APPENDIX F

DREDGED MATERIAL MANAGEMENT AND BENEFICIAL USE PLAN

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1.0 PURPOSE

The purpose of the Dredged Material Management/Beneficial Use Plan (DMM/BU PLAN) is to guide the Federal and non-Federal sponsors in the placement of material to be dredged from the Corpus Christi Ship Channel – Channel Improvement Project (CCSCCIP) for the 50-year life of the project. This DMM/BU PLAN will apply to both construction and maintenance dredging.

The DMM/BU PLAN was developed by the U.S. Army Corps of Engineers (USACE), Galveston District; the Port of Corpus Christi Authority (PCCA), the non-Federal sponsor; and the Regulatory Agency Coordination Team (RACT), whose members are listed in Section 1.6 of the FEIS. The DMM/BU PLAN includes both the creation of beneficial use (BU) sites with construction material, a limited use of maintenance material for BUs, and modification of existing practices for the rest of the maintenance material.

2.0 CCSCCIP DESCRIPTION

2.1 PROJECT CHANNELS

The proposed deepening and widening project is 37.3 miles long and consists of 5 main reaches of channel: the Entrance Channel (offshore) reach, Lower Bay reach, Upper Bay reach, the Inner Harbor reach, and the La Quinta Channel Extension (figures 1-2 and 1-3 of the FEIS). The project also includes adding barge shelves along both sides of the improved ship channel traversing Corpus Christi Bay. No widening or deepening is proposed for the La Quinta Channel. The improvement that is proposed for La Quinta Channel is extending it a distance of 7,200 feet with a 1,200-foot turning basin at the end. The channel extension will be 300 feet wide at an authorized depth of –39 feet MLT.

2.2 INNER HARBOR REACH

The Inner Harbor reach is 51,150 feet long. It begins at Sta. 1050+00 in Corpus Christi Bay and ends at Sta. 1561+50 at the Viola Turning Basin (see Plates C-1 through C-5 in the Feasibility Report). The required depth of the channel will range from –53 to –58 feet, and its bottom width will vary from 300 to 450 feet. The turning basins in the channel will range in width from 545 to 1,200 feet. Channel side slopes in this reach will be 1 vertical on 2 horizontal (1V on 2H).

2.3 UPPER BAY REACH

This channel reach is 51,000 feet long. It begins at Sta. 540+00 and ends at Sta. 1050+00, near the City of Corpus Christi (see Plates C-5 through C-10 in the Feasibility Report). The required depth of the channel will range from –54 to –58 feet MLT and its bottom width will be 530 feet. Channel side slopes will be 1V on 3H.

2.4 LOWER BAY REACH

This channel reach is 52,745 feet long. It begins at Sta. 12+55, near the junction of the Entrance Channel, and crosses Redfish Bay, ending at Sta. 540+00, near Port Ingleside (see Plates C-10

through C-15 in the Feasibility Report). The required depth of the channel will be –54 feet MLT and its bottom width will be 530 feet. Channel side slopes will be 1V on 3H.

2.5 ENTRANCE CHANNEL

This channel reach is 34,782 feet long. It begins at offshore Sta. 310+00 (at the 56-foot depth contour) and ends at Sta. –37+82 in the Inner Basin at Port Aransas (see Plates C-15 through C-18 in the Feasibility Report). The channel will have a required depth range of –54 to –56 feet MLT and bottom widths ranging from 600 to 700 feet in the channel, and 1,280 to 1,395 feet in the turning basin. Channel side slopes will be 1V on 10H beyond Sta. 72+50 and 1V on 3H shoreward.

Barge shelves, each 200 feet wide as measured from the bottom limit of the widened channel, flank both sides of the channel through the bay reach. The barge shelves will extend from Sta. 540+00 (near the La Quinta Junction) to Sta. 1050+00 (near Beacon 82).

2.5.1 Barge Shelves

Barge Shelves, each 200 feet wide as measured from the bottom limit of the widened channel, will flank both sides of the channel through the bay reach. The barge shelves will extend from Sta. 540+00 (near the La Quinta junction) to Sta. 1050+00 (near Beacon 82).

2.5.2 La Quinta Channel Extension

The La Quinta Channel extension will be 7,248 feet in length and will begin at Sta. 309+52 in the La Quinta Channel and end at Sta. 382+00, as shown on Drawing C-19 in the Feasibility Report. The channel extension will be dredged to a required depth of 41 feet plus one or two feet of allowable overdepth, having a bottom width of 300 feet in the channel and bottom widths ranging from 583 to 1,447 feet in the turning basin. Channel side slopes will be 1V on 2H.

3.0 GEOTECHNICAL INVESTIGATIONS

The level of geotechnical engineering performed for this report is fully sufficient to substantiate the recommended plan. Additional investigations and analyses, briefly outlined in Section 4.4, in accordance with ER 1110-2-1150, Appendix C-4, will be performed during both the Pre-construction Engineering and Design (PED) and Construction General phases of the project, and documented in a Design Documentation Report before each feature is constructed.

3.1 REFERENCES

The following documents comprise part of this appendix and are available for independent examination. They are referenced in the text where applicable.

"Channel Scour and Methods of Assessment of Their Stability," by T.S. Mirtskhulava, Kolos Publishing House, 1967. E. Razmyv Rusel I Metodica Otsenki ih Ustoichivosti.

"Corpus Christi Ship Channel Improvement, Shoreline Erosion Study, Task 2," prepared for the PCCA by Vladimir Shepsis of Pacific International Engineering, Inc., January 2001.

"Corpus Christi Ship Channel, Mustang and Harbor Islands Shoreline Stabilization Projects, Texas," prepared for the Texas General Land Office by Pacific International Engineering, Inc., November 2000.

Engineering Regulation (ER) 1110-2-1150 – "Engineering and Design - Engineering and Design for Civil Works Projects," Appendix C-4 – "Content of Engineering Appendix to Feasibility Report," August 31, 1999.

"River Training Techniques, Fundamentals, Design and Applications," by Przdwjiski, Blazejewaski, and Pilarczyk, A.A. Balkema, Rotterdam, 1980.

3.2 SUBSURFACE INVESTIGATIONS

3.2.1 Project Channels

Soil borings were taken at 317 separate locations along the entire reach of the project channels, extending into the Gulf of Mexico to Offshore Sta. 325+00. The locations of the borings are shown on Plates C-1 through C-18 in the Feasibility Report. Corresponding logs of the borings are shown on Plates F-1 through F-2 in the Feasibility Report. The subsurface soils were classified in accordance with American Society for Testing Materials (ASTM) Standard D 2487-00 – "Standard Classification of Soils for Engineering Purposes" (Unified Soil Classification System). Other relevant information, such as moisture contents, unit dry weights, dry density, liquid limits, and plastic limits are included on the plotted logs of borings.

3.2.2 Existing Upland Placement Areas

Supplement No. 2 to Design Memorandum No. 1 for the Corpus Christi Ship Channel, Texas 45-Foot Project, entitled "Nueces Bay / South Shore Plan" indicates that there were a total of 30 soil borings taken between 1968 and 1981 to investigate foundation conditions for IH-PAs 1, 2, 3, 7 and 8. The report provides a layout and logs of borings, revealing the foundation conditions for these areas. Since the foundation conditions have changed over the years, and will change during the implementation of this project, no additional soil borings were taken for this report. Instead, the existing levees will be used to contain the new work material, which will profoundly change the foundation conditions of the levee for future levee raisings. Therefore, soil borings for these upland sites will be deferred until completion of new work dredging, so that accurate foundation conditions may be ascertained. The same concept will apply for PA 13. PA 10 will be used to contain 2.8 mcy over the next 50 years. Therefore nominal levee raisings will be required periodically and no future levee design is anticipated. Fifty-eight (58) soil borings were taken at Mustang Island (PA 6) during 1989 for the plans and specifications to construct a turning basin and docking area at Ingleside. This information was used to design the existing levee; therefore, it is not necessary to include this information in this report. In addition, current plans for use of this area to contain 2.7 mcy of new work material are not expected to require additional foundation investigations for this area.

3.2.3 Proposed Beneficial Use Placement Areas, Shore Protection, and Breakwater

Seven (7) soil borings were taken in the vicinity of BU Site I, BU Site R, BU Site S, BU Site CQ and BU Site Pelican. The logs of borings are shown on Plate F-28 in the Feasibility Report.

3.2.4 Remaining Project Features

Subsurface investigations for the remaining project features, including all open-water placement areas, the proposed breakwater near Ingleside-on-the-Bay (BU Site P), the proposed habitat protection at Pelican Island (BU Site Pelican), and the proposed erosion protection near the Mustang Island flat (BU Site L) have not yet been undertaken. For the purpose of this report, the foundation conditions were considered similar to the conditions at adjacent beneficial use locations. The subsurface investigation work will be deferred until final design of the features.

3.3 DREDGED MATERIAL DESCRIPTION

3.3.1 Dredged Material Quantities

3.3.1.1 New Work Quantity

The total quantity of new work material to be dredged in conjunction with the proposed channel improvements is 40.7 mcy, as presented in Table F-1. The quantities were determined by calculating the average end area for each improved cross-sectional template cut into the existing channel and multiplying it by the length between cross sections.

