THE WATER INSTITUTE OF THE GULF®

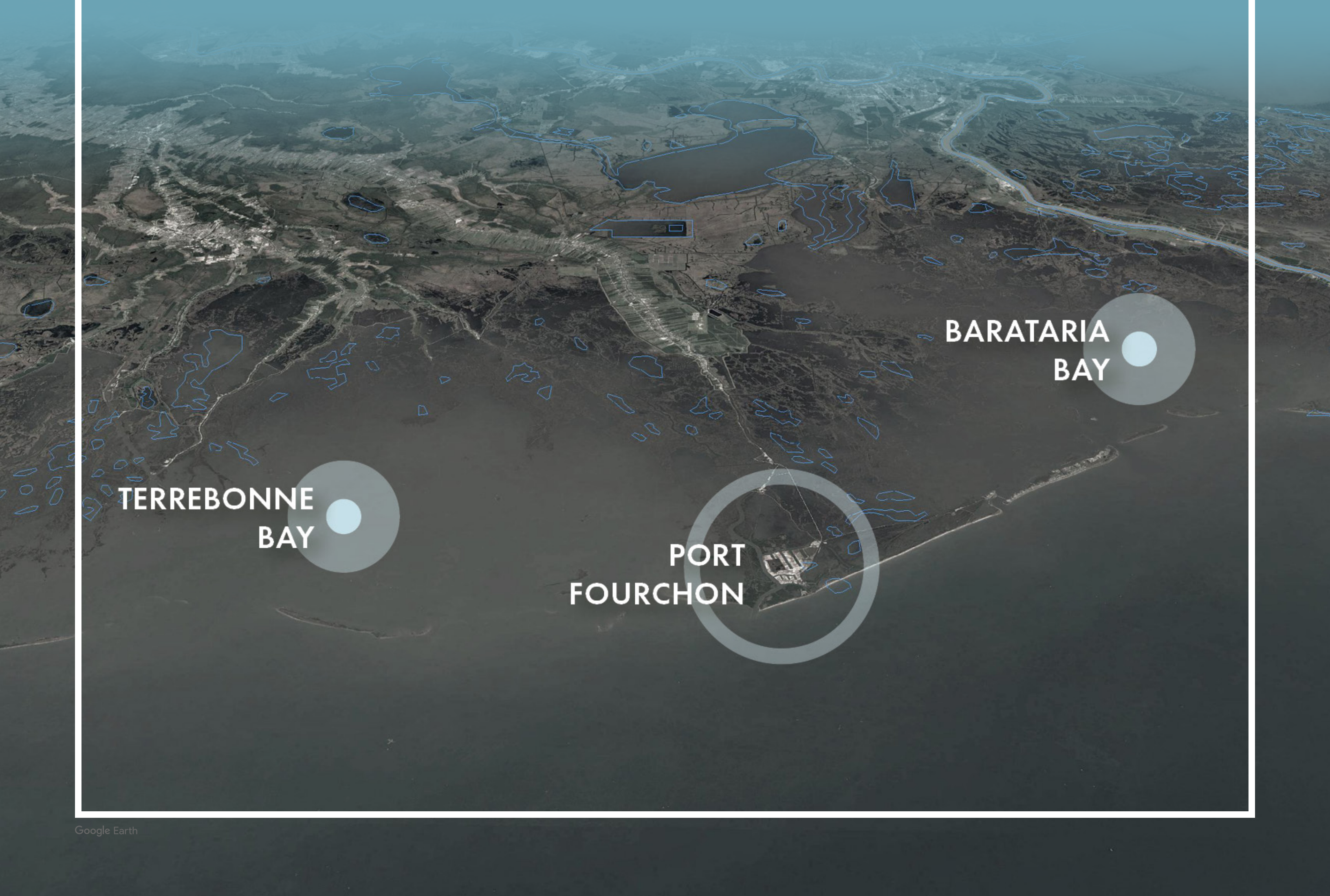
PARTNERSHIP FOR OUR WORKING COAST

A Community-Informed Transdisciplinary Approach to

MAXIMIZING BENEFITS OF DREDGED SEDIMENT FOR WETLAND RESTORATION PLANNING

at Port Fourchon, Louisiana

EXECUTIVE SUMMARY



INTRODUCTION

The Greater Lafourche Port Commission (GLPC) operates Port Fourchon, the nation's premier oil and gas services port, which services more than 90 percent of all U.S. Gulf of Mexico deepwater oil and gas exploration, development, and production activities. Port Fourchon is also home to the land booster pump station for the Louisiana Offshore Oil Port (LOOP) which transfers both foreign and domestically produced crude oil to large storage tanks and an underground storage facility adjacent to the South Lafourche Airport in Galliano, Louisiana via a booster station in Port Fourchon.

LOOP transfer infrastructure also includes the land shore base through which several of Chevron and Shell's major pipelines bring ashore domestically produced crude from the U.S. Gulf of Mexico for its journey to marketplaces, refineries, and the Strategic Petroleum Reserve along the Mississippi River corridor and many points beyond. Port Fourchon is vital in the import of approximately 20 percent of the nation's oil supply.

A 2014 study found that a three-week closure of Port Fourchon would cause the loss of 65,502 jobs nationwide. As GLPC looks to the future, they are working to expand their operations to provide services for the growing offshore wind energy industry.

The Port Fourchon facility covers 1,700 acres and is located in the Barataria-Terrebonne Basin, at the point where Bayou Lafourche meets the Gulf of Mexico. This highly dynamic and productive coastal ecosystem is experiencing the nation's highest rates of relative sea level rise (~9 mm yr-1),[1] shoreline retreat (~3 km century-1),[2] and land loss (~28 km2 yr-1 for 1932-2016).[3] To maintain operations as a vital component of the Nation's energy supply in such a challenging landscape prone to natural disasters, Port Fourchon must be resilient. The GLPC understands that a critical component of resilience is to maintain and enhance the habitat and environment that helps to afford protection to the Port and associated infrastructure.

[1] NOAA (2019). Relative Sea Level Trend 8761724 Grand Isle, Louisiana.
[2] Miner, M. D., Kulp, M. A., FitzGerald, D. M., Flocks, J. G., & Weathers, H. D. (2009). Delta lobe degradation and hurricane impacts governing large-scale coastal behavior, south-central Louisiana, USA. Geo-Marine Letters, 29(6), 441–453.
[3] Couvillion, B. R., Beck, H., Schoolmaster, D., & Fischer, M. (2017). Land Area Change in Coastal Louisiana (1932 to 2016), 26. CPRA. (2022). CIMS Coastal Basin Metadata.

