MIDNIGHT PASS
COMPREHENSIVE MANAGEMENT PLAN

DRAFT

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COASTAL PLANNING & ENGINEERING, INC.

MIDNIGHT PASS
COMPREHENSIVE MANAGEMENT PLAN

SUBMITTED TO:
SARASOTA COUNTY
DEPARTMENT OF NATURAL RESOURCES MANAGEMENT

PREPARED BY:
COASTAL PLANNING & ENGINEERING, INC.

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EXECUTIVE SUMMARY

A comprehensive management plan is developed for the reopening, management, and maintenance of Midnight Pass and the adjacent beaches. The reopening of the Pass will help alleviate the water quality problems that have been occurring in Little Sarasota Bay in the vicinity of Midnight Pass.

The management plan is comprised of three phases: initial construction, adjustment and long term maintenance. The initial construction phase includes the dredging of the pass and bay channels. Dredge material will be placed on the adjacent beaches. The adjustment phase includes annual monitoring of the Pass, shoals and beaches. It is expected that an ebb shoal will form, taking sand from the littoral system and eroding the adjacent beaches. This plan provides for regular maintenance dredging of the deposition basin and channels and supplemental nourishments of the beaches in order to maintain the beaches. It is estimated that the ebb shoal will reach equilibrium and completely bypass sand in 20 to 30 years. An approximate schedule for maintenance has been determined but actual maintenance of the pass and beaches will be determined through detailed monitoring.

The long term maintenance phase occurs after the ebb shoal has reached equilibrium. This phase consists of annual monitoring of the pass, shoals and beaches. The deposition basin and channels will be dredged as monitoring indicates is necessary to maintain the pass.

This comprehensive plan will be administered by the Sarasota County Department of Natural Resources Management.

MIDNIGHT PASS COMPREHENSIVE MANAGEMENT PLAN

I. INTRODUCTION

A. SCOPE

This management plan provides a framework for the reopening and long-term management of Midnight Pass and adjacent beaches in Sarasota County (Figure 1). This management plan outlines a mitigation program for the adverse impacts to the beach and dune system caused by the opening of Midnight Pass as required by Chapter 161.041(1) of the Florida Statutes. This management plan is based on a littoral budget developed using existing historical information and theoretical predictions. However, the pass may respond somewhat differently than predicted, and as such, the responses outlined in this plan may have to be modified. Monitoring of the pass and beaches will be performed for the purpose of adequately managing the inlet and beaches. This report outlines the long term management of the inlet and neighboring beaches in terms of 3 phases: Initial Construction, Adjustment and Long-term Maintenance. Within each phase a general description is provided, permitting and environmental considerations are discussed, design requirements are delineated and funding sources are presented.

B. PROJECT GOAL

The goal of reopening Midnight Pass is two fold: (1) Reduce the frequency of Class III Water Quality violations and (2) Achieve a net improvement in water quality of Little Sarasota Bay. A method that accomplishes this is to simulate the historical hydraulic conditions which would give the maximum exchange of water while still maintaining hydraulic stability of the Pass.

C. HISTORY OF MIDNIGHT PASS

Midnight Pass was originally opened by the December 1921 Hurricane. The hurricane breached a spit associated with a previous pass (Little Sarasota Pass, or Blind Pass) that existed to the north. The previous pass subsequently closed. Historical records indicate the two channels around Bird Key have been persistent.

Between 1921 and the mid 1960's, Midnight Pass had a history of migrating both north and south. This has been documented by Chiu (1979). In the mid 1960's, the Corps of Engineers dredged the Intracoastal Waterway throughout Little Sarasota Bay. This dredging appears to have changed the hydraulics of Little Sarasota Bay and reduced the hydraulic efficiency of the north channel to Midnight Pass.

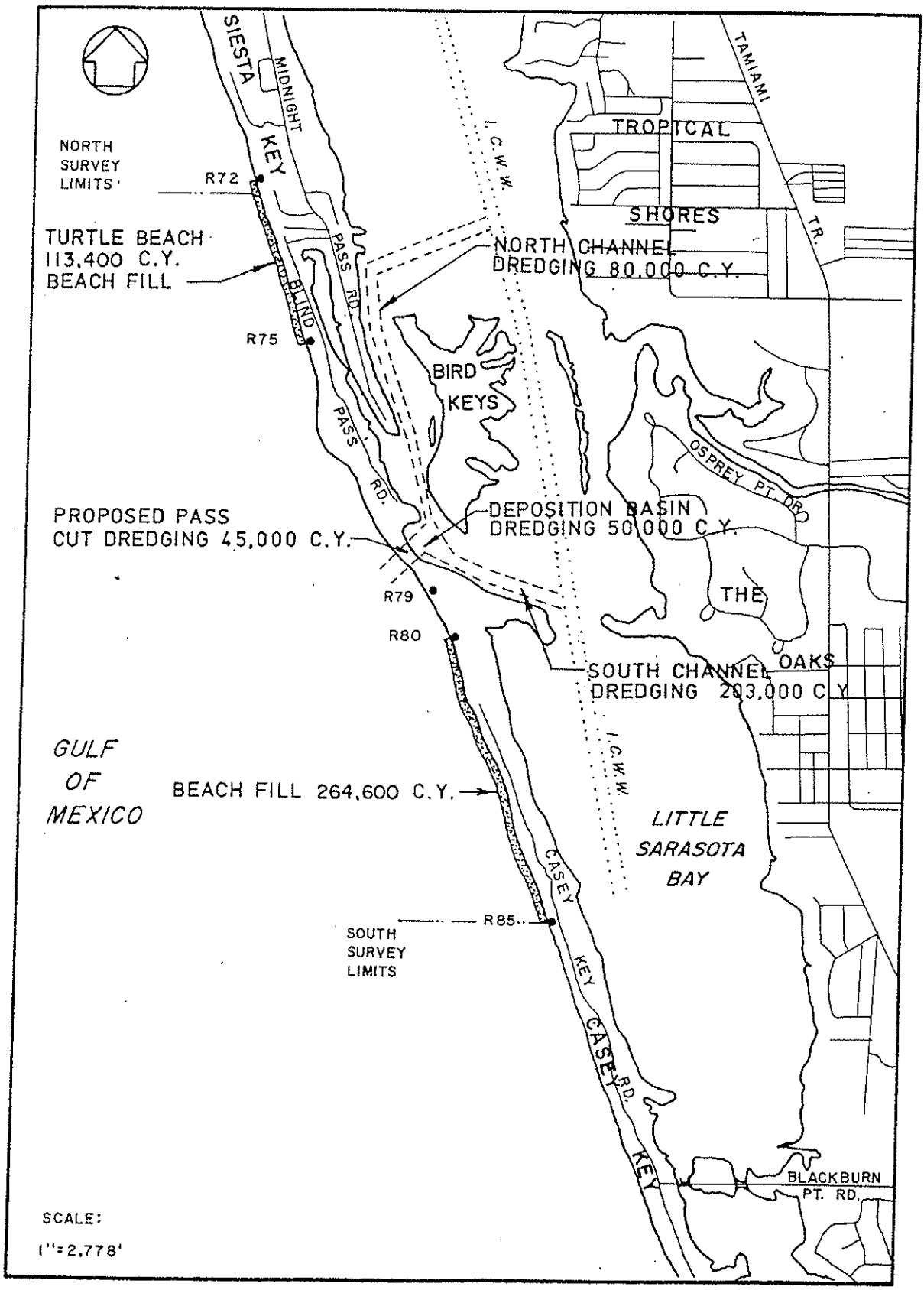

FIGURE 1

MIDNIGHT PASS DREDGING

Sometime, after the Intracoastal dredging in the early 1960's, the north channel shoaled with sand. At the same time, the net sediment transport on the beaches was to the north as indicated by aerial photographs. This resulted in a longer south channel which was hydraulically less efficient. The loss in hydraulic efficiency resulted in deposition of sand in the channel and the inlet migration threatened residences to the north. The inlet was finally closed in September 1983 by local interests. Five attempts were made to dredge a channel through the barrier island at a new location to the south, all of which failed. It should be noted that the back channels were not dredged in these attempts.

In May 1984, the Blue Ribbon Panel on Midnight Pass found that the pass was a factor in diluting pollutants in Little Sarasota Bay and closure would likely change the biota of the bay. The panel recommended opening of the pass. In February 1985, Mote Marine Laboratory also recommended reopening the pass to prevent further environmental damage to Little Sarasota Bay. Sarasota County (1985) reported that a deterioration of the water quality, and a reduction in the ecological richness near Midnight Pass had occurred in 1984.

D. PUBLIC INTEREST

Since the closure of Midnight Pass, Sarasota County has sought to reopen the Pass for the purpose of improving and maintaining the water quality of Little Sarasota Bay. The Midnight Pass Society, a citizens' group who are in favor of reopening Midnight Pass, claim to have support of over 6000 individuals. Other organizations who support the reopening of the pass are: Mote Marine Laboratory, Natural Resources and Recreation Advisory Board, Council of Neighborhood Association, Taxpayers Association of Sarasota County, and the West Coast Inland Navigation District.

II. PHYSICAL PROCESSES AND LITTORAL BUDGET

This section documents the expected flood and ebb shoal growth rates and describes the effects that the loss of sand to the shoals will have on the adjacent beaches. A littoral budget is developed which shows the need for a mitigation plan as well as quantifies the mitigation dredging volumes.

A. Flood Shoal Growth Rates

An evaluation of flood shoal growth from 1965 to the Pass closing indicates a growth rate of 16,400 cubic yards/year. This is based on the assumption that the majority of the pass shoaling occurred between 1965 and 1983, after the dredging of the ICWW.

