# *Sebastian Inlet Management Plan*

## Office of Resilience and Coastal Protection

## Florida Department of Environmental Protection

**November 2023**

# Final Order Adopting
# Sebastian Inlet Management Plan

WHEREAS, pursuant to Section 161.161, Florida Statutes, the Florida Department of Environmental Protection shall "evaluate each improved, modified or altered inlet and determine whether the inlet is a significant cause of beach erosion. With respect to each inlet determined to be a significant cause of beach erosion, the plan shall include the extent to which such inlet causes beach erosion and recommendations to mitigate the erosive impact of the inlet, including, but not limited to, inlet sediment bypassing; improvement of infrastructure to facilitate sand bypassing; modifications to channel dredging, jetty design and disposal of spoil material; establishment of feeder beaches; and beach restoration and beach nourishment."

WHEREAS on March 16, 2000, the department adopted the Sebastian Inlet Management Study Implementation Plan, which contained corrective measures to mitigate the identified impacts of the inlet; and

WHEREAS in 2008, the Florida Legislature amended Section 161.142, Florida Statutes, finding, "The Legislature recognizes the need for maintaining navigation inlets to promote commercial and recreational uses of our coastal waters and their resources. The Legislature further recognizes that inlets interrupt or alter the natural drift of beach-quality sand resources, which often results in these sand resources being deposited in nearshore areas or in the inlet channel, or in the inland waterway adjacent to the inlet, instead of providing natural nourishment to the adjacent eroding beaches. Accordingly, the Legislature finds it is in the public interest to replicate the natural drift of sand which is interrupted or altered by inlets to be replaced and for each level of government to undertake all reasonable efforts to maximize inlet sand bypassing to ensure that beach-quality sand is placed on adjacent eroding beaches. Such activities cannot make up for the historical sand deficits caused by inlets but shall be designed to balance the sediment budget of the inlet and adjacent beaches and extend the life of proximate beach restoration projects so that periodic nourishment is needed less frequently;" and

WHEREAS in 2022-23, the department and the Sebastian Inlet District sponsored an inlet management study of Sebastian Inlet based upon the State of the Inlet Report (2021), which

compiled new survey data and information regarding its coastal processes and inlet and shoreline dynamics and updated its sediment budget; and

WHEREAS, in November 2023, the department finalized the development of an updated inlet management plan that contains corrective measures to mitigate the identified inlet erosion impacts to adjacent beaches; and

WHEREAS the Sebastian Inlet District is responsible for dredging and sand bypassing at Sebastian Inlet and, therefore, responsible for implementation of the inlet management plan; and

WHEREAS this inlet management plan (attached) is consistent with the department's program objectives under Chapter 161, Florida Statutes,

**THEREFORE:**

The department does hereby adopt the following updated implementation strategies, as set forth in the attached **Sebastian Inlet Management Plan**. Future inlet management activities conducted by the Sebastian Inlet District shall be consistent with the following five strategies:

1.) **A comprehensive beach and inlet hydrographic monitoring program** shall be conducted to evaluate the performance and impact of existing sand bypassing and nourishment projects and to periodically update the inlet sediment budget. Beach and nearshore surveys between FDEP Range/Reference Monuments R-179 (Brevard County) to R-30 (Indian River County) shall be conducted. Periodic inlet hydrographic surveys to include the inlet channel, the sand trap, and the ebb and flood shoals in their entirety should be conducted. Along with topographic and hydrographic surveys of the inlet system and adjoining beaches, hydraulic monitoring may be conducted to enhance future modeling input data for investigations of inlet management alternatives.

2.) **Sand bypassing shall be performed from the inlet system to the adjacent Atlantic-fronting beaches to the south of the inlet between the south jetty near FDEP Range/Reference Monuments R-1 and R-30.** The quantity of material to be bypassed shall be based on available inlet reservoir quantities documented through the monitoring protocol of Strategy #1 above.

3.) **On an average annual basis, the initial target inlet sand bypassing quantity shall be 75,000 cubic yards per year to the south.** This target quantity may be modified or updated based on a minimum of four years of additional monitoring data indicating a change in the sediment budget. However, the sediment budget should cover a period of at least 10 years.

4.) **The source of sediment for meeting the target sand bypassing quantities in Strategy # 3 may be the Sebastian Inlet sand trap and channel, or as otherwise authorized by permit. The inlet channel and sand trap shall be prioritized for a portion of the bypass material, but other alternatives may be considered for further geotechnical and engineering design and permitting and implementation to develop an environmentally acceptable project with suitable quality sediment.** Acceptable beach quality sand may also be obtained from the inlet's tidal pool, upland sand mines or offshore sources to achieve the target sand bypassing quantities.

5.) **The north and south jetties, which have been impacted by numerous recent major storms like Hurricanes Sandy, Matthew, Irma, Dorian, Ian, and Nicole as well as numerous northeasters, shall be repaired and maintained.**

Inlet management actions conducted by the Sebastian Inlet District that implement the strategies contained in this plan are subject to further evaluation and subsequent authorization or denial, as part of the department's permitting process. Activities that implement these adopted strategies shall be eligible for state financial participation pursuant to Section 161.143, Florida Statutes, subject to department approval of a funding request and an appropriation from the Florida Legislature. The level of state funding shall be determined based on the activity being conducted and the department's rules. The department may choose not to participate financially if the proposed method of implementation is not cost effective or fails to meet the intent of Section 161.142, Florida Statutes, and this final order. Activities ineligible for cost sharing include, but are not limited to navigational construction, operation, and maintenance activities, except those elements whose purpose is to place or keep sand on adjacent beaches. Nothing in this plan precludes the evaluation and potential adoption of other strategies for the effective management of Sebastian Inlet and the adjacent beaches.

# Approval of Adoption

Alex Reed

Director of the Office of Resilience and Coastal Protection

Florida Department of Environmental Protection

# Filing and Acknowledgement

FILED, on this date with the designated Deputy Clerk, pursuant to

Section 120.52, F.S., receipt of which is hereby acknowledged.

Deputy Clerk

11/09/2023

Date

**Electronic Copies Furnished to:**

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# Notice of Rights

This action is final and effective on the date filed with the clerk of the department unless a petition for an administrative hearing is timely filed under Sections 120.569 and 120.57, F.S., before the deadline for filing a petition. On the filing of a timely and sufficient petition, this action will not be final and effective until further order of the department. Because the administrative hearing process is designed to formulate final agency action, the hearing process may result in a modification of the agency action or even denial of the request for a variance or waiver.

Petition for Administrative Hearing

A person whose substantial interests are affected by the department's action may petition for an administrative proceeding (hearing) under Sections 120.569 and 120.57, F.S. Pursuant to Rule 28-106.201, F.A.C., a petition for an administrative hearing must contain the following information:

(a) The name and address of each agency affected and each agency's file or identification number, if known;

(b) The name, address, telephone number and any e-mail address of the petitioner; the name, address, telephone number and any email address of the petitioner's representative, if any, which shall be the address for service purposes during the course of the proceeding; and an explanation of how the petitioner's substantial interests are or will be affected by the agency determination;

(c) A statement of when and how the petitioner received notice of the agency decision;

(d) A statement of all disputed issues of material fact. If there are none, the petition must so indicate;

(e) A concise statement of the ultimate facts alleged, including the specific facts that the petitioner contends warrant reversal or modification of the agency's proposed action;

(f) A statement of the specific rules or statutes that the petitioner contends require reversal or modification of the agency's proposed action, including an explanation of how the alleged facts relate to the specific rules or statutes; and

(g) A statement of the relief sought by the petitioner, stating precisely the action that the petitioner wishes the agency to take with respect to the agency's proposed action.

The petition must be filed (received by the clerk) in the Office of General Counsel of the department at 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida 32399-3000. Also, a copy of the petition shall be mailed to the applicant at the address indicated above at the time of filing.

Time Period for Filing a Petition

In accordance with Rule 62-110.106(3), F.A.C., petitions for an administrative hearing must be filed within 21 days of receipt of this written notice. The failure to file a petition within the appropriate time period shall constitute a waiver of that person's right to request an administrative determination (hearing) under Sections 120.569 and 120.57, F.S., or to intervene in this proceeding and participate as a party to it. Any subsequent intervention (in a proceeding initiated by another party) will be only at the discretion of the presiding officer upon the filing of a motion in compliance with Rule 28-106.205, F.A.C.

