Bakers Haulover Inlet Management Plan

Office of Resilience and Coastal Protection

Florida Department of Environmental Protection

August 2021

Final Order Adopting
Bakers Haulover 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. Regarding 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 September 5, 1997, the department adopted the Bakers Haulover Inlet Management 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 2018-2019, the department and Miami-Dade County sponsored an inlet management study of Bakers Haulover Inlet performed by Moffatt and Nichol, Inc., which

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

WHEREAS, in August 2021, 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, Miami-Dade County and the U.S. Army Corps of Engineers (USACE) are the entities responsible for dredging at Bakers Haulover 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 **Bakers Haulover Inlet Management Plan**. Future inlet management activities conducted by Miami-Dade County or the U.S. Army Corps of Engineers 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. This monitoring program shall include topographic and hydrographic surveys of the inlet system, its ebb and flood shoals, and adjoining beaches between FDEP reference monuments R7 and R38.
2) **On an average annual basis, the initial minimum target inlet sand bypassing quantity shall be 36,900 cubic yards to the adjacent Atlantic beaches south of Bakers Haulover Inlet.** This target quantity may be modified or updated based on a minimum of four years or more of monitoring data or additional inlet model studies indicating a change in the sediment budget.

3) **Sand bypassing shall be performed from the Atlantic Intracoastal Waterway and Bakers Haulover Inlet federal navigation project channel and may be performed from the previously permitted Ebb Shoal Borrow Area, to be placed on the adjacent Atlantic beaches south of the inlet between FDEP Reference Monuments R27 and R32.** The quantity of material to be bypassed from the navigation channels shall be based on available deposition quantities documented through the monitoring protocol of Strategy #1 above.
4) The proposed project investigated in the inlet management study was determined to be feasible by the preliminary modeling and economic analysis, which would include **extension of the north jetty by 164 feet (50 meters) and sand bypassing from the beach immediately north of the inlet to the beach south of the inlet at a quantity not to exceed 30,000 cubic yards per year**. Detailed engineering design and permitting shall be conducted prior to this beach bypassing with monitoring that shall specifically evaluate beach recovery north of the inlet and an analysis of public safety. The 2016 shoreline shall be the landward baseline to limit beach excavation and the post dredging adjustment of the beach profile shall not erode into the federally mandated design berm of the beach erosion control and hurricane protection project. A detailed geotechnical analysis shall be conducted that shall include an evaluation of the design dredge depth. Detailed engineering design to extend the north jetty that will include hydraulic modeling, public safety analysis, and environmental impact shall be conducted to develop an environmentally acceptable project. Should sand be entrapped seaward of the 2016 shoreline in excess of the quantity necessary to meet the southerly target bypassing quantity, the excess sand may be bypassed to the proximate beach restoration project to the north.
5) **Sand may be obtained from the inlet's ebb shoal or flood shoals for nourishment of adjacent eroding beaches or proximate beach restoration projects provided sufficient engineering design, geotechnical analyses, and environmental impacts analyses justify the excavation.** Priority will be given to federal projects; however, beach fill placement between R27 and R32 shall be included in the target sand bypassing quantity.

Inlet management actions conducted by Miami-Dade County and the U.S. Army Corps of Engineers 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 other than the federal navigation project 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. Nothing in this plan precludes the evaluation and potential adoption of other strategies for the effective management of Bakers Haulover 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.

Jacob Koerner 8/11/2021

Deputy Clerk Date

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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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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 Bakers Haulover Inlet in Miami-Dade County, Florida.

Bakers Haulover Inlet Management Plan updates strategies for Bakers Haulover Inlet that were adopted in the *Bakers Haulover Inlet Management Implementation Plan* (FDEP, 1997) to be consistent with current statutes and observed erosion[1] conditions. The *Strategic Beach Management Plan* (FDEP, 2020) called for placing all beach compatible maintenance dredging material on adjacent beaches in areas of greatest need, to update the sediment budget and to adopt an updated inlet management plan. The Department and Miami-Dade County sponsored an updated inlet management study of Bakers Haulover Inlet in 2018-19 that was performed by Moffatt & Nichol.

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.

[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.

> 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 on the inlet and adjacent beaches must be supported by separately approved inlet management plans or inlet components of the statewide comprehensive beach management plan."

Miami-Dade County and the U.S. Army Corps of Engineers have been the entities responsible for dredging Bakers Haulover Inlet and consequently, mitigating the extent of beach erosion caused by the inlet, as specified in Subsection 161.142 (6), Florida Statutes.

History of Bakers Haulover Inlet

Bakers Haulover Inlet is in Miami-Dade County on the southeast coast of Florida connecting the Atlantic Ocean with the northernmost waters of Biscayne Bay (**Figure 1**). The inlet is located 13.3 miles south of Port Everglades and 9.5 miles north of Government Cut, the nearest adjacent inlets, and separates Haulover Park to the north from the Village of Bal Harbour to the south. The Atlantic Intracoastal Waterway enters Biscayne Bay adjacent Bakers Haulover Inlet.

It is important to understand the history of Bakers Haulover 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 to change inlet management strategies over time. Bakers Haulover Inlet was originally constructed by local interests in 1925 (USACE, 1975). Prior to 1925, Bakers Haulover was the site of a marine railway, which was used to portage marine vessels across the narrow sand barrier between Biscayne Bay and the Atlantic Ocean (USACE, 1946). Opening an inlet to navigation substantially relieved the effort to portage vessels over land.

Figure 1. Bakers Haulover Inlet, Google Earth imagery, 2019.

The original inlet was 1,100 feet long with a width of 300 feet at its ocean entrance and a width of 500 feet at the bay entrance (USACE, 1975). Controlling depths were 16 feet between and seaward of two short boulder mound jetties, and 14 feet within the inlet channel. Steel sheet-pile bulkheads with lime rock boulders for scour protection were constructed along the inlet shorelines landward of the jetties.

