



OFFICIAL CORPS REPORT EXCERPT

Galveston Ring Barrier

Selected Pages from the 2021
Final Feasibility Report

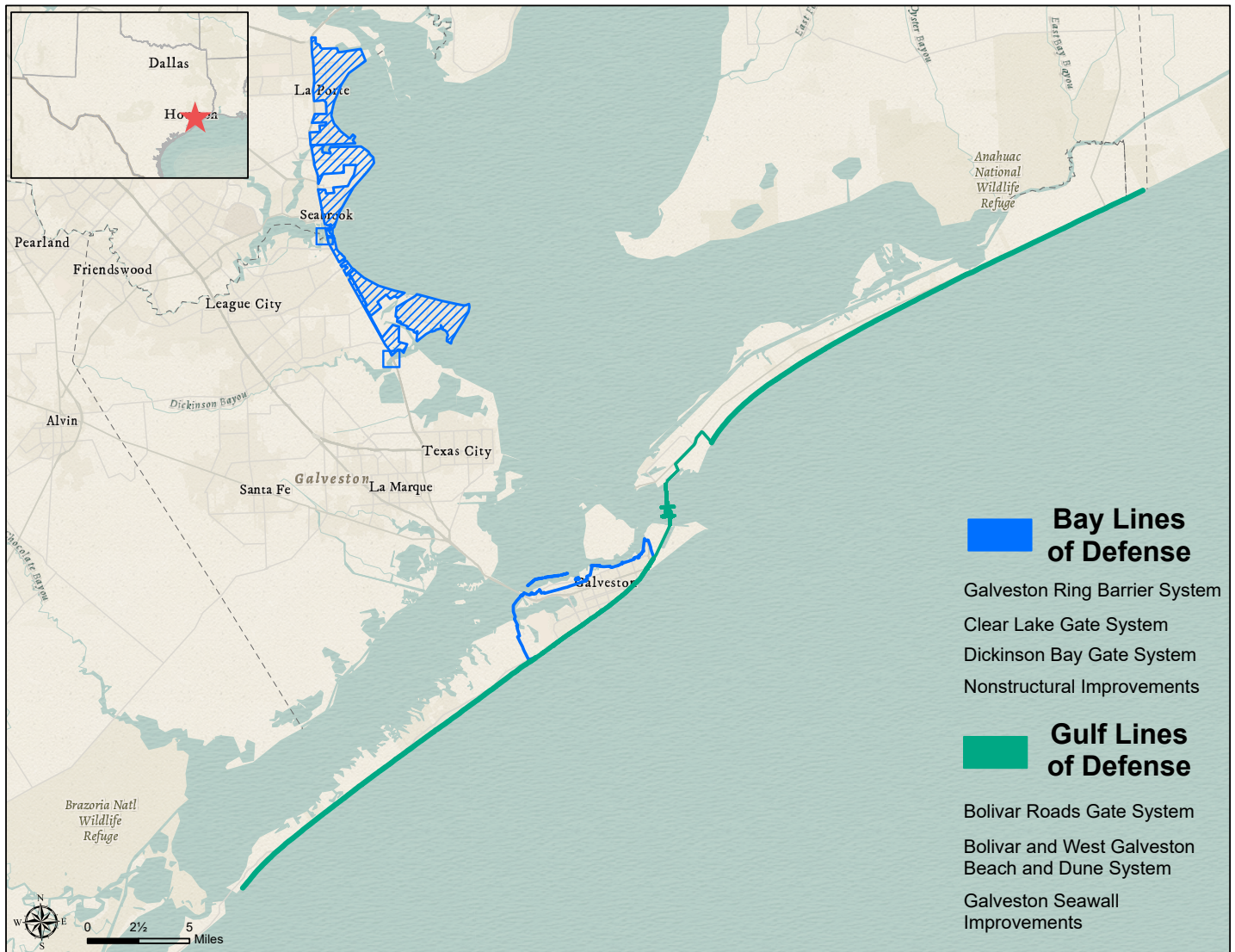
WHAT THIS EXCERPT CONTAINS

The following pages are reproduced unchanged from the U.S. Army Corps of Engineers' Coastal Texas Protection and Restoration Feasibility Study Final Report. They describe the proposed Galveston Ring Barrier System, including its alignment, floodwalls, gates, pump stations, drainage structures, and principal reaches.

Original report pages: 100-110

Source: U.S. Army Corps of Engineers, Galveston District

This cover was added by Protect Galveston Now for reader convenience. It is not part of the Corps report.



3.4.2. Bay Defenses

Similar to those proposed for the TSP, the Bay defenses include four independent but connected features, explained in detail in the indicated sections:

- **Section 3.4.2.1:** An 18-mile GRBS that impedes Bay waters from flooding neighborhoods, businesses, and critical health facilities within the City of Galveston;
- **Section 3.4.2.2:** A surge gate at Clear Lake that would reduce surge volumes that push into neighborhoods in the Clear Lake area;
- **Section 3.4.2.3:** A surge gate at Dickinson Bay that would reduce surge volumes that push into neighborhoods in the low-lying areas along Dickinson Bayou; and
- **Section 3.4.2.4:** Complementary non-structural measures to further reduce Bay-surge risks along the western perimeter of Galveston Bay.