Extension of Time

Under Rule 62-110.106(4), F.A.C., a person whose substantial interests are affected by the department's action may also request an extension of time to file a petition for an administrative hearing. The department may, for good cause shown, grant the request for an extension of time. Requests for extension of time must be filed with the Office of General Counsel of the department at 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, FL 32399-3000, before the applicable deadline for filing a petition for an administrative hearing. A timely request for extension of time shall toll the running of the time period for filing a petition until the request is acted upon.

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**Figure 1.** Sebastian Inlet on the east coast of Florida. Photo taken by Atlantic Photo Technologies in 2006 & courtesy of the District.

## *Introduction*

Pursuant to Subsection 161.101(2), Florida Statutes, the Florida Department of Environmental Protection (Department or FDEP) is the beach and shore preservation authority for the State of Florida. As part of the Department's statewide beach management plan adopted pursuant to Section 161.161, Florida Statutes, the Department is adopting this inlet management plan for Sebastian Inlet (**Figure 1**) in Brevard and Indian River Counties, Florida (**Figure 2**). *Sebastian Inlet Management Plan* updates strategies for Sebastian Inlet that were adopted in the *Sebastian Inlet Management Implementation Plan* (FDEP, 2000) to be consistent with current statutes and observed erosion[1] conditions. In 2008, the *Strategic Beach Management Plan* (FDEP, 2008) called for bypassing suitable sediment to the beaches south of the inlet from dredging the inlet sand trap and from alternative sources as needed to meet or exceed an annual bypassing objective of 90,000 cubic yards; maintaining beaches south of the inlet that have been restored; implementing a comprehensive beach and inlet monitoring program; and, based on the data updating the inlet sediment budget and management plan. The Sebastian Inlet District (District) sponsored an updated inlet management study of Sebastian Inlet in 2021 that was performed by the Florida Institute of Technology, Department of Ocean Engineering and Marine Sciences.

[1] As used in this document, the term "erosion" means wearing away of land or the removal of consolidated or unconsolidated material from the coastal system by wind or wave action, storm surge, tidal or littoral currents or surface water runoff. As used in this document, the term "accretion" means the buildup of land or accumulation of unconsolidated material within the coastal system caused by wind and wave action, storm surge, or tidal or littoral currents. The descriptions of coastal processes in this document are not intended to affect title to real property or real property boundaries.

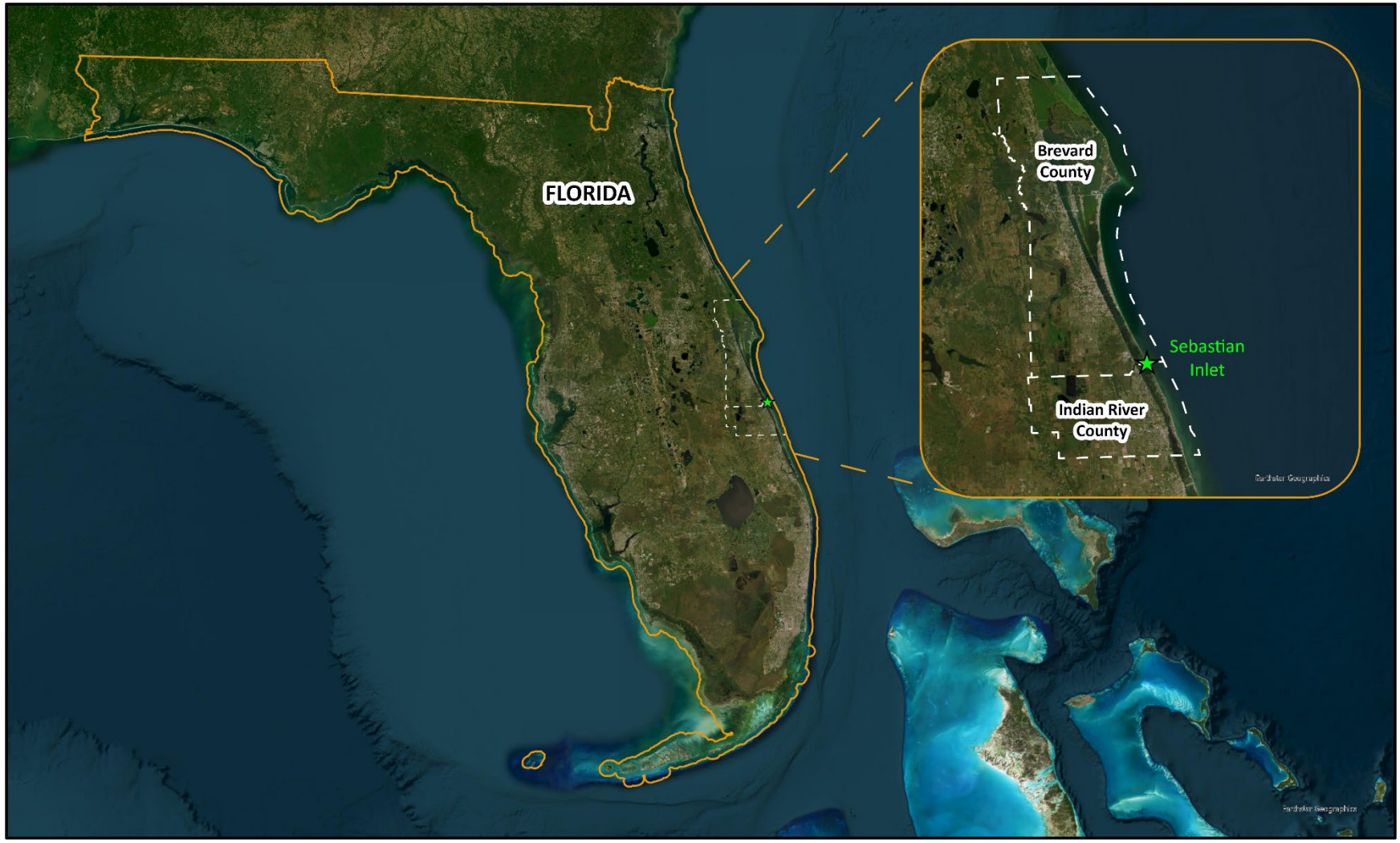


**Figure 2.** Sebastian Inlet along the east of Florida between Brevard County and Indian River County.

## *Program Objectives and Statutory Responsibilities for Inlet Management*

In 2008, the Florida Legislature amended Section 161.142, Florida Statutes, finding,

"The Legislature recognizes the need for maintaining navigation inlets to promote commercial and recreational uses of our coastal waters and their resources. The Legislature further recognizes that inlets interrupt or alter the natural drift of beach-quality sand resources, which often results in these sand resources being deposited in nearshore areas or in the inlet channel, or in the inland waterway adjacent to the inlet, instead of providing natural nourishment to the adjacent eroding beaches. Accordingly, the Legislature finds it is in the public interest to replicate the natural drift of sand which is interrupted or altered by inlets to be replaced and for each level of government to undertake all reasonable efforts to maximize inlet sand bypassing to ensure that beach-quality sand is placed on adjacent eroding beaches. Such activities cannot make up for the historical sand deficits caused by inlets but shall be designed to balance the sediment budget of the inlet and adjacent beaches and extend the life of proximate beach restoration projects so that periodic nourishment is needed less frequently."

Pursuant to Section 161.143, Florida Statutes,

"Studies, projects and activities for the purpose of mitigating the erosive effects of inlets and balancing the sediment budget of the inlet and adjacent beaches must be supported by separately approved inlet management plans or inlet components of the statewide comprehensive beach management plan."

The Sebastian Inlet District has been the entity responsible for dredging Sebastian Inlet and, consequently, mitigating the extent of beach erosion caused by the inlet, as specified in Subsection 161.142 (6), Florida Statutes. The District currently has an active joint coastal permit (JCP) # 0270746-006-JC issued by the Department in 2013 for the purpose of maintenance dredging of the inlet channel and sand trap. The permit expires in 2028.