Hine (1986) computed a flood shoal size of 1,300,000 c.y. in 1957. This would give an approximate rate of 36,100 cy. per year, if shoaling is estimated to have occurred since the opening of the pass in its most recent location (1921). Hine considered all of Bird Keys as the flood shoal and all of this volume cannot be attributed to Midnight Pass at its most recent location. Much of Bird Keys already existed in 1883, prior to the pass being in this location, as shown in navigation charts. In addition, part of Bird Keys was used as a spoil island for the Intracoastal Waterway dredging. Therefore, the rate should be less than 36,000 c.y. per year. The estimated rate of 16,400 c.y. was considered to be indicative of the recent shoaling rates and was used for development of the littoral budget. The shoaling inside the inlet will occur in the north and south channels, and in the deposition basin.

B. Ebb Shoal Growth Rates

The ebb shoal size from the 1955 bathymetry was computed by comparing the 1955 shoal contours to a series of contours parallel to the beach and computing a volume change. It is assumed that without the inlet, the nearshore contours would be parallel to the beach as is generally the case. This methodology is further described in the Shore Protection Manual (1984).

The computed volume of the 1955 ebb shoal was 930,000 cy. and is plotted in Figure 2. The 1932 nautical chart indicated that there was not a shoal in the vicinity of the Pass. Thus, the average growth rate (1932-1955) can be estimated at 41,700 cy/yr. if a linear growth rate is assumed.

The computed shoal volume of 930,000 cy. compares with the value of 750,000 as predicted by Walton and Adams (1976) for the 1955 inlet cross-sectional area (Figure 2). Hine (1986) estimated a shoal volume of 630,000 cubic yards in 1982 (Figure 2) which was at the time when the inlet was diminishing in size. The 1988 hydrographic survey of the shoal indicated a shoal size of approximately 130,000 cy.

The maximum growth rate for the new ebb shoal could be approximately 83,600 cy/yr. This would occur if the pass traps the entire gross littoral drift (100,000 cy/yr). The assumption for this estimate is that the deposition basin would shoal at 16,400 cy/yr. and the ebb shoal would grow at 83,600 cy/yr. (i.e., 100,000-16,400 cy.). This is not a probable situation.

Another method which could be used to determine ebb shoal growth rates is Galvin's "transport ratio" method (1982). Galvin's "transport ratio" method was originally proposed to determine channel shoaling rates. Galvin indicated the volume of material trapped in a navigation channel:

$$Q_T = Q_G \left(1 - \left(\frac{d_n}{d_D} \right)^{2.5} \right) \qquad (1)$$

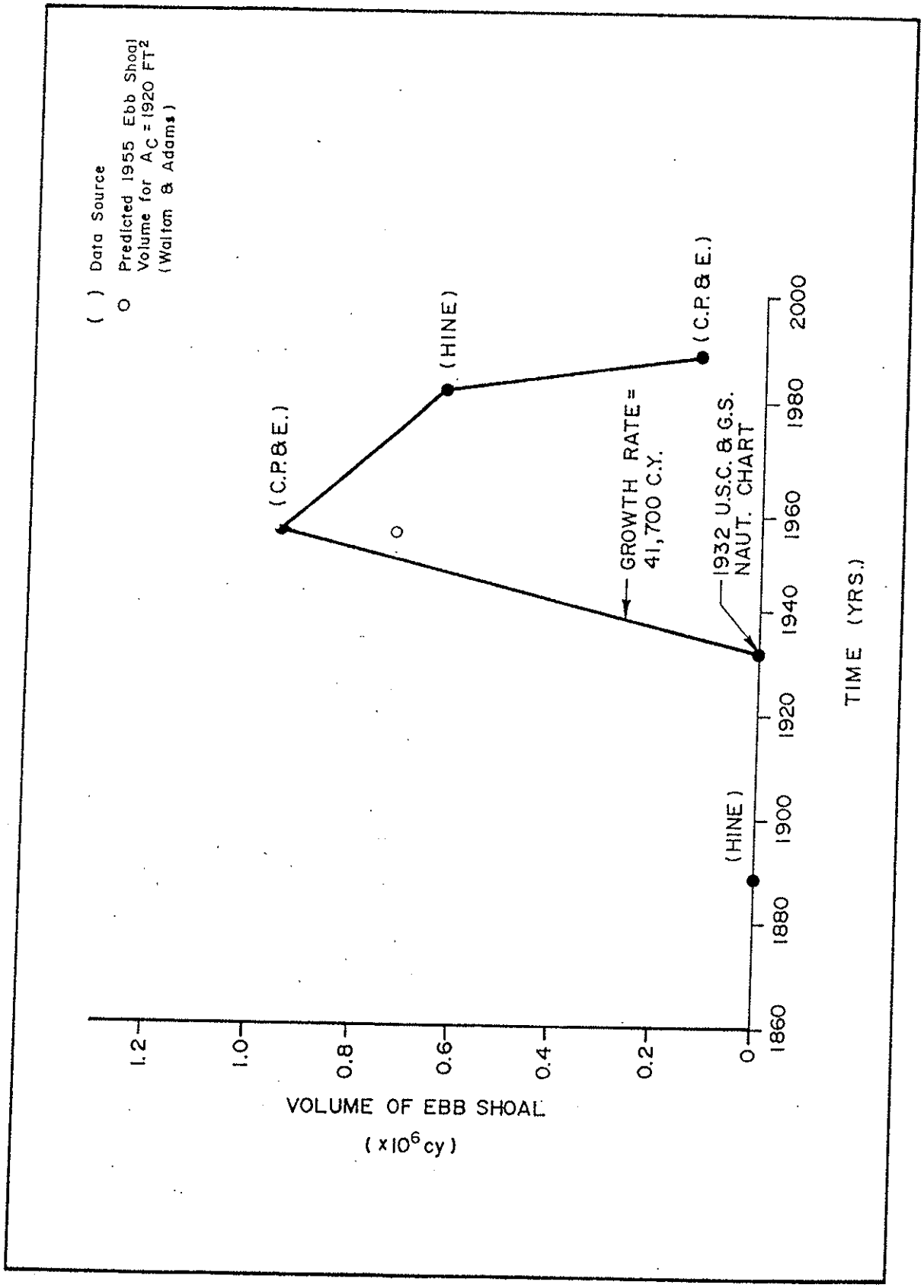

FIGURE 2

MIDNIGHT PASS HISTORICAL EBB SHOAL VOLUMES

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where Q_G is the gross littoral drift, d_n is the natural depth of the channel and d_D is dredged channel depth. By calculating the deposition rate, d_D can be calculated over a period of time.

To extend Galvin's hypothesis to an ebb shoal, it is assumed that the trapped sand is uniformly deposited over the entire area of the shoal. Therefore, if Q_G and d_n are known, Equation 1 gives an estimate of the volume of trapped sand (above the bottom, rather than within a channel) and the depth of the shoal d_D as a function of time.

The historical natural depth (over the bar) of inlets on the west coast is approximately 6 feet (Vincent and Corson, 1980). The average initial depth over the entire ebb shoal area is 9 feet. The ebb shoal area was taken as the 1955 ebb shoal area which is approximately 14,583,000 ft^2. The volume of trapped sand is given in Table 1. Table 1 indicates it would take approximately 18 years for the ebb shoal to reach its maximum historical volume.

Walton and Adams (1976) developed a relationship between ebb shoal volumes, V, and the inlet cross-sectional area, A_c. For mildly exposed coasts (e.g., Gulf of Mexico),

$$V = 45.7A_c^{\ 1.28} \qquad (2)$$

For a 3000 square foot inlet, the potential equilibrium ebb shoal volume is 1.3 million cubic yards. Table 1 shows that it will take approximately 28 years to reach the potential equilibrium volume if no sand is dredged from the shoal.

Table 1
Ebb Shoal Growth Rates
Galvin's Method

Year	Annual Volume of Sand Accreted (cy)	Average Depth to Shoal (ft)	Cumulative Volume of Sand Accreted (cy)
0	0	9.0	0
1	63,700	8.8	63,700
2	62,500	8.7	126,200
3	61,250	8.6	187,450
4	60,000	8.5	247,450
5	58,650	8.4	306,100
6	57,300	8.3	363,400
7	55,900	8.2	419,300
8	54,500	8.1	473,800
9	53,100	8.0	526,900
10	51,650	7.9	578,550
11	50,200	7.8	628,750
12	48,700	7.7	677,450
13	47,200	7.65	724,650
14	45,700	7.6	770,350
15	44,100	7.5	814,450
16	42,600	7.3	857,050
17	41,000	7.25	898,050
18	39,500	7.25	937,550
19	38,000	7.2	975,550
20	36,500	7.1	1,012,000
21	35,000	7.0	1,047,000
22	33,400	7.0	1,080,400
23	32,000	6.9	1,112,400
24	30,500	6.8	1,142,900
25	29,100	6.8	1,172,000
26	27,700	6.7	1,199,700
27	26,300	6.7	1,226,000
28	24,900	6.6	1,250,900
29	23,600	6.6	1,274,500
30	22,400	6.6	1,296,900
31	21,100	6.5	1,318,000
32	20,000	6.5	1,338,000
33	18,800	6.4	1,356,800
34	17,700	6.4	1,374,500
35	16,700	6.4	1,391,200
36	15,700	6.3	1,406,900
37	14,700	6.3	1,421,600
38	13,800	6.3	1,435,400

This evaluation has shown the range of potential ebb shoal growth rates. These are plotted in Figure 3. The rate predicted by Galvin's method appears to be an average and was therefore used to further develop the littoral budget.