The inlet was severely impacted by the hurricane of September 18, 1926. With a storm surge exceeding 10 feet, severe erosion was sustained throughout the area and the inlet's jetties were substantially destroyed (USACE, 1946). In 1927, the U.S. Army authorized reconstruction of the inlet, which involved the construction of two parallel steel sheet-pile jetties 325 feet apart and steel sheet-pile bulkheads extending along the ocean shoreline 700 feet north and south of the inlet. Five steel groins were constructed south of the inlet spaced 100 feet apart, the bridge across the inlet was repaired, and the inlet shorelines were armored with steel bulkheads and boulders (USACE, 1946).

The USACE (1946) investigation determined that most of the steel structures had been compromised corrosion, abrasion and the effects of major storms. A storm in 1936 damaged the groins and bulkheads requiring replacement of the bulkhead south of the inlet. Deteriorating steel in the south jetty led to its repair by the construction of a new wall, filling voids with concrete, and constructing a concrete cap over the jetty by 1940. A new bridge was constructed over the inlet 200 feet west of the old bridge in 1950 and the old bridge was removed in 1952.

In a 1958 study, The USACE recommended various improvements to the inlet, including replacing the corroded steel jetties with granite boulder mound jetties, armoring the inlet shoreline bulkheads with boulders, widening the entrance channel to reduce scouring velocities, and constructing a sand transfer plant to bypass beach material from north to south of the inlet. In 1960, Dade County constructed a boulder mound groin 300 feet south of the inlet to anchor nourishment efforts. The River and Harbor Act of 1960 authorized the dredging of the channel to maintain dimensions recommended in the 1958 report – 200 feet wide and 11 feet deep in the entrance channel, and 100 feet wide and 8 feet deep west of the jetties. The boulder mound north jetty and north inlet shoreline revetment were completed in 1963 (USACE, 1975). By the end of 1964, the relocated boulder mound south jetty had been constructed along with the south inlet

shoreline revetment, resulting in an inlet width of 400 feet between the jetties (USACE, 1975). Due to lack of funding, a sand transfer plant was never constructed.

In 1974, the Florida Department of Natural Resources (FDNR) authorized a coastal construction permit for the City of Bal Harbour to extend the south jetty to a length of 735 feet with a curve to the south. Five adjustable concrete groins were also constructed to the south of the inlet. Subsequently, 1,625,000 cubic yards of sand were placed along 0.8 mile of Bal Harbour's beach in July 1975 (FDEP, 2020). FDNR authorized additional construction on the north jetty involving sand tightening and lengthening the north jetty with a curve to the north. These modifications were completed in 1986.

In 1992, Category 5 Hurricane Andrew made landfall 34 miles south of Bakers Haulover Inlet although conditions at the inlet were comparable to a Category 1 hurricane. Hurricane Andrew caused little damage to the inlet although the Haulover Beach Pier to the north was substantially damaged and two interior pier sections were destroyed by storm waves and a storm tide of +6.1 feet NGVD measured at the inlet (Schmidt, Taplin, and Clark, 1993). **Figure 2** by Coastal Planning & Engineering, Inc. (1995) depicts the various structures around the inlet and their date of construction.

The Department's *Strategic Beach Management Plan* (2020) lists numerous beach nourishment projects through the years both north and south of Bakers Haulover Inlet. Between 1978 and 1982, the federal beach restoration project known as the Dade County Beach Erosion Control and Hurricane Surge Protection Project, placed 12.2 million cubic yards of material between Bakers Haulover Inlet and Government Cut, 9.65 miles to the south, and 300,000 cubic yards to the north of the inlet along Haulover Park. All the material was obtained from offshore borrow areas. In 1987, an addition 235,000 cubic yards of offshore sand was nourished along Haulover Park north of the inlet, and in 1988 the Sunny Isles beach restoration project was constructed north of the inlet with the placement of 1.32 million cubic yards of offshore sand. Through the years, sand has been dredged from the inlet channel, from the inlet's ebb and flood shoals, and from the IWW inside the inlet. **Table 1** lists the dredging history at Bakers Haulover Inlet.

