Flagler County, FL

BEACH AND DUNE MANAGEMENT STUDY

Prepared for:

Flagler County
Engineering Department
&
Flagler County Board of County Commissioners

FLAGLER COUNTY FLORIDA

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olsen associates, inc. Coastal Engineering

Flagler County, FL
Beach and Dune Management Study

Report Prepared for:
Flagler County Engineering Department and
Flagler County Board of County Commissioners

Prepared by:
Olsen Associates, Inc., Jacksonville, FL

July 2022

EXECUTIVE SUMMARY

This report summarizes the findings of a beach management study for the Flagler County, Florida Atlantic Ocean shoreline and presents preliminary recommendations for developing and implementing a county-wide beach management plan. At present, Flagler County does not have a comprehensive, proactive beach management strategy to restore the beach and dune, perform long-term maintenance, or repair episodic storm damages. The purpose of this study is to evaluate conditions of the beach and dune using a comprehensive April 2021 physical survey, develop and evaluate project alternative concepts, summarize the general tasks required to initiate a program, and estimate funding requirements to implement a comprehensive, county-wide plan. Of particular interest is the probable, order of magnitude financial responsibility of the local community to implement a comprehensive beach management program.

County-wide beach and dune project concepts were developed with consideration of historical beach and dune erosion rates, varying scopes of restoration, planned shore protection and restoration projects, protected natural resources, and available funding mechanisms. This study focuses on the entire 18 miles of Atlantic Ocean shoreline in Flagler County. In this report, the following topics are evaluated:

- Existing beach and dune conditions,
- Beach and dune project alternative concepts (initial construction and 50-year maintenance),
- Sand volume requirements
- Sand source options,
- Beach management concept performance assessment,
- Project cost analysis,
- Cost-sharing analysis and opportunities,
- Funding requirements, and
- Project implementation considerations.

The findings are based upon the use of the existing physical, engineering, and economic information and are intended to support a relative comparison of project alternative concepts and the selection of a general management strategy for the Flagler County beach and dune. Subsequent detailed data collection, analyses, and engineering are needed to design, permit and implement a county-wide project.

The alternative concepts described in this report are intended to reestablish and maintain a wide protective beach and dune, while minimizing impacts to the coastal system and adjacent natural resources. A restored beach and dune would provide recreational benefits and environmental habitat in addition to storm protection. For this study, it is assumed that the management program will seek to establish and maintain conditions for a 50-year period. This is consistent with typical U.S. Army Corps of Engineers (USACE) project planning studies.

Key findings that may be considered in selecting a beach and dune management strategy for Flagler County include the following:

- The Flagler County beach and dune experienced significant impacts during Hurricanes Matthew (2016), Irma (2017), and Dorian (2019). The effects of these storms to the county's beach and dune and the realization that an effective proactive storm response plan would benefit the community at-large highlighted the need to consider, develop and implement a county-wide beach and dune management program.

- The Flagler County shoreline (~18 miles) lost approximately 3.6 million cubic yards (Mcy) of sand (~38 cy/ft, on average) between June 1972 and April 2021 (~48.9 years), measured to profile closure. On an average annual basis, this is equivalent to about 73,500 cy/yr, or about 0.8 cy/ft/yr for the 18 miles of county shoreline.

- The Flagler County shoreline lost approximately 1.1 Mcy of sand (~12 cy/ft, on average) between July 2011 and April 2021 (~9.7 years) for the 18 miles of shoreline, measured to profile closure. On an average annual basis, this is equivalent to a sand loss rate of about 112,000 cy/yr, or about 1.2 cy/ft/yr.

- The average annual sand loss rate from the Flagler County beach and dune was about 76% higher over the 9.7 years from July 2011 to April 2021 than the rate that occurred over the previous ~39 years between June 1972 and July 2011. The equivalent average annual sand loss rate between June 1972 and July 2011 was about 63,500 cy/year. The noted increase in sand volume loss rate is believed to be directly related to the significant impacts associated with Hurricanes Matthew, Irma and Dorian.

- There are hardbottom resources (coquina rock outcroppings on the beach and nearshore) located along about 7.6 miles of northern Flagler County shoreline, from the Marineland rock revetment through most of Hammock Dunes (R-2.3 to R-43.5). The rock is a natural resource protected by both the Federal government and the State of Florida. The presence of beach and nearshore rock will affect the scope of a beach and dune plan and associated construction methodology. Impacts to this resource from project-related activities such as burial with beach fill sand and indirect turbidity effects must be avoided or minimized and mitigated. Only those impacts that are demonstrated to be unavoidable and justified are eligible for mitigation. Temporal and spatial variability of rock exposure is typical and will influence how project impacts to the rock may be viewed.

- This study exclusively considers sand volume replacement (beach nourishment and dune restoration) to restore and maintain suitable beach and dune conditions along the Flagler County shoreline. Prior analyses performed by the USACE (2015b) evaluated other beach management and shore-stabilization approaches, but ultimately beach and dune restoration and maintenance was demonstrated to be the most feasible method.

- Presently, there are two planned and permitted beach and dune restoration projects to address portions of the southern county shoreline. These are (1) the Federal USACE Coastal Storm Risk Management (CSRM) project (R-80 to R-94) and (2) the Local Flagler/FDOT project (R-70 to R-80 and R-94 to R-101) *. The location and extent of these is denoted as the "current plan" in **Figure ES-1**.

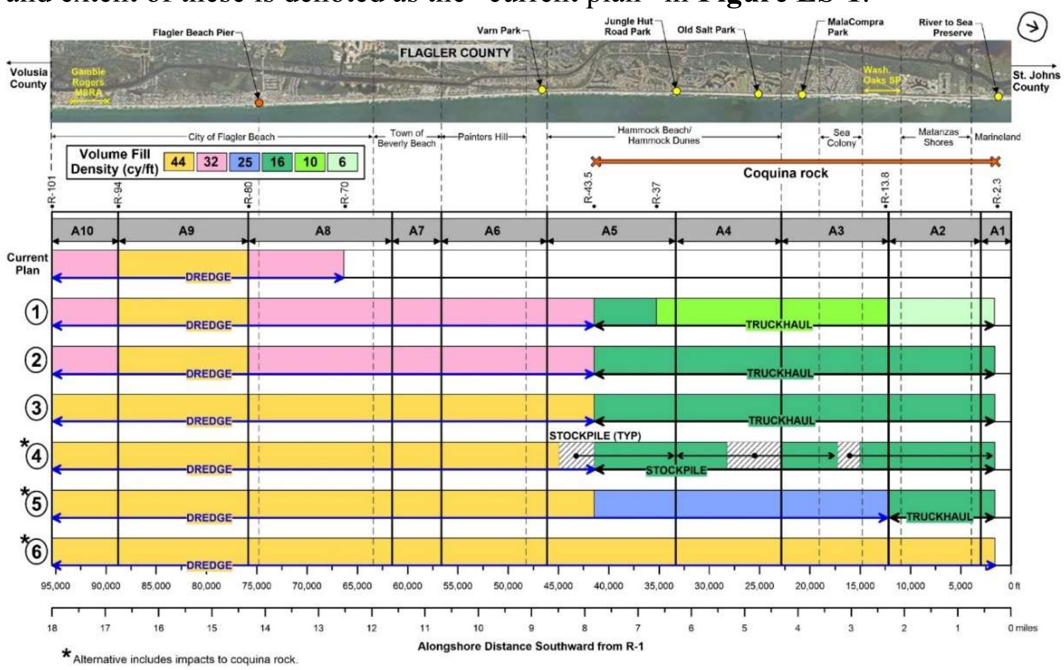

Figure ES-1: Assumed initial beach and dune fill volume densities for Flagler County, FL beach management concepts.

* Due to local budgeting constraints, the northern limit of the northern segment of the Local Project was reduced from R-64.5 to R-70 during the engineering design phase of the project.

- There are two other planned dune repair projects in northern Flagler County. One is sponsored by the Hammock Dune Owners Association (HDOA) (R-35.1 and R-47.9) and the other is sponsored by Flagler County (R-2.3 to R-11.8, R-15.9 to R-24.3, and R-47.9 to R-65). These projects are limited in scope and only allow limited sand placement above the mean high-water line. They do not provide for fill restoration and maintenance of the beach and dune.

- For this study, six project alternative concepts were developed for county-wide beach and dune restoration and maintenance. Several factors were considered, including: historical conditions, long-term sand loss rates, anticipated future sand loss rates, sea level rise, planned projects (USACE CSRM & Flagler/FDOT), construction methodologies, location and extent of coquina rock, and possible dune enhancements for resiliency. The assumed alongshore fill densities for initial construction of each of the six alternatives is summarized in the **Figure ES-1**.

- The estimated sand volume required to construct and maintain these six alternatives for the 50-year planning period ranges from 9.3 to 11.1 Mcy. The initial placement volume ranges from 2.3 Mcy to 4.2 Mcy of sand. This is based upon April 2021 beach and dune conditions and the 2021 scope of the Federal project. Required volume may increase in the future as continued sand losses from the beach and dune occur. The sand volume required to maintain the restored beach and dune after initial construction is the same for all six alternatives and totals 6.9 Mcy. This is equivalent to about 138,000 cy/yr over the 50-year planning period. The annual equivalent placement rate is higher than the historical sand loss rate of 112,000 (2011-2021) for two reasons: (1) the larger maintenance volume assumed by USACE was adopted herein for the 2.6-mile Federal CSRM project and (2) the sand loss rate is higher when considering only the upper beach. The upper beach sand loss rate was used for 7.6 miles of shoreline where coquina rock occurs, as sand placement will likely be limited to the area above mean low water. The assumed alongshore fill densities for maintenance renourishment of each of the six alternatives is summarized in **Figure ES-2**.

- An acceleration in sea level rise (SLR), assuming currently accepted USACE Intermediate project for future sea level rise, will increase the sand demand volume and corresponding cost. The USACE Intermediate SLR projection would increase the total required maintenance sand volume by 22%, from 6.9 Mcy to 8.4 Mcy.

- Typically, hydraulic sand placement using a dredge is not cost-effective where fill densities are small (i.e., less than about 20 cy/ft or so). As noted in **Figure ES-2**, mechanical placement is assumed in these areas. Mechanical placement refers to upland sand delivered via truck, or offshore sand pumped into stockpiles and subsequently transported to the desired location. Where coquina rock occurs, it is expected that fill densities will need to be small to avoid impacts to the rock resource. For areas with larger fill densities, it is assumed that all beach and dune construction and maintenance will be constructed by dredge.

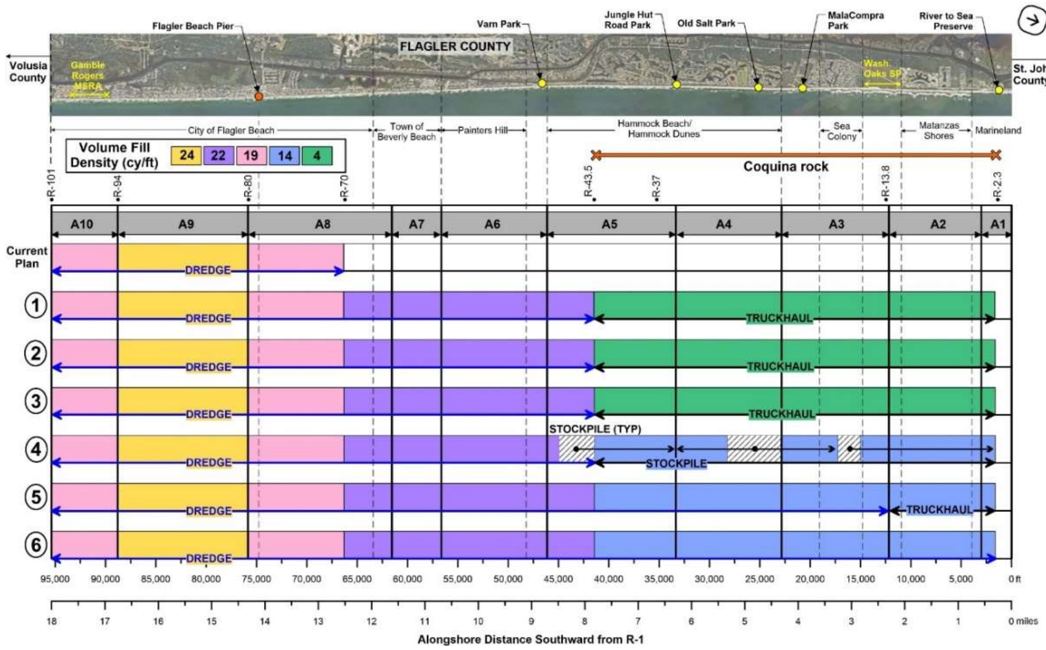

Figure ES-2: Assumed future maintenance beach and dune fill volume densities for Flagler County, FL beach management concepts.

- Both offshore and upland sand sources are available for beach and dune restoration and maintenance for the 50-year project planning period.

- The offshore sand source that has been identified is about 11 nautical miles offshore of central Flagler County. It is located in an area described in past USACE sand search investigations as Area 3 (**Figure ES-3**).

- Portions of sand from Area 3A, which is within the larger Area 3, have been delineated and permitted for the planned Federal CSRM project and Flagler/FDOT project. Additional sand volume is available in this area to accommodate the 50-year sand volume requirement for a beach management program for the 18 miles of Flagler County shoreline. Area 3 is believed to contain more than 43 Mcy of sand, which is about 4 times the amount needed to construct and maintain the largest beach and dune restoration (Alternative 6) considered in this study. The area contains more than 3.4 times the required sand volume when considering the potential effects of sea level rise. As such, it is expected that this sand source could also accommodate sand requirements for future post-storm repairs that may occur during the 50-year planning period.

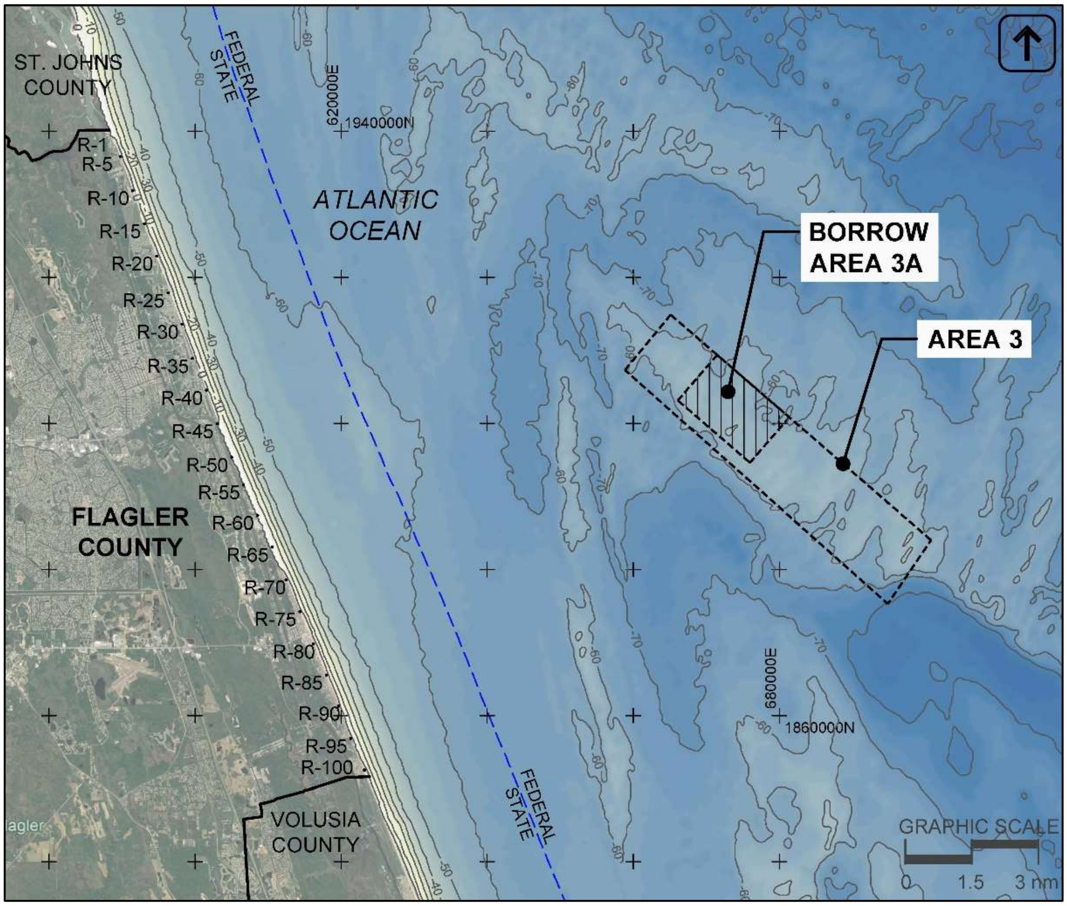

Figure ES-3: Location of offshore sand source Area 3A relative to Flagler County shoreline.

- Additional geotechnical data, analyses, design, permitting, and Bureau of Ocean Energy Management (BOEM) lease agreements will be required to access and use additional sand within Area 3A. To access sand within the larger Area 3 sand shoal yet outside of the Area 3A limits, geophysical is additionally required.

- Upland sand that has been deemed suitable by FDEP for placement on the Flagler County beach and dune is available through commercial mining operations located between 60 and 120 miles from Flagler County.

- In this study, probable order of magnitude costs are based upon those associated with typical construction techniques to build beach and dune projects using offshore (dredging) and upland sand (truck haul). Costs assumptions used in the analysis were based upon recent market conditions, recent similar projects, and costs typical to each respective industry.

- The cost analysis considers the total cost for initial construction of the beach and dune and the total cost of future periodic events required to maintain the restored beach and dune. For intercomparison of project concepts, the total probable cost for implementation of the alternatives is annualized to a probable Equivalent Annual Cost (EAC). A planning period of 50 years and discount rate of 2.25% is used. The EAC represents the annual equivalent cost of a project for the 50-year planning period. That is, to meet the total project cost requirement, a funding amount equivalent to the EAC will be required annually for 50 years.

- The <u>total</u> probable EAC for the six alternatives considered in this study ranges from $7.9M to $15.9M, including the alternatives that are assumed to impact hardbottom resources. Avoidance of impacts to the rock resource reduces the cost by eliminating the need for costly rock resource mitigation. Based upon similar recent projects in Florida, it is assumed that the cost to construct the likely required rock mitigation will be $2,350,000 per acre, plus 15% contingency. For the alternatives assumed to avoid impacts to the north county rock resources, the <u>total</u> EAC ranges from $7.9M to $8.8M.

- It is anticipated that a future acceleration of SLR will increase the overall cost to implement a beach management program in Flagler County. The cost increase is directly related to the additional sand that is expected to be required to accommodate the erosional effect of future SLR. For example, the USACE Intermediate SLR scenario would increase the total probable EAC by 14%, from $8.8M to $10.0M, for the "average" project concept that includes full beach restoration in the south county and dune restoration and enhancement in the north county (Alternative 3, see **Figure ES-1**).

- The initial cost to construct the first five alternative concepts ranges from $70.5M to $137.7M. Existing Federal, State and FDOT funding as well as existing cost-share opportunities from the State (for Critically Eroded shorelines and State Parks) can provide between 28% and 42% of the initial cost. To accommodate the remaining balance, Flagler County would need to consider funding opportunities within the county. This would apply to initial construction, as well as future periodic nourishment events. Funding vehicles such as loans, bonds, etc. may be required to cover expenses at the time of a construction event and repaid over time using revenue from cost-sharing opportunities and a local funding source.

- It is anticipated that program cost for any selected alternative will not be the sole responsibility of Flagler County and the local stakeholders. That is, there are cost-sharing opportunities available with the USACE and the State of Florida. Currently, cost-sharing is available for 2.6 miles of shoreline included in the authorized Federal CSRM (R-80 to R-94) and 8.1 miles shoreline designated as critically eroded by FDEP. The Federal CSRM provides for 65% USACE funding during initial construction. The non-Federal portion is eligible for FDEP cost-sharing because that reach of shoreline is also designated at critically eroded. The areas of the county shoreline that are designated at critically eroded by FDEP are eligible for up to 50% cost-sharing from the State of Florida for all project-related costs. Presently, about 45% of the Flagler County shoreline is designated as critically eroded. Flagler County and local stakeholders will be responsible for all other project-related costs.

- Applying the maximum existing cost-sharing opportunities to the total probable EAC, the probable local EAC responsibility ranges from \$5.5M to \$13.1M per year for the 6 alternatives considered in this investigation, including those with assumed impacts to rock resources. For those alternatives that are assumed to avoid impacts to the rock resources, the local responsibility for the total probable EAC ranges from \$5.5M to \$6.2M.

- Expansion the of the length of shoreline that is designated as Critically Eroded by FDEP and the length of shoreline along which an authorized Federal CSRM project is located would increase cost-sharing opportunities and potentially reduce the local responsibly for project costs. Areas most likely eligible for increases in either of the length of designated critically eroded shoreline and a Federal CSRM project are those areas south of R-50 (i.e., Varn Park) that are not already covered by FDEP and USACE eligibility for cost-sharing.

- In this study, future cost-sharing scenarios were evaluated to determine potential reductions in the cost to the local sponsor. This was done through simple assumptions of eligibility, not a detailed analysis that considered all of the USACE and FDEP eligibility criteria. Three expanded cost-sharing scenarios are shown in **Figure ES-4**. The two most probable scenarios are Scenarios 1 and 2. These were applied to the total probable EAC for the "average" project concept (Alternative 3) to determine the resulting reduction in the local share. Application of Scenario 1 resulted in 3.7% decrease in the local probable EAC requirement, from \$6.2M to \$6.0M. Likewise, application of Scenario 2 resulted in a 13.2% decrease in the local probable EAC requirement, from \$6.2M to \$5.4M.

- Scenario 3 represents a theoretical, but unlikely future cost-sharing scenario, which assumes that the entire county shoreline (18 miles) will be eligible for the maximum cost-sharing from both the USACE and FDEP. This scenario demonstrates that even under the most favorable theoretical condition, the County and local stakeholders will be responsible for contributing local funds to implement a beach and dune management program. This highlights the essential need for Flagler County to establish a dedicated source of local funding regardless of project scope and/or project cost-sharing opportunities.

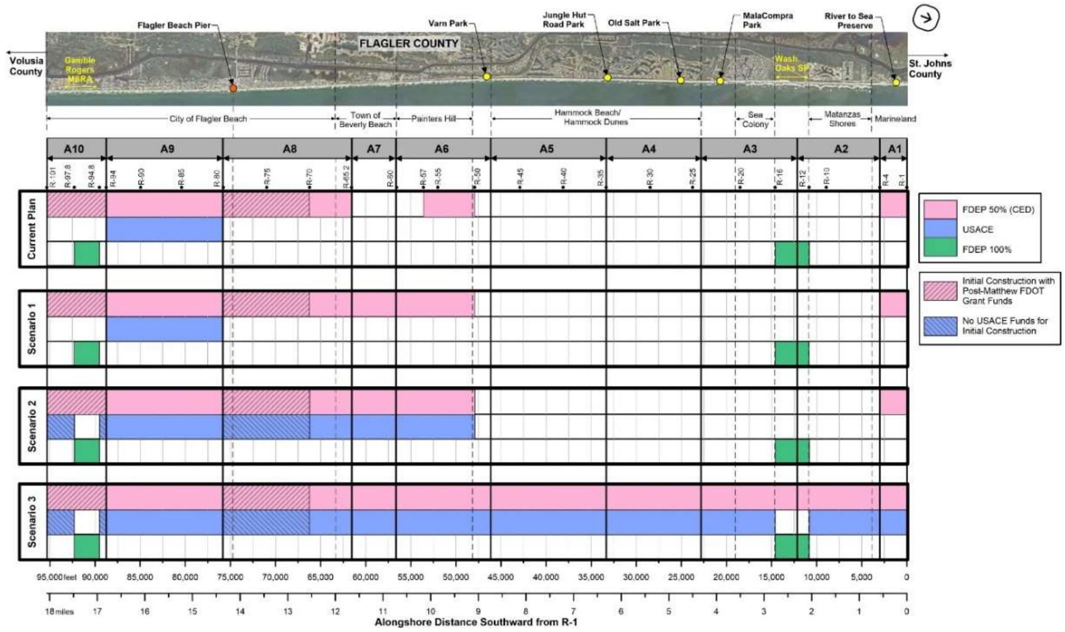

Figure ES-4: A comparison of current and potential future cost-sharing scenarios for Flagler County, FL beach management.

Principal recommendations and implementation items include:

1. <u>Establish governance and administrative structure for the beach management program.</u> A comprehensive approach to beach and dune management will be the most effective and successful approach to reestablish and maintain desired beach and dune conditions. It is recommended that Flagler County consider assuming governance over all 18 miles of shoreline and assume the position as Local sponsor and administrative head for all beach management activities in Flagler County. There are administrative, physical, and financial benefits to all stakeholders by the county government assuming this role. These include, but are not limited to: (1) management of a community-wide program with a common goal; (2) development of a comprehensive plan for the entire shoreline, rather than piecemeal programs that may not have common objectives; and (3) contracting representation with cost-sharing government agencies (i.e., USACE, FDEP, FEMA, etc.) that is not available for non-governmental interests. This does not necessarily mean that Flagler County will be entirely financially responsible for the local share, only serve as the administrative head to access potential funds. The administrative responsibilities could be support through a stakeholder association or committee to reduce specific county responsibilities.

2. Identify and establish a local funding source. To support the implementation of a comprehensive county-wide beach management program, the local community (Flagler County and benefiting stakeholders) will need to establish a local source of revenue. Project construction will not be possible without local funding. State of Florida and USACE funding opportunities require cost-sharing from the local project sponsor. Given that Flagler County does not have a current funding plan, it is recommended that the County consider commissioning a funding study to evaluate community interest in establishing both a local funding source and the method of revenue collection from stakeholders that will benefit from a beach management program.

3. Survey the physical extent and habitat conditions of coquina rock outcroppings along the beach and nearshore. Prior to development of a detailed project plan, it is recommended that high-resolution mapping of the rock be conducted by the County to quantify the rock location, limits, and variability. This information is necessary for gaining permission to construct a project (beyond minimal dune repairs) along the northern county shoreline. The extent and functionality of the rock will determine the scope of possible restoration that can be implemented along the northern 7-8 miles of county shoreline. It will also facilitate regulatory review of possible impacts and required mitigation. It is recommended that the County limit the extent of potential project-related impacts to hardbottom.

4. Assess feasibility of various sand delivery methods and implications for nearshore resources. A combination of offshore and upland sand will likely be needed for beach and dune restoration and maintenance along the Flagler County shoreline.

    a. Hydraulic placement of offshore sand by dredge is most applicable for regions of Flagler County where nearshore rock and hardbottom do not exist (R-43.5 to R-101), since this placement method poses several potential impacts to hardbottom, including direct burial from sand placement, indirect impacts due to turbidity and sedimentation from hydraulic effluent, and direct burial from pipeline deployments.

    b. Dredged sediment could also be pumped into stockpiles and subsequently loaded and transported by off-road trucks along the beach. This delivery method for offshore sand may be utilized to potentially eliminate impacts associated with direct hydraulic sand placement in areas where hardbottom is present. If sand stockpiles are to be constructed north of R-43.5, where beach and nearshore rock are common, the detailed coquina rock mapping survey should be used to inform stockpile placement location decision-making. Locations where nearshore rock does not exist or is limited should be targeted in order to reduce impacts to resources and thus associated mitigation requirements.

c. Truckhaul projects delivering upland sand are most practical for regions of Flagler County with nearshore hardbottom resources (R-2.3 to R-43.5). Mechanical placement of upland sand is more controlled and less impactful than hydraulic placement sand. However, upland sand purchased from commercial mines is expensive, in part due to transportation costs. Additionally, sand placement rates are much lower compared to offshore sources.

5. Initiate a detailed design investigation of the selected plan. If the County agrees to pursue a comprehensive program and identifies a preferred project plan, it is recommended that a detailed design investigation be initiated as soon as possible to develop a more specific project scope and support regulatory permitting. The investigation would verify required beach and dune dimensions as well as sand borrow area requirements. This effort can be conducted simultaneously with efforts to established a project funding program.

6. Expand the limits of the permitted offshore borrow area. It is recommended that priority be given to acquiring additional geotechnical data in subregion Area 3A to support design and permitting of additional sand borrow area(s) to meet the County's beach and dune restoration and maintenance needs. It is recommended that data collection occur during the summer season when wind and wave conditions are most favorable for offshore work. Additionally, a multibeam survey, a detailed geophysical (seismic sub-bottom, sidescan, and magnetometer) analysis, and geotechnical data collection (Vibracores) will be required to utilize the larger "Area 3" shoal identified in USACE 2015b and OAI 2020b.

7. Seek regulatory permits for a selected plan and expanded borrow area. Additional State and Federal permits are required to implement a comprehensive beach management program along the entire 18 miles of Flagler County shoreline. The current authorizations, permits and BOEM lease agreements for the Federal and Local projects are adequate for placing beach fill along ~6.5 miles of shoreline from R-64.5 (southern Beverly Beach) to R-101 (Volusia County line). State permits for this area will need to be renewed every 15 years. Additionally, the USACE permit for the Local project has a 15-year life.

New USACE and FDEP permits will be required to extend a larger project north of R-64.5 and expand the offshore borrow area beyond currently permitted limits. Additionally, an expansion of the offshore sand borrow area in Federal waters will required a new BOEM lease agreement.

Applications for regulatory permits to support a county-wide project can be initiated as soon as a preferred plan is selected and more detailed design for the beach and dune and borrow area is completed.

8. Seek long-term easements along the entire 18 miles of county shoreline. Prior to construction of the currently planned and permitted Federal and Local projects, easements need to be secured for the entire shoreline between R-64.5 and R-101 (Volusia County line). Future expansion of the managed beach along Flagler County will require easements north of R-64.5.

9. Seek expansion of shoreline length that is designated as critically eroded by the Florida Department of Environmental Protection (FDEP). It is recommended that Flagler County continue to monitor beach and dune conditions and communicate any significant changes that occur to FDEP. In Flagler County, the most obvious location where this may be considered is between R-57 and R-65.2. This ~1.5-mile segment of shoreline exists between presently designated critically eroded segments of shoreline. Adding this segment of shoreline would result in a total of ~9.6 miles (about 53% of the total shoreline) of designated critically eroded shoreline in Flagler County.

10. Consider the efforts and benefits associated with a new USACE Feasibility Study that may increase the length of shoreline eligible for Federal cost-sharing. If initiated, a new CSRM feasibility study would assess the existing conditions and eligibility for federal participation along any requested reach of the Local Sponsor's (Flagler County's) shoreline. A new study would also include the effects of recent hurricanes that have occurred since the 2015 feasibility study (USACE, 2015b). Therefore, a new benefit-cost analysis could allow previously economically unjustified reaches of shoreline (where the benefits did not exceed costs) to be reconsidered for Federal participation.

    It is recommended that Flagler County consider potential benefits and outcomes from a new CSRM investigation. The cost-sharing benefit of the addition of any new eligible areas should be weighed against the cost to the County for the study and the time required to gain authorization and subsequent appropriations.

11. Conduct county-wide public beach access and parking inventory. Prior to a decision by the County to pursue a new CSRM study, it is recommended that a parking and access investigation be conducted. A beach access and parking assessment can serve and a preliminary, low-cost assessment for CSRM eligibility as well as be informative for the local communities to consider implementing potential enhancements to public parking and access to become eligible.

Flagler County, FL
Beach and Dune Management Study

Report Prepared for:
Flagler County Engineering Department and
Flagler County Board of County Commissioners

Prepared by:
Olsen Associates, Inc., Jacksonville, FL

July 2022

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Beach and Dune Management Study

July 2022

1.0 INTRODUCTION

This report summarizes the findings of the 2021-22 beach and dune management planning study for the entire 18 miles of Atlantic Ocean shoreline in Flagler County, Florida. Concepts and preliminary recommendations for future management activities are presented herein. Preliminary findings from this investigation were presented to the Flagler County Board of County Commissioners and the public on February 7, 2022.

1.1. Report Scope and Purpose

The purpose of this study is to support the development of a comprehensive, county-wide beach and dune management plan. Flagler County's beach and dune management needs will be identified and conceptual approaches for restoration and maintenance of the beach and dune will be presented. The work will also investigate the probable long-term costs and local financial requirements to support a management program. Accordingly, the following topics are included in this study:

- Background (physical setting and shoreline history),
- Current shoreline conditions,
- Management areas,
- Expected future sand requirements,
- Available sand resources,
- Restoration and maintenance alternatives,
- Cost analysis,
- Funding sources,
- Cost-sharing scenarios, and
- Project implementation considerations.

The findings herein are based upon the existing physical, engineering, and economic information and are intended to support a relative comparison of management approaches and the selection of a general strategy. Subsequent detailed engineering and design analyses will be required for the implementation of a specific project scope.

1.2. Study Authorization

This study was authorized by the Flagler County Board of County Commissioners as the Sixth Amendment to Flagler County Agreement RSQ No. 17-032Q. The notice to proceed was issued on February 8, 2021. The firm of Olsen Associates, Inc. of Jacksonville, Florida was selected by and contracted with the County through a Request for Qualifications (RSQ) for Professional Services for Coastal Engineering. The base contract was amended to provide for the services to conduct this study. The study is intended to serve as a strategic planning tool for future management initiatives for the restoration and preservation of the Flagler County Atlantic Ocean sandy beach and dune. Field data collection to document current beach and dune conditions was completed in April 2021 and made available to Olsen Associates, Inc. in June 2021.

1.3. Study Area

Flagler County is located on the northeast coast of Florida between St. Johns County to the north and Volusia County to the south (**Figure 1.1**). Flagler County has approximately 18 miles (95,000 feet) of sandy Atlantic Ocean shoreline. The shoreline is located on a barrier island, ~47 miles in total length that extends from Matanzas Inlet in St. John County (2.5 miles north of the Flagler County north county line) to Ponce de Leon Inlet in Volusia County (26.5 miles south of the Flagler County south county line). There are no tidal inlets along the Flagler County Atlantic Ocean coastline.

Along the Flagler County Atlantic Ocean shoreline, there are several municipalities and developed areas, including (from north to south):

- The Town of Marineland (R-1 to R-4.6)
- Unincorporated (R-4.6 to R-60.5)
    - Matanzas Shores OA (R-5 to R-11.9)
    - Sea Colony HOA (R-16 to R-20)
    - The Hammock (R-24.2 to R-47.9)
        - Hammock Beach HOA (R-24.2 to R-29.3)
        - Ocean Hammock HOA (R-29.3 to R-34.8)
        - Hammock Dunes HOA (R-35 to R-47.9)
    - Painters Hill (R-49.4 to R-60.5)
- Town of Beverly Beach (R-60.5 to R-66.8)
- City of Flagler Beach (R-66.8 to R-101)

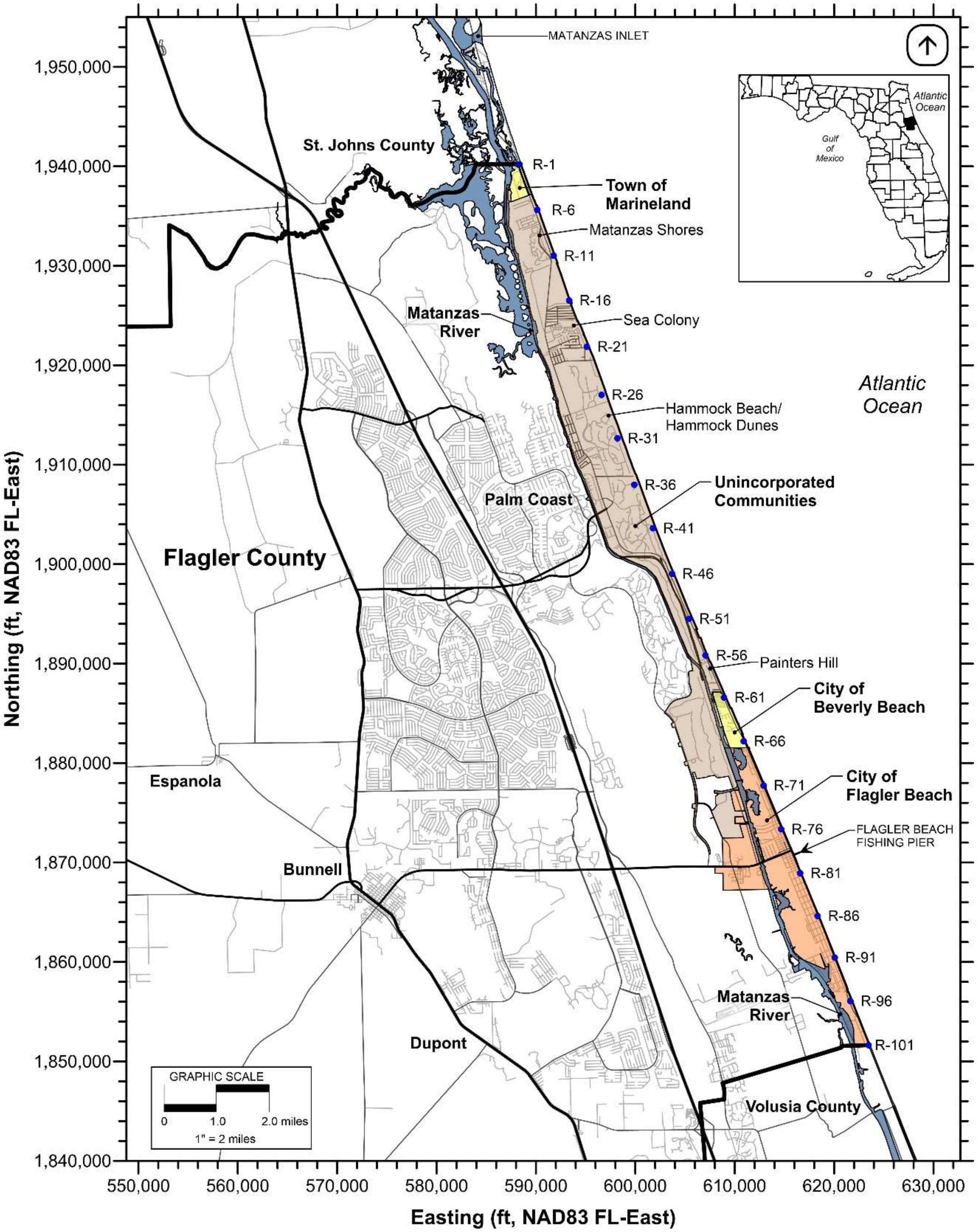

Figure 1.1: Location map of Flagler County within Florida and the local municipalities along the County shoreline.

The location and extent of the developed parks and beach access areas is also of interest in beach management planning considerations. The public parks along the Flagler County coastline are, from north to south:

- River to Sea Preserve (County Park; R-2.3 to R-4.2)
- Washington Oaks State Park (State of Florida; R-12 to R-16)
- MalaCompra Park (County Park; R-20.6 to R-24.2)
- Old Salt Park (County Park; R-26.9 to R-27.3)
- Jungle Hut Road Park (County Park; R-34.8 to R-35)
- Varn Park (County Park; R-47.9 to R-49.4)
- Gamble Rogers Memorial State Recreation Area
  (State of Florida; R-94.8 to R-97.8)

The Flagler Beach Municipal Pier is located in the City of Flagler Beach at the intersection of SR-100 and SR A1A, about 4 miles north of the Volusia County line and immediately north of monument R-79.

Critically Eroded Shorelines. As of June 2022, the Florida Department of Environmental Protection (FDEP) has recognized three reaches of the Flagler County Atlantic Ocean shoreline as critically eroded (FDEP, 2022). Both qualitative assessments and quantitative data and analyses are used to determine if a segment of shoreline is eligible to be deemed as critically eroded. The reaches are listed in **Table 1.1.** These designations are consistent with the observed locations of the most severely eroded areas of the County's shoreline as well as those areas where upland development is most vulnerable to erosion and the effects of coastal storms. This is not to say, however, that other areas of the County's shoreline are not threatened by ongoing erosion and vulnerable to the effects of storms. These areas simply do not meet the State of Florida criteria for a critical erosion designation following FDEP guidelines. Beach management activities along beaches in the State of Florida that are deemed critically eroded by FDEP are eligible for funding through Beach Management Funding Assistance Program.

Table 1.1: Flagler County designated critically eroded reaches (FDEP, 2022).

Location	FDEP R-monument Range	Alongshore Distance (miles)
Marineland	R1 - R4	0.6
Painters Hill	R50 - R57	1.1
Beverly Beach/Flagler Beach	R65.2 - R101	6.4
	Total	8.1

1.4. Beach Management Past & Present

To-date, Flagler County has not implemented a proactive county-wide beach management program. Rather, many of the past activities have been completed in response to the effects of long-term beach and dune erosion and episodic storm impacts. Such activities have included the construction of shore-stabilizing revetments, seawalls, and localized dune restoration. These efforts have not fully addressed long-term sand volume loss of the beach and dune. Furthermore, revetments and seawalls have exacerbated the loss of sand volume from the beach and dune.

Currently, Flagler County has pending plans for implementation of two beach restoration and maintenance projects along 5.4 miles of shoreline. These include (1) the Flagler County Coastal Storm Risk Project (Federal) and (2) Flagler County/FDOT project. The scope and funding for initial construction of these two projects have been identified and the permits with regulatory agencies are in place. However, the source of funding to maintain these two projects as well as funding to expand beach and dune management activities throughout the remainder of Flagler County has not been identified.

1.5. Goals

Given the severely eroded condition the County's coastline and the combined effects of future sea level rise and elevated storm activity, proactive beach management along the Flagler County shoreline will be necessary to protect the beach and dune system, as well as the physical and financial interests of the larger Flagler County community. A comprehensive beach management plan will equip the County to restore and maintain their beach and dune system, which provides storm protection, recreational space and environmental habitat. The goals of future beach management should be to identify the scope and scale of a project design, determine the most cost-effective means of constructing and maintaining the project, maximize cost-sharing opportunities, quantify the amount of local funding needed, and establish a reliable source of local revenue to support a long-term program.

2.0 BACKGROUND

The Flagler County shoreline is comprised mostly of sandy beaches backed by dunes of varying crest elevation. The beaches are comprised of a mixture of quartz sand and shell hash. The high percentage of coarse shell hash leads to a relatively large median grain size and steep beach profiles. In 2020, samples collect in support of the Flagler County Beach/Dune Restoration Project exhibited a mean grain size of 0.23 mm (OAI, 2020b). The shell is derived from outcroppings originating near the coastline during the Anastasia formation known as coquina, and it is responsible for providing the unique orange color seen in Flagler County. Periodic natural coquina rock outcroppings are present along the northern beaches and serve as important habitat to marine fauna. The rock is considered a valuable natural resource and is protected by both Federal and State regulatory agencies.

The dunes along the County range in height from 9 to 22 ft, NAVD88, and are characterized by relatively steep faces composed of coquina shell hash and fine quartz sand. The upper crest elevation of the existing dune is typically situated at about +18 ft, NAVD88. The lower limit of dune vegetation, which is typically seen at the landward limit of recent dune erosion, is typically found to be at an elevation of about +11 ft, NAVD88. Seaward thereof, the typical natural beach berm elevation ranges from about +8 to +10 ft, NAVD88, on average. The beach face tends to slope at 1:10 seaward from the berm to about -6 ft, NAVD88. The depth of closure (the depth beyond which there is normally no change in profile elevation with time) along the County is assumed to be -24 ft, NAVD88. A complete set of plan view contour maps from an April 2021 LiDAR survey of the dry beach and dune system from R-1 to R-101 is provided in **Appendix B**. Additionally, profile plots for various timeframes are provided in **Appendix C**.

Coastal armoring and upland development encroach onto the dune footprint in various locations along the County and thereby restrict the natural development of dunes and evolution of the beach. Particular characteristics of the Flagler County beach, dune, and upland conditions that are relevant to beach management planning and possible future management activities are discussed in more detail below.

2.1. Natural Resources

With respect to future beach management planning, there are resources on and adjacent to the beach that may limit the scope and scale of future beach management activities and access to the beach. Most importantly are flora and fauna resources and associated habitat that occur along and adjacent to the beach and dune including dune vegetation and coquina rock.

<u>Dune Vegetation.</u> The Flagler County dunes are heavily vegetated, with the exception of locations where beach access breaks and overwalks are located. The dune vegetation on the dune face is regularly exposed to high winds, salt spray, and sand burial from wind-blown sand. In addition to these stressors, plants on the upper beach are also subject to occasional inundation during high seasonal or storm-related tides and periodic destruction by strong wave activity. Due to these persistent stressors, the dune and upper beach vegetation community is typically composed of plants that are able to rapidly re-colonize after disturbances (USACE, 2015b).

The beach dune vegetation is a predominantly herbaceous plant community consisting of wide-ranging coastal species on the upper beach and foredune. These areas are classified as coastal scrub (FLUCCS, 1999). This community is built by sea oats (*Uniola paniculata*) and grasses that can tolerate sand burial including bitter panic grass (*Panicum amarum*) and saltmeadow cordgrass (*Spartina patens*). Camphorweed (*Hetrotheca subaxillaris*) grows with sea oats often where sand burial is absent or moderate within a disturbed community. Seacoast marsh elder (*Iva imbricata*), a succulent shrub, is found at the seaward base of the foredune. These species may also occupy the face left from dune disturbance due to storm erosion where sand is not yet stabilized by vegetation (Myers and Ewel, 1990).

The upper beach area (seaward of the foredune) is less stable and frequently disturbed by high spring or storm tides, and is continually re-colonized by annual species such as sea rocket (*Cakile lanceolata.*), crested saltbush (*Atriplex cristata*), and Dixie sandmat (*Chamaesyce bombensis*); or by trailing species like railroad vine (*Ipomoea pes-caprae*), beach morning glory (*Ipomoea imperati*), and the salt-tolerant grasses seashore paspalum (*Paspalum vaginatum*) and seashore dropseed (*Sporobolus virginicus*) (Taylor, 1998). Other species found in the beach dune community include dune sunflower (*Helianthus debilis*), sand spur (*Cenchrus spp.*), and shoreline sea purslane (*Sesuvium portulacastrum*) (USACE, 2015b). **Figure 2.1** and **Figure 2.2** show dune vegetation conditions between R-97 and R-98 and R-73 and R-74, respectively, during a site inspection on February 13th, 2020. **Figure 2.3** shows dune vegetation conditions between R-97 and R-98 during a site visit on November 9th, 2021.

<u>Gopher tortoises.</u> The Flagler County dunes are also habitat for several species of particular interest. Most importantly, Gopher tortoises (Gopherus polyphemus) live in the dunes. The tortoises create burrows that they share with up to share their burrows with more than 350 other species throughout their range in Florida. Therefore, they are referred to as a keystone species. In Florida, the gopher tortoise is listed as Threatened. Both the tortoise and its burrow are protected under state law.

Beach management activities will be required to protect dune vegetation and habitat. Limited modifications to the dunes may be allowed with appropriate mitigation to accommodate access to construction equipment.

Figure 2.1: Existing dune vegetation between R-97 and R-98, February 13th, 2020.

Figure 2.2: Typical dune vegetation between R-73 and R-74, February 13th, 2020.

Figure 2.3: Typical dune vegetation between R-50 and R-51, November 9th, 2021.

Beach and Nearshore Rock. Periodic natural coquina rock outcroppings are present along the northernmost beaches, between the northern County line (R-1) and southern Hammock Dune (R-43.5). The rock is present from the upper dry beach to the lower intertidal zone from just south of the Marineland revetment (R-2.3) to central Washington Oaks State Park (R-13.8). The rock continues southward strictly along the lower intertidal regional to southern Hammock Dunes (~R-43.5). There are occasional breaks in the outcroppings that are populated exclusively with sand. Herein, "beach rock" refers to rock that is located above the MHWL (+1.42 ft, NAVD88) (**Figure 2.4**) and "nearshore rock" refers to that which is below the MHWL (**Figure 2.5**).

The location and extent of the coquina rock outcropping has been estimated from available aerial photography and site inspections. These suggest that the rock extends both above and below the MHWL from R-2.3 through about R-13.8 and occurs below the MHWL from about R-13.8 to about R-43.5. This is generally consistent with FDEP (1999), which suggested that the rock occurs between R-3 and R-16 and between R-20 and R-43. FDEP also suspected that outcrops occurred below the MHWL between R-65 and R-71 and between R-79 and R-92. Follow-up surveys sponsored by the US Army Corps of Engineers in 2011 and Flagler County in 2019 could not identify the occurrence of rock on the beach or in the nearshore south of R-50. Divers from Coastal Eco-Group, Inc. conducted 15 verification dives on July 16, 2019 on features that were similar in appearance to the "presumed hardbottom" in the 2011 survey (Dial Cordy and Associates,

2011) and no hardbottom was observed (CEG, 2019).

Inspection of the 2021 aerial photographs suggests that there may be as much as 200 acres[1] of beach and nearshore area where rock occurs. Of this, it is estimated, again from the available aerial photos only, that about 60 percent of the area has exposed rock and the remainder is interstitial sand. As such, there could be roughly 120 acres of rock that could be impacted by sand placement activities.

The rock outcroppings serve as important habitat to marine fauna and also as a stabilizing influence on beach conditions. As such, the rock is considered a valuable resource that is protected by both Federal and State governments. Specifically, the rock is protected habitat for Federally listed species under the Endangered Species Act as it is foraging habitat for juvenile green sea turtles. The habitat is also Essential Fish Habitat (EFH) and protected under the Federal Magnuson-Stevens Fishery Conservation and Management Act. The State of Florida considers the rock a protected resource that occupies submerged sovereign lands of the State and regulates activities that could potentially impact the resource.

The types of impacts that can occur with beach management activities include (1) direct burial from sand placement, (2) indirect effects due to turbidity and sedimentation from hydraulic dredge effluent; (3) direct burial from pipeline deployments; and (4) indirect burial from beach fill equilibration. Hardbottom resources can only be impacted (i.e., sand burial and/or sedimentation impacts) if impacts are justified, demonstrated to be in the public interest, and/or minimized to the greatest extent practicable and appropriately mitigated according to Florida Uniform Mitigation Assessment (UMAM), Rule 62-345 F.A.C. The benefit of the proposed activity, in this instance beach fill construction, must outweigh the adverse impact to the public resource (i.e., hardbottom). When impacts to hardbottom are considered unavoidable and justified, mitigation is required.

There are five species of sea turtles that occur in the coastal waters off Flagler County. The loggerhead sea turtle (*Caretta caretta*) constitutes the majority of the turtle nests in this region. Low numbers of green sea turtle (*Chelonia mydas*) and leatherback sea turtle (*Dermochelys coriacea)* nests also occur in Flagler County. Kemp's Ridley sea turtles (*Lepidochelys kempii*) rarely nest in Flagler County and Hawksbill sea turtle (*Eretmochelys imbricata*) nests have not been documented, but Flagler County is within their range and individuals may be found offshore. The nesting season for all species of sea turtles is May 1 through October 31, inclusive of the hatching season. Nesting generally

1 This value is highly approximate and should be consider for planning and comparative purposes only. Prior to detailed project planning, a detailed survey of the location and extent as well as habitat quality of the rock areas should be conducted.

ends by September in the region. The Flagler County shoreline is located within Terrestrial Critical Habitat Unit LOGG-T-FL-03 and Neritic Critical Habitat Unit LOGG-N-15 for the loggerhead sea turtle.