C. Effect on Beaches

This section summarizes the potential impacts to beaches by reopening the Pass. The impacts would result from the inlet impounding sand in the ebb and flood shoals. Estimates of shoaling rates have been made in the preceding sections based on measurements from historic bathymetries and theoretical methodologies available.

In discussing the potential impacts to the adjacent beaches, it is important to realize that much of the adjacent shorelines are presently armored. On Siesta Key, the geomorphologic area historically impacted by Midnight Pass extends from Point of Rocks (R63) to the Pass (R77). From R63 to R67, the shoreline is 100% armored either naturally (R63 to R64) or with revetments. On Casey Key, the shoreline is armored with groins and revetments south of R82 to R94.

In developing the potential beach impacts, it is assumed that there exists an available supply of sand equal to the annual potential littoral drift rates. The supply of sand may be limited at times depending on whether it is possible to naturally bypass sand south of Point of Rocks (R63). Wave conditions would also have an effect on the movement of sand with lower than average wave heights reducing the littoral drift.

1) Historical Erosion

Midnight Pass, when it was open, divided Casey Key and Siesta Key into two separate barrier islands. Both islands have significant residential development. Both barrier islands have experienced erosion with Siesta Key experiencing higher erosion rates since the Pass closed (Table 2). From DNR profile lines R67 to R77, the shoreline on the average has been eroding since 1974. More recently, since pass closure, the erosion has increased. Since the Pass closed, there has been accretion between R79 and R85 on Casey Key (Table 2).

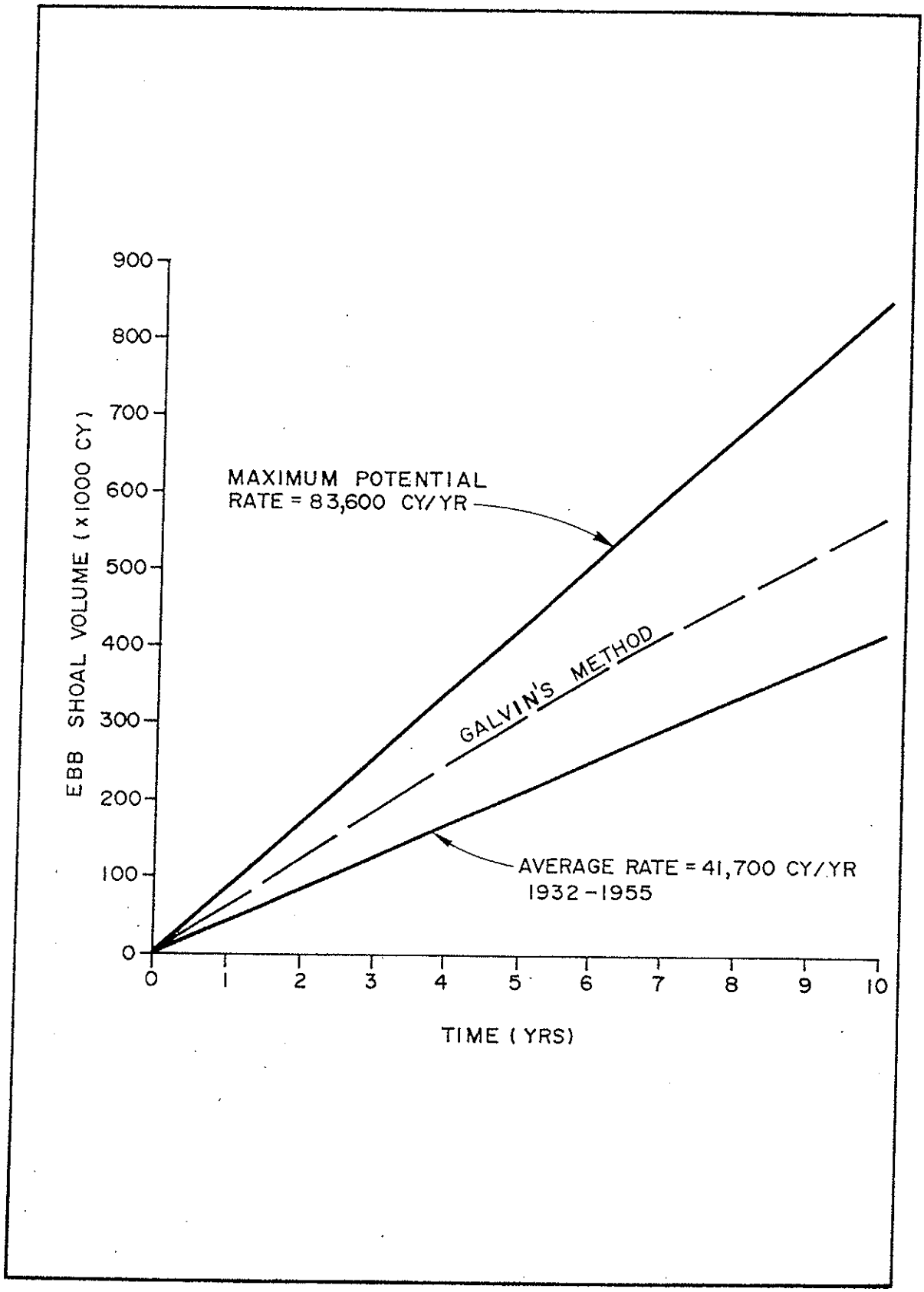

FIGURE 3

POTENTIAL EBB SHOAL GROWTH RATES

Table 2
Erosion - Accretion Rates
(Cubic Yards/foot/year)

Location	DNR Monument	1974-1979	1974-1985	1985-1988
Siesta Key	63			
Point of Rocks	64	+0.15		
	65			
	66	-1.85		
	67			
	68			
	69	-1.8		
	70			
	71			
	72	-15.1		
	73		+2.1	-1.5
Turtle Beach	74	+3.3	-1.4	-6.1
	75	-15.5	-1.7	-16.9
	76		+0.3	-21.8
	77	-31.9	-2.1	-16.8
Proposed Pass	78			
Casey Key	79		-1.2	+6.9
	80		-0.9	+8.1
	81	-7.9	+0.4	+7.4
	82		+1.3	+8.8
	83		-2.0	+8.1
	84	-13.9	-2.7	+2.3

2) Littoral Drift

Walton (1979) indicates that, in the area near Midnight Pass, the gross littoral drift is 70% to the south and 30% to the north. The Corps of Engineers (1984) indicates that the net littoral drift is 40,000 cy/yr to the south. Using Walton's percentages, the annual littoral drift would be 70,000 cy/yr to the south and 30,000 cy/yr to the north. In the development of the littoral budget, it is assumed that all sand bypasses the inlet except that which is captured by the shoals. Since there are no jetties, no shoreline reorientation is expected.

It is assumed that the littoral drift rates will remain constant and that an adequate supply of sediment is available for transport. If the littoral drift rate is less than the average rate then there should be a corresponding drop in the ebb shoal, and flood shoal growth rates. This may postpone required dredging.

3) Beach Impacts

Based on Walton's percentages, the sand lost from Casey and Siesta Keys are determined as follows. The loss to Siesta Key is equal to 30% of the volume of sand trapped. The loss to Casey Key is 70% of the volume of sand trapped by the inlet. Since the volume of sand trapped by the ebb shoal decreases each year (Table 1), the volume of sand eroded from the beaches decreases each year.

D. Littoral Budget

The effect of opening Midnight Pass on the beaches can be seen by establishing a littoral budget. The littoral budget was based on the growth rate of the ebb shoal computed using Galvin's transport ratio equation. Galvin's equation indicates the initial shoal growth rate is 63,700 cy/yr and the growth rate decreases with time (Table 1). The deposition basin was estimated to shoal at 16,400 cy/yr. The total quantity impounded by the inlet varies according to the ebb shoal growth rate.

Based on the littoral drift distribution, the proposed initial dredge material from the inlet and channels was divided into 113,400 cy (30%) on Siesta Key (Turtle Beach) and 264,600 cy (70%) on Casey Key. This material will be placed to partially offset losses to the beach caused by the opening of Midnight Pass and the formation of the shoals.

For the purposes of this evaluation, it was assumed that the flood shoal and channels would be dredged at 4-year intervals and 65,600 cy. would be placed on the beach. For this evaluation, 30% of any dredged sand is placed on Siesta Key and 70% is placed on Casey Key. The actual distribution of the sand between the two beaches would be determined from the monitoring results. The littoral budget calculations are presented in Appendix C.

The littoral budget shows that the beaches erode (volumetrically) back to pre nourishment conditions in approximately six years for both Siesta and Casey Keys. An additional nourishment of the beaches will be required to keep the beaches from eroding volumetrically beyond the pre-opening conditions. The beach erosion will be mitigated by the placement of sand from the dredging of the flood shoals, ebb shoals, or an alternate source. The littoral budget in Appendix C assumes that the additional nourishment will be performed in conjunction with the flood shoal dredging in project years 8, 16 and 28.

The maintenance dredging scenario used in this example includes: dredging 65,000 cubic yards every four years from the deposition basin and channels; dredging 100,000 cubic yards from the seaward side of the shoal; dredging the remainder of the sand deficit from an alternative source. Alternative sand sources are discussed in Appendix B.

A quantitative littoral budget for a project life of fifty years is presented in Appendix C. The littoral budget tracks the volume of sand in the ebb shoal, deposition basin, and on Siesta and Casey Keys. The littoral budget also calculates the volume of sand required for maintaining the beaches. The littoral budget is summarized in Table 3. A graphical representation of the first 16 years is given by CPE (1989a).

