EXECUTIVE SUMMARY

FEMA Survey Results

OBJECTIVE: To update the CAC on the FEMA survey results.

CONSIDERATIONS:

1. Volumetric survey results are complete with the following results:
   - Vanderbilt R24 – R30 -33,932 CY
   - Park Shore R48 – R50 -13,851 CY
   - North Naples R58A – R62 -45,046 CY
   - Central Naples R67 – R76 -24,941 CY

   Total -117,770 CY's

2. Volumetric results do not take into account minimum beach width. Tropical Storm Fay narrowed the beaches but piled the sand higher than 5 ft. Adjustments need to be made to beach profiles to add additional width at 5 ft.

3. Hot spot locations need to be considered with the following decisions made:
   - Should hot spots be wider and higher in the new design?
   - If so, what are the economic relative to FEMA payment (prorated fix cost)?
   - Time required to permit design change.
   - Time required to obtain a MMS lease for sand.

COUNTY ATTORNEY FINDING: A finding by the County Attorney is not required for this item.

FISCAL IMPACT: The Source of funds is from Category "A" Tourist Development Tax.

GROWTH MANAGEMENT IMPACT: There is no impact to the Growth Management Plan related to this action.

RECOMMENDATION: For information only.

PREPARED BY: Gary McAlpin, CZM Director

DRAFT

COLLIER COUNTY BEACH NOURISHMENT PROJECT
POST TROPICAL STORM FAY STORM REPORT

Prepared for:

Collier County Government
Coastal Zone Management

Prepared by:

Coastal Planning & Engineering, Inc.

October 2008

COLLIER COUNTY BEACH NOURISHMENT PROJECT
POST TROPICAL STORM FAY STORM REPORT

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COLLIER COUNTY BEACH NOURISHMENT PROJECT
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COLLIER COUNTY BEACH NOURISHMENT PROJECT
POST TROPICAL STORM FAY STORM REPORT

I. INTRODUCTION

This report describes the 2008 storm losses experienced along the Collier County shoreline within the 2006 beach nourishment project area. The losses were caused by Topical Storm Fay. The project area meets Federal Emergency Management Agency (FEMA) criteria defining a beach nourishment project's eligibility for Public Assistance of permanent work. The total storm losses within the project area eligible for FEMA funding were 277,355 cubic yards for Fay. Descriptions of the storm losses, the pre- and post-storm comparative profiles, the pre- and post-construction comparative profiles of the 2006 project and other required documentation are included or summarized in this report.

The study area encompasses approximately 17 miles of coast from the Lee County line to Gordon Pass (Figure 1). The 2006 project area covers approximately 6 miles of shoreline within that region. Collier County is approximately 115 miles south of the entrance of Tampa Bay and about 100 miles west of Miami, Florida. The County is bordered to the west and southwest by the Gulf of Mexico, to the south by Monroe County, to the east by Dade and Broward Counties, and to the north by Lee and Hendry Counties.

II. 2008 STORM CHARACTERISTICS

The Collier County shoreline was buffeted by many storms this year, in particular Tropical Storm Fay (T.S. Fay) which made landfall August 18, 2008.

Hurricane Fay first made landfall in Florida over the lower Florida Keys as a Tropical Storm with sustained winds of approximately 60 miles per hour during the night of August 18. The storm moved northwest across the Gulf of Mexico and made landfall at Cape Romano as a Tropical Storm with sustained winds of approximately 60 miles per hour during the early morning of August 19. Uncharacteristically, Fay strengthened as the storm moved landward and reached sustained winds of 65 miles per hour while over the western shores of Lake Okeechobee and continued an eastern track where Fay briefly crossed over the Atlantic Ocean on August 20-21 before it turned back west, crossed the state of Florida, and re-entered the Gulf of Mexico at Apalachee Bay early on August 23. Fay then continued a west-northwest track over the Florida panhandle until the storm weakened to a tropical depression on August 24. (http://www.noaa.gov).

