00-290+00)	1,998	-11,286	-16,138	-19,574	-27,394	-16,542	-21,640	-12,022	-17,380	-9,624	-26,568
East End (210+00-290+00)	8,498	-41,183	-54,660	-70,804	-90,600	-54,466	-70,857	-33,942	-48,759	-22,807	-63,605
East - A (300+00-330+00)	3,993	-19,928	-26,854	-29,132	-39,298	-28,681	-43,287	-20,384	-30,660	-21,601	-49,682
East - B (340+00-420+00)	8,948	-24,920	-35,375	-37,492	-50,522	-36,979	-55,334	-12,331	-26,969	-17,842	-43,934
East (300+00-420+00)	12,941	-44,847	-57,398	-66,667	-83,217	-65,551	-89,213	-32,683	-50,590	-39,488	-77,927
Central - A (430+00-450+00)	3,084	-3,203	-7,281	-4,376	-11,652	-4,545	-16,235	2,931	-8,232	6,665	-8,077
Central - B (460+00-500+00)	5,070	-5,187	-10,949	-6,609	-16,494	-11,235	-31,170	2,506	-11,472	8,188	-10,024
Central (430+00-500+00)	8,154	-8,410	-15,458	-10,961	-23,280	-15,749	-38,825	5,495	-12,408	14,799	-8,553
West - A (510+00-550+00)	4,922	-11,513	-17,515	-15,299	-23,893	-24,887	-40,551	-5,657	-17,597	-5,600	-21,466
West - B (560+00-590+00)	4,008	-7,093	-12,827	-8,132	-15,147	-13,022	-24,767	6,609	-6,665	8,888	-5,268
West (510+00-590+00)	8,931	-18,570	-26,917	-23,443	-34,480	-37,859	-57,420	948	-16,869	3,242	-17,916
West End - A (600+00-630+00)	4,002	-7,358	-14,787	-8,985	-16,820	-15,929	-33,546	1,636	-14,641	5,213	-14,761
West End - B (640+00-680+00)	4,479	-31,028	-43,432	-70,005	-90,753	-81,232	-106,068	-82,972	-111,417	-87,053	-121,814
West End (600+00-680+00)	8,481	-38,384	-52,867	-78,959	-101,184	-97,166	-127,660	-81,263	-114,079	-81,875	-121,831
Total Annual Volume Change	**47,005**	**-151,481**	**-177,183**	**-250,854**	**-288,688**	**-271,076**	**-322,678**	**-141,507**	**-188,958**	**-125,872**	**-202,074**

The 50% and 75% probability scenarios were the targeted confidence level to bound the annual volume loss projection. Within the Crystal Ball analyses, all reaches were erosional at the 50% and 75% probability scenario and history has shown that most areas of the island have required nourishment at one time or another. Table 4-2 shows an overall annual loss along Oak Island of approximately 271,076 cy (50%) and 322,678 cy (75%) just to keep up with historical erosion patterns. Since 2014, there have been four major Hurricanes that have impacted the Oak Island shoreline: Hurricane Matthew (2016), Hurricane Florence (2018), Hurricane Dorian (2019), Hurricane Isaias (2020). Given the frequency of these events and the limited historical data, it is necessary to remove the effects of the storm events, which have increased the background erosion rate. This was accomplished by taking the mean and standard deviation of the losses of each storm events listed and using that data as input into Crystal Ball to come up with a projected loss volume per storm event. The results of this analysis indicate the volume loss is between approximately 346,979 cy (50%) and 387,777 cy (75%) per storm event. Based on the long-term historical record, on average one storm event will impact the Oak Island shoreline approximately every 6 years. Table 4-3 shows the long-term nourishment need with the storm effects removed (1 storm ever 6 years). The volume need to account for background erosion is 1.3 Mcy every 6 years, which correlates to a total volume need of 6.5 Mcy over the 30-year plan.

Table 4-3: Oak Island Background Erosion Volume Need

	-12 ft Annual Loss 50% (cy)	**-12 ft Annual Loss 75% (cy)**
Total Annual Volume Change (w/Storm)	-271,076	-322,678
Total Annual Volume Change (w/o Storm)	-213,247	-258,049
6-yr Nourishment Cycle Volume Need (w/o Storm)	-1,279,480 (-1.3 Mcy)	-1,548,293 (-1.55 Mcy)
30-yr Volume Need (w/o Storm)	-6,397,398 (-6.5 Mcy)	-7,741,466 (-7.75 Mcy)

An additional volume need for Oak Island corresponds to the construction of the 2024/2025 Beach Renourishment Project to account for the background erosion. Giving permitting requirements for this project, the project is not anticipated to be constructed until the 2024/2025 dredge season. The planned construction volume is 1.65 Mcy to account for the 6-year nourishment cycle plus additional background erosion that will occur until the time of construction. The future maintenance events will evaluate the entire oceanfront need at each renourishment cycle.

The volume need for anticipated storm events must be accounted for given storm impacts were removed from the background erosion volume estimate above. The Crystal Ball results indicate that storm events account for approximately 350,000 cy (50%) to 390,000 cy (75%) of erosion per storm event. Based on the recent history of storm impacts to Oak Island, it is anticipated that two (2) storm events would impact the oceanfront within a six (6) year nourishment cycle. The conservative estimate of 390,000 cy per event is used going forward which correlates to a volume need of 3.9 Mcy over the 30-year plan. Another reason for the conservative approach here is that there has been considerable variability in the volume loss rates in recent events and the Town desires to be conservative in its estimates of sand need.

A Sea Level Rise (SLR) analysis has been performed for the OIBIMP. The NCCRC Meth–d - Representative Concentration Pathways (RCP) 2.6 estimate of SLR from the Southport, NC Station was utilized for a 30-year time frame, which correlates to a 0.58 ft rise in sea level. The additional volume estimated to account for SLR estimate for Oak Island is approximately 0.4 Mcy over 30 years, which correlates to an additional 80,000 cy per maintenance event.

A summary of the 30-year volume need for Oak Island is summarized in Table 4-4. A 30% buffer is assumed to account for the material losses/compaction, overbuild on beach and general inefficiencies associated with the dredging process to determine the volume dredged versus that designed to be placed on the beach.

Table 4-4: Estimate of Oak Island 30-year Volume Need of Material Placed on Beach and in Borrow Areas

	30 Year Placed Volume Need (cy)	30 Year Dredge Volume Need (cy)
2024/2025 Project	1,650,000	2,145,000
Maintenance Projects (6-yr Cycle)	6,500,000	8,450,000
Storms (2 Storms @75% per Cycle)	3,900,000	5,070,000
SLR	400,000	520,000
TOTAL	12,450,000	16,185,000

4.2 Construction

4.2.1 Proposed 2024/2025 Oak Island Renourishment Project

The proposed 2024/2025 Oak Island Renourishment Project will be primarily a berm only project and dune placement will only be performed in areas where the 10-year LoP is not met. This project is currently in the design stages and is estimated to place 1.65 Mcy along the entire oceanfront of

Oak Island to provide the protection against background erosion in an effort to maintain the 10-year within the dune and berm system throughout the estimated 6-year maintenance cycle. The finalized borrow area has not been determined as of yet and is working through the permitting process. The borrow areas identified in Section 6.0 will be evaluated for use for this project pending sediment compatibility, geographical considerations, and regulatory approval.

4.3 Pre-Project Vegetation Line

The Division of Coastal Management (DCM) has defined the Pre-Project Vegetation Line as the Vegetation Line that existed within one year prior to the onset of construction of a large scale beach fill project (greater than 300,000 cy). The Vegetation Line refers to the first line of stable and natural vegetation (FLSNV) and is utilized as the reference point for measuring oceanfront development setbacks. Planted vegetation may be considered “Stable” in cases where the majority of the plant stems are from continuous rhizomes rather than planted individual rooted sets, and “Natural” in cases when the plants are mature and additional species native to the region have been recruited, as determined by the Local Permit Officer (15A NCAC 07H .0305 (a) (5)). Furthermore, the NCCRC is currently considering rule language that would clarify that planted vegetation cannot be considered "stable' for a minimum of two years after planting. If adopted, the Town will incorporate the new rule language in all future vegetation line determination processes.

4.3.1 Current Pre-Project Vegetation Line

As of August 1, 2022 Oak Island’s Development Line has been replaced with a Pre-Project Vegetation Line. The onset of the 2001 Wilmington Harbor Project was in December 2000; therefore, one year prior was December 1999. The 1999 Vegetation Line was severely impacted by Hurricane Floyd in September 1999. Therefore, DCM established the Pre-Project Vegetation Line as the Vegetation Line from the June 1998 aerial orthophotography (Pre-Floyd) along the majority of the Oak Island oceanfront (Sta 210+00 – Sta 650+00). The remainder of the oceanfront (Sta.650+00 – 685+00) where no Pre-Project Vegetation Line was set based on the 1998 aerial, was supplemented based on Nearmap aerial imagery from January 2021. An example of the current Pre-Project Vegetation Line for Oak Island is shown in Figure 4-2 overlaid with the January 2021 Nearmap Aerial. A complete set of figures documenting the Pre-Project Vegetation Line is shown in Appendix C.

The Ocean Hazards Setback is then determined based on the Coastal Resources Commission’s erosion rate setback factor and the size of the development, all as described in 15A NCAC 07H.0306. The DCM erosion rate setback factor across the Oak Island Oceanfront is 2.0 and therefore the minimum setback across Oak Island is 60 ft landward from the Pre-Project Vegetation Line.

Figure 4-2: Oak Island Pre-Project Vegetation Line

4.3.2 Establishment of Oak Island Beach Management Plan Vegetation Line

The Town has constructed two beach renourishment projects in 2020/2021 and 2021/2022. These projects consisted of a dune and sloped berm designed at a level of protection for a 25-year return period storm event knowing the Town is planning a project in 2024/2025. The Town is committed to maintaining the baseline level of protection against a 10-year storm through maintenance renourishment events as described within this Beach Management Plan, which will also include enhanced plantings and other features. The 2020/2021 and 2021/2022 Oak Island Renourishment Projects included planting of the landward slope and crest of the constructed dune, which included Sea Oats, Bitter Panicum, and Seashore Elder in 2020/2021 and Sea Oats in 2021/2022. The Town is currently seeking approval to plant on a portion of the oceanward side of the dune to establish and facilitate vegetation growth that is considered stable and natural. Progression of the planted dune will be monitored and areas that require additional plants will be supplemented with native species found in Brunswick County.

5.0 PROJECT PERFORMANCE

Future monitoring surveys as part of the OISMP will compare the nourishment trigger volumes developed in the OIBIMP with the average reach volume calculated using each profile to determine the need for a nourishment event. As mentioned in Section 2.6 and 2.7, the 2020/2021 and 2021/2022 Renourishment Projects were designed to provide the 25-year LoP. The Town's goal is to provide protection for a 10-year storm event as part of this Beach Management Plan. The current survey results can be seen in Table 5-1. After the construction completed for both recent projects, the average reach volume in all reaches where placement occurred met the 10-year LoP for all reaches except the East End reach (where no material was placed). The LoP volume will continue to be monitored and supplemental placement within all reaches will occur during the 2024/2025 Renourishment Project as required to provide the 10-year LoP.

