Port Everglades Navigation Improvements-Draft Comprehensive Mitigation Plan and Incremental Cost Analysis

Prepared for

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1.0 PROJECT OVERVIEW

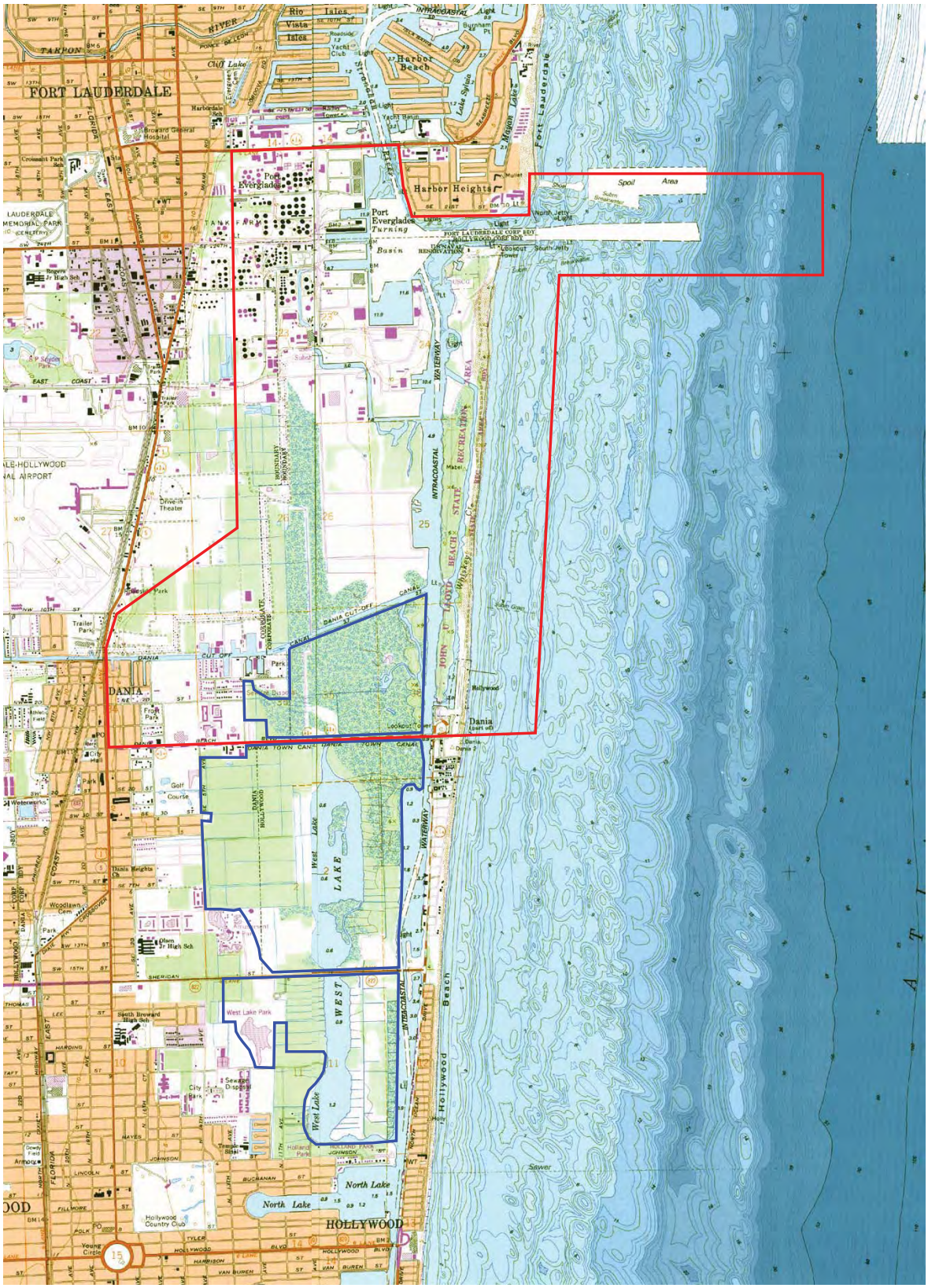
The Port Everglades (Port) is a major seaport located on the southeast coast of Florida (Figure 1). The Port has immediate access to the Atlantic Ocean, and is located within parts of the cities of Hollywood, Dania Beach, and Fort Lauderdale. To the east of the Port is a barrier island that contains a U.S. Navy (USN) facility, a Nova Southeastern University (NSU) facility, a U.S. Coast Guard (USCG) facility, and John U. Lloyd Beach State Park (JUL) and its adjacent beaches. South of the Port's Dania Cutoff Canal (DCC) is the West Lake Park (WLP) area. West of the Port is Federal Highway (U.S. 1) which is flanked by the Fort Lauderdale International Airport (FTL). North of the Port is a mixture of small-craft waterways (Intracoastal Waterway and canals) and commercial and residential development.

The existing federal channel depth of 42 feet at Port Everglades does not provide an adequate, safe depth for large tankers and container ships currently visiting the harbor. Those ships must light-load or wait on tides to enter the harbor resulting in transportation inefficiencies and additional expenses. Additionally, the next generation of container ships requires significantly more channel depth to operate efficiently and safely. Specifically, the next generation of container ships comprises post-Panamax vessels, such as the *MV Susan Maersk* with an overall length of 1,138 feet, an extreme breadth of 141 feet, and a maximum draft of 47.6 feet. In contrast, the current largest Panamax container ships have overall lengths of 965 feet, an extreme breadth of 106 feet, and a maximum draft of 44.3 feet.

Economic analyses have shown that improvements to most of the channels and basins serving the Port are required to achieve efficient transit of the existing fleet and to accommodate the future fleet. Avoiding light-loading of ships, allowing for port calls at all tides, and promoting a fewer number of calls with larger vessels (rather than more calls with smaller vessels) will improve the efficiency of port operations and mitigate the costs of products brought in through the Port.

Port Everglades pilots have expressed significant concern regarding the safety of navigation to and within the existing federal channels. The entrance channel has dangerously strong cross currents which vary in strength and are unpredictable in direction. These currents generally run at right angles to the direction of the narrow entrance channel making transit hazardous, without local knowledge, for deep draft vessels. These currents have been reported to be as much as 5 knots (National Ocean Service 2010). A wider and deeper entrance channel and deeper inner entrance channel will greatly improve the safety of navigation.

The primary objectives of the federal project are to provide for existing and future vessel movements, resolve navigation restriction problems (including those related to navigation safety); and present opportunities for national economic development.



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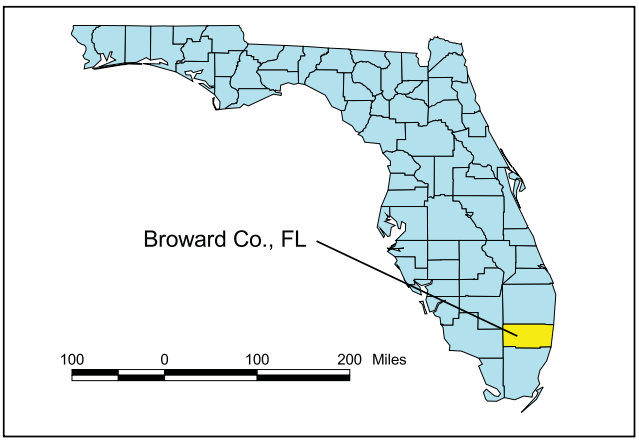


LEGEND

- Approximate Study Limits
- West Lake Park Boundary (approx.)

Study Area	
Port Everglades Navigation Improvements Mitigation Plan	
Scale: 1" = 3,000'	Drawn By: MR
Date: March 2011	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 1

2.0 HABITAT IMPACTS DUE TO PROJECT CONSTRUCTION

The existing authorized Port Everglades Federal Navigation Project comprises an Outer Entrance Channel (OEC), an Inner Entrance Channel (IEC), a Main Turning Basin (MTB), a North Turning Basin (NTB), a South Turning Basin (STB), a Southport Access Channel (SAC), and a Turning Notch (TN). The deepening and widening of various components (see main text of EIS for details and maps) will achieve project objectives. The tentatively selected plan (TSP) consists of the following navigation improvements (see the EIS for figures):

a increase the authorized depth of the OEC from 45 feet (actual existing depths vary) to 48 feet (-48 feet MLLW) (i.e., an *actual* depth of up to 57 feet due to engineering and safety requirements), widen the seaward end of it from 500 feet to 800 feet, and extend the channel 2,200 feet seaward;

b. increase the authorized depth of the Inner Entrance Channel (IEC) from 42 feet to 48 feet (resulting in an actual depth of 50 feet);

c. increase the authorized depth of the Main Turning Basin (MTB) from 42 feet to 48 feet (resulting in an actual depth of 50 feet);

d. widen the rectangular shoal region (the Widener, or "WID") by approximately 300 feet to the southeast of the MTB and deepen it to a new authorized depth of 48 feet (resulting in an actual depth of 50 feet);

e. widen the Southport Access Channel (SAC) in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 feet and relocate the United State Coast Guard (USCG) facility, a General Navigation Feature (GNF), easterly on USCG property;

f. shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition back from the expanded Widener area in the north to the existing federal channel limits to the south;

g. increase the authorized depth of the SAC from 42 feet to 48 feet (from the area adjacent to berth 23 to the south end of berth 32), resulting in an actual depth of 50 feet;

h. deepen the Turning Notch (TN), including an area currently being expanded and incorporated into the TN by the local sponsor, from 42 feet to 48 feet (resulting in an actual depth of 50 feet); widen the SAC to the east (across from the TN) by an additional 100 feet over a length of about 1,845 feet; and widen the western edge of the SAC from near the south end of berth 29 to a width of up to approximately 130 feet at the north edge of the TN;

i. conduct environmental mitigation (see below);

j. pre-treat rock substrates as necessary and take appropriate measures to safeguard protected species during that process;

k. dispose of dredged material east of the Port at the Offshore Dredged Material Disposal Site (ODMDS), which is currently proposed for expansion by USEPA. If it is not expanded, the maximum amount of material that can be placed within the existing site will be deposited, and alternatives will be explored for the deposition of remaining material (NEPA coordination to that effect are currently underway).

The Port's 20-year Master/Vision Plan agreement with the Florida Department of Environmental Protection (FDEP) includes expansion of the TN to increase berth capacity. This 400-foot expansion includes the release from the existing 48.27-acre conservation easement of approximately 8.68 acres west of the TN, and deepening the entire notch to 42 feet MLLW. The notch expansion is considered a future without-project condition, and is the sole responsibility of the sponsor, the Port

To achieve the above expansion and reconfiguration in accordance with the TSP, several resource types will be impacted. These are listed below in Table 1. The existing condition and value of the impacted resources, and anticipated future-without-project condition of these resources, are discussed in detail in the Environmental Impact Statement (Sections 3.5.2, 3.6.1, and 3.6.2; and Sections 4.3.1, 4.4.1.1, and 4.4.2.1, respectively).

USACE guidance on mitigation states that mitigation will be conducted for “significant” ecological resources compared to the future without plan condition. The habitat types noted in Table 1 classified as “Resources for which mitigation is proposed” are jurisdictional mangrove wetlands, seagrass beds, and hardbottom/reef habitats that have not been previously dredged. For areas within the TSP’s footprint that were previously dredged and which will return to their current state in a relatively short time period, such as silt/sand bottom, and channel walls, mitigation will not be provided (USACE *ER 1105-2-100, Appendix C (Environmental Evaluation and Compliance) Appendix C (Paragraph C-3.d (4)(b)).*

To compensate for unavoidable impacts to these habitat types, USACE has proposed a mitigation plan that will restore the ecosystem functions lost due to removal of wetland, seagrass, and hardbottom habitats in areas that were not previously dredged. The functional value of each of these is briefly discussed below. Additional details may be found in the Environmental Impact Statement.

> ***Mangroves*.** Mangroves are the dominant wetland type within the study area. Mangroves also represent the largest natural habitat within the project boundaries, and are found in both natural and created wetlands. These habitats comprise either stands of red mangrove (*Rhizophora mangle*) or mixed stands of red mangrove and black mangrove (*Avicennia germinans*). Major associates include white mangrove (*Languncularia racemosa*) and buttonwood (*Conocarpus erectus*). Mangroves are important for shoreline protection and stabilization. In addition, mangrove habitats provide many important ecological functions, including providing refugia for juvenile stages of managed fish species, and have been identified as significant resources for seven federally protected species, and four federally protected subspecies (Odum and McIvor 1990). These systems also provide organic matter that forms the basis of a littoral-zone, marine food web. Sloughs (channels of slow-moving water) penetrate mangrove wetlands adjacent to channel areas. Some of these sloughs are natural, while some are man-made. These are extremely important areas that provide species with passageways for movement into and out of interior mangrove areas. They are also important for refuge and feeding areas for various fishes and invertebrates. These habitats are important within Broward County since the County is urbanized and most of the previously existing mangrove habitat has been removed.
>
> The largest (by area) mangrove habitats in the project area occur along the western shore of JUL and north and west of the TN. Some fringing mangrove wetlands in JUL comprise habitat created by the Port as mitigation for previous impacts to native areas of mangrove. Mangroves to the north and west of the TN fall under a FDEP conservation easement. Sloughs, both manmade and natural, are associated with both of these major mangrove areas.

Table 1 Approximate Acreages of Direct Impacts of Tentatively Selected Plan (OEC 48-foot Authorized Depth Option) Implementation by Construction Element and Habitat Type

	Habitat Type	Turning Notch	Southport Access Channel	Widener	Main Turning Basin	Inner Entrance Channel	Outer Entrance Channel	Subtotal per Habitat Type
Resources for which **NO** mitigation is proposed	Uplands: forest and scrub-shrub		0.37					0.37
	Previously dredged Inlet channel					26.76	52.99	79.75
	Unconsolidated substrates: soft bottom	26.03	119.28	10.94	120.48	4.12		280.85
	Unconsolidated substrates: sand					3.39	9.44	12.83
----Resources for which mitigation **IS** proposed----	Seagrasses: non-special-status		0.15	0.21	*	0.08		0.44
	Seagrasses: *Halophila johnsonii* only (special-status)		1.77	1.39				3.16
	Seagrasses: *H. johnsonii* with other species		0.18	0.23				0.41
	Wetlands: mangroves		1.16					1.16
	Hardbottom: shallow colonized pavement						0.02	0.02
	Hardbottom: deep colonized pavement						5.07	5.07
	Linear reef: middle tract						5.03	5.03
	Linear reef: outer tract						4.14	4.14
	Spur and groove reef: outer tract						0.93	0.93
	Subtotal per Component	26.03	122.91	12.77	120.48	34.35	77.62	394.16

* Approximately 87 square feet for the sum of two areas. (Data based on ArcInfo GIS analysis conducted in August 2012.)

***Seagrasses*.** The Port project area supports sub-tropical and tropical seagrass communities including *Halophila decipiens* (paddle grass), *Halodule wrightii* (shoal grass), *H. johnsonii* (Johnson's seagrass), and associated green calcareous and brown algae, such as *Penicillus* spp., *Halimeda* spp. and *Caulerpa* spp. Seagrasses colonize soft sediments, generally at the edge of the channel, starting in the IEC, going south to beyond the DCC. These seagrass beds are valuable to fish, manatees and invertebrates which use them as nursery and foraging grounds within Broward County. Since most of the marine inland waters within Broward County are artificially constructed and channelized, suitable habitat for seagrass beds is limited within Broward County.

Hardbottom and Coral Reef. The reef complex within the project area is comprised of a nearshore ridge complex, and a seaward succession of three shore-parallel reefs referred to as the "inner," "middle, and "outer" reefs, or the "first," "second", and "third" reefs, respectively (Goldberg 1973; Moyer *et al*. 2003; Banks *et al*. 2007). The nearshore ridge complex runs parallel to the shore and is made up of carbonate/quartz sandstone and coquina rock (Banks *et al*. 2007). The nearshore ridge complex occurs in 0-12 feet (0-4 m) of water and hosts a hardbottom community of algae, sponges, encrusting octocorals, and hard corals (CSA 2009). These hardbottom communities exist in a dynamic environment, and may be periodically covered and uncovered by sands as a result of storms and/or littoral transport. Seaward of the nearshore ridge complex, the inner reef occurs from approximately 100 to 2,000 feet (30 to 610 m) from shore and crests at 26 feet below MHW (8 m); the middle reef is located 3,000 to 6,000 feet (914 to 1,829 m) from shore in 49 feet (15 m) of water (MHW); and the outer reef is approximately 8,000 feet (2,438 m) or more offshore and crests at 52 feet below MHW (16 m) (USACE 1996; Banks *et al*. 2007). The troughs between the inner and middle, and middle and outer reefs are characterized by sand and coral rubble with isolated patches of hardbottom and hard corals (USACE 1996).

Hardbottom and coral reefs in the project area are dominated by fauna typical of the wider-Caribbean basin (Goldberg 1973). These include in order of abundance, octocorals, sponges and hard corals (DC&A 2009; Moyer *et al*. 2003; Goldberg 1973). These reefs have been characterized as octocoral dominated reefs (Moyer *et al*. 2003; Goldberg 1973). Goldberg (1973) described the rich diversity of octocoral species characteristic of this reef system. Thirty-nine species of octocorals were found to be represented including *Eunicea*, *Plexaura*, and *Pseudopterogorgia,* and twenty-seven species of scleractinian corals have been documented (Goldberg 1973). The predominant hard coral genera in S. Florida include *Siderastrea*, *Montastraea, Stephanocoenia,* and *Porites* (DC&A 2009). Recently, 45 hard coral species were documented in Broward County by Banks *et al*. (2009), while, Moyer *et al*. (2003) found 30 across the county. Nineteen hard coral species were found on the middle and outer reefs within and adjacent to the project area in 2006 (DC&A 2009). Typical sub-tropical sponges are found along the reefs, including, but not limited to members of *Ircina, Agelas, Iotrochota, Verongula*, and *Xestospongia* genera (DC&A 2009). Associated sub-tropical fish species use the reef for foraging, shelter, and breeding habitat.

3.0 MITIGATION PLANNING AND POLICIES

Compensatory mitigation is intended to replace the ecological services that are lost as a result of unavoidable impacts to resources affected by a given project. “Ecological services” refer to the services performed by a resource for the benefit of other resources or the public. The baseline for quantifying lost ecological services is the full complement of services that would have been provided absent project implementation. Lost ecological services are quantified as the reduction in the provision of services below this baseline. Compensatory mitigation must restore services commensurate with the character of lost services. The amount of compensatory mitigation needed to replace lost services depends, in part, on the ability of the affected resources to return to their baseline conditions. Factors relevant in that regard include the quantity of affected resources and how fast and how completely they return to their baseline conditions. The amount of compensatory mitigation also depends on the ability of the selected compensatory mitigation measures to replace lost services. Relevant factors for replacement include how fast the compensatory mitigation measures become fully functional and the relative degree to which they provide additional ecological services (King 1997).

USACE mitigation policies are stated in Section 2036(a) of the Water Resources Development Act (WRDA) of 2007 and implementation Guidance for Section 2030 of WRDA 2007 dated August 31, 2009. The *Memorandum for Commanders, Major Subordinate Commands* regarding *Implementation Guidance for Section 2036(a) of the Water Resources Development Act of 2007- Mitigation for Fish and Wildlife and Wetlands Losses* (31 August 2009) emphasized that “ER 1105-2-100 requires that mitigation planning be an integral part of the overall planning process,” in accordance with the USACE/EPA rule issued on March 31, 2008 discussed above. Section 2036(a) of the 2007 Water Resources Development Act (WRDA ‘07) amends Section 906(d) of the WRDA of 1986 to

- Ensure that any report submitted to Congress for authorization has specific recommendations for mitigating fish and wildlife losses;

- Ensure that other habitat types [i.e., non-wetland] impacted by a project are mitigated to not-less-than in-kind condition, to the extent practicable;

- Require that mitigation plans include (1) “monitoring-until-successful” language; (2) criteria for determining ecological success; (3) a description of available lands for mitigation and the basis for the determination of availability of said lands; (4) development of contingency (adaptive management) plans; (5) identification of parties responsible for monitoring; and (6) establishment of a consultation process with appropriate federal and state agencies in determining the success of mitigation.

Furthermore, USACE requires plans to include information regarding the minimum monitoring actions necessary to evaluate success, including key project-specific parameters.

The USACE *Memorandum for Commanders, Major Subordinate Commands* regarding *Implementation Guidance for Water Resources Development Act of 2007-- Section 2036(c) Wetlands Mitigation* (6 November 2008) noted the importance of use of a mitigation bank to compensate for wetland impacts that occur within the service area of an existing, approved bank. Regarding the proposed project, there are no existing mitigation banks in the watershed to address impacts to mangrove wetlands, seagrass beds or coral and hardbottom communities (www.usace.army.mil/Portals/2/docs/civilworks/Project%20Planning/wrda/2007/sec_2036c.pdf).

USACE will provide compensatory mitigation for functional losses of significant habitats, these being jurisdictional wetlands, seagrass beds, and hardbottom/reef habitats that are outside of the existing

(and maintained) channel limits. The significance of the affected resources in the study area is based on the technical, institutional and public recognition of the ecological, cultural, and aesthetic attributes of the subject resources. Resource scarcity and/or uniqueness (from a national, regional, state, and local perspective) are important considerations in determining significance (Paragraph C-3.d (4)(a) of Appendix C, "Environmental Evaluation and Compliance" of ER 1105-2-100.

WRDA 2007 required USACE to be consistent with regulatory rules 33 CFR 332.3 (regarding type and location of compensatory mitigation) which states the following:

> "the required compensatory mitigation should be located within the same watershed as the impact site, and should be located where it is most likely to successfully replace lost functions and services, taking into account such watershed scale features as aquatic habitat diversity, habitat connectivity, relationships to hydrologic sources (including the availability of water rights), trends in land use, ecological benefits, and compatibility with adjacent land uses. When compensating for impacts to marine resources, the location of the compensatory mitigation site should be chosen to replace lost functions and services within the same marine ecological system (e.g., reef complex, littoral drift cell). Compensation for impacts to aquatic resources in coastal watersheds (watersheds that include a tidal water body) should also be located in a coastal watershed where practicable. Compensatory mitigation projects should not be located where they will increase risks to aviation by attracting wildlife to areas where aircraft-wildlife strikes may occur (e.g., near airports)."

The proposed mitigation for unavoidable impacts due to improvements at Port Everglades meets all of these requirements.

4.0 MITIGATION FOR UNAVOIDABLE IMPACTS TO SEAGRASS HABITATS

4.1 Determining Mitigation Needs for Seagrasses

Mangrove mitigation requirements were determined using the State of Florida's Uniform Mitigation Assessment Method (UMAM) assessment. UMAM is a method used to determine mitigation needs based upon a number of quantitative and qualitative factors. UMAM has been used in other USACE-SAJ projects to help determine mitigation requirements, and its application in this project has been approved for "single-use" for this project by the USACE National Ecosystem Planning Center of Expertise (http://el.erdc.usace.army.mil/ecocx/index.cfm).

Due to the implementation of the TSP, 4.01 acres of seagrass will be impacted. UMAM calculations indicated that compensation of 2.4 seagrass functional units will offset that impact (Table 2). However, because mitigation construction has already been initiated, revised UMAM calculations during the upcoming Preconstruction Engineering and Design (PED) phase of the project will likely indicate that fewer functional units will be required. This is because the time lag factor (time to which mitigation reaches full function) in UMAM will be reduced or nearly eliminated by the time impacts occur.

4.2 Seagrass Mitigation Alternatives

Broward County has very limited options for seagrass mitigation. Most of the saline/estuarine water bodies in Broward County are man-made canals used for navigation or flood water management where specific depths must be maintained and filling for mitigation would not be a viable option.

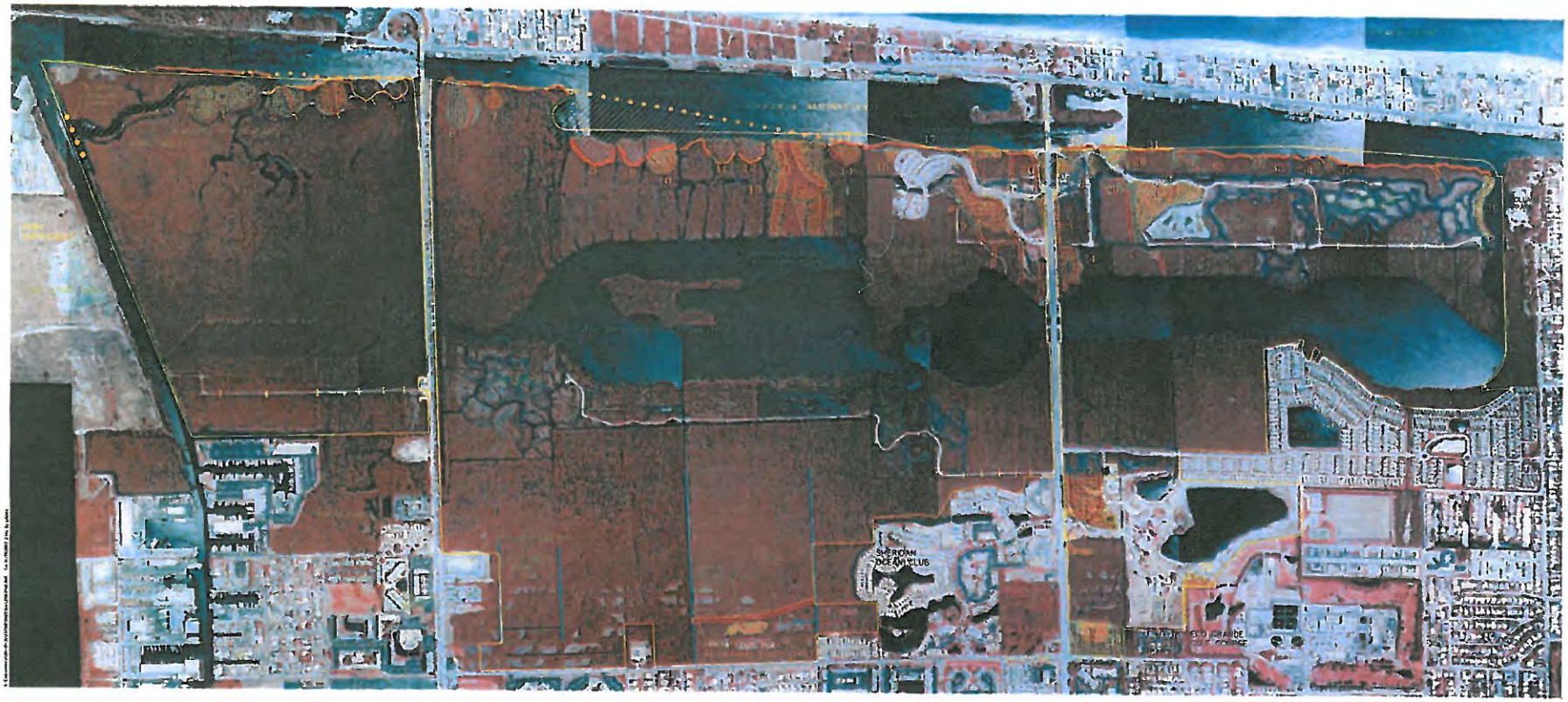
To locate seagrass mitigation options, USACE queried the Broward County Parks department during their development of the West Lake Park Restoration Project (Figure 2). The Parks Department originally planned to create open mud flats (by removing exotic species) for birds to utilize along the east side of the park bounded by the IWW. After discussions with USACE and the Port, some of the mud flat areas were modified by removing more substrate and allowing natural recruitment of seagrasses into the area from adjacent seagrass beds (Figure 3). The details of this mitigation option (WLP project) are described below in Section 4.4.

In addition to the West Lake Park Restoration project, the USACE looked at two other seagrass mitigation options: 1) filling previously dredged holes in Biscayne Bay, Miami-Dade County (19-25 miles south depending on location of dredge hole) or Lake Worth Lagoon (42 miles north) in Palm Beach County or 2) filling prop scars in the same water bodies. While the sites are in the same watershed as the project area ("Southeast Coastal"), the distance from the impact sites to the alternative mitigation sites is fairly excessive and would result in a net loss of seagrass habitats available to the fisheries and protected species that utilize seagrass and mangrove habitats in/near the project area. The Miami-Dade mitigation site is in Biscayne Bay, which is dominated by climax seagrass species, turtle grass and manatee grass, neither of which has been located in the Port Everglades project footprint, while the seagrasses in the project area are pioneer species, mainly Johnson's seagrass and paddle grass (*Halophila sp*.). There has been some success with filling old dredge holes for mitigation/restoration in both Miami-Dade and Palm Beach Counties: Snook Islands Restoration Project (http://www.pbcgov.com/erm/lakes/estuarine/snook/) and the Miami-Dade County dredge-hole demonstration project (Milano and Deis 2006). Dredge-hole filling projects are good for large scale mitigation needs, and would require transporting dredged material from Port Everglades to Biscayne Bay or Lake Worth Lagoon and identifying a dredged hole that could have the material placed in it with sufficient access for shallow water bottom dump barges. This would result in a significant increase in costs associated with seagrass mitigation when compared to utilizing the West Lake Park restoration project, which is less than one mile to the south of the project. Additionally no dredged material transport would be required as part of mitigation construction at West Lake Park. An analysis of the associated costs is included in the Incremental Cost Analysis below.

Table 2 Uniform Mitigation Assessment Methodology Scores for Seagrass Habitats within Impact Area

Impact Polygon	LS Before	LS After	WE Before	WE After	CS Before	CS After	Impact (ac)	Functional Loss
SHD-00818	6	0	6	0	3	0	0.018779	0.0093893
SHD-05641	6	0	6	0	3	0	0.129500	0.0647497
SHJ-77084	6	0	6	0	10	0	1.769605	1.2977104
SMX-01202	6	0	6	0	4	0	0.027594	0.0147168
SMX-00515	6	0	6	0	4	0	0.011823	0.0063054
SMX-02944	6	0	6	0	4	0	0.067585	0.0360453
SMX-00900	6	0	6	0	4	0	0.020661	0.0110192
SMX-02192	6	0	6	0	10	0	0.050321	0.0369023
WHD-08612	6	0	6	0	2	0	0.197704	0.0922620
WHD-00416	6	0	6	0	1	0	0.009550	0.0041383
WHJ-53469	6	0	6	0	3	0	1.227479	0.6137396
WHJ-06911	6	0	6	0	4	0	0.158655	0.0846158
WHJ-10206	6	0	6	0	4	0	0.234298	0.1249586
MHD-00037	6	0	6	0	1	0	0.000849	0.0003680
MHD-00039	6	0	6	0	1	0	0.000895	0.0003879
IHD-03618	6	0	6	0	2	0	0.083058	0.0387603
						Total	4.008356	2.4360698

Positions of polygons within the project area are shown in figures in Section 4.0 of the main text of the Environmental Impact Statement.
Key: LS: Landscape Support; WE: Water Environment; CS: Community Structure.
“Before”/”After” is relative to impact.



AERIEAL PHOTOGRAPH DATE: 2000

DRAFT: Conceptual Plan set. Not for Construction.

NOTE: All channels are 50' unless otherwise noted.

LEGEND

- PARK BOUNDARY
- FLOATING BARRIER
- CULVERT IMPROVEMENT OR RESILT EXISTING CONNECTIONS
- SUPPLEMENT EXISTING RIP RAP
- RESTORE PRIMARY CHANNEL/REMOVE BLOCKS
- REMOVE CENTER BERM TO CREATE CHANNEL
- RIP RAP
- MANATEE PROTECTION AREA
- MANGROVE REVEGETATION – ±19.4 acres
- CHANNELS – ±20.7 acres
- UPLAND HAMMOCK – ±17.2 acres
- MUD FLAT / TIDAL POOLS – ±19.8 acres
- SEAGRASS – ±8.1 acres

BROWARD COUNTY

BROWARD COUNTY PARKS AND RECREATION DIVISION

West Lake Park

PROPOSED IMPROVEMENTS

GRAPHIC SCALE

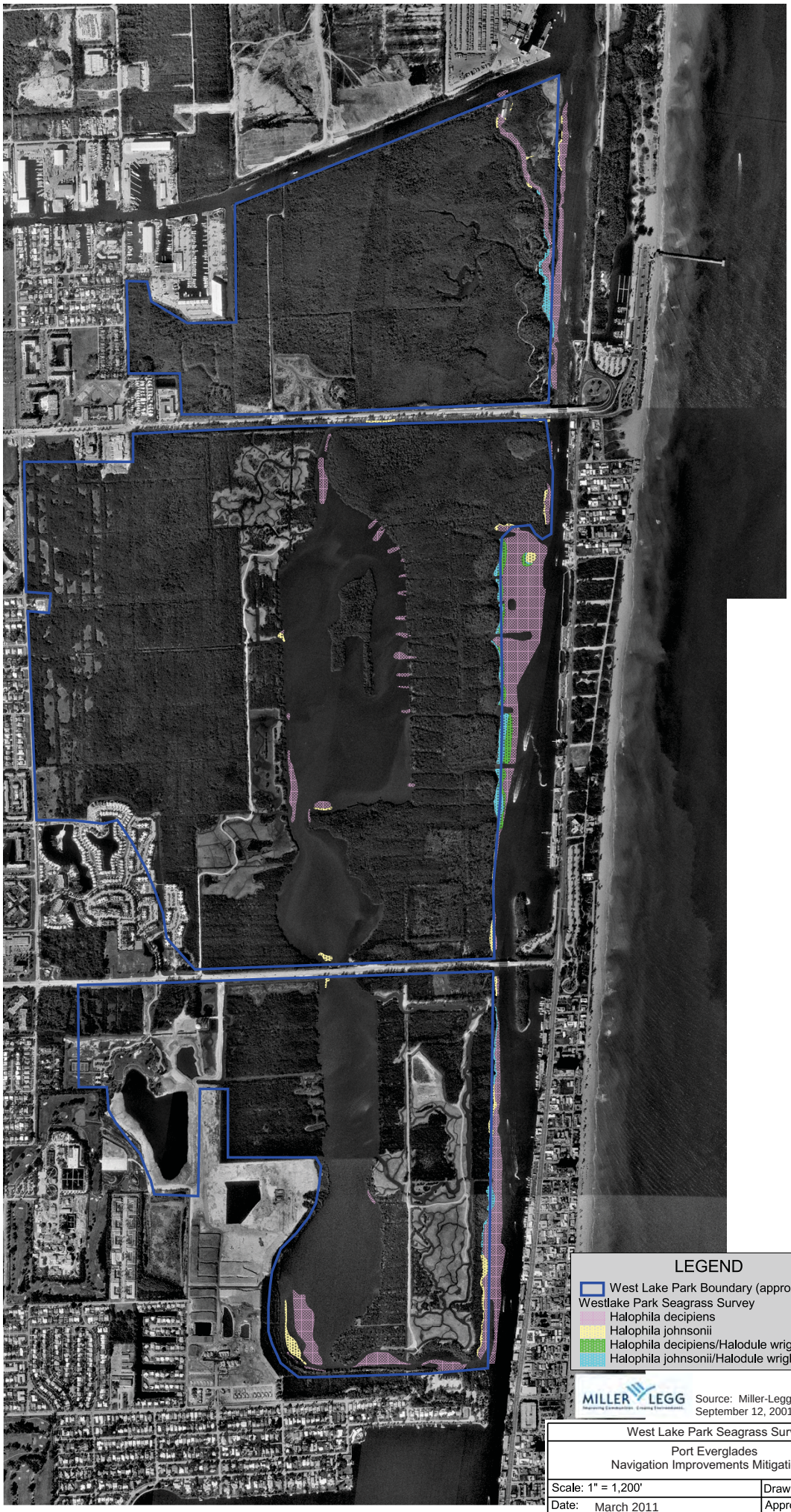
200 0 250 500 1000

(IN FEET)
1 INCH = 500 FEET
WHEN PRINTED AT 24"X 36"

MILLER LEGG

Improving Communities. Creating Environments.

West Lake Park Mitigation Measures Port Everglades Navigation Improvements Mitigation Plan	
	Drawn by: MR
Date: March 2011	Approved By JE
DEAL CORDY AND ASSOCIATES, INC.	J11-1182
	Figure 2



West Lake Park Seagrass Survey

Port Everglades
Navigation Improvements Mitigation Plan

Scale: 1" = 1,200'	Drawn By: MR
Date: March 2011	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 3

4.3 Incremental Cost Analysis Results for Seagrasses Mitigation Alternatives

4.3.1 Expected Cost of Alternative Seagrass Mitigation Plans

As noted below, due to the subject mitigation lands at WLP being owned by the State of Florida and leased/managed by the local sponsor (outside of the requirements for the civil works project), no fee-simple transaction is warranted, and the value of the right-of-entry is essentially $0.00. WLP construction as well as monitoring (as required by environmental permits granted by the State of Florida and USACE Regulatory Division) and any adaptive management of WLP restoration elements are being paid for by Broward County. Those costs are estimated at $4,840,000 for elements related to seagrass restoration/creation. Therefore, for the implementation of the WLP alternative for seagrass mitigation, the estimated maximum potential cost for the elements discussed in the plan (see below) is $4,840,000, given that no real estate costs were involved.

The estimated maximum potential cost for the elements necessary to implement the Miami-Dade County alternative was calculated to be $700,000 per acre of seagrass creation/restoration. UMAM calculations indicate that, to offset 2.44 seagrass functional units that will be lost due to unavoidable impacts of the TSP, approximately 18.47 acres of seagrass creation/restoration will be required. Therefore the initial, expected cost for this mitigation alternative is $12,929,000.

The estimated maximum potential cost for the elements necessary to implement the Palm Beach County alternative was calculated to be $1,000,000 per acre of seagrass creation/restoration. UMAM calculations indicate that, to offset 2.44 seagrass functional units that will be lost due to unavoidable impacts of the TSP, approximately 18.47 acres of seagrass creation/restoration will be required. Therefore the initial, expected cost for this mitigation alternative is $18,470,000.

4.3.2 Seagrass Mitigation Benefits

Approximately three (3) seagrass functional units will be created by the above actions, some of which may be used as mitigation by other County-sponsored projects. It is estimated that 2.4 functional units for seagrasses will be used to compensate for seagrass impacts resulting from improvements at Port Everglades. For the discussion below, functional units will be the basis for determining benefits.

4.3.3 Construction/ Initial Cost per Seagrass Functional Unit

The base-year cost of each alternative mitigation plan is compared to the respective benefit (functional unit) below (see Table 3). Costs are based on FY2011 estimates (annualized values are provided in the Economic Appendix of the Feasibility Study). However, cost will likely be less as fewer functional units are likely to be necessary for use (due to a decreased time lag factor) as discussed in Section 4.1.

Table 3 Construction/ Initial Cost per Functional Unit of Seagrass Mitigation

Seagrass Mitigation Alternative	Construction Cost of Mitigation	Benefits of Mitigation (functional units)	Cost/Functional Unit
WLP Seagrass Enhancements	$4,840,000	1.0	$2,016,667
Miami-Dade Seagrass Enhancements	$12,929,000	1.0	$5,298,770
Palm Beach Seagrass Enhancements	$18,470,000	1.0	$7,569,672

4.3.4 Cost-Effective Seagrass Mitigation Plan

Cost estimates for the above three mitigation alternatives (West Lake Park, Miami-Dade County site, and Palm Beach County site) were calculated (as shown above), and those costs were used in an incremental cost analysis. It was determined through use of USACE Institute of Water Resources (IWR) software (IWR Planning Suite 1.0.11.0, certified 24 September 2008) that the West Lake Park habitat restoration alternative was the "Best Buy" alternative and that the other three alternatives were "Non Cost-Effective." Given that finding, the WLP alternative described above was selected as the proposed mitigation plan for impacts to seagrasses due to the implementation of the TSP.

4.4 Proposed Mitigation Plan for Seagrasses

Unavoidable impacts to mangrove wetlands will be mitigated by using credits (functional units) generated by habitat improvements at West Lake Park. The park land is owned by the State of Florida and leased by Broward County Parks and Recreation Division (BCPRD). Liability for construction, monitoring and success for mitigation at West Lake Park rests solely with Broward County (the local sponsor). No real estate will be purchased by the USACE or the local sponsor. Access to the identified lands to perform the subject construction would be allowed via a right-of-entry for construction (minimum real estate interest sufficient to perform subject construction). The right-of-entry for construction is currently afforded to the local sponsor via an existing lease agreement executed in 1986 for a period of 50 years. Again, fee simple is not required, as the mitigation plan for this project consist only of the construction features as agreed to between the local sponsor and the State of Florida and USACE Regulatory Division. The mitigation plan "does not" have any monitoring or operation/management features. Due to the property being owned by the State of Florida and currently managed by the local sponsor (outside of the requirements for the civil works project), the value of the right-of-entry is essentially $0.00.

The West Lake Master Plan (Miller-Legg 2003) was developed by BCPRD in consultation with Broward County's Port Everglades Department and the Broward County Aviation Department. The functional gains generated by the improvements have been approved (pursuant to county, state, and federal permits) to offset impacts due to projects constructed by various Broward County departments (among which are the Port and the Aviation Department, including Fort Lauderdale-Hollywood International Airport). Permits for WLP habitat improvements (see Appendix E-1) were issued by the South Florida Water Management District in April 2004, by the Broward County Environmental Protection Department in August 2004, and the USACE-SAJ Regulatory Division in March 2006. The WLP project was not permitted as a "mitigation bank." Therefore, there are no "credits" available for purchase by other public or private entities to offset impacts from other projects.

The ecological value of improvements, which will be gained through the WLP project, was assigned via use of State of Florida's UMAM, as is standard practice for Clean Water Act (CWA) Section 404 and Section 401 permitting in the state. As proposed, the WLP plan involves creation of 8.0 acres of seagrass, restoration of 0.5 acre of seagrass habitat, and protection of 30.0 acres of seagrass/manatee habitat. Other measures included in the plan are creation of 7.0 acres of shallow water tidal flats and 8.6 acres of channels, and hydrologic improvements affecting an additional 3.5 acres (Table 4). Specific construction and operational information are detailed in the Department of Army permit, found in Appendix E-1. These activities will result in the accumulation of approximately three wetland functional units, in accordance with permit conditions, for use as mitigation for only Broward County projects.

Table 4 Habitat Restoration and Enhancement Elements at West Lake Park

Element	Acres
Mangrove wetland creation	24.2
Mangrove wetland enhancement	40.4
Mangrove wetland preservation	23.3
Herbaceous saltwater habitat enhancement	10.0
Shallow water tidal flat creation	7.0
Channel creation	8.6
Seagrass creation	8.0
Seagrass restoration (removal of barges)	0.5
Hydrologic improvements*	3.5
Seagrass/Manatee protection	30.0

*Circulation/flushing/dredging improvements are estimated to restore 40-60 acres of SAV in West Lake embayment. Adapted from Miller-Legg (2002)

As noted above in Section 4.1, based on UMAM calculations, USACE Regulatory Division will require 2.4 wetland functional units to compensate for the 4.01 acres of impacts to seagrass beds due to the implementation of the TSP. Therefore, 2.4 units will be removed from the three (3) units generated by the WLP project.

"Seagrass creation" areas (the 8.0 acres listed in Table 4) will be developed through the grading of spoil islands along the IWW (to an elevation consistent with the depths where seagrass beds are present adjacent along the IWW, likely between from -1 foot to -4 feet MSL), as denoted by the yellow-stippled areas on Figure 2. Installation of floating barriers to restrict vessel access will help ensure success. It is anticipated that seagrass recruitment will occur rapidly by shoal grass (*Halodule wrightii)*, paddle grass (*Halophila decipiens),* and Johnson's seagrass (*Halophila johnsonii)*, all of which commonly occur along the shallow flats adjacent to the mangrove fringe. In the event that natural recruitment has not occurred within 12 to 18 months following excavation, methods to plant seagrass donor material will be initiated. Planting methods will follow guidance by Fonseca, et al. (1998).

Submerged aquatic vegetation (SAV) restoration within WLP is also anticipated to occur as a result of enhanced flushing and circulation patterns along the southeastern region of the interior lagoon (Figure 2). As proposed, over 12 acres of flushing channels will be expanded or improved, or will benefit from the installation of culverts, resulting in improved water quality, clarity, and substrate conditions more suitable for seagrass propagation in the interior embayment (Miller Legg 2001b). Seagrass surveys conducted in West Lake serve to illustrate the benefits of flushing channels, as evidenced by the presence of seagrass beds near the mouth of each channel entering the lake (Miller Legg 2001c) (Figure 3). Based on observed changes in seagrass cover and existing seagrass bed occurrences it is anticipated that 40 to 60 acres of SAV, including *H. johnsonii* would be restored.

4.5 Monitoring and Adaptive Management for Seagrass Mitigation

The West Lake Park plan (as proposed by Broward County and permitted by the State of Florida and USACE Regulatory Division) describes the mitigation monitoring as follows:

> A time-zero monitoring event will be performed, and then the seagrass recruitment area shall be monitored quarterly for the required five-year period. Forty paired, one-square meter quadrats will be randomly placed within the created seagrass habitat during each monitoring event. Distribution of the 40 quadrats will be divided equitably between the seven seagrass creation areas. Random, rather than fixed, quadrats will be used so that the results are without bias and can be used to accurately generalize over the entire area (Fonseca, personal communication). Random directions and distances will be chosen using a random number generator. The random direction and distance will be from the approximate center of each seagrass creation area. An equal number of replicate quadrats will be established in the adjacent, surrounding, seagrass beds (at least 50' from the creation areas) to serve as a control. The following data will be collected at each quadrat:
>
> • Relative water depth
> • Time
> • Species present
> • Shoot counts
> • Aerial coverage by photo-documentation
> • Qualitative observations of natural seagrass recruitment and vegetative expansion of planting units
>
> In addition to the above-listed data, the following data may also be collected for each monitoring event: tides, weather, water temperature, and wind. A staff gauge or piezometer shall be installed to record tide level.
>
> Survivorship rates may be assessed based on measurements within the paired 1 m^2 quadrats. Abundance measurements shall be made through visual and photographic assessments of percent aerial coverage by species. The 1 m^2 quadrat shall be divided into 10 cm x 10 cm grid and the number of squares containing seagrasses shall be counted to estimate cover.
>
> In addition, percent aerial coverage will be equated to Cover Classes, based on the Braun-Blanquet technique, as follows:

Table 5 Braun-Blanquet Cover Class Definitions

Cover Class	Description
0	Absent
0.1	Solitary individual shoots, less than 5% cover
0.5	Few individual shoots, less than 5% cover
1	Many individual shoots, less than 5% cover
2	5% - 25% cover
3	25% - 50% cover
4	50%
5	75%

Seagrass success criteria shall be based on the following:

1. A target goal of Cover Class 1 coverage by the third year

2. A target goal of Cover Class 2 or higher by the fifth year

3. Supplemental seagrass will be planted on 2-meter centers if…

   a) at the end of the third year, areas have a Cover Class less than 1 or equivalent to coverage in the ICWW (control site), whichever is lower.

   b) at the end of the fifth year, areas have a Cover Class less than 2 or equivalent to coverage in the ICWW (control site), whichever is lower.

4.6 Seagrass Mitigation Success Criteria

Seagrass success criteria for the WLP seagrass mitigation beds are as follows:

1. A target goal of Cover Class 1 coverage by the third year or equivalent to the coverage in the ICWW (control site) whichever is lower.

2. A target goal of Cover Class 2 or higher by the fifth year or equivalent to coverage in the ICWW (control site) whichever is lower.

If success criteria are not achieved adaptive management will be used to implement contingency planning.

4.7 Adaptive Management/Contingency Plan for Seagrass Mitigation

The contingency plan for taking corrective action will be implemented if and when the seagrass mitigation does not achieve success described in the paragraph above. Supplemental seagrass will be planted on 2-meter centers if:

a) at the end of the third year, areas have a Cover Class less than 1 or equivalent to coverage in the ICWW (control site) whichever is lower.

b) at the end of the fifth year, areas have a Cover Class less than 2 or equivalent to coverage in the ICWW (control site) whichever is lower.

5.0 MITIGATION FOR UNAVOIDABLE IMPACTS TO MANGROVE WETLANDS

5.1 Determining Mitigation Needs for Mangrove Wetlands

Mangrove mitigation requirements were determined using the state of Florida's Uniform Mitigation Assessment Method (UMAM) assessment. UMAM is a method used to determine mitigation needs based upon a number of quantitative and qualitative factors. UMAM has been used in other USACE-SAJ projects to help determine mitigation requirements, and its application in this project has been approved for "single-use" for this project by the USACE National Ecosystem Planning Center of Expertise.

Due to the implementation of the TSP, 1.16 acres of mangroves will be impacted. UMAM calculations indicated that compensation of one (1) wetland functional unit will offset that impact (actually only 0.87 unit is required as indicated in Table 6 below). However, because mitigation construction has already been initiated, revised UMAM calculations during the upcoming Preconstruction Engineering and Design (PED) phase of the project will likely indicate that fewer functional units will be required. This is because the time lag factor (time to which mitigation reaches full function) in UMAM will be reduced or nearly eliminated by the time impacts occur.

Table 6 Uniform Mitigation Assessment Methodology Scores for Mangrove Habitats Within Proposed Impact Areas

			Location & landscape support		Water environment		Vegetation structure		Resulting calculated change (functional units)
EWRAP Zone	Acres	Location	without impact	with impact	without impact	with impact	without impact	with impact	
0.70	0.08	SAC	6	0	7	0	5	0	-0.05
0.70	0.34	SAC	6	0	7	0	5	0	-0.20
0.70	0.13	SAC	6	0	7	0	5	0	-0.08
1.00	0.18	SAC	8	0	8	0	9	0	-0.15
1.00	0.23	SAC	8	0	8	0	9	0	-0.19
1.00	0.00	SAC	8	0	8	0	9	0	0.00
0.97	0.01	SAC	6	0	7	0	9	0	-0.01
0.97	0.26	SAC	6	0	7	0	9	0	-0.19
0.97	0.00	SAC	6	0	7	0	9	0	0.00
Cumulative change in functional value of mangroves in impact area due to project:									-0.87

Note: Data based on interagency meeting, June 2005 Key: SAC = Southport Access Channel.

5.2 Mangrove Wetland Mitigation Alternatives

There are few locations for constructing mangrove mitigation in Broward County. Mangroves require shallow, quiet saline/estuarine waters to germinate, and as previously stated, most of the saline/estuarine waters in Broward County are man-made canals for navigation or flood water drainage. There are a few county and state parks in Broward County with mangroves, or the ability to support mangrove habitat including John U. Lloyd State Park and West Lake Park. To locate mangrove mitigation options, USACE explored options with the Broward County Parks department. These discussions took place during the planning and development of the West Lake Park Restoration Project. The Park's Department plans included removal of exotics and improvement of water flow regimes to create mangrove habitat. Given the proximity of WLP to the project area, county staff concurred that its use for mitigation was a viable option.

Mangrove mitigation options were also available in county and state parks in Miami-Dade and Palm Beach Counties, and while they are in the same watershed ("Southeast Coastal"), the distances from the impact sites to the alternative sites (approximately 19 miles to north Biscayne Bay or 42 miles to Lake Worth Lagoon) were considered excessive and would result in a net loss of mangrove habitats available to the fisheries and protected species that utilize mangrove habitats in the project area. Therefore these options were removed from consideration. Also, no mitigation banks for mangroves were available near the project area.

5.3 Incremental Cost Analysis Results for Mangrove Wetland Mitigation Alternatives

5.3.1 Expected Cost of Alternative Mangrove Wetland Mitigation Plans

For the implementation of the WLP plan, the estimated maximum potential cost for the elements discussed in the plan (see below) comprises $6.16M and $2.88M for mangrove creation and tidal flat (habitats ready for passive mangrove colonization) creation, respectively (Miller Legg 2008). The total cost ($9.04M) will yield 38 mangrove functional units (FU). The Port project requires only 0.87 units (for conservative purposes, we will use 1.0 for estimates/calculations). Therefore the cost for the required amount of mitigation is approximately $237,895 (=$9.04M÷38 FUs) for one functional unit. As noted below, due to the subject mitigation lands being owned by the State of Florida and leased/managed by the local sponsor (outside of the requirements for the civil works project), no fee-simple transaction is warranted, and the value of the right-of-entry is essentially $0.00.

5.3.2 Mangrove Wetland Mitigation Benefits

Approximately 38 mangrove functional units will be created by the actions at WLP detailed below. However, as noted above, based on UMAM calculations, USACE will require use of only 1.0 wetland functional unit for the proposed improvements at Port Everglades. For the discussion below, functional units will be the basis for determining benefits.

5.3.3 Construction/ Initial Cost per Mangrove Wetland Functional Unit

The base-year cost of each alternative mitigation plan is compared to the respective benefit (functional unit) below (see Table 7). Costs are based on FY2011 estimates (annualized values are provided in the Economic Appendix of the Feasibility Study). However, cost will likely be less as fewer functional units are likely to be necessary for use (due to a decreased time lag factor) as discussed in Section 5.1.

Table 7 Construction/ Initial Cost per Functional Unit of Mangrove Mitigation

Mangrove Mitigation Alternative	Construction Cost of Mitigation	Benefits of Mitigation (functional units)	Cost/Functional Unit
WLP Mangrove Enhancements	$237,895	1.0	$237,895

5.3.4 Cost-Effective Mangrove Wetland Mitigation Plan

An alternative is considered cost effective if no other alternative provides the same level of output for less cost, and if no other plan provides more output for the same or less cost (ER 1105-2-100). The table above shows the comparison of plans. However, as only one alternative plan is proposed, that plan is the cost-effective mangrove mitigation plan.

5.4 Proposed Mitigation Plan for Mangrove Wetlands

Unavoidable impacts to mangrove wetlands will be mitigated by using credits (functional units) generated by habitat improvements at West Lake Park. The park land is owned by the State of Florida and leased by Broward County Parks and Recreation Division (BCPRD). Liability for construction, monitoring and success for mitigation at West Lake Park rests solely with Broward County (the local sponsor). No real estate will be purchased by the USACE or the local sponsor. Access to the identified lands to perform the subject construction would be allowed via a right-of-entry for construction (minimum real estate interest sufficient to perform subject construction). The right-of-entry for construction is currently afforded to the local sponsor via an existing lease agreement executed in 1986 for a period of 50 years. Again, fee simple is not required, as the mitigation plan for this project consist only of the construction features as agreed to between the local sponsor and the State of Florida and USACE Regulatory Division. The mitigation plan "does not" have any monitoring or operation/management features. Due to the property being owned by the State of Florida and currently managed by the local sponsor (outside of the requirements for the civil works project), the value of the right-of-entry is essentially $0.00.

The West Lake Master Plan (Miller-Legg 2003) was developed by BCPRD in consultation with Broward County's Port Everglades Department and the Broward County Aviation Department. The functional gains generated by the improvements have been approved (pursuant to county, state, and federal permits) to offset impacts due to projects constructed by various Broward County departments (among which are the Port and the Aviation Department, including Fort Lauderdale-Hollywood International Airport). Permits for WLP habitat improvements (see Appendix E-1) were issued by the South Florida Water Management District in April 2004, by the Broward County Environmental Protection Department in August 2004, and the USACE-SAJ Regulatory Division in March 2006. The WLP project was not permitted as a "mitigation bank." Therefore, there are no "credits" available for purchase by other public or private entities to offset impacts from other projects.

The ecological value of improvements, which will be gained through the WLP project, was assigned via use of State of Florida's Uniform Mitigation Assessment Methodology (UMAM), as is standard practice for Clean Water Act (CWA) Section 404 and Section 401 permitting in the state. As proposed, the WLP plan would include the creation (24.2 acres), enhancement (40.4 acres), and preservation (23.3 acres) of mangrove wetlands, and other improvements to various estuarine resources (Table 4). These activities will result in the accumulation of approximately 38 mangrove wetland functional units, in accordance with permit conditions, for use as mitigation for only Broward County projects.

As noted above in Section 5.1, based on UMAM calculations, USACE Regulatory Division will require one (1) of the 38 WLP mangrove functional units to compensate for the 1.16 acres of mangroves that will be impacted due to the implementation of the TSP.

Principal among the actions for creating mangrove habitat is the grading of existing spoil islands to the appropriate depth (between approximately elevation -0.3 feet, or MLW, and elevation 1.7 feet, or MHW). These new habitats will be located along the Intracoastal Waterway (IWW), as indicated by the green hatching in Figure 2. On the side of the habits bordering the IWW, the substrate and plants (three-gallon size red mangrove, *Rhizophora mangle*, installed on three-foot centers) will be protected by riprap to ensure that vessel wakes do not erode the shoreline. These areas together comprise approximately 19.4 acres, a substantial fraction of the 24.2 acres noted for the "mangrove wetland creation" element listed in Table 4.

5.5 Monitoring and Adaptive Management for Mangrove Wetland Mitigation

The monitoring plan for WLP describes the methods used to monitor mangrove growth and succession:

> "Establish one (1) belt transect within each individual mangrove recruitment area. These transects will be two (2) meters wide and will stretch across the approximate maximum length of each recruitment area. One-square-meter quadrats will be randomly placed along the transects at a minimum density of one (1) quadrat per 10 meters of transect (i.e., 100 meter transect will contain 10 quadrats). Though the quadrats will be randomly placed, they will not be placed within "breaks" (i.e., mud flats, pre-existing mangrove areas) in the mangrove recruitment areas. Percent-aerial-coverage, by naturally recruited species falling within the quadrats, will be visually estimated and recorded.
>
> "Data from these sampling quadrats will then be extrapolated to determine overall percent-coverage within each mangrove recruitment area. Once naturally recruited mangrove trees have obtained sufficient height (±1.5 meters) to be recorded individually, trees falling within the belt transects (base of trunk within the transect) would be flagged and measured for height, spread, and diameter breast height (DBH). These measurements will be at random points along the transect at a frequency of one set of measurements per 10 meters. Measurements of these flagged trees will be repeated during subsequent monitoring events to determine growth rates. Overall health would also be assessed."

5.6 Mangrove Wetland Mitigation Success Criteria

Success criteria for mangroves are those described in the WLP mitigation plan; and is based on aerial percent-coverage of recruited shrubs/trees with the following interim goals:

1. 10% aerial coverage by mangroves by the first year.
2. 40% aerial coverage by mangroves by the third year.
3. 80% aerial coverage by mangroves by the fifth year.

5.7 Adaptive Management/Contingency Plan for Mangrove Wetland Mitigation

If the interim success criteria above are not achieved, supplemental mangrove planting will be performed. Red mangrove seedlings will be installed on three-foot-centers in areas where coverage discrepancies are apparent.

6.0 MITIGATION FOR UNAVOIDABLE IMPACTS TO HARDBOTTOM HABITATS

6.1 Determining Mitigation Needs for Hardbottom Habitats

A Habitat Equivalency Analysis (HEA) takes into account the quantification of ecological services lost from an impact as well as the interval of time necessary for habitats (those either impacted or those proposed for mitigation) to reach optimum performance. Hence, it can be used to determine the appropriate quantity of compensatory mitigation (King 1997). HEA has been used in other USACE-SAJ projects, and its application in this project has been approved for single-use in this project by the USACE National Ecosystem Planning Center of Expertise.

The HEA method (as detailed in NOAA 2000) was used to calculate mitigation requirements (in acres) for reef and hardbottom impacts associated with the proposed project (see DC&A and USACE 2013; i.e., Appendix E-2). The HEA took into account both anticipated impact acreages for various habitats (inner, middle, and outer reefs, as well as channel wall impacts and indirect impacts (see DC&A and USACE 2013 for details) and recovery times to calculate the overall loss of habitat function that occurs from the time a new impact occurs to the time of full functional recovery. Projected impact acreages were classified according to the various relief/profiles and habitat types in the affected areas. Therefore, in effect, several HEAs were conducted, and then resulting acreage assessments combined to arrive at the total mitigation acreage required. The results of the analysis are provided in DC&A and USACE (2013; i.e., Appendix E-2), which details the assumptions (form of recovery function, relative functionality at time “0” and at the end of recovery period, interval of recovery period for each habitat type impacted, etc.) that were used in the analyses. Finally, for performance of an HEA, assumptions concerning mitigation measures must be provided. Due to previous experience with similar projects in southeast Florida, USACE assumed that artificial reef construction using quarried or dredged rock would be the most likely and feasible mitigation, so that was selected as the candidate mitigation for which output data would be configured.

For the HEA runs, two impact scenarios were developed and considered: one in which impacts due to anchors/cables used for dredging occur in addition to the dredging “footprint” in the channel (Scenario 1), and another in which those impacts do *not* occur in addition to the dredging “footprint” in the channel (Scenario 2) . For Scenario 1, **32.30 acres** of direct impacts would occur; for Scenario 2, **15.17 acres** of direct impacts would occur. In addition to these impacts, channel walls

were also included as habitat for which some mitigation would be provided, as were hardbottom habitats surrounding the would-be new channel limits (up to 150 meters away) that may be affected sedimentation/turbidity. Finally, to complete the HEA, a candidate mitigation scenario must be assessed, using its estimated value (and time required to reach its optimal functionality) in calculations. The candidate mitigation project subjected to evaluation was construction of artificial reef including installation of coral colonies. For this mitigation alternative, HEA calculations demonstrated that the mitigation requirement for Scenario 1 was the creation of **27.30 acres** of hardbottom habitat. For Scenario 2, the requirement was the creation of **19.49 acres** of hardbottom habitat. The above-described analysis relates only to the results for use of artificial reef installation (using dredged or quarried rock/boulder) as the mode of mitigation (HEA results are necessarily linked to the type of mitigation proposed). USACE performed other HEAs for various other types of mitigation as well; these are discussed in Section 6.2.

The direct impacts and resulting mitigation requirements associated with Scenario 2 (i.e., approximately 19.5 acres of creation) has been adopted to represent the primary mitigation plan. Mitigation for Scenario 1 is considered a contingency (given evidence that anchor/cable impacts are typically minimal and temporary), and will only be carried out if actual damages to reefs occurred due to anchor and cable impacts (and is verified by post-construction surveys).

6.2 Hardbottom Habitat Mitigation Alternatives

There have been multiple efforts to provide interagency coordination regarding all regulatory issues pertaining to the proposed project, the majority of which are detailed in the main text of the Environmental Impact Statement (EIS) and are hereby incorporated by reference. In addition to those efforts and under direction of USACE, the Port Everglades Reef Group (PERG) was formed. The purpose of PERG was to provide scientific, technical, and logistical guidance and expert advice regarding provision of mitigation for impacts to hardgrounds and reefs due to navigation improvements at Port Everglades. The group held four meetings onsite at the Port's offices. PERG was tasked with this objective in absence of a known mitigation budget and without knowledge of the timeline under which impacts and mitigation were to take place. PERG was informed that funds for mitigation construction and related measures, except monitoring, would be included in the federal budget along with costs for navigation improvements. PERG discussed not only how to best carry out traditional means of mitigation (e.g., artificial reef construction and monitoring), but also methods that are somewhat more cutting-edge, such as coral head translocation and reef restoration/enhancement. Specific issues, such as additional baseline studies, monitoring, and artificial reef siting and construction materials, were also discussed, as was whether the mitigation policies of the various regulatory agencies could allow for certain means of mitigation. The Draft Compensatory Mitigation Recommendations of the Port Everglades Reef Group for Navigation Improvements at Port Everglades Harbor (PERG 2004) is attached in Appendix E-3. The mitigation plan described in the following pages does not take into account many of the draft recommendations of PERG, though some recommendations made by PERG may be utilized for the final mitigation plan if cooperating, regulatory, and natural resource agencies; the local sponsor; and user groups agree on their utility, value, and compliance with mitigation policies. One notable recommendation of PERG that will be implemented is the transplantation of corals larger than 25 cm in diameter/height to the mitigation site (see DC&A and USACE 2013), revised by USACE in August 2011, for details).

The following reef mitigation alternatives were reviewed for feasibility, either during and through PERG, or during subsequent plan formulation discussions/correspondence with regulatory agency staff, academic professionals, and consultants:

1. Removal of tire debris (the “Osborne tire-reef”) between the middle and outer reef line

Approximately 2,000,000 tires were “disposed of” at sea in the 1970s to create fishing reefs. The tires were bundled together with metal bands that over time have rusted and broken, releasing the tires (Figure 4). The tires also did not perform as estimated from a marine life colonization standpoint. The tires are now mobile in the marine environment, and during storms, they wash into the seaward side of the middle reef causing ongoing habitat degradation. Since 2001, a variety of efforts has been made to remove the tires including projects conducted by NOVA University and Broward County, in concert with the US Army and US Navy divers. It is a time-consuming effort that must be carried out by divers, as mechanical equipment would risk damage to the reefs adjacent to the tire field. The previous efforts were funded through Coastal America Grants, and the project has received a Coastal America Award. However, there are still approximately 700,000 tires remaining to be recovered and funding remains a significant limitation to project implementation (K Banks, BCEPD, pers. comm. 2012). This alternative was removed from further consideration because to gain any ecological function of the benthic habitat, nearly all the tires would have to be removed (any remaining tires could drift to other areas and damage reefs). In addition, the resulting functional gains that could be provided would be less than many of the other available mitigation options. Furthermore, the minimal gains would come at a much higher cost than many other options.

Figure 4 Ocean Floor Covered with Tires: “Osborne tire-reef”

2. Artificial reef placement on tire “reef”

Broward County proposed for use as mitigation the placement of artificial reef materials on top of the Osborne Tire Reef (discussed above) to stabilize the tires and prevent them from continuing to move shoreward and impact the middle reef. In theory, the materials would prevent middle-reef damage as well as provide usable hardbottom substrates for reef species colonization. The proposed plan involves the use of limestone boulders, placed over the “tire reef” stabilized with a tremie pour of specialized marine concrete (a “tremie” concrete placement method uses a pipe through which concrete is placed below water level) around the boulders. Each area will be constructed by first placing a layer of boulders onto the seafloor directly over the tires. Concrete will be poured around this layer, filling interstitial spaces and attaching the layer to the sides and bottoms of the adjacent seafloor to the greatest extent possible. The concrete fill will terminate just above the boulders' widest sections to stabilize the boulder layer and provide for secure placement of the next layer. The concrete surface will also be rough to allow for improved adhesion to the upper layer. Layers will be constructed above one another. When restoration is completed, the surface will consist mostly of limestone boulders, with concrete interstitial fill below the boulders' crests. The limestone boulders used in repair will weigh from three to five tons and generally feature diameters of about four feet. Once completed, each reef-repair unit will be a solid structure. The interval required to reach substantial functional productivity of this alternative is estimated to be 30-50 years. This would be shortened to 20-30 years if corals are transplanted from the impact area to the artificial reef.

The relative benefits of this mitigation alternative are that units would be secured to the seafloor, would stabilize the tire-reef “understory,” and they would have moderate functional values at installation. Drawbacks include a high cost per acre of construction (due partly to the need for commercial divers during construction), low aesthetic value relative to nearby natural hardbottom reefs, a lack of beneficial characteristics of tremie compared to natural limestone, and uncertainty regarding whether the structural integrity of the tire-reef could support artificial reefs on top of it.

3. Reef enhancement through water quality improvements

During the PERG discussions, the discussion of water quality improvements was raised as a potential mitigation option, particularly the relocation and/or retrofitting of broken or inadequate sewage outfalls. While the amount of money required to construct mitigation for unavoidable impacts associated with Port Everglades may be significant, it is not sufficient to retrofit or relocate underwater sewage outfalls in Broward County, and USACE does not have a mechanism to set aside the funds and hold them until the remaining funds necessary to complete this effort could be obtained by the local sponsor, County government or other entity. Additionally, it is not clear how success of this mitigation option would be demonstrated. USACE mitigation policy requires that success criteria be established for any mitigation option, and it is not clear how water quality improvements would be monitored, what the geographic area of monitoring would be or how long monitoring would have to be in place to answer the success question. In addition, in 2008, the Florida Legislature passed, and the Florida governor signed a bill requiring that ocean outfalls in the vicinity of coral reef habitats be shut down and decommissioned, including the outfalls In Broward County. According to the law, by 2018 the existing outfall discharges meet advanced wastewater treatment and management requirements and by 2025, 60 percent of the facility flows be reused for beneficial purposes, and use of the outfalls for wastewater disposal be restricted to wet weather flows from permitted reuse systems. Based on the current schedule, the earliest that construction activities could be initiated for Port Everglades is 2017. This is one year before the retrofit of the existing outfalls for compliance with the law, and it is unlikely that institution of this measure by the Port and USACE could be complete within the required legal timelines. Due to these limitations, it was determined that this was not a viable alternative for mitigation for the Port Everglades project.

4. Reef enhancement

A previously impacted area on the outer reef, south of the planned channel expansion, was discerned using LADS data. This area was identified as a possible reef enhancement mitigation option by the interagency working group. During work performed for the DC&A (2009) benthic habitat assessment in early 2006, this area was documented to have large boulders and large amounts of rubble (Figure 5). The source and age of the impact is unknown. The results of the survey indicated this area supports some of the highest hard coral densities on the third reef and similar soft coral densities and numbers of species as the impact site (DC&A 2009), which may mean, that although it is "previously impacted", it is not in need of enhancement. Based on that assessment, it was determined that this was *not* a viable option for mitigation for the Port Everglades project.

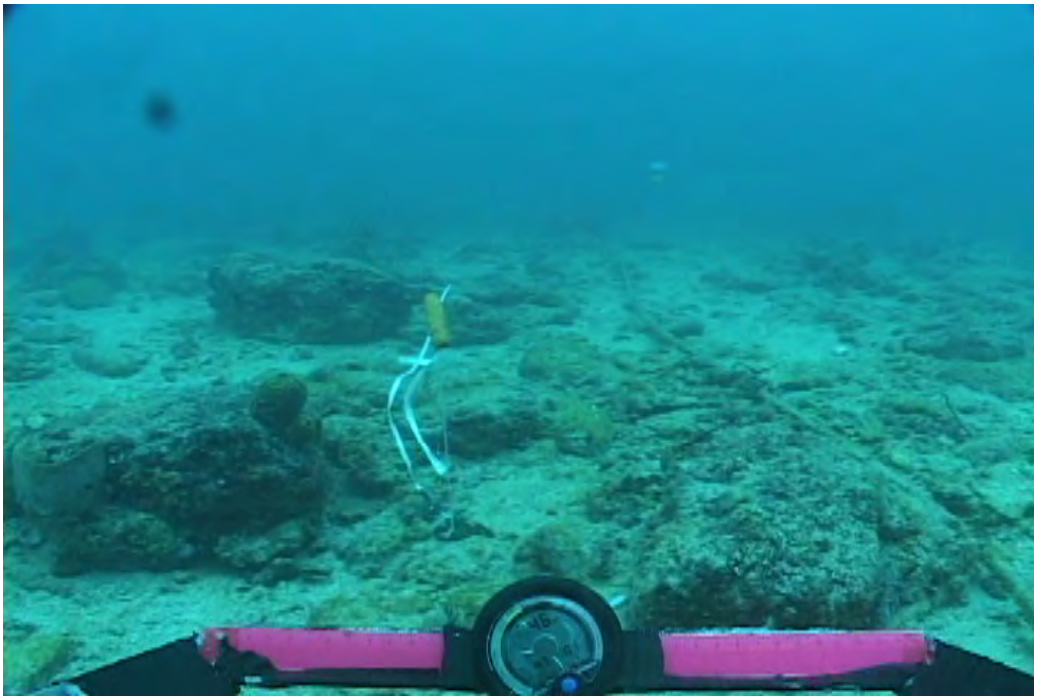


Figure 5 Previously Impacted Area on Outer Reef, South of the Planned OEC Expansion

5. Reef research

During PERG meetings, one or more participants inquired whether some mitigation funds could be used to perform research on reefs, or even just to construct artificial reefs with various materials or in various configurations such that research could be performed, even as the reefs provided targeted ecological functions. This would be considered “value-added” mitigation, where a secondary purpose could be achieved that may have indirect benefits for reef system design in years to come.

USACE mitigation policy requires that mitigation replace lost habitat function and that the success of the mitigation be measureable using success criteria. Although installation of artificial reefs meets this requirement, research does not specifically and directly replace lost habitat function, although the results of research may help resource managers to better assess impacts and create viable habitats for future projects. However, because the functional ecological benefits for the part of this alternative relating to research cannot be directly quantified, this alternative was determined to not be a viable option for mitigation for the Port Everglades project.

6. Repair of grounding sites and subsequent coral installation (transfer from impact sites)

The Southeast Florida Coral Reef Initiative (SEFCRI) and Broward County have identified approximately ten (10.6) acres of injured (unrestored) coral-hardbottom habitat that resulted from damage from vessel groundings. These are in an area north of the Port Everglades OEC that was formerly used as a commercial anchorage (Figure 6). FDEP contracted with NOVA University to prepare an assessment of the grounding sites and their current recovery status (Gilliam and Moulding 2012). A total of ten sites have been documented and are under consideration for use as mitigation for impacts due to implementation of improvements at Port Everglades. Restoration at these sites will include a combination of rubble stabilization, filling depressional areas, restoration of reef structure and complexity, and filling and sealing reef fractures.. In addition, rubble and small rocks from the grounding sites will be used to fill holes in the seabed. The interval required to reach substantial functional productivity of this alternative is estimated to be 30 years. This would be shortened to 10-20 years if corals are transplanted to restored reef structures from the impact sites.

The benefits to this alternative including the following:

- Stabilization of rubble and fractured hardbottom
- Providing relief to flattened reef structure
- Habitat would be directly secured to seafloor
- Creation of enhanced habitat that is aesthetically similar to adjacent, unimpaired natural hard-bottom reef structures
- Integration of restored areas into existing, nearby, natural reef structure
- High functional value reached after a short time interval

The major drawback of this alternative is high cost due to intensive labor associated with diving (commercial and scientific).

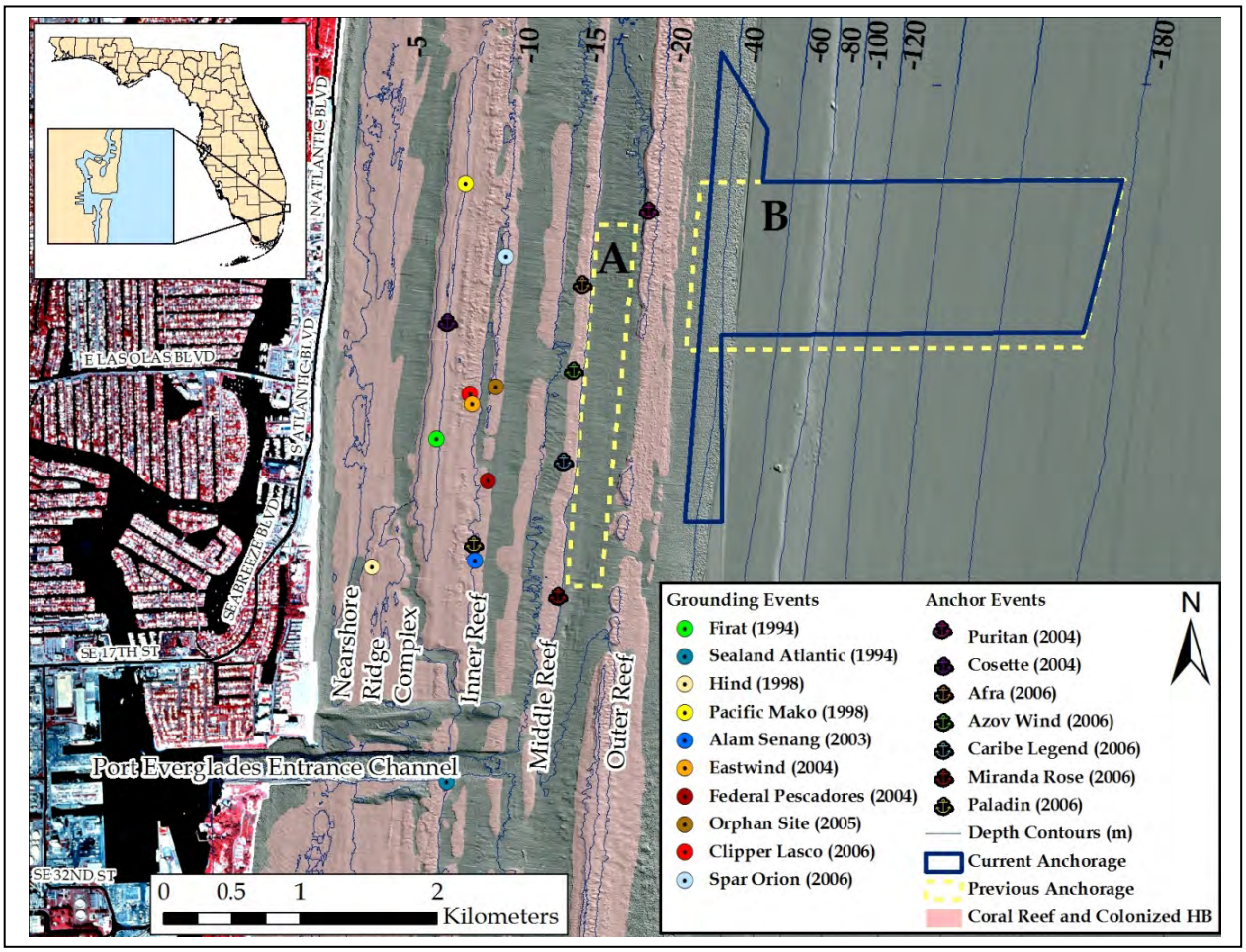


Figure 6 Location of Groundings Offshore of Port Everglades (Gilliam and Moulding 2012)

7. Removal of previous dredged materials from habitat north of the channel

In the nearshore ridge complex, adjacent to the north edge of the existing channel is an area where dredged material had been side-cast for an 1962 Port expansion project (Figure 7). For this mitigation alternative, the deposited material would be removed to expose hardbottom substrates and/or rock would be installed in these areas to facilitate colonization. Other than a study conducted on the western-most portion of the previously dredged material, there is little known information available about the on-site conditions and whether this could be developed into a viable mitigation alternative. Additional studies would be necessary to determine feasibility. For that reason this mitigation alternative was removed from further consideration.

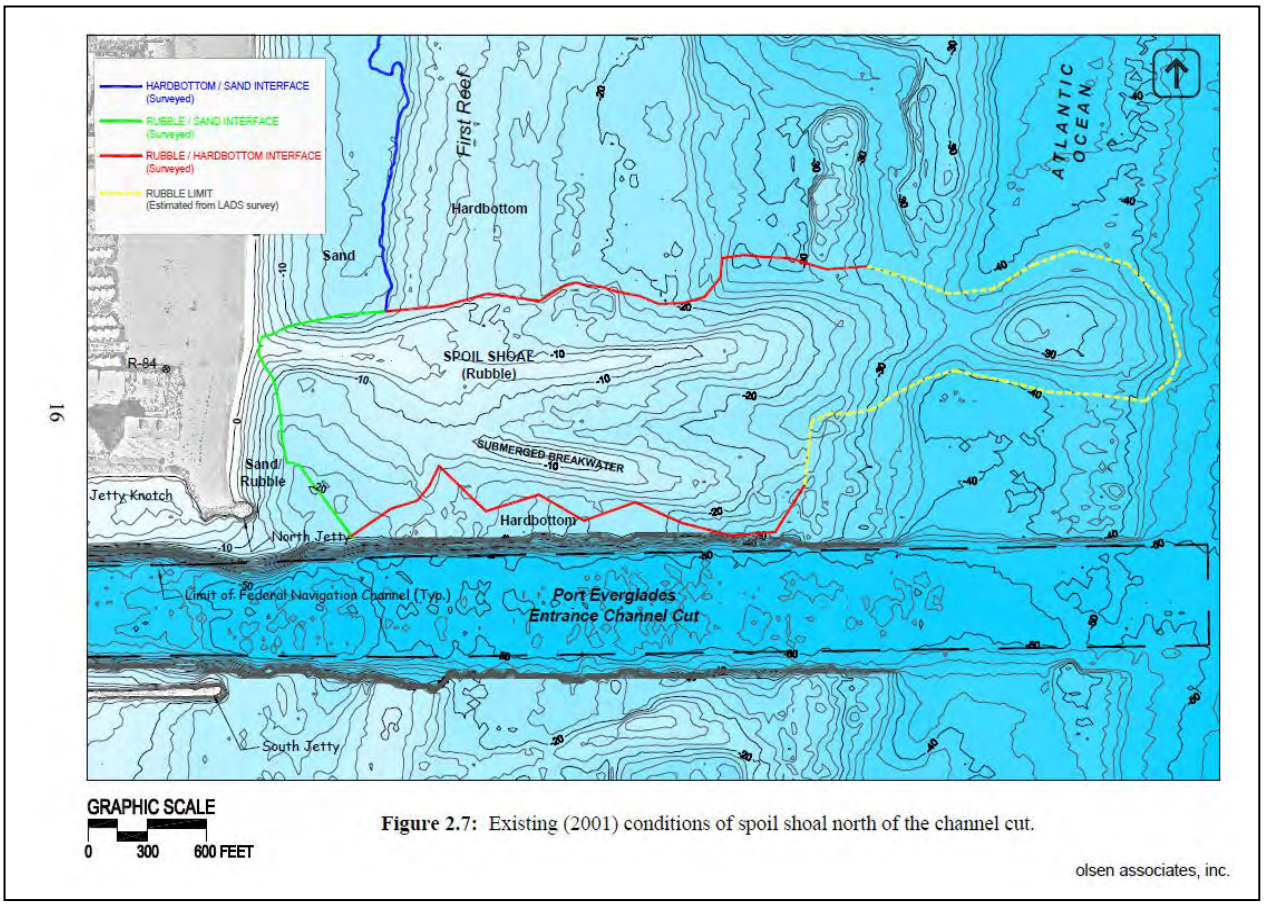


Figure 7 Location of Spoil Shoal Parallel to Port Everglades OEC (Olsen Associates 2004)

8. Artificial reef creation using of quarried or dredged rock

Where restoration and enhancement of reef resources are not available for use as mitigation, hardbottom creation has traditionally been offered (in this geographic area and where similar habitats are affected) as compensation for impacted habitats and lost ecosystem functions.

For the proposed compensatory mitigation for impacts at Port Everglades, the configuration of artificial reef materials will resemble, in profile and in functionality, to the maximum extent practicable those habitats impacted. Since new reef impacts would take place at water depths of approximately 40 to 45 feet (second reef line) and 50 to 55 feet (third reef line) for the channel expansion at Port Everglades, it was suggested that these two depth zones should be used at mitigation sites to achieve in-kind mitigation. Indeed, the use of in-kind mitigation immediately adjacent to the impact site is one of the major benefits to this mitigation alternative. Also, the amount of “high-relief” reef and “low-relief” hardbottom could be created in proportion to the impacted sites, unlike many of the other mitigation options. Mitigation reefs associated with the Port of Miami expansion in 1993 (the last deepwater port expansion with mitigation creation available for assessment) were examined to

determine if the mitigation reefs provided similar habitats, species assemblages and functions as the impact area. This was in fact the case, after seven years of the mitigation reef being in place (and without any transplants of corals to the mitigation reef). Other benefits of use of this mitigation option include the relative stability (on the seafloor) of quarried or dredged limestone/rock; relative ease of construction; and relative low cost.

This plan involves the deployment of piles of limestone that have been either quarried and transported to the mitigation area, or dredged from the channel construction areas. The piles will be configured into rows that are parallel to the existing reef tracts. Two layers of boulders will comprise these piles, given a vertical dimension of approximately 6 to 8 feet of relief. Low relief areas will comprise only one layer of boulders. Similar structures will be constructed near the Port of Miami in 2013. Based on outcomes from that effort, USACE will be able to improve on design and materials specifications for Port Everglades mitigation.

The interval required to reach substantial functional productivity of this alternative is estimated to be 30-50 years. However, with the transplantation of corals from the impact site to the rock reef infrastructure, the interval would be shortened to 23-30 years. As proposed, coral colonies greater than 10 cm (up to 12,235 colonies) in diameter and free of disease and boring sponge would be translocated from the impact area to the mitigation sites, which would be prepared in advance of dredging.

Drawbacks to this alternative are that the artificial reefs, as proposed above, are not as aesthetically pleasing as adjacent natural hard-bottom reef structures, they do not include a tremie concrete pour that would bond them even more securely to the seafloor, and they would be necessarily remove some softbottom (sand) habitats adjacent to existing reefs when the rock is placed on the sand. Finally, just after completion of installation, the functional value of the reefs is relatively low (compared to restored/enhanced reefs or boulders to which corals have been transplanted). Additional details regarding this alternative are found below.

9. Artificial reef creation using modular materials

Creation of artificial reefs using modular materials instead of quarried or dredged rock is another alternative. This alternative is identical to the Reef Creation alternative discussed above, but for the use of modular reef materials. This alternative utilizes modular reef components that are created on-shore and moved to the reef placement site. Modular reef habitat construction as a compensatory restoration alternative would consist of using established technology to construct and place cement reef-replication modules in a manner to provide a range of desirable ecological services. For example, a modular reef can be designed to maximize vertical profile, surface area for settling organisms, crevices for shelter, foraging habitat for pelagic organisms, or some combination of services such as these. Prefabricated reef modules have been used in the United States (including Broward County) to restore coral reefs impacted by vessel groundings and deployment of telecommunication cables. The creation of an artificial reef that mimics low relief hard-bottom coral reef can be designed for both aesthetics and habitat function. The project to construct and place cement reef-replication modules in a shallow or deep hard-bottom environment could be located in one or more favorable settings north or south of the project footprint. Another benefit is that upon installation, they have a moderate (vs. low, as in the rock reef creation alternative) functional value.

Costs for this alternative are relatively higher due to (1) on-shore labor to create the modules, (2) land-based, as well as sea-based, transportation costs, and (3) diver labor necessary to place the modules on the seafloor. However, the benefits include ease of construction and their secure placement on the seafloor.

The interval required to reach substantial functional productivity of this alternative is estimated to be 30-50 years. This would be shortened to 23-30 years if corals are transplanted to artificial reef structures, as noted in the above alternative. Coral colonies greater than 10 cm (up to 12,235 colonies) in diameter and free of disease and boring sponge would be translocated.

10. Coral propagation and active species enhancement

NOAA's National Marine Fisheries Service (NMFS), a cooperating agency with USACE for development of the Environmental Impact Statement (EIS), independently estimated that the tentatively selected plan would impact 137.83 acres of coral, coral reef, and hardbottom (collectively referred to here as "reef": 20.34 acres of coral reef in the channel and 117.49 acres of coral reef located outside the channel). In May 2013, NMFS recommended that USACE mitigate these impacts by propagating coral colonies at in-water and land-based nurseries and then outplanting the colonies to suitable recipient sites on the reef tracts. NMFS estimates this approach would require 20 years to complete and would cost approximately $35.6M to $42.3M (including risk contingencies).

NMFS's recommendation is based on successes of coral propagation and enhancement programs in Atlantic and Caribbean waters. Scientifically vetted practices for nursery propagation, outplanting, and monitoring have been developed and used by coral nursery managers in the Florida Keys, Broward County, Puerto Rico, U.S. Virgin Islands, and other Caribbean islands to reproduce *Acropora* spp. asexually (e.g., Johnson et. al 2011). Typically, small fragments less than five centimeters (cm) in diameter are collected from the reef and held in an underwater or tank-based nursery environment through their juvenile life-stage. Offshore nurseries are sited based on a number of factors including habitat feasibility and water quality conditions, potential for future impacts, and permitting status/considerations. Once the stock nursery population is established, no more coral is collected from natural reef communities. The physical and genetic origin of each coral is tracked from fragment collection to ensure that both nursery and outplanting operations are done in a scientifically responsible way. Regular maintenance is performed on nursery structures and the corals themselves to ensure all are free of coral competitors and predators. Once coral fragments have grown to a size where the probability of survival on natural reefs has increased to an acceptable level (this usually requires 12 to 18 months), the corals are outplanted. Decisions regarding which species to propagate and outplant (in addition to staghorn coral) and the balance (relative percent-cover, or relative population densities) among all species would be based on findings from the most recent peer-reviewed literature at the time the project is funded. Additionally, outplant recipient sites would be selected using a strategy that maximizes likelihood of outplant survival while minimizing risk from natural and human disturbances.

Using a type of Habitat Equivalency Analysis, specifically "resource-to-resource" equivalency analysis, NMFS estimated that 195,000 to 250,000 corals need to be outplanted from nurseries to offset the impacts to coral from expanding the Port's OEC. These costs are included in the budget for this alternative. In addition to eventually establishing those colonies on recipient sites, NMFS also assumes that preconstruction avoidance and minimization measures related to coral translocation are taken (these costs are NOT included in the budget for this alternative). These include the following:

- Relocation of all corals listed under the Endangered Species Act from impact areas, regardless of size.
- Relocation of a subset of massive corals and all corals proposed to be listed under the Endangered Species Act that are 5 cm or larger.
- Relocation of all other corals greater than 10 cm diameter.

The proposed coral propagation and outplanting program is based on utilizing existing NMFS programs to support the implementation of the project in partnership with local resource agencies (e.g., FDEP), academic institutions (e.g., NSUOC), and other coral restoration partners in the local area. One benefit of this alternative is that it is designed to maximize the chances of successful natural coral reproduction; larval transport; settling and colonization into new areas; and genetic mixing required for survival and recovery of the species. Furthermore, this proposal is consistent with the NMFS Acropora Recovery Strategy (under development) and other coral recovery plans for coral species that may be listed under the Endangered Species Act. The entire draft proposal for this alternative is located in Appendix E-4. Should this alternative be selected, it will undergo full USACE review, and meet all USACE policy requirements.

11. Blending of components from various mitigation alternatives

For this alternative, USACE may utilize components from alternatives 2, 6, 8, and/or 10 above. Details regarding the appropriate blend are not available at this time, including those regarding cost and ecological/functional benefits. Details will be developed in consultation with cooperating and agency partners and be included in the final EIS for review and comment. Should this alternative be selected, Should this alternative be selected, it will undergo full USACE review, and meet all USACE policy requirements.

6.3 Incremental Cost Analysis Results for Hardbottom Habitat Mitigation Alternatives

6.3.1 Expected Cost of Alternative Hardbottom Habitat Mitigation Plans

The estimated costs of the four practicable mitigation alternatives to provide compensation of ecosystem services due to unavoidable impacts of the TSP are shown in Table 8 (Scenario 2, i.e., no anchor/cable impacts, as discussed in Section 6.2 above, for the OEC authorized depth option of -48 feet MLLW). The table also lists the impact acreages per habitat type, and the resulting mitigation requirement (in acres) for each of the candidate mitigation alternatives. Finally, along the top row, the table also compares the recovery rates (in years) for seafloor habitats and channel wall habitats that were used in the HEAs. Total mitigation cost ranged from $20 million to $34 million among the four alternatives.

6.3.2 Hardbottom Habitat Mitigation Benefits

The basis for determination of benefits will be <u>one acre of restored or created hardbottom habitat.</u> USACE would restore 19.10 acres of reef if the “grounding site restoration” alternative is selected or create 19.49 acres of hardbottom habitat if any of the other three alternatives is selected.

6.3.3 Construction/ Initial Cost per Hardbottom Habitat Functional Unit

The base-year cost of each alternative mitigation plan is compared to the respective benefit (functional unit, or acre) below (see Table 9). Costs are based on FY2012 estimates (annualized values are provided in the Economic Appendix of the Feasibility Study). Cost per acre ranged from approximately $1 million to $1.8 million among the four alternatives.

Table 8 Total Cost of Mitigation Alternatives Based on Habitat Equivalency Analyses for OEC Impacts under Scenario 2 with 48-foot *authorized* depth/ 57-foot *actual* depth

		Required Mitigation (in acres), Cost per Acre, Coral Relocation Costs, and Total Cost			
	Impact Area (Acres)	Restore grounding habitat using transplants	Artificial reef creation using modules and coral transplants	Placement of rock/ boulders to stabilize tire field; with coral transplants	Artificial reef creation using rock/boulders and coral transplants
Time to Recovery: Seafloor/ Channel Wall (yrs)		20	30/26	30/26	30/26
Middle and outer reef direct impacts	15.17	18.66	19.05	19.05	19.05
Middle reef channel wall impacts	0.36	0.32	0.32	0.32	0.32
Indirect outer reef impacts	37.69	0.04	0.04	0.04	0. 04
Indirect impacts: all other habitats	75.55	0.08	0. .08	0. .08	0. .08
Total mitigation area (acres) required to offset impacts		19.10	19.49	19.49	19.49
Cost per Acre		$1,260,000	$1,320,000	$1,225,000	$588,524
Coral Relocation (Not more than 12,235 colonies)		(included above)	$8,662,380	$8,662,380	$8,662,380
Total Mitigation Cost		$23,955,120	$34,389,180	$32,537,630	$20,132,713

Table 9 Construction/ Initial Cost per Acre of Hardbottom Mitigation

Reef Mitigation Alternative	Construction Cost of Mitigation	Benefits of Mitigation (acres)	Cost/Acre
Grounding Restoration Sites	$23,955,120	19.10	$1,254,195
Artificial Reef Creation- Modules	$34,389,180	19.49	$1,764,453
Tire Field Stabilization w Art. Reef Creation	$32,537,630	19.49	$1,669,453
Artificial Reef Creation- Boulders	$20,132,713	19.49	$1,032,977

6.3.4 Cost-Effective Hardbottom Habitat Mitigation Plan

Cost estimates for the above alternatives that were determined to be practicable (reef creation on tire debris field, reef restoration in former anchorage area, and reef creation, including the modular-reef option) were calculated, and those costs were used in an incremental cost analysis. An alternative is considered cost effective if no other alternative provides the same level of output for less cost, and if no other plan provides more output for the same or less cost (ER 1105-2-100). The table above shows the comparison of plans. It was determined through use of USACE IWR software (IWR Planning Suite 1.0.11.0, certified 24 September 2008) that the reef creation alternative (using quarried rock or rock produced from dredging) was the “Best Buy” alternative and that the other three alternatives were “Non Cost-Effective.” Given that finding, the “reef creation” alternative described above was selected as the proposed mitigation plan for impacts to hardbottom habitats due to the TSP.

6.3.5 Hardbottom Habitat Mitigation Cost Based on Selected OEC Depth Option

Several alternative authorized depths are under consideration for the TSP’s Outer Entrance Channel element. These authorized depths result in actual depths ranging from 55 to 59 feet (one-foot increments; “authorized” or “project” depths are seven feet less then these depths). Each depth would affect/impact a different amount of hardbottom habitat. The following table (Table 10) shows what those differences are (in acres) and lists the different mitigation requirements and costs for each depth under consideration, based on the Best Buy mitigation alternative noted above.

Table 10 Incremental Mitigation Construction/ Initial Costs for TSP (Plan 2E) Reef Impacts

Actual Dredge Depth (includes +7'+1'+1' for safety) Increment for Outer Entrance Channel	Direct Impacts to Reef and Hardbottom Project Footprint (acres)	Mitigation Required (acres)	Mitigation Cost for Cost-Effective Mitigation Alternative (Art Reef w/ Boulder/Rock and transplanted corals)
59 ft	16.66	21.34	$21,913,906
58 ft	16.00	20.52	$21,110,592
57 ft	15.17	19.49	$20,132,713
56 ft	14.27	18.33	$18,954,425
55 ft	13.33	17.16	$17,749,012

6.4 Proposed Mitigation Plan for Hardbottom Habitats

6.4.1 General Artificial Reef Considerations

Artificial reefs are used to mitigate for impacts to natural hardbottom habitats as a result of various anthropogenic activities along the coasts (Zimmer 2006). Artificial reefs have been used as mitigation for beach nourishment projects, dredging projects, and telecommunication cable placement projects that affected natural reef or hardbottom.

Artificial reefs have been used successfully for many years to mitigate impacts in sheltered waters (Duffy 1985 and 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.

Several factors are important to consider when designing a mitigation project using artificial reefs, including site selection (vis-à-vis position in the environmental landscape and relative physical and biological factors), longevity, and achieving design elements that mimic the natural system so that the project replaces, as closely as practicable, the functions lost due to project impacts (i.e., "in-kind" mitigation).

Site selection is an important factor in artificial reef success. Depth, substrate suitability, geo-spatial orientation, and connectivity with other artificial or natural reefs must be considered when selecting a site for artificial reef placement. Since the biological composition of reefs is driven in part by depth and associated factors such as light attenuation, the depth of artificial reef should be similar to the impacted natural reef. The composition (and depth to bedrock, if the overburden is sand) of the substrate on which the rock is placed must be sufficient to support artificial reef structures. Artificial reefs placed in areas having a thick overburden of sand have been documented to sink and thereby lose their functionality as reefs. Ideally, artificial reefs should be placed in an area with a thin veneer of sand over limestone or bedrock. Artificial reefs should be placed in order to mimic the geospatial

aspects of the natural reef as much as possible. For example, if the long axis of natural reefs runs in a north-south direction, then artificial reefs should be designed and placed using the same geospatial orientation. Finally, a candidate site's biological connectivity should be considered when designing and placing artificial reefs for mitigation. The artificial reefs should mimic the connectivity of the natural reefs as much as possible. Biological connectivity also relates to potential exposure of artificial reef structures to pelagic larvae, such as might be carried by the Gulf Stream.

Mitigation reefs have often been required to be built in the immediate vicinity of the natural reefs impacted by construction activities. In areas were the habitat that was impacted was the only habitat in the area, this approach has merit. A guiding principle of artificial reef development has always been that reefs should not be deployed immediately adjacent to productive reef habitats. From a fisheries standpoint, reefs placed in non-reef habitats are biologically more productive as they are trophically coupled with foraging habitats that are unexploited by other reef fishes (Bortone 1998). More importantly, the shifting of reef materials in storms may severely damage adjacent natural habitats. For this reason, the Florida Artificial Reef Development Plan prohibits material from being placed within 100 yards of "live bottom" areas, such as nearshore hardbottom (Myatt and Myatt 1992). Following Hurricanes Andrew, Opal, and Erin, it was found that even massive materials in relatively deep water were moved or broken up by tremendous wave forces (Lin 1998, Turpin 1998). The possibility exists that less massive materials in much shallower water could shift and damage adjacent natural habitats. For the above reasons, sites selected for mitigation reef construction should have no significant areas of natural reef within 100 yards and no reefs should be placed directly seaward and immediately adjacent of any significant area of natural reef.

6.4.2 Location, Materials, and Design

Mitigation reefs will be designed and placed to mimic the impacted natural habitat of the middle and outer reefs. Two types of mitigation reefs will be constructed: High Relief, High Complexity (HRHC) reefs (exceeding three feet of vertical relief) and Low Relief, Low Complexity (LRLC) reefs (approximately three feet of relief). The HRHC reefs are intended to mitigate for impacts to high relief habitat (i.e., linear or spur-and-groove reefs) and the LRLC reefs are intended to mitigate for impacts to lower relief reef (i.e., pavement or channel wall) and hardbottoms outside of the project footprint (i.e., in the indirect effect area). The two reef types will be deployed in acreages proportional to direct impacts expected to each type of natural reef habitat (where impact habitat types were based on data collected in 2006 (DC&A 2009) and published classification systems): 6.92 acres of LRLC habitat and 12.57 acres of HRHC will be created (Table 11).

Due to the large acreage required for mitigation (19.49 acres), and limited available benthic floor space at permitted artificial reef sites, the mitigation area may have to be distributed among two or three sites. However, if one site could be used, it would be the preferred option. Several areas are under investigation to serve as sites for installation of artificial reefs (Figure 8). Due to the amount (and type) of mitigation required, more than one site may be selected. Geotechnical investigations and other reconnaissance (including environmental) will be necessary to determine precisely the best position(s) for reef structures to be installed. Appropriate members of Broward County, FWS, NMFS, FWC, EPA and DEP staffs will be consulted prior to final siting.

Table 11 Mitigation Requirements per Impact Type (Scenario 2)

Impacted cover/ habitat type	Mitigation requirement (acres)
Middle and Outer Reef Direct Impacts, Totaling 15.17 ac, comprising the five categories below:	19.05;….. comprising the five categories below at left, distributed by percent-share of impacts:
-- Colonized Pavement –Outer (33% of 15.17 ac impacts)	(6.29)
-- Linear Reef-Outer (27% of 15.17 ac impacts)	(5.14)*
-- Spur & Groove-Outer (06% of 15.17 ac impacts)	(1.14)*
-- Linear Reef-Middle (33% of 15.17 ac impacts)	(6.29)*
-- Colonized Pavement-Shallow (<1% of 15.17 ac impacts)	(0.19)
Middle Reef Channel Wall Impacts	0.32
Direct/ Anchor and Cable Impacts	0.00
Outer Reef Indirect Impacts	0.04
All Other Indirect Impacts	0.08
TOTAL	**19.49**

*designates acreages of habitats that should be arrayed as high-relief, high-complexity

Limestone rock excavated from the STB, MTB, IEC, and the OEC may be used in reef construction and, if necessary, supplemented with quarried limestone. If the selected contractor chooses to use project-produced rock, they may commence excavation *inside* the harbor, transporting the material offshore for mitigation construction, and then proceed to dredging the entrance channel; i.e., dredging and reef installation will occur simultaneously. Alternatively, the construction contractor will be allowed the option of purchasing quarried native limestone in lieu of using the material from within the project boundaries. Contract specifications/requirements may be stated in the following manner, as they were for another recent federal project in South Florida:

> "The sites [i.e., dredge sites/project components] may be used in any combination to provide the minimum area for both low-relief and high-relief reef and may be used in their entirety if desired. Suitable materials for use in the reef mitigation areas shall consist of rock excavated from the project or native limestone quarried from Palm Beach, Broward, Dade, Monroe, Martin, Glades, Charlotte, Lee, Hendry, and/or Collier Counties. Rock particles shall measure a minimum of 36-inches in length by 36-inches in width, the third dimension remains variable. The stone shall be free from components, minerals, cementing or bonding materials or structural defects that might contribute to spalling or breakdown from handling and placing. The Contractor shall be responsible for removal of all rejected reef construction materials from the staging area, barges or reef. If substandard materials are placed on the reef, the Contractor shall be responsible for removing those materials and replacing them with acceptable reef material or shall place additional stone to achieve the minimum areas for both high-relief and low-relief reef, as directed by the Contracting Officer."

HRHC reefs will likely consist of limestone rock boulders from 1.0 to 10.0 ton each, having a minimum density of 140 pounds per cubic foot. The material will be deployed in shore-parallel strips 50-100 feet wide to mimic the orientation of typical natural reefs. This reef design will have a vertical relief of 6-8 feet and boulders will be partially stacked to provide the maximum structural complexity and to provide refugia for cryptic and reclusive species. As interstitial sand patches associated with reef habitat are thought to be important in the ecological function of the reef habitat, the reef footprint will contain approximately 20 percent open sand surface. If used, quarried marine limestone boulders averaging 4.25 ft. diameter will be individually placed on the seafloor. All boulders will be placed such that they will be in contact with each other; interlocking to form a compact mass. Two layers of boulders will be used to create a high-relief structure that somewhat mimics the surrounding reef environments.

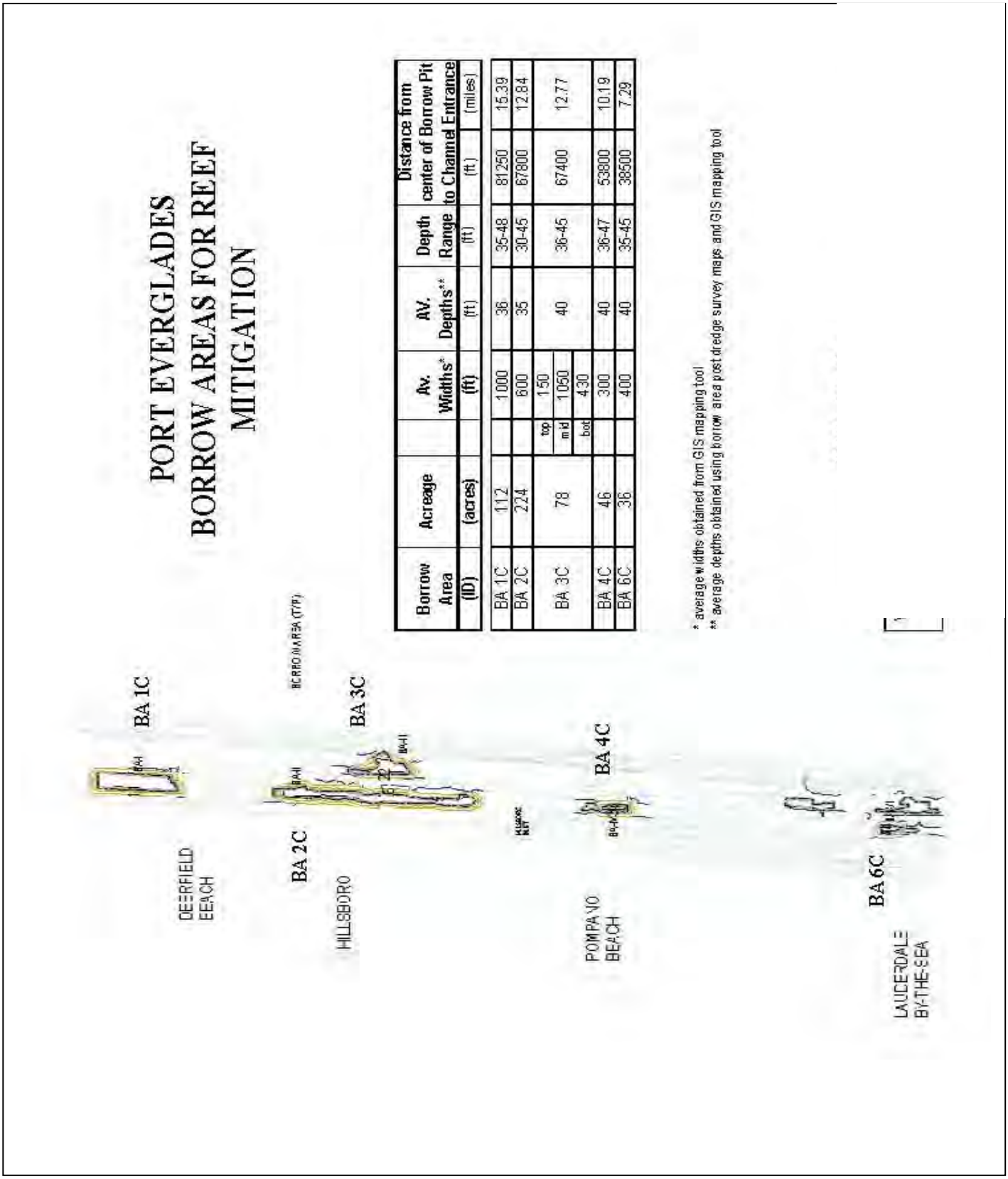
Temporary buoys delineating the deployment strip will mark areas for deployment. Corner buoys for the sites shall be placed using DGPS with sub-meter accuracy. Natural limestone provides an ideal substrate for the establishment of a reef community. An additional advantage of limestone rock boulders is aesthetic. Once colonized by the reef community, the reef is almost indistinguishable from a natural reef, enhancing its value as a recreational resource. HDHC reefs are intended to provide persistent habitat with higher complexity and habitat diversity than typical natural nearshore hardbottom reefs.

For the proposed compensatory mitigation for impacts at Port Everglades, the configuration of reef materials will resemble, if not in profile, at least in functionality, those habitats impacted. The mitigation acreage required per type of impact is detailed in Table 11 which was partially adapted from DC&A and USACE (2013); subcategories for middle and outer reef mitigation requirements were based on the fractions that those types comprised of the middle and outer impact category.

It should be noted, however, that it is unlikely that high-profile reef would completely cover the area designated for such hardbottom habitat. A more likely scenario would be that open, sandy spaces will surround the “rock-pile-rows” to increase habitat variability and increase the exposure of the reef to sea currents and migratory species.

LRLC reefs will likely consist of limestone boulders ranging from 1.0 to 10.0 ton each, having a minimum density of 140 pounds per cubic foot. The material will be deployed in shore-parallel strips 50-100 feet wide to mimic the orientation of typical natural reefs. Boulders will be placed in a single layer along the substrate, without stacking. LRLC reefs may be periodically buried by shifting sands, like the low relief natural reefs they are intended to mimic. It is for this reason, and in an effort to achieve “in-kind” mitigation, that LRLC reefs are included in the mitigation design. To provide interstitial sand habitat, approximately 20 percent of the LRLC reef footprint shall be open sand.

As noted above, transplantation of corals (larger than 10 cm in diameter) from the direct impact area to the new installed substrates will be carried out. This will speed the increase in habitat value of the mitigation sites.



Borrow Area (ID)	Acreage (acres)		Av. Widths* (ft)	Av. Depths** (ft)	Depth Range (ft)	Distance from center of Borrow Pit to Channel Entrance (ft)	(miles)
BA 1C	112		1000	36	35-48	81250	15.39
BA 2C	224		600	35	30-45	67800	12.84
BA 3C	78	top	150	40	36-45	67400	12.77
		mid	1050				
		bot	430				
BA 4C	46		300	40	36-47	53800	10.19
BA 6C	36		400	40	35-45	38500	7.29

* average widths obtained from GIS mapping tool
** average depths obtained using borrow area post dredge survey maps and GIS mapping tool

Figure 8 Proposed Artificial Reef Installation Sites, Broward County

6.5 Monitoring and Adaptive Management for Hardbottom Habitat Mitigation

The monitoring program for the mitigation reefs will include both physical and biological underwater assessment methods for at least five years. Physical monitoring will assess the degree of settling of reef materials, and annual biological monitoring will assess populations of algae, invertebrates, and fishes, and compare them to control sites on natural reefs.

The degree of settling and/or sand covering will be assessed by measuring the relief at each of the permanent quadrat stations established as outlined below. Measurements will be taken with a weighted flexible tape from a point one meter shoreward of the quadrat benchmark to the surface of the water and from the top of the reef structure at the benchmark to the surface of the water, with the difference being the relief. The mean of five such measurements will be used to assess the degree of settling and/or sand covering of the materials. Changes in relief at the control reef quadrat benchmarks will be assessed by the same method. If physical inspection reveals that the acreage or typical relief of the reef has been significantly reduced by subsidence, scour, or sand accretion, additional materials will be added as necessary to restore the reef to the as-built design.

A study design consisting of standard underwater assessment methods will be used in order to statistically compare mitigation reefs to natural reefs (control sites). Success criteria for benthic algae, invertebrates and fish populations will be established in order to demonstrate mitigation success. Success criteria will be based on the biological communities of control sites (natural reefs) and may include species richness, density, and cover of benthic algae, invertebrates, and fishes. Standard methods used to assess these parameters may include, but are not limited to in situ and/or video transect data collection for assessing benthic algae and invertebrate populations; in situ or photo-quadrat data collection for benthic algae and invertebrates; cylinder fish population surveys and/or roving diver fish surveys. Appropriate parametric and non-parametric statistics shall be employed in order to demonstrate mitigation success criteria are met. An example of one possible biological sampling protocol is described below:

> Five randomly selected locations on each type of mitigation reef will be chosen and benchmarked for permanent photo-quadrat stations to assess sessile invertebrate and algae abundance. Randomly selected stations on high and low relief natural hardbottom reefs will also be established to serve as controls. Locations for ½-square-meter photo-quadrats will be established by driving two steel pins into the reef that will precisely locate the quadrat frame. The sites will be benchmarked using a DGPS system with sub-meter accuracy. Invertebrate and algal abundance will be evaluated from digital photography of each quadrat. Species will be identified to the lowest practical taxon and ranked in order of abundance. Superimposing a grid over the digital image and counting bare and colonized grid squares will assess overall percent cover (Bohnsack 1979). Criteria for success of the mitigation reef will be based upon a comparison of a total percent cover of algae and invertebrates at the new reefs and at control reefs. of corresponding relief type. The criteria for success of the mitigation reefs in establishing a similar community structure will be a finding of no significant difference in the rank abundance orders of species between mitigation and control reefs of each type. Statistical comparisons between mitigation and control reefs will be made using the Wilcoxon Rank-Sum (Zar 1984) or similar nonparametric test at p=0.05.

Fish population evaluations will be based on visual censuses conducted separately on HRHC and LRLC mitigation reefs and high and low relief control reefs. The point-count method (Bohnsack and Bannerot 1986) will be used for fish assessment. This method has the advantage of gathering quantitative data in a relatively short time in a very repeatable pattern that is relatively insensitive to differences in habitat structure. Each census will have a duration of five minutes and a radius (the distance from the stationary observer) of 10 feet. Ten censuses will be collected on each of the four reef types. Data from these types of censuses is rarely normally distributed, so the Wilcoxon Rank-Sum or a similar nonparametric test will be used for significance testing. The criteria for mitigation reef success will be a finding of no significant difference at p=0.05 between reef type pairs (HRHC vs. high relief control and LRLC vs. low relief control).

Results of all mitigation reef monitoring efforts will be summarized in an annual report to be completed by December 31 of each year the monitoring program is in place (i.e., until success criteria are met). Copies of the report will be distributed to all agencies and interested parties. Data from monitoring events will be reviewed by USACE staff in consultation with other federal and state agencies to guide decisions on necessary operational or structural changes (adaptive management) that may be needed to ensure that the mitigation project meets success criteria as defined above. Additional details regarding monitoring can be found in the appendices.

6.6 Hardbottom Habitat Mitigation Success Criteria

The following success criteria for the above mitigation alternative are as follows:

1. The mitigation area and impact site must have biota with 75% species similarity by the time of the final, proposed (i.e., fifth year) monitoring event.

2. Percent-cover of major functional groups at the mitigation area will be similar to that of the impact site (80% similarity) by the time of the final, proposed (i.e., fifth-year) monitoring event.

6.7 Adaptive Management/Contingency Plan for Hardbottom Habitat Mitigation

If mitigation is not trending towards success by Year 3 following implementation of mitigation, corrective measures will be engaged; among them, transplantation of additional corals from coral nurseries and deployment of additional reef material. Other options as deemed appropriate by USACE, in consultation with NMFS, FWS, FWC, FDEP, and Broward County may also be carried out, depending on various site-specific factors.

7.0 MITIGATION SUMMARY

Based on unavoidable impacts to significant resources due to the implementation of the TSP, USACE and the local sponsor are proposing mitigation as detailed above, and as summarized in Table 12 below. Construction and mitigation monitoring plans are detailed in Appendix E-5.

Table 12 Proposed Compensatory Mitigation by Habitat/Impact Type

Impact	Mitigation
Direct Impacts to Reefs/Hardbottoms	9.37 acres of hardbottom creation
Indirect Impacts to Reefs/Hardbottoms	0.12 acres of hardbottom creation
Seagrass Beds	2.40 functional units debited from West Lake Park restoration/enhancement project
Mangrove Wetlands	1.00 functional units debited from West Lake Park restoration/enhancement project

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APPENDIX E-1

Environmental Permits for West Lake Park Improvements

Update

Update

Number: _____

Conversion services provided by:

MICROGRAPHICS

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DEPARTMENT OF THE ARMY PERMIT

DUPLICATE

Permittee: Broward County Parks and Recreation Division
Attn: Pat Young
Administrative Manager
950 N.W. 38th Street
Oakland Park, FL 33309

Permit No: SAJ-2002-00072(IP-LAO)

Issuing Office: U.S. Army Engineer District, Jacksonville

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: To provide up-front compensation to be used for wetland impacts associated with future Broward County projects, the County has proposed a mitigation plan for upland, wetland, and seagrass creation, restoration, enhancement and preservation of mangroves and seagrasses within West Lake Park in Broward County.

