Agenda Item: **5A-2**

PALM BEACH COUNTY
BOARD OF COUNTY COMMISSIONERS

AGENDA ITEM SUMMARY

Meeting Date:	October 4, 2022	() Consent ( ) Workshop	(X) Regular ( ) Public Hearing
Department:	Environmental Resources Management		

I. EXECUTIVE BRIEF

Motion and Title: Staff recommends motion to approve the Florida Department of Environmental Protection's (FDEP) South Lake Worth Inlet Management Plan (SLWIMP) dated July 2022.

Summary: The first SLWIMP was adopted by FDEP in 1999 and has guided the management of the inlet since. FDEP requires that state adopted management plans be updated periodically to satisfy Section 161.161, Florida Statutes. The 2022 Plan incorporates minor changes identified in an inlet management study and reinforces historically effective strategies established by the 1999 Plan. The purpose of this agenda item is in response to FDEP's request for the County's support of the updated plan. FDEP's adoption of the 2022 SLWIMP will support the County's eligibility for future state cost sharing and guide future management of the inlet. **There is no cost to the County.** District 4 (SS)

Background and Justification: The County's Environmental Resource Management Department, through partnership with FDEP, has bypassed approximately 2.1 million cubic yards of sediment across the inlet from 1999 to 2019 (110% of the 1999 SLWIMP's stated objective) to mitigate inlet effects and maintain adjacent beaches. The County, through its Annual Coastal and Marine Engineering Contract No. 2019-1542 with Aptim Environment and Infrastructure, LLC, performed a sediment budget analysis as part of an inlet management study for South Lake Work Inlet. The study was submitted to FDEP as a basis for development of the 2022 SLWIMP.

Attachment:
1. South Lake Worth Inlet Management Plan dated July 2022

Recommended by: _____ 9-13-2022
Department Director **Date**

SAS 9/13/22

Approved by: _____ 9/14/2022
Assistant County Administrator **Date**

II. FISCAL IMPACT ANALYSIS

A. Five Year Summary of Fiscal Impact:

Fiscal Years	2023	2024	2025	2026	2027
Capital Expenditures					
Operating Costs					
External Revenues					
Program Income (County)					
In-Kind Match (County)					
NET FISCAL IMPACT					
No. ADDITIONAL FTE POSITIONS (Cumulative)					

Is Item Included in Current Budget? Yes ____ No X

Does this item include the use of federal funds? Yes ____ No X

Budget Account No.: Fund _____ **Department** _____ **Unit** _____ **Object** _____.

Reporting Category _____

B. Recommended Sources of Funds/Summary of Fiscal Impact:

There is no fiscal impact to the County.

C. Department Fiscal Review: L. Neary

III. REVIEW COMMENTS

A. OFMB Fiscal and /or Contract Dev. and Control Comments:

Lisa Martin 9/7/22
OFMB 9A 9/7

9/12/22
Contract Dev. and Control

B. Legal Sufficiency:

9/13/22
Assistant County Attorney

C. Other Department Review:

_____
Department Director

ATTACHMENT 1

South Lake Worth Inlet Management Plan

Office of Resilience and Coastal Protection

Florida Department of Environmental Protection

July 2022

Table of Contents

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 South Lake Worth Inlet in Palm Beach County, Florida.

South Lake Worth Inlet Management Plan updates strategies for South Lake Worth Inlet that were adopted in the *South Lake Worth Inlet Management Implementation Plan* (FDEP, 1999) 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, updating the sediment budget, and adopting an updated inlet management plan. The Department and Palm Beach County sponsored an updated inlet management study of South Lake Worth Inlet in 2018-21 that was completed by Aptim Environmental & Infrastructure, LLC.

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."

Palm Beach County is the entity responsible for dredging South Lake Worth Inlet and consequently, mitigating the extent of beach erosion caused by the inlet, as specified in Subsection 161.142 (6), Florida Statutes.

History of South Lake Worth Inlet

South Lake Worth Inlet (also referred to as Boynton Inlet) is located on the southeast coast of Florida in Palm Beach County between FDEP monuments R-151 and R-152. The inlet separates the Town of Manalapan to the north from the Town of Ocean Ridge to the south, which are connected by the State Highway A1A bridge that traverses the inlet (**Figure 1 and Figure 2**). The inlet channel connects the Lake Worth Lagoon and Intracoastal Waterway (ICW) with the Atlantic Ocean. The nearest inlets are Lake Worth Inlet (also known as Palm Beach Inlet) located 15.5 miles to the north and Boca Raton Inlet located 14.5 miles to the south.

It is important to understand the history of South Lake Worth Inlet, its evolution, and prior inlet management activities, to gain a perspective on the inlet's dynamics and a basis to evaluate/adapt inlet management strategies over time. In 1915, the Florida Legislature approved an act creating a special taxing district in Palm Beach County known as the South Lake Worth Inlet District (APTIM, 2021). The act granted the board of commissioners of this taxing district the authority to construct and maintain an inlet connecting the waters of the Lake Worth Lagoon and Atlantic Ocean to promote circulation of water at the southern end of the Lagoon for improved water quality.

