

# TAPPING THE INGENUITY OF STUDENTS TO DESIGN A RESILIENT TEXAS COAST

## ASBPA Conference

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US Army Corps of Engineers  
Galveston District

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# INNOVATION IN THE WAKE OF HURRICANE HARVEY

## Background

- **Coastal Texas Protection and Restoration Feasibility Study (CTPRS)**  
(Initiated in October 2015)
- **EWN Workshop** (July 2017)
- **Hurricane Harvey** (August 2017)
- **Studio Class** (Spring Semester 2018)
  - Advanced graduate and undergraduate landscape architecture students from **Cornell and Auburn Universities**
  - **USACE Galveston District** personnel from the CTPRS study team
  - **Texas General Land Office (GLO)** (Non-Federal Sponsor for the CTPRS)
  - **USACE Engineering Research and Development Center (ERDC)** - Engineering with Nature (EWN) Program

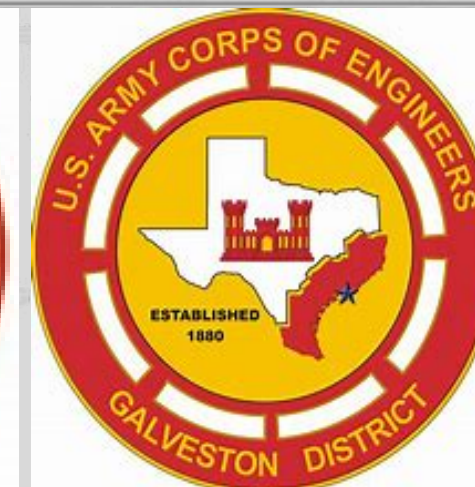


Cornell University



AUBURN

UNIVERSITY







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## COURSE INSTRUCTORS



**Dr. Brian Davis** is an Assistant Professor at Cornell University in the Department of Landscape Architecture. He is the Director of the **Borderlands Research Group**. He is also a registered landscape architect and a member of the **Dredge Research Collaborative**.



**Dr. Rob Holmes** is an Assistant Professor at Auburn University in the School of Architecture, Planning, and Landscape Architecture. He is the co-founder of the **Dredge Research Collaborative**, which investigates human sediment handling practices through publications. He is also the co-author of **Mammoth**, a blog about infrastructures, logistics, landscapes, and architectural possibilities





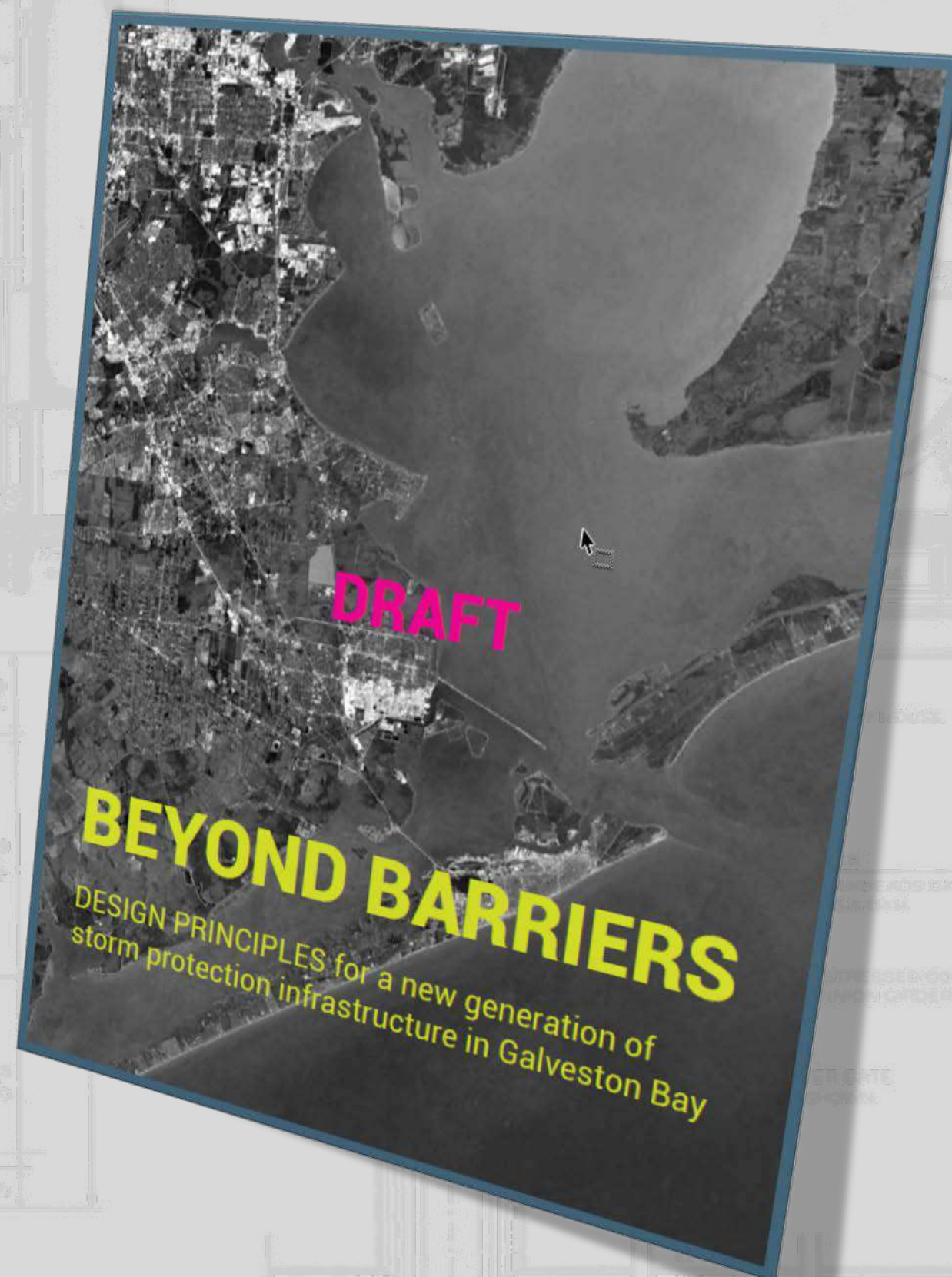
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# INNOVATION IN THE WAKE OF HURRICANE HARVEY



**Studio Class Vision:** Identify landscape architecture concepts that overlap with EWN principles and then design projects that emphasize multifunctional and adaptive relationships between **humans**, their **environment**, and **built infrastructure** in a real-world setting.

**Focus:** Demonstrate technically informed design principles and **characterize the potential of Natural and Nature-based Features (NNBF) at key locations**, including the possibility of the engineering structures to be self-mitigating when possible.







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# CLASS FORMAT



## Graduate Students (Auburn):

- 1) Develop an Atlas of key resources for use by classmates to establish baseline conditions; and
- 2) Select a location and develop an individual EWN-based plan.

## Undergraduate Students (Cornell):

- 1) Working in teams of 2-3 students, select a location and develop an EWN-based plan.

**Course Field Trip:** USACE provides funds for students to travel to Galveston, visit the CTPRS study sites, and interact with the team – learning the study problems, opportunities and constraints along the way.

**Mid-Terms/Finals:** Present preliminary and final designs in a 2 sets of webinars to the USACE and GLO staff for evaluation and critique





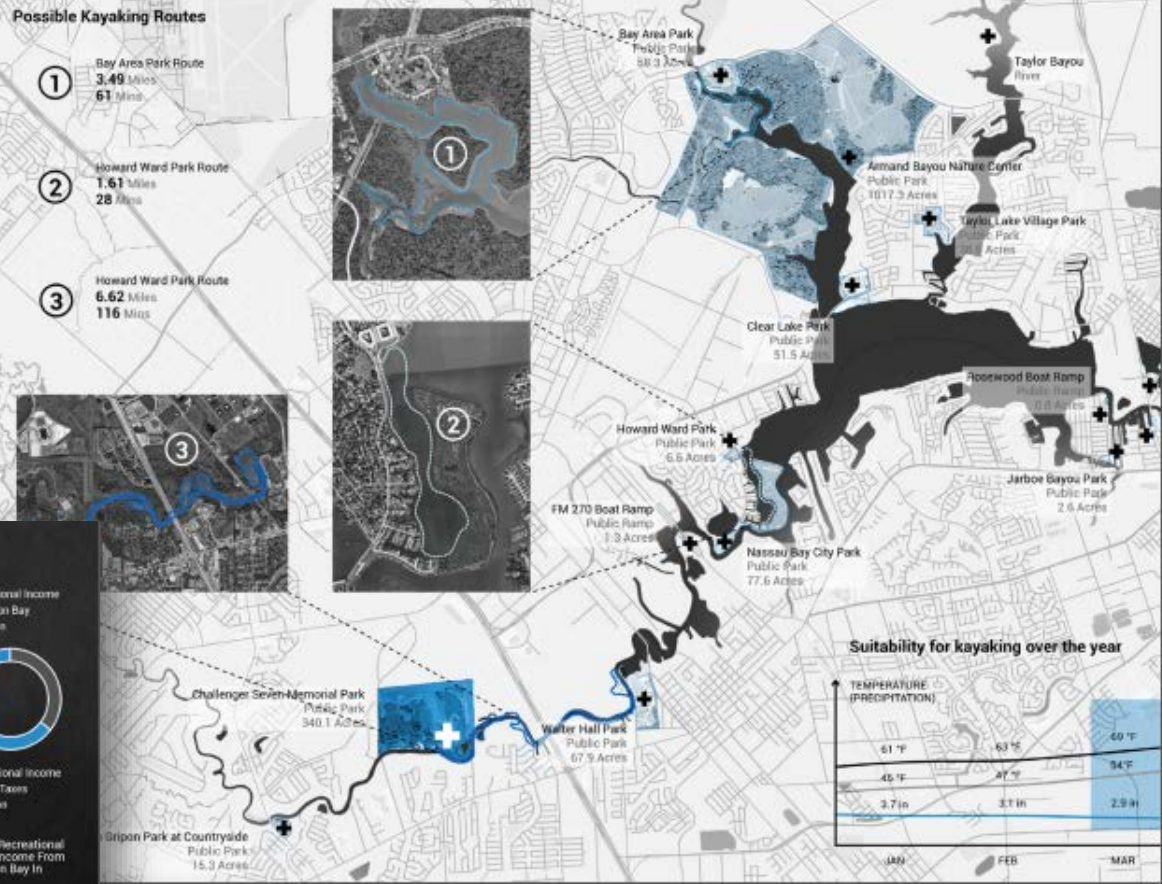
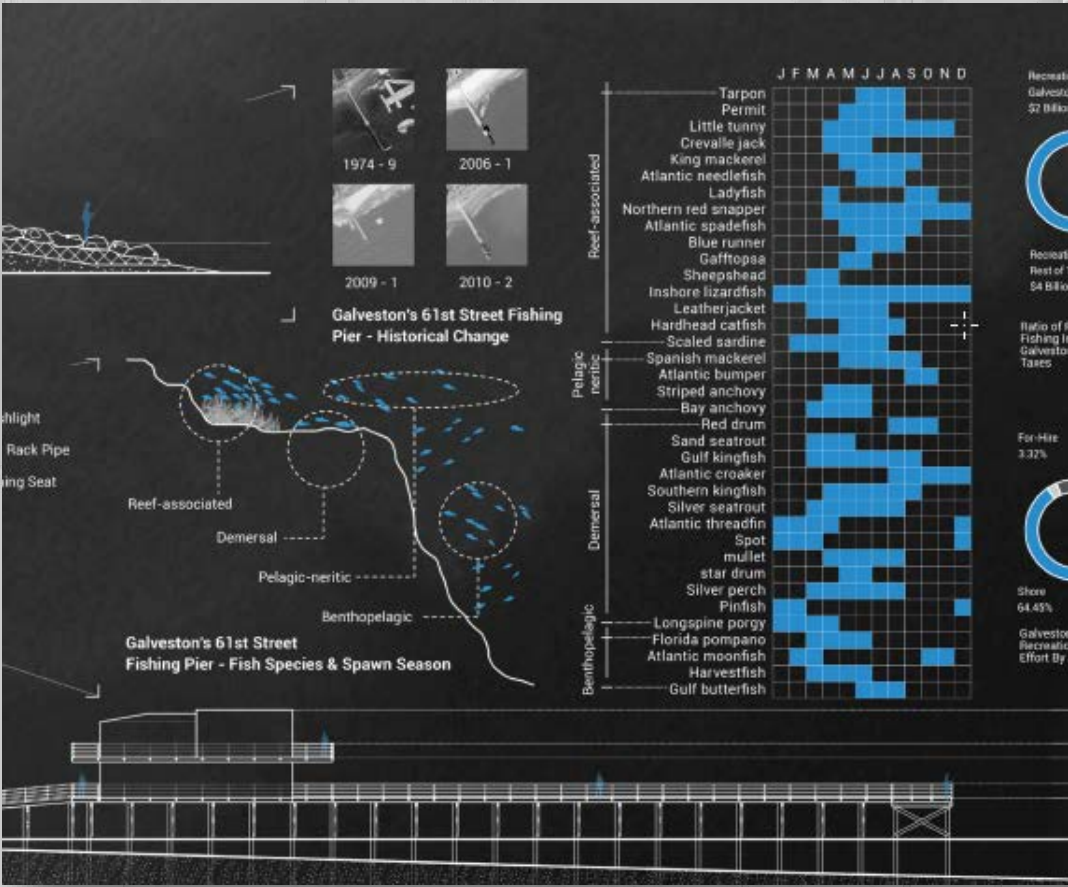