## *History of Sebastian Inlet*

Sebastian Inlet is located on the county line separating Brevard County and Indian River County on the southeast coast of Florida connecting the Atlantic Ocean with the Indian River lagoon (**Figure 3**). The uplands north and south of Sebastian Inlet comprise the Sebastian Inlet State Park. Sebastian Inlet connects with the Indian River Lagoon, which extends north and south of the inlet. Brevard County beaches extend uninterrupted 64 miles to the north to Port Canaveral and Indian River County/ St. Lucie County beaches extends 29 miles to the south to Ft. Pierce Inlet.


**Figure 3.** Sebastian Inlet along the east coast of Florida (Google Earth image, 2023).

It is important to understand the history of Sebastian Inlet, its evolution and prior inlet management activities, and beach erosion control activities along the adjacent beaches, to gain a perspective on the inlet's dynamics and the need for adaptive inlet management strategies over time. Sebastian Inlet is a man-made cut. The inlet's early history is discussed by Mehta, Adams,

and Jones (1976) and by the Sebastian Inlet District (2019). It is believed that the first unsuccessful attempt to create an inlet took place in 1872 by a local landowner, David Peter Gibson, who with volunteers attempted to excavate a cut by hand with shovels. Another unsuccessful attempt was made by Reverend Thomas New in 1881. Gibson's second attempt in 1886 was not completed but in 1895 another attempt was completed only to quickly close due to a storm. Other unsuccessful attempts were made by shovels between 1896 and 1918. In 1918 a dredged channel was excavated, and two jetties were constructed with local lime rock. The interior channel was protected by a bulkhead of palmetto trunks. The channel was 4 to 5 feet deep and 40 to 50 feet wide, but within hours of its opening, a northeaster caused its closure.

The Sebastian Inlet District was established in 1919 by the Florida Legislature as a special taxing district comprising 381 square miles in Brevard County and 334 square miles in Indian River County. In 1923, with authorization from the War Department (U.S. Army Corps of Engineers) dredging a new inlet channel commenced. A 100-foot wide channel, 6 feet deep, was completed in 1924. Two coquina rock jetties were also constructed 600 feet apart on the ocean side. The north jetty extended 400 feet seaward and was 6 feet high, while the south jetty extended 150 feet seaward and was only 2 feet high.

In 1927, the south jetty was raised to 6 feet and an attempt was made to deepen the channel by blasting the rock formation that had limited the depth of initial dredging. Rock fragments were used to reinforce the jetties and extend them landward. The inlet was surveyed by the U.S. Coast and Geodetic Survey in 1930.

In 1931, a steel sheet-pile bulkhead was constructed along the inlet's south shore extending 1,500 feet west of the south jetty's west end. The design intent of the bulkhead was to regulate flow along the inlet's south shore and direct tidal currents in a manner to cause scour of interior flood shoals. The Corps of Engineers conducted several inlet surveys between 1934 and 1940. In April 1939, the District excavated 72,000 cubic yards for a channel 7 feet deep from the Indian River to within 300 feet of the Atlantic Ocean. The 1940 inlet survey showed the inlet throat cross-section had reduced to 980 square feet below mean low water and had a width of only 75 feet. The inlet closed during northeaster conditions in 1941 and 1942 and remained closed during World War II (**Figure 4)**.


**Figure 4.** Sebastian Inlet closed during World War II [February 1943 aerial photo taken by U.S. Department of Agriculture].

Toward the end of World War II, the U.S. Navy used the inlet for training demolition teams (**Figure 5**). A small channel was opened in 1945, but it closed within hours. In 1947, the District dredged 70,000 cubic yards for a channel 8 feet deep and 100 feet wide at the ocean, but by February 1948, the inlet had closed once again. By October 1948, the inlet was re-opened on a new northeast by southwest alignment (**Figure 6**). Dredging for the new alignment resulted in

the excavation of 166,000 cubic yards of sand and over 6,500 cubic yards of rock. Additional dredging in November and December excavated another 36,000 cubic yards of sand.

**Figure 5.** Work began again in 1947 using US Navy demolitions to open the Sebastian Inlet and closed again but was reopened in late 1948 and has been open ever since (Sebastian Inlet District, 2019).


**Figure 6.** Sebastian Inlet was re-opened in October 1948 on a new northeast by southwest alignment (Sebastian Inlet District, 2019).

Shoaling continued, and by April 1949, the controlling depth was only 0.7 feet. However, a major category three hurricane in August 1949 made landfall in southeast Florida and scoured the channel to a controlling depth of 1.8 feet. Post-hurricane maintenance dredging in 1950 excavated 140,840 cubic yards of sand and over 4,800 cubic yards of rock resulting in a channel 1,650 feet long, 160 feet wide and 8 feet deep. In March 1951, the Indian River lagoon approach to the inlet was dredged by excavating 55,000 cubic yards of sand resulting in a channel 1,900 feet long, 150 feet wide and 9 feet deep. Jetty construction was also conducted, and a new north jetty was completed by September 1952, which extended 100 feet to the southeast and another 200 feet to the east. Following jetty construction, an additional 18,000 cubic yards of sand was dredged.

In 1955, additional jetty construction and maintenance dredging was conducted. 60,000 cubic yards of material was removed creating a controlling depth of 8 feet. The north jetty was extended 75 feet east and another 175 feet southeast. The south jetty was extended 175 feet east. In 1958, maintenance dredging of the channel's river approach excavated 65,000 cubic yards resulting in a depth of 5 feet and a width of 80 feet. In 1959, both jetties were extended landward.

A major dredging operation was conducted in 1962, which included the initial dredging of an inlet sand trap. The dredging included a 200-foot wide channel 11 feet deep east of the bridge, and a channel 1,500 feet long, 150 feet wide and 12 feet deep west of the bridge for an excavation total of 45,700 cubic yards. Another 22,100 cubic yards was excavated for a small channel 700 feet long, 125 feet wide and 7 to 9 feet deep at the western end of the inlet near the south bank. The sand trap was excavated to -11 feet at a site 2,500 feet west of the inlet entrance and involved the removal of 214,000 cubic yards of material. The excavated material was used to nourish the inlet banks and the beach south of the inlet. The State Highway A1A bridge was completed across the inlet and the opening day ceremony occurred on February 27, 1965 (**Figure 7)**. The Florida Department of Transportation is expected to construct a new bridge slightly east of the current bridge in the fall of 2025 and construction is expected to take approximately three to four years.

**Figure 7.** State highway A1A bridge opening ceremony on February 27, 1965, (Sebastian Inlet District, 2019).

Between 1968 and 1970, both the north and south jetties were extended (**Figure 8** and **Figure 9**). The north extension was a curved concrete crib and boulder design for 452 feet and the south extension was a straight 80 feet. The concrete crib design employed two rows of vertical piles with an interior row of battered piles along the channel side, all connected by a concrete cap and bent structure with gaps covered with stainless steel grates. Boulders were placed inside the crib structure to break the waves. Uplift forces from breaking waves would pass through the steel grates to minimize wave loads on the crib structure. This design has resulted in a structurally sound fishing pier which has been in service for over 50 years and has weathered many northeasters, tropical storms and hurricanes. Hurricane Floyd (1999) caused damage to the seaward 50 feet and blew out steel grates along its length, but following complete restoration in 2003, Hurricane Frances (2004) blew out 40 to 50 steel grates without causing any major structural damage (Clark, 2010) (**Figure 10**).

**Figure 8.** Construction crane working on the north jetty of Sebastian Inlet in 1969 (Sebastian Inlet District, 2019).

**Figure 9.** Extension of the north jetty at Sebastian Inlet, 1969, (Sebastian Inlet District, 2019).

**Figure 10.** Sebastian Inlet North Jetty Pier lost breakaway grates during Hurricane Frances, 2004.

In 1971, after the State of Florida acquired the land surrounding the inlet, the Sebastian Inlet State Park was established with management by the Florida Park Service under the Department of Natural Resources (now the Department of Environmental Protection).

In 1972, a new deepened and enlarged sand trap was excavated expanding the area to 32 acres. 420,000 cubic yards of material was excavated and placed on the beach south of the inlet. Rock riprap was placed along the south shoreline of the inlet adjacent to the sand trap.

