Coastal regions around the world are rapidly urbanizing at a time when environmental change increasingly threatens these ecologically critical areas.

Galveston Island, recently devastated by Hurricane Ike, offers a case-study for how such cities need to transform and adopt alternative strategies for resilience in the coming century.

This book, the result of a trans-disciplinary collaboration at Rice University presents an atlas of such strategies, examining the scientific factors operating in the coastal environment of the Gulf Coast, related urban ecologies, and offering design examples that project alternative futures for urbanization on Galveston Island and other coastal communities.

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Atlas of Sustainable Strategies for Galveston Island

Christopher Hight, John Anderson, Michael Robinson, Davin Wallace

and the students of the
Rice School of Architecture

Atlas of Sustainable Strategies for Galveston Island

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Atlas of Sustainable Strategies for Galveston Island

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Rice School of Architecture

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Part II Research & Part III Projects
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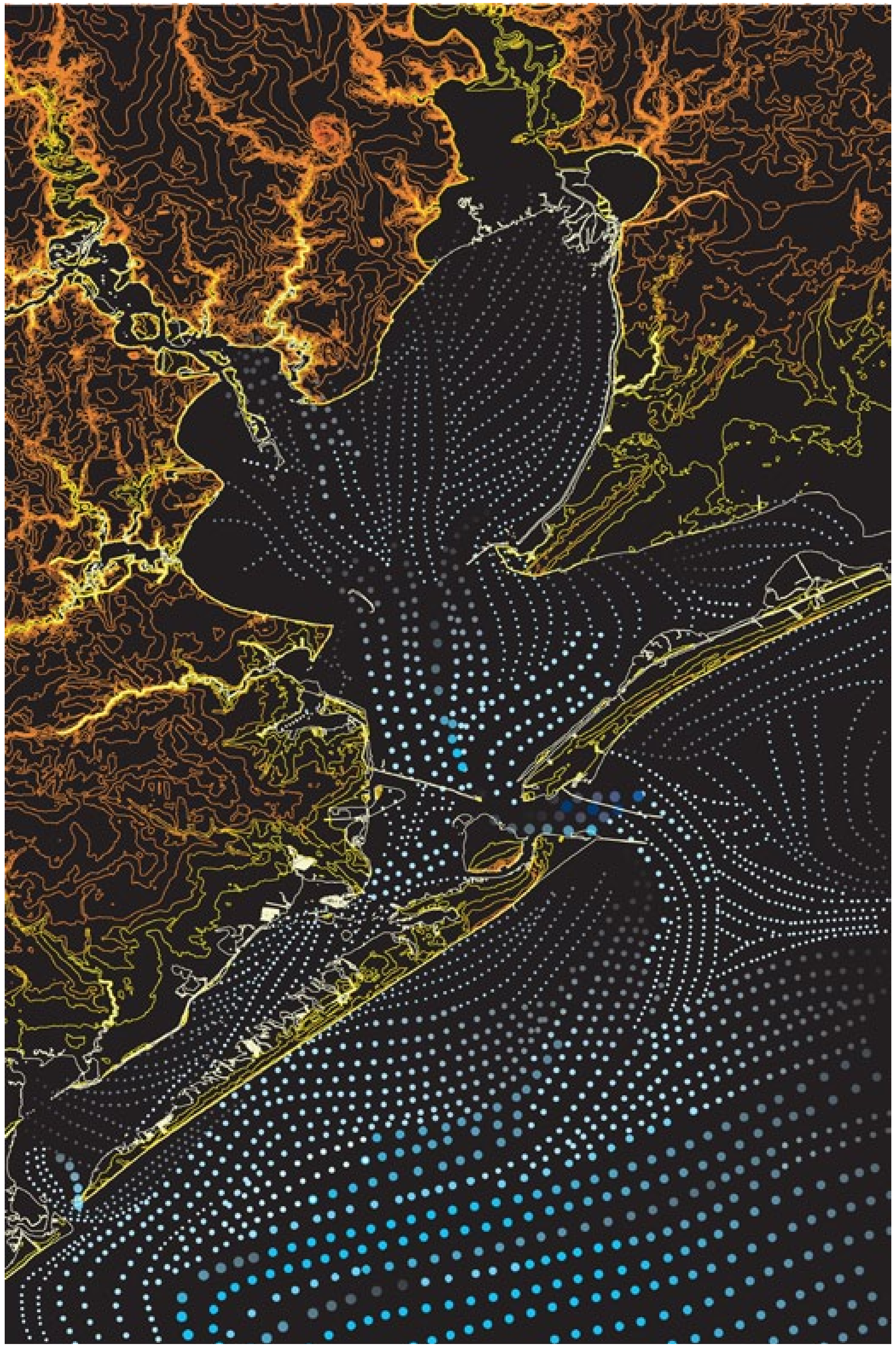


The Galveston Bay Area by Yvette Herrera and Hristiyan Petrov

Introduction

Toward the end of this century our children and grandchildren will have to contend with radically changing coastlines as the rate of sea-level rise continues to accelerate and hurricanes impact increasingly urbanized coastal regions. The challenges they face will be much more manageable if we act now to create a more sustainable and resilient built environment. Both locally and globally, transformative strategies are needed to respond to environmental change and unprecedented rates of urbanization.

This atlas represents a trans-disciplinary collaboration, documenting a two-year scientific research project and selected work from four years of architecture studios. Our overall objective is to present sustainable urban strategies for Galveston Island that rely on the most current scientific information followed by advanced design thinking as a framework for future development. The goal of the research is to insure that future generations, both residents and visitors, inherit a better island by:

1. promoting economic growth and financial independence
2. providing safer, attractive housing, businesses and recreational facilities for residents and visitors to the island
3. encouraging tourism and clean industry
4. minimizing storm hazards
5. preserving natural habitats

Galveston faces many challenges. But, it is also faced with great opportunity that will be brought about by rising fuel costs and urban sprawl in the Houston area. As Houston becomes the third largest city in the US, people will seek recreation on the island, but they will likely travel there on high-speed trains, not automobiles. In order to capitalize on this opportunity, Galveston will need to provide easily accessible lodging, restaurants and other amenities. This is best achieved by focusing future development on the east end of the island.

Galveston Island began to form about 5,500 years ago as the rate of global sea level rise slowed. The island grew until approximately 1,800 years ago when the sand supply that nourished it was exhausted. Since that time the island has experienced significant retreat on both the Gulf and West Bay sides, hence the island is literally shrinking. Our predictions for the changes that will occur on the island by the end of this century are deeply rooted in scientific data that have been subject to peer review. These data do not yield a pretty picture for the future of the island, but there are ways to minimize the impact of rising sea level and hurricanes coupled with minimal sand supply. Indeed, if we act now the island can continue to be a valuable recreational and economic entity for many decades to come. However, to achieve this goal will require changing the way we manage the island's natural resources and bold new approaches to development on the island.

The scientific research in Part I was carried out in two stages. The first employed the latest scientific information on sea-level rise, subsidence and sand budgets to predict changes that will likely occur on Galveston Island by the end of this century. A sand budget analysis for the island was conducted during this project. Secondly, these findings were used to formulate sustainable development strategies for the island. The scientific results indicate that the island will continue to experience significant change over coming decades and that the west end of the island will likely experience rapid change due to accelerated sea-level rise. Attempts to slow the rate of coastal erosion on the west end of the island have failed in the past and they are not likely to work in the future

Monument to the 1900 Storm on Seawall Boulevard

Blue line indicates water level during Hurricane Ike

given the magnitude of the problem. The east end of the island is less susceptible to the impacts of rising sea level and hurricanes and, therefore, is more appropriate for long-term, sustainable development. The east end also offers many socio-economic advantages for development. The City should continue in its efforts to secure property at the East end of the island (East End Flats) and encourage development there that is based on high-density housing and other programs with easy access to the beach, the Strand and downtown complemented by marinas, shopping and restaurants along the current ship channel.

In that regard, Part II and Part III of this atlas represent and synthesize four years of studies at the Rice School of Architecture. John Anderson and his team of researchers collaborated integrally with this graduate design studio, instructing the students in the basic scientific factors and exposing them to the ongoing research. In turn, the students employed this understanding in relationship to other economic, environmental, and social issues of the island and coastal communities in general. Often working in teams, the students sought to produce scenarios that offered pragmatic but alternative patterns of development, planning and detailed design. The key and recurring factors that should be considered as key constraints and opportunities for alternative strategies are presented in Part II of this book. These issues are presented as urban ecologies, constructed through complex entanglements of environmental, social, political, industrial and technical issues.

Part III consists of design proposals based on the insights of the previous two sections. Today it is vitally important that architects employ and transform the specificity of their discipline as a way of researching the complex conditions of the contemporary built environment. Technical, environmental, social and economic factors can be integrated through design. We can see the implications of natural and cultural forces, and how different approaches and scenarios might implicate different results. Design has a synthetic capacity unsurpassed by any other expertise of the built environment, providing for the public an image for alternative possibilities.

In turn, these very same issues demand innovation in terms of design and the architectural discipline, especially in its relationship to ecology, landscape and infrastructure. Along the coast, no building or development exists as an isolated structure because the way it is designed and the uses this design engenders are likely to have significant effects, from erosion rates to wind-born debris. Therefore design decisions made at local scales need to be thought of in relationship to ensembles of such locales and relative adjacent and remote conditions. Of course this also means that all forms are embedded in multiple temporal relationships, from gradual processes to catastrophic events. While this adds complex and even unknowns to the design process, it demands thinking of design as the intertwining of performative relationships between natural dynamics, political-economic conditions and architectural-aesthetic desires. This manifold of relationships

Galveston's Historic District

Recent development on the island

requires innovation in design rather than relying on models derived from the 19th century European industrial metropolis or the pre-modern village.

While these studies are specific to Galveston, the island can serve a case-study, and potentially a model, for cities across the globe. Coastal regions are more rapidly urbanizing than at any other time in history and provide the geographic interface for globalization, whether one is concerned with containerized shipping, energy production and distribution, information technology design and manufacturing, or tourism. One might suggest there is a global network of coastal development, that, not unlike Venice and Lisbon in their day, have as much in common with each other as the cities that lay on their territorial interior. Yet this global littoral is also the most at risk for the effects of climate change, including rising sea levels and transformations to the ecologies that sustain and often protect it from extreme weather and climate related events.

Galveston was once one of the most important ports in North America, called the "Wall Street of the South." Almost erased by a hurricane in 1900, the city was rebuilt with the seawall, a triumph of modern engineering. While the port and petrochemical industry have since relocated to the port of Houston, about twenty miles inland, the seawall has allowed Galveston to exist for a hundred years. The seawall is quite literally and conceptually an infrastructural line that attempts to delineate natural forces (coastal ecology, storms, erosion) and human representations (tourisms, landscape, branding, historicism). In a broader sense, we can understand the line of the seawall as merely the largest example of infrastructures and processes that alter the steady state of the ecology for human use

A little over a hundred years after the 1900 storm, Hurricane Ike hit Galveston and devastated the island. While the Island represents one of the largest and last developable stretches of undervalued coastal real-estate in North America, and is located in one of the fastest growing regions in the country, its future development is now open to question and speculation.

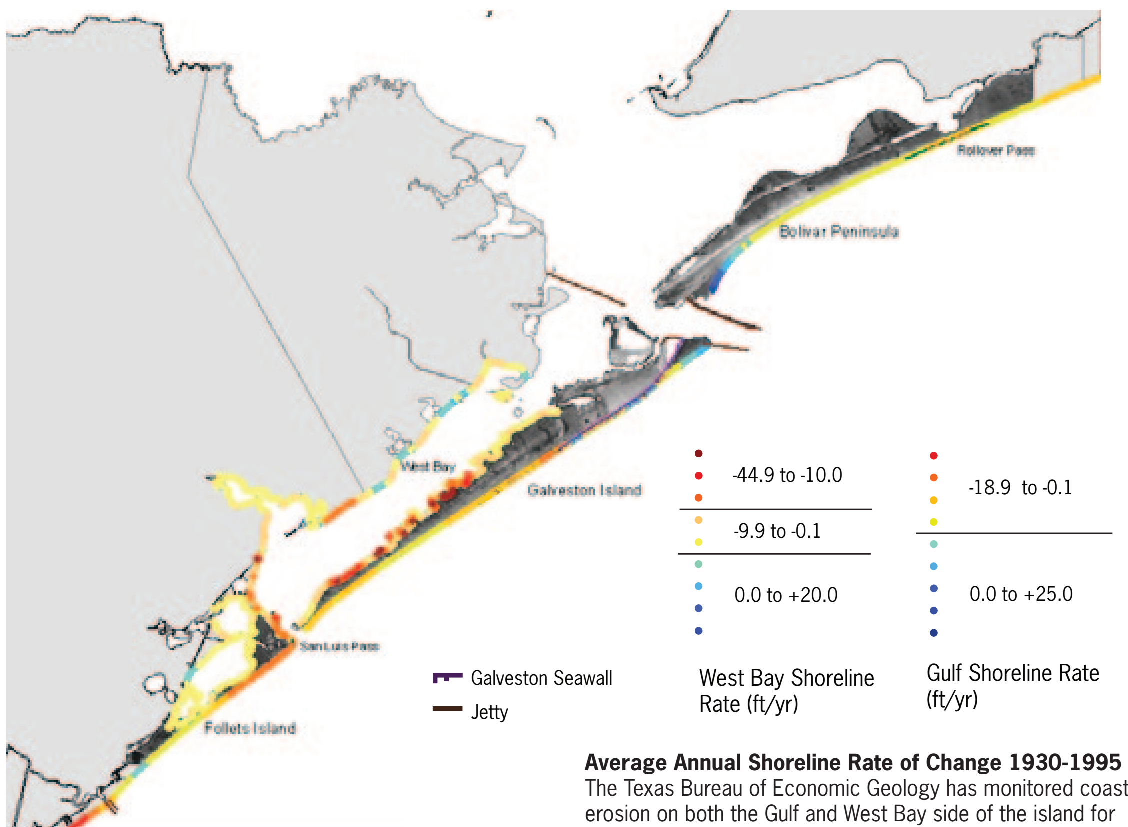
Some recent proposals extend the logic of the seawall, creating even larger protective structures. The effectiveness, environmental impact and even feasibility of such approaches is questionable, however. Moreover, they do little to confront the long term implications of sea level rise, steady coastal retreat and other risk factors. As if that were not enough, it is likely that the seawall itself will need substantial refurbishment in the coming decades.

Galveston was a center of late-19th century industry and imagination. Its historical core, with a gridiron pattern of streets and dense urban fabric, was exemplary of the model of the metropolis that emerged from the industrial revolution. To survive and flourish in the 21st century, a time that will necessarily contend with environmental change and rethink the modern divisions between Nature and Culture, it needs to re-imagine itself as a model for resilient urbanism for the 21st century.

I
Science Behind the Plan

One need not search far to see evidence that our coastline is changing rapidly. But, why is the island eroding and what can be done to slow the rate of erosion?

Shoreline Migration
This figure shows the shoreline location (red dashed line) if the current shoreline migration rates are projected back in time to when the Bolivar, Galveston and Follets barriers formed.



Average Annual Shoreline Rate of Change 1930-1995
The Texas Bureau of Economic Geology has monitored coastal erosion on both the Gulf and West Bay side of the island for several decades. They have performed similar studies for the entire Texas coast, including Bolivar Peninsula to the east and Follets Island to the west. Reference: http://www.beg.utexas.edu/coastal.

Coastal Change

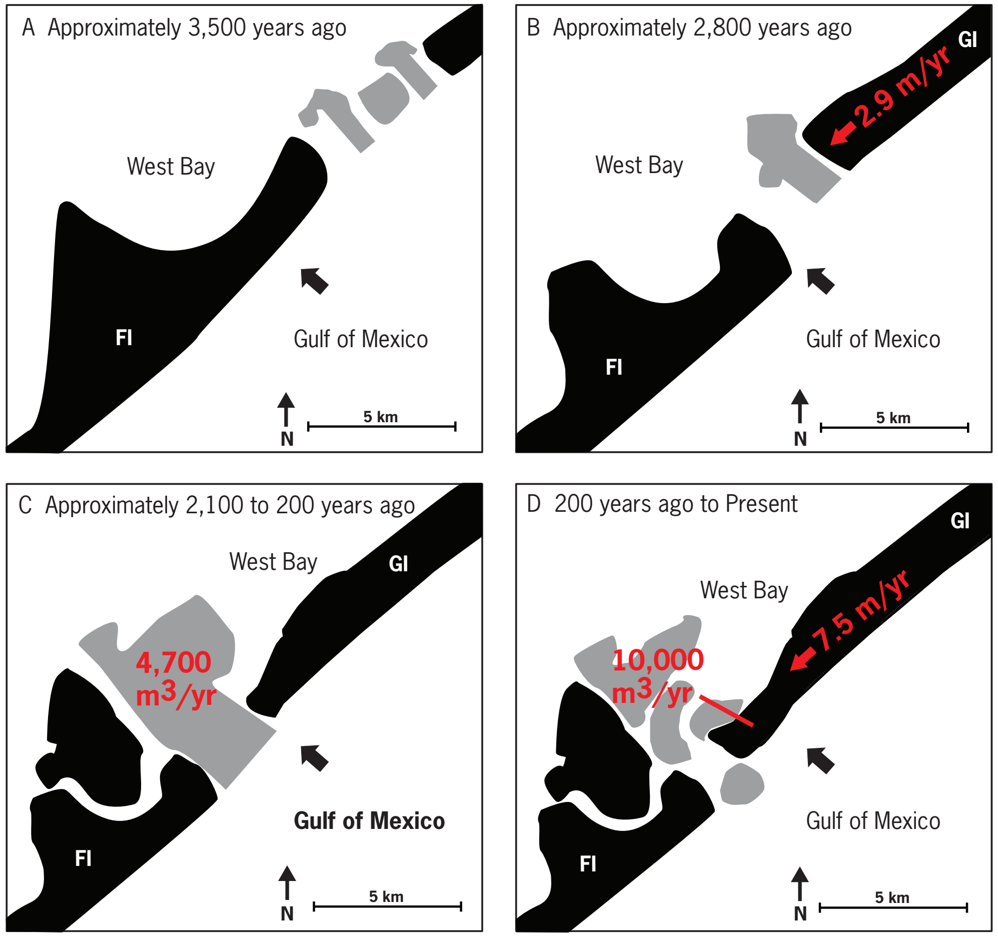
The data from Galveston Island show high rates of shoreline retreat on both the Gulf side and West Bay side of the island. Hence, Galveston Island is eroding, meaning that the island is losing sand. Until about 1,800 years ago Galveston Island was actually growing. This phase of growth ceased as sand supply to the island diminished and the rate of relative sea-level rise decreased. Hurricanes have punctuated retreat of the island by causing the beach profile to shift landward in stepwise fashion.

Modern rates of coastal retreat on the west end of Galveston Island range from 3 to 6 feet per year, while the bay shoreline is retreating at even higher rates in some areas. The only exceptions are those areas where the shoreline has been “hardened” by man-made features, but in these locations the beach is narrower or absent, except where it has been nourished.

At the east end of the island beaches actually have a history of growth. Jetties on either side of the Bolivar Inlet disrupt wave energy and longshore currents, helping trap sand at the eastern end of Galveston Island. Additionally, sand has accreted to the east end beach, the source of which was a large tidal delta that once located offshore of the inlet prior to construction of the Houston Ship Channel.

Recently completed research at Rice University indicates that current rates of coastal retreat are unprecedented for the island’s nearly 6,000-year life span. The figure on the previous page shows the approximate location of the shoreline if the current rate of erosion is projected back in time to just after Bolivar Peninsula, Galveston Island and Follets Island formed (approximately 2,000, 5,500, and 3,000 years ago, respectively). At current rates of shoreline retreat, the barriers would now be located as much as a mile landward of their present locations, with the exception of the Bolivar tidal delta. Clearly, these barriers have not always retreated landward and, as we will describe, there is evidence that the current rates of shoreline change are unprecedented. But, where has the sand that has eroded from the island gone?

Evidence that Galveston Island has been eroding faster in historical time (that is, since the island was first mapped) comes from a recent sand budget analysis for the island. We collected sediment cores offshore of the island and in West Bay to determine the amount of sand that is sequestered in these areas after tropical storms and hurricanes. This analysis allows us to estimate that a significant volume of the sand eroded from the Galveston shoreline ends up offshore in the shoreface (sandy extension of the barrier island) and not in the West Bay. The remaining fraction ends up in the San Luis Pass tidal delta or bypasses the San Luis Tidal Inlet and is transported to the west (Wallace and others, 2010). Sediment cores and radiocarbon ages for the tidal delta were used to estimate its long-term rate of growth and sand supply. This rate is less than half the volume of sand that is currently removed from the island and delivered to the tidal delta. Hence sand supply to the delta has more than doubled in historical time, which indicates increased rates of erosion on the island (Wallace, 2010).

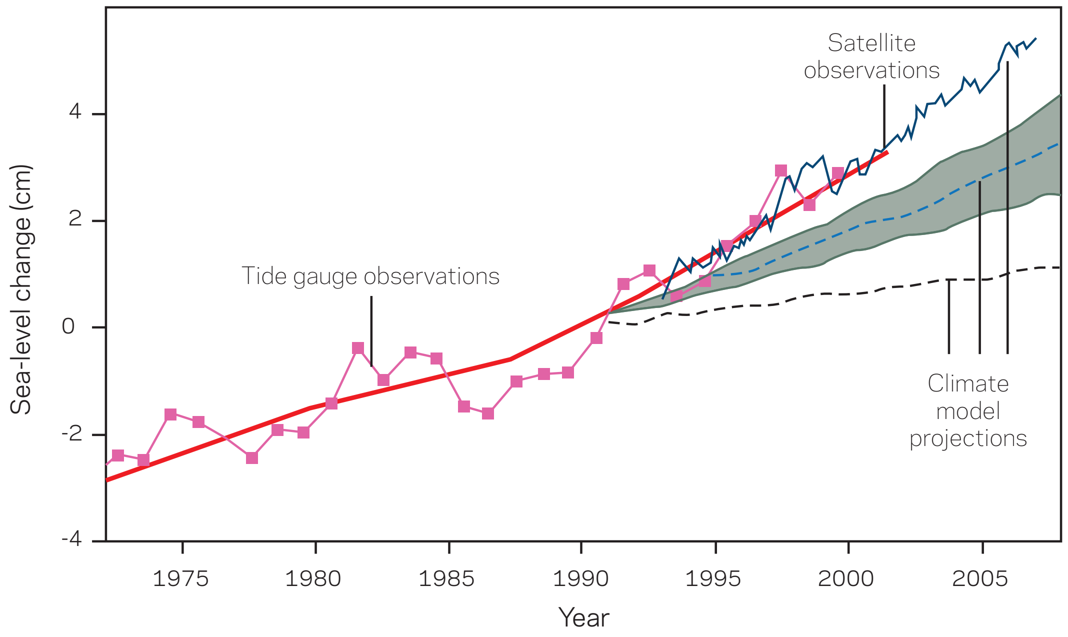


Transformation of San Luis Pass
Changes in San Luis Pass and tidal delta during the past 3,500 years are used to estimate the amount of sand eroded from Galveston Island today versus the long-term erosion rate. Modified from Wallace, 2010. Data was used from Israel and others, 1987 to estimate the sand flux between 2,100-200 years ago. Data was also used from Bernard and others, 1970 to estimate migration rate and sand flux during the past 200 years.

Why is Galveston Island Eroding?

Erosion of a barrier island results when sand supply to the island is too low to keep pace with the rate of relative sea-level rise, which is the combined rise due to global sea-level rise (eustasy) and subsidence. Hurricanes have the effect of punctuating rates of erosion. The main impact of storms is to lower the beach profile, but much of the sand eroded from the beach remains within the longshore sand transport system. Most of that sand ultimately ends up in the San Luis Pass tidal delta. It is not possible to predict the frequency and magnitude of tropical storm and hurricane impacts on the island, so this is the greatest uncertainty in predicting coastal change. However, relative sea level rise and sand supply are reasonably well known, hence we are able to estimate minimum rates of shoreline change with reasonable accuracy.

Image: GlobeXplorer



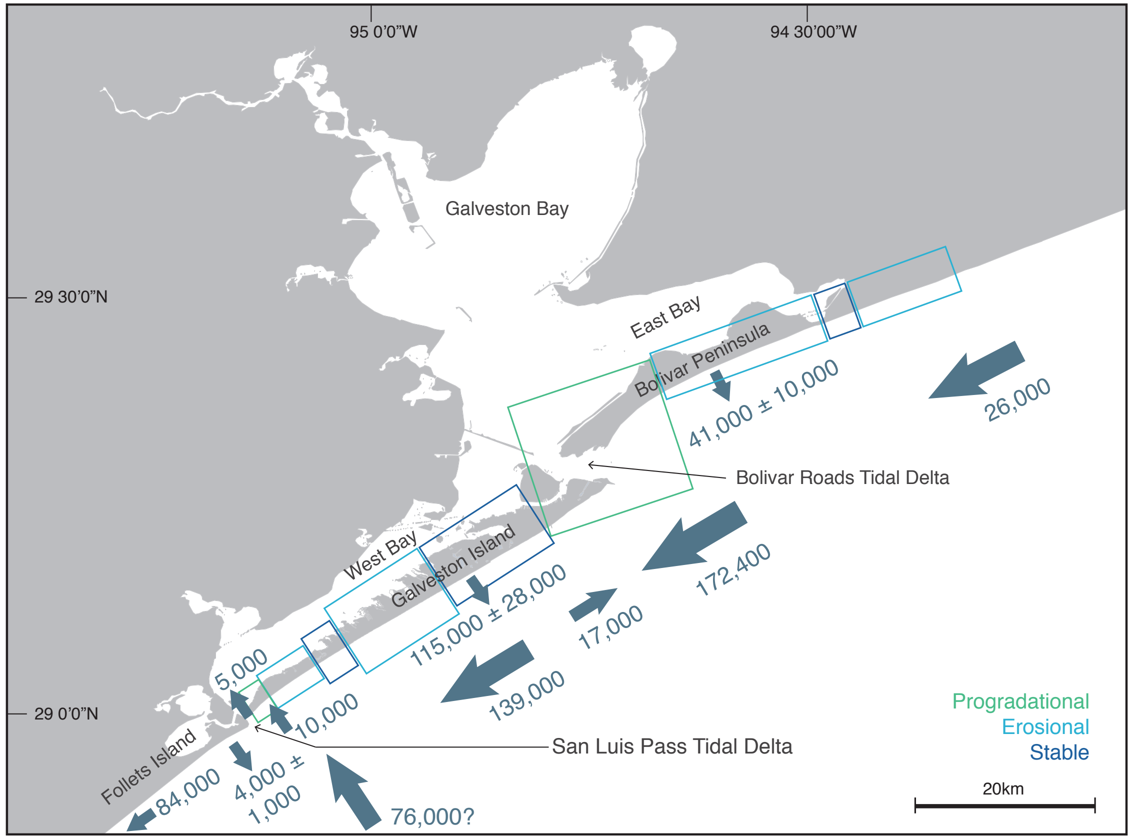
Sea-level Rise
Sea-level rise for the past few decades based on tide gauge records and satellite observations is more than 3 mm per year in the northern Gulf of Mexico. From Rahmstorf, 2007.

Sea Level Rise

The most recent scientific results indicate that the rate of global sea level rise has tripled in recent decades. This increased rate of sea level rise is attributed to expansion of the oceans due to both increased water temperatures (warmer water has greater volume than the same mass of colder water) and the addition of water released into the oceans from melting glacial ice. These effects are now well constrained (Rahmstorf, 2007; Church and others, 2010).

The rate of rise is expected to exceed 5 mm per year by the end of this century. The current rate is more than four times the rate of rise for the past 5,500 years, the time interval during which the island evolved (Anderson and others, 2010).

The last time sea level rose at a rate of 5 mm/year was approximately 7,500 years ago (Milliken and others, 2008). At that time, ancestral barrier islands positioned tens of miles offshore to the present coastline experienced rapid change that ultimately led to their being drowned on the continental shelf or destroyed. Sabine Bank and Heald Bank, two prominent underwater banks located on the inner continental shelf, are examples of drowned barrier islands. Rates of shoreline migration at that time ranged from approximately 5 to 20 meters, or about 16 to 66 feet, per year (Rodriguez and others, 2004), with variations in the rate controlled mainly by the offshore profile. Gulf Coast bays, including Galveston Bay, also experienced rapid change during that time, changes that far exceed those occurring today (Anderson and Rodriguez, 2008).



Sand Budget Analysis
This map shows results from a 2006 Corps of Engineers sand budget analysis (Morang, 2006) compared to results from a similar analysis by Rice University (Wallace and others, 2010). Large arrows show longshore transport flux of sand (in m3/yr) based on the Corps of Engineers study and small arrows show rounded sand flux estimates for several environments from the Rice University study. Shoreline change data from the Texas Bureau of Economic Geology. Modified from Wallace and others, 2010.

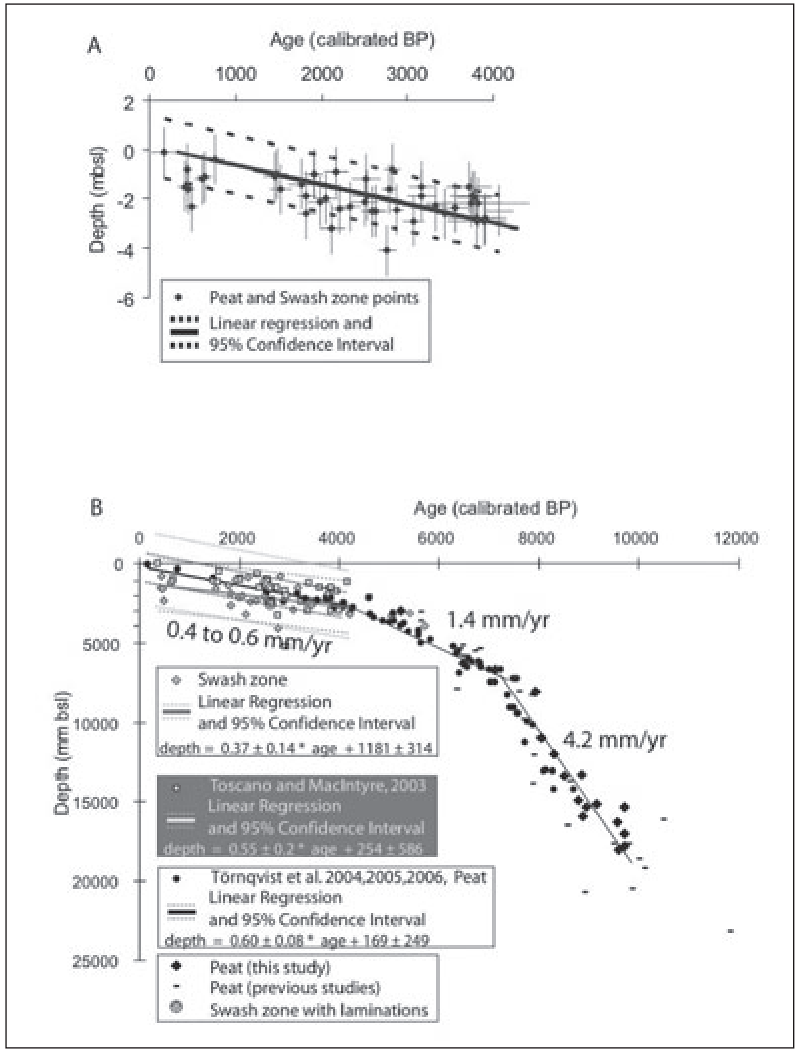
Subsidence

Subsidence is more localized and, over shorter time scales (decades and centuries), is largely due to compaction of sediments. Our study of the long-term sea level history of the Texas Coast has shown that natural subsidence rates along the upper Texas coast have been low compared to Louisiana (Milliken and others, 2008). Humans have in the past contributed to subsidence in a significant way, but current regulations protect against activities that would in the future contribute to subsidence. We do not know if, or how much, subsidence caused by subsurface groundwater extraction prior to the late 1970's contributed to the observed acceleration of coastal erosion. But, it is clear that accelerated sea-level rise is the most significant change occurring today.

Sand Supply

Prediction of coastal response to sea level rise requires information about both the rate of sea level rise and sand supply. If sand supply and dispersal mechanisms are known, it is possible to predict coastal change under different sea-level rise scenarios. A detailed sand budget analysis is also necessary for determining the magnitude of beach nourishment projects needed to combat coastal erosion (Wallace and others, 2010). Sea level is expected to rise between 50 cm and 100 cm by the end of this century. But what about sand supply to the coast? The United States Army Corps of Engineers recently conducted a sediment budget analysis for the upper Texas Coast that yielded a total sand flux of approximately 942,000 cubic meters per year (Morang, 2006). Our analysis (Wallace and others, 2010) has yielded a very different result, so it is important to explain how our methodology differs from that of the Army Corps of Engineers. First, their analysis is based mainly on photo imagery and historical rates of shoreline change and relies on some big assumptions about where sand that is lost from the beach is being sequestered. It includes no results from analysis of sediment cores and seismic data, data that are needed to estimate the actual volumes of sand that resides within the nearshore zone (shoreface) and within tidal deltas and other areas where sand is sequestered. Our analysis includes such data. The Army Corps' analysis assumes that accretionary beaches that occur on either side of the Bolivar jetties are made up of sand that was moving within the longshore transport system and trapped by these jetties. Our data indicate that a significant portion of this sand was derived from erosion of a large ebb-tidal delta that was located off Bolivar Pass prior to the construction of the ship channel and jetties. We also differ in our estimation of the depth of closure, which is the maximum depth at which sand is transported along the coast by coastal currents. Our data suggest that a significant volume of sand is transported to the shoreface environment. In addition, we have conducted a detailed sand budget analysis for the San Luis Pass tidal delta, where much of the sand that is transported west along the Galveston shoreline ultimately accumulates. We estimate the long-term sand flux for San Luis Pass for around the past 2,100 years to be approximately 4,700 cubic meters per year (Wallace, 2010; Wallace and others, 2010), which is an order of magnitude less than the Army Corps of Engineers estimate (Morang, 2006). The combination of these observations is that more sand is moving within the longshore transport system and this system extends farther seaward than estimated by the Army Corps study. Therefore, removal of sand from the shoreface to nourish beaches is not an acceptable practice as it only takes sand from the longshore transport system.

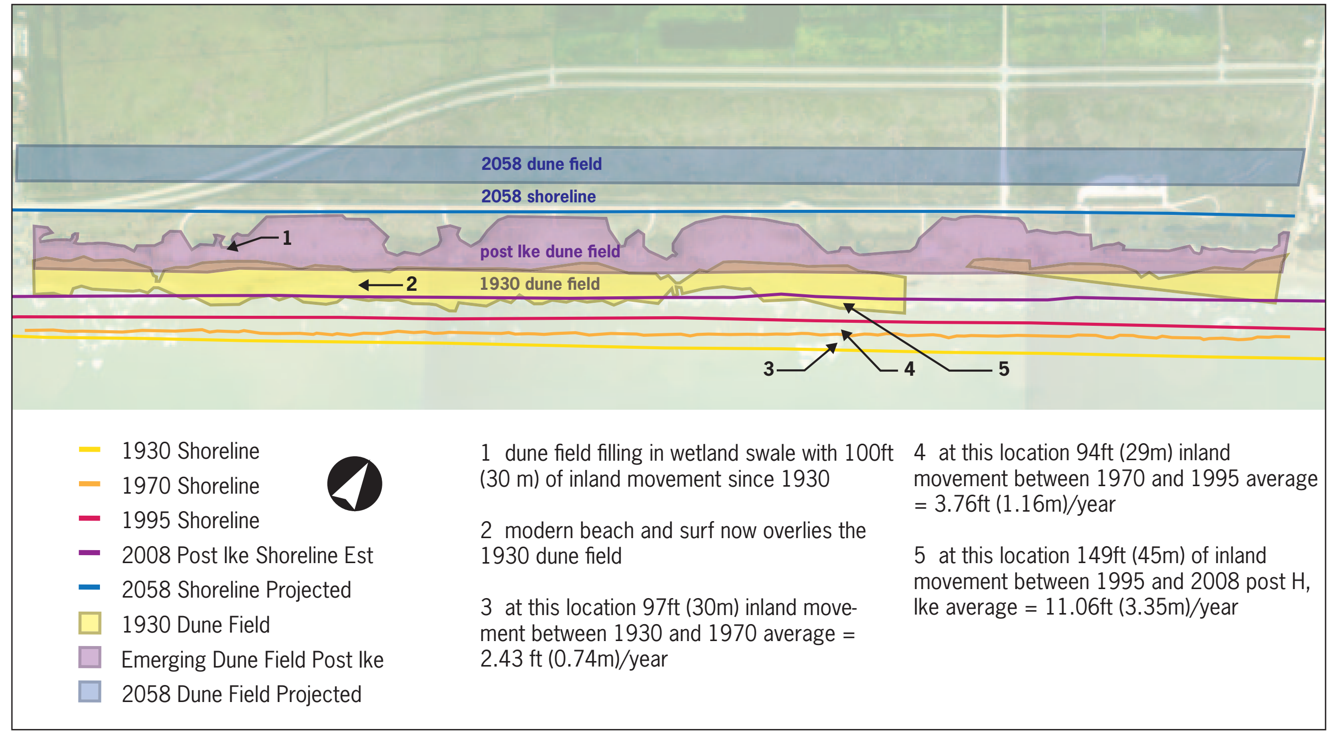
We conclude that sediment supply to the coast is not sufficient to keep up with the current rate of sea-level rise. Thus, beach erosion will only worsen if the rate of sea-level rise increases. These results also indicate that very large volumes of sand would be required to render beach nourishment projects successful. That sand should not be taken from areas immediately offshore of the beach. Because our sand budget analysis adds a previously overlooked component, it can be used to estimate the volumes of sand needed to sustain the beach and the interval of time required for re-nourishment of the beach. We advise against using the Army Corps of Engineers sediment budget analysis alone for beach nourishment projects.



Sea level history for the northern Gulf of Mexico, with emphasis on the Texas and Louisiana region.
From Milliken and others, 2008 (full citations for references within this figure can be found therein). Reprinted with permission.

Predicted Rates of Coastal Erosion in this Century

Relative sea level rise has nearly tripled in recent decades, part of that is due to human-induced subsidence caused by subsurface water extraction prior to 1980. Erosion rates have at least doubled, but there is no evidence that sand supply has changed in the past few decades. Thus, our best estimate is that sea level is the culprit for the observed acceleration in coastal erosion and there is pretty much a one to one ratio between rates of sea level rise and rates of erosion. This being the case, it is possible that the predicted increase in the rate of sea level rise this century could cause the shoreline erosion rates to double or triple, depending on the magnitude of rise.

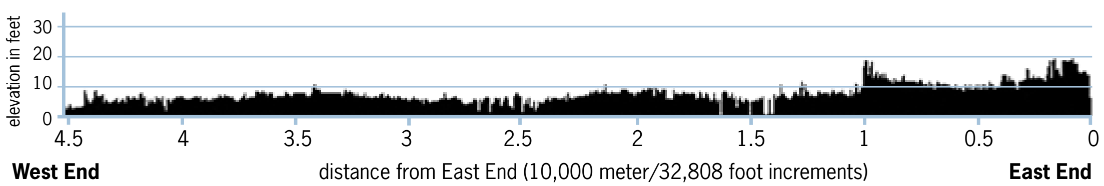


2008 post-Hurricane Ike with Historic Shorelines and Dunes at Galveston State Park
The blue band is the predicted area of the dunes in 2058. The yellow line on the bottom is the shoreline in 1930. Based on a map and research courtesy of Andrew Sipocz.

Hurricane Impact on the Coast

The greatest uncertainty in our predictions about the fate of Galveston Island is how many hurricanes will strike the coast by the end of this century. Hurricane Ike simply amplified lessons learned from past storms, which is that a single storm can cause as much coastal erosion as would normally occur over one to two decades. Ike resulted in up to 50 feet of erosion along the upper Texas coast and lowered the beach profile by as much as five feet in some locations. While some beach recovery, in terms of beach width and elevation, occurred after the storm, those beaches that lost elevation will continue to erode at even faster rates and will remain highly vulnerable to tropical storm and hurricane impacts. Beaches that were located behind geotextile tubes suffered the greatest change in beach profiles because their offshore profiles were re-adjusted to their natural state by the storm. It is unlikely that any additional recovery of the beach will occur at this point in time.

Digital Elevation Map for Galveston Island
This map of the island's elevation highlights the elevation differences, which are also shown by the cross section that extends just north of the highway. Note that the average elevation for East End Flats (shown at a larger scale in the dashed box on the right) is 7 meters (or about 23 feet), which is just below the maximum level of hurricane storm surge. In contrast, the west end of the island averages 1.5 to 3 meters (approximately 5 to 10 feet) of elevation, making it highly susceptible to even modest storm surge, as was experienced during Hurricane Ike.



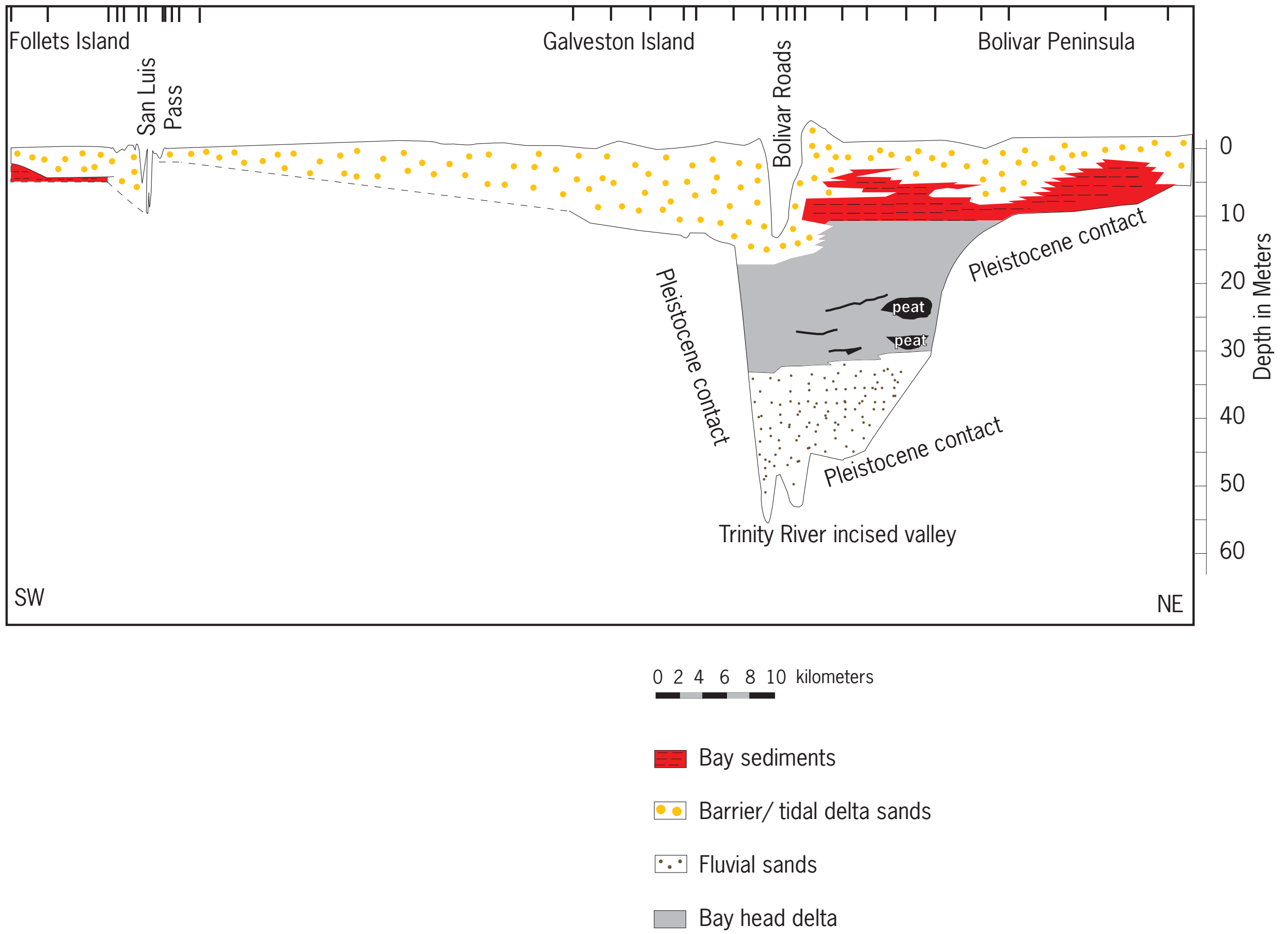
Elevation Profile of Galveston Island

East End's Existing Protection Against Storms

Digital Elevation (LIDAR) Map of Galveston Island and Hurricane Impact

Galveston Island is older, wider, higher and thicker at its eastern end. This is because the island first began to form at that location. As the island grew toward the west, away from its main sand supply, it developed its current morphology. Most notable is the decrease in the number and height of beach ridges from east to west. Beach ridges are nature's barrier to storm waves that move across the island during hurricanes. The island's far west end shares many similarities to Bolivar Peninsula, which suffered great damage during Hurricane Ike and also has a paucity of high elevation beach ridges.

Following the "Great Storm" of 1900, the east end of the island was elevated by an average of 5 feet and the seawall was constructed. Since that time, there have been other man-made features and elevation projects that have helped to fortify the east end of the island. While the elevation difference from east to west across Galveston Island may seem insignificant, the impact from storm waves during Hurricane Ike was considerably greater on the west end of the island than on the east end, even though the eye of the storm was to the east of Galveston. Had the eye of the storm passed over San Luis Pass, the damage to the west end of the island would have been much greater.



Sand Thickness
Sand thickness map for Galveston Island based on sediment cores. Modified from Wallace and others, 2010; originally modified from Anderson and others, 2008; Israel and others, 1987; Rodriguez and others, 1999; Siringan and Anderson, 1993; Wallace and others, 2009.

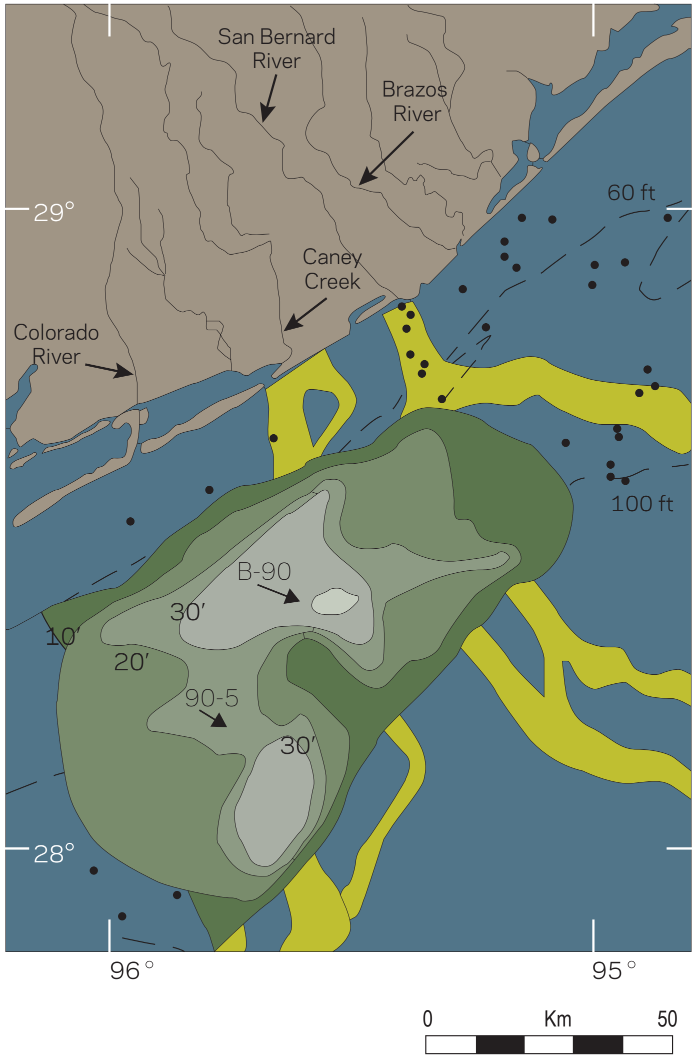
Barrier Thickness

In general, the stability of a barrier island is controlled by its width, height and thickness. Breaching of a barrier is most likely to occur where it is narrower, lower and thinner. The Pleistocene surface on which the barriers of the upper Texas coast were constructed shows considerable relief, hence barrier thickness varies considerably along the coast. Follets Island, located to the west of Galveston Island, is a narrow, low, thin barrier island that rests on soft, water-saturated clay. It is currently retreating landward at an average rate of 10 feet per year. Although it is located well to the east of the track of Hurricane Ike, the island suffered significant impact, breaching at a number of locations and undercutting the highway in multiple locations. Many houses on the island shifted due to liquifaction of the soft clay substrate as the wind shook the houses. In the aftermath of Ike, Follets Island lost up to 30 feet of beach and the elevation of the beach was lowered by up to 4 feet, making it more vulnerable to future storm impact. Likewise, Bolivar Peninsula is a relatively low, thin barrier, which contributed to the great impact from Hurricane Ike. Galveston Island is much thicker at its east end where the island was constructed over the valley of the ancestral Trinity River. It is here that the island is least susceptible to breaching during severe storms. The west end of the island is thinner and, like Follets Island, barrier sands rest on soft, water-saturated clay. Thus, the west end is more vulnerable to storm impact. In addition, beach ridges, which provide an obstacle to storm surge, are mainly confined to the eastern part of the island, east of Jamaica Beach.

Can We Fix The Erosion Problem?

The State of Texas has spent tens of millions of dollars in recent years in the attempt to stabilize beaches and coastal dunes. This includes everything from "straw dunes" to geotextile tubes. None of these projects have worked. In fact, the geotextile tubes only gave a false sense of protection until Hurricane Ike, which resulted in greater inland erosion on Bolivar Peninsula where these tubes breached during the storm, to significant lowering of the beach profile along the west end of Galveston Island where the hurricane re-adjusted the beach profile to its natural state resulting in significant undermining of foundations of many houses.

We Texans don't give up without a fight, even when our opponent is Mother Nature. Recently, there has been much discussion about construction of a dike (the Ike Dike) that would extend from Freeport to High Island. Unfortunately, the Ike Dike is little more than a vision; there has been very little science or engineering to test this concept. If such a dike were constructed it would likely provide some protection to inland areas, provided the locks at the inlets work so that storm waters are allowed to flow offshore. But, the Ike Dike will just as likely increase the vulnerability of the shoreline to storm waves by focusing their energy seaward of the dike. Thus, the Ike Dike is not the solution to our coastal erosion problem. In view of this fact, beach nourishment is the most feasible means of slowing the rate of coastal erosion, but where will the sand come from?



Map of the Colorado Delta
This map shows the thickness of the ancestral Colorado River delta that is believed to be the most viable offshore sand resource for nourishing east Texas beaches. Two long cores, B-90 and 90-5, penetrated the delta and sampled quartz sand and mud interbeds. Modified from Anderson, 2007.

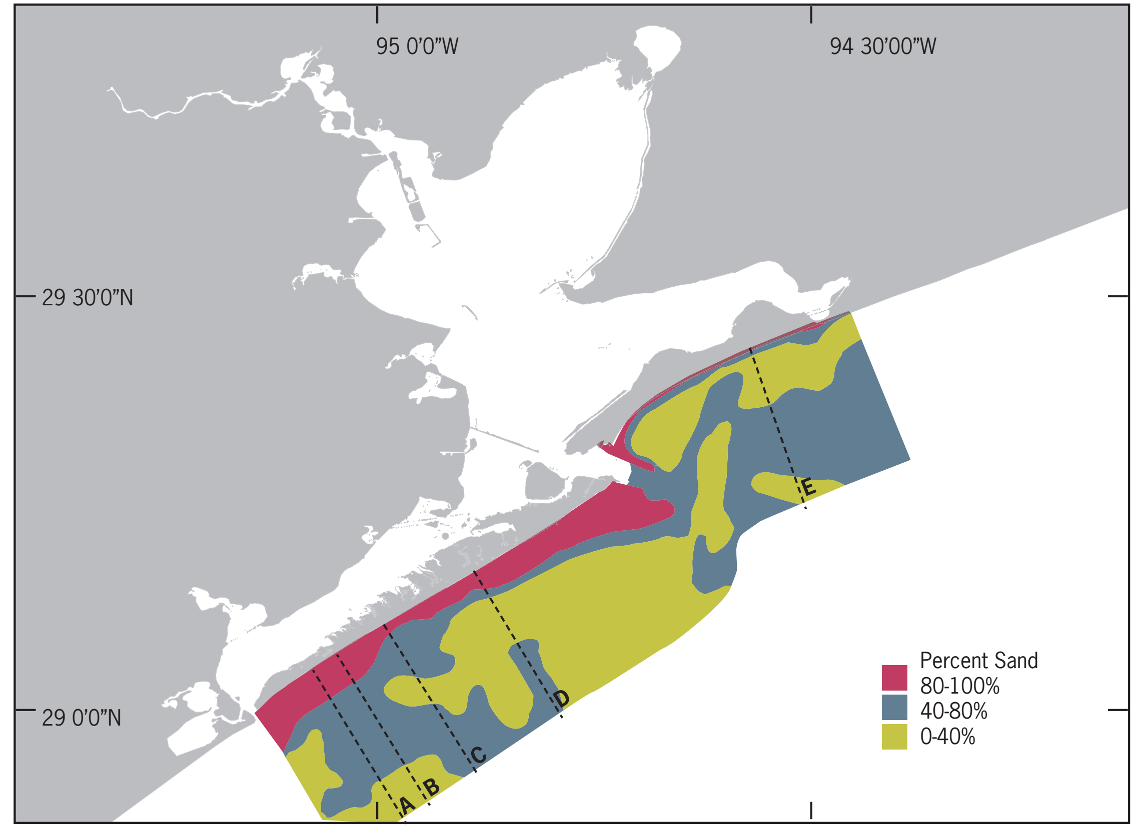
Old river valleys

Location of delta with thickness in tens of feet

Sediment core location

Water depth

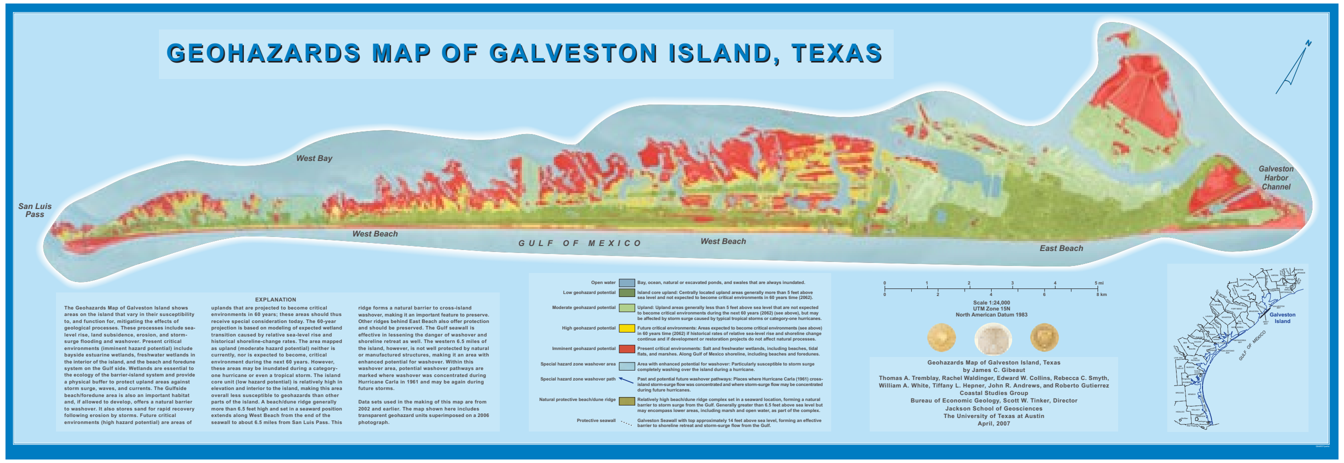
Opposite Page, Offshore Sand Distribution
This map displays the distribution of sand offshore Galveston Island, showing sediment core transects collected by Rice University (labeled A through E) and surface samples adapted from White and others, 1985. Most beach quality sand resides nearshore in water depths shallower than 24 feet, which means it will ultimately make its way back onto the beach without human intervention.



