Above: An infrared satellite photo of the area of concern, with the Texas Gulf Intercoastal Waterway centerline shown as a red dotted line.

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REDUCING SHOALING IN THE TEXAS GIWW AND EROSION OF BARRIER ISLANDS ALONG WEST GALVESTON BAY

ABSTRACT

This project utilised a Regional Sediment Management (RSM) approach in an attempt to quantify the source of sediments, develop a conceptual design and associated cost estimation for remediation techniques to allow for the continued maintenance dredging of this portion of the Texas Gulf Intracoastal Waterway (GIWW). The erosion of the thin string of upland placement areas sheltering the GIWW from Galveston Bay is contributing to the shoaling rate; however the presence of these islands is reducing the amount of sediment load the channel would otherwise be experiencing.

The analyses conducted for this effort included: shoaling estimates using historical dredging records; aerial photography for shoreline erosion rate calculations; the ERDC Sediment Budget Analysis System (SBAS) was applied to compile existing sediment erosion and shoaling estimates; numerical modelling using the US Army Engineer Research and Development Center's (ERDC) Coastal Modelling System (CMS) was used to verify the observed trends; and various design alternatives were analysed for their potential for reducing channel shoaling and shoreline erosion.

This article is based on a paper that was published in the proceedings of the 33rd PIANC World Congress, held in San Francisco, California in June 2014. It was presented by Corragio Maglio at the Congress, where it was awarded the IADC Young Authors Award. This year's Award more than fulfilled its goal to recognise younger people working in the fields of dredging and maritime research. Of the nine authors, eight met the requirement for the award of being under the age of 35. The young author's award is presented by the International Association of Dredging Companies at selected conferences and comprises a gift of € 1000, a certificate of recognition and potential publication in *Terra et Aqua* Journal. The article is reprinted here in a slightly adapted form with permission of PIANC.

INTRODUCTION

The Texas Gulf Intracoastal Waterway (GIWW) is primarily a land cut navigation channel constructed by the Federal government starting in 1873 after the passing of the Rivers and Harbors Act. One of the primary functions of the GIWW was to provide protected inland transportation of goods and troops during World War II. Since then, the waterway has expanded to accommodate commercial and recreational vessels.

In 2010, more than 72.7 million tonnes of cargo transitted along the Texas portion of the GIWW with an estimated value of $40.7 billion. When measured against all the ports in the United States, the Texas portion of the GIWW ranks seventh in the US with respect to total tonnage. The GIWW provides an intra- and inter-state link between the Gulf deep-draft ports, refineries and chemical processing facilities and will continue to play an important role after the expansion of the Panama Canal.

Maintaining the Texas GIWW is becoming increasingly difficult as traditional dredge placement options are becoming reduced or eliminated. The traditional method of maintaining the channel was to hydraulically dredge and pump the material onto the land on either side of the channel, since this was both convenient and economical. These placement areas had been improved with frontage levees to ensure the dredged material did not return back into the channel. Since the shorelines are erosional, these frontage levees are continually in recession, and, if allowed to further erode, they will eventually become unavailable for storage of future dredged material.

This study developed a regional sediment budget and assessment of coastal sediment needs along the GIWW from just north of Greens Lake to Chocolate Bay, and investigated several design alternatives to reduce dredging requirements and prevent erosion of the barrier islands. The area of study encompasses Station (Sta.) 40+000 to Station 120+000 (old stationing), with the primary focus on the region of Placement Areas 62 through 65 (Figure 1).

Placement Areas (PAs) 62 and 63, which serve as barrier islands along the GIWW, are experiencing the most significant erosion in this area at 8,000 cy/yr (cubic yards per year) (1 cy = 0.76455 m^3) per 5,000 lft (linear feet) (one lft = 0.30480 metres).

Sediment is being lost on both the channel and bay sides as a result of a combination of currents, wind-generated waves and ship wakes. PAs 62 and 63 are semi-confined, and as they erode and the frontage levees are breached, sand and silt pass through and are deposited in the channel. If the placement areas are allowed to further erode, they will no longer be considered uplands and will become unavailable for the storage of future dredged material. To combat this problem, the Galveston District has identified several sediment management options to prevent erosion of these placement areas, stabilise the inlets and reduce shoaling.

Figure 1. Overview of the area of concern, PAs 62-65, along the Texas Gulf Intracoastal Waterway (GIWW).

Table I. Annual shoaling rates in the Texas GIWW, Stations 50+000 to 100+000.

Begin Station	End Station	25 Year Average (CY/YR)	50 Year Average (CY/YR)	Adjacent PA
50+000	55+000	21,200	25,700	PA 62
55+000	60+000	13,900	15,900	PA 62
60+000	65+000	19,500	18,600	PA 62
65+000	70+000	13,100	14,900	PA 63
70+000	75+000	14,100	15,200	PA 63
75+000	80+000	13,700	15,400	PA 63
80+000	85+000	15,500	16,300	PA 63
85+000	90+000	18,800	20,900	PA 64
90+000	95+000	15,600	22,500	PA 65
95+000	100+000	11,900	20,800	PA 65

Table II. Average annual erosion rates along the Texas GIWW.

Sta. Start	Sta. End	Total Mainland Erosion, 1995-2012 (SY)	Total Channelside Island Erosion, 1995-2012 (SY)	Avg. Annual Mainland Erosion (SY/YR)	Avg. Annual Channelside Island Erosion (SY/YR)	Total Avg. Annual Erosion along the GIWW (CY/YR)
54+000	65+000	98500	38700	5500	2200	22900
65+000	75+000	42700	25500	2400	1400	11400
75+000	85+000	57100	31400	3200	1700	14700
85+000	90+000	14800	N/A	800	N/A	2500
90+000	95+000	21600	N/A	1200	N/A	3600
95+000	98+000	12000	N/A	700	N/A	2000