Table 5-1: Project Performance Comparison

Reach	10-yr Level of Protection Trigger Volume (cy/ft)	25-yr Level of Protection Trigger Volume (cy/ft)	2022 Reach Average Volume (cy/ft)
Oak Island-East End 210+00 - 290+00 (Eastern Town Limits – SE 63rd St)	307	315	296
Oak Island-East 300+00 - 420+00 (SE 63rd St – 16th Pl East)	257	283	275
Oak Island-Central 430+00 - 500+00 (16th Pl East – 10th Pl West)	235	244	252
Oak Island-West 510+00 - 590+00 (10th Pl West – 42nd Pl West)	231	242	263
Oak Island-West End 600+00 - 680+00 (42nd Pl West – West End Parking Lot)	238	249	284

6.0 PLANNED BORROW AREAS

As part of the OIBIMP, an extensive sediment sampling program was implemented in 2019 to identify the native beach sediment characteristics and verify the compatibility and quantity of existing sediment sources adjacent to Oak Island. This effort determined the quantity and quality of potential sediment sources available for the next 30 years through both geophysical (Multibeam Survey, Side Scan and Magnetometer Survey, and Sub-bottom Survey) and geological data (Vibracore Sampling and Sediment Gradation Analysis) collection . Offshore sources consist of Frying Pan Shoals, which lies both within and outside of State waters), the Old and New ODMDS's, Lockwoods Folly Inlet Complex, Jay Bird Shoals, and Yellow Banks. Additional vibracore samples are being collected in the Fall of 2022 to refine the Frying Pan Shoals and ODMDS borrow areas. Sampling will also take place in the Wilmington Harbor Navigation Channel borrow area. Figure 6-1 shows a summary of the potential sediment sources identified for use over the next 30 years.

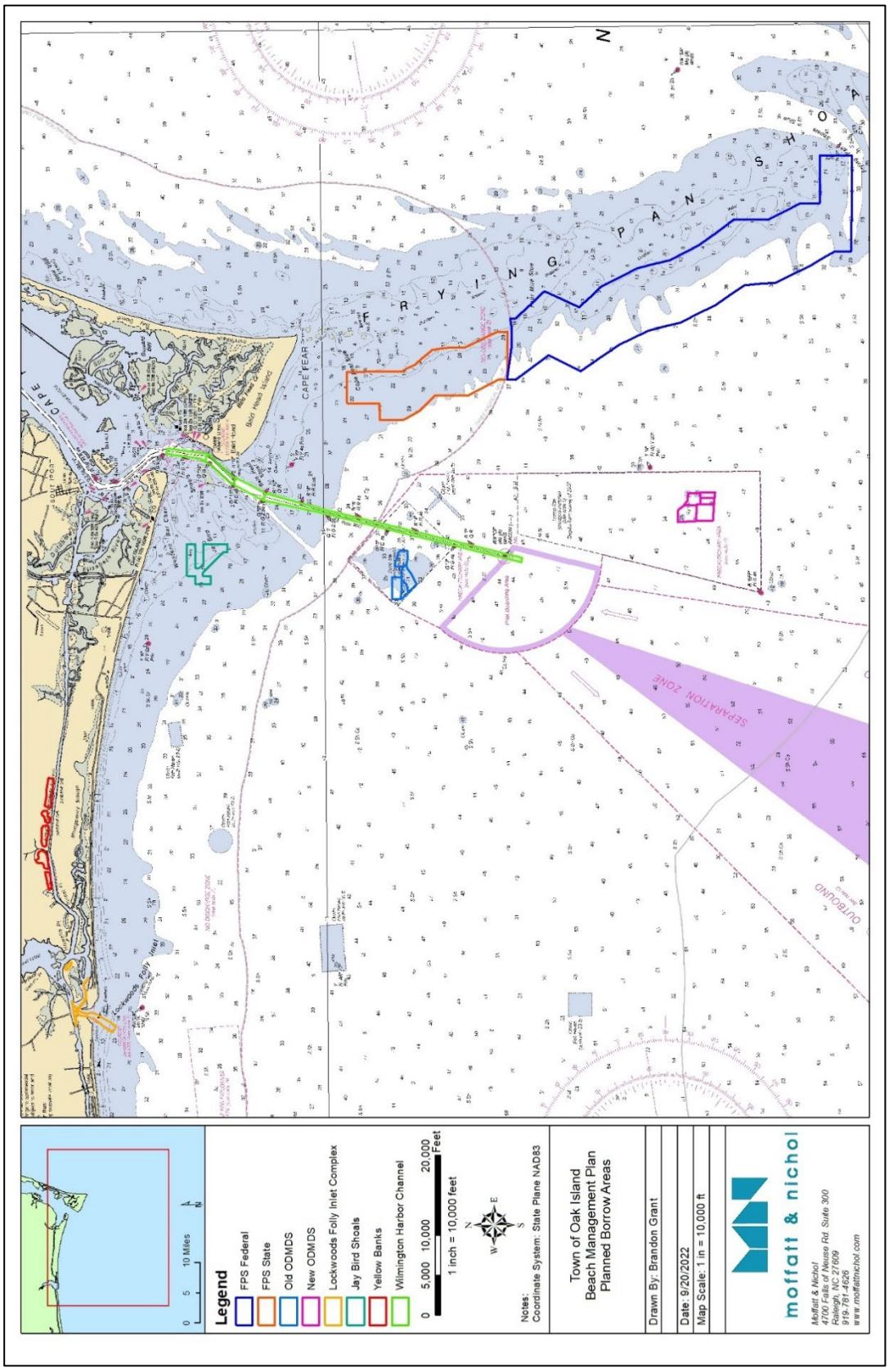

Figure 6-1: Beach Management Plan Potential Sediment Sources

A detailed analysis of these areas from the 2019 sampling effort, in comparison to the native beach, is provided in the following sections. The collection of the nearshore vibracore samples (Lockwoods Folly Inlet, Eastern Channel, and AIWW and laboratory sediment analysis was performed by Athena, Amdrill (Formerly AVS), and Terracon.

6.1 Native Beach

Native beach data was collected by the USACE as well as Terracon Consulting Engineers and Scientists (Terracon) prior to 2016. These data indicate a native grain size ranging from 0.2 mm to 0.3 mm. Table 6-1 summarizes the available native beach data.

Table 6-1: Historical Native Beach Data

Date	Source	Mean Grain Size (mm)	Coverage
2012	USACE	0.21 & 0.25	East Oak Island & West Oak Island
2014	Terracon	0.28	Oak Island Station 600+–0 - 680+00

The most recent comprehensive native sediment data was collected by Athena Technologies Inc. (Athena) in 2019. The native sediment distribution for the Town was defined based on the percent gravel, granular, sand, fine-grained, and calcium carbonate present in samples taken from 13 positions along transects spanning the length of island spaced no more than 5,000 ft apart as specified in North Carolina Administrative Code (NCAC) "Technical Standards for Beach Fill Projects" 15A NCAC 07H.0312 (1). These 13 samples were then averaged to obtain a composite average for each transect. The composite average for each of the 11 transects (Figure 6-2) were then averaged to obtain a global mean for the native beach.

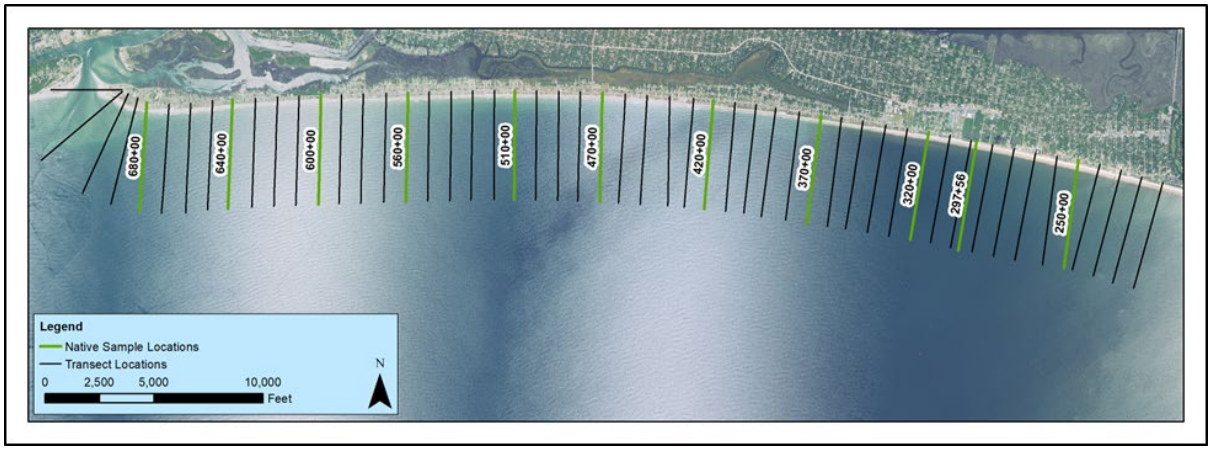

Figure 6-2: Native Sediment Sample Transects

The native beach characteristics and parameters identified by the 15A NCAC 07H .0312 are presented in Table 6-2. With the exception of Frying Pan Shoals, any borrow areas in State waters ultimately used for beach nourishment activities must fall within these guidelines. With regards to the portion of Frying Pan Shoals located within State waters, 15A NCAC 07H .0312(a)(2) states that characterization of sediments from this shoal system is not required. However, to ensure that any materials removed from this area are considered "beach quality", an analysis similar to those required in 15A NCAC 07H .0212 will be implemented. Similar analysis's will be conducted on those portions of Frying Pan Shoals that fall within Federal waters. A summary of the distribution and statistics for the native sediment is provided in Table 6-3.

Table 6-2: Native Beach Characteristics and NCAC Rule Parameters

Characteristic	2019 Native Global Mean	NCAC Requirements	NCAC Maximum
Gravel (>#4)	Reported: 0.45%	native + 5%	≤ 6%
Granular (>#10 & <#4)	Reported: 0.71%	native + 10%	≤ 11%
Sand (>#230 & <#10)	Reported: 96.96%	-	-
Fines (<#230)	Reported: 1.88%	native +5%	≤ 7%
Calcium Carbonate	Reported: 9.72%	native + 15%	≤ 25%

Table 6-3: Native Beach Sediment Statistics

Sediment Compatibility	2019 Native Global Mean
Median (mm)	0.26
Median (φ)	1.97
Mean (mm)	0.27
Mean (φ)	1.90
Standard Deviation (σφ)	0.81

For this report, a median grain size of 0.26 mm is selected as the best representation of the native beach based updated samples analyzed by Athena in 2019.

