# PROJECT COMPLETION REPORT

CAMERON-CREOLE MAINTENANCE & REPAIRS PROJECT (CS-004-A)
STORM DAMAGE REPAIRS
CAMERON PARISH, LOUISIANA

ROYAL PROJECT NO. 2022-038-002

***PREPARED FOR:***

COASTAL PROTECTION AND RESTORATION AUTHORITY
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***PREPARED BY:***

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# 1.0 INTRODUCTION

## 1.1 Background

Located in the Calcasieu-Sabine Basin in Louisiana's Cameron Parish and operated by the Coastal Protection and Restoration Authority, the Cameron-Creole Watershed encompasses approximately 64,000 acres of fresh-to-saline marshes to the east of Calcasieu Lake. Restorative and preventative measures aimed at protecting the watershed's emergent-marsh ecosystem from the seasonal unsuitable conditions of Lake Calcasieu began in the early 1980's. In 1981, construction of a 19-mile protection levee along the Eastern rim of Lake Calcasieu was initiated. By 1989, the protection levee project, which included the installation of five (5) water control structures situated along the levee at locations where natural bayous previously flowed freely to and from the lake, was completed. Since then, a number of features have been added for the purpose of improving functionality and optimizing conditions within the watershed. These improvements, among others, include two interior canal plugs (constructed in 1996), which allow for watershed operations to be isolated into specific sections, and five (5) monitoring sites, which provide live data for making operations decisions. Additional improvements, in the form of maintenance and repair projects previously completed, include the Levee Breach Repairs Project, the restoration of the Cameron-Creole Watershed Levee Project Phases I and II, and the Lake Shore Protection Project.


*Figure 1. Project Vicinity Map*

*Figure 2. Mangrove Bayou Water Control Structure, Pre-Hurricane Laura*

*Figure 3. Mangrove Bayou Interior Canal Plug, Pre-Hurricane Laura*

*Figure 4. Grand Bayou Water Control Structure, Pre-Hurricane Laura*

*Figure 5. Grand Bayou Interior Canal Plug, Pre- Hurricane Laura*


*Figure 6. Grand Bayou Levee Breach Structure, Pre-Hurricane Laura*


*Figure 7. Lambert Bayou Levee Breach Structure, Pre-Hurricane Laura*

*Figure 8. No Name Bayou Water Control Structure, Pre-Hurricane Laura*


*Figure 9. No Name Bayou Levee Breach Structure, Pre-Hurricane Laura*

## 1.2 Project Features and Locations

The specific project area ranges between 3 and 9 miles northeast of Cameron along the eastern portion of Lake Calcasieu (Figure 1). The Cameron-Creole Maintenance Project (CS-004-A) – Storm Damage Repairs, also known as the Cameron-Creole Maintenance and Repairs Project, is for maintenance and repair activities to be performed on the following watershed features: (1) Mangrove Bayou: Outlet Channel at Water Control Structure and Interior Canal Plug, (2) Grand Bayou: Water Control Structure, Interior Canal Plug, and Levee Breach, (3) Lambert Bayou: Water Control Structure and Levee Breach, and (4) No Name Bayou: Water Control Structure and Levee Breach. The coordinates of each project feature listed above can be seen in Table 1.

*Table 1. CS04a Project Location Centers*

| PROJECT LOCATION CENTERS | | | | |
|---|---|---|---|---|
| **Project Feature** | **Northing** | **Easting** | **Latitude** | **Longitude** |
| **Mangrove Bayou** | | | | |
| Water Control Structure | N: 511824.95 | E: 2679481.79 | 29°53'37.2700" N | 93°13'52.5300" W |
| Interior Canal Plug | N: 511401.35 | E: 2679540.88 | 29°53'33.2300" N | 93°13'51.6100" W |
| **Grand Bayou** | | | | |
| Water Control Structure | N: 500749.15 | E: 2677937.03 | 29°51'47.5300" N | 93°14'07.8200" W |
| Interior Canal Plug | N: 499690.46 | E: 2677687.86 | 29°51'37.0100" N | 93°14'10.4499" W |
| Levee Breach | N: 500028.12 | E: 2677674.09 | 29°51'40.3500" N | 93°14'10.6700" W |
| **Lambert Bayou** | | | | |
| Water Control Structure | N: 495461.23 | E: 2674178.43 | 29°50'54.5700" N | 93°14'49.5001" W |
| Levee Breach | N: 495381.85 | E: 2673971.02 | 29°50'53.7500" N | 93°14'51.8400" W |
| **No Name Bayou** | | | | |
| Water Control Structure | N:492112.38 | E: 2650779.42 | 29°50'17.4800" N | 93°19'14.5200" W |
| Road/Levee Breach | N:492184.48 | E: 2650408.97 | 29°50'18.1300" N | 93°19'18.7400" W |

## 1.3 Project Objectives

Several of the watershed's features incurred significant damages during Hurricane Laura (August 2020) which resulted in full connectivity between the watershed and Lake Calcasieu. This open system dynamic presented a risk for potential deterioration of the ecosystem and made hydrologic management of the watershed impossible. The objective of this repairs project was to reestablish the Cameron-Creole watershed hydrologic boundary along Lake Calcasieu and regain functionality of the watershed's infrastructure and features, which allow CPRA to regulate surface water and interstitial salinities within the watershed. Figures 10 through 16 depict the extensive damage throughout the Cameron-Creole Watershed, brought upon by Hurricane Laura.