The project is to install culvert connections to increase flushing of a 1500+ acre mangrove forest, tidal flushing channels, construct a riprap/crib structure for shoreline stabilization along approximately 3 miles of shoreline adjacent to the mangrove edge along the ICW and for approximately 1.5 miles along the Dania Cutoff canal. The riprap/crib structure shall be created using piling supports on one or both sides of the riprap with pilings parallel to the shoreline with horizontal reinforcing bars to create the support structure for the riprap. A geotube base filled with clean fill will be laid within the crib structure for stabilization. Where the structure is adjacent to resources, as shown in the attached drawings, riprap placement will be within a 5-foot wide crib structure which is vertical on both sides with pilings and stringers. Where the riprap will not be placed adjacent to resources, the piling support structure will be only built on the landward edge of the mangrove fringe and the riprap will be placed against and waterward of it with the waterward slope of the riprap being no steeper than 1.5 horizontal to 1 vertical.

The project will also include the scrape down and/or removal of exotic vegetation from approximately 63 acres of upland soil to create mangrove, mudflat, tidal flats and pools, seagrass, and maritime hammock habitat. Additionally, exotic vegetation removal will occur in smaller areas throughout the park. A temporary expansion of an existing road involving 0.03 acres of impacts will be installed to allow spoil removal.

The project is proposed to create ±24.2 acres of mangrove habitat, 7.0 acres of mud flats/tidal pools, 8.6 acres of tidal channels, 8.0 acres of seagrass habitat, 13.4 acres of maritime hammock, 1.9 acres of structural habitat in the form of a riprap crib structure along the ICWW, and 2.0 acres of supplemental structural habitat (riprap) along the Dania Cut-off Canal. Project restoration would consist of 1.5 acres of mud flats/tide pools, and improving 3.5 acres of flushing channels within the Dania Salt Marsh, and removing derelict barges which currently shade 0.5 acres of potential seagrass habitat within Whiskey Creek. Project enhancement/creation consists of 32 acres of mangroves, removal of 8.4 acres of exotic vegetation and replanting of sea oxeye daisy, and removing and preventing future exotic infestations in 10 acres. Project preservation consists of 23.3 acres of outparcel acquisition, and 30 acres of seagrass/manatee protection areas.

The work described above is to be completed in accordance with the 33 pages of drawings and 8 attachments affixed at the end of this permit instrument, specifically Attachment 4 which outlines the projects construction methodology, monitoring requirements, and timing.

Project Location: The project is located in West Lake Park, a county park composed almost entirely of a mangrove forest west of the Intracoastal Waterway and south of the Dania Cutoff Canal, Dania Beach (Sections 1, 2 and 11, Township 50 south, Range 42 east, Broward County, Florida.

Directions to site: From I-95 in Fort Lauderdale, exit east at Sheridan Street and go east 2.6 miles. The project is on both sides of Sheridan Street.

Latitude & Longitude: Latitude: 26° 2′ 20" North
Longitude: 80° 7′ 10" West

Permit Conditions

General Conditions:

1. The time limit for completing the work authorized ends on **February 28, 2011**. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and State coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature and the mailing address of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

1. Submittals required herein shall be directed to:

Department of the Army
Jacksonville District Corps of Engineers
Regulatory Division, Enforcement Section
P.O. Box 4970
Jacksonville, Florida 32232-0019

A courtesy copy of any required enhancement/creation reports will also be provided to:

U.S. Army Corps of Engineers
South Permits Branch Office
4400 PGA Boulevard, Suite 500
Palm Beach Gardens, FL 33410

2. Prior to commencement of construction in or adjacent to wetlands and/or Waters of the United States, the perimeter of the enhancement/creation construction area(s) shall be enclosed with staked and trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas.

3. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date.

4. The permittee shall conduct a pre-construction meeting prior to commencement of construction in order to notify in-house staff, field crews, contractors, subcontractors, and all persons involved in the construction of West Lake Park Enhancement/creation Project of the conditions of this permit. The permittee shall educate and inform staff members and contractors of these procedures. Copies of the permit and specific conditions shall be displayed at the construction site.

5. All storage or stockpiling of tools or materials (i.e. lumber, pilings, etc.) shall be limited to uplands or within the impact areas authorized by this project.

6. All temporary wetland impacts associated with the enhancement/creation construction activities shall be restored to preexisting wetland conditions immediately following completion of the construction element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time-zero enhancement/creation monitoring report and shall

be maintained and monitored in conjunction with the enhancement/creation monitoring program provided for in the enclosed exhibits.

7. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the Corps may require the permittee to provide appropriate enhancement/creation to the Corps. The Corps may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

8. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or Waters of the United States prior to disposal in a suitable upland spoil disposal area or placement in the geotube base for the riprap crib.

9. The permittee shall comply with the attached Manatee Construction Conditions enclosed in attachment #3 which are also outlined in this condition. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

The permittee shall advise all construction personnel that there are civil penalties and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water wherever possible.

If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all

appropriate precautions shall be implemented to ensure protection of the manatee(s). these precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida.
Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 8 ½ by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida.

10. The permittee shall install and maintain permanent manatee awareness signs/education displays.

11. As provided in Attachment 4, Broward County Parks and Recreation Division shall be responsible for the enhancement/creation construction, five year maintenance and monitoring and perpetual management of the proposed enhancement/creation efforts at West Lake Park.

12. A maintenance program shall be implemented in accordance with Attachment 5 for the enhancement/creation areas on a regular basis to ensure the integrity and viability of those areas as permitted. Maintenance shall be conducted in perpetuity to ensure that the enhancement/creation areas are maintained free from Category 1 exotic vegetation (as defined by the Florida Exotic Pest Plant Council at the time of permit issuance) immediately following a maintenance activity. Coverage of exotic and nuisance

plant species shall not exceed 5% of total cover between maintenance activities. In addition, the permittee shall manage the conservation areas such that exotic/nuisance plant species do not dominate any one section of those areas.

13. A time zero monitoring report for the West Lake Park enhancement/creation project shall be conducted in accordance with Attachment 5 for all completed enhancement/creation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

14. The permittee shall submit annual monitoring reports to the Corps for a period of five years, the first not later than one year after the submission of the time-zero report. Each monitoring report shall provide a narrative, professional biological opinion of the condition of the enhancement/creation improvements. The monitoring report shall also contain a plan view describing the vegetative community, the percent cover for each community, a list of species and their percent cover for each community, the percent cover of wetland and of exotic plant species, the sum of the survivors of those planted plus those recruited, a description of any unusual climatic or other factors, and photos from the same point as where the photos for the time-zero report.

15. Perpetual maintenance of the enhancement/creation areas shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

16. Generally, the enhancement/creation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater, and/or estuarine wetland communities. The use of mitigation units from this project shall be limited to projects undertaken by or for Broward County. The Corps will determine if the use of mitigation credits from this project is warranted and appropriate for use as mitigation on other projects. The suitability of this enhancement/creation area

to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

17. The amount of potential credit generated by the enhancement/creation efforts must be confirmed through post-project monitoring to reveal if actual habitat creation and enhancement/creation occurs. These ecological benefits were estimated using the Uniform Mitigation Assessment Method (UMAM) and are summarized in Attachment 6. The values are presumed correct, but are adjustable by the Corps if adequate lift has not been achieved or if proposed acreages for mitigation areas are not enhanced/created as proposed. Verification methods to determine actual acreages for Improvement and verification of potential credits generated from this creation/enhancement project are shown in Attachment 7. Use of such enhancement/creation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the enhancement/creation credit. Any habitat restoration/enhancement/creation that occurs as a result of this project does not preclude the need to fully adhere to the federal sequential enhancement/creation requirements on future regulated activities.

18. Management items identified in Attachment 8 and described in Attachment 4 may be later considered for enhancement/creation credit through a modification of this permit if supporting information to justify enhancement/creation credit for items has been sufficiently demonstrated to the Corps.

19. No modifications to this permit shall be required for construction methodology variations from those described in Attachment 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that Corps staff concurs with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by Corps regulatory or compliance staff.

20. Select mangrove trimming necessary to accomplish the planned enhancement/creation efforts described herein shall be authorized by this permit.

21. Since the installation of the buoys for the 'boating exclusion zone" is located within the Federal right-of-way for the Federal Channel, **a Department of the Army Consent to Easement is also required *prior* to commencement of installation of the**

buoys. By copy of this letter, the permit is being forwarded to the Corps Real Estate Division for action on the Consent.

22. Enhancement/creation credit for the designated manatee/seagrass protection areas shall be granted only after documentation of a Consent to Easement for installation of the manatee protection barriers from the U.S. Army Corps of Engineers Real Estate Division has been submitted to the offices as outlined in Special Condition #21.

23. The Permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structures or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the Permittee will be required, upon due notice from the U.S. Army Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

24. Fill material used with this project (temporary road expansion and geotube creation) shall be limited to suitable, clean fill material, which excludes materials such as trash, debris, car bodies, asphalt, construction materials, concrete block with exposed reinforcement bars, and any soils contaminated with any toxic substance in toxic amounts (see Section 307 of the Clean Water Act).

25. Following completion of the crib installation, the permittee shall complete a post-installation seagrass survey from the riprap crib structure waterward for a distance 50 feet. This post construction seagrass survey will be conducted in the growing season (April 1-August 31) following the crib construction and shall be submitted to Corps no later than October 1 that year. The seagrass survey shall be compared with the 2002 seagrass survey done by Miller Legg and Associates, Inc. If the post construction seagrass survey shows that seagrasses have been impacted or are no longer growing in their previous locations (adjacent to the crib structure), a UMAM analysis on the seagrass habitats affected based on the Corps earlier UMAM analysis of the West Lake Seagrass areas should be conducted by the permittee and submitted to the Corps for approval. The UMAM debits from the areas affected shall be deducted from any actual seagrass creation/enhancement credits earned through this overall

project. If sufficient actual mitigation credits are not available to offset the impacts caused to seagrasses by the crib structure, the Corps will require remedial measures and will require additional mitigation as necessary to fully offset impacts resulting from the installation of the crib structure.

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

( ) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, State, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal projects.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision: This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (see 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions: General Condition 1 establishes a time limit for the completion of the activity authorized by this permit.

Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

(PERMITTEE) 2/28/06
(DATE)

PAT YOUNG
(PERMITTEE NAME-PRINTED)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

(DISTRICT ENGINEER) 3-2-2006
(DATE)
Robert M. Carpenter
Colonel, U.S. Army

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

_____ _____
(TRANSFEREE-SIGNATURE) (DATE)

_____
(NAME-PRINTED)

_____
(ADDRESS)

_____
(CITY, STATE, AND ZIP CODE)

Attachments to Department of the Army Permit Number SAJ-2002-00072(IP-LAO)

1. PERMIT DRAWINGS: Thirty-three (33) pages, dated February 17, 2006.

2. WATER QUALITY CERTIFICATION: Specific Conditions of the water quality permit/certification in accordance with General Condition number 5 on page 2 of this DA permit. Six (6) pages.

3. Standard Manatee Construction Conditions dated July 2005.

4. Letter of responsibility from Broward County dated May 28, 2002.

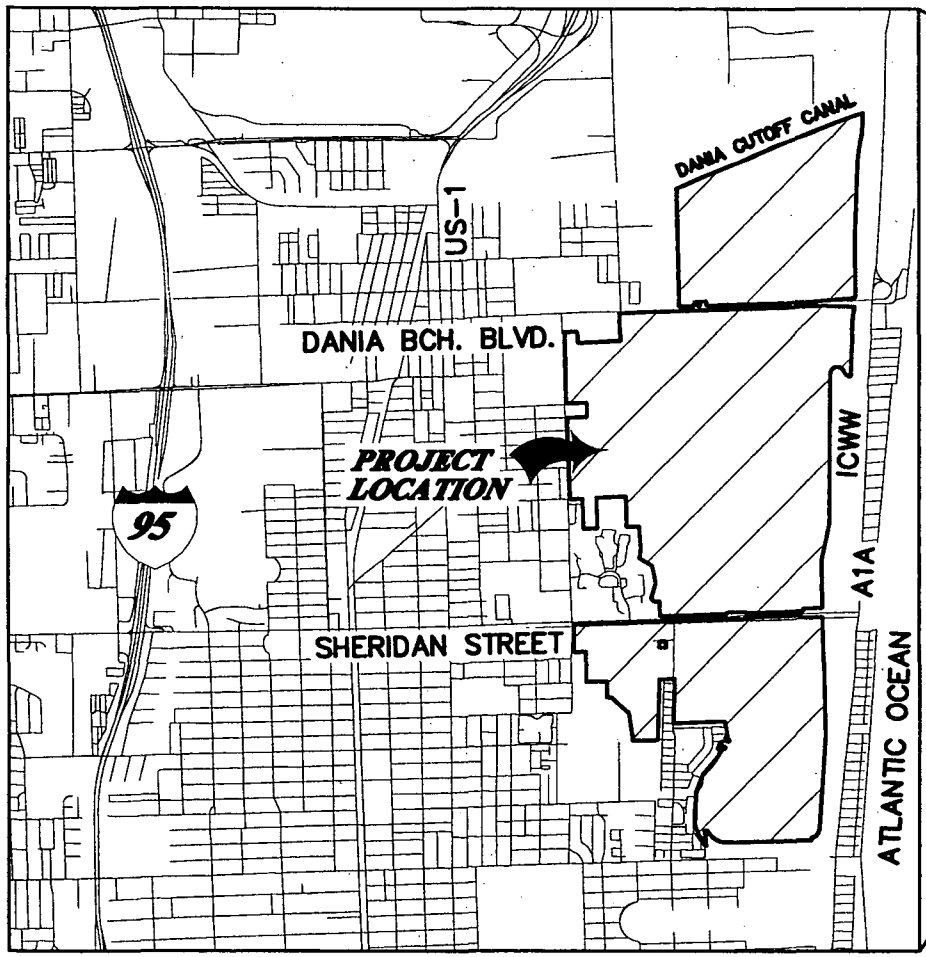
5. West Lake Park Mitigation Plan dated November 25, 2003. Thirty-eight (38) pages.

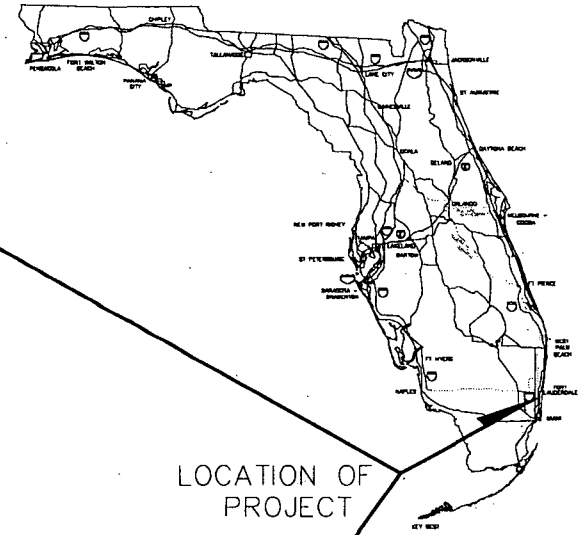
6. West Lake Mitigation - US Corps of Engineers Estimated Mitigation Credit Chart.

7. West Lake Mitigation - Methods to Determine Acreages for Improvements.

8. West Lake Mitigation - West Lake Mitigation Unit (Acreage) Estimates

MITIGATION PERMIT SKETCHES





NOTES:

PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

SECTION 35, TOWNSHIP 50, RANGE 42

LOCATION MAP

N.T.S.

LOCATION MAP

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 1 of 33

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WEST LAKE PARK

BROWARD COUNTY, FLORIDA

FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION

REVISIONS

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CERTIFICATE OF AUTHORIZATION: EB7318 LB6680 LC0137

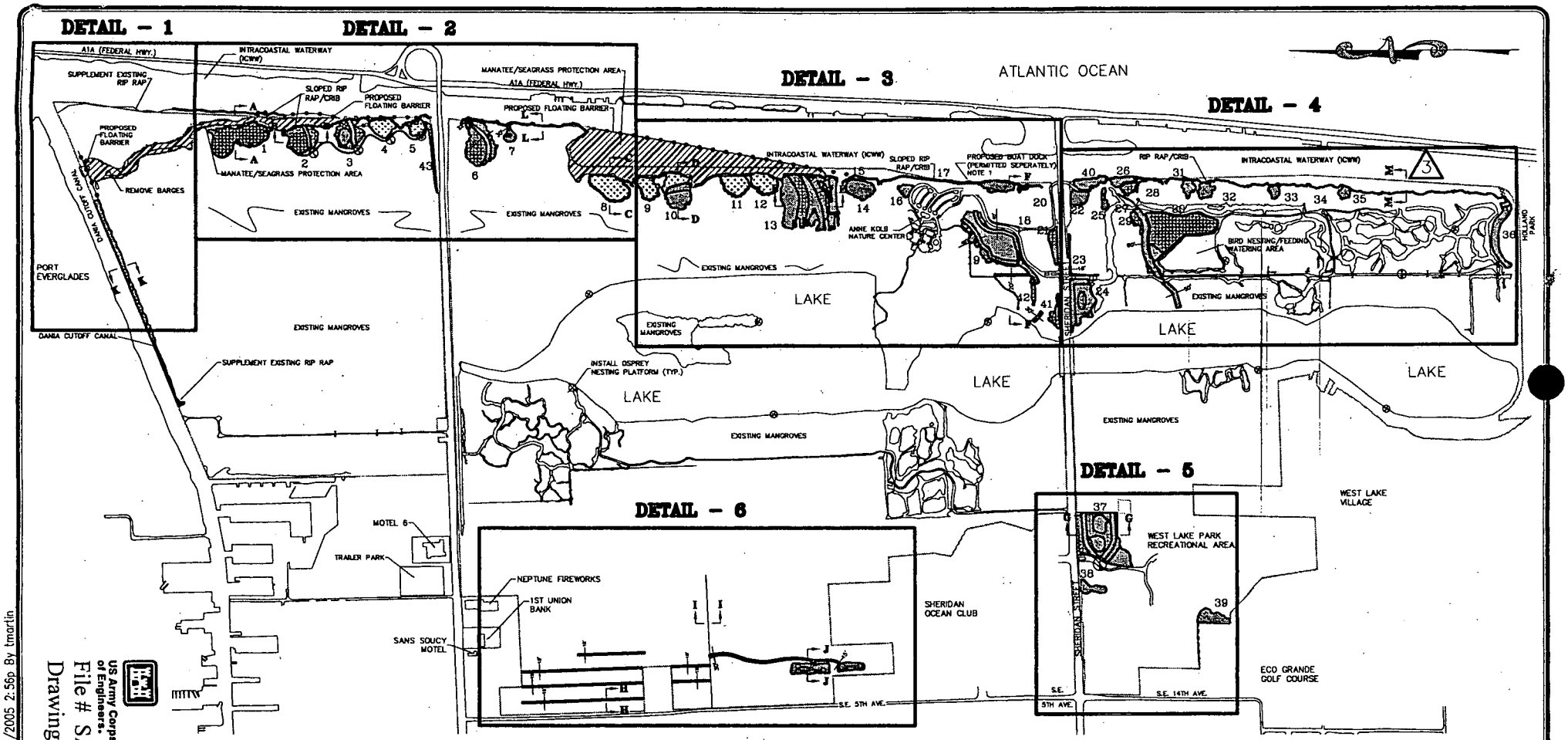
TCM MEB

PROJECT / FILE NO. 937503

DRAWING NO. LOC-1

DATE DRAWN 9-20-02

1 / 33



NOT TO SCALE

LEGEND

- PARK BOUNDARY
- FLOATING BARRIER
- CULVERT IMPROVEMENT OR DESILT EXISTING CONNECTIONS
- NEW CULVERT INSTALLATION
- OSPREY NESTING PLATFORM
- SUPPLEMENT EXISTING RIP RAP
- DESILT CHANNEL/REMOVE BLOCKS
- RIP RAP / CRIB
- RIP RAP / SLOPED
- MANATEE PROTECTION AREA
- MANGROVE CREATION – ±24.1 acres
- CHANNEL CREATION – ±11.6 acres
- UPLAND HAMMOCK CREATION– ±12.9 acres
- MUD FLAT/TIDE POOL CREATION– ±8.5 acres
- SEAGRASS CREATION– ±7.7 acres

DRAFT:
CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION

MITIGATION PLAN KEY SHEET

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 2 of 33

V:\Non-Project\Environmental\West Lake Temp\permit_sketches.dwg Tue 12/20/2005 2:56p By tmartin

No.	Date	REVISIONS	Dwn.	Chk.
3	03-31-03	MINOR REVISIONS	TEW	
2	02-28-02	PLAN REVISIONS	EDP	
1	01/15/02	PLAN REVISIONS	EDP	

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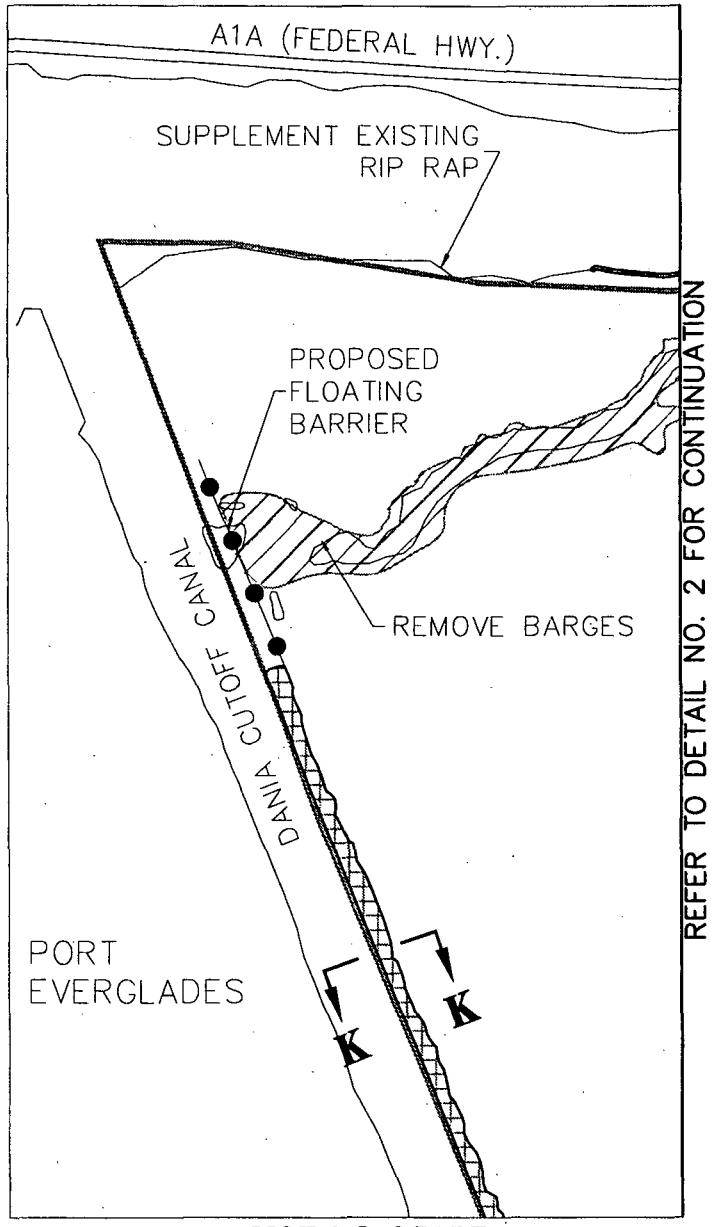
CERTIFICATE OF AUTHORIZATION: EB7318 LB6680 LC0337

PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02 | 2 of 33

DETAIL 1



NOT TO SCALE

LEGEND

- PARK BOUNDARY
- FLOATING BARRIER
- SUPPLEMENT EXISTING RIP RAP
- MANATEE PROTECTION AREA
- MANGROVE CREATION

DRAFT: CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION
MITIGATION PLAN

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 3 of 33

V:\Non-Project\Environmental\West Lake Temp\permit_sketches.dwg Tue 12/20/2005 2:56p By tmartin

2	07-07-02	PLAN REVISIONS	
1	06-06-02	PLAN REVISIONS	
No.	Date	REVISIONS	By

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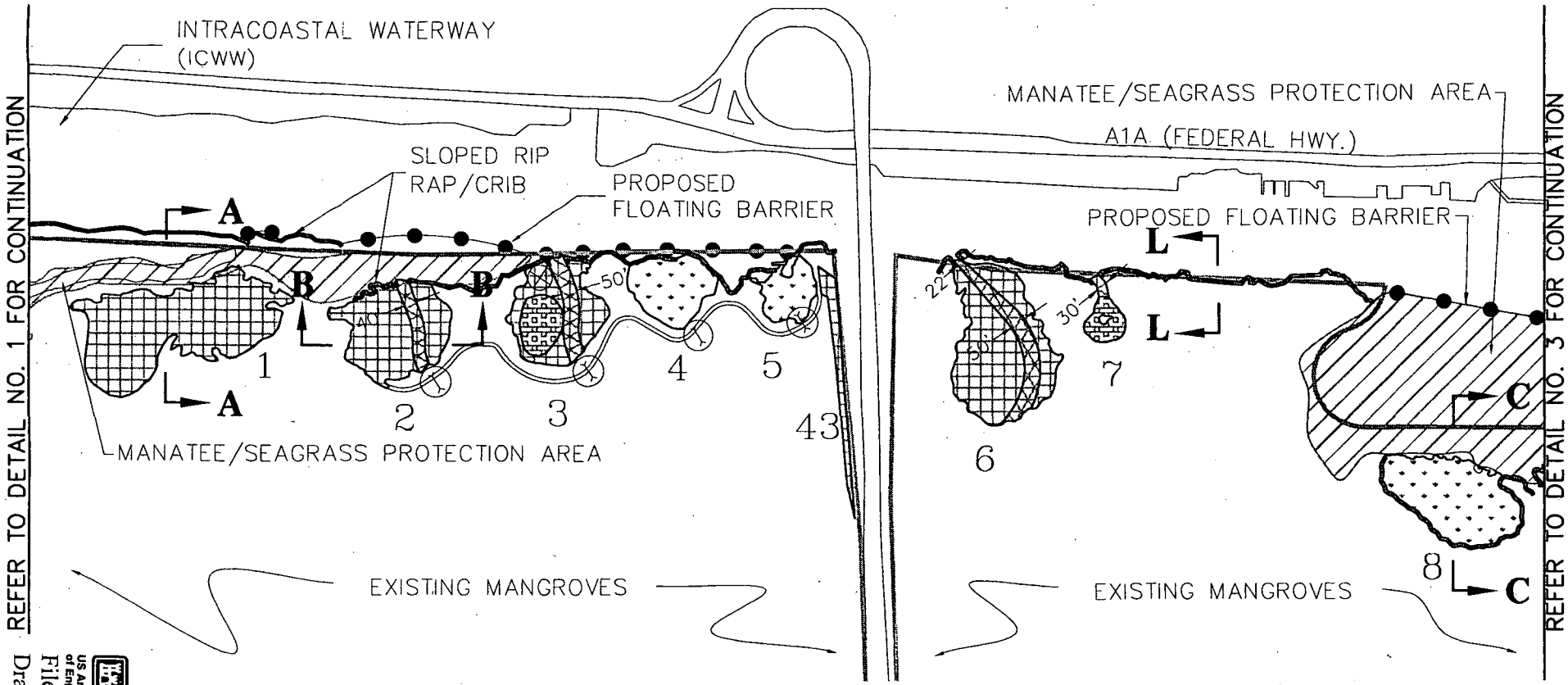
PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02

DETAIL 2



NOT TO SCALE

LEGEND

PARK BOUNDARY	SUPPLEMENT EXISTING RIP RAP	MANGROVE CREATION – ±24.1 acres
FLOATING BARRIER	DESILT CHANNEL/REMOVE BLOCKS	CHANNEL CREATION – ±11.6 acres
CULVERT IMPROVEMENT OR DESILT EXISTING CONNECTIONS	RIP RAP / CRIB	UPLAND HAMMOCK CREATION– ±12.9 acres
NEW CULVERT INSTALLATION	RIP RAP / SLOPED	MUD FLAT/TIDE POOL CREATION– ±8.5 acres
OSPREY NESTING PLATFORM	MANATEE PROTECTION AREA	SEAGRASS CREATION– ±7.7 acres

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 4 of 33

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MITIGATION PLAN

REVISIONS		
2	06-03-02	PLAN REVISIONS
1	05-30-02	PLAN REVISIONS

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DRAWING NO. VPP-1

DATE DRAWN 6-3-02 PAGE 4 OF 33

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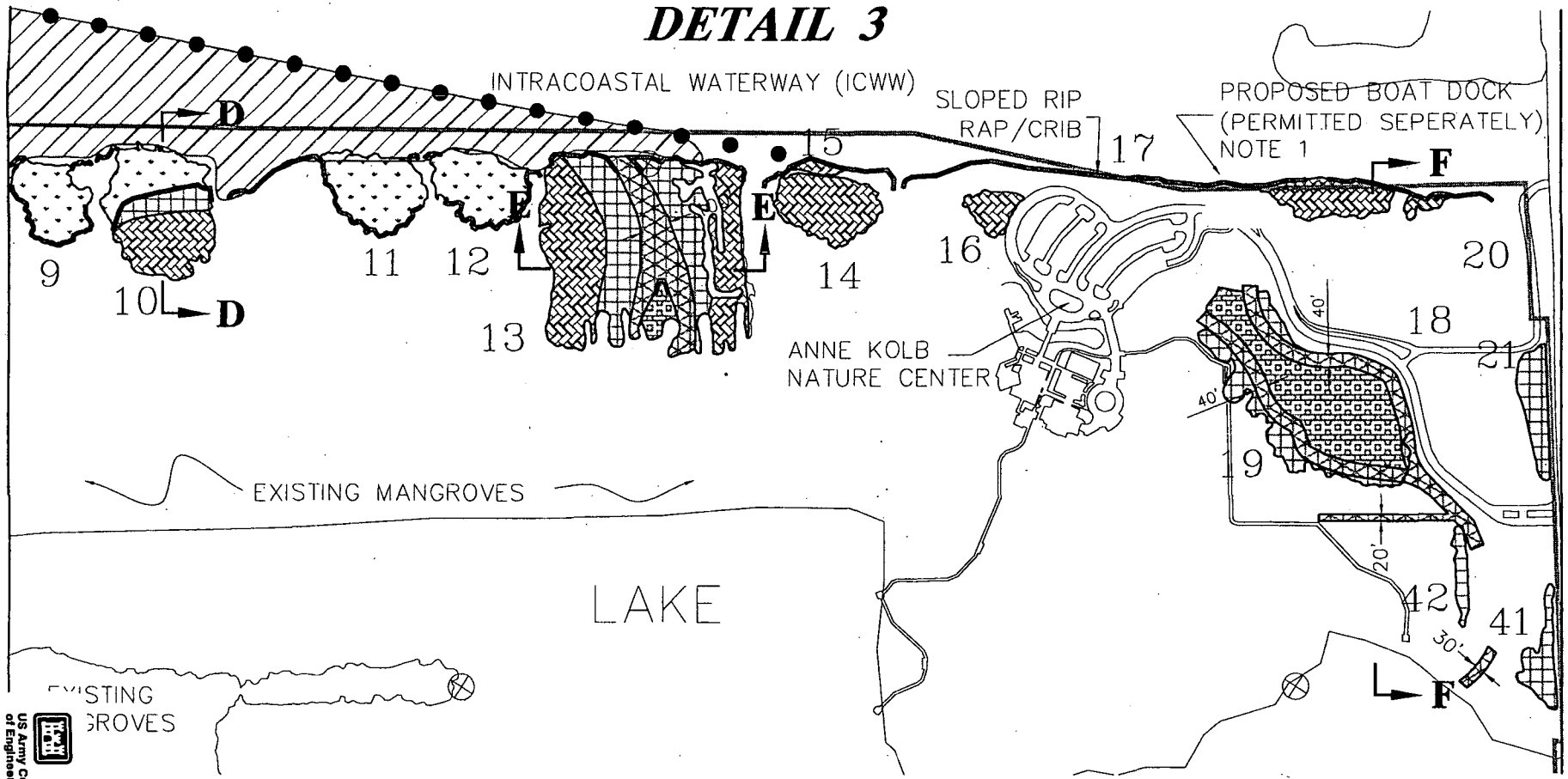
DETAIL 3



NOT TO SCALE

GEND

PARK BOUNDARY	SUPPLEMENT EXISTING RIP RAP	MANGROVE CREATION – ±24.1 acres
FLOATING BARRIER	DESILT CHANNEL/REMOVE BLOCKS	CHANNEL CREATION – ±11.6 acres
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OSPREY NESTING PLATFORM	MANATEE PROTECTION AREA	SEAGRASS CREATION– ±7.7 acres

NOTE 1:

DPEP LICENSE DF 01-1096
FDEP PERMIT No. 06-017518
USACOE PERMIT No. 199201346 (IP-DSG)

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MITIGATION PLAN

US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 5 of 33

2	10-22-02	PLAN REVISIONS	
1	10-20-02	PLAN REVISIONS	
No.	DATE	REVISIONS	BY

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PROJECT / FILE NO. 937503
DRAWING NO. VPP-1
DATE DRAWN 6-3-02
5 / 33

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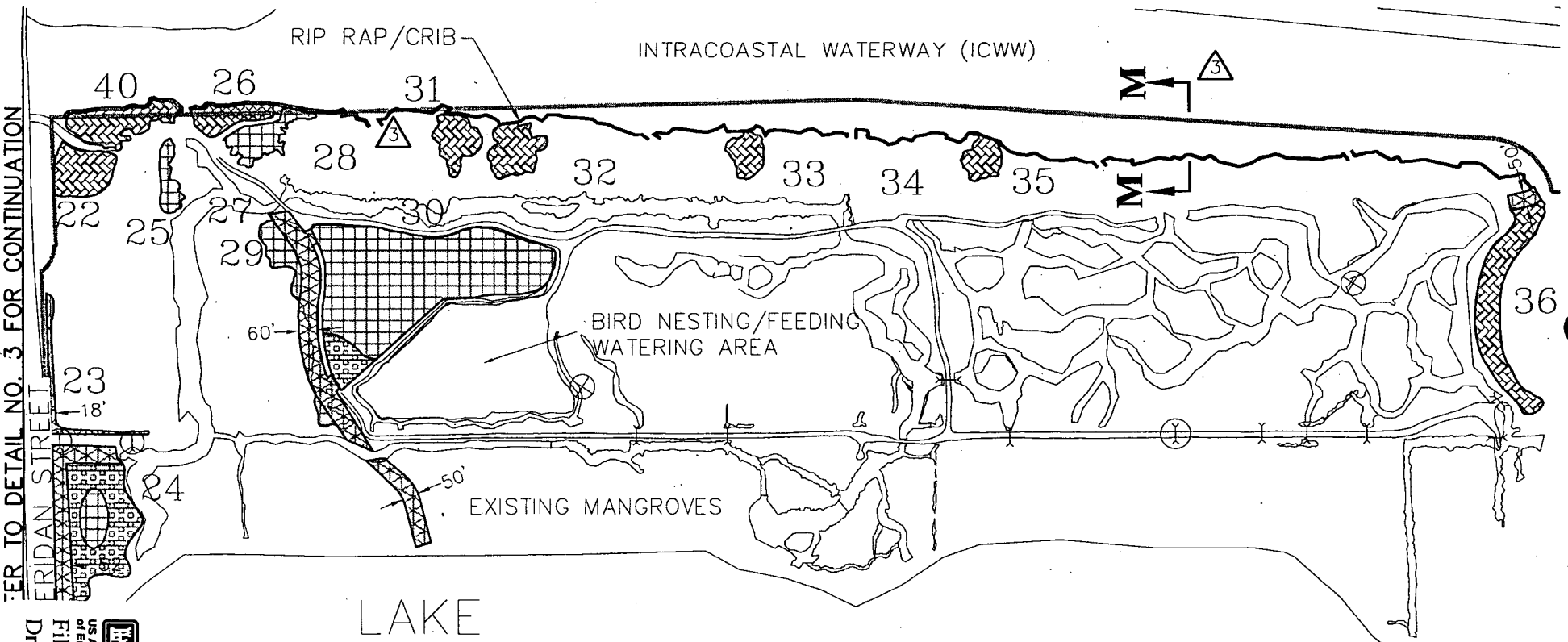
DETAIL 4



ER TO DETAIL NO. 3 FOR CONTINUATION

ERIDAN STREET

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 6 of 33

NOT TO SCALE

LEGEND

PARK BOUNDARY	SUPPLEMENT EXISTING RIP RAP	MANGROVE CREATION – ±24.1 acres
FLOATING BARRIER	DESILT CHANNEL/REMOVE BLOCKS	CHANNEL CREATION – ±11.6 acres
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DRAFT: CONCEPTUAL PLAN SET
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MITIGATION PLAN

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BROWARD COUNTY, FLORIDA

FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION

3	09-24-04	LEGEND RE VISIONS
2	07-01-04	PLAN RE VISIONS
1	05-25-04	PLAN RE VISIONS
No.	DATE	REVISIONS

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DRAWING NO. VPP-1

DATE DRAWN 6-3-07

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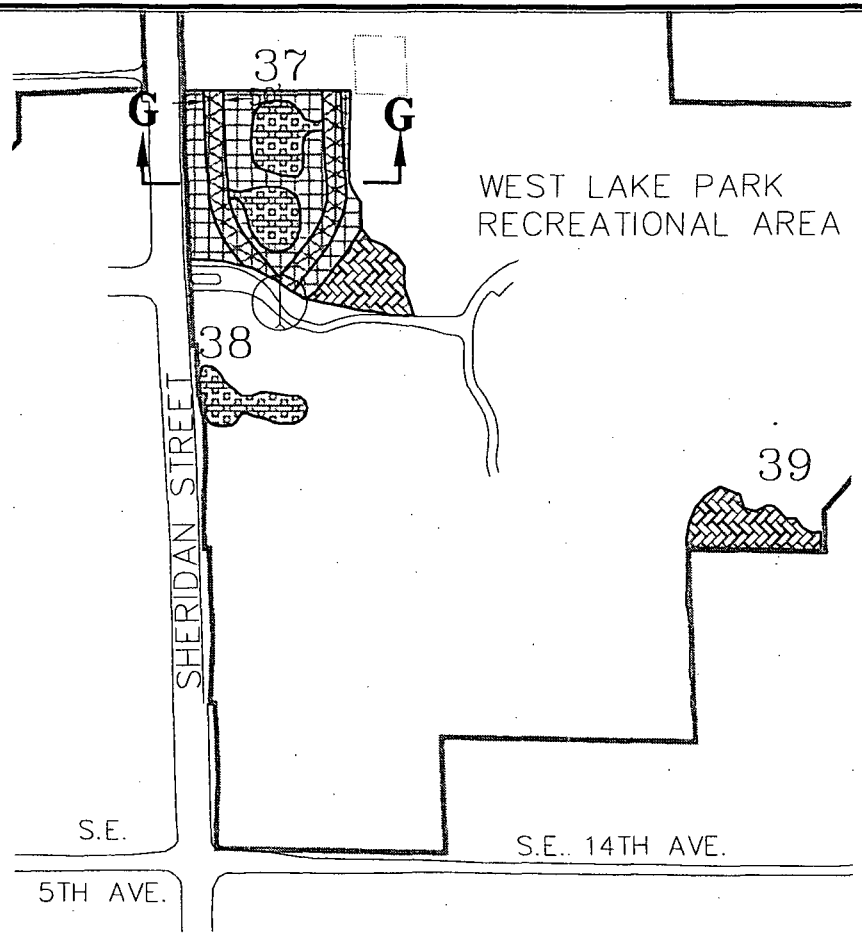
DETAIL 5



NOT TO SCALE

LEGEND

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DRAFT: CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION

MITIGATION PLAN

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File # SAJ-2002-72(IP-LAO)
Drawing # 7 of 33

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REVISIONS		
2	07-07-03	PLAN REVISIONS
1	10-29-02	PLAN REVISIONS

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EB7318 LB6680 LD0337

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VPP-1

6-3-02

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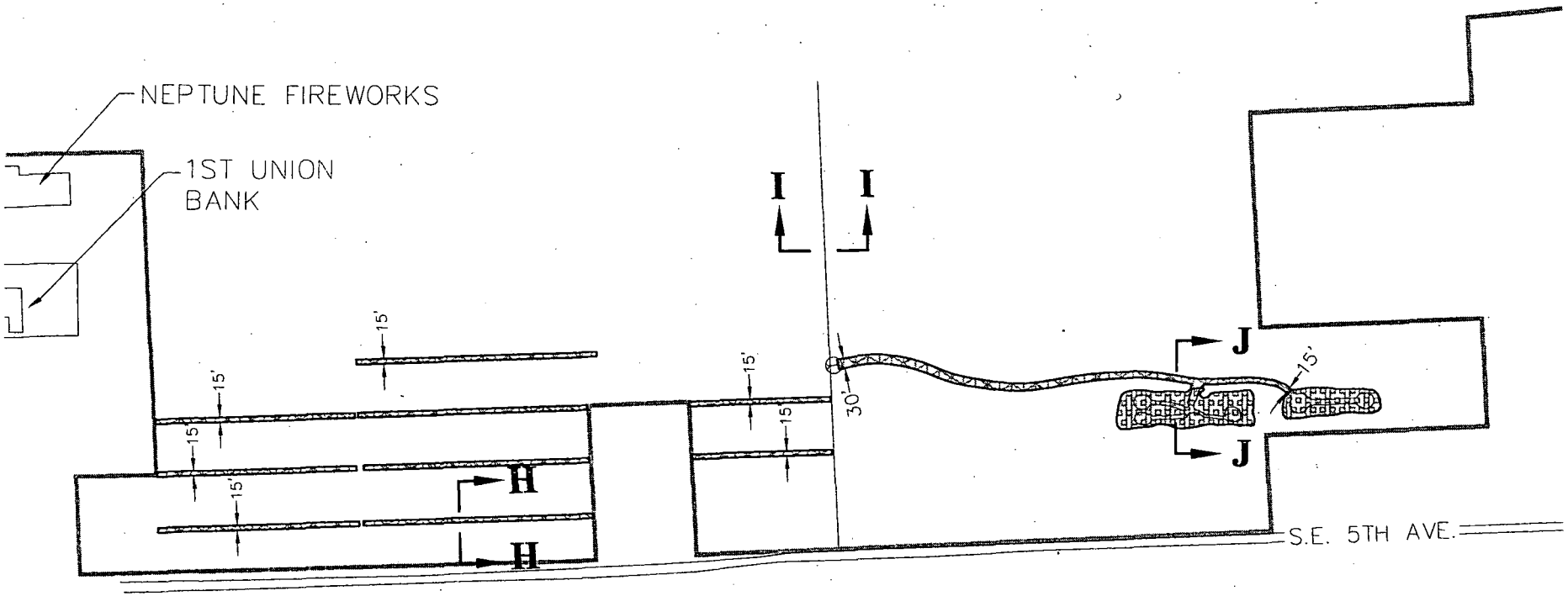
DETAIL 6



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LEGEND

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DRAFT: CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION

MITIGATION PLAN

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 8 of 33

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2	03-07-02	PLAN REVISIONS
1	06-26-02	PLAN REVISIONS

REVISIONS

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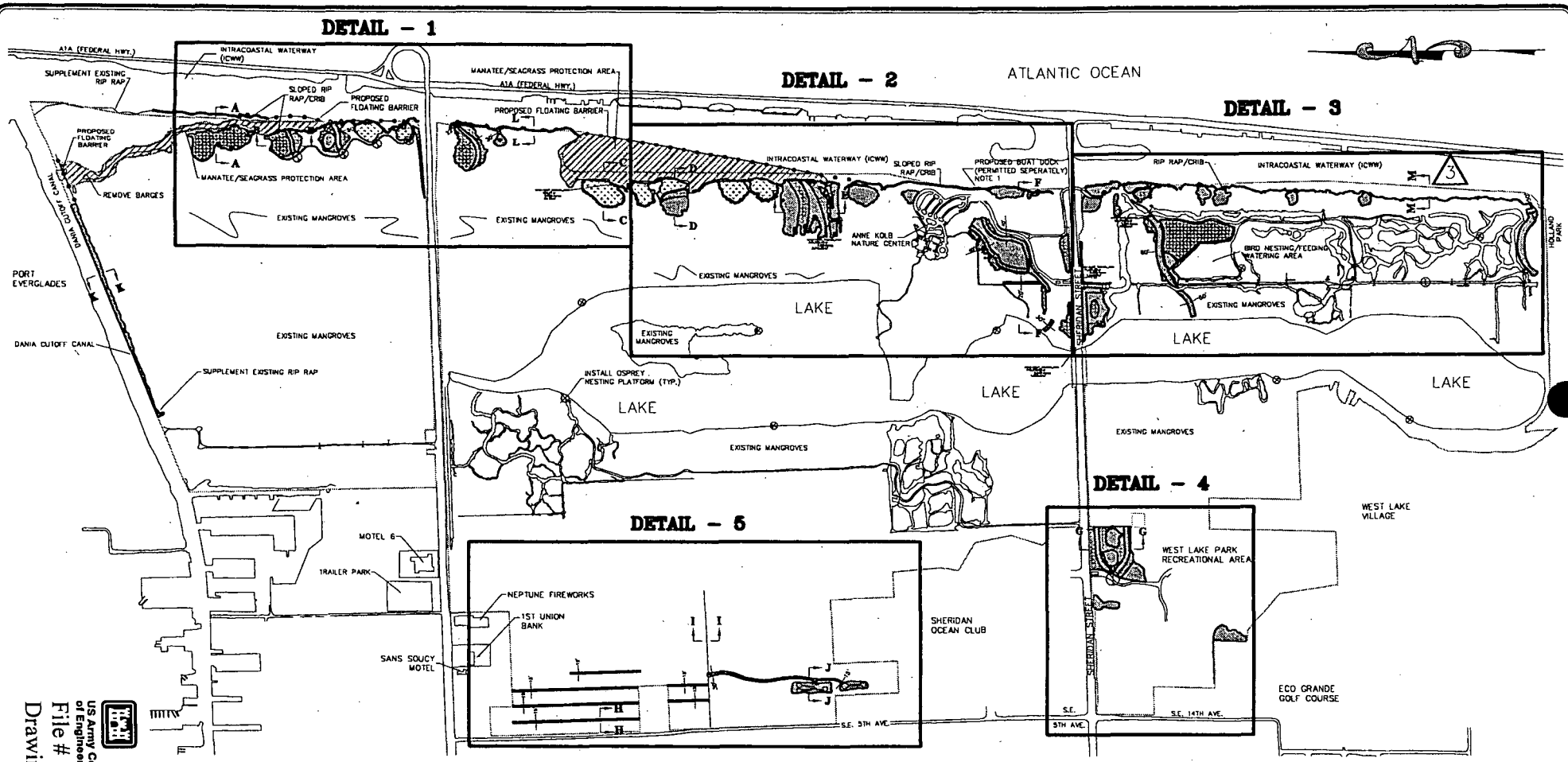
PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02

PAGE 8 OF 33



NOT TO SCALE

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 9 of 33

DRAFT:
CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION

MONITORING LOCATION KEY SHEET

WEST LAKE PARK

BROWARD COUNTY, FLORIDA

FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION

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3	03-31-03	UPDATE REVISIONS
2	02-07-02	PLANS RE-VISIONS
1	02/28/01	PLANS RE-VISIONS

REVISIONS

CERTIFICATE OF AUTHORIZATION: EB7318 LB6680 LC0337

PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02

9 / 33

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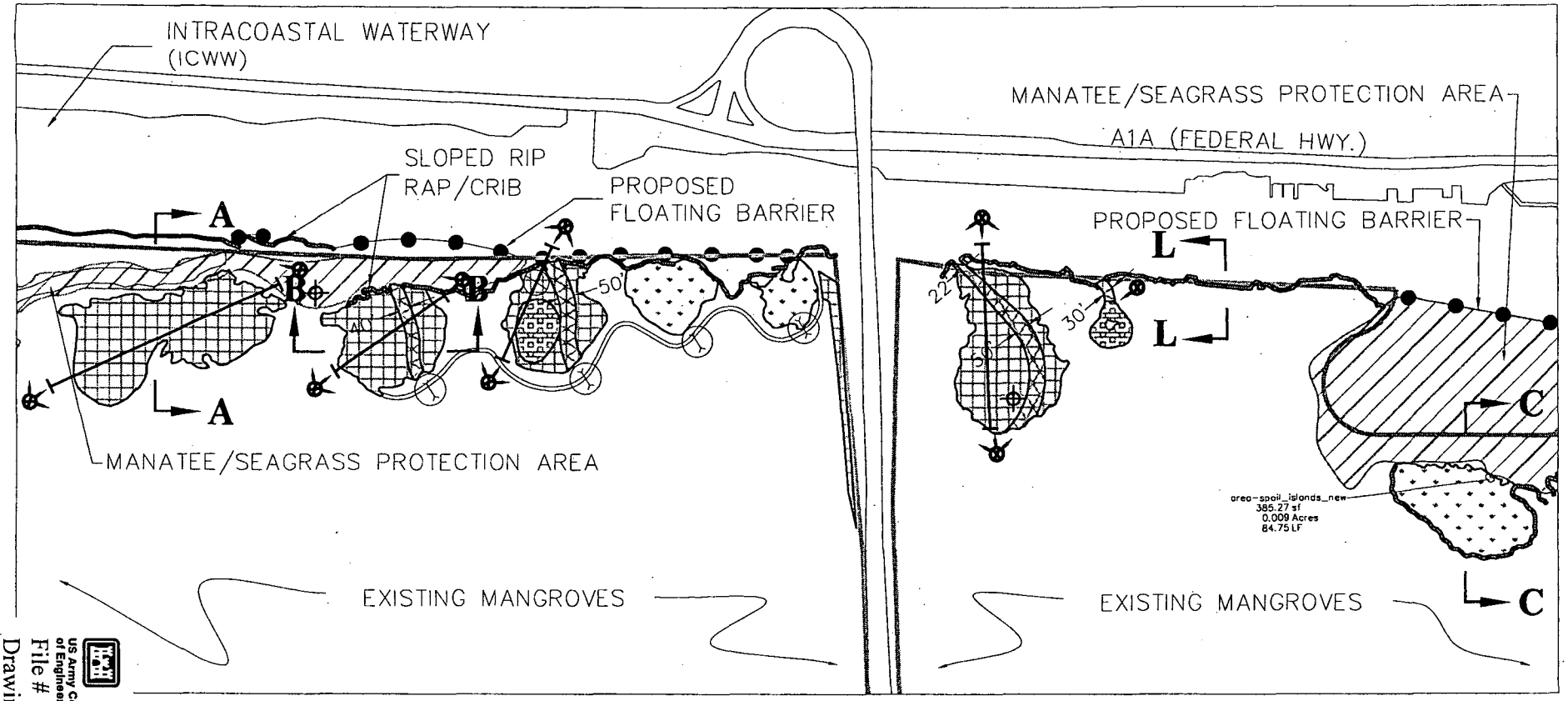
DETAIL 1 - MONITORING



NOT TO SCALE

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 10 of 33

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DRAFT: CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION

MONITORING LOCATION PLAN

WEST LAKE PARK

BROWARD COUNTY, FLORIDA

FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION

REVISIONS

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EB7316 LB5660 LC0337

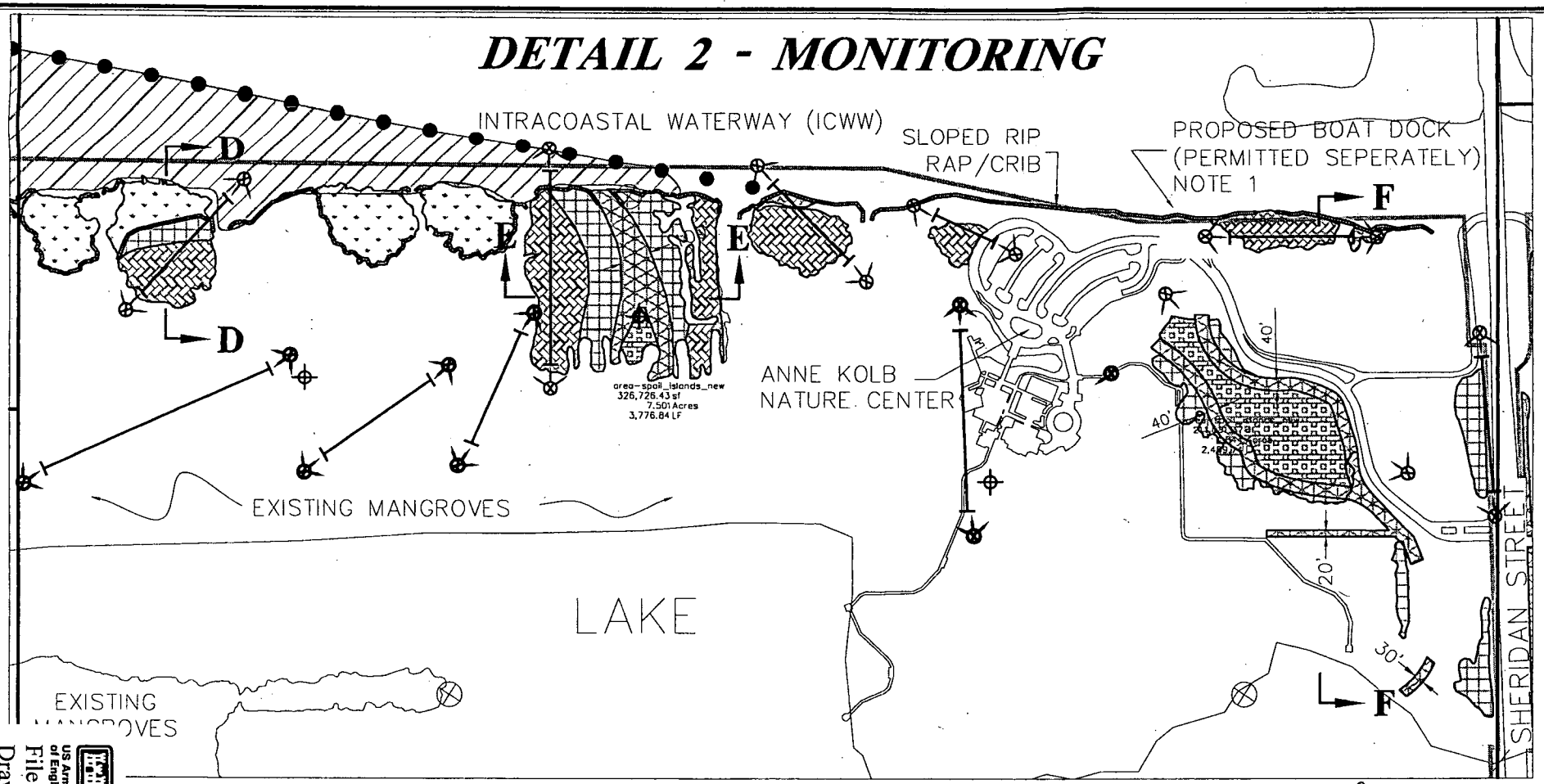
937503

VPP-1

6-3-02

10 of 33

DETAIL 2 - MONITORING



NOT TO SCALE

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 11 of 33

DRAFT: CONCEPTUAL PLAN SET
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MONITORING LOCATION PLAN

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ENGINEER / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02

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REVISIONS

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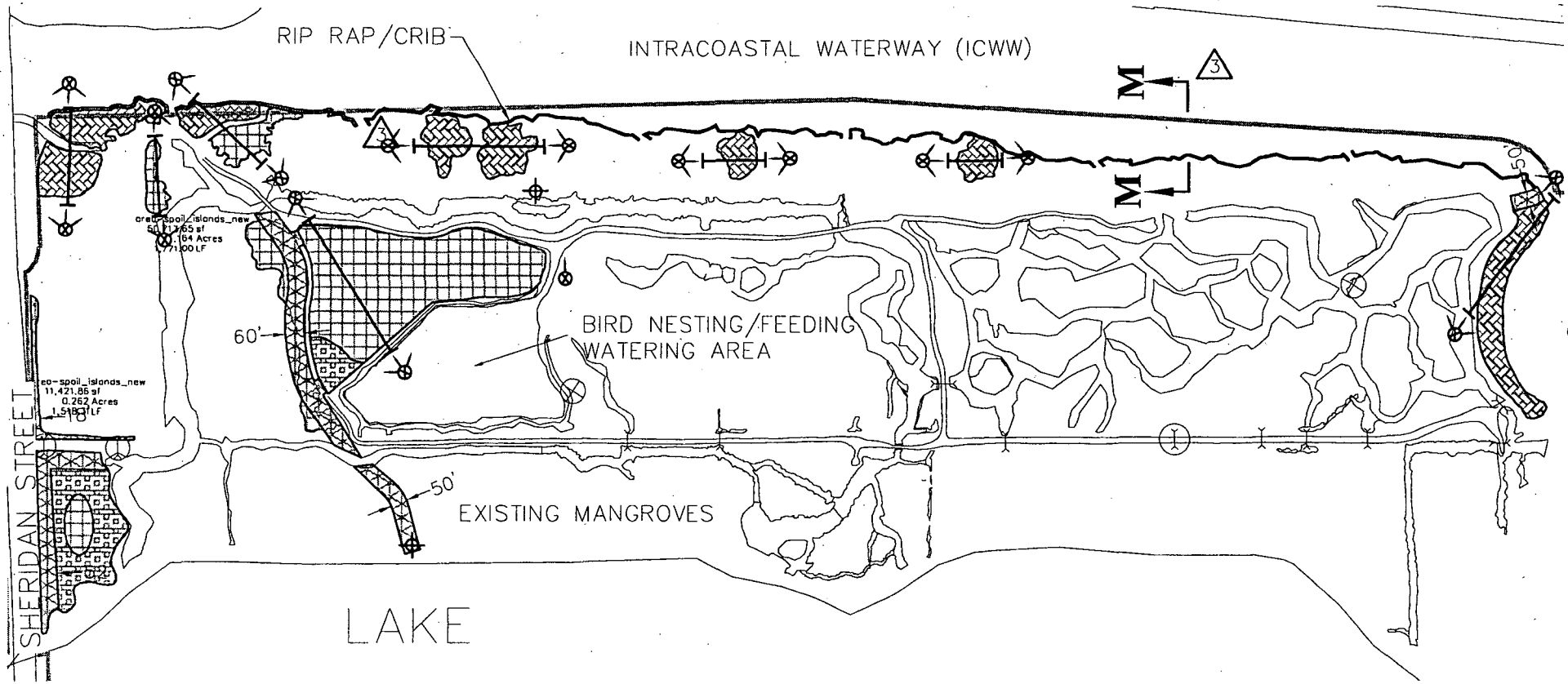
DETAIL 3 - MONITORING



NOT TO SCALE

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 12 of 33

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MONITORING LOCATION PLAN

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CERTIFICATE OF AUTHORIZATION	EB7318 LB6680 LC0337
PROJECT / FILE NO.	937503
DRAWING NO.	VPP-1
DATE DRAWN	6-3-02
SHEET	12 of 33

3	03-29-05	VARIOUS REVISIONS	DM
2	07-02-03	PLAN REVISIONS	DM
1	06-26-03	PLAN REVISIONS	DM
No.	DATE	REVISIONS	BY

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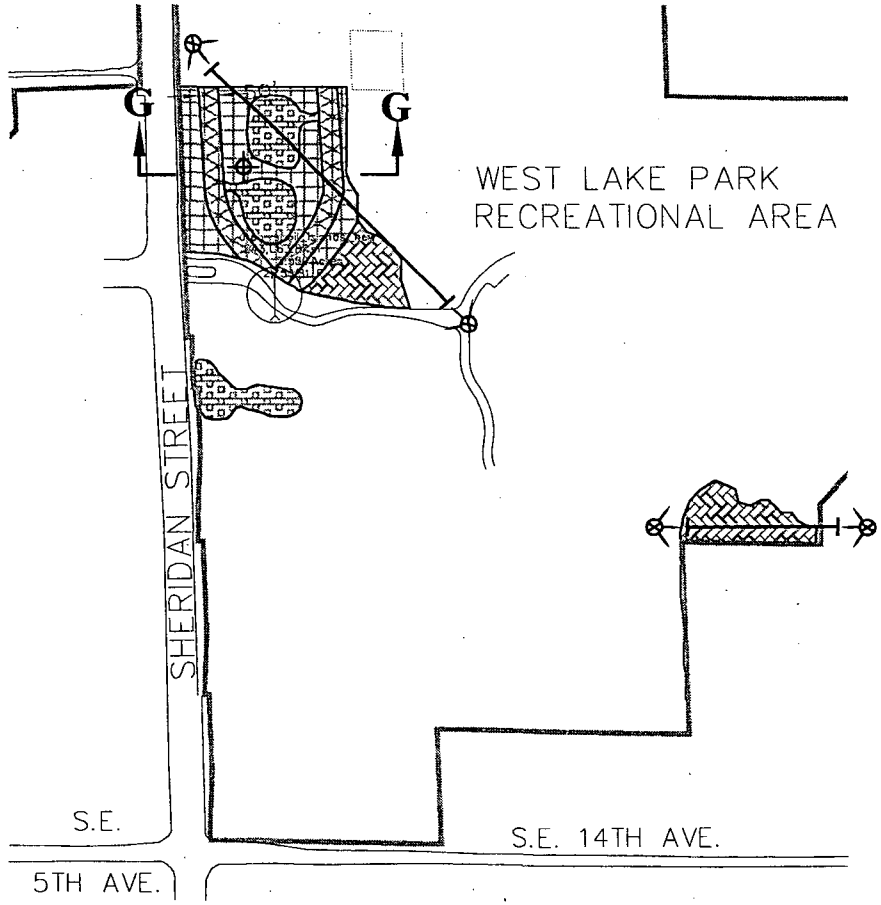
DETAIL 4 - MONITORING



NOT TO SCALE

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 13 of 33

DRAFT: CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION

MONITORING LOCATION PLAN

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CA7318 LB5680 LC0337

PROJECT / FILE NO. 937503
DRAWING NO. VPP-1
DATE DRAWN 6-3-02
13 of 33

3	12-07-02	PLAN REVISIONS	
2	10-28-02	PLAN REVISIONS	
1			
REVISIONS			

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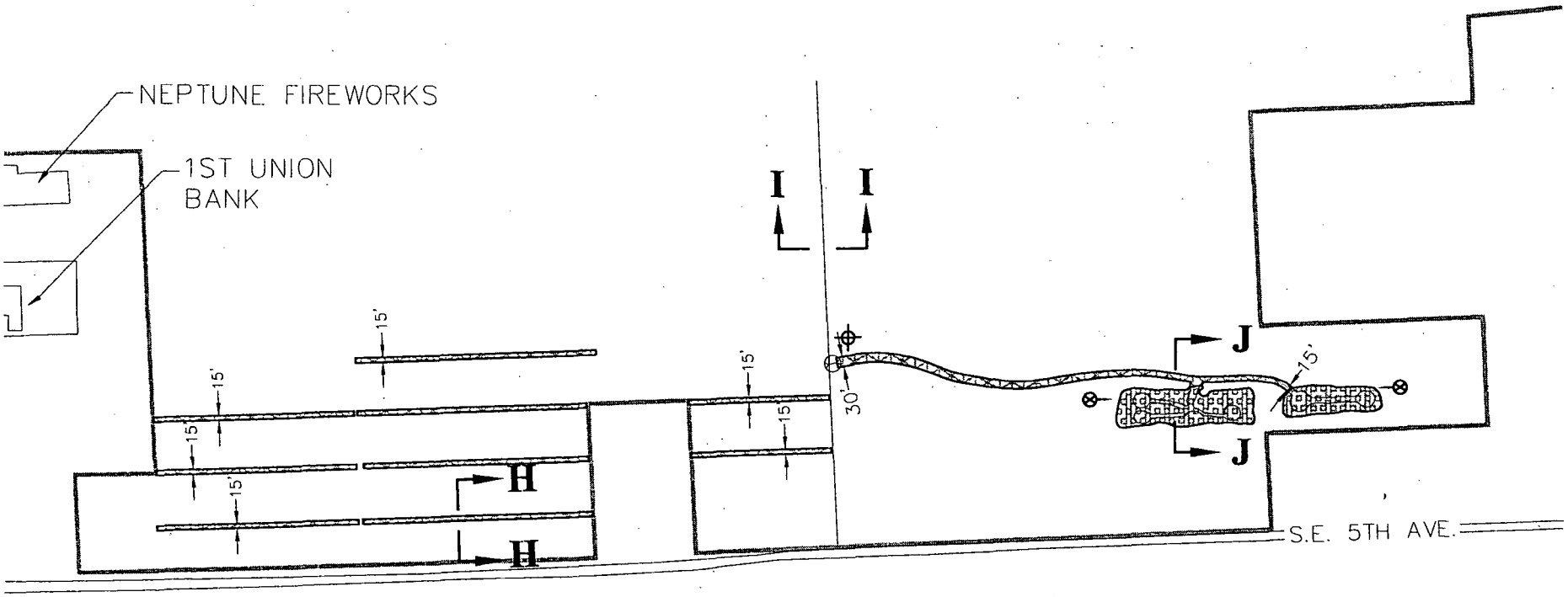
DETAIL 5 - MONITORING



NOT TO SCALE

DRAFT: CONCEPTUAL PLAN SET
NOT FOR CONSTRUCTION

MONITORING LOCATION PLAN

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 14 of 33

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REVISIONS

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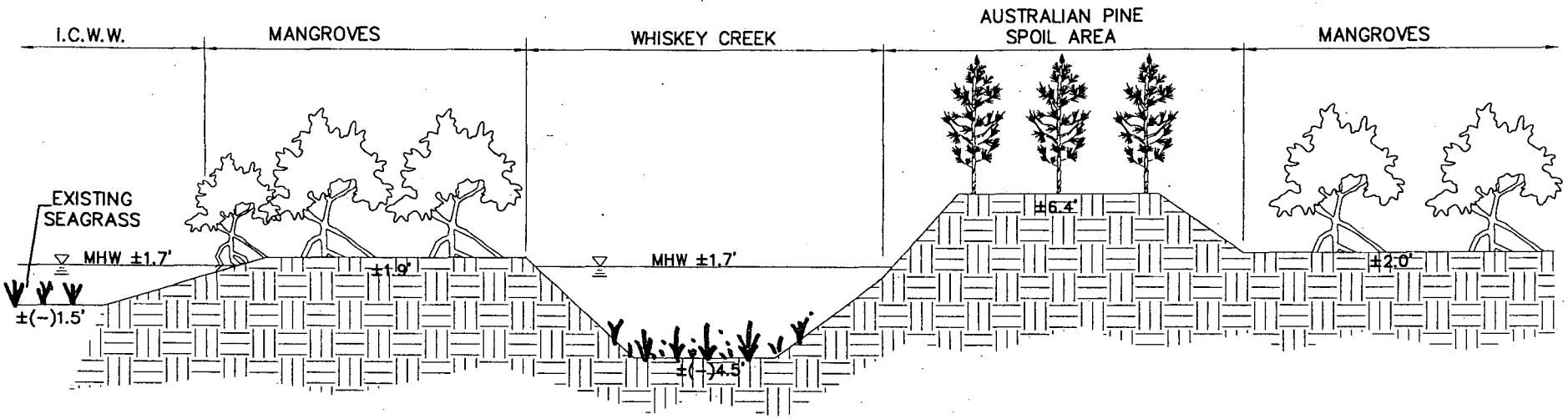
PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02

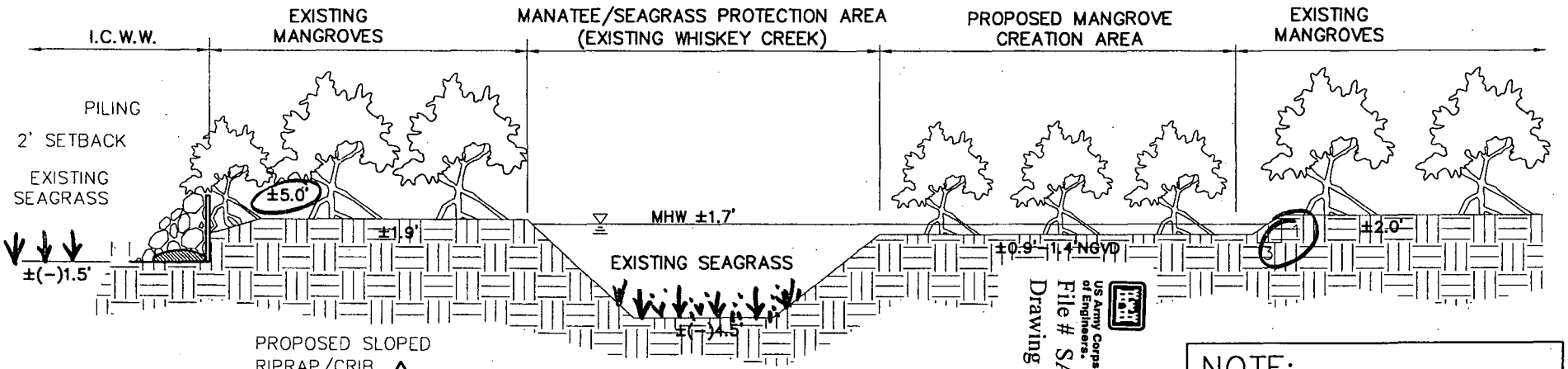
14 of 33



EXISTING CONDITIONS

SECTION 'A–A'

N.T.S.



LEGEND:

– EXISTING GROUND

PROPOSED CONDITIONS

SECTION 'A–A'

N.T.S.

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 15 of 33

NOTE:

1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION A-A

WEST LAKE P K

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PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02

15 OF 33

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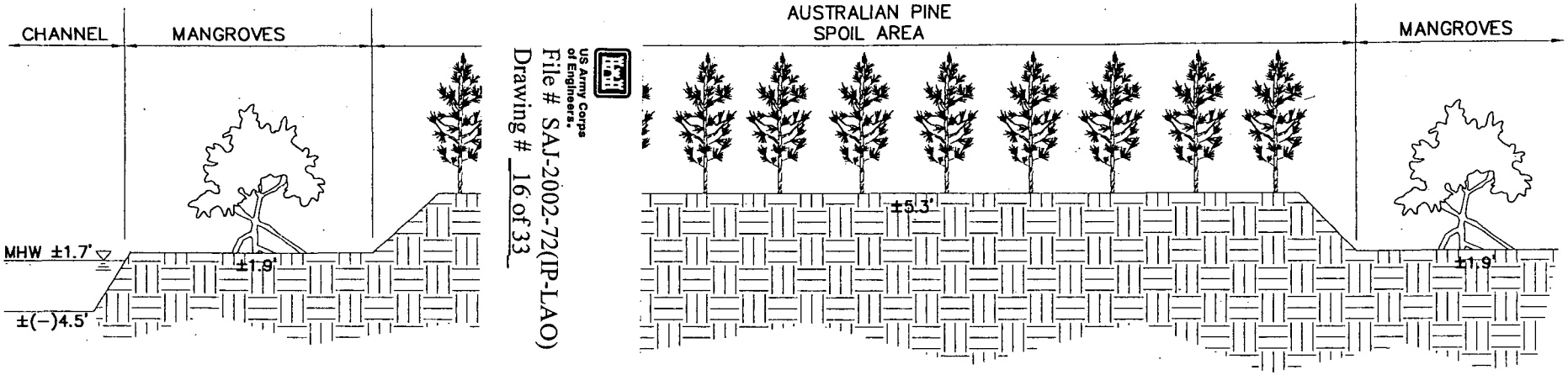
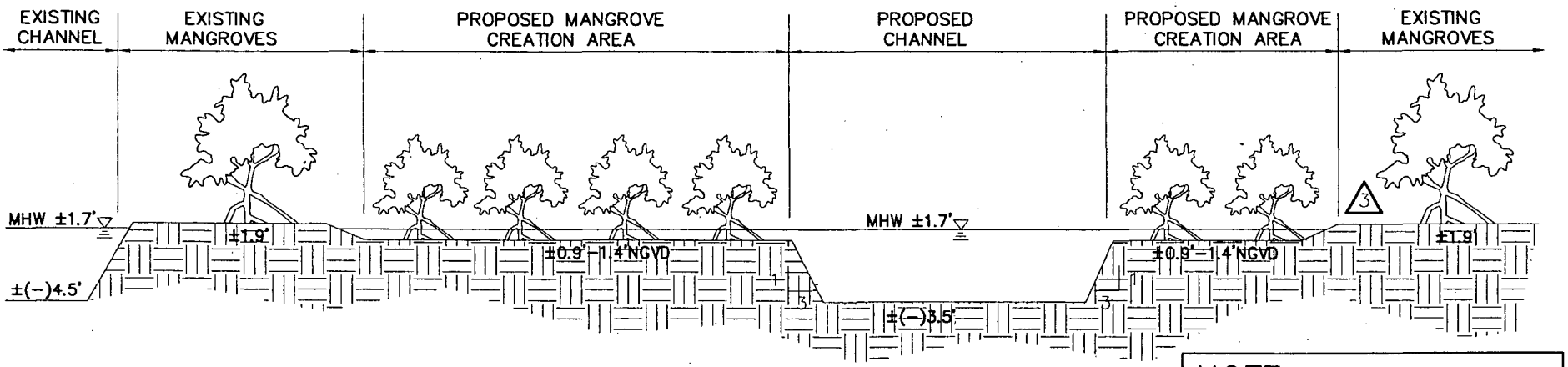


EXISTING CONDITIONS

SECTION 'B–B'

N.T.S.



PROPOSED CONDITIONS

SECTION 'B–B'

N.T.S.

LEGEND:

– EXISTING GROUND

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

NOTE:

1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION B-B

US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
Drawing # 16 of 33

3	12-24-02	MINOR REVISIONS	MW
2	07-07-02	PLAN REVISIONS	CDM
1	03-26-02	PLAN REVISIONS	CDM
#	DATE	REVISIONS	APP.

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PROJECT / FILE NO. 937503

DRAWING NO. VPP–1

DATE DRAWN 6-3-02 | 16 / 33

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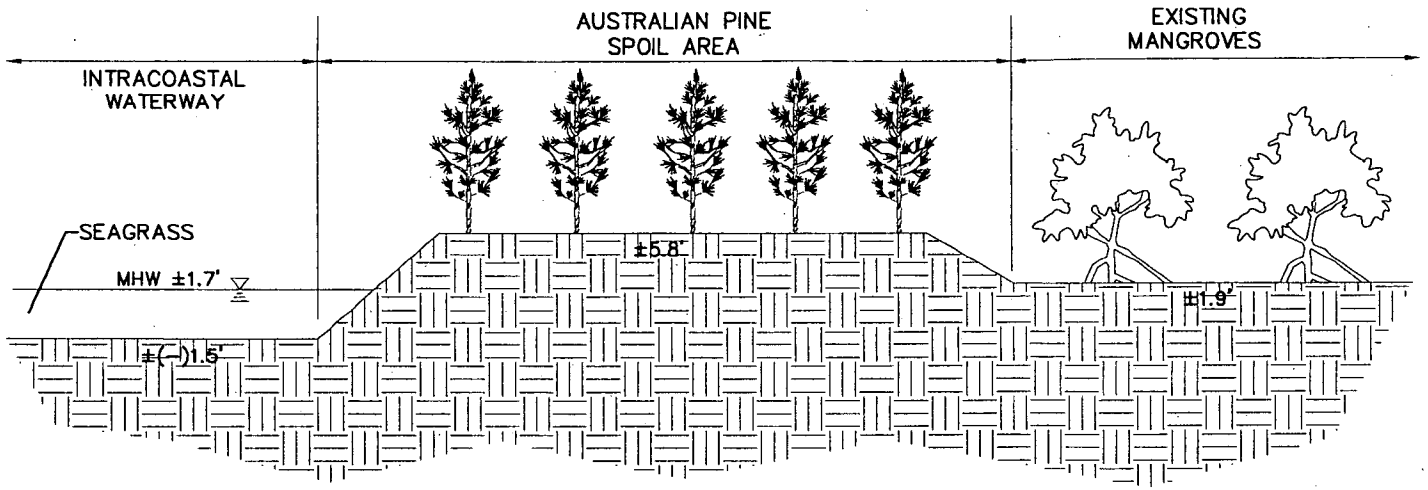
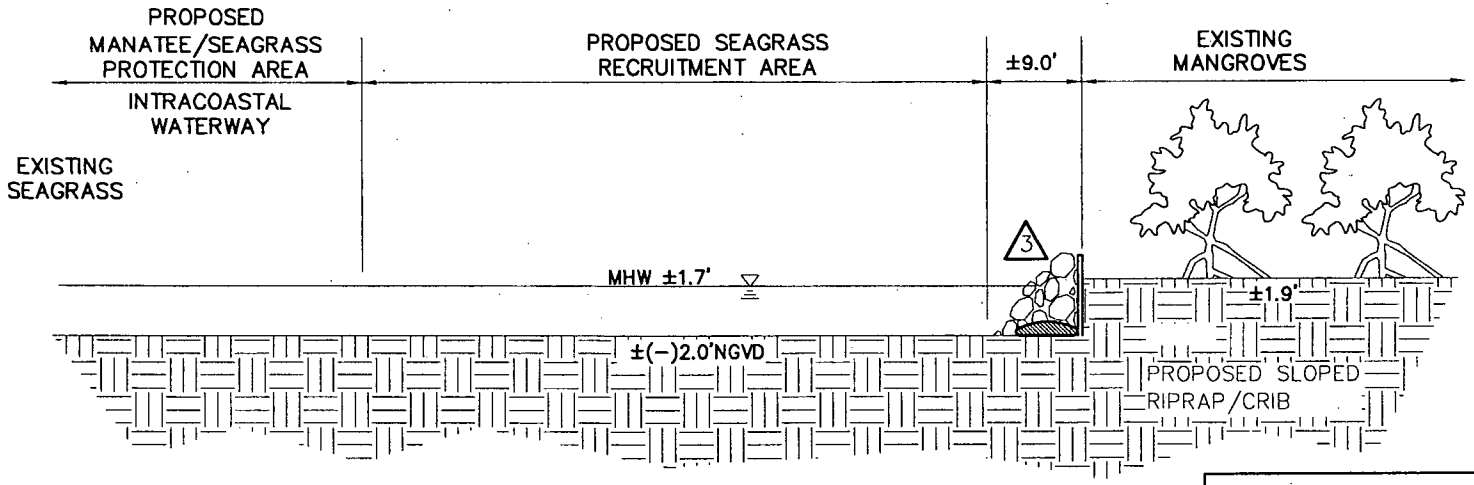


EXISTING CONDITIONS

SECTION 'C–C'

N.T.S.



PROPOSED CONDITIONS

SECTION 'C–C'

N.T.S.

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

LEGEND:

– EXISTING GROUND

NOTE:

1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION C-C

US Army Corps of Engineers

File # SAJ-2002-72(IP-LAO)

Drawing # 17 of 33

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3	12-21-04	LEASED REVISIONS	TGH
2	12-07-04	PLANS REVISIONS	BW
1	12-20-02	PLAN REVISIONS	BW
No.	Date	REVISIONS	Drn. Chk.

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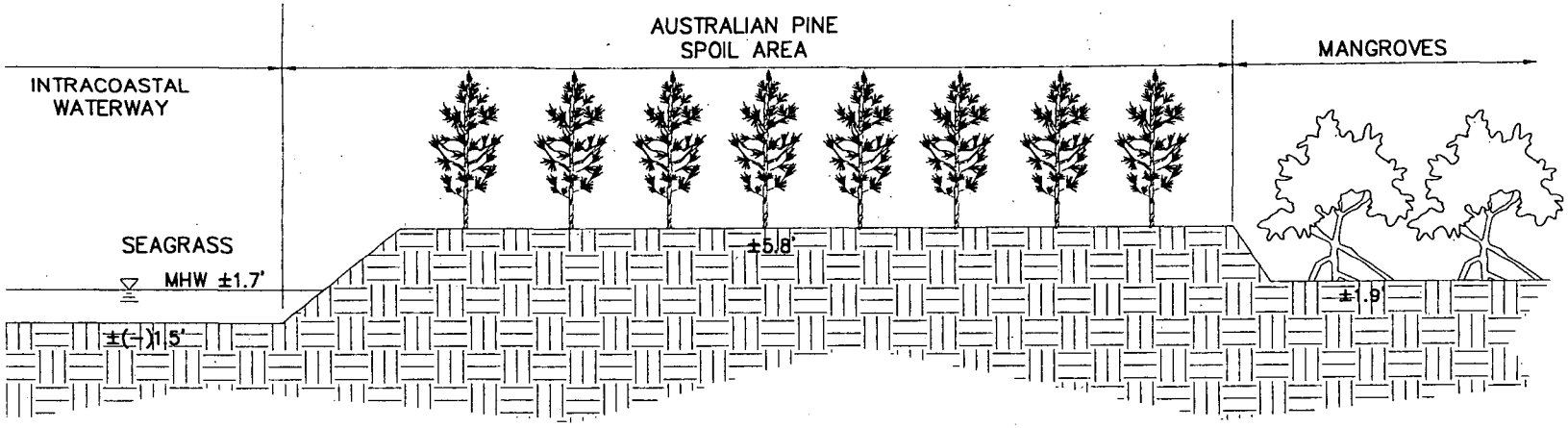
PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02 PAGE 17 OF 33

US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 18 of 33



EXISTING CONDITIONS
SECTION 'D–D'
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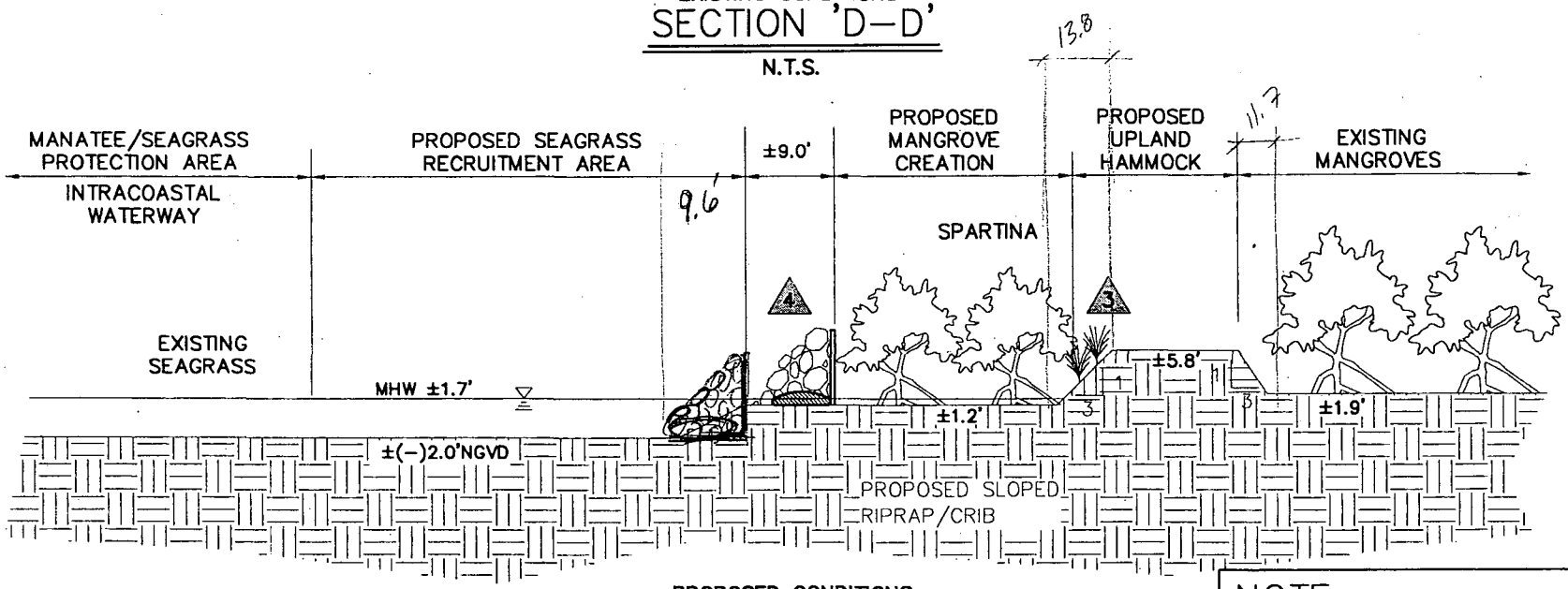
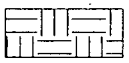


PROPOSED CONDITIONS
SECTION 'D–D'
N.T.S.

LEGEND:



– EXISTING GROUND

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION D-D

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PROJECT / FILE NO. 937503
DRAWING NO. VPP–1
DATE DRAWN 6-3-02
18 / 33

REVISIONS

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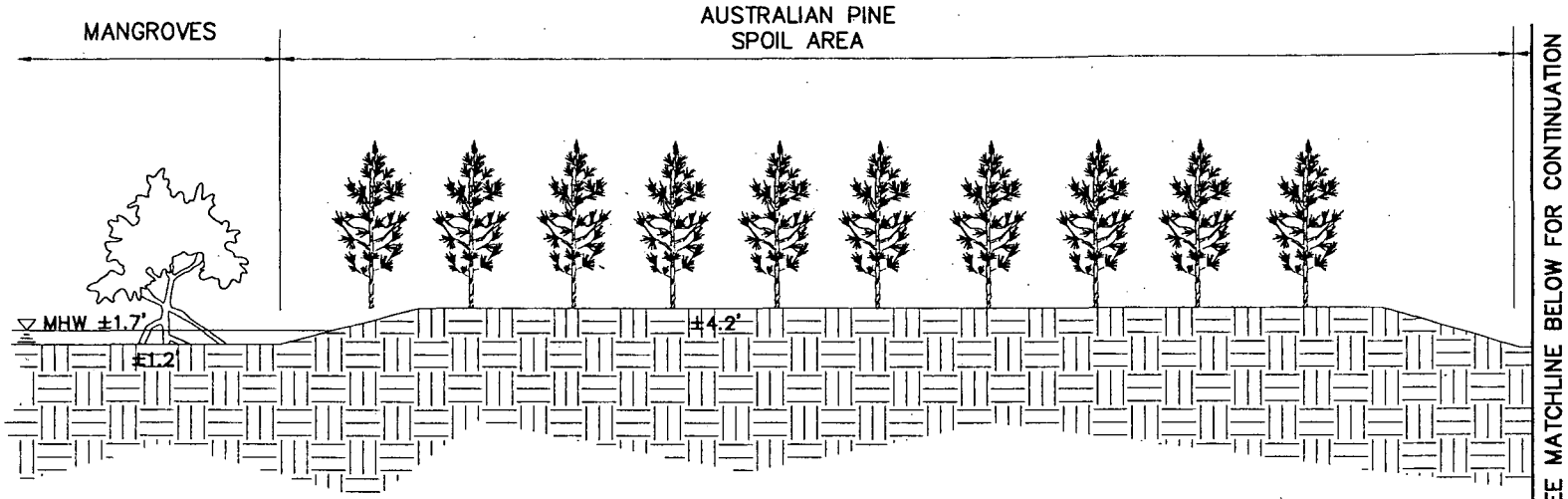

EXISTING CONDITIONS
SECTION 'E–E'
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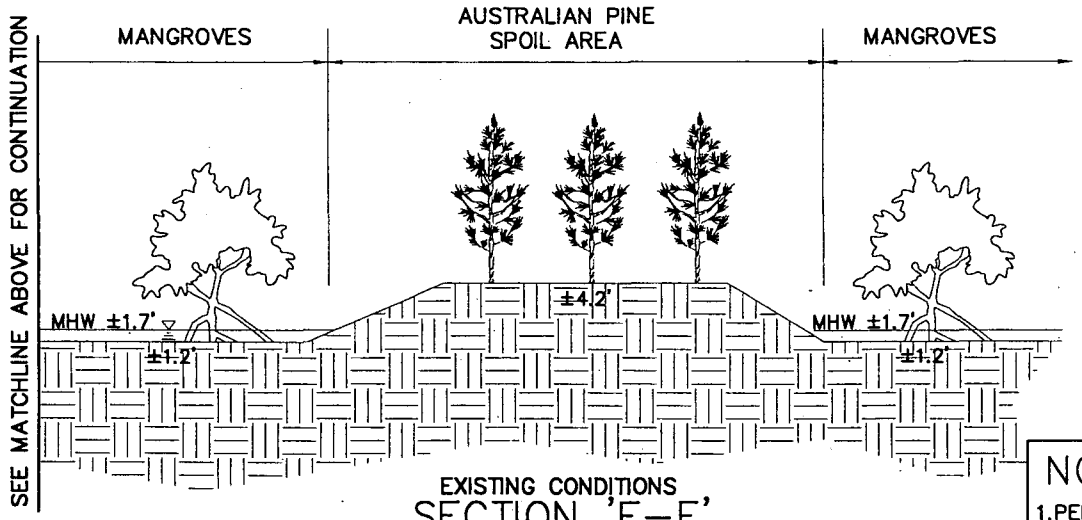

EXISTING CONDITIONS
SECTION 'E–E'
N.T.S.

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

LEGEND:

– EXISTING GROUND

NOTE:

1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION E-E

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 19 of 33

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2	02-04-04	PLAN RE-VISIONS	
1	04-04-04	PLAN RE-VISIONS	
		REVISIONS	

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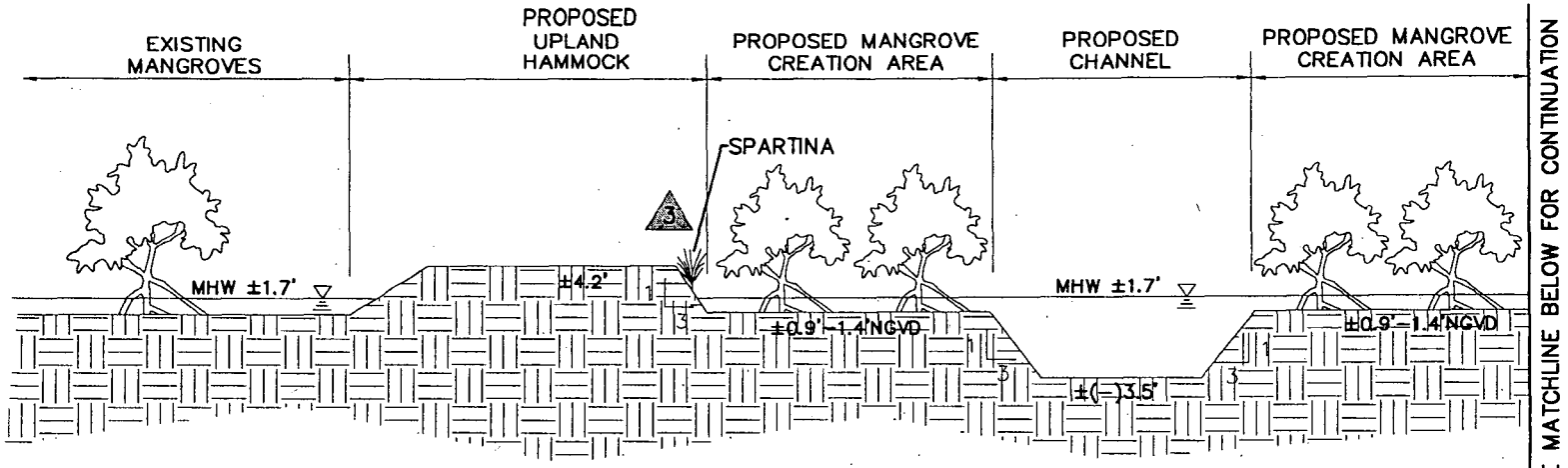
PROJECT / FILE NO. 937503

DRAWING NO. VPP–1

DATE DRAWN 6-3-02



PROPOSED CONDITIONS
SECTION 'E-E'
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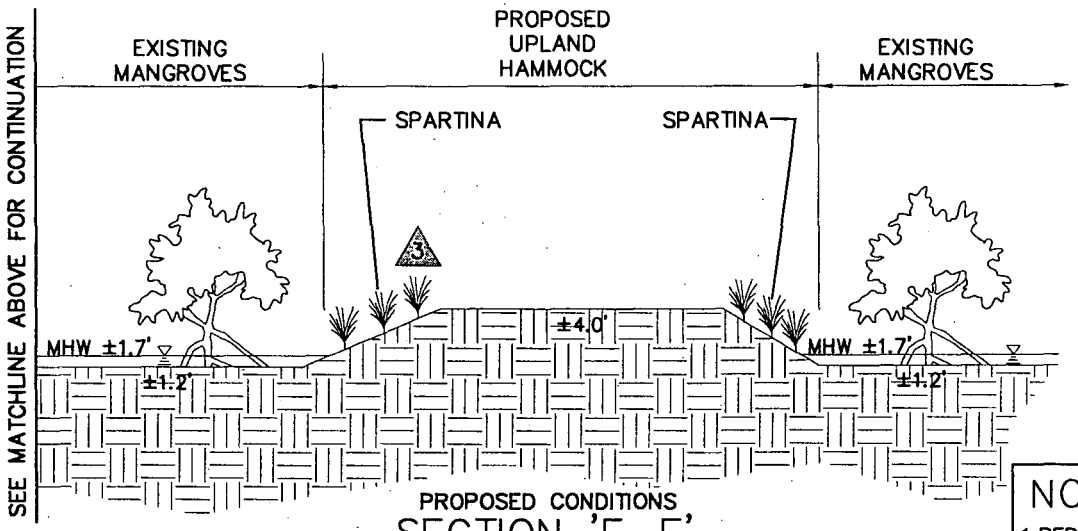

PROPOSED CONDITIONS
SECTION 'E-E'
N.T.S.

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

NOTE:

1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

LEGEND:

– EXISTING GROUND

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 20 of 33

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CROSS SECTION E-E

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2	05-07-02	PLAN RE-VISIONS
1	05-30-02	PLAN RE-VISIONS
REVISIONS		

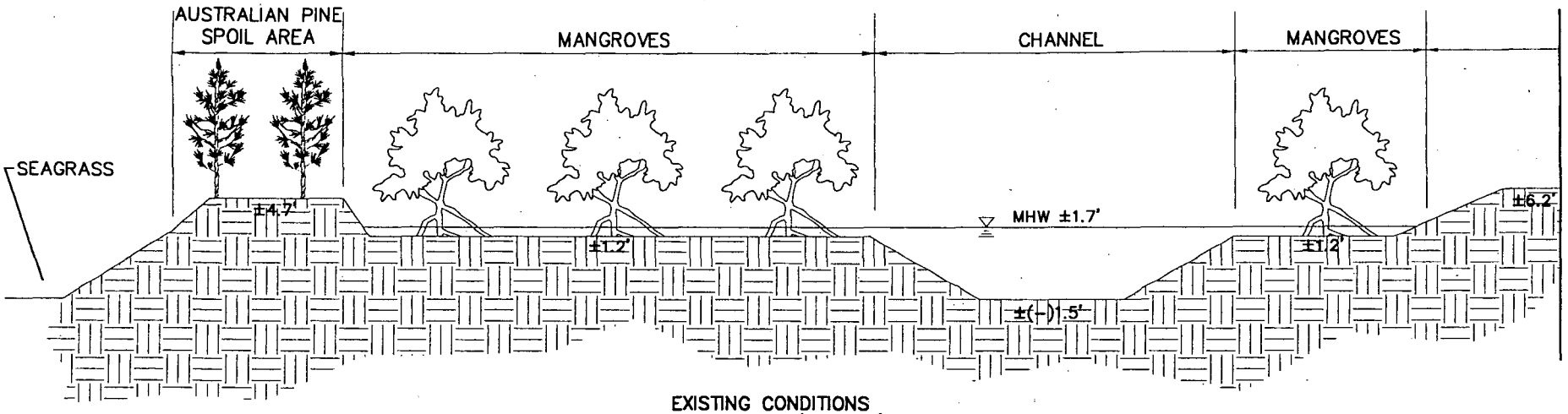
CERTIFICATE OF AUTHORIZATION EB7318 LB6680 LC0337

PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02

20 / 33



EXISTING CONDITIONS
SECTION 'F–F'
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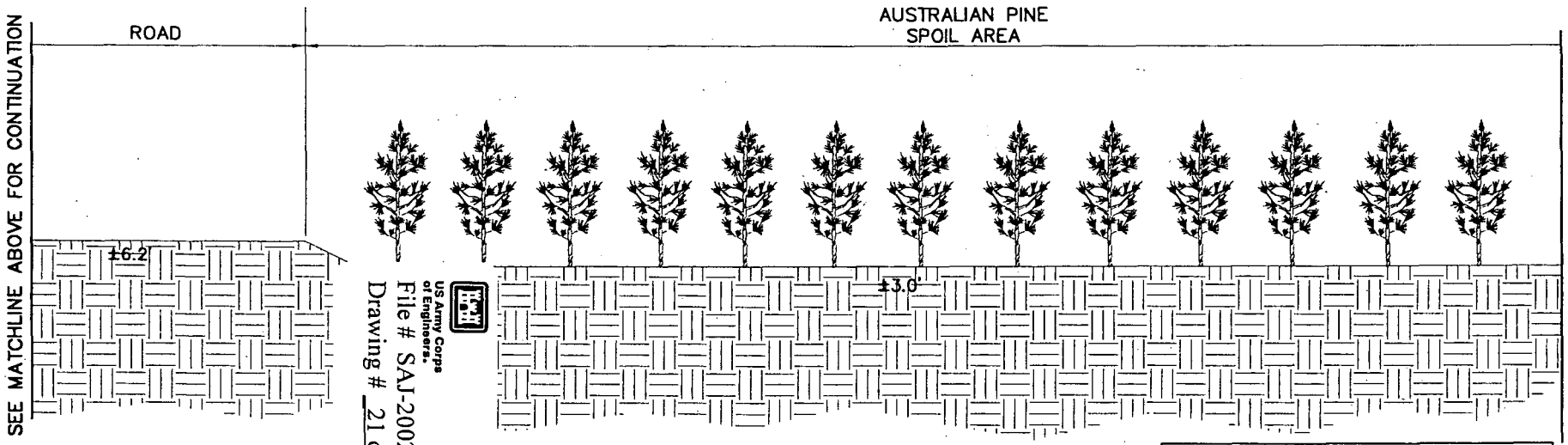

EXISTING CONDITIONS
SECTION 'F–F'
N.T.S.

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

LEGEND:

– EXISTING GROUND

NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 21 of 33

CROSS SECTION F-F

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2	07-07-02	PLAN REVISIONS
1	03-26-02	PLAN REVISIONS
No.	DATE	REVISIONS

REFERENCE OF AUTHORIZATION: CB7318 LB6680 LC0137
PROJECT / FILE NO. 937503.
DRAWING NO. VPP-1
DATE 6-3-02
21 / 33

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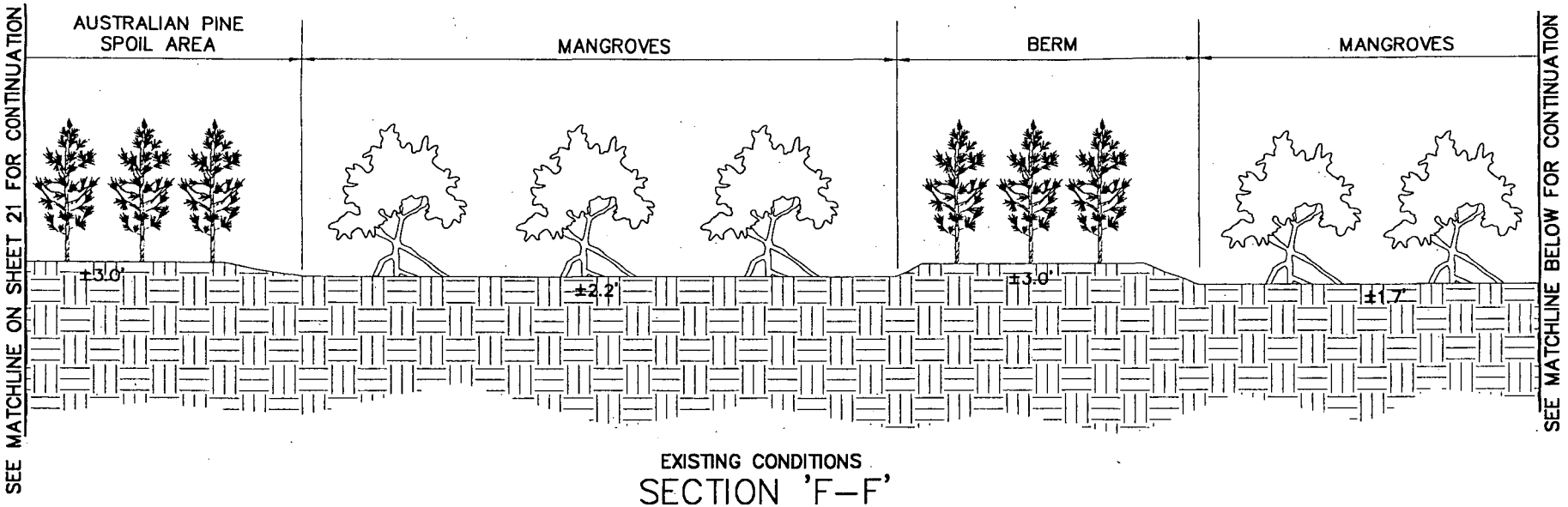

EXISTING CONDITIONS
SECTION 'F–F'
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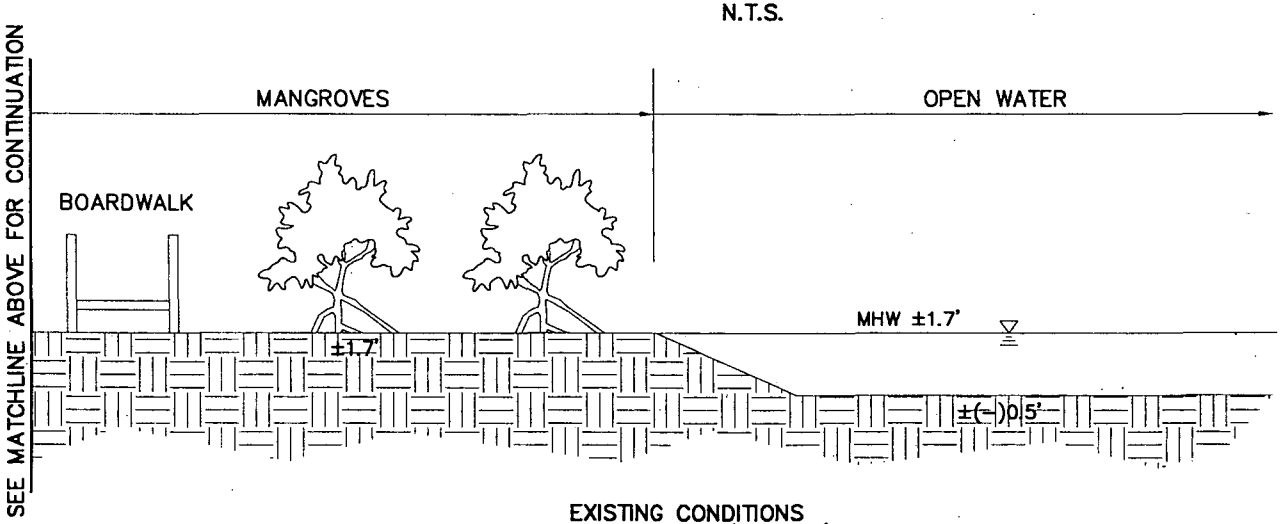

EXISTING CONDITIONS
SECTION 'F–F'
N.T.S.

US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 22 of 33

LEGEND:

– EXISTING GROUND

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION F-F

2	07-07-05	PLAN RE-VISIONS	RDW
1	07-06-05	PLAN RE-VISIONS	RDW
NO.	DATE	REVISIONS	BY

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PROJECT / FILE NO. 937503
DRAWING NO. VPP-1
DATE ORIGINAL 6-3-02
22 / 33

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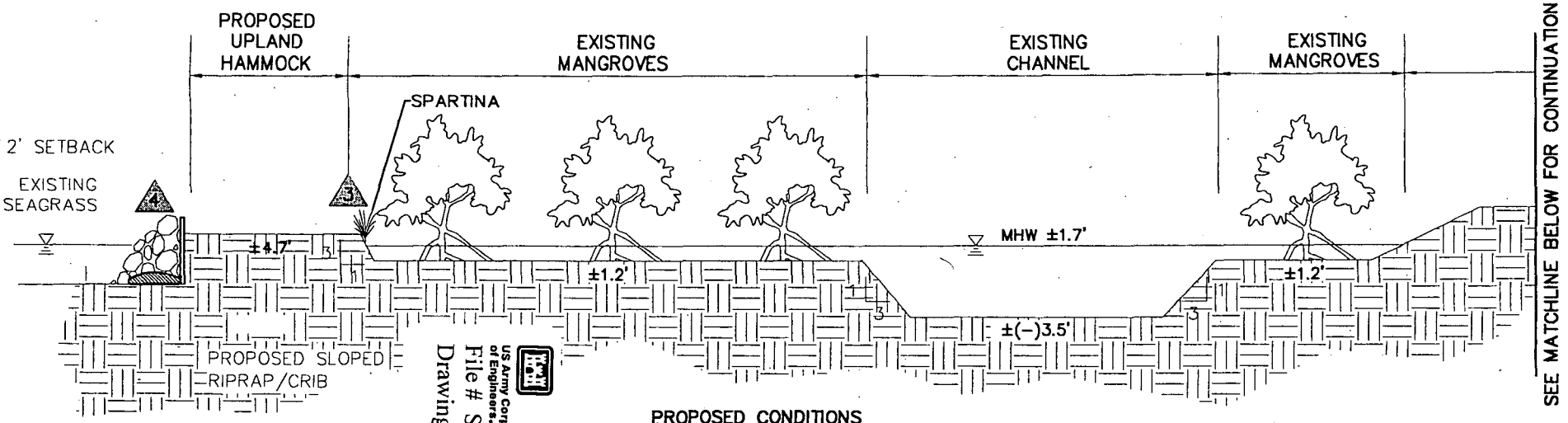

PROPOSED CONDITIONS
SECTION 'F–F'
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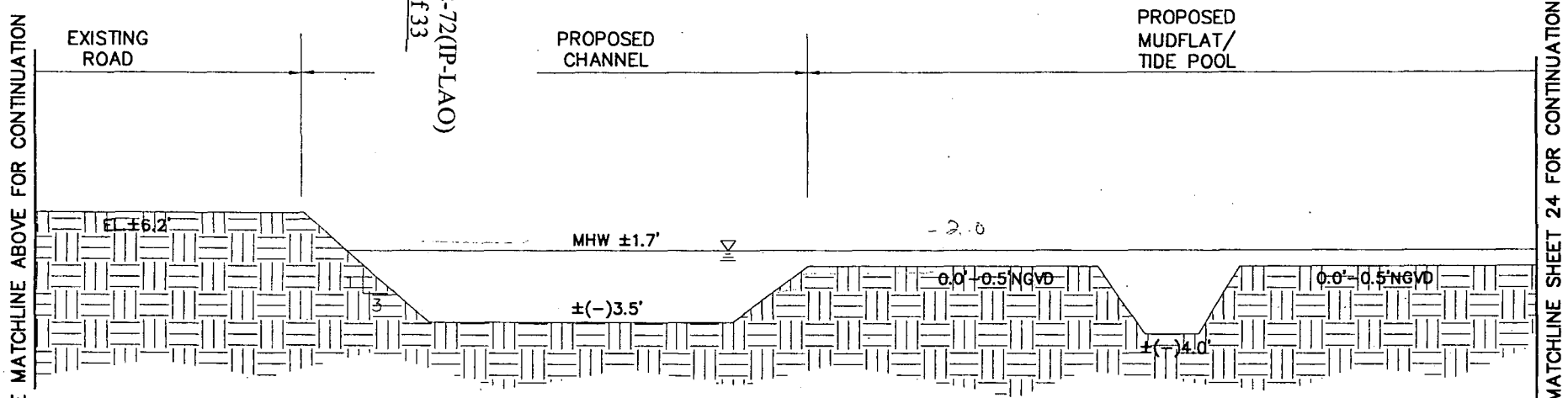

PROPOSED CONDITIONS
SECTION 'F–F'
N.T.S.

LEGEND:

– EXISTING GROUND

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

NOTE:

1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

File # SAJ-2002-72(IP-LAO)
Drawing # 23 of 33

US Army Corps of Engineers.

CROSS SECTION F-F

4	03-24-05	ADDED REVISIONS	TGM
3	06-17-03	PLAN REVISIONS	RDP
2	07-07-02	PLAN REVISIONS	RDP
1	07-05-02	PLAN REVISIONS	RDP
NO.	DATE	REVISIONS	BY

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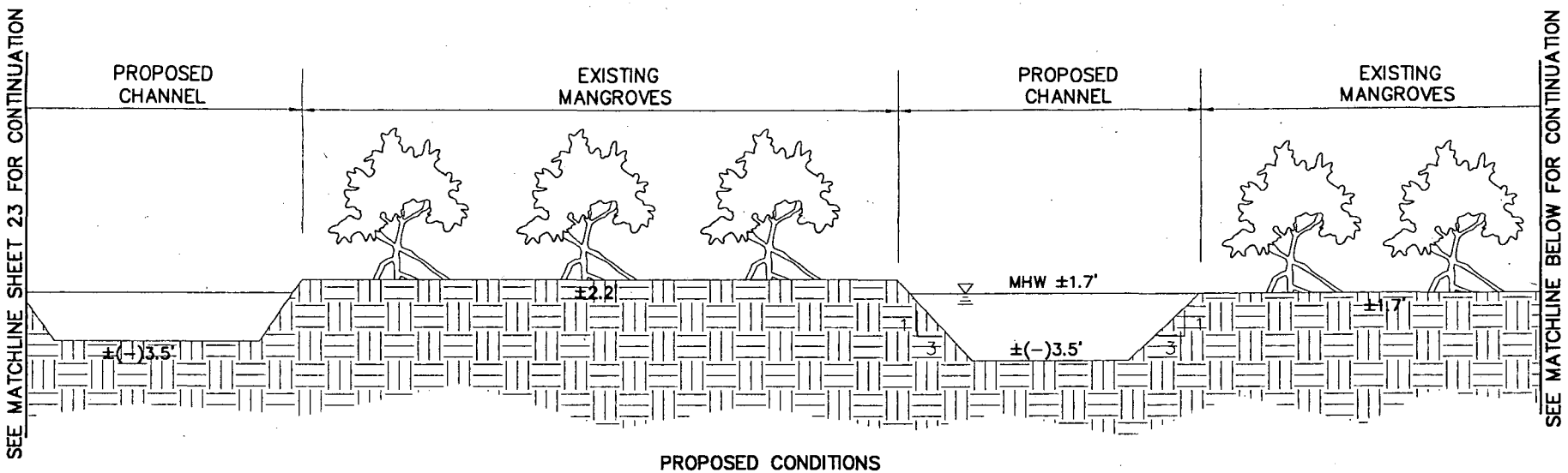
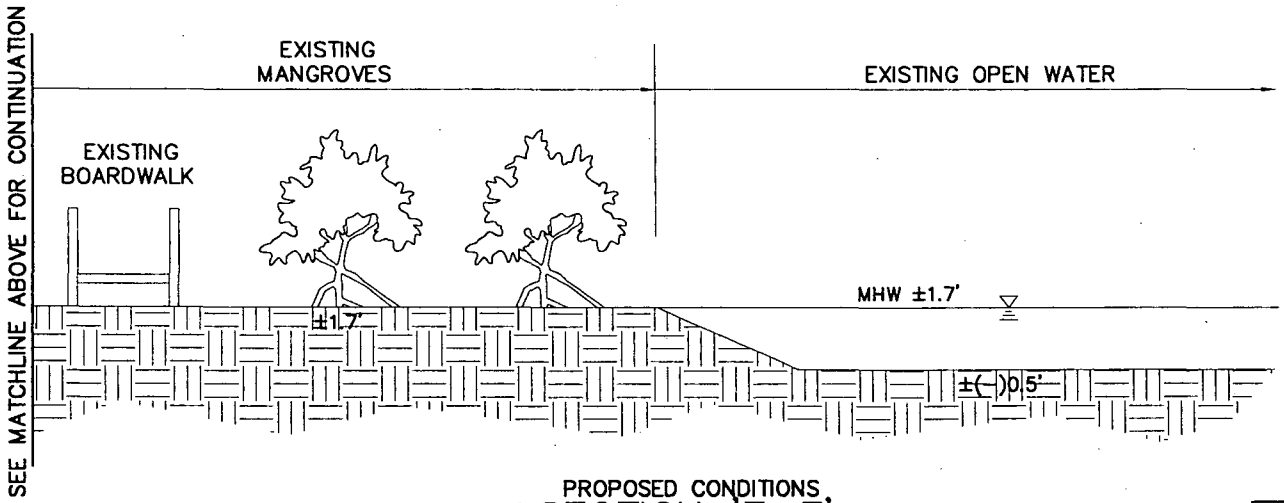
EB7318 LB5680 LC0337

PROJECT / FILE NO. 937503
DRAWING NO. VPP-1
DATE DRAWN 6-3-02
23 / 33

V:\Non-Project\Environmental\West Lake Temp\permit_sketches.dwg Tue 06/07/2005 9:10a By tmartin



PROPOSED CONDITIONS
SECTION 'F–F'
N.T.S.



PROPOSED CONDITIONS
SECTION 'F–F'
N.T.S.

