February 2004

Volume II of II

FINAL

Economics – Appendix A

Engineering – Appendix B

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Pertinent Correspondence – Appendix D

Preliminary Assessment - DMMP – Appendix E

Mitigation Plan – Incremental Cost Analysis – Appendix F

For the

Miami Harbor Navigation Study General Reevaluation Report

Miami-Dade County, Florida - 010140

US Army Corps of Engineers®

Jacksonville District
South Atlantic Division

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Economics – Appendix A

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INTRODUCTION

LOCATION

The Port of Miami is an island facility consisting of 660 acres that is located at the northern part of Biscayne Bay in South Florida. The city of Miami is located on the west side of Biscayne Bay; the city of Miami Beach is located on a peninsula on the northeast side of the bay, opposite Miami. Both cities are located in Miami-Dade County, Florida, and are connected by several causeways crossing the bay. The Port is the southernmost major Atlantic Coast port (see **Figure A-1**). Referenced to other major South Atlantic Region ports, the Port is located 21 nautical miles south of Port Everglades (Fort Lauderdale), Florida; 83 nautical miles south of Palm Beach, Florida; 173 nautical miles south of Port Canaveral, Florida; 306 nautical miles south of Jacksonville, the most northern port on Florida's Atlantic Coast; 386 nautical miles south of Savannah, Georgia; and 420 nautical miles south of Charleston, South Carolina. It is 144 nautical miles north of Key West, the southernmost port in Florida.

FEDERAL PROJECT

The present Federal navigation project consists of:

(1) An entrance channel, with a 44-foot depth over a bottom width of 500 feet from the ocean to the beach line, with two rubble stone jetties;

(2) An inner channel (Government Cut) with a 42-foot depth and bottom width of 500 feet from the beach line to the Fisher Island turning basin;

(3) The Fisher Island turning basin with a 42-foot depth over a triangular-shaped bottom area;

(4) A channel (Fisherman's Channel) with a 42-foot depth over a bottom width of 400 feet from the Fisher Island turning basin along the south side of Lummus Island to the Lummus Island turning basin;

(5) The Lummus Island turning basin with a 42-foot depth and a turning diameter of 1,500 feet;

(6) A channel with a 34-foot depth over a bottom width of 400 feet extending west 1,200 feet from the Lummus Island turning basin;

(7) A (Main) channel with a 36-foot depth over a bottom width of 400 feet from the Fisher Island turning basin west along the north side of Lummus and Dodge Islands to a third turning basin;

(8) A (Main) turning basin with a 36-foot depth with a turning basin diameter of 1,650 feet at the west end of the 36-foot Main Channel;

(9) A channel with a 15-foot depth in the Miami River over a varying bottom width of 150 feet at the mouth to 90 feet 5.5 miles inland; and

(10) Maintenance of the constructed project.

PURPOSE AND SCOPE

The current project features for the inner (Government Cut) and Fisherman's channels and the Fisher Island turning basin were designed for Panamax container ships; however, the world container ship fleet has significantly changed since these features were authorized in 1989. Since 1989, Post-Panamax container ships that were deployed in the Far East trade region (Europe/Mediterranean/Far East trade route) have become more numerous and are now deployed in the Pacific trade region (U.S. West Coast/Far East trade route). It is anticipated that within the next five years, Post-Panamax container ships will be deployed in the Atlantic trade region and will call at U.S. East Coast ports. Thus, one purpose of this economic analysis is to estimate the National Economic Development (NED) benefits associated with harbor improvements, specifically channel deepening, that are designed to allow for the efficient utilization of Post-Panamax container ships.

In addition to assessing the NED benefits of channel deepening, the economic analysis will also estimate the NED benefits of improvements designed to remedy navigation problems within the harbor that were identified in a letter from the Biscayne Bay Pilots to the Port Authority, dated October 23, 1997. The improvements call for widening the project channels at three locations.

The first location is the outer entrance channel at Outer Bar Cut. "The currents in this area are variable and unpredictable, putting large deep draft vessels at risk when making their approach to Miami.... Several container ships have already grounded off Buoy 1." The Pilots recommended that the outer channel be tapered with an 800-foot wide entrance.

The second area is on the south side of Government Cut between Beacon 13 and Beacon 15. In this area, ships are turning from one channel to another (Government Cut to Fisherman's Channel). "The strong currents in this area compounded by the necessity for the ship to have as little speed as possible, makes it important for the ship to have as much swinging room as possible.... Tugboats assisting ships in this area have grounded and sustained damage." The Pilots recommended widening the channel between Beacons 13 and 15 as much as possible.

The third area of concern is the Lummus Island Cut (Fisherman's Channel), just south of the gantry crane area. Ships transiting the Fisherman's Channel pass extremely close to vessels docked at the gantry crane berths on Dodge Island. This results in a "surging" effect on the ships at the berths. Moreover, frequently vessels with on-board cranes have their cranes swung outboard 90 degrees, thereby blocking a portion of the channel. "Given the variables of wind, current, ship size, draft, etc., this creates an unsafe condition." The Pilots recommended that the southern edge of the Lummus Island Cut be extended 100 feet further to the south.

The number of people taking cruises has been growing, and this growth is expected to continue in the future. In response to this increasing demand, cruise ship companies have been constructing larger cruise ships to carry more passengers. The largest cruise ships in the world are Royal Caribbean International's VOYAGER-class cruise ships. Two of these vessels, the VOYAGER OF THE SEAS and the EXPLORER OF THE SEAS, currently homeport at Miami Harbor. These cruise ships are 1,019 feet long and carry 3,114 passengers. Because of the increase in size, both length and breadth, of cruise ships, the amount of berthing area at the current cruise ship terminals has been reduced. To provide more berthing area for cruise ships, the Port is berthing small cruise ships at Cruise Terminal 12 located at the southwest corner of Dodge Island. Terminal 12 serves Passenger Bays 183 to 195.

Because cruise ships will continue to increase in size, harbor improvements will be required to accommodate the larger cruise ships at Bays 183 to 195. Accordingly, NED benefits will be estimated for extending the current Federal channel from a point 1,200 feet west of the Lummus Island turning basin to the southwest corner of Dodge Island (Passenger Bay 195) and constructing a separate turning basin within this segment.

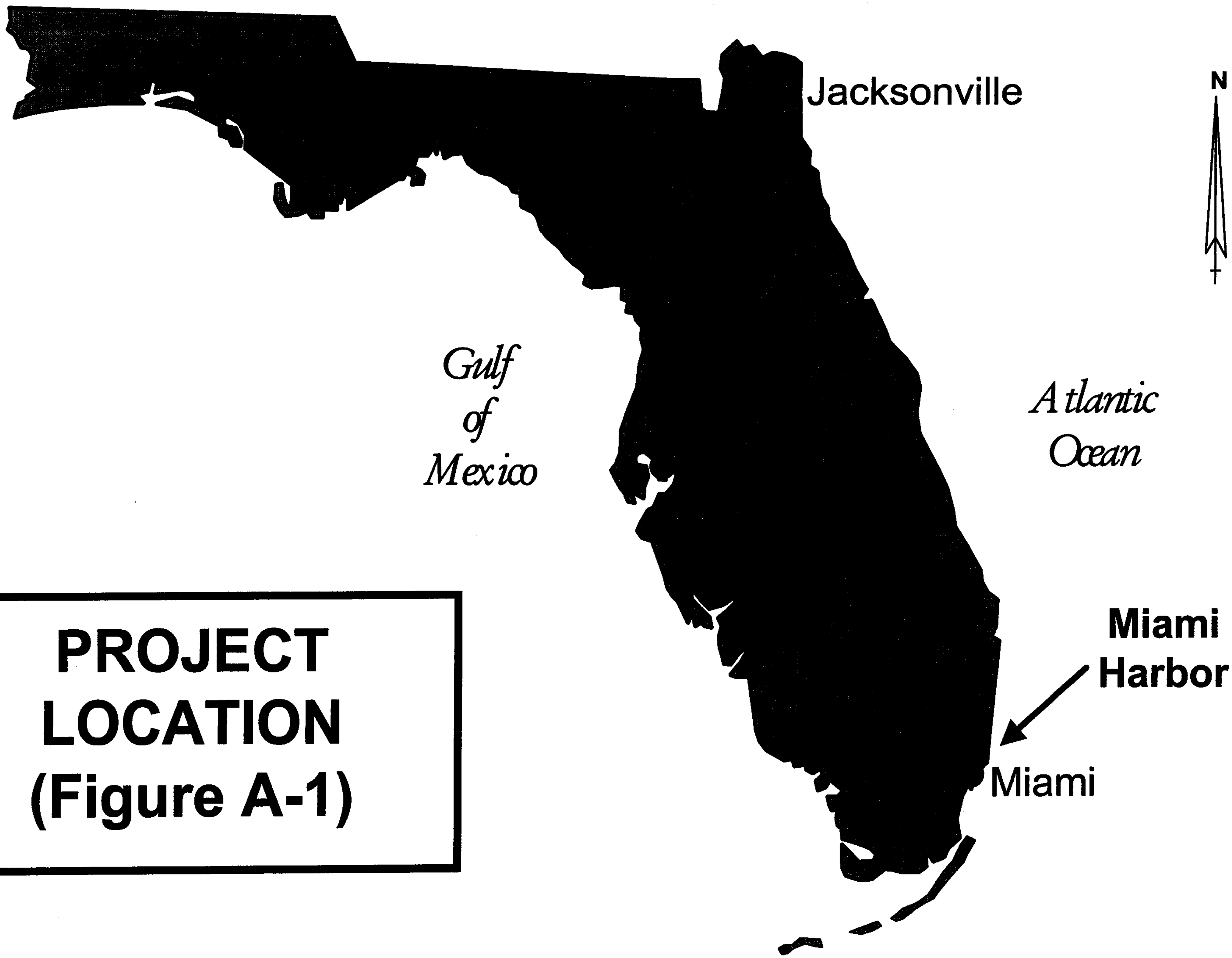
The purpose of the benefits analysis is to estimate NED benefits associated with harbor improvements designed to accommodate larger, more efficient cruise and container ships and to eliminate or significantly reduce the navigation problems that have been identified by the Biscayne Bay Pilots. Because this is a General Reevaluation Report (GRR), the analysis was conducted at a level of detail commensurate with a feasibility study.

PORT INFRASTRUCTURE

The Port of Miami is a 660-acre island facility created from two spoil islands, Dodge Island and Lummus Island. As shown in **Figure A-2**, the western end is Dodge Island, and the eastern end is Lummus Island. The Port is connected to the Miami mainland by two bridges, a 65-foot high, fixed span vehicular bridge and a road and a rail bridge linking to the Florida East Coast Railroad Company's main line track.

The Port of Miami is a "clean port", the designation of a seaport that does not handle bulk cargoes or potentially dangerous or hazardous cargoes such as fuel oil. The Port handles only palletized, roll-on/roll-off (RO/RO), and containerized cargo. In addition to cargo traffic, the Port of Miami is also a major cruise ship port. It is the year-round homeport of the largest cruise ship in the world, the VOYAGER OF THE SEAS. As reported in the 1999 Port of Miami Master Development Plan (April 30,1999), the Port consists of 518 acres of actual landmass. Of the 518 acres, 372.5 acres (71.9 percent) is devoted to cargo operations, mainly on Lummus Island, and 52 acres (10.0 percent) is devoted to cruise operations on Dodge Island. The Port also leases 34 acres from the Florida East Coast Railway at its Buena Vista yard, which is located approximately 2.5 miles northwest of the Port. This leased property is used as an intermodal container marshaling and storage area for transshipments.

The Port of Miami is a landlord port, owned by Miami-Dade County, Florida and managed by the Miami-Dade County Seaport Department. The Port Director reports to the County



PROJECT LOCATION (Figure A-1)

NOTES:
1] DRAFT Environmental Baseline Resource Survey (underwater features) provided February 2001, by Dial Cordy & Associates, Jacksonville Beach, FL
2] USACE Survey Number 00-058, March 2000
3] Beacons, aids to navigation, and soundings are in approximate locations based on NOAA Nautical Charts (number 11468, 36th Ed., July 24 1999, and number 11466, 34th Ed., February 6 1999)
4] Elevations in feet and refer to mean lower low water
5] Projection Stateplane Coordinate System, NAD27, Fipszone 0901
6] Background aerial photos taken September 1 1999

LEGEND:

Existing Navigation Channel
- Existing Centerline
- Existing Channel Edge

Proposed Components
- Cmp1c
- Cmp2a
- Cmp3b
- Cmp4
- Cmp5
- Cmp5a
- Cmp6
- Cmp6a

2000 0 2000 4000 6000 Feet

MIAMI HARBOR GENERAL REEVALUATION REPORT
Proposed Navigation Channel Modifications

U.S.ARMY CORPS OF ENGINEERS
Jacksonville District

Figure A-2

Manager. Facilities are leased to port users and operators. There are three principal terminal operators at the Port: Seaboard Marine, the Port of Miami Terminal Operating Company (POMTOC), and Universal Maritime/Maersk. Seaboard Marine's container terminal and storage areas are located along the southern portion of Dodge Island and the southwest corner of Lummus Island. POMTOC's container terminal is located exclusively on Lummus Island, as is Universal Maritime/Maersk's (northeastern portion). The Port's infrastructure that supports cargo and cruise ship operations is identified in **Table A-1** to **Table A-4**.

The berthing areas are identified in **Figure A-2**. The berth specifications (length, depth, berthing area, and use) are shown in **Table A-1**. Cargo supporting storage (transit sheds and open storage) and gantry cranes are displayed in **Table A-2**. The specifications for the gantry cranes are shown in **Table A-3**. As shown in **Table A-3**, currently there are three Panamax and seven Post-Panamax gantry cranes; two super-Post-Panamax gantry cranes are scheduled to arrive in 2003/2004. Panamax, Post-Panamax, and Super-Post-Panamax gantry cranes are designed to reach across 13 containers (approximately 8 feet wide), 17 containers, and 22 containers, respectively.

In addition to gantry cranes, the Port's cargo handling equipment includes forklifts, toploaders, and mobile truck cranes including three Mi-Jack 850-P Rubber Tire Gantries (RTGs), which allow containers to be stacked 6-wide and 4-high.

There are eleven passenger terminals that accommodated 3.3 million passengers in fiscal year 2000. The Port's passenger terminals are designated Terminals 1 through 5, Terminal 6/7, Terminal 8/9, Terminal 10, and Terminal 12 (see **Figure A-2**). The berth and terminal specifications are identified in **Table A-1** and **Table A-4**, respectively.

As identified in the Port's 1999 Master Plan, approximately 47.5 acres of the Port's land area is utilized by support facilities: parking, 17.0 acres; circulation and open space, 10.5 acres; office – Federal Government, 8.5; recreation, 7.5 acres; office-miscellaneous and office-Seaport Department, 1.7 acres.

CSX Transportation, Inc serves the Port of Miami. The Miami-Dade County Seaport Department owns 2.1 miles of trackage at the Port of Miami on Dodge Island, which consists of a main line track extending the length of the island and a four-track, closed-end intermodal rail yard. The main track on Dodge Island connects with the Florida East Coast Railway via a rail bridge. A connection with CSX Transportation, Inc. is effected through an interchange in the west part of the city of Miami. Moreover, the Port is less than one mile from major highways: Interstate 95 and Federal Route 1 via Interstate 395, and Interstate 75 via Dolphin and Palmetto Expressways. The Miami International Airport (MIA) is located on a 3,300-acre site about five miles northeast of downtown Miami.

There is a private petroleum facility at Fisher Island (see **Figure A-2**). This facility receives Number 6 fuel oil and diesel fuel by tankers and barges (integrated tug and barge units - ITBs). The fuel is used solely for bunkering the Port's cargo and cruise ships, which are bunkered at the berth by tank truck or by bunkering barge. This facility has an 800-foot long berth with a depth of 36 feet and 12 storage tanks having a total capacity of 667,190 barrels.

As reported in the U.S. Army Corps of Engineers' Port Series No. 16 document (revised 1999), within Metropolitan Miami and Dade County 12 companies operate warehouses having a total of over 1,000,000 square feet of dry storage space and over 6,000,000 cubic feet of cooler and freezer space. All except three of the warehouses have railroad connections, and each is accessible to arterial highways.

Anchorage for deep-draft cargo vessels lies north of the entrance channel to Miami Harbor. There are no bridges crossing the shipping channels for Dodge and Lummus Islands.

Table A-1: Specifications for Current Berths (Bays)[1]

Berth Number	Length (feet)	Depth (feet)	Berthing Area [2] (feet)	Use(s)
Bays 213, 214, 219 (Passenger Terminal 6)	750	32	125	Cruise, RO-RO [3]
Bays 1-25 3/4 (Passenger Terminals 1-5 & 10)	3,220	36	125	Cruise
Bays 25 3/4 -38	1,600	36	125	Cruise
Bays 38-45 (Passenger Terminals 8 &9)	1,680	36	125	Cruise
Bays 45-55	1,200	36	125	Cruise
Bay 55W	900	36	125	RO-RO, LO-LO [3]
Bay 59W	550	32	125	RO-RO, LO-LO
Bay 65W	690	32	125	RO-RO, LO-LO
Bays 99-140 (Gantry Crane Berths)	5,500	42	125	Container, RO-RO, LO-LO
Bays 144-148	600	25	125	RO-RO, LO-LO
Bay 154	670	25	125	RO-RO, LO-LO
Bay 155	550	25	125	RO-RO, LO-LO
Bay 165-177	1,450	25	125	RO-RO, LO-LO
Bays 183-195 (Passenger Terminal 12) [4]	1,450	25	125	Cruise

[1] Source: Port of Miami, 2000 Official Directory, page 53. Note: Ships' berths are noted with bay numbers that begin at the northwest corner of Dodge Island. Bay numbers increase in a clockwise direction around the port in increments of approximately 120 feet per bay.
[2] Linear distance perpendicular to the berth bulkhead. Based on the extreme breadth of the largest vessel using the berth, plus an amount for mooring fenders and cargo discharging equipment.
[3] Roll-On/Roll-Off; Lift-On/Lift-Off.
[4] Bay 183 is the Fisher Island Ferry Terminal.

Table A-2: Dry Cargo Facilities and Gantry Cranes

	Transit Sheds		Open Storage	Gantry Cranes	
General Location	Number	Cargo Space (Sq. Ft.)	Area (Acres)	Number	Type
Bays 213, 214, 219 (Passenger Terminal 6)					
Bays 1-25 3/4 (Passenger Terminals 1-5 & 10)	2	93,000			
Bays 25 3/4 -38					
Bays 38-45 (Passenger Terminals 8 &9)	2	288,000			
Bays 45-55	1	119,000			
Bay 55W					
Bay 59W					
Bay 65W					
Bays 99-140 (Gantry Crane Berths)			230 [4]	10	3 Panamax 7 Post-Panamax
Bays 144-148			[4]		
Bay 154	1	36,000	70 [4]		
Bay 155			[4]		
Bay 165-177	1	73,500	[4]		
Bays 183-195 (Passenger Terminal 12) [5]			[4]		

[1] Source: Port of Miami, 2000 Official Directory, page 53. Note: Ships' berths are noted with bay numbers that begin at the northwest corner of Dodge Island. Bay numbers increase in a clockwise direction around the port in increments of approximately 120 feet per bay.
[2] Linear distance perpendicular to the berth bulkhead. Based on the extreme breadth of the largest vessel using the berth, plus an amount for mooring fenders and cargo discharging equipment.
[3] Roll-On/Roll-Off; Lift-On/Lift-Off.
[4] The Port of Miami has 300 acres of open storage. Of the 300 acres, 230 acres is located on the eastern end of Lummus Island extending east to west from Bays 99 to 148. The remaining 70 acres is located on the southern end of Dodge and Lummus Islands extending from Bays 148 to 190.
[5] Bay 183 is the Fisher Island Ferry Terminal.

Table A-3: Gantry Crane Specifications

Area	Lummus Island	Lummus Island	Lummus Island
Location (Berths)	Bays 99-140	Bays 99-140	Bays 99-140
Number	3	7	2
Type	Panamax Diesel-Electric, Traveling Gantry Crane with Hinged-Cantilevered Boom	Post-Panamax Diesel-Electric, Traveling Gantry Crane with Hinged-Cantilevered Boom	Super-Post-Panamax Electric, Traveling Crane with Hinged-Cantilevered Boom
Lift Capacity Below Spreader (Long Tons)	40	50	50
Outbound Reach (feet)	125	151	213
Back Reach (feet)	-	85	85
Maximum Clear Hoist (feet)	135	150	181
Rail Gauge (feet)	100	100	100

[1] Source: For Panamax and Post-Panamax cranes: Ports of Miami, Port Everglades, Palm Beach, and Port Canaveral, Florida, Port Series No. 16 Revised 1999, U.S. Army Corps of Engineers (NDC-99-P-4), page29. For Super-Post Panamax Cranes that are on order and scheduled for delivery in October 2002, Port Authority specification documentation.

Table A-4: Cruise Passenger Terminals

Passenger Terminal	Location	Gross Floor Area (Sq. Ft.)	Year Constructed/Significant Renovation
Terminal No. 1-5	North side of Dodge Island	17,975 (each)	1969-1970
Terminal No. 6/7	North side of Dodge Island	150,000	1971-1972
Terminal No. 8/9	North side of Dodge Island	190,000	1978/1996-1997
Terminal No. 10	North side of Dodge Island	58,000	1986
Terminal No. 12	South side of Dodge Island	66,500	1988

1 Source: Table 2.8, Cruise Passenger Terminals, 1999 Port of Miami Master Development Plan, April 30, 1999.

CARGO MOVEMENTS AND FLEET COMPOSITION

The Port of Miami handles container, trailer, neobulk (united/bundled), and breakbulk (loose non-containerized) cargo. As shown in **Table A-5**, Port Authority records for fiscal year 2000 (October 1999 to September 2000) report a total of 7,804,946 short tons of cargo. Containerized cargo, which consists of containers and trailers, represented 97.4 percent of all cargo: containers 61.8 percent, and trailers 35.6 percent. Neobulk and breakbulk cargo represented only 2.6 percent of all cargo. Cargo vessels recorded 2,424 calls, or 70.3 percent of all ship calls (3,447). The cargo is carried on container ships, Roll-On/Roll-Off (RO/RO) ships, and Lift-On/Lift-Off (LO/LO) ships. The LO/LO ships have on-board cranes, and are primarily used in the Caribbean and Latin American trade, as many of the ports in these trade areas do not have gantry cranes. The trailer cargo is containerized cargo that is carried on RO/RO ships that, except for auto carriers, carry fixed-wheel trailers on the lower decks, and often carry containers on the upper deck. Most cargo is carried on "cellular" container ships that are designed to carry only containers.

Most of the container and trailer cargo recorded at the Port is classified as general cargo, not otherwise specified (N.O.S.). Examples of individual classes are refrigerated fruits and vegetables, miscellaneous apparel, textiles, and foodstuff. Buses and trucks are examples of breakbulk cargo. Lumber is an example of neobulk cargo.

In addition to handling cargo traffic, the Port of Miami is a major homeport for 17 cruise ships belonging to Carnival Cruise Lines, Norwegian Cruise Line, and Royal Caribbean International. These companies offer 4 to 11 day cruises. As shown in **Table A-5**, 3,364,643 passengers embarked/disembarked, and 1,023 ship calls were recorded in fiscal year 2000, representing 29.7 percent of the total number of calls.

The vessels currently calling at Miami Harbor range in size from small general cargo vessels to Royal Caribbean International's VOYAGER-class cruise ships (length overall, 1,021 feet; breadth, 156 feet; draft, 28 feet). The largest dry cargo vessel class is the Panamax class of containership (length overall, 965 feet; breadth, 106 feet; draft, 44 feet). A Panamax class vessel is a vessel with dimensions that allow it to transit the Panama Canal: 950 feet long with a beam of 106 feet, except for passenger and container ships, which may have a length of 965 feet (lock dimensions are 1,000 feet long and 110 feet wide). The Panama Canal has a vessel draft restriction of 39 feet, 6 inches freshwater (equivalent to 38 feet, 8 inches saltwater).

Table A-5: Miami Harbor Waterborne Commerce Fiscal Year 2000				
Cargo	Short Tons /Passengers	Percentage Of Total Cargo Tonnage	Ship Calls	Percentage of Total Calls
Container	4,827,102	61.8%		
Trailer	2,771,475	35.6%		
Other [2]	206,369	2.6%		
Cargo Tonnage Total	7,804,946	100.0%	2,424	70.3%
Passengers	3,364,643		1,023	29.7%
Total Ship Calls			3,447	100.0%

[1] Source: State of the Port 2001, Port of Miami.
[2] Neobulk (united/bundled) and breakbulk (loose non-containerized) cargo.

PROBLEMS AND OPPORTUNITIES

Channel Widening

Channel widening measures comprise widening the seaward portion of the entrance channel from 500 feet to 800 feet (Component 1C), dredging the widener between buoys 13 and 15 (Component 2A), and widening Fisherman's Channel approximately 100 feet to the south (Component 5A). The purpose of Channel Widening is to increase safety, reduce damages, reduce delays, and avoid increases in tug assist costs for the Post-Panamax vessels that are expected to call in the future. Ships have grounded at entrance due to currents. Existing conditions allow surging that prevents cargo vessels at berth from discharging or loading cargo when a vessel passes.

In the without-project condition, as Post-Panamax vessels begin to call, grounding frequency and associated safety reduction and incurred damages will increase. Surging caused by passing vessels will worsen. The Post-Panamax vessels will require extra tug assistance.

In the with-project condition, groundings will be significantly reduced. Surging caused by passing vessels will be lessened. Post-Panamax vessels will require less tug assistance.

Benefits attributable to channel widening include: (1) reduced damages; (2) reduced delays (vessels holding until grounded vessel is removed and less interruption to discharging vessels); (3) increase in navigation safety; (4) reduced transit times; and (5) reduced tug assist costs.

Fisher Island Turning Basin Extension

The existing Fisher Island Turning Basin is not large enough for the Post-Panamax container ships that are expected to call in both the without- and with-project conditions to turn. Without the Fisher Island Turning Basin Extension (Component 3B), these vessels can turn in the previously authorized 42-foot deep Lummus Island Turning Basin, but extending the Fisher Island turning basin would provide a closer place to turn for the larger vessels. Therefore, this increment would provide more flexibility in allocating turning basin use among vessels, leading to timesaving efficiencies.

Shipping Channel, Fisher Island Turning Basin, and Lummus Island Turning Basin Deepening

Panamax and future-calling Post-Panamax container vessels arriving to or departing from Miami Harbor cannot fully load because of current channel depths. In the without-project condition, this light loading of vessels will sustain current transportation costs. Deepening the channel will allow vessels to more fully load, increasing efficiency. Benefits to deepening are reduced transportation costs resulting from the partial or full elimination of light loading.

METHODOLOGY

GENERAL

National Economic Development (NED) benefits will be assessed for the alternatives identified in the PROBLEMS/OPPORTUNITIES section following the methodology for deep draft commercial navigation analysis described in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* and other relevant Corps of Engineers analyses and policy guidance.

Benefits equal the difference between without- and with-project transportation costs. All costs are adjusted to the base year of the project, 2010, and are then converted to Average Annual Equivalent (AAEQ) values using the Fiscal Year (FY) 2004 Federal discount rate of 5.625 percent, assuming a 50-year study period. All costs are at October 2003 price levels. The benefits estimated for the separable elements of each alternative will be compared to its cost to determine its economic justification. The plan that maximizes net benefits (benefits less cost) is the National Economic Development (NED) Plan. The NED Plan is the Federal recommended plan, and may or may not be equal to the locally preferred plan.

Specific procedures, assumptions and parameters for estimating vessel utilization savings (deepening benefits), vessel operational time savings (delay reduction benefits), and benefits during construction are discussed in the BENEFITS section of this Appendix under BENEFIT ESTIMATION PROCEDURES/ASSUMPTIONS/PARAMETERS.

Please note that the same type of summary values in the tables presented herein, for example total export short tons for 2000, may not exactly match each other due to the rounding of values and/or to values obtained from different sources. These differences are insignificant and as such do not affect the analysis.

DESIGN VESSELS

A design vessel represents the largest vessel class that is expected to call over the study period of analysis. It is important to identify the design vessel(s) so that decision makers can be reasonably confident that the significant study and project costs will result in a channel design that will accommodate vessel traffic for the foreseeable future at Miami Harbor. As previously discussed, Miami Harbor is a "clean port"; that is, it does not handle bulk cargoes or potentially dangerous or hazardous cargos such as fuel oil. Accordingly, only two types of vessels need to be considered: container ships and passenger (cruise) ships.

To identify the design vessels, the following steps were taken: (1) the world fleet and ships on order were reviewed using Lloyd's Register of Ships CD ROM., which includes ships on order through 2005; (2) future projections from companies like Clarkson's Research Studies were reviewed; and (3) cargo shipping companies and cruise ship companies were contacted to get their assessment on the largest vessels that will call at Miami Harbor in the foreseeable future.

The container ship design vessel research focused on Maersk, as (1) it is the largest container ship company in the world, (2) its fleet consists of the largest container ships in the world, (3) its vessels provide liner service at the Port of Miami, and (4) its terminal subsidiary, Universal Maritime, operates a terminal at the Port of Miami.

Maersk advised the District that the largest container ships that it would use at the Port of Miami in the near-term future are its 6,600-TEU S-Class container ships that are 1,138.4 feet long with an extreme breadth 140.8 feet and a design draft of 47.6 feet. Maersk has 18 S-Class vessels in its fleet, which are currently deployed in the Europe-Far East trade and the Far East-U.S. West Coast trade.

In 1998, Maersk tested the utilization of one of its six 6,000-TEU K-Class container ships, the REGINA MAERSK, at U.S. East Coast ports. The K-Class vessels are smaller than the S-Class ones. They have a length of 1,044.1 feet, an extreme breadth of 140.4 feet, and a design draft of 47.6 feet. The REGINA MAERSK could not call at Miami Harbor because the Port lacked a turning basin to accommodate the vessel. With the construction of the previously authorized 1,500-foot diameter Lummus Island Turning Basin in the without-project condition, Post-Panamax container ships can call at Miami Harbor, albeit light-loaded, prior to the base year of the project.

A review of the dimensions of every steamship company's in-service and on-order (through 2004) container ship fleet in Lloyd's Register of Ships demonstrated that the Maersk S-Class vessels are representative of the largest container ships in the world fleet that will call on a regular basis at Miami Harbor. Therefore, the SUSAN MAERSK was selected as the container ship design vessel.

Lloyd's Register of Ships was also reviewed for the selection of a cruise ship design vessel. Based on the review, the Royal Caribbean International's VOYAGER OF THE SEAS was selected as the design vessel for the study. It is 137,300 GRT, is 1,021 feet long, and has a beam of 156 feet and a design draft of 28.2 feet. This cruise ship, which is currently calling, is considered the largest cruise ship likely to call at Miami Harbor for the foreseeable future. Presently, Royal Caribbean International has two VOYAGER-class ships calling a Miami Harbor: the VOYAGER OF THE SEAS and the EXPLORER OF THE SEAS. The draft requirement of the design vessel does not present a problem as the Main Channel has a project depth of 36 feet. Modern cruise ships are designed with drafts that can be accommodated by the shallow depths at their ports-of-call. However, the QUEEN MARY II, which is scheduled for completion in 2003, will be 1,131 feet long with a beam of 131 feet and a design draft of 32.8 feet. Thus, the QUEEN MARY II is 110 feet longer than the VOYAGER OF THE SEAS, but its beam is 25 feet less. Because it is longer, and could potentially call, the SUSAN MAERSK container ship with a length of 1,138 feet and a beam of 141 feet was turned in the Main Channel Cruise Ship Turning Basin during the ship simulation. There were no problems with turning the large container ship.

Because of the growth in cruises, channel improvements, as well as a Dodge Island turning basin, are being considered for the Dodge Island Terminal Number 12 (south western side

of Dodge Island). In November 2001, Celebrity Cruise Lines' HORIZON began utilizing this terminal. The HORIZON is 682 feet long, with a beam of 96 feet, and a draft of 24 feet. Based on discussions with the Port, the CARNIVAL DESTINY was selected as the design vessel for this project alternative. The CARNIVAL DESTINY is 893.5 feet long, with a beam of 116, and a draft of 27 feet.
The specifications of the design vessels are summarized below:

Container ship: SUSAN MAERSK.
Length Overall: 1,138.4 feet.
Extreme Breadth: 140.8 feet.
Maximum Draft: 47.6 feet.
Cargo Capacity: 6,600 TEUs reported by Maersk (6,418 TEUs reported in Lloyd's Register of Ships).

For Berths (Bays) 213 to 219 and 1 to 50 at northwest side of Dodge Island using the Main Channel:
Cruise Ship: VOYAGER OF THE SEAS.
Length Overall: 1,020.7 feet.
Extreme Breadth: 155.5 feet.
Maximum Draft: 28.2 feet.
Passenger Capacity: 3,840.

For Berths (Bays) 183 to 195 at southwest side of Dodge Island using Fisherman's Channel:
Cruise Ship: CARNIVAL DESTINY
Length Overall: 893.5 feet.
Extreme Breadth: 116.6 feet.
Maximum Draft: 27.2 feet.
Passenger Capacity: 2,642.

BENEFITS

PORT AND INDUSTRY TRENDS

Cargo and Passengers

Historical Cargo Traffic

The direction of cargo movements for Miami Harbor for fiscal year 2000 is displayed in **Table A-6**. As reported in the Port's Performance Report (Statistical), September 2000, 57.18 percent of commodity movements were inbound (foreign imports and domestic receipts). Of all inbound movements, 89.06 percent were foreign imports. Likewise, on the outbound side, 94.72 percent were foreign exports. Thus, the origin of inbound cargo and destination of outbound cargo are mostly foreign ports. Consequently, 91.48 percent of all cargo was transported on foreign flag vessels.

As shown in **Table A-7**, historically the annual distribution of import and export tonnage has been close with import tonnage representing only slightly more. Over the 10-year period 1990 to 2000, import tonnage has averaged 52 percent of the total annual tonnage with a tight range from 49.25 percent in 1992 to 57.18 percent in 2000. Slightly higher import tonnage reflects the general U.S. trade deficit situation.

Table A-8 displays cargo traffic by trade region for fiscal year 2000. The South American trade region recorded the most tonnage with 24.18 percent of all cargo tonnage. The European trade region was a close second with 23.81 percent. The Central American and Caribbean trade regions recorded 20.48 percent and 15.47 percent, respectively. The Far East/Asia/Pacific trade represented 11.37 percent. Domestic, North American, trade represented 4.10 percent; and Middle East/South West Asia/Africa represented 0.58 percent of all tonnage in 2000. Thus, the Latin American and Caribbean trade region represented 60.14 percent of all cargo tonnage recorded at Miami Harbor. This trade region along with the European and Far East trade regions represents 95.32 percent of all tonnage handled at the Port. As shown in **Table A-8**, except for the Caribbean and South American trade regions, import tonnage exceeds export tonnage.

Historical tonnage for these three trade regions for the 10-year period 1990 to 2000 is displayed in **Table A-9**. These regions have historically represented about 96 (95.75) percent of all tonnage handled at the Port. All three regions have experienced significant positive growth for both the 10-year period as well as the 5-year period 1995 to 2000, except for the Far East region. The negative growth in the Far East trade region is due to an exceptionally high amount of tonnage in 1995, which skews the compound annual growth rate. But, in fact the tonnage for the Far East trade region has remained stable from 1994 to 2000 when excluding the tonnage recorded in 1995, varying within a tight range of 805,330 short tons in 1998 to 887,509 short tons in 2000. The European trade region has experienced the highest compound annual growth rates: 9.94 percent for the 10-year period and 14.28 percent for the 5-year period.

The list of the top ten trade countries for Fiscal Years 1992 and 2000 are compared in **Table A-10**. In 1992, the Latin American and Caribbean countries dominated with 50 percent of

Table A-6: Miami Harbor Waterborne Commerce Fiscal Year 2000

	Inbound	% of	% of	% of	**Outbound**	% of	% of	% of	**Total**	% of
U.S. Flag	(Short Tons)	U.S. Flag	Inbound	Total	(Short Tons)	U.S. Flag	Outbound	Total	(Short Tons)	Total
Containers	390,306	79.92%	8.75%	5.00%	138,690	78.66%	4.15%	1.78%	528,996	6.78%
Trailers	98,003	20.07%	2.20%	1.26%	37,562	21.30%	1.12%	0.48%	135,565	1.74%
Other	50	0.01%	0.00%	0.00%	73	0.04%	0.00%	0.00%	123	0.00%
Sub-total	488,359	100.00%	10.94%	6.26%	176,325	100.00%	5.28%	2.26%	664,684	8.52%
	Inbound	% of	% of	% of	**Outbound**	% of	% of	% of	**Total**	% of
Foreign Flag	(Short Tons)	Foreign Flag	Inbound	Total	(Short Tons)	Foreign Flag	Outbound	Total	(Short Tons)	Total
Containers	2,756,323	69.34%	61.76%	35.32%	1,541,783	48.71%	46.14%	19.75%	4,298,106	55.07%
Trailers	1,102,260	27.73%	24.70%	14.12%	1,533,650	48.45%	45.89%	19.65%	2,635,910	33.77%
Other	116,244	2.92%	2.60%	1.49%	90,002	2.84%	2.69%	1.15%	206,246	2.64%
Sub-total	3,974,827	100.00%	89.06%	50.93%	3,165,435	100.00%	94.72%	40.56%	7,140,262	91.48%
Total Inbound	4,463,186			**Total Outbound**	3,341,760			**Total**	7,804,946	
% of Total	57.18%			% of Total	42.82%					
Source: Performance Report (Statistical), Metropolitan Dade County Seaport Department, September 2000.										

Table A-7: Historical Tonnage Export/Import (Short Tons)

Year	Export	% of Total	Import	% of Total	Total
1990	1,579,809	43.99%	2,011,128	56.01%	3,590,937
1991	1,886,942	48.60%	1,995,342	51.40%	3,882,284
1992	2,332,873	50.75%	2,263,608	49.25%	4,596,481
1993	2,568,576	49.41%	2,629,716	50.59%	5,198,292
1994	2,775,575	49.79%	2,798,677	50.21%	5,574,252
1995	2,778,368	47.57%	3,062,447	52.43%	5,840,815
1996	2,899,486	49.48%	2,960,052	50.52%	5,859,538
1997	3,364,124	49.95%	3,371,264	50.05%	6,735,388
1998	3,480,397	49.32%	3,576,267	50.68%	7,056,664
1999	3,190,769	46.04%	3,739,603	53.96%	6,930,372
2000	3,341,760	42.82%	4,463,186	57.18%	7,804,946
Compound					
Annual					
Growth					
Rate					
1990-2000	7.78%		8.30%		8.07%
1995-2000	3.76%		7.82%		5.97%
Source: Port reports.					

Table A-8: Regional Cargo Traffic By Trade Region Fiscal Year 2000 (Short Tons)

		% of Region		% of Region		
Region	Export	Total	Import	Total	Total	% of Total
Caribbean	894,252	26.76%	313,280	7.02%	1,207,532	15.47%
Central America	719,388	21.53%	879,169	19.70%	1,598,557	20.48%
Europe	344,650	10.31%	1,513,975	33.92%	1,858,625	23.81%
Far East, Asia,Pacific	278,311	8.33%	609,198	13.65%	887,509	11.37%
Middle East, SW Asia, Africa	9,042	0.27%	35,840	0.80%	44,882	0.58%
North America	78,347	2.34%	242,043	5.42%	320,390	4.10%
South America	1,017,768	30.46%	869,682	19.49%	1,887,450	24.18%
Total	3,341,758	100.00%	4,463,187	100.00%	7,804,945	100.00%
	42.82%		57.18%		100.00%	
Source: State of the Port 2001, Port of Miami.						

Table A-9: Historical Cargo Tonnage by Trade Regions (Short Tons)

Year	All Cargo	Latin America & Caribbean	% of Total	Far East	% of Total	Europe	% of Total	Total Tonnage for the Three Trade Regions	% of Total
1990	3,590,937	2,428,389	67.63%	301,781	8.40%	720,707	20.07%	3,450,877	96.10%
1991	3,882,284	2,697,312	69.48%	376,856	9.71%	660,511	17.01%	3,734,679	96.20%
1992	4,596,481	3,190,281	69.41%	538,424	11.71%	740,227	16.10%	4,468,932	97.23%
1993	5,198,292	3,635,157	69.93%	616,459	11.86%	783,031	15.06%	5,034,647	96.85%
1994	5,574,252	3,409,595	61.17%	849,510	15.24%	849,510	15.24%	5,108,615	91.65%
1995	5,840,815	3,551,551	60.81%	1,064,880	18.23%	953,711	16.33%	5,570,142	95.37%
1996	6,002,744	3,839,378	63.96%	873,678	14.55%	944,856	15.74%	5,657,912	94.26%
1997	6,735,388	4,721,323	70.10%	880,395	13.07%	1,008,924	14.98%	6,610,642	98.15%
1998	7,056,634	4,815,156	68.24%	805,330	11.41%	1,233,800	17.48%	6,854,286	97.13%
1999	6,930,372	4,296,831	62.00%	831,645	12.00%	1,455,378	21.00%	6,583,854	95.00%
2000	7,804,946	4,693,539	60.14%	887,509	11.37%	1,858,625	23.81%	7,439,673	95.32%
Compound									
Annual									
Growth									
Rate									
1990-2000	8.07%	6.81%		11.39%		9.94%		7.98%	
1995-2000	5.97%	5.73%		-3.58%		14.28%		5.96%	
Source: Port of Miami Annual Reports.									

Table A-10: Top 10 Trade Countries

		FY 1992		% of	% of	FY 2000		% of	% of
Top 10 Import Countries	Rank	Country	Short Tons	Sub-total	Total	Country	Short Tons	Sub-total	Total
	1	Hong Kong	201,000	13.74%	8.88%	Spain	522,699	17.39%	11.71%
	2	Venezuela	179,000	12.24%	7.91%	Guatemala	457,372	15.22%	10.25%
	3	Honduras	165,000	11.28%	7.29%	Italy	345,302	11.49%	7.74%
	4	Colombia	165,000	11.28%	7.29%	Honduras	344,387	11.46%	7.72%
	5	Guatemala	165,000	11.28%	7.29%	Taiwan	301,107	10.02%	6.75%
	6	Italy	154,000	10.53%	6.80%	Brazil	297,073	9.89%	6.66%
	7	Japan	118,000	8.07%	5.21%	Hong Kong	241,241	8.03%	5.41%
	8	Spain	115,000	7.86%	5.08%	Belgium	178,768	5.95%	4.01%
	9	Taiwan	114,000	7.79%	5.04%	Venezuela	163,047	5.43%	3.65%
	10	Costa Rica	87,000	5.95%	3.84%	Netherlands	154,185	5.13%	3.45%
Sub-total			1,463,000	100.00%	64.63%		3,005,181	100.00%	67.33%
Total			2,263,608		100.00%		4,463,187		100.00%
Top 10 Export Countries	Rank								
	1	Venezuela	434,000	28.70%	18.60%	Dominican Republic	336,825	16.22%	10.08%
	2	Puerto Rico	186,000	12.30%	7.97%	Venezuela	311,032	14.98%	9.31%
	3	Guatemala	165,000	10.91%	7.07%	Honduras	284,979	13.73%	8.53%
	4	Jamaica	152,000	10.05%	6.52%	Guatemala	269,254	12.97%	8.06%
	5	Dominican Republic	110,000	7.28%	4.72%	Jamaica	245,373	11.82%	7.34%
	6	Honduras	109,000	7.21%	4.67%	Panama	169,305	8.15%	5.07%
	7	Panama	99,000	6.55%	4.24%	Brazil	144,738	6.97%	4.33%
	8	Chile	89,000	5.89%	3.82%	Japan	121,594	5.86%	3.64%
	9	Costa Rica	84,000	5.56%	3.60%	Costa Rica	96,648	4.66%	2.89%
	10	Spain	84,000	5.56%	3.60%	Chile	96,467	4.65%	2.89%
Sub-total			1,512,000	100.00%	64.81%		2,076,215	100.00%	62.13%
Total			2,332,873		100.00%		3,341,758		100.00%

Source: State of the Port 2001 and 1993, Port of Miami.

Table A-11: Top 10 Commodities

		FY 1992		% of	% of	FY 2000		% of	% of
Top 10 Import Commodities	Rank	Commodity	Short Tons	Sub-total	Total	Commodity	Short Tons	Sub-total	Total
	1	Refrigerated Fruit/Vegetables	320,054	32.84%	14.14%	General Cargo, N.O.S.	1,231,138	45.17%	27.58%
	2	Stone, Clay, Tile, Brick	223,352	22.92%	9.87%	Tiles, Marble & Granite	544,486	19.98%	12.20%
	3	Coffee, Tea, Spices	87,264	8.95%	3.86%	Fruits & Vegetables, Refrigerated	324,631	11.91%	7.27%
	4	Apparel/Finished Textiles	82,248	8.44%	3.63%	Apparel, Miscellaneous	185,191	6.80%	4.15%
	5	Iron/Steel/Metal	50,571	5.19%	2.23%	Lumber & Wood	95,628	3.51%	2.14%
	6	Canned/Preserved Fruit	48,558	4.98%	2.15%	Iron, Steel & Other Metal Products	77,942	2.86%	1.75%
	7	Alcoholic Beverages	46,133	4.73%	2.04%	Beverages, Alcoholic	77,423	2.84%	1.73%
	8	Seafood Refrigerated	41,287	4.24%	1.82%	Beverages, Non-Alcoholic	71,417	2.62%	1.60%
	9	Plastic & Rubber Goods	38,115	3.91%	1.68%	Coffee, Tea, Spices	63,820	2.34%	1.43%
	10	Spare Parts	36,892	3.79%	1.63%	Paper & Paper Products	53,680	1.97%	1.20%
Sub-total			974,474	100.00%	43.05%		2,725,356	100.00%	61.06%
Total			2,263,608		100.00%		4,463,187		100.00%
Top 10 Export Commodities	Rank								
	1	Paper/Newsprint	118,131	15.62%	5.06%	General Cargo, N.O.S.	1,289,256	63.70%	38.58%
	2	Spare Parts	101,001	13.36%	4.33%	Textiles	169,217	8.36%	5.06%
	3	Iron/Steel/Metal	92,485	12.23%	3.96%	Paper & Paper Products	146,603	7.24%	4.39%
	4	Textiles/Fabric/Carpet	77,200	10.21%	3.31%	Foodstuff	86,273	4.26%	2.58%
	5	Trucks & Buses	71,480	9.45%	3.06%	Building Materials	76,343	3.77%	2.28%
	6	Refrigerated Fruit/Vegetables	70,909	9.38%	3.04%	Spare Parts	61,755	3.05%	1.85%
	7	Non-Refrigerated Food Products	60,740	8.03%	2.60%	Iron, Steel & Other Metal Products	52,726	2.61%	1.58%
	8	Construction Machinery	59,085	7.81%	2.53%	Electrical Machinery Equipment	50,965	2.52%	1.53%
	9	Automobiles	55,722	7.37%	2.39%	Machinery & Industrial Equipment	45,653	2.26%	1.37%
	10	Electrical Machinery Equipment	49,349	6.53%	2.12%	Plastic & Rubber Goods	45,186	2.23%	1.35%
Sub-total			756,102	100.00%	32.41%		2,023,977	100.00%	60.57%
Total			2,332,873		100.00%		3,341,758		100.00%

Source: State of the Port 2001 and 1993, Port of Miami.

Table A-12: Historical Number of TEUs

Year	TEUs	
1990	373,851	
1991	408,034	
1992	519,954	
1993	572,170	
1994	629,259	
1995	656,175	
1996	706,217	
1997	761,183	
1998	813,762	
1999	777,821	
2000	868,178	
Compound		
Annual		
Growth		
Rate		
1990-2000	8.79%	
1995-2000	5.76%	
Source: State of the Port reports		
and Performance Reports,		
Port of Miami.		

Table A-13: Historical Number of Passengers

Year	Passengers	
1990	2,734,816	
1991	2,928,532	
1992	3,095,487	
1993	3,157,130	
1994	2,967,081	
1995	2,974,703	
1996	3,052,450	
1997	3,191,885	
1998	2,960,264	
1999	3,112,355	
2000	3,364,643	
Compound		
Annual		
Growth		
Rate		
1990-2000	2.09%	
1995-2000	2.49%	
Source: State of the Port reports		
and Performance Reports,		
Port of Miami.		

Table A-14: Historical Import (Inbound) and Export (Outbound) Cargo Tonnage (Short Tons) - Container, Trailer, Other

	Container	Container	Container	Trailer	Trailer	Trailer	Other	Other	Other	Total	Total	
Year	Import	Export	Total	Import	Export	Total	Import	Export	Total	Import	Export	Total
1990	1,326,301	898,851	2,225,152	490,048	555,694	1,045,742	194,779	125,264	320,043	2,011,128	1,579,809	3,590,937
1991	1,252,731	1,000,262	2,252,993	575,176	751,218	1,326,394	167,435	135,462	302,897	1,995,342	1,886,942	3,882,284
1992	1,394,822	1,159,172	2,553,994	693,118	855,678	1,548,796	175,668	318,023	493,691	2,263,608	2,332,873	4,596,481
1993	1,692,653	1,275,257	2,967,910	755,036	993,893	1,748,929	182,027	299,426	481,453	2,629,716	2,568,576	5,198,292
1994	1,867,563	1,443,937	3,311,500	760,531	1,032,470	1,793,001	170,583	299,168	469,751	2,798,677	2,775,575	5,574,252
1995	2,250,544	1,523,922	3,774,466	743,096	1,031,683	1,774,779	68,807	222,763	291,570	3,062,447	2,778,368	5,840,815
1996	2,130,232	1,651,937	3,782,169	773,555	1,069,728	1,843,283	56,265	177,821	234,086	2,960,052	2,899,486	5,859,538
1997	2,393,678	1,881,294	4,274,972	915,965	1,308,289	2,224,254	61,621	174,541	236,162	3,371,264	3,364,124	6,735,388
1998	2,618,232	1,944,396	4,562,628	891,886	1,347,967	2,239,853	66,149	188,034	254,183	3,576,267	3,480,397	7,056,664
1999	2,671,115	1,683,253	4,354,368	959,449	1,384,045	2,343,494	109,039	123,471	232,510	3,739,603	3,190,769	6,930,372
2000	3,146,629	1,680,473	4,827,102	1,200,263	1,571,212	2,771,475	116,294	90,075	206,369	4,463,186	3,341,760	7,804,946
Compound												
Annual												
Growth												
Rate												
1990-2000	9.02%	6.46%	8.05%	9.37%	10.95%	10.24%	-5.03%	-3.24%	-4.29%	8.30%	7.78%	8.07%
1995-2000	6.93%	1.98%	5.04%	10.06%	8.78%	9.32%	11.07%	-16.56%	-6.68%	7.82%	3.76%	5.97%

Source: Performance Reports (Statistical), Metropolitan Dade County Seaport Department.

the top 10 import countries and 80 percent of the top 5 import countries. In 2000, there were an equal number of countries from the European and Latin American and Caribbean trade regions. This finding is consistent with the high compound annual growth rates for the European trade region displayed in **Table A-9**. From 1992 to 2000, the list of top ten export countries remained dominated by countries within the Latin American and Caribbean trade region, which accounted for 9 of the top 10 countries and all 5 of the top 5 countries. The only change is that an Asian trade region country, Japan, replaced Spain, a European trade region country.

The list of top ten commodities for Fiscal Years 1992 and 2000 are compared in **Table A-11**. The most significant difference between the two years for both imports and exports is the inclusion of the cargo category General Cargo, N.O.S. (Not Otherwise Stated) for fiscal year 2000. The amount this category represents, 45.17 percent of imports, and 63.07% of exports, which accounts for its significance. Of the "stated" commodities, the most significant is the cargo category of Tiles, Marble & Granite found under imports. It is significant because this commodity is an import from Europe (Spain and Italy), and has increased from 223,352 short tons in 1992 to 544,486 short tons in 2000, or an increase of 144 percent. The significant growth in this cargo is an individual example of the significant overall growth rate for commodities in the European trade region, as shown in **Table A-9**; as well as the increase in the number of European countries in the top 10 import countries displayed in **Table A-10**.

The historical total annual number of TEUs is displayed in **Table A-12**. Typically 70 percent are full containers. The compound annual growth rates are consistent with those for tonnage displayed in **Table A-7**: 1990 to 2000, TEUs 8.79 percent, tonnage 8.07 percent; 1995 to 2000, TEUs 5.76 percent, tonnage 5.97 percent.

Historical Cruise Ship Passengers

The historical annual number of cruise ship passengers is shown in **Table A-13** for the 10-year period 1990 to 2000. The number of cruise ship passengers has increased by 629,827 passengers, or an increase of 23 percent from 1990 to 2000. This growth results in a compound annual growth rate of 2.09 percent. Moreover, for the period 1995 to 2000, the compound annual growth rate is slightly higher, 2.49 percent.

Future Container and Trailer Cargo Traffic

As shown in **Table A-5**, container and trailer cargo represents 97.4 percent of all cargo. The remaining 2.6 percent consists of neobulk and breakbulk cargo. Historical growth rates for these commodity types are displayed in **Table A-14** for the 10-year period 1990 to 2000. Container cargo grew from 2,225,152 short tons in 1990 to 4,827,102 short tons in 2000, which represents a 117 percent increase, or a compound annual growth rate of 8.05 percent. For the 5-year period 1995 to 2000, the compound annual growth rate was about 3 percent lower (5.04 percent). This resulted from slower growth in export container trade for this period (1.98 percent). Container imports demonstrated the most growth. From 1990 to 2000, the compound annual growth rate was 9.02%, and only about 2 percent lower for the period 1995 to 2000.

The overall compound annual growth rates of 9.02 percent for imports and 6.46 percent for exports are higher than the overall world and overall United States rates. As reported in Lloyd' Register's Fairplay Market Forecast - Container (February 2000), "Containership trade expansion has nearly doubled the world growth rate in the 1990s. Loaded TEU volumes averaged just under 7 percent annual growth in the 1990s." In "U.S. Industry & Trade Outlook 2000", The McGraw-Hill Companies reported an annual growth rate in United States liner import trade of 7.5 percent and 3.6 percent for United States liner export trade for the period 1993 to 1999.

Historically, cargo growth has varied by trade region and by direction (origin/destination). It is expected that cargo will continue to grow in a similar pattern in the future; that is, the future will reflect, in part, the past, as no significant changes in the pattern of cargo traffic are anticipated without or with the project. Historical export and import tonnage by trade region is presented in **Table A-15** and **Table A-16**, respectively. Using compound average annual growth rates for exports and imports for each trade region rather than a single, composite compound average annual growth rate for all cargo traffic will result in a more accurate cargo projection by significantly reducing the uncertainty associated with using a general composite rate.

Exports: Tonnage for the Caribbean, South America, Central America and Mexico are combined into one category, Latin America and Caribbean. Cargo is shipped in both containers and trailers. At the Port of Miami, all cargo shipped in trailers is within this general trade region. As shown in **Table A-15,** export growth has been fueled by South American trade (11.59 percent) from 1990 to 2000. However, slower growth (2.12 percent) in this trade between 1995 and 2000 has offset significant average annual growth in the Caribbean and Central American and Mexico trades: 11.87 percent and 11.92 percent, respectively. The average annual rate of growth in exports to Europe is greater during the second half of the period 1990 to 2000: 9.44 percent compared to 4.68 percent, respectively. In contrast, exports to the Far East have a very high average annual growth rate (28.25 percent) for the period 1990 to 2000, but they have been positive but modest (0.47 percent) from 1995 to 2000. Exports to the Middle East/South West Asia/Africa are marginal in relative volume (9,042 short tons in 2000) and have demonstrated negative growth (-12.09 percent) from 1990 to 2000. North American exports are almost nonexistent until 1994, when there was a major single-year increase in tonnage (314,615 short tons). In contrast, the following year only 20,884 short tons were exported. From 1996 to 2000, North American exports (shipments), which include U.S. domestic and Canadian cargo, have recorded an average annual rate of growth of 3.78 percent, compared to the 28.56 percent from 1995 to 2000, which is skewed by the relatively low tonnage recorded in 1995 compared to later years. Canadian trade tonnage is only about 13.4 percent of the North American inbound trade; and 12.1 percent of all North American trade tonnage.

Table A-15: Export Cargo Tonnage by Region

Export Tonnage by Region						***Short Tons*** [1]					
Fiscal Year	Caribbean	Central America & Mexico	South America	Latin America & Caribbean Total	Europe	Far East, Asia, Pacific	Middle East, SW Asia, Africa	North America	Other	All Outbound Total	Foreign Export Total
1990	595,982	356,024	339,797	1,291,803	218,188	23,127	32,800	0	n/a	1,565,918	1,565,918
1991	544,142	443,928	598,092	1,586,162	208,866	24,706	37,964	3,714	n/a	1,861,412	1,857,698
1992	667,527	483,890	810,849	1,962,266	304,441	26,515	n/a [2]	na/	42,123	2,335,345	2,293,222
1993	840,030	511,121	883,508	2,234,659	218,480	44,733	n/a	n/a	66,295	2,564,167	2,497,872
1994	798,601	332,974	892,276	2,023,851	239,168	182,237	15,704	314,615	n/a	2,775,575	2,460,960
1995	510,278	409,580	916,503	1,836,361	219,534	271,858	38,178	20,884	n/a	2,386,815	2,365,931
1996	608,729	533,994	1,194,350	2,337,073	317,411	284,664	51,709	63,236	n/a	3,054,093	2,990,857
1997	807,328	658,682	1,534,103	3,000,113	258,335	306,604	8,768	61,751	n/a	3,635,571	3,573,820
1998	994,965	624,387	1,517,254	3,136,606	260,153	242,831	9,548	82,875	n/a	3,732,013	3,649,138
1999	1,021,046	658,575	924,366	2,603,987	232,926	261,005	14,996	77,855	n/a	3,190,769	3,112,914
2000	894,252	719,388	1,017,768	2,631,408	344,650	278,311	9,042	73,348	n/a	3,336,759	3,263,411
1990-2000	4.14%	7.29%	11.59%	7.37%	4.68%	28.25%	-12.09%			7.86%	7.62%
1995-2000	11.87%	11.92%	2.12%	7.46%	9.44%	0.47%	-25.03%	28.56%		6.93%	6.64%

[1] Source: State of the Port.

[2] n/a: not applicable, that is, no tonnage reported.

Table A-16: Import Cargo Tonnage by Region

Import Tonnage by Region — ***Short Tons*** [1]

Fiscal Year	Caribbean	Central America & Mexico	South America	Latin America & Caribbean Total	Europe	Far East, Asia, Pacific	Middle East, SW Asia, Africa	North America	Other	All Inbound Total	Foreign Import Total
1990	259,214	412,452	464,920	1,136,586	502,519	278,654	30,035	48,301	n/a	1,996,095	1,947,794
1991	212,968	383,924	514,258	1,111,150	451,645	352,150	35,452	35,040	n/a	1,985,437	1,950,397
1992	246,582	457,193	524,240	1,228,015	435,786	511,909	n/a [2]	n/a	55,148	2,230,858	2,175,710
1993	267,945	467,618	664,935	1,400,498	564,551	571,726	n/a	n/a	60,338	2,597,113	2,536,775
1994	274,176	379,373	732,195	1,385,744	529,563	667,273	70,413	145,684	n/a	2,798,677	2,652,993
1995	314,712	555,833	844,645	1,715,190	734,177	793,022	84,462	137,324	n/a	3,464,175	3,326,851
1996	268,975	568,528	664,802	1,502,305	627,445	589,014	68,438	128,499	n/a	2,915,701	2,787,202
1997	284,386	655,709	781,115	1,721,210	750,589	573,791	45,007	200,019	n/a	3,290,616	3,090,597
1998	321,919	704,512	654,119	1,680,550	973,647	562,499	35,335	215,487	n/a	3,467,518	3,252,031
1999	303,656	713,142	624,140	1,640,938	1,252,393	605,068	26,925	214,279	n/a	3,739,603	3,525,324
2000	313,280	879,169	869,682	2,062,131	1,513,975	609,198	35,840	242,043	n/a	4,463,187	4,221,144
1990-2000	1.91%	7.86%	6.46%	6.14%	11.66%	8.14%	1.78%	17.49%		8.38%	8.04%
1995-2000	-0.09%	9.60%	0.59%	3.75%	15.57%	-5.14%	-15.76%	12.00%		5.20%	4.88%

[1] Source: State of the Port.
[2] n/a: "not applicable", that is, no tonnage reported.

Imports: As shown in **Table A-16**, imports for the Latin America and Caribbean trade recorded a lower average annual growth rate than exports for the period 1990 to 2000: 6.14 percent compared to 7.37 percent. This is the result of modest (1.91 percent) annual growth in Caribbean imports from 1990 to 2000, demonstrating no growth from 1995 to 2000, and modest growth (0.59 percent) in the South America trade. In contrast, European imports were robust over the period 1990 to 2000, and even stronger between 1995 and 2000, recording average annual growth rates of 11.66 percent and 15.57 percent, respectively. Far East imports were robust between 1990 and 2000, recording an average annual growth rate of 8.14 percent. In contrast, for the period 1995 to 2000, the average annual growth rate was –5.14 percent. This is due to the highest amount of import tonnage being recorded in 1995. Using the period 1996 to 2000 results in a more accurate representation of the more recent past, showing positive but modest average annual growth (0.84 percent). Imports in the Middle East/South West Asia/Africa trade recorded a modest average annual growth rate (1.78 percent) for the period 1990 to 2000, with a negative average annual rate (-15.76 percent) for the period 1995 to 2000. North American imports (receipts), which include U.S. domestic and Canadian cargo, recorded robust average annual growth rates for both the 1990 to 2000 and 1995 to 2000 periods, 17.49 percent and 12.00 percent, respectively.

With respect to projecting future growth in cargo traffic, Corps guidance states: "Generally, specific commodity studies are of limited value for projections beyond approximately 20 years. Given this limitation, it is preferable to extend the traffic projections to the end of project life through the use of general indices on a regional and industry basis." (*Principles and Guidelines*, page 63). Historical cargo traffic trends and near-term general economic activity indicators are used to project future cargo traffic over the project life consistent with the guidance, which is intended to account for progressively greater levels of uncertainty.

National and regional economic indicators that are relevant to the general level of economic active are presented in **Table A-17**. The indicators are average annual rates of change (growth). Historical rates are shown for the period 1990 to 2000, as are near-term forecasted rates for the period 2000 to 2010. This information was obtained from various sources; for example, the estimated compound average annual growth trade for exports and imports was obtained from an article entitled "The U.S. economy to 2010" the *Monthly Labor Review*, November 2001, published by the U.S. Department of Labor.

The projected national average annual rates of change for exports and imports for 2000 to 2010, weighted per goods handled at Miami Harbor, are used as a guide to growth in export and import cargo from 2001 to 2030 (year 20 of the project life). Specifically, the values are used to set the upper boundary of the annual rate of change (growth) that any trade region will experience on average. The maximum average annual growth rate was set 7.6 percent for imports and 6 percent for exports. If the historical average annual rate of growth exceeded this rate, it would be reduced to this level. For those regions that experienced average annual growth rates less than this maximum, the historical (1990 to 2000) average annual rate of growth was used through 2030.

Using this method of setting an upper growth rate parameter that represents a national average, accounts for the distribution of future cargo traffic between U.S. East Coast ports.

Specifically, the projected future cargo traffic at Miami Harbor is less likely to include a shift of some cargo traffic from other U.S. East Coast ports.

Corps guidance recommends using "general indices on a regional and industry basis" after year 20 of the project life. The Bureau of Economic Analysis (U.S. Department of Commerce) was the main source of the long-term regional projections. However, it discontinued preparing and publishing its OBERS projections in 1996. In lieu of these projections, other general economic activity indicators were reviewed for the purpose of projecting cargo growth after year 20 of the project life: national gross domestic product (GDP), gross state product (GSP), and national, state and regional (Miami) personal income and population growth. This economic data is presented in **Table A-17**. As noted in the Table, national data was obtained from publications prepared by the Bureau of Economic Analysis, BEA, (U.S. Department of Commerce) and the Bureau of Labor Statistics, BLS, (U.S. Department of Labor); while state and regional data was obtained from the Bureau of Economic and Business Research, BEBR, (University of Florida).

Table A-17: National and Regional Economic Indicators of Cargo Exports and Imports-Average Annual Rate of Change (Growth)

National - U.S. Period	GDP [1] (real dollars)	GSP [2] (real dollars)	All Goods Exports [1] (real dollars)	Weighted per Miami Goods Exports [3] (real dollars)	All Goods Imports [1] (real dollars)	Weighted per Miami Goods Imports [3] (real dollars)	Personal Income [1] (current dollars)	Population
1990 - 2000	3.20	3.46	7.80	5.70	10.20	9.50	5.40	1.23 [2]
2000 - 2010	3.40		8.10	6.00	8.40	7.60	5.50	0.86 [4]
2010 - 2020								0.81 [4]
2020 - 2030								0.78 [4]
2030 - 2040								0.72 [4]
2040 - 2050								0.68 [4]
2050 - 2060								0.68 [4]
Regional								
Florida								
1990 - 2000		3.72 [2]					6.28 [5]	2.11 [2]
2000 - 2010							6.45 [5]	1.66 [5]
2010 - 2020							7.01 [5]	1.45 [5]
2020 - 2030								1.19 [5]
2030 - 2040								
2040 - 2050								
2050 - 2060								
Miami PMSA								
1990 - 2000							5.31 [5]	1.54 [2]
2000 - 2010							5.71 [5]	1.46 [5]
2010 - 2020							6.53 [5]	1.14 [5]
2020 - 2030								0.96 [5]
2030 - 2040								
2040 - 2050								
2050 - 2060								

[1] Bureau of Labor Statistics, U.S. Department of Labor.
[2] Bureau of Economic Analysis, U.S. Department of Commerce.
[3] Compound average annual rates for cargo types specifically handled at the Port of Miami weighted by their relative tonnage in fiscal year 1999.
[4] U.S. Census Bureau.
[5] Bureau of Economic and Business Research, University of Florida.

Unlike bulk commodities, like coal and petroleum products, containerized cargo traffic growth does not correlate well with population growth. Commodities like coal for power generation and gasoline for vehicle use have average annual growth rates of 1 to 2 percent in large urban areas, which have similar average annual population growth rates. However, for ports serving major urban areas and hinterland markets, like Miami Harbor, historical (1990 to 2000) annual containerized cargo growth has been, on average, three times the annual population growth rates, or approximately 6 to 8 percent compared to 1 to 2 percent. For some trade regions, mainly Europe and Asia, the historical average annual growth rate for containerized has exceeded 10 percent. A small portion of the growth in containerized cargo is explained by the shipment of commodities previously shipped break bulk being shipped in containers. But, the current difference between the rate of annual population growth and containerized cargo growth is too great to use the projected annual population growth rate for the containerized cargo growth rate after year 20 of the project period.

As shown in **Table A-17**, state and regional economic indicators (GSP, personal income and population growth) have historically been equal to or slightly greater than the same national values. This is true for near-term projections of personal income and population average annual growth rates. Based on this fact, national GDP was selected as a general economic indicator of the base level of economic activity for the Port of Miami that estimates that 70 percent of all cargo handled by the Port originates or is destined for the Miami area.

Accordingly, after 2030, the national GDP for the period 2000 to 2010, or 3.4 percent, is used as a guide to projecting the average annual growth rate between 2030 and 2060. This value represents roughly one-half (50 percent) of the compound average annual growth rates set for imports (7.6 percent) and exports (6.0 percent): 44.7 and 56.6 percent, respectively. As such, one-half of the expected average annual growth rates projected for 2001 to 2030 were assumed to be the upper boundary for the average annual rate of change (growth) that any trade region would experience. For example, for a region with the maximum upper boundary import rate of 7.6 percent for the period 2001 to 2030, its upper boundary for the period 2030 to 2060, would be 3.8 percent, or slightly more (+0.4 percent) than the GDP annual rate of change (growth) in real dollars projected for 2000 to 2010. Regions with lower rates for 2001-2030 would have rates less than 3.8 percent. The maximum upper boundary export annual rate is 3 percent or slightly less (-0.4 percent) than the GDP annual rate of change (growth).

A modification of this procedure was used for North America. For North America, only about 12 percent of the cargo is Canadian. So, all North American cargo is considered U.S. domestic cargo for the analysis. Based on a review of U.S. Domestic/Miami Harbor waterborne commerce for calendar year 2000, it was determined that almost all of the goods are manufactured products (7900, not elsewhere classified). As such, the Labor Department's projected average annual rate of growth for durable goods, 4 percent, for the period 2000 to 2010 is used for the rate of growth for the period 2003 to 2030 rather than the projected export and import rates weighted for a variety of goods; and 2 percent or one-half, for the period 2030 to 2060. The Port Authority provided actual cargo tonnage and TEUs for 2001 and 2002. A summary of projected average annual rates of growth, as well as effective average annual rates of growth, by trade region is presented in **Table A-18**.

As shown in **Table A-18**, the overall average annual growth rate for all regions is 4.72 percent for the period 2002 to 2060, and 4.47 percent over the project life, 2010 to 2060.

In **Table A-19**, projected cargo traffic is displayed in TEUs. The number of TEUs handled by the Port of Miami increases from 980,743 in 2002 (actual) to 14,251,029 in 2060. Approximately 30 percent of the total TEUs are empty containers. Also shown in this table is the relative proportion (percentage) of total TEUs each trade region represents. Over the 58 years the relative proportions change due to varying projected growth rates. Latin America/Caribbean, Middle East and North America decline, while Far East and Europe increase. The increase in European and Far East trade is consistent with current and projected burgeoning market trends for countries within these general trade regions, for example, Russia and Poland, China and Vietnam. Projected short tons are displayed in **Table A-20**.

TABLE A-18: PROJECTED AND EFFECTIVE AVERAGE RATES OF GROWTH BY TRADE REGION

Last Year of Recorded Tonnage: 2002 Base Year: 2010	Projected Average Annual Rate (%)						Effective Average Annual Rate (%) for Period [1]	
	2003 to 2009		2010 to 2029		2030 to 2060		2002 to 2060	2010 to 2060
Trade Region	Import Cargo	Export Cargo	Import Cargo	Export Cargo	Import Cargo	Export Cargo	All Cargo	All Cargo
Latin America/Caribbean	6.14	6.00	6.14	6.00	3.07	3.00	4.43	4.17
Far East	7.60	6.00	7.60	6.00	3.80	3.00	5.26	4.97
Europe	7.60	4.68	7.60	4.68	3.80	2.34	5.28	5.00
Middle East/Africa	1.78	0.00	1.78	0.00	0.89	0.00	0.99	0.95
North America (Domestic/Canadian)	4.00	4.00	4.00	4.00	2.00	2.00	2.93	2.76
All Regions							4.72	4.47

[1] Effective average annual rate (%): Resultant compound average annual rate using projected average annual rates for imports and exports for each trade region.

Table A-19: Summary of Projected TEUs by Trade Region from 2002 to 2060

Year	Latin America & Caribbean TEUs Full	Container TEUs Full	Trailer TEUs Full	TEUs Empty	Container TEUs Empty	Trailer TEUs Empty	Far East (Asian) TEUs Full	TEUs Empty	Europe TEUs Full	TEUs Empty	Middle East TEUs Full	TEUs Empty	North America TEUs Full	TEUs Empty	All Regions TEUs Full	TEUs Empty	Total TEUs
2002	417,609	129,459	288,150	178,975	55,482	123,493	85,592	36,682	153,749	65,892	15,096	6,470	14,475	6,204	686,521	294,223	980,743
2003	442,918	137,305	305,614	189,822	58,845	130,977	91,673	39,288	164,522	70,510	15,281	6,549	15,054	6,452	729,449	312,621	1,042,069
2004	469,762	145,626	324,136	201,326	62,411	138,915	98,190	42,081	176,072	75,459	15,470	6,630	15,656	6,710	775,150	332,207	1,107,357
2005	498,233	154,452	343,781	213,528	66,194	147,334	105,176	45,075	188,455	80,766	15,662	6,712	16,282	6,978	823,808	353,060	1,176,868
2006	528,430	163,813	364,616	226,470	70,206	156,264	112,663	48,284	201,732	86,457	15,857	6,796	16,934	7,257	875,616	375,264	1,250,879
2007	560,456	173,742	386,715	240,195	74,461	165,735	120,690	51,724	215,970	92,558	16,056	6,881	17,611	7,548	930,783	398,907	1,329,689
2008	594,425	184,272	410,153	254,753	78,973	175,780	129,294	55,412	231,238	99,102	16,259	6,968	18,315	7,849	989,531	424,084	1,413,615
2009	630,452	195,440	435,012	270,193	83,760	186,433	138,518	59,365	247,613	106,120	16,465	7,056	19,048	8,163	1,052,096	450,898	1,502,994
2010	668,663	207,286	461,378	286,570	88,837	197,733	148,407	63,603	265,176	113,647	16,675	7,146	19,810	8,490	1,118,731	479,456	1,598,187
2011	709,191	219,849	489,341	303,939	94,221	209,718	159,010	68,147	284,016	121,721	16,888	7,238	20,602	8,830	1,189,706	509,874	1,699,580
2012	752,175	233,174	519,000	322,360	99,932	222,429	170,377	73,019	304,226	130,382	17,105	7,331	21,426	9,183	1,265,309	542,275	1,807,584
2013	797,764	247,307	550,457	341,899	105,989	235,910	182,565	78,242	325,907	139,674	17,326	7,426	22,283	9,550	1,345,846	576,791	1,922,637
2014	846,118	262,296	583,821	362,621	112,413	250,209	195,634	83,843	349,169	149,644	17,552	7,522	23,175	9,932	1,431,647	613,562	2,045,209
2015	897,402	278,195	619,207	384,600	119,226	265,374	209,648	89,849	374,128	160,340	17,781	7,620	24,102	10,329	1,523,061	652,740	2,175,800
2016	951,795	295,056	656,739	407,912	126,453	281,459	224,676	96,290	400,910	171,818	18,014	7,720	25,066	10,742	1,620,461	694,483	2,314,943
2017	1,009,486	312,941	696,545	432,636	134,117	298,519	240,792	103,196	429,650	184,136	18,251	7,822	26,068	11,172	1,724,247	738,962	2,463,210
2018	1,070,673	331,909	738,765	458,860	142,246	316,613	258,075	110,603	460,494	197,354	18,493	7,925	27,111	11,619	1,834,846	786,362	2,621,207
2019	1,135,570	352,027	783,543	486,672	150,868	335,804	276,610	118,547	493,597	211,541	18,739	8,031	28,196	12,084	1,952,711	836,875	2,789,587
2020	1,204,401	373,364	831,037	516,171	160,013	356,158	296,489	127,067	529,127	226,769	18,989	8,138	29,323	12,567	2,078,330	890,712	2,969,042
2021	1,277,405	395,996	881,410	547,459	169,712	377,747	317,810	136,204	567,265	243,113	19,244	8,247	30,496	13,070	2,212,220	948,093	3,160,314
2022	1,354,834	419,999	934,836	580,643	179,999	400,644	340,679	146,005	608,204	260,659	19,503	8,358	31,716	13,593	2,354,937	1,009,258	3,364,195
2023	1,436,958	445,457	991,501	615,838	190,910	424,929	365,210	156,518	652,153	279,494	19,767	8,471	32,985	14,136	2,507,072	1,074,458	3,581,530
2024	1,524,060	472,459	1,051,601	653,168	202,482	450,686	391,522	167,795	699,335	299,715	20,035	8,587	34,304	14,702	2,669,257	1,143,966	3,813,223
2025	1,616,442	501,097	1,115,345	692,760	214,756	478,005	419,748	179,892	749,992	321,425	20,309	8,704	35,676	15,290	2,842,167	1,218,070	4,060,237
2026	1,714,425	531,472	1,182,953	734,753	227,773	506,979	450,027	192,869	804,382	344,735	20,587	8,823	37,103	15,901	3,026,525	1,297,081	4,323,605
2027	1,818,348	563,688	1,254,660	779,291	241,580	537,711	482,511	206,790	862,784	369,764	20,870	8,944	38,588	16,538	3,223,100	1,381,327	4,604,427
2028	1,928,571	597,857	1,330,714	826,530	256,224	570,306	517,359	221,725	925,496	396,641	21,158	9,068	40,131	17,199	3,432,716	1,471,162	4,903,878
2029	2,045,477	634,098	1,411,379	876,632	271,756	604,876	554,747	237,749	992,841	425,503	21,451	9,193	41,736	17,887	3,656,253	1,566,964	5,223,216
2030	2,107,474	653,317	1,454,157	903,202	279,993	623,209	574,804	246,344	1,029,002	441,000	21,601	9,257	42,571	18,245	3,775,451	1,618,049	5,393,500
2031	2,171,350	673,118	1,498,231	930,577	288,479	642,098	595,592	255,254	1,066,501	457,071	21,751	9,322	43,423	18,610	3,898,616	1,670,834	5,569,450
2032	2,237,162	693,520	1,543,642	958,783	297,223	661,560	617,139	264,488	1,105,387	473,737	21,903	9,387	44,291	18,982	4,025,882	1,725,376	5,751,258
2033	2,304,969	714,540	1,590,429	987,843	306,231	681,612	639,471	274,059	1,145,713	491,019	22,056	9,453	45,177	19,361	4,157,386	1,781,735	5,939,121
2034	2,374,832	736,198	1,638,634	1,017,784	315,513	702,271	662,619	283,979	1,187,531	508,941	22,211	9,519	46,080	19,749	4,293,273	1,839,972	6,133,246
2035	2,446,812	758,512	1,688,300	1,048,633	325,076	723,557	686,612	294,262	1,230,899	527,527	22,367	9,586	47,002	20,144	4,433,692	1,900,152	6,333,844
2036	2,520,974	781,502	1,739,472	1,080,417	334,929	745,487	711,481	304,920	1,275,873	546,802	22,524	9,653	47,942	20,547	4,578,795	1,962,339	6,541,134
2037	2,597,385	805,189	1,792,196	1,113,164	345,081	768,083	737,259	315,968	1,322,514	566,791	22,683	9,721	48,901	20,957	4,728,742	2,026,602	6,755,344
2038	2,676,112	829,595	1,846,517	1,146,904	355,540	791,364	763,978	327,419	1,370,885	587,521	22,844	9,790	49,879	21,377	4,883,697	2,093,011	6,976,708
2039	2,757,225	854,740	1,902,485	1,181,667	366,317	815,350	791,673	339,288	1,421,049	609,021	23,005	9,859	50,876	21,804	5,043,829	2,161,639	7,205,468
2040	2,840,798	880,647	1,960,150	1,217,483	377,420	840,064	820,381	351,592	1,473,075	631,317	23,168	9,929	51,894	22,240	5,209,316	2,232,562	7,441,878
2041	2,926,903	907,340	2,019,563	1,254,386	388,860	865,526	850,139	364,345	1,527,031	654,441	23,333	10,000	52,932	22,685	5,380,338	2,305,857	7,686,195
2042	3,015,619	934,842	2,080,777	1,292,407	400,646	891,761	880,985	377,564	1,582,991	678,424	23,499	10,071	53,990	23,139	5,557,084	2,381,605	7,938,689
2043	3,107,025	963,178	2,143,847	1,331,581	412,790	918,791	912,959	391,268	1,641,028	703,297	23,666	10,143	55,070	23,602	5,739,748	2,459,890	8,199,638
2044	3,201,201	992,372	2,208,829	1,371,942	425,302	946,640	946,103	405,472	1,701,222	729,094	23,835	10,215	56,172	24,074	5,928,532	2,540,797	8,469,329
2045	3,298,232	1,022,452	2,275,780	1,413,527	438,193	975,333	980,460	420,197	1,763,652	755,850	24,006	10,288	57,295	24,555	6,123,645	2,624,417	8,748,061
2046	3,398,205	1,053,443	2,344,761	1,456,372	451,475	1,004,897	1,016,075	435,460	1,828,402	783,600	24,178	10,362	58,441	25,046	6,325,301	2,710,840	9,036,141
2047	3,501,208	1,085,375	2,415,834	1,500,516	465,160	1,035,356	1,052,994	451,283	1,895,560	812,382	24,351	10,436	59,610	25,547	6,533,723	2,800,164	9,333,888
2048	3,607,334	1,118,274	2,489,060	1,545,999	479,260	1,066,739	1,091,265	467,684	1,965,216	842,235	24,526	10,511	60,802	26,058	6,749,143	2,892,487	9,641,630
2049	3,716,677	1,152,170	2,564,507	1,592,860	493,787	1,099,073	1,130,938	484,687	2,037,463	873,198	24,703	10,587	62,018	26,579	6,971,799	2,987,911	9,959,710
2050	3,829,335	1,187,094	2,642,241	1,641,142	508,754	1,132,388	1,172,065	502,313	2,112,399	905,313	24,881	10,663	63,258	27,111	7,201,938	3,086,542	10,288,480
2051	3,945,408	1,223,077	2,722,332	1,690,888	524,175	1,166,712	1,214,699	520,585	2,190,124	938,623	25,061	10,740	64,524	27,653	7,439,815	3,188,489	10,628,305
2052	4,065,000	1,260,150	2,804,850	1,742,141	540,064	1,202,077	1,258,896	539,526	2,270,742	973,174	25,242	10,818	65,814	28,206	7,685,695	3,293,866	10,979,562
2053	4,188,218	1,298,348	2,889,870	1,794,949	556,434	1,238,515	1,304,714	559,163	2,354,364	1,009,012	25,425	10,897	67,130	28,770	7,939,851	3,402,790	11,342,641
2054	4,315,171	1,337,703	2,977,468	1,849,357	573,301	1,276,056	1,352,213	579,519	2,441,100	1,046,185	25,610	10,976	68,473	29,346	8,202,566	3,515,382	11,717,949
2055	4,445,972	1,378,251	3,067,721	1,905,415	590,679	1,314,736	1,401,453	600,622	2,531,069	1,084,743	25,796	11,056	69,842	29,932	8,474,133	3,631,768	12,105,901
2056	4,580,739	1,420,029	3,160,710	1,963,172	608,583	1,354,589	1,452,501	622,500	2,624,391	1,124,738	25,984	11,136	71,239	30,531	8,754,855	3,752,077	12,506,932
2057	4,719,592	1,463,074	3,256,519	2,022,680	627,031	1,395,649	1,505,422	645,180	2,721,193	1,166,224	26,174	11,217	72,664	31,142	9,045,045	3,876,444	12,921,489
2058	4,862,654	1,507,423	3,355,231	2,083,993	646,038	1,437,955	1,560,286	668,694	2,821,604	1,209,258	26,365	11,299	74,117	31,765	9,345,027	4,005,008	13,350,035
2059	5,010,054	1,553,117	3,456,937	2,147,164	665,621	1,481,543	1,617,165	693,070	2,925,761	1,253,896	26,558	11,382	75,600	32,400	9,655,138	4,137,912	13,793,050
2060	5,161,922	1,600,196	3,561,726	2,212,250	685,797	1,526,452	1,676,133	718,342	3,033,805	1,300,201	26,753	11,465	77,112	33,048	9,975,723	4,275,306	14,251,029
2060	**Total**					7,374,171		2,394,475		4,334,005		38,218		110,159			14,251,029
	% of Total					51.74%		16.80%		30.41%		0.27%		0.77%			100.00%
2002	**Total**					596,584		122,275		219,641		21,565		20,678			980,743
	% of Total					60.83%		12.47%		22.40%		2.20%		2.11%			100.00%

Notes: (1) 2002 is latest complete fiscal year of reported cargo from Port records.
(2) 2010 is the Base Year of the study period. (3) Approximately 12 short tons (12.33) overall per full TEU.

Table A-20: Summary of Total Short Tons by Trade Region from 2000 to 2060

Year	Latin America & Caribbean Total Short Tons	Far East (Asian) Total Short Tons	Europe Total Short Tons	Middle East Total Short Tons	North America Total Short Tons	All Regions Total Short Tons
2000	4,693,539	887,509	1,858,625	44,882	320,391	7,804,946
2001	5,072,892	954,163	1,817,706	62,981	339,262	8,247,004
2002	5,281,079	1,082,402	1,944,306	190,899	183,049	8,681,735
2003	5,601,144	1,159,296	2,080,549	193,243	190,371	9,224,603
2004	5,940,609	1,241,712	2,226,607	195,630	197,986	9,802,543
2005	6,300,651	1,330,050	2,383,201	198,058	205,905	10,417,865
2006	6,682,516	1,424,739	2,551,105	200,530	214,141	11,073,032
2007	7,087,528	1,526,242	2,731,151	203,046	222,707	11,770,674
2008	7,517,091	1,635,051	2,924,233	205,607	231,615	12,513,598
2009	7,972,692	1,751,700	3,131,311	208,213	240,880	13,304,796
2010	8,455,910	1,876,757	3,353,418	210,866	250,515	14,147,465
2011	8,968,419	2,010,833	3,591,661	213,566	260,536	15,045,015
2012	9,511,995	2,154,586	3,847,234	216,314	270,957	16,001,087
2013	10,088,522	2,308,721	4,121,416	219,111	281,796	17,019,565
2014	10,699,997	2,473,992	4,415,584	221,957	293,067	18,104,598
2015	11,348,538	2,651,213	4,731,217	224,855	304,790	19,260,613
2016	12,036,394	2,841,254	5,069,904	227,804	316,982	20,492,337
2017	12,765,948	3,045,051	5,433,354	230,805	329,661	21,804,819
2018	13,539,727	3,263,609	5,823,402	233,860	342,847	23,203,446
2019	14,360,414	3,498,005	6,242,024	236,969	356,561	24,693,973
2020	15,230,851	3,749,397	6,691,339	240,134	370,824	26,282,545
2021	16,154,056	4,019,027	7,173,629	243,354	385,657	27,975,723
2022	17,133,227	4,308,230	7,691,344	246,633	401,083	29,780,517
2023	18,171,759	4,618,437	8,247,120	249,969	417,126	31,704,411
2024	19,273,249	4,951,187	8,843,788	253,365	433,811	33,755,400
2025	20,441,515	5,308,132	9,484,393	256,821	451,164	35,942,025
2026	21,680,606	5,691,043	10,172,210	260,339	469,210	38,273,408
2027	22,994,816	6,101,825	10,910,756	263,920	487,979	40,759,296
2028	24,388,700	6,542,522	11,703,815	267,564	507,498	43,410,099
2029	25,867,089	7,015,329	12,555,454	271,273	527,798	46,236,944
2030	26,651,098	7,268,967	13,012,751	273,161	538,354	47,744,330
2031	27,458,872	7,531,855	13,486,961	275,065	549,121	49,301,873
2032	28,291,132	7,804,332	13,978,716	276,987	560,103	50,911,271
2033	29,148,621	8,086,752	14,488,673	278,925	571,305	52,574,276
2034	30,032,104	8,379,479	15,017,511	280,881	582,731	54,292,706
2035	30,942,368	8,682,893	15,565,936	282,854	594,386	56,068,437
2036	31,880,225	8,997,386	16,134,682	284,844	606,274	57,903,411
2037	32,846,513	9,323,366	16,724,507	286,853	618,399	59,799,638
2038	33,842,092	9,661,256	17,336,200	288,879	630,767	61,759,195
2039	34,867,852	10,011,494	17,970,580	290,923	643,382	63,784,232
2040	35,924,707	10,374,534	18,628,495	292,986	656,250	65,876,972
2041	37,013,599	10,750,848	19,310,827	295,067	669,375	68,039,716
2042	38,135,500	11,140,924	20,018,490	297,166	682,763	70,274,843
2043	39,291,412	11,545,270	20,752,432	299,284	696,418	72,584,815
2044	40,482,364	11,964,410	21,513,637	301,421	710,346	74,972,178
2045	41,709,420	12,398,890	22,303,128	303,577	724,553	77,439,568
2046	42,973,674	12,849,275	23,121,963	305,752	739,044	79,989,708
2047	44,276,253	13,316,152	23,971,243	307,946	753,825	82,625,420
2048	45,618,321	13,800,128	24,852,109	310,160	768,902	85,349,620
2049	47,001,073	14,301,835	25,765,744	312,394	784,280	88,165,326
2050	48,425,745	14,821,925	26,713,378	314,647	799,965	91,075,660
2051	49,893,605	15,361,077	27,696,287	316,921	815,965	94,083,854
2052	51,405,965	15,919,994	28,715,792	319,215	832,284	97,193,250
2053	52,964,173	16,499,407	29,773,267	321,529	848,930	100,407,305
2054	54,569,619	17,100,070	30,870,137	323,864	865,908	103,729,598
2055	56,223,736	17,722,769	32,007,880	326,220	883,226	107,163,832
2056	57,927,999	18,368,318	33,188,032	328,596	900,891	110,713,836
2057	59,683,929	19,037,560	34,412,183	330,994	918,909	114,383,575
2058	61,493,092	19,731,371	35,681,986	333,413	937,287	118,177,149
2059	63,357,103	20,450,658	36,999,156	335,854	956,033	122,098,803
2060	65,277,624	21,196,363	38,365,471	338,316	975,153	126,152,927
Average Annual Rate of Growth	**4.43%**	**5.26%**	**5.28%**	**0.99%**	**2.93%**	**4.72%**

Notes: (1) 2002 is latest complete fiscal year of reported cargo from Port records.
(2) 2010 is the Base Year of the study period.

Future Neobulk and Breakbulk Cargo Traffic
As shown in **Table A-5**, neobulk and breakbulk ("Other") cargo represent 2 to 3 percent of all tonnage handled at the Port. Lumber, steel reinforcing bars, and paper are examples of this type of cargo. As shown in **Table A-14**, these commodity types have experienced overall negative growth: 1990 to 2000, -4.29 percent; 1995 to 2000, -6.68 percent. However, imports for the period 1995 to 2000 had a positive compound annual growth rate, 11.07 percent. Many of these commodities are dependent on construction activity, which is dependent on population growth and the general level of business activity and expansion. As such, it is anticipated that future compound annual growth rate for neobulk and breakbulk cargo will be between 1 and 2 percent for imports, while no growth is predicted for exports. Because neobulk cargo and breakbulk cargo represent such a small portion of the overall cargo handled at the Port of Miami, they have an insignificant impact on current and future cargo and vessel traffic at the Port. Accordingly, for the analysis, neobulk cargo and breakbulk cargo are not analyzed separately, but are accounted for by including them in containerized cargo. Specifically, tonnage associated with these cargo types is accounted for in the projected future TEUs displayed in **Table A-19**. This is a reasonable simplification as more and more neobulk and breakbulk cargos are being shipped in containers. It should be noted that this procedure does not impact deepening benefits, as this cargo is not transported on draft-constrained vessels. However, vessels carrying this cargo would be part of the calculations for vessel delay reduction benefits.

Future Cruise Ship Passengers
It is assumed for this analysis that the compound annual growth rate for cruise ship passengers will be 2 percent, the same as the historical compound annual growth rate for the 10-year period, 1990 to 2000, displayed in Table A-13.

<u>Fleet</u>

Container Ships (Containerized Cargo)

Current Trade Routes and Vessel Itineraries

The trade routes and vessel itineraries were reviewed to identify general patterns for the container ships calling at Miami Harbor. For the European, Mediterranean, and Asian trade regions, the overall general itinerary pattern is that Miami Harbor is part of an itinerary in which it is not the originating port, nor is it the first or the last port of call. This pattern is generally true for the U.S. ports within the itineraries, but there are exceptions where Miami Harbor is the first, or the last U.S. port of call. The container ships are mainly foreign-flag, Panamax size, with a cargo capacity of 2,500- to 4,500-TEUs. These general vessel itineraries are generally applicable to the Latin American and Caribbean trade routes. However, in contrast to the European, Mediterranean, and Asian trade routes, Miami Harbor is the port of origin within the itinerary. The container ships are also mainly foreign-flag, but are smaller in size than those on the European, Mediterranean, and Asian trade routes. The maximum cargo capacity is 3,700 TEUs. Moreover, all cargo handled at the Port of Miami that is carried on Roll-on/Roll-off (Ro-Ro) vessels is traded within the Latin American and Caribbean regions.

European export cargo destined for the United States east coast ports is usually carried on container ships that typically call first at Halifax, Canada, or New York/New Jersey, United States. These container ships then call at ports along the U.S. east coast discharging import cargo and loading export cargo. With respect to Miami's position in the itinerary, at this time Charleston is typically the prior port of call. After calling at Miami, the itineraries vary.

If Gulf service is included, vessels call at New Orleans and/or Houston, then call at Freeport (Freeport Container Terminal, Grand Bahamas Island), or call at a U.S. East Coast port (Charleston or Savannah), from which they transit back to Europe with U.S. containerized cargo. Alternatively, after departing Miami, the container ships sail to U.S. Gulf ports (New Orleans and/or Houston), then call at ports in Mexico, like Vera Cruz or Alta Mira, then call at Freeport or a U.S. East Coast port prior to returning to Europe with U.S. and Latin American containerized cargo.

If Gulf service is not involved, the container ships tend to go from Miami directly to Europe or to Freeport, and then return to Europe.

In some cases, after calling at Miami, the container ships will call at Manzanillo International Terminal at Cristobal, Panama (Atlantic side of the Panama Canal). In this case, the itinerary is a world all-water itinerary in which European, U.S., and Latin American containerized cargo is shipped on the westbound transit and Asian, U.S., and Latin American containerized cargo is shipped on the eastbound transit. In this itinerary, for the westbound transit, the vessel sails from Europe to U.S. East Coast ports, then calls at Manzanillo International Terminal prior to transiting the Panama Canal. After transiting the canal, the vessel typically calls at Manzanillo, Mexico, before calling at a U.S. West Coast port, such as Long Beach. From the U.S. West port, the container ship sails to Asian ports at which it loads cargo prior to sailing east to U.S. West Coast ports. It then sails to Manzanillo, Mexico, transits the Panama Canal, then calls at U.S. East Coast Ports prior to returning to Europe.

Except for vessels that transit the Panama Canal, the only potential constraint to the efficient utilization of Post-Panamax container ships would be the depth at United States East Coast ports.

Container ships in the Mediterranean/United States East Coast Container Trade have itineraries that are similar to the itineraries in the European/United States East Coast Container Trade. There is one significant difference. Some of the Mediterranean itineraries are actually part of an Asia/Mediterranean/United States East Coast itinerary, which includes transiting the Suez Canal.

Since the vessels in the Mediterranean/U.S. East Coast trade do not transit the Panama Canal and since the Suez Canal has a maximum vessel draft of 56 feet, the only potential constraint to the efficient utilization of Post-Panamax container ships would be the depth at United States East Coast ports.

Asian containerized cargo arrives at United States East Coast ports on container ships that have either transited the Panama Canal or the Suez Canal. Container ships transiting the Suez Canal typically stop at Mediterranean ports; then continue on to United States East Coast ports (Asia/Mediterranean/United States East Coast itinerary). The alternative itinerary includes transiting the Panama Canal, where Miami Harbor is often the first U.S. East Coast port-of-call. Currently, container ships using the Panama Canal are limited in size to Panamax vessels. Without canal improvements, the only way to currently use Post-Panamax container ships is to transship cargo at the port of Balboa on the Pacific side of the canal, and/or transship cargo at the Manzanillo International Terminal on the Atlantic side. Containers would be transferred from the Post-Panamax container ships to either smaller vessels that can transit the canal or rail cars for land transshipment. However, there are plans to modify the locks and channel to accommodate Post-Panamax vessels. If funding is provided and an engineering solution is developed for expanding the fresh water supply required for the operation of the larger locks, it is estimated that the Panama Canal could be capable of handling Post-Panamax vessels by 2010.

Latin American and Caribbean trade represents a significant portion of Miami Harbor's cargo activity. Latin American trade includes ports in Mexico, Central and South America. The vessel itineraries in this trade form a pattern that is similar to those in the European, Mediterranean, and Asian trade routes, except that in some itineraries, Miami Harbor is the originating port. The typical pattern is for the container ships to combine calls at various U.S. East Coast ports and Latin American and/or Caribbean ports. Most often, a shipping company will have a separate itinerary for the west and east coasts of South America. The itineraries that involve the west coast of South America include a transit through the Panama Canal. Because of the relatively shallow harbor depths and the absence of landside gantry cranes at ports in Latin America and the Caribbean, the container ships usually have onboard cranes for cargo handling. Moreover, because of the site conditions at the ports and the onboard cranes, the container ships are smaller than those used in the European, Mediterranean, and Asian trade routes. Furthermore, the lack of landside gantry cranes is also the reason for the extensive use of Roll-on/Roll-off (RoRo) vessels, which carry trailers, as well as containers.

Trends

There are three containerized cargo industry trends: (1) the formation of partnerships among the shipping companies to share vessels to reduce available container slots on certain trade routes to increase rates, which have been depressed by excess capacity; (2) shipping companies consolidating their operations at a single port to reduce administrative and logistical costs; and (3) utilization of larger container ships to reduce unit transportation costs.

Shipping companies have been forming alliances and partnerships. For example, there is the Grand Alliance that includes NYK Line, Hapag-Lloyd, P&O Nedlloyd, and Orient Overseas Container Line (OOCL); the New World Alliance consists of Mitsui O.S.K. Lines, Neptune Orient Lines, and Hyundai Merchant Marine; the MSC-ACL that includes Mediterranean Shipping Company and Atlantic Container Line; and Cosco-Yang Ming-"K" Line that consists of China Ocean Shipping Company, Yang Ming Line, and Kawasaki Kisen Kaisha. The alliance between Maersk and Sealand worked so well that the companies merged.

In the partnerships, or alliances, the shipping companies operate under a Vessel Sharing Agreement (VSA). Under a VSA, the total number of container slots is distributed among the steamship companies. Each company pays for a fixed number of container slots. Thus, the cost of the container slots is the same whether full or empty containers are carried. These VSAs are designed to reduce the number of vessels deployed in a given trade region. The reduction in the number of available container slots increases rates, as the supply of slots is more in line with the demand for them.

Some shipping companies have been consolidating their operations at a single port to reduce administrative and logistical costs. A shipping company's announcement that it intends to develop a hub port generates keen competition among ports due to the long-term revenues generated by this business, even though significant infrastructure expenditures are usually required. For example, after months of negotiations, Maersk Sealand selected the port of New York/New Jersey as its North American East Coast hub in May 1999, disappointing the other final candidates: the ports of Baltimore, and Halifax, Canada.

The current world cellular container ship fleet and cellular container ships on order are displayed in **Table A-21** and **Table A-22**, respectively. To illustrate the trend toward the utilization of larger containerships, as of April 2001, 5000+ TEU container ships represented 4.01 percent of the world fleet; yet they represented almost 24.62 percent of the container ships on order. Moreover, there are no 7000+ TEU container ships in the world fleet, but there are six on order. It is anticipated that this trend toward the utilization of larger container ships will continue, and as such, the container ships deployed in the Atlantic trade will likewise increase in size. Hence, it is anticipated that in the future larger containerships will call at Miami Harbor; specifically, the current Panamax container ships will be replaced by Post-Panamax container ships.

As shown in **Table A-21** and **Table A-22**, there are 105 Post-Panamax (5000+TEU) container ships in the world cellular (containers only) containership fleet; and 82 are on order. There are 37 6000+ TEU container ships in the world fleet. Of the 37, Maersk Sealand owns and operates 21, which until recently were solely employed in the Europe-Asia trade, transiting the Suez Canal. In August 2002, Maersk Sealand began using SUSAN MAERSK-size (S-class) Post-Panamax container ships in an Asian/U.S. West Coast itinerary, calling at its new terminal at the Port of Los Angeles. The other 16 6000+ TEU container ships are owned and operated by companies like P&O Nedlloyd and Hapag-Lloyd. There are 44 6000+ TEU container ships on order. Even larger TEU container ships are anticipated: "Experts believe that ship sizes between 10000- and 12000-TEU can be anticipated in the future, although practical considerations seem to preclude an advance in the medium-term to drafts greater than 50 feet or 15.3 meters" (New Dimension for Hapag-Lloyd, Maritime Reporter/Engineering News, May 2001). Based on this trend toward larger container ships, Maersk Sealand's SUSAN MAERSK was selected for the design vessel for the economic analysis. The SUSAN MAERSK has 1,138-foot length over all (LOA), a maximum beam of 140.8 feet, and a maximum design draft of 47.6 feet. It has a beam that is approximately 35 feet greater than the current Maersk Sealand container ships calling at Miami Harbor.

As the larger container ships are deployed in a trade route, they replace the existing smaller ones, which are deployed in another trade route. The largest container ships are deployed in the East-West Atlantic and Pacific trades. As larger container ships replace those deployed in the East-West Atlantic and Pacific trades, the now smaller container ships are deployed in the North-South Atlantic trade, for example. An industry expert from one of the major shipping companies said in an interview that based on his company's container ship class development history, he expects 10000 TEU container ships to be deployed between Europe and a U.S. hub port by 2004. Drewry Shipping Consultants predict that 12000 TEU container ships will inter the East-West trade "during the later part of this decade (2008/2009), once the ports/terminal operating companies have made the necessary investments in new equipment, berths, etc to handle them" (Post-Panamax Containerships – The Next Generation, Drewry Insight, August 2001).

Given that so many Post-Panamax container ships are being built, it is assumed that Post-Panamax container ships will be deployed on the East-West Atlantic trade route, with calls at select "hub" U.S. East-Coast ports, before the base year (2010) of the Miami Harbor project; it is also assumed that some itineraries will include calls at select "non-hub" U.S. ports in the North-South trade. Based on current itineraries and the volume of cargo traffic at Miami Harbor, it is reasonable to assume that Miami Harbor will be part of the initial transition from Panamax to Post-Panamax container ships. Accordingly, it is assumed for this analysis that the Panamax container ships currently calling at Miami Harbor as part of the European, Mediterranean, and Asian trade will be gradually replaced by Post-Panamax container ships over the study period beginning prior to the base year (2010) of the study.

Containerized cargo in the U.S. East Coast/Far East trade can be transported by way of the Panama Canal or the Suez Canal. Because Post-Panamax container ships are too large to transit the Panama Canal, they would use the Suez Canal, which is the most cost effective alternative transportation route. For Post-Panamax container ships to use the Panama Canal route, the locks would have to be enlarged or transshipment at ports at each end of the Panama Canal would have to be used. Specifically, cargo would have to be transshipped at ports on the Atlantic and Pacific side of the Canal, Manzanillo and Balboa, respectively, if the size of the canal locks were not increased. The ports of Manzanillo and Balboa, Panama, have been developed for transshipment. Both have harbor depths and equipment to handle Post-Panamax container ships. For example, Manzanillo International Terminal currently has an access channel depth of 46 feet and six Post-Panamax rail mounted gantry cranes.

Most containerized cargo imported from Asia arrives at U.S. West Coast ports, such as Long Beach and Oakland, and is transshipped by rail or truck to various cities, including U.S. East Coast ones. The reason is time. For goods that are time sensitive in the market, such as clothing, transportation time is important. It takes about 5 days for goods to be shipped by rail from Los Angeles to Baltimore, while it takes roughly 13 days for the goods to be shipped via the Panama Canal.

However, the all-water route via the Panama Canal is less expensive than the intermodal (ship-rail/truck) route. For some shippers, price is taking charge over just-in-time inventory. Several developments have or are taking place that demonstrate that the Panama Canal is going to be a viable economic option for future containerized cargo transportation, including the utilization of Post-Panamax container ships.

The Panama Canal Commission is spending $1 billion to widen the Gaillard Cut, improve the locks and purchase more tugboats and electrical locomotives to pull the ships through the canal. This will increase the canal's capacity 20 percent by 2005.

Feasibility studies are to be completed by the end of 2002 for conceptual design of a new set of locks that would accommodate the next generation of Post-Panamax ships. If all goes smoothly, the canal authority expects its Post-Panamax locks to operate in 2010 (Agustin Arias, canal capacity project manager, Panama's Canal Holds Visions of New Growth, Waterway's new transportation and development projects to build legacy and economic future, by Aileen Cho in Panama, ENR, 7/30/2001).

A joint venture of Kansas City Southern and Mi-Jack Products has rebuilt the Panama Canal Railway. The railway parallels the canal connecting Cristobal on the Atlantic side and Balboa on the Pacific side. The 47.6-mile railway began service in November 2001. The two companies operate it under a contract with a 25-year renewal clause. The Panama Canal Railway is currently providing intermodal service for major steamship companies. Initially, the company expects to carry 75,000 containers a year between Cristobal and Balboa.

Major port management and steamship companies are investing in the port infrastructures at Balboa and Cristobal. Hutchinson Port Holdings Group, Hong Kong, won a 25-year concession contract in 1997 to operate Balboa and Cristobal ports. It has invested $140-million in cargo handling equipment, dredging, and landside improvements. Most of the investment ($110 million) is for Balboa. The channel and berths have been dredged to 42 feet (12.9 meters), and a new 20.7-acre (8.4-hectare) container storage area equipped with three Post-Panamax and six Panamax gantry cranes has nearly doubled port capacity to some 900,000 TEUs.

On the Atlantic side, Colon Container Terminal SA, a subsidiary of Evergreen Marine Corp., Taiwan, has invested $110 million in developing a marine terminal at Cristobal. The investments in cranes, expanded quay and container yard area are designed to increase the facility's capacity to about 1 million TEUs a year.

The Manzanillo International Terminal (MIT) at Cristobal on the Atlantic side, operated by Seattle-based Stevedores of America, has a channel depth of 46 feet, 6 Post-Panamax and 2 super Post-Panamax cranes for handling containers on the largest container ships in the world. It also has direct access to the Colon Free Zone (CFZ), which is the second-largest free zone after Hong Kong. The local operator of the Manzanillo International Terminal is looking at a possible second container terminal on the Pacific side, near Balboa.

In the future, it appears that the current three trade routes (ship-rail/truck, all-water via the Panama Canal and the Suez Canal) are viable options for the utilization of Post-Panamax container ships. However, based on discussions with shipping companies, the most likely use of Post-Panamax container ships is the all-water trade route using the Suez Canal. Although transshipment at the Panama Canal is possible for the U.S. East Coast/Far East trade, shippers felt that this option is less likely due to high transshipment costs. Moreover, due to the high cost to modify the Panama Canal locks and no clear source for the funds, they felt that modifying the locks to accommodate Post-Panamax container ships is highly unlikely for the foreseeable future. Thus, the analysis assumes that Panamax container ships will be transitioned to Post-Panamax container ships in the Suez Canal route only. Moreover, it is also assumed that the Panama Canal will continue to be used for the Far East trade during the study period. Thus, both canal routes are assumed to be utilized for the economic analysis: Panamax container ships using the Panama Canal and Post-Panamax container ships using the Suez Canal.

The only thing that is physically preventing the deployment of Post-Panamax container ships at Miami Harbor is an adequate size turning basin. The Lummus Island Turning Basin has been authorized, funded, and will be constructed prior to the base year. Its 1,500-foot radius is sufficient for turning the Post-Panamax container ship design vessel SUSAN MAERSK. The Ship Simulation verified this. Thus, it is assumed that Post-Panamax container ships will call in the without-project condition, prior to the base year. The depth of the Lummus Island Turning Basin will be commensurate with the existing project channel depth, 42 feet.

Roll-On/Roll-Off (Ro-Ro) Vessels (Trailer cargo)

As shown in **Table A-5** about 36 percent of all cargo tonnage (short tons) handled at the Port is transported in trailers. The trailers are carried on Ro-Ro vessels, which also carry a few containers. Lloyd's Register of Ships classifies 887 vessels as Ro-Ro Cargo Ships. The largest of these vessels have deadweights that range for 38,000 to 48,000 metric tons with design drafts that range from 35.4 feet to 40.2 feet, and container capacities that range from 2,025 to 2,833 TEUs. The typical draft is 38 feet. Lloyd's also has seven vessels classified as Container Ro-Ro Cargo Ships. The deadweight of the five largest ones is 51,648 metric tons; these vessels' design drafts are 38 feet, and their container capacity is 2,908 TEUs. With a project depth of 42 feet, these vessels have sufficient depth. It is anticipated that the current project depth at Miami Harbor will provide sufficient transit depth for Ro-Ro vessels in the future.