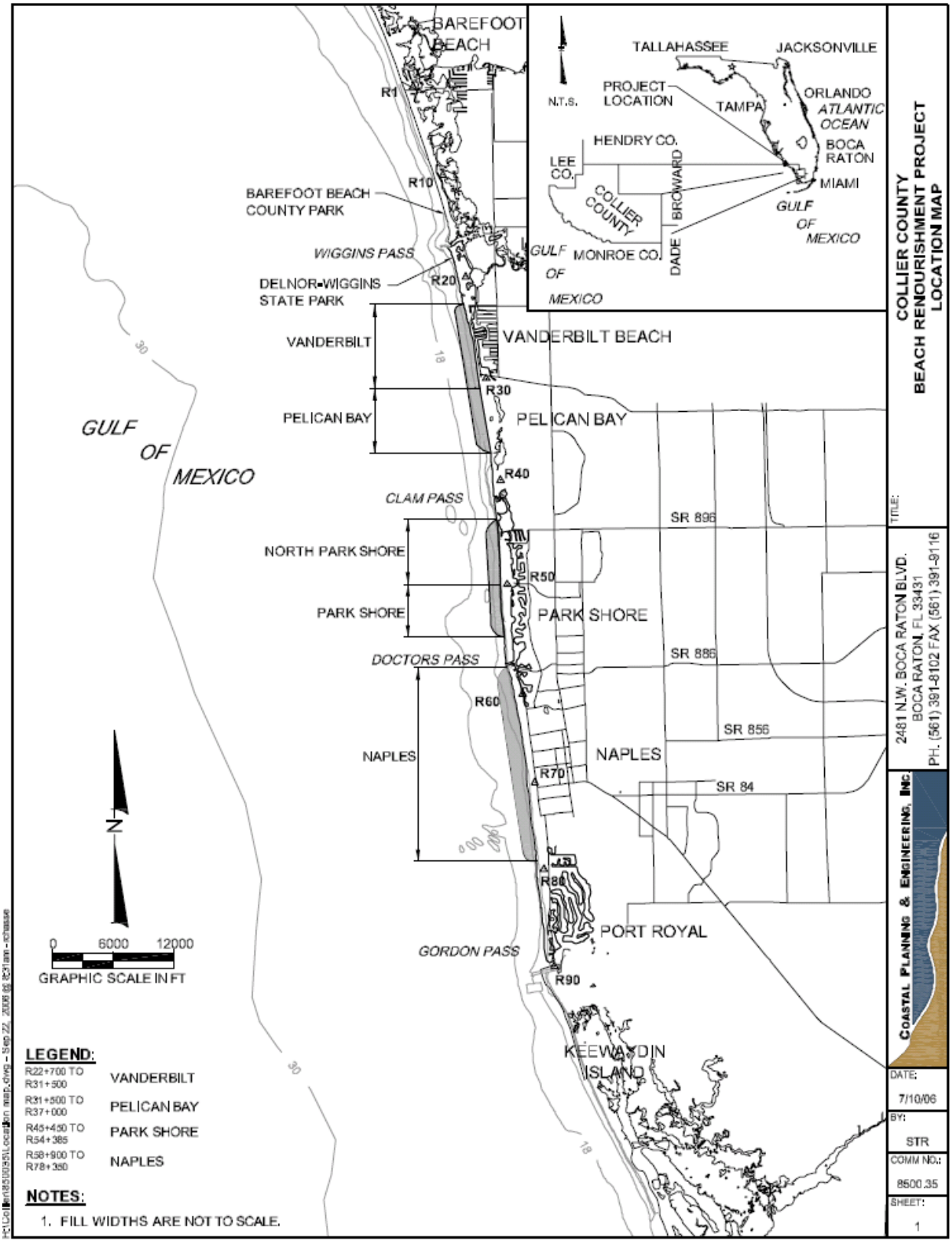

FIGURE 1. 2006 PROJECT AREA AND LOCATION MAP

III. FEDERAL EMERGENCY MANAGEMENT AGENCY ELIGIBILITY

The beaches of Collier County have been actively maintained for 12 years, and they provide critical infrastructure along the Gulf Shoreline. The areas of focus are the three segments of the 2006 Beach Restoration Project between FDEP monuments R-22 and R-78. These three reaches have been renourished periodically since 1995 through inlet maintenance and upland sand renourishment, and are viewed as permanent public infrastructure projects meeting the criteria for FEMA assistance. Collier County's engineered beaches have been constructed entirely without the United States Army Corps of Engineers (USACE) assistance, making the full extent of storm losses attributed to T.S. Fay eligible for FEMA consideration.

IV. BEACH MANAGEMENT HISTORY

Structures, beach nourishment and inlet bypassing have been used to maintain Collier County's beaches (Figure 1). The County has not gone longer than four years without renourishing their beaches by some means (Table 1). The most significant beach maintenance event to date placed approximately 1.2 million cubic yards of fill material on Vanderbilt Beach, Park Shore Beach, and Naples Beach in 1996 (CPE, 2003). In addition to that construction volume, a significant amount of sand has been introduced to the project area beaches since completion of the project. From 1996 through 2003, an estimated 434,000 cubic yards of sand has been added to the beaches between Wiggins Pass and Gordon Pass from truck haul (184,000 CY) and inlet bypassing (250,000 CY). The inlet bypassing program has been specifically engineered to maintain the beaches, in conjunction with inlet maintenance. In 2006, 667,562 cubic yards of sand was placed on Vanderbilt Beach, Park Shore Beach, and Naples Beach via hopper dredge. In addition to the beach fill project in 2006, channel dredging of Doctor's Pass in 2006 (53,600 CY)), Wiggins Pass in 2005 and 2007 (97,400 CY) (Humiston & Moore, 2007), and Clam Pass in 2007 (20,000 CY) (Humiston & Moore, 2007) has resulted in the placement of 122,000 CY of sand between R-18 and R-62.

TABLE 1
SUMMARY OF PERIODIC COLLIER COUNTY NOURISHMENT PROJECT

		Location		
Year	**Description**	**Vanderbilt Beaches**	**Park Shore Beaches**	**Naples Beaches**
1995-6	Initial Nourishment	322,800	90,700	759,150
1996	Mechanical Inlet Bypassing Truck Haul	3,000		55,000
1998	Truck Haul			15,516
2000	Truck Haul		35,000	7,420
2001	Mechanical Inlet Bypassing		24,230	39,800
2002	Truck Haul	22,138	9,067	45,047
2006	Renourishment	178,422	141,739	347,381
2006	Doctors Pass Dredging			53,630
2005/2007	Wiggins Pass Dredging	97,400		
2007	Clam Pass Dredging		20,000	

2006 Collier County Beach Renourishment Project (CPE 2007)

The 2006 beach restoration project was an engineered beach meeting FEMA criteria. The design was based on analysis of the beach and borrow area sands for compatibility along with the selection of a beach width and elevation to accommodate the County's long term plan. The project took place from January 23, 2006 to May 23, 2006. After a mobilization period of about one month, the 2006 Collier County Beach Renourishment Project started pumping sand on February 21, 2006 to renourish 8.5 miles of shoreline. The project areas included; Vanderbilt Beach, Pelican Bay, North Park Shore, Park Shore and Naples Beach. These beaches were renourished with approximately 667,562 cubic yards from Borrow Area T-1 which is located approximately 33 miles northwest of Delnor-Wiggins State Park. A summary of the sand characteristics of Borrow Area T-1 can be seen in Table 3.

Vanderbilt Beach (R-22 to R-31) and Pelican Bay (R-31 to R-37)

Vanderbilt Beach was the first project reach to be filled, as construction was north to south. The first day of pumping was on February 21, 2006 and the last day of pumping was March 11, 2006. The as-built volume of sand for Vanderbilt Beach was 121,487 cubic yards.

Pelican Bay is adjacent to Vanderbilt Beach and construction continued the next day on March 12, 2006 was finished by March 18, 2006. The as-built renourishment quantity for Pelican Bay was 56,955 cubic yards.

Park Shore (R-45 to R-55)

After completing construction on Pelican Bay, a period of eleven days took place before construction started on the Park Shores reach. Construction started March 29, 2006 and was finished on April 10, 2006. The as-built quantities for North Park Shore and Park Shore were 27,705 and 114,034 cubic yards, respectively.

Naples Beach (R-58A to R-79)

One week after completing the Park Shores reach construction on the Naples Beach reach began. Pumping started on April 17, 2006 and was completed on May 23, 2006 for a total as-built quantity of 347,381 cubic yards.

1996 Collier County Beach Restoration Project

Construction of the Collier County Beach Restoration Project was initiated on November 26, 1995 to restore nearly six miles of critically eroded shoreline (CEC, 1996). Fill material from offshore borrow areas was placed on Vanderbilt Beach, Park Shore Beach, and Naples Beach under FDEP permit numbers DBS9A0308CO and 112544739. The main objective of the 1996 project was to provide an enhanced recreational beach and storm protection benefits. The design standard was set to achieve the above objectives and avoid toe of fill migration that could impact nearshore hardbottom resources.