The features which comprise the Bay defenses, and their location compared to the Gulf defenses, are shown in Figure 3.35. Additional detail on each of these features are provided in the following sections.

Figure 3.35: Bay defenses



A photo of Kemah on Clear Lake

3.4.2.1. Galveston Ring Barrier System

The GRBS, a CSRM measure consisting of a system of floodwalls, gates, pump stations, and levee sections, is proposed to address the residual risk that persists for the area as a result of wind driven storm surges from the Bay and provides flood risk management for approximately 15.8 square miles of the City of Galveston. The Bay is large enough that increased water surface elevations in the area can result from wind and fetch within the bay, even as the Bolivar Roads Gate System significantly reduces the storm surge entering the Bay from the Gulf of Mexico. The proposed GRBS ties into the existing Seawall and proceeds clockwise from the west end of the Seawall north in the proximity of 103rd Street to Offatts Bayou, crosses the Teichman Point area and ties into I-45, continues east along the Harborside area to the 47th street area, then continues north to the Galveston Ship Channel, then continues east through the Port of Galveston to the University of Texas Medical Branch (UTMB), turns northward to the Ferry and then back south to the Seawall. Numerous tradeoffs between project cost, project impacts and overall effectiveness of the GRBS were evaluated and made during the refinement of the alignment. The team will continue to avoid and minimize impacts where possible as the system is refined in the PED phase.

The elevation of the walls and gates were set at an elevation of 14.0 ft (NAVD88), based on TWL, which considers still water level and wave overtopping, with a 1% AEP under the Intermediate RSLC Scenario. Determination of this elevation, which is subject to revision during the PED phase, is detailed further in Section 2.7.1 in Appendix D.

The general layout of the GRBS is shown in Figure 3.37. Additional descriptions of the eleven primary segments/components of the GRBS are detailed in the following subsections. In addition, Figure 3.36 includes multiple conceptual renderings which show common features employed across the GRBS, including floodwalls, vehicle closure gates, and drainage structures. Additional information on the GRBS is provided in Section 4.4 and Section 6.4 of Appendix D.

By the Numbers: GRBS

- 10.0 mi of Floodwall
- Sector Gate at Offatts Bayou
- Gates at Roadways (34) and Rail Crossings (7)
- Dredging of Crash Boat Basin
- 16 Drainage Structures
- 4,500 cfs Pump Station at Offatts Bayou
- 50 cfs Pump Station at Gas Pipeline
- Nonstructural Measures in Channelview
- Offshore breakwaters
- 5,000 cfs pump station at 48th Street
- 1,500 cfs pump station at Pier 19
- 5,000 cfs pump station at UTMB
- 500 cfs pump station at Fort Point Rd
- Mitigation for Direct and Indirect Impacts