*Figure 10. Mangrove Bayou Outlet Channel- Siltation & Debris, Post-Hurricane Laura*

*Figure 11. Mangrove Bayou Interior Canal Plug - Scouring of Eastern Tie-in, Post-Hurricane Laura*

*Figure 12. Grand Bayou Interior Canal Plug - Scouring of Eastern Tie-In, Post-Hurricane Laura*

*Figure 13. Grand Bayou Levee Breach Structure - Overview of Scouring on North End, Post-Hurricane Laura*

*Figure 14. Lambert Bayou Levee Breach Structure - Overview of Scouring on North East End, Post-Hurricane Laura*

*Figure 15. No Name Bayou Water Control Structure - Scouring of Tie-Ins, Post-Hurricane Laura*

*Figure 16. No Name Bayou Levee Breach Structure - Scouring Around Structure, Post-Hurricane Laura*

## 1.4 Project Team

The following organizations and companies participated in the construction of the Cameron-Creole Maintenance and Repairs Project:

*Table 2. Project Team - Organizations*

| Company/Organization Name | Acronym | Role |
|---|---|---|
| Coastal Protection and Restoration Authority | CPRA | Contracting Agency |
| Royal Engineers & Consultants, LLC. | Royal | Engineer / Resident Project Representative |
| Gulf Inland Contractors, Inc. | GIC | Construction Contractor |

Key personnel participating in the construction of the Cameron-Creole Maintenance and Repairs Project included:

*Table 3. Project Team - Personnel*

| Name | Position |
|---|---|
| Dion Broussard, P.E. | CPRA - Construction Manager |
| Jody White, P.E. | CPRA - Engineer Supervisor |
| Beau Tate, P.E. | Royal - Engineer of Record / Project Manager |
| Bryon Richard | Royal - Construction Inspector |
| Brennon Bourgeois, E.I. | Royal - Engineer Intern / Resident Project Representative |
| Josh Brothers | GIC - Project Manager |

## 2.0 KEY PROJECT DESIGN CONSIDERATIONS

Engineering and design were performed by Royal from May 2022 to December 2022. Because the need for this project came as the result of the Hurricane Laura disaster event, the project was eligible for FEMA funding, therefore setting the basis for the repairs to be designed and constructed in a like-kind manner to what originally existed prior to the storm. Preliminary analyses of the damaged features utilized survey data collected by T. Baker Smith, LLC. to characterize the damaged conditions, including those below the surface of the water, and identify the extents of damages needing repairs. This information was then compared with the original design drawings and as-builts of the damaged features to develop a conceptual design for the repair of the damages. Design calculations were performed to ensure that the "like-kind" repair features proposed for this project were sufficient for the field conditions and final design ensued by extending the original design concepts over the damaged areas.

## 3.0 ITEMS OF WORK, CONSTRUCTION CHANGE ORDERS, AND FIELD CHANGES

### 3.1 Items of Work

The project involved several general repair activities which aimed to restore CPRA's ability to regulate surface water and interstitial salinities within the watershed. These activities are listed in Table 4, below.

*Table 4. Summary of Tasks and Repair Activities by Project Feature*

| CS-04a: SUMMARY OF TASKS BY PROJECT FEATURE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Mangrove Bayou** | | **Grand Bayou** | | | **Lambert Bayou** | | **No Name Bayou** | |
| **WCS** | **Int. Canal Plug** | **WCS** | **Levee Breach** | **Int. Canal Plug** | **WCS** | **Levee Breach** | **WCS** | **Levee Breach** |
| *Excavation and Removal of Siltation and Debris w/in Outlet Channel (Lake-side)* | *Scour Repairs* | *Scour Repairs* | *Extension of Steel Dam Structure* | *Scour Repairs* | *Mechanical Repairs* | | *Scour Repairs* | *Scour Repairs* |
| | | *Mechanical Repairs* | | | *Extension of Steel Dam Structure* | | *Mechanical Repairs* | |

Each activity listed in Table 4 entails one or more Contract Work Item(s) which make up the specific activity. The following breakdown includes details regarding which Contract Work Item(s) is(are) associated with the activities listed in Table 4.

*Excavation and Removal of Siltation and Debris*
- EXCAVATION (TS-370): Contract Item No. 3

*Scour Repairs*
- RIP RAP (TS-700): Bid Item Nos. 4, 6, 8, 20 and 23
- WOVEN GEOTEXTILE FABRIC (TS-601): Contract Item Nos. 5, 7, 9, 21 and 24

*Mechanical Repairs to Water Control Structures*
- MECHANICAL REPAIRS TO WCS: Contract Item Nos. 10, 17 and 22
    - Gates (TS-520), Buoys (TS-802), Fencing (TS-950), Railing (TS-951), Stairs (TS-952), Metals (TS-980)

*Extension of Levee Breach Structures (Sheet Pile Wall)*
- RIP RAP (TS-700): Contract Item Nos. 11 and 15
- WOVEN GEOTEXTILE FABRIC (TS-601): Contract Item Nos. 12 and 16
- PERMANENT STEEL SHEETING (TS-920): Contract Item Nos. 13 and 18
- PILES (TS-921): Contract Item Nos. 14 and 19

An in-depth table of Contract Work Items listing additional details associated with each item (including estimated quantity, bid price, installed quantity, dollar value of work completed, etc.) can be found under Appendix F.

### 3.2 Construction Change Orders

There were two change orders executed for this project. Change Order No.1 was required to address unavoidable delays during construction at no fault of the Contractor. The awarded contract was a total of 152 calendar days. Change Order No.1 was executed to extend Contract Time by 102 days for a total of 254 calendar days. Active Construction including fabrication, mobilization and demobilization was delayed due to weather or water level conditions (51 Days), rock delivery delays (14 Days), specialized pile driving equipment approval and repair (10 Days), 48-hour notice to LDWF for access (2 Days), Ingress/Egress Travel obstructions and delays (5 Days), Landowner negotiations for access (20 Days). Additional detail regarding the delays listed above is included in the Change Order No. 1 document, which can be seen under Appendix A.