US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 24 of 33

LEGEND:

– EXISTING GROUND

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION F-F

WEST LAKE PARK

BROWARD COUNTY, FLORIDA

FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION

REVISIONS

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EB7318 LB6680 LC0337

PROJECT / FILE NO. 937503
DRAWING NO. VPP-1
DATE DRAWN 6-3-02
24 / 33

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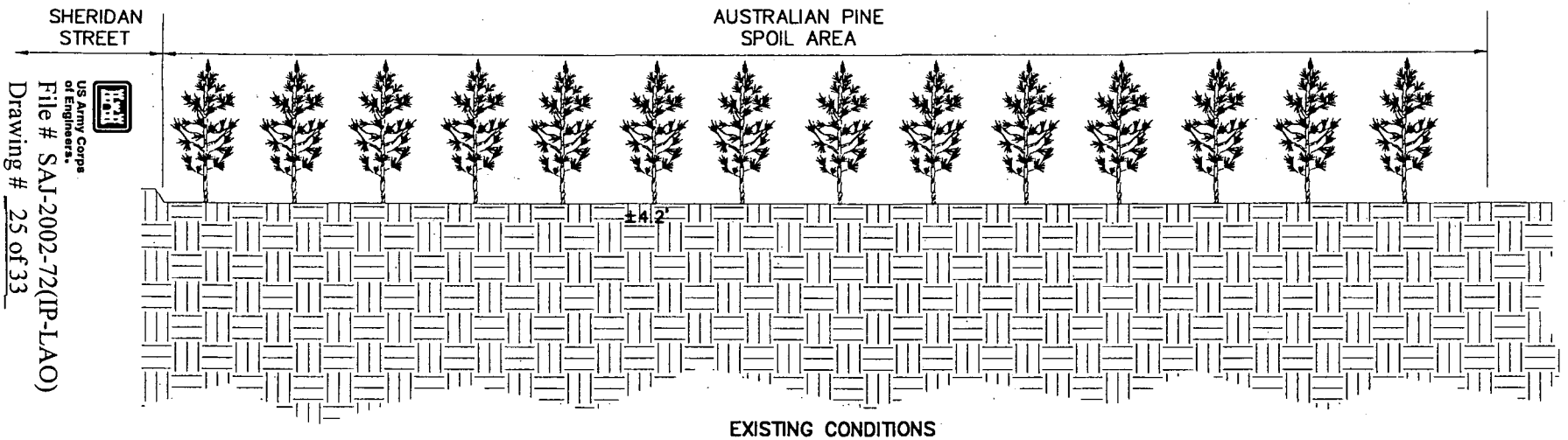
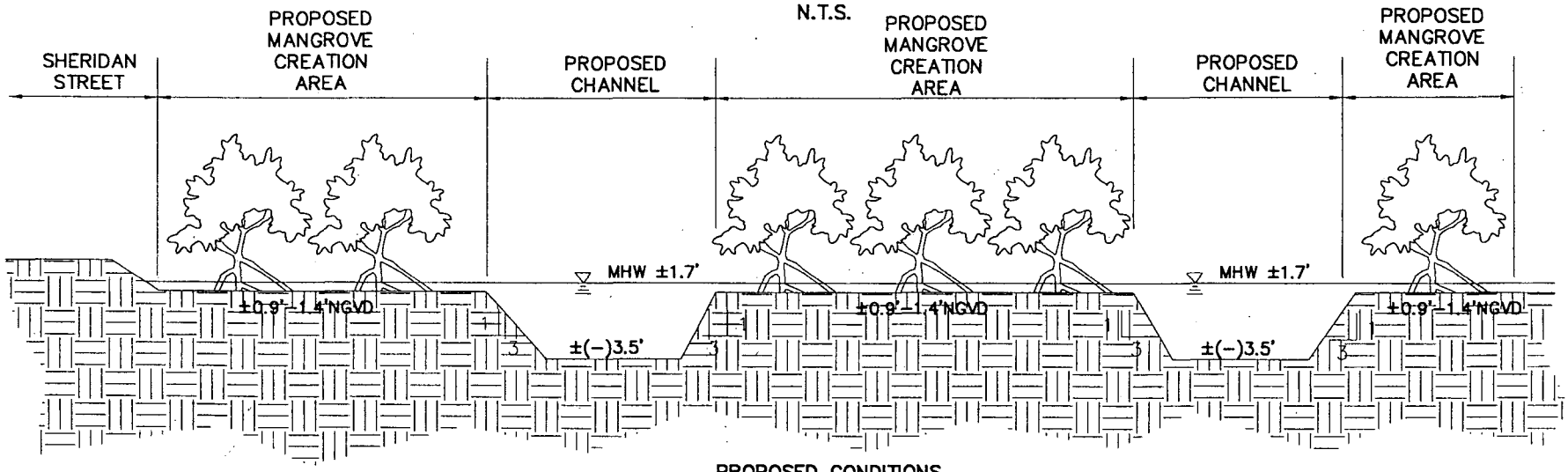
File # SAJ-2002-72(IP-LAO)
Drawing # 25 of 33

US Army Corps of Engineers.



EXISTING CONDITIONS
SECTION 'G–G'
N.T.S.



PROPOSED CONDITIONS
SECTION 'G–G'
N.T.S.

LEGEND:

– EXISTING GROUND

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

NOTE:
1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION G-G

3	07-29-02	PLAN REVISIONS	
1	07-26-02	PLAN REVISIONS	
No.	Date	REVISIONS	Dwn. Chk.

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EB7318 LB6680 LC0137

Date | Dwn. | Chk.

Project / File No. 937503

Drawing No. VPP–1

Date Drawn 6–3–02 | 25 of 33

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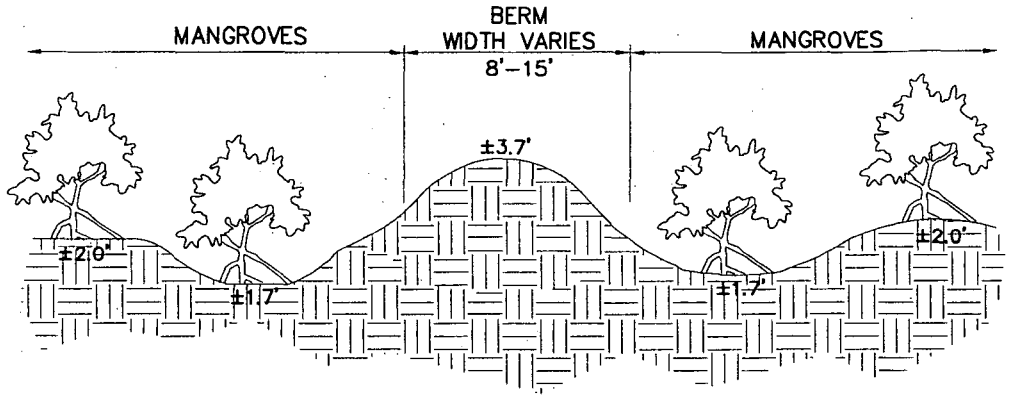
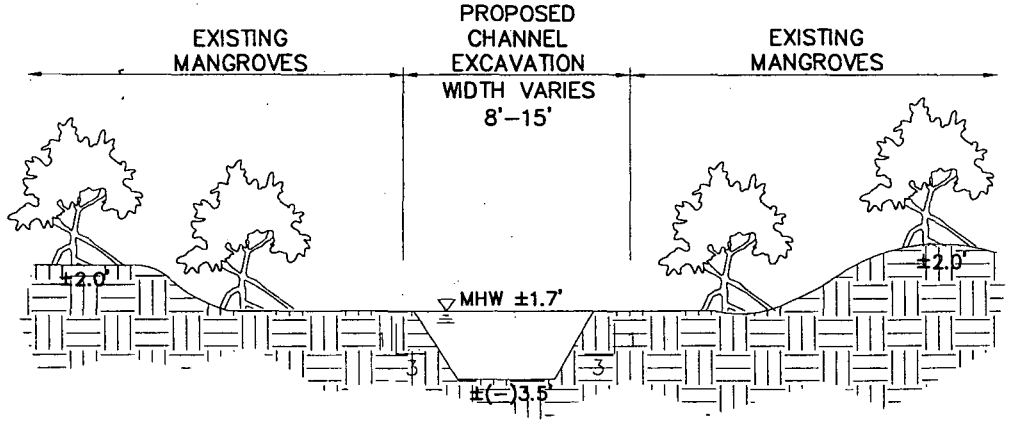


EXISTING CONDITIONS

SECTION H-H

N.T.S.



PROPOSED CONDITIONS

SECTION H-H

N.T.S.

NOTE: ' - ELEVATIONS REFERENCED TO N.G.V.D.

LEGEND:

- EXISTING GROUND

NOTE:

1. PERMIT SET - REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 26 of 33

CROSS SECTION H-H

WEST LAKE PARK

BROWARD COUNTY, FLORIDA

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2	07-07-05	PLAN REVISIONS	
1	06-16-05	PLAN REVISIONS	
No.	Date	REVISIONS	By

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PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE 6-3-02 26 / 33

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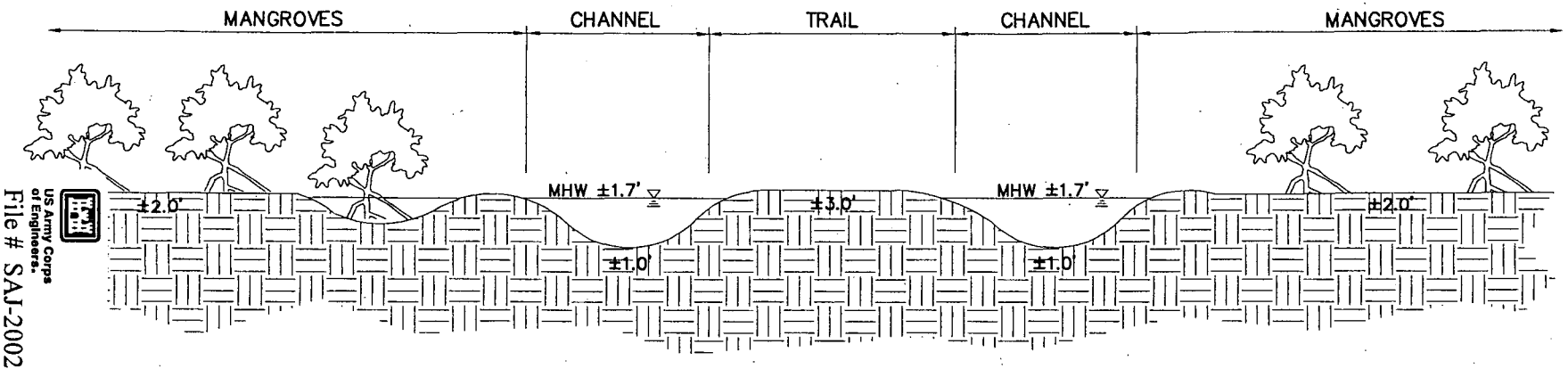
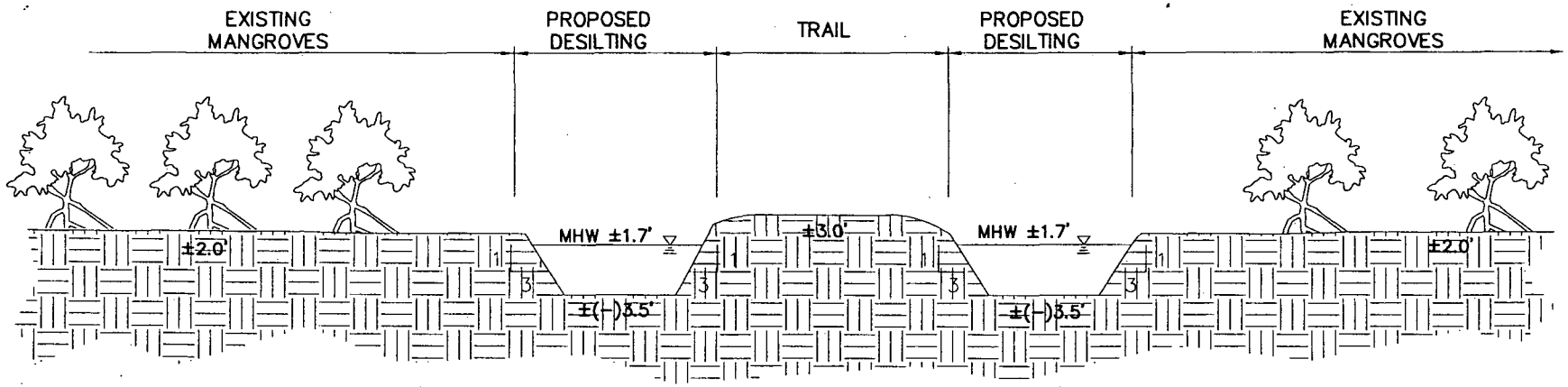


EXISTING CONDITIONS
SECTION I–I
N.T.S.



PROPOSED CONDITIONS
SECTION I–I
N.T.S.

LEGEND:

– EXISTING GROUND

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

NOTE:

1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION I-I

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 27 of 33

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2	07-07-03	PLAN REVISIONS	
1	02-06-03	PLAN REVISIONS	
REVISIONS			

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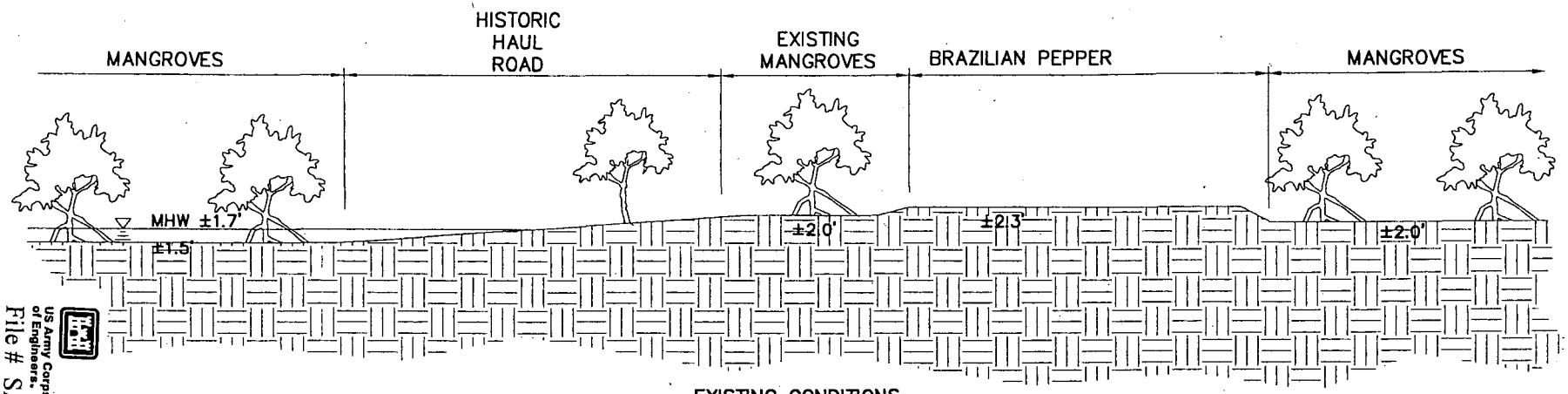
937503

VPP-1

6-3-02

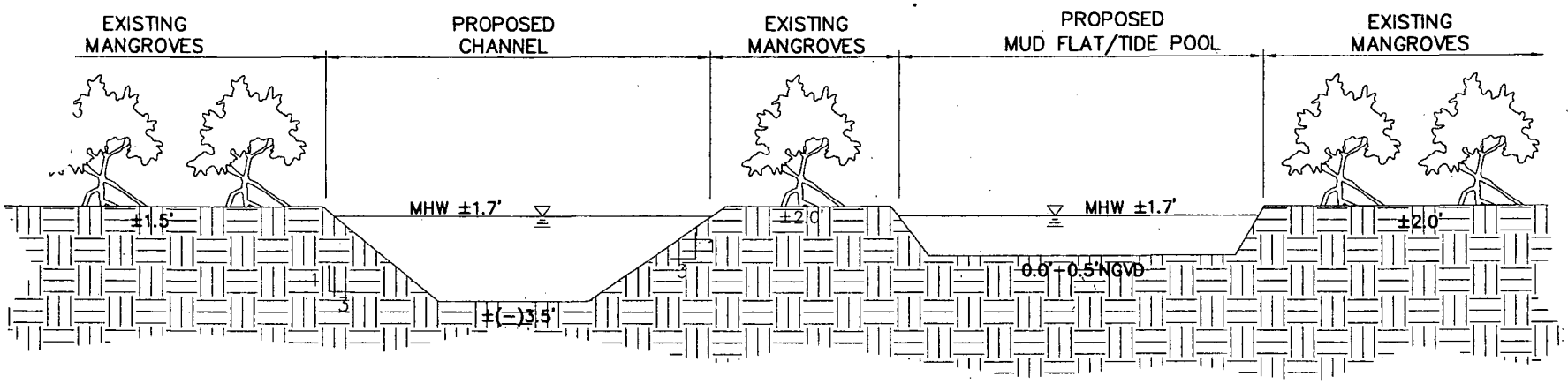
27 / 33



EXISTING CONDITIONS

SECTION J–J

N.T.S.



PROPOSED CONDITIONS

SECTION J–J

N.T.S.

LEGEND:

– EXISTING GROUND

NOTE: – ELEVATIONS REFERENCED TO N.G.V.D.

NOTE:

1. PERMIT SET – REVIEW CONSTRUCTION LEVEL PLANS & SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY

CROSS SECTION J-J

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PROJECT / FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02 28 / 33

REVISIONS

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File # SAJ-2002-72(IP-LAO)

Drawing # 28 of 33

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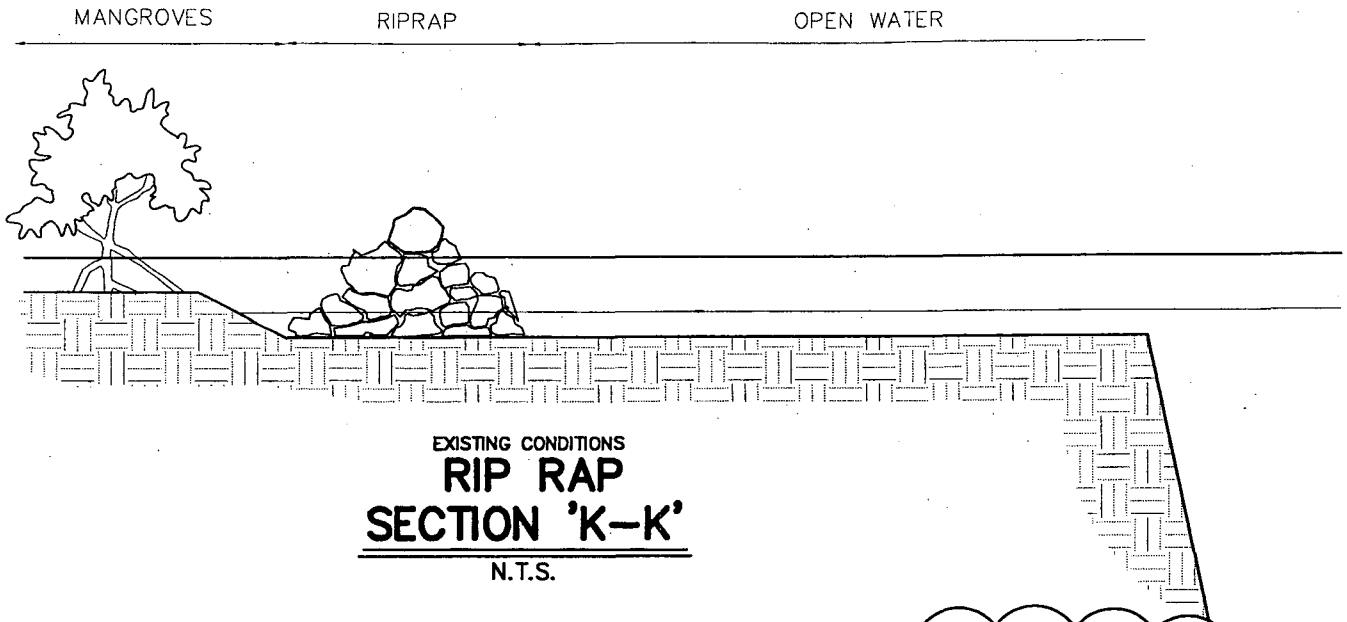
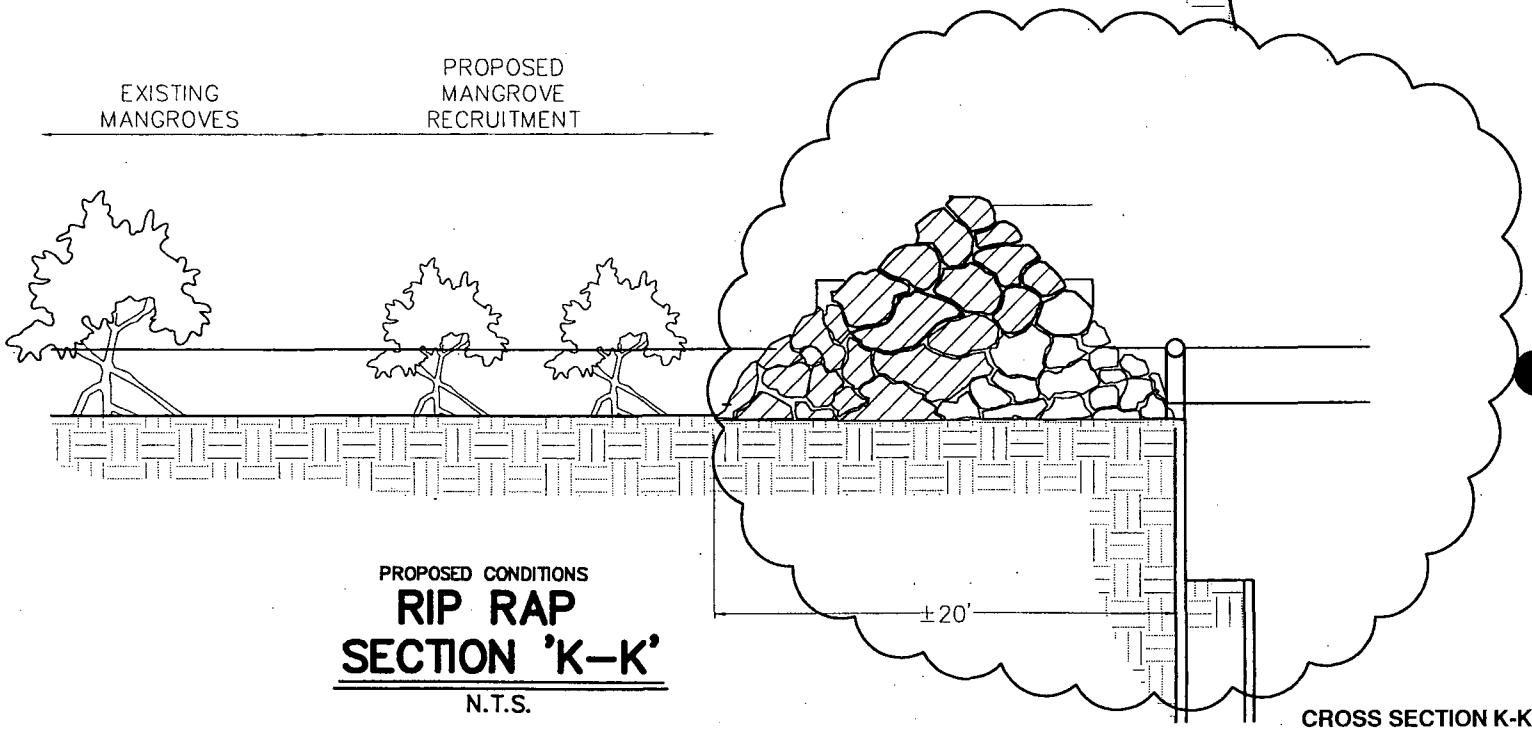


EXISTING CONDITIONS

RIP RAP SECTION 'K–K'

N.T.S.



PROPOSED CONDITIONS

RIP RAP SECTION 'K–K'

N.T.S.

CROSS SECTION K-K

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 29 of 33

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2	02-07-03	PLAN RE-VISIONS	
1	02-06-03	PLAN RE-VISIONS	
No.	Date	REVISIONS	By

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PROJECT / FILE NO. 937503

DRAWING NO. VPP–1

DATE DRAWN 6-3-02

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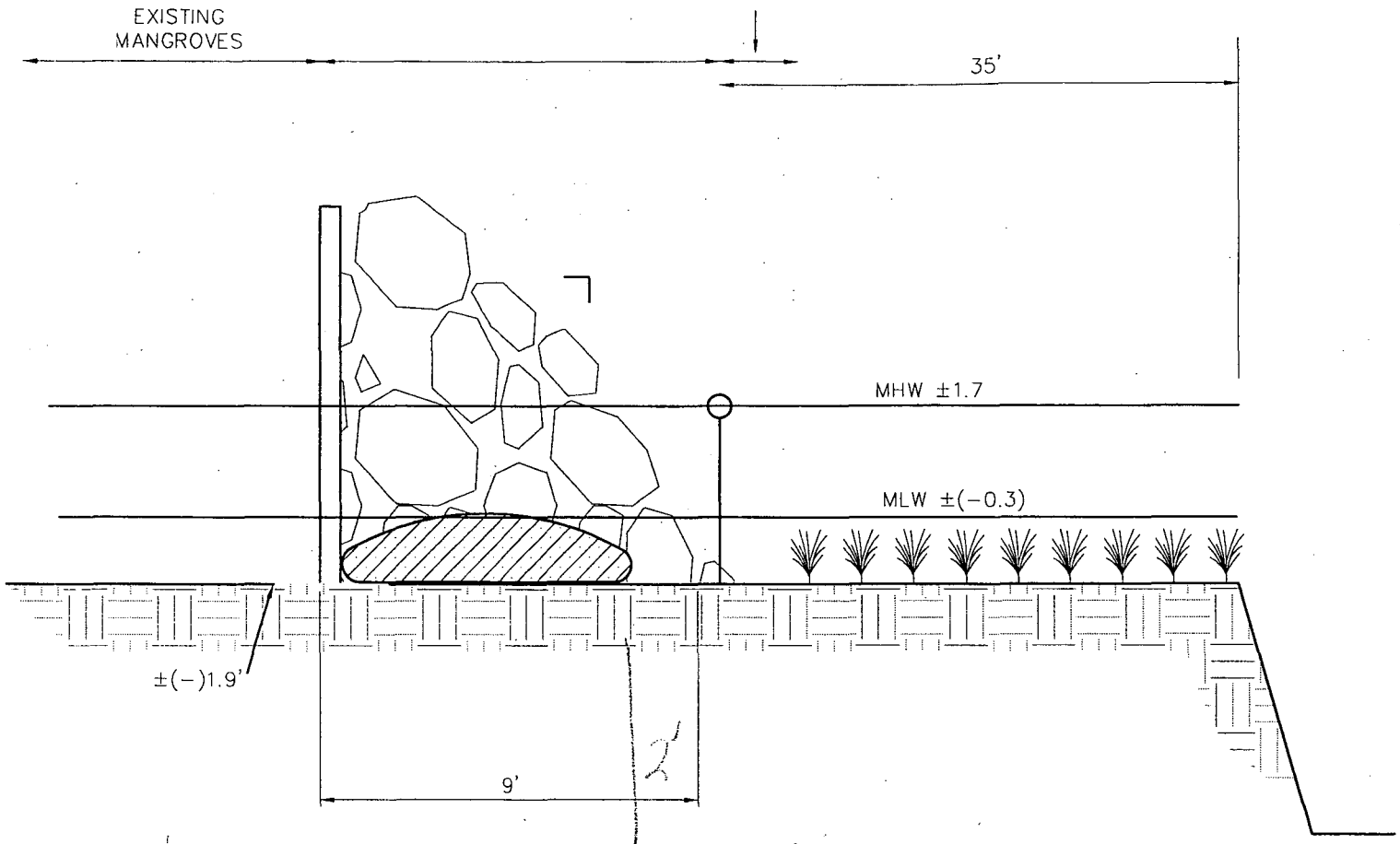
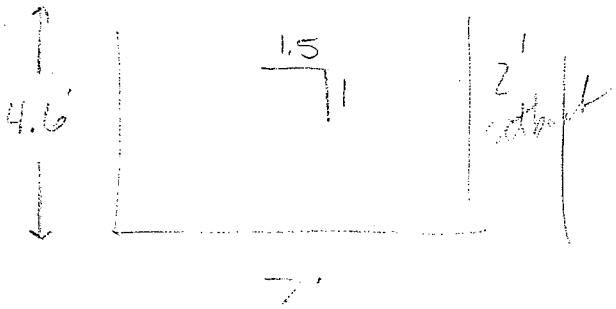


SLOPED RIP RAP/CRIB
SECTION 'L-L' 3

N.T.S.



CROSS SECTION L-L

US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 30 of 33

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CERTIFICATE OF AUTHORIZATION: CA7318 LB5660 LC0337

PROJECT / FILE NO.	937503
DRAWING NO.	VPP-1
DATE DRAWN	6-3-02
SHEET	30 of 33

3	03-31-05	LICENSE RE-VISIONS	TCM
2	09-07-02	PLAN RE-VISIONS	TCM
1	09-06-02	PLAN RE-VISIONS	TCM
NO.	DATE	REVISIONS	BY

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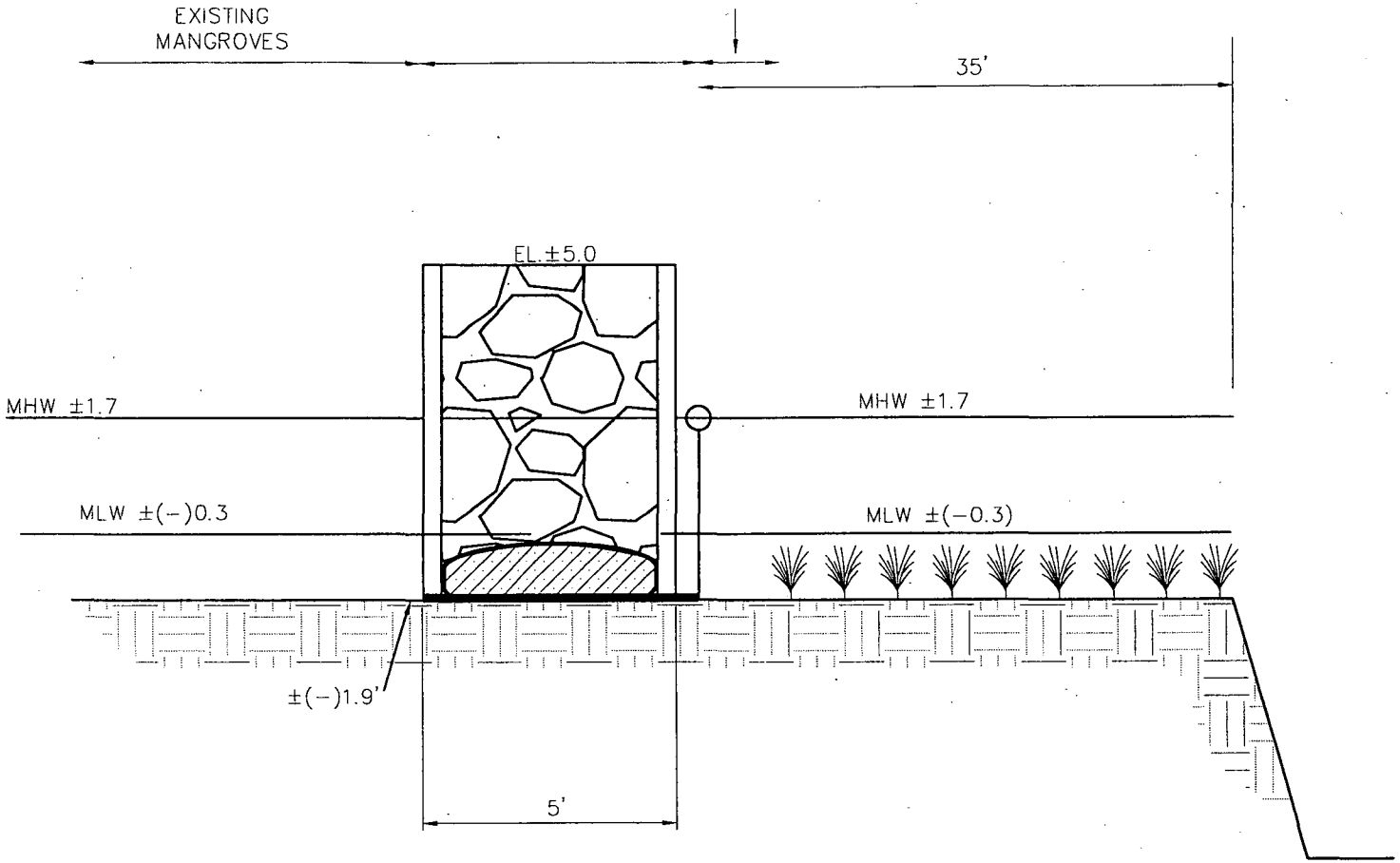

RIP RAP/CRIB
SECTION 'M-M'

N.T.S.

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 311 of 33

CROSS SECTION M-M

WEST LAKE PARK

BROWARD COUNTY, FLORIDA

FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION

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VPP-1

6-3-02

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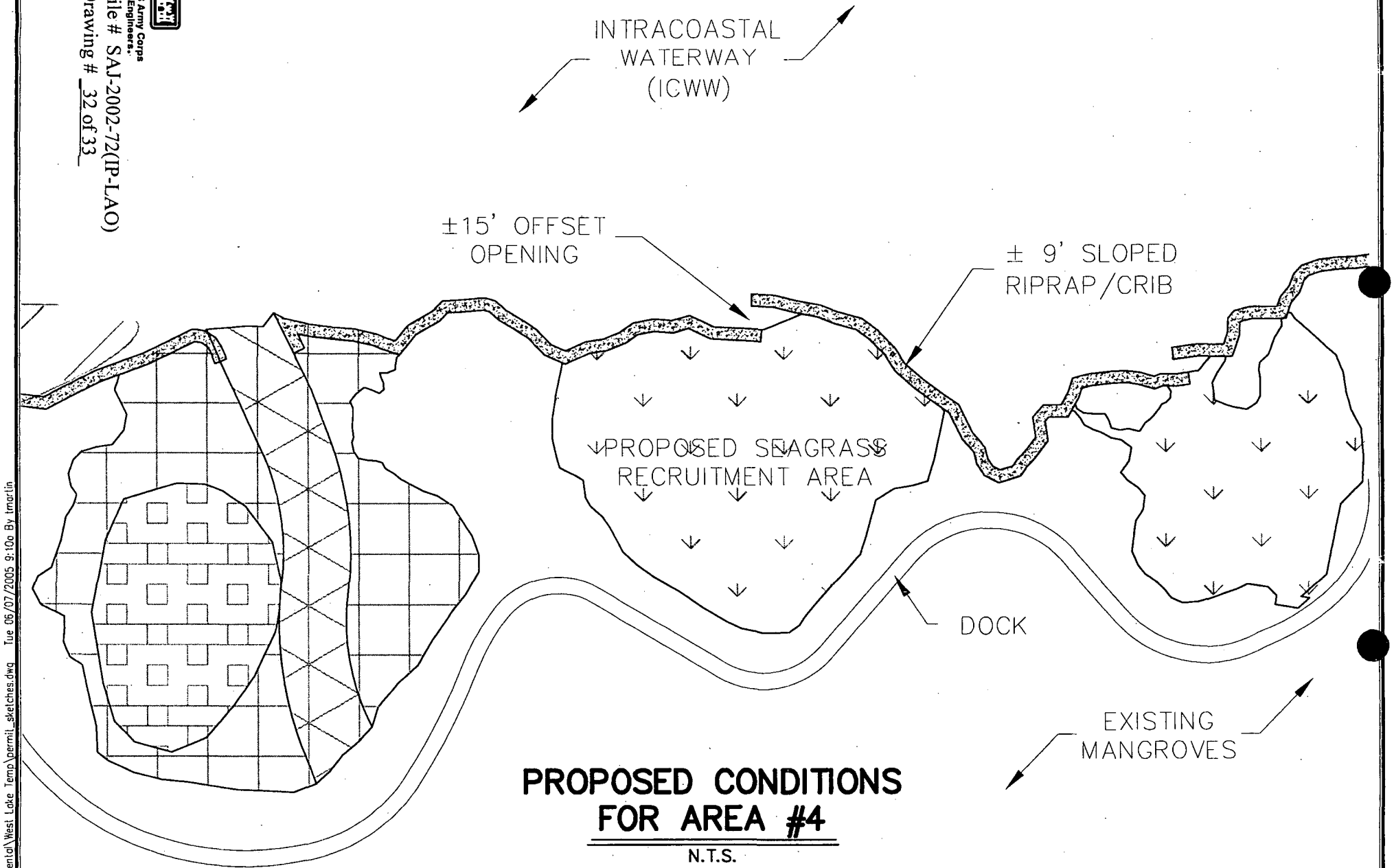
US Army Corps of Engineers.
File # SAJ-2002-72(IP-LAO)
Drawing # 32 of 33



PROPOSED CONDITIONS FOR AREA #4

N.T.S.

RIP RAP/CRIB OFFSET OPENING DETAIL

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FOR: BROWARD COUNTY PARKS AND RECREATION DIVISION

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CERTIFICATE OF AUTHORIZATION: EB7318 LB6660 LC0337

PROJECT # FILE NO. 937503

DRAWING NO. VPP-1

DATE DRAWN 6-3-02 | 32 OF 33

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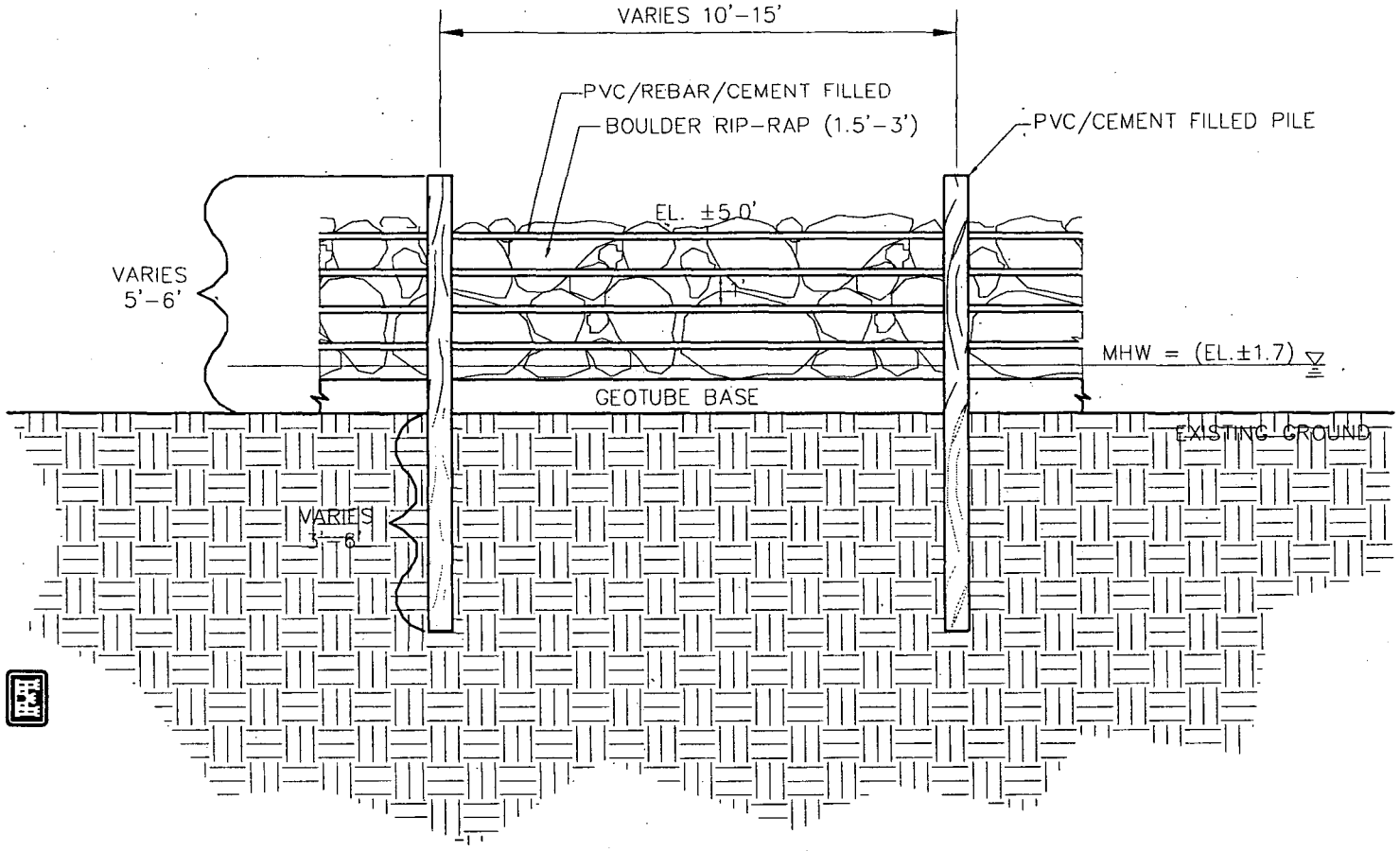

RIP RAP/ CRIB PROFILE

N.T.S.

NOTES:

1. PERMIT SET - REVIEW CONSTRUCTION PLANS & LEVEL SPECIFICATIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITY.
2. MLW ELEVATION ±(-)0.3'

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)

Drawing # 33 of 33

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RIP RAP CRIB PROFILE

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937503

VPP-1

6-3-02

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REVISIONS

SPECIAL CONDITIONS

1. The construction phase of this permit shall expire on April 15, 2009.

2. The permittee shall be responsible for the correction of any erosion, shoaling or water quality problems that result from the construction or operation of the surface water management system.

3. Measures shall be taken during construction to insure that sedimentation and/or turbidity violations do not occur in the receiving water.

4. The District reserves the right to require that additional water quality treatment methods be incorporated into the drainage system if such measures are shown to be necessary.

5. Facilities other than those stated herein shall not be constructed without an approved modification of this permit.

6. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the District may require the permittee to provide appropriate mitigation to the District or other impacted party. The District may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

7. All barge activity shall occur in areas where a minimum one-foot bottom clearance is maintained.

8. All contractors must be provided with a copy of the staff report and permit conditions prior to the commencement of construction. The permittee is responsible for ensuring that all contractors adhere to the project construction details and methods indicated on the attached permit Exhibits and described herein.

9. The successful completion of the mitigation plan is heavily dependent on proper site grading. Therefore, prior to demobilizing equipment from the site and prior to planting, the permittee shall schedule an inspection by District Environmental Resource Compliance staff to ensure that appropriate elevations and slopes have been achieved.

10. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or other surface waters prior to disposal in a suitable upland spoil disposal area.

11. Prior to the commencement of construction in or adjacent to wetlands and/or other surface waters, the perimeter of the mitigation construction area(s) shall be enclosed with stakedand trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas. The permittee shall notify the District's Environmental Resource Compliance staff in writing upon installation of the silt fencing and/or turbidity screens and schedule an inspection of this work. The silt fencing and/or turbidity screens shall be subject to District staff approval. The permittee shall modify the silt fencing/turbidity screens if District staff determines that it is insufficient or is not in conformance with the intent of this permit. The silt fencing and/or turbidity screens shall remain in place until all adjacent construction activities are complete.

12. All temporary wetland impacts associated with mitigation construction activities shall be restored to preexisting wetland conditions immediately following completion of the mitigation element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time zero mitigation monitoring report and shall be maintained and monitored in conjunction with the mitigation monitoring program provided for in the enclosed exhibits.

13. This permit only applies to authorization from the South Florida Water Management District; it is possible that additional permits may be necessary from other agencies. Nothing contained herein relieves the permittee from timely complying with applicable laws of other federal, state or local governments.

14. Manatee exclusion grates shall be placed across the openings of existing or proposed culverts or pipes that are greater than eighteen inches but smaller than six feet in diameter. The installation of grates applies to any submerged or partially submerged pipes and culverts accessible to manatees during any tidal phase. Permittee shall keep all grates free and clear of debris.

15. Endangered species, threatened species and/or species of special concern have been observed onsite and/or the project contains suitable habitat for these species. It shall be the permittee's responsibility to coordinate with the Florida Fish and Wildlife Conservation Commission and/or the U.S. Fish and Wildlife Service for appropriate guidance, recommendations and/or necessary permits to avoid impacts to listed species.

16. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

    The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

    Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

    All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

    If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

    Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (1-561-562-3909) in south Florida.

    Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 81/2" by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. The U.S. Fish and Wildlife Service should also be contacted in Jacksonville (1-904-232-2580) for north Florida or in

Vero Beach (1-561-562-3909) for south Florida.

17. Due to the proximity of this project to areas of known manatee concentrations, all work conducted waterward of the existing shoreline during the months of December, January and February shall be subject to the following conditions:

a) The Bureau of Protected Species Management shall be notified one week prior to the commencement of the work;

b) at least one person shall be designated as a manatee observer at each site when in-water work is being performed. the manatee observer must be on site during all in-water construction activities and will advise personnel to cease operation upon sighting a manatee within 50 feet of any in-water construction activity. Movement of a work barge, other associated vessels, or any in-water work shall not be performed after sunset, when the possibility of spotting manatees is negligible; and

c) the permittee shall ensure that the contractor maintains a log detailing sightings, collisions, or injuries to manatees should they occur during the contract period. Following project completion, the logs shall be submitted to the Bureau of Protected Species Management, 620 South Meridian Street, Tallahassee, Florida 32399-1600;

18. The following exhibits for the permit are incorporated by reference herein and are located in the permit file:

Exhibit No. 14 List of Outparcels within West Lake Natural Preserve and Recreation Area, dated 12/19/01
Exhibit No. 17 Sublease Agreement for West Lake Park, between FDNR and Broward County, executed 12/22/88
Exhibit No. 18 Management Plan for West Lake Park, by Broward County Parks and Recreation Division
Exhibit No. 19 Management Plan Update for West Lake Park, authorized by FDEP on 2/7/02

19. No construction is authorized on land that the permittee does not own until the permittee acquires title to such land.

20. This permit does not eliminate the need to obtain any and all necessary easements and rights of way prior to the start of any activity approved herein. This permit does not convey to the permittee, or create for the permittee, any property right, or any interest in real property; nor does it authorize any entrance upon, or activities on, property which is not owned or controlled by the permittee; or convey any rights or privileges other than those specified in the permit and Chapter 40E-4 or Chapter 40E-40, F.A.C..

21. As provided in Exhibit No. 10, Broward County Parks and Recreation Division shall be responsible for the mitigation construction, five year maintenance and monitoring and perpetual management of the proposed mitigation efforts at West Lake Park.

22. Perpetual maintenance of the mitigation area shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

23. The use of the mitigation units from this project shall be limited to projects undertaken by Broward County. Generally, the mitigation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater and/or estuarine wetland communities. The suitability of this mitigation area to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

The amount of potential credit generated by the mitigation efforts has been

determined using the Uniform Mitigation Assessment Method, 62-345, FAC (UMAM) through an assessment conducted jointly by District and Broward County Department of Planning and Environmental Protection staff and the applicant's representatives and is reflected in the UMAM worksheets provided in Exhibit No. 22. Use of the mitigation credits shall be addressed at the time of application for the wetland impact projects.

24. At the time of application for any that includes wetland impacts and proposes to use mitigation credit from this West Lake mitigation plan, the permittee shall demonstrate that an adequate portion of the mitigation plan has been or shall be executed and completed in a timely manner (i.e., concurrent with the wetland impacts) and that the specified mitigation will adequately offset the wetland impacts associated with that construction project.

25. A mitigation program for West Lake Park shall be implemented in accordance with the enclosed exhibits. The permittee shall create 51.7 acres of wetlands, restore 5.5 acres of wetlands, restore 13.4 acres of uplands, enhance 50.4 acres of wetlands, and preserve 53.3 acres of wetlands.

26. The District reserves the right to require renedial measures to be taken by the permittee if monitoring or other information demonstrates that adverse impacts to onsite or offsite wetlands, upland conservation areas or buffers, or other surface waters have occurred due to project related activities.

27. A mitigation monitoring program shall be implemented in accordance with the enclosed exhibits to ensure that the targeted success criteria are met. The monitoring program shall extend for a period of 5 years with annual reports submitted to District Environmental Resource Compliance staff. The permittee shall be responsible for ensuring that the mitigation areas described herein meet the specified percent coverage and/or survivorship of planted and/or recruited vegetation throughout the duration of the monitoring program, with replanting as necessary. If native wetland, transitional, and upland species do not achieve the specified percent coverage and/or survivorship at any time during the monitoring program, native species shall be planted in accordance with the maintenance program. At the end of the 5 year monitoring program the entire mitigation area shall contain an 80% survival of planted vegetation and an 80% coverage of desirable plant species suitable for that mitigation area.

28. A maintenance program shall be implemented in accordance with Exhibit Nos. 4 and 7 for the mitigation areas on a regular basis to ensure the integrity and viability of those areas as permitted. Maintenance shall be conducted in perpetuity to ensure that the conservation area is maintained free from Category 1 exotic vegetation (as defined by the Florida Exotic Pest Plant Council at the time of permit issuance) immediately following a maintenance activity. Coverage of exotic and nuisance plant species shall not exceed 5% of total cover between maintenance activities. In addition, the permittee shall manage the conservation areas such that exotic/nuisance plant species do not dominate any one section of those areas.

29. A time zero monitoring report for the West Lake Park mitigation project shall be conducted in accordance with Exhibit Nos. 4 and 7 for all completed mitigation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

30. The permittee shall comply with applicable state water quality standards including:
a) 62-302.500 - Minimum criteria for all surface waters at all places and all times;
b) 52-302.510 - Surface waters: general criteria
c) 62-302.560 - Class III waters; recreation, propagation and maintenance of a healthy, well balanced population of fish and wildlife;
d) 62-302.600 - Classified waters.

31. A turbidity control plan shall be implemented in accordance with Exhibit Nos. 4 and 7. Prior to the commencement of construction in or adjacent to the Intracoastal Waterway or other surface water bodies within West Lake Park, floating turbidity curtains with weighted skirts that extend to the submerged bottom shall be properly installed to isolate adjacent waters from the work area. The floating turbidity curtains shall be maintained and shall remain in place until all construction is complete and turbidity levels in the project area are within 29 NTUs of background levels. The permittee shall be responsible for ensuring that turbidity control devices are inspected daily and maintained in good working order so that there are no violations of state water quality standards outside of the turbidity screens.

32. A water quality monitoring program shall be implemented in accordance with Exhibit No. 4 and as outlined below:

    Turbidity expressed in nephelometric turbidity units (ntu). Background samples shall be taken 200 feet upstream of any construction activity within adjacent surface waters Samples shall also be taken 200 feet downstream. Samples shall be taken at least twice daily, with at least a four-hour interval, during all work authorized by this permit involving spoil removal, grading or other forms of earthwork that may generate turbidity in other surface waters.

    Monitoring shall begin on the first day of construction for all activities within or adjacent to surface waters. Monitoring shall cease when all construction activities are completed. The monitoring data must demonstrate that turbidity 200 feet downstream of all proposed activities is less than or equal to 29 NTU's above natural background turbidity (or meets OFW standards) and 200 feet upstream of each proposed activity for a period of 7 consecutive days after completion of construction. If monitoring shows such levels to be exceeded, construction shall cease and District compliance staff shall be notified immediately. Work shall not resume until District staff is satisfied that adequate corrective measures have been taken and turbidity has returned to acceptable levels.

    All monitoring data shall be maintained on site and be available to District staff during regular business hours. The content of the data shall include:

    1) permit and application number; (2) dates of sampling and analysis; (3) statement describing the methods used in collection, handling, storage and analysis of the samples; (4) a map indicating the sampling locations and (5) a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, limits of detection and accuracy of the data.

    Monitoring reports shall also include the following information for each sample that is taken:
    (a) time of day samples taken;
    (b) depth of water body;
    (c) depth of samples;
    (d) antecedent weather conditions;
    (e) wind direction and velocity;

33. Documentation of ownership of the Priority 1 outparcels by the County identified in Exhibit Nos. 14 and 15 must be provided to the District in order to be credited as mitigation for preservation credit and before any other mitigation element is constructed which relies on those outparcels for their construction, access or other purposes.

34. Those portions of the park which are under County ownership and where mitigation is proposed that have been determined to potentially be vulnerable to subsequent alteration (refer to Exhibit No. 13) shall be placed under a conservation easement dedicated to the District. A draft conservation easement document along with boundary surveys and legal descriptions for the identified areas to be protected under the conservation easement shall be submitted for review by District staff and, upon their approval, shall be recorded in County records before mitigation credit for those areas may be used as compensation to offset wetland impacts associated

with other County projects.

35. Management items outlined in Exhibit No. 5 and described in Exhibit Nos. 4 and 7 may be later considered for mitigation credit through a modification of this permit if supporting information to justify mitigation credit for items has been sufficiently demonstrated to the District.

36. Any mitigation credit generated by the planned mitigation activities described herein shall only be eligible for use as compensation to offset tidal, saltwater or estuarine wetland impacts associated with projects proposed by Broward County. Use of such mitigation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the mitigation credit.

37. Early transplanting of seagrass from the impact site to the proposed seagrass creation areas shall be voluntary and shall not be subject to survival criteria. However, the recruitment and coverage criteria specified in this permit shall apply.

38. No modifications to this permit shall be required for construction methodology variations from those described in Exhibit No. 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that District staff concur with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by District regulatory and/or compliance staff.

39. Select mangrove trimming necessary to accomplish the planned mitigation efforts described herein shall be authorized by this permit.

40. Mitigation credit for the designated manatee protection areas shall be granted only after documentation of an agreement, easement or other necessary form of authorization for installation of the manatee protection barriers from the U.S. Army Corps of Engineers has been submitted to the District.

41. Activities associated with the implementation of the mitigation, monitoring and maintenance plan(s) shall be completed in accordance with the work schedule attached as Exhibit No. 21. Any deviation from these time frames will require prior approval from the District's Environmental Resource Compliance staff. Such requests must be made in writing and shall include (1) reason for the change, (2) proposed start/finish and/or completion dates; and (3) progress report on the status of the project development or mitigation effort.

STANDARD MANATEE CONDITIONS FOR IN-WATER WORK
July 2005

The Permittee shall comply with the following conditions intended to protect manatees from direct project effects:

a. All personnel associated with the project shall be instructed about the presence of manatees and manatee speed zones, and the need to avoid collisions with and injury to manatees. The Permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act, the Endangered Species Act, and the Florida Manatee Sanctuary Act.

b. All vessels associated with the construction project shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

c. Siltation or turbidity barriers shall be made of material in which manatees can not become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.

d. All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, must be shutdown if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.

e. Any collision with or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (1-561-562-3909) for south Florida.

f. Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the Permittee upon completion of the project. Awareness signs that have already been approved for this use by the Florida Fish and Wildlife Conservation Commission (FWC) must be used. One sign measuring at least 3 ft. by 4 ft., which reads *Caution: Manatee Area* must be posted. A second sign measuring at least 81/2" by 11" explaining the requirements for "Idle Speed/No Wake" and the shut down of in-water operations must be posted in a location prominently visible to all personnel engaged in water-related activities.

CAUTION: MANATEE HABITAT

All project vessels

IDLE SPEED / NO WAKE

When a manatee is within 50 feet of work all in-water activities must

SHUT DOWN

Report any collision or injury to :
1-888-404-FWCC (1-888-404-3922)

Florida Fish and Wildlife Conservation Commission

Permanent Manatee Sign Information

(Revised June 2001)

There are two types of approved permanent manatee signs that may be required by permit or lease: educational signs and awareness signs (see page 2 for detailed descriptions). These educational signs are non-regulatory in nature.

The permit/lease holder should forward a project site plan to the Bureau of Protected Species Management (620 South Meridian Street, OES-BPS, Tallahassee, FL 32399-1600) with the type, number, and location of signs indicated on the site plan. The applicant should also include a location map of the facility in relation to waterways, a county location map, and the permit and/or lease number associated with the project. BPSM will review the sign placement proposed for the project and notify the applicant within 30 days of receiving the plan if the signs and locations are unacceptable. Correspondence may be sent to offer suggestions on the type, number, and location of the signs. If the applicant has not received a response within 30 days, the proposed signs and their locations should be considered approved. Letters indicating approval of a sign site plan are available upon request.

The educational signs must be placed in a prominent location for maximum visibility, such as near walkways, dockmaster offices, restrooms, or foot traffic access points to piers/docks. The awareness signs should be placed facing land on walkways or docks. Permanent manatee signs should not be installed on pilings in the water nor be attached to navigational markers. If a facility has multiple docks with separate walkways, signs should be installed near each walkway or dock. These signs should be oriented so that boaters using the facility will be reminded of the presence of manatees. The signs are not required to be in view of the general boating public. If approved signs and their locations are found to be out of accordance with these guidelines, the permit/lease holder will have to relocate or install additional signs.

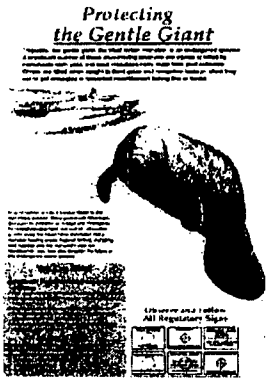
The following specifications should only be considered guidelines for typical projects. Project locations near manatee important habitat, or involving other special circumstances may warrant additional signs.

Facility (wet, dry, temporary, or permanent)	Recommended Signs
Residential with less than 10 slips	• Site by site determination required
Boat ramps, charters or cruises, boat rental or restaurant facilities	• Educational Signs • Awareness Signs (may require multiple signs - site by site determination for quantity)
Facilities with greater than 10 slips	• Educational Signs (may require multiple signs - site by site determination for quantity) • Awareness Signs (may require multiple signs - site by site determination for quantity)

Manatee Awareness Sign

The **"Caution: Manatee Area"** sign is 3' by 4' and is available from all of the companies listed on the sign supplier list. These caution signs are intended to remind boaters using the facility of the presence of manatees while on the water. This sign will meet the manatee awareness display condition required by lease/permit.

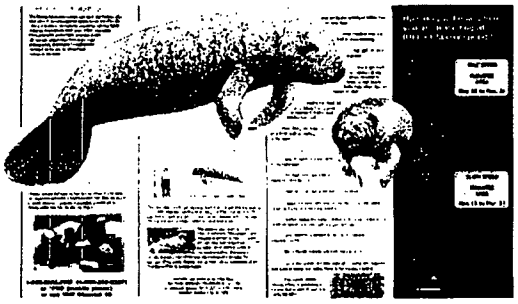
Manatee Educational Signs



These signs are 2' by 3' and are available only through Wilderness Graphics. **"Protecting the Gentle Giant"** lists the potential threats to manatees and what the public can do to help protect them. **"The Florida Manatee"** provides a general description of manatees and their behavior. These two signs must be displayed as a pair to meet the manatee educational display condition required by lease/permit.

Manatee Basics for Boaters

The **"Manatee Basics for Boaters"** sign is 3' by 4' and is available from all of the companies listed on the sign supplier list. This educational sign provides information on the characteristics of manatees and the potential threat to this endangered species from boat operation. This sign will meet the manatee educational display required by lease/permit.



FWC Approved Manatee Educational Sign Suppliers

ASAP Signs & Designs
624-B Pinellas Street
Clearwater, FL 33756
Phone: (727) 443-4878
Fax: (727) 442-7573

Wilderness Graphics, Inc.
Box 1635
Tallahassee, FL 32302
Phone: (850) 224-6414
Fax: (850) 561-3943
www.wildernessqraphics.com

Cape Coral Signs & Designs
1311 Del Prado Boulevard
Cape Coral, FL 33990
Phone: (239) 772-9992
Fax: (239) 772-3848

Municipal Supply & Sign Co.
1095 Fifth Avenue, North
P. O. Box 1765
Naples, FL 33939-1765
Phone: (800) 329-5366 or
(239) 262-4639
Fax: (239) 262-4645
www.municiDalsiqns.com

Vital Signs
104615 Overseas Highway
Key Largo, FL 33037
Phone: (305) 451-5133
Fax: (305) 451-5163

Universal Signs & Accessories P. O.
2912 Orange Avenue
Ft. Pierce, FL 34947
Phone: (800) 432-0331 or
(772) 461-0665
Fax: (772) 461-0669

New City Signs
182928 Street North
St. Petersburg, FL 33713
Phone: (727) 323-7897
Fax: (727) 323-1897

United Rentals Highway Technologies
309 Angle Road
Ft. Pierce, FL 34947
Phone: (772) 489-8772 or
(800) 489-8758 (FL only)
Fax: (772) 489-8757

BROWARD COUNTY
FLORIDA

PARKS AND RECREATION DIVISION
950 N.W. 38TH Street • Oakland Park, Florida 33309-5982 • 954-357-8100 • TTY 954-537-2844 • FAX 954-537-2849

Winner of the National Gold Medal Award for Excellence in Park and Recreation Management
Accredited by the Commission for Accreditation of Parks and Recreation Agencies (CAPRA)

May 28, 2002

Dylan Larson, P.W.S.
Miller, Legg & Associates, Inc.
1800 N. Douglas Road, Suite 200
Pembroke Pines, FL 33024-3200

Re: Master Mitigation for West Lake Park
RLI #021899-RB
BCPRD #425-00A, MLA #937503

Dear Mr. Larson:

The purpose of this letter is to acknowledge responsibility for mitigation construction, five year maintenance and monitoring, and perpetual management of the overall mitigation efforts underway at West Lake Park.

As previously discussed with you, the published Request for Letters of Interest and our subsequent Agreement with Miller, Legg & Associates, Inc. both state that the consultant shall be responsible for construction administration and overseeing the monitoring and maintenance for the required warranty period. Therefore, Miller, Legg & Associates, Inc. will be responsible for these activities acting as agent for Broward County. Broward County Parks and Recreation Division will be responsible for overseeing your project activities and for the perpetual management after the warranty period expires.

If you have any questions, please contact me at (954) 357-8181.

Sincerely,

Pat Young
Administrative Manager

PY:pay

US Army Corps
of Engineers.
File # SAJ-2002-72(IP-LAO)
ATTACHMENT 4

a:\5 yr monitor.wpd

West Lake Park

Mitigation Plan

Prepared for:
Broward County Parks and Recreation Division
950 N.W. 38th Street
Oakland Park, FL 33309

Prepared by:

Miller, Legg & Associates, Inc.
1800 N. Douglas Road, Suite 200
Pembroke Pines, FL 33024-3200

November 25, 2003

US Army Corps
of Engineers.
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1.0 PREAMBLE

West Lake Park is a ±1,522 acre park in Sections 25, 35, and 36 in Township 50S, Range 42E and Sections 1, 2, 11, and 12 in Township 51S, Range 42E in Broward County Florida. The Park is currently managed by Broward County Parks and Recreation Division (BCPRD). The Park includes mangrove, seagrass, mud flat, upland, open water communities and community recreation facilities. The Park also currently contains ±65.3 acres of exotic plant-dominated spoil islands and uplands.

The development of the West Lake Park Mitigation Plan is a continuation of the previously successful mitigation efforts at West Lake Park. This plan is intended to address ecosystem-level improvements through a comprehensive plan for the entire West Lake region and the surrounding environment. The improvements are intended to allow the ecosystem to function as naturally as possible with minimal human influence.

Restoration and enhancement of tidal wetland functions and associated benefits to significant wildlife species should occur through the implementation of 12 key mitigation components with a focus on exotic upland spoil/vegetation removal and hydrologic flushing improvements. These key ecological improvement concepts envisioned include:

- Exotic vegetation removal,
- Creation of mangroves, mudflats, channels, tidal pools, seagrass recruitment areas, and native upland hammocks from exotic-infested spoil areas,
- Shoreline protection along the Intracoastal Waterway (ICWW) and Dania Cutoff Canal,
- Improvement of flushing and circulation within the Dania Salt Marsh by the creation of a north-south flushing channel and removing hindrances to water movement,
- Outparcel acquisition,
- Improvements to Park flushing throughout West Lake Park, either through installation of culverts, upsizing, or desilting existing culverts to enhance and restore water flow within the Park,
- Protection of established bird nesting, feeding, and watering area,
- Installation of additional osprey nesting platforms,
- Establishment of two manatee protection areas along the ICWW,
- Desilting specific existing channels,
- Creation of a crocodile basking area away from current development
- Removal of existing barges from Whiskey Creek.

1.1 Project Description

West Lake Park contains habitats that are significantly imperiled in the South Florida region. The estuarine wetlands and upland upland hammocks historically located on top and east of the Southeast Ridge within Broward County have been mostly lost due to development. Due to its location and size, West Lake Park provides a vista of Broward

County's historic mangrove environment. This important natural area provides wildlife resources, upland recreational possibilities, and sensitive wetland estuarine habitat.

Implementation of the West Lake Park Mitigation Plan should result in identifiable ecological benefits to the Park and the surrounding watershed. These benefits include:

- Removal of ±80 acres of exotic vegetation and resulting seed source that degrades the natural communities in this and adjacent areas,
- Increasing habitat diversity in the Park,
- Protecting the shoreline from continued erosion due to wave energy and storm events,
- Increasing the carrying capacity of fisheries in the Dania Salt Marsh,
- Acquiring outparcels will bring the land under clear public ownership to preserve and protect the property in perpetuity,
- Reducing the threat of predation on birds using the bird nesting area,
- Increasing the potential for nesting success for ospreys in Broward County,
- Protection of the West Indian Manatee and submerged natural resources,
- Reducing turbidity in the Park,
- Creating an alternative crocodile habitat in a more isolated location,
- Increasing areas for seagrass recruitment,
- Shoreline stabilization, reduction of sediment contribution, and increased floral diversity.

1.2 Goals

The goals of the West Lake Park Mitigation Plan are as follows:

- To establish and enhance a large unified mitigation area that provides a diverse estuarine wetland system of high quality. This will encourage propagation of desirable invertebrates and additional use by birds, fish, amphibians, reptiles, and mammals.
- To remove exotic and invasive plant species and recruit desirable flora to provide valuable habitat for wildlife.
- To attain a minimum of 80% survivorship of planted species, and 80% coverage of desirable plant species in the mitigation creation areas.
- To attain a mitigation system that includes functional wetlands and uplands that benefit both wildlife and the surrounding community.

1.3 Existing Conditions

West Lake Park currently consists of approximately 990.5 acres of mangrove swamps, ±246.9 acres of lakes, ±65.3 acres of exotic plant-dominated spoil areas, and ±221.7 acres of other habitats, including waterways, saltwater marsh, tidal flats, barren land, seagrass, and roads and highways. The Park is tidally influenced by direct connection to the

ICWW on the east and the Dania Cutoff Canal to the north. The Park is sectioned by Sheridan Street and Dania Beach Boulevard, dividing the Park into three areas.

Hydrologic and Water Quality Conditions

West Lake Park is tidally influenced through direct connection and through numerous channels that connect the interior of the Park to the ICWW. The tidal cycle in Florida is semi-diurnal, that is, two high and low tides each day. Freshwater inputs are mainly limited to stormwater runoff and direct rainfall. In the Dania Salt Marsh, a maintenance road and remnant berms limit tidal flow.

In addition, an extensive canal system is present in the western half of the Park. Approximately 12 miles of channels were historically created when the area was in agricultural operations back in the 1950s, however, some of them are nearly silted-in and, therefore, provide limited flushing. These canals provide a collection and channeling system for rainwater and also provide a system for tidal flushing of surface water. Both functions are necessary to provide optimum conditions for brackish water estuaries vital to development of nurseries for fishes such as the snook (*Centropomus undecimalis*) and tarpon (*Megalops atlanticus*) and serve as foraging areas for wading birds.

Water quality was analyzed at 10 stations throughout West Lake Park to establish baseline water quality data. Water levels were recorded at Stations 1-8 using RDS WL80 Automated Well Piezometers.

Water quality parameters were collected thirteen times and water levels were recorded hourly between June 21 and December 11, 2000. The placement of the piezometers was designed to measure tidal flow rates running north-south through the Park and east-west between the ICWW and the interior of West Lake and to determine Mean High Water (MHW) and Mean Low Water (MLW) elevations (in feet NGVD) at various locations throughout the Park. This information was used to determine proper elevations for construction of proposed mud flats, mangrove islands, flushing channels, etc.

Vegetative Community Types

The dominant vegetative community is the mangrove swamp; approximately 990 acres of mangroves exist within the Park. Red mangroves (*Rhizophora mangle*), black mangroves (*Avicennia germinans*), and white mangroves (*Laguncularia racemosa*) are abundant. Buttonwood (*Conocarpus erectus*) and sea oxeye daisy (*Borrichia* spp.) are also present within the Park to the lesser extent.

Various other native species are present at Anne Kolb Nature Center and the recreational portion of the Park (south of Sheridan Street). These species include gumbo limbo (*Bursera simaruba*), cabbage palm (*Sabal palmetto*), pigeon plum (*Coccoloba diversifolia*), sea grape (*Coccoloba uvifera*), and blolly (*Guapira discolor*).

Approximately 80 acres of Australian pine (*Casuarina equisetifolia*) and other exotic vegetation exist throughout the Park. Of those 80 acres, approximately 40 acres of these Australian pine dominated areas are along the ICWW and exist on spoil islands created during the historical dredging of the ICWW. The remaining 40 acres are scattered inland throughout the Park. These exotic plant-dominated areas are targeted for conversion to desirable native vegetative communities.

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2.0 ESTABLISHMENT OF WEST LAKE PARK MITIGATION IMPROVEMENTS

The proposed improvements at West Lake Park are designed to improve the functional values of the estuarine wetlands within the Park and have been divided into nine phases:

1) Dania Cutoff Canal to Dania Beach Boulevard
2) Dania Beach Boulevard to Anne Kolb Nature Center,
3) Anne Kolb Nature Center to Bird Nesting Area,
4) Bird Nesting Area to South End of Park,
5) West Lake Park Recreational Area/Sheridan Street,
6) Dania Salt Marsh,
7) Exotic Vegetation Eradication,
8) Dania Cutoff Canal,
9) Outparcel Acquisition

These phases were divided based on geographic location, i.e. all improvements in each phase are located within the same general area (refer to attached phasing map). The only exceptions are for Phases 7 and 9 (exotic vegetation eradication and outparcel acquisition are park-wide phases).

2.1 Phase 1 – Dania Cut-off Canal to Dania Beach Boulevard

This phase includes the installation of new culverts to increase flushing, the creation of a manatee protection area along the ICWW, the creation of mangrove, seagrass, mudflat, and channel areas from exotic plant-dominated spoil areas, and installation of shoreline protection.

Flushing Improvements

Four culverts are proposed to be installed north of Dania Beach Blvd. to allow greater surface water exchange between areas of the Park. Insufficient water exchange can lead to stunted mangroves, stagnant water/low water quality, limited fisheries usage, and increased siltation.

Manatee Protection Areas

The West Indian manatee or sea cow (*Trichechus manatus*) is a large, herbivorous, aquatic mammal that uses a variety of habitats such as shallow coastal waters, rivers, and springs in Florida. This species is endangered throughout its range. A low reproductive rate, combined with loss of habitat and high rates of mortality, often from human-related causes such as boats and watercraft, threaten its future. This species is the focus of a wide range of protection efforts by federal, state, and local agencies. In addition universities, corporations, and non-profit conservation organizations are supporting efforts to protect these animals.

Based on information from the Management Plan for West Lake and personal observations, the manatees are occasionally seen in the shallow waters of West Lake Park, and are regularly observed in the Intracoastal Waterway, Whiskey Creek, and the Dania Cutoff Canal adjacent to West Lake Park. These waters, except for the interior lakes, are heavily traveled by boats/personal watercraft.

Boat-related mortality is probably the greatest single threat to the manatee. Regulation of boat speeds and boat exclusion areas are being enforced to reduce boat-related injuries and harassment. The effect of boats on manatee populations is particularly critical because it is mostly adults that are killed. Manatees must maintain a high adult survivorship due to their low reproductive rates to keep populations stable. In Whiskey Creek and the cove area south of Dania Beach Blvd., there is minimal protection for the manatee from boat traffic. However, manatees regularly travel through the main channel of the Intracoastal Waterway and the Whiskey Creek area and must contend with heavy boat and barge traffic.

Manatee/seagrass protection areas (MPAs) are proposed to be established in Whiskey Creek, the southern end of the Creek, and at the Cove area south of Dania Beach Blvd. The MPAs will be designated using appropriate signage and floating barrel lines that would prohibit boats and personal watercraft from entering the protected area while still allowing manatees, fishes, and other fauna to pass.

The primary benefit is a safe retreat for manatees in areas of high boat traffic. Another benefit is the protection of seagrass beds, a known source of food for manatees, from prop scars and turbid conditions caused by boats/personal watercraft wakes. Without these barriers, manatees will remain at risk of injury within these heavily traveled areas.

Creation of Mangrove Mudflat, Seagrass, and Channels from Spoil Areas

Exotic plant-dominated upland spoil areas in this area will be replaced by extensive wetland creation areas following practices used successfully on previous projects within West Lake Park. Exotic plant-dominated uplands will be converted into desirable, native communities including mangroves, mud flats, tidal pools, seagrass beds, and native upland hammocks to encourage usage by a diversity of plant and animal species.

Mangrove Creation Areas. Mangroves provide physical habitat for many species of plants and animals that could not survive alone in the intertidal zone. Mangrove systems contain a highly complex food web, with many organisms dependent upon one another for their survival. In addition, mangrove areas function as nurseries for a wide variety of recreationally and commercially important fish species, including snook, tarpon, and snapper. Upland areas infested with exotic vegetation will be cleared and scraped down to the proper elevation to support natural recruitment of mangroves. If necessary, these areas may also receive supplemental mangrove plantings to promote their spread and establishment (refer to the permit sketches for details).

Mud Flat/Tidal Pool Creation Areas. Mud flats are important to shorebirds, allowing them to feed on prey stranded on and in the exposed surface of the tidal pools. Certain exotic plant infested uplands will be cleared and scraped down to serve as mud flats and tidal pools. Based on the current wildlife usage of the existing mud flats/tidal pools within West Lake Park, these proposed areas should serve as habitat for numerous invertebrates and provide new foraging areas for wetland dependent bird species (e.g., ibis, wood stork, herons, spoonbills, sandpipers, and knots). An osprey platform will be installed at the edge of the mud flat/tidal pool to provide a perching and nesting location. (Refer to the permit sketches for details).

Seagrass Creation Areas. Seagrass beds rank among the most productive ecosystems. Certain upland areas infested with exotic vegetation will be cleared and scraped down to serve as natural recruitment areas for seagrasses. An extensive survey revealed that seagrasses were present nearly the entire length of the ICWW's western half adjacent to West Lake Park (MLA, 2002). The dominant seagrass was paddle grass (*Halophila decipiens*). Johnson's seagrass (*Halophila johnsonii*), a threatened species, and shoal grass (*Halodule wrightii*) were also present. These seagrasses were present as patchy beds of varying density, usually with rubble and overgrowing algae interspersed. The seagrass areas will be specifically created from existing spoil islands along the ICWW adjacent to existing, dense seagrass beds. A sediment analysis was performed, and it was determined that the sediment in the spoil areas was similar to the sediment in the ICWW currently supporting seagrasses (Tierra, 2002).

Shoreline Protection – Riprap/Crib

The purpose of shoreline protection is to halt the constant erosion occurring along the ICWW caused by many factors such as boat traffic and storms. A shoreline regression analysis estimated the shoreline has eroded at a rate of ±1.5' per year. The placement of shoreline protection options are proposed to reduce further erosion of this shoreline and the mangrove population.

Based on a detailed shoreline analysis for the entire length of West Lake Park:

a) 15% of the shoreline does not require any stabilization (channel openings, bridge right-of-way, etc.)
b) shoreline protection could be placed along approximately 35% of the shoreline without incurring mangrove impacts,
c) an additional intermittent 15% of the shoreline may have room for narrow shoreline protection
d) the remaining 35% of the shoreline has virtually no separation between mangroves and seagrasses. The table below summarizes this information.

Note that this shoreline length is based on the limits from the mangroves on the north side of the channel by Holland Park northward to existing riprap ±1,200 ft. south of the Dania Cut-off Canal.

1) Cove (no protection needed)	±	997	linear feet	5%
Road Right-of-Way (no protection needed)	±	401	linear feet	2%
Channel openings (no protection needed)	±	952	linear feet	5%
Revetment on side of maintenance road	±	654	linear feet	3%
2) 7' to 15' width for shoreline protection *	±	6,744	linear feet	35%
3) ≥ 5' to ± <7' width for shoreline protection *	±	2,855	linear feet	15%
4) 0 to < 5' for shoreline protection*	±	6,582	linear feet	35%
Total Shoreline	±	19,185	linear feet	100%

* Separation between existing seagrasses and mangroves

The proposed riprap/crib structure will have a footprint of approximately 5 feet in width and will be constructed of vertical pilings with horizontal reinforcing bars, creating a crib. Riprap boulders (1' to 3' diameter) will be placed inside the crib. The base of the structure will be a geotube or equivalent stabilization. (Refer to the permit sketches for details). This will allow construction to occur without the use of a large barge and/or other heavy equipment.

Shoreline Protection – Enhance Existing Riprap

Supplemental riprap will be placed onto existing riprap along the ICWW from the Dania Cutoff Canal southward approximately ±1,500'. This riprap will most likely be placed from a shallow-draft barge with hand guidance. Because the riprap is being placed on already existing, but poorly functioning, riprap, primary and secondary impacts are not anticipated.

2.2 Phase 2 – Dania Beach Boulevard to Anne Kolb Nature Center

This phase includes the creation of a manatee protection area along the ICWW, the creation of mangrove, seagrass, mudflat, channels and upland hammock from exotic plant-dominated spoil areas, and installation of shoreline protection.

Upland hammock Creation Areas. Certain exotic plant infested uplands will be cleared and planted with native upland hammock floral species to create an alternative habitat to the surrounding wetlands. These upland hammock areas are intended to be used by faunal species for shelter, nesting/denning, and foraging. Reestablishment of upland hammocks will add new habitat opportunities for faunal species. These hammocks, minimally at West Lake Park, will add diversity and complexity to the Park's habitats. (Refer to the permit sketches for details).

A detailed description for the mangrove, mudflat/tidal pool, and channel improvements in this phase is discussed above in Section 2.1.

2.3 Phase 3 – Anne Kolb Nature Center to Bird Nesting Area

This phase includes the installation of new culverts to increase flushing, the creation of mangrove, seagrass, mudflat/tidal pool, upland hammock, and channel areas from exotic plant-dominated spoil areas, and installation of shoreline protection. A detailed description for each type of improvement in this phase is discussed above in Section 2.1 and 2.2.

2.4 Phase 4 – Bird Nesting Area to South End of Park

This phase includes the installation of new culverts to increase flushing, the creation of mangrove, mudflat, channels, and upland hammock from exotic plant-dominated spoil areas, and installation of shoreline protection. A detailed description for each type of improvement in this phase is discussed above in Section 2.1 and 2.2.

2.5 Phase 5 – West Lake Recreational Park/Sheridan Street

This phase includes the installation of new culverts to increase flushing, the creation of mangrove, mudflat, channel, and upland hammock areas from exotic plant-dominated spoil areas, and installation of shoreline protection. A detailed description for each type of improvement in this phase is discussed above in Section 2.1.

2.6 Phase 6 – Dania Salt Marsh

The Dania Salt Marsh (DSM) was originally a freshwater marsh system prepared for agricultural purposes approximately 100 years ago (BCPRD, 1998). At that time, the marsh was channeled for irrigation and the fields planted with tomatoes. Subsequent to those events, Joseph Young, a Hollywood developer, purchased most of the land in this area and sold individual lots as part of a large-scale development plan for this area. Hurricanes and the Great Depression discouraged further development of the area at that time. The surrounding development, dredging of the ICWW, and drainage led to saltwater intrusion, which ended the tomato farming in this area during the 1950s. The conditions at the site encouraged the establishment of a salt marsh sea oxeye daisy (*Borrichia* spp.) habitat that has been evolving to a mangrove-dominated habitat in recent years.

Based on previous fisheries studies (Mangrove Systems, Inc. 1983, Lewis Environmental Services 1994; Roberts, 1994), and County staff observations, the western portions of West Lake Park are an important nursery habitat for commercial, recreational, and threatened fish species such as snook (*Centropomus undecimalis*), tarpon (*Megalops atlanticus*), mangrove snapper (*Lutjanus griseus*), and mangrove rivulus (*Rivulus marmoratus*) - listed as a Species of Special Concern by the Florida Fish and Wildlife Conservation Commission. The DSM has incurred physical changes throughout the years, that somewhat limit its function as a nursery habitat.

Channel Improvements

Presently, portions of the primary channel (running east-west through the center of the salt marsh) contain surface water during both high and low tides. However, secondary channels contain minimal surface water during lower portions of the tidal cycle, thus limiting their availability to fish and other aquatic species.

This lack of surface water serves to limit the carrying capacity of fisheries within portions of the DSM. Without improvements to the salt marsh's hydrology, this area will continue to be underutilized by fish species when compared to its overall size.

Certain berms that run throughout the salt marsh are eroding with the resultant material filling in the smaller channels. In addition, this area received historic dumping of tires and debris, which also has had an effect on flushing and biological productivity.

Large fields of sea oxeye daisy (*Borrichia* spp.) became established within this area. The sea oxeye daisy portions of the salt marsh are being naturally displaced by mangrove (mainly white mangroves) and Brazilian pepper (*Schinus terebinthifolius*). Between 1980 and 2000, there was an 85% decrease of the sea oxeye daisy habitat within the DSM.

The proposed improvements for this area plan to be phased, beginning with the removal of blockages that hinder water movement in the existing primary channels. The effects of blockage removal will be monitored prior to proceeding with the other listed improvements.

One existing primary east-west channel near the center of the DSM will be cleared of material that now hinders water movement. This is intended to increase flushing and would increase the area of surface water coverage during low tide. This work would be performed in a manner as to minimize impacts to existing mangroves.

Four north-south channels will be created north of the FPL substation from spoil berms located between small secondary channels that filled in due to erosion of the spoil berm.

Channel/Mudflat Creation

The creation of a primary north-south flushing channel near the western boundary of West Lake Park will increase flushing and retain surface water during low tide in an area that is normally dry; this is intended to increase the amount of usable habitat for juvenile fish species. This work is proposed in the area of an historic haul road and dumpsite.

Certain secondary north-south channels will also be cleared of material that hinders water movement. This is intended to increase flushing and would increase the area of surface water coverage during low tide. This work is anticipated to be performed in a manner as to minimize impacts to existing mangrove trees with the assistance of a small suction dredge and a small backhoe.

The new channel will also create additional red mangrove habitat along both sides of the channel along the entire length.

The above habitat improvements to the salt marsh will benefit commercial, recreational, and threatened fisheries by increasing the area's carrying capacity for fishes, including snook, mangrove snapper, tarpon, and other important fishes.

Enhancement/protection of the Dania Salt Marsh will also allow for the protection of *Rivulus* sp., a Species of Special Concern, which has been documented by BCPRD to inhabit the Dania Salt Marsh.

The American crocodile (*Crocodylus acutus*) is an endangered reptile that averages 7'-11' in length. At least one crocodile is known to inhabit West Lake Park. This crocodile has been observed on numerous occasions basking near the Sheridan Ocean Club residential community adjacent to the west side of the Park. Currently there are limited areas within West Lake Park where a crocodile can bask. The creation of a basking area within the Dania Salt Marsh will provide this and other crocodiles with an additional secluded retreat, thereby reducing the possibility of disturbance.

2.7 Phase 7 – Exotic Vegetation Eradication

Approximately 8.4 acres of exotic plant-dominated areas currently exist in isolated locations that are not targeted for other alterations. For these areas, exotic species will be treated and/or removed and native species allowed to revegetate.

2.8 Phase 8 – Riprap Relocation/Mangrove Creation along Dania Cutoff Canal

Presently, the northern boundary of West Lake Park extends waterward into the Dania Cutoff Canal (DCC). The existing riprap along the DCC would be moved north to the Park boundary. Approximately 2.0 acres of open water would then exist behind the riprap. These ±2.0 acres of open water will be filled using suitable material dredged from the spoil areas to the proper elevation to support natural recruitment of mangroves. If necessary, these areas may also receive supplemental mangrove plantings to promote their spread and establishment. (Refer to the permit sketches for details).

2.9 Phase 9 – Outparcel Acquisition

There are approximately 200 outparcels (±23 acres) that, if not acquired, would prevent the completion of some key proposed mitigation improvements.

The outparcels have been prioritized in order of importance (i.e., outparcels within a proposed improvement area have greater priority) to secure the land or vacate an encumbrance(s).

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3.0 POTENTIAL CONSTRUCTION ALTERNATIVES

This section describes environmentally sensitive construction alternatives and precautions that could be used during construction activities of this project. The contractor, however, will determine the appropriate alternative of construction based on the environmental constraints. The contractor shall provide protection, operate temporary facilities, and conduct construction in ways and that comply with environmental regulations, minimize the possibility that air, waterways, and subsoil may become contaminated or polluted, or result in other undesirable effects. While exact means and methods of the contractor cannot be dictated, the conceptual framework of guidelines discussed below would provide the appropriate restrictions.

Due to the environmental sensitivity of this project, the contractor and the appropriate subcontractors shall attend an environmental pre-construction meeting with appropriate owner and agency representatives. (Refer to the permit sketches and the attached phasing map for the locations of the improvements discussed herein).

3.1 Phase 1 – Dania Cut-off Canal to Dania Beach Boulevard

This phase includes the installation of new culverts to increase flushing, the creation of a manatee protection area along the ICWW, the creation of mangrove, seagrass, mudflat, and channel areas from exotic plant-dominated spoil areas #1-5, and installation of shoreline protection. The proposed improvements for this phase could be accessed using the existing maintenance road that connects to Dania Beach Blvd.; therefore, secondary impacts to adjacent resources are not anticipated. A suitable staging and stockpiling area for this phase exists just north of Dania Beach Blvd. and west of the ICWW along the existing maintenance road.

3.1.1 Spoil Area #1

Spoil Area #1 is targeted for conversion to a mangrove creation area. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia)*. Vegetation on the islands are proposed to be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation can access the spoil area using the existing maintenance road. Minor temporary impacts to mangroves (±0.03 acres) are anticipated to occur in order to widen the end of the maintenance road that will be used to access the spoil area.

To avoid and minimize impacts, the edge of the mangroves are proposed to be demarcated with visible fencing, where appropriate to protect mangroves from damage prior to clearing. In addition, exotic vegetation should be removed by non-mechanical means where mangroves and other natural vegetation is in close proximity to the exotic vegetation. The pile could be burned or removed by truck using the existing maintenance road and disposed of in an appropriate upland location in accordance with state and local regulations.

In order to provide turbidity control and containment, excavation of spoil material could proceed from the center of the spoil area outward. Material should be excavated using appropriate mechanical means, such as a small backhoe and/or bulldozer that can access the area using the existing maintenance road. Silt fencing/turbidity curtains shall be placed at the edge of mangroves after clearing of vegetation and shall remain until the end of construction in this area. The entire spoil area will be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment.

Spoil material may be used to 1) fill the geotubes discussed in Section 3.1.4, and/or 2) create the substrate for the ±2.0 acre mangrove creation area along the Dania Cutoff Canal that is discussed in Section 3.8 below. Excess spoil material may be removed from the site by dump trucks using the existing maintenance road. The contractor shall be responsible for placement of spoil on a suitable upland site to be used for public purposes unless otherwise appropriately addressed.

3.1.2 Spoil Areas #2 and #3

Spoil Areas #2 and #3 are targeted for conversion to mangrove, mud flat, and channel areas. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).* Methods for exotic vegetation removal, sediment excavation and use/removal, staging, containment, avoidance and minimization are the same as described in Section 3.1.1. The mangrove portions of the spoil areas will be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment, ±0.0' to 0.5' NGVD for mud flat, and the channel areas will be excavated to an elevation of ± (-)3.5' NGVD.

Two 72" diameter culverts, one at Spoil Area #2 and one at #3, are proposed to be installed at the west end of the proposed channels under the existing maintenance road to increase flushing to the mangroves west of the maintenance road. Prior to installation, silt fence and turbidity screens should be installed, as appropriate, to reduce turbidity. The culverts could be installed by excavating an appropriate portion of the existing maintenance road using a small excavator. Minor mangrove trimming may be necessary to install the culverts. Culverts could then be placed in the excavated area and covered with a portion of the excavated material to achieve the same elevation as prior to installation.

3.1.3 Spoil Areas #4 and #5

Spoil Areas #4 and #5 are targeted for conversion to seagrass creation areas. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).* Methods for exotic vegetation removal and excavation are the same as described for Spoil Area #1 above. The entire spoil areas are proposed to be excavated to an elevation of ± (-)2.0 for natural seagrass recruitment. Methods for exotic vegetation removal, sediment excavation and use/removal, staging, containment, avoidance and minimization are the same as described in Section 3.1.1.

Two 72" diameter culverts, one at Spoil Area #4 and one at #5, are proposed to be installed at the west end of the proposed channels under the existing maintenance road to increase flushing to the mangroves west of the maintenance road. Construction alternatives will be as described in Section 3.1.2.

3.1.4 Spoil Area #43

Spoil Area #43 is targeted for conversion to a mangrove creation area. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).* Methods for exotic vegetation removal and excavation are the same as described for Spoil Area #1 above. The entire spoil area is proposed to be excavated to an elevation of ± (-)2.0 for natural seagrass recruitment. Methods for exotic vegetation removal, sediment excavation and use/removal, staging, containment, avoidance and minimization are the same as described in Section 3.1.1.

3.1.5 Shoreline Protection along the ICWW

Shoreline protection is proposed as the primary means of erosion control along the heavily traveled ICWW. The preferred option is a riprap/crib structure that is designed to be placed within a ±5' wide footprint. Shoreline protection along the ICWW is proposed to protect it against erosion caused by storm events and wave energy generated by storms and boat traffic.

Prior to installation of the shoreline/crib, the landward edge of the seagrass beds are to be visibly demarcated to prevent impacts. The riprap/crib structure will consist of a crib with vertical and horizontal concrete filled PVC pipe piles. Riprap boulders of 1-3' size will be placed within this crib. The base of the crib is proposed to be a geotube or similar structure. This geotube may be filled with sand or material excavated from the spoil areas potentially using a Piranha Pump or similar suction dredging equipment. The base could then be used as a platform for the remainder of construction of the crib, eliminating the need for a heavy barge or crane. Vertical pilings for the crib could be jetted into the substrate using a hand-held machine or from a small johnboat. The vertical pilings are proposed to consist of a metal rebar core surrounded by a 4" diameter PVC pipe that would be filled with concrete. The PVC pipe would serve to contain the concrete and could allow the removal of the sediment within the tube by suction dredge. This proposed design minimizes the possibility of turbidity issues during pile installation. The horizontal rails of the crib is proposed to be constructed in a similar fashion and attached to the inside of the vertical pilings so that once riprap is placed within the crib the riprap boulders themselves would keep the horizontal railings in place.

The design of the riprap/crib structure will not block tidal flow into existing or proposed channels connecting West Lake to the ICWW. Placement is proposed to follow the horizontal contours of the shoreline and wrap around the sides of the channel inlets. It is anticipated that the riprap/crib structure will also stabilize the position of the channels by directing tidal currents.

From the existing riprap southward to the small mangrove island east of Spoil Area #1, the riprap/crib can be installed in open water and avoid mangrove and seagrass impacts. The installation of the riprap/crib can be performed from the geotube base and from small work boats with a maximum draft of 30". A barge could be staged at Port Everglades to store riprap and the small work boats could load from the barge for transport to the crib installation site.

For Areas #1-5, the riprap/crib can be constructed from land using the existing maintenance roads and could be installed at the upland edge except at Areas #4 and #5. At Areas #4 and #5, mangroves are present on the eastern edge of the spoil areas. The riprap/crib is proposed to be installed at the eastern edge of the mangroves in these two areas to protect them from erosion. This would require limited trimming of the mangroves for the riprap/crib placement.

For mangrove areas between Spoil Areas #1-5, the riprap/crib structure can be installed in the same manner as discussed above, working from the base and a shallow draft work boat. Some select mangrove trimming may be required in these areas.

3.1.6 Manatee Protection Areas

This improvement would most likely be performed from a boat/barge along the ICWW and will involve the installation of approximately 2,000 linear ft. of a barrier float system along Whiskey Creek. The buoy lines will be secured by anchoring them to the bottom at regular intervals and proposed be maintained by the BCPRD.

3.1.7 Remove Barges at Whiskey Creek

This improvement will most likely occur by attaching the barges, all of which are currently floating, to a vessel capable of moving them from their current location with minimal disturbance.

3.2 Phase 2 –Dania Beach Blvd. to Anne Kolb Nature Center

This phase includes the creation of mangrove, upland hammock, seagrass, mudflat, and channel areas from exotic plant-dominated Spoil Areas #6-13, and the installation of shoreline protection.

3.2.1 Spoil Areas #6 and #7

Spoil Area #6 is targeted for conversion to a mangrove creation area and Spoil Area #7 is targeted for a mudflat. These areas can be accessed from the ICWW using a shallow draft boat. Seagrasses are not present in the immediate vicinity of these areas and, therefore, should not be an issue.

Spoil Area #6 can be accessed from the ICWW by a small front-loading work boat that can bow up to the edge of the spoil area and offload equipment.

Mangroves completely surround Spoil Area #7 and therefore approximately 0.05 acres of mangrove impacts may be necessary to access this island. This narrow impact zone is proposed to be converted to a channel to allow proper flushing into and out of the proposed mudflat. The mangroves to be impacted are proposed to be removed by non-mechanical means.

To avoid and minimize impacts, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage prior to clearing. In addition, exotic vegetation should be removed by non-mechanical means where mangroves and other natural vegetation are in close proximity to the exotic vegetation. The pile could be burned in accordance with state and local regulations.

Spoil material could be used to 1) fill the geotubes or base discussed in Section 3.1.4, and/or 2) create the substrate for the ±2.0 acre mangrove creation area along the Dania Cutoff Canal that is discussed in Section 3.8. Excess spoil material should be removed from the site by suction dredge (such as a Piranha Pump) to a containment/settling area (such as the large Spoil Area #19 at the entrance to Anne Kolb Nature Center). This area could be cleared of exotic vegetation and serve as the settling area prior to its conversion to mangroves, mud flats, and channels as discussed in Section 3.3.1. The sediment/water slurry would be allowed to settle for an appropriate amount of time (per State criteria), and the return water could then be discharged via filtration and/or settlement into the ground and/or marsh. The point of discharge of the return water would be surrounded by a turbidity curtain and/or other appropriate turbidity control measures. The sediment would then be loaded onto dump trucks for transport to a suitable upland site and used for public purposes unless otherwise appropriately addressed.

Excavation of spoil material could proceed from the center of the spoil area outward to provide turbidity control and containment. Material could be excavated using appropriate mechanical means, such as a small backhoe and/or bulldozer that can access the spoil areas from a front loading work boat. Silt fencing/turbidity curtains shall be placed at the edge of mangroves after clearing of vegetation and would remain until the end of construction in this area. Spoil Area #6 is proposed to be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment and ± (-) 3.5' NGVD for a channel through the center of the area. Spoil Area #7 is proposed be excavated to an elevation of 0.0' to 0.5' NGVD for the mudflat and ± (-) 3.5' NGVD for a channel connecting the ICWW to the mudflat. The contractor shall be responsible for placement of spoil on a suitable upland site and used for public purposes unless otherwise appropriately addressed.

3.2.2 Spoil Areas #8-13

Spoil Areas #8, 9, 11, and 12 are targeted for conversion to seagrass creation areas. Spoil Area #10 is targeted for conversion to seagrass, mangrove, and upland hammock creation areas. Spoil Area #13 is targeted for conversion to mangrove, mudflat, upland hammock,

and channel creation areas. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).*

Vegetation on the islands is proposed to be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation could access the spoil area by a shallow draft front loading work boat that could access the areas in-line with the channel between Areas #10 and #11. The area in front of and the channel itself is devoid of seagrasses; therefore, no seagrass impacts are anticipated. The boat could offload the equipment on Spoil Area #10. Temporary bridges could be erected between Spoil Area #10 and #9 and between Spoil Area #9 and #8 to allow access to those areas. To install the temporary bridges, approximately 0.02 and 0.07 acres of temporary mangrove impacts may occur, respectively. After construction, the temporary bridges would be removed to allow natural recruitment by mangroves.

Likewise, to access Spoil Area #11-13, a small front loading work boat could access Spoil Area #13 by approaching in-line with the channel between Areas #12 and #13. The boat could offload the equipment at Spoil Area #12. Temporary bridges could be erected between Spoil Area #12 and #11, and between Spoil Areas #12 and #13 to allow access to these areas. To install the temporary bridges, approximately 0.02 and 0.03 acres of mangrove impacts may occur, respectively. After construction, the temporary bridges would be removed to allow natural recruitment by mangroves.

To avoid and minimize impacts, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage prior to clearing. In addition, exotic vegetation could be removed by non-mechanical means where mangroves and other natural vegetation are in close proximity to the exotic vegetation. The pile could be burned in accordance with state and local regulations.

Excavation of spoil material is proposed to proceed from the center of the spoil area outward to provide turbidity control and containment. Material could be excavated using appropriate mechanical means, such as a small backhoe and/or bulldozer that can access the area by a front-loading workboat. Silt fencing/turbidity curtains would be placed at the edge of mangroves after clearing of vegetation and would remain until the end of construction in this area. The spoil areas are proposed to be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment, to ± (-) 1.5' NGVD to allow natural seagrass recruitment, to ± (-) 3.5' NGVD for the channels, and to 0.0' to 0.5' NGVD for the mudflat area. The upland hammock areas would not be excavated but graded prior to planting.

Spoil material could be used to 1) fill the geotubes or base discussed in Section 3.1.4, and/or 2) create the substrate for the ±2.0 acre mangrove creation area along the Dania Cutoff Canal that is discussed in Section 3.8 below. Excess spoil material could be removed from the site by suction dredge (such as a Piranha Pump) to a containment/settling area (such as the large Spoil Area #19 at the entrance to Anne Kolb

Nature Center). This area could be cleared of exotic vegetation and serve as the settling area prior to its conversion to mangroves, mud flats, and channels as discussed in Section 3.3.1 below. The sediment/water slurry would be allowed to settle for an appropriate amount of time (per State criteria), and the return water would then be discharged via filtration and/or settlement in the ground and/or marsh. The sediment would then be loaded onto dump trucks for transport to a suitable upland site and used for public purposes unless otherwise appropriately addressed.

If feasible, seagrasses from proposed impact sites will be transplanted to these seagrass creation areas.

3.2.5 Shoreline Protection along the ICWW

The riprap/crib structure is proposed to consist of a crib with vertical and horizontal concrete filled 4" to 6" PVC pipe piles. Riprap boulders of 1-3' size will be placed within this crib. Construction of the riprap crib is described in Section 3.1.4. The riprap/crib is proposed to be installed in upland spoil areas, open water, and along mangroves. This should require minimal trimming of mangrove prop roots and branches between the spoil areas, where necessary.

3.2.6 Manatee Protection Areas

This improvement would most likely be performed from a boat/barge along the ICWW and involve the installation of approximately 3,000 linear ft. of a barrier float system along the cove area between Dania Beach Blvd. and Sheridan Street. The buoy lines could be secured by anchoring them to the bottom at regular intervals and are proposed to be maintained by the BCPRD.

3.3 Phase 3 – Anne Kolb Nature Center to Bird Nesting Area

This phase includes the creation of mangrove, upland hammock, mudflat, and channel areas from exotic plant-dominated Spoil Areas #14-30 and #40-42, and installation of shoreline protection.

3.3.1 Spoil Areas #14-30 and #40-42

Spoil Areas #14-30, and #40-42 are targeted for conversion to mangrove, channel, mudflat, and upland hammock creation areas. The proposed improvements for these areas can be accessed from Anne Kolb Nature Center and existing maintenance roads; therefore, secondary impacts to adjacent resources are not anticipated.

Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).* Vegetation on the islands is proposed to be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation can access the spoil areas using the existing roads.

To avoid and minimize impacts, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage prior to clearing. In addition, exotic vegetation could be removed by non-mechanical means where mangroves and other natural vegetation are in close proximity to the exotic vegetation. The pile could be burned or removed by truck using existing roads and disposed of in an appropriate upland location in accordance with state and local regulations.

Excavation of spoil material is proposed to proceed from the center of the spoil area outward to provide turbidity control and containment. Material could be excavated using appropriate mechanical means, such as a small backhoe and/or bulldozer that could access the area using the existing maintenance road. Silt fencing/turbidity curtains would be placed at the edge of mangroves after clearing of vegetation and would remain until the end of construction in this area. The spoil areas are proposed to be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment, ± (-) 3.5' NGVD for channels, and 0.0' to 0.5' NGVD for mudflats. The upland hammock areas should not be excavated but graded prior to planting.

Spoil material could be used to 1) fill the geotubes or base discussed in Section 3.1.4, and/or 2) create the substrate for the ±2.0 acre mangrove creation area along the Dania Cutoff Canal that is discussed in Section 3.8 below. Excess spoil material could be removed from the site by dump trucks using the existing roads. The contractor shall be responsible for placement of spoil on a suitable upland site and used for public purposes unless otherwise appropriately addressed. The contractor shall be responsible for placement of spoil on a suitable upland site and used for public purposes.

A small flushing channel is proposed west of Spoil Area #19 and #30 to connect existing channels to the interior lake. Approximately 0.68 acres of mangroves may be impacted and could be removed by non-mechanical means. The channels could be created by small using a small suction dredge such as a Piranha Pump to a containment/settling area (such as the large Spoil Area #19 at the entrance to Anne Kolb Nature Center and Spoil Area #30 south of Sheridan Street next to the bird nesting area). This area can be cleared of exotic vegetation and serve as the settling area prior to its conversion to mangroves, mud flats, and channels. The sediment/water slurry would be allowed to settle for an appropriate amount of time (per State criteria) and the return water would then be discharged via filtration and/or settlement in the ground and/or marsh. The sediment could then be loaded onto dump trucks for transport to a suitable upland site and used for public purposes unless otherwise appropriately addressed. The exact location of the channels will be field located to minimize mangrove impacts.

3.3.2 Enhance/Protect Bird Nesting and Feeding Habitat

This improvement can be accessed from existing maintenance roads and staged from Spoil Area #30 and the maintenance road. The existing channel could be dredged by using a small suction dredge such as a Piranha Pump to a containment/settling area (such as the large Spoil Area #30 adjacent to the bird nesting area). This area can be cleared of

exotic vegetation and serve as the settling area prior to its conversion to mangroves, mud flats, and channels. The sediment/water slurry would be allowed to settle for an appropriate amount of time (per State criteria) and the return water would then be discharged via filtration and/or settlement in the ground and/or marsh. The sediment could then be loaded onto dump trucks for transport to a suitable upland site and used for public purposes unless otherwise appropriately addressed.

Felled trees that cross the channels are proposed to be removed and trees with branches that extend far over the channel would be trimmed. The contractor shall install and be responsible for maintenance of the appropriate turbidity controls (such as silt fence and floating turbidity barriers) for the duration of the project to ensure the continuous protection of water quality standards. Turbidity controls would be placed to protect existing mangrove areas and water bodies from silt and water-borne debris and prevent degradation of the water quality in surrounding waters.

3.3.3 Shoreline Protection along the ICWW

The riprap/crib structure is proposed to consist of a crib with vertical and horizontal concrete filled PVC pipe piles. Riprap boulders of 1-3' size are proposed to be placed within this crib. The base of the crib is proposed to be a geotube or similar structure that can be placed without the need of a barge or crane. The riprap crib can be constructed from land using the existing maintenance roads and Anne Kolb Nature Center. Where existing mangroves prohibit direct access to the shoreline for the riprap/crib placement, the riprap/crib could be constructed in the same manner as discussed in Section 3.1.4. The riprap/crib could be installed in upland spoil areas, open water, and along mangroves. This may require minimal trimming of mangrove prop roots and branches, if necessary.

3.3.4 Culverts along Maintenance Road

Two 72" diameter culverts will be installed under the existing maintenance road to increase flushing to the mangroves west of the maintenance road. Prior to installation, silt fence and turbidity screens are proposed to be installed to reduce turbidity. The culverts could be installed by excavating an appropriate portion of the existing maintenance road. Culverts could then be placed in the excavated area and covered with a portion of the excavated material to achieve the same elevation as prior to installation. Excess material may be removed from the site by truck to a suitable upland site and used for public purposes unless otherwise appropriately addressed.

3.4 Phase 4 – Bird Nesting Area to South End of Park

This phase includes the creation of upland hammock, and channel areas from exotic plant-dominated Spoil Areas #31-36 and installation of shoreline protection. Access to perform the improvements discussed below would be from the ICWW by a shallow-draft work vessel such as a pontoon boat.

3.4.1 Spoil Areas #31-36

Spoil Areas #31-36 are targeted for conversion to upland hammock. A small channel is also proposed through the eastern edge of Spoil Area #36.

Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).*

Vegetation on Spoil Areas #31-35 may be cleared, grubbed and piled using non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Access to these areas could be by a johnboat or similar equipment.

Vegetation on Spoil Area #36 is proposed to be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation can access the spoil area using the existing maintenance road.

To avoid and minimize impacts, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage prior to clearing. In addition, exotic vegetation may be removed by non-mechanical means where mangroves and other natural vegetation are in close proximity to the exotic vegetation. The pile could be burned or removed by truck using the existing maintenance road and disposed of in an appropriate upland location in accordance with state and local regulations.

3.4.2 Shoreline Protection along the ICWW

The riprap/crib structure is proposed to consist of a crib with vertical and horizontal concrete filled 4"-6" PVC pipe piles. Riprap boulders of 1-3' size are proposed to be placed within this crib. The base of the crib will be a geotube or similar structure. This geotube is proposed to be filled with sand or material excavated from the spoil areas. Construction of the riprap/crib can then proceed along the base, eliminating the need for a barge or crane. The design of the riprap/crib structure should not block tidal flow into existing or proposed channels connecting West Lake to the ICWW. Placement is proposed to follow the contours of the shoreline and wrap around the sides of the channel inlets. It is anticipated that the riprap/crib structure will also stabilize the position of the channels by directing tidal currents.

3.5 Phase 5 –West Lake Park Recreational Area/Sheridan Street

This phase includes the installation of new culverts to increase flushing, the creation of mangrove, mudflat, and channel areas from exotic plant-dominated Spoil Areas #37-39. West Lake Park Recreation Area provides access to and may serve as a suitable staging area. The proposed improvements for this phase can be accessed from the recreation area and, therefore, secondary impacts to adjacent resources are not anticipated.

3.5.1 Spoil Areas #37-39

Spoil Areas #37-39 are targeted for conversion to mangrove, channel, mudflat, and upland hammock creation areas. Existing exotic vegetation consists primarily of Australian pine *(Casuarina equisetifolia).* Vegetation on the islands is proposed to be cleared, grubbed and piled. Prior to clearing, the edge of the mangroves is proposed to be demarcated by visible means to protect mangroves from damage. Exotic vegetation is proposed to be cleared and grubbed using appropriate mechanical means except where mangroves and other natural vegetation is in close proximity to the exotic vegetation; in which case vegetation may be removed using non-mechanical means. The pile could be burned or removed by truck and/or disposed of in an appropriate upland location in accordance with state and local regulations.

Excavation of spoil material could be phased to provide turbidity control and containment (i.e. excavation will proceed from the center of the spoil area outward). Material will be excavated using appropriate mechanical means. Material could then be loaded onto trucks for transfer to the staging area. Silt fencing/turbidity curtains would be placed at the edge of mangroves after clearing of vegetation and would remain until the end of construction in this area. The spoil areas are proposed to be excavated to an elevation of ±0.9' to 1.4' NGVD for natural mangrove recruitment, ± (-) 3.5' NGVD for channels, and MSL for mudflats. The upland hammock areas would not be excavated but graded prior to planting. The contractor shall be responsible for placement of spoil on a suitable upland site and used for public purposes unless otherwise appropriately addressed.

3.5.2 Culvert under West Lake Park Entrance Road

One 72" diameter culvert shall be installed under the existing entrance road to increase flushing to the mangroves west of the road. Prior to installation, silt fence and turbidity screens should be installed to reduce turbidity.

3.6 Phase 6 – Dania Salt Marsh

This phase includes the excavation of new channels to increase flushing, the creation of mudflat creation areas from exotic plant-dominated areas, and desilting of certain channels and removal of blocks to water flow. The Florida Power & Light (FPL) substation along SE 5th Avenue could serve as a suitable staging area for this phase. The proposed improvements for this phase can be accessed from SE 5th Avenue. Minor secondary impacts to adjacent resources may occur but should be limited to trimming.

3.6.1 Flushing Channels from Existing Berms

The creation of new channels from existing berms would most likely be performed by using a small backhoe and excavator. They could access the site by laying a geogrid mat over the existing path that exists in the sea oxeye fields. This mat would be only wide enough for the small excavator and backhoe. The sediment could then be placed in a small Toolcat™ work machine for transport to the staging area. Another possibility is the

use of a conveyor system that could transfer the excavated sediment directly to the staging area. These channels are proposed to be excavated to a ±(-) 3.5' NGVD unless bedrock is encountered above ±(-) 3.5' NGVD in which case the channel is proposed to be excavated to bedrock elevation. The contractor shall install, and be responsible for, maintenance of turbidity controls (silt fence and floating turbidity barriers) for the duration of the project to help ensure compliance with water quality standards. Turbidity controls should be placed, as appropriate, to protect existing mangrove areas and water bodies from silt and water-borne debris, preventing degradation of the water quality to surrounding waters and/or wetlands.

3.6.2 Mudflats from Exotic Plant-Dominated Areas

This improvement would most likely be performed using a small backhoe to excavate sediment to MSL. The existing historic haul road that is proposed to be converted to a channel could be used to access these mudflat creation areas. The channel would then be excavated from the mudflats to the historic haul road. The mudflats are proposed to be excavated to an elevation of 0.0' to 0.5' NGVD.

Existing exotic vegetation consists primarily of Brazilian pepper (*Schinus terebinthifolius).* Vegetation may be cleared, grubbed and piled using a combination of mechanical and non-mechanical means. Non-mechanical means refers to clearing by chainsaws, trimmers, etc. that do not move the soil. Mechanical equipment used to clear vegetation can access the spoil areas using the existing haul road and trail.

3.6.3 Flushing Channel along Historic Haul Road

The creation of a flushing channel along the historic haul road is proposed to be excavated in the manner described in Section 3.6.1. An existing trail could provide access to the site with minimal mangrove trimming. This channel is proposed to start on the north at the main double east-west channel and be approximately 30 feet wide. The channel is proposed to taper to about 15 feet wide on the southern end at its terminus at the southernmost created mudflat. Prior to excavation, the channel is proposed to be demarcated by visible means to protect mangroves outside the proposed channel from damage and to minimize mangrove impacts. The channel creation is proposed to follow the existing remains of a historic haul road. Up to 0.5 acres of white and black mangroves may, however, be impacted at the southern end of the channel to connect to the southern mudflat.

The channel is proposed to be excavated to a ±(-)3.5' NGVD unless bedrock is encountered above ±(-)3.5' NGVD in which case the channel is proposed to be excavated to bedrock elevation. The contractor shall install, and be responsible for, maintenance of turbidity controls (silt fence and floating turbidity barriers) for the duration of the project to help ensure compliance with water quality standards. Turbidity controls will be placed, as appropriate, to protect existing mangrove areas and water bodies from silt and water-borne debris; preventing degradation of the water quality to surrounding waters and/or wetlands.

3.6.4 Desilt Existing Channels

Desilting the primary channels would most likely be performed by using a small hydraulic dredge, such as a Piranha Pump to excavate sediment to the specified elevation. The sediment can be sent through hoses to the transport location. These channels are proposed to be desilted to a ±(-) 3.5' NGVD unless bedrock is encountered above ±(-) 3.5' NGVD in which case the channel will be desilted to bedrock elevation. The contractor shall install, and be responsible for, maintenance of turbidity controls (silt fence and floating turbidity barriers) for the duration of the project to help ensure compliance with water quality standards. Turbidity controls should be placed, as appropriate, to protect existing mangrove areas and water bodies from silt and water-borne debris, preventing degradation of the water quality to surrounding waters and/or wetlands. Turbidity controls will remain in place until side slope stabilization is achieved.

3.6.5 Protect/Preserve Sea Oxeye Fields from Exotic Invasion

The remaining sea oxeye fields in the DSM should be maintained free of exotic vegetation through quarterly monitoring. If exotic vegetation is observed, it shall be removed by hand or through chemical treatment, as appropriate.

3.7 Phase 7 – Exotic Vegetation Eradication

Approximately 8.4 acres of exotic plant-dominated areas throughout the Park are not targeted for habitat improvements. These areas are not targeted for other improvements because of their relative small size and/or accessibility. Exotic vegetation in these areas is proposed to be accessed on foot or by small vessel and exotic vegetation may be removed by non-mechanical means. Exotic vegetation shall be removed and planted with *Borrichia frutescens* and *B. arborescens*. Disposal shall be in a manner that will not encourage reinfestation by those nuisance/exotic species as well as comply with applicable State and local codes and regulations.

3.8 Phase 8 – Dania Cutoff Canal

Riprap should be placed north of existing riprap along the Dania Cutoff Canal (DCC). This riprap could most likely be placed from a shallow-draft barge with hand guidance. Some mangroves are present on the already existing, but poorly functioning, riprap. Therefore, any existing riprap with mangroves on them should remain in place. The relocation of the existing riprap is proposed to be permitted separately by others along with the installation of new bulkhead.

Following the proposed bulkhead and riprap installation along the DCC by others, approximately 2.0 acres are proposed to be filled behind the newly placed riprap to an elevation of ±0.9' to 1.4' to allow for mangrove recruitment. The average current elevation in this area is ±(-) 1.4' NGVD. Therefore, approximately 2.3' of fill will be required for the ±2.0 acre area. This results in a total of 7,421 cubic yards of fill.

Sediment from the spoil area excavation could be placed in this area from a barge along the Dania Cutoff Canal. The vertical sheet pile that may be installed for stability of the newly placed riprap could be extended to above the high tide line during construction to help ensure compliance with water quality standards. This may be comprised of temporary or supplemental sheet pile that will be adjusted to the appropriate final elevation. Floating turbidity curtains can be placed on the south side of this creation area to protect existing mangrove areas and water bodies from silt and waterborne debris; preventing degradation of the water quality to surrounding waters and/or wetlands.

3.9 *Archaeological and Historic Resources*

Based upon previous research by Florida Department of State Division of Historical Resources, it is not anticipated that historic or archaeological remains are present. However if historic or archaeological remains are discovered, the contractor shall be notify the appropriate Federal and State agencies. In addition, ground disturbing work in the immediate vicinity of artifacts if found will be halted until the area can be further investigated.

3.10 *Cleanup and Restoration*

During and upon completion of the project, the contractor shall keep the project site clean. The contractor should be allowed to temporarily store equipment, surplus materials, etc., within the limits of construction only if appropriately approved. No discarded equipment or materials, rubbish, or equipment material shall be placed outside of the construction limits.

Upon completion, the contractor shall remove from the project site and adjacent property all equipment, surplus and discarded materials, rubbish and temporary structures; the contractor shall restore, in an acceptable manner, property, both public and private, which may have been damaged during execution of the work. Waterways shall be left unobstructed upon project completion.

4.0 TURBIDITY MONITORING PLAN

Prior to and during construction operations that may generate turbidity within surface waters, erosion controls will be implemented as necessary to prevent exceeding turbidity standards as outlined in Chapter 62-302, F.A.C. Turbidity control devices used shall remain in place until turbidity, as measured in Nephelometric Turbidity Units (NTUs), within the work areas return to within 29 NTUs of background levels.

The contractor may be responsible for monitoring turbidity in areas where waterward construction activity occurs. Turbidity levels shall be monitored and recorded every six hours during dredging and filling. Samples shall be taken one foot below the surface and mid-depth at monitoring stations, which shall be located as follows:

- ±50' (up current) of the work sites and/or outside the influence of construction activities (control).
- Within ±50' down current of the work site and within the densest portion of any visible turbidity plume.

If turbidity exceeds standards (29 NTUs above background), work may be temporarily halted until the above standard is achieved.