Coastal Engineering Consultants, Inc. (CEC) reported that 1,172,650 cubic yards of sand was placed along the shorelines of Vanderbilt Beach, Park Shore Beach, and Naples Beach between November 1995 and May 1996 (CEC, 1996). Comparisons of as built profile data (Appendix C) in the project areas between pre-construction (1995) and post-construction (1996) surveys indicate a fill volume of 1,270,600 cubic yards, as measured above –10 feet NGVD. Sand for the project was dredged from four offshore borrow areas and supplemented with fill from upland sand sources. The sand sources were selected because the sand grain size was compatible with the native beaches, as described in the design reports extracts contained in Appendix E. The project included extension of the north jetty of Doctors Pass by approximately 75 feet, removal of 36 groins, and restoration of 6 rock groins and a 345-foot pile cluster groin. The project also included restoration and extension of 10 existing stormwater outfalls on northern Naples Beach.

Vanderbilt Beach

Vanderbilt Beach received approximately 322,800 cubic yards of fill along 8,000 feet of shoreline between 700 feet south of FDEP monument R-22 and 500 feet north of R-31 (CEC, 1996). CEC Borrow Areas 6, NB-II A, and NB-II B were utilized. A dual layer fill placement was performed between T-25 and 500 feet south of R-27. Material from Borrow Area 6 was placed below MHW and capped with additional fill from Borrow Area 6 and NB-II B. Upland sand was trucked in from Bonita Farms to complete the construction template.

Park Shore Beach

Park Shore Beach received approximately 90,700 cubic yards of fill along 3,800 feet of shoreline between 350 feet south of FDEP monument T-50 and 150 feet north of T-54 (CEC, 1996). CEC Borrow Areas NB-II B and NB-II C were utilized.

Naples Beach

Naples Beach received approximately 759,150 cubic yards of fill along 17,800 feet of shoreline between 900 feet north of FDEP monument R-58 (Doctors Pass south jetty) and 350 feet north of R-78 (CEC, 1996). CEC Borrow Areas NB-II A, NB-II B, and NB-II C were utilized.

Inlet Management

Periodic dredging and bypassing has taken place at Wiggins Pass, Clam Pass, Doctors Pass and Gordon Pass in recent decades. The total volume of sand bypassed to adjacent beaches from the four inlets from the 1996 project to the 2006 project and through 2007, is approximately 293,060 CY (Table 1), at an average annual rate of 26,642 CY/yr. The maintenance programs have been important in sustaining the littoral drift along the coast, since the erosion rate would increase by an amount approaching this value if the bypassing stopped. The program has continued since 2006.

In addition to the beach fill project in 2006, channel dredging of Doctor's Pass in 2006 (53,600 CY)), Wiggins Pass in 2005 and 2007 (97,400 CY) (Humiston & Moore, 2007), and Clam Pass in 2007 (20,000 CY) (Humiston & Moore, 2007) has resulted in the placement of 122,000 CY of sand between R-18 and R-62.

Supplemental Fill Projects

In addition to the 1996 construction volume and inlet bypassing, a significant amount of sand has been added to the project area beaches through various truck haul projects. The supplemental fill has helped extend the life of the project by acting as advanced nourishment. The sources of upland fill have included Bonita Grande, Big Island and E.R. Jahna (Collier County, 2003).

Approximately 3,000 cubic yards of fill was added to Vanderbilt Beach in 1996 and 22,100 cubic yards in 2002. Pelican Bay also received 5,100 cubic yards as dune protection in 2002. The beaches of Park Shore received a total of 72,300 cubic yards of upland sand from 2000 through 2002. Between Doctors Pass and Gordon Pass, Naples Beach has received approximately 81,400 cubic yards of upland fill since 1996. The total volume of truck haul sand brought into the study area through 2002 is estimated at 184,000 cubic yards (Table 1). Nourishment by truck haul within the project area is summarized in Table 1B.

Project Maintenance

The beaches are maintained and managed by the Collier County Coastal Zone management Office, under its Director, Gary McAlpin. The beach is surveyed annually, with a monitoring report prepared for each survey. The County also cleans the beach, periodically removing rock debris and dead marine life as needed. The beach is a vital structure for storm protection and an asset for recreation and tourism.

V. PROJECT PERMITS AND STRATEGIC BEACH MANAGEMENT PLAN

The State's beach management plan represents the State's beach objectives. Projects which meet State objectives are easier to permit and receive State funding. In 2008, the FDEP Office of Beaches and Coastal Systems released the Strategic Beach Management Plan for the Southwest Gulf Coast Region. The sub-region for Collier County (Naples Coast) extends from the Lee County line in the north to the midpoint of Keewaydin Island in the south. The barrier beaches are separated from the mainland by mangrove swamp, salt marsh and small bays. The Plan identifies 8.5 miles of critically eroded beach in this sub-region attributed to winter storms, tropical weather systems and the effects of the inlets. The following sections are excerpts from the Management Plan (FDEP, 2008) update in references and illustrate the State's commitment to maintaining Collier County's beaches:

> **Strategies for Inlets and Critically Eroded Beaches**
>
> **Wiggins Pass, Collier County. Strategy:** Place beach quality maintenance dredged material on adjacent beaches north and south of Wiggins Pass within areas of greatest need; monitoring and analysis of inlet effects.

Vanderbilt Beach, Collier County, R22.3-R30.5. Strategy: Maintain the project through monitoring and nourishment using sand from offshore and bypassing sources.

Clam Pass, Collier County. Strategy: Monitor.

Park Shore, Collier County, R50.65-R57.5. Strategy: Maintain the project through monitoring and nourishment using sand from offshore and bypassing sources.

Collier County, Doctors Pass. Strategy: Place all beach quality dredged material on the beach or nearshore zone south of the inlet meeting a minimum bypassing goal of 10,000 cubic yards on an average annual basis.

Naples, Collier County, R57.8-R89. Strategy: Maintain the project through monitoring and nourishment using sand from offshore and bypassed from Doctor's Pass; evaluate alternatives to restore the remaining critically eroded shoreline.

Since the project area qualifies for the State's program, permits are easier to acquire. Collier County has secured a 10-year Joint Coastal State Permit and USACE Permit for renourishing the project beaches in 2005. As such, any approved FEMA project can be built using these permits. The Federal permit number is SAJ-2003-12405(IP-MN). The State permit number is 0222355-001-JC and was issued by FDEP on January 12, 2005.

