MANATEE HARBOR, FLORIDA
LIMITED REEVALUATION REPORT

APPENDIX B
ENGINEERING

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A. INTRODUCTION

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

2. Recommended Plan. The selected plan would include construction of wideners along both the north and south sides of the channel at the intersection with the Tampa Harbor Channel and construction of a 900-foot diameter turning basin at the eastern end of the Manatee Harbor Channel. A plan view of the selected plan is shown on Plate B-2. The project features included in this report represent Phase II of the Manatee Harbor Project and would be dredged to the existing authorized depth of 40 feet. Construction of the Phase I portion of the project was completed in 1997 and consisted of dredging the existing 400-foot channel to 40 feet and the berthing areas to their respective depths. Contract Plans and Specifications for the Phase II portion of the project are currently available. A discussion of the plan formulation involved in the selection of the recommended plan is presented in the main portion of this report. All soundings presented in this report are at Mean Lower Low Water.

B. HYDROLOGY AND HYDRAULICS

3. General. The currents and water surface elevations in Tampa Harbor are subject to the irregular gulf tide, the effects of winds, upland drainage, and the variations in barometric pressure. These factors serve as boundary conditions for the hydraulic forces influencing the smaller scale limits of this study area.

4. Tides. The gulf tide is the most important factor in the circulation of water within the bay and in the variation of water elevations. The tide is a variation of the mixed type as two high waters and two low waters generally occur in a tidal day, but with marked inequality between consecutive tidal cycles. The tidal inequalities continuously change from a semi-daily tide to a daily tide over an approximately 14-day period, with most tides of the mixed type. Diurnal tide ranges vary from about 2.1 feet at Egmont Key to about 2.0 feet at the entrance to McKay Bay. Additionally, mean tide levels are 1.1 and 1.4 feet at Egmont Key and McKay Bay, respectively.

5. Currents. Tidal currents within the entire Tampa Bay estuary are not severe but are significant in the overall circulation pattern. The maximum currents are

found at the mouth of the estuary near Egmont Key where maximum ebb currents in excess of 6.0 feet per second are frequently experienced. At the same location, the maximum flood velocity rarely exceeds 3.5 feet per second (about 60 percent of the ebb velocity). The same pattern is observed throughout the estuary with maximum ebb velocities tending to be nearly double the maximum flood velocities. The maximum currents are observed during periods when the diurnal tidal characteristic dominates to produce stronger ebb tides.

The currents within the estuary decrease roughly as the distance from the mouth increases, with currents in Hillsborough Bay and the more northerly reaches of Old Tampa Bay being less than 10 percent as strong as those at the mouth (about 0.6 feet per second). At some locations in the bays, it is difficult to measure any predominate ebb or flood current. Tidal current velocities can be higher, however, in areas of localized flow constrictions that connect water bodies of sufficient volume.

6. Ship Simulator Modeling. a. General. The tidal currents in Tampa Bay in the vicinity of Manatee Harbor are almost perpendicular to the project channel. As a result, the turn into the project channel from the Tampa Harbor channel can be hazardous, strong cross currents acting on the vessel after it has completed the turn and is maneuvering in the channel. The Corps of Engineers Waterways Experiment Station undertook a navigation study in 1989 and again in 1999 to analyze these effects and to provide recommendations to improve navigation. The results of the latest study are included in Attachment B to this report.

b. 1989 Ship Simulator Study. On 15 August 1989 the Waterways Experiment Station completed a ship simulation study for Manatee Harbor. The study recommended a reduced turn widener for Tampa Harbor entrance channel on the south side of its intersection with the Tampa Harbor Main Channel. The study also recommended a turn widener be provided on the north side of that intersection. Neither the authorized document nor previous studies contained a widener at this location. Figure 2 shows the approximate location of the turn wideners. Another recommendation of the study was to shift the turning basin slightly to the north.