The following data will be recorded and presented in each water quality monitoring report:

- permit and permit number
- dates of sampling and analysis
- turbidity sampling results
- description of data collection methods
- a map indicating the sampling locations
- time of sampling
- depth of water
- weather conditions at time sampling
- tidal stage and direction of flow
- wind direction and velocity
- water temperature

5.0 PLANTING SCHEDULE

UPLAND HAMMOCK CREATION - ±13.4 ACRES

Canopy/Shrub Layer

QUANTITY		SPECIES	SPACING	SIZE	ELEVATION (FT NGVD)
±343	*±5%*	*Conocarpus erectus* (Green buttonwood)	10' O.C.	3 gal.	±≥4.0
±343	*±5%*	*Conocarpus erectus* (Green buttonwood)	10' O.C.	7 gal.	±≥4.0
±343	*±5%*	*Bursera simaruba* (Gumbo limbo)	10' O.C.	3 gal.	±≥4.0
±343	*±5%*	*Bursera simaruba* (Gumbo limbo)	10' O.C.	10 gal.	±≥4.0
±343	*±5%*	*Coccoloba diversifolia* (Pigeon plum)	10' O.C.	7 gal.	±>4.0
±343	*±5%*	*Simarouba glauca* (Paradise tree)	10' O.C.	7 gal.	±≥4.0
±343	*±5%*	*Simarouba glauca* (Paradise tree)	10' O.C.	3 gal.	±≥4.0
±343	*±5%*	*Rapanea guianensis* (Myrsine)	10' O.C.	7 gal.	±≥4.0
±343	*±5%*	*Rapanea guianensis* (Myrsine)	10' O.C.	3 gal.	±≥4.0
±343	*±5%*	*Coccoloba uvifera* (Sea grape)	10' O.C.	7 gal.	±≥4.0
±343	*±5%*	*Coccoloba uvifera* (Sea grape)	10' O.C.	3 gal.	±≥4.0
±343	*±5%*	*Chrysophyllum oliviforme* (Satin leaf)	10' O.C.	7 gal.	±≥4.0
±343	*±5%*	*Chrysophyllum oliviforme* (Satin leaf)	10' O.C.	3 gal.	±≥4.0
±172	*±5%*	*Psychotria nervosa* (Wild coffee)	5' O.C.	3 gal.	±≥4.0
±172	*±5%*	*Hamelia patens* (Firebush)	5' O.C.	3 gal.	±≥4.0
±343	*±5%*	*Sabal palmetto* (Cabbage palm)	10' O.C.	8-14'	±≥4.0
±343	*±5%*	*Chrysobalanus icaco* (Cocoplum)	10' O.C.	7 gal.	±≥4.0
±343	*±5%*	*Chrysobalanus icaco* (Cocoplum)	10' O.C.	3 gal.	±≥4.0
±5,832	*±5%*	TOTAL			

Ground Cover

QUANTITY		SPECIES	SPACING	SIZE	ELEVATION (FT NGVD)
±21,000	*±5%*	*Spartina bakeri* (Cordgrass)	5' O.C.	bare root	±≥3.5
±4,500	*±5%*	*Nephrolepis biserrata* (Sword fern)	5' O.C.	1 gal.	±≥3.5
±25,500	*±5%*	TOTAL			

MANGROVE CREATION AREAS - ±24.2 ACRES

Canopy/Shrub layer vegetation will consist of naturally recruited mangrove species *(Rhizophora mangle, Avicennia germinans, and Laguncularia racemosa).*

EXOTIC VEGETATION REMOVAL AREAS - ±8.4ACRES

QUANTITY		SPECIES	SPACING	SIZE	ELEVATION (FT NGVD)
±20,328	±5%	*Borrichia frutescens* (sea oxeye daisy)	3' O.C.	1 gal.	±≥2.0
±20,328	±5%	*Borrichia arborescens* (sea oxeye daisy)	3' O.C.	1 gal.	±≥2.0
±40,656	±5%	TOTAL			

6.0 MONITORING PLAN

6.1 Seagrasses

A time-zero monitoring event will be performed, and then the seagrass recruitment area shall be monitored quarterly for the required five-year period.

Forty paired, one-square meter quadrats will be randomly placed within the created seagrass habitat during each monitoring event. Distribution of the forty quadrats will be divided equitably between the seven seagrass creation areas. Random, rather than fixed quadrats, will be used so that the results are without bias and can be used to accurately generalize over the entire area (Fonseca, personal communication). Random directions and distances will be chosen using a random number generator. The random direction and distance will be from the approximate center of each seagrass creation area. An equal number of replicate quadrats will be established in the adjacent, surrounding seagrass beds (at least 50' from the creation areas) to serve as a control. The following data will be collected at each quadrat:

- Relative water depth
- Time
- Species present
- Shoot counts
- Aerial coverage by photo-documentation
- Qualitative observations of natural seagrass recruitment and vegetative expansion of planting units

In addition to the above-listed data, the following data may also be collected for each monitoring event: tides, weather, water temperature, and wind. A staff gauge or piezometer shall be installed to record tide level.

Survivorship rates may be assessed based on measurements within the paired 1 m^2 quadrats. Abundance measurements shall be made through visual and photographic assessments of percent aerial coverage by species. The 1 m^2 quadrat shall be divided into 10 cm x 10 cm grid and the number of squares containing seagrasses shall be counted to estimate cover.

In addition, percent aerial coverage will be equated to Cover Classes, based on the Braun-Blanquet technique, as follows:

Cover Class	Description
0	Absent
0.1	Solitary individual ramet, less than 5% cover
0.5	Few individual ramets, less than 5% cover
1	Many individual ramets, less than 5% cover
2	5% - 25% cover
3	25% - 50% cover

Cover Class	Description
4	50% - 75% cover
5	75% - 100% cover

Seagrass success criteria shall be based on:

1. A target goal of Cover Class 1 coverage by the third year

2. A target goal of Cover Class 2 or higher by the fifth year

3. Supplemental seagrass will be planted on 2 m centers if:
   a) at the end of the third year areas have a Cover Class less than 1 or equivalent to coverage in the ICWW (control site) whichever is lower.
   b) at the end of the fifth year areas have a Cover Class less than 2 or equivalent to coverage in the ICWW (control site) whichever is lower.

The contingency plan for supplemental seagrass planting is to obtain donor stock from the adjacent seagrass beds and transplant the seagrasses using the plug method as described in Fonseca *et. al.* (1998) Guidelines *for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters.*

If the seagrass creation areas have not been completely covered by natural seagrass recruitment, seagrass from impact site(s) may be transplanted to the seagrass creation areas in West Lake Park.

Panoramic photo-stations shall be established and underwater photographic documentation of each quadrat shall also be collected.

Aquatic macrofauna (vertebrates and invertebrates) are proposed to be identified and recorded within the visible radius along 20 meter transects. This identification would be performed prior to monitoring of seagrasses to minimize disturbance. Benthic fauna would be identified, however interstitial fauna shall not. The following data shall be collected for each transect:

- Identification of fauna to lowest practical taxonomic level
- Number of individuals of a given species (abundance)
- Number of species (diversity)
- Location of identified fauna (sediment surface, water column)
- Behavior of identified fauna (swimming, foraging, etc.)
- Time to complete transect

In addition, incidental faunal observations shall be recorded.

6.2 Mangrove Areas

Vegetative sampling:

Establish one (1) belt transect within each individual mangrove recruitment area. These transects will be two (2) meters wide and will stretch across the approximate maximum length of each recruitment area. One square meter quadrats will be randomly placed along the transects at a minimum density of one (1) quadrat per 10 meters of transect (i.e., 100 meter transect will contain 10 quadrats). Though the quadrats will be randomly placed, they will not be placed within "breaks" (i.e., mud flats, pre-existing mangrove areas) in the mangrove recruitment areas. Percent aerial coverage by naturally recruited vegetative species falling within the quadrats will be visually estimated and recorded. Data from these sampling quadrats will then be extrapolated to determine overall percent coverage within each mangrove recruitment area.

Once naturally recruited mangrove trees have obtained sufficient height (±1.5 meters) to be recorded individually, trees falling within the belt transects (base of trunk within the transect) would be flagged and measured for height, spread, and diameter breast height (DBH). These measurements will be at random points along the transect at a frequency of one set of measurements per 10 meters. Measurements of these flagged trees will be repeated during subsequent monitoring events to determine growth rates. Overall health would also be assessed.

Success criteria:

Success criteria for mangroves and herbaceous plantings within mangrove recruitment areas will be based on percent coverage.

Percent coverage success criteria will be based on the following interim goals:

1. 10% aerial coverage by mangroves by the first year.
2. 40% aerial coverage by mangroves by the third year.
3. 80% aerial coverage by mangroves by the fifth year.

If the interim coverage mentioned above are not achieved, supplemental mangrove planting will be performed; red mangrove seedlings will be installed 3' on center in areas where coverage discrepancies are noted.

6.3 Mudflat/Tidal Pool Areas

Mud flat/tidal pool creation areas will be monitored for incidental wildlife, including benthic macroinvertebrates observed on the surface. Photo-documentation of each mudflat/tidal pool area and incidental wildlife observations will be recorded.

6.4 Upland hammock Areas

Vegetative sampling:

Establish one (1) belt transect within each individual upland hammock area. These transects will be two (2) meters wide and will stretch across the approximate maximum length of each planting area. One square meter will be randomly placed along the transects at a minimum density of one (1) quadrat per 10 meters of transect. Percent aerial coverage by installed and naturally recruited vegetative species falling within the quadrats will be visually estimated and recorded. Data from these sampling quadrats will then be extrapolated to determine overall percent coverage within each mangrove recruitment area.

All installed tree species falling within the belt transects (base of trunk within transect) will be flagged and measured for height, canopy spread, and DBH (if applicable). Measurements of these flagged trees will be repeated during subsequent monitoring events to determine growth rates. Overall health will also be assessed for each installed tree species.

Success criteria

Success criteria for tree/shrub species within the upland hammock areas shall be based upon survivorship rates of 80% or greater for planted species by the second annual monitoring period.

6.5 Success Criteria for Planting Areas

Success criteria is a target of 2% or less coverage by nuisance/exotic vegetative species within the recruitment/planting areas.

The following information will be included in the Time Zero and quarterly monitoring reports:

1) A summary of visual field observations, including survivorship and percent coverage or survivorship data obtained from the above-noted sampling activities.
2) Physical conditions during the monitoring event including: weather, wind direction and speed; tide direction, water temperature, salinity, and turbidity levels.
3) A photographic record taken from fixed photo stations.
4) Piezometer water level readings from the time period of monitoring activities.
5) Incidental observations of fish/wildlife utilization and sampling for aquatic macrofauna.
6) Evaluation of the success of the mitigation and maintenance effort.
7) Comments and/or recommendations for permit compliance.

7.0 MAINTENANCE PLAN

Maintenance shall be performed for a period of five (5) years and in perpetuity, as needed. A survival rate of 80% for installed tree/shrub species in the upland hammock planting areas, 80% coverage by desirable herbaceous species in the upland hammock areas, 80% for the planted species in the upland areas and 80% coverage of desirable obligate and facultative wetland species in the aquatic and marsh areas is anticipated through implementation of this mitigation program.

The permitee is responsible for the removal of nuisance and exotic vegetation and debris from the mitigation area for the length of the monitoring period and in perpetuity, as needed. Exotic vegetation shall include such species currently listed by the Florida Exotic Pest Plant Council. Mitigation areas shall be free from exotic/nuisance vegetation immediately following maintenance periods. Total coverage of exotic and nuisance species shall not exceed 2% between maintenance activities.

Maintenance is anticipated to be conducted during the monitoring period and in perpetuity, on an as needed basis. Appropriate methods of control shall be used, which will include, but will not necessarily be limited to, cutting, mowing, chemical treatment, hand removal, or any combination thereof.

Upon completion of the required 5-year monitoring period, BCPRD shall continue to be responsible for the perpetual maintenance and management of the mitigation areas.

8.0 SCHEDULE

Activities	Anticipated Date
Begin earthwork	6/05
Complete earthwork	6/08
Begin planting	7/08
Complete planting	7/09
Submit Time-zero Monitoring Report	8/09
Submit first Annual Monitoring Report	9/10
Submit Second Annual Monitoring Report	9/11
Submit Third Annual Monitoring Report	9/12
Submit Fourth Annual Mmonitoring Report	9/13
Submit Fifth Annual Monitoring Report	9/14

9.0 REFERENCES

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		Size (Acres)	Project	Relative Functional Gain (RFG)	Mitigation Credit (FG)	Management Items
I. Master Plan - ESTIMATED MITIGATION CREDIT FOR WEST LAKE PROJECT						
A. Physical Habitat Alteration						
1	Structural habitat along the Intracoastal Waterway ICWW	1.9	Structure/ fill			
2	Mangrove protection and enhancement by riprap placement	24.0	Enhancement	0.26	6.24	
3	Supplemental structural habitat along Dania cut-off Canal	2.0	Structure/ fill			
4	Mangrove protection by riprap supplement	8.0	Enhancement	0.26	2.08	
5	Nuisance/Exotic Plant Control	8.4	Enhancement	0.11	0.92	
6	Spoil island and exotic dominated upland areas conversion					
6a	Mangrove	22.2	Creation	0.47	10.43	
6b	Mud Flat/tide pool	7.0	Creation	0.65	10.14	
6c	Channel	8.6				
6d	Seagrass	8.0	Creation	0.16	1.28	Seagrass
6e	Maritime Hammock	13.4	Creation	0.23	3.08	
7	Mangrove creation from Dania Cutoff Canal (open water)	2.0	Creation	0.21	0.42	
B. Land Acquisition (within existing park)						
1	Outparcel Acquisition					X
2	Vacate utility easements					X
3	Vacate FIND easements					X
4	Outparcel Acquisition (OUTSIDE IMPROVEMENT AREAS)	23.3	Preserv.	0.06	1.40	
C. Habitat Improvements						
1	Creation of Mantee Protection Areas					
1a	Seagrass/manatee protection area in Whiskey Creek (WC)	9.0	Preserv.	0.03	1.0	Seagrass
1b	Seagrass/manatee protection - ICWW south of Dania Beach Blvd.	21.0				Seagrass
2	Enhance/protect bird nesting, and feeding habitat					X
3	Establishment of Osprey towers					X
4	Mud flat/tide pool creation from Brazilian pepper areas in Dania Salt Marsh	1.5	Restoration	0.22	0.33	
5	Protect/preserve sea oxeye fields from exotic invasion	10.0	Enhancement	0.22	2.20	
D. Hydrologic Improvements						
1	Dania Salt Marsh (DSM)/flushing channel improvements	3.5	Enhancement	0.22	0.77	
2	Desilt existing culverts					X
3	Increase number of or upsize culverts					X
4	Desilting channels/ongoing maintenance dredging					X
E. Miscellaneous Improvements						
1	Remove the barges at Whiskey Creek (expose bottom for SAV recruitment)	0.5	Enhancement	0.08	0.04	Seagrass
	TOTAL	174.30				
	Mangrove Mitigation Credits				20.57	
	Seagrass Mitigation				2.22	
	Other Mitigation Credits				17.45	

US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)
ATTACHMENT 6

West Lake Mitigation - Methods to Determine Acreages for Improvements

		Method to Determine Acreage
I. Conceptual Master Plan		
A. Physical Habitat Alteration		
1	Rip rap placement along the Intracoastal Waterway ICWW	As-built survey
1a	Mangrove protection and enhancement by riprap placement	Areas Subject to Erosion Exhibit - previously submitted
2	Supplemental placement/enhancement of rip rap along Dania cut-off Canal	As-built survey
2a	Mangrove protection by riprap supplement	Areas Subject to Erosion Exhibit - previously submitted
3	Nuisance/Exotic Plant Control	As-built survey
4	Spoil island and exotic dominated upland areas conversion	
4a	Mangrove	As-built survey
4b	Mud Flat/tide pool	As-built survey
4c	Channel	As-built survey
4d	Seagrass	As-built survey
4e	Maritime Hammock	As-built survey
4f	Edge effect enhancement of areas surrounding 4a - 4e	
5	Mangrove creation from Dania Cutoff Canal (open water)	As-built survey
B. Land Acquisition (within existing park)		
1	Within ICWW south of Dania Beach Blvd.	Proof of ownership, Conservation easement, sketch & description
2	Vacate utility easements	Proof of ownership, Conservation easement, sketch & description
3	Vacate FIND easements	Proof of ownership, Conservation easement, sketch & description
4	Outparcel Acquisition	Proof of ownership, Conservation easement, sketch & description
5	Sheridan Street ESL addition (former Albertsons site)	Proof of ownership, Conservation easement, sketch & description
C. Habitat Improvements		
1	Creation of Mantee Protection Areas	
1a	Manatee protection area in Whiskey Creek (WC)	Acreage calculation within MPA buoyed-area
1b	Seagrass protection by manatee protection area in WC	Acreage calculation within MPA buoyed-area
1c	Manatee protection - ICWW south of Dania Beach Blvd.	Acreage calculation within MPA buoyed-area
1d	Seagrass protection by manatee protection area in ICWW	Acreage calculation within MPA buoyed-area
2	Crocodile basking within Dania Salt Marsh	As-built survey
3	Enhance/protect bird nesting, and feeding habitat	As-built survey
4	Establishment of Osprey towers	As-built survey
5	Stabilize areas with herbaceous planting	As-built survey
6	Mud flat/tide pool creation from exotic-dominated sea oxeye fields	As-built survey
D. Hydrologic Improvements		
1	Dania Salt Marsh (DSM)/flushing channel improvements	As-built survey
1a	Improvements from flushing channels in DSM and throughout Park	As-built survey from #1
2	Desilt existing culverts	As-built survey
2a	Enhancement of mangroves from desilting culverts	As-built survey from #2
3	Increase number of or upsize culverts	As-built survey
3a	Enhancement of mangroves from increasing culverts	As-built survey from #3
4	Desilting channels/ongoing maintenance dredging	As-built survey
4a	Improvements to mangroves/lakes by desilting	As-built survey from #4
E. Miscellaneous Improvements		
1	Remove the barges at Whiskey Creek (expose bottom for SAV recruitment)	Photos showing barges gone
2	Increase educational signage througout park	Photos of signs installed at park
F. Additional Factors		
1	Conservation easement over County-owned land	Sketch and Description

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US Army Corps of Engineers.

File # SAJ-2002-72(IP-LAO)
ATTACHMENT 7

West Lake Mitigation Unit Estimates

		Mitigation Items				
		Creation (Acres)	Restoration (Acres)	Enhancement (Acres)	Preservation (Acres)	Management Items
I. Master Plan						
A. Physical Habitat Alteration						
1	Structural habitat along the Intracoastal Waterway ICWW	1.9				
2	Mangrove protection and enhancement by riprap placement			24.0		
3	Supplemental structural habitat along Dania cut-off Canal	2.0				
4	Mangrove protection by riprap supplement			8.0		
5	Nuisance/Exotic Plant Control			8.4		
6	Spoil island and exotic dominated upland areas conversion					
6a	Mangrove	22.2				
6b	Mud Flat/tide pool	7.0				
6c	Channel	8.6				
6d	Seagrass	8.0				
6e	Maritime Hammock	13.4				
7	Mangrove creation from Dania Cutoff Canal (open water)	2.0				
B. Land Acquisition (within existing park)						
1	Outparcel Acquisition					X
2	Vacate utility easements					X
3	Vacate FIND easements					X
4	Outparcel Acquisition (OUTSIDE IMPROVEMENT AREAS)				23.3	
C. Habitat Improvements						
1	Creation of Manatee Protection Areas					
1a	Seagrass/manatee protection area in Whiskey Creek (WC)				9.0	
1b	Seagrass/manatee protection - ICWW south of Dania Beach Blvd.				21.0	
2	Enhance/protect bird nesting, and feeding habitat					X
3	Establishment of Osprey towers					X
4	Mud flat/tide pool creation from Brazilian pepper areas in Dania Salt Marsh		1.5			
5	Protect/preserve sea oxeye fields from exotic invasion			10.0		
D. Hydrologic Improvements						
1	Dania Salt Marsh (DSM)/flushing channel improvements		3.5			
2	Desilt existing culverts					X
3	Increase number of or upsize culverts					X
4	Desilting channels/ongoing maintenance dredging					X
E. Miscellaneous Improvements						
1	Remove the barges at Whiskey Creek (expose bottom for SAV recruitment)		0.5			
	TOTAL	65.1	5.5	50.4	53.3	

***Definitions**

Creation = The establishment of new wetlands or surface waters by conversion of other land forms.

Restoration = Converting back to a historic condition those wetlands, surface waters, or uplands which currently exist as a land form which differs from the historic condition.

Enhancement = Improving the ecological value of wetlands, other surface waters, or uplands that have been degraded in comparison to their historic condition

Preservation = The protection of wetlands, other surface waters or uplands from adverse impacts by placing a conservation easement or other comparable land use restriction over the property or by donation of fee simple interest in the property.

Management Items - Items that the Broward County Parks and Recreation Department plan to do, however mitigation credit is not being requested for these items at this time. These items may be considered and evaluated by the reviewing agencies for credit, if applicable, at that time.

US Army Corps of Engineers.

CESAJ-RD-S
SAJ-2002-00072(IP-LAO)

FEB 2 8 2006

MEMORANDUM FOR RECORD

SUBJECT: Department of the Army Environmental Assessment and Statement of Finding for Above-Numbered Permit Application

1. Applicant: Broward County Parks and Recreation Division
Attn: Pat Young
Administrative Manager
950 N.W. 38th Street
Oakland Park, FL 33309

2. Location, Existing Site Conditions, Project Description, Changes to Project:

a. Location: The project is located in West Lake Park, a county park composed almost entirely of a mangrove forest west of the Intracoastal Waterway and south of the Dania Cutoff Canal, Dania Beach (Sections 1, 2 and 11, Township 50 south, Range 42 east, Broward County, Florida.

b. Existing Site Conditions: The project site contains ±1,522 acres of which ±990.5 acres are mangrove swamps, ±246.9 acres are lakes, ±65.3 acres are exotic plant dominated spoil areas, and ±221.7 acres are other habitats, including waterways, saltwater marsh, tidal flats, barren land, seagrass, roads, and highways. The site is a public park facility managed by the Broward County Parks and Recreation Division. The mangrove swamps, lakes, waterways, saltwater marshes, and tidal flats are considered to be jurisdictional waters of the United States. The site is bordered by the Dania Cut-off Canal to the north, the ICWW to the east, and residential to the south and west. Because of the site's proximity to the ICW and high speed boat traffic, erosion is an concern for Park Managers.

The project site is comprised primarily of mangrove dominated estuarine wetlands, with the red (*Rhizophora mangle*), black (*Avicennia germans*), and white (*Languncularia racemosa*) mangrove species present. Green buttonwood (*Conocarpus erectus*) and silver buttonwood (*Conocarpus erectus* var. *sericeus*) are also present, typically growing on higher elevations than the mangroves. Isolated sea ox-eye daisy (*Borrichia* spp.) marshes are also found within western portions of the project site. In addition, two large manmade interconnected lakes are present within this park.

Paddle grass and Johnson's seagrass are present within the Intracoastal Waterway adjacent to West Lake Park. The dominant

seagrass is paddle grass (*Halophila decipiens*). Johnson's seagrass (*Halophila johnsonii*), a Threatened species, is present throughout, but is more prevalent on the southern end. Shoal grass (*Halodule wrightii*) is also present. These seagrasses are present as patchy beds of varying density, usually with rubble and overgrowing algae interspersed.

Paddle grass and Johnson's seagrass were also present within the interior lakes in areas where the sediment was somewhat compacted and where limestone was present with overlying sediment of 3 inches or less. The largest concentration of seagrass within the interior lakes of West Lake Park is at the extreme southern end.

The nuisance/exotic species Australian pine (*Casuarina equisetifolia*) is established on the spoil islands and other fill areas associated with historic dredging of West Lake and the Intracoastal Waterway. Brazilian pepper (*Schinus terebinthifolius*) is also established in many locations in the Dania Salt Marsh area of the Park.

c. Project Description: To provide up-front compensation to be used for wetland impacts associated with future Broward County projects, the County has proposed a mitigation plan for upland, wetland, and seagrass creation, restoration, enhancement and preservation of mangroves and seagrasses within West Lake Park in Broward County.

The project in is to install culvert connections to increase flushing of a 1500+ acre mangrove forest, construct a riprap/crib structure for shoreline stabilization along approximately 3 miles of shoreline adjacent to the mangrove edge along the ICW and for approximately 1.5 miles along the Dania Cutoff canal. The riprap/crib structure shall be created using piling supports on one or both sides of the riprap with pilings parallel to the shoreline with horizontal reinforcing bars to create the support structure for the riprap. A geotube base filled with clean fill will be laid within the crib strucuture for stabilization. Where the structure is adjacent to resources, as shown in the attached drawings, riprap placement will be within a 5-foot wide crib structure which is vertical on both sides with pilings and

stringers. Where the riprap will not be placed adjacent to resources, the piling support structure will be only built on the landward edge of the mangrove fringe and the riprap will be placed against and waterward of it with the waterward slope of the riprap being no steeper than 1.5 horizontal to 1 vertical.

The project will also include the scrape down and/or removal of exotic vegetation from approximately 63 acres of upland soil to create mangrove, mudflat, tidal flats and pools, seagrass, and maritime hammock habitat. Additionally, exotic vegetation removal will occur in smaller areas throughout the park. A temporary expansion of an existing road involving 0.03 acres of impacts will be installed to allow spoil removal.

The project is proposed to create ±24.2 acres of mangrove habitat, 7.0 acres of mud flats/tidal pools, 8.6 acres of tidal channels, 8.0 acres of seagrass habitat, 13.4 acres of maritime hammock, 1.9 acres of structural habitat in the form of a riprap crib structure along the ICWW, and 2.0 acres of supplemental structural habitat (riprap) along the Dania Cut-off Canal. Project restoration would consist of 1.5 acres of mud flats/tide pools, and improving 3.5 acres of flushing channels within the Dania Salt Marsh, and removing derelict barges which currently shade 0.5 acres of potential seagrass habitat within Whiskey Creek. Project enhancement/creation consists of 32 acres of mangroves, removal of 8.4 acres of exotic vegetation and replanting of sea oxeye daisy, and removing and preventing future exotic infestations in 10 acres. Project preservation consists of 23.3 acres of outparcel acquisition, and 30 acres of seagrass/manatee protection areas.

Ecological benefits generated from the proposed improvement may be used as mitigation to offset future estuarine wetland impacts associated, if appropriate, with projects conducted by or for Broward County. The Corps will determine if mitigation credit for this project is warranted and appropriate for use as mitigation on other projects. Any habitat restoration or enhancement that occurs as a result of this project does not preclude the need to fully adhere to the federal sequential mitigation requirements on future regulated activities.

While post-project monitoring will reveal if actual habitat creation and enhancement occurs, these ecological benefits were estimated using the Uniform Mitigation Assessment Method (UMAM) and are summarized in the following table:

		Size (Acres)	Project	Relative Functional Gain (RFG)	Mitigation Credit (FG)	Management Items
I. Master Plan						
A. Physical Habitat Alteration						
1	Structural habitat along the Intracoastal Waterway ICWW	1.9	Structure/ fill		-1.24	
2	Mangrove protection and enhancement by riprap placement	24.0	Enhancement	.26	6.24	
3	Supplemental structural habitat along Dania cut-off Canal	2.0	Structure/ fill			
4	Mangrove protection by riprap supplement	8.0	Enhancement	.26	2.08	
5	Nuisance/Exotic Plant Control	8.4	Enhancement	.11	0.92	
6	Spoil island and exotic dominated upland areas conversion					
6a	Mangrove	22.2	Creation	.47	10.43	
6b	Mud Flat/tide pool	7.0	Creation	.65	10.14	
6c	Channel	8.6				
6d	Seagrass	8.0	Creation	.16	1.28	
6e	Maritime Hammock	13.4	Creation	.23	3.08	
7	Mangrove creation from Dania Cutoff Canal (open water)	2.0	Creation	0.21	0.42	
B. Land Acquisition (within existing park)						
1	Outparcel Acquisition					X
2	Vacate utility easements					X
3	Vacate FIND easements					X
4	Outparcel Acquisition (OUTSIDE IMPROVEMENT AREAS)	23.3	Preservation	0.06	1.40	
C. Habitat Improvements						
1	Creation of Mantee Protection Areas					
1a	Seagrass/manatee protection area in Whiskey Creek (WC)	9.0	Preservation	0.03	0.9	
1b	Seagrass/manatee protection - ICWW south of Dania Beach Blvd.	21.0				
2	Enhance/protect bird nesting, and feeding habitat					X

		Size (Acres)	Project	Relative Functional Gain (RFG)	Mitigation Credit (FG)	Management Items
3	Establishment of Osprey towers					X
4	Mud flat/tide pool creation from Brazilian pepper areas in Dania Salt Marsh	1.5	Restoration	0.22	0.33	
5	Protect/preserve sea oxeye fields from exotic invasion	10.0	Enhancement	0.22	2.20	
D.	**Hydrologic Improvements**					
1	Dania Salt Marsh (DSM)/flushing channel improvements	3.5	Enhancement	0.22	0.77	
2	Desilt existing culverts					X
3	Increase number of or upsize culverts					X
4	Desilting channels/ongoing maintenance dredging					X
E.	**Miscellaneous Improvements**					
1	Remove the barges at Whiskey Creek (expose bottom for SAV recruitment)	0.5	Enhancement	0.08	0.04	
	TOTAL	**174.30**				
	Mangrove Mitigation Credits				**20.57**	
	Seagrass Mitigation Credits				**2.28**	
	Other Mitigation Credits				**17.45**	

While the Corps recognizes the value of the mudflats, tidal pools and channels to a healthy mangrove system, future use of mitigation credits earned through the creation of these habitats in order to offset mangrove or other habitat impacts should be done only when deemed appropriate by the Corps.

d. Changes to Project: The following changes have been made to the proposed improvements from the original to the current submittal that has resulted in avoidance and minimization of wetland impacts for the project:

a. The proposed channels and mudflats behind Spoil Island #13 have been eliminated to avoid mangrove impacts.

b. Riprap (the original shoreline protection option) was deemed to have too great an impact to resources (mangroves and seagrass) due to the 15'-20' footprint.

Multiple alternative alignments were investigated. The project was then changed to a crib only structure that is only 5' wide with the riprap held between the two sided piling support structure. However, the creation of the crib structure alone was believed to create secondary impacts by the creation of vertical structure and the severing of flow of water and fauna into and out of the mangrove forest. In order to balance the need for stabilization of the mangroves with the need to avoid other impacts to resources, the project was broken up into separate areas. Whenever possible the riprap will be constructed with a piling supported back structure with a riprap height of +5 NGVD. The riprap will be placed in front of it at a slope no steeper than 1.5:1 horizontal:vertical. In areas adjacent to seagrasses, the crib structure shall be utilized with a 5-foot wide crib filled with riprap. Placement of the crib structure will be micro-sited to ensure avoidance of all seagrass impacts. To ensure flow through the riprap structure, gaps between the riprap structure will be created as shown in the attached drawings.

c. All but one of the proposed channels just north of Sheridan Street near Anne Kolb Nature Center have been eliminated to reduce mangrove impacts to a minimum.

d. Proposed channel desilting in the Dania Salt Marsh has been reduced from desilting four channels to desilting only 25% of the main central channel at the western edge to reduce significant mangrove trimming and removal that would be necessary to accomplish the originally proposed desilting effort.

e. The large flushing channel proposed in the Dania Salt Marsh has been reduced in width from 50' to a variable width ranging from 30' to 15' to reduce mangrove impacts.

f. The locations of certain mangrove recruitment areas and upland hammock have been relocated to reduce the amount of material that would need to be removed from more

isolated locations (i.e. areas that would have to be accessed by boat).

A combined total of ±15 acres of direct mangrove impacts have been eliminated since the original design.

3. Project Purpose:

a. Basic: The project's basic purpose is the enhancement and restoration of a tidal and estuarine system.

b. Overall: The overall project purpose is to provide ecological benefits and improvement to a tidal and estuarine system located at West Lake Park within eastern Broward County, Florida.

4. Scope of Analysis: The corps' jurisdiction includes the proposed project site and the surrounding areas where construction equipment will be staged/located. The proposed project site does exhibit unique and/or rare characteristics. However, it is these characteristics that are proposed for restoration and enhancement.

5. Statutory Authority: Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344).

6. Other Federal, State, and Local Authorizations Obtained or Required and Pending:

a. State Permit/Certification: The South Florida Water Management District (SFWMD) permit number 06-04016-P was issued on 22 April 2004.

b. Coastal Zone Management (CZM) consistency/permit: Issuance of a SFWMD permit certifies that the project is consistent with the CZM plan.

c. Other Authorizations: Broward County Department of Planning and Environmental Protection (DPEP) issued Environmental Resource License number DF30-1117 on 12 AUG 2004.

7. Date of Public Notice and Summary of Comments:

a. Pre-application meeting(s): The Corps attended a pre-application meeting on site on 6 SEP 2000. In attendance were Pat Young, Gil MacAdam, Mike Kroll, Dylan Larson, and Bob Paulson.

b. Important Dates: The Corps, Jacksonville District received the application on 11 January 2002. The Corps project manager requested additional information necessary to complete a Public Notice for an Individual Permit on 24 April 2002. The applicant responded with additional information on 10 June 2002, and the Corps considered the application complete. The Corps conducted a jurisdictional determination on 16 August 2002. The Corps completed the Public Notice on 21 November 2003, which was published on the web. The Public Notice was sent to all interested parties including appropriate State and Federal agencies.

c. Public Notice Comments: The Corps has reviewed all of the comments submitted in response to the circulation of the Public Notice. The Corps has summarized these comments below:

(1) U.S. Environmental Protection Agency (EPA): The EPA responded to the Public Notice on 19 DEC 2003. The EPA requested Estuarine-Wetland Rapid Assessment Procedure (E-WRAP) scores for the proposed project, as well as a table which lists the total amount of credits and debits that would be generated by the proposed project. In addition, the EPA requested detailed drawings with an explanation of how the proposed riprap construction will affect fisheries and wildlife habitat.

(2) U.S. Fish and Wildlife Service (USFWS): The USFWS responded to the Public Notice on 26 JAN 2004. The USFWS concurred with the Corps determination that the project may affect, but is not likely to adversely affect the West Indian Manatee or result in adverse modification to critical manatee habitat. The USFWS also concurred with the Corps determination that the project may affect but not likely to affect the wood stork. On 22 April 2005, the Corps sent an additional request for coordination to the US FWS for the American Crocodile. By letter dated 18 July 2005, the US FWS concurred with the Corps determination that the project may affect, but is not likely to

adversely affect the American crocodile. The USFWS therefore did not object to the proposed project.

(3) National Marine Fisheries Service (NMFS)-Habitat Conservation Division: The NMFS-HCD responded to the Public Notice on 9 DEC 2003. The NMFS stated concerns that construction of the proposed riprap crib would damage existing habitats and would occupy submerged bottoms that are used for movement between requisite forage, cover and maturation sites, ultimately reducing the abundance and diversity of fishery resources in the area. In addition, water movement could be restricted and localized water quality degradation could result. NMFS has recommended that alternatives to creation of the riprap crib be explored. Further evaluation of enforcement issues involving vessel wake and shoreline erosion at West Lake Park was also recommended as part of the alternatives analysis.

(4) National Marine Fisheries Service (NMFS)-Protected Resources Division: The NMFS-PRD responded by letter dated 9 DEC 2003. The NMFS-PRD concurred with the Corps determination that the project may affect, but is not likely to adversely affect Johnson's seagrass or result in adverse modification to Johnson's seagrass critical habitat. The NMFS-PRD also concurred with the Corps determination that the project may affect but not likely to affect the small toothed sawfish or swimming seaturtles. The NMFS-PRD therefore did not object to the proposed project.

(5) State Historic Preservation Officer (SHPO): By letter dated 5 December 2003, the SHPO indicated that no significant archaeological or historical resources are recorded within the project area.

(5) Other State and local agencies: No other agencies responded to the public notice.

(6) Organizations: No organizations responded to the public notice.

(7) Individuals: By letter dated 12 December 2003, Mr. Steven Tarr, President of Stelly-Hoven, Inc., owner of a lot within the State park area objected to the issuance of a

Department of the Army permit for this work stating that the project would directly and indirectly affect his lot. Mr. Tarr's lot is at the most waterward part of the mangrove forest. There are no access roads to it and it is on the coastline that is eroding at an estimated rate of 1.5 ft/year. There is a condition of the SFWMD permit that the project cannot be performed on an project location that is not owned or under easement by the applicant, Broward County. Additionally, the county is taking steps to obtain ownership of several outparcels which may be affected by various stages of this project. Therefore, the Corps believes that Mr. Tarr's property rights are being adequately considered.

(8) Internal Coordination: The project was coordinated with the Construction/Operations Division due to its proximity to the ICW. Construction Operations did not object to the project.

8. Alternatives:

a. No less damaging alternatives were available which would have provided the same ecological benefits and utilization of the site. Selection of another site is not feasible, as the site consists of tidal and estuarine habitats, which are the targeted habitats for the desired restoration. Through project modifications, approximately 15 cres of impact to mangrove wetlands were avoided.

b. Minimization: The project has been minimized to the maximum extent possible as discussed on page 5 under Section D (Changes to the project). The project proposes temporary, minimal incidental impacts. The Corps believes the end result of the restoration and enhancement activities would be more beneficial to the aquatic environment than the current condition which will result in continued loss of mangrove habitat. A review of alternative stabilization methods was reviewed and the proposed method is the least environmentally damaging alternative that would meet the project purpose. No less damaging alternatives were available which would have provided the same environmental benefits and utilization of the site.

c. Mitigation: Mitigation is not proposed for the temporary, minimal, incidental impacts to the existing resources since implementation of the proposed ecological improvements will benefit the entire estuarine system at West Lake Park.

d. Conclusions of Alternatives Analysis: The Corps believes that the overall ecological improvements to the site will offset the temporary minimal incidental impacts. The project as proposed represents the less damaging, practicable alternative.

9. Evaluation of the 404(b)(1) Guidelines: The Corps reviewed the proposed project in accordance with the 404 (b)(1) Guidelines. The review demonstrates that the Corps analyzed all of the alternatives and that the proposed alternative is the least environmentally damaging and practicable alternative considering expense, existing technology, and logistics. The project would not cause or contribute to violations of State Water quality standards, jeopardize the existence of any endangered species or affect a marine sanctuary. The Corps does not expect significant degradation and the Applicant has taken all available practicable steps to minimize impacts.

a. Restrictions on discharges:

(1) Alternatives (See paragraph 8):

(a) The activity is located in a special aquatic site (wetlands, sanctuaries and refuges, mud flats, vegetated shallows, coral reefs, riffle and pool complexes).

(b) The activity does need to be located in a special aquatic site to fulfill its basic purpose.

(c) It has been demonstrated in paragraph 8 above that there are no practicable nor less damaging alternatives which would satisfy the project's overall purpose.

(2) Other program requirements

(a) The proposed activity does not violate applicable State water quality standards or Section 307 prohibitions or effluent standards.

(b) The proposed activity does not jeopardize the continued existence of federally listed threatened or endangered species or affect their critical habitat.

(c) The proposed activity does not violate the requirements of a federally designated marine sanctuary.

(3) The activity will not cause or contribute to significant degradation of waters of the United States, including adverse effects on human health, life stages of aquatic organisms, ecosystem diversity, productivity and stability; and recreational, aesthetic, and economic values.

(4) Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.

b. Findings: The proposed site for the discharge of dredged or fill material complies with the Section 404 (b)(1) Guidelines with the inclusion of the following special conditions:

Special Conditions:

1. Submittals required herein shall be directed to:

Department of the Army
Jacksonville District Corps of Engineers
Regulatory Division, Enforcement Section
P.O. Box 4970
Jacksonville, Florida 32232-0019

A courtesy copy of any required enhancement/creation reports will also be provided to:

U.S. Army Corps of Engineers
South Permits Branch Office
4400 PGA Boulevard, Suite 500

Palm Beach Gardens, FL 33410

2. Prior to commencement of construction in or adjacent to wetlands and/or Waters of the United States, the perimeter of the enhancement/creation construction area(s) shall be enclosed with staked and trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas.

3. Appropriated soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date.

4. The permittee shall conduct a pre-construction meeting prior to commencement of construction in order to notify in-house staff, field crews, contractors, subcontractors, and all persons involved in the construction of West Lake Park Enhancement/creation Project of the conditions of this permit. The permittee shall educate and inform staff members and contractors of these procedures. Copies of the permit and specific conditions shall be displayed at the construction site.

5. All storage or stockpiling of tools or materials (i.e. lumber, pilings, etc.) shall be limited to uplands or within the impact areas authorized by this project.

6. All temporary wetland impacts associated with the enhancement/creation construction activities shall be restored to preexisting wetland conditions immediately following completion of the construction element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time-zero enhancement/creation monitoring report and shall be maintained and monitored in conjunction with the enhancement/creation monitoring program provided for in the enclosed exhibits.

7. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the Corps may require the permittee to provide appropriate enhancement/creation to the Corps. The Corps may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

8. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or Waters of the United States prior to disposal in a suitable upland spoil disposal area.

9. The permittee shall comply with the attached Manatee Construction Conditions enclosed in attachment #3 which are also outlined in this condition. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

The permittee shall advise all construction personnel that there are civil penalties and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water where the draft of the vessel provides less than a four-foot clearance from the

bottom. All vessels will follow routes of deep water wherever possible.

If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee(s). these precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida. Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 8 ½ by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida.

10. The permittee shall install and maintain permanent manatee awareness signs/education displays.

11. As provided in Attachment 4, Broward County Parks and Recreation Division shall be responsible for the enhancement/creation construction, five year maintenance and

monitoring and perpetual management of the proposed enhancement/creation efforts at West Lake Park.

12. A maintenance program shall be implemented in accordance with Attachment 5 for the enhancement/creation areas on a regular basis to ensure the integrity and viability of those areas as permitted. Maintenance shall be conducted in perpetuity to ensure that the enhancement/creation areas are maintained free from Category 1 exotic vegetation (as defined by the Florida Exotic Pest Plant Council at the time of permit issuance) immediately following a maintenance activity. Coverage of exotic and nuisance plant species shall not exceed 5% of total cover between maintenance activities. In addition, the permittee shall manage the conservation areas such that exotic/nuisance plant species do not dominate any one section of those areas.

13. A time zero monitoring report for the West Lake Park enhancement/creation project shall be conducted in accordance with Attachment 5 for all completed enhancement/creation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

14. The permittee shall submit annual monitoring reports to the Corps for a period of five years, the first not later than one year after the submission of the time-zero report. Each monitoring report shall provide a narrative, professional biological opinion of the condition of the enhancement/creation improvements. The monitoring report shall also contain a plan view describing the vegetative community, the percent cover for each community, a list of species and their percent cover for each community, the percent cover of wetland and of exotic plant species, the sum of the survivors of those planted plus those recruited, a description of any unusual climatic or other factors, and

photos from the same point as where the photos for the time-zero report.

15. Perpetual maintenance of the enhancement/creation areas shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

16. Generally, the enhancement/creation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater, and/or estuarine wetland communities. The use of mitigation units from this project shall be limited to projects undertaken by or for Broward County. The Corps will determine if the use of mitigation credits from this project is warranted and appropriate for use as mitigation on other projects. The suitability of this enhancement/creation area to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

17. The amount of potential credit generated by the enhancement/creation efforts must be confirmed through post-project monitoring to reveal if actual habitat creation and enhancement/creation occurs. These ecological benefits were estimated using the Uniform Enhancement/creation Assessment Method (UMAM) and are summarized in Attachment 6. The values are presumed correct, but are adjustable by the Corps if adequate lift has not been achieved or if proposed acreages for mitigation areas are not enhanced/created as proposed. Verification methods to determine actual acreages for Improvement and verification of potential credits generated from this creation/enhancement project are shown in Attachment 7. Use of such enhancement/creation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the enhancement/creation credit. Any habitat restoration/enhancement/creation that occurs as a result of

this project does not preclude the need to fully adhere to the federal sequential enhancement/creation requirements on future regulated activities.

*Corps UMAM scores on this project were done separately from those submitted by the applicant in conjunction with SFWMD, future scoring should be done in line with those values which can be found in the file.

18. Management items identified in Attachment 8 and described in Attachment 4 may be later considered for enhancement/creation credit through a modification of this permit if supporting information to justify enhancement/creation credit for items has been sufficiently demonstrated to the Corps.

19. No modifications to this permit shall be required for construction methodology variations from those described in Attachment 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that Corps staff concurs with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by Corps regulatory or compliance staff.

20. Select mangrove trimming necessary to accomplish the planned enhancement/creation efforts described herein shall be authorized by this permit.

*This condition is to allow installation of the crib structure among the mangroves on the most southern 1/3 end of the project area. In order to avoid impacting seagrasses in these areas, the crib structure shall be placed within the edge of the mangroves. Therefore, it will be necessary to perform some selective trimming and possibly minor root removal without affecting the health of any mangroves.

21. Since the installation of the buoys for the 'boating exclusion zone" is located within the Federal right-of-way for the Federal Channel, **a Department of the Army Consent to Easement is also required *prior* to commencement of construction.** By copy of this letter, the permit is being

forwarded to the Corps Real Estate Division for action on the Consent.

22. Enhancement/creation credit for the designated manatee/seagrass protection areas shall be granted only after documentation of a Consent to Easement for installation of the manatee protection barriers from the U.S. Army Corps of Engineers Real Estate Division has been submitted to the offices outlined in Special Condition #1.

*This credit for preservation is based on the belief that by creating a boating exclusion zone along the shoreline and in Whiskey Creek, the overall impacts to the seagrass from boat wakes and other impacts will provide a net benefit. If the barrier is not installed and maintained permanently, then no credit should be given.

23. The Permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structures or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the Permittee will be required, upon due notice from the U.S. Army Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

24. Fill material used with this project (temporary road expansion and geotube creation) shall be limited to suitable, clean fill material, which excludes materials such as trash, debris, car bodies, asphalt, construction materials, concrete block with exposed reinforcement bars, and any soils contaminated with any toxic substance in toxic amounts (see Section 307 of the Clean Water Act).

25. Following completion of the crib installation, the permittee shall complete a post-installation seagrass survey from the riprap crib structure waterward for a distance 50

feet. This post construction seagrass survey will be conducted in the growing season (April 1-August 31) following the crib construction and shall be submitted to Corps no later than October 1 that year. The seagrass survey shall be compared with the 2002 seagrass survey done by Miller Legg and Associates, Inc. If the post construction seagrass survey shows that seagrasses have been impacted or are no longer growing in their previous locations (adjacent to the crib structure), a UMAM analysis on the seagrass habitats affected based on the Corps earlier UMAM analysis of the West Lake Seagrass areas should be conducted by the permittee and submitted to the Corps for approval. The UMAM debits from the areas affected shall be deducted from any actual seagrass creation/enhancement credits earned through this overall project. If sufficient actual mitigation credits are not available to offset the impacts caused to seagrasses by the crib structure, the Corps will require remedial measures and will require additional mitigation as necessary to fully offset impacts resulting from the installation of the crib structure.

*The applicant was encouraged to avoid installation of the crib structure along the seagrass areas and to instead install a sloped riprap structure. The Corps is concerned that the crib structure may act similar to a vertical seawall with energy rebound which may affect the ability for seagrass to grow in a these areas. However, due to the close proximity of mangroves and seagrass, the wider footprint of the sloped riprap would have created an immediate impact for one habitat type or the other. The permittee stated that because of the permeability and roughness (not a solid sheet) of the riprap structure that even though it is vertical there should not be the same energy rebound off of it. The seagrass survey will be required to ensure that the grasses adjacent to the crib structure is not required. Because the sloped riprap is not being placed adjacent to seagrass areas, there is no need to provide a post project survey for these areas.

10. Public Interest Review:

a. Public interest factors: The Corps reviewed all of the public interest factors including, but not limited to, the effects the work might have on conservation, economics, esthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, land use, navigation, shore erosion and accretion, recreation, water quality, safety, and consideration of property ownership. The Corps has determined that the proposed project will not adversely affect any of the public interest factors.

b. Describe the relative extent of the public and private need for the proposed structure or work: The public need includes increase fish and wildlife utilization and conservation, habitat protection, and an increase in natural areas for recreational and educational use.

c. Describe the practicability of using reasonable alternative locations and methods to accomplish the objective of the proposed work where there are unresolved conflicts as to resource use: There are no unresolved conflicts regarding resource use. The proposed project is consistent with the land use classification.

d. Describe the extent and permanence of the beneficial and/or detrimental effects, which the proposed work is likely to have on the public, and private uses to which the area is suited: Detrimental impacts are expected to be temporary during construction. Beneficial effects associated with the project and the public benefits listed above would be permanent.

e. Threatened or endangered species: After coordination on endangered species, the USFWS concurred with the Corps' determination that the proposed project may affect, but is not likely to adversely affect the West Indian manatee, the wood stork, and the American Crocodile and would not adversely affect Manatee Critical Habitat. The NMFS-PRD concurred with the Corps' determination that the project may affect, but would not likely adversely affect Johnson's seagrass or its critical habitat, the small toothed sawfish, or swimming seaturtles.

f. Corps wetland policy: The proposed temporary minimal incidental impacts are necessary to achieve the project purpose.

The proposed work should not result in any adverse environmental impacts. The benefits of the project associated with overall ecological improvements offset the temporary minimal incidental impacts. Therefore, the project is in accordance with the Corps wetland policy.

g. Cumulative and Secondary Impacts: Cumulative and/or secondary impacts are not anticipated as a result of the project. The proposed project will not have an adverse cumulative effect on the aquatic ecosystem because the impacts are minimal, temporary, incidental, and are not for development purposes. The site is surrounded by the ICWW to the east the Dania Cut-off Canal to the north and residential development to the west and south.

h. Corps analysis of comments and responses: The Corps is in agreement with the comments from the United States FWS and the NMFS and the subsequent responses of the applicant.

11. Essential Fish Habitat (EFH): The project will incidentally affect but not adversely affect essential fish habitat because the proposed project involves habitat creation, restoration, enhancement, and preservation including hydrologic improvements to West Lake Park that will provide improvements to Essential Fish Habitat. Coordination with NMFS - HCD with respect to EFH was resolved on February 6, 2006 with a final letter that states the following:

> …NMFS notes that post-project monitoring will reveal if actual habitat creation and enhancement occurs. Further, additional coordination with NMFS would be necessary to determine if credit is warranted and appropriate for use as mitigation on other projects *(see note below)*. Also, we emphasize that any habitat restoration or enhancement that occurs as a result of this project does not preclude the need to fully adhere to the federal sequential mitigation requirements on future regulated activities.
>
> We appreciate efforts by the applicant and your staff to protect NMFS' trust resources. With inclusion of the aforementioned changes as special conditions of the issued DA permit, the goals of the Magnuson-Stevens Fishery

Conservation and Management Act and the regulations for implementing the EFH requirements of the Act would be met.

Note - The Corps did not agree to coordinate with NMFS on future projects to determine if credit usage from this enhancement is warranted and appropriate for use as mitigation on other projects. Other projects will undergo their own EFH review and appropriateness of mitigation can be addressed through that process.

12. Public Hearing Evaluation: No public hearing was requested; therefore, no public hearing was held.

13. Determinations:

a. Finding of No Significant Impact (FONSI): Having reviewed the information provided by the applicant and all interested parties and an assessment of the environmental impacts, I find that this permit action will not have a significant impact on the quality of the human environment. Therefore, an Environmental Impact Statement will not be required.

b. Compliance with 404(b)(1) Guidelines: Having completed the evaluation in paragraph 9 above, I have determined that the proposed discharge complies with the 404 (b)(1) guidelines.

c. Section 176 (c) of the Clean Air Act General Conformity Rule Review: The proposed permit action has been analyzed for conformity applicability pursuant to regulations implementing Section 176 (c) of the Clean Air Act. It has been determined that the activities proposed under this permit will not exceed de minimus levels of direct or indirect emissions of a criteria pollutant or its precursors and are exempted by 40 CFR Part 93.153. Any later indirect emissions are generally not within the Corps' continuing program responsibility and generally cannot be practicably controlled by the Corps. For these reasons a conformity determination is not required for this permit action.

d. Public Interest Determination: I find that the issuance of a department of the Army permit is not contrary to the public interest.

CESAJ-RD-S **SAJ-2002-00072(IP-LAO)**
SUBJECT: Department of the Army Environmental Assessment and Statement of Findings for the Above-Numbered Permit Application

PREPARED BY:

Leah A. Oberlin
Project Manager

REVIEWED BY:

John F. Studt
Chief, South Permits Branch

APPROVED BY:

Robert M. Carpenter
Colonel, Corps of Engineers
Commanding

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
4400 PGA BOULEVARD, SUITE 500
PALM BEACH GARDENS, FLORIDA 33410

REPLY TO
ATTENTION OF

FEB 03 2011

Palm Beach Gardens Section
SAJ-2002-00072(IP-LAO)
Modification-5

Broward County Parks and Recreation Division
c/o Pat Young
Administrative Manager
950 NW 38th Street
Oakland Park, Florida 33309

Dear Mr. Young:

The U.S. Army Corps of Engineers has completed the review and evaluation of your modification request received 24 January 2011 in which you asked to modify Department of the Army permit number SAJ-2002-00072, for activities at the West Lake Park and adjacent wetlands, issued February 28, 2006. The project is located in navigable waters of the U.S, west of the Intracoastal Waterway and south of the Dania Cutoff Canal, Dania Beach (Sections 1, 2, and 11, Township 50 south, Range 42 east), Broward County, Florida.

The proposed modification is to extend the expiration date to complete your proposed project. This authorization is hereby extended for five years from the date of this letter.

The impact of your proposal on navigation and the environment has been reviewed and found to be insignificant. The permit is hereby modified in accordance with your request. You should attach this letter to the permit. All other conditions of the permit remain in full force and effect.

If you have any questions concerning permit modification, please contact the project manager Melody White at the letterhead address, by telephone at 561-472-3508 or by electronic mail at Melody.J.White@usace.army.mil.

Thank you for your cooperation with our permit program. The Corps Jacksonville District Regulatory Division is committed to improving service to our customers. We strive to perform our duty in a friendly and timely manner while working to preserve our environment. We invite you to take a few minutes to visit http://per2.nwp.usace.army.mil/survey.html and complete our automated Customer Service Survey. Your input is appreciated - favorable or otherwise.

Please be aware this web address is case sensitive and should be entered as it appears above.

BY AUTHORITY OF THE SECRETARY OF THE ARMY:

Alfred A. Pantano, Jr.
Colonel, U.S. Army
District Commander

Enclosure

Copies Furnished:

Miller Legg
c/o Dylan Larson
2005 Vista Parkway
Suite 100
West Palm Beach, FL 33411
Email: Jennifer Shipley: jshipley@millerlegg.com
Dylan Larson: dlarson@millerlegg.com

CESAJ-RD-PE

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
3301 Gun Club Road, West Palm Beach, Florida 33406 • (561) 686-8800 • FL WATS 1-800-432-2045 • TDD (561) 697-2574
Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680 • www.sfwmd.gov

CON 24

Permit No. 06-04016-P
Application No. 011226-21

April 22, 2004

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
(WEST LAKE PARK)
115 SOUTH ANDREWS AVE STE 421
FT LAUDERDALE, FL 33301

Dear Permittee:

Enclosed is your Permit as authorized by the Governing Board of the South Florida Water Management District at its meeting on April 14, 2004.

Please note that there are pre-construction documentation requirements which must be met prior to commencement of any construction. Failure to comply with these requirements may result in formal enforcement action to force cessation of construction activities pending permit compliance.

Special Conditions to your Permit require reports to be filed with this District. Please read these Conditions and use the enclosed form(s), as applicable, for your submittal of these required reports.

Should you have any questions concerning these requirements, please feel free to contact this office.

Sincerely,

Elizabeth Veguilla

Elizabeth Veguilla
Deputy Clerk
Environmental Resource Regulation Department

Enclosures

GOVERNING BOARD

Nicolás J. Gutiérrez, Jr., Esq., Chair
Pamela Brooks-Thomas, Vice-Chair
Irela M. Bagué
Michael Collins
Hugh M. English
Lennart E. Lindahl, P.E.
Kevin McCarty
Harkley R. Thornton
Trudi K. Williams, P.E.

EXECUTIVE OFFICE

Henry Dean, Executive Director

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENVIRONMENTAL RESOURCE PERMIT NO. 06-04016-P
DATE ISSUED: APRIL 14, 2004

FORM #0145
Rev. 08/95

PERMITTEE: STATE OF FLORIDA
(WEST LAKE PARK)
DIVISION OF STATE LANDS,3900 COMMONWEALTH BOULEVARD
TALLAHASSEE , FL 32399

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
(WEST LAKE PARK)
115 SOUTH ANDREWS AVE,STE 421
FT LAUDERDALE , FL 33301

PROJECT DESCRIPTION: AUTHORIZATION FOR CONSTRUCTION AND OPERATION OF A MITIGATION PROJECT WITHIN THE 1522.2 ACRE WEST LAKE PARK TO PROVIDE COMPENSATION FOR FUTURE WETLAND IMPACTS THAT MAY BE ASSOCIATED WITH FUTURE BROWARD COUNTY PROJECTS

PROJECT LOCATION: BROWARD COUNTY , SECTION 35,36 TWP 50S RGE 42E
SECTION 1,2,11 TWP 51S RGE 42E

PERMIT DURATION: See Special Condition No:1. See attached Rule 40E-4.321, Florida Administrative Code.

This Permit is issued pursuant to Application No. 011226-21 , date(December 13, 2001. Permittee agrees to hold and save the South Florida Water Management District and its successors harmless from any and all damages, claims or liabilities which may arise by reason of the construction, operation, maintenance or use of activities authorized by this Permit. This Permit is issued under the provisions of Chapter 373 , Part IV Florida Statutes (F.S.), and the Operating Agreement Concerning Regulation Under Part IV, Chapter 373 F.S., between South Florida Water Management District and the Department of Environmental Protection. Issuance of this Permit constitutes certification of compliance with state water quality standards where neccessary pursuant to Section 401, Public Law 92-500, 33 USC Section 1341 , unless this Permit is issued pursuant to the net improvement provisions of Subsections 373.414(1)(b), F.S., or as otherwise stated herein.

This Permit may be transferred pursuant to the appropriate provisions of Chapter 373, F.S, and Sections 40E-1.6107(1) and (2), and 40E-4.351(1), (2), and (4), Florida Administrative Code (F.A.C.). This Permit may be revoked, suspended, or modified at any time pursuant to the appropriate provisions of Chapter 373, F.S. and Sections 40E-4.351(1), (2), and (4), F.A.C.

This Permit shall be subject to the General Conditions set forth in Rule 40E-4.381, F.A.C., unless waived or modified by the Governing Board. The Application, and the Environmental Resource Permit Staff Review Summary of the Application, including all conditions, and all plans and specifications incorporated by reference, are a part of this Permit. All activities authorized by this Permit shall be implemented as set forth in the plans, specifications, and performance criteria as set forth and incorporated in the Environmental Resource Permit Staff Review Summary. Within 30 days after completion of construction of the permitted activity, the Permittee shall submit a written statement of completion and certification by a registered professional engineer or other appropriate individual, pursuant to the appropriate provisions of Chapter 373, F.S. and Sections 40E-4.361 and 40E-4.381, F.A.C.

In the event the property is sold or otherwise conveyed, the Permittee will remain liable for compliance with this Permit until transfer is approved by the District pursuant to Rule 40E-1.6107, F.A.C.

SPECIAL AND GENERAL CONDITIONS ARE AS FOLLOWS:

SEE PAGES 2 - 7 OF 10 (41 SPECIAL CONDITIONS).
SEE PAGES 8 - 10 OF 10 (19 GENERAL CONDITIONS).

FILED WITH THE CLERK OF THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT

ON April 22, 2004

BY Rosaura Veguilla
DEPUTY CLERK

SOUTH FLORIDA WATER MANAGEMENT DISTRICT, BY ITS GOVERNING BOARD

BY
ASSISTANT SECRETARY

BOARD OF SOUTH FLORIDA WATER MANAGEMENT DISTRICT
STATE OF FLORIDA
SEAL
Established 1949

SPECIAL CONDITIONS

1. The construction phase of this permit shall expire on April 15, 2009.

2. The permittee shall be responsible for the correction of any erosion, shoaling or water quality problems that result from the construction or operation of the surface water management system.

3. Measures shall be taken during construction to insure that sedimentation and/or turbidity violations do not occur in the receiving water.

4. The District reserves the right to require that additional water quality treatment methods be incorporated into the drainage system if such measures are shown to be necessary.

5. Facilities other than those stated herein shall not be constructed without an approved modification of this permit.

6. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the District may require the permittee to provide appropriate mitigation to the District or other impacted party. The District may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

7. All barge activity shall occur in areas where a minimum one-foot bottom clearance is maintained.

8. All contractors must be provided with a copy of the staff report and permit conditions prior to the commencement of construction. The permittee is responsible for ensuring that all contractors adhere to the project construction details and methods indicated on the attached permit Exhibits and described herein.

9. The successful completion of the mitigation plan is heavily dependent on proper site grading. Therefore, prior to demobilizing equipment from the site and prior to planting, the permittee shall schedule an inspection by District Environmental Resource Compliance staff to ensure that appropriate elevations and slopes have been achieved.

10. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or other surface waters prior to disposal in a suitable upland spoil disposal area.

11. Prior to the commencement of construction in or adjacent to wetlands and/or other surface waters, the perimeter of the mitigation construction area(s) shall be enclosed with stakedand trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas. The permittee shall notify the District's Environmental Resource Compliance staff in writing upon installation of the silt fencing and/or turbidity screens and schedule an inspection of this work. The silt fencing and/or turbidity screens shall be subject to District staff approval. The permittee shall modify the silt fencing/turbidity screens if District staff determines that it is insufficient or is not in conformance with the intent of this permit. The silt fencing and/or turbidity screens shall remain in place until all adjacent construction activities are complete.

12. All temporary wetland impacts associated with mitigation construction activities shall be restored to preexisting wetland conditions immediately following completion of the mitigation element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time zero mitigation monitoring report and shall be maintained and monitored in conjunction with the mitigation monitoring program provided for in the enclosed exhibits.

13. This permit only applies to authorization from the South Florida Water Management District; it is possible that additional permits may be necessary from other agencies. Nothing contained herein relieves the permittee from timely complying with applicable laws of other federal, state or local governments.

14. Manatee exclusion grates shall be placed across the openings of existing or proposed culverts or pipes that are greater than eighteen inches but smaller than six feet in diameter. The installation of grates applies to any submerged or partially submerged pipes and culverts accessible to manatees during any tidal phase. Permittee shall keep all grates free and clear of debris.

15. Endangered species, threatened species and/or species of special concern have been observed onsite and/or the project contains suitable habitat for these species. It shall be the permittee's responsibility to coordinate with the Florida Fish and Wildlife Conservation Commission and/or the U.S. Fish and Wildlife Service for appropriate guidance, recommendations and/or necessary permits to avoid impacts to listed species.

16. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

    The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

    Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

    All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

    If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

    Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (1-561-562-3909) in south Florida.

    Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 81/2" by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. The U.S. Fish and Wildlife Service should also be contacted in Jacksonville (1-904-232-2580) for north Florida or in

Vero Beach (1-561-562-3909) for south Florida.

17. Due to the proximity of this project to areas of known manatee concentrations, all work conducted waterward of the existing shoreline during the months of December, January and February shall be subject to the following conditions:

a) The Bureau of Protected Species Management shall be notified one week prior to the commencement of the work;

b) at least one person shall be designated as a manatee observer at each site when in-water work is being performed. the manatee observer must be on site during all in-water construction activities and will advise personnel to cease operation upon sighting a manatee within 50 feet of any in-water construction activity. Movement of a work barge, other associated vessels, or any in-water work shall not be performed after sunset, when the possibility of spotting manatees is negligible; and

c) the permittee shall ensure that the contractor maintains a log detailing sightings, collisions, or injuries to manatees should they occur during the contract period. Following project completion, the logs shall be submitted to the Bureau of Protected Species Management, 620 South Meridian Street, Tallahassee, Florida 32399-1600;

18. The following exhibits for the permit are incorporated by reference herein and are located in the permit file:

Exhibit No. 14 List of Outparcels within West Lake Natural Preserve and Recreation Area, dated 12/19/01
Exhibit No. 17 Sublease Agreement for West Lake Park, between FDNR and Broward County, executed 12/22/88
Exhibit No. 18 Management Plan for West Lake Park, by Broward County Parks and Recreation Division
Exhibit No. 19 Management Plan Update for West Lake Park, authorized by FDEP on 2/7/02

19. No construction is authorized on land that the permittee does not own until the permittee acquires title to such land.

20. This permit does not eliminate the need to obtain any and all necessary easements and rights of way prior to the start of any activity approved herein. This permit does not convey to the permittee, or create for the permittee, any property right, or any interest in real property; nor does it authorize any entrance upon, or activities on, property which is not owned or controlled by the permittee; or convey any rights or privileges other than those specified in the permit and Chapter 40E-4 or Chapter 40E-40, F.A.C..

21. As provided in Exhibit No. 10, Broward County Parks and Recreation Division shall be responsible for the mitigation construction, five year maintenance and monitoring and perpetual management of the proposed mitigation efforts at West Lake Park.

22. Perpetual maintenance of the mitigation area shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

23. The use of the mitigation units from this project shall be limited to projects undertaken by Broward County. Generally, the mitigation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater and/or estuarine wetland communities. The suitability of this mitigation area to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

The amount of potential credit generated by the mitigation efforts has been

determined using the Uniform Mitigation Assessment Method, 62-345, FAC (UMAM) through an assessment conducted jointly by District and Broward County Department of Planning and Environmental Protection staff and the applicant's representatives and is reflected in the UMAM worksheets provided in Exhibit No. 22. Use of the mitigation credits shall be addressed at the time of application for the wetland impact projects.

24. At the time of application for any that includes wetland impacts and proposes to use mitigation credit from this West Lake mitigation plan, the permittee shall demonstrate that an adequate portion of the mitigation plan has been or shall be executed and completed in a timely manner (i.e., concurrent with the wetland impacts) and that the specified mitigation will adequately offset the wetland impacts associated with that construction project.

25. A mitigation program for West Lake Park shall be implemented in accordance with the enclosed exhibits. The permittee shall create 51.7 acres of wetlands, restore 5.5 acres of wetlands, restore 13.4 acres of uplands, enhance 50.4 acres of wetlands, and preserve 53.3 acres of wetlands.

26. The District reserves the right to require remedial measures to be taken by the permittee if monitoring or other information demonstrates that adverse impacts to onsite or offsite wetlands, upland conservation areas or buffers, or other surface waters have occurred due to project related activities.

27. A mitigation monitoring program shall be implemented in accordance with the enclosed exhibits to ensure that the targeted success criteria are met. The monitoring program shall extend for a period of 5 years with annual reports submitted to District Environmental Resource Compliance staff. The permittee shall be responsible for ensuring that the mitigation areas described herein meet the specified percent coverage and/or survivorship of planted and/or recruited vegetation throughout the duration of the monitoring program, with replanting as necessary. If native wetland, transitional, and upland species do not achieve the specified percent coverage and/or survivorship at any time during the monitoring program, native species shall be planted in accordance with the maintenance program. At the end of the 5 year monitoring program the entire mitigation area shall contain an 80% survival of planted vegetation and an 80% coverage of desirable plant species suitable for that mitigation area.

28. A maintenance program shall be implemented in accordance with Exhibit Nos. 4 and 7 for the mitigation areas on a regular basis to ensure the integrity and viability of those areas as permitted. Maintenance shall be conducted in perpetuity to ensure that the conservation area is maintained free from Category 1 exotic vegetation (as defined by the Florida Exotic Pest Plant Council at the time of permit issuance) immediately following a maintenance activity. Coverage of exotic and nuisance plant species shall not exceed 5% of total cover between maintenance activities. In addition, the permittee shall manage the conservation areas such that exotic/nuisance plant species do not dominate any one section of those areas.

29. A time zero monitoring report for the West Lake Park mitigation project shall be conducted in accordance with Exhibit Nos. 4 and 7 for all completed mitigation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

30. The permittee shall comply with applicable state water quality standards including:
a) 62-302.500 - Minimum criteria for all surface waters at all places and all times;
b) 52-302.510 - Surface waters: general criteria
c) 62-302.560 - Class III waters; recreation, propagation and maintenance of a healthy, well balanced population of fish and wildlife;
d) 62-302.600 - Classified waters.

31. A turbidity control plan shall be implemented in accordance with Exhibit Nos. 4 and 7. Prior to the commencement of construction in or adjacent to the Intracoastal Waterway or other surface water bodies within West Lake Park, floating turbidity curtains with weighted skirts that extend to the submerged bottom shall be properly installed to isolate adjacent waters from the work area. The floating turbidity curtains shall be maintained and shall remain in place until all construction is complete and turbidity levels in the project area are within 29 NTUs of background levels. The permittee shall be responsible for ensuring that turbidity control devices are inspected daily and maintained in good working order so that there are no violations of state water quality standards outside of the turbidity screens.

32. A water quality monitoring program shall be implemented in accordance with Exhibit No. 4 and as outlined below:

    Turbidity expressed in nephelometric turbidity units (ntu). Background samples shall be taken 200 feet upstream of any construction activity within adjacent surface waters Samples shall also be taken 200 feet downstream. Samples shall be taken at least twice daily, with at least a four-hour interval, during all work authorized by this permit involving spoil removal, grading or other forms of earthwork that may generate turbidity in other surface waters.

    Monitoring shall begin on the first day of construction for all activities within or adjacent to surface waters. Monitoring shall cease when all construction activities are completed. The monitoring data must demonstrate that turbidity 200 feet downstream of all proposed activities is less than or equal to 29 NTU's above natural background turbidity (or meets OFW standards) and 200 feet upstream of each proposed activity for a period of 7 consecutive days after completion of construction. If monitoring shows such levels to be exceeded, construction shall cease and District compliance staff shall be notified immediately. Work shall not resume until District staff is satisfied that adequate corrective measures have been taken and turbidity has returned to acceptable levels.

    All monitoring data shall be maintained on site and be available to District staff during regular business hours. The content of the data shall include:

    1) permit and application number; (2) dates of sampling and analysis; (3) statement describing the methods used in collection, handling, storage and analysis of the samples; (4) a map indicating the sampling locations and (5) a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, limits of detection and accuracy of the data.

    Monitoring reports shall also include the following information for each sample that is taken:
    (a) time of day samples taken;
    (b) depth of water body;
    (c) depth of samples;
    (d) antecedent weather conditions;
    (e) wind direction and velocity;

33. Documentation of ownership of the Priority 1 outparcels by the County identified in Exhibit Nos. 14 and 15 must be provided to the District in order to be credited as mitigation for preservation credit and before any other mitigation element is constructed which relies on those outparcels for their construction, access or other purposes.

34. Those portions of the park which are under County ownership and where mitigation is proposed that have been determined to potentially be vulnerable to subsequent alteration (refer to Exhibit No. 13) shall be placed under a conservation easement dedicated to the District. A draft conservation easement document along with boundary surveys and legal descriptions for the identified areas to be protected under the conservation easement shall be submitted for review by District staff and, upon their approval, shall be recorded in County records before mitigation credit for those areas may be used as compensation to offset wetland impacts associated

with other County projects.

35. Management items outlined in Exhibit No. 5 and described in Exhibit Nos. 4 and 7 may be later considered for mitigation credit through a modification of this permit if supporting information to justify mitigation credit for items has been sufficiently demonstrated to the District.

36. Any mitigation credit generated by the planned mitigation activities described herein shall only be eligible for use as compensation to offset tidal, saltwater or estuarine wetland impacts associated with projects proposed by Broward County. Use of such mitigation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the mitigation credit.

37. Early transplanting of seagrass from the impact site to the proposed seagrass creation areas shall be voluntary and shall not be subject to survival criteria. However, the recruitment and coverage criteria specified in this permit shall apply.

38. No modifications to this permit shall be required for construction methodology variations from those described in Exhibit No. 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that District staff concur with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by District regulatory and/or compliance staff.

39. Select mangrove trimming necessary to accomplish the planned mitigation efforts described herein shall be authorized by this permit.

40. Mitigation credit for the designated manatee protection areas shall be granted only after documentation of an agreement, easement or other necessary form of authorization for installation of the manatee protection barriers from the U.S. Army Corps of Engineers has been submitted to the District.

41. Activities associated with the implementation of the mitigation, monitoring and maintenance plan(s) shall be completed in accordance with the work schedule attached as Exhibit No. 21. Any deviation from these time frames will require prior approval from the District's Environmental Resource Compliance staff. Such requests must be made in writing and shall include (1) reason for the change, (2) proposed start/finish and/or completion dates; and (3) progress report on the status of the project development or mitigation effort.

GENERAL CONDITIONS

1. All activities authorized by this permit shall be implemented as set forth in the plans, specifications and performance criteria as approved by this permit. Any deviation from the permitted activity and the conditions for undertaking that activity shall constitute a violation of this permit and Part IV, Chapter 373, F.S.

2. This permit or a copy thereof, complete with all conditions, attachments, exhibits, and modifications shall be kept at the work site of the permitted activity. The complete permit shall be available for review at the work site upon request by District staff. The permittee shall require the contractor to review the complete permit prior to commencement of the activity authorized by this permit.

3. Activities approved by this permit shall be conducted in a manner which does not cause violations of State water quality standards. The permittee shall implement best management practices for erosion and pollution control to prevent violation of State water quality standards. Temporary erosion control shall be implemented prior to and during construction, and permanent control measures shall be completed within 7 days of any construction activity. Turbidity barriers shall be installed and maintained at all locations where the possibility of transferring suspended solids into the receiving waterbody exists due to the permitted work. Turbidity barriers shall remain in place at all locations until construction is completed and soils are stabilized and vegetation has been established. All practices shall be in accordance with the guidelines and specifications described in Chapter 6 of the Florida Land Development Manual; A Guide to Sound Land and Water Management (Department of Environmental Regulation, 1988), incorporated by reference in Rule 40E-4.091, F.A.C. unless a project-specific erosion and sediment control plan is approved as part of the permit. Thereafter the permittee shall be responsible for the removal of the barriers. The permittee shall correct any erosion or shoaling that causes adverse impacts to the water resources.

4. The permittee shall notify the District of the anticipated construction start date within 30 days of the date that this permit is issued. At least 48 hours prior to commencement of activity authorized by this permit, the permittee shall submit to the District an Environmental Resource Permit Construction Commencement Notice Form Number 0960 indicating the actual start date and the expected construction completion date.

5. When the duration of construction will exceed one year, the permittee shall submit construction status reports to the District on an annual basis utilizing an annual status report form. Status report forms shall be submitted the following June of each year.

6. Within 30 days after completion of construction of the permitted activity, the permitee shall submit a written statement of completion and certification by a registered professional engineer or other appropriate individual as authorized by law, utilizing the supplied Environmental Resource Permit Construction Completion/Certification Form Number 0881. The statement of completion and certification shall be based on onsite observation of construction or review of as-built drawings for the purpose of determining if the work was completed in compliance with permitted plans and specifications. This submittal shall serve to notify the District that the system is ready for inspection. Additionally, if deviation from the approved drawings is discovered during the certification process, the certification must be accompanied by a copy of the approved permit drawings with deviations noted. Both the original and revised specifications must be clearly shown. The plans must be clearly labeled as "As-built" or "Record" drawing. All surveyed dimensions and elevations shall be certified by a registered surveyor.

7. The operation phase of this permit shall not become effective: until the permittee has complied with the requirements of condition (6) above, and submitted a request for conversion of Environmental Resource Permit from Construction Phase to Operation Phase, Form No. 0920; the District determines the system to be in compliance with the permitted plans and specifications; and the entity approved by the District in

accordance with Sections 9.0 and 10.0 of the Basis of Review for Environmental Resource Permit Applications within the South Florida Water Management District, accepts responsibility for operation and maintenance of the system. The permit shall not be transferred to such approved operation and maintenance entity until the operation phase of the permit becomes effective. Following inspection and approval of the permitted system by the District, the permittee shall initiate transfer of the permit to the approved responsible operating entity if different from the permittee. Until the permit is transferred pursuant to Section 40E-1.6107, F.A.C., the permittee shall be liable for compliance with the terms of the permit.

8. Each phase or independent portion of the permitted system must be completed in accordance with the permitted plans and permit conditions prior to the initiation of the permitted use of site infrastructure located within the area served by that portion or phase of the system. Each phase or independent portion of the system must be completed in accordance with the permitted plans and permit conditions prior to transfer of responsibility for operation and maintenance of the phase or portion of the system to a local government or other responsible entity.

9. For those systems that will be operated or maintained by an entity that will require an easement or deed restriction in order to enable that entity to operate or maintain the system in conformance with this permit, such easement or deed restriction must be recorded in the public records and submitted to the District along with any other final operation and maintenance documents required by Sections 9.0 and 10.0 of the Basis of Review for Environmental Resource Permit applications within the South Florida Water Management District, prior to lot or units sales or prior to the completion of the system, whichever comes first. Other documents concerning the establishment and authority of the operating entity must be filed with the Secretary of State, county or municipal entities. Final operation and maintenance documents must be received by the District when maintenance and operation of the system is accepted by the local government entity. Failure to submit the appropriate final documents will result in the permittee remaining liable for carrying out maintenance and operation of the permitted system and any other permit conditions.

10. Should any other regulatory agency require changes to the permitted system, the permittee shall notify the District in writing of the changes prior to implementation so that a determination can be made whether a permit modification is required.

11. This permit does not eliminate the necessity to obtain any required federal, state, local and special district authorizations prior to the start of any activity approved by this permit. This permit does not convey to the permittee or create in the permittee any property right, or any interest in real property, nor does it authorize any entrance upon or activities on property which is not owned or controlled by the permittee, or convey any rights or privileges other than those specified in the permit and Chapter 40E-4 or Chapter 40E-40, F.A.C..

12. The permittee is hereby advised that Section 253.77, F.S. states that a person may not commence any excavation, construction, or other activity involving the use of sovereign or other lands of the State, the title to which is vested in the Board of Trustees of the Internal Improvement Trust Fund without obtaining the required lease, license, easement, or other form of consent authorizing the proposed use. Therefore, the permittee is responsible for obtaining any necessary authorizations from the Board of Trustees prior to commencing activity on sovereignty lands or other state-owned lands.

13. The permittee must obtain a Water Use permit prior to construction dewatering, unless the work qualifies for a general permit pursuant to Subsection 40E-20.302(3), F.A.C., also known as the "No Notice" Rule.

14. The permittee shall hold and save the District harmless from any and all damages, claims, or liabilities which may arise by reason of the construction, alteration, operation, maintenance, removal, abandonment or use of any system authorized by the permit.

15. Any delineation of the extent of a wetland or other surface water submitted as part

of the permit application, including plans or other supporting documentation, shall not be considered binding, unless a specific condition of this permit or a formal determination under Section 373.421(2), F.S., provides otherwise.

16. The permittee shall notify the District in writing within 30 days of any sale, conveyance, or other transfer of ownership or control of a permitted system or the real property on which the permitted system is located. All transfers of ownership or transfers of a permit are subject to the requirements of Rules 40E-1.6105 and 40E-1.6107, F.A.C.. The permittee transferring the permit shall remain liable for corrective actions that may be required as a result of any violations prior to the sale, conveyance or other transfer of the system.

17. Upon reasonable notice to the permittee, District authorized staff with proper identification shall have permission to enter, inspect, sample and test the system to insure conformity with the plans and specifications approved by the permit.

18. If historical or archaeological artifacts are discovered at any time on the project site, the permittee shall immediately notify the appropriate District service center.

19. The permittee shall immediately notify the District in writing of any previously submitted information that is later discovered to be inaccurate.

40E-4.321 Duration of Permits

(1) Unless revoked or otherwise modified the duration of an environmental resource permit issued under this chapter or Chapter 40E-40, F.A.C. is as follows:

(a) For a conceptual approval, two years from the date of issuance or the date specified as a condition of the permit, unless within that period an application for an individual or standard general permit is filed for any portion of the project. If an application for an environmental resource permit is filed, then the conceptual approval remains valid until final action is taken on the environmental resource permit application. If the application is granted, then the conceptual approval is valid for an additional two years from the date of issuance of the permit. Conceptual approvals which have no individual or standard general environmental resource permit applications filed for a period of two years shall expire automatically at the end of the two year period.

(b) For a conceptual approval filed concurrently with a development of regional impact (DRI) application for development approval (ADA) and a local government comprehensive plan amendment, the duration of the conceptual approval shall be two years from whichever one of the following occurs at the latest date:

1. the effective date of the local government's comprehensive plan amendment.
2. the effective date of the local government development order.
3. the date on which the District issues the conceptual approval, or
4. the latest date of the resolution of any Chapter 120.57, F.A.C., administrative proceeding or other legal appeals.

(c) For an individual or standard general environmental resource permit, five years from the date of issuance or such amount of time as made a condition of the permit.

(d) For a noticed general permit issued pursuant to chapter 40-E-400, F.A.C., five years from the date the notice of intent to use the permit is provided to the District.

(2)(a) Unless prescribed by special permit condition, permits expire automatically according to the timeframes indicated in this rule. If application for extension is made in writing pursuant to subsection (3), the permit shall remain in full force and effect until:

1. the Governing Board takes action on an application for extension of an individual permit, or
2. staff takes action on an application for extension of a standard general permit.

(b) Installation of the project outfall structure shall not constitute a vesting of the permit.

(3) The permit extension shall be issued provided that a permittee files a written request with the District showing good cause prior to the expiration of the permit. For the purpose of this rule, good cause shall mean a set of extenuating circumstances outside of the control of the permittee. Requests for extensions, which shall include documentation of the extenuating circumstances and how they have delayed this project, will not be accepted more than 180 days prior to the expiration date.

(4) Substantial modifications to Conceptual Approvals will extend the duration of the Conceptual Approval for two years from the date of issuance of the modification. For the purposes of this section, the term "substantial modification" shall mean a modification which is reasonably expected to lead to substantially different water resource or environmental impacts which require a detailed review.

(5) Substantial modifications to individual or standard general environmental resource permits issued pursuant to a permit application extend the duration of the permit for three years from the date of issuance of the modification. Individual or standard general environmental resource permit modifications do not extend the duration of a conceptual approval.

(6) Permit modifications issued pursuant to subsection 40E-4.331(2)(b), F.A.C. (letter modifications) do not extend the duration of a permit.

(7) Failure to complete construction or alteration of the surface water management system and obtain operation phase approval from the District within the permit duration shall require a new permit authorization in order to continue construction unless a permit extension is granted.

Specific authority 373.044, 373.113 F.S. Law Implemented 373.413, 373.416, 373.419, 373.426 F.S. History—New 9-3-81, Amended 1-31-82, 12-1-82, Formerly 16K-4.07(4), Amended 7-1-86, 4/20/94, Amended 7-1-86, 4/20/94, 10-3-95

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
3301 Gun Club Road, West Palm Beach, Florida 33406 • (561) 686-8800 • FL WATS 1-800-432-2045 • TDD (561) 697-2574
Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680 • www.sfwmd.gov

CON 24 - 06
Environmental Resource Regulation Department

PRE- AND DURING CONSTRUCTION REQUIREMENTS:

- Permit conditions require these forms to be completed and submitted to District staff within specified time frames.
- These forms are provided to the **PERMITTEE ONLY**, as the entity responsible to satisfy permit conditions, and not his or her agent.

CONSTRUCTION COMMENCEMENT NOTICE (Form No. 0960)

- For Environmental Resource / Surface Water Management Permits
- Submit within 30 days of permit issuance.
- If dates are not known, notify the District in writing to avoid post-permit compliance action; submit form once dates are determined. Be sure to reference both the application number and permit number on any correspondence.

ANNUAL STATUS REPORT FOR SURFACE WATER MANAGEMENT SYSTEM (Form No. 0961)

- For Environmental Resource / Surface Water Management Permits
- Submit yearly from the date of construction commencement if construction exceeds one (1) year.

(Rev 6/02)

GOVERNING BOARD

Nicolas J. Gutiérrez, Jr., Esq., *Chair*
Pamela Brooks-Thomas, *Vice-Chair*
Irela M. Bagué
Michael Collins
Hugh M. English
Lennart E. Lindahl, P.E.
Kevin McCarty
Harkley R. Thornton
Trudi K. Williams, P.E.

EXECUTIVE OFFICE

Henry Dean, *Executive Director*

Projects in the following counties should respond to the corresponding SFWMD Service Center:

Broward, Highlands, Miami-Dade, Martin, Monroe, Okeechobee, Palm Beach, and St. Lucie Counties:
Please respond to the West Palm Beach Service Center.

SFWMD
Environmental Resource Compliance Division
MSC 4230
P.O. Box 24680
West Palm Beach, FL 33416-4680

(561) 686-8800; (800) 432-2045

Charlotte, Collier, Glades, Hendry, and Lee Counties:
Please respond to the Ft. Myers Service Center.

SFWMD
Environmental Resource Compliance Division
MSC 4720
2301 McGregor Blvd.
Ft. Myers, FL 33901

(941) 338-2929; (800) 248-1201

Orange, Osceola, and Polk Counties:
Please respond to the Orlando Service Center.

SFWMD
Environmental Resource Compliance Division
MSC 4710
1707 Orlando Central Parkway, Suite 200
Orlando, FL 32809

(407) 858-6100; (800) 250-4250

(Rev 6/02)

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Environmental Resource/Surface Water Management Permit Construction Commencement Notice

FORM 0960
08/95

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Field Engineering Division

PROJECT NAME: _____ PHASE: _____

I hereby notify the South Florida Water Management District Field Engineering Division that construction of the surface water management system, authorized by Environmental Resource/Surface Water Management Permit No. _____ under Application No._____ has commenced/is expected to commence on _____ 199___ and will require a duration of approximately _____/months _____/weeks _____/days to complete. Should the construction term extend beyond one year, I will submit Form No. 0961, Environmental Resource/Surface Water Management Permit Annual Status Report for Surface Water Management System Construction, to the District.

PLEASE NOTE: If the actual construction commencement date is not known, District staff should be so notified in writing. This will eliminate the necessity of further post permit compliance action concerning satisfaction of the Permit condition.

_____ _____
Permittee's or Authorized Agent's Signature — Title and Company

_____ _____
Phone — Date

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Environmental Resource/Surface Water Management Permit Annual Status Report for Surface Water Management System Construction

FORM 0967
08/95

(Required whenever construction duration exceeds one (1) year)

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Field Engineering Division

PERMIT NO. _____ APPLICATION NO. _____
PROJECT NAME: _____ PHASE: _____

Control Structure(s)	% of Completion	Date of Anticipated Completion	Date of Completion

Benchmark Description (one per major control structure): _____

SWM Facilities	% of Completion	Date of Anticipated Completion	Date of Completion
Lake(s)			
Ditch(es)/Swale(s)			
Exfiltr. Trench			
Dry Area(s)			
Berm(s)			

Print Name _____ Phone _____ Date _____

Permittee's or Authorized Agent's Signature _____ Title and Company _____

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
3301 Gun Club Road, West Palm Beach, Florida 33406 • (561) 686-8800 • FL WATS 1-800-432-2045 • TDD (561) 697-2574
Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680 • www.sfwmd.gov

CON 24 - 06
Environmental Resource Regulation Department

POST-CONSTRUCTION REQUIREMENTS
For projects remaining under single ownership

CONSTRUCTION COMPLETION / CONSTRUCTION CERTIFICATION (Form No. 0881)

- For Environmental Resource / Surface Water Management Permits
- Submit within 30 days of construction completion
- A Florida registered professional engineer must certify that all surface water management system facilities are constructed in substantial conformance with plans and specifications approved by the District
- Required by Sections 373.117 and 373.419, Fla. Stat.
- If another certification form is used by the engineer, it must address all components of the surface water management system
- Statement that **all** permit conditions are satisfied

(Rev 6/02)

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Orlando, FL 32809

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(Rev 6/02)

South Florida Water Management District

ENVIRONMENTAL RESOURCE / SURFACE WATER MANAGEMENT PERMIT
SURFACE WATER MANAGEMENT SYSTEM
CONSTRUCTION COMPLETION CERTIFICATION

FORM 0881A
09/2003

ENVIRONMENTAL RESOURCE COMPLIANCE DIVISION

PERMIT NO._____ APPLICATION NO(s)._____

PROJECT NAME: _____ PHASE: _____

The subject surface water management system has been designed, constructed and completed as follows (check all that apply):

DISCHARGE STRUCTURE(S) Please provide the requested information for all permitted discharge structures. Attach additional sheets if needed.

Structure Identification Number: _____

☐ **Weir**: width _____ crest _____

☐ **Bleeder**: type _____ dimensions _____ invert _____

☐ Additional discharge structure information attached.

RETENTION/DETENTION AREA(S): Please provide the requested information for all permitted retention/detention areas. Attach additional sheets if needed.

Retention/Detention Area Identification Number: _____ Size (acres) _____

Side Slope (h:v) _____

☐ Additional retention/detention area information attached.

☐ **EXFILTRATION TRENCH** – Confirmation of cross-section with pipe size and invert, trench width, height and length is provided on the attached.

☐ **CONVEYANCE SYSTEM ONLY** - The components of the permitted surface water management consist of inlets, pipes or other form of conveyance system. Confirmation of ditches, canals, and/or swales with cross-sections, pipe diameters, inverts, and lengths is provided on the attached.

Please indicate the location of the benchmark(s) used to determine the above information on the record drawings (40E-4.381(1)(f), F.A.C. Code). All elevations should be according to National Geodetic Vertical Datum (NGVD). _____

_____

I HEREBY NOTIFY THE DISTRICT OF THE COMPLETION OF CONSTRUCTION OF ALL THE COMPONENTS OF THE SURFACE WATER MANAGEMENT FACILITIES FOR THE ABOVE REFERENCED PROJECT AND CERTIFY THAT THEY HAVE BEEN CONSTRUCTED IN SUBSTANTIAL CONFORMANCE WITH THE PLANS AND SPECIFICATIONS PERMITTED BY THE DISTRICT. [A COPY OF THE APPROVED PERMIT DRAWINGS IS ATTACHED WITH DEVIATIONS NOTED, IF APPLICABLE.]

Engineer's Signature, Seal and Date:

Please Print or Type:

Engineer's Name_____

Company Name_____

Address_____

_____

Authorization No. of Engineering Business (if applicable): _____

Telephone Number _____

E-mail _____

APPENDIX E-2

Draft Compensatory Mitigation Recommendations of the Port Everglades Reef Group for Navigation Improvements at Port Everglades Harbor (2004)

Mitigation Requirements Analysis for Hardbottom Resources Associated with Port Everglades Harbor Navigation Improvements

Prepared for
U.S. Army Corps of Engineers
Jacksonville District
701 San Marco Blvd.
Jacksonville, FL 32207

by
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490 Osceola Avenue
Jacksonville Beach, FL 32250

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West Palm Beach, FL 33401

Revised October 2012 by USACE-SAJ

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September 25 & 26, 2007
November 27, 2007

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1.0 INTRODUCTION

The Jacksonville District U.S. Corps of Engineers (USACE) is presently completing a feasibility study in part to evaluate the widening and deepening of the Outer Entrance Channel (OEC) of Port Everglades Harbor (Broward County, Florida). The proposed project would impact offshore marine biological resources, including reef communities offshore of the port. Dial Cordy and Associates Inc. (DC&A) was contracted by the USACE to complete two distinct tasks. First, DC&A was charged with mapping benthic habitats and assessing population levels of reef biota, particularly reef fishes and sessile organisms (i.e., macroalgae, sponges, gorgonian corals and hard corals) associated with the two north-south oriented, parallel reef tracts that are likely to be directly or indirectly impacted by OEC improvements (see DC&A 2009). Second, and the subject of this report, DC&A was charged with coordinating a habitat equivalency analysis (HEA) for use in determining suitable compensatory mitigation for hardbottom resource impacts identified in the mapping and assessment effort. The Corps followed with an additional mitigation requirement analysis utilizing the Visual HEA software package developed by the National Coral Reef Institute (NCRI) (Kohler and Dodge, 2006 included in Appendix A).

The Corps has conducted a modified HEA using a 0% discount rate, in compliance with OMB Circulars and Corps regulations and guidance. There was significant disagreement between the Core Group and the Corps's science staff regarding the input parameters into the HEA, and a result, all inputs into the Corps' modified HEA are based on peer reviewed literature. The analysis determined that 35.75 acres of mitigation is required for impact scenario 1 and 27.94 acres of mitigation is required for impact scenario 2.

2.0 THE ROLE OF HABITAT EQUIVALENCY ANALYSES

Compensatory mitigation is intended to replace the ecological services that are lost as a result of unavoidable impacts to resources affected by a given project. "Ecological services" refer to the services performed by a resource for the benefit of other resources or the public. The baseline for quantifying lost ecological services is the full complement of services that would have been provided absent project implementation. Lost ecological services are quantified as the reduction in the provision of services below this baseline. Compensatory mitigation must restore services commensurate with the character of lost services. The *amount* of compensatory mitigation needed to replace lost services depends, in part, on the ability of the affected resources to return to their baseline conditions. Factors relevant in that regard include the quantity of the affected resources and how fast and how completely they return to their baseline conditions. The amount of compensatory mitigation also depends on the ability of the selected compensatory mitigation measures to replace lost services. Relevant factors for replacement include how fast the compensatory mitigation measures become fully functional and the relative degree to which they provide additional ecological services. An HEA takes into account the above factors, and can be used to determine the appropriate quantity of compensatory mitigation (King 1997).

Habitat equivalency analysis is specifically designed to determine the compensation the public is due to reconcile injuries to the ecosystem and the lost services the ecosystem provides to the biotic component. King (1997) noted "when injured resources and/or services are primarily of indirect human use the appropriate basis for evaluating and scaling the restoration is HEA." The HEA method is specifically used in cases of habitat injury when the service of the injured area is ecologically equivalent to the service that will be provided by the replacement habitat. This approach is termed "service-to-service" (Strange 2002) and assumes the public is willing to accept a one-to-one trade-off between the service lost and the service gained by the restoration

(National Oceanic and Atmospheric Administration, or "NOAA" 1997). Of course, HEAs are, by necessity, simplified representations of very complex ecosystems.

Multiple types of injuries can be quantified in an equivalent manner through the use of HEA (Dunford *et al*. 2004). For marine environments, the HEA method has been successfully applied to vessel groundings on coral reefs (Milon and Dodge 2001) and seagrass damage cases (Fonseca *et al*. 1998; Fonseca *et al*. 2000). When this approach is used for scaling losses of fish, birds, and other wildlife, the method is sometimes termed resource equivalency analysis (REA). REA is a resource-to-resource method that references the number of organisms lost and gained. NOAA has recently used the REA method to scale injuries to coral resources related to vessel groundings within the Florida Keys National Marine Sanctuary (FKNMS) by evaluating the losses to stony corals and not the entire habitat affected. A similar approach was employed by the National Coral Reef Institute (NCRI 2003) for a cable injury to hardbottom resources in the vicinity of Hillsboro Inlet in Broward County.

HEA has also been used in other policy contexts involving the loss of ecological services. For example, it is widely used in natural resource damage assessments conducted under the Oil Pollution Act of 1990 (33 U.S.C. 2701 *et seq.*) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601 *et seq.*).

3.0 HEA THEORY AND METHODOLOGY

King and Adler (1991) first described habitat equivalency analysis as a methodology for scaling compensatory mitigation under Section 404 of the Clean Water Act. A more recent description of the methodology can be found in Allen, Chapman, and Lane (2005). Briefly, HEA calculates compensatory mitigation so that the total quantity of ecological services it provides is sufficient to offset the total quantity of lost ecological services resulting from the project impacts. When quantifying ecological services, it is important to note that they have a temporal dimension as well as a geographic dimension (e.g., a given area of coral habitat provides beneficial services over a period of time). Therefore, ecological services are quantified in HEA as units of measure, such as acre-years. <u>An acre-year refers to all the ecological services provided by one acre of habitat for one year</u>. For example, 100 acre-years of services might be provided by a 5-acre habitat over a period of 20 years, or by a 10-acre habitat over a 10-year period. This characterization captures not only the important aspect of the physical size of a resource, but also the time interval during which functions are provided.

This measure ("acre-years") of ecological services is obviously habitat-specific, as different habitats provide different services. Therefore, it is important to select compensatory mitigation measures that provide replacement services that are comparable to the lost services (i.e., in-kind replacement). If that is not possible, some meaningful adjustment must be made to equate the replacement services to lost services.

Another important consideration in the quantification of services is time preference. In general, many people prefer present resource uses over future uses for a variety of reasons (such as uncertainty and impatience). This time preference is important when considering how to balance lost and replacement services that occur at different times, since their tradeoffs vary through time. Therefore, the quantities of ecological services occurring at different times are not valued on an equivalent basis and must be adjusted before they can be compared in a meaningful way. <u>This adjustment process, known as discounting, permits one to examine quantities occurring at different times on a comparable basis</u>. The adjustment involves decreasing future quantities and increasing past quantities each year by a proportional amount, known as the discount rate. Discounting, in this context, is analogous to a bank's calculation of compound interest for a

deposit or loan. The common time period to which all lost and replacement ecological services are discounted for sake of comparison is known as the present time period.

Through this process of quantifying and discounting ecological services, HEA takes into account losses and gains that occur over different timeframes to determine a scale of compensatory mitigation that is commensurate with the type, level, and duration of lost services. Because HEA accounts for all these important aspects, different compensatory mitigation projects will generally have different scales. For example, a compensatory mitigation project that becomes fully functional in five years will have a smaller indicated scale than one that requires ten years to become fully functional. Therefore, it is important that the compensatory mitigation projects selected for analysis be chosen carefully. HEA is not used to select compensatory mitigation projects, only to determine their scale.

The public is considered fully compensated for ecological losses when the scale of restoration needed to offset losses of resources and services is achieved. HEA establishes the discounted service acre-year as the "common currency" for comparison of the public's value of past injury and future restoration in a common time frame (Julius 1999). One service acre-year is defined as the ecological service provided by one acre in one year. Economic discounting is used to express past injury and future restoration units in a common time (Julius 1999). So, <u>one discounted service acre-year (DSAY) is the service provided by one acre in one year "discounted" to net present value</u>. Area of injured habitat, percent loss of ecological services, duration of injury, are considered in HEA to determine DSAYs.

Cumulative DSAYs earned for a particular restoration project are dependent upon the type of habitat that is restored, the increases in habitat services offered as a result of restoration construction, and the amount of time over which services are provided by the restored habitat. The DSAYs earned over the duration of the restoration project are then translated to present time using a 0% discount rate (see discussion of selection of discount rate below) per USACE and Office of Management and Budget regulations and guidance for Federal water resource development projects.

Two different methods of calculating HEA exist, Landscape and Population HEA (Milon and Dodge, 2001). Landscape HEA is most appropriate when the impacted habitat is relatively uniform landscapes with little difference in biological functions across the injured area, this is the method historically employed by NOAA. Examples include injuries to coral reef (Juliuis, et al, 1995), and seagrass (Zieman, 1997) environments in the Florida Keys National Marine Sanctuary. Population HEA may be considered where the total injury area is characterized by a variety of organism groups with different life histories (i.e lifespan). The Population HEA is calculated using the proportional cover of the different groups which make up the community. This results in a recovery time for the population of the group(s) chosen for HEA analysis.

4.0 TECHNICAL APPROACH FOR PORT EVERGLADES HEA

4.1 USACE Involvement in Two HEA Study Efforts

In addition to the HEA performed by DC&A for the USACE, the USACE convened a panel of invited experts (a.k.a. "Core Group") on a number of occasions between November 2006 and November 2007 to assist in using HEA to determine the quantity of mitigation that would be required for this project. The panel met with USACE to determine the necessary HEA input parameters and to run the HEA. Consensus as to which values to use for the various input parameters was never achieved between the panel and the USACE. Disparate parameters

included everything from the discount rate to recovery projections. Accordingly, the outcome of these meetings resulted in the Core Group and USACE performing a number of HEAs using a wide variety of input values. The extreme upper limits for required compensatory mitigation were calculated with input values assigned by the Core Group, while the outcomes presented in this report were calculated with input values selected by USACE in consultation with DC&A. DC&A, in associated with the Battelle Memorial Institute, developed these input values for these HEAs using peer-reviewed scientific literature, *in situ* field conditions and quantitative measurements, local project knowledge and expertise, and assumptions regarding best management practices during project implementation (construction). The analyses for the various HEAs were performed by Dr. Steven Thur (NOAA-Office of Response & Restoration) at the request of, and using values proposed by, USACE as a result of DC&A/Battelle research and investigations. After determining that discount rates should not be applied to Federal water resource development projects per Office of Management and Budget Circulars A-4 and A-94 (Regulatory Analysis and Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, respectively), when federal agencies are determining costs and benefits, USACE reran the HEAs utilizing the NCRI "Visual HEA" software package and verified the numbers utilizing a copy of the NOAA spreadsheets obtained through the District's regulatory branch to ensure that the change in discount rate from 3% to 0% resulted in similar results. Screenshots of the input parameters and annualizer table results for the resulting HEAs from Visual HEA are included as Appendix A to this report. All assumptions developed by the Resource agency team regarding function of impact sites and mitigation sites were incorporated into these analyses. Where the agencies and the Corps disagreed on an input parameter, the Corps' parameter was chosen and inputted into the model. All of the assumptions from the September 2007 HEA workshop and the final meeting notes from that workshop are included in this report as Appendix B. Determination of resource impacts was based on the most recent impact footprint provided in GIS shapefile format from the Corp's Engineering Division. This shapefile was overlaid on the Walker *et al* (2007) dataset from FLDEP's SEFCRI program and the impacts to each of identified habitat types were calculated.

4.2 Type of HEA Used for Analyses

For the purpose of the Port Everglades HEA, the method employed by the Corps uses a Landscape HEA with stony corals as the representative proxy for the entire habitat affected. While stony coral coverage is <1% in the project footprint and vicinity (Gilliam *et al*. 2004, DC&A 2008), we did not use a proportional analysis to calculate the coral impacts. Instead, the losses are calculated as the amount of time it would take for the slowest-growing members of the ecosystem, in this case the stony corals, to recover to baseline, for the entire project footprint. Therefore, it is assumed that all other functional attributes of the system (octocorals, sponges, calcareous algae, mobile fauna, etc.) will recover to baseline in less time. This landscape HEA is an extremely conservative estimate of the recovery for the entire ecosystem and therefore, is the most appropriate method for scaling the required compensatory mitigation for impacts from a large-scale project such as the proposed Port Everglades expansion.

When comparing the two types of HEAs, the rationale previously used by NCRI (2003) for using a Population HEA to assess the anchor cable damage associated with cable damage in a hardbottom habitat located north of Port Everglades was that "State agencies have indicated they feel the presence of hard coral, soft corals and sponges to be equally important." However, because the recovery projections for both octocoral and sponge assemblages (15 years) are more rapid than stony corals, the NCRI (2003) method underestimates the value of the benthic resources at the landscape scale, and therefore, was dismissed as a viable method for the Port Everglades evaluation.

4.3 Characterization of Hardbottom Resources in Proposed Impact Area

Due to the significant level of disagreement between the Core group and the Corps, we believe it is necessary to clearly delineate the basis for the impact assumptions used by the Corps in our mitigation assessment using a modified HEA.

Hubbard (2001) noted the importance in distinguishing between "true reefs" and "isolated stands of coral that may be ephemeral in nature and shift from spot to spot." Therefore, understanding the precise meaning of the term as it pertains to the biology and geology of the submerged resources of the southeast Florida shelf is essential and necessary for determining the input parameters necessary to accurately perform this HEA. Outstanding reviews on the "coral reef" problem can be found in Buddemeier and Hopley (1988), Hubbard (2001), and Kleypas et al. (2001), among others. Specifically, Buddemeier and Hopley (1988) stated: "as a minimal definition of a potential reef-building community, we specify that it must contain a significant and robust population of the major classes of reef-building organisms (e.g., framework building corals) and must be capable of developing average community calcification rates that permit vertical and/or lateral accretion." Following this premise, Kleypas et al. (2001) noted that, for a coral community to be a reef, its "[$CaCO_3$] accumulation must exceed zero to meet the most common definitions of a coral reef. The local coral-algal community must be responsible for most of the carbonate addition to the reef…" These conventions have been adopted in recent coral reef classifications such as ReefBase (McManus and Vergara 1998), which distinguishes between coral reefs and non-reef building communities that contain some living coral.

Literature indicates that the offshore hardbottom ridges and terraces in Broward County may not be true coral reefs. The northward extension of the "Florida Reef Tract" to areas north of Fowey Rocks (Miami) was first proposed by Shaler (1890). While noting that individual colonies of stony corals were present north of Fowey Rocks, Vaughan disputed this "reef" interpretation based upon a series of investigations (Vaughan 1914, 1916, 1916, 1918, 1919a, 1919b). Vaughan specifically noted that: (1) the main reef building coral species of *Acropora palmata* and *Orbicella annularis* (*Montastraea annularis sensu stricto*) were essentially absent from areas north of Fowey Rocks due to cold-water limitations; (2) Fowey Rocks was the northernmost limit of constructional bank reefs that built their structures to sea level; and (3) while there are some living reef corals in the vicinity of and to the north of Fowey Rocks, there was no thriving reef. It was precisely the fact that there were no living reefs north of Fowey Rocks that limited Vaughan's reef investigations to south of that latitude and not the contrary view that reefs were always there but he just overlooked them due to a lack of rigorous sampling. The fact that Vaughan's reported northern limit to reef growth in Florida to be at Fowey Rocks has been repeatedly validated by numerous reef scientists, is a testament to his keen observational skills.

Using sparker profiles, Duane and Meisburger (1969a, 1969b) identified a number of linear "drowned reef-like features" and "low reef-like ridges that run parallel to shore" that were suggestive of reef buildups. They identified these ridges as "barren;" however, they did not study the biology of the communities living on these ridges and were very careful not to call these structures contemporary, living coral reefs. They used an abbreviated term "reef-line" to graphically depict the progressive reef-like ridges in their bathymetric profiles and plan view map. The term "reef-line" of Duane and Meisburger (1969) was used strictly in a geomorphic sense. In a larger, more regional geologic study that included extensive biological sampling of these submerged ridges, Macintyre and Milliman (1970) commented "The lack of active reef-framework construction on this ridge and the presence of deeper reef fauna (such as alcyonarians, sponges, and scattered coral heads) give this feature the surface characteristics of a submerged reef or drowned reef…However, this ridge cannot be considered a submerged reef because it is well

within the depth range (<20m) for the vigorous growth of reef building corals." Macintyre and Milliman (1970) used the term "inactive coral reef" to describe the benthic community found on the ridges between Palm Beach and Fort Lauderdale. They also noted, at the time of their study, that "data are insufficient to speculate on the age or specific mode of accretion (of these ridges)." Soon thereafter, in a master's thesis that focused on the recent sedimentology of the nearshore environments of Broward County, Raymond (1972) described the three parallel hardgrounds (reefs) off Fort Lauderdale as "primarily dead reef rock with an impoverished community of hard corals." At approximately the same time, Goldberg (1973) studied the ecology of the three shore-parallel submarine terraces that stretch from Miami to Palm Beach. Goldberg (1973) stated that "…the exact nature of these structures is not known. They may be coral reefs, or they may consist of a recent coral veneer overlying Pleistocene beachrock. For the purposes of this paper, the term 'reeflike ridges' will be abbreviated and the term 'reef' will be used where physiographically applicable." Careful reading of these scholarly works does not support the use of the term *reef* in a biological sense. In fact, these authors were all careful to not call these true reefs and qualified the usage of the term.

In the 1970s, a series of offshore wastewater outfalls was constructed in south Florida. These man-made trenches provided an unprecedented opportunity to study the internal structure, architecture, and reef facies of the relict ridges on the southeast Florida shelf (Lighty 1977, 1985; Shinn *et al*. 1977; Lighty *et al*. 1978, 1979). These studies revealed, for the first time, a glimpse into the Holocene history and the environments north of Fowey Rocks. Shinn et al. (1977) briefly described "an almost continuous unnamed 'fossil' reef… that extends northward to at least Palm Beach…" Lighty (1977, 1985; Lighty *et al*. 1978, 1979) studied this outer ridge in the vicinity of Hillsboro Inlet in Broward County. Lighty (references above) described a spectacular, relict shelf-edge barrier reef system dominated by massive wave-resistant growth forms of fossil *Acropora palmata*. Samples of collected *A. palmata* taken from within the trench were radiocarbon dated. These corals ranged in age from 7,145 $\pm$ 80 to 9,440 $\pm$ 85 (uncorrected) years before present (BP). Lighty (1977) used these dates to mark the end of active reef growth on this third terrace in Broward County. He stated "the shallow-water reef 'died' about 7,000 years ago and there has been no active reef-framework accumulation since that time." Lighty (1977), discussing the distribution of the modern fauna living on this outer ridge, highlighted the fact that "although this is shallow enough for vigorous coral growth [there is an] apparent absence of several tropical coral species, including *A. palmata* on the present surface of the relict reef." By combing the Holocene history of this reef structure, with the depauperate nature of its present living epifaunal biotic community, Lighty (1977) concluded this early-to-middle Holocene age fossil reef to be "inactive," following the terminology in Macintyre and Milliman (1970).

In a recent detailed study of the Broward County ridges, Banks et al (2007) characterized the area as, "The Holocene shelf-edge and mid-shelf reef/ridge complex extending along the continental coast of SE Florida from Biscayne Bay northward to offshore of Riviera Beach in northern Palm Beach County, a distance of 128 km." The location of these reefs identifies them as a distinct and also presently non-accreting reef tract (Macintyre 1988) and although previous studies have stated that they are a continuation of the Florida Keys reef tract (Goldberg 1973; Toscano and Macintyre 2003), there has been no confirmation of this. The growth of corals on the Florida Keys reef tract is generally considered to terminate at Fowey Rocks (Vaughan 1914; Jaap 1984; Shinn et al. 1989). Lighty (1977), Lighty et al. (1978, 1982) suggest 14C ages for the outer reef of the northern, continental complex as between 8,000 and 11,000 cal BP [calibrated 14C age in years before present (Toscano and Macintyre 2003)]. The demise of the reefs has been variably attributed to cold counter-current water from the north, a major influx of sediment-rich water originating from the south during the Holocene transgression (Macintyre and Milliman 1970; Lighty et al. 1978; Macintyre 1988), low water temperatures during the early Holocene (Lighty et al. 1978)." This work further confirms the relict (fossil) nature of the terraces (ridges)

but says nothing about the ephemeral benthic living resources that are present on the upper surface of the hardbottom.

In the 1980s, a series of papers was published describing the conditions favorable for coral reef development in south Florida. One of these was a community profile report by Jaap (1984), in which he noted that, "the region of maximum coral reef development is restricted to south and west of Cape Florida…" In specifically addressing the area from Palm Beach to Miami (Cape Florida), he stated, "elements of the tropical coral reef biota become increasingly important in a north-to-south gradient; however, the building of three-dimensional reef structures does not occur. This area is characterized as an octocoral-dominated hardground community." Dodge (1987) also noted, "In general, southeast Florida reefs are considered to be 'relict' or fossil structures which are not in an active growth mode, but which are now veneered by a variety of living organisms. The area has been characterized as an octocoral-dominated hardground community (Goldberg 1973, Jaap 1984)." Furthermore, the South Atlantic Fisheries Management Council classified the benthic habitat throughout Broward County as a "hardbottom," where that term constitutes a group of communities characterized by a thin veneer of live corals and other biota overlying assorted sediment types. Hardbottoms are usually of low relief and many are associated with relict reefs, where the coral veneer is supported by dead corals (SAFMC 1998). More recently, a synoptic survey was published by Moyer et al. (2003) where they noted, "The reef-like ridges are a relict (no active accretion due to exceedingly low cover of reef builders)." In ground-truthing these benthic habitats, Moyer et al. commented that, "scleractinian coral cover was low in all areas (and) colony size is small…, and that, alcyonarians were typically the most important faunal group in determining community structure." In addition, Precht and Miller (2006) noted the following:

> "…coral reefs in the Florida Keys that are typically described as the ones in need of salvation represent only a fraction—about 2%—of the total coral habitat in the Florida Keys. These are the shallow spur-and-groove locations that, until recently, were dominated by *A. palmata* and *A. cervicornis*, and they are the reefs that kept pace with rising sea level through the Holocene; they are the named reefs on nautical charts. The other 98% of coral habitat in the Keys are vast stretches of shallow and deep hardbottom habitats characterized by low hard-coral cover, variable but often-high algal cover, and variably abundant gorgonians and sponges. Many of these habitats have probably changed very little over the last 20 years (and possibly much longer), but monitoring programs do not typically include such sites in their studies."

These hardbottom coral communities that have been described throughout the Florida Keys National Marine Sanctuary are similar in composition and make-up to the offshore hardbottom resources found within the project area in Broward County.

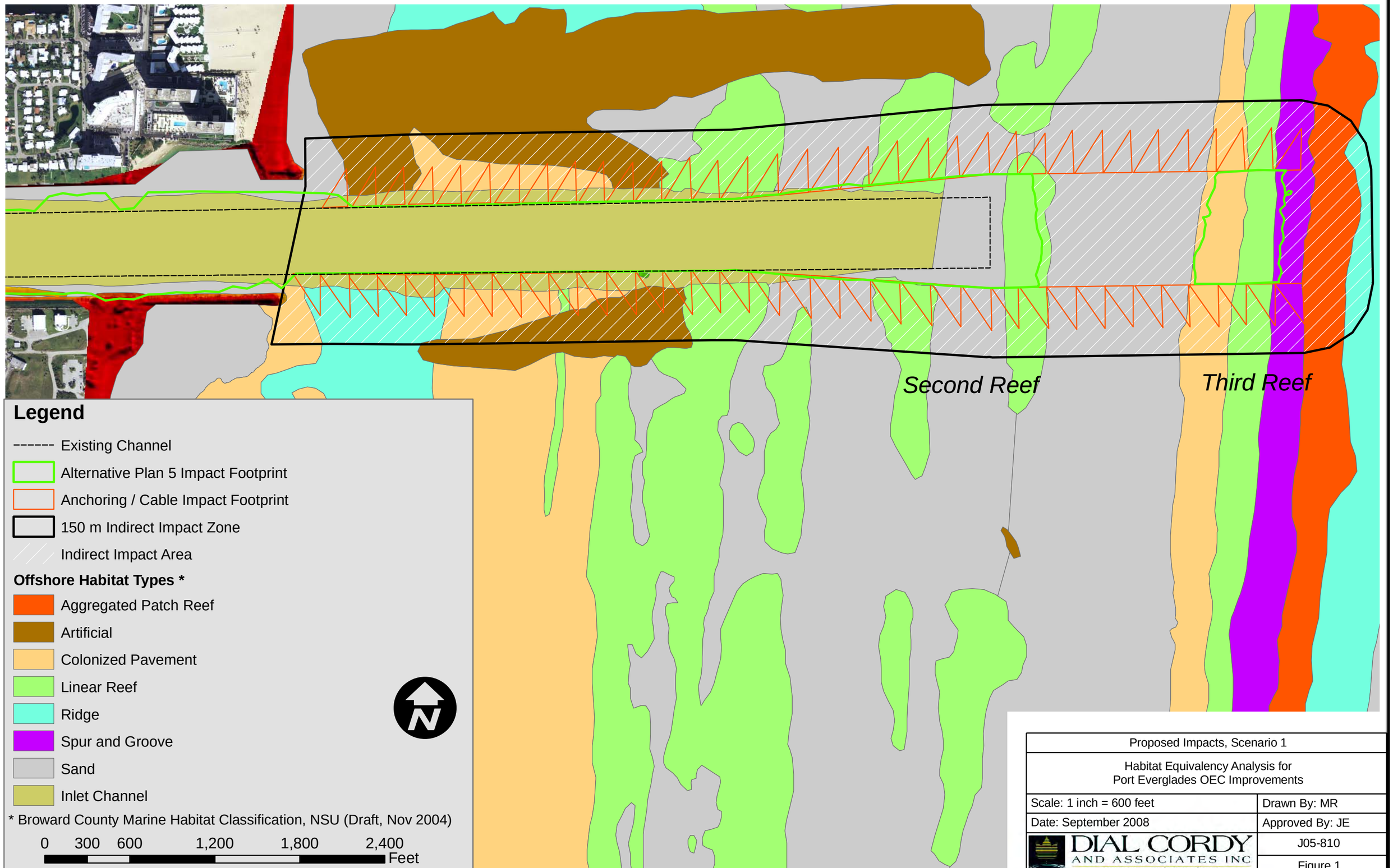
Climate change is an important determinant of the distribution of high-latitude reef systems. Under current scenarios of global warming, the continued, rapid northward expansion of *Acropora*-dominated reefs in the western Atlantic is a strong possibility and we cannot discount the possibility of acroporid coral thickets moving progressively northward (Precht and Aronson 2004). On the other hand, the negative effect of global climate change through increased sea surface temperatures may be evidenced in the project area through (1) coral bleaching, (2) disease-induced stress resulting in morbidity and mortality of the corals and other biota, and (3) direct physical impacts from hurricanes and tropical storms. It should be noted, however, that within the context of HEA recovery projections, there is no allowance for a "shifting baseline" caused by changes in the condition of the reference community due to these or other factors into the future.