3.3.1.2 Maintenance Material Quantity

The quantity of maintenance material to be removed over the 50-year project life is estimated to be 208.0 mcy, as presented in Table F-2. This quantity was determined by reviewing maintenance dredging contracts within the project area for the last 20 years and applying an incremental increase in dredging due to the widened and deepened channel. The ERDC modeled different variations of a widened and/or deepened channel, and made predictions as to the increase in maintenance volumes per reach. These modeling results were used to predict shoaling rates for the 52-foot x 530-foot channel.

3.3.2 Dredged Material Classification

Dredged material to be removed from the channel deepening and widening, where applicable, was classified by reach for the design of both existing and new beneficial use placement areas. Soil classifications were generally in accordance with Table B-2 of ER 1110-2-1300. These classifications are used by the dredging industry and dredge estimators to classify the material being dredged. They are correlated to the average in-place density of soils, and are described as mud and silt, loose sand, compacted sand, and stiff clay. For the purpose of this report, the material having in-place densities in the range of 1,400 grams per liter (g/l) to 1,600 g/l was considered to be soft, silty sands or soft, sandy / silty clays. Materials having in-place densities around 1,700 to 1,900 g/l were considered to be loose sand or shell. Stiff clays were assumed for clays having in-place densities greater than 2,000 g/l. Very dense sands were assumed for sands having in-place densities greater than 2,300 g/l. Finally, medium dense sands were assumed for sands having in-place densities below 2,300 g/l. Soil borings were plotted on the cross sections in each reach of channel to be dredged and the quantity of each material type was calculated using a percentage of the total cross-sectional area. The average end-area method of quantity calculations was used to determine the volume of each material type. The results of

TABLE F-1

NEW WORK MATERIAL VOLUMES *

From Station	To Station	Soft, Soft Silty, Soft Sandy Clay	Stiff to Hard Clay	Loose Sand and Shell	Dense to Medium-Dense Sand	Very Dense Silty Sand	Total Volume (cy)
Entrance Channel							
310+00	150+00	2,246,988	0	0	300,044	48,533	2,595,565
150+00	50+00	382,738	0	24,946	317,464	539,456	1,264,604
50+00	-37+82	0	0	0	98,336	378,646	476,982
		2,629,726	0	24,946	715,844	966,635	4,337,151
Lower Bay							
12+55	180+00	927,023	127,672	22,247	1,190,605	434,427	2,701,974
180+00	340+00	164,571	2,956	353,422	1,150,581	550,470	2,222,000
340+00	540+00	398,159	452,223	286,814	1,495,235	1,197,630	3,830,061
		1,489,753	582,851	662,483	3,836,421	2,182,527	8,754,035
Upper Bay, Including Barge Shelves							
540+00	620+00	1,481,287	297,066	0	837,968	23,134	2,639,455
620+00	830+00	5,059,494	75,760	0	776,407	0	5,911,661
830+00	880+00	1,113,036	0	0	211,797	0	1,324,833
880+00	1030+00	3,496,881	0	0	421,046	0	3,917,927
1030+00	1050+00	623,261	0	0	1,388	0	624,649
		11,773,959	372,826	0	2,248,606	23,134	14,418,525
Inner Harbor							
1050+00	1172+00	543,938	1,112,742	0	260,284	243,115	2,160,079
1172+00	1320+00	91,576	1,313,297	12,352	205,064	346,599	1,968,888
1320+00	1460+00	54,399	1,164,115	0	283,729	47,857	1,550,100
1460+00	1561+00	166,462	806,979	0	21,482	242,262	1,237,185
		856,375	4,397,133	12,352	770,559	879,833	6,916,252
La Quinta							
309+51	382+00	198,658	3,402,510	135,688	2,519,921	0	6,256,777
		198,658	3,402,510	135,688	2,519,921	0	6,256,777
						Total, New Work Dredging	40,682,740

* Excluding 271,000 cy from the barge lanes.

TABLE F-2

50-YEAR MAINTENANCE MATERIAL VOLUMES

From Station	To Station	Very Soft to Soft Clay	Silt or Sandy Silt	Fine or Silty Sand	Sand	Total Volume (cy)
Entrance Channel						
310+00	150+00	0	0	35,000,000	0	35,000,000
150+00	50+00	0	0	24,500,000	0	24,500,000
50+00	-37+82	0	0	2,500,000	0	2,500,000
		0	0	62,000,000	0	62,000,000
Lower Bay						
12+55	180+00	0	0	0	0	0
180+00	340+00	0	0	0	3,500,000	3,500,000
340+00	540+00	0	0	8,200,000	0	8,200,000
		0	0	8,200,000	3,500,000	11,700,000
Upper Bay, Including Barge Shelves						
540+00	620+00	0	9,700,000	0	0	9,700,000
620+00	830+00	0	30,000,000	0	0	30,000,000
830+00	880+00	0	7,400,000	0	0	7,400,000
880+00	1030+00	0	29,400,000	0	0	29,400,000
1030+00	1050+00	0	5,700,000	0	0	5,700,000
		0	82,200,000	0	0	82,200,000
Inner Harbor						
1050+00	1172+00	0	21,000,000	0	0	21,000,000
1172+00	1320+00	0	1,000,000	0	0	1,000,000
1320+00	1460+00	0	1,100,000	0	0	1,100,000
1460+00	1561+00	0	1,000,000	0	0	1,000,000
		0	24,100,000	0	0	24,100,000
La Quinta						
12+74	309+51	0	18,500,000	0	0	18,500,000
309+51	382+00	0	9,500,000	0	0	9,500,000
		0	28,000,000	0	0	28,000,000
					Total, 50-Year Maintenance Dredging	208,000,000

these calculations are shown by channel reach in Table F-1. Historical shoaling data were used to classify the materials by reach for the future (50-year) maintenance disposal. This information is provided in Table F-2.

3.3.3 Placement Plans

Placement plans are required to ensure that there will be sufficient capacity within the designated placement areas to contain both new work material from construction of the improved channels, and maintenance (shoal) material from repeated dredging of the channel to maintain the project depths over a 50-year period.

3.4 FOUNDATION DESIGN

3.4.1 Project Channels

The existing CCSC will be deepened and widened along its present alignment. Channel widening is prescribed only for the Lower and Upper Bay reaches, and for "spot" widening in the Entrance Channel and in the Inner Harbor Channel reach. Therefore, empirical knowledge and available subsurface soil information were used in the channel side slope stability analyses.

3.4.1.1 Entrance Channel

The side slopes will be 1V on 10H from Sta. 72+50 to Sta. 310+00. No slope stability analysis was necessary for this reach. Channel side slopes will be 1V on 3H from Sta. 72+50 through the Inner Basin at Port Aransas. The channel has been designed to ensure that the top of cut of the existing channel is not compromised. As such, the deepening will control the bottom cut for the new turning basin dimensions. Soil borings in the vicinity indicate the deepening will occur in a layer of very dense silty sand. Factor-of-safety computations for cohesionless material of this type indicate typical values of about 1.7 for a 1V on 3H side slope. Therefore, stability analyses are not necessary for this reach.

3.4.1.2 Lower Bay Reach

"After Dredging," or as-built cross sections, dated January 1974, were reviewed to determine whether it was necessary to analyze the stability of the slopes due to the proposed deepening and minimal widening from 500 to 530 feet. Logs of soil borings were plotted on the cross sections at the locations they were taken, allowing visual verification of existing side slopes cut through various in situ material. The borings revealed that foundation soils were consistently stiff clays or medium to very dense silty sands at depths between –40 and –50 feet MLT. In addition, the cross sections revealed that the after-dredging cut lines at the toe of the existing channel generally extended well past the required template width. When the deepened and widened template in this reach was compared to the cross sections of the existing channel, the side slopes of the proposed deepened channel side slopes either matched or fell within the existing slope lines. Sections adjacent to known infrastructure and land features were studied to ensure that the new top of cut did not affect he integrity of these land features. According to the plan drawings, existing improvements include docks on the north bank and breakwaters on the south bank near Sta. 20+00, a ferry landing on the south bank near Sta. 40+00, bulkheads on both sides

of the bank near Sta. 50+00, hopper dredge docks on the south bank near Sta. 60+00, and a pier on the north bank near Sta. 470+00. Therefore, these cross sections were singled out for closer examination. The cross sections showed that the deepening at the south banks of Sta. 20+00, 40+00 and 50+00, and 60+00, and at the north banks of Sta. 20+00, 50+00, and 470+00 will occur in a layer of stiff to very stiff clayey sand and medium to very dense silty sands. The sections show the existing bank cuts are 1V on 3H or slightly steeper. It can be concluded, therefore, that maintaining the existing channel widths in this reach at a required depth of –54 feet MLT will not affect the stability of nearby land features caused by failure of the side slopes.