North Atlantic right whales occur offshore of Flagler County. The Southeast U.S. coast critical habitat unit (2) for the North Atlantic Right Whale (50 CFR Part 226) includes waters immediately offshore Flagler County.

Figure 2.4: Coquina beach rock above the MHWL between R-7 and R-8, March 29th, 2022.

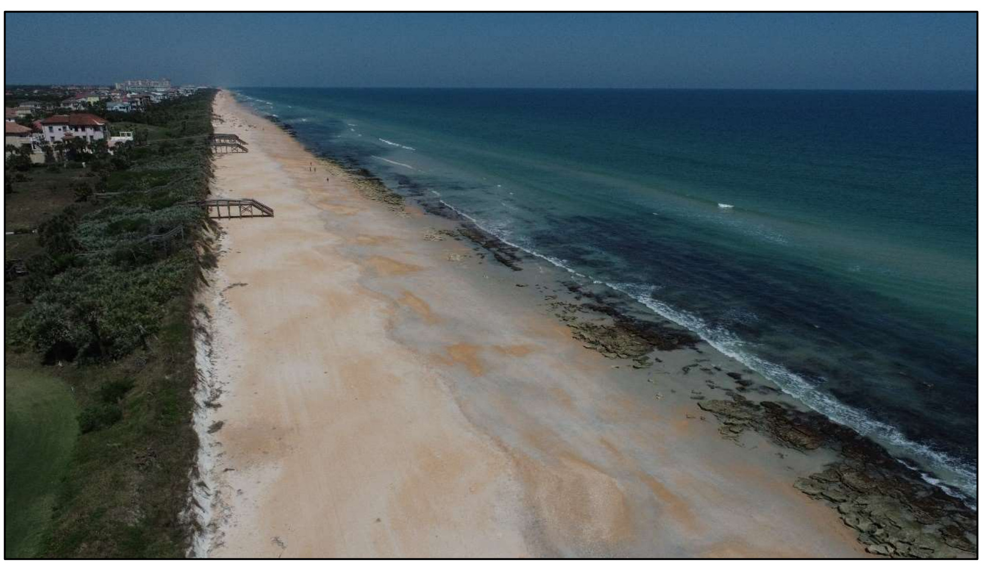

Figure 2.5: Coquina nearshore rock below the MHWL between R-36 and R-37, March 29th, 2022.

2.2. Upland Development

2.2.1. Encroaching Infrastructure

The coastal development conditions along Flagler County vary from lightly developed parks such as Washington Oaks State Park to fully developed conditions with infrastructure such as A1A in Flagler Beach. There are large areas of the shoreline with public and private infrastructure development that encroach the active literal zone. In this analysis, encroachment is defined as infrastructure that resides within 80 feet of the established vegetation line/bare sandy beach. In total, approximately 11.5 miles (64%) of the Flagler County coastline has encroaching infrastructure within 80 feet of the vegetation line. Of this, 5.9 miles (32%) of the county shoreline is attributed solely to A1A encroachment in southern Beverly Beach and Flagler Beach. The encroaching infrastructure varies from golf courses, public and private residences, pool decks, parking lots, streets, and development associated with the Flagler Beach pier. Upland development conditions, as well as other hardened shoreline features including armor and coquina rock, are portrayed in **Figure 2.6**. The following section provides more detail on the existing coastal armoring along the County.

There are specific regions of extreme encroachment, where infrastructure significantly impedes dune and beach dynamics:

- <u>Marineland marine park (R-1 to R-2.3).</u> In Marineland, wave/water interaction with the revetment and subsequent wave reflection promotes severe beach scour and results in no dry beach during normal conditions.

- <u>Beverly Beach Camptown RV Resort (R-60.8 – R-62.1).</u> The RV Resort has the capacity for ~100 RVs and resides entirely seaward of A1A. It is supported by a seawall that protrudes onto the beach, past adjacent vegetation line limits. Wave uprush does interact with the wall during periods of elevated water levels, which induces beach scour.

- <u>SR A1A (R-65 to R-94.2, and R-97.5 to R-101).</u> A1A, an integral part of the county's infrastructure, resides within 50 feet of the beach for about 5 miles in Flagler Beach. There are significant segments of A1A that lie within 30 feet of the beach.

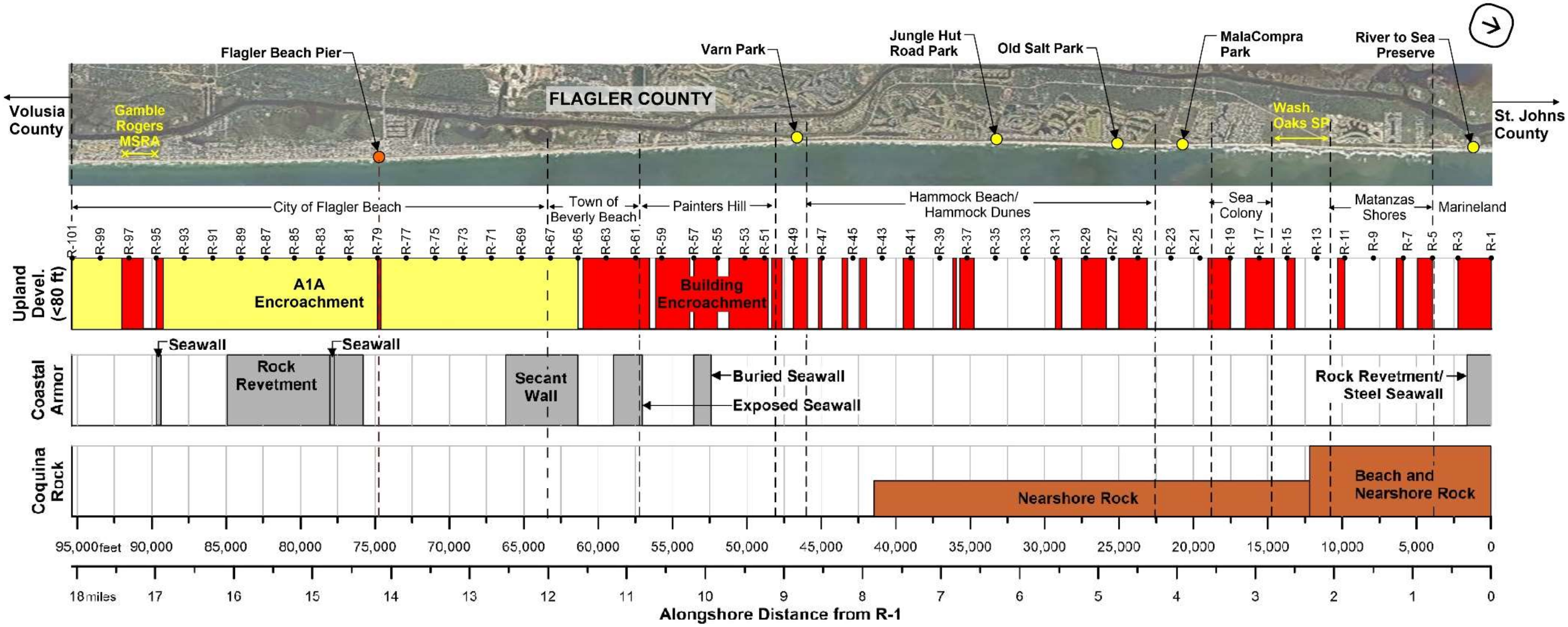

Figure 2.6: Upland development conditions and hardened shoreline features including armoring and coquina rock along the Flagler County coastline.

2.2.2. Existing Coastal Armoring

Figure 2.6 above also illustrates the location and extent of the known coastal armor structures along the County. Coastal armoring is a hardened shoreline stabilization technique which significantly alters beach dynamics and is important to take into consideration for beach and dune management planning. State assistance from past storm damage has resulted in the construction of revetments, seawalls and temporary structures, structure condemnation, and various shore protection measures by private property owners in response to catastrophic erosion events (USACE, 2015b). To-date, approximately 21% percent (19,495 feet) of the Flagler County shoreline is armored. The construction of the armor varies, and although there are significant armored sections of the shoreline that provide some level of erosion and storm damage protection to threatened areas, the County remains one of the least armored shores along Florida's east coast (Bush et al, 2004). A brief description of each structure, from north to south, is provided below and summarized in **Table 2.1**.

Town of Marineland Revetment. The 1,350-ft long revetment along Marineland (R-1 to R-2.3) was originally constructed with coquina rock in 1938 along with 5 coquina groins spaced ~400 ft apart seaward of the revetment (**Figure 2.7**). Hurricane Floyd (1999) substantially impacted the entire revetment along Marineland, resulting in failure at multiple locations. The revetment was replaced in 2001 with granite/gneiss stones (2-4 tons each) and a sheet pile anchored seawall. In addition to the replaced revetment, a 1,500-ft steel seawall was constructed from the southern point of the revetment and buried with a reconstructed dune and boardwalk (USACE, 2015). Though, aerial photography suggests the steel seawall only extends 1,000 feet south of the revetment.

Figure 2.7: The revetment at Marineland, R-1 to R-2.3.

Varn Park (**Figure 2.8**). Remnants of a once 160-ft seawall remain at the southern end of Varn Park (R-49.3). The wall was significantly damaged during Hurricane Matthew (October 2016) and was further destroyed during Hurricane Irma (September 2017). Some remnants appear to have been removed during the 2018/2019 Flagler County dune restoration project.

Figure 2.8: Remnants of the seawall at Varn Park, 9 November 2021.

Painters Hill. Along the Painters Hill shoreline there is a vinyl sheetpile seawall with a concrete cap (**Figure 2.9**). The full extent of the wall was constructed in 2018 following Hurricane Matthew. This wall is located between R-55.2 to R-57 and protects 18 upland properties. A portion of the area was originally stabilized by a wall in 2009 when a small wall was constructed seaward of two properties around R-56.5. The original wall and adjacent properties were severely affected by Hurricanes Matthew (2016) and Irma (2017) leading to the need to expand the length of the wall in 2018. The seawall has a top elevation of +16 ft, NAVD88 and a total length of ~1,400 feet. There is some limited dune and dune vegetation along the seaward wall face.

Figure 2.9: Looking north along the seawall in Painters Hill, 18 April 2019.

Beverly Beach. A 1,500-ft long concrete seawall is located along a portion of the Beverly Beach shoreline (R-60.8 to R-62.1) (**Figure 2.10**). The wall was constructed around 1990. The Camptown RV Resort is situated immediate landward of this wall. The wall has an average crest elevation of +16.5 ft, NAVD88 and there is no dune along this reach of shoreline. It appears that the wall is frequently impacted by high water levels and wave uprush. In additional to the absence of a dune, the frequent interaction of the wall with water levels and wave has resulted in degraded (narrower) beach conditions along this reach of shoreline.

Figure 2.10: A portion of the seawall at the Beverly Beach Camptown RV Resort, 09 November 2021.

North Flagler Beach – FDOT Secant Wall (**Figure 2.11**). Following the passage of Hurricane Matthew in October 2016, an emergency temporary revetment was constructed along a 1-mile segment of shoreline from 650 feet south of Osprey Drive (R-65) to North 18th Street (R-70). In 2019, the County and FDOT removed the revetment and constructed a ~5,000-ft secant-pile constructed seawall in approximately the same footprint, from R-65 to R-70. The secant seawall is comprised of 1847 glass-fiber-reinforced polymer (GFRP) concrete piles and a continuous 4-ft thick pile-cap. The wall was subsequently buried with a vegetated dune.

Figure 2.11: Construction of the FDOT secant wall and dune in northern Flagler Beach/southern Beverly Beach.

Flagler Beach State Road (SR) A1A Revetment. In the City of Flagler Beach there is a 9,100 ft long rock revetment that protects SR A1A (**Figure 2.12**). This revetment is location between R-80 (7th St. South) to R-90 (23rd St. South). The revetment has a crest elevation of about +18 ft, NAVD88 and a seaward slope that varies from 1H:1V to 1H:2V. A 140-ft segment of concrete seawall is also located within this revetment area around R-82 (**Figure 2.13**). The crest elevation of the concrete wall is about +16 ft, NAVD88.

The revetment was originally constructed to protect A1A from chronic shoreline erosion in central Flagler Beach. Initial work on the revetment because in the late 1960's following impacts from Hurricane Dora in 1964. This original work consisted of coquina rock and sand placement. In 1999, granite stones were added to the revetment to repair damaged areas and reinforce the structures. FDOT continually maintains the revetment and typically spends about $1.25 million per year, on average – based upon 2000 and 2007 expenditures. The revetment was severely damaged in 2016 due to the effects of Hurricane

Matthew. In fact, some areas of the revetment were completely destroyed and SR A1A was severely damaged. Following the storm, the revetment and A1A was repaired to design conditions.

Figure 2.12: A portion of the revetment along SR A1A, looking north from R89.5, 18 March 2020.

Figure 2.13: The 140-ft segment of seawall (R-82) that located within the larger rock revetment in the City of Flagler Beach (18 March 2020).

Concrete Seawall, Southern Flagler Beach. South of the SR A1A rock revetment is a small reach of shoreline with four properties developed on the seaward side of A1A and where a natural dune would otherwise be (R-94.5). Along this area, a ~145-ft long concrete capped seawall built in 2004 (**Figure 2.14**) protects the southern two properties, a hotel property (Suites on The Beach) and a multi-dwelling private property, from the effects of erosion, high water levels and wave impacts. The wall has an average crest elevation of about +14 ft, NAVD88 and there is some dune established landward of the wall. The Snack Jack restaurant and another private property reside immediately north of this wall, without seawalls abutting their properties.

Figure 2.14: The 145-ft seawall in southern Flagler Beach abutting two properties.

Table 2.1: Existing coastal armoring along the Flagler County shoreline.

Location	Construction / Repair date(s)	Type	FDEP R-monument Range	Material	Elevation (ft-NAVD88)	Alongshore Distance (ft)
Town of Marineland	1938 / 2001	Revetment; five groins	R-1 to R-2.3	granite/gneiss; coquina	+13.0 to +15.0	1,350
Town of Marineland	2001	Seawall	R-2.3 to R-3	steel	-	1,000
Varn Park	-	Derelict seawall	R-49.3	concrete capped steel sheet pile	-	-
Painters Hill	2018	Seawall	R-55.2 to R-57	concrete capped vinyl sheet pile	+16.0	1,400
Town of Beverly Beach	1990	Seawall	R-60.8 to R-62.1	concrete capped steel sheet pile	+16.5	1,500
North Flagler Beach	2019	Secant seawall	R-65 to R-70	GFRP concrete piles and a concrete pile-cap	+18.0	5,000
City of Flagler Beach	1960s / 1980s-present	Revetment	R-80 to R-90	coquina; granite	+18.0	9,100
City of Flagler Beach	-	Seawall	R-82	concrete capped steel sheet pile	+16.0	140*
South Flagler Beach	2004	Seawall	R-94.5	concrete capped steel sheet pile	+14.0	145
					Total:	19,495

*Seawall at R-82 located within the footprint of the Flagler Beach Revetment and therefore not included in the total length.

2.3. Oceanographic Setting

Flagler County beaches are influenced heavily by water levels, winds, and waves, particularly during storm events. The oceanfront shoreline is vulnerable to wave energy from both short period wind-waves and longer period open- ocean swells. Large swells from hurricanes and tropical storms moving through the Atlantic can propagate long distances, causing erosion along the Flagler County shoreline. The shoreline is also exposed to the effects of sea level rise. It is expected that future sea level conditions will influence project planning and performance.

2.3.1. Water Levels

Astronomical tides at the study site are semidiurnal (i.e., two low and two high tides per day) with a mean tide range of about 4.26 feet, on average. Water level datums and astronomical tidal predictions for the study area are represented by an average of information from the National Oceanographic and Atmospheric Administration (NOAA) Station 8720587 (St. Augustine Beach, FL) and 8721120 (Daytona Beach Shores, FL). The relevant study area tidal datums relative to the North American Datum of 1988 (NAVD88) are listed in **Table 2.2**.

Table 2.2: Tidal datums in vicinity of study area. The study area is located approximately halfway between the ocean tidal datum sites in St. Augustine Beach and Daytona Beach Shores. The "average" is assumed to approximately represent water level datums at the study site.

Water Level Datums Near Study Site (Feet - NAVD88)				
Description	**Datum**	**8720587 St. Augustine Beach, FL**	**8721120 DAYTONA BEACH SHORES, FL**	**Average**
Mean Higher-High Water	MHHW	2.01	1.57	1.79
Mean High Water	MHW	1.64	1.20	1.42
North American Vertical Datum of 1988	NAVD88	0.00	0.00	0.00
Mean Tide Level	MTL	-0.67	-0.76	-0.72
Mean Sea Level	MSL	-0.70	-0.79	-0.75
Mean Diurnal Tide Level	DTL	-0.56	-0.65	-0.61
Mean Low Water	MLW	-2.97	-2.71	-2.84
Mean Lower-Low Water	MLLW	-3.13	-2.86	-3.00
Tide Range (feet)				
Great Diurnal Range (feet)	GT	5.15	4.43	4.79
Mean Range of Tide (feet)	MN	4.61	3.90	4.26

2.3.2. Wind and Waves

Wind and wave information representing typical conditions offshore of the Flagler shoreline are available through the USACE Wave Information Study (WIS). The regional hindcast study performed by the USACE generated continuous offshore wind and wave conditions at a 3-hr increment for the period from January 1, 1980 to December 31, 2019. Conditions typical of the focus area are represented by WIS Hindcast Atlantic Station #63423. This hindcast station is located approximately 10 nautical miles east of the City of Flagler Beach in about 70 feet of water.

Wind and wave roses for the hindcast time series data set are shown in **Figure 2.15**. Winds speeds are typically highest from the southwest to northeast direction. Those that affect the shoreline most are from the south to northeast directions, due to the orientation of the Flagler County shoreline (~22° counter-clockwise from due north). The wave data suggest that the most significant waves in terms of height and frequency arrive from the east and northeast directions.

Figure 2.16. includes a month-by-month breakdown of significant wave heights. As expected, these data indicate the predominance of larger waves, greater than about 4.5 feet, on average, during the fall and winter months. The summer months are typically characterized by the smallest waves of the year, averaging about 3.0 feet.

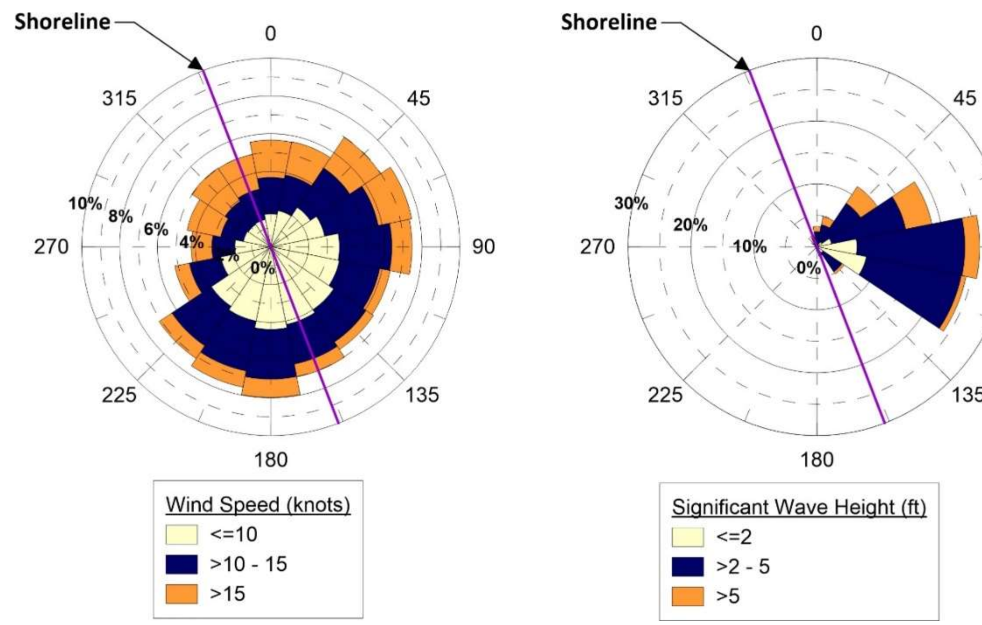

Figure 2.15: Wind and wave roses summarizing offshore significant wind speed, wind direction, wave height, and wave direction data from WIS Hindcast Atlantic Station #63423, from January 1, 1980 to December 31, 2019.

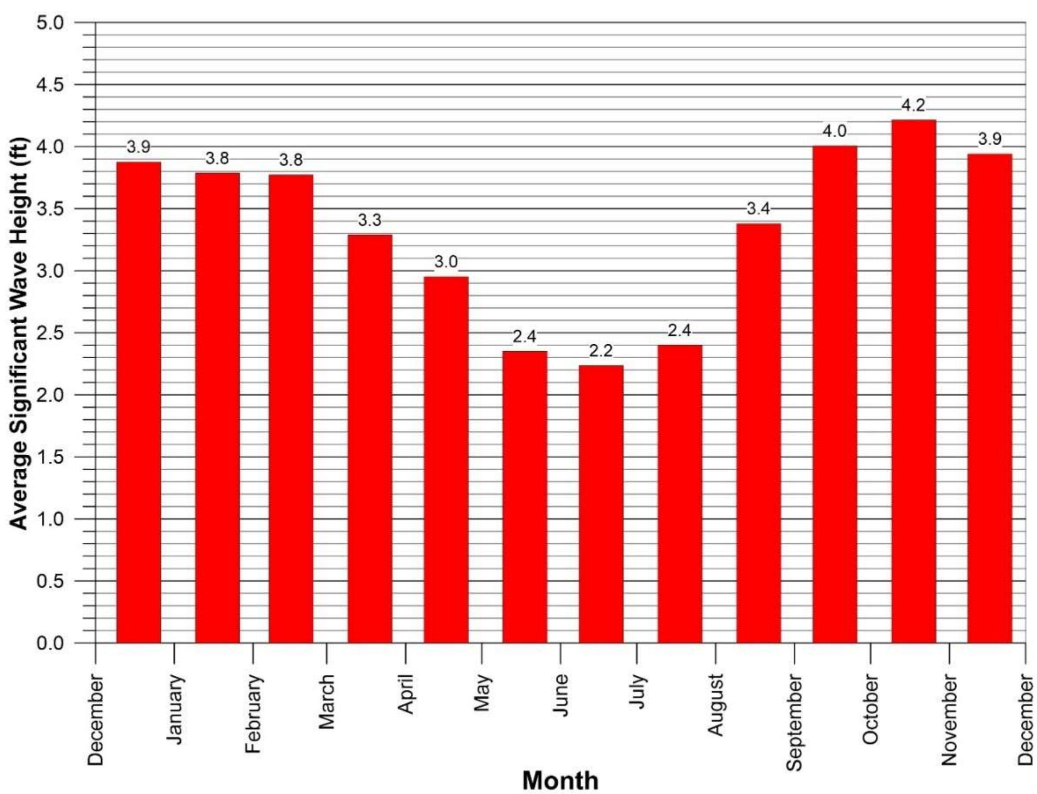

Figure 2.16: Monthly variation in offshore average significant wave height (Hs, ft) from WIS Hindcast Atlantic Station #63423, from January 1, 1980 to December 31, 2019.

2.3.3. Storm History

The Flagler County shoreline is susceptible to the erosional effects of seasonal tropical storms. The National Oceanic and Atmospheric Administration (NOAA) maintains an online database of historical storm tracks and associated meteorological data. **Figure 2.17** depicts the storm tracks since 1851 in the vicinity of Flagler County. Over the entire 169-year period of record (1852-2021), the central path of 41 cyclonic storms of tropical storm force or greater have passed within 30 nm of central Flagler County (R-50) and 131 storms within 100 nm. The present study includes the analysis of beach profile surveys collected between July 1972 and April 2021. Over that 49-year time period, a total of 14 cyclonic storms passed within 30 nm of the R-50 and 40 storms within 100 nm. The number of storms to pass within 100 nm has increased slightly from 0.8 storms/year since 1852 and 1972, to 1.0 storms/year since 2000, and 1.1 storms/year since 2011.

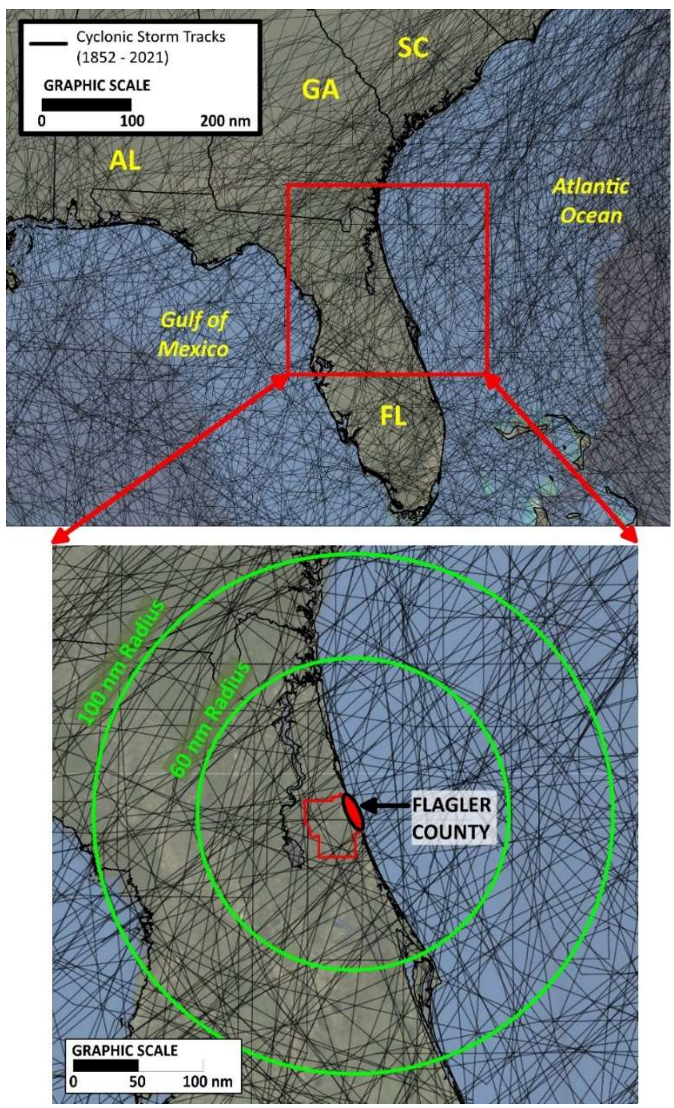

Figure 2.17: Cyclonic storm activity in the vicinity of Flagler County (1852-2021).

There has been a recent increase in the frequency of occurrence of significant tropical storms of record affecting the Flagler County shoreline. Hurricanes Matthew (2016) and Hurricane Irma (2017) together caused a level of damage and net sand volume loss to the County's beach and dune that has not been observed over the past 50 years. Since then, additional storm events have contributed to additional damages and sand losses with the most notable storm being Hurricane Dorian in 2019. The storm tracks along with the dates of occurrence and storm magnitudes for Hurricanes Matthew, Irma and Dorian are illustrated in **Figure 2.18**. The hydrological conditions and associated with each of these tropical storms and resulting effects to the Flagler County shoreline are described in detail in the following subsections. The beach and dune erosion that occurred between 2016 and 2021 exposed large areas of upland development and infrastructure, including State Road A1A, to an increase level of vulnerability to future coastal storms.

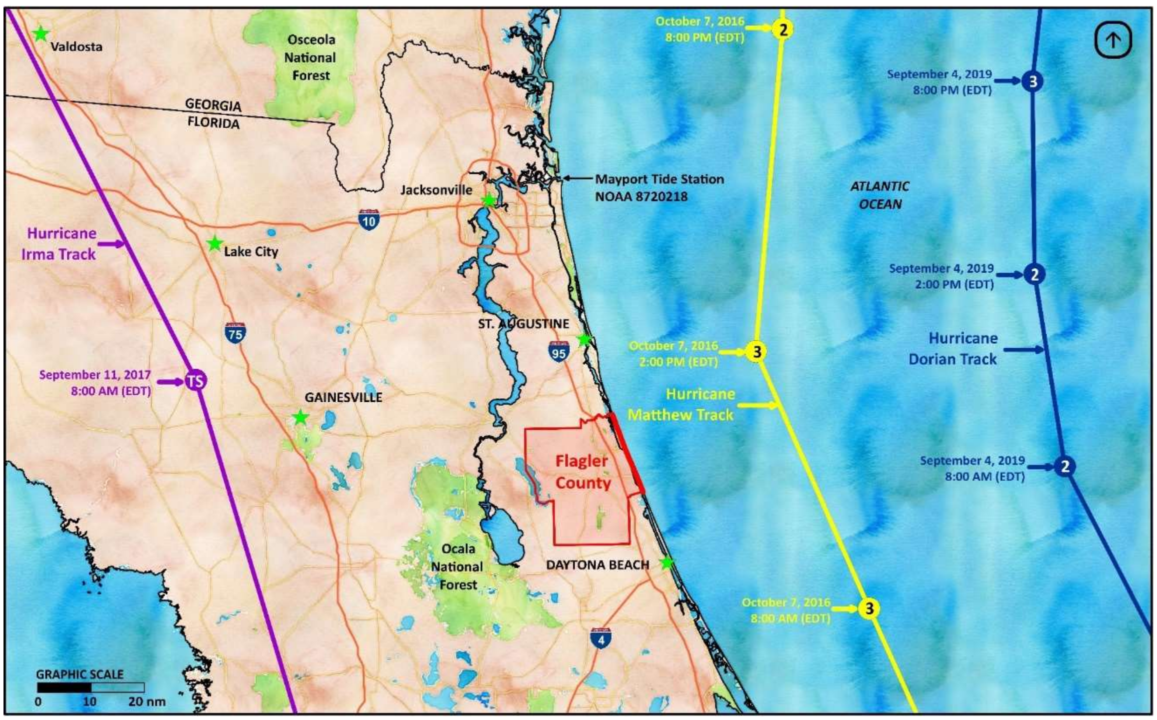

Figure 2.18: Storm tracks for Hurricane Matthew (October 2016), Hurricane Irma (September 2017) and Hurricane Dorian (September 2019) in the vicinity of Flagler County.

<u>Hurricane Matthew</u> impacted Flagler County primarily on October 7th, 2016, becoming the second of two of the strongest U.S. hurricane landfalls of the 2016 Atlantic Hurricane season. Matthew was the thirteenth of an eventual fifteen named storms of the season and fifth of seven hurricanes. Due to the significant impacts of the storm, the name Matthew was retired by the World Meteorological Organization in March 2017. On October 8, 2016, Hurricane Matthew was declared a major disaster in eight Florida counties

(including Flagler County) making available Individual Assistance and Public Assistance on a cost-sharing basis by the Federal Emergency Management Agency (FEMA DR-4283). Hurricane Matthew passed Flagler County at 28 nautical miles offshore as Category 3 storm. The impact of Hurricane Matthew prompted FDEP to add a 1.1-mile segment of Painters Hill (R-50 to R-57) and a 0.6-mile segment in southern Flagler Beach (R-98 and R-101) to the list of critically eroded beaches (FDEP, 2022).

During Matthew, elevated surge levels were experienced along the shoreline for roughly 12 to 18 hours, peaking at just over +5.2 ft-NAVD88 at the Mayport NOAA station 8720218, 3.5 ft above the Mean High Water (MHW) level. Large waves persisted along the coast for a significant duration of time with significant wave heights greater than 10 feet lasting for more than 18 hours and waves greater than 8 feet for 45 hours (1.9 days) (NOAA buoy 41112, Fernandina Beach). Tidal surge of 7-ft and wave runup of 11 ft-NAVD88 undercut A1A in Flagler Beach and caused dune overwash throughout the County (**Figure 2.19**) (USGS, 2016). In the central portion of the County, many areas completely lost the entire primary frontal dune which is illustrated in **Figure 2.20** in Painters Hill (R-55). Direct beach profile comparisons, from June 2016 to November 2016, a total of 360,000 cy of sand were lost above +7 ft, NAVD88 along the entire County shoreline (R-1 to R-101), with 320,000 cy lost between R-3 to R-61.

Figure 2.19: Example of complete beach and dune loss as well as impacts to SR A1A during Hurricane Matthew (October 2016) along the southern Flagler County Atlantic Ocean shoreline.

Hurricane Irma impacted Flagler County primarily on September 11th, 2017, becoming the second of four U.S. hurricane landfalls of the 2017 Atlantic Hurricane season. Irma was the tenth of an eventual seventeen named storms of the season and fourth of ten hurricanes. Due to the significant impacts of the storm, the name Irma was retired by the World Meteorological Organization in April 2018. Hurricane Irma was declared a disaster statewide, making all 67 counties in Florida eligible for 100 percent federal assistance by the Federal Emergency Management Agency on September 10, 2017 (FEMA DR-4337). Hurricane Irma was the most intense hurricane observed in the Atlantic in the last decade and passed at about 74 nautical miles west of Flagler County as a Category 1 storm. The impact of Hurricane Irma prompted FDEP to add a 1.6-mile segment to the list of critically eroded beaches in 2019 (FDEP, 2022).

During Irma, elevated surge levels were experienced along the shoreline for two days, peaking at +5.4 ft-NAVD88 at the Mayport station, 3.7 feet above the Mean High Water level. The largest recorded significant wave height was measured to be 22.8 ft, and the dominant wave period peaked at about 13 seconds during this time (NOAA buoy 41117, St. Augustine). Waves exceeding 10 ft persisted for over 35 hours, and waves exceeding 15 ft persisted for more than 17 hours. The wave and tidal conditions produced wave runup of 9 to 10-ft and surge tide levels of 6.7 ft-NAVD88 (NOAA, 2017). Hurricane Irma further eroded the post-Matthew beaches, both above and below the MHWL. The beaches in central and southern Flagler County became significantly steepened in the post-Irma profile (**Figure 2.20**).

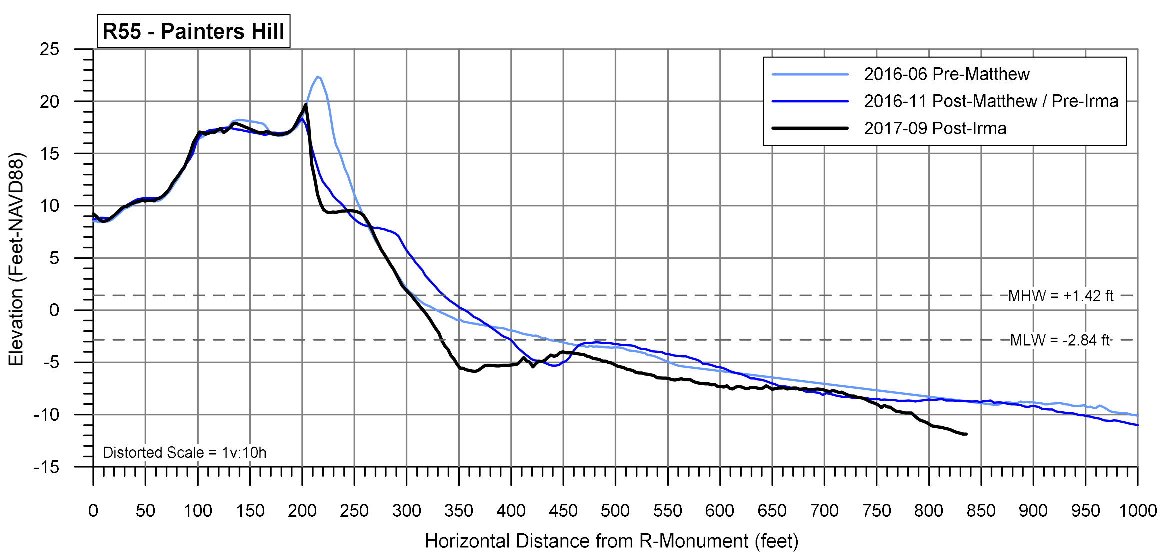

Figure 2.20: Beach profile change from pre- to post-Hurricane Matthew and pre- to post-Hurricane Irma in Painters Hill (R-55).

Hurricane Dorian was the most intense cyclone of the 2019 Hurricane Season, which was the (record-breaking) fourth consecutive Season of a category 5 storm forming in the Atlantic basin. Dorian was the 5th of 20 named storm of the 2019 Hurricane Season and. On October 21st, 2019, Hurricane Dorian was declared a major disaster in the State of Florida by the Federal Emergency Management Agency, which made available Public Assistance available to 12 Counties, including Flagler County (FEMA DR-4468). Dorian passed Flagler County at 87 nautical miles offshore as Category 2 storm on September 4th, 2019. Actual water levels in the days leading up to Hurricane Dorian already exceeded the predicted levels by about 1 ft. Elevated surge first peaked during low tide in the morning of September 4th, and reached +4.1 ft-NAVD88 during high tide at the Mayport station. The largest recorded significant wave height was measured to be 17 ft, and the dominant wave period peaked at about 12.5 seconds during this time (NOAA buoy 41117, St. Augustine). Large waves persisted along the coast for a significant duration of time with significant wave heights greater than 14 feet lasting for 10.5 hours and greater than 8 feet for 38 hours (1.6 days). The wave and tidal conditions produced wave runup of about 7 ft and surge tide levels of 5.4 ft-NAVD88 (NOAA, 2019).

Storm return period. The recent hurricanes Dorian, Irma, and Matthew were estimated to be roughly 12-, 23- and 28-year storm events, respectively, for Flagler County (**Table 2.3**). These return periods were estimated using **Figure 2.21**, developed by Wang (2011) for FDEP. The "total combined storm tide" includes storm surge, astronomical tide and dynamic wave setup. Estimated total combined storm tide levels were derived from either USGS or NOAA water level sensor stations within the vicinity of Flagler County. The storm return period represents the probability that the event will be exceeded in any one year at a given location. For example, the storm tide elevation of a 25-year storm has a 4% chance of exceedance in a year.

Table 2.3: Storm tide elevations for Hurricanes Matthew (2016), Irma (2017) and Dorian (2019) and corresponding approximate FDEP storm return periods (Wang, 2011) for Flagler County, FL.

	Estimated Surge Tide Level including Wave Setup (ft-NAVD88)	Location	Source	Approximate Storm Return Period, FDEP 2011 Surge Estimates
Hurricane Dorian Sept. 2019	5.4	Fort Matanzas	NOAA, 2019	~12 year event
Hurricane Irma Sept. 2017	6.7	Crescent Beach	NOAA, 2017	~23 year event
Hurricane Matthew Oct. 2016	7.1	Flagler Beach Pier	USGS, 2016	~28 year event

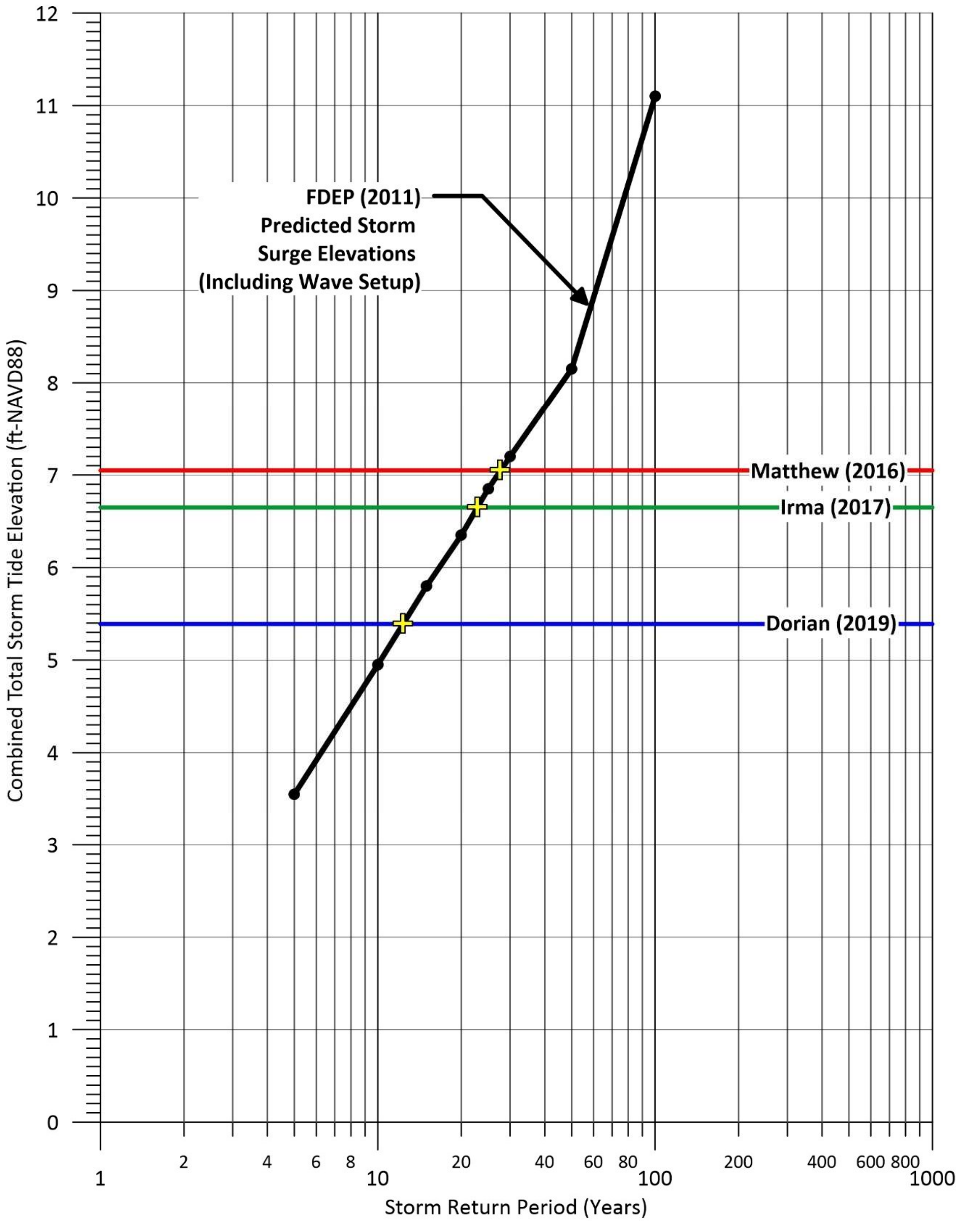

Figure 2.21: Predicted and actual storm tide elevations and corresponding approximate storm return periods (FDEP 2011) for Hurricanes Matthew (2016), Irma (2017) and Dorian (2019) for Flagler County, FL.

Nor'easters. In addition to seasonal tropical storms, Flagler County is susceptible to severe erosion associated with winter storms, or nor'easters. Nor'easters are thought to have a greater impact on shoreline change than hurricanes in Flagler County because these winter storms occur more frequently and with longer duration of damaging waves and storm surge (USACE, 2015b). Notable nor'easter storm events affect Flagler County during the years 1984, 1993 and 1994 (USACE, 2015b). In 2007, several nor'easter storms intensified erosion in some areas of Flagler County and prompted FDEP to add a shoreline segment at Painters Hill to the 2008 critically eroded beaches listing.

Recently, a nor'easter storm from 5-8th November 2021 significantly affected an already vulnerable Flagler County coastline. Significant wave heights recorded at the NOAA buoy 41117 in St. Augustine, about 30 miles north of R-50 in ~77 feet of water, reached a maximum of 15.6 ft-NAVD88, and exceeded 10 ft for 35 hours (1.5 days) The dune system was affected throughout the County, but most notably in the northern and central segments of the County, including Sea Colony, the Hammocks, Painters Hill, and Beverly Beach. Flagler County collected upper beach and dune profiles following the storm between R-2 and R-65 in January 2022. **Figure 2.22** shows a typical profile comparison showing loss to the dune and **Figure 2.23** shows damage from an image collected a few days after the storm. From direct profile comparison from R-2 to R-65, an estimated 106,200 cy of sand were lost above the survey limits (about MLW), and 85,200 cy were lost above the +7 ft contour.

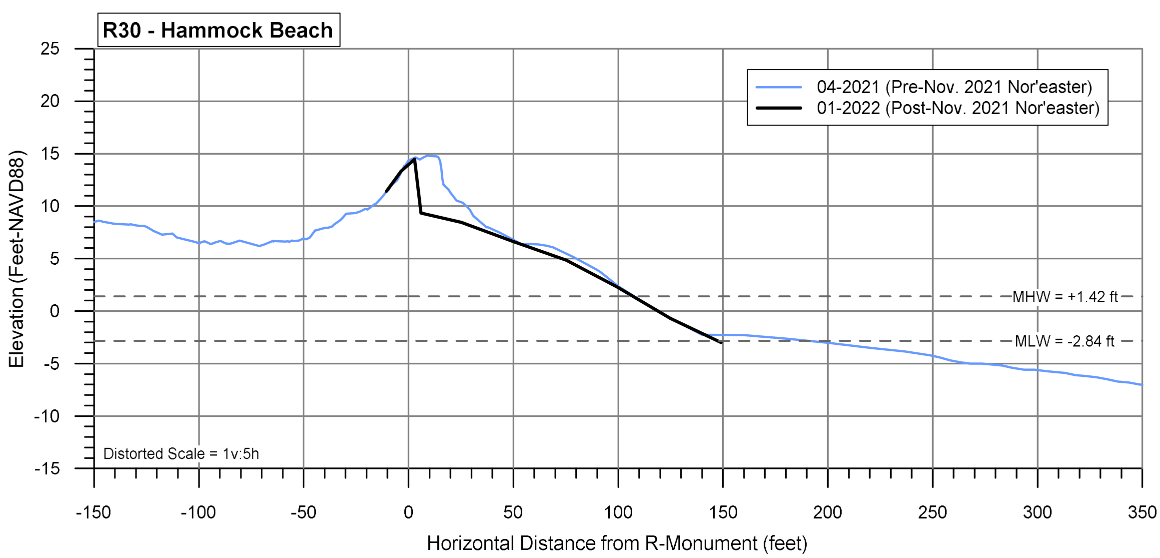

Figure 2.22: A typical pre- to post-November 2021 nor'easter profile in Hammock Beach representing dune losses in the northern and central segments of the County.

Figure 2.23: Damage from the November 2021 nor'easter at Jungle Hut Road Park and northern Hammock Dunes (R-35), 09 November 2021.

2.3.4. Sea Level Rise (SLR)

The sea level will continue to rise in the future as a result of local subsidence (vertical land movement), global climate change, deglaciation, and glacial isostatic adjustment. It is anticipated that the rate of sea level rise (SLR) will accelerate beyond historical levels due to future climate change. In 2022, National Oceanographic and Atmospheric Administration (NOAA) projections for SLR along the US East Coast were updated and cite an average increase of 1.0 feet over the next 30 years (Smith et al., 2022). This is equivalent to the same level of SLR change that occurred over the last 100 years. Future climate change and the associated acceleration in the Mean Sea Level (MSL) will increase storm surge levels, which in turn will exacerbate coastal erosion and flooding/inundation of low-lying areas. SLR will additionally adversely affect the performance, benefits and feasibility of beach nourishment projects. Specifically, an increase in the mean water level will contribute to shoreline recession and increase the sand loss rate from the beach.

The U.S. Army Corps of Engineers (USACE) provides guidance for quantifying and incorporating potential changes in the absolute elevation of MSL into beach fill project design. Guidance for incorporating SLR into project design is derived from USACE Engineering Circular EC 1165-2-212 and is most recently updated in ER 1100-2-8162 (USACE, 2019) which provides a methodology for determining potential SLR throughout the life of a project. The prescribed methodology incorporates three estimates of sea level change, which are based on (a) a baseline estimate of historical changes in MSL, (b) an intermediate estimate of changes in MSL, and (c) a high estimate of changes in MSL. The method considers local and global components of sea level changes to estimate local Relative Sea Level Rise (RSLR).

The total baseline (background) rate of sea level rise for the present analysis was determined to be 2.74 mm/yr, which is the addition of 1.70 mm/yr as the global average (IPPC, 2007) and 1.04 mm/yr from local subsidence obtained from a NOAA station in Mayport, FL from 1929 through 2021 (93 years). However, an updated global estimate for the lower bound of the *very likely* GSLR range of 3.0 mm/yr was published in IPCC, 2018 and is recognized in ER 1100-2-8162, but the 1.7 mm/yr rate is presently utilized in the USACE methodology.

In this analysis, it is assumed that construction of a potential project will commence in 2022 and conclude in 2072. This approach synchronizes a potential project with the presently authorized 50-year Federal construction schedule.

Table 2.4 presents calculated future values of sea level rise for the baseline, intermediate, and high trend estimates throughout the life of the project. These predictions are derived from modified National Research Council (NRC) curves that include local estimates of future sea level rise and incorporate the global eustatic MSL trend with the local rate of vertical land movement. The "USACE Intermediate Curve" assumes an NRC Curve I scenario where global eustatic sea-level rise 0.5 meters by the year 2100. The "USACE High Curve" assumes an NRC Curve III scenario where global eustatic sea-level rise 1.5 meters by the year 2100. The results indicate the average annual baseline, intermediate, and high sea level rise rates are:

- Baseline: 2.74 mm/yr (0.0090 ft/yr)
- Intermediate (NRC I): 5.72 mm/yr (0.0188 ft/yr)
- High (NRC III): 15.17 mm/yr (0.0498 ft/yr)

Additionally, **Figure 2.24** plots the range of SLR estimates in time.

A complete analysis utilizing these projected rates of RSLR to compute shoreline recession and volume loss through the 'Bruun Rule' methodology for the entire Flagler County coastline is provided in **Appendix F**.

Table 2.4: Predicted Relative Sea Level Rise for a 50-year period for Flagler County using ER 1100-2-8162 (USACE, 2019).