In addition to the intrinsic depauperate nature of the benthic resources both within and outside of the proposed project area, these coral communities are also subject to on-going natural and human disturbances. These disturbances include the negative effects of both hyper- and hypothermic stress; acute heavy wave action during hurricanes and storms; chronic turbidity, siltation and sedimentation associated with terrigenous runoff; sediment resuspension; low salinity caused by freshwater inputs; nutrient availability from sewer outfalls; seasonal algal blooms related to upwelling; low abundance and diversity of herbivores (echinoids and fish); overfishing; physical impacts caused by recreational boat anchoring and by slack ship towing cables that scrape the seafloor and major grounding of large vessels (Vaughan 1916; Goldberg 1973; Rogers 1990; Telesnicki and Goldberg 1995; Szmant 2002; Moyer *et al*. 2003; Gilliam *et al*. 2004; Precht and Aronson 2004; Paul *et al*. 2005; Jaap *et al*. 2006). These disturbances, both separately and in combination, are responsible for the way these communities appear and function today.

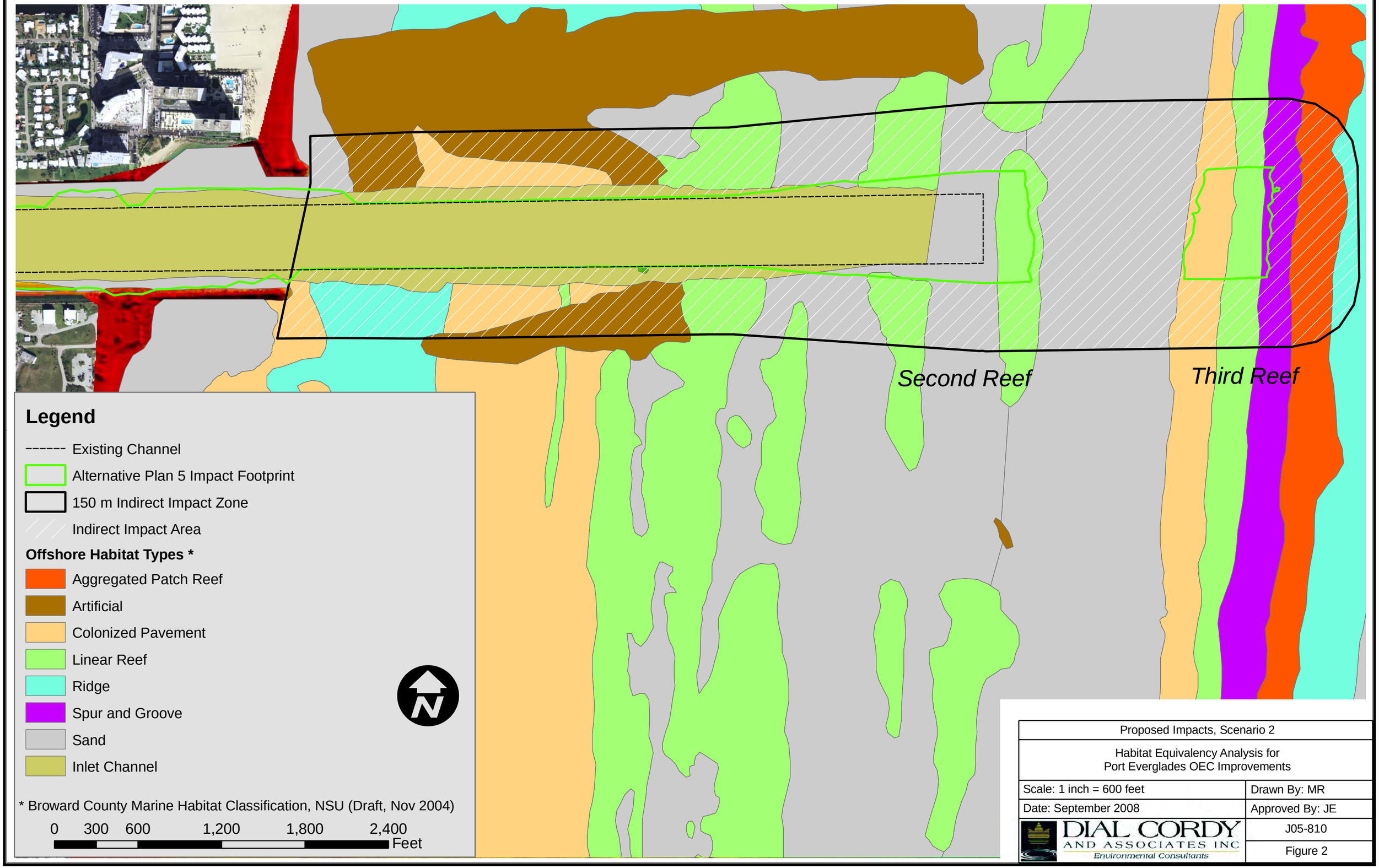
The above discussion of the diminished present condition of the benthic community, compared to its former condition millennia ago, however, is not meant to diminish its present or future value in terms of socio-economic services and resource use. It is intended to be used as a guide for developing an accurate baseline for determining the scale and scope of ecosystem service losses expected as a result of implementation of the proposed Port Everglades navigation improvements, and determining sufficient compensation to the public for damage to affected natural resources.

4.4 Quantification of Biological Impacts

To carry out a detailed impact analysis, and subsequently determine suitable compensation, an understanding of the spatial arrangement of live-bottom resources near the port is necessary. The reef complex offshore of Broward County comprises three, north-south oriented, parallel tracts in waters ranging from approximately 25 to 70 feet deep. The three reef tracts are alternatively referred to (depending on source of information, i.e., historic or recent literature or study) as the “inner,” “middle, and “outer” reefs, or the “first,” “second”, or “third” reef, respectively. Hence, the “outer” or “third” reef refers to the reef tract furthest from shore. Various researchers have also found it useful to refer to the first, second, and third reefs as “Reef 1,” “Reef 2,” and “Reef 3,” particularly when designating sample stations (i.e., R1, R2, R3). The footprint for the proposed Port Everglades OEC widening and deepening includes impacts to sections of the middle reef (or Reef 2) and the outer reef (or Reef 3) off Broward County (see Figures 1 and 2).



Proposed Impacts, Scenario 1	
Habitat Equivalency Analysis for Port Everglades OEC Improvements	
Scale: 1 inch = 600 feet	Drawn By: MR
Date: September 2008	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J05-810
	Figure 1



Proposed Impacts, Scenario 2	
Habitat Equivalency Analysis for Port Everglades OEC Improvements	
Scale: 1 inch = 600 feet	Drawn By: MR
Date: September 2008	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J05-810
	Figure 2

As discussed above, the communities that occupy the middle and outer reefs are dominated by octocorals and sponges and support relatively few scleractinians that are generally small in size (Moyer *et al*. 2003; Gilliam *et al*. 2004; DC&A 2009). Findings of DC&A (2009), along with the support of various other literature, primarily guided the quantification of interim losses (i.e. injury to biota resulting in decreased services) associated with the proposed construction plans.

DC&A was contracted by the USACE to conduct a survey of the benthic habitats and assess population levels of hardbottom communities (sessile organisms and reef fish) offshore of Broward County on the middle (Reef 2 or R2) and outer reefs Reef 3 or R3) that may be directly and indirectly impacted by improvements to Port Everglades. A summary of methods and results excerpted from DC&A (2009) follows (the report text, figures, and appendices of that report should be consulted for details, including those regarding the precise positions of sampling stations):

> "During February and March 2006, a total of 41 sampling stations among distinct 13 sampling areas (zones) were assessed on the two reef tracts furthest from shore. Sample areas included areas both within and adjacent to the proposed OEC improvements. Benthic organisms were assessed using underwater videography and *in situ* visual observation by divers. Individual belt transects were 10 meters (m) long and 1 m wide for the *in situ* visual assessments, and 10 m long and 40 centimeters (cm) wide for video transects. The dimensions of the belt transects were based on methods applied to coral habitats in Florida and the Caribbean province (e.g., Loya 1976; Rogers et al. 1983; Liddell et al. 1984; Aronson and Precht 1995). Parameters used to characterize the benthic organisms from visual surveys included scleractinian (hard coral) species diversity (*H'*), species richness, and colony density. *In situ* data collected for octocorals and sponges were taken to the lowest possible taxonomic level. Videographic surveys yielded information on the percent cover of scleractinians, octocorals, hydrocorals, macroalgae, turf algae, unconsolidated sediments, and rubble on the seafloor. Species richness was also evaluated from the videographic transects. Fish censuses included stationary counts and counts conducted along belt transects. These censuses provided data regarding fish species richness, abundance, and size.
>
> "Analyses of collected data indicated many differences between the biota of the outermost and middle reef tracts. Middle reef (i.e., second reef, or "Reef 2") sites (in zones R2-Z1 and -Z2) were depauperate in live benthic cover and high in sediment cover compared to outer reef (i.e., third reef, or "Reef 3") sites (in zones R3-Z1, -Z2, and -Z3). Outer reef sites were more developed biologically, as they supported greater hard coral colony densities, coral cover, and octocoral colony densities (these findings support those of Gilliam et al. 2006). The analyses of the data collected for this study corroborated Gilliam et al.'s (2004) assessments of the differences between middle and outer reef benthic communities.
>
> "Outer reef (i.e., third reef, or "Reef 3") zones R3-Z1, -Z2, and -Z3 are located within the proposed (OEC) expansion area. Site substrates at the Third Reef locations consisted of hardbottom, rubble, rocks, pockets of coarse and fine sand, and few artificial substrates. Less than 3% of the scleractinians observed at the Third Reef had some form of bleaching or coral mortality (species most affected were *S. siderea* and *S. intersepta*). Overall, sampling sites in zones R3-Z1, -Z2, and -Z3 supported more developed benthic communities than middle reef (i.e., R2) sites."

Study data summarized above were used to inform assumptions that were used in the quantification of ecosystem losses that may be directly (or indirectly) caused by the widening and deepening of the OEC. Factors such as hardbottom species composition, percentage of cover and sizes of the species present, other observations (e.g., fish counts), and relevant literature detailed in DC&A (2008) were all considered in the HEAs that were performed for two possible impact scenarios.

4.5 Impact Scenarios

4.5.1 Direct and Incidental Impacts

The middle and outer reefs would be impacted by the expansion of the OEC. There are two possible impact scenarios; Scenario 1 and Scenario 2. Scenario 1 (Figure 1) includes direct dredging impacts as well as incidental impacts from equipment anchor and cable impacts associated with the dredging operation. These impacts are limited to just the deployment of a cutterhead dredge. It is possible that these impacts will be avoidable, either by using a different piece of equipment, or, by minimizing the impacts through floats on the cables or by deployment methodologies set by the contractor, which would minimize them to the maximum extent practicable. Thus the impacts assumed here is the conservative, worst-case assessment. Under Scenario 2 (Figure 2), *no* impacts would occur associated with cables and anchors; presumably some other alternative for dredge equipment stabilization and positioning would be possible at the time of construction.

Scenario 1 would result in impacts totaling 25.72 acres on the middle and outer reefs and 7.40 acres of nearshore hardbottom and inner reef habitats for a total of 33.12 acres of impact. 17.13 acres of these impacts would be attributed to incidental anchor and cable impacts. Scenario 2, i.e., in the event of no cable and anchor impacts, would result in 16.64 acres of impact to the middle and outer reef combined, of the project is dredged to the recommended alternative – 57 feet total dredge depth (50+7+1+1 = authorized depth (ft) + required underkeel clearance + required overdredge (ft) + allowable overdrege (ft)). Anchor-cable impacts to the inner (first) reef and nearshore hardbottom habitats (including rubble from historic previous dredging events) located shoreward of the second reef were calculated at 7.40 acres. Scenario 1 is the only scenario with direct impacts to nearshore hardbottom and first reef habitats. For the purposes of mitigation calculations, these habitats were determined to be equal in habitat value as the second and third reefs, due to the lack of quantitative surveys specific to these areas, even though the peer reviewed literature demonstrates that these habitats are less species rich and have fewer hard corals than the second and third reefs (Moyer *et al* 2003; Gilliam *et al* 2004, 2005, 2006, 2007, 2008). While the Corps could have chosen other non-site specific surveys in Broward County to serve as proxy for the nearshore hardbottom and inner reef, we choose to use the data from Reef #2 to ensure the most conservative approach is being used for mitigation calculations. As stated previously, the worst case scenario of total removal of all biota by the anchor-cable system was used for calculating impacts for mitigation requirements and the EIS. The Corps reviewed two previous projects that used a cutterhead dredge with the anchor-cable configurations: 1980 in Port Everglades and 1990 at Miami Harbor. In 1980, the project was monitored for impacts associated with the dredging, and no impacts associated with the use of the cutterhead anchoring system are noted in the final report (CSA, 1981). In the 1990 Miami Harbor Phase I project, the Miami-Dade County Department of Environmental Protection calculated the area of impact for each anchor/cable point, using a float on the cable to minimize impact, was 0.029 acres. The impacts associated with the traditional deployment of the anchor cable dredging method is only associated with cutterhead dredges. The Corps cannot dictate types of dredging equipment that a contractor may use (per the Competition in Contracting Act),

so the potential remains for all of the potential contractors to propose to use a cutterhead dredge with the traditional anchor cable configuration. In an attempt to be extremely conservative regarding potential impacts, the Corps chose not to assume that the float system would or could be used in association with the Port Everglades project. This approach was another effort by USACE to be conservative in determining the necessary mitigation for the project. Table 1 provides details regarding impact location for each scenario.

Table 1 Acreages of Direct Impacts to Middle and Outer Reef Tracts by Impact Scenario – Recommended 50 ft authorized depth/59 ft dredged depth

	Nearshore Hardbottom and Inner Reef Scenario 1	Middle Reef Scenario 1	Outer Reef Scenario 1	Middle Reef Scenario 2	Outer Reef Scenario 2
Cable and anchor impacts (ac)	7.40	4.69	5.04	0.00	0.00
Direct dredging impact (ac)	0.00	5.34	11.09	5.56	11.09
Total direct impact by reef (ac)	7.40	10.03	16.13	5.56	11.09
Total impact by scenario (ac)	**33.12**			**16.64**	

4.5.1.1 Scenario 1

4.5.1.1.1 Middle Reef

The surface area of the middle (second) reef in the path of the proposed OEC expansion (5.34 acres) and the area proposed to be impacted by cable and anchor impacts (4.69 acres) totals 10.03 acres. Based on a mean total live cover at R2 (second reef) sites, approximately 56.2% of this area supports live cover (DC&A 2009). Percent-cover data by organism group taken from the video assessment portion of the DC&A 2009 study for R2 sites, and the estimated impacts (provided in m^2) by organism group are listed in Table 2.

Table 2 Estimated Impact of Scenario 1 on Middle Reef Biota

Organism Group	Percent Cover on Reef Tract*	Species-specific Impact (m^2)
		Across 10.03 ac
Scleractinian corals	0.36	146
Hydrocorals	0.01	4
Octocorals	0.96	390
Sponges	2.62	1063
Zoanthids	0.01	4
Tunicates	0.08	32
Turf Algae	45.19	18343
Macroalgae	6.99	2837

*based on DC&A (2009)

Using the worst case scenario, where the use of an anchor-cable system completely removes all biota from the substrate. This is not typically the case with this dredging methodology, however, to ensure that the mitigation calculations are conservative; the Corps has opted to make this assumption for the purposes of this assessment. Based on scleractinian colony density averaged at R2 (0.48 colonies/m^2), and 10.03 acres of direct impact, approximately 19,913 scleractinian colonies, 83% less than 10 cm in diameter, would be removed from the middle reef. [According to Edmunds *et al*. (1998), 10 cm corresponds to approximately three years worth of lateral growth]. Octocoral density at R2 sites averaged 0.34 colonies/m^2. Therefore approximately 13,896 octocoral colonies, 72% less than 25 cm in height, would be removed. (For more detailed information on colony survey data, see DC&A 2009.)

4.5.1.1.2 Outer Reef

Under Scenario 1 the surface area of the section of outer reef in the path of the proposed OEC expansion, and potential impacts from cable and anchors amounts to 16.13 acres. Based on mean total live cover at R3 sites, approximately 73% of this area supports live cover (DC&A 2009). Based on percent-cover data by organism group calculated from the video assessment portion of DC&A (2009) for R3 sites (not including "previously impacted" or "control" sites), estimated impacts (provided in m^2) are listed in Table 3.

Table 3 Estimated Impact of Scenario 1 on Outer Reef Biota

Organism Group	Percent Cover on Reef Tract*	Species-specific Impact (m^2) Across 16.13 ac
Scleractinian corals	0.88	574
Hydrocorals	0.07	46
Octocorals	2.47	1612
Sponges	5.18	3381
Zoanthids	0.25	163
Tunicates	0.08	52
Turf Algae	54.62	35654
Macroalgae	9.32	6084
TOTAL	**72.87**	**47,566**

*based on DC&A (2009)

Based on colony density estimates at R3 sites (excluding previously impacted and control sites) (1.88 colonies/m^2), and 15.69 acres of direct impact, up to approximately 122,093 scleractinian colonies, 86% less than 10 cm in diameter, would be removed from the outer reef. Octocoral density at R3 sites (excluding previously impacted and control sites) averaged 1.44 colonies/m^2. Therefore approximately 94,000 octocoral colonies, 82% less than 25 cm in height, would be removed.

4.5.1.2 Scenario 2

4.5.1.2.1 Middle Reef

The surface area of the middle reef in the path of the proposed OEC expansion is 5.34 acres. Based on mean total live cover at R2 sites, approximately 56.2% of this area supports live cover (DC&A 2009). Based on percent-cover data by organism group calculated from the video assessment portion of DC&A (2009) for R2 sites, the estimated impacts (provided in m^2) are listed in Table 4.

Based on colony density estimates at R2 (0.48 colonies/m^2), up to approximately 10,801 scleractinian colonies, 83% less than 10 cm in diameter, would be removed from the middle reef. Octocoral density at R2 sites averaged 0.34 colonies/m^2. Approximately 7,538 octocoral colonies, 72% less than 25 cm in height, would be removed.

Table 4 Estimated Impact of Scenario 2 on Middle Reef Biota

Organism Group	Percent Cover on Reef Tract*	Species-specific Impact (m^2) Across 5.34 ac
Scleractinian corals	0.36	78
Hydrocorals	0.01	2
Octocorals	0.96	207
Sponges	2.62	566
Zoanthids	0.01	2
Tunicates	0.08	17
Turf Algae	45.19	9766
Macroalgae	6.99	1511
TOTAL	**56.22**	**12,149**

*based on DC&A (2009)

4.5.1.2.2 Outer Reef

Under Scenario 2 the surface area of the section of the outer reef in the path of the proposed OEC expansion totals 10.65 acres. Based on mean total live cover at R3 sites, approximately 73% of this area comprises live cover (DC&A 2009). Based on percent-cover data by organism group taken from the video assessment portion of DC&A (2009) for R3 sites (not including "previously impacted" or "control" sites), estimated impacts (provided in m^2) are listed in Table 5.

Table 5 Estimated Impact of Scenario 2 on Outer Reef Biota

Organism Group	Percent Cover on Reef Tract*	Species-specific Impact (m^2) Across 11.09 ac
Scleractinian corals	0.88	395
Hydrocorals	0.07	31
Octocorals	2.47	1109
Sponges	5.18	2325
Zoanthids	0.25	112
Tunicates	0.08	36
Turf Algae	54.62	24513
Macroalgae	9.32	4183
TOTAL	**72.87**	**32,704**

*based on DC&A (2009)

Based on colony density estimates at R3 (1.88 colonies/m^2) and direct impact of 11.09 acres, up to approximately 89,943 scleractinian colonies, mostly less than 10 cm in diameter, would be removed from the outer reef. Octocoral density at R3 sites (excluding "previously impacted" and

"control" sites) averaged 1.44 colonies/m^2. Approximately 64,629 octocoral colonies, mostly less than 25 cm in height, would be removed from the outer reef.

4.5.2 Indirect Impacts

USACE proposed the establishment of an "indirect impact zone" extending 150 meters around the proposed OEC footprint for both scenarios. This zone includes many habitat types, including outer, middle, and inner reefs, nearshore hardbottom, and rock/rubble habitat. The 150 meter buffer is based on a review of two previous navigation projects in southeast Florida (Port Everglades and Key West) where project monitoring showed that sedimentation impacts did not impact adjacent corals along the sides of the navigation channels (CSA 1981; CSA. 2007a; CSA 2007b). Additionally, in a recent consultation under Section 7 of the Endangered Species Act the National Marine Fisheries Service concluded that the effects of sedimentation on the adjacent threatened coral, *Acropora cervicornis*, to be insignificant, as the rates of sedimentation documented in a similar offshore dredging project were within the bounds of sedimentation documented to occur naturally. Finally NMFS concluded that due to this sedimentation rate, and a proposed 400 foot buffer between the dredging area and the threatened corals, the effects on the coral would be "insignificant" (NMFS 2009). In an effort to be extremely conservative and protective of any resources adjacent to the Port Everglades outer entrance channel, the Corps decided to implement a 150-meter indirect impact buffer for sedimentation impacts, and calculate necessary mitigation for impacts associated with dredging activities that might result in impacts from sedimentation. The actual amount of mitigation shall be based upon during project monitoring. These calculations are a planning and budgetary tool. This impact would be limited strictly to the construction timeframe, which is expected not to exceed two ½ years (roaded to 3 years) of construction in the OEC. Because there are no differences in the "with project" and "without project" vessel call estimations into Port Everglades (USACE 2012, Economic Appendix), there are no associated increases in either turbidity or sedimentation directly associated with the deepening project beyond those for construction activities. Therefore, any turbidity or sedimentation impacts to coral or hardbottom resources adjacent to the channel associated with ship passage into or out of the harbor are not attributable to the project and will not be calculated as an impact requiring mitigation.

For the purposes of this analysis, only those impacts that permanently remove habitat via dredging are considered direct. All other impacts are considered indirect, since they are solely temporal in nature. The amount of indirect impacts differs according to scenario; indirect impacts under Scenario 1 are temporary sedimentation or turbidity effects to 96.11 acres of hardbottom habitat (outer middle and inner reef habitats, as well as nearshore hardbottom and rubble areas). The areas calculated as incidental effects associated with the cutterhead dredge anchor-cable impacts (17.13 acres) are not included here, as they have already been calculated as a full removal of all biota in the footprint of the anchor-cable, and to include them here would be double counting (Figure 1). Indirect impacts under Scenario 2 comprise approximately 113.24 acres of temporary impacts to outer middle and inner reef habitats, as well as nearshore hardbottom and rubble areas solely associated with sedimentation and turbidity (Figure 2).

4.6 Assumptions for HEAs

As previously stated, assumptions developed during the Sept and Nov 2007 inter-agency HEA meetings were utilized for this analysis. Summary tables from the final meeting notes for each habitat type and scenario, and both summary reports from the two meetings are included in their entirety in Appendix B for reference. The group discussed the parameter values for the outer, middle and inner reef areas for direct impacts and then the three reef areas for the indirect

impacts. The tables below show values agreed to in "normal" font. Where there wasn't agreement, options were identified are shown in "*italics*."

Each of the impact areas was addressed with a separate analysis. Where the same numbers were agreed to, notations are included. Not all areas of impact were assessed by the HEA team.

Since the 2007 HEA meetings, the Corps has revised amount of impacts to the reefs and project area as a result of refined engineering analysis and additional, higher resolution habitat maps; modified project duration due to refined construction timelines and the nature of impacts associated with indirect effects associated with vessel movements in the OEC as a result of the economic analysis. These changes are noted in Tables 6, 7, 8, 9 and 10 by the number being in BOLD and inside parenthesis ().

Table 6 Outer Reef Direct Impacts

INJURY		**COMPENSATORY ACTION**	
1. Claim year = Date of Injury	2012	13. Date of compensatory action	2012
2. Site name	Outer reef		
3. Type of injury (direct, indirect+)	Direct	14. Type of compensatory action	Calculate boulders and have suite of options
4. # of injured area units	13.54 a **(10.65a)**		
5. Pre-injury service level =100%	100%	15. Pre-restoration service level (%)	Close to 0%
6. Degree of service lost of resources immediately following injury (%)	100%	16. Service level of compensatory action upon initial installation (<u>of designed boulder placement</u>)	0-5%
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	*0, 5 &15%*	17. Equilibrium level of service from CA expected (for boulders with specified transplants)	75,100%
9. Injury recovery time to equilibrium	*50 for 5-15* *0 for 0*	18. Time for services to develop from installation to equilibrium	65, 55, 50
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit (%)	*3or6%,*	21. Discount rate	*3-6%*

* The middle reef was discussed briefly and everyone agreed to use the same numbers as the outer reef even though the makeup is somewhat different.

Table 7 2nd Reef Channel Walls, Direct Impacts

INJURY		COMPENSATORY ACTION	
1. Claim year= Date of Injury	2012	13. Date of compensatory action	2012
2. Site name			
3. Type of injury (direct, indirect+)	Direct	14. Type of compensatory action	Boulders
4. # of injured area units	.3564a **(.36a)**		
5. Pre-injury service level =100%	100%	15. Pre-restoration service level (%)	0%
6. Degree of service lost of resources immediately following injury (%)	100%	16. Service level of CA upon initial installation	5-10%
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	85%	17. Equilibrium level of service From CA expected	75, 100
9. Injury recovery time to equilibrium	26 yr	18. Time for services to develop from installation to equilibrium	26
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit (%)	3-6%	21. Discount rate	3-6%

Table 8 Outer Reef Turbidity/Sedimentation Impacts (Indirect w Anchor/Cable)

INJURY		COMPENSATORY ACTION	
1. Claim year= Date of Injury	2012	13. Date of compensatory action	2012
2. Site name			
3. Type of injury (direct, indirect+)	Indirect	14. Type of compensatory action	Boulders
4. # of injured area units	28.26a **(32.65a)**		
5. Pre-injury service level =100%	100	15. Pre-restoration service level (%)	0
6. Degree of service lost of resources immediately following injury (%)	2, 5%	16. Service level of CA upon initial installation	10
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	98%	17. Equilibrium level of service From CA expected	75,100
9. Injury recovery time to equilibrium - **duration of construction**	35, 75yr **(3yr)**	18. Time for services to develop from installation to equilibrium (no transplantation)	50,75
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit (%)	3-6%	21. Discount rate	3-6%

Table 9 Sedimentation/Turbidity Impacts to all Habitats (Indirect w/o Anchor/cable impacts)

INJURY		**COMPENSATORY ACTION**	
1. Claim year= Date of Injury	2012	13. Date of compensatory action	2012
2. Site name			
3. Type of injury (direct, indirect)	Indirect sed/turb	14. Type of compensatory action	Boulders
4. # of injured area units	15.89a **(113.24a)**		
5. Pre-injury service level	100%	15. Pre-restoration service level (%)	0%
6. Degree of service lost of resources immediately following injury (%)	5%	16. Service level of CA upon initial installation	~~10 %~~ 0-5%
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	98%	17. Equilibrium level of service From CA expected	100% *75%*
9. Injury recovery time to equilibrium – **duration of construction**	35 yrs *15 yrs* **(3yrs)**	18. Time for services to develop from installation to equilibrium	50 yrs *75 yrs*
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit (%)	3%, *6%*	21. Discount rate per time unit (%)	3%, *6%*

Table 10 Direct Impacts of Anchoring – Combination of areas in the Inner, Middle, and Outer reefs

INJURY		COMPENSATORY ACTION	
1. Claim year= Date of Injury	2012	13. Date of compensatory action	2012
2. Site name	Anchor-cable		
3. Type of injury (direct, indirect)	Direct - anchor/cable	14. Type of compensatory action	Boulders
4. # of injured area units	11.91 a *17.13 a*		
5. Pre-injury service level	100 %	15. Pre-restoration service level	0%
6. Degree of service lost of resources immediately following injury (mortality)	50%	16. Service level of CA upon initial installation	10% *0-5%*
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	98% *85-95%*	17. Equilibrium level of service From CA expected	100% *75%*
9. Injury recovery time to equilibrium	50 years *100 years*	18. Time for services to develop from installation to equilibrium	35 yrs w/transplant s or 50, *75* yrs without
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit	3% *6%*	21. Discount rate per time unit (%)	3% *6%*

After the completion of the meetings, additional guidance was received from USACE-HQ and the Ecosystem PCX regarding the use of discount rates in Federal Projects and new analysis was completed regarding future ship calls at Port Everglades. Additionally, although the team had originally assumed an increase in vessel calls associated with the expansion of Port Everglades and this increase in vessel calls would have an incremental increase in the turbidity and sedimentation effects on coral and hardbottom resources adjacent to the channel directly attributable to the project. However, the Economic Analysis included in the Economic Appendix shows no difference in the number of vessel calls, instead it shows a difference in how the ships that are calling would use the channel depth and how fully loaded they would be. Because there is no change in the number of vessel calls, there is not an increase in the number of vessels arriving at the port in the future with the expansion project, there is not an incremental increase in turbidity and sedimentation. The only impacts of turbidity and sedimentation assessed for the project will be those directly attributable to construction activities. These changes were incorporated into the necessary mitigation analysis.

4.6.1 Context for Live-bottom Community Impacts and Recovery

The proposed dredging would have direct and indirect effects on the benthic communities and seafloor substrate within and outside of the proposed project footprint. The direct (i.e., construction) disturbance on the middle reef and outer reef caused by the dredging and

subsequent removal of biota will be relatively short in duration, but will have an acute effect on the sessile and mobile reef organisms (biological environment), and the seafloor substrate (physical environment). All live cover (including scleractinians, octocorals, sponges, hydrocorals, zonathids, tunicates, and algae) will be removed. The removal of the substrate will cause the loss of the three-dimensional structure and shelter used by sessile and mobile biota. The dredging will also uncover (denude) large open spaces, frequently comprising hard substrates/consolidated surfaces, which will be available for colonization by benthic organisms. Following a major disturbance, colonization of bare substrate typically begins with the recruitment of opportunistic pioneering algae, usually cyanobacteria and some green algae (Jaap 2000). Within one to two years, recruited reef organisms will include crustose coralline algae, sponges, *Pseudopterogorgia* (pioneer octocoral), zoanthids, and scleractinians (pioneer brooding species including *Porites astreoides* and *Agaricia agricites*) (Jaap 2000). Within eight to ten years, a high density of sponges and octocorals can be expected, although scleractinian density will remain somewhat depressed (Jaap 2000). Those scleractinians present will consist mostly of short-lived, highly fecund species such as *Agaricia agaricites*, *Porites porites*, *Porites asteroides*, *Favia fragum*, and *Colpophyllia natans* (Hughes 1985; Jaap 2000).

Any ecologically significant recovery of newly dredged substrates may take decades (Maragos 1974; Precht 1998). Major and minor factors associated with the proposed port expansion project that may prevent recovery to pre-injury status include the deepening of the seafloor substrate (major); the removal of reef topographic complexity (major); sedimentation and siltation during the dredging (minor); and the predicted level of sediment resuspension and siltation following dredging operations (minor). It should be noted that after the last Port Everglades expansion project, follow-up monitoring of corals surrounding the impact areas was performed to assess the stress from sedimentation and turbidity. One-year after the completion of the project, no coral mortality or morbidity was observed (CSA 1981). In short, the middle and outer reef areas to be dredged will be subject to unavoidable short-term acute impacts, followed by some minor degree of long-term impacts compounded by existing disturbances.

Any pre- and post-dredging restoration actions (i.e., those that “jump-start” recovery) will be beneficial to habitat recovery because coral growth rates are slow even under optimal conditions, and barren areas have low natural recruitment rates (Jaap 2000). Following the recommendations in Jaap (2000) and Precht and Dodge (2003), the highest priority for restoration action should be the salvage of corals and sponges and subsequent transplantation, which will accelerate recovery and improve the aesthetic value of the reef system. Discussing the importance of using these salvaged corals in restoration projects, K. Banks (of Broward County Biological Resources Division) noted “If it takes a reef 50 years to regain its coral community once it's damaged; knocking 10 years off that is gaining a lot” (Wyman 2000). Structural three-dimensional reconstruction can be attained outside the project limits by installing limestone boulders that will provide surface area for coral, sponge, and algae recruits, and provide habitat to fish and lobsters (Jaap 2000).

Suspected indirect effects of adjacent dredging and filling activities include sub-lethal effects (injury, decreased fecundity, etc.) on corals due to sedimentation and turbidity. Several biological monitoring studies have documented coral “health” related to adjacent dredging activities or sand placement. Pre-, during-, and post-construction monitoring activities were conducted for the dredging of Key West Harbor (CSA 2007a, CSA 2007b). During that project, project and control sites monitored for bleaching and paling showed similar levels of bleaching and paling. Pre-, during-, and post-construction activities were also conducted for the Broward County Shore Protection Plan (Gilliam *et al*. 2008, Gilliam *et al*. 2006, Gilliam *et al*. 2004, Fisher *et al.* 2011). A seven-year biological monitoring effort documented reef community changes before and during beach nourishment activities in Broward County. Results showed no effect of sand placement

activities or dredging of borrow areas on corals or other biological components of adjacent reefs. In sum, the above reports suggest that corals were not measurably affected by adjacent dredging activities or sand placement during and after these activities. This may be because of strict water quality standards implemented by the State of Florida which require construction shut-downs when turbidity levels exceed a pre-determined level.

4.6.2 Recovery Rates

An assessment of how long it would take resources subject to each injury type to fully recover was conducted by determining the trajectory of the recovery over time. These recovery trajectories depend on the species of coral affected, the type and degree of injury, any primary restoration to be implemented, and the type of environment in which the injury occurred. Data from literature and field observations and best professional judgment were used to inform values for these parameters. While the successions of most coral reef ecosystems follow the law of sigmoidal growth, a linear recovery trajectory was used for all HEAs performed in this report. This is common industry practice and includes most HEAs performed to date for marine resource valuations that deal with corals.

Observations of reef injuries from vessel groundings in the FKNMS informs biologists of the importance of providing restoration actions (such as installation of "starter" colonies, or re-attaching injured colonies), in concert with natural recovery of impacted areas, in order to "jump-start" recovery rates. Although some compensatory ecological value can be attributed to naturally recovering live-bottom habitats, simply using only that as compensation is not practicable due to the amount of time that would be required for a community to fully recover to pre-impact conditions from an uncolonized substrate (Precht *et al*. 2001; Shutler *et al* 2006; Piniak *et al*. 2006). The application of a recovery rate of 70 to 100 years for such a situation would result in lower service gains (hence rendering such compensation as essentially impracticable) because service gains per year (and cumulatively) are so heavily discounted (S. Thur, NOAA, pers com), i.e., the value of incrementally provided services so far into the future would be of little value.

Under optimum conditions, overall coral reef growth rates are slow (0.65 to 4.85 m/1000 yr, or 2 to 16 ft/1000 yr according to Shinn *et al*. 1977). However, some studies have documented decadal-scale recovery after the coral reef system experienced moderate disturbance (Jaap 2000). To date, most HEAs that have been performed on coral habitats in Florida have used recovery projections that vary between 15 and 75 years; most average between 35 and 50 years. In the past, for practical purposes, NOAA generally has used a 50-year recovery projection for most coral injuries within the FKNMS (S. Shutler, FKNMS, pers com) while the State of Florida typically has used 35 years for coral injuries in Broward County (W. Jaap, University of South Florida, pers com). While in Miami-Dade County, resource economists have used a 43-year projection for recovery for coral injuries within Biscayne National Park (B. Peacock, Biscayne National Park, pers com). Unfortunately, many of these approximations for recovery projections used in previous HEAs have been based on little evidence and, therefore, are not defensible from a quantitative standpoint. Hence, it is imperative to use all available scientific information to develop accurate recovery projections for the resources in the project footprint and surrounding environments. For example, in specifically addressing impacts in Broward County, NCRI (2003) noted the following:

> "… it is recognized that there are some, but very few, corals which are older than 35 years. Inspection of size-frequency curves from other similar locations on the middle and outer reefs indicates that by far the majority of coral specimens present are younger than 35 years. This recovery time has been used for the Broward County beach renourishment HEA to determine the amount of compensatory restoration. It was also used for the USS

Memphis submarine grounding case as well as for settlement purposes in other injuries in Broward County involving hard corals."

Using the demographic history of coral populations for Broward's stony corals, a "50-year recovery" to pre-disturbance baseline conditions is an appropriate metric for most injury conditions (W. Precht, unpublished data). Moyer et al. (2003), NCRI (2003), Gilliam *et al*. (2004), and DC&A (2009) discussed the relatively small size of the coral species present within the project area. Using published average growth rates and measured sizes (~25 cm) of the five most common species in the project area, an average recovery rate of approximately 50 years was calculated (Table 6). Therefore, a linear 50-year recovery trajectory for use in HEAs is both reasonable and scientifically defensible. From a similar analysis, using the average growth rates and sizes of the largest (i.e., ≤ 40 cm) species recorded in the project area, a similar value resulted (approximately 50-year recovery projection) (Table 7). Recovery projections in excess of 50 years for most Broward County hardbottom communities, such as those proposed throughout the Core Group's HEA, are not consistent with the known growth rates and life history strategies for the impacted species within the project footprint, nor are they consistent with previous HEAs developed for the second and third reefs as described above (see NCRI 2003). While there are some long-lived, centuries-old *Montastraea annularis* species complex corals within Broward County, none were found in the project area. As such, using these corals as a template for recovery projections for this project is not defensible. Furthermore, it should be noted that there are some injury types, as well as habitat types, that have recovery times that are in the range of only 35 years. For instance, the well-established coral communities that are presently observed on the walls and lip of the existing channel entrance to Port Everglades have developed in less than 30 years, the length of the interval since the last channel widening operation. Finally, many corals found within the project area have life expectancies that are <50 years (e.g. *Porites astreoides*; see Kissling 1977) further supporting the use of the conservative 50-year recovery value.

In practice, recovery rates can be attenuated below the 50-year mark by limiting sedimentation, siltation, and turbidity during dredging; and salvaging and transplanting scleractinian, octocoral, and sponge colonies from the impact site to the recovery site. Actual recovery rates of both the impacted area and the mitigation site should be assessed through a dedicated, long-term monitoring program that evaluates the effectiveness of the mitigative measures by assessing the functional attributes of sessile and mobile reef organisms (Precht and Aronson 2006).

Table 11 Coral Growth Rates of Most Common Species Observed in the Project Area

Siderastrea siderea	2.2 to 7.1 mm/yr Avg = 4.65	Vaughan 1916, Landon 1975, Jaap 1984, Huston 1985, Torres and Morelock 2002
Stephanocoenia intersepta	< 8.0 mm/yr	Shinn et al. 1989
Porites astreoides	2.3 to 5.0 mm/yr Avg = 3.65	Kissling 1977, Gladfelter et al. 1978, Huston 1985, Torres and Morelock 2002
Montastraea cavernosa	3.6 to 6.8 mm/yr Avg = 5.2	Weber and White 1977, Huston 1985
Siderastrea radians	< 3 mm/yr Avg = 1.5	Vaughan 1916

Table 12 Coral Growth Rates of Largest Species Observed in the Project Area

Colpophyillia natans	2.2 to 7.1 mm/yr Avg = 4.65	Vaughan 1916, Landon 1975, Jaap 1984, Huston 1985, Torres and Morelock 2002
Stephanocoenia intercepta	~8.0 mm/yr	Shinn et al. 1989
Montrastraea annularis (sc)	4.8 to 11.2 mm/yr Avg = 8.0	Baker and Weber 1975, Dustan 1975, Gladfelter et al. 1978, Hudson and Robbin 1981, Huston 1985, Hudson 1981a & 1981b
Montastraea cavernosa	3.6 to 6.8 mm/yr Avg = 5.2	Weber and White 1977, Ghihold and Enos 1982, Huston 1985
Diploria strigosa	3.5 -10 mm/yr Avg = 6.75	Vaughan 1916, Dodge and Vaisnys 1975, Logan et al. 1994

4.6.3 Discount Rates

When weighing the benefits and costs of coastal restoration projects and other environmental management programs, the selection of a “discount rate” is a key consideration. The discount rate is the rate at which society, as a whole, is willing to trade-off “present” for “future” benefits. In essence, to make past and future losses and gains comparable, a discount rate must be applied. Federal regulations and NOAA (1999 and 2005) recommend using a 3% discount rate when scaling compensatory restoration for discounting interim service losses and restoration gains. NOAA recommends using the social, or consumer, rate of time preference for discounting interim service losses and restoration gains, when scaling compensatory restoration (NOAA 1997; NOAA 2000; NOAA 2005).

When weighing the decision to undertake a project with long-term benefits versus one with short-term benefits and long-term costs, the discount rate plays an extremely important role in determining the outcome of the analysis. High discount rates tend to discourage projects that generate long-term benefits, and favor those that create short-term benefits. Specifically, the discount factor decreases the value of future services and increases the value of past services in order to reflect how much the public values future (or past) service benefits today. This incorporates the assumption that services provided sooner are more highly valued than those provided later (Kohler and Dodge 2006). However, this assumption does not well represent our present society's strong preference to ensure the long-term sustainability of our natural and environmental resources. In other words, they fail to recognize that the concerns/values of future generations are relevant when resource management and policy-making decisions are evaluated (see Prager and Shertzer 2006). Hence, many authors have recently recommended capping a discount rate for environmental projects at 1%.

For this analysis, Dr. Thur performed the calculations for the HEAs using the discount rate that is being used by NOAA and other federal agencies for HEAs involving natural resource damages. NOAA does not address the OMB guidance regarding discount rates for Federal water resource development projects. This is calculated by using the federal cost of capital. The generally accepted practice is to apply the effective yield on comparable-term treasury securities. During the 1990s, the average 10-year Treasury bond rate was 6.01%, whereas inflation averaged 2.88%. Thus, the real rate of interest on treasury bonds was roughly 3.13% (Bellas and Zerbe

2003). Alternatively, from 1990 to 2003, real gross domestic product grew by 2.96% (NOAA 2005). Thus, using productivity over that period as the basis of the discount rate also generates an approximate 3.0% rate.

The outcome of the analysis in an HEA is highly sensitive to the discount rate. A high discount rate reduces the benefit-cost ratio, because the costs associated with the restoration project are experienced disproportionately during the first half of the recovery analysis timeframe. Arbitrarily selecting discount rates to meet short-term political goals could have long-term consequences. For example, high discount rates tend to discourage projects with high up-front costs, such as the proposed Port Everglades construction project. However, they also discourage hardbottom and reef restoration programs that may be associated with such projects.

Below are the published discount rates from the White House Office of Budget and Management (Federal Register 73(20), January 30, 2008); note that the federal discount rate is presently lower than the 3% used in the NOAA calculations:

REAL INTEREST RATES ON TREASURY NOTES AND BONDS OF SPECIFIED MATURITIES
[In percent]

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
2.1	2.3	2.4	2.6	2.8	2.8

As previously stated, Under Office of Management and Budget Circulars A-4 and A-94 (Regulatory Analysis and Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, respectively), when federal agencies are determining costs and benefits of a federal water resources development project, *no discounting should occur* (emphasis added). Specifically Circular A-94 states "Specifically exempted from the scope of this Circular are decisions concerning water resource projects (guidance for which is the approved Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies." The Port Everglades Feasibility Study, and all of the components of that study, falls under the aforementioned water resource principles and guidelines.

Additionally, Under Corps Regulations (ER 1105-2-100, Appendix E, Pg E-154), any mitigation plan developed for the Port Everglades Feasibility Study will be evaluated using a Cost Effectiveness/Incremental Cost Analysis (CE/ICA). The regulations for CE/ICA require that the models utilized to determine benefits (or habitat recovery when assessing mitigation) not utilize a discount rate to be in compliance with the OMB guidance documents previously presented. The regulations for CE/ICA require that the models utilized to determine benefits (or habitat recovery when assessing mitigation) not value the same quality habitat less in the future than in the present. While the NOAA HEA utilizes a 3% discount rate, to abide by the OMB guidance for Federal water resources development projects and Corp's regulations for CE/ICA, the modified HEA prepared by the Corps does not utilize a discount rate and for the calculations, 0% will be used and will be referred to as the "modified HEA". The mitigation needs analysis performed by the Corps utilized the Visual HEA software package (Kohler and Dodge, 2006) method utilizing a 0% discount rate. The Corps was unable to replicate Dr. Thur's calculations, as NOAA did not provide spreadsheets with the formulas embedded to the Corps.

The final determination of mitigation required for the project will be determined in coordination between the Plan Development Team, the resource agencies, the Corps' regional and HQ policy offices and finally the office of the Assistant Secretary of the Army for Civil Works.

4.6.4 Scaling the Values of Compensatory Actions

In order to determine the action (or funds) required for compensation (mitigation), the scale of restoration was determined by calculating the benefit from a reef mitigation project constructed with boulders. The calculations regarding benefits of this action were divided into two components: (1) boulder emplacement, and (2) transplantation of mature coral colonies from the dredging area onto the constructed boulder-reef. Representative recovery rates were then estimated for both components using a similar boulder mitigation project established for a recent beach nourishment project (Kohler and Dodge 2006). In that analysis, it was assumed that the mitigation boulders would naturally recover to 100% full reef services in 50 years. However, they would recover to 100% full services in *less* time by transplanting corals onto the boulders. A similar rationale and methodology was included in this HEA for the Port Everglades OEC expansion project.

The Core Group used extremely conservative estimates for the replacement boulder reef mitigation project. This included long recovery times and diminished services compared to natural reef areas. This is again contrary to published literature (Kohler and Dodge 2006, Milon and Dodge 2001) and the results of similar mitigation projects performed in the region. For instance, only five years after implementation, the Bal Harbour Boulder Reef Mitigation Project had yielded the following conclusions from Blair *et al*. (2008):

> "It does appear that the artificial reef structures are providing habitat for diverse benthic and fish assemblages. Benthic assemblages have a moderately high level of similarity to the natural reefs in species composition and relative species representation, which may indicate that the artificial reef materials are developing communities that are comparable to the natural reef areas. Trends identified in the benthic data indicate potential for continued convergence of the artificial and natural population constituents. Fish assemblages on the artificial reef do share many species in common with the natural reef areas."

USACE reviewed another compensatory mitigation project associated with a port deepening project in SE Florida to help provide information on what may be expected from a reef boulder mitigation project associated with channel construction; USACE reviewed the artificial reef constructed for the Miami Harbor's 1991 entrance channel deepening project. Dredging of the channel was completed in 1991 and the artificial reefs were placed in the mitigation sites in 1994 (DERM, 2004). The 1991 deepening project is very similar to the proposed Port Everglades expansion, as it cut through the third reef to lengthen and deepen the channel. The artificial reef site consisted of individual reefs of the following make up:

- Two linear series of "spur" formations each consisting of:
  - Five to six linear rows of limerock boulders with spacing of 50 to 75 feet between each row.
  - Each row is 40 to 60 feet wide, 8 to 10 feet high and 450 to 500 feet long.
  - The footprint of each "spur and groove" formation is estimated to cover approximately 4.2 acres.
- Thirty-six individual oblong "patch reefs" consisting of:
  - An area 80 to 100 feet long, 50 to 60 feet wide and 8 to 10 feet high.
  - Patch reefs were placed on 100 foot centers.
  - The cumulative footprint of the 36: "patches" totals approx. 4.5 acres.

No coral relocation was performed from the impact areas to the artificial reef sites. In the assessment of the reefs performance, DERM took biological characterization data from pre-

dredge surveys of impact areas in 1990-1991 and compared the artificial reefs biota to those reports. Species assessed included fish and benthic communities. The age of these communities at the time of the report was nine (8) years. They were constructed between June and November of 1995 and the surveys for this report were completed in 2003. A summary table of the results of the Miami Channel surveys in 1991 and the POM-B artificial reef boulders is included below (DERM, 2004).

Table 13 Miami Harbor Pre-Dredge Survey vs 2003 Mitigation Survey

Taxonomic Group	1991 Pre-Dredging # Taxa	POM A # Taxa	POM B # Taxa
Algae	Not Noted	5*	5*
Anemone	Not Noted	1	0
Bivalve	1	2	2
Bryozoan	Not Noted	1	2
Corallimorph	Not Noted	1	0
Echinoderm	1	2	0
Hard Coral	18	18	25
Hydroid	Not Noted	1	1
Hydrocoral	Not Noted	1	1
Soft Coral	8	1	14
Sponge	9	27	28
Tunicate	Not Noted	6	4
Zoanthid	Not Noted	0	0
TOTALS	**37**	**61**	**77**

The Miami Channel was characterized by 37 different biotic non-fish species. The boulder reefs at Site POM-B were characterized by 77 species, with taxonomic groups not seen in the channel being present on the reefs. Hard coral species richess increased by 28%; octocoral species richness increased by 43%. Over species richness of the boulder reefs was 52% higher than the channel that was impacted. An additional survey was conducted by DERM in 2007 in association with a Florida Fish and Wildlife Conservation Commission grant. This study looked at percent coverage of each functional habitat group.

Functional Group	POM A % cover	POM B % cover
Algae	79.90	76.54
Scleratinia	3.57	4.04
Milleporidae	0.42	0.38
Octocorallia	4.83	11.73
Porifera	10.49	5.14
Ascidaria	0.00	0.11
Zoanthidae	0.04	0.04
Other live	0.49	0.23

For the Port Everglades HEA, using the assumption of similar boulder reef construction, in water depths similar to the third and second reef impact areas (like in Miami) and assuming an extremely conservative colonization rate and functional equality timeframe of 50 years based on the input from the inter-agency team. However, if we limited ourselves to the information from the Miami Harbor artificial reef reports in 2003 and 2007, which is the most comparable mitigation project to what is being proposed for Port Everglades, a timeframe of 10 years may be

more appropriate. At this time, USACE plans to continue with the timeframes agreed to in the 2007 inter-agency meetings.

5.0 Results

Results for the portion of the USACE HEA dealing with cumulative functional losses for Scenario 1 and Scenario 2 (the scenario where no anchor/cable impacts occur) are listed in Tables 14 and 15, respectively (more detail is provided in Appendix A). Each table provides the following (left to right in the tables): information regarding reef injury category (location and type of impact), acreage of category-specific impact, anticipated service level at recovery equilibrium (a "100%" value would indicate a complete functional recovery to pre-impact conditions), time interval until equilibrium services are reached, and finally, *discount service acre-years lost* ("DSAYs" lost) (see formula, p. 21 of NOAA 2006). DSAYs for anchor and cable impacts (shown in third row, far right, in Table 8), including those on the middle and outer reefs, were calculated at a reduced service-lost rate due to the type of injury that may occur (evidence from other projects indicates these impacts are less severe than direct dredging impacts). Although indirect impacts are not anticipated by USACE, they have been accounted for (using a 2% initial service loss value) in the event of failure of best management practices and any lapse in water quality monitoring efforts during construction. As shown in the tables, the total acre-years lost for Scenario 1 and Scenario 2 are 1014.58 DSAYs and 792.25 DSAYs, respectively. The latter value is lower due to the assumed lack of impacts from dredge equipment anchors/cables for that impact scenario.

For proper compensation, the service gains attributed to mitigation activities must offset the total service losses attributed to the reef impacts. A convenient way to begin to determine the total "value" of mitigation activities, such as those proposed for this project (i.e., construction of a boulder reef on which transplanted colonies are installed), is to evaluate the gain attributed to a single acre of such an effort. For the project at hand, two categories for reef restoration/replacement were proposed, each with different compensatory objectives depending on impact type. One category of mitigation pertained to providing compensation for impacts to live-bottom communities on horizontal seafloor substrates, and another pertained to providing compensation for impacts to live-bottom communities on entrance channel walls. These restoration/replacement categories were developed because the channel walls had notably less coverage of live-bottom species. As shown in Table 10, both restoration/replacement categories would provide 10% service initially and 100% at maturity. With differing expectations for resulting biota for the two categories of mitigation, the anticipated time to full recovery was different. Calculation details are found in NOAA (2006) and Kohler and Dodge (2006).

Table 14 USACE HEA Input Vales and Calculated Losses for Scenario 1 Impacts

Injury Category	Area (acres)	Initial Service Loss (%)	Recovery Service Level (%)	Time to Recovery (years)	DSAY losses
Middle and Outer Reef Direct Impacts- Recovery to 15%	16.64	100	15	50	783.74
Middle Reef Channel Wall- Recovery to 95%	0.36	100	95	26	4.93
Incidental Anchor and Cable Impacts- Recovery to 98%	17.13	50	98	50	223.03
Indirect Impacts - Outer Reef- 2% loss	32.65	2	98	50	0.98
Indirect Impacts - Middle, Inner, Nearshore, Rubble- 2% loss	63.46	2	98	50	1.90
Total	**130.24**				**1014.58**

Table 15 USACE HEA Input Vales and Calculated Losses for Scenario 2 Impacts

Injury Category	Area (acres)	Initial Service Loss (%)	Recovery Service Level (%)	Time to Recovery (years)	DSAY losses
Middle and Outer Reef Direct Impacts- Recovery to 15%	16.64	100	15	50	783.74
Middle Reef Channel Wall- Recovery to 95%	0.36	100	95	26	4.93
Direct Anchor and Cable Impacts- Recovery to 98%	0.00	N/A	N/A	N/A	0.00
Indirect Impacts - Outer Reef- 2% loss, perpetual loss (no recovery)	37.69	2	98	50	1.31
Indirect Impacts - Middle, Inner, Nearshore, Rubble- 2% loss, perpetual loss (no recovery)	75.55	2	98	50	2.27
Total	**130.24**				**792.25**

Table 16 USACE HEA Calculations for Proposed Compensatory Mitigation

Category of Restoration/Replacement	Area (acres)	Initial Service Gained (%)	Recovery Service Level @ Maturity (%)	Time to Full Recovery (yrs)
1) Created boulder reef for all impacts but channel wall	1.0	10	100	50
2) Created boulder reef for channel wall impacts	1.0	10	100	26

The impact and recovery parameters are entered into the Visual HEA software package and each impact and mitigation activity are analyzed by the software, which calculates the necessary mitigation for the impact. Based on the input parameters, and outputs from Visual HEA, the mitigation required for the Port Everglades OEC expansion is the creation of 35.75 acres of boulder mitigation with transplanted corals under Scenario 1 (Table 17) and 27.94 acres under Scenario 2 (Table 18). Construction of either "compensation area" would yield a stream of benefits that would extend for the life of the created boulder reef. In addition, there would be increased values (service gains) from the natural recovery of the impacted area over some interval of time, even if that area were to be maintenance-dredged in 10, 20, or 30 years following construction of the proposed OEC expansion. Therefore, in sum, the total ecological services rendered by (1) the temporal services provided in the impact area between maintenance events and (2) the creation of either 28 or 36 acres of new live-bottom habitat will provide sufficient compensation for the proposed project. The creation acreages reflect calculations guided by assumptions based on scientific literature and field observations, and use of conservative natural resource principles in the absence of documentation, as detailed on previous pages.

Table 17 Acres of mitigation required per impact category for Scenario 1

Mitigation Requirement	
Category	**Acres**
Middle and Outer Reef Direct Impacts	27.50
Middle Reef Channel Wall Impacts	0.32
Direct Anchor and Cable Impacts	7.83
Outer Reef Indirect Impacts - Construction	0.03
Middle/nearshore Impacts – Construction	0.07
Total Requirement	**35.75**

Table 18 Acres of mitigation required per impact category for Scenario 2

Mitigation Requirement	
Category	**Acres**
Middle and Outer Reef Direct Impacts	27.50
Middle Reef Channel Wall Impacts	0.32
Direct Anchor and Cable Impacts	0.00
Outer Reef Indirect Impacts - Construction	0.04
Middle/nearshore Impacts – Construction	0.08
Total Requirement	**27.94**

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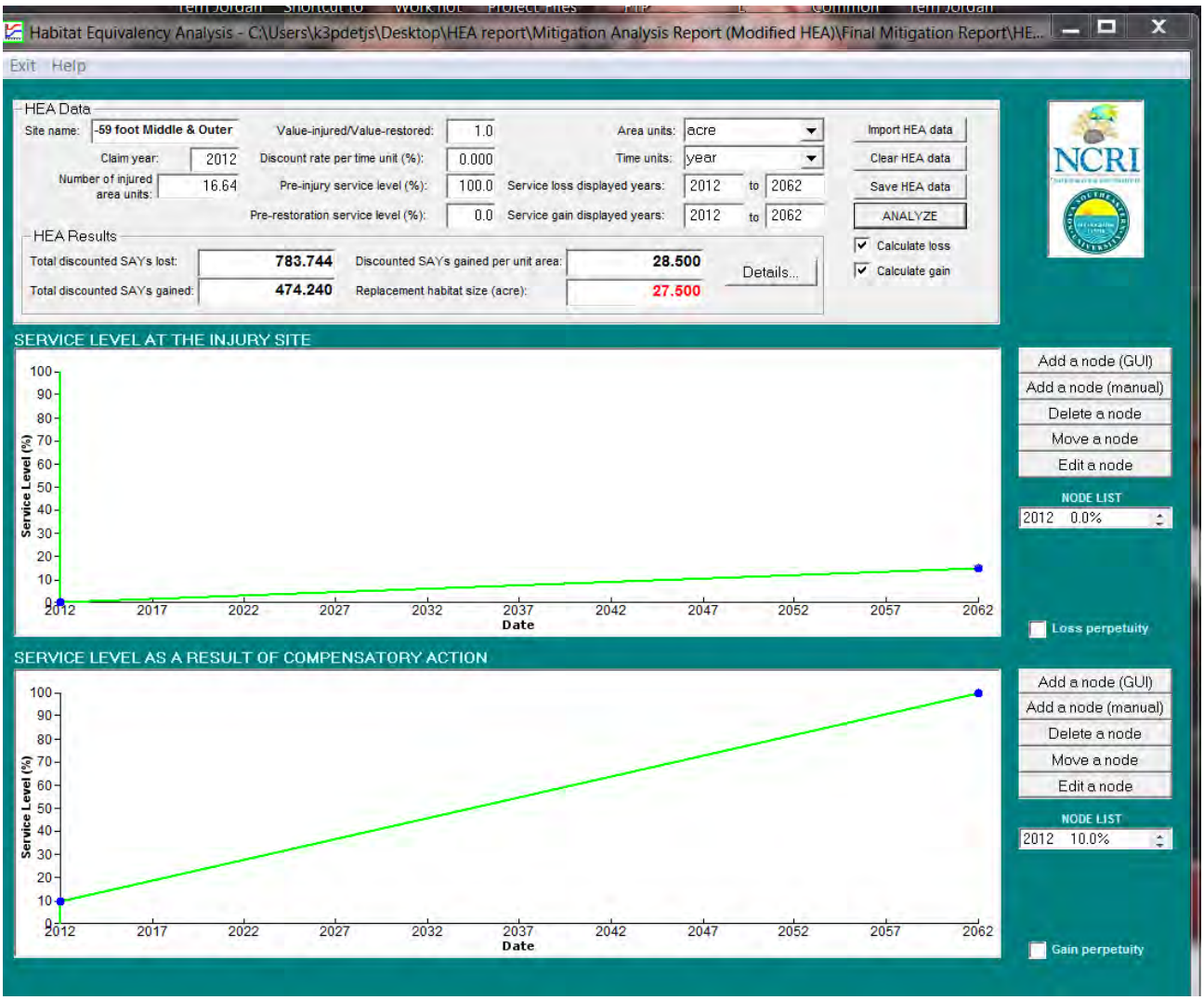
APPENDIX A

HEA Input/Output Summaries and Data
Complete HEA Data are included on the enclosed CD.

-59 foot dredge – Outer and middle reef



HABITAT EQUIVALENCY ANALYSIS

Sitename: -59 foot Middle & Outer reef direct - recovery to 15%

Date: 8/11/2012 10:53:24 AM
Datafile: C:\Users\k3pdetjs\Desktop\HEA report\Mitigation Analysis Report (Modified HEA)\Final Mitigation Report\HEA files\-59 middle & outer reef direct - recovery to 15%.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 16.64
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	100.00%	99.70%	99.85%	16.615	1.000	16.615
2013	99.70%	99.40%	99.55%	16.565	1.000	16.565
2014	99.40%	99.10%	99.25%	16.515	1.000	16.515
2015	99.10%	98.80%	98.95%	16.465	1.000	16.465
2016	98.80%	98.50%	98.65%	16.415	1.000	16.415
2017	98.50%	98.20%	98.35%	16.365	1.000	16.365
2018	98.20%	97.90%	98.05%	16.316	1.000	16.316
2019	97.90%	97.60%	97.75%	16.266	1.000	16.266
2020	97.60%	97.30%	97.45%	16.216	1.000	16.216
2021	97.30%	97.00%	97.15%	16.166	1.000	16.166
2022	97.00%	96.70%	96.85%	16.116	1.000	16.116
2023	96.70%	96.40%	96.55%	16.066	1.000	16.066
2024	96.40%	96.10%	96.25%	16.016	1.000	16.016
2025	96.10%	95.80%	95.95%	15.966	1.000	15.966
2026	95.80%	95.50%	95.65%	15.916	1.000	15.916
2027	95.50%	95.20%	95.35%	15.866	1.000	15.866
2028	95.20%	94.90%	95.05%	15.816	1.000	15.816
2029	94.90%	94.60%	94.75%	15.766	1.000	15.766
2030	94.60%	94.30%	94.45%	15.716	1.000	15.716
2031	94.30%	94.00%	94.15%	15.667	1.000	15.667
2032	94.00%	93.70%	93.85%	15.617	1.000	15.617
2033	93.70%	93.40%	93.55%	15.567	1.000	15.567
2034	93.40%	93.10%	93.25%	15.517	1.000	15.517
2035	93.10%	92.80%	92.95%	15.467	1.000	15.467
2036	92.80%	92.50%	92.65%	15.417	1.000	15.417
2037	92.50%	92.20%	92.35%	15.367	1.000	15.367
2038	92.20%	91.90%	92.05%	15.317	1.000	15.317
2039	91.90%	91.60%	91.75%	15.267	1.000	15.267
2040	91.60%	91.30%	91.45%	15.217	1.000	15.217
2041	91.30%	91.00%	91.15%	15.167	1.000	15.167
2042	91.00%	90.70%	90.85%	15.117	1.000	15.117
2043	90.70%	90.40%	90.55%	15.068	1.000	15.068
2044	90.40%	90.10%	90.25%	15.018	1.000	15.018
2045	90.10%	89.80%	89.95%	14.968	1.000	14.968
2046	89.80%	89.50%	89.65%	14.918	1.000	14.918

2047	89.50%	89.20%	89.35%	14.868	1.000	14.868
2048	89.20%	88.90%	89.05%	14.818	1.000	14.818
2049	88.90%	88.60%	88.75%	14.768	1.000	14.768
2050	88.60%	88.30%	88.45%	14.718	1.000	14.718
2051	88.30%	88.00%	88.15%	14.668	1.000	14.668
2052	88.00%	87.70%	87.85%	14.618	1.000	14.618
2053	87.70%	87.40%	87.55%	14.568	1.000	14.568
2054	87.40%	87.10%	87.25%	14.518	1.000	14.518
2055	87.10%	86.80%	86.95%	14.468	1.000	14.468
2056	86.80%	86.50%	86.65%	14.419	1.000	14.419
2057	86.50%	86.20%	86.35%	14.369	1.000	14.369
2058	86.20%	85.90%	86.05%	14.319	1.000	14.319
2059	85.90%	85.60%	85.75%	14.269	1.000	14.269
2060	85.60%	85.30%	85.45%	14.219	1.000	14.219
2061	85.30%	85.00%	85.15%	14.169	1.000	14.169
2062	85.00%	85.00%	85.00%	14.144	1.000	14.144

Total discounted SAYs lost: 783.744

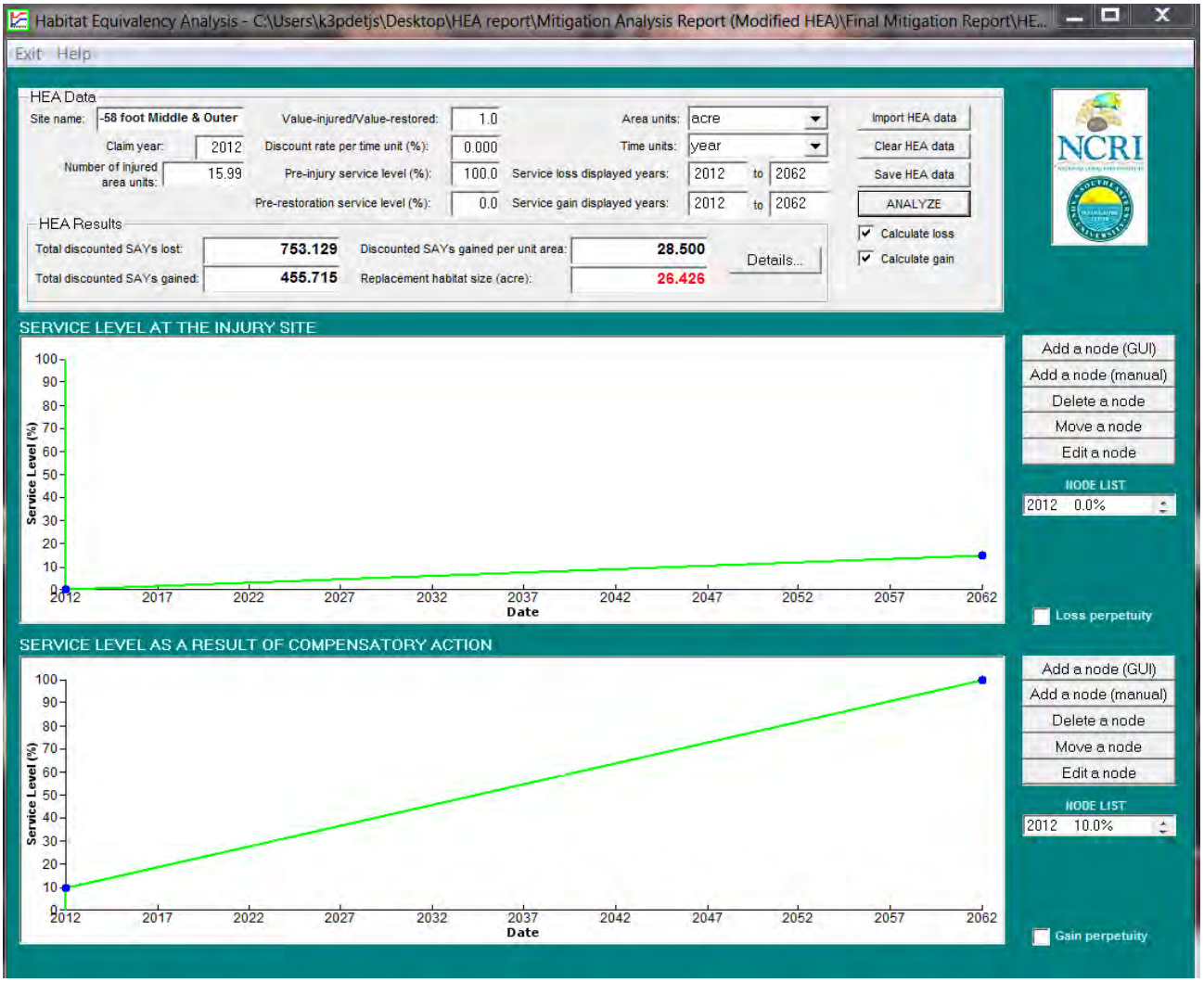
SERVICE GAIN AT THE COMPENSATORY AREA

Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	1.814	1.000	1.814
2013	11.80%	13.60%	12.70%	2.113	1.000	2.113
2014	13.60%	15.40%	14.50%	2.413	1.000	2.413
2015	15.40%	17.20%	16.30%	2.712	1.000	2.712
2016	17.20%	19.00%	18.10%	3.012	1.000	3.012
2017	19.00%	20.80%	19.90%	3.311	1.000	3.311
2018	20.80%	22.60%	21.70%	3.611	1.000	3.611
2019	22.60%	24.40%	23.50%	3.910	1.000	3.910
2020	24.40%	26.20%	25.30%	4.210	1.000	4.210
2021	26.20%	28.00%	27.10%	4.509	1.000	4.509
2022	28.00%	29.80%	28.90%	4.809	1.000	4.809
2023	29.80%	31.60%	30.70%	5.108	1.000	5.108
2024	31.60%	33.40%	32.50%	5.408	1.000	5.408
2025	33.40%	35.20%	34.30%	5.708	1.000	5.708
2026	35.20%	37.00%	36.10%	6.007	1.000	6.007
2027	37.00%	38.80%	37.90%	6.307	1.000	6.307
2028	38.80%	40.60%	39.70%	6.606	1.000	6.606
2029	40.60%	42.40%	41.50%	6.906	1.000	6.906
2030	42.40%	44.20%	43.30%	7.205	1.000	7.205
2031	44.20%	46.00%	45.10%	7.505	1.000	7.505
2032	46.00%	47.80%	46.90%	7.804	1.000	7.804
2033	47.80%	49.60%	48.70%	8.104	1.000	8.104
2034	49.60%	51.40%	50.50%	8.403	1.000	8.403
2035	51.40%	53.20%	52.30%	8.703	1.000	8.703
2036	53.20%	55.00%	54.10%	9.002	1.000	9.002
2037	55.00%	56.80%	55.90%	9.302	1.000	9.302
2038	56.80%	58.60%	57.70%	9.601	1.000	9.601
2039	58.60%	60.40%	59.50%	9.901	1.000	9.901
2040	60.40%	62.20%	61.30%	10.200	1.000	10.200
2041	62.20%	64.00%	63.10%	10.500	1.000	10.500
2042	64.00%	65.80%	64.90%	10.799	1.000	10.799
2043	65.80%	67.60%	66.70%	11.099	1.000	11.099
2044	67.60%	69.40%	68.50%	11.398	1.000	11.398
2045	69.40%	71.20%	70.30%	11.698	1.000	11.698

2046	71.20%	73.00%	72.10%	11.997	1.000	11.997
2047	73.00%	74.80%	73.90%	12.297	1.000	12.297
2048	74.80%	76.60%	75.70%	12.596	1.000	12.596
2049	76.60%	78.40%	77.50%	12.896	1.000	12.896
2050	78.40%	80.20%	79.30%	13.196	1.000	13.196
2051	80.20%	82.00%	81.10%	13.495	1.000	13.495
2052	82.00%	83.80%	82.90%	13.795	1.000	13.795
2053	83.80%	85.60%	84.70%	14.094	1.000	14.094
2054	85.60%	87.40%	86.50%	14.394	1.000	14.394
2055	87.40%	89.20%	88.30%	14.693	1.000	14.693
2056	89.20%	91.00%	90.10%	14.993	1.000	14.993
2057	91.00%	92.80%	91.90%	15.292	1.000	15.292
2058	92.80%	94.60%	93.70%	15.592	1.000	15.592
2059	94.60%	96.40%	95.50%	15.891	1.000	15.891
2060	96.40%	98.20%	97.30%	16.191	1.000	16.191
2061	98.20%	100.00%	99.10%	16.490	1.000	16.490
2062	100.00%	100.00%	100.00%	16.640	1.000	16.640

Total discounted SAYs gained	474.24
Discounted SAYs gained per unit area:	28.50
Replacement habitat size (acre): 1.00 * 783.744/28.5	27.500

-58 Foot dredge – Outer and middle reef



HABITAT EQUIVALENCY ANALYSIS

Sitename: -58 foot Middle & Outer reef direct - recovery to 15%

Date: 8/11/2012 10:51:16 AM
Datafile: C:\Users\k3pdetjs\Desktop\HEA report\Mitigation Analysis Report (Modified HEA)\Final Mitigation Report\HEA files\-57 middle & outer reef direct - recovery to 15%.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 15.99
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	100.00%	99.70%	99.85%	15.966	1.000	15.966
2013	99.70%	99.40%	99.55%	15.918	1.000	15.918
2014	99.40%	99.10%	99.25%	15.870	1.000	15.870
2015	99.10%	98.80%	98.95%	15.822	1.000	15.822
2016	98.80%	98.50%	98.65%	15.774	1.000	15.774
2017	98.50%	98.20%	98.35%	15.726	1.000	15.726
2018	98.20%	97.90%	98.05%	15.678	1.000	15.678
2019	97.90%	97.60%	97.75%	15.630	1.000	15.630
2020	97.60%	97.30%	97.45%	15.582	1.000	15.582
2021	97.30%	97.00%	97.15%	15.534	1.000	15.534
2022	97.00%	96.70%	96.85%	15.486	1.000	15.486
2023	96.70%	96.40%	96.55%	15.438	1.000	15.438
2024	96.40%	96.10%	96.25%	15.390	1.000	15.390
2025	96.10%	95.80%	95.95%	15.342	1.000	15.342
2026	95.80%	95.50%	95.65%	15.294	1.000	15.294
2027	95.50%	95.20%	95.35%	15.246	1.000	15.246
2028	95.20%	94.90%	95.05%	15.198	1.000	15.198
2029	94.90%	94.60%	94.75%	15.151	1.000	15.151
2030	94.60%	94.30%	94.45%	15.103	1.000	15.103
2031	94.30%	94.00%	94.15%	15.055	1.000	15.055
2032	94.00%	93.70%	93.85%	15.007	1.000	15.007
2033	93.70%	93.40%	93.55%	14.959	1.000	14.959
2034	93.40%	93.10%	93.25%	14.911	1.000	14.911
2035	93.10%	92.80%	92.95%	14.863	1.000	14.863
2036	92.80%	92.50%	92.65%	14.815	1.000	14.815
2037	92.50%	92.20%	92.35%	14.767	1.000	14.767
2038	92.20%	91.90%	92.05%	14.719	1.000	14.719
2039	91.90%	91.60%	91.75%	14.671	1.000	14.671
2040	91.60%	91.30%	91.45%	14.623	1.000	14.623
2041	91.30%	91.00%	91.15%	14.575	1.000	14.575
2042	91.00%	90.70%	90.85%	14.527	1.000	14.527
2043	90.70%	90.40%	90.55%	14.479	1.000	14.479
2044	90.40%	90.10%	90.25%	14.431	1.000	14.431
2045	90.10%	89.80%	89.95%	14.383	1.000	14.383
2046	89.80%	89.50%	89.65%	14.335	1.000	14.335

2047	89.50%	89.20%	89.35%	14.287	1.000	14.287
2048	89.20%	88.90%	89.05%	14.239	1.000	14.239
2049	88.90%	88.60%	88.75%	14.191	1.000	14.191
2050	88.60%	88.30%	88.45%	14.143	1.000	14.143
2051	88.30%	88.00%	88.15%	14.095	1.000	14.095
2052	88.00%	87.70%	87.85%	14.047	1.000	14.047
2053	87.70%	87.40%	87.55%	13.999	1.000	13.999
2054	87.40%	87.10%	87.25%	13.951	1.000	13.951
2055	87.10%	86.80%	86.95%	13.903	1.000	13.903
2056	86.80%	86.50%	86.65%	13.855	1.000	13.855
2057	86.50%	86.20%	86.35%	13.807	1.000	13.807
2058	86.20%	85.90%	86.05%	13.759	1.000	13.759
2059	85.90%	85.60%	85.75%	13.711	1.000	13.711
2060	85.60%	85.30%	85.45%	13.663	1.000	13.663
2061	85.30%	85.00%	85.15%	13.615	1.000	13.615
2062	85.00%	85.00%	85.00%	13.591	1.000	13.591

Total discounted SAYs lost: 753.129

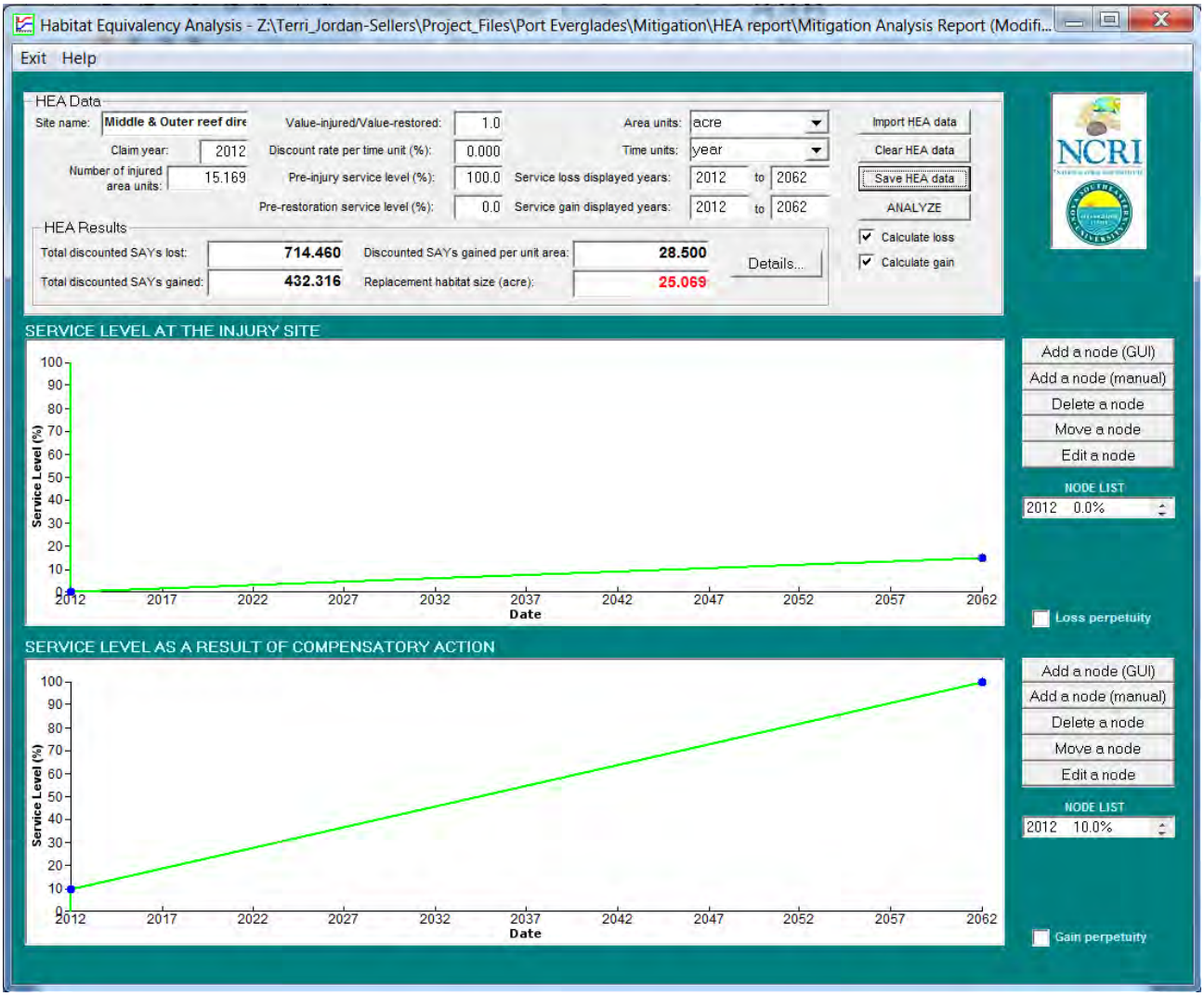
SERVICE GAIN AT THE COMPENSATORY AREA

Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	1.743	1.000	1.743
2013	11.80%	13.60%	12.70%	2.031	1.000	2.031
2014	13.60%	15.40%	14.50%	2.319	1.000	2.319
2015	15.40%	17.20%	16.30%	2.606	1.000	2.606
2016	17.20%	19.00%	18.10%	2.894	1.000	2.894
2017	19.00%	20.80%	19.90%	3.182	1.000	3.182
2018	20.80%	22.60%	21.70%	3.470	1.000	3.470
2019	22.60%	24.40%	23.50%	3.758	1.000	3.758
2020	24.40%	26.20%	25.30%	4.045	1.000	4.045
2021	26.20%	28.00%	27.10%	4.333	1.000	4.333
2022	28.00%	29.80%	28.90%	4.621	1.000	4.621
2023	29.80%	31.60%	30.70%	4.909	1.000	4.909
2024	31.60%	33.40%	32.50%	5.197	1.000	5.197
2025	33.40%	35.20%	34.30%	5.485	1.000	5.485
2026	35.20%	37.00%	36.10%	5.772	1.000	5.772
2027	37.00%	38.80%	37.90%	6.060	1.000	6.060
2028	38.80%	40.60%	39.70%	6.348	1.000	6.348
2029	40.60%	42.40%	41.50%	6.636	1.000	6.636
2030	42.40%	44.20%	43.30%	6.924	1.000	6.924
2031	44.20%	46.00%	45.10%	7.211	1.000	7.211
2032	46.00%	47.80%	46.90%	7.499	1.000	7.499
2033	47.80%	49.60%	48.70%	7.787	1.000	7.787
2034	49.60%	51.40%	50.50%	8.075	1.000	8.075
2035	51.40%	53.20%	52.30%	8.363	1.000	8.363
2036	53.20%	55.00%	54.10%	8.651	1.000	8.651
2037	55.00%	56.80%	55.90%	8.938	1.000	8.938
2038	56.80%	58.60%	57.70%	9.226	1.000	9.226
2039	58.60%	60.40%	59.50%	9.514	1.000	9.514
2040	60.40%	62.20%	61.30%	9.802	1.000	9.802
2041	62.20%	64.00%	63.10%	10.090	1.000	10.090
2042	64.00%	65.80%	64.90%	10.378	1.000	10.378
2043	65.80%	67.60%	66.70%	10.665	1.000	10.665
2044	67.60%	69.40%	68.50%	10.953	1.000	10.953
2045	69.40%	71.20%	70.30%	11.241	1.000	11.241

2046	71.20%	73.00%	72.10%	11.529	1.000	11.529
2047	73.00%	74.80%	73.90%	11.817	1.000	11.817
2048	74.80%	76.60%	75.70%	12.104	1.000	12.104
2049	76.60%	78.40%	77.50%	12.392	1.000	12.392
2050	78.40%	80.20%	79.30%	12.680	1.000	12.680
2051	80.20%	82.00%	81.10%	12.968	1.000	12.968
2052	82.00%	83.80%	82.90%	13.256	1.000	13.256
2053	83.80%	85.60%	84.70%	13.544	1.000	13.544
2054	85.60%	87.40%	86.50%	13.831	1.000	13.831
2055	87.40%	89.20%	88.30%	14.119	1.000	14.119
2056	89.20%	91.00%	90.10%	14.407	1.000	14.407
2057	91.00%	92.80%	91.90%	14.695	1.000	14.695
2058	92.80%	94.60%	93.70%	14.983	1.000	14.983
2059	94.60%	96.40%	95.50%	15.270	1.000	15.270
2060	96.40%	98.20%	97.30%	15.558	1.000	15.558
2061	98.20%	100.00%	99.10%	15.846	1.000	15.846
2062	100.00%	100.00%	100.00%	15.990	1.000	15.990

Total discounted SAYs gained	455.71
Discounted SAYs gained per unit area:	28.50
Replacement habitat size (acre): 1.00 * 753.129/28.5	26.426

-57 Foot dredge – Outer and middle reef



HABITAT EQUIVALENCY ANALYSIS

Sitename: Middle & Outer reef direct - recovery to 15%

Date: 10/23/2012 4:27:28 PM
Datafile: Z:\Terri_Jordan-Sellers\Project_Files\Port Everglades\Mitigation\HEA report\Mitigation Analysis Report (Modified HEA)\Final Mitigation Report\HEA software files\-57 middle & outer reef direct - recovery to 15%.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 15.169
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	100.00%	99.70%	99.85%	15.146	1.000	15.146
2013	99.70%	99.40%	99.55%	15.101	1.000	15.101
2014	99.40%	99.10%	99.25%	15.055	1.000	15.055
2015	99.10%	98.80%	98.95%	15.010	1.000	15.010
2016	98.80%	98.50%	98.65%	14.964	1.000	14.964
2017	98.50%	98.20%	98.35%	14.919	1.000	14.919
2018	98.20%	97.90%	98.05%	14.873	1.000	14.873
2019	97.90%	97.60%	97.75%	14.828	1.000	14.828
2020	97.60%	97.30%	97.45%	14.782	1.000	14.782
2021	97.30%	97.00%	97.15%	14.737	1.000	14.737
2022	97.00%	96.70%	96.85%	14.691	1.000	14.691
2023	96.70%	96.40%	96.55%	14.646	1.000	14.646
2024	96.40%	96.10%	96.25%	14.600	1.000	14.600
2025	96.10%	95.80%	95.95%	14.555	1.000	14.555
2026	95.80%	95.50%	95.65%	14.509	1.000	14.509
2027	95.50%	95.20%	95.35%	14.464	1.000	14.464
2028	95.20%	94.90%	95.05%	14.418	1.000	14.418
2029	94.90%	94.60%	94.75%	14.373	1.000	14.373
2030	94.60%	94.30%	94.45%	14.327	1.000	14.327
2031	94.30%	94.00%	94.15%	14.282	1.000	14.282
2032	94.00%	93.70%	93.85%	14.236	1.000	14.236
2033	93.70%	93.40%	93.55%	14.191	1.000	14.191
2034	93.40%	93.10%	93.25%	14.145	1.000	14.145
2035	93.10%	92.80%	92.95%	14.100	1.000	14.100
2036	92.80%	92.50%	92.65%	14.054	1.000	14.054
2037	92.50%	92.20%	92.35%	14.009	1.000	14.009
2038	92.20%	91.90%	92.05%	13.963	1.000	13.963
2039	91.90%	91.60%	91.75%	13.918	1.000	13.918
2040	91.60%	91.30%	91.45%	13.872	1.000	13.872
2041	91.30%	91.00%	91.15%	13.827	1.000	13.827
2042	91.00%	90.70%	90.85%	13.781	1.000	13.781
2043	90.70%	90.40%	90.55%	13.736	1.000	13.736
2044	90.40%	90.10%	90.25%	13.690	1.000	13.690
2045	90.10%	89.80%	89.95%	13.645	1.000	13.645
2046	89.80%	89.50%	89.65%	13.599	1.000	13.599

2047	89.50%	89.20%	89.35%	13.554	1.000	13.554
2048	89.20%	88.90%	89.05%	13.508	1.000	13.508
2049	88.90%	88.60%	88.75%	13.462	1.000	13.462
2050	88.60%	88.30%	88.45%	13.417	1.000	13.417
2051	88.30%	88.00%	88.15%	13.371	1.000	13.371
2052	88.00%	87.70%	87.85%	13.326	1.000	13.326
2053	87.70%	87.40%	87.55%	13.280	1.000	13.280
2054	87.40%	87.10%	87.25%	13.235	1.000	13.235
2055	87.10%	86.80%	86.95%	13.189	1.000	13.189
2056	86.80%	86.50%	86.65%	13.144	1.000	13.144
2057	86.50%	86.20%	86.35%	13.098	1.000	13.098
2058	86.20%	85.90%	86.05%	13.053	1.000	13.053
2059	85.90%	85.60%	85.75%	13.007	1.000	13.007
2060	85.60%	85.30%	85.45%	12.962	1.000	12.962
2061	85.30%	85.00%	85.15%	12.916	1.000	12.916
2062	85.00%	85.00%	85.00%	12.894	1.000	12.894

Total discounted SAYs lost: 714.460

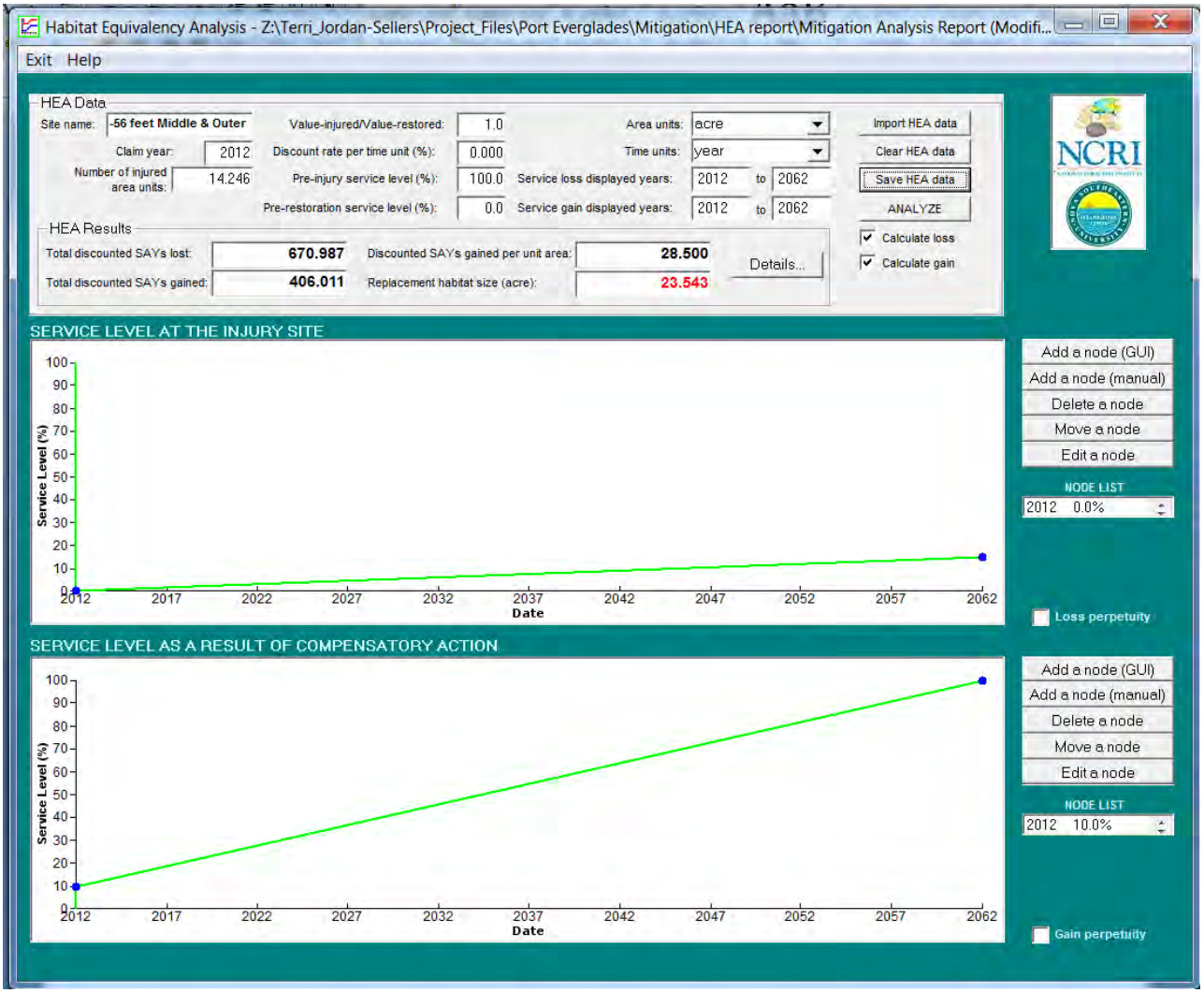
SERVICE GAIN AT THE COMPENSATORY AREA

Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	1.653	1.000	1.653
2013	11.80%	13.60%	12.70%	1.926	1.000	1.926
2014	13.60%	15.40%	14.50%	2.200	1.000	2.200
2015	15.40%	17.20%	16.30%	2.473	1.000	2.473
2016	17.20%	19.00%	18.10%	2.746	1.000	2.746
2017	19.00%	20.80%	19.90%	3.019	1.000	3.019
2018	20.80%	22.60%	21.70%	3.292	1.000	3.292
2019	22.60%	24.40%	23.50%	3.565	1.000	3.565
2020	24.40%	26.20%	25.30%	3.838	1.000	3.838
2021	26.20%	28.00%	27.10%	4.111	1.000	4.111
2022	28.00%	29.80%	28.90%	4.384	1.000	4.384
2023	29.80%	31.60%	30.70%	4.657	1.000	4.657
2024	31.60%	33.40%	32.50%	4.930	1.000	4.930
2025	33.40%	35.20%	34.30%	5.203	1.000	5.203
2026	35.20%	37.00%	36.10%	5.476	1.000	5.476
2027	37.00%	38.80%	37.90%	5.749	1.000	5.749
2028	38.80%	40.60%	39.70%	6.022	1.000	6.022
2029	40.60%	42.40%	41.50%	6.295	1.000	6.295
2030	42.40%	44.20%	43.30%	6.568	1.000	6.568
2031	44.20%	46.00%	45.10%	6.841	1.000	6.841
2032	46.00%	47.80%	46.90%	7.114	1.000	7.114
2033	47.80%	49.60%	48.70%	7.387	1.000	7.387
2034	49.60%	51.40%	50.50%	7.660	1.000	7.660
2035	51.40%	53.20%	52.30%	7.933	1.000	7.933
2036	53.20%	55.00%	54.10%	8.206	1.000	8.206
2037	55.00%	56.80%	55.90%	8.479	1.000	8.479
2038	56.80%	58.60%	57.70%	8.753	1.000	8.753
2039	58.60%	60.40%	59.50%	9.026	1.000	9.026
2040	60.40%	62.20%	61.30%	9.299	1.000	9.299
2041	62.20%	64.00%	63.10%	9.572	1.000	9.572
2042	64.00%	65.80%	64.90%	9.845	1.000	9.845
2043	65.80%	67.60%	66.70%	10.118	1.000	10.118
2044	67.60%	69.40%	68.50%	10.391	1.000	10.391
2045	69.40%	71.20%	70.30%	10.664	1.000	10.664

2046	71.20%	73.00%	72.10%	10.937	1.000	10.937
2047	73.00%	74.80%	73.90%	11.210	1.000	11.210
2048	74.80%	76.60%	75.70%	11.483	1.000	11.483
2049	76.60%	78.40%	77.50%	11.756	1.000	11.756
2050	78.40%	80.20%	79.30%	12.029	1.000	12.029
2051	80.20%	82.00%	81.10%	12.302	1.000	12.302
2052	82.00%	83.80%	82.90%	12.575	1.000	12.575
2053	83.80%	85.60%	84.70%	12.848	1.000	12.848
2054	85.60%	87.40%	86.50%	13.121	1.000	13.121
2055	87.40%	89.20%	88.30%	13.394	1.000	13.394
2056	89.20%	91.00%	90.10%	13.667	1.000	13.667
2057	91.00%	92.80%	91.90%	13.940	1.000	13.940
2058	92.80%	94.60%	93.70%	14.213	1.000	14.213
2059	94.60%	96.40%	95.50%	14.486	1.000	14.486
2060	96.40%	98.20%	97.30%	14.759	1.000	14.759
2061	98.20%	100.00%	99.10%	15.032	1.000	15.032
2062	100.00%	100.00%	100.00%	15.169	1.000	15.169

Total discounted SAYs gained	432.32
Discounted SAYs gained per unit area:	28.50
Replacement habitat size (acre): 1.00 * 714.46/28.5	25.069

-56 Foot Dredge - Outer and middle reef



HABITAT EQUIVALENCY ANALYSIS

Sitename: -56 feet Middle & Outer reef direct - recovery to 15%

Date: 10/23/2012 4:29:29 PM
Datafile: Z:\Terri_Jordan-Sellers\Project_Files\Port Everglades\Mitigation\HEA report\Mitigation Analysis Report (Modified HEA)\Final Mitigation Report\HEA software files\-56 middle & outer reef direct - recovery to 15%.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 14.246
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	100.00%	99.70%	99.85%	14.225	1.000	14.225
2013	99.70%	99.40%	99.55%	14.182	1.000	14.182
2014	99.40%	99.10%	99.25%	14.139	1.000	14.139
2015	99.10%	98.80%	98.95%	14.096	1.000	14.096
2016	98.80%	98.50%	98.65%	14.054	1.000	14.054
2017	98.50%	98.20%	98.35%	14.011	1.000	14.011
2018	98.20%	97.90%	98.05%	13.968	1.000	13.968
2019	97.90%	97.60%	97.75%	13.925	1.000	13.925
2020	97.60%	97.30%	97.45%	13.883	1.000	13.883
2021	97.30%	97.00%	97.15%	13.840	1.000	13.840
2022	97.00%	96.70%	96.85%	13.797	1.000	13.797
2023	96.70%	96.40%	96.55%	13.755	1.000	13.755
2024	96.40%	96.10%	96.25%	13.712	1.000	13.712
2025	96.10%	95.80%	95.95%	13.669	1.000	13.669
2026	95.80%	95.50%	95.65%	13.626	1.000	13.626
2027	95.50%	95.20%	95.35%	13.584	1.000	13.584
2028	95.20%	94.90%	95.05%	13.541	1.000	13.541
2029	94.90%	94.60%	94.75%	13.498	1.000	13.498
2030	94.60%	94.30%	94.45%	13.455	1.000	13.455
2031	94.30%	94.00%	94.15%	13.413	1.000	13.413
2032	94.00%	93.70%	93.85%	13.370	1.000	13.370
2033	93.70%	93.40%	93.55%	13.327	1.000	13.327
2034	93.40%	93.10%	93.25%	13.284	1.000	13.284
2035	93.10%	92.80%	92.95%	13.242	1.000	13.242
2036	92.80%	92.50%	92.65%	13.199	1.000	13.199
2037	92.50%	92.20%	92.35%	13.156	1.000	13.156
2038	92.20%	91.90%	92.05%	13.113	1.000	13.113
2039	91.90%	91.60%	91.75%	13.071	1.000	13.071
2040	91.60%	91.30%	91.45%	13.028	1.000	13.028
2041	91.30%	91.00%	91.15%	12.985	1.000	12.985
2042	91.00%	90.70%	90.85%	12.942	1.000	12.942
2043	90.70%	90.40%	90.55%	12.900	1.000	12.900
2044	90.40%	90.10%	90.25%	12.857	1.000	12.857
2045	90.10%	89.80%	89.95%	12.814	1.000	12.814
2046	89.80%	89.50%	89.65%	12.772	1.000	12.772

2047	89.50%	89.20%	89.35%	12.729	1.000	12.729
2048	89.20%	88.90%	89.05%	12.686	1.000	12.686
2049	88.90%	88.60%	88.75%	12.643	1.000	12.643
2050	88.60%	88.30%	88.45%	12.601	1.000	12.601
2051	88.30%	88.00%	88.15%	12.558	1.000	12.558
2052	88.00%	87.70%	87.85%	12.515	1.000	12.515
2053	87.70%	87.40%	87.55%	12.472	1.000	12.472
2054	87.40%	87.10%	87.25%	12.430	1.000	12.430
2055	87.10%	86.80%	86.95%	12.387	1.000	12.387
2056	86.80%	86.50%	86.65%	12.344	1.000	12.344
2057	86.50%	86.20%	86.35%	12.301	1.000	12.301
2058	86.20%	85.90%	86.05%	12.259	1.000	12.259
2059	85.90%	85.60%	85.75%	12.216	1.000	12.216
2060	85.60%	85.30%	85.45%	12.173	1.000	12.173
2061	85.30%	85.00%	85.15%	12.130	1.000	12.130
2062	85.00%	85.00%	85.00%	12.109	1.000	12.109

Total discounted SAYs lost: 670.987

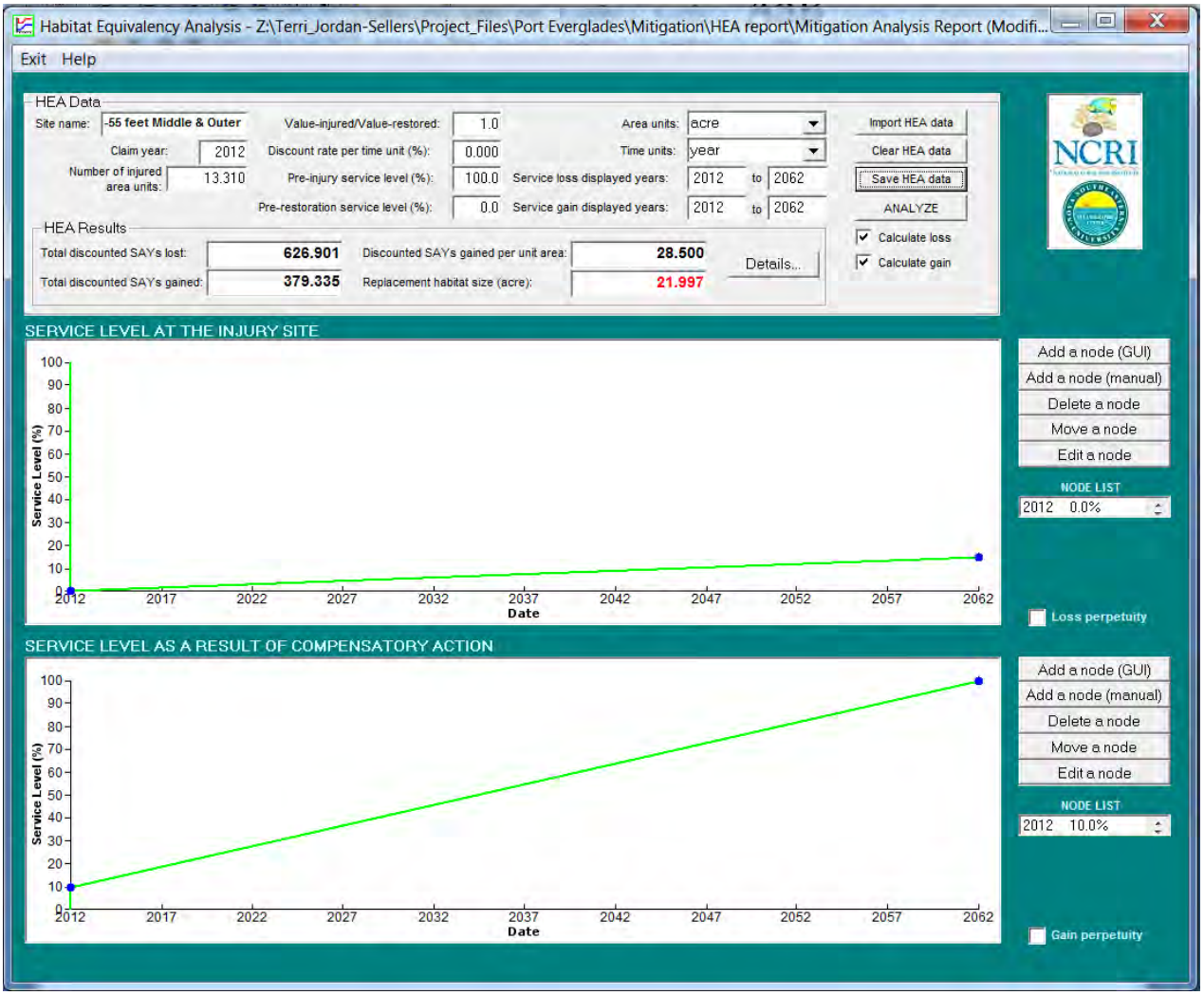
SERVICE GAIN AT THE COMPENSATORY AREA

Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	1.553	1.000	1.553
2013	11.80%	13.60%	12.70%	1.809	1.000	1.809
2014	13.60%	15.40%	14.50%	2.066	1.000	2.066
2015	15.40%	17.20%	16.30%	2.322	1.000	2.322
2016	17.20%	19.00%	18.10%	2.579	1.000	2.579
2017	19.00%	20.80%	19.90%	2.835	1.000	2.835
2018	20.80%	22.60%	21.70%	3.091	1.000	3.091
2019	22.60%	24.40%	23.50%	3.348	1.000	3.348
2020	24.40%	26.20%	25.30%	3.604	1.000	3.604
2021	26.20%	28.00%	27.10%	3.861	1.000	3.861
2022	28.00%	29.80%	28.90%	4.117	1.000	4.117
2023	29.80%	31.60%	30.70%	4.374	1.000	4.374
2024	31.60%	33.40%	32.50%	4.630	1.000	4.630
2025	33.40%	35.20%	34.30%	4.886	1.000	4.886
2026	35.20%	37.00%	36.10%	5.143	1.000	5.143
2027	37.00%	38.80%	37.90%	5.399	1.000	5.399
2028	38.80%	40.60%	39.70%	5.656	1.000	5.656
2029	40.60%	42.40%	41.50%	5.912	1.000	5.912
2030	42.40%	44.20%	43.30%	6.169	1.000	6.169
2031	44.20%	46.00%	45.10%	6.425	1.000	6.425
2032	46.00%	47.80%	46.90%	6.681	1.000	6.681
2033	47.80%	49.60%	48.70%	6.938	1.000	6.938
2034	49.60%	51.40%	50.50%	7.194	1.000	7.194
2035	51.40%	53.20%	52.30%	7.451	1.000	7.451
2036	53.20%	55.00%	54.10%	7.707	1.000	7.707
2037	55.00%	56.80%	55.90%	7.964	1.000	7.964
2038	56.80%	58.60%	57.70%	8.220	1.000	8.220
2039	58.60%	60.40%	59.50%	8.476	1.000	8.476
2040	60.40%	62.20%	61.30%	8.733	1.000	8.733
2041	62.20%	64.00%	63.10%	8.989	1.000	8.989
2042	64.00%	65.80%	64.90%	9.246	1.000	9.246
2043	65.80%	67.60%	66.70%	9.502	1.000	9.502
2044	67.60%	69.40%	68.50%	9.759	1.000	9.759
2045	69.40%	71.20%	70.30%	10.015	1.000	10.015

2046	71.20%	73.00%	72.10%	10.271	1.000	10.271
2047	73.00%	74.80%	73.90%	10.528	1.000	10.528
2048	74.80%	76.60%	75.70%	10.784	1.000	10.784
2049	76.60%	78.40%	77.50%	11.041	1.000	11.041
2050	78.40%	80.20%	79.30%	11.297	1.000	11.297
2051	80.20%	82.00%	81.10%	11.554	1.000	11.554
2052	82.00%	83.80%	82.90%	11.810	1.000	11.810
2053	83.80%	85.60%	84.70%	12.066	1.000	12.066
2054	85.60%	87.40%	86.50%	12.323	1.000	12.323
2055	87.40%	89.20%	88.30%	12.579	1.000	12.579
2056	89.20%	91.00%	90.10%	12.836	1.000	12.836
2057	91.00%	92.80%	91.90%	13.092	1.000	13.092
2058	92.80%	94.60%	93.70%	13.349	1.000	13.349
2059	94.60%	96.40%	95.50%	13.605	1.000	13.605
2060	96.40%	98.20%	97.30%	13.861	1.000	13.861
2061	98.20%	100.00%	99.10%	14.118	1.000	14.118
2062	100.00%	100.00%	100.00%	14.246	1.000	14.246

Total discounted SAYs gained	406.01
Discounted SAYs gained per unit area:	28.50
Replacement habitat size (acre): 1.00 * 670.987/28.5	23.543

-55 foot dredge – outer and middle reef impact



HABITAT EQUIVALENCY ANALYSIS

Sitename: -55 feet Middle & Outer reef direct - recovery to 15%

Date: 10/23/2012 4:30:22 PM
Datafile: Z:\Terri_Jordan-Sellers\Project_Files\Port Everglades\Mitigation\HEA report\Mitigation Analysis Report (Modified HEA)\Final Mitigation Report\HEA software files\-55 middle & outer reef direct - recovery to 15%.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 13.31
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	100.00%	99.70%	99.85%	13.290	1.000	13.290
2013	99.70%	99.40%	99.55%	13.250	1.000	13.250
2014	99.40%	99.10%	99.25%	13.210	1.000	13.210
2015	99.10%	98.80%	98.95%	13.170	1.000	13.170
2016	98.80%	98.50%	98.65%	13.130	1.000	13.130
2017	98.50%	98.20%	98.35%	13.090	1.000	13.090
2018	98.20%	97.90%	98.05%	13.050	1.000	13.050
2019	97.90%	97.60%	97.75%	13.011	1.000	13.011
2020	97.60%	97.30%	97.45%	12.971	1.000	12.971
2021	97.30%	97.00%	97.15%	12.931	1.000	12.931
2022	97.00%	96.70%	96.85%	12.891	1.000	12.891
2023	96.70%	96.40%	96.55%	12.851	1.000	12.851
2024	96.40%	96.10%	96.25%	12.811	1.000	12.811
2025	96.10%	95.80%	95.95%	12.771	1.000	12.771
2026	95.80%	95.50%	95.65%	12.731	1.000	12.731
2027	95.50%	95.20%	95.35%	12.691	1.000	12.691
2028	95.20%	94.90%	95.05%	12.651	1.000	12.651
2029	94.90%	94.60%	94.75%	12.611	1.000	12.611
2030	94.60%	94.30%	94.45%	12.571	1.000	12.571
2031	94.30%	94.00%	94.15%	12.531	1.000	12.531
2032	94.00%	93.70%	93.85%	12.491	1.000	12.491
2033	93.70%	93.40%	93.55%	12.452	1.000	12.452
2034	93.40%	93.10%	93.25%	12.412	1.000	12.412
2035	93.10%	92.80%	92.95%	12.372	1.000	12.372
2036	92.80%	92.50%	92.65%	12.332	1.000	12.332
2037	92.50%	92.20%	92.35%	12.292	1.000	12.292
2038	92.20%	91.90%	92.05%	12.252	1.000	12.252
2039	91.90%	91.60%	91.75%	12.212	1.000	12.212
2040	91.60%	91.30%	91.45%	12.172	1.000	12.172
2041	91.30%	91.00%	91.15%	12.132	1.000	12.132
2042	91.00%	90.70%	90.85%	12.092	1.000	12.092
2043	90.70%	90.40%	90.55%	12.052	1.000	12.052
2044	90.40%	90.10%	90.25%	12.012	1.000	12.012
2045	90.10%	89.80%	89.95%	11.972	1.000	11.972
2046	89.80%	89.50%	89.65%	11.932	1.000	11.932

2047	89.50%	89.20%	89.35%	11.892	1.000	11.892
2048	89.20%	88.90%	89.05%	11.853	1.000	11.853
2049	88.90%	88.60%	88.75%	11.813	1.000	11.813
2050	88.60%	88.30%	88.45%	11.773	1.000	11.773
2051	88.30%	88.00%	88.15%	11.733	1.000	11.733
2052	88.00%	87.70%	87.85%	11.693	1.000	11.693
2053	87.70%	87.40%	87.55%	11.653	1.000	11.653
2054	87.40%	87.10%	87.25%	11.613	1.000	11.613
2055	87.10%	86.80%	86.95%	11.573	1.000	11.573
2056	86.80%	86.50%	86.65%	11.533	1.000	11.533
2057	86.50%	86.20%	86.35%	11.493	1.000	11.493
2058	86.20%	85.90%	86.05%	11.453	1.000	11.453
2059	85.90%	85.60%	85.75%	11.413	1.000	11.413
2060	85.60%	85.30%	85.45%	11.373	1.000	11.373
2061	85.30%	85.00%	85.15%	11.333	1.000	11.333
2062	85.00%	85.00%	85.00%	11.314	1.000	11.314