Change Order No. 2 was executed to address several field changes implemented during construction. These changes were a result of changed conditions, observed from design surveys (June 2022) to the preconstruction surveys (September-October 2023), which was contributed to continuously worsening scour. Under the direction of CPRA and Royal, material quantities associated with the 55-lb rip rap installations proposed for Grand Bayou Water Control Structure (Contract Item 8), No Name Bayou Water Control Structure (Contract Item 20), and No Name

Bayou Breach (Contract Item 23) were decreased for the purpose of allocating additional rip rap to Mangrove Bayou Plug (Contract Item 4), Grand Bayou Plug (Contract Item 6), Grand Bayou Breach (Contract Item 11) and Lambert Bayou Breach (Contract Item 15). The overall 55-lb rip rap material quantity for this project was unchanged as a result of this change order. Additionally, the material quantity and alignment associated with the permanent steel sheeting installation and the location and spacing requirements associated with the batter pile installation, proposed for Grand Bayou Breach (Contract Items 13 and 14, respectively), was modified to achieve a more sufficient tie-in to the adjacent levee system. Change Order No. 2 reconciled the material/installation quantity under runs and over runs associated with the project features mentioned above. The quantity modifications are represented in the Contract Item table included under Appendix F and in-depth details regarding the modifications can be found in the Change Order No. 2 document, which is included under Appendix B.

### 3.3 Construction Field Changes

Several Field Changes occurred during the construction period under Royal's recommendation. These changes are listed and described, below.

*55-lb Rip Rap Adjustments:* Original design alignments, cross sections/templates, and overall footprints were changed during construction at several project feature locations. These changes were included in Change Order No. 2 (Appendix B), and are described in Section 3.2 Construction Change Orders, above. Furthermore, these changes can be viewed in the Final As-Built drawings which are included under Appendix E.

*Grand Bayou Levee Breach Extension:* The original design alignment and length of the Grand Bayou levee breach wall was changed during construction to achieve a more sufficient tie-in to the adjacent levee system. The change involved a modified trajectory of the new sheet pile wall structure from the existing structure, which targeted a new termination location within the adjacent levee system. The new termination location was warranted because the original location determined during the design phase had since washed away as a result of the continued scouring that occurred between design and construction. In order to reach the modified termination location, an additional 10 linear feet of steel sheeting and whaler beam (top cap) were required. Additionally, location and spacing requirements associated with the batter pile installation proposed for this project feature were modified to achieve this feat. These changes were included in Change Order No. 2 (Appendix B) and are also described in Section 3.2 Construction Change Orders, above. Furthermore, these changes are documented in the Final As-Built drawings which are included under Appendix E.

*Grand Bayou/Lambert Bayou Levee Breach – Gusset Plates:* Original gusset plate (batter pile attachment plate) design for the adjacent existing levee breach structures, which were constructed in 2006, was referenced during design and implemented during construction of the Cameron-Creole Maintenance and Repairs Project. It was understood that due to the required 15-degree batter angle of the piles and the intended horizontal orientation of the gusset plate, the hole needed to be larger than the 18" pipe diameter in order to account for the pile angle. Although the gusset

plate parameters and dimensions were originally the same for both the Lambert and Grand Bayou locations, GIC made two separate orders with the Lambert Bayou plates as the initial order. After the first set of batter piles had been driven to the required depth at Lambert Bayou, GIC attempted to install the first gusset plate. The hole dimensions specified in the construction plans (and as-builts) for the adjacent existing structures constructed in 2006, and referenced for this project, were discovered to be too large to obtain sufficient contact length for the weld between the pipe pile and the plate hole perimeter. GIC notified Royal of the issue at hand, and field changes were implemented to achieve a resolution. The first field change included removing an interior slice from the center of the two-hole plate to create two separate one-hole plates which could be sucked in towards the sheet pile wall. This allowed GIC to obtain sufficient contact length for establishing a weld along the back side of the gusset plates and the battered pipe piles, and left only the inward facing side with a gap between the pipe pile and gusset plate. These gaps were addressed by welding an additional cover plate of ½" thickness over them, to establish a minimum of 28 ¼" of contact length with the perimeter of the pipe on the inward facing side. An image depicting the cover plates set in-place prior to being welded is shown below.

*Figure 17. Lambert Bayou Batter Pile Attachment Plates - Cover Plates*

The cover plate was then welded to both the gusset plate and the pipe pile to effectively tie the system in. As-built details drafted for this field change can be seen under Appendix E.4.

In light of the discovery of the gusset plate issues at Lambert Bayou, the project team implemented a second field change which involved revising the originally specified plate hole dimensions before GIC ordered the Grand Bayou gusset plates. This allowed for a smooth installation once the Grand Bayou plates were received. The revised As-Built dimensions for the Grand Bayou gusset plates can be seen under Appendix E.3.

*Lambert Bayou Levee Breach Extension – Adjusted H-pile Tip Elevation:* The design for the Lambert Bayou levee breach extension included a 45-ft long HP16x141 (H-pile) with welded sheet pile knuckles along its web, which served to establish a secure connection to the new PZ-35 wall and achieve a snug tie-in with the adjacent concrete water control structure. The H-pile was originally intended to be driven to a tip elevation of -40.25' (NAVD88), which entailed using all 45 feet of pile to complete the tie-in. Based on observations and experience gained while driving both the sheet piles and batter piles at the Lambert Bayou Breach location, prior to the tie-in phase, GIC strongly opposed using the approved hydraulic impact hammer to drive the H-pile out of fear of causing unavoidable damage to the water control structure during the tie-in. That said, the means and methods utilized by GIC to perform this task entailed hammering the H-pile with a 1000-lb steel device suspended from a crane known as a "close-pin" hammer. The close-pin is designed to drive H-piles by manually lifting and dropping the close-pin via crane boom while straddling the web of the H-pile in order to maintain a plumb vertical alignment with the H-pile while delivering blows. During driving activities with the close-pin hammer, GIC would experience initial refusal at around 20-ft of embedment. The crew then rigged up two 6,000-lb chain winches (come-alongs) to the H-pile to apply the additional force required to obtain additional penetration through the apparent sand layer with the H-pile. GIC was able to continue to gain ground until the crew and resident inspector began to observe significant vibrations occurring throughout the southwest side of the water control structure while delivering blows to the H-pile. After reporting this observation to Royal's Project Engineer and CPRA's Construction Manager, project team members agreed to cut the remaining length of the H-pile. Ultimately, the completed tie-in entailed relaxing the original design length of the H-pile by approximately 5-ft. Therefore, the constructed tip elevation of the H-pile lies at approximately 5-ft above the adjacent sheet pile tip elevation as shown in the Final As-built drawings, under Appendix E.2.