	Historical/Baseline		Intermediate		High	
Year	*mm*	*ft*	*mm*	*ft*	*mm*	*ft*
2022	0	0	0	0	0	0
2027	13.7	0.04	22.5	0.07	50.4	0.17
2032	27.4	0.09	46.4	0.15	106.5	0.35
2037	41.1	0.13	71.6	0.23	168.2	0.55
2042	54.8	0.18	98.2	0.32	235.6	0.77
2047	68.5	0.22	126.1	0.41	308.6	1.01
2052	82.2	0.27	155.4	0.51	387.3	1.27
2057	95.9	0.31	186.0	0.61	471.6	1.55
2062	109.6	0.36	218.0	0.71	561.6	1.84
2067	123.3	0.40	251.3	0.82	657.2	2.15
2072	137.0	0.45	286.1	0.94	758.5	2.49

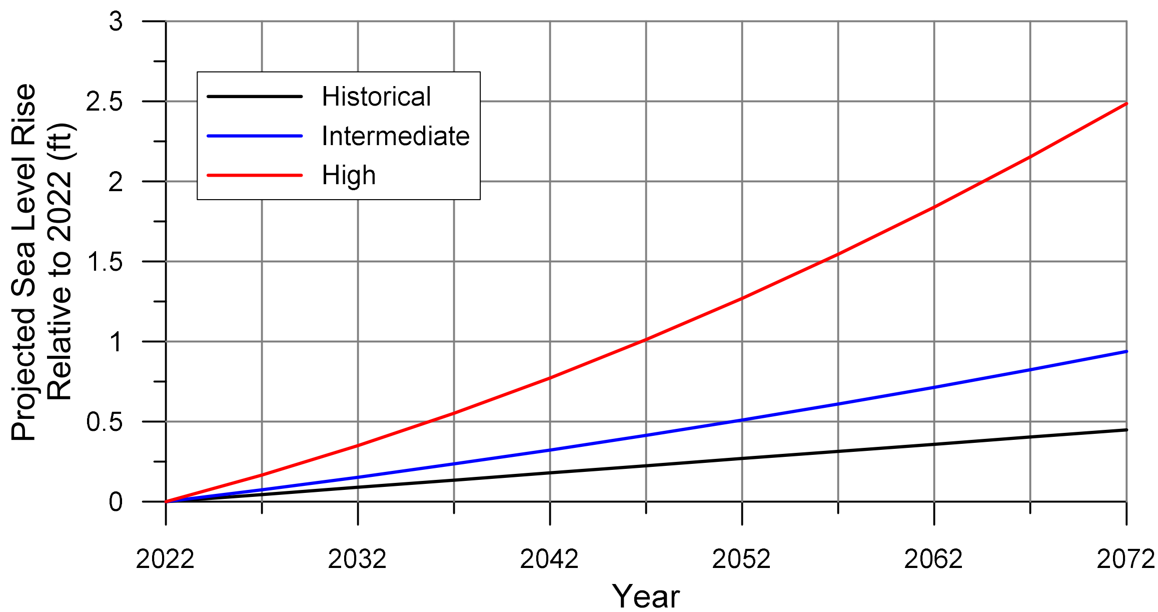

Figure 2.24: Projected Relative Sea Level Rise for a 50-year period (from 2022 to 2027) for Flagler County.

2.4. Past Projects

There have been dune restoration projects constructed within the last five years to address dune impacts and sand volume loss associated with Hurricanes Matthew (2016) and Irma (2017). Three projects of notable magnitude are summarized in **Table 2.5** and described below.

1. In 2017/2018 the Hammock Dunes Owners Association placed approximately 80,000 cy in the dune system from R-36 to R-47 (TEI, 2017). Details of the timing of placement is not available, as this project was conducted independently of the County's involvement. Placement appears to have been placed both pre- and post-Hurricane Irma.

2. In 2018/2019 Flagler County placed approximately 407,000 cy of sand in the dune system in a two-phased project from approximately R-2.5 to R-65 and were constructed under Permit No: SAJ-2017-01052-SCW (TEI, 2017).

3. In 2019 the FDOT placed approximately 68,900 cy over a newly constructed secant wall installation, from R-65 to R-70.

Other minor additions of sand to the dune system, including the placement of ~9,000 cy of sand from R-80 to R-89, have been placed by the FDOT over the past five years. Additionally, there are records of limited dune restoration along areas of the Hammock Dune shoreline during initial development activities there along. To-date, there have been no significant large-scale beach nourishment projects constructed along the Flagler County Atlantic Ocean coastline.

Table 2.5: Known historical dune construction projects in Flagler County.

Date	Sponsor	Location	Volume (cy)
2017/2018	Hammock Dunes OA	R36 to R47	80,000
2018/2019	Flagler County	R2.5 to R65	407,000
2019	FDOT	R65 to R70	68,900

2.5. Planned Shore Protection Projects

There are currently four planned projects for sand placement events, all of which are scheduled to commence in 2022. These projects are described below and are included in **Table 2.6** and **Figure 2.25**. Permitted limits and lengths are included in red to indicate that planned projects will not place sand along the full extent of the permitted limits. Past projects are also shown in **Figure 2.25**.

2.5.1. Federal Flagler County Coastal Storm Risk Management Project
(Federal Project, R-80 to R-94)

Project planning for substantial sand placement along Flagler County originated in 2003 with a Reconnaissance Study conducted by the USACE. The purpose of the study was to make a preliminary determination on whether there was Federal interest in further studying Flagler County shore protection issues. The Reconnaissance Study concluded that there was Federal interest and more detailed planning was initiated, including a Feasibility Cost-Sharing Agreement (FCSA), a Project Management Plan, and a Feasibility Study (initiated in 2014 and completed in 2015). The Feasibility Study evaluated the Flagler County shoreline from R-1 to R-4, and R-50 to R-101). The USACE Feasibility Study did not assess the shoreline segment from R-4 to R-50, since it was not deemed to have excessive erosion such that infrastructure was threatened, or potential benefits likely to outweigh the costs of implementing a solution.

The USACE recommended devoting Federal resources from R-80 to R-94 for a dune and beach restoration, forming the Federal Flagler County Coastal Storm Risk Management Project (Federal Project). Throughout this report, the terms "Hurricane Storm Damage Reduction (HSDR)" and "Coastal Storm Rick Management (CSRM)" are used interchangeably to refer to the Federal Project and associated funding. The project has an anticipated placement volume of 0.55 Mcy. The alternatives analysis in the 2015 USACE Feasibility Study also showed that beach and dune restoration with periodic maintenance would be the most effective means of achieving project objectives for the remaining unarmored sections of the beach with SR A1A adjacent (R-64.5 to R-80 and R-94 to R-101), but a Federally funded project along these areas did not meet the USACE economic screening criteria.

2.5.2. Flagler County/FDOT Beach/Dune Restoration Project
(Local Project, R-70 to R-80 & R-94 to R-101)

Based on the results of the USACE analysis and the desires of Flagler County, FDOT, FDEP, the Town of Beverly Beach and the City of Flagler Beach, the County elected to pursue a beach and dune restoration project along two shoreline reaches from R-70 to R-80 and R-94 to R-101 (Local Project), which would be funded 100 percent by non-federal interests. The Flagler County/FDOT Beach/Dune Restoration Project (Local project) also aims to add shore protection through the use available funding resources to extend the benefits of the Federal project. Constructing the local project coincident with the Federal project could result in significant cost-savings on the mobilization/ demobilization fee for dredging. Due to local budgeting constraints, the northern limit of the northern segment of the Local Project was reduced from R-64.5 to R-70 during the engineering design phase of the project. The total anticipated fill placement for the Local Project is 1.4 Mcy.

2.5.3. The North County Dune Restoration and Maintenance Project
(Flagler County/FEMA, R-2.3 to R-11.8, R-15.9 to R-24.3, and R-47.9 to R-65)

The County has been granted FEMA funding assistance for damages from Hurricane Dorian to three subsegments of the engineered dunes constructed in 2018/2019. The three segments are (1) R-3 to R-12, (2) R-16 to R-24.3, and (3) R-47.9 to R-65. The County conducted a damage assessment and concluded that 49,544 cubic yards of sand and 69,612 dune plants were lost from the engineered dune. The repairs will be made only between the central segment, from R-16 to R-24.3. Sand for the project will be sourced from an upland mine and delivered via truck. Additional details of the eligible work are summarized in FEMA project worksheet (P/W) number 215 for Event DR-4468-FL.

2.5.4. Hammock Dunes Restoration
(Hammock Dunes Owners Association, R-35.1 and R-47.9)

The Hammock Dunes – Dune Restoration Project, locally funded by the Hammock Dunes Owners Associates (HDOA) plans to place 110,000 cy by truck haul along the southern half of their associated shoreline, from R-35.1 through R-47.9. This project reach coincides with where sand was placed during the HDOA project in 2017/2018.

Table 2.6: Anticipated beach and dune placement projects along Flagler County, FL. Permit limits and lengths are included in red.

Date	Sponsor	Location	Length (miles)	Volume (cy)
2022	USACE (Federal Project)	R-80 to R-94	2.6	550,000
2022	Flagler County, FDOT, FDEP, Beverly Beach, Flagler Beach (Local Project)	R-64.5 to R-70, R-70 to R-80, R-94 to R-101	(4.0) 3.0	1,300,000
2022	FEMA	R-3 to R-12, R-16 to R-24.3, R-49.5 to R-65	(6.3) 1.6	49,544
2022	Hammock Dunes OA	R-35.1 to R-47.9	2.3	110,000

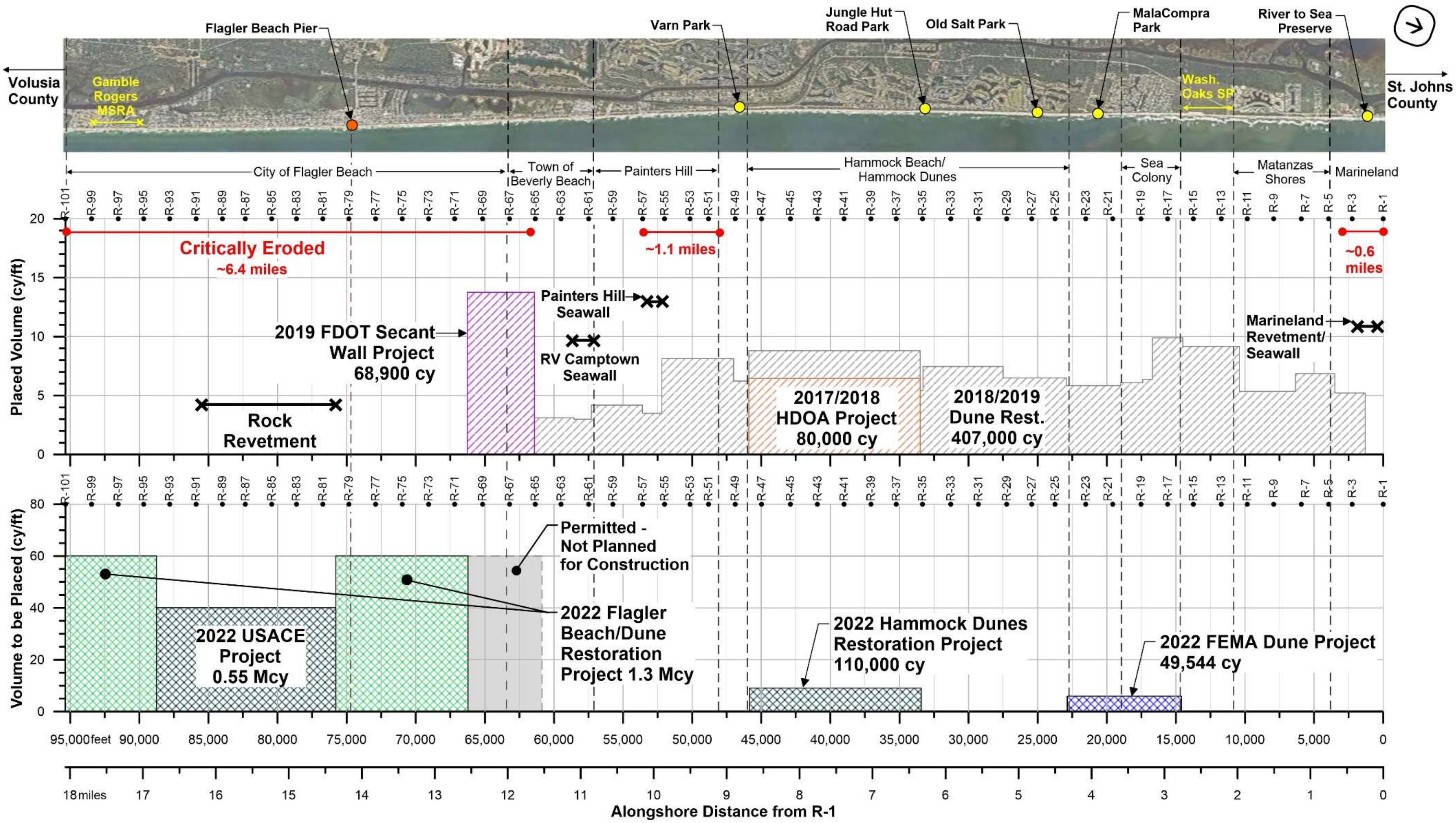

Figure 2.25: Past and planned beach, dune and armoring projects along the Flagler County coastline.

2.6. Permits

A complete listing of permits for the four planned dune/beach restoration and maintenance projects in Flagler County is provided below. At the time of this writing, two of the projects have all of the required regulatory approvals and permits. These projects are (1) the Federal Flagler County Coastal Storm Risk Management Project (Federal project) and (2) the Flagler County/FDOT Beach/Dune Restoration Project (Local project). There are also lease agreements with the Bureau of Ocean Energy Management (BOEM) for these two projects, which plan to use sand from the Outer Continental Shelf (OCS).

Federal Flagler County Coastal Storm Risk Management Project
(USACE Federal Project, *R-80 to R-94*):

- FDEP: P/N 0378136-001-JC (Issue date: 11 February 2020, Expiration date: 11 February 2035)
- USACE: Not Required
- BOEM: Lease Agreement OCS-A 0528 (Issue date: March 23, 2020. Agreement Expires three years from the date of execution of MOA or after 700,000 cy of sand has been placed)

Flagler County/FDOT Beach/Dune Restoration Project
(Local Project, *R-64.5 to R-80 & R-94 to R-101*):

- FDEP: P/N 0379716-001-JC (Issue date: 13 April 2020, Expiration date: 13 April 2035)
- USACE: P/N SAJ-2019-02065 (SP-TMM) (Issue date: 8 October 2020 Expiration date: October 8, 2035)
- BOEM: Lease Agreement OCS-A 0531 (Issue date: August 11, 2020. Agreement expires three years from the date of execution of MOA or after 1.8 Mcy of sand has been placed)

The North County Dune Restoration and Maintenance Project
(Flagler County/FEMA, *(1) R-2.3 to R-11.8, (2) R-15.9 to R-24.3, and (3) R-47.9 to R-65*)

- FDEP: P/N 0414585-001-JC (Application pending)
- USACE: SAJ-2017-01052 (SP-TMM) (Application pending)
- BOEM: N/A

The Hammock Dunes Dune Restoration Project
(Hammock Dunes Owners Association, *R-35.1 and R-47.9*):

- FDEP: P/N 0405821-001-JC (Issue date: 6 December 2021, Expiration date: 6 December 2036)
- USACE: SAJ-2017-01052 (SP-TMM) (Issue date: June 30, 2022)
- BOEM: N/A

3.0 DUNE & BEACH CONDITIONS

The formulation and implementation of a county-wide coastal management plan requires understanding of the historical and existing conditions. Existing conditions of particular interest include the dune crest, dune volume, beach width, beach volume, and shoreline location.

A comprehensive topographic and hydrographic survey was collected by Arc Surveying & Mapping, Inc. from R-1 to R-101 in April 2021. The survey included orthographic aerials, LiDAR, topographic, and bathymetric components. Cross-shore profiles were provided at each FDEP R-monument and were stitched from the LiDAR, topographic, and bathymetric components as discussed below. This dataset served as the present-day condition for this analysis.

Shoreline and volume changes were determined through comparisons with various traditional beach profile surveys, collected at 1,000-ft alongshore intervals at the FDEP R-monuments, including: June 2016, July 2011, June 2000, and June 1972. The long- and short-term timeframes both include the recent changes associated with Hurricanes Matthew, Irma, and Dorian. A multitude of additional storms affected during the June 1972 to April 2021 timeframe (*Section 2.3.3*). Additionally, these timeframes include the influence of several coastal construction projects (from north to south) the 2018/2019 Flagler County Dune Restoration, the 2017/2018 HDOA Project, the 2018/2019 Painters Hill Seawall installation, and the 2019 FDOT Secant Wall Project. Lastly, the subsequent repairs to A1A and the revetment seaward of A1A in Flagler Beach following Hurricane Matthew are included. Historical beach profile plots of the Flagler County shoreline are provided in **Appendix C**. More details from the dune analysis are provided in **Appendix A**.

3.1.1. Existing Dune Conditions

<u>Existing dune crest elevation and volume</u> are two indicators for coastal protection (and vulnerability) to storm surge. The dune crest elevation is defined as the highest elevation of the primary dune system along a given cross-shore transect. For this study, transects were extracted at an alongshore spacing of 2 ft for Flagler County's ~95,000 feet of shoreline (faded gray lines, **Figure 3.1**). A running average with a window of about 600 feet was used to obtain local trends in the dune crest elevation (blue line, **Figure 3.1**).

The crest elevation of the primary dune (before averaging) along Flagler County varies significantly alongshore, between +8.9 and +26.8 ft and averages about +18.2 ft from R-2.3 to R-101. The dune crest is generally higher in the southern portion of the county.

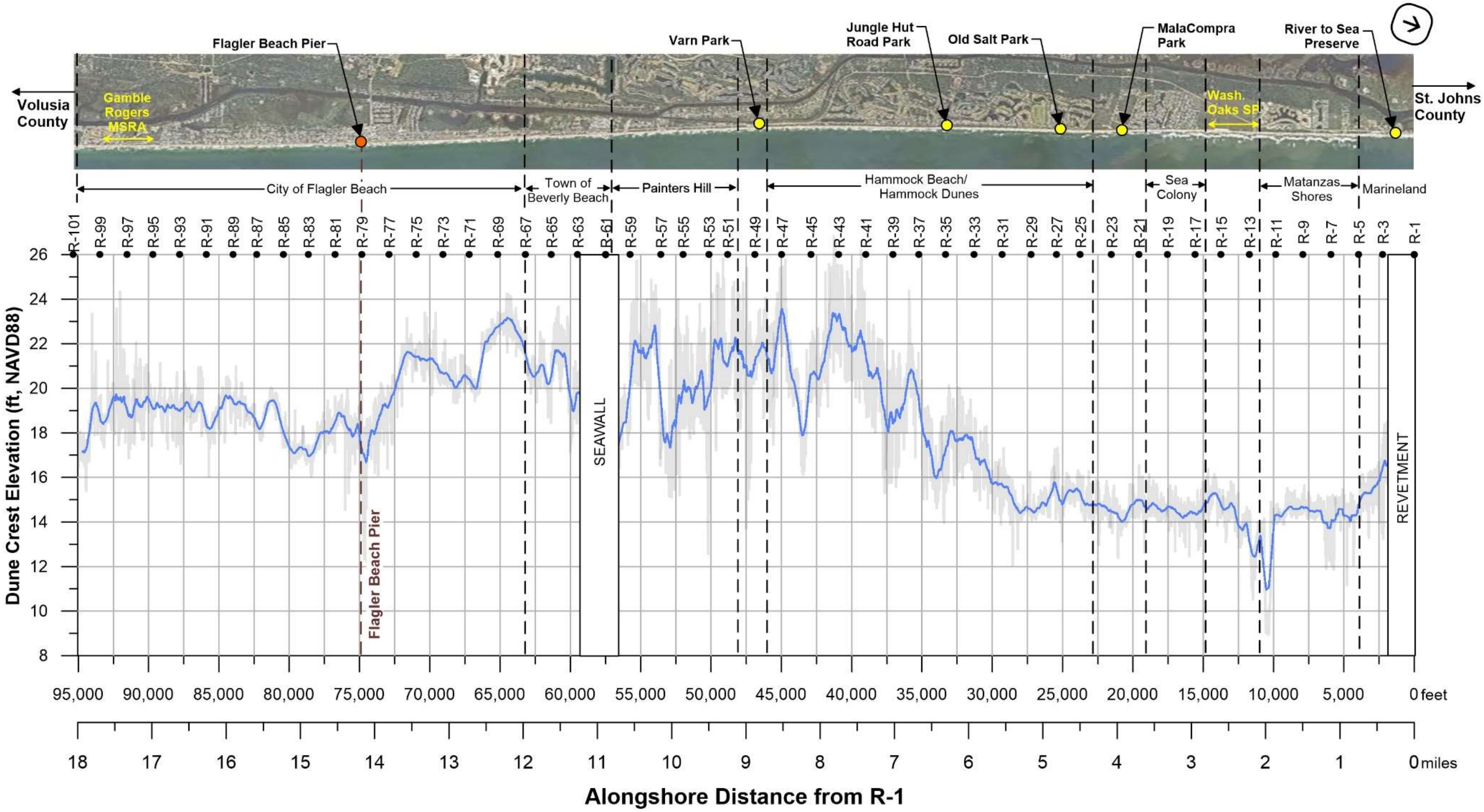

Figure 3.1: Crest elevation (ft, NAVD88) of the frontal dune along Flagler County from R-1 to R-101.

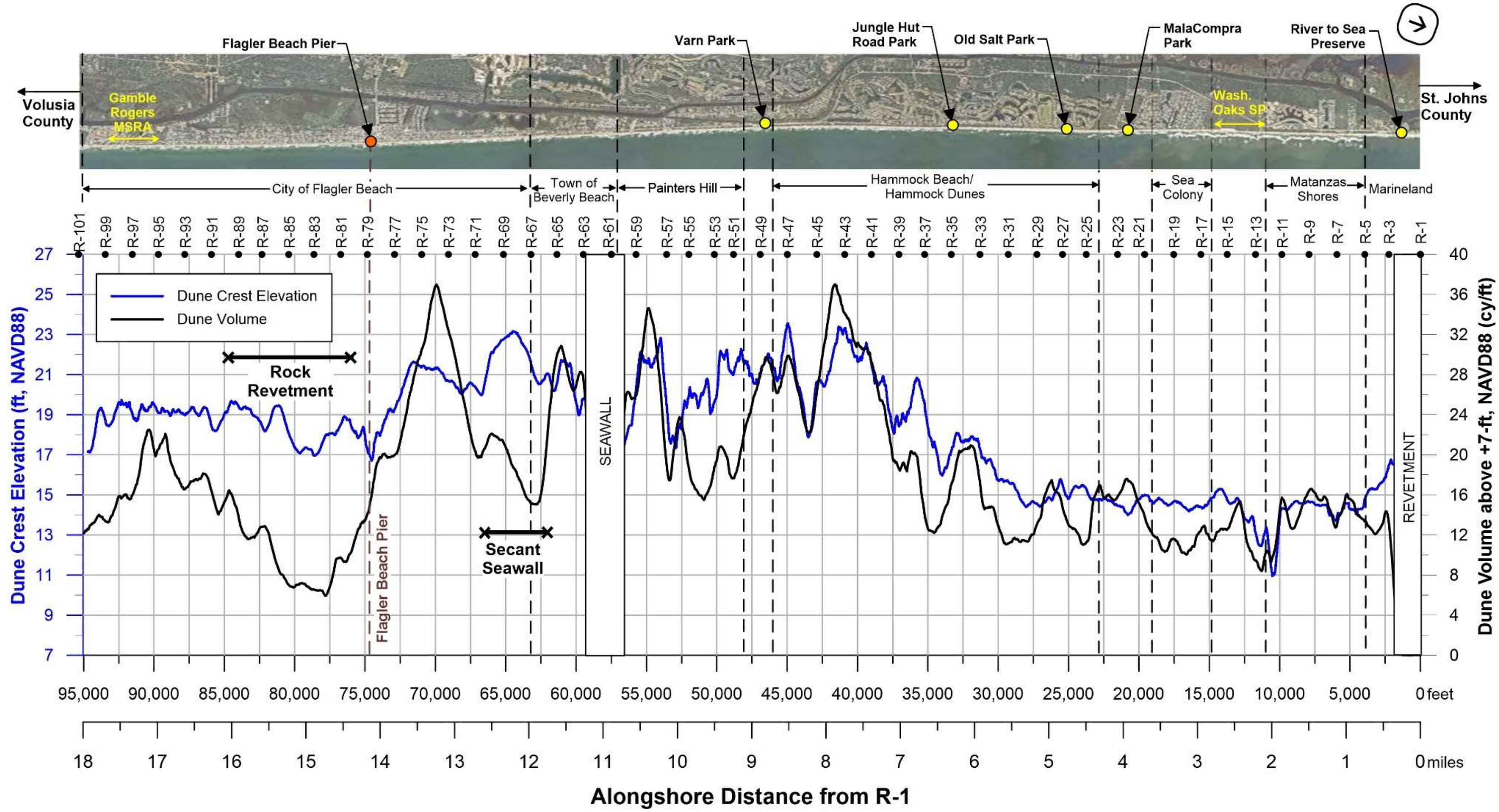

Figure 3.2: The April 2021 dune volume (black lines/y-axis) above +7.0 ft, NAVD88 and dune crest (blue lines/y-axis) from R-1 to R-101. Corresponding county-wide averages of dune volume and crest elevation equal 18.1 cy/ft and +18.2 ft, NAVD88, respectively.

The crest is lowest (average of +15.0 ft) along the northernmost 35,00 feet (6.5 miles) of shoreline. The dune crest in the southern half of The Hammocks, Varn Park, and Painters Hill (R-37 to R-60) is relatively high, reaching maximum elevations of +26.0 feet, but also contains low points in which the dune elevation is below the county average. In Flagler Beach, where A1A is established immediately adjacent to the dunes (generally R-65 through R-101) the dune crest elevation is relatively robust (average of +19.5 feet). The crest elevation is enhanced along the footprint of the 2019 FDOT Secant Wall project (R-65 to R-70) and where A1A is more than 50 feet from the established vegetation line (R-72 to R-76).

The dune volume in this analysis is represented as the volume of sand above +7 ft NAVD88, the average elevation of the seaward dune toe. The +7 ft NAVD88 elevation is also the 1-percent-annual-chance water level (i.e., the 100-year still water level) for Flagler County (FEMA 2020). Dune volume is intended to represent the maximum volume that can be eroded without compromising upland infrastructure to damage from a coastal storm. The dune volume was extracted alongshore at every 50 feet along the same reference line utilized as the dune crest elevation, and averaged about every 700 feet to obtain local trends. Dune crest elevation and volume along the entire county are superimposed to compared the two metrics along the Flagler County coastline and tend to trend similarly (**Figure 3.2**).

Dune volume trends similarly to dune crest elevation, that is, the dune tends to be larger/smaller when the crest is higher/lower, particularly along the northern 11 miles (R-2.3 to R-60). Along the entire county, the dune volume varies between 4.2 cy/ft at R-81.8 (Flagler Beach) to 40.7 cy/ft at R-43.5 (Hammock Dunes), and averages 18.1 cy/ft. The largest discrepancies between dune crest and dune volume are observable in southern Beverly Beach and Flagler Beach, with the exception of a segment from R-72 to R-76. This ~3,800-ft segment is also where A1A is offset more than 50 feet from the established vegetation line, allowing for more dune volume to exist. The largest disparities occur from and R-80 to R-90, where the and revetment maintain robust dune crest elevations and +19.0 ft) but the dune does not contain significant volume (10 cy/ft). The secant wall from R-65 to R-70 secant seawall maintains both a robust crest elevation (+22.0-ft) and volume (20 cy/ft) on average.

Dune crest elevation and volume along the entire county are statistically ranked and superimposed in **Figure 3.3**. About 55% of the dune crest elevation along the entire county is presently (April 2021) below +19.0 ft, which is the USACE design crest elevation for the Flagler County - Federal Coastal Storm Risk Management Project. In terms of volume, about 70% of the dunes in Flagler County contain volumes lower than 20.0 cy/ft. A total of 25% of the dunes contain less than 13.0 cy/ft and have a crest elevation of less than +15.0 ft, which are the most vulnerable dunes subject to washover and/or blowout during a significant storm event.

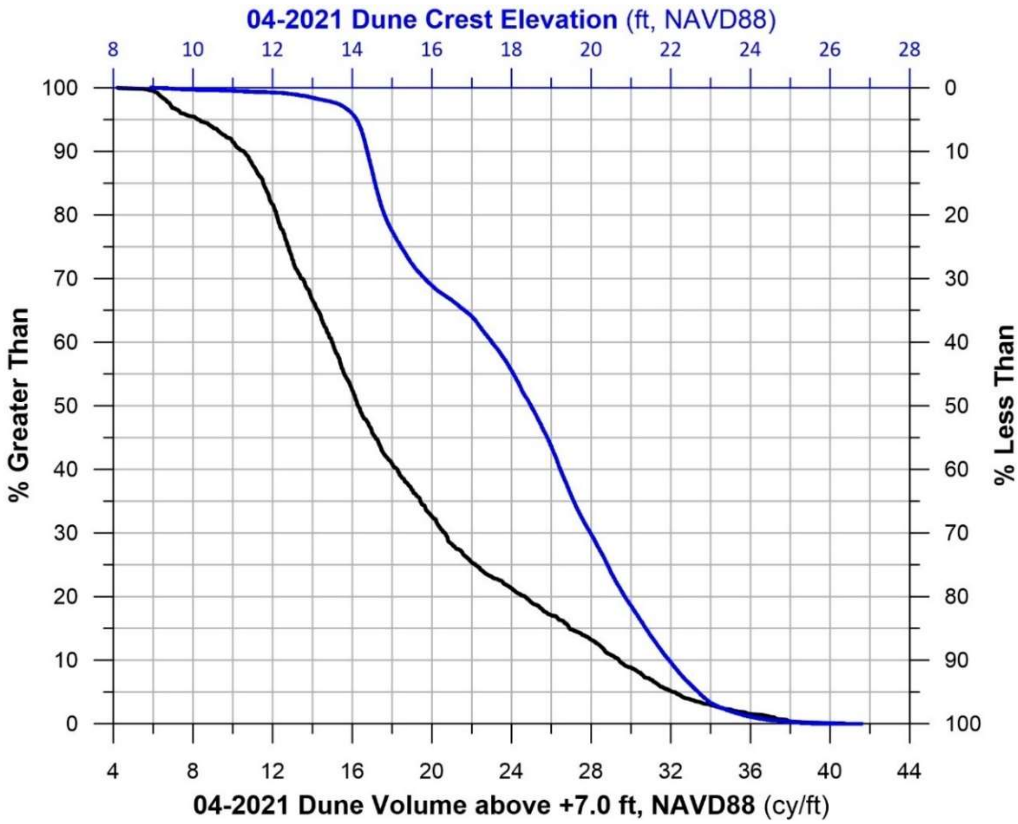

Figure 3.3: Percent exceedance of the dune crest elevation and dune volume along Flagler County, from R-1 to R-101, in April 2021.

3.1.2. Existing Beach Width

In the present analysis, beach width is defined as the distance from the MHWL (+1.42 ft, NAVD88) to the seaward limit of established vegetation or upland development at a single point in time. **Figure 3.4** plots beach width for the entirety of Flagler County, from R-1 to R-100.

The average dry beach width along areas without an exposed revetment or seawall is about 100-ft. The wall along the northern portion of River to Sea Preserve and the secant wall along the southern portion of Beverly Beach into Flagler Beach are buried under vegetated dunes, and therefore do not affect beach width. The narrowest beach widths are located seaward of the revetment at Marineland (~35 feet) and seaward of the revetment along central Flagler Beach (~50 feet). During high tides in the winter season there is no dry beach seaward of the Marineland revetment. Local reductions in beach width are observed seaward of the exposed seawalls along Painters Hill and the RV Camptown in Beverly Beach. The widest segments of beach exist along the undeveloped portions of Washington Oaks State Park (~140 feet) and MalaCompra Park (~125 feet).

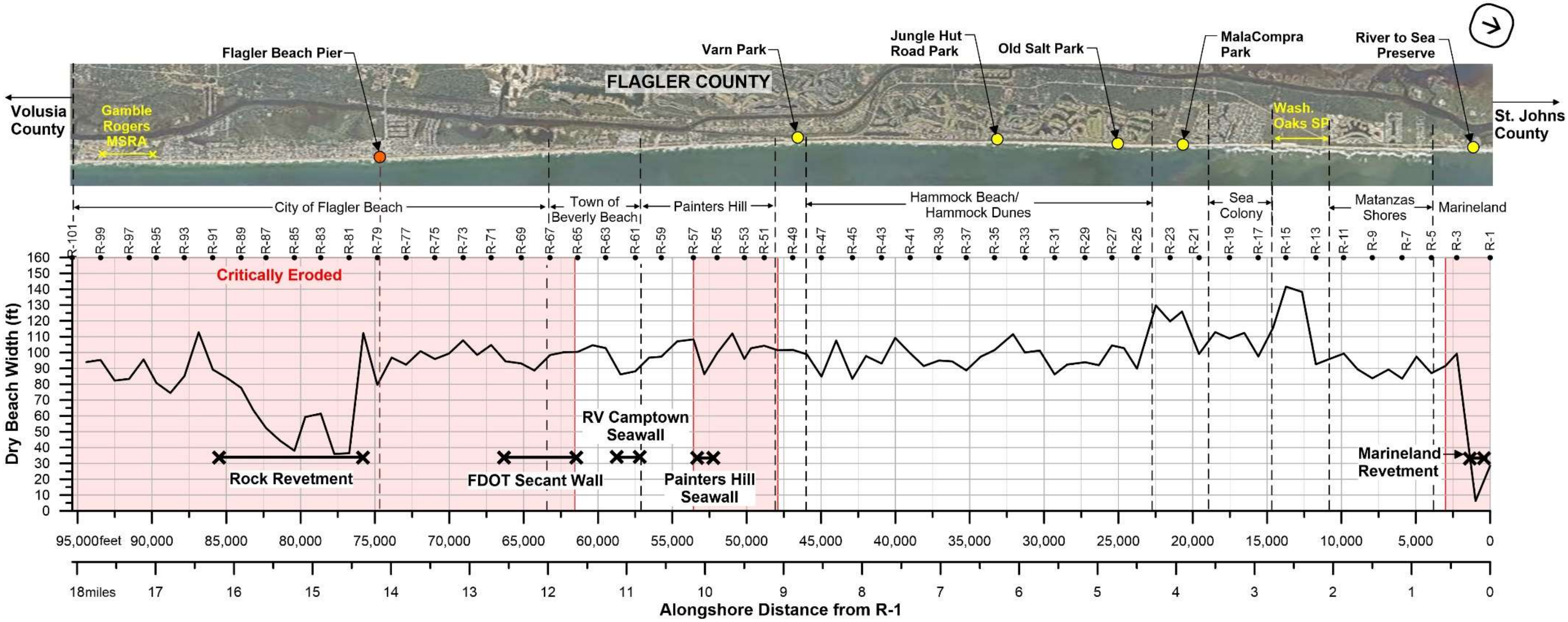

Figure 3.4: Existing (April, 2021) dry beach width measured from seaward-most vegetation/infrastructure to the MHWL (+1.42 ft, NAVD88) along Flagler County.

3.1.3. Shoreline Change and Orientation

Shoreline change analysis is a common tool for identifying areas of stability and as well as potential 'hot spots' of erosion. The April 2021 condition survey was compared with prior surveys from June 1972, July 2011, and June 2016 to determine position changes in the berm and MHWL (**Table 3.1** and **Table 3.2**). Tabulated shoreline recession more than -25 feet is shaded red, while shoreline advancement more than +25 feet is shaded green.

In general, the combined effects of background and storm-induced erosion have caused the County shoreline to retreat landward since 1972, particularly along the northernmost 9 miles by -32 feet when averaging both the changes in berm and MHWL. Maximum recession values in the berm position exist along Sea Colony, Malacompra Park, and most of the Hammock, especially the southernmost 1.5 miles into Varn Park. Along Flagler Beach south of the pier (R-79), there had been a progressive advancement of the berm from June 1972 through July 2011, until June 2016. Disregarding the revetment area at Marineland where no dry beach currently exists, the April 2021 MHWL fluctuates between +40 feet and -60 feet in comparison to historical profiles. In central Beverly Beach and Flagler Beach north of the pier, the April 2021 MHWL has advanced ~10 feet relative to June 1972. When comparing the April 2021 MHWL to the June 1972 MHWL, the location has receded landward most significantly along Washington Oaks SP, Malacompra Park, the northernmost 1.5 miles of the Hammock, the southernmost 1.5 miles of the Hammock through Varn Park most of Painters Hill, and south of the pier in Flagler Beach for ~3 miles. The recession of the MHWL south of the pier becomes less pronounced when comparing the April 2021 data with more recent historical data sets, likely after the construction of the rock revetments and stabilization of the shoreline. **Since 1972, the Flagler County shoreline has receded by an average of -17.0 ft and -21.5 ft, at the berm and MHW contours, respectively.**

Table 3.1: Change of the beach berm (+7.0) location relative to April 2021 along Flagler County.

Location	Mon.	Change in Berm (+7.0) Location (ft) June 2016 to April 2021	July 2011 to April 2021	June 1972 to April 2021	Armor
Town of Marineland	R1	-0.5	-2.1	-68.5	
	R2	0.9	-4.8	-48.1	X
River to Sea Preserve	R3	3.4	-5.2	-49.7	
	R4	-6.4	-17.8	-48.4	
Matanzas Shores	R5	-4.7	-5.8	-28.6	
	R6	1.8	0.4	-22.5	
	R7	-22.7	-27.5	-37.9	
	R8	1.5	-27.0	-18.7	
	R9	-15.4	-24.8	-42.7	
	R10	-9.8	-20.5	-27.3	
	R11	-6.0	-9.9	-18.7	
Washington Oaks State Park	R12	-0.6	-16.6	-21.1	
	R13	-8.6	-20.5	-29.9	
	R14	18.5	-5.5	-56.2	
	R15	14.8	-15.2	-59.8	
Sea Colony	R16	-7.0	-27.1	-56.1	
	R17	-23.3	-36.5	-65.4	
	R18	-29.0	-33.0	-70.8	
	R19	-30.7	-32.0	-64.3	
	R20	-19.5	-33.6	-74.0	
Mala-Compra Park	R21	-5.9	-9.9	-41.4	
	R22	-12.8	-15.7	-53.4	
	R23	3.7	-5.9	-35.6	
	R24	11.6	10.3	-24.2	
Hammock Beach/ Hammock Dunes	R25	-12.6	-10.3	-37.2	
	R26	-1.6	-7.2	-47.7	
	R27	-0.5	-11.4	-30.4	
	R28	-5.0	-2.7	-28.7	
	R29	8.2	0.9	-14.5	
	R30	0.3	-6.5	-25.7	
	R31	-2.6	-10.3	-41.6	
	R32	-5.5	-12.3	-42.0	
	R33	-9.3	-14.2	-32.4	
	R34	-7.3	-5.9	-20.4	
	R35	-12.5	-15.4	-21.4	
	R36	-14.7	-24.6	-31.1	
	R37	-7.5	-14.3	-22.7	
	R38	-7.4	-10.8	-22.8	
	R39	-2.0	-8.1	-17.1	
	R40	0.2	-15.1	-30.3	
	R41	2.5	-10.4	-33.5	
	R42	23.0	-1.4	-16.1	
	R43	5.3	-5.6	-39.9	
	R44	12.5	-4.0	-29.6	
	R45	8.1	-0.1	-16.4	
	R46	-2.4	-26.7	-23.5	
	R47	-12.2	-30.6	-44.3	
Varn Park	R48	-2.6	-13.1	-25.8	
	R49	5.0	1.9	-18.7	
Painters Hill	R50	9.5	-2.3	-22.4	
	R51	16.9	-2.4	-17.4	
	R52	1.6	-17.2	-	
	R53	26.0	13.6	-26.8	
	R54	10.2	-4.0	-17.5	
	R55	13.9	4.7	-12.6	
	R56	-0.7	-18.3	-30.4	X
	R57	-7.0	-24.0	-22.6	
	R58	35.0	10.7	17.3	
	R59	8.3	6.3	-5.1	
	R60	9.8	1.4	-4.8	
Town of Beverly Beach	R61	-2.3	2.9	-2.2	X
	R62	27.0	22.3	22.6	
	R63	19.7	20.8	22.6	
	R64	2.0	-3.0	-10.7	
	R65	-11.8	-5.1	-5.4	
	R66	20.4	3.2	10.0	
	R67	2.8	-12.1	11.5	X
City of Flagler Beach	R68	17.3	12.9	-3.1	
	R69	-11.8	-15.1	-13.9	
	R70	15.6	5.3	-4.3	
	R71	15.1	20.2	3.7	
	R72	22.7	27.8	6.9	
	R73	27.8	31.8	24.2	
	R74	18.8	22.9	27.4	
	R75	4.9	16.7	10.9	
	R76	-4.3	18.2	24.7	
	R77	6.8	22.5	25.1	
	R78	-5.7	26.0	23.1	
PIER →					←
	R79	-5.1	1.9	20.0	
	R80	24.7	41.2	40.6	
	R81	-2.0	-3.8	-11.4	
	R82	-3.3	-2.9	-14.0	
	R83	10.6	11.3	-0.8	
	R84	28.5	30.6	13.5	
	R85	-6.6	-9.3	-29.2	X
	R86	-0.4	13.8	-20.0	
	R87	4.7	25.6	-2.5	
	R88	1.3	23.8	-5.7	
	R89	5.6	22.5	-3.2	
	R90	9.7	37.2	5.6	
	R91	12.0	33.2	8.0	
	R92	30.7	46.4	27.5	
	R93	-3.8	12.7	-7.6	
	R94	-3.6	8.4	-8.8	
	R95	5.5	19.0	14.2	
	R96	-7.7	4.3	-2.1	
	R97	-0.2	20.3	6.5	
	R98	-6.7	0.5	-4.2	
	R99	11.0	16.0	14.5	
	R100	25.9	28.9	26.4	

Table 3.2: Change of the MHWL (+1.42) location relative to April 2021 along Flagler County.

Location	Mon.	Change in MHWL (+1.42) Location (ft): June 2016 to April 2021	July 2011 to April 2021	June 1972 to April 2021	Armor
Town of Marineland	R1	-28.0	-70.3	-69.6	X
	R2	-55.9	-81.5	-70.8	X
River to Sea Preserve	R3	-25.2	-73.6	-15.1	X
	R4	-54.2	-38.7	-44.9	
Matanzas Shores	R5	-2.6	-6.3	-28.1	
	R6	2.7	-4.1	-22.3	
	R7	7.7	-18.6	-23.6	
	R8	9.8	-7.1	-24.0	
	R9	10.6	-11.0	-24.6	
	R10	15.3	6.3	-9.7	
	R11	-24.4	-27.7	-11.4	
Washington Oaks State Park	R12	13.2	-0.5	-16.5	
	R13	10.8	-11.5	-20.6	
	R14	10.8	-15.5	-42.0	
	R15	18.7	-12.8	-45.6	
Sea Colony	R16	10.7	-19.3	-27.3	
	R17	-19.2	-37.3	-46.9	
	R18	-34.6	-21.0	-23.3	
	R19	6.8	-13.4	-12.2	
	R20	11.7	-19.6	-35.6	
MalaCompra Park	R21	-35.7	-36.9	-40.0	
	R22	-30.4	-15.9	-39.3	
	R23	11.1	-5.9	-44.3	
	R24	16.2	3.4	-28.4	
Hammock Beach/ Hammock Dunes	R25	-8.1	-18.7	-23.9	
	R26	3.4	-14.6	-40.8	
	R27	-40.1	-14.7	-30.2	
	R28	-5.7	-8.6	-32.4	
	R29	15.8	-6.0	-13.2	
	R30	12.0	-7.9	-47.0	
	R31	-43.9	-14.3	-35.8	
	R32	2.1	-9.7	-29.3	
	R33	-10.9	-19.4	-44.8	
	R34	-3.3	-5.6	1.3	
	R35	8.9	-4.7	-1.5	
	R36	-10.8	-5.6	-14.7	
	R37	10.3	-3.5	-13.3	
	R38	10.1	2.2	-1.3	
	R39	22.7	16.5	-1.8	
	R40	13.7	-1.7	-29.4	
	R41	25.2	-6.3	-19.4	
	R42	-11.3	1.9	-26.6	
	R43	1.4	-7.3	-32.4	
	R44	36.3	-9.9	-30.0	
	R45	-18.4	-14.4	-33.4	
	R46	22.6	-10.7	10.4	
	R47	-42.3	-31.2	-36.7	
Varn Park	R48	7.4	-16.9	-26.1	
	R49	1.8	-15.6	-18.9	

Location	Mon.	Change in MHWL (+1.42) Location (ft): June 2016 to April 2021	July 2011 to April 2021	June 1972 to April 2021	Armor
Painters Hill	R50	-7.1	-15.7	-19.5	
	R51	27.6	-14.0	-47.4	
	R52	19.5	-11.2	-	
	R53	15.7	-9.1	-41.8	
	R54	-2.4	-8.8	-6.4	
	R55	20.9	-6.4	-30.3	X
	R56	-8.3	-14.5	-54.6	X
	R57	1.6	-20.9	-10.5	X
	R58	1.2	-5.5	-13.5	
	R59	13.4	-8.1	2.9	
	R60	-26.7	-9.3	-26.1	
Town of Beverly Beach	R61	12.0	-8.7	17.3	X
	R62	-0.5	-12.6	20.2	X
	R63	4.9	-9.5	8.6	
	R64	-8.2	-15.7	-5.7	
	R65	-4.0	-18.2	-5.9	X
	R66	-7.0	-30.4	-1.6	X
	R67	-10.1	-30.5	27.3	X
City of Flagler Beach	R68	-9.6	-25.8	-23.2	X
	R69	5.1	-21.3	8.0	X
	R70	2.9	-26.0	-25.7	X
	R71	-10.9	-6.8	-12.7	
	R72	10.0	-13.3	-14.3	
	R73	-7.5	10.4	25.7	
	R74	-0.9	-26.8	11.6	
	R75	-7.9	-17.3	11.6	
	R76	-10.0	-46.8	18.0	
	R77	-17.7	-6.5	13.3	
	R78	-11.4	-9.8	17.9	
PIER →	R79	-32.8	-60.6	-29.2	←
	R80	16.3	13.7	4.8	X
	R81	-19.7	-40.8	-61.3	X
	R82	-43.8	-32.4	-45.9	X
	R83	16.6	7.2	-5.1	X
	R84	15.2	2.5	-7.7	X
	R85	-29.7	-22.9	-54.0	X
	R86	-9.6	-18.6	-56.1	X
	R87	-40.3	5.0	-19.1	X
	R88	-15.6	8.8	-22.0	X
	R89	-6.7	9.2	-16.2	X
	R90	-26.1	2.0	-33.5	X
	R91	-13.4	-2.7	-41.0	
	R92	11.6	15.4	-17.0	
	R93	-17.4	-13.7	-51.2	
	R94	-16.3	-12.0	-34.9	
	R95	-12.0	-11.9	-36.0	
	R96	-13.4	-9.9	-23.0	
	R97	-20.6	-3.2	-35.4	
	R98	-14.4	-13.7	-21.8	
	R99	-27.2	-14.5	-28.6	
	R100	17.9	-7.0	-1.1	

Shoreline changes were normalized to determine annual rates of shoreline change over relatively long time periods (approximately 10 years or more). **Figure 3.5** plots the shoreline position change in feet per year from July 2011 to April 2021 (9.7 years) and from June 1972 to April 2021 (48.9 years). Normalized shoreline changes from June 2016 to April 2021 are not included, since this 4.8-year period is not temporally substantial enough to demonstrate representative change rates, especially considering the increase of detrimental storms (*Section 2.3.3*) and restoration projects (**Section 2.4**) along Flagler County's shoreline during this shorter timeframe.

In summary:

- From July 2011 to April 2021 (9.7 years), the berm has receded at an average rate of -1.4 ft/yr from R-3 to R-53, and advanced at an average of +1.3 ft/yr from R-53 to R-100. The MHWL has receded at an average rate of -1.5 ft/yr along the entire County, from R-1 to R-100.

- From June 1972 to April 2021 (48.9 years), the berm has receded at an average rate of -0.7 ft/yr from R-3 to R-57, and exhibited negligible change from R-57 to R-100. The MHWL has receded at an average rate of -0.4 ft/yr along the entire County, from R-1 to R-100.

The most recent and shortest record (July 2011 to April 2021) indicates the highest shoreline recession rates in the northern half of the County (R-3 to R-52). Along this region in the last 10 years from July 2011 to April 2021 (which include the effects of the recent severe storms) recession of the MHWL worsened by -1.0 ft/yr, yet advancement of the berm increased by +1.0 ft/yr. An increase in berm and a decrease in MHWL is characteristic of beach steepening. This is observed in the profiles in **Appendix C**, for example at R-71, where steepening of the profile continues to occur past the MHWL to below the MLWL.

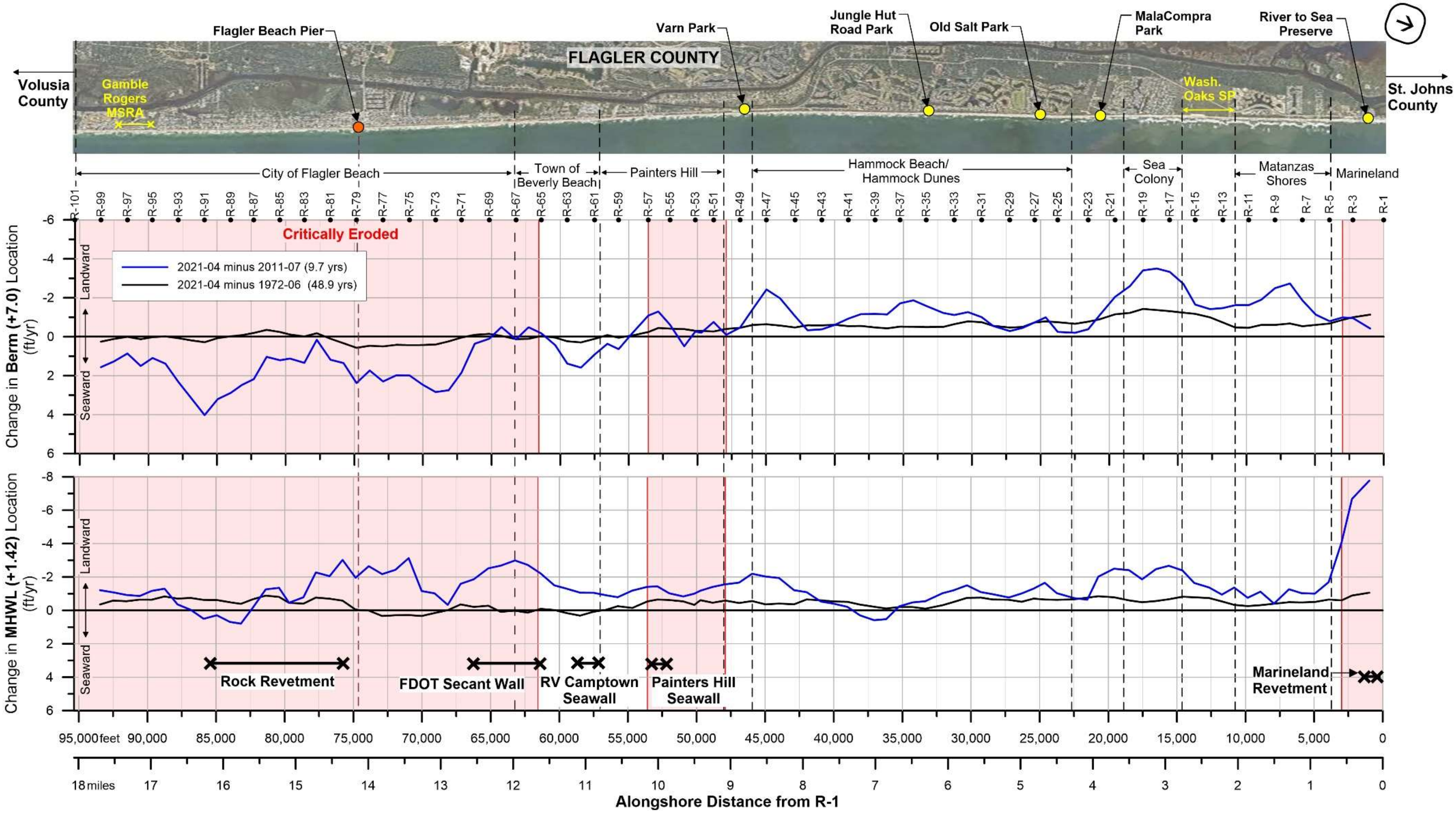

Figure 3.5: Change of the berm (+7.0 ft-NAVD88) and he MHWL (+1.42 ft-NAVD88) locations relative to April 2021, normalized annually.

