Appendix L

Plan Formulation

Brazos Island Harbor, Texas
Channel Improvement Project
Cameron County, Texas

U.S. Army Corps of Engineers, Galveston District
2000 Fort Point Road
Galveston, Texas 77550

December 2013

BRAZOS ISLAND HARBOR
CHANNEL IMPROVEMENT PROJECT

PLAN FORMULATION
APPENDIX L

U.S. Army Corps of Engineers
Southwestern Division
Galveston District

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Acronyms and Abbreviations

AAEQ	average annual equivalent
AM	advance maintenance
BCR	Benefit-to-Cost Ratio
BIH	Brazos Island Harbor
BMP	best management practice
CBRA	Coastal Barrier Resources Act
cy/yr	cubic yards per year
DMMP	Dredged Material Management Plan
EFH	Essential Fish Habitat
EO	Executive Order
EOP	Environmental Operating Principles
ERDC	Engineer Research and Design Center
FWOP	Future Without-Project
FY	fiscal year
HTRW	Hazardous, Toxic and Radioactive Waste
IDC	interest during construction
MCY	million cubic yards
NED	National Economic Development
NEPA	National Environmental Policy Act
O&M	operations and maintenance
ODMDS	Ocean Dredged Material Disposal Site
P&G	Principles and Guidelines
PDT	Project Delivery Team
Pilots	Brazos Santiago Pilots Association
POB	Port of Brownsville
RSLR	Relative sea level rise
SAV	submerged aquatic vegetation
TSP	Tentatively Selected Plan
USACE	U.S. Army Corps of Engineers
VE	Value Engineering
VLCC	Very Large Crude Carrier
WRDA	Water Resources Development Act

1.0 PLAN FORMULATION RATIONALE

Plan formulation is the process of building alternative plans that meet planning objectives and developing alternatives within the planning constraints. Alternative plans are a set of one or more management measures functioning together to address one or more planning objectives. A management measure is a feature that can be implemented at a specific geographic site to address one or more planning objectives. A feature can be a structural element that requires construction or a nonstructural action.

Preliminary plans were formulated by combining management measures. Each plan was formulated in consideration of the following four criteria described in the Principles and Guidelines (P&G):

- Completeness: Extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objectives
- Effectiveness: Extent to which the plan contributes to achieving the planning objectives
- Efficiency: Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment
- Acceptability: Workability and viability of the alternative plan with respect to acceptance by Federal and non-Federal entities and the public, and compatibility with existing laws, regulations, and public policies

The U.S. Army Corps of Engineers (USACE) is required to consider the option of "No Action" as one of the study alternatives in order to comply with the requirements of the National Environmental Policy Act (NEPA). With the No Action Alternative (i.e., the Future Without-Project [FWOP] Condition), it is assumed that no project would be implemented by the Federal Government or by local interests to achieve these particular planning objectives. However, normal operation and maintenance activities, along with other probable channel improvements, are assumed to be performed over the period of analysis. The No Action Alternative, therefore, forms the basis to which all other alternative plans are measured. Details of the No Action Alternative are included in Future Without-Project Conditions section of the main report (Section 3.0).

Initial study efforts involved a determination of the magnitude and extent of the problems along Brazos Island Harbor (BIH) in order to develop and evaluate an array of alternative solutions that meet the existing and long-range future needs of the non-Federal sponsor and the public. At the initiation of the feasibility phase of the project, lines of communication were opened with Federal, state, and local agencies, private groups, and the affected public. A public scoping meeting was held in Brownville, Texas, on January 31, 2007. Attendees were overwhelmingly in favor of the project for the economic benefits it would likely generate for the South Texas area. The public was assured that their involvement would occur throughout the planning process.

2.0 MANAGEMENT MEASURES

The main problems with the existing channel are constraints in accommodating deeper draft vessels like the post-Panamax vessels and the inability to accommodate larger offshore rigs. Nonstructural and structural measures were developed to address at least one of the planning objectives, alone or in combination with other measures. These measures were later combined to form alternatives to be evaluated in this study process. New measures identified in later phases of the Plan Formulation process were also reviewed and considered in the alternative analysis. Measures were formulated to avoid or minimize the following constraints:

- Minimize impacts to designated critical habitat for threatened and endangered species in the study area;
- Minimize impacts to threatened and endangered species in the study area;
- Minimize impacts to cultural resources listed or eligible for the National Register of Historic Places (defined as historic properties);
- Develop alternatives within Coastal Barrier Resources Act (CBRA) guidelines which prohibit new Federal expenditures or financial assistance within any CBRA unit with the exception of improvements to existing navigation channels, disposal areas and related improvements; and
- Limit channel traffic to single lane/one way only.

2.1 NONSTRUCTURAL MEASURES

Based on the economic forecasts discussed in Section 3.1 of the main report, existing vessel management practices and scheduling is sufficient to maintain efficient channel operation in the future. Therefore, no nonstructural alternatives related to vessel management were included.

The nonstructural measures considered included:

- Utilize another port; and
- Alternative modes of commodity transport.

A multiport analysis and alternative modes of commodity transport could be considered to address limitations of vessel and rig movements using other ports. These analyses were performed as part of the economic analysis, but not as separate nonstructural alternatives analyses, with their results fully evaluated during the Plan Formulation analyses. Therefore, utilization of another port and alternative modes of commodity transport have been included in the economics and have been carried forward into the future alternative screenings but have not been discussed separately as nonstructural plans from this point forward.

2.2 STRUCTURAL MEASURES

Structural measures included:

- Deepen only;
- Widen only;
- Deepen and widen channel;
- Widen only up to location of existing offshore rig fabrication operations;
- Relocate turning basin to new location closer to the channel entrance; and
- Widen using shelves to facilitate rig movements on the outer Main Channel.

The purpose of the deepening and/or widening measures of the existing 42-foot channel would be to allow existing ships to more fully utilize the channel while also allowing larger offshore rigs to come into the port for fabrication, maintenance, and repair. The deepening and/or widening measures could also be considered at different scales (various channel depths and widths). Widening specific parts of the channel include widening using shelves on either side of the deep-draft channel to accommodate rigs that need additional widths but not at the deeper channel depth. Widening the channel only up to the existing rig facilities located near the turning basin was also considered as part of the formulation to accommodate wider rigs. Widening considered in any alternative would be limited since the channel would continue to operate for one-way traffic only in the future.

Another measure considered was construction of a new turning basin closer to the channel entrance. This measure would allow for a shorter segment of channel to be improved, allowing the vessels to travel only as far as this new turning basin. For this measure, the remainder of the channel would continue to be maintained at existing conditions and would not be able to serve any future vessels and rigs that require channel improvements. With this new turning basin measure, considerable upland development would be required after completion of channel improvements, with no benefits from the improved channel being realized by existing tenants unless their operations are relocated to this new turning basin area.

Figure 2-1 shows the proposed location of the new turning basin relative to the existing turning basin. This location has a naturally lower elevation to limit dredging requirements. This new basin would allow for shortening the channel length by approximately 10 miles. The addition of the new 2,000-foot by 2,000-foot turning basin provides no increased benefit to navigation unless deepening and widening improvements to the channel were made up to the new turning basin. Therefore, the turning basin measure must be combined with deepening or deepening and widening to be considered viable to carry forward for consideration in the next phase of screening. The non-Federal sponsor also indicated a preference that the channel’s widening extends farther up the channel beyond the location of the proposed turning basin.

Figure 2-1: Location of New Turning Basin

3.0 SUMMARY OF ALTERNATIVE ANALYSIS

Measures were evaluated and screened by the team through several arrays of alternatives. Consistent with new SMART Planning concepts this effort included a qualitative analysis of an Initial Array, and quantitative analysis of an Evaluation and Final Array of alternatives.

In the evaluation of the Initial Array, a combination of deepening and widening alternatives were evaluated qualitatively based on several factors including potential to improve navigation efficiencies, scale of possible environmental and cultural impacts, potential for significant increases in costs, both operations and maintenance (O&M) and construction, as well as possibility for public concern with the different alternatives. The alternatives were scored based on the team's assessment and a reduced combination of widening and deepening alternatives were carried forward into the Evaluation Array.

The Evaluation Array included deepening alternatives at 45, 48, and 50 feet. In this analysis, the sponsor had limited the team to considering only depths up to 50 feet because of cost limitations and the belief at that time that no vessels would utilize depths greater than that. Widening alternatives evaluated were a full 200-foot widening and a 75-foot widening in limited areas (shelves). The 200-foot widening was driven by the possibility for large rig access in the channel. The team also evaluated creation of a new turning basin and associated facilities that would allow rigs to travel a shorter distance to reach their destination.

For the Evaluation Array, the team prepared qualitative assessments, again looking at the potential for improved navigation and environmental impact, as well as quantitative measures that detail costs and economic benefits. Based on the scores the team determined that all three deepening only alternatives as well as the three alternatives that combined deepening with 200-foot widening had the greatest potential for success.

From those results, the team developed a final array that would be evaluated quantitatively for selection of the Tentatively Selected Plan (TSP). In the quantitative results calculated for the Evaluation Array, the 50-foot deepening alternative had the greatest net excess benefits for the deepening only alternatives. Based on this result the team added an alternative to the Final Array of deepening to 52 feet in an attempt to determine whether the 50-foot alternative was in the fact the National Economic Development (NED) Plan. In addition, during the analysis performed for the Evaluation Array, changes to vessel fleet forecasts were realized that would impact the widening alternatives that would need to be evaluated. Changes were made to both expected tanker traffic and rig movements. Also, oil exploration is expected to switch away from rigs to drill ships which do not require large widths but would benefit from deeper depths. Based on these considerations the 200-foot widening was dropped from consideration. However, 50-foot and 100-foot widening were added to ensure that sufficient analysis was conducted to determine if widening would be part of the TSP.

4.0 BASIS FOR CHOICE

The measures identified above were screened to determine if they adequately addressed the problems with BIH. As stated previously, measures that did not meet one of the objectives for this study were dropped from further consideration. The remaining measures were then formed into arrays of alternatives plans, which were screened to determine the most effective alternatives. The screening consisted of three levels:

- Initial Array of Alternatives;
- Evaluation Array of Alternatives; and
- Final Array of Alternatives.

Each level consisted of more detailed analysis when compared to the previous level. The Initial Array was screened on a qualitative level, using screening criteria, scientific judgment from use of mapping and alternative footprints, as well as the professional expertise of a multidisciplinary Project Delivery Team (PDT) to identify the implications of each alternative. Professional judgment was used to provide qualitative assessments of environmental and economic conditions. With the Evaluation Array, a screening matrix was developed, which included quantitative criteria such as quantities, costs, and Benefit-to-Cost Ratios (BCRs), as well as qualitative analysis for improving navigation and environmental concerns. The Final Array of alternatives was evaluated on more detailed calculations for BCRs and on their ability to effectively meet the four criteria in the P&G.

During analysis of the Final Array of alternatives, ship simulation modeling was performed to determine the necessary channel dimensions for ships. A rig geometric analysis was also performed for accommodation of rig movements. In addition, economic analysis was performed to calculate the net excess benefits and BCRs for each of the alternative plans.

The following are the methodology and evaluations that were used to develop the criteria used for screening the three separate arrays of alternatives.

4.1 METHODOLOGY TO DEVELOP TECHNICAL CRITERIA

Technical criteria require the preservation of adequate project dimensions to provide safe passage of commercial navigation traffic while minimizing environmental impacts. These criteria require plans to be compatible with navigation needs and consistent with the requirements of the navigational equipment using this portion of the waterway and to provide a long-term plan for the placement of dredged materials in order to continue maintenance of the waterway in the future.

