

## **Appendix B**

# **PALM BEACH HARBOR DISPOSAL AREA STUDY**

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**PALM BEACH HARBOR**

**DISPOSAL AREA STUDY**

**PALM BEACH HARBOR  
DISPOSAL AREA STUDY**

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# **PALM BEACH HARBOR DISPOSAL AREA STUDY**

## **INTRODUCTION**

The Jacksonville District of the U.S. Army Corps of Engineers performed this study to determine the availability of upland sites in the vicinity of Palm Beach Harbor for disposal of dredged material. The purpose of the study was to determine the availability and feasibility of using upland sites in comparison to offshore dredged material disposal for Palm Beach Harbor. Upland disposal sites underwent an analysis of environmental, engineering, and economic criteria. The economic assessment included the cost to purchase the required land, construct the necessary features, and transport the dredged material to the site. The analysis involves environmental and economic impacts of offshore and upland disposal to obtain a cost comparison which would indicate the most feasible method of disposal. The analysis and evaluation presented in this study include information and conditions existing during the latter half of 1994. Further, more detailed study would be required to implement any upland site recommended in this report.

As this study is primarily for the disposal of dredged material from the Palm Beach Harbor Federal Project, the Federal navigation channel was the major concern. Any material dredged from local access channels and berthing areas was not a consideration at this time. The Intracoastal Waterway - Jacksonville to Miami (IWW) was also excluded from this study as it is not part of the Palm Beach Harbor Federal Project. The IWW crosses Palm Beach Harbor turning basin in Lake Worth. It provides a channel depth of 10 feet over a bottom width of 125 feet. Therefore, portions of the IWW and Palm Beach Harbor Federal projects overlap. The deeper depths of Palm Beach Harbor are maintained in the overlap area (turning basin). The IWW has disposal sites for future maintenance work. Figure 1 is provided to show the location of Palm Beach Harbor. Figure 2 is provided to show the location of the maintenance areas (shoals).

## INITIAL INVESTIGATIONS

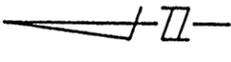
Initial investigations centered on obtaining and reviewing any previous disposal area studies for Palm Beach and other harbors. Recent aerial maps of Palm Beach County were inspected to determine the availability of upland disposal areas within a ten mile arc from the Palm Beach Harbor Turning Basin. Prior studies and reports provided a methodology for an upland area evaluation which included environmental, engineering and economic considerations. Information from several reports on Palm Beach Harbor (Survey-Review Report, General and Detail Design Memorandums, and Feasibility Report and Environmental Assessment) and the Port Everglades Harbor Disposal Area Study were helpful in preparing for this analysis and understanding the problems associated with dredged material disposal.

## SHOAL CHARACTERISTICS

The initial analysis involved a determination of dredged material quantity and classification as well as the dredging interval for the entrance channel and turning basin of the harbor. A dredging history on the Federally constructed entrance channel and main turning basin is available in the Jacksonville District Office. That history contains the quantity of material removed from the entrance channel and turning basin during each dredging event with a recorded time frame. Analysis of the data determined the annual shoaling rate and dredging interval for the entrance channel and turning basin in the harbor. After determination of the annual shoaling rate and dredging interval, an analysis of the Palm Beach Harbor maintenance dredging history determined the location and average depth of shoals within the entrance channel, inner channel and turning basin. Shoal material from the inner and entrance channels has been utilized for beach nourishment and was not included in this study. Shoal quantity, surface area, and depth are important factors related to dredging costs for shoal removal. The results of that analysis are presented in table 1.

## SITE IDENTIFICATION

**Selection Criteria** - To enable potential site identification, specific criteria was established with regard to size, shape, use, and boundary conditions. Potential sites less than 10 acres in size or with any dwelling were not considered for an upland disposal area. Wetlands or other environmentally sensitive areas were also avoided as potential sites. For any small site, shape would be a consideration to enable sufficient settling time

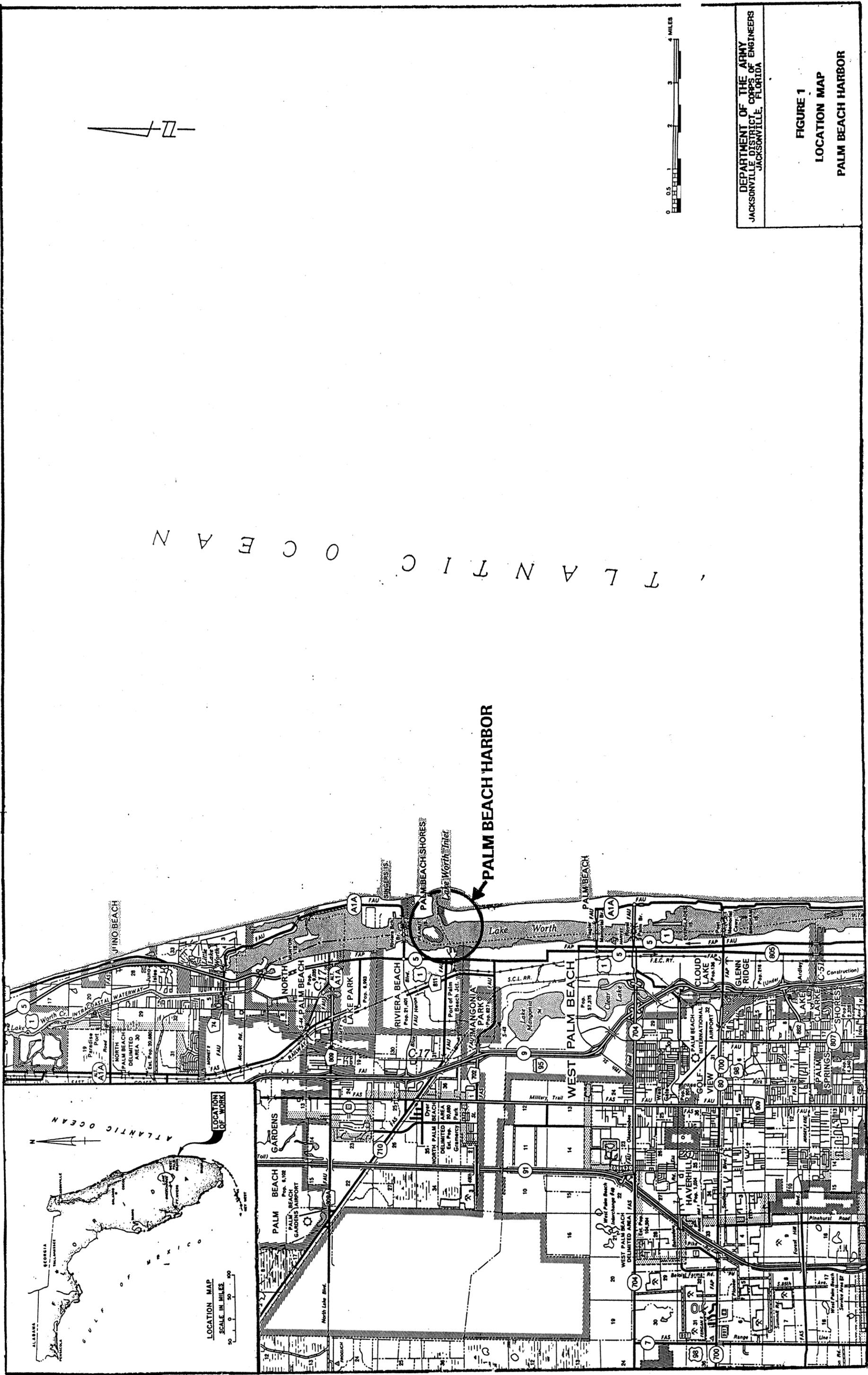


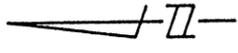
DEPARTMENT OF THE ARMY  
 JACKSONVILLE DISTRICT, CORPS OF ENGINEERS  
 JACKSONVILLE, FLORIDA

**FIGURE 1**  
**LOCATION MAP**  
**PALM BEACH HARBOR**

T L A N T I C  
 O C E A N

**PALM BEACH HARBOR**





O C F A N  
N Y W O O

APPROX. SHORELINE

SINGERS ISLAND

ENTRANCE CHANNEL

LAKE WORTH INLET

APPROX. SHORELINE

EXTENDED TURNING BASIN SHOAL 1 AREA

INNER CHANNEL

PEANUT ISLAND

TURNING BASIN SHOAL 1 AREA

LAKE WORTH

PORT  
OF  
PALM  
BEACH

TURNING BASIN



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PALM BEACH HARBOR

FIGURE 2

LOCATION MAP

MAINTENANCE AREAS

TABLE 1  
 PALM BEACH HARBOR  
 HARBOR SECTIONS AND  
 SHOAL CHARACTERISTICS

| SECTION NAME           | DEPTH (FEET) | SECTION LENGTH (FEET) | ANNUAL SHOALING (CY) | DREDGE INTERVAL (YEARS) | TOTAL QUANTITY (CY) | SURFACE AREA (FEET ^2) | PROJECTED SHOALING (FEET) | MATERIAL TYPE |
|------------------------|--------------|-----------------------|----------------------|-------------------------|---------------------|------------------------|---------------------------|---------------|
| TURNING BASIN          |              |                       |                      |                         |                     |                        |                           |               |
| SHOAL 1                | 33           | 1,650                 | 5,300                | 3                       | 15,900              | 43,500                 | 9.9                       | SAND & SILT   |
| EXTENDED TURNING BASIN |              |                       |                      |                         |                     |                        |                           |               |
| SHOAL 1                | 25           | 1,150                 | 5,000                | 12                      | 60,000              | 203,000                | 7.9                       | SAND & SILT   |

for the return water to meet required water quality standards. Property boundaries influenced site selection because severance damages are a consideration in real estate values. Severance damages are paid to a property owner when purchasing a portion of a parcel of land that devalues the remaining sections. In designating potential sites, utilization of the entire parcel was a major consideration to avoid any additional severance costs. With the criteria in place, the selection process went forward to identify the geographical boundaries as a means of limiting the scope of the search.

**Geographical Boundaries** - The identification of initial geographical boundaries usually involves a consideration for pipeline access to any potential site. The shoreline at the Atlantic Ocean forms the eastern limit. Equipment limitations relating to pumping dredged material to potential sites define the southern, western and northern boundaries. The detailed dredging analysis identifies a maximum pumping distance for this study as approximately 10 miles from the hydraulic dredge plant location. The pumping limit of 10 miles is based primarily on equipment limitations such as pipeline availability. Some respected experts in the dredging field consider only a 5 mile maximum pumping distance as reasonable based upon the availability of pipeline. For this study, however, the limit was extended to ensure all possible alternatives for upland locations in the vicinity of Palm Beach Harbor received full consideration. Geographical boundaries and equipment limitations greatly reduced the extent of potential site locations.

**Site Selection** - REDI maps with aerial photography dated 1992 of Palm Beach County available in the Jacksonville District, U.S. Army Corps of Engineers, Regulatory Division Office were of assistance in determining potential upland disposal site locations. These REDI maps were accessible for inspection in volumes covering the northern, central, and southern portions of Palm Beach County. Utilizing the previously mentioned selection criteria and geographical boundaries, the identification of 122 potential sites was possible in Palm Beach County.

**Site Characteristics** - The selected sites were then measured from copies of the REDI maps to determine size and perimeter. Site numbers and characteristics are provided in table 2 with most site locations being presented in figure 3. Exact site locations are not identified due to real estate requirements.