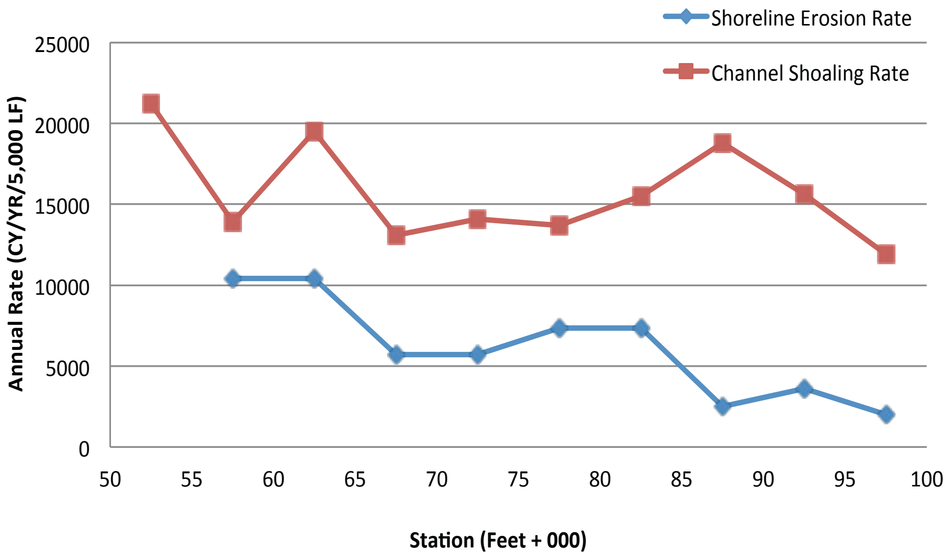


Figure 2. Channel shoaling rate vs. shoreline erosion rate from PA 62 to PA 65

HISTORICAL DREDGING DATA

Existing data were utilised to improve understanding of regional sediment transport in the area. Information from previous field surveys and investigations and dredged material placement activities was gathered in combination with discussions with USACE Galveston District operations managers and engineers.

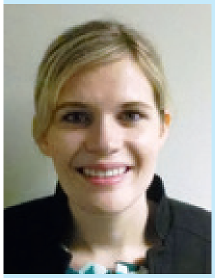
In order to estimate annual shoaling rates in the GIWW, historical dredging quantities from 1943 to 2012 were obtained from the Galveston District's Dredging Histories Database. An annual shoaling rate was calculated for each 5+000 increment of shoreline from Sta. 50+000 to 100+000, which correspond to PAs 62-65, based on the amount of time that had passed since that increment was last dredged. All of these rates were then used to calculate 50-year and 25-year averages. The 25-year averages are used in the sediment budget analysis, since much of the older dredging data is incomplete and recent numbers are more relevant. It was found that shoaling near the north end of the area of interest (Sta. 50+000 to 55+000) was the greatest, at approximately 21,200 cy per year. From Sta. 55+000 to 100+000, the average shoaling rate ranged from 11,900 to 19,500 cy per year, with the mean being approximately 15,100 cy/yr per 5,000 lft (see Table I).

SHORELINE CHANGE DATA

To determine the primary cause(s) of shoaling in the channel, erosion rates along the shoreline were obtained. Google Earth historical imagery was used to compare shoreline positions from 1995, 2004, 2006, 2010 and 2012. Shoreline positions from each year were traced and then overlaid to calculate the area in square yards (sy) of shoreline lost or gained during that time period.

Stations were grouped together according to what placement area they are adjacent to and an average annual erosion rate in sy/yr (square yards per year) for each stretch was calculated. An average depth of 9 ft was assumed and an equilibrium profile approach was taken to estimate the annual volume of sediment lost. This is an appropriate approach because the material in this area is dominated by cohesive sediments; these sediments maintain a relatively constant profile through time, even with erosion, as long as the forces remain unchanged. Because the erosion of cohesive materials is irreversible, once the cohesive bonds are broken, the eroded material can easily be carried long distances in suspension and can become re-suspended relatively easily (USACE 2002).

Results revealed that shoreline erosion rates along the portion of the GIWW that has



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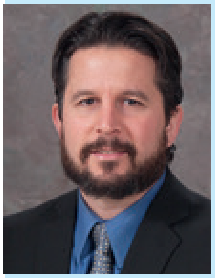

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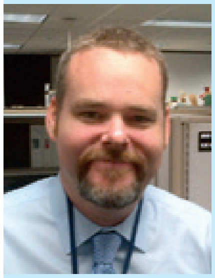

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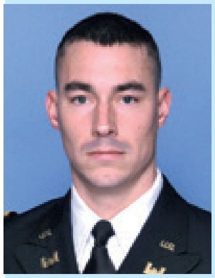

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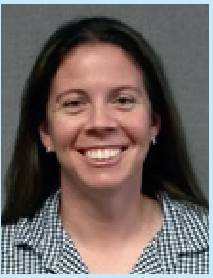

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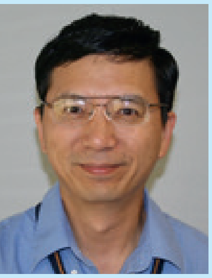

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barrier islands (Sta. 54+000 to 85+000) are fairly close to the estimated annual shoaling rates in that area, using an equilibrium profile approach and without bulking being considered (see Table II). This suggests that a majority of the shoaling in that portion of the channel is a result of erosion of the adjacent shorelines. However, from Sta. 85+000 to 98+000, where there are no barrier islands and the channel is open to West Galveston Bay, the erosion rate is significantly smaller compared to the shoaling rate (see Figure 2). This portion of the shoreline has been armoured with articulating concrete block since 2000, which explains the much smaller erosion rates. This implies that most of the sediment shoaling within this portion of the channel is coming from other sources, particularly West Galveston Bay and nearby Chocolate Bay, likely via a combination of currents and wind-driven waves, and other sources.

Erosion rates inside the GIWW were then compared to shoreline change rates on the bay side of the barrier islands. The conclusion was that the mainland and bay side of the barrier islands are eroding the fastest, with several large stretches losing 4-8 ft/yr between 1995 and 2012. Erosion along the channel side of the barrier islands is more modest, with most areas eroding at roughly 1-3 ft/yr (see Figure 3).

NUMERICAL MODELLING

ERDC's Coastal Modelling System (CMS) was selected to quantify and simulate physical processes near inlets, ports, harbours and coastal structures. The CMS uses an integrated numerical modelling system to model waves, currents, sediment transport and morphology change at coastal inlets and entrances (Demirbilek and Rosati 2011).