3.4.1.3 Upper Bay Reach

This reach of channel will be widened equally on both sides of the channel to 530 feet from its present 400-foot width. Soil borings taken in this reach show a bay bottom consisting of very soft organic clays and silts. This material is not satisfactory for use as construction material and will be disposed of in the existing open water placement areas. A 200-foot wide barge shelf, as measured from the toe of the improved channel, will be constructed along each side of the channel. The barge shelves will be constructed and maintained to an authorized depth of –12 feet MLT. Only a modest amount of dredging will be necessary to achieve this depth since the existing bay bottom flanking the ship channel is already about –11 to –12 feet MLT. Most of the material likely to be encountered in dredging the barge shelves will be soft organic clays and silts.

3.4.1.4 Inner Harbor Reach

Recent hydrographic cross sections of the inner harbor reach were plotted with soil boring information superimposed on the proposed deepened channel template, in order to aid in the determination of which areas might be susceptible to slope failure due to the deepening of the channel. In general, the excavation of the new work materials will be confined to deepening of the existing channel template from 45 to 52 feet. Examination of the cross sections indicates that, in most cases, the existing side slopes will not be affected by the deepening. However, before preparing plans and specifications for the contract work, it will be necessary to obtain bank-to-bank surveys, along with supplemental soil foundation data to ensure that, should the deepening require cutting of the existing bank side slopes, new slope stability analyses should be undertaken. The existing foundation information available in this reach consists of soil borings taken in past years. Accompanying soil reports have not been located in project files and as a result, the available information is not sufficient to accurately predict how the 1 on 2 cut slope will perform after deepening is completed. In addition, the hydrographic surveys that were taken were incomplete, since they were not tied in with land surveys from shallow water to the bank, and beyond. Therefore, assumptions regarding the soil strength as well as presumed bank lines and heights were used to conduct the side slope analyses. After inspection of the cross sections for the entire reach, several channel stations were selected for analysis of the new cut slope, including cross sections at Sta. 1545+00, 1490+00, 1300+00 and 1100+00. Generally, the factors of safety ranged from about 1.6 to 1.9 for deep failures at the toe, due to deepening. Some of the soil borings did indicate a thin stratum of soft clay material present at depths of 17 to 20 feet below the assumed ground surface at some sections. This indicates that, depending upon the actual bank configuration, it is possible that localized slope failures may occur in this stratum, if new bank cuts are required. Therefore, more accurate information

will be required for the preparation of plans and specifications to ensure that bank failures will not be encountered in areas where existing structures or roads are adjacent to the bank. Should bank failures be predicted to occur, design measures will be taken to prevent damage to existing topography.

3.4.1.5 La Quinta Channel Extension

The La Quinta Channel extension will be constructed in very firm foundation soils similar to those in the existing channel. An inspection of the existing channel side slopes shows that banks are stable on side slopes at least equal to those proposed for the channel template for the extension. Therefore, stability analyses were not considered necessary for this reach.

3.4.2 Existing Upland Placement Areas

The existing upland placement areas have been used before and their containment levees can be raised sufficiently to place all the new work material. A typical perimeter levee section is shown on Plate F-41 in the Feasibility Report. Since much of the materials to be dredged from the Inner Harbor reach will be stiff clays and dense sands, the material will "stack" and the containment will be used mostly for discharge of the supernatant from the dredging operations. To extend the life of these existing areas to contain maintenance material for the 50-year life of the project, it is proposed to place the stiff clay material along the inside slope of the entire existing perimeter embankment and stack the material to elevations higher than the existing levee. This will serve to displace soft material to the inside of the placement area, while at the same time providing a large base of material to serve as a firm foundation and a source of borrow for future raising of the embankment over a 50-year period. This dredging operation will require constant field inspection to ensure that the dredge pipeline is continually advanced in order to place material along the entire length of the perimeter levee. This will probably raise the unit cost of dredging for these reaches, but is absolutely necessary to ensure the integrity of the 50-year dredged material management plan.

3.4.2.1 IH-PA 1

New work material from Sta. 1080+00 to Sta. 1125+00 will be deposited into IH-PA 1. Approximately 800,000 cy of material will be excavated and disposed of from this reach of channel. Soil borings taken in the channel indicate that approximately 90 percent of the material that will be encountered in the deepened portion of this channel reach will consist of stiff, lean clays. In addition, the borings indicate that the material in the channel reach beginning at Sta. 1090+00 and ending at Sta. 1125+00 consists mostly of clay will be suitable to ring the perimeter levee of the placement area, the length of which is 17,860 LF. The amount of satisfactory clay available for placement along the inside levee slope should approximate 720,000 cy. Assuming a loss of about 30 percent, it is expected that about 70 percent of the clay volume, or about 504,000 cy can be placed along the perimeter levee. This translates to about 28 cy of material per linear foot of perimeter levee that will be placed along the inside slope of the perimeter levee. For a sense of perspective, this amount of material equates to a clay mound about 12 to 15 feet high, with a 20-foot wide crown, along the inside of the current perimeter levee.

3.4.2.2 IH-PA 2 (Rincon Placement Area)

New work material from Sta. 1125+00 to Sta. 1172+00 will be deposited into IH-PA 2. Approximately 900,000 cy of material will be excavated and disposed of from this reach of channel. Soil borings taken in the channel indicate that approximately 75 percent of the material that will be encountered in the deepened portion of this channel reach will consist of stiff, lean clays. In addition, the borings indicate that the material in the channel reach beginning at Sta. 1125+00 and ending at Sta. 1150+00 consists mostly of clay that will be suitable to ring the perimeter levee of the placement area, the length of which is 14,286 LF. The amount of clay available for placement along the inside levee slope should approximate 675,000 cy. Assuming a loss of about 30 percent, it is expected that about 70 percent of the clay volume, or about 472,500 cy, can be placed along the perimeter levee. This translates to about 33 cy per linear foot of perimeter levee that will be available for future embankment raising.

3.4.2.3 IH-PA 3A (South Shore)

New work material from Sta. 1172+00 to Sta. 1246+00 will be deposited into IH-PA 3A. Approximately 1.0 mcy of material will be excavated and disposed of from this reach of channel. Soil borings taken in the channel indicate that approximately 65 percent of the material that will be encountered in the deepened portion of this channel reach will consist of stiff, lean clays. In addition, the borings indicate that the material in the channel reach beginning at Sta. 1180+00 and ending at Sta. 1220+00 consists mostly of clay that will be suitable to ring the perimeter levee of the placement area, the length of which is 18,298 LF. The amount of clay available for placement along the inside levee slope should approximate 650,000 cy. Assuming a loss of about 30 percent, it is expected that about 70 percent of the material volume, or about 455,000 cy, can be placed along the perimeter levee. This translates to about 25 cy per linear foot of perimeter levee that will be available for future embankment raising.

3.4.2.4 IH-PA 3B (South Shore)

New work material from Sta. 1246+00 to Sta. 1320+00 will be deposited into IH-PA 3B. Approximately 1.0 mcy of material will be excavated and disposed of from this reach of channel. Soil borings taken in the channel indicate that approximately 40 percent of the material that will be encountered in the deepened portion of this channel reach will consist of stiff, lean clays. The predominant material that will be encountered will be dense sand. In addition, the borings indicate that the material in the channel reach beginning at Sta. 1260+00 and ending at Sta. 1280+00 consists mostly of clay that will be suitable to ring the perimeter levee of the placement area, the length of which is 13,322 LF. The amount of clay available for placement along the inside levee slope should approximate 400,000 cy. Assuming a loss of about 30 percent, it is expected that about 70 percent of the material volume, or about 280,000 cy, can be placed along the perimeter levee. This translates to about 21 cy per linear foot of perimeter levee that will be available for future embankment raising.

3.4.2.5 IH PAs 4 and 5

IH PA 4 and PA 5 are privately owned, upland, confined PAs, roughly 120 and 172 acres in size, respectively. Although privately owned and last used during the deepening of the 45-foot project, they are potentially available for use through an agreement with the land owner or by navigational

servitude. They are not scheduled for use during the CCSCCIP construction or maintenance but, as noted, are available if required.

3.4.2.6 IH-PA 6 (Tule Lake)

New work material from Sta. 1320+00 to Sta. 1460+00 will be deposited into IH-PA 6. Approximately 1.6 mcy of material will be excavated and disposed of from this channel reach. Soil borings taken in the channel indicate that approximately 65 percent of the material that will be encountered in the deepened portion of this channel reach will consist of stiff, lean clays. The predominant material that will be encountered will be dense sand. In addition, the borings indicate that the material in the channel reach beginning at Sta. 1330+00 and ending at Sta. 1360+00 consists mostly of clay that will be suitable to ring the perimeter levee of the placement area, the length of which is 16,825 LF. The amount of clay available for placement along the inside levee slope should approximate 1.04 mcy. Assuming a loss of about 30 percent, it is expected that about 70 percent of the material volume, or about 728,000 cy, can be placed along the perimeter levee. This translates to about 43 cy per linear foot of perimeter levee that will be available for future embankment raising, which should be more than adequate. The amount of suitable clay required for the levee raising will be ascertained when the plans and specifications for this channel reach are prepared.