TABLE 2  
PALM BEACH HARBOR  
DISPOSAL AREA STUDY  
SITE INFORMATION

| SITE NUMBER                            | SITE SIZE (ACRES) | SITE NUMBER | SITE SIZE (ACRES) | SITE NUMBER | SITE SIZE (ACRES) | SITE NUMBER | SITE SIZE (ACRES) |
|--|-------------------|-------------|-------------------|-------------|-------------------|-------------|-------------------|
| PALM BEACH COUNTY, FL., NORTH VOLUME   |                   |             |                   |             |                   |             |                   |
| 1                                      | 25                | 15          | 160               | 29          | 33                | 43          | 12                |
| 2                                      | 136               | 16          | 388               | 30          | 52                | 44          | 83                |
| 3                                      | 41                | 17          | 181               | 31          | 60                | 45          | 159               |
| 4                                      | 89                | 17A         | 11                | 32          | 35                | 46          | 315               |
| 5                                      | 110               | 18          | 126               | 33          | 28                | 47          | 267               |
| 6                                      | 112               | 19          | 25                | 34          | 96                | 48          | 147               |
| 7                                      | 350               | 20          | 272               | 35          | 78                | 49          | 57                |
| 8                                      | 232               | 21          | 523               | 36          | 44                | 50          | 19                |
| 8A                                     | 281               | 22          | 553               | 37          | 40                | 51          | 26                |
| 9                                      | 302               | 23          | 69                | 38          | 18                | 52          | 71                |
| 10                                     | 37                | 24          | 94                | 39          | 24                | 53          | 17                |
| 11                                     | 25                | 25          | 307               | 40          | 23                | 54          | 23                |
| 12                                     | 37                | 26          | 29                | 41          | 38                | 55          | 98                |
| 13                                     | 208               | 27          | 42                | 42          | 22                | 56          | 522               |
| 14                                     | 50                | 28          | 63                | 42A         | 12                | 57          | 68                |
|  |                   |             |                   |             |                   | 58          | 203               |
| PALM BEACH COUNTY, FL., CENTRAL VOLUME |                   |             |                   |             |                   |             |                   |
| 59                                     | 47                | 74          | 12                | 89          | 221               | 104         | 38                |
| 60                                     | 27                | 75          | 22                | 90          | 45                | 105         | 14                |
| 61                                     | 15                | 76          | 316               | 91          | 53                | 106         | 13                |
| 62                                     | 153               | 77          | 39                | 92          | 47                | 107         | 148               |
| 63                                     | 117               | 78          | 49                | 93          | 35                | 108         | 27                |
| 64                                     | 60                | 79          | 51                | 94          | 26                | 109         | 22                |
| 65                                     | 155               | 80          | 14                | 95          | 140               | 110         | 169               |
| 66                                     | 86                | 81          | 24                | 96          | 93                | 111         | 24                |
| 67                                     | 54                | 82          | 19                | 97          | 27                | 112         | 14                |
| 68                                     | 94                | 83          | 121               | 98          | 13                | 113         | 12                |
| 69                                     | 54                | 84          | 28                | 99          | 131               | 114         | 20                |
| 70                                     | 108               | 85          | 101               | 100         | 186               | 115         | 16                |
| 71                                     | 89                | 86          | 19                | 101         | 13                | 116         | 20                |
| 72                                     | 275               | 87          | 33                | 102         | 12                | 117         | 17                |
| 73                                     | 19                | 88          | 65                | 103         | 152               | 118         | 14                |
|  |                   |             |                   |             |                   | 119         | 13                |

## **SITE VERIFICATION**

Examination of aerial maps of each selected site enabled an environmental scientist to make initial observations concerning any significant environmental resources in the area. Any site with significant environmental resources was either dropped from consideration or redefined to avoid impacting those resources (see table 3). During initial site selection, the assumption was that each site remained as presented in the 1992 aerial maps and that pipeline access to each site would not prohibit site utilization. A site verification trip provided a more current identification and characterization of each site. The site inspection verified the land use and current conditions of the sites under consideration.

**Changed Conditions** - Site visits identified changes in site conditions that had taken place since the aerial photography was taken in 1992. Site visits to the potential sites revealed changes had taken place in one site. The southern part of site 38 has been developed into a self storage facility. However, this development has taken up only a small portion of site 38 with the remainder of this site still available for a disposal area. Visits to the remaining sites revealed no changes had occurred to make them unsuitable for disposal sites. The results of the site visits have verified that the potential sites are suitable for upland disposal areas.

**Pipeline Access** - An acceptable access route to the upland disposal site location is necessary. Access routes that must cross major highways, railroads, and other land parcels must take into account any environmental impacts and costs considerations to determine the practicality of such an action. Direct access to a site via an inland waterway is the most desired condition. Navigable waters of the United States do not require real estate easements. Small streams, canals, and drainage ditches can also provide access without an easement if they are attached to navigable waters. Access along highways and railroads is also possible and usually achieved by passing through culverts and under bridges. All potential sites have acceptable pipeline accessibility from adequate canals, drainage ditches, culverts, and bridges near the sites.

A potential site may be within the ten mile arc but a direct route to the site may not be available. In that case, the pipeline distance could exceed the ten mile limit and the site would be dropped from further consideration.



TABLE 3  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
INITIAL UPLAND SITES ELIMINATED

| SITE NUMBER                                   | SITE SIZE (ACRES) | REASON FOR ELIMINATION       |
|---|-------------------|------------------------------|
| <b>PALM BEACH COUNTY, FL., NORTH VOLUME</b>   |                   |                              |
| 1   | 25                | PIPELINE DISTANCE > 10 MILES |
| 2   | 136               | PIPELINE DISTANCE > 10 MILES |
| 3   | 41                | PIPELINE DISTANCE > 10 MILES |
| 4   | 89                | PIPELINE DISTANCE > 10 MILES |
| 5   | 110               | PIPELINE DISTANCE > 10 MILES |
| 6   | 112               | PIPELINE DISTANCE > 10 MILES |
| 7   | 350               | PIPELINE DISTANCE > 10 MILES |
| 8   | 232               | PIPELINE DISTANCE > 10 MILES |
| 8A  | 281               | PIPELINE DISTANCE > 10 MILES |
| 13  | 208               | ENVIRONMENTAL CONCERNS       |
| 14  | 50                | ENVIRONMENTAL CONCERNS       |
| 15  | 160               | ENVIRONMENTAL CONCERNS       |
| 17  | 181               | ENVIRONMENTAL CONCERNS       |
| 20  | 272               | PIPELINE DISTANCE > 10 MILES |
| 21  | 523               | PIPELINE DISTANCE > 10 MILES |
| 22  | 553               | PIPELINE DISTANCE > 10 MILES |
| 23  | 60                | ENVIRONMENTAL CONCERNS       |
| 24  | 94                | ENVIRONMENTAL CONCERNS       |
| 25  | 307               | PIPELINE DISTANCE > 10 MILES |
| 26  | 29                | ENVIRONMENTAL CONCERNS       |
| 27  | 42                | ENVIRONMENTAL CONCERNS       |
| 29  | 33                | ENVIRONMENTAL CONCERNS       |
| 34  | 96                | ENVIRONMENTAL CONCERNS       |
| 36  | 44                | ENVIRONMENTAL CONCERNS       |
| 41  | 38                | ENVIRONMENTAL CONCERNS       |
| 46  | 315               | PIPELINE DISTANCE > 10 MILES |
| 47  | 267               | PIPELINE DISTANCE > 10 MILES |
| 55  | 98                | PIPELINE DISTANCE > 10 MILES |
| 56  | 522               | PIPELINE DISTANCE > 10 MILES |
| 57  | 68                | PIPELINE DISTANCE > 10 MILES |
| 58  | 203               | PIPELINE DISTANCE > 10 MILES |
| <b>PALM BEACH COUNTY, FL., CENTRAL VOLUME</b> |                   |                              |
| 59  | 47                | ENVIRONMENTAL CONCERNS       |
| 60  | 27                | PIPELINE DISTANCE > 10 MILES |
| 61  | 15                | PIPELINE DISTANCE > 10 MILES |
| 62  | 153               | PIPELINE DISTANCE > 10 MILES |
| 63  | 117               | PIPELINE DISTANCE > 10 MILES |
| 64  | 60                | PIPELINE DISTANCE > 10 MILES |
| 65  | 155               | ENVIRONMENTAL CONCERNS       |
| 66  | 86                | ENVIRONMENTAL CONCERNS       |
| 67  | 54                | ENVIRONMENTAL CONCERNS       |
| 68  | 94                | PIPELINE DISTANCE > 10 MILES |
| 69  | 54                | PIPELINE DISTANCE > 10 MILES |
| 70  | 108               | ENVIRONMENTAL CONCERNS       |
| 71  | 89                | PIPELINE DISTANCE > 10 MILES |
| 72  | 275               | ENVIRONMENTAL CONCERNS       |
| 73  | 19                | PIPELINE DISTANCE > 10 MILES |
| 74  | 12                | PIPELINE DISTANCE > 10 MILES |
| 75  | 22                | PIPELINE DISTANCE > 10 MILES |
| 76  | 316               | ENVIRONMENTAL CONCERNS       |

TABLE 3  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
INITIAL UPLAND SITES ELIMINATED

| SITE<br>NUMBER                                 | SITE<br>SIZE<br>(ACRES) | REASON FOR ELIMINATION       |
|--|-------------------------|------------------------------|
| PALM BEACH COUNTY, FL., CENTRAL VOLUME(Cont'd) |                         |                              |
| 77   | 39                      | PIPELINE DISTANCE > 10 MILES |
| 78   | 49                      | PIPELINE DISTANCE > 10 MILES |
| 79   | 51                      | PIPELINE DISTANCE > 10 MILES |
| 80   | 14                      | PIPELINE DISTANCE > 10 MILES |
| 81   | 24                      | PIPELINE DISTANCE > 10 MILES |
| 82   | 19                      | PIPELINE DISTANCE > 10 MILES |
| 83   | 121                     | PIPELINE DISTANCE > 10 MILES |
| 84   | 28                      | PIPELINE DISTANCE > 10 MILES |
| 85   | 64                      | PIPELINE DISTANCE > 10 MILES |
| 86   | 19                      | PIPELINE DISTANCE > 10 MILES |
| 87   | 33                      | PIPELINE DISTANCE > 10 MILES |
| 88   | 65                      | PIPELINE DISTANCE > 10 MILES |
| 89   | 221                     | PIPELINE DISTANCE > 10 MILES |
| 90   | 45                      | ENVIRONMENTAL CONCERNS       |
| 91   | 53                      | PIPELINE DISTANCE > 10 MILES |
| 92   | 47                      | PIPELINE DISTANCE > 10 MILES |
| 93   | 35                      | PIPELINE DISTANCE > 10 MILES |
| 94   | 26                      | PIPELINE DISTANCE > 10 MILES |
| 95   | 140                     | PIPELINE DISTANCE > 10 MILES |
| 96   | 93                      | PIPELINE DISTANCE > 10 MILES |
| 97   | 27                      | PIPELINE DISTANCE > 10 MILES |
| 98   | 13                      | PIPELINE DISTANCE > 10 MILES |
| 99   | 131                     | PIPELINE DISTANCE > 10 MILES |
| 100  | 186                     | PIPELINE DISTANCE > 10 MILES |
| 101  | 13                      | ENVIRONMENTAL CONCERNS       |
| 102  | 12                      | PIPELINE DISTANCE > 10 MILES |
| 103  | 152                     | PIPELINE DISTANCE > 10 MILES |
| 104  | 38                      | ENVIRONMENTAL CONCERNS       |
| 105  | 14                      | ENVIRONMENTAL CONCERNS       |
| 106  | 13                      | PIPELINE DISTANCE > 10 MILES |
| 107  | 148                     | PIPELINE DISTANCE > 10 MILES |
| 108  | 27                      | PIPELINE DISTANCE > 10 MILES |
| 109  | 22                      | PIPELINE DISTANCE > 10 MILES |
| 110  | 169                     | PIPELINE DISTANCE > 10 MILES |
| 111  | 24                      | PIPELINE DISTANCE > 10 MILES |
| 112  | 14                      | PIPELINE DISTANCE > 10 MILES |
| 113  | 12                      | ENVIRONMENTAL CONCERNS       |
| 114  | 20                      | PIPELINE DISTANCE > 10 MILES |
| 115  | 16                      | PIPELINE DISTANCE > 10 MILES |
| 116  | 20                      | PIPELINE DISTANCE > 10 MILES |
| 117  | 17                      | PIPELINE DISTANCE > 10 MILES |
| 118  | 14                      | ENVIRONMENTAL CONCERNS       |
| 119  | 13                      | ENVIRONMENTAL CONCERNS       |

## DETAILED SITE ANALYSIS

The detailed site analysis considered the specific characteristics of each site in order to determine preparation requirements and capacity for material disposal. Preparation requirements included such items as clearing and grubbing, dike construction, and weir installation, all of which directly influence costs. Quantification of the work items enabled the development of costs for each site. The total estimated cost of all the work items to prepare a site is then divided by the site capacity to provide a cost per cubic yard (\$/cy). Combining that unit cost with the dredging and real estate costs provides a total cost per cubic yard to utilize each site for disposal.

### SITE SPECIFICS

An accurate determination of conditions at each site is essential in developing the correct site preparation cost. Site capacity depends upon the amount of usable area and dike heights at the site. Dike heights need to be established and the site area cleared for utilization. Each component is directly related to the utilization cost of a potential site.

**Site Capacity** - The volume of material that can be placed within the diked area is defined as the site capacity. Site capacity has three components, usable area within the dikes, dike height, and bulking factor. The sites were first identified in the initial site analysis and further reviewed during a field visit. The usable area has an influence on determining the dike height. Further engineering studies would determine the maximum dike height for each site. Most of the potential sites have acreages which could economically and engineeringly support dike heights of at least 20 feet. A freeboard of two feet in the dike height was a factor in estimating the site capacity. For a dike height of 20 feet, the freeboard consideration would limit material placement to a height of 18 feet. Material used for dike construction normally comes from inside the perimeter of the disposal area. The assumption is that each site has suitable material for dike construction. The dike material from inside the disposal area provides additional space for dredged material disposal. The bulking factor varies according to dredged material characteristics. Sand has a bulking factor of 1 while silt can have a bulking factor of 1.5. Based on previous dredging experience and the nature of the dredged material in the harbor, the bulking factor should be approximately 1.3. Based upon the above information, the estimated capacity of each potential site was calculated and is provided in table 4.