Table 3
Littoral Budget and Management Summary

Component	Volume
Gross Littoral Drift	100,000 cy/yr
Net Littoral Drift	40,000 cy/yr
Deposition Basin/Flood Shoal Growth	16,400 cy/yr
Ebb Shoal Growth	63,700 cy/yr decreasing annually to 13,800 cy @ 38 years.
Loss from Casey Key	70% of sand lost to shoals
Loss from Siesta Key	30% of sand lost to shoals
Deposition Basin Dredging	65,600 cy every 4 years
Ebb Shoal Dredging	
Project Year 8	100,000 cy
Project Year 16	100,000 cy
Project Year 28	100,000 cy
Additional Required Nourishment from Alternate Source	
Project Year 8	373,800 cy
Project Year 16	283,200 cy
Project Year 28	149,800 cy
Ebb Shoal Equilibrium Volume	
Project Year 38	1,300,000 cy

The littoral budget presented is an estimate of how Midnight Pass may perform. In order to provide a workable framework for project management, the following statement has been adopted by Sarasota County (CPE, 1989a):

> "The mitigative sand volume placed, to maintain Siesta and Casey Keys, will be based on losses which can be attributed to the Inlet. The County will only place sand on the beach equivalent to the volume lost to the flood shoal and ebb-shoal, or the volume of sand which is lost from the beach, whichever is less. The mitigation quantity will be determined by the periodic surveys of the shoals and beach. The County will not be responsible for replacing sand lost to other causes (i.e., background erosion rate, or storm losses not resulting in sand gains to the shoals). It has been shown that both Siesta and Casey Keys were eroding for a long period of time with the inlet open."

III. BEACH AND INLET MANAGEMENT PLAN

The management of Midnight Pass will be described in three phases: Initial Construction, Adjustment, and Long-Term Monitoring. The plan will describe the activities, costs, resources and funding that will occur during each phase. The time frame for each phase is also discussed.

A. INITIAL CONSTRUCTION PHASE

1) General Description

This phase would cover the time period from approximately three months prior to construction to two months after construction. During this period of time Sarasota County will be: coordinating the pre-construction and post-construction surveys and final design, and performing environmental monitoring as required by the permitting agencies.

The County or their engineering consultant will be required to oversee the construction contract. This will include establishing a beach baseline survey from which all future monitoring can be compared. Cross-sections of the inlet channels will be surveyed to ensure that the proper cross-section was constructed in order to satisfy the hydraulic requirements. The County will also observe the proper placement of the dredge material on the beaches according to the distribution outlined in this plan.

Sarasota County will conduct an environmental monitoring program and, if necessary, recommend changes in construction technique to the dredge contractor to satisfy permit requirements.

2) Present Status of the Project and Schedule

A project schedule for the reopening of the Pass is shown in Figure 4. The permit applications for the project are currently being finalized. A preliminary design was completed in 1988. The final design is scheduled to be completed in March 1990.

Sea turtle nesting season occurs at the same time construction could begin and this will delay the project until fall of 1990 (Figure 4). An option that may be considered is the development of a monitoring program which would meet the approval of the agencies. It is estimated that construction will take approximately two months with an additional month for mobilization and demobilization.

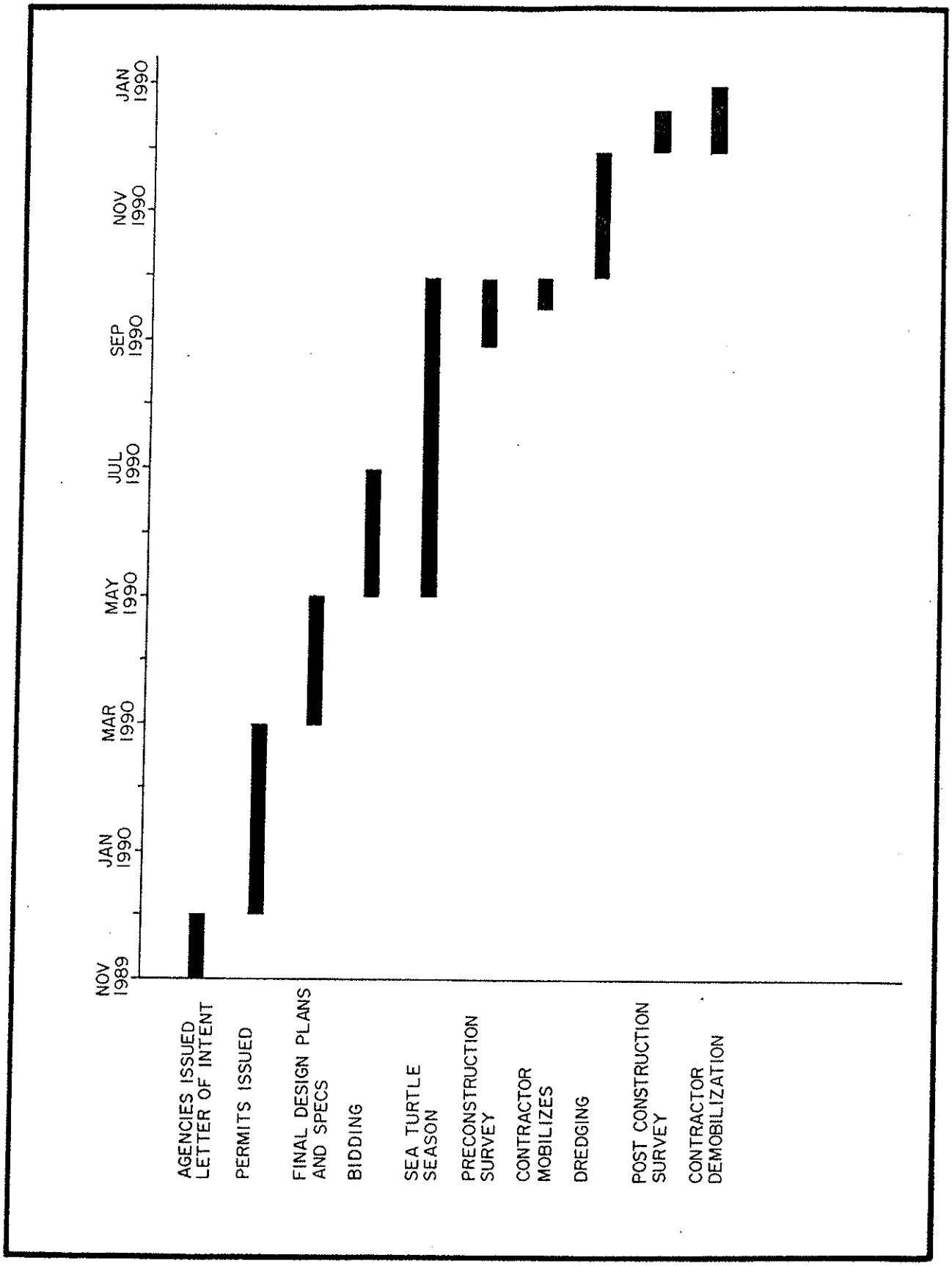

FIGURE 4

MIDNIGHT PASS REOPENING SCHEDULE

(3) Project Costs and Funding

The initial construction cost is estimated using three categories: engineering, environmental and dredging. Costs are estimated as follows:

Engineering - 10% of Dredging Costs	$ 171,200
Dredging	
Mobilization/Demobilization	$ 200,000
378,000 cy. @ $4.00/cy.	1,512,000
10% contingency on dredging and engineering	188,320
Total	$2,071,520
Environmental monitoring as required by DER to be performed by Sarasota County	$ 25,000

The total initial cost including environmental costs is $2.1 million.

Sarasota County is currently arranging funding from the West Coast Inland Navigation District and the County Tourist Tax to pay for the initial construction.

B. ADJUSTMENT PHASE

1) General Description

The time period associated with the adjustment phase starts immediately after construction and continues until the ebb shoal contains an equilibrium volume of sand. Using the ebb shoal volume as a management criteria is appropriate since the ebb shoal volume will indicate what volume of sand is being lost from the adjacent beaches. During this phase the two primary activities will be monitoring and sand transfer/beach maintenance.

A major determination that will be made during the adjustment phase is what the inlet equilibrium cross-sectional area will be. The inlet cross-section was developed based on theoretical evaluations and some adjustment in cross-section would be expected. Monitoring results will be used to assess changes in cross-section and determine the equilibrium cross-section.

The importance of determining the equilibrium cross-sectional area is critical when predicting future sand requirements of the ebb shoal and beaches. If the equilibrium cross-sectional area is smaller than estimated, the size of the predicted equilibrium ebb shoal volume could be considerably less. This will cause the shoal to approach equilibrium faster. This would also reduce the need for future major nourishments aside from the interior shoal dredging.

2. Monitoring

A monitoring and maintenance plan has been developed to assist in sand management for the Pass and the neighboring beaches. The monitoring program will assess the performance of the Pass, the shoal growth rates, and the effects on the beaches. A preliminary maintenance plan has been developed based on the littoral budgets previously discussed. The annual monitoring of the Pass and beach will be used to modify the maintenance program as needed.

a. Inlet Monitoring

Midnight Pass, north and south channels, ebb shoal and flood shoal (deposition basin) will be surveyed at the completion of construction, three months, six months and 12 months after opening. This monitoring should document the initial adjustments in cross-sectional area of the inlet and its hydraulic performance.