VI. ENGINEERING AND MONITORING

Construction of the Collier County Beach Restoration Project was initiated on November 26, 1995, and renourished in 2006, to restore nearly six miles of critically eroded shoreline (CEC, 1996). A monitoring plan was developed to support planning for the first major renourishment in 2006 and the most recent report was completed in 2007, as the 1 year post 2006 construction report. Monitoring has been conducted during the following years, and a monitoring report and beach survey was completed for each monitoring event. The September 2008 survey is in preparation.

Annual Monitoring Dates

1997	1-Year
1998	2-Year
1999	3-Year
2000	4-Year
2001	5-Year
2002	6-Year
2003	7-Year
2004	8-Year
September 2005	9-Year/Pre-Construction/Post-Hurricane Katrina
November 2005	Post – Hurricane Wilma
June 2006	Post-Construction
June 2007	1-Year

2006 Project Performance

The design volume for the entire project area, R-22 to R-79, was 664,421 cubic yards (Table 2). The same area had an as-built volume of 667,562 cubic yards.

TABLE 2
2006 VOLUMETRIC SUMMARY

PROJECT AREA DESIGN, AS-BUILT AND VOLUME REMAINING			
PROJECT AREA	**DESIGN**	**AS-BUILT**	**NOV. 05 to JUN. 07**
VANDERBILT BEACH R-22 TO R-31	121,689	121,487	113,424
PELICAN BAY R-31 TO R-37	57,225	56,955	69,182
NORTH PARK SHORE R-45 TO R-48	27,778	27,705	-845
PARK SHORE R-48 TO R-55	112,446	114,034	99,410
NAPLES BEACH R-58A TO R-79	345,283	347,381	238,021
PROJECT AREA TOTAL R-22 TO R-79	**664,421**	**667,562**	**519,192**

Design Standard

The main objective of the 2006 project was to provide an enhanced recreational beach with secondary storm protection benefits. The design standard was set in the preliminary engineering report (CPE 2003). The design standard can be defined as an added beach width or total beach width. A total beach width standard was used to design the 2006 project. Total beach width is measured from a fixed baseline set at the seawall, edge of vegetation, building line, or equivalent, and provides a measure of the total sandy beach area.

The design standards for Vanderbilt Beach, Park Shore Beach and Naples Beach were 100, 85 and 100 feet respectively, which was achieved by construction. The design standard does not include advanced nourishment, which is the sacrificial part of the design beach which gives the project a life of six years

VII. GEOTECHNICAL CONSIDERATIONS AND INVESTIGATIONS

2006 PROJECT SAND SOURCE

Two primary borrow areas were initially identified for the 2006 project (Figure 2). Borrow Area N5 is located 5 miles offshore of southern Naples Beach. It contains sand similar to the 1995/96 project but with varying levels of shell content. The silt content is 6.97%, which made the sand source unacceptable to the State based on existing guidelines. Borrow Area T1 is located 33 miles from Vanderbilt. It is a large sand ridge and has been permitted as the sole sand source for the project. With cut depths of 12 to 19 feet, dredging quality assurance will be easier for this borrow area. The borrow area (T1) has a coarser grain size and is well sorted, indicating a fairly uniform sand without much shell that is compatible with the existing beach sands. The sand source has the quantity and quality needed to support renourishment and replacement of storm losses.

Beach Sand Characteristics

Beach sediments were sampled in 1988, 1990 and 2003 from FDEP monuments R-27, R-35, R-52, R-64, R-73, and R-84. A summary of this data is provided in Table 3. Current beach sediment is characterized as generally fine grained, quartz sand with an estimated shell content ranging from 0 to 75%. The wet Munsell colors had a uniform Hue, which indicates a color's relation to red, yellow, green, blue, and purple, of 5Y. The Value, indicating a color's lightness, ranged from 5 to 8, while the Chroma, indicating a color's strength, ranges from 1 to 2. The average wet beach color is between 5Y-6/1 and 5Y-6/2. The beach grain size ranges from 0.08 mm to 0.88 mm with a mean of 0.24 mm. The silt content the ranges from 0.35% to 30.51%, with a mean silt content of 2.17%.

The native beach sand characteristics were also evaluated based on sand samples taken prior to the 1995/96 beach restoration project. The sediment characteristics of these historic samples taken by other consultants are also included in Table 3. The average grain sizes were 0.32 mm in 1988 and 0.26 mm in 1990. By comparing these values to recent beach samples (2003) and Borrow Area T1, it is likely that the borrow areas sands will help return the beach closer to the native grain size that existed prior to previous nourishment events. In 1988, the shell content of the beach was estimated between 33.0% and 48.0%.

Borrow Area T1

Borrow Area T1 is located 33 miles from Vanderbilt Beach. Sediment characteristics are presented in Table 3. The material in Borrow Area T-1 is generally fine grained, moderately sorted sand with trace to little shell content. The wet Munsell color of the material is 5Y-7/1 (light gray). This is lighter than the average beach sand color. The grain size for this borrow area ranges from 0.19 mm to 0.54 mm with a mean of 0.31 mm. The silt content the ranges from 0.80% to 6.86% and the mean silt content is 1.75%. Calcium Carbonate ($Ca\ CO_3$) content (by weight) ranged from 18.6% to 26.7%, but is based on only five (5) samples.

The borrow area limits contain 4.7 million cubic yards of beach compatible sand with a mean grain size of 0.31 mm. The cut depths are 12' to 19' above unsuitable materials, predominately

rock layers of carbonate clasts. Beach and borrow area sand characteristics are summarized in Table 3.

TABLE 3
BEACH AND BORROW AREA SEDIMENT STATISTICS

	Mean Grain Size (phi)	Mean Grain Size (mm)	Sorting (phi)	Silt (%)	Wet Color
NATIVE BEACH - 1988 (32nd St, Horizon Way, Vanderbilt Beach)					
Beach Composite	1.63	0.32	1.67	1.10	N/A
NATIVE BEACH - 1990 (R-27, R-33, R-54, R-66)					
Beach Composite	1.93	0.26	1.61	2.96	N/A
EXISTING BEACH - MARCH 2003 (R-27, R-35, R-52, R-64, R-73, R-84)					
Beach Composite	2.08	0.24	1.50	2.17	5Y-6/1.5*
Beach Range	0.18 - 3.60	0.08 - 0.88	0.36 - 2.54	0.35 - 30.51	5Y-5/1 – 5Y-8/1 to 5Y-6/2 – 5Y-8/2
BORROW AREA T1					
T-1 (Composite)	1.67	0.31	0.92	1.75	5Y-7/1
(*standard dev.* □)	0.29	0.06	0.22	1.34	
T-1 Range	0.90-2.36	0.19-0.54	0.60-1.53	0.80-6.86	5Y-7/1