For this study, the CMS was used to calculate sediment transport and show areas of erosion and accretion in Galveston Bay. The model domain covers the entire Galveston Bay with navigation channels connecting the GIWW to the Gulf of Mexico. The CMS grid extends approximately 60 miles (95 km) alongshore and 40 miles (65 km) cross-shore, with the southern offshore boundary reaching to the 60-ft isobaths. The CMS was calibrated with

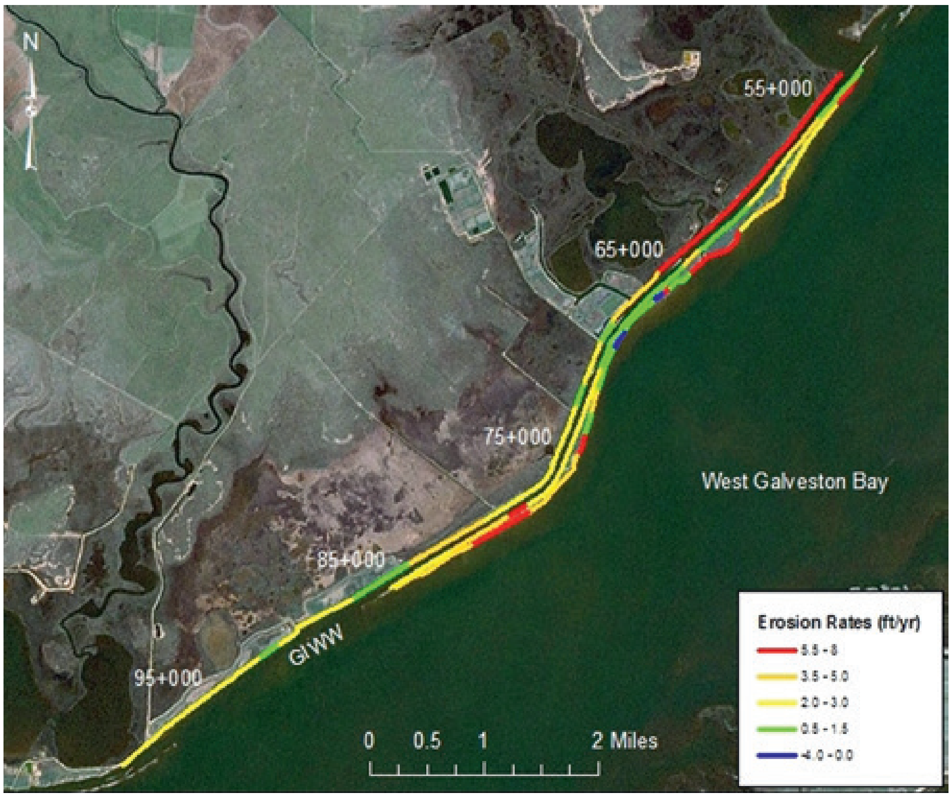

Figure 3. Erosion and accretion along West Galveston Bay and the GIWW.

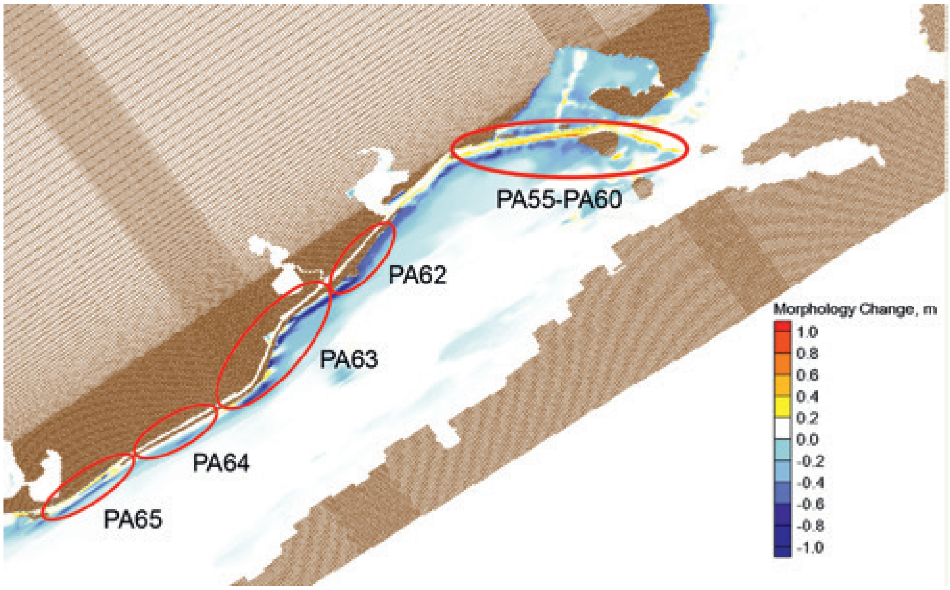

Figure 4. Shoreline change along the West Bay during an 11 day period, 19-30 June 2010.

water level, current and wave data collected around the Bay entrance inlet over a period of 11 days, 19-30 June 2010.

Sediment in Galveston Bay is mixed, with increased percentages of sand near the Bay entrance and inlets, along the coast and surrounding the barrier islands. More silt and clay are found in the landward side of the bay, and in the GIWW and ship channels.

The simulations verified that PAs 62 and 63 are seeing significant erosion; 1.3-2.6 ft (0.4 to 0.8 metres) of shoreline were lost during the 11-day run cycle. Sediment deposition is evidenced further north at PAs 55-60, likely some of the coarser sediment brought in through the Galveston Entrance Channel (Figure 4). It is assumed that there is minimal long-shore transport and wind-generated waves where the barrier island features are still present. Therefore, the majority of erosion is likely coming from some other source, presumably ship-induced waves and tidal flow.

Simulations show strong tidal flow in the GIWW from the Gulf of Mexico via the Galveston Entrance Channel and San Luis Pass. This is a potential source of shoreline erosion and sediment deposition in the channel.

SEDIMENT BUDGET ANALYSIS

The Sediment Budget Analysis System (SBAS) was applied to compile existing sediment erosion and shoaling information along the GIWW from the Galveston Causeway to Bastrop Bayou into a single budget, to gain greater knowledge of the relationship between sinks and sources of sediment within the project area (Figure 5) (Dopsovic 2003). No bulking factor was applied to relate the shoreline-eroded material to the volume deposited in the channel. The difference resulting from consolidation could be significant, but no applicable information was available. Thus, bulking was assumed not to be a factor for this analysis.