After the 12 month survey an assessment of future survey frequency will be made. It is anticipated that the inlet could be surveyed every 6 to 12 months thereafter (typically to detect seasonal changes). The hydrographic survey information will provide documentation to determine the Pass performance. Comparative channel cross-sections will be used to determine scour/deposition rates. Deposition basin volumes will be computed to determine the volume of sand shoaling inside Midnight Pass.

It is expected that it will take a minimum of six months for the inlet to reach equilibrium cross-section. Kana and Mason (1988) report that the relocated Captain Sam's Inlet in South Carolina obtained an equilibrium cross-section within six months. It should be noted that South Carolina has a larger tidal range than Sarasota County; therefore, it is expected that it will take longer than six months for an equilibrium cross-section to develop at Midnight Pass.

Current measurements will be performed in the inlet system to aid in evaluating the overall inlet stability. These measurements will be performed at the same time as the hydrographic surveys. The spring tidal prism will be computed to evaluate tidal flushing and inlet stability. Comparison with known stability theories will be made. The hydrographic and current data will be used to determine trends towards instability (if any).

b. Flood Ebb Shoal Monitoring

Monitoring of the flood and ebb shoals will occur 3 months, 6 months and 12 months after construction is completed. Hydrographic surveys will be used to document the volumetric changes of the inlet shoals. Comparisons with the predicted shoaling rates will be made. After the 12 month survey, future survey monitoring frequency will be evaluated. It is anticipated that a six or twelve month frequency will be used for the remainder of this phase.

c. Beach Monitoring

The Casey Key and Siesta Key beaches will be monitored at the same interval as the Pass. DNR profile lines extending from R72 through R85 will be surveyed to assess changes to the beach profile. All profile lines will be surveyed to the depth of closure. Profile comparisons will be made to measure volumetric erosion/accretion and mean high water shoreline changes. This information will be used in conjunction with the measurement of the shoal volumes to re-evaluate the littoral budget. Predictions of proposed dredging requirements will be updated on an annual basis by updating the littoral budget based on the surveys. The need for and location of beach fill from the maintenance dredging will be determined based on measured erosion.

d. Environmental Monitoring

Sarasota County has an ongoing monitoring program of its coastal bays and tributaries. This program was started in 1980. This program includes monitoring of Little Sarasota Bay. The Department of Environmental Services of Sarasota County has been monitoring the following parameters in Little Sarasota Bay and in the vicinity of Midnight Pass: phosphorus, total nitrogen, transparency, salinity, color turbidity, pH, dissolved oxygen, temperature, fecal coliform and rainfall. Sarasota County plans to continue this monitoring after the project is constructed.

Little Sarasota Bay has been included in the National Estuary Program. This program is establishing a long-term environmental monitoring program for the bays in Sarasota County. A monitoring program developed by Sarasota County has recently been submitted to the National Estuary Program for their review. This program will assess the impacts of the pass opening on the Bay.

? what?

e. Report and Recommendation

After each survey, a report of findings will be prepared. This report will document the surveys, results, inlet performance and beach impacts. Recommendations for modifications (if any) to the maintenance plan will be made. Modifications may include dredging or surveying frequency or location of fill placement. Table 4 delineates specific items which will be evaluated after each survey and the probable action which will be taken. Since the pass will be constructed and maintained without jetties, the pass is more susceptible to morphological changes. If the morphological changes threaten private property or the stability of the pass, then action will be taken.

Table 4

Midnight Pass Corrective Actions

Problem	Solution
Migration of channel within 300 ft. of R77	Realign channel
Migration of channel 400 ft. south of R78	Realign channel
Reduction in throat cross-section to less than 1000 ft.^{2}	Dredge shoaled channel and deposition basin
Deposition basin fills to 50,000 cy.	Dredge deposition basin and channels
Damage to dune due to migration/overwash	Rebuild dunes & vegetation

3. Proposed Sand Transfer/Beach Maintenance Plan

Midnight Pass will become a sediment sink after it is opened. CPE (1989a) has estimated that the ebb shoal may capture 1.3 million cubic yards before the ebb shoal reaches equilibrium. The sediment needed to build the ebb shoal will be lost from the adjacent beaches. As the shoal builds, the amount of sand bypassed across the bar will increase. CPE (1989b) has shown that Midnight Pass should be a bar bypassing inlet.

The two solutions to the erosional stress on the beaches are: 1) build an ebb shoal to permit bar bypassing soon after opening; 2) maintain the beaches and allow the ebb shoal to form slowly. Solution 1) has been considered and rejected since there is no design guidance or practical experience on where to place the shoal. An error in the offshore position or quantity could trap sand offshore with no bypassing occurring. An error in the onshore position or quantity could cause inlet instability. Therefore, this solution was not considered feasible.

The most practical solution to the maintenance of the beaches is placement of sand directly on the beach in sufficient quantity to offset the erosion losses. Several options exist to maintain the beaches. Each option is discussed in the following sections.

a. Dredge Deposition Basin/Entrance Channel

By dredging the deposition basin and entrance channel every four years, approximately 65,600 cubic yards of material will be available for beach maintenance. This dredging will be performed since it also maintains the hydraulic efficiency and stability of the Pass. This quantity will not totally offset the losses which will occur due to the building of the shoal.

b. Beach Maintenance

Due to the potential ebb shoaling rate, dredging the deposition basin alone will not maintain the beaches. Additional maintenance dredging will be required. The beaches can be nourished with material from a number of possible sources. The first option is to dredge sand from an offshore source, thus allowing the ebb shoal to build quickly. The rate of bar bypassing will also increase. Alternative sand sources are discussed in more detail in Appendix B.

A second option is to dredge up to 20% of the ebb shoal and place the sand on the beach. This would provide a sure source of beach quality sand. By dredging the seaward side, bar bypassing should not be severely affected. The use of part of the ebb shoal will still require placing sand from a supplemental source. The use of the ebb shoal

will be evaluated during the monitoring to assess the usable quantities and adjustments will be made on the ratio of ebb shoal vs. supplemental sand source, if necessary.

A third option is to dredge the entire shoal. While it may be the most economical source of sand, this will prevent bar bypassing from ever occurring and will not lead to a long term solution. This option is not considered further.

c. Proposed Plan

Sarasota County proposes to dredge the deposition basin every four years and renourish the beaches every eight years with a supplemental source, possibly including a portion of the ebb shoal. The ebb shoal will be allowed to build up and allow bypassing to occur. Once bypassing occurs, the erosional stress on the shorelines will decrease. Continued maintenance of the interior channels will be required as monitoring finds necessary. Sarasota County will further investigate potential supplemental sand sources prior to the required maintenance. Evaluations will include economics and technical feasibility. This will require geotechnical surveys, engineering, and cost analysis to determine the most cost effective solution. These studies will be performed prior to the first major nourishment (estimated to be project year 8).

d. Maintenance Criteria

In order to effectively implement the sand transfer plan, criteria must be established, which when met, initiate beach or inlet maintenance. For the deposition basin dredging, the dredging should occur when the basin contains at least 50,000 cubic yards, the design capacity. The inlet channels should be dredged if the throat cross-sectional area is less than 1000 $ft.^2$. If either the deposition basin criteria, or the channel cross-section criteria is met, it would be economical to dredge both the channels and the basin. The inlet channel would be returned to the equilibrium cross-sectional area, as determined through monitoring and stability analysis.

The criteria for initiating renourishment of the adjacent beaches is if either beach, on the average erodes back to the pre-project shoreline. The littoral budget (Appendix C), shows both beaches eroding at the same time at a steady rate. Due to natural variations in the littoral drift rates, the fill requirements may vary from those predicted. At the time of nourishment, both beaches should be nourished with quantities as indicated by monitoring. The volume of nourishment should not exceed the volume of sand gained by the shoals. The maintenance criteria are summarized in Table 5.

Table 5

Maintenance Dredging Criteria

Criteria	Action
A. Deposition basin contains 50,000 cy.	Dredge basin and inlet channels
B. Throat cross-sectional shoals to less than 1000 $ft.^2$	Dredge basin and inlet channels
C. Beach fill lost to pre-construction shoreline (an average).	Renourish project beaches as needed.

4. Design Requirements for Maintenance Dredging

This section details the timing and activities associated with maintenance dredging. This process starts with the results of a monitoring survey indicating that a criteria has been met which indicates maintenance dredging is required.

a. Schedule

The maintenance dredging projects will be designed in the two months following the monitoring surveys. Permitting agencies will be notified according to the requirements of the long term permits. The project will be bid and the pre-construction survey will be performed. The construction of the project will begin approximately six months after the original project monitoring survey. A possible exception would be if the stability of the pass were threatened. In that case, the design process may be accelerated.

b. Data Requirements For Design

The primary source of data will be the hydrographic surveys performed during the monitoring of the inlet. Current measurements will also be used to aid in the determination of the inlet's stability.

c. Design and Construction Plans

For each maintenance dredging, a set of construction plans will be created. These plans will identify areas to be dredged as well as locations on the adjacent beaches for the placement of fill. Post-construction surveys will be used to document the quantities of sand transferred from the inlet to the beaches. This is needed to accurately establish the littoral budget for future monitoring.

d. Alternative Technology Solutions

In the past few years, a system has been developed where inlet maintenance could be performed without dredging. Fluidization of the bed material in the inlet channel could be used to reduce interior and channel dredging costs. Two systems are currently available, one by Coastal Stabilization, Inc. and the second by Dyneqs, Ltd. These systems may be evaluated by Sarasota County in the future to determine their cost effectiveness versus standard dredging of the depositional basin and entrance channel.