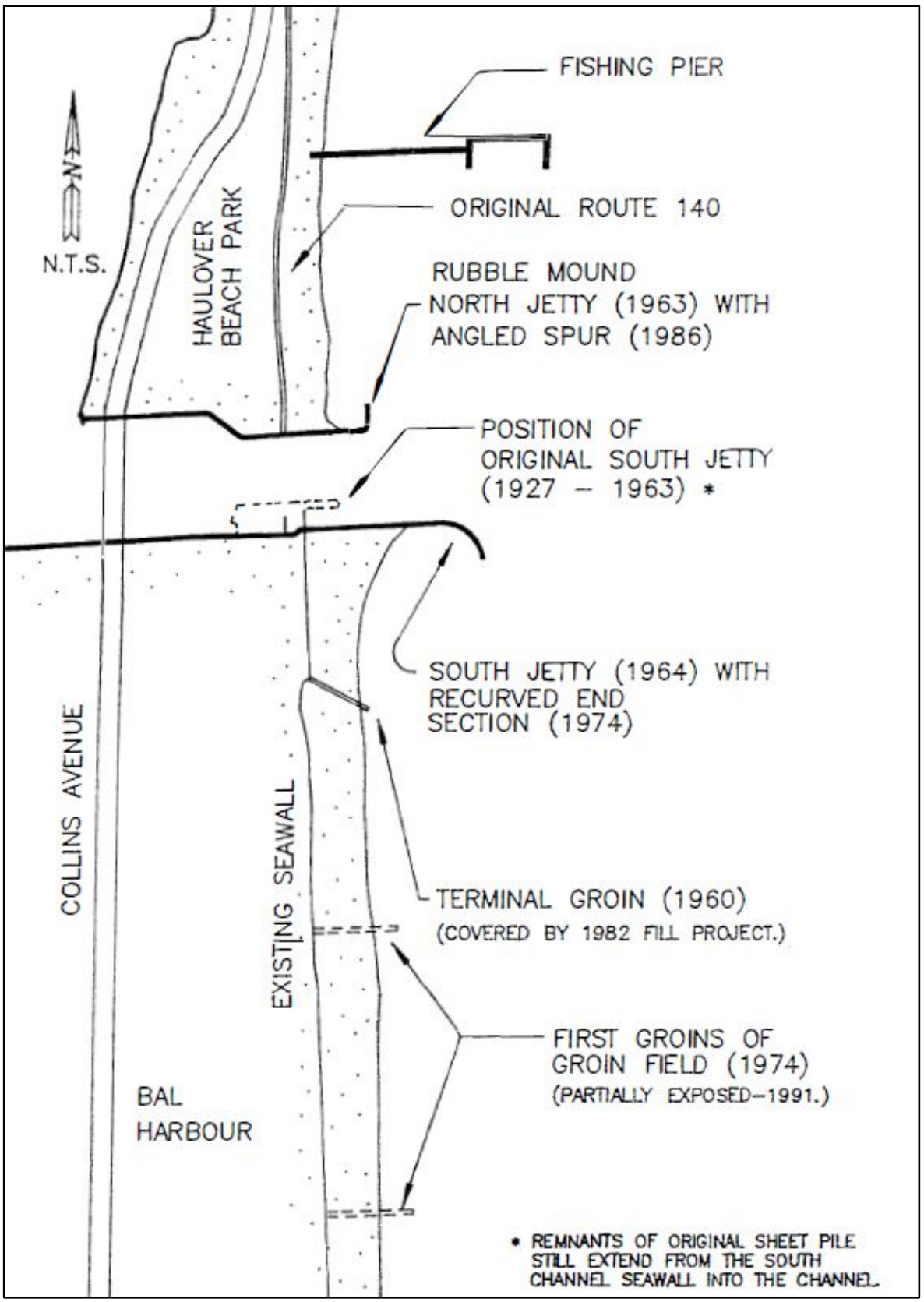

Figure 2. Coastal structures at Bakers Haulover Inlet (CP&E, 1995).

Table 1. Dredging Records and Beach Nourishment Projects near Bakers Haulover Inlet

Date	Source	Nourishment Location	Volume (cy)
1980	Flood Shoal (ICWW)	R19 to R26 (Haulover Park)	43,163
1984-1985	Flood Shoal (ICWW)	R19 to R26 (Haulover Park)	35,000
1987	Offshore	R19 to R26 (Haulover Park)	235,000
1988	Flood Shoal (ICWW)	Beach (not specified)	59,324
1988	Offshore	R7 to R20 (Sunny Isles)	1,320,000
1989	Offshore	R86-R93 (Dr. Von D. Mizell-Eula Johnson State Park)	603,400
1990	Offshore	R27 to R31 (Bal Harbour)	225,000
1991	BHI ICWW[2]	R7 to R9 (Sunny Isles)	31,279
1991	Offshore	R101 - R128 (Segment III)	1,113,000
1994	BHI	R19 to R26 (Haulover Park)	24,560
1997	Upland	R7-R8 & R10 & R16 (Sunny Isles)	9,000
	Offshore	R7 to R10 (Sunny Isles)	80,000
1998	Flood Shoal, Channel	R28 to R31 (Bal Harbour)	282,852[3]
1999	Offshore	R32 to R36 (Surfside)	590,000
2001	Upland	R121 - R123 (Hallandale)	25,000
2001-2002	Offshore	R6 to R19 (Sunny Isles)	737,152
2002	ICWW	Bal Harbour	14,070
2003	Ebb Shoal	R27 to R31 (Bal Harbour)	188,000
2005-2006	Offshore	R86-R92 (Dr. Von D. Mizell-Eula Johnson State Park) and R98.3-R128 (Dania/Hollywood/Hallandale)	1,850,000
2006[1]	Flood Shoal	R27 to R31 (Bal Harbour)	45,100
2009	Upland	R27 to R28.8 (Bal Harbour)	15,000
Jul. 2009	Upland	R7 to R10.5 (Sunny Isles)	10,000
2010	Flood Shoal (ICWW)	Bal Harbour	33,080
2012	Upland	R107 to R109 and R119 to R124 (Dania/Hollywood/Hallandale)	69,400
2013	Port Everglades Inlet	R87-R90 (Dr. Von D. Mizell-Eula Johnson State Park)	116,000
Mar. 2014	Intracoastal Waterway	R28 to R29 (Bal Harbour)	49,592[4]
2014	Ebb Shoal	R27 to R31 (Bal Harbour)	235,733
2014	Upland	R32 to R36 (Surfside)	12,800
2015	Upland	R7 to R9 (Sunny Isles)	2,600
2017	Flood Shoal (ICWW)	R28-R29 (Bal Harbour)	37,281
	Upland	R100-R102	6,020
2017-2018	Upland	R7-R10 and R15-R17 (Sunny Isles)	122,324
2018	Upland	R118.7 - R123.8 Hallandale	59,840
	Upland	R12-R15 (Sunny Isles)	28,446

1. Reported as 30,000 cy in 2007 in other sources. 2. Reported as 1990 in other sources. 3. Includes 34,882 cy from ICWW 4. Pay-volume. Design volume reported as 35,000 cy placed at Sunny Isles (FDEP, 2018). The Post-fill sampling report indicates 49,592 cy placed at Bal Harbour (USACE, 2014). Sources: CP&E 1995; FIND 2002, CSI 2008, 2012; FDEP 2015, 2018; Halcrow, 2008; Olsen 2015; USACE 1982, 2005, 2014, 2016.

Adopted Inlet Management Plan of 1997

In 1991, an inlet management study of Bakers Haulover Inlet by Coastal Planning & Engineering, Inc., was sponsored by the Department and Metro-Dade County (currently Miami-Dade County), addressing the extent to which the inlet causes beach erosion and providing recommendations to mitigate erosion (CP&E, 1995). The study, which was completed in 1995, provided an evaluation of alternative inlet management strategies. Five alternatives were evaluated, including –

- Closing the inlet.
- Continuing the existing federal navigation and beach erosion control projects.
- Dredging the ebb shoal.
- Developing a flood shoal deposition basin.
- Mechanical bypass systems.