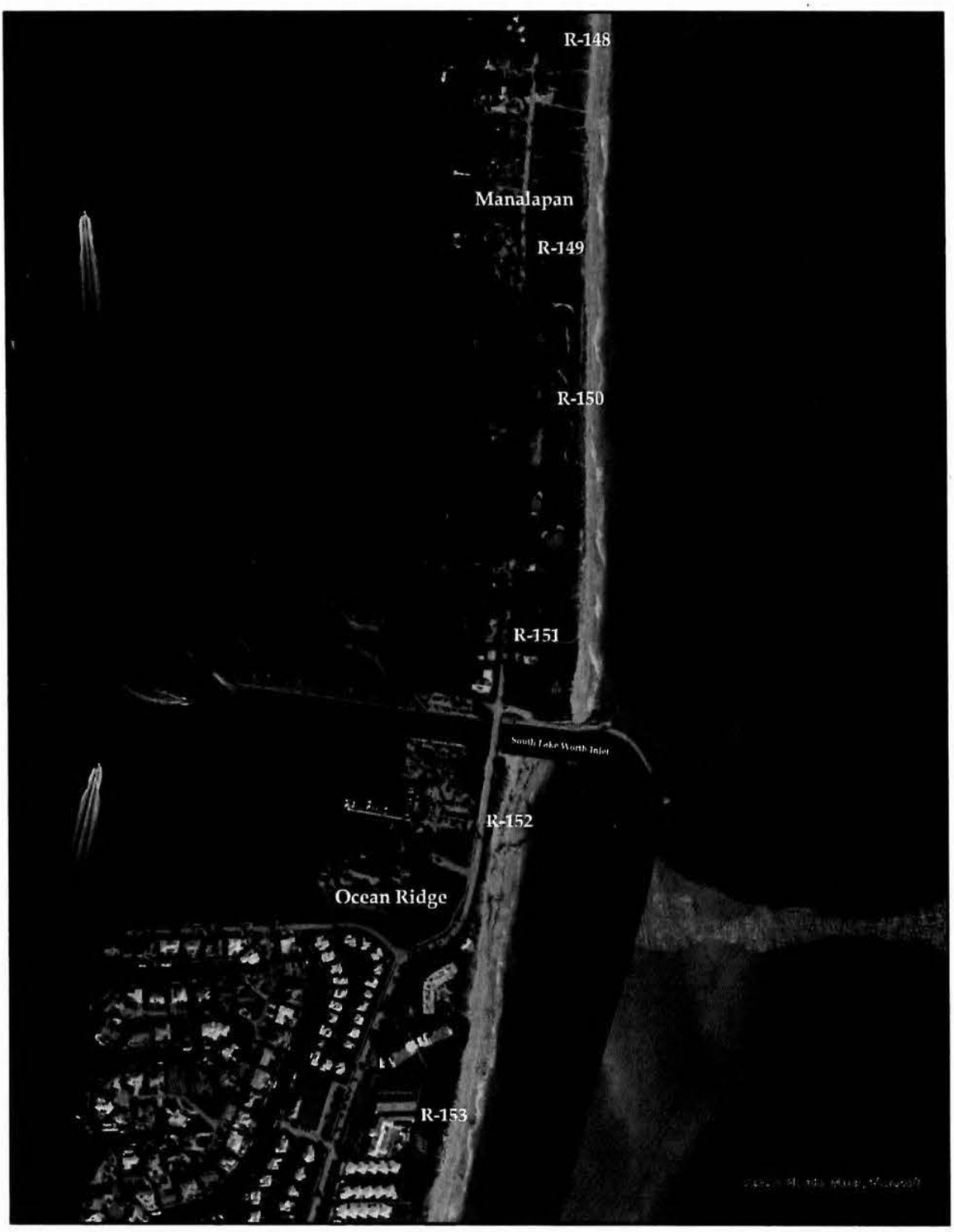

Figure 1. Aerial photograph of South Lake Worth Inlet from 2021, with the Towns of Manalapan and Ocean Ridge shown.

Figure 2. 2016 aerial photograph of South Lake Worth Inlet, facing southwest. Notable features include the north jetty and sand transfer plant, south jetty, T-head groin field, and A1A bridge. Photo courtesy of Palm Beach County.

South Lake Worth Inlet is a man-made inlet that was constructed in 1927. The original channel of South Lake Worth Inlet was 130 feet wide with a depth of -8 feet MLW (Strock & Associates, 1983). In addition, two straight jetties on opposing sides of the inlet, each approximately 350 feet long, were constructed to an elevation of +5 feet MLW to deter shoaling in the navigation channel. By 1932, however, due to the net southerly littoral transport at the inlet resulting in severe downdrift erosion south of the inlet, a 3,000-foot long concrete seawall (the McCormick Wall) was constructed along the Ocean Ridge shoreline to prevent further recession. The opposite shoreline condition was observed north of the inlet, where excessive shoaling resulted in sediment spilling over and around the north jetty. This process was expected to result in the obstruction of the inlet if left unabated (UF, 1964). The north jetty was consequently raised to a crest elevation of +12 ft MLW in 1936 to mitigate the shoaling of material into the channel (Strock & Associates, 1983). Also, in 1936, due to concerns for erosion undermining the McCormick Wall, seven groins were constructed to mitigate the persistent trend of shoreline erosion. However, this effort was deemed a failure, with reports from Caldwell (1950) stating that no discernible accumulation of sediment had occurred within the groin field between 1936

and 1937 due to the lack of littoral material bypassing the inlet. In 1937, a sand transfer plant (**Figure 3**) was constructed as a solution to the persistent erosion and, within six months of its installation, all groins were filled to capacity, thereby advancing the shoreline south of the inlet seaward (Watts, 1953). **Figure 4** is a depiction of the sand transfer plant as it was reconstructed circa 1967.

Figure 3. 1940's photo of South Lake Worth Inlet with short straight jetties and the original sand transfer plant. Photo courtesy of the Boynton Beach Historical Society.

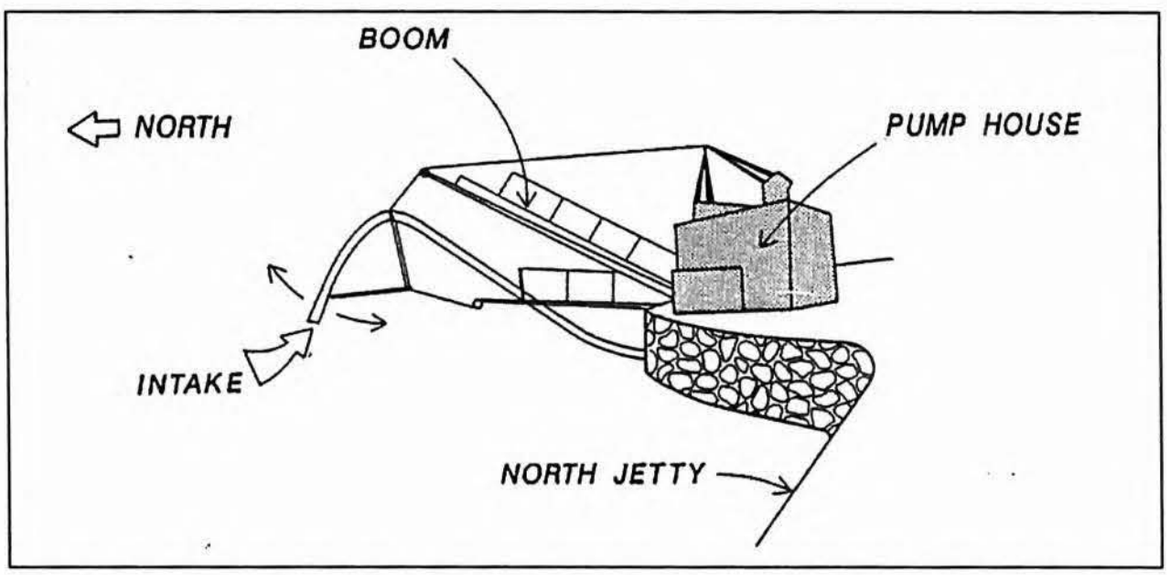

Figure 4. Schematic depicting the South Lake Worth sand transfer plant (Olsen Associates, 1990).

Operation at the sand transfer plant was temporarily halted between 1942 and 1945 due to war-time fuel shortages (Strock & Associates, 1983). During this period, the south side of the inlet again exhibited severe erosion and a large flood shoal developed within Lake Worth Lagoon. This led to the first maintenance dredging event of the flood shoal in 1948. Also, in 1948, the size of the pump at the sand transfer plant was increased from 6 to 8 inches as well as the engine capacity from 65 to 300 horsepower (UF, 1964). These plant improvements increased the maximum sand transfer rate from 55 to 76.2 cubic yards per hour and, as a result, the sand transfer plant was able to sustain an estimated pumping rate of over 70,000 cubic yards per year (Watts, 1953).

In 1964, the Coastal Engineering Laboratory at the University of Florida commenced a study at the request of the South Lake Worth Inlet District Commission to study the dynamics of the inlet and propose improvements to its current operation. Both a field study and a hydraulic physical model were employed to gather information on variables including current velocities, prevailing wave climate, beach erosion, and estuarine circulation to determine how these factors impacted navigation, water quality, and the physical stability of the inlet. The investigation concluded that the hydrodynamic conditions within the inlet, including maximum wave height of 6 feet and current velocities ranging from 7-9 ft/sec during peak ebb and flood tide, were hazardous for navigation.