Beach Nourishment & Sand Resources

Sediment cores and grab samples from offshore Galveston Island show that beach quality sand is restricted to within a few thousand yards of the shoreline. These sands occur mainly in water depths of less than 24 feet, which is above the depth of closure (Rodriguez and others, 2001; Wallace and others, 2010). This means that this sand should not be used for beach nourishment projects as it occurs within the zone of active longshore sand transport. Any sand removed from this zone and placed on the beach will simply move back offshore to re-establish the equilibrium profile of the beach. There are limited sand resources that can be exploited by conventional pipeline dredging, such as the Big Reef sand body, which has already been depleted. The City should guard these sand resources as they will be needed for post storm repair of the seawall.

Sand resources exist on the continental shelf, but these resources are tens of miles from the island, in over 60 feet water depth and locally beneath several feet of mud. The cost of mining these sands will be high, so we will need to use them wisely. East end beaches are less prone to erosion in the future and will be easier to maintain with beach nourishment projects. In contrast, west end beaches will experience even higher rates of erosion in the coming decades and would require more aggressive beach nourishment to combat erosion. There is sufficient information to estimate volumes of sand that will be needed for beach nourishment projects, but additional work will be needed to determine the best offshore sources. The most obvious source, based on available data, is an old Colorado River delta that is located between 20 and 50 miles offshore of the modern Colorado River mouth in 60 to 100 feet of water.



The Galveston Geohazard Map
This map was originally constructed by Dr. James Gibeaut, University of Texas Bureau of Economic Geology, Dr. John Anderson, Rice University, and Dr. Tim Dellapenna, Texas A&M University, Galveston. The map was later digitized and improved by Dr. Gibeaut using digital elevation data and revised habitat boundaries. Available at: www.beg.utexas.edu/coastal/GalvHazidx.php

The Galveston Island Geohazard Map

Given the best scientific information to date, the future of Galveston Island is one that will see changes even more dramatic than those that are occurring today. We can sustain the island for future generations to enjoy, but this will require a different approach to how we inhabit the island, one that is more adaptive to the changes that will occur this century. The first approach to sustainable development is to adopt the existing Geohazard Map for the island.

The concept behind the Geohazard Map is to identify those areas that presently, or in the next few decades, should be off limits to development in order to protect natural habitats and to avoid significant damage to man-made features due to coastal erosion and severe storms. The map was constructed using a highly accurate digital elevation map and habitat boundaries that are based on the digital elevation map, aerial photographs and field verification. There is a strong correlation between the location of natural habitats and elevation. Thus, as sea level rises and the land subsides, habitat boundaries will migrate toward higher elevation. Likewise, the Gulf shoreline and bay shoreline will shift landward. It is important to stress that this map provides a "best case scenario" for future change as it uses historical rates of coastal change and does not assume an increase in the rate of sea-level rise, which is already underway. Nor does it attempt to predict potential impacts from hurricanes that can greatly accelerate rates of coastal erosion. We could generate similar maps that assume a faster rate of sea level rise and assume at least one category 3 hurricane impact every other decade and the result would be a much faster rate of change than is indicated by the current Geohazard Map. The problem is that we still do not know just how fast the rate of sea level rise will be by the end of this century and we have no way of knowing how many hurricanes will make landfall at or near Galveston during this time period. This being the case, we recommend immediate adoption of the current Geohazard Map as a framework for development on the island this century.

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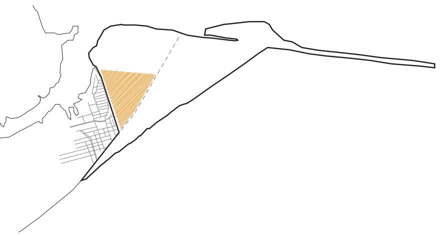
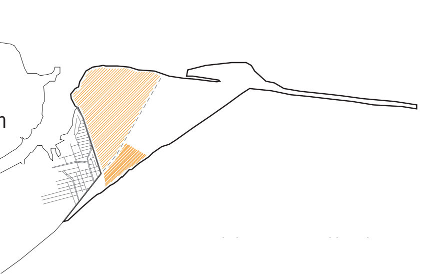
II
Urban Ecologies

A complex network between natural, urban and industrial systems inform coastal environments. However, typical planning and design tends to separate these domains rather than strategize their entangled relationships in order to produce more resilient approaches that link them as interdependent ecologies. While specific to Galveston and its region, these studies by architecture students can also be understood as case-studies within global patterns.

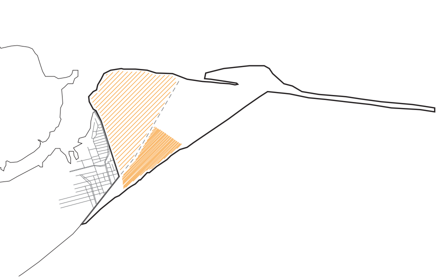
Scenario: Catastrophic Loss
Future Damage by a Hurricane on the extreme West End renders it un-buildable and it returns to nature. The maps to the right show how the displaced population could be accommodated on the East End at different densities.



High Galveston density
(Historic/Urban District)
5285 people/sq mile

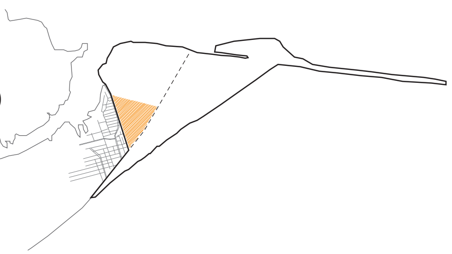


Mixture of high density along beach, with medium density inland

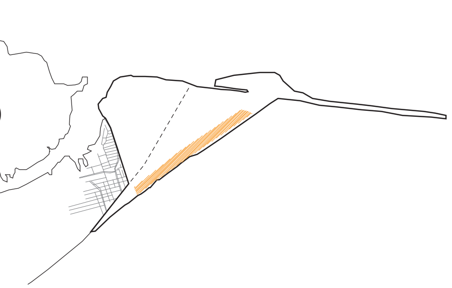


Mixture of high density along beach, with low density inland

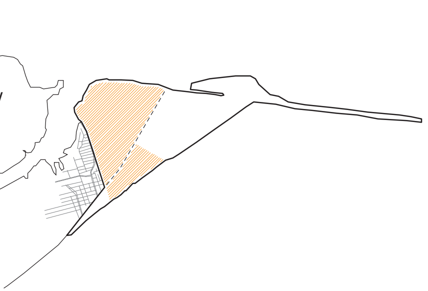
Scenario: Geohazard Risk Map Accommodation
In this scenario, development is halted and existing development slowly phased out from the areas of high and moderate risk on the recent geohazard map, with appropriate set-backs for future erosion along the beach front. The maps to the right show how the displaced population could be accommodated on the East End at different densities.



High Galveston density
(Historic Urban District)
5285 people/sq mile

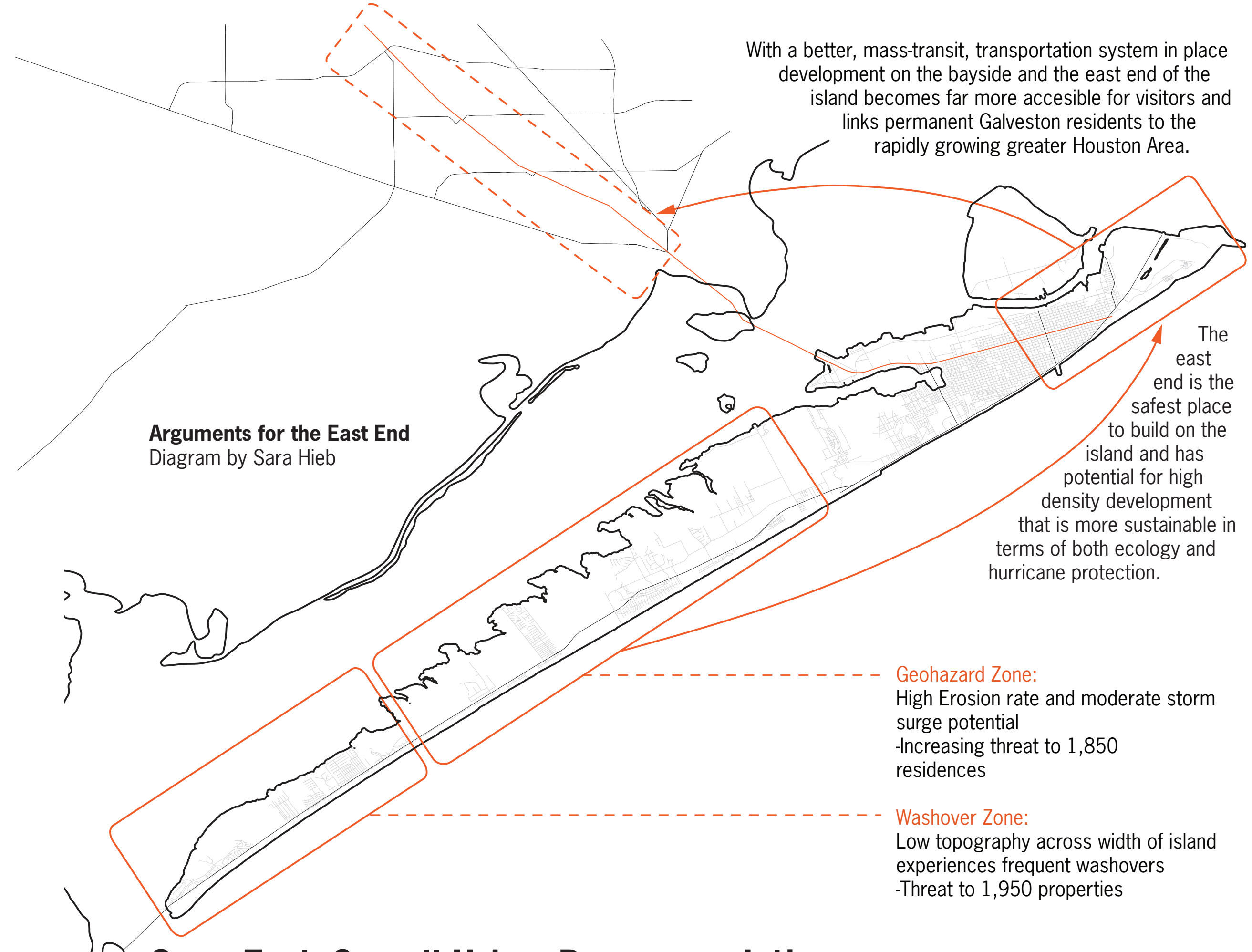


High Galveston density
(Historic Urban District)
5285 people/sq mile



Medium Galveston density
(Typical East End)
1050 people/sq mi

Scenarios and Diagrams by Zhan Chen, Elizabeth Mickey.



Arguments for the East End
Diagram by Sara Hieb

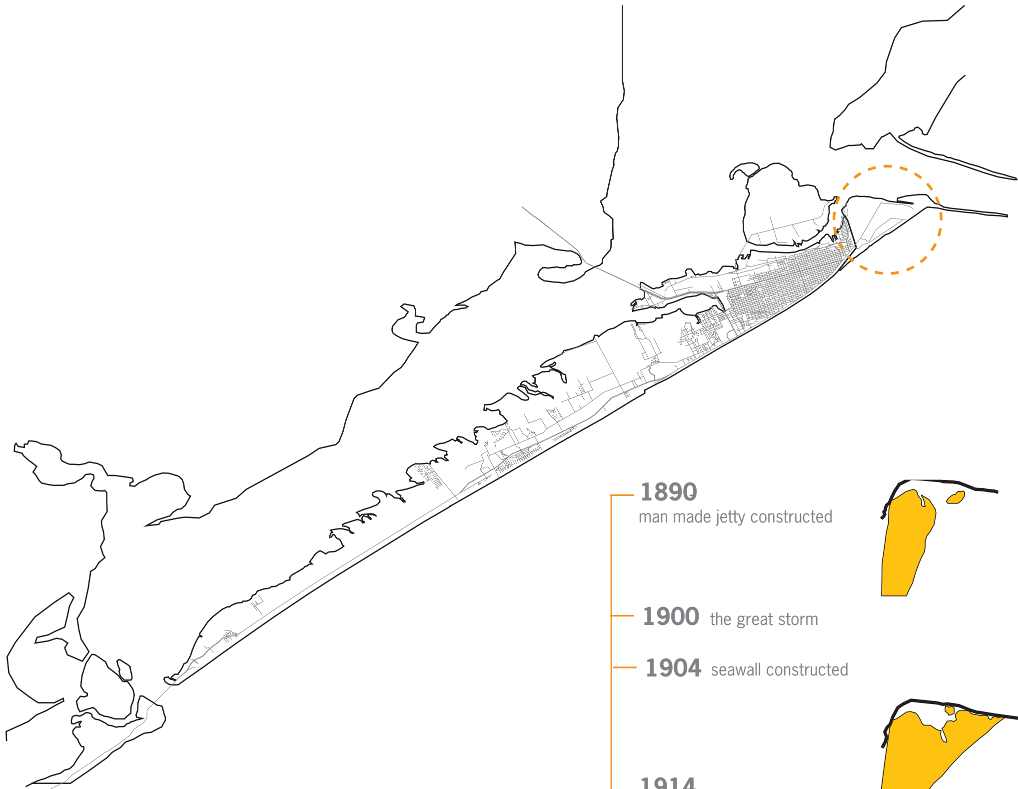
Grow East: Overall Urban Recommendations

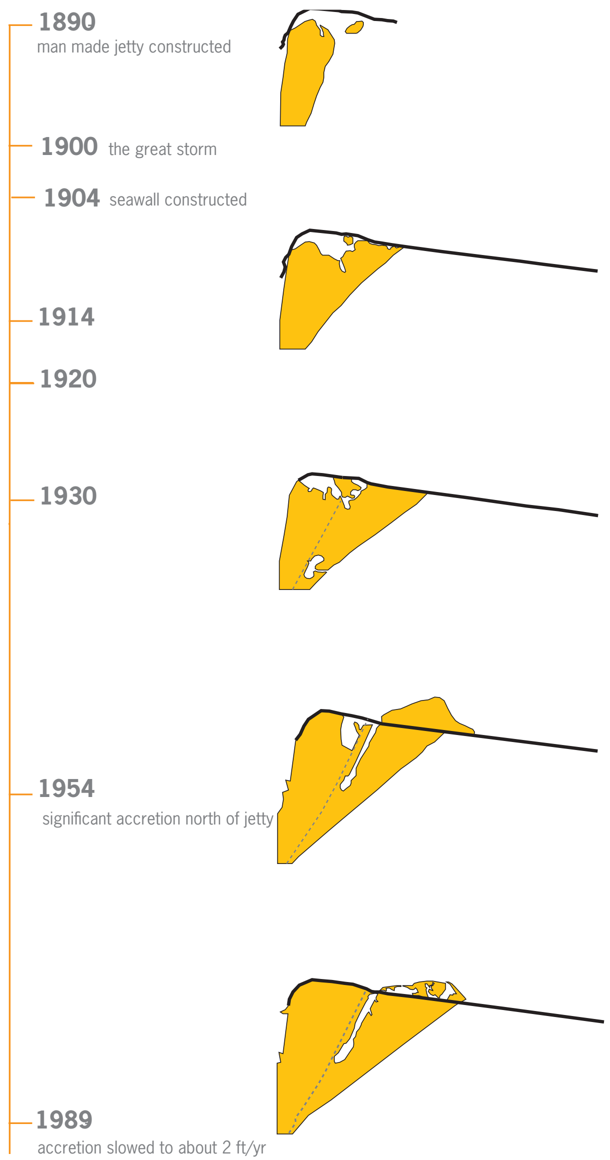
All coastal cities need to plan for the effects of environmental change and natural disasters into future development patterns. While the majority of Galveston's recent development has occurred on its western end, this area is also the most risk prone. An alternative would be to focus on the safer and less environmentally sensitive areas in the East End. Not only is this a real possibility, it is a potential catalyst of economic regeneration.

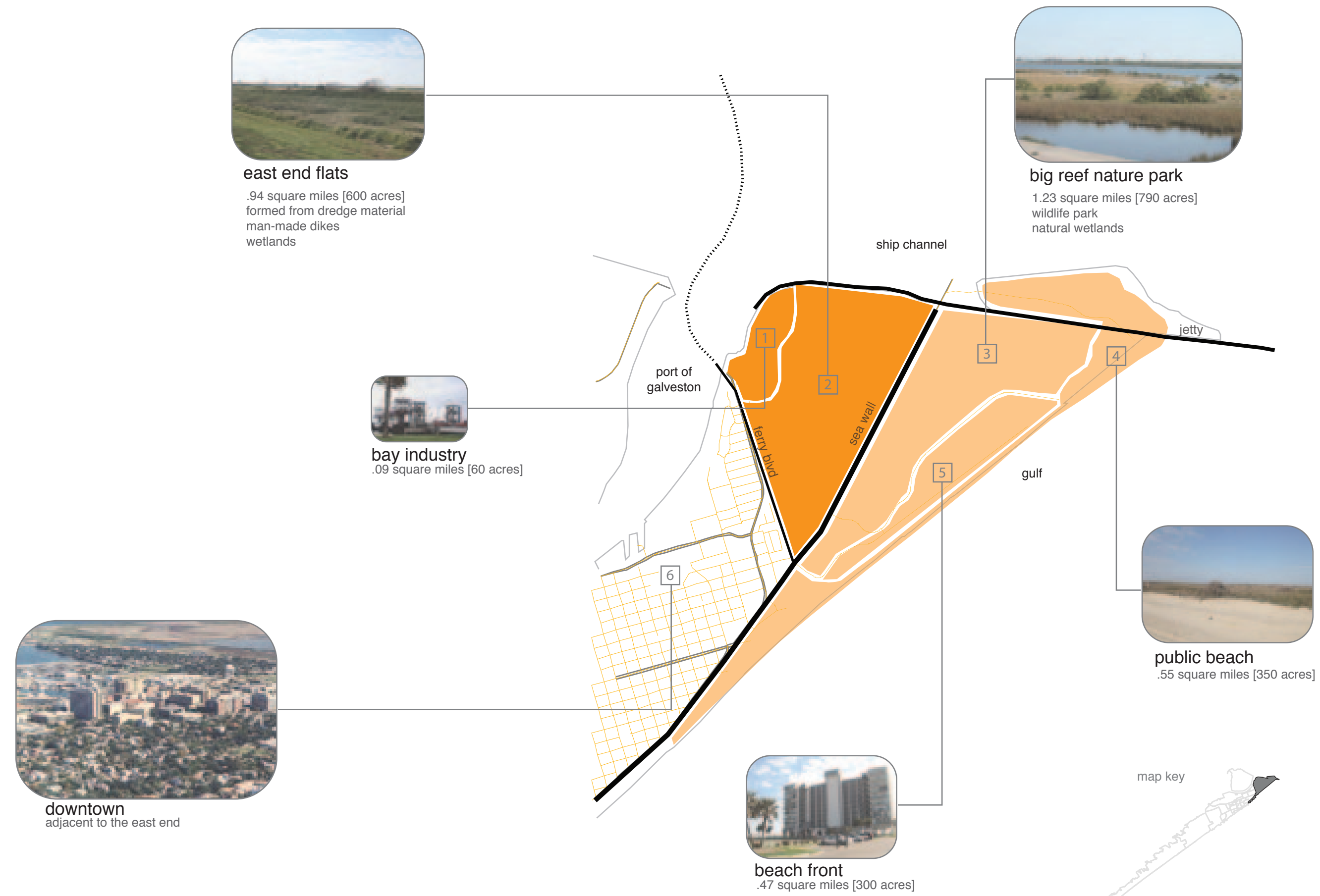
We recommend three scenarios for future development. In the first, basic setback rules are instituted, based on current shoreline retreat multiplied by 60 years (two mortgages). The setback would occur along nearly 18 miles of shoreline from the west end of the seawall to the west end of the island. Suggested by the Texas Land Office, the intent is to establish a coastal hazard buffer-zone along the beach front to help protect property from storms and to allow for natural erosion and accretion cycles to occur and to help maintain public beach access.

The second scenario would expand such environmentally prudent planning rules by adopting the current geohazard map as the basis for development. Nearly 17 square miles of land is in the hazard zone; most is federally protected wetlands. However, one needs to plan for the gradual migration and retreat of these wetland areas due to sea-level rise and other geological factors. Beachfront developments are similarly affected. In this case only a thin sliver of land in the middle of the West End remains developable.

The third scenario permanently abandons the west end of the island. This could become reality if a major hurricane crosses at or near the western tip of the island, significantly changing the geomorphology and making reconstruction untenable. Ongoing processes of shoreline retreat and sea-level rise could eventually lead to the same result. Relocating the entire population west of Jamaica Beach reduces the risk of future storms and shoreline retreat.







Growing Land
The eastern tip of the island has the only growing beach due to the construction of the South Jetty, which caused the collapse of an offshore sand flat, capturing that sediment at the eastern tip. Today accretion continues at a slower rate as the jetty captures much of the limited sediment flow of the longshore current while protecting against erosion from routine storms.

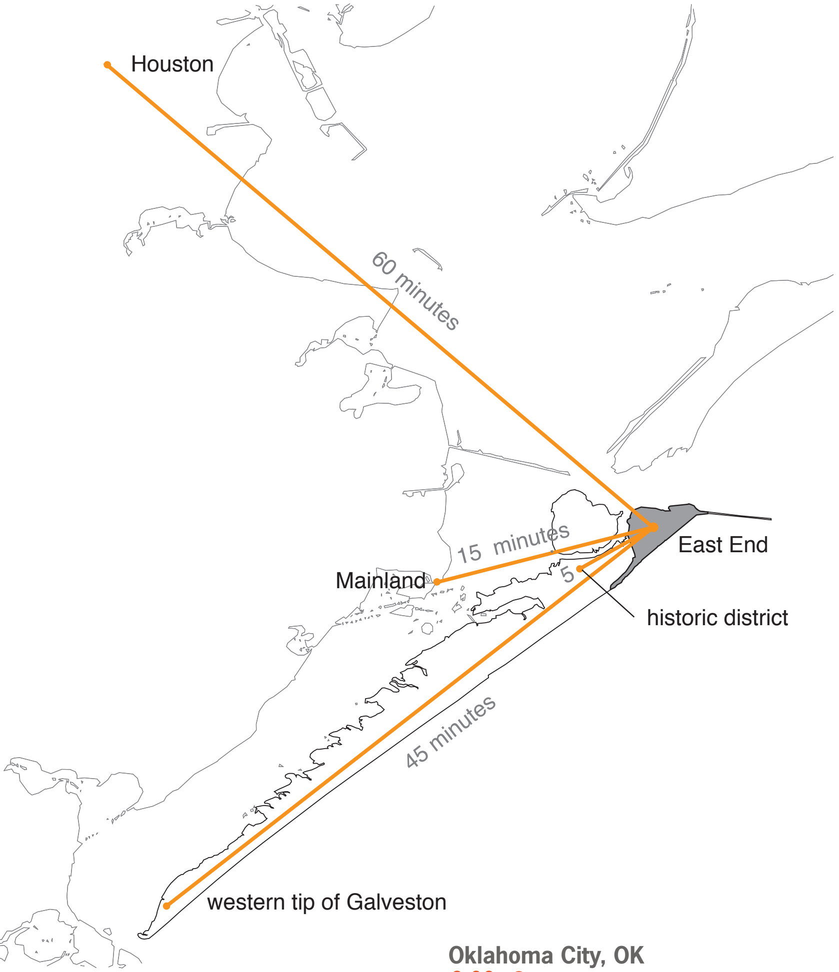
Diagrams on these two pages by Zhan Chen, Elizabeth Mickey.

East is Eden
The East End is adjacent to the historic district and the major sources of non-tourist employment, such as the medical center and the high-wage industrial sector, offering opportunities for a more diverse population growth. Restaurants and shopping located near public transport could provide easy access and therefore could shrink the ecological footprint (see later chapter) while creating urban environments that could attract tourists while providing housing for residents.

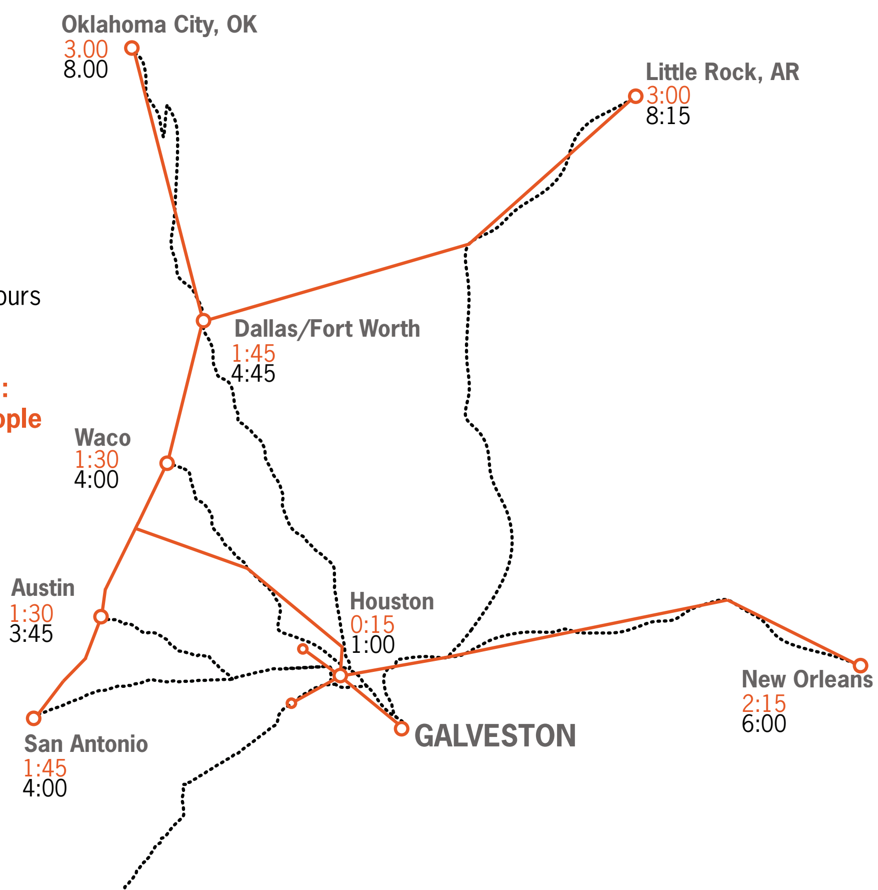
The eastern tip of the seawall provides the possibility of a sheltered cove that could be a large marina. A natural preserve, Big Reef Nature Park, has developed on the channel side of the now landlocked seawall. Between this park and the beach, new development has ranged from residential towers to New Urbanist subdivisions. Behind the protection of the seawall lay the East End Flats, a vast fill site of dredge from the ship channel and other engineering works.

While this dredge will likely require pollutant remediation, these flats could offer a tabula-rasa on which to reinvent coastal urbanism in ecological terms. New sorts of populations, drawn to a distinctive hybrid between ecological and dense urbanism could be attracted to the city. There is enough relatively protected space to completely offset land loss in the West, but it is the only and last such site on the island.

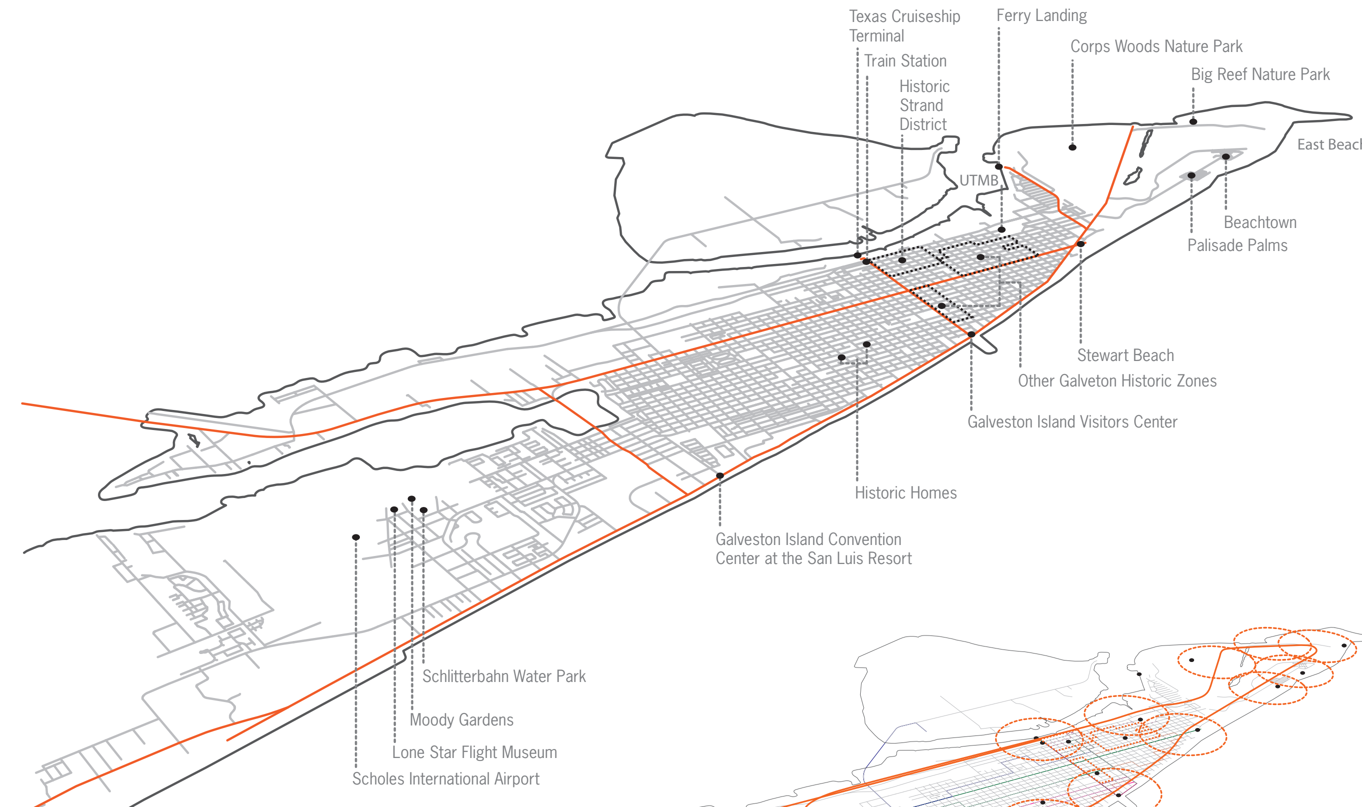
Continuing the piecemeal development that has recently taken place will prevent this area from becoming a thriving new locus for the city. While geographically close, the East End is internally fragmented and separated from the rest of the city. Strategic design could reinvent the island. However, standard design responses, whether isolated towers, or New Urbanist boutique communities, will not adequatly respond to the ecological and urban challenges poised.

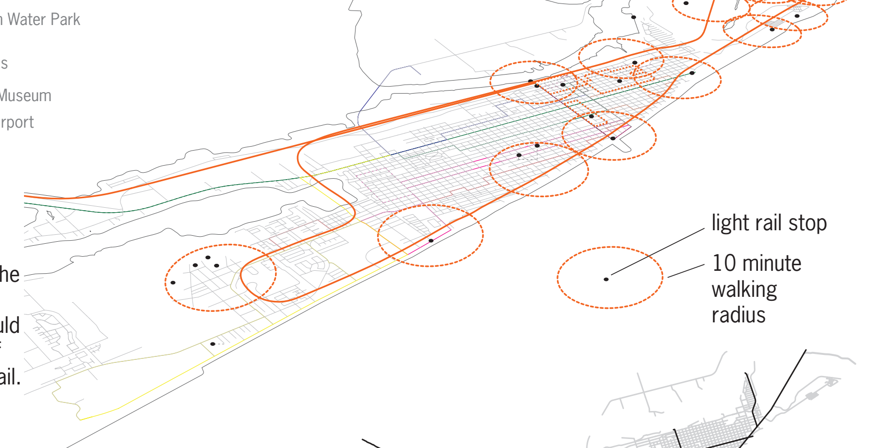


Proximate Densities
The car travel time from the western tip of Galveston to the commercial center approaches that from Houston. Adding more facilities on the West End is problematic and would likely come at the expense of the East End's commercial and historic district. Moreover, not only does the East End have much higher density and diversity to support economic growth, it has a far more even population distribution while the West End resort communities tend to be self-contained concentrations of non-residents or weekend residents. Again this pattern is common to coastal cities, splitting the permanent population employed in the tourist service sector from relatively remote resort development and weekend owners, creating a sharp delineation in terms of urban form, demographic and tax base. This prevents either the local population or the visiting resort populations from creating synergies in terms of economic and cultural development, while increasing strains on infrastructure and services. Diagram by Zhan Chen, Elizabeth Mickey

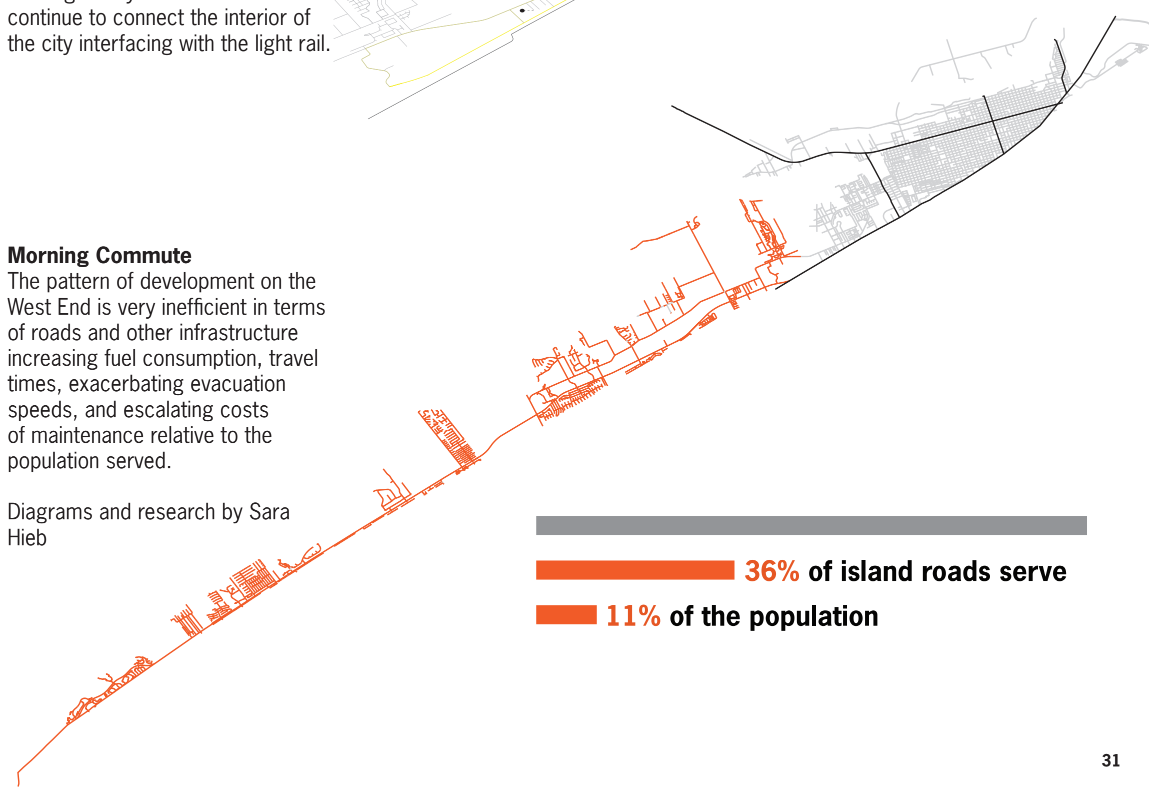


High-speed Rail
As energy costs increase, high speed rail becomes more feasible for linking regional cities. This map shows travel times by car (in black) and current high-speed rail technologies (in orange). Diagram by Sara Hieb





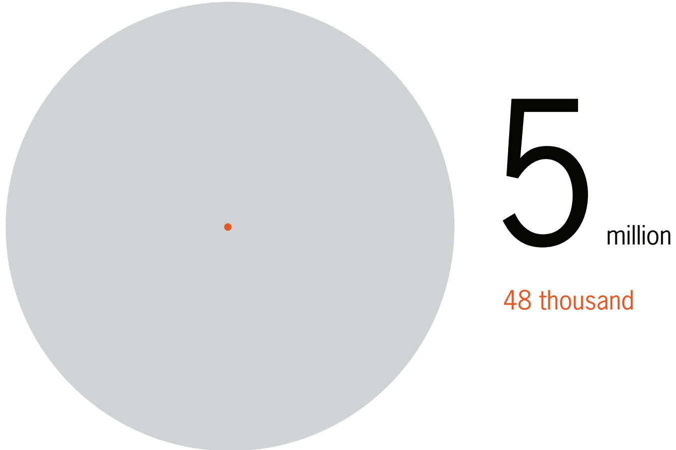
Potential for mass-transit
A light rail system could connect the edges of the island that hold the majority of points of interest. The existing trolley and bus routes could continue to connect the interior of the city interfacing with the light rail.

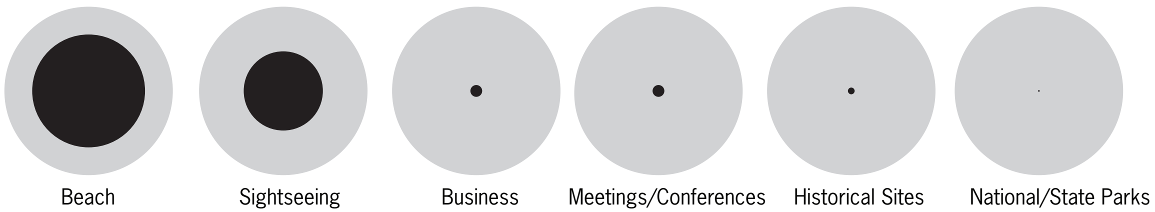


Morning Commute
The pattern of development on the West End is very inefficient in terms of roads and other infrastructure increasing fuel consumption, travel times, exacerbating evacuation speeds, and escalating costs of maintenance relative to the population served.

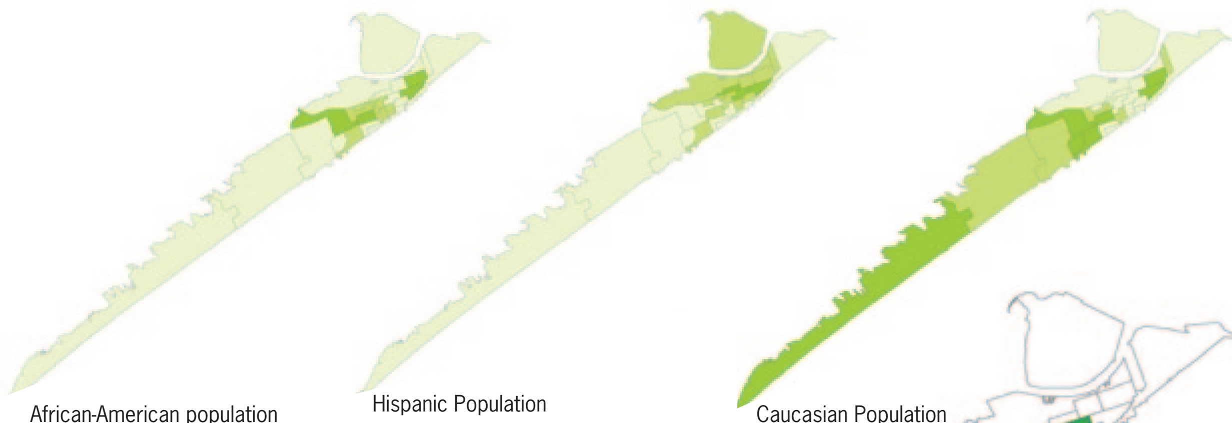
Diagrams and research by Sara Hieb

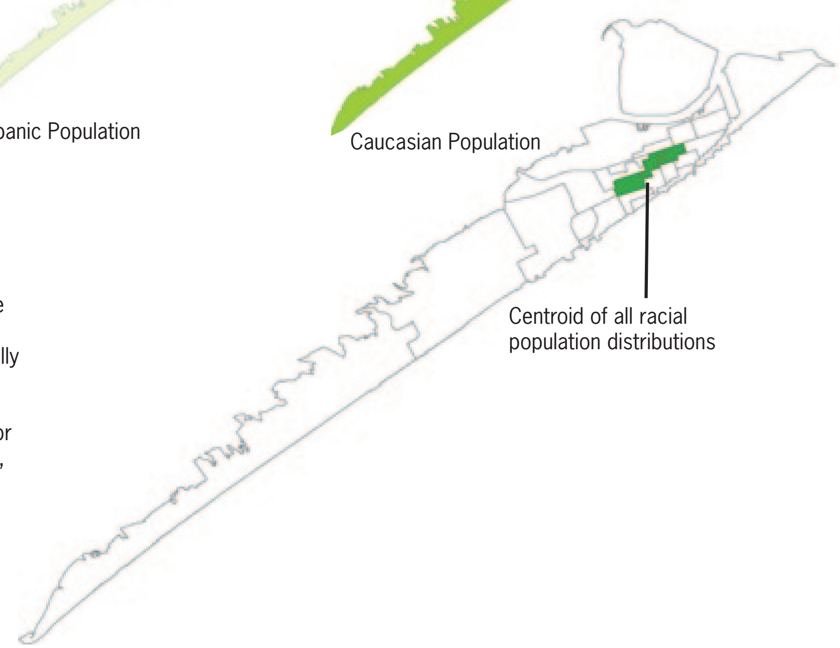
Galveston Visitors per year
Galveston Population



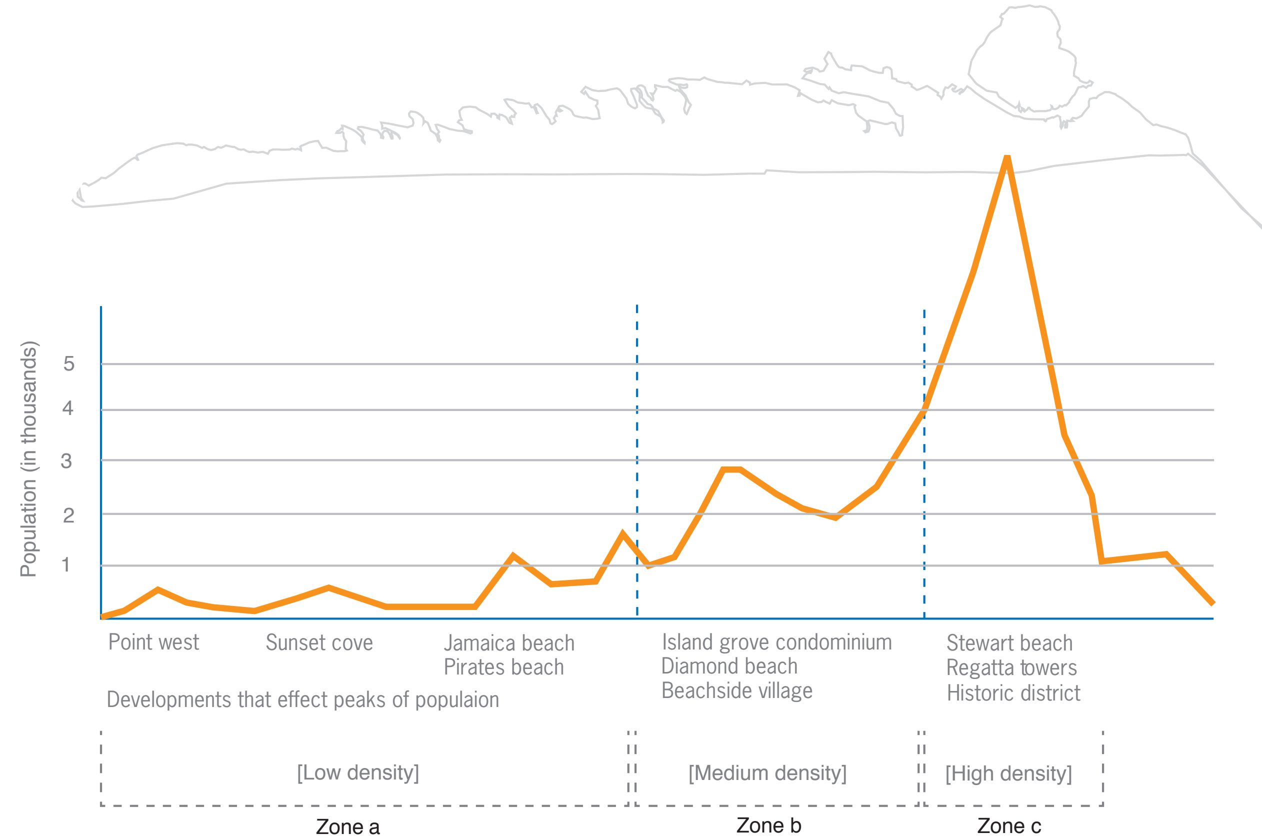


Ratio of Visitors to Residents and the relative importance of destinations of the latter
Diagram by Sara Hieb





Civic Fragmentation
While the island is ethnically diverse, these different groups tend to live in different sectors. Nevertheless, if one geographically locates the center of all these groups, the center of the city remains the statistical locus though it is not currently the social or cultural center. Diagrams by Jason Cross, Ricardo Umansky from 2000 Census data and GIS.



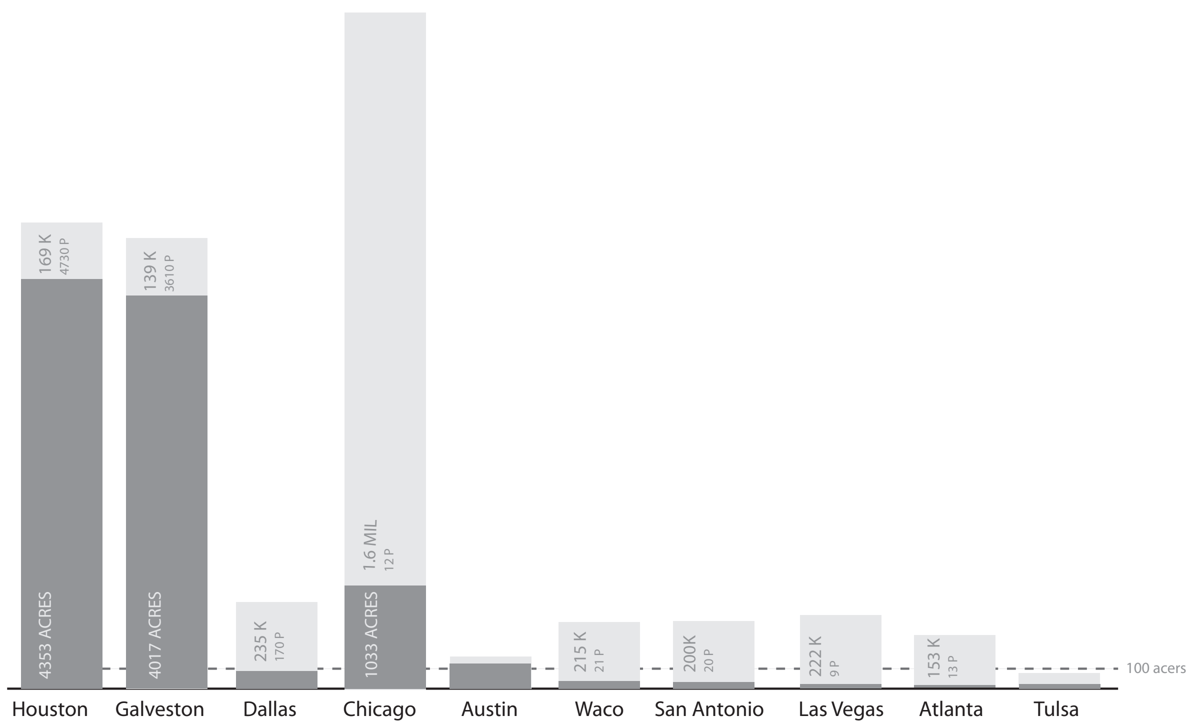
Gradient of Density
The population density of the island is a relatively smooth gradient from high density in the East to low density suburban in the west end. Diagram by Zhan Chen, Elizabeth Mickey.

A Demographic Multitude

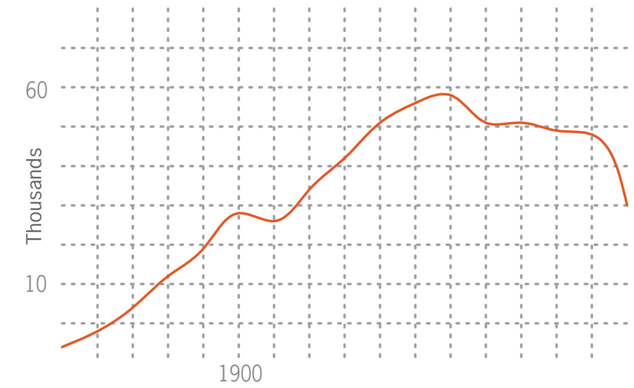
In coastal resort areas there exists not one public realm but many different publics, in some ways sharing the same space and at other times remaining very isolated from one another, and often with divergent and competing interests. Once a trading hub for the entire continent, today Galveston Island epitomizes the frequent divide between a permanent population and local industries in economical and numerical decline, a growing service sector and tourist industry, plus increasing numbers of non-resident landowners. This demographic produces an ethnically, economically and socially polarized condition between the urbanized east end of the city and the resort areas of private communities and incorporated townships on the west end.

The city needs the property tax revenue of the west but increasing development puts greater pressure on city services and infrastructure. This too often produces a condition where short-term revenue and market real-estate values trump long term planning.

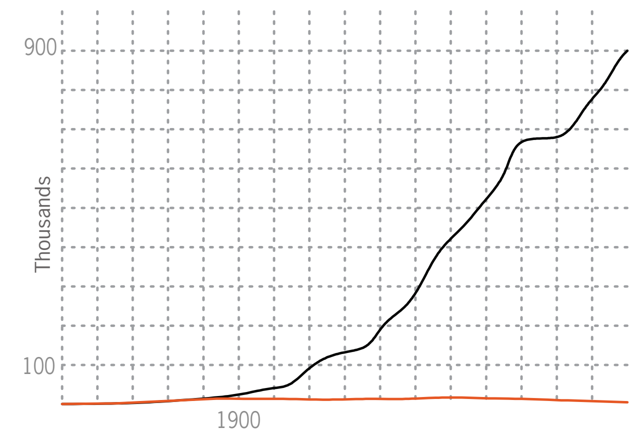
Moreover, the resort developments are frequently master planned communities or incorporated townships that have different degrees of political autonomy from the City of Galveston but which of course rely on this larger entity. This condition tends to further politically polarize the ends of the island while obscuring the mutual dependence of these communities.



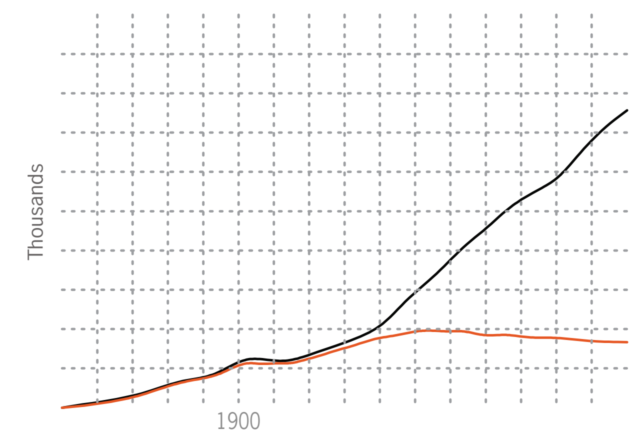
Land ownership
This graph shows the known legal addresses for landowners in Galveston, while the map above shows the island as a sample distribution of off-island landowners. Diagrams by Jason Cross, Ricardo Umansky from 2000 Census data and GIS. Note that these figures and maps are pre-Hurricane Ike.



Galveston Population 1850-2010

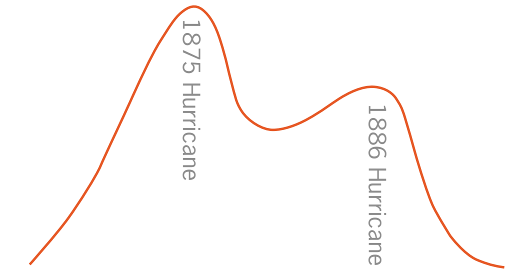


Galveston Vs. Houston Population 1850-2010



Galveston Vs. Galveston County Population 1850-2010

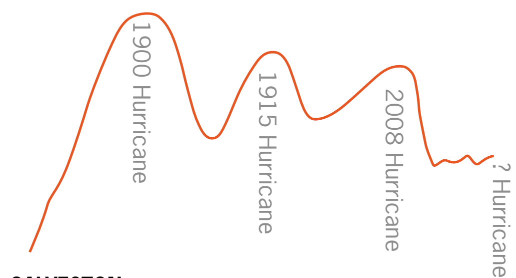
Overall Population Trends
Diagram by Sara Hieb.



INDIANOLA - 100 miles south of Galveston
At one time was Galveston's biggest port competitor in the gulf

1875 - Indianola is severely struck by a hurricane. The town is rebuilt, but the major underpinnings of the economy become stagnant.

1886 - Indianola is struck again by a hurricane, this time completely devastating the economy as discouraged investors moved 10 miles north to Lavaca. They moved the train tracks to Lavaca and now most of Indianola is underwater.



GALVESTON

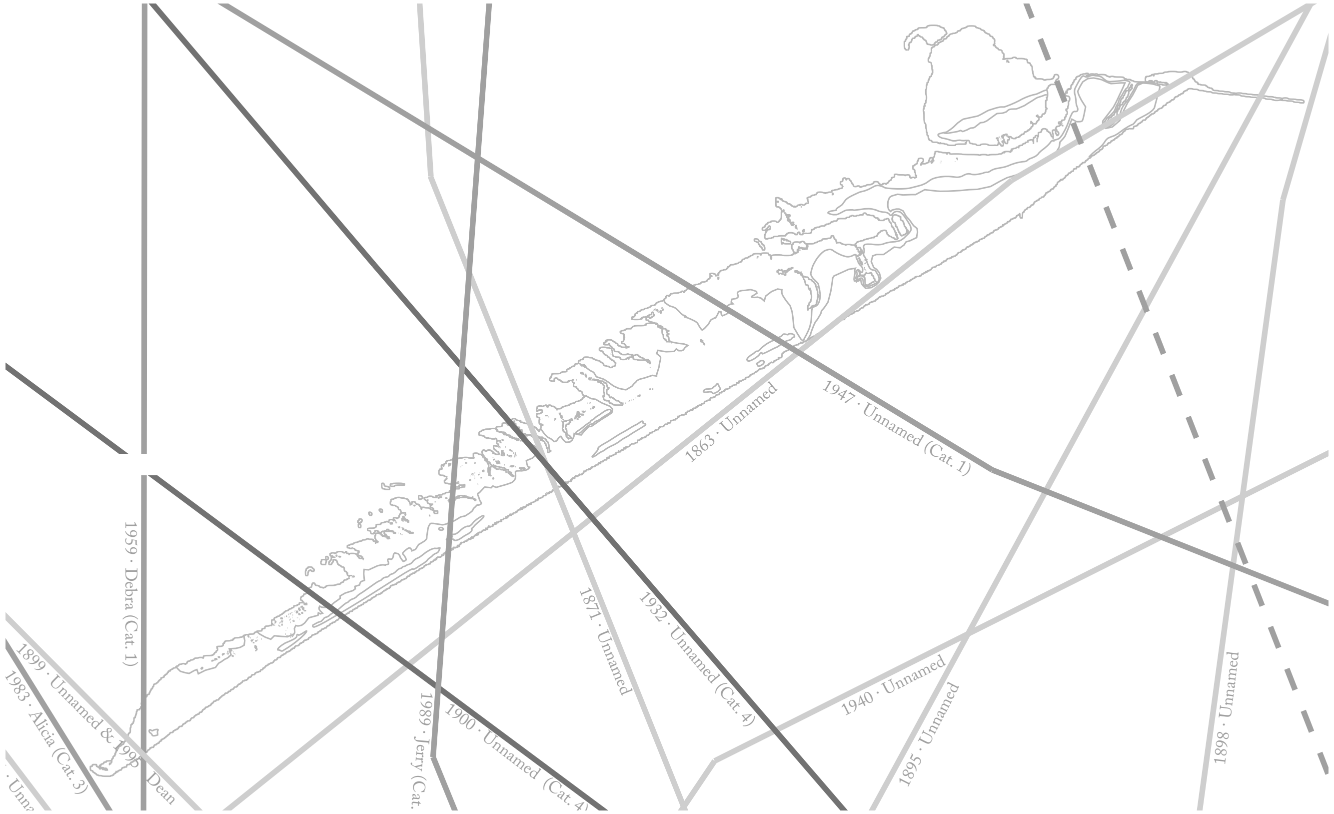
1900 - Galveston is struck by a hurricane that marks the worst natural disaster in North American history. At the time Galveston was the largest city in Texas and had the highest per capita income in the state, and often called the "Wall Street of the South." Over 6,000 people died from the event. An estimate based on inflation prices predicts the total storm damage costs was around 99.4 billion dollars.