5. Environmental Considerations

This section of the management plan addresses major environmental considerations related to the construction activities. The water quality improvements associated with the inlet's opening are also discussed.

a. Sea Turtles

The primary species of sea turtle that nests on Sarasota County's beaches is the loggerhead turtle (Caretta caretta). Coastal Engineering Consultants (1987) report the areas of significant nesting within the County between 1982 and 1986. The nesting densities were found to correlate somewhat with undeveloped areas. The south end of Siesta Key and the north end of Casey Key were reported to have significant nesting densities. Construction activities associated with the pass could impact sea turtle nesting. Impacting sea turtle nests can be avoided by planning construction around sea turtle nesting season or by monitoring the beach during construction and moving the nests to safe areas. Movement of nests would be performed by trained personnel according to DNR procedures. A Sea Turtle Monitoring Program is included as Appendix A.

b. Manatees

Little Sarasota Bay is one of many coastal bays on the Gulf coast that the endangered manatee use during parts of the year. The Florida Game and Freshwater Fish Commission indicates that the north channel area is used by manatees. To minimized boat-manatee collisions the north and south channels will be posted as no wake, idle speed areas during Manatee season. During any dredging activities, the contractor will be required to exercise caution when moving boats or equipment. The noise and activity associated with dredging will probably cause the manatees to stay out of the area.

c. Dredging Impacts

Dredging of the Little Sarasota Bay channels may cause localized turbidity plumes. This turbidity increase will be limited to the duration of the dredging. Sarasota County will consider, prior to each dredging project, methods that can satisfy DER water quality requirements. Options considered may include: obtaining a mixing zone variance, silt curtains, and dredging on ebb tide only.

While the benthic ecology will be disturbed during dredging, the channel bottoms should recolonize within approximately one year. After the initial opening, the benthic community that establishes may differ from the existing community due to higher current velocities and changes in salinity.

d. Water Quality Impacts

CPE (1989a) has shown, that by opening the pass, the tidal mixing should increase by 20% and reduce the average residence time of a conservative constituent to 4 days assuming 100% mixing. Opening Midnight Pass will not solve all the localized water quality problems throughout the bay. The improvements in water quality will be measured using the program established by Sarasota County (see section 2d).

6. Permits

a. DNR, DER, COE Permits

Sarasota County will request that a 25-year DNR permit be granted for the reopening and maintenance of Midnight Pass. A 25-year permit will allow the County to implement this plan of opening and maintaining the pass over the long term, rather than addressing the project in detail at each dredging. Administrative review at 5 year intervals by DNR staff would be appropriate and would allow DNR to make adjustments in permitting conditions if necessary.

For the same reasons, a 25-year maintenance DER permit and a 10-year maintenance COE permit will be sought. Long term permits will also allow for quick response in the event that a storm impacts the pass.

b. State Lands Easement

A State lands easement has been applied for to reopen the pass. Due to the dredging of the pass through the island, the State will re-acquire the acreage of the pass which is lost when the pass closed. Easements will be sought for borrow areas used to renourish the beaches.

7. Storm Considerations

As outlined by CPE (1989a), the barrier island in the vicinity of Midnight Pass is susceptible to storm damage by lower frequency period storms. Damage would occur in this area even if the inlet were not reopened. This section outlines monitoring plans and contingencies in the event that a storm impacts the pass.

a. Post-Storm Monitoring

In the event that the Midnight Pass area is impacted by a severe storm (tropical or extratropical), the following procedures will be followed. First, a qualitative (visual) inspection of the pass will be performed to determine the impact to the pass. Inlet migration, dune overwash, and channel shoaling will be determined qualitatively. If the visual inspection indicates that the impact is severe (threatening the stability of the pass or private property), then a hydrographic survey of the pass will be performed.

b. Criteria for Action

Based on the results of the post-storm monitoring surveys, the impacts to the pass and beaches will be evaluated. The criteria for action are the same as outlined in section B2. Remedial action as outlined in Table 4 will be implemented as needed.

8. Project Administration

The reopening of Midnight Pass and the subsequent beach and inlet maintenance as described by this management plan will be administered by the Sarasota County Department of Natural Resources Management. Sarasota County will also be responsible for securing funding for the project from available sources.

9. Project Costs

The major project costs consist of the following:

a. Re-opening the Pass
b. Annual monitoring
c. Deposition basin maintenance at 4 years
d. Beach maintenance at year 8, 16, 28
e. Design engineering for the dredging projects

The cost for re-opening the pass and placing the dredge material on the beaches is estimated to be $2,071,520. A cost breakdown is given in Table 6.

Maintenance dredging of the pass deposition basin and channels on a 4 year interval is estimated to cost $599,192 (Table 6). The cost of the first beach nourishment, at year 8, is estimated to be $3,215,836 and is detailed in table 6. These costs were used in developing the annual cost and year by year costs are provided in Appendix D.

Due to the long term beach maintenance and deposition basin dredging, as described in the littoral budget (Appendix C), 50-year cost estimates were prepared and an annual cost compiled. Various alternate sand sources were compared for the beach maintenance. The cost estimates were calculated using the unit costs presented in Table 7. Comparisons of the annual cost for opening and maintaining the inlet for 50 years were made. The calculation details are included in Appendix D.

The annual costs are summarized in Table 8. These costs include maintenance dredging of the flood shoal (deposition basin) every four years and beach maintenance in project years 8, 16 and 28. Annual monitoring costs were also included.

Table 6

Cost Summary

Initial Opening	
Mob/Demob	$ 200,000
Dredging (378,000 cy.)	1,512,000
Engineering (1)	171,200
Contingency (2)	188,320
Total	$ 2,071,520
4 Year Deposition Basin Maintenance	
Mob/Demob	$ 200,000
Dredging (65,600 cy.)	295,200
Engineering (1)	49,520
Contingency (2)	54,472
Total	$ 599,192
1st Beach Maintenance (Year 8)	
Mob/Demob	$ 500,000
Dredging (539,429 cy.)	2,157,716
Engineering (1)	265,772
Contingency (2)	292,348
Total	$ 3,215,836

(1) Engineering costs based on 10% of dredge and mobilization costs.

(2) Contingency costs based on 10% of dredge, mobilization and engineering costs.

Table 7

Cost Estimate Parameters

	Unit	Mob/Demob	Contingency	Engineering
Dredging				
Pass Opening	$4.00	$200,000	10%	10%
Flood Shoal	4.50	200,000	10%	10%
Offshore & Ebb	4.00	500,000	10%	10%
Big Pass & Ebb	6.60	800,000	10%	10%
N. Siesta & Ebb	6.60	800,000	10%	10%
Monitoring				
1st Year	$90,000	(3, 6 & 12 Mo.)		
2nd & 3rd Years	60,000/yr	(6 & 12 Mo.)		
4th Year	30,000	(Annually thereafter)		

Table 8

Project Annual Cost

Sand Source	Annual Cost[1] ($)
Offshore and Ebb Shoal	522,100
Big Pass and Ebb Shoal	671,100
North Siesta and Ebb Shoal	671,100

[1] Costs are calculated assuming an 8% interest rate and a 50-year project life.

The annual cost estimates show that if beach quality sand can be found offshore of Midnight Pass, then this would be the most economical sand source to use to maintain the beaches. A detailed geotechnical investigation and cost estimate will be performed prior to the first major renourishment (estimated at year 8).

C. LONG TERM MONITORING AND MAINTENANCE PHASE

1. General Description

The long term monitoring and maintenance phase is the last phase of this comprehensive plan. This phase begins when the ebb shoal reaches equilibrium.

The two major components of this phase are continued monitoring and maintenance dredging of the interior channels and deposition basin. Dredging will be performed only as needed to maintain the inlet.

2. Monitoring Program

The frequency of monitoring will be once every 12 months. The monitoring surveys will include hydrographic surveys of the inlet, channels and shoals. The beach profiles will also be surveyed.

3. Estimated Maintenance Requirements

Estimates of the long term maintenance requirements are outlined in the littoral budget (Appendix C). It is estimated that the inlet will continue to shoal at a rate of 16,400 cy/yr. It will be necessary to dredge the channels and deposition basin of 65,000 cy. every four years. Dredged material will be placed on the adjacent beaches as monitoring indicates is necessary.

4. Design and Permitting

The maintenance dredging will require a level of design similar to that for previous dredging project in the adjustment phase. Construction plans and specifications will be required to complete the dredging project. Permitting agencies will be contacted and the work will be performed according to the existing long term permits.

5. Funding

Funding requirements have been calculated and are included with annual costs estimated in section B8. Yearly dredging and monitoring costs are summarized in Appendix D.

IV. SUMMARY OF COMPREHENSIVE PLAN

This comprehensive plan outlines the procedures, criteria, funding and time schedule for the reopening and maintenance of Midnight Pass. The littoral budget indicates that the flood and ebb shoals will remove sand from the littoral system and cause the neighboring beaches to erode.

The adjacent beaches will be maintained by periodically dredging sand from the deposition basin, channels, ebb shoal, and alternative sources and placing it on the beaches. Sarasota County will be responsible for maintaining the beach with a sand quantity equivalent to the volume that erodes from the beach or is gained by the shoals whichever is less. A maintenance plan has been developed to address the beaches and the pass. The plan is based on littoral budget estimates and calls for periodic dredging of the shoals. An alternate source of sand will be required for maintenance of the beaches to allow the ebb shoal to build.

Sarasota County has secured funding from the West Coast Inland Navigation District and from the Sarasota County Tourist Tax for the initial construction of the project. The initial cost for re-opening the pass is estimated to be $2,096,500.

Sarasota County will monitor the physical and environmental changes that occur with the opening of the inlet. The beaches, shoals, and the pass will be monitored annually to document the littoral processes and determine maintenance requirements. Monitoring will be used to establish the littoral budget at the inlet and to determine maintenance dredging volumes and schedules.

