Garwood Gate Automation Project

Final Report for Texas Water Development Board Grant Contract 2013582448

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Executive Summary

The Lower Colorado River Authority owns and operates three irrigation divisions in the lower Colorado River basin. When water is available for all three irrigation divisions, these systems account for about 40% of total water use from the Highland Lakes and Colorado River in a dry year. In 2020, LCRA began work on a major infrastructure project to remotely control 46 main canal gate structure sites in the Garwood Agricultural Division. The project included retrofitting existing water control gates with equipment to allow the gates to be controlled remotely and integrating these gates into an existing Supervisory Control and Data Acquisition (SCADA) communications system built for the Gulf Coast gate rehabilitation project completed in 2019.

The project is estimated to save about 2,700 acre-feet of water per year and improves water management in the Garwood canal system, particularly during rain events. This project implements irrigation district conveyance improvements recommended as a water management strategy in the 2021 Region K Water Plan. Improved water management in Garwood is of particular benefit because under its purchase agreement, LCRA supplies water to Garwood during drought periods in which other agricultural operations are curtailed or cutoff, which happened in 2022 and 2023.

Gate automation and control in the Garwood canal system is one of the most cost-effective conservation measures to improve system water use efficiency. Information generated through data gathered from full automation of the Garwood canal system will benefit other planned water supply and conservation measures, such as monitoring canal seepage to evaluate the need for and cost effectiveness of canal lining. LCRA will continue to assess the effectiveness of the project through delivery efficiency, including measured reduction in overflows and on-farm water demand performance metrics. LCRA will report the information to the Texas Water Development Board (TWDB) each year for five years and as requested, beyond that time frame as needed.

The project was completed on time and on budget.

1 Introduction and Project Objectives

The Garwood Agricultural Division is in Colorado and Wharton counties (see Figure 1) and was acquired by LCRA is 1998. It has a serviceable area of 90,000 acres, supplied by over 300 miles of managed canals and over 150 structures. The canal system is gravity flow through open channel earthen canals. There is a river pump station which feeds water into the system from the Colorado River and a re-lift pump station which lifts water into a higher elevation gravity fed section in the northern part of the service area. Figure 1 is a general location map of LCRA's irrigation divisions and Figure 2 is an overview of the entire Garwood Agricultural Division canal system.

A typical Garwood structure consists of a concrete wall spanning the width of the canal, with one to four circular cutout sections cast in the wall. These cutout sections allow water to flow from an upstream canal section to the downstream section. Water flow between sections is controlled by cast iron screw gates attached to the face of the concrete wall. The original check structures date back to the 1920s and 30s. Rice is the major crop grown. In 2022, about 21,000 acres of rice were planted, with about 16,000 acres watered for a second crop. In addition, about 3,500 acres were watered to create ponds for attracting wildlife. Total diversions for the Garwood Agricultural Division have ranged from approximately 65,000 acre-feet per year to 100,000 acre-feet per year in the last 10 years. Currently, only agricultural customers are served from the canal system.