1915 - Galveston is struck by another hurricane. After the hurricane of 1900 Galveston rebuilt and was once again the largest city in Texas and the second largest port. However, the Houston Ship Channel was created, and Houston soon took over as the major port city. A 10 mile long and 17 foot high seawall was constructed to protect the city from future hurricane damage. The 1915 hurricane was the seawalls first real test. Most of the buildings not protected by the sea wall were destroyed. An estimate based on inflation prices predicts the total storm damage costs to be about 68 billion dollars.

2008 - Hurricane Ike strikes Galveston just as its economy was slowly beginning to recover. An inital estimate based on inflation prices predicts the total storm damage costs to be around 39 billion dollars.

? - Another Hurricane in Galveston's future under current developmental strategies could be catastrophic.

Historical Impacts of Storms, a Comparative Example.
Diagram by Sara Hieb.



Sample of paths of tropical storms and hurricanes affecting Galveston Island, 1863-1995
Diagram compiled and redrawn by Benson Gillespie, John McWilliams.

Not Shown:			
1527 - ?	1915 - H4	1943 - H2	1974 - H3
1766 - ?	1916 - H3	1945 - >H2	1977 - H4
1818 - ?	1918 - H3	1949 - H2	1978 - TS
1837 - ?	1919 - H4	1957 - H4	1979 - TS
1839 - ?	1921 - H2	1958 - TS	1979 - TS
1842 - ? (1 TS, 1 H)	1931 - H1	1960 - TS	1980 - H3
1854 - ?	1933 - H2	1961 - H4	1980 - TS
1875 - ?	1934 - H2	1963 - H1	1983 - H3
1886 - H5?	1936 - H1	1964 - TS	
1908 - ?	1938 - TS	1967 - H3	
1909 - H3	1940 - H2	1968 - TS	
1909 - H2	1941 - TS	1970 - H3	
1910 - H2	1941 - H3	1970 - TS	
1912 - H1	1942 - H1	1971 - H1	
	1942 - H3	1973 - TS	



Photos of Galveston after the 1900 storm

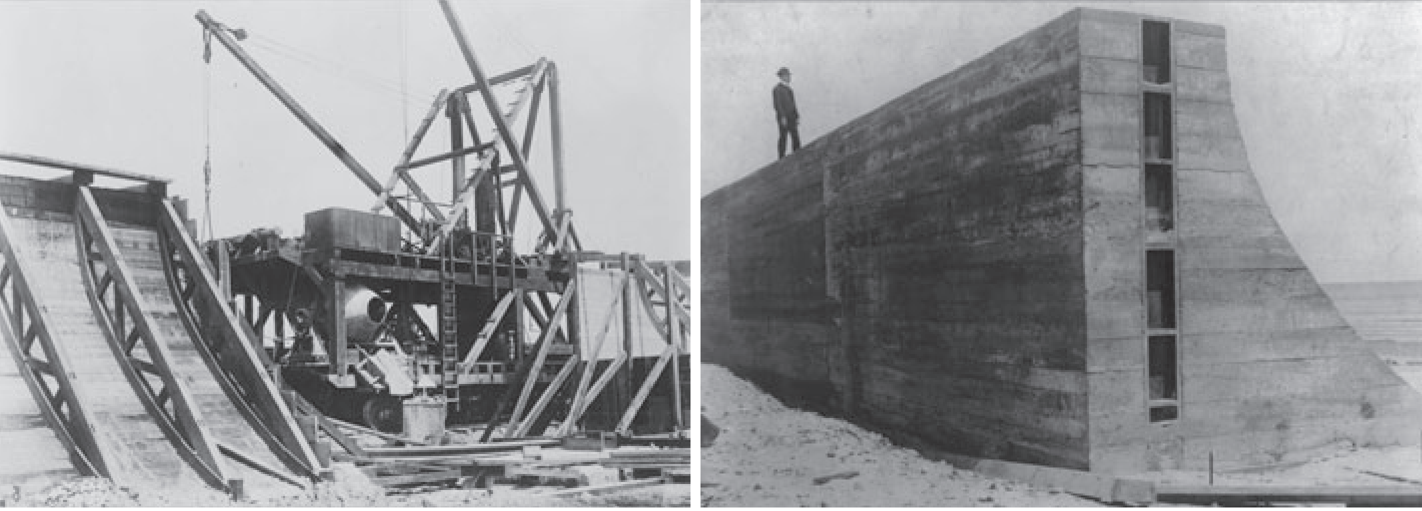
Hurricane Ike from International Space Station, September 10, 2008. NASA

Stormy Weathers

Risk from hurricane damage is a fact of life on the Gulf Coast and the history of the area is in many ways a record of such events and their effects on the communities, from the 1900 Storm that devastated Galveston and set the stage for Houston to usurp the island's economic prominence, to Hurricane Ike just over a hundred years later which once again devastated the city and left its future viability in jeopardy. Although as weather models have improved, the effect of each storm and the damage it may cause is inherently difficult to predict. Even relatively minor storms can cause devastation from wind or surface flooding due to rain fall (as seen in Houston during Tropical Storm Allison). Climate change as well as decadal weather cycles may cause greater variation in storm frequency and strength in this century than in the previous century of urbanization along the coastline.

Like most barrier islands, Galveston's geomorphology indicates several places on the western end where storms have washed over the island, breached or almost breached the land from sea to bay. Because these sites tend to be narrower and have lower elevations, they are even more susceptible to future storm effects. In undeveloped coasts, storms cause immediate damage but recovery often allows for even more robust and rich ecosystems in the long run. Storms are integral to the ecological condition and history of coastal regions.

Urban, infrastructure and architectural design can provide at least some of the resilience found in natural coastal ecologies. Higher density development with commensurable concrete and steel construction can be designed to more readily withstand storm effects. Rather than create expensive and massive fortifications to protect relatively small populations such as found on the West End of the Island, investment should be made in the East End, where the Seawall already exists and where risk mitigation strategies could also enhance urban and economic potentials while reducing the environmental impact of older structures. Because the risk of storm events cannot be eliminated, the reality of living on a dynamic coastline needs to be strategically engaged and integrated into everyday life and the design of the city.



Seawall under construction in 1905

Current condition of the seawall

Biotic Conditions to Seawall
While the postcard on the left suggests that the technological edge is a site for fantastical projection, the reality is somewhat more prosaic. With the loss of natural beach front along the seawall comes the loss of habitat for intertidal species and nesting species such as shorebirds and sea turtles. The hardened edge of the seawall forces these species to concentrate on the coastal edges of Galveston Island east and west of the seawall. These areas, however, are becoming compromised with continued development along the sensitive dunescapes and the mining of sand from the East end to replenish the beach in front of the seawall. Research and diagram by Rachel Dewane, Melissa McDonnell.

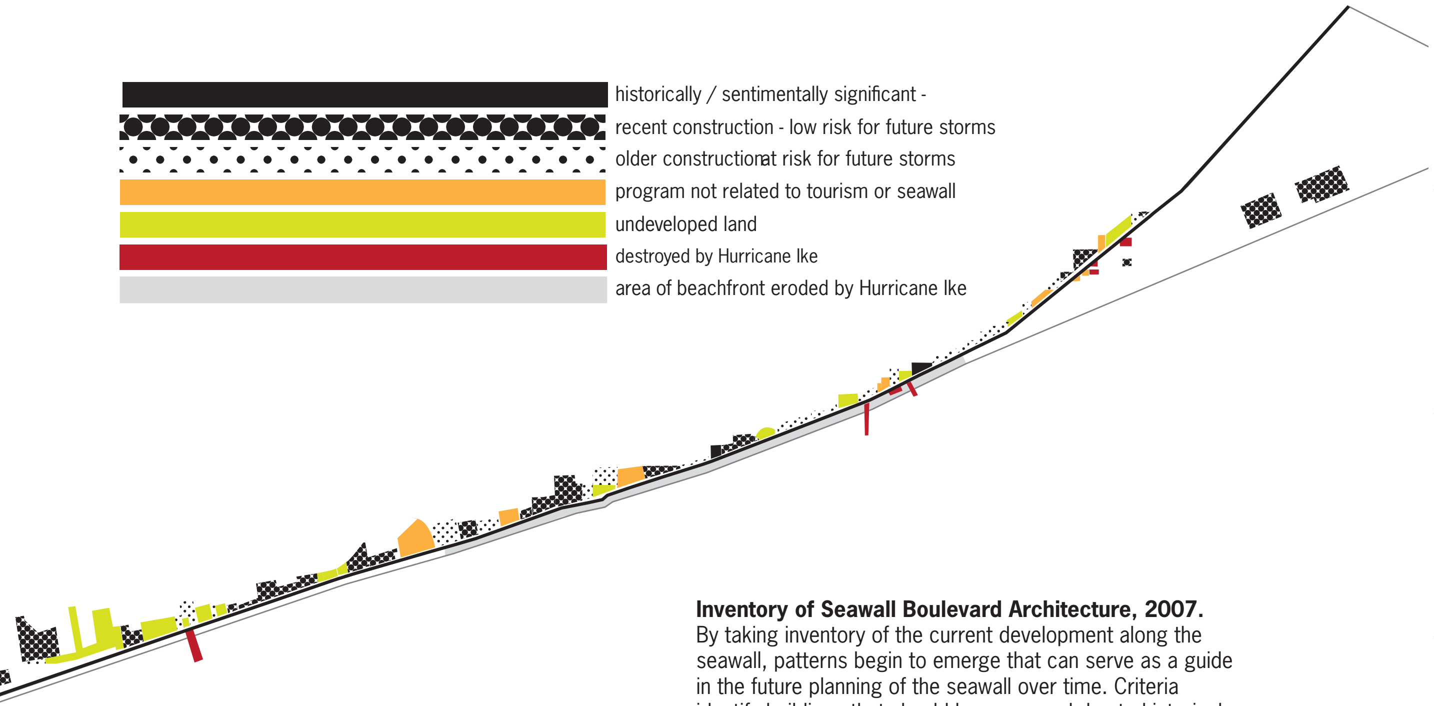
Control Structures

Constructed after the 1900 Storm, the 17 foot high Galveston Seawall epitomizes modern attempts to arrest the dynamics of natural processes. The seawall is literally and conceptually a line in the sand that attempts to delineate natural forces (coastal ecology, storms, erosion) and human representations (tourism, landscape, branding, historicism). In a broader sense, the seawall is the most emblematic of the many infrastructures that alter coastal systems for human use, from jetties, dredging, harbors, to canals and pipelines.

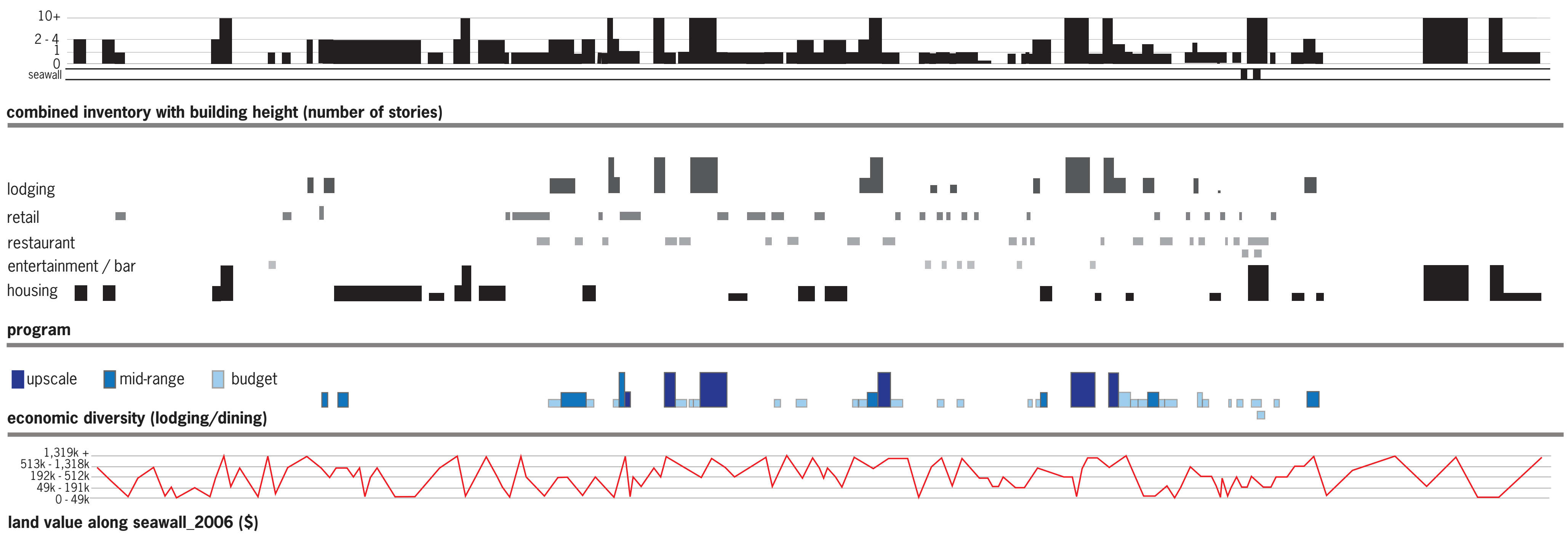
The protection afforded by the seawall has come at the cost of the quality of its waterfront, now Galveston's key economic resource. Similarly, the high-speed road atop the seawall provides efficient traffic flow but further separates the city from the sea, contributing to relatively low land value such that big box stores and parking lots line the waterfront. Moreover, because the shoreline has nowhere to retreat, the beach must be artificially nourished on a regular basis, in part because the beach is a key economic and social amenity but also because it prevents the seawall's foundations from being undermined. Secondary control structures, such as groins, have been constructed to slow the rate of sand erosion. Nonetheless the seawall beach does not perform ecologically and is not sustainable. The seawall thus protects the city during brief storm events but is a detriment to everyday human and non-human use the vast majority of the time.

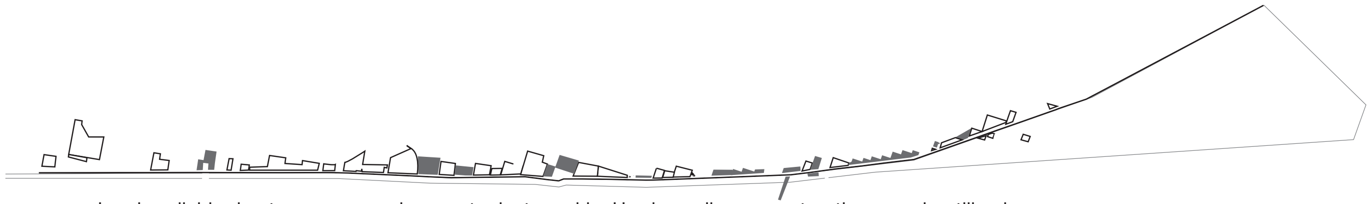
Moreover, as seen with the levees in New Orleans during Hurricane Katrina, when such infrastructures fail the effects are typically catastrophic. Private seawalls and other smaller structures such as geotubes are futile efforts to arrest shoreline retreat and protect private land. While many of these fail immediately others slow erosion at the site of intervention only to accelerate neighboring land loss. Because these structures operate within an extremely dynamic and interdependent environment, smaller structures at best shift forces to another site while massive structures like the seawall and jetties often tip delicate balances and arrest beneficial processes, often accelerating wetland loss, beach and dune erosion and damaging other natural edges that offer significant buffers against storm forces. Nowhere is this more apparent than farther east along the Gulf Coast, where extremely rapid erosion at the mouth of the Mississippi is occuring mainly from anthropgenic factors, including the infrastructure designed to control the river flow. Is this a paradigm of control we want to continue?

Currently, subsidence and rising sea levels are shortening the seawall's projected lifespan. The last easily accessible sand has been used to replenish the beach front after Hurricane Ike, making future nourishments far more expensive and difficult. The city's future is now poised on rethinking the future of this edge and whether it will double-down on top-down mechanisms of control. After Hurricane Ike, proposals have been put forward to construct even more massive dikes, levees and seawalls. Such structures require massive initial capital outlay, ecological destruction and immense ongoing maintenance costs while doing little to address the larger interdependencies of economic and environmental vitality in the area. Such resources could be better spent seeking alternative strategies integrated into the urban and ecological qualities of the area.

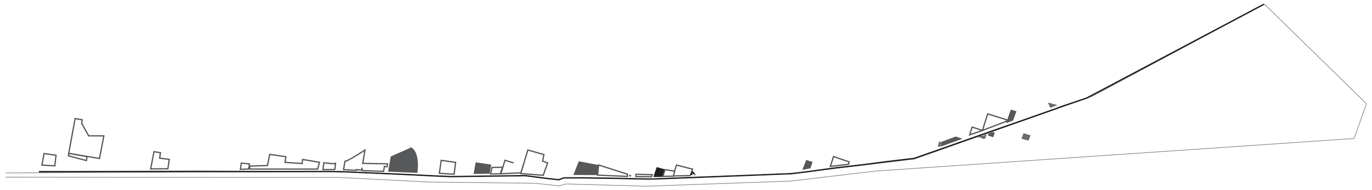


Inventory of Seawall Boulevard Architecture, 2007.
By taking inventory of the current development along the seawall, patterns begin to emerge that can serve as a guide in the future planning of the seawall over time. Criteria identify buildings that should be preserved due to historical or sentimental value opposed to buildings of provisional material or program. These short-term architectures, along with already vacant land, become opportunities for the City of Galveston to begin establishing a strategy for the future of the great seawall. Diagram and research by Rachel Dewane, Melissa McDonnell.

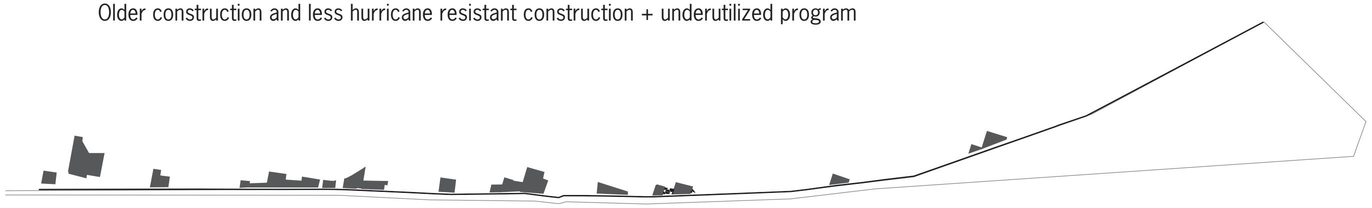




Land available due to vacancy and property destroyed by Hurricane Ike + construction + underutilized program



Older construction and less hurricane resistant construction + underutilized program

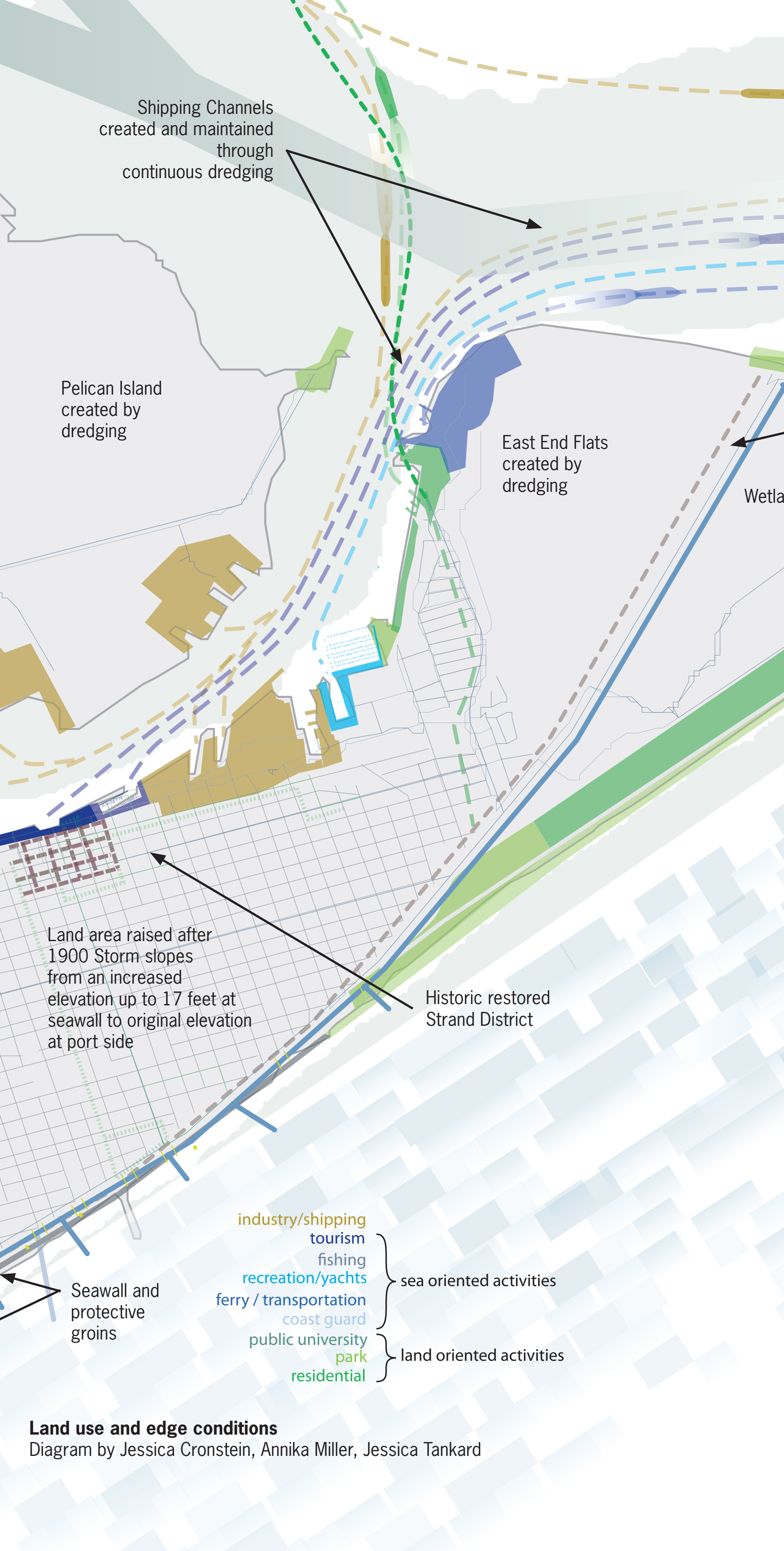


The removal of buildings whose programs underutilize the site of the seawall

Seawall Over Time
In an attempt to begin to charge the Seawall Boulevard with potential, this diagram examines the degree to which the seafront could be transformed in the coming decades based on criteria established in the inventory on the left and the diagram below. Diagram and research by Rachel Dewane, Melissa McDonnell.

Property Diversity Along Seawall
Mapping property type, economic and land value along the seawall exhibits a heterogeneous pattern. Although there is great diversity, there is very little differentiation when mapped along the entirety of the seawall. Diagram and research by Rachel Dewane, Melissa McDonnell.

Raising the elevation of Galveston



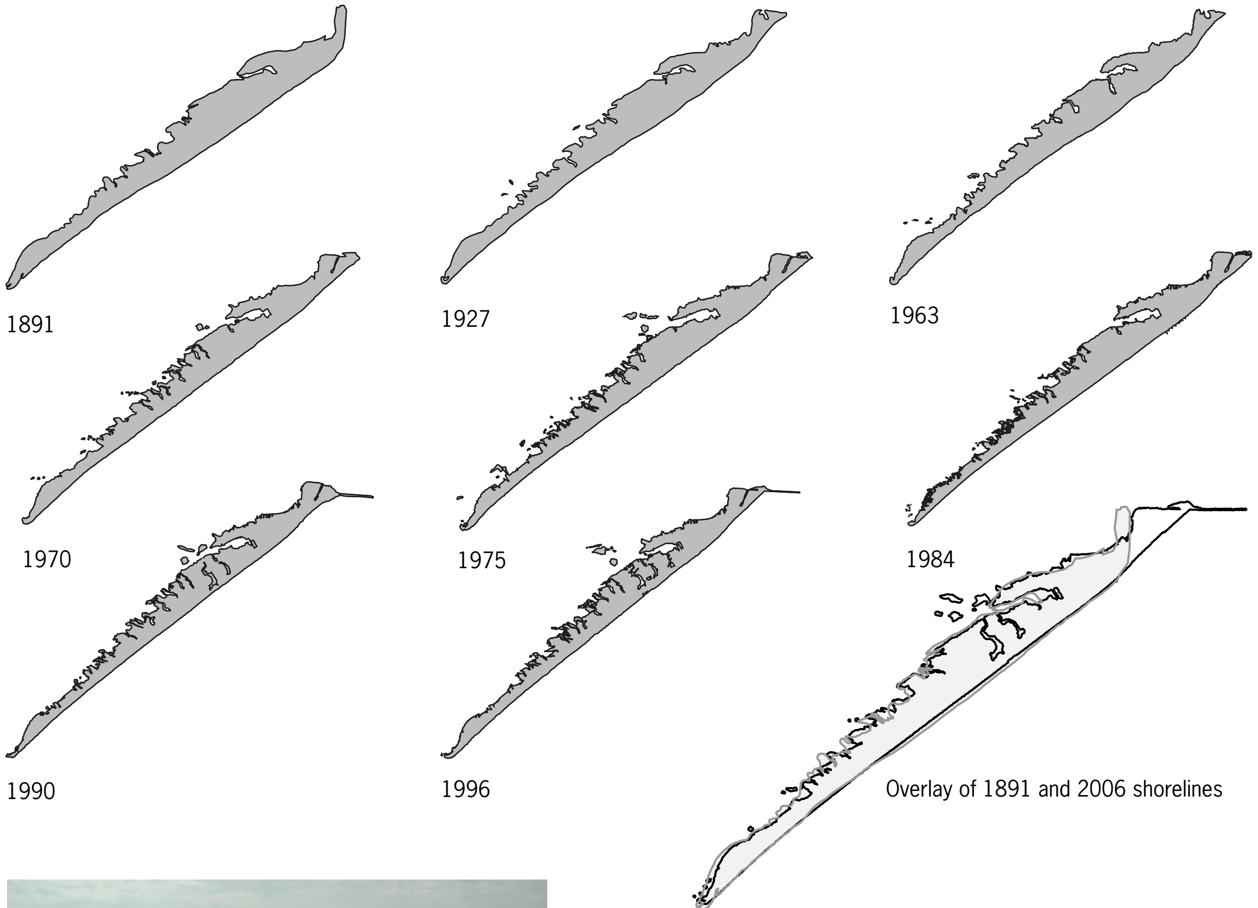
Land use and edge conditions
Diagram by Jessica Cronstein, Annika Miller, Jessica Tankard

Constructed Territories

The eastern end of Galveston has steadily been transformed from a natural barrier island into a hybrid of infrastructure, urbanism and landscape. This process began in the 19th century, when Galveston was one of the most significant ports in North America. Bay edges were hardened, quays excavated and shipping channels dredged. After the 1900 Storm that virtually erased the city, leaving a "tabula rasa," the city recreated itself through stunning technological exuberance. Not only did the seawall create another hard edge on the seaside, much of the land behind it was elevated. Buildings were raised to a new grade level or their lower floors were covered in a dredged slurry carried by boats in specially constructed canals to the center of town and pumped onto land. New roads and infrastructure followed that further hardened the east end. Jetties built to protect the Houston Ship Channel define the island's eastern tip. The largest extends over a mile into the Gulf and caused the destruction of an old tidal delta, leading to sand accumulation on this part of the island and creating the broad beach and the wetland habitats that now stand in front of the seawall, which as a result bisects the eastern tip. The East End Flats area behind the seawall and Pelican Island on the other side of Galveston's Port were both substantially created as dredge dumping sites. A century before the Palm Resort inlands in Dubai were constructed, the eastern end of Galveston became a technological terrain, a palimpsest of interventions that speak to a paradoxical desire for stability through total transformation. The nostalgic and touristic image of the restored Victorian historical town center belies the radical modernity that re-created it in the 20th century.

Pipes used for pumping dredge material from a dredge boat on a canal constructed for the massive project of raising grade level after the 1900 storm.

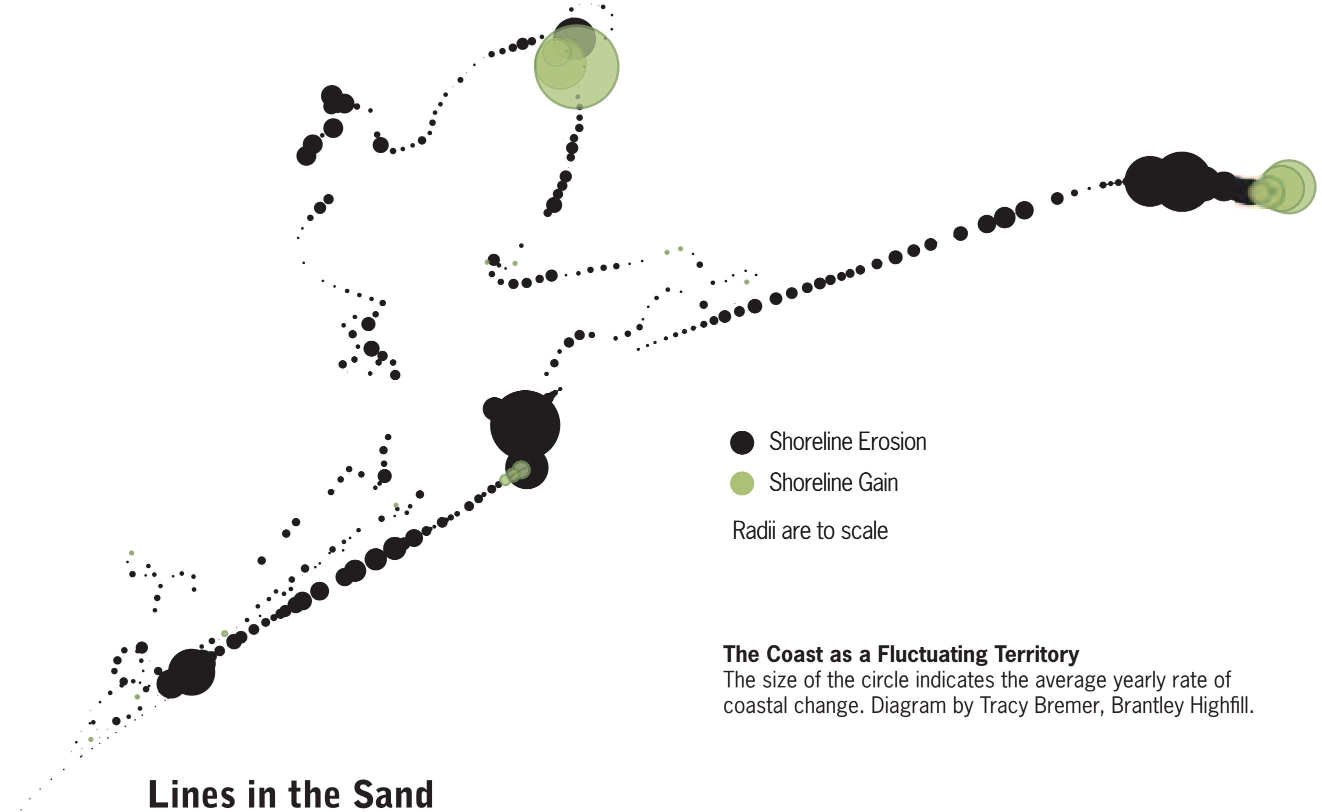
Postcard depicting a fantastical vision of a rebuilt Galveston



Above: Shoreline Change 1891-2006
Diagram by Jinge Chai, Genevieve Rudat

Left: Indexing Change
The end of the seawall, pictured on the top left, demonstrates the retreat of the shoreline in the half-century or so since this part of the structure was constructed. At the time of construction, the western beach was several hundred feet in front of the seawall (to the left of the wall in this photo). This marked the end of Seawall Boulevard and was once extended as a road to the West End. Due to steady shoreline retreat, today this end of line stands well on the ocean side of the breakers with the road moved to the middle of the island. The broken pavement in this photo was collapsed by Hurricane Ike's storm surge as it reached around the end of the seawall and eroded land behind.

The bottom photo indicates the shoreline loss caused by Hurricane Ike. The dune vegetation line was in front of the house before the storm. The fire hydrant and drainage access, now on the beach, indicate the amount of elevation lost. The dune vegetation has yet to re-establish at the time of this photograph, creating an uncertain zone between private land and public beach.



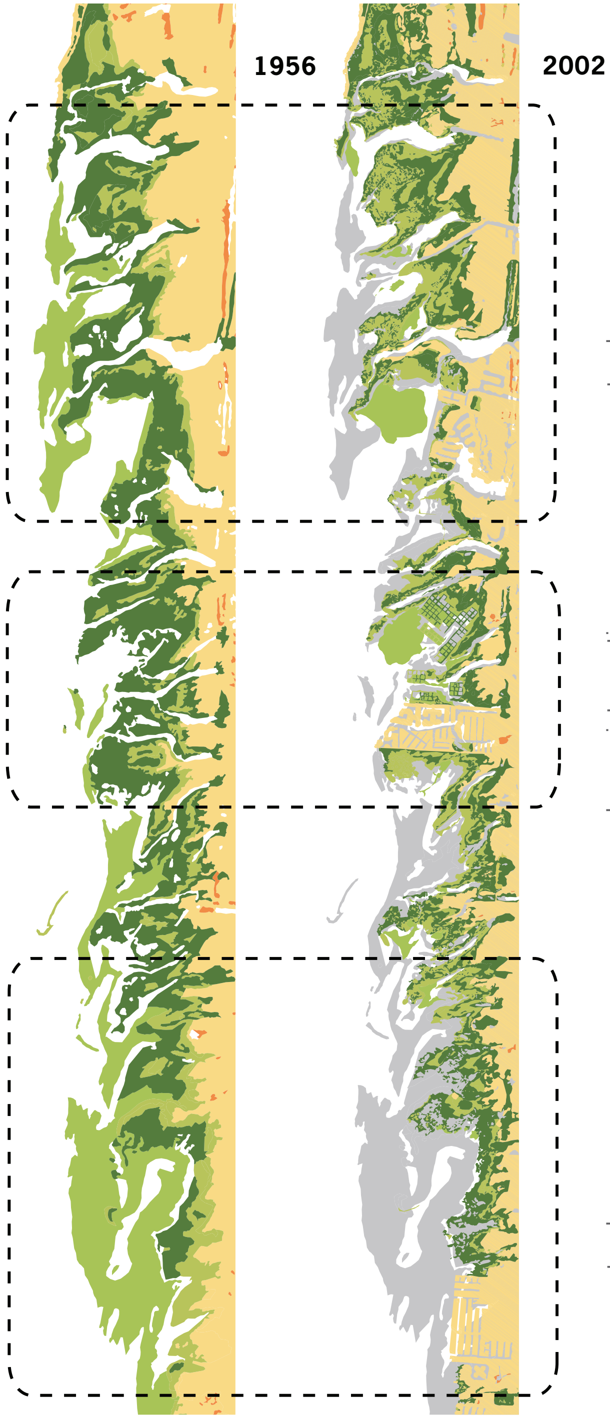
The Coast as a Fluctuating Territory
The size of the circle indicates the average yearly rate of coastal change. Diagram by Tracy Bremer, Brantley Highfill.

Lines in the Sand

Barrier islands are extremely dynamic, migrating over decades, disappearing and reappearing over millennia. Their shorelines are not fixed lines but zones in continual flux. However, anthropogenic factors and structures can vastly alter the "natural" waxing and waning of shorelines even as we attempt to fix the coastlines in stone, literally in the case of seawalls. Therefore, coastal migration is not simply a natural occurrence but also a political, economic and social phenomena.

The center of Galveston island has characteristic ridges and swales that were once beaches and dunes; many have become inland freshwater wetlands as the shoreline advanced seaward. These corrugations provide significant protection during storms, though they are often lowered or erased by standard development patterns that require regrading the ground. However Galveston's beaches have been retreating for over a thousand years and will likely continue to do so. Because the Texas Open Beaches Act defines all land sea-side of dune vegetation as public land that must be accessible, a retreating coastline slowly transforms private property into public space, requiring owners to remove any structures at their own cost. Where such a line is drawn is often contested and private landowners often attempt to fortify their property or create artificial dunes. Such measures are futile but do have unintended impacts. Shoreline structures disrupt the beach and dune system, causing erosion. Jetties may capture some sand or partially protect the immediate coast but can deprive downstream areas from this same sediment, creating even greater economic, political and ecological concerns.

The rigid geometries of conventional planning do not easily accommodate fluctuating territories. Proposed set-backs that could accommodate shoreline retreat on the time scale of a mortgage are sensible policy but politically charged as they reduce the highest land values in any coastal city. Elevating buildings on stilts does not mitigate shoreline retreat and usually produces a banal landscape. Low density private resort development on the western end provides tax revenue for the city but produces the greatest environmental impact in the most risk prone area for the minimum amount of owners while those living inland effectively subsidize insurance and disaster costs. Alternative concepts are required for robust ecological urban realms.



natural occurrence

Losses in wetlands between 1956 - 2002 were caused primarily by subsidence which replaced marshes and tidal flats with open water.

Development and cattle trails also contribute to marsh loss on Galveston Island. Restoration projects are being used in an effort to counteract some of the losses.

human intervention

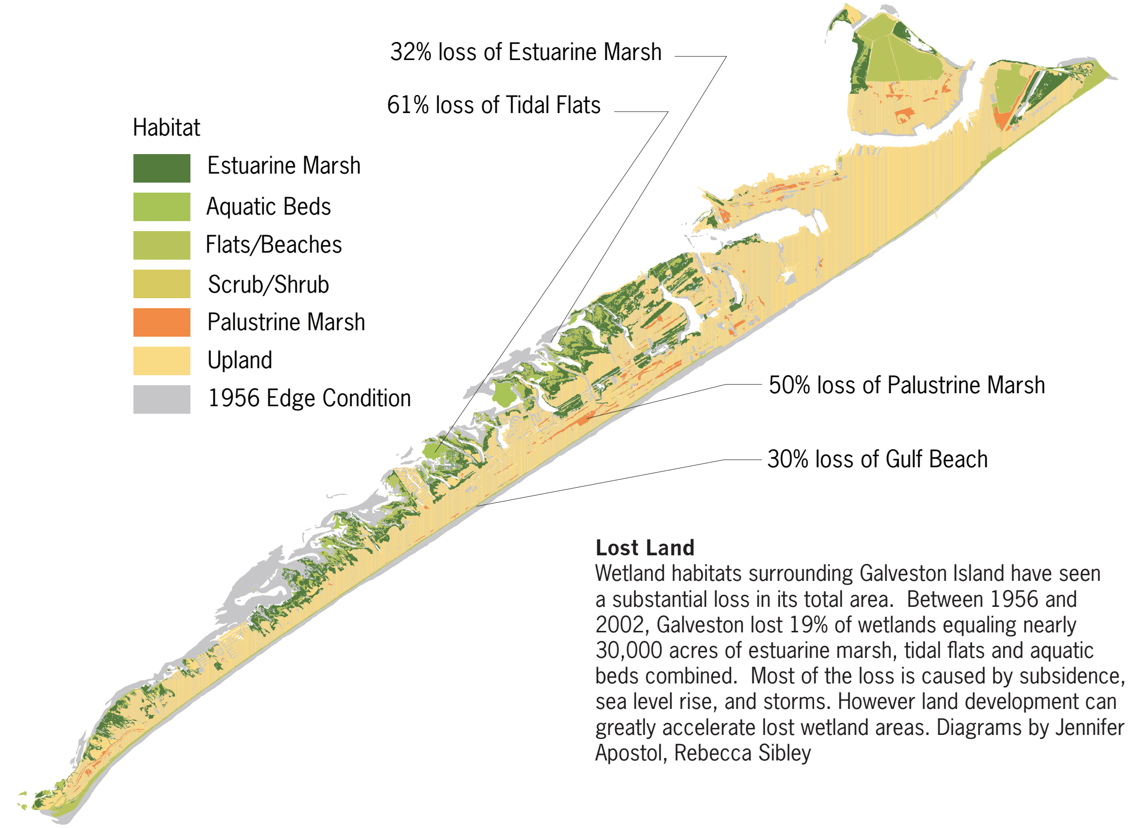
The development of Jamaica Beach in the 1960s created a new bayside development, well protected from flooding, but causing wetlands to deteriorate over time.

Wetland restoration projects have been used to mitigate and even reverse these losses.

natural occurrence

Natural disasters such as hurricanes expedite the already increased erosion rates on the west side of Galveston Island.

Hurricanes and tropical storms are major contributors to the more than 30,000 acres of lost wetlands between 1956 and 2002.

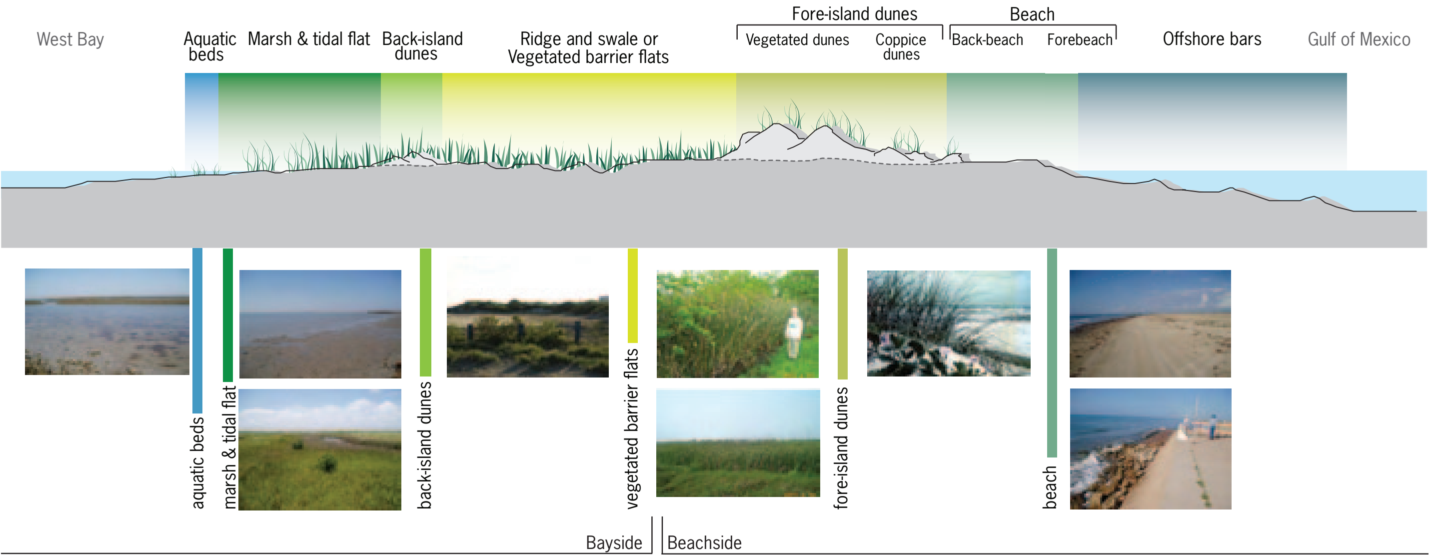


Lost Land
Wetland habitats surrounding Galveston Island have seen a substantial loss in its total area. Between 1956 and 2002, Galveston lost 19% of wetlands equaling nearly 30,000 acres of estuarine marsh, tidal flats and aquatic beds combined. Most of the loss is caused by subsidence, sea level rise, and storms. However land development can greatly accelerate lost wetland areas. Diagrams by Jennifer Apostol, Rebecca Sibley

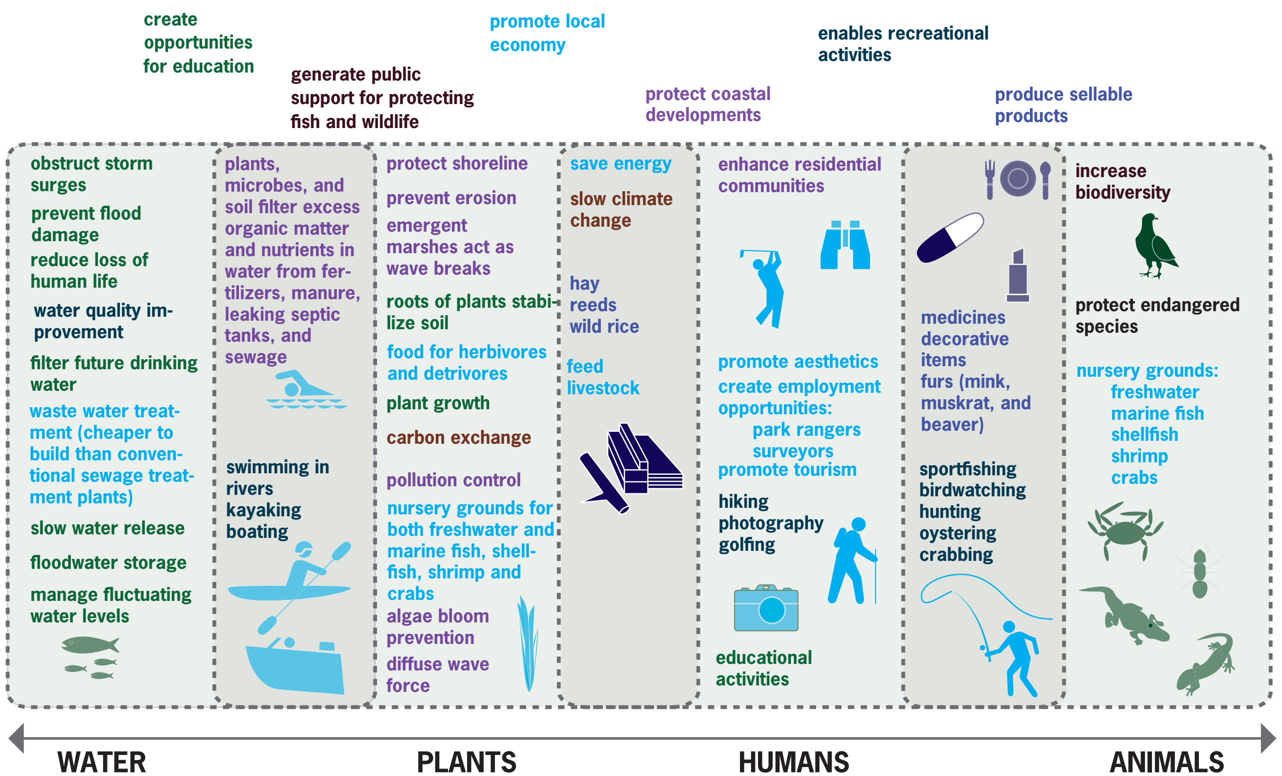
Valuing Wetlands

Just as the beach is eroding, the bayside coast is rapidly retreating, causing acute loss of marsh and wetlands. This loss is in part due to “natural” or at least global factors, such as sea level rise, but is often accelerated by development. Like the beach, the edge of a wetland is not a defined boundary but a fuzzy and dynamic zone while real-estate is defined via geometric logics of platting and the bounded delineations of infrastructure. Once a legal boundary is defined, the tendency is to defend it with bulkheads, mowing and other means regardless of the shifting landscape. But if there is not area for the wetlands to recede the edge simply erodes, in turn hastening the retreat process. Inland wetlands can become isolated from each other due to surrounding development, reducing their ecological performance and exacerbating surface flooding issues. Ironically, real-estate next to wetlands is relatively valuable both due to privacy and natural beauty they afford. Wetlands also provide an important buffer during storms, dissipating wave energy along the coast and providing a sponge for rainwater inlands.

The tension between real-estate value and ecological value can be reversed. Though wetlands are protected, they are understood as having relatively low economic value. However, if one includes the full benefits of wetlands to the economy of the region, such as mitigating storm damage, providing habitat for fish, filtering pollutants, one begins to understand them as precious economic as well as ecological resources. The establishment of wetland banking trusts could allow the marshes to operate as economically viable preserves that offset tax revenue provided by traditional resort development while producing sustainable long-term ecological and economic benefits to the city and entire region. New wetlands could be created on the water’s edge, replenishing habitats while providing a useful buffer for storms and shoreline retreat. Development patterns could then be modified, leaving such areas for sensitive recreational and natural use. Innovations in building and resort typologies could concentrate development as high-density clusters set back from natural wetlands or concentrated in the already urbanized and constructed eastern end of the island.

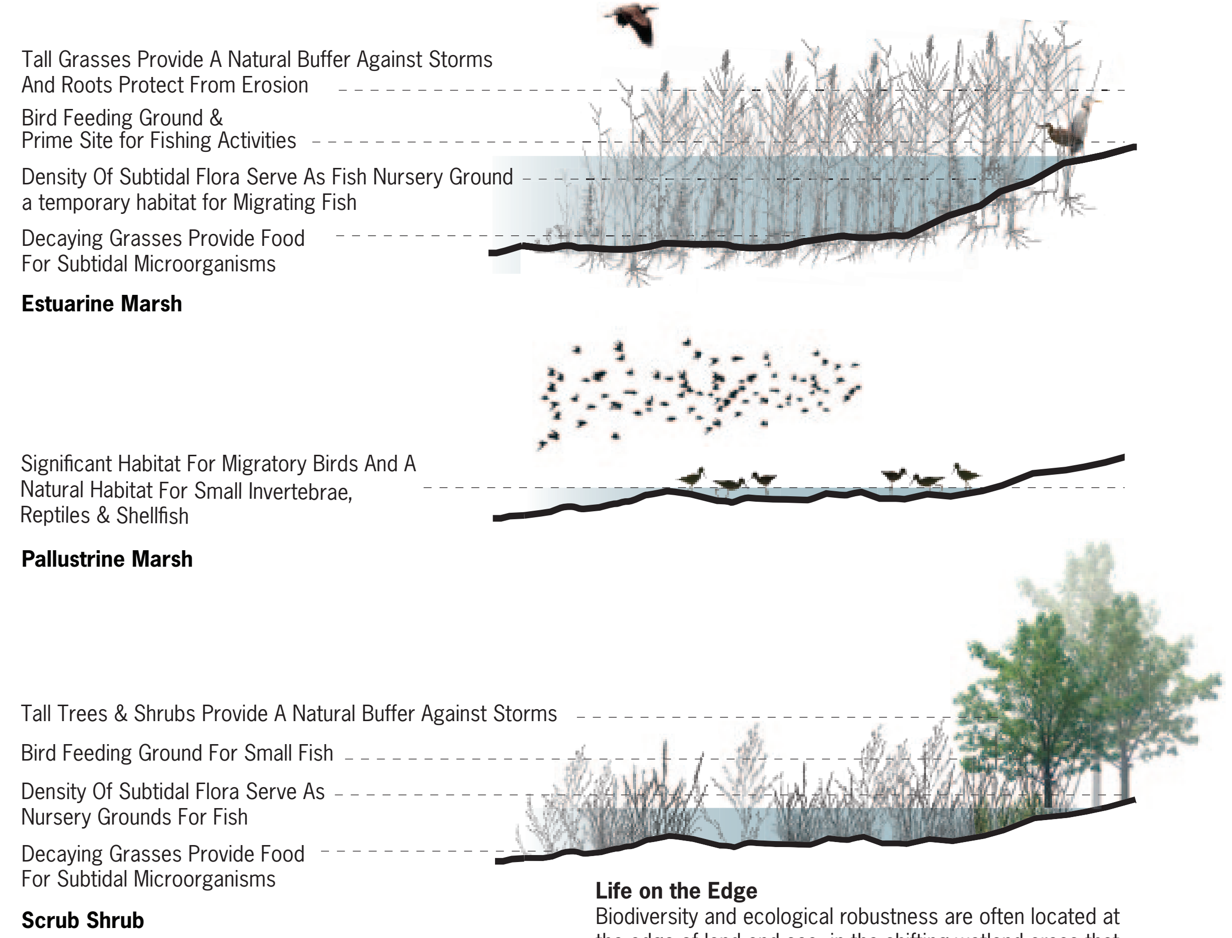


Typical Sectional Geomorphology of a Barrier Island
Diagram by Jennifer Apostol, Rebecca Sibley

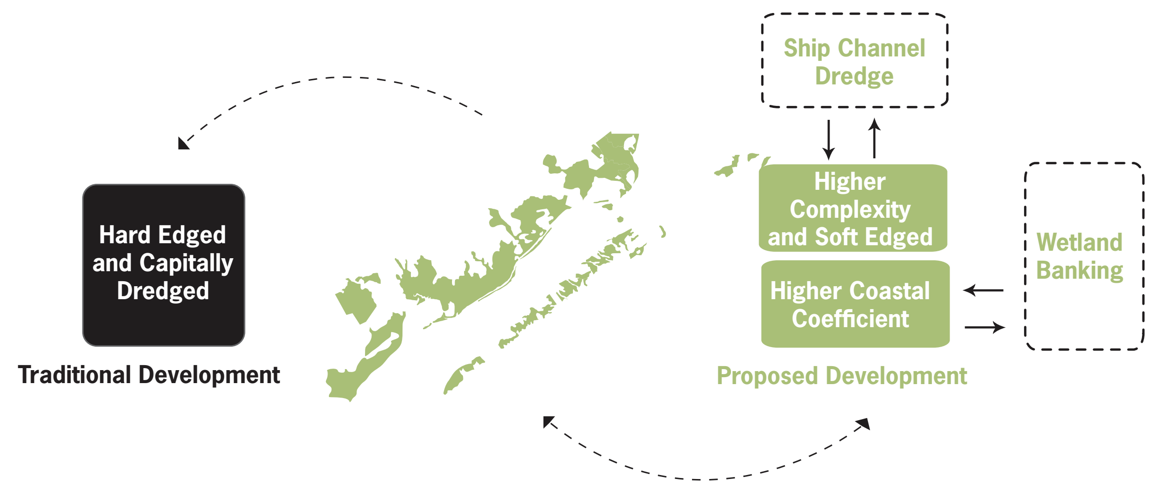


Economical, Ecological and Cultural Benefits of Wetland Areas
Diagram by Jessica Cronstein, Annika Miller, Jessica Tankard

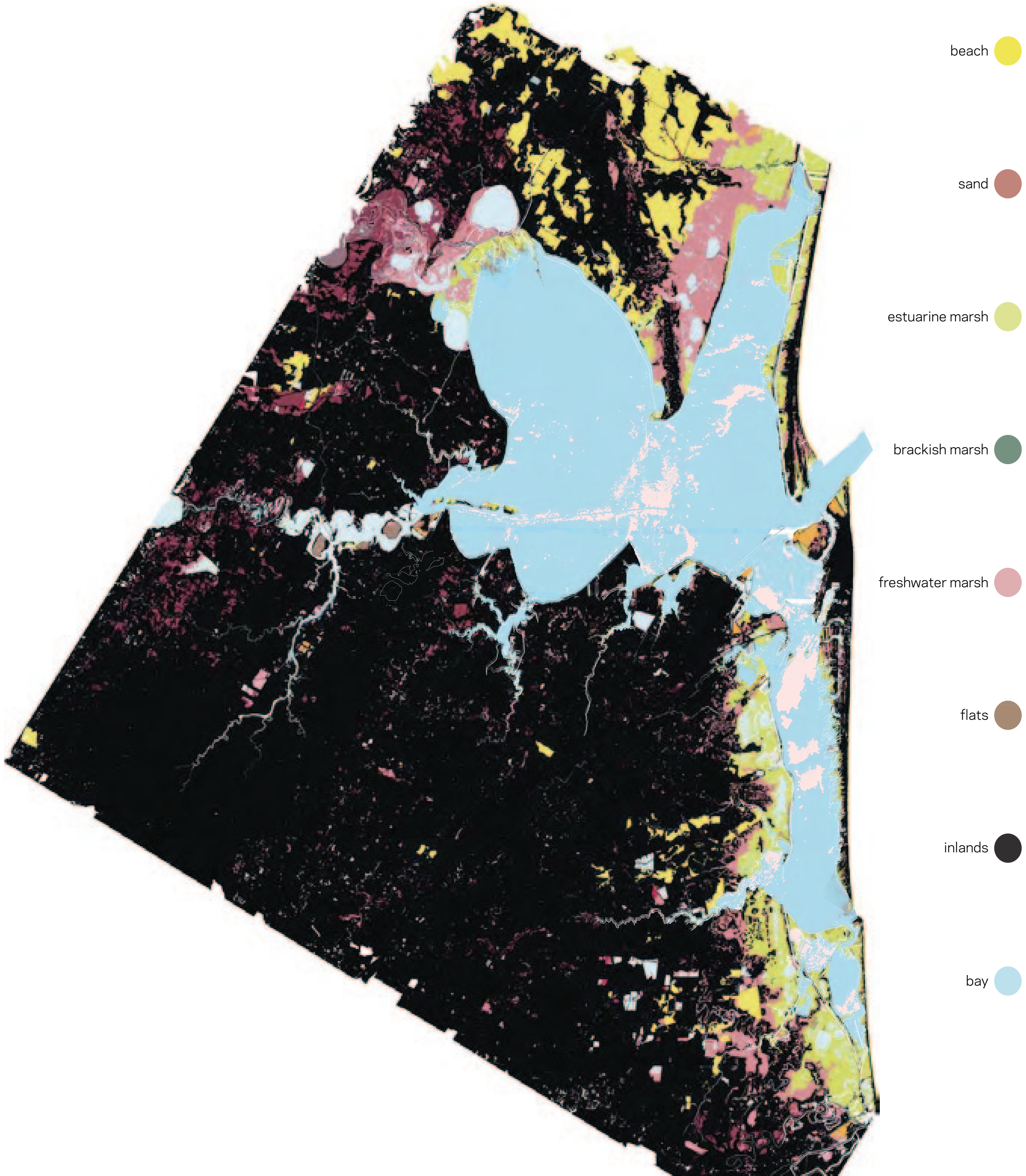
Source: US EPA, "Functions and Values of Wetlands," "Economic Benefits of Wetlands," "Wetlands: Protecting Life and Property from Flooding."