Cruise Ships (Passengers)

In the mid-1990s the largest cruise ship in terms of gross registered tons (GRT) was the QUEEN ELIZABETH II with 70,327 GRT. Today, 16 cruise ships have GRTs in excess of 70,000. Cunard's QUEEN MARY II, which is scheduled for completion in 2003, will be 150,000 GRT. Because of the trend toward larger cruise ships, the Royal Caribbean International's VOYAGER OF THE SEAS was selected as the design vessel for the study. It is 137,300 GRT, is 1,021 feet long, and has a beam of 156 feet and a design draft of 28.2 feet. This cruise ship, which is currently calling, is considered the largest cruise ship likely to call at Miami Harbor for the foreseeable future. Presently, Royal Caribbean International has two VOYAGER-class ships calling a Miami Harbor: the VOYAGER OF THE SEAS and the EXPLORER OF THE SEAS. The draft requirement of the design vessel does not present a problem. Modern cruise ships are designed with drafts that can be accommodated by the shallow depths at their ports-of-call. Even the QUEEN MARY II will have a design draft of only 32.8 feet. However, the QUEEN MARY II will be 1,131 feet long with a beam of 131 feet. Thus, the QUEEN MARY II is 110 feet longer than the VOYAGER OF THE SEAS, but its beam is 25 feet less. Because it is longer, and could potentially call, the SUSAN MAERSK container ship with a length of 1,138 feet and a beam of 141 feet was turned in the Main Channel Cruise Ship Turning Basin during the ship simulation. There were no problems with turning the large container ship.

Because of the growth in cruises, channel improvements, as well as the Dodge Island turning basin, are being considered for the Dodge Island Terminal Number 12 (south western side of Dodge Island). Starting in November 2001, Celebrity Cruise Lines' HORIZON will utilize this terminal. The HORIZON is 682 feet long, with a beam of 96 feet, and a draft of 24 feet. The design vessel for this project alternative is the CARNIVAL DESTINY, which is 893.5 feet long, with a beam of 116, and a draft of 27 feet.

Benefiting Fleet and Cargo

All vessels will benefit from proposed improvements that enhance vessel maneuverability, reduced transit times, and tug assists. But not all vessels and the cargo they carry will benefit from proposed deepening of the existing channel. The first step in identifying the beneficiaries of deepening the channel consisted of a review of the existing fleet calling at specific terminals. **Table A-21** shows the vessel types and their characteristics at the three general berthing areas within the Port. Also shown are the number of recorded calls and the range of the recorded static drafts (draft at dock) of the vessels that called in FY1999. This information was provided by the Biscayne Bay Pilots.

Table A-21: Existing Cargo Vessel Calls and Short Tons by Berth Areas FY 1999

Bay (Berth)	Location	Vessel Types	Vessel Size LOA Range (feet)	Maximum Design Draft (feet)	Recorded Static Draft Range at Berth FY 1999 (feet)	Total Number of Calls FY 1999 [1]	% of Total Calls	Total Short Tons FY 1999 [2]	% of Total Cargo
45 - 65W	Northwest Lummus Island	RO/RO & LO/LO	125 - 648	39.4	7 - 35.1	103	3.9%	259,354	3.7%
99 - 148	Southern Lummus Island	Container	266 - 965	44	9 - 40.3	1,644	61.5%	4,344,386	62.7%
	(Gantry Crane Berths)	RO/RO & LO/LO							
149 - 177	Southern Dodge Island	RO/RO & LO/LO	129 - 560	25.4	9.8 - 23.9	924	34.6%	2,326,632	33.6%
					Total	2,671		6,930,372	

[1] Source: Developed from daily Pilots Logs for FY 1999.
[2] Source: Developed from two separate monthly Miami-Dade Seaport Department reports for FY 1999: Trailer/Container Activity Report, and Daily Dock Report.

Roll-On/Roll-Off (Ro-Ro) and Lift-On/Lift-Off (Lo-Lo) vessels call at all three of the berthing areas, but are concentrated at Berths 45 to 65W located on the northwest side of Lummus Island on the Main Channel (36 feet deep) and Berths 149 to 177 located on the southern side of Dodge Island on the Fisherman's Channel (32 to 42 feet deep). Taking into consideration the design drafts of the vessels and the existing channel depths, vessels calling at these berths have sufficient channel depth. In contrast, the container ships calling at Berths 99 to 148 have design drafts up to 44 feet compared to the 42-foot Fisherman's Channel depth. Thus, depending on their typical loadings and underkeel clearance requirements, some of the large Panamax container ships could potentially benefit from deepening the shipping channel. Almost two-thirds of all vessels call at Berths 99 to 148, which have the Port's gantry cranes. A more detailed breakdown by vessel size (length overall, LOA) of the recorded static drafts for vessels that called at the "gantry-crane berths" (99 to 148) in FY 1999 is displayed in **Table A-22**.

One hundred percent of the containerized cargo handled at Berths 45 to 65W and 149 to 177 is moving in the Latin American and Caribbean trade. Berths 99 to 148 also handle cargo moving in these trade regions, some of which is transported in trailers. All European, Mediterranean, and Asian trade cargo is handled at the gantry-crane berths. No cargo within these trades is shipped by trailer. The larger Panamax container ships are currently utilized in these trades, and Post-Panamax container ships will only be used in these trades.

Thus, the channel-deepening benefit analysis focuses solely on containerized cargo moving in the European, Mediterranean and Asian trades, which will be solely handled at the gantry-crane berths (99 to 148), as the vessels in these trades are cellular container ships, that is, they do not have on-board cranes like those used in the Latin American and Caribbean trades due to the lack off gantry cranes at the ports.

With a channel depth of 42 feet at Miami Harbor, and assuming a minimum of 3 feet of underkeel clearance, a fully loaded Atlantic Class (=>950-foot LOA) container ship would have a light-loaded transit draft of 39 feet. As shown in Table A-22, the majority of these vessels had static (at dock) drafts ranging from 34 to 38 feet inbound, and 32 to 38 feet outbound, during 1999, but static drafts up to 41 feet were recorded. The typical static draft beyond 38 feet occurred for the range 38.1 to 39 feet.

Asian cargo currently transits the Panama Canal, which has a maximum draft restriction of 39 feet. Thus, vessels in this trade route would be expected to have a maximum transit draft of 36 feet, assuming 3 feet of underkeel clearance. For the European and Mediterranean trade routes, the depths of the U.S. East Coast ports would control inbound and outbound vessel drafts within itineraries that included Miami Harbor. The static drafts shown in **Table A-22** were recorded in 1999. At that time, U.S. East Coast ports had authorized depths ranging from 40 to 42 feet. Thus, the expected fully, but light, loaded transit draft would be between 37 to 39 feet, assuming 3 feet of underkeel clearance. As shown in **Table A-22**, many Atlantic Class vessels recorded the calculated maximum drafts. But, there were several calls with recorded static drafts between 32 and 35 feet. Therefore, some vessels arrived or departed Miami Harbor with transit drafts that were 1 to 3 feet less than their potential maximum transit drafts. This fact was taken into consideration when developing the "typical or most likely" applied maximum transit drafts of benefiting Panamax and Post-Panamax container ship classes. See Fully-Loaded Transit Weight and Applied Maximum Transit Draft section and **Table A-33** for detailed fleet transit specifications.

Five classes of container ships were established for the analysis: three classes of Post-Panamax, one class of Panamax, and one Sub-Panamax container ship class. The three Post-Panamax classes are based on the world fleet that includes ships in service and those on order as displayed in **Table A-23** and **Table A-24**. A detailed description of the composite vessel in each class is found in **Table A-33**.

Based on the previously described vessel itineraries, generic vessel itineraries were developed for the purpose of estimated voyage costs for the European, Mediterranean and Asian trades. There are two itineraries for the Asian/U.S. East Coast trade: Panama Canal and Suez Canal itineraries. The Post-Panamax container ships would be utilized solely in the Suez Canal itinerary as only Panamax-size container ships can transit the Panama Canal.

The generic itineraries are based on a review of current ones. The depths are displayed for both the without- and with-project conditions. All major U.S. East Coast ports are either authorized for construction to 50 feet, like New York; or being studied with draft reports proposing depths ranging from 48 to 50 feet, like Norfolk Harbor for which a 50-foot channel is recommended. Construction schedules have completion dates ranging from before to after the base year of the Miami Harbor project (2010).

A 50-foot channel depth has been authorized for New York/New Jersey Harbor with all channel construction completed in 2016, but all berthing areas deepened to 50 feet by 2005. Deepening the container-ship berths to 50 feet in 2005, significantly before all channel deepening to 50 feet is completed, demonstrates that tide will be used to increase the loading efficiency of the large container ships. Based on discussions with steamship companies, future itineraries that include Post-Panamax container ships will include the Port of New York/New Jersey due to the enormous hinterland market that it serves.

The December 2002 Draft Norfolk Harbor (Hampton Roads) Report recommends deepening the inbound channel to 50 feet by 2005. The outbound channel is already 50 feet deep. Thus, it is reasonable to assume that one or more of the major U.S. East Coast ports will be deepened to a depth of 50 feet with others ranging in depth from 48 to 50 feet by around the base year of the Miami Harbor project. Accordingly, for the economic analysis the midpoint of the anticipated range is assumed for the controlling depth at U.S. East Coast ports within the trade itineraries, or 49 feet. The prevalent port depth at European and Far East ports is 15 meters or 49.2 feet. Thus, selecting 49 feet for a controlling depth for U.S. East Coast ports is consistent foreign ports within the trade itineraries.

The itineraries are displayed in **Table A-25**.

These general assumptions and parameters were utilized to focus the detailed benefits analysis, which is contained in the following section: BENEFIT ESTIMATION PROCEDURES/ASSUMPTIONS/PARAMETERS.

Table A-22: Static Vessel Drafts at Gantry Berths by Length Overall (LOA)

Vessel LOA (feet)		Static Vessel Draft at Gantry Crane Berths for Each Transit per Call (feet) * (MLLW)															
		>42	41.1 - 42	40.1 - 41	39.1 - 40	38.1 - 39	37.1 - 38	36.1 - 37	35.1 - 36	34.1 - 35	33.1 - 34	32.1 - 33	31.1 - 32	30.1 - 31	29.1 - 30	<=29	Total Transits
>=951	Inbound	0	0	1	1	7	14	38	19	16	3	0	0	0	0	0	99
	Outbound	0	0	0	2	8	16	14	8	8	15	17	9	2	0	0	99
	Total	0	0	1	3	15	30	52	27	24	18	17	9	2	0	0	198
901 - 950	Inbound	0	0	0	0	0	3	8	11	2	1	2	0	0	0	0	27
	Outbound	0	0	0	0	0	0	2	3	3	7	7	4	0	1	0	27
	Total	0	0	0	0	0	3	10	14	5	8	9	4	0	1	0	54
851 - 900	Inbound	0	0	0	0	0	0	0	1	3	4	2	1	0	0	0	11
	Outbound	0	0	0	0	0	0	0	1	2	4	4	0	0	0	0	11
	Total	0	0	0	0	0	0	0	2	5	8	6	1	0	0	0	22
801 - 850	Inbound	0	0	0	1	2	2	3	12	10	14	11	8	5	6	5	79
	Outbound	0	0	0	0	0	3	3	6	1	8	11	16	6	10	12	76
	Total	0	0	0	1	2	5	6	18	11	22	22	24	11	16	17	155
751 - 800	Inbound	0	0	0	0	1	2	0	1	4	1	3	1	3	2	0	18
	Outbound	0	0	0	0	0	1	1	2	0	1	0	1	3	3	3	15
	Total	0	0	0	0	1	3	1	3	4	2	3	2	6	5	3	33
701 - 750	Inbound	0	0	0	0	4	2	4	1	1	5	2	5	1	0	3	28
	Outbound	0	0	0	0	0	1	3	3	0	5	4	4	4	1	3	28
	Total	0	0	0	0	4	3	7	4	1	10	6	9	5	1	6	56
651 - 700	Inbound	0	0	0	0	3	3	3	9	5	15	19	25	25	18	74	199
	Outbound	0	0	0	0	0	0	0	0	6	14	26	25	28	23	77	199
	Total	0	0	0	0	3	3	3	9	11	29	45	50	53	41	151	398
601 - 650	Inbound	0	0	0	0	0	0	0	2	2	1	6	8	8	14	49	90
	Outbound	0	0	0	0	0	0	0	0	1	3	7	4	8	18	48	89
	Total	0	0	0	0	0	0	0	2	3	4	13	12	16	32	97	179
551 - 600	Inbound	0	0	0	0	0	0	0	0	4	3	8	7	13	40	163	238
	Outbound	0	0	0	0	0	0	0	2	3	0	13	17	10	37	154	236
	Total	0	0	0	0	0	0	0	2	7	3	21	24	23	77	317	474
501 - 550	Inbound	0	0	0	0	0	0	0	0	0	0	1	7	8	8	83	107
	Outbound	0	0	0	0	0	0	0	0	0	0	2	9	7	18	68	104
	Total	0	0	0	0	0	0	0	0	0	0	3	16	15	26	151	211
451 - 500	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	1	132	133
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	2	128	130
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	3	260	263
401 - 450	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	1	111	112
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	1	109	110
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	2	220	222
351 - 400	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117	117
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	115	115
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	232	232
301 - 350	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	173	173
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	176	176
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	349	349
250 - 300	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	214	214
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	215	215
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	429	429
	All Inbound	0	0	1	2	17	26	56	56	47	47	54	62	63	90	1124	1645
	All Outbound	0	0	0	2	8	21	23	25	24	57	91	89	68	114	1108	1630
	All Total	0	0	1	4	25	47	79	81	71	104	145	151	131	204	2232	3275

* Source: Biscayne Bay Pilots Logs for FY 1999. Note: Odd number of calls is due to the outbound or inbound transit occurring prior to or after the fiscal year.

Table A-23: World Container Ship Fleet April 2001[1]

TEU Capacity Range[2]	Total Number of Containerships	Number of U.S. Flag	Average TEU Capacity	Average Gross Registered Tons[3]	Average Net Registered Tons[4]	Average Deadweight (Metric Tons)[5]	Average Length Overall (Feet)	Average Length Between Perpendiculars (Feet)	Average Extreme Breadth (Feet)	Average Maximum Draft (Feet)	Average Speed (Knots)[6]	Average Date of Build	% of Total Containerships
7000-7499	0	0											0.00%
6500-6999	5	0	6,696	80,884	48,436	87,351	983.9	932.5	140.5	45.9	24.5	1,999	0.19%
6000-6499	32	0	6,349	84,086	44,128	93,250	1,070.2	1,021.3	137.4	46.8	24.9	1,998	1.22%
5500-5999	35	0	5,614	66,247	34,431	66,657	912.3	867.8	131.5	44.7	25.6	1,999	1.34%
5000-5499	33	0	5,283	66,751	32,437	66,285	918.7	871.1	133.3	44.6	24.9	1,998	1.26%
4500-4999	66	13	4,725	57,350	26,624	64,664	952.1	911.1	113.2	43.4	23.3	1,995	2.53%
4000-4499	99	5	4,189	51,077	27,578	58,931	940.3	891.4	108.8	42.5	24.0	1,995	3.79%
3500-3999	96	4	3,766	46,012	22,338	51,103	891.6	848.6	105.8	40.7	23.4	1,993	3.67%
3000-3499	137	7	3,239	40,336	18,339	45,138	821.3	774.8	105.8	39.2	21.9	1,992	5.24%
2500-2999	178	12	2,746	36,439	16,430	40,775	760.9	716.6	105.1	38.8	21.5	1,989	6.81%
2000-2499	231	10	2,247	29,264	12,521	33,724	685.0	644.7	101.2	37.3	20.3	1,991	8.84%
1500-1999	362	17	1,699	21,026	9,845	25,507	614.9	575.9	92.2	34.1	19.7	1,992	13.85%
1000-1499	464	16	1,190	15,820	7,276	18,957	560.2	523.8	84.6	30.8	18.6	1,990	17.76%
500-999	471	2	718	9,350	4,470	11,397	457.3	424.3	71.5	26.4	16.8	1,990	18.03%
<500	404	0	301	4,359	2,055	5,479	351.8	324.4	57.0	20.0	14.5	1,985	15.46%
Total	2,613	86											100.00%

[1] Source: Lloyd's Register of Ships CD ROM (April 2001). Includes only fully containerized ships. Not included are general cargo ships and Roll-On/Roll-Off vessels that also carry containers.
[2] TEU: Twenty-Foot Equivalent Unit. Container 20 feet long, and approximately 8 feet high and wide.
[3] Gross Tonnage is the capacity in cubic feet of the spaces within the hull, and of the enclosed spaces above the deck available for cargo, stores, fuel, passengers and crew, divided by 100. Thus, 100 cubic feet of capacity is equivalent to 1 gross ton.
[4] .Net tonnage is derived by deducting from gross tonnage spaces used for the accommodation of master, officers, crew, navigation, and propelling machinery.
[5] Deadweight is the weight in metric tons of cargo, stores, fuel, passengers and crew carried by the ship when loaded to her maximum summer loadline.
[6] Knot: 1 nautical mile per hour = 1.151 statute miles per hour. One nautical mile = 6,076 feet; and one statute mile = 5,280 feet.

Table A-24: Container Ships On Order April 2001[1]

TEU Capacity Range [2]	Total Number of Containerships	Number of U.S. Flag	Average TEU Capacity	Average Gross Registered Tons [3]	Average Net Registered Tons [4]	Average Deadweight (Metric Tons) [5]	Average Length Overall (Feet)	Average Length Between Perpendiculars (Feet)	Average Extreme Breadth (Feet)	Average Maximum Draft (Feet)	Average Speed (Knots) [6]	Average Date of Build	% of Total Containerships
7000-7499	6	0	7,267	86,333	NA	99,833	1,053.1	1,010.5	140.4	47.6	NA	2002	1.80%
6500-6999	9	0	6,643	74,656	NA	79,400	984.4	938.9	134.5	45.5	NA	2001	2.70%
6000-6499	29	0	6,293	76,163	46,427	80,322	1,003.0	979.3	135.4	45.2	NA	2002	8.71%
5500-5999	32	0	5,611	66,434	24,167	65,247	912.1	866.0	131.6	44.6	NA	2002	9.61%
5000-5499	6	0	5,283	65,500	NA	69,229	918.6	NA	130.6	NA	NA	2002	1.80%
4500-4999	6	0	4,800	55,000	NA	62,740	964.6	NA	105.6	44.3	NA	2002	1.80%
4000-4499	51	0	4,207	45,644	21,568	53,522	900.3	853.4	105.8	41.4	NA	2002	15.32%
3500-3999	9	0	3,713	39,900	NA	50,200	844.0	804.6	105.6	41.0	NA	2001	2.70%
3000-3499	20	0	3,140	33,795	14,350	40,395	727.0	689.0	105.9	39.3	NA	2002	6.01%
2500-2999	45	1	2,615	27,379	13,107	33,514	686.1	642.3	102.6	36.9	NA	2002	13.51%
2000-2499	37	0	2,423	25,907	11,997	32,433	973.2	631.3	98.1	36.3	NA	2002	11.11%
1500-1999	23	0	1,683	17,543	8,192	22,394	607.6	566.1	86.8	31.5	NA	2002	6.91%
1000-1499	31	0	1,172	12,816	5,378	15,993	515.5	484.2	80.7	29.9	NA	2002	9.31%
500-999	26	0	792	9,719	2,873	10,188	428.4	405.4	72.7	26.3	NA	2002	7.81%
<500	3	0	391	3,760	1,731	5,327	NA	NA	NA	NA	NA	2001	0.90%
Total	334	1											100.00%

[1] Source: Lloyd's Register of Ships CD ROM (April 2001). Includes only fully containerized ships. Not included are general cargo ships and Roll-On/Roll-Off vessels that also carry containers. Not all ship characteristics are available at this time. Those that are not available are noted with NA.

[2] TEU: Twenty-Foot Equivalent Unit. Container 20 feet long, and approximately 8 feet high and wide.

[3] Gross Tonnage is the capacity in cubic feet of the spaces within the hull, and of the enclosed spaces above the deck available for cargo, stores, fuel, passengers and crew, divided by 100. Thus, 100 cubic feet of capacity is equivalent to 1 gross ton.

[4].Net tonnage is derived by deducting from gross tonnage spaces used for the accommodation of master, officers, crew, navigation, and propelling machinery.

[5] Deadweight is the weight in metric tons of cargo, stores, fuel, passengers and crew carried by the ship when loaded to her maximum summer loadline.

[6] Knot: 1 nautical mile per hour = 1.151 statute miles per hour. One nautical mile = 6,076 feet; and one statute mile = 5,280 feet.

Table A-25: Miami Harbor – Generic Round-trip Vessel Itineraries by Trade Route

Trade Route	Ports in Generic Itinerary [1]	Without-Project Depth (feet) [2]	With-Project Depth (feet) [4]	Mean Tide Range (feet) [5]	Round-trip Nautical Miles [6]
Europe/	Southampton, England	49.2	49.2	5.9	
U.S. East Coast	New York, U.S. [3]	50.0	50.0	4.6	3,169
	Other East Coast, U.S. [3]	48.0 to 50.0	48.0 to 50.0	5.2	600
	Miami, U.S.	42.0	43.0 to 50.0	2.5	420
	Southampton, England	49.2	49.2	5.9	3,866
					8,055
Mediterranean/	Valletta, Malta	50.6	50.6	1.3	
U.S. East Coast	New York, U.S.	50.0	50.0	4.6	4,181
	Other East Coast, U.S.	48.0 to 50.0	48.0 to 50.0	5.2	600
	Miami, U.S.	42.0	43.0 to 50.0	2.5	420
	Valletta, Malta	50.6	50.6	1.3	4,786
					9,987
Asia/					
U.S. East Coast	Hong Kong, China	49.2	49.2	8.2	
Panama Canal	*Panama Canal transit*	39.0	39.0	n.a.	
	Miami, U.S.	42.0	43.0 to 50.0	2.5	10,448
	Other East Coast, U.S.	48.0 to 50.0	48.0 to 50.0	5.2	420
	New York, U.S.	50.0	50.0	4.6	600
	Panama Canal transit	39.0	39.0	n.a.	
	Hong Kong, China	49.2	49.2	8.2	11,213
					22,681
Asia/					
U.S. East Coast	Hong Kong, China	49.2	49.2	8.2	
Suez Canal	*Suez Canal transit*	56.0	56.0	n.a.	
	Valletta, Malta	50.6	50.6	1.3	7,435
	Miami, U.S.	42.0	43.0 to 50.0	2.5	4,786
	Other East Coast, U.S.	48.0 to 50.0	48.0 to 50.0	5.2	420
	New York, U.S.	50.0	50.0	4.6	600
	Valletta, Malta	50.6	50.6	1.3	4,181
	Suez Canal transit	56.0	56.0	n.a.	
	Hong Kong, China	49.2	49.2	8.2	7,435
					24,857

[1] Generic trade-route vessel itineraries based on actual ones as published by steamship companies.

[2] Without-project channel depths are the same as the current channel depths, except for those ports with on-going or most likely future deepening construction projects (see footnote 3).

[3] A 50-foot channel depth has been authorized for New York/New Jersey Harbor with all channel construction completed in 2016, but all berthing areas deepened to 50 feet by 2005. Other U.S. East Coast ports (Norfolk, Charleston, Savannah, for example), are studying deepening to depths up to 50 feet. The December 2002 Norfolk Harbor (Hampton Roads) report recommends deepening the inbound channel to 50 feet by 2005. The outbound channel is already 50 feet. It is anticipated that other East Coast ports will be deepened to a project depth of 48 to 50 feet between 2006 and 2010.

[4] With-project channel depths under consideration for Miami Harbor are 43 to 50 feet. All other channel depths for ports and canals within the vessel itinerary remain the same as those in the without-project condition.

[5] "Tides and Tidal Datums in the United States," Special Report No. 7, U.S. Army Corps of Engineers, February 1981; and "Lloyd's Ports of the World," Lloyd's of London, 1997.

[6] "Distances Between Ports," Defense Mapping Agency Hydrographic/Topographic Center, 1993.

BENEFIT ESTIMATION PROCEDURES/ASSUMPTIONS/PARAMETERS

Cost Reduction Benefits

Benefits Analysis

This section describes the analyses performed in the estimation of cost reduction benefits for proposed channel improvements. The objectives of the proposed channel improvement alternatives include the reduction of transit times and costs for vessels maneuvering within Miami Harbor. Nearly all users of Miami Harbor will benefit from proposed improvements inasmuch as they enhance vessel maneuverability and reduce transit times and necessary tug assists. The paragraphs that follow describe key inputs and assumptions of the analysis and present estimated cost reduction benefits. And, as will be discussed in subsequent sections, additional benefits will accrue to select vessel classes with deepening improvements.

The benefits of channel improvements were estimated in terms of reductions in harbor transit times and consequent vessel delays. Transit times and transportation costs were estimated by analyzing the most likely condition in the absence of an improved channel at Miami Harbor, that is the without project condition, and the proposed channel improvement alternatives for each decade over the period 2010-2060. For this analysis, the alternatives were bundled to estimate cost reduction benefits. The following describes briefly the proposed channel improvement alternatives: widening the entrance channel, inner entrance channel between buoys 13 and 15, and the Fisherman's Channel to provide safe navigation for all vessels, particularly post-Panamax containerships; widening the Fisher Island turning basin to improve vessel access and reduce delays; extending the Dodge Island Channel to provide access to planned expanded cruise facilities; and constructing a turning basin at Dodge Island to accommodate the cruise ships using the channel. Five component sets, each comprising an individual component or several inseparable components, representing the without project condition and four channel improvement scenarios were analyzed:

Without Project Condition - Maintain existing channels; construct Lummus Island turning basin to a diameter of 1,500 feet.

Components 1C, 2A, and 5A - Widen the entrance channel, channel between buoys 13 and 15, and Fisherman's Channel;

Component 3B – Widen the Fisher Island Turning Basin;

Component 6 – Extend the Dodge Island Channel;

Component 6A – Construct the Dodge Island Turning Basin.

Incremental transit costs for the without project condition and each of the four proposed channel improvement component sets represent cost reduction benefits.

As discussed in previous sections, Maersk Sealand's SUSAN MAERSK was selected for the design vessel for the economic analysis. The SUSAN MAERSK has 1,138-feet length over all (LOA), a maximum beam of 140.8 feet, and a maximum design draft of 47.6 feet. It has a beam that is approximately 35 feet greater than the current Maersk Sealand container ships calling at Miami Harbor. The current widths of the entrance channel, channel between buoys 13 and 15, and the Fisherman's Channel are too narrow to allow the

SUSAN MAERSK to transit Miami Harbor safely and cost-effectively. The current channel configurations would necessitate an additional tug assistance and transit at a dead-slow speed.

The proposed improvement alternatives are necessary to accommodate the expected future fleet at Miami Harbor. Additionally, the proposed alternatives will alleviate delays resulting from turning basin use and one-way traffic restrictions and reduce transportation costs for nearly all users of Miami Harbor (note: cruise ships have priority berthing and pilotage because of tight schedules. As such, they do not experience delays). All commercial cargo vessels, regardless of size, however, experience vessel delays; and therefore, would benefit from widening of channels and turning basins, or similar improvements that result in improved maneuverability and reduced transit times.

The channel widening alternative is not intended to create two-way traffic for Post-Panamax or Panamax vessels. Rather widening creates an additional margin of safety that makes it possible for these vessels to traverse the project more expeditiously and fuel-efficiently and, in the case of Post-Panamax vessels, without extraordinary tug assistance. In addition, the widening helps reduce the surging effect on ships at dock along Fisherman's Channel. In the Biscayne Bay Pilots letter dated October 23, 1997, found in the Ship Simulation Modeling Report (Attachment B to Engineering Appendix B in Volume II of the Draft Miami Harbor Navigation Study General Reevaluation Report), the pilots state that the "...Lummus Island Cut just south of the gantry crane area should be widened. At the present time ships transiting this area pass extremely close to vessels docked at the gantry berths. This results in a "surging" effect on the ships at the dock. Also, all too frequently, we are encountering vessels docked at Lummus Island with their cranes swung outboard 90 degrees thereby blocking a portion of the channel."

According to one pilot's comments found at the end of the Ship Simulation Modeling Report after testing the proposed improvements (Attachment B to Engineering Appendix B in Volume II of the Draft Miami Harbor Navigation Study General Reevaluation Report). He states, "...Turning at Fisher Island is more expedient and potential surging of deep container vessels at the berths is minimized if not eliminated. For strong currents and depending on the location and number of deep draft vessels at the berths I would prefer the Lummus Island basin."

With Channel Improvements – The SUSAN MAERSK and other similarly sized Post-Panamax vessels traverse Miami Harbor at speeds of approximately 5-6 knots, with the assistance of 2 tugs. The transit to berth takes approximately 75 minutes. During this transit, the Post-Panamax vessels have exclusive use of the entrance channel and later Fisherman's Channel. Likewise, other large ships, e.g. Panamax, can traverse Miami Harbor at more optimal speeds (6-7 knots), resulting in reduced transit times.

Without project condition – The SUSAN MAERSK and other similarly sized Post-Panamax vessels traverse Miami Harbor as essentially "dead ships," pulled by 3 tugs at a speed of approximately 2-3 knots. The transit to berth takes nearly 2 hours. During this transit, the Post-Panamax vessels have exclusive use of the entrance channel and later

Fisherman's Channel. The narrow channel conditions also make it necessary for Panamax vessels to traverse the project at slower, less fuel-efficient speeds (4-5 knots versus 6-7 knots).

Three widening measures were combined into one alternative, because it is only with improvements to all three areas that the need for the third tug and less-than dead slow speed would be eliminated. With improvements, the container vessels would continue to light-load and require the assistance of two tugs, but could transit the channel at a more normal speed. The net impacts of the widening improvements are reductions in transit time and exclusive channel use of approximately 30 minutes per vessel, as well as elimination of the expense for the Post-Panamax vessels' third tug assistance.

A distinction needs to be made clear between delay benefits based on the reduction of "congestion" and the benefits claimed in the Miami Harbor economic analysis for channel widening improvements. The delays are caused by the interaction of vessels at the harbor. Delay type benefits can result from the reduction of inner harbor transit times and/or waiting times at the bar or at the berth due to conditions at a harbor. Improvements that result in benefits are the construction of a two-way transit channel and/or passing "lanes" and/or turning notches. At Miami Harbor, the outer and inner channels are restricted to one-way transits without or with the project improvements. Thus, the interaction of vessels is simplified, that is, an in-bound vessel(s) has to wait for the out-bound vessel to clear the bar. So, once the channel is clear, it's a straight "shot" to the berth. The proposed widening improvements are based on safety concerns raised by the Biscayne Bay Pilots Association with respect to groundings and passing container ships with their on-board cranes extended toward the channel as they load/unload at the berth using the landside gantry cranes. The widening alternatives address these concerns. However, the only benefits claimed are for efficiencies accruing to the Post-Panamax container ships. The widening of the channel at selected points results in removing safety restrictions for Post-Panamax container ships that will be implemented by the pilots in the without-project condition: reduced vessel speed (dead slow) and a third tug. The elimination of the one half hour of additional transit time and the third tug are not related to "congestion" at the Port. As stated, there is only one-way traffic. So, a vessel has to "clear" the bar before another can transit the channel. So, the one half hour of additional transit time for Post-Panamax container ships is strictly the time from the bar to the berth.

The primary source of data was derived from Miami Harbor's pilot logbooks. The data include detailed information on all aspects of vessel transits. For each vessel transiting Miami Harbor, a record is made in the pilot's log noting the vessel's characteristics, including transit date and time. Data records are made in the pilot's log upon entrance and exit of the harbor. An additional record is made if a pilot shift change occurs during the transit. The existing fleet characteristics are based on CY1999 pilot data.

Transit times for Miami Harbor navigation are largely a function of vessel speed. Variations in vessel speeds are due to vessel size and type and geographic limitations. The larger the vessel, the more difficult it is to maneuver, and therefore, the slower the transit speed. Restricted reaches along the channel also necessitate slower transit speeds. A survey of

Miami Harbor's pilots was conducted to elicit information on transit speeds by vessel class for each reach of the Miami Harbor navigation channel. Additionally, the pilots provided information on transit times based on experience by vessel type and destination berth.

Many berths share a common turning basin, which is generally located nearest the berths; therefore, a vessel in the turning basin obstructs channel entrance and egress for other users of the same turning basin. Nearly all vessels at Miami Harbor require the assistance of at least one tug; the additional width of the tug alongside the vessels increases the effective width of the vessel in the channel and constrains Miami Harbor to one-way traffic.

The berthing spaces previously enumerated in **Tables A-1** through **A-4** overstate the available capacity at Miami Harbor in that concurrent use of some adjacent berths is not possible and other adjacent berths must be combined to provide access for one large vessel. The width of the Fisherman's Channel constrains all commercial cargo traffic to one-way. The only passing that occurs involves small workboats and recreation craft. Vessels destined for berths on the Fisherman's Channel are delayed at the sea buoy, when another vessel is in the channel. Conversely, vessels departing Miami Harbor must wait at berth until the channel is cleared. According to Miami Harbor's pilots, channel delays exceeding one hour are not uncommon.

Vessels were divided into classes according to size and use. The vessel classifications describe the attributes of all vessel types that were analyzed. Vessel classifications were standardized for this effort and are summarized in **Table A-26**. The important characteristics of the existing vessel fleet are the dimensions and types of the vessels. Similarly, the commodities moving in and out of Miami Harbor were aggregated into commodity classes. For this effort, three commodity classes were identified: containers, Ro-Ro/general cargo, and passengers.

Table A-26. Vessel Class Definitions

Vessel Class Definitions		
Class	Type	Length
1	Container	LOA < 500
2	Container	LOA between 500 and 700
3	Container	LOA between 700 and 900
4	Container	Panamax
5	Container	Post-Panamax
6	Gen Cargo, Ro-Ro, Lo-Lo	LOA < 400
7	Gen Cargo, Ro-Ro, Lo-Lo	LOA between 400 and 600
8	Gen Cargo, Ro-Ro, Lo-Lo	LOA > 600
9	Passenger	LOA < 600
10	Passenger	LOA between 600 and 900
11	Passenger	Panamax
12	Passenger	Post-Panamax

Forecast commodity tonnage is displayed in **Table A-27**. As discussed in previous sections, the annual growth rates to be used for the 50-year study period for each of the general commodity groups (containers, 4.53 percent; Ro-Ro cargo, 4.53 percent; and passengers, 2.00 percent) are assumed to occur without or with any harbor improvements.

Table A-27. Forecast Commodity Tonnage

Forecast Commodity Tonnage Without Project/ With Project Conditions	2010	2020	2030	2040	2050	2060
Containers	9,058,295	16,827,157	30,565,148	42,247,460	58,394,870	80,713,985
Ro-Ro, Lo-Lo	5,095,291	9,465,276	17,192,896	23,764,196	32,847,114	45,401,616
Total	14,153,586	26,292,433	47,758,044	66,011,656	91,241,984	126,115,601
Cruise Passengers	4,183,511	5,099,676	6,216,477	7,577,851	9,237,357	11,260,287

Given forecast commodity traffic, future vessels calls were estimated. **Table A-28** displays forecast vessel calls at the port under the without project condition and the proposed channel improvement alternatives. As discussed in previous sections, the future fleet will include the addition of the SUSAN MAERSK and other post-Panamax containerships, as well as the continued arrivals of mega- cruise ships. Forecast commodity will be accommodated in the larger vessels in the future fleet, resulting in fewer vessels calls over the 50-year project life. This assumption was based on information obtained from Miami Harbor's shippers and was discussed in previous sections. It is important to note that the forecast future vessels calls are identical in the with and without project conditions (without deepening).

Table A- 28. Forecast Vessel Trips

Forecast Vessel Trips
Without/ With Project Conditions

Commodity	2010	2020	2030	2040	2050	2060
Containers	1,225	1,391	1,695	2,119	2,642	3,377
Ro-Ro, Lo-Lo	1,313	1,431	1,677	2,004	2,245	2,603
Cruise	1,177	1,224	1,278	1,366	1,525	1,690
Total	3,715	4,046	4,650	5,489	6,412	7,670

Methodology

Vessel operating costs by vessel class for FY2004 were obtained from the Institute for Water Resources (IWR). The costs represent daily operating costs for U.S. and foreign vessel classes engaged in trade at U.S. deep-draft ports and are specific for vessel flag, type, and size. The costs are published annually by IWR in an Economics Guidance Memorandum (EGM) and intended for use in Corps' planning studies. A representative vessel was selected for each vessel class and daily operating costs assigned accordingly, taking into consideration the distribution of domestic and foreign-flagged vessels within each class.

The delay reduction analyses for Miami Harbor were performed without the use of a congestion model. In the absence of a model, a reliable analysis was performed with the use of Excel spreadsheets, by employing similar logic. Each vessel call forecast for Miami Harbor was disaggregated into component movements, each with an associated estimated duration. A vessel call included the following components: 1) arriving at the sea buoy; 2) transiting to berth; 3) berthing; 4) departing the berth and Miami Harbor.

The project lent itself well to such analyses, given that the assumptions for the vessel fleet and traffic forecast were identical in the with- and without- project conditions. The vessel fleet composition is the same under the without- and with-project conditions for three reasons: (1) industry contact persons advised that when their steamship companies introduce Post-Panamax container ships into the European, Mediterranean, and Asian trades, they would continue to use "multi-porting" itineraries that would be similar to those currently in use; (2) if there were no physical constraints that prevent a Post-Panamax container ship from calling at a port, the Post-Panamax container ships would call even though a port's channel configuration may not provide the most efficient utilization of the larger vessels in the short-term, and (3) the Biscayne Bay Pilots Association advised that they would bring in the Post-Panamax container ships in the without-project condition using the current typical underkeel clearance of three feet, but at a significantly reduced speed (dead slow) and with an additional tug (three rather than two) assisting in the transit.

The Port of Miami did not have a turning basin of appropriate size to allow the Post-Panamax REGINA MAESK to call in 1999. With the construction of the Lummus Island Turning Basin in the without-project condition, there are no purely physical constraints preventing Post-Panamax container ships calling at Miami Harbor. Moreover, the pilots would take measures to reduce the risk of grounding the larger container ships: reduce the speed of the vessel and add a third tug.

Given economies in transportation, even a "light-loaded" Post-Panamax vessel results in a lower delivered cost per ton than that of a M-class vessel loaded to the same draft. So much so, that the costs of an additional tug assist and slower transit at Miami Harbor are preferred over the M-class vessel operating unencumbered at the project and on the same itinerary. Given that there are no physical constraints that exclude the S-class vessel from Miami Harbor and the additional transit costs are covered by its economic advantage, it is introduced in the without project condition. Therefore, inclusion of the S-class vessel represents optimization of the without project condition.

Given identical vessel calls in both scenarios, estimating the impacts of proposed improvements on the forecast vessel calls entailed focusing on / isolating only the areas where differences could occur ("areas," in this case, referring to vessel classes and/or components of the overall vessel transit times). In as much as the improvement alternatives removed constraints that contribute to vessel delays, benefits could be estimated for each future decade, with inner years interpolated.

Given the identical vessel fleet and future vessel calls at Miami Harbor in the with and without project conditions, detailed modeling of traffic was unnecessary with the following baseline assumptions:

1) Vessels would call at exactly the same berths with or without the project. The proposed improvements do not include additional berthing capacity.
2) Berthing time would be exactly the same with or without the project. The proposed improvements do not include enhancements to loading/unloading equipment that would not also be in place in a without project setting.
3) Vessels delayed at the sea buoy due to berthing capacity shortfalls (beyond the delays that are expected as the exiting vessels clear the project) are assumed to occur with or without the proposed improvements.
4) The precautions, in the form of slow transits for Panamax vessels, that the Biscayne Bay Pilots currently take, would continue and become more regulated as larger vessels are introduced with no corresponding channel improvements (without project condition).
5) Cruise ships have priority channel usage, and as such, do not experience delay.

The year 1999 was selected as a representative base year for analysis and forecasts. The future year (2010 through 2060) commodity tonnage volumes, vessel loadings, and distributions of vessel classes were extrapolated from pilot data and commodity traffic forecasts discussed in previous sections.

In the absence of modeling, it was still necessary to develop shipment lists for Miami Harbor. A critical input for any congestion model is the expected stream of vessel movements, or shipment list. The shipment list is an annual account of vessel movements specific to the arrival date and time, vessel type and size, commodity type and volume, and destination berth. Shipment lists are developed from an analysis of actual traffic patterns. Future year shipment lists are randomly generated from vessel traffic distribution patterns developed from historic data and increased at a rate commensurate with forecast growth in commodities. The important considerations are the number, types, and sizes of vessel expected to call at Miami Harbor over the life of the project. While the "no-model" method inevitably results in understated estimates of delay at Miami Harbor, it was nevertheless a reliable means of estimating the most-easily quantifiable sources of delay costs.

According to the Biscayne Bay Pilots' Association (BBPA), the transit method and resultant time for a Post-Panamax container vessel would differ greatly between the unimproved without project condition and the improved condition. The BBPA are an invaluable source of information on regarding vessel maneuvers in Miami Harbor. While acknowledging that there would be no physical constraints, the S-class vessel transit would be "tight," necessitating a reduced speed and additional tug assist. Thus given estimates of future vessel calls, which were identical with or without the project, expected delays and delay costs were calculated. Additionally, the estimates of future vessel calls determined the foregone need for a third tug assist. Beyond these estimates, additional delay would be expected to occur as vessels randomly interact with one another –delay that would be mitigated by a more efficient channel configuration. The 30-minute reduction per vessel in transit time translated into 30 additional minutes in the with project condition that the channel was available for use by other vessels, rather than obstructed by the S-class vessel's transit.

For each alternative and decade, transit times including assumed transit delays, were estimated by individual vessel movement. Excel spreadsheets were used to calculate transit time costs by vessel class for each forecast vessel trip, given hourly operating costs by vessel class. For example, to calculate the total transit time for the without project condition in 2010, an annual list of movements was constructed in an Excel spreadsheet. Each movement, given its unique vessel class, commodity type, and origin/destination berth, was assigned an estimated transit time. The transit time included the following components: arrival, berthing, departure, and delay. The Miami Harbors' pilot data, as well as interviews with pilots, provided valuable insights into these component times. **Table A-29** provides an example calculation of per trip incremental cost savings for the SUSAN MAERSK in 2010.

Table A-29. Miami Harbor Cost Reduction Analysis Example

Miami Harbor Cost Reduction Analysis Example Class 5 Containership, 2010		
	Without Project	With Improvements
Transit Time Inbound	1 Hr 48 Min	1 Hr 18 Min
Berth Time	18Hr	18Hr
Transit Time Outbound	71 Min	41 Min
Hourly Operating Cost - at Sea	$2,310	$2,310
Hourly Operating Cost - at Port	$1,259	$1,259
Subtotal Port Cost	$29,939	$27,629
Total Vessel Calls	3,715	3,715
Hourly Arrival Rate*	0.85	0.85
Probability of Encounter	0.72	0.72
Expected Delay Time**	51 Min	30 Min
Expected Delay Cost	$1,964	$1,155
No. of Tugs	3	2
Tug Cost (@ $1,400/hour)	$4,200	$2,800
Total Port Cost	$36,102	$31,584
Incremental Savings Per Call		$4,519

* Annual vessel calls per hour, assuming that with each vessel call there are two legs, or trips (inbound and outbound).

** Expected delay is a function of forecast annual vessel trips. The square of the expected hourly arrival rate represents the probability of a vessel encounter in the channel. Given the one-way traffic constraint, one vessel must yield, and is, therefore, delayed. The delay is set equal to the vessel outbound transit time, and the expected delay time is the product of the outbound transit time and the probability of vessel encounter.

Similar estimates for 2010 were developed for each of the vessel classes and all of the improvement alternatives. The total transit times for the improvement alternatives were compared to the without project condition estimate for each decade. Excel spreadsheets were used to estimate average annual transit costs for each alternative (transit costs between decadal points were interpolated). Incremental transit costs for the without project condition and the improvement alternatives represent cost reduction benefits.

The following summarizes the assumptions for three of the cost reduction benefit alternatives (the fourth, or the Dodge Island Channel Extension, is discussed in the section entitled "Cruise Ship Benefits"):

1). Widening entrance channel, buoys 13-15 and Fisherman's channel - In the absence of improvements in Miami Harbor, the SUSAN MAERSK and similarly-sized vessels, would need to light-load and transit the channel with the assistance of three tugs at a less than dead-slow speed. Consequently, the transit would be 30 minutes slower than normal. Three tug assists represent one additional tug assist over normal operating conditions. The third tug assist would be necessary through each of the three widening components. For example, in the absence of the outer entrance channel flare, a third tug assist would be necessary to allow safe transit of the SUSAN MAERSK or similarly sized vessel. The three widening alternatives were combined into one system, because it is only with improvements to all three areas that the need for the third tug and less-than dead slow speed would be eliminated. The container fleet distribution would change over time, eventually composed mainly of S-class (Post-Panamax) vessels in the Far East and European trades. With improvements, the container vessels would continue to light-load and require the assistance of two tugs, but could transit the channel at a more normal speed. The incremental savings are the foregone costs of the third tug assist and reduced transit time. (input from Biscayne Bay pilots and Coastal Tug and Barge).

2). Widening Fisher Island Turning Basin - In the absence of improvements, Post-Panamax vessels calling at Miami are constrained to use of the Lummus Island turning basin only, resulting in additional transit time and delays for vessels berthing closest to the Fisherman's Channel entrance. With improvements, vessels have the option of turning before or after berthing. Pilots will have more flexibility to manage traffic and minimize delays within Miami Harbor. The incremental savings are the reduced transit times and delays for vessels transiting and berthing on Fisherman's channel.

3). Constructing Dodge Island Turning Basin - In the absence of improvements, cruise ships on the south pier would use the Lummus Island turning basin for maneuvering. Given the priority of cruise ships in Miami Harbor, such use would interfere with commercial cargo operations and result in delays for cargo vessels. With improvements, the cruise ships would have an exclusive turning basin. The incremental savings are the foregone interference and delay costs for cargo vessels transiting Fisherman's channel. The interference costs take into account the cruise ships schedule and probability of being delayed.

Cruise Ship Benefits

In analyzing the benefits of the Dodge Island Channel extension, a different technique was used. According to guidance developed by IWR, benefits associated with cruise ships from harbor improvements could accrue from three sources: 1) existing vessels using a harbor under without-project conditions operate more efficiently in that same harbor under with-project conditions; 2) vessels using one harbor under without-project conditions transfer to the improved harbor under with-project conditions; and 3) new vessels (larger, with more amenities) begin using a harbor under with-project conditions that they did not use under without-project conditions. Benefits could accrue to both vessel operators and passengers under each of the three scenarios.

The difficulty in estimating cruise ship benefits lies in the fact that cruise ships are unique -- ships of the same class cannot be compared to one another when they operate on differing itineraries; likewise differing ships operating on the same, or nearly the same itineraries are not comparable. The comparisons are made more difficult given that the cruise ship companies are not forthcoming with financial information that could be used to estimate daily operating costs or indicate individual vessel performance

Cruise companies measure their vessels' performance in terms of "yield," that is net income per passenger cruise day. A passenger cruise day is one passenger sailing for a period of one day. For example, one passenger sailing on a one-week cruise is seven passenger cruise days. Each vessel within a company's fleet for a given itinerary and season has a unique yield, or profitability. Newer, larger ships tend toward greater levels of profitability, due to economies of scale in provisioning and staffing, as well as increased revenue-generating opportunities from the larger passenger population. Given that the newest mega-ships are destinations in themselves, the income generated per passenger day tends to exceed that of other ships in the fleet. Certain itineraries are more popular, and consequently, more profitable.

A survey of cruise companies' financials provided an estimate of their respective yield or net income per passenger day. The limitation is that the yield is a gross figure for the company. Certainly yields vary quite a bit by vessel and itinerary. Cruise companies are not forthcoming with any specific information on the performance of individual vessels, or even classes of vessels. For this analysis, the financials of three companies were analyzed to develop an estimate of net income per passenger day -- Royal Caribbean Cruise Lines, P&O Princess Cruises, and Carnival Corporation.

These companies were selected because of their market dominance and current operations in Miami Harbor. An estimated net income per passenger day served as a proxy for estimating benefits for improvements at Miami Harbor. In the absence of improvements at Dodge Island, the cruise ship HORIZON would represent the maximum-sized/capacity vessel that could operate on the south pier. The vessel LOA is 727 feet and it passenger capacity is 1,798. With improvements, a larger vessel could operate in place of the HORIZON. The design vessel is the CARNIVAL DESTINY, which has an LOA of 893 feet and a passenger capacity of 2,642. **Table A-30** provides a comparison of the two cruise vessels. Given an identical itinerary, the CARNIVAL DESTINY could accommodate 150 percent of the number of passengers per trip. While additional passengers and a larger vessel result in higher costs per voyage, the opportunity to use the larger vessel on the same itinerary will result in increased income. The incremental benefits are the net incomes that accrue from the additional passengers. The annual reports of the major cruise lines were referenced to calculate a representative net income per passenger estimate. Over time, as the demand for cruises increase, additional vessels would be expected to berth on the south pier.

Table A-30. Miami Harbor Cruise Ship Comparison

Miami Harbor Cruise Ship Comparison Vessel Characteristics		
Item	*Horizon*	*Carnival Destiny*
Gross Registered Tons(GRT)	46,811	101,353
Net Registered Tons (NRT)	24,471	73,081
Deadweight Tonnage (DWT)	5,550	11,142
Length Overall (LOA)	683.8	895.1
Molded Breadth	96.3	116.7
Maximum Draft	24.4	27.3
Year Delivered	1990	1996
Passenger Capacity	1,798	2,642
Crew Capacity	641	1,040
Passenger/Crew Ratio	2.8	2.5
Service Speed	19.5	22.5

Assuming operation of a 7-day itinerary out of Miami Harbor, twenty-six weeks per year initially, increasing to 52-weeks annually, an estimated 41,000 passenger cruise days are lost when the HORIZON is employed in place of the CARNIVAL DESTINY. This loss translates into reductions in net income of more than $0.5 million per year.

Analysis Results

Incremental savings, by decade, for each of the channel improvement components sets are presented in **Table A-31**. Each of the components sets result in significant transportation cost reductions over the without project condition. The Channel Widening results in average annual savings ranging from $ 0.6 million in 2010 to $ 15.1 million in 2060. While the entrance channel widening provides safe navigation for the SUSAN MAERSK and other post-Panamax vessels, another advantage of the widened channel is that it allows smaller vessels (maximum 80' beam) to pass in the channel. These vessels make up a significant proportion of traffic at Miami Harbor. Given that cruise ships do not experience delays because of priority berthing and pilotage, no delay reduction savings were claimed for any of their vessel classes.

Table A-31. Annual Transportation Costs

Annual Transportation Cost Savings (Thousands of FY04 dollars)						
Alternatives	2010	2020	2030	2040	2050	2060
Without Project Condition	--	--	--	--	--	--
Widening (EC, Buoys 13-15, FC)	$431	$1,455	$3,585	$5,466	$9,663	$15,565
Fisher Island Turning Basin Widening	$250	$639	$1,515	$2,570	$4,416	$7,239
Dodge Island Channel Extension	$529	$1,058	$2,115	$2,115	$2,115	$2,115
Dodge Island Turning Basin Construction	$519	$650	$773	$943	$1,123	$1,339

Cost reduction benefits for the proposed channel improvement alternatives for Miami Harbor are summarized in **Table A-32**. The benefits reflect an interest rate of 5 5/8 percent and October 2003 price levels.

Table A-32. Miami Harbor Cost Reduction Benefits Summary

Miami Harbor Improvement Component Sets Benefit Summary (Thousands of FY04 dollars)		
Alternatives	Total Present Worth	Average Annual Benefits
Without Project Condition	--	--
Widening (Ent. Chan., Buoys 13-15, Fishmn's Chan.)	$47,343	$2,848
Fisher Island Turning Basin Widening	$21,483	$1,292
Dodge Island Channel Extension	$23,014	$1,384
Dodge Island Turning Basin Construction	$12,158	$731

Vessel Utilization Savings (Deepening Benefits)

Transportation costs for the without- and with-project conditions were estimated in one-foot increments to compute the National Economic Development (NED) benefits associated with the project deepening. The difference between the without- and with-project costs represents the benefits of the deepened channel. Cost efficiencies accrue as vessels are able to increase loading and reduce transits. It should be noted that delay reduction benefits that are discussed and calculated in Cost Reduction Benefits are not part of the costs used to estimate channel deepening benefits.

Total transportation costs are estimated using the specifications of each vessel (average deadweight, length overall, beam, design draft, speed, and so forth) along with estimated vessel transit characteristics, transit mileage, and vessel hourly operating cost data developed by the Corps' Institute for Water Resources (IWR).

Vessels Potentially Benefiting from Channel Deepening
The Miami Harbor Port Authority provided vessel call data for fiscal year 1999. These data were used to determine which vessels would benefit from deepening the Federal channel. Vessels currently calling that could benefit from a deeper channel at Miami Harbor are the Panamax Class vessels represented by the Maersk Sealand M-class container ships; vessels expected to call in the future that could benefit are Post Panamax container ships, like the design container ship, Susan Maersk, a Maersk Sealand S-class vessel. The analysis assumes that as the Post Panamax vessels begin to call at Miami Harbor, they will gradually replace smaller Sub Panamax vessels; in later years of the project, they will gradually replace some of the Panamax vessels. The analysis focused on these vessel classes and their proportion of the total cargo handled by the Port.

Vessel Specifications and Applied Lading Capacities
The vessel characteristics of all vessels calling during FY 1999 were obtained from Lloyd's Register of Ships, April 2001 CD-ROM.

The lading capacity by volume of the container vessel refers to the number of short tons of cargo and container boxes the vessel will carry when its TEU slots are full, given the weight of a typical container. The weight of a typical container incorporates the weight of the container, the percentage of empty containers, and the average weight of the cargo carried in a filled container.

Independent of its lading capacity by volume, the vessel's lading capacity by weight refers to the maximum number of tons of cargo it can hold regardless of whether its cargo area is volumetrically filled; it equals the deadweight of the vessel less the weight of its non-cargo components.

For a container vessel carrying many empty or light-weighted containers, the lading capacity by weight may exceed the actual capacity of the vessel. For a vessel carrying many full and heavy-weighted containers, the lading capacity by volume may exceed the actual capacity of the vessel. The applied lading capacity of the container vessel refers to its actual capacity given the percentage of empty containers it is carrying and the average weight of its filled containers; it equals the lesser of the lading capacity by weight and the lading capacity by volume.

Table A-33 shows the vessel specifications and applied lading capacities of the container vessels expected to benefit from channel deepening. For the Susan Maersk and the Madison Maersk, lading capacity by weight exceeds lading capacity by volume. This implies that the number of TEU containers these vessels are designed to carry, given the expected weight of the average container, is the factor that limits their capacities. The vessels could carry more cargo, but only by increasing the average loaded weight of the containers they carry.

For the other vessel classes shown, lading capacity by volume exceeds lading capacity by weight. The capacity of each vessel is reached with fewer containers than it is designed to carry, given the expected weight of the average container. This implies that the applied lading capacities shown for these vessels closely represent the true maximum cargo weight they are designed to carry. Increasing the average container weight would require reducing the number of containers carried to compensate.

Fully-Loaded Transit Weight and Applied Maximum Transit Draft
The stated design draft of a vessel is related both to its rated deadweight and to the densest cargo the vessel is designed to carry. The vessel's deadweight assumes both a cargo tonnage level based on the vessel's lading capacity by weight and that the vessel contains 100 percent of its fuel, stores, water, and crew capacity, plus any ballast the vessel is expected to carry. Accordingly, the design draft refers to the maximum possible draft of the vessel.

In contrast, a vessel's applied maximum transit draft is a more accurate prediction of the vessel's deepest draft when traversing a harbor because it is based on a lesser, more likely non-cargo deadweight and a cargo weight equal to the vessel's applied lading capacity. Fuel (bunkerage) represents about 80 percent of non-cargo deadweight; stores, water, and crew requirements together represent about 20 percent. The portion of the vessel's fuel, stores, water, and crew weight remaining upon the vessel's arrival at Miami Harbor is estimated to be two thirds of the full amount. A certain amount of ballast water will also be carried, based on design specifications provided by vessel owners. Adding the adjusted non-cargo weight to the adjusted cargo weight gives the total transit weight of the fully loaded vessel.

Specifically, the amount of weight a vessel carries drives its transit draft. Guidelines from IWR provide the gross cargo capacity of a vessel as a percentage of its deadweight. For example, (see Table A-33), the gross cargo capacity for the Regina Maersk is 94.2%, so the most cargo weight the vessel is able to carry is 79,999 short tons. IWR also supplies expected ballast as a percentage of deadweight, based on vessel type. For container vessels, the ballast assumption is 7.88%, so for the Regina Maersk, ballast is expected to weigh 6,690 short tons. A vessel carrying 94.2% of its deadweight in cargo and 7.88% of its deadweight in ballast would be expected to sail at its maximum, or design draft, because its transit weight is expected to at least match, if not exceed, its deadweight.

However, container vessels often sail at less than their design drafts because the average cargo weight carried per TEU slot is low enough that the TEU slots are accounted for—either by cargo-filled containers, empty containers, or no container—before maximum cargo by weight has been achieved. In this case, the vessel has "cubed out" because its lading capacity by volume is less than its lading capacity by weight.

Whether a vessel first cubes out or reaches its cargo capacity by weight depends on both the design of the vessel and conclusions concerning expected percentage of empty slots, percentage of empty containers carried, and short tons per filled container, which drive the calculation of average weight carried per TEU slot. For Miami Harbor, an analysis was conducted to determine the appropriate parameters to use in the determination of average weight carried per TEU slot. This analysis included (1) as mentioned, IWR data (Table IV-5, Adjustments For Estimating Actual Vessel Capacity, National Economic Development Procedures Manual Deep Draft Navigation, IWR Report 91-R-13, November 1991), (2) vessel capacity data from steamship companies, and (3) actual vessel call data from the Port's database.

The IWR factors (assumptions) for converting design capacity to maximum transit capacity were used as a starting point for the fleet calling at Miami Harbor, as they are based on a broad range of container vessels, under various conditions, which would be generally applicable over time. As a refinement, Maersk graciously provided a detailed breakdown of the deadweight for the design vessel, the SUSAN MAERSK: cargo deadweight, ballast, bunkers and miscellaneous stores tonnage. Maersk also provided the immersion factor as well as the average container weight (cargo and tare weight). The container weight represents an average weight for most of Maersk's services. This information was critical to the analysis as the design vessel class accrues the most benefits from the channel improvements over the 50-year study period.

The third set of data that was factored into the analysis to establish a maximum applied transit capacity and draft was the actual "static" drafts recorded at the Port of Miami by the Biscayne Bay Pilots Association in 1999. This information, which is displayed in Table A-22, reflects current vessel itineraries. As can be observed when comparing the static drafts in this table to the design and maximum applied transit drafts in Table A-33, the largest Panamax container ships (LOA > 950 feet) do not typically fully utilize their design drafts of 44 feet after taking into account underkeel clearance and tide use.

As shown in Table A-33, the maximum applied transit drafts of the ships representing each vessel class are set below their design drafts except for three exceptions (two Post-Panamax classes and the Sub-Panamax class) for reasons described above. It should be noted that the maximum applied transit draft of the design vessel class (SUSAN MAERSK), which will benefit most from the channel improvements, is set at 1.5 feet below its design draft. Thus, even though containerized cargo is forecasted to grow over time, this class of vessels is expected to typically draft less than its design draft.

The immersion rate is the number of tons stowed per inch of draft. Immersion rates are developed for each vessel using an equation provided for different vessel types by the Maritime Administration (MARAD) of the U.S. Department of Transportation. The key vessel characteristics are design draft, length between perpendiculars, maximum breadth, and service speed.

The difference between the total transit weight and the deadweight divided by the immersion rate produces the expected deviation from the design draft in inches. Applying this deviation to the design draft yields the applied maximum transit draft of the vessel, which corresponds to the expected draft of the fully loaded vessel on a typical arrival to or departure from Miami Harbor. In cases in which the total transit weight exceeds the deadweight, zero deviation from deadweight is used, so the calculated applied maximum transit draft equals the design draft.

Table A-33 shows the fully loaded transit weight and applied maximum transit drafts of the container vessels expected to benefit from channel deepening.

Table A-33: Vessel Specifications and Applied Lading Capacities of Benefiting Container Vessel Fleet at Miami Harbor

	Susan Maersk (Post-Panamax)	Regina Maersk (Post-Panamax)	Composite Other Post-Panamax	Madison Maersk (Panamax)	Zim Asia (Sub-Panamax)
Deadweight (Short Tons)	104,696	84,900	67,417	66,524	50,540
Length Between Perpendiculars	1,088	992	863	933	792
Extreme Breadth	140	141	132	106	106
Design Draft (Feet)	47.6	45.9	46.0	44.4	38.6
Speed (Knots per Hours)	24.6	25.0	25.5	24.0	21.7
Gross Cargo Capacity	95.5%	94.2%	93.3%	93.3%	92.3%
Lading Capacity by Weight (Short Tons)	100,011	79,999	62,869	62,036	46,639
TEU Capacity	6,418	6,418	5,340	3,922	3,429
Lading Capacity by Volume	88,008	88,008	73,222	53,781	47,021
Applied Lading Capacity (Short Tons)	88,008	79,999	62,869	53,781	46,639
Bunkerage, Stores, Water, Crew (Short Tons)	3,123	3,267	3,032	2,992	2,601
Ballast (Short Tons)	8,250	6,690	5,312	5,242	3,983
Fully Loaded Transit Weight	99,381	89,956	71,213	62,015	53,222
Block Plane Coefficient	0.66	0.62	0.59	0.67	0.65
Water Plane Coefficient	0.79	0.76	0.74	0.80	0.78
Immersion Rate (Short Tons per Inch)	320.22	257.20	203.68	190.78	159.11
Deviation from Design Draft (feet)	1.38	0.00	0.00	1.97	0.00
Applied Maximum Transit Draft	46.2	45.9	46.0	42.4	38.6
Fully Loaded Transit Depth Requirement	49.2	48.9	49.0	45.4	41.6

Underkeel Clearance

A sample of historical transit drafts of vessels calling at Miami Harbor were matched with actual tide elevations occurring at the times of transit. These data were assembled in spreadsheets and analyzed to identify the minimum underkeel clearance used by each vessel as it transited the channel. The analysis showed that the historical minimum underkeel clearance is at least three feet for Panamax container ships.

Maersk Sealand has a standard of 1.1 meters (3.6 feet) for underkeel clearance for its containerships when they are underway. A review of current practice for the Maersk Sealand Panamax Class (M-class) shows that they use at least three feet of underkeel clearance at the dock. Taking into consideration the Corps of Engineers channel design standard of three feet of underkeel clearance for hard bottom channels, the current actual practice of using at least three feet of underkeel clearance at the dock, and the Maersk Sealand standard of 3.6 feet of underkeel clearance while underway, three feet of underkeel clearance was used for the economic analysis for the large container ships. It should be noted that through a partnering agreement other shipping companies ship their containers on the Maersk Sealand vessels. So, with respect to Maersk Sealand vessels, the Maersk Sealand M-class and S-class container ships are considered generic; that is, they represent similar size container ships owned by other shipping companies.

Fully Loaded Transit Depth Requirement
The applied maximum transit draft of the vessel plus the appropriate underkeel allowance equals the fully loaded transit depth requirement of the vessel, which is shown for each container vessel class in **Table A-33**.

Vessel Itineraries
Trade routes for the benefiting vessels are discussed in a previous section entitled "Current Trade Routes and Vessel Itineraries." For benefit estimation, these trade routes were standardized into the following three trade routes: Far East, Mediterranean, and European.

Applicable Channel Constraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight of Vessel
A critical factor in the analysis is whether the drafts of the container ships calling at Miami Harbor are constrained by the channel depths at the previous and subsequent ports of call or by depths in canals such as the Suez Canal or the Panama Canal. The channel depths of ports within trade route itineraries are presented in **Table A-25**. The constraining channel depths of concern to each itinerary and vessel class are displayed in **Table A-34** through **Table A-43.**

The applied maximum transit depth, which is a function of the vessel and its trade route, is the greatest depth a vessel transiting Miami Harbor could utilize given its maximum transit draft and the constraints it faces at its port of origin or destination or required canal transit. Light loading by the vessel could be eliminated by additional increments of deepening at Miami Harbor as long as the applied maximum transit depth is greater than the without-project depth. The point at which the channel depth equals the applied maximum transit depth is the point at which the channel depth fully accommodates the vessel's needs; no additional depth is beneficial for that vessel.

The actual transit draft of the vessel is the lesser of the channel depth and the maximum transit depth, less the underkeel allowance. The deviation of the actual transit draft from the maximum transit draft applied to the immersion factor gives the amount of light loading necessary to accommodate the actual transit depth. Subtracting the light-loaded tonnage from the applied lading capacity results in the actual short tons carried by the arriving or departing vessel. This actual lading increases as the channel is deepened until light loading has been eliminated.

Adding the actual lading at each channel depth to the estimated short tons of crew, stores, water, bunkerage, and ballast carried by the transiting vessel (see **Table A-33**) produces the expected total transit weight of the vessel at each channel depth.

Tables A-34 to **A-43** show the channel or canal constraint, the applied maximum transit depth, the actual transit draft by project depth, lading in short tons by project depth, and the total transit weight of the vessel by project depth of each vessel class for each trade route for the inbound and outbound transits at Miami Harbor.

Table A-34: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Susan Maersk at Miami Harbor

	Susan Maersk (Post-Panamax) - Far East Trade Region	**Susan Maersk (Post-Panamax) - Europe Trade Region**	**Susan Maersk (Post-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	Hong Kong, China	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.2	49.0	49.0
Applied Maximum Transit Depth	49.2	49.0	49.0
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	46.0	46.0	46.0
Actual Transit Draft at 50 Feet	46.2	46.0	46.0
Lading at 42 Feet	60,391	60,391	60,391
Lading at 43 Feet	64,234	64,234	64,234
Lading at 44 Feet	68,076	68,076	68,076
Lading at 45 Feet	71,919	71,919	71,919
Lading at 46 Feet	75,762	75,762	75,762
Lading at 47 Feet	79,604	79,604	79,604
Lading at 48 Feet	83,447	83,447	83,447
Lading at 49 Feet	87,290	87,290	87,290
Lading at 50 Feet	88,008	87,290	87,290
Total Transit Weight - 42 Feet	71,764	71,764	71,764
Total Transit Weight - 43 Feet	75,607	75,607	75,607
Total Transit Weight - 44 Feet	79,450	79,450	79,450
Total Transit Weight - 45 Feet	83,292	83,292	83,292
Total Transit Weight - 46 Feet	87,135	87,135	87,135
Total Transit Weight - 47 Feet	90,978	90,978	90,978
Total Transit Weight - 48 Feet	94,820	94,820	94,820
Total Transit Weight - 49 Feet	98,663	98,663	98,663
Total Transit Weight - 50 Feet	99,381	98,663	98,663

Table A-35: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Susan Maersk at Miami Harbor

	Susan Maersk (Post-Panamax) - Far East Trade Region	**Susan Maersk (Post-Panamax) - Europe Trade Region**	**Susan Maersk (Post-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	46.0	46.0	46.0
Actual Transit Draft at 50 Feet	46.0	46.2	46.2
Lading at 42 Feet	60,391	60,391	60,391
Lading at 43 Feet	64,234	64,234	64,234
Lading at 44 Feet	68,076	68,076	68,076
Lading at 45 Feet	71,919	71,919	71,919
Lading at 46 Feet	75,762	75,762	75,762
Lading at 47 Feet	79,604	79,604	79,604
Lading at 48 Feet	83,447	83,447	83,447
Lading at 49 Feet	87,290	87,290	87,290
Lading at 50 Feet	87,290	88,008	88,008
Total Transit Weight - 42 Feet	71,764	71,764	71,764
Total Transit Weight - 43 Feet	75,607	75,607	75,607
Total Transit Weight - 44 Feet	79,450	79,450	79,450
Total Transit Weight - 45 Feet	83,292	83,292	83,292
Total Transit Weight - 46 Feet	87,135	87,135	87,135
Total Transit Weight - 47 Feet	90,978	90,978	90,978
Total Transit Weight - 48 Feet	94,820	94,820	94,820
Total Transit Weight - 49 Feet	98,663	98,663	98,663
Total Transit Weight - 50 Feet	98,663	99,381	99,381

Table A-36: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Regina Maersk at Miami Harbor

	Regina Maersk (Post-Panamax) - Far East Trade Region	**Regina Maersk (Post-Panamax) - Europe Trade Region**	**Regina Maersk (Post-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	Hong Kong, China	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.2	49.0	49.0
Applied Maximum Transit Depth	48.9	48.9	48.9
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	45.9	45.9	45.9
Actual Transit Draft at 50 Feet	45.9	45.9	45.9
Lading at 42 Feet	58,703	58,703	58,703
Lading at 43 Feet	61,789	61,789	61,789
Lading at 44 Feet	64,876	64,876	64,876
Lading at 45 Feet	67,962	67,962	67,962
Lading at 46 Feet	71,048	71,048	71,048
Lading at 47 Feet	74,135	74,135	74,135
Lading at 48 Feet	77,221	77,221	77,221
Lading at 49 Feet	79,999	79,999	79,999
Lading at 50 Feet	79,999	79,999	79,999
Total Transit Weight - 42 Feet	68,660	68,660	68,660
Total Transit Weight - 43 Feet	71,747	71,747	71,747
Total Transit Weight - 44 Feet	74,833	74,833	74,833
Total Transit Weight - 45 Feet	77,919	77,919	77,919
Total Transit Weight - 46 Feet	81,006	81,006	81,006
Total Transit Weight - 47 Feet	84,092	84,092	84,092
Total Transit Weight - 48 Feet	87,179	87,179	87,179
Total Transit Weight - 49 Feet	89,956	89,956	89,956
Total Transit Weight - 50 Feet	89,956	89,956	89,956

Table A-37: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Regina Maersk at Miami Harbor

	Regina Maersk (Post-Panamax) - Far East Trade Region	**Regina Maersk (Post-Panamax) - Europe Trade Region**	**Regina Maersk (Post-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	45.9	45.9	45.9
Actual Transit Draft at 50 Feet	45.9	45.9	45.9
Lading at 42 Feet	58,703	58,703	58,703
Lading at 43 Feet	61,789	61,789	61,789
Lading at 44 Feet	64,876	64,876	64,876
Lading at 45 Feet	67,962	67,962	67,962
Lading at 46 Feet	71,048	71,048	71,048
Lading at 47 Feet	74,135	74,135	74,135
Lading at 48 Feet	77,221	77,221	77,221
Lading at 49 Feet	79,999	79,999	79,999
Lading at 50 Feet	79,999	79,999	79,999
Total Transit Weight - 42 Feet	68,660	68,660	68,660
Total Transit Weight - 43 Feet	71,747	71,747	71,747
Total Transit Weight - 44 Feet	74,833	74,833	74,833
Total Transit Weight - 45 Feet	77,919	77,919	77,919
Total Transit Weight - 46 Feet	81,006	81,006	81,006
Total Transit Weight - 47 Feet	84,092	84,092	84,092
Total Transit Weight - 48 Feet	87,179	87,179	87,179
Total Transit Weight - 49 Feet	89,956	89,956	89,956
Total Transit Weight - 50 Feet	89,956	89,956	89,956

Table A-38: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Composite Other Post-Panamax Container Vessels at Miami Harbor

	Composite Other Post-Panamax - Far East Trade Region	**Composite Other Post-Panamax - Europe Trade Region**	**Composite Other Post-Panamax - Mediterranean Trade Region**
Channel or Canal Restraint	Hong Kong, China	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.2	49.0	49.0
Applied Maximum Transit Depth	49.0	49.0	49.0
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	46.0	46.0	46.0
Actual Transit Draft at 50 Feet	46.0	46.0	46.0
Lading at 42 Feet	45,759	45,759	45,759
Lading at 43 Feet	48,204	48,204	48,204
Lading at 44 Feet	50,648	50,648	50,648
Lading at 45 Feet	53,092	53,092	53,092
Lading at 46 Feet	55,536	55,536	55,536
Lading at 47 Feet	57,980	57,980	57,980
Lading at 48 Feet	60,424	60,424	60,424
Lading at 49 Feet	62,869	62,869	62,869
Lading at 50 Feet	62,869	62,869	62,869
Total Transit Weight - 42 Feet	54,104	54,104	54,104
Total Transit Weight - 43 Feet	56,548	56,548	56,548
Total Transit Weight - 44 Feet	58,992	58,992	58,992
Total Transit Weight - 45 Feet	61,436	61,436	61,436
Total Transit Weight - 46 Feet	63,881	63,881	63,881
Total Transit Weight - 47 Feet	66,325	66,325	66,325
Total Transit Weight - 48 Feet	68,769	68,769	68,769
Total Transit Weight - 49 Feet	71,213	71,213	71,213
Total Transit Weight - 50 Feet	71,213	71,213	71,213

Table A-39: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Composite Other Post-Panamax Container Vessels at Miami Harbor

	Composite Other Post-Panamax - Far East Trade Region	**Composite Other Post-Panamax - Europe Trade Region**	**Composite Other Post-Panamax - Mediterranean Trade Region**
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	46.0	46.0	46.0
Actual Transit Draft at 50 Feet	46.0	46.0	46.0
Lading at 42 Feet	45,759	45,759	45,759
Lading at 43 Feet	48,204	48,204	48,204
Lading at 44 Feet	50,648	50,648	50,648
Lading at 45 Feet	53,092	53,092	53,092
Lading at 46 Feet	55,536	55,536	55,536
Lading at 47 Feet	57,980	57,980	57,980
Lading at 48 Feet	60,424	60,424	60,424
Lading at 49 Feet	62,869	62,869	62,869
Lading at 50 Feet	62,869	62,869	62,869
Total Transit Weight - 42 Feet	54,104	54,104	54,104
Total Transit Weight - 43 Feet	56,548	56,548	56,548
Total Transit Weight - 44 Feet	58,992	58,992	58,992
Total Transit Weight - 45 Feet	61,436	61,436	61,436
Total Transit Weight - 46 Feet	63,881	63,881	63,881
Total Transit Weight - 47 Feet	66,325	66,325	66,325
Total Transit Weight - 48 Feet	68,769	68,769	68,769
Total Transit Weight - 49 Feet	71,213	71,213	71,213
Total Transit Weight - 50 Feet	71,213	71,213	71,213

Table A-40: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Madison Maersk at Miami Harbor

	Madison Maersk (Panamax) - Far East Trade Region	**Madison Maersk (Panamax) - Europe Trade Region**	**Madison Maersk (Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	Panama Canal	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	39.0	49.0	49.0
Applied Maximum Transit Depth	39.0	45.4	45.4
Actual Transit Draft at 42 Feet	36.0	39.0	39.0
Actual Transit Draft at 43 Feet	36.0	40.0	40.0
Actual Transit Draft at 44 Feet	36.0	41.0	41.0
Actual Transit Draft at 45 Feet	36.0	42.0	42.0
Actual Transit Draft at 46 Feet	36.0	42.4	42.4
Actual Transit Draft at 47 Feet	36.0	42.4	42.4
Actual Transit Draft at 48 Feet	36.0	42.4	42.4
Actual Transit Draft at 49 Feet	36.0	42.4	42.4
Actual Transit Draft at 50 Feet	36.0	42.4	42.4
Lading at 42 Feet	39,159	46,027	46,027
Lading at 43 Feet	39,159	48,316	48,316
Lading at 44 Feet	39,159	50,606	50,606
Lading at 45 Feet	39,159	52,895	52,895
Lading at 46 Feet	39,159	53,781	53,781
Lading at 47 Feet	39,159	53,781	53,781
Lading at 48 Feet	39,159	53,781	53,781
Lading at 49 Feet	39,159	53,781	53,781
Lading at 50 Feet	39,159	53,781	53,781
Total Transit Weight - 42 Feet	47,393	54,261	54,261
Total Transit Weight - 43 Feet	47,393	56,550	56,550
Total Transit Weight - 44 Feet	47,393	58,840	58,840
Total Transit Weight - 45 Feet	47,393	61,129	61,129
Total Transit Weight - 46 Feet	47,393	62,015	62,015
Total Transit Weight - 47 Feet	47,393	62,015	62,015
Total Transit Weight - 48 Feet	47,393	62,015	62,015
Total Transit Weight - 49 Feet	47,393	62,015	62,015
Total Transit Weight - 50 Feet	47,393	62,015	62,015

Table A-41: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Madison Maersk at Miami Harbor

	Madison Maersk (Panamax) - Far East Trade Region	**Madison Maersk (Panamax) - Europe Trade Region**	**Madison Maersk (Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	42.4	42.4	42.4
Actual Transit Draft at 47 Feet	42.4	42.4	42.4
Actual Transit Draft at 48 Feet	42.4	42.4	42.4
Actual Transit Draft at 49 Feet	42.4	42.4	42.4
Actual Transit Draft at 50 Feet	42.4	42.4	42.4
Lading at 42 Feet	46,027	46,027	46,027
Lading at 43 Feet	48,316	48,316	48,316
Lading at 44 Feet	50,606	50,606	50,606
Lading at 45 Feet	52,895	52,895	52,895
Lading at 46 Feet	53,781	53,781	53,781
Lading at 47 Feet	53,781	53,781	53,781
Lading at 48 Feet	53,781	53,781	53,781
Lading at 49 Feet	53,781	53,781	53,781
Lading at 50 Feet	53,781	53,781	53,781
Total Transit Weight - 42 Feet	54,261	54,261	54,261
Total Transit Weight - 43 Feet	56,550	56,550	56,550
Total Transit Weight - 44 Feet	58,840	58,840	58,840
Total Transit Weight - 45 Feet	61,129	61,129	61,129
Total Transit Weight - 46 Feet	62,015	62,015	62,015
Total Transit Weight - 47 Feet	62,015	62,015	62,015
Total Transit Weight - 48 Feet	62,015	62,015	62,015
Total Transit Weight - 49 Feet	62,015	62,015	62,015
Total Transit Weight - 50 Feet	62,015	62,015	62,015

Table A-42: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Zim Asia at Miami Harbor

	Zim Asia (Sub-Panamax) - Far East Trade Region	**Zim Asia (Sub-Panamax) - Europe Trade Region**	**Zim Asia (Sub-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	Panama Canal	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	39.0	49.0	49.0
Applied Maximum Transit Depth	39.0	41.6	41.6
Actual Transit Draft at 42 Feet	36.0	38.6	38.6
Actual Transit Draft at 43 Feet	36.0	38.6	38.6
Actual Transit Draft at 44 Feet	36.0	38.6	38.6
Actual Transit Draft at 45 Feet	36.0	38.6	38.6
Actual Transit Draft at 46 Feet	36.0	38.6	38.6
Actual Transit Draft at 47 Feet	36.0	38.6	38.6
Actual Transit Draft at 48 Feet	36.0	38.6	38.6
Actual Transit Draft at 49 Feet	36.0	38.6	38.6
Actual Transit Draft at 50 Feet	36.0	38.6	38.6
Lading at 42 Feet	41,674	46,639	46,639
Lading at 43 Feet	41,674	46,639	46,639
Lading at 44 Feet	41,674	46,639	46,639
Lading at 45 Feet	41,674	46,639	46,639
Lading at 46 Feet	41,674	46,639	46,639
Lading at 47 Feet	41,674	46,639	46,639
Lading at 48 Feet	41,674	46,639	46,639
Lading at 49 Feet	41,674	46,639	46,639
Lading at 50 Feet	41,674	46,639	46,639
Total Transit Weight - 42 Feet	48,258	53,222	53,222
Total Transit Weight - 43 Feet	48,258	53,222	53,222
Total Transit Weight - 44 Feet	48,258	53,222	53,222
Total Transit Weight - 45 Feet	48,258	53,222	53,222
Total Transit Weight - 46 Feet	48,258	53,222	53,222
Total Transit Weight - 47 Feet	48,258	53,222	53,222
Total Transit Weight - 48 Feet	48,258	53,222	53,222
Total Transit Weight - 49 Feet	48,258	53,222	53,222
Total Transit Weight - 50 Feet	48,258	53,222	53,222

Table A-43: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Zim Asia at Miami Harbor

	Zim Asia (Sub-Panamax) - Far East Trade Region	**Zim Asia (Sub-Panamax) - Europe Trade Region**	**Zim Asia (Sub-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	38.6	38.6	38.6
Actual Transit Draft at 43 Feet	38.6	38.6	38.6
Actual Transit Draft at 44 Feet	38.6	38.6	38.6
Actual Transit Draft at 45 Feet	38.6	38.6	38.6
Actual Transit Draft at 46 Feet	38.6	38.6	38.6
Actual Transit Draft at 47 Feet	38.6	38.6	38.6
Actual Transit Draft at 48 Feet	38.6	38.6	38.6
Actual Transit Draft at 49 Feet	38.6	38.6	38.6
Actual Transit Draft at 50 Feet	38.6	38.6	38.6
Lading at 42 Feet	46,639	46,639	46,639
Lading at 43 Feet	46,639	46,639	46,639
Lading at 44 Feet	46,639	46,639	46,639
Lading at 45 Feet	46,639	46,639	46,639
Lading at 46 Feet	46,639	46,639	46,639
Lading at 47 Feet	46,639	46,639	46,639
Lading at 48 Feet	46,639	46,639	46,639
Lading at 49 Feet	46,639	46,639	46,639
Lading at 50 Feet	46,639	46,639	46,639
Total Transit Weight - 42 Feet	53,222	53,222	53,222
Total Transit Weight - 43 Feet	53,222	53,222	53,222
Total Transit Weight - 44 Feet	53,222	53,222	53,222
Total Transit Weight - 45 Feet	53,222	53,222	53,222
Total Transit Weight - 46 Feet	53,222	53,222	53,222
Total Transit Weight - 47 Feet	53,222	53,222	53,222
Total Transit Weight - 48 Feet	53,222	53,222	53,222
Total Transit Weight - 49 Feet	53,222	53,222	53,222
Total Transit Weight - 50 Feet	53,222	53,222	53,222

Number of Calls and Total Tonnage Transported

The analysis predicts a gradual transition to larger vessels for the life of the project in both the without- and with-project conditions. The assumed distribution of calls for each year of the project is a function of the distribution of calls that actually occurred in 1999. In the first year of the project, approximately four percent of the predicted calls are by Post-Panamax vessels, with a corresponding reduction in the number of Panamax vessel calls; Panamax vessels replace Sub-Panamax vessels at the same rate. The net effect is no change in the number of Panamax vessel calls, and a reduction in the number of Sub-Panamax vessel calls. The number of Post-Panamax vessel calls increases in a straight-line fashion until year 50 of the project when these calls represent approximately 77 percent of the predicted calls; in the year range 36-40, the Sub-Panamax vessel class disappears from the predicted calls and the additional Post-Panamax vessels begin replacing Panamax vessels instead.

Post-Panamax vessel calls are equally distributed among the three Post-Panamax vessel classes for each year range. **Table A-44** displays the distribution of predicted vessel calls for the life of the project. **Table A-45** displays the actual predicted vessel calls for each vessel class for the life of the project, based on the predicted distribution of calls, the capacity of each vessel class, and the predicted tonnage for each year range.

Table A-44: Expected Percentage of Calls by Vessel Class for the Life of the Project in Both the Without-Project and With-Project Conditions

Project Year	Susan Maersk (Post-Panamax) Percentage of Calls	Regina Maersk (Post-Panamax) Percentage of Calls	Composite Other Post-Panamax Percentage of Calls	Madison Maersk (Panamax) Percentage of Calls	Zim Asia (Sub-Panamax) Percentage of Calls
2002	0%	0%	0%	45%	55%
Years 1 - 5	1%	1%	1%	45%	51%
Years 6 - 10	4%	4%	4%	45%	43%
Years 11 - 15	7%	7%	7%	45%	35%
Years 16 - 20	9%	9%	9%	45%	27%
Years 21 - 25	12%	12%	12%	45%	19%
Years 26 - 30	15%	15%	15%	45%	11%
Years 31 - 35	18%	18%	18%	45%	2%
Years 36 - 40	20%	20%	20%	39%	0%
Years 41 - 45	23%	23%	23%	31%	0%
Years 46 - 50	26%	26%	26%	23%	0%

Table A-45: Expected Total Calls by Vessel Class for the Life of the Project in Both the Without-Project and With-Project Conditions

Project Year	Susan Maersk (Post-Panamax) Predicted Calls	Regina Maersk (Post-Panamax) Predicted Calls	Composite Other Post-Panamax Predicted Calls	Madison Maersk (Panamax) Predicted Calls	Zim Asia (Sub-Panamax) Predicted Calls
Years 1 - 5	4	4	4	141	162
Years 6 - 10	15	15	15	178	172
Years 11 - 15	38	38	38	249	195
Years 16 - 20	71	71	71	338	203
Years 21 - 25	118	118	118	444	186
Years 26 - 30	176	176	176	529	126
Years 31 - 35	246	246	246	631	36
Years 36 - 40	337	337	337	660	0
Years 41 - 45	463	463	463	625	0
Years 46 - 50	614	614	614	553	0

The number of predicted calls for each vessel class times the capacity of each vessel class at each channel depth for the inbound and outbound transit results in a yearly capacity by vessel class for the inbound and outbound transit. The predicted inbound yearly capacities of each vessel class at each depth are shown in **Tables A-46** to **A-54**.

Table A-46: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 42 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	241,564	234,811	183,037	5,521,373	5,000,937
Years 6 - 10	905,865	880,543	686,390	6,970,244	4,209,122
Years 11 - 15	2,294,857	2,230,708	1,738,854	9,750,510	3,417,307
Years 16 - 20	4,287,760	4,167,902	3,248,912	13,235,633	2,625,492
Years 21 - 25	7,126,136	6,926,936	5,399,601	17,386,452	1,833,677
Years 26 - 30	10,628,814	10,331,701	8,053,642	20,714,940	1,041,862
Years 31 - 35	14,856,183	14,440,900	11,256,795	24,709,125	250,047
Years 36 - 40	20,351,762	19,782,858	15,420,893	25,844,726	0
Years 41 - 45	27,961,027	27,179,417	21,186,569	24,474,173	0
Years 46 - 50	37,080,066	36,043,546	28,096,227	21,654,748	0

Table A-47: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 43 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	256,935	247,157	192,814	5,521,373	6,751,265
Years 6 - 10	963,505	926,839	723,053	6,970,244	7,168,009
Years 11 - 15	2,440,879	2,347,991	1,831,733	9,750,510	8,126,522
Years 16 - 20	4,560,591	4,387,036	3,422,449	13,235,633	8,459,918
Years 21 - 25	7,579,573	7,291,130	5,688,014	17,386,452	7,751,452
Years 26 - 30	11,305,126	10,874,905	8,483,818	20,714,940	5,250,984
Years 31 - 35	15,801,483	15,200,152	11,858,064	24,709,125	1,500,281
Years 36 - 40	21,646,747	20,822,972	16,244,584	25,844,726	0
Years 41 - 45	29,740,189	28,608,416	22,318,226	24,474,173	0
Years 46 - 50	39,439,473	37,938,590	29,596,956	21,654,748	0

Table A-48: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 44 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	272,305	259,503	202,591	5,521,373	6,751,265
Years 6 - 10	1,021,145	973,134	759,715	6,970,244	7,168,009
Years 11 - 15	2,586,901	2,465,274	1,924,612	9,750,510	8,126,522
Years 16 - 20	4,833,421	4,606,169	3,595,986	13,235,633	8,459,918
Years 21 - 25	8,033,010	7,655,324	5,976,428	17,386,452	7,751,452
Years 26 - 30	11,981,438	11,418,110	8,913,995	20,714,940	5,250,984
Years 31 - 35	16,746,783	15,959,404	12,459,333	24,709,125	1,500,281
Years 36 - 40	22,941,731	21,863,086	17,068,274	25,844,726	0
Years 41 - 45	31,519,351	30,037,414	23,449,883	24,474,173	0
Years 46 - 50	41,798,880	39,833,634	31,097,685	21,654,748	0

Table A-49: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 45 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	287,676	271,848	212,368	5,521,373	6,751,265
Years 6 - 10	1,078,786	1,019,430	796,378	6,970,244	7,168,009
Years 11 - 15	2,732,923	2,582,557	2,017,491	9,750,510	8,126,522
Years 16 - 20	5,106,252	4,825,303	3,769,524	13,235,633	8,459,918
Years 21 - 25	8,486,446	8,019,518	6,264,842	17,386,452	7,751,452
Years 26 - 30	12,657,750	11,961,315	9,344,171	20,714,940	5,250,984
Years 31 - 35	17,692,083	16,718,656	13,060,603	24,709,125	1,500,281
Years 36 - 40	24,236,715	22,903,199	17,891,964	25,844,726	0
Years 41 - 45	33,298,513	31,466,413	24,581,541	24,474,173	0
Years 46 - 50	44,158,288	41,728,678	32,598,415	21,654,748	0

Table A-50: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 46 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	303,047	284,194	222,144	5,521,373	6,751,265
Years 6 - 10	1,136,426	1,065,726	833,041	6,970,244	7,168,009
Years 11 - 15	2,878,945	2,699,839	2,110,370	9,750,510	8,126,522
Years 16 - 20	5,379,082	5,044,437	3,943,061	13,235,633	8,459,918
Years 21 - 25	8,939,883	8,383,712	6,553,256	17,386,452	7,751,452
Years 26 - 30	13,334,062	12,504,520	9,774,347	20,714,940	5,250,984
Years 31 - 35	18,637,383	17,477,908	13,661,872	24,709,125	1,500,281
Years 36 - 40	25,531,699	23,943,313	18,715,654	25,844,726	0
Years 41 - 45	35,077,676	32,895,412	25,713,198	24,474,173	0
Years 46 - 50	46,517,695	43,623,722	34,099,144	21,654,748	0

Table A-51: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 47 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	318,418	296,539	231,921	5,521,373	6,751,265
Years 6 - 10	1,194,066	1,112,022	869,704	6,970,244	7,168,009
Years 11 - 15	3,024,967	2,817,122	2,203,249	9,750,510	8,126,522
Years 16 - 20	5,651,913	5,263,571	4,116,598	13,235,633	8,459,918
Years 21 - 25	9,393,319	8,747,906	6,841,669	17,386,452	7,751,452
Years 26 - 30	14,010,375	13,047,724	10,204,524	20,714,940	5,250,984
Years 31 - 35	19,582,683	18,237,160	14,263,141	24,709,125	1,500,281
Years 36 - 40	26,826,683	24,983,427	19,539,344	25,844,726	0
Years 41 - 45	36,856,838	34,324,411	26,844,855	24,474,173	0
Years 46 - 50	48,877,103	45,518,765	35,599,873	21,654,748	0

Table A-52: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 48 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	333,788	308,885	241,698	5,521,373	6,751,265
Years 6 - 10	1,251,706	1,158,318	906,366	6,970,244	7,168,009
Years 11 - 15	3,170,989	2,934,405	2,296,128	9,750,510	8,126,522
Years 16 - 20	5,924,743	5,482,704	4,290,135	13,235,633	8,459,918
Years 21 - 25	9,846,756	9,112,100	7,130,083	17,386,452	7,751,452
Years 26 - 30	14,686,687	13,590,929	10,634,700	20,714,940	5,250,984
Years 31 - 35	20,527,983	18,996,412	14,864,410	24,709,125	1,500,281
Years 36 - 40	28,121,668	26,023,540	20,363,034	25,844,726	0
Years 41 - 45	38,636,000	35,753,410	27,976,512	24,474,173	0
Years 46 - 50	51,236,510	47,413,809	37,100,602	21,654,748	0

Table A-53: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 49 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	349,159	319,996	251,474	5,521,373	6,751,265
Years 6 - 10	1,309,347	1,199,984	943,029	6,970,244	7,168,009
Years 11 - 15	3,317,011	3,039,960	2,389,007	9,750,510	8,126,522
Years 16 - 20	6,197,574	5,679,925	4,463,672	13,235,633	8,459,918
Years 21 - 25	10,300,193	9,439,875	7,418,497	17,386,452	7,751,452
Years 26 - 30	15,362,999	14,079,813	11,064,877	20,714,940	5,250,984
Years 31 - 35	21,473,283	19,679,739	15,465,680	24,709,125	1,500,281
Years 36 - 40	29,416,652	26,959,643	21,186,724	25,844,726	0
Years 41 - 45	40,415,163	37,039,509	29,108,170	24,474,173	0
Years 46 - 50	53,595,918	49,119,349	38,601,331	21,654,748	0

Table A-54: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 50 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	352,030	319,996	251,474	5,521,373	6,751,265
Years 6 - 10	1,320,113	1,199,984	943,029	6,970,244	7,168,009
Years 11 - 15	3,344,287	3,039,960	2,389,007	9,750,510	8,126,522
Years 16 - 20	6,248,536	5,679,925	4,463,672	13,235,633	8,459,918
Years 21 - 25	10,384,890	9,439,875	7,418,497	17,386,452	7,751,452
Years 26 - 30	15,489,328	14,079,813	11,064,877	20,714,940	5,250,984
Years 31 - 35	21,649,856	19,679,739	15,465,680	24,709,125	1,500,281
Years 36 - 40	29,658,542	26,959,643	21,186,724	25,844,726	0
Years 41 - 45	40,747,493	37,039,509	29,108,170	24,474,173	0
Years 46 - 50	54,036,632	49,119,349	38,601,331	21,654,748	0

The yearly import capacities of the vessel classes are expressed in **Tables A-55 to A-63** as percentages of the total yearly capacity of the entire fleet. For use in the analysis, export capacities were also calculated.

Table A-55: Percentage of Import Capacity at 42 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	49%	45%
7%	6%	5%	51%	31%
12%	11%	9%	50%	18%
16%	15%	12%	48%	10%
18%	18%	14%	45%	5%
21%	20%	16%	41%	2%
23%	22%	17%	38%	0%
25%	24%	19%	32%	0%
28%	27%	21%	24%	0%
30%	29%	23%	18%	0%

Table A-56: Percentage of Import Capacity at 43 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	1%	43%	52%
6%	6%	4%	42%	43%
10%	10%	7%	40%	33%
13%	13%	10%	39%	25%
17%	16%	12%	38%	17%
20%	19%	15%	37%	9%
23%	22%	17%	36%	2%
26%	25%	19%	31%	0%
28%	27%	21%	23%	0%
31%	29%	23%	17%	0%

Table A-57: Percentage of Import Capacity at 44 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	42%	52%
6%	6%	4%	41%	42%
10%	10%	8%	39%	33%
14%	13%	10%	38%	24%
17%	16%	13%	37%	17%
21%	20%	15%	36%	9%
23%	22%	17%	35%	2%
26%	25%	19%	29%	0%
29%	27%	21%	22%	0%
31%	30%	23%	16%	0%

Table A-58: Percentage of Import Capacity at 45 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	42%	52%
6%	6%	5%	41%	42%
11%	10%	8%	39%	32%
14%	14%	11%	37%	24%
18%	17%	13%	36%	16%
21%	20%	16%	35%	9%
24%	23%	18%	34%	2%
27%	25%	20%	28%	0%
29%	28%	22%	22%	0%
32%	30%	23%	15%	0%

Table A-59: Percentage of Import Capacity at 46 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	42%	52%
7%	6%	5%	41%	42%
11%	11%	8%	38%	32%
15%	14%	11%	37%	23%
18%	17%	13%	35%	16%
22%	20%	16%	34%	9%
25%	23%	18%	33%	2%
27%	25%	20%	27%	0%
30%	28%	22%	21%	0%
32%	30%	23%	15%	0%

Table A-60: Percentage of Import Capacity at 47 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	42%	51%
7%	6%	5%	40%	41%
12%	11%	8%	38%	31%
15%	14%	11%	36%	23%
19%	17%	14%	35%	15%
22%	21%	16%	33%	8%
25%	23%	18%	32%	2%
28%	26%	20%	27%	0%
30%	28%	22%	20%	0%
32%	30%	23%	14%	0%

Table A-61: Percentage of Import Capacity at 48 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
3%	2%	2%	42%	51%
7%	7%	5%	40%	41%
12%	11%	9%	37%	31%
16%	15%	11%	35%	23%
19%	18%	14%	34%	15%
23%	21%	16%	32%	8%
25%	24%	18%	31%	2%
28%	26%	20%	26%	0%
30%	28%	22%	19%	0%
33%	30%	24%	14%	0%

Table A-62: Percentage of Import Capacity at 49 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
3%	2%	2%	42%	51%
7%	7%	5%	40%	41%
12%	11%	9%	37%	31%
16%	15%	12%	35%	22%
20%	18%	14%	33%	15%
23%	21%	17%	31%	8%
26%	24%	19%	30%	2%
28%	26%	20%	25%	0%
31%	28%	22%	19%	0%
33%	30%	24%	13%	0%

Table A-63: Percentage of Import Capacity at 50 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
3%	2%	2%	42%	51%
8%	7%	5%	40%	41%
13%	11%	9%	37%	30%
16%	15%	12%	35%	22%
20%	18%	14%	33%	15%
23%	21%	17%	31%	8%
26%	24%	19%	30%	2%
29%	26%	20%	25%	0%
31%	28%	22%	19%	0%
33%	30%	24%	13%	0%

Hourly Operating Costs, Trip Distance, and Total Voyage Cost

Hourly operating costs are based on standard at-sea and in-port vessel operating costs for vessel types categorized by deadweight. The standard costs are found in an economic guidance memorandum published and updated annually by the Corps' Institute for Water Resources (IWR). Regression analysis is used to estimate the hourly operating costs for vessels calling at each terminal by relating their deadweight values to those used by the IWR.

Trip distances are calculated for the inbound and the outbound voyages for each itinerary. These distances, the vessels' speeds, and the vessels' hourly operating costs at sea are used to determine the total voyage cost for the inbound and outbound voyages. The product of the fixed time spent at berth and the vessels' hourly operating costs in port are added to generate the total costs for the inbound and outbound transits.

Table A-64 and **Table A-65** display the trip distances and total voyage costs for each vessel class's inbound and outbound transit.

Table A-64: Trip Distances and Total Voyage Costs for Inbound Transits to Miami Harbor by Vessel Class

	Inbound Susan Maersk (Post-Panamax)	Inbound Regina Maersk (Post-Panamax)	Inbound Composite Other Post-Panamax	Inbound Madison Maersk (Panamax)	Inbound Zim Asia (Sub-Panamax)
Applicable trip Distance - Far East	12,221	12,221	12,221	10,448	10,448
Applicable trip Distance - Europe	4,189	4,189	4,189	4,189	4,189
Applicable trip Distance - Mediterranean	5,201	5,201	5,201	5,201	5,201
Speed (Knots per Hour)	24.6	25.0	25.5	24.0	21.7
Vessel Operating Cost at Sea	$2,945	$2,439	$1,993	$1,970	$1,563
Transit Cost - Far East	$1,692,748	$1,422,375	$1,187,032	$932,140	$826,661
Transit Cost - Europe	$501,427	$408,751	$328,082	$343,926	$301,636
Transit Cost - Mediterranean	$622,565	$507,499	$407,342	$427,014	$374,507
Fixed Time at Berth	2	2	2	2	2
Vessel Operating Cost at Berth	$1,586	$1,342	$1,127	$1,116	$919
Time at Berth Cost	$3,172	$2,684	$2,253	$2,231	$1,837
Total Voyage Cost - Far East	$1,695,920	$1,425,059	$1,189,285	$934,371	$828,498
Total Voyage Cost - Europe	$504,599	$411,435	$330,335	$346,158	$303,473
Total Voyage Cost - Mediterranean	$625,736	$510,183	$409,595	$429,245	$376,344

Table A-65: Trip Distances and Total Voyage Costs for Outbound Transits from Miami Harbor by Vessel Class

	Outbound Susan Maersk (Post-Panamax)	Outbound Regina Maersk (Post-Panamax)	Outbound Composite Other Post-Panamax	Outbound Madison Maersk (Panamax)	Outbound Zim Asia (Sub-Panamax)
Applicable trip Distance - Far East	12,636	12,636	12,636	12,233	12,233
Applicable trip Distance - Europe	3,866	3,866	3,866	3,866	3,866
Applicable trip Distance - Mediterranean	4,786	4,786	4,786	4,786	4,786
Speed (Knots per Hour)	24.6	25.0	25.5	24.0	21.7
Vessel Operating Cost at Sea	$2,945	$2,439	$1,993	$1,970	$1,563
Transit Cost - Far East	$1,512,541	$1,232,986	$989,651	$1,004,357	$880,858
Transit Cost - Europe	$462,764	$377,234	$302,785	$317,407	$278,378
Transit Cost - Mediterranean	$572,889	$467,005	$374,839	$392,942	$344,624
Fixed Time at Berth	2	2	2	2	2
Vessel Operating Cost at Berth	$1,586	$1,342	$1,127	$1,116	$919
Time at Berth Cost	$3,172	$2,684	$2,253	$2,231	$1,837
Total Voyage Cost - Far East	$1,515,713	$1,235,670	$991,904	$1,006,588	$882,695
Total Voyage Cost - Europe	$465,936	$379,918	$305,038	$319,638	$280,215
Total Voyage Cost - Mediterranean	$576,060	$469,689	$377,092	$395,173	$346,461

Cost per Capacity Ton

The voyage cost of the vessel divided by the tons carried equals the cost per ton of shipping the cargo. With-project cost per capacity ton decreases with each incremental depth if the capacity of the vessel increases, because the voyage cost is fixed. Shown in **Table A-66** through **Table A-75** are the costs per capacity ton at each channel depth, along with the savings per ton transported for the with-project depths, for each of the vessel class's inbound and outbound journeys.

Table A-66: Susan Maersk (Post-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	60,391	60,391	60,391	$28.08	$8.36	$10.36
43	64,234	64,234	64,234	$26.40	$7.86	$9.74
44	68,076	68,076	68,076	$24.91	$7.41	$9.19
45	71,919	71,919	71,919	$23.58	$7.02	$8.70
46	75,762	75,762	75,762	$22.38	$6.66	$8.26
47	79,604	79,604	79,604	$21.30	$6.34	$7.86
48	83,447	83,447	83,447	$20.32	$6.05	$7.50
49	87,290	87,290	87,290	$19.43	$5.78	$7.17
50	88,008	87,290	87,290	$19.27	$5.78	$7.17

Table A-67: Susan Maersk (Post-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	60,391	60,391	60,391	$25.10	$7.72	$9.54
43	64,234	64,234	64,234	$23.60	$7.25	$8.97
44	68,076	68,076	68,076	$22.26	$6.84	$8.46
45	71,919	71,919	71,919	$21.08	$6.48	$8.01
46	75,762	75,762	75,762	$20.01	$6.15	$7.60
47	79,604	79,604	79,604	$19.04	$5.85	$7.24
48	83,447	83,447	83,447	$18.16	$5.58	$6.90
49	87,290	87,290	87,290	$17.36	$5.34	$6.60
50	87,290	88,008	88,008	$17.36	$5.29	$6.55

Table A-68: Regina Maersk (Post-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	58,703	58,703	58,703	$24.28	$7.01	$8.69
43	61,789	61,789	61,789	$23.06	$6.66	$8.26
44	64,876	64,876	64,876	$21.97	$6.34	$7.86
45	67,962	67,962	67,962	$20.97	$6.05	$7.51
46	71,048	71,048	71,048	$20.06	$5.79	$7.18
47	74,135	74,135	74,135	$19.22	$5.55	$6.88
48	77,221	77,221	77,221	$18.45	$5.33	$6.61
49	79,999	79,999	79,999	$17.81	$5.14	$6.38
50	79,999	79,999	79,999	$17.81	$5.14	$6.38

Table A-69: Regina Maersk (Post-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	58,703	58,703	58,703	$21.05	$6.47	$8.00
43	61,789	61,789	61,789	$20.00	$6.15	$7.60
44	64,876	64,876	64,876	$19.05	$5.86	$7.24
45	67,962	67,962	67,962	$18.18	$5.59	$6.91
46	71,048	71,048	71,048	$17.39	$5.35	$6.61
47	74,135	74,135	74,135	$16.67	$5.12	$6.34
48	77,221	77,221	77,221	$16.00	$4.92	$6.08
49	79,999	79,999	79,999	$15.45	$4.75	$5.87
50	79,999	79,999	79,999	$15.45	$4.75	$5.87

Table A-70: Composite Other Post-Panamax Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	45,759	45,759	45,759	$25.99	$7.22	$8.95
43	48,204	48,204	48,204	$24.67	$6.85	$8.50
44	50,648	50,648	50,648	$23.48	$6.52	$8.09
45	53,092	53,092	53,092	$22.40	$6.22	$7.71
46	55,536	55,536	55,536	$21.41	$5.95	$7.38
47	57,980	57,980	57,980	$20.51	$5.70	$7.06
48	60,424	60,424	60,424	$19.68	$5.47	$6.78
49	62,869	62,869	62,869	$18.92	$5.25	$6.52
50	62,869	62,869	62,869	$18.92	$5.25	$6.52

Table A-71: Composite Other Post-Panamax Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	45,759	45,759	45,759	$21.68	$6.67	$8.24
43	48,204	48,204	48,204	$20.58	$6.33	$7.82
44	50,648	50,648	50,648	$19.58	$6.02	$7.45
45	53,092	53,092	53,092	$18.68	$5.75	$7.10
46	55,536	55,536	55,536	$17.86	$5.49	$6.79
47	57,980	57,980	57,980	$17.11	$5.26	$6.50
48	60,424	60,424	60,424	$16.42	$5.05	$6.24
49	62,869	62,869	62,869	$15.78	$4.85	$6.00
50	62,869	62,869	62,869	$15.78	$4.85	$6.00

Table A-72: Madison Maersk (Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth for and Itinerary Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	39,159	46,027	46,027	$23.86	$7.52	$9.33
43	39,159	48,316	48,316	$23.86	$7.16	$8.88
44	39,159	50,606	50,606	$23.86	$6.84	$8.48
45	39,159	52,895	52,895	$23.86	$6.54	$8.12
46	39,159	53,781	53,781	$23.86	$6.44	$7.98
47	39,159	53,781	53,781	$23.86	$6.44	$7.98
48	39,159	53,781	53,781	$23.86	$6.44	$7.98
49	39,159	53,781	53,781	$23.86	$6.44	$7.98
50	39,159	53,781	53,781	$23.86	$6.44	$7.98

Table A-73: Madison Maersk (Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	46,027	46,027	46,027	$21.87	$6.94	$8.59
43	48,316	48,316	48,316	$20.83	$6.62	$8.18
44	50,606	50,606	50,606	$19.89	$6.32	$7.81
45	52,895	52,895	52,895	$19.03	$6.04	$7.47
46	53,781	53,781	53,781	$18.72	$5.94	$7.35
47	53,781	53,781	53,781	$18.72	$5.94	$7.35
48	53,781	53,781	53,781	$18.72	$5.94	$7.35
49	53,781	53,781	53,781	$18.72	$5.94	$7.35
50	53,781	53,781	53,781	$18.72	$5.94	$7.35

Table A-74: Zim Asia (Sub-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	41,674	46,639	46,639	$19.88	$6.51	$8.07
43	41,674	46,639	46,639	$19.88	$6.51	$8.07
44	41,674	46,639	46,639	$19.88	$6.51	$8.07
45	41,674	46,639	46,639	$19.88	$6.51	$8.07
46	41,674	46,639	46,639	$19.88	$6.51	$8.07
47	41,674	46,639	46,639	$19.88	$6.51	$8.07
48	41,674	46,639	46,639	$19.88	$6.51	$8.07
49	41,674	46,639	46,639	$19.88	$6.51	$8.07
50	41,674	46,639	46,639	$19.88	$6.51	$8.07

Table A-75: Zim Asia (Sub-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	46,639	46,639	46,639	$18.93	$6.01	$7.43
43	46,639	46,639	46,639	$18.93	$6.01	$7.43
44	46,639	46,639	46,639	$18.93	$6.01	$7.43
45	46,639	46,639	46,639	$18.93	$6.01	$7.43
46	46,639	46,639	46,639	$18.93	$6.01	$7.43
47	46,639	46,639	46,639	$18.93	$6.01	$7.43
48	46,639	46,639	46,639	$18.93	$6.01	$7.43
49	46,639	46,639	46,639	$18.93	$6.01	$7.43
50	46,639	46,639	46,639	$18.93	$6.01	$7.43

Tonnage

Table A-76 shows actual 2002 tonnage and predicted tonnage for the life of the project. **Table A-77** shows 2002 tonnage as a percentage of total tonnage by trade region and import or export tonnage.