Although closing the inlet would mitigate erosion caused by the inlet, negative impacts to the estuarine system and on local navigation resulted in this alternative not being considered further. The impact of the federal navigation project is mitigated by the federal beach erosion control project. Since the combined federal navigation and beach erosion control projects met the inlet management objectives, they were recommended for inclusion in the plan.

The inlet's ebb shoal was evaluated as a potential source of material to offset inlet impacts. Sediment samples and surveys indicated the availability of 1.4 million cubic yards of material that was considered generally beach quality sand. An estimated recovery rate over 15 years was considered to provide a source of material sufficient to nourish beaches adjacent to the inlet; however, since the federal beach erosion control project already achieved the plan goals, adding the ebb shoal as a separate project was not deemed necessary.

The construction of a dredged sediment impoundment basin adjacent the federal navigation project was considered in the flood shoal area, which would improve navigation and reduce the frequency of channel dredging. An increase of 3,000 cubic yards of sand per year over the existing channel maintenance quantities were expected for an expensive project requiring removal of 55,000 cubic yards of limestone bedrock. A flood shoal deposition basin project was

not recommended due to its high cost and marginal benefits. Likewise, a mechanical sand bypassing operation was investigated, which would involve expensive permanent infrastructure and dedicated governmental personnel to operate it. Projections were made to transfer 24,000 cubic yards per year to the south; however, the project was not recommended due to its high cost and experimental nature.

Based upon the CP&E study and studies conducted by the USACE, on September 5, 1997, the Department adopted the Bakers Haulover Inlet Management Implementation Plan (FDEP, 1997). This plan adopted the following inlet management strategies:

- Placement of all beach compatible maintenance dredge material on downdrift beaches in areas of greatest need based on the comprehensive monitoring program or on updrift beaches if justified by monitoring data.
- Implement a comprehensive inlet, beach and offshore monitoring program in conjunction with the existing federal beach restoration project.

Updated Inlet Management Study of 2019

An update inlet management study was conducted for Miami-Dade County and the Department by Moffat & Nichol in 2018 to 2019 (M&N, 2019). This study updated the inlet sediment budget and investigated the feasibility of bypassing sediment across the inlet. The study specifically evaluated constructing a north jetty extension and optimized bypassing intervals with sand obtained from the beach system north of the inlet and transferred to the south of the inlet. Along with a beach borrow area, the study also evaluated a deeper beach borrow area and an offshore sand trap. Both hydraulic dredge transfer and a truck hauling project were evaluated.

M&N (2019) developed two shoreline evolution models for the beaches north and south of the inlet using the Delft Hydraulic Institute (DHI) model – LITLINE and the MIKE 21 (both spectral wave and hydrodynamic models). These models were applied to evaluate the beach nourishment volumes necessary to mitigate erosion to the beach south of the inlet and to determine the beach recovery volumes for the beach north of the inlet for different north jetty extension lengths. The study recommended a north jetty extension of 164 feet (50 meters) and a bypassing rate of every six years to meet the bypassing objective without having adverse impacts.

In order to optimize the north jetty extension and evaluate a possible ocean sand trap location, six alternatives were analyzed. Alternatives 1 and 2 evaluated jetty extensions of 50 meters and 60 meters. Alternatives 3 and 5 considered the 50- and 60-meters jetty extension and an alongshore sand trap north of the inlet. Alternatives 4 and 6 considered the 50- and 60-meters jetty extension with a shore-normal sand trap north of the inlet. A 5-year sand trap was designed with a dredging volume of 150,300 cubic yards. Based on model results, the jetty extensions would cause accretion of the beach north of the inlet, but the offshore sand traps would not trap a sufficient quantity of sand to justify their construction. Therefore, a beach borrow area was recommended.

Updated Inlet Sediment Budget of 2019

Pursuant to Section 161.142, Florida Statutes, dredging within an inlet system, including its shoals, should result in the placement of all beach quality sand on adjacent eroding beaches to balance the sediment budget between the inlet and adjacent beaches. A sediment budget is a balance of the volumes (or volume rate of change) for sediments entering and leaving a tidal inlet system and its adjacent beaches. A sediment budget quantifies the natural longshore sediment transport by waves and tides to and from the inlet, the entrapment of longshore sediment by the inlet channel and the ebb and flood shoals, and the mechanical "bypassing" of sediment, typically by a hydraulic dredge, from the inlet to the adjacent eroded beaches or nearshore. Sediment transport volumes and pathways are unique to each inlet as influenced by regional geology, morphological characteristics, wave and tide conditions, and sediment characteristics and supply. A sediment budget is determined by comparing two or more surveys of an inlet system, including its channel, ebb and flood shoals, and the adjacent beaches.

M&N (2019) developed an updated sediment budget of current conditions for Bakers Haulover Inlet using the Family of Solutions methodology (USACE, 2006) for the 2007 to 2016 time period. **Table 2** provides the selected values for the Family of Solutions sediment budget for 2007-2016 (M&N, 2019). The updated sediment budget is graphically presented in **Figure 3**, and updated net sediment budget is presented in **Figure 4**.

Noteworthy in **Figure 3** is the gross transport of sediment into the inlet from both north and south. 54,600 cubic yards per year are being transported into the inlet from the north and 6,100

cubic yards per year are being transported into the inlet from the south, which results in a total transport into the inlet of 60,700 cubic yards per year. Dredging of the inlet navigation channel by the Corps of Engineers over the period 2007-2016 has resulted in the removal of 36,300 cubic yards per year, and therefore has left a net of 24,400 cubic yards per year to be lost into the inlet, as shown in **Figure 4**.

Table 2. Family of Solutions sediment budget for 2007-2016 (M&N, 2019).