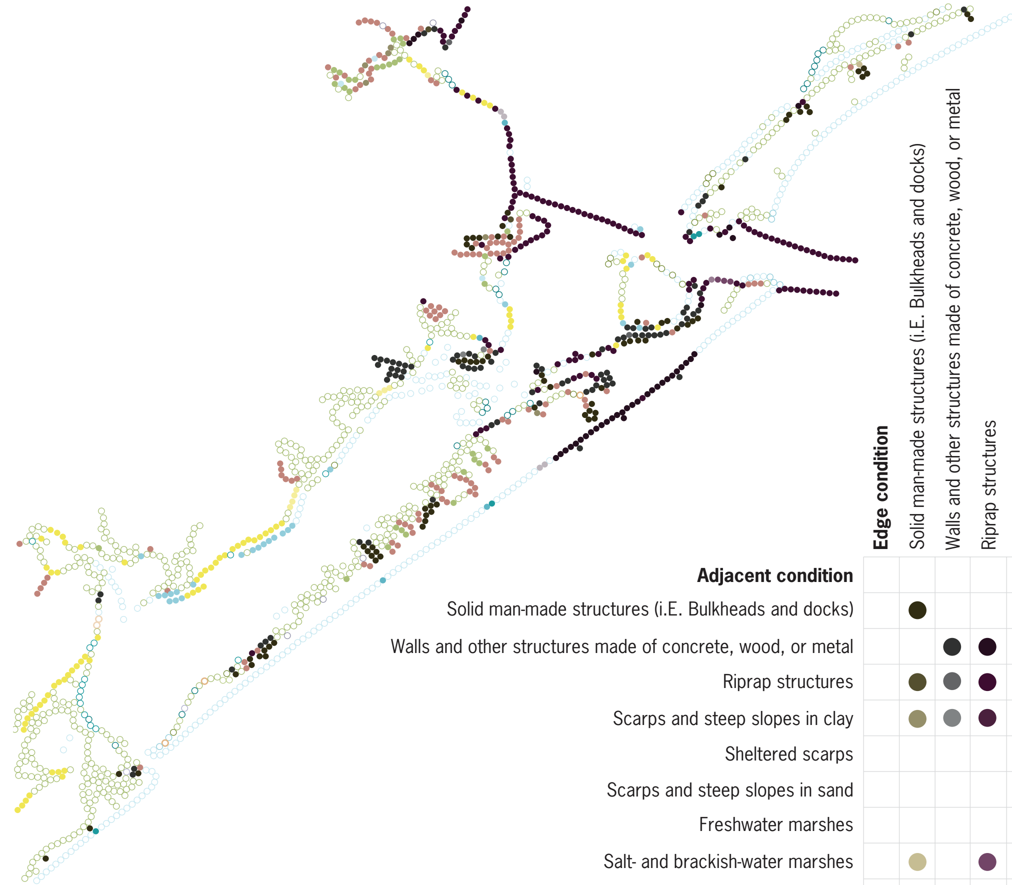
Life on the Edge
Biodiversity and ecological robustness are often located at the edge of land and sea, in the shifting wetland areas that typical development attempts to fix, usually to the detriment of these systems. Diagram by Jennifer Apostol, Rebecca Sibley



Wetland Banking Trust as an alternative development strategy
Diagrams by Tracy Bremer, Brantley Highfill



Biotopes in the Houston-Galveston Coast
Note that in this map, north is oriented to the left. Information from GIS and redrawn by Edward Baer, Marti Gottsch.



Adjacent condition \ Edge condition	Solid man-made structures (I.E. Bulkheads and docks)	Walls and other structures made of concrete, wood, or metal	Riprap structures	Scarps and steep slopes in clay	Sheltered scarps	Scarps and steep slopes in sand	Freshwater marshes	Salt- and brackish-water marshes	Tidal flats	Sand or Gavel Beaches
Solid man-made structures (I.E. Bulkheads and docks)	●									●
Walls and other structures made of concrete, wood, or metal		●	●							●
Riprap structures	●	●	●					●		●
Scarps and steep slopes in clay	●	●	●	●				●		●
Sheltered scarps					●		●	●	●	●
Scarps and steep slopes in sand						○		○		○
Freshwater marshes							○	○	○	
Salt- and brackish-water marshes	●		●	●		○		○	○	○
Tidal flats			●					○	○	○
Sand or gravel beaches		●	●	●				○	○	○

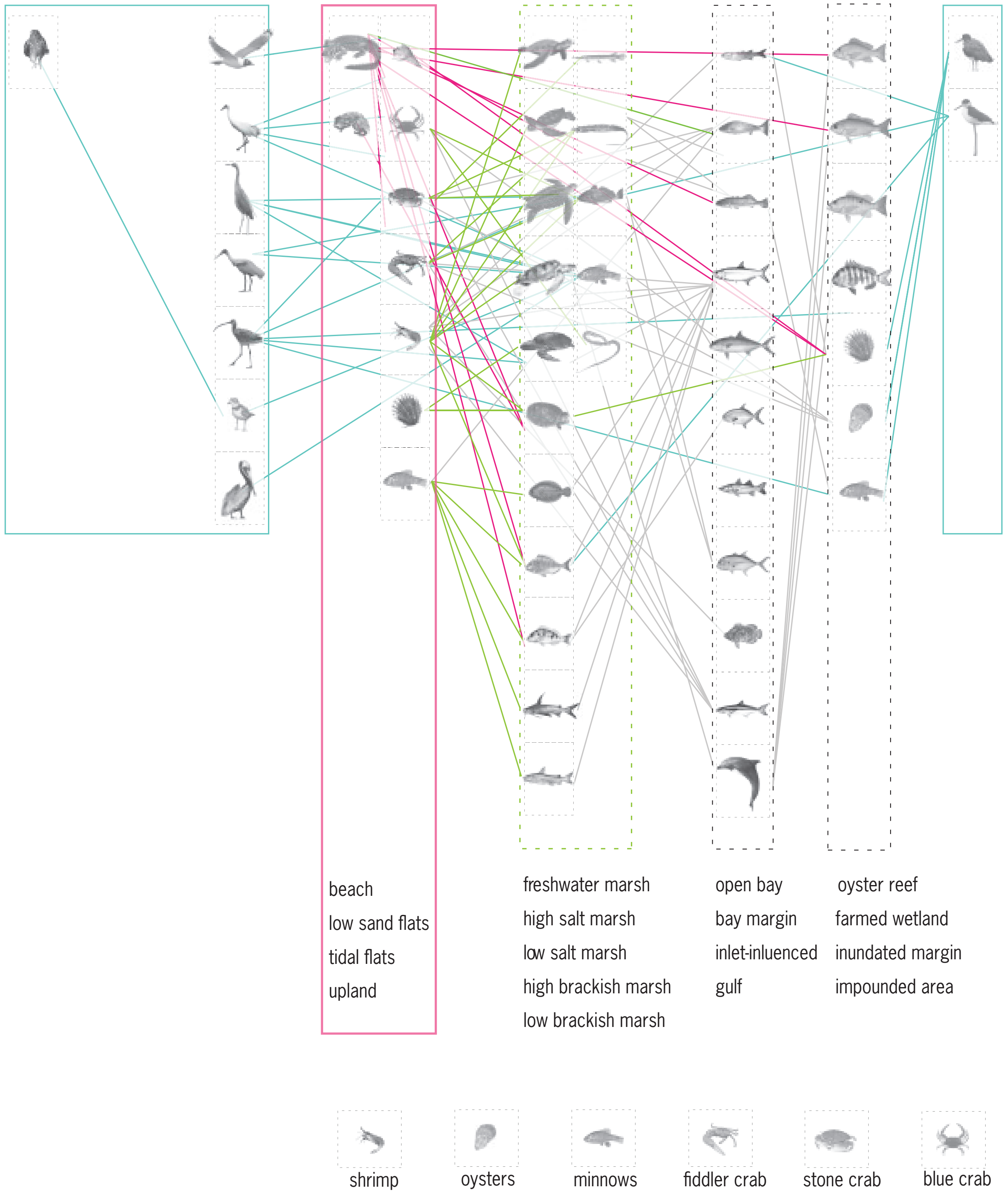
Habitats and coastal edge material conditions
Diagram by Tracy Bremer, Brantley Highfill

Habitats

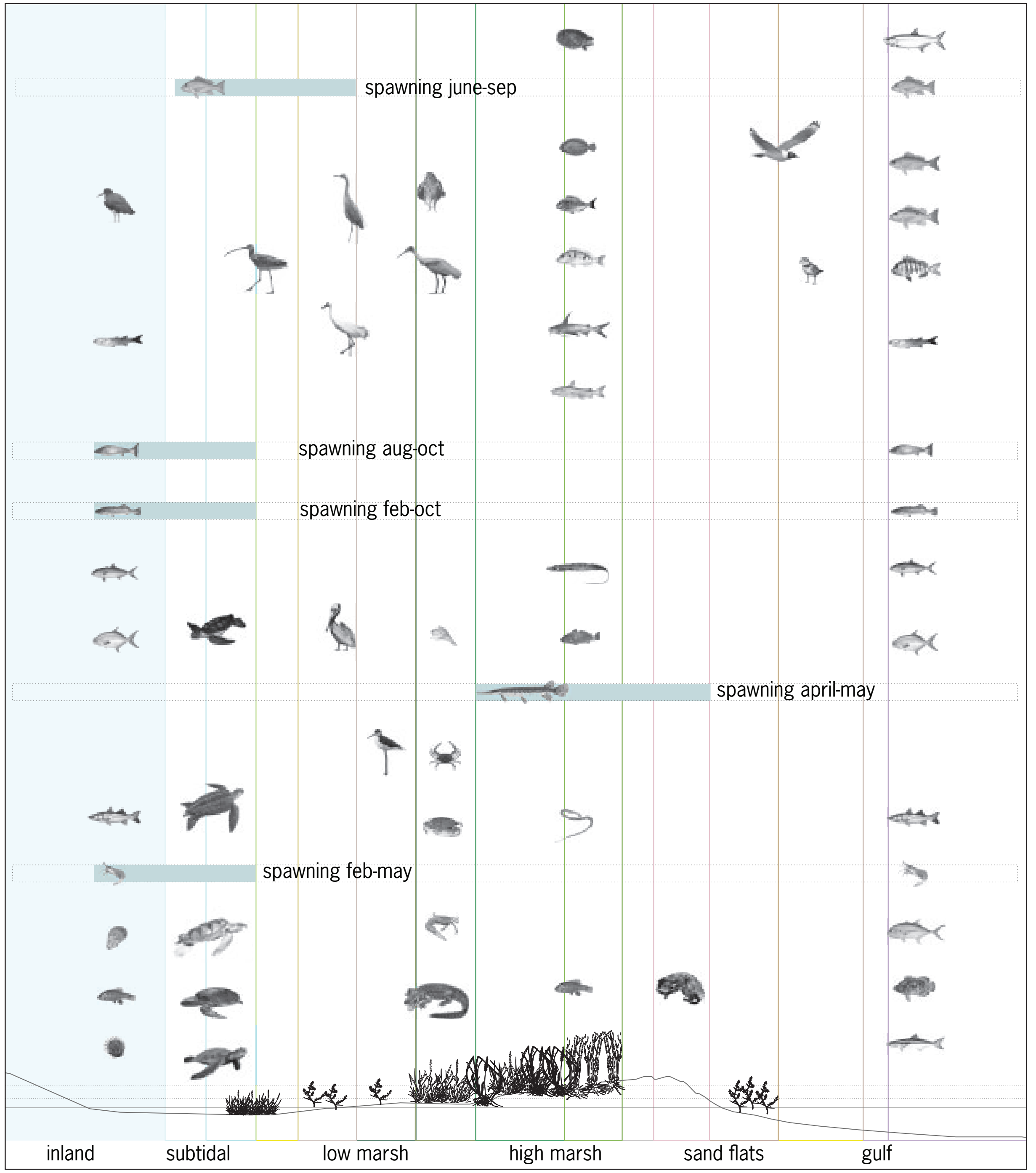
In addition to human populations, coastal systems provide rich biological habitats. The water's edge, marshes and in-land wetlands that naturally fluctuate are intense zones for biodiversity. Key species can often be relatively unnoticed or are not touristically or gastronomically valued, but they are integral to maintaining the overall ecology. An ecological matrix depends on the interrelation of different areas and zones into a complex web of habitats.

Common attempts to stabilize such areas in order to protect real-estate or infrastructure (for example with bulkheads, seawalls, or rip-rap) transform these dynamic zones into hardened edges. "Greenscapes", such as lawns, civic parks and golf courses, can have equivalent effects. Moreover, artificial fertilizers or surface contaminants can often harm sensitive wetland areas. Such delineation of territory can tip balances while destroying or fragmenting habitats both at the site of intervention and farther afield because any particular point along the coast is part of a complex network of relationships (an ecology).

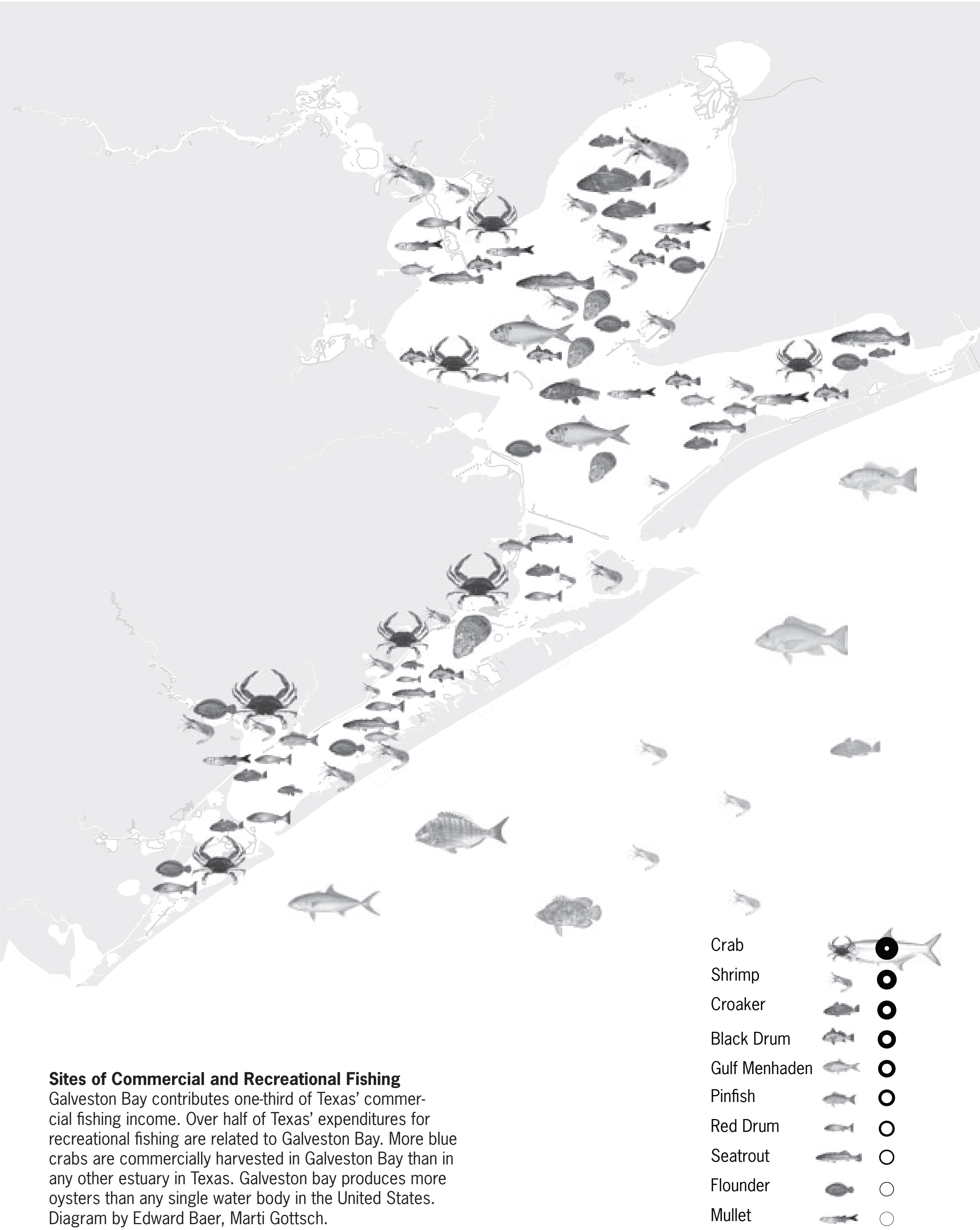
While human habitat (architecture, urbanism and landscape) is typically destructive of non-human habitat, it is not necessarily opposed to Nature. Instead, design and planning can enfold human occupation as an interface between cultural forms and natural processes. However, in order to not be considered a zero-sum game, where human occupation comes at the cost of other considerations, alternative models of "urbanism" need to be developed. Design can articulate an ecological relationship of human territories with animal environments, making legible that which often remains unnoticed, invisible, or simply exploited.



Predation Matrix
Though a complete mapping of the food web shows a very complex interdependence, a clear group operate as keystone species which are especially critical to the maintenance of the overall network. Diagram by Edward Baer, Marti Gottsch.

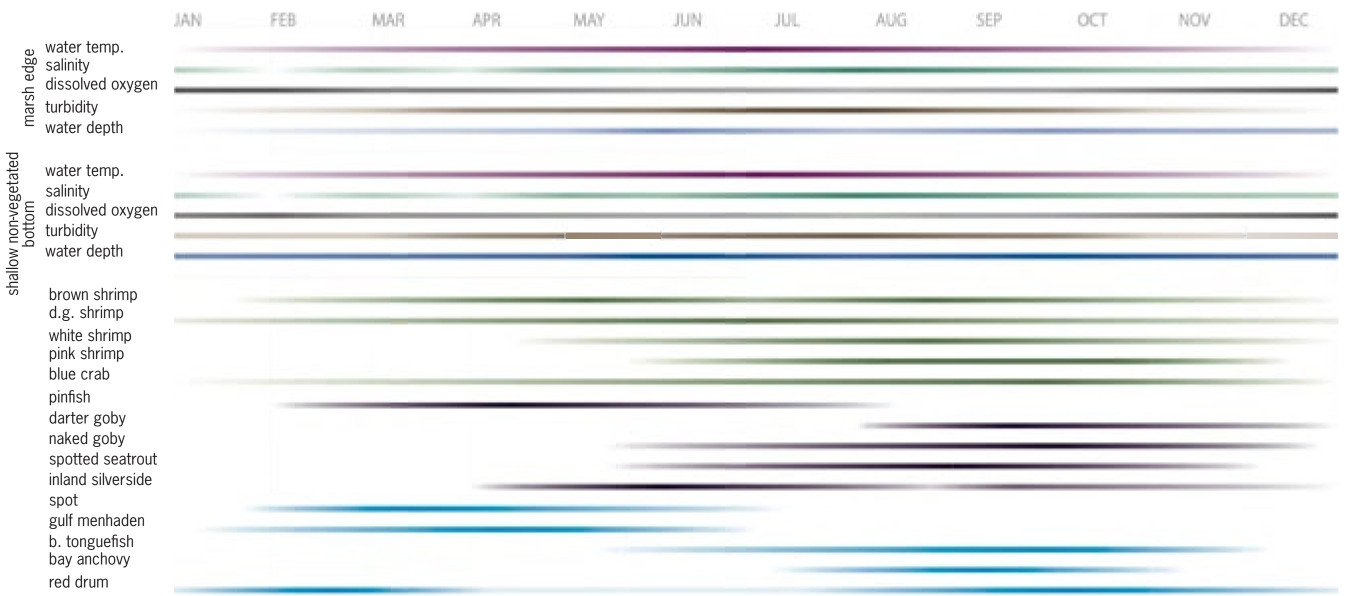


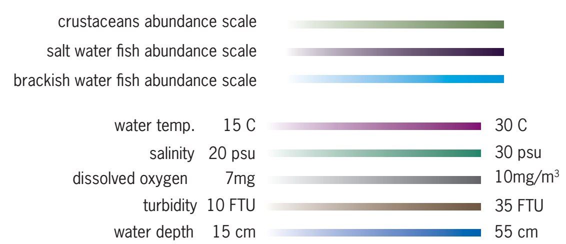
Elevation & Distribution
The complexities of an ecosystem are best understood in relation to the spatial condition over which it is distributed. In the case of coastal ecosystems the relative elevation to fresh or salt water is a key factor for habitats for flora and fauna. Diagram by Michael Edward Baer, Marti Gottsch.



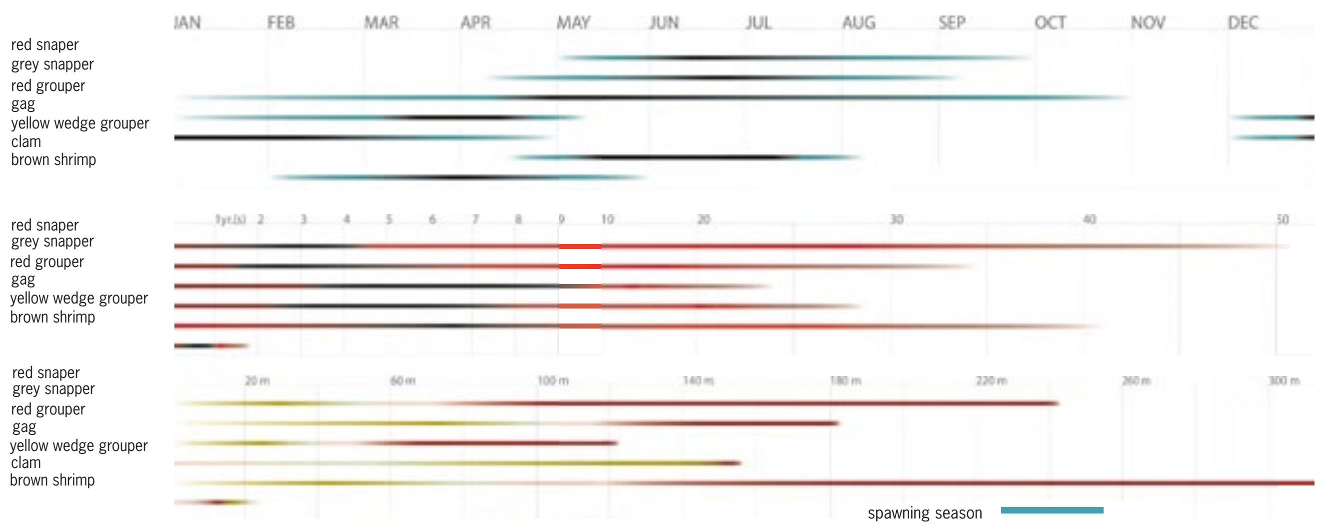
Sites of Commercial and Recreational Fishing
Galveston Bay contributes one-third of Texas' commercial fishing income. Over half of Texas' expenditures for recreational fishing are related to Galveston Bay. More blue crabs are commercially harvested in Galveston Bay than in any other estuary in Texas. Galveston bay produces more oysters than any single water body in the United States. Diagram by Edward Baer, Marti Gottsch.

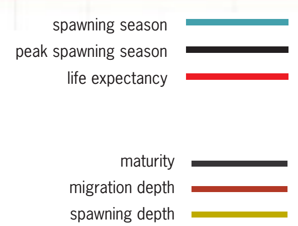
Biodiversity
Crab and shrimp are the two most lucrative commercial organisms in the bay but of course require a larger network of flora and fauna to exist. Likewise, the croaker and the seatrout are the two most lucrative fish for recreational fishing. The middle of the West Bay is highly lucrative as well as Christmas Bay, Trinity Bay, and east Galveston Bay. Diagram by Edward Baer, Marti Gottsch.



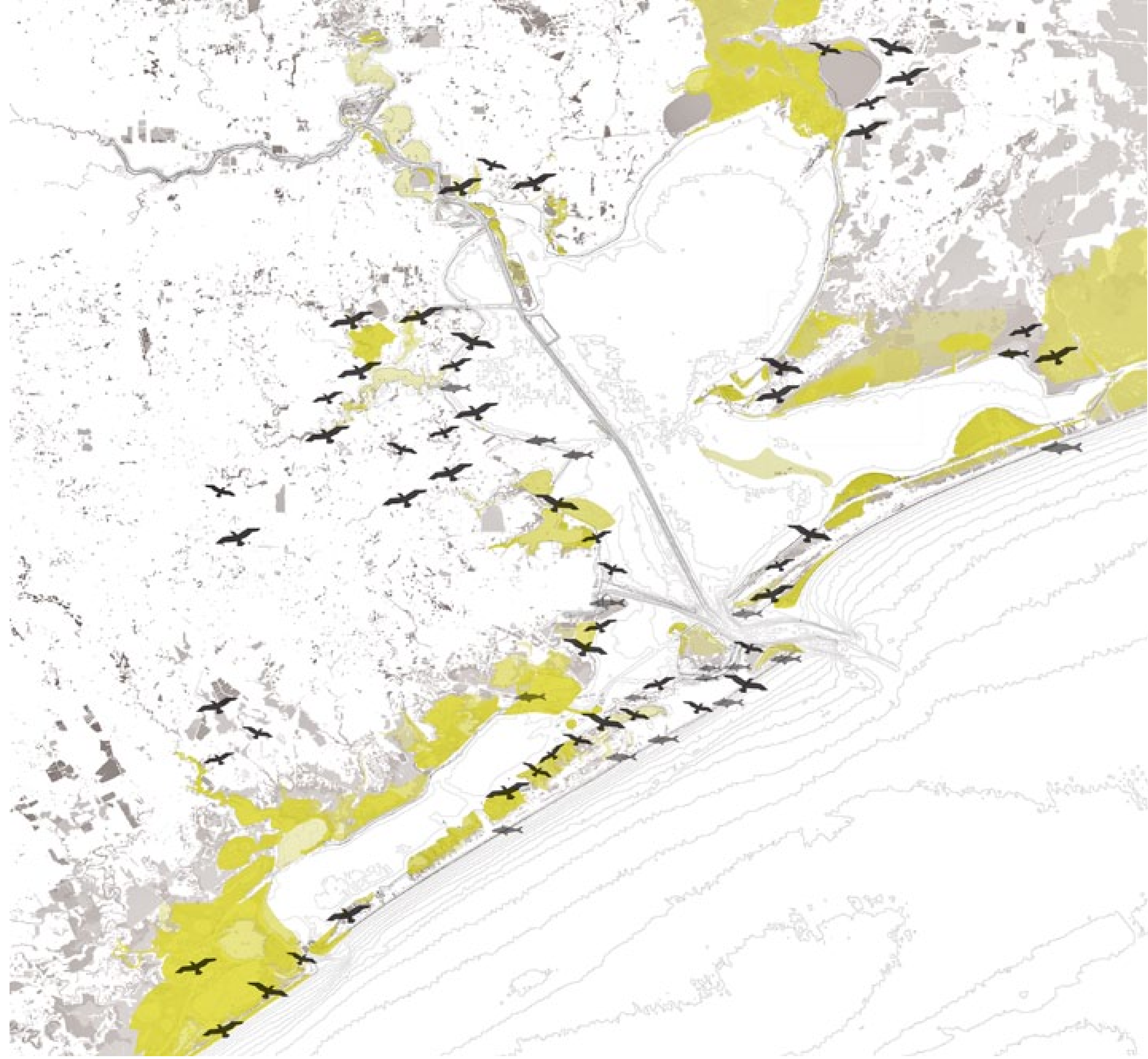


Galveston bay habitat conditions
The bay is most important as a nursery ground during the summer months. The rise in species abundance corresponds with the rise in water temperature, salinity, turbidity, and water depth as well as the fall of dissolved oxygen levels. Diagram by Jessica Cronstein, Annika Miller, Jessica Tankard. Data Source: Rozas, Lawrence P., Thomas J. Minello, Roger J. Zimmerman, and Philip Caldwell. "Nekton Populations, Long-Term Wetland Loss and the Effect of Recent Habitat Restoration in Galveston Bay, Texas, USA". Inter-Research 2007. p. 125-126.





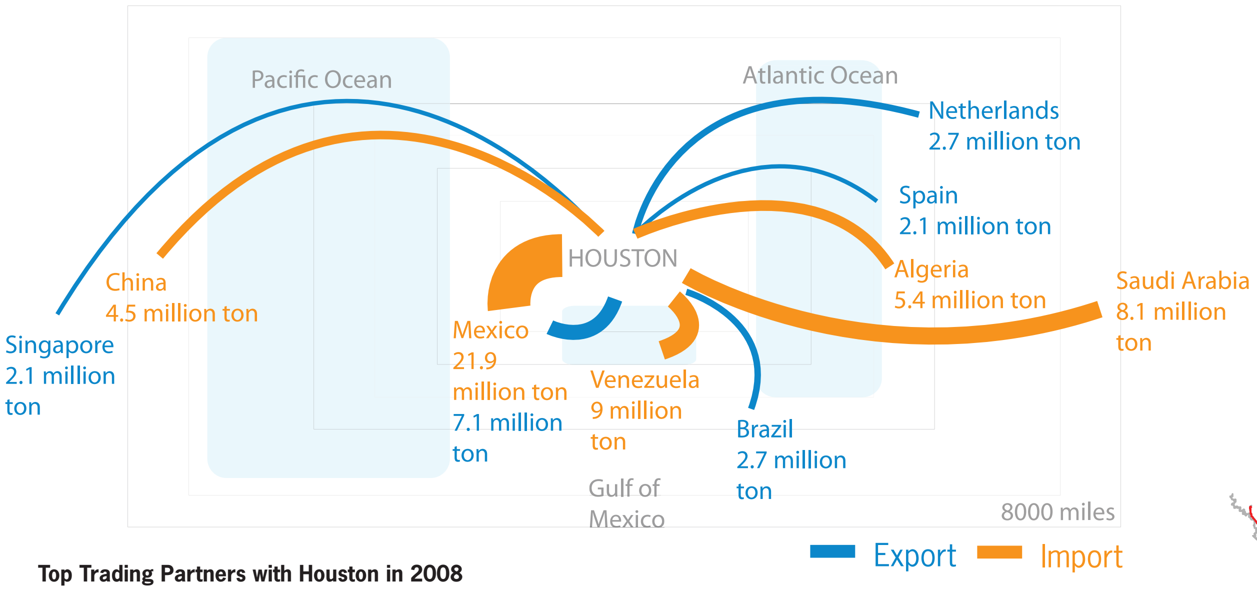
Seasonal fluctuation of Galveston area marine life
Prime spawning season for most fishes is in the summer months. Most fish mature around their fifth year, and spawn offshore. Diagram by Jessica Cronstein, Annika Miller, Jessica Tankard. Data Source: Monterey Bay Aquarium. "Groupers", "Snapper", "Shrimp". Seafood Guides. 2008. Monterey Aquarium Foundation. 21 Jan. 2009



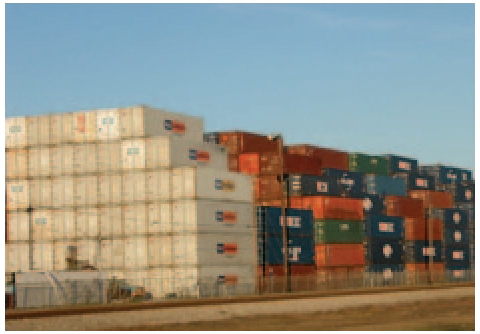
Fishing Sites
51st Street Fishing Pier
Galveston Fishing Pier
Galveston Island State Park
Galveston Island Beaches
Seawolf Park
Galveston North Jetties
Galveston South Jetties

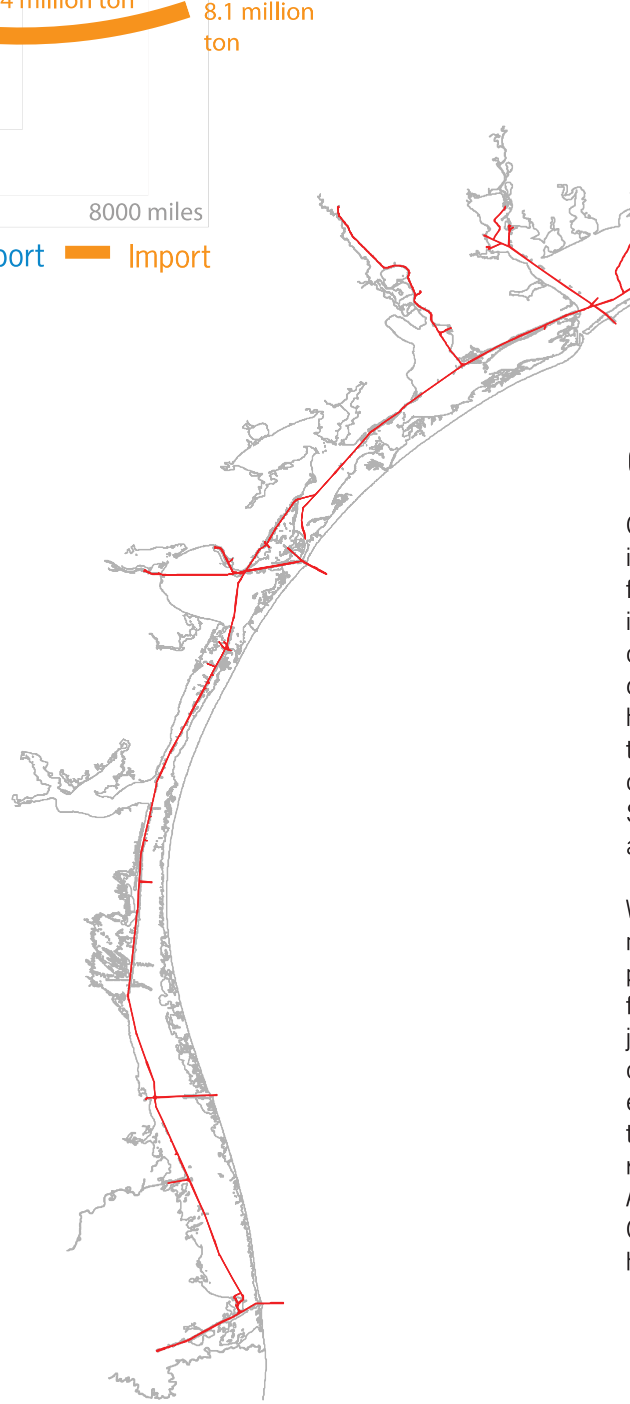
Bird Watching Sites
The Corp Woods
Big Reef and Apfel Park
Kempner
Harborside Wetlands
Offatts Bayou
8-Mile Road and Sportsmans Road
Settegast Road
Lafitte's Cove
Lafitte's Grove
Galveston Island State Park
San Luis Pass

Birdwatching and Fishing Sites in the region
Recreational fishing and bird watching are key economic and cultural activities in the area. Diagram by North Keeragool, Kathryn Pakenham.



Top Trading Partners with Houston in 2008
Total imports in equal 93.8 millions tons; Total exports equal 52.8 million tons. About one-third of imports were cargo, with two-thirds of those energy, related, while almost fifty-five percent of exports were cargo. The Port of Houston is the largest international port in the United States. As of 2008, it had the largest foreign tonnage in the U.S. for 13 consecutive years and largest import for 18 years. The majority of these activities occur in the Gulf of Mexico but trading extends to as far as Singapore and Saudi Arabia. Research and diagram by Jason OuYang





Intercostal waterway with shipping channel
An intercoastal waterway connects all these ports into a network, running over a thousand miles from the borderlands of Mexico to Florida, where it connects to another such waterway that runs along the Atlantic coast. Barges continually shuttle goods along this line between the barrier islands and the mainland. Diagram from GIS and modified by Jessica Cronstein, Annika Miller, Jessica Tankard.

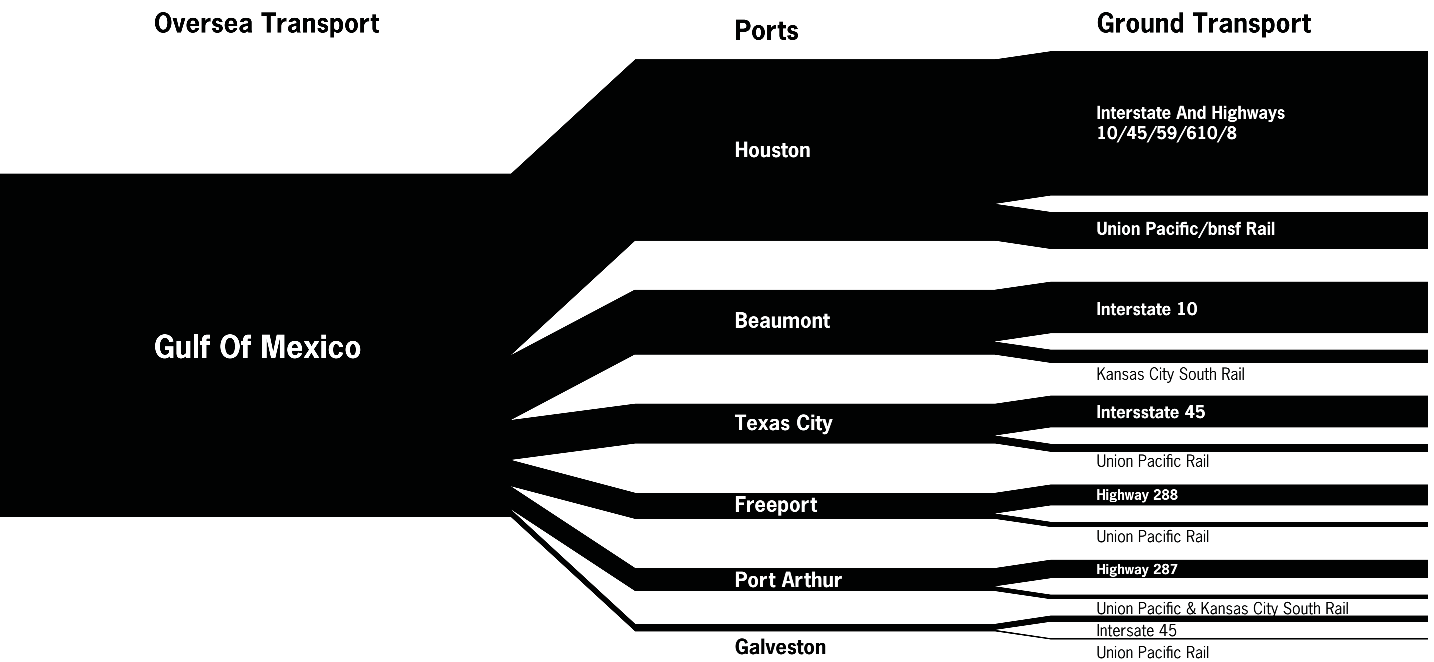
Containerization & Shipping

Containerization of goods is a key innovation and infrastructure of the "logistics revolution" in the past forty years and along with information technology is integral to globalization. The ubiquitous steel containers are a universal standard that can be digitally tracked, moved by ship, rail and road. An heretofore unimaginable riches of things can be transported from any exotic locale to any place on the planet in identical generic boxes. In a post-September 11th world, this anonymous ubiquity is also a source of anxiety and increasing security.

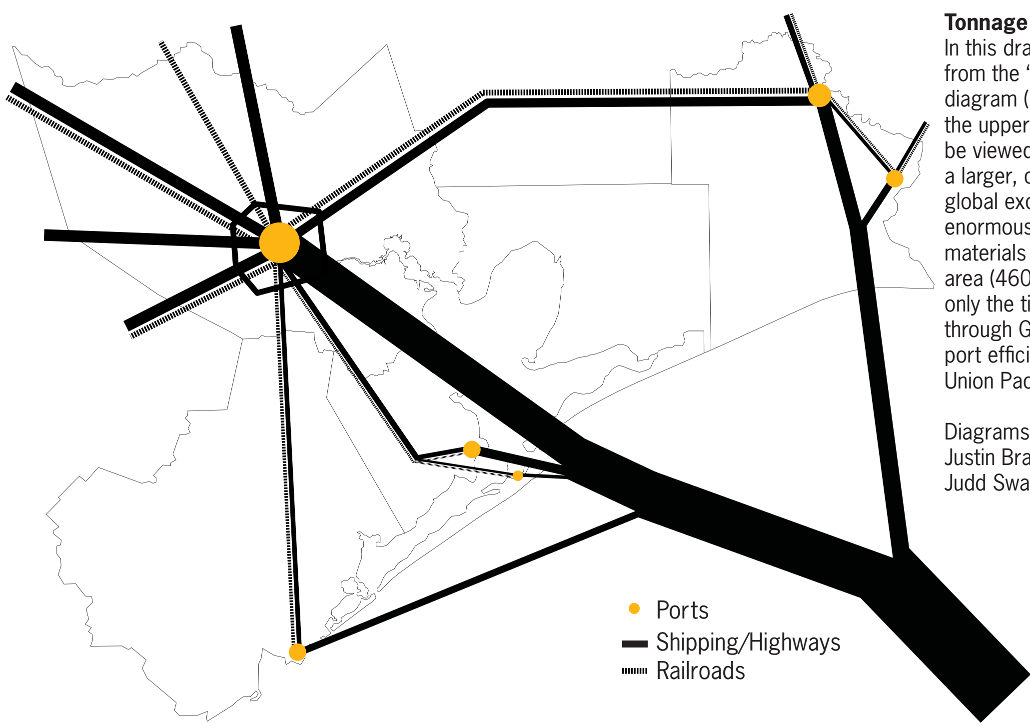
While exponentially faster, air transport is also far more energy intensive, requiring far more fuel per pound restricting the bulk of goods. Moreover, finding sustainable alternatives to high-performance jet fuel is difficult. The diesel based infrastructure of containerization, on the other hand can be relatively easily retrofitted with new fuel sources. At the same time, the expansion of the Panama Canal and the rapid economic development of South and Central America due to energy reserves, positions the US Gulf Coast as a key global interchange for the next hundred years.

Galveston's history has been tied to the story of shipping logistics. Once known as "The Wall Street of the South", the city was the most important American port outside of New England for key mercantile exchanges. Yet while the city recovered from the 1900 Storm, it never recovered from the creation of the Houston Ship Channel shortly thereafter, which created the farthest inland port in North America. The vast majority of shipping moved inland due to available land, proximity to land transport and processing facilities as well as economic incentives.

However, the new generation of larger post-Panamax ships requires far broader and deeper channels to be dredged, requires more maintenance and increases environmental impacts. This makes Galveston's proximity to deep water more attractive in economic and environmental terms. New logistics protocols require less storage on site, while rail connections coupling passenger and freight becomes more feasible as the Houston area grows to the coast and as energy prices increase. Fallow industrial land on the island could be re-born as a shipping port while leaving more environmentally sensitive areas undeveloped, and provide high-wage jobs key to diversifying the existing economic base.



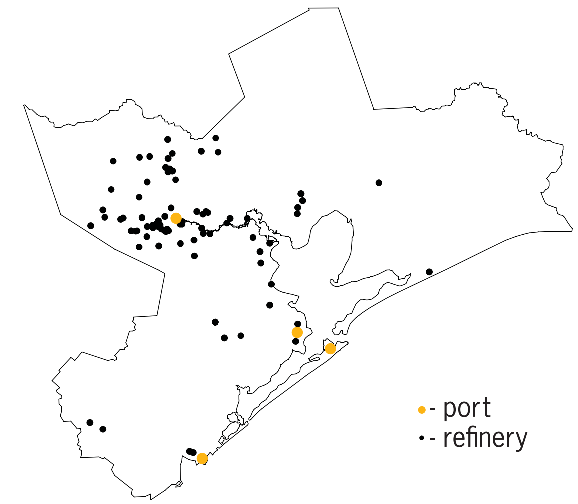
Tonnage distribution over different transportation modalities
Source: Appendix C: Regional Freight Transportation Profiles' ,' from 'Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level', a report published in 2005 by the Federal Highway Administration.

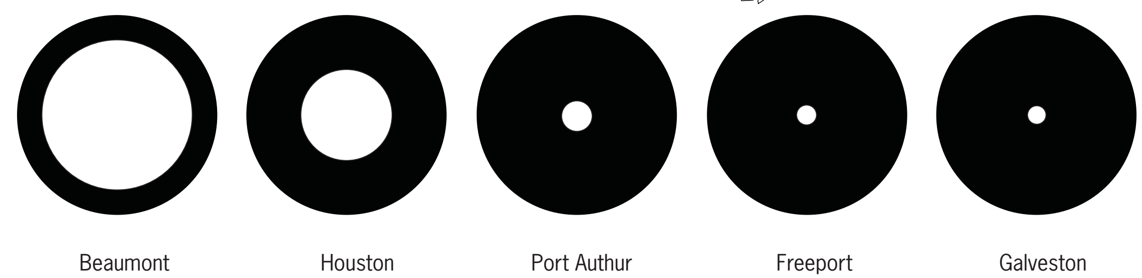


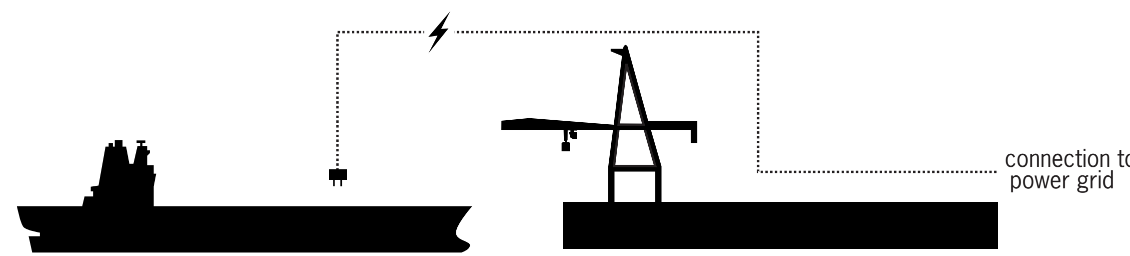
Tonnage distribution network
In this drawing the information from the 'tonnage distribution' diagram (above) is mapped onto the upper Texas coast. This should be viewed as a section cut from a larger, continuous circuit of global exchange. Note that of the enormous amount of goods and materials that circulate through the area (460 million tons in 2006), only the tiniest portion circulates through Galveston. Sources for port efficiency data derived from Union Pacific Rail Road.

Diagrams on these two pages by Justin Brammer, David Dahlbom Judd Swanson.

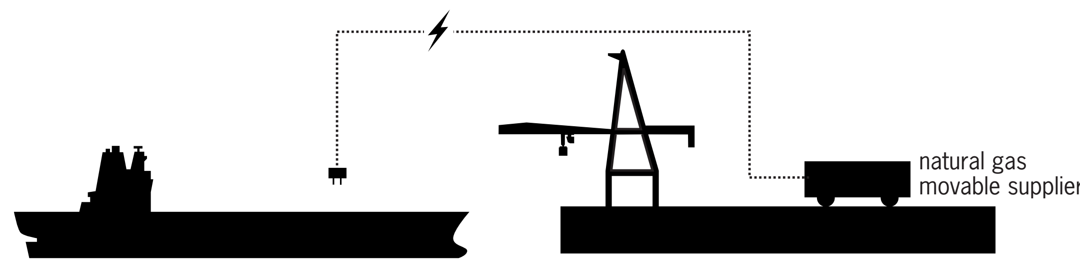
Ratio of loading/unloading capacity to available storage
The "logistics revolution" is premised in the efficient movement of capital across the globe from point of sale, to production, shipping and consumption. Thus, this capital must be in continual motion and any storage or processing time should be reduced to as close to zero as possible. Ships are understood as warehouses in motion, or vectors of capital (Edna Bonacich and Jake Wilson, Getting the Goods, 2007). The efficiency of a port is how fast products can be unloaded from the ships and distributed to other destinations. Storage time should be zero or minimal. This means one can decrease the ratio of storage to capacity of loading and unloading. Sources for port efficiency data derived from Union Pacific Rail Road





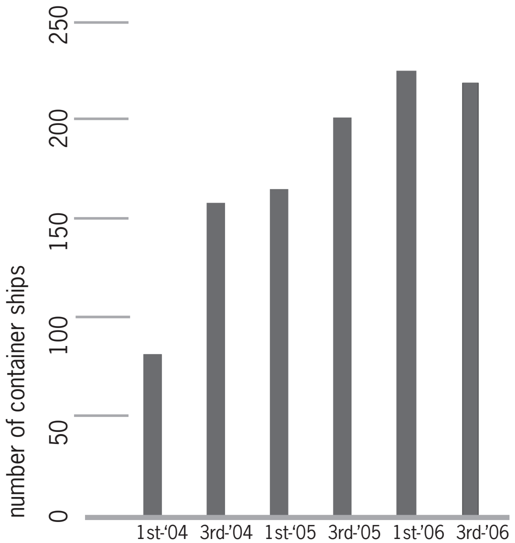


connection to power grid: this method connects the power systems of ship directly to the power grid that supplies the port and is the cleanest and most efficent way of powering ships while in port.

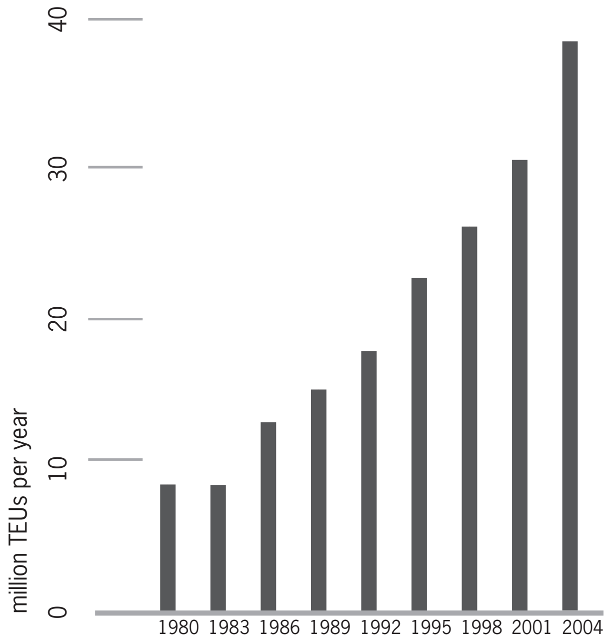


natural gas supplier: the method connects the ship to a natural gas supply that can move to power ships and is significantly cleaner than running on board engines while in port.

Plug-in Shipping
Auxiliary diesel engines often provide power for ships while in port, which is relatively inefficient and produces pollution. To mitigate this, ports can provide the electrical energy for the docked ships through the process of "cold ironing" that connects the ship to cleaner source of power. Source: "U.S. Container Ports and Air Pollution: A Perfect Storm", An Energy Futures, Inc. Study by James S. Cannon.



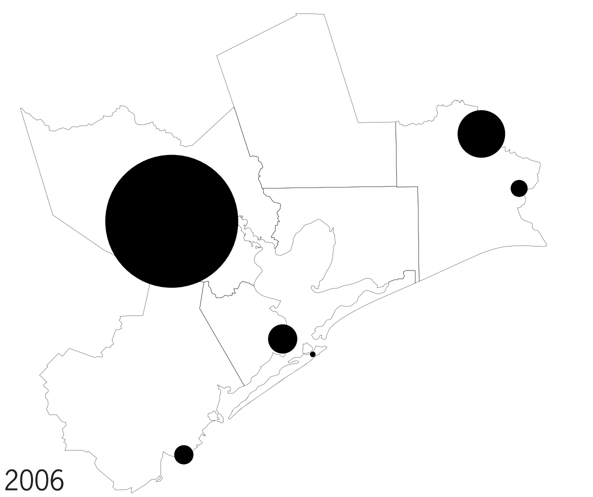
Texas coast container shipping
2004 - 2006 Quaters



United States container shipping

Texas coast container shipping
Texas container numbers redrawn from the National Ballast Information Clearinghouse, a component of the Smithsonian Institute's Marine Invasions Research Lab. Other container shipping info redrawn from, 'U.S. Container Ports and Air Pollution: A Perfect Storm,' An Energy Futures, Inc. Study by James S. Cannon.