Large Sediment Sampling 2019

Moffatt and Nichol conducted a field investigation on May 14, 2019 to estimate the total number of shell and rock material greater than or equal to three inches in diameter, observable on the surface of the beach between mean low water and the frontal dune toe, in a 50,000 square foot area based on requirements of 15A NCAC 07H.0312. Investigations were performed in three locations across Oak Island shown in Figure 6-3. The three locations were chosen as they have experienced various levels of renourishment activities, an average from the three areas were calculated to represent the entire oceanfront. Area 1 was located between Stations 650+00 and 670+00. Area 2 was located between Stations 490+00 and 500+00. Area 3 was located between Stations 210+00 and 230+00. Area 1 was nourished two months prior to the investigation, Area 2 had not been nourished since 2001, and Area 3 had received nourishment in the summer of 2018. Results of the investigation found 165 pieces in Area 1, 44 pieces in Area 2, and 87 pieces in Area 3 of shell material greater than or equal to three inches in diameter. It was observed at the time of the investigation that a recent dune pushing effort had taken place within Area 2 which may have influenced the low number of clasts surveyed assuming that the characteristic shell material was pushed up into the dune and not counted. The average clast count of shell and rock material greater than or equal to three inches in diameter of the three areas surveyed is 99 pieces. This establishes a consistent clast count standard for renourishment projects to use.

Figure 6-3: Clast Survey Areas

Large Sediment Sampling 2021

It is also acknowledged that the requirements in 15A NCAC 07H 0312 (1)(h) for estimating oversized rock and/or shell material were changed in September of 2021. Additional sampling to satisfy these new procedures was conducted in March and April of 2021. The sample transects (300+00, 350+00, 400+00, 450+00, and 500+00) were surveyed in late March/early April in order to avoid effects from the 2020/2021 Renourishment Project which began in early April (4/8/21). The remainder of the sample transects (250+00, 550+00, 600+00, and 650+00) were surveyed in mid-April, as they were outside the 2020/2021 Renourishment Project limits. While effects from the 20/21 Renourishment Project were avoided, all the transects sampled have experienced nourishment events over the years. See Figure 6-4 for the sample locations chosen for the project area.

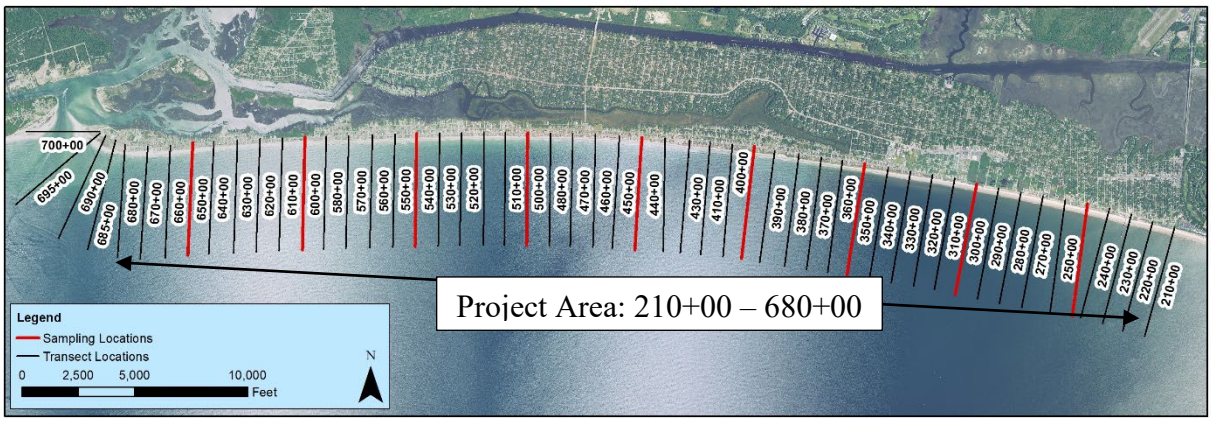

Figure 6-4: Sample Locations within Project Area

The number of sediments greater than or equal to one inch (25.4 millimeters) in diameter, and shell material greater than or equal to three inches (76 millimeters) in diameter shall be differentiated and calculated through visual observation of an area 10,000 square feet centered on each transect, between mean tide level (MTL) and the frontal dune toe within the beach fill project boundaries. A simple arithmetic mean shall be calculated for both sediments and shell by summing the totals of each across all transects and dividing by the total number of transects, and these values shall be considered representative of the entire project area and referred to as the "background" values for large sediment and large shell material. Table 6-4 shows the summary of the large sediment sampling effort by taking the average over the nine transects sampled in the project area, resulting in the background values of 26 shells and 199 sediments. These background values would be used in future permitting efforts for the OIBIMP.

Table 6-4: Summary of Sampling Results

Transect	# Shells ≥3 in	# Sediments ≥1 in
250+00	12	0
300+00	10	19
350+00	11	102
400+00	22	367
450+00	6	505
500+00	2	257
550+00	19	339
600+00	65	92
650+00	89	111
Total	**236**	**1,792**
Average	**26**	**199**

6.2 Frying Pan Shoals

Frying Pan shoals extends from the entrance of the Cape Fear River to approximately 16 nautical miles offshore in the Atlantic Ocean. Frying Pan Shoals and was split into two sections correlating to the portion of Frying Pan Shoals located within State and Federal waters as shown in Figure 6-5. Reconnaissance level investigations of Frying Pan Shoals proposed borrow collected 29 vibracores in State waters and 23 vibracores in Federal waters for a total of 52 vibracores. Spacing of the Frying Pan Shoals State vibracores was 2,000 ft and Frying Pan Shoals Federal was 4,000 ft. Placement of the vibracores targeted the offshore slope of the shoal in an effort to minimize environmental impacts and remain in a deeper depth to facilitate safe dredging given draft limitations of dredge vessel. Sediment compatibility results from these vibracores resulted in beach compatible material in both the State and Federal areas as show below in Table 6-5 and Table 6-6 respectively. The available volume of beach compatible material within the areas shown (studied to date) is estimated to be 29 Mcy in Frying Pan Shoals State and 58 Mcy in Frying Pan Shoals Federal.

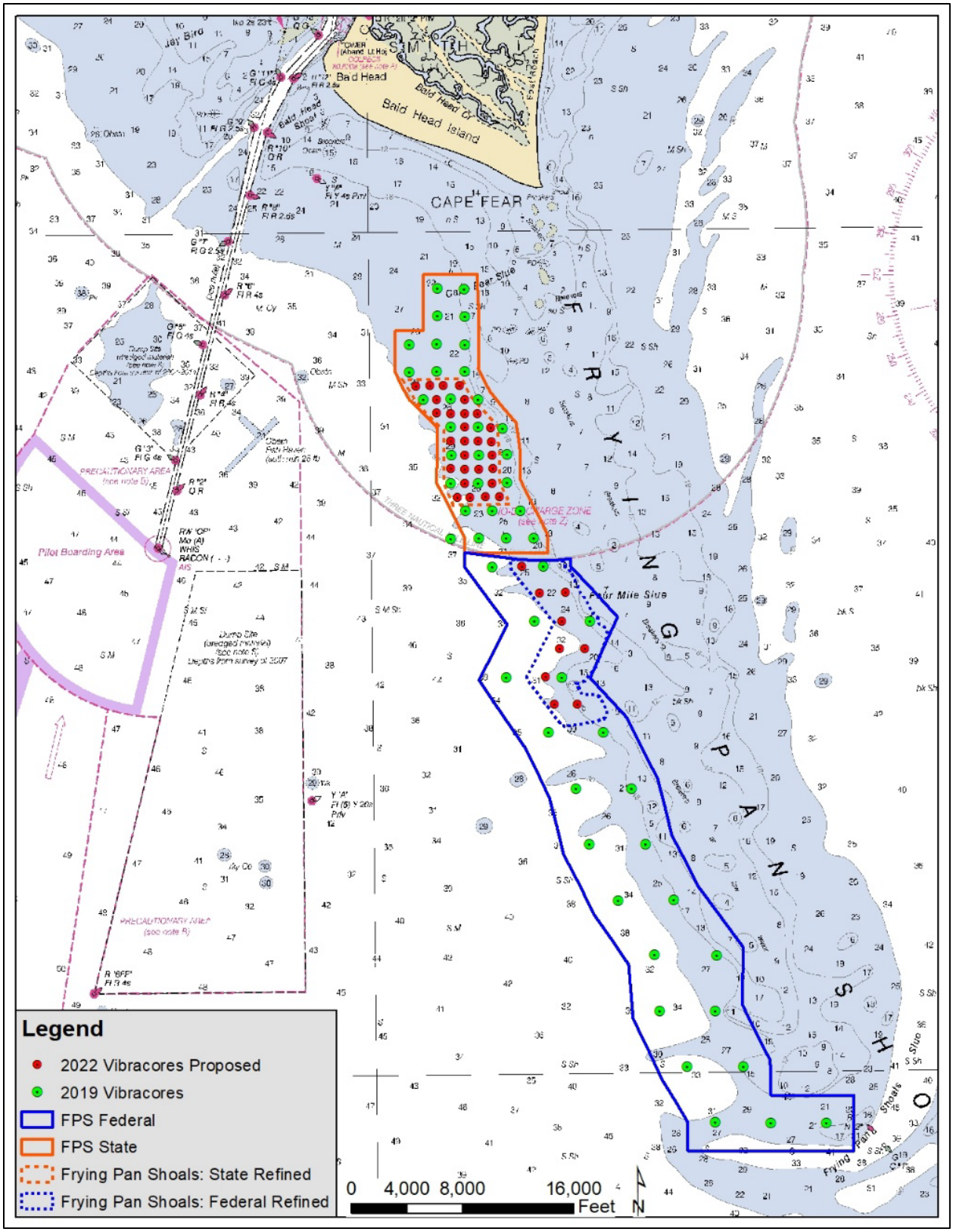

Figure 6-5: Frying Pan Shoals Site and Vibracore Locations

Table 6-5: Frying Pan Shoals State Characteristics and NCAC Parameters

Characteristic	Required Borrow Site Parameters	Frying Pan Shoals **State**
Gravel (>#4)	≤ 6%	**1.1%**
Granular (>#10 & <#4)	≤ 11%	**1.0%**
Sand (>#230 & <#10)	-	**93.3%**
Fines (<#230)	≤ 7%	**4.7%**
Calcium Carbonate	≤ 25%	**9.9%**

Table 6-6: Frying Pan Shoals Federal Characteristics and NCAC Parameters

Characteristic	Required Borrow Site Parameters	Frying Pan Shoals **Federal**
Gravel (>#4)	≤ 6%	**0.7%**
Granular (>#10 & <#4)	≤ 11%	**0.4%**
Sand (>#230 & <#10)	-	**96.6%**
Fines (<#230)	≤ 7%	**2.4%**
Calcium Carbonate	≤ 25%	**8.6%**

Based on the results of the reconnaissance level investigations, the Town contracted with Amdrill for a more detailed level of investigation refining an area within Frying Pan Shoals State and Frying Pan Shoals Federal to take additional vibracore samples to supplement the vibracores taken in 2019. Within the Frying Pan Shoals State site, 28 additional vibracores are proposed to be collected during the Fall of 2022 which will refine the spacing to 1,000 ft. Within the Frying Pan Shoals Federal site, 9 additional vibracores are proposed to be collected during the Fall of 2022 which will refine the spacing to 2,000 ft. The estimated volumes associated with the refined Frying Pan Shoals State and Federal areas are 10 Mcy and 3 Mcy respectively. The estimated sail distance between Town and the refined areas of the State and Federal areas in Frying Pan Shoals ranges between 9.5 to 17 miles and 13.5 to 20 miles respectively.