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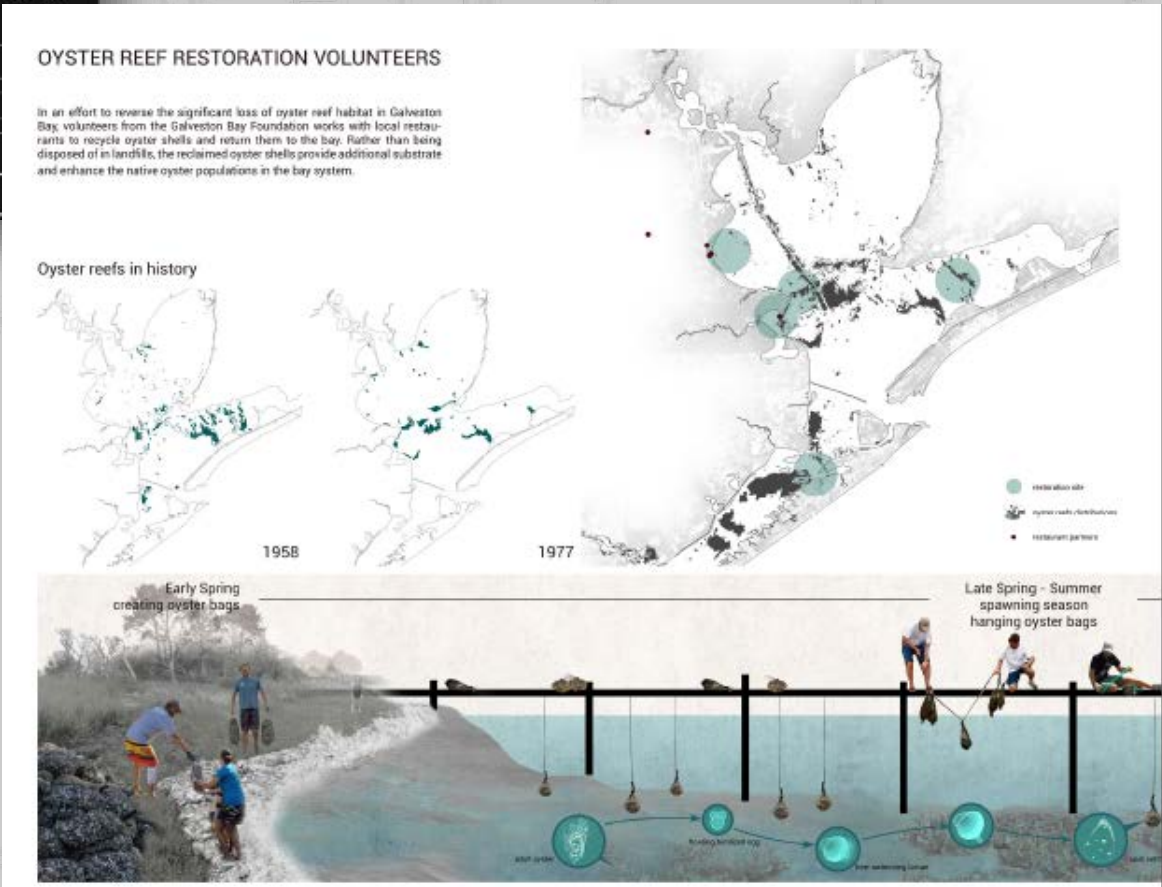
# THE CHALLENGE

## Ideas for projects included:

- Enhancing proposed coastal storm risk reduction measures for the CTPRS
- Identifying opportunities for public access to CSRM
- Improving ecosystem health through restoration features
- Generating ecosystem services through CSRM and ER features
- Enhancing aesthetics of proposed CSRM and ER features



**The Challenge:** Produce visually engaging materials that convey the concepts behind EWN through the use of NNBF that are easily understood by the public and other interested but non-expert parties.







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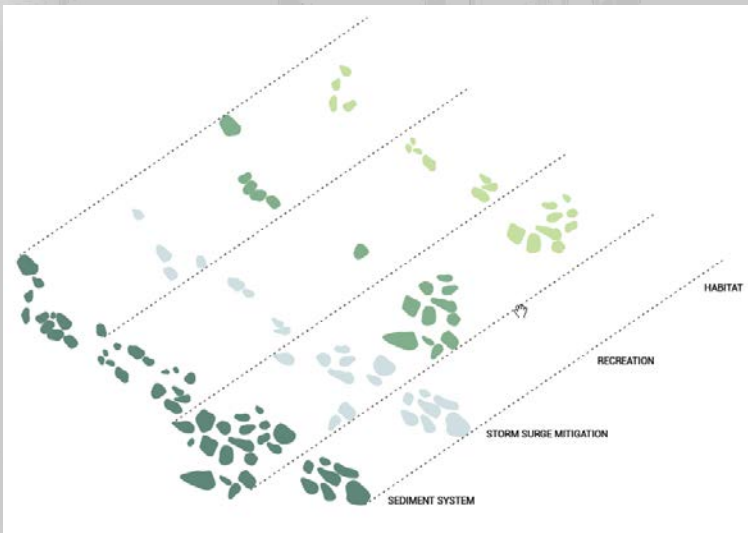


# 1 - OVERLAP USES AND FUNCTIONS

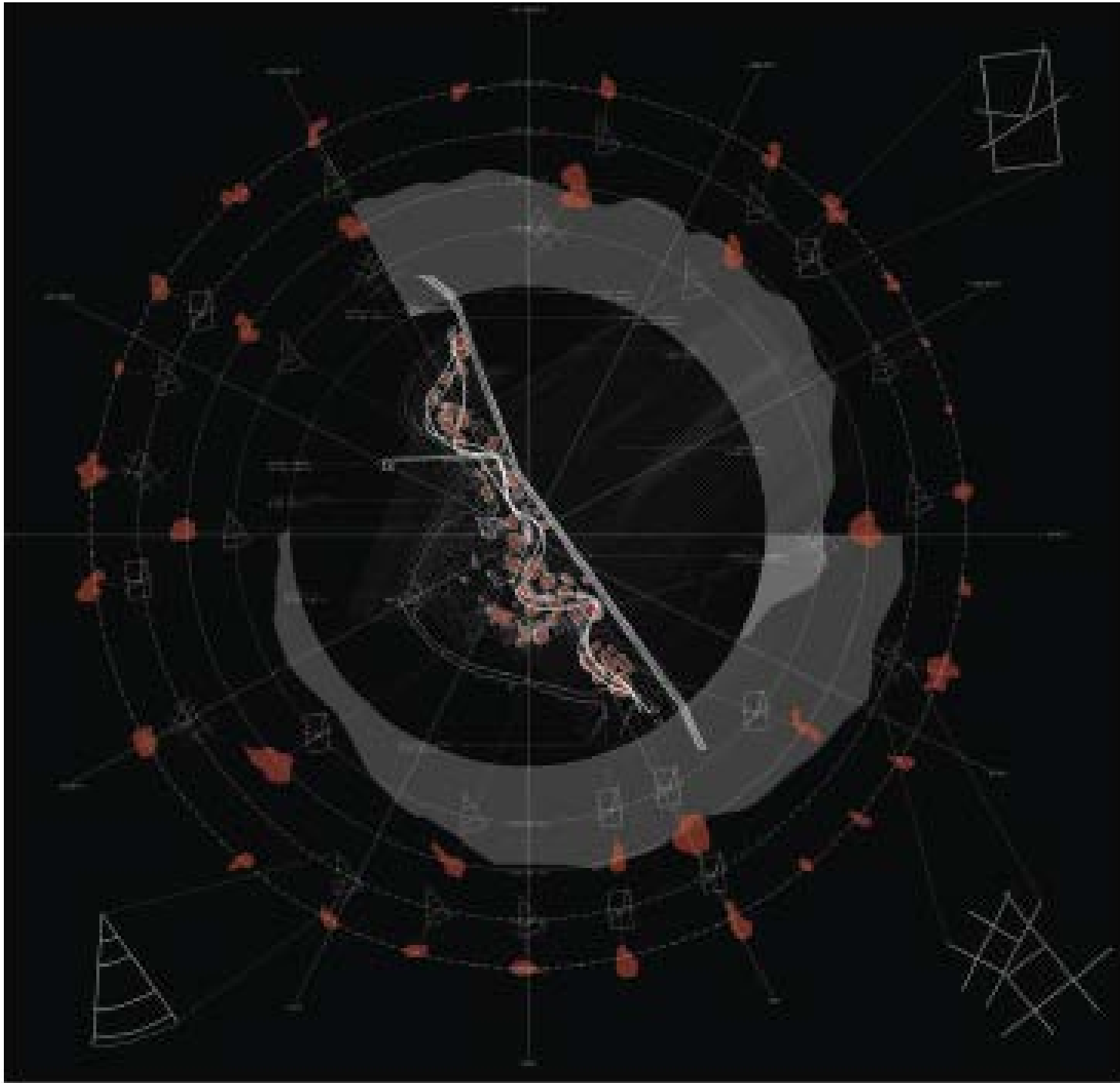
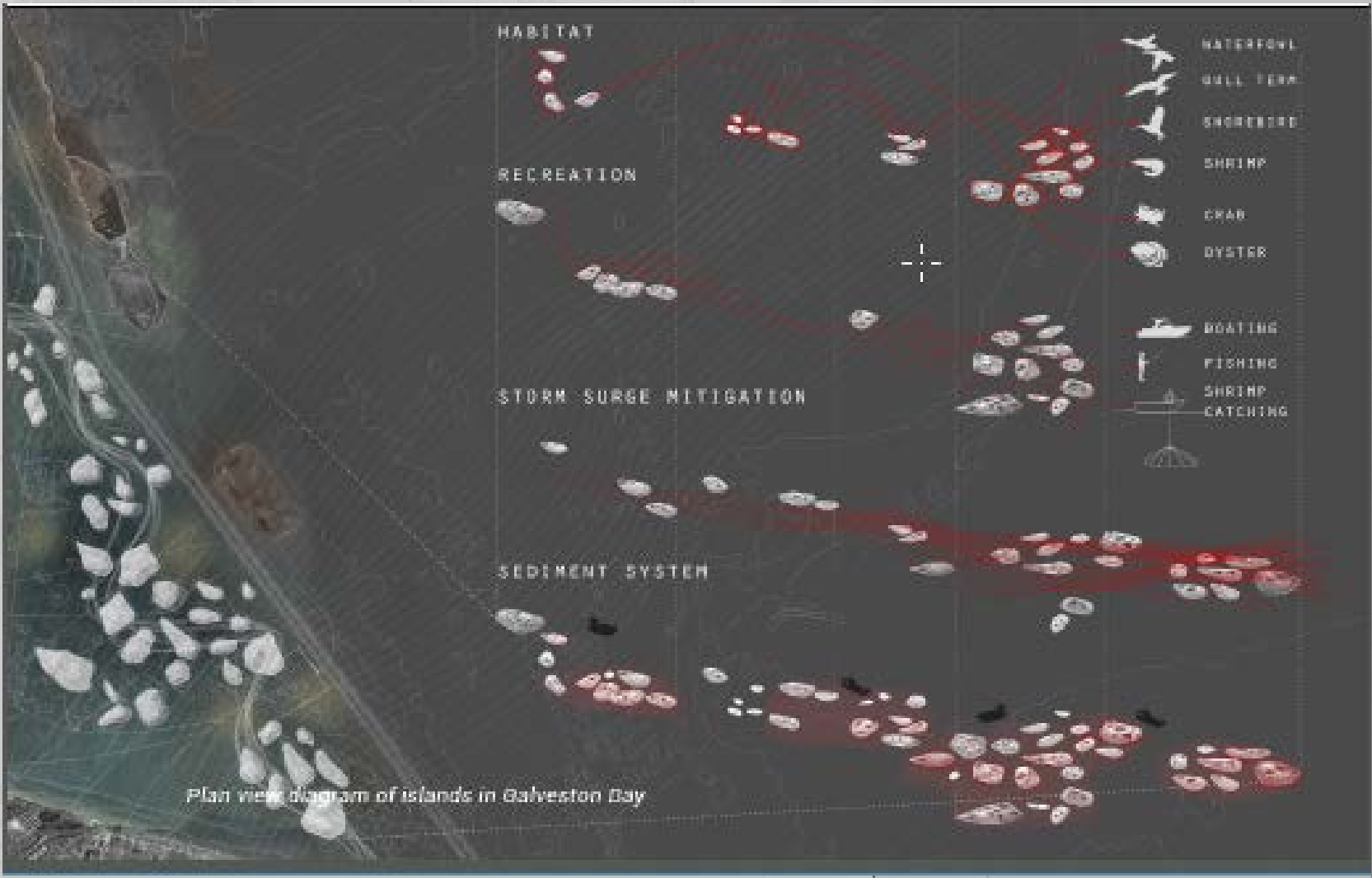
## COASTAL PROTECTION, HABITAT, RECREATION, AND AESTHETIC VALUES