During the 1980's and 1990's, the District conducted multiple projects to maintenance dredge the inlet channel and sand trap as well as to truck upland sand for placement south of the inlet. Over a million cubic yards of sand was transferred south of the inlet with nearly a quarter of the material being trucked from upland sand mines. From February 2000 through November 2002, another nearly 215,000 cubic yards of sand was trucked from sand mines to nourish beaches south of the inlet. In 2007, the District constructed a 3,120-foot channel connecting the inlet to the Atlantic Intracoastal Waterway. This connector channel was excavated to -9 feet NAVD88 deep and 150 feet wide and resulted in the reduction of seagrass damage by prop scars in the flood shoals and Indian River Lagoon (Sebastian Inlet District, 2019).

During 2010 and 2011, the District partnered with Indian River County to construct the Sector 3 beach nourishment project south of the inlet with 298,000 cubic yards of beach compatible sand from an upland mine. Also in 2011, the District, in cooperation with the state park, removed about 10,000 cubic yards of sandy material from the tide pool area west of the bridge on the north side of the inlet and used the material to construct a dredge material management area (DMMA) that is located on state park uplands just northwest of the tide pool (**Figure 11)**. In 2012, maintenance dredging of the inlet sand trap and channel excavated approximately 136,000 cubic yards of sand and transferred 119,900 cubic yards to the beach south of the inlet and approximately 17,000 cubic yards to the DMMA. Sand from the DMMA and upland sand source was used for a 34,600 cubic yards post-Hurricane Sandy dune restoration project in 2013. Between 2014 and 2015, the inlet sand trap was dredged and expanded to 42 acres. Most of the material was bypassed south of the inlet and some was placed in the DMMA for emergency projects. Rock that was removed to create a more uniform depth in the sand trap was used for road and parking area stabilization in the state park.

**Figure 11.** Dredge Material Management Area (DMMA) looking northwest, photo courtesy of Sebastian Inlet District.

In 2019, the navigation channel and sand trap were maintenance dredged and over 113,000 cubic yards of sand was bypassed to the beaches south of the inlet and approximately 52,700 cubic

yards transferred to the DMMA. In 2021, 59,925 cubic yards were trucked from the DMMA to the beaches south of the inlet. Most recently in 2023, 30,019 cubic yards of an upland source was placed on the beaches south of the inlet. **Table 1** enumerates the sand trap and channel dredging projects and inlet sand bypassing since 1972. Also included are projects the District conducted by truck hauling sand from upland sand mines. Since 1972, the District has transferred 2,851,034 cubic yards of sand to nourish the beaches of northern Indian River County.

**Table 1.** Maintenance Dredging events at Sebastian Inlet from 1972 to 2023 (FDEP, 2023).

| Date | Maintenance Dredged – Cubic Yards | Placement to Beach | Dredge Area | Notes |
|---|---|---|---|---|
| 1972 | 440,700 | 420,000 | Sand trap & channel | |
| 1978 | 286,500 | 187,600 | Sand trap | |
| 1980's | 236,916 | 200,038 | Sand trap & channel | 1 |
| 1990's | 602,060 | 888,332 | Sand trap & channel | 2 |
| Feb.-Apr. 2000 | 0 | 50,100 | Upland sand source | |
| November 2001 | 0 | 114,700 | Upland sand source | |
| November 2002 | 0 | 50,000 | Upland sand source | |
| April 2007 | 85,700 | 85,700 | Sand trap | |
| December 2011 | 0 | 298,850 | Upland sand source | |
| December 2012 | 119,900 | 119,900 | Sand trap & channel | |
| Jan.-Feb. 2013 | 17,000 | 34,600 | DMMA & upland | 3 |
| December 2014 | 111,200 | 111,200 | Sand trap | |
| February 2015 | 55,800 | 55,800 | DMMA | |

| Date | Maintenance Dredged – Cubic Yards | Placement to Beach | Dredge Area | Notes |
|---|---|---|---|---|
| December 2017 | | 30,700 | DMMA | |
| December 2019 | 113,570 | 113,570 | Sand trap & channel | |
| December 2021 | 59,925 | 59,925 | DMMA | |
| February 2023 | | 30,019 | Upland sand source | |
| **TOTAL** | **2,129,271** | **2,851,034** | | |

1 – beach placement volume includes 90,000 cubic yards obtained from Coconut Point.
2 – beach placement volume includes 236,272 cubic yards of upland sand trucked to the beach south of the inlet.
3 – beach placement volume includes 18,000 cubic yards of upland sand trucked to the beach south of the inlet.

## *Early Studies of Sebastian Inlet*

The U.S. Army Corps of Engineers (USACE) conducted several inlet surveys in the 1930's and 1940's and following the major channel realignment in 1948. In 1962, the first hydraulics study of the inlet was conducted when the Coastal & Oceanographic Engineering Laboratory, University of Florida, measured surface currents in the inlet (COEL-UF, 1962). The Laboratory conducted tidal observations between July 1963 and April 1964 at multiple points around the inlet and measured currents during a field study in 1963 (COEL-UF, 1965; Chiu, 1966). From this study the data provided an ocean mean tide range of 3.4 feet and a spring tide range of 3.9 feet, and from the west end of the inlet a lagoon tide range averaged 0.23 feet. An inlet peak flood tide velocity was measured at 7.2 feet per second and a peak ebb tide velocity was measured at 9.1 feet per second. A semi-diurnal spring tidal prism was calculated to be 3.04 x $10^8$ cubic feet for an ebb tide with a peak maximum ebb velocity of 9.1 feet per second and 2.35 x $10^8$ cubic feet for a flood tide with a peak maximum flood velocity of 7.2 feet per second. The Laboratory incorporated the current measurements into the design of a fixed bed, steady flow physical model. This study resulted in recommendations for sand trap siting, channel alignments and jetty extensions.

In a Florida Sea Grant Study, Mehta et al (1976) noted that for a tidal prism calculated in the 1963-65 studies, a stable "sandy" inlet cross-section in sedimentary equilibrium would be about 8,460 square feet. The actual reported throat section at the time was only 3,900 square feet (below mean low water) or roughly half the predicted stable flow area. The existing flow area is constricted by the armored shorelines and the rocky bottom of the inlet. Conversely, the tidal prism flowing through the inlet is roughly twice the volume that should flow through a "sandy" inlet of the existing cross-section. This explains the high current velocities that are roughly twice what they should be for a stable flow area in a sandy inlet.

In 1988, an inlet management planning study was conducted by Coastal Technology Corporation (CTC, 1988). The study identified a sediment deficit to the downdrift beaches of Indian River County of 73,800 cubic yards per year based upon the average annual loss of sediment to the Sebastian Inlet system during the period of 1964 to 1987. Following this study, the District adopted a bypassing goal of 70,000 cubic yards per year to the south.

Following field data acquisition in 1990, the Coastal & Oceanographic Engineering Department, University of Florida, conducted a fixed bed model study to evaluate various jetty modifications (Wang et al, 1991) and a movable bed model study to evaluate nine structural configurations to assess the sediment transport processes in the vicinity of the inlet (Wang et al, 1992). The nine tested structural alternatives included various combinations of jetty extensions, ebb shoal material removal and beach nourishment.

Survey based sediment budgets were initiated by the District in 1995. Dally and FitzPatrick (1997) developed a sediment budget for the time period between 1989 and 1995. The sediment budget was updated with an additional four years of data spanning 1989-1999 (Dally and Goshow, 2000) and with an additional two years of data spanning 1989-2001 (Dally and Osiecki, 2002). These sediment budget studies determined that the inlet channel and sand trap impounded sediment at a rate significantly less than the adopted bypassing rate of 70,000 cubic yards per year to the south.

Another study was conducted by the Coastal & Oceanographic Engineering Department, University of Florida, and became the foundation for the 2004 update to the inlet target bypassing objective (Dean, 2003). This study evaluated the coastal processes and sediment flows across Sebastian Inlet with the objective of providing both a sediment budget and a series of

recommendations for sediment management at the inlet. The budget was derived using beach profile data available within the Department's database as well as surveys completed within Sebastian Inlet and on the adjacent shorelines provided by the Sebastian Inlet District. The data extended approximately 30,000 feet north and 30,000 feet south of the inlet and was collected between the winter 1999 and 2002, thereby defining the spatial and temporal domain of the sediment budget. However, a second sediment budget utilizing spatially limited survey data collected from the winter of 1972 to the winter of 2002 was similarly used to create an alternative sediment budget framework to compare and contrast with that of the 1999-2002 sediment budget.