<u>Shoreline Orientation.</u> The Flagler County coastline is not a straight line and continues to evolve with time (**Figure 3.6**). The distance perpendicular from a baseline oriented at 22° counterclockwise from true north to the MHWL April 2021 is plotted in **Figure 3.6**. The alignment of the shoreline is certainly influenced by smaller, 'modern' hardened coastal features such as the revetment/groins at Marineland and the pier in Flagler Beach built in 1928. However, the shoreline has been more substantially shaped by the effects of a broader coastal feature: the presence of (and lack of) the nearshore coquina rock (**Figure 3.6**). The combined effects of coquina rock can lead to a reduction of longshore sediment transport especially in a sand-deprived coastal system such as Flagler County. The shoreline from R-3 to R-17 and from R-23 to R-41 is additionally prone to storm waves approaching the shoreline from the ENE, which create oblique angles with the coastline in these areas, increasing sediment transport potential.

Figure 3.7 compares the position of MHWL in the June 1972 and April 2021 and shading between the two lines is filled red for retreat and green for advance. FDEP, 1999 noted that erosion rates from R-45 to R-55 from 1952/56 to 1986/87/93 worsened to a relative maximum along the County. This region lies immediately south of the outcrop from R-20 to R-43, and also coincides closely with the concave portion of the shoreline. Somewhere in the vicinity of R-60 there is an inflection point in the shoreline, where advancements in the MHWL exist and create a mildly convex curve. This trend terminates at the Flagler Beach pier. Severe shoreline retreat has occurred south of the pier towards the Volusia County line since June 1972. FDEP, 1999 reported that the shoreline from R-86 to R-100 had been advancing through the 1952/56 to 1986/87/93 timeframe and attributed this to the filling of sand around 'suspected rock outcrops'. Along the 1972 to 1986/87/93 timeframe, however, retreat was reported. No consolidated hardbottom has been verified south of R-43.5, as noted in **Section 2.1**.

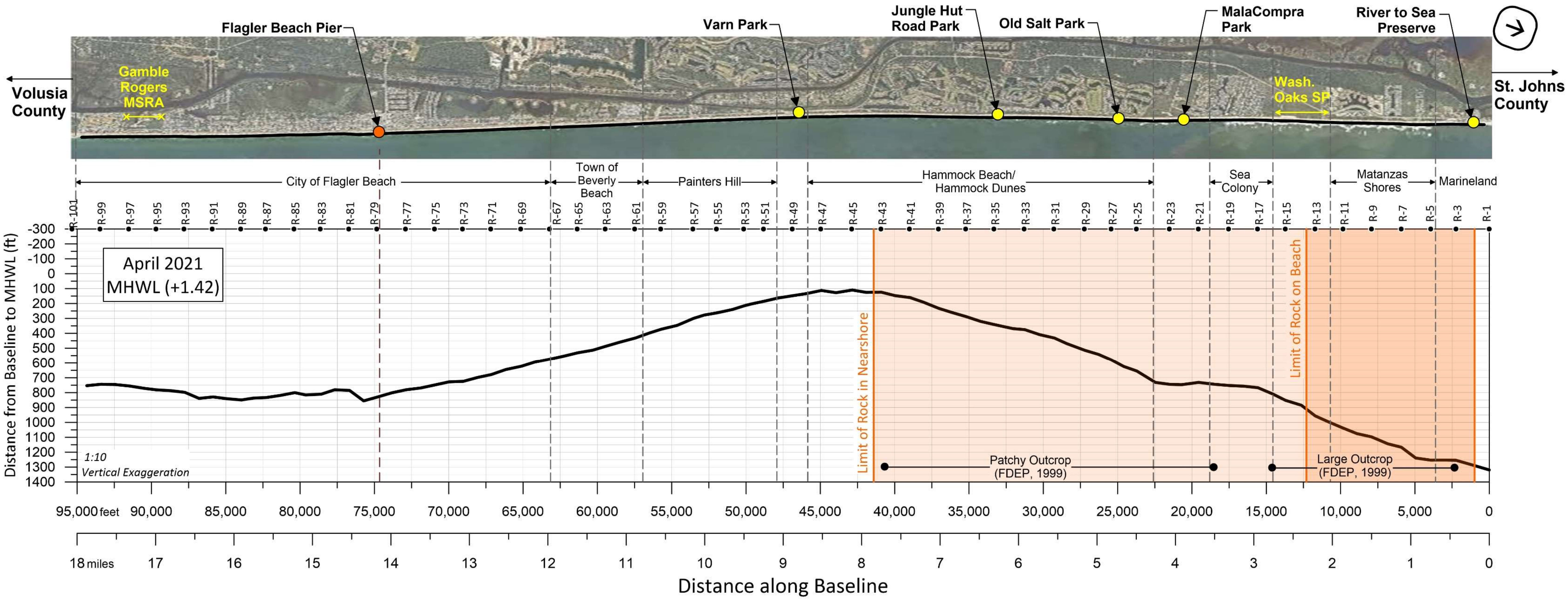

Figure 3.6: Alignment of the Flagler County shoreline through the position of the MHWL (+1.42 ft, NAVD88) in April 2021. Coquina rock locations and extents were estimated from April 2021 aerials and shaded in orange.

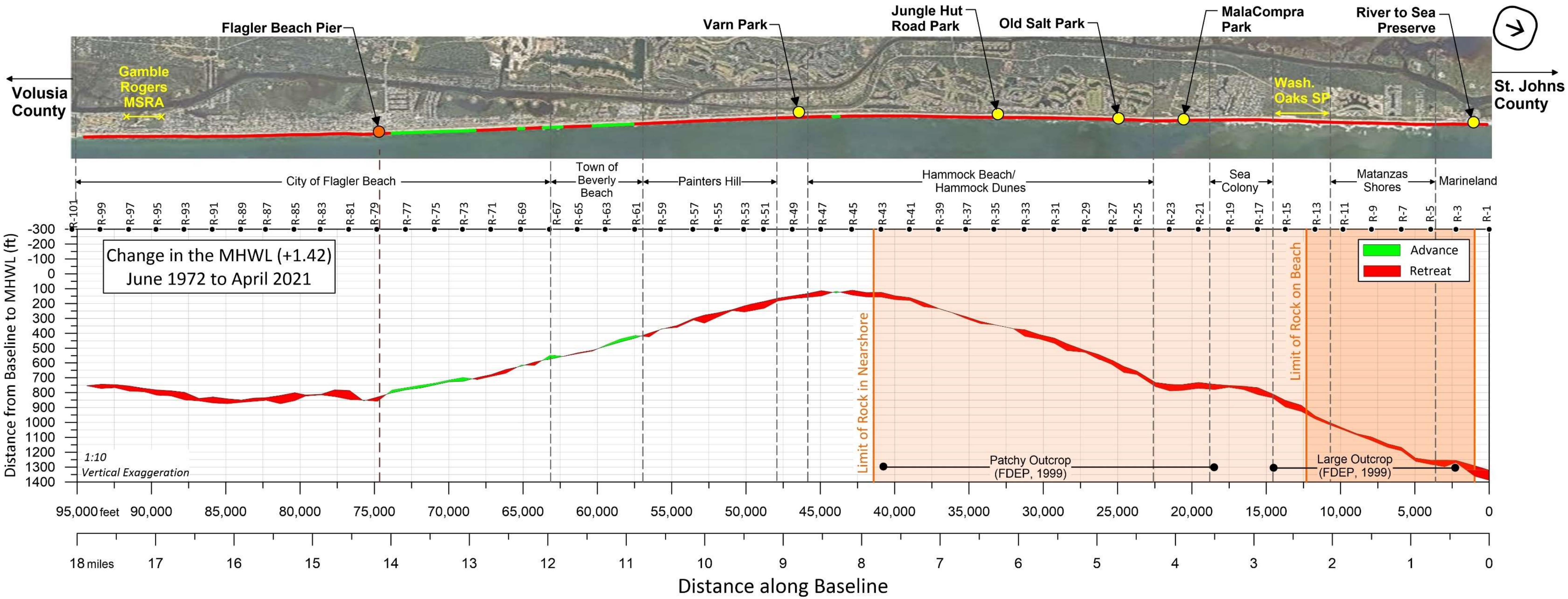

Figure 3.7: Distance to the MHWL (+1.42 ft, NAVD88) in June 1972 to April 2021 (48.9 years), and the change between the two timeframes shaded as red for shoreline retreat and green for shoreline advancement. Coquina rock locations and extents shaded in orange.

3.1.4. Dune and Beach Changes

Dune crest elevation and volume (above +7 ft-NAVD88) are observed since June 2016 and June 1972 (**Appendix A**). On average along the entire County (from R-2.3 to R-100, excluding areas with structures) for both timeframes from June 1972 to April 2021, and June 2016 to April 2021, the dune crest elevation has increased by +0.3 ft. Since June 2016, the dune crest location has receded seaward an average of -10.0 feet from R-2.3 to R-100. Since June 1972, the dune crest location has receded seaward an average of -13.8 ft from R-2.3 to R-100.

The largest improvements of dune crest are observed in the northernmost 25,000 feet (4.7 miles) of the County, along Matanzas Shores, Washington Oaks, and MalaCompra Park (R-2.3 to R-26). Improvements to the dune crest are also noticeable between the Beverly Beach Seawall and the Flagler Beach Pier. Consistent reduction of the dune crest is exhibited along The Hammocks and Painters Hill, with the largest (-3.0 ft) occurring between R-27 - R-33, R-45 - R-46, and R-53 - R-56. Effects of the November 2021 nor'easter have further degraded the dune crest in these locations.

On average from R-3 to R-100 (excluding the seawall at R-61 and R-62) from June 2016 to April 2021, the dune volume has decreased by -0.9 cy/ft (-72,400 cy net total, -165,400 gross total). From June 1972 to April 2021, the dune volume has decreased on average by -2.8 cy/ft (-243,700 cy net total, -297,100 cy gross total).

Beach and dune volume change is quantified through quantitative comparison of surveyed beach profile conditions measured in June 1972, July 2011, and April 2021. The profiles in the June 2016 data set do not extend along the full extent of the beach and therefore are not used to compute volume change. Long-term (1972-2021; ~49 years) and short-term (2011-2021; ~10 years) timeframes are used to evaluate the probable sediment deficit from the beach as well as expected average annual sand loss rates from the beach. Annualized sand volume demand derived from the deficits during these timeframes is described in **Chapter 6.0**. Beach and dune volume change is calculated at each monument. Dune volume is calculated above +7 ft, NAVD88 which is the average elevation of the seaward dune toe. Beach volume is calculated above the assumed depth of closure of -24 ft, NAVD88 and therefore includes dune volumes changes above +7 ft, NAVD88.

2011-2021. A comparison from July 2011 to April 2021 demonstrates the change in volume over the past 9.7 years (**Figure 3.8**, top plot, and **Table 3.3**). Cumulative volume changes from R-1 to R-100 are also plotted and tabulated. The comparative calculations include the volume of the dune, described previously as the volume above +7.0 ft. The volume loss rate from July 2011 to April 2021 ranges from a minimum of -75.5 cy/ft at R-79 (immediately south of the pier) to a maximum of 44.5 cy/ft at R-80, with an average of -11.9 cy/ft. The cumulative change from R-1 to R-100 equates to -1,098,700 cy.

1972-2021. A comparison from June 1972 to April 2021 is performed at approximately every third monument, where the 1972 profiles extend beyond wading depths to closure (**Figure 3.8**, bottom plot, and **Table 3.4**). Volume loss rates range from a minimum of -83.9 cy/ft at R-95 to a maximum of 21.0 cy/ft at R-3, and average -37.8 cy/ft. The cumulative change from R-1 to R-100 equates to -3,575,800 cy.

Upper Beach Volume Change along Beach Rock Area. Placing sand on the beach along areas where nearshore coquina rock exists below the MHWL (R-2.3 to R-43.5) with be resisted by regulatory authorities (FDEP, USACE, etc.). The permissible volume to be placed that will not require mitigation for adverse impact to habitat (i.e., the rock) is likely going to equal the volume correlated to that of the most robust historical profile, above MLW. **Table 3.5** lists the sectional and cumulative gross volume change from June 1972 to April 2021 above MLW (-2.80 ft) from R-2.3 to R-43.5. Sand loss is not accounted for from R-1 to R-2.3, along the revetment in Marineland. A total of -600,000 cy is reported, with an average of -15.2 cy/ft along ~40,100 feet (7.6 miles) of shoreline.

Table 3.3: Beach and dune volume changes for the Flagler County, FL shoreline (R-1 to R-100) from July 2011 to April 2021 (9.8 years) above -24 ft, NAVD88.

Mon.	Alongshore Dist. *(ft)*	Sectional Volume Change *(cy/ft)*	Volume Change between Monuments *(cy)*	Cumulative Volume Change *(cy)*	Mon.	Alongshore Dist. *(ft)*	Sectional Volume Change *(cy/ft)*	Volume Change between Monuments *(cy)*	Cumulative Volume Change *(cy)*
R1	0	-35.7			**R51**	48,822	-29.6	-17,400	-488,500
R2	980	14.1	-10,600	0	**R52**	49,712	-24.4	-24,000	-505,900
R3	2,242	19.1	20,900	-10,600	**R53**	50,161	-35.7	-13,500	-529,900
R4	3,001	5.4	9,300	10,300	**R54**	50,966	-1.0	-14,800	-543,400
R5	3,947	12.5	8,500	19,600	**R55**	51,993	-31.9	-16,900	-558,200
R6	4,952	34.9	23,800	28,100	**R56**	52,852	-43.2	-32,300	-575,100
R7	5,917	18.6	25,800	51,900	**R57**	53,579	-8.4	-18,700	-607,400
R8	6,834	27.5	21,100	77,700	**R58**	54,673	-19.6	-15,300	-626,100
R9	7,922	7.5	19,000	98,800	**R59**	55,746	16.1	-1,900	-641,400
R10	8,913	20.5	13,900	117,800	**R60**	56,561	-21.2	-2,100	-643,300
R11	9,843	15.2	16,600	131,700	**R61**	57,495	15.1	-2,800	-645,400
R12	10,820	-13.3	900	148,300	**R62**	58,489	-9.5	2,800	-648,200
R13	11,720	5.4	-3,600	149,200	**R63**	59,482	21.5	5,900	-645,400
R14	12,655	-9.9	-2,100	145,600	**R64**	60,364	-33.3	-5,200	-639,500
R15	13,733	10.7	400	143,500	**R65**	61,365	-4.3	-18,800	-644,700
R16	14,598	-21.1	-4,500	143,900	**R66**	62,306	-40.4	-21,000	-663,500
R17	15,589	-49.7	-35,100	139,400	**R67**	63,225	4.0	-16,700	-684,500
R18	16,533	-38.6	-41,700	104,300	**R68**	64,277	-5.5	-800	-701,200
R19	17,536	-55.6	-47,300	62,600	**R69**	65,167	2.1	-1,500	-702,000
R20	18,488	-23.5	-37,600	15,300	**R70**	66,224	-19.5	-9,200	-703,500
R21	19,579	-5.2	-15,700	-22,300	**R71**	67,185	8.0	-5,500	-712,700
R22	20,724	6.2	500	-38,000	**R72**	68,125	-23.8	-7,400	-718,200
R23	21,526	11.7	7,200	-37,500	**R73**	69,078	5.4	-8,700	-725,600
R24	22,483	33.1	21,400	-30,300	**R74**	70,025	-46.2	-19,300	-734,300
R25	23,751	-35.6	-1,500	-8,900	**R75**	70,972	-13.3	-28,200	-753,600
R26	24,625	24.5	-4,900	-10,400	**R76**	71,939	6.0	-3,500	-781,800
R27	25,438	-31.3	-2,800	-15,300	**R77**	72,909	14.3	9,800	-785,300
R28	26,312	-6.5	-16,500	-18,100	**R78**	73,878	-9.6	2,300	-775,500
R29	27,240	-25.2	-14,700	-34,600	**R79**	74,840	-75.5	-40,900	-773,200
R30	28,448	-4.8	-18,100	-49,300	**R80**	75,784	44.5	-14,600	-814,100
R31	29,292	-25.6	-12,800	-67,400	**R81**	76,732	-49.0	-2,100	-828,700
R32	30,292	-12.0	-18,800	-80,200	**R82**	77,737	-31.4	-40,400	-830,800
R33	31,290	-42.2	-27,100	-99,000	**R83**	78,641	-5.6	-16,700	-871,200
R34	32,084	-0.8	-17,100	-126,100	**R84**	79,688	14.1	4,400	-887,900
R35	33,333	-21.8	-14,100	-143,200	**R85**	80,418	-34.3	-7,400	-883,500
R36	34,268	-4.9	-12,500	-157,300	**R86**	81,382	1.7	-15,700	-890,900
R37	35,230	-15.1	-9,600	-169,800	**R87**	82,328	-19.4	-8,300	-906,600
R38	36,182	11.6	-1,700	-179,400	**R88**	83,196	1.9	-7,600	-914,900
R39	37,066	-8.8	1,200	-181,100	**R89**	84,001	-23.7	-8,800	-922,500
R40	38,090	-0.1	-4,500	-179,900	**R90**	84,955	-4.7	-13,500	-931,300
R41	39,013	-21.8	-10,100	-184,400	**R91**	85,908	-34.0	-18,400	-944,800
R42	40,011	-5.2	-13,500	-194,500	**R92**	86,857	12.5	-10,200	-963,200
R43	40,928	-27.3	-14,900	-208,000	**R93**	87,812	-7.8	2,200	-973,400
R44	41,978	-16.0	-22,800	-222,900	**R94**	88,761	-13.8	-10,200	-971,200
R45	42,894	-49.3	-29,900	-245,700	**R95**	89,703	-24.4	-18,000	-981,400
R46	43,981	-37.2	-47,000	-275,600	**R96**	90,563	-2.7	-11,600	-999,400
R47	44,970	-70.5	-53,300	-322,600	**R97**	91,533	-20.9	-11,400	-1,011,000
R48	45,953	-31.0	-49,800	-375,900	**R98**	92,508	-16.1	-18,000	-1,022,400
R49	46,899	-45.2	-36,000	-425,700	**R99**	93,460	-53.5	-33,100	-1,040,400
R50	47,904	-8.3	-26,800	-461,700	**R100**	94,411	0.4	-25,200	-1,073,500
									Total **-1,098,700**

Table 3.4: Beach volume change for the Flagler County, FL shoreline (R-1 to R-101) from June 1972 to April 2021 (48.9 years) above -24 ft, NAVD88.

Mon.	Alongshore Dist. *(ft)*	Sectional Volume Change *(cy/ft)*	Volume Change between Monuments *(cy)*	Cumulative Volume Change *(cy)*
R1	0	-50.1		
R3	2,242	21.0	-32,600	0
R6	4,952	-11.8	12,500	-32,600
R9	7,922	-82.5	-139,900	-20,100
R12	10,820	-3.6	-124,800	-160,000
R15	13,733	-32.1	-52,100	-284,800
R18	16,533	-23.3	-77,600	-336,900
R21	19,579	-24.3	-72,500	-414,500
R24	22,483	-21.6	-66,600	-487,000
R27	25,438	-53.6	-111,100	-553,600
R30	28,448	-31.5	-128,000	-664,700
R33	31,290	-36.7	-96,900	-792,700
R36	34,268	-46.8	-124,300	-889,600
R39	37,066	-23.9	-99,000	-1,013,900
R42	40,011	-47.2	-104,700	-1,112,900
R45	42,894	-44.3	-132,000	-1,217,600
R48	45,953	-51.4	-146,400	-1,349,600
R51	48,822	-62.3	-163,100	-1,496,000
R54	50,966	-53.3	-123,900	-1,659,100
R57	53,579	-56.4	-143,300	-1,783,000
R59	55,746	1.9	-59,100	-1,926,300
R62	58,489	-14.3	-17,000	-1,985,400
R65	61,365	-26.9	-59,200	-2,002,400
R68	64,277	-38.3	-94,900	-2,061,600
R71	67,185	-43.7	-119,200	-2,156,500
R74	70,025	-0.3	-62,400	-2,275,700
R77	72,909	-31.8	-46,200	-2,338,100
R80	75,784	-13.2	-64,700	-2,384,300
R83	78,641	-55.0	-97,400	-2,449,000
R86	81,382	-73.7	-176,400	-2,546,400
R89	84,001	-44.2	-154,300	-2,722,800
R92	86,857	-52.3	-137,800	-2,877,100
R95	89,703	-83.9	-193,800	-3,014,900
R98	92,508	-75.5	-223,500	-3,208,700
R100	94,411	*-75.5*	-143,600	-3,432,200
			Total	**-3,575,800**

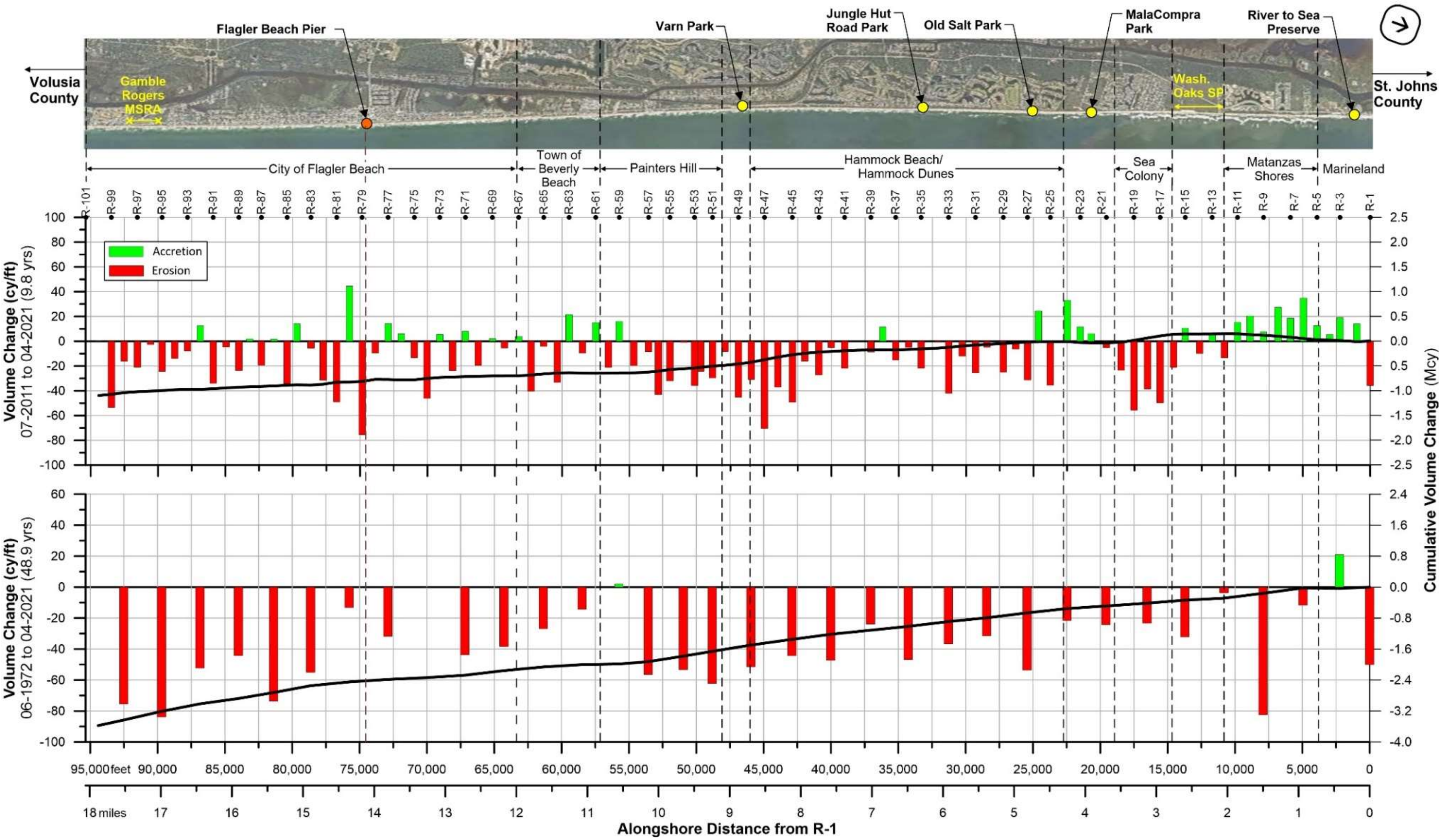

Figure 3.8: Volume change rates (red/green bars) and cumulative volume changes (black lines) from July 2011 to April 2021 (top plot) and from June 1972 to April 2021 (bottom plot) along Flagler County.

Table 3.5: Upper beach volume changes from June 1972 to April 2021 above MLW (-2.80 ft) for the 7.6 miles of Flagler County shoreline between R-2.3 and R-43.5 with coquina rock.

Mon.	Alongshore Dist. *(ft)*	Sectional Volume Change *(cy/ft)*	Volume Change between Monuments *(cy)*	Cumulative Volume Change *(cy)*
R2.3	1,359	-23.2		
R3	2,242	-20.3	-19,200	0
R4	3,001	-20.6	-15,500	-19,200
R5	3,947	-14.5	-16,600	-34,700
R6	4,952	-14.0	-14,300	-51,300
R7	5,917	-13.7	-13,300	-65,600
R8	6,834	-9.2	-10,500	-78,900
R9	7,922	-16.0	-13,700	-89,400
R10	8,913	-9.1	-12,400	-103,100
R11	9,843	-8.9	-8,400	-115,500
R12	10,820	-9.0	-8,700	-123,900
R13	11,720	-13.7	-10,200	-132,600
R14	12,655	-20.8	-16,100	-142,800
R15	13,733	-21.5	-22,800	-158,900
R16	14,598	-16.0	-16,200	-181,700
R17	15,589	-22.2	-18,900	-197,900
R18	16,533	-18.4	-19,200	-216,800
R19	17,536	-18.6	-18,600	-236,000
R20	18,488	-23.9	-20,200	-254,600
R21	19,579	-13.0	-20,100	-274,800
R22	20,724	-21.9	-19,900	-294,900
R23	21,526	-18.8	-16,300	-314,800
R24	22,483	-16.8	-17,000	-331,100
R25	23,751	-19.9	-23,300	-348,100
R26	24,625	-25.0	-19,700	-371,400
R27	25,438	-16.8	-17,000	-391,100
R28	26,312	-10.6	-12,000	-408,100
R29	27,240	-7.4	-8,400	-420,100
R30	28,448	-17.3	-14,900	-428,500
R31	29,292	-16.7	-14,300	-443,400
R32	30,292	-17.2	-16,900	-457,700
R33	31,290	-16.2	-16,700	-474,600
R34	32,084	-4.4	-8,200	-491,300
R35	33,333	-3.3	-4,800	-499,500
R36	34,268	-10.7	-6,500	-504,300
R37	35,230	-11.1	-10,500	-510,800
R38	36,182	-6.2	-8,200	-521,300
R39	37,066	-6.0	-5,400	-529,500
R40	38,090	-12.3	-9,300	-534,900
R41	39,013	-16.4	-13,200	-544,200
R42	40,011	-14.0	-15,100	-557,400
R43	40,928	-23.1	-17,000	-572,500
R43.5	41,453	-17.0	-10,500	-589,500
			Total	**-600,000**

4.0 BEACH MANAGEMENT AREAS

The County's shoreline varies in its level of upland development, existing beach and dune conditions, historical shoreline and beach volume changes, and natural resources. As such, the one management approach may not be appropriate for the entire 18-mile shoreline. **Figure 4.1** evaluates the County's shoreline with regard to the following:

- Municipal/jurisdictional boundaries,
- Existing coastal armor,
- Natural resources (presence of coquina beach & nearshore rock),
- Critically Eroded Shoreline designation by FDEP,
- Past and planned projects, and
- Current vulnerability, as indicated by:

    - Proximity of upland development to the MHWL (within 80 ft as of April 2021 MHWL),
    - Dune crest elevation of less than +19 ft, NAVD88 (April 2021),
    - Dune volume above +7 ft, NAVD88 of less than 20 cy/ft (April 2021),
    - Recent decrease in dune crest elevation of more than 1 ft (2016 pre-Matthew to 2021),
    - Recent loss of dune volume of more than 1 cy/ft (2016 pre-Matthew to 2021),

Additional metrics such as beach width, shoreline change and beach volume were considered in characterizing the shoreline. To facilitate development of appropriate strategies, the shoreline is divided into ten "Management Areas", as follows (from north to south):

- Area 1 – Marineland (R-1 to R-4, **Figure 4.2**)
- Area 2 – Matanzas (R-4 to R-13.8, **Figure 4.3**)
- Area 3 – Wash. Oaks/Sea Colony/MalaCompra (R-13.8 to R-24.1, **Figure 4.4**)
- Area 4 – North Hammocks (R-24.1 to R-35, **Figure 4.5**)
- Area 5 – South Hammocks (R-35 to R-48, **Figure 4.6**)
- Area 6 – Varn Park/Painters Hill (R-48 to R-60.5, **Figure 4.7**)
- Area 7 – North Beverly (R-60.5 to R-65, **Figure 4.8**)
- Area 8 – South Beverly/North Flagler Beach (R-65 to R-80, **Figure 4.9**)
- Area 9 – Federal Beach and Dune Project (R-80 to R-94, **Figure 4.10**)
- Area 10 – South Flagler Beach/Gamble Rogers Memorial State Recreation Area (R-94 to R-101, **Figure 4.11**)

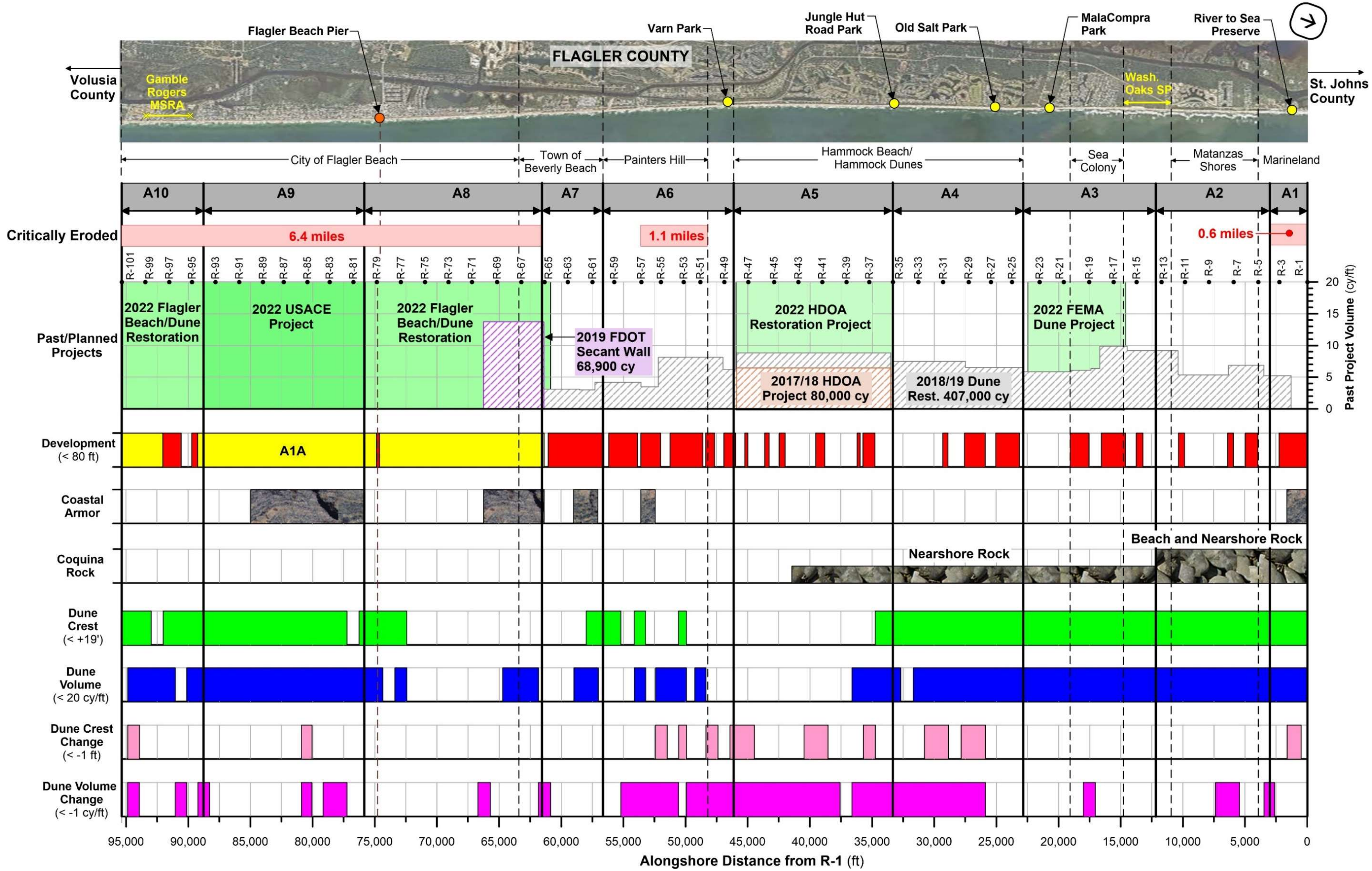

Figure 4.1: Flagler County beach and dune management areas and relevant metrics for shoreline reach classification.

4.1. Management Area 1 – Marineland (R-1 to R-4)

Management Area 1 encompasses the northernmost 3,150 feet (0.6 miles) of Flagler County shoreline and includes the Town of Marineland and the River to Sea Preserve Park. It is designated by FDEP as Critically eroded. As shown in **Figure 4.2**, a 1,400-ft revetment protects the Marineland marine park at the expense of no dry beach or dune.

The dune south of the revetment and bordering the River to Sea Preserve parking lot is below the target crest elevation and volume thresholds. The dune in this area covers a seawall. This area did receive sand placement during the 2018/19 dune restoration. The portion of Area 1 with a dune remains vulnerable in terms of crest height as well as a relatively low volume capacity, however the crest elevation has increased relative to pre-Matthew conditions.

Coquina rock exists on the beach and in the nearshore throughout Area 1. Five weathered and neglected coquina groins also exist in this area. These structures, along with the revetment and buried wall under the dune and pedestrian walkway, provide varying levels of protection along this management area. There is no beach seaward of the revetment during high tides, and the coquina structures are periodically buried and unburied. The long-term average MHWL recession rate is -1.1 ft/year (from June 1972 to April 2021), which is among the highest in Flagler County.

Figure 4.2: Typical conditions beach and dune conditions along Area 1 (09 November 2021); Marineland.

4.2. Management Area 2 – Matanzas (R-4 to R-13.8)

Management Area 2 encompasses the 9,220 feet (1.75 miles) of shoreline immediately south of Area 1 and includes the unincorporated community of Matanzas Shores with moderate encroaching development and a 1,700-ft segment of undeveloped shoreline in Washington Oaks SP (**Figure 4.3**). Coquina rock exists both above and below the MHWL in Area 2, and transitions to being exposed strictly below the MHWL south of this Area. The dune in Area 2 is vulnerable, with a crest elevation and volume below the target thresholds. A particularly low segment of dune with a crest elevation of +9.5-ft along a 600-ft between R-11 and R-12 where sand was not placed during the 2018/19 restoration project. The remainder of Area 2 did receive sand placement during the project, and the crest has increased by +1-ft relative to the pre-Matthew condition. The area remains vulnerable, with a low dune crest and volume capacity. The location of the dune crest has translated 30-ft landward following washover during Hurricane Matthew and restoration at the post-storm location. The long-term erosion rate (from June 1972 to April 2021) of the MHWL and berm along this area average to -0.5 ft/year.

Figure 4.3: Typical conditions beach and dune conditions along Area 2 (09 November 2021); Matanzas Shores.

4.3. Management Area 3 – Washington Oaks/Sea Colony/MalaCompra (R-13.8 to R-24.1)

Management Area 3 (**Figure 4.4**) encompasses the 10,330 feet (1.96 miles) of shoreline immediately south of Area 2 and includes the remainder of undeveloped Washington Oaks State Park, the unincorporated community of Sea Colony with moderate encroaching development throughout, and the undeveloped shoreline of MalaCompra park. Coquina rock exists strictly below the MHWL in Area 3. The dune characteristics of Area 3 are very similar to those of Area 2, with a dune crest elevation volume capacity below the targeted thresholds, leaving this Area vulnerable to storm surge. The dune, however, has been restored and exceeds its pre-Matthew crest elevation and volume capacity conditions. Similar to Area 2, the dune has translated landward significantly, averaging a 40-ft offset from the June 2016 location. The berm retreat rate along Area 3 is among the highest in Flagler County, equaling -1.1 ft/year (similar to Area 1). The MHWL retreats at -0.7 ft/year. The beach width within Area 3, however, is among the highest in the County. This is mainly attributed to the allowance for the deposition of overwash (i.e., dune migration) along the undeveloped parks of Washington Oaks and MalaCompra.

Figure 4.4: Typical conditions beach and dune conditions along Area 3 (09 November 2021); Washington Oaks State Park.

4.4. Management Area 4 – North Hammocks (R-24.1 to R-35)

Management Area 4 encompasses the 10,800 feet (2.05 miles) of shoreline immediately south of Area 3 and includes the northern half of the Hammock, specifically all of Ocean Hammock, and Jungle Hut Road Park. Coquina rock exists strictly below the MHWL throughout Area 4. There is substantial development along Area 4, with infrastructure along the northern half encroaching within 50 feet of the beach, and development along the southern half established more than 80 feet offset from the beach. As shown in **Figure 4.5**, this area includes an oceanfront golf course near R-29.

Varying conditions of the dune exist along Area 4. The dune crest elevation and volume capacity average below the targeted thresholds. In terms of crest elevation change, there has been an average increase of +1.8-ft along the northern quarter, and decrease of -1.6-ft along southern three-quarters since June 2016. When comparing the dune crest since June 1972, Area 4 exhibits the worst loss in elevation in Flagler County. In terms of capacity change, there has been a decrease of -2.1 cy/ft since pre-Matthew above +7.0 ft. The dune along Area 4 had not been restored to pre-Matthew conditions 2-years post-2018/2019 restoration, and was vulnerable in April 2021. Since the April 2021 survey was collected, Area 4 has been severely affected by the November 2021 Nor'easter, with dune recession of 6 to 8-ft having been reported along the Ocean Hammock shoreline. The dune crest location has translated an average of 4 feet relative to the June 2016 position. The MHWL and berm have eroded at a rate of -0.6 ft/year on average from June 1972 to April 2021.

Figure 4.5: Typical conditions beach and dune conditions along Area 4 (09 November 2021); Ocean Hammock.

4.5. Management Area 5 – South Hammocks (R-35 to R-48)

Management Area 5 (**Figure 4.6**) encompasses 12,400 feet (2.35 miles) of shoreline and is comprised of the southern half of the Hammock, specifically Hammock Dunes and Hammock Beach. Area 5 coincides with the limits of the 2017/18 HDOA dune project and the planned 2022 dune restoration project. Coquina rock exists strictly below the MHWL throughout the northern half of Area 5, terminating at approximately R-43.5. There is a moderate amount of encroaching development along Area 5, with most of the infrastructure residing between 50 to 80 feet of the beach. As of April 2021, the dune along Area 5 exhibited among the highest crest elevations and largest volume capacities observed within Flagler County. However, county-wide maximum dune volume loss rates are also observed along this region, exceeding -14.0 cy/ft at multiple locations and averaging -5.9 cy/ft since pre-Matthew above +7.0 ft overall. There has been an average decrease of -0.9 ft in dune crest elevation and a 4.4-ft translation in its location since June 2016. The MHWL and berm have receded at an average rate of -0.5 ft/year from June 1972 to April 2021.

The shoreline orientation through Area 5 is concave. Midway through Area 5, the nearshore coquina rock cropping below MHW terminates at about R-43.5 (**Figure 3.7**).

Figure 4.6: Typical conditions beach and dune conditions along Area 5 (09 November 2021); Hammock Dunes.

4.6. Management Area 6 – Varn Park/Painters Hill (R-48 to R-60.5)

Management Area 6 (**Figure 4.7**) encompasses 11,070 feet (2.1 miles) of Flagler County shoreline and consists of Varn Park and Painters Hill HOA. A 1.1-mile segment within Area 6 from R-50 to R-57 is designated by FDEP as Critically Eroded. A significant amount of encroaching infrastructure exists along almost the entirety of Area 6, most of it being within 50 feet of the beach. Similar to Area 5, there has been a severe loss of dune crest elevation and volume in Area 6, most significantly from R-54 to R-57 (central Painters Hill). An anchored vinyl seawall constructed in 2018 ties into an existing seawall to span a total distance of ~1,400-ft from approximately R-55.5 to R-57. Backfill was placed following the construction of the wall, and no sand was placed along the wall during the 2018/19 County restoration project. A varying degree of wall remains exposed above grade. Despite the loss of elevation and volume due to the recent storms, the dune in Area 6 averages relatively high within the county. The crest elevation averages little change overall since pre-Matthew, but maximum changes of -2.6 ft are observed between R-54 and R-56. The crest has also shifted landward by 5 feet since pre-Matthew conditions. Dune volume changes are significant along Area 6. The shoreline along area 6 has receded at an average rate of -0.4 ft/year from June 1972 to April 2021.

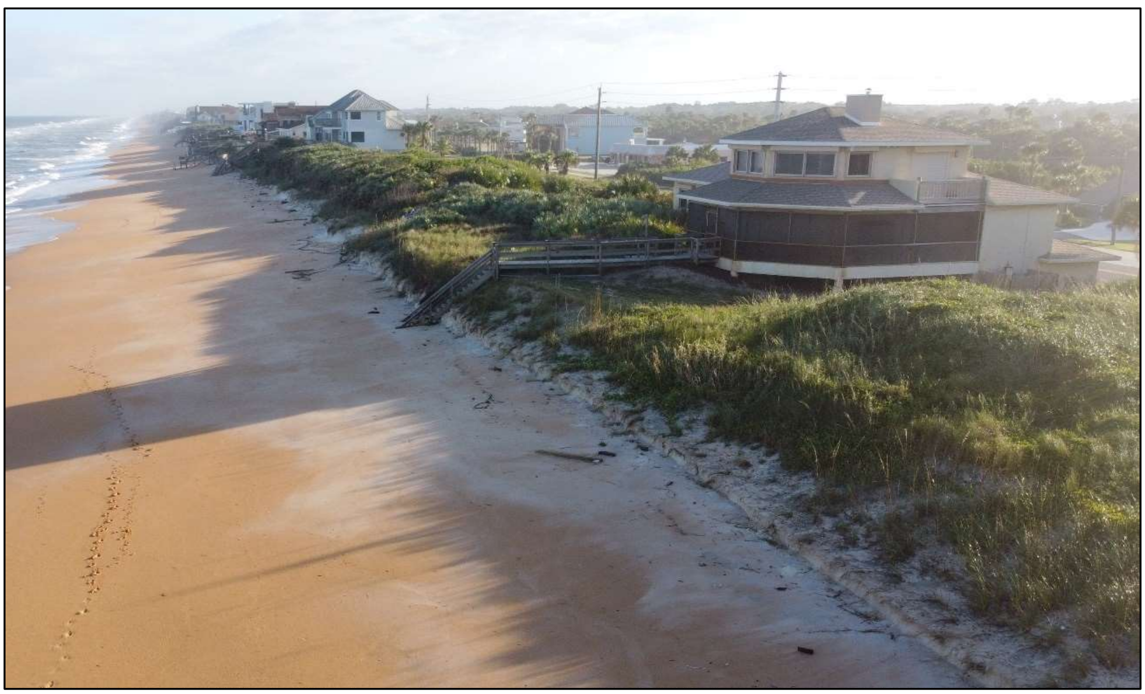

Figure 4.7: Typical conditions beach and dune conditions along Area 6 (09 November 2021); Painters Hill.

4.7. Management Area 7 – North Beverly (R-60.5 to R-64.5)

Management Area 7 (**Figure 4.8**) encompasses 4,490 feet (0.85 miles) of Beverly Beach shoreline. Significant development exists along almost the entirety of Area 7, mostly within 50 feet of the beach. The seawall along the Beverly Beach RV Camptown replaces a natural dune system. South of the seawall, the dune maintains a relatively high and healthy dune crest elevation and dune volume capacity. A modest increase to the crest elevation and volume capacity is observed since June 2016. The crest location has remained stable since Pre-Matthew. The shoreline since 1972 has also remained stable, averaging an increase of 0.1 ft/year for the past ~49 years. The beach and dune (south of the seawall) along Area 7 are among the most stable in Flagler County. Area 7 is positioned immediately south of an apparent inflection point in the shoreline, where the shoreline shape transitions from a concave curve to mildly convex/straight (**Figure 3.7**).

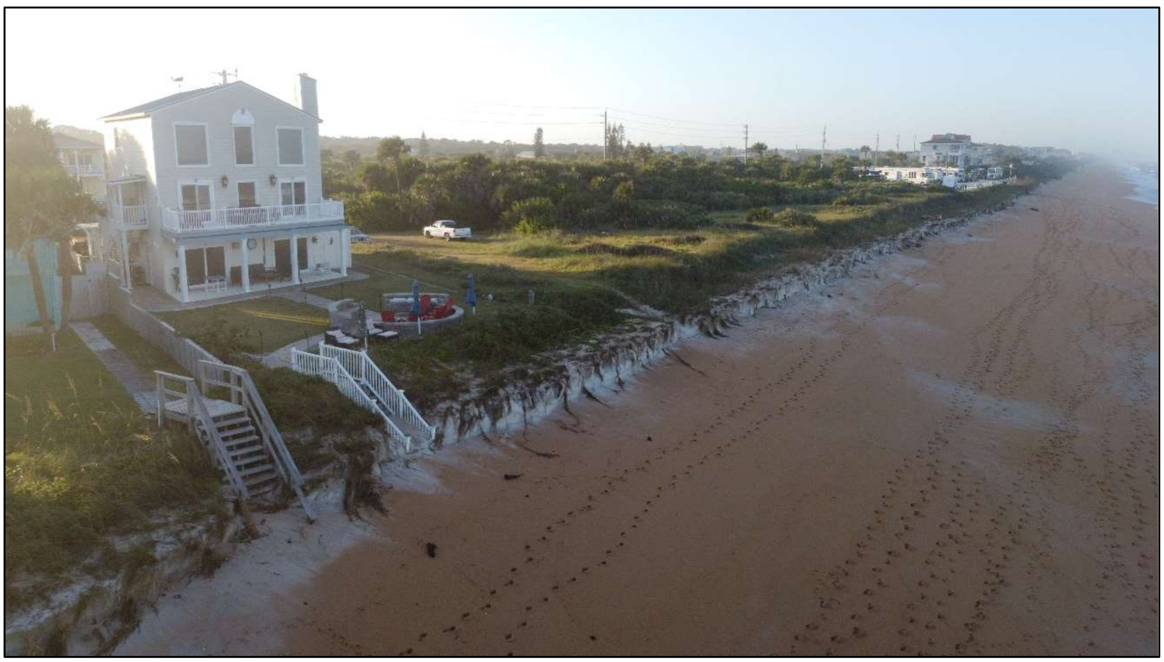

Figure 4.8: Typical conditions beach and dune conditions along Area 7 (09 November 2021); north Beverly Beach.

4.8. Management Area 8 – South Beverly/North Flagler Beach (R-64.5 to R-80)

Management Area 8 encompasses 14,370 feet (2.72 miles) of Flagler County shoreline, including south Beverly Beach, northern Flagler Beach (**Figure 4.9**), and the Flagler Beach pier. It is designated by FDEP as Critically Eroded. Area 8 is permitted for construction, but only a portion of the area (R-70 to R-80) is included in the Flagler County / FDOT Beach and Dune Restoration Project (scheduled for construction in 2022).

A1A is positioned within 80 feet of the shoreline along the entirety of Area 8. The dune is relatively healthy along this segment, but conditions degrade at the northern and southern boundaries. At the northern extent, the dune crest elevation is greater than +19.0 ft, but the dune has a capacity of less than 20 cy/ft. Development around the Flagler Beach pier at the southern extent of Area 8 contribute to the degradation of the dune system. There are no significant changes to the dune crest elevation or dune volume in comparison to pre-Matthew conditions along Area 8 and the crest location has translated landward by 3 feet. The shoreline along Area 8 exhibits the most stability in Flagler County, advancing an average of +0.2 ft/year since June 1972.

Figure 4.9: Typical conditions beach and dune conditions along Area 8 (09 November 2021); northern limit of the City of Flagler Beach.

4.9. Management Area 9 – Federal Beach and Dune Project (R-80 to R-94)

Management Area 9 encompasses 12,990 feet (2.46 miles) of Flagler County shoreline and consists of a segment of south Flagler Beach, south of the pier. It is designated by FDEP as Critically Eroded. Area 9 is the footprint of the Federally sponsored Flagler County Coastal Storm Risk Management (CSRM) Project. A1A is positioned within 50 feet of the beach along the majority of Area 8. As shown in **Figure 4.9**, a rock revetment and dune lie in between the highway and the Atlantic Ocean. The revetment stabilizes the shoreline such that there was little to no change in the dune crest elevation and location compared to June 2016 and June 1972. However, the revetment is continuously repaired to maintain design conditions. Although the berm in this area has exhibited little change in position, the MHWL has receded at a rate of -0.6 ft/year since June 1972.

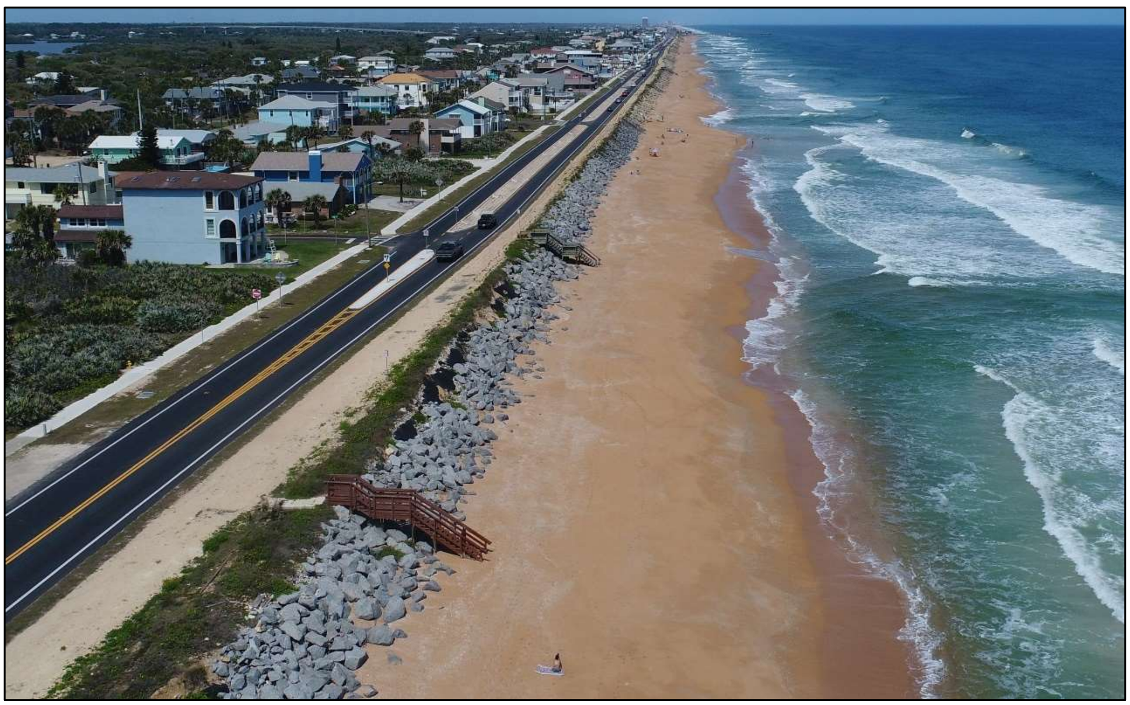

Figure 4.10: Typical conditions beach and dune conditions along Area 9 (09 November 2021); City of Flagler Beach.