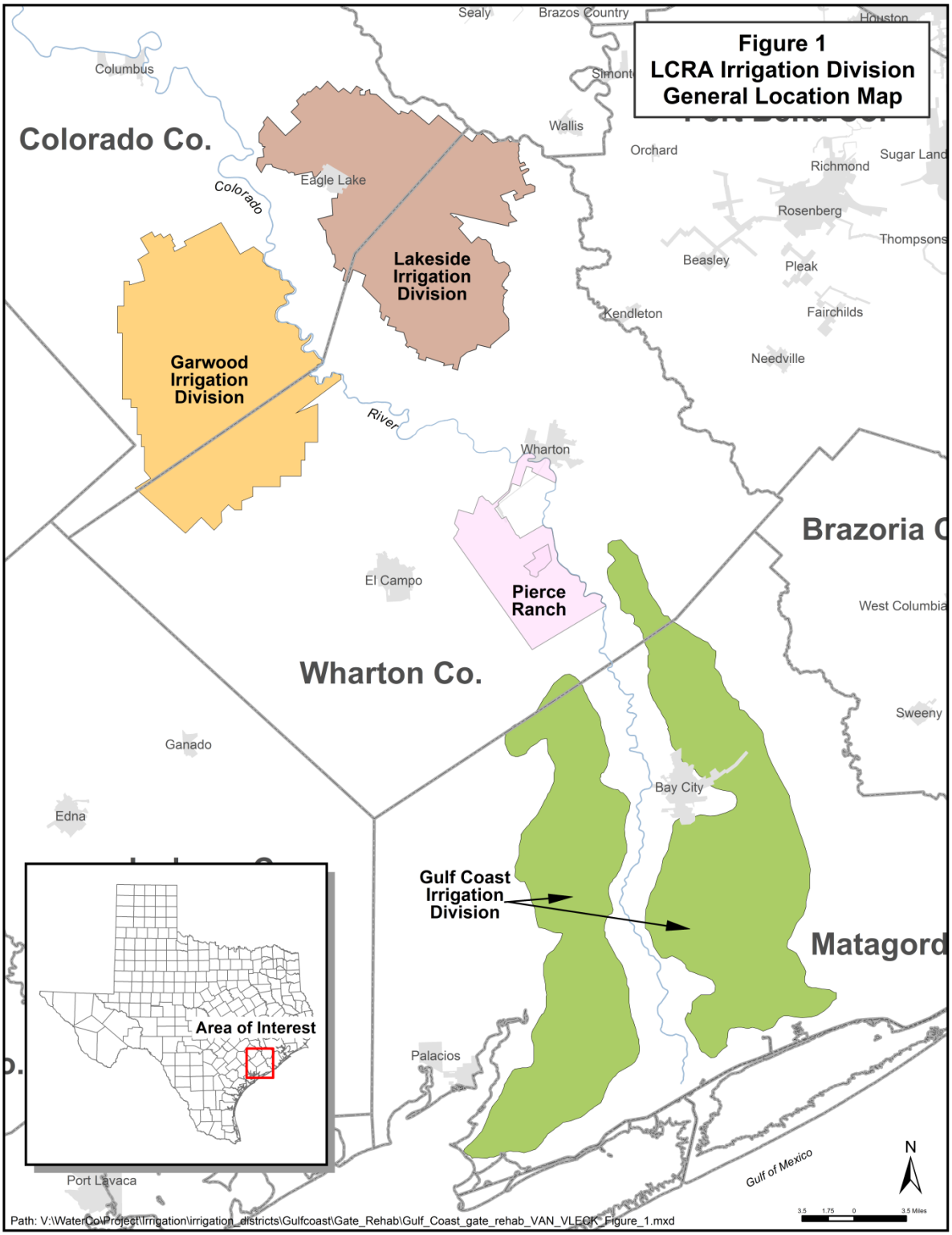
Figure 1
LCRA Irrigation Division
General Location Map
Sealy
Brazos Country
Houston
Columbus
Simonton
Wallis
Orchard
Richmond
Sugar Land
Colorado Co.
Colorado
Eagle Lake
Lakeside
Irrigation
Division
Rosenberg
Thompsons
Beasley
Pleak
Kendleton
Fairchilds
Needville
Garwood
Irrigation
Division
River
Wharton
Brazoria C
El Campo
Pierce
Ranch
West Columbia
Wharton Co.
Sweeny
Ganado
Bay City
Edna
Gulf Coast
Irrigation
Division
Matagord
Area of Interest
Palacios
Port Lavaca
Gulf of Mexico
N
3.5 1.75 0 3.5 Miles
Path: V:\WaterCo\Project\Irrigation\irrigation_districts\Gulfcoast\Gate_Rehab\Gulf_Coast_gate_rehab_VAN_VLECK_Figure_1.mxd