c. 1999 Ship Simulator Study. To help in designing the entrance channel wideners and the proposed turning basin, a computer model was developed to simulate future conditions. The US Army Research and Development Center, Coastal and Hydraulics Laboratory (CHL) conducted a ship simulator based navigation study from September to December 1999. Ship pilots licensed for Port Manatee operated the simulator in "real time". Two design ships were used during the Port Manatee navigation study. One vessel was used for simulating a cargo ship and the other for a cruise ship. The "El Gaucho", a 775-ft long ship with a beam of 106 ft, was loaded to 36-ft draft for simulating a cargo ship. The prototype cruised ship used in the simulation model was the "Disney Magic", which has a 965 feet in length overall (LOA) and a beam of 106 feet (Panamax). The Disney Magic has a maximum draft of 26 feet, which was used as design factor during the ship simulation study. Several conclusions and

recommendations were presented in the ship simulation report (Attachment B). The following recommendations are some of the most relevant concerning this study.

(1) The proposed 900-foot turning basin was found adequate in size given safety reasons concerning winds and currents. However, the ship simulation concluded the turning basin would be better located on the centerline of the entrance channel. This would result in time and tug usage savings. One undesirable aspect of placing the turning basin on the centerline of the entrance channel is it would require additional mitigation for seagrasses. A turning basin located in the centerline would impact more seagrasses and thus essential fish habitat. For these reasons, the sponsor requested the turning basin be located north of the entrance channel and that the diameter be 900 feet, as currently authorized.

(2) The study also recommended widening the entrance channel at its intersection with the Tampa channel and enlarging a portion of the channel south of the entrance to facilitate navigation within this reach.

(3) The study suggested the proposed improvements should allow easing tide/wind restrictions on vessel movements in and out of Port Manatee. Also, the study strongly recommended outbound ranges for the entrance channel.

C. GEOTECHNICAL INVESTIGATIONS

7. Regional Geology. Manatee County is located in the southwestern part of the peninsular Florida and comprises an area of about 800 square miles adjacent to the Gulf of Mexico. Sand, limestone and shell deposits of mainly Pleistocene age and possibly partly of Pliocene age are exposed in many parts of the county. The depths of these deposits range from a few feet to about 90 feet. Interbedded marl, limestone and sands of the Hawthorn of middle Miocene age underlie them. At depths ranging from 175 to 350 feet below sea level, the Hawthorn is underlain by a series of Tertiary limestones, which have a total thickness of over 4,000 feet.

The county lies within the Terraced Coastal Lowlands, which are a subdivision of the Coastal Plain Province. The topography is controlled by a series of marine terraces that are associated with fluctuations in the sea levels and is attributed to the advancing and retreating great continental ice sheets. When the sea was relatively stationary for long periods, the shoreline features and marine plains developed. The remnants of five marine terraces and four shorelines identified in the county are Sunderland, Wicomico, Penholoway, Tolbot and Pamlico.

Table I, in the Attachment to this Appendix, describes the geologic formations found in Manatee County (USGS Report of Investigations No. 18).

8. Local Geology. The shallow surficial deposits in the study area are mostly sands, silts and clays.

9. Previous Investigations. The earliest core borings from the study area are from 1967, which were drilled by the Port's engineering consultant and also those from 1977, which were drilled by the Corps of Engineers. The information on these investigations is present in the General Design Memorandum of 1983. In 1988, 3 core borings and 13 wash probings were drilled towards the west of the harbor entrance. In 1990, 3 core borings and 6 wash probes were drilled towards the north of the harbor entrance along with 8 core borings that were drilled in the 2 wideners at the intersection of Manatee Harbor entrance channel and the Tampa Bay channel.

In the 1977, 1988 and 1990 drilling operations, a Failing 1500 drill which was mounted on the Sea Horse, which is a self-elevating drill barge was used. The core samples were obtained using a 2" sampler and 4" X 5-½ diameter core barrel. The wash probes were obtained by washing a 2" sampler to the top of the rock or at the project's target depth.