The study recommended two alternative schemes to mitigate the navigation risks within the inlet. The first scheme proposed maintaining the active inlet width of 130 feet while removing the abutments of the A1A bridge, widening the inlet entrance to 200 feet with extended north and south jetties, creating a mobile sand bypassing plant with a relatively larger radius, designating a sand trap at the bay entrance to the inlet, and extending the south bulkhead as far west as its counterpart to the north. The second scheme proposed widening the inlet itself to 200 feet and the inlet entrance to 270 feet along with all the changes specified in the first alternative. In 1967, the sand transfer plant was relocated 118 feet seaward and the intake boom was lengthened to 35 feet. Both the north and south jetties were extended 410 feet and 65 feet, respectively, to their current configurations, in which the north jetty curves towards the southeast and extends 400 feet farther seaward than the south jetty (APTIM, 2021; Olsen Associates, 1990). The interior shoaling decreased sufficiently such that the channel maintenance dredging rate fell to an average of only 4,000 cubic yards per year from 1973 to 1990. Independent of the university's recommendations, a north jetty spur was constructed in 1971 to add wave protection for the intake of the sand transfer plant. A summary of improvements is presented in **Figure 5.**

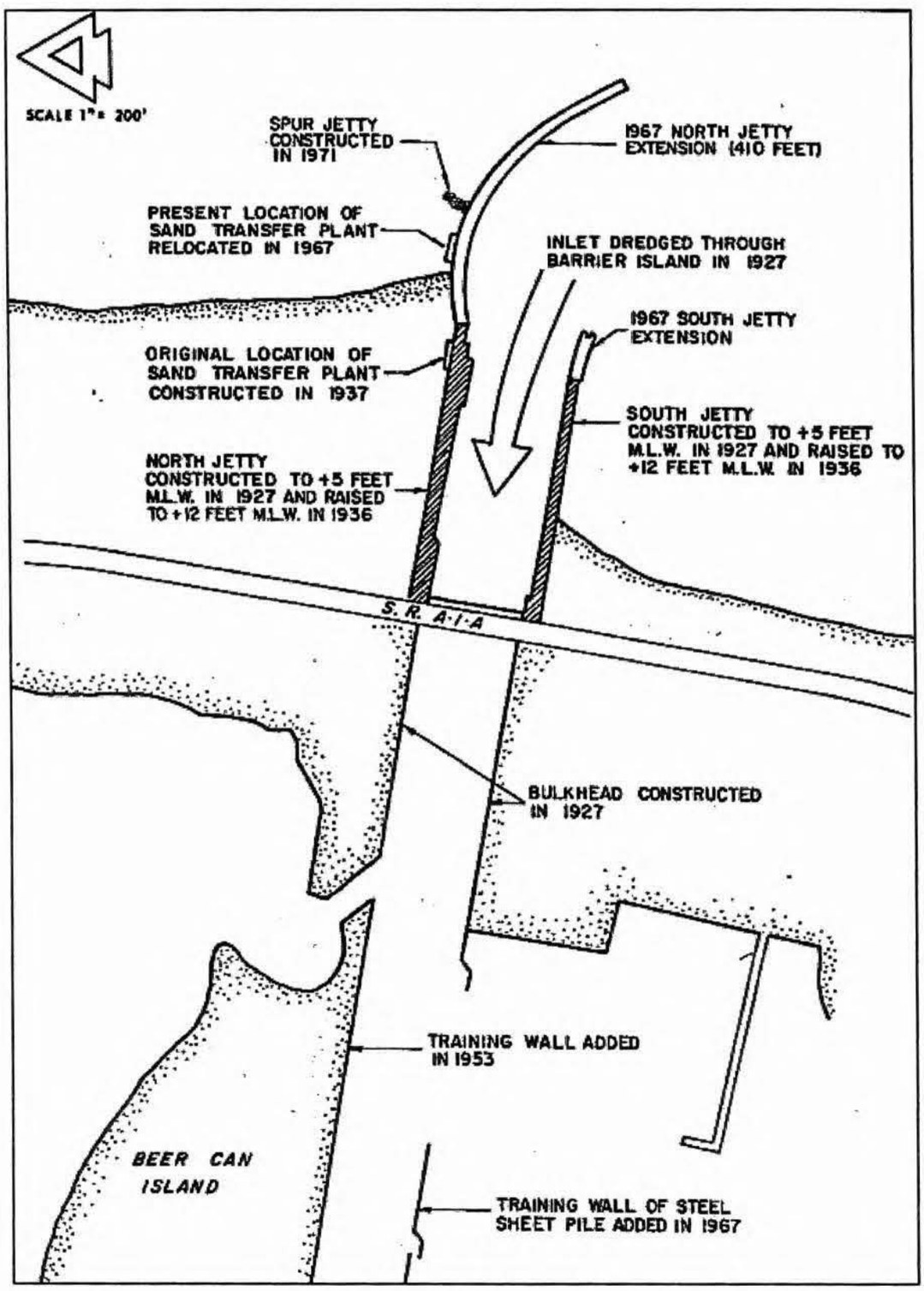

Figure 5. Summary of improvements at South Lake Worth Inlet (Strock & Associates,1983).

In 1983, Strock & Associates completed a study at the request of Palm Beach County with the objective of determining the impact of South Lake Worth Inlet on the adjacent beaches. The beaches of the downdrift towns of Ocean Ridge and Briny Breezes were of particular interest due to their state of critical erosion. It was estimated that the one-mile study area south of the inlet had lost 318,000 cubic yards of sand above the -18-foot contour from 1955 to 1979. On the other hand, the one-mile study area north of the inlet was estimated to have gained 364,300 cubic yards over the same period. The eroded condition south of the inlet coupled with the impacts of several storm events during the winter season of 1978-79 had exposed the seawall protecting State Road A1A. Erosion had become so severe that the outfall pipe from the sand transfer plant, located 500 feet south of the south jetty, was depositing sand directly into the swash zone (**Figure 6**).

Figure 6. Eroded beach conditions south of South Lake Worth Inlet (Boynton Beach News Journal, 05-26-1977).

Strock & Associates (1983) found that all three methods of sand bypassing to the southern beaches (i.e. natural bypassing, inlet dredging, and the fixed sand transfer plant) had been negatively impacted by the 1967 inlet modifications. The 1967 north jetty extension reduced natural sand bypassing from north to south by displacing the sand bypassing bar further offshore. In addition, this extension similarly reduced shoaling in the historical dredging areas within Lake Worth, causing a suspension of interior dredging from 1973 onwards under concerns regarding the depletion of sand from the Manalapan estuarine shorelines. Also, rock settlement at the north jetty increased the structural permeability and led to diminished storage within the sand pit that supplied the sand transfer plant. Although sand volumes bypassed by the fixed sand transfer plant increased by 15+ percent after 1967, this increased quantity was insufficient to compensate for the diminished sediment transfer volumes from the other two sources over the same period. Strock & Associates (1983) explored a number of alternatives to increase bypassing, including removing the 1967 north jetty extension, equipping the sand transfer plant with the capacity for mobility, creating an auxiliary sand intake pump at the original sand transfer plant, relocating the sand transfer plant to the north, adding jet pumps to the existing sand transfer plant operation, constructing a weir jetty to the north of the current north jetty, repairing the north jetty, extending the south jetty, and dredging the flood shoals from Lake Worth Lagoon. The following recommendations were provided; however, none were put into practice at that time:

1. Construct jet pumps to increase sand transfer quantities across South Lake Worth Inlet.
2. Construct a weir jetty 200 feet north of the existing north jetty.
3. Dredge sand from Lake Worth and deposit it on the Ocean Ridge beaches; investigate alternative shoal areas for future dredging.
4. Repair the settlement of the north jetty with grout filled bags.
5. Install a sand transfer plant monitoring system to record the actual sand volume quantities transferred by the installation.
6. Monitor the inlet-adjacent beaches using surveys twice a year for two years post-construction as well as the annual dredging rates.

From 1967 to 1975, the fixed sand transfer plant bypassed approximately 48,733 cubic yards of sand per year. This quantity increased to over 75,000 cubic yards per year from 1976 to 1990 and

continued to rise into the future. Annual and cumulative bypassing quantities through the sand transfer plant are provided in **Table 1 & Table 2.**

Table 1. Historical record of annual and average annual sand transfer plant (STP) bypassing [cy] from 1967 to 2018. Table adopted from Palm Beach County (2021).