3.4.2.7 IH-PA 8 (Suntide Placement Area)

New work material from Sta. 1460+00 to Sta. 1561+00 will be deposited into IH-PA 8. Approximately 1.2 mcy of material will be excavated and disposed of from this channel reach. Soil borings taken in the channel indicate that approximately 75 percent of the material that will be encountered in the deepened portion of this channel reach will consist of stiff, lean clays. The predominant material that will be encountered will be dense sand. In addition, the borings indicate that the material in the channel reach beginning at Sta. 1490+00 and ending at Sta. 1560+00 consists mostly of clay that will be suitable to ring the perimeter levee of the placement area, the length of which is 17,459 LF. The amount of clay available for placement along the inside levee slope should approximate 900,000 cy. Assuming a loss of about 30 percent, it is expected that about 70 percent of the material volume, or about 630,000 cy, can be placed along the perimeter levee. This translates to about 36 cy per linear foot of perimeter levee that will be available for future embankment raising.

3.4.2.8 PA 13 (La Quinta Channel)

Approximately 2.7 mcy of clay will be excavated to construct the La Quinta Channel Extension. This material will be stockpiled in the placement area for future use as a borrow source to raise the placement area levees. Approximately 1.0 mcy of the clay will be placed along the inside slope of the existing perimeter levee. Placement of the material along the perimeter levee is absolutely required in order to displace the soft foundation material along the existing levee. Replacing the soft foundation material will create a firmer foundation for future levee raising to contain maintenance material. Approximately 1.7 mcy of clay can be placed into the northwest corner of the placement area to serve as a stockpile for future levee raising at that end.

3.4.2.9 PA 4

PA 4 is a confined site located north of the CCSC on Harbor Island. It has not been used since the 45-foot deepening project for the placement of new work dredged material. It is owned by the PCCA and may be available for use by the proposed project.

3.4.2.10 PA 5

PA 5 is an upland unconfined site located on the south side of the CCSC west of Port Aransas. It has not been used since before the CCSC was deepened to 45 feet and may be available for use by the proposed project through navigation servitude.

3.4.2.11 PA 9

PA 9 is a 120-acre unconfined emergent placement area located south of the CCSC and east of the GIWW crossing. It has not been used in the past 23 years. It was last used for placement of new work material during the 45-foot deepening project.

3.4.2.12 PA 18

PA 18 is an unconfined open-water placement area that is configured as two narrow, parallel placement corridors oriented perpendicular to the CCSC. PA 18 is available for use, but has not been used recently because of concerns that it could accelerate filling of the small-boat channels near the Corpus Christi City Marina.

3.4.3 New Beneficial Use Sites

The design of the beneficial use placement areas considered the bearing capacity of the existing foundation soils and stability of the channel side slopes for areas fronting the channel. Regarding the channel side slope stability, the embankments and fill areas have been located a sufficient distance from the channel to prevent any impacts from hydraulic fill and erosion protection loads. However, soil borings taken in the vicinity of beneficial use sites contain layers of soft plastic clays that will not withstand the loads imposed by both the hydraulic-fill embankments and the new work material to be deposited inside the areas. It is expected that much of the soft material along the alignment of the perimeter (containment) levees will be displaced by the hydraulic-fill levees during the dredging and placement operations. Depending upon the stratigraphy, it is possible that some of the soft clay will be trapped beneath the hydraulic-fill embankment, setting up the potential for some settlement of the embankment over time. This cannot be avoided however, because of the immediate need for placing the geotubes and armor protection necessary to preserve the sand embankment. The settlement effects should be minimal, and can be corrected by effective and timely maintenance of the embankments. The inside fill areas will also be subject to displacement of foundation soils to varying degrees. It is expected that mud waves will be trapped inside the fill areas and these were incorporated into the design. This does not present a problem however, since the fill area to the elevations specified can be increased without any negative impacts to the one-, two-, and three-sided design configurations, other than a somewhat larger surface area than is depicted.

3.4.3.1 BU Site MN

This area was "positioned" to lie offshore beyond the 30-foot contour and is subject to change based on a determination of the underwater bathymetry. The size of the placement area was determined by comparison with a similar structure designed for the Houston-Galveston Navigation Channels, Texas 45-Foot Project. The intent of the design is to construct underwater mounds of dredged material about 5 to 6 feet high, placed in rows. The final size of and location for the beneficial use site will be finalized during the preparation of plans and specifications for the work. A typical section of what is proposed site is shown on Plate F-36 in the Feasibility Report.

3.4.3.2 BU Site I (Dagger Island)

This area was designed to contain approximately 2.7 mcy of new work channel material within a shallow water habitat configuration open on two sides. The design envisioned an emergent outside containment embankment, protected from ship wakes, that would offer protection to the site, thereby encouraging environmental productivity. It also envisioned the building up of small islands within the area. Typical sections of the proposed containment levee are shown on Plates F-36 and F-37 in the Feasibility Report.

3.4.3.3 BU Site R

This area was designed to contain approximately 2.4 mcy of new work material. It will partially enclose approximately 201 acres of newly created shallow-water habitat, which would have an approximate mudline of –1 to –2 feet MLT, raised from the existing depth of –6 to –10 feet MLT. It will be bordered on the south and west sides by an embankment, protected by riprap and geotubes on the exterior slopes to an elevation of +5 feet MLT. Typical sections for the site are shown on Plate F-37 in the Feasibility Report.

3.4.3.4 BU Site S

This area was designed to contain approximately 1.5 mcy of new work material within a 121-acre, newly created, shallow water habitat configuration open on two sides. The shallow water would have an approximate mudline of –1 to –2 feet MLT, raised from the existing depth of –6 to –10 feet MLT. It will be located south of the ship channel, south of PA 10, and west of the GIWW. It will be bordered on the east side by an embankment, protected by riprap and geotubes to an elevation of +5 feet MLT. Typical sections for the site are shown on Plate F-37 in the Feasibility Report.

3.4.3.5 BU Site CQ – (Upper Bay at La Quinta Channel Junction)

This area was designed to contain approximately 2.9 mcy of new work material within a shallow water habitat configuration open on one side. It is located in open water, adjacent to the south side of the La Quinta Channel extension and west of PA 13 at the terminus of the existing La Quinta Channel. After construction, the site will contain approximately 200 acres of shallow water high and low marsh aquatic and estuarine habitat and will be bordered on the south and west by embankments protected by geotubes and riprap to elevation +6 feet MLT to protect the shoreline and enhance vegetation

colonization. A single row of Spartina would be planted along the inside (north side) of the wave-protection levee creating 6 acres of marsh. Small islands will be "mounded" within the area. Typical sections for the site are shown on Plate F-38 in the Feasibility Report.

3.4.3.6 BU Site GH – (La Quinta Extension)

This area was designed to contain approximately 2.3 mcy of new work material within a 250-acre, shallow-water and emergent island habitat configuration, open on two sides. The new work material would be allowed to flow freely in the deeper eastern half of the site to fill to depths shallow enough to support seagrass. There may be some deeper holes that would not support seagrass, but these areas would provide a mosaic of habitats for marine life. The perimeter of the emergent mounds would be fringed with Spartina to hasten vegetation growth and erosion protection. An armored levee for wave protection and to help contain dredged material would be created around the site on the west, south, and east boundaries with geotubes or rock breakwaters to elevation +6 feet MLT. Typical sections for the site are shown on Plate F-40 in the Feasibility Report.

3.4.3.7 BU Site Pelican (Pelican Island, PAs 7 and 8)

This area will be protected on the northeast corner by riprap, connected to a hydraulic-fill embankment, designed to prevent the migration of material from Pelican Island to Mustang Island, and guard against the possible formation of a land bridge between the two islands. Typical sections for the site are shown on Plates F-37 and F-41 in the Feasibility Report.

3.4.3.8 BU Site L – (Mustang Island Shore Protection)

The shoreline along this reach of channel has been experiencing continual bank erosion, mostly from ship wakes, and this unabated erosion threats the sensitive ecology along the shoreline. Consequently, erosion protection is warranted along this reach of channel, which is shown on Plate F-35. A typical section of the stone erosion protection proposed is shown on Plate F-41 in the Feasibility Report.

3.4.3.9 BU Site P

This breakwater at Ingleside was designed for the express purpose of lessening the impact of shoreline erosion and wave action on the underwater sea grasses located between the ship channel and the landmass. No soil borings were taken at this location. The nearest borings however indicate that soft, underlying clay may be present. If this is true, then the soft foundation conditions will have to be addressed in the final design of the breakwater. One possible way of remedying the problem of a soft foundation would be to displace the soft clay with a hydraulic-fill sand embankment. This could be accomplished by arranging the dredging contracts in such an order that the hydraulic-fill embankment is constructed first so that settlement, consolidation, and stabilization of the foundation could take place along the alignment of the breakwater prior to its construction. Another solution may be to use geotextile material to bridge over the soft clay, and thereby provide support to the breakwater by employing the geotextile's tensile strength. Typical sections for the site are shown on Plate F-39 in the Feasibility Report.

4.0 DREDGED MATERIAL MANAGEMENT

4.1 DISPOSAL OF NEW WORK AND MAINTENANCE MATERIAL

4.1.1 Existing Placement Areas

The project will utilize eight (8) existing upland confined placement areas and one partially confined upland placement area that have been used in conjunction with construction and maintenance of the present authorized 45-foot channel. It will also utilize an existing offshore placement site and eight (8) bay placement areas to confine both new work and maintenance material as described below. Other PAs, as noted in Section 3.5.2, are not scheduled for use by the CCSCCIP but are still viable and available, if needed.