Port Fourchon serves >90% of all U.S. Gulf of Mexico deepwater oil and gas exploration and production. It is vital in the production of ~20% of the nation's oil supply.

Challenges it faces:

~9 mm yr rate of
relative sea level rise

~3 km century
shoreline retreat

~28 km^2 yr
land loss

The results of this study will help inform GLPC as they determine the optimal use of the material from the Port Fourchon dredging and expansion project, to help maintain and improve the resilience of Port Fourchon, serve the long-term needs of local stakeholders, and improve ecosystem services.

An aerial view of Port Fourchon
Photo by Patrick M. Quigley from Weeks Marine, Inc. and CPRA

In 2016, the GLPC formally announced its plans to obtain federal regulatory approval to deepen Belle Pass and the Port's accompanying slips, located at the mouth of Bayou Lafourche in Port Fourchon, to provide an additional port facility capable of handling the heavy maintenance, refurbishment and/or decommissioning needs of the deepwater energy industry.

This large-scale dredging project will initially generate between 13 and 20 million cubic yards of sediment, with additional material produced from maintenance dredging over the long term. The GLPC has made it clear that they intend to see this material used beneficially not only for the project's development and environmental mitigation obligations, but also as an integral and renewable borrow source for coastal ecosystem restoration and protection initiatives locally.

In 2017, energy industry partners Chevron, Shell, and Danos, along with the GLPC and The Water Institute came together to form the Partnership for Our Working Coast (POWC). POWC is a public-private partnership which takes a science-based approach to maximizing the benefits of coastal restoration efforts to: (1) protect critical infrastructure in and around the Port; (2) generate new, quantifiable ecosystem services; (3) improve community understanding and overall resilience from Port Fourchon to Larose; and (4) quantify the carbon-capture benefits.

In Phase One of this collaboration, The Water Institute worked with GLPC to select sites for a beneficial use wetlands creation project based on several criteria, including distance from the channel deepening location and the water depth at the potential placement sites.

In Phase Two, summarized here and detailed within the accompanying report,[4] The Water Institute and POWC partners worked to expand on the Phase One work to analyze and prioritize a list of potential sites for a suite of wetlands restoration projects that can be created by using the material provided by the Port Fourchon dredging and expansion project.

In this work, The Water Institute developed and engaged in an ambitious and rigorous process in which scientists collaborated with local stakeholders and community members to inform the design of potential nature-based wetlands restoration projects. Through this participatory research, potential projects were analyzed for their social and ecological resilience and their potential to sequester carbon. Projects were additionally analyzed for how they would function within, and in response to the drivers of change - such as sea level rise, subsidence, and storms - in the natural system.

[4] The Water Institute of the Gulf. (2022). A community-informed transdisciplinary approach to maximizing benefits of dredged sediment for wetland restoration planning at Port Fourchon, Louisiana: Quantifying social, ecosystem, and carbon emissions reduction benefits of wetland restoration, and ecosystem evolution through 2050 (p. 152 + app.). Baton Rouge, LA: The Water Institute for the Gulf, prepared for and funded by The National Fish and Wildlife Foundation, Shell, Chevron, Danos, and the Greater Lafourche Port Commission.

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Objectives

- Protect critical infrastructure
- Generate new, quantifiable ecosystem services
- Improve community understanding and resilience
- Quantify carbon-capture benefits

Chett Chiasson, Executive Director of Greater Lafourche Port Commission, discusses project objectives with participants during one of the competency group meetings.

THE PROCESS

Scientists from The Water Institute taking frozen soil cores to measure accretion rates in mangrove forest habitats.

Transdisciplinary Approach

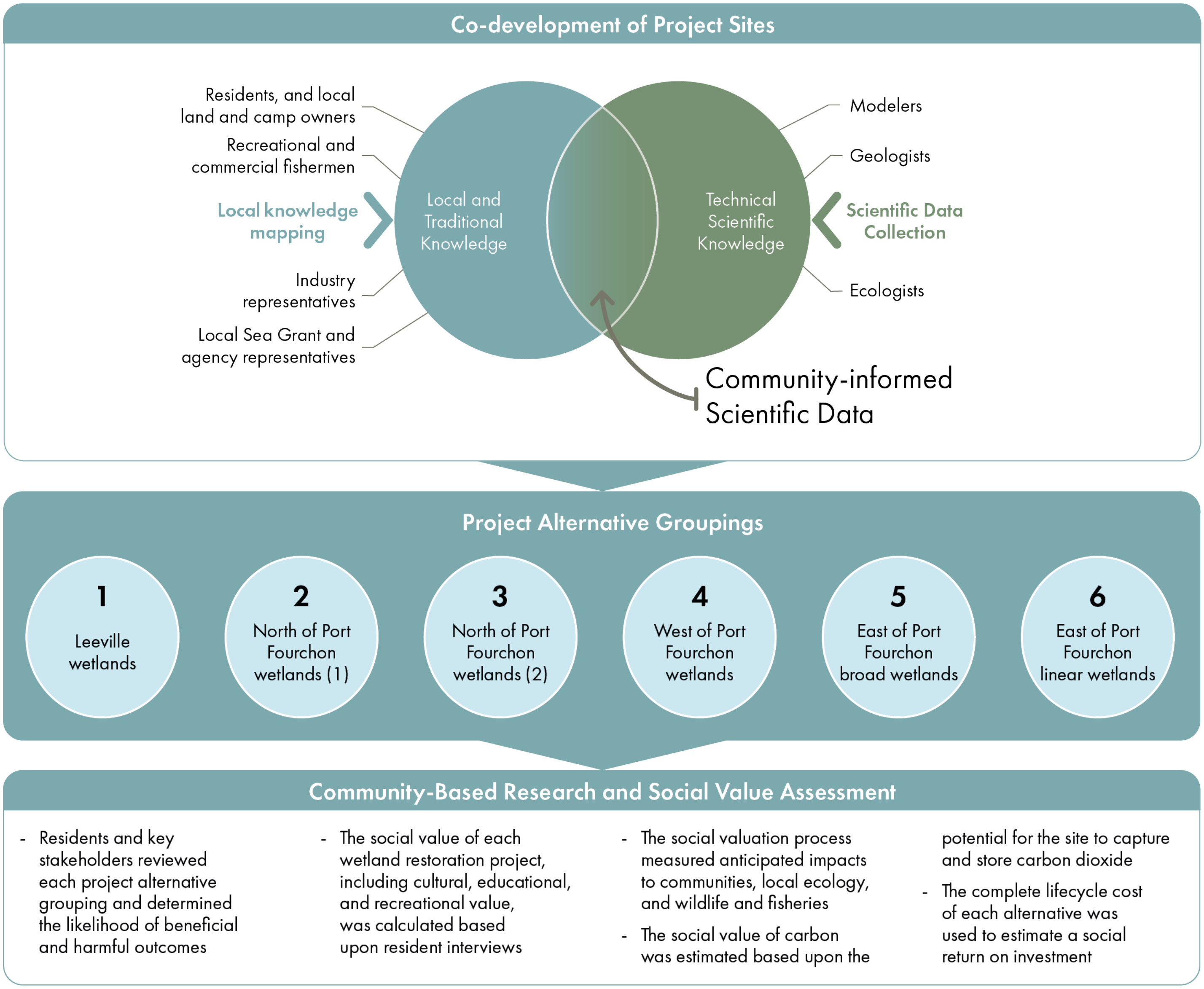
A core aim of this study was to prioritize project site selection based on improving the overall resilience of Port Fourchon. This required an understanding of not only the resilience for the Port, but also for the nearest communities, which are highly dependent on both the Port itself and the natural resources of the area. As a result, the wetlands restoration projects analyzed needed to be quantified not only for land area built and mitigation of future land losses, but also for a range of potential co-benefits; specifically, the ecosystem services, carbon emissions reductions, and social benefits that could be created. In order to understand and quantify these complex factors, it is important to integrate local knowledge with technical, scientific knowledge.