*Between 5Y-6/1 and 5Y-6/2

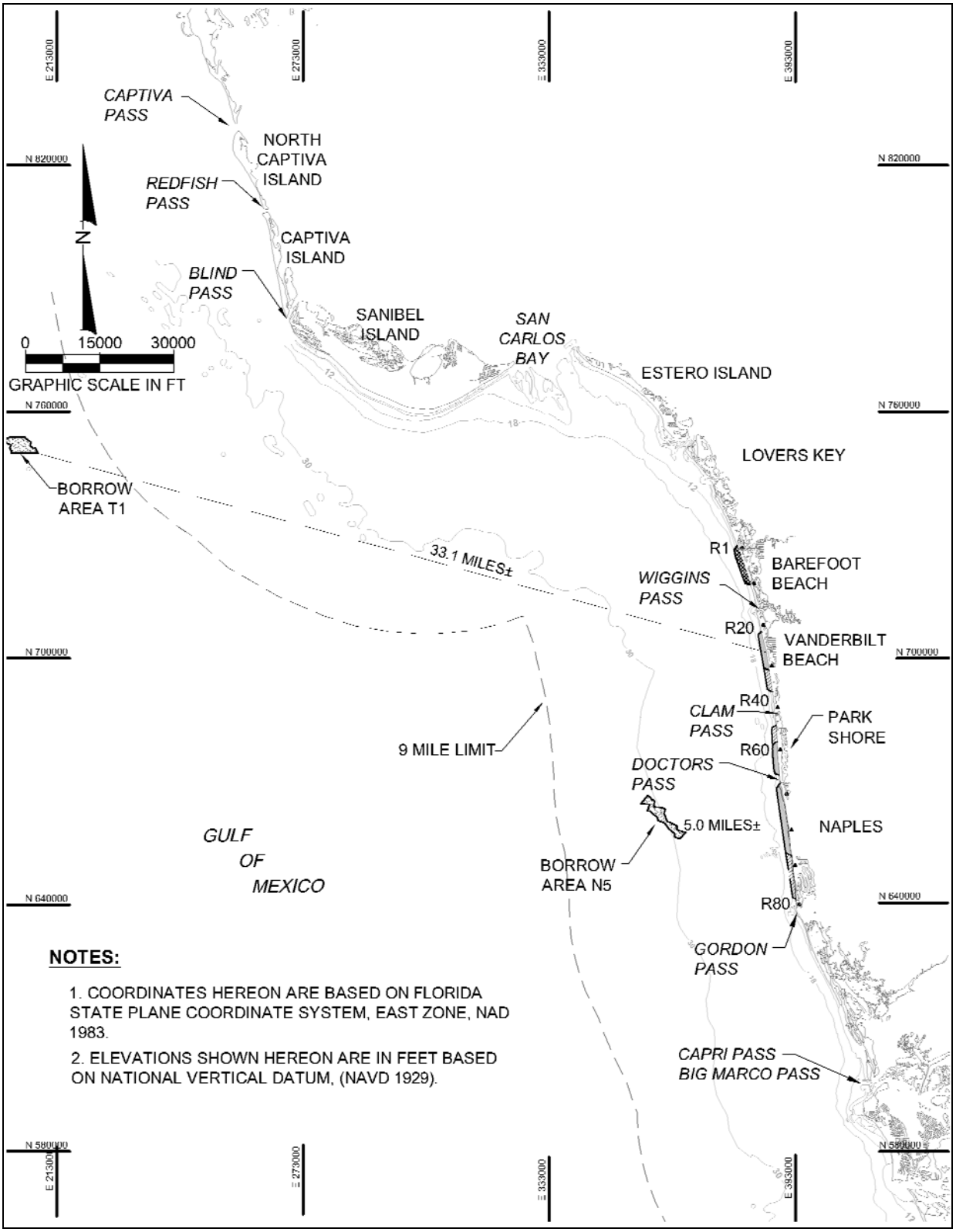

FIGURE 2. BORROW AREA LOCATION MAP

VIII. PUBLIC BEACH OWNERSHIP AND ACCESS

The beaches of Collier County are a publicly owned infrastructure accessible to all members of the public. This benefit is possible because of far sighted programs implemented by the State of Florida decades ago. The basis for this condition is summarized below.

Public Lands

Hurricane storm repairs eligible for FEMA support will be placed overwhelmingly on public lands. These lands are delineated by an Erosion Control Line (ECL). The Erosion Control Lines ECL is a surveyed and recorded line along the beach that separates public lands from private lands. An ECL is established for all beach nourishment projects in Florida, preserving lands seaward of eroded beach MHW line at the time of construction in State ownership and open to public use.

Two Florida Statues (FS) explain this program:

> FS .141 Property rights of state and private owners in beach restoration areas:
> The Legislature declares that it is the public policy of the state to cause to be fixed and determined, pursuant to beach restoration, beach renourishment, and erosion control projects, the boundary line between sovereignty lands of the state bordering on the Atlantic Ocean, the Gulf of Mexico, or the Straits of Florida, and the bays, lagoons, and other tidal reaches thereof, and upland properties adjacent thereto.
>
> However, prior to construction of such a beach restoration project, the board of trustees must establish the line of mean high water for the area to be restored. The resulting additions to upland property are also subject to a public easement for traditional uses of the sandy beach consistent with uses that would have been allowed prior to the need for the restoration project.
>
> FS 161.191 Vesting of title to lands:
> Title to all lands seaward of the erosion control line shall be deemed to be vested in the state by right of its sovereignty.

The three 1995-6 Collier County project areas have erosion control lines established in 1995 prior to the 1995 beach nourishment project. The lands seaward of these lines are public property, and the County has permission from the State to place sand on these lands. These lands include significant dry beach open to the public, and are a corner stone to the County recreation infrastructure and tourism industry.

Public Access:

The ECL is one of the bases of public access to beaches in Florida, and has been a highly successful program. The ECLs in Collier County in conjunction with public access ways, provide public beach for a wide variety of activities. On any given day, the public can be viewed accessing the entire beach front in the three communities, using the beach for sunning, bathing,

walking, swimming, sports, bird watching and a wide variety of other activities. The public accessibility meets the state of Florida criteria, and would meet the Federal criteria if it was a Federal project. The State's criteria is more restrictive than the Federal criteria for beach access. The State recognizes public access, by providing funds for a share of a beach nourishment project, prorated to the beaches accessibility. For Collier County, the State may provide funding towards the upcoming project.