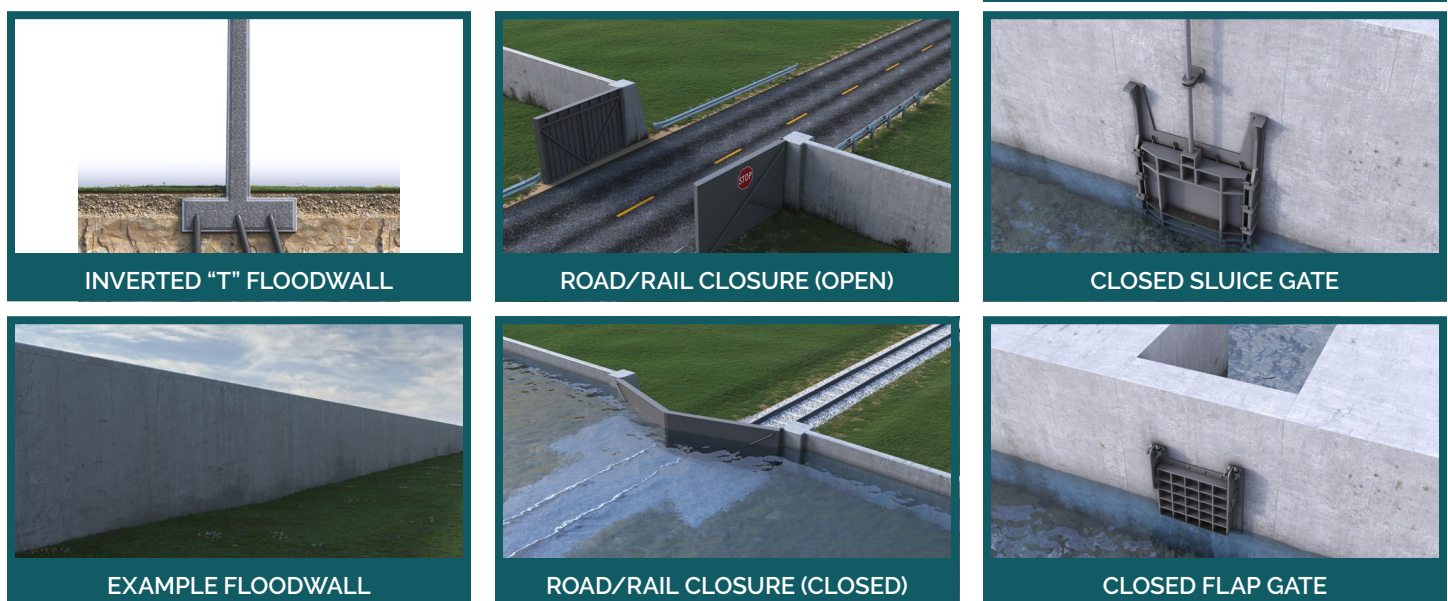


Figure 3.36: Conceptual renderings of GRBS components

Coastal Texas Protection and Restoration Feasibility Study

Galveston Ring Barrier System

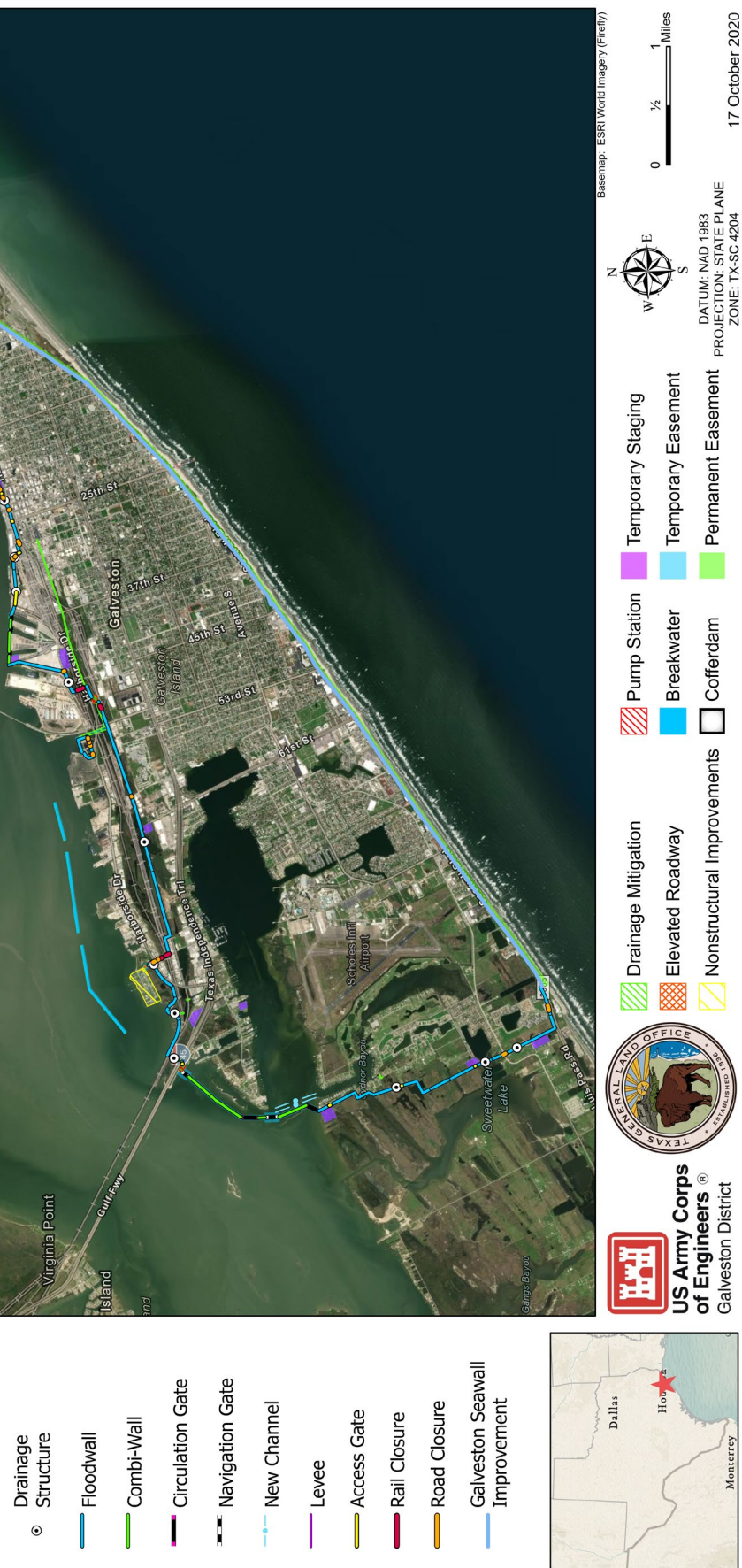


Figure 3.37: Galveston Ring Barrier System

3.4.2.1.1. Seawall Tie-in

The start of the GRBS is at the west end of the Seawall tying into the existing backfill north of the north sidewalk of the Seawall. This section of floodwall extends west, crosses Cove View Boulevard with two vehicle gates, and continues west to the vicinity of the City's Sandhill Crane soccer fields. The barrier here would be an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). Existing drainage would be maintained and modified as needed to avoid any impacts from the construction of the floodwall. The tie-in to the Seawall was chosen to avoid gate closure structures across FM 3005. This allows for FM 3005 and the west end of Galveston Island to remain open to traffic during a storm surge event. This also places the tie-in for the west floodwall of the GRBS behind the Seawall, a more resilient location away from the high energy waves that the dune system may see.

3.4.2.1.2. Seawall Tie-in to Soccer Field Reach

The west floodwall of the GRBS continues north from FM 3005, adjacent to the City's Sandhill Crane soccer fields, and crosses Stewart Road with two vehicle gate structures. The barrier here would be an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). Existing drainage will be maintained and modified as needed to avoid any impacts from the construction of the floodwall. Currently one drainage structure is proposed for this reach of floodwall. Locating the floodwall adjacent to and on City of Galveston property limits the impact to adjacent private property