## 4.0 CONSTRUCTION SEQUENCE AND SYNOPSIS

This section provides an overall linear narrative of major events that occurred.

August 05, 2023: Notice to Proceed.
September 01, 2023 – September 30, 2023: Review and Approval of Submittals.
October 03, 2023: GIC began receiving and offloading rock and materials at their Lowry Dock.
October 16, 2023: GIC established barge drafts and began loading rock on barges.
October 20, 2023: GIC mobilized first barges of rock to Grand Bayou.
October 24, 2023: GIC began installing fabric and rock installation at the Grand Bayou Plug and Breech.
November 04, 2023: GIC began process of clearing Lambert Bayou Breech for access.
November 09, 2023: GIC mobilized to Mangrove Bayou plug and began installing fabric and rock.
November 13, 2023: GIC completed rock installation at Mangrove Bayou Plug and remobilized to Grand Bayou.
November 14, 2023: GIC had divers install fabric at Grand Bayou and rock installation continued.
November 19, 2023: GIC mobilized to Lambert Bayou and began installing fabric and rock.
November 28, 2023: GIC installed handrails and anchors at Lambert and No Name Structures.

December 01, 2023: GIC mobilized to No Name Bayou and began installing fabric and rock.
December 04, 2023: GIC installed remaining handrails at all (3) Structures.
December 13, 2023: GIC began sheet pile wall installation at Lambert Bayou.
December 18, 2023: GIC removed all three flap gate hinges from Grand Bayou WCS. Two of three hinges require replacement due to non-repairable damages. Third hinge to be restored and reinstalled via blast/paint job.
December 30, 2023: GIC completed sheet pile wall installation at Lambert Bayou.
January 03, 2024: Blasting and painting on sheet pile wall at Lambert Bayou completed.
January 04, 2024: GIC began sheet pile wall installation at Grand Bayou.
January 22, 2024: GIC procures services for fabrication of two new flap gate hinges for Grand Bayou WCS (Approved for replacement by CPRA on 1/3/2024 and access to PO approved on 1/22/24).
February 15, 2024: Sheet pile wall installation at Grand Bayou completed.
February 19, 2024: Blasting and painting on sheet pile wall at Grand Bayou began.
February 21, 2024: Fabrication of two new hinges for Grand Bayou WCS Flap Gate completed (30-day duration between PO approval and completed fabrication of new hinges).
February 22, 2024: Blasting and painting on sheet pile wall at Grand Bayou completed.
March 04, 2024: GIC mobilized marsh excavator to Lambert Bayou and matted over levee.
March 06, 2024: Fencing crew installed fencing at No Name Bayou WCS.
March 14, 2024: No Name Bayou fabric and rock installation completed.
March 22, 2024: Lambert Bayou fabric and rock installation completed.
March 23, 2024: Grand Bayou fabric and rock installation completed.
April 13, 2024: Flap gate re-installed at Grand Bayou WCS.
April 30, 2024: Overall job walkthrough with CPRA, Royal and GIC. Final acceptance.

## 5.0 CHALLENGES ENCOUNTERED DURING CONSTRUCTION

This section describes the challenges encountered during construction in 2023 and 2024.

*Change of Conditions*

Several project feature locations had experienced a significant change of conditions as a result of continued scouring and erosion occurring from the time that the original design surveys were performed (June/July 2022) to the completion of the preconstruction surveys (September/October 2023) and the actual start of construction. This issue was evident at Mangrove Bayou Plug (Contract Item 4), Grand Bayou Plug (Contract Item 6), Grand Bayou Breach (Contract Item 11) and Lambert Bayou Breach (Contract Item 15) where preconstruction surveys depicted much larger scours having developed around these features and their tie-ins to the adjacent land. Extreme velocities associated with water movements through the restricted scour areas continually widened and deepened said areas as a result of daily tidal fluctuations within the lake. Additionally, erosion of lands within and around the lake-side construction footprints of the Grand Bayou Breach (Contract Item 11) and Lambert Bayou Breach (Contract Item 15) locations had occurred during this period. At the Grand Bayou Breach the original north side tie-in location for the breach repair, established during the design phase, had been washed away, and at the Lambert Bayou Breach the small island between the existing Hurricane Rita sheet pile repair and the water control structure

had eroded significantly between design and the actual start of construction for this project. The worsened scours and additional erosion that occurred between the time of design and construction necessitated design adjustments, including more rip rap required to fill the larger scour voids, more stone armoring at and around the Lambert Bayou Island, and the relocation of the north-side tie-in at Grand Bayou to a more stable location. Changes to the original design parameters were implemented during construction to ensure that the original project objectives were still met. These changes are described in detail in Change Order No. 2 which can be found under Appendix B. Furthermore, lessons learned with regards to the effects of the highly dynamic environment that exists around Lake Calcasieu, and its relation to the potential for changing of conditions between design and construction, are discussed below in Section 6.0.