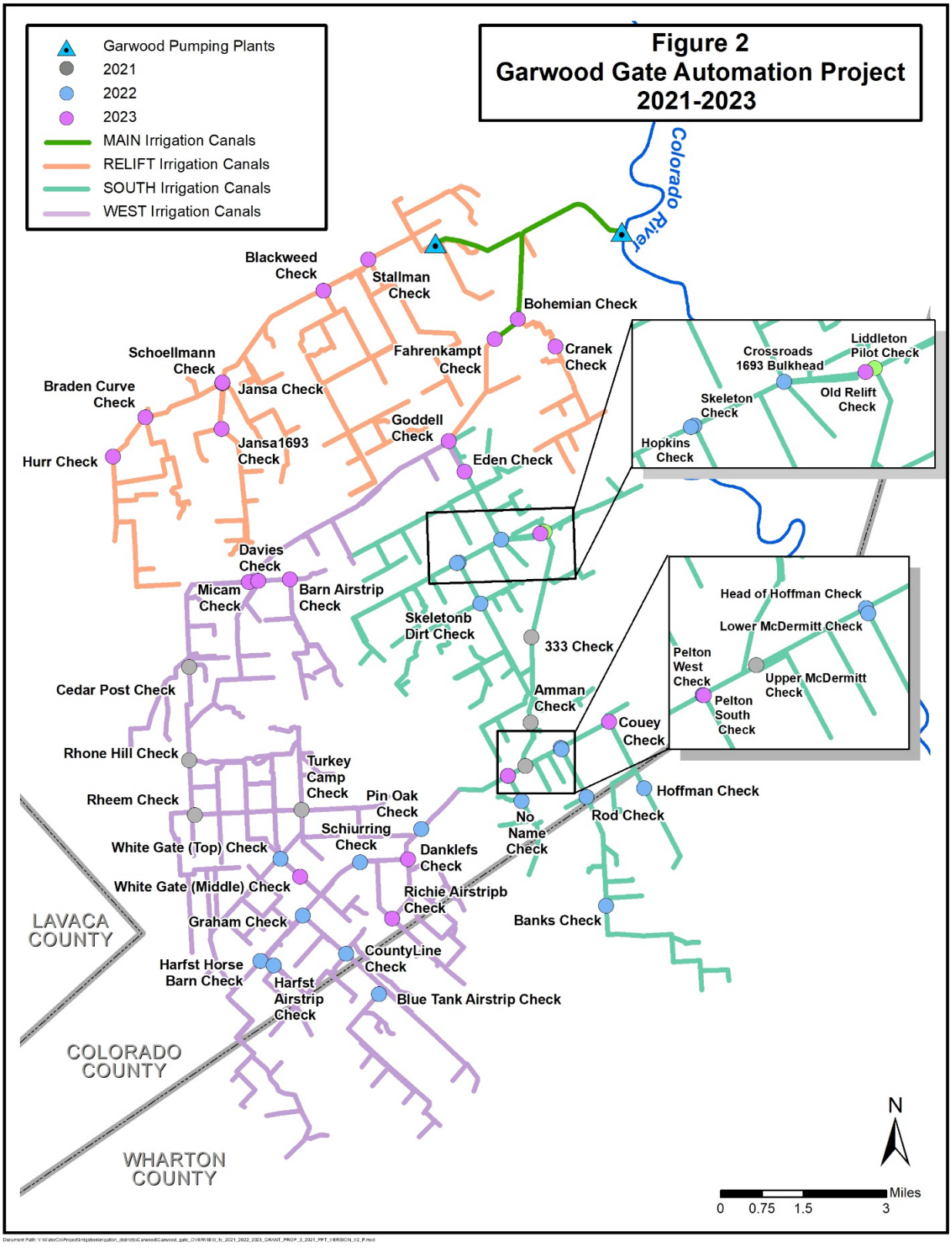
Figure 2
Garwood Gate Automation Project
2021-2023
Garwood Pumping Plants
2021
2022
2023
MAIN Irrigation Canals
RELIFT Irrigation Canals
SOUTH Irrigation Canals
WEST Irrigation Canals
Colorado River
Blackweed Check
Stallman Check
Bohemian Check
Schoellmann Check
Fahrenkampt Check
Cranek Check
Braden Curve Check
Jansa Check
Goddell Check
Jansa1693 Check
Hurr Check
Eden Check
Crossroads 1693 Bulkhead
Liddleton Pilot Check
Skeleton Check
Old Relift Check
Hopkins Check
Davies Check
Micam Check
Barn Airstrip Check
Skeletonb Dirt Check
333 Check
Head of Hoffman Check
Lower McDermitt Check
Pelton West Check
Upper McDermitt Check
Pelton South Check
Cedar Post Check
Amman Check
Couey Check
Rhone Hill Check
Turkey Camp Check
Rheem Check
Pin Oak Check
Hoffman Check
No Name Check
Rod Check
Schiurring Check
White Gate (Top) Check
Dankleſs Check
White Gate (Middle) Check
Richie Airstripb Check
Graham Check
Banks Check
LAVACA COUNTY
CountyLine Check
Harfst Horse Barn Check
Harfst Airstrip Check
Blue Tank Airstrip Check
COLORADO COUNTY
WHARTON COUNTY
N
Miles
0 0.75 1.5 3