Several assumptions were made in order to create this budget:

- Sediment is moving from channel reach to channel reach from currents within the GIWW and from vessel traffic.
- Some recirculation from bayside placement areas back into the GIWW occurs.
- Reaches were created based on the PA allotment of dredged material, which was taken from the most recent dredging contract (2010). An extensive background check of historical material placement was not performed.
- Averages of dredging data over the last 25 years were used, since they depict current conditions more accurately.
- Shoreline erosion rates were calculated using a 9-ft depth, based on historical cross-sections of the channel and no

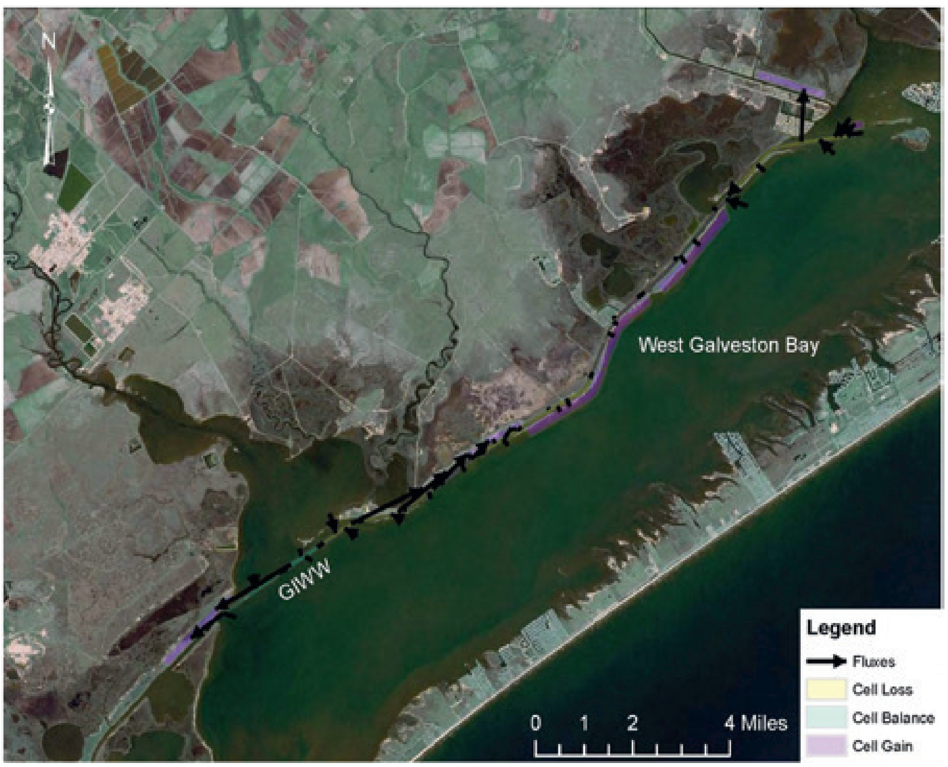

Figure 5. Sediment budget cells from Galveston Causeway to Bastrop Bayou.

bulking factor was applied.
- Thirty-percent uncertainty was used in the budget, which is the standard amount for this type of analysis.

The final product from this task is a sediment budget with cells and lines derived from the regional sediment budget analysis. The sediment budget cells are coloured to represent erosion or accretion within the cell.

Arrows indicate direction of net transport at cell boundaries. The along-shore length of each cell marks the approximate limits of cell boundaries. The arrows show flux in units of cy/year. Placement or removal of sediment is included within the cells where needed, typically to account for beach nourishment or dredging (Figure 6).

The sediment budget indicates that sediment is transported down the channel from reach to reach owing to vessel traffic and tidal currents, which adds to shoaling in the channel. The area experiencing the worst shoaling is around PA 62 (Sta. 50+000 to 65+000), where shoaling quantities cannot be accounted for simply with near-shore erosion.

The assumption is made, therefore, that some sediment originates from West Galveston Bay and Greens Lake in this reach and possibly Jones Bay further east, as well.

The following general conclusions are accepted based on the sediment budget analysis of historical data:

1. From Sta. 50+000 to 65+000, approximately 60% of sediment dredged originates from erosion of adjacent GIWW shorelines. The remaining 40% of sediment is assumed to originate from the bay, Greens Lake, or other unknown sources, or is from reach-to-reach transport.
   a) An exception is that shoaling is locally higher at Carancahua Cut and Greens Cut, where more sediment likely originates from the bay.

2. From Sta. 65+000 to 85+000, 40-50% of sediment dredged originates from erosion of adjacent shorelines. The remainder is a result of reach-to-reach transport and the inflow from the bay through Carancahua Cut.