*Accumulation of Outside Materials Within the Dredge Extents at Mangrove Bayou Outlet Channel*

Dredging activities at Mangrove Bayou Outlet Channel were prolonged due to the accumulation of foreign sediments, from outside of the dredging extents, within areas that had been previously dredged and observed as complete. On several occasions over the course of the project, the dredge crew moved out of the area after determining that they had obtained the finished channel dimensions required by the plans, only to be notified by the survey team on a later date that significant amounts of excavation were still needed to satisfy the dimensions required by the plans. To permanently obtain the finished channel dimensions and elevations depicted in the plans multiple passes of excavations were required. The assumption is that each time materials were removed from the area directly adjacent to the water control structure, it allowed materials that were built up on the marsh-side to flow through the structure and become deposited within the previously dredged outlet channel. This assumption stems from observations made in the field by the dredge crew, where crew members claimed to have seen an increase of flows through the structure each time they returned to the Mangrove Bayou Outlet Channel and excavated the area directly adjacent to the structure.

*Daily Water Levels*

Daily water levels on the project site were taken into consideration throughout construction to avoid disturbing water bottoms in Calcasieu Lake with construction equipment. GIC monitored draft depths on their working barges to ensure that water levels were sufficient to gain access to the project site each day. When tidal water depths were favorable for the approved drafts, access to the site and construction on site were allowed. When the tidal water depths were too low, GIC did not access the project area with construction equipment and work was not performed on those days.

## 6.0 LESSONS LEARNED

*Change of Conditions*

The Cameron-Creole Maintenance and Repairs Project highlighted the significant challenges posed by the highly dynamic environment in coastal areas, particularly where major storm damages are continuingly worsened through daily or common processes that occur within and around large water bodies. As previously mentioned, significant changes in conditions across several project feature locations occurred between the time of the original design surveys in mid-2022 and the start of construction in late 2023. The scour growth and additional erosion that took place between the time of design and construction necessitated design adjustments that had to be implemented after construction had already started. These issues emphasize the need for future projects in similar environments to account for rapidly changing conditions between design and construction, incorporating measures for more frequent site monitoring, potential redesigns, and additional erosion control strategies.

*Accumulation of Outside Materials Within the Dredge Extents at Mangrove Bayou Outlet Channel*

Dredging activities at the Mangrove Bayou Outlet Channel revealed the importance of anticipating potential siltation and sediment movement around large water control structures. Over the course of the project, previously dredged areas within the outlet channel repeatedly filled with foreign sediments, likely due to materials from the marsh-side of the structure flowing through and depositing in the channel after excavations were completed. This issue caused prolonged dredging efforts, as multiple excavation passes were needed to achieve the required channel dimensions. For future projects involving dredging around water control structures, design and planning should incorporate surveys to quantify the accumulation of materials on the opposite or upstream side of the structure. If significant sediment buildup exists, it may be more effective to remove these materials first, before starting the dredging of the outlet channel (downstream), to prevent redeposition of sediments in previously dredged areas. This approach would help reduce the need for repeated dredging efforts and ensure a more efficient process for achieving the required channel dimensions.

*Daily Water Levels*

The year 2023 was a drought year and Gulf levels were trending lower than the prior years. Water levels in the late fall/winter in Calcasieu Lake are typically lower than spring/summer. However, during the period of construction, the area saw water levels below average to the point of high tides being insufficient at times to allow boat travel to and around the Cameron-Creole Watershed, and in some cases, making it difficult to get out of the Ship Channel with shallow draft material barges. Low water conditions can significantly impact contract time in preventing movement of equipment within the work site and access to the work site. This is especially true for areas where Tier 1 oyster seed grounds exist such as Calcasieu Lake. For increased chances of avoiding delays due to low-water events and the presence of oysters, stakeholders might consider a construction start date during the Spring season. This could allow for work to take place during a period when higher water levels are a typical occurrence, during the Spring and Summer months.

*Challenges and Mitigation During Sheet Pile Installation*

During the installation of sheet piles at the Grand and Lambert Bayou Breach Repair locations GIC effectively managed tidal influences by positioning barges on the lake side to reduce tidal flow in the deep scour areas with significant water movement. Tidal movement out of the marsh remained manageable, and the installation progressed smoothly with the use of a template involving pipe piles and beams to support the sheet pile setup. GIC's approach of employing an iron jig box attached to the template beam to drive batter pipe piles proved beneficial and minimized installation difficulties.

*Work Sequencing and Site Access Management*

Work sequencing was critical to the success of this project, especially given the scope and location of the Grand Bayou breach repair and interior canal plug repairs. To ensure efficient maneuvering of large rock barges, the team strategically scheduled the canal plug repairs inside the protection levee prior to the Grand Bayou breach closure. Keeping the breach open initially allowed necessary barge access for the interior repairs. This approach minimized mobilization challenges and maximized equipment access, underscoring the importance of carefully sequencing tasks when site constraints impact movement and logistics.

*Mechanical Repairs and Buoy System Improvements*

A lesson learned regarding the buoy system was that an alternative anchoring method or locking system might provide a more secure attachment, as issues arose when GIC discovered that the cable/anchoring system for the boat bay guide was detached from the buoys and left on the Grand Bayou Water Control Structure, assumably by public/recreational boaters. Prior to completion of the project, GIC returned to the water control structure to re-anchor the buoys to the structure.

*Public Awareness and Stakeholder Notification*

Public notifications, especially regarding recreational and fisheries access, were key to minimizing disruptions. GIC coordinated with the Louisiana department of Wildlife and Fisheries and the U.S Coast Guard for the issuance of a Notice to Mariners. GIC also coordinated with local pipeline operators, local law enforcement, and relevant drainage districts prior to commencing construction to ensure that all relevant entities were informed. Maintaining regular communication with these groups, including Gravity Drainage Districts 3 and 4, proved essential for the project's smooth progression and was highlighted as an important lesson for enhancing public awareness in future projects.