Item	Solution (cy/yr)
Net beach volume changes at north shoreline (Haulover Park beach)	+12,500
Net beach volume changes at south shoreline (Bal Harbour and Surfside beach)	-36,900
Inlet shoaling at flood shoal, ebb shoal and channel from north	+54,600
Inlet shoaling at flood shoal, ebb shoal and channel from south	+6,100
Net natural bypassing	14,900

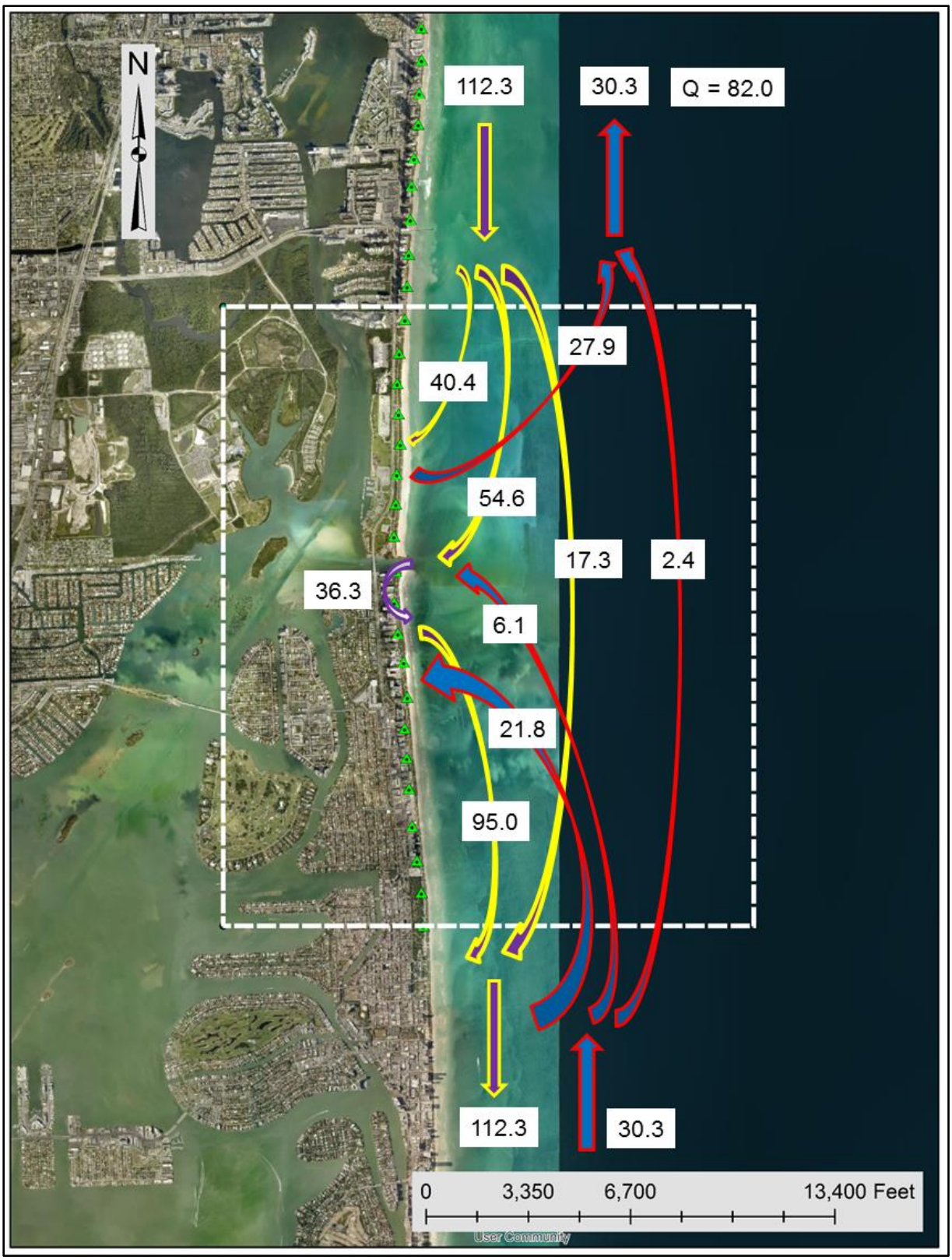

Figure 3. The updated Sediment Budget Solution 2 (Median) for Bakers Haulover Inlet for 2007 to 2016, with 1000's of cy/yr. (M&N 2019).