4.10. Management Area 10 – South Flagler Beach/ Gamble Rogers Memorial State Recreation Area (R-94 to R-101)

Management Area 10 (**Figure 4.11**) encompasses the southernmost 6,600 feet (1.25 miles) of Flagler County shoreline and consists of south Flagler Beach and Gamble Rogers Memorial State Recreation Area. It is designated by FDEP as Critically Eroded. All of Area 10 is included in the Flagler County / FDOT Beach and Dune Restoration Project. A1A is within 80 ft of the shoreline in the southern half of Area 10. Additionally, some the campgrounds in Gamble Rogers MSRA lie within the dune system.

The dune capacity and dune crest elevation along most of Area 10 are below target thresholds, averaging 16.6 cy/ft and 18.8 ft, respectively. Recent erosion of the dune has occurred at R-96 (within Gamble Rogers) and R-100 (south of Gamble Rogers). Similar to Area 9, the berm has remained stable since June 1972 with an average advance of 0.1 ft/year since June 1972. The MHWL has receded at an average of -0.5 ft/year.

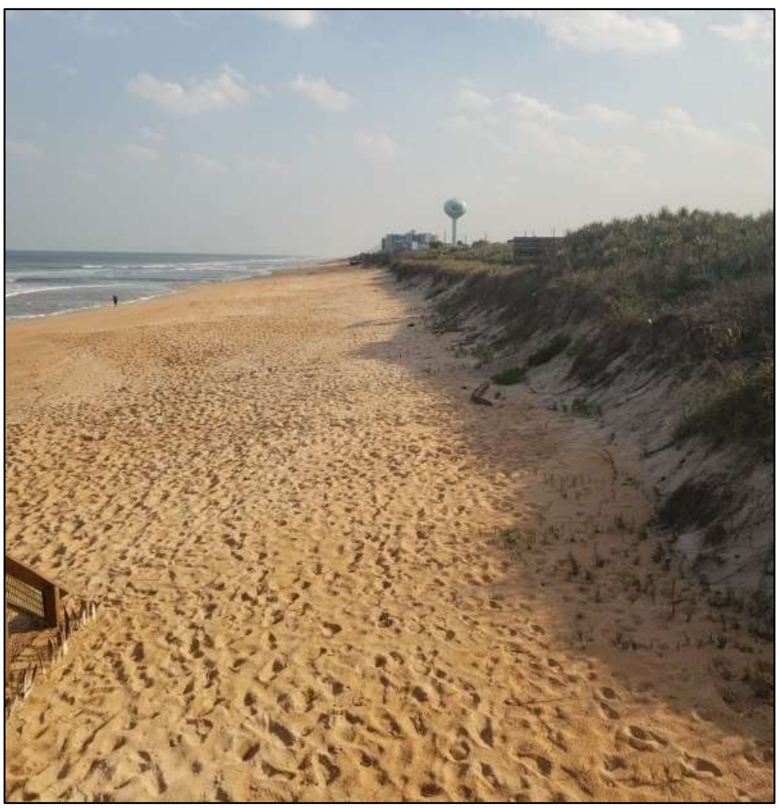

Figure 4.11: Typical conditions beach and dune conditions along Area 10 (March 2020); Gamble Rogers Memorial State Recreation Area.

5.0 BEACH MANAGEMENT ALTERNATIVES

5.1. Introduction

In 2015, the USACE, Jacksonville District conducted a detailed assessment of beach management alternatives for the Flagler County shoreline (USACE, 2015b). This study evaluated 20 alternatives including non-structural and structural approaches. The study focused on the following strategies and combinations thereof: no-action; relocate SR A1A; construct seawalls, revetments and sand-covered structures; construct beach and dune restoration (multiple design configurations, beach widths, beach volumes); groins; submerged artificial reefs; submerged artificial multi-purpose reefs; and dune vegetation. The evaluation concluded that beach and dune restoration with long-term maintenance is the most feasible approach for meeting the storm protection, recreation and environmental objectives of Flagler County. Accordingly, the current beach management study assumes that beach and dune restoration with a long-term commitment to maintenance is an appropriate project approach and should be considered for the entire 18 miles of Flagler County shoreline. Herein, the objective of the project alternative analysis is to evaluate the probable scope and scale of beach and dune restoration and maintenance projects that may be feasible for Flagler County.

In this study, six beach and dune project alternatives are developed. The scope and construction approach of each varies according to required fill volume, construction approach, and resource avoidance and protection requirements (i.e., nearshore coquina rock avoidance).

5.2. Assumptions

In the development of the six project alternatives considered herein, some basic assumptions are applied. These are intended to facilitate a clear, rational comparison of the alternatives for the purpose of accommodating an understanding of the relative cost of each. This also is intended to guide decision making regarding an approach for beach and dune restoration and maintenance to be implemented by the County. The assumptions are based upon an understanding of the goals of Flagler County, shoreline and physical conditions of the beach, the scope and scale of existing project plans along southern Flagler County, and the location and extent of environmental resources (i.e., nearshore rock) that require protection.

> Initial Construction Volume. The optimum fill volume density for initial construction is assumed to be that of the Federal project (44 cy/ft). This fill density was identified by the USACE through current Federal shore protection project planning criteria. The appropriateness of this fill volume has not been verified as part of this study. The planned fill density of the Local (Flagler County / FDOT)

project is 32 cy/ft. The alternatives consider applying these planned fill densities over varying lengths of shoreline. Along regions with hardbottom, the fill densities are smaller, as sand placement is limited to the upper beach and dune to minimize or avoid impacts to these resources.

Construction Method. The alternatives consider hydraulic placement of offshore sand for relatively high fill densities (> 20 cy/ft), mechanical placement of offshore sand using stockpiles, and mechanical placement of upland sand. It is assumed that project fill densities that are than 20 cy/ft will be constructed by mechanical methods[2].

Hardbottom Impacts. As discussed in **Section 2.1**, hardbottom resources (coquina rock) exist along Flagler County that can be impacted by beach fill construction and maintenance. For this study, project alternatives are formulated that (1) avoid all impacts and (2) result in a range of impacts for varying fill densities. Impacts to hardbottom are measured as net loss of exposed rock, commonly in units of acres.

It is assumed that beach rock will only be impacted along the reach of shoreline from R-2.3 to R-43.5. South of R-43.5 there are no known rock resources and the construction of the beach and dune, regardless of size, will not impact rock. Between R-2.3 and R-43.5, the size of the beach and dune fill will need to be limited to avoid impacts to rock. Based upon review of the April 2021 beach and dune conditions between R-2.3 and R-43.5, it is estimated that the maximum fill density that can be placed and avoid impacts to rock is 16 cy/ft. This fill density corresponds to the volume of sand eroded above MLW from 1972 to 2021. Any fill density larger than this will result in impacts to the rock and therefore require some level of mitigation. Quantifying impacts for fill densities larger than 16 cy/ft is estimated through comparison of an assumed construction footprint, equilibrated beach fill template, and the location of existing rock resources.

Hardbottom Mitigation. It is assumed that one acre of mitigation will be required for one acre of hardbottom coverage, or a 1.0 to 1.0 ratio. In reality, the ratio of mitigation to rock impacts will be computed through consideration of habitat quality and the time difference between habitat impact and the time that the mitigation is determined to be in-service. It is rare that the ratio of mitigation to impact is less than 1.0.

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2 Low fill densities compromise the efficiency of dredge pumpout operations, resulting in significant increases in the unit price of dredged sand.

5.3. Beach Management Elements

Project elements include restoration and maintenance of the beach and dune as well as enhancement where the dune elevation and sand volume are below average conditions observed along the Flagler County shoreline. Herein, the dimensions of these elements are considered to be conceptual in nature and sufficient for a planning level evaluation and relative comparison of alternatives. Specific design details regarding the exact scope of restoration and enhancement actions will be determined through design-level evaluation. The six plan alternatives developed and evaluated in this study are based upon combination of the following elements.

5.3.1. Beach Nourishment

Beach nourishment is the least intrusive solution to coastal erosion. Beach nourishment consists of adding a volume of sand to the active beach system to restore or improve beach conditions. A healthy beach system is vital in maintaining a healthy dune system. A nourished beach acts as a sacrificial, first line of defense against major storms and has the ability to recover displaced sand when conditions calm post-storm. However, beach nourishment may not be economically or environmentally practical along all of Flagler County, given the presence of coquina rock along the northern County shoreline.

A nourishment project first involves a restoration, i.e., reconstructing a beach to a magnitude comparable to historic conditions. The alternatives presented herein include beach nourishment construction templates with an average fill density of 25 to 44 cy/ft (**Figure 5.1**) and include dune features. These templates have slopes of either 1V:5H where rock is present or 1V:10H where rock is not present. After an initial restoration, nourishment projects involve periodic renourishments, to retain sufficient sand volumes in the County's beach system to maintain protection and recreation.

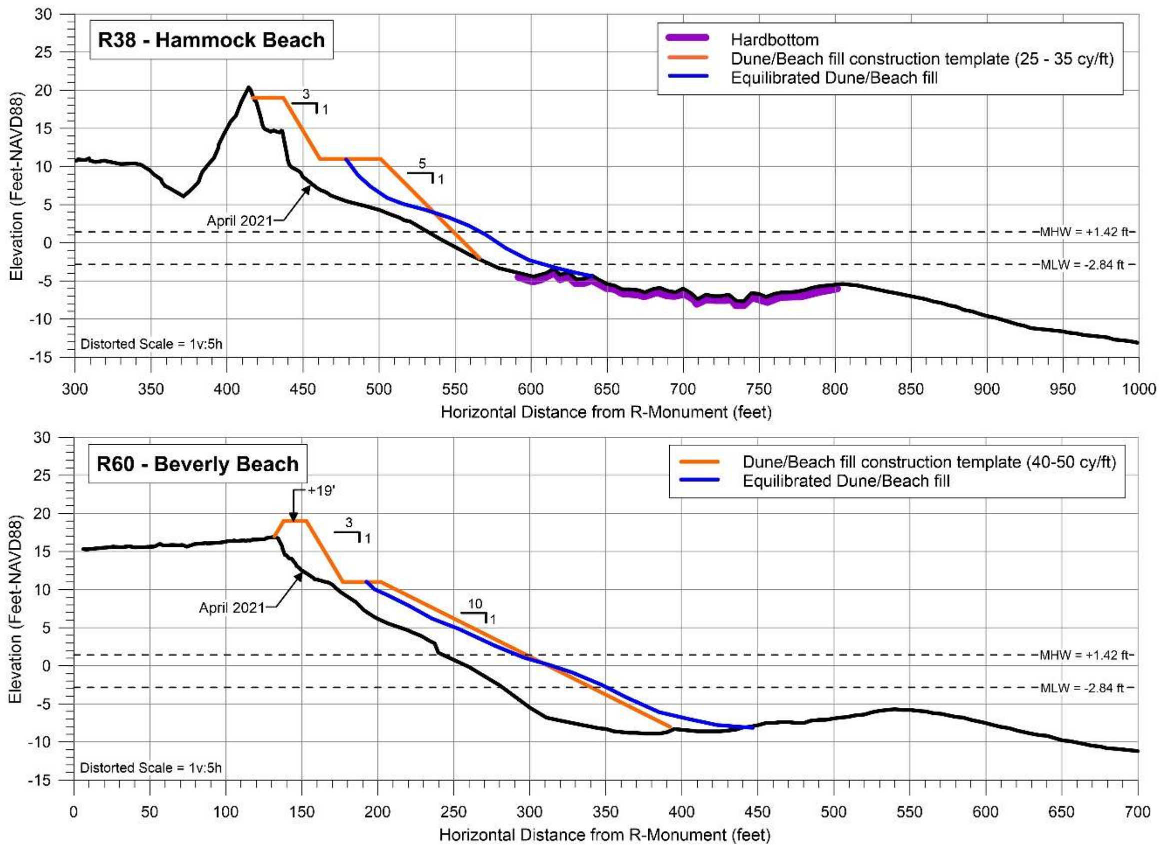

Figure 5.1: Example beach nourishment project templates at R-38 (with coquina rock present) and R-60 (without coquina rock present), and approximate corresponding profiles post-equilibration.

5.3.2. Dune Restoration

The Flagler County dune has experienced severe erosion over the past six years (*Section 3.1.4*). Dune restoration includes extending the present dune crest seaward by a fixed length to achieve a historical benchmark (**Figure 5.2**). Dune restoration templates include less volume (6-16 cy/ft, typ.) and strictly have slopes of 1V:5H.

Establishment of a dune requires not only the addition of sand, but also typically includes the installation of salt- and flood-tolerant dune vegetation and sand fencing. Vegetation and fencing promote the deposition of aeolian transported sediments, nurturing a larger dune system than originally constructed. Dune vegetation has the capacity to endure extreme conditions and, if well established, healthy root systems are vital in dune stabilizing. Post and rope barriers significant help deter pedestrians from treading on the dunes, most importantly while the plants are establishing a root system.

Dune restoration should occur along the entire County where a dune is present. A dune restoration project may be most beneficial along the northern 8 miles of the county given the restrictions associated with impacting the coquina rock present along that shoreline. Covering existing vegetation with sand should be minimized, but not necessarily totally avoided due to the tolerant nature of the vegetation to re-emerge and to limit the extension of the dune toe seaward which increases exposure to wave uprush. The specific extent of dune restoration will vary alongshore and should be laid out with engineering Plans and Specifications, especially to control impacts to the beach and nearshore coquina rock (**Figure 5.2**). New vegetation should replicate native species, include a level of diversity, and avoid invasive species. A dune is not practical in locations where 'hard' solutions are currently implemented as replacements to the natural dune, such as at the revetment at Marineland and the seawall at Beverly Beach. The seawall in Painters Hill has a less intrusive footprint and may permit the re-establishment of a dune both seaward and landward of the seawall cap, which is presently being observed along the wall.

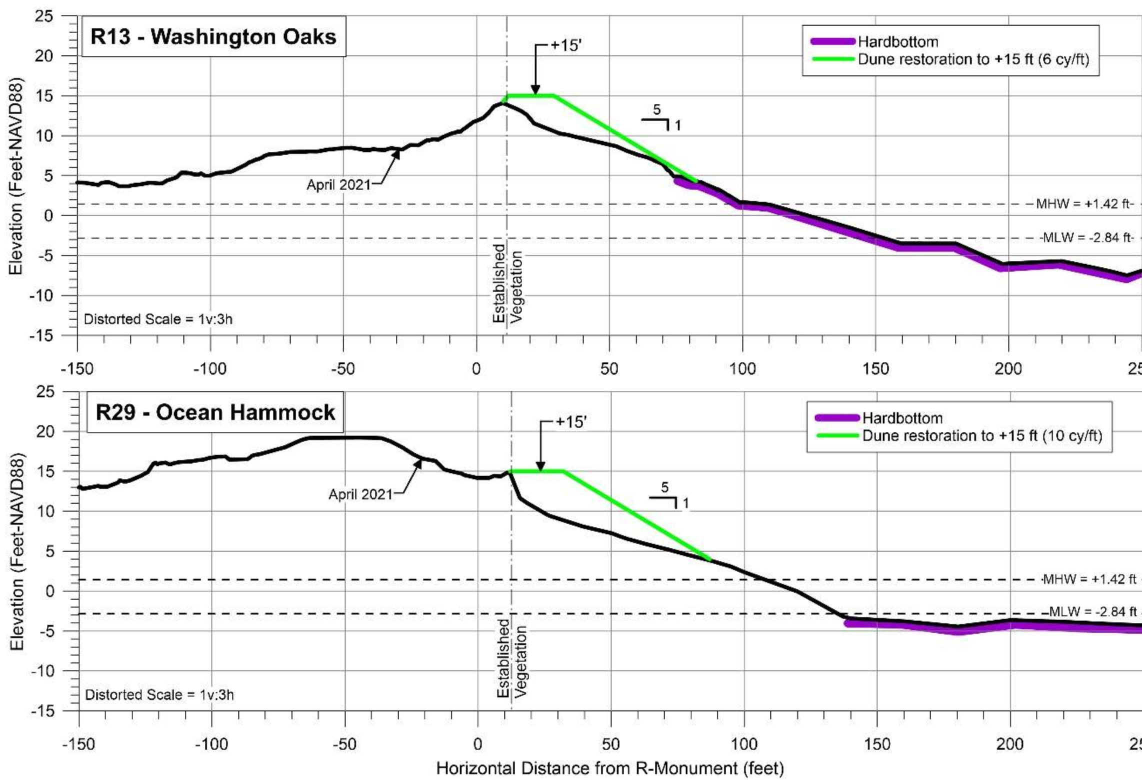

Figure 5.2: Representative cross-shore profiles and design templates for a dune restoration in region of Flagler County with coquina rock.

5.3.3. Dune Enhancement

In addition to a restoration, a dune enhancement specifically involves increasing both the crest elevation and material volume to levels greater than the historical benchmarks. Augmenting the low-lying dune from R-2.3 to R-37 (6.3-miles) greater than historical conditions will provide the county with a relative alongshore uniformity of protection. A crest elevation enhancement to +19 ft from R-2.3 to R-37 would require a volume of ~300,000 cy (~16 cy/ft). The enhancement is intended to address the deficit between the April 2021 crest elevation and the present USACE dune crest design elevation of +19.0 ft, NAVD88, as illustrated in red in **Figure 5.3**. As indicated in **Figure 5.3**, coquina rock is present along the entire dune enhancement reach (R-2.3 to R-37).

Figure 5.4 compares the +19.0 ft dune enhancement and +15.0 ft dune restoration templates at two locations with hardbottom: R-13 (Washington Oaks) and R-29 (Ocean Hammock). The dune enhancement template includes a dune with a steeper seaward slope of 1V:3H to accommodate more sand in approximately the same footprint as the restoration to avoid impacting hardbottom. Existing vegetation is more likely to be impacted due to the larger dune footprint and narrow existing beach width conditions, but should not eliminate the implementation of a dune enhancement. A natural repose on the leeward dune slope helps reduce the enhancement template footprint and minimize impacting vegetation.

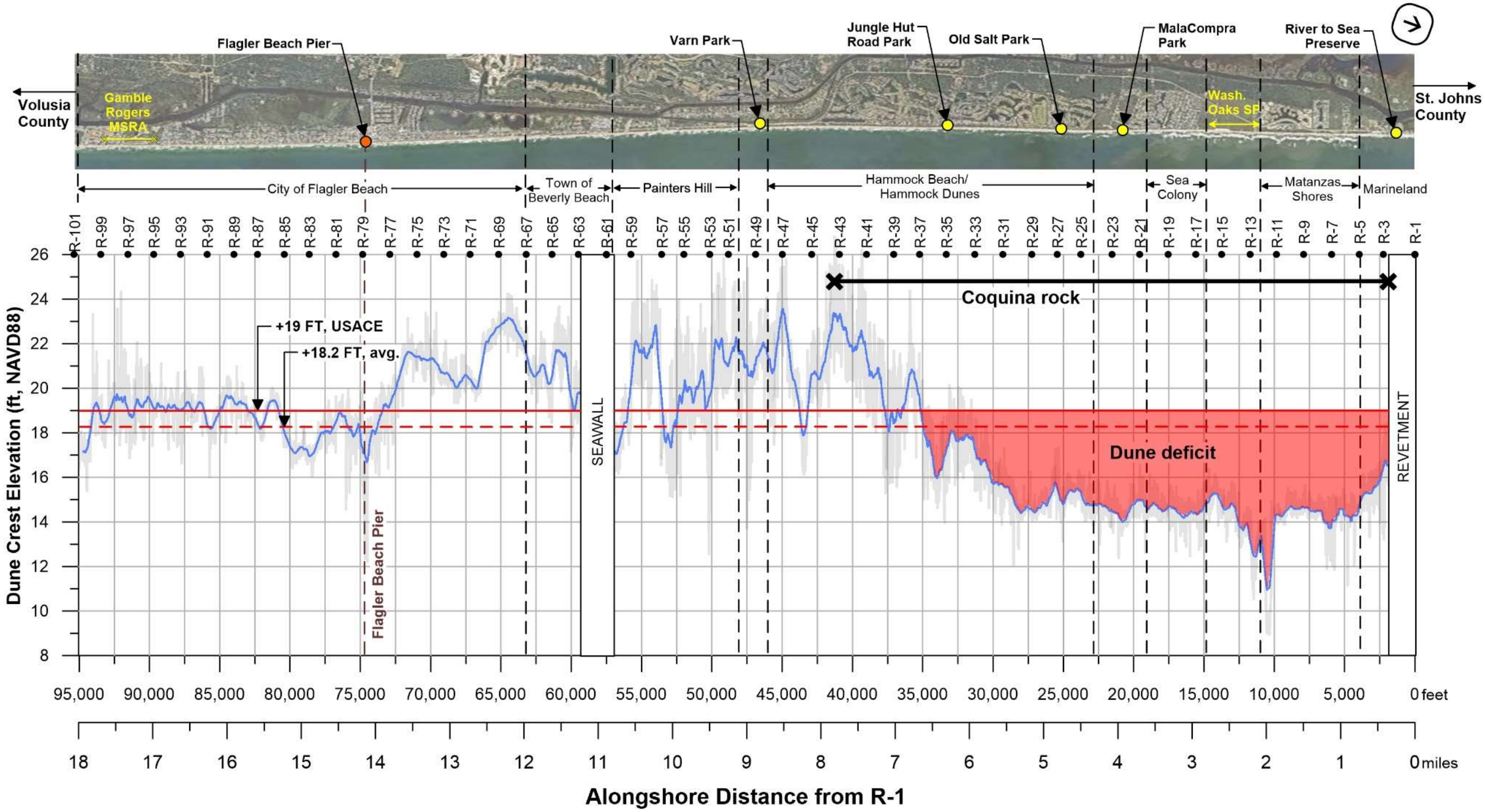

Figure 5.3: Relative vulnerability of the dune crest elevation along the 6.3 miles from R-2.3 to R-37, where coquina rock is additionally present

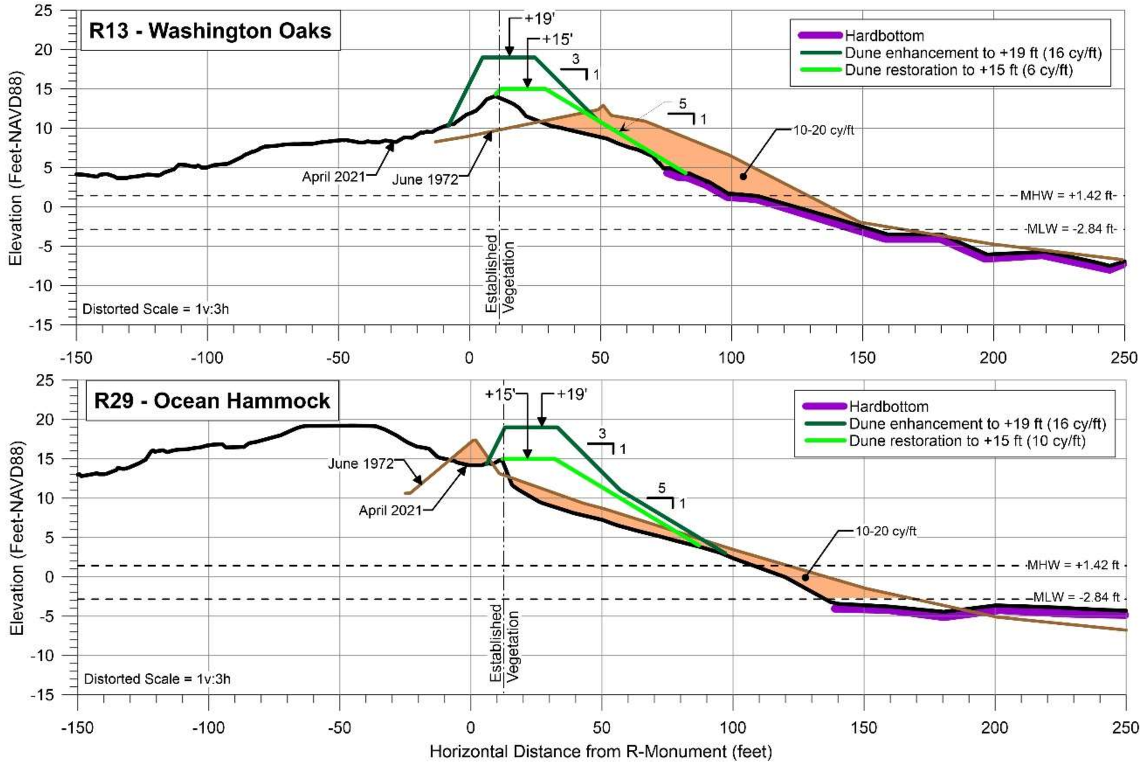

Figure 5.4: Representative cross-shore profiles and design templates for a dune restoration and enhancement in region of Flagler County with coquina rock. The shaded orange area between the April 2021 and June 1972 and above MLW illustrates the likely permittable volume to use for the enhancement.

5.4. Beach Management Alternatives

Through the application of the assumptions described above, six beach and dune project alternatives are developed. The scope of each of these alternatives is depicted graphically in **Figure 5.5**, which describes the location and extent of assumed fill densities and the construction methods for the respective reaches. The details of each alternative are described below.

5.4.1. Alternative 1

This alternative includes the currently planned activities along the southern part of Flagler County (R-70 to R-101). In addition, the fill density of the existing County/FDOT project would extend northward from R-70 to R-43.5. All work between R-43.5 and R-101 would be constructed by dredge using and offshore sand source and occur on an 11-year interval.

North of R-43.5, Alternative 1 includes a dune restoration component that would place upland sand above the Mean Low Water (MLW). The fill would extend to R-2.3, the southern limit of the Marineland revetment, and terminate at R-43.5, the northern limit of the extended dredge project. The fill density would vary alongshore, with 6 cy/ft from R-2.3 to R-13.8, 10 cy/ft from R-13.8 to R-36, and 16 cy/ft from R-36 to R-43.5. Renourishment of R-2.3 to R-43.5 would be every 3 years. There are assumed to be no hardbottom impacts associated with the construction of Alternative 1.

5.4.2. Alternative 2

Alternative 2 builds upon Alternative 1 by enhancing the dune crest along the northernmost ~6.0 miles of the Flagler County shoreline (R-2.3 to R-37) to be generally consistent along the entire County (**Figure 5.3** and **Figure 5.4**). Enhancing the dune would require increasing the fill density northward of R-37 to approximately 16 cy/ft. As in Alternative 1, the segment north of R-43.5 would be constructed with upland sand. There are assumed to be no hardbottom impacts associated with the construction of Alternative 2.

5.4.3. Alternative 3

Alternative 3 augments Alternative 2 solely by increasing the initial construction volume along the County shoreline south of R-43.5. The Federal project fill density (44 cy/ft) would be extended north and south to cover a 10.2-mile span from R-43.5 to R-101. There are no anticipated impacts to hardbottom associated with this alternative.

5.4.4. Alternative 4

Alternative 4 includes the same components as Alternative 3, but differs in the construction method from R-2.3 to R-43.5. For this Alternative, the same dredge utilized for the southern County would pump offshore sand into discrete stock piles at designated alongshore locations. The offshore sand would be subsequently moved to the final placement site by mechanical equipment. This approach allows for the use of offshore sand and also limits impacts to hardbottom resources. There are physical and construction complexities with this approach that would need to be considered, should the County elect to pursue this option. Stockpile construction and subsequent mechanical rehandling and placement are assumed to occur on the same interval as the dredging project, i.e., 11 years.

The construction of sand stockpiles by dredge are anticipated to have localized impacts to nearshore rock strictly where the stockpiles are constructed. It is anticipated that the stockpile could be strategically located after detailed surveys of the location and extent of nearshore rock to minimize any impact. For this purpose of this study, it is assumed that Alternative 4 will impact approximately 12 acres of hardbottom.

5.4.5. Alternative 5

Alternative 5 increases the initial construction volume of Alternatives 3 and 4 by increasing the fill density between R-13.8 and R-43.5 to 25 cy/ft to allow for hydraulic sand placement. Mechanical sand placement would still be required for the reach of shoreline between R-2.3 and R-13.8, and is assumed to take place in the form of a truckhaul project to avoid hardbottom impacts.

Although placement would still be limited to the portion of the profile above MLW to avoid direct burial of hardbottom, the equilibration of the larger construction template would likely cause impacts to the adjacent resources through profile equilibration. Additional impacts are expected from the effects of pipeline deployments and hydraulic dredge effluent. For the purpose of this study, it is assumed that approximately 20 acres of hardbottom would be impacted.

5.4.6. Alternative 6

Alternative 6 has the largest initial volume and includes a beach and dune fill project with a design fill density of 44 cy/ft (equivalent to the Federal project) along the entire 18 miles of Flagler County shoreline. The entire project would be constructed by dredge using an offshore sand source and it is estimated that this project alternative would impact approximately 100 acres of hardbottom.

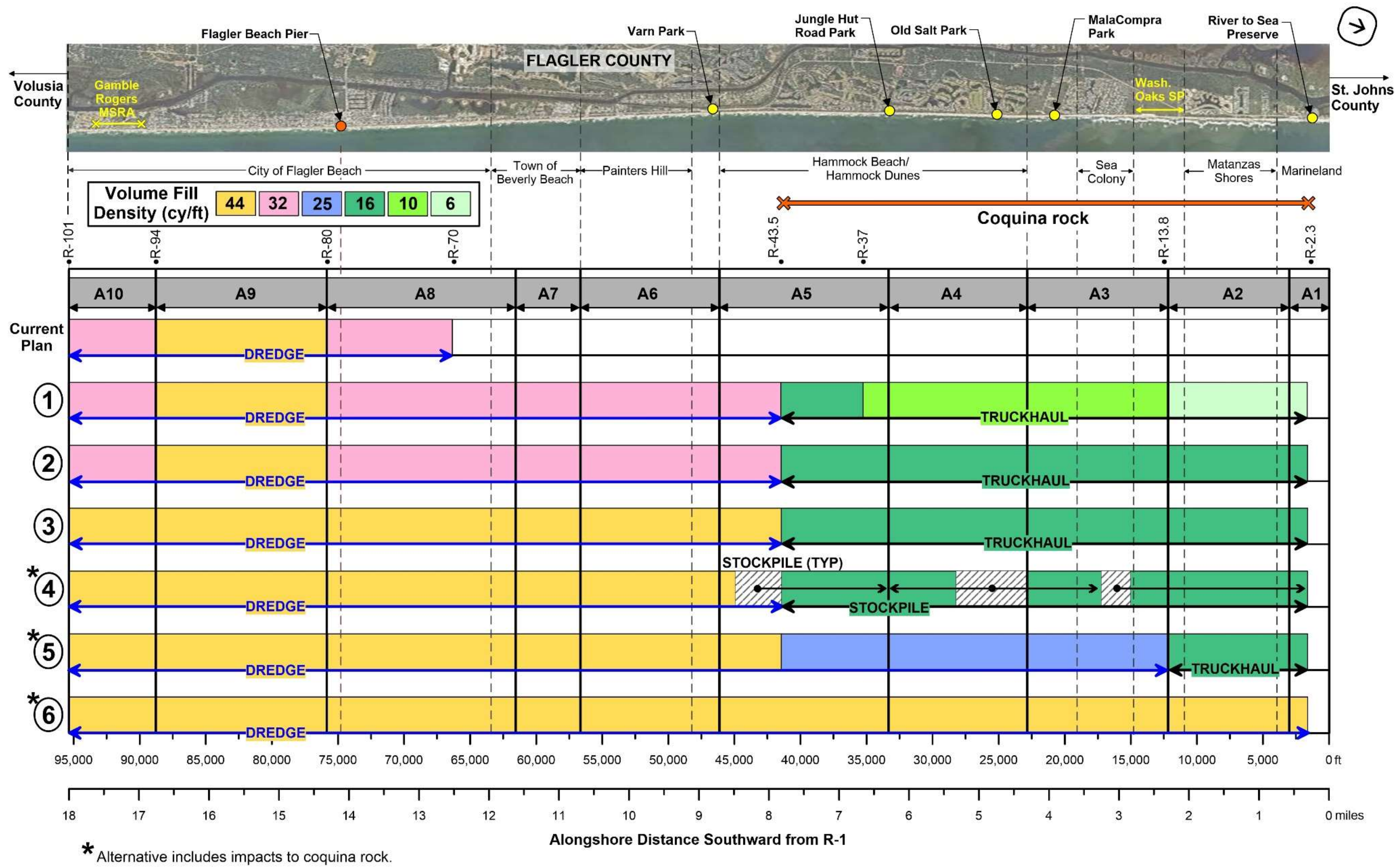

Figure 5.5: The beach and dune restoration project alternatives for Flagler County.

6.0 SAND VOLUME REQUIREMENTS

This study evaluates the volume of sand required to restore and maintain the Flagler County beaches over a 50-year planning horizon. The six alternatives vary in the extent of the initial restoration (and initial construction volume), but the maintenance volume requirement is the same for each. The sand volume required to maintain the restored beach is typically dependent upon the amount of sand that is lost from the beach on an ongoing basis. This loss is commonly represented in terms of the annual sand loss rate and is estimated from historical sand loss conditions and expected future conditions should future changes be expected. Future changes to a historical rate can be related to such things as an acceleration in sea level rise and increase storm activity.

6.1. Initial Sand Volume

As described in **Chapter 5.0**, the required initial sand volume for the six alternatives is based upon consideration of (1) design conditions for the planned Federal project and Flagler/FDOT project (2021 conditions) and (2) maximum sand placement capacity of the beach and dune to avoid impacts to adjacent hardbottom resources. The density of fill placement varies alongshore from five of the six alternatives. The total sand volume requirement for each alternative is estimated using the noted fill densities and the length of the shoreline for which each noted density is applicable.

Table 6.1 summarizes the total fill volumes for each alternative. Also, noted in the table is the construction method, which will affect the cost of the alternative. These alternatives would place between 2.3 to 4.1 Mcy of sand along the Flagler County beach and dune.

Table 6.1: Initial sand volume requirements for the six project alternatives.

Alternative	Volume Required (cy)		
	Initial		
	Hydraulic Placement	Mechanical Placement	Total
1	1,938,000	405,000	2,343,000
2	1,938,000	643,000	2,581,000
3	2,398,000	643,000	3,041,000
4	2,398,000	643,000	3,041,000
5	3,125,000	178,000	3,303,000
6	4,165,000	0	4,165,000

The six alternatives provide differing levels of restoration due to the variation of initial construction quantities. To evaluate the relative magnitude of restoration compared to historical losses, sand losses for the two time periods discussed in *Section 3.1.4* are considered; (1) June 1972 to April 2021 (~50 years) and July 2011 to April 2021 (~10 years). As detailed in *Section 3.1.4*, the Flagler County beach lost approximately 3.5 Mcy of sand between July 1972 and April 2021 and 1.1 Mcy between July 2011 and April 2021.

For perspective, Alternative 1 is estimated to provide about 2.3 Mcy of sand to the Flagler County Beach which is a little more than twice the volume lost from the Flagler County beach and dune between July 2011 and April 2021 (1.1 Mcy). It is also about 66 percent of that lost between July 1972 and April 2021. The largest project (Alternative 6) is estimated to provide about 4.2 Mcy of sand to the Flagler County shoreline which is about 3.7 times the volume of sand lost between July 2011 and April 2021 and 1.2 times that lost form the Flagler County beach and dune between July 1972 and April 2021. The other alternatives vary between the two benchmarks.

6.2. Annualized Maintenance Volume Requirements

Future assumed renourishment volumes are based upon expected future sand loss rates from the restored beach. For this investigation, the future sand placement volume required to maintain the restored beach is based upon documented historical sand losses from the beach and dune. The historical sand loss rates were used for two past time periods to capture both long-term (~50 years) and recent short-term (~10 years) rates. The latter is intended to highlight the effects to the beach and dune associated with Hurricanes Matthew (2016), Irma (2017) and Dorian (2019).

Using these two time periods, the equivalent annual loss rate is calculated by computing the total volume change that occurred over the period and dividing the total volume change by the length of the period, in years. The results from this analysis are presented in **Table 6.2** and **Table 6.3**. These tables also present a summary of the alongshore distribution of change.

In summary, the equivalent average annual sand loss rate for the period between July 1972 and April 2021 is estimated to be about 72,000 cy/yr for the entire 18 miles of Flagler County shoreline. Likewise, the equivalent average annual sand loss rate for the period between July 2011 and April 2021 is estimated to be about 112,000 cy/yr; or about 1.6 times greater than the longer-term average. The noted recent increase in the sand loss rates is likely due to the significant erosional effects associated with Hurricanes Matthew (2016), Irma (2017), and Dorian (2019). At this time, it is not clear if the background sand loss rate, barring the effects of major storms, is increasing. Additionally, it is noted that these rates exclude the volumes of the three projects that placed sand along Flagler's coastline (2017/18 HDOA Project, 2018/19 Dune Restoration Project, and 2019 Secant

Wall Project).

Table 6.2: Annualized volumetric change rates (above -24 ft) from June 1972 to April 2021 (48.9 years) for various reaches along Flagler County.

FDEP Monument Range	Alongshore Distance (ft)	Volume Change (cy/ft)	Volume Change (cy)	Volume Change Rate (cy/ft/yr)	Volume Change Rate (cy/yr)
R-2.3 to R-13.8	11,110	-19.2	-214,000	-0.4	-4,000
R-13.8 to R-43.5	28,990	-34.1	-988,000	-0.7	-20,000
R-43.5 to R-70	24,870	-38.4	-954,000	-0.8	-20,000
R-70 to R-80	9,280	-25.2	-234,000	-0.5	-5,000
R-80 to R-94	13,350	-47.7	-636,000	-1.0	-13,000
R-94 to R-101	6,400	-79.7	-510,000	-1.6	-10,000
R-2.3 to R-101	**93,990**	**-40.7**	**-3,536,000**	**-0.8**	**-72,000**
R-43.5 to R-70	24,870	-38.4	-954,000	-0.8	**-20,000**
R-70 to R-80/ R-94 to R-101	15,680	-47.4	-744,000	-1.0	**-15,000**

Table 6.3: Annualized volumetric change rates (above -24 ft) from July 2011 to April 2021 (9.8 years) for various reaches along Flagler County.

FDEP Monument Range	Alongshore Distance (ft)	Volume Change (cy/ft)	Volume Change (cy)	Volume Change Rate (cy/ft/yr)	Volume Change Rate (cy/yr)
R-2.3 to R-13.8	11,110	13.9	155,000	1.4	16,000
R-13.8 to R-43.5	28,990	-12.6	-364,000	-1.3	-37,000
R-43.5 to R-70	24,870	-19.5	-485,000	-2.0	-50,000
R-70 to R-80	9,280	-15.4	-143,000	-1.6	-15,000
R-80 to R-94	13,350	-9.9	-133,000	-1.0	-14,000
R-94 to R-101	6,400	-18.7	-120,000	-1.9	-12,000
R-2.3 to R-101	**93,990**	**-11.6**	**-1,090,000**	**-1.2**	**-112,000**
R-43.5 to R-70	24,870	-19.5	-485,000	-2.0	**-50,000**
R-70 to R-80/ R-94 to R-101	15,680	-16.8	-263,000	-1.7	**-27,000**

For the region of Flagler County with coquina rock resources (R-2.3 to R-43.5), only erosion above MLW (-2.80 ft) is considered. It is assumed that sand eroded from the upper beach profile could be replaced without impacting hardbottom. Therefore, annualized erosion rates from June 1972 and July 2011 to April 2021 are estimated along Flagler County above MLW from R-2.3 to R-43.5 (**Table 6.4** and **Table 6.5**).

Table 6.4: Annualized volumetric change rates (above MLW, -2.80 ft) from June 1972 to April 2021 (48.9 years) for the region of Flagler County with coquina rock.

FDEP Monument Range	Alongshore Distance (ft)	Volume Change (cy/ft)	Volume Change (cy)	Volume Change Rate (cy/ft/yr)	Volume Change Rate (cy/yr)
R-2.3 to R-43.5	40,100	-15.0	-600,000	-0.3	**-12,000**

Table 6.5: Annualized volumetric change rates (above MLW, -2.80 ft) from July 2011 to April 2021 (9.8 years) for the region of Flagler County with coquina rock.

FDEP Monument Range	Alongshore Distance (ft)	Volume Change (cy/ft)	Volume Change (cy)	Volume Change Rate (cy/ft/yr)	Volume Change Rate (cy/yr)
R-2.3 to R-43.5	40,100	-12.2	-490,000	-1.3	**-50,000**

6.3. Maintenance Renourishment Interval

The Federal and Local projects were designed with a renourishment interval of 11 years for events using offshore sand. As will be discussed in the cost section, timing the Local project with the Federal project leads to significant savings on the cost of mobilization. As such, it is assumed that all projects utilizing offshore sand (direct hydraulic placement and stockpiles) will be constructed on an 11-year maintenance interval. This 11-year interval applies to Alternatives 4 – 6 (county-wide) and to Alternatives 1 – 3 (south of R-43.5 only). Over the 50-year planning period, a total of four dredging projects would occur.

For the mechanical construction of the smaller dune restoration projects along the northern shoreline (R-2.3 to R-43.5) proposed in Alternatives 1 – 3, a renourishment interval of 3 years is assumed. These projects include smaller volumes, which will likely be sourced from an upland mine and delivered by truck. The 50-year planning period includes a total of 15 maintenance events. However, the truckhaul component included in

Alternative 5 for sand placement between R-2.3 and R-13.8 has a renourishment interval of 11 years (and therefore a total of four events) to coincide with the dredge events renourishing the remainder of the county.

6.4. Total Sand Demand for Project Alternatives

Although the initial sand volume varies by project alternative, the anticipated future sand demand is the same. The total maintenance sand demand for Flagler County (R-2.3 to R-101) is equal to 6,930,000 cy. **Table 6.6** lists the initial and maintenance volume requirements for each alternative. To restore and maintain the beach over a 50-year planning horizon, these alternatives would require between 9.3 Mcy and 11.1 Mcy of sand.

Additionally, the table provides a breakdown of the sand demand volume by either hydraulic or mechanical methods during each maintenance event. Each maintenance nourishment of the Federal project will require 320,000 cy (USACE, 2015b). This is consistent throughout the six alternatives. The maintenance nourishment volume for the rest of the County was determined using the erosion rates from the July 2011 to April 2021 timeframe (**Table 6.3** and **Table 6.5**). In the case of Alternatives 1 – 3, the non-Federal shoreline constructed via hydraulic placement includes R-43.5 to R-79.8, and R-94.2 to R-101. From **Table 6.3**, the sediment demand over this area is 77,000 cy/yr. Applying this rate over the 11-year renourishment interval equals 847,000 cy. The summation of 847,000 cy and 320,000 cy yields 1,170,000 cy per hydraulic placement event, as shown in **Table 6.6**. Alternative 4 utilizes hydraulicly placing 1,588,000 cy of sand from R-13.8 to R-101. Alternative 5 places the entire future sand demand by dredge through four events of 1,732,500 cy.

The sand volume for each mechanical placement event is similarly derived. The future sand demand from R-2.3 to R-43.5 (where rock is present) equals 50,000 cy/yr (**Table 6.5**). In Alternatives 1 – 3, where sand will be placed every 3 years, the volume required per maintenance event equals 150,000 cy. Alternative 4 has a longer renourishment interval for mechanical placement and thus a larger placement volume of 562,500 per event[3]. Alternatives 5 includes four events of placing 144,500 cy by truckhaul from R-2.3 to R-13.8 to meet the sand demand for that segment.

3 The sand demand from R-2.3 to R-43.5 for Alternative 4 is slightly increased from 50,000 to 51,136 cy to total the same sand demand with only four mechanical placement events by stockpile instead of 15 by truckhaul.

Figure 6.1 illustrates the future maintenance fill densities associated with each project alternative. The corresponding sand placement methods (dredge/stockpile/truckhaul) along the various project reaches is also indicated. The larger fill densities observed from R-2.3 to R-43.5 for Alternatives 4 – 6 are associated with the less-frequent maintenance event occurring every 11 years and are utilized to provide a uniform level of protection among all project alternatives.

Table 6.6: Current and anticipated future sand requirements for the six Project Alternatives.

Alternative	Volume Required (cy)								
	Initial			Future					Total
	Hydraulic Placement	Mechanical Placement	Total	Hydraulic Placement	# of Events	Mechanical Placement	# of Events	Total	
1	1,938,000	405,000	2,343,000	1,170,000	4	150,000	15	6,930,000	9,273,000
2	1,938,000	643,000	2,581,000	1,170,000	4	150,000	15	6,930,000	9,511,000
3	2,398,000	643,000	3,041,000	1,170,000	4	150,000	15	6,930,000	9,971,000
4	2,398,000	643,000	3,041,000	1,170,000	4	562,500	4	6,930,000	9,971,000
5	3,125,000	178,000	3,303,000	1,588,000	4	144,500	4	6,930,000	10,233,000
6	4,165,000	0	4,165,000	1,732,500	4	0	-	6,930,000	11,095,000

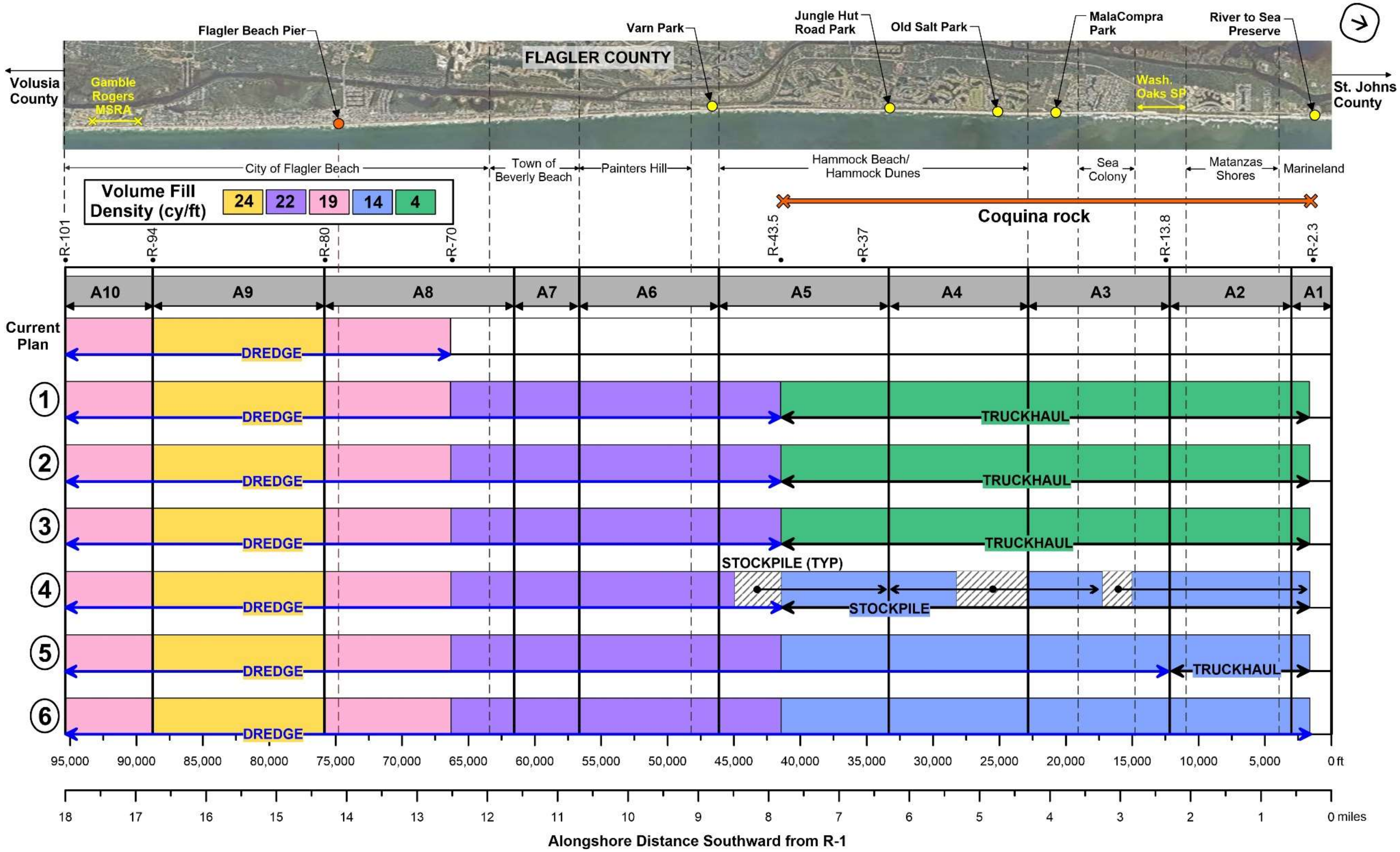

Figure 6.1: The maintenance fill densities for the future renourishment of the Flagler County beach and dune project alternatives.

6.5. Effect of Sea Level Rise (SLR)

Alternatives 1 – 6 are based on the assumption that the volume of sand required to maintain the project over the next 50 years can be estimated through consideration of the historical sand loss rates along Flagler County. These rates implicitly include the historical, or background, rate of sea level rise. Current climate change science, however, suggests that the future rate of sea level rise will accelerate past the rate represented in the historical record.

Herein, two future rates of SLR and their potential effect to future sand requirements to maintain the Flagler County beach and dune are considered. As discussed in *Section 2.3.4***,** a change in sea level rise affects the rate at which sand is lost from a beach. In *Section 2.3.4* predictions for an increase in the sand loss rates along the Flagler County shoreline are made for two projections for accelerated sea level rise: the USACE Intermediate and High Curves. These curves correspond to about 1.0 ft and 2.5 ft of relative SLR, or about 0.5 ft and 2.0 ft of rise above the background rate, respectively. These projections have been incorporated into the expected amount of sand that may be required to maintain the Flagler County beach and dune over a 50-year period with an acceleration in SLR. Simplistically, this results in an increase in the sand volume required on a yearly basis for each beach and dune maintenance event. The USACE Intermediate SLR projection would increase the future sand demand (for all project alternatives) from 6.9 Mcy to 8.4 Mcy (22% increase). **Table 6.7** applies the intermediate and high SLR projections to Alternative 3 to determine the change in total volume requirement (including restoration and maintenance) over the 50-year period. Applying the intermediate SLR projection changes the total volume need from 9.9 Mcy to 11.5 Mcy (15% increase) (**Table 6.7**).