TABLE 4  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
SITE INFORMATION

| SITE NUMBER | PERIMETER LENGTH (YARDS) | SITE SIZE (ACRES) | DIKE HEIGHT (FT) | DIKE X-SECTION (SF) | DIKE QUANTITY (CY) | BULKING FACTOR | CAPACITY DIKED AREA (CY) |
|-------------|--------------------------|-------------------|------------------|---------------------|--------------------|----------------|--------------------------|
| 9           | 6,913                    | 302               | 40               | 5,600               | 4,301,400          | 1.3            | 14,242,000               |
| 10          | 1,875                    | 37                | 30               | 3,300               | 687,500            | 1.3            | 1,285,700                |
| 11          | 2,238                    | 25                | 30               | 3,300               | 820,600            | 1.3            | 868,700                  |
| 12          | 2,248                    | 37                | 30               | 3,300               | 824,300            | 1.3            | 1,285,700                |
| 16          | 5,748                    | 388               | 40               | 5,600               | 3,576,500          | 1.3            | 18,297,700               |
| 17A         | 998                      | 11                | 20               | 1,600               | 177,400            | 1.3            | 245,700                  |
| 18          | 3,668                    | 126               | 40               | 5,600               | 2,282,300          | 1.3            | 5,942,000                |
| 19          | 1,560                    | 25                | 30               | 3,300               | 572,000            | 1.3            | 868,700                  |
| 28          | 3,268                    | 63                | 40               | 5,600               | 2,033,400          | 1.3            | 2,971,000                |
| 30          | 2,080                    | 52                | 40               | 5,600               | 1,294,200          | 1.3            | 2,452,300                |
| 31          | 2,249                    | 60                | 40               | 5,600               | 1,399,400          | 1.3            | 2,829,500                |
| 32          | 1,935                    | 42                | 40               | 5,600               | 1,204,000          | 1.3            | 1,980,700                |
| 33          | 1,802                    | 28                | 30               | 3,300               | 660,700            | 1.3            | 973,000                  |
| 35          | 3,268                    | 78                | 40               | 5,600               | 2,033,400          | 1.3            | 3,678,400                |
| 37          | 1,907                    | 40                | 40               | 5,600               | 1,186,600          | 1.3            | 1,886,400                |
| 38          | 1,462                    | 38                | 30               | 3,300               | 536,100            | 1.3            | 1,320,500                |
| 39          | 1,393                    | 24                | 30               | 3,300               | 510,800            | 1.3            | 834,000                  |
| 40          | 1,505                    | 23                | 30               | 3,300               | 551,800            | 1.3            | 799,200                  |
| 42          | 1,384                    | 22                | 30               | 3,300               | 507,500            | 1.3            | 764,500                  |
| 42A         | 1,244                    | 12                | 20               | 1,600               | 221,200            | 1.3            | 268,100                  |
| 43          | 2,678                    | 64                | 40               | 5,600               | 1,666,300          | 1.3            | 3,018,200                |
| 44          | 2,965                    | 83                | 40               | 5,600               | 1,844,900          | 1.3            | 3,914,200                |
| 45          | 5,786                    | 159               | 40               | 5,600               | 3,600,200          | 1.3            | 7,498,300                |
| 48          | 3,426                    | 147               | 40               | 5,600               | 2,131,700          | 1.3            | 6,932,400                |
| 49          | 2,393                    | 57                | 40               | 5,600               | 1,489,000          | 1.3            | 2,688,100                |
| 50          | 1,173                    | 19                | 20               | 1,600               | 208,500            | 1.3            | 424,400                  |
| 51          | 1,752                    | 26                | 30               | 3,300               | 642,400            | 1.3            | 903,500                  |
| 52          | 2,383                    | 71                | 40               | 5,600               | 1,482,800          | 1.3            | 3,348,300                |
| 53          | 1,399                    | 17                | 20               | 1,600               | 248,700            | 1.3            | 379,800                  |
| 54          | 2,134                    | 23                | 30               | 3,300               | 782,500            | 1.3            | 799,200                  |

**Site Preparation** - Preparation of a potential site for use as a disposal area involves planning and design for dike construction, installation of water control structures (weirs), provisions for returning water from the site, and clearing the site of trees and brush for efficient use. The number of weirs required for a disposal area depends upon disposal area and dredge size. For sites in this study, the area in each is sufficient to accommodate a 30 inch hydraulic dredge. To handle the discharge water from that dredge, each site would need six weirs at a cost of \$75,000 per unit. Site clearing costs depend upon the amount and density of trees and bushes to be removed from an area. Aerial photography and site visit was valuable in determining this factor at each site. Table 5 provides the range of costs for clearing and grubbing. Site 32 is an example for estimating the clearing and grubbing cost. The site is in a medium clearing category that is estimated to cost \$89,460 to clear and grub. The value is derived from the 42 acres site size multiplied by the \$2,130 per acre clearing category. The estimated cost for dike construction is \$1.90 per cubic yard with the quantity provided in table 4. Mobilization and demobilization costs for moving equipment to and from the construction site also depends primarily upon the quantity of material needed for dike construction. Table 6 provides the range of costs employed for mobilization and demobilization. To cover the cost of uncertainties in the estimate, a contingency item is estimated at 25 percent of construction costs. Costs for engineering and design (E&D) and construction management (CM) are a percent of the total estimated construction costs. The combined percentage is 15.

**Site Cost Summary** - The purpose of the detailed site analysis is to determine the site preparation costs for disposal of dredged material. Table 7 provides a site cost summary for each element of cost associated with a potential upland disposal site. The last column in that table provides a cost per cubic yard of dredged material placed in each site. That unit cost is determined by dividing the total cost by the site capacity. The site cost is only a portion of the entire cost for upland disposal. The remaining facets of dredging and real estate are discussed in the following text.

## **EXISTING DISPOSAL AREAS**

At the present time there are no existing disposal areas. Peanut Island has been used as a disposal area for maintenance material from the turning basin. However, Peanut Island is no longer available for a disposal area because it has been determined to have value for wildlife and recreational purposes. Maintenance material from the entrance and inner channels has been placed on the beach area south of the south jetty since the excavated material has been good quality sand.

**TABLE 5**  
**PALM BEACH HARBOR DISPOSAL AREA STUDY**  
**CLEARING AND GRUBBING COST RANGES**

| CLEARING CATEGORY  | COST PER ACRE |
|--------------------|---------------|
| Light (no trees)   | \$ 560        |
| Light (with trees) | 1,230         |
| Light to Medium    | 1,450         |
| Medium             | 1,680         |
| Medium to Heavy    | 2,130         |
| Heavy              | 2,460         |

**TABLE 6**  
**PALM BEACH HARBOR DISPOSAL AREA STUDY**  
**MOBILIZATION AND DEMOBILIZATION COST RANGES**

| CUBIC YARDS            | COSTS     |
|------------------------|-----------|
| 30,000 to 311,000      | \$ 56,000 |
| 312,000 to 1,099,000   | 112,000   |
| 1,100,000 to 1,299,000 | 168,000   |
| 1,300,000 to 5,000,000 | 224,000   |

TABLE 7  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
SITE PREPARATION COSTS

| SITE NUMBER | SITE SIZE (ACRES) | DIKE QUANTITY (CY) | MOB & DEMOB (\$) | DIKE CONSTR (\$) | CLEARING & GRUBBING (\$) | CONTROL STRUCT (\$) | SUBTOTAL (\$) | CONTING @ 25% (\$) | E&D AND CM @ 15% (\$) | TOTAL (\$) | DIKED AREA CAPACITY (CY) | COST (\$/CY) |
|-------------|-------------------|--------------------|------------------|------------------|--------------------------|---------------------|---------------|--------------------|-----------------------|------------|--------------------------|--------------|
| 9           | 302               | 4,301,400          | 224,000          | 8,172,660        | 643,300                  | 450,000             | 9,489,960     | 2,372,490          | 1,423,494             | 13,285,944 | 14,242,000               | 0.93         |
| 10          | 37                | 687,500            | 112,000          | 1,306,250        | 78,800                   | 450,000             | 1,947,050     | 486,763            | 292,058               | 2,725,870  | 1,285,700                | 2.12         |
| 11          | 25                | 820,600            | 112,000          | 1,559,140        | 53,300                   | 450,000             | 2,174,440     | 543,610            | 326,166               | 3,044,216  | 868,700                  | 3.50         |
| 12          | 37                | 824,300            | 112,000          | 1,566,170        | 62,200                   | 450,000             | 2,190,370     | 547,593            | 328,556               | 3,066,518  | 1,285,700                | 2.39         |
| 16          | 388               | 3,576,500          | 224,000          | 6,795,350        | 826,400                  | 450,000             | 8,295,750     | 2,073,938          | 1,244,363             | 11,614,050 | 18,297,700               | 0.63         |
| 17A         | 11                | 177,400            | 56,000           | 337,060          | 18,500                   | 450,000             | 861,560       | 215,390            | 129,234               | 1,206,184  | 245,700                  | 4.91         |
| 18          | 126               | 2,282,300          | 224,000          | 4,336,370        | 268,400                  | 450,000             | 5,278,770     | 1,319,693          | 791,816               | 7,390,278  | 5,942,000                | 1.24         |
| 19          | 25                | 572,000            | 112,000          | 1,086,800        | 53,300                   | 450,000             | 1,702,100     | 425,525            | 255,315               | 2,382,940  | 868,700                  | 2.74         |
| 28          | 63                | 2,033,400          | 224,000          | 3,863,460        | 91,400                   | 450,000             | 4,628,860     | 1,157,215          | 694,329               | 6,480,404  | 2,971,000                | 2.18         |
| 30          | 52                | 1,294,200          | 168,000          | 2,458,980        | 87,400                   | 450,000             | 3,164,380     | 791,095            | 474,657               | 4,430,132  | 2,452,300                | 1.81         |
| 31          | 60                | 1,399,400          | 224,000          | 2,658,860        | 100,800                  | 450,000             | 3,433,660     | 858,415            | 515,049               | 4,807,124  | 2,829,500                | 1.70         |
| 32          | 42                | 1,204,000          | 168,000          | 2,287,600        | 89,500                   | 450,000             | 2,995,100     | 748,775            | 449,265               | 4,193,140  | 1,980,700                | 2.12         |
| 33          | 28                | 660,700            | 112,000          | 1,255,330        | 59,600                   | 450,000             | 1,876,930     | 469,233            | 281,540               | 2,627,702  | 973,000                  | 2.70         |
| 35          | 78                | 2,033,400          | 224,000          | 3,863,460        | 166,100                  | 450,000             | 4,703,560     | 1,175,890          | 705,534               | 6,584,984  | 3,678,400                | 1.79         |
| 37          | 40                | 1,186,600          | 168,000          | 2,254,540        | 58,000                   | 450,000             | 2,930,540     | 732,635            | 439,581               | 4,102,756  | 1,886,400                | 2.17         |
| 38          | 38                | 596,100            | 112,000          | 1,018,590        | 80,900                   | 450,000             | 1,661,490     | 415,373            | 249,224               | 2,326,086  | 1,320,500                | 1.76         |
| 39          | 24                | 510,800            | 112,000          | 970,520          | 29,500                   | 450,000             | 1,562,020     | 390,505            | 234,303               | 2,186,828  | 834,000                  | 2.62         |
| 40          | 23                | 551,800            | 112,000          | 1,048,420        | 33,400                   | 450,000             | 1,643,820     | 410,955            | 246,573               | 2,301,348  | 799,200                  | 2.88         |
| 42          | 22                | 507,500            | 112,000          | 964,250          | 37,000                   | 450,000             | 1,563,250     | 390,813            | 234,488               | 2,188,550  | 764,500                  | 2.86         |
| 42A         | 12                | 221,200            | 56,000           | 420,280          | 20,200                   | 450,000             | 946,480       | 236,620            | 141,972               | 1,325,072  | 268,100                  | 4.94         |
| 43          | 64                | 1,666,300          | 224,000          | 3,165,970        | 136,300                  | 450,000             | 3,976,270     | 994,068            | 596,441               | 5,566,778  | 3,018,200                | 1.84         |
| 44          | 83                | 1,844,900          | 224,000          | 3,505,310        | 139,400                  | 450,000             | 4,318,710     | 1,079,678          | 647,807               | 6,046,194  | 3,914,200                | 1.54         |
| 45          | 159               | 3,600,200          | 224,000          | 6,840,380        | 230,600                  | 450,000             | 7,744,980     | 1,936,245          | 1,161,747             | 10,842,972 | 7,498,300                | 1.45         |
| 48          | 147               | 2,131,700          | 224,000          | 4,050,230        | 213,200                  | 450,000             | 4,937,430     | 1,234,358          | 740,615               | 6,912,402  | 6,932,400                | 1.00         |
| 49          | 57                | 1,489,000          | 224,000          | 2,829,100        | 82,700                   | 450,000             | 3,585,800     | 896,450            | 537,870               | 5,020,120  | 2,688,100                | 1.87         |
| 50          | 19                | 208,500            | 56,000           | 396,150          | 23,400                   | 450,000             | 925,550       | 231,388            | 138,833               | 1,295,770  | 424,400                  | 3.05         |
| 51          | 26                | 642,400            | 112,000          | 1,220,560        | 37,700                   | 450,000             | 1,820,260     | 455,065            | 273,039               | 2,548,364  | 903,500                  | 2.82         |
| 52          | 71                | 1,482,800          | 224,000          | 2,817,320        | 87,300                   | 450,000             | 3,578,620     | 894,655            | 536,793               | 5,010,068  | 3,348,300                | 1.50         |
| 53          | 17                | 248,700            | 56,000           | 472,530          | 24,700                   | 450,000             | 1,003,230     | 250,808            | 150,485               | 1,404,522  | 379,800                  | 3.70         |
| 54          | 23                | 782,500            | 112,000          | 1,486,750        | 28,300                   | 450,000             | 2,077,050     | 519,263            | 311,558               | 2,907,870  | 799,200                  | 3.64         |