Year	Volume (cy)	Interval	Average Annual Volume cy/yr
1967	17,550		
1968	32,250		
1969	73,800		
1970	41,775		
1971	42,675		
1972	28,425		
1973	95,550		
1974	36,300		
1975	70,275	1967 to 1975	48,733
1976	77,850		
1977	85,350		
1978	76,350		
1979	39,600		
1980	41,550		
1981	93,900		
1982	130,350		
1983	99,150		
1984	116,850		

Year	Volume (cy)	Interval	Average Annual Volume cy/yr
1985	87,375		
1986	68,235		
1987	71,175		
1988	59,925		
1989	38,385		
1990	41,130		
1991	24,465		
1992	39,105		
1993	38,250		
1994	35,600		
1995	22,560		
1996	73,040		
1997	32,560	1976 to 1997	63,307
1998	40,200		
1999	58,007		
2000	93,700		
2001	90,010		
2002	56,300	1998 to 2002	67,643
2003	60,140		
2004	72,600		
2005	76,800		

Year	Volume (cy)	Interval	Average Annual Volume cy/yr
2006	91,200		
2007	123,500		
2008	116,050		
2009	59,100		
2010	140,025		
2011	81,750		
2012	70,200	2003 to 2012	89,137
2013	67,200		
2014	55,125		
2015	92,400		
2016	111,462		
2017	82,512		
2018	97,475	2013 to 2018	84,362
2019*	133,612		
2020*	145,338		
2021*	101,063	2019 to 2021	126,671

** = These sand transfer volumes were verified with the county through the 2022 update to the FDEP Annual Inlet Report.*

Table 2. Historical record of cumulative sand transfer plant (STP) bypassing [cy] between 1967 to 2018. Table adopted from Palm Beach County (2021).

Years	Cumulative Volume	Average Annual Volume [cy/yr]
1967 to 1975	438,600	48,733
1976 to 2021	3,508,524	76,273
1967 to 2021	3,947,124	71,766

In 1990, Olsen Associates, Inc. (OAI) performed an inlet sand management study for Palm Beach County, which included a sediment budget representative of the coastal and estuarine conditions from 1975 to 1990 under the assumption that the net incident littoral drift rate was 200,000 cubic yards per year from north to south (**Figure 7**). The sediment budget showed that only 168,000 cubic yards per year exited the south boundary of the inlet system, of which 5,000 cubic yards eroded from the Ocean Ridge shoreline. The sand transfer plant was responsible for nearly 50 percent of the sand bypassing the inlet, which highlighted its key role in mitigating the downdrift impacts of the inlet and jetties at an annual cost of about $200,000 per year or $2.86 per cubic yard. Shoreline accretional trends extended about 5,000 feet north of the inlet with average accretion rates of about +4 feet per year. South of the inlet, chronic shoreline erosion persisted for about 1,200 feet, with shoreline erosion rates reaching a maximum of -8 feet per year at the south jetty to about -2 feet per year near the southern limits of the Town of Ocean Ridge.

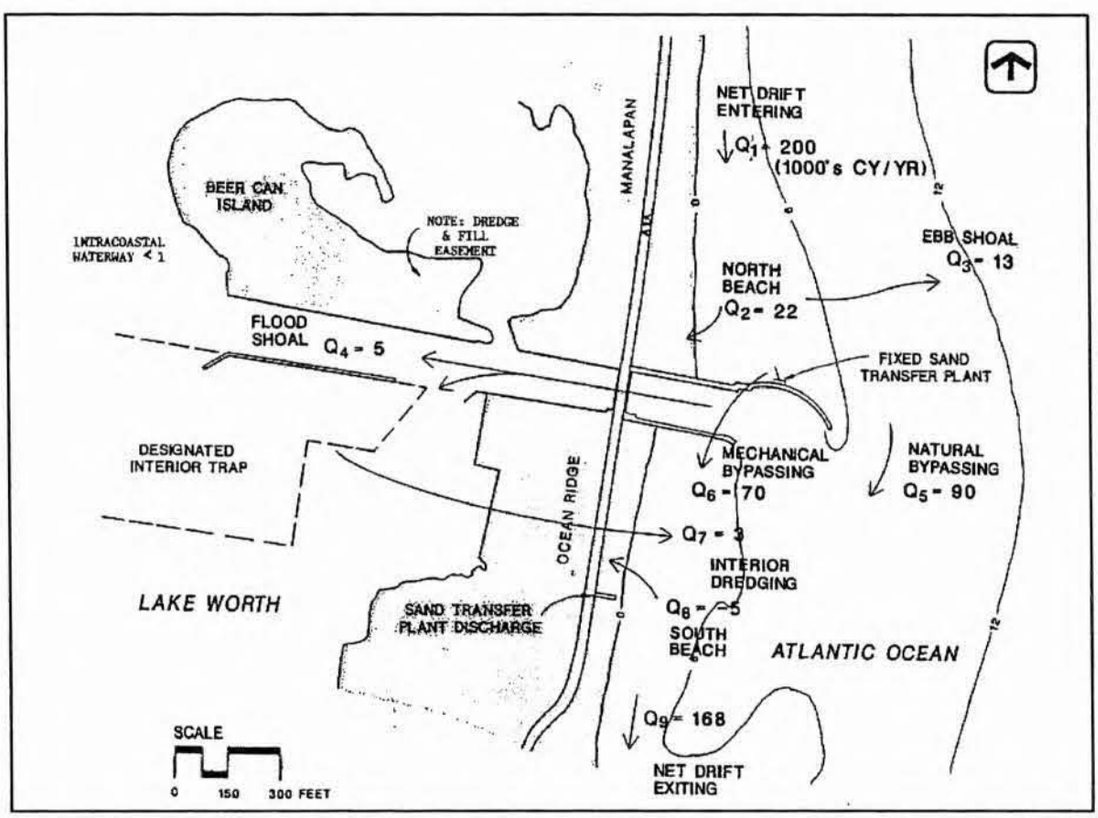

Figure 7. South Lake Worth Inlet sediment budget for conditions between 1975 and 1990. Values are in thousands of cubic yards per year. Figure from Olsen Associates, Inc. (1990).

OAI (1990) also recommended short and long-term strategies to mitigate the beach erosion problems associated with South Lake Worth Inlet. The short-term strategy called for partially restoring the adversely impacted downdrift beaches through beach nourishment. The nourishment would extend from 6,100-13,300 feet south of the inlet (including all of the Ocean Ridge shoreline), deposit 0.4-1.0 million cubic yards of beach sand, and have a nominal project life of 2-4 years within the direct placement area. The long-term strategy called for restoration of a state of littoral equilibrium across the inlet through recommended modifications to the inlet, modifications which mirrored some of those proposed by Strock & Associates in 1983 (e.g. installing jet pumps to assist sand bypassing). Additional recommendations included the installation of structures south of the jetty to stabilize beach fill, surveying of offshore sand sources, and lifting the suspension of dredging from the interior sand trap.

In 1998, the federally authorized Ocean Ridge Shore Protection Project was constructed with the placement of 973,000 cubic yards of sand obtained from an offshore borrow site (**Table 3**). The project was authorized until 2039 with a 6-year nourishment interval and sponsored by Palm Beach County. This project fulfilled the requirements adopted in the South Lake Worth Inlet Management Implementation Plan (FDEP, 1999) to sustain the shorelines south of the inlet with beach- compatible sediment from offshore sources. Prior to the beach restoration project, eight T-head groins were constructed immediately south of the inlet, to retain sediment in the historically erosive beach area from the south jetty to R-153+200 feet.

Table 3. Town of Ocean Ridge beach fill placement volumes [cy] from R-152 to R-159 (FDEP, 2020; APTIM, 2021).