4.1.1.1 Inner Harbor – IH-PA 8 (Suntide Placement Area)

IH-PA 8 is a 306-acre upland confined placement area located just west of the end of the project channel, as shown on Plate F-42 in the Feasibility Report. IH-PA 8 will be used to contain approximately 1.2 mcy of new work dredged material and 1.0 mcy of future maintenance dredged material. This placement area has been used in the past for material disposal, but is not specifically provided or used under the present authorized 45-foot project. Consequently, IH-PA 8 will have to be acquired for the improved channel to satisfy storage capacity needs.

4.1.1.2 Inner Harbor – IH-PA 6 (Tule Lake Placement Area)

IH-PA 6 is a 360-acre upland confined placement area which is south of the ship channel, as shown on Plate F-42 in the Feasibility Report. IH-PA 6 will be used to contain approximately 1.6 mcy of new work material and 1.1 mcy of future maintenance dredged material. Although this placement area is an existing placement area that has been used for material disposal in the past, it is not specifically provided or used under the present authorized 45-foot project. Consequently, IH-PA 6 will have to be acquired for the improved channel to satisfy storage capacity needs.

4.1.1.3 IH-PA 3 (South Shore Placement Area)

IH-PA 3 is an upland confined placement area on the south shore of Nueces Bay, just west of IH-PA 1 and north of the ship channel. It is divided into 3 cells – "A", "B", and "C". Cell "A" is 200 acres in size and Cell "B" is 183 acres (see Plate F-43 in the Feasibility Report). Although no direct use is planned for Cell "C" (shown on Plate C-2 in the Feasibility Report) under this project, the PCCA requested that it be included, in the event future project needs make its use necessary. Furthermore, the PCCA requested that the use of IH-PA 3 be clarified to the extent that, based on projected future alternate land use, Inner Harbor placement area capacities have been determined with limitations placed on Cells "A", "B", and "C". This resulted in material being allocated to these sites in different proportions than would otherwise have been allocated without the requested limitations. It is, therefore, the contention of the PCCA, which is supported by the District, that if the limitations imposed should be relaxed during project construction or maintenance, the existing cells within IH-PA 3 could be more fully utilized for material storage. For the purpose of this report, however, the placement plan that has been developed is sufficient

to satisfy all the disposal requirements for the associated reach of channel at this time. To this end, Cell "A" of IH-PA 3 will be used to contain approximately 1.0 mcy of new work material only. It is not planned for use to contain any future maintenance material. Cell "B" will be used to contain approximately 1.0 mcy of new work material and 1.0 mcy of future maintenance material.

4.1.1.4 IH-PA 2 (Rincon Placement Area)

IH-PA 2 is a 230-acre upland confined placement site north of and contiguous with IH-PA 1 as shown on Plate F-44 in the Feasibility Report. It will be used to contain approximately 900,000 cy of new work material and 5.2 mcy of future maintenance material.

4.1.1.5 IH-PA 1 (Inner Harbor)

IH-PA 1 is a 350-acre upland confined placement site located just north of the Inner Harbor as shown on Plate F-44 in the Feasibility Report. IH-PA 1 is subdivided into two cells (West Cell and East Cell) and will be used to contain approximately 800,000 cy of material obtained from new work dredging and 10.6 mcy from maintenance dredging over a 50-year period.

4.1.1.6 Upper Bay Open-Water Placement Areas 14-A, 14-B, 15-A, 15-B, 16-A, 16-B, 17-A and 17-B)

These openwater placement areas are considered to have unlimited capacity for placement of dredged material. They are located on either side of the ship channel across Corpus Christi Bay as shown on Plates C-6 through C-9 in the Feasibility Report. The areas will be used for the disposal of approximately 11.8 mcy of new work material and 87.4 mcy of future maintenance material.

4.1.1.7 PA 10 (La Quinta Junction)

PA 10 is a 196-acre site upland confined placement area on the south side of the ship channel across from Port Ingleside as shown on Plate F-31 in the Feasibility Report. PA 10 will not be used to contain any new work dredged material. It will only be used to contain maintenance material, which is projected to amount to 2.8 mcy over the life of the project.

4.1.1.8 PA 6 (Mustang Island)

PA 6 is a 304-acre upland confined placement area on the northern point of Mustang Island, south of and adjacent to the CCSC between Port Aransas and the La Quinta junction as shown on Plate C-13 in the Feasibility Report. It has been used only once in the past as a placement area, and has since fallen into disrepair. Before this area can be used, major rehabilitation of the perimeter levees will be required and a new drop structure installed. PA 6 will be used to contain approximately 2.7 mcy of new work material. This placement area is not anticipated to be used for future maintenance dredging of the channel.

4.1.1.9 PA 2 (San Jose Island)

PA 2 is an existing partially confined upland placement area that is approximately 35 acres in size. It is situated on San Jose Island, which is about 1,000 feet north of the North Jetty (see Plate C-15 in the Feasibility Report). While this report assumes minimal quantitative use of this placement area, it is included nevertheless as a viable project placement area, because it may be used on an "as needed" basis to contain small quantities of shoal material collecting within the limits of the Port Aransas Inner Turning Basin between routine maintenance dredging of the Entrance Channel by hopper dredge. The small volume of material will be removed by pipeline dredge and placed in PA 2, with the effluent being allowed to drain off. Because of the nature of the placement area's scattered use, and the comparative small volumes of material that will be placed in it, this placement area was not factored into the storage capacity analysis for the 50-year maintenance of the project.

4.1.1.10 PA 1 (EPA-designated Offshore Maintenance Material Placement Area)

PA 1 is a 510-acre rectangular open-water placement area located approximately 2 miles offshore and 1,000 feet south of the channel centerline as shown on Plate F-29 in the Feasibility Report. The placement area will be used to dispose of approximately 62.0 mcy of maintenance material dredged from the Entrance Channel over a 50-year period.

4.1.1.11 PA 13 (La Quinta Channel)

PA 13 is a 750-acre upland confined placement area at the northeast corner of Corpus Christi Bay flanking the west side of La Quinta Channel as shown on Plate F-45 in the Feasibility Report. PA 13 will be used to contain approximately 3.7 mcy of new work material obtained from excavating the proposed channel extension, and 25.2 mcy of future maintenance material.

4.1.2 Proposed New (Beneficial Use) Placement Areas

The project will utilize the beneficial use of dredged materials to create two offshore sites, one upland site, and 5 open water sites. These beneficial use sites will be used mainly to create protected shallow water and emergent island habitats. Other uses include underwater topographic relief for potential offshore fishery enhancement or as a source of offshore sand for "feeding" the existing sand beach shoreline, for protection of existing habitats, and providing material for the future creation of a buffer zone that will be eventually landscaped as a tree-lined greenbelt between public and industrial properties.

4.1.2.1 Upper Bay – BU Site CQ

BU Site CQ is a proposed rectangular open-water site encompassing approximately 250 acres of shallow water and emergent island habitat. It is located north of the CCSC and west of the La Quinta Channel as shown on Plate F-32 in the Feasibility Report. The placement area will be bordered on three sides by a hydraulic-fill embankment protected by dredge material-filled geotubes and riprap. An emergent "fringe levee" will be constructed along the interior of the embankment for the planting of marine vegetation. The project provides for the deposition of approximately 2.9 mcy of new work material only to

create viable seagrass beds and marsh habitat with small emergent mounds distributed within the area. No future maintenance material will be placed into this area.

4.1.2.2 BU Site S

BU Site S is a proposed triangular-shaped open-water site encompassing approximately 121 acres of shallow water marine habitat. The placement area will be bordered on its east side by a hydraulic-fill embankment protected by riprap and dredge material filled geotubes. BU Site S is on the south side of the ship channel west of the GIWW as shown on Plate F-31 in the Feasibility Report. The project provides for the deposition of approximately 1.5 mcy of new work material only to create a shallow water environment. No future maintenance material is planned to be placed into this area.

4.1.2.3 BU Site R

BU Site R is a proposed triangular-shaped open-water site encompassing approximately 201 acres of shallow water marine habitat. The placement area will be bordered on the south and west sides by a hydraulic-fill embankment protected by riprap and geotubes on the exterior slopes. BU Site R is located on the south side of the ship channel east of the GIWW as shown on Plate F-31 in the Feasibility Report. The project provides for the deposition of approximately 2.4 mcy of new work material only to create a shallow water environment. No future maintenance material is planned to be placed into this area.

4.1.2.4 BU Site I

BU Site I is a proposed triangular-shaped open-water site, encompassing approximately 163 acres of shallow water marine habitat. The placement area will be bordered on the south and east sides by a hydraulic-fill embankment protected on the exterior slopes by riprap and dredge material-filled geotubes. BU Site I is situated on the north side of the ship channel east of the Gulf Intracoastal Waterway (GIWW) as shown on Plate F-30 in the Feasibility Report. The project provides for the deposition of approximately 2.1 mcy of new work material only to create a shallow water habitat, with islands in the interior and a high mound in the protected corner. No future maintenance material is planned to be placed into this area.