### Principle

Wherever possible, new infrastructure should be designed for multiple forms of value, including coastal protection, habitat, recreation, and aesthetic value.



**Jacob Kuhn (Cornell)**  
**Dredged Material Islands - West Galveston Bay**







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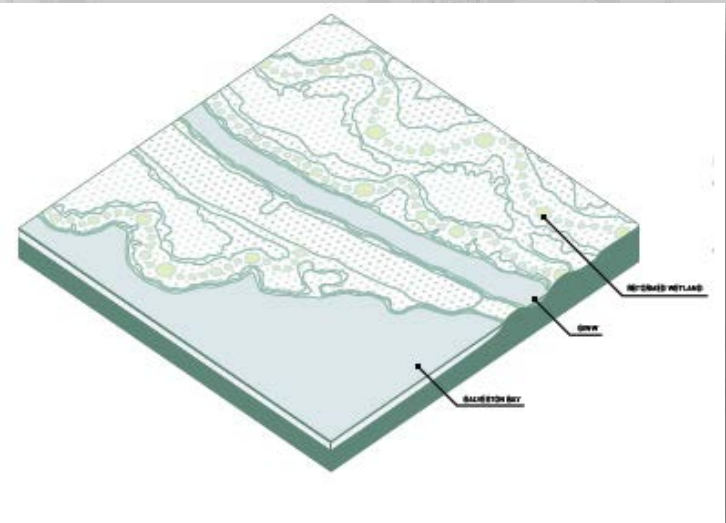
# 2 - DEVELOP REGIONALLY-SPECIFIC FORMS OF INFRASTRUCTURE

## ESTABLISH A BASELINED: THE COASTAL TEXAS ATLAS

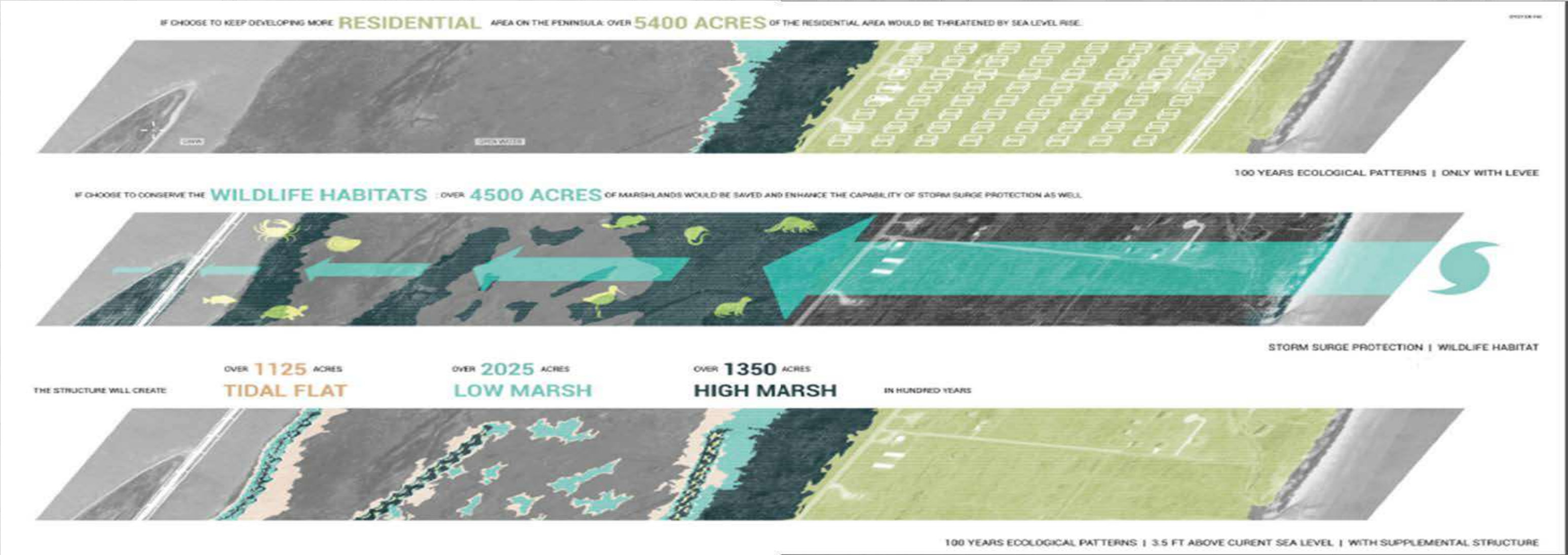


### Principle

The design of Natural and Nature-Based Features can and should look to regional landscapes for inspiration. Local salt marshes, oak mottes, and beach geomorphology can all provide clues for future infrastructure design. As a result, specificity to Galveston Bay can begin with careful examination of existing landforms and ecological patterns of the Texas Coast for patterns, forms, and tactics that can be deployed in protective infrastructures.



**Yuzhou Jin (Auburn)**  
**Modular Sediment Capture - Bolivar Island**







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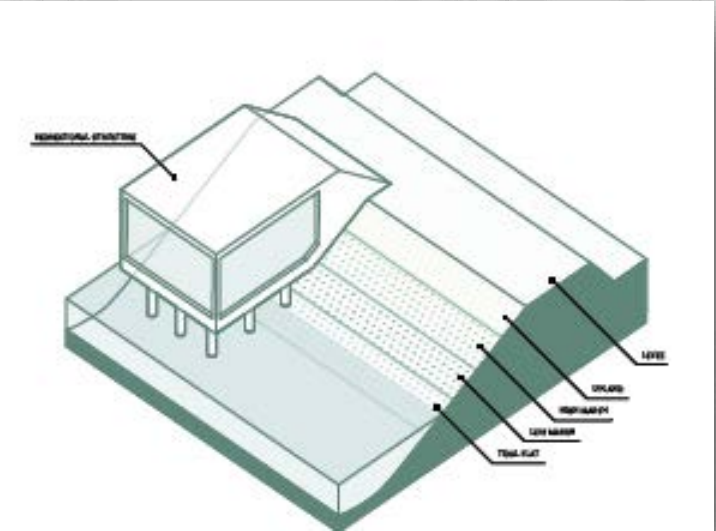
# 3 - ARTICULATE AND DIVERSIFY INFRASTRUCTURE

## IDENTIFY AND STRATEGIC OPPORTUNITIES



### Principle

Recreational and ecological value can often emerge from finding strategic opportunities to articulate protective infrastructure with more diverse forms. Levees, for instance, can be stretched laterally to facilitate vegetative growth on their slopes; platforms, seating, and elevated places can be provided occasionally to open long views in largely flat coastal landscapes; trails and walks can be added along the tops or sides of levees for recreation..



**Yuanyuan Gao (Auburn)**  
**Diversification –**  
**North side of the proposed**  
**Galveston Ring Levee**



Perspective rendering showing ring levee helping create marshes and human interest points



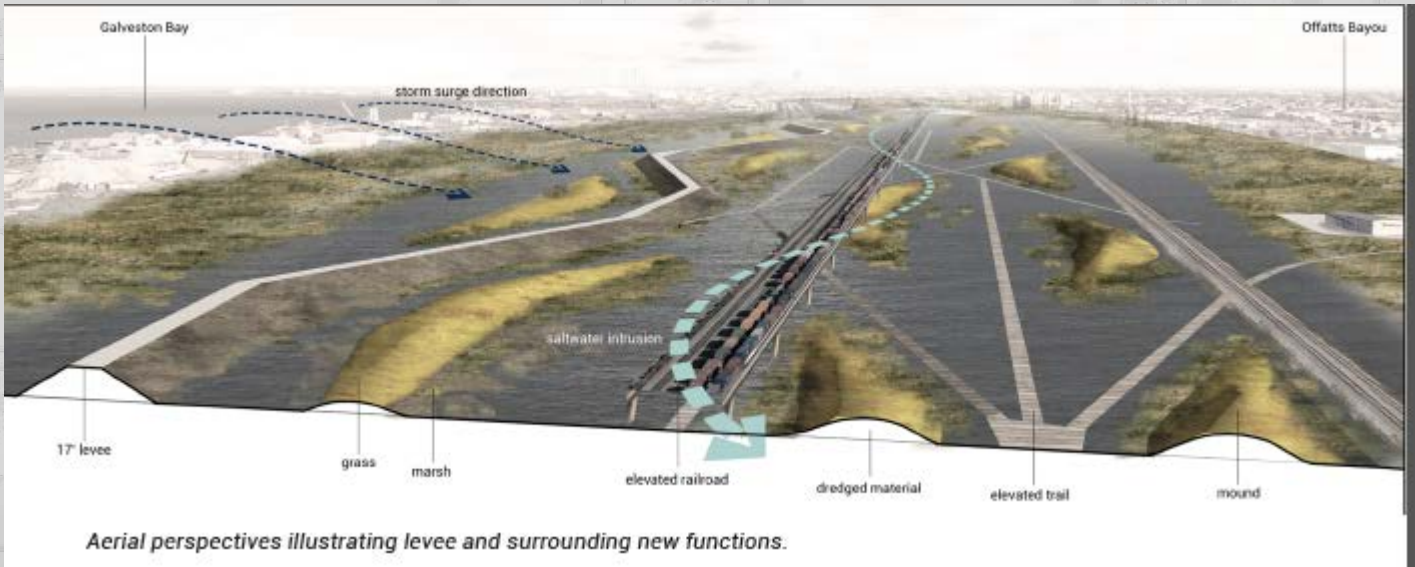
Plan diagram showing levee variation and articulation