owners while taking advantage of open areas and City land to utilize as staging areas. The staging area will have access to both of west Galveston's major roadways, FM 3005 and Stewart Road. The vehicle closure gates at Stewart Road would be closed during a storm surge event. The Stewart Road vehicle traffic will be redirected to FM 3005 during a storm surge event.

3.4.2.1.3. Soccer Field to Galveston Bay Foundation (GBF) Preserve Reach

The west floodwall of the GRBS continues north onto the GBF Sweetwater Preserve until it reaches Offatts Bayou. The barrier here would be an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of +14 ft (NAVD88). Existing drainage will be maintained and modified as needed to avoid any impacts from the construction of the floodwall. Currently two drainage/circulation structures are proposed for this reach of floodwall, allowing for two-way water flow. The drainage structures will be 14 ft wide and 10 ft tall with sill elevations of -5 ft (NAVD88). This section of floodwall has three access gates to allow for maintenance of the GBF property. A small area of drainage impact mitigation is noted in this area to ensure that any impacts created by the construction can be addressed.

Locating the floodwall on GBF property limits the impact to adjacent property while taking advantage of the open undeveloped areas along the property boundaries, avoiding the division of neighborhoods. The staging area will have access to Stewart Road and will be restored to previous condition when the project is complete.



A photo of coastal marsh in West Galveston

Locating the floodwall on GBF property limits the impact to adjacent property while taking advantage of the open undeveloped areas along the property boundaries, avoiding the division of neighborhoods.