This study developed and used an innovative transdisciplinary approach to assess and inform coastal resilience, as summarized in Figure 1. While traditional research relies almost entirely on technical, science-based knowledge, the transdisciplinary approach adopted here brought individuals from different scientific disciplines and from civil society together to actively collaborate and address local resilience issues. This approach facilitated active collaboration and dialogue between residents, stakeholders from the local community, industry representatives, and research scientists. These “local knowledge experts” and “technical knowledge experts” together comprised an Environmental Competency Group.

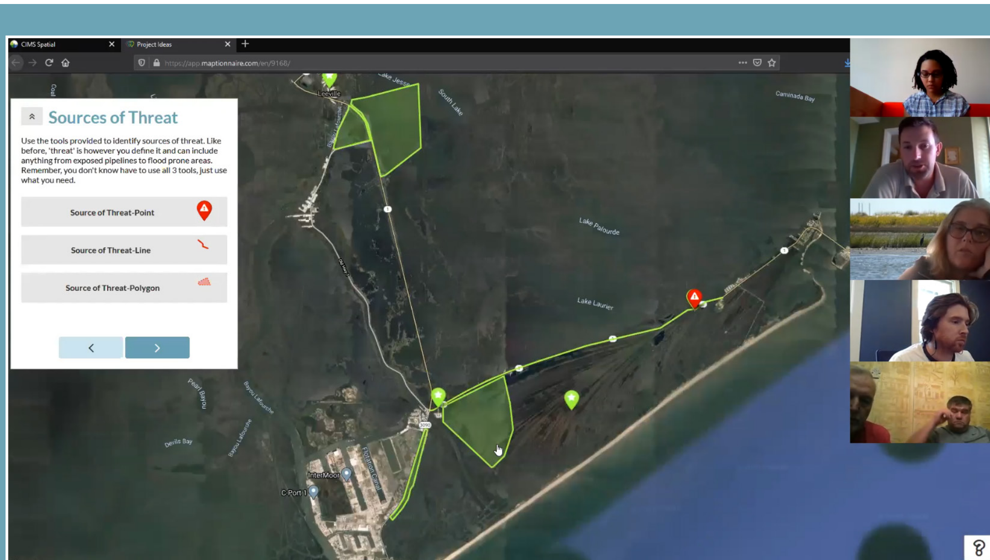
This approach adds significant value by leveraging the methods, knowledge, and principles of the individual disciplines as well as the accumulated local knowledge of residents and local stakeholders. In this approach, all parties worked together on the same problems to co-develop nature-based solutions that fully integrate local and traditional knowledge with physical and social scientific knowledge. By integrating residents and other local knowledge experts into the scientific process, the results are much more actionable than those developed through traditional research.

The Environmental Competency Group relied on residents and local stakeholders to provide new insights into the challenges facing coastal communities and the solutions to address them. Community members were contacted and asked to recommend individuals for the Environmental Competency Group, and those individuals named most frequently by community members were asked to join as local knowledge experts. Technical knowledge experts were individuals selected by The Water Institute based on scientific knowledge of the area around Port Fourchon. The final membership of the Environmental Competency Group included local landowners, recreational and commercial fishermen, representatives of the GLPC and its tenants, the local Sea Grant representative, and modelers, geologists, and ecologists from The Water Institute.

FIGURE 1. APPLICATION OF TRANSDISCIPLINARY APPROACH FOR RESILIENCE OF PORT FOURCHON, ITS TENANTS AND SURROUNDING COMMUNITIES



The social value interviews with residents and local stakeholders were implemented in conjunction with the modeling of project alternatives summarized in Figure 3.