The key recommendations from Dean (2003) for updated coastal management practices at Sebastian Inlet are:

1) The semi-annual surveys should be continued and expanded to 40,000 feet north and south of Sebastian Inlet.
2) Consideration should be given to the extension of the south jetty to reduce loss of sediment from the downdrift beaches due to littoral exchange with the inlet.
3) Consideration should be given to the construction of bypassing facilities on the north jetty to facilitate transfer of sediment volume to the downdrift beaches.

An investigation of the hydraulic characteristics of Sebastian Inlet was conducted for the Department as reported in Clark (2004). Based on available data and additional computations it was concluded that Sebastian Inlet is categorized as an inlet with a very large lagoon area. The lagoon tide range and its repletion coefficient (K), which represents its degree of filling by the tides, are very small, approaching zero. And the phase lag of slack water after low tide or high tide in the ocean approaches 90 degrees. It was determined that Sebastian Inlet would be unstable were it not for the jetties, shoreline armoring and rocky bottom, as its critical cross-section is much greater than its existing throat cross-section. For its tidal prism, a stable sandy inlet cross-section in sedimentary equilibrium would be about twice the existing throat cross-section. Because of this constriction, Sebastian Inlet has flow velocities about double what they should be for a stable flow area in a sandy inlet. Consistent with these high flow velocities, Sebastian Inlet has a very low impedance to flow. From the tide and current data, coefficients of impedance (F) were calculated, which represent the effect of all influences restricting the flow

through the inlet, not just the entrance and exit losses and bottom friction. Sebastian Inlet's hydraulic characteristics were compared with the nearby inlets to the south – Ft. Pierce Inlet, St. Lucie Inlet, and Jupiter Inlet. Sebastian Inlet stood out for its low ratio of bay/ocean tide range, its low repletion coefficient, its high current velocities and its low impedance to flow.

Another study was conducted by the Coastal & Oceanographic Engineering Department, University of Florida, (Dean, 2005). This study evaluated the sediment transport processes in the vicinity of Sebastian Inlet with the objective of developing rational approaches to the management of the inlet. The budget was derived using beach profile data available within the Department's database as well as surveys completed within Sebastian Inlet and on the adjacent shorelines provided by the Sebastian Inlet District. The survey data from 1972, 1986, and 2002 was used to develop sediment budgets with two spatial domains (a) 30,000 feet north and 30,000 ft south of the inlet and (b) for 60,000 feet north and 60,000 ft south of the inlet. A key finding from Dean (2005) is that the effects of the inlet extend farther than the 30,000 feet longshore distances used in the former sediment budget. Dean (2005) recommended to extend surveys to at least ±60,000 feet north and south of the inlet.

## *Adopted Inlet Management Plan of 2000*

The Department, the District, and Brevard and Indian River Counties established a Technical Review Committee (TRC), which reviewed the 1988 Sebastian Inlet District Comprehensive Management Plan and 1997 Survey-Based Sediment Budget Analysis for Sebastian Inlet and developed recommendations for the adoption of an inlet management plan pursuant to Section 161.161, Florida Statutes. The TRC provided findings and recommendations regarding an annual bypassing volume, the long-term effects of the flood shoal, historic impacts of the inlet, the area of inlet influence, the methodology of calculating the sediment budget, the sources of supplemental fill, sand bypassing and placement, environmental issues, structural modifications, and public resources.

On March 16, 2000, the Department adopted the Sebastian Inlet Management Study Implementation Plan calling for the following implementation actions (FDEP, 2000).

1) Continue to bypass suitable sediment to the downdrift beaches. The bypassing objective of 70,000 cubic yards is adopted as an interim measure and will be formally validated or redefined

in subsequent revisions of the plan, based on a comprehensive monitoring plan, within five years of adoption of the Inlet Management Plan.

2) Restore the downdrift beaches designated by the Department as experiencing critical erosion. Downdrift beach restoration will be pursued in conjunction with implementation of shore protection activities under the Indian River County Beach Preservation Plan and be considered an integral part of both plans.

3) Evaluate possible alternatives to facilitate sediment bypassing. Specific alternatives to be investigated include modifications to the trapping capacity of the sand trap, structural changes to the south jetty to minimize re-entrainment of material into the inlet, and identification and use of possible sources of trapped littoral sediments (i.e., flood shoal and north shore) for bypassing to the downdrift beaches.

4) Implement a comprehensive beach and offshore monitoring program. Monitor inlet shoals and shoreline change, identify beach placement locations for future bypassing efforts and revalidate the sediment budget. The program will be coordinated with monitoring activities associated with the Indian River County shore protection projects.

The strategies adopted in the 2000 inlet management plan were substantially conducted.

The Department convened a Technical Advisory Committee (TAC) in June 2004, which recommended an updated bypassing objective of 90,000 cubic yards on an average annual basis. This objective was adopted in the strategies of the 2008 Strategic Beach Management Plan (FDEP, 2008).

## *Updated Inlet Management Study and Sediment Budget of 2020*

Initially, the District contracted with the Florida Institute of Technology (Zarillo, 2007) to model the inlet and coastal processes to analyze the data obtained from tide, wave, and current gauges and to monitor seasonal sea level changes, sediment transport, and the entrapment of littoral sediments in the inlet system (**Figure 12**). The goal of the program is to update the inlet sediment budget and to manage the system with mechanical bypassing of entrapped sand to the adjacent eroded beaches south of the inlet. The ongoing studies are documented in the annual State of the Inlet Reports contracted by the District.

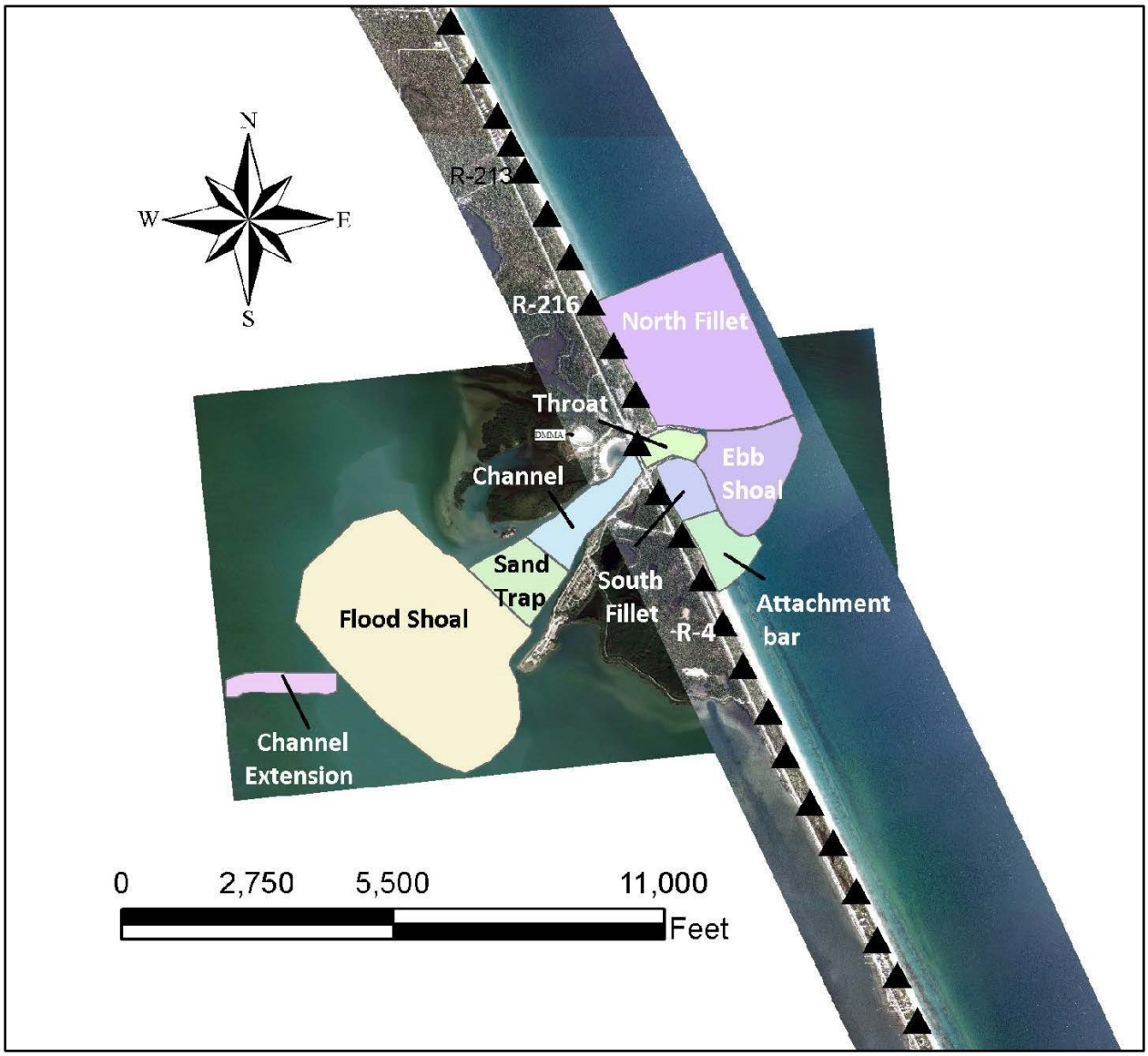


**Figure 12.** Inlet system showing the location of the channel, sand trap, flood shoal and ebb shoal at Sebastian Inlet, (Zarillo et al. 2021).