These investigations revealed that materials from the north of the harbor had layers of clay, silt, sand, hard limestone and moderately hard siltstone of varying thickness. The materials encountered from the west of the harbor entrance were hard sandstones, very hard siltstone, soft siltstones, and highly plastic silt. The material from the intersection of the Manatee Harbor entrance channel and Tampa Bay channel was mainly composed of fine to medium quartz sand with varying amount of silt and clay.

The material encountered in borings CB-MAN00-6 through CB-MAN00-8 and CB-MTH97-1 through CB-MTH97-11 is sand, silt, clay, limestone, sandstone and siltstone. The sands range between fine and coarse and are silty or clayey in places along with layers of sandstones. Phosphatic sands were also noticed at many locations. The clays encountered are (CH) or (CL) depending upon the depth and location. They are associated with phosphatic sands and layers of sandstone. The silts are also present which have a varying sand and clay content. The limestones are moderately hard to hard depending upon the depth and location and are and are interbedded with sandy and clayey seams. The fossil content also depends on the depth and location of the samples. In some borings fine-grained sandstone and siltstones, which are moderately hard, are also seen.

10. Recent Investigations. In 1997, the Corps drilled 31 borings in the area. These drilling operations were performed using a Failing 314 drilling rig on which a 140# hammer with a 30" drop was mounted and a 2.0' split spoon (1 3/8" I.D. X 2" O.D.) was used for sampling.

The most recent investigations in the area were conducted during the current year, and can be broadly divided into two groups. The first group includes the 21

wash probes WP-MAN00-1 through WP-MAN00-21 and the 8 core borings CB-MAN00-1 to CB-MAN00-8 which were contracted out to Ardaman and Associates. The CME 45 mounted on a barge was used. The core borings were obtained using a 140# hammer with a 30" drop used on a 2.0' split spoon (1 3/8 I.D. X 2" O.D). The locations of these wash probes and core borings are identified in Attachment A.

The second group includes the additional investigations that were conducted by the Corps of Engineers' drilling crews and were concentrated in and around the disposal area. These include the 17 core borings CB-MDA00-1 through CB-MDA00-13, CB-MDA00-15, CB-MDA00-16, CB-MDA00-18 and CB-MDA00-19. These borings were drilled using a tripod with an Acker, CME 45, or a Failing 1500 depending on the boring location. The locations of these core borings are identified in Attachment A.

REFERENCES.

1. Groundwater Resources of Manatee County, Florida Geological Survey, No. 18, 1958;
2. Manatee Harbor, Florida, General Design memorandum, Supplement I, 1990;
3. Report of Core Drilling and laboratory Testing for Manatee Harbor, Ardaman and Associates, File No. 00-018, 2000.

11. Results of Recent Investigations. The 1997 investigations indicated that depending upon the depth and location of the borings, the material in the samples consists of clayey or silty sands, silts, clays, soft, hard or moderately hard limestones, siltsones or silty or clayey gravel.

The 21 wash probes indicate that refusal elevations in the study area range between –2.7 feet in areas near probe #21 to –39.3 feet as in the case of probe #1. The information on the X and Y coordinates, tide stages, and bottom and refusal elevations of these wash probes is included in Attachment A.

The 8 core borings CB-MAN00-1 to CB-MAN00-8 indicate that the material encountered consists of sands, silty sands and clays. The size of the quartz in the sands ranges between fine and fine to coarse. In some cases phosphatic sands were also noticed. Both (CH) and (CL) clays were encountered. In some borings fine grained sandstone was also found.

The 17 core borings CB-MDA00-1 to CB-MDA00-13, CB-MDA00-15, CB-MDA00-16, CB-MDA00-18 and CB-MDA00-19 that were collected from the disposal area can be broadly divided into two distinct groups.