Incorporating Local and Traditional Knowledge

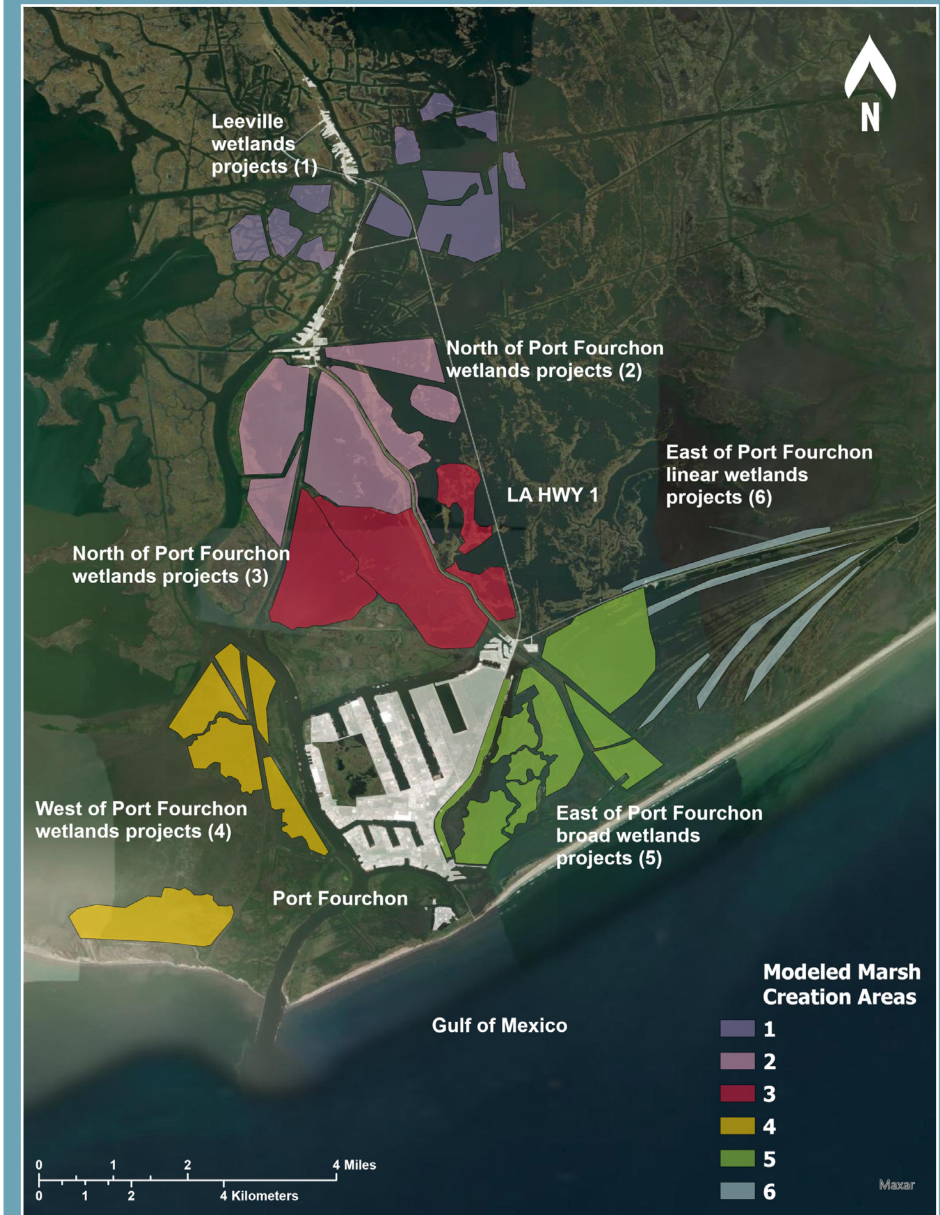
A map-based survey platform was adopted for Local Knowledge Mapping to continue engagement and collaboration with members of the Environmental Competency Group amid COVID-19 restrictions.

Project Site Selection

To ensure the best use of the sediment that will be dredged from Bayou Lafourche, a number of factors can be taken into consideration when selecting sites for the nature-based wetlands restoration project. These factors include the location of sites in relation to existing wetlands or open water areas, which influence the resilience of the built wetlands and how those wetlands are affected by storms and tropical cyclones; the ecological value of the restoration project, including the potential for the site to capture and store carbon dioxide, what the wetlands restoration project sites create in terms of social value, and the complete lifecycle cost of each alternative. Overall the selected suite of beneficial use wetland restoration projects must serve to enhance the resilience of Port Fourchon, its tenants, and the surrounding communities.

A total of 43 beneficial use wetland restoration project sites, organized into six groupings (Figure 2), were developed in consultation with all parties involved in the study. The geographic areas for these groupings were selected during Phase One of the study and adjusted in Phase Two, based on the expected sediment type that will be made available through the dredging activities, and proximity to the dredging site.

FIGURE 2. PROJECT ALTERNATIVE GROUPINGS



1: Leeville wetlands

2: North of Port Fourchon wetlands (1)

3: North of Port Fourchon wetlands (2)

4: West of Port Fourchon wetlands

5: East of Port Fourchon broad wetlands

6: East of Port Fourchon linear wetlands

The list of project sites developed during Phase One was first presented to the Environmental Competency Group who provided comments and adjustments to the list. The Environmental Competency Group and other local stakeholders were then interviewed about these adjustments for a Social Value Assessment.

Then the project sites were presented to representatives of federal and state agencies who are involved in the Coastal Wetland Planning, Protection, and Restoration Act program (namely the National Oceanic and Atmospheric Administration, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the Louisiana Coastal Protection and Restoration Authority). These agencies provided feedback to ensure that other ongoing proposed projects in the area were captured. The Water Institute then presented the proposed wetlands restoration groupings to the POWC who provided comments on, adjustments to, and approval of, the list of project alternative groupings to be modeled and analyzed.

Modeling the Impacts of Project Alternatives

For all proposed beneficial use wetlands restoration project alternatives, The Water Institute sought to assess the outcome and sustainability of each alternative for a simulated 30-year period, from 2020 to 2050. This analysis used numerical models to simulate landscape change, an increasingly common tool used to facilitate coastal planning. Figure 3 presents a summary of the modeling process.

Models can simulate, over the long-term, the daily processes that influence land gain, land loss, and ecosystem trajectory; processes which include wind, waves, tides, sediment deposition, and the vegetation species that populate and persist in an area. Models can additionally simulate the influence of less frequent processes such as tropical cyclones, and longer-term changes such as the combined effects of subsidence and sea level rise (referred to as "relative sea level rise"). The projections of the future landscape evolution resulting from each alternative provided by numerical models can help communities and decision-makers weigh the benefits and drawbacks of different restoration wetlands restoration projects.

The Coastal Systems Modeling Framework

To understand the long-term impacts of each project alternative for this study, The Water Institute developed the Coastal Systems Modeling Framework (Figure 4). This framework consists of four separate models, the Morphology Model, the Hydrodynamics Model, the Coastal Wetland Carbon Model, and the Storm Impacts Model. Each of these models operates independently to simulate different groups of processes on the landscape, including the movement of sediment and water and the landscape changes that occur as a result (e.g. land erosion), the vegetation types that grow in each wetland area for a given set of conditions simulated by the model, and the carbon stored and released by the growth and destruction of vegetation. The information produced by each model informs other models within the Coastal Systems Modeling Framework.