6.3 Wilmington Harbor ODMDS

The Wilmington Harbor Ocean Dredged Material Disposal Site (ODMDS) could also provide a borrow source option. The ODMDS falls approximate to Frying Pan Shoals and Jay Bird Shoals. The ODMDS is divided in to two separate locations: Old ODMDS and New ODMDS. The estimated sail distance between the Town and the Wilmington Harbor ODMDS ranges from approximately 6.5 to 12 miles depending on the eastern or western shoreline limits respectively.

6.3.1 Old ODMDS

The Old ODMDS borrow area is located to the north of the New ODMDS. In 2019, Amdrill collected five (5) vibracores from distinct mounds within the Old ODMDS site as shown in Figure 6-6. To further confirm the sediment quality is consistent across each of the mounds, an additional four (4) vibracores are planned to be collected in the Fall of 2022. This area is estimated to contain

1 Mcy of beach compatible sand. The characteristics of this material are compliant with the parameters defined by the NCAC as shown in Table 6-7.

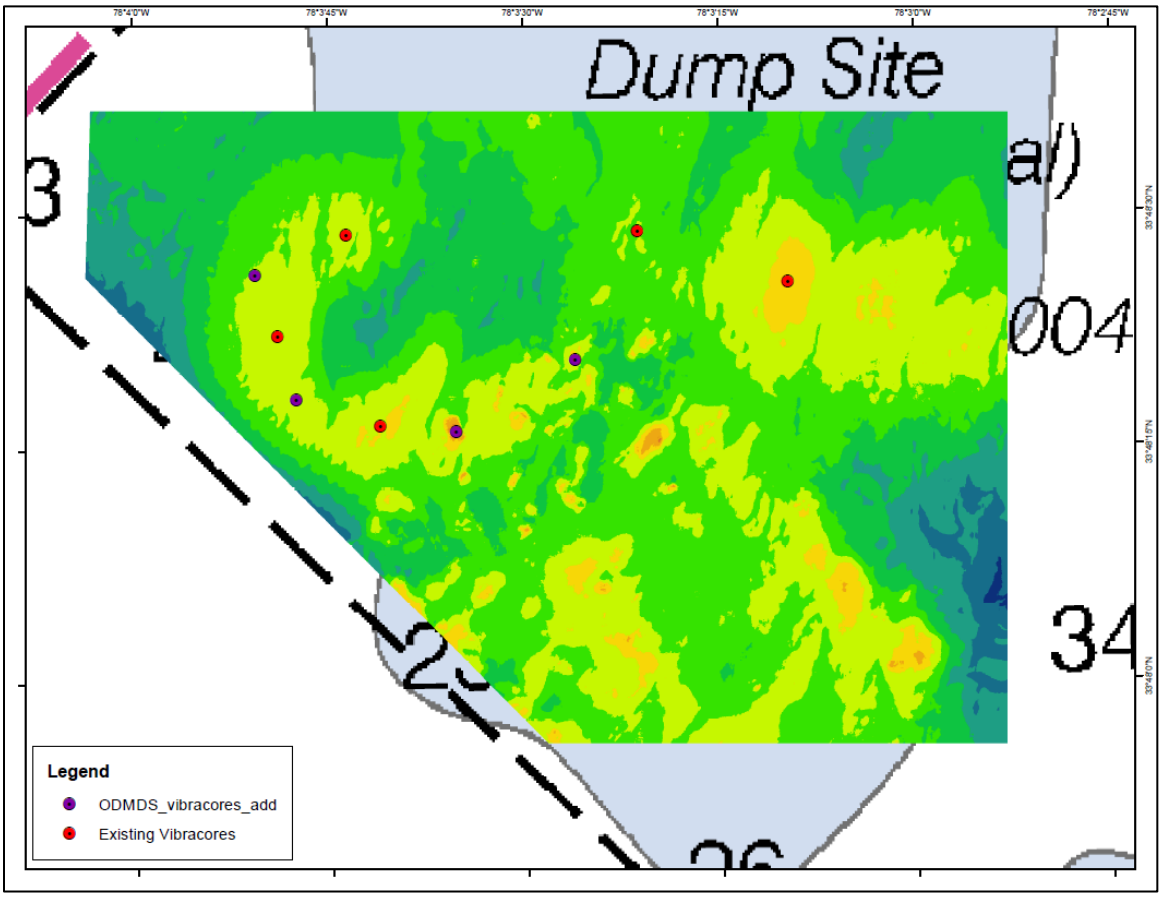

Figure 6-6: Old ODMDS Site and Vibracore Locations

Table 6-7: Old ODMDS Characteristics and NCAC Parameters

Characteristic	Required Borrow Site Parameters	Old ODMDS
Gravel (>#4)	≤ 6%	4.79%
Granular (>#10 & <#4)	≤ 11%	2.67%
Sand (>#230 & <#10)	-	87.60%
Fines (<#230)	≤ 7%	4.94%
Calcium Carbonate	≤ 25%	10.24%

6.3.2 New ODMDS

The New ODMDS borrow area is located farther offshore of the Old ODMDS adjacent to the Federal FPS site. In 2019, Amdrill collected five (5) vibracores from distinct mounds within the New ODMDS site as shown in Figure 6-7. To further confirm the sediment quality is consistent across each of the mounds, an additional seven (7) vibracores are planned to be collected in the Fall of 2022. This area is estimated to contain 0.7 Mcy of beach compatible sand meeting NCAC standards as shown in Table 6-8.

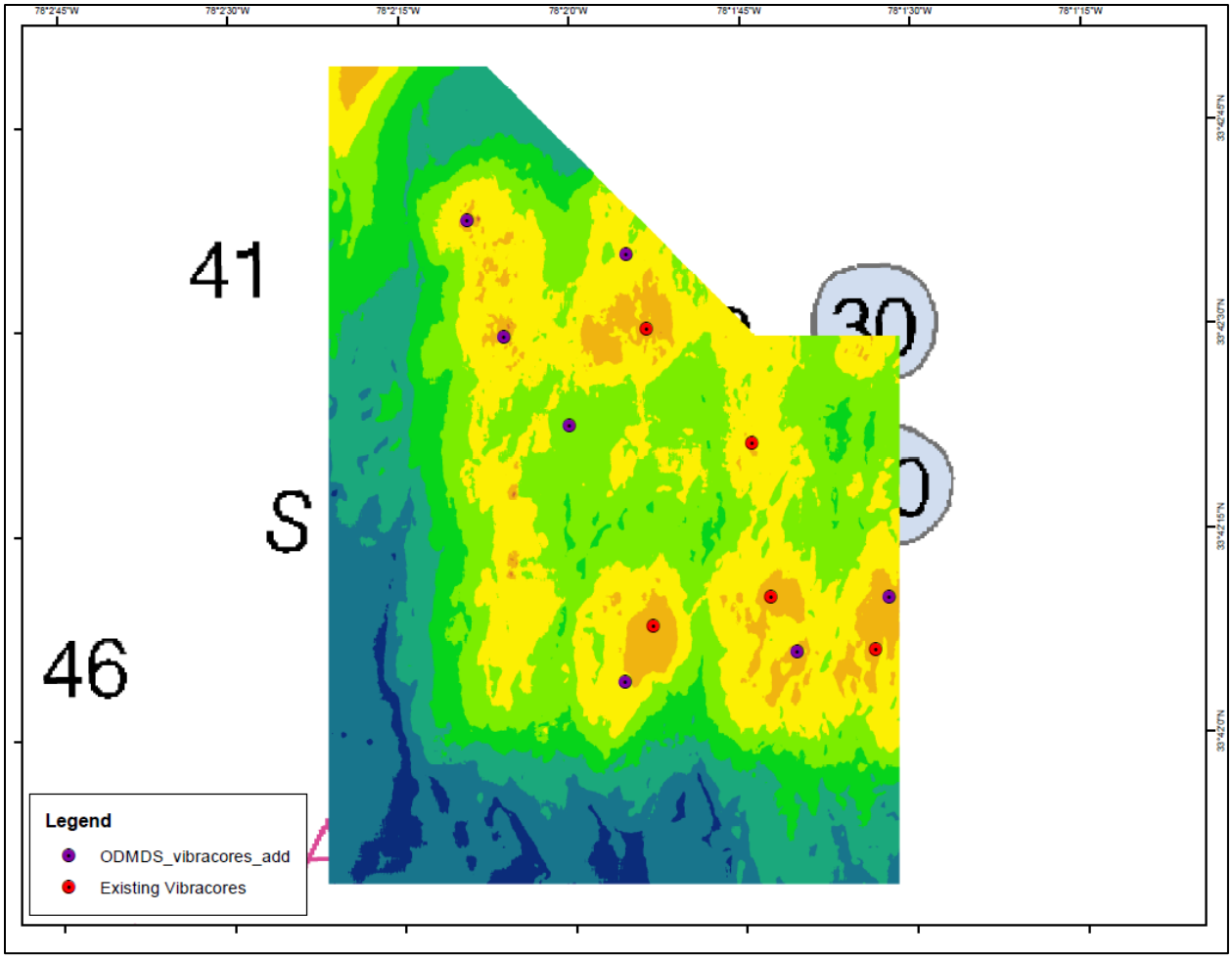

Figure 6-7: New ODMDS Site and Vibracore Locations

Table 6-8: New ODMDS Characteristics and NCAC Parameters

Characteristic	Required Borrow Site Parameters	New ODMDS
Gravel (>#4)	≤ 6%	1.66%
Granular (>#10 & <#4)	≤ 11%	3.05%
Sand (>#230 & <#10)	-	89.50%
Fines (<#230)	≤ 7%	5.78%
Calcium Carbonate	≤ 25%	8.98%

6.4 Lockwoods Folly Inlet Complex

The Lockwoods Folly Inlet Complex includes the Lockwoods Folly Inlet, Eastern Channel, AIWW Crossing and Bend Widener, and Sheep Island as shown in Figure 6-8. Vibracores were collected in 2019 by Athena for all locations except Sheep Island. Landside sampling equipment is required for this location and will be collected at a later date. Vibracore sample data was processed by Terracon and the results for each site shows beach compatible material exists withing each site as shown in Table 6-9 – Table 6-11. These sites are considered a renewable source and would be dredged cyclically.