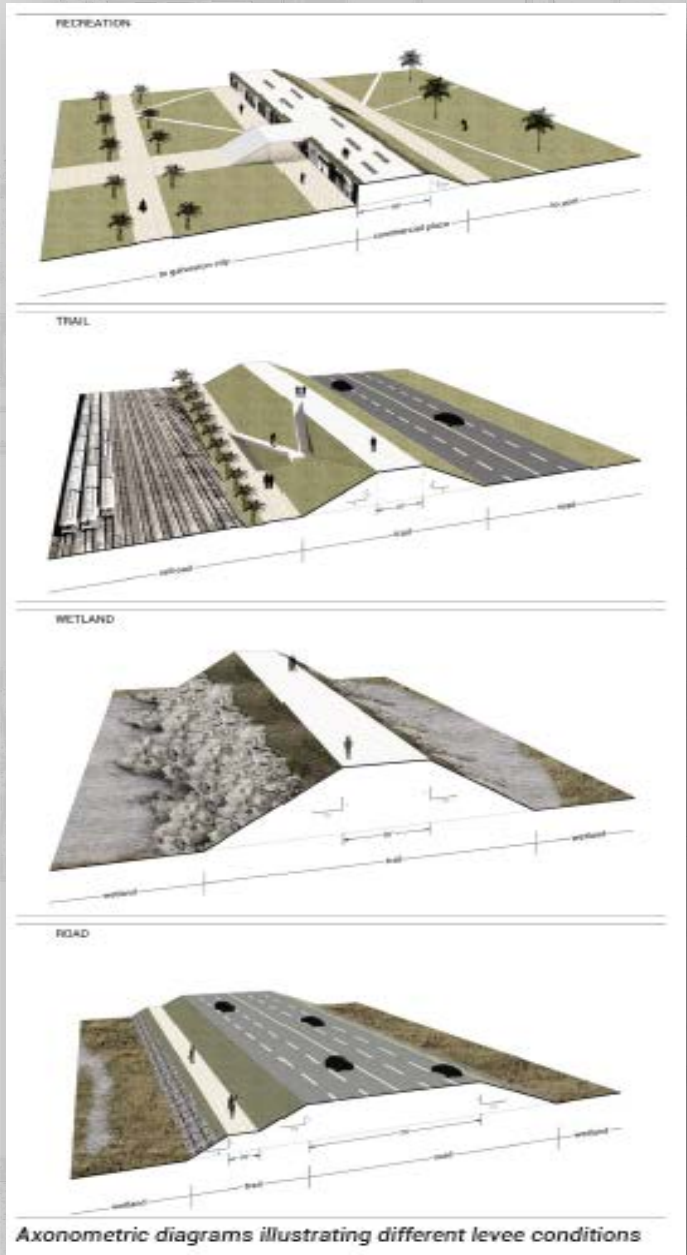


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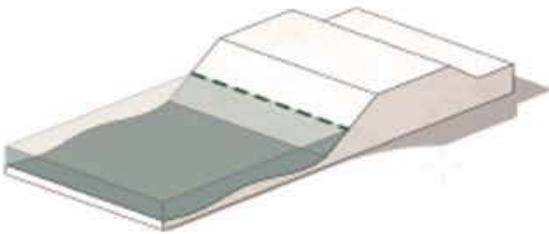
# 3 - ARTICULATE AND DIVERSIFY INFRASTRUCTURE IDENTIFY AND STRATEGIC OPPORTUNITIES (CONTINUED)



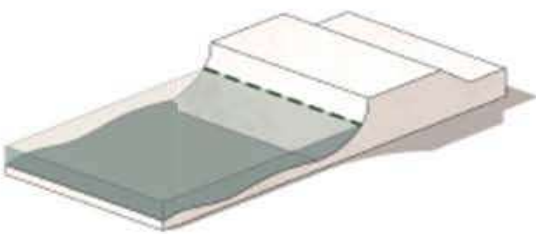
**Yuanyuan Gao (Auburn)**  
Diversification –  
North side of the proposed  
Galveston Ring Levee



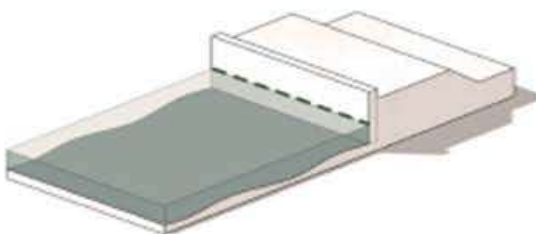
TYPICAL  
LEVEE



rubble-mound



curved

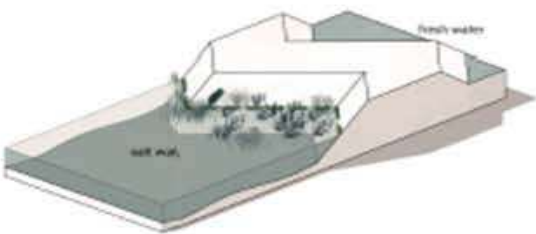


vertical

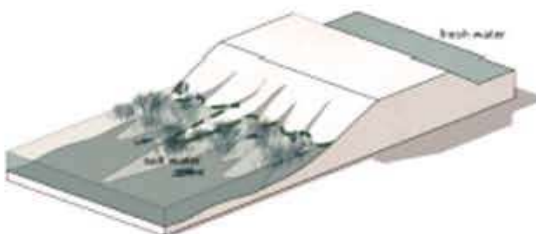
LEVEE  
FOR  
ECOLOGY



curved



zigzag

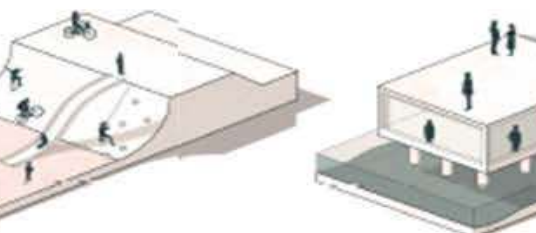


irregular boundary

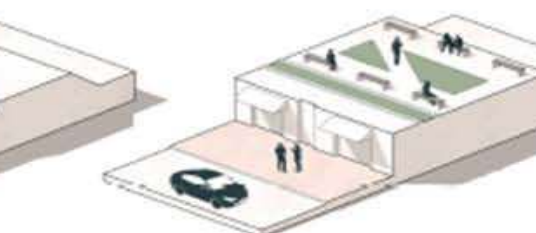
LEVEE  
FOR  
PEOPLE



accessible



recreation



viewing point

integrate with the city





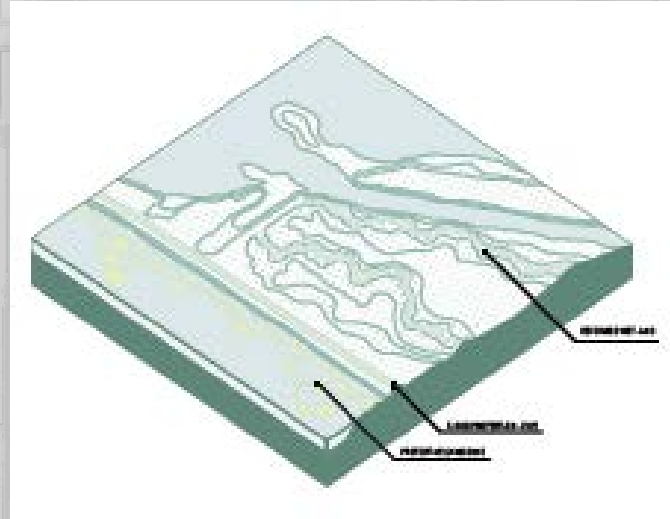
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## 4 - CONSTRUCT MULTIPLE LINES OF DEFENSE IDENTIFY ADAPTIVE SOLUTIONS

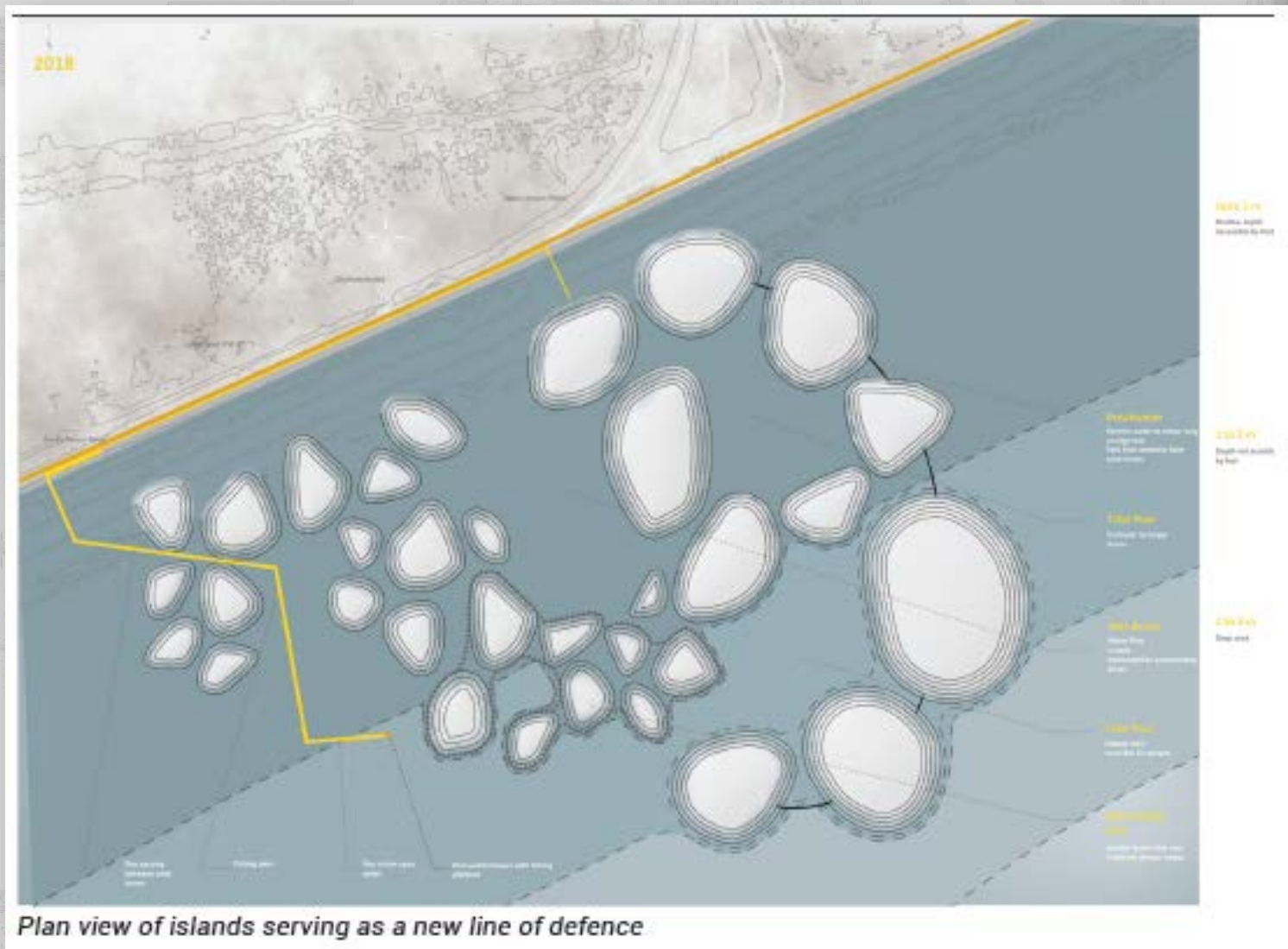


### Principle

Rather than relying on a single, hardened line of protection that is susceptible to catastrophic failure, invest in multiple lines of that include both conventional and landscape-based features and are adaptable to rising sea levels. This principle is not only a key principle of the student work, but has been articulated and prioritized within the planning principles of the Coastal Texas Study.