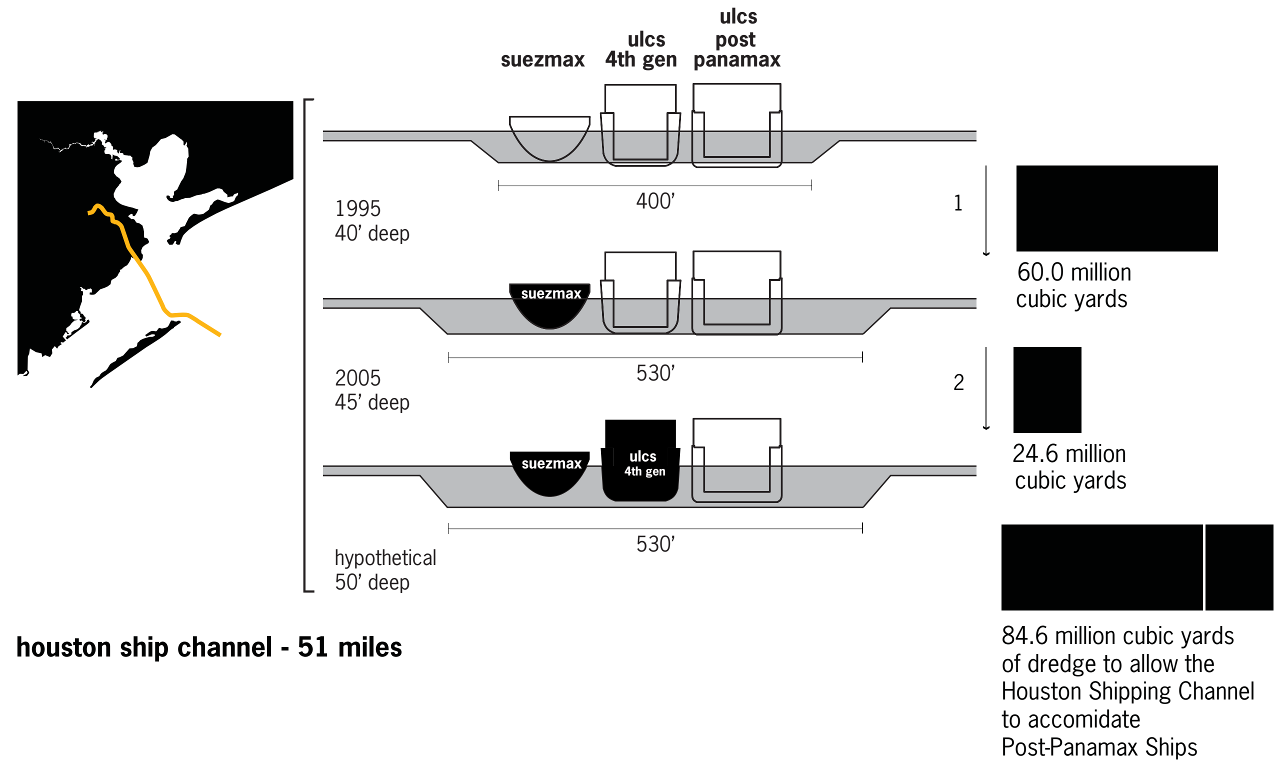
2001



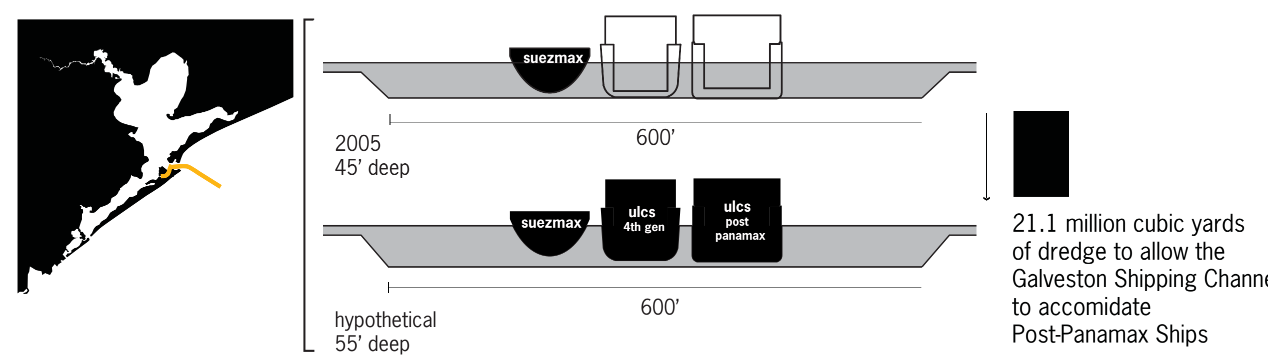
2006

Port tonnages over time
Source: 'Appendix C: Regional Freight Transportation Profiles' ,' from 'Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level', a report published in 2005 by the Federal Highway Administration.

Diagrams on these two pages by Justin Brammer, David Dahlbom Judd Swanson.



houston ship channel - 51 miles



galveston ship channel - 18 miles

Dredging for Post-Panamax Ships
Expanding the Houston Ship Channel to allow the next generation of ships (called Post-Panamax) access to the ports will be extraordinarily expensive and will have massive environmental impacts. This is not a one time cost: these waterways require continual maintenance. While supertankers can be unloaded offshore, container ships benefit from land-based ports.

The diagrams above show the implications for widening and deepening the shipping channels to allow for this new generation of container ships, while the chart on the left shows the increased volume of dredge material that will have to be relocated. Comparing the amount of dredging necessary to deepen the Houston ship channel to Galveston reveals the advantage of the latter. The Galveston shipping channel, which is already wider than the Houston shipping channel,could be deepened to the post-Panamax depth of 55 feet by dredging less material than it would take to dredge the Houston ship channel to a depth of 50 feet. Moreover, in Galveston Bay the dredging material itself could be relocated very near to the site from which it is drawn and used to replace lost wetlands, adding value to the island.

Data is extrapolated from "Navigating the Houston Ship Channel: a reference for commercial users," The Houston-Galveston Navigations Safety Advisory Committee.

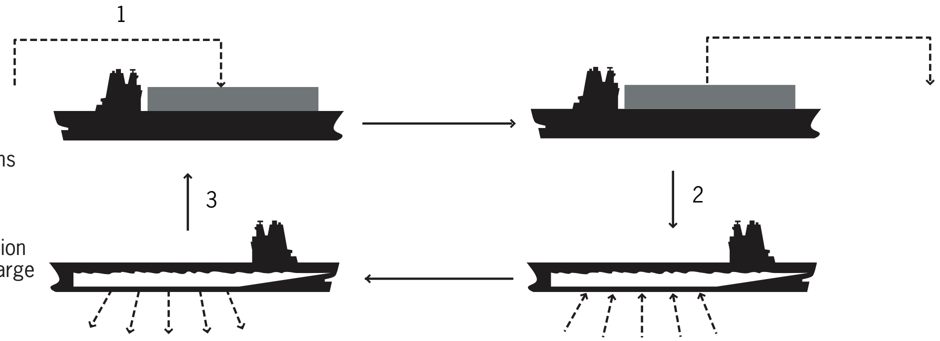
1 Container ship takes on load

2 Deposits load and takes on ballast water

3 Dumps ballast with aquatic organisms at new port and takes on new load

The Port of Houston has about 10 million gallons of container ship ballast discharge per month – about 15 olympic sized swimming pools.

Container ships



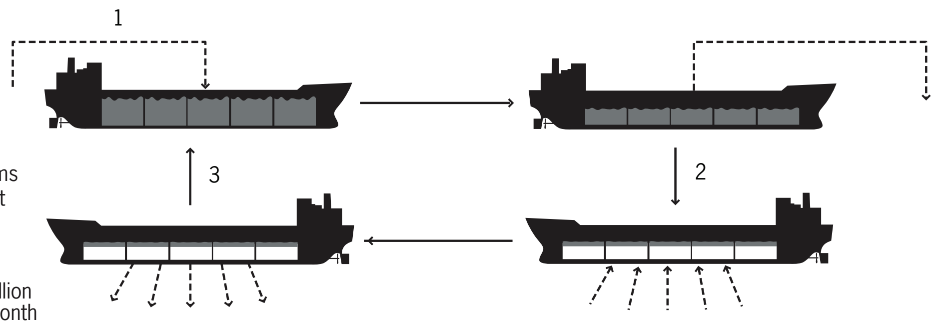
1 Tanker takes on oil load

2 Deposits load and takes on ballast water

3 Dumps ballast, with aquatic organisms and oil contamination at the new port and takes on new load

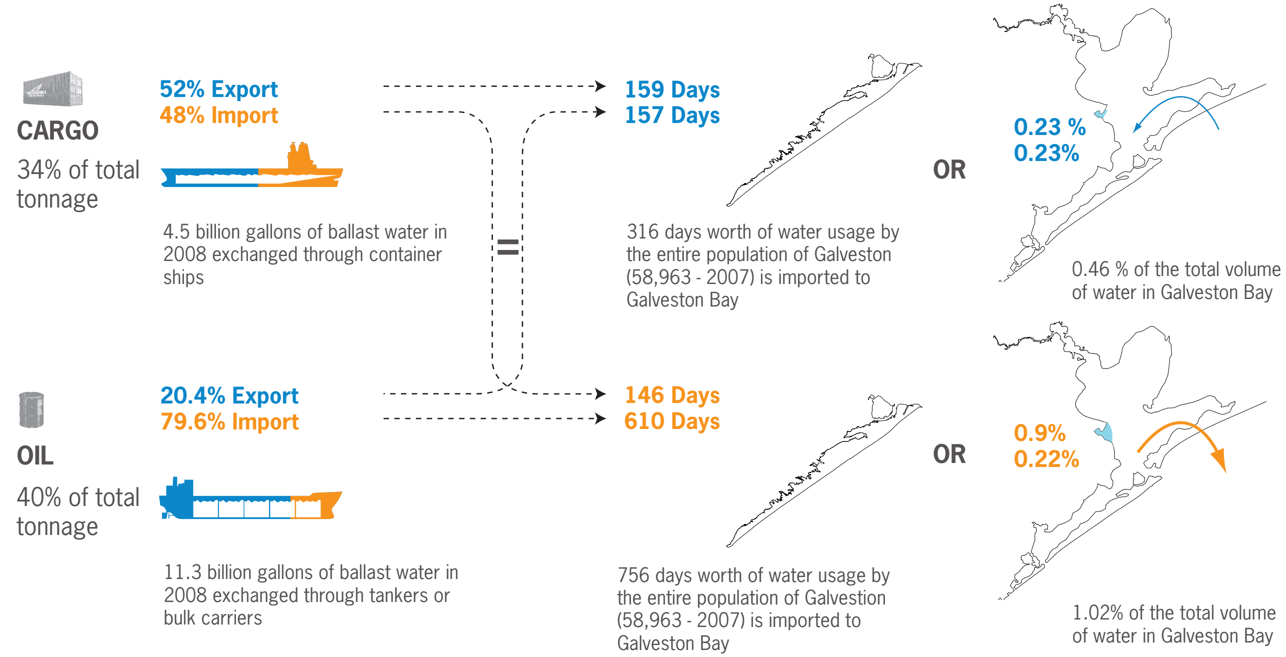
The Port of Houston has about 300 million gallons of tanker ballast discharge a month – about 450 olympic sized swimming pools

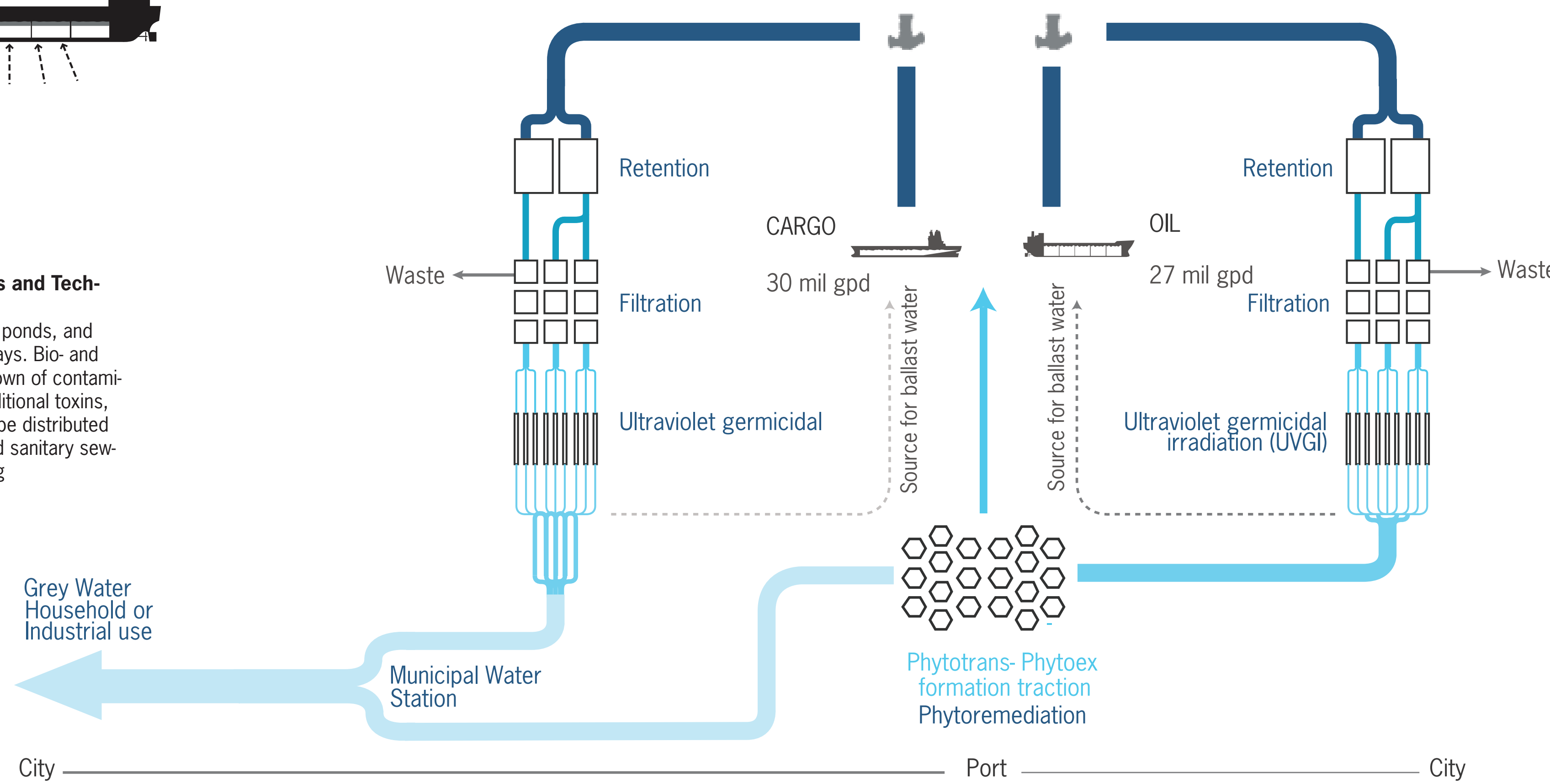
Oil tankers



Above: Ballast Water Ecologies
While massive spills provide a powerful image of the risk of oil shipping, the average public may be unaware of the slower and less apparent effects of ballast water dumping by both oil and cargo tankers. Conventionally, ships take on water from a port as ballast, and then release it at their destination. In doing so, not only are whatever contaminants that may be in the ballast holding tanks released, flora and fauna carried in the water from the distant locale are introduced into a new environment and can produce massive destruction of local species and ecosystems. At a global scale the implications are destructive not simply for local flora and fauna, and human populations, but may reduce the global biodiversity and make ecosystems more unstable. This is a form of accidental environmental colonization, not dissimilar from the seeds, rats, cats and disease brought by ships from Europe to the "New World" in the 15th to 18th centuries. In his seminal book, Ecological Imperialism, Alfred Crosby argues that this process transformed the Americas' environment to something closer to that of Europe and assisted with the subjugations of the indigenous populations and the transformation of the landscape. Diagrams by Justin Brammer, David Dahlbom Judd Swanson. Information on ballast practices and pollution from "Vessel-Source Marine Pollution", by Alan Khee-Jin Tan. Volume information from the National Ballast Information Clearinghouse.

Right: Ballast Water Treatment Processes and Technologies
Ballast water is first retained in large isolated ponds, and then actively filtered and sanitized using UV rays. Bio- and Phyto- remediation (absorption or breaking down of contaminants via bacteria and plants) can absorb additional toxins, such as heavy metals. Finally, this water can be distributed to the city for use as grey water irrigation and sanitary sewers. Research and diagrams by Jason OuYang





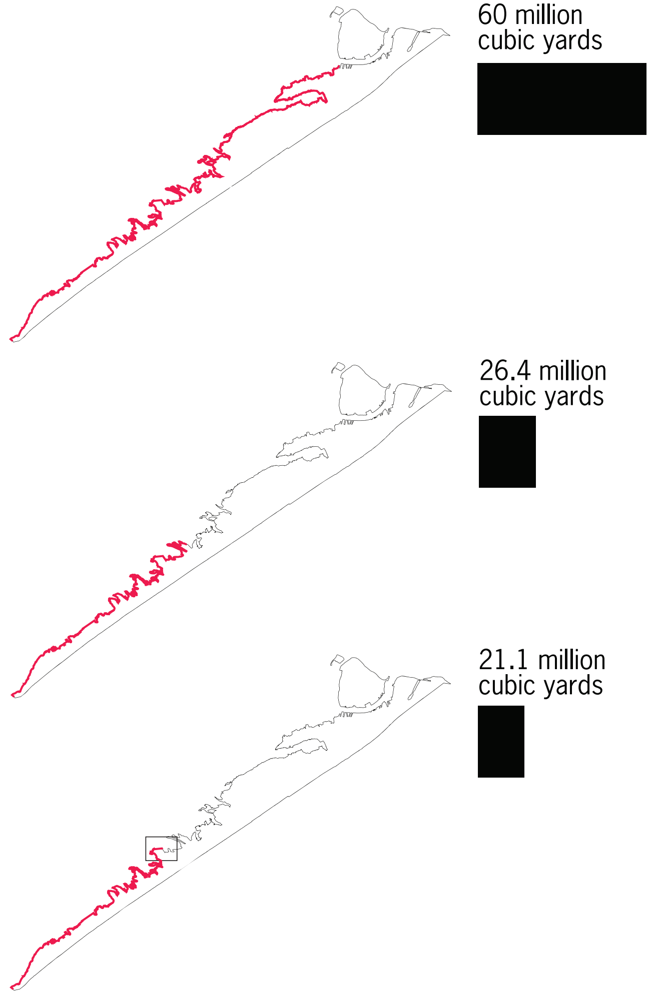
Ballast Water Volume and Issues
Ballast water is used to stabilize ships during the process of transporting goods. Invasive species of flora and fauna, as well as other contaminants, can be introduced into an ecosystem by discharging ballast take onboard at the ship's origin at the destination. It takes 75 years for a complete exchange of the entire volume of water in Galveston Bay at current rate. Research and diagrams by Jason OuYang. Source: Texas Water Department Board. Research and diagrams by Jason OuYang

Strategic Mud
The map on the opposite page indicates dredge deposit sites as of 2009. In addition to the islands and inland fields, most deposit locations follow the shipping channel and intercoastal waterway due to limitations of pumping methods. Many of these are made by filling geotubes with slurry, creating an outline and then pumping more dredge into the center. The creation of these relatively hard islands in long lines can begin to alter current flows within the bay and even salinity levels.

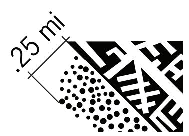
The diagrams on the right show alternative uses of dredge material to offset coastal erosion. Because the barrier islands are typically farther away than current pumping limits, staging the relocation of the deposit would be necessary, perhaps first remediating the often contaminated mud.

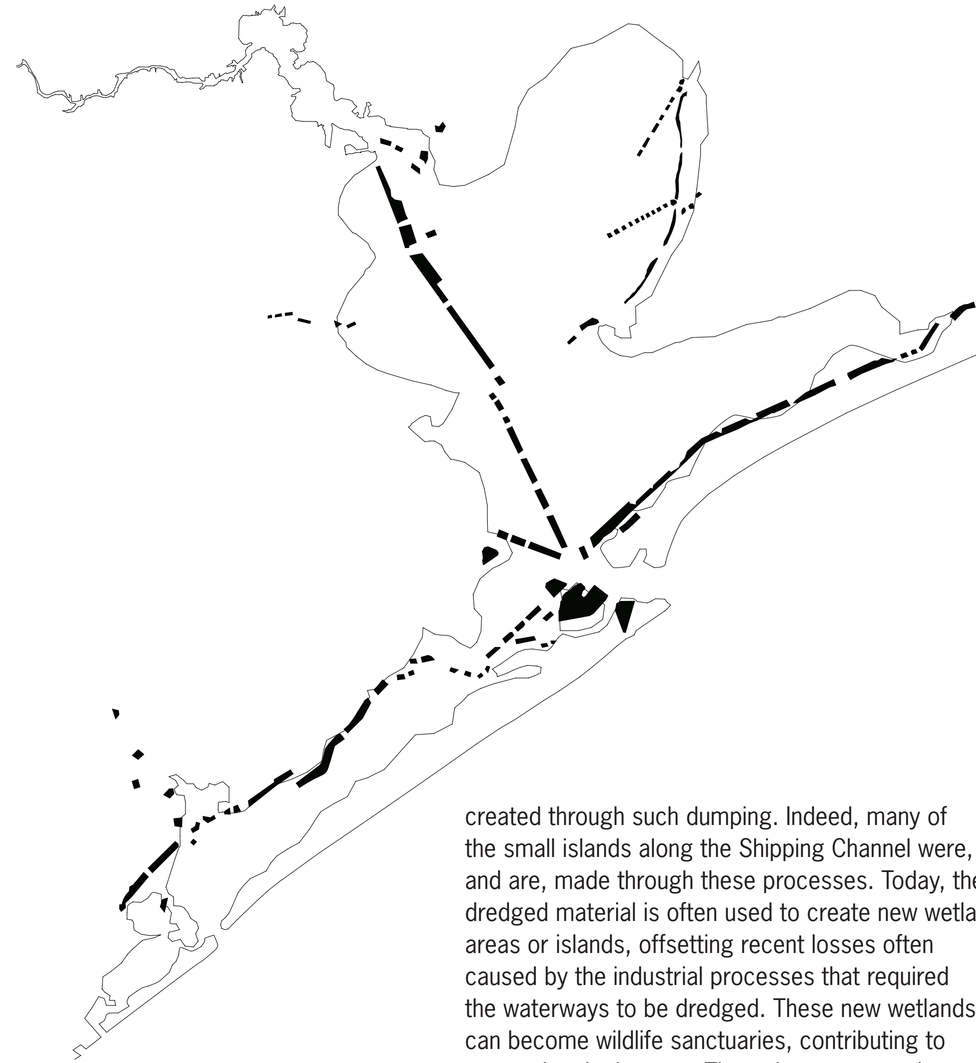
The photos below show an example of such an alternative use of dredge formation strategy. Intermittent geotubes could provide enough protection to dome shaped mounds of slurry, establishing a robust wetland porous to currents and which can be modulated in heights to offer different habitats and differentiated landscapes.

Diagrams by Justin Brammer, David Dahlbom Judd Swanson. Source: 'Dredge and Fill Activities in Galveston Bay,' a volume from the Galveston Bay National Estuary Program (GBNEP-28), April 1993.



Wetland coastal coverage based on an assumed depth of .25 miles



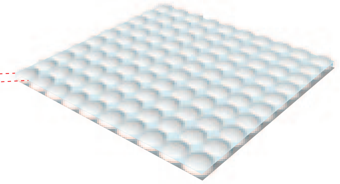


Dredge and Excess

While the Galveston region has a scarcity of sand, it has an excess of mud. Like painting a bridge or washing the windows of a glass skyscraper, the relatively shallow waterways connecting the Houston-Galveston area to the global shipping and regional transportation networks require regular continual dredging, producing a large amount of excess slurry that must be relocated.

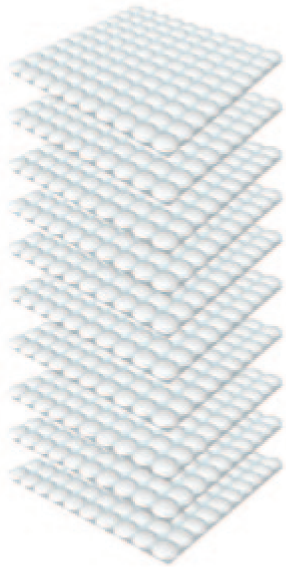
The intercoastal waterway that connects the entire Gulf Coast and extends to the East Coast as well as the local shipping channels for the Port of Houston were created and maintained by dredging. A large part of the eastern tip of Galveston itself, The East End Flats, was once an active dredge dump site. Pelican Island adjacent to Galveston was mostly created through such dumping. Indeed, many of the small islands along the Shipping Channel were, and are, made through these processes. Today, the dredged material is often used to create new wetland areas or islands, offsetting recent losses often caused by the industrial processes that required the waterways to be dredged. These new wetlands can become wildlife sanctuaries, contributing to ecotourism in the area. Thus what appear to be natural islands in the bay are often technologically produced landscapes.

However, this apparently sensitive use has limitations. Dredge material often needs to be remediated as the pollutants in the bay become concentrated in the sediment. Depositing the material buries key flora and fauna on the sea floor and the construction of islands can alter current patterns and even salinity levels in the dynamic bay system, thereby potentially affecting the ecologies of the area. Expanding shipping lanes to accommodate larger, Post-Panamax ships could exponentially increase costs and excess material. Therefore, intelligently managing this by-product excess of mud is a key factor in the future of this landscape that for over a hundred years has been actively reshaped by commerce and its infrastructures.



100 mounds = 1.25 acres

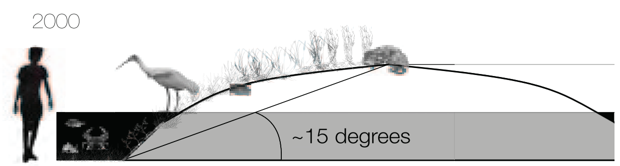
229,500,000 ft^3 of dredge

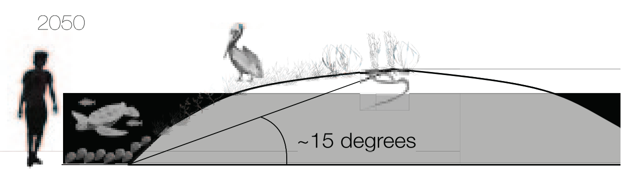


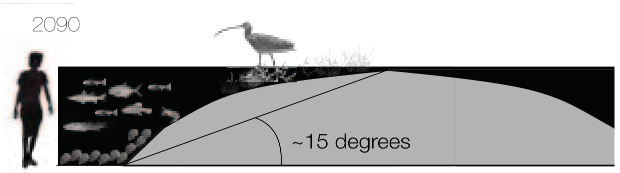
1000 mounds = 12.5 acres

From excess to habitat
Since 2009, an average of almost 230 million cubic feet of dredge material was removed from the ship channel per year. In addition, an estimated 36 million cubic feet of debris from Hurricane Ike was removed form the intercoastal waterway. If used to construct wetlands by using dome-shaped mounds, this material could produce 170,000 mounds, or roughly 2000 acres of wetlands. Phytoremediation can remove toxins from the mud, establishing new habitats and cleaning the overall system.

Research and diagrams by Edward Baer, Marti Gottsch.

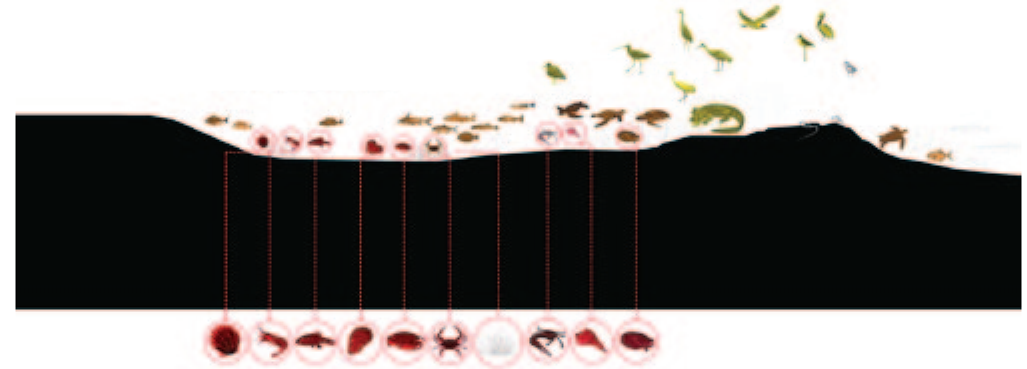




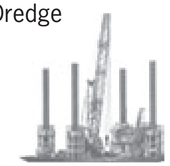


Dredge Dump

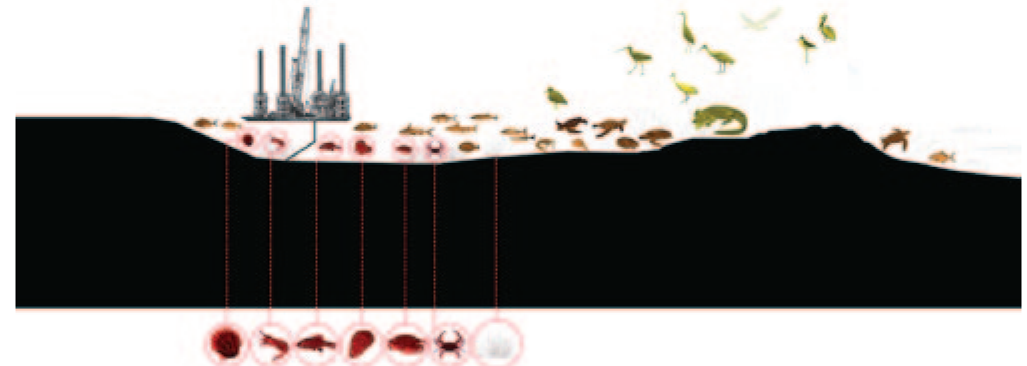
Dredge dumping threatens the estuarine ecosystem as a result of sediment inundation. Benthos habitats, minnows, and seagrass suffer. This effect is the most harmful to the biodiversity of the bay.



Dredge

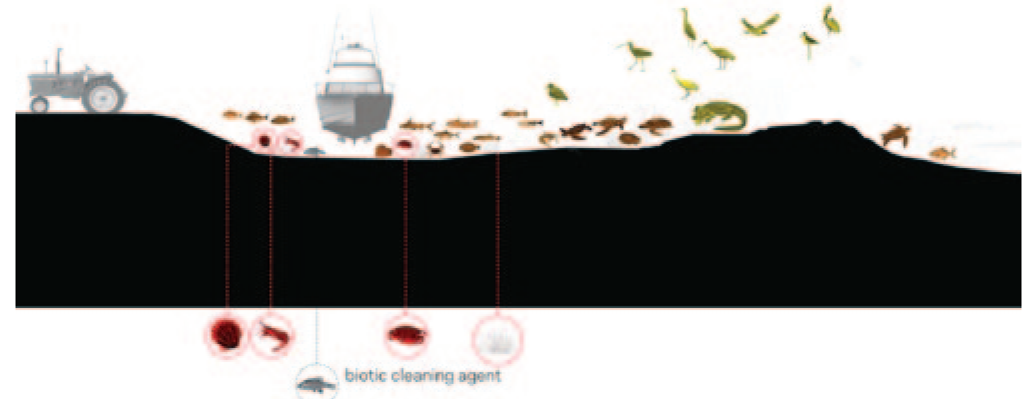


Dredging raises sediment that suffocates the bottom dwellers over time. The dioxins and PCB's thwart benthos habitats from establishing.



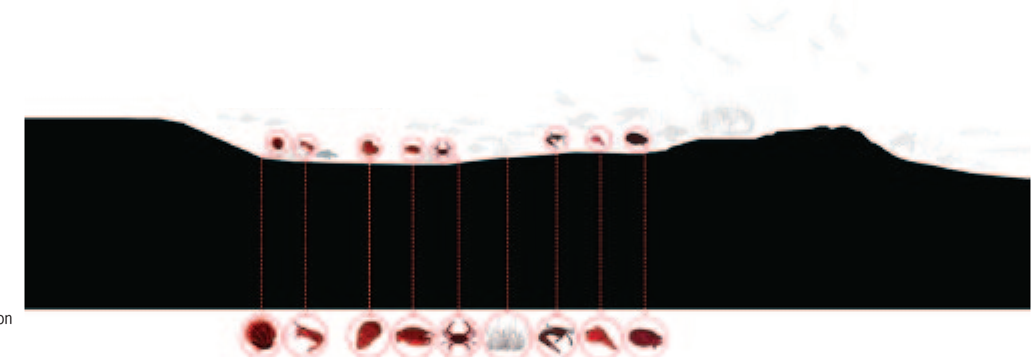
Pollutants

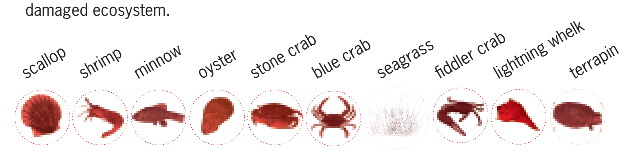
Phosphorous, nitrogen, mercury, and lead are pollutants that leak into the bay. This threatens the benthos population and is the main cause of algal blooms.



Hurricane

Hurricanes have great initial impact to the biodiversity of the bay, but after the initial inundation of water the receding volume carries blackwater, a food rich environment that jumpstarts the damaged ecosystem.





Natural and Technological effectors of sea floor ecologies
Research and diagrams by Edward Baer, Marti Gottsch.

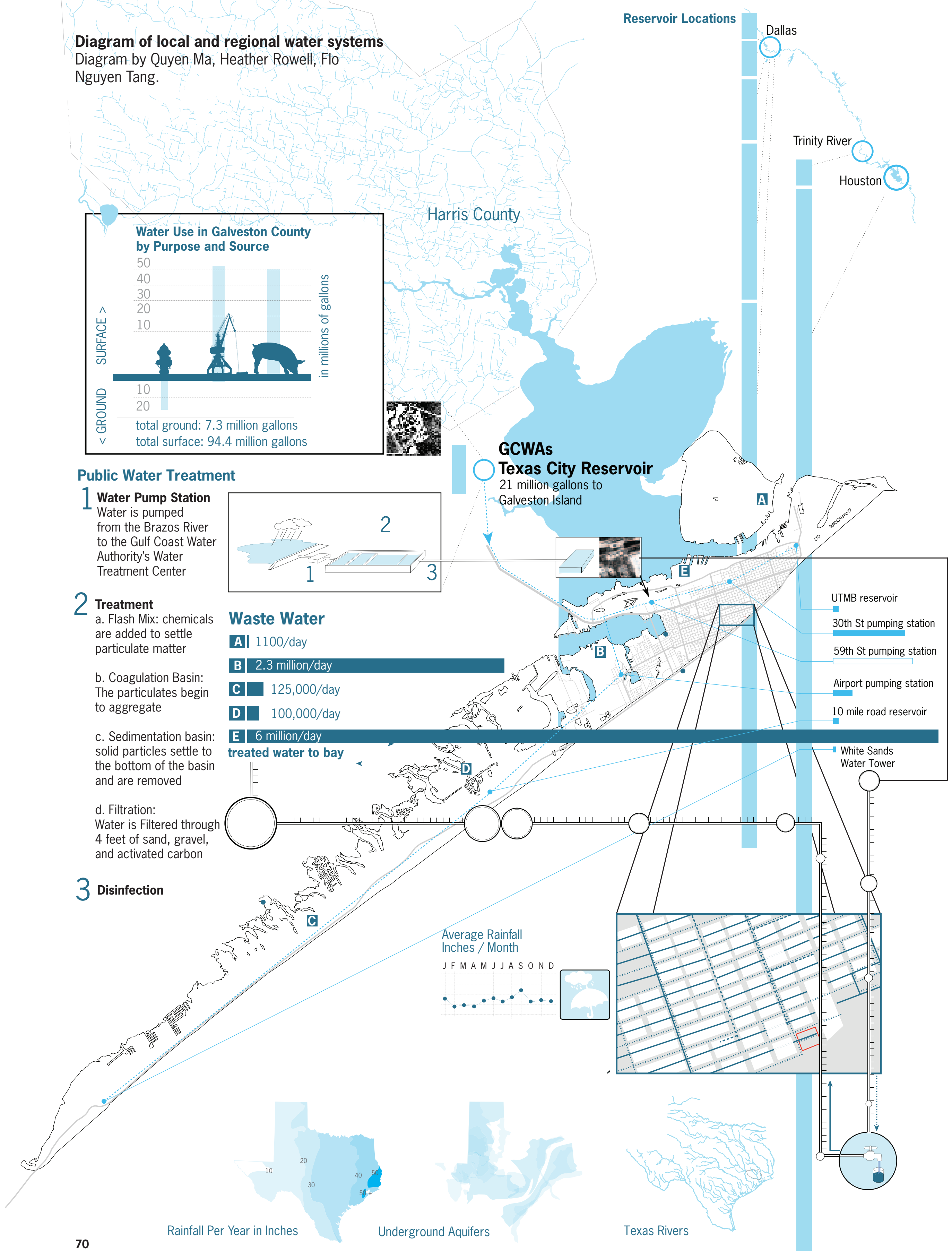
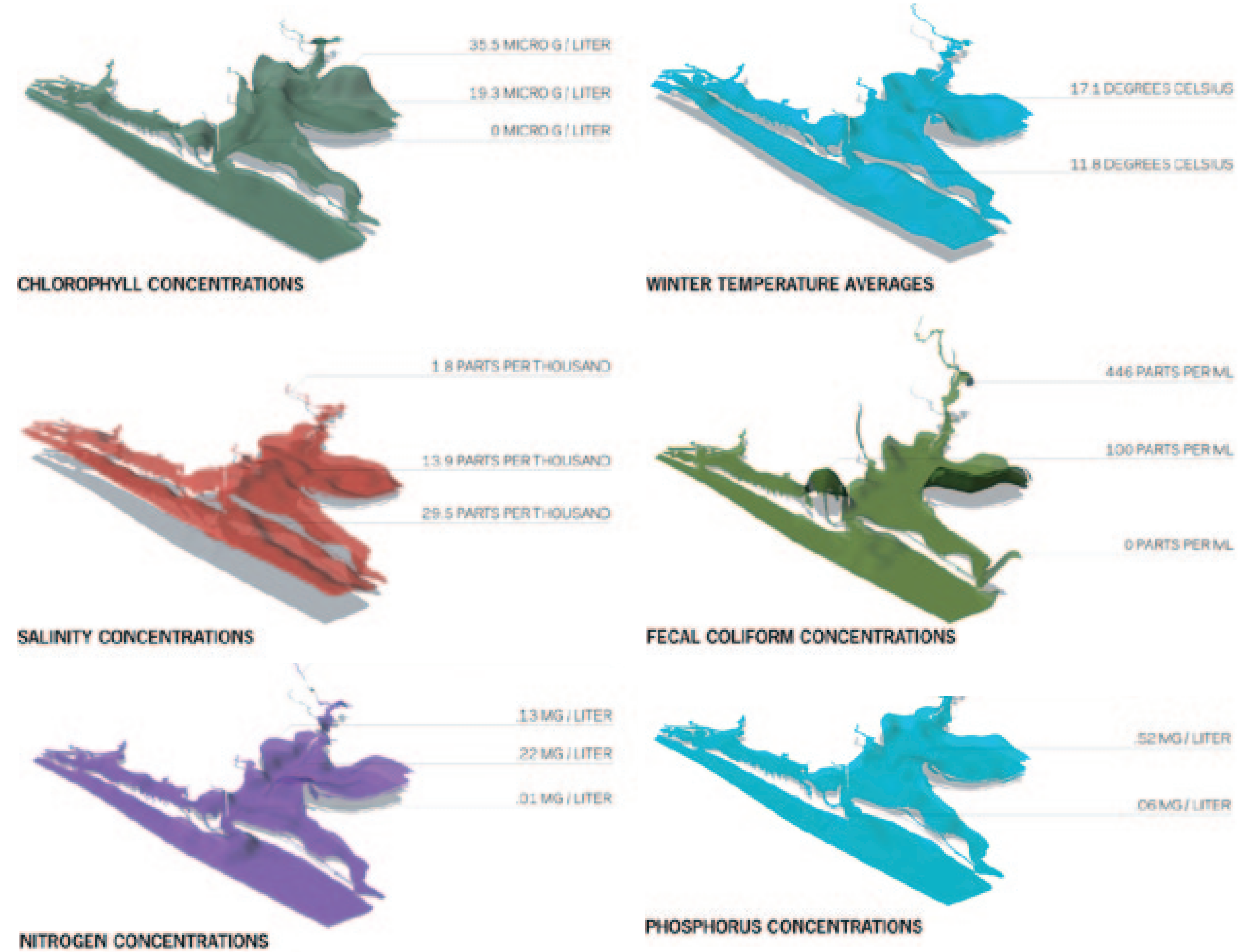


Diagram of local and regional water systems
Diagram by Quyen Ma, Heather Rowell, Flo Nguyen Tang.



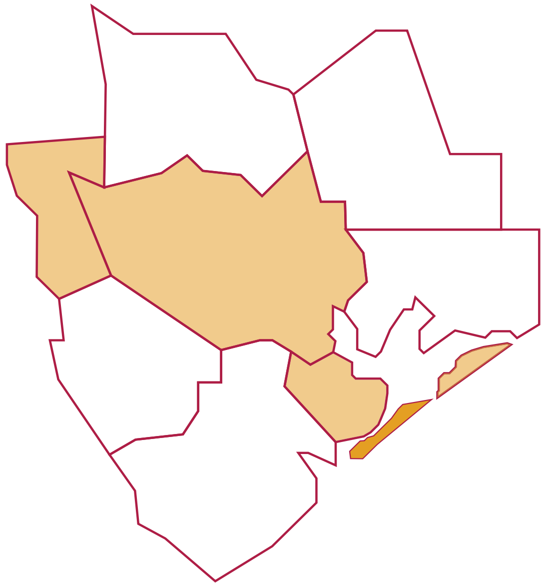
Example water qualities and pollutants in Galveston Bay
Diagrams by Richie Gelles, Marina Nicollier, Amanda Chin

Water: Black and Blue and Grey

While taken for granted by most in the developed world, in the 21st century freshwater will become a far more precious commodity. Many urban areas in the United States depend on water transported from distant locales, and increasingly compete with other municipalities. Even the Gulf Coast area, which seems to have an abundance of water, will be increasingly challenged to supply fresh drinking water and treat wastewater for its rapidly growing population. Resorts typically have very high water usage from hotels, pools, and golf courses. Galveston pumps most of its fresh water from the mainland while its water treatment facilities are mainly on the island and treatment and sewer infrastructure is aging.

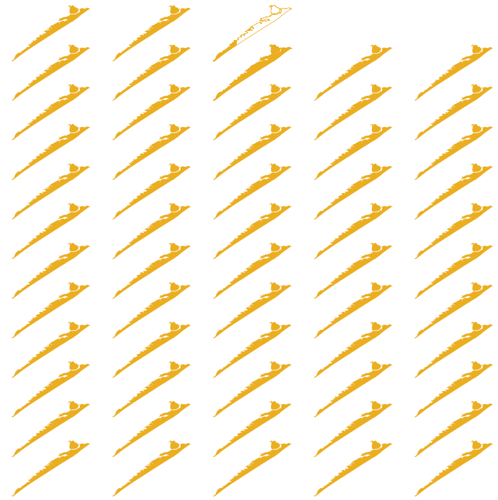
Surface water run off picks up containments left on roads and fertilizers and can affect the surrounding bay water if not treated. Desalinization remains prohibitively expensive and energy intensive. Therefore, managing water systems is a key issue for the island and urban centers in general. New technologies can treat water by organic and decentralized means and cities can adopt grey water systems for irrigation and non-potable use. Local detention of storm water reduces loads on the centralized infrastructure while providing opportunities for phyto-remediation, habitats and water for irrigation.

2008 ecological footprint of Gavleston Island is equivalent to:



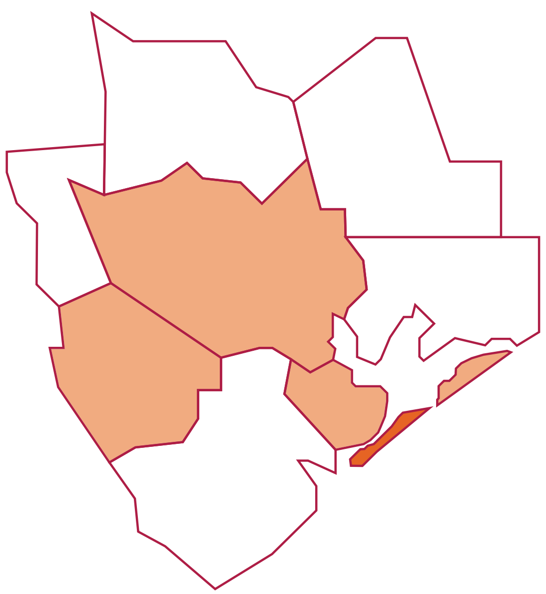
The land area of Galveston, Harris, and Waller Counties

OR



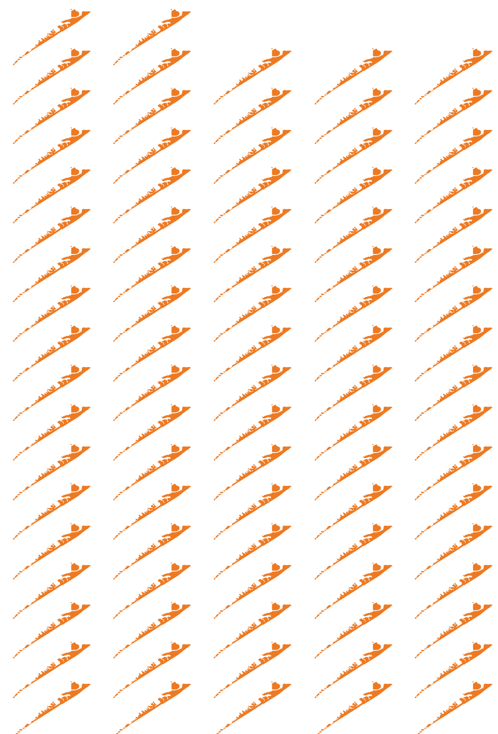
57.2 times the 2008 land area of Galveston Island

The predicted 2058 footprint is equivalent to:

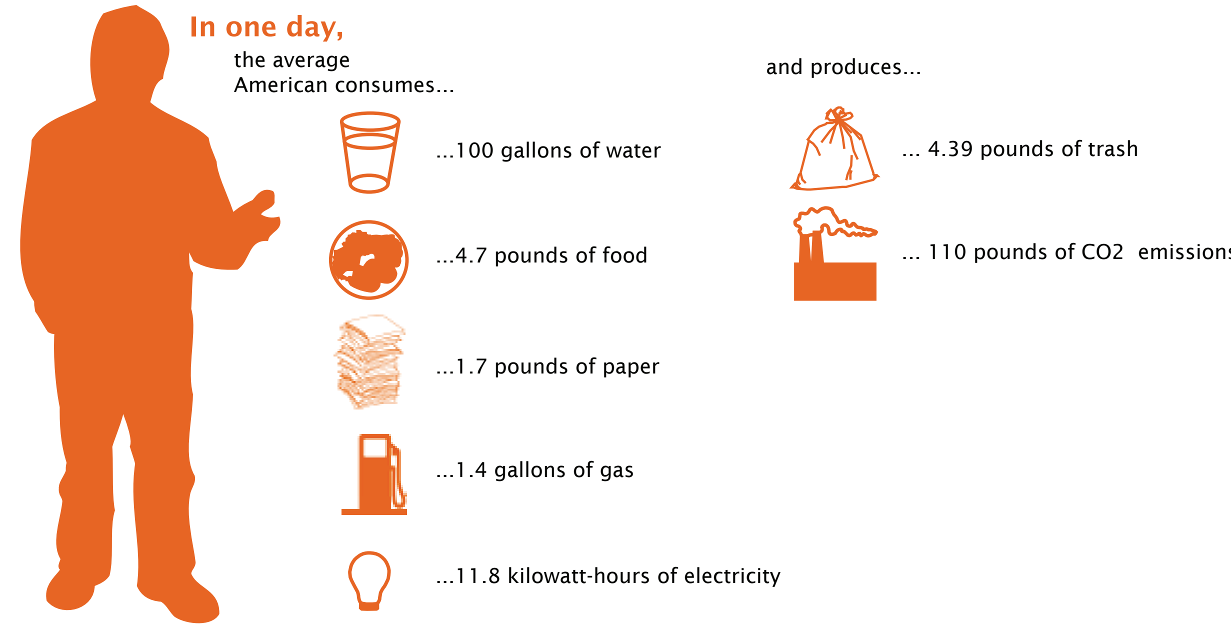


The land area of Galveston, Harris, and Fort Bend Counties

OR



87.0 times the 2058 land area of Galveston Island



Ecological Footprints in the Sand

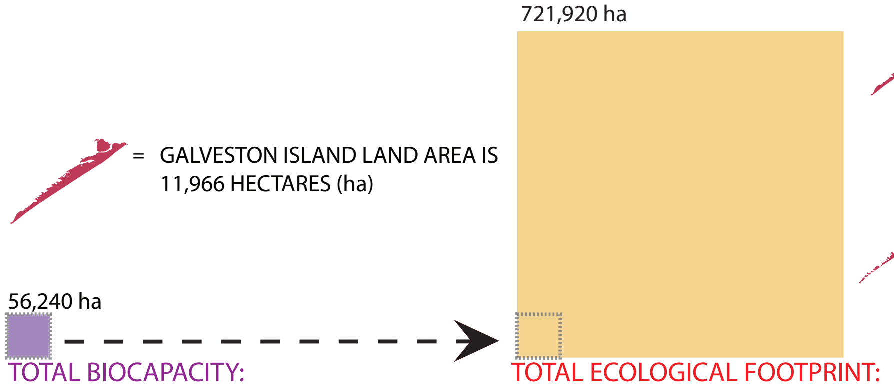
An "ecological footprint" is a measure of the resources needed to maintain a given population. This amount can then be translated into an equivalent area of energy, food or other natural resource production needed for that community.

As with any such measure, a principle issue is where one draws the limits of the systems and populations being measured. Typically dense urban areas rely on a large hinterland of farming, industry and uncultivated land. However, this does not mean large dense cites are less sustainable, but rather that one needs to consider the complex relationship between the urban centers and its region, and the modulation of density of populations and intensity of energy use and production. It is therefore easy to think of a resort island or city as a closed system, but in fact one needs to factor in the larger relationships in which it lies and practice responsible management of these resources. Such thinking and planning suggests ways to manage and integrate awareness of a community's ecological footprint while providing an engine for innovation and development.

While the land area of Galveston is slowly shrinking, its ecological footprint is growing substantially. Coastal development typically has a very large ecological footprint, both because of the degradations of a rich natural ecology produced by such development and because of the intense use of energy for programs such as hotels, casinos, and other tourist attractions. Including the footprint of travel would further engorge the footprint of a resort.

Alternatively, intensive sustainable urban agricultural production can provide jobs and while potentially creating a gastronomical center as chefs increasingly source local supplies and even start their own farms. Of course, sustainable energy, mass-transit and intelligent resource management can also shrink the overall footprint while creating lasting independence.

Research and diagrams in this section by David Dewane, Meredith Epley.



2008
= GALVESTON ISLAND LAND AREA IS 11,966 HECTARES (ha)
[46.2 SQUARE MILES]

ISLAND POPULATION IS APPROX. 71,700
[58,000 PERMANENT + 13,700 NON-PERMANENT]

2058
= GALVESTON ISLAND LAND AREA IS 9,013 HECTARES (ha)
[34.8 SQUARE MILES]

ISLAND POPULATION IS APPROX. 81,700
[68,000 PERMANENT + 13,700 NON-PERMANENT]

	FAIR SHARE (BASED ON BIOCAPACITY)	-	FOOTPRINT	=	ECOLOGICAL DEFICIT (-) OR RESERVE (+)
In 2008, Galveston's Ecological Deficit is:	335,317 ha [1,295 sq. mi.]	-	684,902 ha [2,644 sq. mi.]	=	-349,585 ha [-1,350 sq. mi.]
In 2058, Galveston's Ecological Deficit will be:	383,990 ha [1,483 sq. mi.]	-	784,320 ha [3,028 sq. mi.]	=	-400,330 ha [-1,546 sq. mi.]

2008 SUSTAINABLE POPULATION:

BASED ON U.S. BIOCAPACITY: $\frac{11,966 \text{ ha}}{4.7 \text{ global ha/person}} = 2,545$ people

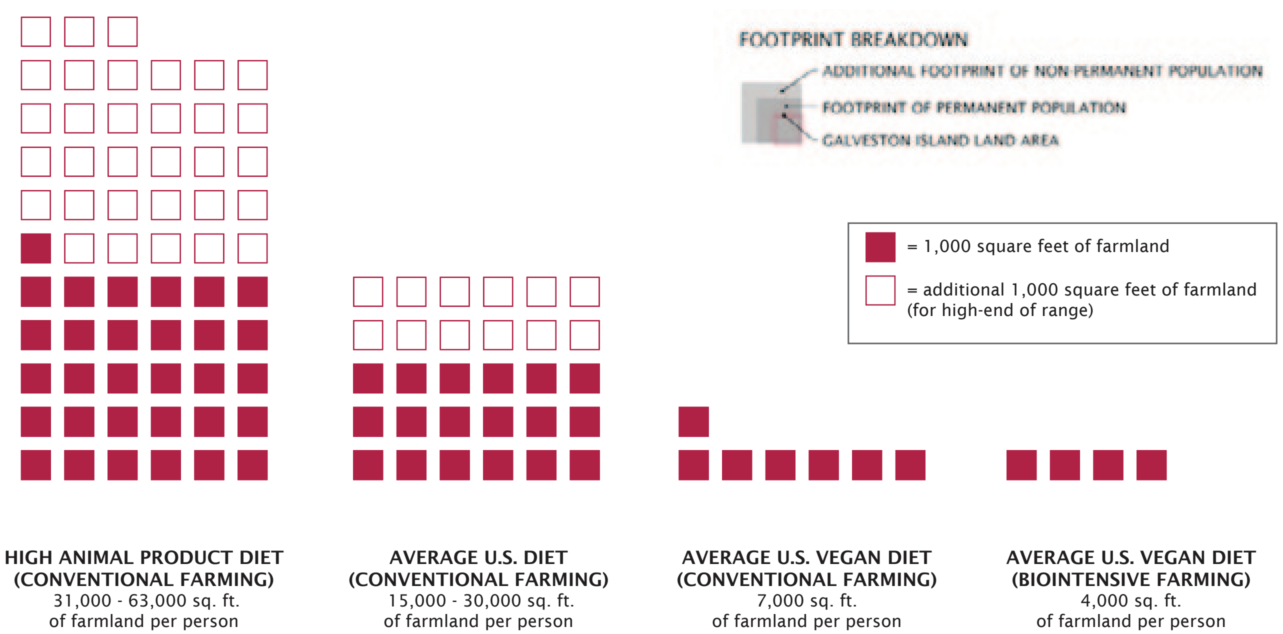
BASED ON WORLD BIOCAPACITY: $\frac{11,966 \text{ ha}}{1.8 \text{ global ha/person}} = 6,648$ people

2058 SUSTAINABLE POPULATION:

BASED ON U.S. BIOCAPACITY: $\frac{9,013 \text{ ha}}{4.7 \text{ global ha/person}} = 1,917$ people

BASED ON WORLD BIOCAPACITY: $\frac{9,013 \text{ ha}}{1.8 \text{ global ha/person}} = 5,007$ people

Calculations and Breakdowns of Ecological Footprint
A typical resort community, the land area needed to support Galveston's population is many times larger than the island's actual surface area.