Placement Volumes for the Ocean Ridge Shore Protection Project	
Year Completed	**Quantity (Cubic Yards)**
1998	973,000
2005	558,000
2014	487,700
2020	463,928

Adopted Inlet Management Plan of 1999

In September 1998, an inlet management study of South Lake Worth Inlet was completed by Coastal Planning & Engineering, Inc., sponsored by the FDEP, Palm Beach County, the Town of Manalapan, and the Town of Ocean Ridge. This study addressed the extent to which the inlet caused beach erosion and provided recommendations to mitigate erosion (CP&E, 1998). The study developed a sediment budget for the inlet and adjacent shorelines that represented the time period between 1990 and 1997 (**Figure 8**). The sediment budget determined a net southerly incident littoral drift of 200,000 cubic yards per year. The study recommended a bypass objective of 88,000 cubic yards per year of which a minimum of 60,000 cubic yards per year would come from operation of the sand transfer plant. Ten management alternatives were evaluated within the study, including:

1) A low-profile groin in Manalapan,
2) A Manalapan erosion control project,
3) Interior deposition basin expansion,
4) Interior shoal dredging,

5) The Ocean Ridge Shore Protection Project,
6) A new sand transfer plant protocol and Manalapan beach markers,
7) Rock ledge removal,
8) Navigation aids,
9) Extend sand bypassing plant discharge pipes, and
10) Physical monitoring plan.

On March 5, 1999, the Department adopted the South Lake Worth Inlet Management Implementation Plan calling for the following four implementation actions (FDEP, 1999).

1) Continue to bypass suitable sediment to the downdrift beaches. As a first priority, place material on the beach in areas most in need and environmentally suited. As a minimum, bypassing of material shall meet average annual placement objectives as stated in the sediment budget. The sediment budget contained in the study report is adopted as an interim measure and shall be formally validated or redefined in subsequent revisions of the plan based on a comprehensive monitoring plan by December 31, 2001.

2) Implement the sand transfer plant protocols subject to verification by the findings of the monitoring program. Average annual bypassing of a minimum of 60,000 cubic yards should be conducted by the sand transfer plant in order to achieve a portion of the mechanical bypassing objective and to maintain a portion of the beach restoration project. The bypassing by the sand transfer plant shall not exceed an amount necessary to maintain the shoreline in Manalapan. Multiple discharge points for the sand transfer plant should be added to optimize performance of the beach restoration project.

3) Construct the expansion of the interior deposition basin to facilitate bypassing objectives as stated above.

4) Implement a comprehensive beach and offshore monitoring program subject to the approval of the Department.

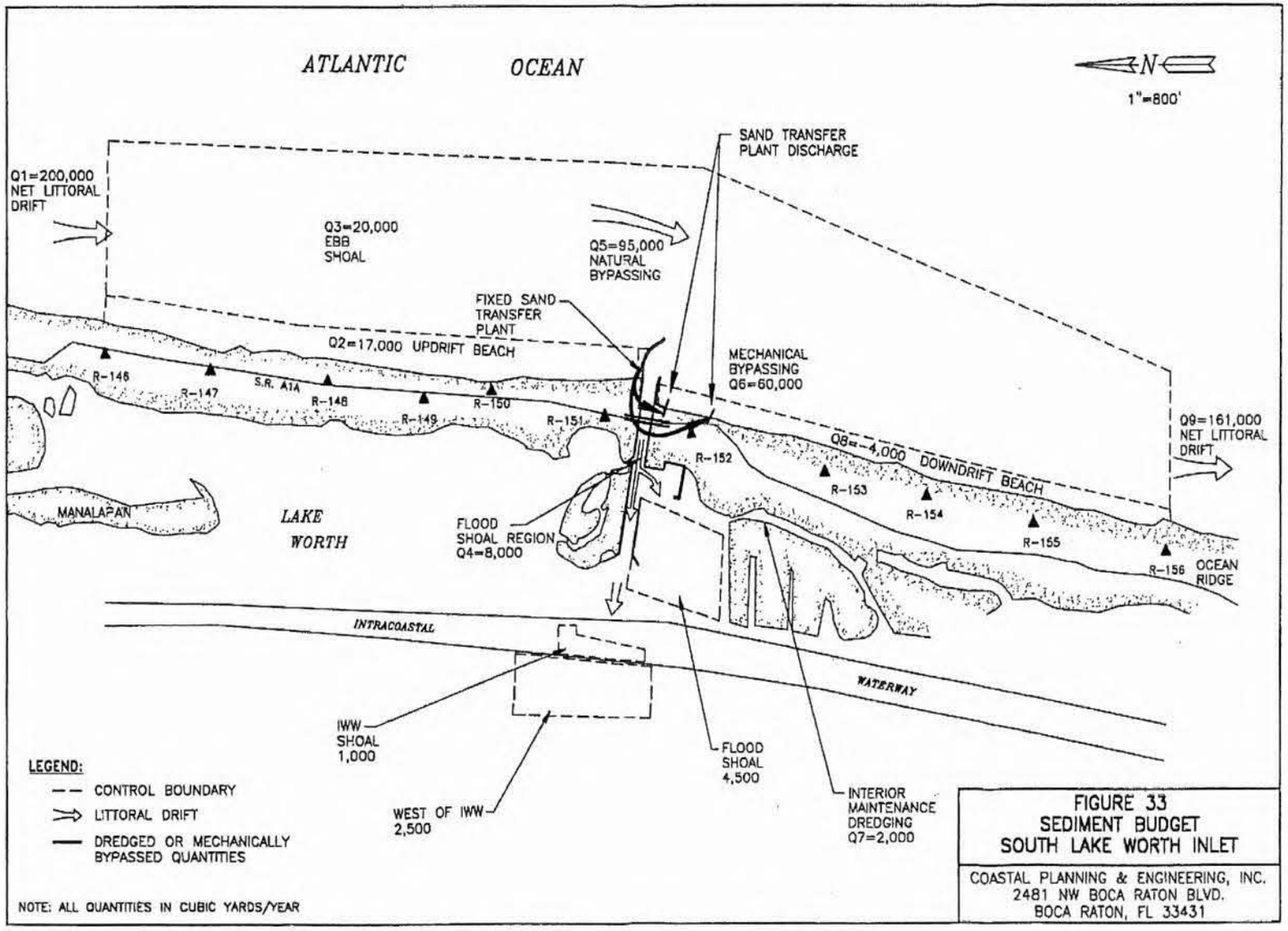

Figure 8. South Lake Worth Inlet sediment budget adopted in the inlet management plan (CP&E, 1998).

Additional Inlet Studies & Construction; 2000-2021

In July 2001, an initial engineering study by Botkin Parssi & Associates provided design parameters to modify the existing sand transfer plant with an estimated cost of $2.5-2.8 million (FDEP, 2020). The primary recommendations specified relocating a new plant directly north of the existing plant and expanding both the size and current network of discharge pipes (which, in 2001, only discharged sediment at Groins 1, 3, and 8). Final designs were completed by Bridge Design and Associates, Inc. Construction of the new sand transfer plant in 2009 provided upgrades including an electric motor and a larger discharge pipe (**Figure 9**).