**Looja Shakya (Auburn)**  
Onshore dunes and nearshore  
sand staging (in anticipation  
of post-storm recovery efforts)  
– Bolivar Island



Plan view of islands serving as a new line of defence



Aerial diagram illustrating constructed islands



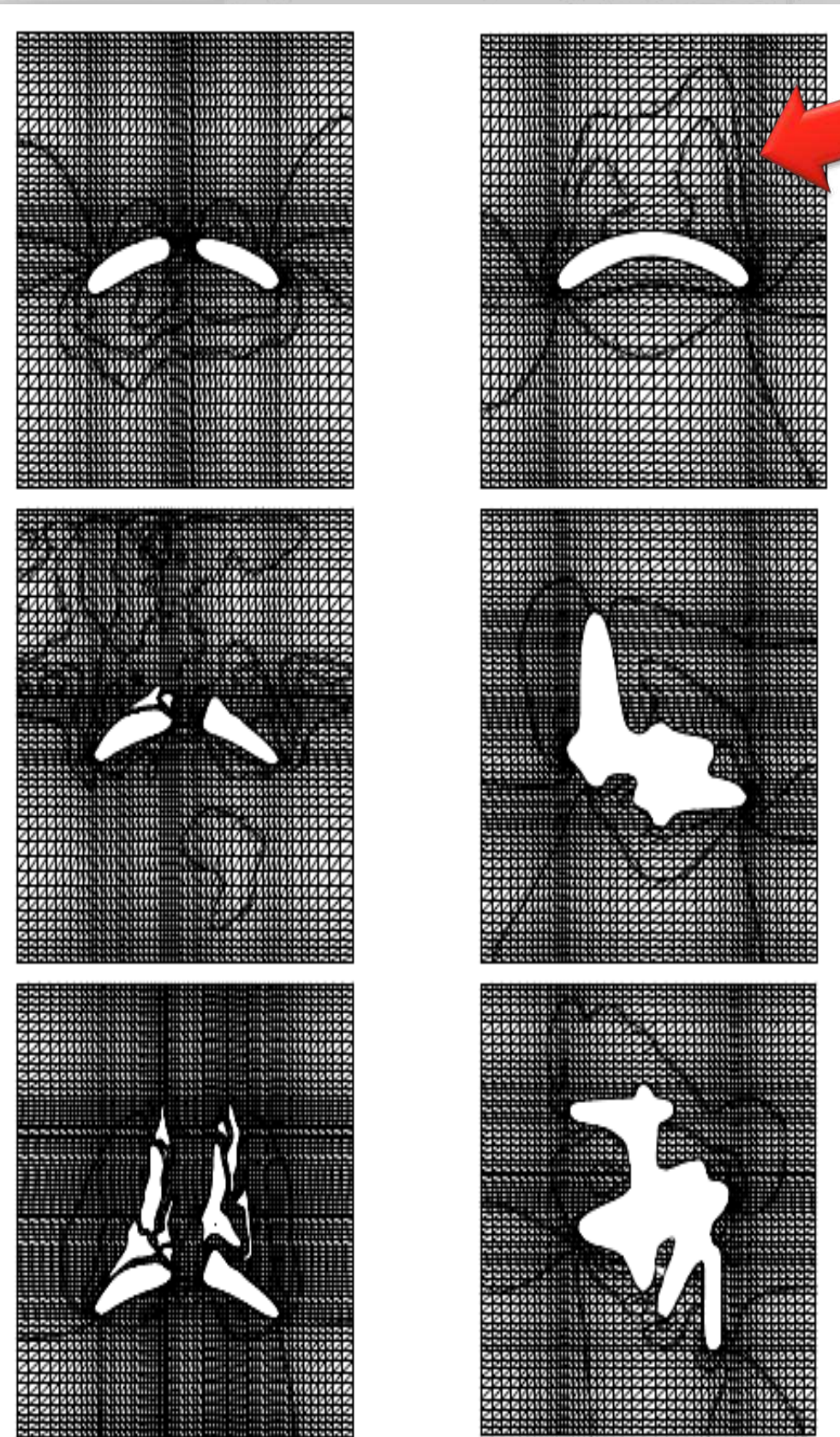


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# 4 - CONSTRUCT MULTIPLE LINES OF DEFENSE

## IDENTIFY ADAPTIVE SOLUTIONS (CONTINUED)



Aerial diagram illustrating constructed islands

Hydrodynamic studies are used to try and find a shape for the offshore berms that can work with longshore currents and wave action to increase habitat complexity over time while still maintain some level of storm protection.

**Woo Choi (Cornell)**  
Stable berms, offshore islands, beach dunes, and levee infrastructure – Bolivar Island



Plan view of islands and stable berms working in conjunction with beach dunes and levee system





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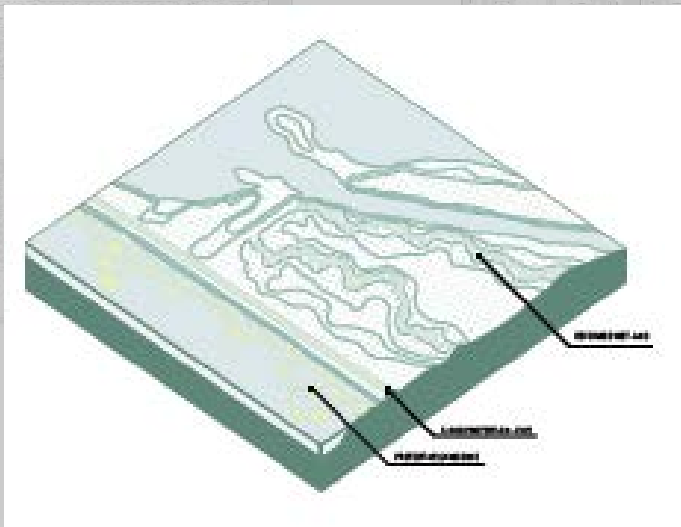
# 4 - CONSTRUCT MULTIPLE LINES OF DEFENSE

## IDENTIFY ADAPTIVE SOLUTIONS (CONTINUED)



### Principle

Rather than relying on a single, hardened line of protection that is susceptible to catastrophic failure, invest in multiple lines of that include both conventional and landscape-based features and are adaptable to rising sea levels. This principle is not only a key principle of the student work, but has been articulated and prioritized within the planning principles of the Coastal Texas Study.



**Trevan Signorelli (Cornell)**  
Partial submerged  
breakwaters to reduce  
vulnerabilities on Highway 87 -  
Bolivar Island



Illustrated plan view of low breakwaters and feeder berms on Bolivar Peninsula





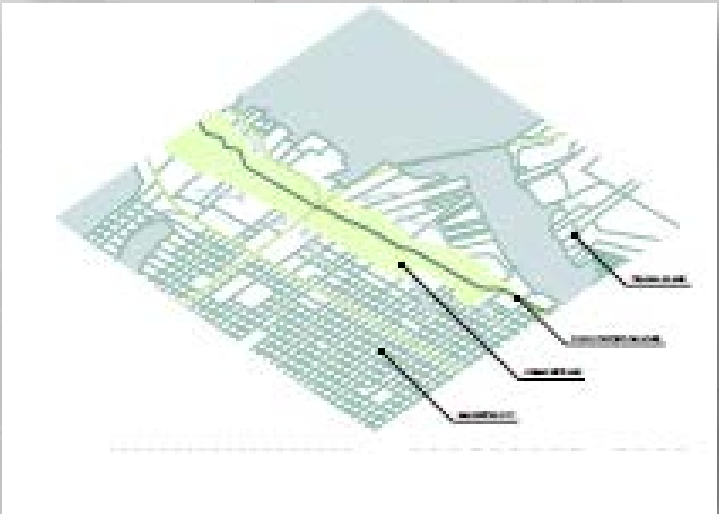
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# 5 - VARY APPLICATION OF STRATEGIES TO RESPOND TO SITE SPECIFICITY DEPLOY SOLUTIONS THAT REFLECT LOCAL CONCERNS



## Principle

When an infrastructure like a levee is deployed across a big and diverse region like Galveston Bay, it should be modified at key cultural and ecological sites to respond to the differing ways those sites relate to the region.



**Yuna Gao (Auburn)**  
Proposed levee modifications to adapt to local conditions – Proposed Galveston Ring Levee



Plan view showing the response of the level to local environmental and social conditions.







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# 5 - VARY APPLICATION OF STRATEGIES TO RESPOND TO SITE SPECIFICITY DEPLOY SOLUTIONS THAT REFLECT LOCAL CONCERNS (CONTINUED)

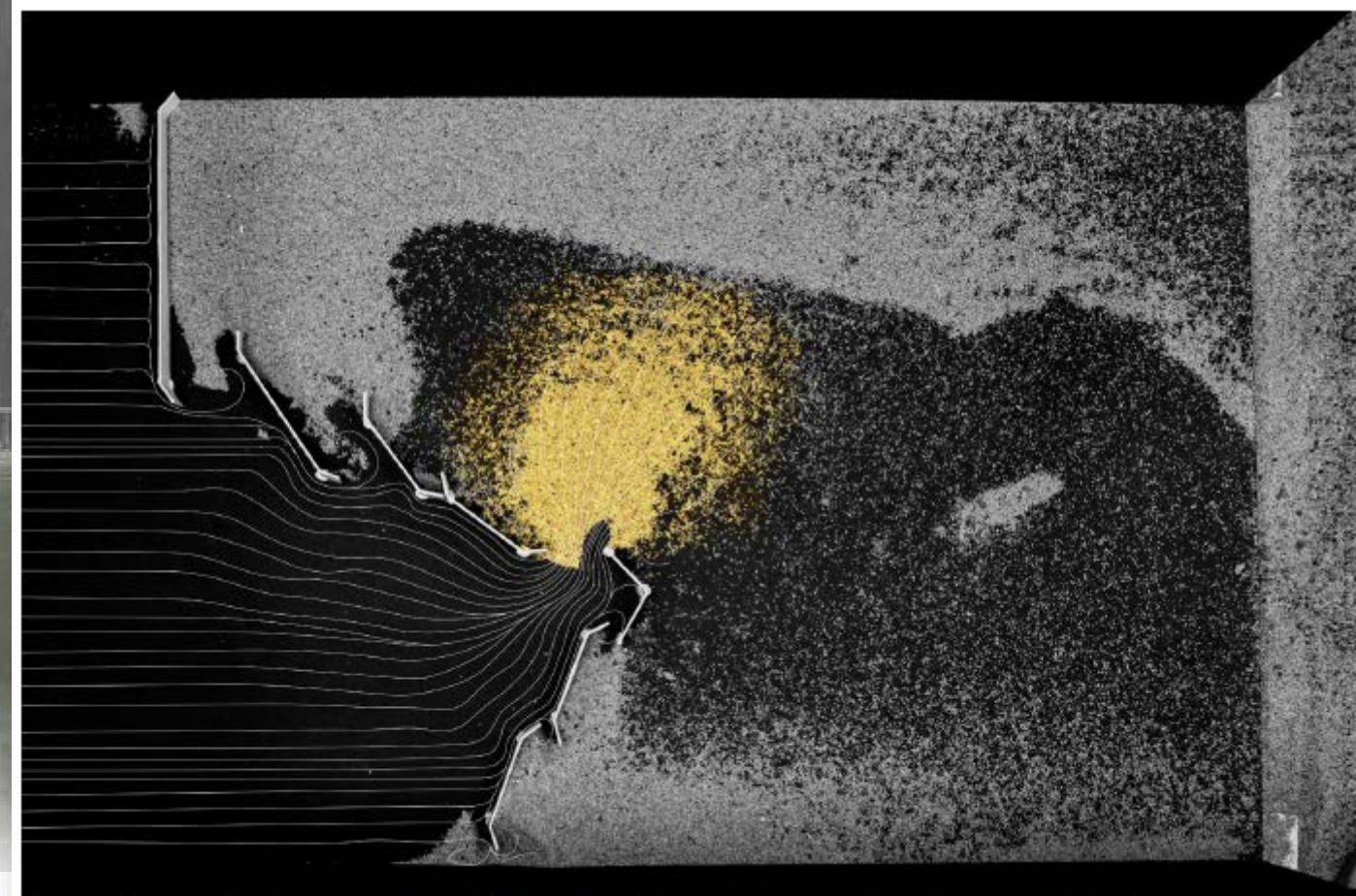


**Cristian Umana (Cornell)**

**Tuning Structures for  
Rollover Pass – Bolivar  
Island**



*Illustrated plan view of Rollover Pass and new tuning structures in the Bay*



*An analog qualitative model quickly simulates tides and allows for structures to be tuned*





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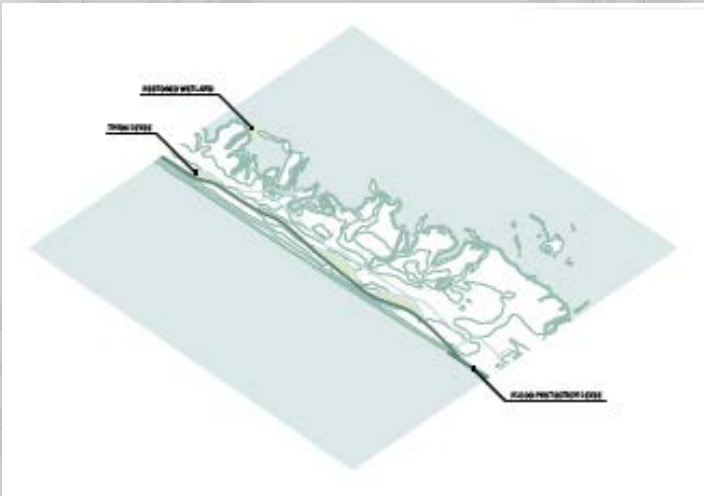
# 6 - CONSIDER BOTH LOCAL AND REGIONAL CONNECTIVITY