The plans must consider specific environmental conditions of the area including soil conditions, topography, and terrestrial and aquatic ecosystems. Formulation of alternative alignments and dredged material placement alternatives and their evaluation are accomplished by analysis of historical and projected shoaling rates in cubic yards per year (cy/yr) and general structural and nonstructural alternatives applicable for conditions in the study area. Initial screening of the alternatives was completed using basic screening criteria, use of mapping and alternative footprints, and professional expertise and scientific judgment of the PDT. More detailed technical information (both historical data and specific information and analyses prepared for this project) would be used during screening of the Evaluation and the Final Arrays of alternatives. Technical information and the corresponding screening level in which this information was used include, but are not limited to, the following:

- Aerial photography (all arrays);
- Historical dredging records (all arrays);
- Previously published scientific reports related to the study area (all arrays);
- Marine and estuarine resource investigations (all arrays);
- HarborSym Widening Modeling (Evaluation and Final Arrays);
- HarborSym Deepening Modeling (Final Array only);
- Ship Simulation Study (Final Array only);
- Geometrical Analysis of Rig Movement (Final Array only);

- Hydrodynamic modeling (Final Array only);
- Salinity modeling (Final Array only);
- Relative sea level rise (RSLR) Analysis (Final Array only);
- Storm surge modeling (Final Array only);
- Sediment and water quality analysis (Final Array only);
- 50-year Dredged Material Management Plan (DMMP) (Final Array);
- Threatened and endangered species considerations (Final Array); and
- Habitat Evaluation Procedure/Habitat Suitability Models (Final Array, if needed).

4.2 METHODOLOGY TO DEVELOP ECONOMIC CRITERIA

The economic criteria require that tangible benefits attributable to projects exceed project costs. Project benefits and costs are reduced to average annual equivalent (AAEQ) values and related in a BCR. This ratio must exceed unity to meet the NED objective. Selected plans, whether structural, nonstructural, or a combination of both, should maximize excess benefits over costs; however, unquantifiable features must be addressed subjectively. These criteria are used to develop plans that achieve the objective of NED and provide a base condition for consideration of economically unquantifiable factors, which may impact project proposals.

The USACE planning guidelines required that the alternative that most reasonably maximizes net economic benefits, consistent with protecting the Nation's environment, be identified as the NED Plan. This NED Plan may be selected as the TSP. However, for a navigation project, if a plan with lesser benefits is preferred by the sponsor due to financial constraints, guidance allows for a categorical exemption to be granted and this lesser plan to be selected as the TSP. This process is addressed in more detail later in this report.

All structural and nonstructural measures for navigation projects would be evaluated using the appropriate 50-year period of analysis beginning in 2017 and the applicable interest rate at the time of analysis. The study was developed over time necessitating the use of different annual discount rates. Total annual costs should include amounts for operation, maintenance, major replacements, and mitigation, as well as amortization and interest on the investment.

4.3 METHODOLOGY TO DEVELOP ENVIRONMENTAL CRITERIA

The general environmental criteria for navigation projects are identified in Federal environmental statutes, executive orders (EOs), and planning guidelines. It is national policy that fish and wildlife resource conservation be given equal consideration with other study purposes in the formulation and evaluation of alternative plans. Care must be taken to preserve and protect significant ecological, aesthetic, and cultural values, and to conserve natural resources. These efforts also should provide the means to maintain and restore, as applicable, the desirable qualities of the human and natural environments. Alternative plans formulated to improve navigation should avoid damaging the environment to the extent practicable and contain measures to minimize or mitigate unavoidable environmental damages.

Throughout the study process, USACE Environmental Operating Principles (EOP) should be considered. The re-energized EOP principles are considered at the same level as economic issues. The seven EOP principles are:

- Foster a culture of sustainability throughout the organization;
- Proactively consider environmental consequences of all USACE activities and act accordingly;
- Create mutually supporting economic and environmental solutions;
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE which may impact human and natural environments;
- Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs;
- Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner; and
- Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

4.4 METHODOLOGY TO DEVELOP SOCIAL AND OTHER CRITERIA

Plans proposed for implementation should have an overall favorable impact on the social well-being of affected interests and have overall public acceptance. Structural and nonstructural alternatives must reflect close coordination with interested Federal and State agencies and the affected public. The effects of these alternatives on the environment must be carefully identified and compared with technical, economic, and social considerations and evaluated in light of public input.

4.5 USACE CAMPAIGN PLAN

In August 2006, as a result of lessons learned from hurricanes Katrina and Rita, the USACE Chief of Engineers initiated the “Actions for Change” in an effort to transform the USACE planning, design, construction, and operation and maintenance principles and decision-making processes. This program has been further developed into the Campaign Plan which was updated in June 2013. The USACE is moving forward with this Campaign Plan to transform the way business is done. The USACE Campaign Plan is available on the internet at: http://www.usace.army.mil/About/CampaignPlan.aspx.

The successful achievement of the goals and objectives contained in this Campaign Plan are dependent on actions implemented by the entire USACE team. The Campaign Plan included four goals for USACE. These goals are:

Goal 1: Support the Warfighter – Deliver innovative, resilient, and sustainable solutions to Department of Defense and the Nation.

Goal 2: Transform Civil Works – Deliver enduring and essential water resource solutions, utilizing effective transformation strategies.

Goal 3: Reduce Disaster Risks – Deliver support that responds to, recovers from, and mitigates disaster impacts to the Nation.

Goal 4: Prepare for Tomorrow – Build resilient People, Teams, Systems, and Processes to sustain a diverse culture of collaboration, innovation and participation to shape and deliver strategic solutions.

Goals 1 and 3 do not apply directly to the USACE planning process and are not discussed in detail. Goals 2 and 4 pertain to water resources planning and directly to the BIH Project. These goals are described in more detail below.

Goal 2: Transform Civil Works

With Goal 2 USACE will focus its talents and energy on comprehensive, sustainable, and integrated solutions to the nation's water resources and related challenges through collaboration with stakeholders (internal, regional, states, local entities, other Federal agencies, etc.), playing traditional or emerging roles (leadership, technical support, broker, data and knowledge provider, etc.), and evaluating the current and required portfolio of water resources infrastructure. This goal refers to not only developing and delivering comprehensive and lasting solutions and products but also, ensuring that the deliverables are sustainable (long lasting, integrated, and holistic) to respond to today's and future challenges.

Goal 4: Prepare for Tomorrow

Goal 4 emphasizes that a USACE will employ a workforce with proven capability to consistently and reliably deliver the highest quality solutions to the Nation's public engineering challenges today. The BIH product delivery team could be relied upon to provide innovative concepts for building strong into our future.

The Campaign Plan results are discussed in Section 8.6 of the main report.

4.6 KEY UNCERTAINTIES

The key uncertainties for this study are:

- Economic forecasts - There is always a degree of uncertainty in the economic forecasts due to unknown factors, but these are minimized to the greatest extent possible through the process.
- RSLR - While the future rate of RSLR in the BIH study area is uncertain, it must be considered in project planning. RSLR consists of two components: global (eustatic) sea level rise and local subsidence. The uncertainty in the rates of eustatic sea level rise is evident in the variability of the different modeled rates given for the National Research Council (1987) projections and the 2007 Intergovernmental Panel on Climate Change. A similar degree of uncertainty exists with the rate of local subsidence although it is considered minor in this area of the coast.

5.0 INITIAL ARRAY OF ALTERNATIVE PLANS

Individual measures were developed to satisfy the planning objectives in providing more efficient navigation along the waterway (for vessels and offshore rigs). Alternative plans were formulated through combinations of remaining management measures.

5.1 FUTURE WITHOUT-PROJECT CONDITION (NO ACTION ALTERNATIVE)

The No Action Alternative provides a baseline against which the benefits and impacts of action alternatives may be measured, and it is required by NEPA to be included among the alternative plans in the Final Array of alternatives. It is described in more detail in Section 3 of the main report.

5.2 INITIAL ARRAY OF ALTERNATIVES

Based on the measures identified previously, four structural alternatives and a No Action Alternative were included in the Initial Array. Various scales of these four structural alternatives were screened with a total of 13 plans evaluated. The specific structural alternatives are identified below:

DEEPENING ONLY

I-1a Deepen existing channel from 42 to 45 feet;

I-1b Deepen existing channel from 42 to 48 feet;

I-1c Deepen existing channel from 42 to 50 feet;

I-1d Deepen existing channel from 42 to 55 feet;

WIDENING ONLY

I-2a Widen channel bottom from 250 to 350 feet;

I-2b Widen channel bottom from 250 to 450 feet;

I-2c Widen channel only to rig fabrication facility;

DEEPENING AND WIDENING

I-3a Deepen from 42 to 45 feet and widen channel bottom from 250 to 350 feet;

I-3b Deepen from 42 to 50 feet and widen channel bottom from 250 to 350 feet;

I-3c Deepen from 42 to 55 feet and widen channel bottom from 250 to 350 feet;

I-3d Deepen channel from 42 to 48 feet and widen with shelves – each side by 75 feet at 45-foot depth;

WITH NEW TURNING BASIN

I-4a Add new turning basin (2,000 feet by 2,000 feet)/deepen to new location;

I-4b Add new turning basin (2,000 feet by 2,000 feet)/deepen and widen to new location;

NO ACTION

I-5 No Action Alternative.

5.3 INITIAL SCREENING CRITERIA

To evaluate and screen the Initial Array of alternative plans to determine those that best meet the study objectives, an initial screening matrix was developed. The first two criteria measure outputs associated with the alternatives as they relate to the study planning objectives. These criteria include:

- **Improves Deep-Draft Navigation -** Potential to increase vessel efficiency by deepening channel; and
- **Improves Navigation (widening needs) -** Potential to increase vessel and rig traffic by widening channel.

The remaining criteria identify outputs as they relate to the overall Federal objective and compliance with environmental protection requirements. These criteria include:

- **Environmental Impact** – Potential to negatively impact environmental and physiographic resources;
- **Cultural Resource Impacts -** Potential to negatively impact existing cultural resources;
- **Operation and Maintenance Cost –** Potential to increase life cycle cost for operating and maintaining the channel;
- **Construction Cost** – Cost to construct the channel design relative to other alternative configurations; and
- **Long-term Disposal Issues –** Anticipated issues with disposal of new work and/or maintenance material.

Real estate issues were not included in the screening because the non-Federal sponsor owns all of the lands adjacent to the channel.

5.4 INITIAL SCREENING OF ALTERNATIVES

An initial screening of the alternatives was conducted to eliminate any alternative that was rated low on the screening criteria. The remaining alternatives were carried forward in the study process to undergo more detailed analyses as a part of the Evaluation Array.

This initial screening was conducted using the screening criteria listed above, scientific judgment from use of mapping and alternative footprints, as well as the professional expertise of the PDT to identify the implications of each alternative. Environmental benefits or costs (e.g. mitigation, construction, O&M, etc.) were not calculated for the alternatives during this initial screening process. The Initial Array of structural improvements was assessed for potential effects to the environment qualitatively. Screening values were determined based on the professional judgment of the PDT.

Table 5-1 presents the results of this initial screening. Each of the alternatives was rated on a qualitative scale of 1 to 10 with 1 having the worst outcome and 10 the best outcome. The rating explanation for each alternative is presented below.

5.4.1 Criteria 1 (Objective 1) – Improves Deep-Draft Navigation

Deepening Only – It was assumed that the first scale of channel deepening from 42 to 45 feet (I-1a) provides substantial benefits to deep-draft vessel operating costs and was, therefore, assigned a 7. Each scale of channel depth after 45 feet provides greater benefits at roughly the same rate, with 48 feet (I-1b) and 50 feet (I-1c) assigned 8 and 9 scores, respectively. For the last scale (I-1d – 55 feet), it is assumed that benefits taper off because the biggest vessel classes cannot utilize this channel, and it, therefore, was assigned the same score as the 50-foot depth.