Total discounted SAYs lost: 626.901

SERVICE GAIN AT THE COMPENSATORY AREA

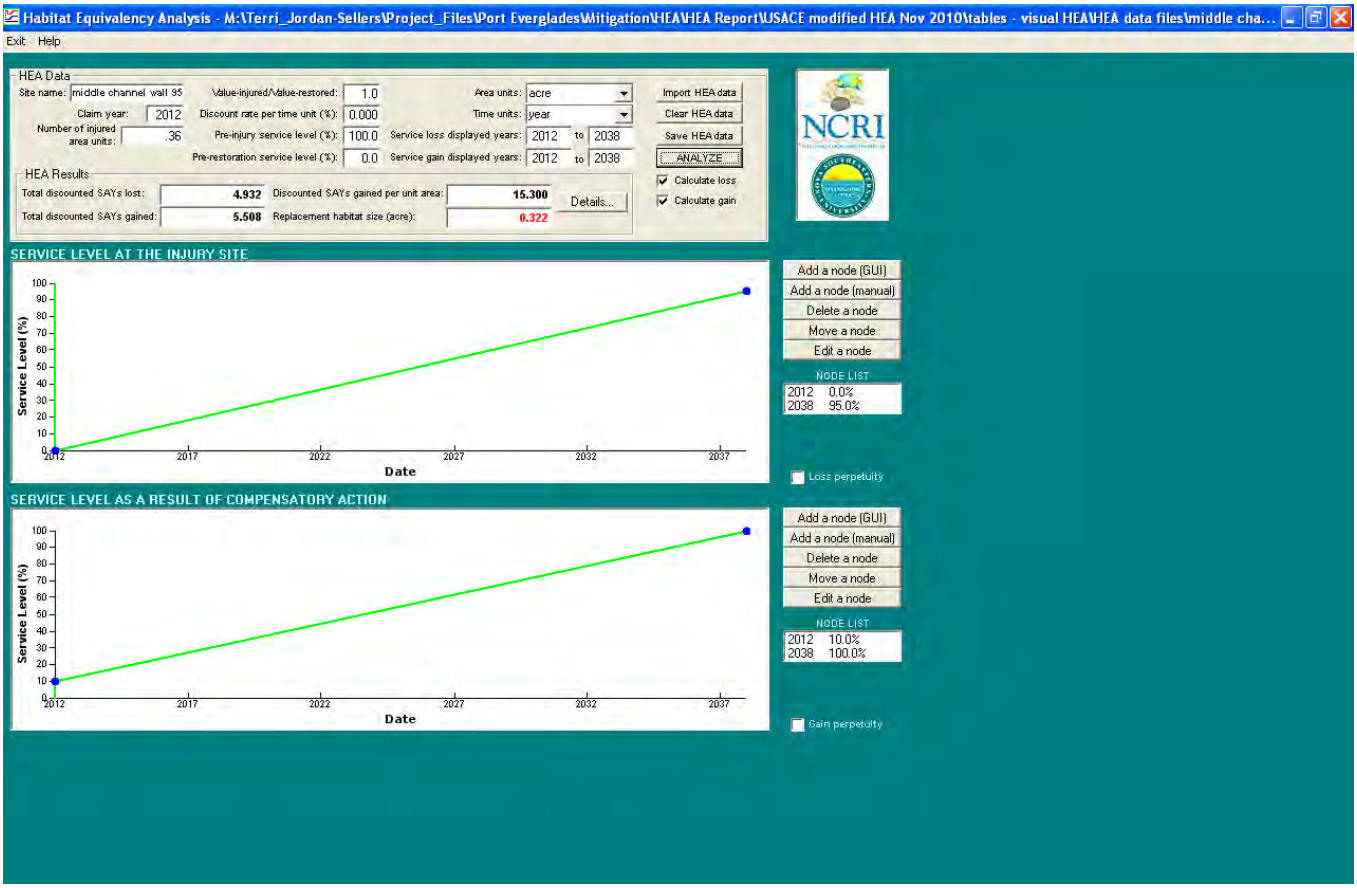
Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	1.451	1.000	1.451
2013	11.80%	13.60%	12.70%	1.690	1.000	1.690
2014	13.60%	15.40%	14.50%	1.930	1.000	1.930
2015	15.40%	17.20%	16.30%	2.170	1.000	2.170
2016	17.20%	19.00%	18.10%	2.409	1.000	2.409
2017	19.00%	20.80%	19.90%	2.649	1.000	2.649
2018	20.80%	22.60%	21.70%	2.888	1.000	2.888
2019	22.60%	24.40%	23.50%	3.128	1.000	3.128
2020	24.40%	26.20%	25.30%	3.367	1.000	3.367
2021	26.20%	28.00%	27.10%	3.607	1.000	3.607
2022	28.00%	29.80%	28.90%	3.847	1.000	3.847
2023	29.80%	31.60%	30.70%	4.086	1.000	4.086
2024	31.60%	33.40%	32.50%	4.326	1.000	4.326
2025	33.40%	35.20%	34.30%	4.565	1.000	4.565
2026	35.20%	37.00%	36.10%	4.805	1.000	4.805
2027	37.00%	38.80%	37.90%	5.044	1.000	5.044
2028	38.80%	40.60%	39.70%	5.284	1.000	5.284
2029	40.60%	42.40%	41.50%	5.524	1.000	5.524
2030	42.40%	44.20%	43.30%	5.763	1.000	5.763
2031	44.20%	46.00%	45.10%	6.003	1.000	6.003
2032	46.00%	47.80%	46.90%	6.242	1.000	6.242
2033	47.80%	49.60%	48.70%	6.482	1.000	6.482
2034	49.60%	51.40%	50.50%	6.722	1.000	6.722
2035	51.40%	53.20%	52.30%	6.961	1.000	6.961
2036	53.20%	55.00%	54.10%	7.201	1.000	7.201
2037	55.00%	56.80%	55.90%	7.440	1.000	7.440
2038	56.80%	58.60%	57.70%	7.680	1.000	7.680
2039	58.60%	60.40%	59.50%	7.919	1.000	7.919
2040	60.40%	62.20%	61.30%	8.159	1.000	8.159
2041	62.20%	64.00%	63.10%	8.399	1.000	8.399
2042	64.00%	65.80%	64.90%	8.638	1.000	8.638
2043	65.80%	67.60%	66.70%	8.878	1.000	8.878
2044	67.60%	69.40%	68.50%	9.117	1.000	9.117
2045	69.40%	71.20%	70.30%	9.357	1.000	9.357

2046	71.20%	73.00%	72.10%	9.597	1.000	9.597
2047	73.00%	74.80%	73.90%	9.836	1.000	9.836
2048	74.80%	76.60%	75.70%	10.076	1.000	10.076
2049	76.60%	78.40%	77.50%	10.315	1.000	10.315
2050	78.40%	80.20%	79.30%	10.555	1.000	10.555
2051	80.20%	82.00%	81.10%	10.794	1.000	10.794
2052	82.00%	83.80%	82.90%	11.034	1.000	11.034
2053	83.80%	85.60%	84.70%	11.274	1.000	11.274
2054	85.60%	87.40%	86.50%	11.513	1.000	11.513
2055	87.40%	89.20%	88.30%	11.753	1.000	11.753
2056	89.20%	91.00%	90.10%	11.992	1.000	11.992
2057	91.00%	92.80%	91.90%	12.232	1.000	12.232
2058	92.80%	94.60%	93.70%	12.471	1.000	12.471
2059	94.60%	96.40%	95.50%	12.711	1.000	12.711
2060	96.40%	98.20%	97.30%	12.951	1.000	12.951
2061	98.20%	100.00%	99.10%	13.190	1.000	13.190
2062	100.00%	100.00%	100.00%	13.310	1.000	13.310

Total discounted SAYs gained 379.34
Discounted SAYs gained per unit area: 28.50

Replacement habitat size (acre): 1.00 * 626.901/28.5 21.997

Middle Reef Channel Wall Direct Impacts – Recovery to 95%



HABITAT EQUIVALENCY ANALYSIS

Sitename: middle channel wall 95%

Date: 11/29/2010 11:00:44 AM
Datafile: C:\Documents and Settings\k3pdetjs\Desktop\middle channel wall 95%.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: .36
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	100.00%	96.35%	98.17%	0.353	1.000	0.353
2013	96.35%	92.69%	94.52%	0.340	1.000	0.340
2014	92.69%	89.04%	90.87%	0.327	1.000	0.327
2015	89.04%	85.38%	87.21%	0.314	1.000	0.314
2016	85.38%	81.73%	83.56%	0.301	1.000	0.301
2017	81.73%	78.08%	79.90%	0.288	1.000	0.288
2018	78.08%	74.42%	76.25%	0.275	1.000	0.275
2019	74.42%	70.77%	72.60%	0.261	1.000	0.261
2020	70.77%	67.12%	68.94%	0.248	1.000	0.248
2021	67.12%	63.46%	65.29%	0.235	1.000	0.235
2022	63.46%	59.81%	61.63%	0.222	1.000	0.222
2023	59.81%	56.15%	57.98%	0.209	1.000	0.209
2024	56.15%	52.50%	54.33%	0.196	1.000	0.196
2025	52.50%	48.85%	50.67%	0.182	1.000	0.182
2026	48.85%	45.19%	47.02%	0.169	1.000	0.169
2027	45.19%	41.54%	43.37%	0.156	1.000	0.156
2028	41.54%	37.88%	39.71%	0.143	1.000	0.143
2029	37.88%	34.23%	36.06%	0.130	1.000	0.130
2030	34.23%	30.58%	32.40%	0.117	1.000	0.117
2031	30.58%	26.92%	28.75%	0.104	1.000	0.104
2032	26.92%	23.27%	25.10%	0.090	1.000	0.090
2033	23.27%	19.62%	21.44%	0.077	1.000	0.077
2034	19.62%	15.96%	17.79%	0.064	1.000	0.064
2035	15.96%	12.31%	14.13%	0.051	1.000	0.051
2036	12.31%	8.65%	10.48%	0.038	1.000	0.038
2037	8.65%	5.00%	6.83%	0.025	1.000	0.025
2038	5.00%	5.00%	5.00%	0.018	1.000	0.018

Total discounted SAYs lost: 4.932

SERVICE GAIN AT THE COMPENSATORY AREA

Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs

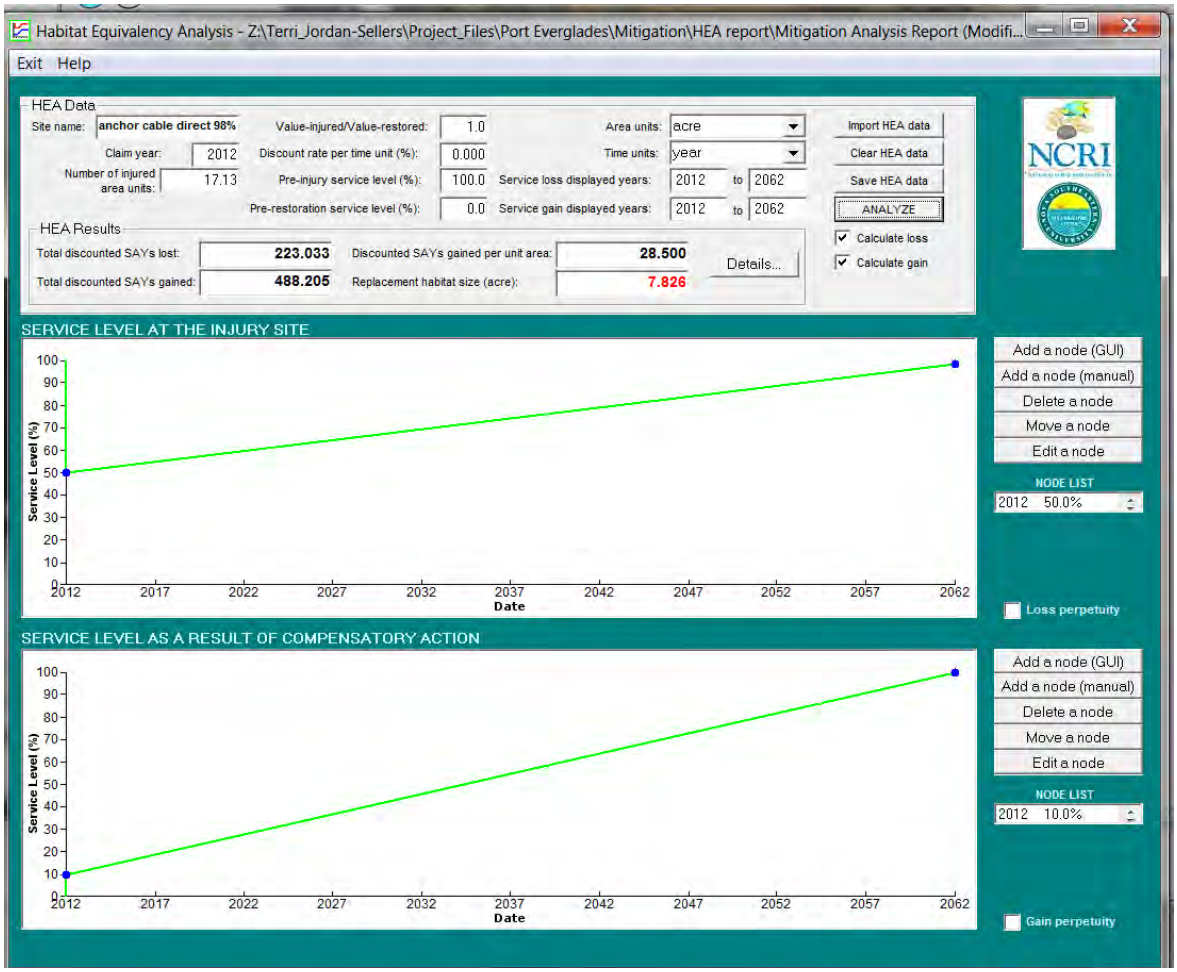
gained

2012	10.00%	13.46%	11.73%	0.042	1.000	0.042
2013	13.46%	16.92%	15.19%	0.055	1.000	0.055
2014	16.92%	20.38%	18.65%	0.067	1.000	0.067
2015	20.38%	23.85%	22.12%	0.080	1.000	0.080
2016	23.85%	27.31%	25.58%	0.092	1.000	0.092
2017	27.31%	30.77%	29.04%	0.105	1.000	0.105
2018	30.77%	34.23%	32.50%	0.117	1.000	0.117
2019	34.23%	37.69%	35.96%	0.129	1.000	0.129
2020	37.69%	41.15%	39.42%	0.142	1.000	0.142
2021	41.15%	44.62%	42.88%	0.154	1.000	0.154
2022	44.62%	48.08%	46.35%	0.167	1.000	0.167
2023	48.08%	51.54%	49.81%	0.179	1.000	0.179
2024	51.54%	55.00%	53.27%	0.192	1.000	0.192
2025	55.00%	58.46%	56.73%	0.204	1.000	0.204
2026	58.46%	61.92%	60.19%	0.217	1.000	0.217
2027	61.92%	65.38%	63.65%	0.229	1.000	0.229
2028	65.38%	68.85%	67.12%	0.242	1.000	0.242
2029	68.85%	72.31%	70.58%	0.254	1.000	0.254
2030	72.31%	75.77%	74.04%	0.267	1.000	0.267
2031	75.77%	79.23%	77.50%	0.279	1.000	0.279
2032	79.23%	82.69%	80.96%	0.291	1.000	0.291
2033	82.69%	86.15%	84.42%	0.304	1.000	0.304
2034	86.15%	89.62%	87.88%	0.316	1.000	0.316
2035	89.62%	93.08%	91.35%	0.329	1.000	0.329
2036	93.08%	96.54%	94.81%	0.341	1.000	0.341
2037	96.54%	100.00%	98.27%	0.354	1.000	0.354
2038	100.00%	100.00%	100.00%	0.360	1.000	0.360

Total discounted SAYs gained 5.51
Discounted SAYs gained per unit area: 15.30

Replacement habitat size (acre): 1.00 * 4.932/15.3 0.322

Indirect Impact – Anchor Cable



HABITAT EQUIVALENCY ANALYSIS

Sitename: anchor cable direct 98%

Date: 5/2/2011 12:47:07 PM
Datafile: Z:\Terri_Jordan-Sellers\Project_Files\Port Everglades\Mitigation\HEA report\Mitigation Analysis Report (Modified HEA)\anchor cable direct impact 98%.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 17.13
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	50.00%	49.04%	49.52%	8.483	1.000	8.483
2013	49.04%	48.08%	48.56%	8.318	1.000	8.318
2014	48.08%	47.12%	47.60%	8.154	1.000	8.154
2015	47.12%	46.16%	46.64%	7.989	1.000	7.989
2016	46.16%	45.20%	45.68%	7.825	1.000	7.825
2017	45.20%	44.24%	44.72%	7.661	1.000	7.661
2018	44.24%	43.28%	43.76%	7.496	1.000	7.496
2019	43.28%	42.32%	42.80%	7.332	1.000	7.332
2020	42.32%	41.36%	41.84%	7.167	1.000	7.167
2021	41.36%	40.40%	40.88%	7.003	1.000	7.003
2022	40.40%	39.44%	39.92%	6.838	1.000	6.838
2023	39.44%	38.48%	38.96%	6.674	1.000	6.674
2024	38.48%	37.52%	38.00%	6.509	1.000	6.509
2025	37.52%	36.56%	37.04%	6.345	1.000	6.345
2026	36.56%	35.60%	36.08%	6.181	1.000	6.181
2027	35.60%	34.64%	35.12%	6.016	1.000	6.016
2028	34.64%	33.68%	34.16%	5.852	1.000	5.852
2029	33.68%	32.72%	33.20%	5.687	1.000	5.687
2030	32.72%	31.76%	32.24%	5.523	1.000	5.523
2031	31.76%	30.80%	31.28%	5.358	1.000	5.358
2032	30.80%	29.84%	30.32%	5.194	1.000	5.194
2033	29.84%	28.88%	29.36%	5.029	1.000	5.029
2034	28.88%	27.92%	28.40%	4.865	1.000	4.865
2035	27.92%	26.96%	27.44%	4.700	1.000	4.700
2036	26.96%	26.00%	26.48%	4.536	1.000	4.536
2037	26.00%	25.04%	25.52%	4.372	1.000	4.372
2038	25.04%	24.08%	24.56%	4.207	1.000	4.207
2039	24.08%	23.12%	23.60%	4.043	1.000	4.043
2040	23.12%	22.16%	22.64%	3.878	1.000	3.878
2041	22.16%	21.20%	21.68%	3.714	1.000	3.714
2042	21.20%	20.24%	20.72%	3.549	1.000	3.549
2043	20.24%	19.28%	19.76%	3.385	1.000	3.385
2044	19.28%	18.32%	18.80%	3.220	1.000	3.220
2045	18.32%	17.36%	17.84%	3.056	1.000	3.056
2046	17.36%	16.40%	16.88%	2.892	1.000	2.892
2047	16.40%	15.44%	15.92%	2.727	1.000	2.727

2048	15.44%	14.48%	14.96%	2.563	1.000	2.563
2049	14.48%	13.52%	14.00%	2.398	1.000	2.398
2050	13.52%	12.56%	13.04%	2.234	1.000	2.234
2051	12.56%	11.60%	12.08%	2.069	1.000	2.069
2052	11.60%	10.64%	11.12%	1.905	1.000	1.905
2053	10.64%	9.68%	10.16%	1.740	1.000	1.740
2054	9.68%	8.72%	9.20%	1.576	1.000	1.576
2055	8.72%	7.76%	8.24%	1.412	1.000	1.412
2056	7.76%	6.80%	7.28%	1.247	1.000	1.247
2057	6.80%	5.84%	6.32%	1.083	1.000	1.083
2058	5.84%	4.88%	5.36%	0.918	1.000	0.918
2059	4.88%	3.92%	4.40%	0.754	1.000	0.754
2060	3.92%	2.96%	3.44%	0.589	1.000	0.589
2061	2.96%	2.00%	2.48%	0.425	1.000	0.425
2062	2.00%	2.00%	2.00%	0.343	1.000	0.343

Total discounted SAYs lost: 223.033

SERVICE GAIN AT THE COMPENSATORY AREA

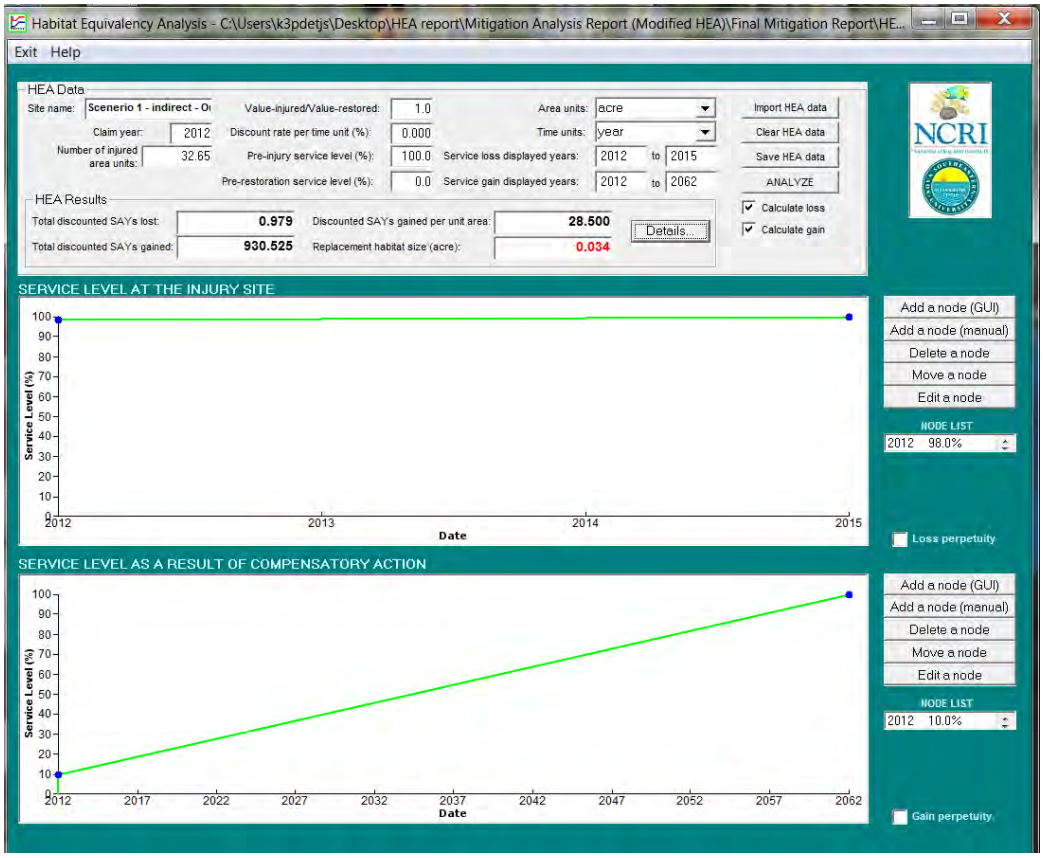
Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	1.867	1.000	1.867
2013	11.80%	13.60%	12.70%	2.176	1.000	2.176
2014	13.60%	15.40%	14.50%	2.484	1.000	2.484
2015	15.40%	17.20%	16.30%	2.792	1.000	2.792
2016	17.20%	19.00%	18.10%	3.101	1.000	3.101
2017	19.00%	20.80%	19.90%	3.409	1.000	3.409
2018	20.80%	22.60%	21.70%	3.717	1.000	3.717
2019	22.60%	24.40%	23.50%	4.026	1.000	4.026
2020	24.40%	26.20%	25.30%	4.334	1.000	4.334
2021	26.20%	28.00%	27.10%	4.642	1.000	4.642
2022	28.00%	29.80%	28.90%	4.951	1.000	4.951
2023	29.80%	31.60%	30.70%	5.259	1.000	5.259
2024	31.60%	33.40%	32.50%	5.567	1.000	5.567
2025	33.40%	35.20%	34.30%	5.876	1.000	5.876
2026	35.20%	37.00%	36.10%	6.184	1.000	6.184
2027	37.00%	38.80%	37.90%	6.492	1.000	6.492
2028	38.80%	40.60%	39.70%	6.801	1.000	6.801
2029	40.60%	42.40%	41.50%	7.109	1.000	7.109
2030	42.40%	44.20%	43.30%	7.417	1.000	7.417
2031	44.20%	46.00%	45.10%	7.726	1.000	7.726
2032	46.00%	47.80%	46.90%	8.034	1.000	8.034
2033	47.80%	49.60%	48.70%	8.342	1.000	8.342
2034	49.60%	51.40%	50.50%	8.651	1.000	8.651
2035	51.40%	53.20%	52.30%	8.959	1.000	8.959
2036	53.20%	55.00%	54.10%	9.267	1.000	9.267
2037	55.00%	56.80%	55.90%	9.576	1.000	9.576
2038	56.80%	58.60%	57.70%	9.884	1.000	9.884
2039	58.60%	60.40%	59.50%	10.192	1.000	10.192
2040	60.40%	62.20%	61.30%	10.501	1.000	10.501
2041	62.20%	64.00%	63.10%	10.809	1.000	10.809
2042	64.00%	65.80%	64.90%	11.117	1.000	11.117
2043	65.80%	67.60%	66.70%	11.426	1.000	11.426
2044	67.60%	69.40%	68.50%	11.734	1.000	11.734
2045	69.40%	71.20%	70.30%	12.042	1.000	12.042
2046	71.20%	73.00%	72.10%	12.351	1.000	12.351

2047	73.00%	74.80%	73.90%	12.659	1.000	12.659
2048	74.80%	76.60%	75.70%	12.967	1.000	12.967
2049	76.60%	78.40%	77.50%	13.276	1.000	13.276
2050	78.40%	80.20%	79.30%	13.584	1.000	13.584
2051	80.20%	82.00%	81.10%	13.892	1.000	13.892
2052	82.00%	83.80%	82.90%	14.201	1.000	14.201
2053	83.80%	85.60%	84.70%	14.509	1.000	14.509
2054	85.60%	87.40%	86.50%	14.817	1.000	14.817
2055	87.40%	89.20%	88.30%	15.126	1.000	15.126
2056	89.20%	91.00%	90.10%	15.434	1.000	15.434
2057	91.00%	92.80%	91.90%	15.742	1.000	15.742
2058	92.80%	94.60%	93.70%	16.051	1.000	16.051
2059	94.60%	96.40%	95.50%	16.359	1.000	16.359
2060	96.40%	98.20%	97.30%	16.667	1.000	16.667
2061	98.20%	100.00%	99.10%	16.976	1.000	16.976
2062	100.00%	100.00%	100.00%	17.130	1.000	17.130

Total discounted SAYs gained 488.20
Discounted SAYs gained per unit area: 28.50

Replacement habitat size (acre): 1.00 * 223.033/28.5 7.826

Scenario #1 – Anchor Cable – Indirect – Outer Reef – 2% loss



HABITAT EQUIVALENCY ANALYSIS

Sitename: Scenerio 1 - indirect - Outer reef 2% loss perpetual

Date: 8/11/2012 11:22:56 AM
Datafile: C:\Users\k3pdetjs\Desktop\HEA report\Mitigation Analysis Report (Modified HEA)\Final Mitigation Report\HEA files\scenerio 1 - indirect-outer reef-2% loss.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 32.65
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	2.00%	1.33%	1.67%	0.544	1.000	0.544
2013	1.33%	.67%	1.00%	0.326	1.000	0.326
2014	.67%	.00%	0.33%	0.109	1.000	0.109
2015	.00%	.00%	0.00%	0.000	1.000	0.000

Total discounted SAYs lost: 0.979

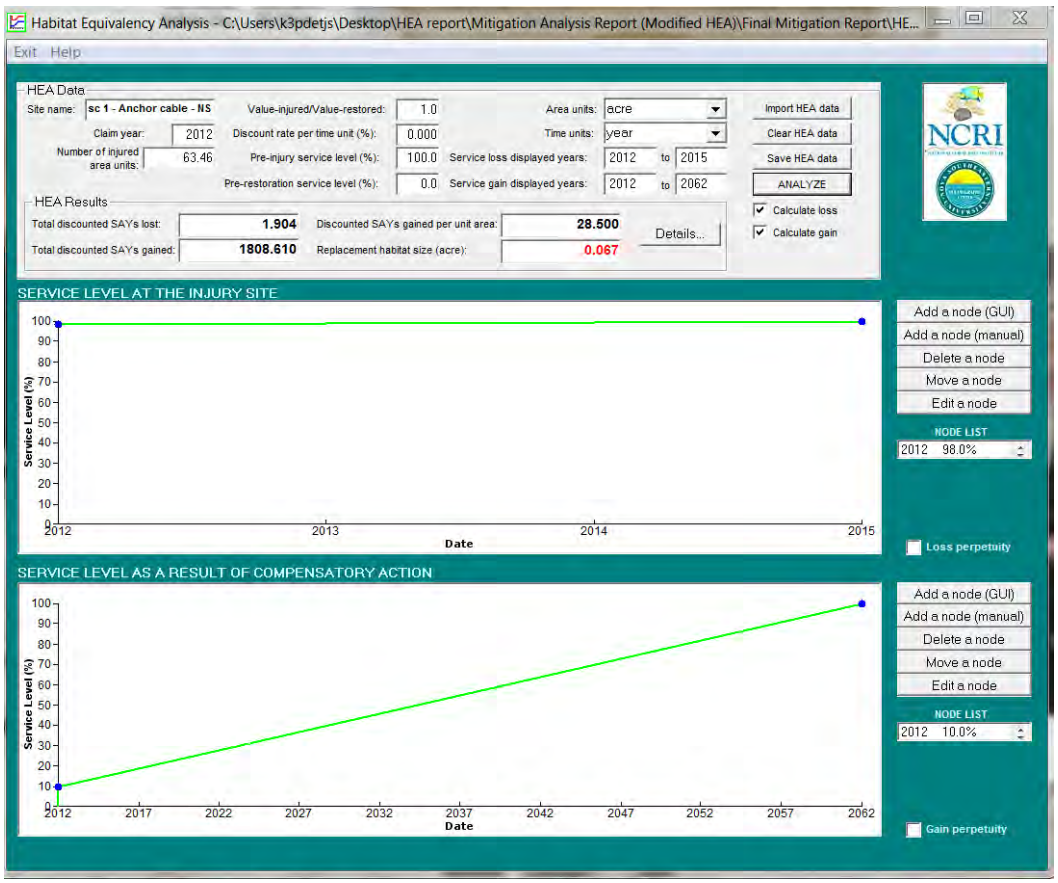
SERVICE GAIN AT THE COMPENSATORY AREA

Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	3.559	1.000	3.559
2013	11.80%	13.60%	12.70%	4.147	1.000	4.147
2014	13.60%	15.40%	14.50%	4.734	1.000	4.734
2015	15.40%	17.20%	16.30%	5.322	1.000	5.322
2016	17.20%	19.00%	18.10%	5.910	1.000	5.910
2017	19.00%	20.80%	19.90%	6.497	1.000	6.497
2018	20.80%	22.60%	21.70%	7.085	1.000	7.085
2019	22.60%	24.40%	23.50%	7.673	1.000	7.673
2020	24.40%	26.20%	25.30%	8.260	1.000	8.260
2021	26.20%	28.00%	27.10%	8.848	1.000	8.848
2022	28.00%	29.80%	28.90%	9.436	1.000	9.436
2023	29.80%	31.60%	30.70%	10.024	1.000	10.024
2024	31.60%	33.40%	32.50%	10.611	1.000	10.611
2025	33.40%	35.20%	34.30%	11.199	1.000	11.199
2026	35.20%	37.00%	36.10%	11.787	1.000	11.787
2027	37.00%	38.80%	37.90%	12.374	1.000	12.374
2028	38.80%	40.60%	39.70%	12.962	1.000	12.962
2029	40.60%	42.40%	41.50%	13.550	1.000	13.550
2030	42.40%	44.20%	43.30%	14.137	1.000	14.137

2031	44.20%	46.00%	45.10%	14.725	1.000	14.725
2032	46.00%	47.80%	46.90%	15.313	1.000	15.313
2033	47.80%	49.60%	48.70%	15.901	1.000	15.901
2034	49.60%	51.40%	50.50%	16.488	1.000	16.488
2035	51.40%	53.20%	52.30%	17.076	1.000	17.076
2036	53.20%	55.00%	54.10%	17.664	1.000	17.664
2037	55.00%	56.80%	55.90%	18.251	1.000	18.251
2038	56.80%	58.60%	57.70%	18.839	1.000	18.839
2039	58.60%	60.40%	59.50%	19.427	1.000	19.427
2040	60.40%	62.20%	61.30%	20.014	1.000	20.014
2041	62.20%	64.00%	63.10%	20.602	1.000	20.602
2042	64.00%	65.80%	64.90%	21.190	1.000	21.190
2043	65.80%	67.60%	66.70%	21.778	1.000	21.778
2044	67.60%	69.40%	68.50%	22.365	1.000	22.365
2045	69.40%	71.20%	70.30%	22.953	1.000	22.953
2046	71.20%	73.00%	72.10%	23.541	1.000	23.541
2047	73.00%	74.80%	73.90%	24.128	1.000	24.128
2048	74.80%	76.60%	75.70%	24.716	1.000	24.716
2049	76.60%	78.40%	77.50%	25.304	1.000	25.304
2050	78.40%	80.20%	79.30%	25.891	1.000	25.891
2051	80.20%	82.00%	81.10%	26.479	1.000	26.479
2052	82.00%	83.80%	82.90%	27.067	1.000	27.067
2053	83.80%	85.60%	84.70%	27.655	1.000	27.655
2054	85.60%	87.40%	86.50%	28.242	1.000	28.242
2055	87.40%	89.20%	88.30%	28.830	1.000	28.830
2056	89.20%	91.00%	90.10%	29.418	1.000	29.418
2057	91.00%	92.80%	91.90%	30.005	1.000	30.005
2058	92.80%	94.60%	93.70%	30.593	1.000	30.593
2059	94.60%	96.40%	95.50%	31.181	1.000	31.181
2060	96.40%	98.20%	97.30%	31.768	1.000	31.768
2061	98.20%	100.00%	99.10%	32.356	1.000	32.356
2062	100.00%	100.00%	100.00%	32.650	1.000	32.650

Total discounted SAYs gained	930.53
Discounted SAYs gained per unit area:	28.50
Replacement habitat size (acre): 1.00 * .979/28.5	0.034

Scenario #1 – Anchor Cable – Nearshore, Inner, Middle & Rubble – 2% loss



HABITAT EQUIVALENCY ANALYSIS

Sitename: sc 1 - Anchor cable - NS

Date: 8/11/2012 11:39:26 AM
Datafile: C:\Users\k3pdetjs\Desktop\HEA report\Mitigation Analysis Report (Modified HEA)\Final Mitigation Report\HEA files\scenerio_1_-_middle_inner_nearshore_rubble_2%_loss-2.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 63.46
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	2.00%	1.33%	1.67%	1.058	1.000	1.058
2013	1.33%	.67%	1.00%	0.635	1.000	0.635
2014	.67%	.00%	0.33%	0.212	1.000	0.212
2015	.00%	.00%	0.00%	0.000	1.000	0.000

Total discounted SAYs lost: 1.904

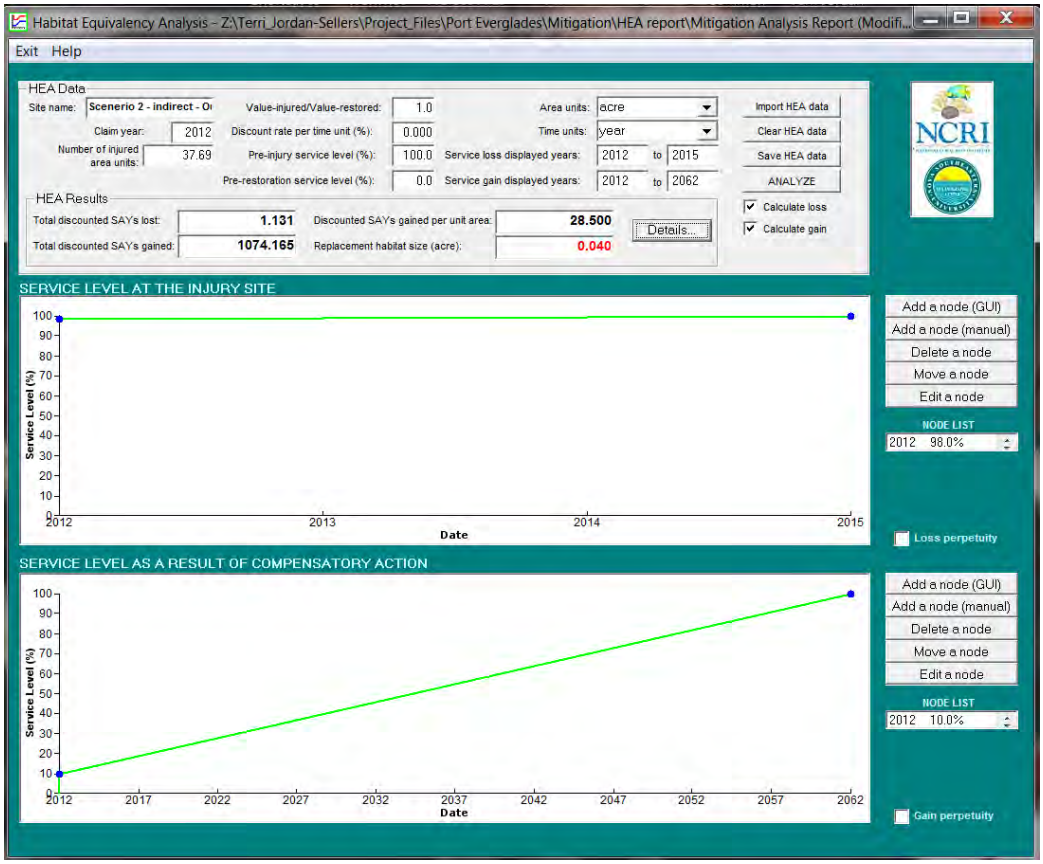
SERVICE GAIN AT THE COMPENSATORY AREA

Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	6.917	1.000	6.917
2013	11.80%	13.60%	12.70%	8.059	1.000	8.059
2014	13.60%	15.40%	14.50%	9.202	1.000	9.202
2015	15.40%	17.20%	16.30%	10.344	1.000	10.344
2016	17.20%	19.00%	18.10%	11.486	1.000	11.486
2017	19.00%	20.80%	19.90%	12.629	1.000	12.629
2018	20.80%	22.60%	21.70%	13.771	1.000	13.771
2019	22.60%	24.40%	23.50%	14.913	1.000	14.913
2020	24.40%	26.20%	25.30%	16.055	1.000	16.055
2021	26.20%	28.00%	27.10%	17.198	1.000	17.198
2022	28.00%	29.80%	28.90%	18.340	1.000	18.340
2023	29.80%	31.60%	30.70%	19.482	1.000	19.482
2024	31.60%	33.40%	32.50%	20.624	1.000	20.624
2025	33.40%	35.20%	34.30%	21.767	1.000	21.767
2026	35.20%	37.00%	36.10%	22.909	1.000	22.909
2027	37.00%	38.80%	37.90%	24.051	1.000	24.051
2028	38.80%	40.60%	39.70%	25.194	1.000	25.194
2029	40.60%	42.40%	41.50%	26.336	1.000	26.336

2030	42.40%	44.20%	43.30%	27.478	1.000	27.478
2031	44.20%	46.00%	45.10%	28.620	1.000	28.620
2032	46.00%	47.80%	46.90%	29.763	1.000	29.763
2033	47.80%	49.60%	48.70%	30.905	1.000	30.905
2034	49.60%	51.40%	50.50%	32.047	1.000	32.047
2035	51.40%	53.20%	52.30%	33.190	1.000	33.190
2036	53.20%	55.00%	54.10%	34.332	1.000	34.332
2037	55.00%	56.80%	55.90%	35.474	1.000	35.474
2038	56.80%	58.60%	57.70%	36.616	1.000	36.616
2039	58.60%	60.40%	59.50%	37.759	1.000	37.759
2040	60.40%	62.20%	61.30%	38.901	1.000	38.901
2041	62.20%	64.00%	63.10%	40.043	1.000	40.043
2042	64.00%	65.80%	64.90%	41.186	1.000	41.186
2043	65.80%	67.60%	66.70%	42.328	1.000	42.328
2044	67.60%	69.40%	68.50%	43.470	1.000	43.470
2045	69.40%	71.20%	70.30%	44.612	1.000	44.612
2046	71.20%	73.00%	72.10%	45.755	1.000	45.755
2047	73.00%	74.80%	73.90%	46.897	1.000	46.897
2048	74.80%	76.60%	75.70%	48.039	1.000	48.039
2049	76.60%	78.40%	77.50%	49.181	1.000	49.181
2050	78.40%	80.20%	79.30%	50.324	1.000	50.324
2051	80.20%	82.00%	81.10%	51.466	1.000	51.466
2052	82.00%	83.80%	82.90%	52.608	1.000	52.608
2053	83.80%	85.60%	84.70%	53.751	1.000	53.751
2054	85.60%	87.40%	86.50%	54.893	1.000	54.893
2055	87.40%	89.20%	88.30%	56.035	1.000	56.035
2056	89.20%	91.00%	90.10%	57.177	1.000	57.177
2057	91.00%	92.80%	91.90%	58.320	1.000	58.320
2058	92.80%	94.60%	93.70%	59.462	1.000	59.462
2059	94.60%	96.40%	95.50%	60.604	1.000	60.604
2060	96.40%	98.20%	97.30%	61.747	1.000	61.747
2061	98.20%	100.00%	99.10%	62.889	1.000	62.889
2062	100.00%	100.00%	100.00%	63.460	1.000	63.460

Total discounted SAYs gained	1808.61
Discounted SAYs gained per unit area:	28.50
Replacement habitat size (acre): 1.00 * 1.904/28.5	0.067

Scenario #2 – Indirect – Outer Reef – 2% loss



HABITAT EQUIVALENCY ANALYSIS

Sitename: Scenerio 2 - indirect - Outer reef 2% loss perpetual

Date: 7/18/2012 2:57:49 PM
Datafile: Z:\Terri_Jordan-Sellers\Project_Files\Port Everglades\Mitigation\HEA report\Mitigation Analysis Report (Modified HEA)\Final Mitigation Report\HEA files\scenerio 2 - indirect outer reef 2% loss.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 37.69
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	2.00%	1.33%	1.67%	0.628	1.000	0.628
2013	1.33%	.67%	1.00%	0.377	1.000	0.377
2014	.67%	.00%	0.33%	0.126	1.000	0.126
2015	.00%	.00%	0.00%	0.000	1.000	0.000

Total discounted SAYs lost: 1.131

SERVICE GAIN AT THE COMPENSATORY AREA

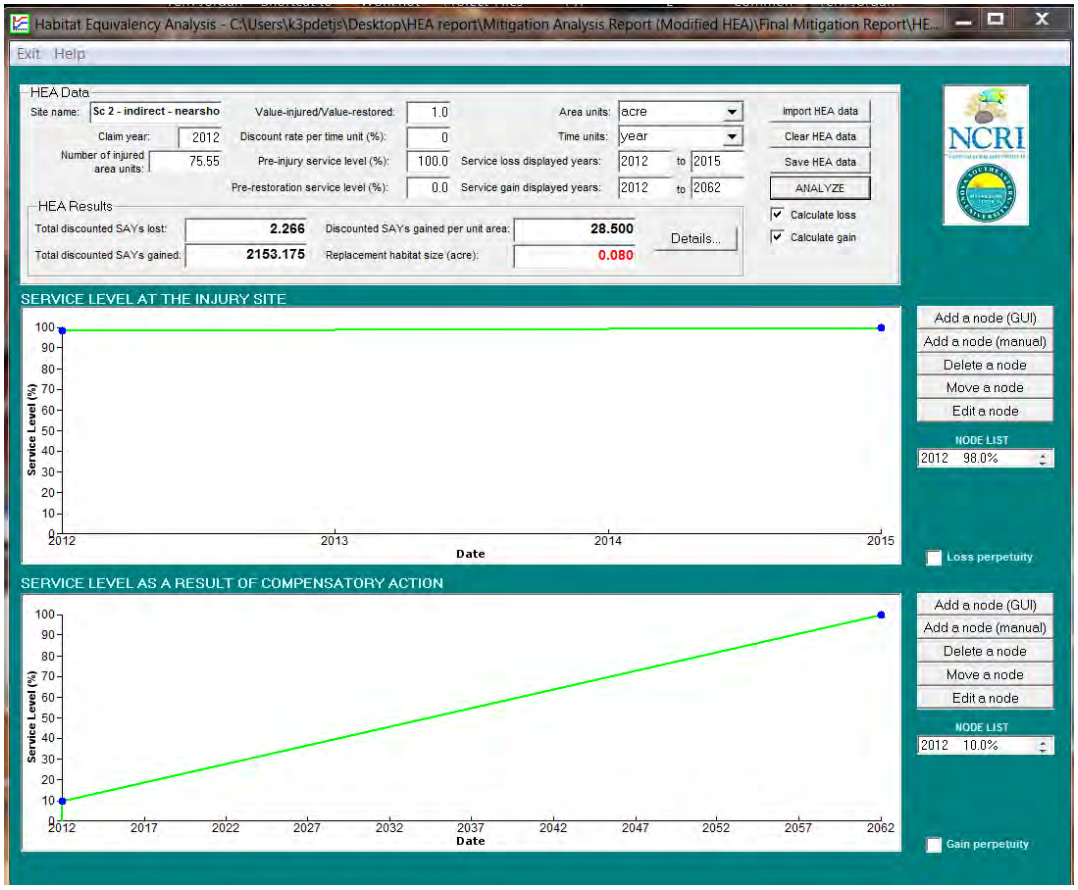
Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	4.108	1.000	4.108
2013	11.80%	13.60%	12.70%	4.787	1.000	4.787
2014	13.60%	15.40%	14.50%	5.465	1.000	5.465
2015	15.40%	17.20%	16.30%	6.143	1.000	6.143
2016	17.20%	19.00%	18.10%	6.822	1.000	6.822
2017	19.00%	20.80%	19.90%	7.500	1.000	7.500
2018	20.80%	22.60%	21.70%	8.179	1.000	8.179
2019	22.60%	24.40%	23.50%	8.857	1.000	8.857
2020	24.40%	26.20%	25.30%	9.536	1.000	9.536
2021	26.20%	28.00%	27.10%	10.214	1.000	10.214
2022	28.00%	29.80%	28.90%	10.892	1.000	10.892
2023	29.80%	31.60%	30.70%	11.571	1.000	11.571
2024	31.60%	33.40%	32.50%	12.249	1.000	12.249
2025	33.40%	35.20%	34.30%	12.928	1.000	12.928
2026	35.20%	37.00%	36.10%	13.606	1.000	13.606
2027	37.00%	38.80%	37.90%	14.285	1.000	14.285
2028	38.80%	40.60%	39.70%	14.963	1.000	14.963
2029	40.60%	42.40%	41.50%	15.641	1.000	15.641

2030	42.40%	44.20%	43.30%	16.320	1.000	16.320
2031	44.20%	46.00%	45.10%	16.998	1.000	16.998
2032	46.00%	47.80%	46.90%	17.677	1.000	17.677
2033	47.80%	49.60%	48.70%	18.355	1.000	18.355
2034	49.60%	51.40%	50.50%	19.033	1.000	19.033
2035	51.40%	53.20%	52.30%	19.712	1.000	19.712
2036	53.20%	55.00%	54.10%	20.390	1.000	20.390
2037	55.00%	56.80%	55.90%	21.069	1.000	21.069
2038	56.80%	58.60%	57.70%	21.747	1.000	21.747
2039	58.60%	60.40%	59.50%	22.426	1.000	22.426
2040	60.40%	62.20%	61.30%	23.104	1.000	23.104
2041	62.20%	64.00%	63.10%	23.782	1.000	23.782
2042	64.00%	65.80%	64.90%	24.461	1.000	24.461
2043	65.80%	67.60%	66.70%	25.139	1.000	25.139
2044	67.60%	69.40%	68.50%	25.818	1.000	25.818
2045	69.40%	71.20%	70.30%	26.496	1.000	26.496
2046	71.20%	73.00%	72.10%	27.174	1.000	27.174
2047	73.00%	74.80%	73.90%	27.853	1.000	27.853
2048	74.80%	76.60%	75.70%	28.531	1.000	28.531
2049	76.60%	78.40%	77.50%	29.210	1.000	29.210
2050	78.40%	80.20%	79.30%	29.888	1.000	29.888
2051	80.20%	82.00%	81.10%	30.567	1.000	30.567
2052	82.00%	83.80%	82.90%	31.245	1.000	31.245
2053	83.80%	85.60%	84.70%	31.923	1.000	31.923
2054	85.60%	87.40%	86.50%	32.602	1.000	32.602
2055	87.40%	89.20%	88.30%	33.280	1.000	33.280
2056	89.20%	91.00%	90.10%	33.959	1.000	33.959
2057	91.00%	92.80%	91.90%	34.637	1.000	34.637
2058	92.80%	94.60%	93.70%	35.316	1.000	35.316
2059	94.60%	96.40%	95.50%	35.994	1.000	35.994
2060	96.40%	98.20%	97.30%	36.672	1.000	36.672
2061	98.20%	100.00%	99.10%	37.351	1.000	37.351
2062	100.00%	100.00%	100.00%	37.690	1.000	37.690

Total discounted SAYs gained 1074.16
Discounted SAYs gained per unit area: 28.50

Replacement habitat size (acre): 1.00 * 1.131/28.5 0.040

Scenario #2 – Nearshore, Inner, Middle & Rubble – 2% loss



HABITAT EQUIVALENCY ANALYSIS

Sitename: Sc 2 - indirect - nearshore

Date: 8/11/2012 11:45:46 AM
Datafile: C:\Users\k3pdetjs\Desktop\HEA report\Mitigation Analysis Report (Modified HEA)\Final Mitigation Report\HEA files\scenerio 2 - middle, inner, nearshore, rubble 2% loss2.hea

Area units: acre
Time units: year

Claim year: 2012
Number of affected area units: 75.55
Pre-injury service level (%): 100.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per time unit (%): 0.00

SERVICE LOSS AT INJURY AREA

Year	%Services Lost			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs lost	factor	SAYs lost
2012	2.00%	1.33%	1.67%	1.259	1.000	1.259
2013	1.33%	.67%	1.00%	0.755	1.000	0.755
2014	.67%	.00%	0.33%	0.252	1.000	0.252
2015	.00%	.00%	0.00%	0.000	1.000	0.000

Total discounted SAYs lost: 2.266

SERVICE GAIN AT THE COMPENSATORY AREA

Year	%Services Gained			Raw	Discount	Discounted
	Beginning	End	Mean	SAYs gained	factor	SAYs gained
2012	10.00%	11.80%	10.90%	8.235	1.000	8.235
2013	11.80%	13.60%	12.70%	9.595	1.000	9.595
2014	13.60%	15.40%	14.50%	10.955	1.000	10.955
2015	15.40%	17.20%	16.30%	12.315	1.000	12.315
2016	17.20%	19.00%	18.10%	13.675	1.000	13.675
2017	19.00%	20.80%	19.90%	15.034	1.000	15.034
2018	20.80%	22.60%	21.70%	16.394	1.000	16.394
2019	22.60%	24.40%	23.50%	17.754	1.000	17.754
2020	24.40%	26.20%	25.30%	19.114	1.000	19.114
2021	26.20%	28.00%	27.10%	20.474	1.000	20.474
2022	28.00%	29.80%	28.90%	21.834	1.000	21.834
2023	29.80%	31.60%	30.70%	23.194	1.000	23.194
2024	31.60%	33.40%	32.50%	24.554	1.000	24.554
2025	33.40%	35.20%	34.30%	25.914	1.000	25.914
2026	35.20%	37.00%	36.10%	27.274	1.000	27.274
2027	37.00%	38.80%	37.90%	28.633	1.000	28.633
2028	38.80%	40.60%	39.70%	29.993	1.000	29.993
2029	40.60%	42.40%	41.50%	31.353	1.000	31.353

2030	42.40%	44.20%	43.30%	32.713	1.000	32.713
2031	44.20%	46.00%	45.10%	34.073	1.000	34.073
2032	46.00%	47.80%	46.90%	35.433	1.000	35.433
2033	47.80%	49.60%	48.70%	36.793	1.000	36.793
2034	49.60%	51.40%	50.50%	38.153	1.000	38.153
2035	51.40%	53.20%	52.30%	39.513	1.000	39.513
2036	53.20%	55.00%	54.10%	40.873	1.000	40.873
2037	55.00%	56.80%	55.90%	42.232	1.000	42.232
2038	56.80%	58.60%	57.70%	43.592	1.000	43.592
2039	58.60%	60.40%	59.50%	44.952	1.000	44.952
2040	60.40%	62.20%	61.30%	46.312	1.000	46.312
2041	62.20%	64.00%	63.10%	47.672	1.000	47.672
2042	64.00%	65.80%	64.90%	49.032	1.000	49.032
2043	65.80%	67.60%	66.70%	50.392	1.000	50.392
2044	67.60%	69.40%	68.50%	51.752	1.000	51.752
2045	69.40%	71.20%	70.30%	53.112	1.000	53.112
2046	71.20%	73.00%	72.10%	54.472	1.000	54.472
2047	73.00%	74.80%	73.90%	55.831	1.000	55.831
2048	74.80%	76.60%	75.70%	57.191	1.000	57.191
2049	76.60%	78.40%	77.50%	58.551	1.000	58.551
2050	78.40%	80.20%	79.30%	59.911	1.000	59.911
2051	80.20%	82.00%	81.10%	61.271	1.000	61.271
2052	82.00%	83.80%	82.90%	62.631	1.000	62.631
2053	83.80%	85.60%	84.70%	63.991	1.000	63.991
2054	85.60%	87.40%	86.50%	65.351	1.000	65.351
2055	87.40%	89.20%	88.30%	66.711	1.000	66.711
2056	89.20%	91.00%	90.10%	68.071	1.000	68.071
2057	91.00%	92.80%	91.90%	69.430	1.000	69.430
2058	92.80%	94.60%	93.70%	70.790	1.000	70.790
2059	94.60%	96.40%	95.50%	72.150	1.000	72.150
2060	96.40%	98.20%	97.30%	73.510	1.000	73.510
2061	98.20%	100.00%	99.10%	74.870	1.000	74.870
2062	100.00%	100.00%	100.00%	75.550	1.000	75.550

Total discounted SAYs gained 2153.18
Discounted SAYs gained per unit area: 28.50

Replacement habitat size (acre): 1.00 * 2.266/28.5 0.080

APPENDIX B

Multi-Agency HEA Working Group Meetings
Final Reports
September and November 2007.

September 25 & 26, 2007
Port Everglades HEA Meeting Summary Report

Project Overview

Meeting Highlights

Opening

Phil Allen, the Port Director, welcomed everyone and expressed the Port's commitment to sustainability. He emphasized the importance of this group and the need to better to understand environmental and economic impacts. As this project moves forward to the challenge will be to achieve the economic projections for the region and to minimize the impact on the environment. The Port Everglades Board has held workshops with stakeholders and the community on how to meet petroleum, cargo and passenger needs over the next 20 years. The projections depend on this dredging project.

Tom Taylor, the facilitator presented the proposed meeting agenda and guidelines (Appendices A and B). The group agreed that there is a need to seek consensus where possible, to clarify the options where there is not agreement and identify research to be considered. All of this input will be used by the USACE in developing the next project documents. All agencies will have additional opportunities to review and provide comments on in future stages of the project.

On the second day, Glenn Wiltshire, the Deputy Port Director addressed the meeting participants and expressed his appreciation for the progress being made and emphasized the importance of this project.

HEA Overview

Bill Precht, a USACE contractor sought to clarify the science and assumptions behind the draft HEA. His presentation addressed:

1. The benthic community/relic reef system of Broward County.
2. Reef study for EIS prepared by Dial Cordy for corps.
3. Using that info - compare to other Broward county and SE FL studies.
4. Development of HEA input parameters for corps study.
5. HEA mitigation needs - boulders, etc.
6. Locations of possible mitigation sites.

Meeting Objectives Clarification

Terri Jordan, USACE, presented the following information on the HEA approval and appeal processes. The group discussed the importance of reaching consensus on as much as possible in this meeting and identified other points where agencies will have opportunities for input.

Map and Table Selection

The group compared the NCRI and USACE maps (See Appendices C and D) and acknowledged that the areas were the same but that some of the titles are different and agreed to use the NCRI map and titles. They also agreed to discuss the outer, middle and inner reef areas for direct impacts and then the same order for the indirect impacts.

Impact Areas

DIRECT TYPE	MODIFIER1
Outer Reef	**Aggregated Patch Reef
	Spur and Groove
	Linear Reef-Outer
	Colonized Pavement-Deep
Middle Reef	Linear Reef-Middle
Inlet Channel Floor	Inlet Channel Floor
Sand	Sand

IN-DIRECT TYPE	MODIFIER1
Outer Reef	Ridge-Deep
	**Aggregated Patch Reef
	Spur and Groove
	Linear Reef-Outer
	Colonized Pavement-Deep
Middle Reef	Linear Reef-Middle
Inner Reef	Linear Reef-Inner
Near shore HB	Colonized Pavement-Shallow
	Ridge-Shallow
Rubble Shoal	Rubble Shoal
Submerged Breakwater	Submerged Breakwater
Inlet Channel Wall	Inlet Channel Wall
Sand	Sand

Input Parameters

The NCRI HEA parameters were presented and the meeting participants suggested additional parameters and reorganized them to create the following list in two categories: injury and compensatory action parameters. These were then used to evaluate each of the categories of polygons.

INJURY		**COMPENSATORY ACTION**	
1. Claim year= Date of Injury		13. Date of compensatory action	
2. Site name			
3. Type of injury (direct, indirect+)		14. Type of compensatory action	
4. # of injured area units			
5. Pre-injury service level =100%		15. Pre-restoration service level (%)	
6. Degree of service lost of resources immediately following injury (%)		16. Service level of CA upon initial installation	
7. Value-injured/value restored=1			
8. Equilibrium level to which recovery can reach		17. Equilibrium level of service From CA expected	
9. Injury recovery time to equilibrium		18. Time for services to develop from installation to equilibrium	
10. Shape of recovery trajectory=linear		19. Shape of trajectory to equilibrium services	
11. Time units=years		20. Time units=years	

Day One Closing

Summary of activities and results
Refine the Day 2 agenda
Agree on assignments as appropriate

September 26 Opening

Opening comments, Glenn Wiltshire, Deputy Port Director
Share insights from overnight
Revise agenda if needed

Continued Discussion and Consensus Seeking

1300-1400 **HEA Spreadsheet Discussion**
Consider models/spreadsheets to be used by USACE and others
Discuss the process for validating models/spreadsheets
Seek consensus on agency procedures and coordination
Identify next steps for still unresolved issues/assumptions

1400-1430 **Mitigation Options**
Identify options for out-of-kind and in-kind mitigation and the related costs
Solicit suggestions for preparing mitigation proposals

1430-1500 **Other issues**
Margin of error – mitigation and funding for unintended impacts

Day Two Closing

Summary of meeting activities, results and next steps
Concluding comments by participants
Meeting evaluation

Consensus Seeking on Parameter Values for Project Areas

The group discussed the parameter values for the outer, middle and inner reef areas for direct impacts and then the three reef areas for the indirect impacts. The table below shows values agreed to in "normal" font. Where there wasn't agreement, options were identified are shown in "*italics*." Comments on items are included after the table and are referenced by number. Where there was more than one option, each of the agencies rated the acceptability of each option using this scale: 3 = good, 2 = concerned but can live with it or 2 = opposed.

Outer Reef Direct Impacts

INJURY		**COMPENSATORY ACTION**	
1. Claim year = Date of Injury	2012	13. Date of compensatory action	2012
2. Site name	Outer reef		
3. Type of injury (direct, indirect+)	Direct	14. Type of compensatory action	Calculate boulders and have suite of options
4. # of injured area units	13.54 A		
5. Pre-injury service level =100%	100%	15. Pre-restoration service level (%)	Close to 0%
6. Degree of service lost of resources immediately following injury (%)	100%	16. Service level of compensatory action upon initial installation (<u>of designed boulder placement</u>)	0-5%
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	*0, 5 &15%*	17. Equilibrium level of service from CA expected (for boulders with specified transplants)	75,100%
9. Injury recovery time to equilibrium	*50 for 5-15 0 for 0*	18. Time for services to develop from installation to equilibrium	65, 55, 50
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit (%)	*3or6%,*	21. Discount rate	*3-6%*

6 - Degree of service lost of resources immediately following injury (%)

- We could look at key species such as corals or algae.
- We don't want to talk about water quality.
- We should use coral and consider the loss 100%.
- There is a question of whether it has some habitat value.

8 - Equilibrium level to which recovery can reach

- Is the baseline the historic level, the current level or some other level?
- We looked at the recovery on the second reef in 26 years and it is about 5% now and may reach 15% in 50 years.
- It will provide some services immediately.
- The middle reef is not comparable to the third reef.
- Consider a 3 dimensional framework.
- Do a complexity voracity ratio.
- Topography complexity is a factor.
- We lack data; the fall back is "professional judgment."
- Functionality could be all mobile and immobile organisms, not just coral.
- Look at areas where outfall pipes were installed, there are not resources there.

There was not agreement on a value. The following are the agency acceptability ratings for 15, 5 and 0% recovery.

15%

	3	2	1
ACE	X		
FWC			X
B Co EPD			X
FWS			X
EPA			X
NOAA			X
DEP			X
NOVA			X

5%

	3	2	1
ACE			X
FWC		X	
Co EPD		X	
FWS		X	
EPA		X	
NOAA		X	
DEP			X
NOVA		X	

0%

	3	2	1
ACE			X
FWC		X	
Co EPD	X		
FWS	X		
EPA	X		
NOAA		X	
DEP	X		
NOVA		X	

Comments After the Acceptability Rating

- 15 seems good because Bill and others looked at recovery on reef 2 after 26 years and considered 3 in 50 years. Why not?
- We heard Ken's experience with the outfall pipes. It is a very low level of recovery.
- It is not reef like recovery. Should not be a type for type recovery. It is a sand rubble habitat. It is a different coral than in the middle reef.
- I have taken palmetto from the wall
- We can extrapolate but we don't know what was really there.
- We are only looking at the bottom not the sides.
- Bill said 7% now and 15% at 50 years. We don't know if it is at equilibrium now.
- Most of the corals are rooting species and we will have more recruits over time. Equilibrium may not happen for 100 years.
- It may have been buried and re-exposed several times over the 25 years. It is just an assumption.
- The brooding assumes that this will continue.
- Focus on what is meant by services. Bill doesn't mean that there will be a similar coral reef. There may be different services. The functions or services are not defined.
- We can conjure up envelops of reasonableness with in the range of 5-15%. We are not sure where we are. We can do histograms that would help us understand. It bothers us to say, "We can live with it." The closer we get to 0 the less significant it is. NOAA gave a 2.
- We don't know what will happen in the future. From the Keys it will be closer to 0 than 15 %. The area that was dredged in Key West is a wasteland and is stirred up regularly.
- 15% and others are professional judgments. We need a study.
- You could look at Miami harbor impacts on the 3rd reef.
- We may want to do a sensitivity study.
- We could review videos of the Miami Harbor.
- We are talking function and how to get to that function and peoples different experiences.

9. Injury recovery time to equilibrium

- This will depend on whether we decide to use 0, 5 or 15% recovery level. It may be 15% for 50 years. Does it matter for 0-5%?

- Bill used 35 years. 95-97% of corals were in a type/size of 20-25 cm. It took 35 years to achieve the size and density. 50 years was conservative. The difference between 35 to 50 is not that much.
- Past HEA's are set at 35 years because of what one attorney did in one case and it has been sited ever since. We have better information now.
- The oldest corals are about 100 years old. We should use that timeframe.
- Dr. Dodge's PowerPoint showed coral age in Broward County.
- On-site all corals on the third reef were less than 40 cm (with a conservative growth rate).
- There was an inadequate sample size. Dodge's sample was larger.
- There is a possibility that there were larger corals and they were not found.
- Could we combine databases?
- Dave's studies are valuable.
- Our sample size of the third reef may be similar to the countywide sample from the third reef.
- There are colonies that are 4-500 years old but not in the project area. We have to use the data we have been dealt.
- I ran the numbers for 5% for 100 years and 15% for 50 years and there is only a 6% difference in the results. We need to put this parameter into perspective.
- The maximum clearance of 46. Consider prop wash. This area is different than the rest of Broward. We could reference the other data.
- The Dial Cordy data is similar and different because of sample size. Look at the larger data set. Don't use an injured baseline.
- DEP applies their analysis to the optimum state and the current state and generally mitigates using the current state.
- It is incumbent to mitigate using the current state.
- HEA focuses on the current.
- Does the sample have suitable replicatable sites?
- Ken did a report. Bill did more analysis and rarefaction curves were flat with no inkling of coming up. This means that more samples would not help.
- We are nibbling at numbers.
- We need to compare this with and without the project. It won't get better as a comparison.
- The geographic area has changed.
- If you are looking for rare species or to characterize an area the sampling process will be different.
- The large corals are probably not there or are very rare.
- I have seen ½ meter deploria on this site.

There was a suggestion to use 50 years for 5-15% recovery and
0 years for 0 % recovery and everyone agreed.

10 - Shape of Recovery Trajectory

At the last meeting the group agreed to use a linear trajectory because it is clearer and simpler even though the actual trajectory may be slightly sigmoid.

12 - Discount Rate Per Time Unit (%)

Comments

- 3% was used because this is the figure required by USACE.
- There are legal precedents for using 3 %
- 6% is suggested based on a NOAA study. This is appropriate if there is a higher social value as indicated in the economic study of reef resources. A review of the studies yielded the 6% figure.
- 3% was used in the Florida Keys National Marine Sanctuary, Key West and other projects. It was also used in a Yellowstone Park project that had high social values.
- 3% is the USACE regulatory standard. There is a question about the real rate of interest versus the nominal rate. NOAA used 3% or the government-borrowing rate that is 3%.
- There is a social rate of time preference – NOAA has a memo on the 3% rate.
- NOAA also says an alternative rate may be used. People of Broward want the payback sooner.
- This is one of the two biggest factors.
- Historically the discount rate is 6%.
- NOAA is not stuck with 3% but there needs to be a clear rationale for anything different.
- The USACE rationale is the same as NOAA. We went with 3% because it would stand up in court and we can justify it to our clients.
- FWS used 3% and so does the DOI.
- I spoke to Grace Johns after arguments for more than 3%.
- Does the public use the area in the ship channel? People don't dive there but they do fish near by.
- DEP is working with 6% in current cases.
- Marie Burns asked for justification for the 6%
- This is new territory. The 3% needs to be looked at because situation has changed since it was first used.

There are the acceptability ratings for using 3 and 6%.

3%

	3	2	1
ACE	X		
FWC		X	
Co EPD		X	
FWS		X	
EPA		X	
NOAA		X	
DEP			X
NOVA			1.5

6%

	3	2	1
ACE			X
FWC		X	
Co EPD	X		
FWS	X		
EPA		X	
NOAA		X	
DEP	X		
NOVA		X	

13 - Date of compensatory action

- This starts with construction

14 - Type of compensatory action

- We asked if we could propose options and the answer was that there was no need for a plan. The resource agencies said that water quality improvements could be used. The decision was to do calculations based on using boulders and then use the funding for boulders and other alternatives to be specified at a later date.
- We need a set of alternatives, locations and materials. The resource agencies may have some suggestions for in-kind, on-site and out-of-kind actions.
- It is good to use boulders for calculations and then have a suite of agreed upon actions.
- Could money be given to the eco-system trust fund?
- We may not be able to commit funds to do that.
- We could give funds to a suite of actions.
- The USACE has more flexibility and is encouraged to explore options, e.g. a mitigation bank.
- We don't know the alternatives so we shouldn't choose them yet.
- We want to save resources in front of the dredge. We need at least enough boulders to place the salvaged corals.
- HEA requires scaling. If we remove boulders it will change the injury (compensation for the injury?).
- There needs to be a placeholder in the report that specifies that changes in the plan will require a collective decision.
- The Port uses an enterprise fund. If there are additional projects there will limits on what can be done.
- Funds could be used for mitigation.
- These dollars can't be mingled with Broward County funds.

At the end of the discussion the group agreed to use boulders for the compensatory action.

15 - Pre-Restoration Service Level (%)

- Boulders go on sand that has a value that will be a cost. We can give it a negative or deduct it from the value of the boulders. See if there are other pre-approved areas.
- The USACE hasn't approved Broward County sites but may.
- Filling borrow pits is a possibility but we can only count the surface not the volume. It would be a waste of boulders.
- It may be too expensive to fill some pits but some may not be too deep.
- We can work with the County to pick the best sites.
- In Biscayne Bay pits were filled and covered with sand to restore sea grasses. This hasn't been cost out.
- NOAA is interested in fisheries habitat in the pits.
- The goal is to pick places with the least impact. There is lots of sand there.

It was agreed to use 0% for the pre-restoration service level.

16 - Service Level of Compensatory Action Upon Initial Installation
(Of designed boulder placement)

- A 20% credit was given for boulder placement in the Kolar and Dodge study that has been sited.
- This was arrived at by a group for a different habitat not by the scientists. 5% would be good. The Hillsborough case was for a different injury. The study was a draft that was not finalized.
- We can review other HEAs that were accepted.
- There have been HEAs that used 20%, some without transplantation and with long linear inputs.
- We may not have to consider historic cases. Consider the services it provides on horizontal and vertical surfaces that are similar to a reef. Rocks provide some services.
- It provides habitat but not places for foraging.
- Fish and other species may take time.
- Are we looking at the biological or physical or both?
- Boulders are not the be all and end all. Boulders are more complex. Many projects use boulders, e.g. Bal Harbor where credit is given and utilization is demonstrated. 20% is widely used and peer reviewed. Whether we use 5 or 20% will not change the numbers much. I am just trying to get quicker recovery.
- Using alternatives to boulders may negate this. Use 5% to be conservative. Boulders provide more complexity and thus more services.
- The date starts the day the project ends.
- This would be a year.
- Past numbers have been thrown in projects. We should use the true numbers.
- There are fish functions with boulder projects. On the site we looked at there are fish and now corals are coming in. In 8 years it should be 5-10%
- 20% may be OK if constructed before the injury.
- The rock at the third reef is not good. 5% is a better figure.
- The boulders are from blasting.

- How well do past situations compare to here?
- May not separate biological and physical services. Work services into 2-5 years and increases.
- Bill will evaluate the third reef and design the project. 5-10% can be used if the complexity is the same and possibly more if there is more complexity. It will be necessary to specify the size and placement of boulders to get benefits as compared to natural areas.
- The USACE suggests using 10%.
- What about transplantation?
- This doesn't apply.
- We can't have more mitigation later so I want it to be 10%.
- The USACE can go 20% over the project cost (902) and this can be used for mitigation and other overruns. It is not available at the feasibility level.
- It may be inappropriate to take absolute worse case scenarios for a plan. We should use the best estimate and use adaptive management. We don't know everything. We can adjust if we have new information. We can learn a lot in 5-10 years. Let's go for the best. We don't know about translocation.
- We have learned about not taking the current case. Things always go wrong and we are told there is no money. We have learned from experience to anticipate the worst case.
- Then do we calculate the best possible economic possibilities?
- Provide a plan for translocation.
- We don't know enough about the bottom.
- Will the 20% extra be available?
- Congress allows us to increase the project cost by 20% without reauthorization. It must be justified.
- There is a required monitoring program. What happens if the mitigation is failing? PBSJ had to mitigate for failures. Dave did a study of success rates. There will be 1000's of translocated corals, maybe 20 species. We have an idea for what we will be moving.
- All of this will be part of the mitigation plan.
- It will also be written into the state permit.
- This is messy and difficult. We will consider 5-10% and make judgments. We want to do this together
- It would be good to have the information Bill gave earlier and to look at other information too.
- Let's try 5%.
- We don't have information so it is important to be conservative.
- Date will be for when the compensatory action is done.
- If you could go negative it would be considered.
- Why would you do this?

The following are the acceptability ratings for 0 and 5% for service level of compensatory action upon initial installation.

16 – 0%

	3	2	1

ACE			X
FWC		X	
Co EPD		X	
FWS		X	
EPA		X	
NOAA		X	
DEP	X		
NOVA		X	

16 -5%

	3	2	1
ACE		X	
FWC	X		
Co EPD	X		
FWS	X		
EPA	X		
NOAA		X	
DEP		X	
NOVA	X		

17 - Equilibrium level of service from CA expected
(For boulders with specified transplants)
18 - Time for services to develop from installation to equilibrium

- The initial should be 100%
- Almost 100% not attainment. There may be a rich community but it will not replace what was there.
- The use of parameters requires breaking complex systems down to simple measures. We have chosen coral that is at 1%. We could be centered on key species as in UMAM. In a HEA we are not looking at 10,000 functions. The question is whether we will we get to a level compared to current conditions.
- We should use the same metric as for impacts – corals.
- Are we assuming transplantation?
- Give the USACE specifications.
- Is it over 15 cm or 8-10 cm? This relates to survival.
- There may be 60-80,000 corals. It takes a lot of time and expense to transplant all of these. We need the USACE to provide the number and costs.
- There are only 20 A in the dredge area. We can give you approximate numbers.
- We don't have numbers for the wall.
- The USACE is not translocating all corals, just over a certain size based on the success rate. It may not make sense to move corals with a 10% success rate.
- All have some success rate (0-90%). We have to try.

Richard Dodge presented a PowerPoint on coral age and size over time.

- 75-100 years depending on size.

- The Dodge paper was not used in the HEA. There was a case study.
- 10% immediate for boulder with transplants
- Age distribution changes over time
- Only transplant 48%.
- When we do age calculations we have greater than 16 cm. 80% less than 10 cm so the curve will be shorter.
- We haven't defined other services. The use of corals may miss services. We may need a different proxy.
- 50 years without translocation. There may be 40 cm corals that are 50 years old. We can't have recovery less than the age of the oldest coral.
- If you remove corals and place them on boulders, those that survive would start immediately and there will be new corals forming.
- The initial numbers were run with transplantation of corals greater than 15 cm. Without transplantation it would be longer.
- It would be 65 years without transplantation based on a growth rate of .25 cm per year.
- Bill did not use a start from nothing. The number was pulled from other HEAs and other numbers to get an equilibrium factor. It is imperative to move large corals. Look at the population and mortality of all the corals, not one coral.
- It is costly to relocate corals and the USACE is committed to do their best.
- There will be a scope of work in the EIS.
- If you don't transplant you need a bigger area.
- Another project transplanted 2000 corals in three weeks.
- Keep the without transplantation on the table. You will need to make an economic decision.
- Transplantation is essential.

These are the acceptability ratings for different combinations of the values for 17 and 18.

100% and 50 years

	3	2	1
ACE		X	
FWC			X
Co EPD			X
FWS			X
EPA			X
NOAA			X
DEP			X
NOVA			X

75% and 65 years

	3	2	1
ACE			X
FWC	X		
Co EPD	X		
FWS	X		

EPA	X		
NOAA	X		
DEP		X	
NOVA	X		

75% and 55 years

	3	2	1
ACE		X	
FWC			X
Co EPD		X	
FWS		X	
EPA		X	
NOAA		X	
DEP			1.5
NOVA		X	

- DEP gave a 2 to the 75%/65 year option based on the assumption that the transplantation costs may be too high and the USACE may not do as much of it.
- Success criteria will be in the EIS and UMAM.
- No mitigation achieves 100%.

Middle Reef Direct Impacts

The middle reef was discussed briefly and everyone agreed to use the same numbers as the outer reef even though the makeup is somewhat different.

2nd Reef Channel Walls Direct Impacts

INJURY		COMPENSATORY ACTION	
12. Claim year= Date of Injury	2012	21. Date of compensatory action	2012
13. Site name			
14. Type of injury (direct, indirect+)	Direct	22. Type of compensatory action	Boulders
15. # of injured area units	.3564A		
16. Pre-injury service level =100%	100%	23. Pre-restoration service level (%)	0%
17. Degree of service lost of resources immediately following injury (%)	100%	24. Service level of CA upon initial installation	5-10%
18. Value-injured/value restored=1	1		
19. Equilibrium level to which recovery can reach	85%	25. Equilibrium level of service From CA expected	75, 100
20. Injury recovery time to equilibrium	26 yr	26. Time for services to develop from installation to equilibrium	26
21. Shape of recovery trajectory=linear	Linear	27. Shape of trajectory to equilibrium services	Linear
22. Time units=years	Years	28. Time units=years	Years
23. Discount rate per time unit (%)	3-6%	29. Discount rate	3-6%

- Are the channel walls included with the floors at the second reef?
- Yes.
- The north wall is currently 385 SF and will be 592 SF afterwards. The south wall is 452 SF and will be 457 SF afterwards. There will be more wall area afterwards for recolonization. The existing wall has been there 26 years.
- Were there pre-dredge surveys?
- The pre and post surveys are on the FTP site and on the CD.
- Yes they will be required.
- Walt Goldberg did some studies.
- Dredges don't always go exactly where they were designed to go.
- The USACE will get information requested by NOAA, if possible.
- If there is a better number than 30 ft. let us know.
- Calculations assume a rectangular profile and a 9 ft. cutter head which is the largest in the US.
- Spudding may not be available.
- Anchors will be required to stay in the channel limits. They have to pay for damage.
- There may be impacts 3-5 feet above the cuts.

- We calculated 5 ft. in Miami.
- Collapses are possible. In Key West we had divers do a survey.
- Key West used a different type of dredge.
- Did the original slop between the permitted area and actual cut differ and will we have the same problem?
- The precision is better than it was 26 years ago.
- The USACE could allow 5' for over cut.
- This was done before DEP permitting.
- How was the calculation done?
- What about the wall outside the reef area?
- This is not significant. It has been dredged in the last 3 years.
- DEP has pictures of large corals.
- USACE has video surveys from 2000, 01 and 02. Terri confirmed that that there are no impacts on the bottom 9 feet.
- DEP's photos of corals are above this 9 feet.
- There have been collapses
- The wall is not straight.
- If you want more information on the channel walls look at the videos.

20 - Injury recovery time to equilibrium

- What would 100% look like? It would not be the historic natural system.
- Treat the wall as a natural wall.
- We know what has happened in 26 years and it will get better.
- We should consider 26 years as the terminal condition.
- This is an HEA. Assume that the reef and the wall are the same.
- They are separate (There was no objection).
- Use 75% because of recruitment.
- We can't apply a shifting baseline.
- The current condition is the baseline.
- We may have bigger ships and the conditions may be worse.
- Having a deeper channel may result in fewer impacts.
- What number should we use? The past is informative.
- If we look at compensation, the new wall will be the same. I can see more than 70%. We have what we replace.
- What is out there is not the only example. We could model it and get a number. We don't have good data for a model. Could use a best guess or use the hard data we have. I prefer the hard data.
- We need to look at the pre and post surveys.
- We haven't analyzed them yet.
- It would be nice to have surveys.
- Water quality will be better in the next 26 years. We have done sampling and the quality is significantly better.
- Our figures show worse water quality conditions. There will be bigger ships and less

recruitment.

25 –

- The new wall can't be counted for compensation. Boulders are the action.
- We will have more new area, about ¼ acres. The floor wall will be 45-55' long.
- This is not a significant addition.
- Any biological resources will be saved.
- The channel wall creation can be considered but it will be small.

27 –

- It will not be 26 years.
- We don't have data on what is there.
- What if we have had no transplants? It will be better with transplanting.
- There are 12-15 ships a day.
- DEP has identified some large corals.

Outer Reef Indirect Impacts

INJURY		**COMPENSATORY ACTION**	
37. Claim year= Date of Injury	2012	40. Date of compensatory action	2012
38. Site name		41.	
39. Type of injury (direct, indirect+)	Indirect	42. Type of compensatory action	Boulders
40. # of injured area units	28.26A	43.	
41. Pre-injury service level =100%	100	44. Pre-restoration service level (%)	0
42. Degree of service lost of resources immediately following injury (%)	2, 5%	45. Service level of CA upon initial installation	10
43. Value-injured/value restored=1	1	46.	
44. Equilibrium level to which recovery can reach	98%	47. Equilibrium level of service From CA expected	75,100
45. Injury recovery time to equilibrium	35, 75yr	48. Time for services to develop from installation to equilibrium (no transplantation)	50,75
46. Shape of recovery trajectory=linear	47. Linear	49. Shape of trajectory to equilibrium services	Linear
24. Time units=years	Years	50. Time units=years	Years
25. Discount rate per time unit (%)	3-6%	51. Discount rate	3-6%

- Anchoring outside the channel would be considered direct impacts to be addressed with a separate HEA.
- There will be no blasting in the outer reef. It may require clamshell equipment.
- Turbidity and sedimentation require a separate HEA. Sedimentation may cause mortality. Turbidity may have short or long term impacts on light.
- Monitoring data is 25 years old.
- We have hopper head dredging monitoring reports and for the Key West dredging. There is also a report on the 80-81 Port Everglades dredging.
- The results depend on the materials and the currents.
- There are 2 activities; dredging or blasting and the removal that may have scowl leakage and disposal discharges. (OSDM is 5 to 5 ½ miles out and has required permits and certifications). Data from Miami shows (ADCP) no problems.
- Will there be blasting, cutter heads or clamshells used?
- The worst turbidity was from dredging in the inter-coastal waterway. The USACE did some OM.
- The USACE predicts low impacts.
- Let's combine turbidity and sedimentation.
- We have data on turbidity and sedimentation.
- There is little impact on big corals. It is hard to evaluate the impact on small corals.
- Include monitoring to get data on impacts on small corals.
- There was some study done by NSU.
- Will the monitoring shutdown the project if the conditions are bad?
- Yes, it can be in the specifications, e.g. no disposal if the current changes.
- What is "immediate?" This needs to be defined.
- We need to revisit this when we have new numbers.
- Cutters suck up the material so there is little turbidity and sedimentation.
- We have before, during and after monitoring.

42 – [Degree of service lost of resources immediately following injury (%)?]

- Past monitoring data suggests a 1-2% figure. Bill used 5% to be conservative.
- 0% is more likely. 5% may be excessive with a cutter head dredge. It may be more with a hopper head but still with no impact. The numbers are below standard.

44 –

- There may be long-term impacts.

45 –

- If 5% and corals are killed we could average the 50-100 and use 75.
- There could be a loss of productivity with death.
- 5% is based on partial morbidity and mortality.
- We consider landscape and population with corals as a proxy.
- There was no mortality on three recent projects.

- We need to be consistent with other HEAs.
- On direct impacts we lost 100%.
- Does it take 75 years to recover 3%?
- Consistency is not an issue for transplantation.
- Distinguish morbidity from mortality to determine age. We are putting too much together.
- Let's run contingencies with two options. Take the money back if thee is no mortality. Consider 2 and 75 and 5 and 35.
- What is the purpose of this? Don't we have to decide now?
- We need to address disposal and have a margin of error discussion. Expansion would require an EIS.
- We have to evaluate water quality.
- Is it OK if EPA addresses this in the OMDES?

What do you need before the next meeting?

1. What are the predicted impacts of the construction activity? Where will you put the spud and anchor?
2. Need a list of all the impacts and activities causing the impacts to occur. Use CEQ definitions.
3. What are the temporal, geographic and spatial areas of impacts?
4. Review the September 10th list of issues, some based on information and lack of information. Use this table as a guide. ACE will send out a comment matrix with responses. Agencies will respond if it was adequate.
5. ACE needs to see if videos of the channel walls can be used.
6. Provide pre and post-bathy surveys. Pace may help.
7. Analysis of coral data, #/sq meter by class in 2nd and 3rd reef for transplanting. Consider which corals do better.
8. Want details on state plan from Shantel on Ecosystem Trust Fund.
9. Share court case information on discount rate.
10. Dave Gilliam and Bill will help with costs of relocation
11. Need letters from cooperating and non-cooperating agencies.
12. Rarefaction curve from Bill.

Appendix A

September 25 & 26, 2007

Port Everglades HEA Meeting Agenda

Meeting Locations

Sept 25 – Port Everglades Port Offices – Room 301

Sept 26 - Port Everglades Port Offices – First Floor Auditorium

September 25, 2007

0900-0915 **Opening**

Welcome and opening comments, Phil Allen, Port Director
Meeting agenda and guidelines
Introductions and expectations

0915-1015 **HEA Overview**

Presentation

1. Overview of benthic community/relic reef system of Broward County.
2. Reef study for EIS prepared by Dial Cordy for corps.
3. Using that info - compare to other Broward county and SE FL studies.
4. Development of HEA input parameters for corps study.
5. HEA mitigation needs - boulders, etc.
6. Locations of possible mitigation sites.

1015-1030 **Break**

1030-1045 **Meeting Objectives Clarification**

Present approval and appeal processes (HEA, ERP and others)
Consideration of other perspectives
Seeking agreement on objectives/products of this meeting

1045-1100 **Map and Table Selection and Specifications**

Evaluate map and table options and select one of each
Specify the boundaries, labels and other attributes
Identify priority polygons for discussion

1100-1130 **Input Parameters** (For any spreadsheet)

Test for acceptability on the NCRI parameters
Seek consensus on any proposed changes in the parameters

1130-1200 **Polygon Discussion and Consensus Seeking,** For each:

Test to see if there are problems with the parameters or assumptions
Clarify the problem (definitions, scientific method, data availability or quality)
Identify options to address the problem
Seek agreement on how to resolve the problem (HEA model input)
Determine next steps for points not resolved (Conditional model input?)

Identify decisions that can be generalized to all or similar polygons

1200-1300 **Lunch,** Ordered in or on-your-own

1300-1615 **Continue Discussion and Consensus Seeking**

1615-1630 **Closing**
Summary of activities and results
Refine the Day 2 agenda
Agree on assignments as appropriate

September 26, 2007

0900-0915 **Opening**
Opening comments, Glenn Wiltshire, Deputy Port Director
Share insights from overnight
Revise agenda if needed

0915-1200 **Continue Discussion and Consensus Seeking**

1200-1300 **Lunch,** Ordered in or on-your-own

1300-1400 **HEA Spreadsheet Discussion**
Consider models/spreadsheets to be used by USACE and others
Discuss the process for validating models/spreadsheets
Seek consensus on agency procedures and coordination
Identify next steps for still unresolved issues/assumptions

1400-1430 **Mitigation Options**
Identify options for out-of-kind and in-kind mitigation and the related costs
Solicit suggestions for preparing mitigation proposals

1430-1500 **Other issues**
Margin of error – mitigation and funding for unintended impacts

1500-1530 **Closing**
Summary of meeting activities, results and next steps
Concluding comments by participants
Meeting evaluation

Appendix B

Meeting Guidelines

The Facilitator's Role:

- Help structure and guide discussions
- Maintain a record of group products
- Assist in compiling the results of the workshop

The Participant's Role:

- Share in keeping to the agenda
- Be focused and concise - balance participation
- Ask questions and verify assumptions
- Express and acknowledge differing views - no attacks or stereotyping
- Make sure recording is accurate
- Seek shared understanding and "consensus solutions"
  - Test acceptability: 3 = Good, 2 = Concerned but can live with it, 1 = Opposed
  - Clarify concerns and supporting science
  - Suggest and seek agreement on refinements
  - Retest acceptability and record any needed next steps

September 25 – 26, 2007 HEA Potential Attendees list

Allan D. Sosnow – Port Everglades
Terri Jordan - USACE
Marie Burns - USACE
Dennis Barnett – USACE, SAD
Steve Ross - USACE
Dick Powell - USACE
Leah Oberlin – USACE RD (Phone)
Jason Evert – USACE Contractor
Bill Precht – USACE Contractor
Bill Kruczynski - USEPA
Ron Miedema - EPA
Pace Wilber – NOAA Fisheries - HCD
Jocelyn Karaszia - – NOAA Fisheries - HCD
Greg Piniak - NOAA
Steve Thur – NOAA (Phone)
Jeff Howe – FWS
Vladimir Kosymin - FLDEP
Steve Macleod - FLDEP
Chantal Collier – FLDEP - CAMA
~~Sid Level – FLDEP parks – JUL (maybe)~~
Lisa Gregg - FWC
Mike Callahan - FWC
Erin McDevitt – FWC
Steve Higgins – BCDPEP (phone)
Lou Fisher - BCDPEP
Ken Banks - BCDPEP
Richard Dodge - NCRI - NSU
Kevin Kohler - NCRI - NSU
David Gilliam - NCRI - NSU
Brian Walker - NCRI - NSU
Alison Moulding - NCRI – NSU

November 27, 2007
Port Everglades HEA Meeting Summary Report

Project Overview

The U.S. Army Corps of Engineers (USACE) is currently conducting a feasibility study for an expansion of Port Everglades, including deepening and widening the approach channel. The primary alternative would cut through the second and third coral reefs tracts offshore of Fort Lauderdale, impacting several dozen acres of hard bottom benthic communities. Dial Cordy and Associates Inc. (DCA) was contracted by the Jacksonville District Army Corps of Engineers to aid in the preparation of the habitat equivalency analysis (HEA) for mitigation plan development for the project. In addition, the USACE convened a panel of invited experts (a.k.a. “Core Group”) to assist USACE in using HEA to determine the quantity of mitigation that would be required for this project.

The HEA method is specifically used in cases of habitat injury when the service of the injured area is ecologically equivalent to the service that will be provided by the replacement habitat.
This approach is termed “service-to-service” (Strange 2002) and assumes the public is willing to accept a one-to-one trade-off between the service lost and the service gained by the restoration (NOAA 1997). HEAs are by necessity, simplified representations of very complex ecosystems. Also, multiple types of injuries can be quantified in an equivalent manner through the use of HEA (Dunford et al. 2004). For marine environments the HEA method has been successfully applied to vessel groundings on coral reefs (Milon and Dodge 2001), and seagrass damage cases (Fonseca et al. 1998; Fonseca et al. 2000).

Habitat equivalency analysis is specifically designed to determine the compensation the public is due to reconcile injuries to the ecosystem and the lost services the ecosystem provides to the biotic component. King (1997) noted, "when injured resources and/or services are primarily of indirect human use the appropriate basis for evaluating and scaling the restoration is HEA." The public is considered to have been made whole for ecological losses when the scale of restoration needed to offset losses of resources and services is achieved. HEA establishes the discounted service acre year (DSAY) as the “common currency” for comparison of the public’s value of past injury and future restoration in a common time frame (Julius 1999). One service acre year is defined as the ecological service provided by one acre in one year. Economic discounting is used to express past injury and future restoration units in a common time (Julius 1999). So, one DSAY is the service provided by one acre in one year “discounted” to net present value. Area of injured habitat, percent loss of ecological services, duration of injury, are considered in HEA to determine DSAYs.

Cumulative DSAYs earned for a particular restoration project are dependent upon the type of habitat that is restored, the increase in habitat services offered as a result of restoration construction, and the amount of time over which services are provided by the restored habitat. The DSAYs earned over the duration of the restoration project are then translated to present time using a 3 percent discount rate (see discussion of selection of discount rate in the report).

<u>Meeting Summary</u>

Opening

This report is on the meeting held at Port Everglades in Fort Lauderdale on November 27, 2007. Everyone was welcomed and given a chance to introduce themselves and indicate who they represented. There are lists of the participants and meeting guidelines in Appendix A. The September 25-26 Meeting Report and Meeting Worksheets were distributed. The proposed meeting plan was to take up the issues that were not addressed at the first meeting and then to revisit unresolved issues from the first meeting if time permitted. Coral relocation and sea grass impacts were added to the initial list of unaddressed issues.

<u>Unaddressed issues</u>

1. Indirect impacts on the second reef from construction related sedimentation & turbidity (see worksheet)
2. Direct impacts of anchoring (see worksheet)
3. Mitigation of channel floor impacts
4. Additional parameters for indirect impacts (sedimentation and turbidity)
5. Additional parameters for anchoring impacts
6. Alternative mitigation strategies and criteria
7. HEA runs
8. *Coral relocation information*
9. *EIS and sea grass impacts*

The USACE restated that the question of channel floor impacts (3) was not open for discussion. Others stated that this was still an issue for them. When the question of additional parameters (4 and 5) was raised, no one had any to add. The group agreed that additional mitigation strategies (6) need to be addressed if time permits. The HEA runs (7) were to be considered as part of the discussions of impacts. The coral relocation information (8) was discussed briefly. It was acknowledged that the sea grass impacts (9) will be addressed in the EIS process and would not be covered at this meeting.

Middle Reef Sedimentation/Turbidity Impacts (Indirect)

(Note that Sedimentation/Turbidity Indirect Impacts to the Outer Reef were discussed at the Sept 25-26 meeting).

The values below in normal font were proposed by the USACE for consideration by the group. The values in *italics* are alternate values proposed by other members of the group and this indicates that there is not consensus on the value for that parameter. Notes from the discussions of the parameter values follow the table

INJURY		**COMPENSATORY ACTION**	
1. Claim year= Date of Injury	2012	13. Date of compensatory action	2012
2. Site name			
3. Type of injury (direct, indirect)	Indirect sed/turb	14. Type of compensatory action	Boulders
4. # of injured area units	15.89		
5. Pre-injury service level	100%	15. Pre-restoration service level (%)	0%
6. Degree of service lost of resources immediately following injury (%)	5%	16. Service level of CA upon initial installation	~~10 %~~ 0-5%
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	98%	17. Equilibrium level of service From CA expected	100% *75%*
9. Injury recovery time to equilibrium	35 yrs *15 yrs*	18. Time for services to develop from installation to equilibrium	50 yrs *75 yrs*
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit (%)	3%, *6%*	21. Discount rate per time unit (%)	3%, *6%*

4. # of injured area units (15.89)

- This number may be affected by anchoring. The area of anchoring impacts may need to be subtracted to avoid double counting.

5. Pre-injury service level (100%)

- 100% is based on the current stress. It is a baseline.

6. Degree of service lost of resources immediately following injury (5%)

- Should we separate turbidity and sedimentation?
- We agreed at the last meeting to consider them together.
- Are we talking about morbidity and/or mortality
- We need a definition of the service level, the USACE considered morbidity. It has been

dredged before. It will be the same. There will be some morbidity but no mortality.

- What does the 5% mean?
- It is not 100%. There is some stress. We have limited scientific data.
- It is the % of stress.
- It should be 5% for 35 years.
- I am OK with the 5% but I am not sure what it means.
- If this is a problem it will be addressed.
- Monitoring shows no effect in terms of mortality or morbidity (stress).
- This does not include the possibility of an unforeseen accident or problem.

8. Equilibrium level to which recovery can reach (98%)

- Are there any stresses?
- The biomarker study shows the impact of outlets (stress); there is no mortality or stress.
- 98% indicates some turbidity and sedimentation from ship traffic.
- There may be less impact because of the deeper channel and fewer ships.
- Currently there is no channel on the 2nd and 3rd reef. With a channel there will be decreased clarity. There will be no hard bottom to buffer the currents.

9. Injury recovery time to equilibrium (35 yrs or *15 yrs)*

- It should be 10-15, not 35 years because of morbidity.
- It should be 35 years.
- Hasn't the impact already been addressed?
- We should focus on sedimentation and turbidity from construction not from ships.
- Recovery is to 98% not 100%.
- The corals are also impacted by poor water quality and other causes.
- We could do a turbidity impact ships estimate.
- Let's use 15 and 35 in a sensitivity analysis to be run by NOAA. (Estimated less than 1% of the mitigation area.) Include scenarios in an appendix in NEPA so the public can see the outcomes. It may convey a low impact. The USACE will do others.
- How do we capture the impact of larger ships?
- Lori Hadley with the USACE can do a simulation.
- This can be addressed in "cumulative impacts" in NEPA not the HEA.
- The USACE is not accountable for impacts that it does not control and reasons for longer time to equilibrium will be addressed in the cumulative impacts section of the EIS, not used in HEA as vessel operations post-construction cannot be accounted for in Corps analyses according to policy
- Not all USACE districts agree on this position.
- When we do an HEA the impacts are broken down into simple metrics/impacts. We have field evidence, peer reviewed evidence and best professional judgments.
- There are gaps in the science, and there will always be gaps.
- It is hard to distinguish stress from mortality. It could be more than 35 years. We can't just separate out construction impacts.
- Just the construction impacts happen early and diminish in 2-3 years to close to the

background level. We have to consider previous construction as a baseline, i.e., max value; this was 28 years ago.

- It should be based on recovery from construction not ship traffic.
- Sensitivity between 35% and 15% is 1% of mitigation acreage.
- In scoring FWS did not consider cumulative impacts, but only construction (direct) impacts
- NOAA considered long-term impacts
- DEP and NSU noted construction only, but indicated that long-term is part of that

Acceptability ratings for 15 vs. 35 yrs for #9. Injury recovery time to equilibrium
Rating Scale: 3 = Good, 2 = Concerned but can live with it, 1 = Opposed

15 years	**3**	**2**	**1**		**35 years**	**3**	**2**	**1**
ACE	**X**				**ACE**			**X**
FWC			**X**		**FWC**		**X**	
Co EPD	**X**				**Co EPD**		**X**	
FWS	**X**				**FWS**		**X**	
EPA					**EPA**			
NOAA		**X**			**NOAA**	**X**		
DEP			**X**		**DEP**	**X**		
NSU			**X**		**NSU**	**X**		

16. Service level of CA upon initial installation (~~10%~~, *0-5%)*

- [After some discussion, it was agreed to use the same figures as for the outer reef]

12, 17, 18 and 21.

- [There was still not agreement on these values that were discussed extensively at the last meeting and no new information was offered.]
- DEP provided a document for Corps review at the meeting, re: discount rates via e-mail prior to the meeting

Direct Impacts of Anchoring

The values below in normal font were proposed by the USACE for consideration by the group. The values in *italics* are alternate values proposed by other members of the group and this indicates that there is not consensus on the value for that parameter. Notes from the discussions of the parameter values follow the table

Combination of areas in the Inner, Middle, and Outer reefs

INJURY		**COMPENSATORY ACTION**	
1. Claim year= Date of Injury	2012	13. Date of compensatory action	2012
2. Site name	Anchor-cable		
3. Type of injury (direct, indirect)	Direct - anchor/cable	14. Type of compensatory action	Boulders
4. # of injured area units	11.91 A (1) *17.15 A*		
5. Pre-injury service level	100 %	15. Pre-restoration service level	0%
6. Degree of service lost of resources immediately following injury (mortality)	50% (2)	16. Service level of CA upon initial installation	10% (3) *0-5%*
7. Value-injured/value restored=1	1		
8. Equilibrium level to which recovery can reach	98% *85-95%*	17. Equilibrium level of service From CA expected	100% (4) *75%*
9. Injury recovery time to equilibrium	50 years (5) *100 years*	18. Time for services to develop from installation to equilibrium	35 yrs w/transplants or 50, *75* yrs without (6)
10. Shape of recovery trajectory=linear	Linear	19. Shape of trajectory to equilibrium services	Linear
11. Time units=years	Years	20. Time units=years	Years
12. Discount rate per time unit	3% (7) *6%*	21. Discount rate per time unit (%)	3% (8) *6%*

4. # of injured area units (11.91, *17.15 A)*

- Nova Southeastern University, NSU, has done a GIS analysis of the area impacted and Broward County is doing numbers. [A map with a table of calculations by area was distributed and is available at the project ftp site.]
- Anchorage direct impacts may change, i.e., decrease, indirect impacts acreage
- The USACE won't include the Rubble Shoal and Submerged Breakwater areas. Terri Jordan will check with the USACE.
- Artificial reefs have a quality of environmental services.

- The USACE does not mitigate for navigational structures.
- In another case they did not mitigate but did transplant corals.
- What is DEP's policy? Does new construction need mitigation, not maintenance? We would consider it on existing resources. There would be no dinging for past impacts.
- Kevin's and USACE's numbers match 12.61 plus 4.51 = 17.151 without the rubble shoal and breakwater. This would be a policy call.
- Pace will talk to Marie.

6. Degree of service lost of resources immediately following injury (mortality/morbidity) (50%)

- Based on the experience in Miami Harbor Phase 2 there were no impacts.
- 50% loss in the triangle areas is used to be conservative.
- There was a 25% (but Corps used a more conservative 50%) impact in Hillsborough where the tugs drug the cables.
- In Miami the cables were pontooned so the impact was 0.
- Vlad recalls damage between two ships not the cutter heads.
- Steve Bair and DERM did monitoring in Miami. There were no cable or anchor impacts.
- We will use a "you break it, your buy it" clause in the contracts as an incentive as we did in Miami. The USACE will require use of the best available technology. Cutter heads are assumed. This is the only technology that will work. We want to calculate the mitigation and then not need it.
- What does 50% mean, 50% mortality or 50% morbidity?
- 50% morbidity was used.
- If they do a great job this page is irrelevant. If the damage is less than 50% we can claim a mitigation credit. If it is greater than 50% the contractor pays.
- This doesn't set a cap on mitigation. The contractor will pay for any additional mitigation.
- Consider requiring a bond for mitigation. The USACE will check on this.
- The USACE and DEP MOU address this as part of "water quality."

8. Equilibrium level to which recovery can reach (98%, *85-95%)*

- Vlad suggests 85% given the rate of recovery, like the channel walls.
- The walls were 85% because of possible caving so this doesn't apply. Caving has not been documented previously at Port Everglades or in the recent Port of Miami. Have to use the available data and comparisons where available.
- 95% may be a better number.

9. Injury recovery time to equilibrium (50 years, *100 years)*

- Should be 100 yrs.
- There are no 100-year corals out there based on the survey. [The USACE wants to use 50 years and others prefer 100 years]

13-21 The discussion of values would be the same as for the sedimentation/turbidity table.

Mitigation Options

An initial list of possible mitigation was presented for discussion based on responses to the pre-meeting worksheet input and consultant suggestions.

Possible Mitigation Options

Boulders
Other types of artificial reefs (locations, including reef gaps & inter-reef soft bottoms, materials, configurations, depths, etc.)
Installing corals on existing substrates (def of "mitigation" vs. "avoid/min")
Water quality improvements
Remove spoil shoal north of channel
Remove spoil shoal south of channel
Removal of maintenance dredge material
Removal of tires from Middle Terrace/Reef
Mooring sites offshore

Possible Option Evaluation Criteria

A. Like-for-like resource benefit (i.e. In-kind)
B. A quantifiable estimation of the benefit
C. A reasonably established chance of success

Discussion Notes

- Like-to-like would be hard bottom to hard bottom in the region.
- The USACE is committed to transplant 13,000 corals.
- Are there artificial reefs in the area without corals?
- There are some but they are shallower and there are not enough.
- It would only be compensatory if it were new rock.
- NOAA would recognize some benefit from existing boulders.
- There are policy problems with using existing boulders.
- This is minimization of impacts and should be required.
- We need to get the HEA numbers for boulders.
- We need structure for structure removal on the outer reef, e.g. 20 acres for 20 acres.
- The mitigation cost estimates will be based on the use of boulders.
- Cost estimates based on boulders could be low.
- Once the calculation is made we can choose the best way to spend the funds and maximize the benefit.
- Should do HEAs for all mitigation options to ensure selected alternatives don't provide less value (Dodge)
- The result is a number for the federal share. Then the USACE can apply for the funds to the better options. The funds also come from the local sponsor. The estimate is the minimal habitat gain for the options.

- We are not locked into boulders forever. There may be more restoration options by 2020.
- Do a habitat gain and cost chart with an error range. This analysis will help in making decisions.
- We can use boulders as a placeholder in the draft mitigation plan that is part of the DEIS. The USACE will work with partners to develop a mitigation plan in the EIS and may create a mitigation bank. If the agencies & USACE cannot develop alternatives to boulders, then the Corps will rely on boulders as the mitigation tool for project.
- Are there sites that have not been restored?
- There are orphan sites and things that can be done.
- Come up with a wish list, e.g. install mooring balls could save 4 acres
- We need to be sure of the benefits.
- I am concerned about the cost estimate.
- The USACE has a rigorous estimating process. It seeks the best value to the government.
- Why use boulders? We scale the HEA based on projects we know.
- I am concerned about boulders. The outer reef rock may not be suitable (Fisher). Outer reef rock is not proposed to be used. The rock will come from the inside of the port and be excavated associated with the proposed blasting (Jordan).
- Can the USACE transfer funding for restoration to NOAA or the State Restoration Fund?
- NOAA doubts a MOA is possible. It could accept funding for specific purposes.
- Audubon has a restoration fund.
- We may be able to use the DEP fund but there are problems.
- FWC has no usable funds and there will be no new ones. There is always a danger that trust funds will be swept by the legislature. A private fund may be OK.
- There is a great administrative burden to set up a fund and there would need to be a trustee council to make the decisions.
- This is a new foray for the USACE. We have new tools.

The group agreed on these provisions:

- We will use boulders to do the mitigation cost estimates following the USACE policy on cost risk analysis for costs and contingencies. The local sponsor will be responsible for 50% plus monitoring, etc.
- The Delphi technique will be used to get input from the partners on priority mitigation options and criteria for evaluation. Questions will be sent out. Answers will be compiled anonymously and resent for comment.

Concluding Comments

At the end the facilitator offered each participant the opportunity to offer a concluding comment if the wanted to. These are the notes on their comments.

- It has been five years since the agency response. We want to avoid a public battle over the EIS. The USACE may want to consider requesting an agency response at this time. Agency participants could talk to their senior management and then send an advisory letter clarifying support and any areas of serious concerns.
- This can be talked about at the cooperating agency meeting on Thursday.
- It would be helpful if the letter identified what issues need more attention.
- A DEIS and EIS should be similar.
- The USACE will do a draft mitigation plan
- Based on regulation – the EIS should address substantive comments on the DEIS and thus, major changes between the Draft and Final EIS are possible and likely.
- We want to go through the NEPA process as smoothly as possible.
- Doing an agency letter is a good idea.
- There is always a flurry of effort at the beginning and end of these processes.
- The USACE has worked on this project for years. There is much work that has been done. Don't assume that nothing has been done. Check with your previous staff and agency files for meeting minutes, e-mails, phone call records, etc. before criticizing the past process and writing "advisory" letters.
- We may have a concurrent 10-point process. There are many ways to do this. (Pace Wilber referencing the port of Savannah's methodology for their expansion project).
- There were project delays and staff changes. The USACE wants the cooperating agencies to be co-authors and partners.

Appendix A

Meeting Participants

Name	Agency & Division	E-mail
Jason Evert	Dial Cordy & Assoc	jevert@dialcordy.com
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Jeff Howe	USFWS	Jeffrey_Howe@fws.gov
Tom Taylor	FSU	ttaylor@fsu.edu

Meeting Guidelines

The Facilitator's Role:

1. Help structure and guide discussions
2. Maintain a record of group products
3. Assist in compiling the results of the workshop

The Participant's Role:

1. Share in keeping to the agenda
2. Be focused and concise - balance participation
3. Ask questions and verify assumptions
4. Express and acknowledge differing views - no attacks or stereotyping
5. Make sure recording is accurate
6. Seek shared understanding and "consensus solutions"
   a. Test acceptability: 3 = Good, 2 = Concerned but can live with it, 1 = Opposed
   b. Clarify concerns and supporting science
   c. Suggest and seek agreement on refinements
   d. Retest acceptability and record any needed next steps

Appendix B

Pre-Meeting Worksheets

With Input from Richard Dodge

Richard Dodge's comments below are referenced in brackets in the table.
Combination of areas in the Inner, Middle, and Outer reefs

INJURY		**COMPENSATORY ACTION**	
13. Claim year= Date of Injury	2012	22. Date of compensatory action	2012
14. Site name	Anchor/cable		
15. Type of injury (direct, indirect)	Direct - anchor/cable	23. Type of compensatory action	Boulders
16. # of injured area units	11.91 A (1)		
17. Pre-injury service level	100	24. Pre-restoration service level	0%
18. Degree of service lost of resources immediately following injury (%)	50% (2)	25. Service level of CA upon initial installation	10%, (3)
19. Value-injured/value restored=1	1		
20. Equilibrium level to which recovery can reach	98%	26. Equilibrium level of service From CA expected	100% (4)
21. Injury recovery time to equilibrium	50 years (5)	27. Time for services to develop from installation to equilibrium	35 years w/transplants or 50 w/o(6)
22. Shape of recovery trajectory=linear	Linear	28. Shape of trajectory to equilibrium services	Linear
23. Time units=years	Years	29. Time units=years	Years
24. Discount rate per time unit	3% (7)	30. Discount rate per time unit	3% (8)

(1) (According to Terri's table supplied on the FTP site, this is the area figure for the Inlet Channel. It is not a combo area of the impact to reefs. The sum of Inner, Middle, and Outer impact area is 12.61 a. Please explain how the 11.91 figure was obtained.)
(2) (This should be 100%. The anchor and chain scrape the substrate completely bare and so there is a de facto 100% loss.)
(3) (This should be 0% or at most 5%)
(4) (This should be 75% to be consistent with previous discussions. 50% is preferable)
(5) (This should be 100 years)
(6) (This should be 75 years without transplants and 65 years with. Where are the transplants coming from? Is the ACE proposing to remove all corals from expected anchor areas?)
(7) (This should be 6%)
(8) (This should be 6%)

Summary Table Prepared by Richard Dodge

TABLE OF Anchor and Anchor Chain Impacts		
Habitat	Sq ft	Acre
Outer Reef	219904.87	5.048
Channel Wall	515226.34	11.828
Middle Reef	204508.23	4.695
Inner Reef	124842.51	2.866
Nearshore HB	197795.83	4.541
Rubble Shoal	22386.38	0.514
Submerged Breakwater	54518.13	1.252
Sand	647803.03	14.871

The HEA Results – For discussion use only

Injury Category	Area (Acres)	Initial Service Loss	Equi Servic
1. Middle and Outer Reef Direct Impacts- Recovery to 0%	20.34	100	
2. Middle and Outer Reef Direct Impacts- Recovery to 5%	20.34	100	
3. Middle and Outer Reef Direct Impacts- Recovery to 15%	20.34	100	
4. Middle Reef Channel Wall- Recovery to 85%	0.3654	100	
5. Middle Reef Channel Wall- Recovery to 95%	0.3654	100	
6. Turbidity All 3 Reefs & HB- 2% loss, perpetual loss (no recovery)	80.35	2	
7. Turbidity All 3 Reefs & HB- 5% loss, 35 year recovery	80.35	5	

Injury Category	Area (Acres)	Initial Service Loss	Equilibrium Service Level
1. Middle and Outer Reef Direct Impacts- Recovery to 0%	20.34	100	0
2. Middle and Outer Reef Direct Impacts- Recovery to 5%	20.34	100	5
3. Middle and Outer Reef Direct Impacts- Recovery to 15%	20.34	100	15
4. Middle Reef Channel Wall- Recovery to 85%	0.3654	100	85
5. Middle Reef Channel Wall- Recovery to 95%	0.3654	100	95
6. Turbidity All 3 Reefs & HB- 2% loss, perpetual loss (no recovery)	80.35	2	98
7. Turbidity All 3 Reefs & HB- 5% loss, 35 year recovery	80.35	5	98

Restoration Requirement Matrix (in acres)

Comp HEA	Injury HEA 1	2	3	4	5	6	7
8	35.68	34.75	32.89				
9	51.39	50.05	47.36				
10	56.35	54.88	51.94				
11				0.20	0.17		
12				0.28	0.23		
13						2.82	4.41
14						4.85	7.59

Summary

Direct Reef Impacts: 32.89 to 56.35 acres
Channel Wall Impacts: 0.17 to 0.28 acres
Turbidity Impacts: 2.82 to 7.59 acres

min* 35.88
max* 64.22

*Caveats associated with HEAs
1) The results of these HEAs are based on a range of parameters and they are considered draft HEAs.
2) The draft HEAs represent a summation of three injury categories ONLY.
3) The HEAs are not representative of the total restoration requirement
In order to develop a more complete restoration requirement, discussion is needed on the remaining reef injury categories, in addition to mangrove and seagrass injury categories.

Richard Dodge Pre-Meeting Worksheet Comments on the HEA Runs

- The HEA runs are also incomplete.
- The HEA has no output for the case of 6% discount rate. 6% was the preferred rate according to the Rating
- The HEA has no output for the case for 0% initial services for the CA. This was a valid case to be examined.

- **We need to "vote" on 4 vs. 5:**
  4. Middle Reef Channel Wall- Recovery to 85%
  5. Middle Reef Channel Wall- Recovery to 95%
- **We need to "vote" on 6 vs. 7:**
  6. Turbidity All 3 Reefs & HB- 2% loss, perpetual loss (no recovery)
  7. Turbidity All 3 Reefs & HB- 5% loss, 35-year recovery
- **We need to "vote" on 11 vs. 12:**
  11. Boulders for Channel Wall Impacts- 10% initial, 100% max, 26 years
  12. Boulders for Direct Reef Impacts- 5% initial, 75% max, 26 years
- **We need to "vote" on 13 vs. 14:**
  13. Boulders for Turbidity Impacts- 10% initial, 100% max, 50 years
  14. Boulders for Turbidity Impacts- 5% initial, 75% max, 75 years

Unresolved Direct Impact Values from the Last Meeting

These are the parameters and alternative values developed at the last meeting with selected references to science and professional judgments from the meeting report.

8. Equilibrium level to which recovery can reach

Direct Impacts to Outer and Middle reefs *0, 5 or 15%*

Science and professional judgment supporting 0%

- Look at areas where outfall pipes were installed, there are not resources there.
- We don't know what will happen in the future. From the Keys it will be closer to 0% than 15 %. The channel that was dredged in Key West is a wasteland and is stirred up regularly.
- In the time relevant to the HEA calculations (e.g., ~300 years), there will be effectively no recovery of the injured reef towards its former state. Hence 0% is the most reasonable figure. RD
- It boggles the mind to propose a recovery number greater than 0% for a reef that is effectively obliterated and removed. The reef has been removed. It is missing! While there may be a small number of living organisms that colonize the channel floor over time, it is difficult to imagine a return to services of anything like 5% and certainly not 15%. If pressed, a 0.5% recovery is possible to give a nod to very minor recovery. RD

Science and professional judgment supporting 5%

- We can conjure up envelops of reasonableness with in the range of 5-15%. We are not sure where we are. We can do histograms that would help us understand. It bothers us to say, "We can live with it." The closer we get to 0 the less significant it is.

Science and professional judgment supporting 15%

- We looked at the recovery on the second reef in 26 years and it is about 5% now and may reach 15% in 50 years.
- The Middle reef is not comparable to the Outer reef.
- 15% seems good because Bill and others looked at recovery on reef 2 **[was this the**

channel floor??] after 26 years and considered 3 in 50 years. Why not?

- We are only looking at the bottom not the sides.
- Most of the corals are brooding species and we will have more recruits over time. Equilibrium may not happen for 100 years.

We already "voted" on the above for Direct Outer and Middle. RD

9. Injury recovery time to equilibrium

Direct Impacts to Outer and Middle reefs *50 yr for 5-15% or 0 yr. for 0%*

Science and professional judgment supporting 50 yr for 5-15%

- Bill used 35 years. 95-97% of corals were in a type/size of 20-25 cm. It took 35 years to achieve the size and density. 50 years was conservative. The difference between 35 to 50 is not that much.
- Past HEA's are set at 35 years because of what one attorney did in one case and it has been sited ever since. We have better information now.
- The oldest corals are about 100 years old. We should use that timeframe.
- Dr. Dodge's PowerPoint showed his interpretation of coral age in Broward County.
- On-site all corals on the third reef were less than 40 cm (with a conservative growth rate).
- There was an inadequate sample size. Dodge's sample was larger.
- I ran the numbers for 5% for 100 years and 15% for 50 years and there is only a 6% difference in the results. We need to put this parameter into perspective.

12. Discount rate per time unit

Direct outer and middle reefs *3 or 6%*
Direct channel wall impacts, 3 or 6%

Science and professional judgment supporting 3%

- 3% was used because this is the figure required by USACE. **[Where is the statute that says 3% is required? Please provide this RD]**
- There are legal precedents for using 3%
- 3% was used in the Florida Keys National Marine Sanctuary, Key West and other projects. It was also used in a Yellowstone Park project that had high social values.
- 3% is the USACE regulatory standard. There is a question about the real rate of interest versus the nominal rate. NOAA used 3% or the government-borrowing rate that is 3%.
- There is a social rate of time preference – NOAA has a memo on the 3% rate.
- FWS used 3% and so does the DOI.

Science and professional judgment supporting 6%

- 6% is suggested based on a NOAA study. This is appropriate if there is a higher social value as indicated in the economic study of reef resources. A review of the studies yielded the 6% figure.
- NOAA also says an alternative rate may be used. People of Broward want the payback sooner.
- State of Florida has used 6%.

16. Service level of compensatory action [of Direct?] upon initial installation (boulders) ***0-5%***

Science and professional judgment supporting 0%

- It may be inappropriate to take absolute worse case scenarios for a plan. We should use the best estimate and use adaptive management. We don't know everything. We can adjust if we have new information. We can learn a lot in 5-10 years. Let's go for the best. We don't know about translocation.

Science and professional judgment supporting 5%

- A 20% credit was given for boulder placement in the Kohler and Dodge study that has been sited.
- This was arrived at by a group for a different habitat and not by the scientists. 5% would be good. The Hillsborough case was for a different type of injury. The study was a draft that was not finalized.
- There have been HEAs that used 20%, some without transplantation and with long linear inputs.
- We may not have to consider historic cases. Consider the services it provides on horizontal and vertical surfaces that are similar to a reef. Rocks provide some services.
- Boulders are not the be all and end all. Boulders are more complex. Many projects use boulders, e.g. Bal Harbor where credit is given and utilization is demonstrated. 20% is widely used and peer reviewed. Whether we use 5 or 20% will not change the numbers much. I am just trying to get quicker recovery.
- Using alternatives to boulders may negate this. Use 5% to be conservative. Boulders provide more complexity and thus more services.
- The rock at the third reef is not good. 5% is a better figure.
- Bill will evaluate the third reef and design the project. 5-10% can be used if the complexity is the same and possibly more if there is more complexity. It will be necessary to specify the size and placement of boulders to get benefits as compared to natural areas.
- The USACE suggests using 10%.