Table A- 76: Actual and Predicted Tonnage at Miami Harbor by Trade Region

	Far East		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	746,862	335,540	1,082,402
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	1,043,083	436,817	1,479,900
Years 6 - 10	1,349,168	536,617	1,885,786
Years 11 - 15	1,945,931	718,115	2,664,046
Years 16 - 20	2,700,290	932,219	3,632,509
Years 21 - 25	3,619,777	1,176,935	4,796,712
Years 26 - 30	4,361,828	1,364,391	5,726,219
Years 31 - 35	5,255,999	1,581,703	6,837,702
Years 36 - 40	6,333,475	1,833,627	8,167,102
Years 41 - 45	7,631,833	2,125,676	9,757,509
Years 46 - 50	9,196,352	2,464,242	11,660,594
	Europe		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	1,549,637	394,669	1,944,306
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	2,164,254	484,842	2,649,096
Years 6 - 10	2,799,340	570,231	3,369,571
Years 11 - 15	4,037,542	716,753	4,754,295
Years 16 - 20	5,602,734	879,864	6,482,599
Years 21 - 25	7,510,544	1,056,515	8,567,059
Years 26 - 30	9,050,199	1,186,050	10,236,249
Years 31 - 35	10,905,483	1,331,466	12,236,949
Years 36 - 40	13,141,099	1,494,710	14,635,809
Years 41 - 45	15,835,014	1,677,970	17,512,983
Years 46 - 50	19,081,179	1,883,698	20,964,877
	Mediterranean		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	131,713	59,186	190,899
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	142,440	59,186	201,626
Years 6 - 10	151,727	59,186	210,913
Years 11 - 15	165,720	59,186	224,906
Years 16 - 20	179,393	59,186	238,579
Years 21 - 25	192,511	59,186	251,697
Years 26 - 30	201,232	59,186	260,418
Years 31 - 35	210,347	59,186	269,533
Years 36 - 40	219,876	59,186	279,062
Years 41 - 45	229,836	59,186	289,022
Years 46 - 50	240,248	59,186	299,434
	All Trade Routes		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	2,428,212	789,395	3,217,607
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	3,349,777	980,845	4,330,622
Years 6 - 10	4,300,236	1,166,034	5,466,270
Years 11 - 15	6,149,193	1,494,054	7,643,247
Years 16 - 20	8,482,418	1,871,270	10,353,687
Years 21 - 25	11,322,831	2,292,637	13,615,468
Years 26 - 30	13,613,259	2,609,627	16,222,886
Years 31 - 35	16,371,830	2,972,355	19,344,184
Years 36 - 40	19,694,450	3,387,524	23,081,973
Years 41 - 45	23,696,683	3,862,832	27,559,515
Years 46 - 50	28,517,779	4,407,125	32,924,904

Table A-77: Actual 2002 Tonnage by Trade Region

Trade Region	2002 Import Tonnage	Trade Region Share of Import Tonnage	2002 Export Tonnage	Trade Region Share of Export Tonnage	2002 Total Tonnage	Trade Region Share of Total Tonnage
Far East	746,862	31%	335,540	43%	1,082,402	34%
Europe	1,549,637	64%	394,669	50%	1,944,306	60%
Mediterranean	131,713	5%	59,186	7%	190,899	6%
Total	2,428,212	100%	789,395	100%	3,217,607	100%

Discounted Transportation Cost Savings (Benefits) at Each Depth

Table A-78 to **A-85** display the process of using the cost per ton savings calculated for the Susan Maersk's inbound transit for each channel depth for each trade route to find the total savings by year of the project at each potential depth. (A similar procedure is used to determine the savings per project year for the outbound transit and for the inbound and outbound transits of the other four vessel classes.) In **Table A-78** to **A-85**, expected tonnage is assigned to a vessel class and trade route utilizing the percentages found in **Tables A-66** to **A-75** and **Table A-77**.

Table A-78: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 43 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	6,356	$10,678	13,187	$6,592	1,121	$695	$17,964
Years 6 - 10	23,868	$40,098	49,523	$24,754	4,209	$2,609	$67,461
Years 11 - 15	59,635	$100,186	123,735	$61,850	10,517	$6,519	$168,555
Years 16 - 20	111,191	$186,799	230,706	$115,320	19,609	$12,155	$314,274
Years 21 - 25	184,670	$310,242	383,165	$191,528	32,568	$20,187	$521,957
Years 26 - 30	267,826	$449,943	555,703	$277,772	47,233	$29,277	$756,993
Years 31 - 35	369,848	$621,338	767,384	$383,583	65,225	$40,430	$1,045,351
Years 36 - 40	498,687	$837,787	1,034,709	$517,207	87,946	$54,514	$1,409,508
Years 41 - 45	663,979	$1,115,474	1,377,666	$688,636	117,096	$72,583	$1,876,693
Years 46 - 50	867,279	$1,457,015	1,799,487	$899,487	152,949	$94,807	$2,451,308

Table A-79: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 44 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	6,717	$21,294	13,936	$13,146	1,185	$1,386	$35,825
Years 6 - 10	25,085	$79,528	52,049	$49,097	4,424	$5,175	$133,800
Years 11 - 15	62,297	$197,501	129,258	$121,927	10,986	$12,851	$332,279
Years 16 - 20	115,585	$366,439	239,822	$226,221	20,384	$23,844	$616,503
Years 21 - 25	191,092	$605,822	396,491	$374,003	33,700	$39,420	$1,019,245
Years 26 - 30	275,814	$874,414	572,276	$539,819	48,641	$56,897	$1,471,130
Years 31 - 35	379,310	$1,202,531	787,018	$742,381	66,893	$78,248	$2,023,160
Years 36 - 40	509,488	$1,615,235	1,057,119	$997,164	89,851	$105,102	$2,717,500
Years 41 - 45	675,806	$2,142,512	1,402,205	$1,322,678	119,182	$139,411	$3,604,601
Years 46 - 50	879,799	$2,789,234	1,825,463	$1,721,930	155,157	$181,493	$4,692,657

Table A-80: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 45 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	7,075	$31,849	14,680	$19,662	1,248	$2,072	$53,583
Years 6 - 10	26,283	$118,308	54,533	$73,037	4,635	$7,698	$199,043
Years 11 - 15	64,884	$292,066	134,625	$180,307	11,443	$19,004	$491,377
Years 16 - 20	119,813	$539,324	248,596	$332,951	21,130	$35,093	$907,368
Years 21 - 25	197,218	$887,753	409,201	$548,053	34,780	$57,765	$1,493,571
Years 26 - 30	283,361	$1,275,516	587,936	$787,438	49,972	$82,997	$2,145,951
Years 31 - 35	388,181	$1,747,347	805,422	$1,078,723	68,458	$113,698	$2,939,768
Years 36 - 40	519,538	$2,338,636	1,077,971	$1,443,755	91,623	$152,173	$3,934,564
Years 41 - 45	686,731	$3,091,232	1,424,873	$1,908,369	121,109	$201,143	$5,200,744
Years 46 - 50	891,290	$4,012,031	1,849,306	$2,476,823	157,184	$261,059	$6,749,913

Table A-81: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 46 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	7,432	$42,343	15,420	$26,141	1,311	$2,755	$71,239
Years 6 - 10	27,460	$156,452	56,976	$96,586	4,843	$10,180	$263,218
Years 11 - 15	67,398	$383,996	139,842	$237,059	11,886	$24,986	$646,042
Years 16 - 20	123,886	$705,828	257,046	$435,742	21,848	$45,928	$1,187,498
Years 21 - 25	203,068	$1,156,960	421,338	$714,248	35,812	$75,282	$1,946,491
Years 26 - 30	290,505	$1,655,126	602,758	$1,021,790	51,232	$107,697	$2,784,614
Years 31 - 35	396,513	$2,259,098	822,710	$1,394,652	69,927	$146,997	$3,800,748
Years 36 - 40	528,913	$3,013,438	1,097,422	$1,860,342	93,277	$196,081	$5,069,861
Years 41 - 45	696,853	$3,970,263	1,445,875	$2,451,037	122,894	$258,341	$6,679,641
Years 46 - 50	901,875	$5,138,356	1,871,267	$3,172,158	159,050	$334,348	$8,644,863

Table A-82: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 47 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	7,787	$52,778	16,156	$32,582	1,373	$3,434	$88,795
Years 6 - 10	28,619	$193,977	59,380	$119,752	5,047	$12,622	$326,350
Years 11 - 15	69,844	$473,400	144,916	$292,253	12,317	$30,804	$796,456
Years 16 - 20	127,811	$866,298	265,189	$534,808	22,540	$56,369	$1,457,476
Years 21 - 25	208,659	$1,414,286	432,939	$873,108	36,798	$92,026	$2,379,421
Years 26 - 30	297,275	$2,014,928	616,806	$1,243,914	52,426	$131,109	$3,389,951
Years 31 - 35	404,354	$2,740,706	838,979	$1,691,972	71,310	$178,335	$4,611,013
Years 36 - 40	537,678	$3,644,377	1,115,609	$2,249,852	94,822	$237,136	$6,131,365
Years 41 - 45	706,258	$4,787,010	1,465,390	$2,955,255	124,552	$311,486	$8,053,751
Years 46 - 50	911,656	$6,179,193	1,891,562	$3,814,718	160,775	$402,074	$10,395,984

Table A-83: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 48 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	8,139	$63,153	16,888	$38,987	1,435	$4,109	$106,250
Years 6 - 10	29,759	$230,897	61,745	$142,544	5,248	$15,024	$388,466
Years 11 - 15	72,223	$560,380	149,853	$345,950	12,737	$36,463	$942,793
Years 16 - 20	131,596	$1,021,056	273,043	$630,348	23,208	$66,439	$1,717,844
Years 21 - 25	214,009	$1,660,500	444,039	$1,025,108	37,742	$108,047	$2,793,656
Years 26 - 30	303,702	$2,356,432	630,139	$1,454,741	53,559	$153,331	$3,964,504
Years 31 - 35	411,747	$3,194,757	854,318	$1,972,280	72,614	$207,880	$5,374,916
Years 36 - 40	545,892	$4,235,596	1,132,651	$2,614,841	96,271	$275,606	$7,126,043
Years 41 - 45	715,020	$5,547,868	1,483,569	$3,424,970	126,097	$360,994	$9,333,832
Years 46 - 50	920,722	$7,143,917	1,910,373	$4,410,289	162,374	$464,848	$12,019,055

Table A-84: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 49 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	8,491	$73,476	17,617	$45,360	1,497	$4,781	$123,617
Years 6 - 10	30,888	$267,298	64,089	$165,016	5,447	$17,393	$449,707
Years 11 - 15	74,571	$645,318	154,725	$398,386	13,151	$41,990	$1,085,694
Years 16 - 20	135,326	$1,171,077	280,784	$722,963	23,866	$76,201	$1,970,240
Years 21 - 25	219,285	$1,897,628	454,986	$1,171,498	38,672	$123,477	$3,192,603
Years 26 - 30	310,062	$2,683,191	643,337	$1,656,465	54,681	$174,593	$4,514,248
Years 31 - 35	419,112	$3,626,872	869,600	$2,239,046	73,913	$235,997	$6,101,915
Years 36 - 40	554,161	$4,795,551	1,149,809	$2,960,528	97,729	$312,042	$8,068,121
Years 41 - 45	723,991	$6,265,207	1,502,182	$3,867,819	127,680	$407,671	$10,540,697
Years 46 - 50	930,229	$8,049,934	1,930,098	$4,969,618	164,051	$523,801	$13,543,354

Table A-85: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 50 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	8,491	$73,476	17,617	$45,360	1,497	$4,781	$123,617
Years 6 - 10	30,888	$267,298	64,089	$165,016	5,447	$17,393	$449,707
Years 11 - 15	74,571	$645,318	154,725	$398,386	13,151	$41,990	$1,085,694
Years 16 - 20	135,326	$1,171,077	280,784	$722,963	23,866	$76,201	$1,970,240
Years 21 - 25	219,285	$1,897,628	454,986	$1,171,498	38,672	$123,477	$3,192,603
Years 26 - 30	310,062	$2,683,191	643,337	$1,656,465	54,681	$174,593	$4,514,248
Years 31 - 35	419,112	$3,626,872	869,600	$2,239,046	73,913	$235,997	$6,101,915
Years 36 - 40	554,161	$4,795,551	1,149,809	$2,960,528	97,729	$312,042	$8,068,121
Years 41 - 45	723,991	$6,265,207	1,502,182	$3,867,819	127,680	$407,671	$10,540,697
Years 46 - 50	930,229	$8,049,934	1,930,098	$4,969,618	164,051	$523,801	$13,543,354

Yearly transportation savings by depth for the five vessel classes are summed together and discounted to the base year of the project using the current federal rate of 5.625 percent, and the total of the discounted yearly transportation savings at a given depth represents the total base year benefit of the project at that depth. **Table A-86** presents the total discounted transportation savings for each potential channel depth.

Using the Federal discount rate of 5.625 percent and the fifty-year life of the project to annualize the benefits produces the Average Annual Equivalent (AAEQ) benefits of the project at each depth. **Table A-86** displays total AAEQ benefits for each potential channel depth.

Table A-86: Total Discounted and Average Annual Equivalent Benefits for Each Potential Project Depth at Miami Harbor

Channel Depth	Transportation Benefits	AAEQ Transportation Benefits
Deepen System to 43 Feet	$40,788,344	$2,453,354
Deepen System to 44 Feet	$78,205,117	$4,703,914
Deepen System to 45 Feet	$112,673,088	$6,777,108
Deepen System to 46 Feet	$139,055,626	$8,363,976
Deepen System to 47 Feet	$160,522,169	$9,655,154
Deepen System to 48 Feet	$180,868,182	$10,878,934
Deepen System to 49 Feet	$199,628,174	$12,007,318
Deepen System to 50 Feet	$200,133,356	$12,037,704

Benefits During Construction (BDC)

There will be no benefits during construction associated with the Miami Harbor project because all widening improvements must be in place to accrue vessel delay elimination benefits, and deepening of the harbor will occur simultaneously with widening improvements.

Advance Utility Replacement Benefits

Replacement of two utility lines will be necessary for any deepening alternative. The cost of these utility replacements is charged as a project cost. The benefit of the extended useful life of each utility line is added to the project benefits. See the Main Report for more information about the replacement of the utility lines and the calculation of the advanced utility replacement benefits.

Total Benefits

Total benefits include channel improvement benefits and benefits associated with advance utility replacement. Total AAEQ project benefits are shown in **Table A-87**.

Table A-87: Total AAEQ Benefits

Project	AAEQ Improvement Benefits	AAEQ Advance Utility Replacement Benefits	Total Benefits
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$2,848,000		$2,848,000
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$4,140,000		$4,140,000
Deepen System to 43 Feet	$6,593,354	$84,268	$6,677,622
Deepen System to 44 Feet	$8,843,914	$84,268	$8,928,182
Deepen System to 45 Feet	$10,917,108	$84,268	$11,001,376
Deepen System to 46 Feet	$12,503,976	$84,268	$12,588,243
Deepen System to 47 Feet	$13,795,154	$84,268	$13,879,422
Deepen System to 48 Feet	$15,018,934	$84,268	$15,103,202
Deepen System to 49 Feet	$16,147,318	$84,268	$16,231,586
Deepen System to 50 Feet	$16,177,704	$84,268	$16,261,972

COSTS

CONSTRUCTION COSTS

Construction costs for each project are summarized in **Table A-88**. See the Main Report and Appendix B for a complete discussion of the costs shown in **Table A-88**.

INTEREST DURING CONSTRUCTION

Interest During Construction (IDC) is calculated to account for the opportunity cost of expended funds before the benefits of the project are available. Using the project schedule for each increment (see Main Report), projected expenditures are plotted on a construction timeline and the opportunity costs of those expenditures are calculated using the current Federal discount rate of 5.625 percent.

Adding the IDC to the construction cost for each project produces the real cost of the project at the point in time that the project is completed. See **Table A-88** for IDC costs for each alternative project.

FISHER ISLAND BULKHEAD REPLACEMENT COST

Damage to the Fisher Island Bulkhead, as described in the Main Report, is treated as an economic cost of the project. The appropriate cost figure is the difference between the without-project cost of repairing the bulkheads, thereby deferring replacement, and the higher with-project cost of immediately replacing them. Future maintenance costs are also included in the computations. The costs are calculated based on the present value of the expected fifty-year cash flows associated with each condition.

The Port of Miami's Fisher Island Bulkhead Assessment Report (September 5, 2003), prepared by Shaw Environmental & Infrastructure, Inc., evaluates the condition of the bulkheads and provides a financial cost analysis for repairs and maintenance. Repair and replacement costs with remaining useful life estimates are in Table 1 of the report. Maintenance costs are also provided.

The report states that "Segment A is in poor condition and requires immediate repair or replacement. Segment B is in fair condition and needs immediate repair or replacement within 5 years. Segment C is in good condition and needs only minor maintenance." The remaining useful life after repairs is given as one to two years for Segment A, three to five years for Segment B, and greater than 15 years for Segment C. Based on these figures, the without-project cost of the bulkheads was calculated assuming Segment A has a useful life after repairs of only one year due to its "poor" condition and Segment B has a useful life of five years due to its "fair" condition.

For Segment A the cost of repairing and then replacing the bulkhead (i.e., the without project condition) is $989,275. The cost of replacing the bulkhead upfront (i.e., the with project condition) is $1,036,522. This results in a cost of $47,247 for Segment A. For

Segment B the cost of repairing and then replacing the bulkhead is $792,373 and the cost of replacing the bulkhead upfront is $1,036,522, resulting in a cost of $244,149 for Segment B. Segment C only has repair costs. Ferry Slip does not have any costs.

Total cost for Fisher Island Bulkhead replacement is $291,395, as shown in **Table A-88**; total AAEQ cost is $17,527, as shown in **Table A-89**.

Table A-88: Construction Cost and Economic Costs

Project	Construction Cost	IDC	Fisher Island Bulkhead Replacement Cost	Total Cost
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$22,599,315	$1,306,100	$291,395	$24,196,810
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$26,229,817	$1,626,130	$291,395	$28,147,342
Deepen System to 43 Feet	$92,381,593	$8,976,522	$291,395	$101,649,510
Deepen System to 44 Feet	$104,480,828	$10,899,345	$291,395	$115,671,568
Deepen System to 45 Feet	$111,995,359	$12,078,924	$291,395	$124,365,678
Deepen System to 46 Feet	$118,831,812	$12,873,054	$291,395	$131,996,261
Deepen System to 47 Feet	$127,362,809	$14,337,505	$291,395	$141,991,710
Deepen System to 48 Feet	$137,487,666	$15,924,445	$291,395	$153,703,506
Deepen System to 49 Feet	$149,033,579	$19,262,453	$291,395	$168,587,427
Deepen System to 50 Feet	$157,506,768	$21,568,088	$291,395	$179,366,251

AVERAGE ANNUAL EQUIVALENT (AAEQ) COSTS

Just as project benefits are converted to AAEQ benefits, project costs are converted to AAEQ costs using the Federal discount rate of 5.625 percent to annualize the costs over the 50-year life of the project.

Table A-89 displays AAEQ construction cost, AAEQ IDC, and total AAEQ costs for each project.

Table A-89: Miami Harbor AAEQ Costs

Project	AAEQ Construction Cost	AAEQ IDC	AAEQ Fisher Island Bulkhead Replacement Cost	AAEQ Total Cost
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,359,313	$78,560	$17,527	$1,455,400
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher	$1,577,682	$97,809	$17,527	$1,693,018
Deepen System to 43 Feet	$5,556,606	$539,924	$17,527	$6,114,057
Deepen System to 44 Feet	$6,284,356	$655,578	$17,527	$6,957,462
Deepen System to 45 Feet	$6,736,343	$726,528	$17,527	$7,480,398
Deepen System to 46 Feet	$7,147,545	$774,294	$17,527	$7,939,366
Deepen System to 47 Feet	$7,660,671	$862,378	$17,527	$8,540,576
Deepen System to 48 Feet	$8,269,665	$957,830	$17,527	$9,245,022
Deepen System to 49 Feet	$8,964,134	$1,158,606	$17,527	$10,140,267
Deepen System to 50 Feet	$9,473,782	$1,297,286	$17,527	$10,788,596

NATIONAL ECONOMIC DEVELOPMENT PLAN ANALYSIS

The National Economic Development (NED) plan is determined by analyzing the increments of the project in order to evaluate alternative plans. Components of the project—individual construction features that improve the channel—are discussed in detail in the Main Report. Project increments are either individual components that generate benefits independently or inseparable groups of components that generate benefits interdependently. Alternative Plans are different combinations of project increments.

Three categories of potential transportation cost reduction benefits are attainable through improvements to the Port:

- The first benefit category is a reduction in the number of tug assists needed for Post-Panamax container vessels, as well as a reduction in the transit time for Post-Panamax container vessels, resulting from widening the channel (interdependent components 1C, 2A, and 5A).
- The second benefit category is a decrease in the time spent by vessels while navigating the channel because of the availability of an additional turning basin, resulting from extending the Fisher Island Turning Basin (independent component 3B).
- The third benefit category is a reduction in, or an elimination of, light loading, resulting from deepening the channel (independent component Deepening to Optimal NED depth).

Eight Alternative Plans can be formed from the three benefit categories:

- Alternative Plan A: No Action Plan
- Alternative Plan B: Widen the Channel (Components 1C, 2A, and 5A)
- Alternative Plan C: Extend the Fisher Island Turning Basin (Component 3B)
- Alternative Plan D: Widen the Channel (Components 1C, 2A, and 5A) and Extend the Fisher Island Turning Basin (Component 3B)
- Alternative Plan E: Deepen the Previously-Authorized Channel Configuration
- Alternative Plan F: Widen the Channel (Components 1C, 2A, and 5A) and Deepen the Resulting Channel Configuration
- Alternative Plan G: Extend the Fisher Island Turning Basin (Component 3B) and Deepen the Resulting Channel Configuration
- Alternative Plan H: Widen the Channel (Components 1C, 2A, and 5A), Extend the Fisher Island Turning Basin (Component 3B), and Deepen the Resulting Channel Configuration

An additional Alternative Plan, Alternative Plan I, comprises the extension of the Dodge Island Channel and the construction of the Dodge Island Turning Basin. These components were found to be unfeasible following a preliminary benefit/cost analysis and were not included in the final set of Alternative Plans.

Utilized to select the plan from the Alternative Plans A-H that provides the highest net NED benefits, the NED Plan Analysis process compares costs to NED benefits for each increment of the project. In order to be included in the NED plan, each increment must be justified (provide benefits that exceed costs) based on a comparison of its marginal costs and benefits. By including only those increments that have positive net benefits, the NED Plan maximizes the net benefits of the project. **Table A-90** provides AAEQ costs and benefits, and net benefits for each project increment, revealing those increments that have positive net benefits.

Table A-90: Costs and Benefits of Project Increments

Increment	Incremental AAEQ Cost	Incremental AAEQ Benefits	Net Incremental AAEQ Benefits
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,455,400	$2,848,000	$1,392,600
3B Extend Fisher Island Turning Basin	$237,618	$1,292,000	$1,054,382
Deepen System from 42 Feet to 43 Feet	$4,421,039	$2,537,622	-$1,883,417
Deepen System from 43 Feet to 44 Feet	$843,405	$2,250,560	$1,407,155
Deepen System from 44 Feet to 45 Feet	$522,937	$2,073,194	$1,550,257
Deepen System from 45 Feet to 46 Feet	$458,967	$1,586,868	$1,127,900
Deepen System from 46 Feet to 47 Feet	$601,210	$1,291,179	$689,968
Deepen System from 47 Feet to 48 Feet	$704,446	$1,223,780	$519,334
Deepen System from 48 Feet to 49 Feet	$895,244	$1,128,384	$233,140
Deepen System from 49 Feet to 50 Feet	$648,329	$30,386	-$617,943

The first increment examined is channel widening. A comparison of the benefits and cost of Components 1C, 2A, and 5A shows that the benefits exceed the cost, so this increment has a positive net benefit and is part of the NED plan. This finding eliminates four of the alternative plans, leaving Alternative Plans B, D, F, and H.

The second increment examined is extending the Fisher Island Turning Basin. A comparison of the additional benefits and cost of the project resulting from adding Component 3B shows that the marginal benefits exceed the marginal cost, so this increment has a positive net benefit and is part of the NED plan. This finding eliminates two of the remaining alternative plans, leaving Alternative Plans D and H.

The final set of increments examined is deepening the newly configured channel from its current depth of 42 feet to depths up to 50 feet. A comparison of the benefits and costs of the potential deepening projects shows that one foot of deepening (to 43 feet in the inner channel and 45 feet in the outer channel) has a negative net benefit; however, further deepening produces positive net benefits that are maximized at 49/51 feet of project depth. Therefore, 49 feet is the NED depth for the deepening project, and deepening the channel to 49 feet is part of the NED plan, eliminating Alternative Plan D and leaving Alternative Plan H as the NED Plan.

Table A-91 confirms that NED net benefits are maximized with Alternative Plan H, which includes widening the channel, extending the Fisher Island Turning Basin, and deepening the resulting channel system to 49/51 feet. The benefit/cost ratio of the NED Plan is 1.60.

Table A-91: Costs and Benefits of Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,455,400	$2,848,000	$1,392,600	1.96
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$237,618	$1,292,000	$1,054,382	5.44
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,693,018	$4,140,000	$2,446,982	2.45
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$6,114,057	$6,677,622	$563,565	1.09
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$6,957,462	$8,928,182	$1,970,720	1.28
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,480,398	$11,001,376	$3,520,977	1.47
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$7,939,366	$12,588,243	$4,648,878	1.59
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,540,576	$13,879,422	$5,338,846	1.63
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$9,245,022	$15,103,202	$5,858,180	1.63
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$10,140,267	$16,231,586	$6,091,320	1.60
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$10,788,596	$16,261,972	$5,473,376	1.51

MULTIPORT ANALYSIS

GENERAL

The purpose of the multiport analysis is to assess whether or not improvements at Miami Harbor would result in a diversion of cargo traffic from competing ports to Miami Harbor. Diverted traffic from competing U.S. ports is not a National Economic Benefit (NED) as there is no increase in the net value of the national output of goods and services. If it is determined that there is an impact, the forecasted cargo traffic at Miami Harbor would be adjusted by an amount derived from the analysis cargo movements and transportation costs at competing ports.

Miami Harbor is the southernmost major port on the Atlantic coast. Its location referenced to other major South Atlantic Region ports is as follows: 21 nautical miles south of Port Everglades, Florida; 83 nautical miles south of Palm Beach, Florida; 173 nautical miles south of Port Canaveral, Florida; 306 nautical miles south of Jacksonville, the most northern port on Florida's Atlantic Coast; 386 nautical miles south of Savannah, Georgia; and 420 nautical miles south of Charleston, South Carolina. These ports, as well as, Tampa, Florida, could be a competing port for one or more of the commodities handled by Miami Harbor.

As shown in **Table A-5**, about 97 percent of all cargo handled by the Port of Miami is containerized cargo transported in containers or trailers. The remaining 3 percent is neobulk and breakbulk cargo. Thus, only containerized cargo movements at competing ports needs to be considered.

For containerized cargo, this analysis will (1) identify containerized cargo volumes at competing ports; (2) assess the extent of the overlap in the flow of containerized cargo in the hinterlands served by each of the potential competing ports, and (3) identify any advantages/disadvantages in (a) transportation costs, and (b) institutional and/or cargo capacity constraints resulting from port administration, terminal operators, and/or stevedore companies' policies, and/or future growth; and then, if appropriate, (4) quantify any diverted containerized cargo traffic due to improvements at Miami Harbor.

Ports also compete for cruise ship business. For Miami Harbor, the competition includes Port Canaveral, the Port of Tampa, and Port Everglades Florida. Each of these ports has sufficient channel depth to accommodate the largest cruise ships. Cruise ships with overall lengths of 800 feet or more have design drafts of 24 to 30 feet. Only two older large cruise ships, the NORWAY (1961) and QUEEN ELIZABETH 2 (1969), have design drafts in excess of 30 feet, 34.4 feet and 32.6 feet, respectively. The QUEEN MARY 2, which is scheduled for completion in 2003, will have a design draft of 32.8 feet. The design cruise ship for the study, the VOYAGER OF THE SEAS, has a design draft of 28.2 feet. Thus, deepening the Main Channel at Miami Harbor from its current 36 feet would not divert any cruise ship business to Miami Harbor. Accordingly, deepening the Main Channel was not considered.

Cruise ship operators stated that they are concerned mostly with sufficient berthing area to accommodate several large cruise ships at the same time. The Port proposed that additional berthing space be developed for smaller cruise ships at Terminal 12 at the southeastern end of Dodge Island. This would provide additional berthing space for the larger cruise ships at the main cruise terminals at the northwestern end of Dodge Island. However, a preliminary analysis determined that benefits were insufficient to justify the construction of this alternative (Alternative 6). Even without the development of this new facility, there does not appear to be any reason for a transfer of cruise ship business from Miami Harbor due to the adequacy of berthing space, as competing ports face the same berthing constraints.

CONTAINERIZED CARGO

Import and export (non-domestic) liner tonnage is shown in **Table A-92** for Miami Harbor, Port Everglades, Palm Beach Harbor, Port Canaveral, Jacksonville Harbor, and Tampa Harbor. In 1999, Miami Harbor had the most containerized cargo tonnage (4,399,517 short tons), approximately 1.7 times that of Port Everglades (2,599,447 short tons), which had the second highest volume of containerized cargo. Jacksonville had the third highest volume (1,457,143 short tons), about 56 percent of Port Everglades' total and 33 percent of Miami Harbor's total. It should be noted that the total for Jacksonville Harbor does not include containerized cargo trade with Puerto Rico, which represents a significant portion of it's overall containerized cargo trade, as it is classified as domestic tonnage (cargo moving between U.S. ports). Palm Beach Harbor, Tampa Harbor, and Port Canaveral have significantly less containerized cargo trade than Miami Harbor: 421,098; 199,886; and 44,225 short tons, respectively.

Tampa Harbor serves a different hinterland than Miami Harbor, as does Jacksonville Harbor. Palm Beach Harbor overlaps the northern portion of Miami Harbor's hinterland. However, it is not anticipated that improvements at Miami Harbor would shift a significant portion of containerized cargo from Palm Beach Harbor to Miami Harbor, or for that matter, Port Everglades, as the cargo delivered to Palm Beach Harbor supplies the local market. Port Canaveral's containerized cargo is also consumed locally, and by the Port's cruise ship business (Disney cruise ship homeport).

The ports of Savannah, Georgia, and Charleston, South Carolina, are respectively 386 and 420 nautical miles north of the Port of Miami. Due to the significant landside trucking costs associated with transshipping cargo between the Port of Miami and either the Port of Savannah or the Port of Charleston, potential cargo shifts among them were not considered economical viable.

Miami Harbor and Port Everglades are only 21 nautical miles from each other. Thus, their hinterlands overlap. If any shifting of containerized cargo did occur due to improvements at Miami Harbor, it would most likely be from Port Everglades.

Table A-93 displays recorded entries from Piers Import Export Reporting Service (PIERS) for select containerized cargo types (vegetable products, food products, and manufactured products) for Miami Harbor and Port Everglades in 1999. As shown in **Table A-93**, the two ports strongly compete in the Central American market as demonstrated by similar total of recorded entries: Miami Harbor, 140; Port Everglades, 154, based on the sample countries: Costa Rica, Guatemala, Nicaragua, and Panama. In this trade, container ships are generally small due to constraints at Central American ports (shallow depths and lack of gantry cranes). But, small Panamax class (maximum beam 106 feet) containerships are employed in this trade region. These small Panamax class container ships have design drafts between 38 and 41 feet. But, they normally do not fully load. So, their actual transit drafts are typically less than their design drafts. Currently, both Miami Harbor and Port Everglades have 42-foot channel depths. Thus, deepening Miami Harbor beyond 42 feet would not impact these vessels; and accordingly, would not bring about a shift in cargo traffic from Port Everglades to Miami Harbor.

The most significant difference in the level of containerized cargo traffic between Miami Harbor and Port Everglades is in the European and Asian trade regions. As shown in **Table A-93**, Miami had 244 total records in the sample of European countries (France, Italy, Spain, and the United Kingdom), while Port Everglades had only 119. Similarly, in the sample of Asian countries (Mainland China, Hong Kong, and Japan), Miami had 124 records, while Port Everglades had 23. If Port Everglades remains at 42 feet, while Miami Harbor is deepened beyond 42 feet, it is possible that some containerized cargo could shift from Port Everglades to Miami Harbor. Landside costs are comparable between the two ports, and the shipping distances between these ports and those in various trade regions are, for all practical purposes, the same. Moreover, most containerized cargo is trucked from the ports. Therefore, land transportation costs are approximately the same and would not change. With a deeper channel, container ships can transport more cargo, reducing the shipping cost per ton. If Miami Harbor were two to three feet deeper than Port Everglades for an extended period of time, the reduction in at sea transportation costs could induce some cargo to shift from Port Everglades to Miami Harbor. However, it is very doubtful that any significant difference in channel depth would continue for a long enough period to induce any shift. The rational economic ("most likely") action for both port authorities would be to insure, at a minimum, channel depth parity. Currently, both ports are 42 feet deep.

Throughput constraints are very critical with respect to potential inducements to shift cargo movements to another port. As cargo traffic grows in the future, both Miami Harbor and Port Everglades will have to make capital expenditures in storage facilities, cargo handling equipment, and intermodal facilities to insure that cargo can be efficiently handled. Accordingly, general indicators of capacity constraints will be used herein to assess the potential for a shift in cargo movements. The intent is to assess the their overall capacities, not the capacities of individual terminals within them.

In fiscal year 2000, Miami Harbor recorded 868,178 TEUs, while Port Everglades recorded 676,760 TEUs. Miami Harbor currently has 363 acres (274 onsite and 89 offsite), while Port Everglades has 302 acres of dedicated container storage. Thus, Miami had a productivity rate (throughput per acre) of 2,392 TEUs per acre, while Port Everglades had a productivity rate of 2,241 TEUs per acre. Both ports are projected to have an overall average annual growth rate of between 4 and 5 percent over the 50-year study period; that is, 2010 to 2060. The single-payment-compound-growth factor for a 60-year period (current year, 2000, to end of study period, 2060) at an annual growth rate of 4.5 percent (midpoint of 4 and 5 percent) is 14.027408. Multiplying each port's number of TEUs in fiscal year

2000 by 14.027408 results in 12,178,287 TEUs for Miami Harbor and 9,493,189 TEUs for Port Everglades. So, by 2060, the ports would have to be able to respectively handle 12.2 and 9.5 million TEUs, assuming a uniform average weight per container.

Cargo throughput capacity consists of a series of connected components: gantry cranes, wharf, terminal equipment, temporary storage facilities, and intermodal connections. The level of cargo that can be handled by these components will depend on key factors: gantry crane and cargo storage handling equipment capacity utilization, container dwell time, storage density, and general operating characteristics (hours per day and days per week day).

With respect to equipment capacity utilization, the big factor is hours of operation. To illustrate, gantry cranes are utilized to their maximum operational capacity at Asian ports, operating on a daily schedule of 20 hours of operations and 4 hours of maintenance, 365 days a year: Twenty hours per day x 40 container moves (minimum) per hour x 1.7 (ratio of total containers to TEUs) x 365 days = 496,400 TEUs per year. So, by year 50 of the study period (2060), Miami would need 25 (12,178,287 TEUs/496,400 TEUs), while Port Everglades would need 20 cranes (9,493,189 TEUs/496,400 TEUs). Currently, Miami Harbor has 12 (2 of the 12 will arrive in 2003/4); it will have to add 13 over the 60-year period. Port Everglades Harbor has 7 gantry cranes; it would also have to add 13. Thus, both ports would have to add approximately two to three (2.6) gantry cranes every 10 years and appropriate cargo-storage handling equipment, if they implemented a "24/7" operation, with equipment operating 20 hours per day. Most of the terminals at the ports do not operate on a "24/7" schedule. Both ports advised that there are no institutional restrictions to a "24/7" operation. The terminal operators set the daily hours of operation (yard hours). The hours of operation reflect the level of container traffic. As container traffic increases over time, it is reasonable to expect that the terminal operators would expand their operational hours, since this would be "economically rational" behavior. Moreover, increasing the number of container moves per hour would reduce the number of required gantry cranes. For example, doubling the number on container moves from 40 to 80 would eliminate the need for additional gantry cranes. Thus, this illustration demonstrates that amount of equipment and the extent of its utilization does not present a capacity constraint at either port.

Because of limited availability and cost, land for the temporary storage of containers (loaded and empty) has the potential to constrain future growth. Currently, Miami Harbor as 363 acres, while Port Everglades Harbor has 302 acres of dedicated container storage. Based on information from a cargo handling equipment manufacturer, 480 loaded containers can be stored on one acre (6 rows of containers wide, 4 containers high, and 20 rows deep) with either a reach-stacker or Rubber Tire Gantry (RTG). If a top-loader is used, 320 loaded containers can be stored on one acre. Empty containers can be stacked higher, up to eight containers high. Stacking eight containers high results in an additional 480 containers per acre. Empty containers represent 25 to 30 percent of both ports' total annual TEUs. In the future, the ports will most likely stack empties higher as an easy way to increase temporary container shortage capacity. But, for this general assessment to determine if throughput constraints over time would result in containerized cargo shifts among competing ports, this assumption does not affect the results. Moreover, trailers are stored at about 50 40-footers per acre, or 100 TEUs per acre. Since trailers are not stacked, one acre can accommodate 100 loaded or empty TEUs. Trailers represent about 40 percent at Miami Harbor and about 10 percent of total annual TEUs at Port Everglades. Trailers will be replaced with containers, as storage space becomes a constraint. This transition has begun at Miami Harbor. Seaboard Marine is already replacing RO/RO vessels with "Combos," that is, vessels that carry both trailers and containers.

Both ports provided information on container dwell time. The weighted average for loaded and empty containers for both ports is about 9 days. Containers on one acre would turn over 40.5 times (365 days in a year/9 days). So, one acre has an annual container storage capacity of 19,440 TEUs (480 TEUs x 40.5) with RTGs or reach-stacker, and 12,960 TEUs (320 TEUs x 40.5) with a top-loader.

Presently, Miami Harbor currently uses a combination of RTGs and toploaders. Assuming a utilization of 30 percent RTGs and 70 % toploaders, Miami Harbor has an annual container storage capacity of 5,410,152 TEUs (363 acres x 14,904 TEUs per acre). Port Everglades uses only toploaders. Therefore, Port Everglades Harbor currently has an annual container storage capacity of 3,913,920 TEUs (302 acres x 12,960 TEUs per acre). The year in which each ports container storage capacity would be exceeded for various annual growth rates is displayed in **Table A-94**. For illustrative purposes, the projected average annual growth rate for both ports is assumed to be 4.5 percent, as previously discussed. At this rate of annual growth, the projected annual container throughput at Miami Harbor would exceed the port's overall container storage capacity in year 42 from the current year (2000) and in year 32 from the base year of the study period (2010); for Port Everglades Harbor, years 40 and 30 respectively, assuming no change in container storage acreage, in the composition ("mix") of cargo handling equipment, and in general landside container handling over time. Any improvements in these operational factors would increase the number of years of estimated storage capacity. But, given the stated assumptions, both ports would reach their temporary container storage capacity to handle future growth at about the same time in the distant future with their current dedicated container storage acreage.

Based on discussions with port staff, both ports have additional land that could be used for container storage, but the amount is limited; as is available acreage at or adjacent to the existing port facilities. In the future, the most likely course of action would be to purchase or lease off-site acreage for the storage of empty containers, which can be stored at twice the density of loaded containers. Furthermore, as containerized cargo tonnage increases over time, it is reasonable to expect that the average container weight will increase. Therefore, fewer containers will be transporting more cargo in the future. The values shown in **Table A-94** assume no change in the uniform average container weight over the 60-year period. Thus, containers grow at the same annual rate as cargo. With heavier, but fewer containers, both ports would reach their container storage capacities later than the years shown in **Table A-94**.

The terminals at ports are as efficient as the circumstances require. The Port of Miami efficiently moves the current number of containers and trailers. However, as the amount of containerized cargo grows, operational and infrastructure changes will need to occur. The

Port of Miami plans for these changed conditions through their Port Master Development Plan and associated capital improvement program (POM 2020 Master Implementation Plan). Recently, larger, faster gantry cranes have been installed and more are on order. Rubber-Tire Gantry (RTG) cranes have replaced traditional stackers. These cranes allow for higher stacking of containers, freeing up more Port-side yard space. Additional Port-side yard space is being made available by the transition from trailers to "grounded" containers, and the utilization of off-site storage facilities for empty containers. On-island transportation improvements, particularly separation of cruise and cargo traffic and construction of cargo gates, is also expected to improve the efficiency of cargo movement. Moreover, the Port is committed to promoting rail delivery of regional waterborne cargo through on-Port rail improvements and the development off-site intermodal container transfer facilities. Furthermore, the Florida Department of Transportation (DOT)'s planned multi-lane tunnel from Dodge Island to Watson Island will facilitate Port traffic, reducing congestion in the immediate Port area. These improvements, which are part of the Port Master Development Plan, will significantly reduce truck traffic to and from the Port on local (particularly Downtown Miami), regional and state roads. On-island capital improvements are paid for by tariffs, terminal leases, and state and federal grants. Given the Port's landside capital improvement record and planned improvements via the Master Plan, it is reasonable to assume that any future growth in cargo and vessel calls would be handled by capital and operational improvements financed by the Port and paid for by tariffs and terminal leases, as well as grant and loan programs. Off-island improvements are funded through local, state and federal programs. Accordingly, it is assumed that necessary capital and operational improvements will be implemented in a planned manner as needed over time and paid for without the project.

Berthing capacity is not anticipated to be a problem for benefiting cargo vessels at Miami Harbor. To illustrate, Table A-1 shows that Bays 99 to 140 (Gantry Crane Berths) have a total of 5,500 liner feet of continuous berthing space. Base on discussions with the Biscayne Bay Pilots Association, the pilots allow about 66 feet (20 meters) between vessels at the berth. They refer to this practice as "shoehorn" or "steel-to-steel" berthing, which is common worldwide. This practice would continue with the Post-Panamax container ships. Taking into account this distance between vessels, four S-Class (SUSAN MAERSK, LOA 1,138 feet) container ships can be berth at a time. A maximum of five Post-Panamax container ships can be accommodated depending on the combination of sizes: S-Class SUSAN MAERSK, LOA 1,138 feet; K-Class REGINA MAERSK, LOA 1,044 feet; and a Composite-Class, LOA 909 feet (see Table A-33). Currently, the large container ships are at the dock between 12 and 15 hours, or an average of 13.5 hours. So, dividing the total hours in a year, 8,760, by 13.5 hours results in 649, which is the maximum annual number of vessels per individual berthing space. Multiplying this value by the total number of vessels that can be accommodated at a single time results in the total annual number of vessels that can be berthed at Bays 99 to 140: 649 x 4 = 2,596 and 649 x 5 = 3,244 vessels. As shown in Table A-45, 1,842 Post-Panamax and 553 Panamax calls, or a total of 2,395 calls are forecasted for years 46 to 50 of the planning period. With the annual capacity to handle between 2,600 and 3,200 Post-Panamax ship calls, this berthing area will be able to accommodate forecasted ship calls benefiting from deepening the channel, minimizing any potential harbor congestion.

Most local capital improvements and related land acquisitions are budgeted for two time periods: short-term, 1 to 5 years; and long-term, 6 to 10 years. Local master plans usually cover a 20-year time horizon, and very often include recommended capital improvements and land acquisitions that are intended to implement the objectives of the master plan. Future cargo facility plans and associated capital expenditures were reviewed for each port, and found to be commensurate with projected growth in containerized cargo growth within their normal planning and budgeting time frames. For example, both ports are investing in additional land storage areas, intermodal facilities, and upgraded gantry cranes for the next generation of Post-Panamax container ships. Thus, the ports have demonstrated that they have historically provided and would provide in the future the funds to purchase land and equipment, as well as extend their hours of operation, as required to accommodate growth in containerized cargo traffic.

Thus, the general indicators of port capacity to handle future growth show that there is no compelling evidence that improvements at either port would result in a shift in cargo movements from one port to the other due to throughput capacity constraints.

The projected future containerized cargo tonnage is based, primarily, on historical annual growth at Miami Harbor with no planned change in current trade region vessel itineraries. The annual growth in Asian and European trade regions is assumed to apply uniformly to all competing ports. As such, no shifting of cargo is expected to result from this growth.

SUMMARY

Based on a review of factors that would indicate whether the improvements at Miami Harbor could potentially result in a shift in containerized cargo from competing ports to Miami Harbor, it is concluded that no significant amount of cargo tonnage would shift.

Table A-92: Liner Imports and Exports for Port Everglades, Miami Harbor, Palm Beach Harbor, Port Canaveral, Jacksonville Harbor, Tampa Harbor 1999 (Short Tons)

Port	Total	Imports	% Of Total	Exports	% Of Total
Port Everglades	2,599,447	1,264,240	48.63%	1,335,207	51.37%
Miami	4,399,517	2,554,021	58.05%	1,845,495	41.95%
Palm Beach	421,098	94,756	22.50%	326,341	77.50%
Canaveral	44,225	39,753	89.89%	4,472	10.11%
Jacksonville	1,457,143	793,121	54.43%	664,022	45.57%
Tampa	199,886	88,555	44.30%	111,331	55.70%

Source: U.S. Imports and Exports, U.S. Customs, Maritime Administration, National Date Center of the U.S. Army Corps of Engineers Web Site.

Table A-93: Foreign Cargo Imports and Exports Recorded Entries for Sample of Containerized Cargo Types: Vegetable Products, Food Products, and Manufactured Products - 1999

	Port Everglades		**Miami Harbor**		**Port Everglades**		**Miami Harbor**		**Port Everglades**		**Miami**
	#66 Vegetable Products	#66 Vegetable Products	#66 Vegetable Products	#66 Vegetable Products	#68 Food Products	#68 Food Products	#68 Food Products	#68 Food Products	#70 Manufactured Products	#70 Manufactured Products	#70 Manufactured Products
	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import
Central America											
Costa Rica	6	5	1	4	6	8	6	6	10	11	5
Guatemala	5	5	4	4	7	7	4	6	8	7	6
Nicaragua	3	1	0	3	4	3	3	5	5	4	2
Panama	6	8	7	8	6	8	11	9	8	13	12
Total	20	19	12	19	23	26	24	26	31	35	25
Europe											
France	1	1	4	1	3	4	8	6	7	5	11
Italy	5	0	14	2	4	4	16	9	9	9	21
Spain	4	2	12	3	7	5	11	9	8	8	17
United Kingdom	2	1	4	4	4	3	13	7	15	8	24
Total	12	4	34	10	18	16	48	31	39	30	73
Asia											
China	0	0	6	0	0	0	7	3	10	1	29
Hong Kong	0	0	2	1	0	0	2	2	3	0	3
Japan	0	0	5	3	0	1	6	10	6	2	26
Total	0	0	13	4	0	1	15	15	19	3	58

	Port Everglades		**Miami Harbor**		
	Total Import Records	Total Export Records	Total Import Records	Total Export Records	Total Records
Central America	74	80	61	79	140
Europe	69	50	155	89	244
Asia	19	4	86	38	124

Source: Port Import Export Reporting Service (PIERS) from Corps of Engineers Navigation Data Center Web Site

Table A-94: Year Number of Projected TEUs Exceeds Current Container Storage (Acres) At Various Annual Growth Rates

	Port Everglades Harbor	Miami Harbor
FY 2000 TEUs	676,760	868,178
Current Container Storage (Acres) [1]	302	363
Current TEU Capacity (TEUs) [2]	3,913,920	5,410,152
Current Year 2000 = Year 0 Base Year of Study 2010 = Year 10 (Study period 2010 – 2060)	Year Throughput > Capacity From Current Year /Study Base Year	Year Throughput > Capacity From Current Year/Study Base Year
Annual Rate = 4.0%	Year 45/35	Year 47/37
Annual Rate = 4.5%	Year 40/30	Year 42/32
Annual Rate = 5.0%	Year 36/26	Year 38/28

[1] Source: Port Authority. Acres dedicated to temporary container storage.
[2] Number of current container storage acres x capacity of one acre per year:
Port Everglades Harbor: 12,960 TEUs (320 TEUs per acre x 40.5 turnover factor).
Miami Harbor: 14,904 TEUs (368 TEUs per acre x 40.5 turnover factor).

RISK AND UNCERTAINTY

SENSITIVITY ANALYSES

Risk and uncertainty associated with the economic analysis are addressed through sensitivity analyses that modify the values associated with key assumptions and/or input parameters to determine the impact of the change on estimated benefits and costs, as well as project formulation. For this study, cargo growth rates and interest rates were identified for sensitivity tests.

INCREASE OR DECREASE IN FEDERAL DISCOUNT RATE

The current Federal interest rate is 5 5/8 percent. By policy, the Federal interest rate cannot change more than one-quarter of a percent per year; therefore, to account for a potential annual adjustment in the interest rate, interest rates of 5 3/8 percent and 5 7/8 percent were used. The impacts on benefits and costs resulting from these changes are shown in **Table A-95 and Table A-96**. These tables show that with an increase or a decrease in the Federal Discount rate, the NED plan for Miami Harbor would remain Alternative H deepened to 49 feet.

Table A-95: Sensitivity: NED Analysis with Increase in Federal Discount Rate

Costs, Benefits, Net Benefits, and Benefit/Cost Ratio for Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,513,685	$2,848,000	$1,334,315	1.88
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$247,579	$1,292,000	$1,044,421	5.22
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,761,264	$4,140,000	$2,378,736	2.35
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$6,365,099	$6,600,660	$235,561	1.04
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$7,244,959	$8,786,425	$1,541,466	1.21
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,790,486	$10,800,441	$3,009,956	1.39
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$8,268,540	$12,337,148	$4,068,607	1.49
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,896,090	$13,584,195	$4,688,104	1.53
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$9,630,974	$14,766,735	$5,135,761	1.53
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$10,569,160	$15,857,601	$5,288,440	1.50
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$11,248,280	$15,887,075	$4,638,795	1.41

Table A-96: Sensitivity: NED Analysis with Decrease in Federal Discount Rate

Costs, Benefits, Net Benefits, and Benefit/Cost Ratio for Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,401,951	$2,848,000	$1,446,049	2.03
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$228,536	$1,292,000	$1,063,464	5.65
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,630,487	$4,140,000	$2,509,513	2.54
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$5,872,269	$6,745,992	$873,723	1.15
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$6,680,015	$9,063,709	$2,383,694	1.36
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,180,854	$11,198,225	$4,017,370	1.56
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$7,621,096	$12,837,114	$5,216,018	1.68
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,196,564	$14,174,082	$5,977,518	1.73
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$8,871,229	$15,440,637	$6,569,408	1.74
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$9,724,753	$16,607,922	$6,883,169	1.71
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$10,343,146	$16,639,250	$6,296,104	1.61

ZERO GROWTH

To determine if future cargo growth is required for project justification, a sensitivity analysis was conducted assuming zero growth from the base year, 2010, to the end of the project life, 2060. The results of this assessment are displayed in **Table A-97**. This assessment shows that growth in cargo traffic is required for benefits to exceed costs. Zero growth is not a realistic assumption; however, it is an expeditious way to demonstrate whether or not a project is economically justified without growth.

Table A-97: Sensitivity: Costs and Benefits of Project Increments with Zero Growth

Costs, Benefits, Net Benefits, and Benefit/Cost Ratio for Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,457,397	$2,848,000	$1,390,603	1.95
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$237,976	$1,292,000	$1,054,024	5.43
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,695,372	$4,140,000	$2,444,628	2.44
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$6,116,498	$4,769,994	-$1,346,504	0.78
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$6,959,919	$5,278,047	-$1,681,873	0.76
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,482,864	$5,748,211	-$1,734,653	0.77
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$7,941,833	$6,079,440	-$1,862,393	0.77
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,543,052	$6,328,980	-$2,214,072	0.74
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$9,247,506	$6,568,110	-$2,679,396	0.71
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$10,142,780	$6,790,886	-$3,351,893	0.67
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$10,791,125	$6,797,335	-$3,993,790	0.63

GROWTH CONSISTENT WITH RECENT HISTORICAL GROWTH

A more realistic test of growth assumptions is to assess the impact of modifying an assumption that represents a deviation from the historical average annual rate of growth and that could have a major impact on project benefits. Specifically, in the analysis, future growth rates for European and Far East import cargo were assumed to be less than their historical average annual rates from 1990 to 2000, 7.6 percent compared to 8.14 and 11.66 percent, respectively. The results of assuming the higher rates of growth at least for the near-term, from 2003 to the base year, 2010, are shown in **Table A-98**. As shown in these tables, the NED plan for Miami Harbor remains Alternative H to 49 feet.

Table A-98: Sensitivity: Costs and Benefits of Project Increments with High Growth

Costs, Benefits, Net Benefits, and Benefit/Cost Ratio for Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,457,397	$2,848,000	$1,390,603	1.95
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$237,976	$1,292,000	$1,054,024	5.43
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,695,372	$4,140,000	$2,444,628	2.44
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$6,116,498	$10,328,304	$4,211,805	1.69
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$6,959,919	$15,919,288	$8,959,369	2.29
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,482,864	$21,057,378	$13,574,513	2.81
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$7,941,833	$25,102,884	$17,161,051	3.16
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,543,052	$28,471,142	$19,928,090	3.33
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$9,247,506	$31,649,507	$22,402,001	3.42
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$10,142,780	$34,567,965	$24,425,185	3.41
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$10,791,125	$34,644,184	$23,853,058	3.21

February 2004

Volume II of II

FINAL

Engineering – Appendix B

For the

Miami Harbor Navigation Study General Reevaluation Report

Miami-Dade County, Florida - 010140

US Army Corps of Engineers®

Jacksonville District
South Atlantic Division

MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

APPENDIX B
ENGINEERING

MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

APPENDIX B
ENGINEERING

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MIAMI HARBOR, FLORIDA
APPENDIX B
ENGINEERING

A. INTRODUCTION

1. General. This appendix presents the discussion of applicable design considerations and construction methods utilized to adequately address the project requirements and to establish a basis for the cost estimates. General requirements for real estate and operation and maintenance are also presented.

2. Selected Plan. The selected plan would include construction of the recommended NED plan with the addition of the locally preferred deepening option. The plan would include several components as follows:

Component 1c. The entrance channel from Station 0+00,Cut-1 to Station 10+00,Cut-1 would be widened from 500 feet to 800 feet symmetrically about the centerline. From Station 10+00,Cut-1 to Station 20+00,Cut-1 the channel width would uniformly transition back to 500 feet. The project depth would be increased from 44 feet to 52 feet.

Component 2a. A turn widener would be constructed from Station 10+00,Cut-3 (Range 400) to Station 19+00,Cut-3 (Range 505). The project depth would be increased from 42 feet to 50 feet.

Component 3b. The Fisher Island Turning Basin in Cut-3 would be increased from 1200 feet to 1500 feet , and the project depth would be increased from 42 feet to 50 feet. The northeast portion of the Turning Basin would be truncated to avoid potential impacts to the existing sea grasses.

Component 4. The western end of the main channel would be realigned approximately 200 feet to the south to provide for future construction of additional cruise ship berths along the north side of the channel. The channel would transition from Station 65+50 Cut-4 to Station 91+65 Cut-4. The project depth would remain at 36 feet and no additional dredging is anticipated.

Component 5a. Fisherman's Channel along the south side of Lummus Island would be widened 100 feet to the south and the Lummus Island Turning Basin would be reduced to a 1500 foot diameter from the currently authorized diameter of 1600 feet. The project depth would be increased from 42 feet to 50 feet.

An overall view of the Miami Harbor Project with the proposed alternatives is presented on Plate B-1. Detailed plan views of the project channel are provided on Plates B-3 through B-15. An index of these plan views is shown on Plate B-2.

A discussion of the plan formulation involved in the selection of the selected plan is presented in the main portion of this report. All soundings presented in this report are at Mean Lower Low Water. The relationship between datums and NGVD 1929 is provided on Plate B-2.

B. HYDROLOGY AND HYDRAULICS

3. General. A detailed discussion of the natural forces affecting the study area was presented in the Miami Harbor Feasibility Report and Environmental Impact Statement, dated June 1989. The areas of discussion include waves, winds, tides, currents, tropical storms, and hurricanes.

In general, however, the currents and water surface elevations in Miami Harbor are subject to the astronomical Atlantic Ocean and Gulf Stream eddies, the effects of winds, upland drainage, and the variations in barometric pressure. The tidal currents in Government Cut cause the greatest influence on navigation. The highest currents are during flood tide, but currents during both ebb and flood present a navigation problem.

4. Velocity and Salinity Assessment. The Coastal and Hydraulics Laboratory (CHL) at the Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi prepared a report summarizing the findings from a depth-averaged two-dimensional finite element hydrodynamic circulation modeling study investigating velocities and salinity in the harbor and on velocities along the coastal ocean shoreline in the vicinity of Government Cut. The report details the boundary conditions used to drive the simulation, and the existing harbor configuration, to those obtained for the proposed harbor configuration. The report is included as Attachment A to this Appendix.

5. Ship Simulator Modeling. a. Previous. The Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi conducted a ship simulator study in support of preparation of the Miami Harbor Design Memorandum, dated October 1991. The final report was published in April 1991

b. Recent. During the Fall of 2000, a navigation study consisting of real-time ship simulation modeling was conducted by the Simulation, Training, Assessment and Research (STAR) Center in Dania, Florida. The results and recommendations of this latest study are included in Attachment B to this Appendix.

6. Projected Impacts to Channel Shoaling. Recent sediment budget studies[1] have been performed along the length of the Dade County Beach Erosion Control project, which extends along the length of the Dade County Atlantic shoreline from northern Sunny Isles southward to Government Cut. These sediment budget studies indicate that the net littoral transport in the vicinity of

Government Cut is about 24,000 cy/yr to the south, which represents the maximum potential sediment transport rate into the channel. The most recently calculated sediment budgets conclude that an average of 15,000 cy/yr is deposited in the interior channels, while 9,000 cy/yr is deposited in shoals along the outer reaches of the channel. These values agree closely with observed shoaling rates as determined from dredging records.

The proposed widening and deepening of the entrance channel would tend to further decrease any sediment bypassing, but under the existing conditions the Miami Harbor entrance channel already forms a complete littoral barrier. Examination of the sediment budget for Government Cut shows that the entire volume of southward-directed sediment transport is deposited into the interior and exterior reaches of the channel, and the volume of sediment bypassed across the entrance channel to downdrift beaches is essentially zero. The proposed deepening and widening of the existing project cannot therefore further increase the rate of channel shoaling or decrease the volume of sediment bypassing.

Numerical modeling of the proposed channel improvements has been performed, and the results of these simulations show that negligible changes to current velocities and salinity levels will occur throughout the extent of the project as a result of the proposed improvements.

Due to the lack of sediment bypassing under the existing conditions, and due to the negligible changes in tidal current velocities as determined by numerical modeling, no significant changes to the existing shoaling rates and patterns of deposition are expected due to construction of the proposed channel improvements at Miami Harbor.

[1] Dade County Regional Sediment Budget, Coastal Systems International, January 1997; Dade County Evaluation Report, Jacksonville District,COE, October 2001

C. GEOTECHNICAL INVESTIGATIONS

7. Geologic History. Due to previous dredging projects of the harbor and entrance channel, the majority of the project area is exposed rock. A few localized areas are mantled by a few feet of sand due to shoaling. The sand is usually tan or gray, contains some fines and also fills solution holes in the underlying rock. A portion of Cut 1 in the Entrance Channel, between the reefs, is sand with no rock. In areas not previously dredged, yellow to white massive limestone and sandstone units of the Miami Oolite Formation are overlain by sand and silts. The Miami Oolite Formation has many solution channels and is very permeable. It has a maximum thickness of 30 feet in the project area and has its base at an approximate elevation of –35.0 ft. MLW. The presence of a hard basal conglomerate at this elevation signifies the unconformable contact with the older Fort Thompson Formation. The Fort Thompson consists of tan

colored, sandy limestone, calcareous sandstone and seams of sand. With deeper depths, the sand seams increase in size and are thicker than the rock strata in some places. Many solution holes are present and are either open or filled with sand or secondary limestone. In both the Miami Oolite and the Fort Thompson Formations solution activity and re-crystallization have created zones of differential rock strength that cause the rock to fragment into large pieces that makes excavation difficult.

8. Investigations. Many of the borings taken in Miami Harbor are from previous dredging projects and are of limited use as the material they represent has already been removed. These core borings and locations can be found in the Miami Harbor Channel, Florida, General Design Memorandum (GDM), Revised May 1991. Additional borings have been drilled since the last dredging event. Borings were taken in 1993 to investigate a rock claim in the entrance channel from Station 8+00 to Station 40+00. To investigate the area around Dodge Island, 11 additional core borings were drilled in 1995. The cores from the borings that are useable from these sources were disposed of when the Port Authority took control of the project and are no longer available for viewing. Eighteen borings were drilled in January 2001 to further investigate the Lummus Island Turning Basin and gather additional information for the General Reevaluation Report (GRR). Prior to obtaining the additional borings that will be required for Plans and Specifications, it is recommended that a Resistivity study be conducted using the Aquares System. This will provide information on the relative hardness (based on density) of the rock to be excavated and help identify areas that are more likely to require blasting. It will also delineate sand and rock interfaces, both vertically and horizontally. In addition, it will identify rock slabs or boulders that may exist within the channel limits as a result of previous construction. [2] The 2001 core borings encountered primarily rock but recovered very little solid core due to the porous nature of the rock and breakage during drilling operations.

9. Previous Dredging. The last deepening was excavated in two phases using cutterhead and hydraulic excavator dredges. The entrance channel and half of Fisherman's Channel was Phase I and was dredged to –42.0 ft. using a cutterhead dredge with great difficulty. The Lummus Island Turning Basin area was Phase II and with the exception of a few places, could not be dredged below about – 35.0 ft. with a large hydraulic excavator. The excavator could not find the fractures needed to wedge the bucket into the rock for removal. An unconformity was identified in the GDM at about this depth where the rock gets harder and is believed to be the contact with the Fort Thompson Formation. The remainder of the rock is scheduled for removal to a depth of –42.0 ft.

10. Materials Encountered. A description of the materials encountered during subsurface investigations is provided as follows:

[2] 6/03/04 - Added previous four sentences

COMPONENT 1

Widening seaward portion of Cut 1 from 500 to 800 ft.

Sta. 0+00 to Sta. 20+00. The material to be removed is hard to very hard, fossiliferous limestone with coral from the surface down, with exception to the western end of the transition zone, outside of the reef area, which is sand. The limestone is porous and massive, containing many voids and vugs. The rock was highly broken due to the nature of the rock and the drilling process resulting in little or no recovery of solid core.

Channel Deepening from -44 feet to -52 ft. MLLW.

Sta. 0+00 to Sta. 14+00. This is a reef area where limestone and sandstone is exposed at the channel surface. The seaward 500 feet of the channel is in increasingly deep water that is below the depths considered for deepening. The limestone is moderately hard to hard, very porous, massive and vuggy with cavities throughout the rock due to the formation of the rock in a reef environment and/or through solution activity and replacement. Divers reports have confirmed rock fragments up to 20 inches covering the channel bottom. These fragments are present due to rock breaking off of the reef and previous dredging episodes where the larger fragments could not be picked by the hopper dredge and were actually pushed up in rows along the channel. The bottom of the channel was reported to undulate by over 3 feet due to furrows produced by past dredging operations.

Sta. 14+00 to Sta. 34+00. Carbonate and quartz sand and shell is the dominant material between the reefs with little or no rock being present except scattered rock fragments throughout and in areas in close proximity to the reefs. Initial core borings indicate that the sand is continuous to approximately –59.0 ft.

Sta. 34+00 to Sta. 55+00. This is an area that requires further delineation. The divers report confirmed an area of continuous limestone with rock fragments ranging in size from gravel to boulders up to 20 inches. This area was characterized as having "wind rows" with a 1-foot height difference on the surface of the channel due to cutterhead dredging activities. The report indicated an adjacent sand area with rock fragments primarily 1-6 in. with no continuous rock. The area had boulders 4-5 feet in diameter strewn about. Recent core borings in the reef area shows sand to –52.0 ft. with a 1-foot layer of limestone that was disturbed by dredging, as reported by the diver survey. Data is very sparse in this area and older borings show that the material removed previously was rock in most of this area. The borings did not go deep enough to indicate what material was below that. Until further data is collected, based on old borings and the diver survey, the majority of this area is considered rock. An area of sand does occur to –53.0 ft. in the southern end of the channel at Sta. 46+00 extending to the northern side of the channel at Sta. 52+00. The sand then continues on the northern half of the channel to Sta. 67+00. The sand on the North side of the channel may go deeper than –54 ft. as that is where the borings terminated.

Sta. 55+00 to Sta. 83+00. The reach primarily consists of hard sandstone from the surface to at least –54.0 ft. with one area of sand in the area of boring CB-MH89-12 on the North side of the channel from Sta. 55+00 to Sta. 67+00, as described in the above paragraph. The sandstone is porous, fossiliferous, and vuggy and contains many cavities. The rock also contains many small seams (< 1 foot) of moderately hard sandstone and sand with shell within the unit. Coral with calcite deposits were encountered from –51.2 to –53.2 ft. in boring CB-MH89-121.

Sta. 83+00 to Cut 2 Sta. 13+00. The materials in the bend joining Cuts 1 and 2 and widener are represented by hard limestone and moderately hard to hard sandstone from the surface down. All of the rock is porous, vuggy, and fossiliferous and contains cavities. The rock units contain thin seams of moderately hard and hard limestone and loose or poorly cemented sand. Sections of solid core (4 foot) representing more competent rock were recovered in core borings CB-MH89-21 and 128. This area may prove more resistant to dredging.

Cut 2 Sta. 13+00 to Cut 3 Sta. 0+00. The materials in the channel are represented by hard limestone, moderately hard and hard sandstone. A 1-2 foot layer of sand at the surface is present throughout, on average to –48 ft. Transitioning West from the dogleg to Cut 3, the rock becomes primarily moderately hard sandstone with thin lenses of hard sandstone. Hard limestone and sandstone units occur but in lesser amounts. Larger sand and shell layers up to approximately 2 feet thick also become prevalent. The rock in this reach is porous, vuggy, massive and fossiliferous containing cavities and sand seams.

COMPONENT 2

Add turn widener at Buoy #15, deepen to –50.0 ft. MLLW.

Cut 3 Sta. 12+00 to Sta. 19+00. The widener is a triangular cut along Fisher Island at the junction of the Cut 3 Entrance Channel and Fisherman's Channel alignments. The water depths vary from –46.0 ft., near the channel, to -9.0 ft. near Fisher Island. Materials to be dredged from the surface to –24.0 feet include moderately hard to hard limestone. The limestone is massive, very fossiliferous and permeable with approximately 1.0 foot solid core pieces occurring between -10.5 and -16.5 ft. (hard limestone area). From –24.0 to –50.0 ft., a clean sand (SP) is the dominant lithology. The sand contains thin seams of hard sandstone to –32.5 ft. From –32.5 to –36.0 ft., a moderately hard sandstone with seams of sand and hard limestone occurs. From –36.0 to –50.0 ft., the sand contains thin seams of hard sandstone and limestone with occasional layers of hard limestone that are approximately one foot thick. Rock is present below –50.0 ft.

COMPONENT 3

Deepen remainder of Cut 3 from –42.0 to –50.0 ft. MLLW.

Cut 3 Sta. 0+00 to Sta. 26+00. The materials to be removed are moderately hard sandstone with seams of loose sand and clean sand with thin sandstone lenses. A one-foot layer of hard limestone occurs between –47.0 and –48.0 ft. in the southern part of the channel. Hard limestone exists at approximately –50.0 ft..

Expand Fisher Island Turning Basin.

Cut 3 Sta. 26+00 to Sta. 42+00, North Expansion. Surface depths range from -11.0 to -47.0 ft. From the surface to depths of approximately -30.0 ft., the materials are predominantly sand, both clean and silty, with areas of soft to moderately hard limestone beginning at –15.0$_3$ Below 30.0 ft., are units of hard to very hard, fossiliferous limestone and sandstone with seams of loose sand and poorly cemented rock. Ranging between –45.0 ft. and –48.0 to –50.0 ft., the lithology is clean sand with many thin lenses of sandstone with hard limestone below –50.0 ft.

Fisher Island Turning Basin Deepening to –50.0 ft. MLLW.

Surface depths vary from –43.0 to –48.0 ft. with the extreme western end having a high area of –31.0 ft. This area is characterized with an intermittent 0.5-1.0 foot layer of clean sand at the surface followed by moderately hard, porous sandstone with thin seams of loose sand, poorly cemented rock and hard sandstone to approximately –48.0 ft. Below –48.0 ft. is a hard to very hard limestone. The limestone is massive and permeable containing many cavities that have been filled and solidified. Secondary recrystallization of the limestone is present in addition to hard coral. This area requires further investigation to define the limits of the hard rock.

COMPONENT 5

Fisherman's Channel extension 100 feet to the South.

Existing surface depths vary from –3.0 to –46.0 ft. MLW. From Sta. 0+00 to Sta. 20+00, the rock contact from the surface is at –41.0 ft. grading up to –12.0 ft. at Sta. 20+00. The rock contact in the shallow area from Sta. 20+00 westward continues at approximately –12.0 ft., fluctuating to –17.0 ft. where Fisherman's Channel opens into the Lumus Island turning widener. The unconsolidated material above the rock is shelly, silty or clayey sand at the surface underlain by clay, silt, shell and/or clean sand. The rock, in general, is a moderately hard to hard limestone or sandstone, depending on the sand content. The rock is massive, porous, sandy, fossiliferous and is riddled with partially filled voids or cavities. Sand layers occur throughout the rock but is more prevalent on the eastern end of Fisherman's Channel between Sta. 3+00 and

40+00. A 10-12 ft. layer of sand exists between the rock units dipping to the east from Sta. 40+00 beginning at –23.5 ft. to Sta. 13+00 at –32.5 ft.

The rock is initially about 10 foot thick before a one to three foot sand layer and or cavity separates it from a very hard and dense limestone layer that varies from 2-4 feet thick. This layer occurs at elevations varying between –27.0 to –32.0 ft. from Sta. 30+00 to the western end of the extension. The limestone contains hard coral and re-deposited crystalline limestone. Although solid cores were taken from this layer during drilling operations, the layer does contain voids and is permeable. This may represent the contact between the Miami Oolite and Fort Thompson Formations. Below this rock is a hard, massive limestone that is very porous and contains many cavities and solution holes that are partially filled with secondary, soft to moderately hard limestone. At about –43.0 ft., the rock becomes harder more solid and coralline with crystalline secondary deposits.

Fisherman's Channel Deepening from –42.0 to –50.0 ft. MLLW.

The materials underlying Fisherman's Channel are hard to very hard, massive sandy limestone and calcareous sandstone. The rock is fossiliferous, permeable and porous containing many solution channels. Some areas have undergone secondary recrystallization and are very hard and dense, while certain areas have seams of sand intermixed throughout the rock. Sta. 15+00 – Sta. 21+00 is predominantly sand to about –47.0 ft. where the borings end or rock is encountered. The majority of the channel has been cut to approximately –46.0 ft. with exception to the extreme western section where removal of the rock to –42.0 ft. is scheduled to occur.

Lumus Island Turning Basin Deepening from –42.0 to –50.0 ft. MLLW.

The turning basin is scheduled to be deepened to –42.0 ft. in 2002. The materials below –42.0 are similar to that in Fisherman's channel, consisting of moderately hard to very hard limestone and sandstone. A 1-4 ft. sand layer is continuous throughout most of the turning basin. The sand layer varies in depth from approximately –45.0 to –53.0 ft.. The sand layer was exposed on the eastern portion of the turning basin that had been dredged to –45.0 ft. The sand layer is not found in the southwestern portion of the turning basin. It is difficult to predict the amount of limestone overlying the sand layer until the deepening of the basin to –42.0 ft. is complete as the depth of dredging in the past has been well below the project depth.

11. Laboratory Analyses. Representative samples of unconsolidated materials from selected core logs were sent to Law Engineering and Environmental Services in Jacksonville, Florida for analysis. The applicable logs, and laboratory reports of specific gravity, unconfined compression tests, grain size distribution curves, and settling rates testing are included in Attachment C to this Appendix.

12. Blasting and Excavation. The majority of the material to be removed is rock and most of that rock is moderately hard to hard to very hard and may [3] require blasting. Also, from previous dredging experience, gravel, cobbles and boulders are expected to be present throughout the project. The following requirements for blasting would be included in the construction contract plans and specifications:

Blasting shall conform to the requirements specified within the Plans and Specifications. The contractor is required to follow all regulations regarding the transporting, handling and storage of explosives, safety, and any state, county, municipal, Port Authority and Coast guard laws or codes. The contractor must hold a public meeting to answer, by a blasting specialist, any questions concerning blasting prior to blasting. The contractor is required to make the necessary plans, examinations, pre-blast vibration surveys and test blasts. Blasting shall only be performed in conjunction with an Endangered Species Watch Plan as discussed in the EIS. Prior to the commencement of blasting operations, the contractor is required to submit a detailed blasting plan including, the location, size, spacing, type of explosives, sequence and pattern of delays, anticipated peak particle velocity, maximum peak positive airblast overpressure at the nearest structure to the blast and a description of and purpose for special methods. The plan must be approved by the contracting officer. A specialist in vibration control will monitor the seismograph readings to verify vibrations from blasting. If underground utilities have not been removed at the time of blasting, a 50-foot no-blast radius around the utility should be observed. The Contractor shall coordinate blasting operations with the Miami Harbor Port Authority and the U.S. Coast Guard.

D. DESIGN AND CONSTRUCTION

13. General. A project plan and plan plate index with location map are shown on Plate B-1 and Plate B-2, respectively. The proposed project plan with channel wideners and turning basins is shown on Plates B-3 through B-15. The diked upland disposal area on Virginia Key (Plate B-16) would be used for the placement of the excavated sands. Some typical sections of the proposed project excavation are provided on Plates B-19, B-20, and B-21.

14. Channel Wideners. The channel wideners in Cut-1 would be constructed from Station 0+00 to Station 10+00 to a width of 150 feet each side of the existing channel limits. A uniform transition would be constructed from Station 10+00 to Station 20+00. The wideners would be excavated to a project depth of 52 feet plus applicable overdepths.

15. Turning Basins. The proposed Fisher Island Turning Basin (approximately 1500-foot diameter) would be located on the centerline of the

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[3] 6/03/04 - Changed "will" to "may"

channel at approximately Station 21+30. The turning basin would be excavated to a project depth of 50 feet plus applicable overdepths.

16. Side Slopes. For estimating purposes, the average side slope for the proposed excavation was determined to be 1 vertical on 3 horizontal (1V:3H) in sand and approximately 1vertical on 0.5 horizontal (1V:0.5H) in rock.

During project construction, the contractor would be required to implement adequate quality control measures to minimize excavation beyond the channel limits. This will insure a more vertical side slope and thereby minimize sea grass impacts.

17. Environmental Considerations. The environmental impacts of the project, including the proposed mitigation plan, are discussed in detail in the main report and in the Environmental Impact Statement (EIS). For information on side slope determinations refer to Appendix G of the EIS.

The dredging in sand or unconfined material would be performed as a box cut. Most of the cut in rock should remain vertical after dredging. However, it is anticipated that the sediment above the rock will fall in at slopes as flat as 1V:0.5H to 1V:7H. It is anticipate that in time (1 to 5 years) the typical slope along the subject channel will become 1V:7H due to wave action and ongoing settlement of materials. The materials from this long-term sloughing will settle in the bottom of the channel adjacent to the vertical rock cut making the rock cut appear to be non-vertical in future surveys.

18. Overdepths. An additional 1-foot of overdepth is included in the excavation quantities to allow for dredging inaccuracies.

19. Disposal Areas. The existing diked upland disposal area located on Virginia Key would be used for placement of the sand material from construction of the project. A minimal cost for preparation of the disposal area is included in the project cost estimate. The rock would be placed in the mitigation areas located offshore and in Biscayne Bay north of the Julia Tuttle Causeway. Refer to Plates B-1, B-16, and B-17. An excavation and disposal plan is provided on Plate B-22. This plate identifies the approximate quantities of sand and rock that would be excavated from the various reaches of the project, and the anticipated method of construction and subsequent disposal.

20. Construction Procedure. For cost estimating purposes, it is anticipated that a rock cutterhead dredge would be used for excavation of both sand and rock in Cuts 1 & 2. This material would be loaded into scows and hauled to the ocean disposal area. The sand from the Fisher Island Turning Basin and Fisherman's Channel expansions would be excavated by hydraulic pipeline dredge and placed into the diked-upland disposal area on Virginia Key. The rock would be blasted and then removed by hydraulic excavator and loaded into barges. A portion of the rock would be used to construct the offshore artificial reefs and the seagrass mitigation area in Biscayne Bay, and the excess would

be hauled to the ocean disposal area. A detailed discussion of the estimate assumptions is included in the project cost estimate.

E. RELOCATIONS

21. General. The project sponsor will be required to assume the costs of all relocations and alterations. Two utilities likely to be relocated prior to construction of this project would be affected if they remain in their current locations. The utilities are WASD 54-inch sewer line crossing Component 2 and one 24-inch water main crossing Fisherman's Channel in Component 5.

22. Utilities. The location of utilities within the project area is shown on Plate B-18. The Miami-Dade Water and Sewer Department (WASD) owns a force sewer main in a submarine crossing within Component 2 leading from Miami Beach to its Fisher Island treatment plant. The crossing consists of a 54-inch ductile iron pipe running under the riverbed with top of pipe elevation at elevation –50 feet. If relocation were required, SAJ estimates that design and construction would cost $5 million to $6 million and take two years to complete using the directional drilling method. Installation and removal of the 54-inch sewer main using the trenching method resulted in a lower cost and, therefore, is included as the relocation cost in the project cost estimate in Table B-1.

Additionally, WASD owns a water main in a submarine crossing within Component 5 leading from Fisher Island to Lummus Island. This crossing consists of a 20-inch concrete pipe running under the riverbed with top of pipe elevation at elevation –53.0 feet. If relocation were required, SAJ estimates that design and construction would cost $2.5 million to $5 million and take two years to complete using the directional drilling method. Installation and removal of the 20-inch water main using the trenching method resulted in a lower cost and, therefore, is included as the relocation cost in the project cost estimate in Table B-1.

The Florida Power and Light Company (FP&L) owns two transmission lines in a submarine crossing within Component 5 leading from its Fisher Island plant to Lummus Island. The crossing consists of one 69 kV circuit and one 138 kV circuit each inside 24-inch pipe conduits with top of pipe elevation at elevation –45.8 feet and 45.6 feet Local Mean Low Water (LMLW). These transmission lines will be relocated as part of the continued construction of the currently authorized project. Further discussion is presented in the main report.

23. Berthing Areas. As an item of local cooperation, the Port of Miami would be responsible for the dredging of the project berthing areas to provide the appropriate depths. It is proposed in this report to increase the width of the

berthing areas in Fisherman's Channel to 160 feet. The current width is 100 feet. A discussion of this topic is presented in the main report.

F. OPERATION AND MAINTENANCE

24. General. The Federal Government would be responsible for operation and maintenance of the navigation improvements proposed in this report upon completion of the construction contract. The Federal Government currently maintains the existing project. The contractor would be responsible for all maintenance during the construction contract.

25. Maintenance Dredging. Miami Harbor experiences very little shoaling. Since construction of the 36-foot project in 1973, the harbor has been maintained only once to remove an estimated 250,000 cubic yards of shoal material. This was in 1989, resulting in an average shoaling rate of about 15,000 cubic yards. Based on this shoaling history, it is anticipated that implementation of the selected plan would have only minimal effect on the average annual maintenance costs. A discussion of the sediment budget studies and numerical modeling in Miami Harbor is presented in paragraphs 170 through 173 in the main report.

26. Dredged Material Management Plan (DMMP). A preliminary dredged material management plan assessment has been prepared and a discussion is provided in the main report. See Appendix E to the main report.

27. Navigation Aids. The U.S. Coast Guard would be responsible for providing and maintaining navigation aids. Additional aids to navigation would be required for this project, and the estimated cost is included in the project cost estimate. The U.S. Coast Guard anticipates that the following changes would be required.

Component 1c. No Change.

Component 2a. Relocate several buoys at no cost. Relocate Light 15 to the center of the widener. The estimated cost would be $150,000.

Component 3b. Relocate one Light at an estimated cost of $7,500.

Component 4. No Change.

Component 5a. Relocate one Light at an estimated cost of $7,500, and discontinue one Light at an estimated cost of $1,000.

G. QUANTITIES AND COST ESTIMATES

28. Summary of Costs. The estimates of first cost for construction of the both the NED plan and the Selected Plan were prepared using M-CACES software and are presented in Table B –1. The estimate includes a narrative, a summary cost, and a detailed cost showing quantity, unit cost, and the amount for contingencies for each cost item. The costs of the non-construction features of the project are also included in the cost estimate.

The costs have been prepared for an effective date of October 2003.

H. SCHEDULE FOR DESIGN AND CONSTRUCTION

29. Schedule for Design and Construction: An estimated schedule for completion of plans and specifications and other applicable construction milestones is provided as below. The schedule is based on authorization of the project in a Water Resources Development Act (WRDA) of 2004. Preconstruction, Engineering, and Design (PED) would begin after receipt of the Division Engineer's Public Notice.

1st CONTRACT (Components 1c and 2a)

Complete Draft Plans and Specifications	October 2005
BCO Review and Final Plans and Specifications *	February 2006
Advertise / Award Contract	May 2006
Start Construction (12 Months)	August 2006
Complete Construction	July 2007

2nd CONTRACT (Components 3b and 5a)

Complete Draft Plans and Specifications	April 2006
BCO Review and Final Plans and Specifications	August 2006
Advertise / Award Contract	November 2006
Start Construction (29 Months)	February 2007
Complete Construction Dredging	June 2009
Complete Offshore Reefs (4 Months)	October 2009
Complete Seagrass Mitigation (4 Months)	February 2010

* BCO represents Bidability, Constructibility, and Operability

TABLE B-1

PROJECT COST ESTIMATE
NED Plan and Selected Plan

Miami Harbor GRR - FY2004
NED Recommended Plan -
(49' and 51' Project Depth)
Locally Preferred Plan -
(50' and 52' Project Depth)

Designed By: Jacksonville District
Estimated By: CESAJ-EN-C

Prepared By: B. Blake

Preparation Date: 12/15/03
Effective Date of Pricing: 10/01/03

Sales Tax: 7.30%

Planning Estimate for General Reevaluation Report (GRR), including Profit and Contingency (Final NED Recommended Plan and Locally Preferred Plan)

Miami Harbor, Florida

NED Recommended Plan - 49'(*) and 51'(**) Project Depths
Locally Preferred Plan - 50'(*) and 52'(**) Project depths

(*) - Inner Harbor Segments
(**) - Outer Harbor Segments

Reference Email of 12 December 2003 from CESAJ-PD-PN/R. Powell requesting final MCACES be prepared for the Final Report. This included the NED Recommended Plan and Locally Preferred Plan final cost requirements.

* - Final revisions made to the final plans MCACES following review by the Study Manager, R. Powell on 17 December 2003.

Revised quantity computations covering each plan segment ere provided by CESAJ-EN-DL/J. McRae on 12 September 2003. This included separation of the dredge materials into rock not requiring drilling and blasting and non-rock materials. It is assumed that the material in Segment 1C Cut-1/2 PI-Widener will be rock requiring drilling and blasting according to the final geotechnical analysis of the plans.

CESAJ-EN-DL/R. Henderson provided the final revised Seagrass mitigation site design information and the offshore reef mitigation site design requirements including quantities to be included in the final plans.

Final NED Plan as follows:

1C - Cuts 1 and 2 and PI-Widener: 51' Required Depth + 1' Allowable Overdepth with disposal into the Miami Harbor ODMDS.

2A - Cut 3 New Widener: 49' Required Depth + 1' Allowable Overdepth with disposal of the rock material into the offshore artifical reefs or into the Miami Harbor ODMDS.

3B - Cut 3 (Fisher Island T. Basin): 49' Required Depth + 1' Allowable Overdepth with disposal of rock into the offshore artificial reefs or into the Miami Harbor ODMDS. Non-rock material will go into the Virginia Key upland site.

5A - Fisherman's Channel and Lummus Island T. Basin: 49' Required Depth + 1' Allowable Overdepth. Also, designated Port Berthing Areas adjacent to Fisherman's Channel to 49' Required Depth + 1' Allowable Overdepth with disposal of rock into the offshore artificial reefs, Biscayne Bay seagrass mitigation hole, or into the Miami Harbor ODMDS. Non-rock material will go into the Virginia Key upland site with some of the material being used later to cap the Biscayne Bay seagrass mitigation hole.

Final LPP Plan as follows:

1C - Cuts 1 and 2 and PI-Widener: 52' Required Depth + 1' Allowable Overdepth with disposal into the Miami Harbor ODMDS.

2A - Cut 3 New Widener: 50' Required Depth + 1' Allowable Overdepth with disposal of the rock material into the offshore artifical reefs or into the Miami Harbor ODMDS.

3B - Cut 3 (Fisher Island T. Basin): 50' Required Depth + 1' Allowable Overdepth with disposal of rock into the offshore artificial reefs or into the Miami Harbor ODMDS. Non-rock material will go into the Virginia Key upland site.

5A - Fisherman's Channel and Lummus Island T. Basin: 50' Required Depth + 1' Allowable Overdepth. Also, designated Port Berthing Areas adjacent to Fisherman's Channel and Lummus Island T. Basin to 50' Required Depth + 1' Allowable Overdepth with disposal of rock into the offshore artificial reefs, Biscayne Bay seagrass mitigation hole, or into the Miami Harbor ODMDS. Non-rock material will go into the Virginia Key upland site with some of the material being used later to cap the Biscayne Bay seagrass mitigation hole.

Future Project Maintenance Requirements.

There will be no additional maintenance dredging required resulting from the construction of the final plans as indicated in the Main Report under "Future Operations and Maintenance Section according to CESAJ-EN-HC/T. Martin.

Mitigation Requirements as follows:

Construct Offshore Reefs - One Low Relief Low Complexity (LRLC) south of Cut-1 Entrance Channel and one High Relief High Complexity (HRHC) south of Cut-1 Entrance Channel with dredged rock from the project.

* - Fill existing holes located in Northern Biscayne Bay with dredged rock and sand from the project using the DERM recommended mitigation site location.

Preconstruction, Construction, and Post Construction Monitoring added to the estimate based on the costs and requirements provided by Mr. Steve Dial of Dial-Cordy Associates via CESAJ-PD-E/Terri Jordan.

Revised the Post Construction Monitoring from 3 to 5 years.

Seagrass Mitigation Oversite and Monitoring (5 years) cost added to the estimate that were provided by the Port's consultant, Ms. Pat McNeese.

* - Seagrass planting added to the environmental mitigation based on estimate of $576,000 that was provided in Email dated 17 November 2003 from the Port of Miami, Ms. Amy Kimball-Murley.

Estimate Assumptions:

1. Dredging of rock material will be accomplished using a hydraulic excavator dredge loading scow barges. Drilling and blasting will be required of all rock prior to dredging except within Segment 1C, Cuts 1 and 2 (Outer Government Cut).

Dredging in Cuts 1/2 and PI-Widener based on using a Rock cutterhead dredge loading scow barges vs. the hydraulic excavator with blasting. Blasting will be required in the Cut 1/2 PI-Widener only according to the latest geotechnical analysis.

2. Dredging of non-rock (unclassified) material will be accomplished using a 30-inch cuttersuction pipeline dredge with boosters.

3. The dredging costs were computed using the Cost Engineering Dredge Estimating Program (CEDEP) in accordance with ER 1110-2-1302. Dredge production used in CEDEP was derived from historic contract production for similar work.

4. The construction of the offshore mitigation reefs will use rock material dredged from the project utilizing the same dredge and scow barges. An additional clamshell dredge or barge mounted crane capable of offshore operations will be required for precise placement of the rock specified for the construction the HRHC reef.

5. The cost estimate for the mitigation constructon is the ADDED cost only. This is based on the assumption that all the material used to construct the offshore reef and for filling the bay holes will come from the dredging. If the dredge material is later found not to be satisfactory for mitigation purposes, the cost estimate will have to be revised upward to account for obtaining offsite material. This could result in a substantial cost increase for the mitigation.

The filling of the holes in Northern Biscayne Bay will use rock material dredged from the project utilizing the same dredge but requiring the use of smaller scow barges due to the limited depths along the Waterway route accessing the holes. The sand material for capping the holes following the placement of the rock material will require the use of a smaller crane barge to offload the material from the Virginia Key upland disposal site into the same small scow barges. The loaded scow barges will then be hauled to the holes and place the sand on top of the previously placed rock.

The following quantities and design requirements for the seagrass and offshore reef mitigation (increased) provided by CESAJ-EN-DL 8 Dec 03.

25 Acre Hole - 2,125lf x 500lf using 720,000 cyds rock and 80,000 cyds sand.
Low Relief LRLC - 35.1 acres using 100,000 cyds of rock from dredging.
High Relief HRHC - 20.0 acres using 150,000 cyds of rock from the dredging.

6. The removal of the existing utilities crossing the channel impacted by the new project construction will follow the relocation (installation) of the replacement utilities as part of the construction dredging for the new project. The existing utilities are a 54" concrete force main crossing Government Cut-2 and a 20" ductile iron water main crossing Fisherman Channel, according to the WASD asbuilts.

The relocation will include cleaning and inspection of the abandoned lines prior to removal. The excavated/removed pipeline and dredged material will be disposed of in a specified offshore disposal location (either the Miami Harbor ODMDS or for reef creation).

The relocation (installation) of the replacement pipelines (54" Concrete Sewer Force Main and 20" Ductile Iron Water Main) will involve the excavation by hydraulic excavator dredge and scow barges of a 100 foot wide open trench following drilling and blasting for the cover area and a 20 foot wide trench for the pipeline placement. New lines to be same type pipeline and construction as the original lines for the estimate.

The new lines will then be placed within the trench and covered and compacted with specified backfill material which will either consist of a portion of the excavation material along with disposal material already located at Virginia Key upland disposal site if needed. This will be accomplished using a small clamshell crane barge with scow barges. The remaining excavation material not used for backfilling the trenches will be disposed of in designated offshore location (either the Miami Harbor ODMDS or for reef creation).

The new lines with then be pressure tested and inspected by the WASD.

Most of the construction equipment required for the utility relocation work will already be on site to be used for the dredging work. This will significantly reduce the mobilization cost for the utility relocation work.

On 2 December 2003 CESAJ-EN-DM/G. Deloach provided final design requirements including the construction of cofferdams at either end of the pipeline relocations for disconnection/reconnections below Mean High Water elevation.

7. Turbidity Monitoring and Endangered Species Monitoring costs are included in the dredging unit costs.

Estimate Parameters:

1. Contractor Field Overhead, Home Office G&A, Profit, and Bond indirect costs are included in the estimate computed in MCACES based on historic contractor rates for similar work.

2. Used 20 percent contigency on the estimated construction costs which is appropriate for the level of project design.

3. PED and S&A non-construction costs ARE included in the estimate. The percenatage of total construction cost as indicated by CESAJ-EN-DL/R. Henderson is 3 percent for PED and by CESAJ-CO-CS/S. Anderson is 8.5 percent for S&A.

4. Real Estate/Lands and Damages costs ARE included in the estimate. These costs were provided separately by Real Estate Division (CESAJ-RE).

5. Aids To Navigation costs ARE included in the estimate and were provided by the U.S. Coast Guard, 7th District, Mr. Joe Embress via his letter dated 31 October 2001.

6. Utility Relocation costs for existing utility crossings impacted by the new project ARE included in the estimate. The applicable depths of impact and the diminsions for the new utility trenches were provided by CESAJ-EN-DM/G. Deloach and CESAJ-PD-PN/R. Powell.

7. Port Bulkheads ARE included in the estimate and were provided by the Miami Port Authority via their letter to CESAJ-DP-C/Mr. Bradd Schwichtenberg dated 8 March 2002. These costs are under the Associated General Items work category in MCACES.

8. Preconstruction, Construction, and Post-Construction monitoring of the mitigation areas is included in the estimate based on the cost and requirements provided by Mr. Steve Dial, Dial-Cordy Associates.

Estimated Construction Times for Final Plans.

NED Recommended Plan - 49'/51' Project Depths:

Segment 1C	= 1 month mob/demob	+ 6.25 months construction	=	7.25	months
Segment 2A	= 0 month mob/demob	+ 0.16 months construction	=	0.16	months
Segment 3B	= 0 month mob/demob	+ 5.78 months construction	=	5.78	months
Segment 5A	= 1 month mob/demob	+17.90 months construction	=	18.90	months
Offshore Reefs	= 1 month mob/demob	+ 3.00 months construction	=	4.00	months
Fill Bay Holes	= 1 month mob/demob	+ 3.00 months construction	=	4.00	months

Total Estimated Construction Time 49'/51' Project Depths = 40.09 months

Locally Prefered Plan - 50'/52' Project Depths:

Segment 1C	= 1 month mob/demob	+ 6.49 months construction	=	7.49	months
Segment 2A	= 0 month mob/demob	+ 0.17 months construction	=	0.17	months
Segment 3B	= 0 month mob/demob	+ 6.48 months construction	=	6.48	months
Segment 5A	= 1 month mob/demob	+19.67 months construction	=	20.67	months
Offshore Reefs	= 1 month mob/demob	+ 3.00 months construction	=	4.00	months
Fill Bay Holes	= 1 month mob/demob	+ 3.00 months construction	=	4.00	months

Total Estimated Construction Time 50'/52' Project Depths = 42.81 months

NOTE: Other project construction such as the Port's Bulkheads, Mitigation Areas, Utility Relocations and Aids to Navigation could be assumed to be done concurrently with the above dredging work.