Table 5-1. Initial Array of Alternatives Screening Matrix

ALTERNATIVE Scoring: (1 = Worst Outcome 10 = Best Outcome)		Objective 1 Improves Deep-Draft Navigation	Objective 2 Improves Navigation Widening Needs	Environmental Impact	Cultural Resource Concerns	O&M Costs	Construction Costs	Long-Term Disposal Issues	Total
DEEPENING ONLY									
I-1a	Deepen existing channel from 42 to 45 feet	7	2	7	9	9	9	9	52
I-1b	Deepen existing channel from 42 to 48 feet	8	2	6	9	8	8	8	49
I-1c	Deepen existing channel from 42 to 50 feet	9	3	5	9	7	7	7	47
I-1d	Deepen existing channel from 42 to 55 feet	9	4	4	9	6	6	6	44
WIDENING ONLY									
I-2a	Widen channel bottom from 250 to 350 feet	5	8	7	8	7	7	7	49
I-2b	Widen channel bottom from 250 to 450 feet	6	9	6	7	5	6	6	45
I-2c	Widen channel only to rig fabrication facility	3	6	7	7	5	6	6	40
DEEPENING AND WIDENING									
I-3a	Deepen from 42 to 45 feet and widen channel bottom from 250 to 350 feet	7	8	7	8	7	7	7	51
I-3b	Deepen from 42 to 50 feet and widen channel bottom from 250 to 350 feet	9	9	5	8	6	6	6	49
I-3c	Deepen from 42 to 55 feet and widen channel bottom from 250 to 350 feet	9	9	3	5	5	4	4	39
I-3d	Deepen from 42 to 48 feet and widen with shelves - each side by 75 feet at 45-foot depth	8	8	6	6	6	5	6	45
WITH NEW TURNING BASIN									
I-4a	Deepen only up to new turning basin location	8	4	5	5	8	9	8	47
I-4b	Deepen and widen up to new turning basin location	9	7	4	5	7	7	7	46
NO ACTION									
I-5	No Action Alternative	1	1	10	10	10	10	10	52

Note: Objective 1 – Reduce costs of navigation associated with vessel movement entering and leaving Port of Brownsville (POB)
Objective 2 – Improve channel dimensions to accommodate current and future offshore rigs into POB for fabrication, maintenance, and repair

Widening Only – Widening provides incidental benefits to deep-draft navigation because a wider channel provides better maneuverability for deep-draft vessels as the depth increases. It was assumed that the first alternative I-2a (widening from 250 to 350 feet) would provide average benefits and was assigned a score of 5. The second scale for alternative I-2b (widening from 250 to 450 feet) would provide slightly higher benefits and was assigned a score of 6. The third scale (I-2c widening the channel only to rig fabrication facility) would not widen the entire channel and fewer benefits would accrue to deep-draft vessels, therefore it was assigned a score of 3.

Deepening and Widening – The first three scales of this alternative assume deepening to 45, 50, and 55 feet, respectively, with widening to 350 feet. These scales combine the benefits of deepening and widening, and therefore were assigned scores equivalent to the highest of the corresponding deepening or widening benefits. The 45-foot (I-3a), 50-foot (I-3b), and 55-foot (I-3c) depths received scores of 7, 9, and 9 respectively. The fourth scale would deepen the channel to 48 feet and widen using shelves that are each 75 feet wide at a 45-foot depth (I-3d), resulting in a total widening of 150 feet. This scale received a score of 8 because it would provide deep-draft benefits intermediate of those for the 45- and 50-foot scales.

With New Turning Basin – The first scale would create a new turning basin near Port Isabel and deepen only up to the new turning basin (I-4a). The second scale creates the same new turning basin and deepens and widen to the same location (I-4b). It was assumed that most facilities would relocate to the new turning basin to reduce transit costs on the channel. Based on substantial potential reductions in transportation costs, the first scale was assigned a score of 8, and the second scale was assigned a score of 9 since widening would provide incidental benefits of vessel maneuverability.

5.4.2 Criteria 2 (Objective 2) – Improves Navigation Widening Needs

Deepening Only – It was assumed that the first two scales of channel deepening from 42 to 45 feet (I-1a), and from 42 to 48 feet (I-1b) provide minor incidental widening benefits as new side slopes are established for the deeper cross-section. These two depth scales, therefore, each received a score of 2. The 48-foot (I-1c) and 55-foot (I-1d) scales would provide additional incidental widening and were assigned scores of 3 and 4, respectively.

Widening Only – It was assumed that greater channel widths would provide significant benefits for large oil rigs and other large deep-draft vessels using the channel. The largest scale (I-2a widening to 450 feet) would provide the most benefits and was assigned a score of 9 while widening to 350 feet (I-2b) would provide fewer benefits and was assigned a score of 8. The third scale would widen the channel only to the existing rig fabrication facility (I-2c), and fewer benefits would accrue to other deep-draft vessels that need to access the remainder of the channel. Therefore, the third scale was assigned a score of 6.

Deepening and Widening – The first three scales of this alternative assume deepening to 45, 50, and 55 feet, respectively, with widening to 350 feet. These scales combine the benefits of deepening and widening and therefore were assigned scores equivalent to the highest of the corresponding deepening or widening benefits. The 45-foot (I-3a), 50-foot (I-3b), and 55-foot (I-3c) depths received scores of 8, 9, and 9, respectively. The fourth scale would deepen the channel to 48 feet and widen using shelves that are each 75 feet wide at a 45-foot depth (I-3d), resulting in a total widening of 150 feet. This scale received a score of 8 because it would provide widening benefits similar to that of the 350-foot widening scale.

With New Turning Basin – The first scale would create a new turning basin near Port Isabel and deepen only up to the new turning basin (I-4a). The second scale creates the same new turning basin and deepens and widen to the same location (I-4b). It was assumed that most facilities would relocate to the new turning basin to reduce transit costs on the channel. Based on substantial potential reductions in transportation costs for vessels needing a wider channel, the first scale was assigned a score of 4, and the second scale was assigned a score of 7.

5.4.3 Criteria 3 – Environmental Impact

Deepening Only – It was assumed that deepening only would impact submerged lands immediately adjacent to the channel because incidental widening would occur as new side slopes are established and that impacts to uplands would be minimal. Impacts to channel bottom and aquatic organisms would be the lowest for the first scale of channel deepening from 42 to 45 feet (I-1a) and was therefore assigned a 7. Increasing impacts would result in lower scores as the lowest score represents the worst outcome. Each scale of channel depth after 45 feet provides larger respective impacts, and therefore the 48- (I-1b), 50- (I-1c), and 55- (I-1d) foot scales were assigned scores of 6, 5, and 4, respectively.

Widening Only – It was assumed that widening from 250 to 350 feet (I-2a) would only impact submerged lands along the top of the channel cut. This would result in low to moderate impacts of aquatic and was assigned a score of 7. It was assumed that widening from 250 to 450 feet (I-2b) would impact an upland corridor up to 100 feet wide along both sides of the channel. Much of this corridor does not contain environmentally sensitive habitats, and most of the area within the corridor on the south side of the Main Channel is comprised of existing placement areas (PAs). However, the corridor south of the channel across from Port Isabel is part of a CBRA unit and is designated critical habitat for the piping plover. Channel widening in this area might be prohibited by CBRA, but significant impacts to critical habitat would not be expected. Based on these considerations, Scale I-2b would cause more impacts and was assigned a score of 6. Scale I-2c (widening the channel only to the existing rig fabrication facility) would widen most of the channel and was assigned a score of 7.

Deepening and Widening – The first three scales of this alternative assume deepening to 45, 50, and 55 feet, respectively, with widening to 350 feet. These scales combine the environmental impacts of deepening with widening to 350 feet. Impacts would increase and scores would decrease as the depth increases. The 45-foot (I-3a), 50-foot (I-3b), and 55-foot (I-3c) depths received scores of 7, 5, and 3, respectively. The fourth scale would deepen the channel to 48 feet and widen using shelves that are each 75 feet wide at a 45-foot depth (I-3d), resulting in a total widening of 150 feet. This scale received a score of 6 because it would cause impacts intermediate of those of the 45- and 50-foot scales.

With New Turning Basin – The first scale would create a new turning basin near Port Isabel and deepen only up to the new turning basin ((I-4a). The second scale creates the same new turning basin and deepens and widen to the same location (I-4b). Creation of the new turning basin would create more environmental impacts than any of the other alternatives because it would impact sensitive uplands adjacent to the Bahia Grande. Based on substantial expected impacts only through the Port Isabel area, the first scale was assigned a score of 5, and the second scale was assigned a score of 4 since widening would provide channel bottom impacts.

5.4.4 Criteria 4 – Cultural Resource Impacts

Deepening Only – It was assumed that deepening only would impact submerged lands immediately adjacent to the channel because incidental widening would occur as new side slopes are established and that impacts to uplands would be minimal to none. Research has identified no historic shipwrecks along the channel which could be impacted, and therefore cultural resource impacts would not be expected for any of the deepening scales. All of the scales (I-1a, I-1b, I-1c, and I-1d) were, therefore, assigned a score of 9.

Widening Only – It was assumed that widening from 250 to 350 feet (I-2a) would only impact submerged lands along the top of the channel cut, while the 450-foot widening (I-2b) would impact an upland corridor up to 100 feet wide along the channel. Much of this corridor does not contain landforms with a high probability for the presence of archeological sites, so cultural resource impacts would not be extensive. It does contain some high probability areas near Port Isabel and, therefore, the first widening scale (from 250 to 350 feet) could result in some cultural resource impacts and was assigned a score of 8. The second scale (from 250 to 450 feet) could result in more impacts and was assigned a score of 7. The third scale (I-2c widening the channel only to rig fabrication facility) would impact the area near Port Isabel and, therefore, was assigned the score of 7.

Deepening and Widening – The first three scales of this alternative assume deepening to 45, 50, and 55 feet, respectively, with widening to 350 feet. Few cultural resource impacts would be anticipated for scales I-3a and I-3b (deepening to 45 and 50 feet, respectively, and widening to 350 feet) since all impacts would be to submerged lands with low potential for the presence of historic shipwrecks. Scales I-3a and I-3b were, therefore, both assigned scores of 8. The 55-foot depth with 350-foot widening, however, would result in substantial incidental widening of the top of cut. As this would increase the potential for cultural resource impacts, scale I-3c received a score of 5. The fourth scale (I-3d) would deepen the channel to 48 feet and widen using shelves that are each 75 feet wide at a 45-foot depth, resulting in a total widening of 150 feet. This scale received a score of 6 because it would cause impacts slightly less than those of scale I-3c.

With New Turning Basin – Scale I-4a would create a new turning basin near Port Isabel and deepen only up to the new turning basin. Scale I-4b would create the same new turning basin and deepen and widen to the same location. Creation of the new turning basin would create more cultural resource impacts than any of the other alternatives because it would impact high potential landforms adjacent to the Bahia Grande. Based on substantial expected impacts in the Port Isabel area, scales I-4a and I-4b were both assigned a score of 5.

5.4.5 Criteria 5 – O&M Costs

Deepening Only – It was assumed that deepening would increase shoaling by small amounts, with the shoaling increasing with increasing depths. Scale I-1a (deepening to 45 feet) would cause the lowest increase and was assigned a score of 9. Scales I-1b, I-1c, and I-1d were assigned scores of 8, 7, and 6, respectively, based on the assumption that shoaling would increase at roughly the same rate as the depth increased.

Widening Only – It was assumed that widening would have a greater impact on shoaling than deepening, as the wider cross-section would have a greater dampening effect on velocities within the channel than a deeper cross-section. Further, it was assumed that shoaling would increase as the widening increased. Scale I-2a (widening from 250 to 350 feet) was assigned a score of 7, and scale I-2b was assigned a score of 5. Scale I-2c (widening the channel to the existing rig fabrication facility) would impact shoaling over most of the channel and was assigned a score of 5.

Deepening and Widening – Scales I-3a, I-3b, and I-3c of this alternative assume deepening to 45, 50, and 55 feet, respectively, with widening to 350 feet. These scales combine the shoaling impacts of deepening to various depths with widening to 350 feet. Impacts of a combination of widening and deepening were assumed to be similar to those discussed above. Therefore, scales I-3a, I-3b, and I-3c were assigned scores of 7, 6, and 5, respectively. Scale I-3d would deepen the channel to 48 feet and widen using shelves that are each 75 feet wide at a 45-foot depth, resulting in a total widening of 150 feet. This scale received a score of 6 because it would cause shoaling impacts slightly less than those of scale I-3c.

With New Turning Basin – Scale I-4a would create a new turning basin near Port Isabel (approximately Station 20+000) and deepen only up to the new turning basin. Scale I-4b would create the same new turning basin and deepen and widen to the same location. Creation of the new turning basin at Port Isabel would significantly reduce the channel length over which shoaling would increase, and scales I-4a and I-4b were assigned scores of 8 and 7, respectively.

5.4.6 Criteria 6 – Construction Costs

Deepening Only – It was assumed that construction costs would increase as the channel excavation increased. Thus, scale I-1a (deepening to 45 feet) with a deepening of only 3 feet was assigned a score of 9, and scales I-1b, I-1c, and I-1d were assigned scores of 8, 7, and 6, respectively.

Widening Only – It was assumed that construction costs would increase as the channel widening increased, and that channel widening would generally result in more excavation than deepening. Scale I-2a (widening from 250 to 350 feet) was assigned a score of 7, and scale I-2b was assigned a score of 6. Scale I-2c (widening the channel to the existing rig fabrication facility) would cost nearly the same as scale I-2b and was assigned the score of 6.