## INTEGRATE INFRASTRUCTURE INTO EXISTING SYSTEMS & FACILITIES



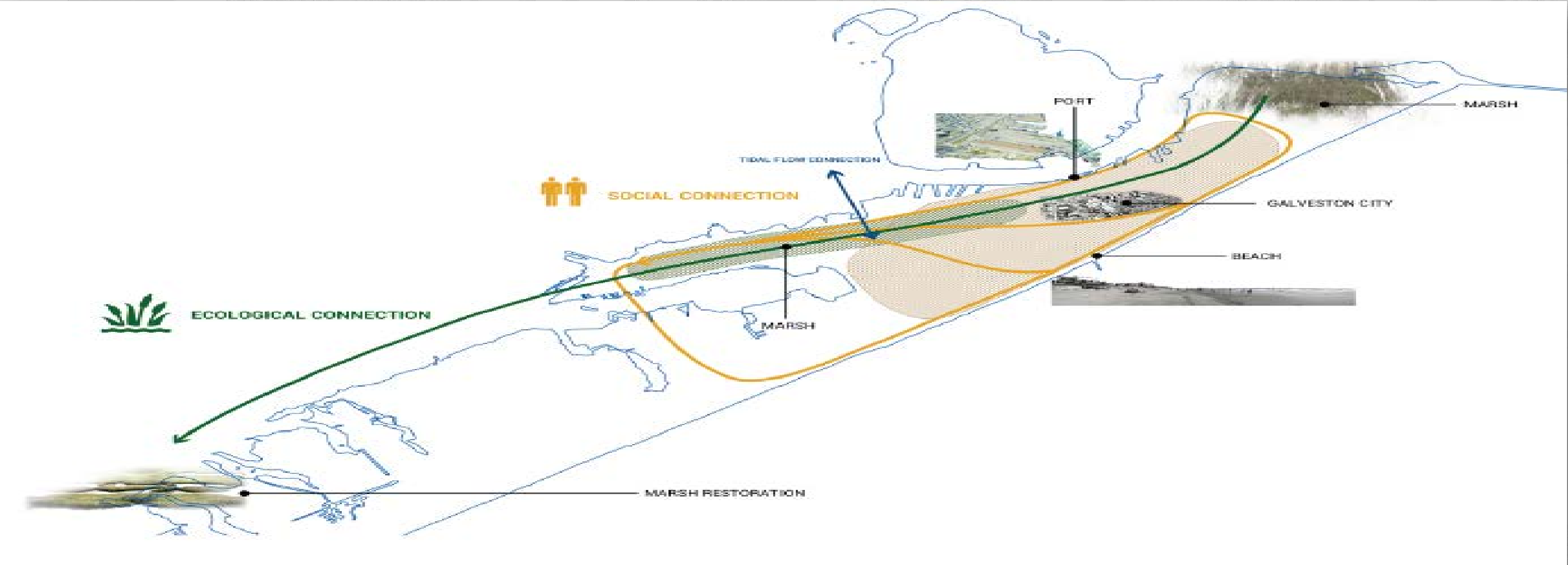
### Principle

Poorly-designed protective infrastructures can function as barriers, cutting communities off from water bodies or separating communities from one another. Consider opportunities to integrate infrastructure into existing transportation systems to facilitate valuable new opportunities for connection and recreation.



### Yuna Gao (Auburn)

Proposed levee modifications suggests an integrated trail system running along the length of the proposed Galveston ring levee, joining urban fabric to beach and bay – Galveston Island

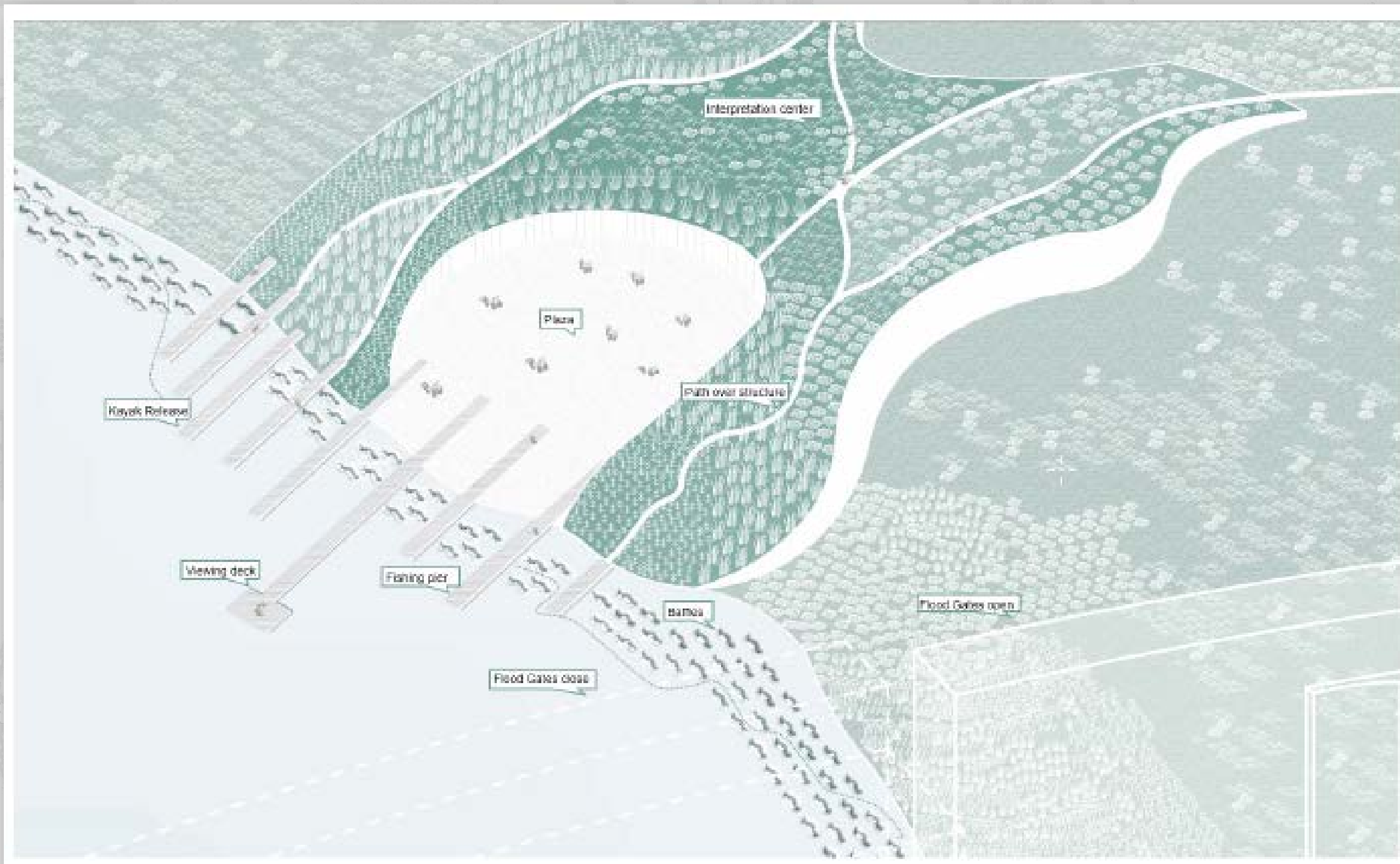






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## 6 - CONSIDER BOTH LOCAL AND REGIONAL CONNECTIVITY INTEGRATE INFRASTRUCTURE INTO EXISTING SYSTEMS & FACILITIES (CONTINUED)

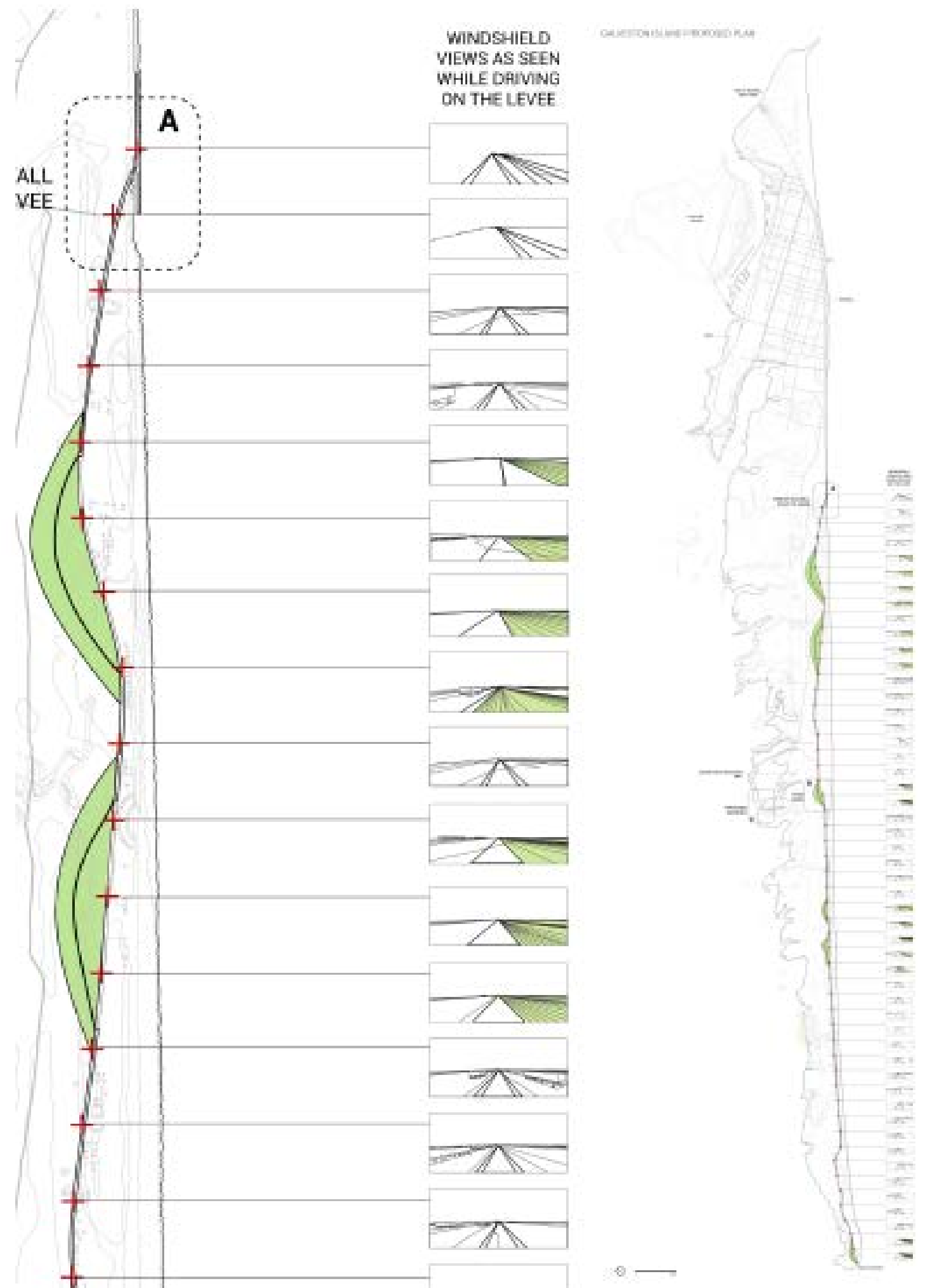


**Jaspuneet  
Kaur  
(Auburn)**  
New  
interpretive  
center facing  
the proposed  
surge gates –  
Houston Ship  
Channel





**Radhika Shenoy (Cornell)**  
Strategically-thickened levee along Galveston Island treats the levee as a spine for pedestrian, bike, and automotive circulation, linking movement to views and recreational opportunities.