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** PROJECT OWNER SUMMARY - Contract **

		QUANTY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
01	NED RECOMMENDED PLAN (49'&51')			126,318,728	22,517,686	148,836,414	
02	LOCALLY PREFERRED PLAN (50'&52')			133,499,717	23,809,883	157,309,600	

** PROJECT OWNER SUMMARY - Category **

	QUANTY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
01 NED RECOMMENDED PLAN (49'&51')						
01_ A Construction Cost			112,563,428	22,512,686	135,076,114	
01_ B Non-Construction Cost			13,755,300	5,000	13,760,300	
TOTAL NED RECOMMENDED PLAN (49'&51')			126,318,728	22,517,686	148,836,414	
02 LOCALLY PREFERRED PLAN (50'&52')						
02_ A Construction Cost			119,024,417	23,804,883	142,829,300	
02_ B Non-Construction Cost			14,475,300	5,000	14,480,300	
TOTAL LOCALLY PREFERRED PLAN (50'&52')			133,499,717	23,809,883	157,309,600	

** PROJECT OWNER SUMMARY - Task **

	QUANTY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
01 NED RECOMMENDED PLAN (49'&51')						
01_ A Construction Cost						
01_ A\02 Relocations						
01_ A\02.03 Cemetery, Utilities, & Structure						
01_ A\02.03.01 Mob, Demob & Preparatory Work						
01_ A\02.03.01\ 01 Drilling & Blasting Mob/Demob			65,399	13,080	78,479	
01_ A\02.03.01\ 02 Hydraulic Dredge Mob/Demob			47,087	9,417	56,505	
01_ A\02.03.01\ 03 Clamshell Crane Barge Mob/Demob			12,949	2,590	15,539	
01_ A\02.03.01\ 04 Pipeline Installation			45,779	9,156	54,935	
TOTAL Mob, Demob & Preparatory Work			171,215	34,243	205,457	
01_ A\02.03.18 Utilities						
01_ A\02.03.18\ 01 Trench Excavation - 20" Water	26996	CY	957,483	191,497	1,148,980	42.56
01_ A\02.03.18\ 02 Trench Excavation - 54" Sewer	43403	CY	1,493,555	298,711	1,792,265	41.29
01_ A\02.03.18\ 03 Pipeline Installation 20" Line	1000.00	LF	201,895	40,379	242,274	242.27
01_ A\02.03.18\ 04 Pipeline Installation 54" Line	1500.00	LF	285,262	57,052	342,314	228.21
01_ A\02.03.18\ 05 Backfill Trench - 20" Water Line	22822	CY	311,523	62,305	373,828	16.38
01_ A\02.03.18\ 06 Backfill Trench - 54" Sewer Line	35500	CY	442,675	88,535	531,210	14.96
01_ A\02.03.18\ 07 Test - Inspect New 20" Pipeline	1000.00	LF	1,387	277	1,665	1.66
01_ A\02.03.18\ 08 Test - Inspect New 54" Pipeline	1500.00	LF	2,204	441	2,645	1.76
01_ A\02.03.18\ 09 Clean & Abandon Old 20" Pipeline	1000.00	LF	5,663	1,133	6,795	6.80
01_ A\02.03.18\ 10 Clean & Abandon Old 54" Pipeline	1500.00	LF	14,787	2,957	17,744	11.83
01_ A\02.03.18\ 11 Cofferdams old 20" Pipeline			21,219	4,244	25,463	
01_ A\02.03.18\ 12 Cofferdams old 54" Pipeline			44,555	8,911	53,466	
01_ A\02.03.18\ 13 Cofferdams new 20" Pipeline			21,219	4,244	25,463	
01_ A\02.03.18\ 14 Cofferdams new 54" Pipeline			44,555	8,911	53,466	
TOTAL Utilities			3,847,981	769,596	4,617,577	
01_ A\02.03.28 Credits for Salvaged Material						
TOTAL Cemetery, Utilities, & Structure			4,019,195	803,839	4,823,034	
TOTAL Relocations			4,019,195	803,839	4,823,034	
01_ A\12 Navigation Ports and Harbors						
01_ A\12.02 Harbors						
01_ A\12.02. 1 Mobil, Demobil & Prep Work						

** PROJECT OWNER SUMMARY - Task **

	QUANTY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
01_ A\12.02. 1\ 1 Mechanical Dredge Mob/Demob			466,395	93,279	559,675	
01_ A\12.02. 1\ 2 Pipeline Dredge Mob/Demob			799,703	159,941	959,643	
01_ A\12.02. 1\ 3 Drilling & Blasting Mob/Demob			653,990	130,798	784,788	
01_ A\12.02. 1\ 4 Rock Cutterhead Dredge Mob/Demob			1,360,299	272,060	1,632,359	
TOTAL Mobil, Demobil & Prep Work			3,280,387	656,077	3,936,464	
01_ A\12.02. 2 Drilling and Blasting						
01_ A\12.02. 2\ 1 Alternative 1C - Cut 1/2 PI.WID.	66204	CY	1,539,835	307,967	1,847,803	27.91
01_ A\12.02. 2\ 3 Alternative 2A - Cut 3 Widener	18660	CY	236,159	47,232	283,391	15.19
01_ A\12.02. 2\ 4 Alternative 3B - Cut 3	489965	CY	8,563,636	1,712,727	10,276,364	20.97
01_ A\12.02. 2\ 5 Alternative 5A - F.C. & L.I.T.B.	1627006	CY	29,308,884	5,861,777	35,170,661	21.62
01_ A\12.02. 2\ 6 Alternative 5A - Port Berths	228617	CY	4,120,027	824,005	4,944,032	21.63
TOTAL Drilling and Blasting	2430452	CY	43,768,542	8,753,708	52,522,250	21.61
01_ A\12.02. 3 Mechanical Dredging						
01_ A\12.02. 3\ 3 Alternative 2A - Cut 3 Widener	18660	CY	143,024	28,605	171,629	9.20
01_ A\12.02. 3\ 4 Alternative 3B - Cut 3	489965	CY	4,050,262	810,052	4,860,315	9.92
01_ A\12.02. 3\ 5 Alternative 5A - Fisherman Chan.	1627006	CY	13,151,602	2,630,320	15,781,922	9.70
01_ A\12.02. 3\ 6 Alternative 5A - Port Berths	228617	CY	1,847,983	369,597	2,217,580	9.70
TOTAL Mechanical Dredging	2364248	CY	19,192,872	3,838,574	23,031,446	9.74
01_ A\12.02. 4 Pipeline Dredging						
01_ A\12.02. 4\ 0 Alternative 1C - Cut 1/2 & WID.	1764160	CY	14,537,159	2,907,432	17,444,591	9.89
01_ A\12.02. 4\ 4 Alternative 3B - Cut 3	326643	CY	777,581	155,516	933,097	2.86
01_ A\12.02. 4\ 5 Alternative 5A - F.C. & L.I.T.B.	406752	CY	893,799	178,760	1,072,559	2.64
01_ A\12.02. 4\ 6 Alternative 5A - Port Berths	47036	CY	103,357	20,671	124,029	2.64
TOTAL Pipeline Dredging	2544591	CY	16,311,897	3,262,379	19,574,276	7.69
01_ A\12.02. 5 Disposal Areas (Virginia Key)						
01_ A\12.02. 5\ 1 Replace Dike Material	50000	BCY	235,161	47,032	282,193	5.64
01_ A\12.02. 5\ 2 Excavation for CMP			19,416	3,883	23,300	
01_ A\12.02. 5\ 3 Wood Piles, 50 lf each	18.00	EA	7,510	1,502	9,013	500.69
01_ A\12.02. 5\ 4 Driving Wood Piles	18.00	EA	27,666	5,533	33,199	1844.38
01_ A\12.02. 5\ 5 Metal Hardware			392	78	471	
01_ A\12.02. 5\ 6 CMP Materials			176,941	35,388	212,329	
01_ A\12.02. 5\ 7 Positioning Weirs	3.00	EA	4,611	922	5,533	1844.38
01_ A\12.02. 5\ 8 Attaching Weirs to Piles	3.00	EA	1,131	226	1,357	452.44
01_ A\12.02. 5\ 9 Pipeline Placement	16.00	EA	4,895	979	5,874	367.15
01_ A\12.02. 5\ 10 Transport material			5,371	1,074	6,445	

** PROJECT OWNER SUMMARY - Task **

		QUANTY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
01_ A\12.02. 5\ !1	Precise Material Placement	3000.00	CY	3,975	795	4,770	1.59
01_ A\12.02. 5\ !2	Compaction around Pipeline			7,121	1,424	8,546	
01_ A\12.02. 5\ !3	Other Compaction			3,713	743	4,456	
	TOTAL Disposal Areas (Virginia Key)			497,905	99,581	597,486	
01_ A\12.02. 6	Environmental Mitigation						
01_ A\12.02. 6\ 1	LRLC Reef Mitigation (35.1 AC.)	100000	CY	125,566	25,113	150,679	1.51
01_ A\12.02. 6\ 2	HRHC Reef Mitigation (20.0 AC.)	150000	CY	3,169,719	633,944	3,803,663	25.36
01_ A\12.02. 6\ 3	Fill North Biscayne Bay Holes	720000	CY	1,584,110	316,822	1,900,932	2.64
01_ A\12.02. 6\ 4	Capping Material For Bay Holes	80000	CY	881,840	176,368	1,058,208	13.23
01_ A\12.02. 6\ 5	Turbidity Control at Bay Holes			155,395	31,079	186,474	
01_ A\12.02. 6\ 6	Seagrass Planting at Bay Holes	3.00	AC	576,000	115,200	691,200	230400
	TOTAL Environmental Mitigation			6,492,630	1,298,526	7,791,156	
01_ A\12.02. 7	Associated General Items						
01_ A\12.02. 7\ 4	Port Bulkhead Construction			19,000,000	3,800,000	22,800,000	
	TOTAL Associated General Items			19,000,000	3,800,000	22,800,000	
	TOTAL Harbors			108,544,233	21,708,847	130,253,079	
	TOTAL Navigation Ports and Harbors			108,544,233	21,708,847	130,253,079	
	TOTAL Construction Cost			112,563,428	22,512,686	135,076,114	
01_ B	Non-Construction Cost						
01_ B\01	Lands and Damages						
01_ B\01.01	Acquisition/Administration Costs						
01_ B\01.01. 1	Federal			10,000	2,500	12,500	
01_ B\01.01. 2	Non-Federal			10,000	2,500	12,500	
	TOTAL Acquisition/Administration Costs			20,000	5,000	25,000	
	TOTAL Lands and Damages			20,000	5,000	25,000	
01_ B\20	Mitigation Monitoring						
01_ B\20.01	Pre-Reef Deployment Site Surveys			25,000	0	25,000	
01_ B\20.02	Baseline Biological Surveys			25,000	0	25,000	
01_ B\20.03	Construction Monitoring	10.00	DY	50,000	0	50,000	5000.00

** PROJECT OWNER SUMMARY - Task **

	QUANTY UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
01_ B\20.04 Completion Report		20,000	0	20,000	
01_ B\20.05 Post-Construction Monitoring	5.00 YR	250,000	0	250,000	50000
01_ B\20.06 Seagrass Mitigation Oversite		235,000	0	235,000	
TOTAL Mitigation Monitoring		605,000	0	605,000	
01_ B\30 Planning, Engineering & Design		3,380,000	0	3,380,000	
01_ B\31 Construction Management (S&I)		9,570,000	0	9,570,000	
01_ B\99 Aids to Navigation					
01_ B\99. 1 Alternate 2A					
01_ B\99. 1. 1 Relocated Light 15		150,000	0	150,000	
01_ B\99. 1. 2 Light 15 Annual Maintenance		15,000	0	15,000	
TOTAL Alternate 2A		165,000	0	165,000	
01_ B\99. 2 Alternative 3B					
01_ B\99. 2. 1 Relocate One Light		7,100	0	7,100	
TOTAL Alternative 3B		7,100	0	7,100	
01_ B\99. 3 Alternative 5A					
01_ B\99. 3. 1 Relocate One Light		7,100	0	7,100	
01_ B\99. 3. 2 Discontinue One Light		1,100	0	1,100	
TOTAL Alternative 5A		8,200	0	8,200	
TOTAL Aids to Navigation		180,300	0	180,300	
TOTAL Non-Construction Cost		13,755,300	5,000	13,760,300	
TOTAL NED RECOMMENDED PLAN (49'&51')		126,318,728	22,517,686	148,836,414	
02 LOCALLY PREFERRED PLAN (50'&52')					
02_ A Construction Cost					
02_ A\02 Relocations					
02_ A\02.03 Cemetery, Utilities, & Structure					
02_ A\02.03.01 Mob, Demob & Preparatory Work					
02_ A\02.03.01\ 01 Drilling & Blasting Mob/Demob		65,399	13,080	78,479	

** PROJECT OWNER SUMMARY - Task **

	QUANTY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
02_ A\02.03.01\ 02 Hydraulic Dredge Mob/Demob			47,087	9,417	56,505	
02_ A\02.03.01\ 03 Clamshell Crane Barge Mob/Demob			12,949	2,590	15,539	
02_ A\02.03.01\ 04 Pipeline Installation			45,779	9,156	54,935	
TOTAL Mob, Demob & Preparatory Work			171,215	34,243	205,457	
02_ A\02.03.18 Utilities						
02_ A\02.03.18\ 01 Trench Excavation - 20" Water	26996	CY	957,483	191,497	1,148,980	42.56
02_ A\02.03.18\ 02 Trench Excavation - 54" Sewer	43403	CY	1,493,555	298,711	1,792,265	41.29
02_ A\02.03.18\ 03 Pipeline Installation 20" Line	1000.00	LF	201,895	40,379	242,274	242.27
02_ A\02.03.18\ 04 Pipeline Installation 54" Line	1500.00	LF	285,262	57,052	342,314	228.21
02_ A\02.03.18\ 05 Backfill Trench - 20" Water Line	22822	CY	311,523	62,305	373,828	16.38
02_ A\02.03.18\ 06 Backfill Trench - 54" Sewer Line	35500	CY	442,675	88,535	531,210	14.96
02_ A\02.03.18\ 07 Test - Inspect New 20" Pipeline	1000.00	LF	1,387	277	1,665	1.66
02_ A\02.03.18\ 08 Test - Inspect New 54" Pipeline	1500.00	LF	2,204	441	2,645	1.76
02_ A\02.03.18\ 09 Clean & Abandon Old 20" Pipeline	1000.00	LF	5,663	1,133	6,795	6.80
02_ A\02.03.18\ 10 Clean & Abandon Old 54" Pipeline	1500.00	LF	14,787	2,957	17,744	11.83
02_ A\02.03.18\ 11 Cofferdams old 20" Pipeline			21,219	4,244	25,463	
02_ A\02.03.18\ 12 Cofferdams old 54" Pipeline			44,555	8,911	53,466	
02_ A\02.03.18\ 13 Cofferdams new 20" Pipeline			21,219	4,244	25,463	
02_ A\02.03.18\ 14 Cofferdams new 54" Pipeline			44,555	8,911	53,466	
TOTAL Utilities			3,847,981	769,596	4,617,577	
02_ A\02.03.28 Credits for Salvaged Material						
TOTAL Cemetery, Utilities, & Structure			4,019,195	803,839	4,823,034	
TOTAL Relocations			4,019,195	803,839	4,823,034	
02_ A\12 Navigation Ports and Harbors						
02_ A\12.02 Harbors						
02_ A\12.02. 1 Mobil, Demobil & Prep Work						
02_ A\12.02. 1\ 1 Mechanical Dredge Mob/Demob			466,395	93,279	559,675	
02_ A\12.02. 1\ 2 Pipeline Dredge Mob/Demob			799,703	159,941	959,643	
02_ A\12.02. 1\ 3 Drilling & Blasting Mob/Demob			653,990	130,798	784,788	
02_ A\12.02. 1\ 4 Rock Cutterhead Dredge Mob/Demob			1,360,299	272,060	1,632,359	
TOTAL Mobil, Demobil & Prep Work			3,280,387	656,077	3,936,464	
02_ A\12.02. 2 Drilling and Blasting						
02_ A\12.02. 2\ 1 Alternative 1C - Cut 1/2 PI.WID.	74737	CY	1,643,656	328,731	1,972,388	26.39
02_ A\12.02. 2\ 3 Alternative 2A - Cut 3 Widener	20002	CY	249,485	49,897	299,382	14.97

** PROJECT OWNER SUMMARY - Task **

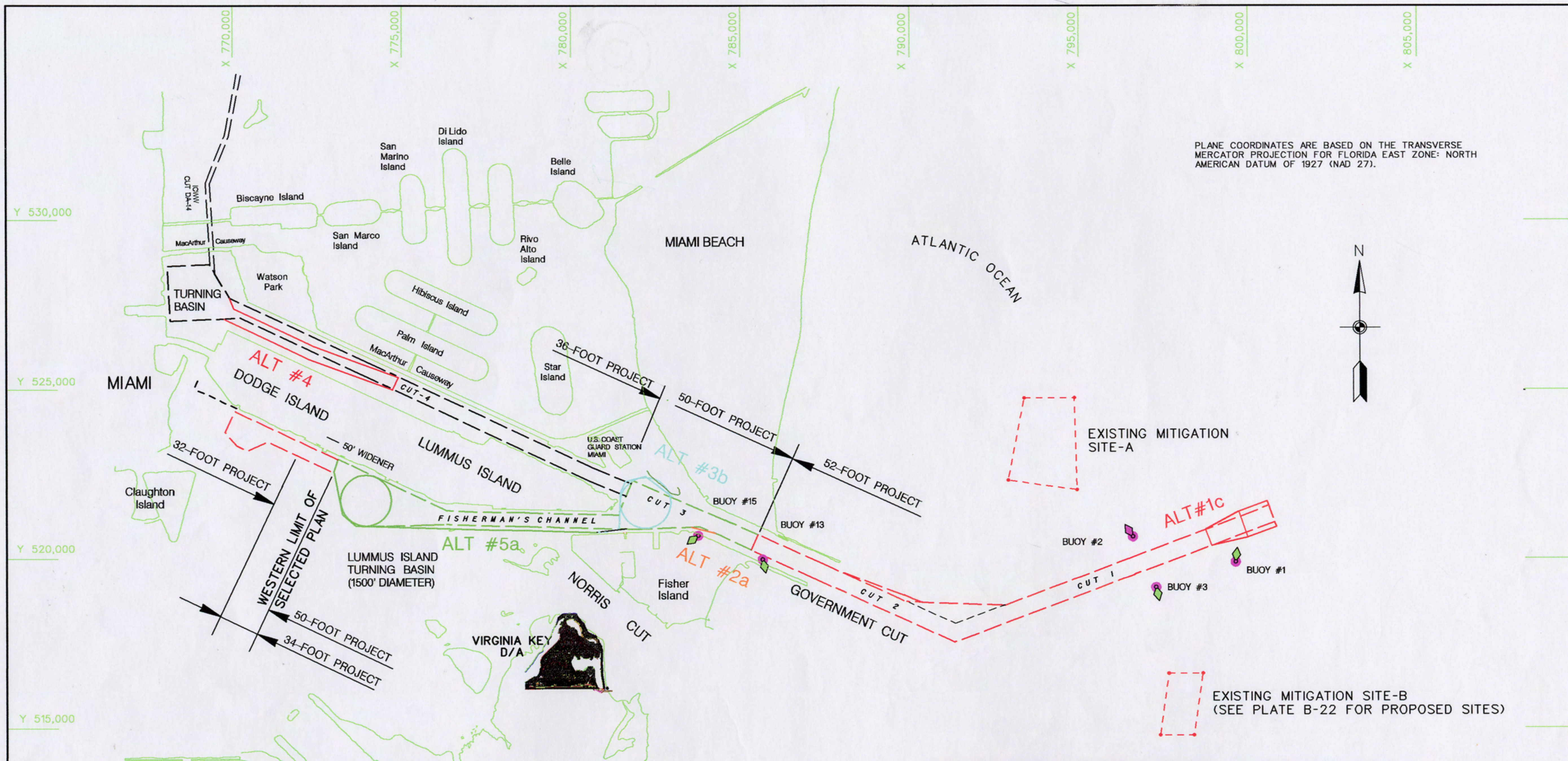
		QUANTY	UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
02_ A\12.02. 2\ 4	Alternative 3B - Cut 3	563829	CY	9,425,451	1,885,090	11,310,541	20.06
02_ A\12.02. 2\ 5	Alternative 5A - F.C. & L.I.T.B.	1831123	CY	31,713,021	6,342,604	38,055,625	20.78
02_ A\12.02. 2\ 6	Alternative 5A - Port Berths	254725	CY	4,412,406	882,481	5,294,887	20.79
	TOTAL Drilling and Blasting	2744416	CY	47,444,019	9,488,804	56,932,823	20.74
02_ A\12.02. 3	Mechanical Dredging						
02_ A\12.02. 3\ 3	Alternative 2A - Cut 3 Widener	20002	CY	151,218	30,244	181,461	9.07
02_ A\12.02. 3\ 4	Alternative 3B - Cut 3	563829	CY	4,528,108	905,622	5,433,730	9.64
02_ A\12.02. 3\ 5	Alternative 5A - F.C. & L.I.T.B.	1831123	CY	14,514,135	2,902,827	17,416,962	9.51
02_ A\12.02. 3\ 6	Alternative 5A - Port Berths	254725	CY	2,019,041	403,808	2,422,850	9.51
	TOTAL Mechanical Dredging	2669679	CY	21,212,502	4,242,500	25,455,003	9.53
02_ A\12.02. 4	Pipeline Dredging						
02_ A\12.02. 4\ 0	Alternative 1C - Cut 1/2 & WID.	2105972	CY	15,095,037	3,019,007	18,114,044	8.60
02_ A\12.02. 4\ 4	Alternative 3B - Cut 3	375886	CY	880,056	176,011	1,056,067	2.81
02_ A\12.02. 4\ 5	Alternative 5A - F.C. & L.I.T.B.	457781	CY	999,943	199,989	1,199,932	2.62
02_ A\12.02. 4\ 6	Alternative 5A - Port Berths	47036	CY	102,742	20,548	123,290	2.62
	TOTAL Pipeline Dredging	2986675	CY	17,077,777	3,415,555	20,493,333	6.86
02_ A\12.02. 5	Disposal Areas (Virginia Key)						
02_ A\12.02. 5\ 1	Replace Dike Material	50000	BCY	235,161	47,032	282,193	5.64
02_ A\12.02. 5\ 2	Excavation for CMP			19,416	3,883	23,300	
02_ A\12.02. 5\ 3	Wood Piles, 50 lf each	18.00	EA	7,510	1,502	9,013	500.69
02_ A\12.02. 5\ 4	Driving Wood Piles	18.00	EA	27,666	5,533	33,199	1844.38
02_ A\12.02. 5\ 5	Metal Hardware			392	78	471	
02_ A\12.02. 5\ 6	CMP Materials			176,941	35,388	212,329	
02_ A\12.02. 5\ 7	Positioning Weirs	3.00	EA	4,611	922	5,533	1844.38
02_ A\12.02. 5\ 8	Attaching Weirs to Piles	3.00	EA	1,131	226	1,357	452.44
02_ A\12.02. 5\ 9	Pipeline Placement	16.00	EA	4,895	979	5,874	367.15
02_ A\12.02. 5\ !0	Transport material			5,371	1,074	6,445	
02_ A\12.02. 5\ !1	Precise Material Placement	3000.00	CY	3,975	795	4,770	1.59
02_ A\12.02. 5\ !2	Compaction around Pipeline			7,121	1,424	8,546	
02_ A\12.02. 5\ !3	Other Compaction			3,713	743	4,456	
	TOTAL Disposal Areas (Virginia Key)			497,905	99,581	597,486	
02_ A\12.02. 6	Environmental Mitigation						
02_ A\12.02. 6\ 1	LRLC Reef Mitigation (35.1 AC.)	100000	CY	125,566	25,113	150,679	1.51
02_ A\12.02. 6\ 2	HRHC Reef Mitigation (20.0 AC.)	150000	CY	3,169,719	633,944	3,803,663	25.36
02_ A\12.02. 6\ 3	Fill North Biscayne Bay Holes	720000	CY	1,584,110	316,822	1,900,932	2.64

** PROJECT OWNER SUMMARY - Task **

	QUANTY UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
02_ A\12.02. 6\ 4 Capping Material For Bay Holes	80000 CY	881,840	176,368	1,058,208	13.23
02_ A\12.02. 6\ 5 Turbidity Control at Bay Holes		155,395	31,079	186,474	
02_ A\12.02. 6\ 6 Seagrass Planting at Bay Holes	3.00 AC	576,000	115,200	691,200	230400
TOTAL Environmental Mitigation		6,492,630	1,298,526	7,791,156	
02_ A\12.02. 7 Associated General Items					
02_ A\12.02. 7\ 4 Port Bulkhead Construction		19,000,000	3,800,000	22,800,000	
TOTAL Associated General Items		19,000,000	3,800,000	22,800,000	
TOTAL Harbors		115,005,221	23,001,044	138,006,266	
TOTAL Navigation Ports and Harbors		115,005,221	23,001,044	138,006,266	
TOTAL Construction Cost		119,024,417	23,804,883	142,829,300	
02_ B Non-Construction Cost					
02_ B\01 Lands and Damages					
02_ B\01.01 Acquisition/Administration Costs					
02_ B\01.01. 1 Federal		10,000	2,500	12,500	
02_ B\01.01. 2 Non-Federal		10,000	2,500	12,500	
TOTAL Acquisition/Administration Costs		20,000	5,000	25,000	
TOTAL Lands and Damages		20,000	5,000	25,000	
02_ B\20 Mitigation Monitoring					
02_ B\20.01 Pre-Reef Deployment Site Surveys		25,000	0	25,000	
02_ B\20.02 Baseline Biological Surveys		25,000	0	25,000	
02_ B\20.03 Construction Monitoring	10.00 DY	50,000	0	50,000	5000.00
02_ B\20.04 Completion Report		20,000	0	20,000	
02_ B\20.05 Post-Construction Monitoring	5.00 YR	250,000	0	250,000	50000
02_ B\20.06 Seagrass Mitigation Oversite		235,000	0	235,000	
TOTAL Mitigation Monitoring		605,000	0	605,000	
02_ B\30 Planning, Engineering & Design		3,570,000	0	3,570,000	
02_ B\31 Construction Management (S&I)		10,100,000	0	10,100,000	
02_ B\99 Aids to Navigation					
02_ B\99. 1 Alternate 2A					

** PROJECT OWNER SUMMARY - Task **

	QUANTY UOM	CONTRACT COST	CONTINGN	TOTAL COST	UNIT
02_ B\99. 1. 1 Relocated Light 15		150,000	0	150,000	
02_ B\99. 1. 2 Light 15 Annual Maintenance		15,000	0	15,000	
TOTAL Alternate 2A		165,000	0	165,000	
02_ B\99. 2 Alternative 3B					
02_ B\99. 2. 1 Relocate One Light		7,100	0	7,100	
TOTAL Alternative 3B		7,100	0	7,100	
02_ B\99. 3 Alternative 5A					
02_ B\99. 3. 1 Relocate One Light		7,100	0	7,100	
02_ B\99. 3. 2 Discontinue One Light		1,100	0	1,100	
TOTAL Alternative 5A		8,200	0	8,200	
TOTAL Aids to Navigation		180,300	0	180,300	
TOTAL Non-Construction Cost		14,475,300	5,000	14,480,300	
TOTAL LOCALLY PREFERRED PLAN (50'&52')		133,499,717	23,809,883	157,309,600	



PROPOSED MODIFICATION ALTERNATIVES (See Note)

ALTERNATIVE #1 – WIDEN SEAWARD PORTION OF CUT–1 FROM 500 FEET TO 800 FEET AND DEEPEN CUT–1 AND CUT–2. (EXISTING DEPTH = 44 FEET, DEEPEN TO 52 FEET)

ALTERNATIVE #2 – ADD TURN WIDENER BETWEEN BUOY #13 AND BUOY #15. (EXISTING DEPTH = 42 FEET, DEEPEN TO 50 FEET)

ALTERNATIVE #3 – EXPAND FISHER ISLAND TURNING BASIN FROM 1200 FEET TO 1500 FEET. (EXISTING DEPTH = 42 FEET, DEEPEN TO 50 FEET)

ALTERNATIVE #4 – RELOCATE THE WESTERN END OF THE MAIN CHANNEL TO ALLOW FOR ADDITIONAL CRUISE SHIP BERTHS.

ALTERNATIVE #5 – WIDEN FISHERMAN'S CHANNEL APPROXIMATELY 100 FEET TO THE SOUTH. (EXISTING DEPTH = 42 FEET, DEEPEN TO 50 FEET) DEEPENING WOULD INCLUDE CUT–3, STA. 0+00 TO CUT–3, STA. 42+00.

Note: The Alternatives identified on the following plates are referred to as Components in the Report text and Environmental Impact Statement (EIS)

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Dated: FEBRUARY 2004
GRR-ENGINEERING APPENDIX

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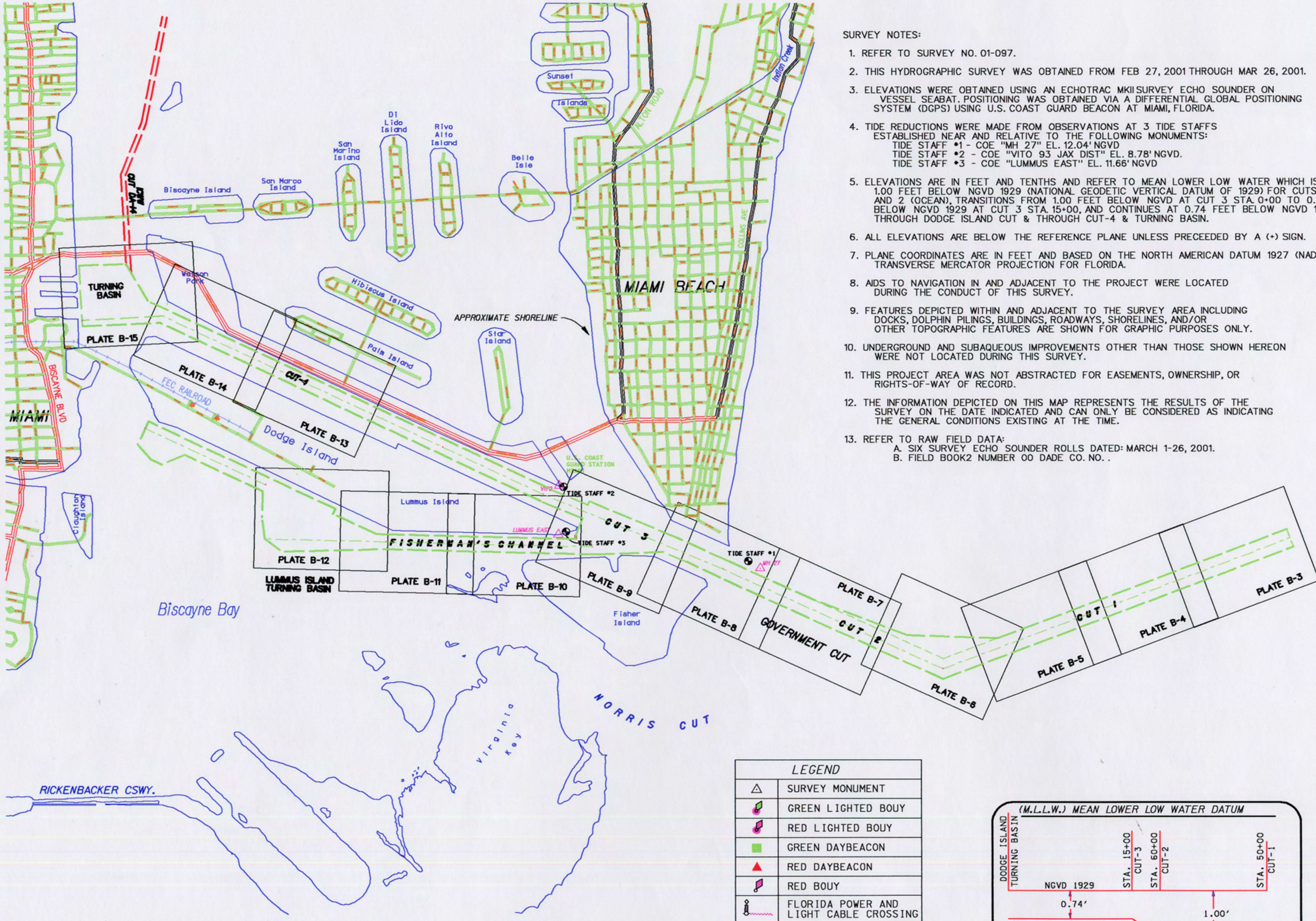
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

SELECTED PROJECT PLAN

NED PLAN WITH ADDITIONAL 2 FEET LOCAL OPTION

PLATE
B-1

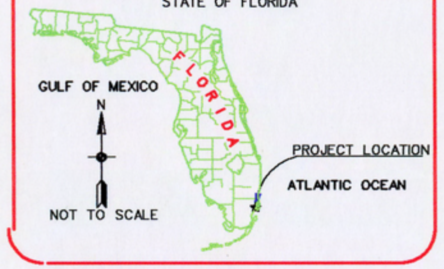


SURVEY NOTES:

1. REFER TO SURVEY NO. 01-097.
2. THIS HYDROGRAPHIC SURVEY WAS OBTAINED FROM FEB 27, 2001 THROUGH MAR 26, 2001.
3. ELEVATIONS WERE OBTAINED USING AN ECHOTRAC MKII SURVEY ECHO SOUNDER ON VESSEL SEABAT. POSITIONING WAS OBTAINED VIA A DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS) USING U.S. COAST GUARD BEACON AT MIAMI, FLORIDA.
4. TIDE REDUCTIONS WERE MADE FROM OBSERVATIONS AT 3 TIDE STAFFS ESTABLISHED NEAR AND RELATIVE TO THE FOLLOWING MONUMENTS:
   TIDE STAFF #1 - COE "MH 27" EL. 12.04' NGVD
   TIDE STAFF #2 - COE "VITO 93 JAX DIST" EL. 8.78' NGVD.
   TIDE STAFF #3 - COE "LUMMUS EAST" EL. 11.66' NGVD
5. ELEVATIONS ARE IN FEET AND TENTHS AND REFER TO MEAN LOWER LOW WATER WHICH IS 1.00 FEET BELOW NGVD 1929 (NATIONAL GEODETIC VERTICAL DATUM OF 1929) FOR CUTS 1 AND 2 (OCEAN), TRANSITIONS FROM 1.00 FEET BELOW NGVD AT CUT 3 STA. 0+00 TO 0.74 FEET BELOW NGVD 1929 AT CUT 3 STA. 15+00, AND CONTINUES AT 0.74 FEET BELOW NGVD 1929 THROUGH DODGE ISLAND CUT & THROUGH CUT-4 & TURNING BASIN.
6. ALL ELEVATIONS ARE BELOW THE REFERENCE PLANE UNLESS PRECEEDED BY A (+) SIGN.
7. PLANE COORDINATES ARE IN FEET AND BASED ON THE NORTH AMERICAN DATUM 1927 (NAD27) TRANSVERSE MERCATOR PROJECTION FOR FLORIDA.
8. AIDS TO NAVIGATION IN AND ADJACENT TO THE PROJECT WERE LOCATED DURING THE CONDUCT OF THIS SURVEY.
9. FEATURES DEPICTED WITHIN AND ADJACENT TO THE SURVEY AREA INCLUDING DOCKS, DOLPHIN PILINGS, BUILDINGS, ROADWAYS, SHORELINES, AND/OR OTHER TOPOGRAPHIC FEATURES ARE SHOWN FOR GRAPHIC PURPOSES ONLY.
10. UNDERGROUND AND SUBAQUEOUS IMPROVEMENTS OTHER THAN THOSE SHOWN HEREON WERE NOT LOCATED DURING THIS SURVEY.
11. THIS PROJECT AREA WAS NOT ABSTRACTED FOR EASEMENTS, OWNERSHIP, OR RIGHTS-OF-WAY OF RECORD.
12. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF THE SURVEY ON THE DATE INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THE TIME.
13. REFER TO RAW FIELD DATA:
   A. SIX SURVEY ECHO SOUNDER ROLLS DATED: MARCH 1-26, 2001.
   B. FIELD BOOK2 NUMBER 00 DADE CO. NO. .

LOCATION MAP

STATE OF FLORIDA



LEGEND	
△	SURVEY MONUMENT
	GREEN LIGHTED BOUY
	RED LIGHTED BOUY
■	GREEN DAYBEACON
▲	RED DAYBEACON
	RED BOUY
	FLORIDA POWER AND LIGHT CABLE CROSSING
	TIDE STAFF
□	GENERAL BEACON
	MARINA

(M.L.L.W.) MEAN LOWER LOW WATER DATUM

DODGE ISLAND TURNING BASIN
STA. 15+00 CUT-3
STA. 60+00 CUT-2
STA. 50+00 CUT-1
NGVD 1929
0.74'
1.00'
M.L.L.W. BISCAYNE BAY
M.L.L.W. OCEAN

NOTE: Some historical data for the project may refer to MLW, which is 0.81 feet below NGVD 1929.

ABBREVIATIONS	
NGVD	NATIONAL GEODETIC VERTICAL DATUM OF 1929
MLW	MEAN LOW WATER
P.I.	POINT OF INTERSECTION
EL	ELEVATION (FEET)
DNR	FLORIDA DEPARTMENT OF NATURAL RESOURCES
RGE.	RANGE
STA.	STATION
ICWW	INTRACOASTAL WATERWAY
NGS	NATIONAL GEODETIC SURVEY
FC	FISHERMAN'S CHANNEL
LITB	LUMMUS ISLAND TURNING BASIN
T.B.	TURNING BASIN

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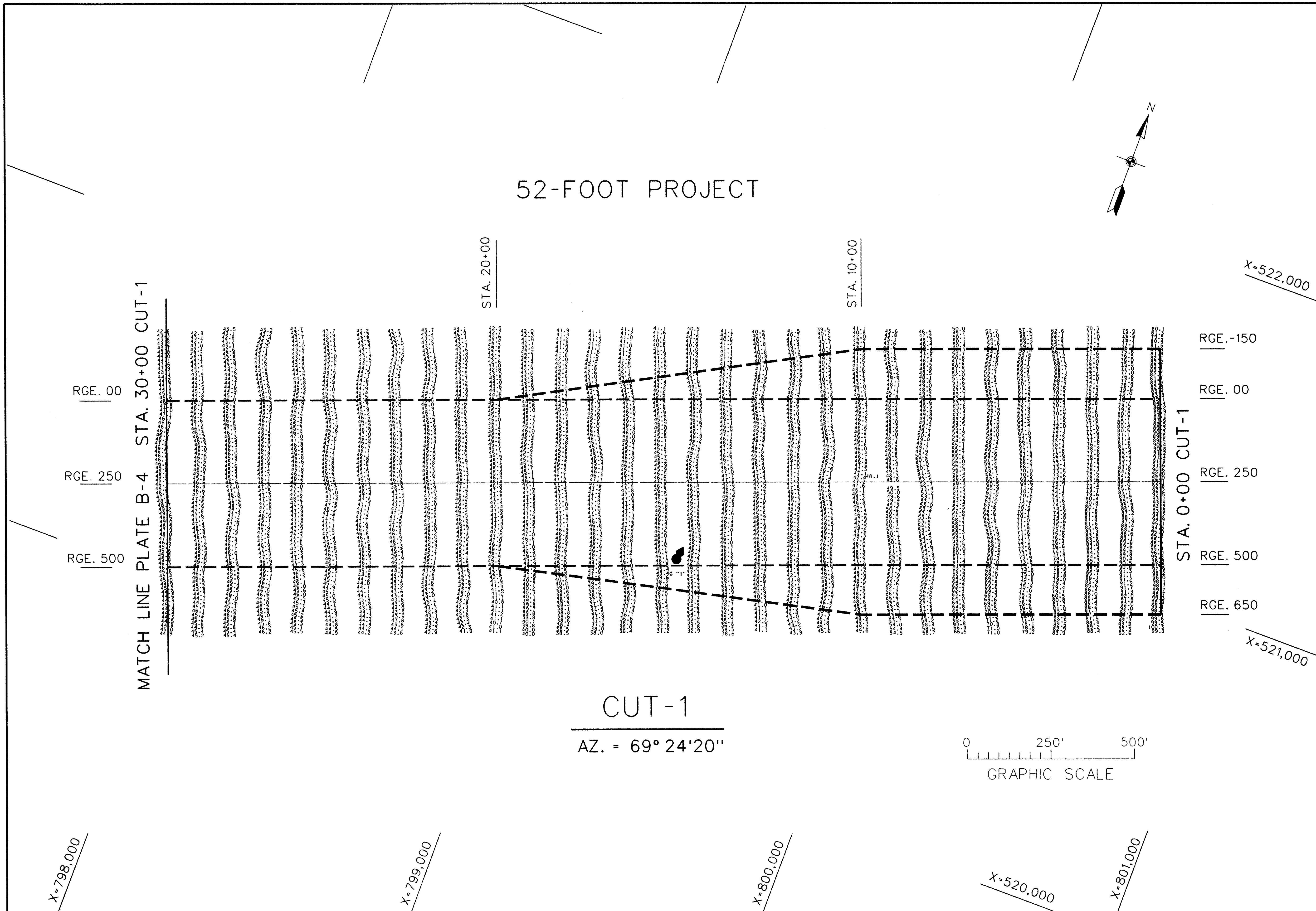
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

PLAN PLATES INDEX

ENGINEERING APPENDIX

PLATE
B-2



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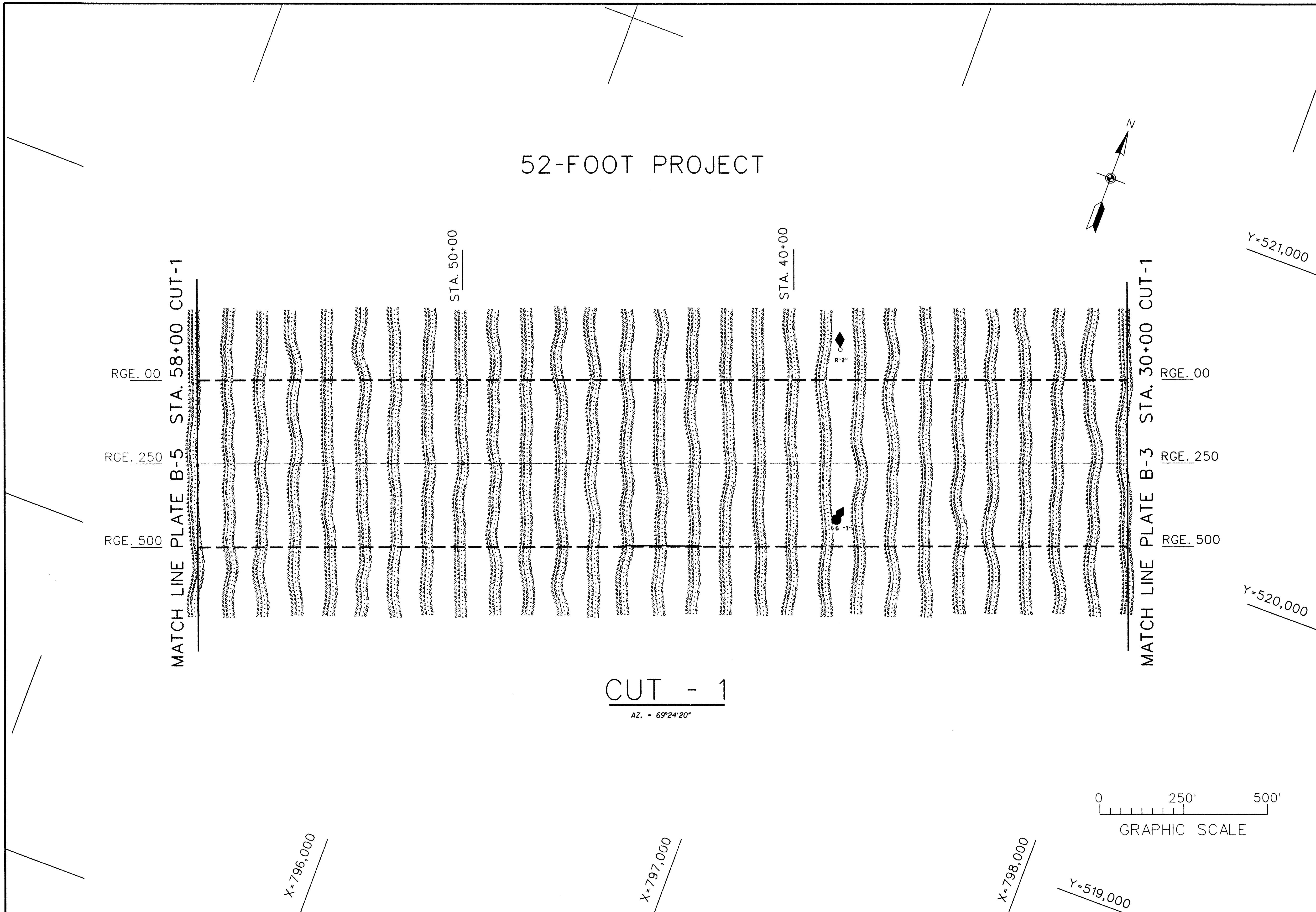
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

PLAN - CUT 1 (ALT #1C)

STA. 0+00 CUT1 TO STA. 30+00 CUT1

PLATE
B-3



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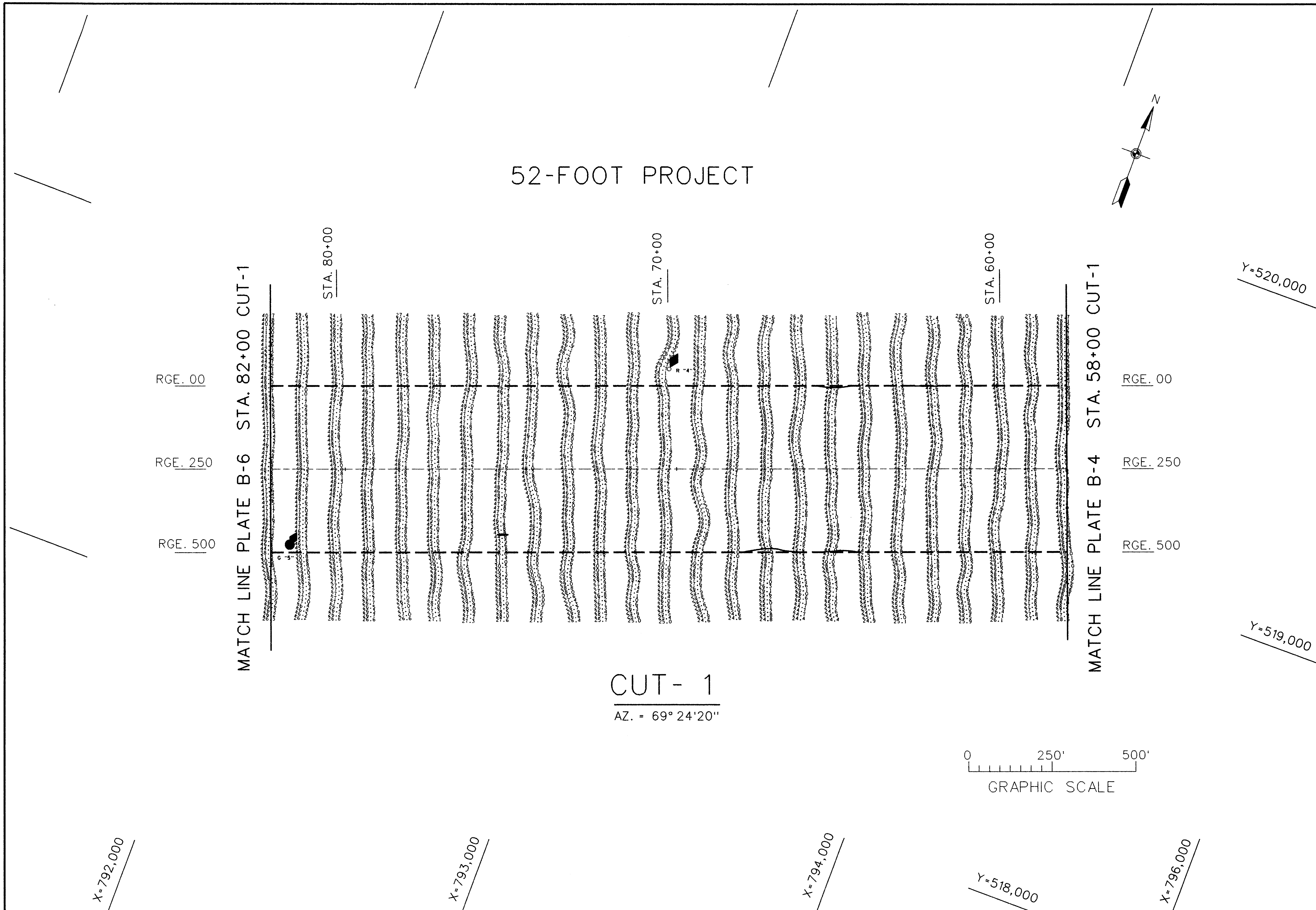
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

PLAN - CUT1

STA. 30+00 CUT1 TO STA. 58+00 CUT1

PLATE
B-4



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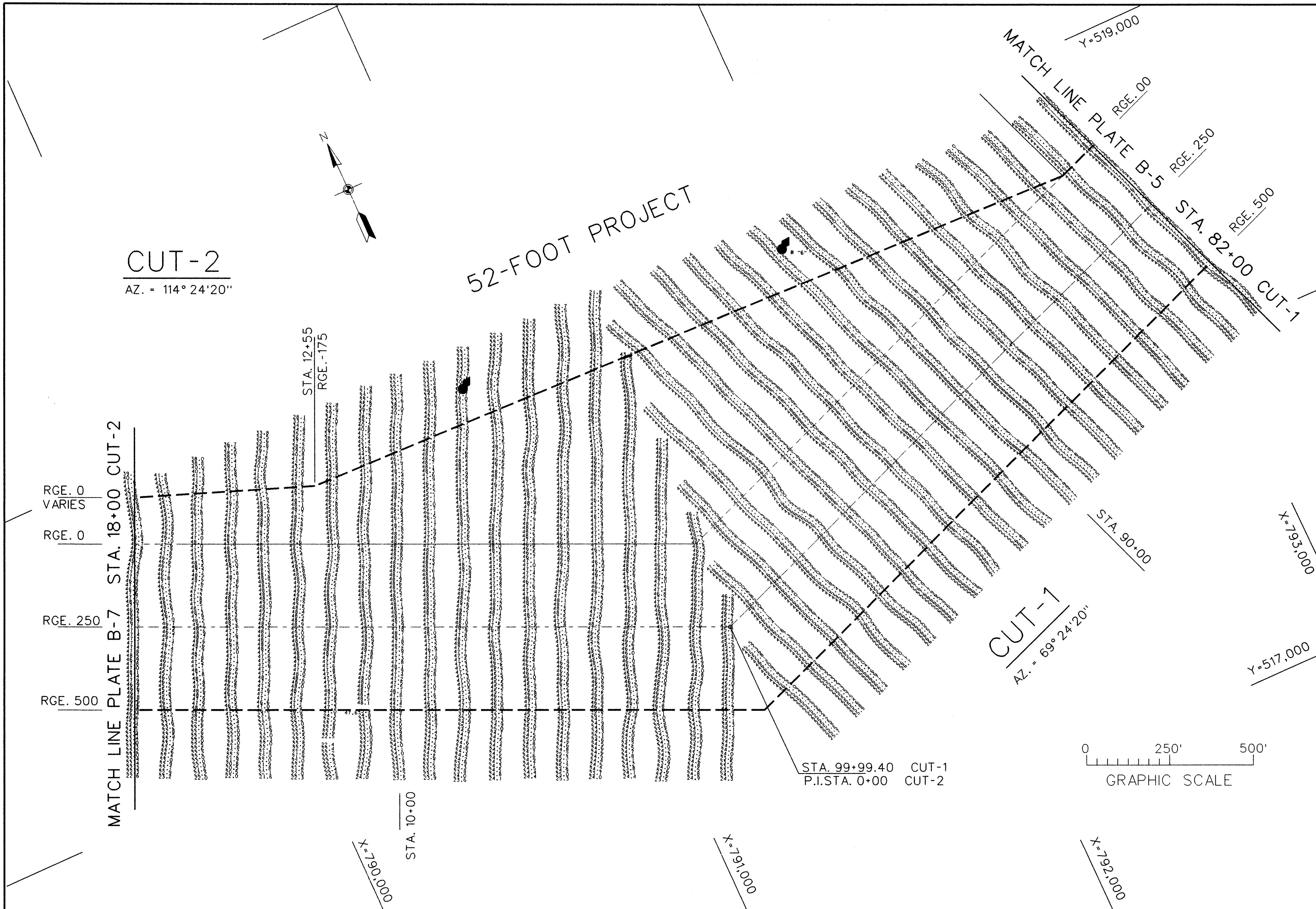
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

PLAN - CUT 1

STA. 58+00 CUT1 TO STA. 82+00 CUT1

PLATE
B-5



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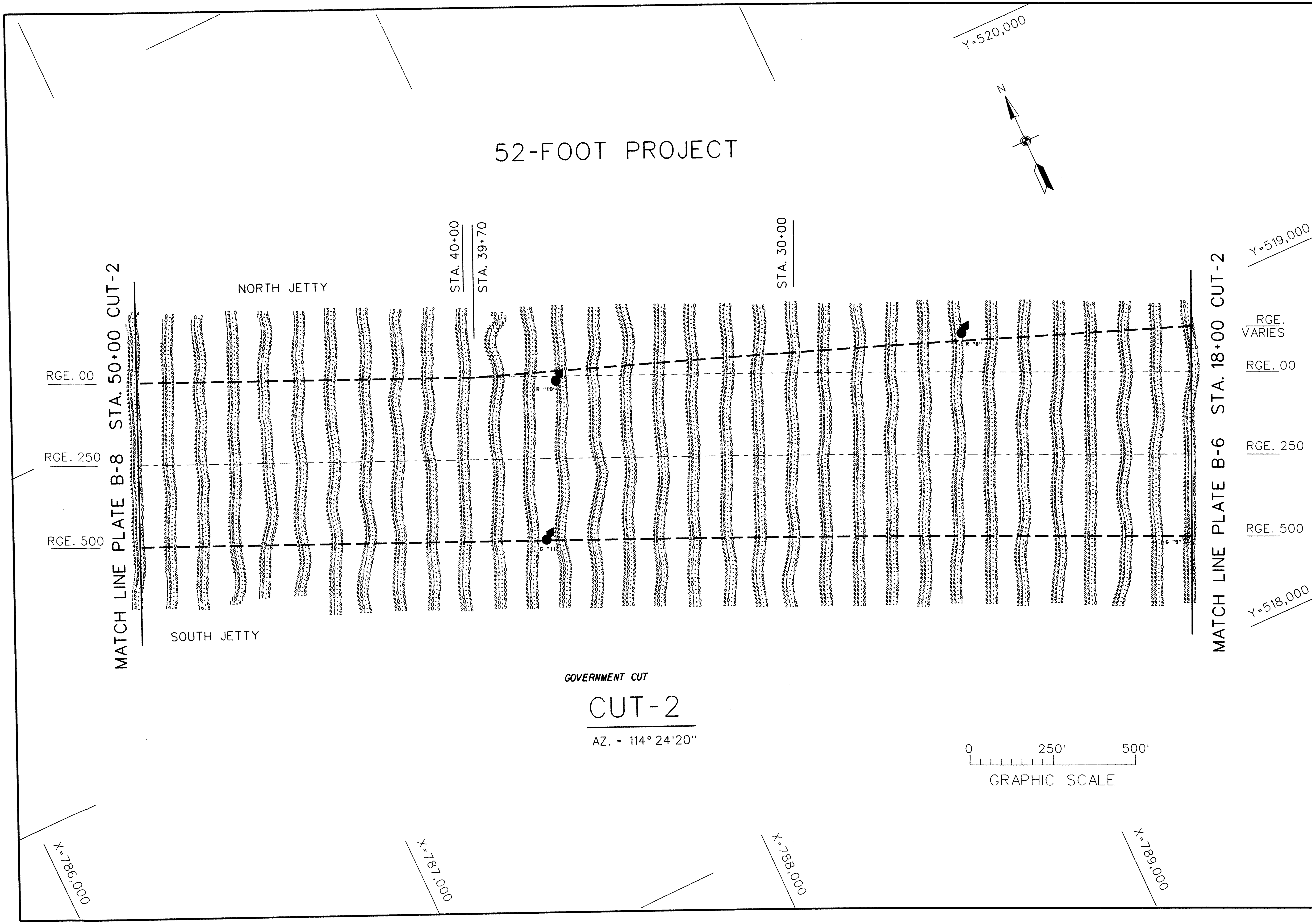
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

PLAN - CUTS 1 & 2

STA. 82+00 CUT1 TO STA. 18+00 CUT2

PLATE
B-6



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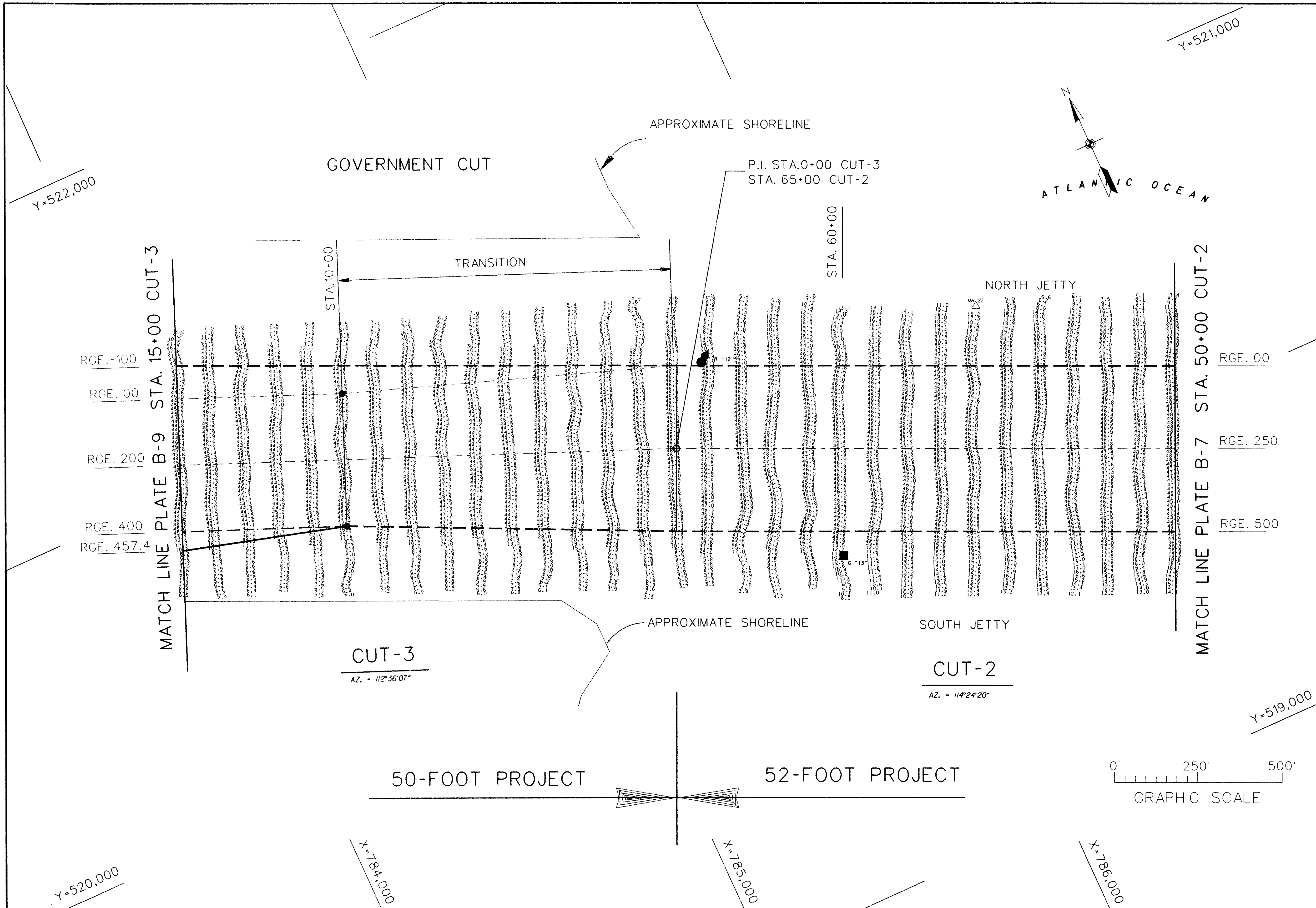
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

PLAN - CUT 2

STA. 18+00 CUT2 TO STA. 50+00 CUT2

PLATE
B-7



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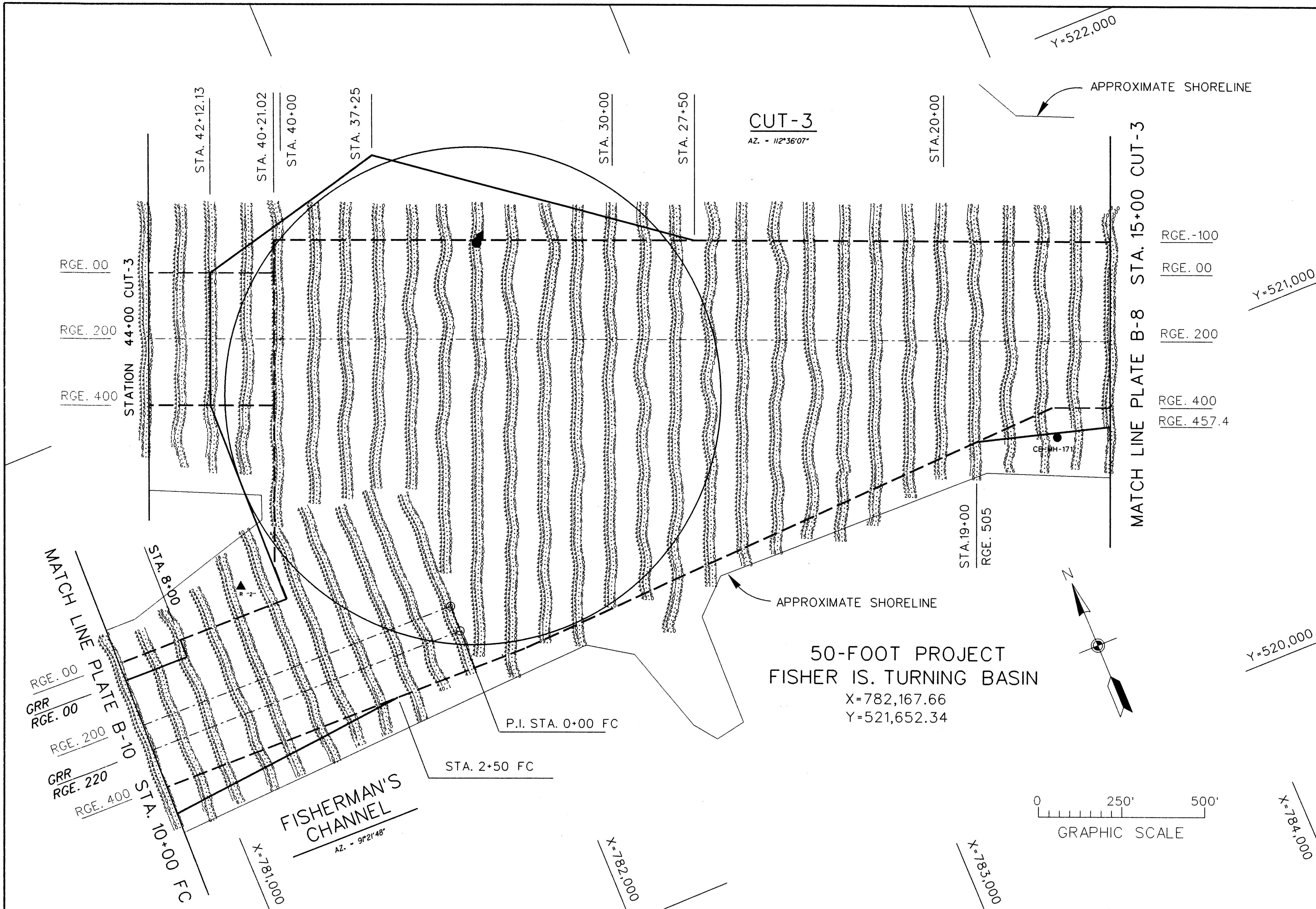
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

PLAN - CUTS 2 & 3

STA. 50+00 CUT2 TO STA. 15+00 CUT3

PLATE
B-8



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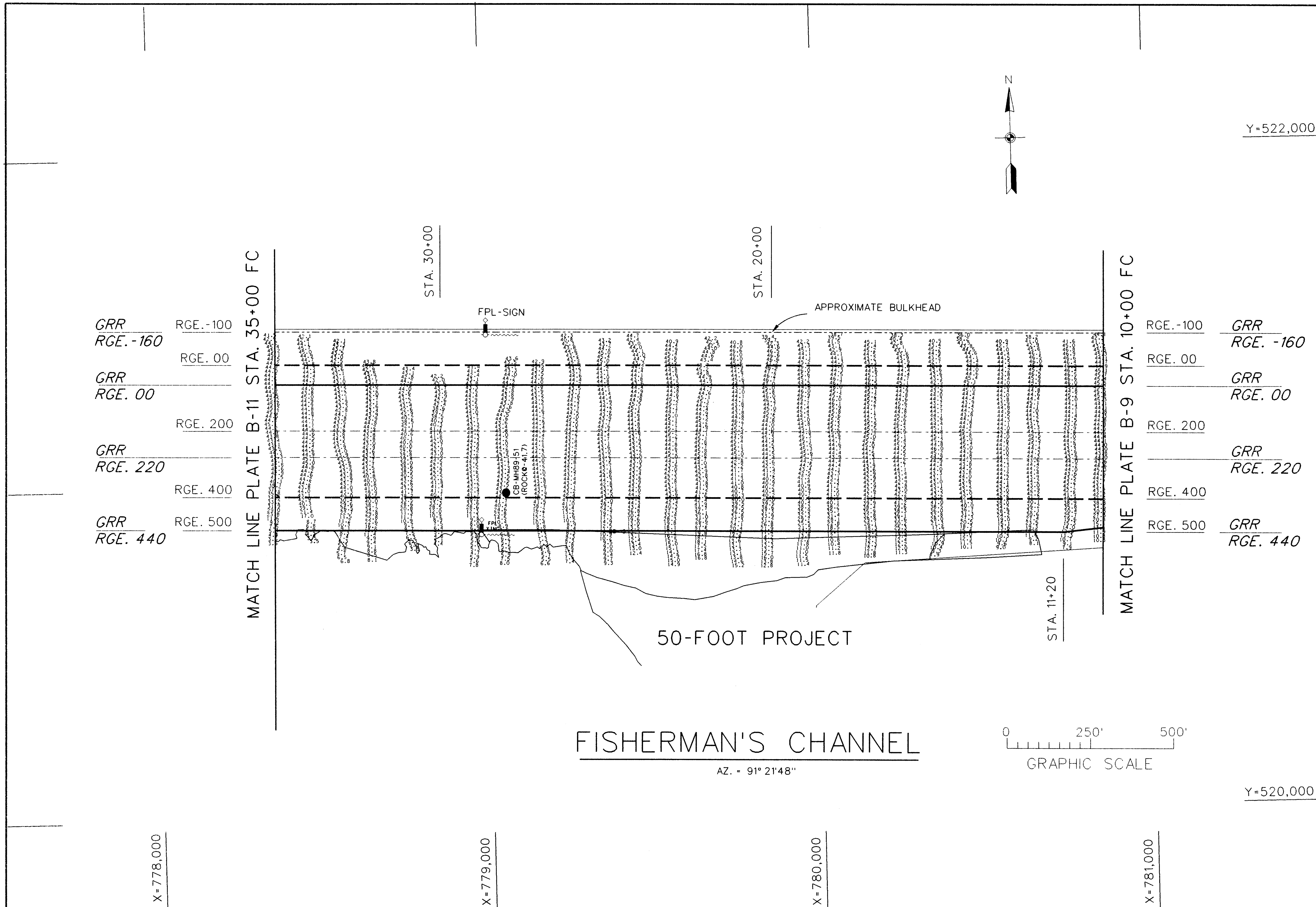
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

PLAN-CUT3 & FISHMN'S CH.

STA. 15+00 CUT3 TO STA. 10+00 FC

PLATE
B-9



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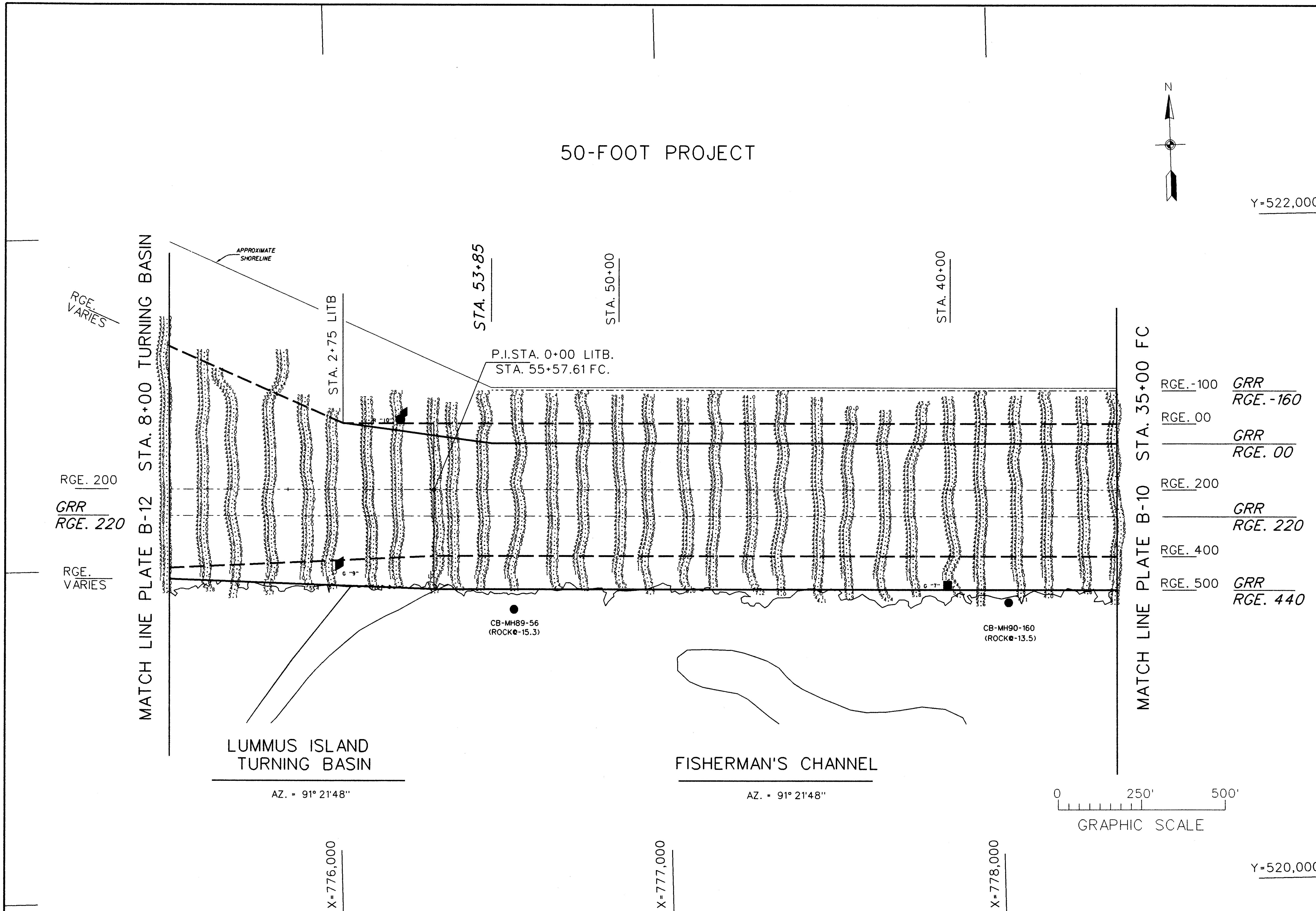
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT
PLAN - FC (ALT #5)
STA. 10+00 FC TO STA. 35+00 FC

PLATE
B-10



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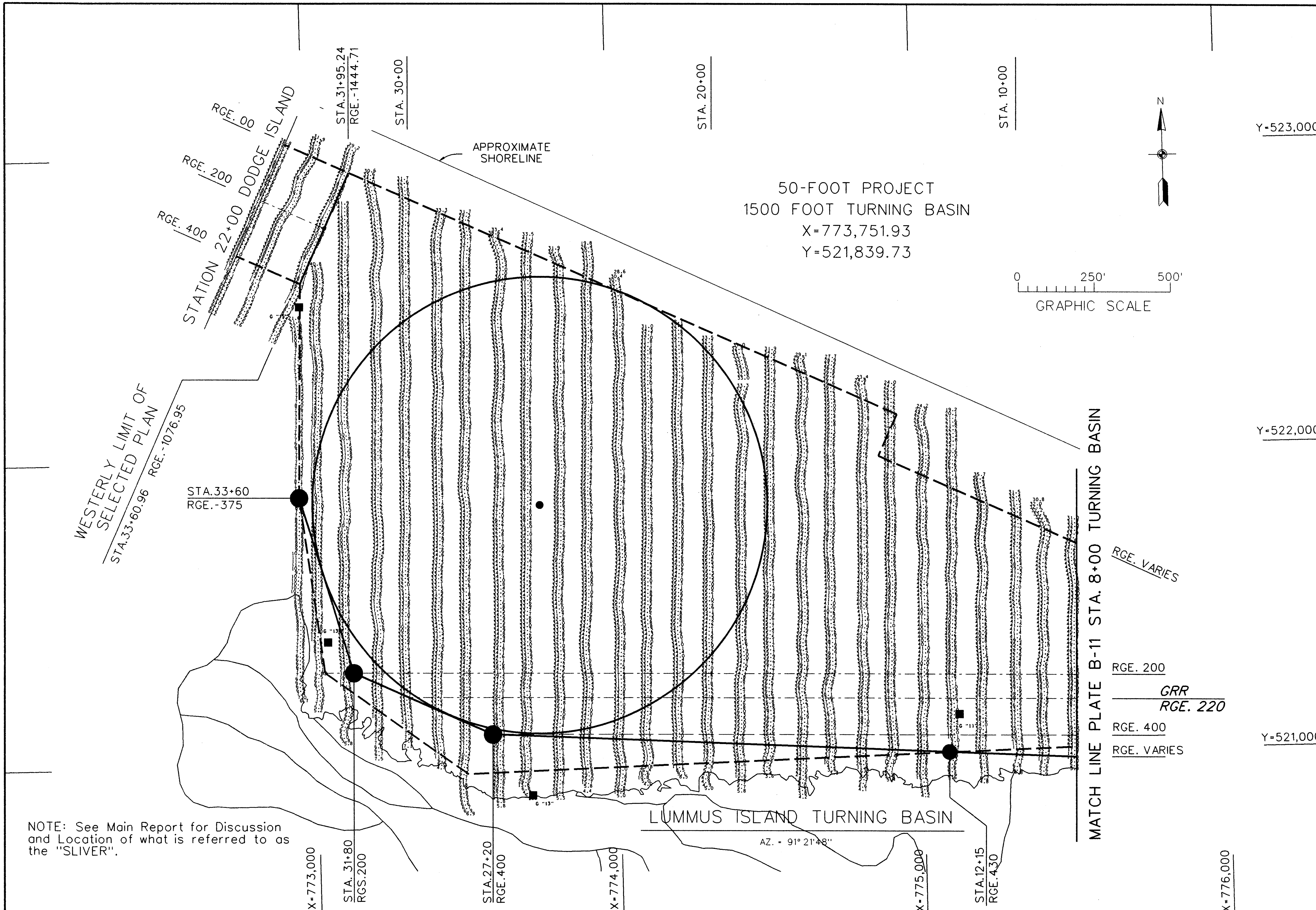
GENERAL REEVALUATION REPORT
PLAN - FISHERMAN'S CHANNEL
& LUMMUS ISLAND TB
STA. 35+00FC TO STA. 8+00 LITB

PLATE
B-11



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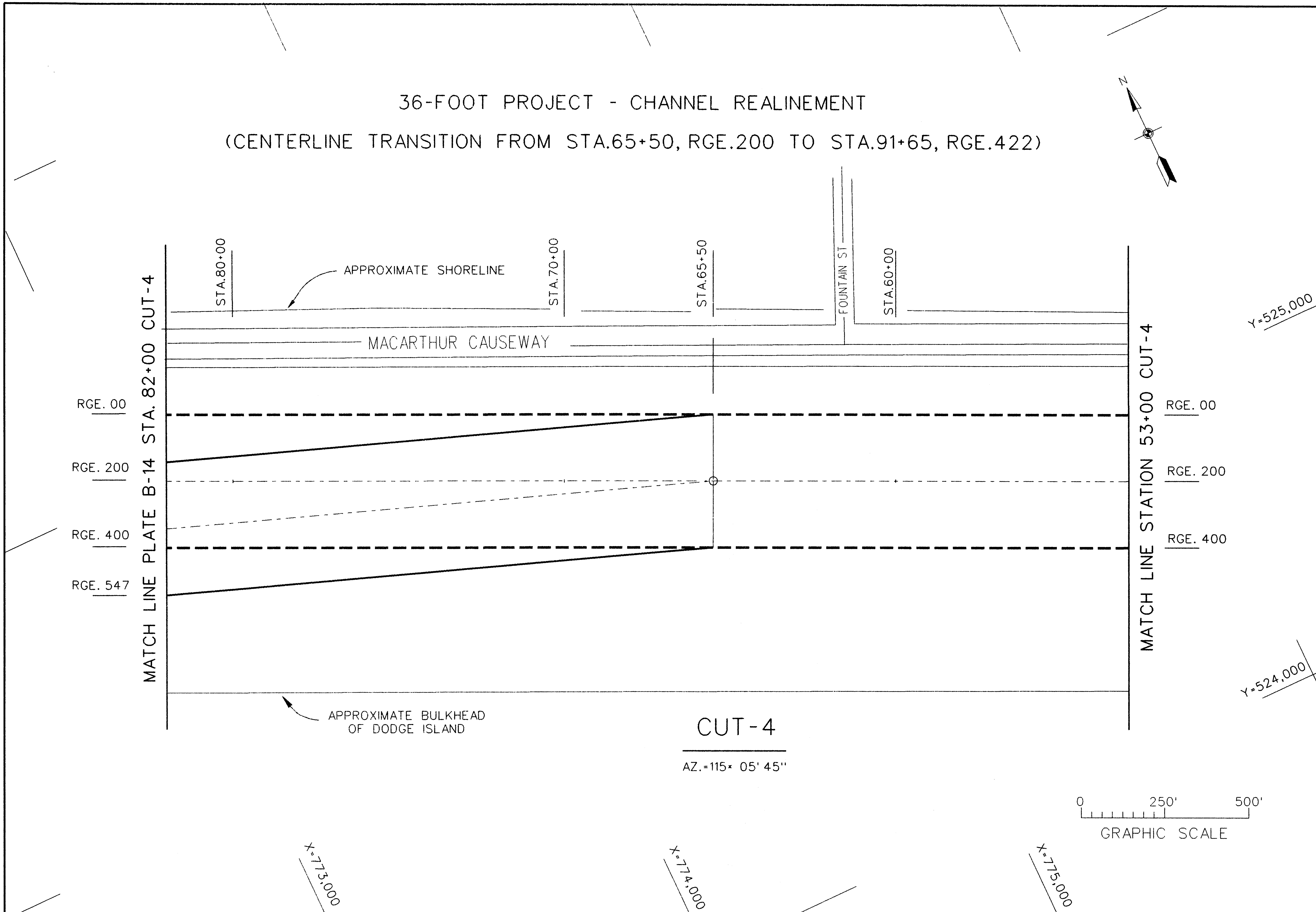
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT
LUMMUS ISLAND TURNING BASIN
STA. 8+00 LITB TO STA. 35+76.89 LITB

PLATE
B-12

36-FOOT PROJECT - CHANNEL REALINEMENT

(CENTERLINE TRANSITION FROM STA.65+50, RGE.200 TO STA.91+65, RGE.422)



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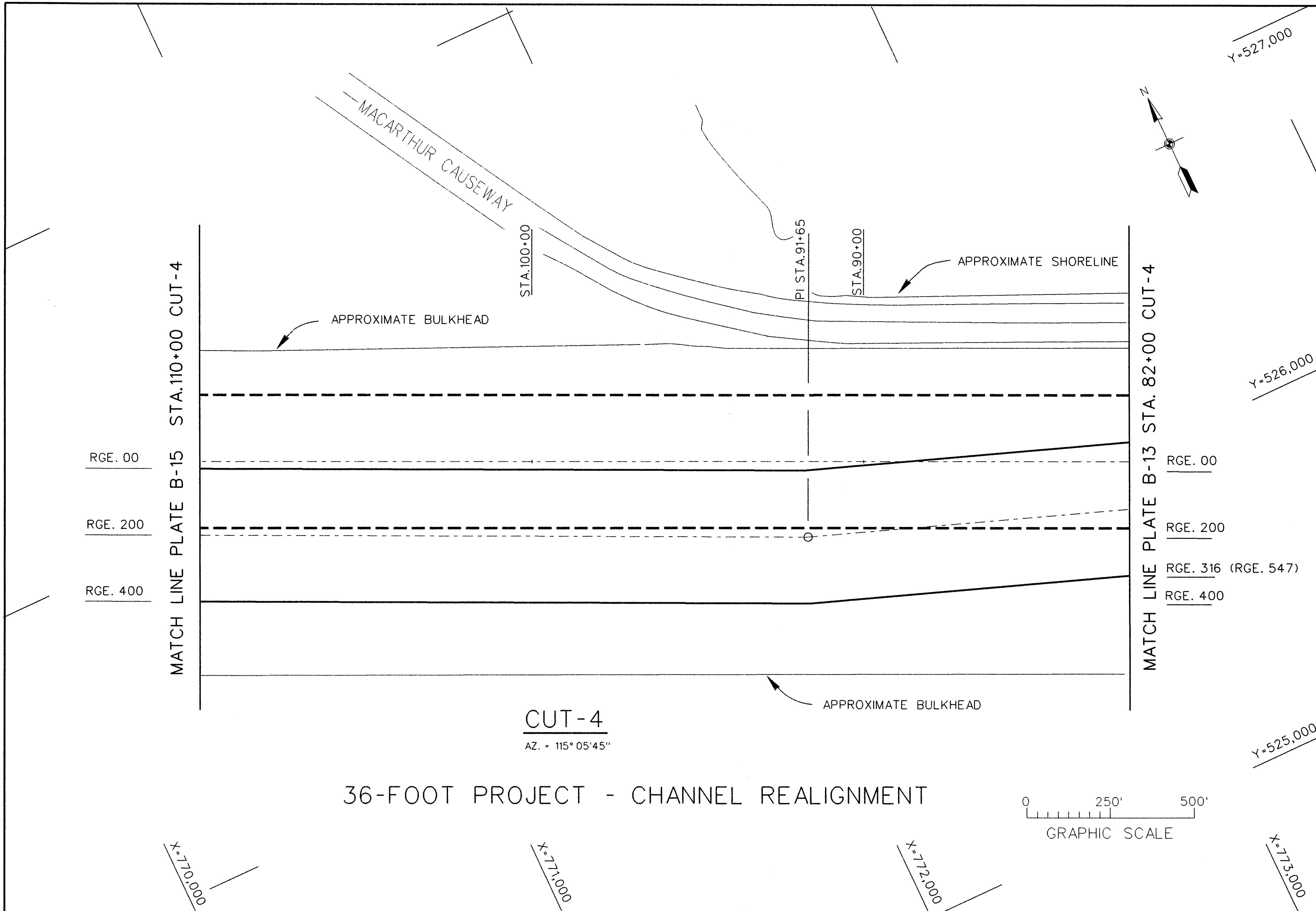
GENERAL REEVALUATION REPORT
PLAN CUT-4
STA. 53+00 CUT4 TO STA. 82+00 CUT4

PLATE
B-13



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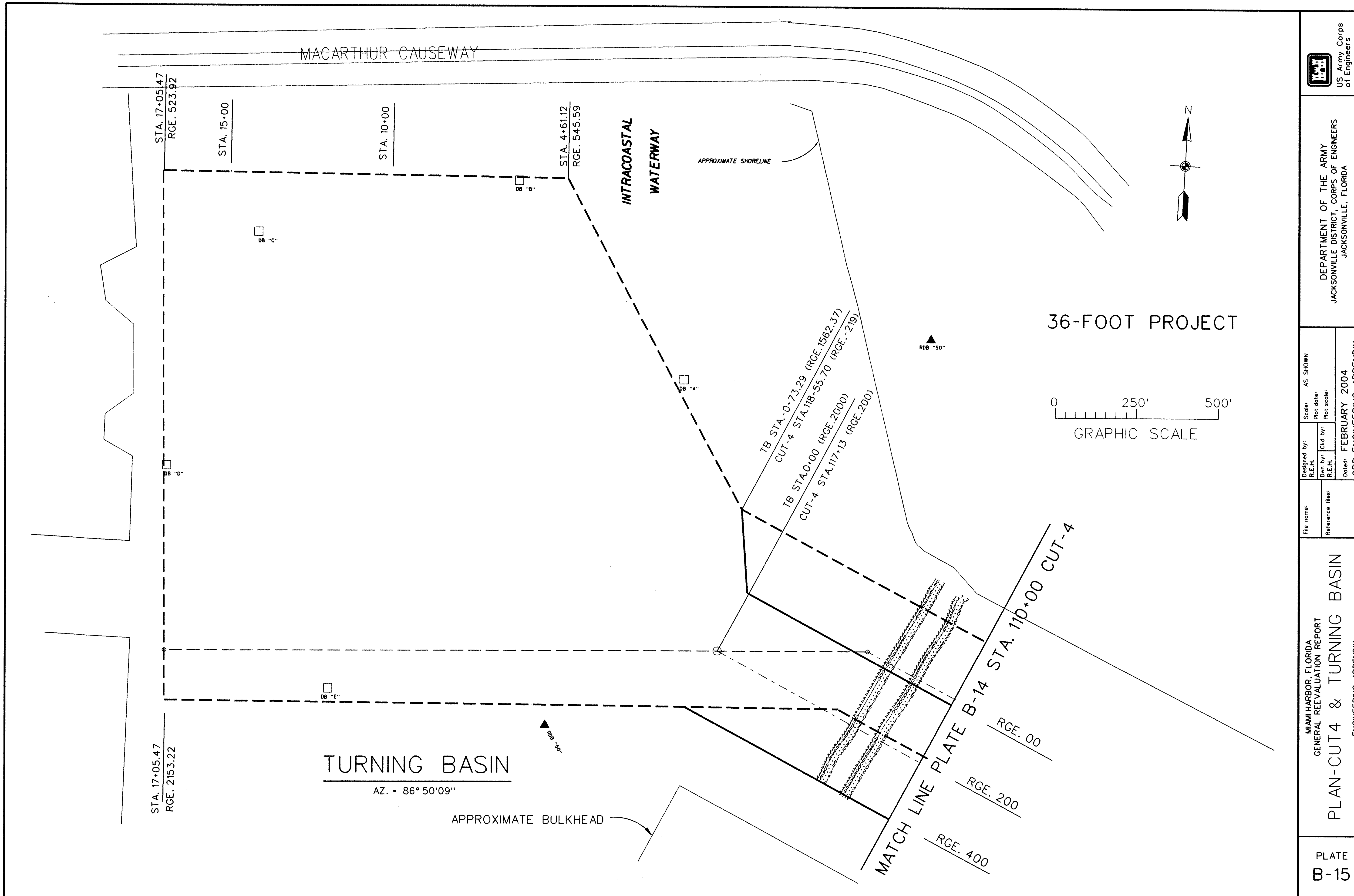
GENERAL REEVALUATION REPORT

PLAN - CUT 4

STA. 82+00 CUT4 TO STA. 110+00 CUT4

PLATE
B-14



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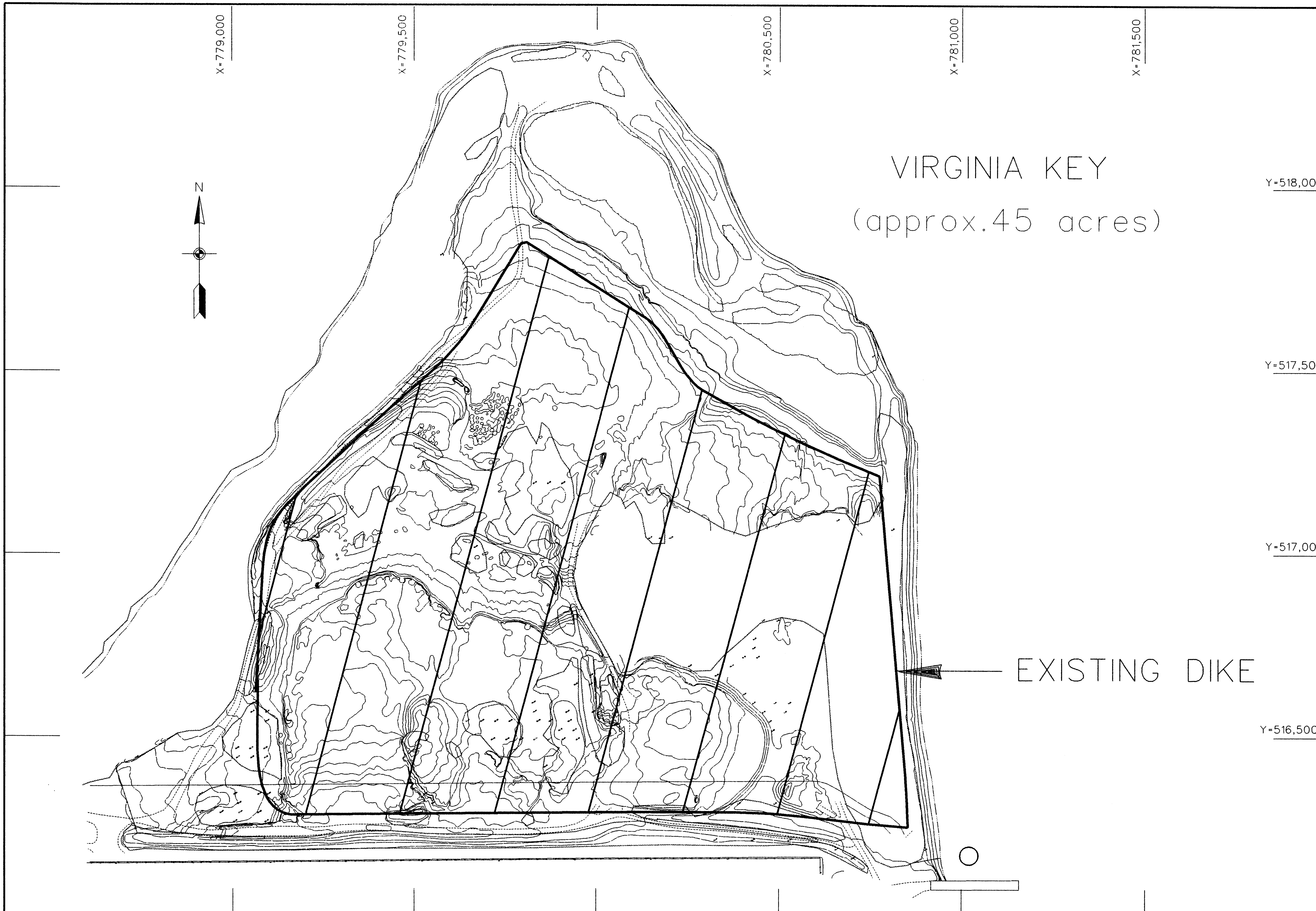

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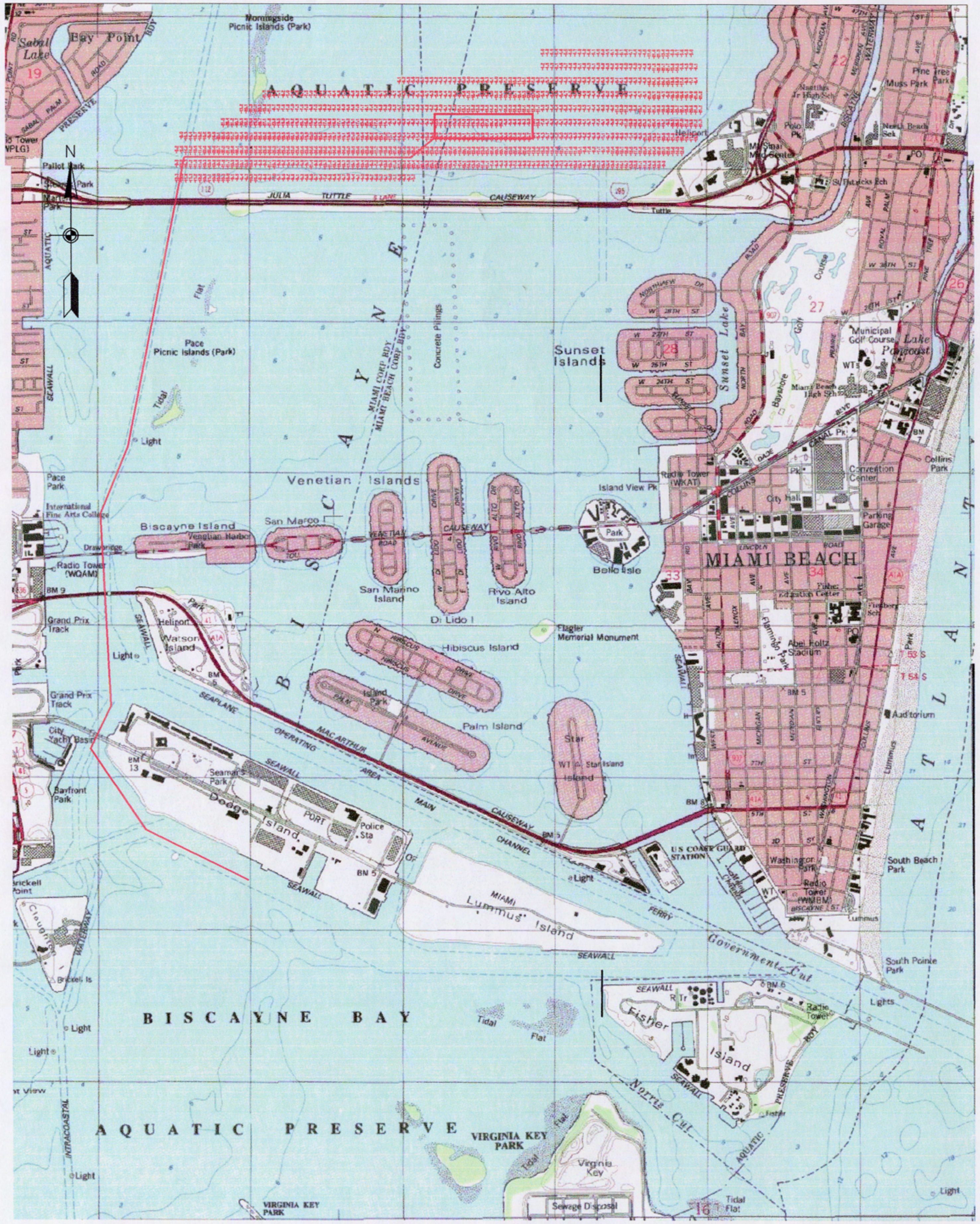
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT
VIRGINIA KEY DISPOSAL AREA

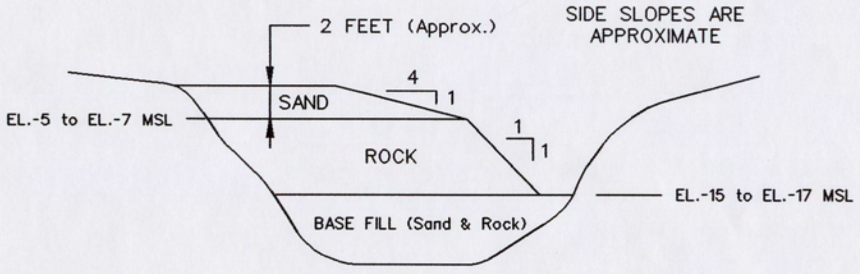
PLATE
B-16



MITIGATION AREA IS APPROXIMATELY 25 ACRES.

-4.4	-5.4	-8.6	-28.2
-4.9	-5.3	-15.0	-26.3
-4.2	-4.5	-19.6	-23.8
-6.6	-12.9	-19.5	-23.3
-7.0	-16.7	-20.7	-23.0
-6.1	-16.6	-22.1	-22.9
-4.2	-14.1	-24.3	-22.5
-5.0	-15.0	-23.6	-20.7
-12.1	-15.6	-21.5	-19.3
-13.1	-14.9	-20.1	-20.1
-13.1	-14.9	-21.7	-22.2
-13.9	-19.3	-26.5	-23.8
-13.5	-18.0	-27.9	-25.2
-8.9	-23.0	-28.9	-23.3
-15.5	-27.8	-31.0	-23.1
-14.2	-28.4	-30.1	-22.6
-12.6	-28.5	-29.1	-20.7
-7.2	-26.8	-30.4	-20.7
-12.6	-5.8	-28.6	-22.0
-12.3	-5.8	-28.3	-23.5
-12.9	-6.6	-27.8	-23.4
-13.0	-8.9	-27.2	-24.0
-12.1	-8.3	-29.2	-22.6
-11.9	-9.0	-25.7	-13.2
-12.2	-10.3	-8.4	-13.5
-11.7	-10.6	-5.4	-13.2
-9.5	-7.9	-4.3	-15.3
-4.3	-4.7	-5.7	-15.5

MITIGATION AREA INSET
(Not to Scale)



MITIGATION AREA SECTION
(NOT TO SCALE)

NOTE: FOR MORE INFORMATION ON MITIGATION AREA LOCATION AND SECTION REFER TO THE E.I.S.

5000'

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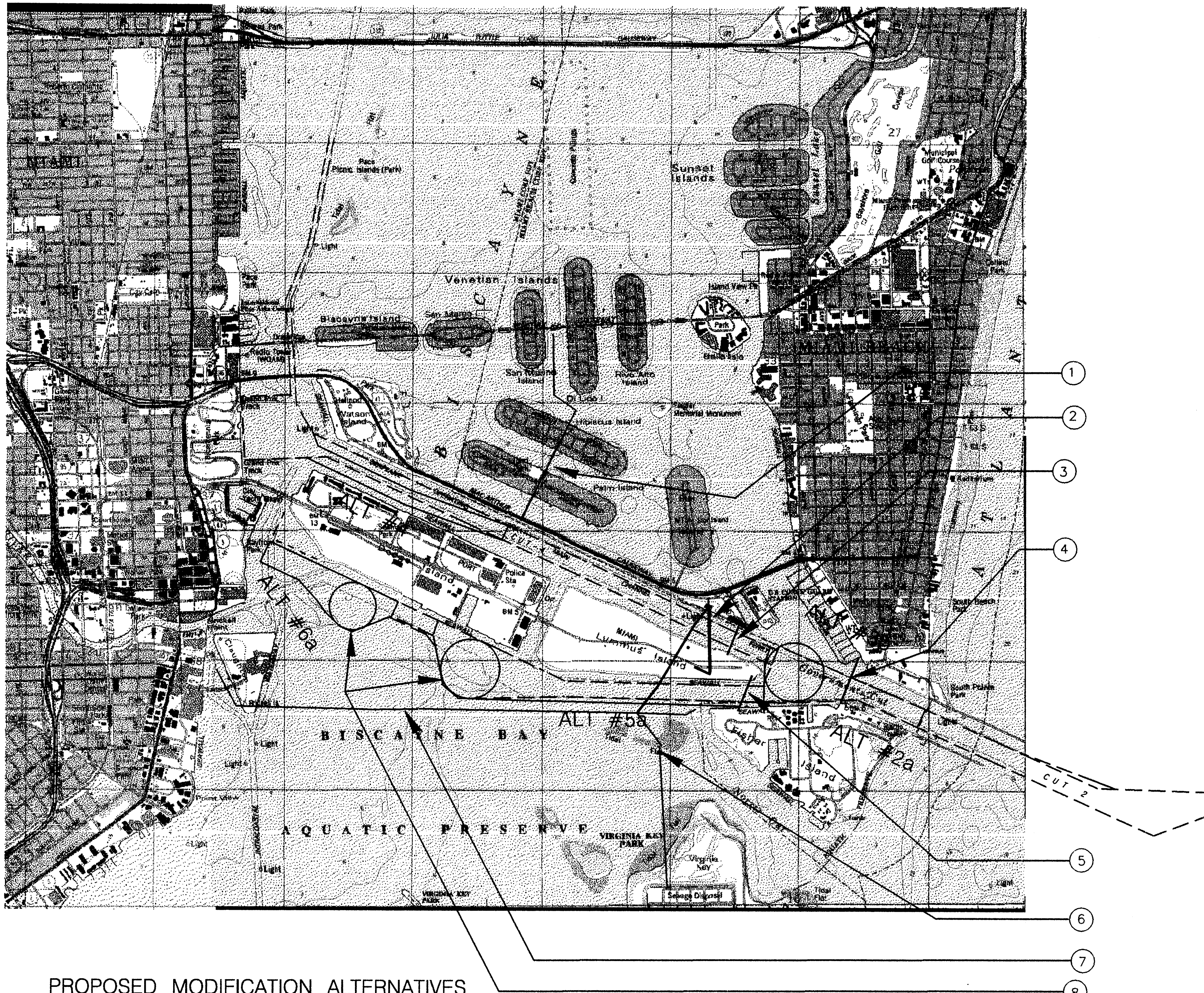
MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

BISCAYNE BAY MITIGATION AREA

PLATE
B-17



KEYED NOTES:

(1) NO UTILITY CONFLICT
FP&L 15 KV FEEDER CABLES ALONG MACARTHUR CAUSEWAY. RELOCATING WESTERN END OF CHANNEL WOULD NOT CAUSE CONFLICT. CABLE WOULD NOT HAVE TO BE RELOCATED

(2) NO WORK PROPOSED.
FP&L 69 KV AND 138 KV TRANSMISSION CABLES IN CUT 4. CABLES WILL NOT HAVE TO BE RELOCATED.

(3) NO WORK PROPOSED
MIAMI-DADE WASD WATER MAIN IN CUT 3. TOP OF PIPE ELEVATION AT MINUS 48-FT. PROPOSED CHANNEL DEPTH MINUS 40-FT

(4) UTILITY CONFLICT - RELOCATION REQUIRED
WASD 54-IN SEWER FORCE MAIN IN ALT #2A AND ALT #3B TOP OF PIPE ELEVATION AT MINUS 50-FT. WIDENING THE CHANNEL WOULD CAUSE CONFLICT. PIPE WILL REQUIRE RELOCATING TO 6-FT BELOW PROJECT DEPTH PLUS ALLOWED OVERDEPTH.

(5) UTILITY CONFLICT - RELOCATION REQUIRED.
WASD WATER MAIN IN ALT #5. TOP OF PIPE ELEVATION AT MINUS 52.8-FT. WIDENING THE CHANNEL WOULD CAUSE CONFLICT. PIPE WOULD REQUIRE RELOCATING TO 6-FT BELOW PROJECT DEPTH PLUS ALLOWED OVERDEPTH.

(6) UTILITY CONFLICT - PREVIOUS PROJECT TO RELOCATE FP&L 138 KV FEEDER CABLES IN ALT #5. CHANNEL DEEPENING WOULD CAUSE CONFLICT. TOP OF CABLE ELEVATION AT MINUS 45.8-FT. PROPOSED CHANNEL DEPTH MINUS 50-FT. CABLE WOULD REQUIRE RELOCATING TO 6-FT BELOW PROJECT DEPTH PLUS ALLOWED OVERDEPTH.

(7) UTILITY CONFLICT - PREVIOUS PROJECT TO RELOCATE FP&L 69 KV FEEDER CABLES IN ALT #5. CHANNEL DEEPENING WOULD CAUSE CONFLICT. TOP OF CABLE ELEVATION AT MINUS 45.5-FT. PROPOSED CHANNEL DEPTH MINUS 50-FT. CABLE WOULD REQUIRE RELOCATING TO 6-FT BELOW PROJECT DEPTH PLUS ALLOWED OVERDEPTH.

(8) NO UTILITY CONFLICT
BELLSOUTH TELEPHONE CABLES IN ALT #5 AND ALT #3B APPROXIMATELY 30-FT BELOW BAY FLOOR. DEEPENING WOULD NOT CAUSE CONFLICT. CABLE WOULD NOT HAVE TO BE RELOCATED.

PROPOSED MODIFICATION ALTERNATIVES

ALTERNATIVE #1 - WIDEN SEAWARD PORTION OF CUT-1 FROM 500 FEET TO 800 FEET AND DEEPEN CUT-1 AND CUT-2. (EXISTING DEPTH = 44 FEET, DEEPEN TO 52 FEET)

ALTERNATIVE #2 - ADD TURN WIDENER BETWEEN BUOY #13 AND BUOY #15. (EXISTING DEPTH = 42 FEET, DEEPEN TO 50 FEET)

ALTERNATIVE #3 - EXPAND FISHER ISLAND TURNING BASIN FROM 1200 FEET TO 1500 FEET. (EXISTING DEPTH = 42 FEET, DEEPEN TO 50 FEET)

ALTERNATIVE #4 - RELOCATE THE WESTERN END OF THE MAIN CHANNEL TO ALLOW FOR ADDITIONAL CRUISE SHIP BERTHS.

ALTERNATIVE #5 - WIDEN FISHERMAN'S CHANNEL APPROXIMATELY 100 FEET TO THE SOUTH. (EXISTING DEPTH = 42 FEET, DEEPEN TO 50 FEET) DEEPENING WOULD INCLUDE CUT-3, STA. 0+00 TO CUT-3, STA. 42+00.

ALTERNATIVE #6 - DEEPEN DODGE ISLAND CUT AND THE PROPOSED 1200 FOOT DIAMETER TURNING BASIN FROM 32 & 34 FEET TO 36 FEET AND RELOCATE WESTERN END OF DODGE ISLAND CUT TO ACCOMODATE PROPOSED PORT EXPANSION.

US Army Corps of Engineers
Jacksonville District

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

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		GRR-ENGINEERING APPENDIX

MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT

UTILITIES PRESENT BY PROJECT SEGMENT

MECHANICAL AND ELECTRICAL

PLATE
B-18

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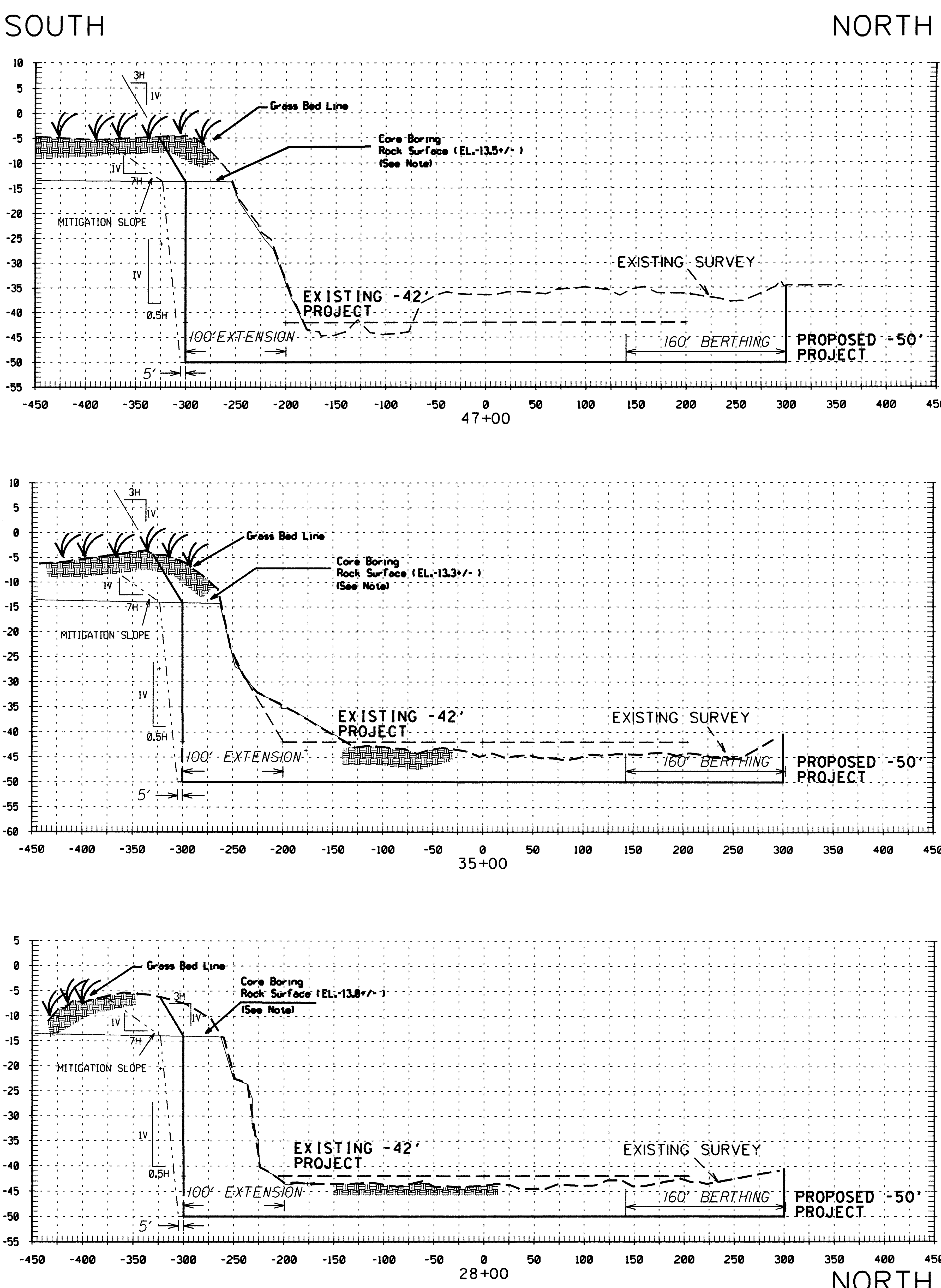
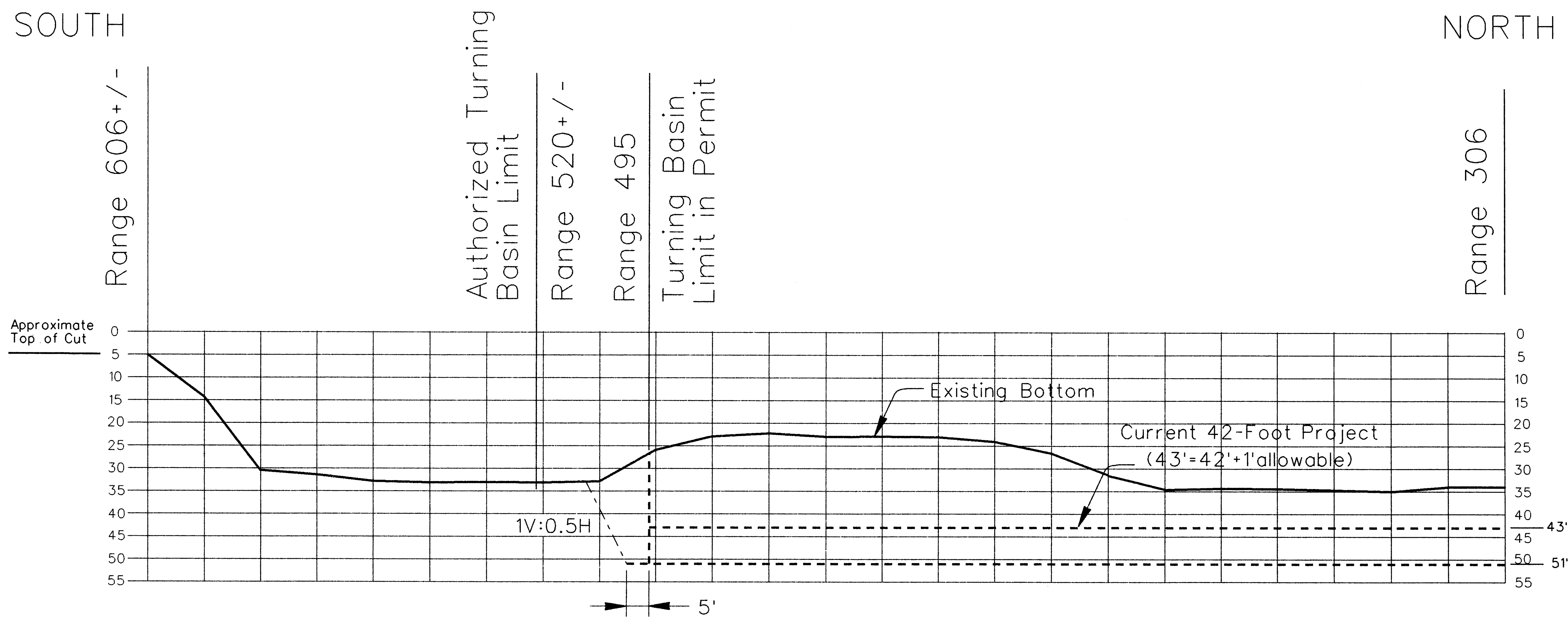


FISHERMAN'S CHANNEL

Note: Approximate rock elevations estimated from core borings located in the vicinity of the typical sections. The approximate average elevation along Fisherman's Channel is estimated at El.- 13 MLLW.

08/14/03

PLATE B-19	MIAMI HARBOR, FLORIDA GENERAL REEVALUATION REPORT TYPICAL SECTIONS FISHERMAN'S CHANNEL	File name: TYP-XSCT.DGN Reference files: TYPBDR11X17.DGN Designed by: R.E.H. Dwn by: R.E.H. Ckd by: Scale: AS SHOWN Plot date: Plot scale: Dated: FEBRUARY 2004 GRR-ENGINEERING APPENDIX	DEPARTMENT OF THE ARMY JACKSONVILLE DISTRICT, CORPS OF ENGINEERS JACKSONVILLE, FLORIDA	US Army Corps of Engineers Jacksonville District



1500' - LUMMUS ISLAND TURNING BASIN
(STATION 22+95)

MIAMI HARBOR - PROPOSED DEEPENING PROJECT
(51' Depth = 50' Project Depth +1' Allowable Overdepth)

NOTE:
1. Deepening would be in rock, side slope would be generally vertical.
2. All depths refer to Mean Lower Low Water (MLLW) which is approximately 0.74 feet below Mean Sea Level (MSL) NGVD 29.

0 25 50
SCALE IN FEET

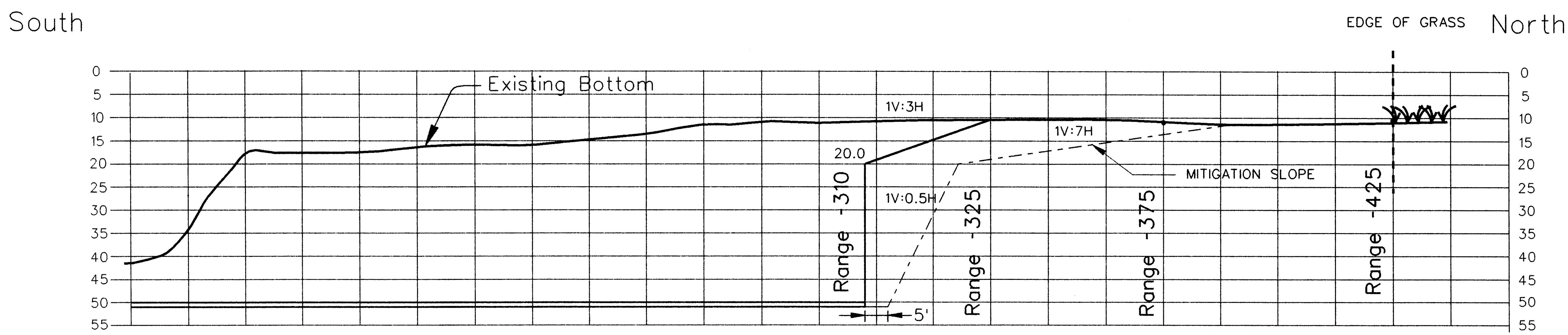
US Army Corps of Engineers
Jacksonville District

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

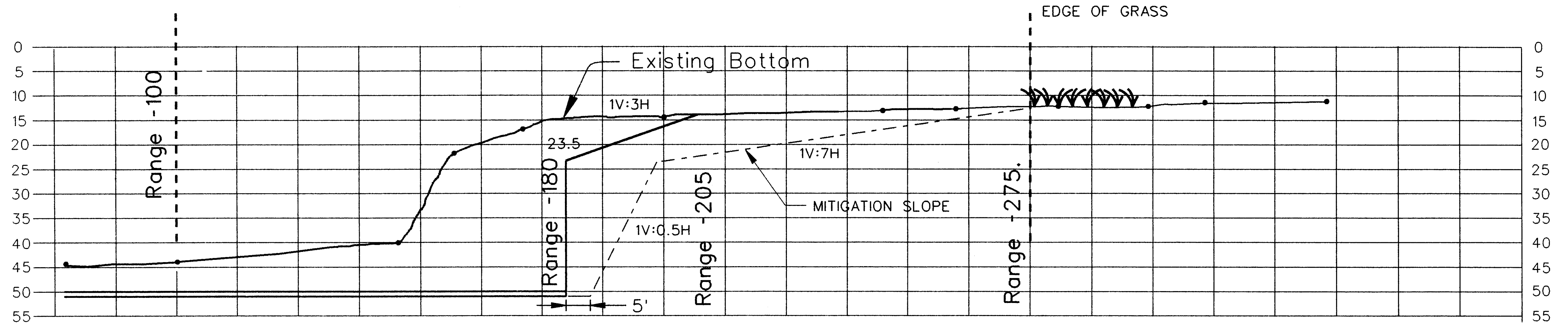
Designed by: R.E.H.
Dwn by: R.E.H.
Ckd by:
Scale: AS SHOWN
Plot date:
Plot scale:
Dated: FEBRUARY 2004
GRR-ENGINEERING APPENDIX
File name:
Reference files:

MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT
TYPICAL PARTIAL SECTION
LUMMUS ISLAND TURNING BASIN

PLATE
B-20



1500' - FISHER ISLAND TURNING BASIN
(STATION 35+50)



1500' - FISHER ISLAND TURNING BASIN
(STATION 30+50)

50-FOOT PROJECT DEPTH + 1-FOOT ALLOWABLE OVERDEPTH

NOTE:

1. The side slope in rock would be approximately 1 Vertical on 0.5 Horizontal
2. All depths refer to Mean Lower Low Water (MLLW) which is approximately 0.74 feet below Mean Sea Level (MSL) NGVD 29.

0 25 50
SCALE IN FEET

08/14/03

US Army Corps of Engineers Jacksonville District

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JACKSONVILLE, FLORIDA

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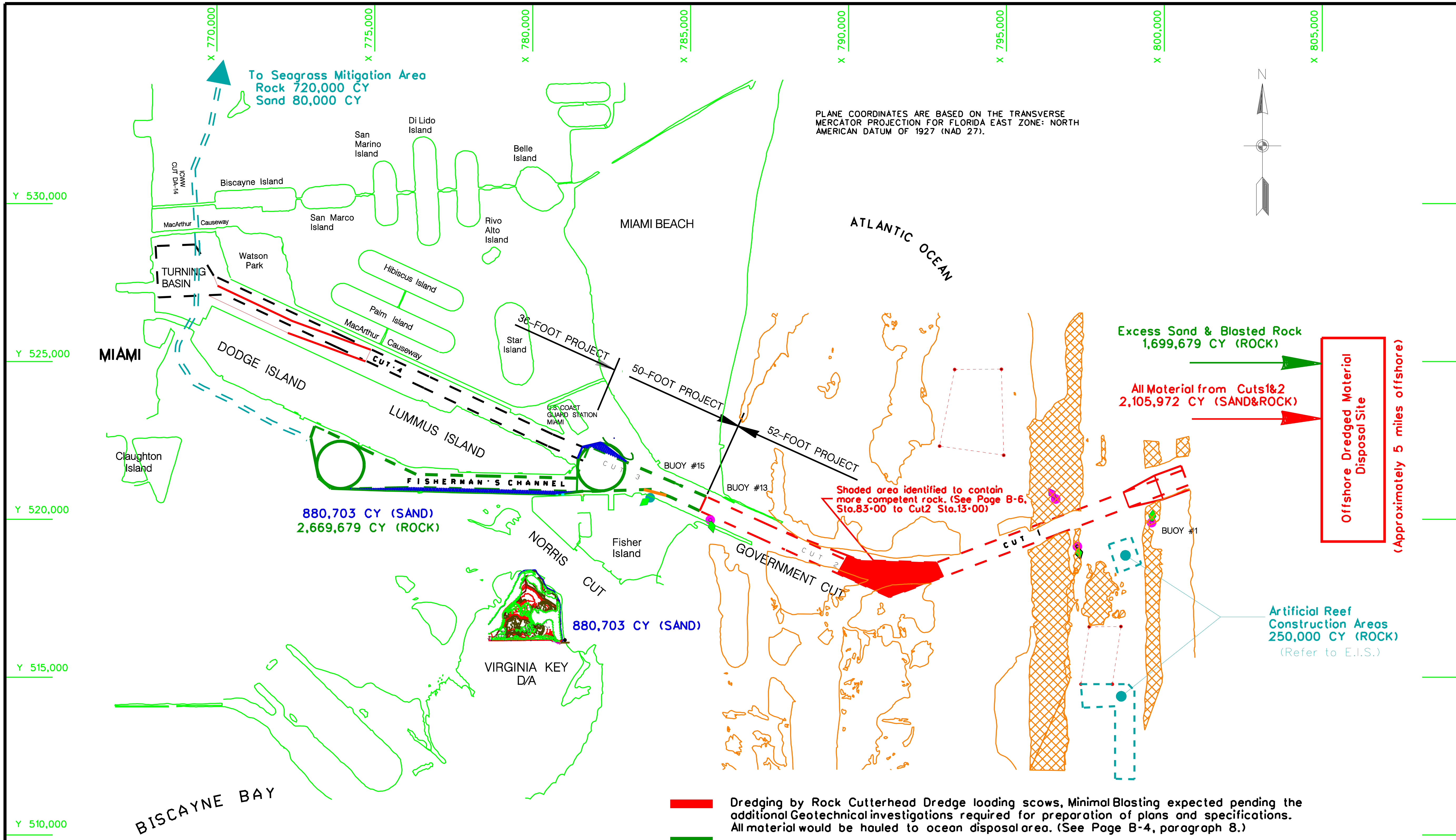
GRR-ENGINEERING APPENDIX

MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT
TYPICAL PARTIAL SECTION
FISHER ISLAND TURNING BASIN

PLATE
B-21



CONTRACT 1 - CUTS 1&2 (Estimated construction period = 12 months)
CONTRACT 2 - REMAINDER (Estimated construction period = 31 months)

Total Estimated Construction Period including Offshore Reefs and Seagrass Mitigation = 43 Months.