Deepening and Widening – Scales I-3a, I-3b, and I-3c of this alternative assume deepening to 45, 50, and 55 feet, respectively, with widening to 350 feet. These scales roughly combine the construction costs of deepening to various depths with widening to 350 feet as discussed above. Therefore, scales I-3a, I-3b, and I-3c were assigned scores of 7, 6, and 4, respectively. Scale I-3d would deepen the channel to 48 feet and widen using shelves that are each 75 feet wide at a 45-foot depth, resulting in a total widening of 150 feet. This scale received a score of 5 because construction costs would be slightly less than those of scale I-3c.

With New Turning Basin – Scale I-4a would create a new turning basin near Port Isabel (approximately Station 20+000) and deepen only up to the new turning basin. Scale I-4b would create the same new turning basin and deepen and widen to the same location. Creation of the new turning basin at Port Isabel would significantly limit the length of channel to be improved and therefore scales I-4a and I-4b were assigned scores of 9 and 7, respectively.

5.4.7 Criteria 7 – Long-Term Disposal Issues

Deepening Only – It was assumed that sufficient capacity would be available within existing PAs to accommodate all dredged material from the various channel depths. Offshore PAs are located in dispersive environments and essentially have no maximum capacity. For upland PAs, containment dikes would need to be raised to a higher final elevation for the deeper channel depths. Scale I-1a (deepening to 45 feet) would cause the lowest increase in costs for containment dikes and was assigned a score of 9. Scales I-1b, I-1c, and I-1d were assigned scores of 8, 7, and 6, respectively, based on the assumption that costs to raise the dikes would increase at roughly the same rate as the depth increased.

Widening Only – It was assumed that widening would have a greater impact on shoaling than deepening, and that costs to raise containment dike heights around upland PAs would be correspondingly higher. Scale I-2a (widening from 250-350 feet) was assigned a score of 7, and scale I-2b was assigned a score of 6. Scale I-2c (widening the channel to the existing rig fabrication facility) would result in dike raising costs roughly equivalent to scale I-2b and was assigned the score of 6.

Deepening and Widening – Scales I-3a, I-3b, and I-3c of this alternative assume deepening to 45, 50, and 55 feet, respectively, with widening to 350 feet. These scales combine the long-term disposal needs of deepening to various depths with widening to 350 feet. Therefore, scales I-3a, I-3b, and I-3c were assigned scores of 7, 6, and 4, respectively. Scale I-3d would deepen the channel to 48 feet and widen using shelves that are each 75 feet wide at a 45-foot depth, resulting in a total widening of 150 feet. This scale received a score of 6 because it would result in dike raising cost slightly lower than those of scale I-3c.

With New Turning Basin – Scale I-4a would create a new turning basin near Port Isabel (approximately Station 20+000) and deepen only up to the new turning basin. Scale I-4b would create the same new turning basin and deepen and widen to the same location. Creation of the new turning basin at Port Isabel would significantly reduce the incremental cost to raise containment dikes, and therefore scales I-4a and I-4b were assigned scores of 8 and 7, respectively.

Table 5-2 presents numerical rankings for each alternative, which were calculated by adding the individual rankings for the criteria together. These alternative rankings have been sorted from highest (best) to lowest (worst) and are a basis for comparison of the alternatives from this qualitative analysis. This comparison supports the screening out of the plans discussed above and resulted in Alternatives I-1d, I-2c, I-3, and I-5 being dropped from further consideration. The remaining alternatives were reformulated and carried into the next phase: development of the Evaluation Array of alternatives. These alternatives being brought into the next phase had higher total scores than those that were disregarded from further study.

Table 5-2. Numerical Ranking of Initial Array of Alternatives

ALT. NO.	ALTERNATIVE DESCRIPTION (Higher Score = Best Outcome; 60 possible points)	TOTAL SCORE*	RETAINED FOR NEXT PHASE
I-1a	Deepen existing channel from 42 to 45 feet	52	Yes
I-5	No Action Alternative	52	Yes
I-3a	Deepen from 42 to 45 feet and widen channel bottom from 250 to 350 feet	51	Yes
I-1b	Deepen existing channel from 42 to 48 feet	49	Yes
I-2a	Widen channel bottom from 250 to 350 feet	49	Yes
I-3b	Deepen from 42 to 50 feet and widen channel bottom from 250 to 350 feet	49	Yes
I-1c	Deepen existing channel from 42 to 50 feet	47	Yes
I-4a	Deepen only up to new turning basin location	47	Yes
I-4b	Deepen and widen up to new turning basin location	46	Yes
I-2b	Widen channel bottom from 250 to 450 feet	45	Yes
I-3d	Deepen channel from 42 to 48 feet and widen with shelves - each side by 75 feet at 45-foot depth	45	Yes
I-1d	Deepen existing channel from 42 to 55 feet	44	No
I-2c	Widen channel only to rig fabrication facility	40	No
I-3c	Deepen from 42 to55 feet and widen channel bottom from 250 to 350 feet	39	No

* Summation of screening criteria determined by PDT consensus (see Table 5-1)

6.0 EVALUATION ARRAY OF ALTERNATIVE PLANS

6.1 EVALUATION ARRAY OF ALTERNATIVES

During the evaluation screening, offshore rig width was considered the primary driver for widening the channel. Input from the non-Federal sponsor regarding needs by the shipping industry and rig facilities also supported the need for an increase beyond the 350-foot channel width that was carried forward from the initial screening. The comparison of the world fleet and the Brownsville offshore rig fleet presented in Section 2.0 of the main report indicates that only 20 percent of the world fleet uses Brownsville with 32 percent of the world fleet with widths between 350 and 399 feet that could possibly benefit from widening beyond the 350-foot width. This economic data supported a change of all evaluation screening to widening from 250 to 450 feet, rather than maintaining both original widening alternatives (widening from 250 to 350 and 450 feet, respectively).

The Evaluation Array was developed based on the same four main structural alternatives considered in the initial screening with changes to the scales evaluated. Once the evaluation screening was completed and more detailed analysis of the economics for the rig fleet was done, the channel width could be revisited and possibly reformulated based on the latest forecasts. The Evaluation Array of alternative plans included:

DEEPENING ONLY

E-1a Deepen existing channel from 42 to 45 feet;

E-1b Deepen existing channel from 42 to 48 feet;

E-1c Deepen existing channel from 42 to 50 feet;

WIDENING ONLY

E-2 Widen channel bottom from 250 to 450 feet;

DEEPENING AND WIDENING

E-3a Deepen from 42 to 45 feet and widen channel bottom from 250 to 450 feet;

E-3b Deepen from 42 to 48 feet and widen channel bottom from 250 to 450 feet;

E-3c Deepen from 42 to 50 feet and widen channel bottom from 250 to 450 feet;

E-3d Deepen from 42 to 45 feet and construct 75-foot wide and 42-foot deep shelves on either side of the channel;

E-3e Deepen from 42 to 48 feet and construct 75-foot wide and 42-foot deep shelves on either side of the channel;

E-3f Deepen from 42 to 50 feet and construct 75-foot wide and 42-foot deep shelves on either side of the channel;

WITH TURNING BASIN

E-4a Construct new turning basin, deepen channel from 42 to 45 feet from channel entrance to new turning basin, widen entire channel from 250 to 450 feet;

E-4b Construct new turning basin, deepen channel from 42 to 48 feet from channel entrance to new turning basin, widen entire channel from 250 to 450 feet;

E-4c Construct new turning basin, deepen channel from 42 to 50 feet from channel entrance to new turning basin, widen entire channel from 250 to 450 feet; and

NO ACTION

E-5 No Action Alternative.

Screening of the evaluation array of alternatives resulted in a Final Array of alternative plans, which were carried forward for detailed analysis and evaluation, and selection of the TSP. The Final Array of alternative plans is presented in the next section of this report.

6.2 EVALUATION SCREENING CRITERIA

In order to evaluate and screen the Evaluation Array of alternatives to best meet the study and non-Federal sponsor objectives, a more detailed screening matrix was developed, which included quantitative criteria such as quantities, costs, and BCRs. Other criteria were qualitative in nature with these screening values being determined by consensus of the PDT. The following screening criteria were identified and used in screening the alternatives:

Dredging Quantities in million cubic yards (MCY)

Navigational Improvement

Environmental Considerations

Cultural Resource Concerns

Hazardous, Toxic, and Radioactive Waste (HTRW) Considerations

Real Estate Issues

Mitigation Costs

O&M Costs

Construction Costs

Average Annual Costs

Net Excess Benefits

BCRs

Screening values were determined using the professional judgment of the PDT. Based on preliminary analyses of the structural alternatives, a deeper and wider channel should not require additional PAs since new work construction and maintenance material could be placed in existing PAs (with necessary containment dike raisings) or in the existing Ocean Dredged Material Disposal Site (ODMDSs). Structural alternatives evaluated during this screening appeared to address the problems with the existing BIH while having minimal impact on the environment.

The construction costs were developed by USACE – Galveston Cost Engineering using October 2011 price levels that were the current price levels at the time of this screening. The BCRs were calculated using an interest rate of 4.625 percent. These costs are preliminary costs to be used for comparative purposes only.

6.3 EVALUATION SCREENING OF ALTERNATIVES

A summary of the screening analysis is provided in Table 6-1. Mitigation costs for each of the alternatives were calculated and included in the first cost of construction. The criteria for Objectives 1 and 2 were combined into one score for navigation improvement during this analysis. Deepening and widening alternatives have the greatest potential for improving navigation while widening only has the least.

Environmental and cultural analyses of the alternatives indicate that the new turning basin alternative would be the most environmentally damaging of the alternatives and would require the greatest amount of mitigation for both resources, as reflected in the scores presented in Table 6-1. This turning basin alternative could potentially require removal of a large area of sand/algal/mud flats in Vadia Ancha and the removal of some upland habitat on the Loma de la Draga. Moving the turning basin closer to the Gulf of Mexico provided only minor economic benefits from shorter transit times in the channel and could increase the facility’s vulnerability to hurricane damages and RSLR effects. The least environmentally damaging alternatives would be the deepening only ones.

Differences between the deepening and widening alternatives could not be greatly distinguished environmentally, as was reflected in the mitigation costs developed for each. Widening would also have the potential to affect piping plover critical habitat and a CBRA unit on the south side of the Main Channel near PAs 2, 4A, and 4B.

For cultural resource impacts, the more the upland areas are impacted by project activities, the greater the potential for impacting currently unrecorded cultural resources. The area near the Laguna Madre and Brazos Island has the highest probability for cultural impacts while the work within the channel has the lowest probability.

Additionally, work that enlarges the footprint of the channel has potential for HTRW impacts. Deepening only alternatives have little concern for HTRW impacts while the alternatives that widen the channel, especially in the developed portion near the turning basin, have a much greater potential for impacts, dependent on the area to be widened.

Real Estate acquisition issues are expected to be minimal because all of the property within the study area is already owned by the POB.