17. Equilibrium level of service from CA expected (boulders with transplants)

Direct outer and middle reefs, *75, 100%*
Channel Wall impact, *75 or 100%*

Science and professional judgment supporting 75%

- 75% is a compromise between 50% and 100% RD
- It is difficult to believe that the services of a pile of boulders will actually replicate the services of a reef to a level of more than 75%. RD

Science and professional judgment supporting 100%

18. Time for services to develop on the CA from installation to equilibrium

Direct Impacts to Outer and Middle reefs, ***50, 55 or 65 years***

Science and professional judgment supporting 50 years

- 50 years without translocation. There may be 40 cm corals that are 50 years old. We can't have recovery less than the age of the oldest coral.

Science and professional judgment supporting 55 years

Science and professional judgment supporting 65 years

- Without any transplants, the CA would take at least as long to recover as the natural reef (that had no structural removal). This is 100 years without transplantation for the natural reef. 75 years was chosen because the recovery is only to 75% RD
- Richard Dodge presented a PowerPoint on coral age and size over time. 75-100 years depending on size.
- The estimate of recovery time with transplantation would be 65 years assuming 75 years without transplantation. RD
- Even though corals are the keystone organism, transplantation of the oldest age class does not convey enormous credit. Some credit is possible. RD
- DEP gave a 2 to the 75%/65 year option based on the assumption that the transplantation costs may be too high and the USACE may not do as much of it.

21. Discount rate

Direct outer and middle reefs *3 or 6%*
Channel wall impacts, *3 or 6%*

Science and professional judgment supporting 3%
Science and professional judgment supporting 6%

Unresolved Indirect Impact Values from the Last Meeting

These are the parameters and alternative values developed at the last meeting with references to science and professional judgments from the meeting report.

6. Degree of service lost of resources immediately following injury

Indirect (sedimentation/turbidity) Outer and Middle reef, *2 or 5%*

Science and professional judgment supporting 2%

- Past monitoring data suggests a 1-2% figure. Bill used 5% to be conservative.
- 0% is more likely. 5% may be excessive with a cutter head dredge. It may be more with a hopper head but still with no impact. The numbers are below standard.
- We have hopper dredging monitoring reports for the Key West and Broward County Shore protection project dredging.
- The results depend on the materials and the currents.
- There is little impact on big corals. It is hard to evaluate the impact on small corals.
- Include monitoring to get data on impacts on small corals.
- There was the Broward County Shore Protection Project study done by NSU.

- Cutters suck up the material so there is little turbidity and sedimentation.

Science and professional judgment supporting 5%
- Same as above

Science and professional judgment supporting some effects RD
- There needs to be some level of impact for sedimentation and turbidity above 0%. It is difficult to imagine that a large cutter head dredge deepening and widening the channel will generate no sedimentation and turbidity.
- What about turbidity generated by all the dredging within the Port when the interior is deepened and widened?
- John Proni's data shows that the same water often goes into and out of the port several times, thus the turbidity will likely be sucked in and out on multiple tidal cycles, exacerbating the problem.

9. Injury recovery time to equilibrium

Indirect Outer and middle reef, *35 or 75 years*

Science and professional judgment supporting 35 years
- There was no mortality on three recent projects.

Science and professional judgment supporting 75 years
- If 5% and corals are killed we could average the 50-100 and use 75 years.
- Does it take 75 years to recover 3%?
- An injury is an injury. The % injured refers to dead corals. Hence the time required is the time for coral replacement which we have previously estimated at ~75 years. RD

12. Discount rate per time unit

Indirect outer and middle reef, *3 or 6%*

Science and professional judgment supporting 3%
- 3% was used because this is the figure required by USACE. **[Where is the statute that says 3% is required? Please provide this RD]**
- There are legal precedents for using 3%
- 3% was used in the Florida Keys National Marine Sanctuary, Key West and other projects. It was also used in a Yellowstone Park project that had high social values.
- 3% is the USACE regulatory standard. There is a question about the real rate of interest versus the nominal rate. NOAA used 3% or the government-borrowing rate that is 3%.
- There is a social rate of time preference – NOAA has a memo on the 3% rate.
- FWS used 3% and so does the DOI.

Science and professional judgment supporting 6%
- 6% is suggested based on a NOAA study. This is appropriate if there is a higher social value as indicated in the economic study of reef resources. A review of the studies

yielded the 6% figure.

- NOAA also says an alternative rate may be used. People of Broward want the payback sooner.
- State of Florida has used 6%.

17. Equilibrium level of service from CA expected (boulders with transplants)

Indirect Outer and middle reef, *75 to 100%*

Science and professional judgment supporting 75%

- 75% is a compromise between 50% and 100% RD
- It is difficult to believe that the services of a pile of boulders will actually replicate the services of a reef to a level of more than 75%. RD

Science and professional judgment supporting 100%

18. Time for services to develop on the CA from installation to equilibrium

Indirect Outer and Middle reef, 50 or 75 years with transplantation

Science and professional judgment supporting 50 years

Science and professional judgment supporting 75 years

21. Discount rate

Indirect Outer and middle reef, *3 or 6%*

Science and professional judgment supporting 3%

Science and professional judgment supporting 6%

See comments under 12. (Note we already "voted" on this) RD

Resolution Status Summary Prepared by Richard Dodge

DIRECT TYPE	Resolution Status
Outer Reef	Partially
Middle Reef	Partially
Inlet Channel Floor	Partially
Sand	Not Yet Addressed

Sedimentation/Turbidity	
	Partially
Middle Reef	Partially
Inner Reef	Partially

Near Shore HB	
Rubble Shoal	Not Yet Addressed
Submerged Breakwater	Not Yet Addressed
Inlet Channel Wall	Partially
Sand	Not Yet Addressed
ANCHORING	
Outer Reef	Not Yet Addressed
Middle Reef	Not Yet Addressed
Inner Reef	Not Yet Addressed
Near shore HB	Not Yet Addressed
Rubble Shoal	Not Yet Addressed
Submerged Breakwater	Not Yet Addressed
Inlet Channel Wall	Not Yet Addressed
Sand	Not Yet Addressed

APPENDIX E-3

Mitigation Requirements Analysis for Impacts to Hardbottom Resources Associated with Port Everglades Harbor Navigation Improvements

Recommendations of the Port Everglades Reef Group Regarding Compensatory Mitigation for Navigation Improvements at Port Everglades Harbor

Photo: T. Jordan

Prepared for

U.S. Army Corps of Engineers
Jacksonville District
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Jacksonville, Florida 32207

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17 May 2005

PREFACE

The U.S. Army Corps of Engineers is conducting a study to determine the feasibility of constructing navigation improvements at Port Everglades (Broward County, Florida). The goal of the Port Everglades Reef Group (PERG) was to elicit comments from participants (scientists, regulatory officials, and stakeholders) regarding what types of compensatory mitigation should be considered by the Corps, and how mitigation should be carried out in order to maximize benefits to the ecosystem and ensure long-term performance/benefits. PERG commenced deliberations on 12 June 2002 and suspended activity on 17 May 2005. Great care was taken to include all opinions and recommendations of PERG members. However, due to the limited scope of PERG, some were not included herein. PERG participants are encouraged to provide the Corps with any comments or opinions that were not included in this document. Readers are cautioned that the contents of the document provides draft conclusions based on hypothetical mitigation scenarios, and that statements and recommendations do not necessarily represent those of participants' institutions or agencies.

The information contained in this document is accurate as of 17 May 2005. The mitigation plan used during discussions and deliberations of PERG, described in Section 6.0, reflects the preliminary plan proposed by the Corps. That plan may have changed since this report was drafted. Furthermore, anticipated impacts resulting from construction of navigation improvements at Port Everglades may now differ from those presented in Section 4.0. Finally, additional field investigations detailing resources associated with reefs within, adjacent to, and offshore of the existing entrance channel have been carried out recently, and some of the information presented in Section 3.0 may now be out-dated.

Since suspension of formal PERG activities, several members have engaged in further natural resource investigations within and adjacent to the project area, corresponded and met with the Corps, and advised the Corps regarding offshore resources, construction plans, and mitigation issues. Though several years have passed since the Study was initially authorized, the Corps intends to continue to work with regulatory and natural resource agencies and incorporate findings from PERG as practicable in order to pursue project goals on behalf of the local sponsor and stakeholders.

Jason Evert, PERG Facilitator
Dial Cordy and Associates Inc.
17 October 2006

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1.0 INTRODUCTION

Port Everglades (Broward County, Florida) is one of South Florida's strongest economic engines, with annual operating revenues of more than $112.5 million and total waterborne commerce exceeding 22 million tons in liquid, break bulk, and containerized cargoes. More than 6,400 ships call at Port Everglades (the "Port") in a year forming the basis of a diverse maritime operation that includes: a thriving cruise industry and a reputation as the "world's premier cruise port;" a growing containerized cargo business that establishes Port Everglades among the nation's top seaports; a major petroleum storage and distribution hub; South Florida's primary bulk cargo depot; and a favorite U.S. Navy liberty port.

Construction for Port Everglades was initiated in 1925, and the Port was officially established as a deepwater harbor in 1927 by the state legislature and dedicated in 1928. Although the federal project (waterways within the port constructed and maintained by the federal government) was completed in 1984, the most recent modifications to the Port were carried out between 1984 and 1991. Modifications during that period included deepening and widening of the Southport Access Channel, construction of a bulkhead, and creation of the Turning Notch (USACE 1990). The Dania Cutoff Canal, which flows into the Southport Access Channel, serves local drainage needs and lends access to Port Denison from the Intracoastal Waterway. In 1985-1986, the Port dredged that canal to –16' MLW +1 overdredge.

In May 1996, the Port Everglades Feasibility Study was authorized by a U.S. House of Representatives resolution. Congress added funding in the appropriations for fiscal year (FY) 1997 to begin the Feasibility Study, which investigates alternatives for the expansion and deepening of the Port and associated channels. The U.S. Army Corps of Engineers ("Corps") and Broward County, the local sponsor, entered into a cost sharing agreement on April 17, 1997. On June 29, 1999 the Port requested that the Corps re-scope the Feasibility Study in order to address future calls of larger container vessels than original plans forecasted. In addition, the Port recognized that larger (i.e., wider beam) cruise vessels at berth would impact transiting of larger container vessels to Southport. Therefore, the Port suggested that the Corps not only take into account the Southport Access Channel (SAC), but also the entire waterway system within the Port. The Study Agreement was amended April 4, 2000, February 2, 2001, March 25, 2002, and May 19, 2003, June 5, 2005, and January 10, 2006 (one additional is pending). Preliminary plans for construction of elements developed through the Study involve impacts to approximately 25 acres of previously- and not-previously-impacted reef and hardground habitats (see Section 3 for details). Further details regarding the project will be available in the *Draft Environmental Impact Statement, Navigation Improvements, Port Everglades Harbor*.

The purpose of the Port Everglades Reef Group (PERG) was to provide guidance and expert advice on the most scientifically, technically, and logistically sound methods to provide mitigation for impacts to reefs and hardgrounds due to proposed navigation improvements at Port Everglades. Consultants contracted by the Jacksonville District of the Corps coordinated PERG. Details regarding the framework in which PERG operated are found in the following section, and its findings are presented in Sections 7 and 8, following several sections describing the project setting and affected natural resources, anticipated project impacts, preliminary mitigation plans, and mitigation requirements of regulatory and natural resource agencies.

2.0 PORT EVERGLADES REEF GROUP

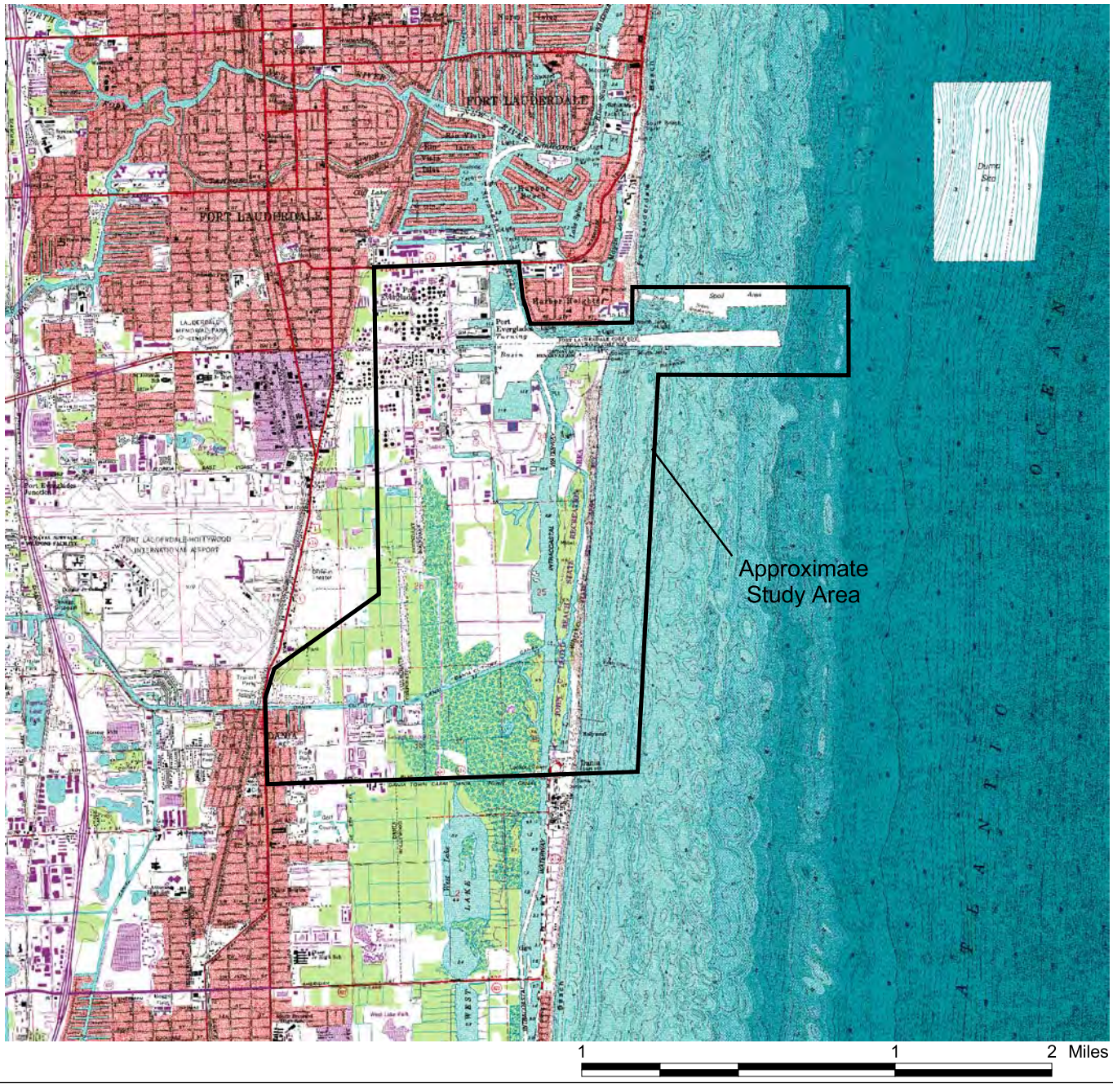
The Port Everglades Reef Group (PERG) was formed under direction of the Jacksonville District of the Corps to solicit guidance and expert advice on the most scientifically, technically, and logistically sound methods to adequately provide mitigation for impacts to reefs and hardgrounds due to navigation improvements at Port Everglades. PERG was tasked with this objective in absence of a known budget and without knowledge of the timeline under which impacts and mitigation were to take place. Furthermore, members were provided the results of the preliminary Habitat Equivalency Analysis (HEA) assigning an approximate amount, or acreage, of reef creation that might be necessary as compensation for impacts. PERG was informed that funds for mitigation construction and related measures would be included in the federal budget along with costs for navigation improvements. In general, PERG members necessarily discussed mitigation measures within only a conceptual framework. For example, PERG members were presented with questions such as "if reef construction were to be carried out, what materials should be used, and where and how should materials be placed?" or "what other types of mitigation should be investigated that would provide ecological benefits similar to those provided by artificial reefs?" or "what ecological and biological considerations must the Corps be aware of when carrying out mitigation?"

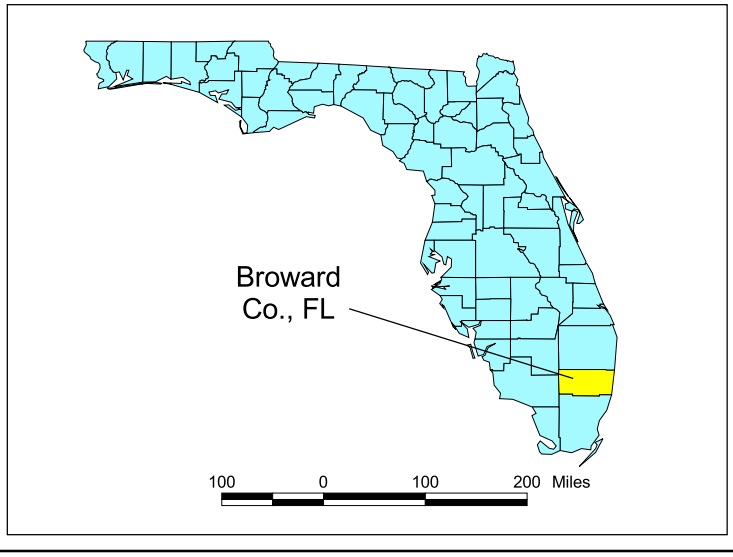
PERG conducted four meetings at the Port Everglades administration building between May 2002 and April 2003 in Fort Lauderdale, one of which was in conjunction with a field visit to impact and potential mitigation sites. The membership comprised scientists, resource coordinators/managers, and regulatory staff representing a variety of agencies/institutions. Participant names, affiliations, and contact information are listed in Appendix A. Other individuals were invited to be part of the group, but declined. Notes from meetings are included in Appendix B. Those notes comprise paraphrased statements, indicating some of the issues that were discussed at the meeting. They are not, nor were they intended to be, direct or complete transcripts. During meetings and subsequent communications, mitigation options, methods, and techniques were recommended based on conceptual mitigation options. In some cases, needs for additional information that would be critical in the formulation of a comprehensive mitigation program were identified, and additional sources of information were indicated.

3.0 PROJECT SETTING

3.1 Environment

Port Everglades Harbor is the waterway servicing the seaport, which is situated on the southeastern coast of the Florida peninsula within the three cities of Fort Lauderdale, Hollywood, and Dania Beach, as well as unincorporated Broward County (Figure 1). It is approximately 23 miles north of Miami, 48 miles south of West Palm Beach, and 312 miles south of Jacksonville. Port Everglades' jurisdiction encompasses a total of 2,190 acres (887 hectares), which includes 1,742 acres of upland and 448 acres of submerged land.





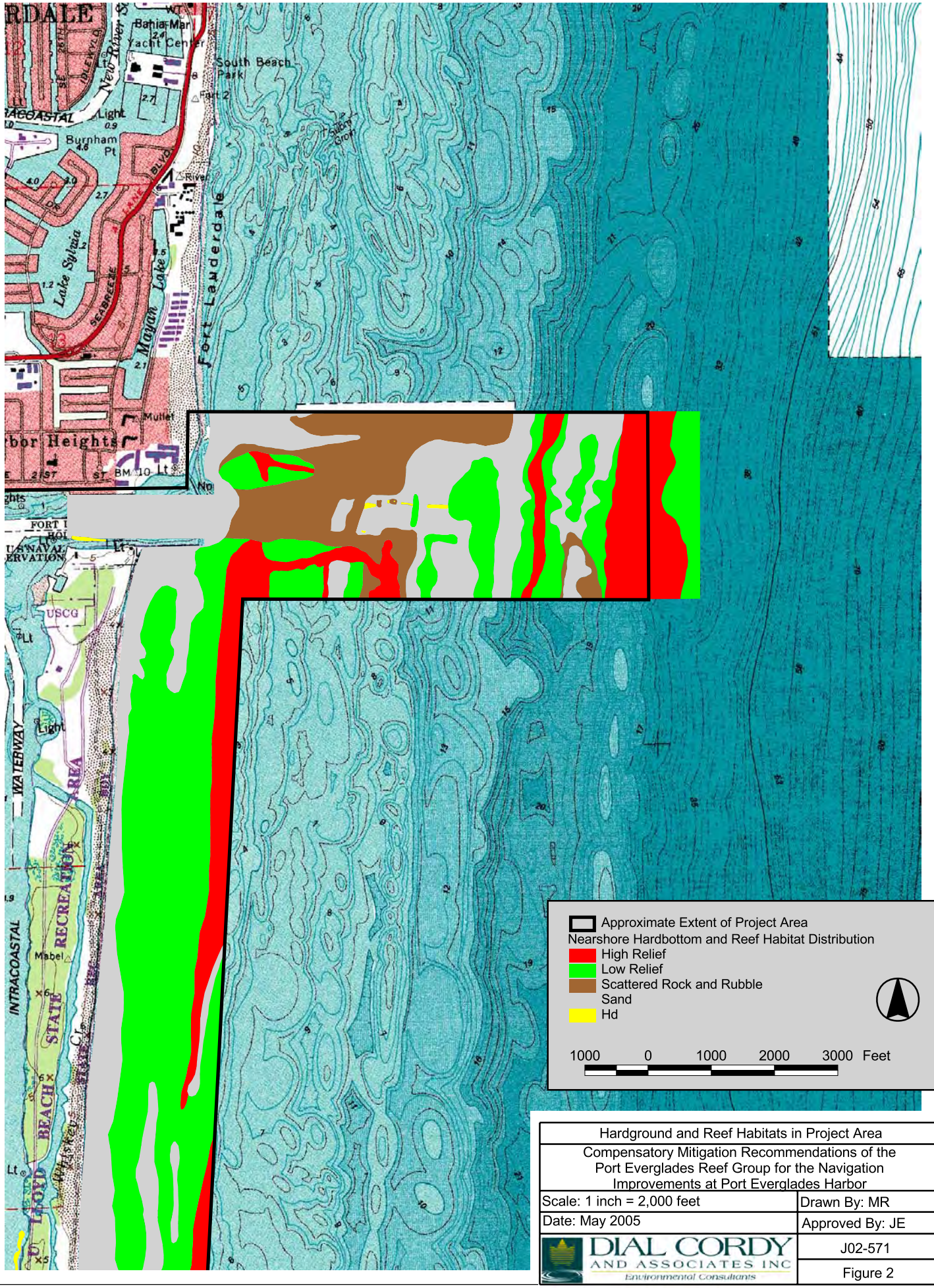
Project Location	
Compensatory Mitigation Recommendations of the Port Everglades Reef Group for the Navigation Improvements at Port Everglades Harbor	
Scale: 1 inch = 1 mile	Drawn By: MR
Date: May 20 5	Approved By: E
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	02- 1
	Figure 1

3.2 Hardground and Reef Resources

The most prevalent hardground and reef zones within and adjacent to the project area fall within four areas: a nearshore hardbottom zone and three offshore reef tracts (see Figure 2). The nearshore hardbottom communities typically occur in 0 to 10 feet of water and exist in a physically stressed environment (high turbidity and sedimentation, wave action, etc.). Although sections of the zone may be covered with broken shell and sand, wave action frequently exposes the hard substrate. Some nearshore hardbottom areas east of John U. Lloyd State Recreation Area (JULSRA) have been characterized by permanent belt transects. Depending on distance from shore, these relict shoreline deposits may support communities dominated by algae and sponges with interspersed gorgonians and hard corals.

Seaward of the nearshore, hardbottom area there are three separate parallel reef tracts. The first reef occurs from approximately 100 to 2,000 feet from shore; the second reef is 3,000 to 6,000 feet offshore; and the third reef is approximately 8,000 feet or more offshore (USACE 1996). There is an extensive sand area located between the second and third reef lines (USACE 1996). The area between the first and second reef lines is characterized by small isolated hardbottom patches and interspersed coral rubble interrupting areas of open sand. These reefs, particularly south of the Outer Entrance Channel (OEC), may be subject to pulses of decreased water quality (e.g., suspended sediments, turbidity, pollution, lowered salinity) due to urban and agricultural runoff that exits via the channel. These reefs are lower profile than the outermost reef and less biologically diverse. The outermost reef, in general, has a higher percent cover of coral, greater diversity, and greater coral biomass than other reef areas.

Limestone rock and rubble remaining from previous dredging events (1984-1991) provide hardgrounds with variable-depth profiles in the 42-foot deep Outer Entrance Channel. Since the previous dredging event, gorgonians, corals and sponges have colonized these substrates. These low- and high-relief reef areas are found among softbottom habitats, rock/rubble habitats, and patchy *Halophila decipiens* beds. In general, these rock-reefs are not as biologically diverse as reefs that have not been subjected to dredging outside the channel zone (DC&A 2001). However, where the channel-bed rock-reefs and channel walls lie adjacent to undredged offshore reef lines, biodiversity and colony density increase. Channel-wall habitats have less coral coverage than channel-bed habitats, but provide significant refugia for reef-associated fishes. Even channel wall habitats not associated with reef lines are significant resources. These may be considered “vertical hardgrounds.” Seaward from the confluence of the Inner Entrance Channel with the Intracoastal Waterway, biotic cover of channel bed and wall substrates increase, and undergo a progression from scattered algae and sponges to a mixture of live-bottom species including gorgonians and typical encrusting marine fauna (DC&A 2001). Extensive biotic cover of channel-wall substrates occurs from the jetty to the end of the Outer Entrance Channel. This pattern is more pronounced on the north side, as fish species richness and population density increase.



Hardground and Reef Habitats in Project Area	
Compensatory Mitigation Recommendations of the Port Everglades Reef Group for the Navigation Improvements at Port Everglades Harbor	
Scale: 1 inch = 2,000 feet	Drawn By: MR
Date: May 2005	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J02-571
	Figure 2

3.3 Biological Communities

Live hardbottom and reef communities of Florida's southeast coast have been characterized (Dodge et al. 1991; and others) and are considerably speciose. Species composition of the nearshore hardground and the three offshore reef tracts is related to depth, distance to shore, exposure to waves and currents, light penetration, and disturbance/dredging regime.

Nearshore Hardbottom. The nearshore hardbottom habitat is very dynamic and populations of associated species are able to quickly recover from the stresses imposed by the environmental conditions. Dominant algae associated with these communities include *Caulerpa* sp., *Jania* sp., *Laurencia* sp., *Dictyota* sp., and *Halimeda* sp. (Dodge et al. 1991; Vare 1991). Also associated with the nearshore hardbottom are the algal-mat species Cladophora, *Chaetomorpha*, and *Gelidiopsis* (USACE 2000). The rock outcrops in this area tend to be covered with sponges of the genera *Ircinia* sp., *Niphates* sp., *Cliona* sp., and *Iotrochota* sp. Interspersed among these sponges are colonial anemones (*Zoanthus* sp.), and hydrocorals (*Millepora alcicornis*). This habitat often provides suitable habitat for a variety of other invertebrate species (USACE 2000).

Nearshore hardbottom fish assemblages are characterized by diverse, tropical faunas that are dominated by early life stages. Over 190 species within 62 families have been recorded in association with nearshore hardbottom habitats of mainland southeast Florida. At least 90 species are utilized in recreational, commercial, bait, or aquaria fisheries. Additional ecologically important species that utilize the nearshore hardbottom reefs at some point during their lifecycle include jacks, Florida pompano, tarpon, grunts, and drums. Lindeman and Snyder (1999) concluded that at least 35 species utilize nearshore hardbottom as a primary or secondary nursery area. At least ten of these species are managed under the South Atlantic Fisheries Management Council *Snapper/Grouper Fishery Management Plan*. Detailed information on the snapper/grouper complex (containing ten families and 73 species) and other federally managed fisheries and their Essential Fish Habitat (EFH) is provided in the 1998 amendment of the Fishery Management Plans for the South Atlantic region prepared by the South Atlantic Fisheries Management Council (SAFMC). The 1998 generic amendment was prepared in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (P.L. 104-297).

Hardgrounds Within Channel Zone. This area of low-relief hardbottom is rock exposed from prior dredging events and supports many quickly colonizing species such as sponges (e.g. *Ircinia* sp., *Niphates* sp., *Cliona* sp., and *Iotrochota* sp.) and gorgonians (e.g. *Eunicea* sp., *Plexaura* sp. and *Pseudopterogorgia* sp). Species diversity and colony densities are lower within the channel than they are in reefs adjacent to the channel that have not been dredged. Channel walls, like the channel bed, that were created as the entrance channel was dredged, now provide substantial habitats for many species, particularly fishes (see below).

Adjacent Reefs/Hardgrounds. The three distinct reef tracts offshore of Broward County are consistent with the overall assemblage of stony corals, sponges, and gorgonians found throughout Dade, Broward, and Palm Beach Counties (USACE 2000). The most dominant feature of the reef communities near Port Everglades is the high density of gorgonians. These gorgonian corals are primarily of the genus *Eunicea* sp., *Plexaura* sp., and *Pseudopterogorgia* sp. Hard coral species also make up a significant part of the reef assemblages in this area and include *Porites asteroides, Diploria clivosa, Siderastrea siderea,* and *Montastrea cavernosa* (Dodge et al. 1991; Vare 1991; M. Johnson, pers com). The most diverse of the adjacent reefs is the outermost reef tract. Also, that reef has the highest density of colonies.

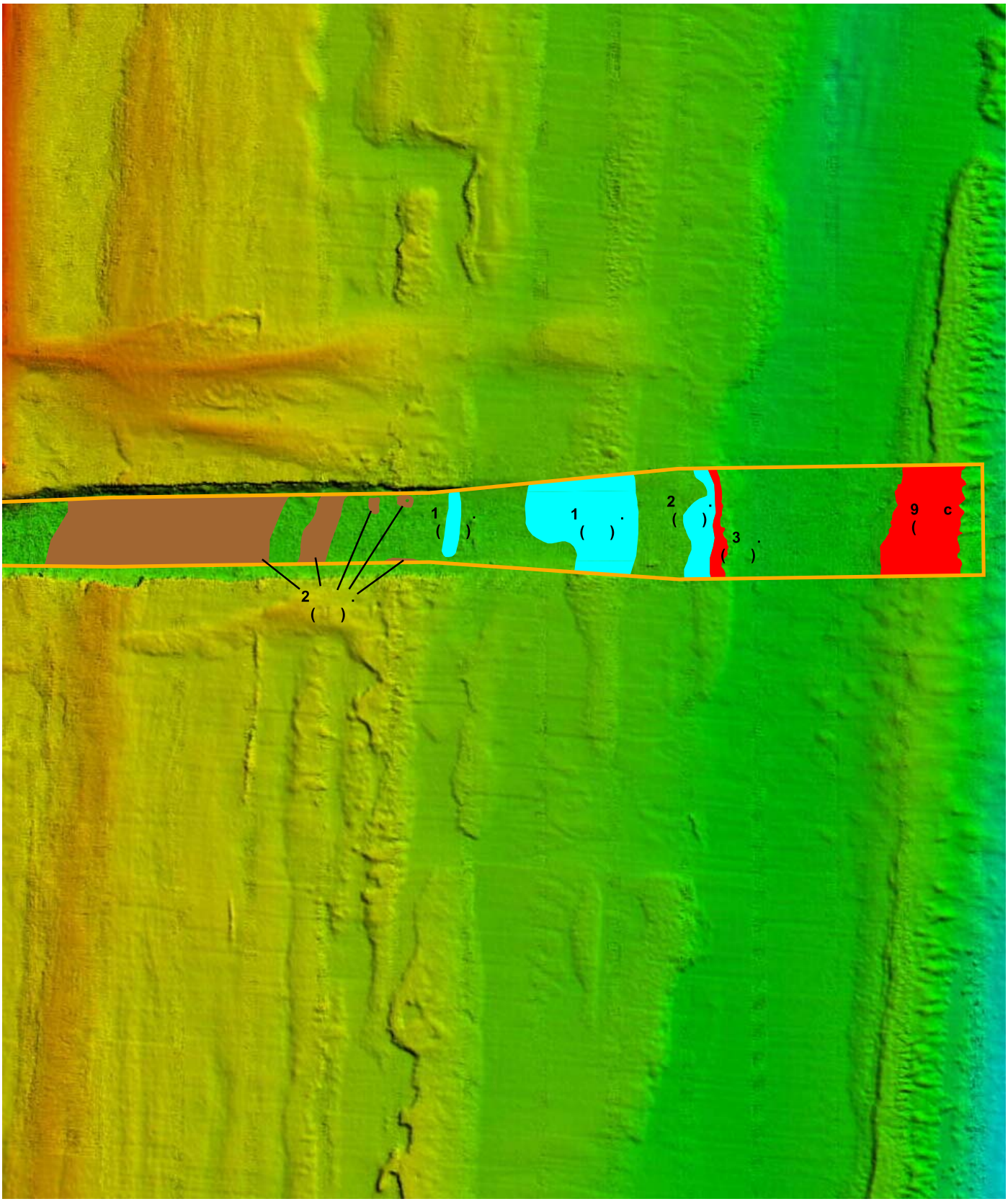
4.0 SUMMARY OF PROPOSED IMPACTS

4.1 Direct Impacts Inside the Existing Channel

Direct impacts to hardbottom and reef communities will occur as a result of proposed dredging to deepen and widen the Outer Entrance Channel (Figure 3). There will be 9.14 acres of impact to low-relief hardgrounds within the existing channel. Sessile invertebrates and hard substrates, such as boulders, outcrops, limerock shelves, and exposed hardbottom form the backbone of a diverse, and economically and ecologically important ecosystem. Impacts to habitats within the existing channel are significant even though they are not as speciose as habitats outside the existing channel. Although these live-bottom habitats have been dredged in the past, their value to fish and wildlife is considerable. Assemblages of sessile organisms in previously dredged areas may recover and reach the functional value of hardground habitats currently found in the channel in approximately 10-15 years.

4.2 Direct Impacts Outside the Existing Channel

Approximately 16.57 acres of previously undredged reef habitat will be impacted by widening and extending the Outer Entrance Channel (Figure 3). New impacts outside the existing channel will include dredging 5.75 acres of low-relief reef and 10.82 acres of high-relief reef. The coral reef forming the outermost tract is one of the most important coral reef resources in southeast Florida. Its distance from shore and the harbor possibly results in less disturbance and subsequently improved ecological condition in comparison to the other two reef tracts. Impact to the reef habitat at the end of the OEC would result in direct removal of many corals and gorgonians. These organisms dominate the community and are important for many fish and other invertebrate species. Impacts to this reef habitat will decrease the offshore ecosystem's carrying capacity for many reef-dependent invertebrate and vertebrate species, including managed species. Therefore, loss of coral reef habitat will likely result in changes at the population level for many species, and possibly an overall change in fish community structure in the immediate vicinity, due to alterations in physical habitat characteristics. Individual coral colonies, which may have taken hundreds of years to form, will be lost unless relocated.



Port Everglades LPP Project Footprint
Outer Entrance Channel (OEC)
Outer Entrance Channel pacts
High Relief
Low Relief
Scattered Rock and Rubble

1000 0 1000 2000 Feet

Projected Hardground and Reef pacts	
Compensatory itigation Recom endations of the Port Everglades Reef roup for the avigation Improvements at Port Everglades Harbor	
Scale: 1 inch 1,000 feet	rawn R
Date: ay 2005	Approved E
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J02-571
	Figure 3

4.3 Indirect Impacts

Indirect impacts of dredging hardbottom and reef habitat may include temporary changes in adjacent habitats. In particular, reef and hardbottom habitats just outside the new entrance channel may be affected. Potential indirect impacts may include the re-suspension and deposition of sediments on nearby coral reef assemblages. This re-suspension of sediments may also result in periods of increased turbidity within the area. The effects of this turbidity may include a temporary reduction of photosynthetic activity on the reef, as well as sublethal effects to coral colonies. Although biological indicators of coral stress may be evidenced for a short period of time, other effects, such as bleaching, excessive mucous production, tissue swelling, pathology, and adverse effects on reproduction resulting from shock may have long-term consequences. In addition, the period of physiological stress to corals can exceed that of the environmental disturbance. Other indirect effects include the displacement of fishes and invertebrates during dredge operations. These effects may be short-term.

5.0 MITIGATION GUIDELINES AND POLICIES

5.1 U.S. Army Corps of Engineers

Damage to fish and wildlife resources must be prevented to the extent practicable through thorough planning and prudent design that incorporate the mitigation principles defined within the Council on Environmental Quality's (CEQ) NEPA guidelines. Impact avoidance is of primary importance, followed by impact minimization, and, finally, compensation for unavoidable damages to significant fish and wildlife resources. The U.S. Army Corps of Engineer's Regulatory Guidance Letter 02-2 reinforces that compensatory mitigation is the last step in the sequencing requirements of the Clean Water Act §404(b)(1) guidelines. Measures to offset unavoidable damages to significant fish and wildlife resources will be included in projects when the cost of these measures are justified by the combined monetary and non-monetary benefits attributable to the proposed measures. These mitigation plans are to contain the most efficient and least costly measures appropriate to compensate for fish and wildlife resource losses. Mitigation of losses will be provided to the maximum extent practicable through the development and implementation of mitigation measures on-site. If on-site areas cannot support mitigation requirements, then separable public lands (or waters) adjacent to the project, to the extent possible, are given consideration. Acquisition of an interest in any lands or waters for mitigation of damages to fish and wildlife resources that do not comply with the limited authority provided by Subsection 906(b) of WRDA 1986 requires specific congressional authorization (See paragraph 19-8a(2)). Measures to mitigate project-caused damages to significant fish and wildlife resources are "project costs" and will be allocated to the responsible (causative) purposes of the project in the same way as other project costs. Mitigation costs will also be shared to the same extent as the other costs allocated to such purposes are shared. The mitigation costs include separable first costs (any lands and construction) and separable operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs (USACE 1999).

5.2 U.S. Fish and Wildlife Service

In developing the U.S. Fish and Wildlife Service (USFWS) Mitigation Policy (*Federal Register* 46 (15), Pg. 7656), the definition of mitigation contained in the Council on Environmental Quality's National Environmental Policy Act regulations (40 CFR 1508.20[a-e]) was used. As such, mitigation can include:

1. avoiding the impact all together by not taking a certain action or parts of an action;
2. minimizing impacts by limiting the degree of magnitude of the action and its implementation;
3. rectifying the impacts by repairing, rehabilitating, or restoring the affected environment;
4. reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
5. compensating for the impact by replacing or providing substitute resources or environments.

This definition recognizes mitigation as a step-wise process that incorporates both careful project planning and compensation for unavoidable losses and represents the desirable sequence of steps in the mitigation planning process. Initially, project planning should attempt to ensure that adverse effects to fish and wildlife resources are avoided or minimized as much as possible. In many cases, however, the prospect of unavoidable adverse effects will remain in spite of the best planning efforts. In those instances, compensation for unavoidable adverse effects is the last step to be considered and should be used only after the other steps have been exhausted.

The Service's Mitigation Policy focuses on the mitigation of fish and wildlife habitat values, and it recognizes that not all habitats are equal. Thus, four resource categories, denoting habitat type of varying importance from a fish and wildlife resource perspective, are used to ensure that the mitigation planning goal will be consistent with the importance of the fish and wildlife resources involved. These categories are based on the habitat's value for the fish and wildlife species in the project area (evaluation species) and the habitat's scarcity on a national, regional, or local basis. Resource Category l is of the highest value and Resource Category 4, the lowest. Mitigation goals are established for habitats in each resource category.

The mitigation goal for Resource Category 1 habitats is no loss of habitat value since these unique areas cannot be replaced. The goal for Resource Category 2 habitats is no net loss of in-kind habitat value. Thus, a habitat in this category can be replaced only by the same type of habitat (i.e., in-kind mitigation). The mitigation goal for Resource Category 3 habitats is no net loss of overall habitat value. In-kind replacement of these habitats is preferred, but limited substitution of different types of habitat (out-of-kind mitigation) perceived to be of equal or greater value to replace the lost habitat value may be acceptable. The mitigation goal for Resource Category 4 habitats (considered being of marginal value) is to minimize loss of habitat value (section supplied by B. Rieck, USFWS).

5.3 National Marine Fisheries Service

As described in the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), the Essential Fish Habitat (EFH) provisions of the act support the objective of maintaining sustainable fisheries. Mitigation would be required for impacts to seagrass, reef/hardbottom habitats**,** and mangroves. NOAA Fisheries does not have an official mitigation policy and, therefore, evaluates projects and the associated sequential mitigation requirements on a case-by-case basis. Mitigation may not be required for dredging softbottom habitats lacking seagrasses.

The focus of the sequential mitigation policy is to conserve and enhance EFH and to avoid, minimize, and compensate for impacts to EFH due to development activities. Like other federal agencies with regulatory responsibilities, the first priority of the National Marine Fisheries Service (NMFS) is natural resource impact avoidance when presented with any proposed project. When unavoidable impacts to EFH are proposed, NMFS will recommend measures to minimize unavoidable impacts. Finally, NOAA Fisheries may recommend mitigative measures to compensate for any loss of resource value, including loss of functional value from indirect impacts or temporal loss of habitat availability. Recommendations may include restoration of riparian and shallow coastal areas (i.e., reestablishment of vegetation, restoration of hardbottom characteristics, removal of unsuitable material, and replacement of suitable substrate), upland habitat restoration**,** water quality improvement or protection, watershed planning, and habitat creation. Compensatory mitigation may be provided in the form of enhancement of existing habitat, habitat restoration, and/or creation of new habitat.

5.4 The State of Florida

The Florida Department of Environmental Protection (DEP) and the Florida Fish and Wildlife Conservation Commission (FWC) share responsibility for preserving and protecting reef and hardground habitat in state waters. Reef and hardground mitigation serves the stated strategic goal for the Marine and Estuarine Conservation component of the Marine Resources Program of DEP, which is to "preserve, enhance, and restore the desired natural functions of Florida's marine and estuarine ecosystems and the diversity fish and wildlife populations." (*People, Progress, and the Environment, Agency Strategic Plan for FY 1998-2003*, V. Wetherell, DEP. 94 pp.). Indicators of progress include the "restoration of critical marine and estuarine habitats," and an "increase in abundance of priority marine and estuarine plant and animal species …" To determine adequate mitigation for impacts within surface waters and wetlands in the State of Florida, the Uniform Mitigation Assessment Method (UMAM) has been implemented (F.S. 62-345). UMAM is used to estimate and compare ecological function in impact areas and mitigation areas. To-date, no UMAM has been performed in reef impact areas or respective mitigation areas.

With guidance from the United States Coral Reef Task Force, the Florida Department of Environmental Protection, and the Florida Fish and Wildlife Conservation Commission have coordinated formation of an interagency Southeast Florida Action Strategy Team (SEFAST) for coral reef conservation and management. This team has completed a Local Action Plan in December 2004 to improve coordination of technical and financial support for the conservation

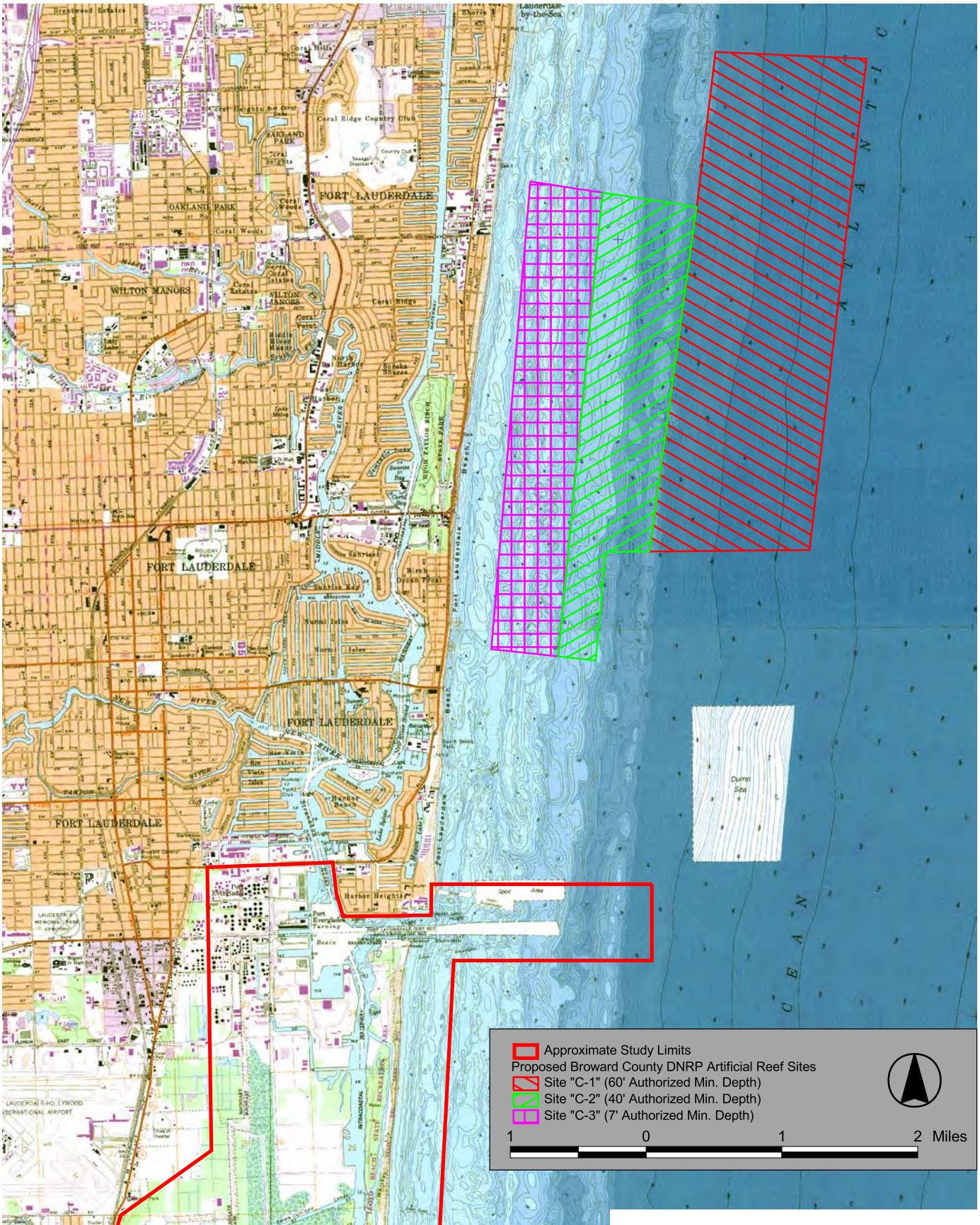
and management of the coral reefs from the southern Miami-Dade County line to Hobe Sound (Martin County). A copy is available on-line at www.dep.state.fl.us/coastal/programs/coral/.

5.5 Broward County

The mission of the Biological Resource Division of the Broward County Environmental Protection Department (EPD) is to protect, restore, and enhance the biological productivity, abundance, and diversity of marine, estuarine, freshwater, and terrestrial resources. This is accomplished through dredge and fill regulation, mitigation, a tree preservation ordinance, beach restoration, coral and artificial reef management, and beach erosion studies. The Marine Resources Section of EPD, in executing its charge to protect, restore, and enhance the County's marine resources, is committed to the highest standards of technical and scientific integrity and to conducting its activities in the safest and most efficient manner possible. The Section's duties are project-oriented, rather than regulatory, and can be divided into two general subject areas: coastal engineering/beach erosion control, and marine biological projects/studies.

6.0 PRELIMINARY CORPS-PROPOSED MITIGATION PLAN

The Corps and local sponsor intend to compensate ecological functions lost due to direct impacts to reef and hardbottom habitats from construction of the proposed project (see DC&A 2004b). Direct impacts would be mitigated for by the creation of artificial reef habitat at a 2:1 ratio (mitigation acres: impact acres) for high-relief reef habitat, 1.3:1 ratio for low-relief reef habitat. Mitigation values were determined using HEA, which take into account recovery times of mitigation and impacted areas as well as the acreage of direct impacts. Mitigation reefs would be constructed in two different designs and to reflect the differences in the habitat structure of the two types of reef/hardbottom habitat to be impacted. A total of 7.54 acres of Low Complexity-Low Relief (LCLR) hardgrounds would be created to mitigate for impacts to not-previously-dredged, low-relief hardgrounds and previously impacted (i.e., existing channel-bottom) hardbottom habitat. A total of 21.33 acres of High Complexity-High Relief (HCHR) reef would be created to mitigate for the high-relief impact. The proposed locations for mitigation reefs are previously permitted, Broward County artificial reef sites (Figure 4). HRHC relief will range in profile from 3 to 6 feet, whereas LRLC will range from 1 to 2 feet. Limestone rock excavated from the Outer Entrance Channel, Inner Entrance Channel, Main Turning Basin, and South Turning Basin, and, if necessary, supplemental, quarried limestone will be used in reef construction. 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 and for temporal impacts to hardbottom habitat previously impacted by channel dredging (DC&A 2004b).



Mitigation Area Proposed by Corps	
Compensatory Mitigation Recommendations of the Port Everglades Reef Group for the Navigation Improvements at Port Everglades Harbor	
Scale: 1 inch = 1 mile	Drawn By: MR
Date: May 2005	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J02-571
	Figure 4

Artificial reefs constructed for mitigation must be monitored to ensure viability and adequate compensatory value. The monitoring program for the mitigation reefs will consist of both physical and biological components. Physical monitoring will assess the degree of settling of the reef materials, and biological monitoring will assess populations of algae, invertebrates, and fishes, as compared with concurrent control sampling of natural reefs. Monitoring will be conducted annually in the summer months. In order to supplement quantitative monitoring efforts and provide a permanent record of reef conditions and biota, each sampling effort will include a video transect swim covering the entire area of the mitigation reefs.

The degree of settling and/or sand covering will be assessed by measuring the relief at each of the permanent quadrat stations established as outlined below. Measurements will be taken with a weighted flexible tape from a point one meter shoreward of the quadrat benchmark to the surface of the water and from the top of the reef structure at the benchmark to the surface of the water, with the difference being the relief. The mean of five such measurements will be used to assess the degree of settling and/or sand covering of the materials. Changes in relief at the control reef quadrat benchmarks will be assessed by the same method.

Five randomly selected locations on each type of mitigation reef will be used as photoquadrat stations to assess sessile invertebrate and algae abundance. Randomly selected stations on high- and low-relief natural hardbottom reefs will also be established to serve as controls. Locations for ½-square-meter photoquadrats will be marked using steel pins and DGPS. Invertebrate and algal abundance will be evaluated from digital photography of each quadrat. Species will be identified to the lowest practical taxon and ranked in order of abundance. Superimposing a grid over the digital image and counting bare and colonized grid squares will assess overall percent cover (Bohnsack 1979). Criteria for success of the mitigation reef will be based upon a comparison of a total percent cover of algae and invertebrates at the new reefs and at control reefs of corresponding relief type. The criteria for success of the mitigation reefs in establishing a similar community structure will be a finding of no significant difference in the rank abundance orders of species between mitigation and control reefs of each type. Statistical comparisons between mitigation and control reefs will be made using the Wilcoxon Rank-Sum (Zar 1984) or similar nonparametric test at p=0.05.

Fish population evaluations will be based on visual censuses conducted separately on HRHC and LRLC mitigation reefs and high and low relief control reefs. The point-count method (Bohnsack and Bannerot, 1986) will be used for fish assessment. This method has the advantage of gathering quantitative data in a relatively short time in a very repeatable pattern that is relatively insensitive to differences in habitat structure. Each census will have a duration of five minutes and a radius (the distance from the stationary observer) of 10 feet. Ten censuses will be collected on each of the four reef types. Data from these types of censuses is rarely normally distributed, so the Wilcoxon Rank-Sum or a similar nonparametric test will be used for significance testing. The criteria for mitigation reef success will be a finding of no significant difference at p=0.05 between reef type pairs (HRHC vs. high relief control and LRLC vs. low relief control).

Results of all mitigation-reef monitoring efforts will be summarized in an annual report to be completed by December 31 of each year the monitoring program is in place. Copies of the report will be distributed to all concerned agencies and interested parties.

7.0 FINDINGS OF PERG

7.1 Compensatory Mitigation Objectives

Discussions during PERG meetings focused on reviewing common mitigation practices and procedures, critiquing past mitigation efforts, and investigating several novel or unconventional mitigation measures that could be carried out while fulfilling the mitigation guidelines of federal, state, and local regulatory agencies. Because mitigation guidelines of various agencies are not identical, and due to the differing focal issues and interests for each agency, it was necessary first to determine how agencies interpreted mitigation guidelines and whether those guidelines allow for any flexibility to consider alternative mitigation measures and compensatory values.

Compensatory mitigation is usually an option only after impacts have been avoided and minimized to the maximum extent practicable. When mitigation becomes necessary, restoration and enhancement of habitats is generally preferred by regulatory agencies to new habitat creation. This may be because regulatory agencies have found that functional benefits of mitigation sites involving restoration or enhancement are usually reached more quickly, and with less risk of failure, than with sites involving new habitat creation.

When restoration and enhancement options are not available, compensation for lost ecosystem functions must be provided in other ways. The most common method of meeting this objective is through habitat creation. Agencies espouse the "like-for-like" mitigation paradigm, i.e., that compensatory mitigation must provide habitat like that which is impacted during a given action. Although like-for-like (LFL), or "in-kind," mitigation seems like a simple concept, is can be difficult to apply in a complex, 3-dimensional, marine environment. For example, where it may be feasible to provide one physical characteristic that is "like" the impacted resource, it may not be possible to provide another. Hence, no habitat replacement can be *exactly* LFL because the compensatory mitigation will take place in at least a slightly different location than where the impact occurs. By virtue of that fact alone, especially in a marine environment, compensation will provide slightly different services to the ecosystem and resident flora and fauna. One should note that there might be several ways to define LFL habitat as well, such as same depth, same distance to shore, same distance to cross or Gulf currents, same wave action, or same substrate. LFL could incorporate all of these, some of these, as many of these as possible, or a select number of these that achieve some ultimate goal. In summary, it seems that the definition and goals of LFL mitigation should be adaptive, compensating the ecosystem for lost ecological services, but retaining as many of the characteristics of the impacted system as possible.

The definition of LFL was discussed, and, in particular, whether the policy objective was in-kind *habitat* creation, or in-kind *species assemblage* creation. Which one of these is the focus could determine how mitigation is carried out. For example, as noted above, variables such as water depth and exposure to Gulf currents must be taken into consideration if an in-kind species assemblage, rather than habitat, is the ultimate objective. In essence, the goals of LFL compensatory mitigation for habitat may not necessarily result in LFL community or population replacement. During PERG discussions, a faculty member from Nova Southeastern University (NSU) asked, assuming that in-kind habitat replacement was the objective, whether LFL could be

met by providing "like" depth, substrate, or assemblage. USFWS staff responded that depth was usually the operative parameter.

The practicality of repeated application of the LFL paradigm was addressed by PERG. It was noted that simply creating artificial reef after artificial reef for all coastal projects would result in an excess of reefs that may be either depth- or structurally appropriate for mitigation purposes, but would not necessarily provide many of the important ecological services provided by reefs that have been impacted.

7.2 Additional Baseline Studies and Success Criteria

For any type of compensatory mitigation, success is measured by determining how well mitigation measures replace ecosystem functions lost via impacts due to a given action (for which the mitigation is provided). Therefore, success criteria are defined as a specific set of ecological objectives, or functions that the mitigation must provide, and specific levels of performance for each objective/function. Before determining how well mitigation measures function and what the mitigation objectives are, a detailed assessment of the functions provided by the habitats that will be impacted should be carried out.

At a minimum, a *qualitative* assessment of likely impacts should be conducted at each impact site. Dial Cordy and Associates Inc. (DC&A) has conducted such investigations for the proposed navigation improvements at Port Everglades. However, PERG members stressed the importance of *quantitative* data that would be used to establish more precise levels of performance for mitigation success criteria.

Various methods/sources could be used to gain comprehensive information about impact sites. Information from additional underwater video transects or reconnaissance dives using SCUBA would provide a more fine-scale assessment of impact areas than that which currently exists, and would be useful to aid in planning the placement of transects and quadrats that would be used for quantitative studies. Investigations should focus on collection of data for fishes and invertebrates, including both corals and motile organisms. Of particular interest are stocks of managed species utilizing essential fish habitats (EFHs), such as snapper and grouper taxa, since specific guidelines for impacts to EFH must be observed. Fish data can be used to determine baseline conditions (functionality) among impact sites, which may provide guidance in designing mitigation sites.

In addition to obtaining data on impact sites, obtaining baseline information at each of the proposed mitigation sites is necessary to gauge the success of mitigation, particularly where habitat restoration or enhancement is planned. Data from the planned impact and mitigation sites should be compared to other known data sets to determine whether they resemble those from the wider reef ecosystem, and to detect changes in the overall reef system once impacts and mitigation occur (e.g., do mitigation sites act as "attractors? "). NSU faculty indicated that they have a great deal of fishery data (collected at ¼-mile intervals along the coast) available for such use.

Prior to relocation of hard or soft corals, assessments should be carried out. They should comprise *in situ* data collection to quantify the number, size, and species of corals (and other relevant fauna) within the impact zone. Such data will allow a more detailed understanding of the feasibility of relocation of numbers and sizes of colonies. Donor and recipient sites for coral translocation must be identified also, and these must also be assessed for suitability and current environmental characteristics prior to carrying out mitigation activities.

7.3 Reef Enhancement

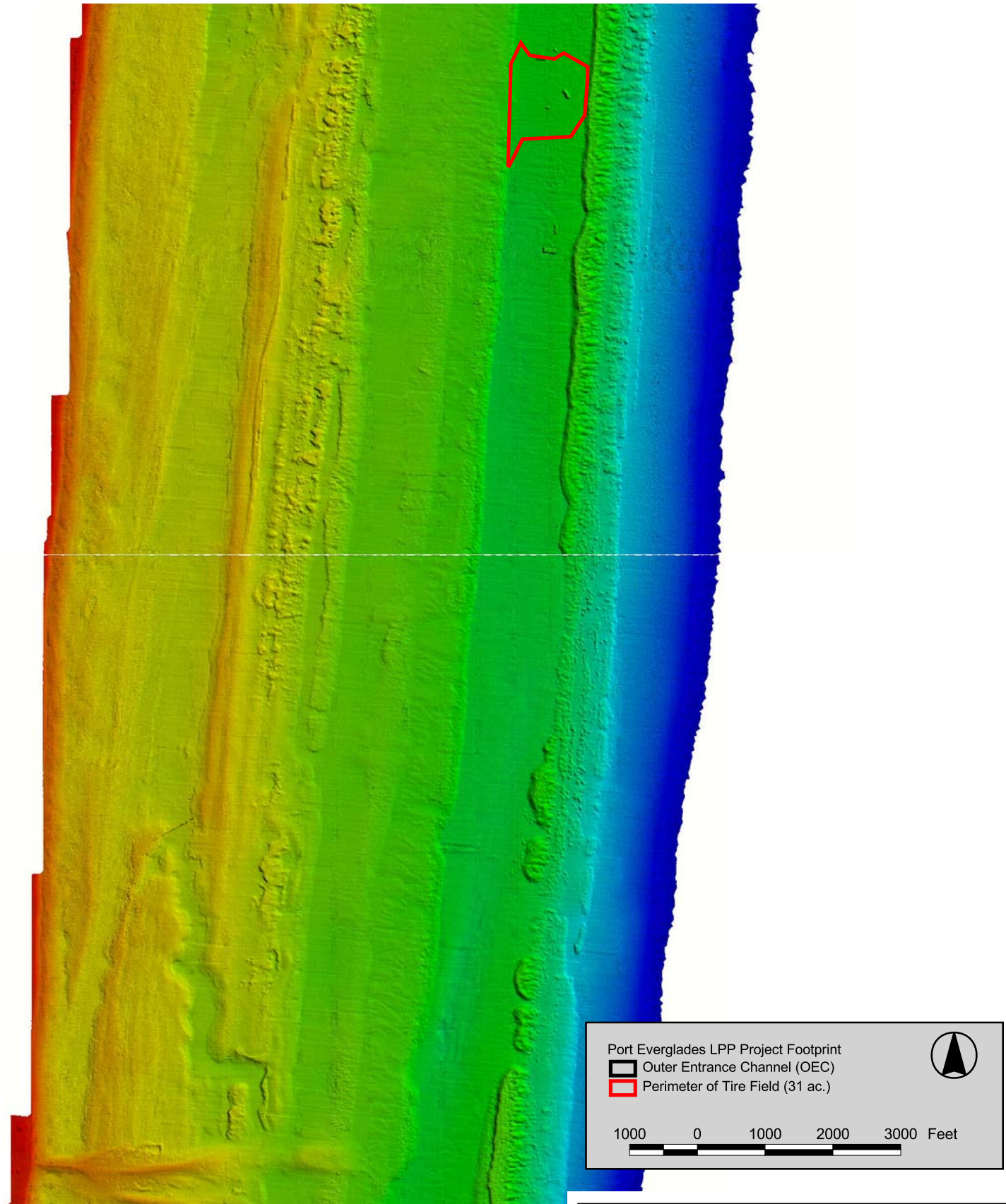
Based on LADS (Laser Aerial Depth Sounding), there appears to be an area of extreme low profile substrates in the third reef line south of the proposed channel. The area appears to have been previously impacted, and therefore is a candidate site for reef enhancement or restoration ("restoration" if further investigations determine the area was previously impacted). Enhancement of the reef at this site may qualify for funding through a federal Section 1135 (Water Resources Development Act) program. This site and mitigation option should be further investigated via field reconnaissance.

7.4 Reef Restoration and Preservation: Tire Removal

Approximately 31 acres of Broward County hardgrounds associated with the second reef line and adjacent softbottom habitats are covered by used automotive tires that had been deployed in the early 1970s for use as artificial reefs. The tire bundles subsequently broke apart, and now litter offshore habitats (Figure 5). These tires, particularly during strong currents, tides, or storms, have, and will likely continue to, move over, brush against, and abraid the natural reef surfaces, and even damage existing coral colonies. They also cover softbottom habitats, creating environments inhospitable to natural sand-dwelling flora and fauna. Although there is some coral and sponge growth inside and on top of tires, NMFS indicated that it is an inferior substrate for colonies, and hardgrounds and softbottom habitats would provide more suitable substrates. Several parties have video footage of diver tire transects, including Broward County Biological Resources Division, Dr. Robin Sherman of NSU, and the Florida Fish and Wildlife Conservation Commission.

A more comprehensive tire-removal operation was thoroughly considered by PERG, and participants had an opportunity to visit sites where impacts were occurring. PERG participants agreed that restoring reefs and further protecting existing ones by removing tires would be a valid form of compensatory mitigation for impacts of the navigation project to the second reef line.

The success of such a project may rest on the method that is used for tire removal, as that would dictate costs and the compensatory effectiveness of the task. Broward County staff conducted video surveys in June 2003, to define the areal extent of the tire field and characterize the impacts at the proposed enhancement site. Video records were geo-referenced using a HYPACK hydrographic survey system to allow integration into Geographic Information System (GIS) software, and areas were prioritized for removal. Because the tire-field is so expansive and removing all tires may be cost-prohibitive, it is unlikely that the entire lot would be removed at once. DEP suggested that tire-removal measures start at the southern



PERG - Recommended Mitigation Sites: Tire-field Areas	
Compensatory Mitigation Recommendations of the Port Everglades Reef Group for the Navigation Improvements at Port Everglades Harbor	
Scale: 1 inch = 2,000 feet	Drawn By: MR
Date: May 2005	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J02-571
	Figure 5b

extent of the tire field, because otherwise the prevailing currents moving south to north may push tires into already cleared areas. Following a previous removal of approximately 1,600 tires (August 2001), newly exposed substrates were covered again by tires due to ocean currents. Another consideration for determining which tires should be removed is whether certain tires are closer to, or currently impacting, very sensitive habitats. Such "priority" areas have not yet been determined, but reconnaissance diving and underwater videography could aid in that effort. Depending on how tire removal is conducted, there may be secondary impacts to reefs. Therefore, more environmentally sensitive methods should be used within the reef habitats (than in softbottom habitats), such as diver removal of tires, or diver-mediated collection of tires (transfer to underwater bins/compartments which can be lifted). Hand removal of tires by divers in sensitive reef areas would prove to be much more expensive than bulk removal procedures, which could possibly be used over softbottom areas. In some cases, corals and sponges may be removed from tires and re-located to appropriate substrates. USFWS stated that any tire removal activities should be subject to monitoring to ensure that efforts are effective, and to demonstrate the utility of such a project.

There is additional appeal to include tire removal as part of the compensation package for navigation improvements. The project would be visible to the public, and could serve as a model program for environmental restoration. Since all tires cannot be removed simply through this mitigation program, non-governmental organizations (NGOs) and local sponsors could become involved, after having the Corps/Port provide somewhat of a "demonstration" program. NMFS voiced concern that any partial solution to the tire issue would be less favorable than a comprehensive plan. However, if the Corps/Port could take the lead in starting the restoration program, the momentum could result in comprehensive tire clean-up. The Port indicated that it should not be held accountable for the larger tire issue, even if it is willing to carry out compensatory measures by removing some sections of tires.

The costs for tire removal vary based on methods used, the spatial extent of removal, and the disposal of tires. Unconfirmed information from participants indicated that it would cost approximately $10 to remove one tire (not including land-based transportation and ultimate disposal of tires). If "number of tires removed" is used as the measure of compensation credit, and each tire is approximately five square feet in area, a theoretical "acre" of tires would comprise 8,712 tires. Therefore, it costs $87,120 per acre of tire removal, and $2,178,000 for 25 acres. For comparative purposes, it costs approximately $7,500,000 for placement of 25 acres of quarried limestone (for an artificial reef). Generally, it is likely that as more removal is conducted, cost per tire should decrease. Port staff noted that tipping fees would comprise a significant amount of the expenditures for tire removal activities. Therefore, it may prove useful to investigate alternative uses for tires (recycling, etc.). The Corps, Port, and local sponsors may benefit from applying for additional federal monies through Section 1135 and/or 206 programs to expand the tire-removal effort. The amounts and limits of such monies available should be determined. Additional funds may be available through other federal agencies (e.g., NOAA) or non-governmental organizations (e.g. National Fish and Wildlife Foundation). More accurate and detailed expense estimates should be sought for all components of the tire-removal program. If expenses are too high, a demonstration project could be initiated that would allow for the Port to provide adequate mitigation for impacts, but not be responsible for removal of all two-million tires from the second reef line and adjoining softbottom habitats.

Port staff indicated interest in investigating additional funding sources for tire-removal and in investigating the scope of the impact of tires to the second reef line. It was also suggested that a pilot program for tire removal should be conducted prior to any major operation in order to fine-tune a large-scale program.

7.5 Reef Habitat Creation

Where restoration and enhancement of reef resources are not available for use as mitigation, habitat creation has traditionally been offered as compensation for impacted habitats and lost ecosystem functions. Since new reef impacts would take place at water depths of approximately 40±2 feet (at first reef line where "flair" is planned), 52±2 feet (at second reef line), and 52±4 feet (at the third reef line) for the channel expansion at Port Everglades, it was suggested that these depths should influence the design of mitigation sites so that they achieve in-kind, LFL compensation. Though simply replicating depth might not replicate species assemblage, it is certainly one of the components that will need to be considered in order to supply proper compensation. Specific locations, reef design, and reef construction materials are other factors that must be considered, as they encourage recruitment by various assemblages. Mitigation should replicate the structural elements present at the impact site as closely as possible. For example, if investigations find that impacts to the third reef will involve removal of a flat, elevated plateau, then the replacement habitat should be built as flat, elevated plateau. In addition, the species assemblage present at the impact site should be examined so that the replacement habitat can be specifically engineered to create habitats conducive for recruitment of a similar assemblage.

7.5.1 Siting

Determining locations that would provide the appropriate depths was among the first matters discussed by PERG. Previously DEP-permitted Broward County artificial reef sites seemed to allow some opportunity for habitat creation. Navy staff confirmed that there are no Navy structures/cables in any of the permitted reef sites. However, Broward County staff indicated that most of the larger, depth-appropriate sites are already used, earmarked for use as mitigation, or reserved for research purposes. Large plots are currently available at only 25, 65, and over 75-foot depths. County staff noted that they retain maps of the permitted sites to 150'-deep. Generally, any sites shallower than 40' were excluded from further consideration as they may attract only juveniles and smaller fish, and thereby would not adequately replace the impacted assemblage.

Other possible locations at which reef habitats could be constructed include "reef-gaps." Reef-gaps are natural geologic formations where the profile of a reef line decreases appreciably, sometimes down to softbottom substrates. These reef-gaps can be readily seen on LADS plots. The geologic cause of these gaps is unknown. The gaps provide a nexus between deepwater offshore habitats outside the third reef line and the intra-reef area between the third and second reef lines, and, to a lesser extent, between the second and first reef lines. The gaps considered by

PERG were those in the third reef line, which could provide sites for LFL reef construction to compensate for impacts to the third reef line due to navigation improvements.

The utilization of third reef gap sites offers a unique opportunity that would not be available at mitigation sites found inside the third reef line. Because the gap sites are exposed to Gulf Stream currents, the physical conditions more closely replicate the situation at the third reef line impact site. Biological conditions at the reef-gap site are also more likely to recruit an LFL assemblage than more nearshore sites due to their position and physical environment. In other words, relative position of the mitigation site may be as important ecologically as depth.

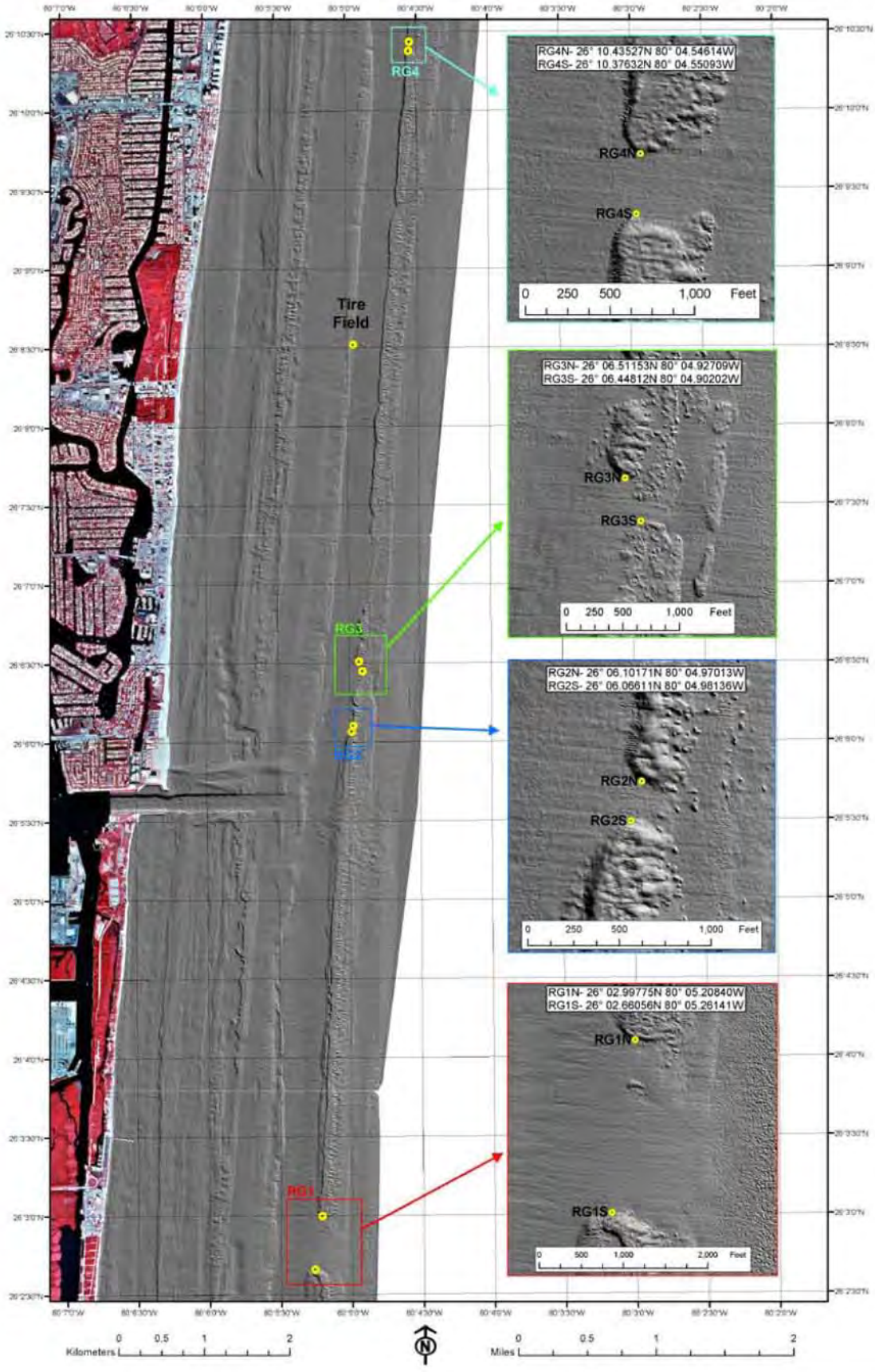
Several reef-gap sites were considered (Figure 6), although some sites may not be usable for one reason or another. DEP staff mentioned that a party has applied for a permit to install a pipeline through RG2 ("Reef-gap 2"). Also, utility/communications companies and the Navy may have equipment (e.g., fiber optics) buried in the sands at reef-gaps southeast of the proposed channel. The Navy should be contacted to determine if there are no structures/equipment running through the candidate reef gap sites. Some reef-gap sites may be too far from the impact area to effectively compensate for impacts of navigation improvements.

Other concerns regarding the placement of materials in reef-gap sites were raised. For example, analyses would have to be carried out to determine if reef materials and configurations would be hardy enough to endure swift, strong currents from the Gulf stream that enter the gaps. Also, care must also be taken during construction to avoid direct damage to existing reefs scattered within and adjacent to the reef-gaps. Finally, consideration would have to be given to whether habitat construction in these areas may have adverse environmental impacts on existing hardground and softbottom resources. Existing currents may have a significant physical and biological influence on habitats interior to the third reef line. Inhibiting or altering currents could have profound impacts on surrounding reef and softbottom habitats. It may be possible to mediate these possible effects by staggering constructed reef structures, limiting their profile, and/or moving reefs off from the central area of the reef-gap, i.e., toward the second reef line. This may be preferred anyway, because a staggered configuration more closely represents the natural reef characteristics near the gaps. Also, a more flat, elevated hardground plateau would more closely mimic the natural profile in this area. However, even if interruption of current to the intra-reef area did occur, these interruptions would be in effect "mitigated for" at the navigational channel impact site, where a new "reef-gap" will be created.

In case there is an excess of rock requiring disposal from the navigation project (i.e., over 50 acres), NSU faculty suggested some deep reefs (below 200 feet deep, or at 400+ feet) should be built. They noted that siting and monitoring could be achieved through use of ROVs.

7.5.2 Materials and Design

The use of habitat replacement materials must be carefully considered for logistical purposes, cost, and desired outcome. Materials should be selected following consideration of findings from baseline surveys at the impact sites and subsequent determination of success criteria. NSU retains some information on the effectiveness and uses of certain materials, and FWC noted that long-term (11-year) data for recruitment of constructed reefs at Sunny Isle are now available for



PERG - Recommended Mitigation Sites: Reef-gap Areas	
Compensatory Mitigation Recommendations of the Port Everglades Reef Group for the Navigation Improvements at Port Everglades Harbor	
Scale: as shown	Drawn By: MR
Date: May 2005	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J02-571
	Figure 5a

examination. FWC also mentioned a document regarding artificial reefs permitted by the Corps that should be consulted. Finally, Broward County artificial reef sites should also be examined to determine if the assemblages recruited on those reefs would be considered LFL for the proposed project's impacts.

There was general consensus among PERG members regarding which material should be used for habitat construction. NSU faculty and DEP staff agreed that natural limerock should be used in some way at habitat construction sites, and Broward County staff referred to limestone as the "best" substrate. NMFS staff (M. Johnson) indicated that colonization was not as prolific on concrete as on limestone, but NSU faculty stated that concrete might last longer. Another option is a coquina-based concrete with crushed limestone veneer. It increases stability due to the use of concrete. DEP staff noted that FMRI recommends marl boulders.

Limestone should be available from blasting operations in the harbor's basins and certain parts of the navigational channels, such as the Southport Access Channel, but according to NSU faculty, it is not likely that any rock will be recovered from new dredging at the third reef line due to the underlying geology. Dredging and/or blasting methods and procedures will determine the type and size of rock that will be available for habitat construction. Use of quarried limestone boulders is another option, albeit more expensive ($300,000/acre) not including placement). Use of rock/rubble from within the current channel should also be explored, as rock/rubble dumped offshore has provided usable LFL low-relief habitat for other projects.

Some PERG members displayed some concern for the strict classification of, and constructing reefs defined as, "high-relief" and "low-relief." Participants seemed to place emphasis more on reef construction materials and depth of placement to achieve biological goals, although NMFS and DEP noted its concern for LFL replacement. Port staff noted that if high relief yields better biological results than low relief, it would be better to use the rock from additional low relief and instead use it to increase the profile of constructed habitats.

Depth of placement may influence reef design, as stability becomes increasingly important with depth. For example, at 40 feet of water, a limerock diameter of more than 3 to 4 feet is required to maintain stability (K. Banks). At 20 to 25 feet, only 3 feet of profile is necessary (H. Hudson). In deeper water, where there are no small habitats to try to avoid, use of prefabricated reef modules is sometimes better logistically.

Following additional studies of the impact area and its resident biota, attempts should be made to imitate the structure of impacted areas. Effectively "re-creating" the impacted habitats would involve adjusting constructed reef profile, size, shape, and structural configuration. For example, if impacts to the third reef involve removal of a flat, elevated plateau, replacement habitat should be built as flat, elevated plateau. In addition, the species assemblage present at third reef line should be examined so that the replacement habitat can be specifically engineered to create habitats conducive for recruitment of a similar assemblage. Sinking of substrates, scouring around substrates, and partial submersion in sand by substrates should be expected, anticipated, and where applicable, compensated for, during construction.

7.5.3 Logistics

To increase the success of compensation through habitat creation, materials for both structure and biological recruitment ("seed" material or translocated corals) are necessary, and several challenges exist in order to bring these elements together. The Port is currently further investigating geotech data, and is attempting to discern if it is possible to stage work west to east in the Main Turning Basin and entrance channel, working in the Southport Access Channel last. This would allow for some rock to be exported to mitigation sites in advance of dredging in the eastern portions of the project, thereby supplying a destination for corals translocated from the Outer Entrance Channel before it itself is dredged. Rock material for artificial reef construction will most likely be collected from rock-blasting operations in the Southport Access Channel and Main Turning Basin. Overlying rock/rubble will have to be pulled up prior to blasting. If neither dredged nor blasted rock is available for advance placement (at mitigation sites) to receive relocated corals (see Section 7.6), pre-fabricated modules could be installed at habitat creation sites as relocation substrate so that no colonies are lost during blasting/dredging. Just as with the relocation of corals, it may be desirable to transfer seed materials/colonies and parent rock/rubble to habitat replacement sites. Though mortality of colonies attached to rock may be high, some of the hardier biota may survive. Costs may be prohibitive. In conclusion, timing of work should allow for maximum relocation of corals from impact zone and use of native substrate materials. Blasting/dredging should not occur in offshore areas until colonies can be relocated from impact sites and transferred to enhancement and reef construction sites. If no mitigation areas are yet available to receive corals, some colonies from the inner channel and outer channel could be relocated to reef modules in previously permitted Broward County reef areas between the second and third reef lines.

7.5.4 Value-Added Habitat Creation

Since the size of reefs to be constructed is significantly large (approximately 20 acres of high-relief reef, in addition to 7.5 acres of low-relief reef, unless HEA is modified to include restoration/enhancement/coral relocation options), several PERG members suggested placing the reefs in such a way as to maximize their use as a platform for research. Reef modules/structures would be placed in lines, groups, or randomly, so as to produce replicates at various sites and at various depths. NSU faculty noted that eight replicate reefs (totaling 30 acres) would provide some statistical power for research purposes. The configuration and spacing of reefs is yet to be determined. Construction of reefs yielding some scientific usefulness may prove to be much more valuable to the future of reef conservation than simply constructing reefs in a simple or careless manner, and could be carried out in such a way as to not make the project significantly more expensive. Findings may help scientists and resource managers make better decisions regarding reef construction in the future based on findings from examination of reef dynamics, particularly those involving long-term datasets. To maximize use of these reef plots, baseline data should be taken at natural reference sites, and at the construction site immediately following construction. The Port expressed concern about spending additional resources on acquiring a reef design scheme that may benefit reef science, when it seemed that the first priority of PERG was to conduct mitigation (i.e., artificial reef creation) utilizing input from previous scientific work. Regardless of how such a project is designed, providing adequate mitigation for the navigation improvement project and achieving cost-efficiency should be the primary goal.

An ancillary goal of created reef sites could be placement and construction of artificial reef areas for research purposes. Providing (by regulatory agencies) additional mitigation credit for research-configured, created reef sites, because of their value in making future creation efforts more ecologically effective, was discussed.

7.6 Coral Relocation

NMFS typically advises that coral colony relocation constitutes a major part of avoidance and minimization criteria for impacts. The preferred manner to relocate is to use colonies from impact sites to create an initial assemblage at mitigation sites. In this way, the restoration site is more ecologically valuable as there is less temporal lag in the new community. Corals should be relocated by experienced personnel using established methods. Recently, for another project, approximately 600 colonies collected from 10 acres were relocated. The largest, and hence oldest, coral components of the site that was to be impacted were removed and transplanted.

Which restoration sites/construction sites should serve as recipient sites for translocated corals should be carefully considered. DEP noted that there may be a greater risk of losing corals due to impacts from drifting tires if placed at areas of the second reef line from which tires had been removed. This risk could be diminished if tires "upstream" (of current flow) from recipient sites were removed and no other tires posed a risk. Reef-gap sites and other constructed reef sites remain good candidates for receiving colonies. The colonies will have to be relocated to constructed habitats and restoration areas prior to dredging in outer channel/third reef, which will likely provide the greatest amount of raw biological material. Minimum size of colonies advisable for relocation is 12-15 cm (4¾"- 6") in diameter; NMFS recommends re-locating colonies over 6" (15 cm) in diameter. NSU staff indicated that this equates to corals approximately 15 years old. Dial Cordy staff questioned whether certain colonies should be given priority during the translocation process, i.e., those with the highest likelihood of survival, or rare species. NOAA staff questioned whether soft corals would be candidates for relocation. NMFS indicated that hard corals would be a higher priority because of longer recovery times. NOAA staff mentioned that it would be worthwhile to relocate older soft coral colonies; Broward County staff indicated that it was still possible to relocate them. DEP staff mentioned that those larger soft corals are more reproductively active and therefore more valuable. DEP also stressed the importance of relocating many colonies to one area rather then multiple sites, so that reproductive activity could be facilitated.

In order to minimize stress on colonies, maximize transplant survival, and thereby capitalize on assemblage function at the recipient sites, transplantation logistics need to be carefully planned and executed. NSU data indicate that coral transplant survival rate can be greater than 80 percent. Broward County staff noted that their survival rate was over 90 percent.

This activity should lower the overall mitigation area that was determined through use of HEA, because the severity of impacts will be lessened at the impact sites, and habitat creation sites will have a reduced recruitment interval.

Experienced marine biologists should be used to determine which corals should be relocated and to carry out the translocation. Transects should be conducted as per Section 7.2 to monitor growth following translocation.

7.7 Preservation: Water Quality Improvement

NSU and DEP staff suggested that improvements in water quality in the local area could help to preserve existing coral colonies. Locating and retrofitting broken or inadequate sewage outfalls could be a wise investment and appropriate use of dollars set aside for mitigation.

7.8 Compensation Credit

Initial Evaluation. HEA performed by the Corps indicated that 28.87 acres of artificial reef must be created to compensate for impacts that would occur to reefs and hardgrounds outside the current channel zone. If the proposed mitigation represents in-kind, LFL compensation, in order to reflect the ecological differences between the reef types impacted, approximately 21.33 acres would comprise HCHR, while approximately 7.54 acres of LCLR hardgrounds would be installed. These compensation acreages are for new habitat creation, and do not take into account any use of relocated corals (see Section 7.6 above) or deposition/installation of any biological material on constructed reefs.

Restoration and Enhancement. The issue of determining how the Corps/Port will receive compensation credit for partial tire-field clean-up has yet to be determined. There are several alternative methods of assigning credit that were discussed during PERG. One method could be to allow one-acre of tire clean-up on the second reef line to compensate for one acre of impact to the second reef line. However, the longevity of benefits provided by removing tires from the reef line only would likely be minimal without removing tires that are up-current form the restoration area. Those tires could drift back on to the cleared area, eliminating the benefits of removal. Possibly, two types of credit could be given, one type for tire removal on reefs, and another for removal over sand flats adjacent to reefs. Sand-flat removal of tires could be considered “preservation credit”, and have slightly lower values than “restoration credits” on reefs. A sliding scale could also be used, i.e., credit per tire could be judged by distance to, and/or current impact on, hardground habitats. These credits would be applied to the HEA and Mitigation Bank Review Team (MBRT) calculations that were used to determine the number of acres of new habitat construction. Other methods of assigning credit to tire-removal include credit based on the depth of tires removed, and credit based on each tire, i.e., each tire occupies a fixed area (about 5 sf), and in sum, translates directly to a specific acreage of tires. NSU faculty noted that credit could also be applied to temporary impacts to the channel if biological assemblages currently in the channel were similar to those that occupy habitats adjacent to the second reef line north and south of the tire field.

Habitat Creation. DEP staff mentioned that the monitoring report for the Gulf Stream pipeline project includes several years of data and is now available for review. Information such as this could be used to more accurately predict recruitment intervals for constructed reefs. Re-location of corals to constructed habitats decreases HEA recovery-time values, and thereby can decrease the amount (acreage) of compensatory mitigation required. The “value” (credit) of re-location

will depend on the number and size of colonies re-located. Just as with the translocation of corals (see Section 7.6 above), if seed materials/colonies and parent rock/rubble were removed and transferred to habitat replacement sites, HEA recovery intervals would decrease. It is thought that mortality for colonies still attached to rocks would be high, whereas those physically removed and cemented onto the new reef substrates would have survival rates between 80 and 90 percent. HEA should be revised to reflect recruitment interval changes. Also, if it is agreed that high-relief reef can be used in lieu of low-relief, HEA calculations would have to be revised.

Reef Research. Even if required acreage of reef creation decreases (from levels previously calculated via HEA) due to incorporation of restoration work and reduction of recruitment times on created reefs, there will still be enough to lend value to attempting to create replicate reefs for scientific research. Whether positioning reef units in a manner conducive to research, or whether keeping all materials in a continuous group (i.e., like at impact sites) should be further discussed. It is possible that since additional planning and labor may be necessary to plan/install reef replicates, regulatory agencies may choose to award some nominal mitigation credit for the future resource value (beneficial "indirect" future effects) that could be gained from such an investment. NMFS staff noted, however, that this might not be legally feasible because there is no statistical evidence that future resource value would be gained. The Port could decide to create "research arrays" of reefs on its own, but if additional costs are involved, regulatory agencies should consider whether issuing additional compensatory credit for such work has merit. Although USFWS expressed concern regarding assigning compensation credit for measures that were not considered "in-kind," NMFS also noted that LFL should be the rule, but indicated that some experimental work could impart on future reef work possible insights that have not been available to this point. DEP noted that research on the prevalence of cover of local corals by blue-green algae would also be worthy of note, and could be valuable for the preservation of area reef habitats.

7.9 Habitat and Environmental Monitoring

All elements that are proposed as mitigation sites (i.e., hardground restoration sites and habitat creation sites) will require monitoring before, during, and after implementation in order to guide specific mitigation decisions and ensure the success of each measure. Monitoring should include observation of the physical environment (scouring, sedimentation, etc.) as well as the biological communities, at both mitigation sites and adjacent areas. Recovery at impact sites should also be observed and recorded. Monitoring at sites *adjacent to* impact and mitigation sites should be carried out to ensure that sedimentation to adjacent reef areas does not occur. According to DEP, the minimal interval for monitoring should be 3 to 5 years, but NOAA Fisheries suggests a minimum of 5 years of monitoring.

Navy staff noted that if mitigation sites near their equipment were used, cables could be used in the transmission of real-time monitoring data. However, it appears that the most practicable mitigation sites are away from such equipment.

Monitoring data has more uses then simply tracking the progress of mitigation and ensuring the lost ecosystem functions are compensated. Monitoring on re-located rock substrates would

provide information on the effectiveness/mortality associated with such bulk rock-recovery processes. Of course, monitoring at sites where reefs have been built to provide replication for research purposes will allow scientists to gather important information regarding constructed habitats and recovery that was difficult to find during previous projects.

NSU scientists also recommended consultation and participation with the U.S. Coral Reef Task Force (USCRTF), to whom success criteria and mitigation monitoring data should be supplied. USCRTF should also be apprised of the success of mitigation measures, and supplied with recommendations to improve future mitigation projects. NSU staff also recommended that the Jacksonville District utilize two recent U.S. Fish and Wildlife Service documents (USFWS 2003 and USFWS 2004) regarding the efficacy of mitigation efforts in the Pacific and Atlantic for guidance (respectively).

7.10 Ancillary Mitigation Issues

Quantification of compensation. Through the PERG process, questions were occasionally raised regarding the amount of mitigation that the Corps and local sponsor should provide. For example, the USFWS noted that mitigation should provide compensation for impacts to hard-surfaced channel walls due to attached livebottom communities. Also, NSU faculty re-calculated HEA values taking into account different assumptions than were used by the Corps and their analyses indicated that up to 50 acres of high-relief reef was required for mitigation. Because it was not within the scope of PERG to determine the amount of mitigation necessary for the project (values can be negotiated only among regulatory personnel and the Corps), PERG used only the mitigation values that have been formally proposed by the Corps to form the hypothetical basis for recommendations in this document. It is possible, however, that through the NEPA process, regulators will require additional mitigation or types/quantities of mitigation that differ from what has been proposed by the Corps.

Logistics. It is imperative that activities at all mitigation sites are minimum-impact, and that best management practices are carried out during the construction, restoration, and enhancement of reef and hardground habitats.

Timing. It may be possible for the Port to conduct certain mitigation measures prior to the initiation of navigation improvements, and Port staff indicated an interest in doing so. Unlike habitat construction, tire-removal could be conducted at any time, i.e., before, during, or after channel/basin construction. Initiation of reef enhancement at the sites south of the planned channel (third reef line) could also be initiated early.

Scientific references. PERG members suggested that several individuals outside PERG be contacted for assistance with guiding the mitigation process, particularly as it relates to relocation and recovery of hard and soft corals. Those personnel included Jennie Wheaton of the Florida Marine Research Institute for assistance regarding octocorals, Walt Jaap of the Florida Marine Research Institute for assistance regarding scleractinians, John Dodrill (850.922.4340), artificial reef coordinator for the State of Florida, and George Henderson of the Florida Marine Research Institute for Florida Fish and Wildlife Conservation Commission consistency.

8.0 CONCLUSIONS

Compensatory Mitigation Objectives. Like-for-like mitigation is an important criterion. The definition and goals of LFL mitigation should be adaptive, compensating the ecosystem for lost ecological services, but retaining as many of the characteristics of the impacted system as possible. However, the practicality of repeated application of the LFL paradigm was addressed by PERG. It was noted that simply creating artificial reef after artificial reef for all coastal projects would result in an excess of reefs that may be either depth- or structurally appropriate for mitigation purposes, but would not necessarily provide many of the important ecological services provided by reefs that have been impacted. Some in PERG indicated that restoration/enhancement could be considered LFL.

Additional Baseline Studies and Success Criteria. Before determining how well mitigation measures function and what the mitigation objectives are, a detailed assessment of the habitats and functions provided by the habitats that will be impacted should be carried out. At a minimum, a *qualitative* assessment of likely impacts should be conducted at each impact site. PERG members stressed the importance of *quantitative* data that would be used to establish more precise levels of performance for mitigation success criteria. Prior to relocation of hard or soft corals, assessments should be carried out. They should comprise *in situ* data collection to quantify the number, size, and species of corals (and other relevant fauna) within the impact zone. Donor and recipient sites for coral translocation must be identified also, and these must also be assessed for suitability and current environmental characteristics prior to carrying out mitigation activities. In addition to obtaining data on impact sites, obtaining baseline information at each of the proposed mitigation sites is necessary to determine the success of mitigation, particularly where habitat restoration or enhancement is planned.

Reef Enhancement Opportunities. Based on LADS maps, there appears to be an area of extreme low profile substrates south of the planned channel in the third reef line. The area appears to have been previously impacted, and therefore is a candidate site for reef enhancement or restoration. This site and mitigation option should be further investigated via field reconnaissance.

Reef Restoration and Preservation. Approximately 31 acres of Broward County hardgrounds associated with the second reef line and adjacent softbottom habitats are covered by discarded automotive tires that had been deployed in the early 1970s for use as artificial reefs. PERG participants agreed that restoring reefs and further protecting existing ones by removing tires would be a valid form of compensatory mitigation to be considered for impacts of the navigation project to the second reef line. There is additional appeal to include tire removal as part of the compensation package for navigation improvements. The project would be visible to the public, and could serve as a model program for environmental restoration. Since all tires cannot be removed simply through this mitigation program, non-governmental organizations (NGOs) and local sponsors could become involved, after having the Corps/Port provide somewhat of a “demonstration” program. NMFS voiced concern that any partial solution to the tire issue would be less favorable than a comprehensive plan.

Reef Habitat Creation. Where restoration and enhancement of reef resources are not available for use as mitigation, habitat creation has traditionally been offered as compensation for impacted habitats and lost ecosystem functions. Since new reef impacts would take place at water depths of approximately 40 to 45 feet (second reef line) and 50 to 55 feet (third reef line) for the channel expansion at Port Everglades, it was suggested that these two depth zones should be used at mitigation sites to achieve in-kind, LFL compensation. The species assemblage present at the impact site should be examined so that the replacement habitat can be specifically engineered to create habitats conducive for recruitment of a similar assemblage.

Siting. Determining locations that would provide the appropriate depths was discussed at length by PERG. Generally, any sites shallower than 40' were excluded from further consideration as they may attract only juveniles and smaller fish, and thereby would not adequately replace the impacted assemblages. Other possible locations at which reef habitats could be constructed include "reef-gaps." The gaps considered by PERG were those in the third reef line, which could provide sites for LFL reef construction to compensate for impacts to the third reef line due to navigation improvements. In case there is an excess of rock requiring disposal from the navigation project (i.e., over 50 acres), NSU faculty suggested some deep reefs (below 200 feet deep, or at 400+ feet) should be built. They noted that siting and monitoring could be achieved through use of ROVs.

Materials and Design. The use of habitat replacement materials must be carefully considered for logistical purposes, cost, and desired outcome. Materials should be selected following consideration of findings from baseline surveys at the impact sites and subsequent determination of success criteria. There was general consensus among PERG members regarding which material should be used for habitat construction: limerock. Another option is a coquina-based concrete (since concrete lasts longer) with crushed limestone veneer. Some PERG members displayed some concern for the strict classification of, and constructing reefs defined as, "high-relief" and "low-relief." Participants seemed to place emphasis more on reef construction materials and depth of placement to achieve biological goals, although NMFS and DEP noted its concern for LFL replacement (providing identical structure and reef profile as was in impacted areas). Following additional studies of the impact area and its resident biota, attempts should be made to imitate the structure of impacted areas.

Logistics. To increase the success of compensation through habitat creation, materials for both structure and biological recruitment ("seed" material or translocated corals) are necessary. Allow for some rock to be exported to mitigation sites in advance of dredging in the eastern portions of the project, thereby supplying a destination for corals translocated from the Outer Entrance Channel before it itself is dredged. If neither dredged nor blasted rock is available for advance placement (at mitigation sites) to receive relocated corals, pre-fabricated tetrahedrons could be installed at habitat creation sites so that no colonies are lost during blasting/dredging. Just as with the translocation of corals, it may be desirable to transfer seed materials/colonies and parent rock/rubble to habitat replacement sites. Timing of work should allow for maximum translocation of corals from impact zone and use of native substrate materials. Blasting/dredging should not occur in offshore areas until colonies can be translocated from impact sites and relocated to enhancement and reef construction sites. If no mitigation areas are yet available to receive corals, some colonies from the inner channel and

outer channel could be relocated to reef modules in previously permitted Broward County reef areas between the second and third reef lines.

Value-Added Habitat Creation. PERG members suggested placing any mitigation reefs in such a way as to maximize their use as a platform for research. Reef modules/structures would be placed in lines, groups, or randomly, so as to produce replicates at various sites and at various depths. Findings may help scientists and resource managers make better decisions regarding reef construction in the future based on findings from examination of reef dynamics, particularly those involving long-term datasets.

Coral Relocation. NMFS typically advises that coral colony relocation constitutes a major part of avoidance and minimization criteria for impacts. The preferred manner in which to carry out relocation is to use colonies from impact sites to create an initial assemblage at mitigation sites. Corals should be relocated by experienced personnel using established methods.

Habitat and Environmental Monitoring. All elements that are proposed as mitigation sites will require monitoring before, during, and after implementation in order to guide specific mitigation decisions and ensure the success of each measure. Monitoring should include observation of the physical environment as well as the biological communities, at both mitigation sites and adjacent areas. Recovery at impact sites should also be observed and recorded. Monitoring at sites *adjacent to* impact and mitigation sites should be carried out to ensure that sedimentation to adjacent reef areas does not occur. NOAA Fisheries suggests a minimum of five years of monitoring.

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APPENDIX A

PERG Member and Participant List

PERG Member and Participant List

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FDEP	**Vladimir Kosmynin**	850-487-4471 x121	vladimir.kosmynin@dep.state.fl.us
FWS	**Brad Rieck**	561-562-3909 x231	brad_rieck@fws.gov
FWS	Trish Adams	561-562-3909	trish_adams@fws.gov
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Nova Southeastern Univ	**Richard Spieler**	954-262-3613	spielerr@ocean.nova.edu
Nova Southeastern Univ	Pat Quinn	954-262-3642	quinn@nova.edu
NOAA Florida Keys NMS	**Harold Hudson**	305-852-7717 x29	harold.hudson@noaa.gov
U.S. ACOE	**Terri Jordan**	904-899-5195	Terri.L.Jordan@saj02.usace.army.mil
U.S. Navy	Kenny Geddings	843-820-5739	geddingskl@efdsouth.navfac.navy.mil
U.S. Navy	**William Venezia**	954-926-4001	veneziawa@nswccd.navy.mil
FWC	Keith Mille	850-922-4340 x207	keith.mille@fwc.state.fl.us

APPENDIX B

PERG Meeting Notes

Port Everglades Reef Group
Meeting #1
12 June 2002
1000 hrs

Participants

SD	= Steve Dial	Dial Cordy and Associates
BV	= Bill Venezia	U.S. Navy
KG	= Ken Geddings	U.S. Navy
DD	= Dick Dodge	Nova Southeastern University
AS	= Allan Sosnow	Port Everglades, Broward County
RS	= Richard Spieler	Nova Southeastern University
PF	= Pamela Fletcher	Broward County Dept of Planning and Environmental Protection
MJ	= Mike Johnson	National Marine Fisheries Service
KB	= Ken Banks	Broward County Dept of Planning and Environmental Protection
AW	= Allen Webb	US Fish and Wildlife Service
TJ	= Terri Jordan	US Army Corps of Engineers
JE	= Jason Evert	Dial Cordy and Associates
EK	= Ellen Kennedy	Port Everglades, Broward County

Not in attendance

HH	= Harold Hudson	Reef Relief/NOAA Restoration
KL	= Ken Lindeman	Environmental Defense Fund

The following are paraphrased statements, indicating some of the issues that were discussed at the meeting. It is not intended to be a direct or complete transcript of the meeting. Corrections and clarifications should be made at next meeting, if necessary.

KB	Minimum stability of reefs at water depth of 40 feet is 3-4'
DD	No rock will be available from 3rd reef line for use in art. reef construction due to geology
SD	Target what qualitative impacts are, and replicate those in the art. reefs
DD	Use science to guide plan, but also use placement/materials and resulting data to gain knowledge of art reefs
KB	Much of sites are already used, schedule for use, or for research
PF	Permitted art reef areas are mapped to 150' deep
SD	Target snapper/grouper taxa, as they are the managed spp. under EFH, which we are trying to replace
RS	If reefs are placed shallower than 40', they may attract only juveniles and smaller fish
TJ	Orientation of reefs that will cover 50 total acres, i.e., spaced, in a line, groups, etc.?
SD	Use different depth zones
KB	LR & HR is meaningless as biology goes
BV	Use of cables south of channel to take real-time baseline and monitoring data?
JE	Are we stuck with federal like-for-like constraints, or can we be more creative?
AW	Hesitant to go outside in-kind compensatory mitigation
DD	Coral replacement to any art reef to decrease HEA acreage calculation?
MJ	Replacement of any and all heads is recommended.
AS	Can't we simply use the best information available to do the art reefs? Why worry about the design strictly from an academic standpoint when the first priority is mitigation?
KB	limestone is best substrate
MJ	Like for like mitigation should be the rule, but have room for some experimental
KB	Large plots only available @ 25', 65', (or *over* 75'?)
SD	Let's try 2/3 of acreage at shallow and 1/3 at deep
RS	What is like-for-like? Depth? Substrate? Spp. assemblage?
AW	Yes, like-for-like = depth
RS	Mitigation for 3rd reef impacts should involve art reefs exposed to Gulf current to allow for in-kind biota to recruit (so maybe depth not only consideration, but position is also important…)
SD	Prefabricated reefs better biologically or cheaper? Logistic difficulties in deep water?

KB	Deeper water with prefabs sometimes better logistically - no small habitats to try to avoid
AS	Decrease time-lag impacts by replacing boulders in channel (since that's what would be removed)?
??	Mortality would probably be high (of live-bottom orgs assoc with boulders), and boulders *extensively* cover channel bed, so that would be very expensive
KB	In another case, rock-rubble dumped offshore made nice habitat
SD	Can rock-rubble replace LR habitat? We could extend KB's already existing site
JE	Restoration opportunities available, or other non-art-reef-building options?
KB	Cover tires? (2 million of them?)
DD	Tire removal has been done before
MJ	Willing to entertain the idea
SD	Propose 30 acres in 40'-60' depth; 10 ac in deepwater, and 10 acres credit for restoring?
SD	How about reef design?
MJ	Concrete colonization not as great as limestone
RS	Not necessarily – plus, concrete may last longer
TJ	Harold Hudson's concrete = coquina-based concrete with limestone crushed
AW	Is settling prohibitive?
KB	No, but scouring occurs
JE	Number of separate reef structures (replicates) at each depth?
RS	Some experimental power with 8 reps - (for 30 acres)
SD	Configuration and spacing? Specific siting? GIS data?
BV	No Navy structure in permitted reef sites.

Other issues mentioned after dismissal:

??	value of relocation of corals? value of relocation of tire removal? (with respect to values calculated via MBRT or HEA)
MJ	relocation of corals is actually a form of avoidance and minimization
RS	need for baseline data
SD	for now, we need to use what we know, and keep planning mostly conceptual
??	a need for physical/sedimentation monitoring on adjacent corals (impact or art reef site?)

Port Everglades Reef Group
Meeting #2
26 August 2002
1330 hrs

	Participants	Phone Number	E-mail
AS	Allan Sosnow		
JE	Jason Evert	904-241-8821	jevert@dialcordy.com
MJ	Mike Johnson	305-595-8352	mike.r.johnson@noaa.gov
KB	Ken Banks	954-519-1207	kbanks@broward.org
HH	Harold Hudson	305-852-7717 x29	harold.hudson@noaa.gov
RS	Richard Spieler	954-262-3613	spielerr@nova.edu
RD	Richard Dodge	954-262-3651	dodge@nova.edu
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GB	Gary Bogumill	954-523-3404 x3681	gbogumill@broward.org
VK	Vladamir Kosmynin	850-487-4471 x121	vladimir.kosmynin@dep.state.fl.us
SR	Stacey Roberts (DEP)		

Not in Attendance

Bill Venezia	U.S. Navy
Ken Geddings	U.S. Navy

The following are paraphrased statements, indicating *some* of the issues that were discussed at the meeting. It is not intended to be a direct or complete transcript of the meeting. Corrections and clarifications should be made at next meeting, if necessary.

re: Tire Removal

MJ: tire removal should be considered in-kind
KG: in-kind for tires at the 2nd reef line
JE: tire removal could be done in advance of impacts
AS: secondary impacts due to tire removal?
RS: Robin has footage of tires
[KB and PF acknowledged that they also have footage]
JE: the work would be preventative and restorative, depending on sand flat or 2nd reef line
KG: should start at southern extent

re: Construction of Artificial Reefs in Geologic Gaps in 3rd Reef Line

TJ: source of available rock from blasting in port/channels only, not offshore
VK: 1 ac. limestone boulder = $300,000 if purchased
KB: hydrodynamics to 2nd reef – recruitment (??)
HH: stability of placement in such locations?
KB: stability analyses necessary
KG: sure meets 3rd reef in-kind replacement!
KG: cable corridor project - fiber optics (??)

re: Materials

KG: FMRI says marl boulders are best
HH: concrete best for stability - use concrete to hold rocks in place. Therefore, you get additional benefit of use of rocks by benthos.
HH: must mimic structure of impacted habitats
HH: engineering/stability - 20-25’ of water - only 3’ high necessary
TJ: depths of 40 - 60’?

RS: some impacts will be within current channel, and channel critters (the larger ones) are different than what would be at artificial reef. We need to do something to replace those - not just make reef, i.e., place reef with exposure to Gulf current to allow for big fish
AS: science done in impact areas (??)
KG: pilot testing?
AS: yes
KG: i.e., for tire removal, gap-reef-fill, etc.
AS: go with high-relief if better biologically - using less low-relief = less impact on existing systems on which the reefs would be built
MJ: however, still need to replace like with like
KG: true, low for low, high for high

re: Translocation of Corals
DD: minimum size: 12-15 cm (4 ¾”- 6”) diameter
MJ: agree with Fish and Wildlife Coordination Act Report recommendations to relocate those over 6” (15 cm) in diameter
DD: that equates to 15-yr-old corals
MJ: agree with idea that translocation fills the avoidance requirement. Also decreases time-lag value used in HEA. a weighted % (??)
JE: priority corals (i.e. rare spp.) and those with high likelihood of survival?
KG: relocation survival rate?
KB: over 90%
TJ: should conduct site visit for next meeting to determine if and how many corals to relocate
DD: Broward County hardgrounds: relocation of 1,000 - 1,500 corals on 10 acres will occur
HH: for the Port Everglades project, should soft corals be relocated also?
MJ: hard corals more important due to longer recovery times
HH: older colonies of soft corals can/should be translocated
JE: are larger colonies more reproductively active and therefore more valuable?
VK: yes, they are.
VK: also, corals should not be translocated twice
VK: many colonies translocated to one area is better then multiple sites
JE: allowable mitigation? (?)
KB: Budget for translocation? Schedule?
TJ: To begin in 2004, or if Water Resources Development Act not passed by Congress, then it would be 2005
TJ: Construction budget includes mitigation components
AS: Port is in favor of mitigation prior to construction
KG: monitoring itself does not equate to success criteria, which should be established early

[Other topics discussed included setting up a site visit and other state personnel that may become involved. Those personnel included Jennie Wheaton for octocorals, Walt Jaap for scleractinians, John Dodrill (850.922.4340) as state artificial reef coordinator, and George Henderson for FWC consistency. A pre-meeting conference with Nova faculty was held to determine availability of fishery data for the impact areas; at that conference, DD/RS noted that any efforts for restoration should be minimum-impact, and that timing should correspond to maximum recovery of corals in impact zone, i.e., interior channel/basin blasting produces rock for use in art reef constr (in reef gaps?); coral translocated to art reefs/restoration areas prior to dredging in outer channel/3rd reef.]

Port Everglades Reef Group
Meeting #3
21 November 2002

	Participants	Phone Number	E-mail
AS	Allan Sosnow	954-523-3404 x3883	asosnow@broward.org
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KB	Ken Banks	954-519-1207	kbanks@broward.org
RS	Richard Spieler	954-262-3613	spielerr@nova.edu
DD	Richard Dodge	954-262-3651	dodge@nova.edu
TA	Trish Adams	772-562-3909 x232	trish_adams@fws.gov
KG	Kurtis Gregg	850-487-2231	Kurtis.Gregg@dep.state.fl.us
TJ	Terri Jordan	904-899-5195	terri.l.jordan@saj02.usace.army.mil
JK	Jocelyn Karazsia	305-595-8352	jocelyn.karazsia@noaa.gov
PQ	Pat Quinn	954-262-3642	quinn@nova.edu
GG	George Getsinger	904-232-2580 x121	george.getsinger@noaa.gov

By Conference Call:

KM	Keith Mille	850-922-4340 x207	keith.mille@fwc.state.fl.us

The following are paraphrased statements, indicating *some* of the issues that were discussed at the meeting. It is not intended to be a direct or complete transcript of the meeting. Corrections and clarifications should be made at next meeting, if necessary.

re: Overall picture

DD: USCRTF: See datasheet from DD and RS
AS: Organizations already doing monitoring?
RS: ¼ internal fish survey data
JE: Does USCRTF provide guidance, science, etc.?
DD: No
DD: pt. #2, re: baseline
RS: see pt. #3; coral transplant survival rate >80%

re: Tire removal

RS: 1600 tires removed, then those areas covered again - they move
GG: Tires = bad substrate
KB: To get credit for acres, must remove all tires in front of reef also [that may move onto area credit was given for]
RS: credit for depth of tires
RS: hand removal at reef line - expensive
KM: Sunny Isle long-term (11-yr) data now available
GG: Trish mentioned dumping limestone on tires to keep them from moving
KG: Priority tires, [i.e., those at most sensitive areas]?
GG: Restoration money? [Section 1135/206?] Amount/limit of $$$??
AS: Costs?
RS: use tires for to compensate for channel impacts also
KM: calc. amount of tire damage by ac. to get credit
DD: use acres protected as credit in HEA
KG: Use # tires removed as success criteria
[JE calcs: 5 sf/tire; 8,712 tires/ac; $87,120/ac; x 25 ac = $2,178,000, vs. 25 ac limestone for $7,500,000]
AS: a swatch approach won't work - tires would be replaced
JE: Value/tire could be judged by distance to, and current impact on, reef
KM: economy of size
KM: Monitoring
AS: Port willing to investigate scope of impact to 2nd reef line

Port willing to remove tires near impact area
Port willing to investigate other funding sources
GG: Partial solutions not good

re: Construction of Artificial Reefs in Geologic Gaps in 3rd Reef Line

KG: Pipeline permit applied for at RG2
KB: Some hydrodynamics/sand flow occurs there
??: "creation" of new gap = 3rd reef impacts
JE: RG2 only several hundred feet from impact area?
TA: Section 1135 project for area of 3rd reef line impacts?
DD: Improve 3rd reef south of impact area? And study for mitigation goal purposes
TJ: Move reef off from gaps
JE: Scattered is more natural
KG: 1st find out about 3rd reef evaluation south of impacts
KG: Do both reef gap and improve 3rd reef line
JE: Is in kind more flat, elevated plateau?
RS: Examine 3rd reef line for assemblage to know what in-kind is
RS: Has data on materials
TJ: Sunny Isles - materials
KM: Artificial reefs permitted via Corps doc
KG: "habitat replacement" should be used rather then "artificial reef" (which in effect means "fishing spot")
JE: Use Broward County sites?
KM: Either way
JE: Materials?
RS: Data available, and from other sources
TJ: Seed materials/rock removed- decreases HEA recovery intervals
PQ: Tetrahedrons
AS: Place tetrahedrons in restoration site to receive corals prior to impacts
AS: Need to get GeoTech, but can stage work W to E in MTB and entrance channel, Southport Access Channel is last
KG: agree w/ DD; prefer use of natural limerock component in some way
GG: Use small rubble/rock in channel to seed-source new mitigation site; it's better than the sand as a source
KG: Anticipate sinking/scouring/covering by sand
AS: Rock in channel was from punch-barge, not cutterhead - 2 types of equipment may be necessary: pull-up rubble, then blasting.
GG: Build reef with that in mind
KG: Gulfstream pipeline EIS - data on recovery
JE: Need assistance with revising/adjusting HEA to accommodate seed-source and coral translocation
KB: Plenty down there to relocate
KB: Gorgonians difficult but do able
JE: Replication still on table, given smaller 20% of acreage still given
DD: Yes
KB: 1 acre still huge!
DD: Especially with respect to corals
AS: Success criteria? Responsibility for results?
KG: Big picture considered - research consideration. Gulf Stream – 15-year monitoring
JE: Yes, but credit?
KG: Long-term monitoring, i.e. over 3-5 years should be done
TA: Centralized database for cumulative impacts
AS: Sources to reduce duplication of efforts
KG: Kevin Madley (FMRI) database - habitat classification
JE: Recipient sites for coral? Like for like?
KG: Uncertainty of tire re-impacts - all corals might better go to artificial reef structures (habitat replacement units)
KG: Dynamic positioning of dredge? Monitor impacts of equipment

Port Everglades Reef Group
Meeting #4
30 April 2003

	Participants	Phone Number	E-mail
AS	Allan Sosnow	954-523-3404 x3883	asosnow@broward.org
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DD	Richard Dodge	954-262-3651	dodge@nova.edu
TJ	Terri Jordan	904-899-5195	terri.l.jordan@saj02.usace.army.mil
JK	Jocelyn Karazsia	305-595-8352	jocelyn.karazsia@noaa.gov
BY	Beverly Yoshioka		(USFWS-Caribbean Field Office/PR)
KM	Keith Mille	850-922-4340 x207	keith.mille@fwc.state.fl.us
VK	Vladimir Kosmynin	850-487-4471 x121	vladimir.kosmynin@dep.state.fl.us
BR	Brad Rieck	772-562-3909 x231	brad_rieck@fws.gov

The agenda for this meeting included participant introductions, a report from the Corps on Port Everglades project status, explanation of the goals of PERG, and soliciting comments/edits for the draft document. First, comments on the overall structure/content were received, then specific comments on Sections 6.0 and 7.0 of the document were noted by the facilitator. In addition, various parties submitted hardcopies of information pertaining to agency mitigation policies and hand-written comments noted on copies of the draft document itself. The following are some of the issues raised by PERG members. It is not intended to be a direct or complete transcript of the meeting. Corrections and clarifications should be submitted to the facilitator, if necessary.

Comments on Draft PERG Document:

Section 4.0 (Mitigation Guidelines and Environmental Policy)
- state if no formal hardground policy exists per each agency
- intro: recognize stakes- intent, mandates, - ea. diff. laws- e.g., H20 qual cert req fr state,
  but no permit requirements
- refer to Section 7.1
- Broward has dredge and fill up to 3 miles out
- use statement of Port toward environment—Port Master Plan (Master Vision 2020) on web
- check with Office of Protected Species, NMFS- ask JK for coordination/ mitigation/ policy

VK: Where do water quality impacts come into play with regard to impacts (particularly run-off from Port properties and indirect impacts)? Is there some type of compensation provided for these impacts? Also, do these impacts decrease likelihood of success of mitigation?