FIGURE 3. MODELING THE IMPACTS OF PROJECT ALTERNATIVES

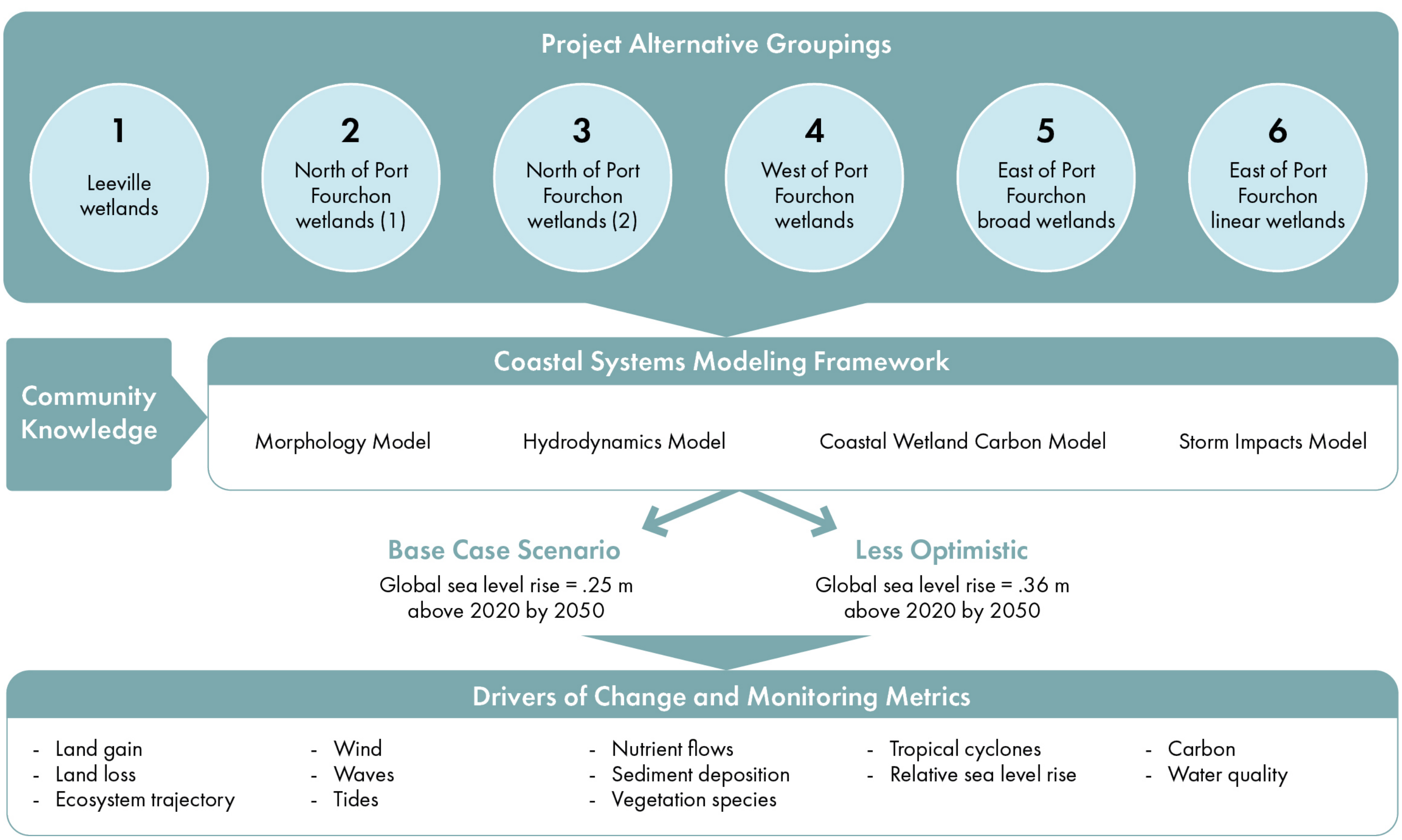
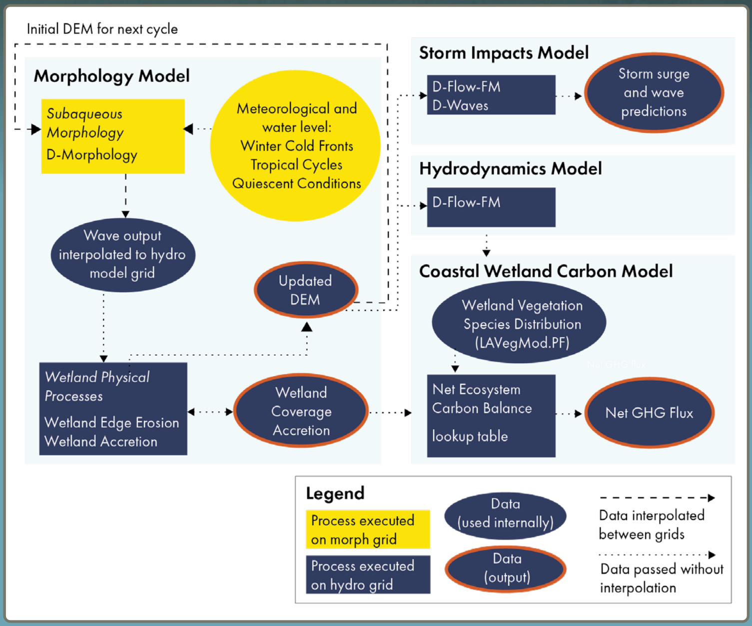


FIGURE 4. COASTAL SYSTEMS MODELING FRAMEWORK



The models used addressed various aspects of the natural environment and were constructed from a range of environmental datasets, each of which were carefully reviewed and ground-truthed by the full Environmental Competency Group. The ability of the projects to build wetlands, including saltmarsh and mangroves, and to reduce wave impacts on infrastructure was modeled for each project grouping.

Environmental Scenarios

To develop projections about the future landscape, it is necessary to input information into the models about future environmental conditions. For this study, two environmental scenarios were developed: a 'Base Case' scenario and a 'Less Optimistic' scenario, and projections were made for all project alternatives using each of the two scenarios.

Both scenarios used the same rates of subsidence. These values vary across the Barataria-Terrebonne Basin, with the highest rates occurring in Terrebonne Basin (7.6 to 9 mm/yr), lower rates in Barataria Basin (6.1 to 7.5 mm/yr) and the lowest rates in Caminada Headland (3 mm/yr).

The choice was made to model both the Base Case and the Less Optimistic environmental scenario to account for uncertainty about the ability of wetlands to maintain elevation above the combined impacts of subsidence and eustatic sea level rise.

Base Case Scenario

In the Base Case environmental scenario, eustatic sea level rise (global sea level rise) was set to reach 0.25 m above 2020 sea level by 2050. At this rate, the wetlands within the model would gain land elevation (accrete) such that the land would remain above the water in spite of the combined effects of sea level rise and subsidence. A lower energy set of varying tropical storms was used for this environmental scenario.