4.1.2.5 BU Site Pelican

BU Site Pelican, shown on Plate F-34 in the Feasibility Report, is an existing site adjacent to and south of the channel between BU Site R and PA 6. This area will not be used for the placement of new work material, but will continue to be used for placement of maintenance material that is part of the ongoing rookery island enhancement. The existing open water channel between Pelican and Mustang Islands will be maintained to prevent land bridge access by predators to Pelican Island from Mustang Island. The project will provide for 1,500 linear feet of shore protection on the northeast corner of the island. It will also provide for approximately 2,200 LF of dredge-filled geotube extending south on the east end of the island. Although no new work material will be disposed in the placement area per se, approximately 300,000 cy of suitable quality new work material will be used to fill the geotubes.

4.1.2.6 BU Site MN

BU Site MN is a proposed 440-acre offshore site located 10,000 feet south of the centerline of the project channel centerline, just outside the 30-foot contour as shown on Plate F-29 in the Feasibility Report. Approximately 1.7 mcy of new work material will be placed into this area, providing topographic relief to the offshore gulf bottom, and thereby enhancing the marine ecosystem in the area. The project does not allow for the deposition of any future maintenance dredged material into this area.

4.1.2.7 BU Site ZZ

BU Site ZZ (EPA-designated Navy Homeport ODMDS) is a proposed 1,150-acre offshore deep-water site, located south of the project channel centerline as shown on Plate F-29 in the Feasibility Report. Approximately 2.6 mcy of new work material will be placed into this area to provide topographic relief to the ocean bottom, thereby enhancing the marine ecosystem in the area. The project does not allow for the deposition of any future maintenance materials into this area.

4.1.2.8 BU Site E

BU Site E, or Buffer Zone, is a proposed 100-acre upland site located on Port of Corpus Christi Authority property just north of the new turning basin proposed for the La Quinta Channel Extension, as shown on Plate F-33 in the Feasibility Report. Approximately 1.0 mcy of new work material (primarily clay) will be placed in this area to serve as a future source of borrow for landscaping an environmentally aesthetic greenbelt that will separate public-use lands from industrial sites.

4.1.2.9 BU Site GH

BU Site GH is a proposed rectangular open water site encompassing approximately 200 acres of shallow water marine habitat. The placement area will be bordered on the south and west by hydraulic-fill embankments protected by dredge material-filled geotubes and riprap. An emergent fringe levee will be constructed along the interior of the embankment for the planting of marine vegetation. BU Site GH is located at the end of the existing La Quinta Channel just west of PA 13 as shown on Plate F-33 in the Feasibility Report. The project provides for the deposition of 2.5 mcy of new work material only to create a shallow water habitat. No maintenance material will be placed into this area. Fifteen (15) acres of seagrass will be planted on the eastern portion of the area to mitigate for five (5) acres of seagrass affected by the creation of the La Quinta extension.

4.1.3 Additional Beneficial Use Project Features

Other project features beneficial to the existing coastal environment will be constructed. Although these features will not employ the beneficial use of dredged material, as the beneficial use sites discussed above do, they nevertheless will benefit the environment by providing needed erosion protection along select areas of shoreline. Shore protection is proposed along the north shoreline of Mustang Island, which is on the south side of the ship channel near Port Aransas, and a rock breakwater is proposed off Port Ingleside at the La Quinta Channel junction.

4.1.3.1 BU Site L

BU Site L was selected as a plan feature to protect the existing sensitive coastal "sand flats" habitat that is eroding due to ship wakes along the channel. The area is located on the south bank of the channel between Piper Channel and the public fishing pier just west of Port Aransas, as shown on Plate F-35 in the Feasibility Report. Stone protection will be added to the existing bank to preserve the shoreline and offer protection to the east flats area.

4.1.3.2 BU Site P

BU Site P was selected as a plan feature to serve as a breakwater along the east bank of the La Quinta Channel and Port Ingleside, as shown on Plate F-32 in the Feasibility Report. BU Site P will function as a breakwater to minimize bank erosion and offer protection to the shallow water seagrass habitat, currently in place.

4.1.4 New Work Material

The quantities of new work material to be disposed of, by reach, are shown in Table F-1 above. The placement plan was developed using the beneficial use plan developed cooperatively by the Corps of Engineers, the PCCA, and participating resource and regulatory agencies. In addition to the seven (7) new beneficial use sites, sixteen (16) existing sites are proposed for use, which include nine (9) open water areas and seven (7) upland confined areas. The beneficial use sites were sized using bathymetry information furnished by Pacific International Engineering (PIE), the project's shoreline erosion study engineering consultant, that was generated from surveys taken by the Corps of Engineers, in conjunction with the alignments for the hydraulically-placed levees obtained from the beneficial use plan. PIE designed and calculated the quantities of the beneficial use site's containment and erosion protection. The Corps of Engineers determined the quantities by channel reach to be deposited into each beneficial use site to ensure the beneficial use plan for environmental enhancement could be realized. Use of the existing open water sites is unrestricted because their capacity to contain maintenance material is considered to be unlimited. The design considerations for the existing upland confined placement areas are discussed below. The placement plan that was developed for new work dredging is presented in Table F-3 below.

4.1.5 50-Year Maintenance Material

The quantities of maintenance material to be disposed of, by reach, are shown in Table F-2 above. The placement areas to be used for this work consist of the designated offshore site, Pelican Island beneficial use site, the eight (8) bay (open water) sites, one open water beneficial use site, and seven (7) existing upland confined sites. Again, the open water sites are considered to have unlimited capacity to contain the maintenance material, and are therefore not a concern. However, in an effort to improve management practices at these open-water sites and possibly reduce dredging frequency, in accordance with the non-Federal sponsors request, the dredge pipes will be placed at the back limits of the designated placement sites to release dredged material as far from the channel as possible. Material for nourishing Pelican Island will be placed in a semi-confined upland portion of the island and allowed to flow to the beach/open water. The upland confined placement areas will be

TABLE F-3

PLACEMENT PLAN FOR NEW WORK MATERIAL

Station	Station	Dredging Quantity (mcy)	Designated Placement Area Number	Designated Placement Area Size (acres)
Entrance Channel				
310+00	150+00	2.6	BU Site ZZ	1,150
150+00	-37+82	1.7	BU Site MN	440
Lower Bay				
12+55	180+00	2.7	PA 6	304
180+00	330+00	2.1	BU Site I	163
330+00	350+00	0.3	BU (Pelican)	NA
350+00	475+00	2.4	BU Site R	201
475+00	549+00	1.5	BU Site S	121
Upper Bay				
549+00	649+00	2.9	BU Site CQ	250
649+00	670+00	0.9	PA 14-A	NA
670+00	725+00	1.6	PA 14-B	NA
725+00	780+00	1.6	PA 15-A	NA
780+00	840+00	1.7	PA 15-B	NA
840+00	900+00	1.5	PA 16-A	NA
900+00	960+00	1.6	PA 16-B	NA
960+00	1020+00	1.6	PA 17-A	NA
1020+00	1080+00	1.4	PA 17-B	NA
Inner Harbor				
1080+00	1125+00	0.8	IH-PA 1	350
1125+00	1172+00	0.8	IH-PA 2	230
1172+00	1246+00	1.0	IH-PA 3A	200
1246+00	1320+00	1.0	IH-PA 3B	183
1320+00	1460+00	1.6	IH-PA 6/Tule Lake	360
1460+00	1561+00	1.2	IH-PA 8/Suntide	306
La Quinta				
309+51	362+00	2.7	PA 13	750
362+00	370+00	1.0	PA 14 (E)	100
370+00	382+00	2.5	BU Site GH	200
TOTAL		40.7		

designed to contain the maintenance material removed from the channel over a 50-year period. This can be accomplished only if the design incorporates the infusion of new work material in a manner that will allow for future raising of the perimeter levee embankments to the elevations necessary to contain the anticipated volume of dredged material. The placement plan developed for disposal of the project life maintenance material is presented in Table F-4 below. The table includes the dredging frequency for each channel reach.

4.2 DESIGN CONSIDERATIONS

4.2.1 Existing Upland Placement Areas

The existing upland placement areas designated for use under this project will require embankment designs necessary to contain both new work material from project deepening and widening, as well as maintenance material over a 50-year period. The existing upland confined PAs generally have very limited capacities, mainly due to poor foundation conditions that restrict the height to which the levees can be built. This is because, as the embankment crown is continually raised to the inside of the existing confined placement area perimeter alignment, the foundation soils upon which the raised portion of the embankment is constructed, gradually become the confined maintenance materials from past maintenance dredging operations. Maintenance materials include all materials that collect in the channel bottom over time, and are generally very soft, highly plastic clays and clayey silts, very unsuitable as foundation material. A section typical of the existing upland placement areas is shown on Plate F-41 in the Feasibility Report. Existing levees must be raised regularly to elevations sufficient to contain the maintenance material. However, the levees can only be raised as high as the available satisfactory material allows.