The State's work sheet on public access is provided in Appendix D. The state has identified 36 public beach access points in their inventory of the 1995 project area, with 5.3 miles of beach publicly accessible by the state criteria, with over 1100 parking spaces located in supporting distance of the access points. The county is actively seeking to increase their beach access. They have built a parking garage at Vanderbilt Blvd solely for beach access, which will significantly increase parking.

In summary, because of a local commitment and strong Florida polices preserving public lands and supporting public access, the beach front is a publicly owned asset providing strong upland damage protection and recreational benefits to the community.

The public access and public lands in Collier County can be confirmed by the Florida Department of Environmental Protection, which administers the beach project (850-922-7721). A memorandum prepared by FDEP explaining these matters can be found in Appendix B.

IX. TROPICAL STORM FAY IMPACT ASSESSMENT

Tropical Storm Fay made landfall at Cape Romano, Florida with 60 mph sustained winds on August 18, 2008. Before coming ashore at Cape Romano, the storm tracked across the Dominican Republic, Cuba, and the Florida Keys as shown in Figure 3 and Figure 4. The following excerpt is from the Tropical Weather Summary maintained by the National Hurricane Center for the month of August 2008:

> **MONTHLY TROPICAL WEATHER SUMMARY...CORRECTED**
> **NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL**
> **300 PM EDT FRI SEP 19 2008**
>
> FAY WAS A LONG-LIVED AND SLOWLY-MOVING TROPICAL STORM THAT SPENT MOST OF ITS LIFE CENTERED NEAR OR OVER LAND...DUMPING HEAVY RAINS THAT PRODUCED DAMAGING AND DEADLY FLOODS OVER PORTIONS OF THE GREATER ANTILLES AND FLORIDA. ORIGINATING FROM A TROPICAL WAVE...FAY FORMED ON 15 AUGUST AS A TROPICAL STORM WITH MAXIMUM WINDS OF ABOUT 40 MPH AS IT CROSSED THE EASTERN COAST OF HISPANIOLA. ITS STRENGTH CHANGED LITTLE AS IT TRAVERSED THAT ISLAND AND THE WINDWARD PASSAGE ON THE FOLLOWING DAY. THE STORM GAINED A LITTLE STRENGTH WITH MAXIMUM WINDS OF ABOUT 50 MPH ON 17 AUGUST AS ITS CENTER PASSED JUST OFFSHORE THE SOUTHERN COAST OF EASTERN CUBA. RESPONDING TO A BREAK IN A SUBTROPICAL RIDGE OVER FLORIDA...FAY TURNED NORTH-NORTHWESTWARD OVER CENTRAL CUBA THE NEXT DAY. MAXIMUM WINDS INCREASED TO ABOUT 60 MPH AS THE STORM MOVED INTO THE FLORIDA STRAITS...AND THE CENTER OF THE CYCLONE PASSED OVER THE LOWER FLORIDA KEYS LATE ON 18 AUGUST. FAY TURNED NORTHEASTWARD ON 19 AUGUST...MAKING LANDFALL EARLY THAT DAY ON THE SOUTHWESTERN COAST

OF THE FLORIDA PENINSULA AT CAPE ROMANO WITH MAXIMUM WINDS OF 60 MPH. AFTER MOVING INLAND...FAY UNUSUALLY STRENGTHENED...EXHIBITING WHAT RESEMBLED A CLASSICAL EYE IN RADAR AND SATELLITE IMAGERY...AND IT REACHED ITS PEAK INTENSITY OF ABOUT 65 MPH AS IT PASSED OVER THE WESTERN SHORES OF LAKE OKEECHOBEE. IN CONTRAST...DURING 20-23 AUGUST...CONTINUED INTERACTION WITH THE LANDMASS OF NORTHERN FLORIDA PREVENTED STRENGTHENING...AND FAY'S MAXIMUM WINDS REMAINED 50-60 MPH DURING MOST OF THAT PERIOD. THE CENTER OF FAY MADE TWO BRIEF REAPPEARANCES OVER WATER...OFF THE NORTHEASTERN FLORIDA COAST ON 20-21 AUGUST...AND OVER APALACHEE BAY EARLY ON 23 AUGUST. UNDER THE INFLUENCE OF A HIGH PRESSURE RIDGE OVER THE EASTERN UNITED STATES...FAY HEADED SLOWLY WEST-NORTHWESTWARD OVER THE FLORIDA PANHANDLE ON 23 AUGUST...FINALLY WEAKENING TO A DEPRESSION EARLY THE NEXT DAY. FAY REMAINED A DEPRESSION FOR THE NEXT COUPLE OF DAYS AS IT MOVED SLOWLY OVER THE SOUTHEASTERN UNITED STATES...AND EVENTUALLY DEGENERATED INTO A REMNANT LOW OVER NORTHERN ALABAMA ON 26 AUGUST. DUE TO FAY'S VERY SLOW MOTION...STORM-TOTAL RAINFALL AMOUNTS IN SOME AREAS WERE STAGGERING...INCLUDING A FEW LOCATIONS IN EAST-CENTRAL FLORIDA THAT RECEIVED MORE THAN TWO FEET OF RAIN. FAY'S RAIN-INDUCED FLOODS CAUSED SIGNIFICANT DAMAGES AND WERE DIRECTLY RESPONSIBLE FOR NUMEROUS DEATHS IN THE DOMINICAN REPUBLIC...HAITI...AND FLORIDA. HOWEVER...FINAL FATALITY TOTALS AND DAMAGE COST ESTIMATES HAVE NOT YET BEEN COMPILED.