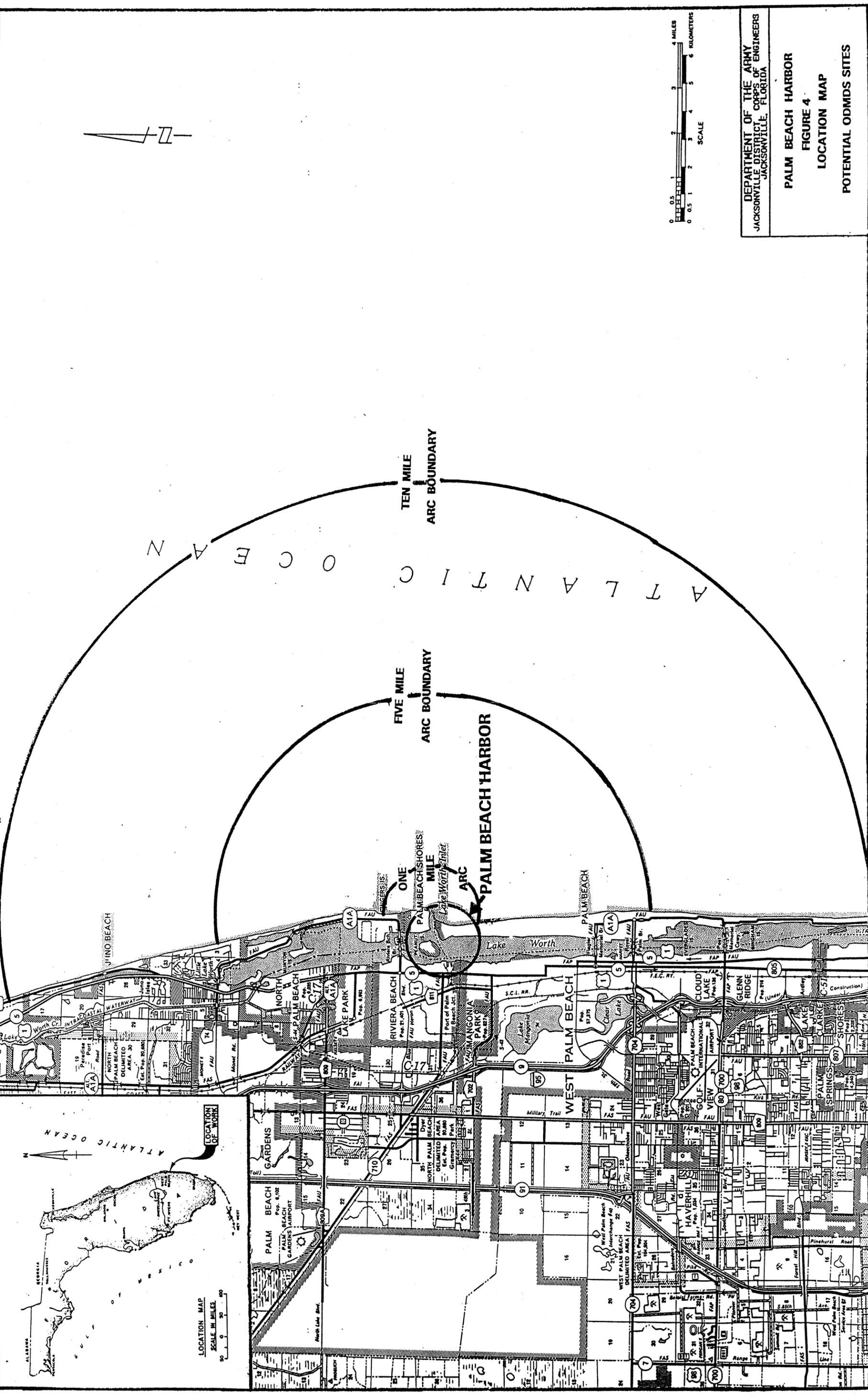
## DETAILED DREDGING ANALYSIS

Dredging involves both the removal of material from the channel bottom and transportation to the designated disposal area. The analysis examined three methods of dredging. Clamshell dredging with barge transport and hopper dredging provide the most efficient methods to dispose of material in the offshore dredged material disposal site (ODMDS). Traditional hydraulic dredging with pipeline for transport to an upland site provides an efficient method for moving dredged material to upland disposal sites. As stated in the geographical boundaries section of this study, hydraulic dredging has a pumping limit of 10 miles which is based primarily on equipment limitations such as pipeline availability. Some respected experts in the dredging field consider a 5 mile maximum pumping distance as reasonable based upon the availability of pipeline. For this study, the limit was extended to ensure all possible alternatives for upland locations in the vicinity of Palm Beach Harbor received full consideration.

### OCEAN DISPOSAL

The dredging analysis included two methods for ocean disposal of dredged material as mentioned earlier. Hopper dredging as well as clamshell dredging with barge transport are both applicable methods for ocean disposal. Currently, no usable ODMDS exists at Palm Beach Harbor. In order to determine cost for ocean disposal without a definite location for an ODMDS, cost estimates were computed for potential offshore sites in 1 mile increments from the Palm Beach Harbor entrance channel to 10 miles offshore. Figure 4 shows the location of the 1, 5, and 10 mile boundaries.

**Hopper Dredge Estimates** - The hopper dredge for estimating purposes has a carrying capacity of 3,600 cubic yards (cy). A hopper dredge hydraulically removes shoal material from the channel bottom and places it in a hopper on the dredge. When the hopper is full, the dredge proceeds to the ODMDS where the bottom of the hopper opens depositing the material on the ocean floor. The material classification which greatly influences dredging efficiency and therefore cost was discussed in the shoal characteristics section of this study. As stated in the same section, the project was broken into sections or cuts (see figure 2). A sample estimate to hopper dredge one of the Palm Beach Harbor cuts is provided in table 8. Note that the unit cost given at the top excludes any costs for mobilization, contingencies, engineering and design, as well as construction management. Table 9 provides the total dredging and transportation costs for each cut in the Palm Beach Harbor Federal Project. The costs for mobilization and demobilization are prorated over the project. Hopper dredge costs increase with with the distance to the ODMDS as shown in table 9.



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

PALM BEACH HARBOR  
 FIGURE 4  
 LOCATION MAP  
 POTENTIAL ODMDS SITES

SCALE  
 0 0.5 1 2 3 4 5 6  
 MILES  
 0 0.5 1 2 3 4 5 6  
 KILOMETERS

ATLANTIC OCEAN

TEN MILE  
 ARC BOUNDARY

FIVE MILE  
 ARC BOUNDARY

PALM BEACH HARBOR

ONE MILE  
 ARC BOUNDARY

LOCATION MAP  
 SCALE IN MILES  
 0 50 100

LOCATION OF WORK

**TABLE 8  
PALM BEACH HARBOR  
DISPOSAL AREA STUDY  
HOPPER DREDGE ESTIMATE**

CHECKLIST FOR INPUT DATA.  
Planning Est. 12 July 94

BID QUANTITY 159,500 C.Y.  
UNIT COST... \$3.55 PER C.Y.  
EXCAV. COST. \$566,225  
TIME..... 0.075 MONTHS

PG 1 OF 14: PROJECT TITLES

PROJECT - Palm Beach Harbor DAS  
LOCATION - Ocean Disposal  
INVIT # - Turning Basin -> 10.0 miles  
BID ITEM # - 2  
FILENAME - PBH401H  
EST - Al Fletcher  
MIDPT DATE - Oct-94  
DESCRIPTION ENTERED? -

PG 13 OF 14: MARKUPS USED

O.H. - 15.0%  
PROFIT - 10.0%  
BOND - 1.0%

PG 2 OF 14: EXCAVATION QTY'S

DREDGING AREA - 43,500 sf  
REQ'D EXCAVATION - 15,950 cyds  
% MUD - 50%  
% SAND - 50%  
% GRAVEL - 0%  
PAY OVERDEPTH - 0 cyds  
O.D. NOT DREDGED - 0 cyds  
OVERDIG FOOTAGE - 1.00 ft  
NONPAY YARDAGE - 16,100 cyds  
GROSS YARDAGE - 175,600 cyds

PG 3 OF 14: LOCAL AREA FACTORS

FUEL COST - \$0.79 /gal  
CFC RATE - 7.000%  
USE MONTHS / YEAR - 10 mo/yr  
MARINE INSUR - 1.5%  
TAXES - 1.0%  
PROVISIONS & SUPP - \$15 /man

PG'S 5-7 OF 14: PRODUCTION WORKSHEET

HOPPER CAPACITY - 3,600 cyds  
EFF. HOPPER CAP. - 1,500 cyds  
AVAIL DREDGING RATE - 2,100 cy/hr  
AVAIL. DRAGHEADS - 2 ea  
ACT. DRAGHDS USED - 1 ea  
DRDGE RATE USED - 1,050 cy/hr  
TURNS/CYCLE - 2 ea  
MIN. PER TURN - 3 min  
DISPOSAL DIST - 11.1 mi  
TRVL SPD TO DISP - 10.8 mph  
MAX TRVL SPD LOADED - 12.7 mph

PG 4 OF 14: DREDGE SELECTION (ALT-D)

DREDGE: SUGAR ISLAND  
LOADS PER DAY - 5.67  
CYCLE TIME - 216 min/load

PG'S 8-9 OF 14: PLANT OWN. & OPER.

DREDGE - \$361,328  
PROPULSION TUG - self prop.  
SURVEY VESSEL - \$30,000  
BOOSTER - \$0  
CRANE BARGE - \$0  
TENDER TUG - \$0  
SHORE EQUIP - \$0

PG'S 10-12 OF 14: LABOR, 24 Jun 88

OVERTIME % - 28.00%  
VACATION/HOLIDAY % - 8.64%  
TAX & INSUR % - 30.61%  
FRINGE BENEFITS - \$4.35 /hr  
DREDGE CREW:  
SUGG. CREW SIZE - 14 ea  
USED CREW SIZE - 14 ea  
SHORE CREW:  
USED CREW SIZE - 0 ea  
GOVERNMENT PERSON - 3 ea  
FRE. PD TRAVEL - 28 days  
RT TRAVEL COST - \$400