V. REFERENCES

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12. Kana, T. and Mason, J., "Evolution of an Ebb-Tidal Delta After an Inlet Relocation," Hydrodynamics and Sediment Dynamics of Tidal Inlets, Springer-Verlag, New York, 1988.

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Appendix A

Sea Turtle Protection Plan

(To be provided by Sarasota County)

Appendix B

Borrow Area Source Evaluation

Appendix B

Borrow Area Source Evaluation

In order to maintain the beaches on Siesta and Casey Keys, the littoral budget (Appendix C) indicates it will be necessary to renourish the beaches with sand from outside of the Midnight Pass area. Potential sites for borrow material are shown in Table B-1. The quality of the material is also indicated in Table B-1. Prior to using any site, Sarasota County would complete an analysis of the area's geotechnical resources. The two inland sources are included which could be used for small maintenance nourishment or for dune improvements.

Table B-1

Potential Sand Sources for Beach Maintenance

Site	Location	Material/Quality	Reference
North Siesta Key	1/2 mile offshore	Fine sand w/shell	COE, 1984
Big Sarasota Pass	Ebb shoal	Unknown sand	Hine, et al. 1986
Midnight Pass	1-2 miles offshore	Unknown thick layer of sediment	COE, 1984
Midnight Pass	Ebb shoal	Compatible sand(1)	
Midnight Pass	Flood shoal/ deposition basin	Compatible sand	
Myakka River Resources	Laurel, FL (inland)	Sand .25 to 1.28 mm.	Company contacted
Quality Aggregates	Tallevast, FL (inland)	Sand .43 to .63 mm.	Company contacted

(1) Impact of dredging on littoral budget may be significant.

Appendix C

Littoral Budget Evaluation

Appendix C

Littoral Budget Evaluation

A spreadsheet was developed to quantify the littoral budget for a 50-year project life. This appendix describes the calculations used in the littoral budget. The littoral budget is split into two tables.

In the second table the volumetric losses to the shoals from Siesta and Casey Keys are calculated. The volume lost, V_L,

$$V_L = V_{ebb} + V_{flood} - V_{ebb\ dredge} - V_{nourishment} \qquad (C1)$$

where V_{ebb} is the ebb shoal growth volume, V_{flood} is the flood shoal growth, $V_{ebb\ dredge}$ is the volume dredged from the ebb shoal and placed on the beach, and $V_{nourishment}$ is the volume dredged from an offshore site and placed on the beach.

The volume lost from Siesta Key is 30% of V_L and the volume lost from Casey Key is 70% of V_L. This is based on Walton's (1979) littoral drift distribution.

For the determination of V_L, the ebb shoal growth rate is given by Equation 1 of the main text, and the flood shoal growth rate is 16,400 cy/yr. The ebb shoal dredge volumes were determined by assuming a maximum of 20% (approximately 100,000 cy) could be dredged without significantly decreasing the bypassing. The volume of supplemental nourishment was determined to be equal to the volume of sand stored in the ebb shoal since the previous nourishment minus the volume dredged from the ebb shoal. The nourishment volume in year 28 was decreased so that the minimum amount of sand was required to maintain the beaches with just the flood shoal dredge volumes.

The first table of the littoral budget keeps track of the volumes of sand that exist on the beaches and in the shoals. The initial volumes are listed in year 0. As can be seen in the deposition basin column, the deposition basin shoals at a rate of 16,400 cy/yr and is dredged every four years.

The beaches on Siesta and Casey Keys are permitted to erode slightly past the original baseline in order to dredge the offshore area, the ebb shoals and the flood shoal in the same year. This will keep dredging costs down.

The nourishment volume in year 28 was adjusted so that in year 39 the beach would erode to a 0 cy volume. This will not happen exactly in reality. The littoral budget shows that as the shoal reaches equilibrium, the volume required for supplemental nourishment can be decreased so that only the flood dredging is necessary for maintaining the beach.

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MIDNIGHT PASS LITTORAL BUDGET

EBBSHOAL RATE: GALVIN

YEAR	SIESTA KEY VOLUME(CY)	DEPOSITION BASIN VOLUME(CY)	EBB SHOAL GROWTH VOLUME(CY)	CASEY KEY VOLUME(CY)	TOTAL BEACH VOLUME(CY)	TOTAL EBB SHOAL VOLUME(CY)
0	113400	0	0	264600	378000	130000
1	89367	16400	63711	208522	297889	193711
2	65699	32800	126205	153297	218995	256205
3	42405	49200	187450	98945	141350	317450
4	39176	0	247412	91412	130588	377412
5	16662	16400	306061	38877	55539	436061
6	-5450	32800	363366	-12716	-18166	493366
7	-27149	49200	419298	-63349	-90498	549298
8	113400	0	373829	264600	378000	503829
9	92549	16400	426934	215947	308495	556934
10	72132	32800	478589	168308	240440	608589
11	52157	49200	528773	121699	173856	658773
12	52308	0	577468	122053	174361	707468
13	33232	16400	624657	77540	110772	754657
14	14611	32800	670326	34092	48703	800326
15	-3551	49200	714466	-8286	-11837	844466
16	113400	0	657070	264600	378000	787070
17	96161	16400	698135	224375	320535	828135
18	79382	32800	737662	185226	264608	867662
19	63065	49200	775654	147151	210216	905654
20	66885	0	812119	156066	222951	942119
21	51480	16400	847069	120121	171601	977069
22	36526	32800	880518	85226	121752	1010518
23	22016	49200	912485	51370	73385	1042485
24	27623	0	942992	64455	92078	1072992
25	13982	16400	972065	32624	46605	1102065
26	761	32800	999732	1777	2538	1129732
27	-12046	49200	1026025	-28108	-40155	1156025
28	70160	0	950978	163708	233868	1080978
29	58146	16400	974627	135673	193819	1104627
30	46510	32800	997012	108524	155034	1127012
31	35242	49200	1018172	82232	117474	1148172
32	44009	0	1038150	102687	146696	1168150
33	33437	16400	1056988	78021	111458	1186988
34	23195	32800	1074731	54121	77315	1204731
35	13267	49200	1091423	30956	44223	1221423
36	23321	0	1107110	54415	77736	1237110
37	13983	16400	1121836	32627	46610	1251836
38	4920	32800	1135646	11480	16400	1265646
39	0	49200	1135646	0	0	1265646
40	14760	0	1135646	34440	49200	1265646
41	9840	16400	1135646	22960	32800	1265646
42	4920	32800	1135646	11480	16400	1265646
43	0	49200	1135646	0	0	1265646
44	14760	0	1135646	34440	49200	1265646
45	9840	16400	1135646	22960	32800	1265646

Midnight Pass Littoral Budget
(cont.)

46	4920	32800	1135646	11480	16400	1265646
47	0	49200	1135646	0	0	1265646
48	14760	0	1135646	34440	49200	1265646
49	9840	16400	1135646	22960	32800	1265646
50	4920	32800	1135646	11480	16400	1265646

NORTH DRIFT	30000	CY/YR
SOUTH DRIFT	70000	CY/YR
DEP.BASIN	16400	CY/YR
B GROWTH VARIES		CY/YR

INITIAL DREDGE VOLUME	378000	CY
INITIAL FILL SIESTA	113400	CY
INITIAL FILL CASEY	264600	CY
INITAL EBB VOLUME	130000	CY

YEAR	EBB SHOAL GROWTH (CY)	LOST 2 PASS SIESTA KEY (CY)	LOST 2 PASS CASEY KEY (CY)	EBB SHOAL DREDGING (CY)	SUPPLEMENT NOURISHMENT (CY)
0	0	0	0	0	0
1	63711	24033	56078	0	0
2	62494	23668	55226	0	0
3	61245	23294	54352	0	0
4	59962	22909	53453	0	0
5	58649	22515	52534	0	0
6	57305	22112	51594	0	0
7	55932	21700	50632	0	0
8	-45469	-120869	-282029	100000	373829
9	53105	20852	48654	0	0
10	51655	20417	47639	0	0
11	50184	19975	46609	0	0
12	48695	19529	45567	0	0
13	47189	19077	44512	0	0
14	45669	18621	43448	0	0
15	44140	18162	42378	0	0
16	-57396	-97271	-226966	100000	283241
17	41065	17240	40226	0	0
18	39527	16778	39149	0	0
19	37992	16318	38074	0	0
20	36465	15860	37006	0	0
21	34950	15405	35945	0	0
22	33449	14955	34894	0	0
23	31967	14510	33857	0	0
24	30507	14072	32835	0	0
25	29073	13642	31831	0	0
26	27667	13220	30847	0	0
27	26293	12808	29885	0	0
28	-75047	-62527	-145896	100000	149776
29	23649	12015	28034	0	0
30	22385	11636	27150	0	0
31	21160	11268	26292	0	0
32	19978	10913	25465	0	0
33	18838	10571	24667	0	0
34	17743	10243	23900	0	0
35	16692	9928	23164	0	0
36	15687	9626	22461	0	0
37	14726	9338	21788	0	0
38	13810	9063	21147	0	0
39	0	4920	11480	0	0
40	0	4920	11480	0	0
41	0	4920	11480	0	0

Midnight Pass Littoral Budget

(cont.)