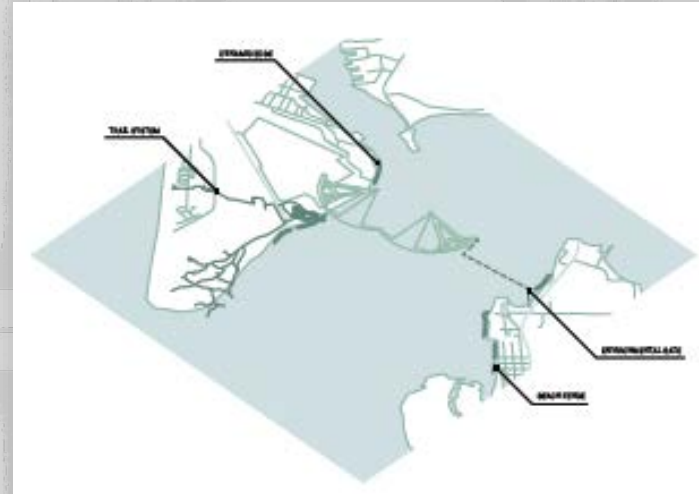
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# 7 - EMPHASIZE KEY CULTURAL AND RECREATIONAL MOMENTS FOCUS ON CRITICAL LINKAGES AND VULNERABILITIES

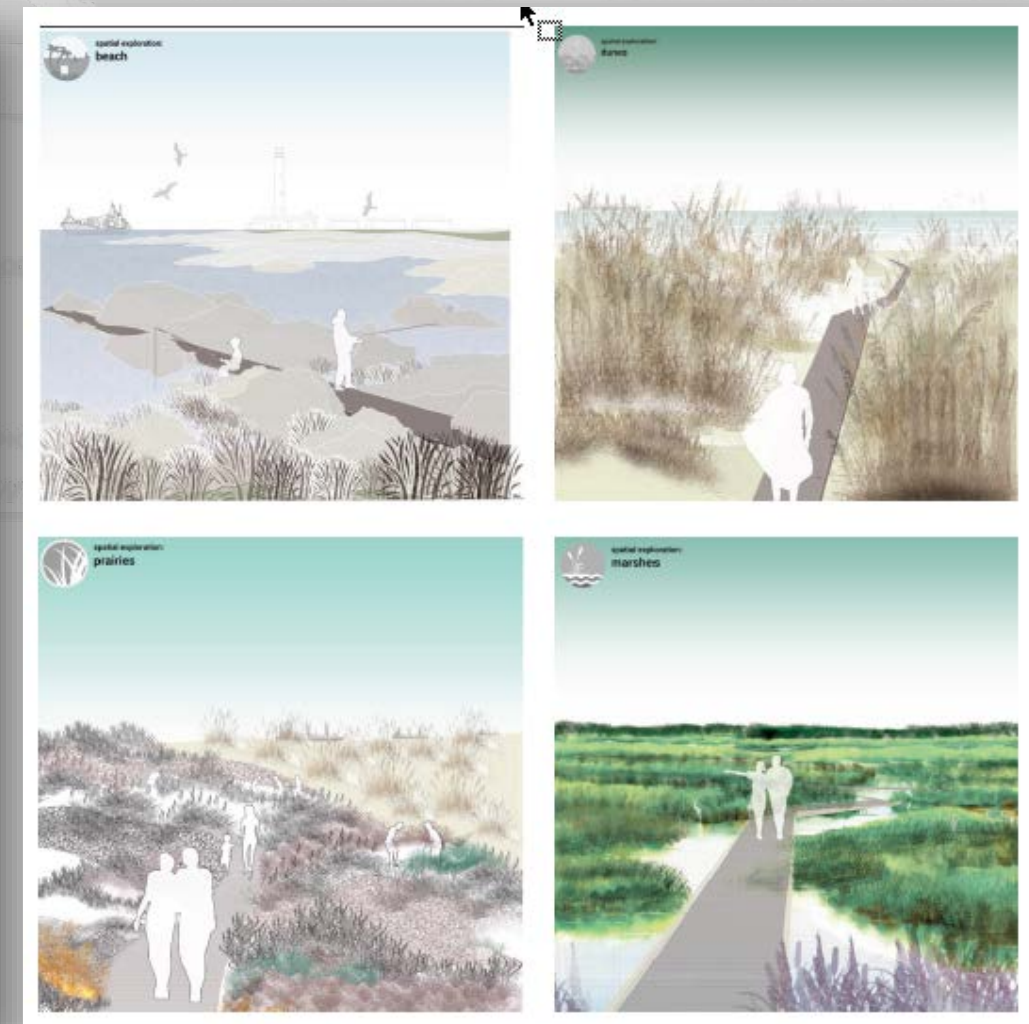
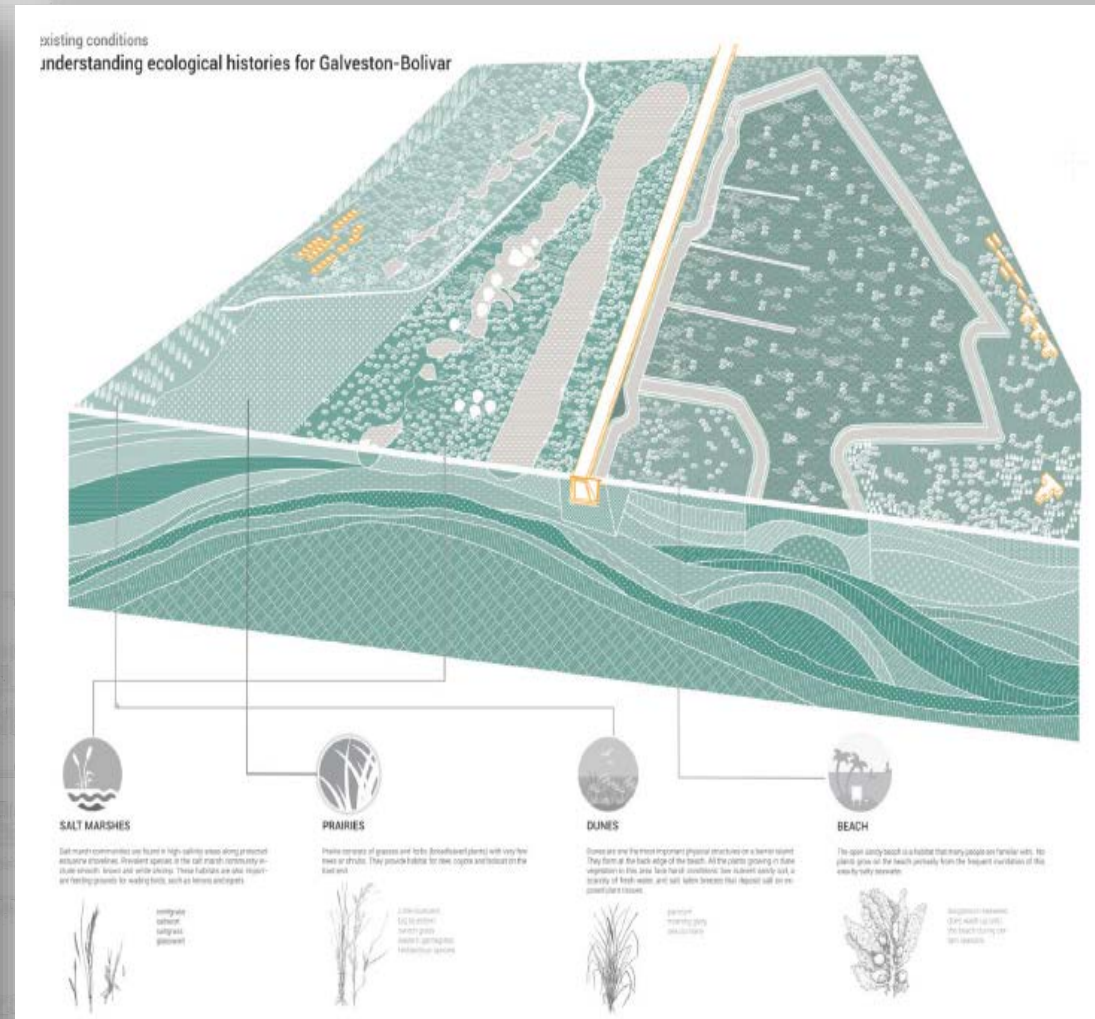
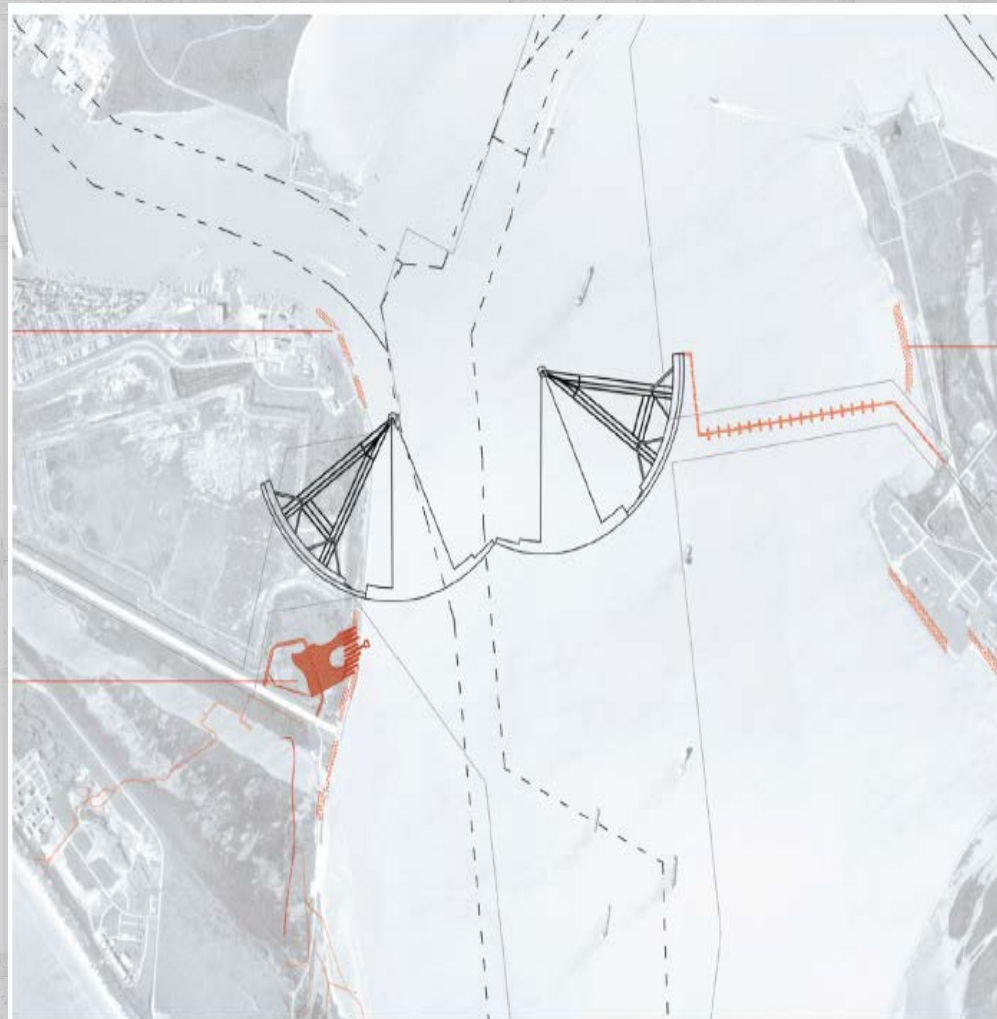


## Principle

The points where an infrastructural line starts or stops are often critical linkages or vulnerable areas in an infrastructure system. These points demand special attention and integration into surrounding context through the design of public accessibility, view enhancement, recreational opportunities, and multiple lines of defense.



**Jaspuneet Kaur (Auburn)**  
interpretative center and a network  
of new trails organized to lead  
visitors through the delicate,  
ephemeral ecosystems of the  
island's most newly-accreted land  
– Bolivar Roads Pass







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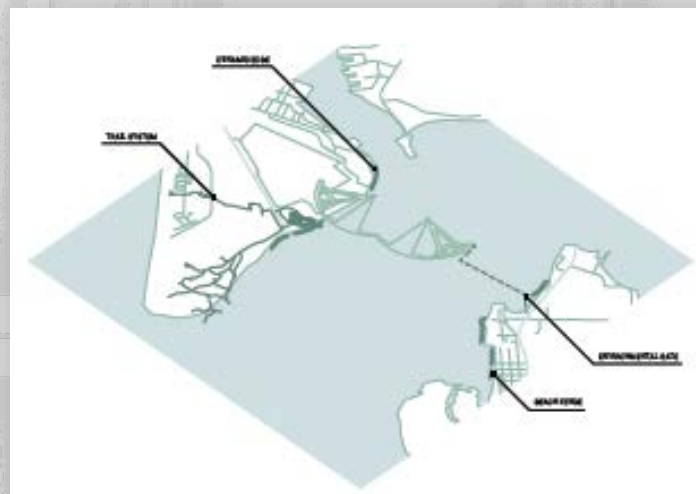
# 7 - EMPHASIZE KEY CULTURAL AND RECREATIONAL MOMENTS

## FOCUS ON CRITICAL LINKAGES AND VULNERABILITIES



### Principle

The points where an infrastructural line starts or stops are often critical linkages or vulnerable areas in an infrastructure system. These points demand special attention and integration into surrounding context through the design of public accessibility, view enhancement, recreational opportunities, and multiple lines of defense.