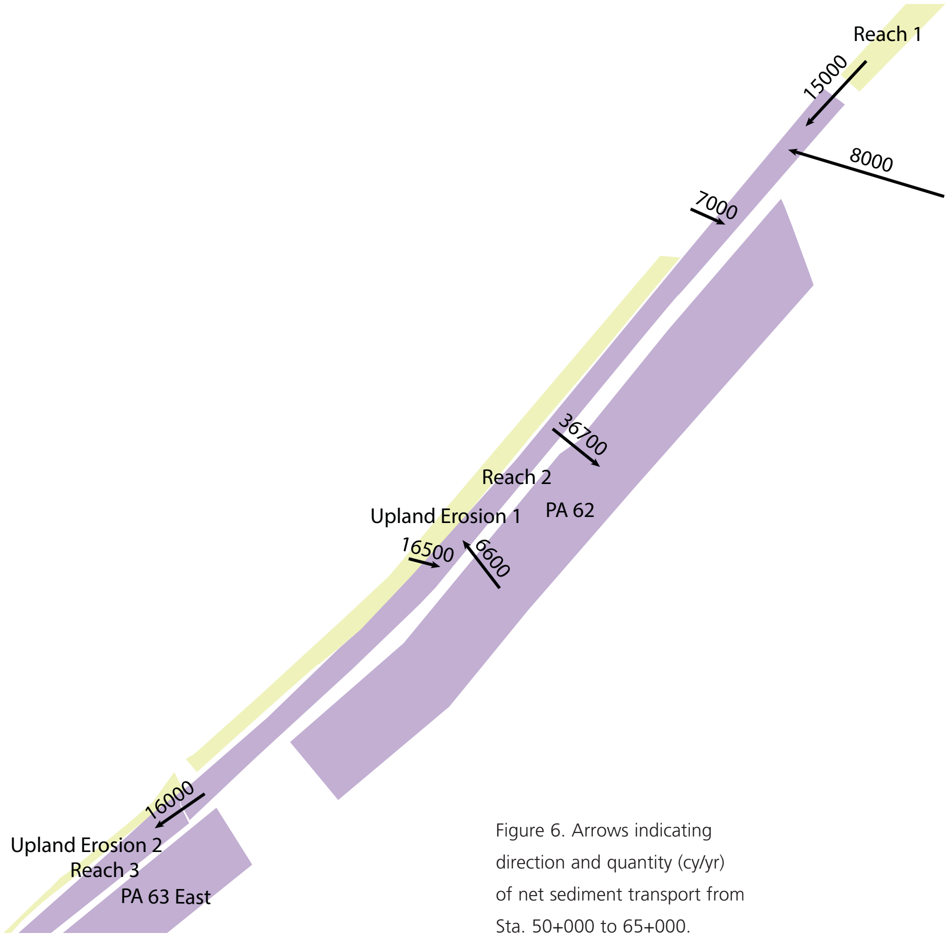

Figure 6. Arrows indicating direction and quantity (cy/yr) of net sediment transport from Sta. 50+000 to 65+000.

3. From Sta. 85+000 to 100+000, 75-85% of dredged sediment is from near-shore erosion in West Galveston Bay, erosion of previously submerged barrier islands and from Chocolate Bay. The remaining 15-25% is from shoreline erosion or other unknown sources.

4. From Sta. 100+000 to 120+000, 90% of the dredged sediment is coming from near-shore erosion in West Galveston Bay and from a combination of wave action and currents from Chocolate Bay. The remaining 10% is presumably from shoreline erosion or other unknown sources.

5. Substantially higher shoaling rates from Sta. 50+000 to 55+000, 60+000 to 65+000 and 85+000 to 90+000, where the barrier islands have already eroded, suggest that the barrier islands may reduce shoaling rates by as much as 5,000 cy/year per 5,000 lft section (= 1 cubic yard/year/linear foot).

6. Comparison of shoreline erosion and dredging requirements suggests that halting shoreline erosion within the GIWW may reduce shoaling by up to 8,000 cy/year per 5,000 lft section (1.6 cy/year/lft).

INITIAL ALTERNATIVES

The primary metric for selecting one or more of these alternatives is quantifiable shoaling reduction. The alternative(s) must stabilise the inlets and reduce near-shore erosion.

The alternative(s) must also be economically feasible and have the potential to be approved by resource agencies. Beneficial use is a preference. Below are the alternatives that were posed for consideration.

On the bay side of the barrier islands, the following initial alternatives were posed for consideration:

- Breakwaters
  - Articulated concrete block (ACB)
  - Rip rap

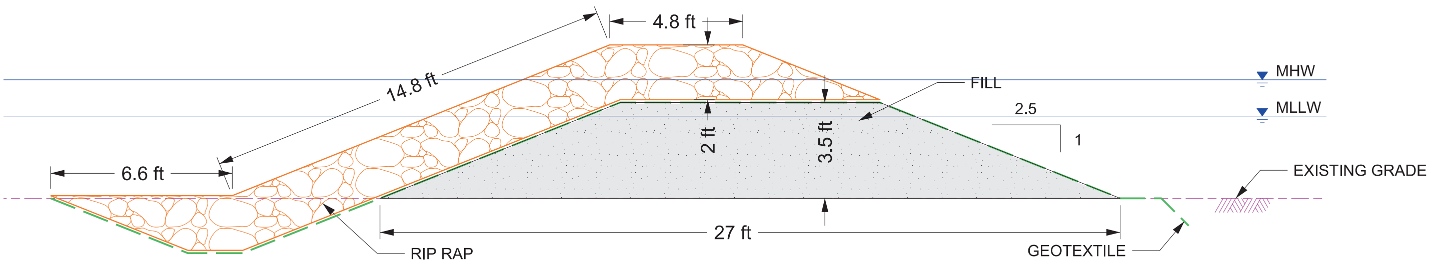

Figure 7. Typical cross-section for rip rap revetment.

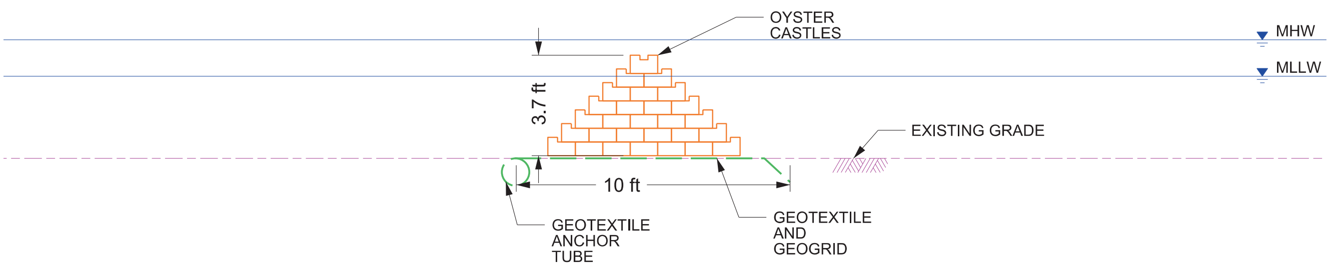

Figure 8. Typical cross-section for Oyster Castle® breakwater.

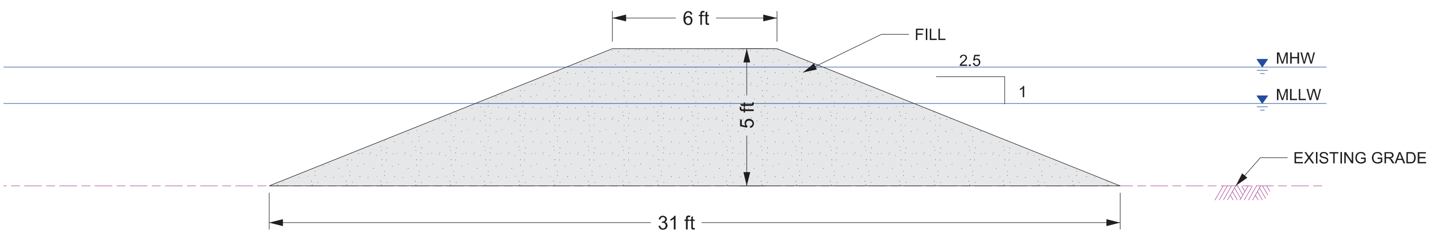

Figure 9. Typical cross-section for sacrificial berm.