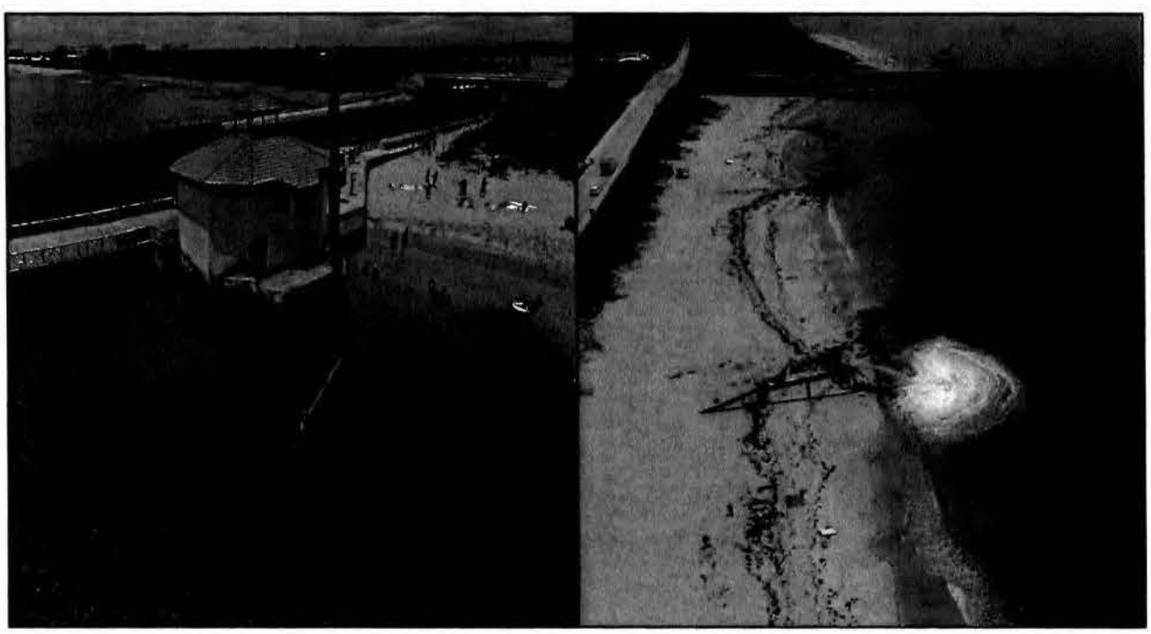

Figure 9. Imagery of the South Lake Worth Inlet sand transfer plant (left) and discharge pipe nearest to the south jetty (right). Photos from 2016 and courtesy of Palm Beach County.

In 2004, the Palm Beach County Board of County Commissioners authorized a study by Coastal Planning and Engineering, Inc. (CP&E) to review the 1997-2002 beach profile and bathymetric data for South Lake Worth Inlet as well as update the sediment budget for the timeframe (CP&E, 2004). This sediment budget was compared to the sediment budget adopted in the inlet management plan, which spanned the period 1990-1997. In addition, CP&E (2004) reviewed several proposed sand transfer options and documented inlet activities undertaken by the county since 1997. The Manalapan beaches were determined to have demonstrated higher rates of sediment accretion than during 1990-1997 despite an increase in mechanical sand bypassing.

Additionally, while the inlet ebb shoal continued to grow, it grew at a lower rate from 1997-2002 than from 1990-1997. CP&E (2004) recommended a reduction of bypassing to the groin 3 discharge location to mitigate sediment losses into the inlet while suggesting that initializing bypassing to groin 8 may be a feasible option to increase supply of sediment to the Ocean Ridge beaches.

Other notable changes which took place within the South Lake Worth coastal system during the period defined by the first IMP include the following Palm Beach County (2021):

- 2002: Removal of the rock ledge within the throat of the inlet; creation of sand trap south of the south training wall.
- 2008: Rock removal from the sand trap and inlet throat.
- 2009 – 2011: Rehabilitation of north and south jetties; replacement of sand transfer plant.
- 2013: Modification of groin field by lowering the crest elevation of the groin stems for groins 4 through 8.
- 2014: Rock removal for expansion of the sand trap.
- 2005, 2014: Ocean Ridge shore protection project beach nourishment (**Table 3**).
- 2002, 2008, 2014: Maintenance dredging of the flood shoal, sand trap, and interior waterways (**Table 4**).

Table 4. Flood shoal dredging and disposal records from 2001-2018. Flood shoal dredging occurred within the sand trap (ST) and interior waterways, including the Intercoastal Waterway (ICW) channel referred to as Cut P50 and the Boynton Boat Club Channel (BC). Table adopted from Palm Beach County (2021).

Years	Flood Shoal Dredge Sites	Placement Site: Sand Bypassing at beach south of inlet (cy)	Placement Site: Beneficial Use – Lake Worth Lagoon (cy)	Placement Site: Upland (cy)
2001-2002	ST	41,640	9,250	
2001-2002	ST/P50		6,000	
2001-2002	Cut P50	30,000		
2001-2002	BC	1,325		1,325
2001-2002	**Subtotal**	**72,965**	**15,250**	**1,325**

Years	Flood Shoal Dredge Sites	Placement Site: Sand Bypassing at beach south of inlet (cy)	Placement Site: Beneficial Use – Lake Worth Lagoon (cy)	Placement Site: Upland (cy)
2008	ST	26,222		
2008	Cut P50	21,766		
2008	BC	4,480		
2008	**Subtotal**	**52,468**		
2013-2014	ST	23,314	28,730	
2013-2014	Cut P50	10,745	9,142	
2013-2014	Cut P50/ BC		11,182	
2013-2014	BC	4,894		
2013-2014	**Subtotal**	**38,953**	**49,054**	
2001-2014	**Total**	**164,386**	**64,304**	**1,325**

ST = Sand Trap; Cut P50 = a portion of ICW navigation channel; BC = Boynton Boat Club Channel. Note: Park renamed to Harvey E. Oyer Jr. Park in 2011.

2021 Inlet Management Study

An updated inlet management study sponsored by the department and Palm Beach County was completed in 2021 by APTIM, which assessed historical volumetric changes across beach profiles and updated the inlet sediment budget from its most recent update in 2004 by CP&E (APTIM, 2021). Specifically, the sediment budget was split into the time periods from 2002 to 2012 and from 2012 to 2021.

APTIM (2021) determined the limits of inlet influence for the two sediment budgets using a combination of methods. The first method utilized the assumption that bathymetric contours would appear parallel to a given shoreline provided that the shoreline was not under the influence of an inlet. Therefore, the intersection of the -10 and -20 foot depth contours from the 2018 bathymetry with the transposed shore-parallel -10 and -20 foot depth contours were deemed as the extent of inlet influence. Aerial imagery was similarly used to demarcate the

limits of the inlet influence and differentiate individual littoral cells. The northern and southern limits of inlet influence were determined to extend from R-146 in Manalapan to as far south as R-159 in Ocean Ridge. Also, historical bypassing quantities and beach nourishment volumes were incorporated into the sediment budgets for the two time periods.

The individual littoral cells (**Figure 10**) were defined within APTIM (2021) as the following:
Q1: The net sediment transport reaching the northern end of the Manalapan beach cell at R-146.
Q2: Nearshore beach changes from R-146 to the north jetty of SLWI.
Q3: Ebb shoal changes. Computations also allowed the identification of Q3N ebb shoal changes north of the inlet, Q3C ebb shoal changes from the north jetty to Groin 8, and Q3S ebb shoal changes south of Groin 8 and north of R-156.
Q4: Volumetric changes within the flood shoal region including the sand trap, the Intracoastal Waterway, and the Boat Club channel.
Q5: The natural transport of sand from north of SLWI to south of SLWI. Q6: Nearshore beach changes from the south jetty to Groin 8.
Q7: Sediment transport at the beach immediately adjacent to the south jetty. Q8: Mechanically bypassed sand by the sand transfer plant.
Q9: Sediment transport at Groin 8.
Q10: Dredging of sand from the offshore borrow area. The borrow area is defined to be outside of the influence of the inlet.
Q11: Nearshore beach changes between Groin 8 and R-156.
Q12: Interior dredging of the flood shoal region with deposition within the Q11 cell. Q13: Sediment transport at R-156.
Q14N: Nearshore beach changes between R-156 and R-159. Q14O: Offshore beach changes between R-156 and R-159.
Q15: Net sediment transport at R-159 into the southern portions of Ocean Ridge.

The transport estimates were divided into four primary segments: north of the inlet, the inlet to Groin 8, Groin 8 to R-156, and R-156 to R-159. Each of these segments was comprised of several of the aforementioned littoral cells from which transport estimates were derived using a number of unique assumptions for each individual segment. These transport estimates were then summed to comprise the net sediment budget.

The gross sediment transport quantities over both timeframes exhibit a bidirectional but predominantly southerly transport pattern. The gross transport from 2002-2012 is characterized by a smaller southerly transport magnitude than that of its counterpart from 2012-2018. The north and south sediment transport quantities for the four segments for each time period is summarized below in **Table 5**.