42	0	4920	11480	0	0
43	0	4920	11480	0	0
44	0	4920	11480	0	0
45	0	4920	11480	0	0
46	0	4920	11480	0	0
47	0	4920	11480	0	0
48	0	4920	11480	0	0
49	0	4920	11480	0	0
50	0	4920	11480	0	0

Appendix D

Annual Cost Calculations

Midnight Pass Dredging Costs
Using Offshore Borrow Area and Ebb Shoal Sand

MIDNIGHT PASS DREDGING COSTS

YEAR	DREDGE VOLUME (CY)	MONITORING COSTS ($)	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH
1990	378000	0	$2,071,520	1.00000	$2,071,520
1991	0	90000	$90,000	0.92593	$83,333
1992	0	60000	$60,000	0.85734	$51,440
1993	0	30000	$30,000	0.79383	$23,815
1994	65600	30000	$629,192	0.73503	$462,475
1995	0	30000	$30,000	0.68058	$20,417
1996	0	30000	$30,000	0.63017	$18,905
1997	0	30000	$30,000	0.58349	$17,505
1998	539429	30000	$3,245,836	0.54027	$1,753,624
1999	0	30000	$30,000	0.50025	$15,007
2000	0	30000	$30,000	0.46319	$13,896
2001	0	30000	$30,000	0.42888	$12,866
2002	65000	30000	$625,925	0.39711	$248,563
2003	0	30000	$30,000	0.36770	$11,031
2004	0	30000	$30,000	0.34046	$10,214
2005	0	30000	$30,000	0.31524	$9,457
2006	448841	30000	$2,807,390	0.29189	$819,451
2007	0	30000	$30,000	0.27027	$8,108
2008	0	30000	$30,000	0.25025	$7,507
2009	0	30000	$30,000	0.23171	$6,951
2010	65000	30000	$625,925	0.21455	$134,291
2011	0	30000	$30,000	0.19866	$5,960
2012	0	30000	$30,000	0.18394	$5,518
2013	0	30000	$30,000	0.17032	$5,109
2014	65600	30000	$629,192	0.15770	$99,223
2015	0	30000	$30,000	0.14602	$4,381
2016	0	30000	$30,000	0.13520	$4,056
2017	0	30000	$30,000	0.12519	$3,756
2018	315376	30000	$2,161,420	0.11591	$250,538
2019	0	30000	$30,000	0.10733	$3,220
2020	0	30000	$30,000	0.09938	$2,981
2021	0	30000	$30,000	0.09202	$2,760
2022	65600	30000	$629,192	0.08520	$53,607
2023	0	30000	$30,000	0.07889	$2,367
2024	0	30000	$30,000	0.07305	$2,191
2025	0	30000	$30,000	0.06763	$2,029
2026	65600	30000	$952,504	0.06262	$59,650
2027	0	30000	$30,000	0.05799	$1,740
2028	0	30000	$30,000	0.05369	$1,611
2029	0	30000	$30,000	0.04971	$1,491
2030	65600	30000	$629,192	0.04603	$28,962
2031	0	30000	$30,000	0.04262	$1,279
2032	0	30000	$30,000	0.03946	$1,184
2033	0	30000	$30,000	0.03654	$1,096
2034	65600	30000	$629,192	0.03383	$21,288
2035	0	30000	$30,000	0.03133	$940
2036	0	30000	$30,000	0.02901	$870
2037	0	30000	$30,000	0.02686	$806
2038	65600	30000	$629,192	0.02487	$15,647
2039	0	30000	$30,000	0.02303	$691
2040	0	30000	$30,000	0.02132	$640
SUM OF PRESENT WORTHS					$6,385,970
CAPITAL RECOVERY FACTOR					0.08174

AVERAGE ANNUAL VALUE	$522,007

SAND SOURCE=	OFFSHORE & EBB	PASS OPENING	DISPOSITION BASIN
SAND MOB/DEMOB($)=	500,000	200,000	200,000
SAND UNIT COST($/CY)=	4.00	4.00	4.50

BASE YEAR=	1990
INTEREST =	0.08
PROJ.LIFE=	50

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Midnight Pass Dredging Costs
Using North Siesta Key Borrow Area and Ebb Shoal Sand

MIDNIGHT PASS DREDGING COSTS

YEAR	DREDGE VOLUME (CY)	MONITORING COSTS ($)	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH
1990	378000	0	$2,071,520	1.00000	$2,071,520
1991	0	90000	$90,000	0.92593	$83,333
1992	0	60000	$60,000	0.85734	$51,440
1993	0	30000	$30,000	0.79383	$23,815
1994	65600	30000	$629,192	0.73503	$462,475
1995	0	30000	$30,000	0.68058	$20,417
1996	0	30000	$30,000	0.63017	$18,905
1997	0	30000	$30,000	0.58349	$17,505
1998	539429	30000	$5,305,880	0.54027	$2,866,602
1999	0	30000	$30,000	0.50025	$15,007
2000	0	30000	$30,000	0.46319	$13,896
2001	0	30000	$30,000	0.42888	$12,866
2002	65000	30000	$625,925	0.39711	$248,563
2003	0	30000	$30,000	0.36770	$11,031
2004	0	30000	$30,000	0.34046	$10,214
2005	0	30000	$30,000	0.31524	$9,457
2006	448841	30000	$4,582,444	0.29189	$1,337,572
2007	0	30000	$30,000	0.27027	$8,108
2008	0	30000	$30,000	0.25025	$7,507
2009	0	30000	$30,000	0.23171	$6,951
2010	65000	30000	$625,925	0.21455	$134,291
2011	0	30000	$30,000	0.19866	$5,960
2012	0	30000	$30,000	0.18394	$5,518
2013	0	30000	$30,000	0.17032	$5,109
2014	65600	30000	$629,192	0.15770	$99,223
2015	0	30000	$30,000	0.14602	$4,381
2016	0	30000	$30,000	0.13520	$4,056
2017	0	30000	$30,000	0.12519	$3,756
2018	315376	30000	$3,516,593	0.11591	$407,621
2019	0	30000	$30,000	0.10733	$3,220
2020	0	30000	$30,000	0.09938	$2,981
2021	0	30000	$30,000	0.09202	$2,760
2022	65600	30000	$629,192	0.08520	$53,607
2023	0	30000	$30,000	0.07889	$2,367
2024	0	30000	$30,000	0.07305	$2,191
2025	0	30000	$30,000	0.06763	$2,029
2026	65600	30000	$1,521,882	0.06262	$95,307
2027	0	30000	$30,000	0.05799	$1,740
2028	0	30000	$30,000	0.05369	$1,611
2029	0	30000	$30,000	0.04971	$1,491
2030	65600	30000	$629,192	0.04603	$28,962
2031	0	30000	$30,000	0.04262	$1,279
2032	0	30000	$30,000	0.03946	$1,184
2033	0	30000	$30,000	0.03654	$1,096
2034	65600	30000	$629,192	0.03383	$21,288
2035	0	30000	$30,000	0.03133	$940
2036	0	30000	$30,000	0.02901	$870
2037	0	30000	$30,000	0.02686	$806
2038	65600	30000	$629,192	0.02487	$15,647
2039	0	30000	$30,000	0.02303	$691
2040	0	30000	$30,000	0.02132	$640
SUM OF PRESENT WORTHS					$8,209,809
CAPITAL RECOVERY FACTOR					0.08174
AVERAGE ANNUAL VALUE					$671,093

SAND SOURCE:	N. SIESTA&EBB	PASS OPENING	DEPOSITION BASIN
SAND MOB/DEMOB($)_=	800,000	200,000	200,000
SAND UNIT COST($/CY)=	6.50	4.00	4.50

BASE YEAR= 1990
INTEREST = 0.08
PROJ.LIFE= 50

Midnight Pass Dredging Costs
For Big Sarasota Pass Ebb Shoal and Midnight Pass Ebb Shoal Sand

MIDNIGHT PASS DREDGING COSTS

YEAR	DREDGE VOLUME (CY)	MONITORING COSTS ($)	FUTURE WORTH	PRESENT WORTH FACTOR	PRESENT WORTH
1990	378000	0	$2,071,520	1.00000	$2,071,520
1991	0	90000	$90,000	0.92593	$83,333
1992	0	60000	$60,000	0.85734	$51,440
1993	0	30000	$30,000	0.79383	$23,815
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2000	0	30000	$30,000	0.46319	$13,896
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2002	65000	30000	$625,925	0.39711	$248,563
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2005	0	30000	$30,000	0.31524	$9,457
2006	4488441	30000	$44,582,444	0.29189	$1,337,572
2007	0	30000	$30,000	0.27027	$8,108
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2024	0	30000	$30,000	0.07305	$2,191
2025	0	30000	$30,000	0.06763	$2,029
2026	65600	30000	$1,521,882	0.06262	$95,307
2027	0	30000	$30,000	0.05799	$1,740
2028	0	30000	$30,000	0.05369	$1,611
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2032	0	30000	$30,000	0.03946	$1,184
2033	0	30000	$30,000	0.03654	$1,096
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2035	0	30000	$30,000	0.03133	$940
2036	0	30000	$30,000	0.02901	$870
2037	0	30000	$30,000	0.02686	$806
2038	65600	30000	$629,192	0.02487	$15,647
2039	0	30000	$30,000	0.02303	$691
2040	0	30000	$30,000	0.02132	$640
SUM OF PRESENT WORTHS					$8,209,809
CAPITAL RECOVERY FACTOR					0.08174
AVERAGE ANNUAL VALUE					$671,093

SAND SOURCE=	BIG PASS & EBB	PASS OPENING	DEPOSITION BASIN
SAND MOB/DEMOB($)=	800,000	200,000	200,000
SAND UNIT COST($/CY)=	6.50	4.00	4.50

BASE YEAR= 1990
INTEREST = 0.08
PROJ.LIFE= 50