The most recent annual State of the Inlet report, titled "State of Sebastian Inlet Report: 2020", is provided in Zarillo et al. (2021), which includes five major areas of work and analysis. These are:

1) An update of the analysis of the volumes contained in the sand reservoirs of the inlet system.
2) Analysis of the sediment budget based on the results of the sand volume analysis.
3) Analysis of morphologic changes within the inlet system.
4) An update of the shoreline change analysis.

5) A description of the real-time and forecast coastal processes numerical model that includes Sebastian Inlet.

A series of inlet sediment budgets were included in the documentation. These budgets encompassed the area between monuments R-189 in Brevard County and R-030 in Indian River County. Temporally, the budgets covered distinct timeframes, including three-year (2017-2020), five-year (2015-2020), and ten-year (2010-2020) intervals. Volume changes ($\Delta V$) were computed using either summer or winter bathymetric data to control for seasonal variability. In addition, the initial sediment flux entering the littoral system ($Q_{Initial}$) of 150,000 cubic yards per year was specified based on regional sediment budget calculations described in Zarillo et al. (2007). This value was increased to 200,000 cubic yards per year in select cases to accommodate time intervals corresponding with higher mean transport rates, due to the elevated winter storm activity.

Historically, hydrographic surveys, employing both single-and-multibeam techniques, were conducted at Sebastian Inlet. These surveys extended 30,000 ft to the north and south of the inlet and defined the maximum spatial domain of the littoral cells in the State of the Inlet Report (**Figure 13**). Within these bounds, individual littoral cells, four to the north, four to the south, and one comprising the inlet itself, were defined. The cells extend from the beach down to a maximum depth of -40 ft NAVD88, which exceeds the historically cited depth of closure of -17.4 ft NAVD88 for this area to fully capture cross-shore volume changes arising from exceptionally severe storm conditions (ATM, 2021). The littoral cells are defined in **Table 2**.

**Table 2.** Description of the sediment budget cell boundaries (Zarillo et al. 2021)

| Cell Label | Cell Domain |
|---|---|
| N4 | R-189 to R-195 |
| N3 | R-195 to R-203 |
| N2 | R-203 to R-209 |
| N1 | R-209 to R-216 |
| Inlet Cell | R-216 to R-219 (BRE); R-1 to R-4 (IRC). This cell comprises the flood shoal, inlet channel, sand trap, and ebb shoal. |

| Cell Label | Cell Domain |
|---|---|
| S1 | R-4 to R-10 |
| S2 | R-10 to R-16 |
| S3 | R-16 to R-23 |
| S4 | R-23 to R-30 |

Zarillo et al (2021) provided the following key conclusions and recommendations:

- The Sebastian Inlet sand reservoirs are in a long-term dynamic equilibrium characterized by occasional large seasonal changes in volume superimposed on longer term trends of a lower order of magnitude.
- Large sand volume gains and losses occur over the entire region rather than being inversely linked to gains or losses in adjacent subsections of the coast.
- It is recommended that the Sebastian Inlet District plan for time scales of 10 years and beyond when sea level is projected to continue rising at higher rates and more extreme interannual variations in sea level amplify the impact of rising seas along the coast.

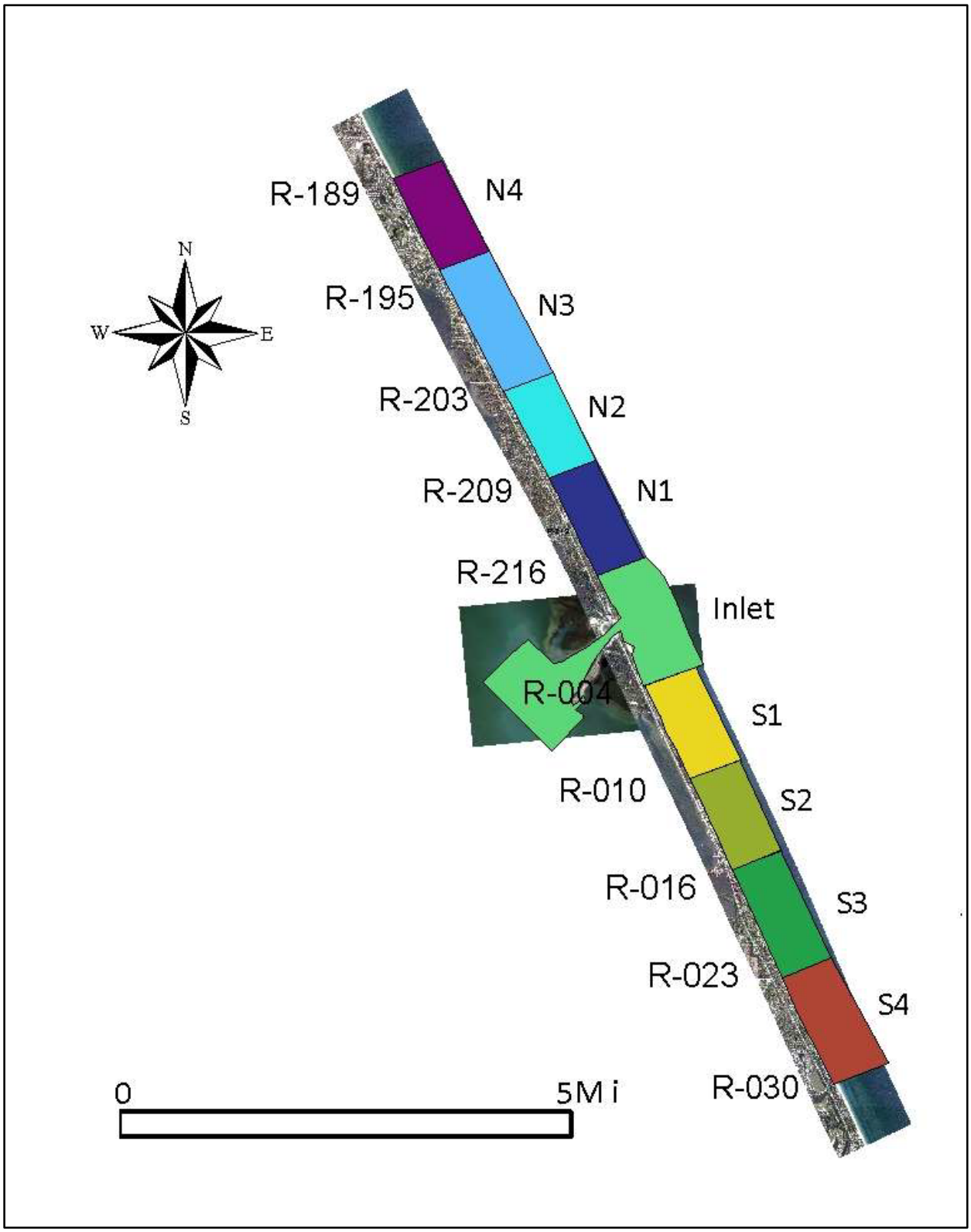


**Figure 13.** Schematic depicting the spatial boundaries of the inlet littoral cells at Sebastian Inlet. Figure from Zarillo et al. (2021).