Table 5. Summary of the north, and total gross transport quantities during the 2002-2012 and 2012-2018 time intervals. Transport quantities are presented in [kcy/yr]. Note the convention in which northern transport is (-) and southern transport is (+). Table adopted from APTIM (2021).

Time Interval	North of Inlet		South Beach to Groin 8		Groin 8 to R-156		R-156 to R-159	
	North	South	North	South	North	South	North	South
2002-2012	-61	170	-1	90	-2	237	-2	263
	109 Total		89 Total		235 Total		261 Total	
2012-2018	-25	143	-1	90	0	270	-14	304
	118 Total		89 Total		270 Total		290 Total	

APTIM (2021) presented the inlet sediment budget for the time period from 2002 to 2012 (**Figure 10**). Within this timeframe, the estimated net southerly transport from Manalapan entering the area of inlet influence was determined to be Q1 = 251,000 cubic yards per year, using calculations of wave energy which were calibrated to match the net transport of previous sediment budgets. The Manalapan shorelines accreted a total of 20,000 cubic yards per year in the nearshore and 12,000 cubic yards per year in the offshore littoral cells for a total of 32,000 cubic yards per year. During this period, the downdrift Ocean Ridge shorelines lost -6,000 cubic yards per year in the nearshore littoral cells and accreted 16,000 cubic yards per year in the offshore cells. These rates reflect the contribution of mechanically bypassed material from the sand transfer plant and beach nourishment projects over the period from 2002 to 2012, as well as the sediment deposited through natural bypassing. The sand transfer plant exceeded the minimum bypassing rate called for in the inlet management plan and assisted in sustaining the beaches downdrift of the inlet.

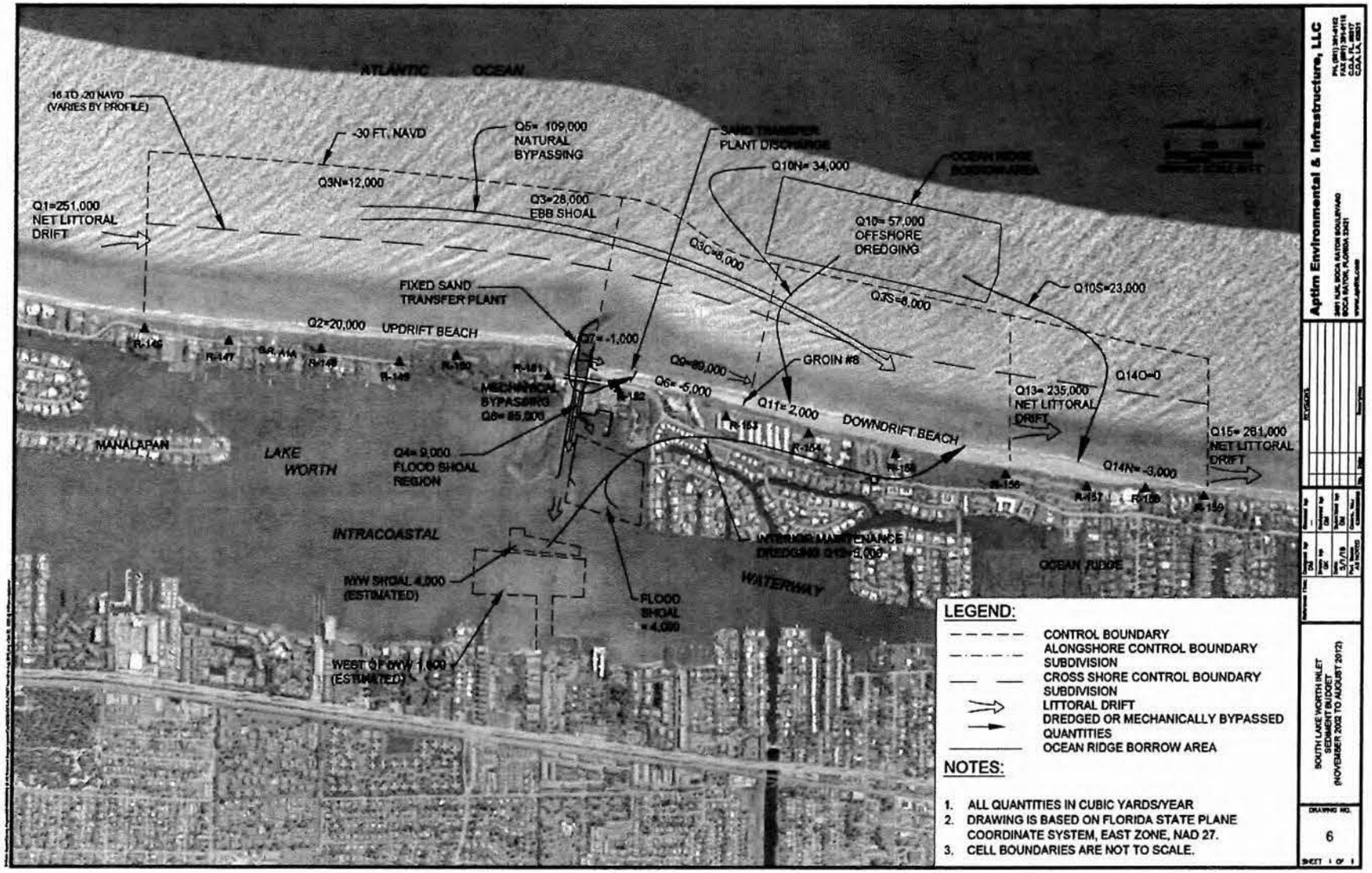

Figure 10. Net Sediment budget for South Lake Worth Inlet, 2002-2012 (APTIM, 2021).

APTIM (2021) similarly presented the net sediment budget for the time period from 2012 to 2018 (**Figure 11**). Within this timeframe, the estimated net southerly transport from Manalapan entering the area of inlet influence was determined to be 242,000 cubic yards per year, using the 2012-2018 wave climate and pre-calibrated transport coefficient. The Manalapan shoreline eroded by 36,000 cubic yards per year in the nearshore zone and accreted in the offshore zone by 53,000 cubic yards per year for a total gain of 17,000 cubic yards per year. During this period the downdrift Ocean Ridge shorelines lost 20,000 cubic yards per year in the nearshore and accreted 31,000 cubic yards per year in the offshore cells. These rates reflect the contribution of mechanically bypassed material from the sand transfer plant and beach nourishment projects over the 2012-2018 timeframe, as well as the sediment deposited through natural bypassing. The sand transfer plant similarly exceeded the minimum bypassing rate called for in the inlet management plan during this time period as it did for the prior period of 2002-2012. Overall, a slightly lower wave energy climate occurred over this period, although the area did experience the passage of two major hurricanes, Sandy and Irma. Furthermore, beach nourishment contributed to the influx of sand into the coastal system, highlighted by the southern net southward transport value of 290,000 cubic yards per year, which exceeds that of the northern net southward transport value of 242,000 cubic yards per year.

The 2012-2018 sediment budget was used to derive the target bypassing objective for the 2022 South Lake Worth Inlet IMP. This quantity provides the guidelines which dictate how much sediment must be mechanically transferred to the downdrift beaches and replicate the natural bypassing of the coastal system as if the inlet were not present (i.e. eliminate inlet impacts). These guidelines established by the target bypassing objective remain in place until the IMP receives a future update. The inlet impact (and thereby bypassing objective) is composed of the sediment sinks and mechanical bypassing volume which are directly a consequence of the presence of the inlet, namely the accretion of the updrift beach (Q2), ebb shoal (Q3), and flood shoal (Q4) in summation with the sediment bypassed through the sand transfer plant (Q8). Following this calculation, the inlet impact for the 2012-2018 time period was found to be 124,000 cy/yr.