The first group that includes borings CB-MDA00-1 to CB-MDA00-4 is located on the dikes surrounding the disposal area. The material encountered includes silty sands, sands and clayey sands.

The second group which includes the remaining 11 borings in the CB-MDA00 series are those borings which were drilled inside the disposal area. The material encountered includes sands, silty sands and dark greenish gray clays depending on their location and distance from the initial discharge area of the dredged material which was recovered from the ocean. The two near surface samples CB-MDA00-14 and CB-MDA00-17 resemble the other similar samples obtained and also with those at the requested locations and were dark greenish gray clays.

The locations of the applicable core borings are shown on Plate B-2.

12. Laboratory Analyses. Representative samples of unconsolidated materials from selected core logs were sent to the Corps of Engineers South Atlantic Division Laboratory. The applicable boring logs and gradation curves are included in the Attachment A to this Appendix.

13. Excavation. With a proposed project depth of - 40 feet MLLW, plus applicable overdepths, construction of the channel wideners would involve excavation of unconsolidated materials. Construction of the turning basin would involve excavation of both unconsolidated material and rock. The unconsolidated materials and the soft to moderately hard rock could be excavated with a rock-cutterhead hydraulic pipeline dredge.

D. DESIGN AND CONSTRUCTION

14. General. A project location map is shown on Plate B-1. The proposed project plan is shown on Plates B-2. The diked upland disposal area is shown on Plate B-3. Typical sections of the proposed channel wideners and turning basin are provided on Plate B-4.

15. Channel Wideners. The channel wideners would be constructed from approximately Station 93+00 to the intersection eastern edge of the Tampa Harbor Channel – Cut B. The wideners would be excavated to a project depth of 40 feet plus applicable overdepths.

16. Turning Basin. The proposed 900 -foot diameter turning basin would be located adjacent to the northern edge of the channel with the center at approximately Station 25+80 and Range -450. The turning basin would be excavated to a project depth of 40 feet plus applicable overdepths.

17. Side Slopes. For estimating purposes, the average side slope for the proposed excavation was determined to be 1 vertical on 3 horizontal (1V: 3H).

18. Overdepths. An additional 1-foot of dredging depth is included in the excavation quantities as an allowable overdepth to provide for inaccuracies in

the dredging process. An additional 1-foot of required overdepth in addition to the 1-foot of allowable overdepth is included in the estimated excavation quantities for the turning basin. This required overdepth would be necessary to facilitate future maintenance of the turning basin area due to the existence of hard material at project depth.

19. Disposal Area. The existing diked upland disposal area located on port property would be used for placement of all dredged material from both initial construction and future maintenance. It is currently planned to raise the dikes approximately 26 feet to elevation 55 ft (NGVD 1929) to provide for disposal of the material excavated during completion of Phase II of the project construction included in this report and for anticipated future maintenance. This cost for preparation of the disposal area and raising the dikes should be included as an economic cost in the project benefit \cost analysis presented in the main report.

20. Construction Procedure. For cost estimating purposes, it is anticipated that a cutterhead pipeline dredge would be used for construction of the Manatee Harbor entrance channel wideners and turning basin.

E. RELOCATIONS

21. General. In accordance with the Project Cooperation Agreement (PAC), the project sponsor would be required to assume the costs of all lands, easements, rights-of-way, and relocations as required.

22. Berthing Areas. As an item of local cooperation, the Manatee County Port Authority would be responsible for the dredging of the project berthing areas to provide the appropriate depths. No additional dredging of existing berths is expected as a result of this project. A discussion of this topic is presented in the main report.

F. OPERATION AND MAINTENANCE

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

24. Estimated Annual Cost. Without adequate historical maintenance data or a comprehensive shoaling analysis, it is difficult to quantify the anticipated average annual shoaling for the Manatee Harbor project. However, it is anticipated that the quantity of shoal material would remain relatively constant,

and that an increase in the maintenance quantity resulting from construction of the Phase II portion of the project presented in this report would be minimal. For the current dredging contract at Manatee Harbor, there was no shoaling at the intersection of the Manatee and Tampa Harbor channel.