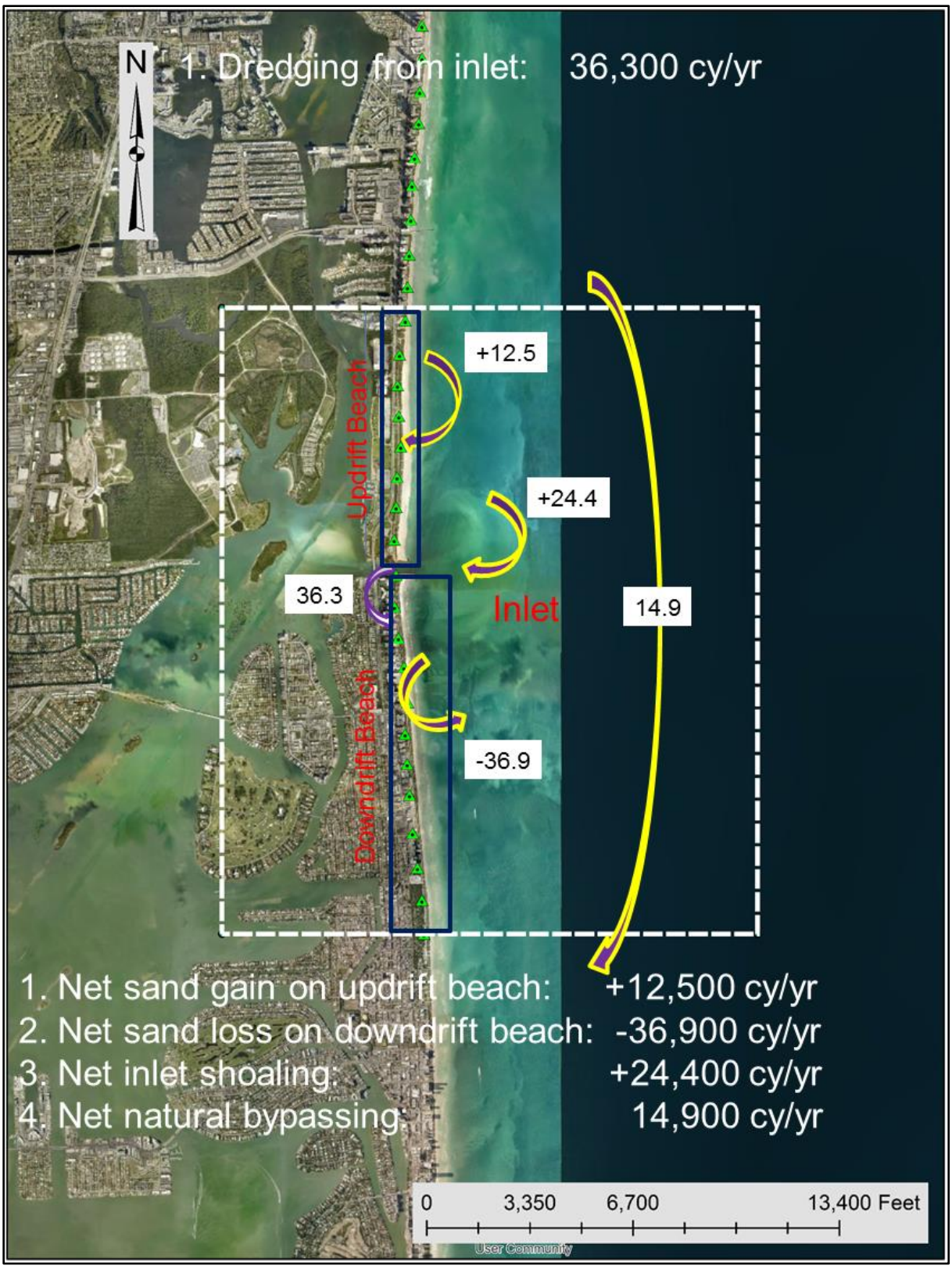

Figure 4. Net Sediment Budget Solution 2 for Bakers Haulover Inlet for 2007 to 2016, numbers in boxes are 1000's of cy/yr (M&N, 2019).

Given the recommendations to construct a 50-meter extension to the north jetty and conduct inlet sand bypassing from a beach borrow area north of the inlet, M&N (2019) developed a sediment budget estimate for these recommended projects using the Family of Solutions methodology for the 2007 to 2016 time period. Due to the north jetty extension, sand will accumulate north of the inlet as determined by the shoreline model. This accumulation of sand is to be mechanically bypassed to the south of the inlet. **Table 3** provides the selected sediment budget Family of Solutions values for the recommended project.

Table 3. Family of Solutions sediment budget for the recommended project (M&N, 2019).

Item	Solution (cy/yr)
Net beach volume changes at north shoreline (Haulover Park beach)	+30,000
Net beach volume changes at south shoreline (Bal Harbour and Surfside beach)	-36,900
Inlet shoaling at flood shoal, ebb shoal and channel from north	+10,100
Inlet shoaling at flood shoal, ebb shoal and channel from south	+3,100
Net natural bypassing	11,900

The sediment budget for the recommended project is graphically presented in **Figure 5** and the net sediment budget for the recommended project is presented in **Figure 6**.

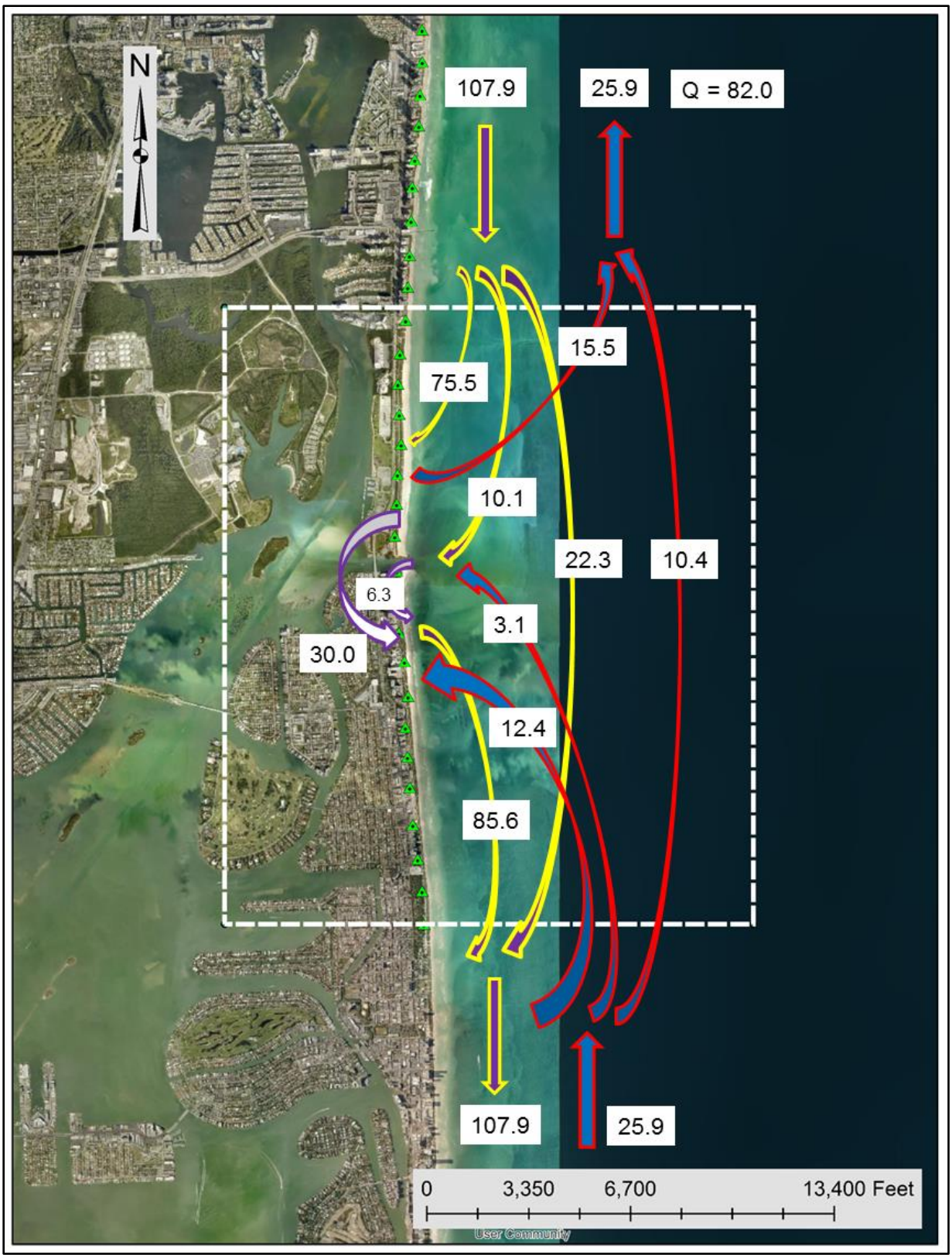

Figure 5. The sediment budget for the recommended project, 1000's/ cy/ yr. (M&N, 2019).