The project also required coordination with the Cameron Prairie National Wildlife Refuge to manage access restrictions and signage. GIC received approval to temporarily close the Water Control Structure (WCS) access on the marsh side during interior work, which helped streamline work activities and limit public interference. Once the work was complete, the refuge promptly reopened the gates. This sequence of coordination highlights the importance of close communication with stakeholders to maintain both safety and project continuity.

*Land Rights and Access Limitations*

Accessing the No Name Structure site posed unique challenges due to limited land rights that permitted access only from the lake side. Equipment had to be offloaded onto the bank for rock armoring, and fluctuating water levels delayed barge access. Negotiations with the landowner added an additional 20 days to the timeline as GIC awaited CPRA's directive before accessing the property. This experience underscores the importance of early land rights coordination and proactive communication with property owners to avoid work interruptions.

*Limited Availability of Rolled Batter Piles*

Coordination with Nucor Skyline revealed specific challenges in sourcing rolled batter piles and sheet piles, as Nucor only produces these materials within limited, scheduled rolling windows. For this project, Nucor's next available rolling period for pipe piles was not until 2024, meaning that if materials were not secured within their current inventory, the project could face significant delays. This experience highlights the need to proactively plan around supplier production cycles and secure materials early. Establishing backup suppliers or alternative material options may also help mitigate timeline impacts when relying on intermittently available materials.

## 7.0 FINAL AS-BUILT FEATURES

In total, the Cameron-Creole Maintenance and Repairs Project included the installation of approximately 8,200 tons of rip rap, 165 linear feet of sheet pile wall, 4,000 cubic yards of mechanical dredging, and various mechanical and aesthetic repairs to existing water control structures. The recent completion of this project will restore CPRA's ability to regulate surface water and interstitial salinities within the watershed, which will significantly benefit the pursuit towards the ultimate goal of reclaiming emergent marshes converted to open water as a result of increased surface water and saltwater intrusion. The Final As-Built drawings can be viewed under Appendix E. Further detail regarding the finished product for each of the watershed's features is provided below.

*Mangrove Bayou Water Control Structure Outlet Channel*

Beginning at the outlet channel's transition to Lake Calcasieu (also referred to as the mouth of the outlet), the dredged footprint begins with a width of approximately 104-ft which gradually tapers down as it traverses east, nearing the WCS, to a width of approximately 77-ft. The dredged channel bottom elevation is -4.5' (NAVD88) and the dredged side slopes are 3:1 (H:V). In total, approximately 4,000 cubic yards of materials were mechanically excavated and removed from the channel over an extent of 500 linear feet. In addition to siltation and sediments deposited within the channel during Hurricane Laura, other materials excavated and removed from the channel included vegetation, driftwood, and old timber board mats. Materials were removed from the channel via bucket dredging utilizing a combination of barged excavators and an amphibious excavator or marsh buggy. Once excavated, materials were stockpiled on barges then barged offsite to an approved disposal site. No items were encountered that required special handling during the dredging of the Mangrove Bayou Outlet Channel. Figure 18 depicts the completed work at Mangrove Bayou outlet channel.

*Figure 18. Mangrove Bayou Outlet Channel, Post-Construction*

*Mangrove Bayou Interior Canal Plug*

Beginning at each end of the existing weir structure, 55-lb rip rap was used to fill in scoured areas as well as cap and protect what is left of the existing tie-in embankment. The finished repair entails a rip rap berm, built up to an elevation of +2.0' (NAVD88) with varying crown width and side slope. Figure 19 depicts the completed work at Mangrove Bayou interior canal plug.

*Figure 19. Mangrove Bayou Interior Canal Plug, Post-Construction*

*Grand Bayou Interior Canal Plug*

Beginning at each end of the existing weir structure, 55-lb rip rap was used to fill in scoured areas as well as cap and protect what is left of the existing tie-in embankment. The finished repair entails a rip rap berm, built up to an elevation ranging between +1.5' and +2.0' (NAVD88) with varying crown width and side slope. Figure 20 depicts the completed work at Grand Bayou interior canal plug.

*Figure 20. Grand Bayou Interior Canal Plug, Post-Construction*

*Grand Bayou Water Control Structure*

At the Grand Bayou Water Control Structure, 55-lb rip rap was used to fill in and build up the scoured area around the southern end of the structure to an elevation of +5.0' (NAVD88). In addition to the scour repair, several mechanical repair activities took place to regain full functionality of the structure. Details regarding the mechanical repairs are provided in Table 5, below.

*Table 5. Mechanical Repairs to Grand Bayou Water Control Structure*

| MECHANICAL REPAIRS TO GRAND BAYOU WCS | | |
|---|---|---|
| **ACTION** | **QUANTITY** | **ITEM DESCRIPTION** |
| 1. Remove & Replace | (32) EACH | Treated timber board for lower gate -- 10.6 FT long x 6 IN wide x 3 IN thick |
| 2. Replace | (1) EACH | Rodney Hunt FV-T treated timber flap gate (three hinge connections) OR APPROVED EQUAL -- 118 IN wide x 70 IN long |
| 3. Inspect/Document/Photograph | (12) EACH | Lake-side Flap Gate Hinges. |
| 4. Remove & Replace | (4) EACH | Hand/guard-rails --Galvanized steel pipe with posts -- 2 IN dia. schedule 40 & 2 IN dia. schedule 80 (fabricated lengths will vary) |
| 5. Remove & Replace | (8) EACH | Anchor bracket for guard rail |
| 6. Replace | (6) EACH | Jim Buoy Mo. 4418 Industrial Float -- Industrial floating buoys connected by steel cable |
| 7. Replace | (2) EACH | Jim Buoy Mo. 3000 Regulatory Buoy/Channel Marker w/ Concrete Buoy Anchor (steel cable connection) -- Industrial floating buoys connected by steel cable |

For the flap gate replacement listed under Item 2 in the above table, GIC opted to self-fabricate the gate after the original gate manufacturer, Rodney Hunt, informed them that although they are still able to supply replacement parts and components, they no longer offer the whole timber flap gate as a product. With this information, GIC procured the required timber boards from Coastal Timbers, Inc. (New Iberia, LA) and the required connection hardware from STS Industrial, Inc. (Sulphur, LA) in order to fabricate the gate themselves, in-house. All gate components were obtained and assembled by GIC in accordance with the dimensions shown in the Final As-Built drawings under Appendix E.