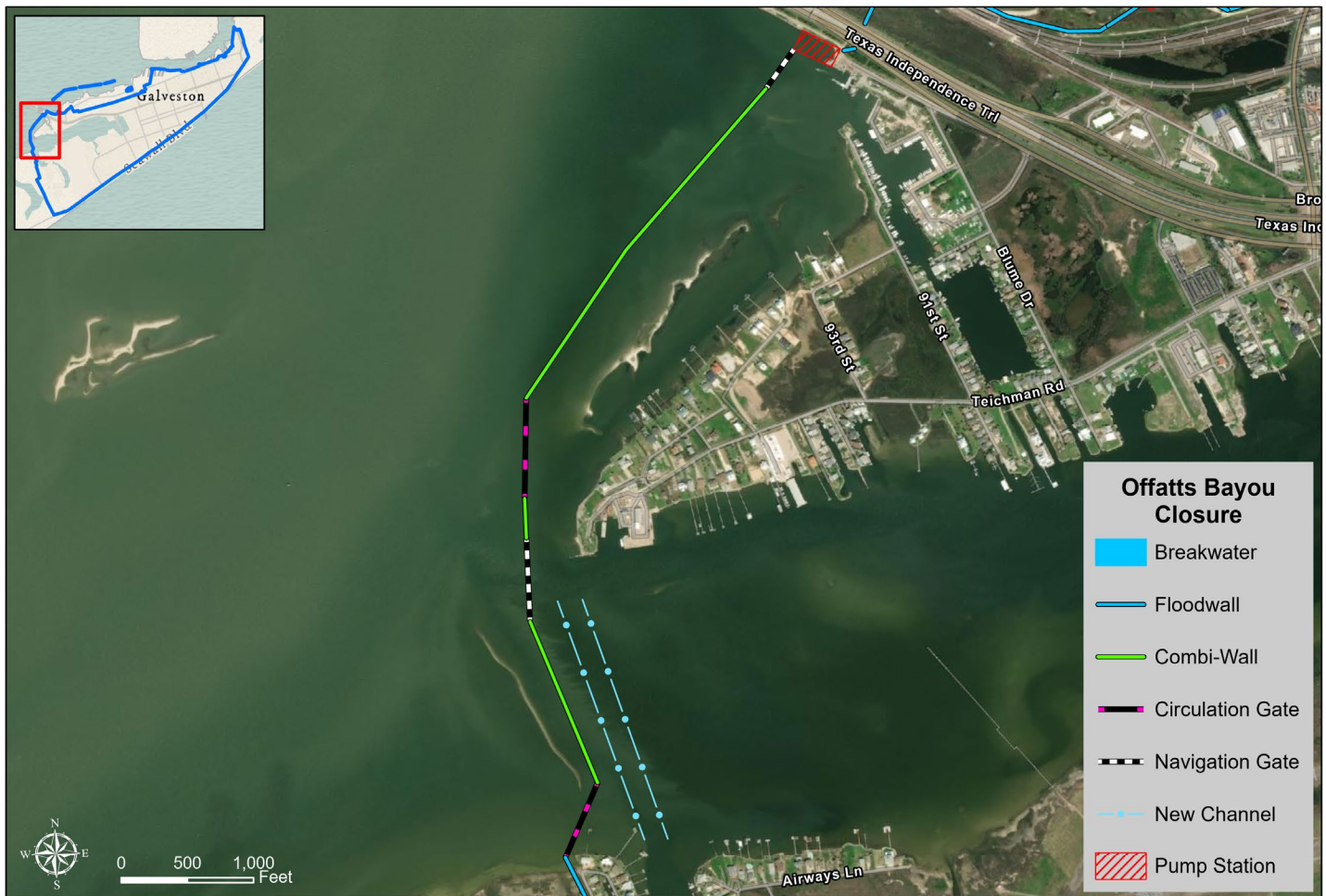


Figure 3.38: Offatts Bayou crossing

3.4.2.1.4. Offatts Bayou Crossing Reach

The closure of Offatts Bayou starts at the edge of the GBF property, continuing north then northeast offshore of the Teichman Point neighborhood, then ending at the proposed Offatts Bayou pump station adjacent to the Galveston Causeway. This barrier is a combination floodwall system (combi-wall), consisting of vertical piling, batter piling, and a concrete cap system. This feature also includes sections of shallow water environmental gates/water circulation gates and two shallow-draft navigation sector gates. Figure 3.38 provides additional detail for the Offatts Bayou crossing.

Two main alternatives were evaluated for the Offatts Bayou crossing in the Teichman Road neighborhood. They consisted of the chosen alignment and an alternate alignment that excluded the neighborhood from the GRBS. The alternate alignment would have paralleled the shoreline of the Crash Boat Basin neighborhood and placed the Offatts Bayou pump station adjacent to a residential area. The alternate alignment would have an inverted "T" floodwall section with a road raising, road closures, and drainage features. The planning

level assessment of the cost of the two alternatives resulted in the chosen alignment being taken forward in the study.

The Offatts Bayou crossing impacts the Crash Boat Basin access channel, so a new channel is proposed as shown. The shallow water circulation gates are placed in areas where existing circulation will be impacted by the construction. The shallow-draft navigation gates are shown as sector gates to ensure the existing use of the channels are not impacted by the construction. The offshore floodwall is located in an area to limit impacts to known habitat.

3.4.2.1.5. Offatts Bayou Pump Station and Galveston Causeway to 77th Street Reach

The proposed 4,000 cubic foot per second (cfs) Offatts Bayou pump station will be located at the intersection of the combi-wall and the Galveston Causeway. The pump station is situated at this location to allow for easy access during operations and to provide separation from residential structures. The sizing of this pump station will be refined during PED, when the interior drainage analysis is updated.

The Galveston Causeway crossing is a floodwall and vehicle closure gate from the Offatts Bayou pump station to the bridge abutment. The high ground of the bridge abutment will be incorporated into the alignment as a barrier at the I-45 crossing. An inverted "T" floodwall will then proceed east to the railroad bridge, where the high ground of the railroad bridge will be incorporated into the alignment as the barrier at the railroad crossing. The inverted "T" floodwall will continue east to southeast along the railroad abutment, then loop out to include the natural gas facility, and then continue east along Harborside Drive to 77th Street. This section of floodwall is an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). Existing drainage will be maintained and modified, as needed, to avoid any impacts from the construction of the floodwall. A circulation drainage structure is located on the floodwall section between I-45 and the railroad bridge, and a storm water drainage structure is located near the natural gas facility.

A photo of the Galveston Causeway

The utilization of the bridge abutments for crossing I-45 and the railroad bridge allows for GRBS to avoid closing off access to the Island. This alignment also limits impacts to the continuous functionality of the rail lines on and off the Island. The inclusion of the natural gas facility provides flood risk management to critical infrastructure.





Figure 3.39: Channelview mitigation measures

3.4.2.1.6. 77th Street Crossing and the Channelview Neighborhood

The 77th Street crossing is proposed to be an elevated roadway crossing to eliminate the need for a gate structure and avoid locking out the residents located outside of the GRBS. This will allow for continuous access to the Channelview neighborhood during a surge event. The road raising will consist of a floodwall that will be buried under the roadway along with retaining walls that will allow for the entire roadway to be raised from Pruitt Street to Harborside Drive.