The project's objective was to expand the gate automation project completed in 2019 for the Gulf Coast Agricultural Division by retrofitting and automating 46 check gate structures in LCRA's Garwood Agricultural Division. The project retrofitted manually operated cast iron screw gates with equipment and communication systems to allow for automatic water level control and remote operation. This project utilizes a radio-based data communication system (DCS) and a SCADA system run with solar power. The SCADA component provides LCRA operations the ability to remotely control water levels and flow rates within the canal system. This additional control improves operating efficiency, reduces energy consumption and conserves water throughout the canal system.

The project goals included:

- Improving water management within the system by controlling water levels, utilizing the storage capacity of the canal system, and remotely monitoring water levels.
- Improving water delivery measurements by maintaining near-constant water levels within the canal and/or by using water flow information at the bottom of the canal line to control water fed into the top of the canal line.
- Reducing water loss within the Garwood canal system.
- Reducing pumping hours and motor runtimes by maintaining full canals and reducing the frequency and number of canal recharges.
- Reducing energy consumption by limiting the driving miles required to manually operate check gates.

2 Scope of Work

2.1 Engineering Design, Procurement and Construction

Engineering Design and Procurement

In 2020, LCRA engineering staff completed the engineering design plans and submitted them to TWDB for review and approval. In March 2021, TWDB staff notified LCRA that the Garwood gate automation project was exempted from formal environmental review requirements, granting it a “Determination of No Effect.” In November 2021, TWDB engineering staff approved LCRA’s plans and specifications for the project. LCRA’s engineering services and purchasing staff procured the equipment and materials for the gates and radio system. All the major equipment identified for the project was acquired from the same vendors utilized for the Gulf Coast gate rehabilitation project.

Gate Installation and Field Construction

LCRA Irrigation Operations staff completed the field construction in spring 2023 with support and inspection by LCRA Engineering Services and LCRA Telecom. Staff completed construction in three phases between November and March outside of the normal irrigation season starting in 2021. Work included preparing each site for installation of the actuators, mounting poles for the electrical supply, wiring control cabinets and installing radio communications equipment.

2.2 Radio and SCADA Systems Programming and Integration

Radio Data Communication System

LCRA Engineering Services staff and LCRA Telecom staff developed radio systems for each new site and integrated them into the existing radio communication system to reliably communicate data from the field sites (gates) to the control room at the division office. Due to the geographic distance from the Gulf Coast office’s radio tower, a new communication topology had to be developed. Many of the sites were automated but operated locally for the first two irrigation seasons until a new communication topology could be developed and implemented.

LCRA’s radio network has over 60 sites on towers across Texas. Data from each gate site is polled and received at multiple locations including the closest towers to Garwood, which are in Columbus and New Taiton. Data goes from these towers to the radio system core in Austin and then out to the irrigation SCADA network.

SCADA Programming

There are two programming components to this project. The first is the SCADAPack Remote Terminal Unit (RTU) controller programmed using Telepace software and data reporting necessary to operate and monitor the gate installations via the radio data communication system. Communication is done over Transmission Control Protocol (TCP)/Distributed Network Protocol (DNP3). The SCADAPack RTU requires a login (username/password) to connect to any port.

The second SCADA component is ClearSCADA advanced human machine interface (HMI). This integrated the new gates into the SCADA system built during the original gate automation in Gulf Coast Agricultural Division. The SCADA system is used to monitor and control canal gates remotely from the Gulf Coast and Garwood offices. There is a firewall between the switch in the control room and the ClearSCADA server. An LCRA user/password login is required to access the ClearSCADA application over the control network and another user/password login is required to make any control or application changes. The SCADA system also includes alarm functions sent to operations staff through SMS and email. All data from the gates is stored on a computer server technically referred to as a "local historian," which can be used to detect trends and generate reports. An LCRA irrigation operator can set the gates in auto upstream level control or "Set to Order" (STO). The 46 new gates were added into the existing SCADA system with minimal programming modification because it was created with a template-based design for each check structure site. LCRA Irrigation Operations staff with some support from LCRA Engineering Services completed all HMI/SCADA programming work to integrate the 46 new gates into the system. Figure 3 shows a screen shot of the user interface for the software.