PG 14 OF 14: DREDGE OPER. ADJ. FACTORS

PUMP LOAD FACTOR - 50%  
RPR & MAINT. ADJ - 1.00  
JET PUMP % USAGE - 100%

TABLE 9  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
HOPPER DREDGE AND OCEAN DISPOSAL COSTS

| CUT NAME          | SHOAL QUANTITY (CY) | MOB & DEMOB PER CUT | EXCAVATION COST PER CUT | SUBTOTAL COSTS PER CUT | CONT COSTS 25% | E&D AND CM 15% | HOPPER TOTAL \$ | DREDGING COSTS \$/(CY) |
|-------------------|---------------------|---------------------|-------------------------|------------------------|----------------|----------------|-----------------|------------------------|
| 1 MILE OFFSHORE   |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 31,700                  | 84,400                 | 21,100         | 12,700         | 118,200         | 7.41                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 81,200                  | 278,500                | 69,600         | 41,800         | 389,900         | 6.53                   |
| TOTALS - 1 MILE   | 75,650              | 250,000             | 112,900                 | 362,900                | 90,700         | 54,500         | 508,100         |                        |
| 2 MILES OFFSHORE  |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 34,000                  | 86,700                 | 21,700         | 13,000         | 121,400         | 7.61                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 91,300                  | 288,600                | 72,200         | 43,300         | 404,100         | 6.77                   |
| TOTALS - 2 MILES  | 75,650              | 250,000             | 125,300                 | 375,300                | 93,900         | 56,300         | 525,500         |                        |
| 3 MILES OFFSHORE  |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 36,200                  | 88,900                 | 22,200         | 13,300         | 124,400         | 7.80                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 101,500                 | 298,800                | 74,700         | 44,800         | 418,300         | 7.01                   |
| TOTALS - 3 MILES  | 75,650              | 250,000             | 137,700                 | 387,700                | 96,900         | 58,100         | 542,700         |                        |
| 4 MILES OFFSHORE  |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 39,200                  | 91,900                 | 23,000         | 13,800         | 128,700         | 8.07                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 111,600                 | 308,900                | 77,200         | 46,300         | 432,400         | 7.24                   |
| TOTALS - 4 MILES  | 75,650              | 250,000             | 150,800                 | 400,800                | 100,200        | 60,100         | 561,100         |                        |
| 5 MILES OFFSHORE  |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 42,300                  | 95,000                 | 23,800         | 14,300         | 133,100         | 8.34                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 123,600                 | 320,900                | 80,200         | 48,100         | 449,200         | 7.52                   |
| TOTALS - 5 MILES  | 75,650              | 250,000             | 165,900                 | 415,900                | 104,000        | 62,400         | 582,300         |                        |
| 6 MILES OFFSHORE  |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 44,700                  | 97,400                 | 24,400         | 14,600         | 136,400         | 8.55                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 134,300                 | 331,600                | 82,900         | 49,700         | 464,200         | 7.78                   |
| TOTALS - 6 MILES  | 75,650              | 250,000             | 179,000                 | 429,000                | 107,300        | 64,300         | 600,600         |                        |
| 7 MILES OFFSHORE  |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 48,300                  | 101,000                | 25,300         | 15,200         | 141,500         | 8.87                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 143,900                 | 341,200                | 85,300         | 51,200         | 477,700         | 8.00                   |
| TOTALS - 7 MILES  | 75,650              | 250,000             | 192,200                 | 442,200                | 110,600        | 66,400         | 619,200         |                        |
| 8 MILES OFFSHORE  |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 50,600                  | 103,300                | 25,800         | 15,500         | 144,600         | 9.07                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 156,400                 | 353,700                | 88,400         | 53,100         | 495,200         | 8.29                   |
| TOTALS - 8 MILES  | 75,650              | 250,000             | 207,000                 | 457,000                | 114,200        | 68,600         | 639,800         |                        |
| 9 MILES OFFSHORE  |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 53,000                  | 105,700                | 26,400         | 15,900         | 148,000         | 9.28                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 166,000                 | 363,300                | 90,800         | 54,500         | 508,600         | 8.52                   |
| TOTALS - 9 MILES  | 75,650              | 250,000             | 219,000                 | 469,000                | 117,200        | 70,400         | 656,600         |                        |
| 10 MILES OFFSHORE |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 56,600                  | 109,300                | 27,300         | 16,400         | 153,000         | 9.59                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 177,300                 | 374,600                | 93,700         | 56,200         | 524,500         | 8.79                   |
| TOTALS - 10 MILES | 75,650              | 250,000             | 233,900                 | 483,900                | 121,000        | 72,600         | 677,500         |                        |
| 20 MILES OFFSHORE |                     |                     |                         |                        |                |                |                 |                        |
| TURNING BASIN     | 15,950              | 52,700              | 83,700                  | 136,400                | 34,100         | 20,500         | 191,000         | 11.97                  |
| EXT TURNING BASIN | 59,700              | 197,300             | 283,000                 | 480,300                | 120,100        | 72,000         | 672,400         | 11.26                  |
| TOTALS - 20 MILES | 75,650              | 250,000             | 366,700                 | 616,700                | 154,200        | 92,500         | 863,400         |                        |

**Clamshell Estimates** - The clamshell dredging techniques are similar to the hopper dredge. The clamshell removes shoal material from the channel bottom which is deposited in an ocean going barge for transport to the ODMDS. One benefit of the clamshell operation is that with multiple barges the clamshell dredge can operate almost continuously. However, the additional equipment does cost more to mobilize to the dredging location. The clamshell dredge (26 cy) utilizes a 26 cy bucket to remove silty material and a 21 cy bucket to remove sandy material. The dredge is estimated to need two barges for transporting the material. The clamshell dredge works continuously. While one barge is enroute to the ODMDS, the clamshell is loading another barge. The number of barges influences the operating efficiency of the dredge. Table 10 provides a sample estimate summary similar to the hopper dredge estimate in table 8. Again, the mobilization and other costs absent in table 8 are also absent in the clamshell sample estimate. Table 11 provides the total dredging and transportation costs using a clamshell for each cut as shown in table 9. As with the hopper dredge costs, distance to the ODMDS is a factor influencing clamshell dredging costs.

## **UPLAND DISPOSAL**

Upland disposal costs involved the traditional hydraulic dredging and transport to an upland site. As mentioned earlier, hydraulic dredging and material movement via pipeline has a 10 mile limit due to equipment limitations and dredging efficiencies. A pipeline access route was established to each potential upland site. The total cost for upland disposal includes dredging and transportation costs, site preparation cost, and site procurement cost. Further discussion of dredging and transportation costs is in the subsequent text.

**Hydraulic Dredging** - As stated throughout this report, hydraulic dredging is the traditional method for upland disposal and generally, the most economical for pumping distances less than 5 miles. This fact is possible because the dredge can work continuously without stopping to empty the hopper as with a hopper dredge or having to wait for a barge to return as with a clamshell dredge. A sample estimate for hydraulic dredging is given in table 12. The total cost is in table 13. The dredging costs shown in \$ per cubic yard in table 13 reveal that potential disposal sites 9, 10, 11, 12, 16, 17A, 18, 19, 28, 30, 31, 39, 48, 50, 51, 52, 53, and 54 have significantly higher dredging costs than the rest of the potential sites. These sites were then dropped from further consideration. As described earlier, hydraulic dredging to a disposal site is restricted to a distance of approximately 10 miles. The mobilization cost for each maintenance event was prorated over the entire harbor. The assumption was made that maintenance of the turning basin areas would coincide with maintenance of the remainder of the harbor. Since the dredge and approximately 1.6 miles of pipe will be required to accomplish the beach placement only the mobilization costs for additional pipeline and booster pumps required for upland disposal were attributed to this portion of the study.

**TABLE 10  
PALM BEACH HARBOR  
DISPOSAL AREA STUDY  
MECHANICAL DREDGE ESTIMATE**

CHECKLIST FOR INPUT DATA.

Palm Beach Harbor DAS

BID QUANTITY            15,942 C.Y.  
UNIT COST...            \$2.69 PER C.Y.  
EXCAV. COST.            \$42,884  
TIME.....                0.07 MONTHS

PG 1 OF 9: PROJECT TITLES

FILENAME - PBH401M  
PROJECT - Palm Beach Harbor DAS  
LOCATION - Ocean Disposal  
INVIT # - Turning Basin -> 10.0 miles  
DATE OF EST. - 12 July 94  
EST. BY - Al Fletcher  
MOB. BID ITEM # -            0  
EXCAV. BID ITEM # -            0  
TYPE OF EST. - Planning Estimate

PG 5 OF 9: HAULING PRODUCTION WORKSHEET

DUMP OR PUMPOUT -            20 min  
DISENGAGE TOW -            10 min  
TOW EFFICIENCY -            80 %  
SCOW DESCRIPTION -        3000 CY Split Hull Scow  
USEABLE VOLUME -            90 %  
% SOLIDS -                    80 %

PG 2 OF 9: EXCAVATION QTY'S

DREDGING AREA -            43,514 sf  
REQ'D EXCAVATION -        15,942 cyds  
PAY OVERDEPTH -            0 cyds  
CONTRACT AMOUNT -        15,942 cyds  
NOT DREDGED -              0 cyds  
NONPAY YARDAGE -           1,600 cyds  
GROSS YARDAGE -            17,542 cyds  
NONPAY HEIGHT -            1.0 ft overdig.  
TOTAL BANK HEIGHT -        10.9 ft

PG 6 OF 9: EQUIPMENT MATCHING

|                    |      |
|--------------------|------|
| # OF PIECES:       | Used |
| DREDGES -          | 1    |
| SCOWS PER DREDGE - | 1    |
| TOWING VESSELS -   | 1    |
| SCOWS PER TOW -    | 1    |
| ADDITIONAL SCOWS - | 0    |
| TOT SCOWS ON JOB - | 2    |

PG 3 OF 9: EXCAVATION PRODUCTION WORKSHEET

DREDGE SELECTED - 21 CY Clamshell Dredge  
TYPE OF MATERIAL - SAND  
BUCKET SIZE -                16  
BUCKET FILL FACTOR -        0.70  
OPTIMUM BANK -              8  
BANK FACTOR -                1.00

PG 7 OF 9: SPECIAL LABOR & EQUIPMENT

QUARTERS ON DREDGE? -        NO  
SURVEY BOAT? -                YES  
CREW BOAT? -                  NO

PG 4 OF 9: EXCAVATION PRODUCTION WORKSHEET

BUCKET CYCLE TIME -        55 Seconds  
OTHER FACTOR -              1.00 >  
CLEANUP -                    10% More Time  
TIME EFFICIENCY -          65.0% of EWT

PG 8 OF 9: LOCAL AREA FACTORS

PRESENT YEAR -                1993  
ECONOMIC INDEX -            4718  
LAF -                            0.840  
INTEREST RATE -              7.000% /yr  
TIME PERIOD - July to December, 1994  
PLANT AVAILABLE -            10 mos/yr  
FUEL PRICE -                  \$0.79 /gal

PG 5 OF 9: HAULING PRODUCTION WORKSHEET

TUG DESCRIPTION -        3000 HP Diesel--Twin Screw  
PREPARE SCOW TOW -        15 min  
HAUL DIST -                  11.1 mi  
SPEED TO D/A -              5 mph  
SPEED FROM D/A -            6 mph

PG 9 OF 9: OTHER ADJUSTMENTS

SPECIAL COST/MO -        \$7,000 Turbidity Monitoring  
SPECIAL COST LS -        \$0 >  
CONTRACTOR'S O.H. -        15.0%  
CONTRACTOR'S PROFIT -      10.0%  
CONTRACTOR'S BOND -        1.0%

TABLE 11  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
MECHANICAL DREDGE AND OCEAN DISPOSAL COSTS

| CUT NAME          | SHOAL QUANTITY (CY) | MOB & DEMOB PER CUT | EXCAVATION COST PER CUT | SUBTOTAL COSTS PER CUT | CONT COSTS 25% | E&D AND CM 15% | TOTAL \$ | DREDGING COSTS \$/(CY) |
|-------------------|---------------------|---------------------|-------------------------|------------------------|----------------|----------------|----------|------------------------|
| 1 MILE OFFSHORE   |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 33,600                  | 86,300                 | 21,600         | 12,900         | 120,800  | 7.57                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 118,200                 | 315,500                | 78,900         | 47,300         | 441,700  | 7.40                   |
| TOTALS - 1 MILE   | 75,650              | 250,000             | 151,800                 | 401,800                | 100,500        | 60,200         | 562,500  |                        |
| 2 MILES OFFSHORE  |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 34,300                  | 87,000                 | 21,800         | 13,100         | 121,900  | 7.64                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 120,600                 | 317,900                | 79,500         | 47,700         | 445,100  | 7.46                   |
| TOTALS - 2 MILES  | 75,650              | 250,000             | 154,900                 | 404,900                | 101,300        | 60,800         | 567,000  |                        |
| 3 MILES OFFSHORE  |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 34,900                  | 87,600                 | 21,900         | 13,100         | 122,600  | 7.69                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 123,000                 | 320,300                | 80,100         | 48,000         | 448,400  | 7.51                   |
| TOTALS - 3 MILES  | 75,650              | 250,000             | 157,900                 | 407,900                | 102,000        | 61,100         | 571,000  |                        |
| 4 MILES OFFSHORE  |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 35,700                  | 88,400                 | 22,100         | 13,300         | 123,800  | 7.76                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 125,400                 | 322,700                | 80,700         | 48,400         | 451,800  | 7.57                   |
| TOTALS - 4 MILES  | 75,650              | 250,000             | 161,100                 | 411,100                | 102,800        | 61,700         | 575,600  |                        |
| 5 MILES OFFSHORE  |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 36,300                  | 89,000                 | 22,300         | 13,400         | 124,700  | 7.82                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 127,800                 | 325,100                | 81,300         | 48,800         | 455,200  | 7.62                   |
| TOTALS - 5 MILES  | 75,650              | 250,000             | 164,100                 | 414,100                | 103,600        | 62,200         | 579,900  |                        |
| 6 MILES OFFSHORE  |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 37,000                  | 89,700                 | 22,400         | 13,500         | 125,600  | 7.87                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 130,100                 | 327,400                | 81,900         | 49,100         | 458,400  | 7.68                   |
| TOTALS - 6 MILES  | 75,650              | 250,000             | 167,100                 | 417,100                | 104,300        | 62,600         | 584,000  |                        |
| 7 MILES OFFSHORE  |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 37,600                  | 90,300                 | 22,600         | 13,500         | 126,400  | 7.92                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 132,500                 | 329,800                | 82,500         | 49,500         | 461,800  | 7.74                   |
| TOTALS - 7 MILES  | 75,650              | 250,000             | 170,100                 | 420,100                | 105,100        | 63,000         | 588,200  |                        |
| 8 MILES OFFSHORE  |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 38,400                  | 91,100                 | 22,800         | 13,700         | 127,600  | 8.00                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 138,500                 | 335,800                | 84,000         | 50,400         | 470,200  | 7.88                   |
| TOTALS - 8 MILES  | 75,650              | 250,000             | 176,900                 | 426,900                | 106,800        | 64,100         | 597,800  |                        |
| 9 MILES OFFSHORE  |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 39,100                  | 91,800                 | 23,000         | 13,800         | 128,600  | 8.06                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 148,700                 | 346,000                | 86,500         | 51,900         | 484,400  | 8.11                   |
| TOTALS - 9 MILES  | 75,650              | 250,000             | 187,800                 | 437,800                | 109,500        | 65,700         | 613,000  |                        |
| 10 MILES OFFSHORE |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 42,900                  | 95,600                 | 23,900         | 14,300         | 133,800  | 8.39                   |
| EXT TURNING BASIN | 59,700              | 197,300             | 158,800                 | 356,100                | 89,000         | 53,400         | 498,500  | 8.35                   |
| TOTALS - 10 MILES | 75,650              | 250,000             | 201,700                 | 451,700                | 112,900        | 67,700         | 632,300  |                        |
| 20 MILES OFFSHORE |                     |                     |                         |                        |                |                |          |                        |
| TURNING BASIN     | 15,950              | 52,700              | 67,800                  | 120,500                | 30,100         | 18,100         | 168,700  | 10.58                  |
| EXT TURNING BASIN | 59,700              | 197,300             | 259,100                 | 456,400                | 114,100        | 68,500         | 639,000  | 10.70                  |
| TOTALS - 20 MILES | 75,650              | 250,000             | 326,900                 | 576,900                | 144,200        | 86,600         | 807,700  |                        |

**TABLE 12  
PALM BEACH HARBOR  
DISPOSAL AREA STUDY  
HYDRAULIC DREDGE ESTIMATE**

CHECKLIST FOR INPUT DATA.