Many of the residential homes in the Channelview neighborhood are already raised to prevent inundation from coastal storm surges. However, a portion of the homes on the interior streets are still slab on grade homes. Due to the close proximity of residential structures to the floodwall, and due to concerns with wave action deflecting off the floodwall, mitigation measures are being

included in the recommendation to address the uncertainty surrounding the issue.

Offshore breakwaters (blue lines on Figure 3.39) are recommended to reduce wave heights during storm events to mitigate part of the risk. Nonstructural measures for residential structures in the Channelview neighborhood (yellow cross hashed area in Figure 3.39) are also recommended to address risk due to the proximity of the neighborhood to the floodwall. Although a cost estimate was developed for voluntary home elevations, the uncertainty associated with successful implementation of raising houses caused this option to be set aside for nonstructural buyouts. The higher cost of buying out homes is carried forward in the recommendation. In PED, the existing surge risk, and induced surge risk from the floodwall, will be further investigated to determine if the nonstructural mitigation measures need to be implemented.

3.4.2.1.7. 77th Street to 47th Street Pump Station

The GRBS alignment through the Harborside area, from 77th Street to the proposed 47th Street pump station, goes south from the 77th Street crossing, then east adjacent to the railroad track, then under the 51st Street bridge to the 47th Street pump station. This section of barrier is an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). Existing drainage will be maintained and modified as needed to avoid any impacts from the construction of the floodwall. This reach also includes an offshore breakwater, as noted in Section 3.4.2.1.6, to mitigate the wave impacts to residential and industrial areas.

The alternate alignments evaluated through this area included an alignment along the north side, south side and middle of Harborside drive, and immediately south of the industrial area along Harborside drive. The impacts of these alignments on the industrial area and traffic on Harborside were significant and the efforts to minimize the impacts resulted in the recommended alignment. The proposed alignment limits the required number of gate closure structures for rail and roads and maintains a comparable length to keep similar costs. This reach also includes a structural measure at the wastewater treatment facility at 51st Street. This measure is currently proposed as a floodwall but could potentially be reduced in scope or possibly eliminated in PED after the facility is thoroughly evaluated.

3.4.2.1.8. Pump Station at 47th Street.

The proposed pump station at 47th Street is a 4,000 cfs in size and includes gravity drainage and drainage impact mitigation features that extend from Galveston Bay to 27th Street. The pump station is situated at this location to allow for easy access during operations and to provide separation from residential structures. The sizing of this pump station will be refined during PED, when the interior drainage analysis is updated. This pump station will have gravity drainage features that allow for the drainage of rainfall without the operation of the pumps.

This pump station also has two significant drainage impact mitigation features. The first drainage feature is the outlet channel. The pump station is located inland and will require a discharge channel to be constructed through an area that has significant existing railroad infrastructure. This will require replacing culverts along rail lines with bridges to allow for the flow of the water from the pump station to Galveston Bay. There is also a road that will need to be converted to a bridge to allow for the increased flow. The second drainage feature is an intake canal that will bring water to the pump station. This feature is required to connect some of the existing gravity drainage systems that will be cut off during construction and operation of the

GRBS. This feature will proceed from the pump station at 47th Street, generally along the Mechanic Street corridor to 28th Street, and will be a combination of open channel and large buried drainage conduit. The size of these drainage impact mitigation features will be refined during PED when the interior drainage analysis is updated.

3.4.2.1.9. 47th Street Pump Station through Port of Galveston to 19th Street.

The alignment of the barrier from the 47th Street pump station, through the Port of Galveston, and to the Pier 19 area is a combination of features including floodwall, moveable floodwall sections, and vehicle closure structures. The alignment starts at the 47th Street pump station then proceeds east to the Harborside Drive bridge abutment. The system turns north and passes through the bridge abutment, incorporating the bridge abutment into the alignment, then continues across the rail lines and proceeds in a north-northeast direction to the Galveston Ship Channel. This section of floodwall is an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). The alignment then turns east and proceeds across the dock and closes off the three existing shipping slips. This section of floodwall is also an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). The floodwall would include an above ground height of approximately 3 ft with limited areas of 4 ft above the ground height. The alignment continues east as a moveable floodwall section through the laydown area. The floodwall would consist of a moveable "stem" section, with the foundation, and footing below ground. The alignment then weaves through the grain elevator area and the cruise ship terminal to the Pier 19 area. This section of floodwall is also an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). The floodwall would have an above ground height of approximately 6 ft with limited areas of 8 ft above the ground height. Existing drainage will be maintained and modified as needed to avoid any impacts from the construction of the floodwall.