Less Optimistic Scenario

In the Less Optimistic environmental scenario, eustatic sea level rise was set to 0.36 m above 2020 values by 2050. In this scenario, the simulated wetlands accretion rate was set to be 2 mm less per year than the combined effect of sea level rise and subsidence, such that the wetlands would be below the water level. A higher energy set of tropical storms was used for this environmental scenario.

WHAT WE FOUND

The results of the study presented herein are for each wetlands restoration project alternative grouping based on the following model projections **from 2020 to 2050:**

Land Changes

CO2 Blue Carbon

Storm Surge, Waves, and Water Level

Social Return on Investment

		With restoration	Without restoration
1	**Leeville**	>1,200 acres created, 230 acres lost Some smaller areas of wetland creation are lost entirely Does not create long-term land gain in the future	Loses ~130 acres
2&3	**North of Port Fourchon**	>4,000 acres created, <400 acres lost Maintain the separation of the Barataria Basin from the Terrebonne Basin provided by the natural levees of Bayou Lafourche, which is presently degrading	Loses almost all existing ~600 acres of wetlands
4	**West of Port Fourchon**	~980 acres created, 160 acres lost All constructed wetlands projects are largely intact by 2050	Loses >230 acres, with only a thin strip of land remaining to separate Bayou Lafourche from Timbalier Bay
5	**East of Port Fourchon** Broad wetlands	1,800 acres created, >250 acres lost Helps to maintain land between Port Fourchon and the Gulf of Mexico by creating continuous wetland from the beach	Loses ~250 acres
6	**East of Port Fourchon** Linear wetlands	~320 acres created, ~320 acres lost The finer sediments that are expected to be available for construction use from dredging of Port Fourchon is very difficult to stack to the geometry that would be required for the area's long, narrow ridges	Loses ~230 acres

Port Fourchon is expected to face continued, increasing risk from various coastal threats, including subsidence, sea level rise, wetlands loss, and impacts from storms over the 2020-2050 period of analysis used in this study. The model simulations for this study predict that the main driver of wetlands loss in the Barataria-Terrebonne Basin is erosion of the marsh edge, rather than submergence. Project alternatives located in areas with less open water and less edge habitat exposed to open water therefore showed the least land loss by 2050.

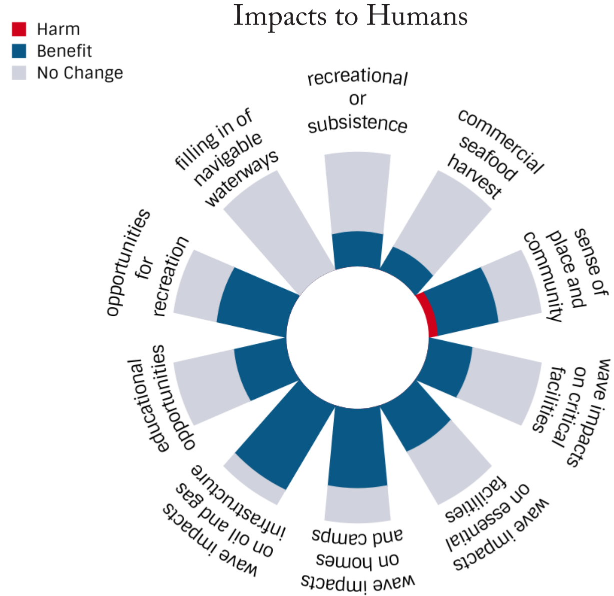
RESULTS

CO2		
1,421 acres of brackish and saline marshes GHG emission net sink (2020): -0.02 MMT CO2e Transitions to GHG net source: ~+0.05 MMT CO2e	No consistent reduction	While there was some reduction in wave height at the project locations, wave heights nearby were increased with project implementation
4,941 acres of brackish and saline marshes GHG emission net sink: -0.03 MMTCO2e	Decreases of 5-25 cm in peak and time-averaged wave heights for all modeled storms	Impacts of the storms varied little between project creation and 2050 as the wetlands restoration projects remained largely intact
1,670 acres dominated by black mangroves GHG emission net sink: -0.03 MMT CO2e	Modest reductions in peak storm surge height (<5 cm) and greater reductions in peak and average wave height (5-25 cm)	Projected reductions in wave heights are largely consistent regardless of the storm track
2,356 acres co-dominated by mangrove forests and brackish and saline marshes GHG emission net sink: -0.02 MMT CO2e	Increased water levels were projected for both 2020 and 2050 In 2050 some reduction in storm surge is seen for some storm tracks, after an initial increase in storm surge for 2020	Wave heights are reduced by up to 25 cm within the project footprint, even with increased storm surge. However, where water levels are increased, the wave heights also increase
697 acres of brackish and saline marshes GHG emission net sink (2020): -0.01 MMT CO2e Transitions to GHG net source: +0.01 to +0.08 MMT CO2e	Peak water levels for 2050 increase for some storm tracks and decrease for others	Wave height reductions for 2050 are minimal for all modeled storms, and in some cases, those wave heights are increased

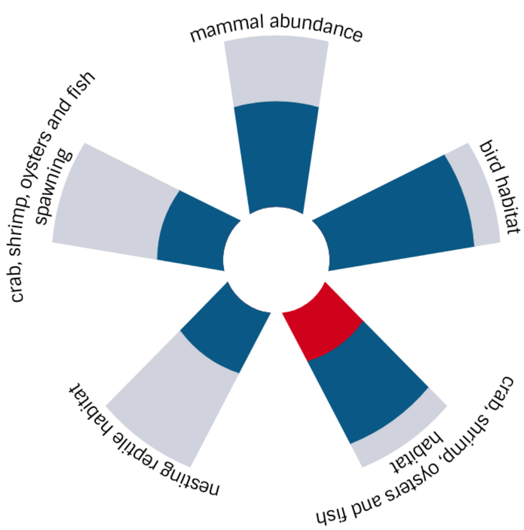
West of Port Fourchon

This project grouping is largely expected to generate the greatest social return on investment. Surveyed respondents expect that a beneficial use marsh creation project in this location will increase saline marsh and mangrove habitats, leading to an increase in bird and mammal habitat that will bring an increase in crab, oyster, shrimp, and fish habitat. The majority of respondents believe the reduction in wave impacts will benefit oil and gas infrastructure and fish camps and improve recreational opportunities.