For placement area locations, the only place to obtain satisfactory material for embankment raising, short of costly hauling in the material, is to use side-cast material from inside the placement area. Normally, the soft, silty / clayey dredged material cannot be used for this purpose because it is too wet to be used for fill. However, the material does dry out over time and forms a crust that can be excavated and used in the raising the levee embankments. Unfortunately, the material that can be recovered by side casting is limited, and therefore the height to which the levee can be raised is limited. Without the introduction of stiff clay material into the area, the remaining volumetric storage capacities of the areas will not be sufficient to accommodate 50 years of maintenance material deposition. Therefore, the project proposes to use new work material excavated in conjunction with the channel deepening and widening to "ring" the inside of existing levees. This will require positioning the dredge discharge pipe along the inside slope of the existing levee and continuously moving it such that the satisfactory material will stack and displace the soft material. By doing this, a good foundation can be established, upon which the levees can be raised to the heights necessary to contain the future maintenance material.

4.2.2 Proposed Beneficial Use Placement Areas

Eight (8) of the nine (9) beneficial use sites will be used to contain new work material removed from the channel (BU Site Pelican will only be used to store maintenance material). These "new

TABLE F-4

PLACEMENT PLAN FOR 50-YEAR MAINTENANCE MATERIAL

From Station	To Station	Dredging Frequency (mcy)	Dredging Quantity (mcy)	Designated Placement Area
Entrance Channel				
310+00	-37+82	3	62.0	PA 1
Lower Bay				
12+55	540+00	6	11.7	BU Pelican
Upper Bay				
540+00	629+00	6	11.0	PA 14-A
629+00	706+00	6	10.9	PA 14-B
706+00	783+00	6	10.9	PA 15-A
783+00	854+00	6	10.9	PA 15-B
854+00	916+00	3	11.0	PA 16-A
916+00	972+00	3	10.9	PA 16-B
972+00	1028+00	3	10.9	PA 17-A
1028+00	1080+00	3	10.9	PA 17-B
Inner Harbor				
1080+00	1142+00	3	10.6	IH-PA 1
1142+00	1172+00	3	5.2	IH-PA 2
1172+00	1320+00	3	1.0	IH-PA 3B
1320+00	1460+00	3	1.1	IH-PA 6 or Mustang Isl.
1460+00	1561+00	3	1.0	IH-PA 6 or Tule Lake
La Quinta				
12+74	57+00	4	2.8	PA 10
57+00	382+00	4	25.2	PA 13
TOTAL			208.0	

work" sites must first be partially enclosed with hydraulically-placed levees along alignments having water depths of up to 12 feet. Satisfactory material, as determined from the information summarized in Table F-1 above, will be used to construct these emergent levees. The constructed levees will in turn provide a firm foundation for the dredge material-filled geotubes and other erosion protection of sufficient height to provide a sheltered environment conducive to establishing a shallow water habitat. Once the containment levees are in place, the remaining new work material to be dredged from a particular reach of channel can be placed to the lines and grades necessary to create shallow water environments, high mounds, and scattered small islands for estuarine habitat. The remaining beneficial use site, BU Site Pelican, will only require a similar hydraulically-placed containment levee.

4.2.3 Remaining Beneficial Use Sites

The two remaining beneficial use sites, BU L and BU P, are strictly erosion protection features that will be used to protect environmentally important habitat. BU Site L will serve to protect the shoreline from further erosion and encroachment to the existing barrier islands flats. BU P will serve as a breakwater to protect existing seagrass habitat between the ship channel and existing shoreline.

4.2.4 Entrance Channel Inlet at Jetties

Plate C-15 in the Feasibility Report shows the possible remnants of an old submerged rock groin immediately adjacent to the Entrance Channel's north bank from approximate Sta. 0+00 to Sta. –28+00. Recent hydrographic surveys, some probings, and interviews with Southern Area Office personnel (who administer maintenance dredging contracts) have failed to verify either the location or even the existence of such a rock groin. Therefore, additional probings will be required before plans and specifications for the new work dredging contract are prepared to ascertain whether submerged rock associated with the existence of this feature is actually present, as that may impact dredging operations in the area. If such probing work does indicate the possibility of submerged rock, then the plans and specifications will be composed to ensure that the rock that could be expected to be encountered in the deepening (and incidental widening of the side slopes) will be required to be removed before any new work dredging in this reach. For this reason, this report assumes the removal of about 1,000 LF of this rock groin, or approximately 16,000 tons, as part of the new work dredging for this reach of channel.

4.3 CONSTRUCTION TECHNIQUES

4.3.1 Project Channels

Pipeline and hopper dredges of sufficient size and power will be needed to pump the new work material to the areas shown on the plates in the Feasibility Report. The dredges used to place the material in the offshore sites will have to have the capability of precisely depositing the material in a prescribed manner within defined discharge corridors. The dredging industry has sufficient plant and equipment available in this area and nationwide that are capable of accomplishing the work.

4.3.2 Existing Upland Placement Area Sites

Pipeline dredges of sufficient size and power will be needed to excavate and pump new work material to, and completely along the existing perimeter levees. This will require constant monitoring and moving of the pipeline discharge to ensure that the new work clay balls discharged are properly stacked and placed along the existing levee side slopes. The stacking of material within discharge corridors other than along the inside slopes of existing levees may be allowed, depending upon the type of material that is expected to be excavated from the channel reach and upon the future borrow needs of the placement area for levee raising. This determination will not be made until plans and specifications are prepared for each specific channel reach.

4.3.3 New Beneficial Use Sites

Where hydraulic-fill embankments are required, the new work dredging contracts will be structured to direct the dredging contractor to use the dredge pipeline to initially pump the dredged material along the embankment alignment. The discharge pipes will have to be continually moved both laterally and along the alignment, in order to achieve the design embankment template. The material may be mounded to a height sufficient to allow for the mechanical movement and shaping of material to the lines and grades specified. Once the hydraulic-fill embankments are completed to a satisfactory length, a second, smaller dredge may begin to install the dredge-material-filled geotubes on the embankment crown. Other land-based equipment may complete the placement of required excavation and placement of geotextile fabric and stone protection. Where stone protection is required only to be placed underwater, barges with backhoes may be used in excavating to the lines and grades required and placing the blanket stone. Larger backhoes or cranes on barges may be required to place the larger stones of the breakwater. Smaller barges and backhoes, possibly in combination with land-based equipment, may be used to excavate to grade, and place geotextile fabric and stone protection for the shore protection required by the project.

4.4 SELECTION OF DESIGN PARAMETERS

4.4.1 Project Channels

Design parameters for the slope stability analyses performed were derived from individual or groups of soil borings in the proximity of the channel reach analyzed. Computer software used to analyzed cut slopes included the UTEXAS4 program distributed by the ERDC.

4.4.2 Placement Areas

Design parameters to evaluate the stability of the upland confined placement area levee embankments will be determined after new work material has been placed to the inside of the existing, in-place embankments. Because of the nature of the foundation material on which the new work material will be placed, there will be both initial- and near-term settlement involved. After a period of stabilization, soil borings will have to be taken to finalize the design for future crown raisings of the perimeter levees along all sites. Design parameters for beneficial use placement areas were used to the extent necessary to satisfy the designer that the proposed hydraulic-fill embankments were practical and feasible. Selected

soil borings in the vicinity of each area were used to evaluate the general bearing capacities of foundation soil, but only to the extent necessary to verify that placement of the dredged material could be accomplished in the manner prescribed. Because of the nature of the finished product (shallow water habitat, open on one side), the design of the embankments, protected with stone protection and geotubes, will be of primary importance, with the inside fill areas receiving the remainder of the new work material for a given reach of channel. Practically speaking, this means that the inside "footprint" or acreage of the shallow water habitat cannot be predicted with absolute accuracy at this time. Therefore, the technical specifications for placing the material will be of utmost importance to the design of the embankments, and will dictate the design parameters for the final design when the plans and specifications are prepared.

4.4.3 Shoreline Erosion and Breakwater Protection

Pacific International Engineering (PIE), a consulting firm initially contracted by the PCCA to conduct an erosion study of the shoreline along the CCSC and La Quinta Channel, designed the beneficial use shoreline protection and breakwater features depicted. The design criteria included crest elevation, depth of scour, and rock size. Two basic assumptions were used in developing the design criteria. The first was that the breakwater structures would be designed to protect the placed dredged material from direct vessel-generated wakes and surges, and from wind-generated waves. The second was that they would not be designed so conservatively that they would withstand impacts from severe hydrological events, such as tropical storms and hurricanes. The crest elevation design criterion was premised on analysis of the water surface elevation fluctuations in the project area (refer to PIE reports entitled "Corpus Christi Ship Channel Improvement, Shoreline Erosion Study, Task 2, PCCA," dated January 2001, and "Corpus Christi Ship Channel, Mustang and Harbor Islands Shoreline Stabilization Projects, Texas General Land Office," dated November 2000). A 10-year return period of extreme surge estimated at approximately 5.0 feet mean lower low water (MLLW) was selected as a design criterion. This period, which is conservative because it assumes a relatively high frequency of occurrence of this event (usually the frequency of extreme surge events are 25, 50, or 100 years) was selected assuming that no significant damage to the placement area site would occur during overtopping of the crest. The potential depth of scour was estimated using two different engineering methods and then comparing the results calculated between the two. The methods used in the depth of scour analysis were:

a. Method 1 - CRESSWIN Model (Delft Hydraulics Lab). This method is based on a formula that calculates the scouring in front of a vertical wall in a fine, sandy bottom under wave impact. Input parameters and values for this method of calculation were: a wave height of 1.4 feet, a wave period of 3.0 seconds, and a water depth of 4.2 feet.

b. Method 2 - Combined formulae from studies by De Graauw and Pilarczyk (1980) and Mirtskhulava (1967). This method, from combined formulae, uses horizontal steady flow as a function of water depth, flow velocity, bed material, and the duration of the scour to derive the potential depth of scour.