Farmland required to support yearly per capita food consumption

2008 SUB- FOOTPRINTS

326,265 ha - PERMANENT POPULATION
+ 77,542 ha - NON- PERMANENT POPULATION
403,807 ha - TOTAL FOOTPRINT
2008 CARBON FOOTPRINT
33.7 Galvestons

32,281 ha - PERMANENT POPULATION
+ 7,672 ha - NON- PERMANENT POPULATION
39,953 ha - TOTAL FOOTPRINT
2008 NUCLEAR FOOTPRINT
3.3 Galvestons

56,491 ha - PERMANENT POPULATION
+13,426 ha - NON- PERMANENT POPULATION
69,917 ha - TOTAL FOOTPRINT
2008 CROP LAND FOOTPRINT
5.8 Galvestons

26,516 ha - PERMANENT POPULATION
+ 6,302 ha - NON- PERMANENT POPULATION
32,818 ha - TOTAL FOOTPRINT
2008 GRAZING LAND FOOTPRINT
2.7 Galvestons

13,258 ha - PERMANENT POPULATION
+ 3,151 ha - NON- PERMANENT POPULATION
16,409 ha - TOTAL FOOTPRINT
2008 FISHING GROUND FOOTPRINT
1.4 Galvestons

69,749 ha - PERMANENT POPULATION
+16,577 ha - NON- PERMANENT POPULATION
86,326 ha - TOTAL FOOTPRINT
2008 FOREST FOOTPRINT (TIMBER, PULP & PAPER)
7.2 Galvestons

1,729 ha - PERMANENT POPULATION
+ 411 ha - NON- PERMANENT POPULATION
2,140 ha - TOTAL FOOTPRINT
2008FOREST FOOTPRINT (FUELWOOD)
0.2 Galvestons

27,093 ha - PERMANENT POPULATION
+ 6,439 ha - NON- PERMANENT POPULATION
33,532 ha - TOTAL FOOTPRINT
2008 BUILT- UP LAND FOOTPRINT
2.8 Galvestons

2058 SUB- FOOTPRINTS

384,880 ha - PERMANENT POPULATION
+ 77,542 ha - NON- PERMANENT POPULATION
462,422 ha - TOTAL FOOTPRINT
2058 CARBON FOOTPRINT
51.3 Galvestons

38,080 ha - PERMANENT POPULATION
+ 7,672 ha - NON- PERMANENT POPULATION
45,752 ha - TOTAL FOOTPRINT
2058 NUCLEAR FOOTPRINT
5.1 Galvestons

66,640 ha - PERMANENT POPULATION
+13,426 ha - NON- PERMANENT POPULATION
80,066 ha - TOTAL FOOTPRINT
2058 CROP LAND FOOTPRINT
8.9 Galvestons

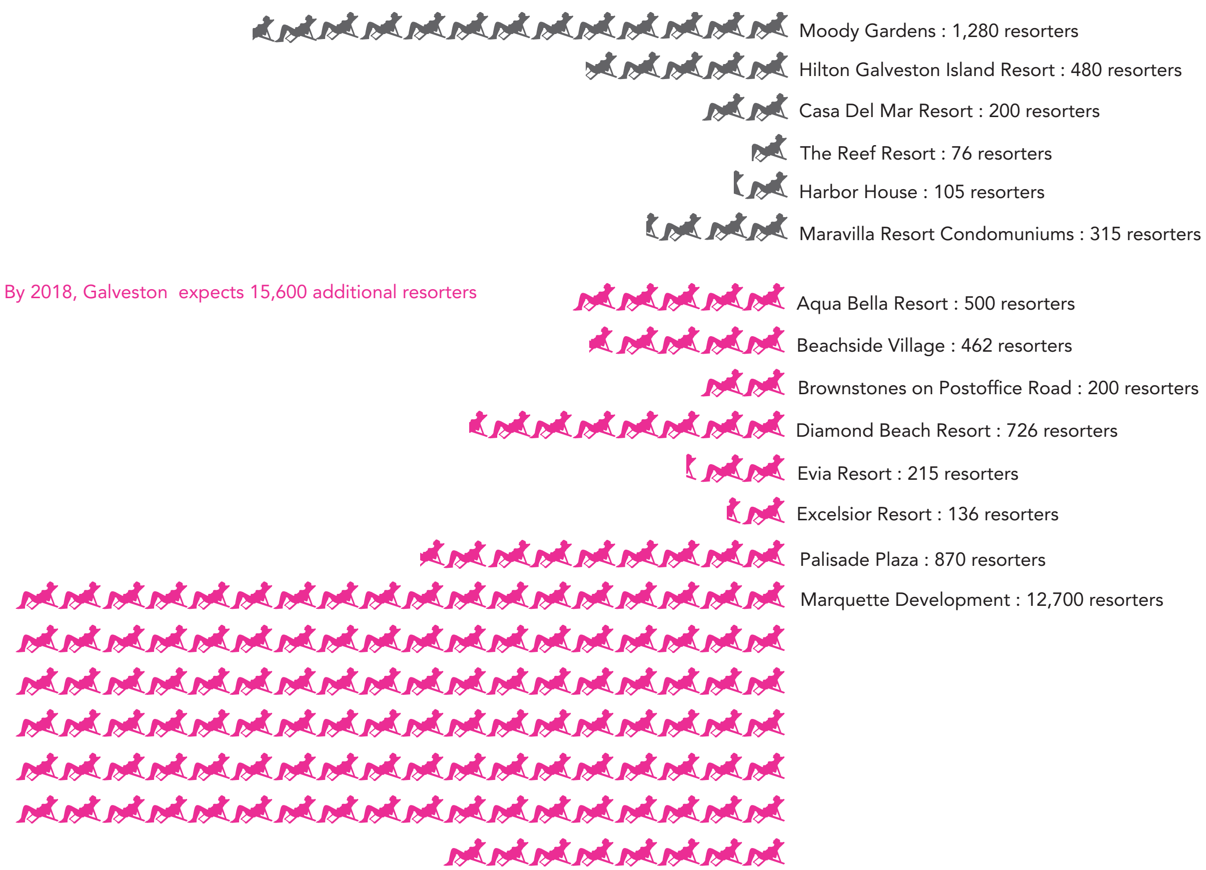
31,280 ha - PERMANENT POPULATION
+ 6,302 ha - NON- PERMANENT POPULATION
37,582 ha - TOTAL FOOTPRINT
2058 GRAZING LAND FOOTPRINT
4.2 Galvestons

15,640 ha - PERMANENT POPULATION
+ 3,151 ha - NON- PERMANENT POPULATION
18,791 ha - TOTAL FOOTPRINT
2058 FISHING GROUND FOOTPRINT
2.1 Galvestons

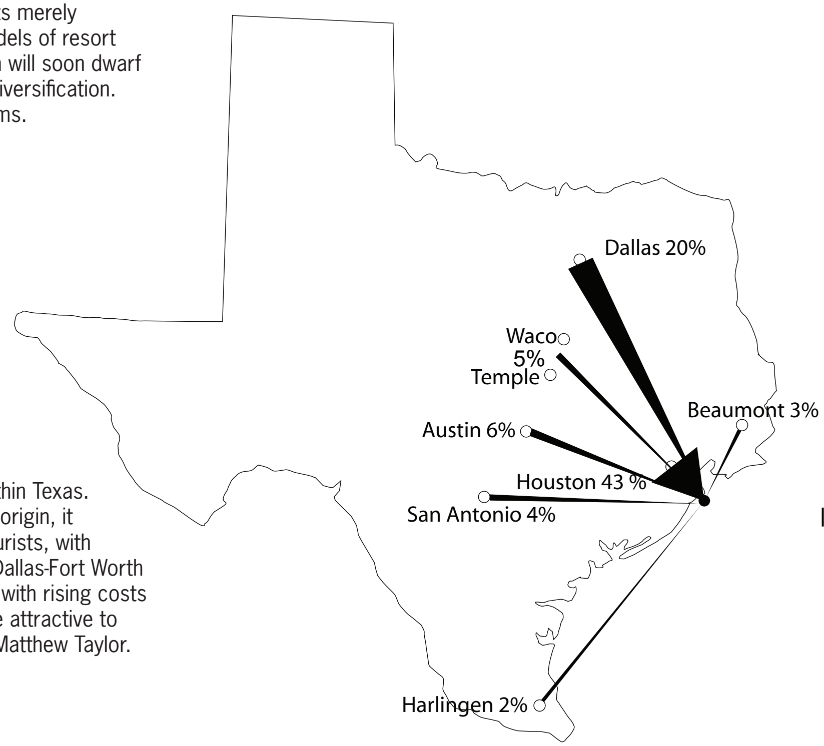
82,280 ha - PERMANENT POPULATION
+16,577 ha - NON- PERMANENT POPULATION
98,857 ha - TOTAL FOOTPRINT
2058 FOREST FOOTPRINT (TIMBER, PULP & PAPER)
11.0 Galvestons

2,040 ha - PERMANENT POPULATION
+ 411 ha - NON- PERMANENT POPULATION
2,451 ha - TOTAL FOOTPRINT
2058 FOREST FOOTPRINT (FUELWOOD)
0.3 Galvestons

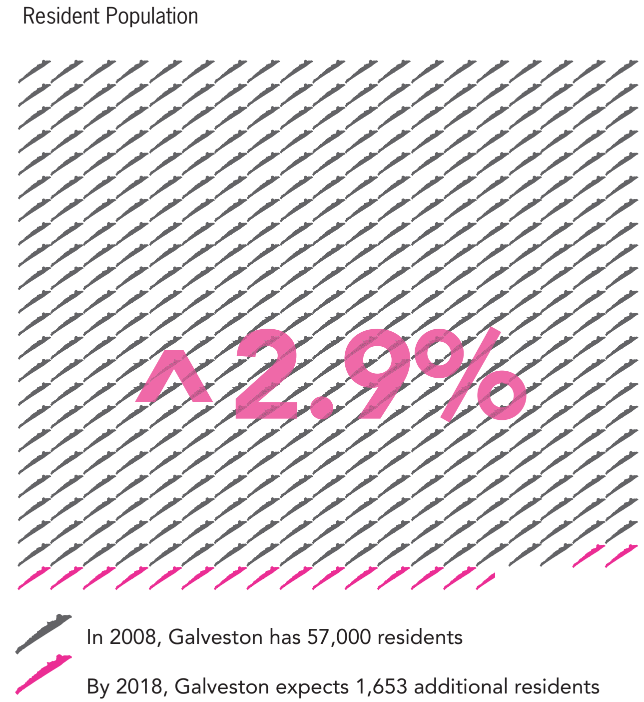
31,960 ha - PERMANENT POPULATION
+ 6,439 ha - NON- PERMANENT POPULATION
38,399 ha - TOTAL FOOTPRINT
2058 BUILT- UP LAND FOOTPRINT
4.3 Galvestons

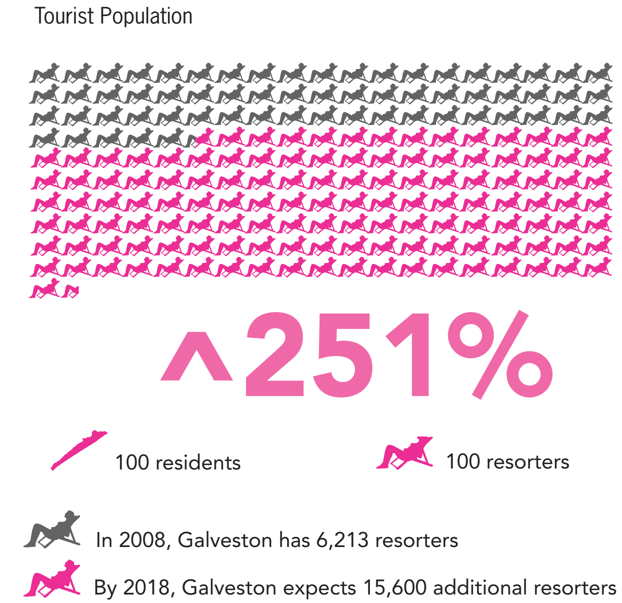


More of the Same
Current major tourist destinations and projected projects and need (in pink). Currently planned projects merely replicate already existing programs and models of resort and resort living. However, expected growth will soon dwarf existing resorts, offering opportunities for diversification. Diagram by Benson Gillespie, John McWilliams.



Regional Attractor
This diagram shows the origin of visitors within Texas. While Houston is the largest single point of origin, it accounts for less than half of total Texas tourists, with one-fifth travelling over five hours from the Dallas-Fort Worth area. Regional high-speed light rail, feasible with rising costs of energy, would make Galveston even more attractive to these areas. Diagram by Ninoslav Krgovic, Matthew Taylor.





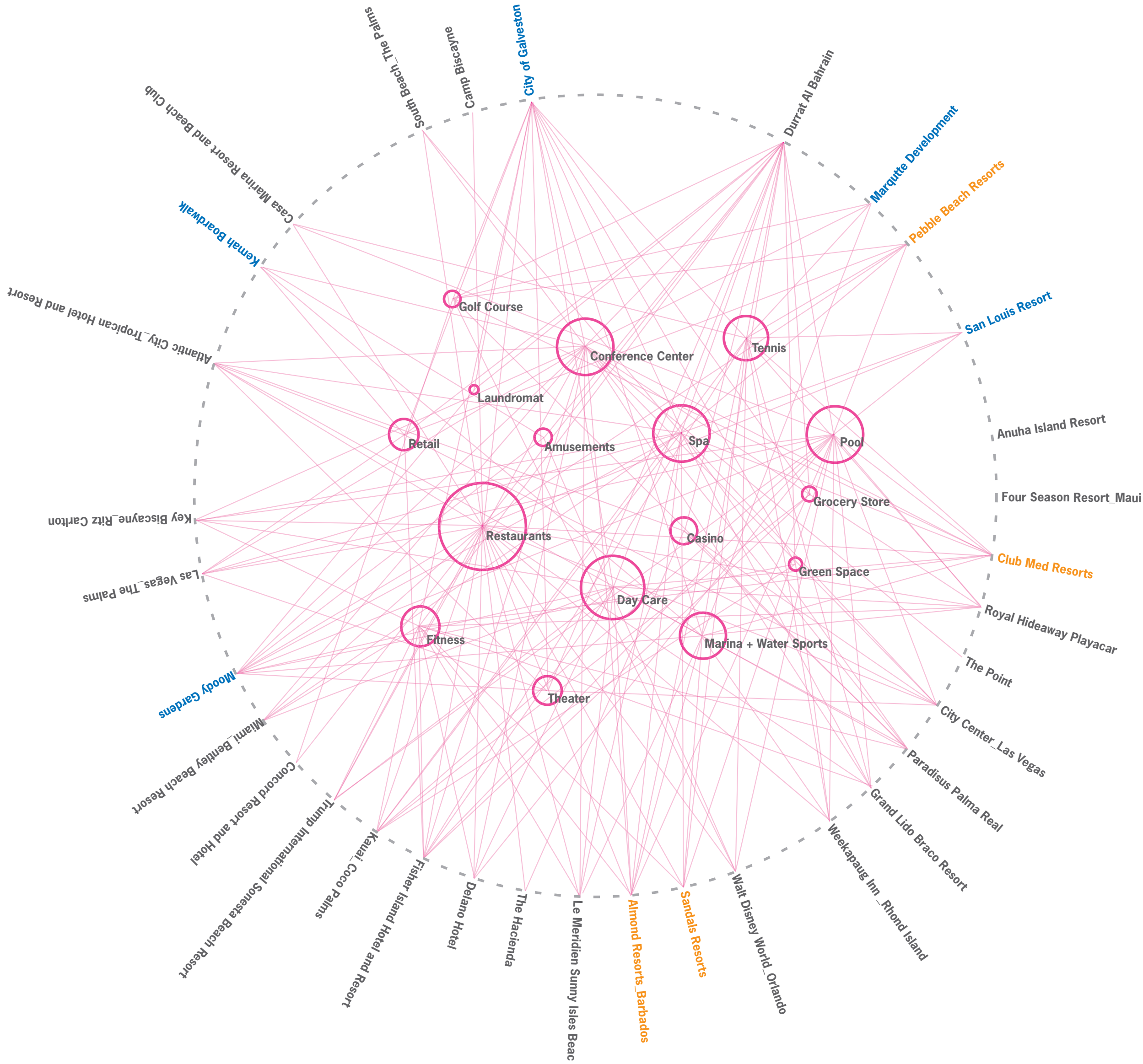
Projected growth of resident population versus tourist populations
Diagram by Benson Gillespie, John McWilliams.

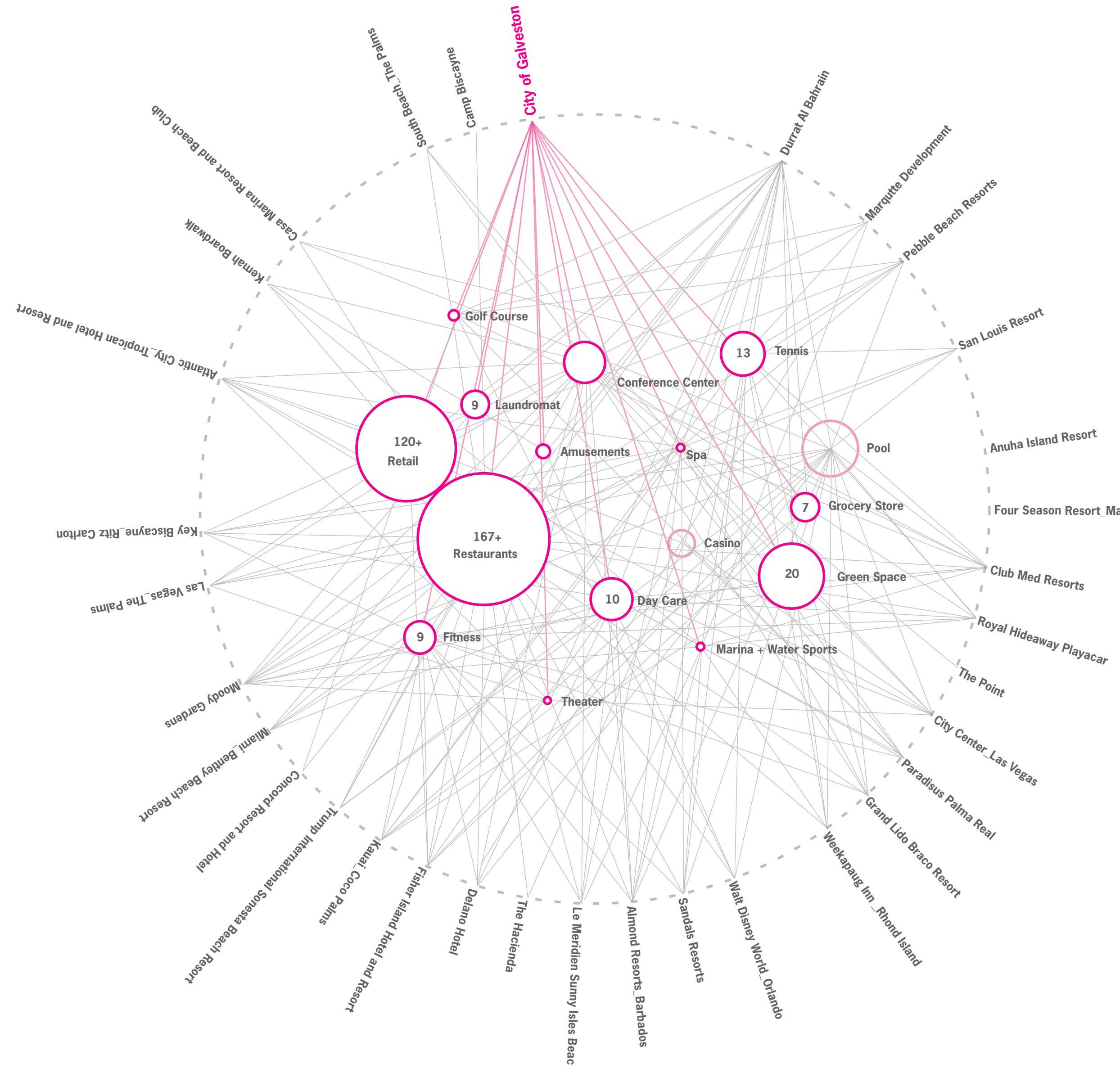
Tourism and the post carbon economy

Globally, if all the tourists each year were one nation, they would constitute the third largest country in terms of population (just behind India). If global tourist revenue were added together it would be the equivalent of the 18th largest economy in terms of GDP. Since World War Two, tourism has been one of the fastest growing sectors of the world economy and a cultural leader in processes of globalization. Between 1950 and 2005, tourism increased at an average annual rate of 6.5% with over an 11% average increase in revenue each year, exceeding the average growth of the US stock exchange. Moreover, while only 15 cities accounted for almost 90% of total tourist traffic, the top destinations now account for only about 60% of traffic (figures from the World Tourism Organization). Tourism is now the largest sector of the world economy.

This dramatic growth has been enabled by the growth of discretionary income in the middle classes, liberalized markets, deregulation of airline industries, cheap labor and cheap fuel. International air flight arrivals are expected to surpass 1.5 billion by 2020, exceeding the current population of China. However, the status quo may be transformed by the impact of higher travel costs (due to fuel costs or environmental offsets) and shifting markets.

The UN World Tourism Organization predicts that by 2018, international travel will create 2.5 billion tons of carbon dioxide. This is 2 billion tons greater than in 1990–a figure that would seriously impact international attempts to curtail greenhouse gas emissions. Moreover, a shrinking middle class, static wages and poor market performance in the United States and parts of Europe may restrict spending in what has been the core demographic. Increasing incomes in emerging markets may transform travel patterns. All this suggests that tourism might be poised on the cusp of a dramatic transformation. One possibility is an increase in local and regional tourism relative to more distant travel.





The Global Resort City

Based on research of top resort destinations across the globe, the diagram above shows the relative size and relationships of their program components, producing an aggregate picture of resorts around the world. Resorts in blue are on Galveston Island. Resorts in orange can be considered key beach themed competitors.

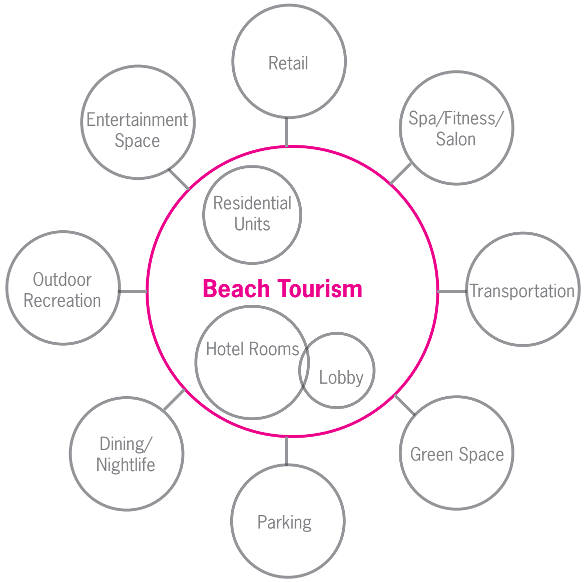
The diagram on the right compares Galveston as a whole to the ideal resort above, showing its strengths and weaknesses as a resort city. To capitalize on growth in local and regional tourism, the city needs to incentivize missing categories while not producing redundant or out of date tourist programs, looking for those that produce the greatest economic benefits to the city in general, as opposed to private resorts while also fostering a local economy of high-wage jobs in addition to the relatively low-wage tourist service sector.

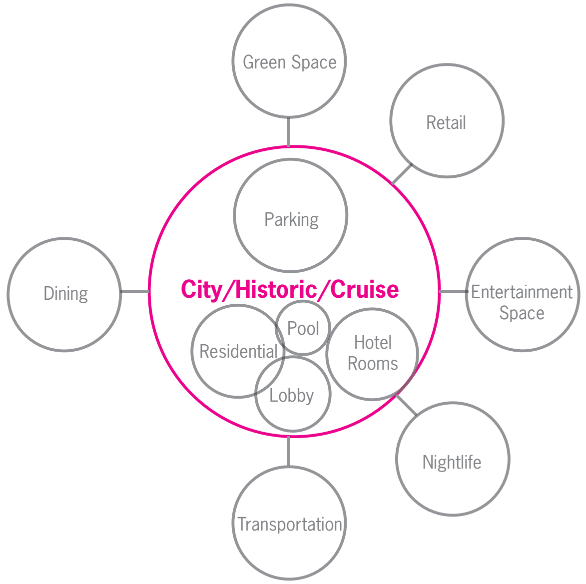
Growth in local and regional tourism may be expected as a more economical and sustainable form of tourism in a carbon restricted and possible internationally protectionist future. As indicated in the 1999 United Nations report, “Tourism and Sustainable Development,” traveling closer to home shrinks the ecological footprint of tourism while providing for local economies in post-industrial areas.

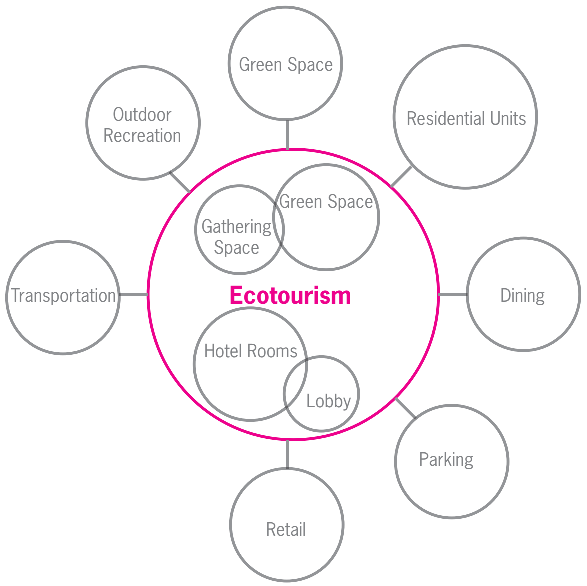
All this suggests that local coastal communities, such as Galveston, may be poised to recover a significant portion of the tourist dollars they have lost due to the growth of international tourism in favour of more exotic locales. Local business and conference revenue might increase due to similar factors.

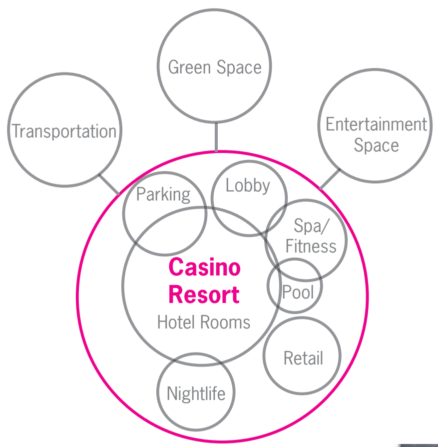
However, these cities need to foster the amenities and qualities that can compete at the regional scale. Also, they need to find ways of producing synergies between tourism and local industrial economies in order to maintain a resident population that can support this increasingly demanding industry at levels of living wages. Even with the reduced travel distances, sustainable tourism requires smarter use of local resources. For example, in the large chain eateries that dominate the tourist restaurant culture of Galveston very little of the fish comes from the local waters, and are instead frozen or flown in fresh from far-away destinations. Lastly, this development needs to occur in a way that does not strangle the city in a ring of private and exclusive developments that ultimately hurts both the city and its attraction as a tourist destination.

Research and diagrams by Benson Gillespie, John McWilliams.



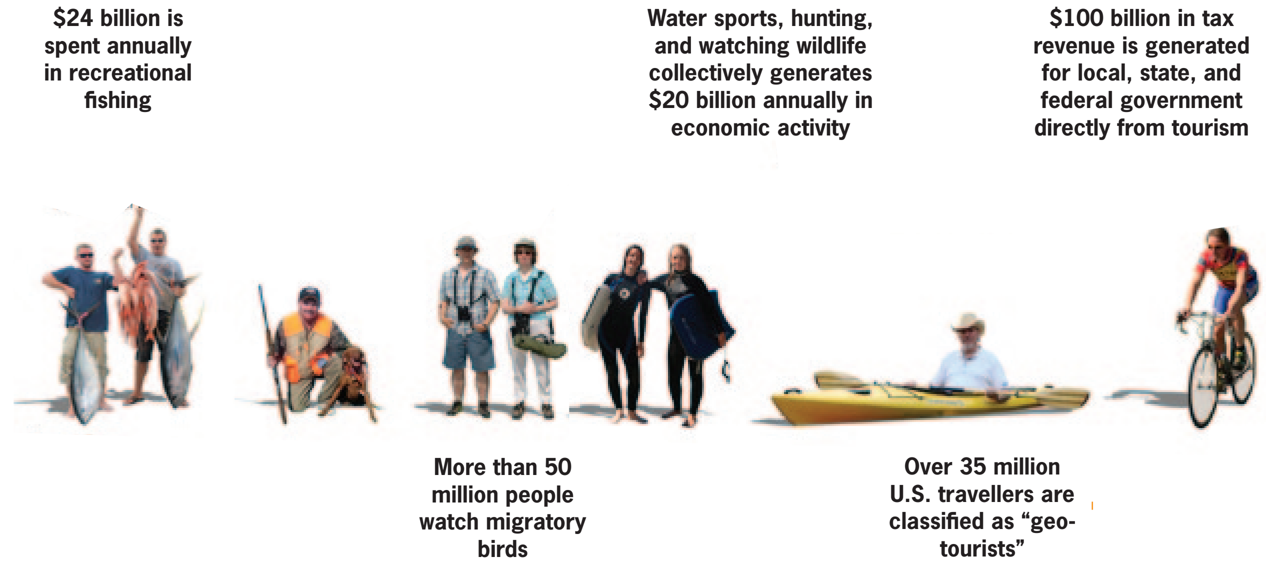






Above: Potential Synergies of Ecotourism with Existing Tourist Attractors on the Island.
Diagram and research by Sara Hieb

Right: Growth of Ecotourist Economy in Costa Rica, an ecotourist epicenter.
Research by Kathering (Green) Hays & Lyslie Oliveros



Revenues from different types of ecotourism.
Research and diagrams by North Keeragool, Kathryn Pakenham.

Ecotourism

Eco-tourism is a quickly growing global industry that seeks to minimize the impact of its activities and increase environmental and cultural awareness while offering direct financial benefits to the local communities. While one tends to think of eco-tourist destinations as far-off and romantic locales, islands such as Galveston are an ecotourist gold mine awaiting discovery, or at least, capitalization.

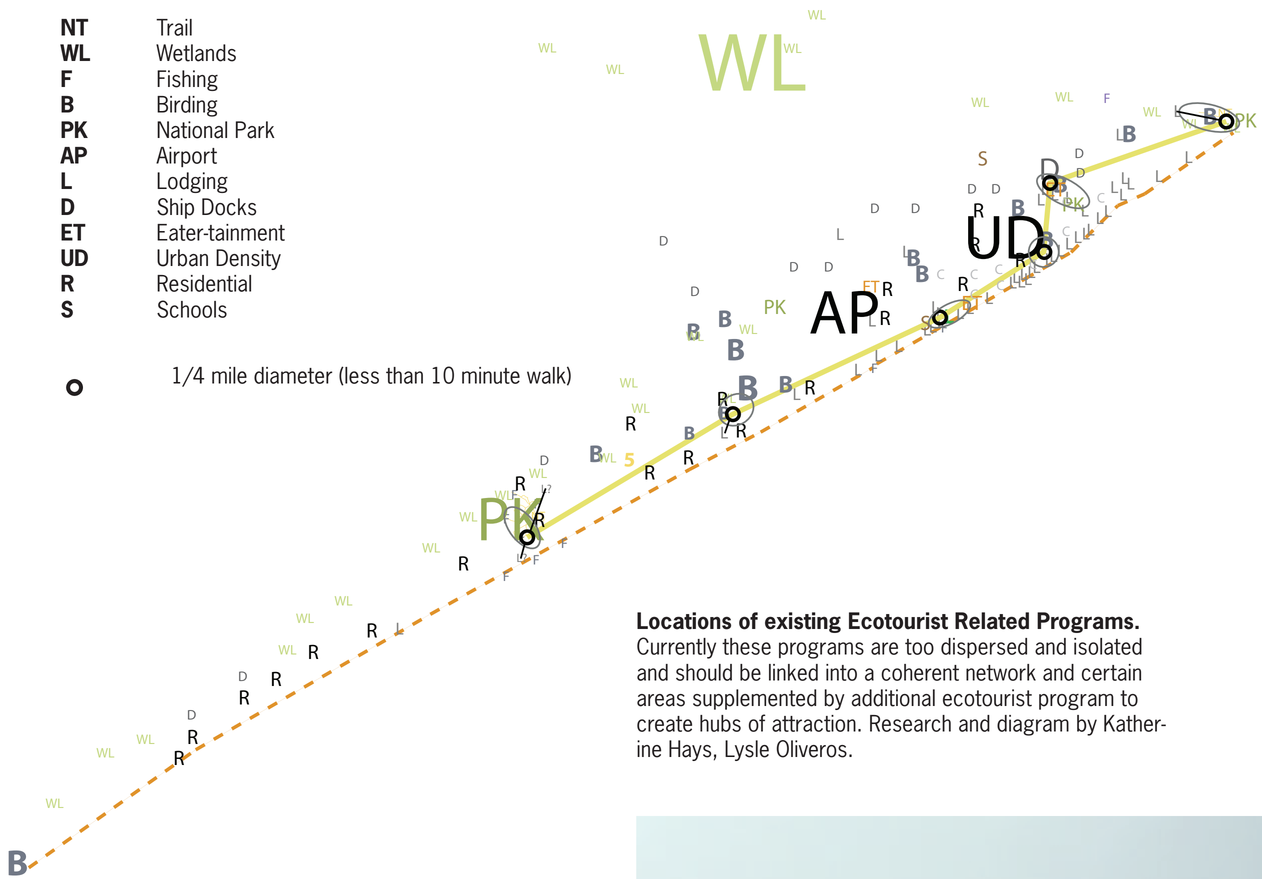
In 2007, 5.4 million visitors came to Galveston, about 90 times the population of the city. Every $60,000 of tourism creates one job, and over $4000 in state and local taxes. Of these visitors, over two-thirds spent their time on the beach or waterfront, while only 1% went to the state or national parks. Yet if only 1% of the visitors were involved in eco-toursim, it would equal $35 million spent in Galveston each year by ecotourists.

Nationally, bird and wildlife watching adds $29 billion to the national economy every year (according to the U.S. Fish & Wildlife Service). The Texas Gulf Coast, and Galveston in particular, is situated along the main migratory paths from North to South America and is already a hub of bird watching activity and recreational fishing.

Sites and programs can be developed that diversify eco-touristic potential, tapping into a regionally under served market to restore and reconstruct such areas in the wake of environmental disaster. For example, if areas become uninsurable or uninhabitable due to shoreline retreat or storm damage, they could be transformed into ecotourist attractors. Indeed, protection of all shoreline habitats through reasonable setbacks could produce longer term and sustainable tax revenue that could offset property tax losses and generate jobs for the community that are more desirable than those of the typical tourist service sector. This potential is made even greater by the possibility of the rising importance of local and regional tourism with rising travel and energy costs.

NT	Trail
WL	Wetlands
F	Fishing
B	Birding
PK	National Park
AP	Airport
L	Lodging
D	Ship Docks
ET	Eater-tainment
UD	Urban Density
R	Residential
S	Schools

○ 1/4 mile diameter (less than 10 minute walk)

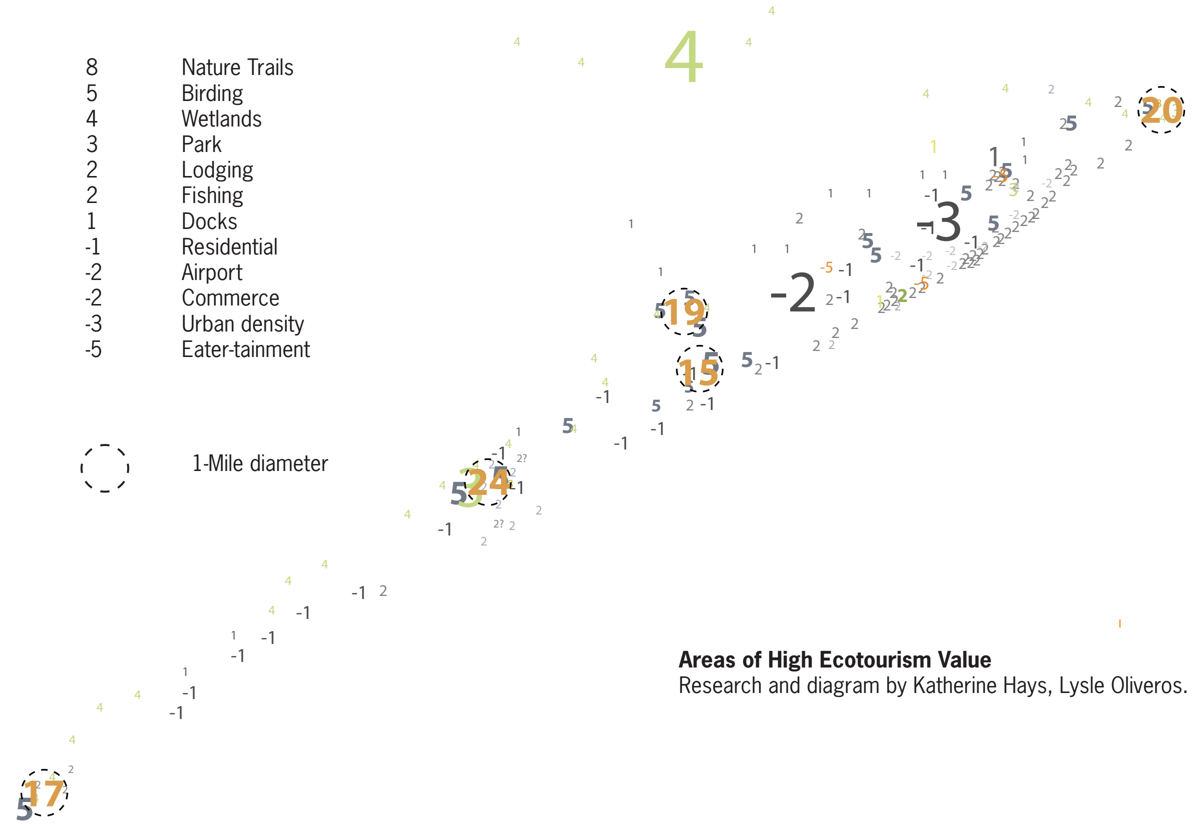


Locations of existing Ecotourist Related Programs.
Currently these programs are too dispersed and isolated and should be linked into a coherent network and certain areas supplemented by additional ecotourist program to create hubs of attraction. Research and diagram by Katherine Hays, Lysle Oliveros.

Migratory Bird Paths
The Houston-Galveston Area is a key stop over for birds on their annual migrations. However, wetland loss and climate change is beginning to alter these patterns. Diagram by Jessica Cronstein, Annika Miller, Jessica Tankard.

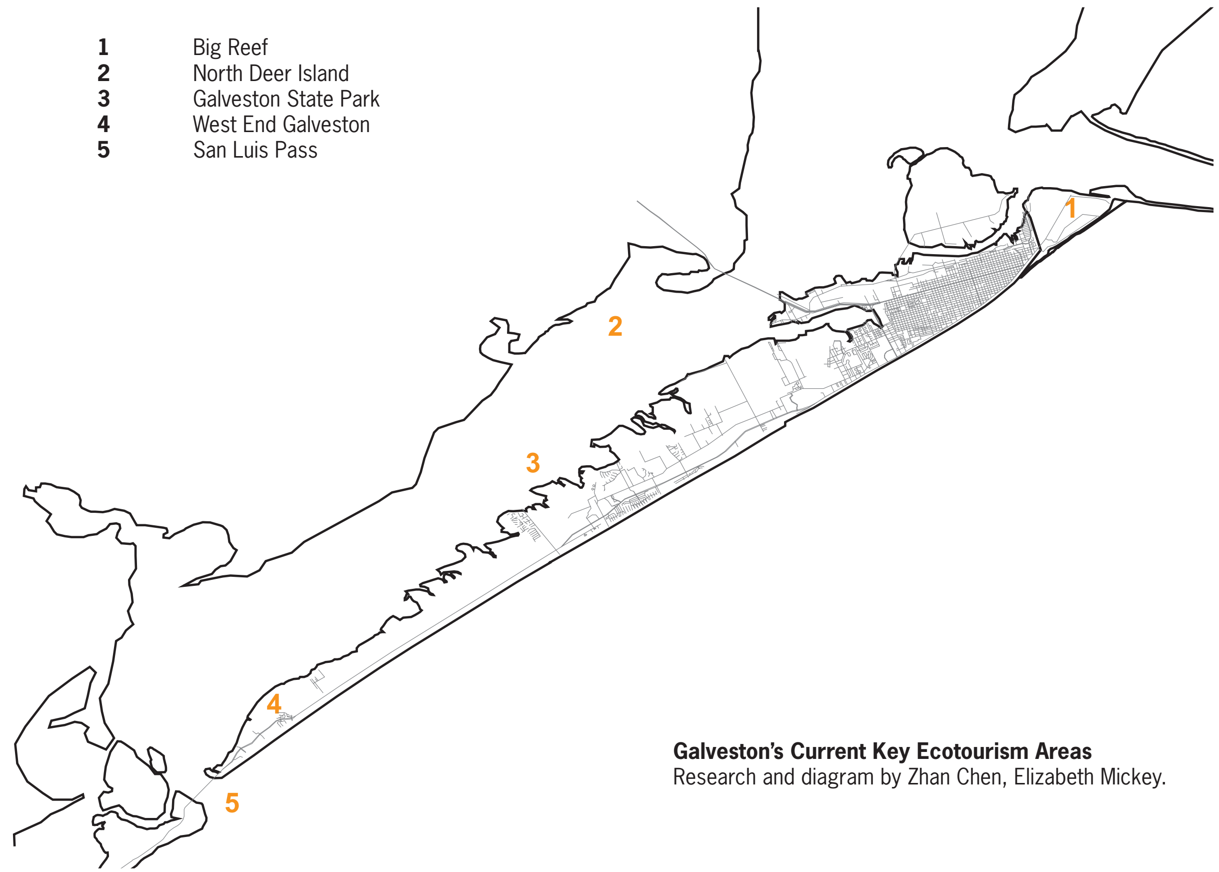
8	Nature Trails
5	Birding
4	Wetlands
3	Park
2	Lodging
2	Fishing
1	Docks
-1	Residential
-2	Airport
-2	Commerce
-3	Urban density
-5	Eater-tainment

1-Mile diameter



Areas of High Ecotourism Value
Research and diagram by Katherine Hays, Lysle Oliveros.

1	Big Reef
2	North Deer Island
3	Galveston State Park
4	West End Galveston
5	San Luis Pass



Galveston's Current Key Ecotourism Areas
Research and diagram by Zhan Chen, Elizabeth Mickey.

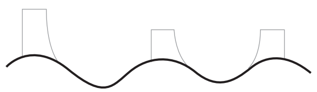
III

Design Proposals

The following projects offer examples of alternative futures for the Island. Each project strategically relates multiple scientific, ecological and urban factors of Sections I and II that, as we have argued, configure coastal development and Galveston in particular. Design is understood as a way of synthesizing these often competing factors, creating speculative proposals for a more resilient and sustainable urbanism. In doing so, the projects also advance new disciplinary combinations of architecture, urbanism and landscape for our green century. The projects are organized from East to West, except for the last five projects, which offer inspiring and disturbing visions of extreme scenarios extrapolated from current trends.

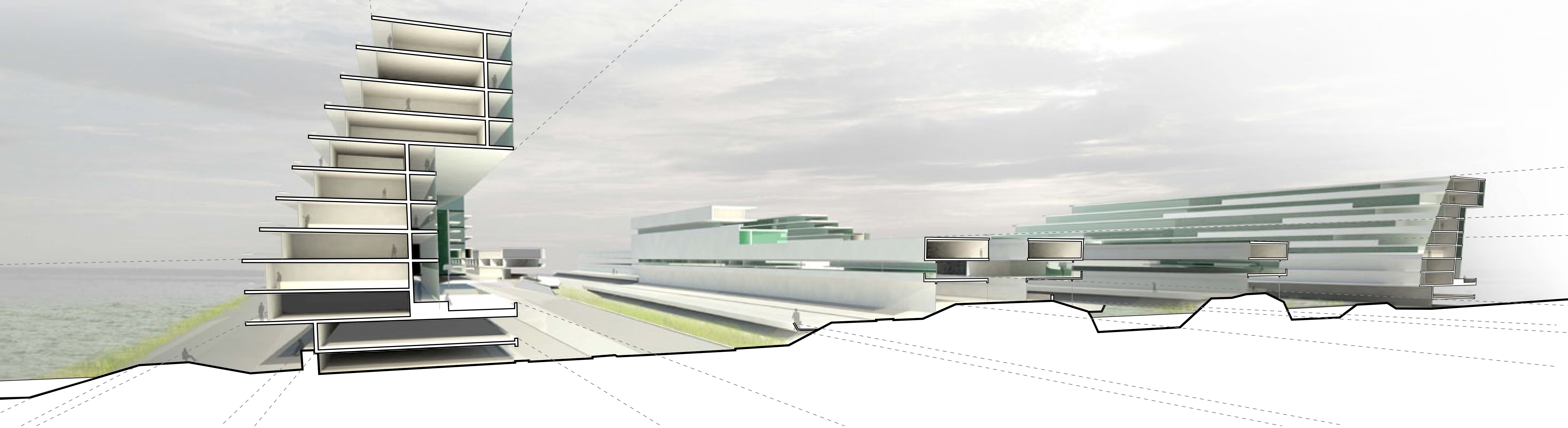
typical development flattens the landscape

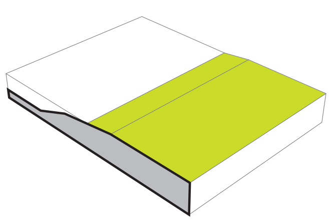
proposed strategy amplifies the protective and ecological performance of the landscape



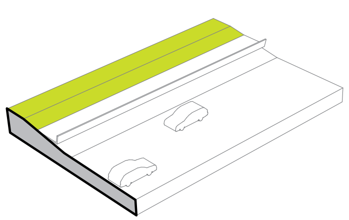
Urban Corrugations

Zhan Chen, Elizabeth Mickey
2009

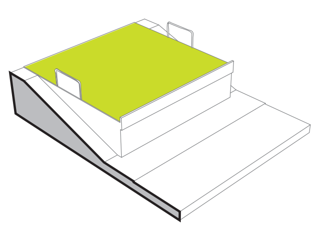




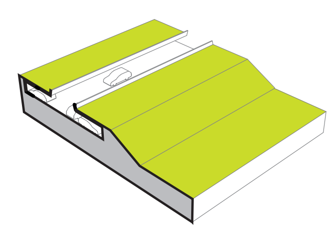
Gentle slopes encourage lateral connectivity and interfaces between urban and natural systems



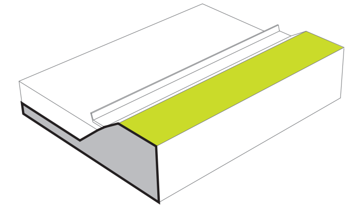
Sectional variation can allow transitions between modes of circulation, or occupation of edges



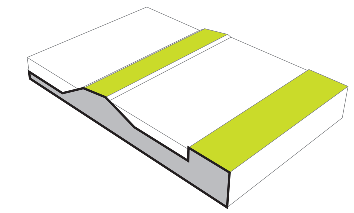
Retail program embedded into berms serves as retaining structures and provide roof landscapes



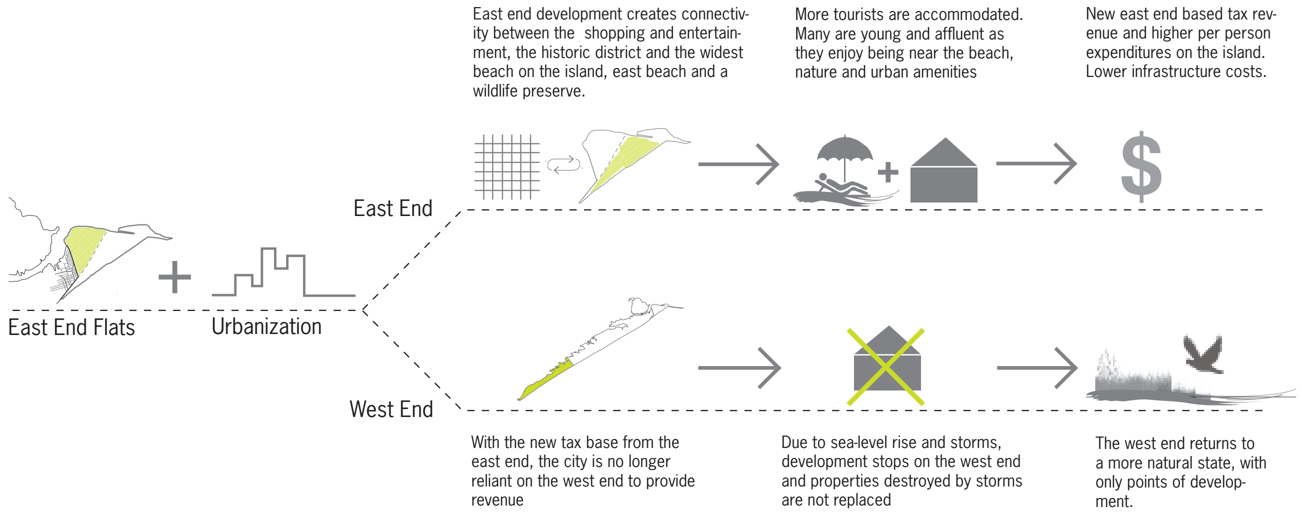
Cuts within berm provide for vehicles, parking and services



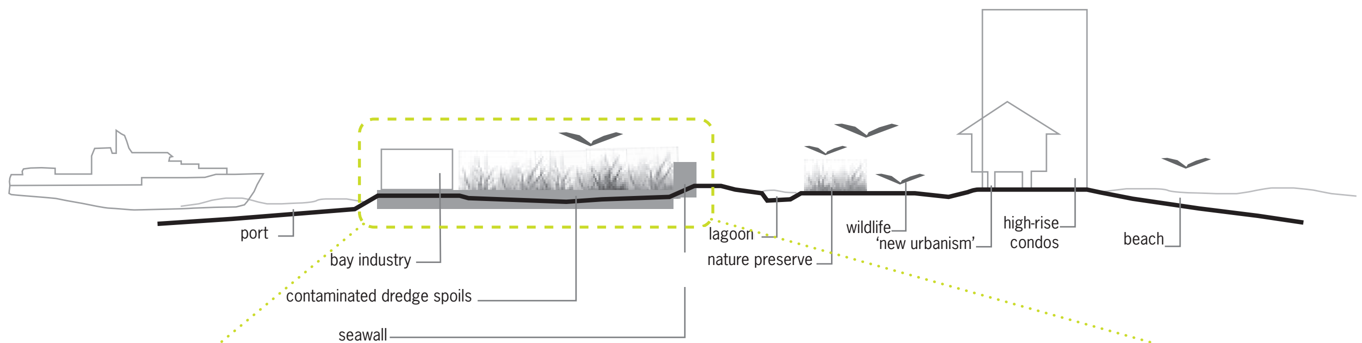
Cantilevered pedestrian paths allow circulation and visual and physical connection to canals and other landscape features



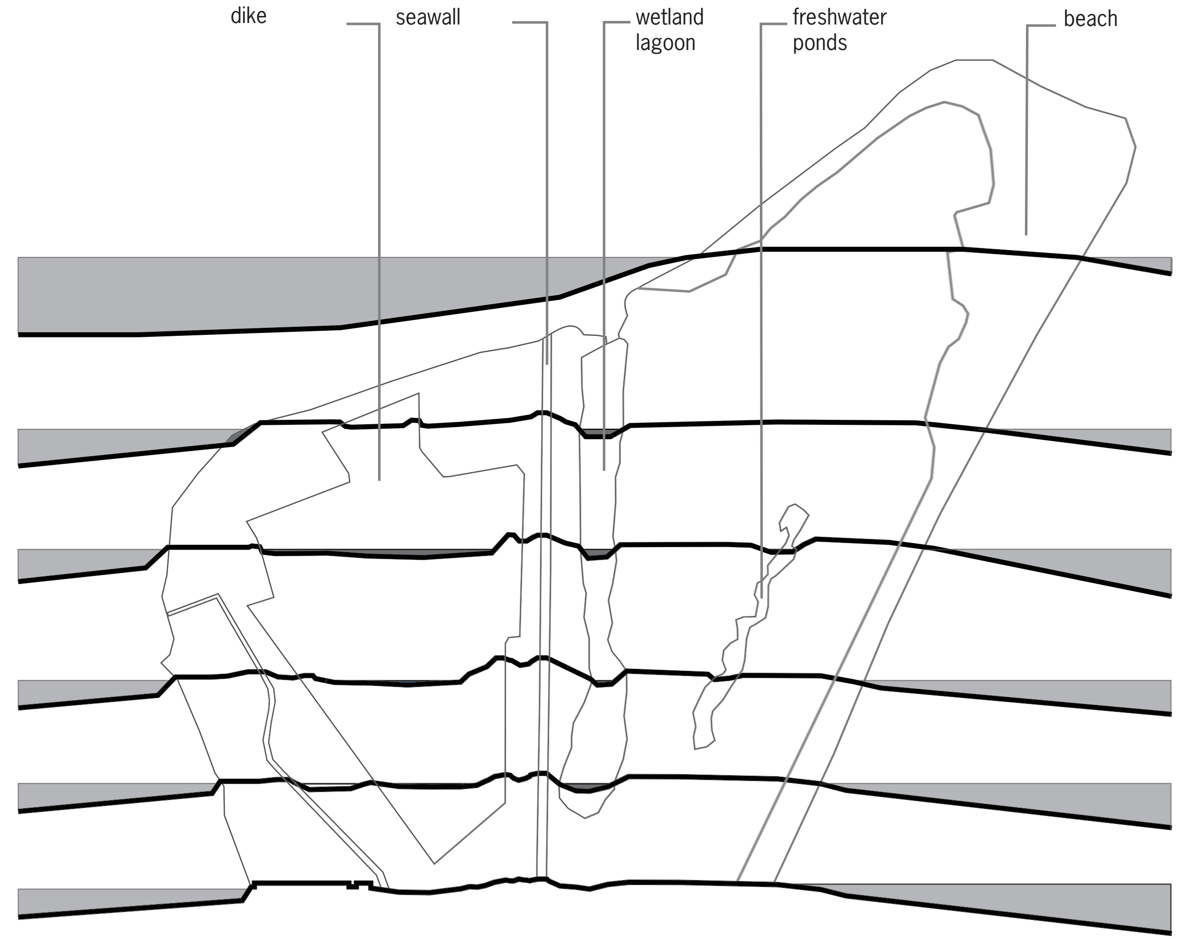
Berms are shaped to support a variety of recreational programs, including boating canals, marinas, swimming, wetlands and parks



City of Forking Paths
By relocating growth from certain hazard zones, the biodiversity and wetland habitats of the West End of Galveston can be increased. Concurrently, development on the East Beach would generate economic returns for the island in the form of an increased tax base and tourist revenue.



Byproduct Territories
The proposed site was created as a by-product of the industrial ecologies of the area. The land was formed by the dumping of spoils from dredging for shipping, the construction of jetties to protect these ship channels and by the seawall, which in this location now bisects the island due to the accretion of sediment trapped by the long jetty on the eastern tip of the island.