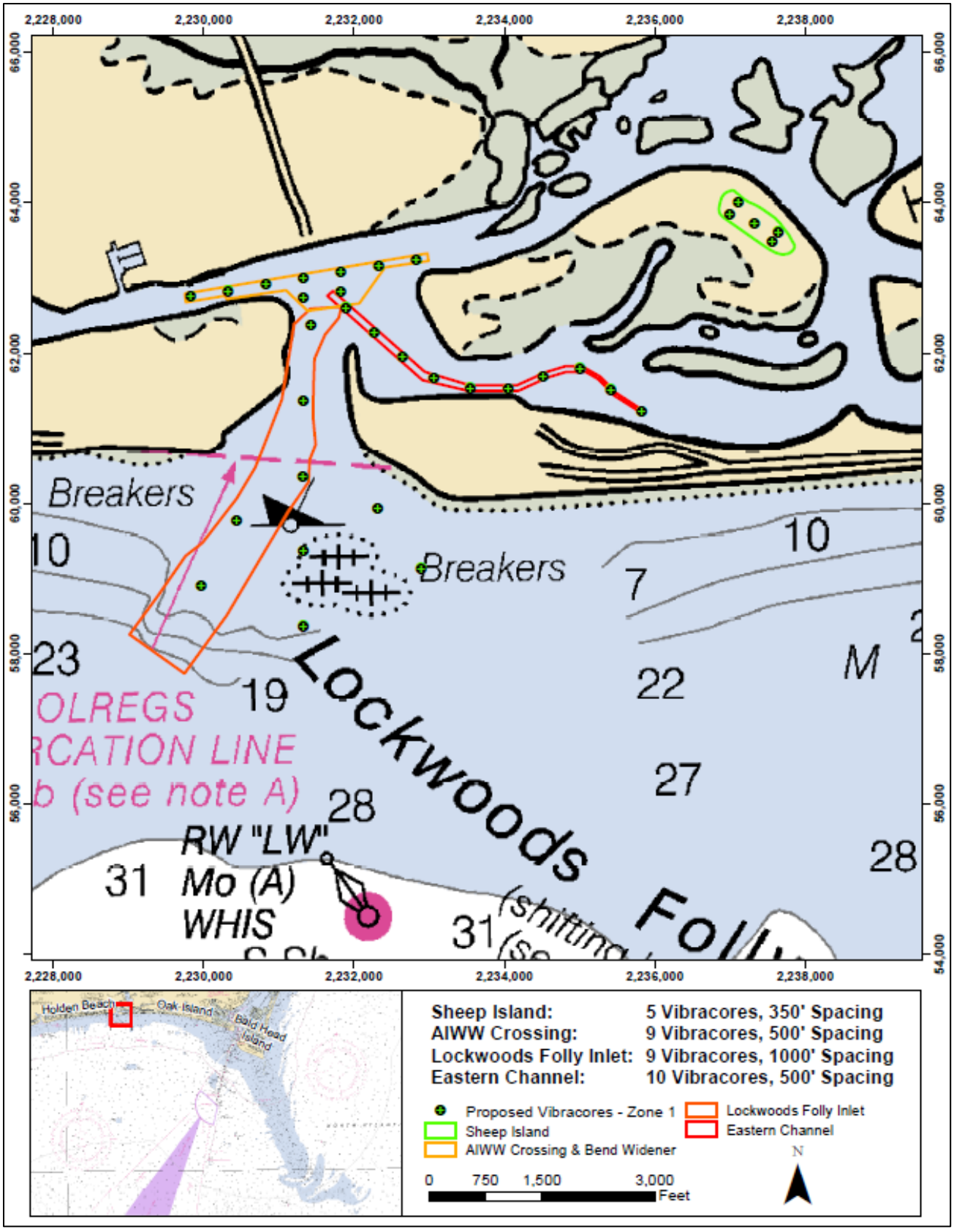

Figure 6-8: Lockwoods Folly Inlet Complex Sites and Vibracore Locations

Table 6-9: Lockwoods Folly Inlet Characteristics and NCAC Parameters

Characteristic	Required Borrow Site Parameters	Lockwoods Folly Inlet
Gravel (>#4)	≤ 6%	**2.9%**
Granular (>#10 & <#4)	≤ 11%	**1.6%**
Sand (>#230 & <#10)	-	**93.2%**
Fines (<#230)	≤ 7%	**2.3%**
Calcium Carbonate	≤ 25%	**15.9%**

Table 6-10: Eastern Channel Characteristics and NCAC Parameters

Characteristic	Required Borrow Site Parameters	Eastern Channel
Gravel (>#4)	≤ 6%	**0.6%**
Granular (>#10 & <#4)	≤ 11%	**0.4%**
Sand (>#230 & <#10)	-	**98.0%**
Fines (<#230)	≤ 7%	**1.0%**
Calcium Carbonate	≤ 25%	**9.4%**

Table 6-11: AIWW Crossing and Bend Widener Characteristics and NCAC Parameters

Characteristic	Required Borrow Site Parameters	AIWW Crossing and Bend Widener
Gravel (>#4)	≤ 6%	**0.7%**
Granular (>#10 & <#4)	≤ 11%	**0.3%**
Sand (>#230 & <#10)	-	**96.6%**
Fines (<#230)	≤ 7%	**2.4%**
Calcium Carbonate	≤ 25%	**11.0%**

Currently, the USACE maintains the Lockwoods Folly navigation channel to a depth of -8 MLLW and width of 150 ft . The USACE generally dredges the inlet channel and sidecast the material adjacent to the inlet; however, hopper dredges have also placed material in the nearshore along the adjacent shoreline. The maintenance events historically have occurred four (4) times per year or once a quarter.. Based on historic maintenance records, the channel experiences a shoaling rate of approximately 125,000 cy/yr (Offshore and Coastal Technologies, 2008). The sediment shoaling within the navigation channel could provide the Town of Oak Island a cost effective means to obtain material for shoreline management. The action would most likely require a management agreement with the USACE and potentially the Town of Holden Beach. Over the next 30 years, Lockwoods Folly Inlet could provide 3.75 Mcy of material total (1.9 Mcy to Oak Island if a 50/50 split with Holden Beach is reached). However, with the current authorized depth of only -8 ft MLLW, the channel would have to be deepened to allow dredge plants that could actually place material on the beach. Since the current authorized depths do not allow for dredge access to facilitate beach placement, no volume is assumed to be available from the Lockwoods Folly Navigation Channel.

The Eastern Channel, located along the western end of Oak Island, provides an additional sediment source for beneficial use material. The Town of Oak Island conducted the Lockwoods Follow Habitat Restoration Project in 2015 which dredged material from Eastern Channel and beneficially placed approximately 227,315 cy of beach compatible material along the West End Reach shoreline. The Shoreline Mapping Program monitors the infilling of Eastern Channel within the area containing beach compatible material. Historical shoaling patterns indicate that the channel reaches and equilibrium where approximately 100,00 – 150,000 cy of material would be required to be dredged to meet the permitted template after 3 years. Therefore, over the next 30 years, Eastern Channel could provide 1.5 Mcy of material.

Similar to the Lockwoods Folly inlet navigation channel, the USACE also holds the authorization to maintain the crossing and bend widener. However, the Town of Oak Island has shared the authorization through a Memorandum of Agreement (MOA) with the USACE. Typically, the USACE places material excavated from the AIWW and bend widener along the beachfront as a beneficial re-use every two years on Oak Island (the other years go to Holden Beach). The previous two dredge events (2019 and 2021) have been placed within the West End Reach on Oak Island. The 2019 event placed approximately 120,000 cy of material from the AIWW Crossing on the Oak Island shoreline. The 2021 event placed approximately 160,000 cy of material from the AIWW Crossing and Bend Widener on the Oak Island shoreline. It will be assumed going forward that the 1-yr dredge cycle and beneficial re-use placement will continue to be split between Holden Beach and Oak Island. Therefore, over the next 30 years, the AIWW Crossing and Bend Widener could provide 2.1 Mcy of material to the western end of Oak Island.

Finally, Sheep Island (DA286) is located at the confluence of Eastern Channel and the AIWW. Oak Island has 5 vibracores proposed within the disposal area to test the sediment compatibility. Anecdotal information from USACE has indicated that beach quality material has been placed in this site. The Comprehensive Shoreline Management Plan (MN, 2016) estimated the volume of Sheep Island for a one-time use of 452,000 cy. Sediment compatibility and volume will be confirmed in future data collection efforts.

The combined volume associated with the Lockwoods Folly Inlet Complex is 4.05 Mcy.

6.5 Jay Bird Shoals

Jay Bird Shoals, located adjacent to the mouth of the Cape Fear River as shown in Figure 6-9, was utilized in the 2020/2021 and 2021/2022 Renourishment Projects on Oak Island. Approximately 2 Mcy of material combined over the 2 projects have been removed from Jay Bird Shoals. Jay Bird Shoals will continue to be monitored by Oak Island to quantify recharge of the shoal for potential use in the future. Currently, no projects are planned to utilize this site in the near future until adequate monitoring has been completed based on permitting agency comments.

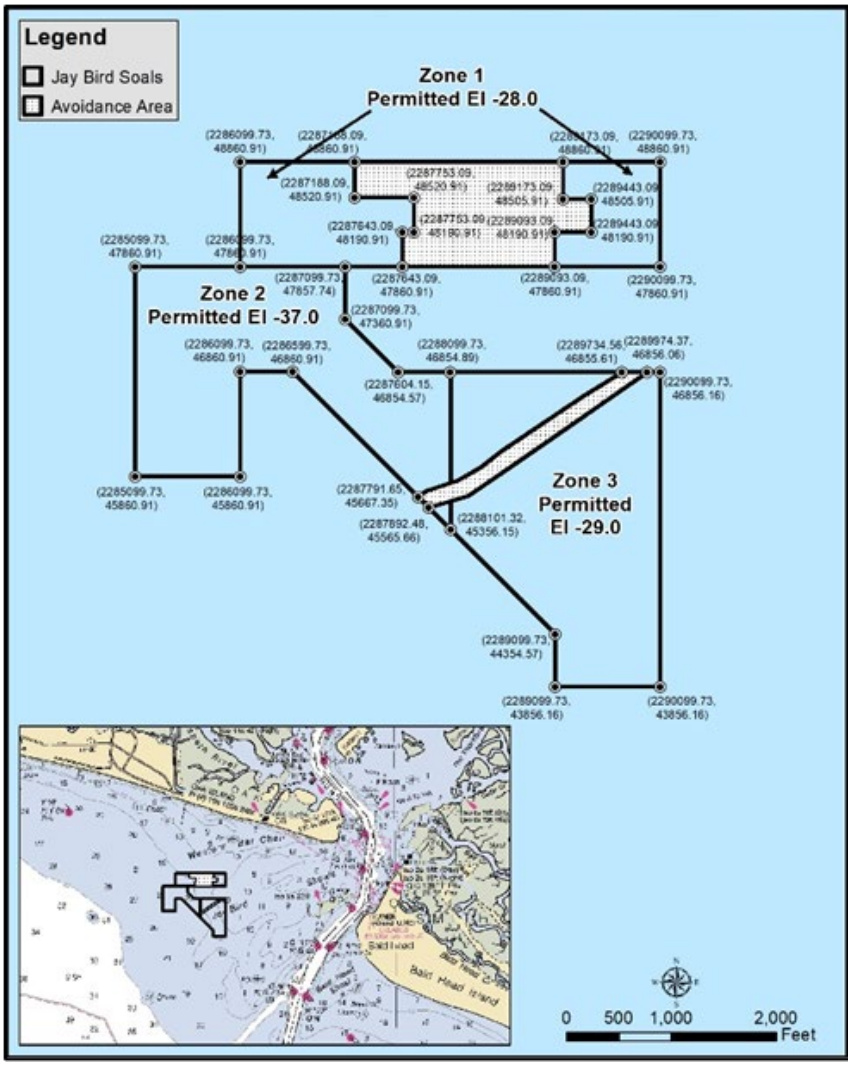

Figure 6-9: Jay Bird Shoals Site

6.6 Yellow Banks

The Yellow Banks disposal site sits approximately midway between the jurisdictional limits of the Town and Lockwoods Folly Inlet along the northern bank of the AIWW as shown in Figure 6-10. Estimates suggest Yellow Banks disposal area currently contains approximately 4.2 Mcy of beach compatible material (USACE, 2012). However, based on results of a 2002 project conducted by the USACE, the beach compatible material was intermixed with rock even though no rock was present in the USACE vibracores. Thus, the site will have test pits dug, in addition to vibracores, as an increased level of sediment sampling in an effort to identify the presence of rock prior to placement of material. Each site will contain five (5) vibracores to verify sediment compatibility.