- (red) Dredging by Rock Cutterhead Dredge loading scows, Minimal Blasting expected pending the additional Geotechnical investigations required for preparation of plans and specifications. All material would be hauled to ocean disposal area. (See Page B-4, paragraph 8.)
- (green) Rock Dredging with Hydraulic Excavator loading scows, Includes Blasting. Excess rock and sand would be hauled to ocean disposal aera.
- (blue) Sand Dredging with Pipeline Dredge with direct upland disposal on Virginia Key. If capacity is limited, excess sand would be placed in the ODMDS.
- (cyan) Construction of Artificial Reefs with blasted rock from inner reaches. Seagrass Mitigation with blasted rock from Fisherman's Channel and sand from the Virginia Key disposal area

US Army Corps of Engineers
Jacksonville District

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JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

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File name:
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MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT
EXCAVATION AND DISPOSAL PLAN
NED PLAN WITH ADDITIONAL 2 FEET LOCAL OPTION

PLATE
B-22

ATTACHMENT A

Velocity and Salinity Assessment

Miami Harbor Channel Deepening Velocity and Salinity Assessment
Phase 1: 2D Assessment

Investigators: Gary L. Brown (ERDC-CHL-MS)
William L. Boyt (ERDC-CHL-MS)
Mitch A. Granat (CESAJ-EN-HI)

Introduction

The Coastal and Hydraulics Laboratory (CHL) at ERDC has been tasked by the Army Corps of Engineers, Jacksonville District (CESAJ-EN-H) to perform a 2D numerical model study of the impacts of the proposed Miami Harbor deepening on velocities and salinity in Miami Harbor, and on velocities along the coastal ocean shoreline in the vicinity of Government Cut. The study had been conducted using a previously verified 2-dimensional TABS-MDS numerical model of Biscayne Bay and Miami Harbor. The computational mesh used for the Biscayne Bay study was refined in the vicinity of Miami Harbor, in order to more effectively capture the local bathymetry and currents.

This report details the boundary conditions used to drive the simulation, and the results of comparing the velocity and salinity fields obtained for the existing harbor configuration, to those obtained for the planned harbor configuration.

Model Mesh and Boundary Conditions

The model mesh for the entire model domain is given in Figure 1. The refined model mesh in the vicinity of Miami Harbor is given in Figure 2. The existing bathymetry in the harbor was updated to reflect the most recent survey data, given in Survey No. 01-097 (February-March 2001). Figure 3 shows the locations of the various harbor improvements. All 6 alternatives were implemented in the plan condition for this study. The specific changes associated with each alternative are given as follows:

- *Alternative 1:* widen seaward portion of Cut-1 from 500 feet to 800 feet and deepen Cut-1 and Cut-2 (existing depth = 44 feet, deepen to 52 feet)
- *Alternative 2:* Add turn widener between Buoy #13 and Buoy #15 (existing depth = 42 feet, deepen to 50 feet)
- *Alternative 3:* expand Fisher Island Turning Basin from 1200 feet to 1500 feet (existing depth = 42 feet, deepen to 50 feet)
- *Alternative 4:* relocate western end of the main channel to allow for additional cruise ship berths
- *Alternative 5:* widen Fisherman's Channel approximately 100 feet to the south (existing depth = 42 feet, deepen to 50 feet, deepening would include Cut-3 sta. 0+00 to cut-3 sta. 42+00)
- *Alternative 6:* deepen Dodge Island Cut and the proposed 1200 foot diameter turning basin from 32 and 34 feet to 36 feet and relocate western end of Dodge Island Cut to accommodate proposed port expansion.

data related to the last 14 days of the simulation (the investigation period) are illustrated and analyzed in this report.

Results

The model was run for all 5 simulations. Data were extracted for the following quantities, and used to generate vector and contour plots:

- A representative maximum ebb condition (chosen at hour 65)
- A representative maximum flood condition (chosen at hour 71)
- The velocity residuals, or the time-averaged velocities, averaged over the 14 day simulation
- The salinity residuals, or the time-averaged salinities, averaged over the 14 day simulation

The representative maximum ebb and flood conditions were chosen at a period mid-way between the neap and spring tides. Hence they represent an average tidal condition.

Additional data were extracted at selected locations in the vicinity of Miami Harbor, and used to generate time-history plots of velocity, water volumetric flux, and salinity. These locations were chosen as follows: the vector and contour plots were inspected to determine locations where maximum change is observed between the existing and plan conditions, and locations where volumetric flux measurements can be accurately calculated. This inspection yielded the following locations of interest:

- *Point 1 and Range 1*: These are located inside Government Cut. Velocity and salinity data were extracted at Point 1 (located at the channel centerline, with existing and plan condition depths of 44 and 52 feet MLLW, respectively), and volumetric flux data were extracted across Range 1.
- *Point 2 and Range 2*: These are located inside Fisherman's Channel. Velocity and salinity data were extracted at Point 2 (located at the channel centerline, with existing and plan condition depths of 42 and 50 feet MLLW, respectively), and volumetric flux data were extracted across Range 2.
- *Point 3 and Range 3*: These are located inside the western end of the Main Channel, north of Dodge Island. Velocity and salinity data were extracted at Point 3 (located at the channel centerline, with identical existing and plan condition depths of 40 feet MLLW), and volumetric flux data were extracted across Range 3.
- *Point 4 and Range 4*: These are located at the western end of Dodge Island northwest of the Dodge Island turning basin. Velocity and salinity data were extracted at Point 4 (located at the Intracoastal Waterway channel centerline, with identical existing and plan condition depths of approximately 10 feet MLLW), and volumetric flux data were extracted across Range 4.
- *Point 5*: This is located south of Dodge Island, near the proposed Dodge Island Cut Turning Basin. Salinity data were extracted at Point 5 (with existing and plan condition depths of 34 and 36 feet MLLW, respectively).

Two points of interest regarding maximum ebb velocity vector results include the noticeable change in ebb velocities west of Dodge Island (no deepening in this location) illustrated between Figures 7 (existing condition) and 8 (plan condition) and the resulting direction of ebb velocity differences in Figure 9. The existing and plan ebb conditions each indicate flows to the north at this location towards the north side of Dodge Island. Maximum ebb velocity magnitudes for the plan condition are reduced relative to the existing condition, possibly as a result of deeper depths and related higher transport along Fisherman Channel (south side of Dodge Island).

As illustrated in Figure 9, plan minus existing condition ebb velocity magnitude differences results in the direction of the difference vectors seeming to be in the opposite flow direction, i.e., in this case, towards the south. This is a result of the "plan minus existing condition" calculation convention, i.e., when the plan condition velocity is reduced relative to the existing condition velocity, the difference vector results in an apparent negative result, or in this case, with flow to the south.

This calculation convention artifact similarly explains the apparent direction contradiction illustrated at most of the remaining ebb vector differences illustrated in Figure 9, i.e., plan condition velocity is reduced relative to existing condition velocity. The fact that velocity did not change in the main harbor channel along the north side of Dodge and Lummus Islands (this portion of channel was not deepened for the plan condition) supports the assumption that additional transport occurs along the deepened plan channel to the south along Fisherman Channel.

Maximum Flood: The maximum flood velocities for the existing and plan conditions are given in Figures 10 and 11, and the flood velocity differences are given in Figure 12. There are differences observable in Government Cut, Fisherman's Channel and Dodge Island Cut. The differences are generally smaller than the maximum ebb differences (Figure 9). All flood differences are on the order of 1 ft/sec or less. Similar findings of interest as described above (with respect to ebb flow) are also evident in the flood flow analysis. Also, there are no observable flood flow differences along the coastline.*

Residual Velocities (Average Flow Hydrograph): The residual velocities for the existing and plan conditions are given in Figures 13 and 14, and the residual velocity differences are given in Figure 15. The residual velocity vectors illustrate the 14-day tidal cycle average, or net non-tidal circulation characteristics. Generally similar flow patterns are illustrated for the existing (Figure 13) and plan (Figure 14) conditions, i.e., Government Cut has a net outflow while Norris Cut has a net inflow and the locations of vortices (ocean north of Government Cut and west of Dodge Island) are similarly located. The vortices on the south side of

* These simulations were not designed to include coastal processes such as littoral currents, and hence any assessment of the impact of harbor deepening on coastal currents should be made with an understanding of this limitation.

Salinity Plot Comparisons

Figures 23 –28 are plots of residual (average) salinity and residual salinity differences. Note that the salinity scale for Figures 23, 24, 26, and 27 ranges from 0 to 36 ppt, whereas the scale for Figures 25 and 28 (the difference plots) range from –0.5 to 0.5 ppt.

> Average Flow Condition: The residual salinities (i.e. 14-day average salinities) for the existing and plan conditions are given in Figures 23 and 24, and the salinity differences are given in Figure 25. The maximum differences are observed just west of Dodge Island Cut, with differences observable in Fisherman's Channel, the western end of the main channel, and to the northwest of the main channel. The maximum and minimum salinity differences for the average flow condition are 0.97 ppt and -0.90 ppt, respectively.
>
> Based on Figures 23 and 24, residual salinity conditions indicate that for the plan condition residual salinity appears to intrude further west along the main navigation channel on the north side of Lummus and Dodge Island and north of Watson Island into Northern Biscayne Bay. Residual salinity intrusion on the south side of Lummus/Dodge Island appears to be somewhat reduced for the plan condition. This affect is better illustrated in Figure 25 (residual salinity differences) where residual salinity difference increases up to +0.3 to +0.4 ppt are indicated north of Lummus/Dodge and Watson Islands and +0.2 to +0.3 ppt north of Biscayne Island. The largest reduced residual salinity difference, -0.4 to –0.5 ppt, is indicated along the south and west side of Dodge/Lummus Island. The largest increased salinity differences are located just north of Miami River further to the west of Dodge Island.
>
> High Flow Condition: The residual salinities for the existing and plan conditions are given in Figures 26 and 27, and the salinity differences are given in Figure 28. The salinity differences exhibit a similar pattern to that observed for the average flow condition, but the impacts are more pronounced. The maximum and minimum residual salinity differences for the high flow condition are 0.97 ppt and –1.04 ppt, respectively.

Salinity Time-History Comparisons:

Figures 29 – 34 give salinity time-history comparisons between the existing and plan conditions for Points 1 – 6 (as depicted in Figure 6). The plots contain time-history comparisons for both the average flow condition and the high flow condition. A summary of some of the observed differences between the time-histories for the existing and plan conditions in Figures 29 – 34 are given in Table 2. These are given together with residual difference values taken from Figures 25 and 28:

for the plan condition west of Dodge Island. There is no observable impact on the Atlantic Ocean shoreline tidal velocities in any of the simulations.*

Subtle differences in salinity were identified between existing and plan channel conditions. These changes are close to detection limits and confidence levels of present field data collection capability and associated model assessments. The salinity comparisons yielded maximum salinity differences on the order of 1.0 ppt. The maximum differences occur just west of Dodge Island Cut, with differences observable in Fisherman's Channel, the western end of the main channel, and to the northwest of Miami Harbor. The differences observed west of Dodge Island may be influenced by the attenuated tidal amplitude and tidal phase lag induced by the channel deepening. The influence of channel deepening on the salinity north of Miami Harbor appears to be most pronounced during neap tides.

* These simulations were not designed to include coastal processes such as littoral currents, and hence any assessment of the impact of harbor deepening on coastal currents should be made with an understanding of this limitation.

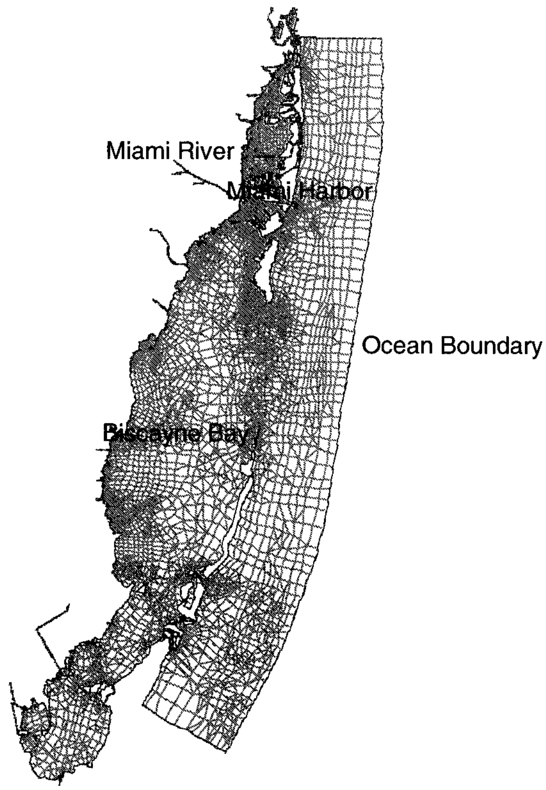


Figure 1: Entire TABS-MDS Mesh

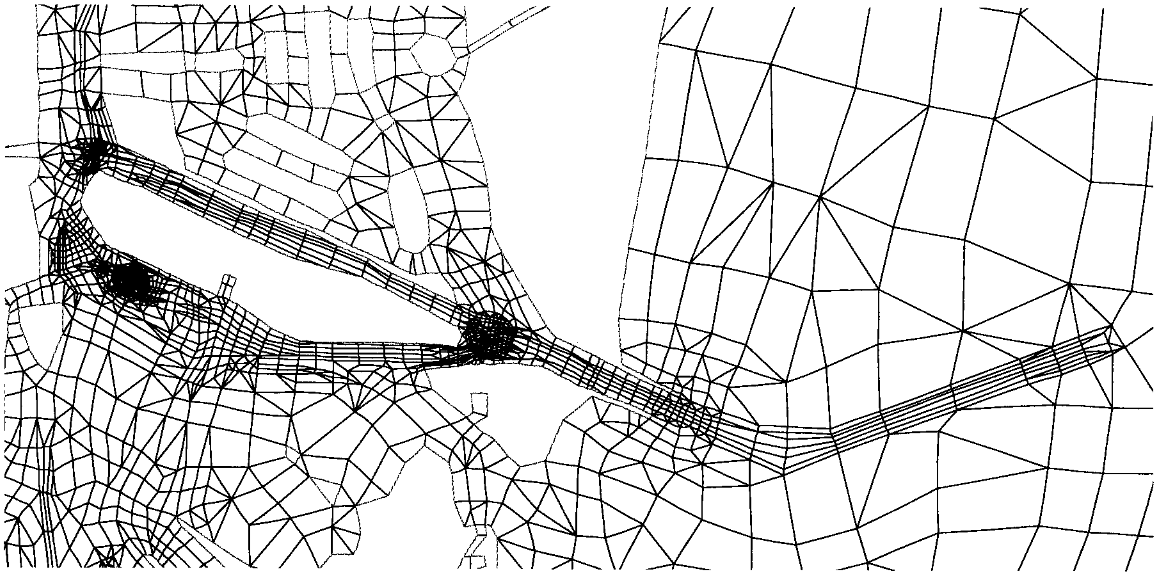


Figure 2: Finite Element Grid in the Vicinity of Miami Harbor

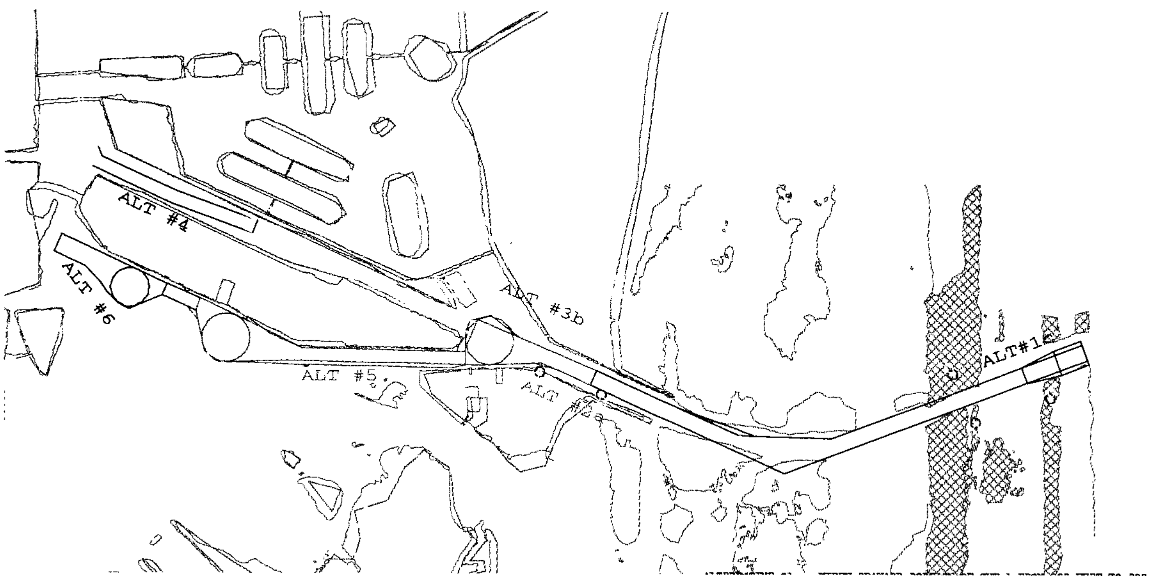


Figure 3: Deepening Plan for Miami Harbor

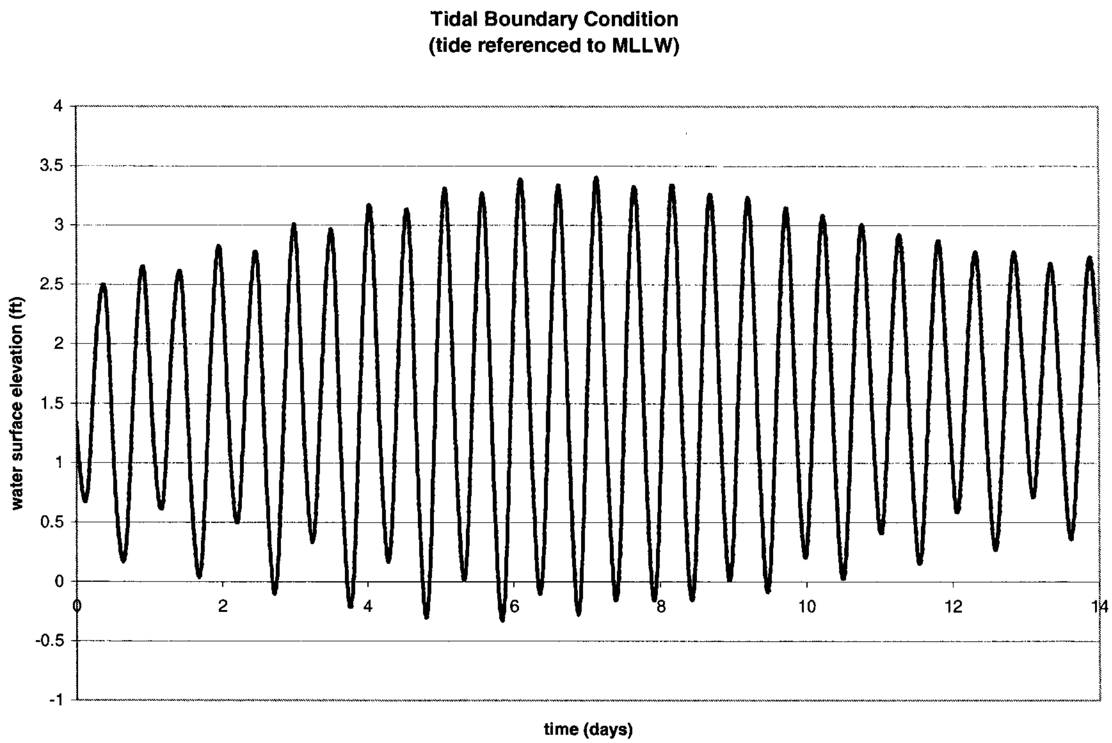


Figure 4: Tidal Boundary Condition for Miami Harbor Deepening Study

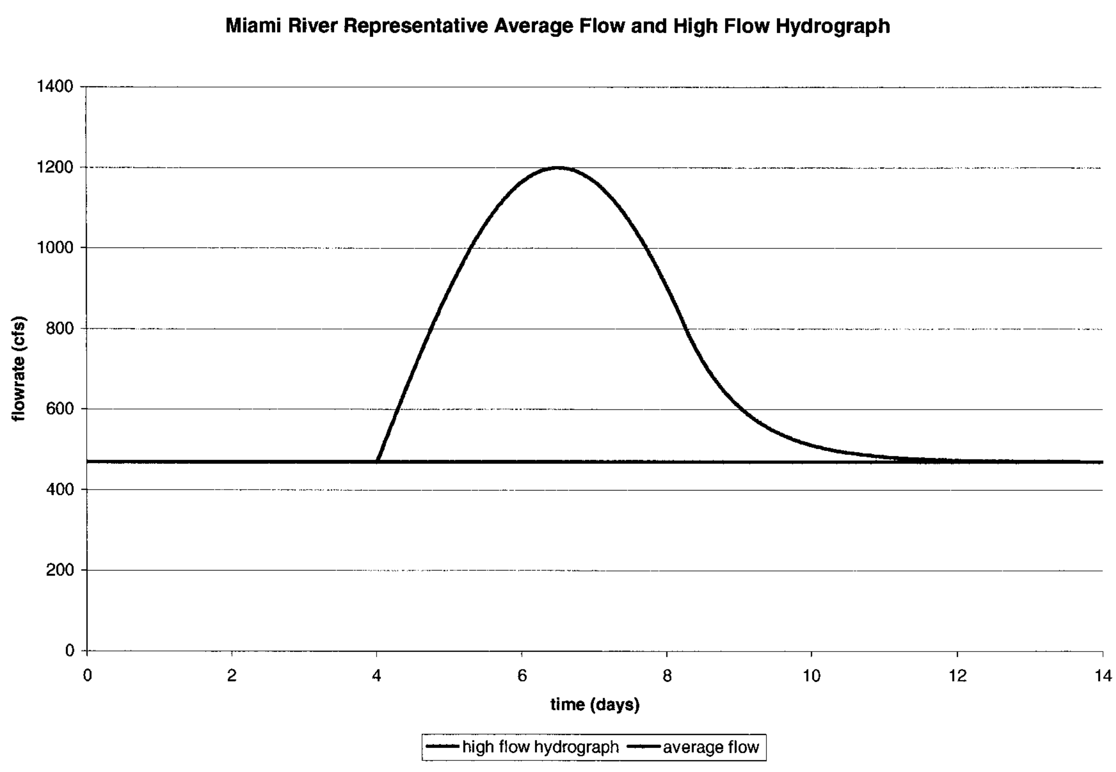


Figure 5: Miami River Flow Boundary Conditions for Miami Harbor Deepening Study

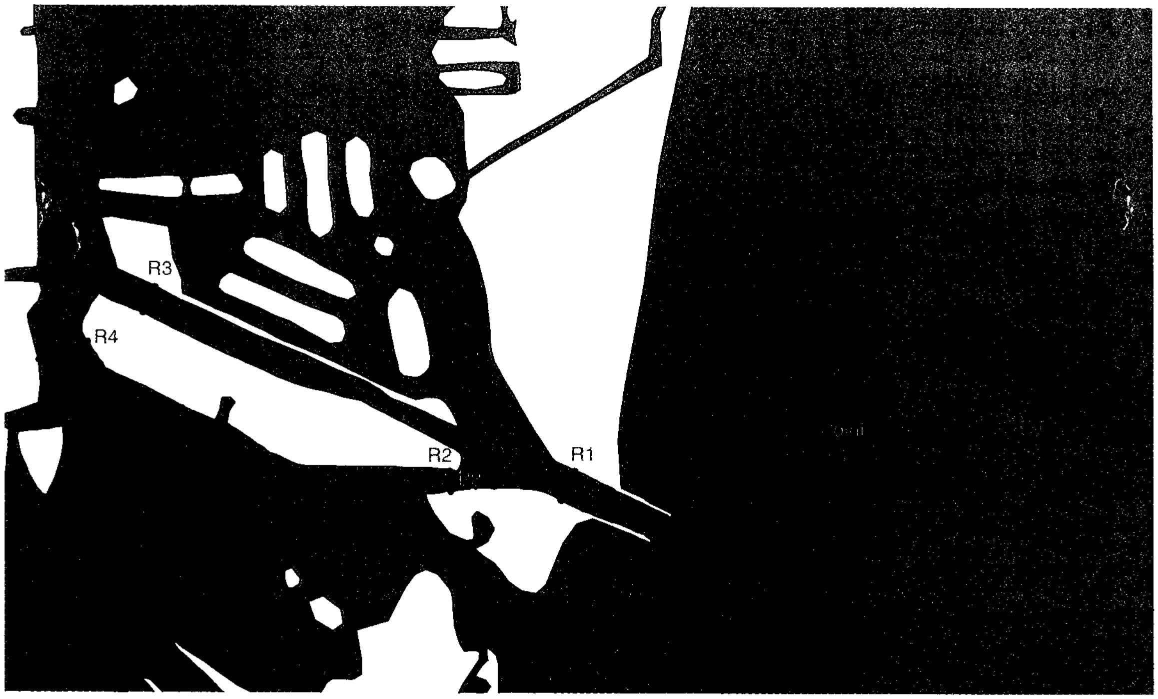


Figure 6: Locations of Observation Points and Ranges

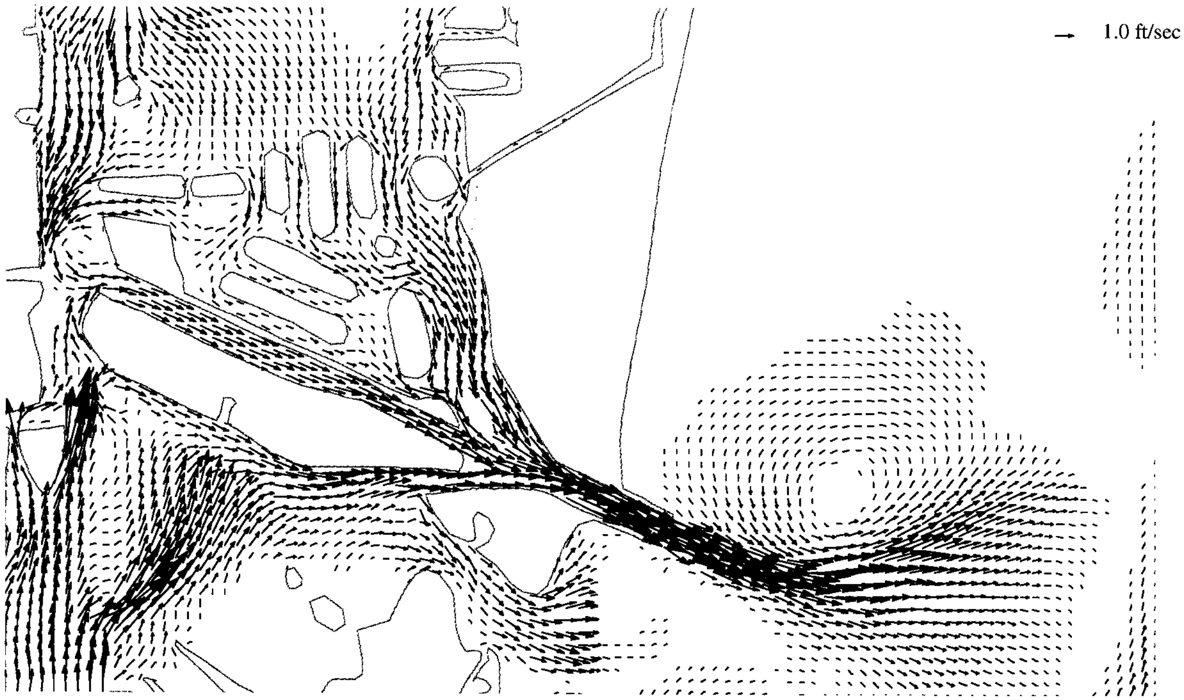


Figure 7: Maximum Ebb, Existing Conditions

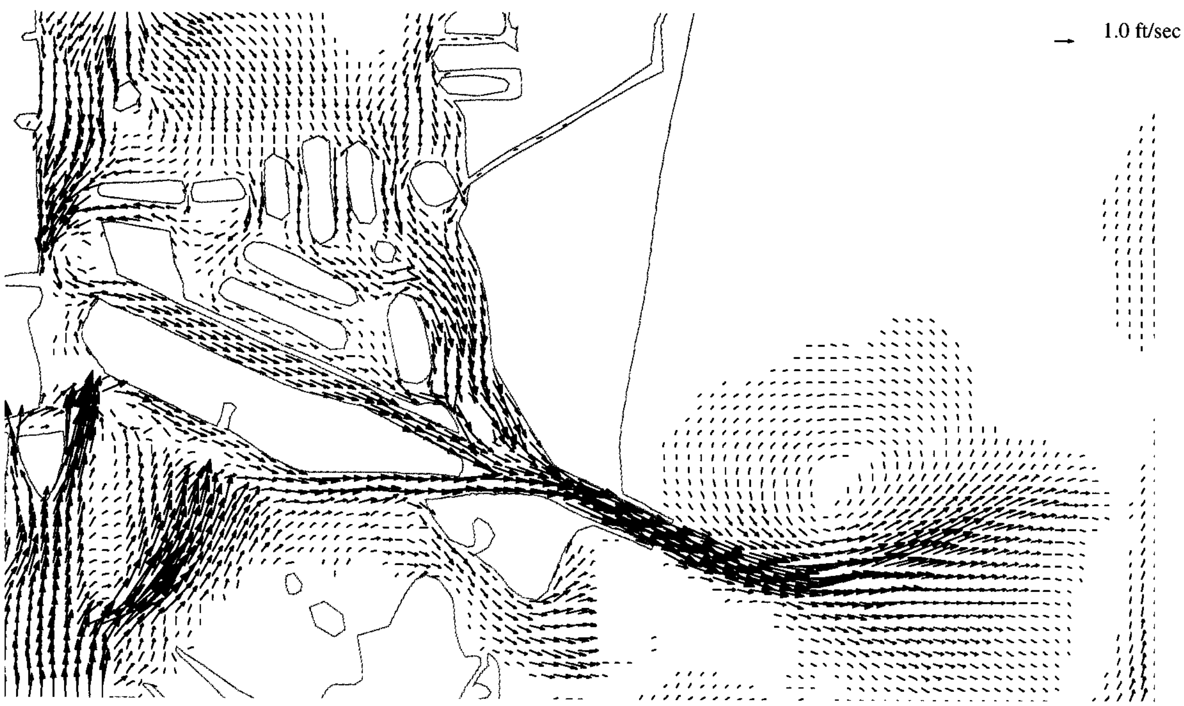


Figure 8: Maximum Ebb, Plan Conditions

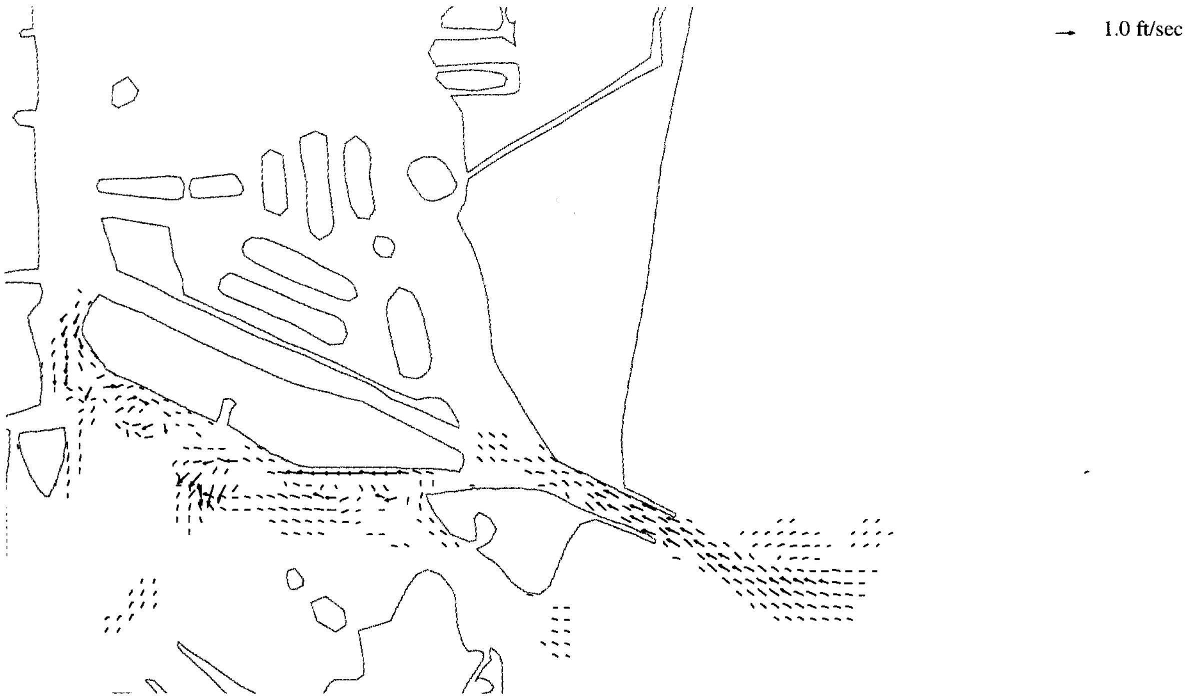


Figure 9: Ebb Velocity Difference (Plan – Existing)

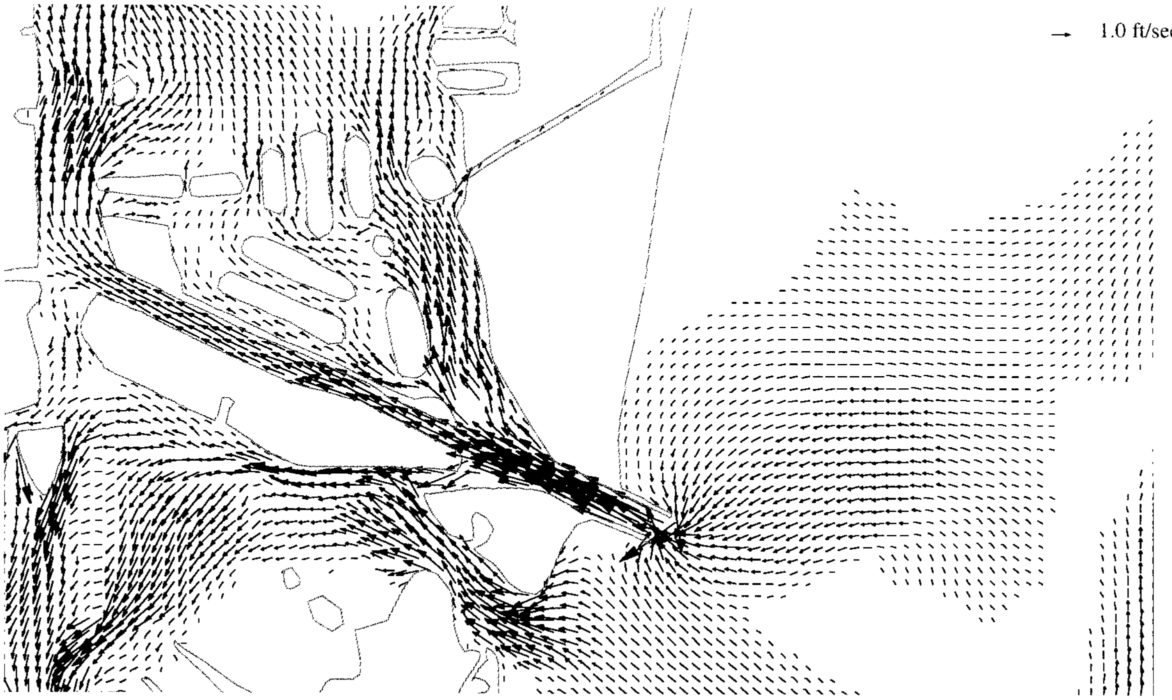


Figure 10: Maximum Flood, Existing Conditions

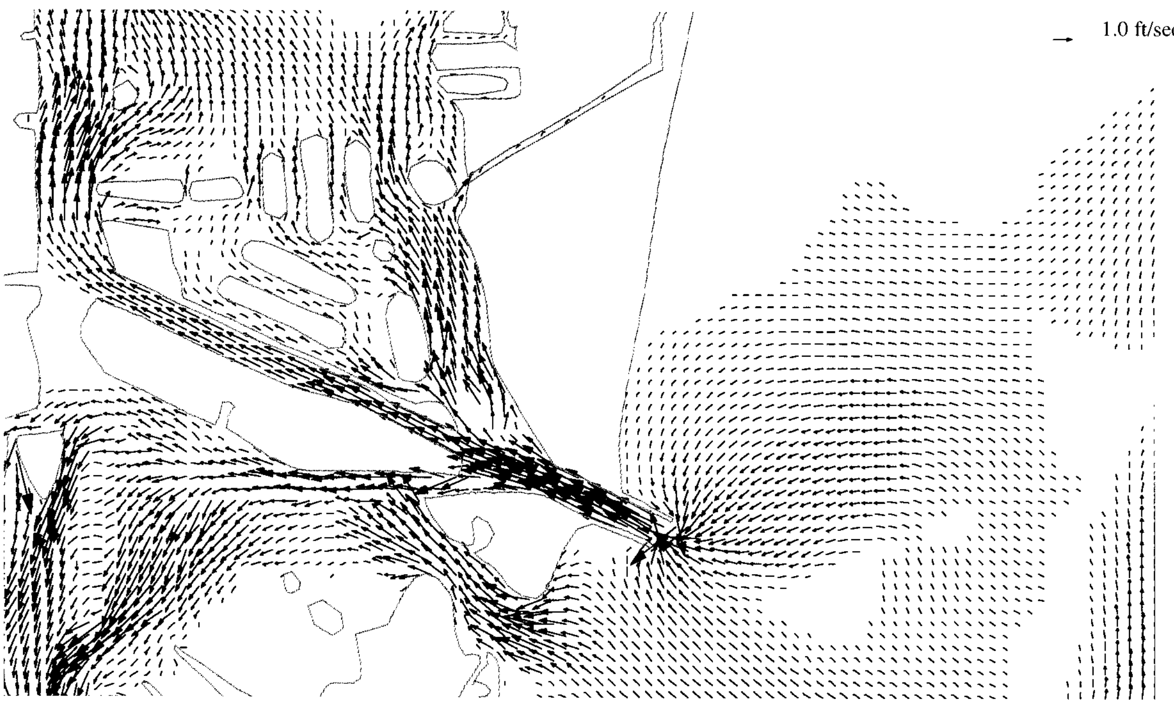


Figure 11: Maximum Flood, Plan Conditions

Figure 12: Flood Velocity Difference (Plan – Existing)

Figure 13: Residual Velocities, Existing Conditions, Average Flow Hydrograph

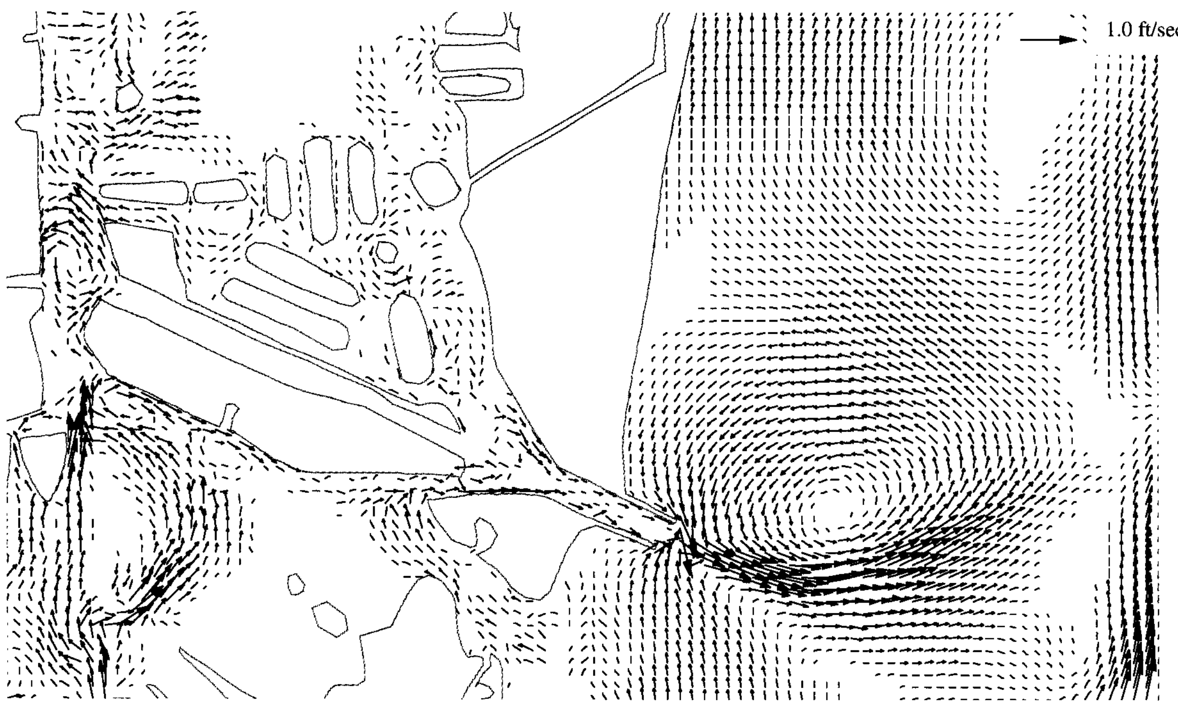


Figure 14: Residual Velocities, Plan Conditions, Average Flow Hydrograph

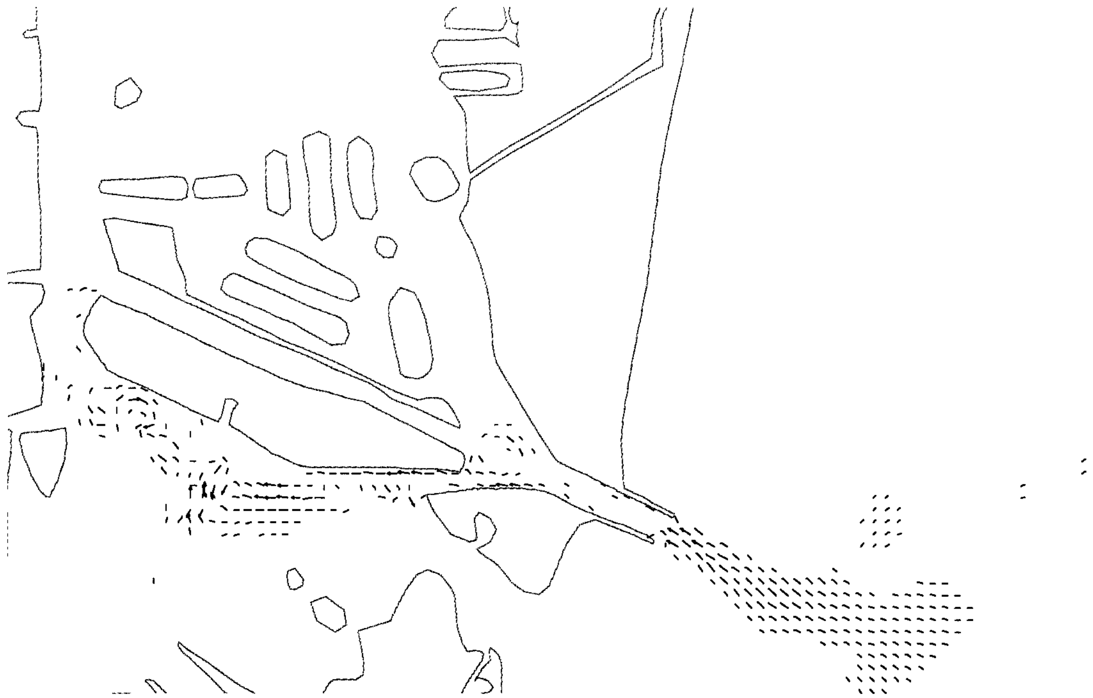


Figure 15: Residual Velocity Difference, Average Flow Hydrograph

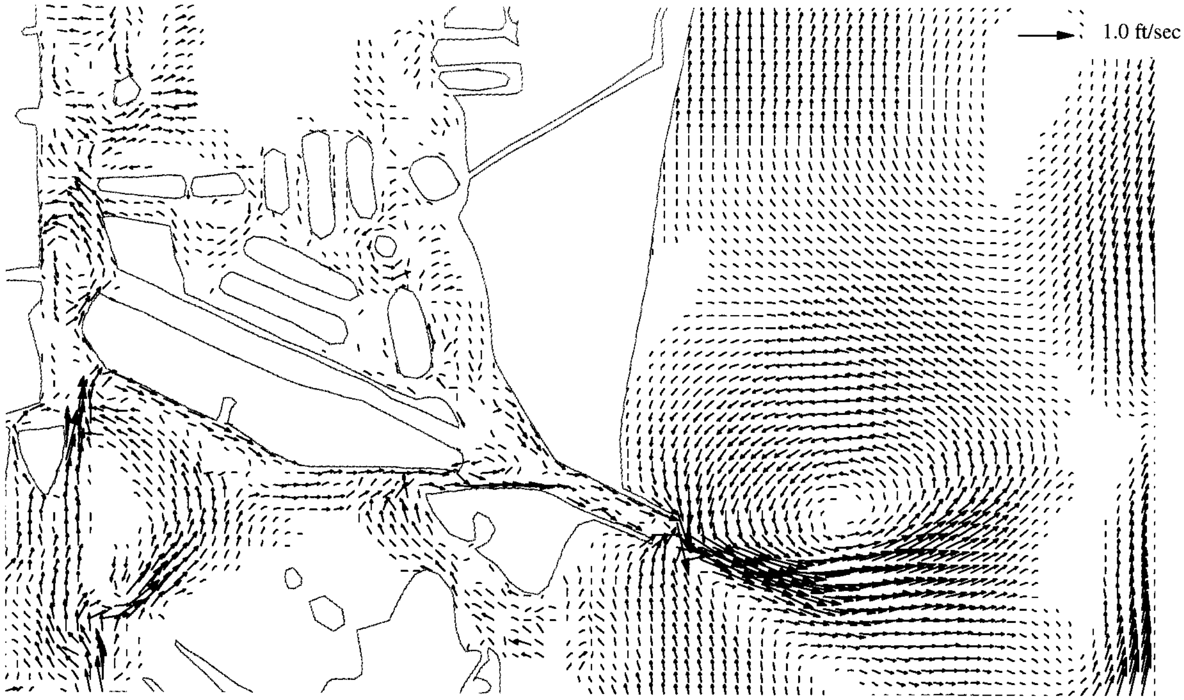


Figure 16: Residual Velocities, Existing Conditions, High Flow Hydrograph

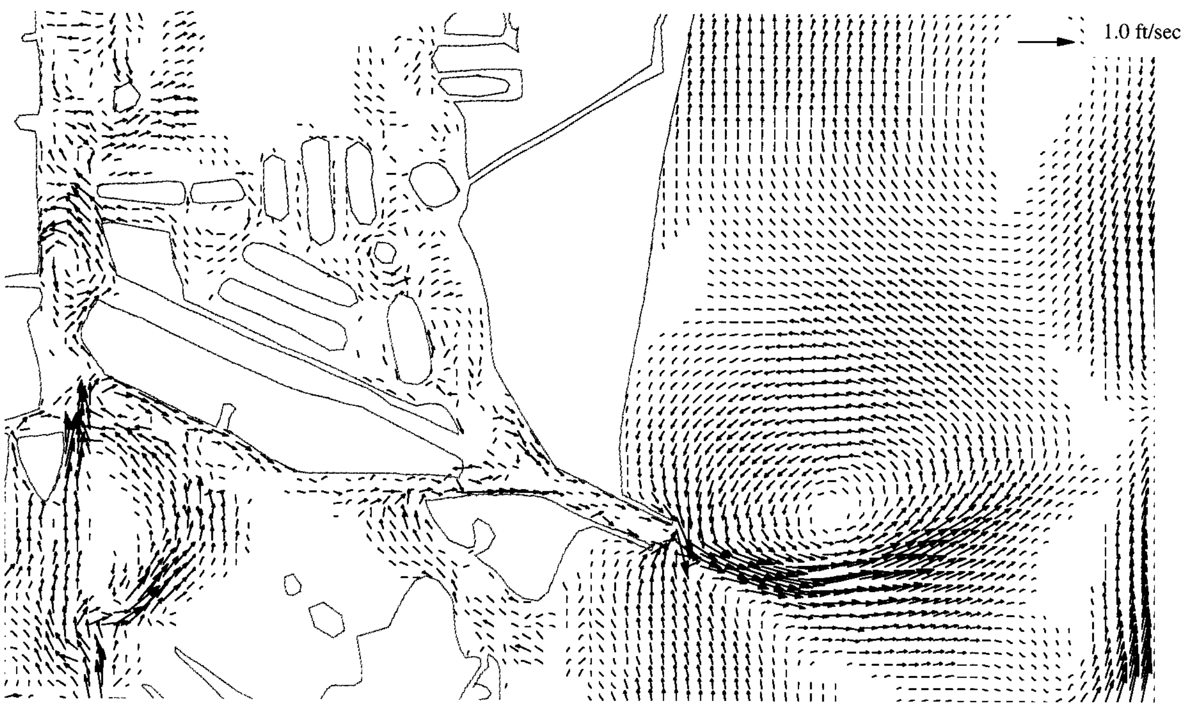


Figure 17: Residual Velocities, Plan Condition, High Flow Hydrograph

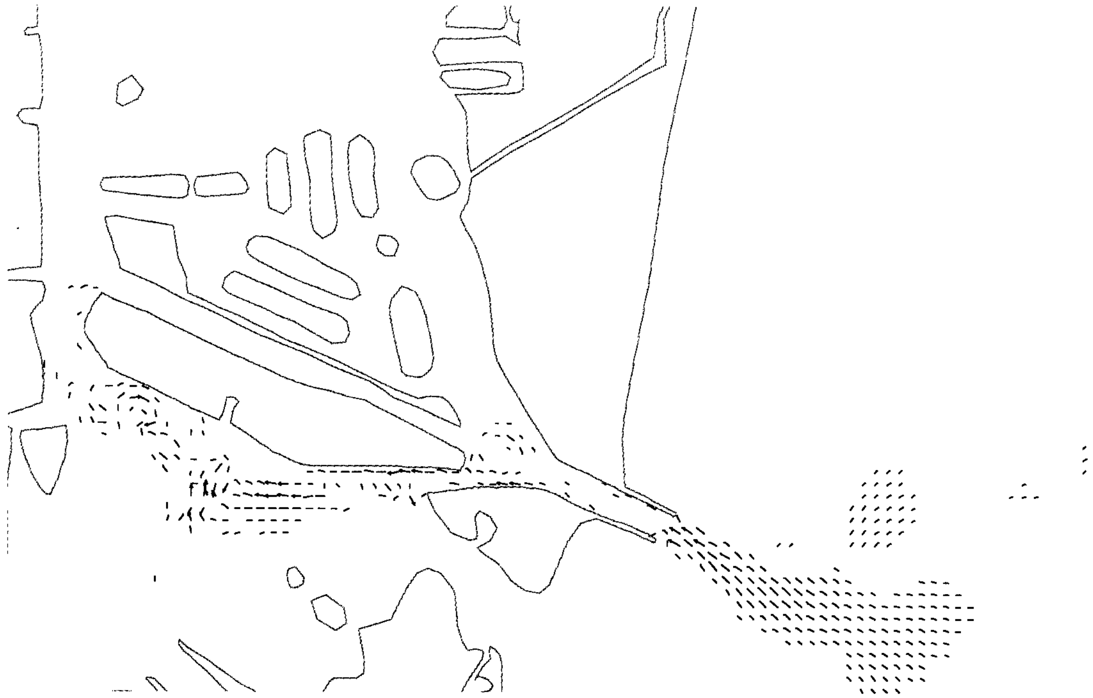


Figure 18: Residual Velocity Difference, High Flow Hydrograph

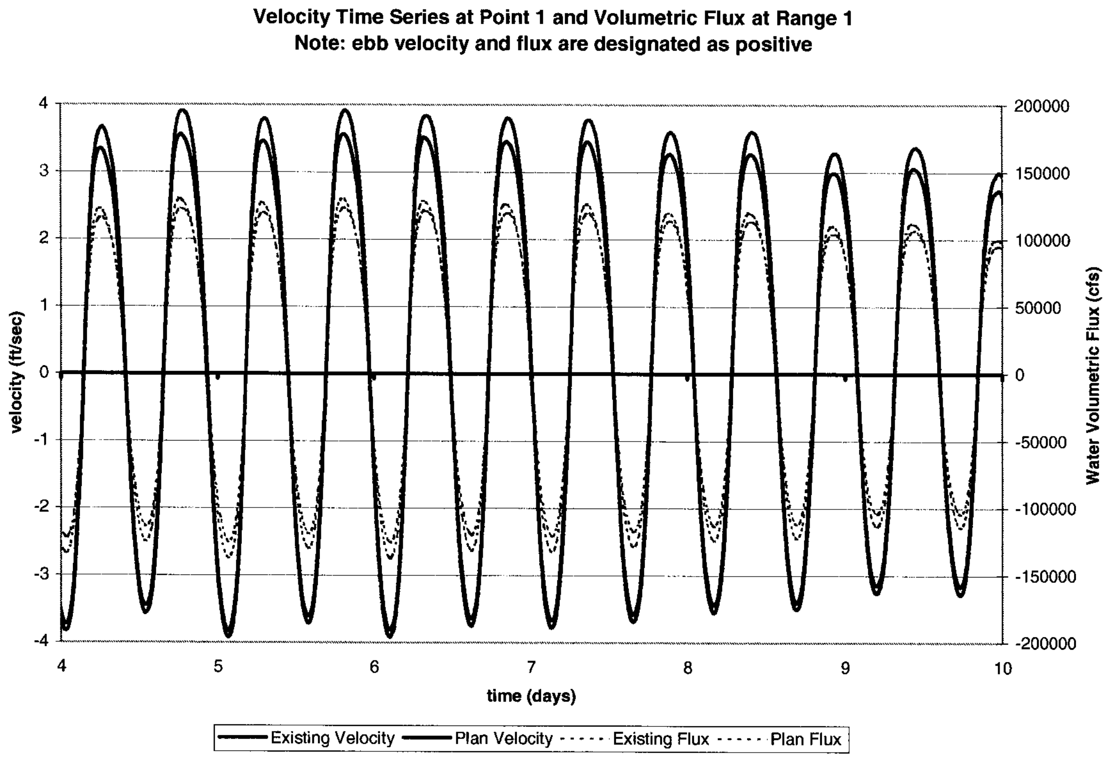


Figure 19: Velocity and Volumetric Flux Time History for Point/Range 1

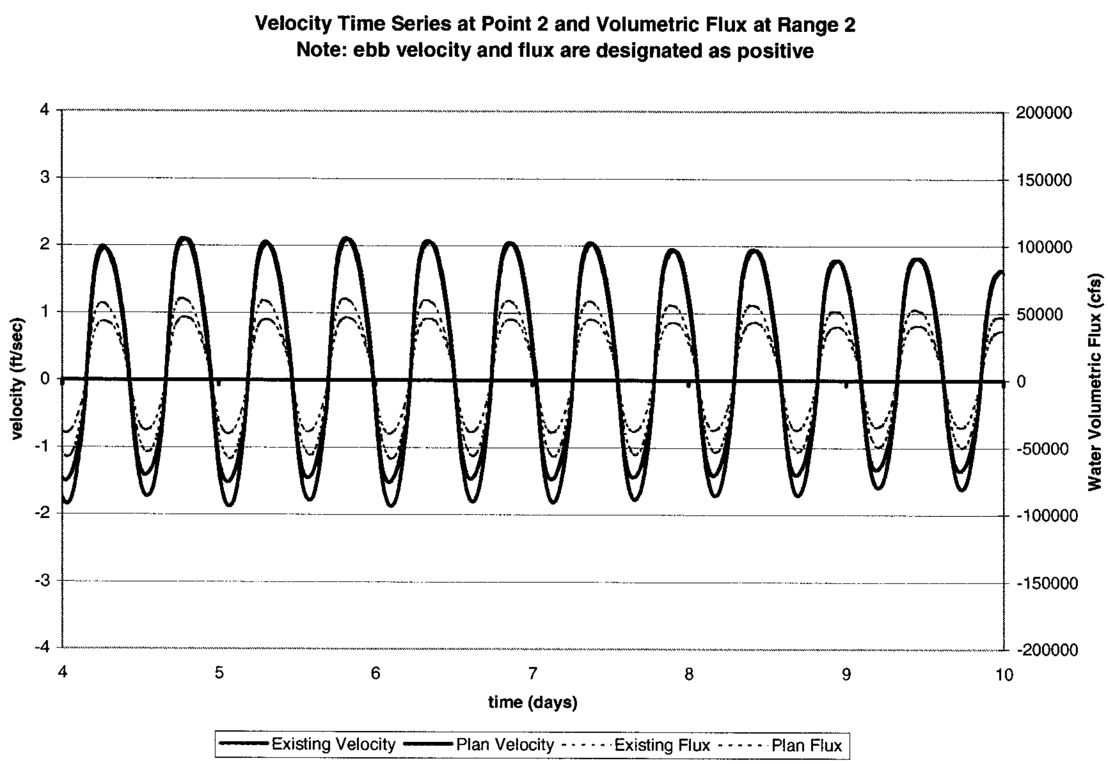


Figure 20: Velocity and Volumetric Flux Time History for Point/Range 2

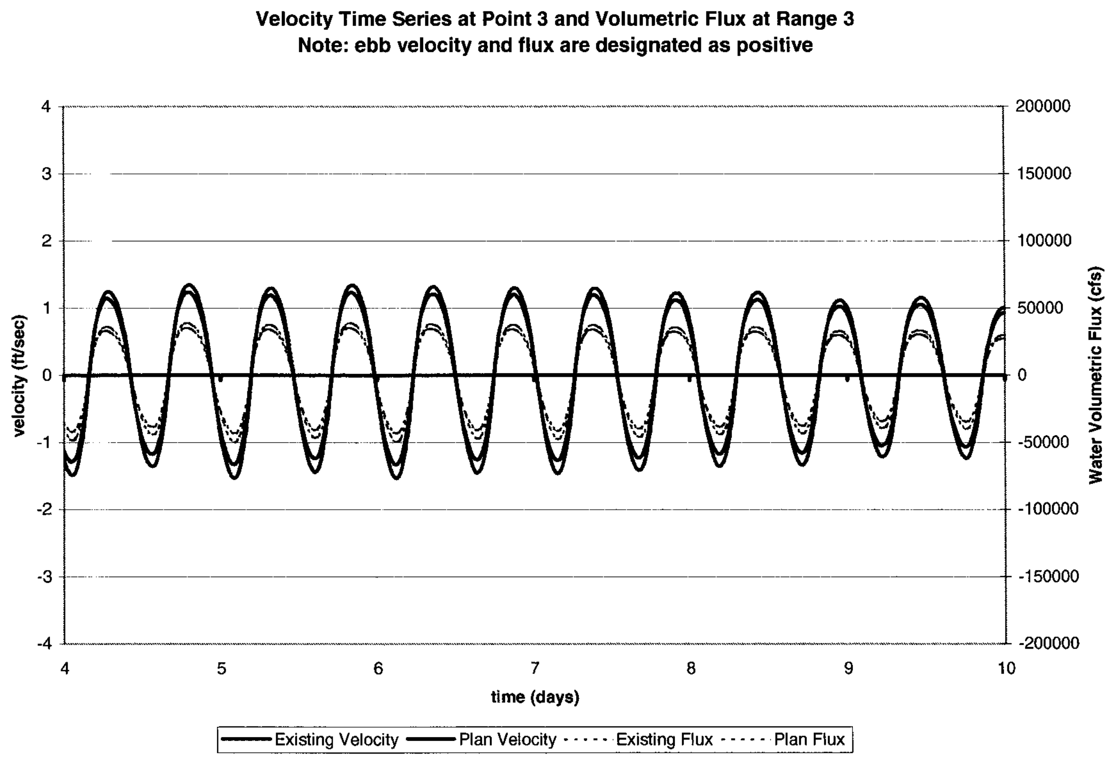


Figure 21: Velocity and Volumetric Flux Time History for Point/Range 3

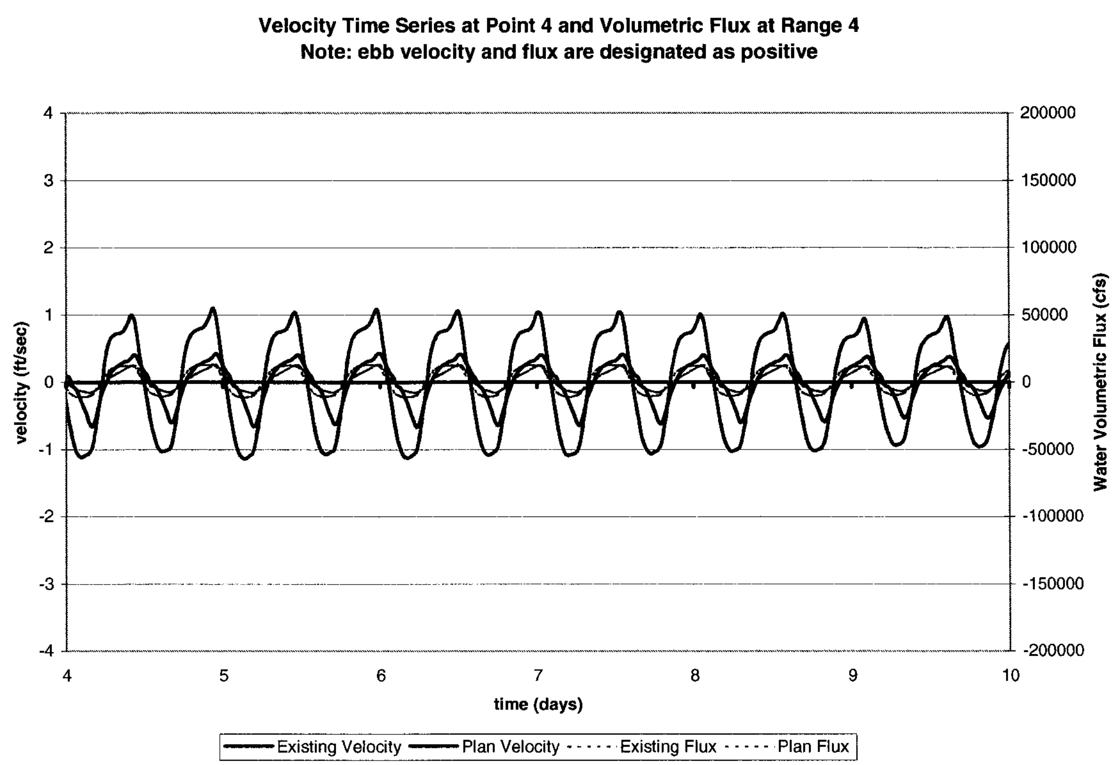


Figure 22: Velocity and Volumetric Flux Time History for Point/Range 4

Figure 23: Residual Salinity, Existing Condition, Average Flow Hydrograph

Figure 24: Residual Salinity, Plan Condition, Average Flow Hydrograph

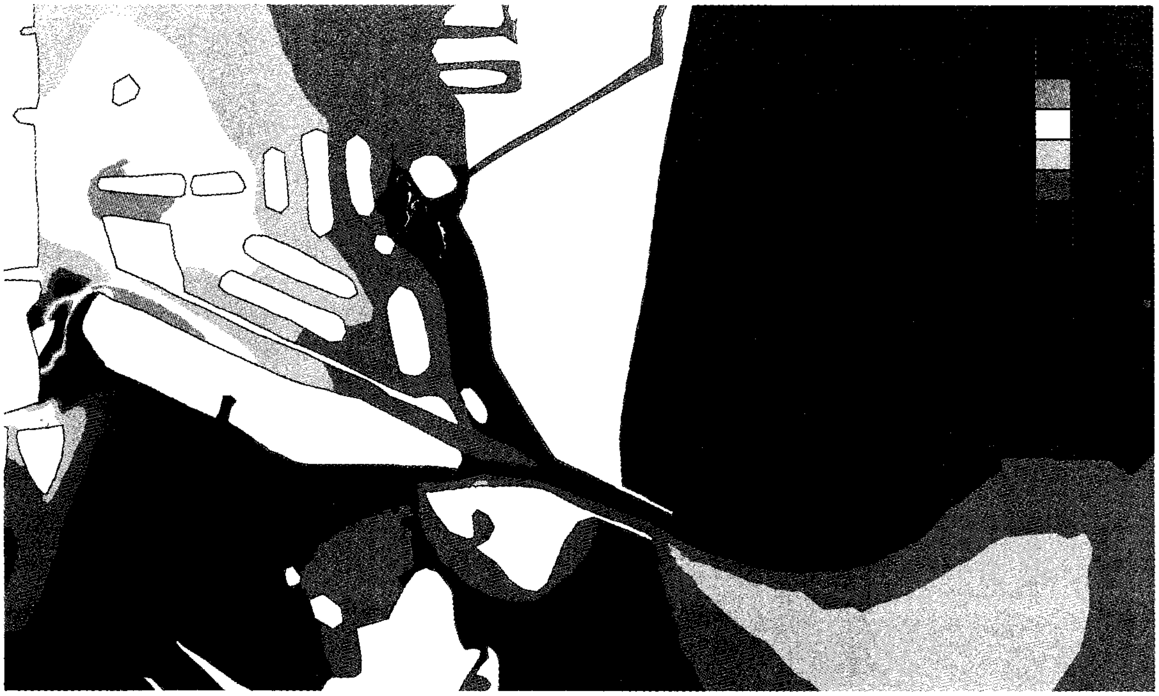


Figure 25: Residual Salinity Difference, Average Flow Hydrograph

Figure 26: Residual Salinity, Existing Condition, High Flow Hydrograph

Figure 27: Residual Salinity, Plan Condition, High Flow Hydrograph

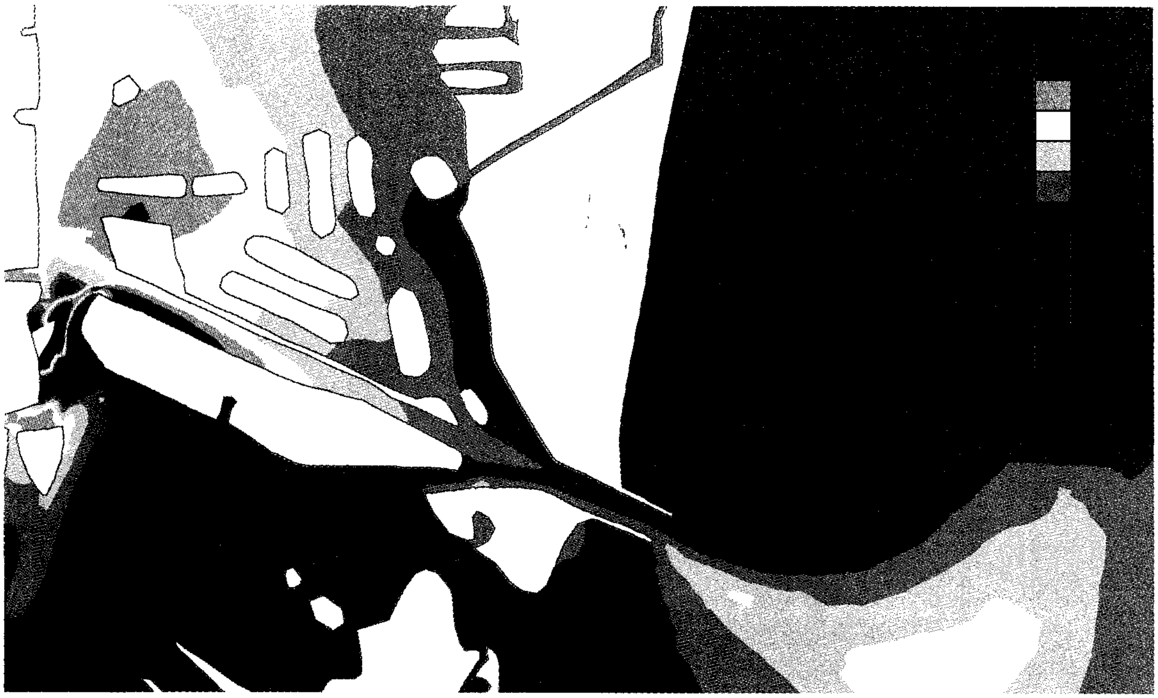


Figure 28: Salinity Difference, High Flow Hydrograph

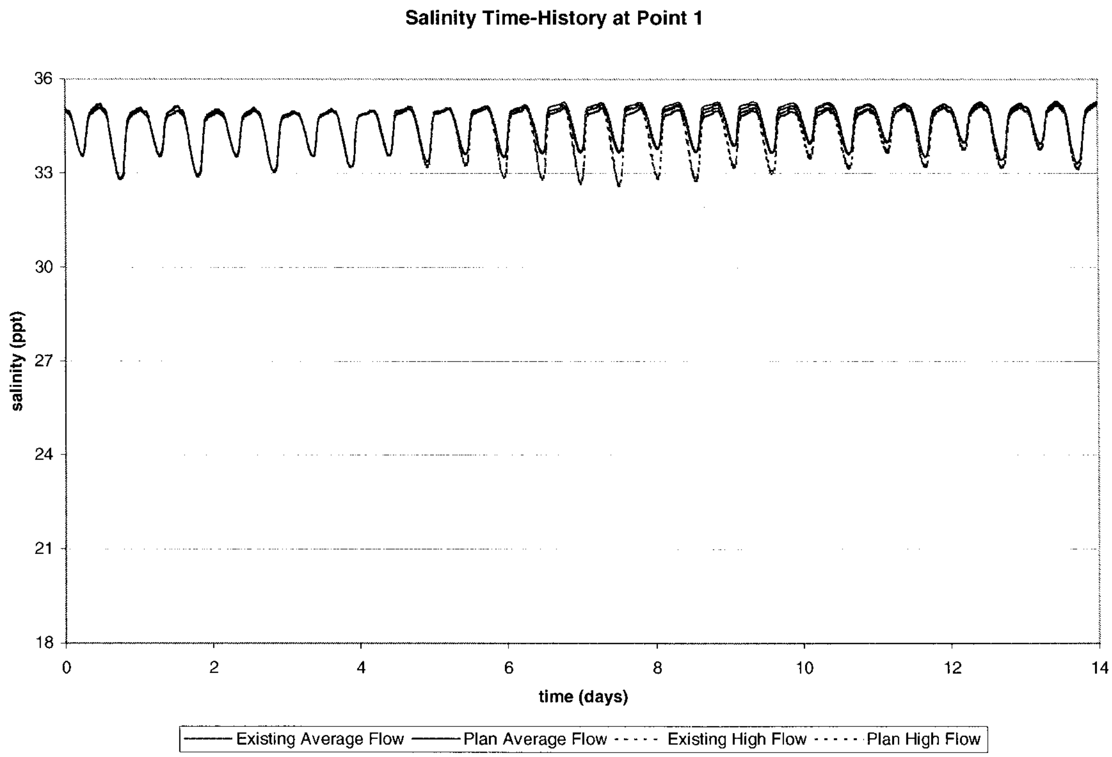


Figure 29: Salinity Time-History at Point 1

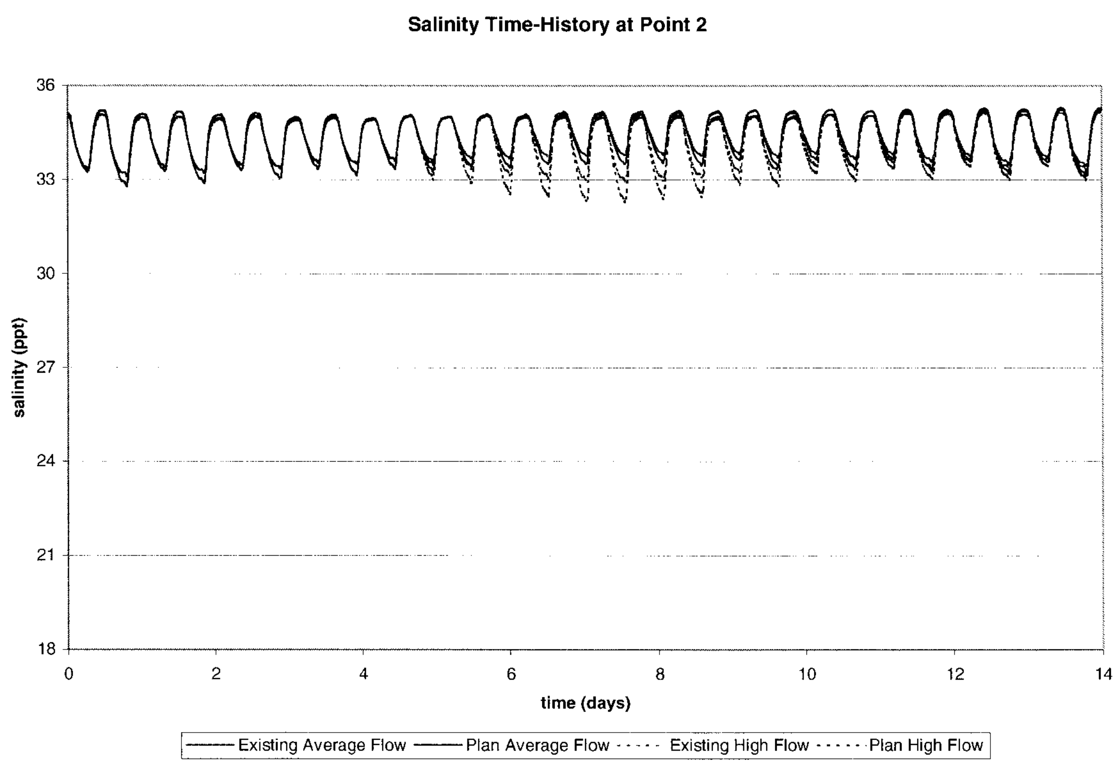


Figure 30: Salinity Time-History at Point 2

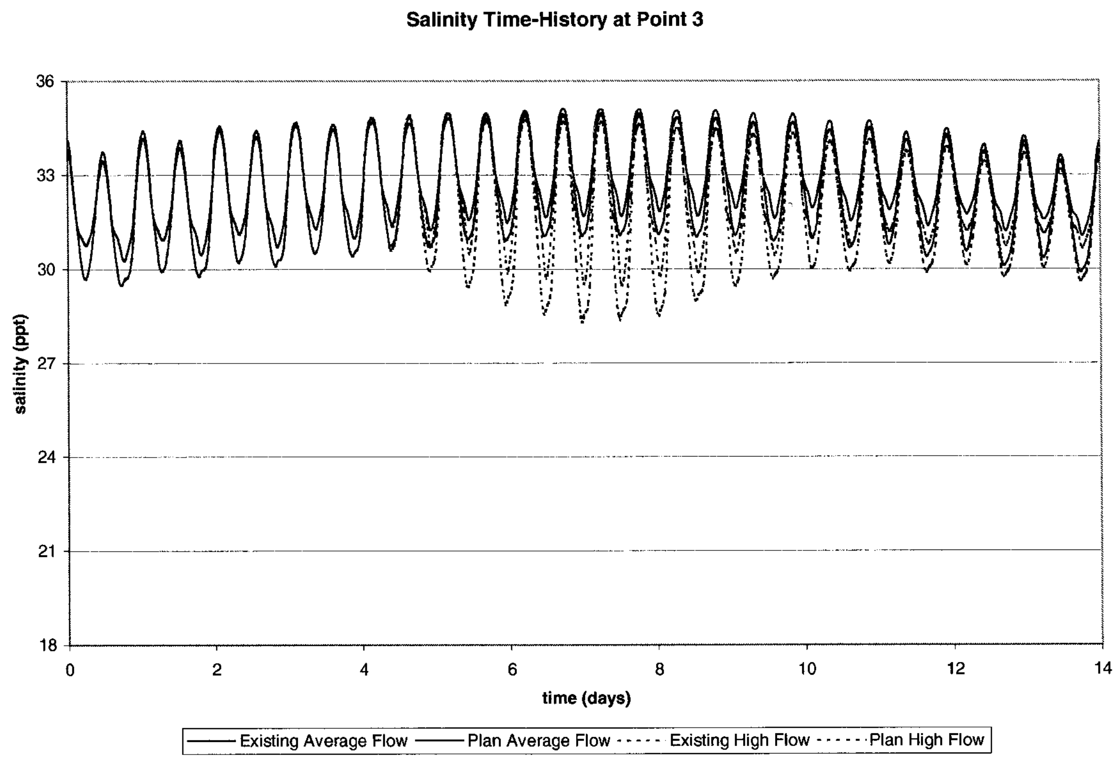


Figure 31: Salinity Time-History at Point 3

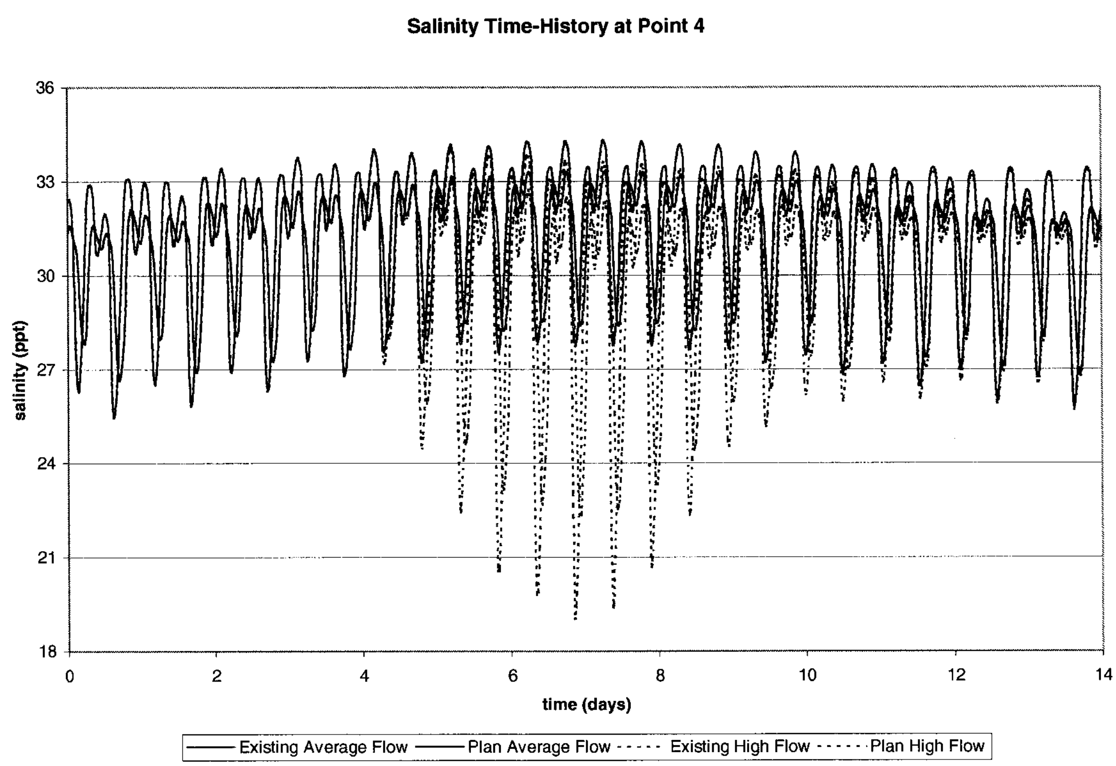


Figure 32: Salinity Time-History at Point 4

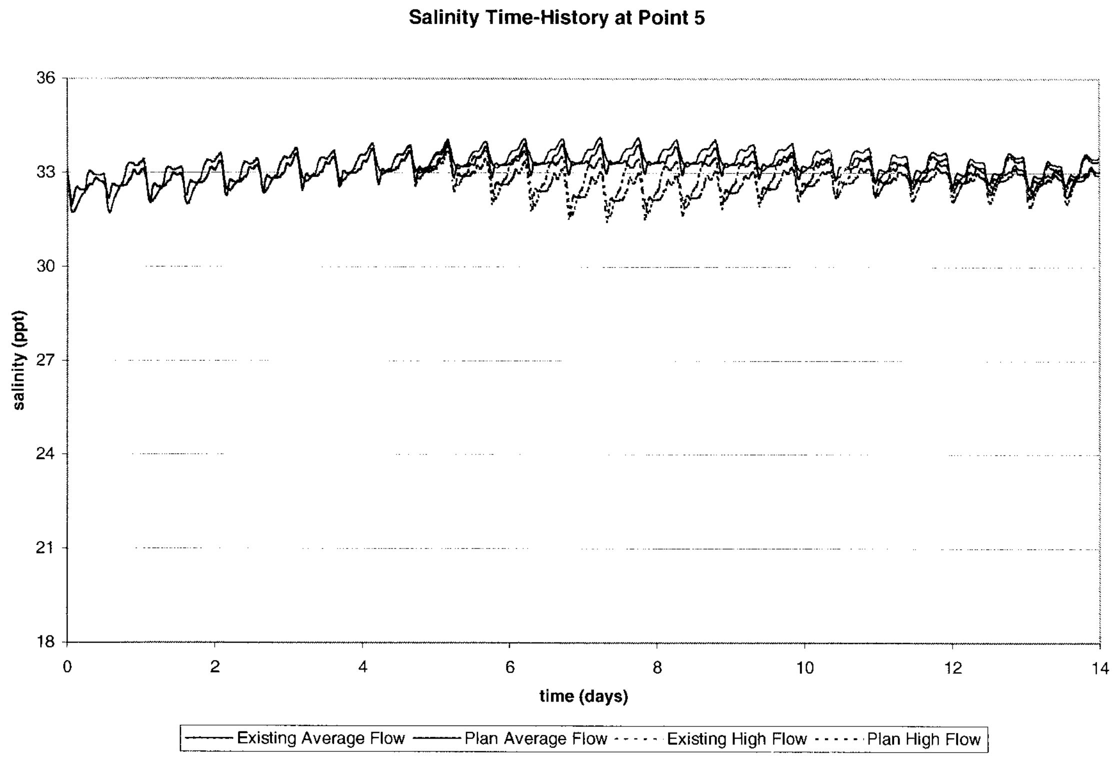


Figure 33: Salinity Time-History at Point 5

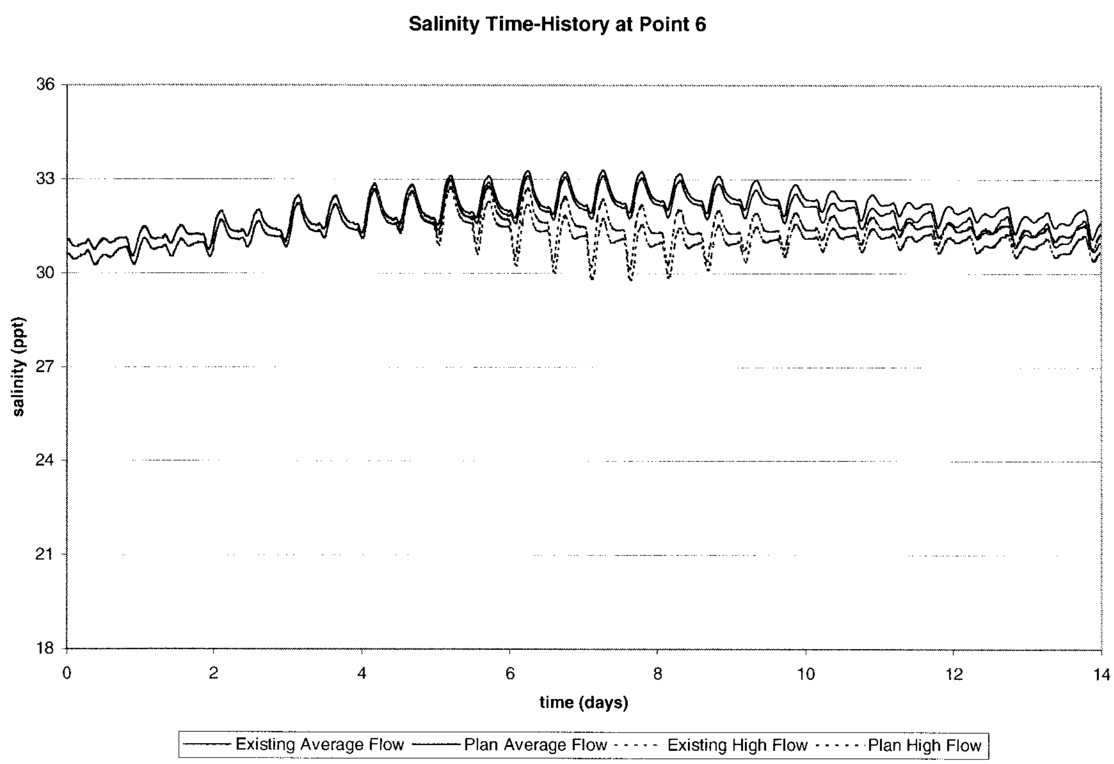


Figure 34: Salinity Time-History at Point 6

ATTACHMENT B

Ship Simulation Modeling Report

MEMORANDUM FOR THE RECORD

SUBJECT: Miami, Florida Navigation Study, Results and Recommendations

From: CEERDC-HN-N Webb

To: CESAJ Sylvester

1. Introduction. The Port of Miami is located on the eastern side of the southern tip of the Florida peninsula, Figure 1. Port traffic is primarily cruise ship or containerships.

2. To allow larger cruise and container ships to call the Port of Miami, the U.S. Army Engineer District, Jacksonville (CESAJ) has proposed a series of improvements to the navigation channels. These improvements, or alternatives, are shown in Figure 2 and are described as follows:

   Alternative 1. Government Cut serves as the entrance channel for the port. It consists of a series of channel segments. It is proposed to deepen Government Cut from 44 to 52 ft. The deepest any of the inner harbor channels are proposed to be is 50 ft. The additional 2 ft is to allow for vertical motion due to waves. This alternative also widens the seaward portion of Cut 1 from 500 to 800 ft. An additional bend widener, on the northern side of the turn between Cuts 1 and 2 is also proposed.

   Alternative 2. To ease the turn between Government Cut and Fisherman's Channel, a widener on the south side of Government Cut, just inside the jetties, was proposed. The proposed channel would be 50 ft deep.

   Alternative 3. Expand Fisher Island Turning Basin from 1200 ft to 1500 ft. Ships turning to back into Fisherman's Channel will use the enlarged turning basin. The proposed turning area will be 50 ft deep.

   Alternative 4. To allow additional cruise ship berths on the north side of the main channel, CESAJ proposes to shift the western end of the main channel south. This will allow ships transiting to the turning basin to pass ships docked at the proposed berths. This improvement would not be deepened and will remain at ?? ft.

   Alternative 5. Widen Fisherman's Channel 100 ft to the south. This will allow beamier containerships to pass vessels docked along the Fisherman's Channels piers.

   Alternative 6. Deepen Dodge Island Cut and the proposed 1200 ft turning basin to 36 ft. The western end of Dodge Island Cut will be swung southward to accommodate proposed port expansion.

3. In order to evaluate the six improvements proposed for Miami Harbor, a navigation study consisting of real-time ship simulation modeling was undertaken. Because of their proximity to the project site, the study was contracted to the Simulation Research Analysis and Training (STAR) Center in Fort Lauderdale, FL. The online testing for the simulation study was conducted during the fall of 2000.

4. The design vessels used during the simulation runs are shown in Table 1.

Table 1. Design Vessels for Miami Simulation Runs				
Name	Type	Length (ft)	Beam (ft)	Draft (ft)
Susan Mærsk	Container Ship	1139	141	44
Jutlandia	Container Ship	965	106	38
Atlantic Class	Container Ship	950	106	38
Nordic Empress	Cruise Ship	692	113	22.5
Destiny	Cruise Ship	892	117	27
Voyager of The Seas	Cruise Ship	1020	156	29

5. Results. Results of the real-time simulation testing are presented as track plots in Figures 3 – 31. These track plots and pilot ratings (Appendix I) constitute the data analyzed in this report.

6. Container ships, Inbound to Berth 110. Track plots for container ships inbound to Berth 110 are presented in Figures 3 – 6. The composite track plot of the Jutlandia inbound to Berth 110 with flood tide and 15 knots wind from the northwest is shown in Figure 3. This scenario corresponds to STAR run M02. Two of the ships left the channel while transiting the Government Cut. One ship left the north side of the channel when entering the bend widener between Cuts 1 and 2. The other ship left the channel on the north side when leaving the same bend widener. One ship left the south side of Fisherman's Channel while backing towards the berth.

7. The composite track plot of the Susan Maersk transiting the proposed channel under the same conditions is shown in Figure 4. Alternatives 1, 2, 3 and 5 were tested in this exercise, which corresponds to STAR run M01. One ship left the north side of the Government Cut channel when entering the bend widener between Cuts 1 and 2. Two ships utilized the extra widener on the northeast side of Cut 2. The ships took advantage of the extra 100 ft on the south side of

Fisherman's Channel provided by Alternate 5. None of the ships left Fisherman's Channel while backing to Berth 110.

8. The composite track plot of the Jutlandia inbound to Berth 110 with ebb tide and 15 knots wind from the northwest is shown in Figure 5. This scenario corresponds to STAR run M04. One ship left the south side of Cut 1 and several ships left the south side of Fisherman's Channel while either turning or backing to Berth 110.

9. The composite track plot of the Susan Maersk transiting the proposed channel under the same conditions is shown in Figure 6. Alternatives 1, 2 and 5 were tested in this exercise, which corresponds to STAR run M03. One ship crossed the south side of Cut 1 by about 15 ft, but in general, the Susan Maersk runs remained in the channel while transiting the Government cut due to the flare proposed in Alternative 1. The tracks of the ships transiting Cut 1 are consistent, rather than erratic as the runs shown in Figure 5 were. None of the ships left the channel while turning in the Fisher Island Turning Basin, or while backing to Berth 110.

10. <u>Container ships, Inbound to Berth 120.</u> Track plots for container ships inbound to Berth 120 are presented in Figures 7 – 11. The runs were started with the ship inside the jetties to save simulation time and allow more conditions to be tested. This was possible because the Government Cut was tested in the scenarios shown in Figures 3 – 6. The composite track plot of the Jutlandia inbound to Berth 120 with flood tide and 15 knots wind from the northwest is shown in Figure 7. This scenario corresponds to STAR run M06. None of the vessels left the authorized channel limits while transiting Fisherman's Channel. One ship crossed the channel limits while turning in the Lummus Island Turning Basin.

11. The composite track plot of the Susan Maersk transiting the proposed channel under the same conditions is shown in Figure 8. Alternatives 2 and 5 were tested in this exercise, which corresponds to STAR run M05. None of the vessels left the authorized channel limits while transiting Fisherman's Channel. One ship crossed the channel limits while turning in the Lummus Island Turning Basin. The simulation observer reported this was due to excess speed.

12. The composite track plot of the Jutlandia inbound to Berth 120 with ebb tide and 15 knots wind from the northwest is shown in Figure 9. This scenario corresponds to STAR run M08. One ship left the south side of Fisherman's Channel while passing the ships docked at Berths 100 and 110. The simulation observer reported this was due to the pilot increasing ship speed in anticipation of a stronger ebb tide. Two ships crossed the channel limits while turning in the Lummus Island Turning Basin.

13. Extra Susan Maersk Run. I will add this later. There is a discrepancy in the STAR data.

14. The composite track plot of the Susan Maersk transiting the proposed channel under the same conditions is shown in Figure 10. This scenario corresponds to STAR run M07 and examines Alternatives 2 and 5. Although two ships came within 10 ft of the southern edge of Fisherman's Channel, none of the vessels left the authorized channel during this exercise.

15. <u>Cruise Ships to Biscayne Island Turning Basin.</u> Composite Track plots of cruise ships transiting Government Cut to call at berths near the Biscayne Island Turning Basin are shown in Figures 12– 15. The Voyager of the Seas, an Eagle Class cruise ship drawing 29 ft was used for all simulations of this scenario. The main purpose of this scenario was to evaluate Alternative 4.

16. The composite track plot of the Voyager of the Seas inbound, in the existing channel, with flood tide and a 15 knot wind from the northeast is shown in Figure 12. This scenario corresponds to STAR exercise M13. Several of the runs left the north side of the bend widener in the Entrance Channel. However, none of the ships would have grounded due to their draft of 29 ft. Two of the ships left the south side of the channel as they approached the turning basin. However, none would have grounded because this area is a deep as the navigation channel.

17. The composite track plot of the Voyager of the Seas, transiting the proposed channel, under the same environmental conditions, is shown in Figure 13. Alternatives 1 and 4 were tested in this exercise which corresponds to STAR test M14. Although this vessel is not restricted to the authorized channel limits in Cuts 1 and 2, the ship did not leave north side of the bend widener by as much as the runs shown in Figure 12. Although several ships came close to the channel limits, none of the ships left the Main Channel.

18. The composite track plot of the Voyager of the Seas inbound, in the existing channel, with an ebb tide and a 15 knot wind from the northeast is shown in Figure 14. This scenario corresponds to STAR exercise M15. Several of the ships left the Government Cut, but this is not significant due to their 29 ft draft. Several runs also left the southwest portion of the authorized limits Main Channel. This is the berthing area. None of the ships would have run aground.

19. The composite track plot of the Voyager of the Seas inbound, in the proposed channel, with an ebb tide and a 15 knot wind from the northeast is shown in Figure 15. This scenario tested Alternatives 1 and 4 and corresponds to STAR exercise M16. One pilot began his approach to the Government Cut further north than the other pilots. This was done at his request because he felt he would be further north in real life. Other than ship which began the simulation further north, none of the ships left the Government Cut. None of ships had any difficulties maneuvering through the Main Channel.

20. Cruise Ships to Berth 195. Composite Track plots of the Nordic Empress and the Destiny transiting Government Cut to call at berth 195 are shown in Figures 16–19. The Nordic Empress draws 22.5 ft and the Destiny draws 27 ft. This scenario evaluates Alternatives 2, 5 and 6.

21. The composite track plot of the Nordic Empress inbound, in the existing channel, with ebb tide and a 15 knot wind from the southeast is shown in Figure 16. This scenario corresponds to STAR exercise M10. Three of the four ships left the south side of Fisherman's Channel across from Berth 110. One of the ships left the turning basin.

22. The composite track plot of the Destiny inbound, in the proposed channel, with ebb tide and a 15 knot wind from the southeast is shown in Figure 17. This scenario tested Alternatives 2, 5 and 6 and corresponds to STAR exercise M09. None of the ships used Alternative 2 while making the turn from Government Cut to Fisherman's Channel. None of the ships left Fisherman's Channel while passing the ships at Berths 100 and 110. One pilot chose to turn his ship in the Lummus Island and back to the berth. Two of the ships left the channel between the Lummus Island Turning Basin and the Dodge Island Turning Basin. Both ships left the channel by about 50 ft. One of the ships leaving the channel was the ship backing to the berth. One of the ships turned too far east and left the Dodge Island Turning basin by about 30 ft while turning. The other two ships easily turned in the area provided.

23. The composite track plot of the Nordic Empress inbound, in the existing channel, with flood tide and a 15 knot wind from the southeast is shown in Figure 18. This scenario corresponds to STAR exercise M12. One of the ships left Fisherman's Channel while passing the ships at Berths 100 and 110. One pilot (the same pilot as in Figure 17) chose to turn his ship in the Lummus Island and back to the berth. Two of the ships left the Dodge Island Turning Basin.

24. The composite track plot of the Destiny inbound, in the proposed channel, with flood tide and a 15 knot wind from the southeast is shown in Figure 19. This scenario tested Alternatives 2, 5 and 6 and corresponds to STAR exercise M11. None of the ships used Alternative 2 while making the turn from Government Cut to Fisherman's Channel. None of the ships left Fisherman's Channel while passing the ships at Berths 100 and 110. One pilot (the same pilot as in Figures 17 and 18) chose to turn his ship in the Lummus Island and back to the berth. One of the ships left the channel between the Lummus Island Turning Basin and the Dodge Island Turning Basin, by about 40 ft. One of the ships turned too far north and left the Dodge Island Turning basin by about 60 ft while turning. The other two ships easily turned in the area provided.

25. Container ships, Outbound from Berth 120. Track plots for container ships outbound from Berth 120 with flood tide are presented in Figures 20 - 23. The runs were stopped with the ship inside the jetties. This was done to save

simulation time because outbound ships do not have problems transiting Government Cut.

26. The composite track plot of the Jutlandia outbound from Berth 120 with flood tide and 15 knots wind from the southeast is shown in Figure 20. This scenario corresponds to STAR run M18. Two of the ships left Fisherman's Channel while passing the ships docked at Berths 100 and 110. The composite track plot of the Susan Maersk transiting the proposed channel in the same conditions (Fig re 21) shows none of the ships left the channel. The Susan Maersk did not use Alternative 2.

27. The composite track plot of the Jutlandia outbound from Berth 120 with ebb tide and 15 knots wind from the southeast is shown in Figure 22. This scenario corresponds to STAR run M20. Three of the four ships left Fisherman's Channel while passing the ships docked at Berths 100 and 110. The composite track plot of the Susan Maersk transiting the proposed channel in the same conditions (Fig re 23) shows none of the ships left the channel. The Susan Maersk did not use Alternative 2.

28. <u>Cruise Ships, Outbound through the Main Channel.</u> Track plots of cruise ships, outbound through the Main Channel are presented in Figures 24 – 27. This exercise examines Alternatives 2 and 5. All runs, both existing and proposed, were completed with incident. Any vessels that cross the channel limits did so in an area where the water was at least as deep as the navigation channel. Alternative 2 was not used.

29. <u>Cruise Ships, Outbound through the Fisherman's Channel.</u> Track plots of cruise ships, outbound through Fisherman's Channel are presented in Figures 28 – 31. This exercise tests Alternatives 2, 5, and 6.

30. The composite track plot of the Nordic Empress outbound, in the existing channel, with flood tide and a 15 knot wind from the southeast is shown in Figure 28. This scenario corresponds to STAR exercise M26. One ship cross the channel limits between the Dodge Island and Lummus Island Turning Basins. One ship crossed the limits of Fisherman's Channel will passing the ships docked at Berths 100 and 110.

31. The composite track plot of the Destiny outbound, in the proposed channel, with flood tide and a 15 knot wind from the southeast is shown in Figure 29. This scenario corresponds to STAR exercise M25. One ship crossed the channel limits between the Dodge Island and Lummus Island Turning Basins. One ship crossed the limits of Fisherman's Channel will passing the ships docked at Berths 100 and 110.

32. The composite track plot of the Nordic Empress outbound, in the existing channel, with ebb tide and a 15 knot wind from the southeast is shown in Figure

30. This scenario corresponds to STAR exercise M28. One ship touched the edge of the channel on the northwest end of Lummus Island Turning Basin. One ship crossed the limits of Fisherman's Channel.

33. The composite track plot of the Destiny outbound, in the proposed channel, with ebb tide and a 15 knot wind from the southeast is shown in Figure 31. This scenario corresponds to STAR exercise M27. One ship crossed the channel limits between the Dodge Island and Lummus Island Turning Basins. One ship crossed the limits of Fisherman's Channel will passing the ships docked at Berths 100 and 110.

34. <u>Pilot Questionnaires</u>. The pilots' final questionnaires are included as Appendix A. The pilots were supportive of the channel improvements tested, but did have some concerns about wind/current combinations not tested.

35. <u>Conclusions and Recommendations</u>. Based upon the results of the simulator study, the following conclusions and recommendations are given.

36. Alternative 1. Widening the seaward end of Government Cut 1 allowed additional room for the vessel to adjust to Gulfstream currents and greatly reduced the number of containerships leaving the authorized channel during simulation runs. Alternative 1 is recommended. Modifications to Alternative may be considered provided they are examined in real-time simulation exercises.

37. Alternative 2. Alternative 2 was not used during any of the simulated exercises. Alternative 2 is not recommended.

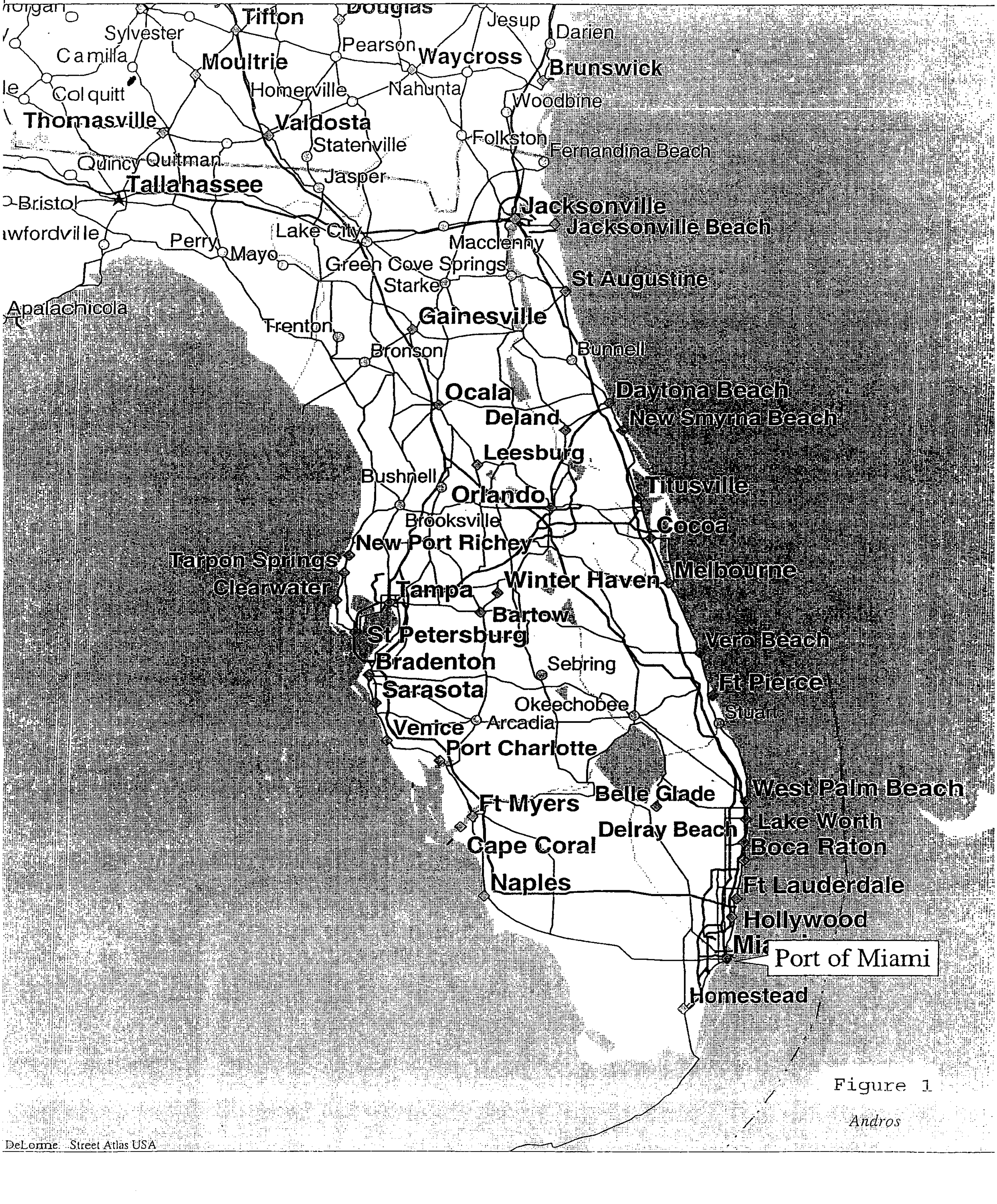
38. Alternative 3. Alternative 3 provided adequate room for the Susan Maersk to turn and back into Fisherman's Channel and is recommended. The ships did not use the northernmost portion of the basin. However, additional simulation runs should be conducted prior to considering any reduction in Alternative 3.

39. Alternative 4. Alternative 4 is recommended to allow addition cruise ship docks on the western end of the main channel.

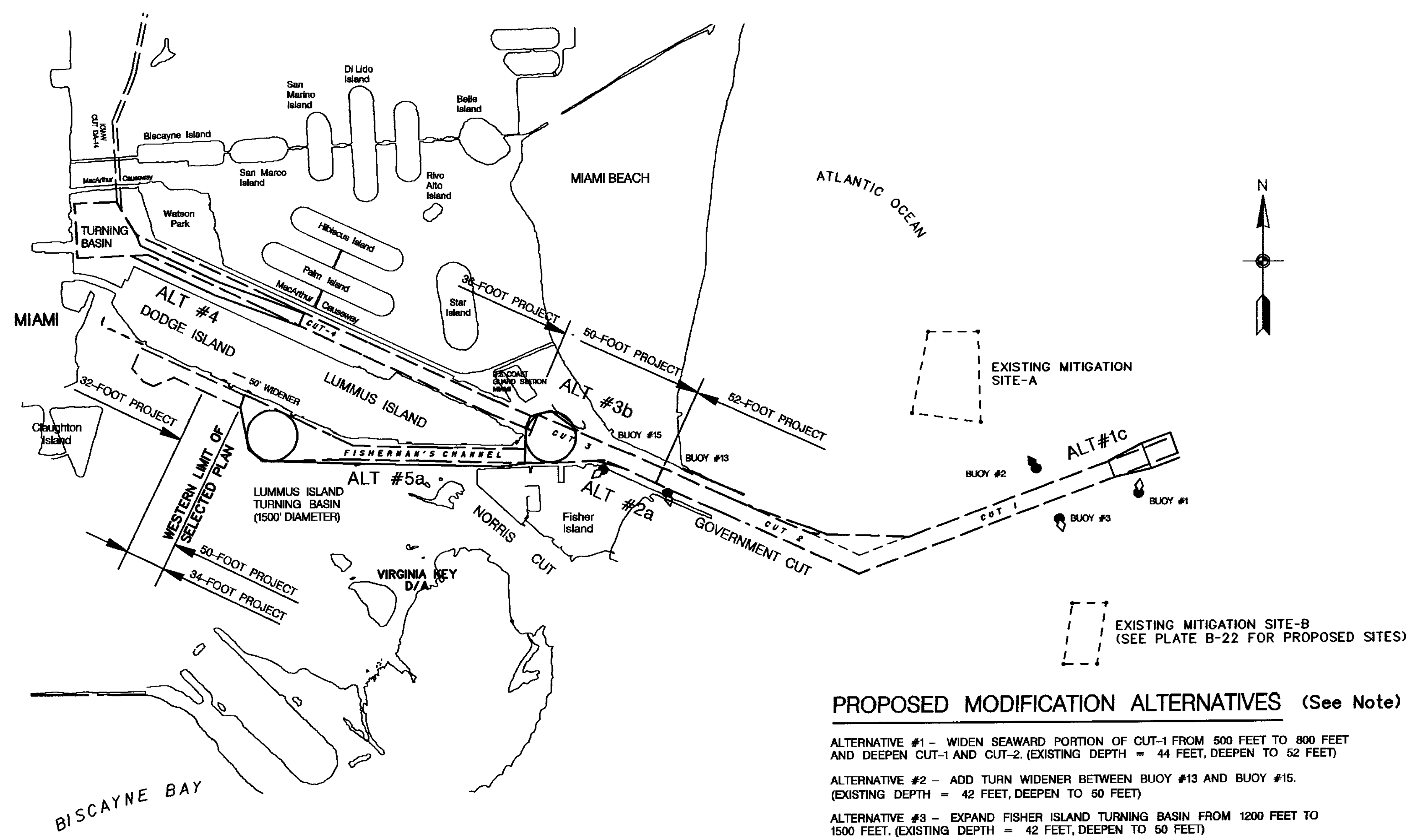
40. Alternative 5. Alternative 5 provided additional room while passing berthed ships and was used during nearly every proposed condition test in Fisherman's Channel. Existing condition runs showed frequent grounding across from Berth 100 and 110. Alternative 5 eliminated those grounding, even with the larger containership. Alternative 5 is strongly recommended.