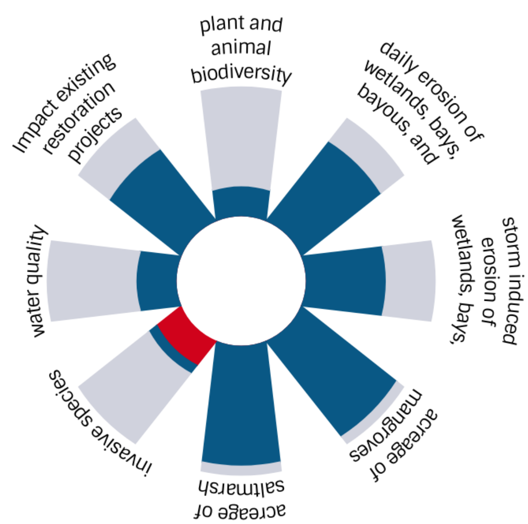
Impacts to Humans



Impacts to Wildlife and Fisheries



Impacts to Ecosystem



East of Port Fourchon

Broad wetlands

Respondents largely believe this project alternative would provide the greatest protection to homes, fishing camps and infrastructure. However, a number of stakeholders expect the project would harm crab, shrimp, oyster, and fish habitat and cause harm to fisheries

East of Port Fourchon

Linear wetlands

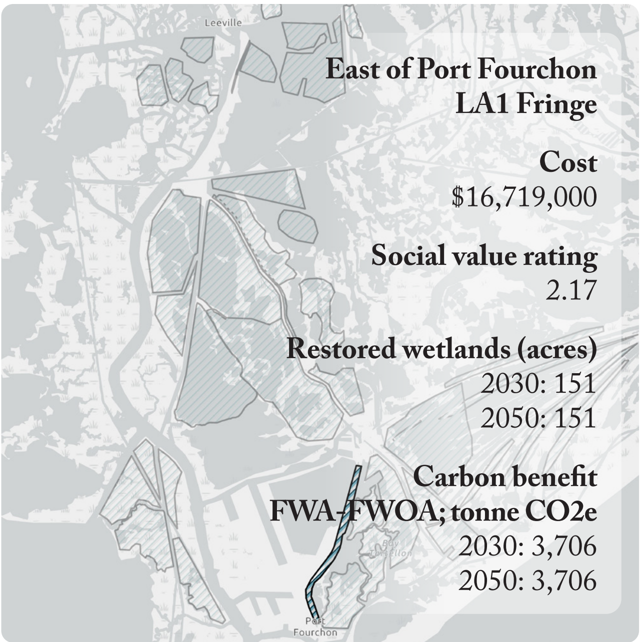
LA 1 Fringe: Respondents suggested benefits in terms of bird and mammal habitat, and a reduction of wave impacts on oil and gas infrastructure. However, the project would also reduce access to the area for subsistence and recreational fishing.

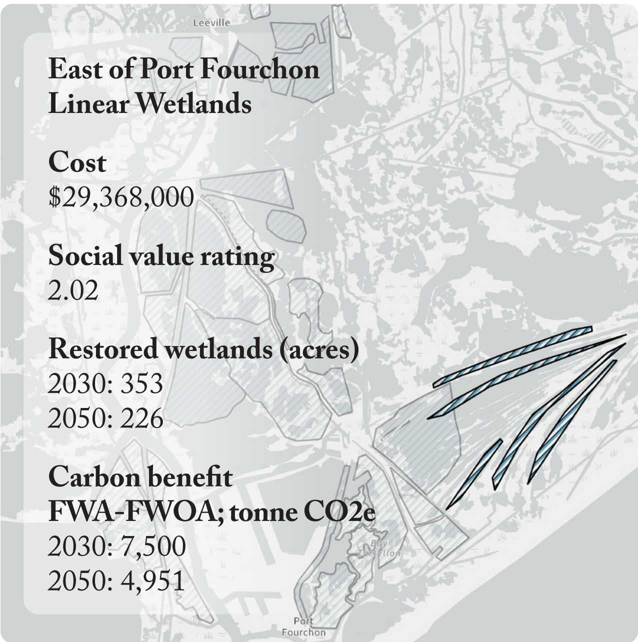
Linear Wetlands: Respondents perceived positive ecosystem benefits from this project with improved habitat and reduced erosion. Overall, however, this project alternative was seen as not particularly beneficial to local communities, residents, or as having any co-benefits for oil and gas infrastructure.

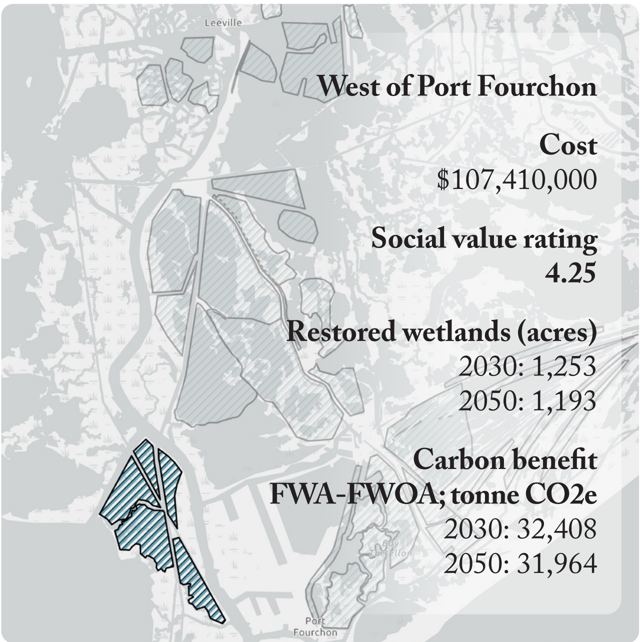
Cost Evaluation

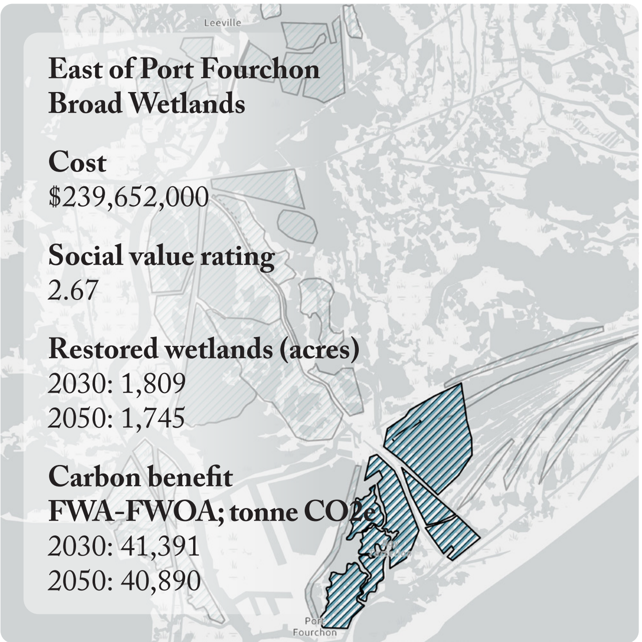
A cost evaluation was conducted for each of the six project alternatives, using a combination of standard industry practices and existing tools for cost estimation developed for the Louisiana Coastal Master Plan and the Coastal Wetlands Planning, Protection, and Restoration Act program.