Palm Beach Harbor DAS

BID QUANTITY            15,942 C.Y.  
UNIT COST...            \$1.59 PER C.Y.  
EXCAV. COST.            \$25,348  
TIME.....                0.02 MONTHS

PG 1 OF 9: PROJECT TITLES

FILENAME - PBH401P  
PROJECT - Palm Beach Harbor DAS  
LOCATION - Site 45  
INVIT # - Turning Basin  
DATE OF EST. - 12 July 94  
EST. BY - Al Fletcher & Tim Murphy  
MOB. BID ITEM # - 0  
EXCAV. BID ITEM # - 0  
TYPE OF EST. - Planning Estimate

PG 2 OF 9: EXCAVATION QTY'S

DREDGING AREA - 43,514 sf  
REQ'D EXCAVATION - 15,942 cyds  
PAY OVERDEPTH - 0 cyds  
CONTRACT AMOUNT - 15,942 cyds  
NOT DREDGED - 0 cyds  
NONPAY YARDAGE - 1,600 cyds  
GROSS YARDAGE - 17,542 cyds  
NONPAY HEIGHT - 1.0 ft overdig.  
TOTAL BANK HEIGHT - 10.9 ft

PG 3 OF 9: MAXIMUM PIPELINE REQUIRED

FLOATING - 2,000 ft  
SUBMERGED - 31,300 ft  
SHORE - 1,000 ft  
TOTAL - 34,300 ft  
COST CATEGORY - 2 SAND  
EQUIVALENT - 0 ft

PG 4 OF 9: MATERIAL FACTOR

| DESCRIPTION       | FACTOR | PERCENTAGE |
|-------------------|--------|------------|
|                   |        | %          |
| MUD & SILT        | 3      | 0          |
| MUD & SILT        | 2.5    | 50         |
| MUD & SILT        | 2      | 0          |
| LOOSE SAND        | 1.1    | 0          |
| LOOSE SAND        | 1      | 50         |
| COMP. SAND        | 0.9    | 0          |
| STIFF CLAY        | 0.6    | 0          |
| COMP. SHELL       | 0.5    | 0          |
| SOFT ROCK         | 0.4    | 0          |
| BLAST. ROCK       | 0.25   | 0          |
| <br>RESULTANT     |        |            |
| MATERIAL FACTOR - | 1.43   |            |

PG 5 OF 9: DREDGE SELECTION

DREDGE SELECTED - 30" HYDRAULIC DREDGE  
COMPUTED BANK FACTOR - 1.1  
BANK FACTOR USED - 1.1 >  
OTHER FACTOR - 1 >  
CLEANUP - 10% More Time

PG 6 OF 9: HORSEPOWER CONSIDERATIONS

CHART H.P. - 9,000 hp  
AVAILABLE H.P. - 9,000 hp  
BOOSTER H.P. - 5,200 hp(ea)  
LOSS PER BOOSTER - 15%

PG 7 OF 9: CHART PRODUCTION ANALYSIS

AVE. PIPELINE - 33,400 ft  
BOOSTERS - 2  
BOOSTER FACTOR - 0.70  
% EFF WORK TIME (GROSS) - 65.0%  
MAX. POSSIBLE - 63,526 ft  
TOTAL HP AVAIL - 19,400 hp  
% EFF WORK TIME (NET) - 45.5%  
OPERATING TIME - 332 hours per month

PG 8 OF 9: GROSS PRODUCTION & LOCAL AREA FACTORS

PRODUCTION OVERRIDE - NO  
NET PRODUCTION - 2,134 net cy per hour  
OPERATING TIME - 332 hours per month  
BASED ON - 2 booster(s)  
PAY PRODUCTION - 797,100 pay cy per month  
PRESENT YEAR - 1993  
ECONOMIC INDEX - 4718  
LAF - 0.84  
INTEREST RATE - 7.000% /yr  
TIME PERIOD - July to December, 1994  
PLANT AVAILABLE - 9 mos/yr  
FUEL PRICE - \$0.79 /gal

PG 9 OF 9: OTHER ADJUSTMENTS

SPECIAL COST/MO - \$7,000 Turbidity Monitoring  
SPECIAL COST LS - \$0 >  
CONTRACTOR'S O.H. - 15.0%  
CONTRACTOR'S PROFIT - 10.0%  
CONTRACTOR'S BOND - 1.0%

TABLE 13  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
HYDRAULIC DREDGE AND UPLAND DISPOSAL COSTS

| CUT NAME          | SHOAL QUANTITY (CY) | MOB & DEMOB PER CUT | EXCAVATION COST PER CUT | SUBTOTAL COSTS PER CUT | CONT COSTS 25% | E&D AND CM 15% | TOTAL \$  | DREDGING COSTS \$/(CY) |
|-------------------|---------------------|---------------------|-------------------------|------------------------|----------------|----------------|-----------|------------------------|
| <b>SITE 9</b>     |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 132,300             | 49,400                  | 181,700                | 45,400         | 27,300         | 254,400   | 15.95                  |
| EXT TURNING BASIN | 59,750              | 495,500             | 186,900                 | 682,400                | 170,600        | 102,400        | 955,400   | 15.99                  |
| TOTALS – SITE 9   | 75,700              | 627,800             | 236,300                 | 864,100                | 216,000        | 129,700        | 1,209,800 |                        |
| <b>SITE 10</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 108,700             | 39,200                  | 147,900                | 37,000         | 22,200         | 207,100   | 12.98                  |
| EXT TURNING BASIN | 59,750              | 407,100             | 170,100                 | 577,200                | 144,300        | 86,600         | 808,100   | 13.52                  |
| TOTALS – SITE 10  | 75,700              | 515,800             | 209,300                 | 725,100                | 181,300        | 108,800        | 1,015,200 |                        |
| <b>SITE 11</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 125,500             | 48,900                  | 174,400                | 43,600         | 26,200         | 244,200   | 15.31                  |
| EXT TURNING BASIN | 59,750              | 470,300             | 185,100                 | 655,400                | 163,900        | 98,300         | 917,600   | 15.36                  |
| TOTALS – SITE 11  | 75,700              | 595,800             | 234,000                 | 829,800                | 207,500        | 124,500        | 1,161,800 |                        |
| <b>SITE 12</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 127,600             | 49,100                  | 176,700                | 44,200         | 26,500         | 247,400   | 15.51                  |
| EXT TURNING BASIN | 59,750              | 478,200             | 185,700                 | 663,900                | 166,000        | 99,600         | 929,500   | 15.56                  |
| TOTALS – SITE 12  | 75,700              | 605,800             | 234,800                 | 840,600                | 210,200        | 126,100        | 1,176,900 |                        |
| <b>SITE 16</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 99,800              | 38,700                  | 138,500                | 34,600         | 20,800         | 193,900   | 12.16                  |
| EXT TURNING BASIN | 59,750              | 374,000             | 154,600                 | 528,600                | 132,200        | 79,300         | 740,100   | 12.39                  |
| TOTALS – SITE 16  | 75,700              | 473,800             | 193,300                 | 667,100                | 166,800        | 100,100        | 934,000   |                        |
| <b>SITE 17A</b>   |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 128,900             | 49,100                  | 178,000                | 44,500         | 26,700         | 249,200   | 15.62                  |
| EXT TURNING BASIN | 59,750              | 482,900             | 186,300                 | 669,200                | 167,300        | 100,400        | 936,900   | 15.68                  |
| TOTALS – SITE 17A | 75,700              | 611,800             | 235,400                 | 847,200                | 211,800        | 127,100        | 1,186,100 |                        |
| <b>SITE 18</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 128,500             | 49,100                  | 177,600                | 44,400         | 26,600         | 248,600   | 15.59                  |
| EXT TURNING BASIN | 59,750              | 481,300             | 185,700                 | 667,000                | 166,800        | 100,100        | 933,900   | 15.63                  |
| TOTALS – SITE 18  | 75,700              | 609,800             | 234,800                 | 844,600                | 211,200        | 126,700        | 1,182,500 |                        |
| <b>SITE 19</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 109,900             | 39,400                  | 149,300                | 37,300         | 22,400         | 209,000   | 13.10                  |
| EXT TURNING BASIN | 59,750              | 411,900             | 170,100                 | 582,000                | 145,500        | 87,300         | 814,800   | 13.64                  |
| TOTALS – SITE 19  | 75,700              | 521,800             | 209,500                 | 731,300                | 182,800        | 109,700        | 1,023,800 |                        |
| <b>SITE 28</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 113,300             | 39,400                  | 152,700                | 38,200         | 22,900         | 213,800   | 13.40                  |
| EXT TURNING BASIN | 59,750              | 424,500             | 170,100                 | 594,600                | 148,700        | 89,200         | 832,500   | 13.93                  |
| TOTALS – SITE 28  | 75,700              | 537,800             | 209,500                 | 747,300                | 186,900        | 112,100        | 1,046,300 |                        |
| <b>SITE 30</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 98,100              | 38,600                  | 136,700                | 34,200         | 20,500         | 191,400   | 12.00                  |
| EXT TURNING BASIN | 59,750              | 367,700             | 145,100                 | 512,800                | 128,200        | 76,900         | 717,900   | 12.02                  |
| TOTALS – SITE 30  | 75,700              | 465,800             | 183,700                 | 649,500                | 162,400        | 97,400         | 909,300   |                        |
| <b>SITE 31</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 109,100             | 39,200                  | 148,300                | 37,100         | 22,200         | 207,600   | 13.02                  |
| EXT TURNING BASIN | 59,750              | 408,700             | 170,100                 | 578,800                | 144,700        | 86,800         | 810,300   | 13.56                  |
| TOTALS – SITE 31  | 75,700              | 517,800             | 209,300                 | 727,100                | 181,800        | 109,000        | 1,017,900 |                        |
| <b>SITE 32</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 73,000              | 37,600                  | 110,600                | 27,700         | 16,600         | 154,900   | 9.71                   |
| EXT TURNING BASIN | 59,750              | 273,300             | 128,400                 | 401,700                | 100,400        | 60,300         | 562,400   | 9.41                   |
| TOTALS – SITE 32  | 75,700              | 346,300             | 166,000                 | 512,300                | 128,100        | 76,900         | 717,300   |                        |
| <b>SITE 33</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 49,300              | 24,100                  | 73,400                 | 18,400         | 11,000         | 102,800   | 6.45                   |
| EXT TURNING BASIN | 59,750              | 184,500             | 108,100                 | 292,600                | 73,200         | 43,900         | 409,700   | 6.86                   |
| TOTALS – SITE 33  | 75,700              | 233,800             | 132,200                 | 366,000                | 91,600         | 54,900         | 512,500   |                        |
| <b>SITE 35</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 46,700              | 23,900                  | 70,600                 | 17,700         | 10,600         | 98,900    | 6.20                   |
| EXT TURNING BASIN | 59,750              | 175,100             | 95,500                  | 270,600                | 67,700         | 40,600         | 378,900   | 6.34                   |
| TOTALS – SITE 35  | 75,700              | 221,800             | 119,400                 | 341,200                | 85,400         | 51,200         | 477,800   |                        |
| <b>SITE 37</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 70,300              | 25,300                  | 95,600                 | 23,900         | 14,300         | 133,800   | 8.39                   |
| EXT TURNING BASIN | 59,750              | 263,500             | 123,600                 | 387,100                | 96,800         | 58,100         | 542,000   | 9.07                   |
| TOTALS – SITE 37  | 75,700              | 333,800             | 148,900                 | 482,700                | 120,700        | 72,400         | 675,800   |                        |