41. Alternative 6. The Dodge Island Turning Basin provided adequate turning area for the Destiny. However, a number of ships left the south side of the channel segment between Lummus Island Turning Basin and Dodge Island Turning Basin. We recommend Alternative 6 on the condition that the southern edge of that segment is widened by 50 ft. The widening is shown in Figure 32.

Figure 1. Port Miami Location Map



DeLorme Street Atlas USA



PROPOSED MODIFICATION ALTERNATIVES (See Note)

ALTERNATIVE #1 – WIDEN SEAWARD PORTION OF CUT-1 FROM 500 FEET TO 800 FEET AND DEEPEN CUT-1 AND CUT-2. (EXISTING DEPTH = 44 FEET, DEEPEN TO 52 FEET)

ALTERNATIVE #2 – ADD TURN WIDENER BETWEEN BUOY #13 AND BUOY #15. (EXISTING DEPTH = 42 FEET, DEEPEN TO 50 FEET)

ALTERNATIVE #3 – EXPAND FISHER ISLAND TURNING BASIN FROM 1200 FEET TO 1500 FEET. (EXISTING DEPTH = 42 FEET, DEEPEN TO 50 FEET)

ALTERNATIVE #4 – RELOCATE THE WESTERN END OF THE MAIN CHANNEL TO ALLOW FOR ADDITIONAL CRUISE SHIP BERTHS.

ALTERNATIVE #5 – WIDEN FISHERMAN'S CHANNEL APPROXIMATELY 100 FEET TO THE SOUTH. (EXISTING DEPTH = 42 FEET, DEEPEN TO 50 FEET) DEEPENING WOULD INCLUDE CUT-3, STA. 0+00 TO CUT-3, STA. 42+00.

Note: The Alternatives identified on the following plates are referred to as Components in the Report text and Environmental Impact Statement (EIS)

FIGURE 2

Special Note regarding the absence of Figures 3 through 32.

Figures 3 through 31 illustrate the composite ship tract plots generated using different vessels under varying conditions. There are inbound and outbound plots using the existing port configuration and the proposed port configuration. For the Ship Simulation Modeler, these plots are valuable in evaluating the adequacy of proposed changes in channel widths (including wideners) and channel depths.

Further, some of the Pilot Associations operating at Florida ports have objected to public release of the ship tract plots because they contain proprietary information. Copies of the ship track plots from the simulation study are held on file at the Jacksonville District office. Point of contact is Philip Sylvester (904) 232-1142.

Figure 32 shows the widening segment of the channel between the Lummus Island Turning Basin and the Dodge Island Turning Basin and this Alternative was eliminated during the plan formulation process.

Miami Operational Operation
Final Evaluation Comments

Name________________________________ **Date**____________________

1) Were there any differences in the response of the simulated ship model when compared to your experience with the actual ship. If so, please indicate how this difference has affected the results of the simulation study. If you have never maneuvered the actual vessel, please respond with "N/A"

____

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____

2) The entrance channel between buoys 1 and 2 was widened at the seaward end. Did it help to funnel inbound and outbound traffic into and out of the channel ? Did you notice any significant handling difference in Cut #1 or #2 channel deepening?

____

____

____

3) The Fisher Island turning basin was widened by 400 feet to 1600 feet and dredged to 50 feet. Do you feel that this improvement better facilitated turning in the basin? Do you prefer the use of this turning basin or Lummus Island basin for container vessels? Why?

____

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4) Fisherman's Channel was widened about 100' to the South, deepened to 50 feet. Do you feel this will easier passage with ships alongside the dock. Higher maneuvering speeds and less surge at the dock?

____

____

____

5) Western end of the Main channel was relocated south to allow berthing at Watson Island. Did you think this provides ample room to and from the turning basin? Please explain.

6) With the improvements Dodge Island Cut and Dodge Island turning basin, do you think this provides ample room to maneuver vessel to and from berth 12? Please explain.

7) Additional Comments:

Phone: 601-634-2455
Fax: 601-634-3218

facsimile transmittal

To:	Phil Sylvester	From:	Dennis W. Webb
Fax:	(904) 232-1772	Date:	February 8, 2001
Phone:		Pages:	8
Re:		CC:	

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

Miami Pilot comments

Miami Operational Operation
Final Evaluation Comments

Name Michael McDonnell   Date September 1, 2000

1) Were there any differences in the response of the simulated ship model when compared to your experience with the actual ship. If so, please indicate how this difference has affected the results of the simulation study. If you have never maneuvered the actual vessel, please respond with "N/A"

SUSAN MAERSK - N/A
JUTLANDIA - N/A
DESTINY
NORDIC EMPRESS } THERE WAS NO DIFFERENCE
EAGLE CLASS

2) The entrance channel between buoys 1 and 2 was widened at the seaward end. Did it help to funnel inbound and outbound traffic into and out of the channel ? Did you notice any significant handling difference in Cut #1 or #2 channel deepening?

TO HAVE THE ENTRANCE CHANNEL WIDENED AND DEEPENED WAS A NOTICEABLE DIFFERENCE IN THE HANDLING OF THE VESSELS. IT WAS A MUCH SAFER MANEUVER AND ALLOWED ME TIME TO ADJUST FOR STRONG CROSS CURRENTS.

3) The Fisher Island turning basin was widened by 400 feet to 1600 feet and dredged to 50 feet. Do you feel that this improvement better facilitated turning in the basin? Do you prefer the use of this turning basin or Lummus Island basin for container vessels? Why?

THE FISHER ISLAND TURNING BASIN WIDENED AND DREDGED TO 50' IS A MUST NEEDED IMPROVEMENT. THIS IMPROVEMENT MADE FOR A MUCH SAFE MANEUVER. I PREFER TURNING IN FISHER IS. BECAUSE IT EXPEDITES THE MANEUVER, AND WHEN I BACK DOWN TO MY BERTH OR TO THE BASIN I AM GOING AT A SLOWER SPEED PAST THE SHIPS AT DODGE IS. WHICH PREVENTS SURGE AND I HAVE BETTER CONTROLS OF A TUGS,

4) Fisherman's Channel was widened about 100' to the South, deepened to 50 feet. Do you feel this will easier passage with ships alongside the dock. Higher maneuvering speeds and less surge at the dock?

YES, THIS A VERY IMPORTANT MODIFICATION AND SHOULD NOT BE DELETED. THIS IS ESPECIALLY NEEDED SINCE THE PORT IS LOOKING TO FINISH THE WEST END OF THE BERTHS. ALSO YOU NEED TO LOOK A SHIP AT DODGE IS. WITH 135' BEAM, A SHIP DOCKING AND GOING PAST THIS SHIP WITH 135' BEAM AND A TUG 100' LONG ALONG SIDE THE DOCKING SHIP THIS EQUALS 375'. WITH THE EXISTING CHANN...

5) Western end of the Main channel was relocated south to allow berthing at Watson Island. Did you think this provides ample room to and from the turning basin? Please explain.

YES, WITH TWO EAGLE CLASS SHIPS, ONE AT WATSON AND THE OTHER AT DODGE IS. THIS STILL GIVES ANOTHER VESSEL A 550' CHANNEL TO WORK IN WHICH IS MORE THAN ENOUGH CHANNEL TO WORK WITH FOR LEEWAY

6) With the improvements Dodge Island Cut and Dodge Island turning basin, do you think this provides ample room to maneuver vessel to and from berth 12? Please explain.

YES. THE PROPOSED CUT ALLOWS YOU TO GET FURTHER TO THE SOUTH AND AWAY FROM THE BERTHS AT DODGE IS. THIS WILL REDUCE ANY SURGE. THE PROPOSED TURNING BASIN ALLOWS YOU TO SAFELY TURN THE VESSEL OFF THE BERTH. THE ONLY AREA THAT I WOULD LIKE TO SEE CHANGED IS THE CHANNEL BETWEEN LUMMUS IS TURNING BASIN AND DODGE IS. TURNING BASIN, THIS

7) Additional Comments: SHOULD BE WIDENED 100 FEET, BECAUSE SHIPS DO DOCK A DODGE IS. ABEAM OF THIS CHANNEL. AND WITH A SOUTH WIND THIS COULD BE A PROBLEM AREA.

Miami Operational Operation
Final Evaluation Comments

Name Stuart Lilly **Date** August 23, 2000

1) **Were there any differences in the response of the simulated ship model when compared to your experience with the actual ship. If so, please indicate how this difference has affected the results of the simulation study. If you have never maneuvered the actual vessel, please respond with "N/A"**

SUSAN MAERSK - N/A
JUTLANDIA N/A
NORDIC EMPRESS
CARNIVAL DESTINY \ Vessels responded in a manner acceptable for the purposes of
VOYAGER OF THE SEAS* this simulation
* During transits passing berthed vessels, this vessel experienced sudden shears. ALSO ABEAM OF USCG BASE NEAR LB#17
This is unrealistic. THIS APPARENT "interaction" does not occur.

2) **The entrance channel between buoys 1 and 2 was widened at the seaward end. Did it help to funnel inbound and outbound traffic into and out of the channel ? Did you notice any significant handling difference in Cut #1 or #2 channel deepening?**

Yes the widened channel would help funnel two-way traffic at the Sea Buoy,
No, there was no noticeable handling difference among the vessels in Cut 1 or Cut 2

3) **The Fisher Island turning basin was widened by 400 feet to 1600 feet and dredged to 50 feet. Do you feel that this improvement better facilitated turning in the basin? Do you prefer the use of this turning basin or Lummus Island basin for container vessels? Why?**

YES, turning is better facilitated for the Susan Maersk and Jutlandia. This improvement may allow the Pilots to relax turning restrictions for similar sized vessels.
The use of this enlarged basin will be dictated by the following: berth assignments, other vessel movements; efficiency of vessel movements and availability of suitable tugs.

4) **Fisherman's Channel was widened about 100' to the South, deepened to 50 feet. Do you feel this will easier passage with ships alongside the dock. Higher maneuvering speeds and less surge at the dock?**

This widening does provide for more safe transits, however any estimation of less surge is inconclusive. The transits of the Nordic Empress and Destiny were successful at 6 to 7 knots. The critical factor is leeway. More wind, more leeway, and thus increased Track Beam, thus less clearance between ship and cranes.
7 knots for a cruise ship in the existing channel is borderline safe.
In scenarios of higher winds, these transits would be unsafe.

5) **Western end of the Main channel was relocated south to allow berthing at Watson Island. Did you think this provides ample room to and from the turning basin? Please explain.**

YES - there is ample room for vessels in and out of the WITB. At this point in the channel there is never two way traffic, only one way. Vessels entering and leaving the Basin are at slow, safe speeds as it is. The addition of an EAGLE Class vessel at Watson Island will not significantly impact on those vessels in transit.

6) **With the improvements Dodge Island Cut and Dodge Island turning basin, do you think this provides ample room to maneuver vessel to and from berth 12? Please explain.**

Based on the simulated runs, I think there is safe room for transit of the Nordic Empress. However, in scenarios of higher Northerly and Southerly winds, these transits would not be safe

7) **Additional Comments:**

1) Antrives

2) Tanker

In order to simulate the most realistic harbor conditions, the two following changes must be made:

- Addition of a berthed tanker at Fisher Island dock with beam of 105 ft
- Removal of shipboard cranes on berthed ACC vessel at container pier and replace with extended booms of landside gantry cranes.

The extended shipboard cranes on the berthed ACC vessels is unrealistic.

Miami Operational Operation
Final Evaluation Comments

Name: Stephen Nadeau Date: September 29, 2000

1) Were there any differences in the response of the simulated ship model when compared to your experience with the actual ship. If so, please indicate how this difference has affected the results of the simulation study. If you have never maneuvered the actual vessel, please respond with "N/A"

The Voyager & Nordic Empress models react fairly typical to to real ships. None of the models were so far from the real ship that it might effect the study.

Susan Maersk & Jutlandia N/A

2) The entrance channel between buoys 1 and 2 was widened at the seaward end. Did it help to funnel inbound and outbound traffic into and out of the channel ? Did you notice any significant handling difference in Cut #1 or #2 channel deepening?

1. No. Bouys are used lay outside the channel return them to the channel edge.
2) after deepening vessels handled better in all cases widening of cut 1 was great improvement

3) The Fisher Island turning basin was widened by 400 feet to 1600 feet and dredged to 50 feet. Do you feel that this improvement better facilitated turning in the basin? Do you prefer the use of this turning basin or Lummus Island basin for container vessels? Why?

Yes, The widening add to the ports ability to serve the larger ships restrictions will be lifted due to the two basins, more maneuvers capable for larger ships.
Both basins are useful Lummus will have little restrictions & more flexability but FI could be used for larger ships & tankers as well.

4) Fisherman's Channel was widened about 100' to the South, deepened to 50 feet. Do you feel this will easier passage with ships alongside the dock. Higher maneuvering speeds and less surge at the dock?

Yes, Absolutely. Also reduced stress, more flexability & higher safety margins

5) Western end of the Main channel was relocated south to allow berthing at Watson Island. Did you think this provides ample room to and from the turning basin? Please explain.

Yes The re-Drawing of the Channel Limits will in No Way effect Navigation & will allow Berthing on North Side of Watson Is.

6) With the improvements Dodge Island Cut and Dodge Island turning basin, do you think this provides ample room to maneuver vessel to and from berth 12? Please explain.

Yes This will give the Port The Much Needed Space to Turn Larger vessels and utilize The South Channel Terminal. A wider Channel at the approach will allow easier access.

7) Additional Comments:

The Long range planning to 50', wider channels and added Turning Space will give the Port The Need [illegible] up to the larger ships that are being built & Forced on US Ports.

The Cut 1 widening is essential for safer Maneuvers. Alt 1

Widening Alt 5 will give Large Ships the Chance To Pass Moored Vessels with a larger Chance of Safety.

Should any questions arise ore this report or any other aspect of the project do not hesitate To contact us.

MIAMI OPERATIONAL OPERATION FINAL EVALUATION COMMENTS

Name Michael Jaccoma
Date September 15,2000

1) Jutlandia-N/A
Susan Maersk- N/A
Nordic Empress – Seemed similar to my recollection. *
Voyager of the Seas – Similar*
Destiny – Similar*
*Note: All cruise vessels seemed to maintain more lateral momentum in the simulator then my actual experience. This should not effect the results of this study.

2) I did not feel this portion of the project was adequately addressed in the simulated exercises. However any increase in channel width would definitely improve the flow of inbound and outbound traffic in safety and expedience. See item 7).

3) It definitely improved turning in the basin for all size vessels. It is essential for turning the Susan Maersk in that basin. I prefer this basin for vessels berthing at the East End of the container dock if current velocity is not excessive. Turning at Fisher Island is more expedient and potential surging of deep container vessels at the berths is minimized if not eliminated. For strong currents and depending on the location and number of deep draft vessels at the berths I would prefer the Lummus Island basin.

4) Definitely it will help. I don't know that it alone will be sufficient. On windy days maneuvering may require tug assistance and the practical limits may at times be exceeded for light draft high-sided vessels.

5) Yes. With the vessels and situations simulated I always felt I had ample room to control the vessel.

6) Yes. During simulations there was adequate room for maneuvering the vessels here. My concern was more in passing any vessels berthed at the container pier at Lummus Island.

7) The influence of the Gulfstream very frequently impacts the entrance to the channel. The effect usually results in a north current from 1 ½ to 3 ½ knots as far in as buoys #2 and #3. A counter current can occasionally occur just as strong to the south. This requires boarding the larger deep draft vessels from 1 to 3 miles east of the sea buoy. This condition was not simulated. Two known grounding of "M" class Maersk vessels have occurred in the vicinity of the #1 buoy. One during a strong North current with the outbound vessel brushing the North bank. The other was during a strong south current and the inbound vessel brushed the South bank.

Correspondence

BISCAYNE BAY PILOTS
Serving the Port of Miami since 1911

2911 PORT BOULEVARD • MIAMI, FLORIDA 33132 • TELEPHONE (305) 375-8483 • CABLE: MIAMIPILOT

4/7/99 -
Nancy -
This was given to me by Capt.
Fernandez at yesterday's
Waterways Committee
meeting. They (the Pilots)
consider it valid.
V.I.
John Pearce
(4857)

October 23, 1997

Mr. Claude Bullock
Assistant Port Director
1015 N. America Way
Miami, Florida 33132

Dear Claude,

In order to assist the seaport in determining its needs for future dredging projects, the Biscayne Bay Pilots Association submits the following recommendations. We believe that as the channel is deepened it is vitally important that the channel also be widened. As you know Miami is one of the busiest ports in the nation. Last year our association handled over 9800 ship movements. The worlds largest cruise and container ships call here on a regular basis.

We have identified three specific areas in the channel that need to be widened. I have enclosed charts for each of these areas and highlighted that portion of the channel we feel should be widened.

The first and most critical area is the main channel entrance at Outer Bar Cut. The currents in this area are variable and unpredictable, putting large deep draft vessels are at risk when making their approach to Miami. Several Maersk container vessels have already grounded off of buoy "1". Our recommendation is to create a tapered entrance channel with an 800 foot wide entrance.

The second area of concern is on the south side of government cut between beacon 13 and beacon 15. This is an area where ships are turning from one channel into another. The strong currents in this area compounded by the necessity for the ship to have as little speed as possible, makes it important for the ship to have as much swinging room as possible. On at least three occasions that I know of, tugboats assisting ships in this area have grounded and sustained damage. Our recommendation is to widen the channel as much as possible between beacons 13 and 15.

Finally, Lummus Island Cut just south of the gantry crane area should be widened. At the present time ships transiting this area pass extremely close to vessels docked at the gantry berths. This results in a "surging" effect on the ships at the dock. Also, all too frequently, we are encountering vessels docked at Lummus Island with their cranes swung outboard 90 degrees thereby blocking a portion of the channel. Given the variables of wind, current, ship size, draft, etc., this creates an unsafe condition. Our recommendation is to extend the southern edge of Lummus Island Cut 100 feet further to the south.

I am certain that these critical channel improvements will enhance the commercial viability of the Port of Miami. Please feel free to call me if you have any questions.

Sincerely,

Robert K. Brownell
Chairman
Biscayne Bay Pilots

Encl.: 2
cc: Captain of the Port

JUL 16 2001

Planning Division
Plan Formulation Branch

Captain John R. Fernandez
Biscayne Bay Pilots
2911 Port Boulevard
Miami, Florida 33132

Dear Captain Fernandez:

The enclosed drawing contains modifications to the proposed study alternatives based on the recommendations of you and Captain Stephen McDonald at the Port of Miami offices on May 16, 2001. The enclosed drawing includes modifications to alternatives1, 2, 3, and 5 that will either avoid or reduce impacts to environmental resources.

Approval of those proposed changes by the Biscayne Bay Pilots association will allow us to continue calculations for our quantity and cost estimates. Please provide a written response by July 23, 2001.

Contact Jerry Scarborough at 904-232-2042 or Philip Sylvester at 904-232-1142 if you have any questions concerning the proposed changes. Thank you for your continued support and assistance.

Sincerely,

Richard E. Bonner, P.E.
Deputy District Engineer
for Project Management

Enclosure

Copy Furnished:

Ms. Amy Kimball-Murley, AICP, The Curtis & Kimball Company, 4101 Laguna Street, Coral Gables, Florida 33146

Carl E. Fielland, Port Engineer, Port of Miami, 1015 N. America Way, 2nd Floor, Miami, FL 33132

bcc:
CESAJ-PD-PN (D. Powell)
CESAJ-EN-HI (Choate)
CESAJ-EN-HI (Sylvester)
CESAJ-EN-DL (Henderson)

7-9-01 RBP Powell/PD-PN/SLW 7/5/01
Schmidt/PD-PN
Strain/PD-P
Sylvester/EN-HI
Choate/EN-HI
Henderson/EN-DL
Duck/PD
Scarborough/DP-I
Dollar/DP-A
Bonner/DP

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J5

July 20, 2001

Richard E. Bonner, P.E.
Deputy District Engineer
For Project Management
Department of the Army
P.O. Box 4970
Jacksonville, Fl. 32232-0019

Dear Mr. Bonner,

Please be advised that the Biscayne Bay Pilots approve the proposed modifications to the alternatives 1,2,3 and 5.

Should you need further assistance please feel free to call on Captain McDonald or myself.

Sincerely,

John R. Fernandez,
Chairman
Biscayne Bay Pilots

JS
PP
Perez

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May 14, 2003

Mr. Rene Perez
Project Manager
U.S. Army Corps of Engineers
PO Box 4970
Jacksonville, Florida 32232

Dear Mr. Perez:

The Miami harbor pilots wholeheartedly endorse all components of the Locally Preferred plan to deepen and widen the Miami ship channel.

Large newly constructed vessels are routinely arriving at ports of call with drafts in excess of 46 feet. If the Seaport of Miami is to remain a viable and competitive destination for ocean-going commerce on the eastern seaboard then the outer channel should be dredged to preferably 52 feet and the inner channel deepened to 50 feet.

The proposed widening of the channel (cut 1 from 500 feet to 800 feet) is needed to ensure safe transit of the large post panamax ships. With a length of 1138 feet and a beam of 141 feet, these vessels will encounter strong cross currents requiring a leeway or crab angle of 10 to 15 degrees to stay in the channel. This significantly increases the effective beam. Widening Fishermen's Channel an additional 100 feet is another critical "must." The present 500 foot channel provides only 100 to 120 feet of open water clearance if a large beamed vessel (141 feet) using tug assistance was to pass another berthed vessel of similar beam. Increasing the width would reduce the surge affect, increase clearance and should allow for safe routine passages.

If the Miami pilots can be of any assistance please contact us.

Thank you.

Yours truly,

Michael M. Wiegert

Michael M. Wiegert
Vice Chairman

TABLE OF CONTENTS

PLATES

Plate

PLATE-1 Core Boring Locations..

REPRESENTATIVE AND NEW BORINGS

Location

Alternative 1..CB-MIAX-3
CB-MH01-1
CB-MH01-2
CB-MH01-3
CB-MH01-4
CB-MH89-117
CB-MH89-20
CB-MH01-5
CB-MH01-6
CB-MH01-7

Alternative 2..CB-MH89-171

Alternative 3..CB-MH01-10
CB-MH01-20
CB-MH01-21
CB-MH90-152
CB-MH89-41
CB-MH89-45

Alternative 5..CB-MH89-145
CB-MH89-154
CB-MH89-51
CB-MH90-160
CB-MH01-12
CB-MH89-56
CB-MH01-13
CB-MH01-14
CB-MH01-15
CB-MH01-16
CB-MH01-17
CB-MH89-69

Alternative 6..CB-MH95-1
CB-MH95-2
CB-MH95-3
CB-MH95-4
CB-MH95-5
CB-MH95-6
CB-MH95-7
CB-MH95-8
CB-MH01-18
CB-MH01-19

NOTE: Alternative 6 is not included in the selected plan presented in this General Reevaluation Report.

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COMPRESSIVE STRENGTH

CB-MH01-1
CB-MH01-12
CB-MH01-13
CB-MH01-18
CB-MH01-21A

GRAIN SIZE DISTRIBUTION CURVES

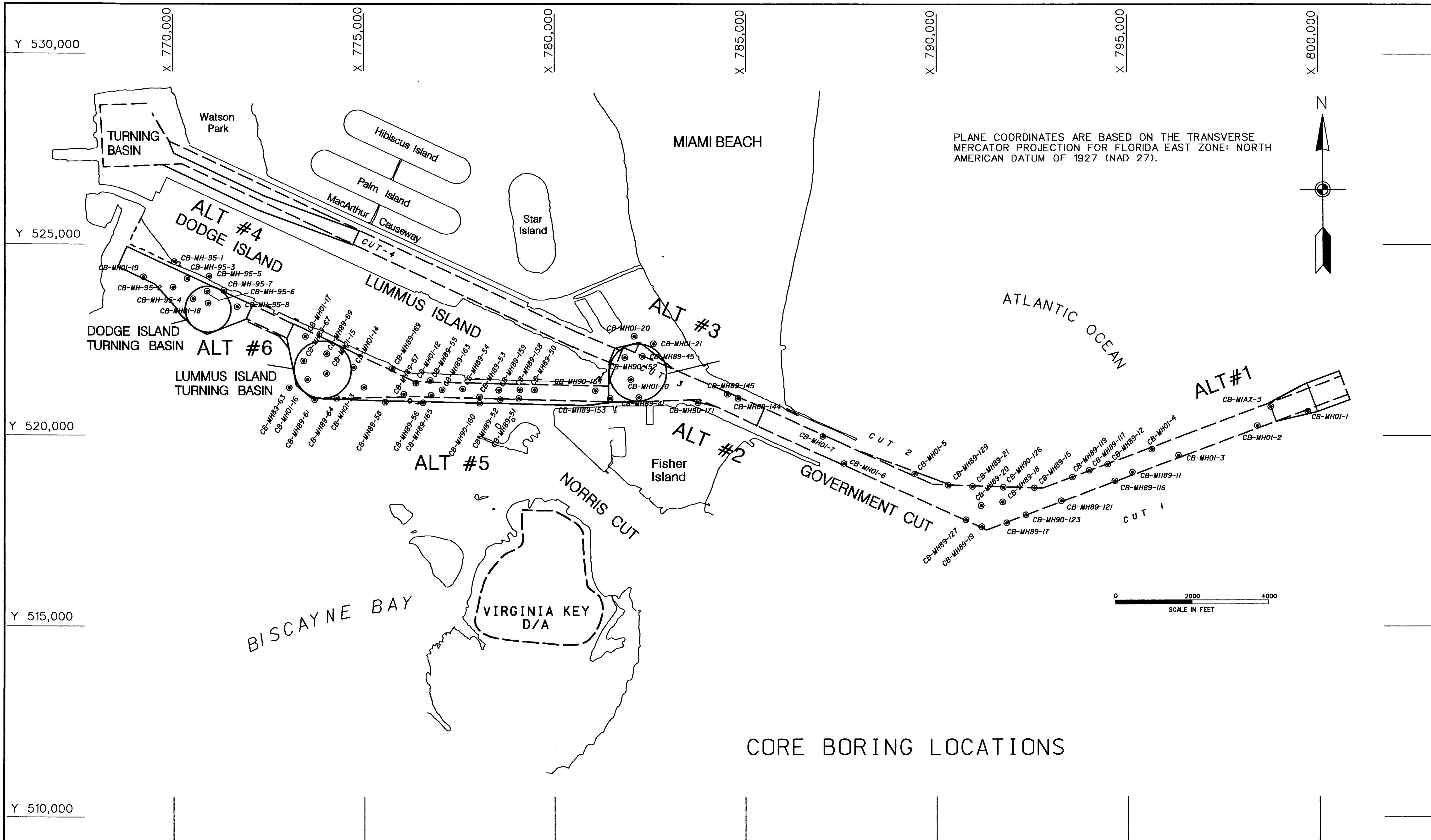
CB-MH01-19
CB-MH01-18
CB-MH01-21

SETTLING RATE TEST

CB-MH01-19
CB-MH01-18
CB-MH01-21

SPECIFIC GRAVITY

CB-MH01-1
CB-MH01-13
CB-MH01-18
CB-MH01-21A



ATTACHMENT C PLATE-1

BORINGS

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 1
1. PROJECT: Miami Harbor Deepening - Rock Claim	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION *(Coordinates or Station)*: X=798750, Y=520755	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*: Mean Low Water, 1.31 ft. below NGVD
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. *(As shown on drawing title and file number)*: CB-MIAX-3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 1 undisturbed: 0
5. NAME OF DRILLER: R. Gordon	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: Tide +1.4
7. THICKNESS OF BURDEN: 0 Ft.	16. DATE HOLE: STARTED 4/13/93 COMPLETED 4/13/93
8. DEPTH DRILLED INTO ROCK: 0 Ft.	17. ELEVATION TOP OF HOLE: -47.1 Ft.
9. TOTAL DEPTH OF HOLE: 12.5 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 40 %
	19. SIGNATURE OF GEOLOGIST: J. Gentile

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/1'
-47.1	0.0					-47.1	
			CARBONATE SAND, Fine to coarse, sand sized shell and limestone fragments, trace of silt, tan, little gravel sized shell fragments, trace of gravel sized limestone fragments. (SW)	40	1	2 inch Sampler	1 9 13 11 14
-52.1	5.0					-52.1	
			No Sample, washed to top of rock.	NoRec	-	Washed with open rods and water	
-59.6	12.5					-59.6	
			Hard Rock below -59.6 Soils are field visually classified in accordance with the Unified Soils Classification System.			Refusal at -59.6 300# Hammer With 18" Drop Used On 2" x 5' Sampler	

Depth scale: 0, 2.5, 5, 7.5, 10, 12., 15, 17., 20, 22

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Hole No.CB-MH01-01

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1

1. PROJECT Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=955,950 Y=520,793	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-MH01-01	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER Pickett	14. TOTAL NUMBER OF CORE BOXES 1 of 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER Tidal
	16. DATE HOLE STARTED 01/28/01 COMPLETED 01/28/01
7. THICKNESS OF BURDEN 1.0 Ft.	17. ELEVATION TOP OF HOLE -39.5 Ft.
8. DEPTH DRILLED INTO ROCK 10.2 Ft.	18. TOTAL CORE RECOVERY FOR BORING 80.4 %
9. TOTAL DEPTH OF HOLE 11.2 Ft.	19. SIGNATURE OF INSPECTOR J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/.5'
-39.5	0.0					-39.5	
-40.5	1.0		LIMESTONE, broken, lt. brownish gray.	53	1	Split Spoon -40.5	60 65 35
			LIMESTONE, fossiliferous, some coral, mod. to highly weathered, hard to very hard, highly pitted and vuggy with small to large vugs, lt. gray. Fragmented: 1.0' - 1.4', 2.0' - 2.7', 3.3' - 6.0', 6.3' - 6.8', 7.1' - 7.7', 8.4' - 9.2'. Low angle breaks with irregular surfaces: 1.4', 2.0', 2.7', 3.3', 6.0', 6.3', 6.8', 7.1', 7.7', 8.4'. 9.2 to 11.2 ft core loss.	100		SPT 0.5 ft into rock. Hyd. Press: 300 PSI, H20 Return: 0% D.T.= 13 min., RQD=22% Note: Used modified RQD rock sections less than 4" were counted if they were part of a hard rock area broken because of vugs. -45.5	
				80	BOX 1	Hyd. Press: 300 PSI, H20 Return: 0% D.T. = 23 min RQD= 1.5/4.0 = 37.5% -49.5	
-50.7	11.2			0		Hyd. Press: 300 PSI, H20 Return: 0% Drilling Time: 11 min -50.7	
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.). 4"X 5.5' core barrel with diamond bit	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-MH01-02

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1

1. PROJECT Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=954,633 Y=520,416	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-MH01-02	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 2 undisturbed: 0
5. NAME OF DRILLER Pickett	14. TOTAL NUMBER OF CORE BOXES 1 of 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 03/01/01 COMPLETED 03/01/01
7. THICKNESS OF BURDEN 4.5 Ft.	17. ELEVATION TOP OF HOLE -48.4 Ft.
8. DEPTH DRILLED INTO ROCK 0.0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 20 %
9. TOTAL DEPTH OF HOLE 4.5 Ft.	19. SIGNATURE OF INSPECTOR J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-48.4	0.0					-48.4	
			SAND, fine to medium, poorly graded, calcareous, light gray. (SP)	33	1	SPT -49.9	18 16 17
				27	2	SPT -51.4	8 8 9
-52.9	4.5			0		SPT -52.9	12 11 10

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Clasification System.

140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.).

Scale (depth): 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT	HOLE NUMBER
Miami Harbor Deepening and Widening	CB-MH01-02

Hole No.CB-MH01-03

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1

1. PROJECT Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=952,569 Y=519,642	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW, Horizonatal Datum: NAD83, FLE
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-MH01-03	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 3 undisturbed: 0
5. NAME OF DRILLER Pickett	14. TOTAL NUMBER OF CORE BOXES 1 of 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 03/01/01 COMPLETED 03/01/01
7. THICKNESS OF BURDEN 4.1 Ft.	17. ELEVATION TOP OF HOLE -48.4 Ft.
8. DEPTH DRILLED INTO ROCK 5.4 Ft.	18. TOTAL CORE RECOVERY FOR BORING 21.1 %
9. TOTAL DEPTH OF HOLE 9.5 Ft.	19. SIGNATURE OF INSPECTOR J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-48.4	0.0					-48.4	
			Silty SAND, fine to medium grained, occasional thin layers of limestone, calcareous, gray. (SM)	33	1	SPT -49.9	14 18 28
			Light gray, medium to coarse grained, thin layer of limestone at 1.5 ft.	67	2	SPT -51.4	40 41 52
-52.5	4.1			46	3	SPT -52.5	33 60
			LIMESTONE, no recovery.	0		Hyd. Press: 200 PSI H2O Return: 0% -55.9	
-57.9	9.5			0		Hyd. Press: 175 PSI H2O Return: 0% Hole blocked -57.9	

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Clasification System.

140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.).

4"X 5.5' core barrel with diamond bit.

Note: Bouncing rods may have been on well packed sand rather than rock.

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

Hole No.CB-MH01-04

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 1
1. PROJECT: Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=951,875 Y=519,801	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. (As shown on drawing title and file number): CB-MH01-04	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 3 undisturbed: 0
5. NAME OF DRILLER: Pickett	14. TOTAL NUMBER OF CORE BOXES: 1 of 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 03/01/01 COMPLETED 03/01/01
7. THICKNESS OF BURDEN: 4.4 Ft.	17. ELEVATION TOP OF HOLE: -47.8 Ft.
8. DEPTH DRILLED INTO ROCK: 0.0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 34.1 %
9. TOTAL DEPTH OF HOLE: 4.4 Ft.	19. SIGNATURE OF INSPECTOR: J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-47.8	0.0					-47.8	
-49.3	1.5		LIMESTONE, mod. hard, some fine to medium sand seams, calcareous, lt. gray	47	1	SPT -49.3	8 22 27
			Silty SAND, fine to medium grained, some small shell fragments, thin layer of limestone at 3.0 ft., light gray. (SM)	33	2	SPT -50.8	22 20 23
-52.2	4.4			36	3	SPT -52.2	43 50 50
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.).	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT: Miami Harbor Deepening and Widening | HOLE NUMBER: CB-MH01-04

Hole No. CB-MH89-117

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1 SHEETS

1. PROJECT Miami Harbor Deepening	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) x = 794,000 y = 519,086	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failings 1500
4. HOLE NO. (As shown on drawing title and file number) CB-MH89-117	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER R. Gordon	14. TOTAL NUMBER CORE BOXES 1
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER Tidal
7. THICKNESS OF OVERBURDEN	16. DATE HOLE STARTED 10-3-89 COMPLETED 10-3-89
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE -40.0
9. TOTAL DEPTH OF HOLE 12'	18. TOTAL CORE RECOVERY FOR BORING 76 %
	19. SIGNATURE OF INSPECTOR Geologist, Joe Gentile

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
-40.0	0.0					-40.0 BLS/0.5'
			SAND, fine to medium quartz & shell fragments, little silt, gray, wet, shelly (SM)	33	1	Split Spoon Settled; -43.0
-43.3	3.3		SAND, fine to medium quartz & shell fragments, trace silt, gray, few thin SAND-STONE lenses, shelly (SP)	88	2	Split Spoon 3 / 5 / 5; -44.5
-44.5	4.5		SANDSTONE, moderately hard, porous, very fossiliferous, many seams of loose sand & shell, light gray	88	3	Split Spoon 12 / 10 / 17; -46.0
-45.9	5.9		SANDSTONE, hard, porous permeable, some seams poorly cemented SANDSTONE, massive, tan, vuggy	100	-	DIA 4" x 5-1/2"; D.T. 40 min; H.P. 75 psi; -51.0
-52.0	12.0			50	-	DIA 4"x5½" H.P. 60 psi D.T. 7 min; -52.0
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0' SPLIT SPOON (1-3/8"I.D. x 2.0"O.D.)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT Miami Harbor Deepening HOLE NO. CB-MH89-117

Hole No. CB-MH89-20

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1 SHEETS

1. PROJECT: Miami Harbor Deepening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): x = 791,165 y = 518,167	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failings 1500
4. HOLE NO. (As shown on drawing title and file number): CB-MH89-20	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: R. Gordon	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Tidal
	16. DATE HOLE: STARTED 9-26-89; COMPLETED 9-26-89
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE: -44.0'
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING: 78 %
9. TOTAL DEPTH OF HOLE: 8.0'	19. SIGNATURE OF ~~INSPECTOR~~: Geologist, Joe Gentile

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
-44.0	0.0					-44.0 BLS/0.5'
-44.3	0.3		SAND, fine to medium quartz, silty, gray, little shell (SM)	80	1	-45.0 10 / 32
-44.7	0.7		Bed of moderately hard SANDSTONE with silty sand lenses from -44.3 to -44.7	88	-	DIA 4" x 5-1/2" D.T. 28 min H.P. 50 psi -49.0
			LIMESTONE, hard, very porous, slightly permeable, very fossiliferous (cemented shell), partly altered, tan, unevenly bedded, isolated seams poorly shell, sandy	63	-	DIA 4" x 5-1/2" D.T. 23 min H.P. 40 psi
-52.0	8.0					-52.0
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 2.0' SPLIT SPOON (1-3/8"I.D. x 2"O.D.)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT Miami Harbor Deepening

HOLE NO. CB-MH89-20

Hole No.CB-MH01-05

DRILLING LOG | DIVISION: South Atlantic | INSTALLATION: Jacksonville District | SHEET 1 OF 1

1. PROJECT: Miami Harbor Deepening and Widening
2. LOCATION (Coordinates or Station): X=945,654 Y=519,157
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-MH01-05
5. NAME OF DRILLER: Pickett
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 7.5 Ft.
8. DEPTH DRILLED INTO ROCK: 0.0 Ft.
9. TOTAL DEPTH OF HOLE: 7.5 Ft.
10. SIZE AND TYPE OF BIT: See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW, Horizontal Datum: NAD83, FLE
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 5 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1 of 1
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 03/01/01 COMPLETED 03/01/01
17. ELEVATION TOP OF HOLE: -45.8 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 42.7 %
19. SIGNATURE OF INSPECTOR: J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/.5'
-45.8	0.0					-45.8	
-47.3	1.5		Silty SAND, fine to medium grained, thin lense of limestone, calcareous, gray (SM)	53	1	SPT -47.3	8 / 25 / 33
			LIMESTONE, mod. hard, some fine to medium sand, calcareous, lt. gray	40	2	SPT -48.8	14 / 17 / 37
				53	3	SPT -50.3	26 / 36 / 50
				33	4	SPT -51.8	14 / 15 / 14
-53.3	7.5			33	5	SPT -53.3	10 / 13 / 23
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.).	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT: Miami Harbor Deepening and Widening | HOLE NUMBER: CB-MH01-05

Hole No.CB-MH01-06

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1
1. PROJECT Miami Harbor Deepening and Widening		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION *(Coordinates or Station)* X=943,811 Y=519,428		11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLW, Horizontal Datum: NAD83, FLE	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. *(As shown on drawing title and file number)* CB-MH01-06		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 4 undisturbed: 0	
5. NAME OF DRILLER Pickett		14. TOTAL NUMBER OF CORE BOXES 1 of 1	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 03/02/01 COMPLETED 03/02/01	
7. THICKNESS OF BURDEN 6.0 Ft.		17. ELEVATION TOP OF HOLE -47.1 Ft.	
8. DEPTH DRILLED INTO ROCK 0.0 Ft.		18. TOTAL CORE RECOVERY FOR BORING 26.7 %	
9. TOTAL DEPTH OF HOLE 6.0 Ft.		19. SIGNATURE OF INSPECTOR J. Arthur, PG	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-47.1	0.0					-47.1	
			LIMESTONE, mod. hard, some fine to medium sand seams, calcareous, lt. brownish gray	40	1	SPT -48.6	11, 18, 40
				27	2	SPT -50.1	22, 20, 10
				20	3	SPT -51.6	13, 15, 12
-53.1	6.0			20	4	SPT -53.1	10, 12, 14
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.).	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-MH01-07

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1
1. PROJECT Miami Harbor Deepening and Widening		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) X=943,259 Y=520,140		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW, Horizontal Datum: NAD83, FLE	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title and file number) CB-MH01-07		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 3 undisturbed: 0	
5. NAME OF DRILLER Pickett		14. TOTAL NUMBER OF CORE BOXES 1 of 1	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 03/02/01 COMPLETED 03/02/01	
7. THICKNESS OF BURDEN 4.5 Ft.		17. ELEVATION TOP OF HOLE -47.8 Ft.	
8. DEPTH DRILLED INTO ROCK 0.0 Ft.		18. TOTAL CORE RECOVERY FOR BORING 24.4 %	
9. TOTAL DEPTH OF HOLE 4.5 Ft.		19. SIGNATURE OF INSPECTOR J. Arthur, PG	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-47.8	0.0					-47.8	
			LIMESTONE, mod. hard, some fine to medium sand, calcareous, lt. grayish brown		1	SPT -49.3	12 26 20
					2	SPT -50.8	10 17 27
-52.3	4.5				3	SPT -52.3	15 16 30
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.).	

Scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
Miami Harbor Deepening and Widening	CB-MH01-07

DRILLING LOG

DIVISION	South Atlantic
INSTALLATION	Jacksonville District
SHEET	1 OF 2 SHEETS
1. PROJECT	Miami Harbor Deepening
2. LOCATION (Coordinates or Station)	x = 783,747 y = 520,865
3. DRILLING AGENCY	Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number)	CB-MH90-171
5. NAME OF DRILLER	R. Gordon
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	41.5'
10. SIZE AND TYPE OF BIT	See remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M L W
12. MANUFACTURER'S DESIGNATION OF DRILL	Failing 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	3
15. ELEVATION GROUND WATER	Tidal
16. DATE HOLE	STARTED 7/24/90 COMPLETED 7/25/90
17. ELEVATION TOP OF HOLE	-8.5'
18. TOTAL CORE RECOVERY FOR BORING	63 %
19. SIGNATURE OF INSPECTOR	Geologist, J. Gentile

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
						Bit or Barrel
-8.5	0.0					-8.5 Blows/0.5 Ft
			LIMESTONE, moderately hard, porous, permeable, very fossiliferous (cemented shell), tan, massive bedded	66	1	Split Spoon 8, 11; -10.0 20
-10.5	2.0			NO REC		-10.5 " 20
			LIMESTONE, hard, porous, slightly permeable, massive bedded, very fossiliferous (cemented shell & little sand), sandy in composition, tan-gray, solid core samples (1.0' pieces),	100		4x5½ Dia DT 17 min HP wt tools; -13.5
-16.5	8.0		brecciated, cemented angular fragments of very hard brown limestone, foss-iliferous, tan, massive bedded from -13.5 to -16.5	100		4x5½ Dia DT 19 min HP 75 psi; -16.5
			LIMESTONE, moderately hard, porous, permeable, very fossiliferous, oolitic, granular, tan, clean, massive bedded, seams poorly cemented oolites	93		4x5½ Dia DT 10 min HP 50 psi; -19.5
-22.0	13.5			100		4x5½ Dia DT 11 min HP wt of tools
-22.5	14.0		bed hard limestone from -22.0 to -22.5			-22.5
-24.0	15.5		SAND, fine to medium, quartz, clean, trace shell, tan, isolated sandstone lenses (SP)	NO REC		4x5½ Dia DT 11 min HP wt of tools; -25.5
				56	2	Split Spoon 23, 25; -27.0 45
			clean, no limestone lenses below -28.5	80	3	" settled 10; -28.5 20

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE: -8.5' | **Hole No.** CB-MH90-171

PROJECT: Miami Harbor Deepening | INSTALLATION: Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	[redacted] SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
						Bit or Barrel
						-28.5 Blows/0.5 Ft
				50	4	settled; Split Spoon; 8; 21; -31.5
-31.5	23.0		many lenses moderately hard sandstone from -31.5 to -32.5	88	5	"; 27; 21; 18; -33.0
-32.5	24.0		SANDSTONE, moderately hard, porous, permeable, many seams hard sandy limestone, seams friable poorly cemented sandstone, seams loose sand, fossiliferous, tan, massive bedded, isolated hard SS lenses riddled seams loose sand from -34.5 to -36.0	60		"; 38; 21; 27; -34.5
				66	6	"; 11; 6; 8; -36.0
-36.0	27.5		SAND, fine to medium quartz, tan, clean, few sandstone lenses (SP)	88	7	"; 15; 20; 27; -37.5
-37.5	29.0		LIMESTONE, hard, porous, tan, fossiliferous, sandy in composition, moderately hard sandstone from -38.5 to -39.	40		2x2-7/8 Dia; DT 6 min; HP 50 psi; -39.5
-38.5	30.0					
-39.0	30.5		SAND, fine to medium quartz, clean, tan, trace shell, isolated sandstone lenses (SP), bed hard porous limestone, tan, solution holes from -41.3 to -42.0, sand (SP), trace silt, limy, riddled with lenses hard limestone from -42.0 to -46.	60	8	Split Spoon; 7; 7; 8; -41.0
-41.3	32.8			80	9	-41.5 " 50
-42.0	33.5			NO REC	10	2x2-7/8 Dia; DT 11 min; HP 50 psi; -44.0
				66	11	Split Spoon; 15; 22; 20; -45.5
			45% hard limestone from -46.0 to -47.0	88	12	"; 15; 56; 47; -47.0
-47.0	38.5		LIMESTONE, hard, porous, tan, solid core sample, very fossiliferous (cemented shell), sandy	50		2x2-7/8 Dia; DT 6 min; HP 75 psi; -49.0
-48.0	39.5					
			SAND, fine to medium, quartz, tan, slightly limy, many lenses hard sandstone (SP)	80	13	Split Spoon; 100; 100; -50.0
-50.0	41.5		LIMESTONE, hard			Refusal
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# hammer with 30" drop used on 2.0' split spoon. (1-3/8" ID x 2" OD)

Hole No.CB-MH01-10

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1
1. PROJECT Miami Harbor Deepening and Widening		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION *(Coordinates or Station)* X=938,226 Y=521,630		11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLW, Horizontal Datum: NAD83, FLE	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. *(As shown on drawing title and file number)* CB-MH01-10		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 3 undisturbed: 0	
5. NAME OF DRILLER Pickett		14. TOTAL NUMBER OF CORE BOXES 1 of 1	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 02/26/01 COMPLETED 02/26/01	
7. THICKNESS OF BURDEN 3.2 Ft.		17. ELEVATION TOP OF HOLE -45.3 Ft.	
8. DEPTH DRILLED INTO ROCK 8.0 Ft.		18. TOTAL CORE RECOVERY FOR BORING 17.5 %	
9. TOTAL DEPTH OF HOLE 11.2 Ft.		19. SIGNATURE OF INSPECTOR J. Arthur, PG	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-45.3	0.0					-45.3	
-46.8	1.5		LIMESTONE, mod. hard, some sand, calcareous, lt. brownish gray	27	1	SPT -46.8	5 5 6
-48.3	3.0		SAND, fine to medium poorly graded, trace of limestone, calcareous, lt. gray (SP)	25	2	SPT -48.3	10 10 30
				100		-48.5	10
-50.5	5.2		LIMESTONE, very hard, fossiliferous, highly wea., pitted, lt. yellow brown stains, badly broken at 3.2 - 3.6 ft., gray 3.2 - 3.6 ft, 4.6 - 5.2 ft, Coral, very hard.	40		Hyd. Press: 250 PSI H2O Return: 0% RQD = 20% D.T.: 4 min	
-53.5	8.2		SAND, no recovery		Box 1	-53.5	
-56.5	11.2		LIMESTONE, fossilferous, highly wea., pitted, very hard, medium to coarse grained, few light yellow brown stains, gray Badly broken at 9.0 - 10.0 ft. Low angle irregular breaks at 9.0 and 9.3 ft.	60		Hyd. Press: 400 PSI H2O Return: 0% -56.5	
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.). 4"X 5.5' core barrel with diamond bit. Casing and rod bent and broke while pulling out barrel. 20' of casing dropped on the channel bottom.	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-MH01-20

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2

1. PROJECT Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION *(Coordinates or Station)* X=938314,.02 Y=522761,.41	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. *(As shown on drawing title and file number)* CB-MH01-20	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 12 undisturbed: 0
5. NAME OF DRILLER Pickett	14. TOTAL NUMBER OF CORE BOXES 1 of 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 01/26/01 COMPLETED 01/26/01
7. THICKNESS OF BURDEN 18.7 Ft.	17. ELEVATION TOP OF HOLE -10.7 Ft.
8. DEPTH DRILLED INTO ROCK 9.8 Ft.	18. TOTAL CORE RECOVERY FOR BORING 55 %
9. TOTAL DEPTH OF HOLE 28.5 Ft.	19. SIGNATURE OF INSPECTOR J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/.5'
-10.7	0.0					-10.7	
			SAND, fine to medium poorly graded, some small shell fragments, light gray. (SP)	0		SPT -12.2	WOH, WOH, 4
-13.7	3.0			100	1	SPT -13.7	12, 20, 25
-15.2	4.5		Silty SAND, fine to medium grained, some small shell fragments, calcareous, light gray. (SM)	100	2	SPT -15.2	21, 27, 24
			LIMESTONE, some shell fragments, moderately hard, some sand, lt. gray	100	3	SPT -16.7	13, 26, 23
				100	4	SPT -18.2	35, 4, 8
				100	5	SPT -19.7	24, 66, 34
-21.2	10.5			87	6	SPT -21.2	14, 16, 16
			SAND, fine poorly graded, some limestone gravel, white to light gray. (SP)	20	7	SPT -22.7	6, 6, 5
				20	8	SPT -24.2	3, 6, 9
			thin lense of limestone at 13.5 ft.	13	9	SPT -25.7	5, 5, 5
				20	10	SPT -27.2	6, 8, 10
				20	11	SPT -28.7	10, 8, 19
-29.4	18.7		limestone lense from 18.0 - 18.7 ft.	100	12	SPT -29.4	65, 100
			LIMESTONE, fossiliferous, mod. to highly wea., highly porous, pitted and vuggy with small to large vugs, very hard, dark gray	100	Box 1	Hyd. Press: 350 PSI H20 Return: 0% RQD = 100% -30.4	
			19.1 - 19.7 ft, fragmented. Low angle irregular open joints: 19.1, 19.8, 20.4, 20.8, 21.6, 22.0, 22.5.	100		Hyd. Press: 300 PSI H20 Return: 0% RQD = 57.9%	
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

Hole No.CB-MH01-20

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE -10.7 Ft.	SHEET 2 OF 2
PROJECT Miami Harbor Deepening and Widening	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-33.2	22.5		20.5 - 21.6 ft, highly wea., vuggy, badly broken. 23.4 - 23.8 ft, highly wea., soft to mod. hard, sandy.	100		Hyd. Press: 300 PSI H20 Return: 0% RQD = 57.9% (-34.2)	
			no recovery from 23.5 - 28.5 ft.	0	Box 1	Hyd. Press: 300 PSI H20 Return: 0% RQD = 0% (-38.2)	
-39.2	28.5			0		Hyd. Press: 200 PSI H20 Return: 0% RQD = 0% (-39.2)	
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.). 4"X 5.5' core barrel with diamond bit.	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

Hole No.CB-MH01-21

DRILLING LOG | DIVISION: South Atlantic | INSTALLATION: Jacksonville District | SHEET 1 OF 2

1. PROJECT: Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=938,817 Y=522,569	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. (As shown on drawing title and file number): CB-MH01-21	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 15 undisturbed: 0
5. NAME OF DRILLER: Pickett	14. TOTAL NUMBER OF CORE BOXES: 3 of 3
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 02/27/01 COMPLETED 02/28/01
7. THICKNESS OF BURDEN: 12.0 Ft.	17. ELEVATION TOP OF HOLE: -11.3 Ft.
8. DEPTH DRILLED INTO ROCK: 31.8 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 90 %
9. TOTAL DEPTH OF HOLE: 43.8 Ft.	19. SIGNATURE OF INSPECTOR: J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/.5'
-11.3	0.0					-11.3	
			Silty SAND, fine to medium grained, some small shell fragments, calcareous, lt. gray (SM)	67	1	SPT -12.8	3, 3, 4
				33	2	SPT -14.3	4, 10, 15
			trace limestone at 4.5 ft.	27	3	SPT -15.8	4, 13, 10
				33	4	SPT -17.3	10, 13, 7
			trace limestone at 6.0 ft.	67	5	SPT -18.8	14, 28, 27
			white, fine grained, no clay at 7.5 ft.	33	6	SPT -20.3	13, 15, 40
			trace limestone at 9.0 ft.	33	7	SPT -21.8	9, 18, 15
-23.3	12.0		medium to coarse grained at 12.0 ft.	27	8	SPT -23.3	10, 12, 11
-24.8	13.5		LIMESTONE, mod. hard, some coarse sand and small shell fragments, lt. gray	27	9	SPT -24.8	6, 4, 6
-26.3	15.0		SAND, medium to coarse grained, poorly graded, trace limestone, small shell fragments, lt. gray (SP)	53	10	SPT -26.3	6, 7, 11
-27.8	16.5		LIMESTONE, mod. hard, some fine sand, trace of shell fragments, lt. gray	20	11	SPT -27.8	11, 10, 10
			Silty SAND, fine to medium grained, trace limestone, calcareous, lt. gray (SM)	33	12	SPT -29.3	22, 18, 40
-30.5	19.2			67	13	SPT -30.5	40, 40, 60
			LIMESTONE, gray, fossiliferous and sandy, fine to medium grained, slightly to mod. wea., hard, highly porous and pitted. Low angle open joints: 19.2, 19.8, 20.3, 20.8, 21.5, 21.9, 22.4, 22.8 ft.	100	Box 1	Hyd. Press: 400 PSI H20 Return: 0% RQD = 100% D.T. = 7 min.	
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

Hole No.CB-MH01-21

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE -11.3 Ft.	SHEET 2 OF 2
PROJECT Miami Harbor Deepening and Widening	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-33.8	22.5						
			Near verical open joint: 21.5 - 23.8 ft. Fragmented: 23.8 - 24.2 ft.	100	Box 1	Hyd. Press: 400 PSI H2O Return: 0% RQD = 100% D.T. = 7 min. -35.1	
-37.6	26.3		25.0 - 25.3 ft, soft, clayey, some fine to medium sand, poorly cemented, badly broken and fragmented.	100		Hyd. Press: 500 PSI H2O Return: 0% RQD = 100% D.T. = 6 min. -37.6	
			Silty SAND,fine grained, calcareous, olive gray (SM) trace limestone 27.8 ft.	47	1	SPT -39.1	8 19 36
-39.8	28.5			100	2	SPT -39.8	62 33
			LIMESTONE, fossiliferous, sandy, mod. to highly wea., highly porous and pitted, some small vugs, mod. hard hard to very hard 29.5 - 30.6 ft. hard, fragmented 30.6 - 31.8 ft. low angle open joints: 28.6, 28.8, 29.2, 29.3, 29.5, 30.3, 30.6 ft.	100		Hyd. Press: 250 PSI H2O Return: 100% RQD = 61% D.T. = 4 min -43.1	
-47.6	36.3		mod. hard and highly vuggy with small to larger vugs: 31.8 - 33.2 ft. mod. porous and pitted: 33.2 - 34.9 ft.	80	Box 1	Hyd. Press: 200 PSI H2O Return: 100% RQD = 64% -48.1	
-49.7	38.4		Silty SAND, fine grained, trace limestone, calcareous, lt. brown, (SM)			Hyd. Press: 350 PSI H2O Return: 75% RQD = 20%	
-50.5	39.2		LIMESTONE, fossiliferous, highly wea., pitted and vuggy, sandy, soft to mod. hard, lt. brown	80			
-51.5	40.2		Silty SAND, fine grained, trace limestone, lt. brown (SM)				
			LIMESTONE, highly wea., pitted and vuggy, hard, fossiliferous, highly broken		Box 2	-53.1	
-55.1	43.8		low angle open joints: 38.4, 38.8, 39.8, 40.3, 40.6, 40.9, 41.9, 42.2, 43.1, 43.5 ft.	75		-55.1	

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Clasification System.

SAMPLE NO.	SAMPLE ELEVATION	LAB CLASS.
1	-11.3/-12.8	SP-SN
2	-12.8/14.3	SM

*Lab visual classification based on gradation curve. No Atterburg Limits.

140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.). 4" X 5.5'core barrel with diamond bit

Note: Hole terminated at -37.6. Drilled next day from -37.6 to -55.1. Second setup at X=938,823, Y=522,556. Two logs combined into one.

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

Hole No. CB-MH90-152

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville	SHEET 1 OF 1 SHEETS
1. PROJECT Miami Harbor Deepening		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) x = 781,832 y = 522,046		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) M L W	
3. DRILLING AGENCY US Army Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title and file number) CB-MH90-152		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER R. Gordon		14. TOTAL NUMBER CORE BOXES 1	
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER Tidal	
		16. DATE HOLE	STARTED 3/15/90 COMPLETED 3/15/90
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE -41.0	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING 34 %	
9. TOTAL DEPTH OF HOLE 11.0'		19. SIGNATURE OF INSPECTOR Geologist, J. Gentile	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						Bit or Barrel
-41.0	0.0					-41.0 Blows/0.5 FT
-42.0	1.0		SAND, medium to fine, quartz, trace gravel, trace shell, light gray, trace clay (SP)	27	1	Split Spoon; settled 3, 1; -42.5
			SANDSTONE, moderately hard	NO	REC	-43.0 Split Spoon 15
-44.0	3.0					
-44.5	3.5		LIMESTONE, hard, very fossiliferous (cemented shell) porous	16		4 x 5½ Dia; D.T. 7 min; H.P. 25 psi
			SANDSTONE, moderately hard, alternate beds of hard sandstone and limy (SP) sand, tan, thin bedded, porous, slightly permeable			-46.0
-48.5	7.5			16		4 x 5½ Dia; D.T. 22 min; H.P. 75 psi; -49.0
-52.0	11.0		LIMESTONE, very hard, crystalline limestone, riddled with large open solution holes, some unaltered coral heads, tan-gray, massive bedded, very permeable	94		4 x 5½ Dia; D.T. 17 min; H.P. 50 psi; -52.0
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140 pound hammer with 30 inch drop used on 2.0' split spoon (1-3/8" ID x 2" OD)

DRILLING LOG

Field	Entry
DIVISION	South Atlantic
INSTALLATION	Jacksonville District
SHEET	1 OF 1 SHEETS
1. PROJECT	Miami Harbor Deepening
2. LOCATION (Coordinates or Station)	x = 782,594 y = 520,936
3. DRILLING AGENCY	Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number)	CB-MH89-41
5. NAME OF DRILLER	R. Gordon
6. DIRECTION OF HOLE	[x] VERTICAL [ ] INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	7.9'
10. SIZE AND TYPE OF BIT	See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MLW
12. MANUFACTURER'S DESIGNATION OF DRILL	Failings 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	1
15. ELEVATION GROUND WATER	Tidal
16. DATE HOLE	STARTED 7/20/89 COMPLETED 7/20/89
17. ELEVATION TOP OF HOLE	-37.7'
18. TOTAL CORE RECOVERY FOR BORING	71 %
19. SIGNATURE OF INSPECTOR	Geologist Joe Gentile

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
-37.7	0.0					-37.7 BLS/0.5'
			SAND, fine to medium, quartz, very silty, gray, wet (SM)	100	1	SPLIT SPOON Settled 1
-39.2	1.5					-39.2 2
			SANDSTONE, moderately hard, porous, permeable, many seams, loose or poorly cemented SAND, gray, some fossils	80	2	" 2 3
						-40.7 11
				0	-	" 9
-41.6	3.9					-41.6 11
			SANDSTONE, hard porous, permeable, massive bedded, fossiliferous with coral heads, gray, vuggy, seams poorly cemented SANDSTONE	75	-	DIA 4" x 5½" D.T. 13 min H.P. 50 psi
-45.6	7.9					-45.6

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0' SPLIT SPOON (1 3/8"I.D. x 2.0"O.D.)

SAMPLE ELEVATION	LABORATORY CLASSIFICATION
-37.7 to -39.2	(SM-SC) *

NOTE:
* Visual classification based on Gradation Curve. No Atterberg Limits.

Hole No. CB-MH89-45

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 1 SHEETS

1. PROJECT: Miami Harbor Deepening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): x = 782,290 y = 522,078	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failings 1500
4. HOLE NO. (As shown on drawing title and file number): CB-MH89-45	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: R. Gordon	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Tidal
	16. DATE HOLE: STARTED 8/11/89, COMPLETED 8/11/89
	17. ELEVATION TOP OF HOLE: -37.5
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING: 40 %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF ~~INSPECTOR~~ Geologist: Joe Gentile
9. TOTAL DEPTH OF HOLE: 14.0'	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
-37.5	0.0					-37.5 BLS/0.5'
-38.2	0.7		SAND, fine to medium quartz and shell fragments, gray, trace of silt (SP)	80	1	SPLIT SPOON 5 / 32
-39.0	1.5				2	-39.0 33
			SANDSTONE, hard, porous, permeable, friable, many seams poorly cemented	66	3	" 8 / 7 / -40.5 12
			SANDSTONE, some seams loose sand, fossiliferous, light gray, massive, moderately hard, many loose sand seams from -38.2 to -39.0	66	4	" 6 / 8 / -42.0 12
				40	5	" 6 / 9 / -43.5 10
-43.5	6.0			0	---	OVERDROVE CASING
			SANDSTONE, moderately hard, porous, permeable, fossiliferous, light gray, many seams of very poorly cemented rock and seams loose sand. Thin lenses HARD SANDSTONE from -47.0 to -48.5	0		DIA 4" x 5½" D.T. 4 min H.P. 30 psi -47.0
				33	6	SPLIT SPOON 4 / 15 / -48.5 17
-48.5	11.0		SAND, fine to medium quartz, light gray, clean, 20% thin sandstone lenses, damp (SP)	56	7	" 14 / 16 / -50.0 23
				46	8	" 8 / 14 / -51.5 20
-51.5	14.0					

Soils are field visually classified in accordance with the Unified Soils Classification System.

SAMPLE ELEVATION	LABORATORY CLASSIFICATION
-37.5 to -38.2	(SP) *

Note:
* Visual classification based on Gradation Curve. No Atterberg Limits.

140# HAMMER WITH 30" DROP USED ON 2.0' SPLIT SPOON (1 3/8"I.D. x 2.0"O.D.)

Hole No. CB-MH89-145

DRILLING LOG

DIVISION	South Atlantic
INSTALLATION	Jacksonville District
SHEET 1 OF 1 SHEETS	
1. PROJECT	Miami Harbor Deepening
2. LOCATION (Coordinates or Station)	x = 784,521 y = 521,083
3. DRILLING AGENCY	Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number)	CB-MH89-145
5. NAME OF DRILLER	R. Gordon
6. DIRECTION OF HOLE	XX VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	12'
10. SIZE AND TYPE OF BIT	See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MLW
12. MANUFACTURER'S DESIGNATION OF DRILL	Failings 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	1
15. ELEVATION GROUND WATER	Tidal
16. DATE HOLE	STARTED 8/1/89 COMPLETED 8/1/89
17. ELEVATION TOP OF HOLE	-37.9
18. TOTAL CORE RECOVERY FOR BORING	51 %
19. SIGNATURE OF ~~INSPECTOR~~ XXXXXXX	Geologist Joe Gentile

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
-37.9	0.0					-37.9 BLS/0.5'
			SAND, fine to medium quartz and sand size shell fragments, tan, wet, (SP)	56	1	Split Spoon 2 / 1 / -39.4 2
-39.9	2.0			93	2	" 1 / 4 / -40.9 6
			LIMESTONE (oolitic) very fossiliferous, tan, porous, riddled with seams loose sand and shell, seams poorly cemented SAND and SHELL, moderately hard, thin lenses hard SANDSTONE	80	3	" 2 / 6 / -42.4 3
-42.4	4.5			46	4	" 9 / 9 / -43.9 20
			SANDSTONE, moderately hard, porous, permeable, thin bedded, riddled with seams loose sand, seams poorly consolidated SANDSTONE, light gray	54	5	" 22 / 18 / -45.4 13
-45.4	7.5			33	6	" 2 / 5 / -46.9 12
-46.4	8.5		Bed (SP) SAND with SANDSTONE lenses from -45.4 to -46.4	12	7	" 9 / 20 / -48.4 33
				33	8	" 6 / 12 / -49.9 23
-49.9	12.0		LIMESTONE, hard			REFUSAL

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# HAMMER WITH 30" DROP USED ON 2.0' SPLIT SPOON (1 3/8"I.D. x 2.0"O.D.)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: MIAMI HARBOR DEEPENING — HOLE NO. CB-MH89-145

Hole No. CB-MH90-154

DRILLING LOG

DIVISION	South Atlantic
INSTALLATION	Jacksonville District
SHEET 1 OF 1 SHEETS	
1. PROJECT	Miami Harbor Deepening
2. LOCATION (Coordinates or Station)	x = 781,059 y = 521,174
3. DRILLING AGENCY	US Army Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number)	CB-MH90-154
5. NAME OF DRILLER	R. Gordon
6. DIRECTION OF HOLE	[x] VERTICAL [ ] INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	11.5'
10. SIZE AND TYPE OF BIT	See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M L W
12. MANUFACTURER'S DESIGNATION OF DRILL	Failing 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	2
15. ELEVATION GROUND WATER	Tidal
16. DATE HOLE	STARTED 3/14/90 COMPLETED 3/14/90
17. ELEVATION TOP OF HOLE	-39.9
18. TOTAL CORE RECOVERY FOR BORING	86 %
19. SIGNATURE OF INSPECTOR	Geologist, J. Gentile

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	[redacted] SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
						Bit or Barrel
-39.9	0.0					-39.9 Blows/0.5 FT
-41.4	1.5		SANDSTONE, moderately hard, very porous, permeable, honey-combed with voids	33	1	Split Spoon 3 / 1 / 4; -41.4
-42.9	3.0		partly filled with loose sand, riddled with seams loose sand, light gray	56	2	Split Spoon 8 / 12 / 10; -42.9
-43.4	3.5		SAND, fine to medium, quartz, riddled with lenses moderately hard sandstone, clean, light gray, moderately hard sandstone from -42.9 to -43.4	100	3	-43.4 " " 20
			LIMESTONE, very hard, crystalline, brittle, riddled with solution holes partly filled with secondary moderately hard limestone, vuggy, tan, massive bedded, a few fossils	100		4 x 5½ Dia; D.T. 25 min; H.P. 60 psi; -46.4
				100		4 x 5½ Dia; D.T. 38 min; H.P. 50 psi
-51.4	11.5					-51.4

Soils are field visually classified in accordance with the Unified Soils Classification System.

140# hammer with 30" drop used on 2.0' split spoon (1-3/8" ID x 2" OD)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

DRILLING LOG

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 1 SHEETS

1. PROJECT: Miami Harbor Deepening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): x = 779,056 y = 520,975	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failings 1500
4. HOLE NO. (As shown on drawing title and file number): CB-MH89-51	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: R. Gordon	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: Tidal
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 8-28-89; COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE: -39.2
9. TOTAL DEPTH OF HOLE: 13'	18. TOTAL CORE RECOVERY FOR BORING: 80 %
	19. SIGNATURE OF ~~INSPECTOR~~ Geologist: Joe Gentile

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
-39.2	0.0					-39.2 BLS/0.5'
			SAND, fine to medium quartz, light gray (SP)	80	1	SPLIT SPOON -40.7 — Settled 4 / 5 / 2
-41.7	2.5			88	2	Split Spoon -42.2 — 4 / 12
-43.0	3.8		LIMESTONE, hard, very permeable, riddled with large solution holes, fossiliferous, tan, massive, bed of (SP) SAND with many lenses of hard SANDSTONE, from -43.0' to -44.2'	43	-	DIA 4" x 5-1/2" D.T. 18 min H.P. 30 psi -45.2
-44.2	5.0		hard, very porous, riddled with solution holes, tan, massive, solid core from -44.2 to -45.2 sandy, large solution holes partly filled with secondary porous hard LIMESTONE from -45.2' to -51.2'	100	-	DIA 4" x 5-1/2" D.T. 35 min H.P. 45 psi -48.2
				82	-	DIA 4" x 5-1/2" D.T. 27 min H.P. 40 psi -50.2
-52.2	13.0			100	-	DIA 4" x 5-1/2" D.T. 16 min H.P. 45 psi -52.2
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# Hammer with 30" DROP USED ON 2.0' SPLIT SPOON (1-3/8" I.D. x 2" O.D.)

SAMPLE ELEVATION	LABORATORY CLASSIFICATION
-39.2 to -40.7	(SP) *

NOTE:
*Visual Classification based on Gradation Curve. No Atterberg Limits.

Hole No. CB-MH90-160

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 3 SHEETS

1. PROJECT	Miami Harbor Deepening
2. LOCATION (Coordinates or Station)	x = 778,028 y = 520,847
3. DRILLING AGENCY	US Army Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number)	CB-MH90-160
5. NAME OF DRILLER	R. Gordon
6. DIRECTION OF HOLE	[x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	47.0'
10. SIZE AND TYPE OF BIT	See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	M L W
12. MANUFACTURER'S DESIGNATION OF DRILL	Failing 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	3
15. ELEVATION GROUND WATER	Tidal
16. DATE HOLE	STARTED 4/16/90 COMPLETED 4/17/90
17. ELEVATION TOP OF HOLE	-3.0
18. TOTAL CORE RECOVERY FOR BORING	66 %
19. SIGNATURE OF INSPECTOR	Geologist, J. Gentile

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						Bit or Barrel
-3.0	0.0					-3.0 Blows/0.5 FT
-4.0	1.0		SAND, fine to medium, quartz and shell fragments, little silt, gray, little shell (SM)	46	1	Split Spoon; settled; -4.5
			CLAY, slightly plastic, trace silt, trace to little shell, gray (CL)	60	2	Split Spoon; settled; -6.0
				0		Split Spoon; settled; -7.5
-7.5	4.5		CLAY, plastic, gray, little shell, trace silt (CH)	93	3	Split Spoon; settled; -9.0
				100	4	Split Spoon; settled; -10.5
				100	5	Split Spoon; settled; -12.0
				20	6	Split Spoon; settled; -13.5
-13.5	10.5		LIMESTONE, moderately hard, porous, slightly permeable, very fossiliferous, sandy, riddled with voids filled with limy sandy silt, fractured voids filled with soft clay from -13.5 to -15.0	26	7	Split Spoon; 4, 4, 3; -15.0
-15.0	12.0			93	8	Split Spoon; 2, 22, 32; -16.5
-16.0	13.0		LIMESTONE, hard, porous, slightly permeable, very fossiliferous, vuggy, hard limestone, sandy with voids filled with secondary moderately hard to soft, very fossiliferous, buff limestone; solid core; completely riddled with large solution holes filled with secondary soft fossiliferous limestone from -19.5 to -22.5	100		4" x 5½" Dia; D.T. 14 min; psi wt of rods; -19.5
-19.5	16.5			100		4" x 5½" Dia; D.T. 21 min; psi wt of rods; -22.5
-22.5	19.5					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: Miami Harbor Deepening HOLE NO. CB-MH90-160

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE: -3.0 | **Hole No.** CB-MH90-160

PROJECT: Miami Harbor Deepening | INSTALLATION: Jacksonville District | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-22.5	19.5					Bit or Barrel -22.5 Blows/0.5 FT
-23.5	20.5		moderately hard limestone from -22.5 to -23.5	0		4" x 5½" Dia D.T. 3 min psi wt of rods dropped -23.5 to -24.5
-24.5	21.5	Cavity	large open cavity from -23.5 to -24.5			-24.5
			SAND, fine to medium, quartz, many thin lenses hard sandstone, light gray (SP)	33	9	Split Spoon 1 / 3 / 2 -26.0
				40	10	Split Spoon 7 / 3 / 5 -27.5
				66	11	Split Spoon 2 / 5 / 8 -29.0
				56	12	Split Spoon 5 / 4 / 2 -30.5
-32.1	29.1			40	13	Split Spoon 2 / 2 / 8 -32.0
			LIMESTONE, very hard, many solution holes partly filled with secondary moderately hard fossiliferous limestone, tan-gray, massive bedded, permeable, isolated coral, solid core	100		-32.1 -32.7
-36.1	33.1			97		4" x 5½" Dia D.T. 33 min H.P. 50 psi -35.5
			completely riddled with large open solution holes, very permeable, tan, limonitic stain from -36.1 to -39.8	100		4" x 5½" Dia D.T. 26 min H.P. 50 psi -37.5
-39.8	36.8			50		2" x 2-7/8" Dia D.T. 26 min H.P. 50 psi -40.5
-43.5	40.5		solution holes and voids filled with secondary, porous, fossiliferous, moderately hard limestone from -39.8 to -43.5	69		2" x 2-7/8" Dia D.T. 22 min H.P. 100 psi -43.5
			very fossiliferous (cemented shell), porous, tan, massive bedded	94		2" x 2-7/8" Dia D.T. 7 min H.P. 120 psi -45.5
-47.5	44.5			66		2" x 2-7/8" Dia D.T. 10 min H.P. 120 psi -47.5

Hole No.CB-MH01-12

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2
1. PROJECT Miami Harbor Deepening and Widening		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) X=932,593 Y=521,535		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW, Horizontal Datum: NAD83, FLE	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title and file number) CB-MH01-12		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0	
5. NAME OF DRILLER Pickett		14. TOTAL NUMBER OF CORE BOXES 2 of 2	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 01/31/01 COMPLETED 01/31/01	
7. THICKNESS OF BURDEN 0.0 Ft.		17. ELEVATION TOP OF HOLE -32.4 Ft.	
8. DEPTH DRILLED INTO ROCK 19.5 Ft.		18. TOTAL CORE RECOVERY FOR BORING 84.5 %	
9. TOTAL DEPTH OF HOLE 22.6 Ft.		19. SIGNATURE OF INSPECTOR J. Arthur, PG	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel
-32.4	0.0		LIMESTONE, lt. gr. with brn. stains, fossiliferous, mod. to highly wea., hard to very hard, highly vuggy, fragmented 0.9 - 1.5 ft, highly wea., mod. hard, badly broken. 1.5 - 1.8 ft, mod. wea., very hard, highly vuggy.	88	Box 1	-32.4 Hyd. Press: 500 PSI H2O Return: 0% D.T. = 13 min. RQD = 13.3%
			1.8 - 3.0 ft, highly wea., soft to mod. hard, badly broken. 3.4 - 4.5 ft, highly wea., mod. hard, fragmented to badly broken. 4.5 - 7.4 ft, mod. to highly wea., highly vuggy.	100		-35.8 Hyd. Press: 700 PSI H2O Return: 0% D.T. = 19 min. RQD = 27.5%
			5.0 - 5.4 ft, mod. hard to hard. 5.4 - 5.8 ft, hard. 5.8 - 7.4 ft, soft to mod. hard, badly broken. 7.4 - 9.9 ft, some lt. brn. sand filled vugs, highly vuggy, mod. to highly wea., hard to very hard, fragmented and badly broken. 9.9 - 12.4 ft, no sand, highly wea., mod. hard to hard, fragmented.	100		-39.8 Hyd. Press: 700 PSI H2O Return: 0% D.T. = 17 min. RQD = 40%
			Fragmented: 9.9 - 12.4, 13.8 - 14.2, 19.2 - 19.3 ft. sl. wea., highly pitted and vuggy with small vugs, very hard at 12.4 ft. Low angle open joints: 13.5, 13.8, 14.0, 14.2, 16.1, 16.7, 16.8, 17.1, 17.2, 17.4, 17.6, 18.1, 18.6, 18.8, 19.3 ft. sl. to mod. wea., small to large vugs at 17.4 ft.	100	Box 2	-44.8 Hyd. Press: 550 PSI H2O Return: 0% D.T. = 15 min. RQD = 96.2%
			Mod.to highly wea. at 18.6 ft. Badly broken: 18.6 - 18.8 ft. 18.8 - 19.3 ft, highly vuggy with large vugs.	38		-50.0 Hyd. Press: 500 PSI H2O Return: 0% D.T. = 7 min. RQD = 34%
-51.9	19.5		SAND, no recovey			
						(continued)

Hole No.CB-MH01-12

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE -32.4 Ft.	SHEET 2 OF 2
PROJECT Miami Harbor Deepening and Widening	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel
-54.9 -55.0	22.5 22.6					-55.0
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.). 4"X 5.5'core barrel with diamond bit.

22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 3 SHEETS

1. PROJECT Miami Harbor Deepening	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) x=776,536 y=520,860	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failings 1500
4. HOLE NO. (As shown on drawing title and file number) CB-MH89-56	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED: — UNDISTURBED:
5. NAME OF DRILLER R. Gordon	14. TOTAL NUMBER CORE BOXES 3
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER Tidal
	16. DATE HOLE — STARTED 9-18-89 — COMPLETED 9-18-89
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE -2.8
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING 63 %
9. TOTAL DEPTH OF HOLE 47'	19. SIGNATURE OF INSPECTOR Geologist Joe Gentile

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						Bit or Barrel
-2.8'	0.0					-2.8' BLS/0.5'
-4.8	2.0		SAND, fine quartz, shelly, silty, gray, wet (SM)		1	Settled Split Spoon
-10.3	7.5		SILT, gray, damp, little clay (ML)	27	2	-10.3
-14.8	12.0		Silt, slightly plastic, clayey, trace shell from -10.3 to -14.8	33	3	Settled Split Spoon -14.8
-15.3	12.5		bed of silty shell from -14.8 to -15.3			1
			LIMESTONE, moderately hard, porous, permeable, vuggy, voids filled with poorly cemented SANDSTONE and loose sand, massive, fossiliferous, very sandy, tan-gray.	73	4	Split Spoon 12/15 -16.3
				80	5	" 2/12/18 -17.8
-18.8	16.0			80	6	" 18/50 -18.8
-22.3	19.5		LIMESTONE, hard, solid core, porous, permeable, vuggy, solution holes filled with friable SANDSTONE, tan-gray massive fossiliferous, very sandy.	100	-	DIA 4" x 5-1/2" D.T. 10 min H.P. 20 psi -21.8

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE -2.8 | **Hole No.** CB-MH89-56

PROJECT Miami Harbor Deepening | INSTALLATION Jacksonville District | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
-22.3	19.5					BIT OR BARREL BLS/0.5'
-24.8	22.0		SANDSTONE, moderately hard, porous, permeable, riddled with seams poorly cemented SANDSTONE and seams of loose sand, light gray.	53	-	DIA 4" x 5-1/2" D.T. 34 min H.P. 70 psi -24.8
-27.3	24.5		SAND, fine to medium quartz, clean, tan, trace shell, wet (SP)	60	7	Split Spoon Settled -27.3
				100	-	-27.8 DIA 4" x 5-1/2"
-28.9	26.1		LIMESTONE, very hard, dense, slightly fossiliferous, tan, redeposited crystalline LIMESTONE			DIA 4" x 5-1/2" D.T. 11 min H.P. 40 psi
-31.1	28.3		LIMESTONE, soft, weathered, chalky, friable, fossiliferous, white, massive, porous, non-permeable. bed quartz, SAND (SP) from -31.1 to -32.3.	90	-	30.8
-32.3	29.5			25	8	DIA 4" x 5-1/2" D.T. 19 min H.P. 30 psi -32.8
			LIMESTONE, moderately hard, porous, permeable, weathered, fossiliferous, completely riddled with solution holes, tan, massive.	33	-	Split Spoon 5 / 8 / 12 -34.3
-35.3	32.5			73	-	Split Spoon 15 / 21 / 50 -35.8
			LIMESTONE, hard, porous, permeable, vuggy, riddled with large open solution holes, slightly fossiliferous, tan, massive.	76	-	DIA 4" x 5-1/2" D.T. 36 min H.P. 50 psi -40.8
-43.8	41.0			66	-	DIA 4" x 5-1/2" D.T. 21 min H.P. 70 psi -43.8
			SANDSTONE, hard, porous slightly permeable, well cemented, very fossiliferous, tan, massive, solid core.	100	-	DIA 4" x 5-1/2" D.T. 15 min H.P. 50 psi -46.8

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE -2.8 **Hole No.** CB-MH89-56

PROJECT Miami Harbor Deepening | INSTALLATION Jacksonville District | SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL -46.8 BLS/0.5'
-49.8	47.0			100	-	DIA 4" x 5-1/2" D.T. 12 min H.P. 40 psi -49.8
			Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE ELEVATION — LABORATORY ANALYSIS -2.8 to-4.8 — (SC)* -4.8 to-10.3 — (CL)* Note: *Visual Classification based on Gradation Curve. No Atterberg Limits.			140# Hammer with 30" DROP USED ON 2.0' Split Spoon (1-3/8" I.D. x 2" O.D.)

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1980 OF-628-603 PROJECT Miami Harbor Deepening HOLE NO. CB-MH89-56

Hole No.CB-MH01-13

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 1
1. PROJECT: Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=931,232 Y=521,423	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW, Horizonatal Datum: NAD83, FLE
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. (As shown on drawing title and file number): CB-MH01-13	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 3 undisturbed: 0
5. NAME OF DRILLER: Pickett	14. TOTAL NUMBER OF CORE BOXES: 2 of 2
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER:
	16. DATE HOLE: STARTED 03/06/01 COMPLETED 03/06/01
7. THICKNESS OF BURDEN: 2.4 Ft.	17. ELEVATION TOP OF HOLE: -38.6 Ft.
8. DEPTH DRILLED INTO ROCK: 13.9 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 85.4 %
9. TOTAL DEPTH OF HOLE: 16.3 Ft.	19. SIGNATURE OF INSPECTOR: J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-38.6	0.0					-38.6	
			Silty SAND, fine grained, trace of small shells fragments, calcareous, gray. (SM)	35	1	SPT	WOH, WOH, WOH, WOH
-40.6	2.0					-40.6	
			LIMESTONE, fossilferous, mod. to highly wea., very hard, highly vuggy, lt. gray.	42	2	-41.0 SPT	17, 35, 65
			2.4 - 3.1 ft, badly broken. 3.1 - 7.4 ft, clay filled vugs with fine crystal coating, mod. weathered. Low angle irregular open joints: 3.1, 3.5, 3.7, 4.4, 4.9, 5.2, 5.3, 5.9, 6.1, 6.4, 6.8, 6.9, 7.1, 7.4, 8.1, 8.8 and 9.6 ft.	100	Box 1	Hyd. Press: 300 PSI H20 Return: 0% D.T. = 23 min. RQD = 84% -46.0	
			7.4 - 12.1 ft, no clay in vugs. Low angle irregular open joints: 10.2, 10.9, 11.5, 12.1, 12.5, 12.7, 13.2, 13.7, 14.0, 14.2 and 14.4 ft.	100		Hyd. Press: 200 PSI H20 Return: 0% RQD = 100% -50.7	
			12.1 - 14.4 ft, mod. vuggy with small vugs, fine crystal coating inside vugs, sl. to mod. wea. 14.0 - 14.4 ft, mod. wea., mod. hard, few small to large vugs.	100	Box 2	Hyd. Press: 200 PSI H20 Return: 0% RQD = 91.3% -53.0	
-53.4	14.8		14.4 - 14.7 ft, low angle open joint.	100		-53.4 HP: 200, H20: 0%, RQD: 100%	
			SAND, fine poorly graded, calcareous, light gray. (SP)	67	3	SPT	WOH, WOH, WOH
-54.9	16.3					-54.9	
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.). 4"X5.5'core barrel with diamond bit	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-MH01-14

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1

1. PROJECT Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=930,960 Y=521,947	11. DATUM FOR ELEVATION SHOWN (TBN or MSL) MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-MH01-14	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER Pickett	14. TOTAL NUMBER OF CORE BOXES 2 of 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/25/01 COMPLETED 02/25/01
7. THICKNESS OF BURDEN 0.0 Ft.	17. ELEVATION TOP OF HOLE -37.2 Ft.
8. DEPTH DRILLED INTO ROCK 18.5 Ft.	18. TOTAL CORE RECOVERY FOR BORING 70.7 %
9. TOTAL DEPTH OF HOLE 18.8 Ft.	19. SIGNATURE OF INSPECTOR J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel
-37.2	0.0					-37.2
			LIMESTONE, fossiliferous, mod. to highly wea., hard, highly vuggy with large vugs, some pale yellow fine crystal coatings, lt. gray Low angle irregular breaks: 0.2, 0.8, 1.2, 1.7, 1.9 ft. Badly broken: 0.2 - 0.8, 1.2 - 1.7, 1.9 - 3.5, 5.8 - 9.3 ft.	100		Hyd. Press: 200 PSI H20 Return: 0% RQD = 20% D.T. = 19 min. -41.2
				100	Box 1	Hyd. Press: 700 PSI H20 Return: 0% RQD = 0% D.T. = 26 min. -44.0
			Fragmented: 3.5 - 5.8, 6.8 - 9.3 ft. 5.8 - 6.8 ft, highly wea., soft to mod. hard, sandy. Low angle irregular breaks: 9.3, 9.8 ft.	75		Hyd. Press: 700 PSI H20 Return: 0% RQD = 12.5% D.T. = 36 min. -48.0
-51.0	13.8		10.8 - 13.8, mod. wea., hard to very hard. 10.8 - 11.7, broke core to remove from drill bit. Fragmented: 12.1 - 13.0 ft. Badly broken: 13.0 - 13.8 ft.	60		Hyd. Press: 300 PSI H20 Return: 0% RQD = 44% D.T. = 12 min.
-53.0	15.8		SAND, no recovery		Box 2	-53.0
-53.5	16.3		LIMESTONE, fossiliferous, fine to medium gr., highly vuggy with small to large vugs, some pale yellow, fine crystal coatings, fragmented, lt. gray	17		Hyd. Press: 100 PSI H20 Return: 0% RQD = 0% D.T. = 3 min.
-56.0	18.8		SAND, no recovery			-56.0
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			4"X 5.5'core barrel with diamond bit

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
Miami Harbor Deepening and Widening	CB-MH01-14

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2

1. PROJECT: Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=930247,.53 Y=521787,.70	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. (As shown on drawing title and file number): CB-MH01-15	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 1 undisturbed: 0
5. NAME OF DRILLER: Pickett	14. TOTAL NUMBER OF CORE BOXES: 2 of 2
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 01/30/01 COMPLETED 01/30/01
7. THICKNESS OF BURDEN: 1.5 Ft.	17. ELEVATION TOP OF HOLE: −34.0 Ft.
8. DEPTH DRILLED INTO ROCK: 20.0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 90.5 %
9. TOTAL DEPTH OF HOLE: 21.5 Ft.	19. SIGNATURE OF INSPECTOR: J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/.5'
−34.0	0.0					−34.0	
−35.5	1.5		LIMESTONE, soft to mod. hard, light gray	47	1	SPT −35.5	0 0 27
			LIMESTONE, brown stains, fossiliferous, mod. to highly wea., hard, fragmented, lt. gray 2.0 − 3.2 ft, moderately hard, badly broken. 3.2 − 4.0 ft, hard to very hard, highly pitted, vuggy, fragmented.	100	Box 1	Hyd. Press: 500 PSI H20 Return: 0% RQD = 42.9% D.T. = 20 min. −39.0	
			Low angle irregular breaks: 4.0, 4.2, 4.4, 4.7 ft. 5.7 − 10.7 ft, hard to very hard, some vugs, fragmented.	100		Hyd. Press: 700 PSI H20 Return: 0% RQD = 76.6 D.T. = 17 min. −43.7	
			10.7 − 13.6 ft, lt. grayish brown, mod. wea., very hard, highly porous, pitted, mod. vuggy. Low angle slightly irregular breaks: 10.7, 11.1, 11.8, 12.3, 12.4, 12.7, 13.1 ft. Fragmented: 13.1 − 13.6 ft, 17.3 − 17.4 ft, 17.8 − 21.5 ft.	67		Hyd. Press: 400 PSI H20 Return: 0% RQD = 55.2% D.T. = 11 min. −49.5	
			15.5 − 16.8 ft, highly wea., mod. hard, fragmented. 16.8 − 17.3 ft, mod. wea., mod. vuggy, very hard.	100	Box 2	Hyd. Press: 500 PSI H20 Return: 0% RQD = 43.5% D.T. = 10 min. −51.8	
−55.5	21.5		17.3 − 17.8 ft, highly vuggy with large vugs, hard to very hard. Low angle open joints, 16.8, 17.3 ft. Machine breaks: 17.3, 17.4, 17.8 ft. 17.8 − 21.5 ft, hard.	100		Hyd. Press: 500 PSI H20 Return: 0% RQD = 10.8% D.T. = 10 min. −55.5	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

(continued)

Hole No.CB-MH01-15

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE -34.0 Ft.	SHEET 2 OF 2
PROJECT Miami Harbor Deepening and Widening	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.). 4"X 5.5' core barrel with diamond bit.	

Scale: -22.5, -25, -27.5, -30, -32.5, -35, -37.5, -40, -42.5, -45, -47.5, -50

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PROJECT	HOLE NUMBER
Miami Harbor Deepening and Widening	CB-MH01-15

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 2
1. PROJECT Miami Harbor Deepening and Widening		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) X=929,753 Y=521,634		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW, Horizontal Datum: NAD83, FLE	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title and file number) CB-MH01-16		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 3 undisturbed: 0	
5. NAME OF DRILLER Pickett		14. TOTAL NUMBER OF CORE BOXES 2 of 2	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 01/29/01 COMPLETED 01/29/01	
7. THICKNESS OF BURDEN 4.2 Ft.		17. ELEVATION TOP OF HOLE -33.6 Ft.	
8. DEPTH DRILLED INTO ROCK 16.3 Ft.		18. TOTAL CORE RECOVERY FOR BORING 68.7 %	
9. TOTAL DEPTH OF HOLE 20.5 Ft.		19. SIGNATURE OF INSPECTOR J. Arthur, PG	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/.5'
-33.6	0.0					-33.6	
-35.1	1.5		SILT, lean, some fine sand, gray. (ML)	40	1	SPT -35.1	0, 0, 1
-36.6	3.0		Silty SAND, fine to medium grained, trace limestone, lt. gray. (SM)	73	2	SPT -36.6	0, 6, 13
-37.8	4.2		LIMESTONE, mod. hard, some fine sand, lt. gray	92	3	SPT -37.8	10, 64, 36
			LIMESTONE, sandy, highly wea., soft to mod. hard, gray Poorly cemented, badly broken: 4.2 - 4.6 ft. Fossiliferous, mod. to highly wea., hard to very hard, mod. vuggy at 4.6 ft. Fragmented: 4.6-5.2, 6.2-7.0, 8.1-8.4, 10.9-11.0 ft. 7.7-11.0 ft, highly vuggy, very hard, brown stains. Low angle irregular breaks: 7.0, 7.3, 7.7, 8.1, 8.4, 9.1, 9.6, 10.5, 10.9 ft.	100	Box 1	HP: 400 PSI, H20 Ret.: 0% RQD = 60%, D.T.= 5 min -38.8	
				100		Hyd. Press: 850 PSI H20 Return: 80% RQD = 77.5% D.T. = 15 min. -40.6	
				100		Hyd. Press: 350 PSI H20 Return: 0% RQD = 77.5% D.T. = 19 min. -44.6	
-48.6	15.0		11.0 - 11.2 ft, lt. brownish gray, mod. wea., highly porous and pitted, few small vugs. 11.2 - 11.5 ft, lt. gray, highly wea., soft to mod. hard, badly broken. Very hard, mod. vuggy at 11.5 Fragmented: 11.5 - 11.9, 12.3 - 12.5, 16.2 - 16.8, 17.3 - 18.5 ft. Low angle irregular breaks: 11.9, 12.3 ft.	30		Hyd. Press: 350 PSI H20 Return: 0% RQD = 24% D.T. = 10 min	
-49.6	16.0		SAND, no recovery			-49.6	
			LIMESTONE, ft, hard to very hard, mod. vuggy, highly pitted, mod. wea., lt. gray 16.8 - 17.3 ft, highly wea., mod. hard to hard, badly broken.	100	Box 2	Hyd. Press: 400 PSI H20 Return: 0% RQD = 40% D.T. = 13 min. -52.1	
-54.1	20.5			15		Hyd. Press: 450 PSI H20 Return: 0% RQD = 15% D.T. = 6 min. -54.1	
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT	HOLE NUMBER
Miami Harbor Deepening and Widening	CB-MH01-16

Hole No.CB-MH01-16

DRILLING LOG (Cont. Sheet)	ELEVATION TOP OF HOLE -33.6 Ft.	SHEET 2 OF 2
PROJECT Miami Harbor Deepening and Widening	INSTALLATION Jacksonville District	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.). 4"X 5.5' core barrel with diamond bit. Used Modified RQD. Rock sections less than 4" were counted if they were part of a hard rock area broken because of vugs.	

22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50

Hole No.CB-MH01-17

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2

1. PROJECT: Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION *(Coordinates or Station)*: X=929,714 Y=522,721	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*: MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. *(As shown on drawing title and file number)*: CB-MH01-17	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
5. NAME OF DRILLER: Pickett	14. TOTAL NUMBER OF CORE BOXES: 2 of 2
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 02/25/01 COMPLETED 02/26/01
7. THICKNESS OF BURDEN: 0.0 Ft.	17. ELEVATION TOP OF HOLE: -33.0 Ft.
8. DEPTH DRILLED INTO ROCK: 22.5 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 64 %
9. TOTAL DEPTH OF HOLE: 22.5 Ft.	19. SIGNATURE OF INSPECTOR: J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-33.0	0.0					-33.0	
			LIMESTONE, mod. hard, some sand, lt. gray	20	1	SPT; -34.5	10, 10, 11
-36.0	3.0			33	2	SPT; -36.0	15, 14, 26
			LIMESTONE, fossiliferous, mod. to highly wea., mod. hard to hard, highly vuggy with small to large vugs, lt. gray lt. brown, highly wea. at 2.9 ft. 2.9-4.7 ft., poorly cemented, badly broken. 4.7 - 8.7 ft, lt. yellow brown stains. 4.7 - 6.7 ft, mod. hard to hard, badly broken.	100		Hyd. Press: 700 PSI H20 Return: 0% RQD = 16% D.T. = 36 min. -40.5	23, 16, 23, 20, 30, 70
			6.7 - 7.5 ft, fragmented, hard. 7.5 - 8.7 ft, lt. gray, some lt. brown stains. 7.5 - 7.9 ft, mod. wea., hard to very hard fragments. 7.9 - 8.7 ft, poorly cemented, badly broken. Fragmented: 8.7-10.0, 10.5-11.2, 11.6-12.5 ft. 8.7-12.5 ft, lt. brown fine crystal coatings.	100		Hyd. Press: 700 PSI H20 Return: 0% RQD = 32% D.T. = 13 min. -45.5	
-48.0	15.0		Fragmented: 12.5 - 15.0 ft. 12.5 - 13.0 ft, hard to very hard. 13.0 - 15.0 ft, highly wea.	50		Hyd. Press: None H20 Return: 0% RQD = 10% D.T. = 5 min.	
-50.5	17.5		SAND, no recovery			-50.5	
-50.8	17.8		LIMESTONE, fossiliferous, mod. to highly wea., very hard, highly pitted, few small to large vugs, lt. gray				
-55.5	22.5		SAND, no recovery	67		Hyd. Press: 200 PSI H20 Return: 0% RQD = 6% D.T. = 4 min. -55.5	
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE	SHEET 2 OF 2
-33.0 Ft.	

PROJECT	INSTALLATION
Miami Harbor Deepening and Widening	Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
						-55.5	
			Notes: 1. Soils are field visually classified in accordance with the Unified Soils Clasification System.			140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.). 4"X 5.5' core barrel with diamond bit Hole terminated at -40.4. SPT first 6.0'. Drilled next day from -33.0 to -55.5. Cored after first 3.0'. Second setup X=929,714 Y=522,724	

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

Hole No. CB-MH89-69

DRILLING LOG

Field	Entry
DIVISION	South Atlantic
INSTALLATION	Jacksonville District
SHEET	1 OF 2 SHEETS
1. PROJECT	Miami Harbor Deepening
2. LOCATION (Coordinates or Station)	x = 774,020 y = 522,147
3. DRILLING AGENCY	Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number)	CB-MH89-69
5. NAME OF DRILLER	R. Gordon
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	22.5'
10. SIZE AND TYPE OF BIT	See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MLW
12. MANUFACTURER'S DESIGNATION OF DRILL	Failings 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: — UNDISTURBED: —
14. TOTAL NUMBER CORE BOXES	2
15. ELEVATION GROUND WATER	Tidal
16. DATE HOLE	STARTED 9-28-89 COMPLETED 9-28-89
17. ELEVATION TOP OF HOLE	-27.5
18. TOTAL CORE RECOVERY FOR BORING	66 %
19. SIGNATURE OF INSPECTOR	Geologist, Joe Gentile

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL
-27.5	0.0					-27.5 BLS/0.5'
-28.2	0.7		SAND, fine to medium quartz, shelly, gray (SP)	88	1 2	Split Spoon Settled 2 -29.0 4
-29.0	1.5		LIMESTONE, tan, soft, weathered, loosely cemented seams with compacted calcareous silt from -30.5 to -33.5	80	-	-29.5 " 9
-30.5	3.0			100	-	DIA 4" x 5-1/2" D.T. 7 min H.P. 20 psi -30.5
				0	-	DIA 4" x 5-1/2" D.T. 5 min H.P. 20 psi
-33.5	6.0		moderately hard, porous permeable, riddled with solution holes, fossiliferous, tan, massive from -33.5 to -35.5	60	4	-33.5 Split Spoon 10 5 -35.0 9
-35.5	8.0			100	5	-35.5 " 25
			LIMESTONE, very hard, crystalline, dense, solid, solid core, few fossils	100	-	DIA 4" x 5-1/2" D.T. 58 min H.P. 60 psi -39.5
			Many large open solution holes lined with calcite crystals, tan, massive, solid core from -36.3 to -37.5	100	-	DIA 4" x 5-1/2" D.T. 18 min H.P. 75 psi -41.5
			riddled with large open solution holes from -37.5 to -41.5	73	-	DIA 4" x 5-1/2" D.T. 32 min H.P. 80 psi -44.5
-45.8	18.3			33	-	DIA 4" x 5-1/2" D.T. 26 min H.P. 30 psi
-47.0	19.5		SANDSTONE, moderately hard			
			SAND, fine to medium quartz, trace silt, tan, wet, a few SANDSTONE lenses (SP)			

DRILLING LOG (Cont Sheet) ELEVATION TOP OF HOLE -27.5 **Hole No.** CB-MH89-69

PROJECT Miami Harbor Deepening | INSTALLATION Jacksonville District | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	[redacted] SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						BIT OR BARREL BLS/0.5'
						-48.5
						Split Spoon 10 11 12
-50.0	22.5			80	6	-50.0
			Soils are field visually classified in accordance with the Unified Soils Classification System. SAMPLE ELEVATION / LABORATORY ANALYSIS -48.5 to -50.0 (SP) * NOTE: * Visual classification based on Gradation Curve. No Atterberg Limits.			140# hammer with 30" drop used on 2.0' split spoon (1 3/8" I.D. x 2"O.D.)

Hole No.CB-MH-95-1

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 1

1. PROJECT: Miami Harbor Deepening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=770,027 Y=524,555	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 314
4. HOLE NO. (As shown on drawing title and file number): CB-MH-95-1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
5. NAME OF DRILLER: C. Robbins	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED	15. ELEVATION GROUND WATER: Tidal
	16. DATE HOLE: STARTED 4/24/95 COMPLETED 4/24/95
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: -21.0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 58 %
9. TOTAL DEPTH OF HOLE: 21.7 Ft.	19. SIGNATURE OF GEOLOGIST: J.Aurthur

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ 1'
-21.0	0.0					-21.0	
-25.3	4.3		CLAY, silty, fat, some fine quartz sand, gray (CH) Soils are field visually classified in accordance with the Unified soils Classification System 140 # Hammer with 30 inch drop used used on 2' Split Spoon (1 3/8" I.D. X 2" O.D.)		1	SPLIT SPOON -25.3	SETTLED
			LIMESTONE, moderately hard, solution riddled, silt and sand (quartz) filled cavities, light gray		2	SPLIT SPOON -26.8	27
-28.3	7.3				3	SPLIT SPOON -28.3	14
-31.3	10.3	CAVIT	open cavity from -28.3 to -31.3			SPLIT SPOON -31.3	DROPPED
			LIMESTONE, very hard, fossiliferous, highly pitted and vuggy with small to large vugs, moderately weathered, light gray to white, fraactured and broken zones	100		DIA 4 X 5 1/2 D.T. 13 MIN H.P. 110 PSI -32.4	
				24		DIA 4 X 5 1/2 D.T. 40 MIN H.P. 100 PSI -36.6	
			SAMPLE ELEVATION -24.3/-28.9 LABORATORY ANALYSIS (ML)* NOTE: *Visual classification based on grain size curve no Atterberg Limits.	31		DIA 4 X 5 1/2 D.T. 21 MIN H.P. 100 PSI -40.5	
				63		D.T. 20 MIN H.P. 100 PSI -41.3	
-42.7	21.7			100		DIA 4 X 5 1/2 D.T. 45 MIN H.P. 120 PSI -42.7	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-MH-95-2

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1
1. PROJECT Miami Harbor Deepening		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) X=769,993 Y=523,885		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314	
4. HOLE NO. (As shown on drawing title and file number) CB-MH-95-2		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0	
5. NAME OF DRILLER C. Robbins		14. TOTAL NUMBER OF CORE BOXES 1	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER Tidal	
		16. DATE HOLE STARTED 4/25/94 COMPLETED 4/25/94	
7. THICKNESS OF BURDEN 0 Ft.		17. ELEVATION TOP OF HOLE -24.3 Ft.	
8. DEPTH DRILLED INTO ROCK 0 Ft.		18. TOTAL CORE RECOVERY FOR BORING 35 %	
9. TOTAL DEPTH OF HOLE 10.9 Ft.		19. SIGNATURE OF GEOLOGIST J.Aurthur	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
-24.3	0.0					-24.3	SETTLED
			CLAY, silty, fat, some fine quartz sand, gray (CH)		1	SPLIT SPOON	
-28.9	4.6		LIMESTONE, moderately hard, solution riddled, silt and sand (quartz) filled cavities, light gray			-28.9	
-29.4	5.1			100	2	-29.4 SPLIT SPOON	7
			LIMESTONE, moderately hard to hard, fossiliferous, highly pitted and vuggy with small to large vugs, moderately weathered, light gray to badly broken from -29.4 to -30.7 fragmented from -30.7 to -31.4	19		DIA 4 X 5 1/2 D.T. 13 MIN H.P. 110 PSI -30.7	
				0		DIA 4 X 5 1/2 D.T. 40 MIN H.P. 100 PSI	
-35.2	10.9					-35.2	
			Note: Soils are field visually classified in accordance with the Unified Soils Classification.			140# Hammer with 30" drop used on 2' Splitspoon (1 3/8 I.D. X 2" O.D.)	

Scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT	HOLE NUMBER
Miami Harbor Deepening	CB-MH-95-2

Hole No.CB-MH-95-3

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 1
1. PROJECT: Miami Harbor Deepening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=770,366 Y=524,111	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 314
4. HOLE NO. (As shown on drawing title and file number): CB-MH-95-3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
5. NAME OF DRILLER: C. Robbins	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: Tidal
	16. DATE HOLE: STARTED 5/4/94 COMPLETED 5/4/94
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: -26.7 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 88 %
9. TOTAL DEPTH OF HOLE: 16.1 Ft.	19. SIGNATURE OF GEOLOGIST: J.Aurthur

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel
-26.7	0.0					-26.7
			LIMESTONE, very hard fossiliferious, broken, moderately weathered, and vuggy gray to light gray	100		DIA 4 X 5 1/2 D.T. 28 MIN H.P. 80 PSI -29.7
				100		DIA 4 X 5 1/2 D.T. 18 MIN H.P. 80 PSI -31.7
				100		DIA 4 X 5 1/2 D.T. 15 MIN H.P. 80 PSI -34.7
				49		DIA 4 X 5 1/2 D.T. 10 MIN H.P. 80 PSI -38.6
				100		DIA 4 X 5 1/2 D.T. 16 MIN H.P. 100 PSI -41.9
-42.8	16.1			100		D.T. 19 MIN H.P. 110 -42.8

Scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT	HOLE NUMBER
Miami Harbor Deepening	CB-MH-95-3

Hole No.CB-MH-95-4

DRILLING LOG

- DIVISION: South Atlantic
- INSTALLATION: Jacksonville District
- SHEET 1 OF 1
- 1. PROJECT: Miami Harbor Deepening
- 2. LOCATION (Coordinates or Station): X=770,518 Y=523,584
- 3. DRILLING AGENCY: Corps of Engineers
- 4. HOLE NO. (As shown on drawing title and file number): CB-MH-95-4
- 5. NAME OF DRILLER: C. Robbins
- 6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
- 7. THICKNESS OF BURDEN: 0 Ft.
- 8. DEPTH DRILLED INTO ROCK: 0 Ft.
- 9. TOTAL DEPTH OF HOLE: 19.7 Ft.
- 10. SIZE AND TYPE OF BIT: See Remarks
- 11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW
- 12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 314
- 13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
- 14. TOTAL NUMBER OF CORE BOXES: 2
- 15. ELEVATION GROUND WATER: Tidal
- 16. DATE HOLE: STARTED 5/3/95 COMPLETED 5/3/95
- 17. ELEVATION TOP OF HOLE: -23.7 Ft.
- 18. TOTAL CORE RECOVERY FOR BORING: 88 %
- 19. SIGNATURE OF GEOLOGIST: J.Aurthur

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/1'
-23.7	0.0					-23.7	
			CLAY, silty, fat, trace fine sand and small shell fragments, gray (CH) Soils field visually classified in accordance with the Unified Soils Classification System 140 # Hammer with 30 inch drop used on 2' Split Spoon (1 3/8" I.D. X 2' O.D.)		1	SPLIT SPOON	SETTLED
-28.4	4.7					-28.4	
			LIMESTONE, moderately hard, fossiliferous, moderately to highly weathered, highly pitted and vuggy with small to large vugs, badly broken, some silt and clay, light gray to white	100		DIA 4 X 5 1/2 D.T. 21 MIN H.P. 80 PSI -29.9	
				100		DIA 4 X 5 1/2 D.T. 12 MIN H.P. 100 PSI -31.8	
				59		DIA 4 X 5 1/2 D.T. 25 MIN H.P. 100 PSI -34.0	
-35.4	11.7						
			LIMESTONE, very hard, moderately weathered, moderately vuggy, fragmented and broken zones, gray	42		DIA 4 X 5 1/2 D.T. H.P. 100 PSI -37.8	
				100		DIA 4 X 5 1/2 D.T. 16 MIN H.P. 80 -39.4	
				100		DIA 4 X 5 1/2 D.T. 27 MIN H.P. 80 -41.7	
				100		DIA 4 X 5 1/2 D.T. 10 MIN H.P. 80 -43.4	
-43.4	19.7						
			SAMPLE -23.7/-28.4 LABORATORY (SM)* NOTE: *Visual classification based on grain size curve No Atterberg Limits.				