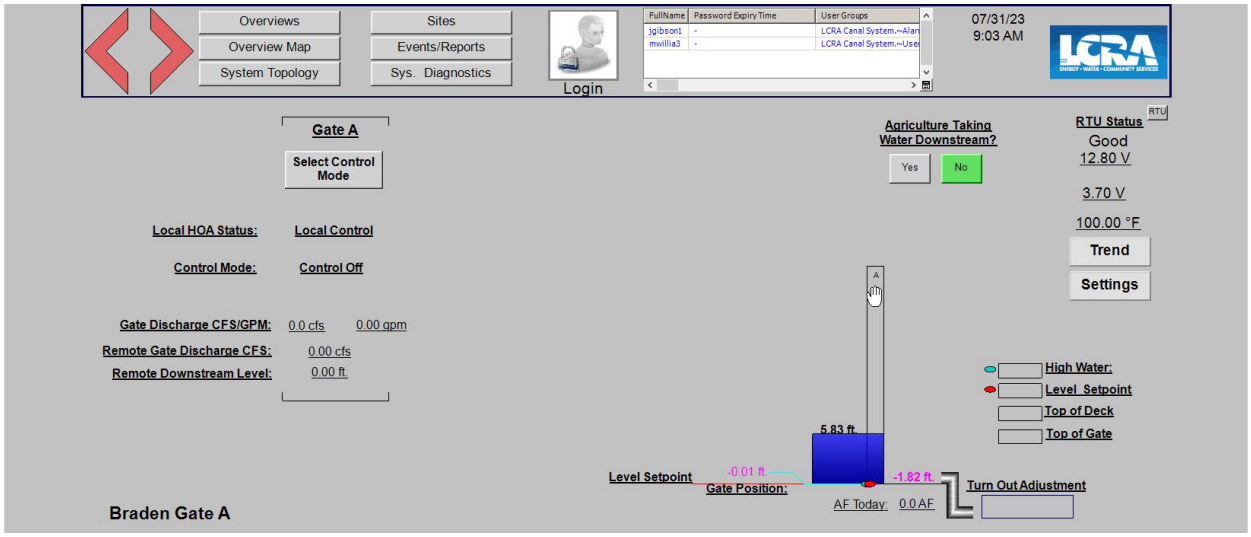

Figure 3: User interface for gate control software

Startup and Acceptance Testing

Testing included integrating all the various subsystems, check structures, SCADA and radio DCS into a functional check structure monitoring and control system. LCRA Irrigation Operations staff did the performance and reliability testing and acceptance.

2.3 Regulatory and Conservation Reporting

Staff received approval to proceed with construction from the TWDB, completed an internal environmental checklist and received clearance from TWDB engineering. An LCRA project manager and project analyst oversaw the execution, procurement, control and closeout of the project. This included organizing and directing the project team, processing payment requests, updating the project schedule and preparing progress reports. LCRA water conservation staff completed the final report.

LCRA staff organized and held an agricultural water conservation field day in Garwood on Feb. 1, 2023. The event included a keynote speaker from the USDA-ARS Delta Water Management Research Unit who discussed water management techniques on rice fields in Arkansas, panel discussions featuring local producers on optimizing water management on land leveled fields and enhancing land leveled field designs, and a presentation by LCRA staff on LCRA's agricultural water conservation programs. A site tour of a gate automation project site in Garwood was planned, but due to inclement weather, LCRA staff led a question and answer session about the project instead. About 25 producers attended the event, which was well received by participants and generated engaged discussions on several different topics related to water conservation. Staff plans to organize similar events in the future

Water savings reported for the five years following the completion of construction will be measured by delivery efficiency (on-farm water delivered/total water diverted at the river) and on-farm water demand (water delivered/acres watered) compared to previous years.