- Reef Balls™
- Floating breakwaters
- Oyster Castle®

- Sacrificial Berm – Offshore, continuous placement, beyond environmentally sensitive areas
- Unconfined water placement (historical disposal)
- Sacrificial islands
- Geotubes (if suitable material is present)
- Revetment - ACB with geotextile underlay through which grass can grow, rip rap, Reef Ball™ and so on.
- Vegetation
- Do nothing

For the mainland and channel side of the barrier islands, the following initial alternatives were developed:

- Breakwaters
  - ACB
  - Rip rap
  - Reef Balls™ (Not recommended for the channel side of the islands)
  - Floating Breakwaters
  - Oyster Castle®
- Revetment
- Vegetation
- Do nothing

COST ESTIMATE AND FINAL SELECTION OF ALTERNATIVES

The above initial list of alternatives was later narrowed down to those deemed the most pragmatic for this project area: ACB, rip rap, Reef Ball™, and Oyster Castle® breakwaters; rip rap and Reef Ball™ revetments; and sacrificial berms.

A detailed design was done for each of these alternatives and a cost comparison per linear foot (lft) was performed. Based on the cost comparison, a rip rap revetment was selected as the lowest cost alternative for structures adjacent to channels, costing $501 per lft (Figure 7). Pre-fabricated concrete unit breakwaters, although cheaper at $402 per lft, were not selected for these locations because of the potential for impacts with barges, which would compromise their integrity and require routine maintenance.

The lowest cost alternative for bay side structures is the Oyster Castle®, at $352 per lft (Figure 8). This is also the most constructible alternative for these areas, as this material can be delivered to the construction location on small shallow draft

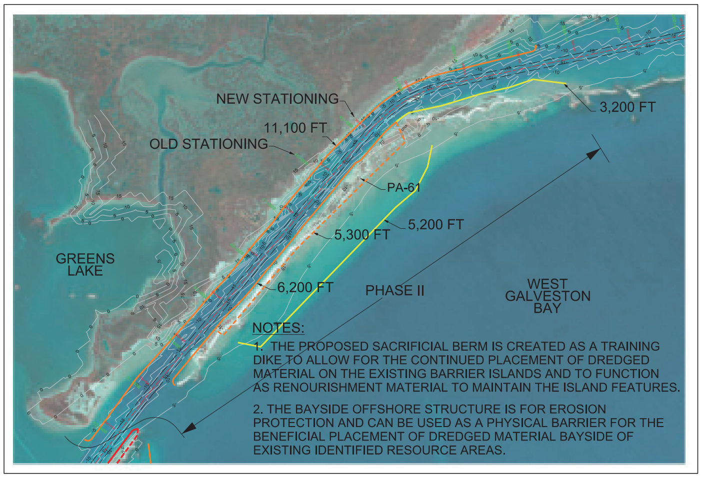

Figure 10. Proposed design layout north of Greens Lake.

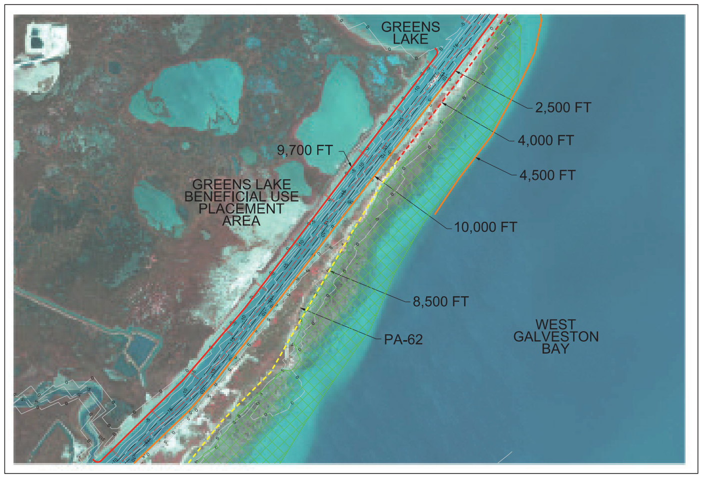

Figure 11. Proposed design layout at PA 62.

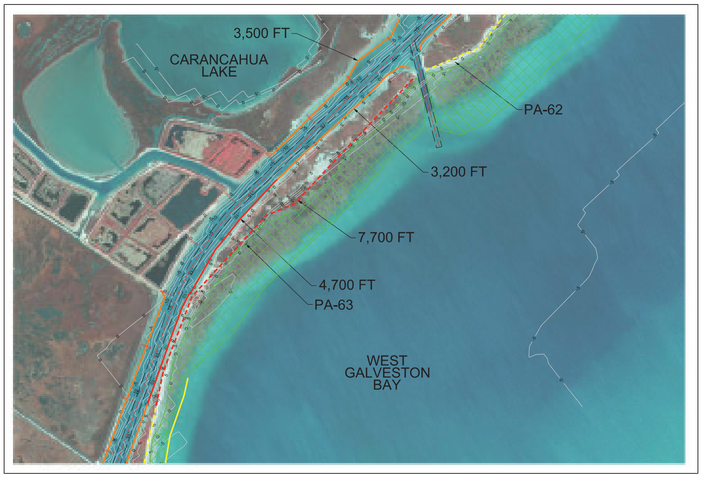

Figure 12. Proposed design layout along PA 63 North.

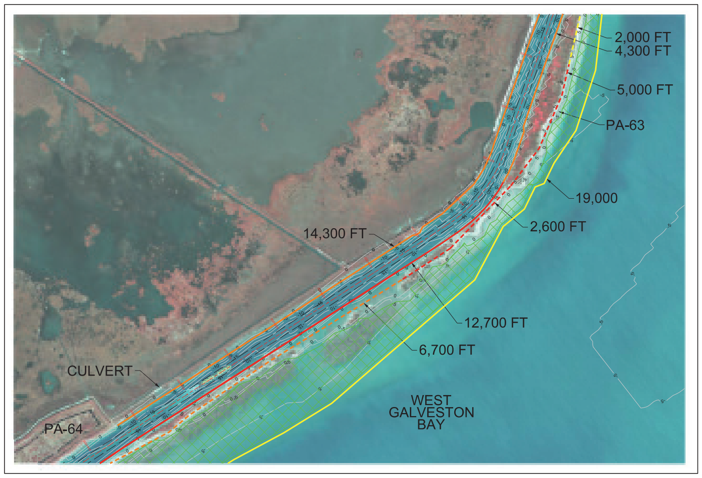

Figure 13. Proposed design layout along PA 63 South.