Table 6.7: Current and anticipated future sand requirements for Alternative 3 with consideration for the USACE (1) intermediate and (2) high projections of relative SLR.

	Volume Required (cy)								
	Initial			Future					Total
Alternative	Hydraulic Placement	Mechanical Placement	Total	Hydraulic Placement	# of Events	Mechanical Placement	# of Events	Total	
3	2,398,000	643,000	3,041,000	1,170,000	4	150,000	15	6,930,000	9,971,000
3 (w/ Inter. SLR)	2,398,000	643,000	3,041,000	1,386,000	4	193,000	15	8,439,000	11,480,000
3 (w/ High SLR)	2,398,000	643,000	3,041,000	2,071,000	4	329,000	15	13,219,000	16,260,000

7.0 SAND SOURCE OPTIONS

Offshore and upland sand sources are available to Flagler County to support a long-term beach management program that includes beach and dune restoration and maintenance. Prior dune restoration projects and sand search investigations suggest that these sand sources are compatible with the native beach. This section provides an overview of the native beach sediment characteristics as well as that of potential offshore and upland sources.

Offshore and upland sand sources are assumed to be available for Flagler County beach management projects. In general, offshore sand sources can be more cost-effective than upland sources for large beach fill construction and maintenance. This is principally due to the fact that there is not a fee for offshore sand and it is relatively cost-effective to rapidly place large volumes of sand once the dredge mobilization is mobilized to the site. Use of upland sand often requires the sand be purchased from a commercial mine, transported in small quantities (i.e., by the truck load) to the beach and placed mechanically.

There are limitations to the cost-effectiveness of offshore sand. A rule-of-thumb in project planning assumes that offshore sand sources cannot be placed at fill densities less than 20 cy/ft without incurring significant additional costs associated with compromising the efficiency of dredge pumpout operations.

7.1. Native Beach Sand

Flagler County is unique compared to the counties to the north and south in that the shoreline sediment contains a higher percentage of coarse shell hash (**Figure 7.1**) which produces a larger median grain size and steeper beach profiles. The balance of sand material on the Flagler County beaches is quartz. The shell is derived from outcroppings originating near the coastline during the Anastasia formation known as coquina, and it is responsible for providing the unique orange color seen in Flagler County. An in-depth analysis of the existing sediment between R-65 and R-97 was conducted in support of the Flagler County Beach/Dune Restoration Project (OAI, 2020b). The analysis concluded that the composite mean grain size for the six collected samples was 0.23 mm. Some of the discrete samples contain sediments which are greater than 0.3 mm, some being as large as 2.0 mm. The analysis also revealed the variation of sediment sizes across the beach and stated a bi-modal tendency is observed towards 0.15 mm and 0.85 mm (**Figure 7.2**). The larger gain size materials (shell and shell hash) were limited to samples collected on the berm and at mid-tide elevations.

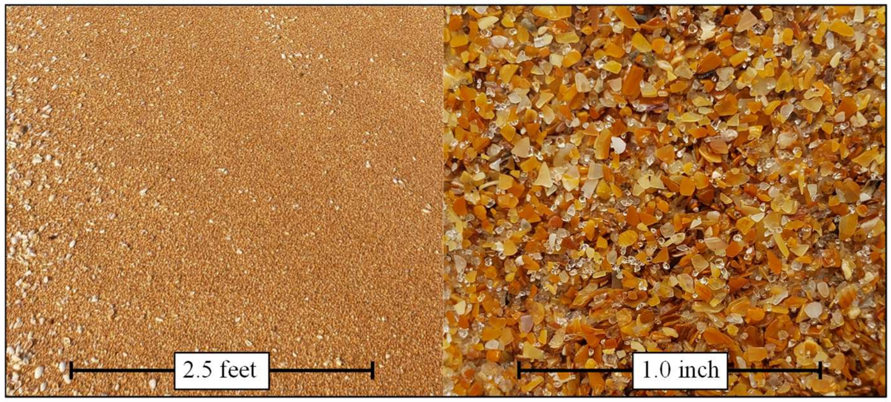

Figure 7.1: Sediment on Flagler beach comprised of orange shell fragments and quartz.

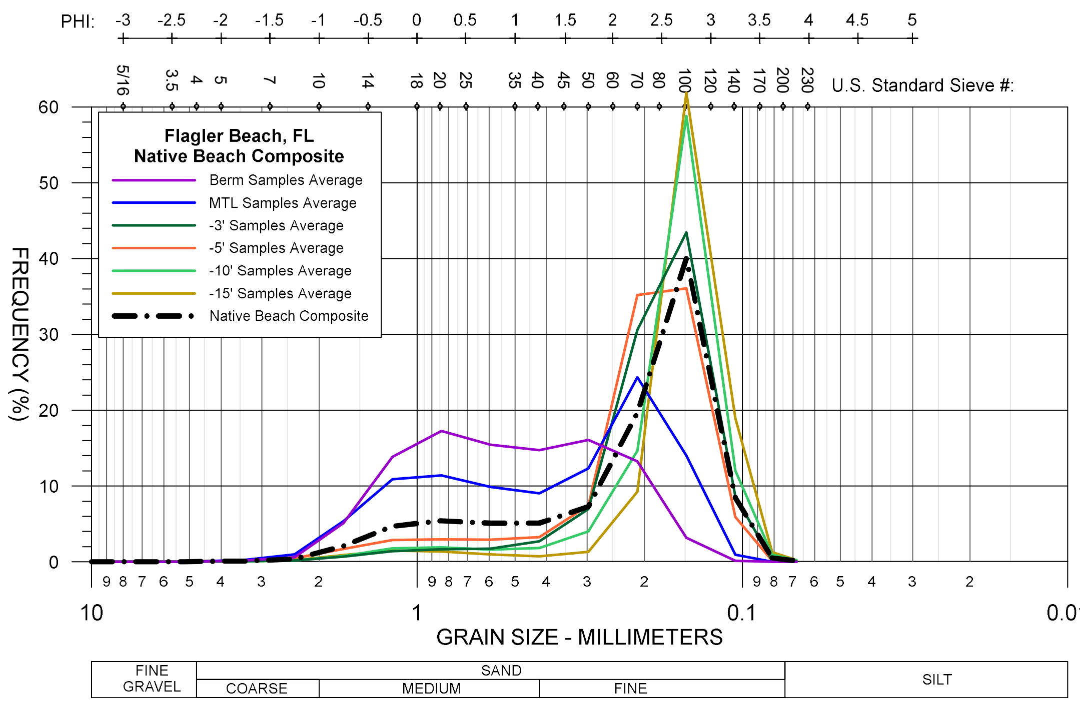

Figure 7.2: Frequency grain size distributions for the averaged cross-shore positions of the native beach (colored lines) and overall native beach composite grain size.

7.2. Offshore Sand Sources

7.2.1. Geological Setting

The Florida Plateau is a partially submerged platform that has existed for millions of years, alternating between dry land, due to periods of relative drops in sea level, and shallow sea, during periods of inundation. The submerged portions of the plateau define the area of the continental shelf that extends into the ocean to a depth of approximately 300 feet (USACE, 2015). A wide variety of mineral deposits are left behind during each dry land exposure which have formed the present-day sandy beaches, offshore bars, and barrier islands in Flagler County (Randazzo and Jones, 1997; USACE, 2015).

7.2.2. Previous Investigations

Previous offshore sand source investigations were detailed in OAI 2020b and are briefly summarized herein. In 2004, the USACE sponsored a reconnaissance level investigation of potential sand sources offshore of Flagler County. The study area and focus sites are depicted in **Figure 7.3**.

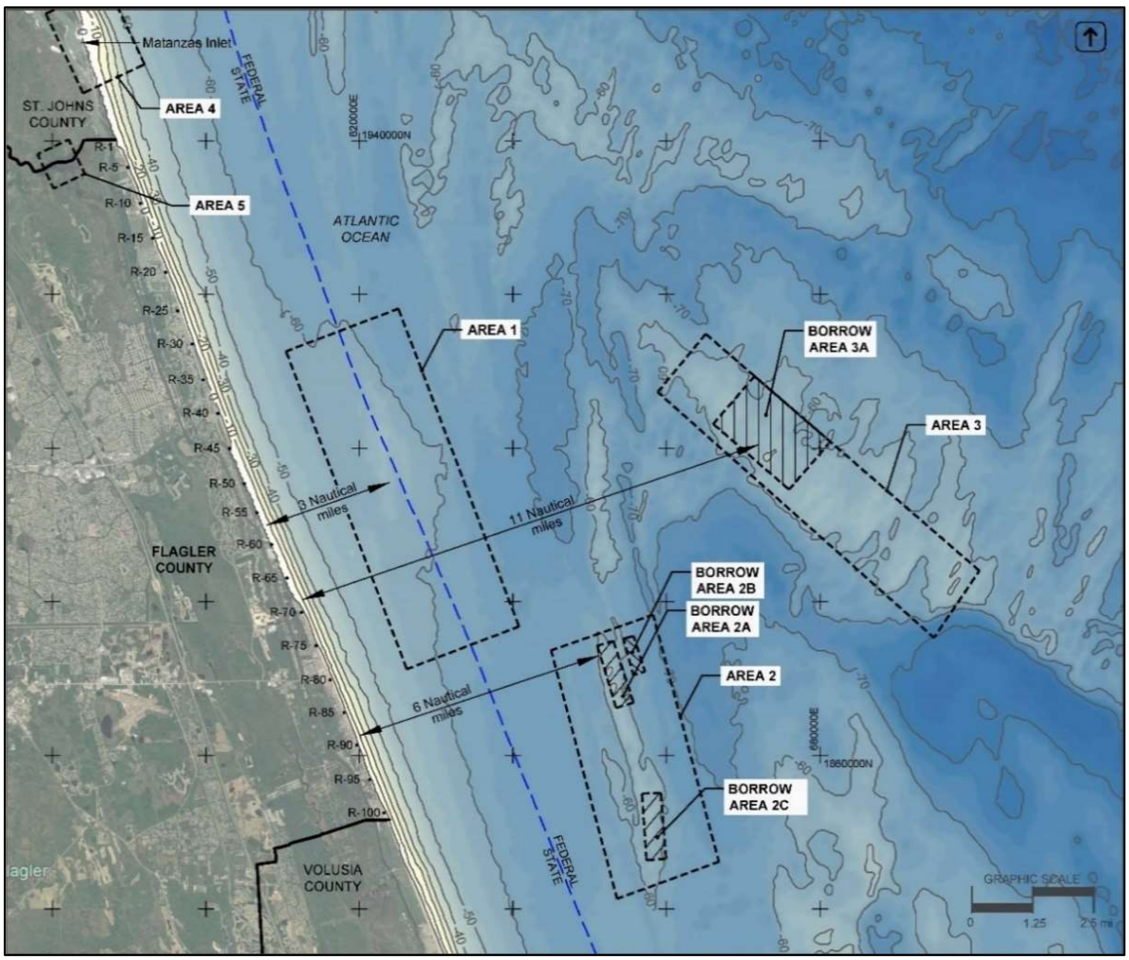

Figure 7.3: Previous sand source investigation areas for Flagler County.

This effort identified four potential sand source areas -- Areas 2 through 5 -- offshore of Flagler County. A fifth potential area (Area 1) was investigated during a sand search operation by Halcrow, Inc. in 2010. The sand search sought to determine if a sufficient volume of beach compatible sand was located offshore of Flagler County to support a Federal Shore Protection Project. It was originally projected that the project would require about 6.4 Mcy.

Halcrow (2010) concluded Areas 1, 4 and 5 were not appropriate sources for the intended project. Only a portion of Area 1 was found to contain potentially compatible sediment. The material, estimated to total about 220,000 cy, is comprised of very fine sediment. Material in Area 4, located on the ebb shoal of the Matanzas Inlet, was not considered suitable for detailed geotechnical investigation since extracting the required project volume from this site would likely have adverse implications on adjacent coastline. The relatively small size of the area, as well as likely encountering problems with acquiring approval to dredge in the vicinity of the inlet were additional reasons that this area was eliminated from further consideration. Area 5, located in the Intracoastal Waterway between Matanzas Inlet and the southern Flagler County line, was not likely to yield a sufficient quantity of material and did not meet other project objectives. Halcrow (2010) concludes that Areas 2 and 3 were likely the most suitable sources for future beach restoration activities.

Area 2 and Area 3 were further investigated by the USACE in 2015. Area 2 (divided into sub areas 2A, 2B and 2C**)** was estimated to contain about 5.5 Mcy of beach-compatible sand. On average, that sediments within these areas had a composite mean grain size of 0.26 mm (1.98 phi). The detailed investigation of Area 3 was focused to a sub-region named Area 3A. This sub-region is a large sand shoal estimated to contain about 20 Mcy of beach-compatible sand. The average composite mean grain size of the sediments within this area is 0.29 mm (1.79 phi).

In 2019, the USACE Jacksonville District conducted a more detailed investigation of the geotechnical conditions within Areas 2A, 2B, and 2C as part of the design and permitting of the Flagler County Coastal Storm Risk Management Project (Federal Project). Area 2C was eliminated from further consideration for the Flagler County project because of the relatively poor quality of sediments in that Area compared to Areas 2A and 2B. Additionally, Area 2C is located offshore of Volusia County. Preliminary coordination with the Florida Department of Environmental Protection (FDEP) concluded that the accessible material contained within Borrow Areas 2A and 2B would not be suitable for beach placement. The material was found to have an overall fines content that would not meet FDEP Sand Rule criteria (F.A.C 62B-41.007j). As a result, the USACE focused on Area 3A.

Area 3A is located about 11 nautical miles offshore of the central Flagler County shoreline. In 2019, the USACE conducted design level geophysical and geological data collection in Area 3A. This work included a complete geophysics suite (seismic sub-bottom, sidescan, and magnetometer) and the collection of 48 Vibracores on a 1,000 ft grid spacing. The Vibracores were collected in the western half of Area 3A (**Figure 7.4**). Following review of the geophysical data and vibracores, the USACE Jacksonville delineated the sand source to provide for initial construction and 50-years of maintenance for the Federal Project.

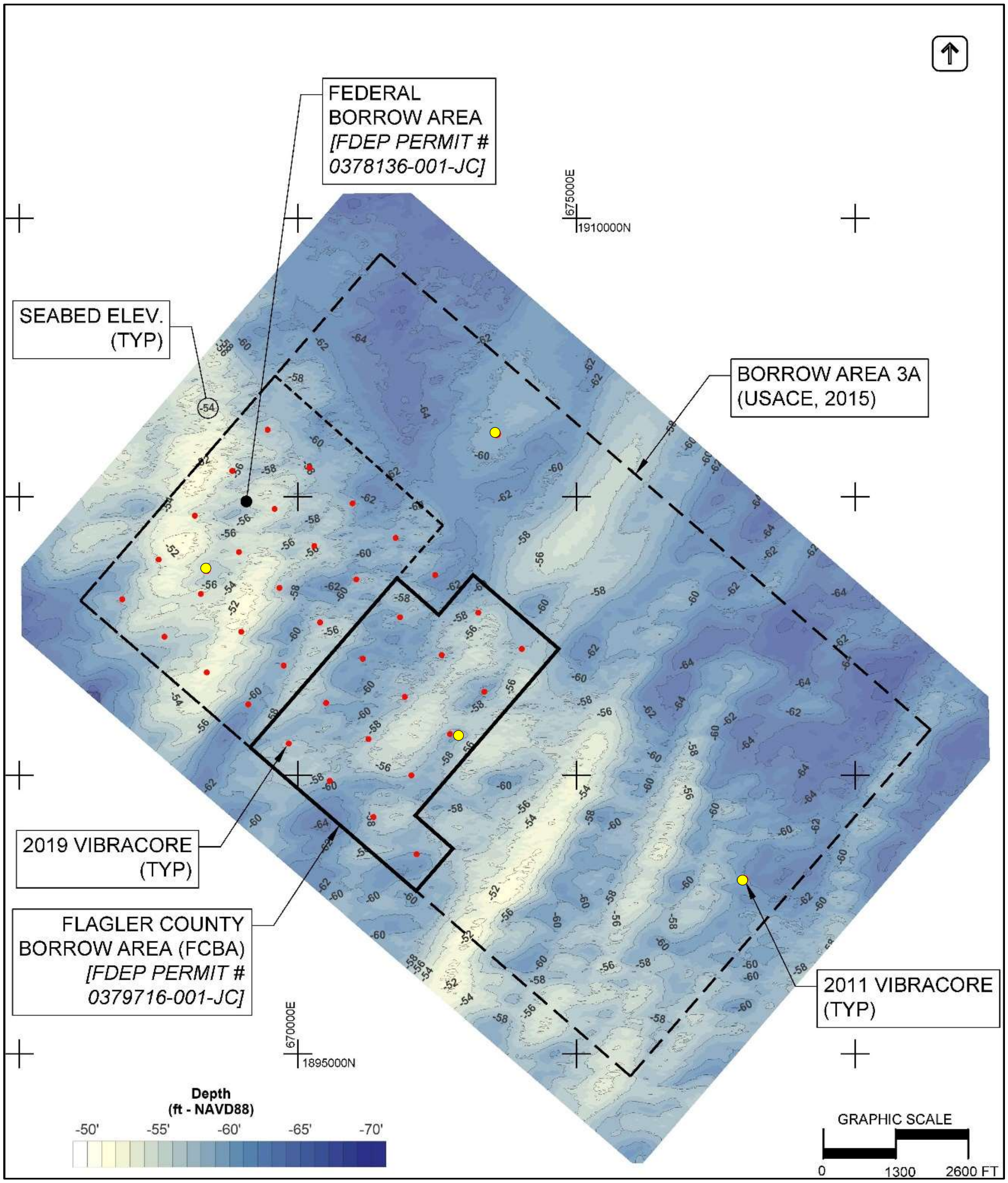

Figure 7.4: Detailed plan view of Area 3A and the two delineated and permitted borrow areas within the larger boundary; (1) the "Federal Borrow Area" (FDEP Permit #0378136-001-JC) and (2) the Flagler County (FDEP Permit # 0379716-001-JC). The multi-beam survey was collected in was May 2019.

The Federal borrow area encompasses the area represented by 32 of the 48 cores. This area contains approximately 4.44 Mcy of beach compatible sand above -62.5 ft, NAVD88. Flagler County leveraged the remaining 16 cores and delineated a borrow area for the Flagler County/FDOT project. This area contains about 2.34 Mcy of sand above -62.5 ft, NAVD88 and is estimated to be sufficient to meet the sand volume requirements for the initial construction of the Flagler County/FDOT project.

A summary of the sediment characteristics in Local project (Flagler County / FDOT) borrow area and Area 3A (USACE, 2015b) is presented below. Beach fill compatibility was determined through visual inspection of the proposed beach fill sediments, comparison of color grades, shell content, and a quantitative comparison of grain size characteristics using an overfill analysis. **Table 7.1** presents a summary of the typical sediment characteristics of the Flagler County native beach and proposed typical borrow area sediments. These representative data for the sediments are used in the general compatibility assessment and overfill ratio analysis (Dean, 2000; James, 1974).

Table 7.1: Summary comparison of the native beach sediment to the proposed borrow area composite sediment with overfill ratios.

	Folk and Ward (1957) Method			Method of Moments					Munsell Color		
	D_{16} (mm)	D_{50} (mm) (Median)	D_{84} (mm)	Mean (phi)	Mean (mm)	Sorting (phi)	Carbonate Content (%)	Passing #230 (%)	Hue	Value	Chroma
Native Beach 2020 Composite	0.13	0.18	0.57	2.11	0.23	1.04	19.2	0.23	10YR	7	2
Flagler County 2020 FCBA Composite	0.16	0.23	0.45	1.89	0.27	0.92	20.4	1.63	10Y	6	1
USACE 2019 Federal BA Composite	-	0.24	-	1.86	0.28	0.93	17.8	1.55	10Y	6	1

Figure 7.5 presents a comparison of composite grain size distribution curves for both the borrow area and native beach sediments, along with envelopes that represent the range of conditions for the discrete individual samples that were used to develop the composite curves. All of the sampled borrow area material fall well within the range of material sizes that occur on the project beach.

The most notable difference between the native beach and borrow sediments is that the native beach sediments have a wider range of sediment sizes than the proposed borrow area material. The borrow area material is slightly coarser, on average, than the native beach sediments and appears to have a more uniform distribution of sediment sizes. The native beach, however, has more occurrences of coarse grains between about 0.6 and 2.0 mm, which is likely related to the shell content of the native beach. This coarser material composite that contributes to the bi-modal tendency of the native sediment and is apparent peaking around the 0.9 mm range in the bottom sub-plot of **Figure 7.5**.

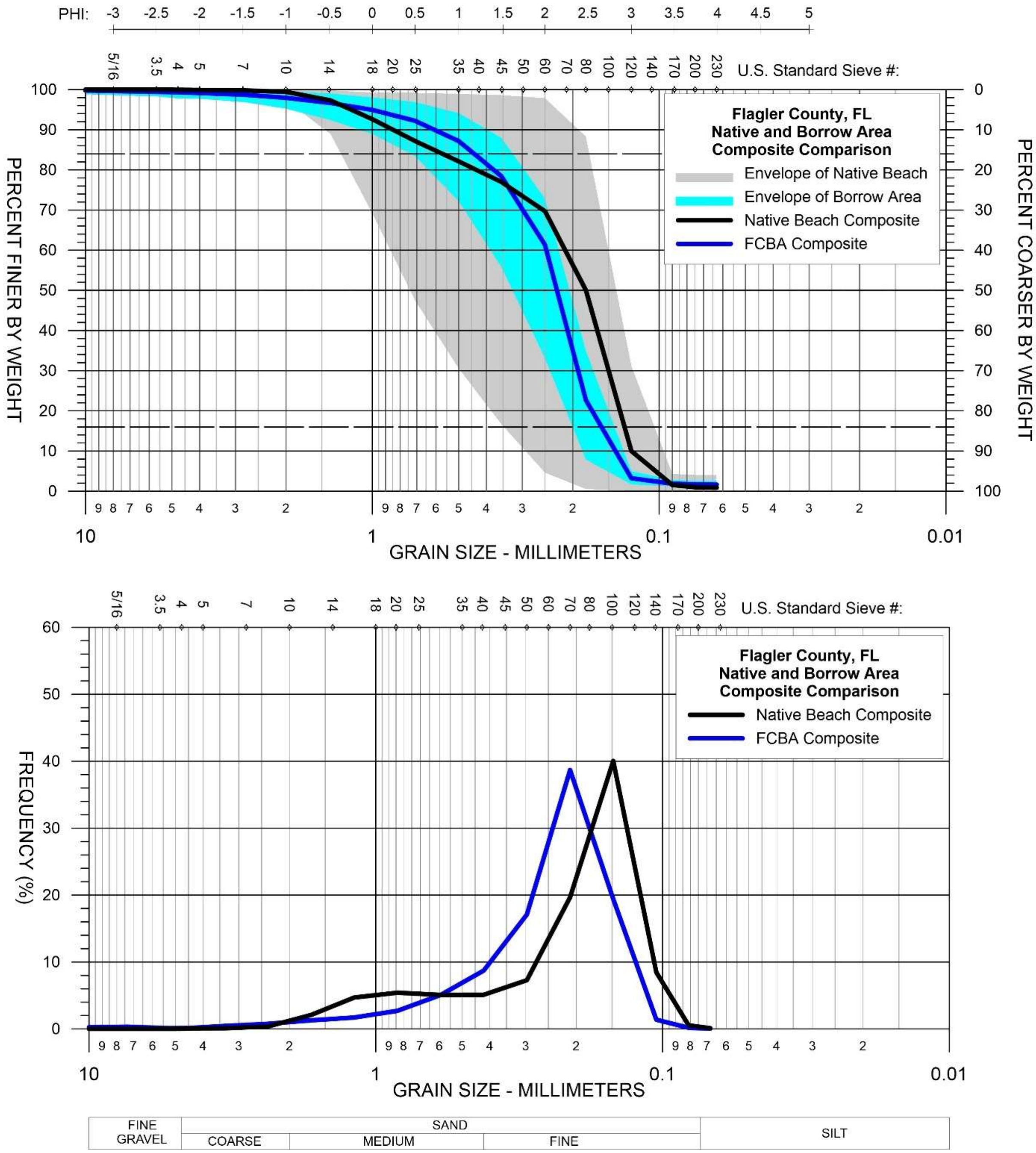

Figure 7.5: Cumulative grain size and frequency curves for the Flagler County Borrow Area (Local project) and the native beach, with envelopes of the discrete sand samples from both areas that were used to develop the composite curves.

7.2.3. Future Offshore Sand Sources

Existing geotechnical data suggest that the most reliable source of offshore sand for Flagler County is the larger sand shoal that includes Area 3A (and the two permitted borrow areas) (**Figure 7.6**). Assuming that the sediments in the larger shoal feature are similar to those sampled in the Federal and Flagler County/FDOT borrow areas, this shoal feature may contain up to 43.3 Mcy of accessible (i.e., a sand layer thickness of 4 feet or greater) beach compatible sand. The permitted Federal borrow areas contains about 10% (4.4 Mcy) of the total estimated available volume in this area. Another 5% (2.3 Mcy) is permitted for the planned Local (Flagler/FDOT) project.

The two impending nourishment projects along Flagler County with utilize portions of available resources within Borrow Area 3A. The non-Federal project is expected to require approximately 2.1 Mcy of sand, with 1.5 Mcy for the initial nourishment and a maximum of 0.6 Mcy for a maintenance renourishment over the 15-year life of the Project permit. The FCBA (prescribed within BA 3A) contains 2.34 Mcy of beach-compatible sand, enough suitable for the non-Federal project. The Federal project requires 1.3 Mcy (assuming 30% loss from excavation to placement) if constructed on 26 June 2023, which would be excavated from the prescribed Federal Borrow Area.

The use of sand resources outside of Area 3A (potentially up to 23 Mcy) will require a detailed geophysical (seismic sub-bottom, sidescan, and magnetometer) and geological analysis. Preliminary data, including ten Vibracores from the 2011 investigation, indicate a significant amount of beach-compatible material above a depth of -64.5 ft outside of the 3A limits. An offshore multibeam survey of the larger sand shoal is needed for an accurate estimate of available sediment. Additional Vibracore samples at strategic locations will also be required to develop and permit a borrow area. Suggested locations of potential future design level and exploratory level vibracore locations are indicated in **Figure 7.6**.

<u>Other Sources</u>. Apart from the shoal feature in the vicinity of Area 3, other offshore sources likely exist offshore in Federal Waters. Potential sand source examples include the shoal features ~3 miles north of Area 2A and ~7 miles northwest of Area 3A (**Figure 7.3**). Developing a borrow area from these sources requires the same permitting and detailed geophysical and geological analysis as described above.

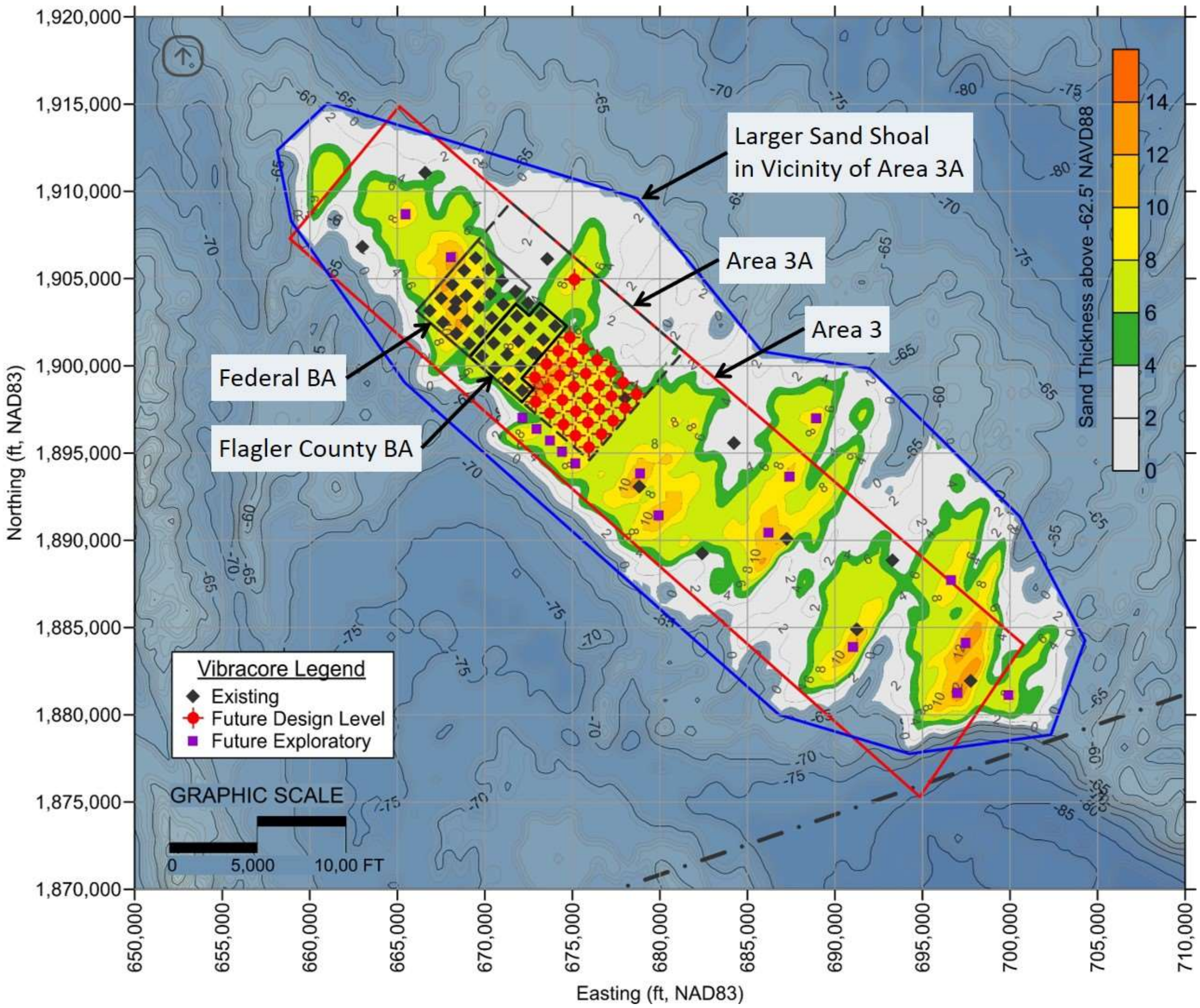

Figure 7.6: Location and extent of larger sand shoal upon which Area 3A (USACE, 2015b) is located. This shoal feature is expected to be a viable long-term sand source to support future beach management activities in Flagler County. Additional geophysical and geological data collection and investigation will be required to confirm the sediment conditions of the larger shoal and support design and permitting activities.

7.3. Upland Sand Sources

A multitude of beach-compatible commercial sand mines deemed suitable by FDEP for placement on the Flagler County beach and dune exist within ~120 miles (~2 hours) of the Flagler County shoreline (**Figure 7.7**). Nine mines are included here, five of which have been permitted for use and placed on the Flagler County beach in the past. The extensive shoreline length of 18 miles will likely require multiple construction access points for truck-haul delivery, staging and access to place sand. Two proposed staging and access locations are at Washington Oaks State Park (R-14.5) and Varn Park (R-49). Both sites were utilized for staging and access for the 2018/2019 Dune Restoration Project.

Beach sand available from the nine permitted mines is compatible with Flagler County's native sand. Sediment characteristics, specifically grain size distribution, minimum fines content and color, are acceptable and well-suited for use on Flagler County beaches (**Table 7.2**). All mines result in an overfill ratio of 1 (i.e., no natural loss of imported sediment to account for sorting losses). Grain size distribution for the candidate upland sand mines and the composite native beach as well as the composite for the offshore FCBA (Flagler County Borrow Area) are compared in **Figure 7.8**.

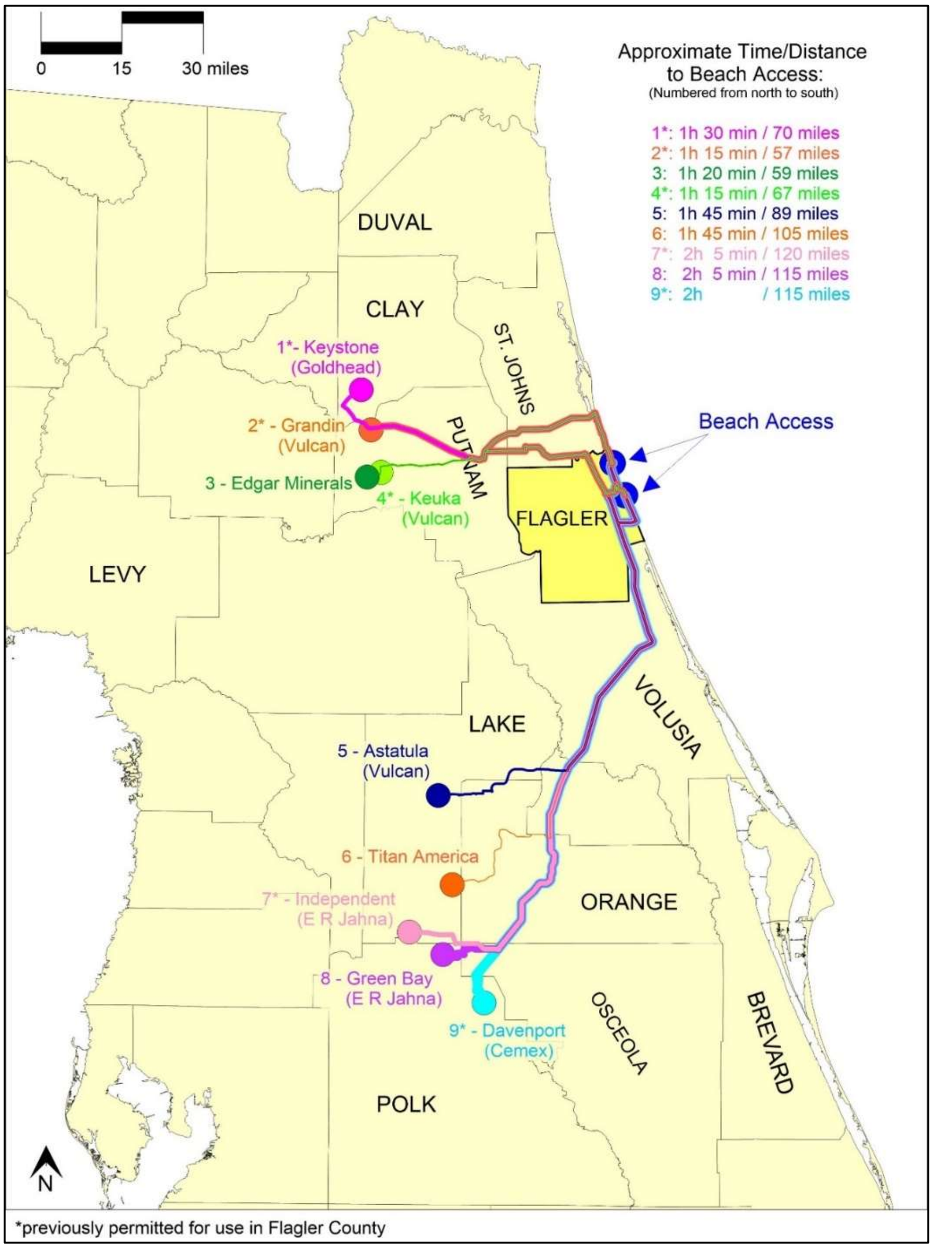

Figure 7.7: Potential upland sand sources for a beach/dune nourishment project along Flagler County.

Table 7.2: Grain size parameters for candidate upland sand mines for the Flagler County shoreline.

Mine	Mean (mm)	Mean (ϕ)	Sorting (ϕ)	Retained #4	Passing #230	Carbonate (%)	Color	Overfill Ratios
Independent North - Jahna	0.38	1.41	1.09	0.00	0.35	0.60	10YR 7/1	1.00
Davenport - CEMEX	0.30	1.75	0.51	0.00	0.10	0.40	10YR 7/3	1.00
Goldhead - Vulcan	0.37	1.43	0.73	0.15	0.06	0.10	7.5YR 8/1	1.00
Keuka - Vulcan	0.36	1.46	0.48	0.00	0.03	0.06	7.5YR 8/2	1.00
Grandin - Vulcan	0.22	2.20	0.62	0.00	0.11	N/A	N/A	1.00

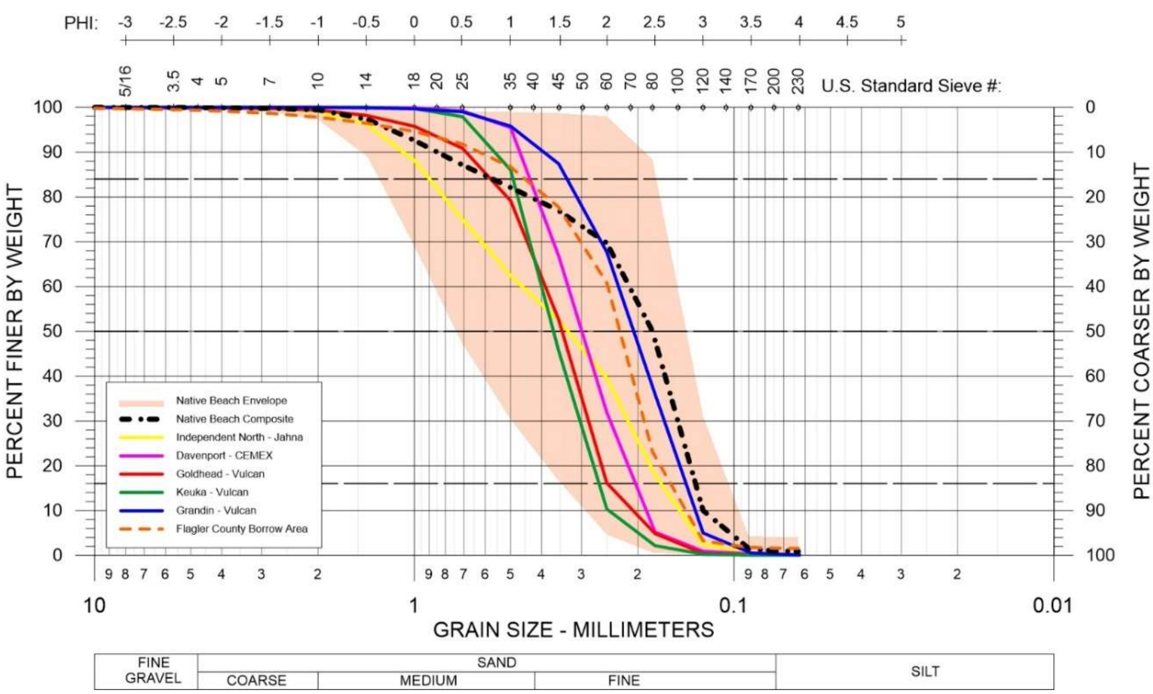

Figure 7.8: Cumulative grain size curves for the candidate upland sand sources, the Flagler County Borrow Area, and the native beach, with envelopes of the discrete sand samples from both areas that were used to develop the composite curves.

8.0 ALTERNATIVE PERFORMANCE ASSESSMENT

This section summarizes the findings of an engineering analysis using the numerical model SBEACH (Storm Induced BEAch Change model) to quantitatively compare the potential storm protection provided from the project alternatives described in **Chapter 5.0**. The beach and dune templates associated with the proposed alternatives were developed given the restriction with the hardbottom resources will offer varying levels of protection. The purpose of the analysis is to describe the performance of the existing beach and dune in future storms and to relatively assess the added storm protection benefits associated with the proposed project alternatives. An in-depth description of the setup, analysis and results are provided in **Appendix D**.

8.1. SBEACH Model Setup

The SBEACH model was calibrated with site specific conditions to simulate storm induced cross-shore beach change at Flagler County beaches. Many of the input parameters used in the present model are derived from the parameters established by the Florida Department of Environmental Protection for northerly adjacent St. Johns County (FDEP, 2011a). Additional parameters were taken from sediment data collected in support for the Flagler County/FDOT Beach/Dune Restoration Project. All input parameters used fall within the range of FDEP recommended values for SBEACH input parameters in northeast Florida.

8.1.1. Topographic/Bathymetric Inputs

The beach and dune profiles used in the model from April 2021, consistent with the other analyses in this report. The April 2021 profiles represent the existing or "*without project*" condition in the SBEACH modeling. In addition to the "*without project*" conditions, post-project profiles were modeled using the proposed alternatives described **Chapter 5.0**. Four representative profiles were examined, including R-13, R-27, R-38, and R-55 to evaluate the various project fill densities and construction templates associated with each alternative. Various project alternatives for the shoreline south of R-55 were studied extensively by the USACE (2015b). The alternatives and corresponding project placement densities modeled are as follows:

- R-13
  - "*Without Project*"
  - "*16 cy/ft*" (Alternatives 2 – 5)*
  - "*44 cy/ft*" (Alternative 6)

- R-27

- "*Without Project*"
- "*16 cy/ft*" (Alternatives 2 – 4)*
- "*25 cy/ft*" (Alternative 5)
- "*44 cy/ft*" (Alternative 6)

- R-38
  - "*Without Project*"
  - "*16 cy/ft*" (Alternatives 1 – 4)
  - "*25 cy/ft*" (Alternative 5)
  - "*44 cy/ft*" (Alternative 6)

- R-55
  - "*Without Project*"
  - "*32 cy/ft*" (Alternatives 1 & 2)
  - "*44 cy/ft*" (Alternative 3 – 6)

*Fill configurations for the "*6 cy/ft*" at R-13 and "*10 cy/ft*" at R27 associated with Alternative 1 (**Section 5.4**) were not modeled.

Of particular interest in this analysis is the "*16 cy/ft*" project configuration at R-13, R-27, and R-38, which is the upper limit of the likely permissible volume to be placed where hardbottom resources are present in the nearshore. The "*16 cy/ft*" project configuration at R-13 and R-27 represents the 'dune enhancement' described in *Section 5.3.3*. The profile at R-38 has an existing +19.0 ft dune elevation, and therefore the "*16 cy/ft*" project configuration at this location is modeled in the form of a dune restoration and beach berm.

The "*25 cy/ft*" project configuration corresponds to Alternative 5 and is intended to provide better long-term protection with a more-robust beach fill than the "*16 cy/ft*" configuration. This configuration is represented at R-27, and R-38 and implies that some impacts will occur to hardbottom between R-13.8 and R-43.5.

The "44 *cy/ft*" project configuration corresponds to Alternative 6 and provides a beach fill consistent with the Federal Project alongshore fill volume density. This configuration is represented at R-13, R-27, and R-38 and implies that significant hardbottom impacts will occur to hardbottom north of R-43.5.

8.1.2. Hydrodynamic Inputs

Six storms were modeled with varying return periods: 5, 10, 15, 25, 50 and 100-year return periods. The FDEP uses the 25-year event as a benchmark to determine the level of vulnerability of upland infrastructure. The higher-frequency events are of particular interest since they are more likely to occur in a given year. FDEP storm hydrographs (FDEP 2011b) were used as input for the return period storm model runs. The published 15- and 25-year storm hydrographs were adjusted to create hydrographs for the various return period storm events by matching peak tide levels for those respective curves to match the published peak storm tide levels.

No measured wave condition information was available for the various return period storms. However, the FDEP model calibration for St. Johns County indicated that a constant wave condition can provide a reasonable proxy for measured time series wave data (FDEP 2011a). Additionally, calibrations in other areas of Florida (OAI, 2020c) indicate that relatively consistent SBEACH predictions can be achieved if input water levels and wave conditions are adjusted so that the output model water levels on the beach match the target maximum water levels.

Therefore, constant wave conditions throughout the duration of a storm event are applied for all SBEACH simulations. FDEP uses the same constant wave heights and wave periods (10 ft & 10 seconds) for 15- and 25-year storm simulations in SBEACH analyses of St. Johns and Volusia Counties (FDEP 2011a). The input wave and water level conditions for the remaining modeled storm events were adjusted to match the output water levels. The resulting wave conditions are all within the expected range of available storm data and listed in **Table 8.1**.

Since the FDEP storm hydrographs and the peak storm tide levels include dynamic wave setup, the storm hydrographs for those return periods were adjusted downward to account for the wave setup calculated within the SBEACH model. Through an iterative process, the FDEP input hydrographs were proportionally reduced based upon the average SBEACH-generated setup across "*without project*" profiles using the input wave conditions (**Figure 8.1**). This resulted in a set of final average maximum water elevations for all of the profiles that approximately matches the FDEP peak storm tide levels listed in **Table 8.1**. Since the hydrographs were adjusted using an average of these profiles, the output water levels for a storm at an individual profile may vary from the target maximum water level.

Table 8.1: Input wave conditions and water levels for predictive SBEACH model runs.

Storm Event	Wave Height (ft)	Wave Period (s)	FDEP (2011) Peak Storm Water Level (ft-NAVD)	Adjusted Peak for SBEACH input (ft-NAVD)
5-Year	9	9	3.5	1.7
10-Year	9.5	10	4.9	2.9
15-Year	10	10	5.7	3.4
25-Year	10	10	6.7	4.4
50-Year	12.5	11	8	5.1
100-Year	16	12	11.2	7.2

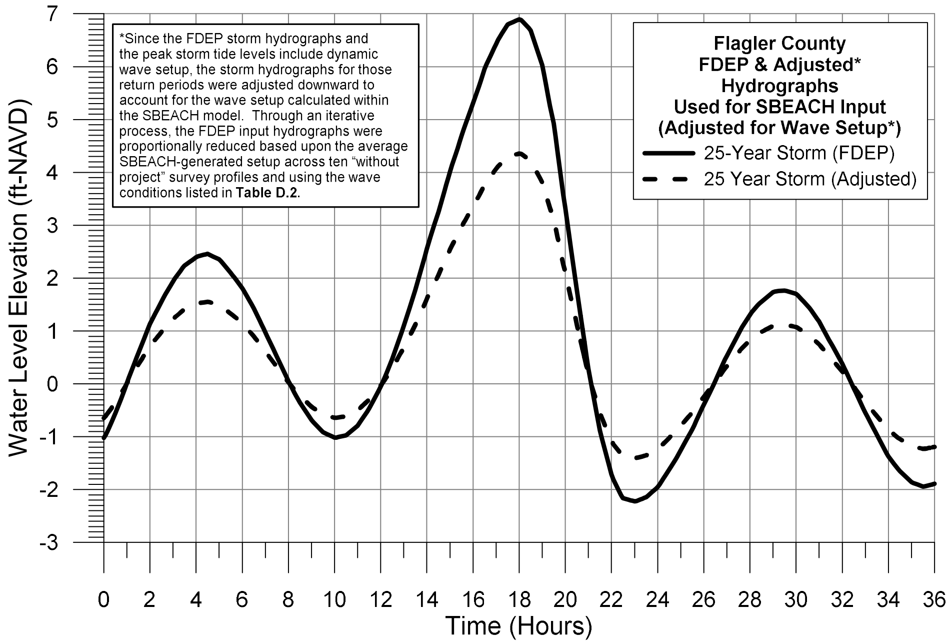

Figure 8.1: FDEP and adjusted for SBEACH input 25-year storm hydrographs, Flagler County, FL. Input hydrograph adjusted from published hydrograph (FDEP 2011b) to account for model generated wave setup.

8.2. SBEACH Predictions of Shoreline Recession

Appendix D - Attachment 1 plots the resulting profiles for all of the above stated project alternatives and modeled storm events. For the "*without project*" condition, represented by the April 2021 profiles, the model demonstrates increasing erosion to the existing berm and dune system with increasing storm intensity for the 5-, 10-, 15-, and 25-year simulations. The 100-year simulation indicates that the erosion extends well into the upland vegetated dunes, potentially destroying a swath of vegetation up to 100+ ft wide and threatening upland infrastructure.

The various project alternatives and associated fill configurations provide differing levels of protection relative to existing condition scenarios (April 2021). Simplistically, the higher the fill density, the lower the dune erosion and shoreline recession. For example, the SBEACH simulations at R-27 for the various alternatives are provided in **Figure 8.2** and **Figure 8.3**. The *"16 cy/ft"* configuration prevents overwash during all the modeled storms except the 100-year event, but the dune is almost completely eroded during the 50-year event. The *"25 cy/ft"* dune and upper beach fill is capable of withstanding a 50-year storm and prevents overwash during all the modeled storms except the 100-year event. With a *"44 cy/ft"* fill, the profile exhibits no loss of dune until the 50-year storm. The profile additionally exhibits significantly less overwash during the 100-year storm than the other alternatives.

The SBEACH results allow for a comparison of project alternatives through the recession of beach and dune contours for the various storm return periods. For example, **Figure 8.4** illustrates the predicted recession at R-27 for all fill configurations modeled versus storm return period for the +10, +8, and +5 ft-NAVD88 contours. As expected, for both existing conditions and all project configurations, the level of recession of the selected contours increases with increasing storm intensity. All of the "*with project*" configurations experienced less recession relative to the pre-storm, pre-project condition for the various contours. For example, the *"16 cy/ft"* fill configuration reduced shoreline recession of the +10 ft contour by 20 – 30 feet compared to the *"without project"* condition for all storms (excluding the 100-year event). The *"25 cy/ft"* configuration tends to reduce shoreline recession by about 10 feet for all of the selected contours, independent of return period. The *"44 cy/ft"* configuration prevents recession of the pre-project to post-project/post-storm profiles for all of the select contours except for two instances of minor recession of the +5 ft contour.

The modeled SBEACH shoreline recession per individual storm scenario can be compared for the full cross-sectional beach and dune profiles and for all fill configurations, as seen in **Figure 8.6** and **Figure 8.7** at the four modeled transect locations. The figures demonstrate how the various fill configurations limit the landward extent of recession (post-project/post-storm) relative to existing (pre-project) conditions during the 25-year storm event. For example, during the 25-year storm event at R-27, shoreline recession is limited to strictly below the +10 ft contour for the *"16 cy/ft"* fill, to strictly below the +9 ft for the *"25 cy/ft fill"*, and to strictly +5.5 ft for the *"44 cy/ft"* fill. The higher contours (greater than ~8 ft) tend to receive the most benefit to increased storm return periods with an increase in fill density with.