Then, a weighted average was applied in conjunction with the inlet impacts for the following sediment budgets:

- 2002-2012; APTIM (2021)
- 1997-2002; CPE (2004)
- 1975-1998; CPE (1998)

This weighted average yielded a target bypassing quantity of 115,000 cy/yr for the 2022 IMP. A similar approach was applied to establish the minimum annual transfer volume for the sand transfer plant. The 2012-2018 sediment budget found an annual transfer rate of 87,000 cy/yr for the sand transfer plant (Q8). When this was averaged utilizing the aforementioned reports, a minimum transfer volume of 70,000 cy/yr was established for the 2022 IMP.

With the information provided through the net and gross sediment budgets, a summary of the conclusions determined by APTIM (2021) include the following:

- Deeper portions of the ebb shoal continue to accrete sediment. Natural bypassing continues through the ebb shoal bypassing bar.
- Mechanical bypassing through the sand transfer plant exceeded the inlet management plan goal and nearly maintained downdrift beaches within the groin field. Flood shoal dredging similarly assisted in returning sand to the Ocean Ridge beaches and maintaining the interior channels.
- The gross sediment transport exhibits predominantly southerly with minor northerly transport periods, likely due to both the sheltering of southeastern waves by the ebb shoal and the western offset of the Ocean Ridge coastline that induces high southerly sediment diffusivity.

Palm Beach County accomplished the intent of the adopted 1999 Inlet Management Plan for South Lake Worth Inlet as highlighted within the FDEP Annual Inlet Report (2021). 2,138,892 cy of sediment were bypassed across the inlet from 1999-2019, cumulatively bypassing 110.48% of the annual bypass objective of 88,000 cy/yr over that timeframe.

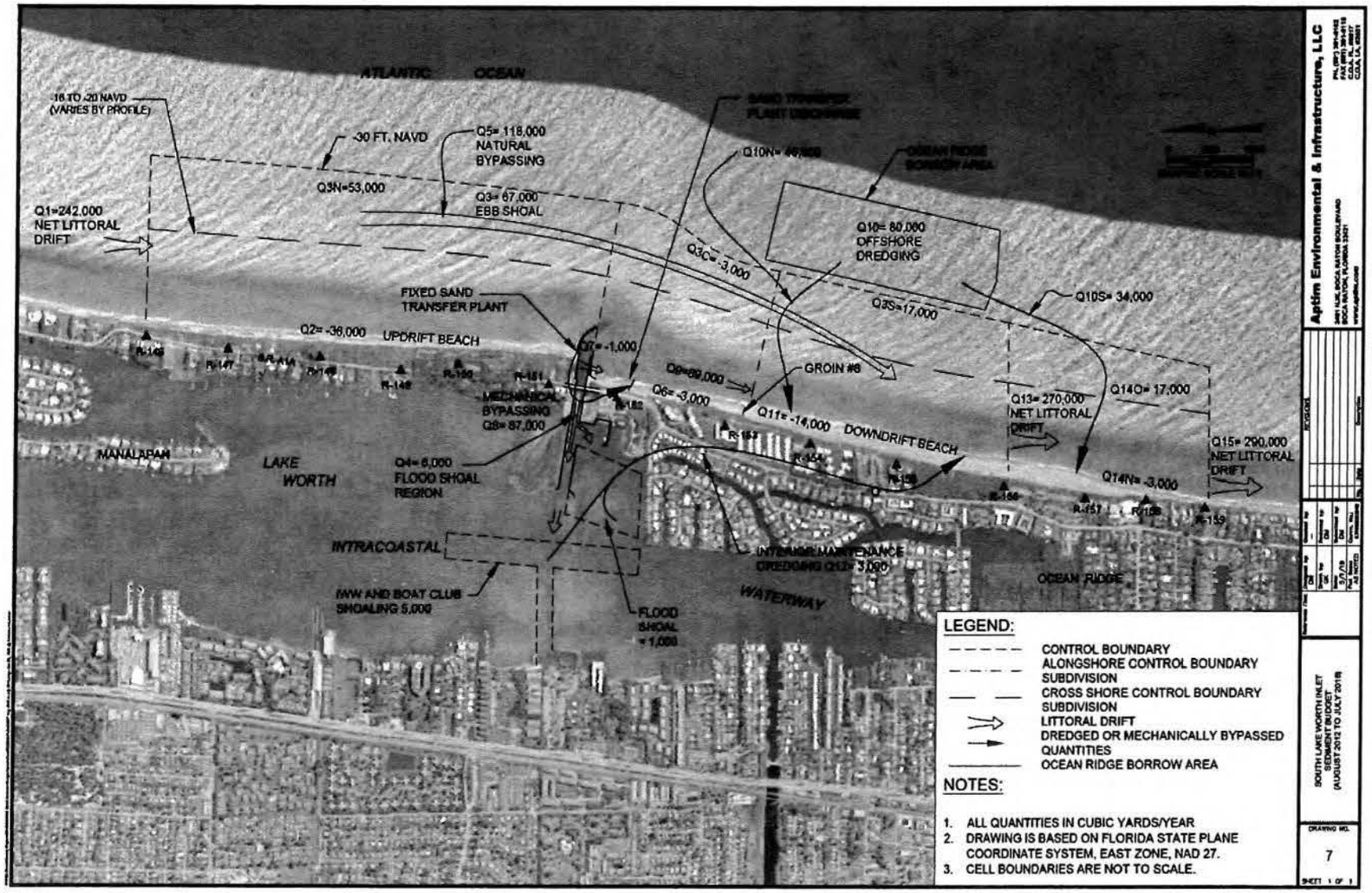

Figure 11. Net Sediment budget for South Lake Worth Inlet, 2012-2018 (APTIM, 2021).

Recommended Inlet Management Plan Strategies

The Department 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 any sand bypassing and nourishment projects, and to periodically update the inlet sediment budget. Beach and nearshore surveys between FDEP Reference Monuments R-146 and R-159 shall be conducted. Periodic inlet hydrographic surveys to include the inlet channel and the ebb and flood shoals should also be conducted.

Discussion – A comprehensive beach and inlet hydrographic monitoring program is an important element to manage the sediment at South Lake Worth 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.

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 Reference Monument R-152 and R-159.** The quantity of material to be bypassed shall be based on available quantities documented through the monitoring protocol of Strategy #1 above and the target bypassing identified in Strategy #3 below.

Discussion – The beach immediately south of South Lake Worth Inlet is the adjacent critically eroded beach directly impacted by the inlet system. Sediment bypassing to the beaches south of South Lake Worth Inlet will mitigate the inlet's downdrift impacts.

3) **On an average annual basis, the initial target inlet sand bypassing quantity shall be 115,000 cubic yards per year to the south with a minimum of 70,000 cubic years per year from the bypassing plant.** 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.

Discussion – The recent sediment budget indicates a need to place an annual quantity of approximately 115,000 cubic yards of sand on the eroded beaches south of the inlet to account for the inlet's impact. Additional sand may be placed that is obtained from acceptable offshore sources or inland sand mines.

4) **The sources of sediment for meeting the target sand bypassing quantities in Strategy #3 shall be the beach north of the inlet accessible to the sand transfer plant, maintenance dredging of the navigation channel, and the authorized sediment impoundment basin or as otherwise authorized by permit.** A flood shoal dredging alternative may be considered for further geotechnical and engineering design and permitting to develop an environmentally acceptable project with suitable quality sediment. Acceptable beach quality sand may also be obtained from inland sand mines and offshore sources to achieve the target sand bypassing quantities.

Discussion – During the period between 2012 and 2018, as described in the updated sediment budget, the quantity of sand entering the inlet was 6,000 cubic yards per year. Of this, 3,000 cubic yards per year were dredged from the inlet and transferred to the south during maintenance dredging. This interior maintenance dredging obtained beach-compatible sediment from the sand trap and intracoastal waterway, providing a viable alternative source of material which has continued to accrete over time.

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