Figure 6. The net sediment budget for the recommended project (M&N, 2019).

Economic Analysis of Inlet Management Study

M&N (2019) compared the costs of the following alternatives for bypassing sand at Bakers Haulover Inlet.

A. No Action: considers the Miami-Dade County Beach Erosion Control and Hurricane Protection Project Plausible Nourishment Scenario (USACE, 2016) which refers to the placement of 330,000 cy of sand from the SL10-T41 offshore sand source at Bal Harbour in 2019. It also includes the ICWW dredging approximately every 3 years.

B. No Action modified: considers the actual current practice, based on the historical dredging records and the Ebb Shoal production rates from USACE (2016): dredging the Ebb Shoal approximately every 10 years and ICWW (flood shoal) approximately every 3 years.

C. North Jetty Extension + Dredging the Beach Borrow Area (BBA) + Inlet Dredging every 4 years

1. BBA to be dredged every 4 years
2. BBA to be dredged every 6 years

E. North Jetty Extension + Truck Hauling sand from the Beach Borrow Area + Inlet Dredging every 4 years

1. Truck Hauling sand from the BBA every 4 years
2. Truck Hauling sand from the BBA every 6 years

Table 4 from M&N (2019) summarizes the individual construction and beach fill projects for each scenario during a 20-year period in terms of volumes of sand. This planning horizon was selected in order to obtain comparable total quantities of sand. The projected volumes for the "no action" scenarios were based on the literature review, and the volumes for other scenarios were based on updated sediment budgets from M&N (2019).

Table 4. Individual construction and beach fill projects for each scenario from (M&N, 2019).

Date	Source A	Quantity (cy) A	Source B	Quantity (cy) B	Source C1	Quantity (cy) C1	Source C2	Quantity (cy) C2	Source E1	Quantity (cy) E1	Source E2	Quantity (cy) E2
2018												
2019	SL 10-T41*	330,000			Jetty Construction		Jetty Construction		Jetty Construction		Jetty Construction	
2020	Flood Shoal	35,000	Flood Shoal	35,000	Flood Shoal	35,000	Flood Shoal	35,000	Flood Shoal	35,000	Flood Shoal	35,000
2021												
2022												
2023	Flood Shoal	35,000	Flood Shoal	35,000	BBA**	120,000			BBA	120,000		
2024			Ebb Shoal	300,000	Inlet	25,200	Inlet	25,200	Inlet	25,200	Inlet	25,200
2025							BBA	180,000			BBA	180,000
2026	Flood Shoal	35,000	Flood Shoal	35,000	BBA	120,000			BBA	120,000		
2027					Inlet	25,200	Inlet	25,200	Inlet	25,200	Inlet	25,200
2028												
2029	Flood Shoal	35,000	Flood Shoal	35,000								
2030												
2031					BBA	120,000	BBA	180,000	BBA	120,000	BBA	180,000
2032	Flood Shoal	35,000	Flood Shoal	35,000	Inlet	25,200	Inlet	25,200	Inlet	25,200	Inlet	25,200
2033												
2034			Ebb Shoal	300,000								
2035	Flood Shoal	35,000	Flood Shoal	35,000	BBA	120,000			BBA	120,000		
2036					Inlet	25,200	Inlet	25,200	Inlet	25,200	Inlet	25,200
2037							BBA	180,000			BBA	180,000
2038	Flood Shoal	35,000	Flood Shoal	35,000								
Total		**575,000**		**845,000**		**615,800**		**675,800**		**615,800**		**675,800**

* SL 10-T41is an offshore borrow site from Bal Harbour, Fl. ** BBA stands for Beach Borrow Area.

To compare the scenarios, the costs of the individual construction events were estimated, and a cash flow based on the schedule presented in **Table 4** was developed for each alternative over the next 20 years. The value of future expenditures was adjusted by calculating their present worth using a discount (interest) rate of 2.75% (USACE, 2017). The sum of present values was determined for each alternative followed by the total annualized costs, which was calculated based on a capital recovery factor. Costs were estimated based on recent market conditions and on the best information available regarding the anticipated scope of each scenario. M&N (2019) cautions the cost opinions should be considered approximate and should only be used primarily for relative comparison of scenarios in terms of order-of-magnitude. Additional engineering design would be required to refine the cost estimates. The calculated total annualized cost was then divided by the total volume of placed sand over the 20-year period in order to compare different scenarios. M&N (2019) notes the cost of truck hauled sand is less than the cost of dredging due to the higher mobilization costs of dredge equipment. Scenario B is more economical than C1 or C2 because the mobilization costs are optimally amortized due to the 10-year project interval as opposed to 4 or 6 years. The results are presented in **Table 5**, which shows that the scenario with the most economical annual cost per cubic yard of sand is scenario B.

Table 5. Summary of probable costs of each scenario from M&N (2019).