## *Sediment Budget – FDEP Technical Memorandum, 2023*

In response to discussions of the TAC (2022-2023), the Department refined the sediment budget presented in the 2020 State of Sebastian Inlet Report (FDEP, 2023). The TAC recommended utilizing a 10-year time interval for the sediment budget to integrate over seasonal sand volume changes and capture an enduring depiction of the inlet's behavior. The time interval with the most recently available data (2011-2021) was selected for this purpose. In addition, the summer bathymetric surveys were utilized to capture the volume changes across the inlet domain instead of the winter surveys, because the summer bathymetry would reflect a less volatile bathymetric condition. Another change from the sediment budgets presented in the 2020 State of the Inlet report was to subdivide the inlet into three distinct segments (cells) to further distinguish the sand reservoirs that exchange volume under the influence of tides, currents, and waves. The three subdivisions are as follows:

- Inlet Interior: This cell comprises the inlet channel, including the sand trap, as well as the flood shoal to the maximum spatial extent limited by the historical bathymetric surveys.
- Inlet Upper: R-216 to R-219 (Brevard); R-1 to R-4 (Indian River); This cell comprises the beach and the ebb shoal down to the -20 ft NAVD88 contour.
- Inlet Lower: R-216 to R-219 (Brevard); R-1 to R-4 (Indian River); This cell comprises the deeper portion of the ebb shoal beneath the -20 foot NAVD88 contour.

Three key steps were used to develop the 2011-2021 sediment budget, which are as follows:

1) Computation of the volume changes within boundaries of the sediment cells.
2) Validation of the mechanical placement and removal volumes within the sediment cells.
3) Balancing of the volume fluxes across the cells and computation of the target bypassing objective.

The changes in cell volumes from 2011 to 2021 were determined using data obtained from the Sebastian Inlet bathymetric survey data. Two bathymetric surfaces representing the bathymetry of Sebastian Inlet in summer 2011 and 2021 were created in ArcGIS Pro, clipped to the extent of the respective cell geometries, and the difference between the volumes of the bounded surfaces were calculated. The computed volume differences were divided by 10 to provide an annualized

estimate of volume change per cell. These steps resolved discrepancies in prior sediment budget methodologies and resulted in the volumes of net accretion and erosion displayed in **Figure 14**.

Historical records detailing sediment placement and removal volumes as well as the R-monument ranges of nourishment and dredging events within the coastal domain of the Sebastian Inlet sediment budget were provided by Brevard County, Indian River County, and the Sebastian Inlet District. Only placement and removal events which occurred between summer 2011 and summer 2021 were included. The volume of sediment placed and/or removed during each event was proportionally allocated to the respective cells in accordance with the cell boundaries defined in **Table 3**.

**Table 3.** Revised annualized placement (+) and removal (-) volumes per cell.

| Cell | Placement (+) & Removal (-) Volumes [cy/yr] |
|---|---|
| **N4** | 3,269 |
| **N3** | 3,727 |
| **N2** | 2,283 |
| **N1** | 1,522 |
| **Inlet Interior** | -46,806 |
| **Inlet Upper** | - |
| **Inlet Lower** | - |
| **S1** | 12,807 |
| **S2** | 34,082 |
| **S3** | 9,646 |
| **S4** | 21,270 |

Finally, utilizing the Sediment Budget Analysis System, a geospatial toolbox from the USACE for ArcGIS Pro, the sediment budget was balanced and the fluxes into and out of each cell were determined. The target bypassing objective was derived in accordance with the methodology described in Appendix A of, FDEP (2023). The resulting budget as well as the computation of the potential target bypassing objective of 82,812 cubic yards per year are presented in **Figure 14**.

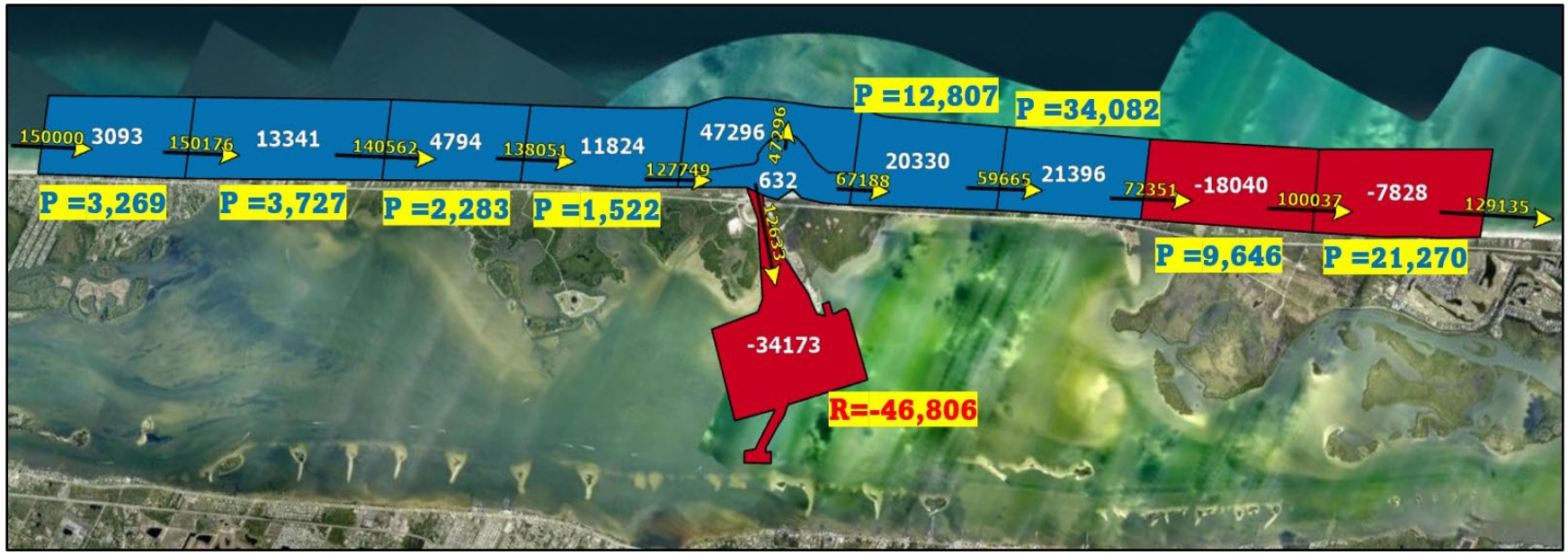


**Figure 14.** FDEP revisions to the Sebastian Inlet sediment budget. ΔV values are presented in white with updated placement (P) and removal (R) values from Table 6. Blue and red cells respectively correspond with areas of accretion and erosion.

FDEP Target Bypassing Objective Calculation:

$$\boldsymbol{T = \sum(\Delta V + |R| - P)_{Updrift;Ebb\ Shoal;Channel;Flood\ Shoal}}$$

$$\boldsymbol{T = [\Delta V + |R| - P]_{FS} + [\Delta V + |R| - P]_{ES} + [\Delta V + |R| - P]_{In.Up} + [\Delta V + |R| - P]_{N4+N3+N2+N1}}$$

$$\boldsymbol{T = 82,812\ cy/yr}$$

Following a review by the TAC, a lower target bypassing objective of 75,000 cubic yards per year was recommended by the district and county governments. Several justifications were deemed appropriate by the department for the utilization of a lower target bypassing objective than that entailed within FDEP (2023). First, the potential to disrupt natural bypassing to the downdrift beaches by dredging the ebb shoal is suggested by Zarillo (2021). The ebb shoal, which displays the largest net accretion of the sediment budget cells, may respond negatively to significant sediment removal events by decreasing the rate of littoral transport across the attachment bar. Second, the methodology used to compute the target bypassing objective in FDEP (2023) represents an upper limit of the total volume of sediment to transfer to the downdrift beaches due to its formulation comprising a sum of the sinks attributable to the inlet within the survey domain. In other words, 82,812 cubic yards per year represents the quantity of sediment necessary to transfer to the downdrift beaches such that all the accretion in the updrift and inlet cells (N4; N3; N2 N1; Inlet Interior; Inlet Upper; Inlet Lower) would be mechanically removed and the cells would experience no accretion ($\Delta V = 0$). Removal of any additional sand would begin to erode said cells; hence, it represents an upper limit (or maximum) for the target bypassing quantity.