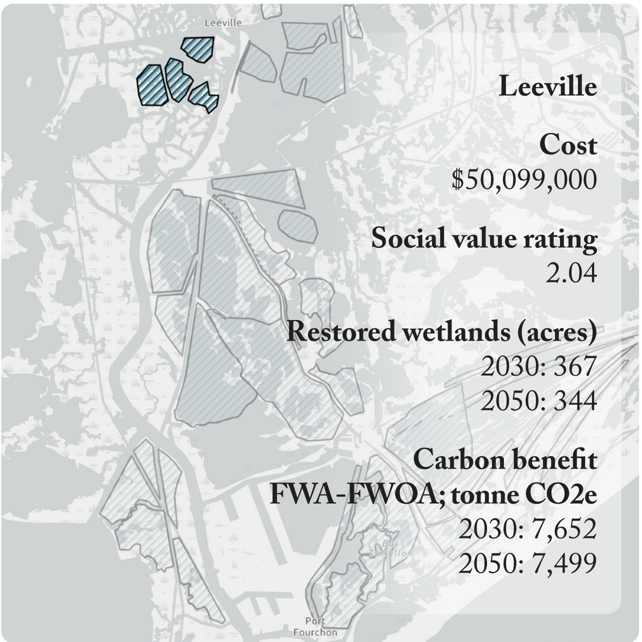
All costs presented below are in 2020 U.S. dollars and evaluate the cost for construction in addition to the cost of monitoring and maintenance for 30 years.











CONCLUSION

THE VALUE OF COLLABORATIVE MANAGEMENT IN BUILDING COMMUNITY RESILIENCE

In order for Port Fourchon and the communities in and around Lafourche Parish to remain viable into the future, it is necessary to support both the region's valuable fisheries and the critical industrial infrastructure that supports offshore oil and gas production. As the GLPC moves toward port improvements that could generate an initial 13 to 20 million cubic yards of sediment, the work set out in this report was initiated to inform the design of potential nature-based wetlands restoration projects using this future sediment resource.

Beyond providing protection for communities, wetlands are tied to the region's history and cultural heritage. Restored wetlands can provide enhanced opportunities for recreation and education. Indeed, much of coastal Louisiana's sense of community and place is rooted in a long-standing relationship between the human and natural environments. These more intangible aspects of coastal protection and restoration are not as readily modeled but are no less important when it comes to building community resilience.

The transdisciplinary approach developed and operationalized in this study resulted in a suite of wetland restoration project alternatives that are all expected to generate a range of ecological and societal co-benefits that will maximize social value and enhance community resilience. The Environmental Competency Group approach to participatory modeling – which brought together researchers, scientists, stakeholders and community members – actively incorporated the local and traditional knowledge of residents and resource users into the numerical models developed by scientists and other technical knowledge experts. This process was built on the principles of collaborative management and actively encouraged residents and local stakeholders to work with scientists and other technical knowledge experts to co-design a suite of projects that, by their very nature, support local values and concerns.[5]

The resulting proposed projects were analyzed for their ability to support social and ecological resilience, their potential to sequester carbon, and how well they would function in response to the drivers of change in the natural system such as sea level rise, subsidence, and storms.

The transdisciplinary approach developed and operationalized in this study resulted in a suite of wetland restoration project alternatives that are all expected to generate a range of ecological and societal co-benefits that will maximize social value and enhance community resilience. These co-benefits were assessed directly through numerical modeling, and addressed various aspects of the natural environment and were constructed from a range of environmental datasets. Each were carefully reviewed and ground-truthed by the full ECG.

Key to the success of this research will be the ability of the final project or projects constructed to generate the anticipated social and ecological co-benefits in the future. Several of these co-benefits were assessed directly through numerical modeling. The models used addressed various aspects of the natural environment and were constructed from a range of environmental datasets, each of which were carefully reviewed and ground-truthed by the full Environmental Competency Group. The ability of the projects to build wetlands, including saltmarsh and mangroves, and to reduce wave impacts on infrastructure was modeled for each project grouping. In addition, each project was assessed to determine its ability to serve as a carbon sink or a source and modeled for its ability to protect surrounding homes and camps from storm surge and flooding.

Finally, to address the more intangible aspects of restored and constructed wetlands, a social valuation model was developed based upon survey research and interviews with a group of residents and local stakeholders. The research team worked with partners from EcoMetrics LLC to incorporate the interviews and survey results into an adapted social valuation methodology previously developed by the Restore the Earth Foundation.

The participation of local knowledge experts in this planning process provided insight into social and cultural values that could not be gained through traditional scientific approaches alone, allowing the technical team to generate more alternatives, resulting in flexible actions and mutual co-benefits similar to the findings of Stringer et al. and Zedler.[6,7]

This work found a general agreement between the results of the social valuation model and those of the ecological and hydrodynamic models demonstrating that coastal protection and restoration planning supported by the incorporation of reliable knowledge drawn from both the scientific community and from the local community results in more effective and sustainable outcomes.[8]

The framework developed and operationalized through this research represents a key advancement in the collaborative management of coastal protection and restoration planning and provides a framework and tools that can be leveraged to enhance resilience within the study area and adapted for other locations globally.

[5] Hemmerling, S. A., DeMyers, C. A., & Carruthers, T. J. (2022). Building Resilience through Collaborative Management of Coastal Protection and Restoration Planning in Plaquemines Parish, Louisiana, USA. Sustainability, 14(5), 2974.
[6] Stringer, L. C., Dougill, A. J., Fraser, E., Hubacek, K., Prell, C., & Reed, M. S. (2006). Unpacking "participation" in the adaptive management of social–ecological systems: a critical review. Ecology and Society, 11(2).
[7] Zedler, J. B. (2017). What's new in adaptive management and restoration of coasts and estuaries? Estuaries and Coasts, 40(1), 1–21.
[8] Hemmerling, S. A., Barra, M., & Bond, R. H. (2020). Adapting to a smaller coast: Restoration, protection, and social justice in coastal Louisiana. In S. Laska (Ed.), Louisiana's Response to Extreme Weather: A Coastal State's Adaptation Challenges and Successes (pp. 113–144). Cham, Switzerland: Springer International Publishing.

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