Table 6-1. Evaluation Array of Alternative Screening Matrix
(Cost in 1,000s, October 2011 price levels)

		SUMMARY OF PRELIMINARY ANALYSES										
STRUCTURAL ALTERNATIVES Scoring: (1 = Greatest Impacts, 10 = Least Impacts)		**Dredging Quantities (MCY)**	**Objectives 1&2 Navigation Improvement**	**Environmental Considerations**	**Cultural Resource Concerns**	**HTRW Concerns**	**Mitigation Costs**	**O&M Costs Over 50 years**	**First Cost of Construction**	**Average Annual Construction Costs**	**Net Excess Benefits**	**BCR**
DEEPENING ONLY												
E-1a	Deepen existing channel from 42 to 45 feet	7	6	8	8	9	$0	$354,301	$123,210	$6,975	$142	1.0
E-1b	Deepen existing channel from 42 to 48 feet	12	6	8	8	9	$0	$354,390	$190,446	$10,752	$2,077	1.2
E-1c	Deepen existing channel from 42 to 50 feet	15	6	8	8	9	$0	$358,648	$239,098	$13,589	$7,369	1.5
WIDENING ONLY												
E-2	Widen channel bottom from 250 to 450 feet	24	5	4	5	3	$550	$364,394	$364,394	$20,310	–$7,604	0.6
DEEPENING AND WIDENING												
E-3a	Deepen from 42 to 45 feet and widen from 250 to 450 feet	26	9	4	5	3	$550	$364,860	$407,217	$23,226	–$3,432	0.9
E-3b	Deepen from 42 to 48 feet and widen from 250 to 450 feet	32	9	4	5	3	$550	$369,189	$495,756	$28,322	–$2,786	0.9
E-3c	Deepen from 42 to 50 feet and widen from 250 to 450 feet	36	9	4	5	3	$550	$372,654	$554,589	$31,720	$1,945	1.1
E-3d	Deepen from 42 to 45 feet and widen with 75-foot shelves at 42 feet deep	21	7	6	6	4	$550	$364,397	$324,146	$18,515	–$7,710	0.6
E-3e	Deepen from 42 to 48 feet and widen with 75-foot shelves at 42 feet deep	26	7	6	6	4	$550	$363,348	$393,084	$22,397	–$5,849	0.7
E-3f	Deepen from 42 to 50 feet and widen with 75-foot shelves at 42 feet deep	29	7	6	6	4	$550	$364,664	$440,460	$26,303	–$1,625	0.9
WITH NEW TURNING BASIN												
E-4a	Deepen from 42 to 45 feet up to and creation of new turning basin, widen entire channel to 450 feet	24	6	1	1	3	$3,2776	$363,258	$419,917	$23,916	–$6,748	0.7
E-4b	Deepen from 42 to 48 feet up to and creation of new turning basin, widen entire channel to 450 feet	26	6	1	1	3	$3,2776	$364,420	$448,335	$25,545	–$4,763	0.8
E-4c	Deepen from 42 to 50 feet up to and creation of new turning basin, widen entire channel to 450 feet	28	6	1	1	3	$3,2776	$366,776	$469,032	$26,763	–$3,930	0.9
NO ACTION												
E-5	No Action Alternative		1	10	10	10		$353,766				

Note: Objective 1 – Reduce costs of navigation associated with vessel movement entering and leaving POB

Objective 2 – Improve channel dimensions to accommodate current and future offshore rigs into POB for fabrication, maintenance, and repair

Based on the economic analyses, which included benefits for commodities such as steel, iron ore, and rigs and the estimated costs for O&M and mitigation costs as well as the cost of construction of the project, the deepening only alternatives (E-1a, E-1b, and E-1c), and the alternative that deepened the channel from 42 to 50 feet while widening from 250 to 450 feet (E-3c) were considered to be economically justified (positive net excess benefits and a BCR of 1.0 or higher). Alternatives with shallower depths while widening from 250 to 450 feet (E-3a and E-3b) and widening from 250 to 450 feet alone (E-2) have BCRs below unity.

The alternatives, which deepened the channel and widened with shelves (E-3d, E-3e, and E-3f), did not provide the depth and width combination needed to accommodate thrusters that are attached below the rigs. These thrusters help to propel rigs when they are being moved from one location to another. These alternatives were disregarded from further analysis.

The BCR of the turning basin alternatives (E-4a, E-4b, and E-4c) was slightly below the justified BCR of 1.0. However, the costs developed in this screening for such an extensive undertaking of building a new turning basin in an environmentally sensitive area were preliminary in nature. Any further analysis would most likely increase the costs and result in the alternative not being viable. Therefore, this alternative was removed from further consideration in determining the TSP.

Table 6-2 presents a summary of the alternatives screened from the Evaluation Array of alternatives. This screening was performed using the BCRs and a summation of the criteria presented in Table 6-1. Additionally, this table shows which alternatives were retained for the Final Array of alternatives.

From Table 6-2, it is shown that the deepening only alternatives E-1a, E-1b, and E-1c and deepening and widening alternatives E-3a, E-3b, and E-3c were carried forward into the Final Array of alternatives for more detailed analyses. The remaining alternatives that had BCRs below unity were dropped from further consideration with the exception of the alternatives that deepened from 42 to 45 and 48 feet with widening from 250 to 450 feet (E-3a and E-3b). Although these alternatives that widen from 250 to 450 feet had BCRs below 1.0, there is a potential to decrease the cost for these alternatives by decreasing the change in width. This reformulation in the widening would result in a decrease in cost and could result in an economically justified project because this cost savings for less widening translates into an increase in net excess benefits and BCRs. Additional economic analysis found that the 450 foot width was excessive for the vessels and rigs expected to utilize the channel in the future. These alternatives are also needed for optimization of the 50-foot depth. Therefore, when being carried into the Final Array of alternatives, the widening alternatives were scaled back to lower the cost and to avoid violating planning constraints to minimize impacts to designated critical habitat and comply with CBRA guidelines.

6.4 FINAL ARRAY OF ALTERNATIVE PLANS CARRIED FORWARD

The evaluation screening discussed above resulted in the identification of the Final Array of alternatives to be carried to the final screening. The Final Array of alternatives included deepening and/or widening of the channel. The existing 42-foot channel could be deepened to 45, 48, 50, or 52 feet without widening or any of these depths could be combined widening from 250 feet to 300 or 350 feet. These width increases were reformulated to scale back from the 450-foot channel widening and were selected from examination of project economics and the expected vessel traffic to utilize the channel in the future. Additionally, since deepening only to 50 feet had the highest BCR, a depth of 52 feet was added back into the analysis to attempt to identify the NED plan. For the 45-foot deep channel, the current offshore section would extend from Station –13+000 to –15+000, adding approximately 2,000 feet to the length of the existing channel. The 48-foot deep channel would extend to Station –16+000, lengthening the channel 3,000 feet while the 50-deep channel would terminate at Station –16+400 or 3,400 feet more. The 52-foot deep channel would extend to Station –17+000 or 4,000 feet more. Detailed discussion on this economic information is included in Section 7.3 below and in the Appendix A of the main report. This Final Array is discussed in more detail in the Section 7.0.

7.0 FINAL ARRAY OF ALTERNATIVE PLANS

7.1 DESCRIPTION OF FINAL ARRAY OF ALTERNATIVES

Reformulation between the evaluation and the final screenings resulted in different widening options being developed for the final screening. The evaluation screening results indicated the need for this reformulation to less widening, as described previously in Section 6.3. These final array-widening options were based on the updated economic forecasts for potential vessels and rigs expected in the channel.

Additionally, the 52-foot deepening was added back into the array to attempt to bracket the NED plan. The non-Federal sponsor originally indicated during the initial screening that they did not support deepening beyond 50 feet. However, after more detailed economics was developed indicating the possibility of the NED plan at a depth beyond 50 feet, the non-Federal sponsor reconsidered this limitation and fully supports alternatives up to 52-foot depths.

Table 7-1. Numerical Ranking by BCRs for Evaluation Array

ALT NO.	ALTERNATIVE DESCRIPTION	BCR	CRITERIA TOTAL SCORE	RETAINED FOR NEXT PHASE
E-5	No Action Alternative		31	Yes
E-1c	Deepen existing channel from 42 to 50 feet	1.5	31	Yes
E-1b	Deepen existing channel from 42 to 48 feet	1.2	31	Yes
E-3c	Deepen from 42 to 50 feet and widen from 250 to 450 feet	1.1	21	Yes
E-1a	Deepen existing channel from 42 to 45 feet	1.0	31	Yes
E-3a	Deepen from 42 to 45 feet and widen from 250 to 450 feet	0.9	21	Yes
E-3b	Deepen from 42 to 48 feet and widen from 250 to 450 feet	0.9	21	Yes
E-3f	Deepen from 42 to 50 feet and widen with 75-foot shelves at 42 feet deep	0.9	23	No
E-4c	Deepen from 42 to 50 feet up to and creation of new turning basin, widen entire channel to 450 feet	0.9	11	No
E-4b	Deepen from 42 to 48 feet up to and creation of new turning basin, widen entire channel to 450 feet	0.8	11	No
E-3e	Deepen from 42 to 48 feet and widen with 75-foot shelves at 42-foot depth	0.7	23	No
E-4a	Deepen from 42 to 45 feet up to and creation of new turning basin, widen entire channel to 450 feet	0.7	11	No
E-3d	Deepen from 42 to 45 feet and widen from 250 to 450 feet	0.6	23	No
E-2	Widen channel bottom from 250 to 450 feet	0.6	17	No

For the Final Array of alternatives, the alternatives considered at various scales in depths that were screened included channel widths of 250, 300, and 350 feet. These alternatives included:

DEEPENING ONLY

F-1a Deepen from 42 to 45 feet;

F-1b Deepen from 42 to 48 feet;

F-1c Deepen from 42 to 50 feet;

F-1d Deepen from 42 to 52 feet;

DEEPENING AND WIDENING (300 feet)

F-2a Deepen from 42 to 45 feet and widen channel from 250 to 300 feet;

F-2b Deepen from 42 to 48 feet and widen channel from 250 to 300 feet;

F-2c Deepen from 42 to 50 feet and widen channel from 250 to 300 feet;

F-2d Deepen from 42 to 52 feet and widen channel from 250 to 300 feet;

DEEPENING AND WIDENING (350 feet)

F-3a Deepen from 42 to 45 feet and widen channel from 250 to 350 feet;

F-3b Deepen from 42 to 48 feet and widen channel from 250 to 350 feet;

F-3c Deepen from 42 to 50 feet and widen channel from 250 to 350 feet;

F-3 Deepen from 42 to 52 feet and widen channel from 250 to 350 feet; and

NO ACTION

F-4 No Action Alternative.

7.2 FINAL SCREENING CRITERIA

In order to evaluate and screen the Final Array of alternatives to best meet the study and non-Federal sponsor objectives, screening was performed using quantitative criteria such as quantities, costs, and BCRs. The following screening criteria were identified and used in screening the alternatives:

Dredging Quantities
Environmental Considerations
Construction Costs
Navigation Benefits
Net Excess Benefits
BCRs

As a result of additional detailed analyses of the structural alternatives, none of the alternatives would require additional PAs since new work construction and maintenance material could be placed in existing PAs (with necessary containment dike raisings) or in the ODMDSs. Structural alternatives evaluated during this screening appeared to address the problems with the existing BIH while having minimal impact on the environment.

The construction costs were developed by USACE – Galveston Cost Engineering using October 2012 price levels, the price level at the time of these calculations. Benefits and costs were calculated with a base year of 2017 using the fiscal year (FY) 2013 discount rate of 3.5 percent and the Office of Management and Budget required 7.0 percent. These costs are preliminary costs to be used for comparative purposes only. Final detailed costs would be completed on the TSP only.

Benefits were calculated using HarborSym deepening and widening models for the traditional benefits. These benefits are the difference in benefits from the improved channel and any benefits realized in the most likely without-project condition, previously described in Section 2 of the main report.

7.3 ECONOMIC ANALYSIS FOR FINAL SCREENING

7.3.1 Traditional NED Benefit Analysis

To calculate economic benefits for the Final Array of alternatives, alternatives for 45-, 48-, 50-, and 52-foot depths with channel widths of 250, 300, and 350 feet were evaluated. These alternatives were each modeled in HarborSym for the years 2017, 2037, and 2067. The project benefits were calculated based on reductions in transportation costs generated for more efficient vessel transportation and less restrictions on transit of larger oil drilling rigs. The proposed channel improvements are in response to the need for deeper access by allowing the existing fleet to load more fully and for the introduction of larger vessels, to include oil drilling rigs.

A multiport analysis was used to assess whether improvements at BIH would result in a diversion of cargo traffic that would either shift to or from competing ports to or from BIH. Diverted traffic from competing U.S. ports is not a NED benefit as there is no increase in the net value of the national output of goods and services, except when the diversion results in a net reduction in transportation costs. This analysis identified those commodities that would benefit from improvements to the Federal project. For each benefiting cargo group, it identified their cargo volumes at competing ports, assessed the extent of the overlap in the flow of these commodities and in the hinterlands served by each of the potential competing ports, and identified any advantageous/disadvantageous transportation costs and institutional and/or cargo capacity constraints resulting from port administration, terminal operators, and/or stevedore companies' policies, and/or future growth. The analysis did not find for any reason to assume a shift in cargo to or from BIH would occur.

The growth rates used for the commodity forecast were based on several variables, including the historical tonnage trends as calculated from the Waterborne Commerce Statistics, interviews with end-users, as well as similar rates used in other regional projects based on Department of Energy forecasts. Current transit rules established by the Brazos Santiago Pilots Association (Pilots) are expected to continue with an improved channel and were used in the analysis.