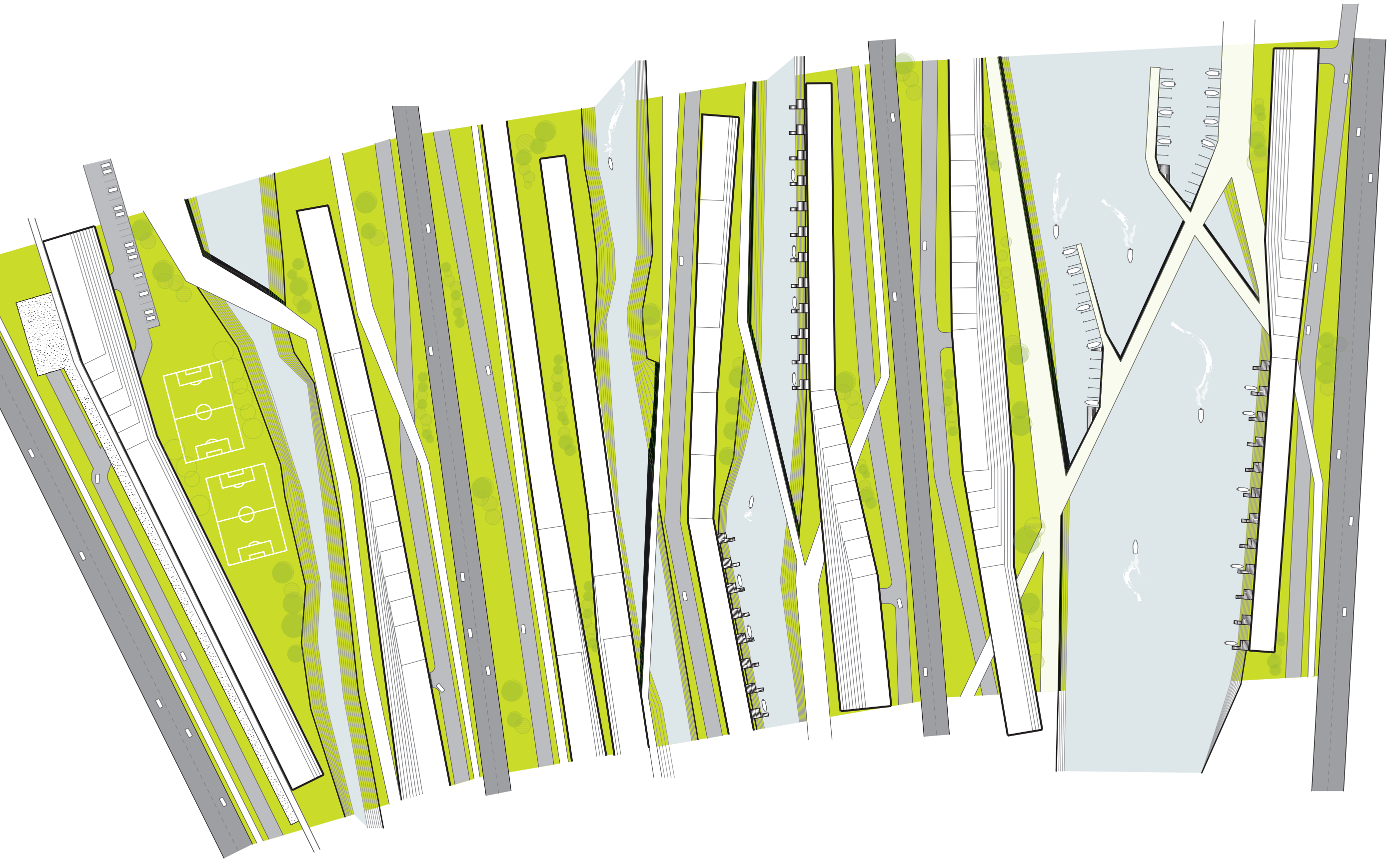


Urban Corrugations seeks to provide a framework for a mixed- use residential community that connects Galveston's existing urban conditions with the natural amenities of East Beach. This new approach for urban development responds to Galveston's environmental challenges to inform the shaping of new landscape and building typologies.

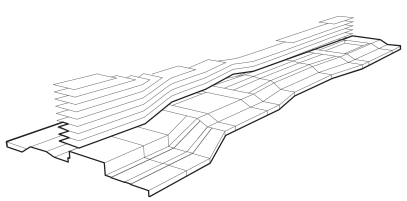
By corrugating the landscape to form a system of earth berms, housing structures are provided with an elevated ground that both eliminates the traditional piloti construction while offering another level of protection from storm surges. Simultaneously, berm construction creates inverse landscape cuts that form a system of water canals that create natural atmospheres and sustain recreational functions.

A synthesis of nature and urbanism along with fluctuations in building height allow for a range of views and scales. This allows a mixture of density types to emerge on the site that have direct relationships to landscape conditions based on relational planning strategies. Other site components such as walking paths and secondary roads follow the linear logic of the buildings, providing both vehicular and pedestrian connectivity across the site. Larger recreation zones focused on public space and community interaction are also integrated in the design.

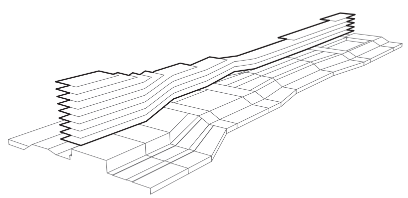
Urban Corrugations synthesizes the various environmental and urban qualities of Galveston into a protective setting, creating intimate spaces while still providing panoramic views and public spaces. The East End Flats, in turn, are approached as a crucial resource for the future of the Island, as the landscape is modulated to produce a rich variety of scales, atmospheres and views that intermingle buildings and landscape.



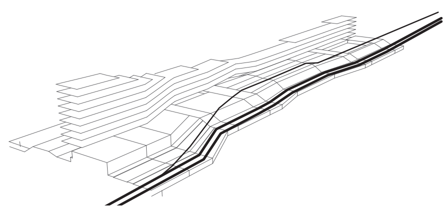
Detail Plan
The existing seawall is on the left edge, with a new marina on the right.



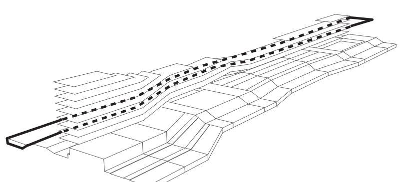
Berms
Berms create an alternate landscape surface that contain both recreational and service programs



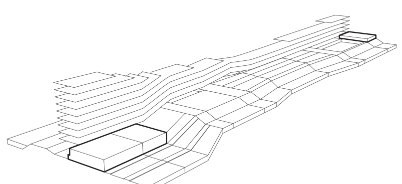
Housing
As an alternative to piloti housing on top of landscape, berms offer flood and storm protection. Housing type and density informs the sectional qualities of the berms.



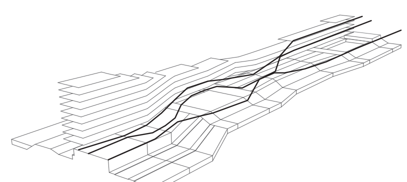
Secondary Roads
Main vehicular traffic runs along berms while secondary crossover and access roads peel off when berm elevation is low.



Canals
A system of canals along housing provides residents with a network of semi-public and public recreational areas.

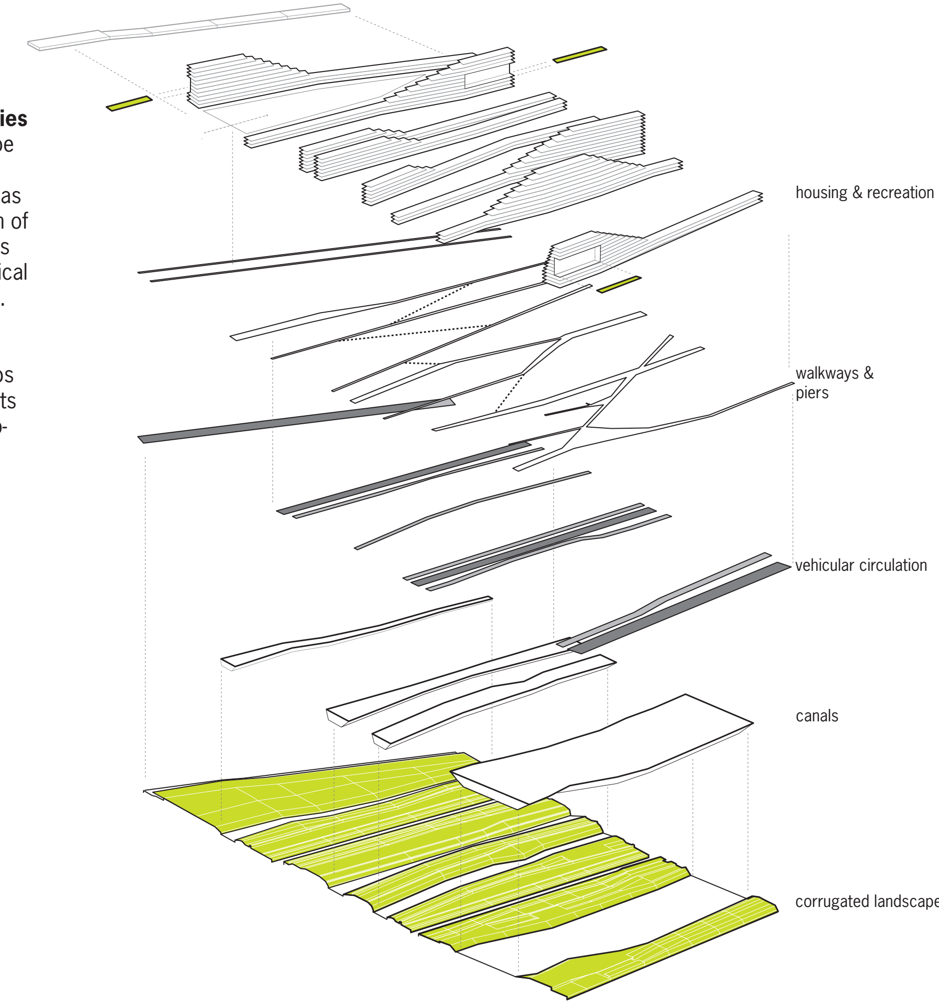


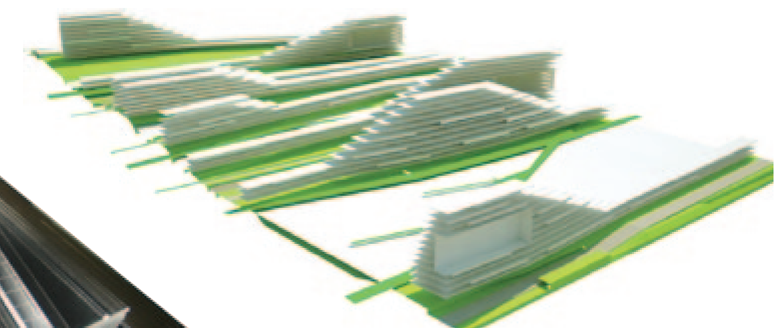
Retail
Retail businesses are integrated into the landscape berms and provide large public open and park space on the surface above.



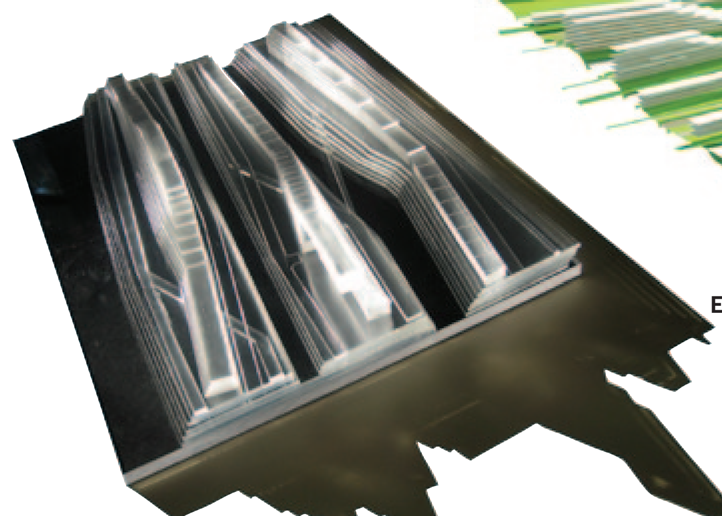
Walking Paths
Pedestrian paths or strings of public green space on the berms promote social interaction among residents and provides for efficient walking mobility.

Assemblage Strategies
Buildings and landscape are seen not as two different elements but as part of a single system of co-evolved components that occupy an ecological performance envelope. Massing and topography are determined by parametric relationships between these elements rather than rigid typologies.

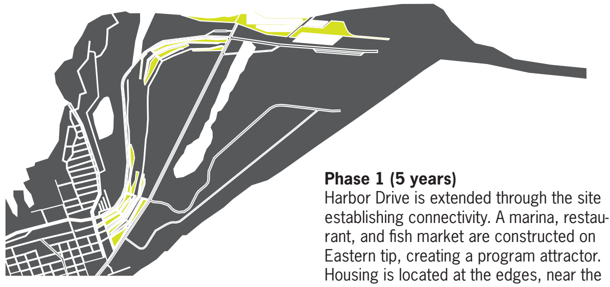




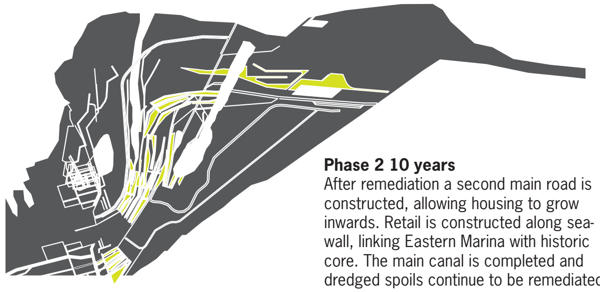
Exploded Axonometric of Parametric Systems



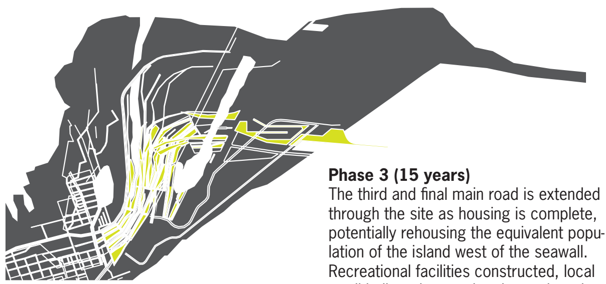
Sectional Model



Phase 1 (5 years)
Harbor Drive is extended through the site establishing connectivity. A marina, restaurant, and fish market are constructed on Eastern tip, creating a program attractor. Housing is located at the edges, near the marina and the historic urban core. Main canal is dredged and spoils remediated in the center as landscaped berms.

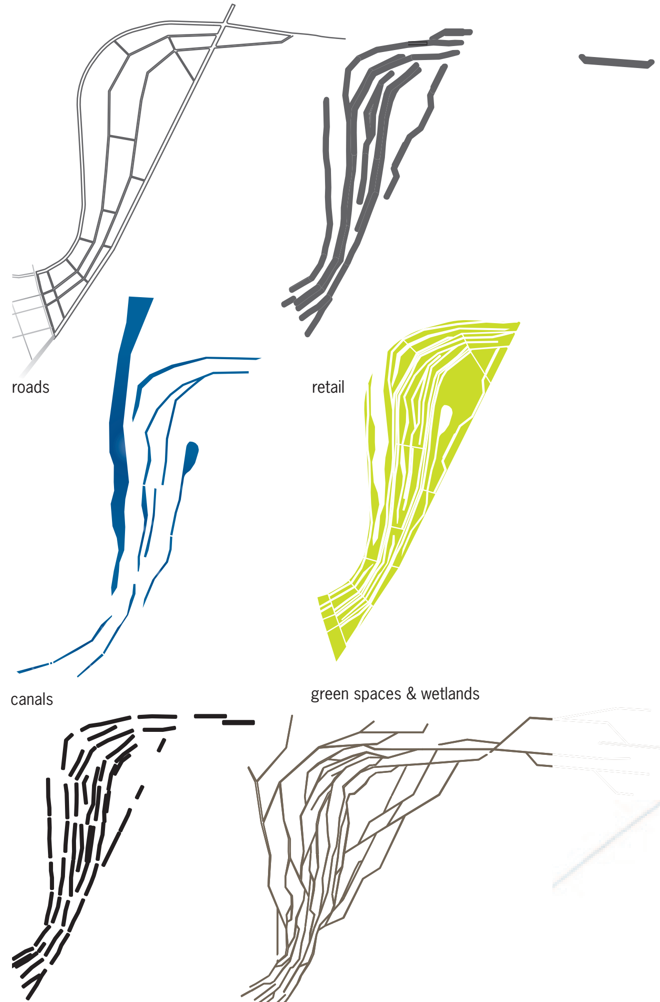


Phase 2 10 years
After remediation a second main road is constructed, allowing housing to grow inwards. Retail is constructed along seawall, linking Eastern Marina with historic core. The main canal is completed and dredged spoils continue to be remediated in the center.



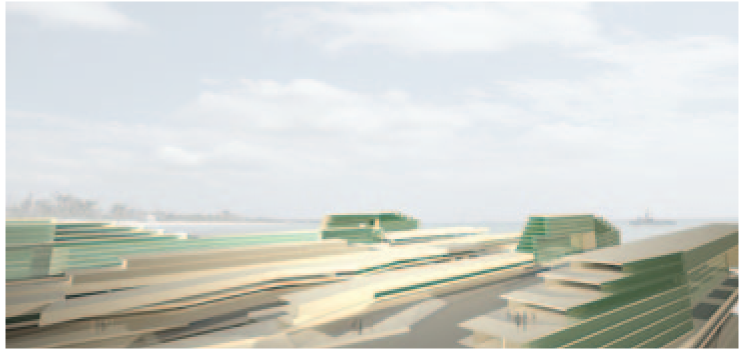
Phase 3 (15 years)
The third and final main road is extended through the site as housing is complete, potentially rehousing the equivalent population of the island west of the seawall. Recreational facilities constructed, local retail built and secondary internal marina completed.

Sequencing and Staging

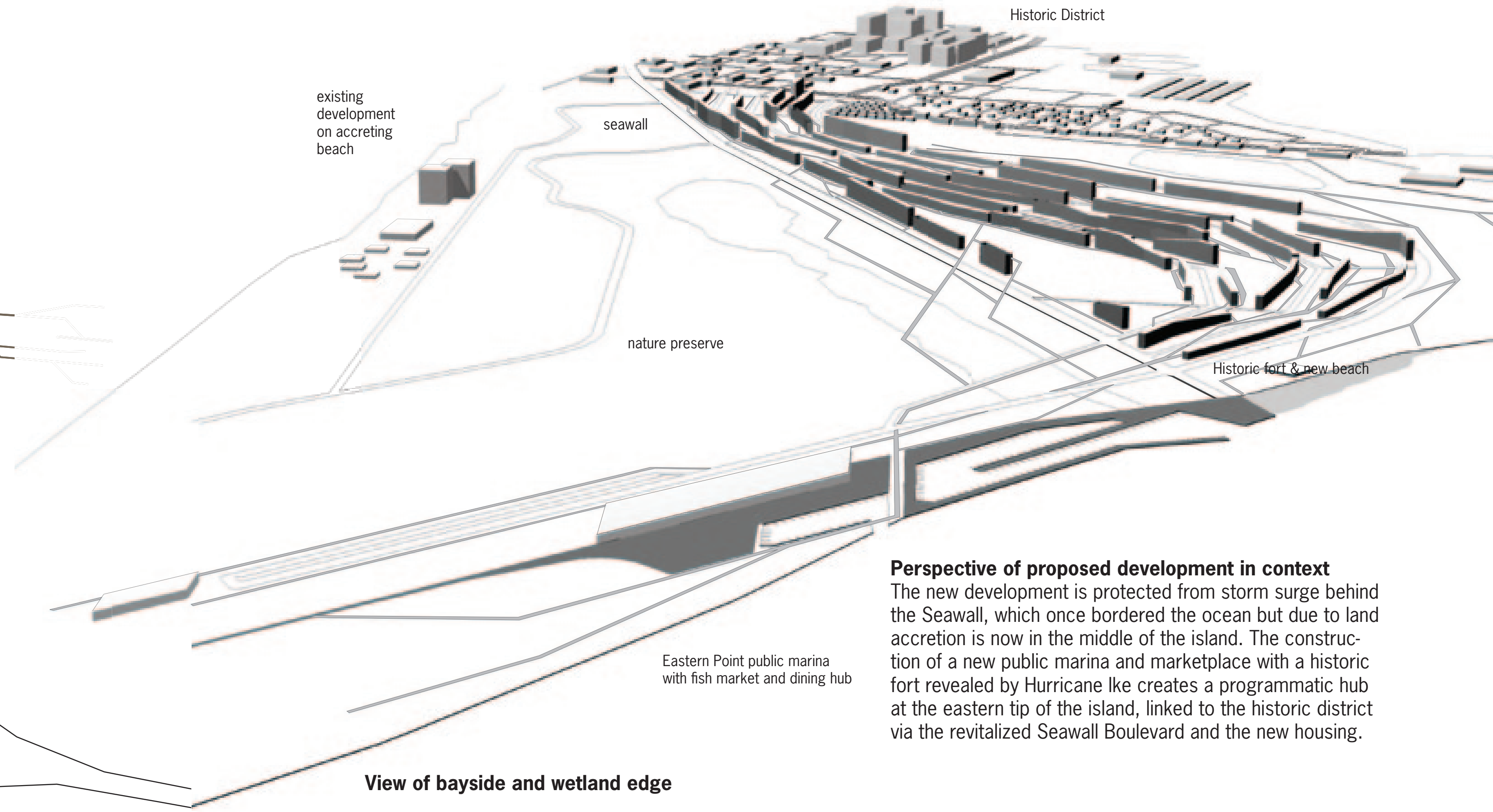


Urban Systems

Site Plan

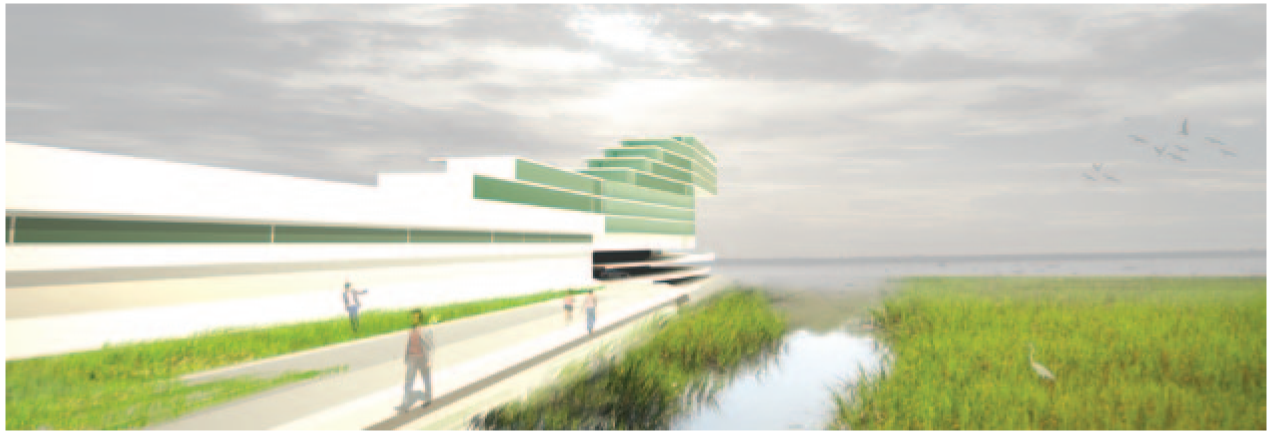


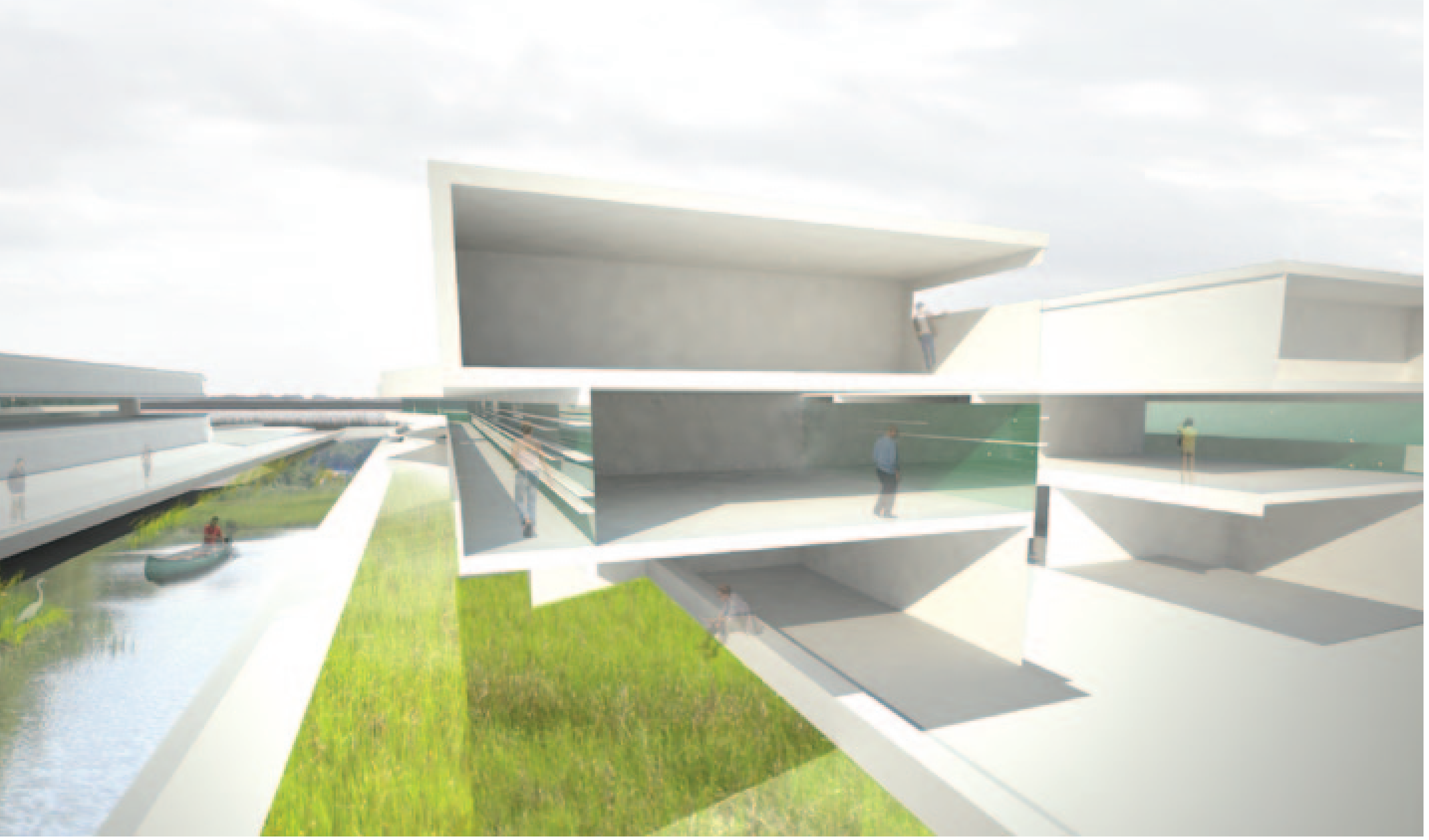
A Landscape of Views
Modulating the section of the landscape and building ensures every unit has a view. Low units for families have a view and direct access to recreational landscapes, new canals and wetlands. Higher units all have a view of the ocean and bay with rooftop terraces, many of which are planted.



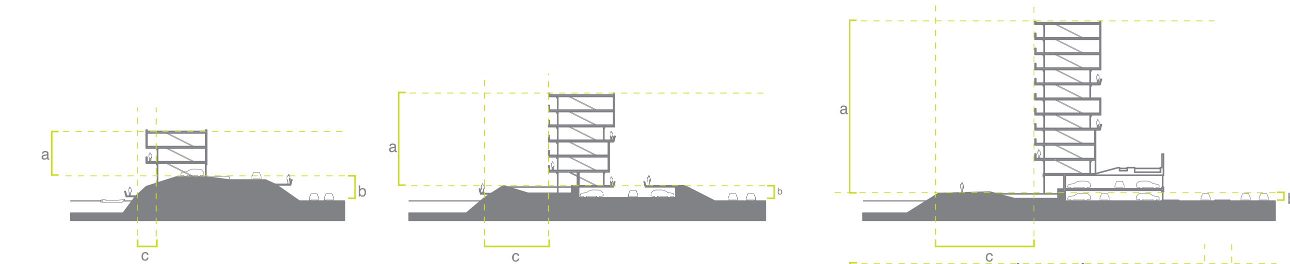
Perspective of proposed development in context
The new development is protected from storm surge behind the Seawall, which once bordered the ocean but due to land accretion is now in the middle of the island. The construction of a new public marina and marketplace with a historic fort revealed by Hurricane Ike creates a programmatic hub at the eastern tip of the island, linked to the historic district via the revitalized Seawall Boulevard and the new housing.

View of bayside and wetland edge

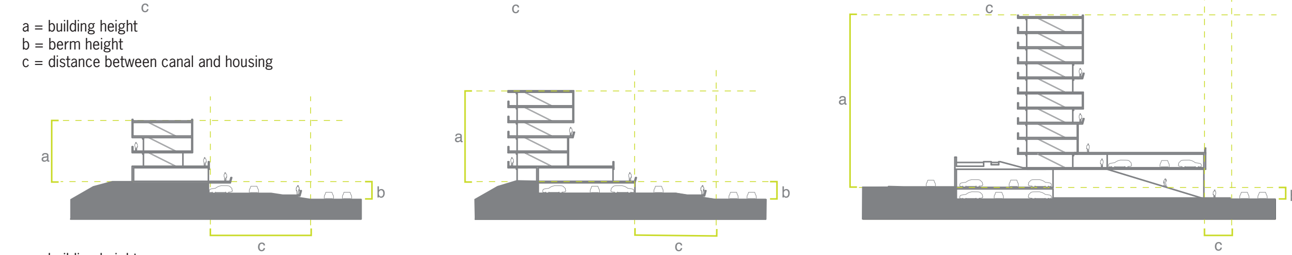




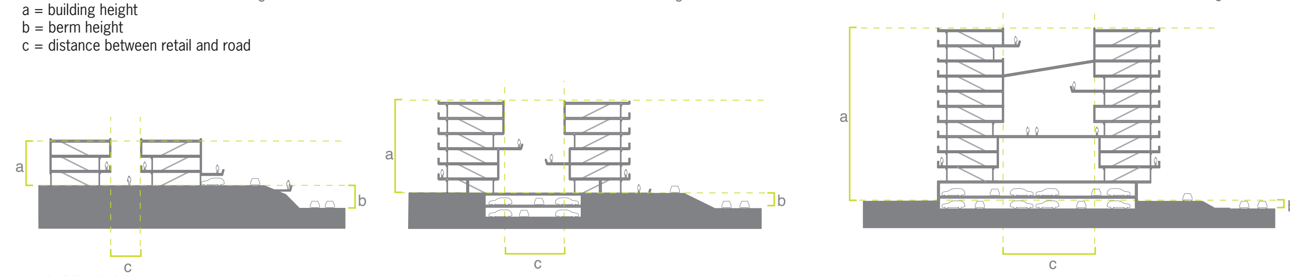
View of Low rise unit adjacent to canal



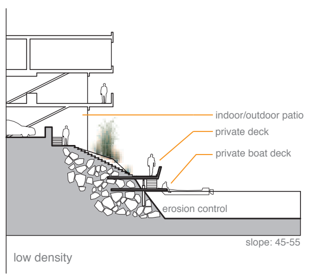
a = building height
b = berm height
c = distance between canal and housing

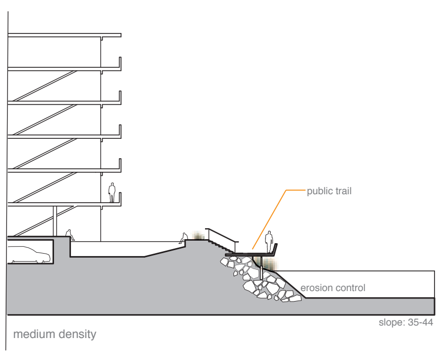


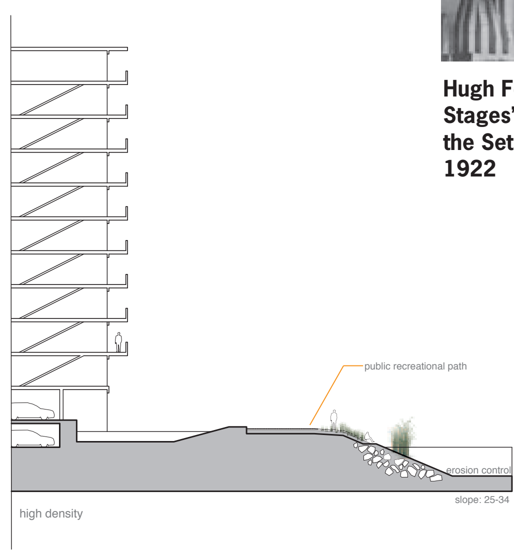
a = building height
b = berm height
c = distance between retail and road

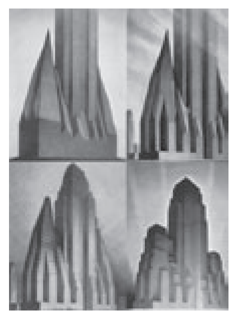


a = building height
b = berm height
c = distance between housing



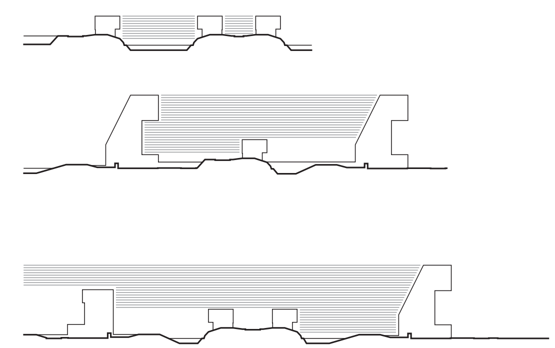




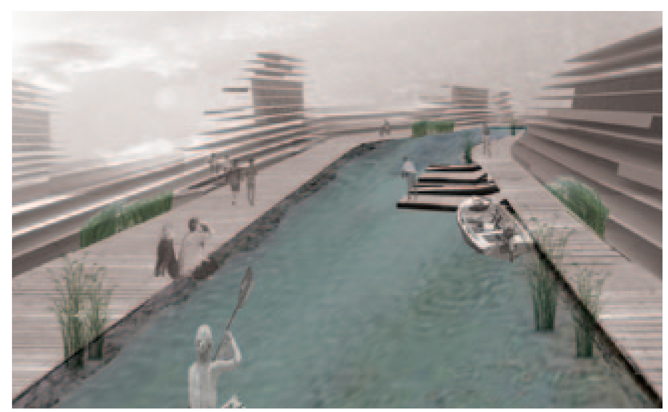


Hugh Ferriss, "The Four Stages" or "Evolution of the Set-back Building," 1922

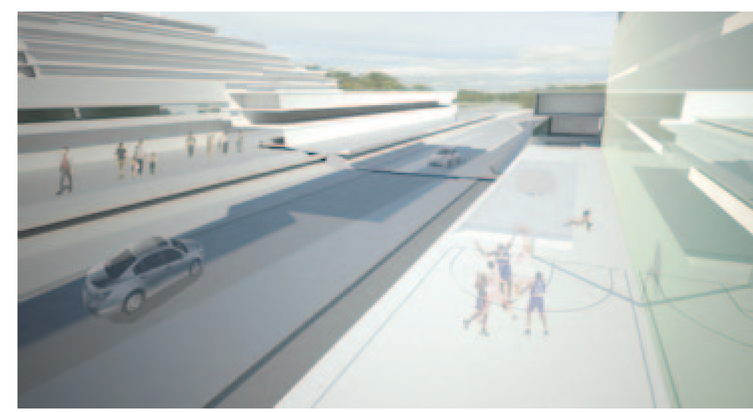
Parametric Massing
The landscape and building morphology is co-evolved through parametric relationships between density, verticality, landscape atmospheres, from most "natural" to most "urban," views and programmatic mixing and adjacency. This approach is inspired by Hugh Ferriss' experiments based on the 1916 Zoning Law for Manhattan, which prescribed setbacks to allow light down to the street level. Urban Corrugations defines building envelopes through a complex set of variables tuned to coastal and ecological development. Thus, the design develops a new "generic" system within which many variations could be specified.



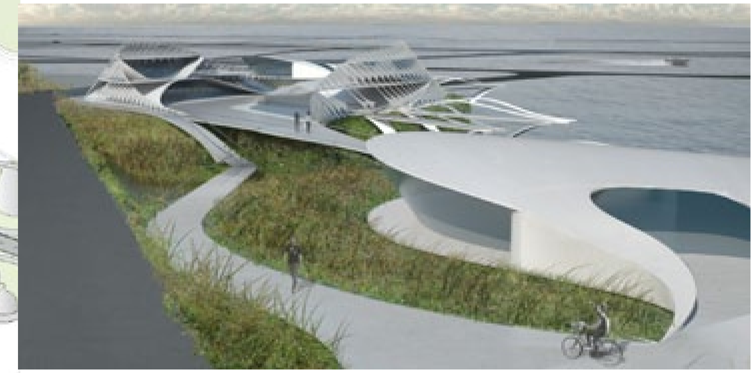
View diagram

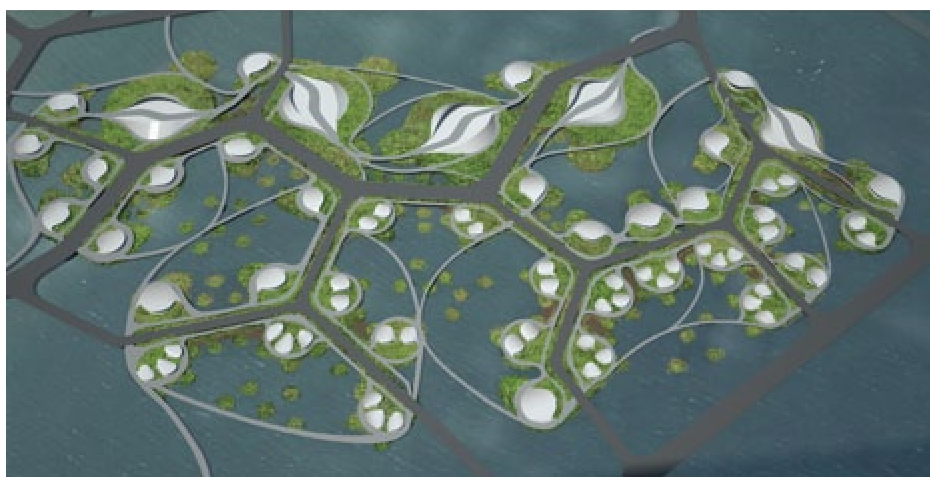


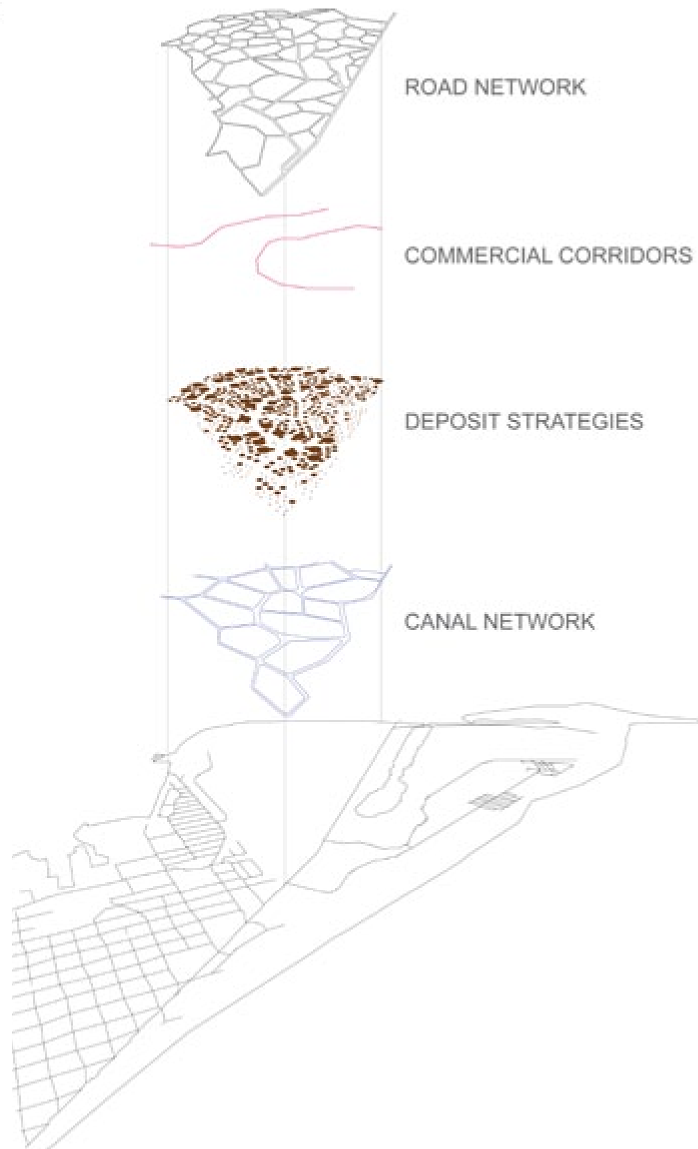
View of high-density section adjacent to canal with boardwalk and boat docks



View of urban boulevard with shopping on ground and recreational decks





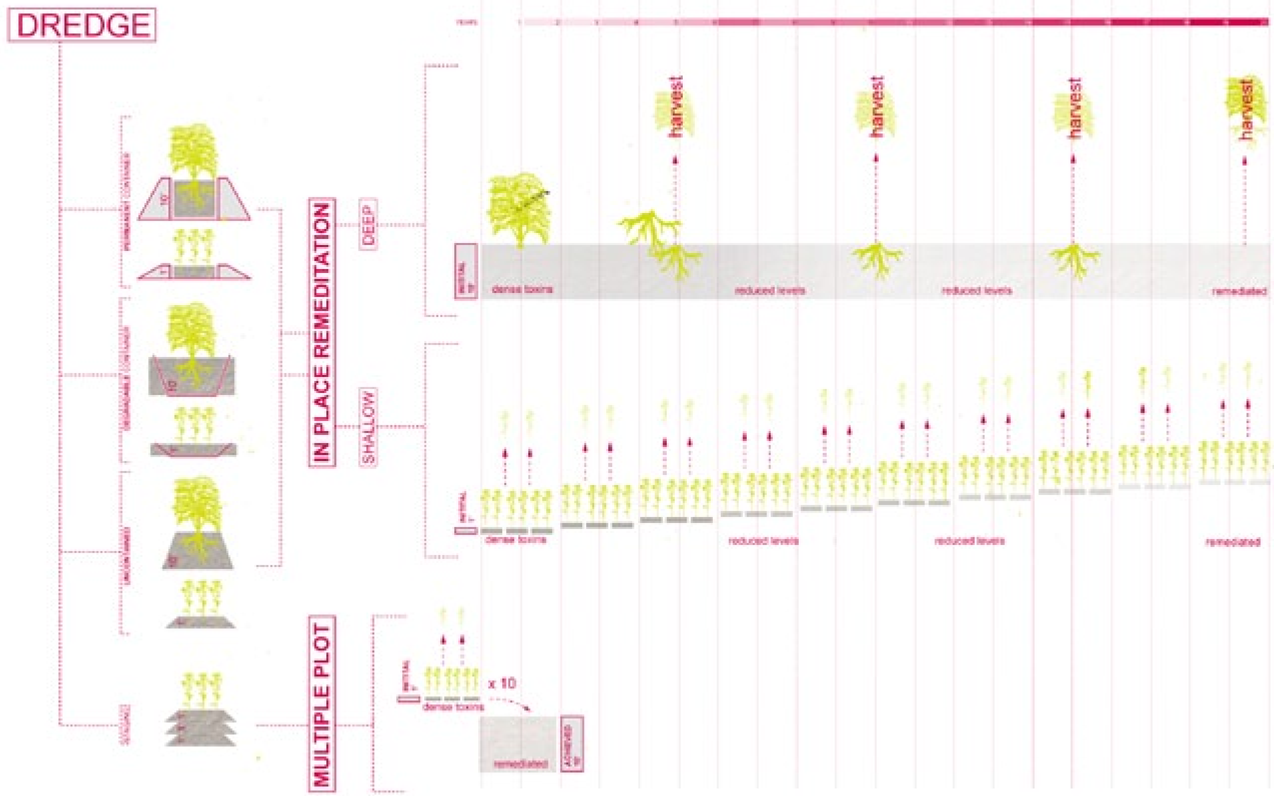


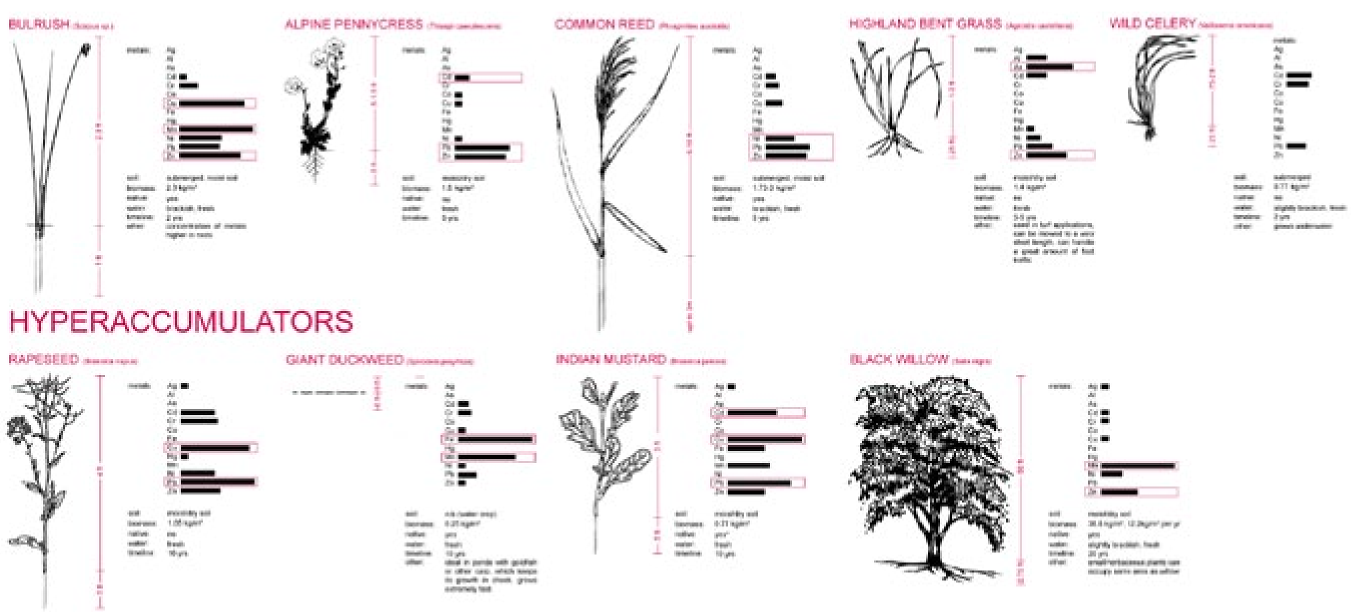
Reclaimed Cohabitation

Amy Westermeyer
2010

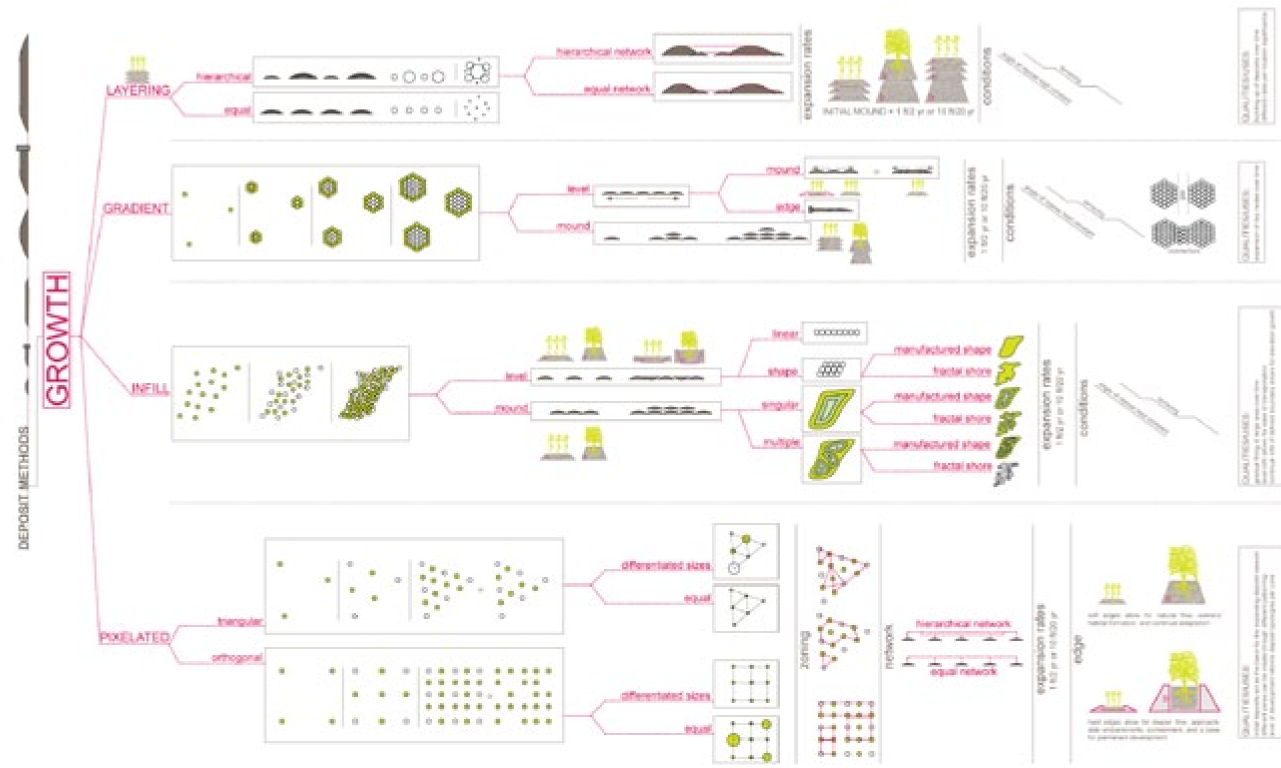
This project creates a balance between nature and inhabitation, using dredge remediation wetlands as devices from which development emerges and successfully integrates with the local ecology. The development and wetland ecologies can coexist in a network of territories and clusters that provide both immediate access to modern convenience and exposure to natural flora and fauna. As it stands now, many of those interested in coastal living had settled themselves on the west end, but due to a lack of natural defense, and recent hurricane devastation, this project is located on the more protected eastern end of the island, which is also closer to other urban amenities and the only large-scale stable beach.

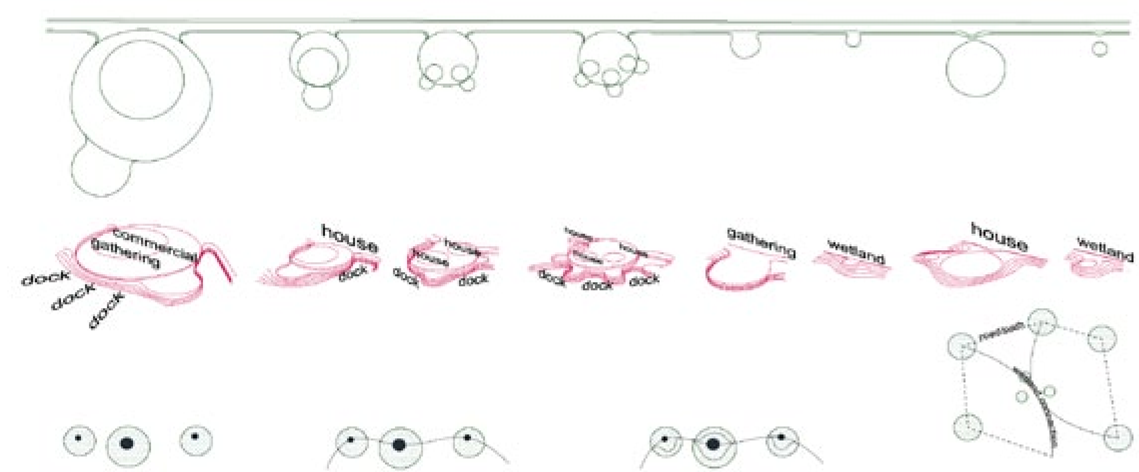
The site is an existing dredge spoils dumping ground. By carving new water channels according to a Voronoi based network geometry, small patches of this dredge are isolated for bio remediation. The re-dredged slurry is blown into small dome-like islands for optimum remediation. As patches are cleaned, some are reterritorialized for occupation, with each house having direct access to the capillary system of waterways as well as proximity to productive wetlands. The variation of networks and densities offer a variety of atmosphere and programs.



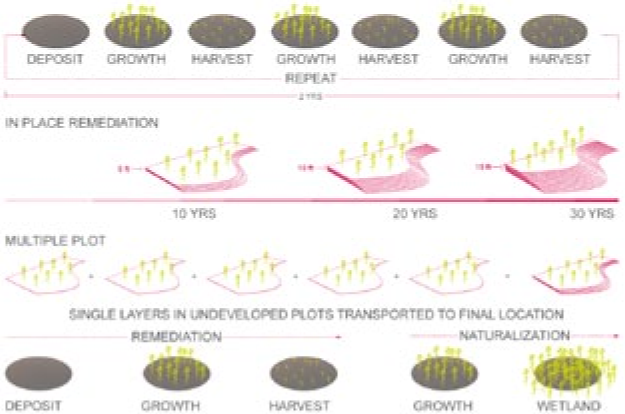


Phyto-remediation Processes
Phytoremediation removes toxins from soils and dredge deposits through plants that absorb these materials over time. Plants that are especially effective are called hyper-accumulators. This diagram shows the successive stages of plantings and harvesting that not only lead to cleaner soils that can then be opened for other uses, but also produce habitats and provide for ecological succession and robust ecosystems.