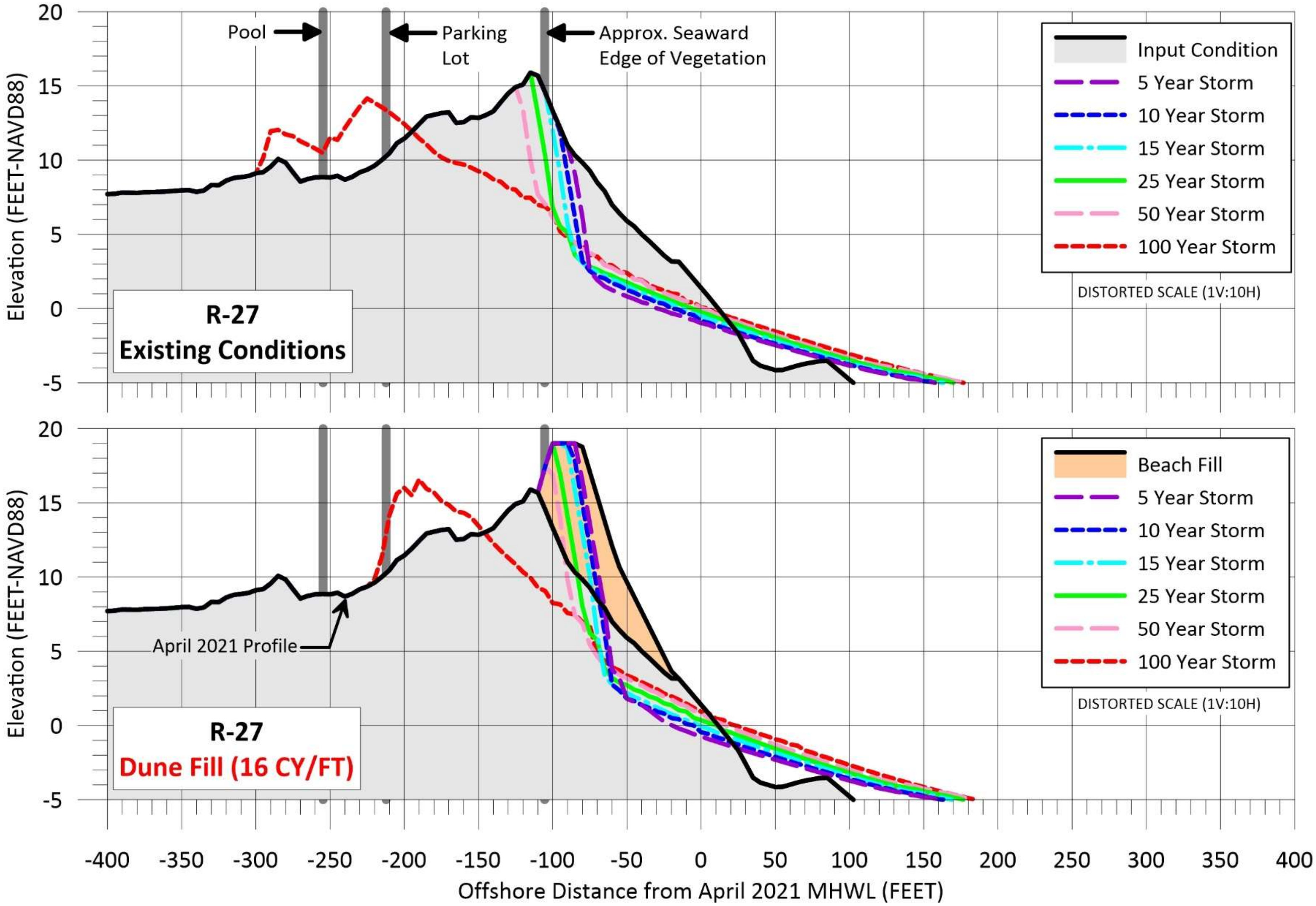

Figure 8.2: SBEACH simulations at R-27 for exiting conditions (top plot) and Alternatives 2 – 4 (bottom plot).

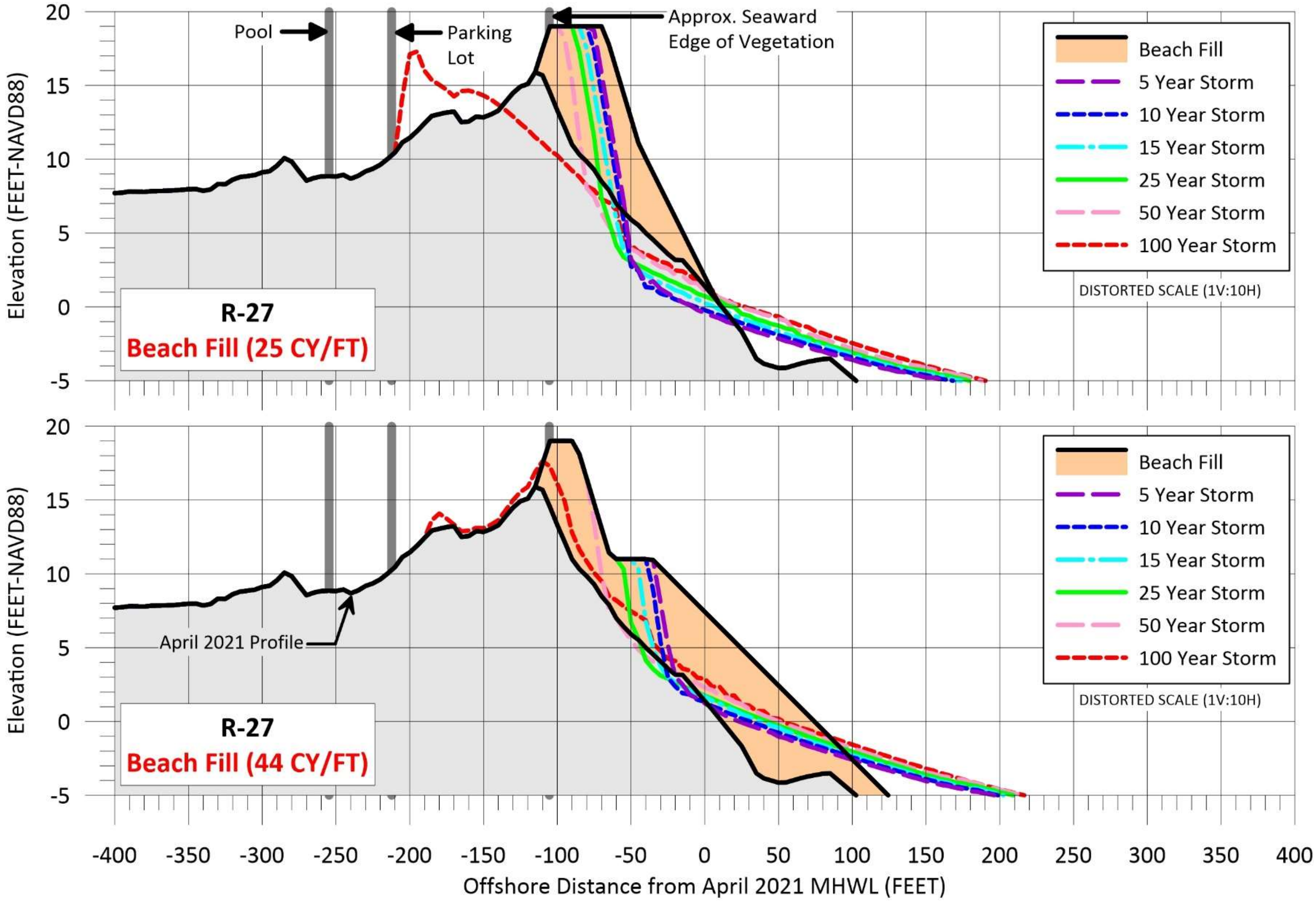

Figure 8.3: SBEACH simulations at R-27 for Alternative 5 (top plot) and Alternative 6 (bottom plot).

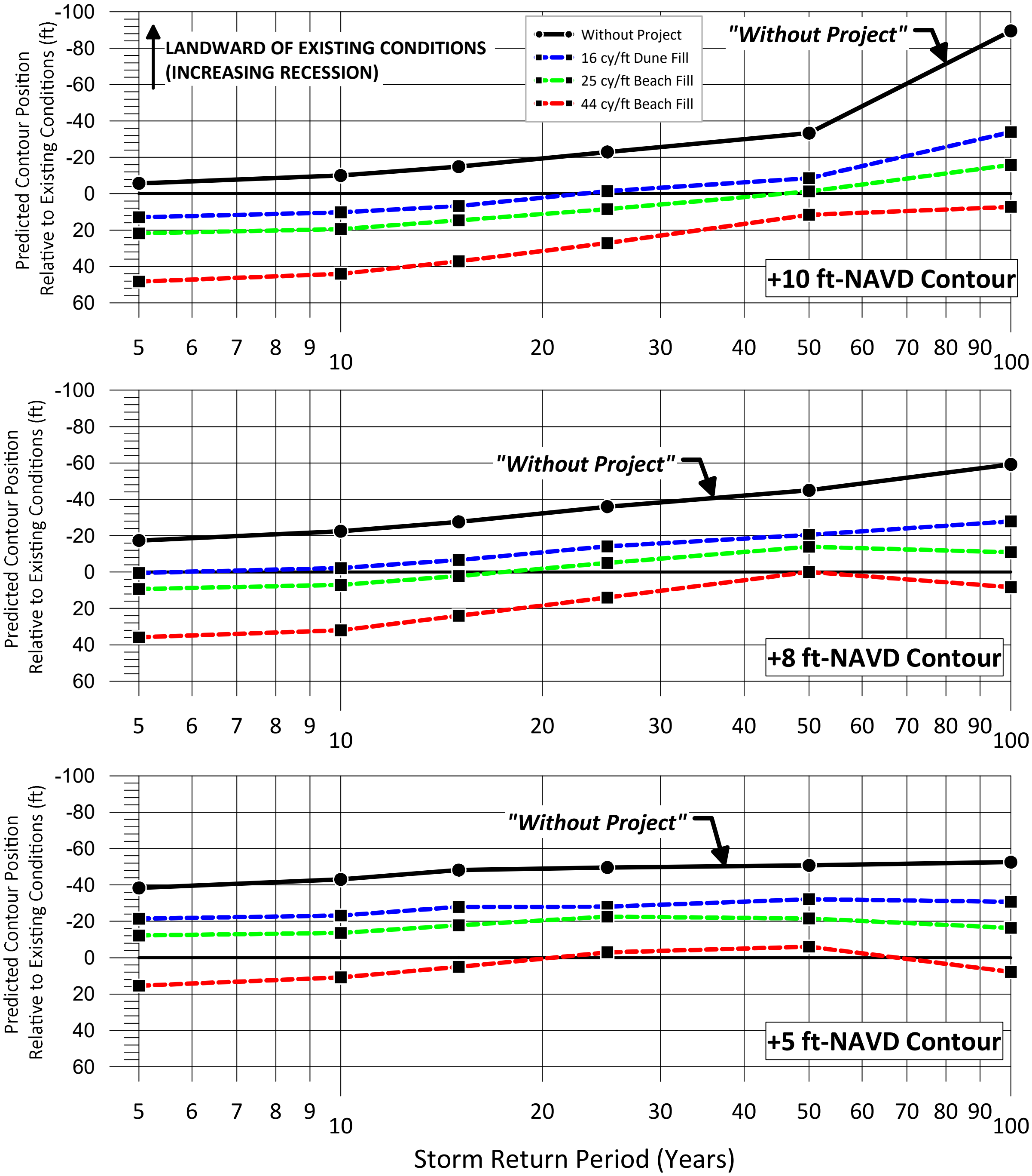

Figure 8.4: Prediction of recession versus storm return period at **R-27** for the +10, +8, and +5 ft-NAVD contour for the "without project" (existing) and the three fill configurations modeled (16 cy/ft, 25 cy/ft, and 44 cy/ft fills). Recession values are plotted relative to the April 2021 pre-project and pre-storm conditions (assumed to be existing conditions).

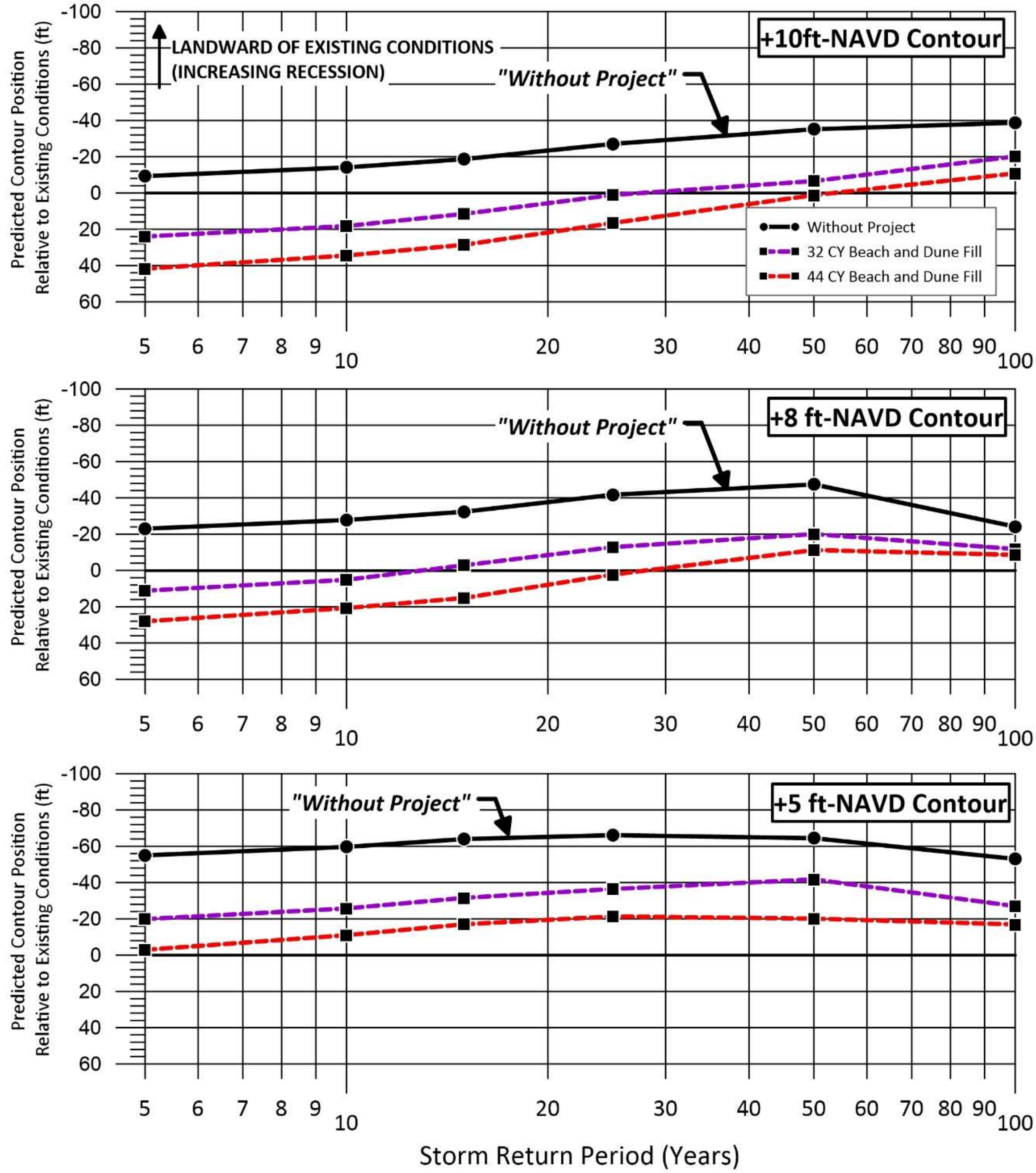

Figure 8.5: Prediction of recession versus storm return period at **R-55** for the +10, +8, and +5 ft-NAVD contour for the "without project" (existing) and the three fill configurations modeled (32 cy/ft and 44 cy/ft fills). Recession values are plotted relative to the April 2021 pre-project and pre-storm conditions (assumed to be existing conditions).

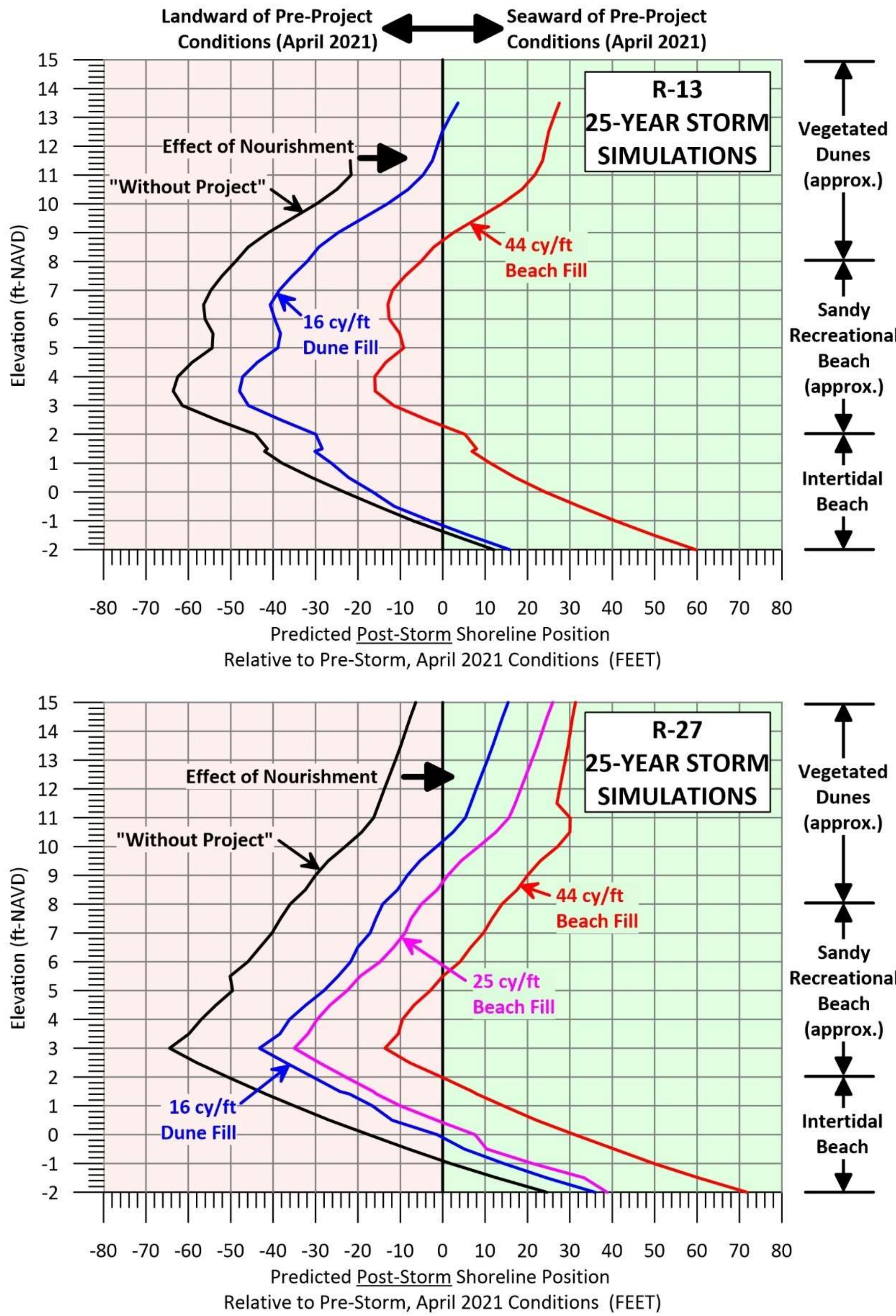

Figure 8.6: Predictions of post-storm (25-year SBEACH simulations) contour positions by elevation relative to existing conditions (April 2021) for "*without project*" and proposed beach fill configurations at R-13 & R-27.

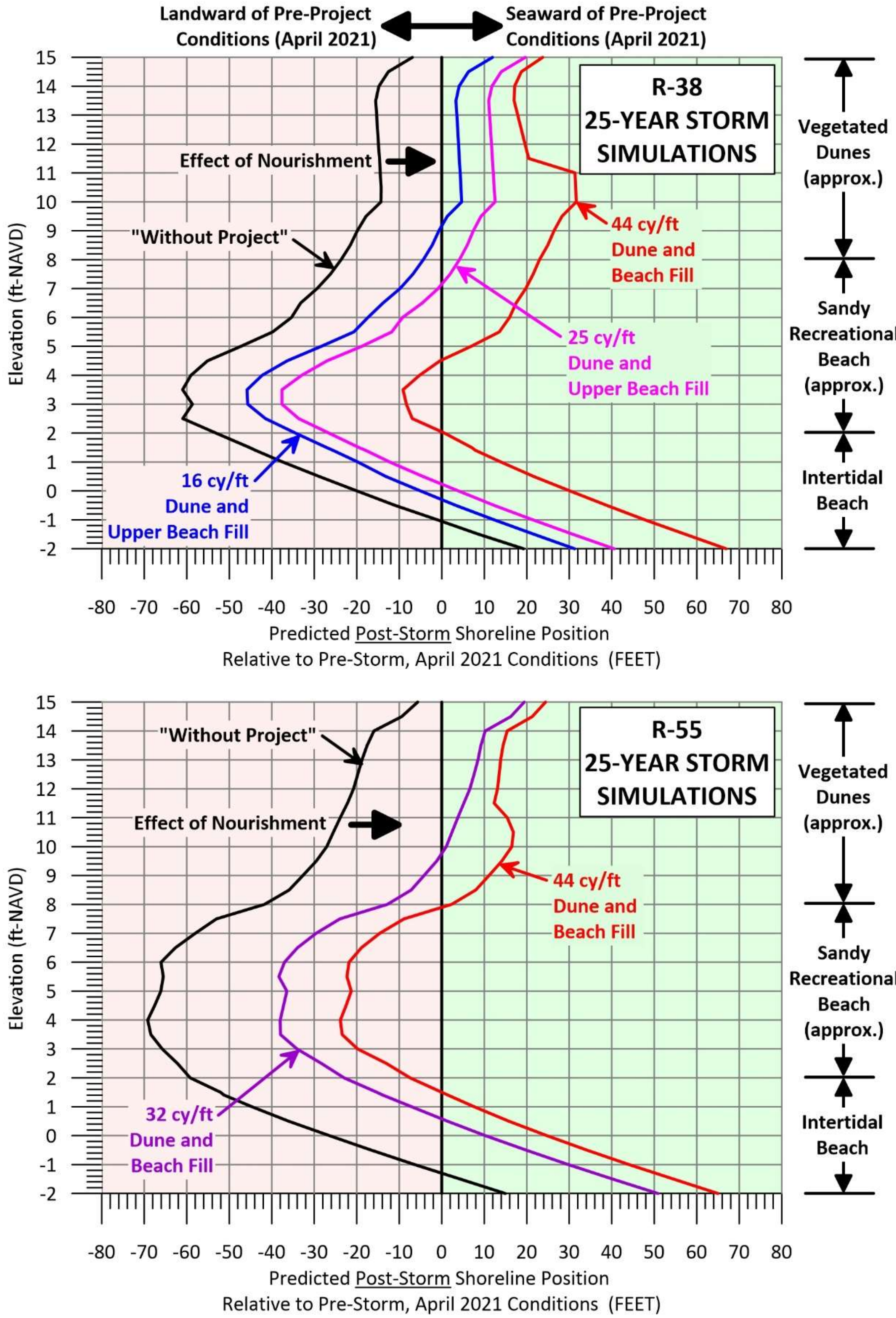

Figure 8.7: Predictions of post-storm (25-year SBEACH simulations) contour positions by elevation relative to existing conditions (April 2021) for "*without project*" and proposed beach fill configurations at R-38 & R-55.

8.3. Summary & Conclusions

The Flagler County shoreline has been subject to a number of damaging storms/hurricanes in the past. Numerous recent storms, including Hurricanes Matthew (2016) and Irma (2017) have produced significant damage to the county shoreline, leaving it vulnerable to future storms. An SBEACH numerical storm recession analysis was performed at four locations (R-13, R-27, R-38 and R-55) along the Flagler County shoreline to describe the performance of the existing beach in future storms and to assess the added storm protection benefits associated with the proposed beach fill alternatives described in **Section 5.4**.

At all of the R-monuments modeled under existing, "*without project*" conditions, exhibited some degree of profile deflation at the existing seaward edge of vegetation during the 25-year storm event. By comparison, for all of the dune/beach fill alternatives modeled, all elevations above -2.0 ft-NAVD, remain seaward of the post-storm "*without project*" condition and none exhibited profile deflation, relative to existing conditions, at the existing seaward edge of vegetation. While the post-project beach and dunes are predicted to experience significant erosion during the more severe storms in the form of profile deflation and vegetation loss, the upland infrastructure is predicted to remain protected from storm surge and wave impacts.

The SBEACH predictions suggest the construction and maintenance of all the proposed projects will enhance the protection of the existing dune system and upland infrastructure, notably during a 25-year storm event. The model results demonstrate how the wider beach berm associated with all of the *beach* fill configurations limit the landward extent of profile recession.

In the north County (north of R-43.5), hardbottom resources will likely limit the fill density to 16 cy/ft (*Section 3.1.4*). Hardbottom is present above and below the MHWL at R-13, and strictly below the MHWL at R-27 and R-38. No hardbottom is present at R-55. A dune fill associated with the *"16 cy/ft"* at R-13 and R-27 does provide significant protection against all modeled storms (except for the 100-year event) and prevents overwash and shoreline recession at these dune locations. The upper beach portion of the *"16 cy/ft"* configuration at R-38 further protects the dune and prevents complete dune loss during even during the 50-year storm.

The *"25 cy/ft"* template, which will likely impact nearshore hardbottom, does provide additional protection over the *"16 cy/ft"* fill and is capable of withstanding a 50-year storm and prevents overwash during all the modeled storms except the 100-year event. The additional 7 cy of sand modeled below the berm in *"25 cy/ft"* configuration at R-38 significantly reduces the amount of erosion exhibited in the dune.

The *"32 cy/ft"* beach and dune configuration at R-55 limits shoreline recession to strictly below the berm (11-ft contour) for storms up to 25 years in return period. Increasing the fill density at R-55 to the *"44 cy/ft"* configuration reduces shoreline recession by about 10 to 20 feet for all modeled storms except the 100-year event.

With the *"44 cy/ft"* fill, dune erosion begins to occur during the 50-year storm event. The *"44 cy/ft"* configuration during a 100-year storm at R-27 significantly reduces overwash, and at R-38 and R-55 is capable of completing withstanding overwash and elimination of the dune. The *"44 cy/ft"* configuration, however, would impact large quantities of hardbottom in the north County (R-13, R-27 and R-38).

9.0 COST ANALYSIS

9.1. Introduction

This section compares the probable cost to construct each of the project alternatives described in **Chapter 5.0**. A thorough discussion of the details of the cost analysis is provided in **Appendix E**. The costs and assumptions made herein are considered appropriate for a planning level investigation and general long-term budgeting guidance. As such, these costs should be considered approximate and representative of order-of-magnitude totals only. Specific budgeting should utilize definitive project plans and updated costs and market analyses.

Assumptions typical for the industry are made for the relative percentages for Planning Engineering and Design / Permitting (PED/Permitting), Construction Engineering and Inspection/Monitoring (CEI/Monitoring), and a contingency. The latter is applied to all bottom-line costs. The analysis estimates the cost of sand placement from both offshore and upland sources as well as hardbottom mitigation. As discussed previously, the mitigation is based on a probable order-of-magnitude for impacting coquina rock. It is assumed that one acre of mitigation will be required for one acre of hardbottom coverage, or a 1.0 to 1.0 ratio. This analysis also considers the impacts of sea level rise (SLR) to the long-term sand placement requirements and project costs.

The Flagler County Federal project is proposed to be constructed by dredge using and offshore sand source. Future maintenance of the Federal project will also be constructed by dredge from the same offshore sand source. Following initial construction, the Federal project will be renourished (i.e., maintained) every 11 years.

For this study, it is assumed that county-wide beach management work that can be constructed by dredge (i.e., will fill densities larger than ~20 cy/ft) will be constructed by dredge at the same time and on the same intervals as the Federal project. The purpose of this will be to leverage the availability of the dredge equipment and reduce the mobilization cost to non-Federal project work. Fill densities less than 20 cy/ft must be constructed by mechanical means using either sand from upland sources

<u>Cost Assumptions.</u> Input costs for the various project elements are based upon 2021 market conditions, USACE cost analyses performed for the Flagler County Coastal Storm Risk Management (CSRM) Project, and 2021 bid results for USACE beach and dune projects in northeast Florida. Three specific example projects that were used to verify assumed costs are (1) the St. Johns County - Vilano Beach CSRM Project, (2) the Brevard County - Mid-Reach 2017-2019 Hardbottom Mitigation Project and (3) Brevard County - Mid-Reach 2019/20 Beach Restoration. The following unit costs were assumed for this analysis:

Dredging (Offshore Sand)

Mob/Demob: $3.5 million/event*

Sand (hydraulic placement): $16/cy

*Included in the cost of the Federal project

Truck-haul (Upland)

Mob/Demob: $250,000/event

Sand (mechanical placement): $55/cy

Stockpiling (Offshore Sand)

Mob/Demob (stockpile area): Included in the Dredging Mob/Demob cost

Sand (stockpile & mechanical rehandling and placement): $55/cy

Hardbottom Mitigation

Mitigation Units: $2.35 million/acre

Percentage Cost Elements

PED/Permitting: 5% of total construction cost

CEI/Monitoring: 5% of total construction cost

Contingency: 15% of total cost

Excavation of offshore sand requires the costly mobilization of a dredge and supporting equipment. Recent bid results suggest the cost of mobilization and demobilization (Mob/Demob) is on the order of $3.5M. It is recommended that Flagler County time their dredging and beach nourishment projects to coincide with the construction of the Federal project. If these projects are scheduled appropriately, the County could take advantage of significant savings on the cost of Mob/Demob. This analysis assumes that the Federal project would bear the cost of the Mob/Demob and the County would only pay for the additional sand to be excavated from the offshore borrow area. Additionally, the Mob/Demob cost is assumed to be a constant $3.5M/event independent of the scope and scale of a dredge project.

Trucking in sand from an upland mine also has a mobilization cost, but it is much smaller than that of a dredging project. Before upland sand can be placed on the beach, a contractor must first relocate personnel and equipment to the site and establish construction access points for sand delivery. For this analysis, the cost of Mob/Demob is assumed to be on the order of $250,000. Although the cost of mobilization is lower, the cost of sand is much higher at ~$55/cy.

The final construction method considered is mechanical placement of stockpiled dredged sand. This option is considered only in areas with hardbottom resources. The mobilization cost of the dredge and supporting plant is assumed to be covered by the

Federal project. However, mechanical placement of stockpiled sand is much less efficient than hydraulic placement. The dredge has to first pump sand into stockpiles and then that sand has to be rehandled, i.e., loaded into off-road trucks to be transported to its final destination. The dredge contractor will make up for the decreased productivity by increasing the price of the sand. For a recently constructed (2019-2021) Brevard County Mid-Reach project that was constructed using offshore sand stockpiling, the cost for in-place sand was $52/cy. Initial excavation and placement of sand in the stockpile was $20.65/cy. Rehandling the sand raised the unit price by more than a factor of 2. That project had a separate line item for the mobilization of extra equipment for transporting the sand from the stockpiles. The mobilization cost for rehandling stockpiled sand is not estimated in the present analysis, but instead absorbed into the unit cost for stockpiled sand. Therefore, the total estimated unit cost for in-place sand (excluding Mob/Demob) is assumed to be the same as upland sand, at $55.00/cy.

These cost assumptions are applied to the six project concept alternatives discussed in *Section 5.4*. For each alternative, it is assumed that there will be sand placement for (1) initial restoration and (2) 50-years of beach maintenance. As discussed in Ch. 6, the frequency of sand placement will vary according to the construction method and sand source. When a dredge is required (i.e., when offshore sand is used), it is assumed that construction will occur on the same schedule as the Flagler County Federal CSRM Project (Federal Project). A graphic illustrating the assumed scope and scale of each alternative is presented in **Figure 5.5**, and a summary of each is written below.

Alt 1: <u>South County – Beach Restoration (Extend Planned Projects)</u>
<u>North County – Dune Restoration</u>
Initial Beach and Dune Restoration
- Offshore Sand (R-80 to R-94): 580,000 cy
- Offshore Sand (R-43.5 to R-80; R-94 to R-101): 1,358,000 cy
- Upland Sand (R-2.3 to R-43.5): 394,000 cy
- No Mitigation

Maintenance over 50 years:
- Offshore Sand (R-80 to R-94): 1,280,000 cy
- Offshore Sand (R-43.5 to R-80; R-94 to R-101): 3,400,000 cy
- Upland Sand (R-2.3 to R-43.5): 2,250,000 cy

Alt 2: <u>South County – Beach Restoration (Extend Planned Projects)</u>
<u>North County – Dune Restoration & Enhancement</u>
Initial Beach and Dune Restoration and Maintenance for 50 years
- Offshore Sand (R-80 to R-94): 580,000 cy
- Offshore Sand (R-43.5 to R-80; R-94 to R-101): 1,358,000 cy
- Upland Sand (R-2.3 to R-43.5): 643,000 cy
- No Mitigation

Maintenance over 50 years:

Offshore Sand (R-80 to R-94): 1,280,000 cy

Offshore Sand (R-43.5 to R-80; R-94 to R-101): 3,400,000 cy

Upland Sand (R-2.3 to R-43.5): 2,250,000 cy

Alt 3: South County – Beach Restoration (Increase Scale to Match Federal Project)

North County – Dune Restoration & Enhancement

Initial Beach and Dune Restoration and Maintenance for 50 years

Offshore Sand (R-80 to R-94): 580,000 cy

Offshore Sand (R-43.5 to R-80; R-94 to R-101): 1,818,000 cy

Upland Sand (R-2.3 to R-43.5): 643,000 cy

No Mitigation

Maintenance over 50 years:

Offshore Sand (R-80 to R-94): 1,280,000 cy

Offshore Sand (R-43.5 to R-80; R-94 to R-101): 3,400,000 cy

Upland Sand (R-2.3 to R-43.5): 2,250,000 cy

Alt 4: South County – Beach Restoration (Increase Scale to Match Federal Project)

North County – Dune Restoration & Enhancement

Initial Beach and Dune Restoration and Maintenance for 50 years

Offshore Sand (R-80 to R-94): 580,000 cy

Offshore Sand (R-43.5 to R-80; R-94 to R-101): 1,818,000 cy

Offshore Stockpiled Sand (R-2.3 to R-43.5): 643,000 cy

12 acres of Hardbottom Impact and Mitigation

Maintenance over 50 years:

Offshore Sand (R-80 to R-94): 1,280,000 cy

Offshore Sand (R-43.5 to R-80; R-94 to R-101): 3,400,000 cy

Offshore Stockpiled Sand (R-2.3 to R-43.5): 2,250,000 cy

Alt 5: South County – Beach Restoration (Increase Scale to Match Federal Project)

North County A (R-2.3 to R-13.8): Dune Restoration & Enhancement

North County B (R-13.8 to R-43.5) – Beach Restoration

Initial Beach and Dune Restoration and Maintenance for 50 years

Offshore Sand (R-80 to R-94): 580,000 cy

Offshore Sand (R-43.5 to R-80; R-94 to R-101): 1,818,000 cy

Offshore Sand (R-13.8 to R-43.5): 727,000 cy

Upland Sand (R-2.3 to R-13.8): 148,000 cy

20 acres of Hardbottom Impact and Mitigation

Maintenance over 50 years:

Offshore Sand (R-80 to R-94): 1,280,000 cy

Offshore Sand (R-43.5 to R-80; R-94 to R-101): 3,400,000 cy

Offshore Sand (R-13.8 to R-43.5): 1,672,000 cy
Upland Sand (R-2.3 to R-13.8): 578,000 cy

Alt 6: Entire County – Beach Restoration (Increase Scale to Match Federal Project)
Initial Beach and Dune Restoration and Maintenance for 50 years
Offshore Sand (R-80 to R-94): 580,000 cy
Offshore Sand (R-43.5 to R-80; R-94 to R-101): 1,818,000 cy
Offshore Sand (R-2.3 to R-43.5): 1,768,000 cy
100 acres of Hardbottom Impact and Mitigation
Maintenance over 50 years:
Offshore Sand (R-80 to R-94): 1,280,000 cy
Offshore Sand (R-43.5 to R-80; R-94 to R-101): 3,400,000 cy
Offshore Sand (R-2.3 to R-43.5): 2,250,000 cy

For each alternative, the unit cost assumptions discussed above were applied to provide total cost, including initial construction and maintenance over a 50-year period. These costs were then annualized to compute the Equivalent Annual Cost (EAC) of each alternative. The EAC is used for intercomparison and selection of the most cost-effective plan. EAC is often used to evaluate shore protection projects alternatives with different maintenance intervals (i.e., renourishment intervals) and for capital budgeting decisions. For this analysis, a discount rate of 2.25% (FY22)[4] was used to convert future monetary values to present worth. It is assumed that each alternative would consist of an initial restoration at the beginning of Year 1 and periodic future renourishment (i.e., maintenance events) at varying intervals thereafter.

9.2. Results

The probable initial total cost for all alternatives to restore all 18 miles of the County shoreline ranges from about $70.5M to more than $386.0M. The latter is exceptionally high because of the anticipated extent of impacts to hardbottom areas and the cost of associated mitigation. The initial cost for alternatives that are expected to avoid impacts to hardbottom (Alternatives 1 – 3) is substantially lower, with a range from about $70.5M to $96.8M. Mitigation costs, however, are only applied to the initial project and are assumed to not be required during future maintenance events. As such, the EAC does not follow the trend of the initial cost.

4 The discount rate for Federal water resources planning for fiscal year 2022 is 2.25 percent.

Table 9.1 summarizes the probable cost to construct and maintain the six project alternatives described herein. The EAC for all alternatives ranges from $7.9M to $15.9M. For alternatives not involving hardbottom mitigation (Alternatives 1 – 3), the total average EAC ranges from $7.9M to $8.8M. For those alternatives that include impacts to hardbottom (Alternatives 4 – 6), the EAC ranges from $8.1M to $15.9M. The EAC should be viewed from a long-term project planning perspective. That is, a project plan would be expected to require, on an annual basis, a funding rate equivalent to the EAC. Obviously, the funds will not be expended on an annual basis but rather at discrete instances in time when a project element is constructed.

Effect of Sea Level Rise (SLR). In **Section 6.5** the predicted increase of volume loss along the Flagler County shoreline are made for two projections for accelerated sea level rise: the USACE Intermediate and High Curves. These projections have been incorporated into the expected amount of sand that may be required to maintain the Flagler County beach and dune over a 50-year period with an acceleration in SLR. An increase in the sand volume required on a yearly basis for each beach and dune maintenance event coincides with a higher EAC to consider for beach management planning.

The increase in cost due to the acceleration of SLR is represented in this analysis by using Alternative 3 as the basis for comparison (**Table 9.2)**. The USACE Intermediate SLR projection would increase the EAC from $8.8M to $10.0M, or 14% higher than the baseline. Applying the USACE High SLR projection increases the EAC to $13.9M, or 58% higher than the baseline. Similar increases to the EAC due to SLR are expected for the other alternatives.

Table 9.1: Summary of Initial and Total Equivalent Annual Cost (EAC) for the six project alternatives.

Alternative	Volume (cy)						Assumed Hardbottom Mitigation		Construction Cost					Total Equivalent Annual Cost (EAC)****
	Initial			Future					Initial Cost	Future Hydraulic Placement		Future Mechanical Placement		
	Hydraulic Placement	Mechanical Placement	Total	Hydraulic Placement	Mechanical Placement	Total	Area (acres)	Cost (Million $)			Freq. (yrs)		Freq. (yrs)	
1	1,937,500	405,000	2,342,500	1,170,000	150,000	6,930,000	0	$ -	$ 70,481,000	$ 28,108,300	11	$ 10,752,500	3	**$ 7,910,100**
2	1,938,000	643,000	2,581,000	1,170,000	150,000	6,930,000	0	$ -	$ 87,627,250	$ 28,108,300	11	$ 10,752,500	3	**$ 8,484,800**
3	2,398,000	643,000	3,041,000	1,170,000	150,000	6,930,000	0	$ -	$ 96,827,250	$ 28,108,300	11	$ 10,752,500	3	**$ 8,793,200**
4*	2,398,000	643,000	3,041,000	1,170,000	562,500	6,930,000	12.0	$ 28.2	$ 133,345,927	$ 28,108,300	11	$ 39,135,938	11	**$ 9,543,900**
5**	3,125,000	178,000	3,303,000	1,588,000	144,500	6,930,000	20.0	$ 47.0	$ 137,742,814	$ 36,568,620	11	$ 10,369,838	11	**$ 8,159,000**
6***	4,165,000	0	4,165,000	1,732,500	-	6,930,000	100.0	$ 235.0	$ 386,000,886	$ 39,493,300	11	$ -	11	**$ 15,918,300**

* Assumes that permits can be acquired that allow stockpile construction by dredge along shoreline from R-2.3 to R-43.5. This would require discharge effluent across hardbottom and some direct impact.
** Assumes that permits can be acquired that allow direct placement of dredge material along shoreline from R-2.3 to R-43.5 and coverage of a limited amount of exposed hardbottom.
*** Assumes that permits can be acquired that allow direct placement of dredge material along shoreline from R-2.3 to R-43.5 and coverage of about 75% of exposed hardbottom.
**** 50-year project life. 2.25% discount rate.

Table 9.2: Summary of the Initial Cost and Total Equivalent Annual Cost (EAC) for Alternative 3 with consideration for the (1) intermediate and (2) high projections of relative SLR.

Alternative	Volume (cy)						Assumed Hardbottom Mitigation		Construction Cost					Total Equivalent Annual Cost (EAC)*
	Initial			Future					Initial Cost	Future Hydraulic Placement		Future Mechanical Placement		
	Hydraulic Placement	Mechanical Placement	Total	Hydraulic Placement	Mechanical Placement	Total	Area (acres)	Cost (Million $)			Freq. (yrs)		Freq. (yrs)	
3	2,398,000	643,000	3,041,000	1,170,000	150,000	6,930,000	0	$ -	$ 96,827,250	$ 28,108,300	11	$ 10,752,500	3	**$ 8,793,200**
3 (w/ Inter. SLR)	2,398,000	643,000	3,041,000	1,385,847	192,773	8,434,985	0	$ -	$ 96,827,250	$ 32,477,052	11	$ 13,728,432	3	**$ 10,011,200**
3 (w/ High SLR)	2,398,000	643,000	3,041,000	2,070,045	328,356	13,205,524	0	$ -	$ 96,827,250	$ 46,325,214	11	$ 23,161,635	3	**$ 13,871,800**

* 50-year project life. 2.25% discount rate.

10.0 COST-SHARING ANALYSIS

This section evaluates the expected magnitude of the County's financial responsibility to construct and maintain each of the six project alternatives over a 50-year period. The costs are firstly evaluated under existing agreements and grants, and secondly evaluated under three future scenarios, which involve increasing the financial responsibility of the cost-sharing partners.

This analysis considers cost-sharing with USACE (for a federal project), cost-sharing with FDEP (Beach Management Funding Assistance), grants from FDOT (post-Matthew), and grants from FDEP (for construction in Florida State Parks). FEMA funding is not considered, as it would only be available if a disaster was declared and impacts were documented to the constructed and maintained engineered beach. There is no long-term agreement with FDOT for beach and dune funding. FDOT funds from the post-Matthew grant are applied herein, but no future FDOT funds are considered.

The following assumptions are made for initial construction:

- Federal project (R-80 to R-94):
  65% Federal funding, 35% FDOT Post-Matthew grant
- Planned FDOT/Local project (R-70 to R-80 and R-94 to R-101, except Gamble Rogers Memorial State Recreation Area):
  100% FDOT Post-Matthew grant
- Planned FDOT/Local project (R-94.8 to R-97.8, Gamble Rogers MSRA portion):
  100% FDEP Post-Matthew grant
- Critically eroded beaches outside planned project (R-2.3 to R-4, R-50 to R-57, & R-65.2 to R-70):
  50% FDEP funding, 50% Local funding
- Washington Oaks State Park (R-12 to R-16): 100% FDEP funding
- Remaining shoreline (R-2.3 to R-12, R-16 to R-50, & R-57 to R-65.2):
  100% Local funding

The following assumptions are made for maintenance construction:

- Federal project (R-80 to R-94):
  50% Federal funding, 25% FDEP funding, 25% Local funding
- Critically eroded beaches (R-2.3 to R-4, R-50 to R-57, R-65.2 to R-94.8, & R-97.8 to R-101):
  50% FDEP funding, 50% Local funding
- Gamble Rogers MSRA (R-94.8 to R-97.8):
  100% FDEP funding
- Washington Oaks State Park (R-12 to R-16):
  100% FDEP funding
- Remaining shoreline (R-2.3 to R-12, R-16 to R-50, & R-57 to R-65.2):
  100% Local funding

10.1. Existing Cost-Sharing Opportunities

The existing cost-sharing scenario is illustrated in **Figure 10.1**. For intercomparison among alternatives, the Equivalent Annual Cost (EAC) is used. **Table 10.1** summarizes the distribution of cost-sharing responsibilities of the USACE, FDEP, FDOT, and local stakeholders. It is noted that the USACE and FDOT contributions are the same for all of the alternatives. The USACE funding is consistent in Alternatives 1-6 because the scope of the Federal project is consistent. The FDOT funding is a fixed amount available for initial construction.

Of particular interest to this investigation is the magnitude of the local responsibility. The “Local” share of the EAC for all alternatives ranges from about $5.5M to $13.1M. For alternatives not involving hardbottom mitigation (Alternatives 1 – 3), the average annual equivalent cost ranges from $5.5M to $6.2M. The Local share increases for those alternatives that include hardbottom impacts (Alternatives 4 – 6), as the average annual equivalent cost ranges from $6.9M to $13.1M.

It is also of interest to evaluate potential benefits of existing cost-sharing opportunities to the total initial cost when implementing the six 18-mile project alternatives. **Table 10.2** summaries the distribution of total initial construction cost among the available cost-sharing partners. Given available cost-sharing opportunities, the probable local responsibility for initial cost ranges from about 58% to 88% among the six alternatives.

Table 10.1: The distribution of EAC among three cost-sharing partners for Flagler County beach construction management.

Alternative	**Equivalent Annual Cost (EAC)** (Planning Period: 50 years - Discount Rate: 2.25%)				
	Total	**USACE**	**FDEP**	**FDOT**	**Local**
1	**$ 7,910,100**	$ 689,900	$ 1,394,600	$ 373,300	**$ 5,452,400**
2	**$ 8,484,800**	$ 689,900	$ 1,486,700	$ 373,300	**$ 5,935,000**
3	**$ 8,793,200**	$ 689,900	$ 1,498,800	$ 373,300	**$ 6,231,300**
4	**$ 9,543,900**	$ 689,900	$ 1,585,900	$ 373,300	**$ 6,894,900**
5	**$ 8,159,000**	$ 689,900	$ 1,633,600	$ 373,300	**$ 5,462,200**
6	**$ 15,918,300**	$ 689,900	$ 1,727,400	$ 373,300	**$ 13,127,800**

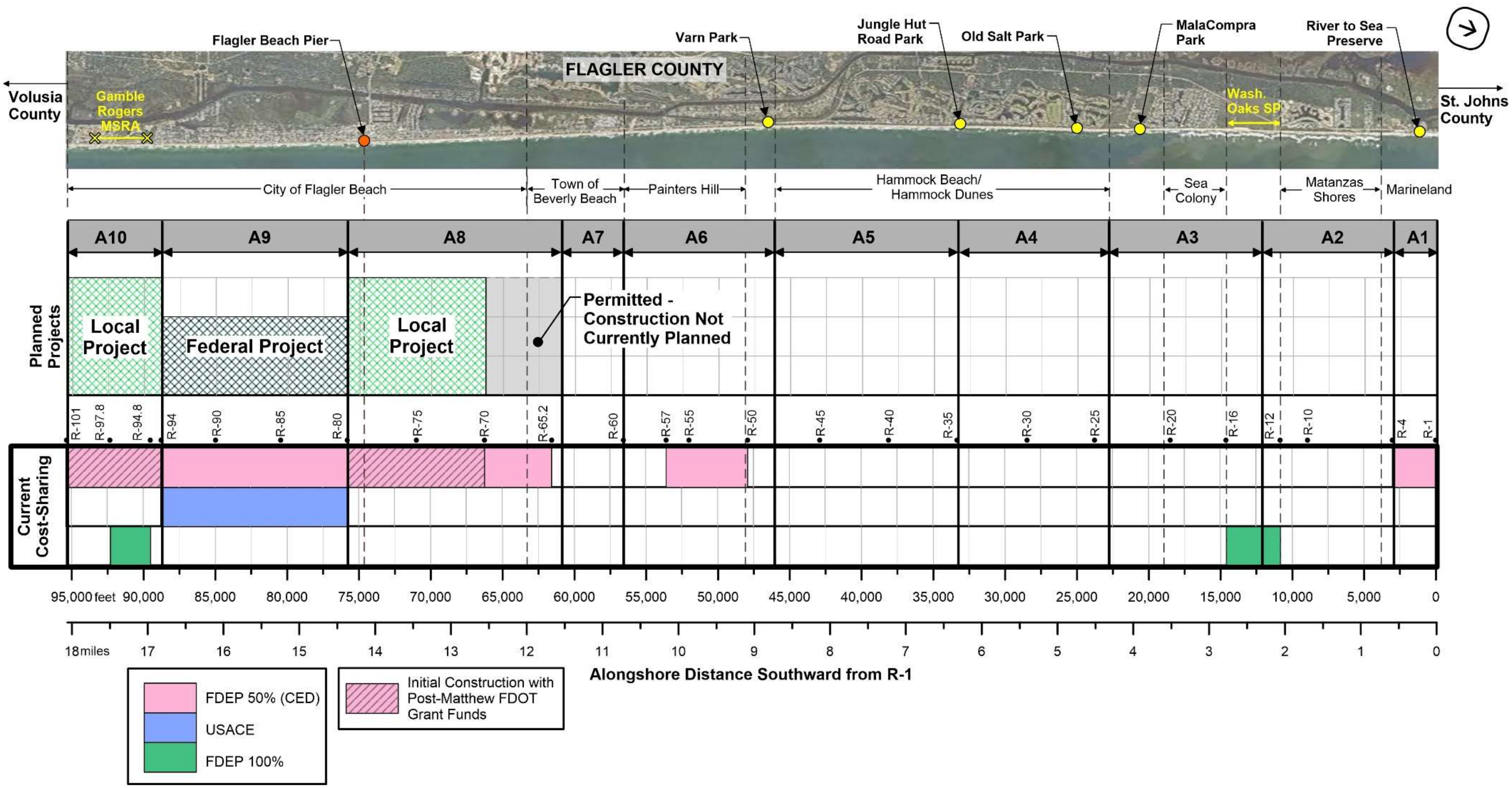

Figure 10.1: The existing cost-sharing scenario for Flagler County.

Table 10.2: Probable distribution of cost-sharing for initial construction cost.