It should be noted that soil conditions along the proposed shoreline protection are not uniform. For a conceptual level of study, non-cohesive soil conditions were assumed for all sites. The critical velocity assumed for the non-cohesive soil was 1.5 ft per second. A depth of scour equal to 3.0 feet was estimated to be a design criterion. The size of rock used for the breakwater and toe

protection structures is derived from the analysis of two hydrodynamic effects – drawdown (pressure fields) and wind waves. Pressure-field effects analysis (PIE, January 2001) has identified the maximum rock size that will be stable on slopes of 1V on 2H as 2,200 lbs. This size rock is stable for design conditions that would be created by a single deep-draft vessel, 920 feet long by 174 feet wide, drafting 47 feet of water, and moving at a speed of 10 knots. For areas affected by wind waves, the maximum rock size requirement was estimated to be 1,000 lbs. This size rock is stable for a design wave height up to 2.5 to 3.0 feet for a 3- to 4-second period (PIE, January 2001).

4.5 CONSTRUCTION CONTRACTS

Seven construction contracts are planned. The first contract will be for the excavation of the La Quinta Channel Extension, constructing the barge lanes across Upper Upper Bay, and constructing the breakwater at Ingleside (BU Site P). The subsequent contract reaches in order will be:

- Entrance Channel (Sta. –30+00 to Sta. 310+00)
- Inner Basin/Port Aransas (Sta. 12+55 to Sta. 180+00)
- Lower Bay (Sta. 180+00 to Sta. 670+00)
- Upper Bay (Sta. 670+00 to Sta. 1080+00)
- Inner Harbor/Main Turning Basin and Industrial Canal (Sta. 1080+00 to 1320+00)
- Inner Harbor/Tule Lake and Viola Channels (Sta. 1320+00 to 1561+00)

As stated earlier, this appendix makes liberal assumptions regarding the design of the geotechnical features. Considering this, additional detailed engineering investigations and design analyses will have to be done when preparing the plans and specifications for each construction contract. The purposes of these investigations and analyses will be to affirm the assumptions made in this appendix and to document the design analysis for each engineering feature associated with the project in accordance with Corps of Engineers quality assurance policy. The following are brief descriptions of the additional work that will likely be necessary for each contract:

4.5.1 Contract No. 1: Dredging La Quinta Channel Extension (Sta. 309+51 to Sta. 382+00), Ingleside Breakwater (BU Site P), and Barge Lanes (Sta. 540+00 to 1050+00)

This work involves dredging to construct the La Quinta Channel Extension and the construction of three beneficial use sites (BU Site GH, BU Site P and BU Site E), as well as the "strategic placement" of new work material along the interior of PA 13, along the La Quinta Channel. The work also involves dredging of the proposed barge shelves across Upper Corpus Christ Bay, and the construction of a rock breakwater just off the shore of Ingleside-on-the-Bay adjacent to the existing La Quinta Channel. Material dredged from the barge shelves is to be placed into Open Water Placement Areas 14-A, 14-B, 15-A and 15B. At the time the plans and specifications for this contract are prepared, land surveys will have to be acquired for the two upland sites to be used for disposal and for BU Site E and PA 13. Additional hydrographic surveys will also have to be acquired for BU Site GH and along the alignment of the channel extension. Geotechnical investigations will include soil borings (on land) at the proposed beneficial use sites – BU Site E and PA 13. Additional hydrographic soil borings (in water) will have to be obtained for BU Site GH (shallow water habitat) and BU Site P (breakwater), and possibly some grab

samples within the prescribed barge shelves will have to be taken. Geotechnical design will be required for the embankments and outlet works at BU Site E and PA 13, for the (submerged) embankments at BU Site GH, and the breakwater at BU Site P. At a minimum, the design work will include design of geotubes, jetties and erosion (stone) protection, and settlement investigations, depending upon the foundation conditions along the alignment for the embankment.

4.5.2 Contract No. 2: Dredging Entrance Channel (Sta. –37+82 to Sta. 310+00)

This work involves dredging the offshore reach of the project from Port Aransas into the Gulf of Mexico and placing the material into two separate offshore beneficial use placement areas – BU Site MN and BU Site ZZ. In the reach of channel from Sta. –37+82 to Sta. 150+00, the soil borings indicate that the material consists mostly of silty sand. This material will be deposited into BU Site MN, which will have a minimum prescribed water depth of 30 feet, utilizing a dumping pattern that will provide for underwater topographic relief. The material placed in this area will lend itself to providing a source of offshore material that may be transported by wave action to the surf zone and beach. From Sta. 150+00 to Sta. 310+00, the material is shown to have a more clayey consistency. This material will be placed in BU Site ZZ, utilizing a more solid mounding pattern further offshore, in an effort to enhance marine productivity by providing underwater topographic relief. The design of these beneficial use sites may require the use of a computer program, such as the ERDC program STFATE (Short Term FATE). The STFATE program calculates the location and geometry of a single "dump" from a hopper dredge. From the short-term characteristics of a single dump, the overall design (size) of the placement area can then be verified for sufficiency.

4.5.3 Contract No. 3: Dredging Lower Bay / Inner Basin at Port Aransas (Sta. 12+55 to Sta. 180+00)

This work involves dredging the channel westward from Port Aransas, construction of one beneficial use site (BU Site Pelican), and rehabilitation of PA 6, which is an existing placement area on Mustang Island adjacent to and south of the channel near Port Aransas. At the time the plans and specifications are prepared, land surveys will have to be acquired at both sites. PA 6 will require cross sections around its entire alignment. BU Site Pelican will require cross sections of the shoreline for the length of riprap to be placed along the channel. Soil borings may be necessary to validate information already on hand. The outlet works at PA 6 will require complete rehabilitation or a new structure, depending upon the condition of the present structure at the time the plans and specifications for this contract are being prepared.

4.5.4 Contract No. 4: Dredging Lower Bay Reach (Sta. 180+00 to Sta. 670+00)

This work involves dredging of the Lower Bay reach of channel and the construction of five beneficial use sites (BU Site I, BU Site R, BU Site S, BU Site CQ and BU Site Pelican). At the time the plans and specifications are prepared, hydrographic surveys, and perhaps some limited land surveys will have to be acquired at all sites. Geotechnical investigations will include soil borings and grab samples taken on the water from a spud barge at all sites. Geotechnical design will be required for the hydraulic-fill

embankments and associated erosion protection, including armor plating with riprap or cellular-concrete mattress and geotubes.

4.5.5 Contract No. 5: Dredging Upper Bay Channel Reach (Sta. 670+00 to Sta. 1080+00)

This work involves dredging of the channel reach through Upper Bay. No construction work other than dredging will be required under this contract. The dredged material is to be placed into existing open water placement areas adjacent to the channel. The geotechnical effort involved in the preparation of this contract is expected to be minimal. Hydrographic surveys for the open water placement areas will have to be obtained.

4.5.6 Contract No. 6: Dredging Inner Harbor - Industrial Canal (Sta. 1080+00 to Sta. 1320+00)

This work involves the dredging of the channel reach from Upper Bay landward, into the land-locked portion of the channel, through the Main Turning Basin, Avery Point Turning Basin and Chemical Turning Basin. New work material removed from the channel will be "strategically placed" along the interior of existing upland confined placement areas IH-PA 1, IH-PA 2, IH-PA 3A, and IH-PA 3B. At the time the plans and specifications are prepared, land surveys will have to be acquired along the perimeter of the placement areas. Geotechnical investigations will include some additional soil borings and hand auger samples taken to supplement and verify known information, and to furnish new information on the characteristics of the soil at the time the work is planned. Soils design, including, but not limited to slope stability and settlement analyses, will be required at all upland sites. Structural analyses, including either rehabilitation or redesign of the outlet works at all sites will also be required.

4.5.7 Contract No. 7: Inner Harbor – Tule Lake and Viola Channels (Sta. 1320+00 to Sta. 1561+50)

This work involves the dredging of the land-locked industrial canal from the Tule Lake lift bridge near the Main Turning Basin through the end of the channel at the Viola Turning Basin. New work dredged material removed from the channel will be "strategically placed" along the interior of two existing upland confined placement areas – IH-PA 6 (Tule Lake) and IH-PA 8 (Suntide). At the time the plans and specifications are prepared, land surveys will have to be acquired along the perimeter of the placement areas. Geotechnical investigations will include some additional soil borings and hand auger samples taken to supplement and verify known information, and to furnish new information on the characteristics of the soil at the time the work is planned. Soils design, including, but not limited to slope stability and settlement analyses, will be required at the confined sites. Structural analyses, including either rehabilitation or redesign of the outlet works at all sites will also be required.