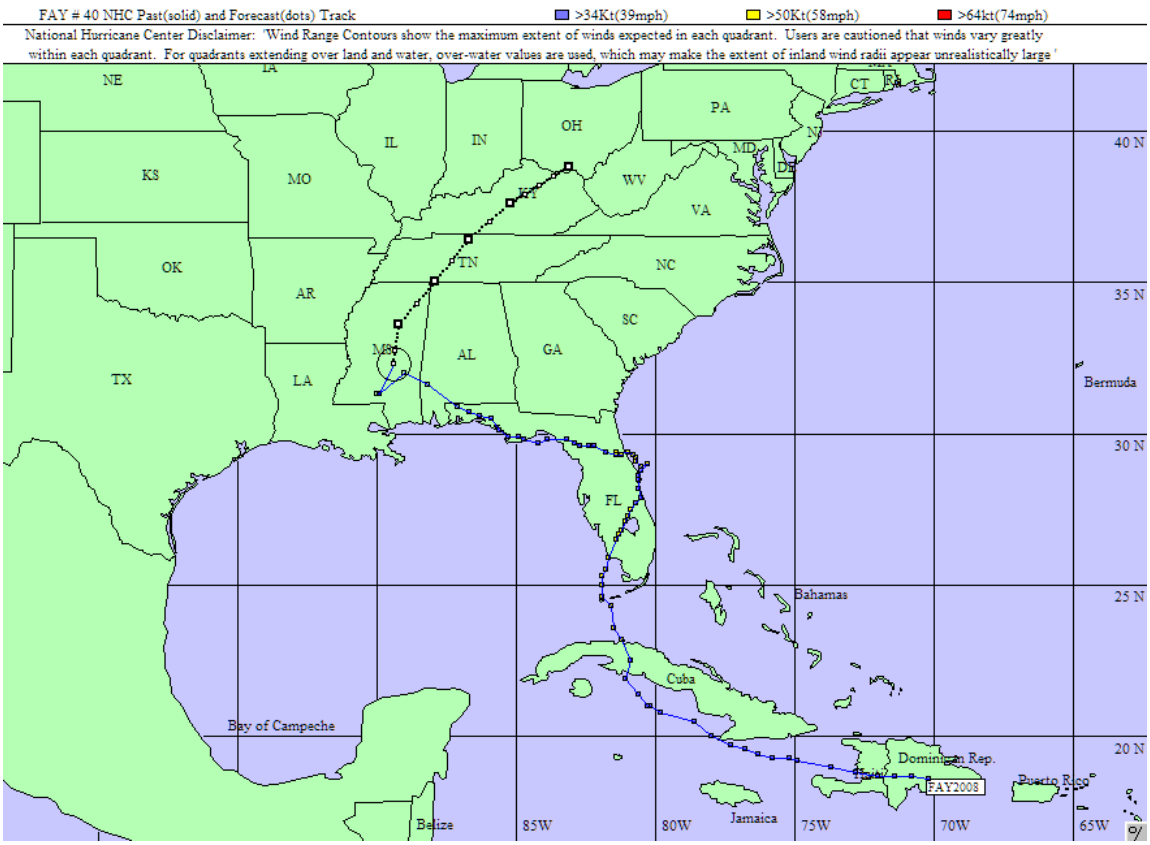

FIGURE 3. TROPICAL STORM FAY TRACK (SOURCE: NATIONAL HURRICANE CENTER)

FIGURE 4. RADAR IMAGERY OF TROPICAL STORM FAY (SOURCE: http://www.weather.com).

Storm Loss and Cost Estimate

Tropical Storm Fay impacted the beaches of Collier County. The storm impact analysis is based on surveys taken in June 2007 and September 2008. The Mean High Water (MHW) elevation measured at each profile is used to represent the typical shoreline location. In Collier County, the MHW elevation is +0.33 ft NAVD 88. The MHW shoreline is approximated by the high-tide mark on the beach. The MHW shoreline changes from June 2007 to Sept 2008 are listed in Tables 4-6 for the project areas. The comparative profiles are provided in Appendix A.

The MHW water change rates are a measured of the storm protection and recreational benefit losses to the beach. The beach can be returned to its pre-storm position by adding a volume of fill calculated based on the shoreline change rate. This calculation is based on the following formula: $\left[\frac{BermHeight + DOC}{27} \times Eff.Dist.\right]$. The following tables show that every reach constructed in 2006 lost shoreline width. The greatest average loss was in Vanderbilt Beach, which lost an average of 16 feet. North Park Shore had the least, losing an average of 1 foot. Two profiles in Vanderbilt Beach lost over 24 feet (R-25 and R-26). The amount of sand needed to bring these profiles back to their pre-storm condition (June 2008) is 266,000 CY for all the constructed reaches.

The volumetric changes discussed in this report represent the difference in the quantity of sand measured along the beach between surveys. All volumetric changes are given in cubic yards. All volumetric loss measured using comparative profiles is based on the volume needed to replace the storm losses. Volumetric changes were calculated between the dunes (upland) and the approximate depth of closure. The depth of closure is defined as the seaward limit of the active beach profile and it is assumed that sand transport beyond this depth is negligible. A depth of closure of -11.3 ft NAVD was used to determine volumetric changes for each monitoring area. Storm losses were concentrated at a few spots generally located in Vanderbilt

Beach (R22 - R30), Park Shore Beach (R48 and R50), north Naples Beach (R58A – R64) and central Naples Beach (R67 – R76). The greatest losses occurred in Naples Beach at 70,700 CY.

TABLE 4
VOLUME CHANGES AT THE VANDERBILT BEACHES

PROFILE AREA	EFFECTIVE DISTANCE (FT)	MHW SHORELINE CHANGE (FT) JUNE. 07 to SEPT. 08	VOLUME LOSS BASED ON SHORELINE CHANGE (CY) JUNE. 07 to SEPT. 08	VOLUME CHANGE BASED ON PROFILES (CY) JUNE. 07 to SEPT. 08	VOLUME LOSSES BASED ON PROFILES (CY) JUNE. 07 to SEPT. 08	TOTAL VOLUME NEEDED TO RESTORE BEACH WIDTH (CY)
R-22	474	-9	-2,306	53	0	2,306
R-23	984	-14	-7,568	-960	-960	7,568
R-24	1,039	-17	-9,858	-1,433	-1,433	9,858
R-25	1,011	-24	-13,698	-1,582	-1,582	13,698
R-26	974	-25	-13,421	-6,577	-6,577	13,421
R-27	1,083	-16	-9,850	-10,281	-10,281	10,281
R-28	1,010	-14	-7,622	-3,247	-3,247	7,622
R-29	923	-15	-7,491	-4,968	-4,968	7,491
R-30	1,017	-22	-12,559	-4,937	-4,937	12,559
R-31	1,006	-5	-2,961	4,083	0	2,961
R-32	997	-16	-8,678	2,903	0	8,678
R-33	1,008	2	0	8,569	0	0
R-34	996	-21	-11,753	217	0	11,753
R-35	986	-20	-10,695	2,033	0	10,695
R-36	1,019	-13	-7,594	2,650	0	7,594
R-37	1,009	-8	-4,219	4,031	0	4,219
VANDERBILT	9,018	-16	-85,853		-33,985	86,285
R-22 TO R-31						
PELICAN BAY	6,518	-12	-44,420		0	44,420
R-31 TO R-37						
PROJECT AREA	**15,536**	**-15**	**-130,273**		**-33,985**	**130,704**
R-22 TO R-37						