DD: Define HR (high-relief) and LR (low-relief) and substantiate the classification, or use another more specific classification system, and use such a revised system in the description of impacts, mitigation design and construction.
KM: Add impacts table-
[JE note: Add compensation table as well]
KM: Re: recovery rate, when was last time channel was dredged?
VK: Examine size classes of corals in impact zones to more accurately obtain recovery rates.
DD: ½ cm per year depending on spp. and water clarity
VK: many exhibit a non-linear growth rate
JK: take into account indirect impacts due to water quality decreases?
VK: monitoring for adjacent impacts?
DD: sedimentation impacts?
BR: impacts from de-watering of dredged sediments? impacts to water quality from dredge operation?
DD: For Section 7.7, include HEA calculations
TJ: MBRT?
VK: Relief, substrate, and depth are operative elements of “like-for-like” mitigation

DD: depth alone does not accurately predict the assemblage at the 3rd reef line, TOP of reef is the operative depth
VK: Conduct transects, in belt form:

#colonies	cover
0-5 per size class/sq. meter	
6-10	
11-15	

for hard corals, octocorals, sponges, macroalgae

BR: ID and locate corals for translocation
KB: Quarterly fish counts
VK: Video is quicker
TJ: Encrusting corals are likely to be damaged, so not as good as candidates for relocation
TJ: Harold Hudson should be consulted for translocation methods
KM: Mark/delineate effective impact areas underwater for use by divers to locate outer boundaries
VK: match diversity at recipient site
TJ: will send Broward County plan- [?]
BR: conduct benthic infauna studies in reef gaps
KM: differentiate LADS vs. LIDAR- use depths
multi-spectral imagery??

Section 7.3:
- enhancement area: remove overburden?
- add historical information (Great Lakes Dredging?)
- 79-81 Corps dredging in Harbor Phase II [??]

- {use area [?]} Avoidance/minimization

KM: use picture of area in paper
See KB, "Section 9" observation site [??]

Section 7.4:

KB: include Horn & Mille paper – available electronically

- 0.3 tires/square foot 1600 off of 100'x50' pulled by Robin
- get Robin's final report prepared for NOAA

KB: removal of corals difficult; encrusting corals break-up
KB: can get $/ac cost for Broward [tire removal cost, or disposal?]
DD: recovery rate, direction of movements of tire study
KB: armiflex to cover tires when pushed/placed offshore & placed in row- new consideration?
TJ: method- cutterhead?
KM: no economy of scale [?]
[JE note: AS supplied tipping fee amounts/ 100K tires - $1 per tire for recycling]
TJ: partnership for solid waste disposal?
KM: has info for disposal of tires

APPENDIX E-4

NMFS-Developed Mitigation Plan for Impacts to Reefs and Hardbottom Habitats

NOAA DISCUSSION DRAFT
CORAL PROPOGATION AND ACTIVE SPECIES ENHANCEMENT PROGRAM
June 7, 2013

Summary
Expansion of the Port Everglades Outer Entrance Channel will remove 20.34 acres of coral reef, and an additional 117.49 acres of reef is expected to be impacted by the anchoring of construction equipment and sedimentation (Figure 1 and Table 1)[1]. NOAA recommends the Jacksonville District Corps of Engineers (USACE) mitigate these impacts by propagating corals at one land-based nursery and approximately six nursery sites located offshore of Broward County and then transplanting the reared corals to natural reefs to enhance those reefs or to restore degraded sites. NOAA estimates this approach would require 20 years to complete and would cost approximately $28M to $36M. NOAA's recommendation is based on careful evaluation of the expected losses of scleractinian coral and octocorals from the expansion of the port's Outer Entrance Channel and the successes of coral propagation and enhancement programs in Atlantic and Caribbean waters.

The mitigation in this proposal would expand upon existing NOAA and partner programs that have been developed to manage and implement coral reef active propagation and population enhancement efforts. Specifically the work that was greatly expanded, but no longer supported, by the American Reinvestment and Recovery Act project titled *Threatened Coral Recovery in Florida and the U.S. Virgin Islands*. In Broward County, Florida, this project has been to date implemented through a partnership between NOAA, Nova Southeastern University, Broward County, The Nature Conservancy, and other coral restoration partners in Florida. NOAA would anticipate a continued partnership with these and other institutions to implement this mitigation project.

The recommended approach focuses on living corals, not on the reef framework (geologically described as rock and fossilized coral) that form the complex, three-dimensional structure upon which living corals occur. NOAA is still evaluating options to address impacts to the reef framework. Options include the beneficial use of excavated dredge material if that material meets size, shape, and quality specifications; emphasizing in the mitigation plan coral species that have significant three-dimensional structure (e.g., *Acropora cervicornis*); a combination of either approach; or approaches not yet considered. NOAA has not yet estimated the amount of structure that would need to be created, and we would like to work with the USACE and other resource agencies to determine the best path forward. Based on recent coordination with Florida Department of Environmental Protection (FDEP), we understand the FDEP would like to see up to 5 acres of boulder reef in the mitigation plan to offset the loss of reef structure. NMFS believes this approach has merit combined with the approach described in this proposal and we plan to further develop this with USACE and FDEP. Please note these comments only address the impacts to coral and hardbottom habitat; impacts to seagrass, mangroves, tidal creeks, and other habitats require separate discussions.

The cost of NOAA's recommended approach for mitigating the coral impacts is still under development and appears to be similar to the $32.4M estimated by the USACE for using boulder piles for mitigation (DCA 2011b). The proposed coral propagation and outplanting program has the added benefit of being designed to maximize the chances of successful natural coral reproduction, larval transport, settling and colonization into new areas, and genetic mixing required for survival and recovery of the species. Furthermore, this proposal is consistent with the NMFS *Acropora* Recovery Strategy (under development) and other coral recovery plans for coral species that may be listed under the Endangered Species Act. Next steps are described below.

[1] Additional corals are also present along the channel wall and existing channel bottom

Background
NOAA is a cooperating agency with the USACE for development of the Environmental Impact Statement (EIS) examining the Port Everglades expansion project. NOAA expects the EIS will describe a project alternative that we have determined to impact to 137.83 acres of coral, coral reef, and hardbottom (collectively referred to here as "reef"). NOAA informed the USACE that boulder piles would not offset the reef impacts and alternative mitigation approaches should be examined (see NOAA letter dated July 7, 2011). NOAA recommends the USACE mitigate the coral impacts by propagating coral colonies within nurseries and then outplanting the colonies to suitable sites off the Broward County coast. Coral colonies from propagation nurseries (Rinkevich 2005; Epstein et al. 2001; Becket et al. 2001; Horoszowski-Fridman et al. 2011) and salvaged from impact areas (Stephens 2007; Monty et al. 2006; Brownlee 2010; Thorton et al. 2000) have been successfully outplanted to natural and artificial substrates. NOAA's Restoration Center successfully uses this approach to mitigate damages to Caribbean reefs from vessel groundings, and this mitigation approach is rated the highest for southeast Florida by 25 coral resource trustees and scientists working in Florida and the U.S. Caribbean (Ladd 2012).

The key steps in formulating a mitigation strategy for the reef impacts are: (1) quantifying the reef impacts, (2) examining alternatives for offsetting the impacts, and (3) selecting an alternative based on cost, likelihood of success, and risk of failure. While additional information is needed to fully describe each of these key points, the initial screening has been done with the existing information and is discussed below.

Quantifying the Reef Impacts
Based on the information received from the USACE, NOAA anticipates the draft EIS will describe a tentatively selected plan that we have determined would result in direct impacts from dredging to 20.34 acres of reef (see Figure 1 and Table 1). An additional 117.49 acres of reef impacts are expected from anchoring of construction equipment and sedimentation. The number of corals within the 20.34-acre dredging area is on the order of 157,000 (DCA 2006); the number within the 117.49-acre indirect impact area has not been estimated. The five available survey reports for the direct impact area shows 29 species of scleractinian corals and 12 genera of octocorals are present (Karazsia and Wilber 2011). While staghorn coral (*Acropora cervicornis*), currently threatened and proposed as endangered under the Endangered Species Act (ESA), was not seen in towed-camera surveys (DCA 2010), these areas are designated critical habitat for *Acropora* spp., and staghorn coral occurs within 150 meters of the channel (Gilliam and Walker 2011). Thus, the 137.83 acres of reef and hard bottom impacts identified also constitute 137.83 acres of designated critical habitat potentially affected by the project. Additionally, NOAA has proposed ESA listing for seven Atlantic and Caribbean coral species, six of these species occur in the project area (DCA 2006).

As described in more detail later, NOAA estimates 195,000 to 250,000 corals need to be outplanted from nurseries to offset the impacts to coral from expanding the Port Everglades Outer Entrance Channel. NOAA's estimate assumes impacts to corals would be minimized by relocating many corals from the impact area to suitable locations; the estimate would need to be refined once the details of the relocation plan are clearer[2]. For current planning purposes, NOAA assumed the coral species and size classes presented in Table 2 would be relocated from impact areas prior to destruction or modification of coral reef habitat. More or less impact minimization would result in a lower or higher mitigation requirement. The cost of project minimization is not included this proposal.

[2] While coral impacts may be minimized through transplanting, considering the magnitude of the project, it may not be logistically feasible to transplant small coral colonies. Also, except for the anchoring locations, it may not be prudent to transplant coral colonies from the indirect impact area.

Alternatives for Offsetting the Impacts

Boulder Reefs: Based on an email from USACE dated May 31, 2013, NOAA anticipates the draft EIS will propose creation of 19 to 27 acres of boulder piles as compensatory mitigation at a cost of $12M to $13M and the EIS will describe that coral impact minimization measures (i.e., coral relocation) will cost an additional $8M. This approach aims at replacing the three-dimensional structure but does not compensate for the replacement of the living organisms. Boulder reefs have a high of risk of failure because the boulders do not mimic a natural reef system. Miller et al. (2009) documented an overall lack of similarity between natural reef and artificial reef assemblages. In addition, Gilliam (2012) concluded the length of time boulder reefs require to mitigate lost reef resources in southeast Florida, assuming a total loss of the impacted community from events such as dredging, is longer than 17 years (the age of the oldest boulder reef assessed in this study).

Coral Propagation and Transplanting: Ladd (2012) describes a thorough review of 11 reef mitigation and restoration options in southeast Florida. Based on consultation with 25 coral scientists and resource trustees from Florida and the U.S. Caribbean and a review of over 190 publications, enhancement of coral populations by nursery propagation and outplanting was preferred over other mitigation approaches due to logistical practicability and scientific feasibility. As noted above, coral propagation and outplanting, predominantly using *Acropora* spp., has been successfully used over the past decade in Florida and the Caribbean for reef rehabilitation. These efforts focused on *Acropora* spp. because these species exhibit faster growth rates than other Caribbean coral species, reproduce predominantly via asexual fragmentation, and can be propagated efficiently using both in-water and shore-based nurseries. When located where the likelihood of natural and human threat is low, propagation nurseries provide a low risk setting for growth of coral fragments (Herlan and Lirman 2008). While work to date has largely focused on *Acropora* species efforts are underway to transfer these successes to other coral species.

Scientifically vetted best practices for nursery propagation, outplanting, and monitoring have been developed and used by nursery managers in the Florida Keys, Broward County, Puerto Rico, U.S. Virgin Islands, and other Caribbean islands to reproduce *Acropora* spp. asexually (e.g., Johnson et. al 2011). Small fragments less than five centimeters in diameter are collected from the reef and held in an underwater or tank-based nursery environment through their juvenile life stage. Offshore nurseries are sited balancing a number of factors including, among others, appropriate habitat and water quality conditions, potential for future impacts, permitting. Once the stock nursery population is established, no more coral is collected from natural reef communities. The physical and genetic origin of each coral is tracked from fragment collection to ensure that both nursery and outplanting operations are done in a scientifically responsible way. Regular maintenance is performed on nursery structures and the corals themselves to ensure all are free of coral competitors and predators. Once coral fragments have grown to a size where the probability of survival on natural reef has increased to an acceptable level (this usually requires 12 to 18 months), the corals are outplanted to the natural reef.

Similar to nursery siting, outplanting sites are selected balancing several factors to maximize success. During outplanting, care is taken to ensure external stresses are minimized and that a population with an acceptable level of genetic diversity and environmental tolerance is developed. Algae and predators are removed from the outplanted corals until they are firmly established on the reef. A stock population is maintained within the nursery to provide new colonies for outplanting. The reduced levels of competition and predation, compared to natural reef communities, allow corals growing in a nursery to allocate their energy towards growth, and growth rates often exceeding those found in published studies, with small five-centimeter *A. cervicornis* fragments generating in excess of 50 centimeters of linear extension annually and 400% increase in biomass (personal communication to Tom Moore, NOAA Restoration Center; personal communication from Sean Griffin, PhD, NOAA Restoration Center, December 2012).

Thousands of 2nd and 3rd generation *Acropora* spp. corals have already been propagated and grown to maturity using these methods, including several sites in Broward, Miami-Dade, and Monroe Counties, Florida (TNC 2013; Young et al. 2012). When coupled with advanced genetics, nursery-reared corals with high survivorship potential can be outplanted to both healthy and degraded reefs to enhance the genetic diversity and size of remnant coral populations. These supplemented corals improve local reef structure and function but more importantly increase the likelihood of successful sexual reproduction[3] and contribute directly to the pool of coral larvae available to colonize adjacent reefs. Therefore, in addition to enhancing reef conditions generally, propagating and outplanting acroporids also serves the function of supporting the conservation goal identified in the final rule designating critical habitat for Acropora (73 FR 72210).

While much of the attention in the Atlantic and Caribbean to propagate corals has been directed towards *Acropora* spp., efforts in the past two years by NOAA and partners, including The Nature Conservancy, The Coral Restoration Foundation, Mote Marine Lab, University of Miami, Nova Southeastern University, Florida Fish and Wildlife Conservation Commission, The National Park Service, Puerto Rico Department of Natural and Environmental Resources, Sea Ventures Inc., Reef Scaping Inc., have focused on other scleractinian corals (e.g., *Madracis mirabilis* and *Dendrogyra cylindrus*). Techniques for propagating these species are still under development, and the life-history characteristics of most other species would result in longer nursery times before outplanting can occur. The mitigation for Port Everglades would need to balance the relative certainty of success using *Acropora* spp. for propagation against the need for species diversity.

While replacing coral colonies is an essential component of the reef mitigation, replacing the three-dimensional structure of the reef also is important. Beneficial use of excavated dredge material, assuming the material meets size, shape, and quality specifications, is one option for providing this structure. Another option is to use coral species that provide significant three-dimensional structure through their normal growth patterns (e.g., *Acropora cervicornis*). NOAA has not yet estimated the amount of structure that would need to be created, but is happy to work with the USACE, FDEP, and other resource agencies to determine the best path forward. Based on coordination with Florida Department of Environmental Protection, we believe that up to 5 acres of artificial reef creation may be appropriate to offset the loss of reef structure if combined with the approach described in this proposal.

Selecting an Alternative Based on Cost, Likelihood of Success, and Risk of Failure

Using Coral Propagation to Address the Impacts: NOAA recommends using Size/Species Frequency Distribution Equivalency Analysis, describe the reef ecosystem services that would be lost from the proposed Port Everglades expansion. As described in Viehman et al. (2009), this modified type of Habitat/Resource Equivalency Analysis (HEA/REA) uses a resource-to-resource method that references the number of organisms lost and the number gained through mitigation. In the coral reef environment, this approach examines the size-frequency distributions at the species or functional group level to reflect the life history strategies of different corals and allows representation of the typically non-linear relationship between services and colony size, thus providing insights into ecological function. Using this approach, the metric for scaling becomes a coral colony year (CCY). A CCY is not equal to coral age. CCY is a proxy for services provided or lost during a one-year period for a particular size and type of coral. The key inputs into this analysis are the size-by-species distribution and recovery time. The analysis also reflects economic considerations and other inputs used in REA and Habitat Equivalency Analysis, such as relative function, time to maturity, and project lifespan. Importantly, this analysis can

[3] There is a positive correlation between population size or density and the mean individual fitness (often measured as *per capita* population growth rate) of a population or species; this phenomenon is known as the Allee effect (Courchamp et al. 2008).

help determine the amount of compensatory mitigation needed to offset the expected losses from the Port Everglades expansion.

Using this analysis, NOAA estimates a 20-year program is needed to mitigate for the loss of corals within the direct and indirect impact areas from expanding the Port Everglades Outer Entrance Channel. This 20-year program would include six offshore nurseries and one land-based nursery to produce, outplant, and monitor enough corals to achieve the targets of surviving outplants. Existing in-situ and land based nurseries, located near the Port in waters offshore Broward County and managed by Nova Southeastern University, will likely be expanded and new sites added. The decision on species to be propagated and outplanted will be based on the state of the science and adaptive management. It is reasonable to expect that this program would result in outplanting of 195,000 to 250,000 nursery-grown corals depending on the species mix.

Adaptive Management: As with all mitigation projects, sound evaluation criteria, performance goals, capacity for adaptive management, and appropriate risk considerations are key. For example, studies are in progress to evaluate the target coral densities in areas to be outplanted at restoration sites to maximize success. Results from these studies will be incorporated into the outplant site selection plan. Further, outplanting site selection should reduce location-based sources of risk; however, should a site perform poorly due to local environmental conditions, an alternate site would be identified. For this project, NOAA is planning for a robust monitoring and evaluation program be included to assess the performance of both nursery operations and outplant survival against pre-established performance criteria. NOAA recognizes specific measures and estimated costs will need to be negotiated with the USACE for the final agreement. Given the extended duration of project implementation and the potential for a shifting baseline, performance goals should be established relative to the performance of other coral population enhancement programs and general reef health in the region. Deviations from performance goals would be addressed through the adaptive management framework.

Risk Management: The project would manage risk of failure by using six offshore nurseries and one land-based nursery, in addition to numerous outplanting locations, in order to maximize work windows, decrease exposure to localized stressors, and provide overall redundancy. Disadvantages of in-water coral nurseries include exposure to hurricanes, predators, diseases, extreme weather events, and tampering or inadvertent damage by the fishermen and boaters. Careful planning, monitoring, outreach, and education on fishing and anchoring issues and careful nursery site selection can decrease these risks.

NOAA also recommends final plans include contingencies to allow for recover from a catastrophic event that would otherwise not allow for project competition and/or meeting project goals. Such a contingency would need to allow for complete infrastructure replacement as well as sufficient operational funds to allow for recovery of the program. This is currently estimated to be $6.9M to 8M.

These risk management strategies are offered as discussion points. An examination of “force majeure” provisions in federal mitigation banking instruments may assist in moving this discussion along. NOAA recognizes specific contingencies and estimated costs will need to be negotiated with the USACE for the final agreement.

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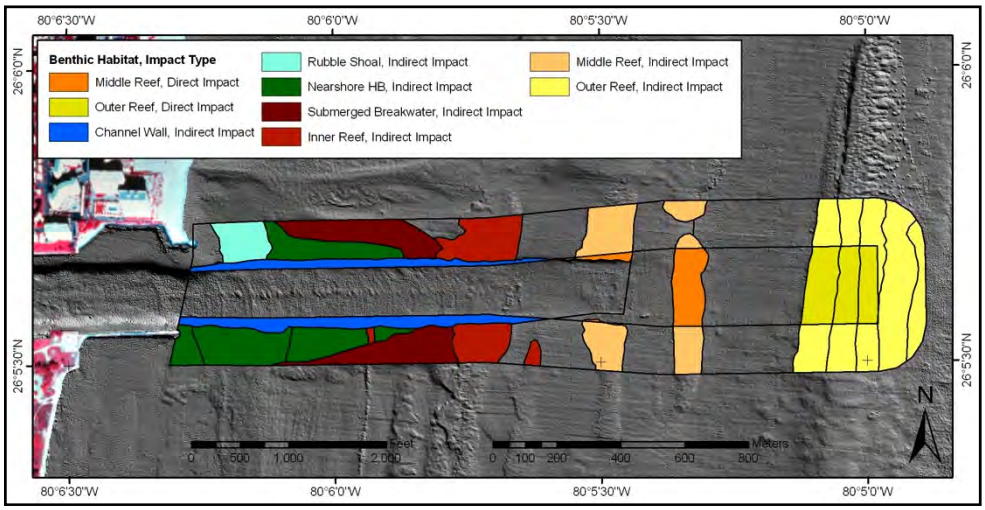

Figure 1: Coral Reef Habitat Types within the Port Everglades Expansion Area (from Walker et al. 2009)

Table 1: Coral Reef Habitat Types within the Port Everglades Expansion Area (from Walker et al. 2009)

Direct Impacts

HABITAT	TYPE	MODIFIER1	AREA (ft²)	ACRES	TYPE ac
Coral Reef and Colonized Hardbottom	Outer Reef	Aggregated Patch Reef**	301	0.01	13.54
		Spur and Groove	154971	3.56	
		Linear Reef-Outer	180259	4.14	
		Colonized Pavement-Deep	254450	5.84	
	Middle Reef	Linear Reef-Middle	296089	6.80	6.80
Inlet Channel Floor	Inlet Channel Floor	Inlet Channel Floor	2341644	53.76	53.76
Unconsolidated Sediments	Sand	Sand	1245485	28.59	28.59

Indirect Impacts

HABITAT	TYPE	MODIFIER1	AREA (ft²)	ACRES	TYPE ac
Coral Reef and Colonized Hardbottom	Outer Reef	Ridge-Deep	178647	4.10	28.26
		Aggregated Patch Reef**	257808	5.92	
		Spur and Groove	265158	6.09	
		Linear Reef-Outer	245716	5.64	
		Colonized Pavement-Deep	283893	6.52	
	Middle Reef	Linear Reef-Middle	692024	15.89	15.89
	Inner Reef	Linear Reef-Inner	589069	13.52	13.52
	Nearshore HB	Colonized Pavement-Shallow	639856	14.69	22.67
		Ridge-Shallow	347739	7.98	
Rubble Shoal	Rubble Shoal	Rubble Shoal	208071	4.78	4.78
Submerged Breakwater	Submerged Breakwater	Submerged Breakwater	748786	17.19	17.19
Inlet Channel Wall	Inlet Channel Wall	Inlet Channel Wall	661113	15.18	15.18
Unconsolidated Sediments	Sand	Sand	2413861	55.41	55.41

**** Aggregated Patch Reef is considered 50% reef/50% sand therefore the polygon area has been reduced by 50%**

Table 2: Coral species and size classes assumed for relocation outside of the project area (modified from Karazsia and Wilber 2011, table 4). Note for octocorals, we would expect that different size classes would be relocated. The * indicates the species has been documented within 150 meters of the federal channel.

Species	Size Class	Documented in the project area	ESA listing status
Acropora cervicornis	all	Yes*	listed
Acropora palmata	all	No	listed
Agaricia lamarcki	≥ 5 cm	Yes	proposed threatened
Dendrogyra cylindrus	≥ 5 cm	No	proposed endangered
Dichocoenia stokesii	≥ 5 cm	Yes	proposed threatened
Montastraea annularis	≥ 5 cm	Yes	proposed endangered
Montastraea faveolata	≥ 5 cm	No	proposed endangered
Montastraea franksi	≥ 5 cm	No	proposed endangered
Mycetophyllia ferox	≥ 5 cm	Yes	proposed endangered
Colpophyllia natans	≥ 5 cm	Yes	n/a
Dichocoenia stokesii	≥ 5 cm	Yes	n/a
Montastraea cavernosa	≥ 5 cm	Yes	n/a
Diploria clivosa	≥ 10 cm	Yes	n/a
Diploria labyrinthiformis	≥ 10 cm	Yes	n/a
Diploria strigosa	≥ 10 cm	Yes	n/a
Eusmilia fastigiata	≥ 10 cm	Yes	n/a
Madracis decactis	≥ 10 cm	Yes	n/a
Madracis pharensis	≥ 10 cm	Yes	n/a
Manicina areolata	≥ 10 cm	Yes	n/a
Meandrina meandrites	≥ 10 cm	Yes	n/a
Mussa angulosa	≥ 10 cm	Yes	n/a
Mycetophyllia aliciae	≥ 10 cm	Yes	n/a
Mycetophyllia lamarckiana	≥ 10 cm	Yes	n/a
Scolymia spp.	≥ 10 cm	Yes	n/a
Siderastrea siderea	≥ 10 cm	Yes	n/a
Solenastrea bournoni	≥ 10 cm	Yes	n/a
Solenastrea hyades	≥ 10 cm	Yes	n/a
Stephanocoenia intersepta	≥ 10 cm	Yes	n/a
Agaricia agaricites	≥ 10 cm	Yes	n/a
Porites astreoides	≥ 10 cm	Yes	n/a
Siderastrea radians	≥ 10 cm	Yes	n/a
Eunicea sp.		Yes	n/a
Muricea sp.		Yes	n/a
Plexaura sp.		Yes	n/a
Plexaurella sp.		Yes	n/a
Pterogorgia sp.		Yes	n/a

Budget	Item
Salaries	
	Program Director
	Field Project Manager/Senior Scientist
	Ops Coordinator
	Senior Field Tech
	Senior Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Labor Costs Assume Fully Loaded FTE's or Contractors
Travel/Supplies/Equipment	
	Supplies
	Field Equipment
	Travel
	IT Resources
	Vehicles Lease
	Acquisition and Replacement of 2-3 Vessels
	Vessel Scheduled and Anticipated Maintenance
	Dockage
	Office
	Storage
	Fuel
	Total
	Risk Mitigation
	Option 1 - USACE Maintains Risk for Project Failure and Cost Ove
	Option 2 - Project includes funds to rebuild from a catastrophic loss

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
$145,000	$150,075	$155,328	$160,764	$166,391	$172,215
$115,000	$119,025	$123,191	$127,503	$131,965	$136,584
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$100,000	$20,000	$21,000	$22,050	$50,000	$25,000
$35,000	$36,750	$38,588	$40,517	$42,543	$44,670
$35,000	$15,000	$15,750	$16,538	$40,000	$18,000
$14,500	$15,225	$15,986	$16,786	$17,625	$18,506
$650,000					
$10,000	$10,350	$10,712	$11,087	$11,475	$11,877
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$40,000	$41,400	$42,849	$44,349	$45,901	$47,507
$10,000	$10,350	$10,712	$11,087	$11,475	$11,877
$50,000	$51,750	$53,561	$55,436	$57,376	$59,384
$1,689,500	$920,150	$953,660	$988,408	$1,073,924	$1,062,263

rruns

s (major hurricane) that occurs prior to the completion of the project. Cost is calculated assuming that years 1-3 (p

Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
$178,242	$184,480	$190,937	$197,620	$204,537	$211,696
$141,364	$146,312	$151,433	$156,733	$162,219	$167,897
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$26,250	$27,563	$28,941	$100,000	$35,000	$36,750
$46,903	$49,249	$51,711	$54,296	$57,011	$59,862
$18,900	$19,845	$20,837	$45,000	$23,000	$24,150
$19,431	$20,403	$21,423	$22,494	$23,619	$24,800
			$850,000		
$12,293	$12,723	$13,168	$13,629	$14,106	$14,600
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$49,170	$50,891	$52,672	$54,516	$56,424	$58,399
$12,293	$12,723	$13,168	$13,629	$14,106	$14,600
$61,463	$63,614	$65,840	$68,145	$70,530	$72,998
$1,101,035	$1,141,244	$1,182,943	$2,168,923	$1,274,162	$1,320,837

ɪroject build out years) need to be repeated in order to get the project back on track and that Year 1

Year 13	Year 14	Year 15	Year 16	Year 17	Year 18
$219,105	$226,774	$234,711	$242,926	$251,428	$260,228
$173,773	$179,855	$186,150	$192,665	$199,408	$206,388
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$38,588	$40,517	$70,000	$44,000	$46,200	$48,510
$62,855	$65,998	$69,298	$72,762	$76,401	$80,221
$25,358	$26,625	$50,000	$29,000	$30,450	$31,973
$26,040	$27,342	$28,709	$30,144	$31,652	$33,234
$15,111	$15,640	$16,187	$16,753	$17,340	$17,947
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$60,443	$62,558	$64,748	$67,014	$69,359	$71,787
$15,111	$15,640	$16,187	$16,753	$17,340	$17,947
$75,553	$78,198	$80,935	$83,767	$86,699	$89,734
$1,369,250	$1,419,467	$1,521,056	$1,524,563	$1,580,561	$1,638,651

8, 19, & 20 actually occur in Year 21, 22, & 23 and therefore are approrpatiely inflation adjusted.

Year 19	Year 20	
$269,336	$278,763	$4,100,554
$213,611	$221,088	$3,252,163
$139,312	$144,188	$2,120,976
$139,312	$144,188	$2,120,976
$139,312	$144,188	$2,120,976
$102,162	$105,738	$1,555,382
$102,162	$105,738	$1,555,382
$102,162	$105,738	$1,555,382
$102,162	$105,738	$1,555,382
$37,150	$38,450	$565,594
$50,936	$53,482	$884,785
$84,232	$88,443	$1,157,308
$33,571	$35,250	$554,246
$34,896	$36,641	$479,456
		$1,500,000
$18,575	$19,225	$282,797
$37,150	$38,450	$565,594
$74,300	$76,900	$1,131,187
$18,575	$19,225	$282,797
$92,874	$96,125	$1,413,984
$1,698,913	$1,761,430	#########

Budget	Item
Salaries	
	Program Director
	Field Project Manager/Senior Scientist
	Ops Coordinator
	Senior Field Tech
	Senior Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Labor Costs Assume Fully Loaded FTE's or Contractors
Travel/Supplies/Equipment	
	Supplies
	Field Equipment
	Travel
	IT Resources
	Vehicles Lease
	Acquisition and Replacement of 2-3 Vessels
	Vessel Scheduled and Anticipated Maintenance
	Dockage
	Office
	Storage
	Fuel
	Total
	Risk Mitigation
	Option 1 - USACE Maintains Risk for Project Failure and Cost Ove
	Option 2 - Project includes funds to rebuild from a catastrophic loss

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
$145,000	$150,075	$155,328	$160,764	$166,391	$172,215
$115,000	$119,025	$123,191	$127,503	$131,965	$136,584
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$30,000	$31,050	$32,137	$33,262	$34,426	$35,631
$250,000	$20,000	$21,000	$22,050	$50,000	$25,000
$35,000	$36,750	$38,588	$40,517	$42,543	$44,670
$35,000	$15,000	$15,750	$16,538	$40,000	$18,000
$14,500	$15,225	$15,986	$16,786	$17,625	$18,506
$750,000					
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$25,000	$25,875	$26,781	$27,718	$28,688	$29,692
$40,000	$41,400	$42,849	$44,349	$45,901	$47,507
$15,000	$15,525	$16,068	$16,631	$17,213	$17,815
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$2,119,500	$1,096,100	$1,135,768	$1,176,890	$1,269,002	$1,264,170

rruns

s (major hurricane) that occurs prior to the completion of the project. Cost is calculated assuming that years 1-3 (p

Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
$178,242	$184,480	$190,937	$197,620	$204,537	$211,696
$141,364	$146,312	$151,433	$156,733	$162,219	$167,897
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$36,878	$38,168	$39,504	$40,887	$42,318	$43,799
$26,250	$27,563	$28,941	$250,000	$35,000	$36,750
$46,903	$49,249	$51,711	$54,296	$57,011	$59,862
$18,900	$19,845	$20,837	$45,000	$23,000	$24,150
$19,431	$20,403	$21,423	$22,494	$23,619	$24,800
			$950,000		
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$30,731	$31,807	$32,920	$34,072	$35,265	$36,499
$49,170	$50,891	$52,672	$54,516	$56,424	$58,399
$18,439	$19,084	$19,752	$20,443	$21,159	$21,900
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$1,310,009	$1,357,531	$1,406,801	$2,650,616	$1,513,964	$1,569,032

ɪroject build out years) need to be repeated in order to get the project back on track and that Year 1

Year 13	Year 14	Year 15	Year 16	Year 17	Year 18
$219,105	$226,774	$234,711	$242,926	$251,428	$260,228
$173,773	$179,855	$186,150	$192,665	$199,408	$206,388
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$45,332	$46,919	$48,561	$50,260	$52,020	$53,840
$38,588	$40,517	$70,000	$44,000	$46,200	$48,510
$62,855	$65,998	$69,298	$72,762	$76,401	$80,221
$25,358	$26,625	$50,000	$29,000	$30,450	$31,973
$26,040	$27,342	$28,709	$30,144	$31,652	$33,234
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$37,777	$39,099	$40,467	$41,884	$43,350	$44,867
$60,443	$62,558	$64,748	$67,014	$69,359	$71,787
$22,666	$23,459	$24,280	$25,130	$26,010	$26,920
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$1,626,132	$1,685,339	$1,796,234	$1,809,372	$1,875,339	$1,943,746

8, 19, & 20 actually occur in Year 21, 22, & 23 and therefore are approrpatiely inflation adjusted.

Year 19	Year 20	
$269,336	$278,763	$4,100,554
$213,611	$221,088	$3,252,163
$139,312	$144,188	$2,120,976
$139,312	$144,188	$2,120,976
$139,312	$144,188	$2,120,976
$111,449	$115,350	$1,696,781
$111,449	$115,350	$1,696,781
$111,449	$115,350	$1,696,781
$111,449	$115,350	$1,696,781
$111,449	$115,350	$1,696,781
$111,449	$115,350	$1,696,781
$55,725	$57,675	$848,390
$50,936	$53,482	$1,184,785
$84,232	$88,443	$1,157,308
$33,571	$35,250	$554,246
$34,896	$36,641	$479,456
		$1,700,000
$37,150	$38,450	$565,594
$46,437	$48,063	$706,992
$74,300	$76,900	$1,131,187
$27,862	$28,838	$424,195
$111,449	$115,350	$1,696,781
$2,014,686	$2,088,255	#########

Budget	Item
Salaries	
	Program Director
	Field Project Manager/Senior Scientist
	Ops Coordinator
	Senior Field Tech
	Senior Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Labor Costs Assume Fully Loaded FTE's or Contractors
Travel/Supplies/Equipment	
	Supplies
	Field Equipment
	Travel
	IT Resources
	Vehicles Lease
	Acquisition and Replacement of 2-3 Vessels
	Vessel Scheduled and Anticipated Maintenance
	Dockage
	Office
	Storage
	Fuel
	Total
	Risk Mitigation
	Option 1 - USACE Maintains Risk for Project Failure and Cost Ove
	Option 2 - Project includes funds to rebuild from a catastrophic loss

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
$145,000	$150,075	$155,328	$160,764	$166,391	$172,215
$115,000	$119,025	$123,191	$127,503	$131,965	$136,584
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$55,000	$56,925	$58,917	$60,979	$63,114	$65,323
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$100,000	$20,000	$21,000	$22,050	$50,000	$25,000
$35,000	$36,750	$38,588	$40,517	$42,543	$44,670
$35,000	$15,000	$15,750	$16,538	$40,000	$18,000
$14,500	$15,225	$15,986	$16,786	$17,625	$18,506
$650,000					
$10,000	$10,350	$10,712	$11,087	$11,475	$11,877
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$40,000	$41,400	$42,849	$44,349	$45,901	$47,507
$10,000	$10,350	$10,712	$11,087	$11,475	$11,877
$50,000	$51,750	$53,561	$55,436	$57,376	$59,384
$1,689,500	$920,150	$953,660	$988,408	$1,073,924	$1,062,263

rruns

s (major hurricane) that occurs prior to the completion of the project. Cost is calculated assuming that years 1-3 (p

Year 7	Storm Year	Recovery Year 1	Recovery Year 2	Year 8	Year 9
$178,242	$184,480	$190,937	$197,620	$204,537	$211,696
$141,364	$146,312	$151,433	$156,733	$162,219	$167,897
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$67,609	$69,975	$72,424	$74,959	$77,583	$80,298
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$25,875	$103,500	$27,000	$27,945	$28,923	$30,369
$46,233	$47,851	$49,526	$51,260	$53,054	$55,706
$18,630	$36,000	$19,000	$19,665	$20,353	$21,371
$19,154	$19,824	$20,518	$21,236	$21,979	$23,078
	$850,000				
$12,293	$12,723	$13,168	$13,629	$14,106	$14,600
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$49,170	$50,891	$52,672	$54,516	$56,424	$58,399
$12,293	$12,723	$13,168	$13,629	$14,106	$14,600
$61,463	$63,614	$65,840	$68,145	$70,530	$72,998
$1,099,443	$2,081,360	$1,176,076	$1,217,238	$1,259,842	$1,305,801

ɪroject build out years) need to be repeated in order to get the project back on track and that Year 1

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
$219,105	$226,774	$234,711	$242,926	$251,428	$260,228
$173,773	$179,855	$186,150	$192,665	$199,408	$206,388
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$83,109	$86,018	$89,028	$92,144	$95,369	$98,707
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$100,000	$35,000	$36,750	$38,588	$40,517	$70,000
$58,492	$61,416	$64,487	$67,712	$71,097	$74,652
$45,000	$23,000	$24,150	$25,358	$26,625	$50,000
$24,232	$25,444	$26,716	$28,052	$29,455	$30,927
$1,000,000					
$15,111	$15,640	$16,187	$16,753	$17,340	$17,947
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$60,443	$62,558	$64,748	$67,014	$69,359	$71,787
$15,111	$15,640	$16,187	$16,753	$17,340	$17,947
$75,553	$78,198	$80,935	$83,767	$86,699	$89,734
$2,444,134	$1,403,845	$1,455,152	$1,508,364	$1,563,553	$1,670,293

8, 19, & 20 actually occur in Year 21, 22, & 23 and therefore are approrpatiely inflation adjusted.

Year 16	Year 17	Year 18	Year 19	Year 20	
$269,336	$278,763	$288,519	$298,618	$309,069	$4,996,760
$213,611	$221,088	$228,826	$236,835	$245,124	$3,962,948
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$102,162	$105,738	$109,438	$113,269	$117,233	$1,895,323
$102,162	$105,738	$109,438	$113,269	$117,233	$1,895,323
$102,162	$105,738	$109,438	$113,269	$117,233	$1,895,323
$102,162	$105,738	$109,438	$113,269	$117,233	$1,895,323
$37,150	$38,450	$39,796	$41,189	$42,630	$689,208
$44,000	$46,200	$48,510	$50,936	$53,482	$1,045,644
$78,385	$82,304	$86,419	$90,740	$95,277	$1,372,678
$29,000	$30,450	$31,973	$33,571	$35,250	$629,683
$32,474	$34,097	$35,802	$37,592	$39,472	$568,681
					$2,500,000
$18,575	$19,225	$19,898	$20,594	$21,315	$344,604
$37,150	$38,450	$39,796	$41,189	$42,630	$689,208
$74,300	$76,900	$79,592	$82,377	$85,260	$1,378,417
$18,575	$19,225	$19,898	$20,594	$21,315	$344,604
$92,874	$96,125	$99,489	$102,972	$106,576	$1,723,021
$1,679,137	$1,740,665	$1,804,484	$1,870,681	$1,939,348	#########

Budget	Item
Salaries	
	Program Director
	Field Project Manager/Senior Scientist
	Ops Coordinator
	Senior Field Tech
	Senior Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Field Tech
	Labor Costs Assume Fully Loaded FTE's or Contractors
Travel/Supplies/Equipment	
	Supplies
	Equipment
	Travel
	IT Resources
	Vehicles Lease
	Acquisition and Replacement of 2-3 Vessels
	Vessel Scheduled and Anticipated Maintenance
	Dockage
	Office
	Storage
	Fuel
	Total
	Risk Mitigation
	Option 1 - USACE Maintains Risk for Project Failure and Cost Ove
	Option 2 - Project includes funds to rebuild from a catastrophic loss

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
$145,000	$150,075	$155,328	$160,764	$166,391	$172,215
$115,000	$119,025	$123,191	$127,503	$131,965	$136,584
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$75,000	$77,625	$80,342	$83,154	$86,064	$89,076
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$30,000	$31,050	$32,137	$33,262	$34,426	$35,631
$250,000	$20,000	$21,000	$22,050	$100,000	$25,000
$35,000	$36,750	$38,588	$40,517	$42,543	$44,670
$35,000	$15,000	$15,750	$16,538	$40,000	$18,000
$14,500	$15,225	$15,986	$16,786	$17,625	$18,506
$750,000					
$20,000	$20,700	$21,425	$22,174	$22,950	$23,754
$25,000	$25,875	$26,781	$27,718	$28,688	$29,692
$40,000	$41,400	$42,849	$44,349	$45,901	$47,507
$15,000	$15,525	$16,068	$16,631	$17,213	$17,815
$60,000	$62,100	$64,274	$66,523	$68,851	$71,261
$2,119,500	$1,096,100	$1,135,768	$1,176,890	$1,319,002	$1,264,170

rruns

s (major hurricane) that occurs prior to the completion of the project. Cost is calculated assuming that years 1-3 (p

Year 7	Storm Year	Recovery Year 1	Recovery Year 2	Year 8	Year 9
$178,242	$184,480	$190,937	$197,620	$204,537	$211,696
$141,364	$146,312	$151,433	$156,733	$162,219	$167,897
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$92,194	$95,421	$98,761	$102,217	$105,795	$109,498
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$36,878	$38,168	$39,504	$40,887	$42,318	$43,799
$25,875	$255,000	$27,000	$27,945	$28,923	$30,369
$46,233	$47,851	$49,526	$51,260	$53,054	$55,706
$18,630	$36,000	$19,000	$19,665	$20,353	$21,371
$19,154	$19,824	$20,518	$21,236	$21,979	$23,078
	$850,000				
$24,585	$25,446	$26,336	$27,258	$28,212	$29,199
$30,731	$31,807	$32,920	$34,072	$35,265	$36,499
$49,170	$50,891	$52,672	$54,516	$56,424	$58,399
$18,439	$19,084	$19,752	$20,443	$21,159	$21,900
$73,755	$76,337	$79,009	$81,774	$84,636	$87,598
$1,308,416	$2,449,148	$1,399,933	$1,448,931	$1,499,643	$1,553,995

ıroject build out years) need to be repeated in order to get the project back on track and that Year 1

Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
$219,105	$226,774	$234,711	$242,926	$251,428	$260,228
$173,773	$179,855	$186,150	$192,665	$199,408	$206,388
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$113,330	$117,297	$121,402	$125,651	$130,049	$134,601
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$45,332	$46,919	$48,561	$50,260	$52,020	$53,840
$250,000	$35,000	$36,750	$38,588	$40,517	$70,000
$58,492	$61,416	$64,487	$67,712	$71,097	$74,652
$45,000	$23,000	$24,150	$25,358	$26,625	$50,000
$24,232	$25,444	$26,716	$28,052	$29,455	$30,927
$950,000					
$30,221	$31,279	$32,374	$33,507	$34,680	$35,894
$37,777	$39,099	$40,467	$41,884	$43,350	$44,867
$60,443	$62,558	$64,748	$67,014	$69,359	$71,787
$22,666	$23,459	$24,280	$25,130	$26,010	$26,920
$90,664	$93,837	$97,122	$100,521	$104,039	$107,681
$2,801,016	$1,669,717	$1,730,330	$1,793,174	$1,858,330	$1,975,388

8, 19, & 20 actually occur in Year 21, 22, & 23 and therefore are approrpatiely inflation adjusted.

Year 16	Year 17	Year 18	Year 19	Year 20	
$269,336	$278,763	$288,519	$298,618	$309,069	$4,996,760
$213,611	$221,088	$228,826	$236,835	$245,124	$3,962,948
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$139,312	$144,188	$149,234	$154,457	$159,863	$2,584,531
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$55,725	$57,675	$59,694	$61,783	$63,945	$1,033,812
$44,000	$46,200	$48,510	$50,936	$53,482	$1,547,144
$78,385	$82,304	$86,419	$90,740	$95,277	$1,372,678
$29,000	$30,450	$31,973	$33,571	$35,250	$629,683
$32,474	$34,097	$35,802	$37,592	$39,472	$568,681
					$2,550,000
$37,150	$38,450	$39,796	$41,189	$42,630	$689,208
$46,437	$48,063	$49,745	$51,486	$53,288	$861,510
$74,300	$76,900	$79,592	$82,377	$85,260	$1,378,417
$27,862	$28,838	$29,847	$30,891	$31,973	$516,906
$111,449	$115,350	$119,387	$123,566	$127,891	$2,067,625
$1,994,910	$2,067,490	$2,142,748	$2,220,785	$2,301,705	#########

NMFS Responses to Questions Raised by Jason Spinning

US Army Corps of Engineers, Jacksonville District

June 7, 2013

Overall comment: To minimize confusion, recommend NMFS and COE we adopt a common terminology:

- Transplant = relocate off natural reef as a minimization measure
- Outplant = relocate propagated corals from nursery to reef

1. Please explain the cost of the proposed mitigation and how it would be spread over the 20 years. Understanding that the potential funding may not be provided until the project is Authorized, Appropriated, Permitted, and the Contract Awarded. Timeframe cannot be determined. First major step is completion of a policy compliance Feasibility Study and Chief's Report awaiting a Water Resources Development Act (WRDA) bill signed. Last one was 2007 and before that 2000.

- A draft budget spreadsheet is attached.

2. What would be the final location for transplantation? This goes to the potential of compensating for the impacts at the project footprint.

- In this response, we assume that when Jason uses the term *transplantation*, he is asking about the outplants from the nursery (versus corals relocated outside of the project area as minimization). Generally outplanting will occur on reef located offshore Broward County. Identifying the exact locations for ouplanting will not be problematic, but is not appropriate to do at this point in time. Outplant site selection will be determined based on a strategy designed and included in the NOAA active propagation plan that is currently being developed. Therefore there is no risk that there will not be appropriate sites available for outplanting. Current and anticipated regulatory mechanisms and conservation priorities will also increase the feasibility of identifying suitable outplanting efforts.

3. How would the proposed coral propagation mitigation alternative compensate for the impacts generated by the project? Written statement?

- This mitigation alternative has the capability to replace coral ecosystem functions lost as a result of expansion at Port Everglades. Additionally, the coral propagation program will allow for the type of larval transport, settling and colonization into new areas, and genetic mixing required for

survival and recovery of the species. NOAA's recommendation is based on careful evaluation of the expected losses of live scleractinian coral and octocorals from the expansion of the port's Outer Entrance Channel and the successes of coral propagation and enhancement programs in Atlantic and Caribbean waters. This proposal is based on utilizing existing NOAA programs and experience to manage the implementation of the project in conjunction with local resource agencies and universities. The success of past active population enhancement and coral propagation efforts, combined with the potential for this option to considerably contribute to improved southeast Florida coral reef ecosystem health and protected resources conservation, identifies coral propagation and species enhancement as NOAA preferred option for coral reef mitigation.

The project will increase production of propagated corals, help rebuild populations of this threatened species, restore coral reefs, improve ecosystem services, and invest in the infrastructure needed for future restoration activities. When coupled with advanced genetics, nursery-reared corals with high survivorship potential (typically 1 year or more in age) can be outplanted to adjacent degraded reefs to enhance the genetic diversity and population size of remnant coral populations. These supplemented corals will improve local reef structure and function but more importantly they directly contribute to the pool of coral larvae available to adjacent reefs during normal coral spawning periods. It is estimated that a coral reef that is seeded with just 35 nursery-raised *Acropora* colonies per year can recover to 1970's levels of coral cover within 10 years. Natural rates of recovery would require several decades under best case scenarios. By building on the success of the previous restoration work in South Florida, we will be able to restore corals to reefs that have been chronically degraded by bleaching, disease, hurricanes, coastal development and destructive fishing gear, as well as reefs acutely damaged by ship grounding and anchor damage.

Coral restoration techniques have the potential to reverse the population decline and accelerate the re-growth of a reef after disturbances. Based on current models from Center for Marine Biodiversity and Conservation and NOAA, under ideal conditions with no action it will take at least 300 years for the Acropora population to recover to historic norms. However, with large-scale active restoration, this time frame could be notably reduced. By increasing population numbers through restoration of genetically diverse transplanted fragments, the likelihood of successful cross-fertilization between these corals is increased. This will help acroporid corals overcome the Allee effect, where reproduction and survival of individuals decrease in smaller populations and increase recruitment rates within both regions.

4. We may be looking at a combination of alternatives or even components of each alternative as the overall solution. What is the proposed structural component for the transplantation understanding that beneficial use of dredged rock may not be appropriate due to material size? What about using known grounding locations for transplantation or relocation in combo?

- In this response, we assume that when Jason uses the term *transplantation*, he refers to the corals relocated from natural reef as minimization and *relocation* refers to corals outplanted from a nursery. We recommend the EIS include all options for these corals including natural reef, artificial reef material, and known grounding locations that have been meet minimum requirements that we could jointly develop – for example, suitable grounding sites include those that have had rubble stabilized. FDEP Coral Reef Conservation Program maintains a list of known orphaned grounding sites. Per a phone conversation on June 6, 2013, with the FDEP CRCP Regional Administrator, Joanna Walczak, FDEP believes nursery reared corals will be needed for planned restoration activities at these sites. Using a combination of transplanted and outplanted corals at the same restoration site would require careful planning to ensure that performance criteria could be measured. The EIS could list the components in tabular form and then ask the public which of these elements, or if all of these elements are needed in the mitigation plan. If possible, flexibility should be maintained for the resource managers to determine the exact mix of site types and site locations until closer to actual project implementation.

5. Since there is no Acropora within the project footprint but the site is within CH, what is the reasonable assurance that the propagation and transplantation would be successful?

- While *Acropora* spp. have not yet been documented to occur directly within the project site, the species do occur near the site and throughout the waters of Broward County, in varying densities. Further, as designated critical habitat, it is NMSF's judgment that the area (i.e., impacted reef and reefs throughout Broward County) could support recruitment and growth of the species. This has proven true through the successful implementation of nursery and outplanting operations in Broward County.

  For example, the NOAA proposal builds on the success of the previous restoration work in South Florida. Coral propagation projects were started in 2000 by the Coral Restoration Foundation (CRF) in the Keys in 2000. In 2004, The Nature Conservancy (TNC) and Coral Restoration Foundation (CRF) initiated a Staghorn Coral Restoration Project funded through the National Partnership between NOAA Community-Based Restoration Program and The Nature Conservancy (NOAA/TNC CRP). All outplanting has been monitored to evaluate survivorship and growth rates as related to coral genotype. Results and lessons learned from this pilot project have been integrated into the NOAA proposal to ensure the practices are followed that yield the highest growth and survivorship rates.

  In August 2006, additional funding was received through the NOAA/TNC CRP to expand the Upper Keys restoration efforts and replicate the restoration approach in three more sub-regions of the Florida Reef Tract (i.e. Lower Keys, Biscayne, and Broward). In each sub-region a new nursery site was established by a new project partner (i.e. Mote Marine Laboratory, University

of Miami, and Nova Southeastern University respectively) which coordinated permitting and field work with local resource management agencies (i.e. FKNMS, Biscayne National Park [BNP], Broward County Department of Environmental Protection respectively). This expanded project allow comparisons between genotypic fitness in staghorn coral across much of the Florida Reef Tract. Evaluation of sub-regional and zonal variation in survivorship and growth established a solid basis for siting larger-scale restoration efforts to provide the greatest returns in restoration success and corresponding improvements in goods and services.

By building on the success of the previous restoration work in South Florida, and partnering with the local academic and coral reef management agencies we will be able to replicate success and restore corals to reefs that have been degraded by a myriad of issues that may include coastal development, bleaching, disease, hurricanes, and/or reefs acutely damaged by ship grounding and anchor damage.

6. All Acropora and corals >5cm, again what is the likelihood for success for these individuals at this small size?

- In calculating impacts, we generously estimated that 90% of the corals are relocated and 85% survive relocation after three years. The likelihood of success is high. Corals greater than or equal to 5 centimeters in diameter can be successfully relocated. Brownlee (2010) successfully transplanted small coral (*Siderastrea siderea, Dichocoenia stokesii,* and *Porites porites*) with greater than 80 percent survivorship after 13 months. Monty et al. (2006) successfully transplanted 250 corals (14 species) ranging from 5 to 40 centimeters in diameter with a high rate of survivorship. These corals were monitored for 13 months. Eight species had 100 percent survivorship, including 78 *Siderastrea siderea*. Thornton et al. (2000) transplanted 271 corals from an outfall pipe in Broward County to an articulated concrete mat. *Siderastrea siderea* comprised 90 percent of the corals <1 to 100 square centimeters in size. After 27 months, 266 of the corals had survived (87 percent), as compared to 83 percent survival for corals on the nearby natural substrate. In addition, Stephens (2007) salvaged from a coastal construction impact site in Broward County and 92 to 100% of the transplants survived after 18 to 24 months.

7. Contingency planning, the Corps does not have the capability for the extra funding (risk) if the propagation efforts fail. Management would be against being on the hook if NOAA efforts or other entity efforts would not be successful. They view this as a mitigation banking type arrangement where the money for the work would be provided and then we would walk away. If this is a component of the mitigation plan then the Corps will need to limit liability for overall success of this effort and to ensure there is not a cost risk above normal contingencies.

- We understand this and that is why we are willing to include the contingency funds as part of the project. Based on this feedback, we can revise the overall cost to include contingency and

drop the discussion of risk having multiple options. This is reflected as "Option 2" in the attached budget.

Literature Cited:

Brownlee A.S. 2010. Transplantation and parrotfish predation: A study on small *Siderastrea sidereal* offshore Broward County, FL USA. Master's Thesis. NOVA Southeastern University Oceanographic Center.

Monty J.A., Gilliam D.S., Banks K.W., Stout D.K., Dodge R.E. 2006. Coral of opportunity survivorship and the use of coral nurseries in coral reef restoration. Proceedings to the 10th International Coral Reef Symposium: 1665-1673.

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SAFMC. 2009. Fishery Ecosystem Plan of the South Atlantic Region. www.safmc.net/ecosystem/Home/EcosystemHome/tabid/435/Default.aspx

Stephens, N.R. 2007. Stony coral transplantation associated with coastal and marine construction activities. Master's Thesis submitted to Nova Southeastern University Oceanographic Center. 75 pp.

Thornton S.L., Dodge R.E., Gilliam D.S., DeVictor R., Cook P. 2000. Success and growth of corals transplanted to concrete armor mat tiles in southeast Florida: Implications for reef restoration. Proceedings to the 9th International Coral Reef Symposium: Volume 2:23-27.

Viehman, S., Thur, S. and Piniak, G. 2009. Coral Reef Metrics and Habitat Equivalency Analysis. Ocean and Coastal Management 52: 181-188.

APPENDIX E-5

Monitoring Protocols

PORT EVERGLADES EXPANSION MONITORING PLAN
U.S. ARMY CORPS OF ENGINEERS (USACE)

All monitoring and associated reporting for the seagrass and mangrove mitigation at West Lake Park shall be performed by the Broward County Parks Department or their contractors as required under Department of Army Permit Number #2002-00072. Those requirements are incorporated by reference.

This monitoring plan is based on the Monitoring Plan developed for the Miami Harbor Expansion Project as part of the Florida Department of Protection Permit # 0305721-001-BI issued May 22, 2012. It may be updated based on the lessons learned from and results of the Miami Harbor expansion project scheduled to begin construction in early 2013.

Pre and During Construction Monitoring

MONITORING IN THE AREA OF HARDBOTTOM COMMUNITIES AND CORAL REEFS:
The proposed monitoring of the Port Everglades Channel deepening and widening project includes monitoring for direct and indirect impacts to hardbottom and coral reef communities in the project area and adjacent areas. Monitoring activities shall include pre-, during, and post-construction surveys of hardbottom and coral reef communities.

Monitoring Stations
Stations will be established within each habitat type identified in the Benthic and Fish Community Assessment at Port Everglades Harbor Entrance Channel, hereafter referred to as the "Benthic Assessment" (DCA, 2009), adjacent to of the Entrance channel to evaluate potential construction and sediment impacts as well as evaluate any long-term impacts to the benthic assemblages. An example of these stations is presented in Figure 1. Three 20-m transects will be established 10 meters from the channel edge in a north-south direction, at each hard bottom habitat type station identified in the Benthic Assessment (R3N-1; R3N-2; R3N-3; R3S-1; R3S-2; R3S-3; R2N-1; R2N-2; R2S-1; R2S-2; HBN-1; HBN-2; HBS-1; HBS-2 for a total of 14 stations and 42 transects, 20 meters long by 40 cm (0.40 meters) wide equaling 336 m^2 of project area being directly monitored. Additionally, 12 control sites with three transects per site (36 transects) in analogous habitat areas of equal length and width for a total of 288m^2 will also be established and monitored to detect natural variation in the resources and to assist in determining the effects of the actual dredge operations on the resources surrounding the project area.

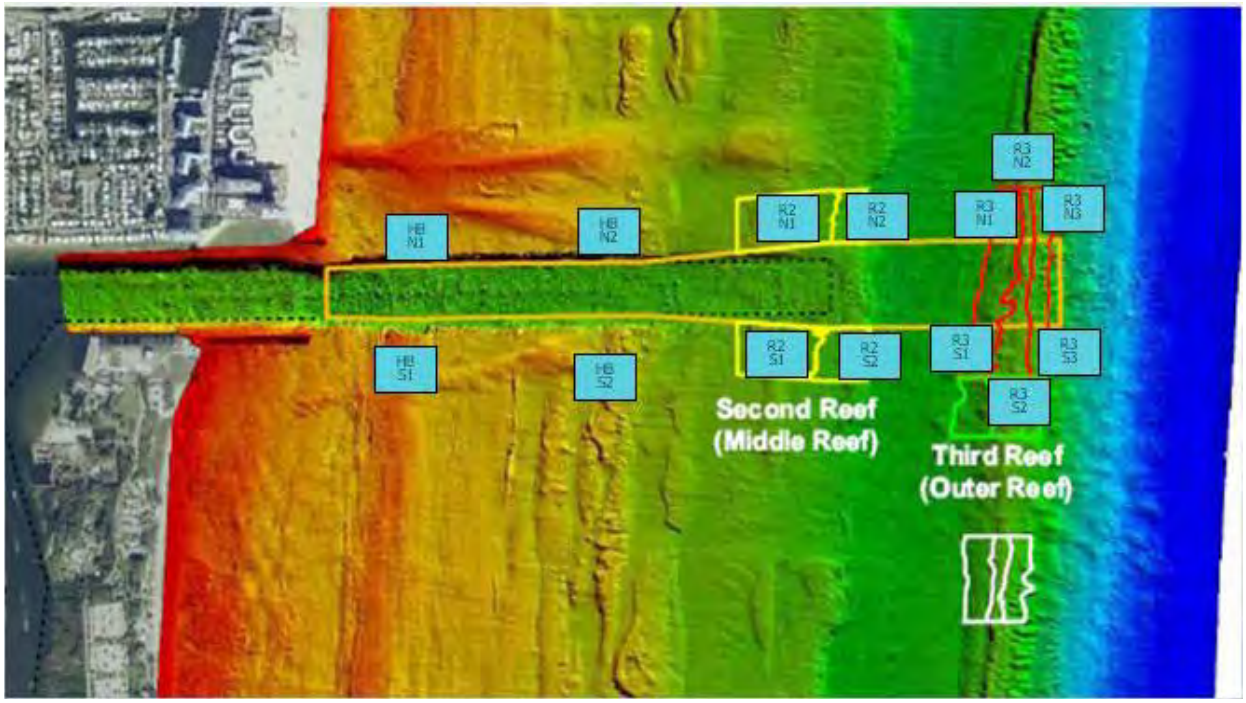

Figure 1 - Monitoring Station Locations

Transects will be located within hard bottom/reef resources adjacent to the project area and within comparable reference areas previously identified in the Baseline Report. Individual station transects will be at least 5 m apart within each habitat type. They will be randomly positioned within areas that include coral colonies and other attached fauna within each specific resource type. Stainless steel eyebolts (3/8-in. by 8-in.) will be drilled and epoxied into the bottom at 0, 10, and 20 meters along each transect at the hard bottom and reef sites. A small closed-cell foam float coated with anti-fouling paint will be attached to each eyebolt with a short length of nylon braided line to aid in transect relocation. All transect marker eyebolts and buoys will be removed following completion of the monitoring program. Vertical-format quantitative digital video data will be collected along each transect with the camera positioned 40 cm above and perpendicular to the substrate. This will yield an approximately 40-cm wide video field-of-view. The video camera will be equipped with lights and a measuring stick or calibrated lasers to ensure the camera remains at the 40-cm distance to the bottom. The diver will swim the camera along each transect at a speed of no greater than approximately 5-meters per minute. This method will be used to evaluate both the coral health and potential sedimentation stress during construction at both the dredge location site and the control monitoring station sites as further described below:

Quality Assurance/Quality Control (QA/QC) and Safety. Qualified marine biologists trained in conducting hardbottom and seagrass monitoring surveys shall conduct this work (minimum qualification of BS in marine biology). Inter-observer variability exists through the level of detail as defined by each marine biologist when utilizing similar survey methods, particularly in methods of rapid assessment that will used for this survey. Therefore, additional QA/QC measures will include the collection of a sample data set by each marine biologist in two transects of the initial set of transects. This QA/QC test will be conducted **prior** to collecting project-specific data (i.e., before commencement of dredging). The initial QA/QC exercise shall observe swimming technique and measurement collection along the transect line. The sediment depth measurements of each surveying crew member shall be compared to one another and statistically treated. The results of the sample data set shall be reviewed by the team to ensure consistency in species identification, percent cover (not more than 10% deviation), sediment thickness (not more than 5mm average difference), and/or the level of detail of organisms observed. Variability of $\geq$10% and/or unidentified organisms may require the collection of a second sample data set, to be determined onsite by the team leader.

Prior to entering the data into a project-specific Microsoft Access database, the field forms will receive a final review for completeness and accuracy. The database will be used to manage the data collected during the monitoring events. This form of database management incorporates quality control during the data entry process through standardized formatting and summation of functional groups. Data review and interpretation shall be a permanent process of comparison of repeatable surveys. The comparison will be conducted by individual transect (i.e., what is the change in each individual transect), and then by the entire set of transects on one side of the channel, and finally, a comparison of the changes documented on one side of the channel to those documented on the other side.

The contractor's diving operations shall comply with all the requirements of Section 30 of the U.S. Army Corps of Engineers "Safety and Health Requirements Manual", EM 385-1-1 (3 September 1996); and "Contract Diving Operations", to Jacksonville District Regulation CESAJR 385-1-1 (1 September 1998); or any subsequent updated manuals. A diving operations plan and the other submittal items specified below must be reviewed and accepted by USACE District Diving Coordinator and the Safety Office prior to the commencement of diving operations. If not specifically stated in the referenced documents above, then a "small craft advisory" would be considered the basis for conducting dive operations; whereby no diving would be conducted under such adverse weather conditions.

BIOLOGICAL MONITORING DURING CONSTRUCTION

Construction Period Surveys for Coral Health

1) Construction surveys will be conducted at each transect by the Contractor within each monitoring station by qualified marine biologists and involve:
    a. Evaluating benthic organisms (scleractinian corals, octocorals, sponges, etc.) for standing sediment that is not removed by normal currents or wave action.
    b. On each of the transects, a set of ten (10) stony coral colonies composed of at least four different species will be selected for monitoring. Ten colonies was chosen as the number of colonies to be monitored per station based upon baseline survey dives throughout the project area. Selected species may include Agaricia agaricites, *Colpophyllia natans, Dichocoenia stokesi, Diploria clivosa, Diploria strigosa, Montastrea annularis, Montastrea cavernosa, Porites astreoides, Siderastrea siderea, Solenastrea bournoni*, and *Stephanocoenia michelini*. Each colony will be healthy, greater than 10 cm in diameter, have a nearly horizontal orientation to the seafloor, and be marked with a numbered tag attached to a stainless steel pin drilled and epoxied into the bottom next to the colony. The position of each colony also will be mapped relative to the location of the net sediment accumulation block (distance and bearing) and recorded to allow relocation on subsequent surveys. Coral health assessment parameters will include bleaching, excess mucus production, polyp extension, and disease. Each selected coral colony will be assessed for each of the health parameters and assigned a health level of either "0" or "1" for each parameter. A score of "0" would indicate no observed bleaching, excess mucus production, polyp extension, or disease, while a "1" would be assigned for each parameter with a positive indication. The score for each parameter for each coral colony will be recorded, and the coral health observations will be documented with approximately 15 seconds of video per individual colony. A coral receiving a score of "1" for two or more parameters will be classified as declining in health. Additionally, if three or more corals at any project area site show evidence of either bleaching or disease during a survey, this will indicate declining health at the site. Each monitoring site will have a unique identification number that, along with date and time, will be recorded on videotape at the beginning of each site visit. Individual coral tag numbers also will be recorded on tape for each monitored colony at each site.

2) This data will be collected for each project area transect and each control area transect.
3) Reef conditions during construction surveys will also be documented through digital photographs and video. Photographs will include:
    a. Wide angle reef scenes (as visibility allows).

b. Close-up photographs documenting organism experiencing potential sediment stress (i.e., burial, excess mucus, extruding polyps, color change).
c. Video will be taken of each transect within each monitoring station 40 cm (0.4 meters) from the bottom, perpendicular to the transect, off the bottom.

4) Survey Frequency
    a. Before active dredging, the 14 monitoring stations located in the reef habitats along either side of the entrance channel, and the 12 corresponding reference sites, will be surveyed at least once a week for four (4) weeks to establish baseline conditions at the monitoring stations.
    b. For the duration of active dredging (construction), the reef habitats surrounding the entrance channel and the corresponding habitat reference sites will be surveyed twice a week at the monitoring stations within 750 meters of the dredging activities, and the corresponding reference sites, when dredging occurs within 750 meters of reef or hardbottom habitat.
    c. After active dredging, the 14 the monitoring stations located in the reef habitats surrounding the entrance channels and the 12 corresponding reference sites will be surveyed at least once a week for four (4) weeks.

Reporting –

1) A report will be submitted documenting the survey efforts prior to dredging. This report along with raw data will be submitted to the Contracting Officer (CO) within 15 days upon monitoring completion and provided to the agencies within 45 days of monitoring completion.
2) During active dredging, weekly reports will be submitted to the Corps via e-mail (or ftp site) describing survey results.
3) A report will be submitted after construction detailing the results for the four week post construction surveys. This report along with raw data will be submitted to the CO within 15 days upon monitoring completion and provided to the agencies within 45 days of monitoring completion.
4) The agencies will be notified of sediment stress by phone, fax, or e-mail, and followed by a written report to be submitted within 24 hours and will be notified immediately of the possibility of unacceptably high sediment levels on the reefs (or on the next work day if the indicators are noted on a weekend or holiday). If stress is recorded, the dredging operation may be required to move to a new location, at least 400 feet away, until effected organisms have recovered (signs of stress are no longer visible).

<u>Qualitative Construction Surveys for Indication of Sediment Impact and/or Stress</u>

These stations are the same stations from the construction monitoring stations of coral health, designed to monitor any environmental change or sedimentation impact and/or stress on biological organisms attributed to construction activities previously described. In addition to the construction monitoring, sediment monitoring shall be conducted as detailed below.

1) Construction surveys will be conducted by qualified marine biologists at the monitoring station transects.
2) Survey Frequency:
    a. Before active dredging, the reef habitat surrounding the entrance channel will be surveyed at least once a week for four (4) weeks to establish baseline conditions.
    b. For the duration of active dredging (construction), the reef habitat surrounding the entrance channel will be surveyed twice a week for reef areas adjacent to the channel that are within 750 meters from the dredging and overflow activities, only when dredging and overflow occurs within 750 meters of reef or hardbottom habitat.
    c. After active dredging, the reef habitat surrounding the entrance channels will be surveyed at least once a week for four (4) weeks.
3) Sediment stress will be defined as build-up of sediment significantly above the level found at the control or reference stations sufficient to cause any one or more of the following conditions:
    a. A frequency of observed bleaching (partial or complete) of scleractinian coral colonies.
    b. Excessive mucus produced by scleractinian corals to remove sediment from their surface, resulting in binding of sediments and transport of bound sediments off the coral's surface and subsequent accumulation of the sediments at the base of the coral head. Such accumulations

have been seen to initiate a "self burial" process, causing death of the lower tissue of the coral head.

c. Covering of benthic community components (i.e., sponge, algae) by sediment for sufficient time or sufficient sediment so as to note death or degradation (i.e., bleaching, pigmentation changes) of the underlying organisms.

4) Any change of 5% of more in cover any functional group evaluated in two or more adjacent transects, or on average for the zone of monitoring on one side of the channel, or stress expressed above normal by corals and/or
5) Impacted areas shall continue to be monitored monthly during construction and one month post-construction, in order to document results of the impact. The Contractor shall provide a plan for detecting this change utilizing standard coral reef coverage assessment methodologies and include this proposed methodology in the Request for Proposal package.
6) A stress violation shall require increasing the frequency of surveys and/or activities will be modified to reduce impacts, including potential relocation of dredging or overflow operations.

Reporting -

a. A report will be submitted documenting the survey efforts prior to dredging. This report along with raw data will be submitted to the CO within 15 days upon baseline, pre-dredging monitoring completion and provided to the agencies within 45 days of monitoring completion.

b. During active dredging, weekly reports will be submitted via e-mail (or web site) describing survey results.

c. A report will be submitted after construction detailing the results for the four week post construction surveys. This report along with raw data will be submitted to the CO within 15 days upon monitoring completion and provided to the agencies within 45 days of monitoring completion.

d. The agencies will be notified of sediment stress by phone, fax, or e-mail, and followed by a written report to be submitted within 24 hours and will be notified immediately of the possibility of unacceptably high sediment levels on the reefs (or on the next work day if the indicators are noted on a weekend or holiday)). If stress is recorded, the dredging operation may be required to move to a new location, at least 400 feet away, until effected organisms have recovered (signs of stress are no longer visible).

Quantative Construction Sediment Monitoring

1) Net Sediment Accumulation Data:
    a. A net sediment accumulation block will be placed at each of the 14 monitoring stations and the 12 reference stations. The block location coordinates will be recorded and serve as the center point of the monitoring station. The sediment accumulation block data shall be utilized to determine if sedimentation and individual monitoring site has exceeded threshold levels.
    b. Measured net sediment accumulation levels at project area sites where corals show decline potentially associated with dredging will be used to adjust or ground-truth the sedimentation average rate of 1.5 mm per day above the reference site accumulation currently proposed as the maximum for the project. Evidence of coral decline as defined in "Construction Period Surveys for Coral Health" and "Qualitative Construction Surveys for Indication of Sediment Impact and/or Stress" or a sedimentation rate of 1.5 mm per day above the analogous reference site(s) defines a significant event.
    c. The net sediment accumulation block will consist of an 8" x 8" x 8" concrete block attached to the bottom with hydraulic cement. The block will have one side coated with antifouling paint, which will be oriented as the upper surface. The antifouling paint should help minimize at the bio growth on the upper surface of the block, which could interfere with sediment accumulation and cause increasing errors in sediment accumulation measurements as the program progresses. The block will be cemented to the bottom with the upper surface level at a hard bottom or reef, block will be attached only to expose rock surfaces devoid of benthic fauna and no closer than 30 cm from any stony coral colony.
    d. Following the re-occupation of each station during the subsequent monitoring surveys, sediment depth or accumulation on the block will be measured first to prevent the disturbance of the

sediment layer by divers collecting other data. The accumulated sediment depth will be measured at five positions on the upper surface of the block.

e. Measurements will be made in the center and at four points approximately 2.5 in. toward the center from each corner of the block. Sediment accumulation depth measurements will be recorded from these five positions, and the block will be swept clear of sediments as the last step before leaving the site. Any observations of fishes or invertebrates impacting the sediment layer on the block also will be recorded. Following the completion of the dredging project and monitoring program, all sediment accumulation blocks will be removed from both seagrass areas and hard bottom/reef stations.

2) Survey Frequency:
   a. Installation of sediment blocks and sediment depth transect reference stakes will occur a minimum of 28 days prior to construction activity.
   b. Before active excavation/dredging:
   c. Reef sediment accumulation measurements will be surveyed along the fixed transects at least once a week for four (4) weeks to establish baseline conditions.
   d. For the duration of active construction in the entrance channel:
3) Reef sediment accumulation measurements will be taken along the fixed transects once a week during construction when the dredge and overflow are within 750-m of reef or hardbottom habitats.
   a. After active construction is completed:
4) Reef sediment blocks will be cleaned off 28 days after excavation work is completed at all sediment stations.
   a. Reef sediment accumulation measures will be taken once a week for four weeks after excavation work is completed.
5) Sediment Traps:
   a. Arrays of three sediment traps will be placed at each of the hardbottom monitoring stations (including controls) to allow the comparison of net sediment accumulation block data with sediment trap data for a total of 26 sites. The sediment traps will be constructed of 1.0 in. inside diameter x 8 in. length polyvinyl chloride (PVC) pipe and a 500-ml nalgene collection jar, similar to the design being used in the Dade County and Broward County Shore Preservation Project monitoring programs. Both trap necks and jars will be coated with anti-fouling paint to minimize epibiotal growth. The PVC traps with the attached jar lids will be fastened to the steel sediment trap frame with hose clamps. The frame will be drilled and cemented into the bottom at hard bottom stations. Following completion of the monitoring program, all sediment traps, frames, and blocks will be removed.
   b. The traps will be positioned with the mouth of the trap no more than 18 in. above the bottom. Sediment traps will be changed at 28-day intervals by unscrewing the nalgene trap jars from the PVC collars and capping the jars. New jars then will be attached to the trap collars for the next collection interval. Sediment samples will be transported to the laboratory where the water and sediment will be filtered through labeled pre-weighed filters. The filters and sediments will be rinsed with fresh water to remove salts, and the filters containing the sediments then will be dried in an oven and weighed.

<u>Reporting –</u>

a. Raw data documenting the sedimentation deposition rates (traps) and accumulation measurements (blocks) prior to dredging will be submitted to the CO within 30 days upon completion of the monitoring with a summary reported submitted within 45 days of completion.
b. During active dredging in the entrance channel, weekly reports will be submitted via e-mail (or web site) describing sediment accumulation measurements. Raw data from sediment deposition rate data (traps) will be submitted to the CO within 30 days after lab analysis is completed with a summary report submitted within 45 days of completion. The report will be provided to the agencies after the CO has reviewed and accepted the report.

c. Raw data will be submitted after construction 30 days after last sampling event detailing the results for the four-week post construction surveys. A summary report will be submitted within 45 days of completion.
d. Notification of significant sediment accumulation will be by phone, fax, or e-mail, and followed by a written report to be submitted within 24 hours to the agencies and will be notified immediately of the possibility of significant sediment accumulation levels on the reefs (or on the next work day if the indicators are noted on a weekend or holiday). The dredge may be required to move if a significant event is observed, until signs of the significant impact are no longer visible.

MONITORING ASSOCIATED WITH DREDGING OPERATIONS AND POTENTIAL IMPACTS

VESSEL TRANSIT MONITORING:

Due to the presence of hardbottom habitats and reefs adjacent to the channel, the Contractor shall stay within the marked entrance channel while in transit from the dredging area to/from the ODMDS. In coordination with the Contracting Officer's Representative (COR), the Contractor shall develop an ingress/egress pathway from the channel to the reef mitigation sites and shall record this as the only approved route to and from these sites aboard any vessels transiting to and from these sites. The Contractor shall contract the Florida Department of Environmental Protection's Coral Reef Conservation Program to obtain a copy of the GIS layers and benthic habitat maps. The FLDEP-CRCP contact is Ms. Lauren Waters at 305-795-1203 or via email: Lauren.Waters@dep.state.fl.us for instructions for how to obtain the files.

Hopper dredge and disposal tug/scow transit tracks will be recorded by the Contractor utilizing the Electronic Tracking System (ETS) and reviewed within 24 hours of the transit to the disposal site by the Contractor's environmental manager to ensure the vessel remained in the marked channel or approved corridor to the mitigation sites. If the dredge/tug & scow leaves the channel or approved corridor, the location will be marked and recorded in GIS, water depths of the location will be determined by reviewing existing surveys and, draft of the vessel will be determined by the ETS and the COR notified. If it is determined that the potential exists for an impact to have occurred as a result of the vessel leaving the channel or approved corridor, a survey team will be deployed by the Contractor within 24-hours (weather permitting) to assess any impact that may have occurred and conduct immediate remediation. If the team cannot be deployed within 24-hours, the Contractor shall report the delay to the COR and develop a deployment timeline. Remediation work (including re-attachment of scleractinian corals and octocorals) will be conducted immediately after the survey by the survey crew. Remediation activities should follow the FLDEP-SEFCRI "Rapid Response and Restoration for Coral Reef Injuries in Southeast Florida, Guidelines and Recommendations" dated June 2007 (DEP 2007). This report is available at:

http://www.dep.state.fl.us/coastal/programs/coral/reports/MICCI/MICCI_Project2_Guidelines.pdf

Any such survey and/or remediation efforts shall be at no additional cost to the Government.

Biological triage activities should occur as soon as possible following an injury. Fractured, dislodged, and overturned biological resources have a short window of opportunity in which they can be salvaged and stabilized. Therefore, the first step of biological triage is to right any overturned, dislodged, buried, or otherwise injured living organisms and mark them for repair. Often, it is possible to turn large corals right side up and they will remain stable temporarily without aid; however, small colonies and fragments can be easily overturned or washed off site by surge and wave energy. Small and fragmented stony coral, octocoral, and sponge colonies can be placed in baskets, milk crates, or other containers for temporary safekeeping.

Octocorals and sponges are more prone than other species to being moved by wave energy and surge, and thus need special care. Weighted baskets with lids are commonly used to secure them. These biological resources are vital to primary restoration and should be collected and cached in areas where they will be protected as much as possible from further injury while restoration activities are under way. Rubble should be stabilized or removed as

soon as possible to prevent further injury to the site from rubble movement caused by rough seas or storms. Prompt biological triage and primary restoration are especially critical during the hurricane and winter frontal storm seasons.

The non-remediated part of damage would be estimated and estimations will be included in the additional mitigation for project-related unanticipated damages. The results of damage survey will be provided to the CO immediately after the survey, and the report on the results of remediation and estimates of non-remediated damage will be provided to the CO within two weeks after the completion of remediation work. The CO or COR will coordinate with the appropriate resource agencies.

ANCHOR PLACEMENTS AND MONITORING

The Contractor shall limit dredge anchorage such that contact with and impacts to seagrasses and hardbottoms outside the channel is minimized/avoided to the maximum extent practicable. The approximate locations of these resources are shown in the contract drawings. If the contractor is required to anchor outside the channel to utilize a cutterhead dredge, anchor placement shall be placed to avoid affecting any of the habitat monitoring transects and sedimentation monitoring stations.

Coordinates of all dredge anchor drop points shall be recorded using DGPS technology, accurate to one (1) meter. Unauthorized impacts to seagrasses and hardbottoms shall require remediation and may be subject to further compensatory mitigation requirements. Divers shall visit all anchor locations that were positioned within the perimeter of a seagrass bed or hardbottom area both immediately after anchorage drop and within 2 days of the anchor being removed to investigate and record potential damage to hardbottoms. The contractor shall record all resources within the triangle created from the anchor point to the cable beginning location to the cable ending location. Specifically, the following information will be documented in each anchor triangle area before dredging commences: 1) scleractinian coral colonies, identified to species (maximum diameter measured in cm); 2) octocoral colonies, identified to genus (maximum diameter or height measured in cm, for upright colonies the maximum height would be measured and for flat or encrusting colonies, the maximum diameter would be measured); 3) sponge morphotypes (maximum diameter or height measured in cm); 4) zoanthids (maximum diameter measured in cm); and 5) macroalgae identified to the lowest taxonomic level. Occurrences of sea urchins, including *Diadema antillarum*, will be recorded by area. Rugosity data will be collected within each triangle, and calculated as (1–d/l), where d = the geometric distance of a transect measured using a weighted line and l = the length of the transect. The Florida Resilience Relief Program (FRRP) bleaching assessment protocol will be to characterize scleractinian colony condition. Video-transect data for all triangles will be collected for archival purposes, as previously discussed in the construction monitoring protocol.

After the area has been dredged, and the anchor is removed, the Contractor will resurvey the area, noting any impacts to resources, conducting remediation immediately, as appropriate, in accordance with FLDEP 2007 (previously referenced). Anchor damage to these resources shall be reported to the CO or COR within 48 hours of discovery of impact. A qualified marine biologist, as described above, shall certify these investigations.

Any non-remediated damage will be estimated and estimations will be included in the additional mitigation for project-related unanticipated damages. The results of damage survey will be provided to the resource agencies immediately after the survey, and the report on the results of remediation and estimates of non-remediated damage will be provided to the resource agencies within two weeks after the completion of remediation work.

DRAFT MONITORING

The draft of each disposal vessel shall be monitored via the Contractor's ETS and reviewed within 24 hours of the transit to the disposal site by the Contractor's environmental manager to ensure spillage or leakage has not occurred. If the data show a draft loss of more than one foot in depth from the loading site to the disposal site, the Contractor shall report the load number, scow number and draft loss to the CO or COR by email within 24-hours of the load disposal.

MONITORING OF IMPACTS ALONG CHANNEL WALLS WHERE CHANNEL WIDENING IS NOT PROPOSED.
Cross sectional surveys using multi-beam/side scan will be conducted and evaluated at 50-foot intervals within 30-days of completion of each acceptance section, to determine if dredging impacts occurred outside the channel limits and into existing habitat along the channel walls. If the cross sections indicate dredging outside the federally authorized footprint, additional evaluation will be conducted to determine the full extent of impacts and the impacts will be subject to compensatory mitigation based on established mitigation using the HEA methodology used to determine required compensatory mitigation for the project.

PROTECTED MARINE SPECIES MONITORING DURING CONSTRUCTION AND BLASTING
The Contractor shall keep construction activities under surveillance, management, and control to minimize interference with, disturbance to, and damage of fish and wildlife. Species that require specific attention along with measures for their protection shall be listed in the Contractor's Environmental Protection Plan prior to the beginning of construction operation.

In the event that a threatened or endangered species is harmed as a result of construction activities, the Contractor shall cease all work and notify the Contracting Officer. The order of contact within the Corps of Engineers shall be as follows:

Order of Contact of Corps Personnel

Title	Telephone Number
Corps, Inspector	Onsite/After hours to be provided
Area Engineer, (CESAJ-CD-W)	561-472-3511
Chief, Environmental Branch Planning Division (CESAJ-PD-E)	904-232-1665
Chief, Construction Division (CESAJ-CD)	904-232-1118

Endangered Species Protection
The Contractor shall instruct all personnel associated with the project of the potential presence of manatees, sea turtles, dolphins and whales in the area, and the need to avoid collisions with and harming these animals. All construction personnel shall be advised that there are civil and criminal penalties for harming, harassing, or killing manatees, sea turtles, dolphins or whales which are protected under the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and/or the Florida Manatee Sanctuary Act. The Contractor shall be held responsible for any manatee, sea turtle, dolphin or whale harmed, harassed, or killed as a result of construction activities.

a. Siltation Barriers: If siltation barriers are used, they shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exit from essential habitat.

b. Special Operating Conditions:

(1) All vessels associated with the project shall operate at "no wake/idle" speeds at all times while in waters where the draft of the vessel provides less than a four-foot clearance from the bottom, and vessels shall follow routes of deep water whenever possible. Boats used to transport personnel shall be shallow-draft vessels, preferably of the light-displacement category, where navigational safety permits. Mooring bumpers shall be placed on all barges, tugs, and similar large vessels wherever and whenever there is a potential for manatees to be crushed between two moored vessels. The bumpers shall provide a minimum stand-off distance of four feet.

(2) If a manatee(s) or sea turtle(s) is sighted within 100 yards of the project area, all appropriate precautions shall be implemented by the Contractor to ensure protection of the manatee and/or sea turtle. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee or sea turtle. If a manatee or sea turtle is closer than 50 feet to moving equipment or the project area, the equipment shall be shut down and all construction activities shall cease within the down and all construction activities shall cease within the waterway to ensure protection of the manatee or sea turtle. Construction activities shall not resume until the manatee or sea turtle has departed the project area.

(3) If a turtle is taken by hopper dredge (dead or alive), a copy of the official incident take report shall be e-mailed in PDF format to takereport.nmfsser@noaa.gov and the Contracting Officer.

(4) Hopper Dredging operations shall cease if 3 turtles or 2 endangered turtles are taken until the Contracting Officer notifies the Contractor to resume dredging.

c. Manatee Monitoring (Clamshell Only): During clamshell dredging operations, a dedicated observer shall monitor for the presence of manatees. The dedicated observer shall have experience in manatee observation and be equipped with polarized sunglasses to aid in observing. Nighttime lighting of waters within and adjacent to the work area shall be illuminated, using shielded or low-pressure sodium-type lights, to a degree that allows the dedicated observer to sight any manatee on the surface within 200 feet of the operation. The dredge operator shall gravity-release the clamshell bucket only at the water surface, and only after confirmation that there are no manatees within the safety distance identified in the standard construction conditions.

d. Manatee Signs: Prior to commencement of construction, each vessel involved in construction activities shall display at the vessel control station or in a prominent location, visible to all employees operating the vessel, a temporary sign at least 8-1/2" x 11" reading, "CAUTION: MANATEE HABITAT/IDLE SPEED IS REQUIRED IN CONSTRUCTION AREA." In the absence of a vessel, a temporary 3' x 4' sign reading "CAUTION: MANATEE AREA" shall be posted adjacent to the issued construction permit. A second temporary sign measuring 8-1/2" x 11" reading "CAUTION: MANATEE HABITAT. EQUIPMENT MUST BE SHUTDOWN IMMEDIATELY IF A MANATEE COMES WITHIN 50 FEET OF OPERATION" shall be posted at the dredge operator control station and at a location prominently adjacent to the issued construction permit. The Contractor shall remove the signs upon completion of construction.

Endangered Species Observers (Hopper Dredge Only)

During hopper dredging operations, Endangered Species Observers (ESO) approved by the National Oceanic and Atmospheric Administration - Fisheries (NOAA-Fisheries) for sea turtles and whales shall be aboard to monitor for the presence of the species. Observer coverage shall be 100 percent (24hr/day) and shall be conducted year round. During transit to and from the disposal area, the observer shall monitor from the bridge during daylight hours for the presence of endangered species, especially large whales. During dredging operations, while dragheads are submerged, the observer shall continuously monitor the inflow and/or overflow screening for turtles and/or turtle parts. Upon completion of each load cycle, dragheads should be monitored as the draghead is lifted from the sea surface and is placed on the saddle in order to assure that sea turtles that may be impinged within draghead are not lost and un-accounted for. Observers shall physically inspect dragheads and inflow and overflow screening/boxes for threatened and endangered species take.

(1). Monitoring Reports: The results of the monitoring shall be recorded on the appropriate observation sheets. There is a sheet for each load, a daily summary sheet, and a weekly summary sheet. In addition, there will be a post dredging summary sheet. Observations sheets will be completed regardless of whether any takes of whales, or sea turtles occur. In the event of any sea turtle or take by the dredge, appropriate incident reporting forms shall be completed. Additionally, all specimens shall be photographed with a digital camera. These photographs shall

be attached to respective reports for documentation. Dredging of subsequent loads shall not commence until all appropriate reports are completed from the previous dredging load to ensure completeness and thoroughness of documentation associated with the incidental take Reports shall be submitted to the CO or COR within 24-hours of the take.

(2). Endangered Species Observer(s): A list of ESOs that have been NMFS-approved to monitor threatened/endangered species takes by hopper dredges can be obtained by contacting NOAA Fisheries' Northeast Region, Protected Resources Division. The main contact is Ms. Julie Crocker; she can be reached at julie.crocker@noaa.gov or 978-281-9300 ext.6530.

(3). Digital Photographs: The Contractor shall use a digital camera, with an image resolution capability of at least 300 dpi, in order to photographically report all incidental takes, without regard to species, during dredging operations. Immediately following the incidental take of any threatened or endangered species, images shall be provided, via email, CD, DVD, or USB (thumb/flash/jump drive) to the Contracting Officer's Representative in a .JPG or .TIF format and shall accompany incidental take forms. The nature of findings shall be fully described in the incidental take forms including references to photographs.

Manatee, Sea Turtle, Smalltooth sawfish and Whale Sighting Reports

Any take concerning a manatee, sea turtle, smalltooth sawfish or whale; or sighting of any injured or incapacitated manatees, sea turtles, smalltooth sawfish or whales shall be reported immediately to the CO or COR by notifying the personnel indicated in the table "Order of Contact of Corps Personnel" above.

A copy of the incidental take report shall be provided to the CO within 24 hours of the incident. The Contractor shall also immediately report any collision with and/or injury to a manatee to the Florida Fish and Wildlife Conservation Commission "Manatee Hotline" 1-888-404-FWCC (3922) as well as the U.S. Fish and Wildlife Service, Vero Beach Field Office 772-562-3909 for South Florida. If a sea turtle is taken by the dredge (live or dead) the contractor shall email a PDF version of the incidental take report to NOAA-Fisheries Southeast Region at the following email address within 24 hours of the take - takereport.nmfsser@noaa.gov also providing a cc copy to the CO.

Report Submission

The Contractor shall maintain a log detailing all incidents, including sightings, collisions with, injuries, or killing of manatees, smalltooth sawfish (STSF), sea turtles, dolphins or whales occurring during the contract period. The data shall be recorded on forms provided by the CO. All data in original form shall be forwarded directly to Chief, Environmental Branch, P. O. Box 4970, Jacksonville, Florida, 32232-0019, within 10 days of collection and copies of the data shall be supplied to the CO. Following project completion, a report summarizing the above incidents and sightings shall be submitted to the following:

Chief, Environmental Branch
U.S. Army Corps of Engineers (CESAJ-PD-E)
P.O. Box 4970
Jacksonville, Florida 32232-0019

Area Engineer
U.S Army Corps of Engineers (CESAJ-CD-W)
4400 PGA Boulevard, Suite 203
Palm Beach Gardens, Florida 33410

U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, Florida 32960-3559

National Marine Fisheries Service
Protected Resources Division

263 13th Avenue South
St. Petersburg, Florida 33701

Florida Fish and Wildlife Conservation Commission
Imperiled Species Management Section
620 South Meridian Street, Mail Stop 6A
Tallahassee, Florida 32399-1600

MONITORING ASSOCIATED WITH BLASTING OPERATIONS AND POTENTIAL IMPACTS

A formal coordination meeting shall be held at least two days prior to the first blast event. Attendants will include the observers in the watch program, construction contractors, demolition subcontractors, and other interested parties, such as the U.S. Coast Guard, FDOT, NMFS, FWC, FWS, and DEP. The construction contractors, demolition subcontractors and observers will present the protocol and logistics of the project.

If blasting is proposed during the period of 1 November through 31 March, significant operational delays should be expected due to the increased likelihood of manatees being present within the project area. If possible, avoid scheduling proposed blasting during the period from 1 November through 31 March. In the area where blasting could occur or any area where blasting is required to obtain channel design depth, the following marine mammal (manatees and dolphins) and reptile (sea turtles and crocodiles) protection measures shall be employed, before, during and after each blast:

1) The Contractor shall prepare a Blasting Plan and provide it to the CO at least 30 days before the first blast event is scheduled. The environmental monitoring requirements during blasting shall include, at a minimum, the following.

a. A list of the observers and their contact information, their qualifications, and positions for the watch, including a map depicting the proposed locations for boat or land-based observers. Qualified observers must have significant prior on the job experience observing for protected marine species (including manatees, marine turtles, dolphins, etc.) during previous in-water blasting events where the blasting activities were similar in nature to this project. Each observer's past experience must 1) be in the same observer position proposed for this project; 2) include experience working as part of an observation team during an in-water blasting project; and 3) have extensive manatee or marine turtle observation experience during previous dredging or blasting projects and/or during manatee or marine turtle research studies.

b. The amount of explosive charge proposed, the explosive charge's equivalency in TNT, how it will be executed (depth of drilling, stemming, in-water, etc.), a drawing depicting the placement of the charges, size of each of the 4 zones identified in b. below and how it will be marked (also depicted on a map), tide tables for the blasting event(s), and estimates of times and days for blasting events (with an understanding this is an estimate, and may change due to weather, equipment, etc).

c. For each explosive charge placed, four zones will be calculated, denoted on monitoring reports and provided to protected species observers before each blast for incorporation in the watch plan for each planned detonation. These zones are:

(1) Danger Zone (ft) = 260 [79.25 m] X the cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

(2) Exclusion Zone (ft) = Danger +500.

(3) The Safety zone (ft) = 520 [158.50 m] X cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

(4) The Watch Zone is three times the radius of the Danger Zone to ensure that animals entering to traveling close to the Exclusion Zone are spotted and appropriate actions can be implemented before or as they enter any impact areas (i.e., a delay in blasting activities).

Detonation will not occur if a marine mammal or reptile is known to be (or based on previous sightings, may be) in the Exclusion Zone. Vessel-based surveys will be conducted within the Safety and Watch Zones; while Aerial surveys will cover all zones.

d. The watch program shall begin at least one hour prior to the scheduled start of blasting to identify the possible presence of manatees, dolphins, marine turtles, crocodiles or whales (in the nearshore and offshore areas). The watch program shall continue until at least one half-hour after detonations are complete.

The watch program shall consist of a minimum of six Protected Species Observers. Each observer shall be equipped with a two-way radio that shall be dedicated exclusively to the watch. Extra radios should be available in case of failures. All of the observers shall be in close communication with the blasting subcontractor in order to halt the blast event if the need arises. If all observers do not have working radios and cannot contact the primary observer and the blasting subcontractor during the pre-blast watch, the blast shall be postponed until all observers are in radio contact. Observers will also be equipped with polarized sunglasses, binoculars, a red flag for backup visual communication, and a sighting log with a map to record sightings. All blasting events will be weather dependent. Climatic conditions must be suitable for optimal viewing conditions, as determined by the observers.

The watch program shall include a continuous aerial survey to be conducted by aircraft, as approved by the FAA. The event shall be halted if an animal(s) is spotted within the Exclusion Zone (Danger Zone + 500 feet). An "all-clear" signal must be obtained from the aerial observer before detonation can occur. The blasting event shall be halted immediately upon request of any of the observers. If animals are sighted, the blast event shall not take place until the animal(s) moves out of the area under its own volition. Animals shall not be herded away, lured or harassed into leaving. Specifically, the animals must not be intentionally approached by project watercraft. If the animal(s) is not sighted a second time, the event may resume 30 minutes after the last sighting.

e. The observers and contractors shall evaluate any problems encountered during blasting events and logistical solutions shall be presented to the CO. Corrections to the watch shall be made prior to the next blasting event. If any one of the aforementioned conditions is not met prior to or during the blasting, the watch observers shall have the authority to terminate the blasting event, until resolution can be reached with the CO. The CO/COR will contact FWC, USFWS and NMFS.

f. If an injured or dead marine mammal or marine reptile is sighted after the blast event, the watch observers shall contact the CO/COR and the CO/COR will contact the resource agencies at the following phone numbers:

(1) FWC through the Manatee Hotline: 1-888-404-FWCC and 850-922-4330 (manatees).

(2) USFWS Vero Beach: 772-572-3909 (manatee and crocodile).

(3) NMFS SERO-PRD: 772-570-5312 (sea turtles and sawfish).

(4) NMFS-SEFSC- Emergency Stranding Hotline - 1-877-433-8299.

The observers shall maintain contact with the injured or dead mammal or reptile until authorities arrive. Blasting shall be postponed until consultations are completed and determinations can be made of the cause of injury or mortality. If blasting injuries are documented, all demolition activities shall cease. The CO/COR will then submit a revised plan to FWC, NMFS and USFWS for review.

g. The Contractor shall record the noise associated with 30 blast events on a hydrophone system capable of recording in broad frequency range (75 Hz - 350 kHz). The Contractor shall also record associated work as separate recordings, including borehole drilling and fish repelling charges. Files shall be provided as .wav binary files. The hydrophone shall have the ability to record the blast event, as well as providing voice recording of each hydrophone record in a standard format acceptable to the government (e.g., .cda files). The Contractor shall provide hydrophone records for: the first 20 production blast shots, five (5) production blast shots in approximately the middle of the blasting program, and five (5) production blast shots nearing the end of the blasting program. The Contractor shall provide nearby hydrophone records of drilling operations of 30 minutes over three (3) early contract periods at least 18 hours apart. The Contractor shall provide hydrophone records within the contract area of three (3) 10-minute quiet periods (not necessarily 10 continuous minutes) over three (3) early contract periods at least 18 hours apart or prior to the contractor's full mobilization to the site, and 10 close-approaches of varied vessel sizes. The Contractor shall record as many as 10 periods (not to exceed 30 minutes each) with a hydrophone system within the contract area at the direction of the CO, when provided with a one-week advance notice.

Information to be provided as both an EXCEL file and voice recording for each hydrophone record (.wav file) shall include:

(1) GPS Location of the hydrophone aboard the vessel. The GPS position shall use the same coordinate system as the Blasting Contractor. The vessel shall be moored approximately bow toward the blast/drilling site. The hydrophone shall closer to the blast pattern than the vessel's bow at the waterline. The hydrophone position shall be located outside the range that would cause clipping (overloading of the hydrophone, causing the absolute peaks to be lost).

(2) Water depth of the hydrophone and the water depth to the sediment/rock bottom. The hydrophone shall be placed at the shallower of 3.0 meters (9.84 feet or 9 feet, 10 inches) depth or the mid-water column depth.

(3) Information provided by the Blasting Contractor regarding the blast pattern or drilling. The minimum data shall include, as appropriate for blast shots or drilling; the date, time, and blast number of the shot; the average water depth of the shot pattern or the average depth to sediment/rock at the nearest five (5) shot-holes closest to the hydrophone location; GPS Location of the closest shot-hole in the blast pattern to the hydrophone; minimum explosive depth below the top of rock for the closest shot-hole in the blast pattern to the hydrophone; the maximum charge weight per delay of the shot pattern in pounds of explosives; and, the largest charge weight per delay of the closest delay sequence to the hydrophone.

Reporting: The protected species observers shall prepare a daily report for each blasting event. Data reported shall include:

(1). Event date; observer names; observer locations; weather conditions (cloud cover, wind speed; wind direction; glare; water clarity; water color; beaufort sea state; visibility and tide stage); watch start time; watch end time; total watch time; all zone radii (ft); sunrise time; and sunset time.

(2). A daily summary of protected species observed during the blast event (including species; total number of each species; total number spotted outside exclusion zone; total number spotted inside the exclusion zone; animal behavior inside the exclusion zone; actions taken by observer; comments).

(3). A detailed sighting log for each animal/group of animals (if animals are traveling in a group) including: time; species; total number of animals; number of adults/juveniles; location of reporting observer; closest distance to blast array; bearing from blast array; direction of travel; time of relocation (for each time the animal is relocated); time last seen).

(4). A map shall be prepared for each blasting event illustrating the project area, all zone radii and each animal (or group of animals), the time each animal was first observed and the direction of travel of the animal (or group).

(5). The daily report should be signed by the primary protected species observer for that blast event. Within 15 days after completion of all blasting events, the primary protected species observer shall submit a report to the CO/COR, who will provide it to FWC, NMFS and USFWS providing a summary description of the blasting events, number and location of animals seen and what actions were taken when animals were seen for each blast. Any problems associated with the events and suggestions for improvements shall also be documented in the report.

Fish Mortality Monitoring:

1. After each detonation and the "all clear" signal is given, the contractor shall collect the floating carcasses of/ bodies of fish in the blast zone using a dip net.
2. The carcasses will be inventoried and the attached data sheet for each individual blast completed for all collected fishes.
3. Specific species of fish require additional data to be collected.
   a) Tarpon:
      i) Girth in mm;
      ii) Fork Length and Total Length in mm; and
      iii) A fin clip will be collected for DNA analysis.
         (1) For each sample, record the time, date, and location of capture/sample.
         (2) Provide name and contact information for data collector, when samples are submitted.
   b) Permit:
      i) Fork Length and Total Length in mm;
      ii) A fin clip will be collected for DNA analysis;
      iii) For each sample (fin clip, gonad, and whole fish), record the time, date, and location of capture/sample; and
      iv) Provide name and contact information for data collector, when samples are submitted.
   c) Taking fin clip samples from tarpon and permit:
      i) Cut a piece of tissue from the fin with a pair of scissors; and
      ii) Place the fin clip into a labeled vial of ethanol.
      iii) If vials of ethanol are not available, place each fin clip into a clean plastic zip lock bag and immediately place on ice.
      iv) As soon as possible, place the bag(s) with the fin clip sample(s) in the freezer for storage until preserved.
   d) Samples shall be mailed to: Dr. Kathy Guidon, FWC-FWRI, 100; 8th Ave SE, St. Petersburg, FL 33701.
4. All collected carcasses, not transferred to another entity, shall be disposed of in a manner that will not result in "recapture" of the carcass at a later blasting event - on shore, in a trash receptacle.

Fish Mortality Reporting: Raw data for each day will be compiled onto the Blast/Dredge fish species account dataform. The daily dataform shall be completed and submitted to the Environmental Manager for posting on the project secure FTP site within 24-hours of the blast. A summary report shall be prepared and will be submitted within 30 days after the completion of all blasting operations. All samples submitted to FWC-FWRI shall be summarizes on a spreadsheet and submitted to the CO/COR, weekly.

TRANSPLANTATION AND MONITORING OF TRANSPLANTED CORALS

Scleractinian Corals:

A. Acropora (Staghorn Coral) Survey and Relocation - ***This relocation effort will only be undertaken if Acropora sp. corals are located within 150-m of in the existing or proposed channel footprint. The requirements of this section are taken from the Acropora sp. relocation requirements found in the NMFS Biological Opinion issued for the Miami Harbor Project dated September 8, 2011.***

Fragment Collection

1) Prior to colony collection for relocation, each colony will be photographed, measured in situ and a visual health assessment will be conducted.

2) A 3-cm fragment, or the whole colony for any colonies 3-cm or smaller, is collected from each parent colony. The fragment must be collected from the axial tip of healthy branches using hand tools (e.g., clipper). Fragments must remain in seawater until transfer to the custody a permitted *A. cervicornis* coral nursery within Dade County, Broward County or the Florida Keys. The CO/COR will coordinate with the appropriate *Acropora* nursery prior to collecting these samples to ensure safe transfer. If a colony is less than or equal to 3-cm in length, the entire colony will be collected and treated as a fragment.

3) A second photograph of the colony is taken after the tip is collected, if the colony is greater than 3-cm in size.

Acropora Colony Relocation

1) Colonies will be collected carefully using a hammer and chisel. Upon collection, the colonies must be kept in bins and maintained in seawater at all times. The collected colonies must be kept at the original depth by caching them at the collection site until transplantation commences, and the colonies must be secured in a manner to prevent the container from overturning or the colonies from floating out of the container. A screen is recommended by NMFS to allow for sufficient water circulation while maintaining the colonies in the container. During transportation to the transplant site on board the transfer vessel, the corals must be covered. Transplantation will occur as soon as an operationally feasible and no more than 24-hours after the colony is removed from its original location. If the colonies cannot be transplanted within 24-hours due to weather, equipment failure, emergency or other operational limitation, the Contractor shall notify the CO/COR immediately, who will coordinate with NMFS regarding the delay.

2) All transplanted *Acropora cervicornis* colonies will be re-located to suitable habitat near their original location, between 550 feet - 2,500 feet from edge of the channel on either the north or south side of the channel based upon the original collection location within 24-hours of collection. Suitable habitat is considered: similar depth as origin (+/- 5 ft); consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover occurring in water depths from the mean high water (MHW) line to 30 meters (98 feet); appropriate water quality (based on water quality data and local knowledge), and minimal chances of other disturbances (boat groundings, damage caused by curious divers/fisherman). All efforts should be made to transplant the fragment to the same depth from which it was removed (i.e., +/- 5 ft).

3) Colonies will be attached to suitable substrate with All Fill Epoxy. Before applying the epoxy to the substrate, the substrate will be cleaned of any sediment or algae. The epoxy should then be taken out of the dry lock bag and pressed against the clean substrate. The transplanted colonies will then be pressed gently into the epoxy with proper care. Transplanted colonies must be placed no closer than 0.75 meters from one another.

4) To assist in monitoring efforts, a plastic identification tag must be attached adjacent to each transplanted colony. Finally, the collected location, length, width, depth and orientation of each colony to be transplanted will be recorded. A photograph of the *Acropora cervicornis* colony will be taken at the transplanted location and depth of each colony, as well as the species and identification number will be recorded.

5) After transplantation is complete and is documented photographically, the Contractor shall also conduct a Health Assessment of the transplanted colony. The assessment will review and report the following conditions:
    a. Bleaching and/or paling of tissue or other discoloration.
    b. Recent mortality (denuded skeleton to development of fine "fuzz" on branches indicating mortality within a couple of weeks prior to observation).
    c. Bearded fireworm, *Hermodice carunculata* or the gastropod *Coralliophila abbreviata* in feeding positions (at tissue loss margin).
    d. Microbial mat (e.g., black band cyanobacteria and other organisms at tissue loss margin).
    e. Growth anomalies (altered morphology of tissue and skeleton).

B. **Non-*Acropora* Hard Coral Species**

Scleractinian corals >10 cm in maximum diameter or height shall be collected from direct impact areas in the Middle (2nd) and Outer (3rd) Reef and transplanted to the transplantation areas (mitigation reef or alternative location including grounding restoration sites or adjacent reef areas outside of the impact zone (more than 150 meters north or south of the new channel boundaries) if mitigation reefs are not constructed for mitigation)). If transplantation outside the impact zone is the relocation alternative, the CO/COR will coordinate with the resource agencies to identify a preferred relocation site(s) prior to contract award so that is information can be included in the bid package. If a location cannot be determined by the CO/COR and the resource agencies prior to contract bid, the Contractor shall select a proposed site(s) and include that information in their project bid proposal for review and approval by the CO/COR. Colonies with signs of disease, boring sponge infestation, or colonies that are not expected to survive transplantation shall not be relocated.

Healthy scleractinian corals (without diseases and boring sponges absent) shall be carefully removed from the substrate using a chisel and hammer, and either cached for a short period of time (1-2 days, with no storm in the forecast) in a safe place on the collection site, or collected into baskets and lifted by a diver as the basket is filled or at the end of the collection dive, wrapped in bubble wrap, and then transferred into cooler containers filled with seawater, and transported to the designated transplant areas.

The attachment of corals to the substrate shall be conducted in such a manner that corals of the same species will form small groups of 10-20 colonies growing close to one another with an average density of about 1.0 colony per meter^2 for larger corals. Corals shall be transplanted preferably on micro-relief features (bumps, hills, etc, scale of 0.1-0.3 meters) on the tops of boulders in the artificial reefs; *Agaricia* spp., *Madracis* spp., and *Mycetophyllia* spp., can be transplanted on to vertical or subvertical parts of the mitigation reefs. If found, corals of the genera *Mycetophyllia*, *Scolymia*, *Colpophyllia*, *Dendrogyra*, *Mussa*, *Isophyllia*, *Isophyllastrea*, *Favia*, and *Acropora* shall be transplanted irrespective of size. The surface of the substrate in the recipient location shall be cleaned of algae, cyanobacteria, and sediments with a wire brush. Portland cement and/or underwater epoxy glue can be used for the attachment of scleractinian coral colonies.

The time in the cooler prior to transplantation shall be minimized as much as possible. Coolers shall be kept in the boat away from direct sunlight and external heating.

II. STRUCTURAL ARTIFICIAL REEF MONITORING

If corals are transplanted to an artificial reef constructed as mitigation for the deepening project, and providing that scleractinian corals >10 cm in maximum diameter are transplanted as specified above, artificial reef(s) of 19.49 acres shall be built in a location to be determined north of the channel in the sandy trough between the Outer (3rd) and Inner (2nd) reefs, as mitigation for unavoidable impacts to coral reefs and hardbottom communities from the Project. The artificial reef(s) shall be built of limestone boulders such that the sand patches between the boulders do not exceed 10% of the total reef area. Comparable to the Middle (2nd) and Outer (3rd) reef impact sites, 6.92 acres of artificial reef with a low relief of three (3) feet or less and varying rugosity due to the placement of boulders will be constructed. 12.57 acres of the artificial reef shall contain higher relief of 10 feet or less and

varying rugosity. The rugosity will be measured via side-scan and multibeam survey and reported as part of the as-built surveys.

Monitoring of the artificial reef shall require:

1. A pre-construction bathymetric survey will be conducted to establish baseline conditions. The survey will be used to compare to future post-construction surveys to evaluate any evidence of subsidence.

2. A post-construction bathymetric (multibeam) and side scan survey will be conducted after all reef mitigation material has been placed in its designated site. A comparison between the pre- and post-construction survey will evaluate if the proper amount of high relief high complexity (HRHC) and low relief low complexity (LRLC) was achieved. The survey information will be utilized to demonstrate the boundaries of the sites (including total acreages), relief of the sites (provided in a color coded map to distinguish areas of low and high relief, with total acreages of each relief type), rugosity, and interstitial area (percent sand cover versus percent boulder cover for each reef unit/pile). Calculations for high relief areas and low relief areas are to be conducted separately. Cross sections will be taken at 50 foot intervals to determine relief, rugosity, and interstitial area. The calculations would be run on each cross section, and an overall average. Towed or pole mounted video would be conducted at 100 foot intervals as verification of the survey information. Diver surveys (line-intercep measurements) would only be conducted if the bathymetric survey information is determined to be deficient for estimating the criteria cited above.

   Corrective measurements shall be undertaken if the results of the artificial reef surveys show that less than the required acres of artificial reef is constructed, or if one of components (low relief/high relief) of the artificial reef is incorrect.

Schedule. Within the first 45 days after construction, a bathymetric survey of the mitigation site(s) and mapping of the outline of the reef shall be conducted, and then all other parts of the as-built survey shall follow. If any settlement occurs to the level that the top elevation is not within design tolerances, additional material must be added to make it comply. One final survey will be conducted at 90 days post construction, to ensure physical compliance with the design, prior to biological monitoring and/or relocation of corals to mitigation site beginning.

Reports. The as-built survey report shall be submitted within 45 days of the completion of the survey. .

POST CONSTRUCTION MONITORING

Monitoring of Transplanted Scleractinian Corals:
The size of all scleractinian corals shall be measured prior to the detachment (only the largest dimension), then, after the detachment, sorted and recorded by the species and size classes: I: 25-50 cm; II: >50 cm). After the transplantation of scleractinian corals, depending on their number, the monitoring mode will be selected. If the number of transplanted corals is less than 200, all transplanted corals shall be tagged and monitored. If the number of transplanted corals is from 200 to 500, then at least 50% of all corals shall be tagged and monitored. If the number of transplanted corals is over 500, then at least 30% of all corals shall be tagged and monitored, and if the number exceeds 1,000, at least 25% of all the corals shall be tagged and monitored. All size classes of each species of corals represented during the collection of corals in the impact zone shall be represented in the monitoring surveys.

For each relocated species, an aggregate of 10 reference colonies of any size will be identified, unless the number of transplanted corals was less than 10, in which case the number of control colonies shall be the same as the number of transplanted corals. Corals represented by a single colony shall not be required to have controls for monitoring. All corals selected for tagging and monitoring, including each reference colony will be photographed with a ruler present for scale. At least one photograph should be above the colony from fixed distance to be able to estimate surface area of the colony. At least one photograph should contain the unique identifier label. The following information will be recorded for each coral selected for tagging and monitoring, including each reference colony:

1) Species (to the lowest taxonomic rank possible)
2) Colony size. Scleractinian corals, this will include length (longest axis), width (perpendicular to longest axis), and height (in direction of growth).
3) Depth of water where colony is located.
4) Colony orientation.
5) Overall health (i.e. presence of disease or bleaching, percent live tissue). Reference colonies will, to the greatest extent possible, be free of notable disease, bleaching or other indicators of stress. It is recognized, however, that this may not be possible when regional or broader scale stress inducing events occur.
6) Location of the colony, through either GPS coordinates of the colony or GPS coordinates for a reference location (or relocation) and distance and compass bearing from the reference location.

Monitoring for scleractinian corals relocated to the transplantation site(s) and at the control sites shall be conducted at the following stages: one month after the transplantation, 6 months after transplantation; 1 year after transplantation; and 2 years after transplantation. After the 2 years of monitoring the success of the transplants will be estimated.

Success of scleractinian coral transplantation shall be based on the following criteria: 85% for corals measuring >25cm; 75% for corals measuring 11 cm-24cm. All survival rates shall be compared to survival rates at the baseline control sites and tested for statistically significant differences to capture potential effects of region-wide impacts associated with events outside of the scope of the dredging project.

The initiation and completion of transplantation and the transplantation progress shall be reported to the FLDEP JCP Compliance Officer via e-mail weekly or the information will be made available by web site. Monitoring reports shall be submitted within 90 days upon completion of each survey. Initiation and completion of each survey shall be reported to the FLDEP JCP Compliance Officer.

Mitigation Site/Artificial Reef Biological Monitoring Protocol

1. ***Permanent Transect Establishment and Monitoring.*** In order to monitor benthic colonization and succession, four (4) 20-meter long permanent monitoring transects per acre of artificial reef shall be established with ten (10) 1-meter square quadrats per transect.
   a) Photographs of each quadrat shall be taken to supplement quadrat in situ data along each transect, or
   b) Video Documentation shall be collected along the 20-meter long transects to supplement the quadrat data and analyzed using standard PonitCount99, CPCe, or approved similar method.

2. ***Schedule.*** Within 30 days following construction of the artificial reef, the bathymetric survey of the outline of the reef shall be conducted, and then all other parts of the as-built survey shall follow. The artificial reef permanent monitoring transects shall be monitored annually (summer) for five years following placement of the artificial reef. During the final (fifth) monitoring survey, the artificial reef shall be mapped once again (repeat as-built survey).

3. ***Success***. Success will be achieved when the benthic community and colonization of the mitigation reef has been documented to be comparable to the benthic community and species composition documented in the impact area of the 2nd and 3rd reef during the preconstruction survey (DCA, 2009). Successful mitigation shall be defined by the following criteria: 75% of species found in the impact site shall be present in the mitigation site by the time of the completion of the monitoring period; and percent cover by the major groups of organisms in the mitigation site shall be no less that it was in the impact site.

4. ***Reports.*** The as-built survey report shall be submitted within 30 days of the completion of the survey. The annual mitigative artificial reef monitoring reports shall be submitted within 90 days of the completion of each annual monitoring event, but no later than 1st of December of each year. Monitoring progress shall be reported weekly until the completion of each survey, at which point the JCP Compliance Officer shall be notified that the survey is complete. Each annual report shall document the colonization of the artificial reef

and compare the species composition on this reef to that documented in the impact area during the preconstruction survey. Annual monitoring reports shall include:

- A map of the artificial reef with the associated monitoring transects plotted on it;
- An analysis of the quantitative quadrat data on the benthic biological components of the artificial reef monitoring transects (*e.g.*, percent cover by corals, octocorals, sponges, algae, etc.);
- A comparative analyses of the mitigative artificial reef and natural hardbottom resources to determine mitigation success;
- An analysis of succession based on the comparison of benthic communities found on the artificial reef and natural communities (impact site) by comparison of such parameters as densities, size class distribution, etc.;
- Current acreage, relief, and rugosity of artificial reef (for final report only);
- Copies of all transect video submitted on DVDs; and,
- All raw data in the format that was used for the analysis.

If the artificial reef has either less acreage than was required in the permit by the time of final (5th) survey, or succession does not achieve the status of communities that existed at the impact site (criteria indicated above), then additional mitigation shall be required.