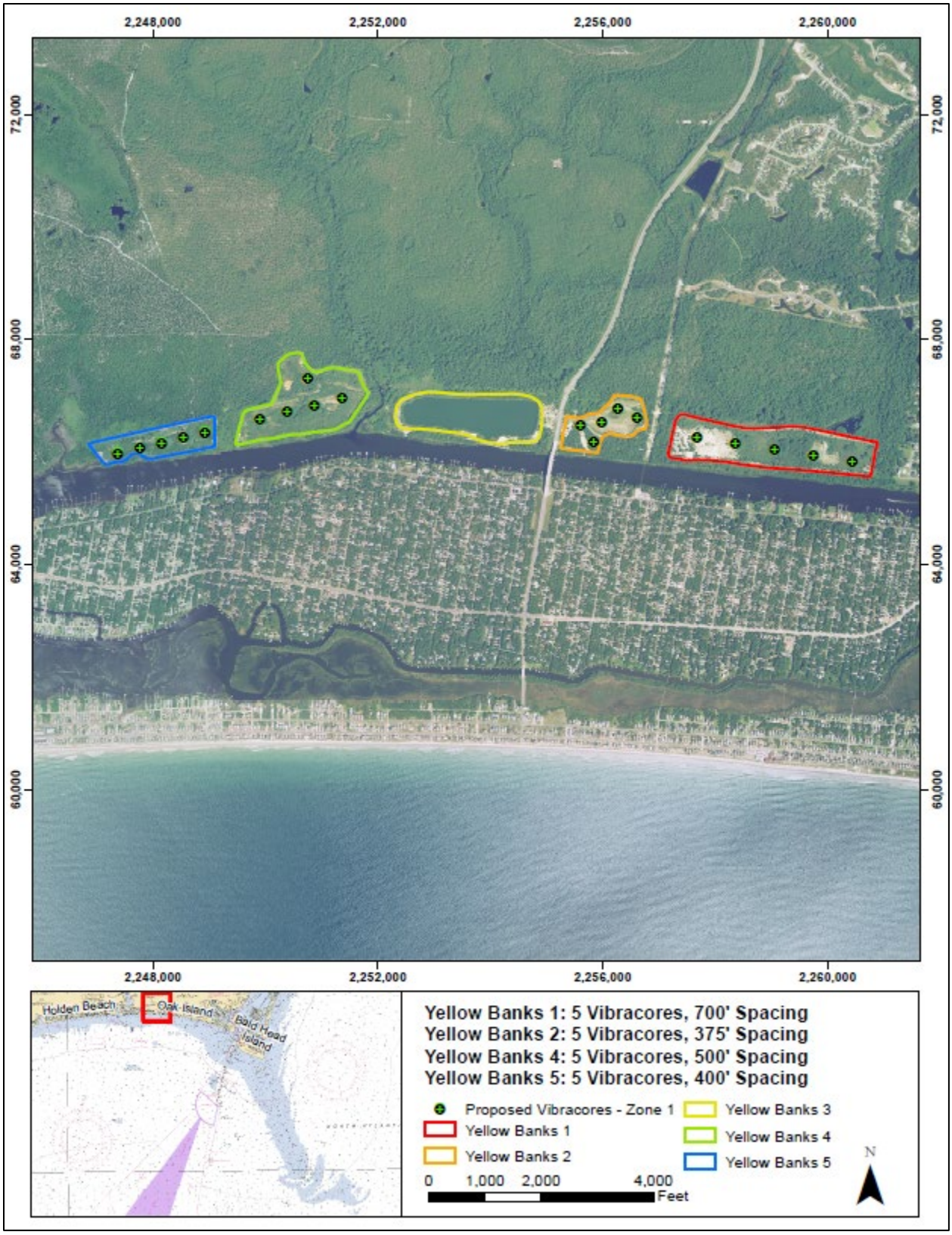

Figure 6-10: Yellow Banks Site and Proposed Vibracore Locations

6.7 Wilmington Harbor Channel

The Wilmington Harbor Channel requires regular maintenance dredging to ensure safe navigation conditions exist to allow access to the Port of Wilmington. Infilling of the channel occurs from sediment transport from the adjacent beaches of Caswell Beach and Bald Head Island as well as from the adjacent shoal system of Jay Bird Shoals and Frying Pan Shoals. Four (4) reaches of the Wilmington Harbor Channel were identified to contain beach compatible material as listed below:

- Smith Island Channel
- Baldhead Shoal Channel Reach 1
- Baldhead Shoal Channel Reach 2
- Baldhead Shoal Channel Reach 3

Reconnaissance level vibracore collection is planned for Fall 2022 with the collection of 10 vibracores; two (2) within Smith Island Channel, two (2) within Baldhead Shoal Channel Reach 1, two (2) within Baldhead Shoal Channel Reach 2, and four (4) within Baldhead Shoal Channel Reach 3 as shown in Figure 6-11. Based on the past two projects to date over the last 18 years, the estimated volume associated with the Wilmington Harbor Channel is 1.6 Mcy over the 30-year plan.

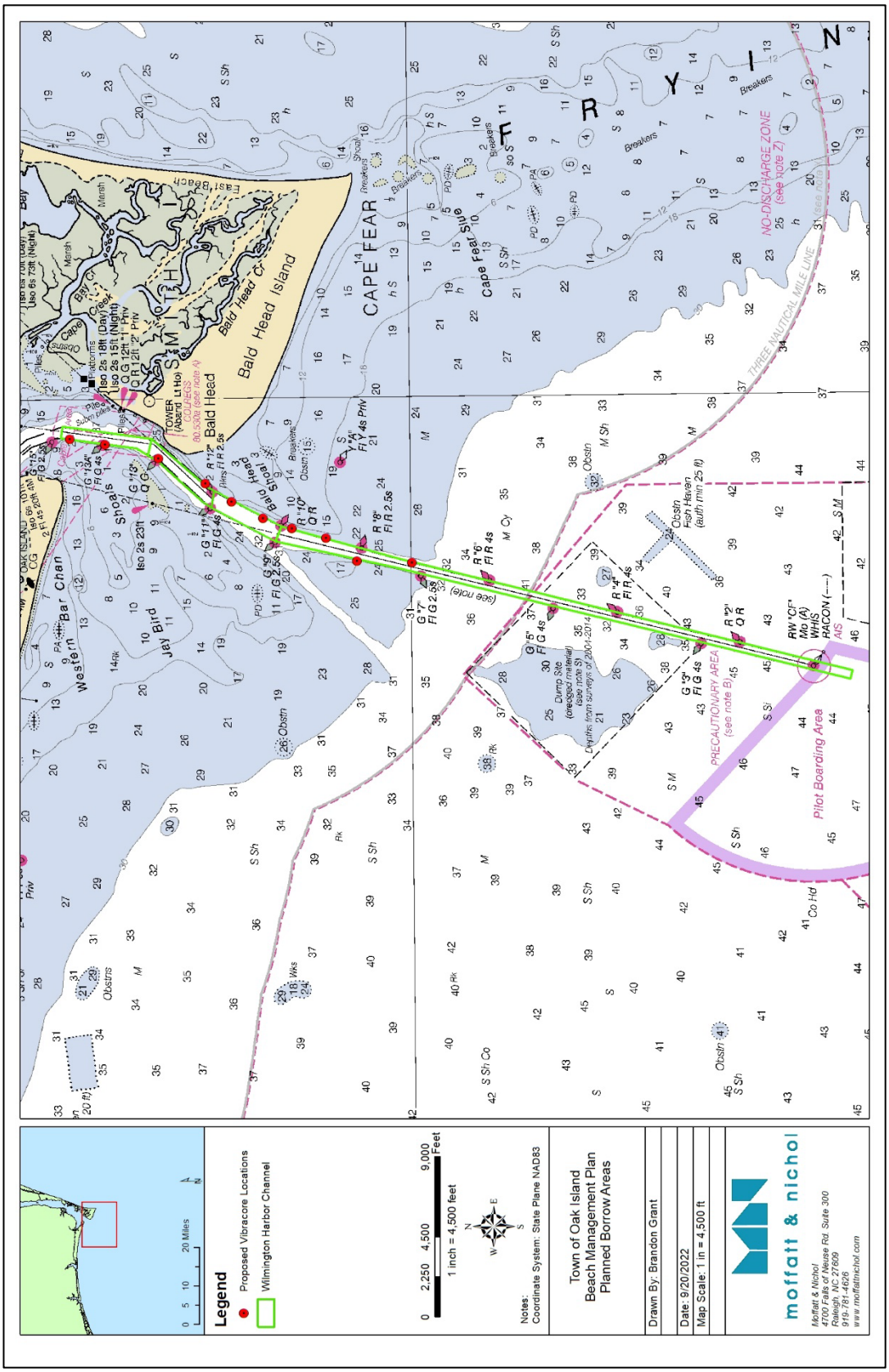

Figure 6-11: Wilmington Harbor Site and Vibracores

6.8 Sand Exploration

The Town also undertook additional borrow area exploration throughout Long Bay with the collection of 111 additional vibracores distributed across three additional sites as show below in Figure 6-12. The laboratory results from this extensive data collection yielded incompatible results for beach placement within the USGS and OKI Exploratory areas. The Central Reach area show results that met the NCAC criteria for beach placement; however, after minimal utilization for the 2021/2022 Beach Renourishment Project, the resultant material was not deemed compatible and therefore the site was abandoned for this project and future projects.