The current deep-draft vessel calls do not come into the POB fully loaded. Therefore, it was assumed that in the future, vessels would come in loaded at capacity, thereby reducing the number of calls. Larger vessels than the largest currently traversing the channel are not anticipated, but the number of vessel calls of the largest vessels would increase over time. It is anticipated that in the future, the fleet would transition from smaller vessels to larger vessels as efficiencies are realized. The number of vessel calls would increase through 2037 as the tonnage increases, but would decrease through 2067 as the fleet transitions from smaller vessels to larger vessels. The underkeel clearance of 3 feet used was based on information from the Pilots.

Offshore oil rigs are routinely required to come into dock for inspections or when they require maintenance and repair. One of the closest current locations for rigs operating in the Gulf of Mexico to have such inspections or repairs performed is the Keppel-AmFELS location at BIH. Keppel-AmFELS' work typically consists of jack-ups and semi-submersible oil rigs. However, over time the semi-submersible rigs have been built wider and deeper, reaching the limitations of the current Brownsville Ship Channel dimensions, which risks the operations being moved to Mexico without channel improvements. The underkeel clearance of 4 feet used for the rigs was based on information from the Pilots.

Some semi-submersibles would be able to traverse the channel if the thrusters are removed at sea, as they add extra depth to the rig. However, this removal costs several million dollars, which can be a limitation for owners when deciding to bring a rig to BIH. As this adds to the transportation costs of the rig, the thruster removal was modeled in HarborSym. A range of \$2,000 to \$4,000 was used for the hourly foreign cost in port for the largest semi-submersible rigs in the without-project condition. No costs were included in the with-project alternatives because it assumed the thrusters would not be required to be removed. Also, because the rigs would be in dry-dock for a minimum of two months, depending on the work required, costs were not included for the at-sea or in-port conditions since it would be unreasonable for costs to accrue like a bulker that spends a week in-port unloading its commodities.

The number of oil rig calls in HarborSym was held constant throughout the period of analysis and was based on historical capacity limits at Keppel-AmFELS, as well as interviews with the Keppel-AmFELS officials. However, the average mix of eight rig calls was varied depending on the channel dimensions. For example, a 50-foot deep channel would accommodate more semi-submersibles than a 43-foot deep channel, which would expect more jack-up rigs.

7.3.2 Section 6009 Benefit Analysis

An economic analysis was completed using the September 13, 2012, USACE implementation guidance for Section 6009 of the Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Tsunami Relief, 2005 (Public Law 109-13) – Offshore Oil and Gas Fabrication Ports (Section 6009). This analysis calculated additional benefits for the oil rigs beyond the traditional NED benefits with the value of future energy exploration and production fabrication contracts for offshore oil rigs.

Separate BCRs were calculated to include the Section 6009 benefits. These calculations include proprietary information, and therefore, are included in a separate addendum for official use only.

7.4 ENGINEERING CONSIDERATIONS FOR FINAL SCREENING

7.4.1 Ship Simulation Results

In May and September of 2010, the Engineer Research and Design Center (ERDC) performed ship simulations for BIH for depths of 42, 45, and 48 feet and various widths. This simulation included a 2-foot allowance so it could also be applied to the 50-foot depth. ERDC modeled two vessels, a tanker with dimensions of 846 feet by 157 feet by 47 feet and a Very Large Crude Carrier (VLCC) with dimensions of 1,087 feet by 195 feet by 24 feet. The tanker was selected because it was one of the vessels ERDC had in their database that was larger than any vessels currently coming into the channel. The VLCC was selected because it was a part of ERDC's database and represented the largest vessel that would come in to be scrapped. Originally a bulker vessel was to be modeled for future conditions, but the one selected could already safely travel in the existing channel dimensions.

During the preliminary simulation runs, it was found that deepening only along the channel was not adequate for the expected traffic and the 200-foot widening was excessive. Additional runs were completed with 300-, 350-, and 400-foot channel widths. The results found that 300-foot width was not sufficient for either of the design vessels with numerous runs leaving the channel. The 350-foot width runs were much more successful with only one run for the larger vessel nearing the channel edge but not leaving the channel. The Pilots felt that the 400-foot width was wider than necessary and were comfortable traversing the channel that was widened to 350 feet. The study noted the current channel varied in width and widening should be limited to a total of 350 feet rather than widening by 100 feet beyond the current channel. If the channel width was currently equal to or wider than 350 feet, that portion would remain at its current width. Based on the ship simulation study, the remainder of the channel should be widened to the 350-foot wide channel.

However, during analysis of the Final Array of alternatives, the economics were reexamined. The previous forecasts for future traffic patterns utilizing the facilities at BIH were no longer expected to come to BIH. The design vessel that was used in the ship simulation was selected based on current traffic patterns at the time and forecasts for those industries. Recent forecasting indicates that no tankers are expected to come in with the size that was previously modeled and it is not expected that this forecast would change. The largest vessel expected in the future is a tanker with dimensions of 793 feet by 138 feet by 46 feet, but this would only come in a maximum of three times a year, and represents less than 3 percent of the deep-draft vessel fleet forecasted.

Additionally, the BIH shipbreaker industry recently conducted a separate ship simulation study with ERDC to model transits of aircraft carriers, which is now the largest vessel that facility expects to service. This simulation study indicated these aircraft carriers can come in under the current channel dimensions. Based on these results, the modeled VLCC should also be able to use the existing channel with no restrictions. The updated forecast and the shipbreaker modeling outcome have negated the results of the 2010 ship simulation so that ship simulation's recommendations should no longer be used as the basis to increase the size of the channel. The ship simulation results were used to determine the modified channel's functionality in vessel transit, which is discussed in detail in the TSP section below, and the Engineering Appendix, which is available upon request.

7.4.2 Geometric Analysis of Rig Movements Results

In May 2010, a geometric analysis was performed by DOF Subsea to show a real time oil rig movement simulation for two rigs. The design rig for the modeling was based on the widest beam and deepest draft expected to be accommodated in future transit of the POB navigation channel. The analysis was performed with the rig's thrusters in place. These thrusters require additional channel depth beneath the oil rig. Significant savings could occur if these thrusters did not have to be removed because the removal process requires additional time and specialized diver expertise. The geometric analysis included channel widths of 300 and 350 feet. This geometric analysis results supported the need for the 50-foot channel depth and 350-foot width.

For the rigs, 43 percent of the original list of rigs used in the rig geometric analysis needed a maximum width of 300 feet, 11 percent more, or 54 percent of total, require 325 feet, and 74 percent of all the rigs could get in with a width of 350 feet. However, the recent report developed for the Section 6009 benefits forecasts more drillships working in the Gulf of Mexico rather than semi-submersibles in the future. These drillships need more depth to traverse the channel and would not need additional widening. This has negated the need to widen the channel to the 350-foot width as was shown in the rig movement analysis.

7.4.3 Value Engineering Study

During the early evaluation of the Final Array of alternative plans, a Value Engineering (VE) study was performed to identify potential savings of project costs and increase the BCR of the final plan. The VE study was limited to a plan for deepening the channel to 50 feet and widening to a 350-foot-wide channel. This VE study was performed after the ship simulation and rig geometric analysis so it was based on the preliminary results from those studies. Any recommendations for design changes from the VE study could be applied to the other channel depths or widths that are evaluated in the Final Array.

The VE study resulted in three alternative suggestions:

VE-1 Only widen the channel to 300 feet from Station 28+000 to 79+415 in lieu of 350 feet;

VE-2 Only deepen the channel to 48 feet from Station 84+200 to the end of the Turning Basin in lieu of 50 feet; and

VE-3 Do not deepen the Turning Basin.

For Alternative VE-1, a 300-foot channel width in the majority of the channel was recommended in lieu of the recommended 350-foot width from the three-dimensional geometric analysis for rig movement. As discussed previously, reanalysis of future vessel calls at BIH indicated few of the potential ships used in the ship simulation and rig geometric analysis would actually come to BIH; therefore, the costs to widen the channel to 350 feet were not found to be justified. Additionally, it was determined that the offshore oil rigs would be transitioning to drillships in the future, and therefore would not need the wider channel. This VE-1 alternative was recommended at a time when channel widening appeared to be supported by preliminary economics. Based on this change in economic forecasts, alternatives which widen the channel are not expected to be justified. Widening alternatives are included in the Final Array to attempt to bracket the widths for the NED plan. If widening is the selected plan, evaluation of this VE alternative will be revisited.

For Alternative VE-2, USACE, Galveston concurred with the VE study recommendations with some modifications. The existing channel transitions from 42 to 36 feet in depth at Station 86+000, and remains at 36 feet through the end of the Turning Basin at 89+500. Economic and operational analysis have determined that deepening to 52 feet beyond Station 84+200 may be needed, but that deepening all the way through the Turning Basin is definitely not needed. Deepening the channel to 48 feet beyond Station 84+200 may not accommodate access by deeper draft vessels to oil docks just beyond that location, as well as the TransMontaigne dock which brings in petroleum products. Further economic analysis will be needed to determine the point (between stations 84+200 and 86+000) through which deepening to 52 feet is needed, but this analysis will be delayed until the final feasibility level design. Additional analysis will be needed to determine the future design drafts expected at these docks. However, it was assumed that there is little risk in delaying this analysis because expected changes would only result in minor changes to dredging quantities and cost.

Alternative VE-3 was implemented in the final screening of alternatives with no deepening of the Turning Basin (from Station 86+000 through 89+500) being considered for any of the plans. It is assumed that vessels utilizing the channel would offload their products prior to using the Turning Basin in order for the vessel to navigate the 36-foot depth of the Turning Basin.

In summary, from the VE study recommendations Alternatives VE-1 and VE-3 were used in the development of the quantities for alternatives and analysis of economics in HarborSym for the final screening. Because the depth for Alternative VE-2 would be the same for all alternatives, it does not affect the screening and would be applied to the final analysis for the TSP only.

7.5 ENVIRONMENTAL CONSIDERATIONS FOR FINAL SCREENING

Environmental impacts of all of the final alternatives were evaluated to determine if differences in impacts and mitigation costs across the alternatives could impact plan selection. Differences in impacts associated with new work and maintenance dredging, PAs, ODMDSs and Feeder Berm were evaluated, as well as differences in impacts to habitats, wetlands, submerged aquatic vegetation (SAV), threatened and endangered species, Essential Fish Habitat (EFH), water and sediment quality, air quality, and cultural resources, among others. The results of this comparison are presented in detail in Section 8.0. Based on this analysis, the environmental effects of all action alternatives would be similar. Almost all impacts would be minor and temporary, requiring no compensatory mitigation. However, two deepening and widening alternatives could cause the permanent loss of a small amount of SAV but mitigation costs would be low and would not affect plan selection.

7.6 FINAL SCREENING OF ALTERNATIVES

The final alternatives, which would be evaluated to determine the TSP, were the alternatives that deepened the channel and/or widened the channel based on the latest forecasts. Therefore, depths of 45, 48, 50, and 52 feet with no widening, as well as widening to 300 and 350 feet, would be carried forward to the final evaluation in Section 8.0. O&M costs for extending the Entrance Channel for the deeper depth alternatives were developed to better estimate project costs of each proposed depth.

7.6.1 Objectives and Constraints

Each of the alternatives was also evaluated to determine whether it met the objectives of the study. The deepening only alternatives meet all the objectives by reducing costs of navigation associated with vessel movement entering and leaving the POB and improving channel dimensions to accommodate current and future offshore rigs into the POB for fabrication, maintenance, and repair.

All alternatives have been developed to minimize impacts to designated critical habitat for Threatened and Endangered species in the study area; minimize impacts to Threatened and Endangered species in the study area; minimize impacts to cultural resources listed or eligible for the National Register of Historic Places (defined as historic properties); develop alternatives within CBRA guidelines which prohibit new Federal expenditures or financial assistance within any CBRA unit with the exception of improvements to existing navigation channels, disposal areas and related improvements; and limit channel traffic to single lane/one way only.

8.0 COMPARISON OF FINAL ARRAY OF ALTERNATIVE PLANS AND DECISION CRITERIA

Table 8-1 presents the Final Array of alternatives along with the corresponding dredged material quantities, average annual costs and benefits, net excess benefits and BCRs using the most current price level and interest rate at the time of calculations (October 2012 and 3.75 percent interest rate).