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-MH-95-5

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1
1. PROJECT Miami Harbor Deepening		10. SIZE AND TYPE OF BIT See Remarks	
2. LOCATION (Coordinates or Station) X=770,938 Y=524,170		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW	
3. DRILLING AGENCY Corps of Engineers		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314	
4. HOLE NO. (As shown on drawing title and file number) CB-MH-95-5		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0	
5. NAME OF DRILLER C. Robbins		14. TOTAL NUMBER OF CORE BOXES 2	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		15. ELEVATION GROUND WATER Tidal	
		16. DATE HOLE STARTED 5/5/95 COMPLETED 5/5/95	
7. THICKNESS OF BURDEN 0 Ft.		17. ELEVATION TOP OF HOLE -25.2 Ft.	
8. DEPTH DRILLED INTO ROCK 0 Ft.		18. TOTAL CORE RECOVERY FOR BORING 81 %	
9. TOTAL DEPTH OF HOLE 17.8 Ft.		19. SIGNATURE OF GEOLOGIST J.Aurthur	

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ 1'
-25.2	0.0					-25.2	
			CLAY, silty, fat, trace fine sand, gray (CH) Soils are field visually classified in accordance with the Unified Soils Classification System 140 # Hammer with 30 inch drop used on 2' Split Spoon (1 3/8" I.D. X 2" O.D.)		1	SPLIT SPOON	SETTLED
-29.5	4.3					-29.5	
			LIMESTONE, hard, fossiliferous, moderately to highly weathered highly pitted and vuggy with small to large vugs, badly broken and fragmented, light gray to white	100		DIA 4 X 5 1/2 D.T. 13 MIN H.P. 100 PSI	
						-31.4	
						DIA 4 X 5 1/2 D.T. 10 MIN H.P. 100 PSI	
-34.0	8.8		Cavity	52			
-36.4	11.2					-36.4	
			LIMESTONE, very hard, slightly to moderately weathered, moderately to highly pitted and vuggy, light gray to white	100		DIA 4 X 5 1/2 D.T. 21 H.P. 100 PSI	
						-39.4	
				100		DIA 4 X 5 1/2 D.T. 33 MIN H.P. 80	
-43.0	17.8					-43.0	
			SAMPLE LABORATORY -25.2/-29.5 (ML)* NOTE: *Visual classification based on grain size curve No Atterberg Limits.				

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-MH-95-6

DRILLING LOG

DIVISION: South Atlantic	INSTALLATION: Jacksonville District — SHEET 1 OF 1
1. PROJECT: Miami Harbor Deepening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=770,887 Y=523,782	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 314
4. HOLE NO. (As shown on drawing title and file number): CB-MH-95-6	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
5. NAME OF DRILLER: C. Robbins	14. TOTAL NUMBER OF CORE BOXES: 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER: Tidal
	16. DATE HOLE: STARTED 5/7/95 COMPLETED 5/7/95
7. THICKNESS OF BURDEN: 0 Ft.	17. ELEVATION TOP OF HOLE: -28.7 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 57 %
9. TOTAL DEPTH OF HOLE: 14.4 Ft.	19. SIGNATURE OF GEOLOGIST: J.Aurthur

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/1'
-28.7	0.0					-28.7	
-31.8	3.1		CLAY, silty, fat, some fine quartz sand, gray (CH) Soils are field visually classified in accordance with the Unified Soils Classification System 140 # Hammer with 30 inch drop used on 2' Split Spoon (1 3/8" I.D. X 2" O.D.)		1	SPLIT SPOON -31.8	SETTLED
			LIMESTONE, hard, fossiliferous, highly pitted and vuggy with small to large vugs, moderately to highly weathered, badly broken zones, light gray to white from -38.1 to -38.7 very hard, slightly to moderately weathered, slightly to moderately pitted, moderately vuggy with small to large vugs	42		DIA 4 X 5 1/2 D.T. 24 MIN H.P. 80 -35.4	
				41		DIA 4 X 5 1/2 D.T. 10 MIN H.P. 80 PSI -37.6	
-38.7	10.0					DIA 4 X 5 1/2 D.T. 14 MIN H.P. 100 PSI	
-41.0	12.3		SANDSTONE, very hard, fine grained, some fossils, slightly to moderately weathered, highly vuggy with large to small vugs. badly broken, gray	56		-41.0	
-43.1	14.4		LIMESTONE, very hard, highly porous, pitted and vuggy, with small to large vugs, moderately weathered, fossiliferous, light gray to gray from -41.9 to -42.5, hard, highly weathered, badly broken	100		DIA 4 X 5 1/2 D.T. 12 MIN H.P. 100 -43.1	

Scale (ft): 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Soils are field visually classified in accordance with the Unified Soils Classification System

SAMPLE ELEVATION	LABORATORY ANALYSIS
-28.7/-31.8	(SM)*

NOTE:
*Visual classification on grain size curve
No Atterberg Limits.

REMARKS: 140 # Hammer with 30 " drop used on 2' Split Spoon (1 3/8" I.D. X 2"O.D.)

Hole No.CB-MH-95-7

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

SHEET 1 OF 1

1. PROJECT: Miami Harbor Deepening
2. LOCATION (Coordinates or Station): X=771,323 Y=523,803
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-MH-95-7
5. NAME OF DRILLER: C. Robbins
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 18.2 Ft.
10. SIZE AND TYPE OF BIT: See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 314
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 2
15. ELEVATION GROUND WATER: Tidal
16. DATE HOLE: STARTED 5/7/95 COMPLETED 5/7/95
17. ELEVATION TOP OF HOLE: -25.4 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 58 %
19. SIGNATURE OF GEOLOGIST: J.Aurthur

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/1'
-25.4	0.0					-25.4	
			CLAY, silty, fat, some fine quartz sand, gray (CH)		1	SPLIT SPOON	SETTLED
-29.2	3.8		LIMESTONE, hard, fossiliferous, highly weathered, highly pitted and vuggy with small to large vugs, badly broken, gray			-29.2	
-29.8	4.4		CLAY, fat, some limestone fragments, greenish gray (CH)	37		DIA 4 X 5 1/2 D.T. 7 MIN H.P. 80 PSI	
-31.0	5.6		LIMESTONE, very hard, fossiliferous, moderately weathered, slightly pitted, a few small to large vugs, gray from - 34.0 to -34.2 fragmented			-34.0	
			from -34.6 to -34.8 moderately to highly weathered, moderately hard, badly broken, low angle breaks	100		DIA 4 X 5 1/2 D.T. 8 MIN H.P. 80 PSI	
-35.7 / -35.9	10.3 / 10.5		SANDSTONE, very hard, fine grained, some fossils, highly vuggy with small to large vugs, moderately weathered, gray from -35.7 to -35.9			-35.7	
			LIMESTONE, very hard, some fine quartz sand, moderately weathered, fossiliferous, moderately to highly pitted and vuggy with small to large vugs, gray from -36.1 to -39.9 light gray to white, low angle breaks	81		DIA 4 X 5 1/2 D.T. 17 MIN H.P. 100 PSI	
			from -40.9 to -43.6 light gray to gray, moderately to highly weathered, highly pitted and vugy with large to small vugs, some light yellow coating inside vugs, low angle breaks	56		-40.9 DIA 4 X 5 1/2 D.T. 10 MIN H.P. 100 PSI	
-43.6	18.2					-43.6	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Soils field visually classificated in accordance with the Unified Soils Classification System

SAMPLE	LABORATORY
-25.4/-27.2	(SM)*

NOTE:*Visual classification based on grain size curve No Atterberg Limits.

140 # Hammer with 30" drop used on 2' Split Spoon (1 3/8" I.D. x 2" O.D.)

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PROJECT: Miami Harbor Deepening

HOLE NUMBER: CB-MH-95-7

Hole No.CB-MH-95-8

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1

1. PROJECT Miami Harbor Deepening	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=771,675 Y=523,377	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MLW
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 314
4. HOLE NO. (As shown on drawing title and file number) CB-MH-95-8	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER C. Robbins	14. TOTAL NUMBER OF CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER Tidal
	16. DATE HOLE STARTED 4/26/95 COMPLETED 4/26/95
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE -22.6 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 70 %
9. TOTAL DEPTH OF HOLE 20.8 Ft.	19. SIGNATURE OF GEOLOGIST J.Aurthur

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ 1'
-22.6	0.0					-22.6	
			CLAY, silty, fat, trace fine sand & small shell fragments, gray (CH) Soils are field visually classified in accordance with the Unified soils Classification System 140 # Hammer with 30 inch drop used on 2' Split Spoon (1 3/8" I.D. X 2" O.D.)		1	SPLIT SPOON	SETTLED
-28.1	5.5					-28.1	
			LIMESTONE, moderately hard, solution riddled, silt and sand (quartz) filled cavities, gray to white		2	SPLIT SPOON -29.6	12
					3	SPLIT SPOON	23
-31.1	8.5					-31.1	
			LIMESTONE, hard, fossiliferous, highly pitted and vuggy with small to large vugs, moderately to highly weathered, fractured and broken zones, gray to white	70		DIA 4 X 5 1/2 D.T. 21 MIN H.P. 40 PSI -32.8	
				100		D.T. 15 MIN H.P. 100 PSI -33.9	
				100		D.T. 13 MIN H.P. 40 PSI -34.9	
				67		D.T. 18 MIN H.P. 40 PSI -36.7	
				100		D.T. 17 MIN H.P. 80 PSI -37.4	
			SAMPLE ELEVATION -22.6/-28.1 LABORATORY ANALYSIS (ML)* NOTE: *Visual classification based on grain size curve No Atterberg Limits	71		DIA 4 X 5 1/2 D.T. 19 MIN H.P. 80 PSI -40.9	
				60		DIA 4 X 5 1/2 D.T. 15 MIN H.P. 100 PSI	
-43.4	20.8					-43.4	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-MH01-18

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2

1. PROJECT: Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=927,151 Y=523,629	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. (As shown on drawing title and file number): CB-MH01-18	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 6 undisturbed: 0
5. NAME OF DRILLER: Pickett	14. TOTAL NUMBER OF CORE BOXES: 2 of 2
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED 03/03/01 COMPLETED 03/03/01
7. THICKNESS OF BURDEN: 16.5 Ft.	17. ELEVATION TOP OF HOLE: -7.3 Ft.
8. DEPTH DRILLED INTO ROCK: 31.8 Ft.	18. TOTAL CORE RECOVERY FOR BORING: %
9. TOTAL DEPTH OF HOLE: 48.3 Ft.	19. SIGNATURE OF INSPECTOR: J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-7.3	0.0					-7.3	
			Silty SAND, fine to medium grained, thin layer oflimestone, gray (SM)	22	1	SPT; -13.1	WOH, WOH, WOH, WOH, WOH, WOH, WOH, WOH, WOH, WOH, WOH, WOH
-17.1	9.8		No recovery from 5.8 - 9.8 ft.	0		-17.1	
			LIMESTONE, mod. hard, some fine to medium grained sand, calcareous, lt. gray	73	2	SPT; -18.6	4, 12, 16
				27	3	SPT; -20.1	7, 6, 7
-21.6	14.3			27	4	SPT; -21.6	5, 5, 9
			Silty SAND, fine grained, trace of fine limestone gravel, calcareous, light gray. (SM)	20	5	SPT; -23.1	9, 14, 11
-23.8	16.5			20	6	SPT; -23.8	16, 45
			LIMESTONE, fossiliferous, mod. to highly wea., vuggy, hard, lt. gray 18.1 - 19.5 ft, mod. hard, badly broken, some sand. 19.5 - 21.0 ft. mod. hard to hard, fragmented. Low angular irregular breaks at 17.7, 18.1 ft.	100	Box 1	Hyd. Press: 350 PSI H20 Return: 0% RQD = 55.6% D.T. = 13 min. -28.3	
			21.0 - 21.6 ft, highly wea., mod., hard, badly broken. 21.6 - 24.0 ft, mod. wea., hard to very hard.	100		Hyd. Press: 400 PSI H20 Return: 0% RQD = 74% D.T. = 15 min.	
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

DRILLING LOG (Cont. Sheet) | ELEVATION TOP OF HOLE: -7.3 Ft. | SHEET 2 OF 2

PROJECT: Miami Harbor Deepening and Widening | INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/ .5'
-29.8	22.5						
			24.0 - 26.0 ft, highly wea. 24.0 - 24.7 ft, hard, fragmented. 24.7 - 26.0 ft, soft to mod. hard, some fine to medium silty sand, badly broken. Low angle open joints: 21.6, 22.7, 23.1, 23.5, 23.7, 24.0 ft. 26.0 - 26.8 ft, highly pitted, vuggy, mod hard to hard. Breaks: 26.8, 27.2 ft.	100	Box 1	Hyd. Press: 400 PSI H2O Return: 0% RQD = 74% D.T. = 15 min. -33.3	
-34.5	27.2		SAND, no recovery	24		Hyd. Press: 350 PSI H2O Return: 0% RQD = 8% D.T. = 4 min. -38.3	
-38.3	31.0		Highly wea.: 31.0 - 32.3, 33.0 - 33.3, 35.3 - 35.5 ft. Soft, mod. hard: 31.0 - 32.3, 35.3 - 35.5 ft. Hard to very hard: 32.3 - 33.0, 33.3 - 35.3 ft. Mod. wea.: 32.3 - 33.0, 33.3 - 35.3 ft.	90	Box 2	Hyd. Press: 400 PSI H2O Return: 0% RQD = 54% D.T. = 12 min. -43.3	
			No recovery from 36.0 - 41.0 ft.	0		Hyd. Press: 600 PSI H2O Return: 0% RQD = 0% D.T. = 6 min. -48.3	
-48.3	41.0						

Depth scale: 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Clasification System.

SAMPLE NO.	SAMPLE ELEVATION	LAB CLASS.
1	-7.3/-13.3	SM

*Lab visual classification based on gradation curve. No Atterburg Limits.

140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.).

4" X 5.5' core barrel with diamond bit

Hole No.CB-MH01-19

DRILLING LOG	DIVISION: South Atlantic	INSTALLATION: Jacksonville District	SHEET 1 OF 2

1. PROJECT: Miami Harbor Deepening and Widening	10. SIZE AND TYPE OF BIT: See Remarks
2. LOCATION (Coordinates or Station): X=925,456 Y=524,317	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MLW, Horizontal Datum: NAD83, FLE
3. DRILLING AGENCY: Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. (As shown on drawing title and file number): CB-MH01-19	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 7 undisturbed: 0
5. NAME OF DRILLER: Pickett	14. TOTAL NUMBER OF CORE BOXES: 1 of 1
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER:
	16. DATE HOLE STARTED: 03/04/01 COMPLETED: 03/04/01
7. THICKNESS OF BURDEN: 16.0 Ft.	17. ELEVATION TOP OF HOLE: -6.7 Ft.
8. DEPTH DRILLED INTO ROCK: 8.5 Ft.	18. TOTAL CORE RECOVERY FOR BORING: 31.4 %
9. TOTAL DEPTH OF HOLE: 24.5 Ft.	19. SIGNATURE OF INSPECTOR: J. Arthur, PG

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/.5'
-6.7	0.0					-6.7	
			Silty SAND, fine to medium grained, trace of small shell fragments, calcareous, dark gray. (SM)	73	1	SPT; SPT; -9.7	WOH, WOH, WOH, WOH, WOH, WOH
				93	2	SPT; -11.2	WOH, WOH, WOH
			Trace of decayed wood at 4.5 ft.	40	3	SPT; -12.7	WOH, WOH, 4
			Dark grayish brown, some decayed wood, trace of limestone at 6.0 ft.	47	4	SPT; -14.2	4, 2, 2
-15.7	9.0		Dark brownish gray, no wood, trace of limestone at 7.5 ft.	33	5	SPT; -15.7	WOH, WOH, WOH
			LIMESTONE, soft to mod. hard, some fine to medium sand and small shell fragments, calcareous, white.	20	6	SPT; -17.2	1, 2, 1
-22.7	16.0		No recovery from 10.5 - 14.5 ft.	0		SPT; -21.2	2, WOH, WOH, WOH, WOH, 2
				20	7	SPT; -22.7	6, 6, 12
			LIMESTONE, fossiliferous, mod. to highly wea., highly pitted and vuggy, hard to very hard, lt. gray 16.3 - 17.2, badly broken, low angle breaks: 16.2, 16.3, 17.2, 17.7 ft. No recovery from 17.7 - 24.5	49	Box 1	Hyd. Press: 250 PSI H2O Return: 0% D.T.= 4 min RQD = 25.7% -26.2	
				0		Hyd. Press: 300 PSI H2O Return: 0% D.T. = 7 min RQD = 0%	
						(continued)	

Scale (ft): 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT	HOLE NUMBER
Miami Harbor Deepening and Widening	CB-MH01-19

Hole No.CB-MH01-19

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE: -6.7 Ft.

PROJECT: Miami Harbor Deepening and Widening

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit & Barrel	BLOWS/.5'
-29.2	22.5						
-31.2	24.5			0	Box 1	Hyd. Press: 300 PSI H2O Return: 0% D.T. = 7 min RQD = 0% -31.2	

Notes:

1. Soils are field visually classified in accordance with the Unified Soils Clasification System.

SAMPLE NO.	SAMPLE ELEVATION	LAB CLASS.
1	-6.7/-9.7	SM
2	-11.2/-12.7	SM
3	-12.7/-14.2	SP-SM

*Lab visual classification based on gradation curve. No Atterburg limits.

140# hammer w/30" drop used with 2.0' split spoon (1 3/8" I.D. X 2" O.D.).

4"X 5.5' core barrel with diamond bit.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

SPECIFIC GRAVITY

LAW
LAWGIBB Group Member
3901 Carmichael Avenue
Jacksonville, FL 32207
(904) 396-5173 • (904) 396-5703

Report of Apparent Specific Gravity (ASTM D-5779)

CLIENT: US Army Corp of Engineers **JOB NO.:** 40564-1-4176-02

PROJECT: Miami Harbor Deepening **DATE:** April 27, 2001

Core No.	Elevation (ft-mlw)	Dry Weight	Weight in Water (g)	Specific Gravity
MH01-01	-49.6 / -50.4	2618.1	1391.8	2.135
MH01-13	-42.3 / -43.1	1598.1	903.6	2.301
MH01-18	-29.3 / -30.2	3524.3	2052.3	2.394
MH01-21A	-40.8 / -41.6	2716.1	1481.5	2.200

COMPRESSIVE STRENGTH

LAW
LAWGIBB Group Member
3901 Carmichael Avenue
Jacksonville, FL 32207
(904) 396-5173 • (904) 396-5703

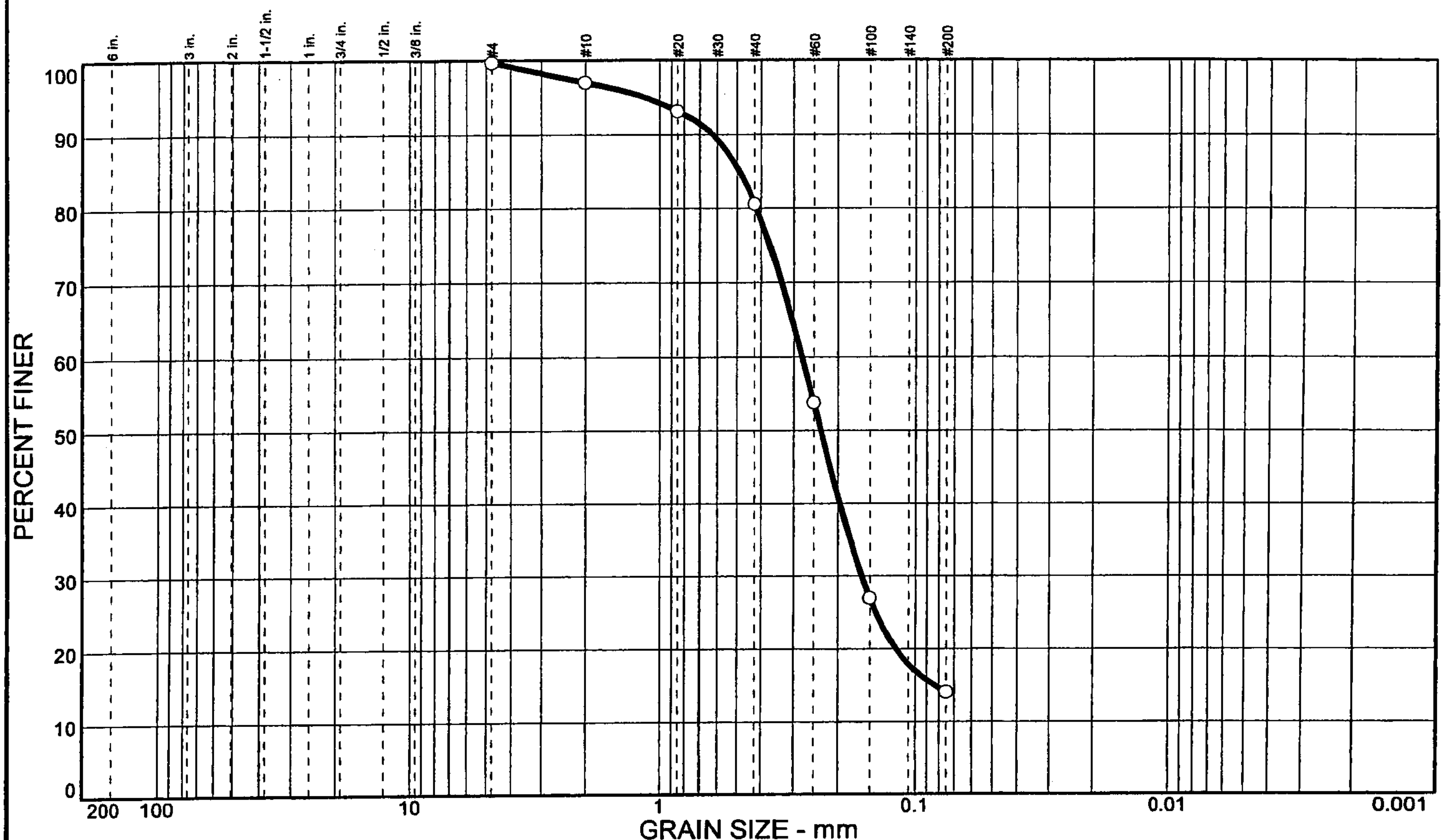
Report of Unconfined Compression Test Results

CLIENT: US Army Corp of Engineers **JOB NO.:** 40564-1-4176-02
PROJECT: Miami Harbor Deepening **DATE:** April 27, 2001

Core No.	Elevation (ft-mlw)	Diameter (inches)	Length (inches)	Area (in^2)	Load (lbs)	Compressive Strength (psi
CBMH01-1	-49.6 / -50.4	3.914	7.595	12.03	8,950	744
CBMH01-12	-44.8 / -45.9	3.955	8.125	12.29	8,050	655
CBMH01-13	-47.3 / -48.1	3.945	7.515	12.22	16,050	1313
CBMH01-18	-29.3 / -30.2	3.932	8.300	12.14	11,600	956
CBMH01-21A	-40.8 / -41.6	3.945	8.075	12.22	5,000	409
CBMH01-21A	-44.4 / -45.6	3.948	8.400	12.24	8,350	682

GRAIN SIZE DISTRIBUTION CURVES

Grain Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○			85.6	14.1		SM	A-2-4(0)		

SIEVE inches size	PERCENT FINER ○		

	GRAIN SIZE		
D_{60}	0.278		
D_{30}	0.161		
D_{10}			

	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	99.7		
#10	97.0		
#20	93.2		
#40	80.6		
#60	53.9		
#100	27.0		
#200	14.1		

SOIL DESCRIPTION

○ SAND, fine quartz, little silt, trace sand-size shell fragments, gray-brown

REMARKS:

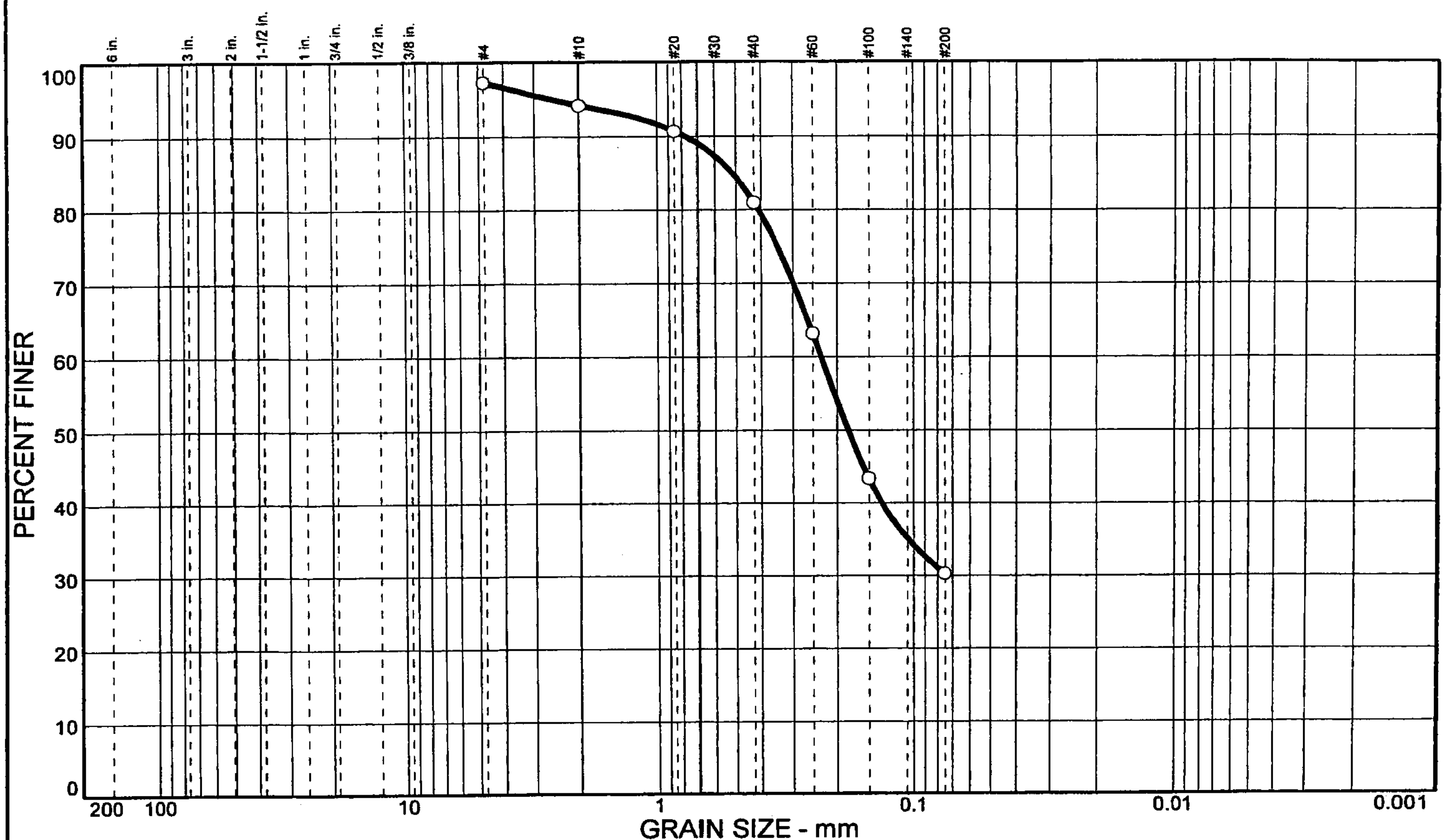
○

○ Source: Boring No. CB-MH01-19 Sample No.: 1 Elev./Depth: -6.7'/-9.7 MLW

Law Engineering and Environmental Services, Inc.

Client: US Army Corp[of Engineers
Project: Miami Harbor Deepening
Project No.: 40564-1-4176-02

Grain Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○			67.0	30.3		SM	A-2-4(0)		

SIEVE inches size	PERCENT FINER ○		
	GRAIN SIZE		
D_{60}	0.231		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	97.3		
#10	94.2		
#20	90.7		
#40	81.0		
#60	63.2		
#100	43.4		
#200	30.3		

SOIL DESCRIPTION

○ SAND, fine quartz, some silt, little fine gravel to medium sand-size shell fragments, gray-brown

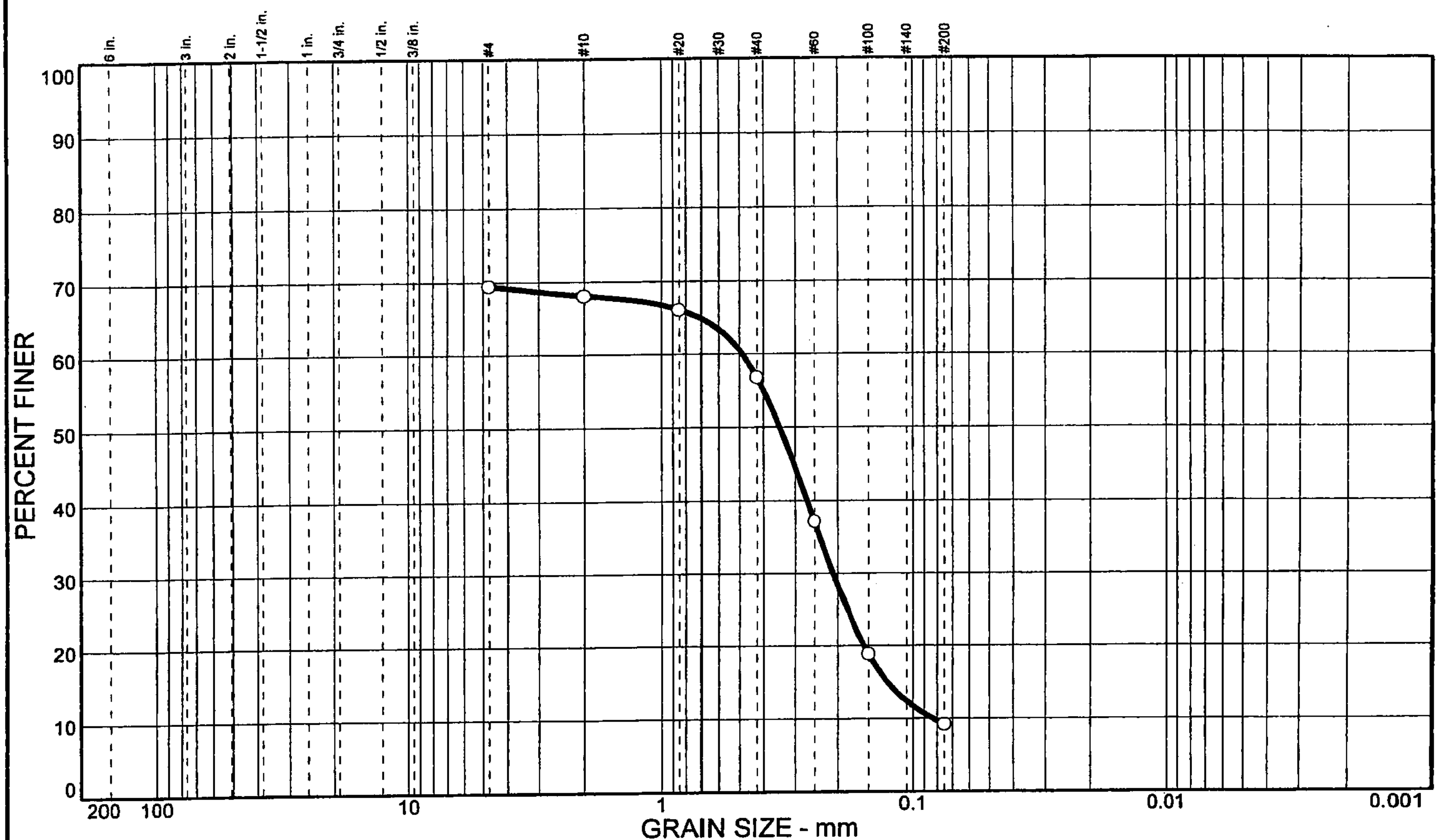
REMARKS:

○

○ Source: Boring No. CB-MH01-19 Sample No.: 2 Elev./Depth: -11.2/-12.7 MLW

Law Engineering and Environmental Services, Inc.	Client: US Army Corp[of Engineers Project: Miami Harbor Deepening Project No.: 40564-1-4176-02

Grain Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○			60.3	9.2		SP-SM	A-3		

SIEVE inches size	PERCENT FINER ○		

	GRAIN SIZE		
D_{60}	0.486		
D_{30}	0.209		
D_{10}	0.0829		

	COEFFICIENTS		
C_c	1.08		
C_u	5.86		

SIEVE number size	PERCENT FINER ○		
#4	69.5		
#10	68.1		
#20	66.1		
#40	56.8		
#60	37.2		
#100	18.9		
#200	9.2		

SOIL DESCRIPTION

○SAND, fine quartz, some gravel size shell and shell fragments, trace silt, brown-black

REMARKS:

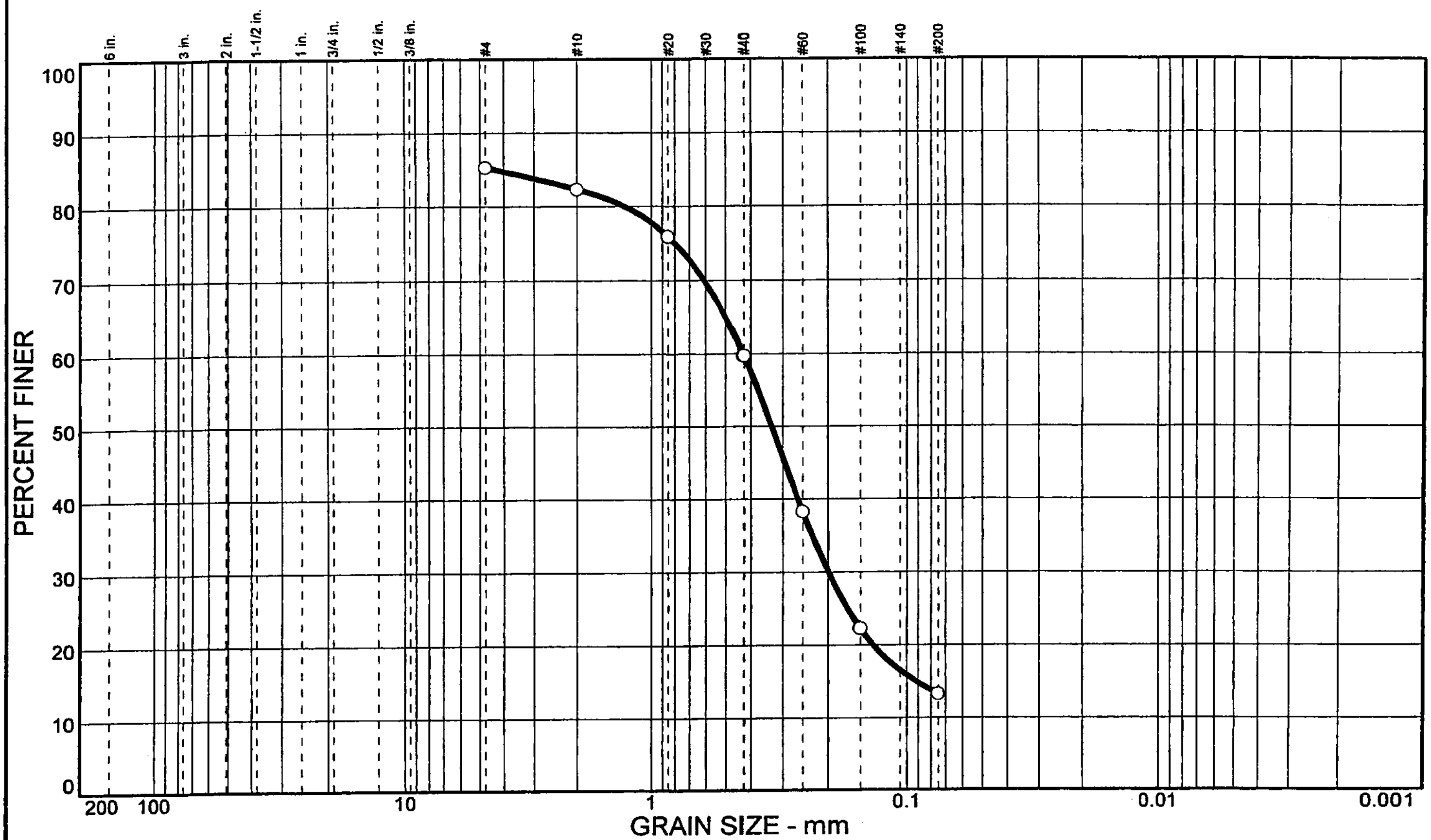
○

○ Source: Boring No. CB-MH01-19 Sample No.: 3 Elev./Depth: -12.7/-14.2 MLW

Law Engineering and Environmental Services, Inc.

Client: US Army Corp[of Engineers
Project: Miami Harbor Deepening
Project No.: 40564-1-4176-02

Grain Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○			72.0	13.3		SM	A-2-4(0)		

SIEVE inches size	PERCENT FINER ○		
	GRAIN SIZE		
D_{60}	0.427		
D_{30}	0.199		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	85.3		
#10	82.3		
#20	75.9		
#40	59.8		
#60	38.3		
#100	22.3		
#200	13.3		

SOIL DESCRIPTION

○ SAND, fine quartz, little gravel to sand-size shell fragments, little silt, gray

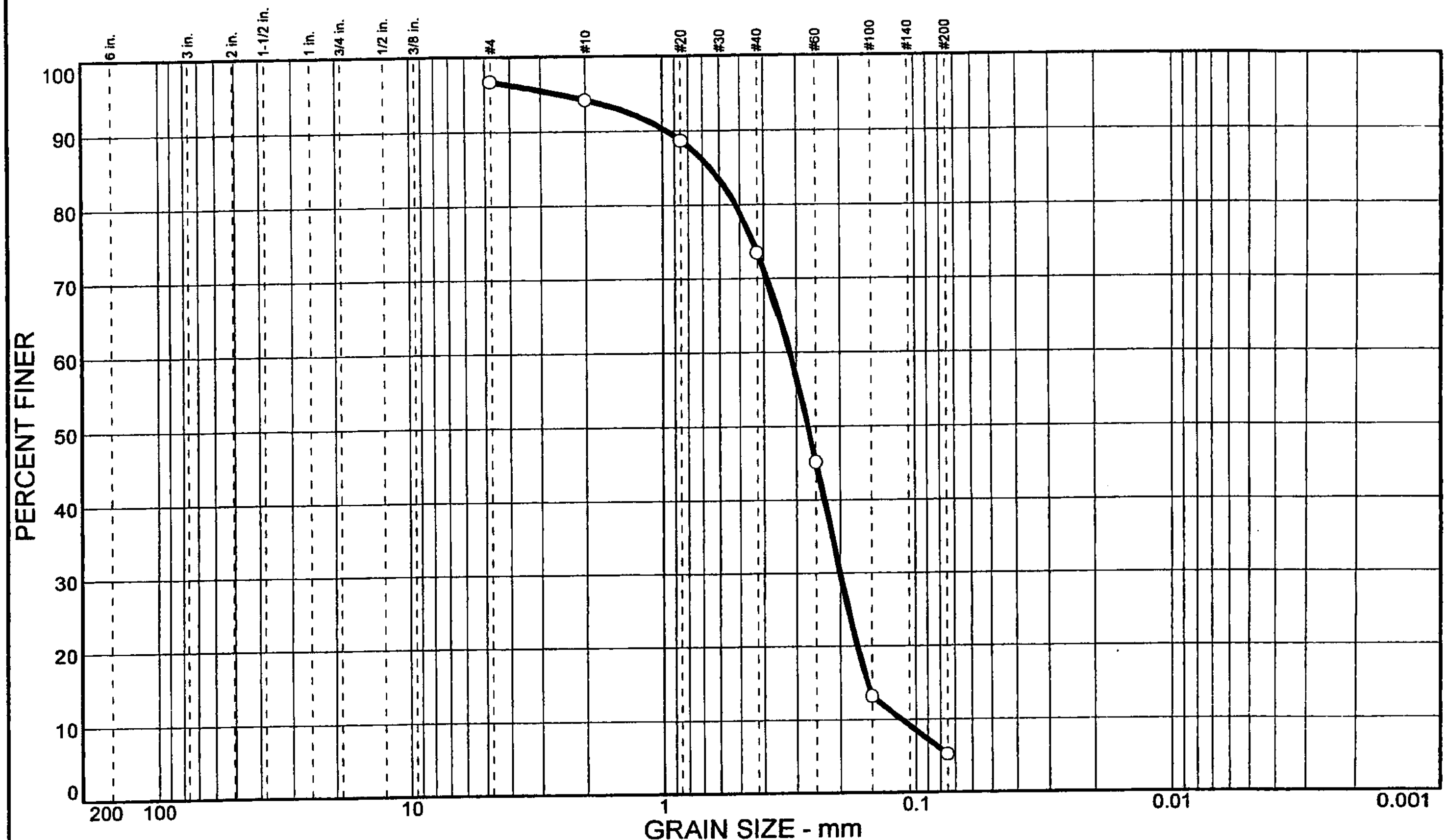
REMARKS:

○

○ Source: Boring No. CB-MH01-18 Sample No.: 1 Elev./Depth: -7.3/-13.3 MLW

Law Engineering and Environmental Services, Inc.	Client: US Army Corp[of Engineers Project: Miami Harbor Deepening Project No.: 40564-1-4176-02

Grain Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○			91.5	5.2		SP-SM	A-3		

SIEVE inches size	PERCENT FINER ○		
	GRAIN SIZE		
D_{60}	0.319		
D_{30}	0.200		
D_{10}	0.114		
	COEFFICIENTS		
C_c	1.11		
C_u	2.80		

SIEVE number size	PERCENT FINER ○		
#4	96.7		
#10	94.2		
#20	88.7		
#40	73.5		
#60	45.2		
#100	13.2		
#200	5.2		

SOIL DESCRIPTION

○ SAND, fine quartz, little fine gravel to sand-size shell fragments, trace silt , gray-brown

REMARKS:

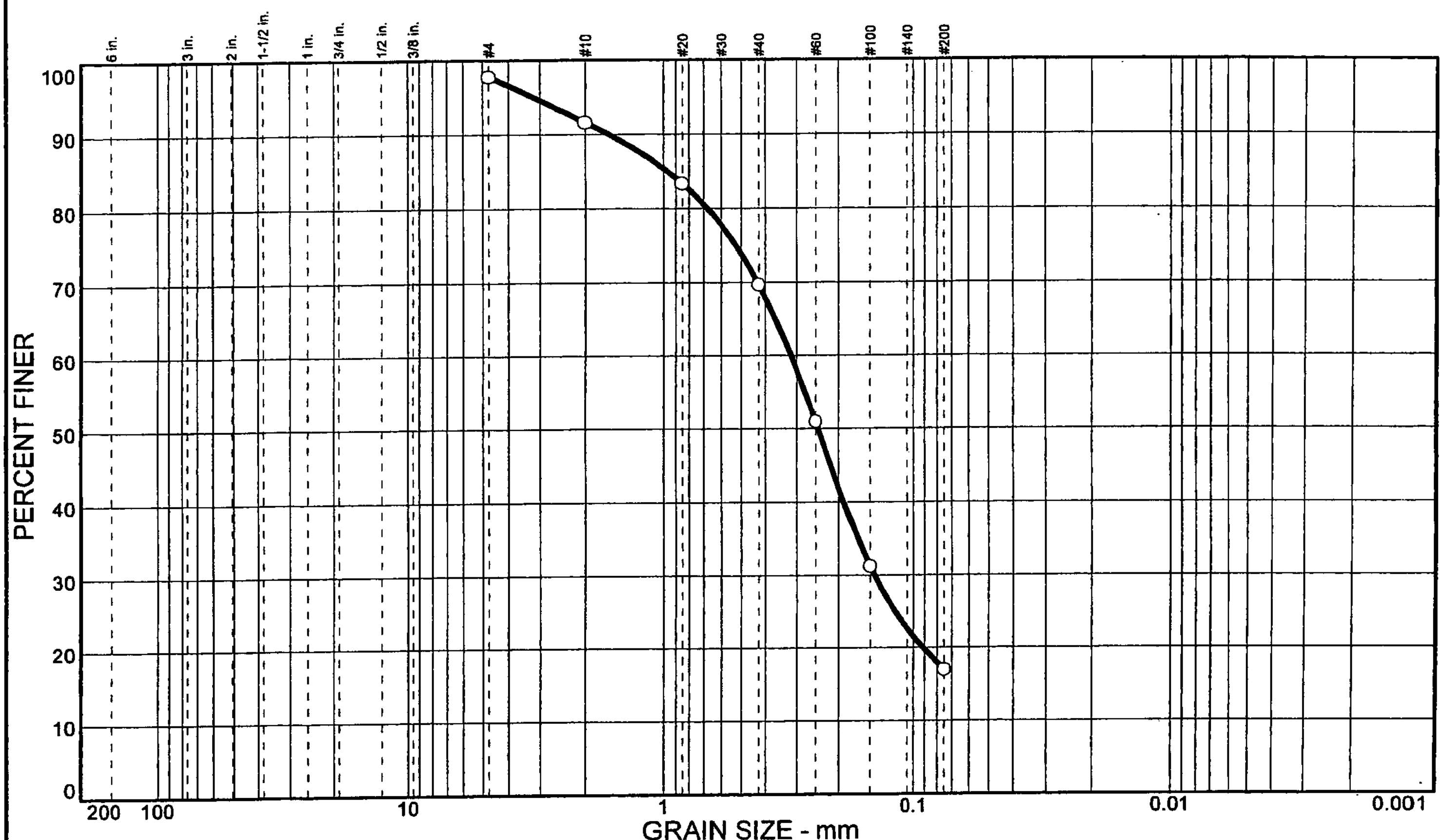
○

○ Source: Boring No. CB-MH01-21 Sample No.: 1 Elev./Depth: -11.3/-12.8 MLW

Law Engineering and Environmental Services, Inc.

Client: US Army Corp[of Engineers
Project: Miami Harbor Deepening
Project No.: 40564-1-4176-02

Grain Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○			80.8	17.0		SM	A-2-4(0)		

SIEVE inches size	PERCENT FINER ○		
	GRAIN SIZE		
D_{60}	0.316		
D_{30}	0.144		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	97.8		
#10	91.6		
#20	83.4		
#40	69.7		
#60	51.0		
#100	31.3		
#200	17.0		

SOIL DESCRIPTION

○ SAND, fine quartz, little fine gravel to sand-size shell fragments, little silt, light gray-tan

REMARKS:

○

○ Source: Boring No. CB-MH01-21 Sample No.: 2 Elev./Depth: -12.8/-14.3 MLW

Law Engineering and Environmental Services, Inc.

Client: US Army Corp[of Engineers
Project: Miami Harbor Deepening
Project No.: 40564-1-4176-02

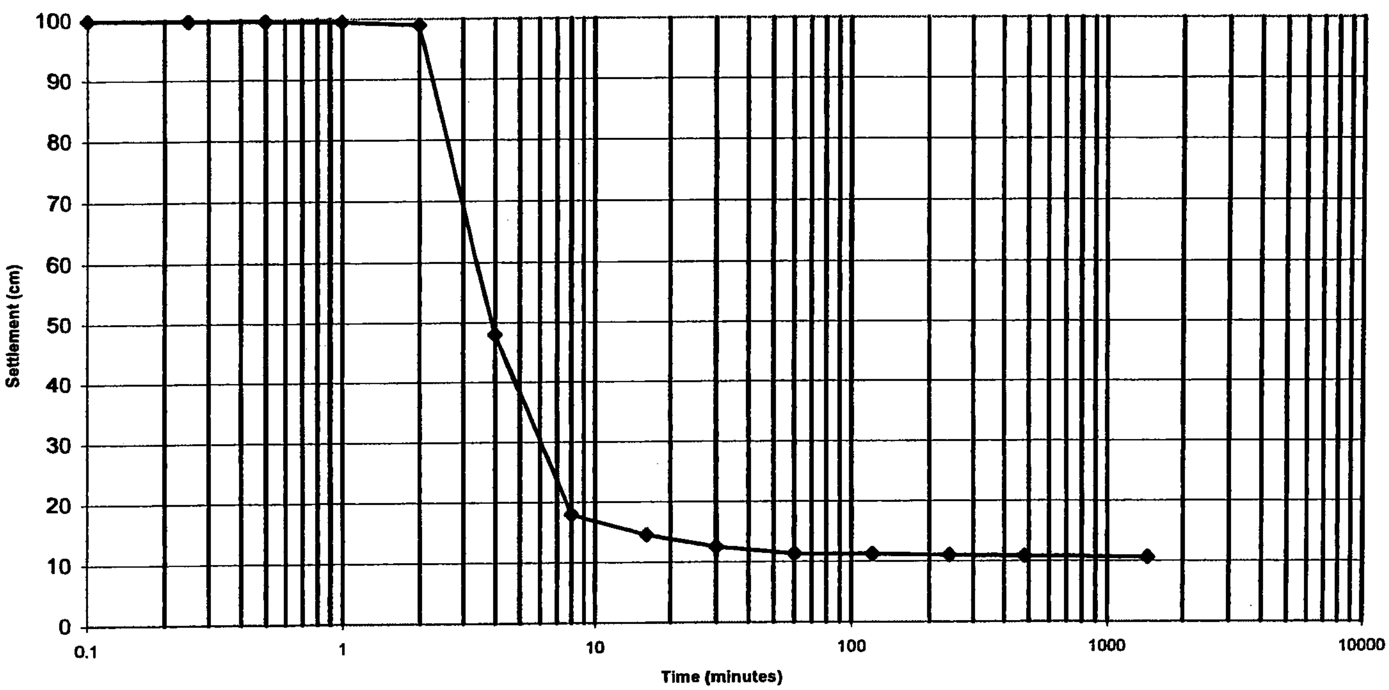
SETTLING RATE TEST

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES
3901 CARMICHAEL AVENUE
JACKSONVILLE, FLORIDA 32207
(904)396-5173

REPORT OF SETTLING RATE TESTING

LAW PROJECT NO: 40564-1-4176-02
PROJECT: Miami Harbor Deepening
CLIENT: USACE, Jacksonville District

SAMPLE : CB-MH01-19
STATION : -6.7'/-9.7' MLW
CONCENTRATION: 100g/L



TIME	INTERFACE (cm)	TIME	INTERFACE (cm)
0.1	99.9	16	14.5
0.25	99.8	30	12.5
0.5	99.7	60	11.3
1	99.5	120	11.2
2	99	240	11
4	48	480	10.8
8	18	1440	10.6

Final concentration: 943.4 g/L

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES
3901 CARMICHAEL AVENUE
JACKSONVILLE, FLORIDA 32207
(904)396-5173

REPORT OF SETTLING RATE TESTING

LAW PROJECT NO: 40564-1-4176-02

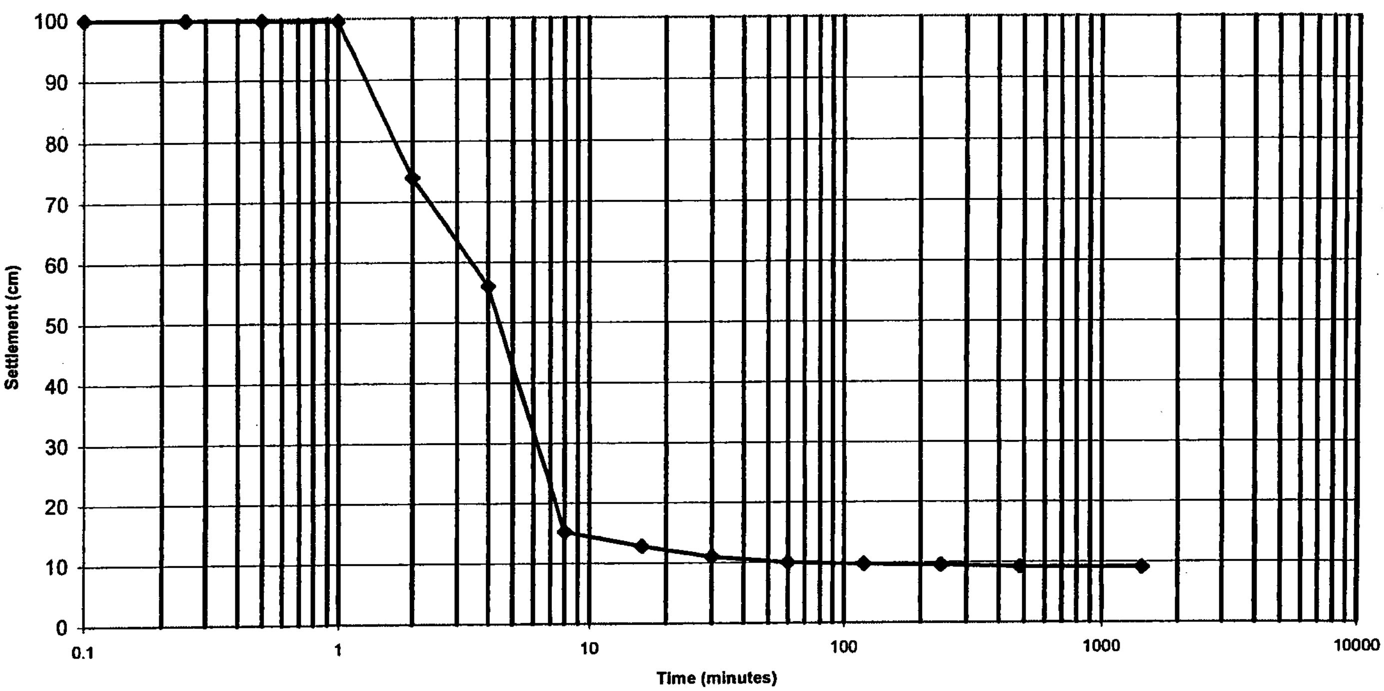
PROJECT: Miami Harbor Deepening

CLIENT: USACE, Jacksonville District

SAMPLE : CB-MH01-18

STATION : -7.3'/-13.3' MLW

CONCENTRATION: 100g/L



TIME	INTERFACE (cm)	TIME	INTERFACE (cm)
0.1	99.9	16	12.8
0.25	99.8	30	11
0.5	99.7	60	10
1	99.5	120	9.7
2	74	240	9.5
4	56	480	9.2
8	15.2	1440	9.1

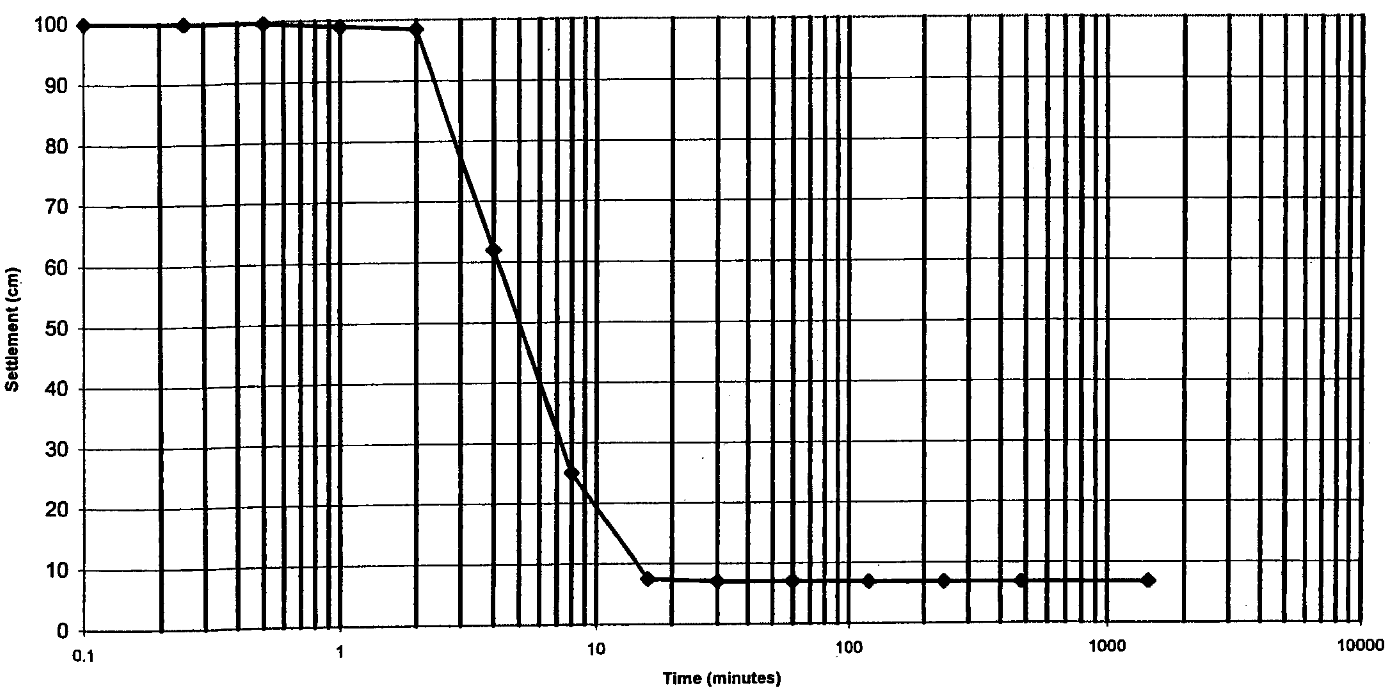
Final concentration: 1098.9 g/L

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES
3901 CARMICHAEL AVENUE
JACKSONVILLE, FLORIDA 32207
(904)396-5173

REPORT OF SETTLING RATE TESTING

LAW PROJECT NO: 40564-1-4176-02
PROJECT: Miami Harbor Deepening
CLIENT: USACE, Jacksonville District

SAMPLE : CB-MH01-21
STATION : -11.3'/-12.8' MLW
CONCENTRATION: 100g/L



TIME	INTERFACE (cm)	TIME	INTERFACE (cm)
0.1	99.9	16	7.5
0.25	99.8	30	7.1
0.5	99.7	60	7
1	99	120	6.9
2	98.5	240	6.8
4	62	480	6.8
8	25	1440	6.8

Final concentration: 1470.6 g/L

February 2004

Volume II of II

FINAL

Real Estate – Appendix C

For the

Miami Harbor Navigation Study
General Reevaluation Report

Miami-Dade County, Florida - 010140

US Army Corps
of Engineers®

Jacksonville District
South Atlantic Division

MIAMI HARBOR, FLORIDA
NAVIGATION STUDY
GENERAL REEVALUATION REPORT (GRR)
FINAL REAL ESTATE APPENDIX

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10/2001.bam
Rev. 3/2002, 6/2002, & 12/2003.bam

MIAMI HARBOR, FLORIDA
GENERAL REEVALUATION REPORT (GRR)
FINAL REAL ESTATE APPENDIX

1. Statement of Purpose. This General Reevaluation Report is intended to study the feasibility of further port deepening to improve navigation on the existing Miami Harbor project. It is tentative in nature for planning purposes only and is subject to change even after its approval.

2. Study Authorization.

a. The study was authorized by the Committee on Transportation and Infrastructure of the United States House of Representatives on October 29, 1997, with additional authorization appearing in subsequent appropriations bills.

b. House Document 101-205, dated June 21, 1990, recommended the current channel dimensions and depths of Miami Harbor. That authorizing document recommended, "that the authorized project for Miami Harbor be modified to include Federal maintenance of the Fisher Island turning basin, and to provide a channel 44 feet deep and 500 feet wide from the open ocean to the existing beach line, 42 feet deep and 500 feet wide from the beach line to cut 3 station 33+00 (near Fisher Island turning basin), and 42 feet deep and 400 feet wide from Fisher Island turning basin to the west end of the container berths located on Lummus/Dodge Island. This channel would terminate in a turning basin with a depth of 42 feet and a diameter of 1,600 feet."

c. Construction of those authorized dimensions as of January 2002 includes the 44-foot deep by 500-foot wide channel from the open ocean to the existing beach line and the 42-foot deep by 500-foot wide segment from the beach line to Cut 3 station 33+00 (near Fisher Island turning basin). The remaining 42-foot deep by 400-foot wide segment from the Fisher Island turning basin to the west end of the container berths on Lummus/Dodge Island is partially complete. The Miami-Dade County Seaport Department has requested the U.S. Army Corps of Engineers to complete construction of that remaining segment under a 204e agreement (to be modified to a Project Cooperation Agreement) which allows the project sponsor to pay for all design and construction initially and then seek reimbursement for the Federal share upon satisfactory completion of each usable increment.

3. Project Location. Miami Harbor, also known as the Port of Miami, is an island consisting of approximately 660 acres that is located at the northern part of Biscayne Bay in South Florida. The City of Miami is located on the west side of Biscayne Bay and the City of Miami Beach is located on a peninsula on the northeast side of the bay, opposite Miami. Both cities are located in Miami-Dade County, Florida, and are connected by several causeways crossing the bay. The Port is the southernmost major Atlantic Coast port.

4. Project Description.

a. The existing Federal project for Miami Harbor navigation features consists of an entrance channel, interior channel, turning basin, protective jetties and berthing areas. The reevaluation is at the request of local interests.

b. The improvements to the project include deepening and widening the existing channel to improve navigation safety. The existing 42-foot project depths are not adequate for many ships. Access to the project areas will be by water.

c. The primary disposal site is the existing offshore dredged material disposal site (ODMDS). These lands are within the navigable waters of the United States and are available to the Federal Government directly by navigation servitude.

d. The secondary disposal alternative is the use of approximately 65 acres at Virginia Key upland disposal area. It is located on the north tip of Virginia Key (See map at the end of this appendix) and was historically used for spoil disposal when dredging Port channels. The property is owned by the City of Miami. A legal determination was made regarding the applicability of the navigational servitude rights within this area. If the property is now or ever was part of a navigable waterway, it would be subject to the navigational servitude interest of the United States of America (Government). As such, the Government can use the land in connection with this navigational project and such use would not constitute a "taking" requiring compensation. Recommend this matter be discussed with the City and the local sponsor. If disagreement is expressed with the exercise of navigational servitude, then a topographical survey will be the deciding factor for establishing its elevation.

e. The local sponsor is responsible for providing a small staging work area located along the Port's undeveloped berthing area north of Lummus Island Turning Basin or the Middle Turning Basin for equipment and supplies. Contractor will coordinate staging area with the sponsor and no estates are required since this area is available through navigation servitude.

f. The 100-foot channel extension of the Lummus Island (Fisherman's Channel) will not extend into the Bill Sadowski Critical Wildlife Area (CWA). The proposed project will be contained within Port-owned lands, outside of the CWA.

g. Real estate requirements for the proposed project improvements are mainly administrative and are estimated at $25,000.

5. Federal Owned Lands. Miami Harbor is a Federal navigation project and under the Commerce Clause of the U.S. Constitution, the Federal Government has the right to use, control, and regulate the navigable waters of the United States and the submerged lands thereunder.

6. Non-Federal Owned Lands. The non-federal sponsor is the Miami-Dade County Seaport Department (Port of Miami) and they would be required to provide all lands, easements, and rights-of-way above the mean high water line. The Port owns the submerged lands under the channels and beyond; however, all lands identified for this project are currently available by navigation servitude.

7. Estates. There are no estates to be acquired for this project.

8. Navigation Servitude. The government will be exercising navigational servitude in support of this project. Navigational servitude will apply to all dredging work, deepening within the channels, disposal on Virginia Key, staging work areas, ocean placement of material, the compensatory reef and seagrass mitigation site(s), and the fill areas identified as III-A, III-B, and III-C. All lands below the mean high water line are within the navigable waters of the United States and are available to the Federal Government directly by navigation servitude. If this should be disputed, a topographical survey will be the decisive action for purposes of establishing the elevation for certainty.

9. Project Map(s). Refer to Figures 1-10 in the Main report for proposed project maps.

10. Real Estate Baseline Cost Estimate.

Lands and Damages	$ 0
Acquisition/Administrative Costs	
Federal	$10,000
Non-Federal	$10,000
Contingencies (25%) (Rounded)*	$ 5,000
Total Estimated Real Estate Costs (RD)	$25,000

*Contingencies of 25% are estimated to cover uncertainties associated with refinement of boundary lines during ownership verification.

11. Relocation Assistance Benefits. There are no persons or businesses to be relocated due to project implementation.

12. Minerals. No known minerals exist in the project area.

13. Non-Federal Sponsor's Authority to Participate. The Miami-Dade County Seaport Department is the non-federal sponsor for this project. Their authority to participate in the project is derived through its creation by Act of the Legislature of the State of Florida, Chapter 63-1447, Laws of Florida. The Port Authority has experience in land acquisition. The non-Federal sponsor has participated in other federally sponsored projects.

14. Real Estate Milestones. No acquisition of real estate is required; however, coordination should be performed for navigation servitude.

15. Relocations of Roads, Bridges, Utilities, Towns, & Cemeteries. There are no known roads, bridges, structures, towns, or cemeteries to be affected as part of the federal project. The following utilities would be impacted by the proposed deepening of Miami Harbor and must be relocated prior to completion of construction of this project.

a. Miami-Dade Water and Sewage Department (WASD) owns a 54-inch sewer main crossing within component #2A from Miami Beach to its Fisher Island treatment plant. This utility shall be treated as a deep draft utility relocation since it is located in a cut with an authorized depth of greater than 45 feet and 50 percent of the cost would be paid by the facility owner and 50 percent would be paid by the non-Federal sponsor.

b. WASD also owns a water main from Fisher Island to Lummus Island and is at a cut with an authorized depth of greater than 45 feet. This, too, shall be treated as a deep draft utility relocation with 50 percent of the cost paid by the facility owner and 50 percent paid by the non-Federal sponsor.

c. The Florida Power and Light Company (FP&L) owns two transmission lines (a 69 kV circuit and a 138 kV circuit each inside a 24-inch pipe conduit) from its Fisher Island plant to Lummus Island. The cables are at a cut with an authorized depth of greater than 45 feet. While this would normally fall under the deep draft utility relocation rule (DDUR), in this case it will be treated as a removal since the work was to have been performed during phase I, which had an authorized depth of less than 45 feet.

The attorney's analysis states that "any betterments that the facility owner may want to add to the new design will not be considered part of the deep draft utility relocation and the sponsor will not share in the attendant costs of such betterments." If FP&L decides to add a new line crossing Fisherman's Channel, no cost shall be borne by the project as such addition is neither a requirement of the project nor a result of a relocation caused by the project. The analysis also states that "should the utilities refuse to remove or relocate their crossings, a determination would have to be made on the responsibility to compel those removals, including the assessment of the capability of the non-Federal sponsor and the state to compel removals at owner cost. As applicable, letters from the non-Federal sponsor and the state would be required, requesting the Corps to exercise its rights under the navigation servitude to compel removals at owner cost. Since the WASD crossings fall under the DDUR, all administrative and legal costs incurred by the Corps to so compel WASD would be shared 50/50 between the non-Federal sponsor and the utility owner."

16. Presence of Contaminants (Hazardous, Toxic and Radioactive Wastes). There are no known hazardous or toxic materials located on the submerged lands or in the local berthing areas.

17. Attitude of Landowners. There are no private property owners directly affected by the federal project.

February 2004

Volume II of II

FINAL

Pertinent Correspondence – Appendix D

For the

Miami Harbor Navigation Study
General Reevaluation Report

Miami-Dade County, Florida - 010140

US Army Corps
of Engineers®

Jacksonville District
South Atlantic Division

APPENDIX D

PERTINENT CORRESPONDENCE

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FLORIDA FISH AND WILDLIFE CONSERVATION COMMISION
REVIEW OF ALTERNATIVES...SEE EIS

FLORIDA DEPARTMENT OF TRANSPORTATION
REVIEW OF ALTERNATIVES...SEE EIS

SOUTH FLORIDA REGIONAL PLANNING COUNCIL
REVIEW OF ALTERNATIVES...SEE EIS

APPENDIX D

PERTINENT CORRESPONDENCE

The study coordination effort was to keep the public informed and obtain feedback. The study participants are listed in this appendix along with the public views and comments obtained during the study.

STUDY PARTICIPANTS

Accomplishment of the study involved close coordination between the Corps of Engineers and the sponsor. The Corps of Engineers conducted the study, consolidated information from other agencies, formulated plans, and coordinated study findings at various points during the study. Coordination involved the following Federal and State agencies in addition to local interest and the sponsor, Miami-Dade County Seaport Department.

Federal
Fish and Wildlife Service
United States Coast Guard
Environmental Protection Agency
National Marine Fisheries Service

State
Department of Environmental Protection
Department of Natural Resources
State Historic Preservation Office
Florida Fish and Wildlife Conservation Commission
Florida Department of Transportation

WRITTEN COORDINATION AND RESPONSES

Coordination with local interests involved field visits and local interviews to obtain their views and provide information. The attached sheets list meetings in which the sponsor and involved agencies met with USACE to discuss the study.

Date	Group(s) Involved With USACE	Topic(s) Discussed
3/13/2000	Department of Environmental Resources Management Dial Cordy and Associates	Environmental Coordination
5/13/2000	Department of Environmental Resources Management National Marine Fisheries Service Department of Environmental Protection Environmental Protection Agency U.S. Fish and Wildlife Service Florida Fish and Wildlife Conservation Commission Port of Miami	Environmental Information Exchange Workshop
7/18/2000	All Port Users and Operators Port of Miami Curtis & Kimball	Overview of Project
11/1/2000	Port of Miami Department of Environmental Protection Environmental Protection Agency U.S. Fish and Wildlife Service Department of Environmental Resources Management Florida Fish and Wildlife Conservation Commission National Marine Fisheries Service	Discussion of Environmental Resource Survey Results
5/16/2001	Biscayne Bay Pilots	Review of Environmental Resource Survey Results And Proposed Navigation Improvements Review of Preliminary Ship Simulation Results
7/10/2001	Port of Miami	Environmental Impact Statement Kickoff Meeting
2/19/2002	Dial Cordy & Associates Inc.	Environmental Issues

Date	Group(s) Involved With USACE	Topic(s) Discussed
4/16/2002	Port of Miami Biscayne Bay Pilots Environmental Protection Agency Department of Environmental Protection U.S. Fish and Wildlife Service Department of Environmental Resources Management Florida Fish and Wildlife Conservation Commission National Marine Fisheries Service	Review of the 6 Potential Alternatives and Consequent Impacts
6/3/2002 to 6/7/2002	Dial Cordy and Associates	Mitigation Survey Field Trip Look At Mitigation Options
6/19/2002	Port of Miami Curtis & Kimball	Alternative Formulation Briefing Preparations
6/20/2002	USACE HQ Dial Cordy and Associates Port Pilots U.S. Fish and Wildlife Service Florida Fish and Wildlife Conservation Commission Department of Environmental Resources Management Department of Environmental Protection National Marine Fisheries Service	Alternative Formulation Briefing
7/3/2002	Port of Miami Curtis & Kimball Dial Cordy and Associates	Editing of Environmental Impact Statement
8/1/2002	Port of Miami Curtis & Kimball	Overall Schedule Utility Relocation Environmental Impact Statement
8/8/2002	Department of Environmental Protection Florida Fish and Wildlife Conservation Commission	Miami Harbor Blasting Issues (In Tallahassee)

file

March 15, 1999

Programs and Project Management Division
Project Management Office

Mr. Carl Fielland
Port of Miami-Dade
1015 North American Way
Miami, Florida 33132

Dear Mr. Fielland:

This letter is to inform you that we have initiated studies this fiscal year to examine channel improvements for Miami Harbor. As you know, the Committee on Transportation and Infrastructure of the U.S. House of Representatives authorized a study to consider deepening Miami Harbor. The funds for the study are now available. Jerry Scarborough, the project manager, will arrange a meeting with you near the end of this month to discuss the study process in more detail.

We look forward to working with you in the continued improvement of the Miami Harbor Federal channels. If you have any questions, please contact me at 904-232-2586 or Mr. Jerry Scarborough at 904-232-2042.

Sincerely,

SIGNED: Richard E. Bonner

Richard E. Bonner, P.E.
Deputy District Engineer for
Project Management

bcc:
CESAJ-PD-PN (D. Powell)

Powell/PD-PN
Schmidt/PD-PN
Strain/PD-P
Duck PD
Scarborough/DP-I
Duke/DP-A
Bonner/DP

I:\group\pd\spo1_ltr.doc

Planning Division
Plan Formulation Branch

Mr. Carl E. Fielland, Port Engineer
Port of Miami
1015 North American Way
Miami, Florida 33132

Dear Mr. Fielland:

As requested in our telephone conversation on September 22, 1999, the enclosed copies of our proposed draft environmental and economic analysis coordination letters are provided for your review. Both letters contain mailing lists related to different interest groups along with a copy of the drawing explaining the proposed modifications to the harbor. Please advise us if you require any changes to the mailing lists, draft letters, or the proposed modifications drawing.

As suggested in a September 7, 1999, e-mail message from Ms. Amy Kimball-Murley to Mr. Robert King of my staff, we agree that a letter from the Port Director will encourage recipients of the benefit analysis coordination letter to respond quickly and thoroughly. A sample letter for that purpose is enclosed for your consideration. The main purposes of the coordination letter are to initiate communication, establish points of contact with the port users, and identify potential benefits associated with the proposed navigation improvements.

If you have any questions concerning the enclosed information, contact Mr. Jerry Scarborough at 904-232-2042 or myself at 904-232-2586.

Sincerely,
SIGNED: Dennis R. Duke

Richard E. Bonner, P.E.
Deputy District Engineer
for Project Management

Enclosures

Copy Furnished:

Ms. Amy Kimball-Murley, AICP, The Curits & Kimball Company, 4101 Laguna Street, Coral Gables, Florida 33146
Ms. Nancy Case O'Bourke, P.E., 1521 Alton Road #112, Miami Beach, FL 33139

bcc:
CESAJ-PD-PN (D. Powell)
CESAJ-PD-ER (Boothby)
CESAJ-PD-D (King)

Planning Division
Plan Formulation Branch

Mr. Carl E. Fielland, Port Engineer
Port of Miami
1015 North American Way
Miami, Florida 33132

Dear Mr. Fielland:

During our visit to the Port of Miami on November 3, 1999, we agreed to correct proposed draft environmental and economic analysis coordination letters to include the revised alternatives discussed during that meeting. The enclosed letters contain the revised alternatives with a drawing explaining the requested modifications to the harbor. Based on additional information you provided, final mailing lists related to different interest groups are also included. Please advise us if you require any changes to the draft letters, the proposed modifications drawing, or mailing lists.

If no other changes are required, please notify us so that we can mail both the environmental and economic analysis coordination letters as soon as possible. We also understand Ms. Amy Kimball-Murley suggested additional revisions to the Port Director's cover letter for the economic analysis coordination letter and that the revised cover letter will be provided soon. As mentioned before, the main purposes of the benefit analysis coordination letter are to initiate communication, establish points of contact with the port users, and identify potential benefits associated with the proposed navigation improvements.

Thank you for providing the database of vessels visiting Miami Harbor. Our economists are using that information to expand their listings of vessels using the port's facilities. If you have any questions concerning the enclosed information, contact Mr. Jerry Scarborough at 904-232-2042 or myself at 904-232-2586.

Sincerely,

SIGNED: Dennis R. Duke

Richard E. Bonner, P.E.
Deputy District Engineer
for Project Management

Enclosures

Copy Furnished:

Ms. Amy Kimball-Murley, AICP, The Curtis & Kimball Company, 4101 Laguna Street, Coral Gables, Florida 33146

bcc:
CESAJ-PD-PN (D. Powell)
CESAJ-PD-ER (Boothby)
CESAJ-PD-D (King)

*** D R A F T ***

Planning Division
Environmental Branch

TO WHOM IT MAY CONCERN:

The Miami-Dade County Seaport Department of the Port of Miami has requested that the U.S. Army Corps of Engineers (Corps), Jacksonville District, study the feasibility of widening and deepening portions of Miami Harbor, Dade County, Florida (enclosure 1). To assist in this effort, the Corps is gathering information to define issues and concerns that will be addressed in a general reevaluation and review (GRR) study of Miami Harbor to consider modifying portions of the deep draft navigation project.

Six alternatives identified by the Biscayne Bay Pilots and the Miami-Dade County Seaport Department are under consideration as indicated on the enclosed drawing and described below:

- The first involves flaring the existing 500-foot wide entrance channel to provide an 800-foot wide entrance at buoy 1. Deepening of the entrance channel along Cut-1 and Cut-2 from an existing depth of 44 feet in one-foot increments to a depth of 52 feet will receive consideration.

- The second alternative will consider adding a turn widener between buoys 13 and 15 and deepening to depths of 50 feet.

- Alternative three involves extending the existing Fisher Island turning basin to the north. A turning notch (1600 feet by 1450 feet) extending approximately 500 feet to the north of the existing channel edge along the West End of Cut-3 would require evaluation. Depths from 43 to 50 feet at one-foot increments below the existing depth of 42 feet will receive consideration in the area of the turning notch.

- Alternative four consists of relocating the main channel (cruise ship channel or Cut-4) about 175 feet to the south between channel miles 2 and 3 over a two or three degree transition to the existing cruise ship turning basin. No dredging is expected for alternative four since existing depths allow for continuation of the authorized depth of 36 feet.

- Alternative five proposes to increase the width of the Lummus Island Cut (Fisherman's Channel) about 100 feet to the south of the existing channel. Deepening would include examination of depths below the existing 42-foot depth at one-foot increments from 43 to 50 feet along the proposed widened channel from Cut-3, Station 0+00 to Cut-3, Station 42+00.

- Alternative six includes deepening of Dodge Island Cut and the proposed 1200-foot turning basin from 32 and 34 feet to 36 feet. It also involves relocating the western end of the Dodge Island Cut to accommodate proposed port expansion.

Examination of the impacts of the proposed dredging alternatives on the harbor system and shoreline processes is also part of the study. During the study our objectives include identifying any problems and needs associated with deep-draft vessel movements serving cargo and cruise ship facilities within Miami Harbor and seeking a solution.

Approval of a prior study allowed the Port of Miami's Miami-Dade County Seaport Department to improve the entrance channel and deepen it from 38 feet to 44 feet during the past Phase I construction effort. That work included addition of a widener on the north side of Government Cut at the Fisher Island turning basin along with deepening from 36 feet to 42 feet through the Fisher Island turning basin to the first half of the Lummus Island Cut or Fisherman's Channel. Under the same authorization the Port of Miami's current Phase II deepening involves extending the 42-foot depth to the end of the Lummus/Dodge Island turning basin.

The Corps welcomes your views, comments, suggestions, and any information about resources, study objectives, and important features within the described study area. Letters of comment or inquiry should be addressed to the letterhead address to the attention of Planning Division, Environmental Coordination Section and received by this office within thirty (30) days of the date of this letter.

Sincerely,

James C. Duck
Chief Planning Division

file

July 10, 2000

Planning Division
Plan Formulation Branch
Coastal/Navigation Section

Dr. Al Devereaux
Director, Office of Beaches and Coastal Systems
Florida Department of Environmental Protection
3900 Commonwealth Boulevard
Mail Station 300
Tallahassee, Florida 32399-3000

Dear Dr. Deveraux:

A conference call was recently held between our respective staffs to discuss ways to improve Corps/FDEP project development/permit decision process for Federal Civil Works projects. It was suggested during the call that a member of your staff join the study teams of some of our current studies. One of the studies suggested was the Miami Harbor General ~~Review~~ Re-evaluation Report (GRR).

The Miami Harbor GRR will consider six alternatives that involve a combination of deepening and widening measures as outlined on the enclosed drawing. Responses from FDEP's letter dated February 22, 2000 have already helped us understand environmental concerns related to the proposed alternatives. Mr. David Mayer's (FDEP) participation in our environmental workshop at DERM on March 13, 2000 also helped us gain additional information concerning Biscayne Bay environmental resources.

Our next Miami Harbor GRR study team meeting is scheduled for July 18, 2000, 1:00 p.m., at the Port of Miami, 1015 N. America Way, 2nd Floor, Miami, Florida. That meeting will include discussions with port users, harbor pilots, and the Port Authority to discuss problems, needs, and opportunities. This is an important step toward determining the without project, existing, and future conditions and development of alternative plans of improvement.

We invite your active participation in the study, including attending study team meetings. We look forward to working together on these important efforts.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosure

Copy Furnished:
Mr. Carl E. Fielland, Port Engineer, Port of Miami, 1015 N. America Way, 2nd Floor, Miami, Florida 33132

Ms. Amy Kimball-Murley, AICP, The Curtis & Kimball Company, 4101 Laguna Street, Coral Gables, Florida 33146

bcc:
CESAJ-DP (Bonner)
CESAJ-DP-A (Duke)
CESAJ-DP-I (Scarborough)
CESAJ-PD-E (Smith)
CESAJ-PD-ER (Dugger)
CESAJ-PD-ER (Boothby)
CESAJ-PD-P (Strain)
CESAJ-PD-PN (Schmidt)

CESAJ-PD-PN Powell/1694
CESAJ-PD-PN Schmidt
CESAJ-PD-P Strain
CESAJ-PD-ER Boothby
CESAJ-PD-ER Dugger
CESAJ-PD-E Smith
CESAJ-DP-I Scarborough
CESAJ-DP-A Duke
~~CESAJ-DP~~ Bonner
CESAJ-PD Duke

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August 30, 2000

Planning Division
Plan Formulation Branch

Dr. Susan Markley
Miami-Dade Department of Environmental Resources Management
33 Southwest 2nd Avenue
Miami, Florida 33130

Dear Dr. Markley:

As you know, a proposed marine environmental baseline survey of Miami Harbor and vicinity will be accomplished as part of the ongoing Miami Harbor studies. We issued a Notice-To-Proceed (NTP) on a task contract order to Dial/Cordy Consultants to initiate this work on August 29, 2000.

The contract allows 90 days for completion of the required fieldwork. Collection of initial data is anticipated to require about two weeks. After the contractor has mobilized and completed a preliminary overview of the study area, we will coordinate with you to determine the best time for the Miami-Dade Department of Environmental Resources Management (DERM) and other interested state and Federal resource agencies to join the survey. We will set up a meeting with DERM to review the results after completion of data processing.

Thank you for assisting us in understanding environmental concerns relating to the study alternatives for Miami Harbor. If you have any questions concerning the enclosed information, contact our Project Manager Jerry Scarborough at 904-232-2042 or David Schmidt at 904-232-1697.

Sincerely,

James C. Duck
Chief, Planning Division

Copy Furnished:

Carl E. Fielland, Port Engineer, Port of Miami
Ms. Amy Kimball-Murley, AICP, The Curtis & Kimball Company
Ms. Nancy Case O'Bourke, P.E., Case O'Bourke Engineering Inc.
Mike Johnson, National Marine Fisheries Service
Chuck Sulzman, US Fish and Wildlife Service

bcc:
CESAJ-PD-ER (R. Boothby)
CESAJ-PD-EE (G. Schuster)
CESAJ-DP-I (J. Scarborough)

Powell/PD-PN
Schmidt/PD-PN
Strain/PD-P
Smith/PD-E
Hundley/CT-C
Scarborough/DP-I
Duke/DP-A
Bonner/DP
Duck/PD

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Planning Division
Plan Formulation Branch

Mr. Carl E. Fielland, Port Engineer
Port of Miami
1015 North American Way
Miami, Florida 33132

Dear Mr. Fielland:

Receipt of preliminary ship simulation results has allowed further evaluation of the environmental resource surveys for Miami Harbor in relation to the current alternatives. The enclosed drawings include modifications to alternative-one (the entrance channel widener) and alternative-three (the Fisher Island Turning Basin) that will either avoid or reduce impacts to environmental resources.

A review of those proposed changes with the Biscayne Bay Pilots association will allow us to determine the best approach to avoid the impacted environmental resources and still provide the changes required to improve navigation of the Federal channels. From your May 8, 2001, telephone conversation with Jerry Scarborough tentative dates of May 15 or May 16, 2001, have been suggested for a meeting at your office with the Biscayne Bay Pilots to review the proposed changes.

Please contact Jerry Scarborough at 904-232-2042 to confirm the most convenient time and place that suits you and the Biscayne Bay Pilots. Thank you for your continued support and assistance.

Sincerely,

Richard E. Bonner, P.E.
Deputy District Engineer
for Project Management

Enclosures

Copy Furnished:

Ms. Amy Kimball-Murley, AICP, The Curtis & Kimball Company, 4101 Laguna Street, Coral Gables, Florida 33146

Captain John Fernandez, Biscayne Bay Pilots, 2911 Port Blvd. Miami, Florida 33132

bcc:
CESAJ-PD-PN (D. Powell)
CESAJ-PD-ER (Boothby)
CESAJ-PD-D (King)
CESAJ-EN-HI (Choate)
CESAJ-EN-HI (Sylvester)
CESAJ-EN-DL (Henderson)

Powell/PD-PN
Schmidt/PD-PN
Strain/PD-P
Sylvester/EN-HI
Choate/EN-HI
Henderson/EN-DL
Duke/PD
Scarborough/DP-I
Dollar/DP-A
Bonner/DP

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Richard B Powell
07/07/2000 02:21 PM

To: carlef@miami-dade.fl.us@SMTP@Exchange
cc: Jerry W Scarborough/CESAJ/SAJ02, David V Schmidt/CESAJ/SAJ02, Shashi Makker/CESAJ/SAJ02, Gerald DeLoach/CESAJ/SAJ02
Subject: Miami Harbor GRR Relocations

Mr. Carl Fielland,

Thank you for your July 5, 2000 letter concerning sewer line relocations.

Relocation of the sewer line between Miami Beach and Fisher Island in the area of alternatives two and five depends on how many feet of deepening the economic analysis justifies. As mentioned in our July 5, 2000 telephone conversation with Jerry Scarborough, our design criteria generally requires six feet between the project depth of the navigation channel and the top of any pipeline. That six-foot clearance also extends about 25 feet beyond the edges of the channel bottom.

When our mechanical and electrical engineering design section has finished coordinating with the utility companies in the Miami area to locate not only the sewage force mains, but any other utility line that may cross the project study area, identification of the utility lines requiring relocation will be made based on the justified project depth, economic, and other environmental considerations. Our current schedule indicates that process should complete by December of this year. As soon as the evaluation is completed, we will discuss the results with you.

Could we also get a copy of any utility location drawings you may have. When we visit you on July 18, 2000, I would like to borrow any drawings you may have at that time. I will return them after copies are made.

Sincerely,

Dick Powell

JUL 16 2001

Planning Division
Plan Formulation Branch

Captain John R. Fernandez
Biscayne Bay Pilots
2911 Port Boulevard
Miami, Florida 33132

Dear Captain Fernandez:

The enclosed drawing contains modifications to the proposed study alternatives based on the recommendations of you and Captain Stephen McDonald at the Port of Miami offices on May 16, 2001. The enclosed drawing includes modifications to alternatives1, 2, 3, and 5 that will either avoid or reduce impacts to environmental resources.

Approval of those proposed changes by the Biscayne Bay Pilots association will allow us to continue calculations for our quantity and cost estimates. Please provide a written response by July 23, 2001.

Contact Jerry Scarborough at 904-232-2042 or Philip Sylvester at 904-232-1142 if you have any questions concerning the proposed changes. Thank you for your continued support and assistance.

Sincerely,

Richard E. Bonner, P.E.
Deputy District Engineer
for Project Management

Enclosure

Copy Furnished:

Ms. Amy Kimball-Murley, AICP, The Curtis & Kimball Company, 4101 Laguna Street, Coral Gables, Florida 33146

Carl E. Fielland, Port Engineer, Port of Miami, 1015 N. America Way, 2nd Floor, Miami, FL 33132

bcc:
CESAJ-PD-PN (D. Powell)
CESAJ-EN-HI (Choate)
CESAJ-EN-HI (Sylvester)
CESAJ-EN-DL (Henderson)

7-9-01 RBP Powell/PD-PN/SLW 7/5/01
Schmidt/PD-PN
Strain/PD-P
Sylvester/EN-HI
Choate/EN-HI
Henderson/EN-DL
Duck/PD
Scarborough/DP-I
Dollar/DP-A
Bonner/DP

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July 20, 2001

Engineering Division
Design Branch

Mr. John Cherlog
Assistant Director, Engineering/Planning
Miami-Dade Water and Sewer Department (WASD)
P.O. Box 330316
Miami, FL 33233-0316

Dear Director Cherlog:

The U.S. Army Corps of Engineers is preparing an engineering appendix of the General Reevaluation Report for various improvements at Miami Harbor that may affect utility lines crossing the channels. The proposed improvements are shown highlighted on the enclosed sheet. Be advised that no decision has been made to accomplish either of the proposed improvements.

The purpose of this letter is to notify your agency of the reevaluation report and to request your assistance in compiling information regarding utilities at Miami Harbor.

At the request of Dade County, the Corps of Engineers will incorporate the sewer main relocation in work to be performed with other construction work at the harbor should channel improvements Alt 2a and 3b be accomplished. Please return by August 13, as-built drawings for the 52-inch force sewer main crossing the channels at Miami Harbor marked to show the locations, characteristics, and elevations or depths. Additionally, locations, depths and pipe characteristics are requested for the two water mains also shown on the enclosed drawing.

Thank you for your cooperation in this matter. The technical point of contact for discussion of these relocations is Mr. Gerald DeLoach at 904-232-1050; FAX 904 232-2131.

Sincerely,

Edward E. Middleton, Ph.D., P.E.
Chief, Engineering Division

Enclosure

bcc (wo/encl.):
CESAJ-DP-I (J. Scarborough)
CESAJ-PD-PN (R. Powell)

DeLoach/CESAJ-EN-DM/1050
Makker/CESAJ-EN-DM
Leicht/CESAJ-EN-D
Sanders/CESAJ-EN-A

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P. O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

FEB 28 2001

REPLY TO
ATTENTION OF

Programs and Project Management Division
Project Management Branch

Mr. William M. Brant, P.E.
Director
Miami-Dade Water and Sewer Department
4200 Salzedo Street
Coral Gables, Florida 33146

Dear Mr. Brant:

This is in regard to your request for the U.S. Army Corps of Engineers (USACE) to accomplish the relocation of the 54″ force main that crosses Government Cut between Miami Beach and Fisher Island. As you know, the USACE is currently involved in a study of Miami Harbor to determine if additional deepening of the harbor is justified. Since the force main crosses the Federal Navigation Channel, the potential relocation of the force main is already being addressed in the USACE study.

At the channel's current depth the force main is barely within USACE guidelines which stipulate that utilities that cross Federal navigation channels should be at a minimum of 6 feet below project depth. The crown of the force main is at an elevation of -50 feet and the current channel depth is -42 feet required plus an additional 2 feet of allowable overdepth. If the allowable overdepth is achieved, as it typically is, there is a maximum of six feet of cover over the force main. Therefore, if any additional deepening is justified by the USACE study, the relocation will be mandatory.

USACE policy stipulates that relocations are the responsibility of the local sponsor, which in this case is Dade County/Port of Miami. The Water Resources Development Act of 1986, Public Law 99-662, established the criteria for utility relocations. This states that "Non-Federal interests shall perform or assure the performance of all relocations of utilities necessary to carry out the project. In the case of a project in excess of 45 feet, one-half of the cost of each such relocation shall be borne by the owner of the facility being relocated and one-half of the costs of each such relocation shall be borne by the non-Federal interests." The relocation costs borne by the local sponsor will be eligible for a credit of up to 10% of the total costs of the general navigation features of the project.

Since the relocation to be done is part of a federal navigation project, the relocation can be done by the USACE on behalf of the non-Federal sponsor at the sponsor's expense. An agreement will be required between Dade County/Port of Miami and the USACE in order to accept the funding to perform the relocation. Miami-Dade Water and Sewer Department can provide funds to Dade County/Port of Miami for the relocation, but the transfer of funds to the USACE must come through the local sponsor, Dade County/ Port of Miami.

Preliminary results from the deepening study will be available in August 2001. These results should indicate whether any deepening is justified, and subsequently, if the relocation of the force main is imperative. In the interim, at the request of the local sponsor, the agreement for the transfer of funds to the USACE for the relocations can be drafted and a scope of work identified. To ensure that the channel dredging is not impeded by existing utilities, all necessary relocations will be scheduled well in advance of the dredging.

Hopefully, this has explained how this relocation can proceed. If you have any additional questions or if additional information is needed, please contact our Project Manager, Mr. Jerry Scarborough, at 904-232-2042.

Sincerely,

Richard E. Bonner, P.E.
Deputy District Engineer
for Project Management

Port of Miami

OFFICE OF THE DIRECTOR • 1015 NORTH AMERICA WAY • 2ND FLOOR • MIAMI, FLORIDA 33132-2081 • PHONE (305) 371-PORT (371-7678) • FAX (305) 347-4843

July 5, 2000

Richard Powell
Civil Engineering Planning Division
USACE
P.O. Box 4970
Jacksonville, FL 32232

RE: GRR

Dear Mr. Powell:

In conjunction with Alternates #2 and #5, please consider whether or not the existing sewer line between Miami Beach and Fisher Island needs to be relocated. Your earliest response will be appreciated.

Sincerely,

C. Fielland

Carl E. Fielland
Port Engineer

Port of Miami

OFFICE OF THE DIRECTOR • 1015 NORTH AMERICA WAY • 2ND FLOOR • MIAMI, FLORIDA 33132-2081 • PHONE (305) 371-PORT (371-7678) • FAX (305) 347-4843

January 15, 2003 **VIA FACSIMILE & MAIL**

Mr. Richard Bonner
Deputy District Engineer
Project Management
US Army Corps of Engineers
400 W. Bay Street
Jacksonville, FL 32232-0019

**Re: Port of Miami GRR
Economics Analysis**

Dear Mr. Bonner:

Thank you for providing an opportunity for the Port of Miami to review draft economic assumptions for the Miami Federal Harbor Project GRR.

Our staff and consultants have analyzed data prepared by your team in response to the Advanced Formulation Briefing, and have also had a productive, informative dialog with your staff on key issues. The Port has information to contribute regarding two assumptions in the draft analysis: the controlling depth of ports on predicted itineraries; and, the growth projections for European and Asian imports.

An independent analysis conducted by the Port indicates that controlling depths for key U.S. East Coast Ports should be set at a minimum of 49' due to the status of approved and recommended deepening projects as well as the typical depths experienced at relevant European and Asian ports. A more detailed summary of our findings is included as Attachment A to this letter.

Further, the Port encourages the USACE to carefully review past growth rates for European and Asian markets, and supporting economic data, provided in Attachment B. The Port's analysis shows that Asian imports should be projected at 8.60 percent and European imports at between 11 and 12 percent.

Past USACE feasibility analysis of the Port of Miami (completed in 1989 for the existing authorized project), greatly underestimated cargo growth at the Port by almost 3,500,000 short tons for 2000. In fact, growth in exports was over two times higher than predicted, and growth in the Asian and European markets was three times that predicted for 2000 (see Attachment C). It is critical that the same underestimation is not repeated in the new study.

portofmiami@co.miami-dade.fl.us
MIAMI-DADE COUNTY FLORIDA SEAPORT DEPARTMENT
www.co.miami-dade.fl.us/portofmiami

We hope that the USACE will incorporate the Port's suggestions into its analysis. We are ready to provide additional input and support as the report moves towards further review by Headquarters.

Sincerely,

Charles A. Towsley
Port Director

Attachments
- A: Controlling Depth Analysis
- B: Memo dated January 13, 2003, from Lambert Advisory
- C: Comparison of Projected Growth Rates in June 1989 Feasibility Study with Actual Rates

cc: Jerry Scarborough, USACE
Rene Perez, USACE
Bob King, USACE
Charles Towsley, Port of Miami
Gerry Cafiero, Port of Miami
Becky Hope, Port of Miami
Amy Kimball-Murley, The Curtis & Kimball Company
Paul Lambert, Lambert Advisory
Reading File

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Attachment A:
Analysis of Controlling Depths on Asian and European Itineraries

Issue: The draft Economics Appendix report establishes two important model trade routes for projection of post-Panamax vessel itineraries in the "with project" conditions at the Port of Miami. They are:

- Europe/US East Coast: Southampton, England; New York, US; Charleston; Miami, US; South Hampton, England.
- Mediterranean/US East Coast: Valletta, Malta; New York, US; Charleston, US; Miami, US; Valleta, Malta.
- Asia/US East Coast via Panama Canal: Hong Kong, China; Miami, US; Charleston, US; New York, US; Hong Kong, China.
- Asia/US East Coast via Suez Canal: Hong King, China; Valletta, Malta; Miami, US; Charleston, US; New York, US; Valletta, Malta; Hong Kong, China.

Depending upon the route, Miami is either the first or the last stop on the US East Coast.

The draft report assumes that depths at other key ports of call on European and Asian itineraries will limit the draft of vessels calling at the Port of Miami. Therefore, the USACE model does not assess benefits for post-panamax vessels for depths greater than the actual limiting port depth (including an additional tidal range factor) on the above-itineraries. The use of actual port depths causes benefits to end at 47' due to constraints at Charleston and New York harbors. Key Asian and European ports are all at 15 meters, or 49.2 feet.

Recommendation: The project timeframe for the Miami GRR study is 50 years, beginning in 2009. Port deepening and expansion projects are undergoing for all the US Ports in the model itineraries, as well as other major US east coast ports. Therefore, it appears reasonable to assess planned and approved port depths along the model itineraries and other major US ports and incorporate them into the model.

The top five US East Coast container ports are, in order of TEU movement in 2001: New York, Charleston, Norfolk (Hampton Roads), Savannah, and Miami (Source, AAPA, 2002). Not surprisingly, a review of proposed, approved and authorized deepening in the United States revealed that all five ports are in various stages of deepening construction, authorization, and study.

A table summarizing draft limitations existing today and predicted for the future, based on the status of federal deepening projects, is included below.

Port	Depth (existing or under construction)	Effective depth with tidal range factor	Expected depth	Expected effective depth with tidal range factor	Authoring mechanism for deepening
New York	45	47.3 [1]	50	52.3 [1]	WRDA 2000 [2]
Charleston	45	47.6 [3]	TBD	TBD	GRR (Congressionally funded 2001)
Norfolk (Hampton Roads)	45 inbound 50 outbound	47.6 [4]	50	52.6 [4]	Feasibility Study, Recommended NED Plan, December 2002 [5]
Savannah	42	45.6 [6]	48	51.6 [6]	WRDA 1999, pending Tier II EIS completion; study for additional depth expected
Miami	42	43.2 [7]	43-50	44.2 – 51.2[7]	Current Study

(1) 4.6 feet mean tidal range, USACE, October 31, 2002
(2) Main channel scheduled for completion by 2009; total project by 2016
(3) 5.2 feet mean tidal range, USACE, October 31, 2002
(4) 45 feet depth plus half of 5.2 mean tidal range, as estimated from USACE, Economic Benefits of Channel Improvements at the Port of Hampton Roads, December 2002
(5) Estimated project completion by 2005, per USACE Economic Benefits of Channel Improvements at the Port of Hampton Roads, December 2002
(6) 3.6 feet mean tidal range, NOAA
(7) 2.5 feet mean tidal range, USACE, October 31, 2002

With the exception of Charleston, which is still in the study stage, all of the key US East Coast Ports have approved or recommended depths approaching 52' (when mean tidal range is considered). The Port of Miami would have equivalent operations with the shallowest of these ports (Savannah), with a dredged depth of 49.0 feet.

All of these U.S. ports will operate at depths consistent with key European and Asian Ports (15 meters or 49.2 feet, tidal range excluded). With European ports taken into account, it appears that the limiting depth used in the USACE analysis should be at least 49.0 feet.

Attachment B

Summary

The United States Army Corps of Engineers (Corps) is drafting a National Economic Benefit Report for the channel deepening at the Port of Miami which has certain assumptions associated with future cargo growth projections at the Port. These projections are important in that they influence the degree of benefit which accrues from further deepening of the channel and turning basin.

Our analysis indicates that the Corps current estimates of growth associated with European and Asian imports are below historical trends and do not fully take into account factors which are expected to drive import demand for the foreseeable future.

In the current draft report, the Corps estimates the annual growth in containerized import cargo to be 7.60 percent between 2001 and 2029 from both the European and Far East regions. Historic trends in these markets, between 1990-2002, have shown compound annual growth of 15 % and 8.14 % respectively. We believe there is a reasonable case to be made that European cargo will grow by 11 to 12 percent annually, and Far Eastern cargo will grow by at least 8.60 percent or 1.0 percent greater than currently projected. We believe that these projections will still allow the Corps to maintain a conservative stance within its overall analysis.

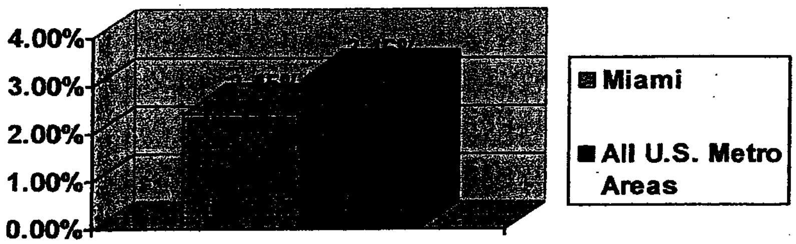
Support for these estimates is detailed below.

Far Eastern Cargo Trends

Between 1990 and 2000, the Port of Miami experienced a significant increase in imports of containerized cargo from the Far East. This increase was similar to Trans-Pacific Eastbound Containerized Trade into the United States, which grew at 9.1% per year (Mitsui O.S.K. Lines), Miami experienced a somewhat slower but similar trend, with 8.14% annual growth (Port of Miami).

Indeed, the Miami-Fort Lauderdale Consolidated Metropolitan Statistical Area (Miami CMSA) had slower Total Personal Income growth than the nation during the past decade. Total Personal Income generally shows a consistent positive correlation to cargo import trends (at least at the national level). The following graph shows Miami CMSA Total Personal Income growth between 1990 and 2000 against all metropolitan areas in the United States (all figures are in constant 1996 dollars).

Total Personal Income Growth:
Miami vs. MSA's 1990-2000
(Percent Change - Constant 1996 dollars)

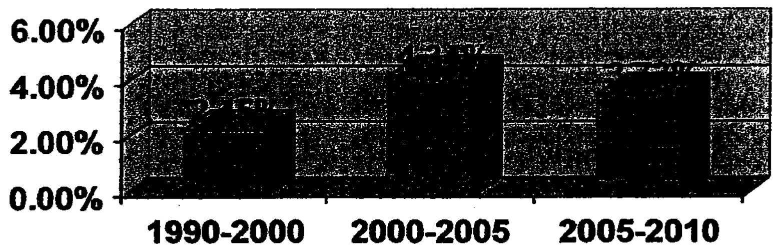


Source: U.S. Department of Commerce; NPA Data Research

More recently, despite slowing rates of growth in Personal Consumption Expenditure in the U.S over the past several years (2.5% in 2001and 3.4% annualized for 2002 vs. 4.9% in 1999 and 4.4% in 2000), the rate of growth in the Port of Miami's Asian imports has actually increased during the past two years. Short tons of Asian cargo increased by approximately 11 percent per year between 2000 and 2002 (compound annual growth). This growth is partially due to the fact that the Miami CMSA is now experiencing increased rates of Personal Income Growth which is in contrast to much of the United States and particularly other markets served by major east coast ports.

The following table depicts historical and projected annual Total Personal Income growth for the Miami metro area for the periods 1990-2000, 2001-2005, and 2005-2010. The projections are developed as part of NPA Data Services' regression model which projects population, income and construction trends for all 315 metropolitan areas of the United States. The model is updated semi-annually and has served as one of the most respected regional projection models available for over a decade.

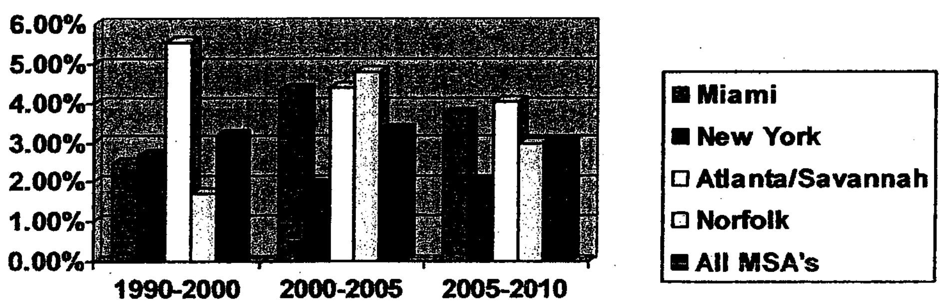
Historical and Projected Personal Income Growth (1990-2010): Miami CMSA (Percent Change - Constant 1996 Dollars)



Source: U.S. Department of Commerce; NPA Data Research

While NPA projects a decline in the growth rate of Total Personal Income for some of the other major U.S. markets served by the largest containerized ports on the east coast of the United States between 2000 and 2005 (with the exception of Norfolk), Miami's is projected to increase at a 4.3% rate between 2001 and 2005 in comparison to 2.5% during the period between 1990 and 2000. The following graph shows a comparison between historical trends and NPA's projections for Miami in comparison to Savannah/Atlanta, New York, Norfolk, and all U.S. Metropolitan Statistical Areas. It should be noted that all data is presented for the Consolidated Metropolitan Statistical Areas when one exists (in this case, Miami and New York).

Historical and Projected Personal Income Growth (1990-2010): Miami CMSA vs. Selected Other Markets (Percent Change - Constant 1996 Dollars)



Source: U.S. Department of Commerce; NPA Data Research

We believe the enhanced personal income growth, which already took hold in the later part of the 1990's and is expected to continue, is the result of a "catching up" from the lingering impacts of Hurricane Andrew in late 1992 which caused a forced out migration from the region. If not for the impact of Hurricane Andrew, Miami CMSA Total Personal Income would have grown at a significantly faster rate through the 1990's. In 1992 alone there was an actual decrease in Total Personal Income in the region of approximately 4 percent. Only recently has the region entirely caught up from this shock to the regional economy.

Given the enhanced growth in Asian cargo imports to Miami during the past two years in the face of a broad national economic downturn, and the fact that an independent respected source projects that the a principal driver of consumption and trade in a regional economy (Total Personal Income) will increase at a significantly faster pace in the future than has been the case during the last decade, there is a reasonable expectation that future growth will at least meet the pace of the last twelve years (8.56 percent annual growth) and may even exceed that rate.

For the above reasons, we encourage the Port to make a case to the Corps of Engineers that Asian import growth in their model should be increased to at least the historical 8.6 percent growth rate. Additionally, the model should be updated to include historical 2001 and 2002 figures as well which only support these higher projections.

European Cargo Trends

The case for increasing the Corps model's growth rate of European imports for the Port of Miami is entirely different than the case for increasing Far Eastern imports.

Unlike Far Eastern imports, European imports into the Port of Miami have for the past decade grown at a rate which far exceeded that of any other major Eastern U.S. market served by a major containerized cargo port, even those markets where Total Personal Income growth has been as much as double the Miami CMSA's.

The following table compares Annual Total Personal Income growth between 1990 and 2000 in key markets to annual growth in European imports expressed in loaded TEU's (as opposed to short tons given the available comparative data).

Market Area	Total Personal Income Compound Annual Growth (1990-2000)	European Imports Loaded TEU's Compound Annual Growth (1991-2000)
Miami CMSA	**2.45%**	15.40%
Savannah MSA + Atlanta MSA	5.53%	9.28%
New York/New Jersey CMSA	1.70%	8.21%
Norfolk MSA	2.68%	6.82%

Source: U.S. Department of Commerce; PIERS

The Port of Miami's European imports grew at more than 6.0 times the rate of the region's Personal Income growth in comparison to 1.7 times for Savannah/Atlanta, 4.8 times for New York, and 2.5 times for Norfolk. The Port of Miami's European imports grew at an annual which was more than six percentage points above Savannah's rate of growth despite the fact that the Savannah/Atlanta market's ability to consume goods grew at a rate more than double the Miami CMSA's.