TABLE 5
VOLUME CHANGES AT THE PARK SHORE BEACHES

PROFILE AREA	EFFECTIVE DISTANCE (FT)	MHW SHORELINE CHANGE (FT) JUNE. 07 to SEPT. 08	VOLUME LOSS BASED ON SHORELINE CHANGE (CY) JUNE. 07 to SEPT. 08	VOLUME CHANGE BASED ON PROFILES (CY) JUNE. 07 to SEPT. 08	VOLUME LOSSES BASED ON PROFILES (CY) JUNE. 07 to SEPT. 08	TOTAL VOLUME NEEDED TO RESTORE BEACH WIDTH (CY)
R-45	1,073	3	0	3,836	0	0
R-46	1,039	7	0	5,827	0	0
R-47	953	0	0	2,440	0	0
R-48	1,000	-13	-7,240	-4,379	-4,379	7,240
R-49	1,076	-7	-4,180	6,787	0	4,180
R-50	1,206	-22	-14,776	-9,472	-9,472	14,776
R-51	1,102	-11	-6,436	3,160	0	6,436
R-52	961	-10	-5,319	6,232	0	5,319
R-53	1,057	-9	-5,566	1,701	0	5,566
R-54	1,058	-2	-1,213	7,334	0	1,213
R-55	983	-2	-1,306	8,594	0	1,306
N. PARK SHORE R-45 TO R-48	3,565	-1	-3,620		-2,190	3,620
PARK SHORE R-48 TO R-55	7,943	-10	-42,416		-11,662	42,416
PROJECT AREA R-45 TO R-55	**11,508**	**-6**	**-46,036**		**-13,851**	**46,036**

TABLE 6
VOLUME CHANGES AT THE NAPLES BEACHES

PROFILE AREA	EFFECTIVE DISTANCE (FT)	MHW SHORELINE CHANGE (FT) JUNE. 07 to SEPT. 08	VOLUME LOSS BASED ON SHORELINE CHANGE (CY) JUNE. 07 to SEPT. 08	VOLUME CHANGE BASED ON PROFILES (CY) JUNE. 07 to SEPT. 08	VOLUME LOSSES BASED ON PROFILES (CY) JUNE. 07 to SEPT. 08	TOTAL VOLUME NEEDED TO RESTORE BEACH WIDTH (CY)
R-58A	877	-4	-2,144	-2,890	-2,890	2,890
R-58	737	-22	-9,144	-11,777	-11,777	11,777
R-59	1,004	-21	-11,815	-12,028	-12,028	12,028
R-60	1,040	-12	-7,180	-7,125	-7,125	7,180
R-61	1,029	-10	-5,867	-2,585	-2,585	5,867
R-62	1,003	-21	-11,652	-8,641	-8,641	11,652
R-63	954	2	0	2,814	0	0
R-64	851	1	0	-778	-778	778
R-65	803	-1	-336	4,977	0	336
R-66	811	-7	-3,334	3,787	0	3,334
R-67	802	-18	-7,980	-2,978	-2,978	7,980
R-68	806	-2	-1,094	167	0	1,094
R-69	801	-11	-4,880	-2,091	-2,091	4,880
R-70	799	-1	-570	-4,099	-4,099	4,099
R-71	803	-7	-3,343	-3,648	-3,648	3,648
R-72	800	-12	-5,175	-2,318	-2,318	5,175
R-73	806	0	0	3,644	0	0
R-74	803	-9	-4,075	-4,591	-4,591	4,591
R-75	791	15	0	8,923	0	0
R-76	795	-7	-2,905	-5,216	-5,216	5,216
R-77	778	-8	-3,469	596	0	3,469
R-78	927	-9	-4,620	6,365	0	4,620
NAPLES BEACH	**18,820**	**-8**	**-89,583**		**-70,765**	**100,615**
R-58A TO R-79						

The two loss calculations were compared, and the value needed to replace the measured loss and return the shoreline to the pre-storm position was determined to be 277,000 CY as shown in Table 7. The total volume loss above the DOC for the entire project area was 118,601 cubic yards, while the estimated volumetric loss to recover the shoreline was 265,892 cubic yards. Survey profile comparisons between June 2007 and September 2008are provided in Appendix A.

The Volume loss measured using survey data is not adjusted for the normal erosion rate. The most recent year that monitoring data is available is June 2006 to June 2007, which had an annual erosion rate of 68,518 CY/yr. This volume is subtracted from the calculated volume in Table 7.

TABLE 7
TROPICAL STORM FAY VOLUMETRIC STORM LOSSES

Location	VOLUME LOSS BASED ON SHORELINE CHANGE (CY) JUNE. 07 to SEPT. 08	VOLUME LOSSES BASED ON PROFILES (CY) JUNE. 07 to SEPT. 08	TOTAL VOLUME NEEDED TO RESTORE BEACH WIDTH (CY)
VANDERBILT BEACHES	-130,273	-33,985	130,704
R-22 TO R-37			
PARK SHORE BEACHES	-46,036	-13,851	46,036
R-45 TO R-55			
NAPLES BEACHES	-89,583	-70,765	100,615
R-58A TO R-79			
LOSSES	-265,892	-118,601	277,355
AVERAGE EROSION	68,518	68,518	68,518
STORM LOSSES	-197,374	-50,083	208,837

Cost

The costs associated with the reconstruction of the beach after T.S. Fay were calculated based on recent dredging cost experienced on similar projects. The cost of dredging has gone up significantly since the hurricanes of 2004 and 2005. The prices of fuel, equipment, and personnel have all risen faster than the inflation rate. The costs for placing 208,837 CY of sand using borrow area T-1 is estimated at $12.65 million (Table 8).

TABLE 8
TROPICAL STORM FAY RENOURISHMENT COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Mobilization	Lump Sum	LS	$4,800,000	$4,800,000
Dredge, Place and Grade Beach Sand	208,837	CY	$30	$6,160,692
Trawling	30	Day	$4,000	$120,000
Turbidity Monitoring	1	LS	$53,000	$53,000
Environmental Monitoring/Protection	1	LS	$50,000	$50,000
Engineering	7%	LS		$783,000
Administration	5%	LS		$559,000
Survey Costs	2	EA	$60,000	$120,000
Total				$12,645,692

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