The alignment in this area was chosen to eliminate the need for vehicle closure gates on Harborside Drive and to minimize dissecting Port facilities. This alignment reflects adjustments made to conform to the Galveston Wharves Strategic Master Plan. Coordination with the port on the proposed alignment led to the elimination of a significant number of vehicle closures, and provides a shorter length of floodwall than was originally proposed. This coordination will continue in PED to further refine and enhance the project features in the port facility.

3.4.2.1.10. Pier 19 Reach

The project features and alignment through the Pier 19 area were refined to conform with the proposed land use changes in the Galveston Wharves Strategic Master Plan. These changes reduced impacts to access and operations within the port area. This refinement also allowed for the elimination of rail closure structures and the consolidation of vehicle and access closure structures. This section of floodwall is an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). The floodwall will have an above ground height of approximately 6 ft.

The proposed pump station at Pier 19 is a 1,500 cfs pump station. This location is being coordinated with the City of Galveston and will likely shift to Pier 16 during PED, where the City is currently in the design phase for a City owned pump station. The size and final location of the Recommended Plan's pump station will be determined during PED, in close coordination with the City of Galveston.

3.4.2.1.11. Pier 19 through Port of Galveston to UTMB

The project features and alignment from Pier 19 through the port were refined to conform to the proposed land use changes in the Galveston Wharves Strategic Master Plan. These changes allowed for the alignment to adjust and reduce impacts to access and operations within the port area. This refinement also eliminated the need for rail closure structures and allowed the consolidation of vehicle and access closure structures. This section is an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). The floodwall would have an above ground height of approximately 8 ft. Existing drainage will be maintained and modified as needed to avoid any impacts from the construction of the floodwall.

3.4.2.1.12. UTMB to Harbor View Reach

The alignment of the GRBS through UTMB generally goes east from the Port of Galveston property, follows the shoreline near the helipad, turns north along the dock area, then east toward the Primary Care Pavilion (PCP), then north-northeast to the Galveston Yacht Basin, then continues to the shoreline at Harbor View Drive. This section is an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). The floodwall would have an above ground height of approximately 8 ft with some areas up to 12 ft. This reach also has a pump station and some drainage impact mitigation features.

The proposed pump station at UTMB is a 4,000 cfs pump station. The location is currently shown on UTMB property adjacent to a channel off of the Galveston Ship Channel. This pump station would require drainage features to bring the water to the pump station. These features would tie into the existing City drainage outlet that is in the vicinity of the proposed pump station. This reach was coordinated with UTMB and the initial alignment was adjusted to remove numerous closure structures and to relocate the pump station away from critical infrastructure. These changes allowed for a reduction in the length, complexity, and impacts of the GRBS. Additional coordination during PED could further enhance the project in this area. The alignment through the Galveston Yacht Basin was chosen to reduce the number of closure structures, while not impacting accessibility. Coordination during PED is needed to reduce impacts and capitalize on opportunities to increase benefits in this area.



A photo of Harbor View

The alignment through the Galveston Yacht Basin was chosen to reduce the number of closure structures, while not impacting accessibility. Coordination during PED is needed to reduce impacts and capitalize on opportunities to increase benefits in this area.

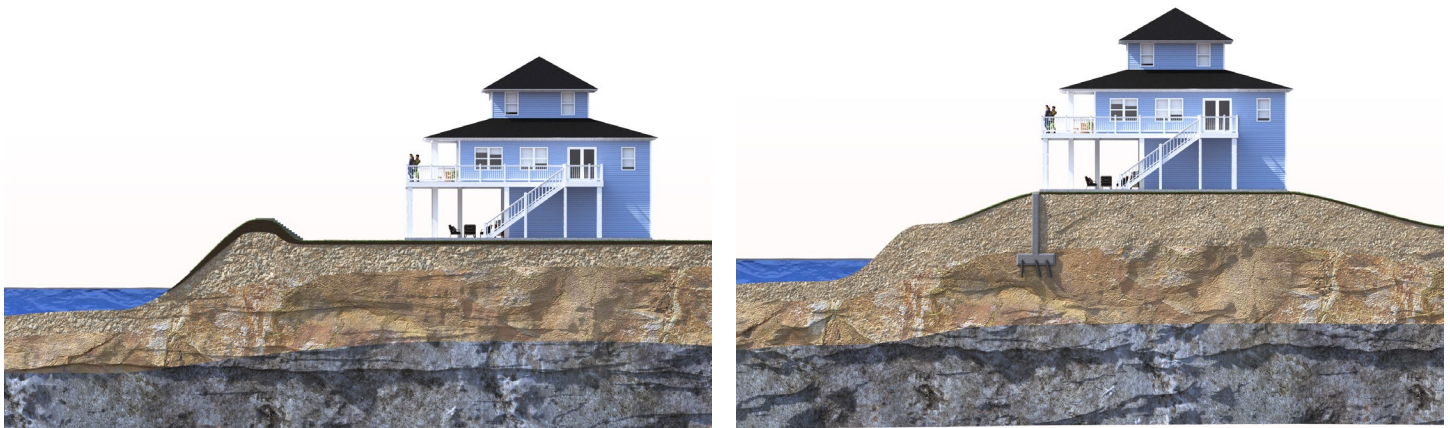


Figure 3.40: Harbor View Drive alternatives

3.4.2.1.13. Harbor View Drive and Circle

The alignment of the GRBS along Harbor View Drive is located along the waterfront, on top of and incorporated into the existing old stone jetty. This feature would require raising the existing jetty to elevation 14 ft (NAVD88) and implementing seepage control measures to prevent seepage through the foundation and structure of the old jetty. These features would be constructed on and within the old jetty and would not extend to the residential structures but could impact pools or other backyard structures.