It is clear that the Port of Miami's tremendous growth in European imports over the past several years is driven by factors which are not entirely quantifiable. We believe one key factor in driving European trade in Miami (and clearly not to the detriment of the other major east coast container ports given their significant albeit slower growth in European trade) is the ability of Miami traders to tap into new and varied supply networks. Indeed, Miami's success is driven by a more traditional driver of trade - relationships; as quaint as that might sound in this electronic and global age. These relationships are largely the result of the multi-ethnic and multi-lingual nature of the region, the relative affluence and high education level of these groups, and particularly strong European language and ethnic ties. This is the one factor which sets Miami apart from each of the other east coast markets served by a major container port with the notable exception of New York (although New York's immigration is now driven to a much greater extent by Far Eastern, Southeast Asian and African born peoples than was the case during previous generations). While hard data does not exist on the nature or extent of these relationships, there are some facts which tend to support this notion.

According to the Immigration and Naturalization Service, the Miami metro area in 2001 was the third ranked metro area behind Los Angeles and New York as the intended place of residence for legal immigrants. This is despite the fact that Miami-Fort Lauderdale is only the 12th largest metropolitan area in the nation. Of a total 65,011 legal immigrants in 2001 who intended on settling in the Miami-Fort Lauderdale CMSA (excluding Canadian immigrants) 68 percent were from a country where the principal language was of European origin. This compares to 59 percent for Los Angeles and 44 percent for New York. Additionally, the second home market in Miami and Miami Beach is heavily driven by affluent international purchasers. Major developers report that over 70 percent of all condominiums priced over $300,000 in the City of Miami are being sold as second homes to international buyers (largely Latin American and European), and as much as 30 to 40 percent in the City of Miami Beach are being sold to this group (principally European).

In sum, there is no quantitative or qualitative support for halving the growth of European imports from its historic pace (as the Corps is projecting). However, we do believe that for the sake of being conservative, and because of the extraordinary growth in the past which is not entirely quantifiable, a more moderate rate than the historical trend is reasonable to use in projections. Therefore, we would suggest that an 11 to 12 percent growth rate as opposed to the historic 15 percent rate be used with regard to projecting European growth for at least the next ten year period.

Attachment C

Comparison of Projected Growth Rates in June 1989 Feasibility Study with Actual Growth Rates (Short Tons)

Port of Miami, Florida

IMPORTS	1990 USACE	Actual 1990	Difference	% Difference	2000 USACE	Actual 2000	Difference	% Difference
Caribbean	152,800	259,214	106,414	170%	194,800	313,280	118,480	161%
Central America	292,500	412,452	119,952	141%	366,800	879,169	512,369	240%
Europe	350,600	502,519	151,919	143%	463,800	1,513,975	1,050,175	326%
Far East/Asia	225,100	278,654	53,554	124%	298,000	609,198	311,198	204%
Mid-East/Africa	16,600	30,035	13,435	181%	22,700	35,840	13,140	158%
South America	498,500	464,920	-33,580	93%	640,500	869,682	229,182	136%
	1,536,100	1,947,794	411,694	127%	1,986,600	4,221,144	2,234,544	212%
EXPORTS	**1990 USACE**	**Actual 1990**	**Difference**	**% Difference**	**2000 USACE**	**Actual 2000**	**Difference**	**% Difference**
Caribbean	752,700	595,982	-156,718	79%	901,200	894,252	-6,948	99%
Central America	325,100	356,024	30,924	110%	405,600	719,388	313,788	177%
Europe	66,400	218,188	151,788	329%	90,200	344,650	254,450	382%
Far East/Asia	48,500	23,127	-25,373	48%	66,800	278,311	211,511	417%
Mid-East/Africa	13,500	32,800	19,300	243%	16,900	9,042	-7,858	54%
South America	648,700	339,797	-308,903	52%	781,200	1,017,768	236,568	130%
	1854900	1,565,918	-288,982	84%	2261900	3,263,411	1,001,511	144%
TOTAL	3,391,000	3,513,712	122,712	104%	4,248,500	7,484,555	3,236,055	176%

Note: Comparison does not include North American trade, which was not factored into the 1989 USACE Analysis

Source: Navigation Study for Miami Harbor Channel, Florida, Feasibility Report, June 1989; Port of Miami-Dade, 2002

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4/7/99 -
Nancy -
This was given to me by Capt. Fernandez at yesterday's Waterways Committee meeting. They (the Pilots) consider it valid.
V1.
John Perez (4857)

October 23, 1997

Mr. Claude Bullock
Assistant Port Director
1015 N. America Way
Miami, Florida 33132

Dear Claude,

In order to assist the seaport in determining its needs for future dredging projects, the Biscayne Bay Pilots Association submits the following recommendations. We believe that as the channel is deepened it is vitally important that the channel also be widened. As you know Miami is one of the busiest ports in the nation. Last year our association handled over 9800 ship movements. The worlds largest cruise and container ships call here on a regular basis.

We have identified three specific areas in the channel that need to be widened. I have enclosed charts for each of these areas and highlighted that portion of the channel we feel should be widened.

The first and most critical area is the main channel entrance at Outer Bar Cut. The currents in this area are variable and unpredictable, putting large deep draft vessels are at risk when making their approach to Miami. Several Maersk container vessels have already grounded off of buoy "1". Our recommendation is to create a tapered entrance channel with an 800 foot wide entrance.

The second area of concern is on the south side of government cut between beacon 13 and beacon 15. This is an area where ships are turning from one channel into another. The strong currents in this area compounded by the necessity for the ship to have as little speed as possible, makes it important for the ship to have as much swinging room as possible. On at least three occasions that I know of, tugboats assisting ships in this area have grounded and sustained damage. Our recommendation is to widen the channel as much as possible between beacons 13 and 15.

Finally, Lummus Island Cut just south of the gantry crane area should be widened. At the present time ships transiting this area pass extremely close to vessels docked at the gantry berths. This results in a "surging" effect on the ships at the dock. Also, all too frequently, we are encountering vessels docked at Lummus Island with their cranes swung outboard 90 degrees thereby blocking a portion of the channel. Given the variables of wind, current, ship size, draft, etc., this creates an unsafe condition. Our recommendation is to extend the southern edge of Lummus Island Cut 100 feet further to the south.

I am certain that these critical channel improvements will enhance the commercial viability of the Port of Miami. Please feel free to call me if you have any questions.

Sincerely,

Robert K. Brownell
Chairman
Biscayne Bay Pilots

Encl.: 2
cc: Captain of the Port

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J 5

July 20, 2001

Richard E. Bonner, P.E.
Deputy District Engineer
For Project Management
Department of the Army
P.O. Box 4970
Jacksonville, Fl. 32232-0019

Dear Mr. Bonner,

Please be advised that the Biscayne Bay Pilots approve the proposed modifications to the alternatives 1,2,3 and 5.

Should you need further assistance please feel free to call on Captain McDonald or myself.

Sincerely,

John R. Fernandez,
Chairman
Biscayne Bay Pilots

JS
PP
Perez

BISCAYNE BAY PILOTS
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2911 PORT BOULEVARD · MIAMI, FLORIDA 33132 · TELEPHONE (305) 375-9453 · CABLE: MIAMIPILOT

May 14, 2003

Mr. Rene Perez
Project Manager
U.S. Army Corps of Engineers
PO Box 4970
Jacksonville, Florida 32232

Dear Mr. Perez:

The Miami harbor pilots wholeheartedly endorse all components of the Locally Preferred plan to deepen and widen the Miami ship channel.

Large newly constructed vessels are routinely arriving at ports of call with drafts in excess of 46 feet. If the Seaport of Miami is to remain a viable and competitive destination for ocean-going commerce on the eastern seaboard then the outer channel should be dredged to preferably 52 feet and the inner channel deepened to 50 feet.

The proposed widening of the channel (cut 1 from 500 feet to 800 feet) is needed to ensure safe transit of the large post panamax ships. With a length of 1138 feet and a beam of 141 feet, these vessels will encounter strong cross currents requiring a leeway or crab angle of 10 to 15 degrees to stay in the channel. This significantly increases the effective beam. Widening Fishermen's Channel an additional 100 feet is another critical "must." The present 500 foot channel provides only 100 to 120 feet of open water clearance if a large beamed vessel (141 feet) using tug assistance was to pass another berthed vessel of similar beam. Increasing the width would reduce the surge affect, increase clearance and should allow for safe routine passages.

If the Miami pilots can be of any assistance please contact us.

Thank you.

Yours truly,

Michael M. Wiegert

Michael M. Wiegert
Vice Chairman

August 9, 2001

Planning Division
Plan Formulation Branch
Navigation Section

Commander, Seventh Coast Guard District (oan)
ATTN: (Mr. Joe Embres)
Chief, Planning and Marine Information Section
Aids to Navigation and
Waterways Management Branch
909 Southeast 1st Avenue (Rm 406)
Miami, Florida 33131

Dear Sir:

We request your review of the enclosed figures 1-7 containing proposed modifications to Miami Harbor. Provide an estimate for initial and annual navigational aids costs for the enclosed plans. Since the plan formulation process may eliminate some alternatives, please breakdown your estimate by the following alternatives:

- Alternative 1C - Figure 1 shows Alternative 1C which increases the entrance channel width from 500 feet to 800 feet over a distance of about 900 feet and then tapers back to the 500-foot width about 2000 feet from the beginning of the existing channel.

- Alternative 2A - Figure 2 contains a widener labeled Alternative 2A near beacon #15.

- Alternative 3B - Figure 2 also contains Alternative 3B which enlarges the Fisher Island Turning Basin to the area shown in the dark blue color.

- Alternative 4 - Figure 3 includes Alternative 4 which shifts the channel alignment to the south. Figure 4 contains the west end of alternative 4.

- Alternative 5 - Figure 5 includes sheet 1 of 2 for Alternative 5 which adds a 100-foot widener to the south of the existing Lummus Island Cut or Fisherman's Channel. Figure 6 has sheet 2 of 2 for Alternative 5 which reduces the diameter of the existing Lummas Island Turning Basin and adds a widener to the west end of the proposed turning basin.

- Alternative 6 - Figure 7 contains alternative 6 which adds a 1200-foot diameter turning basin and extends the Federal channel to the west end of Dodge Island.

A drawing showing the entire Miami Harbor system of Federal channels is also enclosed. If you have any questions or need clarification on the above matter, contact Dick Powell at 904-232-1694.

Sincerely,

James C. Duck
Chief, Planning Division

Enclosures

bcc: CESAJ-DP-I (J. Scarborough)
EN-DL (B. Henderson)

RBP Powell/PD-PN/1694/slw 9/a/01
Schmidt/PD-PN
Strain/PD
Henderson/EN-DL
Scarborough/DP-I
Duck/PD

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.S. Department of Transportation
United States Coast Guard

Commander
Seventh Coast Guard District

909 S.E. 1st Avenue
Miami, FL 33130-3050
Staff Symbol: (oan)
Phone: (305) 415-6730
FAX: (305) 415-6757

16500
Serial #: 1906
31 Oct 01

Mr. James C. Duck
Chief, Planning Division
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Duck:

Thank you for your letter of August 9, 2001 regarding possible aid to navigation changes required as a result of your proposed modifications to Miami Harbor.

After review of the proposed plans, outlined below are the costs for changes to aids to navigation associated with each plan.

ALT 2A – Relocation of several buoys, no cost.

ALT 2A – Relocate Light 15 to the center of the widener. Cost $150,000, annual maintenance $15,000. Due to water depth work will need to be done by a private contractor.

ALT 3B – Relocate 1 Light. Cost $7,100

ALT 4 – No changes

ALT 5 – Relocate 1 Light. Cost $7,100
Discontinue 1 Light. Cost $1,100

If you have any questions, please do not hesitate to call me at (305) 415-6730.

J.B. EMBRES
Chief, Planning and Marine Information Section
Aids to Navigation Waterways Management Branch
Seventh Coast Guard District
By direction of the District Commander

The attached Excel workbook contains the casualty data for the area you described for Miami Harbor for Calendar Years 1992 through 2001. These data were taken from our Marine Safety Management System (MSMS Sybase NT) which contains data up to 13 December 2001.

Our analysis techniques and methods involve writing SQL for extracting data, which limits our finding data for specific locations to those in the shape of squares or rectangles, and not polygons of asymmetric shape. Our moving to GIS capability over the next several months will allow us that capability.

May I call your attention to the fields pri_nature and events 1 through 4. Pri_nature is a single statement of evaluation of the casualty and is subject to interpretation from investigator to investigator. Events 1 through 4 are a sequence of events as they occurred to the vessel in the casualty. Some vessels may be involved in a casualty and yet do not have a chain of events associated with them - this may be due to the vessel being involved causally (maneuvering caused the other vessel to ground) or the casualty/incident did not meet specific reporting or investigation criteria.

Please contact me if you have any questions regarding these data. I remain at your service.

James G. Law
Operations Research Analyst, U.S.Coast Guard
Compliance Analysis Division (G-MOA-2)
Office of Investigations and Analysis, Field Operations Directorate
Assistant Commandant for Marine Safety, Security and Environmental Protection
US Coast Guard Headquarters room 2407
(Voice: 1-800-842-8740 ext. 7-2612 or 202-267-2612
\+ Fax: 202-267-1416
\- Email: jlaw@comdt.uscg.mil

Visit our office website at:
http://www.uscg.mil/hq/g-m/moa/casualty.htm
or the Oil Spill Compendium at:
http://www.uscg.mil/hq/g%2dm/nmc/response/stats/aa.htm

incident_dt	location	service	pri_nature
19-Jan-01	PORT OF MIAMI	PASSENGER	FIRE
25-Dec-93	PORT OF MIAMI	PASSENGER	COLLISION
13-Mar-93	MIAMI SHIP CHANNEL	PASSENGER	ALLISION
14-Oct-96	PORT OF MIAMI	PASSENGER	FIRE
15-Oct-96	PORT OF MIAMI	PASSENGER	FIRE
3-Jan-98	UNDERWAY	PASSENGER	EQUIP FAIL
27-May-93	MIAMI, FL	FREIGHT SHIP	GROUNDING
18-Jul-95	GOVERNMENT CUT ENTRANCE	FREIGHT SHIP	EQUIP FAIL
27-Sep-95	CG BASE MIAMI BEACH FL	FREIGHT SHIP	ALLISION
16-Feb-97	PORT OF MIAMI	PASSENGER	EQUIP FAIL
26-Dec-97	MIAMI ANCHORAGE	FREIGHT SHIP	GROUNDING
14-Dec-95	MIAMI ANCHORAGE	FREIGHT SHIP	CAPSIZE
12-Oct-97	MIAMI BEACH	FREIGHT SHIP	GROUNDING
23-Aug-98	MIAMI ANCHORAGE	FREIGHT SHIP	EQUIP FAIL
29-Jun-99	PORT OF MIAMI ANCHORAGE	FREIGHT SHIP	COLLISION
21-Sep-95	MARKER 25 ICW PORT OF MIAMI	FREIGHT SHIP	POLLUTION
13-Jan-94	PORT OF MIAMI, FLORIDA	FISHING BOAT	GROUNDING
21-Sep-96		FREIGHT SHIP	GROUNDING
6-Mar-93	DODGE ISLAND, MIAMI, FL	FREIGHT SHIP	FLOODING
12-Jan-99	MIAMI BEACH/SOUTH POINT	FREIGHT SHIP	GROUNDING
8-Oct-95	GOVERNMENT CUT	FREIGHT SHIP	GROUNDING
20-Jul-98	MIAMI SEABUOY	PASSENGER	FIRE
23-Sep-99	GOVERMENT-CUT - POM	FREIGHT SHIP	GROUNDING
15-Aug-94	MIAMI ANCHORAGE	FREIGHT SHIP	GROUNDING
22-Oct-00	MIAMI ANCHORAGE	FREIGHT SHIP	SINKING
31-Jan-97	PORT OF MIAMI TERMINAL 2	PASSENGER	ALLISION
27-Jan-00		FREIGHT SHIP	FIRE
18-Nov-00	MIAMI BEACH MARINA	PASSENGER	EQUIP FAIL
22-Sep-93	MIAMI RIVER	FREIGHT SHIP	ALLISION
8-Oct-98	MIAMI BEACH MARINA	PASSENGER	EQUIP FAIL
30-Sep-98	MIAMI RIVER	FREIGHT SHIP	COLLISION
27-Dec-98	GOVERNMENT CUT CHANNEL	FREIGHT SHIP	EQUIP FAIL
25-Dec-99	MIAMI MAIN ENTRANCE CHANNEL	PASSENGER	EQUIP FAIL
15-Dec-99		FREIGHT SHIP	ALLISION
6-Aug-00	FISHER ISLAND SLIP	TOWBOAT/TUGBOAT	EQUIP FAIL
19-Oct-92		RECREATIONAL	SINKING
21-Nov-92	VENETIAN CAUSEWAY BRIDGE	TOWBOAT/TUGBOAT	ALLISION
21-Nov-92	VENETIAN CAUSEWAY BRIDGE	FREIGHT BARGE	ALLISION
11-Aug-94	DODGE ISLAND BRIDGE	TANK BARGE	ALLISION
8-Mar-95	FISHERMANS CHANNEL	TOWBOAT/TUGBOAT	ALLISION
24-Oct-95	MIAMI	TOWBOAT/TUGBOAT	STRUCT FAIL
25-Aug-96	MIAMI BEACH, ICW	PASSENGER	EQUIP FAIL
12-Feb-98	N MIAMI BEACH	RECREATIONAL	SINKING
22-Jun-98	WATSON ISLAND	FISHING BOAT	EXPLOSION
6-Jun-98	GOVERNMENT CUT, MIAMI	PASSENGER	CAPSIZE
18-Nov-99	SUNSET HARBOR MARINA	PASSENGER	COLLISION
20-Jan-00	PORT OF MIAMI, FL	PASSENGER	EQUIP FAIL
11-Dec-99	SW 2ND AVE BRIDGE MIAMI RIVER	TOWBOAT/TUGBOAT	ALLISION
11-Dec-99	SW 2ND AVE BRIDGE MIAMI RIVER	TANK BARGE	ALLISION
11-Dec-99	SW 2ND AVE BRIDGE MIAMI RIVER	TOWBOAT/TUGBOAT	ALLISION
25-Aug-00	FISHER ISLAND FERRY LANDING	PASSENGER	EQUIP FAIL

4-Nov-00	MIAMI - GOV'T CUT	PASSENGER	EQUIP FAIL
26-Jan-01	MIAMI, FL - GOV'T CUT	PASSENGER	EQUIP FAIL
10-Feb-01	MIAMI, FL	PASSENGER	EQUIP FAIL
3-Feb-01	MIAMI, FL (GOV'T CUT)	PASSENGER	EQUIP FAIL
11-Mar-01	MIAMI, FL - GOV'T CUT	PASSENGER	EQUIP FAIL
19-Mar-01	MIAMI, FL - GOV'T CUT	PASSENGER	EQUIP FAIL
15-Feb-01	PORT OF MIAMI	TANK BARGE	GROUNDING
15-Feb-01	PORT OF MIAMI	TOWBOAT/TUGBOAT	GROUNDING
28-Apr-01	MIAMI, FL - GOV'T CUT	PASSENGER	EQUIP FAIL
19-May-01	CAUSEWAY ISLAND, MIAMI, FL	PASSENGER BARGE	ALLISION
19-May-01	CAUSEWAY ISLAND, MIAMI, FL	COMMERCIAL	ALLISION
1-Oct-01	GOVERNMENT CUT	PASSENGER	EQUIP FAIL
18-Jun-92	GOVERNMENT CUT, MIAMI, FL	TOWBOAT/TUGBOAT	GROUNDING
15-Oct-94	1200 WEST AVE. FORTE APTS.	RECREATIONAL	POLLUTION
1-Mar-94	LUMMUS ISLAND	FREIGHT SHIP	ALLISION
19-Jul-95	WEST VENETIAN BRIDGE	TOWBOAT/TUGBOAT	ALLISION
31-Jul-95	PORT OF MIAMI	TOWBOAT/TUGBOAT	CAPSIZE
9-Sep-95	JULIA TUTTLE AND VENETIAN CSYS	TOWBOAT/TUGBOAT	ALLISION
9-Sep-95	JULIA TUTTLE AND VENETIAN CSYS	FREIGHT BARGE	ALLISION
27-Sep-95	CG BASE MIAMI BEACH FL	PUBLIC VESSEL,UNC.	ALLISION
8-Oct-95	GOVERNMENT CUT	TOWBOAT/TUGBOAT	GROUNDING
8-Oct-95	GOVERNMENT CUT	TOWBOAT/TUGBOAT	GROUNDING
2-Dec-95	MIAMI ANCHORAGE	TOWBOAT/TUGBOAT	COLLISION
2-Dec-95	MIAMI ANCHORAGE	FREIGHT BARGE	COLLISION
2-Dec-95	MIAMI ANCHORAGE	RECREATIONAL	COLLISION
8-Mar-96	GOVERNMENT CUT	TOWBOAT/TUGBOAT	GROUNDING
16-Oct-96	SOUTH CHANNEL - P.O.M.	TOWBOAT/TUGBOAT	ALLISION
17-Dec-96	GOVERNMENT CUT BUOY #16	TOWBOAT/TUGBOAT	ALLISION
17-Dec-96	GOVERNMENT CUT BUOY #16	TOWBOAT/TUGBOAT	ALLISION
17-Dec-96	GOVERNMENT CUT BUOY #16	FREIGHT SHIP	ALLISION
19-Mar-97	BAKERS HAULOVER INLET BRIDGE	TOWBOAT/TUGBOAT	ALLISION
16-Apr-97	HAULOVER	PASSENGER	GROUNDING
3-Dec-97	HAULOVER	PASSENGER	GROUNDING
2-Dec-97	PORT OF MIAMI	PASSENGER	COLLISION
2-Dec-97	PORT OF MIAMI	RECREATIONAL	COLLISION
22-Mar-98	GULF OF MEXICO/MIAMI	TANK BARGE	STRUCT FAIL
22-Mar-98	GULF OF MEXICO/MIAMI	OSV	STRUCT FAIL
29-Mar-98	MIAMI HARBOR CHANNEL ENTRANCE	PASSENGER	EQUIP FAIL
22-Jun-98	WATSON ISLAND MARINA	FISHING BOAT	EXPLOSION
27-Jun-98	MIAMI ANCHORAGE	FREIGHT SHIP	EQUIP FAIL
12-Oct-98	MIAMI SOUTH CHANNEL/CUMMUS CUT	PASSENGER	EQUIP FAIL
22-Oct-98	PORT OF MIAMI ENTRANCE CHANNEL	PASSENGER	EQUIP FAIL
31-Oct-98	BISCAYNNE BAY, FL	PASSENGER	EQUIP FAIL
30-Dec-98	HAULOVER INLET, MIAMI BEACH	FREIGHT BARGE	ALLISION
26-Apr-99		PASSENGER	EQUIP FAIL
29-Jun-99	PORT OF MIAMI ANCHORAGE	INDUSTRIAL VESSEL	COLLISION
3-Jul-99		PASSENGER	EQUIP FAIL
20-Aug-99	TERMINAL 12, PORT OF MIAMI	INDUSTRIAL VESSEL	POLLUTION
20-Aug-99	PORT OF MIAMI/	INDUSTRIAL VESSEL	SINKING
15-Dec-99		TANK BARGE	ALLISION
25-Dec-93	PORT OF MIAMI	TANK SHIP	COLLISION
8-Mar-95	FISHERMANS CHANNEL	TANK BARGE	ALLISION

18-Nov-99	SUNSET HARBOR MARINA	RECREATIONAL	COLLISION
22-Sep-93	MIAMI RIVER	TOWBOAT/TUGBOAT	ALLISION
22-Sep-93	MIAMI RIVER	TOWBOAT/TUGBOAT	ALLISION
1-Mar-94	LUMMUS ISLAND	FREIGHT SHIP	ALLISION
19-Jul-95	WEST VENETIAN BRIDGE	FREIGHT BARGE	ALLISION
19-Mar-97	BAKERS HAULOVER INLET BRIDGE	FREIGHT BARGE	ALLISION
30-Sep-98	MIAMI RIVER	TOWBOAT/TUGBOAT	COLLISION
30-Sep-98	MIAMI RIVER	TOWBOAT/TUGBOAT	COLLISION
30-Sep-98	MIAMI RIVER	FREIGHT SHIP	COLLISION
30-Dec-98	HAULOVER INLET, MIAMI BEACH	TOWBOAT/TUGBOAT	ALLISION

MIAMI-DADE WATER AND SEWER DEPARTMENT
4200 Salzedo Street, Coral Gables, Florida 33146 • Tel: 305-669-3700

SERVE • CONSERVE

March 20, 2001

Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Attn: Richard Bonner, P.E.
Deputy District Engineer for Project Management

Re: 54 inch Force Main Relocation Crossing
Government Cut between Miami Beach and Fisher Island

Dear Mr. Bonner:

Thank you for the positive response to our request to have the subject relocation done by the USACE as ancillary work to the proposed Government Cut Deepening Project. It is understood that the port deepening project is not definite at this time, with the study not due to be completed until August 2001. The County would like to go ahead with the preparation of an agreement and scope of work as offered in your letter. It is also understood that the agreement would be between the USACE and the local sponsor, Miami-Dade County/Port of Miami and that the transfer of any funds for this project would be between the local sponsor and the USACE.

Having the 54 inch force main relocation as ancillary work has several advantages. As you indicated, the relocation must be done prior to the dredging, so the schedule coordination will be easier with both projects being managed by the USACE. In addition, the design coordination should be more efficient with a single project manager. Additionally, the construction sequence and overall program management should benefit from engineers experienced in port operations as well as dredging and pipeline construction. We see this partnership in a very positive way with many advantages for both Miami-Dade County and USACE.

As a matter of clarification, both the Port of Miami and Miami-Dade Water and Sewer Department (WASD) are departments of Miami-Dade County, a political sub-division within the State. As such, the local sponsor Miami-Dade County/Port of Miami would include the Miami-Dade Water and Sewer Department. All funding from this project will come from the Miami-Dade Water and Sewer Department through the Port of Miami.

I have contacted Charles Towsley at the Port of Miami to alert him of our intentions and the need for the Port to be involved in the process. John Chorlog, Assistant Director, Wastewater (305)-669-3743 and Carl Fielland, Chief Engineer with the Port will be the primary contacts at Miami-Dade County on this project.

Sincerely,

William M. Brant, P.E.
Director

cc: C. Towsley, Port of Miami
C. Fielland, Port of Miami
J. Chorlog, WASD
H. Codispoti, WASD

MIAMI-DADE WATER AND SEWER DEPARTMENT
P.O. Box 330316, Miami, Florida 33233-0316 • 3575 S. LeJeune Road • Tel: 305-665-7471

SERVE • CONSERVE

Jerry S ✓

October 23, 2000

Ms. Lauren P. Milligan
Environmental Specialist
Office of Beaches and Coastal Systems
Department of Environmental Protection
Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

RE: DEP File No.: 0173770-001-, EI, Dade County
Applicant: U.S. Army Corps of Engineers
Project: Miami Harbor Channels
Maintenance Dredging

Dear Ms. Milligan:

WASD has subaqueous facilities at the following locations not shown on the Corps of Engineers drawings:

1.) A 54-inch sewer force main penciled in on Corps Drawing No. 8. This is the main from South Beach to Fisher island which was broken by a pile driving contractor on June 22, this year. As-built ES-4605 shows a top of pipe elevation of minus 50.0 feet. Proposed dredging depth is minus 44.0 feet plus a 2 foot allowable over dredge to a total cut of minus 46.0 feet.

2.) A 20-inch water main penciled in on Corps Drawing No. 9. This main goes from Terminal Island to Lummus Island. WASD as-built E-2326 only goes to the Lummus Island deed line, where it may change ownership to the City of Miami Beach. Their as-built UW73C shows a top of pipe at minus 48.0 feet. Proposed dredging depth is minus 38.0 feet plus a 2 foot allowable over dredge to a total cut to minus 40.0 feet.

3.) A continuation of the above mentioned 20-inch water main crossing Fisherman's Channel, from Lummus Island to Fisher Island penciled in on Corps Drawing No. 14. As-built E-2326 shows a top of pipe elevation of minus 53.8 feet. Proposed dredging depth is minus 44.0 feet plus a 2 foot allowable over dredge to a total cut to minus 46.0 feet

All three (3) mains are in conflict with any dredging of the channel sides.
As-built locations will have to be field verified, which could be a long and costly process.

Sincerely,

John W. Chorlog, P.E.
Assistant Director, Engineering/
Planning

JWC/RAJ/as

Enclosures: USACOE Drawings Nos. 8, 9 and 14

c: Richard E. Bonner, P.E., Deputy District Engineer, US Army Corps of Engineers
Craig K. Grossenbacher, Coastal Resources Section Chief, Miami-Dade County, Environmental Resources Management

HrbrChan

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960

January 14, 2003

James C. Duck
Chief, Planning Division
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Duck:

As discussed in the September 17, 2002, teleconference with the U.S. Army Corps of Engineers (Corps), the Fish and Wildlife Service (Service) is providing supplemental recommendations to those listed in our Draft Fish and Wildlife Coordination Act (FWCA) Report dated July 24, 2002, for the proposed Miami Harbor Expansion Project located in Miami-Dade County, Florida. This letter is submitted in accordance with provisions of the FWCA of 1958 (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*). The supplemental recommendations discussed in this letter will be included in the Final FWCA report.

History

As stated in the Draft FWCA Report, the Corps estimates that a total of 446.4 acres of aquatic resources, including seagrass communities, unvegetated softbottom, hardbottom, and coral reef habitat will likely be adversely affected as a result of construction activities associated with the expansion of Miami Harbor. Specifically, 6.3 acres of seagrass; 236.4 acres of unconsolidated/ unvegetated benthic habitat (softbottom); 123.5 acres of rock/rubble bottom; 31.4 acres of low relief hardbottom; and 20.7 acres of high relief hardbottom and coral reef habitat may be adversely affected. A portion of the acreage occurs in areas that were impacted during previous dredging activities within Miami Harbor.

The Corps has proposed mitigation for the impacts to hardbottom reefs which were not dredged under previous authorizations, as follows: (1) mitigate for the removal of 2.7 acres of high-relief coral reef habitat at a ratio of 2:1 through the creation of 5.3 acres of high-relief artificial reef habitat based on the National Oceanic and Atmospheric Administration's (NOAA) Habitat Equivalency Analyses (HEA and (2) mitigate for the 0.6 acre of impact to low-relief hardbottom habitat at a ratio of 1.3:1 through the creation of 0.8 acre of low-relief artificial hardbottom habitat.

However, the Corps has not proposed compensation for the removal of the biotic communities, which have colonized the channel hardbottom following the 1990 Miami Harbor dredging event. The Service believes that compensation for the temporal loss of habitat value of previously dredged low and high-relief hardbottom should also be added to the hardbottom mitigation acreage proposed for new impacts to those habitats.

In the Draft FWCA Report for the Miami Harbor Expansion Project, the Service based its hardbottom mitigation recommendations on acreage calculations that omitted impacts to previously impacted low and high-relief hardbottom (Table 1). Therefore, we are supplementing our hardbottom compensation recommendations, as discussed below.

Table 1: Draft FWCA Hardbottom Impact Acreage Summary.

Habitat type	Low-relief hardbottom (previously dredged)	High-relief hardbottom (previously dredged)	Low-relief hardbottom (new impacts)	High-relief hardbottom (new impacts)
Proposed impact acreage	30.7	18.0	0.6	2.7
Proposed mitigation (acres)	0	0	0.8	5.3
			Total= 6.1 acres	
Draft FWCA Report mitigation recommendations (acres)	0	0	4.3 (incl. 2.66 acres of side-wall impacts)	5.3
			Total= 9.6 acres	

Supplemental Recommendations

The Service conducted a Mitigation Bank Review Team (MBRT) analysis to determine the mitigation acreage for previously impacted hardbottom habitat (Table C-1, enclosed). Using a temporal loss factor of 12 years for full functional habitat recovery, the creation of 68.04 acres (58.44 acres for temporal loss of previously mitigated hardbottom plus 9.6 acres for new hardbottom impacts) artificial reef would meet the hardbottom mitigation requirements. However, approximately 48.7 acres of similar habitat base (low relief hardbottom, rock rubble) will remain on the channel bottom after dredging that will likely be recolonized and/or utilized by similar affected biotic communities. Thereby, the remaining 48.7 channel bottom acres could then be subtracted from the 68.04 acres (MBRT temporal loss mitigation acres), which would result in a deficit of 9.74 acres to be fulfilled by "outside-of-channel footprint" hardbottom artificial reef creation. Therefore, if you add the 9.97 acres of outside-of-channel footprint hardbottom to the 9.6 acres of new-impact hardbottom mitigation as recommended in the Draft FWCA report, the Service's total recommended supplemental hardbottom mitigation is 19.34 acres (Table 2).

Table 2: Summary of the Service's supplemental hardbottom mitigation recommendations

	Proposed impact acreage	Proposed mitigation (acres)		Draft FWCA Report Recommendations (acres)		Revised Draft FWCA Report Recommendations (acres)		
Low-relief hardbottom (previously dredged)	30.7	0		0		58.8 (MBRT)	68.04 Total	Post-dredging channel footprint
High-relief hardbottom (previously dredged)	18.0	0		0				48.7 Total
Low-relief hardbottom (new impacts)	0.6	0.8	6.1 Total	4.3	9.6 Total	9.6 (HEA)		Total of supplement hardbottom mitigation recommended (Table 1+2) 9.6+ 9.74 = 19.34
High-relief hardbottom (new impacts)	.27	5.3		5.3				
Softbottom mitigation recommendation	23.3	0		0		23.3		

The Corps has not proposed mitigation for the permanent loss of shallow sandy bottom, which has not been previously dredged. The Service believes that, in southeast Florida in general, this is productive benthic habitat supporting diverse faunal assemblage, as documented and referenced in the Draft FWCA Report for the Port Everglades Navigation Project. Therefore, we recommend that the Corps consider minimization of impacts to shallow sandy bottom. If the impact acres cannot be minimized, then the Service recommends a mitigation ration of 1:1 for the impacts to 23.3 acres of shallow sandy bottom habitat. This may be accomplished by filling dredge holes or channels in Biscayne Bay and/or adjacent waterways. In addition, biological monitoring should be instituted in the sandy bottom mitigation areas.

To summarize, the Service is providing the following additional recommendations:

(1) A minimum of 19.3 acres of in-kind mitigation should be provided for hardbottom impacts to newly and previously dredged hardbottom habitat. This should be included in the hardbottom monitoring plan.

(2) In-kind mitigation should be provided for dredging 23.3 acres of shallow sandy softbottom habitat, at a ratio of 1:1, such as filling or partially filling existing dredge holes and/or abandoned channels in nearby waters.

In addition, the Service is providing the following modifications and clarifications to Section 8 of the Draft FWCA Report, as identified by report recommendation number:

(1) This recommendation addresses monitoring; however, we would like to clarify that the monitoring plan should encompass channel walls **and** previously dredged channel bottom, if it is to be an element of mitigation. Also, hardbottom reef sedimentation monitoring should be instituted during dredging regardless of the water column exemption for turbidity monitoring within the stated 150 foot mixing zone.

(5) Amend: *"Remove and relocate all ~~brain and star coral~~* hard coral colonies larger than 6 inches in diameter *within the ~~2.7 acres of high-relief coral reef impact area related to Component 1~~* project footprint (including the previously dredged areas) *by experienced personnel* through established methods *to suitable* nearby hardbottom substrate. *~~and include monitoring provisions~~."* Biological monitoring should be instituted.

(7) Reads as follows: *"The Service recommends decreasing the impact area as much as possible by narrowing the channel width as much as practicable. Likewise, impacts to reefs at the east end of the entrance channel should also be reduced as much as practicable."* The Service would like to emphasize this recommendation to reduce channel expansion in hardbottom, seagrass, and shallow sandy bottom habitats **prior** to the consideration of mitigation.

Thank you for the opportunity to provide these revisions. If you have any questions concerning these supplemental recommendations and clarifications of our Final FWCA Report, please contact Trish Adams at (772) 562-3909 extension 232.

Sincerely yours,

Linda S. Ferrell
Assistant Field Supervisor
South Florida Ecological Services Office

Enclosure

cc:
NMFS, Miami, Florida
FWC, Vero Beach, Florida
FWC, Tallahassee, Florida
DEP, Tallahassee, Florida

February 2004

Volume II of II

FINAL

Preliminary Assessment-DMMP – Appendix E

For the

Miami Harbor Navigation Study
General Reevaluation Report

Miami-Dade County, Florida - 010140

US Army Corps
of Engineers®

Jacksonville District
South Atlantic Division

PRELIMINARY ASSESSMENT

MIAMI HARBOR, FLORIDA

NATIONAL HARBORS PROGRAM: DREDGED MATERIAL MANAGEMENT PLANS

FEBRUARY 2004

PRELIMINARY ASSESSMENT

MIAMI HARBOR, FLORIDA

NATIONAL HARBORS PROGRAM:
DREDGED MATERIAL MANAGEMENT PLANS

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PRELIMINARY ASSESSMENT
MIAMI HARBOR, FLORIDA

NATIONAL HARBORS PROGRAM:
DREDGED MATERIAL MANAGEMENT PLANS

1. Project Name and Description

1a. Name: Miami Harbor

1b. CWIS #: 010140

1c. Project Description:

The Federal navigation project is in Biscayne Bay, a shallow salt water sound on the Atlantic coast near the southern end of the Florida peninsula. Shallow natural passages between the keys and two artificial cuts, called Bakers Haulover Inlet and Government Cut, connect the bay to the ocean. Government Cut is the main deep-draft ship channel to the Port of Miami. The City of Miami is situated on the western shore of Biscayne Bay. The project is 23 miles south of Port Everglades, 71 miles south of Palm Beach Harbor, and about 130 miles northeast of Key West Harbor.

The authorized project for the Port of Miami is on figure 1. The harbor project provides for following features identified by section:

Section A - An approach channel 44 feet deep over a bottom width of 500 feet from the ocean to the beach line;

Section B - A channel with a 42-foot depth and bottom width of 500 feet from the beach line to the Fisher Island turning basin;

Section C - The Fisher Island turning basin with a depth of 42 feet depth over a triangular shaped bottom area;

Section D - A channel (Fisherman's Channel) 42 feet deep over a bottom width of 400 feet from the Fisher Island turning basin along the south side of Lummus Island to the Lummus Island turning basin;

11" x 17"

FOLD-OUT

FIGURE 1, PAGE 2

MIAMI HARBOR GENERAL REEVALUATION REPORT

PROPOSED NAVIGATION CHANNEL MODIFICATIONS

NOTES:
1] DRAFT Environmental Baseline Resource Survey (underwater features) provided February 2001, by Dial Cordy & Associates, Jacksonville Beach, FL
2] USACE Survey Number 00-058, March 2000
3] Beacons, aids to navigation, and soundings are in approximate locations based on NOAA Nautical Charts (number 11468, 36th Ed., July 24 1999, and number 11466, 34th Ed., February 6 1999)
4] Elevations in feet and refer to mean lower low water
5] Projection Stateplane Coordinate System, NAD27, Flpszone 0901
6] Background aerial photos taken September 1 1999

LEGEND:

Existing Navigation Channel
- Existing Centerline
- Existing Channel Edge

Proposed Components
- Cmp1c
- Cmp2a
- Cmp3b
- Cmp4
- Cmp5
- Cmp5a
- Cmp6
- Cmp6a

2000 0 2000 4000 6000 Feet

MIAMI HARBOR GENERAL REEVALUATION REPORT
Proposed Navigation Channel Modifications

N

U.S.ARMY CORPS OF ENGINEERS
Jacksonville District

Figure 1

Section E - The Lummus Island turning basin with a depth of 42 feet and a turning diameter of 1600 feet;

Section F - A channel 34 feet deep over a bottom width of 400 feet extending west 1200 feet from the Lummus Island turning basin;

Section G - A (Municipal) channel 36 feet deep over a bottom width of 400 feet from the Fisher Island turning basin west along the north side of Lummus and Dodge Islands to a third turning basin;

Section H - A (Municipal) turning basin 36 feet deep with a turning diameter of 1650 feet at the west end of the 36-foot channel;

1d. Current Project as Being Maintained:

The Federal project exists as authorized except for a portion along the south side of Lummus and Dodge Islands. Construction is underway as indicated in table 1 to complete the remaining authorized portion. About half of the 42-foot Fisherman's channel south of Lummus Island was completed under a 204 (e) agreement with the Port of Miami in 1993. Completion of the remaining half of the Fisherman's channel construction and the Lummus Island (Middle) turning basin is pending completion of a new Project Cooperation Agreement (PCA) with the Port of Miami. Completion of the new PCA is scheduled for 2004. The 34-foot channel west of the Lummus Island turning basin has been completed. Figure 1 shows the authorized project and identifies the project features as well as land areas associated with the new work dredging.

New construction in the entrance channel and work underway on the 42-foot depth features of the project have an authorized 1 foot of allowable overdepth for dredging inaccuracies. No allowance is in the authorization for a required overdepth to enable maintenance in the rock bottom. Policy at the time precluded any required overdepth dredging in rock except as justified on the basis of advanced maintenance.

TABLE 1 - PROJECT STATUS:

CWIS Number	Reach or Segment (if more than one)	Nominal Depth (feet) [1] (as auth.)	(as maint.)	Nom. Chan. Width (feet) (as auth.)	(as maint)	Max. Sailing Draft[2] (feet)	Project Sponsor (Y/N)
010140	Entrance Channel	44	44	500	500	41	Y
	Inner Channel	42	42	400	400	39	Y
	Fisher Is. T. B.	42	42	39 acres	39 acres	39	Y
	Fisherman Channel	42	[3]	400	[3]	[3]	Y
	Lummus Island Turning Basin	42	[3]	1600 dia	[3]	[3]	Y
	Fisherman Channel	34	34	400	400	31	Y
	Municipal Channel & T. B.	36	36	400 & 1650 dia	400 & 1650 dia	33	Y
Source: Waterborne Commerce of the United States (CY 2000).							

Name: Miami-Dade County Seaport Department, c/o Port of Miami		
Address: 1015 North American Way		
City: Miami	State: Florida	ZIP: 33132
Point of Contact: Carl Fielland	Phone #: (305) 347-4890	

NOTES: [1] Does not include 1-foot allowable overdepth.
[2] For vessels currently using the harbor with no use of tides. Mean tidal variation is 2.5 feet at the entrance and 2.0 in the bay.
[3] Project feature under construction and not yet complete pending new PCA in 2003.

1e. Sponsor: Miami-Dade County Seaport Department
c/o Port of Miami Harbor
1015 North American Way
Miami, FL 33132

Point of Contact: (307) 347-4890

1f. Name and Status of Cooperation Agreement:

There are several cooperation agreements in effect covering new construction and maintenance dredging contracts including a 203(e) agreement signed in November 1991, which has been amended three times. A new Project Cost Sharing agreement scheduled for execution in 2003 is currently under review by the Miami-Dade County Seaport Department to allow the Corps to takeover completion of the remaining western half of the 42-foot Lummus Island (Fisherman's) channel from the Port of Miami.

2. Authority

The authorizing documents are as follows:

a. River and Harbor Act of June 13, 1902 provided for a channel (Government Cut) 8 feet deep land cut across the peninsula and for jetty construction;

b. River and Harbor Act of March 2, 1907 set the width of the channel at 100 feet
and enabled construction of the south jetty;

c. River and Harbor Act of July 25, 1912 enlarged the channel depth to 20 feet and width to 300 feet and extended the jetties;

d. River and Harbor Act of March 3, 1925 provided for the deepening of the channels to 25 feet and increasing the width of the entrance channel to 500 feet and widening the inner channel to 200 feet across Biscayne Bay;

e. The River and Harbor Act of July 3, 1930 provided for a width of 300 feet in the channel across Biscayne Bay and for enlarging the turning basin;

f. River and Harbor Act of 1935 enabled dredging to provide a depth of 30 feet in the channel and turning basin;

g. River and Harbor Act of 1937 provided for the widening of the 30-foot deep turning basin by 200 feet southward;

h. River and Harbor Act of 1945 enabled the Virginia Key improvements;

i. River and Harbor Act of 1945 consolidated the Miami River and Miami Harbor projects;

j. River and Harbor Act of 1960 widened the channel to 400 feet and enlarged the turning basin 300 feet along both the south and northeasterly sides, and dredged a 39-acre turning basin with a depth of 30 feet along the north side of Fisher Island; deleted the Virginia Key development and Dinner Key approach channel;

k. River and Harbor Act of 1968 enlarged the entrance channel to a 38-foot depth and 500-foot width from the ocean to the existing beach line; deepened the 400-foot wide channel to 36 feet; and deepened the turning basins at Biscayne Boulevard terminal and Fisher Island to 36 feet;

l. Water Resources Development Act of 1986 deauthorized the widening at the mouth of Miami River to existing project widths; the channels from the mouth of Miami River to the turning basin, to Government Cut and to a harbor of refuge in Palmer Lake;

m. Water Resources Development Act of 1990 Public Law 101-640 authorized deepening the existing Outer Bar Cut, Bar Cut, and Government Cut to a depth of 44 feet, enlarging Fisherman's Channel, south of Lummus Island, to a depth of 42 feet and a width of 400 feet, and construction of a 1600-foot diameter Turning Basin near the end of Lummus Island to a depth of 42 feet; and

n. Water Resources Development Act of 1996 authorized deepening a channel to a depth of 34 feet over a bottom width of 400 feet from the Lummus Island turning basin west a distance of 1200 feet.

3. Economic Assessment

The Port of Miami is an important stimulus to the economic growth and progress of the Miami and South Florida area. Job-related industries, transportation of finished products, and cruise-oriented activities have contributed significantly in the expansion of economic activity. The Port of Miami having an estimated impact of $8 billion on the surrounding community supports over 45,000 jobs.

Transportation networks, connecting Miami Harbor to Florida and the remainder of the region, are extensive. A 5-lane high span bridge across the Intracoastal Waterway provides a super highway connection from the port to downtown Miami Streets for access to Interstate 95, a major north-south artery. Two major railroads provide direct service to port facilities. The Miami International Airport is a few miles west of the port and handles a majority of cruise passengers using the port.

The most recent statistical information available on vessels and tonnage is from 2000. During the period of January 1, 2000, to December 31, 2000, the number of vessels calling at Miami Harbor averaged more than 871 per month. The facilities that handled those vessels were on Dodge and Lummus Islands, and Fisher Island Tanker Terminal. About 16 percent of these vessels had drafts of 25 to 40 feet requiring the deeper depths of Miami Harbor for access. Major commodities moving through Miami Harbor in 2000 included tile, marble and granite; textiles; paper and paper products; and refrigerated fruits and vegetables. These commodities account for only 15 percent of Miami's total imports and exports. The majority of traffic is categorized as General Cargo, and accounts for 45.17 percent of imports and 63.7 percent of exports. Waterborne Commerce of the United States shows a total of 8,610,000 tons of waterborne cargo in 2000. Dodge and Lummus Islands accommodate cargo and cruise ship operations, while Fisher Island handles petroleum product, that is, bunker fuel for the cruise ships.

Passenger Terminals and cruise ship operations are mainly on the northwest portion of Dodge Island. The 36-foot deep channel and turning basin provide vessel access to that area. Some of those terminals handle both cargo and passengers. Remaining facilities are for cargo and include some roll/on-roll/off platforms. The number of cruise ship passengers increased from 2,734,816 in 1990 to 3,364,643 in 2000 while general cargo increased from 4,720,000 tons in 1991 to 8,610,000 tons in 2000. The year 2000's tonnage is 212 percent of the projected amount set by a 1989 USACE feasibility study of Miami Harbor [1].

A port development plan in 1979 evaluated the need for further improvements to increase the port's facilities for handling anticipated growth at that point in time for cruise and cargo traffic. That study resulted in an expenditure of about $250 million for capital improvements to expand the port. The main development centered on increasing the acreage of Lummus Island and connecting it to Dodge Island using material dredged from the waterway (Fisherman's Channel) south of the island. That dredging provided deeper channel access to the south side of Lummus Island. Development on Lummus Island included four gantry cranes, container berths and terminals. Development on Dodge Island included construction of a passenger terminal on the south side.

---

[1] Source: Miami-Dade County Florida Seaport Department, Port of Miami GRR Economics Analysis, 2002

The Waterborne Commerce of the United States, 2000, reported 10,456 commercial inbound vessel movements for Miami Harbor in 2000. Those movements include tankers, cargo vessels, barges, and cruise ships. The cargo in 2000 totaled about 8,610,000 short tons in comparison to 4,720,000 short tons in 1991. The average annual increase is about 6.9 percent. The inbound and outbound movements amounted to about 10.4 and 10.4 million, respectively, in 2000. Total petroleum products to the port amounted to about 1,784,000 short tons in 2000. Primary manufactured products through the harbor were 2,249,000 short tons. Food and farm products totaled about 1,969,000 tons. The port's commercial activity is summarized in table 2.

A significant portion of the tonnage movement was in containers and involved transshipment to other ports. The Port of Miami is an important transshipment point for cargo coming from Asia and Europe. That cargo arrives in larger vessels and is then reloaded into smaller vessels for destinations in the Caribbean as well as Central and South America. The port also helps supply various commodities to the Greater Miami and Dade County area. That support includes petroleum products and general cargo.

About 10 percent of the commodities and containerized goods that enter Miami Harbor are transported through terminals and cargo handling facilities along Miami River. The river terminals supply goods to ports in the Caribbean Basin where larger vessels cannot enter due to restricted harbor depths. The terminal operations are structured to a scale that can efficiently utilize the vessel fleet calling on shallower Caribbean Basin ports.

TABLE 2 - ECONOMIC DATA:

Reach or Segment	Benefit Indicators[1]	Current Operations[2]	Trend (Up, Down, Steady)	Summary/ Remarks
Project	COMMODITY TYPES	Petroleum and petroleum prod. Primary manuf. gds. Food and Farm products	Upward Upward Upward	Tonnage Traded by Region (% of Total Tonnage) S. America 24.2 Caribbean 15.5 Far East 11.3 Europe 23.8 Central Am. 20.5 Other 4.7
	TONNAGE	8,610,000	Upward	
	GROWTH RATES	7.2% per year for 1990 to 2000 period	Upward	
	VESSEL TYPES	Breakbulk and container. Bulk carriers, product tankers, tug and barge, commercial fishing vessels and cruise ships	Steady	
	VESSEL SIZES	965 ft./144.4 design draft,/39 ft. constrained draw 60635 DWT. 4300 TEUs Cruise ships - 1035 ft./35 ft. draw	Increased length and draw Increased length and width	3.36 million cruise ship passengers
	RECREATIONAL VESSEL TYPES	Mega yachts; sail and power boats	Upward	
	RECREATIONAL VESSEL SIZES	15 feet to 80 feet	Upward	
	COMMERCIAL FISHING, CHARTER	None	N/A	
	COMMERCIAL FISHING, OTHER	None	N/A	

NOTE: [1] Pertinent indicators taken from sponsor's correspondence, annual report and directories.

[2] For calendar year 2000

4. Maintenance Dredging

Shoals form in three primary areas on the deeper depth portion of the project serving the Port of Miami. The entrance channel shoal occurs mainly from the outer end of the jetties and the shoreline. Surveys in 1996 showed depths of 37.5 and 18.9 feet along the right outside quarter of the channel in that area. Shoaling in Fisherman's channel occurs about midway between Fisher Island and Lummus Island turning basins. Surveys in that area indicated depths of 31.8 feet near the eastern end of Lummus Island. The Municipal Turning Basin has shoaling along the periphery of the bottom. Depths between 29.3 and 32.9 feet can be found along the outside of the Main Turning Basin.

Bar pilots report navigational difficulties in the entrance channel. Large ground swells, effects of the Gulfstream, and northeasterly winds have an impact on vessel movements in that channel. Those conditions vary at different times of the year and make entrance into the harbor very difficult for deep draft ships. The shoaled areas of the channel reduce the bottom width of the channel for the deeper draft vessels. To lessen the probability of groundings, the port monitors the need for maintenance frequently. Maintenance dredging is to the authorized project depths where constructed with an allowance of 1 foot for dredging inaccuracies.

The deep depth project for the port overall experiences very little shoaling with an annual rate of about 15,000 to 21,000 cubic yards. Maintenance volumes for that portion of the project through 2000 are as shown in table 3. Since 1973, the deeper depths have been maintained four times. There are no known reasons for the variance in quantities and intervals of past maintenance dredging events. The 15,000 cubic yards dredged in 1985 may have resulted from the effects of a beach nourishment north of the project. Some material may have passed through the north jetty into the channel. That jetty has been sand tightened now since 1999.

TABLE 3 - MAINTENANCE DREDGING OF FEDERAL CHANNEL FEATURES SERVING THE PORT

Year	Quantity (cubic yards)
1957	80,083
1960	79,689
1965	210,218
1985	15,000
1989	250,000
1993	247,000
1995	3,000

The project has undergone construction dredging 18 times since 1904. The larger construction contracts were in 1927, 1937 -1938, 1939, and 1964. During those years, the total amount of dredged material was about 10.6 million cubic yards. Over 90 percent of the material went to expand Lummus, Dodge, and Fisher Islands as well as Virginia Key. Virginia Key has primarily received new work material, but it could also be available for maintenance material. An additional 8.4 million cubic yards of material planned to come from new work construction that began in 1991 was planned for completion by 1999 under two separate contracts. The first contract required the dredging of 2,395,000 cubic yards (Phase I) and was completed in 1993. All of that dredged material was deposited on Virginia Key. The second contract (Phase II) planned to produce about 6,000,000 cubic yards of material. Negotiations with the Miami-Dade Seaport Department (Port of Miami) are currently in progress for the Corps to take over completion of that Phase II work. The material for Phase II that was completed by the Port of Miami went to the ODMDS, which amounted to about 2.3 million cubic yards. Using the original 6,000,000 cubic yard estimate and subtracting the work done by the Port of Miami (2.3 million) leave about 3,700,000 cubic yards remaining for phase II. More recent surveys used for plans and specifications (D.O. File 20-38,332 provided by EN-DL on 11 Mar 04) for completion of phase II indicate 1,107,000 cubic yards for the base plan plus 199,000 cubic yards for berthing areas if all options are incorporated. The new phase II quantities total 1,306,000 cubic yards if all berthing area options are included.

Maintenance dredging for 1999 through 2003 is in table 4 for the deep draft ship channels. That table shows no maintenance dredging from the project over the past 5 years. The average annual shoaling rate of 21,000 cubic yards shown in table 4 was computed using the most recent survey data available from D.O. File No. 20-38,332 which indicates approximately 232,000 cubic yards of maintenance material could be removed. No significant maintenance dredging has occurred in Miami Harbor since 1993. If dredging does occur in 2004, that maintenance material represents the first significant maintenance-dredging event since 1993 or over the past 11 years (232,000/11 = 21,000). Approximately 91% (210,000 cubic yards) of that maintenance quantity comes from the outer perimeter of the cruise ship or main turning basin located at the extreme western end of the 36-foot Federal project. The Intracoastal Waterway also crosses through the middle of that turning basin. The remaining 22,000 cubic yards is located primarily along the edges of Cuts 1-2 of the entrance channel and east of the end of the jetties.

TABLE 4 – MAINTENANCE DREDGING HISTORY:

Reach or Segment	Primary Dredging Method[1]	Dredging History[2] (000 CY per year)						Disposal Site(s) Used (Identifier)
		1999	2000	2001	2002	2003	Ave.	
Project	1	0	0	0	0	0	21[3]	ODMDS

NOTE: [1] Hopper Dredge with Pump-Off. [2] Amount dredged by year for each of last 5 years. [3] Average for 1993 to 2004 period (232,000/11 = 21,000).

As of 2000, a total of $ 42,938,423, including contributions by the sponsor, has been expended on construction and maintenance on the project. Table 5 shows the expenditure of construction and maintenance dredging cost. Maintenance dredging costs since 1925 indicate an annual average of $298,000 a year.

TABLE 5 - CHANNEL COST HISTORY:

Reach or Segment	Construction/ Acquisition		Dredging Cost (thousands of dollars per year)						
	Year	Cost		1991	1992	1993	1994	1995	Ave
Project	1927 to 1939	3,651,000	Dredging:			980			298
	1964	2,587,423	Transpor-tation:						
	1993	26,000,000	Placement:						
	1994-1999	10,700,000	Env. Studies:						
			Total:			980			298

The most recent hydrographic survey for Miami Harbor No. 02-086 dated February/March 2002 for maintenance dredging indicates 22,000 cubic yards of material in Cut-1 and Cut-2. The north edge of Cut-4 and all four sides of the main (cruise ship) turning basin contain 210,000 cubic yards of material. Removal of those maintenance quantities will occur along with completion of the phase II new construction dredging project currently scheduled to start in 2004 and finish in 2005 as shown in table 6.

As noted above phase II plans and specifications D.O. File No. 20-38,332 (provided by EN-DL on 11 Mar 04) incorporates the latest survey information which indicates that approximately 91% (210,000 cubic yards) of that maintenance quantity comes from the outer perimeter of the cruise ship or main turning basin located at the extreme western end of the 36-foot Federal project. The Intracoastal Waterway also crosses through the middle of that turning basin. The remaining 22,000 cubic yards is located primarily along the edges of Cuts 1-2 of the entrance channel and east of the end of the jetties.

TABLE 6 - ANTICIPATED DREDGING:

Reach or Segment	Programmed Dredging (000 CY) (consistent with 10-year O&M maintenance plan)											Disposal Site(s) to be Used
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	AVG.	
Project	1200[2]	1000[3]	400[3]	900[3]	1100 [3]	670[3]	0	0	0	0	527	ODMDS
Project	274[1]		480[3]	400[3]						190[4]	134	Virginia Key
Project		800[3]									80	Seagrass Mitigation
Project			250[3]								25	Offshore Reef

NOTE: [1] Identified maintenance dredging (232,000) plus allowance for annual sediment accretion (21,000 in 2004 + 21,000 in 2005). [2]1,200,000 cubic yards consist of phase II new work. [3]Represents about 6,000,000 cy of phase III new work dredging, which will go to the ODMDS, Virginia Key CDF, North Biscayne Bay seagrass mitigation borrow sites, and offshore artificial reef mitigation sites identified in figure 2. [4]Next anticipated maintenance dredging project.

The programmed amount of dredged material averages 766,000 cubic yards every year as identified in table 6. The next programmed maintenance dredging is scheduled to occur in 2005 as shown in table 7. As indicated in table 7, the annual maintenance cost is projected to be $2,740,000 over a ten-year period or an average of $274,000 per year.

TABLE 7 - CHANNEL MAINTENANCE COST PROJECTIONS:

Reach or Segment	Programmed Dredging Cost (millions of dollars per year, consistent with 10-year project O&M maintenance schedule)											
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ave[1]
Project	Dredging		2.74									
	Transportation:	BREAKDOWN IS NOT AVAILABLE										
	Placem't:											
	Env. Studies:											
	Disp.Site O&M: ODMDS											
	Total:	0	2.74	0	0	0	0	0	0	0	0	.274

NOTE: [1] Average cost over 10 years.

5. Dredged Material Disposal Site Capacity and Usage

All project dredging in the deep harbor area has been in navigable waters of the United States. Since 1990, disposal of dredged maintenance material was offshore in a designated ocean dredged material disposal site (ODMDS). Table 8 shows the placement history of maintenance material from the deeper harbor area between 1998 and 2002. EPA has approved past disposal in the ODMDS, which is centered 4.5 nautical miles southeast from the mouth of the harbor.

The ODMDS is square with each side being 5,000 feet and the center at 25 degrees 45 minutes north and 80 degrees 3 minutes and 22 seconds west. Depths at that site are from 390 to over 630 feet as shown on figure 2. Disposal in the past has had little impact on depths. Routine maintenance is sporadic and not likely to have a significant impact on depths in that area.

TABLE 8 - PLACEMENT HISTORY:

Disposal Site(s) (Identifier)	Primary Disposal Method[1]	Placement History[2] (000 CY)					
		1999	2000	2001	2002	2003	Ave.
ODMDS	Bottom Dump	2,300[3]					21[2]

NOTE: [1] Bottom Dump
[2] Computed average per year shown since site not used in last 5 years for maintenance.
[3] New work material from phase II placed at ODMDS.

Table 9 provides available information about the ODMDS. That site is in use for disposal of dredged material from the deepening of the harbor serving the port. The first contract for the new work, completed in 1993, did not require disposal of material in the ODMDS.

If all the construction material stayed in the ODMDS, the depth of material in that site would be roughly less than 7 feet assuming a somewhat uniform spread over the entire area. Potential maintenance from the deep harbor area use at about 21,000 cubic yards a year results in about 420,000 cubic yards over 20 years. That is equivalent to less than a foot of depth in the ODMDS. The assessment of the ODMDS capability is that the site can easily handle another 20 to 30 years of disposal including new work dredging without a significant reduction in existing depths of 390 to over 630 feet.

Virginia Key (figure 1) is an upland confined disposal facility (CDF) that could be used during the phase III (February 2004, Miami Harbor GRR and EIS) dredging to potentially receive some of the material dredged from Cuts-1, 2, 3, and 5 by a cutter-suction dredge. Sand removed from the widening of the entrance channel and Fisherman's channel by the cutter-suction could be placed at Virginia Key for later reuse. About 80,000 cubic yards of that sand material from Virginia Key will serve as a beneficial use of dredged material by providing a 2-foot cap over approximately 720,000 cubic yards of rock material from the phase III deepening to fill of a borrow site within north Biscayne Bay for seagrass mitigation as shown in figure 2. As a beneficial use of dredged material the City of Miami has mined material from Virginia Key to use as construction fill. Currently the Virginia Key CDF requires rehabilitation of the dikes and weirs. Rehabilitation of the CDF would provide approximately 1.5 to 2.0 million cubic yards of capacity using existing material within the CDF to rebuild or raise the dikes.

Currently District Project Management and Miami-Dade County Seaport Department plan to develop an agreement with the City of Miami for use of Virginia Key upland CDF as a potential disposal sites for placement of material from the upcoming phase II dredging project. Use of Virginia Key for phase III dredging would also involve a similar agreement.

Other potential beneficial uses of dredged material from the phase III (February 2004, Miami Harbor GRR and EIS) deepening include about 250,000 cubic yards of rock material for development of low and high relief artificial reefs. The artificial reefs will provide mitigation for impacts to existing reef areas as a result of the entrance channel widener shown as component 1C in figure 1.

Future maintenance activities warrant consideration of both the borrow site north of the Julia Tuttle Causeway for placement of dredged material to continue rehabilitation of seagrass areas contiguous to the planned sites and additional artificial reef development. Both future maintenance activities would require the appropriate NEPA documentation and coordination with Local, State and Federal agencies.

TABLE 9 - DISPOSAL SITE DATA:

Disposal Site(s) (Name or Identifier)	Site Type [1] (select)	Disposal Site Capacity		Beneficial Uses (CY/Year)		Other Users[2]	Disposal Site Sponsor (Y/N)
		Original (000)	Percent Filled	Existing	Anti-cipated	(select)	
ODMDS	2	N/A	N/A	N	N	B	Y
Virginia Key	6	1600[8]	N/A	N/A	880	B	Y
Proposed Artificial Reef POM	2	N/A	N/A	0	250	B	Y
Proposed Seagrass Mitigation POM	1	N/A	N/A	0	800	B	Y

Sponsor(s) for Disposal Site(s) (List all individual sponsors)		
Name: Miami-Dade County Seaport Department, c/o Port of Miami		
Address: 1015 North American Way		
City: Miami	State: Florida	ZIP: 33132
Point of Contact: Carl Fielland	Phone # (305) 347-4890	

NOTES:

[1] Disposal Sites:

1 - Open Water, unrestrained
2 - Designated Open Water
3 - Near Shore (surf zone)
4 - On Shore (beach nourishment)
5 - Near Shore Confined (in-water CDF)
6 - Upland Confined (on-shore CDF)
7 - Upland Unconfined
8 – Assumes RFP process for phase II dredging exercises all bid options & rehabs Virginia Key dikes

[2] Non-Corps Users:

A - None, [Corps has exclusive use]
B - Authorized [Other parties allowed to use, with or without Corps consent]
C - Allocated [Space available for project related non-Corps dredging at no cost]
D - Permitted [Space available for non-Corps dredging in the area at a cost]
E - Restricted [Non-Corps use controlled by another party, Corps has full use]
F - Royalty [Site controlled by another party, Corps uses at a cost]

6. Environmental Compliance

A final Environmental Impact Statement (EIS) dated August 09, 1995, resulted in designation of a new ODMDS. Investigations revealed three areas of controversy. The State of Florida believes that all ODMDSs should be restricted to prohibit the disposal of:

a. Beach quality sand,
b. Material with a grain size less than .025 mm, and
c. Material constituted by more than 10 percent fine-grained material.

No issues remain unresolved. The first two issues concerning beach quality sand disposal and prohibition of fine-grained material were resolved with the State. The August 09, 1995 EIS contains the resolution of those issues with associated responses to comments. The EIS states that only dredged material suitable for ocean disposal will be disposed in the Miami ODMDS. The suitability of dredged material for ocean disposal must be verified by the Corps of Engineers and agreed to by EPA prior to disposal. The disposition of beach compatible sand from the deep harbor project will be determined during State water quality considerations. The site management and monitoring plan requires a real-time current monitoring program during disposal until the effects of disposal during eddy currents are better understood. Disposal of fine-grained materials occurs only during certain current conditions.

An Environmental Impact Statement (EIS) submitted as part of the February 2004 Navigation Study for Miami Harbor General Reevaluation Report and Environmental Impact Statement proposes disposal of new work dredging materials at up to four disposal sites. The four sites include seagrass mitigation sites in north Biscayne Bay, artificial reef areas south of the entrance channel, the Virginia Key upland confined disposal facility, or the offshore Miami ODMDS.

The February 2004 EIS, Appendix E, contains an environmental baseline resource survey of the Miami Harbor area. The environmental resource survey includes the results of field investigations (video and diver surveys) which characterize marine habitats with the areas to be impacted.

Few environmental quality resources exist in the deep harbor portions of the project serving the port. Upland areas of the port on Dodge and Lummus Islands are fully developed. The deep-water areas serving the port have low and high relief harbottom reef habitat and seagrass areas outside the edges of the Federal channel. Benthic organisms can be found on the bottom and sides of the deep project. The rocks and crevices of the jetties provide habitat for a variety of fish.

Most terrestrial mammals and birds have been effectively extirpated from the Port of Miami. Development is intense in those areas. Aquatic birds such as pelicans and gulls still range over the areas.

Species that are listed as threatened or endangered that can be found in the area are as follows:

Reptiles	Mammals	Fish
Green turtle	West Indian manatee	Smalltooth Sawfish
Hawksbill turtle	Finback whale	Proposed (E)
Kemp's Ridley turtle	Humpback whale	Designated Critical Habitat
Leatherback turtle	Right whale	Johnson's Seagrass:
Loggerhead turtle	Sei whale	Manatees
American Crocodile	Sperm whale	
	Blue Whale	

A notice of intent to prepare a draft EIS was published in the Federal Register on August 13, 2001. After completion of independent technical reviews and approval by higher authority initiation of the public review period as well as State and Federal agency reviews of the draft EIS will occur.

Archival and literature review along with consultation with the Florida State Historic Preservation Officer (SHPO) identified the potential for significant cultural resources within the channel expansion areas. A survey for underwater cultural resources was recommended and conducted. No significant cultural resources were identified as a result of the survey. Based on that survey SHPO concurred (April 18, 2002 DHR #2002-03669) with the Corps determination that the dredging project would have no effect on cultural resources.

The dredge material will be disposed in existing disposal areas or used to fill previously dredged borrow site areas near the Julia Tuttle Causeway. As such the disposal has no potential to affect cultural resources. The reef construction was developed as mitigation for this project and will require separate SHPO consultation.

Table 10 notes that the environmental documentation is in the process of being updated for completion of the phase II new work dredging and maintenance (WQC #138023199). NEPA documentation for the proposed phase III deepening and widening project is scheduled for submission to higher authority in February 2004 as part of the Navigation Study for Miami Harbor General Reevaluation Report and Environmental Impact Statement.

TABLE 10 - PROJECT COMPLIANCE:

Reach or Segment	Document[1]	Preparation Date	Expiration Date	Scheduled Update
Project	WQC#0173770-001EI	7 March 1986	7 March 2001	April 2004
	General Reevaluation Report & EIS	February 2004	Concurrent with Final Report	Concurrent with Final Report

NOTE: [1] NEPA Document or documentation showing compliance with environmental law or regulation, e.g. Water Quality Certification.

7. Conclusions

Preliminary assessment of the deep harbor serving the port indicates that the disposal of shoal material has no major problems for the foreseeable dredging cycle. Future dredging will utilize the designated ODMDS and/or Virginia Key. The ODMDS is in deep water and has an estimated potential capacity for over 20 years of disposal for maintenance and new work dredged material. Virginia Key has significant capacity remaining with rehabilitation of the dikes, and current fill will continue to be recycled as construction fill and also be a potential source of material for stabilization of the shoreline and preservation of the historic Virginia Key Beach Park or other nearby beach erosion control projects. The Environmental Protection Agency has approved past placements of dredged material from Miami Harbor into the ODMDS.

The economic viability of Miami Harbor is not in question at the present time. Over the years, the amount of cargo tonnage in the deep harbor area has increased from 4,720,000 tons in 1991 to 8,610,000 tons in 2000. Port-related industries have significant investments in terminals and infrastructure to handle the tonnage volume. Available information indicates that Miami Harbor is an economically viable project and justified for future maintenance as indicated in table 11.

Environmental compliance will continue concurrently with the study process for phase III dredging and with subsequent development of plans and specifications for phases II and III. Water Quality Certification (WQC) on that portion will be obtained and environmental impact statements will be updated as noted in table 10.

TABLE 11 - MAINTENANCE SUMMARY STATUS FOR MIAMI HARBOR:

The ability to maintain this project for the next 20 years is limited by:	
Disposal Site Capacity	N
Economic Viability	N
Environmental Compliance	N

8. Recommendations

Miami Harbor - Continued maintenance of this project is warranted on the basis of project usage and indicators of economic productivity, sufficient disposal capacity available, and maintenance activities in compliance with applicable environmental laws and regulations for the next 20 years. Therefore, no additional dredged material management plan (DMMP) is necessary beyond this assessment. See table 12.

This assessment supports that this project's disposal requirements can be met for the next 20 years. A DMMP is not required.

TABLE 12 - ECONOMIC ASSESSMENT OF CONTINUED MAINTENANCE DREDGING

	ECONOMIC STATISTICS	AUTHORIZING STUDY [1]	RECENT STUDY [2]	CURRENT CONDITIONS [3]	ASSESS-MENT	SUMM-ARY
BENEFIT INDICATORS	COMMODITY TYPES	GENERAL CARGO [4]	GENERAL CARGO	GENERAL CARGO	+	+
	TONNAGE ESTIMATES	2.4 MILLION [5]	8.6 MILLION [6]	8.6 MILLION [6]	+	
	GROWTH RATES	5% [7]	8.07% [8]	8.07% [8]	+	
	TRADE ROUTES	[9]	[9]	[9]	+	
	VESSEL TYPES	CONTAINER RO/RO	CONTAINER RO/RO	CONTAINER RO/RO	+	
	VESSEL SIZES	PANAMAX [10]	POST-PANAMAX [11]	PANAMAX [12]	+	
	VESSEL OPERATIONS	MAX LOAD [12]	MAX LOAD [12]	CONSTRAINED[13]	+	
COST INDICATORS	DREDGING CYCLE	NA	10	10	0	0
	DREDGING QUANTITIES/CYCLE	NA	100,000	100,000	0	
	AVG. ANN.MAINT. COST	NA	$3,000,000	$3,000,000	0	
	PRICE LEVEL	NA	2003	2003		
CONCLUSION	JUSTIFICATION OF CONTINUED MAINENANCE DREDGING IS WARRANTED BASED ON THE FEB 2003 ECONOMIC ANALYSIS IN THE MIAMI HARBOR GRR					

Note:

1- JUNE 1989

2- FEB 2003

3- FEB 2003

4- 2002 (PORT CARGO DATA RECORDS)

5- 2.4 MILLION SHORT TONS (1986)

6- 8.6MILLION SHORT TONS

7- 5% Average Annual Growth Rate 1976 to 1986

8- 8.07% Average Annual Growth Rate 1990 to 2000

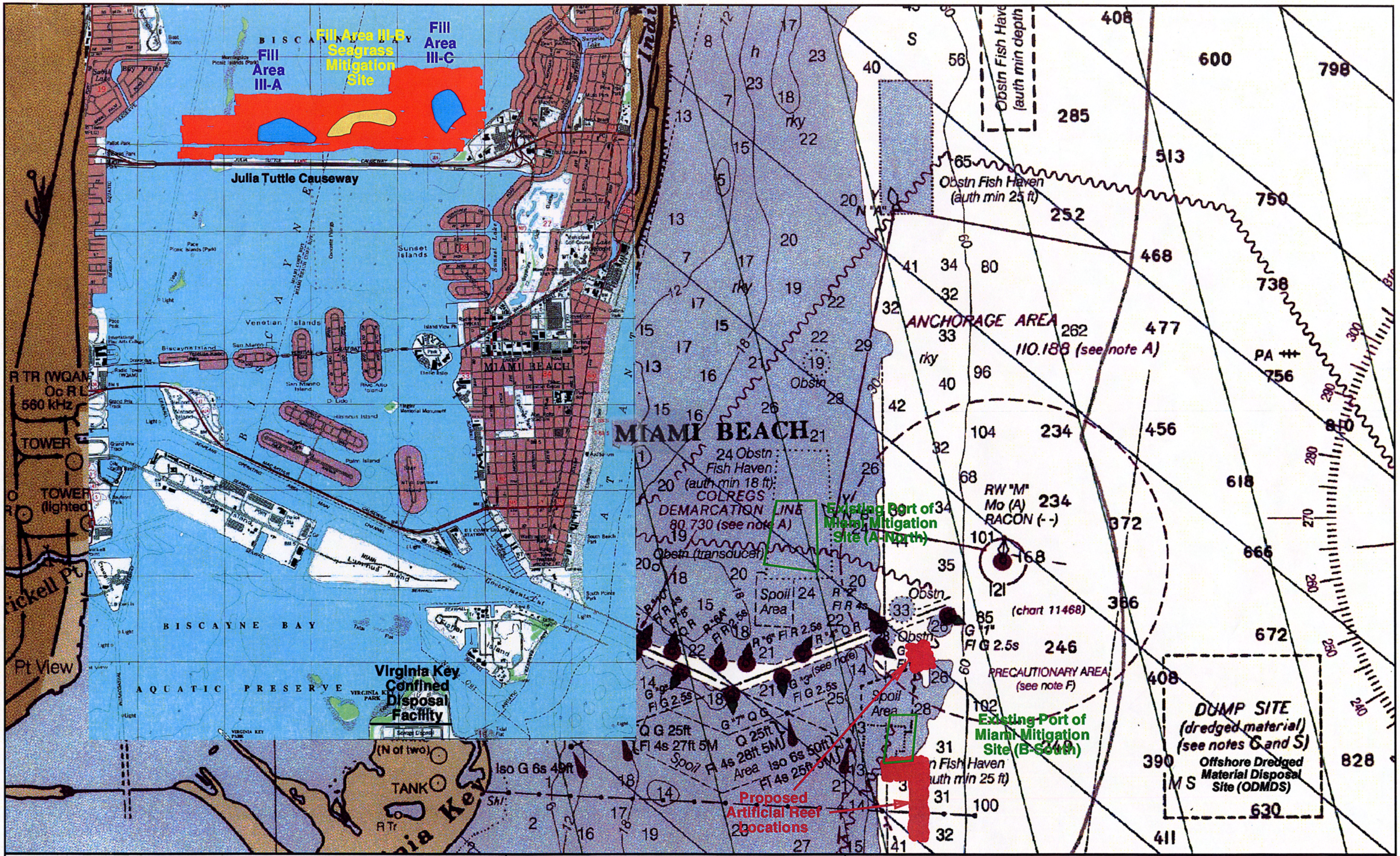
9- Latin America, Europe, Mediterranean, Far East

10- Panamax: 950 feet LOA, 106 feet beam, 43.0 feet draft

11- Post-Panamax: 1,138 Feet LOA, 141 feet beam, 47.6 feet draft

12- Panamax: 965 feet LOA, 106 feet beam, 44.4 feet draft

13- Lightloaded prior to deepening



NOTES:
1] Background images combined NOAA navigational charts 11466, 35th Ed. dated June 2000 and 11468, 38th Ed. dated March 2001.
2] Soundings in feet at mean lower low water.
3] Projection Universal Transverse Mercator (UTM), NAD27, units meters, zone 17.

2000 0 2000 4000 6000 Feet

N

PROPOSED DREDGED MATERIAL DISPOSAL SITES AND MITIGATION LOCATIONS

U.S.ARMY CORPS OF ENGINEERS
Jacksonville District

Figure 2

February 2004

Volume II of II

FINAL

Mitigation Plan – Incremental Cost Analysis

Appendix F

For the

Miami Harbor Navigation Study
General Reevaluation Report

Miami-Dade County, Florida - 010140

US Army Corps of Engineers®

Jacksonville District
South Atlantic Division

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Article I. Seagrass Mitigation

Section 1.01 *Introduction*

Restoring seagrass beds, if successful, can be an appropriate mitigation strategy due to its high ecological value and declining abundance. Seagrass restoration adds habitat value to unvegetated sand or mud substrates. The addition of seagrass beds increases the productivity and diversity of the unvegetated bottom, which can directly compensate for the historic loss in productivity and diversity.

Fonseca et al. (1996a, 1996b) found that within three years, restored seagrass beds (*H. wrightii*) planted on 0.5-m centers reach the same areal density and support animal densities, number of taxa, and species composition equivalent to natural beds. Some restored seagrass beds support invertebrate populations that are as or more abundant than those in natural grassbeds (Bell et al. 1993). Restored seagrass beds appear to be as suitable as natural seagrass beds for juvenile and small adult fish (Brown-Peterson et al. 1993).

Restored seagrass beds support animal densities similar to natural seagrass beds when shoot density is only one-third that of a natural seagrass bed (Fonseca et al. 1996). Thus, the habitat value of a restored seagrass bed is maximized relatively quickly, prior to the restored bed reaching the same vegetative density as a natural seagrass bed. In addition to providing habitat itself, seagrass beds increase the productivity of adjacent habitats. Irandi and Crawford (1997) found that the presence of seagrass beds adjacent to tidal marshes increased the abundance and growth rates of fish in the tidal marsh.

Research has identified that seagrass beds are more diverse and productive than unvegetated substrate. Average fish densities in natural seagrass beds were ten times greater than those on unvegetated areas (~20 individuals/m^2 versus 1.74 individuals/m^2). Shrimp densities in natural shoal grass beds averaged 151 individuals/m^2 compared to 3.02 individuals/m^2 in unvegetated areas. Crab densities in natural seagrass beds were 20 to 50 individuals/m^2 compared to an average of 1.91 individuals/m^2 on unvegetated areas (Fonseca et al. 1996). Within 1.5 years of planting, restored seagrass beds support shrimp, fish, and crab densities similar to natural seagrass beds (Fonseca et al. 1996). Thus, restored seagrass beds can increase the density of shrimp, fish, and crabs by 10 to 50 times compared to unvegetated substrates.

Although research has identified that seagrass beds are more diverse and productive than unvegetated substrates, relatively few studies compare secondary productivity between seagrass beds and other habitats. Heck et al. (1995) determined that eelgrass beds in the northeastern United States had macroinvertebrate production 5 to 15 times higher than adjacent unvegetated habitats. At least a similar increase in productivity is expected for *H. wrightii* and *T. testudium*, which have a higher primary productivity than eelgrass. Also, a similar increase in abundance, diversity, and productivity of fish species may also be expected.

Restoration of seagrass communities, while still considered experimental and not highly successful by resource agencies, can enhance habitat heterogeneity and the diversity of invertebrate and fish communities, if carefully implemented. The recent treatise on seagrass restoration entitled "Guidelines for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters" by Fonseca et al. (1998) discusses the benefits and risks associated with seagrass restoration. Given the documented success of more recent efforts to restore seagrass communities, including those in South Florida, restoration is quickly becoming a proven resource management tool in some areas where conditions are appropriate.

(a) Impacted Acreage and Associated Mitigation Requirements

Impacted seagrass acreage for the recommended plan is 7.9. Mitigation will be performed by filling sections of a borrow site which provided construction material for the Julia Tuttle Causeway; however, the hole we propose to fill has a surface area of 24 acres. To ensure success of the mitigation for the 7.9 acres of seagrass impacts, the Corps must fill the entire 24-acre hole.

(b) Potential Mitigation Sites

Over 25 mitigation options ranging from significant tidal and mangrove habitat restoration in south Biscayne Bay to restoring seagrass habitat in north Biscayne Bay were considered for mitigating seagrass impacts. Based on detailed analysis and significant agency coordination, restoring seagrass habitat in north Biscayne Bay was the preferred option. Evaluation of eight borrow areas resulted in the selection of one site that will provide approximately 24-acres. The additional acreage provided would be banked for future Port use. A table of the different mitigation options considered by the Corps in developing the mitigation plan is included in the mitigation plan, Appendix J of the EIS.

Section 1.02 Alternative Seagrass Mitigation Plans

(a) Placement Method

Two alternatives for placement of the seagrass were considered: planting the seagrass and allowing the seagrass to naturally recolonize.

(i) Plant

Planting of the proposed 24-acre mitigation site is expected to follow a pattern demonstrated by a three-acre restoration site in North Biscayne Bay that was prepared by Miami-Dade County DERM. Restoration of three-acre borrow area in North Biscayne Bay was completed in the late 1990s. Although no monitoring has been done by DERM since planting of the site, a visual inspection by an agency team in 2002 revealed that seagrass occurs throughout the site and was dominated by *H. wrightii* and *T. testudinum*. Discussions with DERM staff indicate the old borrow area was filled with rubble and sand and planting units of both *H. wrightii* and *T. testudinum* installed. Based on this evidence of success, it is agreed that seagrass restoration in deep dredge holes was a viable option for mitigating seagrass loss in Biscayne Bay.

(ii) Recolonize

Another example of successful seagrass restoration is the Miami-Dade sewage cross-bay force main installed by the Miami-Dade Water and Sewer Authority Department in the mid-1990s. The project required trenching of over one mile of Miami Harbor baybottom for pipeline installation, including excavation of 1.80 acres of seagrass beds. Once the pipeline was installed the 22-foot wide trench path was refilled and allowed to recruit with seagrasses. Recruitment had begun within one-year and after two years seagrasses and macroalgaes covered the trench pathway so that it was no longer visible on aerial photography.

(b) Construction Method

Three construction methods for containing the material within the boundaries of the hole were considered: use of sheet pile, use of rock, and use of a combination of sheet pile and rock.

(i) Sheet Pile

Cantilever sheet pile driven or jetted into the sandy bottom material around the borrow site to provide containment would only receive tentative support at the end driven into the bottom material. Additional tiebacks or other methods of lateral support would be required which complicate the construction method before fill material could be added. Dense areas of seagrass surround the borrow site on three sides leaving access for construction equipment from only one side. Construction of the cantilever sheet pile requires careful sequencing to allow shallow draft construction barges and cranes room to exit the borrow site from the one available entry area that has sufficient depths. Filling of the construction site also requires careful sequencing so as to not box-in the construction equipment or limit its access to the borrow site. Construction of the cantilever sheet pile containment system with lateral support and filling of the site would have to occur concurrently from one end or the borrow site and work back to the available access corridor before completion or closing of the access corridor could occur.

(ii) Rock

Rock from the blasting and dredging of the Lummus Island (Fisherman's) channel about two to six miles away provides a good source of fill material for the borrow site. Transportation of rock material from the dredging project along the Intracoastal Waterway to the borrow site requires the use of small shallow draft barges. A crane barge will transfer rock material from the shallow draft barges for placement in the borrow site. Rock placement will occur to within two feet of the optimum level for seagrass development as shown on plate B-17 of Engineering Appendix B. The crane barge will place a 2-foot sand cap on the rock to complete filling of the borrow site to match the depth of the adjacent seagrass areas. Rock provides a stable foundation for capping and seagrass development. Filling of the borrow site with rock followed by a sand cap would occur sequentially from one end of the borrow site and work back to the available access corridor. Sand material for capping would come from the confined upland disposal site on Virginia Key by small shallow draft barge.

(iii) Combination Sheet Pile and Rock

Combining sheet pile with rock involves use of elements from both of the above methods. Driving or jetting the sheet pile into the sandy bottom material would occur as described above under the sheet pile discussion. Rock material would be used to replace the tieback or lateral restrain system required by the sheet pile method. The construction sequence would also be similar to the sheet pile method.

(c) Alternative Plans

The combination of the two placement methods and the three construction methods leads to six alternative seagrass mitigation plans, as shown in Table 1.

Table 1: Alternative Seagrass Mitigation Plans

	Seagrass Placement Method	
Construction Method	*Plant*	*Recolonize*
Sheet Pile	Seagrass Mitigation Alternative 1	Seagrass Mitigation Alternative 2
Rock	Seagrass Mitigation Alternative 3	Seagrass Mitigation Alternative 4
Rock and Sheet Pile	Seagrass Mitigation Alternative 5	Seagrass Mitigation Alternative 6

Section 1.03 Expected Costs of Alternative Seagrass Mitigation Plans

(a) Initial Cost

(i) Construction of Site Cost

Estimated site construction costs vary according to the method employed to contain the material in the hole. See Table 2 for the estimated costs associated with the use of sheet pile, rock, and a combination of sheet pile and rock. There is no cost associated with the use of dredged material for retaining the material within the hole. This is because an analysis of the costs of transporting the dredged material to the mitigation site and the costs of transporting the dredged material to the disposal site showed that there is no marginal (extra) expense associated with using the material for mitigation.

(ii) Planting Cost

As shown in Table 2, the estimated cost to plant seagrass is $45,000 per acre, or $1,080,000 for the entire 24-acre site. Planting costs are only included as initial costs for Alternative Seagrass Mitigation Plans 1, 3, and 5. Initial costs for Alternative Seagrass

Mitigation Plans 2, 4, and 6 do not include planting costs because these plans call for allowing natural colonization to occur.

Table 2: Estimated Costs of Seagrass Mitigation Components

Expense	Cost/Acre	Cost/Project
Planting	$45,000	$1,080,000
Sheet Pile		$30,000
Sheet Pile/Rock		$15,000
Rock		$0
Transportation/Other		$3,836,814

(b) Chance of Success

The chance of successful recolonization of the seagrass in Alternative Seagrass Mitigation Plans 2, 4, and 6 is 95 percent, as shown in Table 3.

(c) Secondary Cost

Secondary costs are incurred under Seagrass Mitigation Alternatives 2, 4, and 6 if recolonization does not occur within two years and planting is performed as a result.

(i) Planting Cost

In the event recolonization does not occur after two years, there would be an additional cost to plant the site at that time.

(ii) Discounted Planting Cost

The secondary cost is discounted from t=2 years to the base year to account for its value at that time.

(d) Estimated Expected Cost of Each Seagrass Mitigation Alternative

Table 3 displays the expected cost of each seagrass mitigation alternative. The expected cost equals the initial cost, plus, if applicable, the discounted secondary cost multiplied by the probability of the secondary cost occurring.

Table 3: Estimated Expected Cost of Seagrass Mitigation by Seagrass Mitigation Alternative Plan

Seagrass Mitigation Alternative	Initial Cost	% Chance Initial Success	Secondary Cost	Discounted Secondary Cost	Expected Secondary Cost	Expected Total Cost
1	$4,946,814	99%	n/a	n/a	n/a	$4,946,814
2	$3,866,814	95%	$1,080,000	$994,887	$49,744	$3,916,558
3	$4,916,814	99%	n/a	n/a	n/a	$4,916,814
4	$3,836,814	95%	$1,080,000	$994,887	$49,744	$3,886,558
5	$4,931,814	99%	n/a	n/a	n/a	$4,931,814
6	$3,851,814	95%	$1,080,000	$994,887	$49,744	$3,901,558

Section 1.04 Seagrass Mitigation Benefits

(a) Coverage

Coverage for seagrass is defined by a real coverage – how much area of the substrate is covered by all of the individuals of a selected species within a defined area.

(i) Plant

Coverage of planted areas would be 100% over the mitigation site right after construction was complete on .5m centers using transplanted species of seagrasses from nearby donor beds to the restoration site. Based on other seagrass restoration sites located in Northern Biscayne Bay, we expect good success with high survivability of all species planted.

(ii) Recolonize

Natural recolonization or recruitment from seagrass beds surrounding the mitigation site is expected to occur rather rapidly. Seagrasses in South Florida demonstrate a sequential hierarchy as they colonize new substrates. It is anticipated that ambient depths will range from -2 feet to -6 feet MSL in the restored areas following restoration and that seagrass recruitment will occur rapidly by *H. wrightii* and *H. decipiens,* both of which likely occur within the shallow flats adjacent to the proposed site. Other species including *T. testudinum* and *S. filiforme* will also colonize the site, but generally only after occupation by the early colonizing species previously cited.

(b) Density

Density of seagrass is defined as the number of individual seagrass shoots of a selected species within a defined area.

(i) Plant

Restored seagrass beds support animal densities similar to natural seagrass beds when shoot density is only one-third that of a natural seagrass bed (Fonseca et al. 1996). Thus, the habitat value of a restored seagrass bed is maximized relatively quickly, prior to the restored bed reaching the same vegetative density as a natural seagrass bed. Since planting will likely occur on .5m centers we can expect the density of each species to be low in the first year and increase as the plant shoots mature and grow.

(ii) Recolonize

Density of naturally recolonized or recruited beds onto the new substrate will likely be higher on the edges of the project site and lower in the middle during the first year post construction – filling from the outside of the project boundaries in toward the middle. We expect that the dominant grass in the area will colonize the site only after pioneering grass species previously discussed colonizes it.

(c) Total Expected Acreage by Half Year

Total expected seagrass acreage for each half year of the project is calculated using the expected density and coverage for that time period. By the end of year two of the project, coverage and density are at their highest potential level regardless of the placement method employed.

(d) Average Annual Equivalent (AAE) Acreage

AAE acreage refers to the average yearly acreage of seagrass expected to exist over the fifty years of the project. AAE acreages for the plant and recolonize options are calculated from the information shown in Table 4. Although after year 2 of the project the acreage is equal for both placement options, AAE acreage is higher for the alternatives that employ planting as a placement method because of the higher acreage experienced in the first two years of the project.

Table 4: AAE Seagrass Benefits by Placement Method

Plant				
Year	0.5	1	1.5	2-50
Coverage	100%	100%	100%	100%
Density	20%	65%	85%	90%
Expected Acreage	4.8	15.6	20.4	21.6
AAE Acreage - Plant	21.14			
Recolonize				
Year	0.5	1	1.5	2-50
Coverage	20%	40%	70%	100%
Density	65%	70%	85%	90%
Expected Acreage	3.1	6.7	14.3	21.6
AAE Acreage - Recolonize	20.98			

Section 1.05 Cost-Effective Plan

(a) AAE Cost per AAE Acre

Base year (discounted) costs of each alternative mitigation plan are annualized and compared to the respective AAE benefits (see Table 5). Alternative plans are compared by calculating their AAE cost per AAE benefit (acreage).

Table 5: AAE Cost per Acre of Seagrass Mitigation by Seagrass Mitigation Alternative Plan

Seagrass Mitigation Alternative	AAE Cost of Mitigation	AAE Benefits of Mitigation (acres)	AAE Cost/Acre
1	$297,543	21.14	$14,072
2	$235,575	20.98	$11,230
3	$295,739	21.14	$13,987
4	$233,770	20.98	$11,144
5	$296,641	21.14	$14,030
6	$234,673	20.98	$11,187

(b) Cost-Effective Seagrass Mitigation Plan

Table 5 shows the process of comparing alternative seagrass mitigation plans and reveals that Seagrass Mitigation Alternative 4 provides the needed acreage at the lowest cost per acre; therefore, Alternative 4 is the Cost-Effective seagrass mitigation plan.

Section 1.06 Estimation of Seagrass Mitigation Costs for Alternative Project Plans

(a) Implemented Plan and Costs Employed for Comparison of Alternative Project Plans

Seagrass mitigation costs were estimated for each project increment. Although the cost-effective mitigation plan, Seagrass Alternative Mitigation Plan 4, is chosen for implementation, the highest possible cost of that plan, rather than the expected cost of the plan, was used for project cost estimation purposes. This means that the costs shown in Table 6 and Table 7 assume that recolonization does not occur and planting is necessary after two years.

(b) Incremental Seagrass Mitigation Costs by Project Increment

Table 6 displays the estimated seagrass mitigation cost by project increment (see Economics Appendix and Main Report for a discussion of project increments and alternative project plans).

Table 6: Incremental Seagrass Mitigation Costs

Increment	Seagrass Mitigation Cost
1C, 2A, 5A	$3,305,756
3B	$531,058
Deepen System from 42 Feet to 43 Feet	$0
Deepen System from 43 Feet to 44 Feet	$0
Deepen System from 44 Feet to 45 Feet	$0
Deepen System from 45 Feet to 46 Feet	$0
Deepen System from 46 Feet to 47 Feet	$0
Deepen System from 47 Feet to 48 Feet	$0
Deepen System from 48 Feet to 49 Feet	$0
Deepen System from 49 Feet to 50 Feet	$0

(c) Seagrass Mitigation Costs by Alternative Plan

Table 7 displays the total estimated seagrass mitigation costs for each alternative project plan.

Table 7: Seagrass Mitigation Costs by Alternative Project Plan

Project	Seagrass Mitigation Cost
Alternative Plan A: No Action	$0
Alternative Plan B: 1C, 2A, 5A	$3,305,756
Alternative Plan C: 3B	$531,058
Alternative Plan D: 1C, 2A, 5A and 3B	$3,836,814
Alternative Plan H: 1C, 2A, 5A and 3B, and Deepen Channel (Any Depth)	$3,836,814

Article II. Artificial Reef Mitigation

Artificial reefs are often proposed for mitigating impacts to natural hardbottom habitats as a result of beach restoration (Lutz 1998). Mitigation reefs differ in several ways from traditional artificial reefs for fishing enhancement. Traditional artificial reefs are usually constructed offshore, are generally of high relief, are promoted as fishing destinations, and often utilize vessels or other non-natural substrate to offer divers an interesting alternative to natural reefs. In contrast, mitigation reefs should be designed to mimic the lost habitat as closely as possible in terms of relief and structural complexity. They should be placed in the same habitat depth zones as the impacted natural hardbottom/reef, and consumptive use of the reefs should be discouraged.

Artificial reefs have been used successfully for many years to mitigate impacts in sheltered waters (Duffy 1985) (Davis 1985) or in relatively deep water offshore (Mostkoff 1993). Reef deployments in shallow, open coastal areas present special challenges in the wave stability of materials and burial by sand movements in this very dynamic habitat. Palm Beach County has had considerable success with deploying shallow water artificial reefs as mitigation measures. The proposed design reflects the limitations on design and placement imposed by navigation regulations, liability issues, construction limitations, and stability concerns.

Section 2.01 Introduction

(a) Impacted Acreage and Associated Mitigation Requirements

Impacted artificial reef acreage for the recommended plan is 0.6 acres of low relief hardbottom and 2.7 acres of high relief hardbottom. Mitigation will be performed at a 2:1 ratio for the high relief hardbottom, resulting in 5.4 acres of mitigation and 1.3:1 ratio for low relief hardbottom, resulting in 0.8 acres of mitigation; therefore, a total of 6.2 acres of artificial reef is required.

(i) Request For Proposal (RFP) Process to Avoid Impacts

The Request for Proposal (RFP) process conducted prior to award of a construction contract will allow for an in-depth evaluation of a potential contractor's proposal. The RFP process as currently planned for this proposed project would rate the technical portion of a contractor's proposal as the most significant. This results in an incentive approach, which will encourage the contractor to avoid impacts to reef areas. As a result, the vessel operational and anchoring plan that best avoids or reduces impacts to reefs would receive the highest evaluation and the incentives that follow. Measures such as the use of surge buoys to lift anchor cables and restricted anchor placement to minimize impacts would be important factors in determining the best construction methodology to avoid reef impacts.

(ii) Worst Case Impacts

If cutterhead dredging is used as the construction method to deepen the Entrance Channel, additional direct impacts to both low relief and high relief hardbottom reefs would occur due to anchoring and cable systems for the cutterhead vessel. Assuming an unrealistic worse case scenario in which the contractor refuses incentives and does nothing to avoid reef impacts the potential exists for up to 26.9 acres of low relief and 10.0 acres of high relief hardbottom reefs to be impacted based on a maximum number of anchor positions and total cable contact with the footprint area. Since the construction method depends on the results of the RFP process, the actual impacts using a cutterhead dredge are unknown. The USACE would conduct pre-construction and post-construction surveys to determine actual impacts and then coordinate with the resource agencies on appropriate mitigation. Costs used in this analysis represent the worst case scenario.

(b) Possible Mitigation Sites

Mitigation reefs will be required in two different designs, to reflect the differences in the habitat structure of the two types of hardbottom/reef habitat to be impacted. The Corps reviewed four potential placement mitigation sites for hardbottom mitigation, two sites that are managed by Miami-Dade County and two sites that are currently unpermitted to receive mitigation reef materials.

Two types of mitigation reefs will be constructed; HRHC reefs and LRLC reefs. The HRHC reefs are intended to mitigate for impacts to high relief habitat and the LRLC reefs are intended to mitigate for impacts to lower relief reef. LRLC reefs will have a vertical relief of 1 to 2 feet and will be placed inshore of, and shallower than, HRHC reefs.

After reviewing the Miami-Dade county permitted sites, it was determined that one of the sites (DERM reef site A – north of the entrance channel) is too shallow to mimic the reef that is being impacted and has very little available space for reef construction. DERM reef site B – located to the south of the entrance channel has 58.3-acres of available space for reef creation. It already has some artificial reef located within the boundaries, which would allow for quicker colonization of artificial reef material, as well as allowing for easier monitoring since it is adjacent to a county mitigation site that is currently monitored. Water depths of this site are similar to the depths of high relief reefs being impacted by the proposed project (40 to 45 feet). The County has already completed the permitting process with the State of Florida for this artificial reef site.

Mitigation reefs will be required in two different designs, to reflect the differences in the habitat structure of the two types of hardbottom/reef habitat to be impacted. The Corps reviewed four potential placement mitigation sites for hardbottom mitigation, two sites that are managed by Miami-Dade County and two sites that are currently unpermitted to receive mitigation reef materials.

Two types of mitigation reefs will be constructed; HRHC reefs and LRLC reefs. The HRHC reefs are intended to mitigate for impacts to high relief habitat and the LRLC reefs are intended to mitigate for impacts to lower relief reef. LRLC reefs will have a vertical relief of 1 to 2 feet and will be placed inshore of, and shallower than, HRHC reefs.

After reviewing the Miami-Dade county permitted sites, it was determined that one of the sites (DERM reef site A – north of the entrance channel) is too shallow to mimic the reef that is being impacted and has very little available space for reef construction. DERM reef site B – located to the south of the entrance channel has 58.3-acres of available space for reef creation. It already has some artificial reef located within the boundaries, which would allow for quicker colonization of artificial reef material, as well as allowing for easier monitoring since it is adjacent to a county mitigation site that is currently monitored. Water depths of this site are similar to the depths of high relief reefs being impacted by the proposed project (40 to 45 feet). The County has already completed the permitting process with the State of Florida for this artificial reef site.

The Corps reviewed two additional sites for placement of reef mitigation material. Both sites are located south of the entrance channel. The northernmost site is located north of DERM reef site B, and has shallower water depths (35 to 40 feet). The southern "L"-shaped site is directly adjacent to the DERM reef site B. However, it was determined that hardbottom communities are located within the proposed site, which would make using the site for mitigation construction difficult due to the requirement to avoid impacts to the existing resources within the site while constructing mitigation reefs.

Section 2.02 Alternative Artificial Reef Mitigation Plans

(a) Placement Method

Two alternatives for placement of the artificial reef were considered. One placement method would involve the use of divers to place the material. The second placement method would be to use a crane barge to place the material.

(i) Divers

Rock would be transferred from the port deepening location to the selected mitigation site on barges. Each rock would be lowered from the barge to the selected site below. A diver (or more than one diver) would be on the bottom and provide guidance for the rock placement, stacking the rock and ensuring that the rocks were securely placed on the bottom and stacked to a height necessary to properly mimic the functions of the impacted reef. While more successful at placing rock and guaranteeing the artificial reef is built to mimic the impacted reef, it is less efficient since it is limited by sea conditions, conditions on the bottom at the construction site (currents, visibility, water temperature) and the amount of time that an individual diver can spend on the bottom. Construction with Divers is typically more expensive than construction without divers.

(ii) Crane Barge

This construction technique is much the same as the with diver option, however, the reef is constructed only with the crane without diver involvement, which may prove more efficient due to not being limited by human SCUBA divers and the associated limitations.

(b) Construction Material

Both dredged rock and purchased quarry rock were considered for use as construction material.

(i) Dredged Rock

Rock blasted from the Harbor Deepening project is proposed to be used for construction of the mitigation reefs because the rock is native limestone, fossilized coral reef material and will quickly colonize with infaunal reef species who live within the rock structure of a coral reef.

(ii) Quarry Rock

Rock quarried from offsite must be of a material that can be utilized by infaunal reef species – so it must match the composition of the native reef material – which limits what rock can be used as a substrate. In south Florida reef environments the rock must be limestone. The rock must be of a large enough size and heavy enough to prevent movement of the reefs during storm events such as hurricanes.

(c) Alternative Plans

The combination of the two placement methods and the two construction materials leads to four alternative artificial reef mitigation Plans, as shown in Table 8.

Table 8: Alternative Artificial Reef Mitigation Plans

	Artifical Reef Placement Method	
Construction Material	*Diver*	*Crane Barge*
Dredged Material	Artifical Reef Mitigation Alternative 1	Artifical Reef Mitigation Alternative 2
Quarry Rock	Artifical Reef Mitigation Alternative 3	Artifical Reef Mitigation Alternative 4

Section 2.03 Expected Costs of Alternative Artificial Reef Mitigation Plans

(a) Cost of Placement

Costs for artificial reef mitigation were calculated based on crane barge placement. Alternatives that include placement by diver are associated with an additional cost that represents the amount by which diver placement is more costly than crane barge placement. See Table 9 for the estimated additional cost associated with the use of diver for placement.

(b) Cost of Material

As shown in Table 9, there is no cost associated with the use of dredged material for artificial reef mitigation. This is because an analysis of the costs of transporting the dredged material to the mitigation site and the costs of transporting the dredged material to the disposal site showed that there is no marginal (extra) expense associated with using the material for mitigation.

Table 9: Estimated Costs of Artificial Reef Mitigation Components

Expense	Cost/Acre	Cost/Project
Diver Placement (Additional Cost)		$692,385
Dredged Material	$0	$0
Quarry Rock	$600,000	$3,720,000
Transportation/Other (Includes Crane Barge Placement)		$3,954,342

(c) Estimated Cost of Each Artificial Reef Mitigation Alternative

Combining the component costs leads to an estimated cost for each Artificial Reef Mitigation Plan, shown in Table 10.

Table 10: Estimated Mitigation Expense by Alternative Artificial Reef Mitigation Plan

Artifical Reef Mitigation Alternative	Estimated Cost
1	$4,646,727
2	$3,954,342
3	$8,366,727
4	$7,674,342

Section 2.04 Artificial Reef Mitigation Benefits

(a) Effective Acreage

The immediate benefits of the newly constructed artificial reefs will be an estimated 20 percent of established reefs and will provide increasing benefits over time. The rate at which the benefits increase varies between low-relief and high-relief reefs, as shown in Table 11.

Table 11: Effective Acreage of Low- and High-Relief Mitigation

Effective Acreage Gained from Recovery of Low-Relief Artificial Reefs		
Project Year	**% Service Level***	**Effective Acreage**
1	20.00%	0.23
2	26.67%	0.30
3	33.33%	0.38
4	40.00%	0.45
5	46.67%	0.53
6	53.33%	0.60
7	60.00%	0.68
8	66.67%	0.75
9	73.33%	0.83
10	80.00%	0.90
11	86.67%	0.98
12	93.33%	1.05
13-50	100.00%	1.13
Effective Acreage Gained from Recovery of High-Relief Artificial Reefs		
Project Year	**% Service Level***	**Effective Acreage**
1	20.00%	1.01
2	22.67%	1.15
3	25.33%	1.28
4	28.00%	1.42
5	30.67%	1.56
6	33.33%	1.69
7	36.00%	1.83
8	38.67%	1.96
9	41.33%	2.10
10	44.00%	2.23
11	46.67%	2.37
12	49.33%	2.50
13	52.00%	2.64
14	54.67%	2.77
15	57.33%	2.91
16	60.00%	3.04
17	62.67%	3.18
18	65.33%	3.31
19	68.00%	3.45
20	70.67%	3.58
21	73.33%	3.72
22	76.00%	3.86
23	78.67%	3.99
24	81.33%	4.13
25	84.00%	4.26
26	86.67%	4.40
27	89.33%	4.53
28	92.00%	4.67
29	94.67%	4.80
30	97.33%	4.94
31-50	100.00%	5.07
*Source: Habitat Equivalency Analysis, Mitigation Plan, Appendix J - DEIS		

(b) Average Annual Equivalent AAE Acreage

AAE acreage refers to the average acreage of Artificial Reef expected to exist over the fifty years of the project. Because the reefs will not be immediately fully beneficial, AAE acreage is less than the total acreage experienced once the reefs are established. AAE for the Artificial Reef Mitigation is shown in Table 12.

Table 12: Total Effective AAE Artificial Reef Acreage

Total Effective AAE Low-Relief Acreage	1.01
Total Effective AAE High-Relief Acreage	3.81
Tota Effective AAE Acreage	4.82

Section 2.05 Cost-Effective Plan

(a) AAE Cost per AAE Acre

Base year (discounted) costs of each alternative mitigation plan are annualized and compared to the respective AAE benefits (see Table 13). Alternative mitigation plans are compared by calculating their AAE Cost per AAE benefit (acreage).

(b) Cost-Effective Artificial Reef Mitigation Plan

Table 13 shows the process of comparing alternative artificial reef mitigation plans and reveals that Artificial Reef Mitigation Alternative 2 provides the needed acreage at the lowest cost per acre; therefore, Alternative 2 is the Cost-Effective Artificial Reef Mitigation Plan.

Table 13: AAE Cost per Acre of Artificial Reef Mitigation by Artificial Reef Mitigation Alternative Plan

Artifical Reef Mitigation Alternative	AAE Cost of Mitigation	AAE Benefits of Mitigation (acres)	AAE Cost/Acre
1	$279,493	4.82	$57,929
2	$237,847	4.82	$49,298
3	$503,245	4.82	$104,305
4	$461,600	4.82	$95,674

Section 2.06 Estimation of Artificial Reef Mitigation Costs for Alternative Project Plans

(a) Incremental Artificial Reef Mitigation Costs by Project Increment

Table 14 displays the estimated artificial reef mitigation cost by project increment (see Economics Appendix and Main Report for a discussion of project increments and alternative plans).

Table 14: Incremental Artificial Reef Mitigation Costs

Increment	Artificial Reef Mitigation Cost
1C, 2A, 5A	$3,954,342
3B	$0
Deepen System from 42 Feet to 43 Feet	$0
Deepen System from 43 Feet to 44 Feet	$0
Deepen System from 44 Feet to 45 Feet	$0
Deepen System from 45 Feet to 46 Feet	$0
Deepen System from 46 Feet to 47 Feet	$0
Deepen System from 47 Feet to 48 Feet	$0
Deepen System from 48 Feet to 49 Feet	$0
Deepen System from 49 Feet to 50 Feet	$0

(b) Artificial Reef Mitigation Costs by Alternative Plan

Table 15 displays the total estimated artificial reef mitigation costs for each alternative project plan.

Table 15: Artificial Reef Mitigation Costs by Alternative Project Plan

Project	Artificial Reef Mitigation Cost
Alternative Plan A: No Action	$0
Alternative Plan B: 1C, 2A, 5A	$3,954,342
Alternative Plan C: 3B	$0
Alternative Plan D: 1C, 2A, 5A and 3B	$3,954,342
Alternative Plan H: 1C, 2A, 5A and 3B, and Deepen Channel (Any Depth)	$3,954,342

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