TABLE 13  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
HYDRAULIC DREDGE AND UPLAND DISPOSAL COSTS

| CUT NAME          | SHOAL QUANTITY (CY) | MOB & DEMOB PER CUT | EXCAVATION COST PER CUT | SUBTOTAL COSTS PER CUT | CONT COSTS 25% | E&D AND CM 15% | TOTAL \$  | DREDGING COSTS \$(/CY) |
|-------------------|---------------------|---------------------|-------------------------|------------------------|----------------|----------------|-----------|------------------------|
| <b>SITE 38</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 73,800              | 37,800                  | 111,600                | 27,900         | 16,700         | 156,200   | 9.79                   |
| EXT TURNING BASIN | 59,750              | 276,500             | 128,400                 | 404,900                | 101,200        | 60,700         | 566,800   | 9.49                   |
| TOTALS – SITE 38  | 75,700              | 350,300             | 166,200                 | 516,500                | 129,100        | 77,400         | 723,000   |                        |
| <b>SITE 39</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 93,100              | 38,300                  | 131,400                | 32,900         | 19,700         | 184,000   | 11.54                  |
| EXT TURNING BASIN | 59,750              | 348,700             | 143,300                 | 492,000                | 123,000        | 73,800         | 688,800   | 11.53                  |
| TOTALS – SITE 39  | 75,700              | 441,800             | 181,600                 | 623,400                | 155,900        | 93,500         | 872,800   |                        |
| <b>SITE 40</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 76,800              | 38,100                  | 114,900                | 28,700         | 17,200         | 160,800   | 10.08                  |
| EXT TURNING BASIN | 59,750              | 287,500             | 129,000                 | 416,500                | 104,100        | 62,500         | 583,100   | 9.76                   |
| TOTALS – SITE 40  | 75,700              | 364,300             | 167,100                 | 531,400                | 132,800        | 79,700         | 743,900   |                        |
| <b>SITE 42</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 74,200              | 37,800                  | 112,000                | 28,000         | 16,800         | 156,800   | 9.83                   |
| EXT TURNING BASIN | 59,750              | 278,100             | 128,400                 | 406,500                | 101,600        | 61,000         | 569,100   | 9.52                   |
| TOTALS – SITE 42  | 75,700              | 352,300             | 166,200                 | 518,500                | 129,600        | 77,800         | 725,900   |                        |
| <b>SITE 42A</b>   |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 74,200              | 37,800                  | 112,000                | 28,000         | 16,800         | 156,800   | 9.83                   |
| EXT TURNING BASIN | 59,750              | 278,100             | 128,400                 | 406,500                | 101,600        | 61,000         | 569,100   | 9.52                   |
| TOTALS – SITE 42A | 75,700              | 352,300             | 166,200                 | 518,500                | 129,600        | 77,800         | 725,900   |                        |
| <b>SITE 43</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 74,000              | 37,800                  | 111,800                | 28,000         | 16,800         | 156,600   | 9.82                   |
| EXT TURNING BASIN | 59,750              | 277,300             | 128,400                 | 405,700                | 101,400        | 60,900         | 568,000   | 9.51                   |
| TOTALS – SITE 43  | 75,700              | 351,300             | 166,200                 | 517,500                | 129,400        | 77,700         | 724,600   |                        |
| <b>SITE 44</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 77,200              | 38,100                  | 115,300                | 28,800         | 17,300         | 161,400   | 10.12                  |
| EXT TURNING BASIN | 59,750              | 289,100             | 129,000                 | 418,100                | 104,500        | 62,700         | 585,300   | 9.80                   |
| TOTALS – SITE 44  | 75,700              | 366,300             | 167,100                 | 533,400                | 133,300        | 80,000         | 746,700   |                        |
| <b>SITE 45</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 70,300              | 25,300                  | 95,600                 | 23,900         | 14,300         | 133,800   | 8.39                   |
| EXT TURNING BASIN | 59,750              | 263,500             | 123,600                 | 387,100                | 96,800         | 58,100         | 542,000   | 9.07                   |
| TOTALS – SITE 45  | 75,700              | 333,800             | 148,900                 | 482,700                | 120,700        | 72,400         | 675,800   |                        |
| <b>SITE 48</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 100,700             | 38,700                  | 139,400                | 34,900         | 20,900         | 195,200   | 12.24                  |
| EXT TURNING BASIN | 59,750              | 377,100             | 154,600                 | 531,700                | 132,900        | 79,800         | 744,400   | 12.46                  |
| TOTALS – SITE 48  | 75,700              | 477,800             | 193,300                 | 671,100                | 167,800        | 100,700        | 939,600   |                        |
| <b>SITE 49</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 75,900              | 37,900                  | 113,800                | 28,500         | 17,100         | 159,400   | 9.99                   |
| EXT TURNING BASIN | 59,750              | 284,400             | 129,000                 | 413,400                | 103,400        | 62,000         | 578,800   | 9.69                   |
| TOTALS – SITE 49  | 75,700              | 360,300             | 166,900                 | 527,200                | 131,900        | 79,100         | 738,200   |                        |
| <b>SITE 50</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 131,400             | 49,300                  | 180,700                | 45,200         | 27,100         | 253,000   | 15.86                  |
| EXT TURNING BASIN | 59,750              | 492,400             | 186,900                 | 679,300                | 169,800        | 101,900        | 951,000   | 15.92                  |
| TOTALS – SITE 50  | 75,700              | 623,800             | 236,200                 | 860,000                | 215,000        | 129,000        | 1,204,000 |                        |
| <b>SITE 51</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 104,000             | 38,900                  | 142,900                | 35,700         | 21,400         | 200,000   | 12.54                  |
| EXT TURNING BASIN | 59,750              | 389,800             | 160,000                 | 549,800                | 137,500        | 82,500         | 769,800   | 12.88                  |
| TOTALS – SITE 51  | 75,700              | 493,800             | 198,900                 | 692,700                | 173,200        | 103,900        | 969,800   |                        |
| <b>SITE 52</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 108,300             | 39,200                  | 147,500                | 36,900         | 22,100         | 206,500   | 12.95                  |
| EXT TURNING BASIN | 59,750              | 405,500             | 169,500                 | 575,000                | 143,800        | 86,300         | 805,100   | 13.47                  |
| TOTALS – SITE 52  | 75,700              | 513,800             | 208,700                 | 722,500                | 180,700        | 108,400        | 1,011,600 |                        |
| <b>SITE 53</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 124,700             | 48,800                  | 173,500                | 43,400         | 26,000         | 242,900   | 15.23                  |
| EXT TURNING BASIN | 59,750              | 467,100             | 184,500                 | 651,600                | 162,900        | 97,700         | 912,200   | 15.27                  |
| TOTALS – SITE 53  | 75,700              | 591,800             | 233,300                 | 825,100                | 206,300        | 123,700        | 1,155,100 |                        |
| <b>SITE 54</b>    |                     |                     |                         |                        |                |                |           |                        |
| TURNING BASIN     | 15,950              | 95,600              | 38,400                  | 134,000                | 33,500         | 20,100         | 187,600   | 11.76                  |
| EXT TURNING BASIN | 59,750              | 358,200             | 143,900                 | 502,100                | 125,500        | 75,300         | 702,900   | 11.76                  |
| TOTALS – SITE 54  | 75,700              | 453,800             | 182,300                 | 636,100                | 159,000        | 95,400         | 890,500   |                        |

## **REAL ESTATE VALUES**

The following evaluations involve an assessment of real estate values on the upland sites. The real estate analysis is last because of the field work involved in obtaining estimates for each site. Engineering and environmental investigations reduced the number of sites prior to initiating the real estate analysis. The real estate evaluations are in Appendix A and the results are in table 14. The estimated real estate values are for a fee simple purchase of the site. The values do not include any easements required for pipeline access to the site. Appendix A provides details concerning the methods used to obtain the real estate values as well as assumptions and limitations of the analysis.

## **COST COMPARISON**

The estimated real estate costs were added to the previously calculated total costs for dredging and upland disposal for each site. Dredging costs for each of the ocean disposal methods provided a base condition for comparison with potential upland sites to determine at this level of detail what upland areas appear feasible for future consideration. The ocean disposal costs in tables 9 and 11 provide the base costs for comparison with total dredging and site preparation cost on a site by site basis. Table 15 uses site 45 as a sample of the comparison generated for each potential upland site. The most economical alternative is identified with an "\*". The cost comparison for all potential sites produced no upland site that was as economical as offshore disposal.

## **SENSITIVITY ANALYSIS**

The method of cost analysis lends itself to sensitivity of several cost elements. The real estate cost for each potential site was reduced by 50 percent. The results still indicated that no upland site was as economical as utilization of an ODMDS located up to 10 miles offshore. A series of cost estimates were compiled based upon hopper dredging and disposal in an ODMDS located 20 miles offshore. The results were identical to the previous sensitivity analysis performed for real estate costs.

TABLE 14  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
REAL ESTATE VALUES

| SITE NUMBER | SITE SIZE (ACRES) | DIKED AREA CAPACITY (CY) | TOTAL COMPENSATORY VALUE |         |
|-------------|-------------------|--------------------------|--------------------------|---------|
|             |                   |                          | (\$)                     | (\$/CY) |
| 9           | 302               | 14,242,000               | NA                       | 0.00    |
| 10          | 37                | 1,285,700                | NA                       | 0.00    |
| 11          | 25                | 868,700                  | NA                       | 0.00    |
| 12          | 37                | 1,285,700                | NA                       | 0.00    |
| 16          | 388               | 18,297,700               | NA                       | 0.00    |
| 17A         | 11                | 245,700                  | NA                       | 0.00    |
| 18          | 126               | 5,942,000                | NA                       | 0.00    |
| 19          | 25                | 868,700                  | NA                       | 0.00    |
| 28          | 63                | 2,971,000                | NA                       | 0.00    |
| 30          | 52                | 2,452,300                | NA                       | 0.00    |
| 31          | 60                | 2,829,500                | NA                       | 0.00    |
| 32          | 42                | 1,980,700                | 4,055,000                | 2.05    |
| 33          | 28                | 973,000                  | 3,459,000                | 3.55    |
| 35          | 78                | 3,678,400                | 10,730,000               | 2.92    |
| 37          | 40                | 1,886,400                | 5,340,000                | 2.83    |
| 38          | 38                | 1,320,500                | 1,790,000                | 1.36    |
| 39          | 24                | 834,000                  | NA                       | 0.00    |
| 40          | 23                | 799,200                  | 9,330,000                | 11.67   |
| 42          | 22                | 764,500                  | 1,691,000                | 2.21    |
| 42A         | 12                | 268,100                  | 923,000                  | 3.44    |
| 43          | 64                | 3,018,200                | 71,700                   | 0.02    |
| 44          | 83                | 3,914,200                | 5,500,000                | 1.41    |
| 45          | 159               | 7,498,300                | 3,404,000                | 0.45    |
| 48          | 147               | 6,932,400                | NA                       | 0.00    |
| 49          | 57                | 2,688,100                | 5,341,000                | 1.99    |
| 50          | 19                | 424,400                  | NA                       | 0.00    |
| 51          | 26                | 903,500                  | NA                       | 0.00    |
| 52          | 71                | 3,348,300                | NA                       | 0.00    |
| 53          | 17                | 379,800                  | NA                       | 0.00    |
| 54          | 23                | 799,200                  | NA                       | 0.00    |

TABLE 15  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
COST COMPARISON

| CUT<br>NAME                                 | QUANTITY<br>PER CUT<br>(CY) | COSTS PER DREDGE AND DISPOSAL TYPE (\$/CY) |                    |                         |
|---|-----------------------------|--|--------------------|-------------------------|
|   |                             | CLAMSHELL<br>TO OCEAN                      | HOPPER<br>TO OCEAN | HYDRAULIC<br>TO SITE 45 |
| PALM BEACH HARBOR                           |                             |  |                    |                         |
| TURNING BASIN                               | 15,950                      | \$8.39 *                                   | \$9.59             | \$10.28                 |
| EXT TURNING BASIN                           | 59,750                      | \$8.35 *                                   | \$8.79             | \$10.96                 |
| * - Most Economical Dredging Method Per Cut |                             |  |                    |                         |

## SUMMARY

The initial analysis involved 122 potential upland disposal sites located within a 10 mile arc of the Palm Beach Harbor Turning Basin. Environmental evaluations determined that 26 sites were unsuitable for disposal. After establishing pipeline access routes to each site, 66 sites were in excess of the 10 mile pipeline limit and removed from further consideration. An examination of hydraulic dredge and upland disposal costs of the remaining 30 potential disposal sites are summarized in table 16. From that table 18 sites have a cost for disposal of over \$13.60 which is very high. Removing those sites from further consideration leaves 12 disposal areas which still exceed the cost for using either ODMDS site. Those 12 sites could be a consideration for disposal of material which is unsuitable for placement in the ODMDS.

During the course of this study, the preparation of over 80 cost estimates enabled a detailed cost comparison between 3 possible dredging techniques. This report shows only a sampling of those estimates. Detailed documentation on the estimates is available in the Jacksonville District Office.

## RESULTS

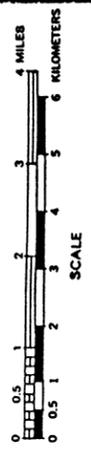
The results presented in tables 15 and 16 demonstrate the need for an Ocean Dredged Material Disposal Site (ODMDS) for the Palm Beach Harbor Federal Project. As shown by table 16, no upland disposal sites were found to be more economical than the use of the ODMDS. However, 12 potential upland sites do exist if the material that does not meet EPA criteria (see table 16).