3 Project Execution

3.1 Engineering Design and Construction

The Garwood gate automation project was completed in June 2023. In September 2020, engineering design plans were finalized and materials were procured and ordered for the first phase of construction in winter 2020-2021. Panel and electrical drawings were approved in December 2020. Pole mounts and installation of equipment enclosures and wiring were completed for the first phase of construction at seven sites by March 2021. This included civil and structural work (supporting structures needed for radio systems and gate tops to fit the actuators onto the gates), setting control panels, and installing solar panels. Staff tracked each site's progress, including civil work and work on the control panel, conduits, level transmitter, wiring, battery and solar panels, gauges, and system grounding. LCRA engineering staff completed site inspections in early fall 2021 and TWDB engineering staff gave final approval in November 2021. LCRA staff began the second phase of construction in November 2021 to install metal poles, control cabinets, solar panels and gate tops at 14 sites and completed those sites by March 2022. The third phase of construction began in November 2022 to complete installation of metal poles, control cabinets, solar panels and gate tops at the 25 remaining sites and that work was completed in March 2023. A contractor was used to install large actuators at three of the largest structures in March 2023.

3.2 Radio and SCADA Systems Programming and Integration

LCRA Engineering Services and Telecom staff began the topology work of mapping pathways in fall 2020. SCADA programming to integrate each new gate into the LCRA radio network for the first phase of construction was completed in March 2021. Due to the geographic distance from the Gulf Coast office's radio tower, a new communication topology had to be developed. Many of the sites were automated but operated locally for the first two irrigation seasons until a new communication topology could be developed and implemented. The remaining radios were installed and integrated into the SCADA system in winter 2022 and fully tested by May 2023.

3.3 Reporting and Water Savings

3.3.1 Budget Reporting

This project was successfully completed on time and on budget. Table 1 shows the schedule associated with each task. Table 2 shows the final budget and schedule performance. The final spend was 97% of the estimated budget. Engineering design costs and project management costs were slightly higher than anticipated but labor costs related to integrating the new sites into the existing radio and SCADA system were lower than budget and covered the overages in the other tasks.

Table 1: Schedule Timeline by Task

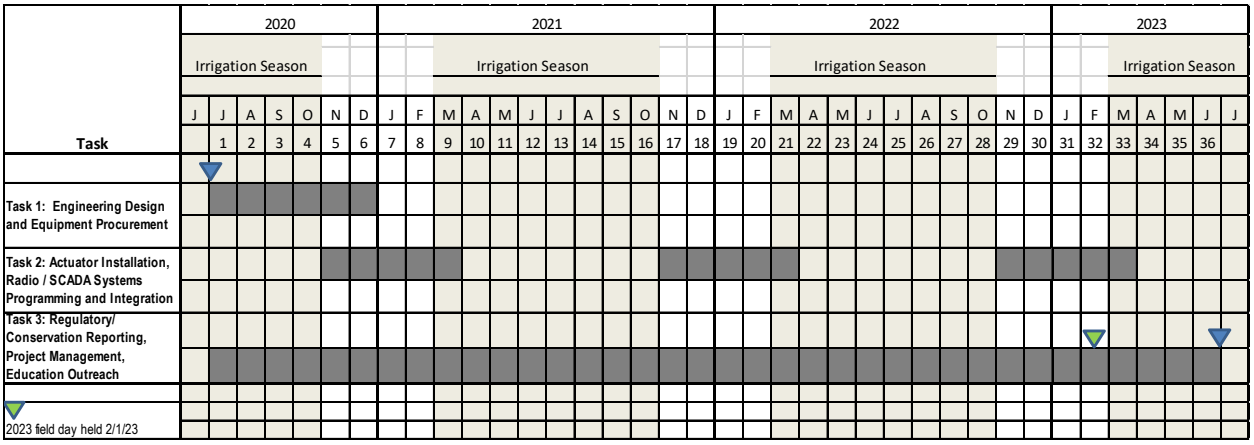

Table 2: Budget and Schedule Performance

Description	Budget	Expenditures To Date
Task 1	$609,025	$621,020
Task 2	$281,914	$224,448
Task 3	$46,132	$68,843
Total	$937,071	$914,311