For the Final Array of alternatives, all of the channel depth alternatives are economically justified at either the current 250-foot or the 300-foot width alternative, but not at the 350-foot width alternative. The deepening alternatives with no widening have the greatest BCRs and net excess benefits compared to those with any widening.

In comparing the deepening only alternatives, the net excess benefits are increasing as the channel depths increase. Interpolation between these depths was used to optimize the plan and possibly identify the NED plan. The Economic Appendix (available upon request) includes this interpolation for all of the final alternatives; whereas, Table 8-2 presents just those interpolated depths for the no widening alternative.

All alternatives in the Final Array were compared based on economic, engineering, environmental, and socioeconomic factors as presented in Table 8-3. PAs do not need to be expanded to accommodate new work material and the 50-year dredged material quantities, and no new PAs are planned. All PA containment dike lifts would be accomplished inside the footprint of the existing containment dikes, and best management practices (BMPs) would be utilized during construction to avoid impacts to water quality, which could affect SAVs or mangroves located near some PAs. All structural alternatives would result in the use of hopper dredges in the Gulf of Mexico and all therefore would have the potential to impact threatened and endangered sea turtles. Reasonable and prudent measures, developed to avoid adverse impacts to these species, would be similar for all alternatives. None of the alternatives would result in impacts to terrestrial resources, wetlands or tidal/algal flats. No oyster reef is located near the alternative impact areas.

The deepening only alternatives (F-1a through F-1d) would result in minor additional widening of the top of cut within the existing waterway. Benthic communities that may be present in the submerged sediment on the edge of the current channel would be destroyed, but they would rapidly recolonize. SAV beds are located near the Port Isabel Wye in the shallow waters of the Main Channel along the emergent shoreline. None of the deepening only alternatives would result in SAV impacts. Among the action alternatives, the deepening only alternatives result in

Table 8-1. Traditional NED Benefit Analysis for Final Array of Alternative Screening (Cost in 1,000s, October 2012 price levels, 3.75% Interest Rate)

Alt. No.	Description	Dredging Quantities (cubic yards)	First Cost	Average Annual O&M	Total Annual Costs[1]	Average Annual Benefits	BCR	Net Excess Benefits
F-1a	Deepen from 42 to 45 feet	3,736,000	89,200.0	856.3	4,932.0	9,717.2	1.97	4,785.2
F-1b	Deepen from 42 to 48 feet	8,274,000	121,340.0	1,084.2	6,670.5	14,204.6	2.13	7,534.1
F-1c	Deepen from 42 to 50 feet	11,430,000	162,170.0	1,324.1	8,861.4	17,380.8	1.96	8,519.5
F-1d	Deepen from 42 to 52 feet	14,093,000	193,950.0	1,503.3	10,586.4	19,873.8	1.88	9,287.4
F-2a	Deepen from 42 to 45 feet/widen from 250 to 300 feet	7,703,000	126,090.0	2,240.2	8,067.3	10,843.1	1.34	2,775.9
F-2b	Deepen from 42 to 48 feet/widen from 250 to 300 feet	12,912,000	189,430.0	2,623.9	11,563.2	13,760.4	1.19	2,197.3
F-2c	Deepen from 42 to 50 feet/widen from 250 to 300 feet	16,503,000	230,730.0	2,853.2	13,867.0	17,939.3	1.29	4,072.2
F-2d	Deepen from 42 to 52 feet/widen from 250 to 300 feet	19,758,000	274,220.0	3,100.8	16,342.2	20,440.4	1.25	4,098.1
F-3a	Deepen from 42 to 45 feet/widen from 250 to 350 feet	14,007,000	204,970.0	4,354.3	14,063.9	8,958.2	0.64	–5,105.7
F-3b	Deepen from 42 to 48 feet/widen from 250 to 350 feet	19,315,000	271,090.0	4,889.2	17,979.5	14,140.2	0.79	–3,839.3
F-3c	Deepen from 42 to 50 feet/widen from 250 to 350 feet	22,569,000	310,880.0	5,272.9	20,342.4	16,687.0	0.82	–3,655.4
F-3d	Deepen from 42 to 52 feet/widen from 250 to 350 feet	26,728,000	365,860.0	5,606.1	23,616.5	19,896.1	0.84	–3,720.4

[1] Total Annual Costs is a sum of Average Annual Cost and Average Annual O&M. Average Annual Costs is a sum of First Cost of Construction and Interest during Construction.

the fewest environmental impacts and there are no significant differences in impacts among them.

The alternatives with widths of 300 and 350 feet would extend the top-of-cut for the deepening another 25 or 50 feet toward both shores, respectively. Based upon current survey information, aerial photographs, and field inspections, the 50-foot widening alternatives for all depths (F-2A through F-2d) and the 100-foot widening alternatives for the two shallower depths (F-3a and F-3b) would not impact SAV beds, but the 350-foot width for the 50- and 52-foot deep (F-3c and F-3d) alternatives could impact approximately 1 acre of SAV beds on the north side of the channel. Mitigation costs for the impacts of Alternatives F-3c and F-3d were not estimated, as they would be minimal in comparison to project construction costs.

Each plan was formulated in consideration of the four criteria in the P&G: completeness, effectiveness, efficiency, and acceptability. With the exception of Alternative F-4, the No Action Alternative, each alternative in the Final Array is considered acceptable. While all of the alternatives which improve the channel would improve navigation efficiency while avoiding and minimizing environmental impacts to the greatest extent possible during the 50-year period of analysis, the plan with the greatest net excess benefits is considered the most complete, efficient, and effective plan. Therefore, Alternative F1-d, the 52-foot deep channel with no additional widening, is the plan which best meets the four P&G criteria. It is also the environmentally preferable alternative because it is the most efficient alternative in terms of minimizing damages to the biological and physical environment while providing the maximum economic benefit for the general welfare of the Nation.

Table 8-2. NED Benefit Analysis for Deepening Only Alternatives
(Cost in 1,000s, October 2012 price levels, 3.75% Interest Rate)

Alt. No.	Description	Average Annual Costs	Average Annual Benefits	BCR	Net Excess Benefits
	Deepen from 42 to 43 feet	3,366.6	3,239.1	1.0	–127.5
	Deepen from 42 to 44 feet	4,148.0	5,795.9	1.4	1,647.8
F-1a	Deepen from 42 to 45 feet	4,932.0	9,717.2	2.0	4,785.2
	Deepen from 42 to 46 feet	5,509.0	11,213.0	2.0	5,704.0
	Deepen from 42 to 47 feet	6,088.5	12,503.7	2.1	6,415.2
F-1b	Deepen from 42 to 48 feet	6,670.5	14,204.6	2.1	7,534.1
	Deepen from 42 to 49 feet	7,761.4	15,792.7	2.0	8,031.4
F-1c	Deepen from 42 to 50 feet	8,861.4	17,380.8	2.0	8,519.5
	Deepen from 42 to 51 feet	9,721.0	18,627.3	2.0	8,906.3
F-1d	Deepen from 42 to 52 feet	10,586.4	19,873.8	1.9	9,287.4

Table 8-3. Comparison of Final Array Alternatives

Alternative Number	No-Action (F-4)	F-1a	F-1b	F-1c	F-1d (TSP)	F-2a	F-2b	F-2c	F-2d	F-3a	F-3b	F-3c	F-3d
Evaluation Criteria	**Future Without-Project (FWOP)**	**Deepen to 45 feet**	**Deepen to 48 feet**	**Deepen to 50 feet**	**Deepen to 52 feet**	**Deepen to 45 feet/ widen to 300 feet**	**Deepen to 48 feet/ widen to 300 feet**	**Deepen to 50 feet/ widen to 300 feet**	**Deepen to 52 feet/ widen to 300 feet**	**Deepen to 45 feet/widen to 350 feet**	**Deepen to 48 feet/widen to 350 feet**	**Deepen to 50 feet/ widen to 350 feet**	**Deepen to 52 feet/ widen to 350 feet**
Construction Dredging Volumes (MCY)	None	3.7	8.3	11.4	14.0	7.7	12.9	16.5	19.8	14.0	19.3	22.6	26.7
Shoaling Rates (cy/yr)	1,098,797	1,155,000	1,198,000	1,227,000	1,255,000	1,256,000	1,302,000	1,333,000	1,364,000	1,438,000	1,502,000	1,545,000	1,587,000
Channel Extension Lengths (feet)	None	2,000	3,000	3,400	4,000	2,000	3,000	3,400	4,000	2,000	3,000	3,400	4,000
Net Excess Benefits (FY2012 price level)	($127,500)	$4,785,200	$7,534,100	$8,519,500	$9,287,400	$2,775,900	$2,197,300	$4,072,200	$4,098,100	($5,105,700)	($3,839,300)	($3,655,400)	($3,720,400)
Construction Air Quality (NO_x Emissions)	It is anticipated that air contaminants in the project area would increase due to continued operational constraints on the existing system and a possible increase in ship traffic resulting both from growth of existing business and from new business	Less than TSP	Less than TSP	Less than TSP	2567 tons NO_x (total for all years of construction)	Less than TSP	About the same as the TSP	About the same as the TSP	More than TSP	About the same as the TSP	More than TSP	More than TSP	More than TSP
Upland PAs	7 existing upland confined PAs	Same as TSP	Same as TSP	Same as TSP	7 existing upland confined PAs	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP
ODMDS	1 existing ODMDS and a Feeder Berm (both dispersive)	Same as TSP	Same as TSP	Same as TSP	1 existing ODMDS and one nearshore Feeder Berm; both dispersive with unlimited capacity	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP
Vegetation / SAV	Ongoing maintenance dredging would not result in impacts to SAV	Same as TSP	Same as TSP	Same as TSP	Construction and maintenance dredging would not result in impacts to SAV	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Construction would permanently impact approximately 1 acre of SAV along the edges of the Main Channel.	Construction would permanently impact approximately 1 acre of SAV along the edges of the Main Channel.

Table 8-3 (Cont'd)

Alternative Number	No-Action (F-4)	F-1a	F-1b	F-1c	F-1d (TSP)	F-2a	F-2b	F-2c	F-2d	F-3a	F-3b	F-3c	F-3d
Evaluation Criteria	**Future Without-Project (FWOP)**	**Deepen to 45 feet**	**Deepen to 48 feet**	**Deepen to 50 feet**	**Deepen to 52 feet**	**Deepen to 45 feet/ widen to 300 feet**	**Deepen to 48 feet/ widen to 300 feet**	**Deepen to 50 feet/ widen to 300 feet**	**Deepen to 52 feet/ widen to 300 feet**	**Deepen to 45 feet/widen to 350 feet**	**Deepen to 48 feet/widen to 350 feet**	**Deepen to 50 feet/ widen to 350 feet**	**Deepen to 52 feet/ widen to 350 feet**
Terrestrial Wildlife Habitat	Ongoing maintenance dredging and placement would cause no impacts to terrestrial wildlife habitats	Same as TSP	Same as TSP	Same as TSP	All impacts would be avoided by restricting construction activities to the existing PA footprints and existing access roads	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP
Wetlands	Ongoing maintenance dredging and placement would not result in new impacts to wetlands	Same as TSP	Same as TSP	Same as TSP	All impacts would be avoided by restricting construction activities to the existing PA footprints and existing access roads	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP
Aquatic Habitat	Temporary water column turbidity associated with maintenance dredging and placement would continue	Less than the TSP	Less than the TSP	Less than the TSP	Short-term, temporary impacts to benthic organisms and increased turbidity are expected, although no significant impacts would be anticipated	Less than the TSP	About the same as the TSP	About the same as the TSP	More than the TSP	About the same as the TSP	More than the TSP	More than the TSP	More than the TSP
Essential Fish Habitat	Ongoing maintenance dredging and placement would not result in new impacts to EFH	Less than the TSP	Less than the TSP	Less than the TSP	Turbidity would be temporary; localized impact during dredging and placement; benthic organisms would be affected until natural recovery occurs. No significant impacts would be anticipated	Less than the TSP	About the same as the TSP	About the same as the TSP	More than the TSP	About the same as the TSP	More than the TSP	More than the TSP	More than the TSP
Threatened and Endangered Species	Ongoing maintenance dredging of the Entrance and Jetty Channels may adversely impact sea turtles	Less than the TSP	Less than the TSP	Less than the TSP	Construction and maintenance dredging of the Entrance and Jetty Channels may adversely impact sea turtles	Less than the TSP	Less than the TSP	Less than the TSP	About the same as the TSP	Less than the TSP	Less than the TSP	Less than the TSP	About the same as the TSP