25. Navigation Aids. The U.S. Coast Guard would be responsible for providing and maintaining navigation aids. Existing navigation aids would need to be relocated for this project, but the requirement for any additional aids has not been established. It is anticipated that the additional costs to the project would be minimal.

G. QUANTITIES AND COST ESTIMATES

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

The costs have been prepared for an effective date of October 2002.

H. SAFETY AS A COMPONENT OF ENGINEERING DESIGN

27. General. Corps of Engineers deep-draft navigation design guidance is clear on the importance of safety as a component in the engineering design process for deep-draft navigation features. That guidance clearly establishes that safety associated with the engineering design has priority over the cost of the design. The following paragraph from EM 1110-2-1613, 31 August 2002, Hydraulic Design of Deep Draft Navigation Projects (Chapter 2, 2-1), is provided for reference.

28. "Design of a navigation project requires an understanding of the port and waterway needs, assembly and evaluation of all pertinent information, and development of a rational improvement plan. The planner/design engineer is responsible for developing and formulating several project design alternatives. This will allow the economically optimum plan to be clearly evident and readily substantiated. Project safety and efficiency should receive primary consideration before the cost-effectiveness of the project is determined."

29. Our understanding of the safety issues associated with each deep-draft navigation feature is usually developed from information that is provided by local harbor pilot organizations. The harbor pilots are the individuals who are most familiar with our deep-draft navigation system. The harbor pilots complete

hundreds of transits through the components (channels, turning basins, anchorage areas), of our deep-draft navigation system per day. The same Engineering Manual that is referenced above provides clear direction for integrating the pilots into the engineering design process.

30. "The designer must consider and include aspects of project safety, efficiency of ship operations, and reliability of the proposed project. Safety of the project will depend on the size and maneuverability of the ships using the waterway, size and type of channel, aids to navigation provided, magnitude and direction of currents in the waterway, wind and wave effects, and experience and judgment of the local pilots. Since human factors (pilot skill and diligence), are involved in navigation channel safety and are difficult to evaluate, potential hazardous conditions should be eliminated in the project design insofar as practicable. Therefore, optimum design of a specific waterway will require an evaluation of the physical environmental conditions, especially the currents and weather conditions and judgment of safety factors based on local pilot information." (Chapter 2, 2-5)

31. "Navigation project planners/designers should develop strong coordination with the local pilot groups throughout the project development. Pilot interviews can be used to determine the user's opinion on existing channel navigation safety and wind and wave conditions to be used for design analysis, and the feasibility and safety of proposed channel design alternatives." (Chapter 5, 5-12)

32. Pilots from the Tampa Bay Pilots Association are responsible for safe navigation at Port Manatee and throughout Tampa Harbor. The Tampa Bay Pilots Association has worked closely with the Jacksonville District to develop safe and efficient designs for deep-draft navigation features throughout Tampa Harbor. Their participation and cooperation associated with the engineering designs for Manatee Harbor have been invaluable.

33. In a letter dated February 28, 2003 from the Tampa Bay Pilots to Mr. Richard E. Bonner, P.E., Deputy District Engineer for Project Development, U.S. Army Corps of Engineers, Jacksonville District, Captain Brian K. Tahaney discusses safety and the dangerous conditions existing at Manatee Harbor for vessels attempting turning maneuvers. Captain Tahaney also discusses an "effective 1300 foot turning basin" that had been presented as a proposal to allow for safe turning maneuvers at Port Manatee. The proposal had been presented by their leadership, for review, discussion, and endorsement at a pilot association meeting. Referring to that "effective 1300 foot turning basin", Captain Tahaney writes, "As I stated above the project requires at least a 1300 foot turning basin." Please see correspondence with the Tampa Bay Pilots in Appendix E.