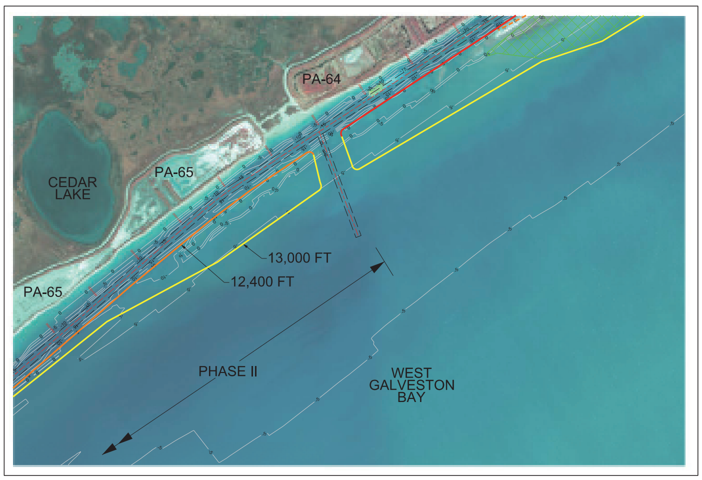

Figure 14. Proposed design layout at PAs 64 and 65.

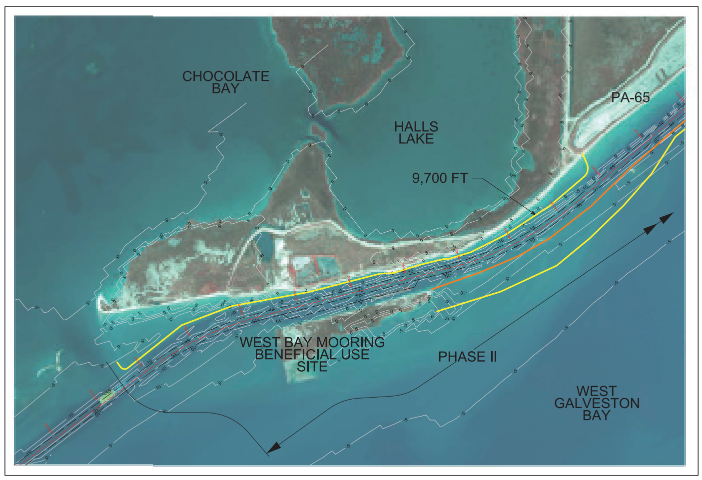

Figure 15. Proposed design layout south of PA 65 to Chocolate Bay.

LEGEND FOR FIGURES 10 THROUGH 15

GIWW CHANNEL
EXISTING CONTOUR
PROPOSED STRUCTURE (PRIORITY 1)
PROPOSED STRUCTURE (PRIORITY 2)
PROPOSED STRUCTURE (BENEFICIAL)
PROPOSED SACRIFICIAL BERM (PRIORITY 1)
PROPOSED SACRIFICIAL BERM (PRIORITY 2)
PROPOSED SACRIFICIAL BERM (BENEFICIAL)
SURVEYED SEAGRASSES
GRAPHIC SCALE
500' 0 500' 1000'
N

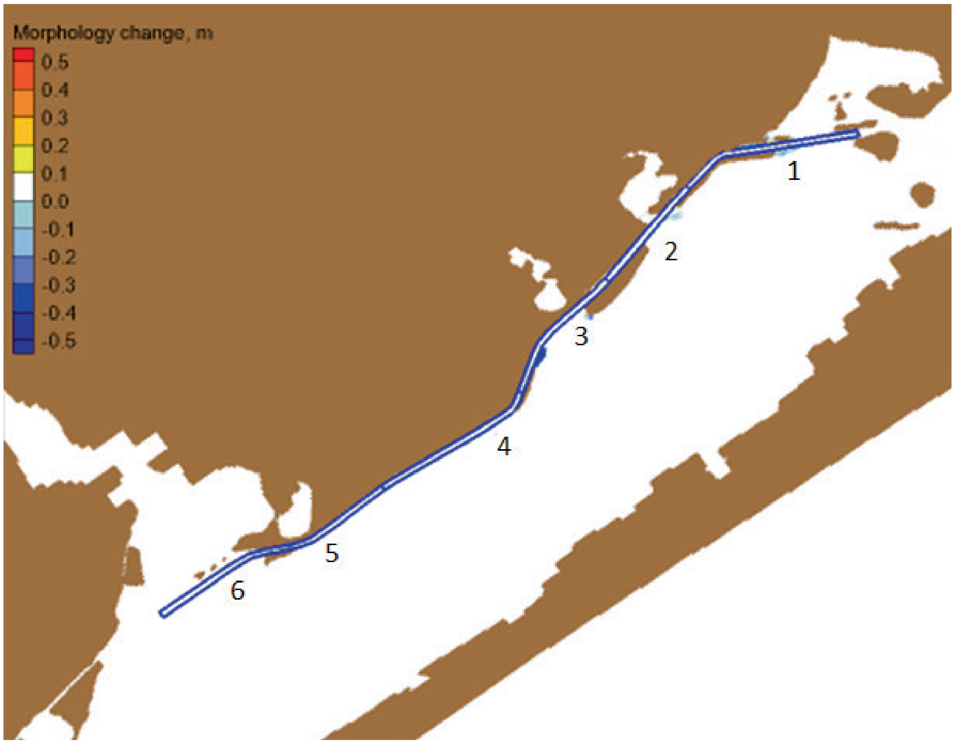

Figure 16. Channel breakdown by section in the Coastal Modelling System (CMS).

boats and can be hand-assembled, requiring no heavy equipment.

However, because the Galveston District has no previous experience implementing Oyster Castles®, implementing mostly rip rap revetment during Phase 1, initially placing Oyster Castles® only where erosion is mild, may prove wiser so that the District can observe how well they work.

In addition to these hard structures, sacrificial berms were chosen for the bay side of the barrier islands, to serve as training dikes and allow for the continued placement of dredged material (Figure 9). The sacrificial berms also function as renourishment material to maintain the island features. The berms are budget friendly, as well, costing under $52 per lft.