In addition, supplemental nourishment material obtained from alternative beach-compatible sediment sources may be used to reach a target bypassing objective (Strategy #4) and mitigate background erosion attributable to non-inlet-related phenomena (e.g., storms, barrier island retreat due to sea level rise, etc.). Finally, maintenance dredging from the inlet has supplied 46,806 cubic yards per year of material between 2011 and 2021. A bypassing objective of 75,000 cubic yards per year represents a reasonable volume given the last decade of inlet dredging. Therefore, consensus was reached at the last TAC meeting (April 5$^{th}$, 2023) on this new bypassing objective of 75,000 cubic yards among the District, Brevard County, and Indian River County under acknowledgment of the District's capacity for funding and mobilization.

To view the Sebastian Inlet system, inlet channel, sand trap, DMMA, critical erosion segment and sand placement area, see **Figure 15**.

## *Project Management Map*

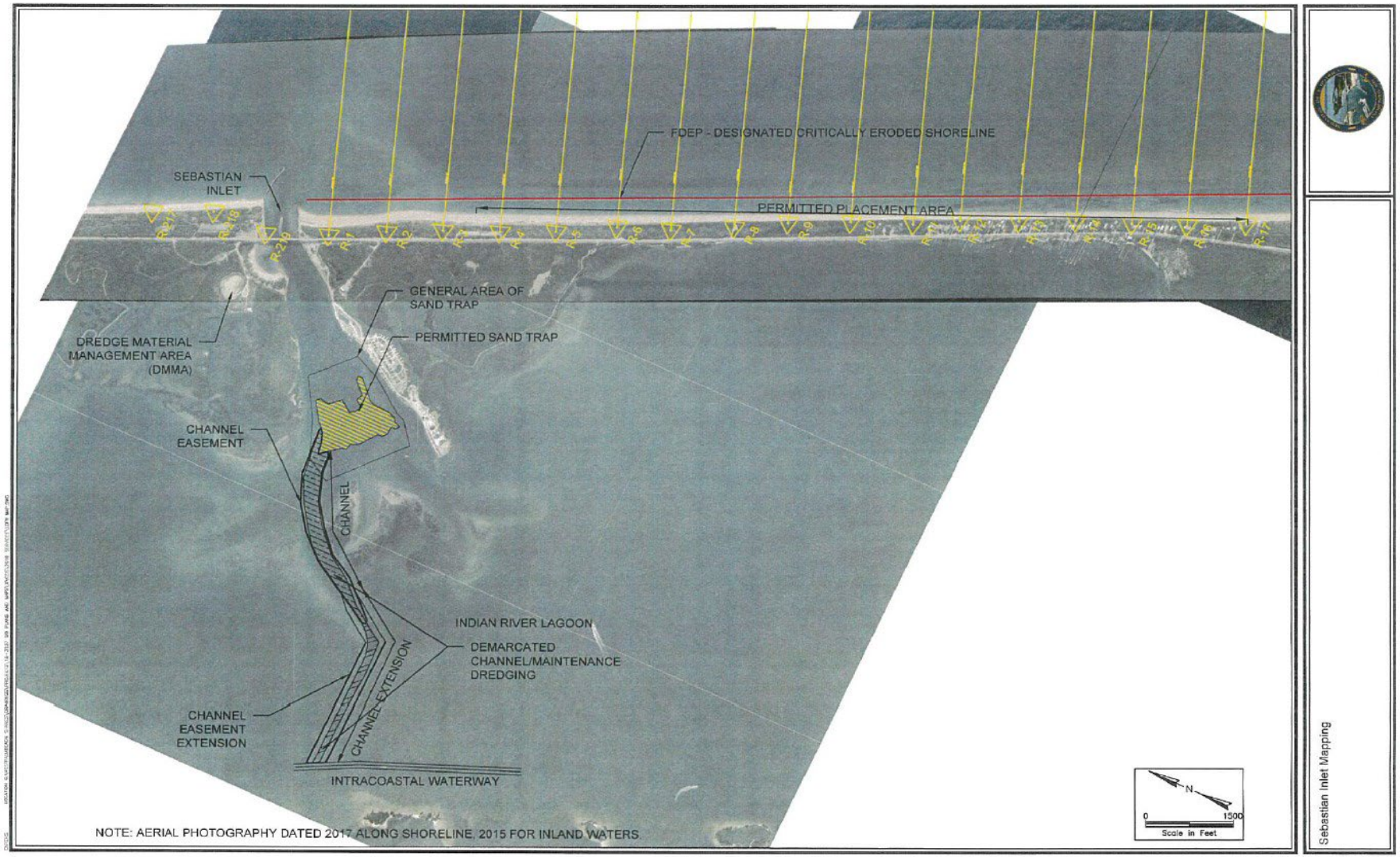


***Figure 15.*** *Project Management Map showing the Sebastian Inlet System, Inlet Channel, Sand Trap, DMMA, Critical Erosion and Sand Placement Area, map courtesy of the District.*

## *Recommended Inlet Management Plan Strategies*

The Department staff recommends the following inlet management strategies be adopted to meet the requirements of Chapter 161, Florida Statutes.

1.) **A comprehensive beach and inlet hydrographic monitoring program** shall be conducted to evaluate the performance and impact of existing sand bypassing and nourishment projects and to periodically update the inlet sediment budget. Beach and nearshore surveys between FDEP Range/Reference Monuments R-179 (Brevard County) to R-30 (Indian River County) shall be conducted. Periodic inlet hydrographic surveys to include the inlet channel, the sand trap, and the ebb and flood shoals in their entirety should be conducted. Along with topographic and hydrographic surveys of the inlet system and adjoining beaches, hydraulic monitoring may be conducted to enhance future modeling input data for investigations of inlet management alternatives.

***Discussion –*** A comprehensive beach and inlet hydrographic monitoring program is the most important element to manage the sediment at Sebastian Inlet. Topographic and bathymetric surveys provide reliable data to estimate the volumetric impact of the inlet on adjacent beaches and to establish a reasonable sand placement protocol that complies with Section 161.142, Florida Statutes.

2.) **Sand bypassing shall be performed from the inlet system to the adjacent Atlantic-fronting beaches to the south of the inlet between the south jetty near FDEP Range/Reference Monuments R-1 and R-30.** The quantity of material to be bypassed shall be based on available inlet reservoir quantities documented through the monitoring protocol of Strategy #1 above.

***Discussion –*** The beaches 9.5 miles to the south of Sebastian Inlet (R-1 to R-51.3) are currently designated critically eroded by the Department (FDEP, 2023). The beach immediately south of Sebastian Inlet is the adjacent eroded beach directly impacted by the inlet system.

3.) **On an average annual basis, the initial target inlet sand bypassing quantity shall be 75,000 cubic yards per year to the south.** This target quantity may be modified or updated based on a minimum of four years of additional monitoring data indicating a

change in the sediment budget. However, the sediment budget should cover a period of at least 10 years.

***Discussion –*** Additional sand may be placed that is obtained from acceptable offshore sources or upland sand mines to account for the inlet's effects or to mitigate sand losses that are attributable to background erosional processes.

4.) **The source of sediment for meeting the target sand bypassing quantities in Strategy # 3 may be the Sebastian Inlet sand trap and channel, or as otherwise authorized by permit. The inlet channel and sand trap shall be prioritized for a portion of the bypass material, but other alternatives may be considered for further geotechnical and engineering design and permitting and implementation to develop an environmentally acceptable project with suitable quality sediment.** Acceptable beach quality sand may also be obtained from the inlet's tidal pool, upland sand mines or offshore sources to achieve the target sand bypassing quantities.

***Discussion –*** Maintenance dredging of the inlet interior accounts for about 46,806 cubic yards per year (2011-2021) bypassed to the beaches south of the inlet. The sand trap (sediment impoundment basin) has a dredge capacity of approximately 150,000 to 175,000 cubic yards every five to seven years.

5.) **The north and south jetties, which have been impacted by numerous recent major storms like Hurricanes Sandy, Matthew, Irma, Dorian, Ian, and Nicole as well as numerous northeasters, shall be repaired and maintained.**

***Discussion –*** Since the construction of the north and south jetties, several hurricanes and northeasters have caused continued structural damages, resulting in settlement of the boulder mound structures and increased sediment permeability. Repair of the jetties to their pre-damage dimensions is expected to prevent further structural compromise.

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