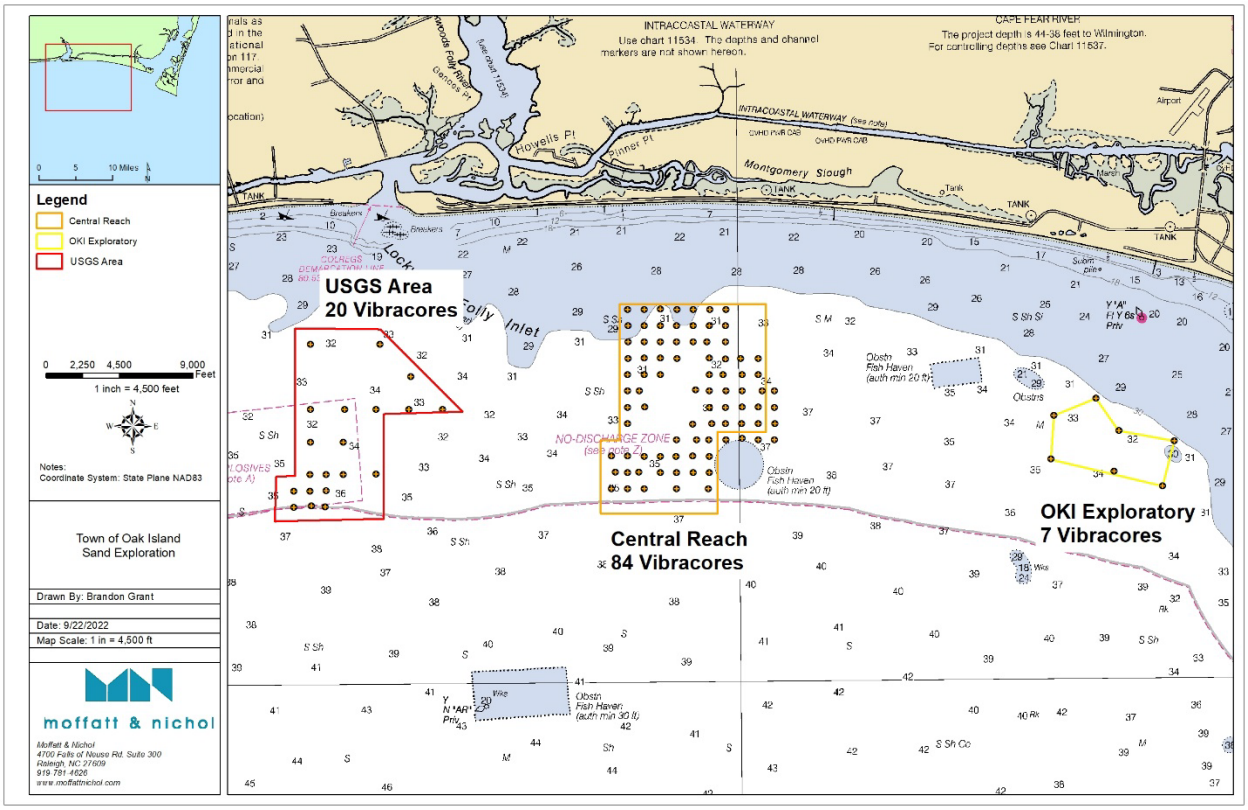

Figure 6-12: Sand Exploration

6.9 Summary of Potential Borrow Areas

The total volume available within all available sources is approximately 99 Mcy as presented in Table 6-12.

Table 6-12: Total Volume Available

Area	Total Preliminary Volume Over 30 - year Plan (cy)
Frying Pan Shoals - State	29,000,000
Frying Pan Shoals - Federal	58,000,000
Old ODMDS	1,000,000
New ODMDS	700,000
Lockwoods Folly Inlet Complex	4,052,000
Jaybird Shoals	NA
Yellow Banks	4,200,000
Wilmington Harbor Channel	1,600,000
TOTAL	**98,552,000**

Therefore, if all mentioned sources are incorporated the available material (99Mcy) would more than meet the 30 year sediment need of approximately 16.2 Mcy which includes background erosion, storm erosion, and potential sea level change. However, it must be noted that some of the borrow areas listed above (such as the Lockwoods Folly Inlet Complex) can only be used for certain areas of the island due to dredge plant constraints (pumping distance, etc.).

7.0 FINANCIAL PLAN

The purpose of this section is to document the financial plan the Town of Oak Island has developed to pay for and maintain this Beach Management Plan. The Town currently has multiple local funding streams to pay for beach management projects including: room occupancy taxes (accommodations fund), a sand tax, and general funds. From 2015 – 2022, the Town of Oak Island has provided approximately $19.9M of local funding toward beach and inlet management projects.

7.1 Room Occupancy Tax (Accommodations Fund)

7.1.1 Occupancy Tax History

This tax on accommodations is currently levied at 5% of gross receipts. The 5% is derived from a 3% tourism-related tax and a 2% beach protection and re-nourishment tax via the enacting legislation (N.C. S.L. 1997-364). Given the current needs for tourism related activities, the Town is planning to use 75% of both of these collections for beach nourishment and this equates to roughly $3.3 - $3.5M per year that can be set aside for beach nourishment. If needed, this amount could be increased to roughly $3.8M per year if 100% of the 2% set aside specifically for beach renourishment is used.

Figure 7-1 shows the historical receipts for the accommodations fund (individual 3% and 2% funding streams as well as the total. As one can see, the recent trends have been affected by COVID-19 and while the Town is hopeful that positive trends will continue, a very conservative growth rate of 1% is currently being used for future projections. The current fund balance as it sits today for the combined 5% accommodations fund is approximately $10.2M.

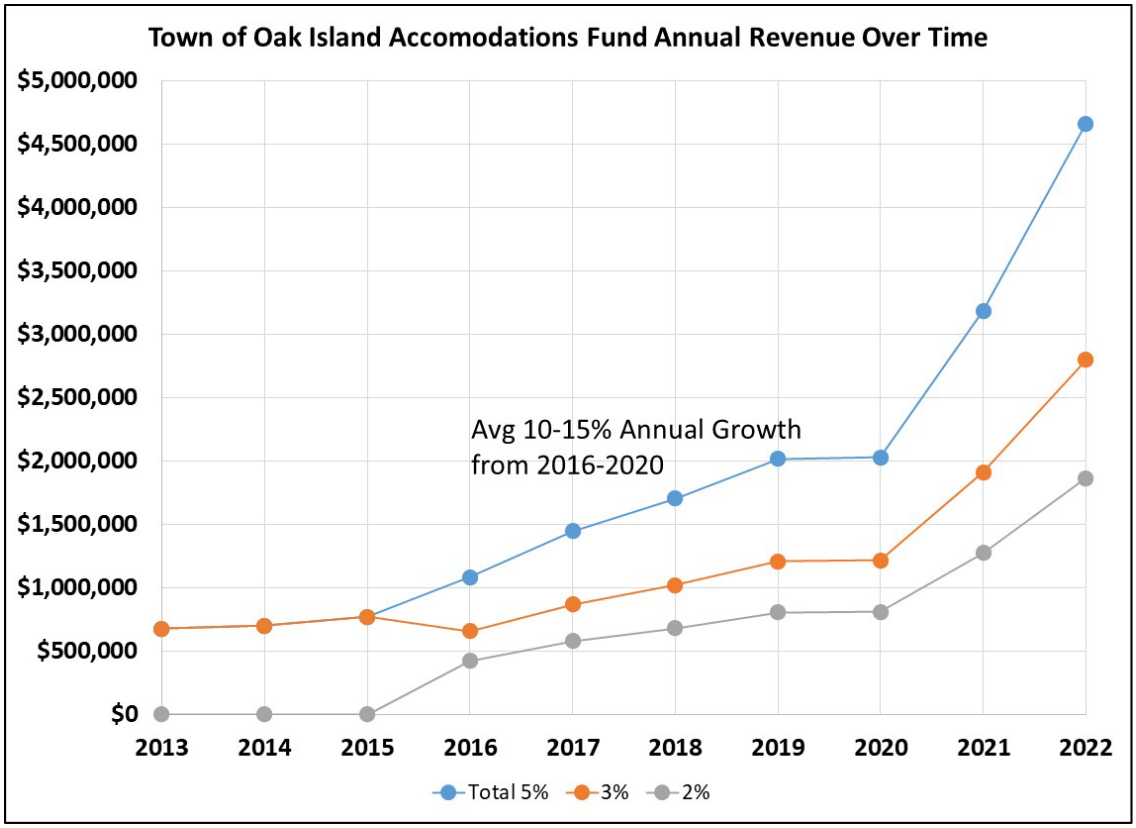

Figure 7-1: Total Yearly Accommodations Fund Tax (2013-2022)

7.2 Local Sand Tax

In addition to the accommodations taxes described above, the Town also collects a local sand tax to pay for beach renourishment projects. This is an ad-valorum tax rate that is currently $0.05 and equates to roughly $1.6M per year in revenue. Property re-evaluations in the future are currently forcasted to allow this fund to rise to $2.0M in 2024 and $3.0M by 2028 as Council sets the tax rate annually.

Figure 7-2 shows the historical receipts for the sand tax fund. The current fund balance as it sits today for the sand tax fund is approximately $2.3M.

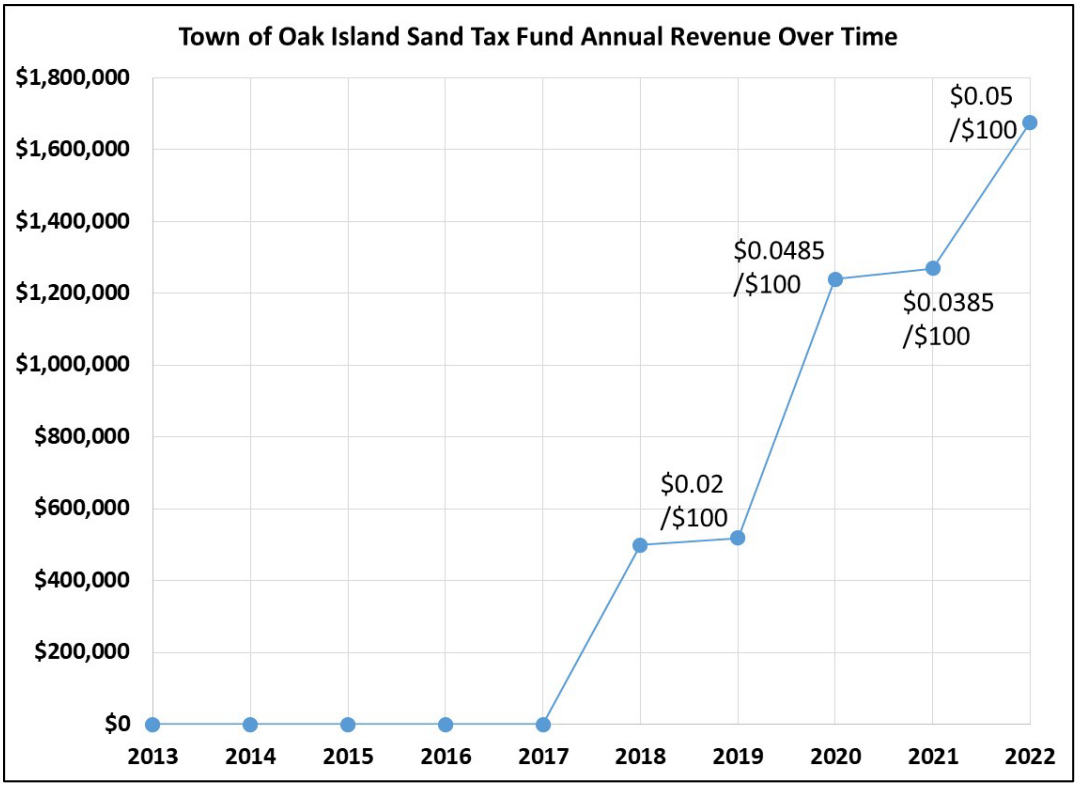

Figure 7-2: Total Yearly Sand Fund Tax (2013-2022)

7.3 General Fund

While usually a last resort, the Town of Oak Island has also in the past used receipts from the general fund to also help pay for beach renourishment projects. This fund consists of an ad-valorum tax rate that is currently $0.23 as well as other receipts from state shared revenues, fire district and permitting fees, etc. The total revenue for the Town's General Fund currently $15-$17M with expenditures of $14-$15.5M allowing for a net annual revenue of approximately $1.5M. The Town has built up a reserve in the general fund of approximately $16M but the Town has to keep a certain percentage of the fund balance to keep its bond ratings. The Town anticipates that approximately $1M per year could be set aside for beach nourishment funding if needed.