**Yiren Du (Cornell)**

**Levee articulation, boardwalks/paths, and plantings will improve aesthetics and public appreciation of the proposed mega structures proposed – Bolivar Roads Pass**



*Illustrated perspective of the articulated levee on the Bolivar Peninsula looking toward Fort Travis*



*Diagrammatic context plan of the entry to Galveston Bay and the ferry terminus on Bolivar Peninsula*





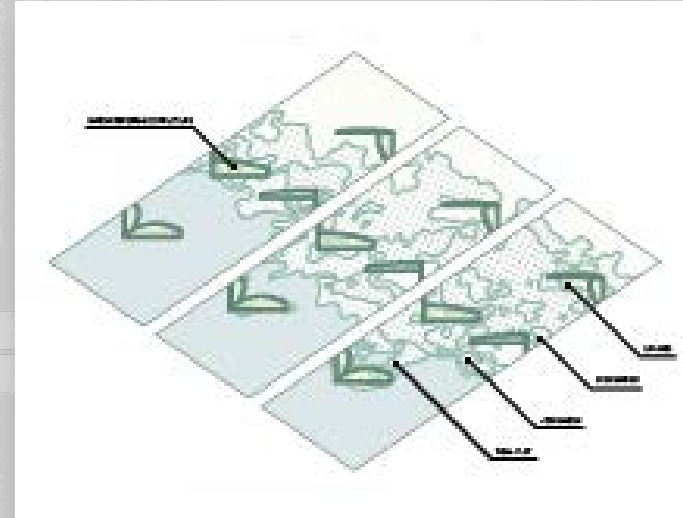
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# 8 - UTILIZE ACTIVE AND DYNAMIC LANDSCAPE PROCESSES DEVELOP INFRASTRUCTURE THAT ACCOMMODATES CHANGING LANDSCAPES

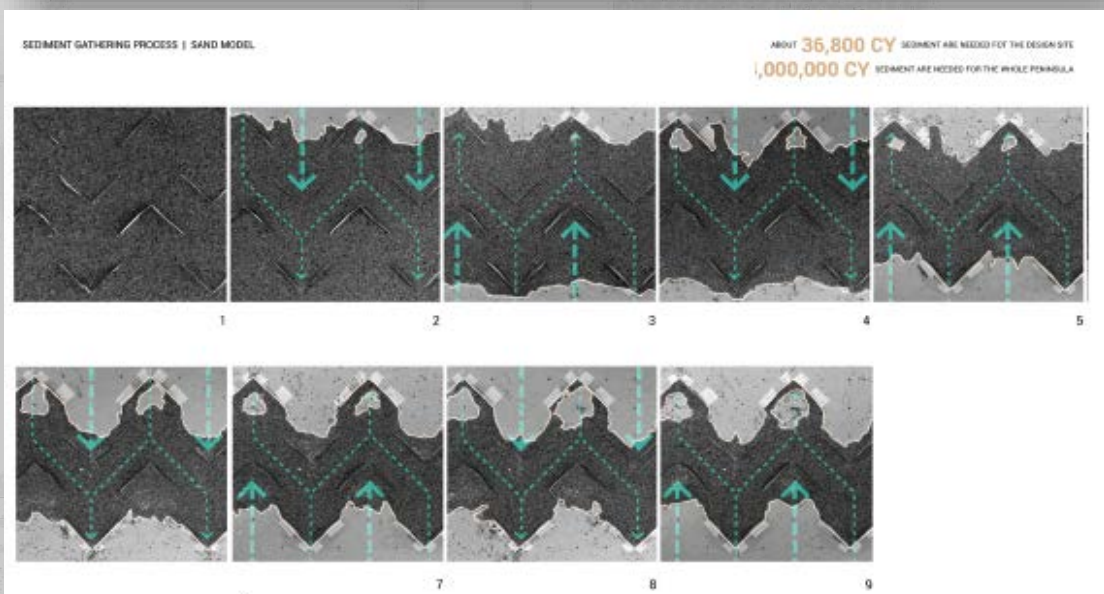
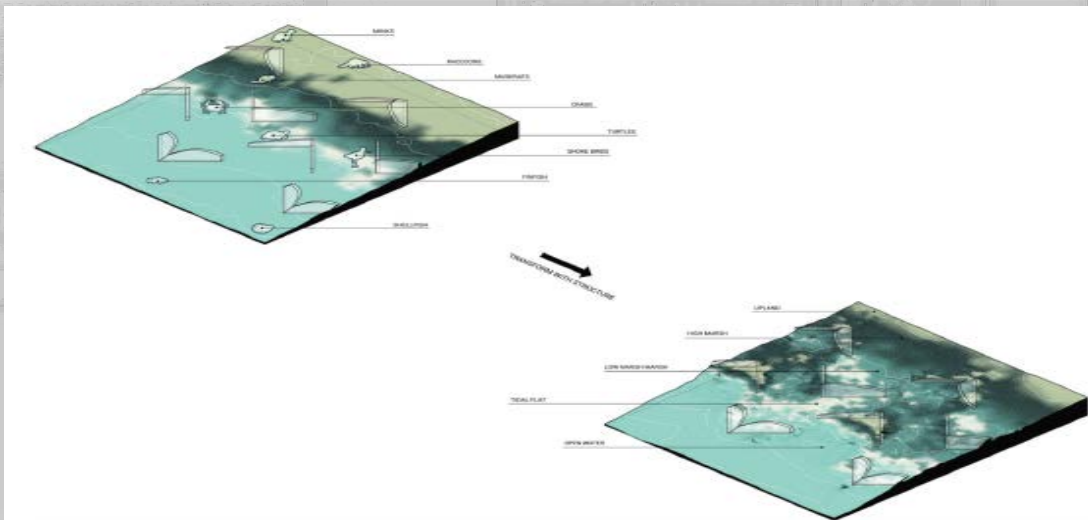


## Principle

Infrastructures that accommodate and take advantage of dynamic landscape processes, such as the accretion-enhancing propensities of marsh communities, can simultaneously provide recreational and ecological value now while being more adaptive to change over long spans of time than static or fixed forms of infrastructure.



**Yuzhou Jin (Auburn)**  
**Marsh creation and maintenance  
by deploying innovative  
infrastructure – Bolivar Island**







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# TAKE AWAYS

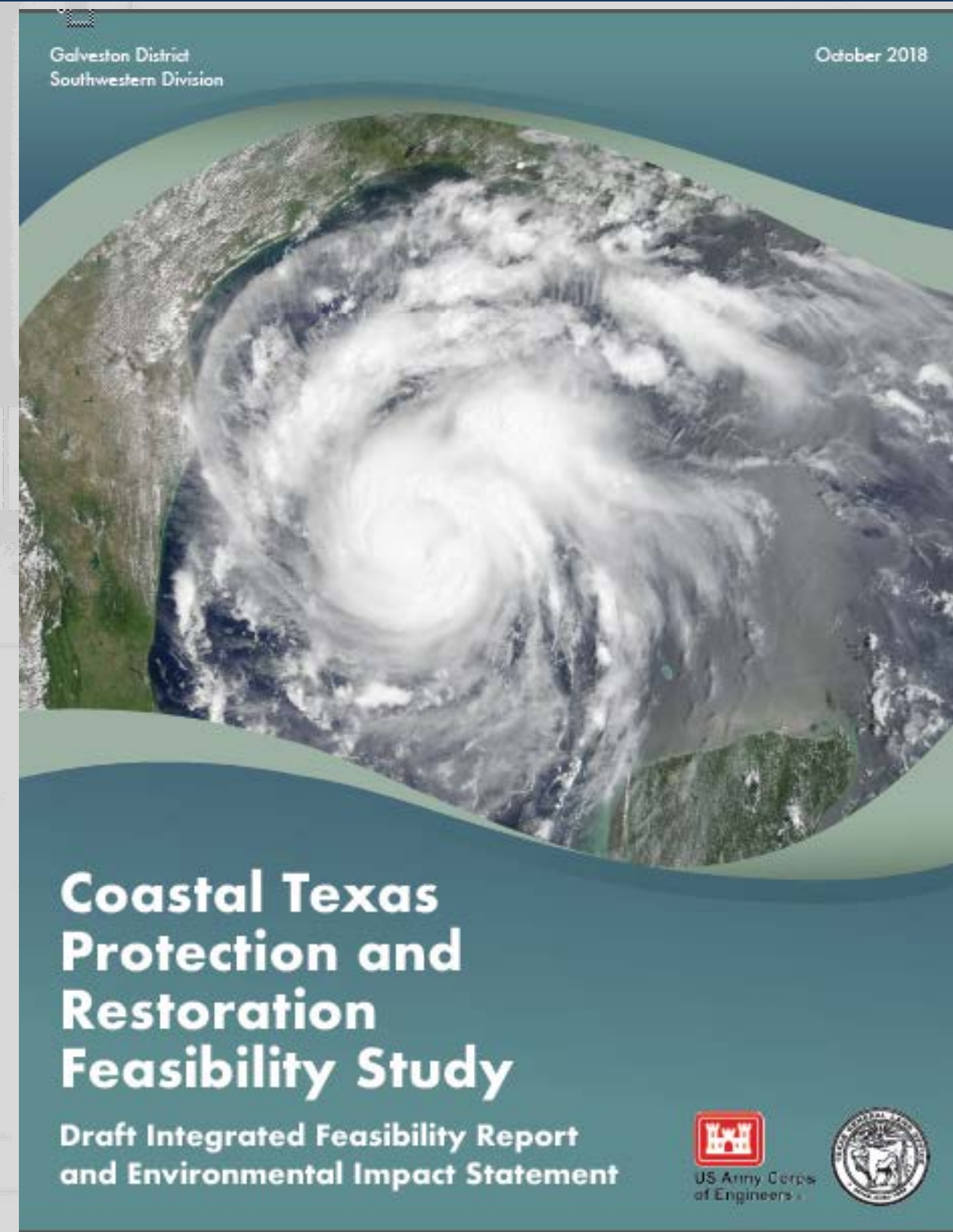
## WIN-WIN

**The Students:** Learned to synthesize techniques for analysis, design, representation, and communication and apply these to a real-world example. They also had to expand their knowledge base to include ecological, hydrological, and engineering factors into their architectural designs.

**The USACE/GLO:** Gained new insights into the complexities of the Coastal Texas study, obtained novel ideas for modifications of the proposed plans, and gained an appreciation of the communication through visually engaging mediums typically used in the landscape architect arena.

**Everyone involved:** Increased their awareness of the human-environment-infrastructure nexus.

#



<http://CoastalStudy.Texas.gov>



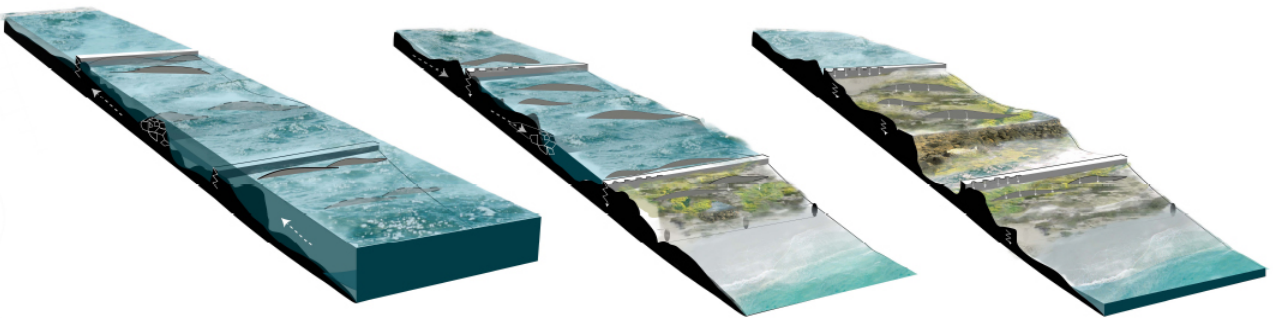


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# QUESTIONS?

Abdulaziz Alrifai (Cornell)

## “Texas Star” Interpretive Center and Viewing Platform for the proposed surge gates – Bolivar Roads Pass



### SEDIMENT DESIGN

DURING SURGE: ENERGY AND DREDGE MOVEMENT

+

AFTER SURGE: DREDGE REARRANGEMENT LIMITED EROSION

+

LATER: SEEDING AND ECOLOGICAL STABILIZATION