3.3.2 Water Savings

In the original project proposal, staff estimated the amount of water conserved through this project would be approximately 2,700 acre-feet per year, or about 60 acre-feet per year per structure. The estimate assumed a reduction of 3.5% of average water use from 2012 to 2018, based on savings achieved from previous gate projects in the Gulf Coast Division as well as initial planning studies completed before the original gate automation project in Gulf Coast. This estimate does not change when updated to include 2019 to 2022 water use data. Planted acreage in Garwood has been very consistent over the past 10 years, averaging about 19,000 acres per year for first crop. Assuming the original savings estimates can be verified, this project will be very cost effective compared to other potential water conserving infrastructure upgrade projects such as a regulating reservoir and canal lining proposed for the Garwood canal system

through previous planning studies. The current unit cost estimate for this project is only $20 per acre-foot per year compared with $125-$200 acre-foot per year for any other project based on both internal previous planning studies and estimates developed for the 2021 Region K water plan.

The average water loss over the past decade for the Garwood Division has remained around 17%. In 2022 and 2023, however, water loss was the lowest ever recorded at less than 10%. In general, system efficiency tends to be the greatest during hot dry summers since significant rain events often lead to system losses. However, the 2022 and 2023 water loss percentages were less than other recent hot and dry summers, such as 2018. The partial automation of the gates is assumed to have played a role in the improved efficiency achieved in 2022 and 2023. Staff will continue to update review savings estimates annually, review water loss monthly using a new tracking tool developed in the last year and will do a more rigorous statistical analysis after the project has been fully operational for five years.

4 Conclusions

The Garwood Gate Automation Project was completed on time and under budget and has been a successful and timely project. In July 2022 under its Water Management Plan, LCRA determined that water from the Highland Lakes would not be available for the Gulf Coast, Lakeside and Pierce Ranch agricultural operations for the second growing season. In March 2023, LCRA determined that no Highland Lakes water would be available to those operations for either 2023 growing season. Under existing contract provisions, the Garwood Agricultural Division received water in 2022 and 2023, and in both of those years, low water loss can be attributed, at least in part, to the positive impact of the automation of gates in the system.

5 Acknowledgments

The successful completion of this project would not have been possible without the hard work of LCRA staff. Particular recognition goes to the entire staff at the Garwood Agricultural Division under the leadership of Director of Irrigation Operations Randy Epps, Irrigation Operations Superintendent for Garwood Brandon Mathis, and project manager Logan Young.

LCRA staff from the following departments also assisted with this project:

- Irrigation Operations (construction): Brandon Mathis, Parker Williams, Tim Jones, Chad Sunderman, Scott Krpec, Brian Turner, John Trapp, Chris Jahn, Chad Fucik, Craig Potter, Dylan Shupak, Carlos Gonzalez, Abel Gorman, Gary Garza, John Heffley, Jody Meismer and Greg Contreras.
- Telecom: Caleb Seifert and Donnie Becka.
- Engineering Services: Daniel Ruiz, KangBin Wang, and Sam Brown.
- Project Management: Carina Hinojosa, Josh Bollich, Logan Young and Jessica Colley.

6 Appendices –

6.1 Agricultural water conservation field day event agenda

Agricultural Water Conservation Field Day

Feb. 1, 2023 | 8 a.m. – 3 p.m.

Welcome	Kelly Payne *LCRA Vice President of Water Operations* Debbie Hoffpauir *HB 1437 Advisory Committee Chair*
Water management techniques on rice fields in Arkansas	Michele Reba *USDA-ARS Delta Water Management Research Unit, Research Hydrologist*
Optimizing water management on land leveled fields	Debbie Hoffpauir, *Moderator*
Utilizing water use data analysis to improve water use efficiency during the crop season	Madison Smith
Reuse of drainage water across multiple fields and row crop irrigation using center pivots	Kevin Hoffman
Enhancing land leveled field design	Glen Minzenmeyer, *Moderator*
Permanent levee field design with field laterals and multiple inlets	Dustin Guthman
Maintenance of fields with permanent levee designs	Chriss Schiurring
Permanent levee designs compatible with sandy soil and row crops	Debbie Hoffpauir
Optimizing water control structure design	Glen Minzenmeyer
LCRA agricultural water conservation programs	Brandon Mathis *LCRA Irrigations Operations Supervisor* Stacy Pandey *LCRA Senior Water Conservation Coordinator*
Lunch (will be provided)	
Site tours	
LCRA Garwood Gate Automation Project site	Brandon Mathis
Fields designed with permanent levees	Chriss Schiurring