Figure 7-3 shows the historical receipts for the general fund. The current fund balance as it sits today for the general fund is $17.7M.

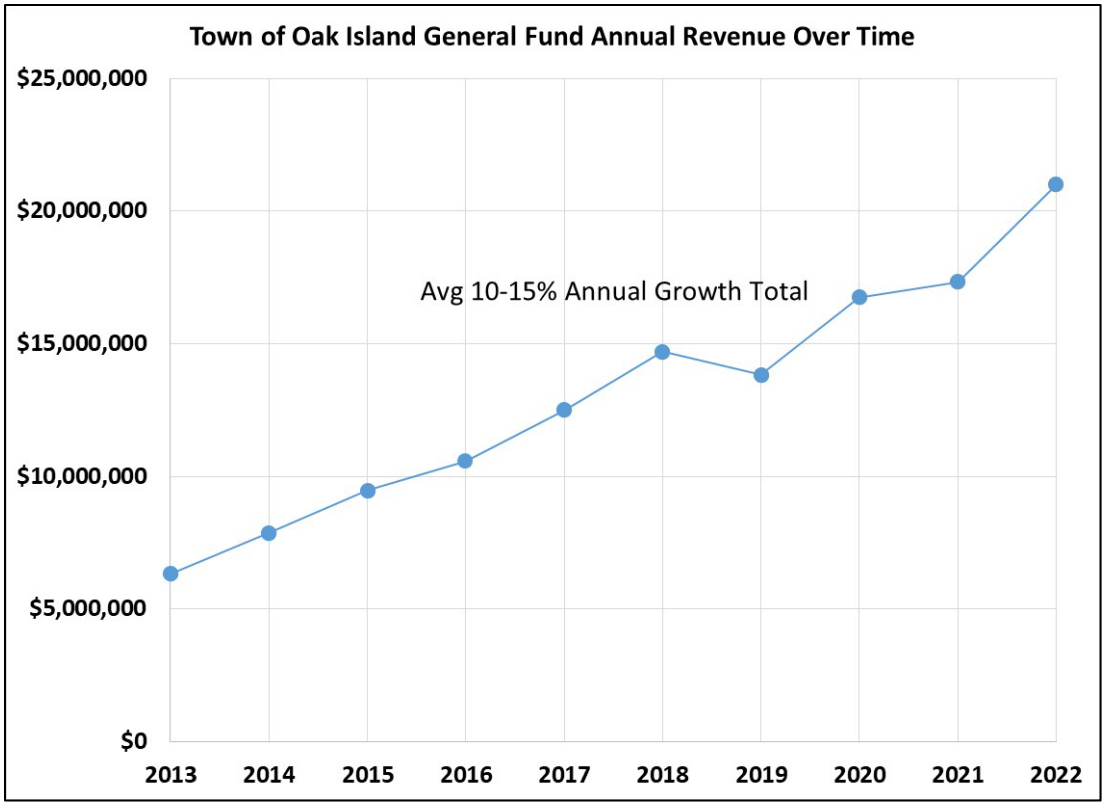

Figure 7-3: Total Yearly General Fund Tax (2013-2022)

7.4 Use Of Funds For Oak Island Beach Management Plan Projects

The anticipated projects for this Beach Management Plan are shown in Table 7-1. The 2024/2025 project is expected to require approximately 1.65 Mcy at a cost of $40M to verify the Town stays over the 10-yr return period storm triggers while the 1.38 Mcy projects, which include background erosion (1.3 Mcy) and SLR estimate (80,000 cy), planned for every 6 years are based on the analysis shown in Section 4.1 above. The costs are based on recent projects and expected borrow sources.

Table 7-1: Beach Management Plan Expected Project Cost

Anticipated Beach Management Plan Projects	Engineering Cost	Mob/Demob	Volume (cy)	Unit Rate ($/cy)	Total Cost
2024/2025 Oak Island Renourishment Project	$2,500,000	$6,500,000	1,650,000	$18.75	$39,937,500
Maintenance Events (6-yr Interval)	$1,000,000	$6,500,000	1,380,000	$18.75	$33,375,000

For the upcoming 2024/2025 renourishment project currently estimated to cost $40M, the Town plans to use the following funding streams (combination of on-hand funds and what will be received over the next 3 years).

- State Grant: $20M
- Accommodations Tax Fund: $9.1M ($10.2M on hand and receiving $3.3-3.8M/year)
- Sand Tax Fund: $7.1M ($2.3M on hand and receiving $1.6-$2.0M/year)
- General Fund: $3.8M ($17.7M on hand and receiving $1.5 M of NET revenue/year)
- Total: $40M

After the 2024/2025 renourishment project is constructed, the 6-yr maintenance projects are expected to commence. As shown in the table above the cost for the maintenance projects in today's dollars is $32M. As can be seen from the above, the total funding in today's dollars that the Town of Oak Island can use to fund the OIBIMP is between $4.9-$5.8M/year ($5.9 - $6.8M/year if general funds are used). Therefore, the $33.4M maintenance projects (in today's dollars) planned for on average every 6 years should have adequate funding over the long term given this funding stream. If unexpected storms or above average erosion occurs, the Town can look at special loans, bonds, adjustments to the tax rate, etc. to make up any potential shortfall.

Finally, it should be noted that all the above analyses do not include any additional State funding. Any additional funds from the State would extend the long-term sustainability of the project.

8.0 Public Involvement Process

15A NCAC 07J 1201(e) requires that the Town provide the opportunity for public comment on this Beach Management Plan. On October 4, 2022, a public information and comment session was held at the Oak Island Town Hall. This public information and comment session was advertised in the State Port Pilot Newspaper on September 21, 2022.

87 comments were received from the public as a result of the comment session. All comments received were taken into consideration by the Town. All such comments and responses are provided in Appendix D of this Beach Management Plan.

9.0 SUMMARY

The Town of Oak Island (Town) has developed this Beach Management Plan utilizing the criteria established in 15A NCAC 07J.1200. The Town is well in to developing the OIBIMP. This plan was developed out of the Comprehensive Shoreline Management Plan (CSMP) (Moffatt & Nichol, 2016) which was finalized in 2016 as a pre-feasibility level study to improve the level of storm protection provided to the citizens and visitors of Oak Island. At the same time, the Town implemented the Oak Island Shoreline Mapping Program (OISMP) in 2016 which assess current and historical beach conditions utilized in the formation of strategies for future beach management efforts. This is accomplished though surveys performed annually and after large storm events to assess storm induced shoreline and volume change. This is a critical aspect of the OIBIMP that will continue to be implemented throughout the life of the plan.

The data collected from the OISMP has allowed the Town to move forward with an in-depth analysis of its beach sand volume needs. This was accomplished through in-depth modeling efforts to quantify sand volume loss associated with the background erosion and storm induced erosion over the next 30-years. The OIBIMP has developed volumetric nourishment triggers to identify when nourishment events should occur. Based on discussions with the Town, this Beach

Management Plan will maintain the 10-year LoP. Results from the most recent surveying efforts are shown in comparison with the 10-year LoP and 25-year LoP below in Table 9-1.

Table 9-1: Project Performance Comparison

Reach	10-yr Level of Protection Trigger Volume (cy/ft)	25-yr Level of Protection Trigger Volume (cy/ft)	2022 Reach Average Volume (cy/ft)
Oak Island-East End 210+00 - 290+00 (Eastern Town Limits – SE 63rd St)	307	315	296
Oak Island-East 300+00 - 420+00 (SE 63rd St – 16th Pl East)	257	283	275
Oak Island-Central 430+00 - 500+00 (16th Pl East – 10th Pl West)	235	244	252
Oak Island-West 510+00 - 590+00 (10th Pl West – 42nd Pl West)	231	242	263
Oak Island-West End 600+00 - 680+00 (42nd Pl West – West End Parking Lot)	238	249	284

A project is expected to occur in 2024/2025 and future maintenance renourishment projects will take place every 6 years along the Oak Island Oceanfront. The total volume need also accounts for storm losses and sea level rise (SLR) projected over the next 30-years. The total volume need is summarized in Table 9-2. Dredge operations that construct the nourishment projects require additional sand to be available. These projects implement dune planting to establish and maintain the vegetation to stabilize the entire dune system for the life of the plan.

Table 9-2: Estimate of Oak Island 30-year Volume Need of Material Placed on Beach and in Borrow Areas

	30 Year Placed Volume Need (cy)	30 Year Dredge Volume Need (cy)
2024/2025 Project	1,650,000	2,145,000
Maintenance Projects (6-yr Cycle)	6,500,000	8,450,000
Storms	3,900,000	5,070,000
SLR	400,000	520,000
TOTAL	**12,450,000**	**16,185,000**

The Town has also undertaken an extensive sediment sampling program was implemented in 2019 to identify the native beach sediment characteristics and verify the compatibility and quantity of existing sediment sources adjacent to Oak Island. This effort determined the quantity and quality of potential sediment sources available for the next 30 years. Offshore sources consist of Frying

Pan Shoals, which lies both within and outside of State waters), the Old and New ODMDS's, Lockwoods Folly Inlet Complex, Jay Bird Shoals, and Yellow Banks. Additional vibracore samples are being collected in the Fall of 2022 to refine the Frying Pan Shoals and ODMDS borrow areas. The total volume available within all available sources is approximately 99 Mcy as presented in Table 9-3.

Table 9-3: Total Volume Available

Area	Total Preliminary Volume Over 30 - year Plan (cy)
Frying Pan Shoals - State	29,000,000
Frying Pan Shoals - Federal	58,000,000
Old ODMDS	1,000,000
New ODMDS	700,000
Lockwoods Folly Inlet Complex	4,052,000
Jaybird Shoals	NA
Yellow Banks	4,200,000
Wilmington Harbor Channel	1,600,000
TOTAL	**98,552,000**

Therefore, if all mentioned sources are incorporated the available material (99 Mcy) would more than meet the 30-year sediment need of approximately 16.2 Mcy which includes background erosion, storm erosion, and potential sea level rise. However, it must be noted that some of the borrow areas listed above (such as the Lockwoods Folly Inlet Complex) can only be used for certain areas of the island due to dredge plant constraints.

Through the Accommodations Fund the Town is planning to use 75% for beach nourishment and this equates to roughly $3.3 - $3.5M per year. The Town is assuming a 1% growth rate for this fund. The Sand Tax Fund equates to roughly $1.6M currently but is forecast to rise to $2.0M in 2024 and $3.0M by 2028. The Town has built up a reserve in the general fund and anticipates that approximately $1M per year could be set aside for beach nourishment funding if needed. The current funding streams available to the Town are adequate for providing and maintaining the 10-year LoP as set by this plan.

The Town held a public information and comment session on October 4, 2022, where comments were recorded and have been included in Appendix D in accordance with 15A NCAC 07J 1201(e).

10.0 REFERENCES

Moffatt & Nichol. (2016). *Town of Oak Island, NC Comprehensive Shoreline Management Plan.*

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