Alternative	Probable Cost-Sharing for Initial Construction (Existing Cost-Share				
	Total	USACE	State/FDEP	FDOT	Flagler
Alt 1 Cost ($M)	$ 70.5	$ 8.3	$ 10.5	$ 11.1	**$ 40.6**
% of Total Cost		12%	15%	16%	**58%**
Alt 2 Cost ($M)	$ 87.6	$ 8.3	$ 12.6	$ 11.1	**$ 55.5**
% of Total Cost		9%	14%	13%	**63%**
Alt 3 Cost ($M)	$ 96.8	$ 8.3	$ 13.6	$ 11.1	**$ 63.8**
% of Total Cost		9%	14%	12%	**66%**
Alt 4 Cost ($M)	$ 133.3	$ 8.3	$ 17.8	$ 11.1	**$ 96.1**
% of Total Cost		6%	13%	8%	**72%**
Alt 5 Cost ($M)	$ 137.7	$ 8.3	$ 21.7	$ 11.1	**$ 96.6**
% of Total Cost		6%	16%	8%	**70%**
Alt 6 Cost ($M)	$ 386.0	$ 8.3	$ 27.1	$ 11.1	**$ 339.5**
% of Total Cost		2%	7%	3%	**88%**

10.2. Possible Future Cost-Sharing Scenarios

The existing USACE cost-sharing opportunities (i.e., the scope of the Federal project) are based upon pre-Matthew (2016) shoreline conditions. Since 2016, there have been significant changes in the County's beach and dune. As such, additional segments of shoreline could be eligible for USACE Hurricane and Storm Damage Reduction (HSDR) funding. Additionally, the existing FDEP cost-sharing opportunities (i.e., the scope of the Critically Eroded Designation) were last updated in 2019 for Flagler County following Hurricane Irma and could be re-evaluated to access additional FDEP Beach Management Funding.

To potentially expand the length of shoreline that may be eligible for USACE HSDR funding, a new USACE HSDR feasibility study will be required. In general, this study would evaluate the potential storm damage reduction to coastal infrastructure that an expanded HSDR project may provide. Should it be determined that other areas of the County are now eligible for Federal funding assistance through an expanded HSDR project, no more than 65% of the initial project costs and no more than 50% of the cost for future schedule maintenance would be provided by the USACE for the new areas. Any increase in the amount of shoreline that is eligible for USACE HSDR funding will result in a reduction in the local funding obligations.

An increase in the length of shoreline that may be eligible for FDEP Beach Management Funding assistance would likewise reduce the local funding responsibility. Again, those areas of the County shoreline that are deemed Critically Eroded (CED) by

FDEP are eligible for cost-sharing by FDEP. The FDEP provides up to 50% of the funds that would otherwise be borne by the Local sponsor.

There are areas of the County shoreline that are not currently classified by Critically Eroded but now may be eligible. The most obvious area for which there may be an opportunity to expand the length of shoreline designated as Critically Eroded is located R-57 and R-65.2 in Painter's Hill and Beverly Beach. This reach of shoreline, located between two adjacent Critically Eroded areas, is about 1.5 miles in length and is highly eroded. Adding this segment of shoreline would result in more than half of Flagler County, or about ~9.6 miles of shoreline being designated as Critically Eroded.

The analyses required to determine a potential expansion of eligibility are highly complex and beyond the scope of this study. For discussion, three possible future cost-sharing scenarios are considered. Each are evaluated to determine how they would affect the local financial responsibility.

Scenario 1: Expanding FDEP CED between R-57 to R-65.2
Scenario 2: Expanding FDEP CED between R-57 to R-65.2; Expanding USACE project to add R-50 to R-80 and R-94 to R-101
Scenario 3: Expanding FDEP CED along the entire County, R-1 to R-101; Expanding USACE project along the entire County, R-1 to R-101

The existing cost-sharing eligibility and three cost-sharing scenarios are illustrated graphically in **Figure 10.2.** As highlighted in the figure, the initial construction cost of the project from R-70 to R-101 is still covered entirely by USACE/FDEP/FDOT. Likewise, the project segments in state parks (Gamble Rogers and Washington Oaks) are still assumed to be covered 100% by FDEP funding.

Table 10.3 compares the EAC associated with each of the cost-sharing scenarios, using Alternative 3 as an example. Assumed cost-sharing Scenario 1 results in a ~$230,000 per year, or about 3.7%, decrease in the EAC local responsibility compared to existing cost-sharing conditions. Again, the only difference between existing conditions and Scenario 1 is the ~1.5-mile increase in the length of shoreline designated as Critically Eroded by FDEP. Scenario 1 is the most immediate likely change to the existing cost-sharing conditions.

Figure 10.2: The location of the current plan and three cost-sharing scenarios for Flagler County beach construction management.

Table 10.3: The distribution of EAC for the current plan and three cost-sharing scenarios for Flagler County beach construction management.

	Scenario	Equivalent Annual Cost (EAC) (Planning Period: 50 years - Discount Rate: 2.25%)				
		Total	USACE	FDEP	Local	FDOT
	Alt 3	**$ 8,793,200**	$ 689,900	$ 1,498,800	**$ 6,231,300**	$ 373,300
1	Alt 3, with CED (R-50 to R-101)	**$ 8,793,200**	$ 689,900	$ 1,728,600	**$ 6,001,400**	$ 373,300
2	Alt 3, with CED and USACE (R-50 to R-101)	**$ 8,793,200**	$ 1,477,200	$ 1,535,300	**$ 5,407,500**	$ 373,300
3	Alt 3, with CED and USACE (R-1 to R-101)	**$ 8,793,200**	$ 3,771,500	$ 2,780,600	**$ 1,867,800**	$ 373,300

Assumed cost-sharing Scenario 2 results in a ~$824,000 per year, or about 13.2%, decrease in the local EAC responsibility compared to existing cost-sharing conditions. Again, this scenario is based upon the assumption that the entire county shoreline south of R-50 will be eligible for the maximum USACE and FDEP cost-sharing. Compared to Scenario 1, assumed cost-sharing Scenario 2 results in a ~$594,000 per year, or about 9.9%, decrease in the EAC local responsibility. This comparison suggests the potential benefit of pursuing a new USACE HSDR feasibility study that could potentially increase the scope of the Federal project along southern Flagler County. The potential long-term cost savings to the local community would need to be compared to the upfront cost (and effort) to the County (~$1.5 million) to support a new USACE HSDR study. It is noted that pursuit of the USACE HSDR study does not guarantee that the project and cost-sharing would be expanded.

Assumed cost-sharing Scenario 3 results in a ~$4,363,500 per year, or about 70.0%, decrease in the EAC local responsibility compared to existing cost-sharing conditions. Given eligibility criteria of the USACE and FDEP, it is unlikely that 100% of the Flagler County shoreline will ever be eligible for maximum cost-sharing opportunities from these agencies. In fact, it is unlikely that many areas north of R-50 would ever become eligible. That is, there are many areas of Flagler County, especially along the northern half of the county, where development densities are relatively low, development is positioned well landward of the active beach and erosional threat, and beach and dune erosion rates fall below required thresholds. Nonetheless, this scenario is included to demonstrate that even under the most extreme cost-sharing opportunity condition, the local community will still be required to contribute funding to the implementation of a project. As such, it is important for Flagler County to prioritize efforts to establish community consensus for the scope of a project and a plan for generating local revenue that is necessary to access funds from cost-sharing opportunities.

In summary, there are marginal benefits to exploring the potential for expanding cost-sharing opportunities along the County. The most realistic change is expected to be similar in scope to Scenario 1 described herein. Although there may also be potential benefits to exploring a potential increase in USACE cost-sharing in the southern part of the County (Scenario 2), this would require and upfront investment of at least $1.5 million from the County with no guarantee that any increase in Federal cost-sharing will be identified after a study. Based upon known USACE and FDEP policies and guidelines regarding cost-sharing eligibility, it is highly unlikely that there would be a meaningful expansion of eligible areas along the northern half of Flagler County (Scenario 3).

11.0 FUNDING

Implementation of a beach management program will require the establishment of a project funding approach to cover expenses associated with the planning, engineering, design, permitting, construction and monitoring of restored beach and dune conditions. This will include leveraging available funds from the USACE, State of Florida (FDEP), and the local community to build and maintain beach management project features. The USACE and FDEP are the only reliable established funding partners available to assist Flagler County with the specific goal of restoring and maintaining a robust beach and dune along its 18 miles of shoreline. These funding partners require the local community to contribute a portion of the total project cost. As such, Flagler County will need to establishing a reliable source of local funding to meet the "local match" requirement. In order to generate sufficient local funds, it is expected that all stakeholders (public and private) within the County will have some level of financial contribution.

Other sources of funding may also be available, including grants from FDOT and post-disaster assistance from the USACE or FEMA. The availability of these funding sources, however, is not considered dependable or predictable for consideration in development of a long-term plan because it is entirely dependent on storms. If the County works to restore and maintain their shoreline, these sources may be available to help repair storm impacts. They will not contribute to the typical maintenance volume requirement. As such, these sources were not included in the development of the long-term cost-sharing analysis (**Chapter 10.0**).

The following discussion provides details regarding the various available funding sources and the respective benefits and requirements of each. Additionally, possible opportunities for generating the local funding share are explored. For this, it is assumed that Flagler County will serve as the administrative head, or local sponsor, for a beach management program and the County will manage all local funding. It is not assumed, however, that all local funding will be generated exclusively through existing County revenue sources.

11.1. USACE Coastal Storm Risk Management (CSRM) Funding

11.1.1. Current Federal Project

Federal funding is available to Flagler County to support Coastal Storm Risk Management (CSRM) projects for areas of a coastline that meet Federal eligibility criteria. In 2015, the USACE, Jacksonville conducted a feasibility study for Flagler County that concluded that only about 2.6 miles of shoreline in south central Flagler County (R-80 to R-94) was eligible for a CSRM project and Federal cost-sharing. The rest of the County was deemed ineligible based on a combination of the following factors: relatively low long-term erosion rates, low development density, limited public access, and relatively large distances between the shoreline and upland development line. The eligible shoreline, which represents only about 14 percent of the Flagler County Atlantic Ocean coast, is south of the Flagler Beach pier, where long-term erosion and a rock revetment have several degraded beach and dune conditions. This area is the most highly eroded and vulnerable area of the entire Flagler County shoreline.

The Federal project has a 50-year period and was authorized by Congress under the Water Infrastructure Improvements for the Nation Act of 2016. A follow-on appropriation of $17.5 million was included in a 2018 Supplemental Bill to support initial planning/permitting/construction of this project. Federal funding will cover 65% of the cost of initial project construction and 50% of the cost of future maintenance renourishment. At this time, there have been no appropriations to support the long-term maintenance of the Federal project.

11.1.2. Potential Federal Project Expansion

It is noted that the 2015 USACE feasibility study used pre-Hurricane Matthew, Irma, and Dorian beach, dune, and development conditions to assess eligible project areas. The effects of these storms, among other events such as seasonal nor'easters, have changed the Flagler County beach and dune significantly since 2015. In many areas, there have been sand volume loss from the beach and dune that have increased the vulnerability of adjacent upland development to future coastal storm impacts. Although post-Matthew and Irma dune restoration projects address some of these losses, recent data suggest that beach and dune conditions have not returned to pre-Matthew conditions.

Identification of any area that may now be eligible under current conditions, however, will require a new CSRM feasibility study by the USACE. USACE feasibility studies cost $3M, which would be shared 50-50 between the USACE and Flagler County, with each entity contributing $1.5M. The study cannot be initiated until the USACE requests and receives the Federal portion of the study funding.

It difficult to predict which areas of the county shoreline may be eligible. However, one relatively low-cost tool to identify areas that may eligible is a beach access and parking study. Areas of the beach that are not accessible by the public through public access points with sufficient public parking will not be eligible for Federal cost-sharing. Therefore, a simple assessment of parking and access with consideration of USACE eligibility guidelines can identify areas that can and cannot be considered in a more detailed CSRM feasibility study. Public access points with sufficient parking spaces should be no more than ½ mile apart. Several segments of the Flagler County shoreline do not appear to meet this requirement. For example, the lack of public parking prohibited the USACE from further participating in the Painters Hill (Design Reach A) shoreline segment noted in the

2015 Feasibility Study.

A new feasibility study could assess the existing conditions and eligibility for federal participation along any reach of shoreline the Local Sponsor (Flagler County) requests, provided funding is available. The study would evaluate storm damage reduction, loss of land, and recreation benefits that could be provided by an extension of the Federal CSRM project. The comparison of the cost to construct and maintain the project over a 50-year project life is compared to the value of benefits generated by the project. This comparison produces a Benefit-to-Cost Ratio, or BCR. For a project to be justified, more than 50 percent of the project benefits must be associated with storm damage reduction and have a BCR of 1.0 or greater.

Flagler County should evaluate the cost and time required to initiate a new CSRM feasibility study and compare those to the potential benefits as well as the likelihood of successful Federal project expansion. The potential benefits associated with an expansion of the CSRM is evaluated in concept in **Chapter 10.0** of this report.

11.2. State of Florida Funding

Funding for the elements of a beach management program in Flagler County is also available from the State of Florida. In 1986, the Florida Legislature identified the protection and restoration of the state's beaches as important to the State of Florida's economy and implemented a comprehensive beach management and funding assistance program. The program is authorized by Section 161.101, Florida Statutes, and rules of Chapter 62B-36, Florida Administrative Code. The Florida Department of Environmental Protection (FDEP) manages the annual appropriation of funding from the State of Florida Legislature to the beach management program.

Under the program, the State provides financial assistance to Florida's county and municipal governments, community development districts, and/or special taxing districts administering shore protection and preservation activities for eligible shorelines.

Eligible activities include beach restoration and nourishment activities, project design and engineering studies, environmental studies and monitoring, inlet management planning, inlet sand transfer, dune restoration and protection activities, and other beach erosion prevention-related activities. In order to be eligible for the Beach Management Funding Assistance Program, projects must be sponsored by a local government and comply with the following criteria:

- Project areas must be on a sandy shoreline in Florida fronting the Atlantic Ocean, Gulf of Mexico, or the Straits of Florida.

- Beach management projects shall be accessible to the general public and access shall be maintained for the life of the project.
- Projects must be consistent with the Strategic Beach Management Plan[5]
- Projects shall be conducted in a manner that encourages cost-savings, fosters regional coordination of local sponsors, optimizes management of sediments and project performance, protects the environment, mitigates impacts caused by modified inlets and provides long-term solutions.

11.2.1. Critically Eroded Beaches

To garner state cost-sharing of up to 50%, the project must address shorelines that are designated as "critically eroded" in the Department's most recent Critical Erosion Report. Presently, there are three areas of the Flagler County shoreline, totaling 8.1 miles in length, that are designated as critically eroded. This covers about 45 percent of the County's Atlantic Ocean shoreline. As mentioned previously, there may be an opportunity to expand the length of shoreline designated as Critically Eroded to include R-57 to R-65.2 in Painter's Hill and Beverly Beach.

11.2.2. State Parks & Recreational Areas

Projects along State-owned land (e.g., State Parks and State Recreational Areas), qualify for State funding at 100 percent State cost-sharing under provisions of Section 161.101 (10), Florida Statutes. These provisions prescribe that "*The department is authorized to pay up to 100 percent of the costs of approved beach erosion control projects when construction and maintenance are on lands of which the state is the upland riparian owner.*" In Flagler County, there are two State parks: Washington Oaks State Park (3,790 ft) and Gamble Rogers Memorial State Recreation Area (2,190 ft). Although, only Gamble Rogers is along a reach of shoreline classified as critically eroded, it is assumed that both of these areas would be eligible for 100 percent state cost participation to restore and maintain the beach and dune there along.

11.3. Local Funding

To support the implementation of a comprehensive county-wide beach management program and access available funding sources, the local community (Flagler County and benefiting stakeholders) will be responsible to contribute a portion of the total project cost. Presently, Flagler County does not have an established local funding source for a beach management program. As such, a critical task in developing a long-term beach management plan will be to determine how the county and local stakeholders will provide funding for the local share. It is assumed that all benefiting stakeholders within the county will contribute to the local share. Benefiting stakeholders are assumed to include, but may

5 https://floridadep.gov/rcp/beaches-inlets-ports/content/strategic-planning-and-coordination

not be limited to the following:

- Flagler County
- City of Flagler Beach
- Town of Beverly Beach
- City of Marineland
- Private Residential
- Commercial

Based upon the assumptions and analyses presented in this report, it is possible that the annual equivalent cost requirement to support the restoration and maintenance of the Flagler County beach and dune along 18 miles of shoreline may range from between about $5.5M and $6.9M per year[6]. That is, funds on this order of magnitude need to be generated from local resources to support a county-wide beach management program. The assumptions used to develop this probable range of cost are based upon current cost-sharing conditions available from the USACE and State of Florida as well as the existing grant funds available following Hurricane Matthew. Potential sources of local funding to meeting the anticipated annual requirement are discussed below.

11.3.1. County General Revenue

County operating revenue is generated from *ad valorem* taxes, real and personal property taxes, and user fees. The Board of County Commissioners can choose to allocate funds to beach management projects within their budget approval authority. It is assumed, however, that there are not sufficient funds within general revenue that can be redirected to support the local share required for a beach management program. That is, it is assumed that a special purpose allocation of additional funds from the community will be required.

11.3.2. Tourist Development Tax

Revenue could be attained from a Tourist Development Tax (TDT) to fund beach management activities. Under § 125.0104, Fla. Stat., counties can levy these taxes, or "Bed Taxes", on transient rental transactions. Tax rates vary by county depending on a county's eligibility to levy particular taxes. The maximum rate allowed by the State is 6%. Flagler County currently levies a tourist development tax of 5% on taxable rental receipts. In general, revenues from the TDT may be used for capital construction of tourist-related facilities, tourist promotion, and beach and shoreline maintenance; however, the authorized uses vary according to the particular bed tax levy chosen by a county. Again, the current Flagler County TDT is not expected to be sufficient to support the financial requirements

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6 Does not include the cost associated with Alternative 6.

of a beach management program without significant impacts to the other existing tourist development activities within Flagler County. Additionally, an increase in the TDT alone may not be sufficient to meet the anticipated requirement of local funding.

11.3.3. Local Option Sales Tax

Counties may levy a Local Option Sales Tax dedicated for a specific application such as beach management activities. Should this approach be of interest to Flagler County, the magnitude of funds to be generated for beach management will need to be considered in establishing the scope of a sale tax increase. It is recommended that any revenue generated for the purpose of beach management be dedicated specifically to the beach management program and not be subject to redesignation to other initiatives within the County.

11.3.4. Special Assessment – Municipal Services Taxing Unit

A special assessment can be used to generate revenue within a community to support funding for any type of services that will benefit the contributing stakeholders. There are two special assessment vehicles that are commonly used for services. These are (1) a Municipal Services Taxing Unit (MSTU) and (2) a Municipal Services Benefit Unit (MSBU).

A Municipal Services Taxing Unit (MSTU) is a form of a special assessment district created pursuant to Florida law (§ 125.01(2r), Fla. Stat.), which relies upon the imposition of special *ad valorem* taxes to meet specifically authorized and established purposes in a defined area, potentially including construction of beach erosion control projects. The County may enact a MSTU by majority vote of the Commission or through a voter referendum.

In Flagler County, more than one MSTU benefit zone (i.e., oceanfront vs. non-oceanfront) may be appropriate in order to reflect different property owner benefits realized by the improvement. Taxes generated over the life of the MSTU will be proportional to assessed property values.

11.3.5. Special Assessment - Municipal Services Benefit Unit

Under Florida law (§ 125.01(2q), Fla. Stat.), a County or other local government can impose and collect a special assessment on properties that will benefit from a capital improvement project such as a beach restoration project through a Municipal Services Benefit Unit (MSBU). An MSBU is a special assessment district that can provide for improvements and/or services to a specifically defined area of the County and financed by a special assessment to only those citizens receiving the benefits of those improvements or services. Moreover, the participation can be structured such that project beneficiaries pay in proportion to the benefits they receive. An MSBU may be initiated by either voter referendum or by a simple majority vote of the County Commission following a mandated process of detailed cost/benefit studies, public hearings, and property owner notifications. In the case of beach nourishment, benefits to each property owner will typically vary according to the property's proximity to the beach, beach frontage, and value. Assessments remain fixed for the duration of the MSBU even if factors affecting the benefit formula subsequently change. To provide for future beach re-nourishment and other maintenance, new assessments can be developed at the end of the prior assessment period.

There are three general characteristics associated with an MSBU:

1) The boundaries of the MSBU are defined and may include all or part of the boundaries of a county or municipality;
2) The special assessment made within the MSBU boundary need not be uniform, but must be reasonably related to the benefit that accrues to the property from the project constructed or the service provided; and,
3) The County has broad discretion in identifying the benefits of a project and in developing a methodology to apportion the benefits (and thus the costs) among the properties in the MSBU.

As an example, interests on the south end of Amelia Island, FL have used an MSBU funding vehicle since 1994 to generate local funding for all beach management activities required on the south end of the island. The MSBU and all project activities are administered through Nassau County by the South Amelia Island Shore Stabilization Association. Nassau County only serves as the administrative head for the MSBU, FDEP and FEMA funding requests. The County does not contribute financially to the operation of the MSBU or any funding required to support the projects and activities funded by the MSBU.

11.3.6. Special Taxing District

Creation of a special district is also a means of establishing a taxing authority to encompass an area of beneficiaries to support a specific activity. A special district defined by Florida Statute is … “a unit of local government created for a special purpose, as opposed to a general-purpose, which has jurisdiction to operate within a limited geographic boundary and is created by general law, special act, local ordinance, or by rule of the Governor and Cabinet.” (Section 189.012(6), Florida Statutes)

Simply put, special districts are units of local special-purpose government. Special districts are very similar to municipalities and counties (local general-purpose government). The only difference between the two is that special districts provide only local specialized governmental services, and have very limited, related and explicit prescribed powers.

The special district authority has been used by many areas within the State of Florida to support beach management needs. Most often these are established as Erosion Control Districts that have specific taxing and administrative authority to address beach erosion problems.

The Dunes Community Development District (DCDD) in Flagler is a special district "unit of special-purpose local government" established by Chapter 190 of the Florida Statutes. The DCDD is a mechanism established to finance and manage major infrastructure facilities and services associated with development in the district service area. The DCDD serves the private communities of Hammock Dunes, Ocean Hammock, Hammock Beach, and Yacht Harbor Village, and is responsible for the management of various utilities including potable water, wastewater, reclaimed water, storm water, in addition to the operations financing and maintenance of the Hammock Dunes Toll Bridge. It could be possible to include beach and dune management as a responsibility of the DCDD to support beach management activities along that specific reach of shoreline or service as the vehicle to collect revenue to support their portion of a larger county initiative.

For Flagler County, a special taxing district could be established to encompass a specific area that benefits from the county's beaches and the long-term maintenance of the resource. The district would have the authority to generate revenue through a specific activity-related tax and be responsible for the administration of the program and related projects.

11.3.7. Bonds

Flagler County and/or the local shorefront communities could also consider the sale of bonds or other long-term financial instruments to cover periodic capital costs associated with commitments for beach restoration and management. This is a common practice for coastal communities throughout Florida and elsewhere. In most instances, the cost to maintain the beach is considered equivalent to expenses associated with any other critical infrastructure for which the community must invest in for community benefit.

Bonds and loans can also be used to cover the costs of each project related activity, such as a large-scale dredging project when a contract requires a large amount of money be available over a short period of time. An established long-term dedicated fund source would be used to as collateral for the loan and the loan payments. This approach is common for communities pursing periodic large-scale infrastructure improvement projects.

11.4. Other Potential Sources of Funding/Cost-Sharing

11.4.1. FEMA Post-Disaster Public Assistance Funding

Once a beach management program is established and projects are constructed, FEMA post-disaster public assistance funding will be available to restore damaged project features following a declare Federal disaster; most commonly a hurricane or tropical storm. The FEMA post-disaster assistance, however, is only available for those areas of a project that were constructed and maintained with non-federal funds. That is, areas of the beach and dune constructed and maintained through a USACE CSRM project will not be eligible for FEMA post-disaster assistance.

The mission of the Federal Emergency Management Agency's (FEMA's) Public Assistance (PA) Program is to provide assistance to state, local, and certain type of private nonprofit (PNP) organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President of the United States. Through the PA Program, FEMA provides supplemental Federal grant assistance for debris removal, emergency protective measures, and the restoration of disaster-damaged, publicly owned facilities and specific facilities of certain PNP organizations. "Facilities" are community infrastructure that have been constructed and maintained with non-federal funding. Those areas of a beach and dune that are appropriately engineered and constructed with non-federal funding by Flagler County would be consider a facility under the FEMA definition. The PA Program also encourages protection of damaged facilities from future incidents by providing assistance for hazard mitigation measures. However, FEMA does not consider advance sand fill placement in the beach or dune as mitigation for protection of a beach and dune facility. FEMA provides this assistance based on authority in statutes, executive orders (EOs), regulations, and policies.

Publicly-owned *engineered* beaches and dunes constructed by non-federal public entities are eligible for assistance because they are improved natural features, assuming they have been regularly maintained and monitored prior to the disaster. There are two types of post-disaster funding assistance available through FEMA to address impacts to the beach and dune; Category B and Category G.

Category B reimbursement is intended for emergency measures and does not require the local government to first have a project in place. If there is a declared storm event, the local sponsor can acquire a Project Worksheet (PW) to ensure reimbursement, and subsequently place up to 6 cy/ft to build an emergency berm to protect upland properties. The County has the opportunity to build a berm along both public and private properties under the same project. The 6 cy/ft is intended to provide protection from a storm with a return interval of 5-years (Hallermeier and Rhodes, 1988). The cost to construct the 6 cy/ft project is typically reimbursed 75% by FEMA, and in Florida another 12.5% by FL

Division of Emergency Management (FLDEM). The final 12.5% remains the responsibility the local sponsor. However, depending on the magnitude of the storm and storm-related damages, FEMA may reimburse more than 75%, as was the case for Hurricane Irma in 2017 upon which FEMA covered 90% of project damages in Florida.

Category G reimbursement is intended for storm-related damages to engineered, construction and maintained facilities. In the event of a damages to the beach and dune due to a declared disaster, FEMA will share in the cost (75%) to restore store related damages. To be eligible, the project sponsor must document the damages through surveys and appropriate documentation.

11.4.2. Public Law 84-99, Emergency Response to Natural Disasters

For areas of the beach and dune that are part of an authorized Federal project and constructed by the USACE, storm related damages will be repaired a 100% Federal expense under Public Law 84-99 authority. This PL grants the USACE basic authority to provide emergency activities in support of state and local governments prior to, during, and after a storm event. Funding for this work is provided through Flood Control and Coastal Emergencies (FCCE) program emergency appropriations that are specific to individual storm events and disasters. Under PL 84-99, the Corps can provide both emergency technical and direct assistance in response to floods and coastal storms, such as hurricanes and nor'easters. The assistance must be requested by the state, or local sponsor, and it must be supplemental to state and local actions including resources and capabilities.

In Flagler County, storm related damages to any area of dune and beach constructed as part of a CSRM project will be eligible for PL 84-99 emergency response funding at 100% federal expense.

12.0 IMPLEMENTATION

This section of the report summarizes issues and tasks that should be considered and prioritized for the implementation of a Flagler County beach management program. This summary should not, however, be viewed as inclusive of all tasks that may be required to implement a management plan. The initial tasks include, but may not be limited to, the following,

1. establish a beach management program with governance and administrative structure;
2. identify and establish a local funding source;
3. survey the physical extent and habitat conditions of coquina rock outcroppings along the beach and nearshore;
4. assess feasibility of various sand delivery methods and implications for nearshore resources;
5. initiate detailed design investigation of a selected plan;
6. expand the limits of the permitted offshore borrow area;
7. seek regulatory permits for a selected plan and expanded borrow area;
8. seek long-term easements along the entire 18 miles of county shoreline;
9. seek expansion of shoreline length that is designated as critically eroded by FDEP;
10. consider the efforts and benefits associated with a new USACE feasibility study that may increase the length of shoreline eligible for Federal cost-sharing; and
11. conduct county-wide public beach access and parking inventory.

Details regarding each of these activities are provided below.

12.1. Beach Management Program Governance

In order to restore and maintain beach and dune conditions along the entire Flagler County shoreline, a common administrative lead for the overall program should be considered. In many instances in the State of Florida, the county serves as the local government administrative head and local sponsor for the local beach management program. There are administrative, physical, and financial benefits to the county government assuming this role. These include, but are not limited to: (1) management of a community-wide program with a common goal; (2) development of a comprehensive plan for the entire shoreline, rather than piecemeal programs that may not have common objectives; and (3) contracting representation with cost-sharing government agencies (i.e., USACE, FDEP, FEMA, etc.) that is not available for non-governmental interests.

Once established as the program administrative lead, Flagler County would seek to acquire Interlocal Agreements (ILA), Memorandums of Agreements (MOA), or other arrangements to establish the administrative and funding responsibilities for the individual stakeholders. Funding responsibilities may vary depending upon benefits provided and access to other cost-sharing opportunities for the various reaches of county shoreline. That is, it is not expected that all areas of the county will be eligible for equivalent cost-sharing opportunities because of varying availability of beach access, parking, and development conditions. Establishing the governing agreements among all stakeholders will be an essential task to initiate and implement a successful beach management program.

It is recommended that Flagler County should consider assuming governance over all 18 miles of shoreline and assume the position as Local Sponsor and administrative head for all beach management activities in Flagler County.

12.2. Local Funding Source

To implement a comprehensive beach management program and leverage available USACE and FDEP funding, Flagler County and local stakeholders will be responsible for contributing local funds to a portion of the total program cost. The amount required from the local community will be dependent upon the total program cost and the amount of funding that will be available from the available cost-sharing agencies. The amount of funding available from the USACE and FDEP will be subject to compliance with eligibility criteria established by each respective agency.

Establishing a local funding program and developing the method for allocating stakeholder responsibilities and collecting funds will be an essential critical beach management program task.

Given that Flagler County does not have a current funding plan, it is recommended that the County consider commissioning a funding study to evaluate community interest in establishing both a local funding source and the method of revenue collection from participating stakeholders. The funding study should include coordination with County staff to understand program goals and limitations; study of community interest in funding a beach management program; delineation of boundaries of potential participating stakeholders; identification of possible, appropriate funding approaches; and formulating funding assessment methodology. The study and associated findings will allow the County to better define the future goals of the county communities for beach management. The County may also want to consider the establishment of a community stakeholder committee to participate in discussions and represent the interest of the various stakeholder groups.

12.3. Beach and Nearshore Coquina Rock Mapping

The coquina rock hardbottom in Flagler County is a unique natural resource and is most prevalent from R-2.3 through R-13.8 (both on the beach and in the nearshore) and from about R-13.8 to about R-43.5 (in the nearshore only). This area represents about 7.6 miles of shoreline, or about 42% of the Flagler County Atlantic coastline. As discussed previously, the coquina rock hardbottom is protected habitat for Federally listed species under the Endangered Species Act as it is foraging habitat for juvenile green sea turtles. The habitat is also considered Essential Fish Habitat (EFH) and protected under the Federal Magnuson-Stevens Fishery Conservation and Management Act. The State of Florida considers nearshore rock a protected resource that occupies submerged sovereign lands of the State and regulates activities that could potentially impact the resource.

Hardbottom resources adjacent to beach and dune projects can be impacted by the activity through (1) direct burial during sand placement, (2) indirect, or gradual burial, through beach and dune equilibration, (3) indirect sedimentation and turbidity due to dredge discharge or sand placement in the water, and (4) direct pipeline placement. Any impact to hardbottom will only be allowed if the impacts are justified and minimized to the greatest extent practicable. And, any impact to hardbottom will require mitigation. Probable mitigation action for hardbottom impacts in Flagler County will likely consist of artificial reef modules that replicate the physical properties and ecological services of the nearshore coquina rock.

An understanding of the natural dynamics of the nearshore rock and sediment will be important to future Flagler County beach management. Equally important will be to coordinate with the resource agencies to formulate management and permit conditions that incorporate the consideration of natural variability in the location of the nearshore hardbottom edge with and without project conditions. <u>Prior to development of a detailed project plan, it is recommended that high-resolution mapping of the rock be conducted by the County to quantify the rock location, limits, and variability.</u> This will allow for a more specific estimate of what the project-related impacts may be and will guide more specific project planning. An accurate assessment of the variability may require more than one survey. Documentation of the location and extent of the rock as well as the natural variability will be critical in attaining regulatory approval a beach and dune project. This survey will be needed even if a proposed plan it not intended to impact the rock. <u>Additionally, it is recommended that the County limit the extent of potential project-related impacts to hardbottom.</u> This will reduce overall project and regulatory complexities and reduce project cost.

12.4. Sand Delivery and Placement Methods

Sand from both offshore and upland mines should be considered for placement along the Flagler County shoreline. Sand from offshore would be excavated from offshore borrow area(s) and delivered to a nearshore location by hopper dredge. Material within the dredge would then be fluidized and transported hydraulically (i.e., as a mixture of sand and water) to the beach through a pipeline. The pipeline between the dredge pumpout area and the beach would be placed within pipeline corridors that have been found to be clear of benthic resources and permitted for use. This method of sand delivery and placement is most applicable for regions of Flagler County where nearshore rock and hardbottom do not exist (R-43.5 to R-101). The potential impacts to hardbottom from dredged material include direct burial from sand placement, indirect effects due to turbidity and sedimentation from hydraulic effluent, and direct burial from pipeline deployments. Indirect burial of hardbottom from beach fill equilibration is independent of sand placement method.

Dredged sediment can also be pumped by pipeline onto the beach at designated locations into stockpiles, and subsequently loaded and transported mechanically by offroad trucks along the beach. An example of a sand stockpile constructed by dredge in Brevard County, FL is shown in **Figure 12.1**. However, mechanical placement and distribution of stockpiled sand is much less efficient than direct hydraulic placement. The dredge has to first pump sand into stockpiles and then that sand has to be rehandled, i.e., loaded into off-road trucks, to be transported to its final destination. The dredge contractor will make up for the decreased productivity by increasing the price of the sand.

Additionally, there are physical restrictions associated with stockpile construction from dredged material. Sufficient beach width is required for the construction and utilization of a stockpile. The footprint of a stockpile is limited at the landward edge by existing vegetation and development, and at the seaward edge by wave uprush and hardbottom resources. The height of a stockpile is limited by the ability for mechanical equipment to pile the sand and by accessibility for mechanical equipment to then load and transport the sand away from the stockpile.

This sand delivery method may be utilized to potentially eliminate impacts associated with direct hydraulic sand placement in areas where hardbottom is present. Potential stockpile locations should be limited to areas with a low presence of nearshore coquina rock, since sand to construct stockpiles would be transported to the beach through pipeline. If sand stockpiles are to be constructed north of R-43.5, where beach and nearshore rock are common, the detailed coquina rock mapping survey (**Section 12.3**) should be used to inform stockpile placement locations. Locations where nearshore rock is limited or of poor quality should be targeted in order to reduce impacts to resources and thus associated mitigation requirements. It is expected that multiple stockpiles will be required to distribute offshore sand along the northern ~8 miles of county shoreline. Otherwise, the alongshore distances to mechanically transport sand south of R-43.5 to the northernmost county shoreline will be too great to make such an approach cost effective.

Figure 12.1: Construction of the stockpile in 2021 along the Mid-Reach in Brevard County, FL to avoid nearshore rock.

A multitude of upland, beach-compatible commercial sand mines exist within ~120 miles (~2 hours) of the Flagler County shoreline (**Figure 7.7**). An upland sand-sourced project would involve transporting sand from upland mines to the beach by highway trucks. With this method, sand would be delivered to the beach by highway trucks through various staging and access sites along the shoreline. The sand is then transferred to offroad trucks for final delivery to a location along the project beach.

Sand delivered from upland sources is more controlled than hydraulically-placed sand and therefore can reduce or eliminate potential impacts to hardbottom resources when present. Truckhaul projects also eliminate the need to deploy pipelines across hardbottom areas to facilitate the delivery of sand from the dredge to the beach. However, upland sand purchased from commercial mines is expensive, in part due to transportation costs. Additionally, sand placement rates are much lower compared to offshore sources.

Truckhaul projects delivering upland sand are most applicable for regions of Flagler County with the presence of nearshore hardbottom (R-2.3 to R-43.5). Specific staging and access locations that may be used for truckhaul construction access are:

- An access path south of River to Sea Preserve; R-4.2,
- Washington Oaks SP; R-14.5,
- MalaCompra Park; R-22,
- Jungle Hut Road Park; R-35, and
- Varn Park; R-49.

12.5. Design Investigation

If the County agrees to pursue a comprehensive program and identifies a preferred project plan, it is recommended that a detailed design investigation be conducted to develop a more specific project scope. This effort should consider desired project performance and anticipated sand source characteristics. The investigation will seek to identify and verify required beach and dune dimensions as well and the sand source to meet project goals. The design details resulting from this investigation will be sufficient to describe the project scope in required permit applications. This effort can be conducted simultaneously with efforts to established a project funding program.

12.6. Offshore Sand Source

The only verified and permitted offshore sand source currently available for placement along the southern portion of the county shoreline is located about 11 nautical miles offshore of central Flagler County. This sand source is specifically allocated for use for the Federal Flagler County CSRM Project (R-80 to R-94) and the Flagler County/FDOT Beach/Dune Restoration Project (R-70 to R-80 and R-94 to R-101). An estimated 6.8 million cubic yards (Mcy) of beach compatible sand is contained within the two permitted areas.

For an expanded project and accommodation of 50-years of maintenance along the entire Flagler County shoreline, additional suitable sand will need to be verified and permitted. As discussed in *Section 7.2.3*, it is estimated that there may be as much as 8.0 Mcy of sand within Area 3A (identified in USACE, 2015b) that has not already been delineated and permitted. Moreover, there is likely an even larger volume of sand available beyond the limits of Area 3A (see **Figure 7.6** in *Section 7.2.3*). Although surveys suggest that a sufficient quantity of additional sand exists, the quality of this resource must be confirmed.

Since Area 3A is located in Federal waters on the Outer Continental Shelf (OCS), authorization from the Bureau of Ocean Energy Management (BOEM) is required to collect geophysical (hydrographic, seismic subbottom, side-scan) and geotechnical (vibracore) data within this area. For Area 3A, multibeam bathymetric and geophysical data already exist. To delineate additional borrow areas within this area, only additional vibracores will need to be collected. Thereafter, information from these cores will be available to support follow-on geotechnical analyses, design, permitting, and BOEM lease agreement development and execution. Should exploration expand beyond Area 3A, geophysical and geotechnical data will need to be collected and further BOEM authorizations required.

Given the expected scope of a beach and dune restoration and maintenance project along the 18 miles of Flagler County shoreline, Area 3A and the surrounding area is likely a reliable source to meet the county's long-term objectives. It is recommended that priority be given to acquiring additional geotechnical data in Area 3A to support design and permitting of future sand borrow areas. It is noted that additional environmental analyses and documentation will also be required to support permitting additional excavation in Area 3A.

12.7. Permitting

Additional State and Federal permits are required to implement a comprehensive beach management program along the entire 18 miles of Flagler County shoreline. Presently, there are four existing permitted projects that provide for sand placement along portions of the Flagler County shoreline. A complete listing of current permits is provided in **Section 2.6**.

The current authorizations, permits and BOEM lease agreements for the Federal and Local projects are adequate for placing beach fill both above and below the MHWL along a continuous ~6.5 miles of shoreline from R-64.5 to R-101. State permits for this area will need to be renewed every 15 years. Additionally, the USACE permit for the Local project has a 15-year life.

The two applicable permits that allow sand placement north of R-64.5 are limited to placing sand above the MHWL and are therefore not adequate for future beach fill projects. These permits also only provide for placement of sand from upland mines.

New USACE and FDEP permits will be required to extend a larger project north of R-64.5 and expand the offshore borrow area beyond currently permitted limits. Additionally, an expansion of the offshore sand borrow area in Federal waters will required a new BOEM lease agreement. Applications for regulatory permits to support a county-wide project can be initiated as soon as a preferred plan is selected and more detailed design for the beach and dune and borrow area is completed.

12.8. Easements

Prior to implementation of the currently planned and permitted Federal and Local projects, easements to build and maintain the beach and dune need to be secured for the entire shoreline between R-64.5 and R-101 (Volusia County line) [7]. The easements are related to that area of the beach between a seawall, revetment, or established vegetation

7 The northern limit of construction for the presently planned Local Project is R-70, though the associated permits for the project allow for placement to R-64.5.

line (toe of dune) and the Erosion Control Line (ECL) or the MHWL. The easements along the Federal CSRM project (R-80 to R-94) will be Federal perpetual Storm Damage Reduction Easements (SDREs). These easements provide for temporary construction access to construct and maintain the project, and perpetual public access to the portion of the private parcel upon which the Federal project is located. The Local (non-federal) project easements allow for access to the private area of the beach for sand placement during initial construction and future maintenance events. The Local project easements do not include the public access provision included in the Federal SRDEs.

Future expansion of the managed beach along Flagler County will require easements north of R-64.5. It is anticipated that easements similar to those acquired for the Local (non-federal) project will be appropriate. If the Federal CSRM project is expanded, additional Federal SDREs would be required in that area.

12.9. Length of Critically Eroded Shoreline (FDEP)

As discussed previously, FDEP funding assistance is only available for those areas of shoreline in the State of Florida that are designated as critically eroded by the state. Presently 8.1 miles, or 45%, of the Flagler County shoreline is designated as Critically Eroded. As such, beach management activities only along 45% of the county shoreline are eligible for FDEP cost-share assistance.

FDEP maintains a current database of those areas of the state's shoreline that qualify as critically eroded. Moreover, as beach conditions change due to storms and at the request of coastal communities, FDEP will evaluate additional areas that may become critically eroded. These updates are performed annually. Review of the Flagler County shoreline in 2022 concluded that there are no additional reaches of the county shoreline that are currently eligible to be designated as critically eroded (FDEP, 2022).

<u>It is recommended that Flagler County continue to monitor beach and dune conditions and communicate any significant changes that occur to FDEP.</u> Additionally, development of a comprehensive beach management plan that includes restoration and maintenance of the beach and dune along all 18 miles of county shoreline may encourage FDEP to consider expanding the designated critically eroded shoreline length for 'continuity of management'. That is, FDEP has the authority to incorporate areas of the shoreline where sand placement will occur between two adjacent areas of critically eroded shoreline. In Flagler County, the most obvious location where this may be considered is between R-57 and R-65.2. This ~1.5-mile segment of shoreline exists between presently designated critically eroded segments of shoreline. Adding this segment of shoreline would result in a total of ~9.6 miles (about 53% of the total shoreline) of designated critically eroded shoreline in Flagler County.

12.10. Coastal Storm Risk Management Project Expansion

In 2015, the USACE completed a feasibility study for the of the entire 18 miles of Flagler County coastline to determine the potential feasibility of a CSRM project along any section of the county's Atlantic shoreline. From the conditions of the beach and dune, access and parking, and development that existed at that time, the study concluded that only the reach of shoreline between R-80 and R-94 -- about 2.6 miles in length, or about 14 percent of the Flagler County shoreline -- was eligible for a CSRM project and the associated Federal cost-sharing. This project has a 50-year authorization under the Water Infrastructure Improvements for the Nation Act of 2016 and is eligible for Federal cost-sharing of all project related expenses for up to 65% for initial construction and 50% for future maintenance for the 50-year period. If the project is constructed in 2022, the authorization will last through 2072.

Since completion of the 2015 study, there have been significant changes to the Flagler County shorefront, particularly to the beach and dune. Hurricanes Matthew, Irma, and Dorian have caused large sand losses from areas of the beach and dune that shifted the primary dune line landward, closer to development in some areas, and lowered the dune crest elevation. Likewise, the available sand volume within the active beach profile decreased which reduces the protective characteristics of the beach itself. Therefore, it is possible that areas of the Flagler County shoreline that were not eligible for a Federal CSRM project in 2014 may now be eligible. The possible location and extent of any additional areas of eligibility cannot be known with certainty without a formal CRSM feasibility study.

A CSRM is a particular USACE Water Resource Project and requires a 3-3-3 SMART (Specific, Measurable, Attainable, Risk Informed, Timely) Feasibility study with 50% local match for the $3M study cost, or $1.5M. The study involves four steps: Scoping, Alternative Evaluation and Analysis, Feasibility-Level Analysis, and Chief's Report development. The 3-3-3 Feasibility study takes 3 years to complete at the cost of $3M, and includes three levels of the Corps engagement (District, Division, and Headquarters) throughout the study (USACE, 2015a).

If initiated, the new Feasibility Study would assess the existing conditions and eligibility for federal participation along any requested reach of the Local Sponsor's (Flagler County's) shoreline. In addition to an assessment of adequate public parking and access (**Section 12.11**), a new study would include the numerical modeling of future damages/erosion rates using past storms, but would now also include the effects of recent hurricanes that have occurred since the 2015 feasibility study (USACE, 2015b). Therefore, a new benefit-cost analysis could allow previously economically unjustified reaches of shoreline (where the benefits did not exceed costs) to be reconsidered for Federal participation. If the study identifies additional shoreline segments that are eligible, a federal project may be authorized. However, authorization does not guarantee financial appropriations.

It is recommended that Flagler County carefully consider potential benefits and outcomes from a new CSRM investigation. The cost-sharing benefit of the addition of any new eligible areas should be weighed against the cost to the County for the study and the time required to gain authorization and subsequent appropriations.

12.11. Public Access and Parking Assessment

Potential expansion of the USACE CSRM project will be subject, in part, to the availability of public parking and access along the county's shoreline. Review of available public access and parking availability and future opportunities can identify areas of Flagler County that may or may not be eligible for USACE CSRM eligibility and cost-sharing. This information can be used to evaluate the potential benefit of pursing a future USACE CSRM study.

Federal guidelines for beach access and Federal participation in CSRM projects are published in USACE Engineering Regulations ER 1105-2-100 (USACE, 2000), as excerpted below.

E-24 (pg. E-133)

d. Public Use and its Relation to Federal Participation. Federal involvement in shore protection developed historically in a beach context, generally with efforts to stabilize, create or restore beaches. It was intended that beaches receiving public aid should not provide exclusively private benefits, and therefore, whenever a hurricane and storm damage reduction project involves beach improvements, real estate interest to ensure public use of the Federal project is required. (See Table E-22 – Fed. Participation.) Items related to public access are discussed below.

(1) User Fees. Reasonable beach recreation use fees used to offset the local share of project costs are allowable.

(2) Parking. Lack of sufficient parking facilities for the general public (including nonresident users) located reasonably near and accessible to the project beaches may constitute a restriction on public access and use, thereby precluding eligibility for Corps participation. Generally, parking on free or reasonable terms should be available within a reasonable walking distance of the beach. The amount of parking should be consistent with the attendance used in benefit evaluation. In some instances, non-Federal plans may encourage or direct substitution of public transportation access for private automobile access. Reports considering public transportation must indicate how the public transportation system would be adequate for the needs of projected beach users.

(3) Access. Provision of reasonable public access rights of way, consistent with attendance used in benefit evaluation is a condition of Corps participation. Reasonable access is access approximately every one-half mile or less.

(4) Beach Use by Private Organizations. Federal aid to private shores owned by beach clubs and hotels which limit beach use to members or guests is contrary to the intent

of Public Law 84-826.

(5) Public Shores with Limitations. Publicly owned beaches, which limit use to residents of the community or a group of communities, are not considered to be open to the general public and are treated as private beaches.

Additional but similar information is provided by the USACE in ER 1165-2-130 (USACE, 1989):

6. Program Policies (Shore Protection)

h. Public Use (pg12). Public use is a condition for Federal participation in hurricane, abnormal tidal or lake flood protection projects. Current shore erosion control law provides that "Shores other than public (i.e., privately owned) will be eligible for Federal assistance if there is a benefit such as that arising from public use..." In the case of beaches used for recreation, public use means use by all on equal terms. This means that project beaches will not be limited to a segment of the public. Unless the protection of privately-owned beaches is incidental to protection of public beaches (paragraph 9), they must be open to all visitors regardless of origin or home area, or provide protection to nearby public property to be eligible for Federal assistance. Items affecting public use are discussed below.

(1) User Fees. A reasonable beach fee, uniformly applied to all, for use in recovery of the local share of project costs is allowable. Normal charges made by concessionaires and municipalities for use of facilities such as bridges, parking areas, bathhouses, and umbrellas are not construed as a charge for the use of the Federal beach project, if they are commensurate with the value of the service they provide and return only a reasonable profit. Fees for such services must be applied uniformly to all concerned and not as a prerequisite to beach use.

(2) Parking. Lack of sufficient parking facilities for the general public (including non-resident users) located reasonably nearby, and with reasonable public access to the project, will constitute de facto restriction on public use, thereby precluding eligibility for Federal participation. Generally, parking on free or reasonable terms should be available within a reasonable walking distance of the beach. Street parking is not considered acceptable in lieu of parking lots unless curbside capacity will accommodate the projected use demands. Parking should be sufficient to accommodate the lesser of the peak hour demand or the beach capacity. In some instances, State and local plans may call for a reduction in automobile pollutants by encouraging public transportation. Thus, public transportation facilities may substitute for or complement parking facilities. However, reports which consider public transportation in this manner must indicate how the public transportation system would be adequate for the needs of projected beach users. In computing the public parking accommodations required, the beach users not requiring parking should be deducted from the design figure.

(3) Access. Reasonable public access must be provided in accordance with the recreational use objectives of the particular area. However, public use is construed to be effectively limited to within one-quarter mile from available points of public access to any particular shore. In the event public access points are not within one-half mile of each other, either an item of local cooperation specifying such a requirement and public use throughout the project life must be included in project recommendations or the cost sharing must be based on private use.

(4) Beach Use by Private Organizations. Federal participation in private shores owned

by beach clubs and hotels is incompatible with the intent of the P.L. 84-826 if the beaches are limited to use by members or paying guests.

(5) Public Shores with Limitations. Publicly-owned beaches which are limited to use by residents of the community or a group of communities are not considered to be open to the general public and will be treated as private beaches.

Although having adequate public access is a requirement, it does not automatically qualify a beach segment for Federal participation and cost-sharing in a CSRM project. The Federal guidance clearly indicates that acceptable beach access rights of way should be located within ½-mile of one other to provide contiguous beach accessibility alongshore. At each access point, the minimum level of publicly available parking (e.g., number of spaces) within a reasonable walking distance would be based upon a projection of the volume of beach users at the lesser of peak hour demand or the beach capacity (assumed to lie within ¼-mile of the access in both directions). Consistent with the ½-mile requirement, a reasonable walking distance from parking to the access point is thus projected to be ¼-mile.

Public transportation can be included in the public access assessment, but stops must be within ¼-mile of an access point. Regarding the frequency of service[8], no specific guidance is provided, as the Federal regulations defer to the projected beach use, which would be determined through a study.

<u>Prior to a decision by the County to pursue a new CSRM study, it is recommended that a parking and access investigation be conducted.</u> A beach access and parking assessment can serve and a preliminary, low-cost assessment for CSRM eligibility as well as be informative for the local communities to consider implementing potential enhancements to public parking and access to become eligible. The results from this screening level investigation can assist the County and USACE to evaluate the potential benefits and focus the scope of a new Feasibility Study before making a financial commitment.

<u>To increase potential eligibility, Flagler County and local stakeholders may need to consider the creation of new beach access areas with parking.</u> The lack of public parking prevented some areas, specifically Painters Hill, from being consider during the 2015 study.

8 The FDEP Beach Management Funding Assistance Program requires that qualifying mass transit must be available to the general public and must operate year-round (Chapter 62B-36.007(1)(c)3 Florida Administrative Code).

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