TABLE 16  
PALM BEACH HARBOR DISPOSAL AREA STUDY  
FINAL COST COMPARISON

| SITE NUMBER  | CAPACITY   | TURNING BASIN |               | EXT TURNING BASIN |               | PROJECT COSTS (\$) | NOTES |
|--|------------|---------------|---------------|-------------------|---------------|--------------------|-------|
|  |            | QUANTITY (CY) | COSTS (\$/CY) | QUANTITY (CY)     | COSTS (\$/CY) |                    |       |
| <b>ODMDS @ 10 MILES WITH HOPPER DREDGE</b>         |            |               |               |                   |               |                    |       |
| ODMDS  | UNLIMITED  | 15,950        | 9.59          | 59,700            | 8.79          | 678,000            |       |
| <b>ODMDS @ 10 MILES WITH CLAMSHELL DREDGE</b>      |            |               |               |                   |               |                    |       |
| ODMDS  | UNLIMITED  | 15,950        | 8.39          | 59,700            | 8.35          | 632,000            | 1     |
| <b>UPLAND DISPOSAL SITES WITH HYDRAULIC DREDGE</b> |            |               |               |                   |               |                    |       |
| 9  | 14,242,000 | 15,950        | 16.38         | 59,700            | 16.43         | 1,242,000          | 2     |
| 10   | 1,285,700  | 15,950        | 14.61         | 59,700            | 15.16         | 1,138,000          | 2     |
| 11   | 868,700    | 15,950        | 18.32         | 59,700            | 18.37         | 1,389,000          | 2     |
| 12   | 1,285,700  | 15,950        | 17.42         | 59,700            | 17.46         | 1,320,000          | 2     |
| 16   | 18,297,700 | 15,950        | 12.31         | 59,700            | 12.53         | 945,000            | 2     |
| 17A  | 245,700    | 15,950        | 20.04         | 59,700            | 20.10         | 1,520,000          | 2     |
| 18   | 5,942,000  | 15,950        | 16.34         | 59,700            | 16.38         | 1,239,000          | 2     |
| 19   | 868,700    | 15,950        | 15.37         | 59,700            | 15.89         | 1,194,000          | 2     |
| 28   | 2,971,000  | 15,950        | 15.10         | 59,700            | 15.62         | 1,173,000          | 2     |
| 30   | 2,452,300  | 15,950        | 13.33         | 59,700            | 13.34         | 1,009,000          | 2     |
| 31   | 2,829,500  | 15,950        | 14.23         | 59,700            | 14.77         | 1,109,000          | 2     |
| 32   | 1,980,700  | 15,950        | 13.38         | 59,700            | 13.08         | 995,000            |       |
| 33   | 973,000    | 15,950        | 12.22         | 59,700            | 12.63         | 949,000            |       |
| 35   | 3,678,400  | 15,950        | 10.43         | 59,700            | 10.56         | 797,000            |       |
| 37   | 1,886,400  | 15,950        | 12.92         | 59,700            | 13.59         | 1,017,000          |       |
| 38   | 1,320,500  | 15,950        | 12.42         | 59,700            | 12.12         | 921,000            |       |
| 39   | 834,000    | 15,950        | 13.67         | 59,700            | 13.66         | 1,034,000          | 2     |
| 40   | 799,200    | 15,950        | 24.14         | 59,700            | 23.82         | 1,807,000          |       |
| 42   | 764,500    | 15,950        | 14.42         | 59,700            | 14.10         | 1,072,000          |       |
| 42A  | 268,100    | 15,950        | 17.74         | 59,700            | 17.42         | 1,323,000          |       |
| 43   | 3,018,200  | 15,950        | 11.20         | 59,700            | 10.89         | 829,000            |       |
| 44   | 3,914,200  | 15,950        | 12.58         | 59,700            | 12.26         | 933,000            |       |
| 45   | 7,498,300  | 15,950        | 9.81          | 59,700            | 10.48         | 782,000            |       |
| 48   | 6,932,400  | 15,950        | 12.75         | 59,700            | 12.97         | 977,000            | 2     |
| 49   | 2,688,100  | 15,950        | 13.35         | 59,700            | 13.05         | 992,000            |       |
| 50   | 424,400    | 15,950        | 18.43         | 59,700            | 18.48         | 1,397,000          | 2     |
| 51   | 903,500    | 15,950        | 14.88         | 59,700            | 15.21         | 1,145,000          | 2     |
| 52   | 3,348,300  | 15,950        | 13.96         | 59,700            | 14.49         | 1,087,000          | 2     |
| 53   | 379,800    | 15,950        | 18.44         | 59,700            | 18.48         | 1,397,000          | 2     |
| 54   | 799,200    | 15,950        | 14.92         | 59,700            | 14.92         | 1,129,000          | 2     |

**NOTE:**

1. The most economical alternative for project maintenance is an ODMDS located up to 10 miles offshore.
2. No real estate values included in project cost.



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JACKSONVILLE, FLORIDA

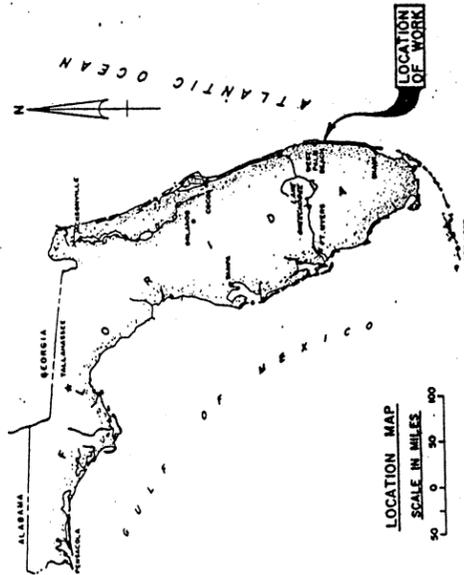
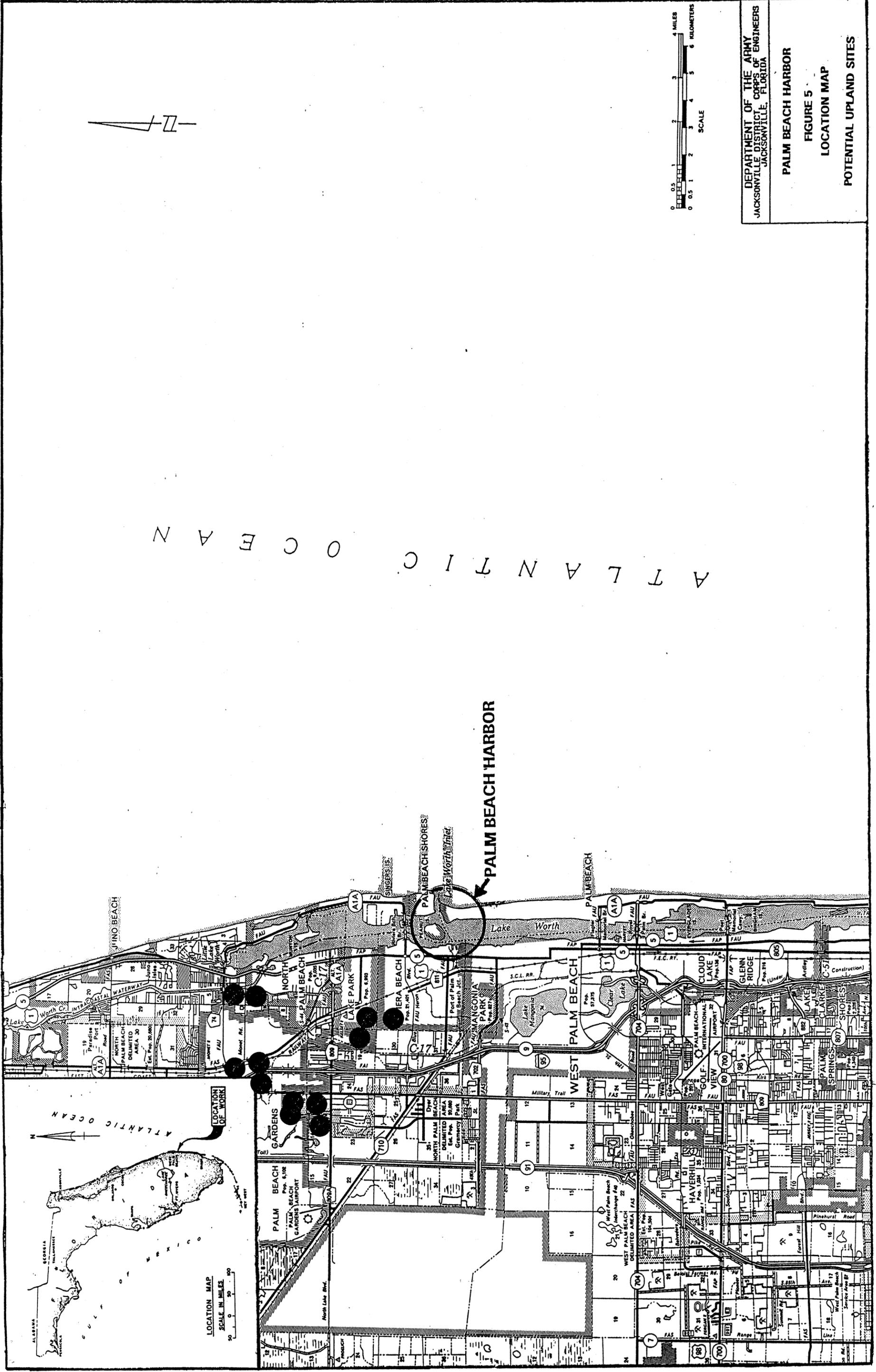
PALM BEACH HARBOR

FIGURE 5  
LOCATION MAP

POTENTIAL UPLAND SITES

A T L A N T I C  
O C E A N

PALM BEACH HARBOR



**PALM BEACH HARBOR DISPOSAL AREA STUDY**

**REAL ESTATE SECTION**

**ATTACHMENT A**

# **PALM BEACH HARBOR DISPOSAL AREA STUDY REAL ESTATE SECTION FOR POTENTIAL UPLAND DISPOSAL SITES**

## **PURPOSE**

The purpose of this study is to investigate potential upland disposal sites to be utilized in conjunction with the Palm Beach Harbor Dredging project. (Refer to Figure 3 for locations of potential sites.)

## **DESCRIPTION OF STUDY AND STUDY AREA**

Twelve sites were selected as suitable for potential upland disposal sites. Each site was evaluated by the appraiser to arrive at an estimate of value for each disposal site. The estimates will enable a comparison of cost between the use of upland sites and the offshore disposal option.

The study area encompasses municipalities in Palm Beach County. The identified potential upland disposal sites are located in Palm Beach County. Potential disposal sites were located through the use of past studies, aerial photography, and geographical limitations. Each site is required to be open land with no dwellings, to meet minimum size requirement of 10 acres, and to be within the maximum pumping distance of approximately 10 miles from the dredge location. The geographical area is roughly bounded by the Atlantic Ocean to the east and a 10 mile arc from the Palm Beach Harbor Turning Basin formed the North, West, and South boundaries. These restrictions and boundaries have limited the scope of the study. The overall area is urbanized, with a mix of residential, commercial, agricultural, and industrial land use.

## **ESTIMATE OF VALUES**

Each potential site was valued in fee simple based on recent tax assessment data and sales information. The indicated values are estimates for each potential site at the date of this study. A more detailed analysis would be necessary if consideration was given beyond the potential analysis stage. The Palm Beach Harbor Disposal Area Study Real Estate Values are provided in Table A-1.

TABLE A-1  
 PALM BEACH HARBOR  
 DISPOSAL AREA STUDY  
 REAL ESTATE VALUES

| SITE<br>NUMBER | SITE<br>SIZE<br>(ACRES) | TOTAL<br>COMPENSATORY<br>VALUE |
|----------------|-------------------------|--------------------------------|
|                |                         | (\$)                           |
| 32             | 42                      | 4,055,000                      |
| 33             | 28                      | 3,459,000                      |
| 35             | 78                      | 10,730,000                     |
| 37             | 40                      | 5,340,000                      |
| 38             | 38                      | 1,790,000                      |
| 40             | 23                      | 9,330,000                      |
| 42             | 22                      | 1,691,000                      |
| 42A            | 12                      | 923,000                        |
| 43             | 64                      | 71,700                         |
| 44             | 83                      | 5,500,000                      |
| 45             | 159                     | 3,404,000                      |
| 49             | 57                      | 5,341,000                      |

The valuations as presented in this Real Estate Section are based upon information and conditions existing during the study period and are preliminary. A more detailed real estate study will be required to implement any upland site recommended in this report.necessary. Access routes that must cross major highways, railroads, and other land parcels must take into account any environmental impacts and costs considerations to determine the practicality of such an action. Direct access to a site via an inland waterway is the most desired condition. Navigable waters of the United States do not require real estate easements. Small streams, canals, and drainage ditches can also provide access without an easement if they are attached to navigable waters. Access along highways and railroads is also possible and usually achieved by passing through culverts and under bridges.

A potential site may be within the ten mile arc but a direct route to the site may not be available. In that case, the pipeline distance could exceed the ten mile limit and the site would be dropped from further consideration.