An alternative solution for this reach could be to raise the residential structures and place a floodwall structure beneath the homes, then backfill with acceptable fill material to place the alignment underneath the homes. This would be invasive to the homeowners but would potentially allow for a less expensive feature that could ultimately be less intrusive than raising the jetty. Conceptual renderings of these different alternatives are shown in Figure 3.40.

3.4.2.1.14. Ferry Landing to Galveston Seawall East End Reach

The GRBS alignment continues from the north end of Harbor View as floodwall going east across Ferry Road to the Fort Point Road pump station, then crossing Fort Point Road, then turning south along the existing levee of the San Jacinto placement area and terminating at the Galveston Seawall. This section is an inverted "T" concrete floodwall with a deep foundation and a top of wall elevation of 14 ft (NAVD88). The floodwall would have an aboveground height of approximately 6 ft with some areas up to 10 ft. This reach also has a pump station and some drainage impact mitigation features along with a levee section.

The proposed pump station at Fort Point Road is a 1500 cfs pump station. The location is currently shown adjacent to Fort Point Road and would require drainage features to bring the water to the pump station and out to the Galveston Ship Channel. These features would tie into the existing City drainage outlet that is in the vicinity of the proposed pump station. The pump station would include gravity drainage features that would allow for drainage without running the pumps.



A photo of East Galveston and Bolivar Roads

3.4.2.1.15. Pump Stations and Drainage Outlets Associated with GRBS

As discussed above, the GRBS includes a series of pump stations and drainage outlets. While the majority of drainage systems in the Galveston area are gravity driven, the City of Galveston is continuing to make improvements to the system, including forced, or pumped, drainage systems. As discussed below, the Recommended Plan only focuses on addressing rainfall when the system is closed. The pumping system has not been formulated or refined to address flooding from Urban Flood Control problems. More focused Urban Flood Control authorities exist in the Galveston area that could be enacted in the future to address localized rainfall flooding. The USACE will continue to work with the City to ensure that there are no conflicts between the City's current or future plans and the Recommended Plan.

As discussed above, the GRBS system would include a series of drainage outlet structures to allow water exchange and hydrologic connectivity. This hydrologic connectivity would be maintained to the extent practicable through water control structures, except during gate closures for surges from hurricanes or tropical storms. When these gates are closed, the pump stations will need to operate to remove water due to rainfall within the GRBS and/or wave overtopping. While the pumps are initially designed to handle 25-year rainfall with surge tail water boundary conditions of 1% AEP (detailed in Section 2.7.4 in Appendix D, the Engineering Appendix), the compound interaction of rainfall and surge has not been fully explored in this phase of the study. The operational criteria of the gates and pump stations will need to be fully assessed in the PED phase. The gate operations will be dependent on the intensity, track and orientation of the approaching storm, which will dictate the trigger condition for gate closings. Pumps will be operated when the intake water level is higher than the outfall water level. This expected rate of closure would be the same regardless of the actual rate of relative sea level rise, as closure of the system is tied to tropical storm surge events and the elevation trigger would be adjusted as sea level rises. The risk reduction system is only authorized to address storm surge caused by hurricane and tropical storm events. It is not authorized to mitigate for or reduce impacts caused by higher day-to-day water levels brought about by increases in sea level rise. To manage rainfall induced flooding of the areas behind the structure, all drainage features through the system were sized to match the existing capacity of the gravity drainage system, and would mimic the existing drainage patterns. Any operational changes implemented to address changing sea level conditions, or for any other non-project-related purpose, would be considered a separate project purpose requiring separate authorization, new NEPA documentation, and/or permit approvals.

The non-Federal sponsor will have obligations related to the operation of the project, specifically the pump stations, to prevent encroachments that would impact the utility of the project when the pump station is operating. The non-Federal sponsor will be required to comply with flood plain management requirements and ensure that project features, such as pump stations, would not be impacted by developments in the areas behind the risk reduction system. The pump system is designed to match the existing gravity drainage capacity. The non-Federal sponsor will have the responsibility to ensure that this operation of the project features is maintained.



A photo of the Strand in Galveston

The risk reduction system is only authorized to address storm surge caused by hurricane and tropical storm events. It is not authorized to mitigate for or reduce impacts caused by higher day-to-day water levels brought about by increases in sea level rise.