During installation, GIC encountered issues with seating the flap gate due to the build-up of corrosion around the interior edges of the thimble/frame. To solve this issue, GIC had to slightly decrease the overall width of the 118-in. wide flap gate. The crew brought the flap gate back to their shop, where they disassembled the seal and retainer strip from the gate, then shaved approximately 1-in. off each side of the gate. After decreasing the width down by a total of two inches, the seals and retainer strips were reattached to the flap gate system, and crews returned to the site for a successful installation.

Figure 21 depicts the completed work at Grand Bayou water control structure.

*Figure 21. Grand Bayou Water Control Structure, Post-Construction*

*<u>Grand Bayou Levee Breach Repair</u>*

The levee breach repair at Grand Bayou is an extension on the north side of an existing Hurricane Rita sheet pile repair to address the new scour area in the Cameron-Creole levee. The sheet pile extension consisted of 90LF of PZ-35 sheet pile wall, having a section length (vertical length) of 60-ft long, anchored with 70-ft batter piles, and encased by approximately 2,600 tons of 55-lb rip rap. The PZ-35 steel sheet piles are anchored by five sets of 18" steel batter piles. The batter piles are connected to the sheet pile wall with gusset plates, which are welded to a W18 x 55 steel whaler beam acting as the top cap of the sheet pile wall. Figure 22 depicts the completed work at Grand Bayou levee breach.

*Figure 22. Grand Bayou Levee Breach Structure, Post-Construction*

*Lambert Bayou Levee Breach Repair*

The levee breach repair at Lambert Bayou is an extension on the northeast side of an existing Hurricane Rita sheet pile repair. The sheet pile wall was extended to the southwestern end of the existing Lambert water control structure. This sheet pile extension consisted of 75-LF ofPZ-35 sheet pile wall, having a section length (vertical length) of 45-ft long, anchored with 60-ft batter piles, and encased by approximately 2,950 tons of 55-lb rip rap. The PZ-35 steel sheet piles are anchored by four sets of 18" steel batter piles. The batter piles are connected to the sheet pile wall with gusset plates, which are welded to a W18 x 55 steel whaler beam acting as the top cap of the sheet pile wall. The extension ties in and connects to the Lambert Bayou Water Control Structure with an HP16x141 (H-pile) that is interlocked with the sheet pile on one side of its web and sized for a snug acceptance of the water control structure's wingwall between the H-pile flanges. Figure 23 depicts the completed work at Lambert Bayou levee breach.

*Figure 23. Lambert Bayou Breach and Water Control Structure, Post-Construction*

*Lambert Bayou Water Control Structure Repair*

At the Lambert Bayou Water Control Structure, 55-lb rip rap was used to fill in and build up the scoured area around the western end of the structure to an elevation of +1.0' (NAVD88). This scour repair also serves as a portion of the rock dike that encases the steel sheet piles installed at this location. In addition to the scour repair, several mechanical repair activities took place to regain full functionality of the structure. Details regarding the mechanical repairs are provided in Table 6, below.

*Table 6. Mechanical Repairs to Lambert Bayou Water Control Structure*

| BID ITEM No. 17 - SCOPE OF WORK: MECHANICAL REPAIRS TO LAMBERT BAYOU WCS | | |
|---|---|---|
| **ACTION** | **QUANTITY** | **ITEM DESCRIPTION** |
| 1. Remove & Replace | (8) EACH | Hand/guard-rails --Galvanized steel pipe with posts -- 2 IN dia. schedule 40 & 2 IN dia. schedule 80 (fabricated lengths will vary) |
| 2. Remove & Replace | (16) EACH | Anchor bracket for guard rail |
| 3. Remove & Replace | (1) EACH | LAPEYRE Aternating Tread Stairs (68 Degree) OR APPROVED EQUAL -- Aluminum alternating tread stair w/ standard handrail --108 IN high |

*No Name Bayou Water Control Structure*

At the No Name Bayou Water Control Structure, 55-lb rip rap was used to fill in and build up the scoured areas around each end of the structure. In addition to the scour repairs, several mechanical repair activities took place in order to regain full functionality of the structure. Details regarding the mechanical repairs are provided in Table 7, below.

*Table 7. Mechanical Repairs to No Name Bayou Water Control Structure*

| BID ITEM No. 22 - SCOPE OF WORK: MECHANICAL REPAIRS TO NO NAME BAYOU WCS | | |
|---|---|---|
| **ACTION** | **QUANTITY** | **ITEM DESCRIPTION** |
| 1. Remove & Replace | (504) LF | Galvanized pipe (framework of the fence including top plus bottom rail and vertical posts) -- 2 IN dia. |
| 2. Remove & Replace | (196) LF | Galvanized fence (surrounds structure) -- 6 FT height w/ a chain link swing gate at each end (2 gates) |
| 3. Remove & Replace | (16) EACH | Anchor bracket for vertical fence posts |
| 4. Remove & Replace | (3) EACH | Hand/guard-rails --Galvanized steel pipe with posts -- 2 IN dia. schedule 40 & 2 IN dia. schedule 80 (fabricated lengths will vary) |
| 5. Remove & Replace | (6) EACH | Anchor bracket for guard rail |

Figure 24 depicts the completed work at No Name Bayou water control structure.