The typical cross-sections of all alternatives used in the cost comparison, as well as the cost estimate for the proposed layout, are available as technical references.

PROPOSED DESIGN LAYOUT

The final layout of protection was divided into two phases to make sure that structures in the most critical areas will be implemented first. Phase 1 encompasses PAs 62 through 64, with the regions to the north and south of these placement areas designated as Phase 2. Within each phase, each structure was labelled with a certain priority, based on the severity of erosion and of channel shoaling along that particular stretch of shoreline. The team chose to categorise the proposed designs in this way to make it very clear what the most critical spots are, in case resources are limited and only certain reaches can be addressed.

North of Greens Lake near PAs 60 and 61, a revetment is proposed along both sides of the GIWW. Along the bay side of these barrier islands, a sacrificial berm wraps all the way around to the channel side to provide continued storage of dredged material. A bayside offshore structure, of either Oyster Castles® or rip rap revetment, serves as a means of erosion protection and a physical barrier for the beneficial placement of dredged material bayside of existing identified resource areas (Figure 10).

Along PA 62, channel shoaling and shoreline erosion are major issues, particularly toward the north end. To counter shoaling in the GIWW, both sides of the channel along PA 62 should be protected by revetments. A sacrificial berm is placed on the bayside of PA 62 to help expand the placement areas and prevent them from losing material to the Gulf. In addition, a hard structure is placed offshore beyond the sea grasses along the north end of the bay side of PA 62 to help protect the barrier island from further erosion. Erosion is not as severe further south along PA 62, so the sacrificial berm in this area is designated "Beneficial" and the offshore hard structure does not continue (Figure 11).

The northern half of PA 63 is also seeing significant erosion and the GIWW shoals steadily in this area, as well. To combat these issues, a revetment is proposed on both sides of the channel (Priorities 1 and 2), and a proposed sacrificial berm runs along the bay side (Priority 1) (Figure 12).

The revetment continues on both sides of the GIWW along the southern half of PA 63, as does the sacrificial berm on the bay side. In addition, a hard structure is placed offshore beyond the seagrasses as a "beneficial"

Table III. Model volume change (cubic yards), Jan-Dec 2010.

Channel Sections	Existing Channel	Priority 1 Structures	All Priorities
1	156,140	155,440	148,920
2	89,530	74,030	35,680
3	125,630	48,840	41,150
4	550	2,750	3,130
5	3,360	2,770	8,880
6	21,530	21,640	25,990
Total (Sec1-6)	396,750	305,470	263,750

structure to prevent further erosion (Figure 13). The proposed revetment along the mainland stops at PA 64 because PAs 64 and 65 are currently armoured with ACB. The hard structure around PA 63 extends southwest all the way towards the west end of PA 64. Another hard structure is proposed offshore adjacent to PA 65 (Figure 14). These new dikes will provide capacity to store a sizable amount of additional dredged material.

West of PA 65, the revetment continues along the mainland side of the GIWW to Chocolate Bay. The offshore dike previously mentioned extends to the West Bay Mooring Beneficial Use Site (Figure 15).

MODELLING PROPOSED STRUCTURES IN CMS

The proposed structures and sacrificial berms were added into the CMS, and the model was run to verify the impact of these designs on channel shoaling rates and morphology in the study area. The model was run for the entire year of 2010 with:

1. existing channel conditions,
2. Priority 1 structures and sacrificial berms implemented, and
3. structures and berms of Priorities 1 and 2 implemented.

The calculated morphology change for 2010 in the GIWW was compared in six channel sections, from PAs 60 and 61 (Section 1) at the north end to Chocolate Bay at the south end (Section 6) (Figure 16).

The model shows a significant reduction in shoaling in the GIWW over the entire project area as a result of the proposed design layout. The reduction is particularly substantial around Sections 2 and 3, which roughly correspond to PAs 62 and 63. Shoaling in Section 2 of the channel is reduced by 60 percent when Priority 1 and 2 structures are added. In Section 3, shoaling is reduced by 67 percent when Priority 1 and 2 structures are added.

While there are a few areas that experience an increase in shoaling as a result of the proposed designs, over the entire study area, shoaling is reduced by 23 percent when Priority 1 designs are implemented and 34 percent when designs of Priorities 1 and 2 are implemented (Table III).

CONCLUSIONS

The Texas Gulf Intracoastal Waterway (GIWW) is primarily a land cut navigation channel constructed by the Federal government starting in 1873. In 2010, more than 72.7 million tonnes of cargo transitted along the Texas portion of the GIWW with an estimated value of $40.7 billion. The GIWW provides an intra- and inter-state link between the Gulf deep-draft ports, refineries and chemical processing facilities and will continue to play an important role after the expansion of the Panama Canal.

Maintaining the Texas GIWW had become increasingly difficult as traditional dredge placement options were reduced or eliminated. This study developed a regional sediment budget and assessment of coastal sediment needs along the GIWW from just north of Greens Lake to Chocolate Bay.

Based on the team’s findings and with US Army Engineer Research and Development Center's (ERDC) Coastal Modelling System (CMS) verification, it is apparent that protecting the barrier islands with a combination of hard structures and sacrificial berms will reduce shoaling in the region and ensure the continued availability of placement areas. Several design alternatives are suggested to protect the barrier islands and reduce shoaling in the Texas Gulf Intracoastal Waterway (GIWW).

Based on the cost comparisons, a rip rap revetment was selected as the lowest cost alternative for structures adjacent to the channels, costing $501 per lft. Pre-fabricated concrete unit breakwaters, although less costly at $402 per lft, were not selected for these locations owing to potential impacts with barges, which would compromise their integrity and require routine maintenance.

The lowest cost alternative for bay side structures is Oyster Castles® at $352 per lft. This is also the most constructible alternative for these areas, as this material can be delivered to the construction location on small shallow draft vessels and hand-assembled, requiring no heavy equipment. In addition to these hard structures, sacrificial berms were chosen for the bay side of the barrier islands, to serve as training dikes and allow for the continued placement of dredged material.

The sacrificial berms also function as renourishment material to maintain the barrier island’s footprint features. The berms are economically friendly, as well, costing less than $52 per lft.

This report is intended to improve Regional Sediment Management (RSM) communication both within the Galveston District and between the Galveston District and its partnering organisations. This work follows the standard procedures of the US Army Corps, RSM programme of first identifying a problem, understanding the physical processes, and then ultimately working to find a solution.

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