Scenario	Total annual cost of projects ($)	Total volume of placed sand per year (cy/yr)	Total annual cost of projects per cy of placed sand ($/cy)
A No action	$ 2,084,000	28,750	$ 72
B No action, modified	$ 1,326,000	42,250	$ 31
C1 Jetty + Dredging BBA 4 yrs	$ 2,163,000	30,790	$ 70
C2 Jetty + Dredging BBA 6 yrs	$ 1,910,000	33,790	$ 57
E1 Jetty + Truck haul BBA 4 yrs	$ 1,495,000	30,790	$ 49
E2 Jetty + Truck haul BBA 6yrs	$ 1,527,000	33,790	$ 45

M&N (2019) believes another factor that should be considered in the economic analysis is the inlet shoaling rate of 24,400 cubic yards per year as determined in the existing conditions sediment budget of 2007-2016. The total quantity of sand transported into the inlet (60,700 cubic yards per year) less the quantity dredged by the Corps of Engineers (36,300 cubic yards per year) results in a loss of 24,400 cubic yards per year into the inlet and flood shoals. The inlet

shoaling rate is reduced to 6,900 cubic yards per year under the project scenarios C1, C2, E1 and E2. Equating the value of this sand to the average cost of recent local nourishment projects using upland sand sources ($60 per cubic yard), M&N (2019) considers the inlet shoaling to represent a loss of $1,464,000 per year of beach compatible sand. M&N (2019) also suggests that with the north jetty construction, the sediment budget sees a reduction in the loss of inlet shoal material as well as in natural bypassing. For the non-project scenarios, A and B, the inlet shoaling less natural bypassing represents a loss of -9,500 cubic yards per year, while the project scenarios C1, C2, E1 and E2 have a gain of 5,000 cubic yards per year. **Table 6** presents the total annual cost of each scenario considering the loss to the system as determined by M&N (2019). These results indicate that scenarios E1 and E2 with the north jetty extension combined with truck hauling sand every 4 to 6 years would be the most economical alternatives.

Table 6. Summary of probable costs of each scenario considering the losses to the system from M&N (2019).

Scenario	Total annual cost of projects ($)	Net Inlet Shoaling (cy/yr)	Natural Bypassing (cy/yr)	Total Loss/Gain (cy/yr)	Total annual cost of loss/gain ($)	Total annual cost ($)	Total annual cost per cy of placed sand ($/cy)
A	2,084,000	-24,400	14,900	-9,500	-570,000	2,654,000	$ 92
B	1,326,000	-24,400	14,900	-9,500	-570,000	1,896,000	$ 45
C1	2,163,000	-6,900	11,900	5,000	300,000	1,863,000	$ 61
C2	1,910,000	-6,900	11,900	5,000	300,000	1,610,000	$48
E1	1,495,000	-6,900	11,900	5,000	300,000	1,195,000	$ 39
E2	1,527,000	-6,900	11,900	5,000	300,000	1,227,000	$ 36

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.

6) **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. This monitoring program shall include topographic and hydrographic surveys of the inlet system, its ebb and flood shoals, and adjoining beaches between FDEP reference monuments R7 and R38.

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

7) **On an average annual basis, the initial minimum target inlet sand bypassing quantity shall be 36,900 cubic yards to the adjacent Atlantic beaches south of Bakers Haulover Inlet.** This target quantity may be modified or updated based on a minimum of four years or more of monitoring data or additional inlet model studies indicating a change in the sediment budget.

Discussion – The sediment budget developed in the inlet management study showed a loss of 36,900 cubic yards per year of beach erosion south of the inlet. This quantity should be the initial minimum quantity of material bypassed to mitigate the effects of the inlet on the adjacent eroding beach.

8) **Sand bypassing shall be performed from the Atlantic Intracoastal Waterway and Bakers Haulover Inlet federal navigation project channel and may be performed from the previously permitted Ebb Shoal Borrow Area, to be placed on the adjacent Atlantic beaches south of the inlet between FDEP Reference Monuments R27 and**

R32. The quantity of material to be bypassed from the navigation channels shall be based on available deposition quantities documented through the monitoring protocol of Strategy #1 above.

Discussion – During the period between 2007 and 2016 described in the updated sediment budget, the quantity of sand entering the inlet was 60,700 cubic yards per year. The quantity of sand dredged from the inlet and transferred to the south was 36,300 cubic yards per year. The periodic dredging of the flood shoal should be done in an environmentally acceptable manner and the material will be credited towards the bypassing objective in strategy # 2.

9) The proposed project investigated in the inlet management study was determined to be feasible by the preliminary modeling and economic analysis, which would include **extension of the north jetty by 164 feet (50 meters) and sand bypassing from the beach immediately north of the inlet to the beach south of the inlet at a quantity not to exceed 30,000 cubic yards per year**. Detailed engineering design and permitting shall be conducted prior to this beach bypassing with monitoring that shall specifically evaluate beach recovery north of the inlet and an analysis of public safety. The 2016 shoreline shall be the landward baseline to limit beach excavation and the post dredging adjustment of the beach profile shall not erode into the federally mandated design berm of the beach erosion control and hurricane protection project. A detailed geotechnical analysis shall be conducted that shall include an evaluation of the design dredge depth. Detailed engineering design to extend the north jetty that will include hydraulic modeling, public safety analysis, and environmental impact shall be conducted to develop an environmentally acceptable project. Should sand be entrapped seaward of the 2016 shoreline in excess of the quantity necessary to meet the southerly target bypassing quantity, the excess sand may be bypassed to the proximate beach restoration project to the north.

Discussion – The economic analysis determined the feasibility of bypassing sand from the beach north of the inlet and extending the north jetty. The north jetty extension combined with bypassing from the beach immediately north of the jetty will have the additional environmental

benefit of reducing loses of beach-compatible sand to a portion of the interior flood shoals where it might not be environmentally acceptable to remove the material.

10) **Sand may be obtained from the inlet's ebb shoal or flood shoals for nourishment of adjacent eroding beaches or proximate beach restoration projects provided sufficient engineering design, geotechnical analyses, and environmental impacts analyses justify the excavation.** Priority will be given to federal projects; however, beach fill placement between R27 and R32 shall be included in the target sand bypassing quantity.

Discussion – The ebb shoal and portions of the flood shoal provide significant quantities of beach quality sediment. Depending on the results of environmental effects, geotechnical data and engineering details, these shoals may be excellent borrow sites for nourishing proximate beach restoration projects.

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