Table 8-3 (Cont'd)

Alternative Number	No-Action (F-4)	F-1a	F-1b	F-1c	F-1d (TSP)	F-2a	F-2b	F-2c	F-2d	F-3a	F-3b	F-3c	F-3d
Evaluation Criteria	**Future Without-Project (FWOP)**	**Deepen to 45 feet**	**Deepen to 48 feet**	**Deepen to 50 feet**	**Deepen to 52 feet**	**Deepen to 45 feet/ widen to 300 feet**	**Deepen to 48 feet/ widen to 300 feet**	**Deepen to 50 feet/ widen to 300 feet**	**Deepen to 52 feet/ widen to 300 feet**	**Deepen to 45 feet/widen to 350 feet**	**Deepen to 48 feet/widen to 350 feet**	**Deepen to 50 feet/ widen to 350 feet**	**Deepen to 52 feet/ widen to 350 feet**
Water and Sediment Quality	Maintenance dredging and placement activities would result in no new impacts. Testing indicates no contaminants of concern would be expected in channel sediments	Same as TSP	Same as TSP	Same as TSP	Construction dredging and placement activities would result in temporary increases in turbidity. Testing indicates no contaminants of concern would be expected in channel sediments	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP
Hazardous, Toxic, and Radioactive Waste	No change from past practices in land use and the occurrence of HTRW sites would be expected	Same as TSP	Same as TSP	Same as TSP	Construction and placement activities would not impact any known HTRW sites	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP
Energy and Mineral Resources	Maintenance of the existing project would have no impact on pipelines and mineral resources	Same as TSP	Same as TSP	Same as TSP	Construction and maintenance of the TSP would have no impact on pipelines and mineral resources.	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP
Cultural Resources	Maintenance of the existing project would have no impact on cultural resources	Same as TSP	Same as TSP	Same as TSP	Construction and maintenance of the TSP would have no impact on cultural resources.	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP
Socioeconomics	Socioeconomic conditions resulting from existing port activities and commerce would be expected to continue	Less than the TSP	Less than the TSP	About the same as the TSP	Economic impacts on the region would increase as a result of the channel improvements, resulting in an increase in the number of jobs.	Less than the TSP	Less than the TSP	Less than the TSP	About the same as the TSP	Less than the TSP	Less than the TSP	Less than the TSP	About the same as the TSP
Environmental Justice	Maintenance of existing project would not impact minority or low-income populations	Same as TSP	Same as TSP	Same as TSP	Construction and maintenance of the TSP would not impact minority or low-income populations	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP
Environmental and Safety Risks to Children	Maintenance of existing project would not cause environmental or safety risks to children	Same as TSP	Same as TSP	Same as TSP	Construction and maintenance of the TSP would not cause environmental or safety risks to children	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP	Same as TSP

9.0 PLAN SELECTION

Alternative F1-d (deepening the channel to 52 feet mean lower low water) is the TSP. This alternative was evaluated and determined to be economically justified, environmentally acceptable, and complete. The costs including interest during construction (IDC), NED AAEQ benefits, and BCR for the TSP is presented in Table 9-1.

Table 9-1. Economic Summary for Plan Selection
(October 2012 price levels, 3.75% interest)

First Cost of Construction	$193,950.0
IDC	$9,824.0
Total Investment	$203,774.0
Total AAEQ Cost	$10,586.4
AAEQ Benefits	$19,873.8
Net Excess Benefits	$9,287.4
BCR	1.9

9.1 NED BENEFITS

NED Benefits were calculated in HarborSym and were based on reductions in transportation costs generated for more efficient vessel transportation and less restrictions on transit of larger oil drilling rigs. The proposed channel improvements are in response to the need for deeper access by allowing the existing fleet to load more fully and for the introduction of larger vessels, including oil drilling rigs.

It is not known if Alternative F1-d is the NED plan which maximizes the net excess benefits because the net excess benefits were still increasing with deeper channel dimensions and a deeper alternative was not included in the Final Array of alternatives. However, Alternative F1-d was the most cost effective of the Final Array of alternatives considered and the deepest channel dimension that the non-Federal sponsor would support at this time. Therefore, Alternative F1-d, deepening the channel to 52 feet with no widening, is the considered the TSP.

The Final Screening determined that Net Excess Benefits would be $9.3 million. The project would be economically justified with a BCR of 1.9.

9.2 CATEGORICAL EXEMPTION

For a navigation project if a plan with lesser benefits is preferred by the sponsor due to financial constraints, guidance allows for a categorical exemption to be granted and this lesser plan to be selected as the TSP. The USACE guidance requires that the NED plan be recommended unless there are believed to be overriding reasons favoring the selection of another alternative. Planning Guidance (Engineering Regulation 1105-2-100) states that if the non-Federal sponsor identifies a financial constraint due to limited resources, and if net benefits are increasing as the constraint is reached, a categorical exemption may be granted and the constrained plan recommended. Categorical exemptions for plans that are lesser projects than the NED plan are cost shared on the same basis as the NED and become a federally supportable plan.

In this study's selection of the TSP, the sponsor has indicated a preference of the 52-foot alternative due to cost restraints. This plan is a justified plan in an array of alternatives in which it is not known if the NED benefits have been maximized. Had alternatives deeper than 52 feet been evaluated and net excess benefits decreased, it would have indicated that the 52-foot alternative was the NED plan. However, because no evaluation deeper than 52 feet was performed, the 52-foot alternative was not identified as the NED plan. This alternative still meets the policies for the high-priority outputs and has greater benefits than the smaller scale plans (Table 8-3). Since the 52-foot plan is the sponsor's preference due to financial constraints and fits all of the criteria regarding categorical exemptions for navigation projects, this plan has been identified as the TSP. The economic analysis indicates that the NED is 52 feet deep or deeper; therefore, cost sharing would be the same as if it was the identified NED plan.

9.3 LEAST COST DISPOSAL ALTERNATIVE

Placement options were evaluated to determine to the best disposal alternative for all material, both new work and O&M. These alternatives considered possible beneficial use of dredged material, as well as traditional PAs.

9.3.1 Beneficial Use Opportunities

Section 2037 of the Water Resources Development Act (WRDA) 2007 amended Section 204 of WRDA 92 dealing with regional sediment management. Section 204 states that a regional sediment management plan shall be developed by the Secretary of the Army for sediment obtained through the construction, operation, or maintenance of an authorized Federal water resources project. The purposes of using sediment for the construction, repair, modification, or rehabilitation of Federal water resource projects are to reduce storm damage to property; to protect, restore, and create aquatic and ecologically related habitats, including wetlands; and to transport and place suitable sediment.

During the Feasibility study, a conceptual sediment budget was developed (HDR, 2008) and the beneficial use of the dredged material was investigated. New work construction would yield primarily clay sediments, which are suitable for dike construction or marsh restoration. New work material from the Main Channel would be stockpiled within the existing PAs and used for future incremental dike raisings. No marshes in need of clay material for restoration were identified near the project area. New work material from the Entrance and Jetty Channels would be placed at the New Work ODMDS; sediments to be dredged would be overwhelmingly clay and would not be suitable for placement at the nearshore Feeder Berm, which was designed to receive sandy sediments.

The potential for beneficial use of maintenance material from the new project was also investigated. Shoaled sediments from the majority of the Main Channel (stations 11+000 to 89+500) are expected to be primarily clay and silt. No marsh areas that would benefit from these sediment types have been identified near the project area. Maintenance dredging of the eastern end of the Main Channel (stations 0+000 to 11+000), and the entire Jetty and Entrance Channels are expected to be primarily sand with some silt, suitable for use in the nearshore Feeder Berm. Sandy material deposited in this nearshore berm is redeposited by cross-shore and longshore currents on the shoreline of South Padre Island, decreasing shoreline erosion. Sandy materials could also be used to nourish eroding beaches fronting the City of South Padre Island; however, beach placement is not a least-cost plan. The incremental difference between the cost of normal placement into the Feeder Berm and the cost to pump material directly onto the beach must be provided by a non-Federal sponsor. In the past, the City of South Padre Island has participated in paying the incremental cost to place the material directly onto the beach at South Padre Island. This incremental cost has been about $2 to $3 million per dredging cycle.

9.3.2 Screening for Least Cost Plan

Based on the possible beneficial use options identified above, several alternative placement plans were considered for the material from Station –17+000 to 11+000. This reach includes the Entrance Channel Extension, Entrance Channel, Jetty Channel, and a portion of the Main Channel. This reach is primarily sandy material which would be suitable for placement in the Feeder Berm, the current least cost disposal plan for maintenance material. Another option for this material would be placement into the Maintenance ODMDS which is located directly adjacent to the channel extension. However, the Maintenance ODMDS has been designated for material only from the Entrance and Jetty Channels. This designation prevents material from Station 0+000 to 11+000 (part of the Main Channel) to be placed in the Maintenance ODMDS. Placement of the material from Station 0+000 to 11+000 is limited to the Feeder Berm because of the lack of capacity in the nearby upland PAs.

Additional advance maintenance (AM) was considered to allow channel dredging cycles to be combined in order to save mobilization and demobilization costs that occur with each dredging contract. Currently 2 feet of AM is included in the channel improvement design for this reach. AM greater than the 2 feet would result in stability issues for the channel, so this option was disregarded from further consideration.

Table 9-2 presents that quantifiable costs and dredging cycles for the two remaining placement options: Placement Plan 1 (Maintenance ODMDS and Feeder Berm) and Placement Plan 2 (Feeder Berm).

Table 9-2. Alternative Placement Plans

Stationing	Placement Location	Dredging Cycle (years)	Average Annual Costs
Placement Plan 1			
Sta. –17+000 to 0+000	Maintenance ODMDS	1.5	$6,246,000
Sta. 0+000 to 11+000	Feeder Berm	4.5	
Placement Plan 2			
Sta. –17+000 to 0+000	Feeder Berm	1.5	$6,387,000
Sta. 0+000 to 11+000	Feeder Berm	4.5	

Use of Placement Plan 2 rather than Placement Plan 1 provides an economically and environmentally balanced, sustainable solution for life cycle sediment management for the BIH project. While life-cycle maintenance dredging costs for Placement Plan 1 are essentially equivalent to Placement Plan 2, environmental benefits of Placement Plan 2 make it the optimal sediment management solution.

Environmental benefits are achieved by regularly placing material trapped by the channel extension back into the littoral system through the use of the Feeder Berm. The material is then available for cross-shore and longshore sediment transport to the beaches of South Padre Island. This improves environmental stewardship, while improving relationships with area stakeholders on South Padre Island, where shoreline erosion has averaged 18 feet per year. Placing material into the Maintenance ODMDS removes the material from the littoral system and keeps it from nourishing the shoreline.

In addition, the Feeder Berm option (Placement Plan 2) has the potential to reduce life cycle costs because sediments from the Entrance and Jetty Channels are placed further upcurrent from the channel than the Maintenance ODMDS option (Placement Plan 1). The current Entrance Channel terminates at the southwest corner of the Maintenance ODMDS, with the majority of this ODMDS offshore of the current channel limits. For the TSP, the Entrance Channel Extension would extend the channel along the Maintenance ODMDS' southern limit. The Maintenance ODMDS site is dispersive in nature; material is generally moved away from the site by the Gulf current within a few weeks to months. While the current flows from south to north most of the time, storms and seasonal reversals sometimes result in the current moving from north to south. If maintenance materials are present at the ODMDS site when the current reverses, they could move back into the channel. The historic dredging records used to establish this study's channel shoaling rates include the current practice of Feeder Berm use for placement of all of the material from the Jetty and Entrance Channels. The Maintenance ODMDS has not been used in more than a decade. Therefore, any increase in shoaling due to the periodic reverse in current flows from north to south has not been accounted for using the recent historic records. Use of the Maintenance ODMDS with the future channel alignment could potentially increase channel shoaling and maintenance costs.

Because of uncertainties described above and the fact that these average annual costs for the two placement plans are nearly identical, these plans' costs are considered equivalent. Therefore, Placement Plan 2, the Feeder Berm option, is the preferred solution because it is the least cost, environmentally preferable plan.

10.0 REFERENCE

HDR. 2008. Desktop Evaluation of Shoaling for Federal Feasibility Study to Deepen and Widen the Brownsville Ship Channel. Prepared for the Port of Brownsville.