*Figure 24. No Name Bayou Water Control Structure, Post-Construction*

*No Name Bayou Levee Breach*

At the No Name Bayou Levee Breach, 55-lb rip rap was used to fill in and build up the scoured areas around the Eastern end of the existing Hurricane Rita Sheet pile Repair. Figure 24 depicts the completed work at No Name Bayou levee breach.

*Figure 25. No Name Bayou Levee Breach Structure, Post-Construction*

## 8.0 CONSTRUCTION EQUIPMENT UTILIZED

Major equipment utilized during construction of this project is summarized in Table 8, below.

*Table 8. Construction Equipment Utilized*

| CONSTRUCTION EQUIPMENT UTILIZED | | |
|---|---|---|
| **Equipment Item/Type** | **Equipment Description** | **Contruction Task Description** |
| **Materials Barges** | BJ-2: 120'x30x7' Deck Barge (3'6" Draft) | Loading/offloading - rip rap installation |
| | BJ-3: 110'x30'x7' Deck Barge (3'6" Draft) | Loading/offloading - rip rap installation |
| | BJ-26: 120'x30'x7' Deck Barge (3'6" Draft) | Loading/offloading - rip rap installation |
| | BJ-30: 120'x30'x7' Deck Barge (3'6" Draft) | Loading/offloading - rip rap installation |
| | MAGGI: 120'x30'x7' Deck Barge (3'6" Draft) | Loading/offloading - rip rap installation |
| | PEPPY: 140'x40'x7' Deck Barge (3'6" Draft) | Loading/offloading - rip rap installation |
| | PAM: 120'x30'x7' Deck Barge (3'6" Draft) | Loading/offloading - rip rap installation |
| | IBR-240: 120'x30'x7' Deck Barge (3'6" Draft) | Loading/offloading - dredging activities |
| **Equipment Barges** | Boudreaux 1: 120'x40'x7' Spud Barge (3'6" Draft) | Crane barge - sheet pile installation |
| | Boudreaux 2: 120'x30'x7' Spud Barge (3'6" Draft) | Material handler barge - rip rap installation |
| | STALLION: 140'x40'x7' Spud Barge (3'6" Draft) | Material handler barge - rip rap installation and dredging activities |
| | Crane Barge: 140'x40'x8' Spud Barge (3'6" Draft) | Crane barge - batter pile installation |
| **Material Handlers** | 300 Volvo Long Reach Trackhoe | Material handler - rip rap installations and dredging activities |
| | 300 Volvo Long Reach Trackhoe | Material handler - rip rap installations |
| | 290 Volvo Long Reach Amphibious Excavator | Material handler - rip rap installations and dredging activities |
| **Cranes and Attachments** | 138 Linkbelt Crane | Sheet pile installation |
| | 338 Linkbelt Crane | Batter pile installation |
| | ICE 22-23 Vibratory Hammer w/ Powerpack | Sheet / Batter pile installation |
| | D19 Diesel Hammer w/ Guiding | Sheet / Batter pile installation |
| | 36"-66" Offshore Lead | Sheet / Batter pile installation |
| **Passenger Vessels** | 300 HP (Twin 150 HP) Six-Passenger Crew Boat | Transport personnel to/from dock to site |
| **Tug Boats** | M/V Brenda B: 61.8'x21.8' (4'6" Draft) | Haul barges to/from dock to ship channel |
| | M/V BLR General: 52.3'x22.3' (3.9' Draft) | Haul barges to/from dock to ship channel |
| | M/V Zoie: 49.1'x20.1' (3'6" Draft) | Haul barges to/from dock to ship channel |
| | M/V Mr. Nick: 40.5'x18' (4'10" Draft) | Haul barges to/from site to ship channel |

## 9.0 KEY CONSTRUCTION DATES

Key construction events and dates associated with the Cameron-Creole Maintenance and Repairs project are listed in Table 9, below.

*Table 9. Key Construction Dates*

| Event Description | Event Date |
|---|---|
| Pre-Bid Conference | May 2, 2023 |
| Construction Contract Award | July 17, 2023 |
| Pre-Construction Conference | August 01, 2023 |
| Notice to Proceed | August 05, 2023 |
| Breach Repair Materials and Rip Rap Ordered (45 Day Lead Time) | Week of 8/27/23 |
| Loading of Breach Repair Materials and Rock on to Barges at Yard Began | October 03, 2023 |
| Pre-Construction Survey Submittal | 09/23 – 10/23 |
| Initial Mobilization | October 20, 2023 |
| Onsite Construction Start | October 24, 2023 |
| As-Built Survey Complete | April 13, 2024 |
| Construction Completion | April 13, 2024 |
| Project Acceptance | April 13, 2024 |
| Final Walkthrough | April 30, 2024 |
| Demobilization | April 30, 2024 |

## 10.0 DAVIS BACON ACT COMPLIANCE

Davis Bacon Act requirements were complied with for the duration of construction. The Davis–Bacon Act of 1931 is a United States federal law that establishes the requirement for paying the local prevailing wages on public works projects for laborers and mechanics. The Contractor submitted all weekly certified payrolls for review. Employee interviews were also held to verify the kind of work being performed and their rates of pay. These can be viewed under Appendix H.

## 11.0 DESIGN, CONSTRUCTION, AND CONSTRUCTION OVERSIGHT COSTS

A summary of project costs from design through construction is provided in Table 10, below.

*Table 10. Summary of Project Costs*

| |
|---|
| **Prime Contractor** – Gulf Inland Contractors |
| **Subcontractor –** Southern Survey |
| **Final Construction Contract -** $4,211,978.06 |
| |
| **Royal Engineers and Consultants, LLC** |
| **Professional Services Task** - $359,505.00 |