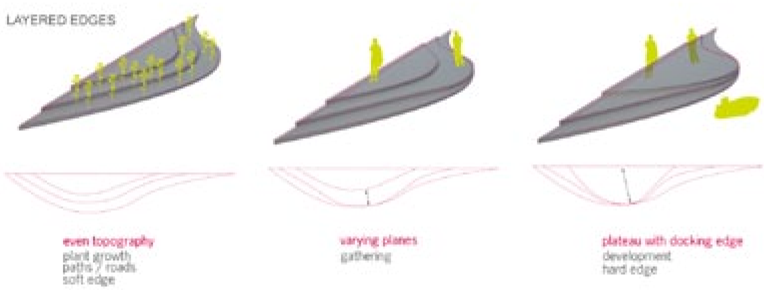




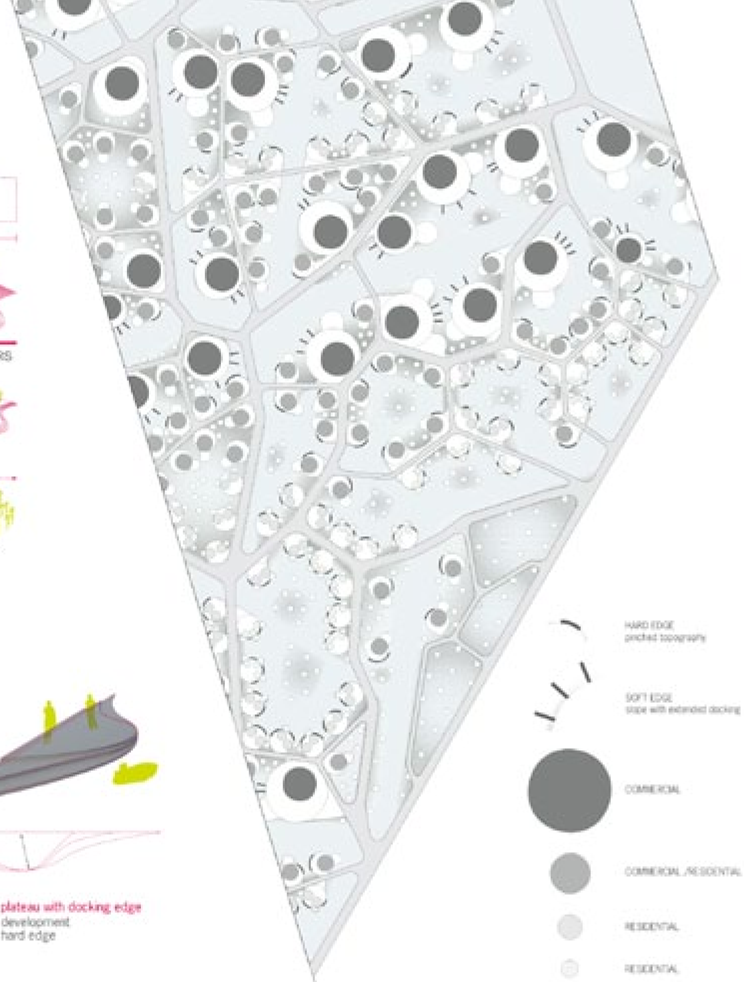
Relationship of mound formation to programmatic occupation

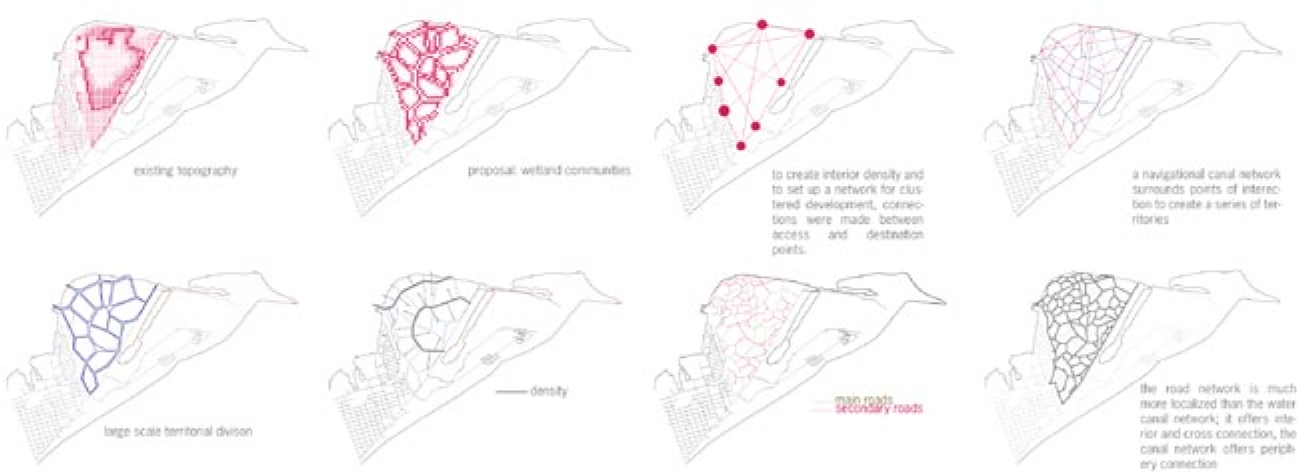


layered remediation

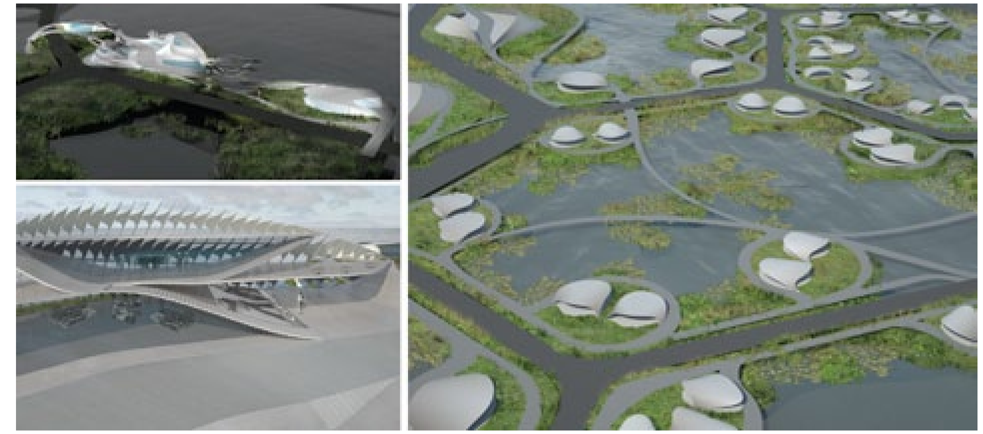


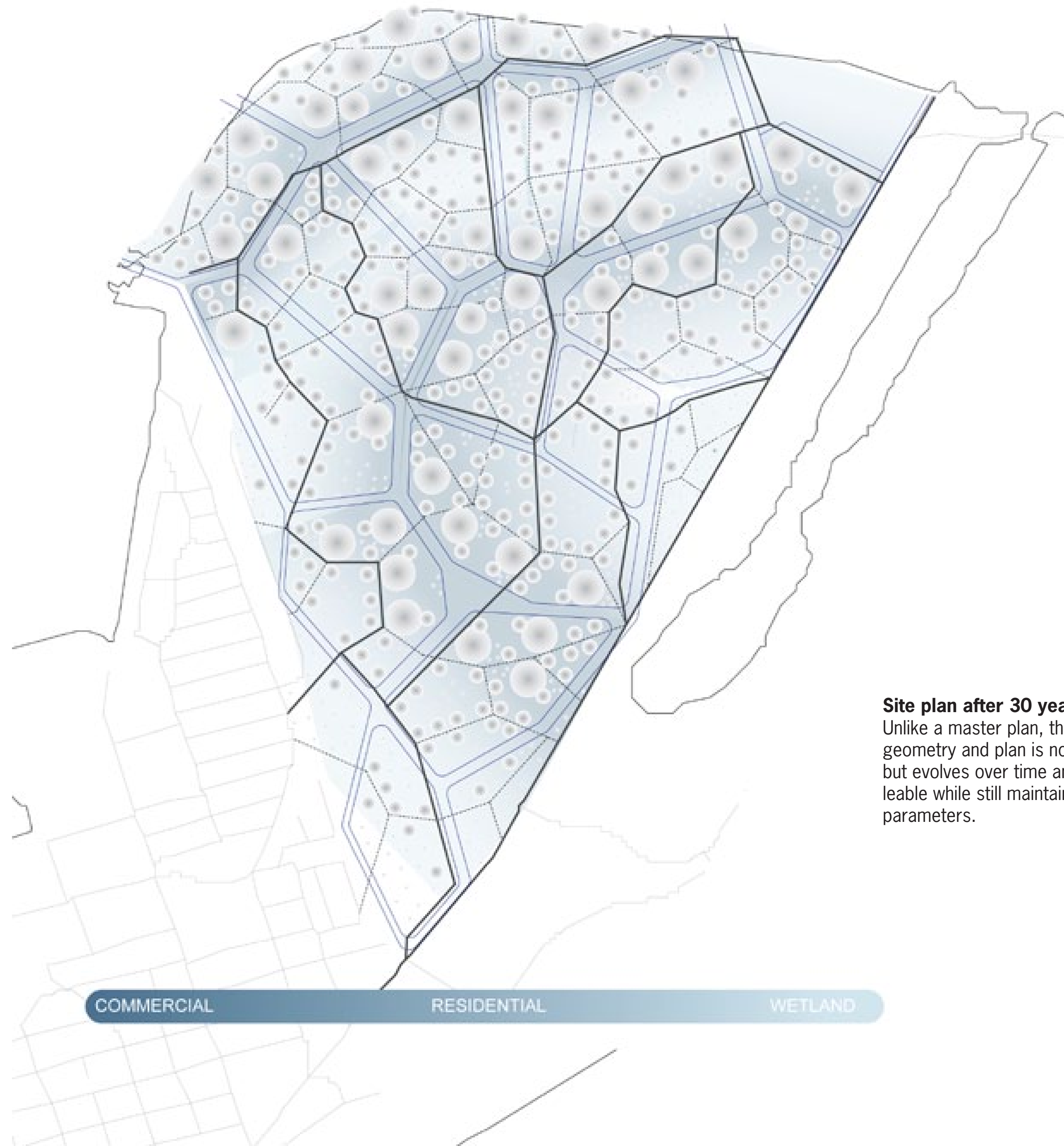
deposit strategy



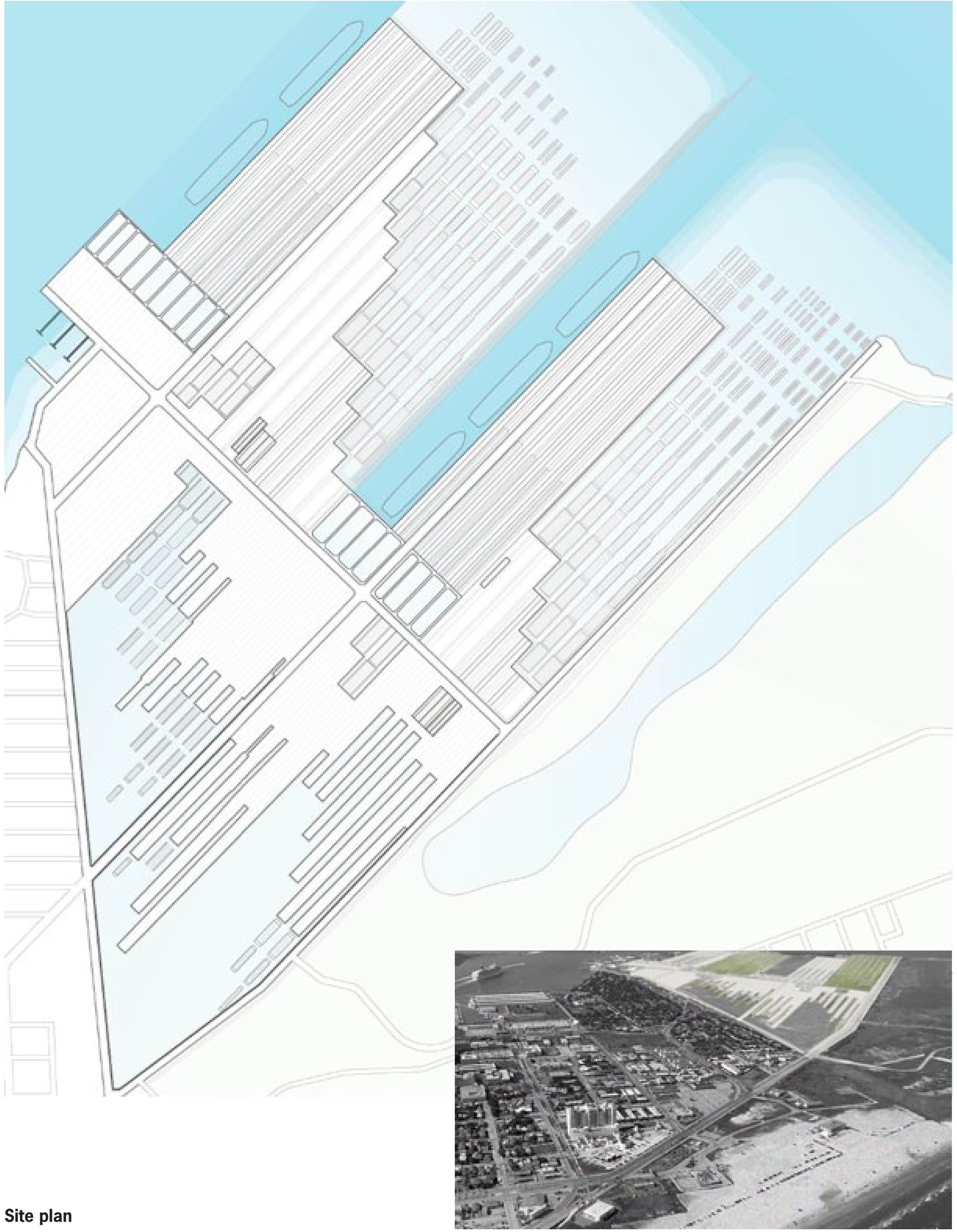


Urban connectivity and construction of territory

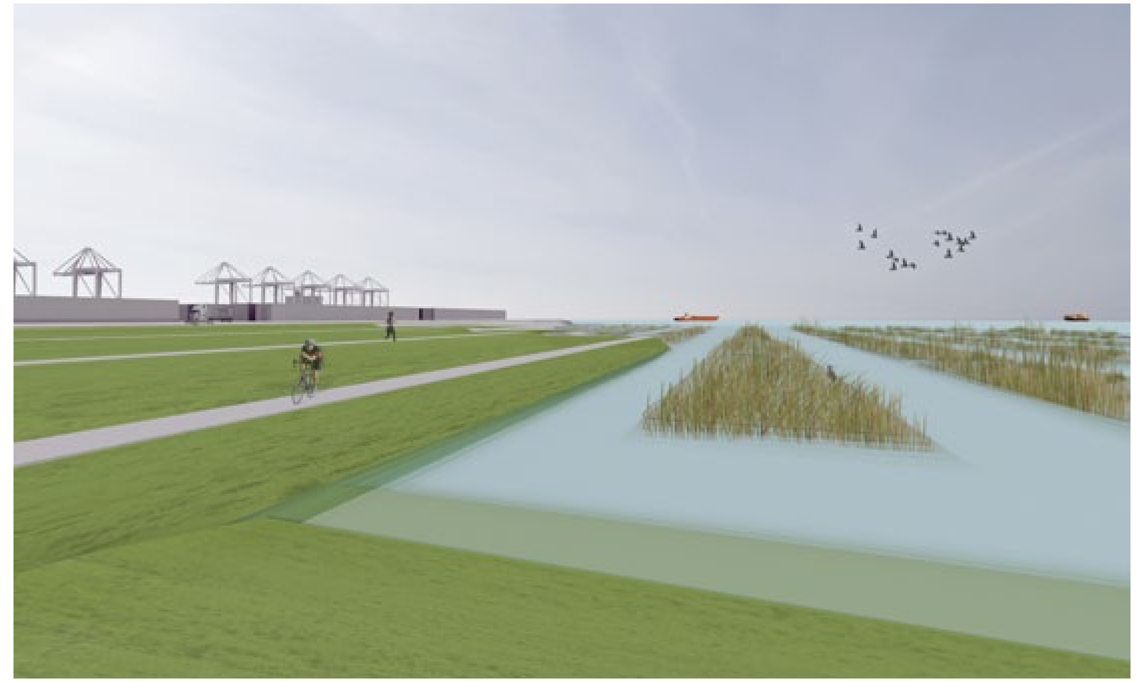




Site plan after 30 years
Unlike a master plan, the geometry and plan is not fixed but evolves over time and is malleable while still maintaining key parameters.



Site plan



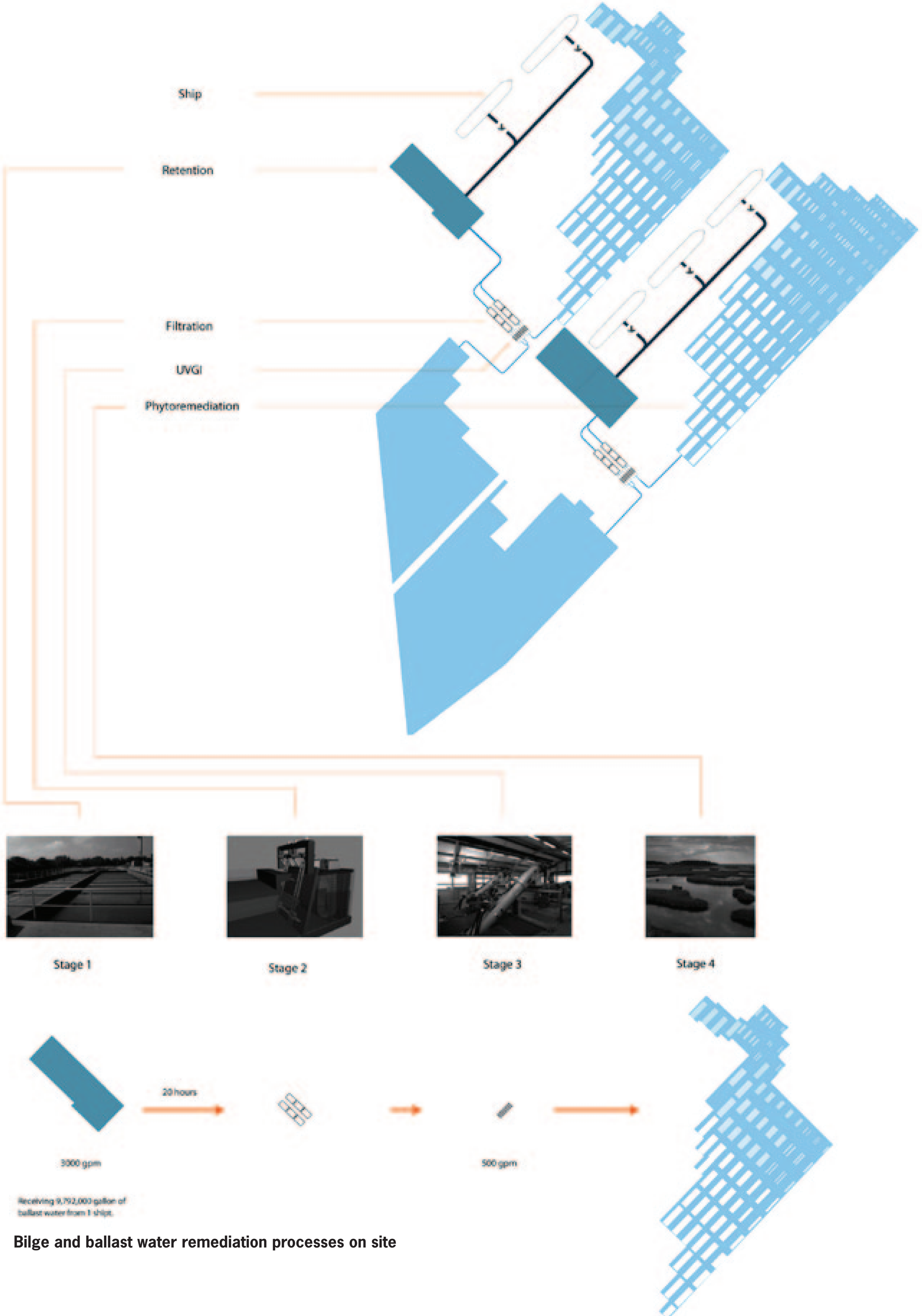
Containment Strategies

Jason Ou-Yang
2010

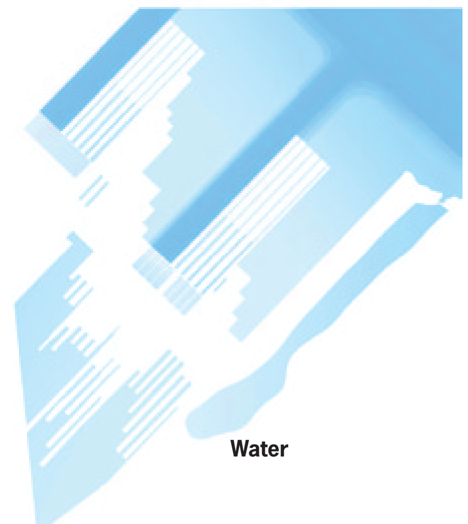
Tankers and container ships carry more than the products of global trade, they also carry micro-organisms and other flora and fauna in their ballast water. These accidental tourists travel from one port and are released in another port often literally across the globe. The result can be significant transformation or even devastation of local ecologies. Thus, globalization does not simply mean that products and places are becoming increasingly alike; biotopes themselves are in some ways becoming more similar.

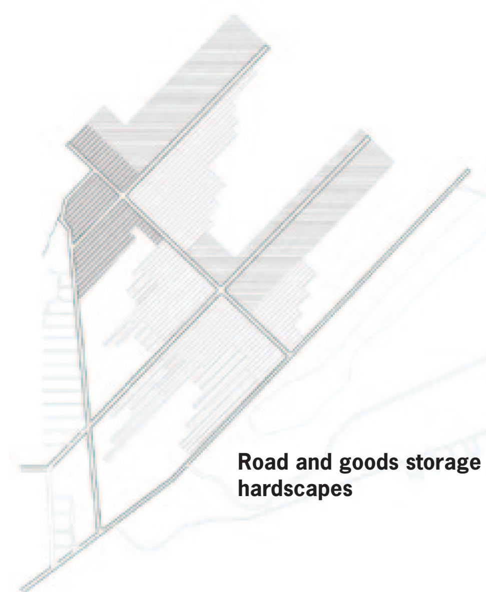
As a result, techniques for ballast water remediation are becoming increasingly important. This project proposes a major Post-Panamax containerized shipping terminal in the East End Flats area of Galveston, a facility that could bring vital trade and well paying jobs to the island without the ecological impact of expanding and maintaining the Houston ship channel. The necessary detention and remediation basics for the bilge water is designed as a landscape open to leisure activities and new wetlands.

These recreational zones are secured and separated from the port terminal not through fences but by sectional variations and waterways. As a result, the huge cranes and mountains of containers become part of this constructed landscape. The design language of striated and pixilated fields reflects this constructed condition, with different scales mapped to performative needs and atmospheric desire. This differentiated field manages the circuits of water treatment as well as program such as recreational boating.

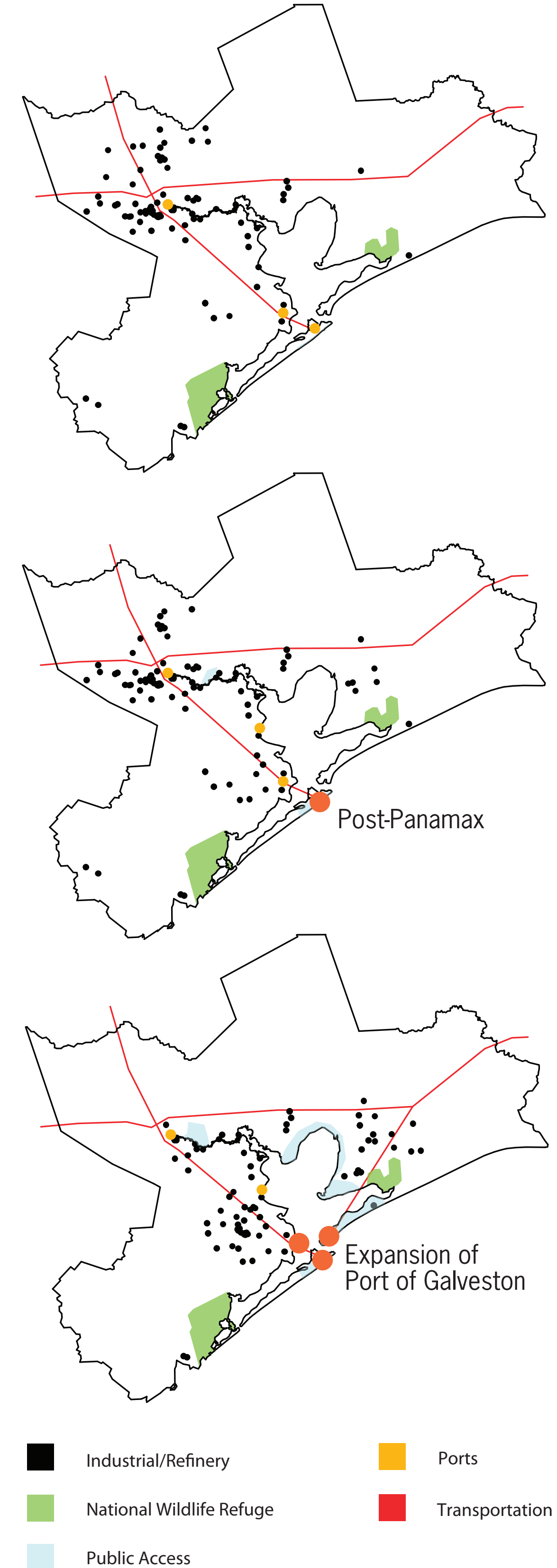


Bilge and ballast water remediation processes on site

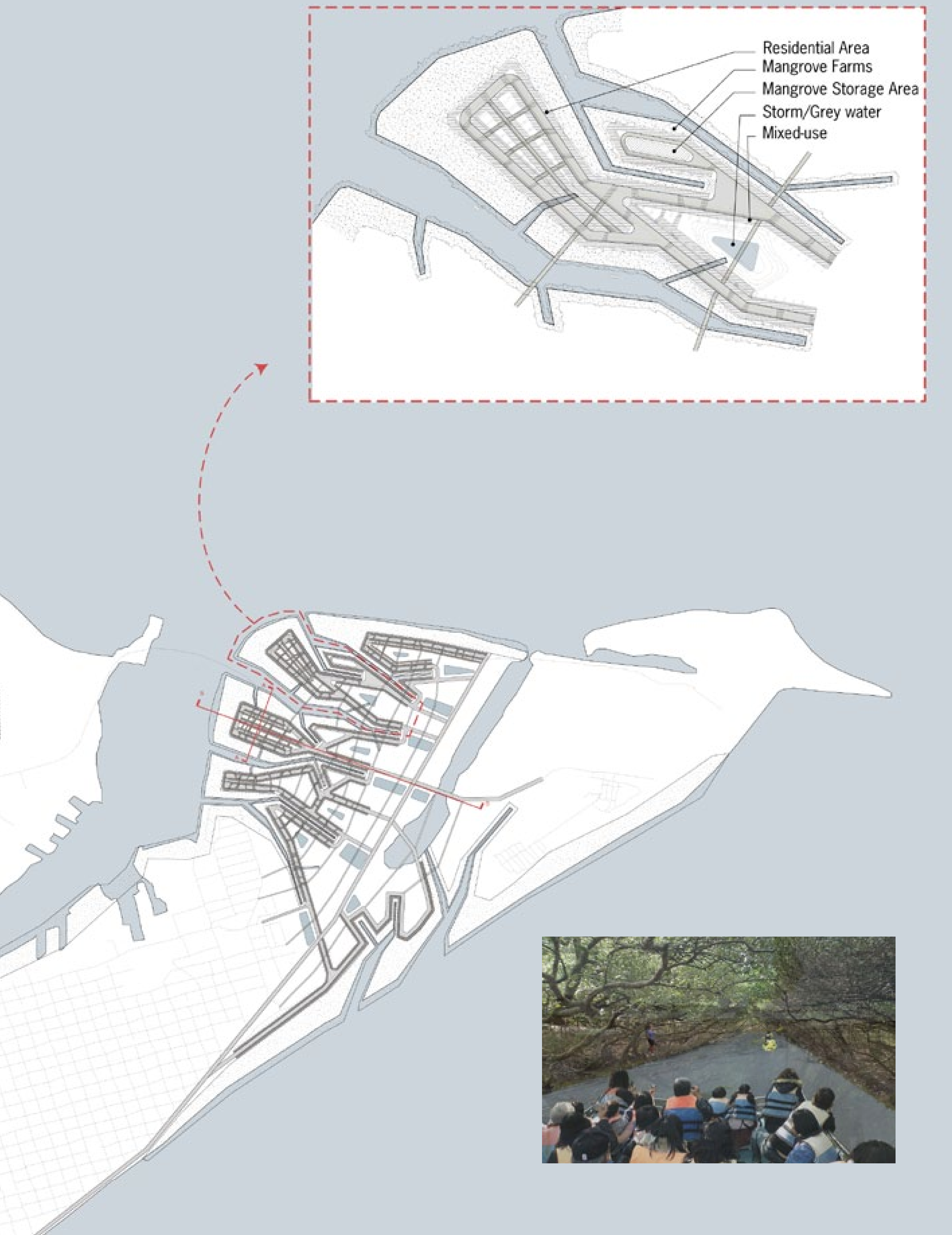




Road and goods storage and hardscapes



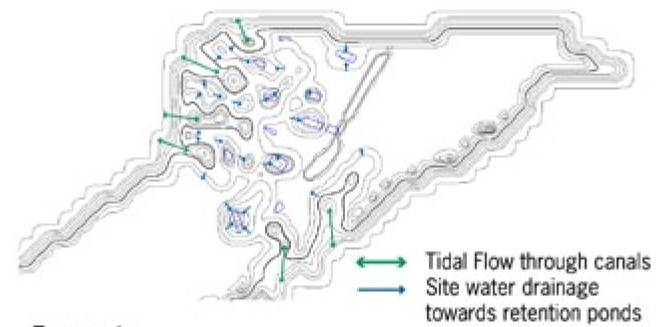
Sequence of development regarding relationship of site to area post-panamax shipping network



Canal System

Existing And New Roads

Building Plan



Topography

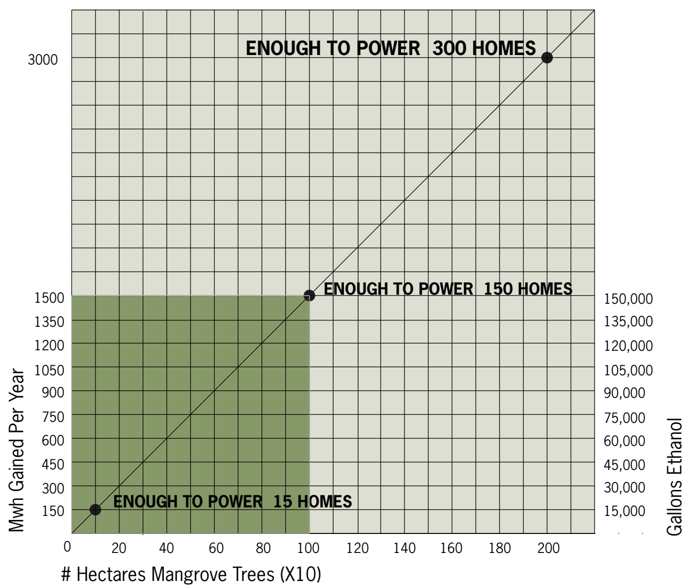
Aqua Farming on Galveston Island

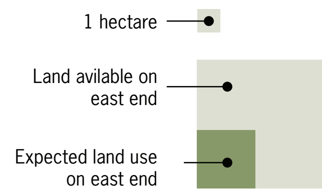
Sue Biolsi

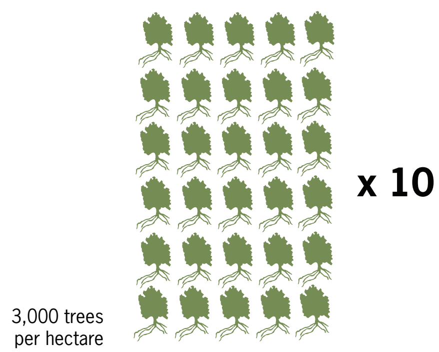
2010

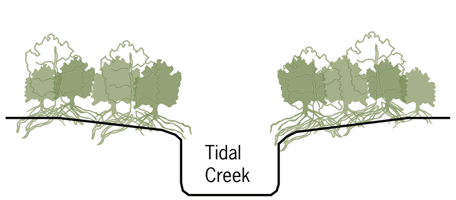
The project embraces the challenge of creating energy on Galveston to develop a new form of urbanism based on community aqua farming. Beginning on the East end of the island the entire community in this new development, including homes and businesses, participate in the harvesting of mangrove trees for the production of biomass. Mangrove farms reduce the amount of carbon dioxide in the air and are a renewable source of biofuel. These halophytic plants, which can reach maturity within six years, require very little maintenance, survive in very harsh climates, protect the shoreline from erosion, promote fish habitats and clean the water. They are an optimal solution for the production of energy on the island and can occupy the topography around the edge of the island that is unsuitable for human development.

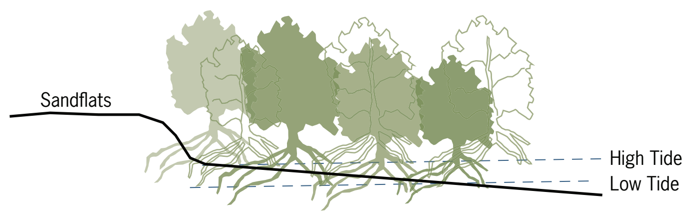
The main factors driving the design are the mangrove farms and the flows of saltwater, greywater and stormwater on the site. In order to ensure a healthy aquatic environment for the mangroves, greywater runoff from these new building units is diverted from the canals into stormwater retention and filtration ponds. The individual units and lots can vary in width and height, but work together as part of a larger system via a second skin customizable roofscape. This roofscape not only directs water but creates a secondary system of circulation and habitation, consisting of varied open and closed environments. The master plan is designed around the collective program of biomass agriculture, which is mapped to the social space of the community. Ultimately the global and local conditions of the topography and the architecture work together towards a new type of community living that is more productive for the future of Galveston Island.

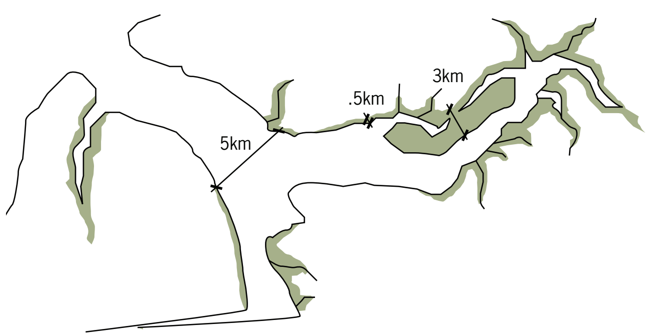


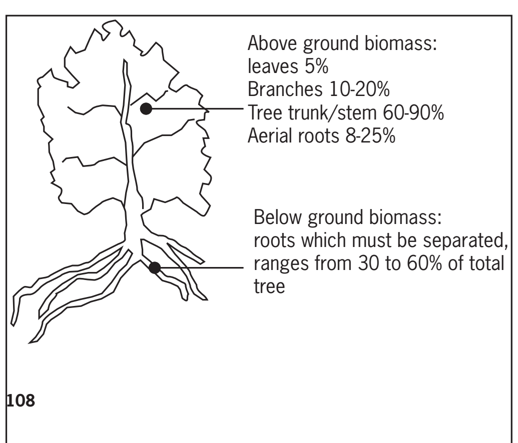








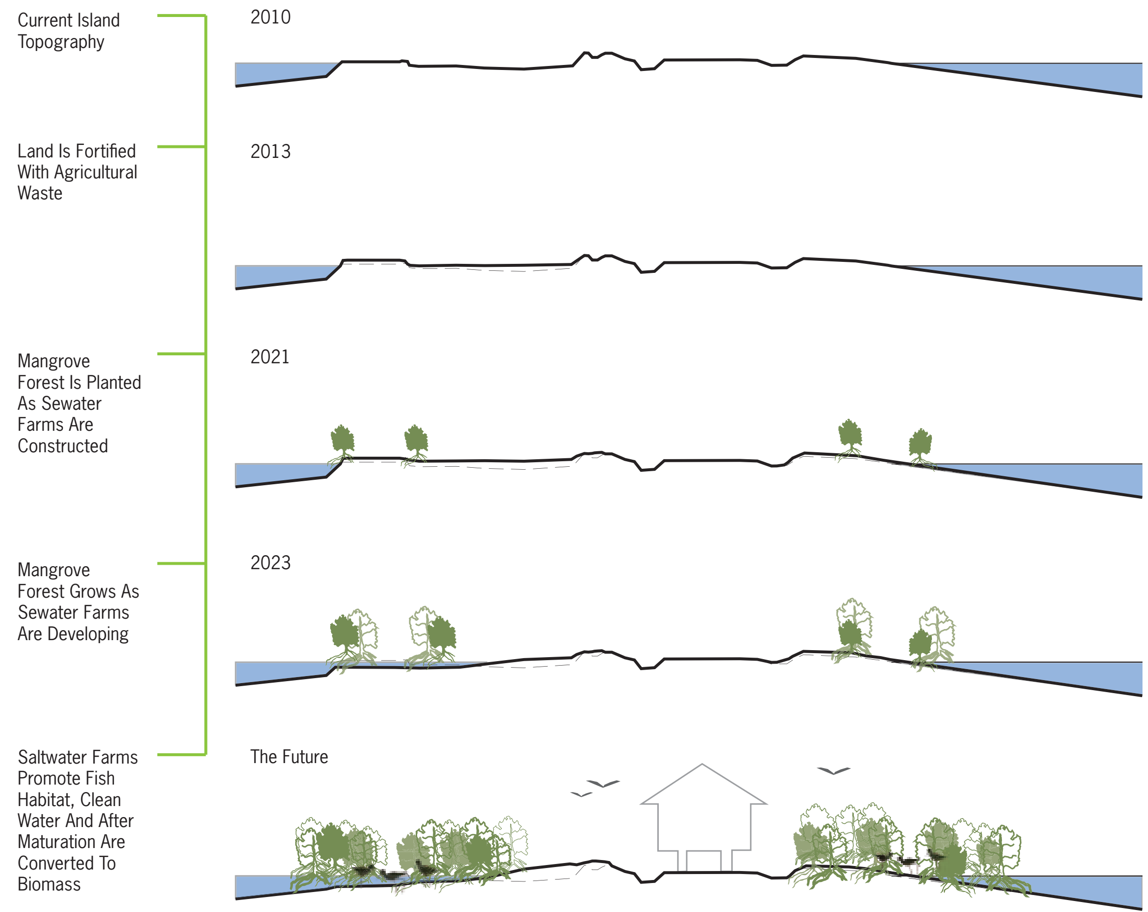


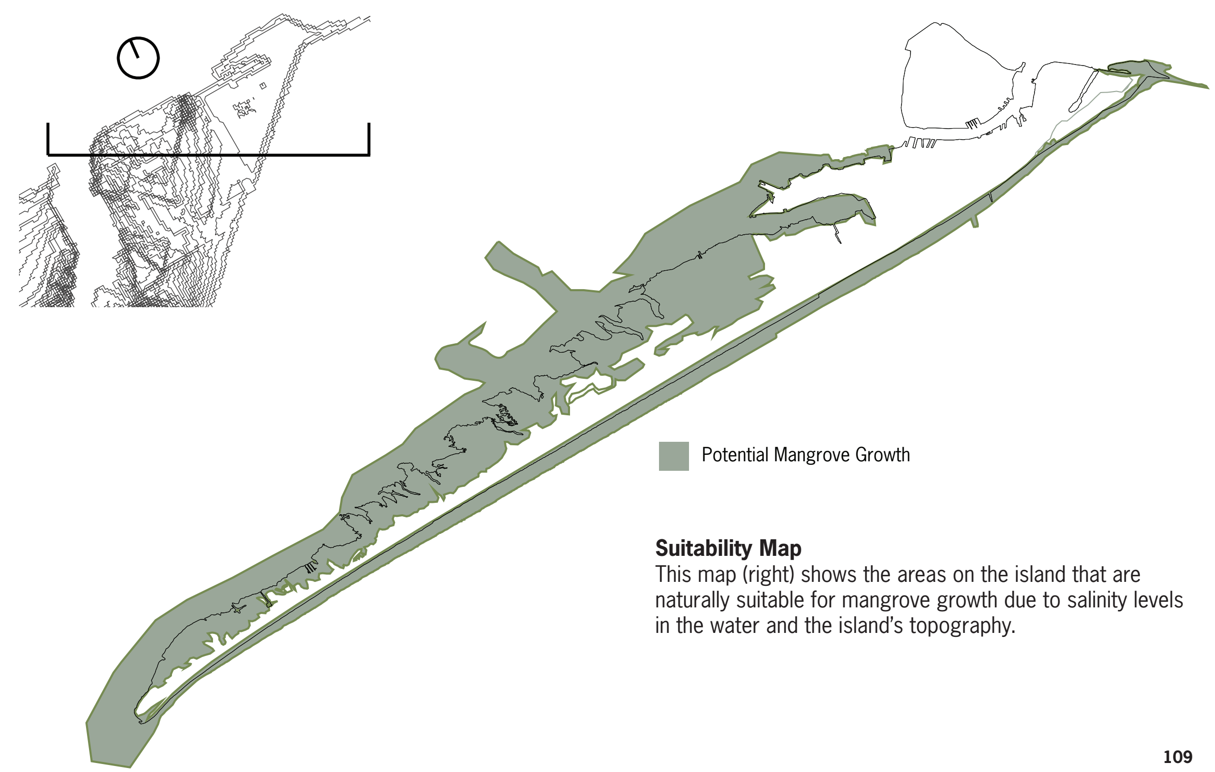


Biomass from Mangrove Trees

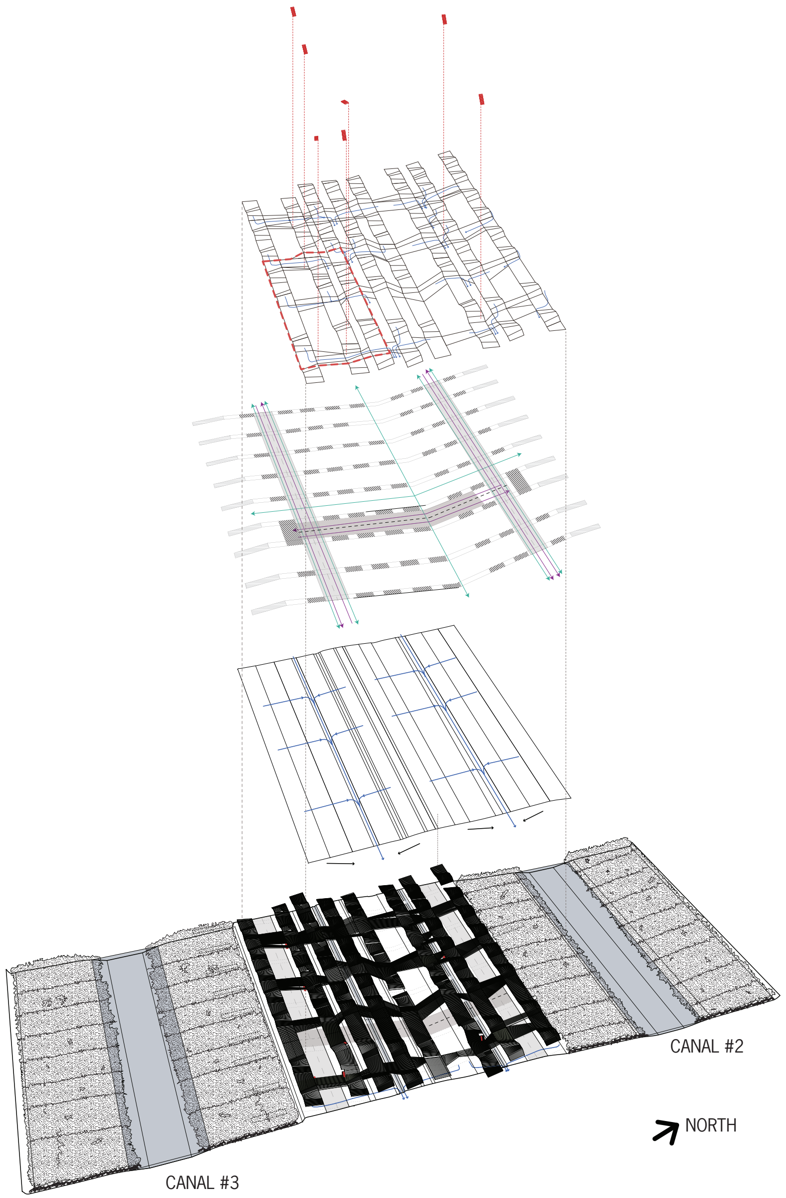
The research on this page shows the viability of growing mangrove trees on Galveston island for the production of biofuels and energy. Mangroves are halophytic trees and shrubs that grow in coastal saline habitats. They dominate 3/4 of tropical coastlines and grow within a range of 0.5-3m of saltwater. Mangrove roots provide oyster habitats and are efficient at dissipating wave energy. Because they grow in brackish water, mangrove farms do not affect the city's water supply in times of drought. One hectare of mangrove trees produces on average of 1650 tons biomass per year, or around 7,333,333 Kilowatt hours per year

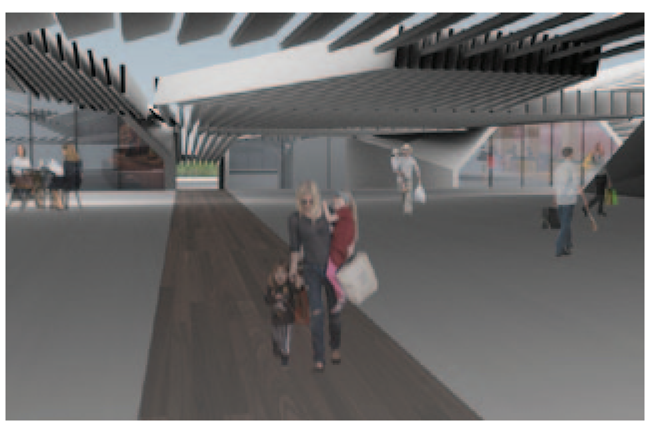
Given the salinity levels in the water around Galveston Bay and the biodiversity in and around the island, Galveston is an ideal place to grow mangrove trees, a highly productive source of biomass that covers three-quarters of tropical coastlines. Through the latest technologies, seawater aqua culture systems are being developed to be the new sources of renewable biofuels, and mangroves are being researched as an optimal source. Because they grow in saltwater, mangrove farms do not consume ground or treated water supplies. Some varieties reach maturity within 6 years, require very little maintenance, survive in very harsh climates, protect the shoreline from erosion, promote fish habitats and clean the water in which fish live, in turn promoting ecotourism.





Suitability Map
This map (right) shows the areas on the island that are naturally suitable for mangrove growth due to salinity levels in the water and the island's topography.





Roof Geometry
A second roof becomes a secondary ground, integrated into the grading of the ground plane to capture rainwater, and informed by solar and wind angles. This accessible surface also provides continuous shade for pedestrian circulation and "porches" linking private and public zones while reducing total energy demands.

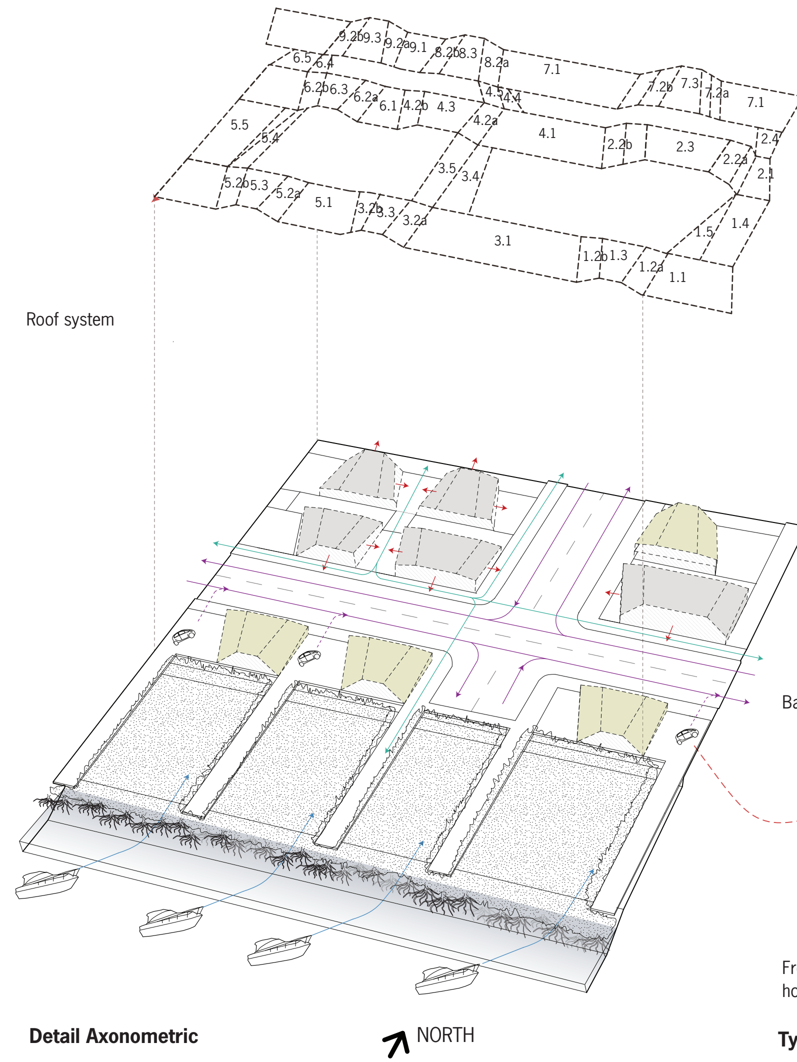
Circulation
Special paths connect each discrete zone, providing a continuous network of pedestrian and bike circulation and full access to the landscape and local retail and leisure programs.

Spines of 4-lane roads connect each house into the broader city fabric and provide each unit space for parking.

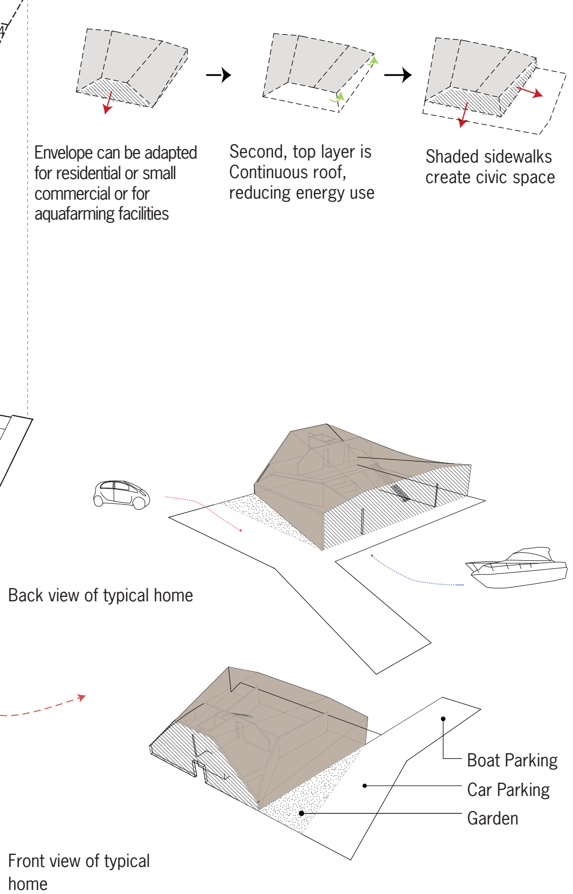
Site Water Drainage
Topography is graded for global drainage into retention ponds where it is phytoremediated and slowly released into the mangrove system and bay.

Legend

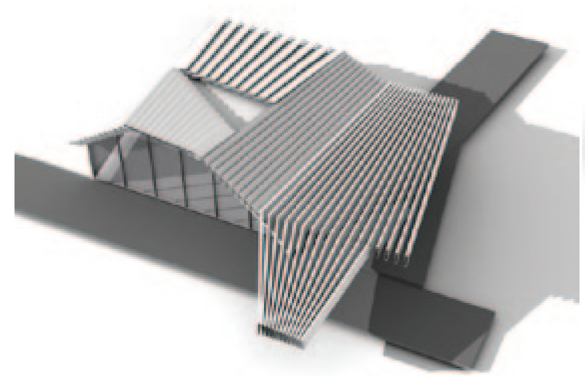
- Pedestrian/Bike Circulation
- Car Circulation
- Boat Circulation
- Store Frontage
- Water Circulation
- Glazing in Front and Rear of Unit
- Mangrove Trees
- Residential Unit
- Commercial Unit
- Parking Space
- Boat Access Ramp



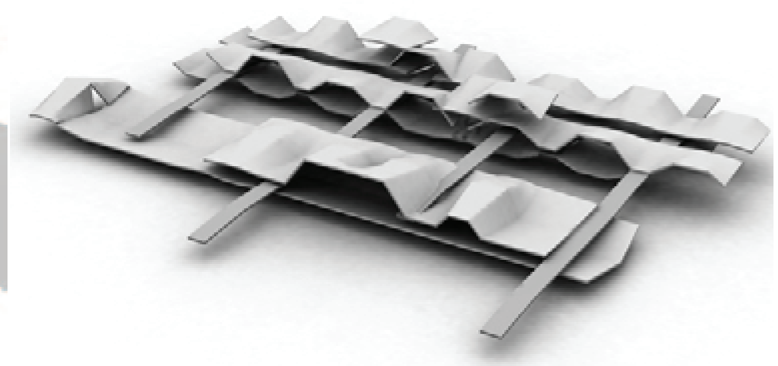
Detail Axonometric



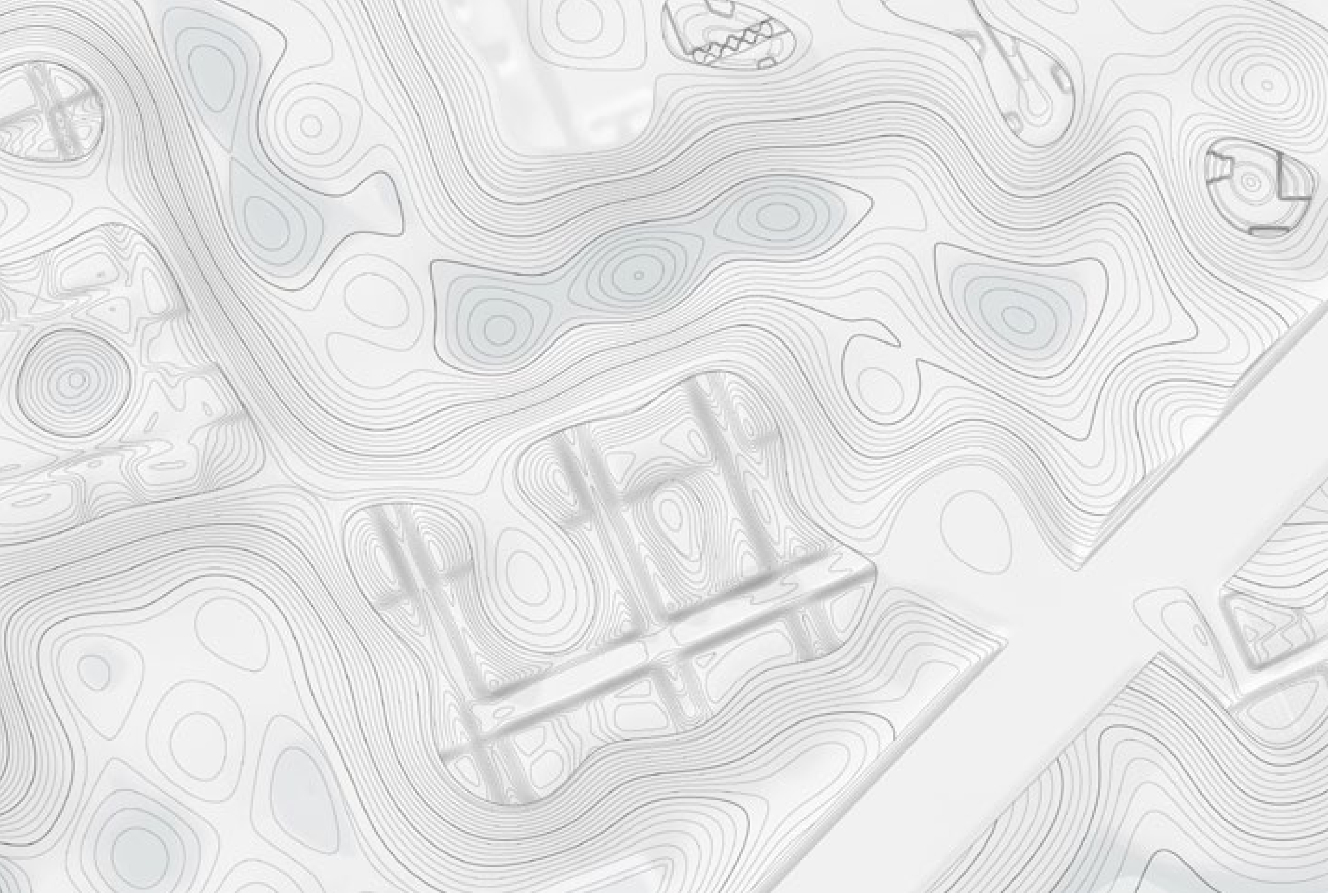
Typical Unit Details



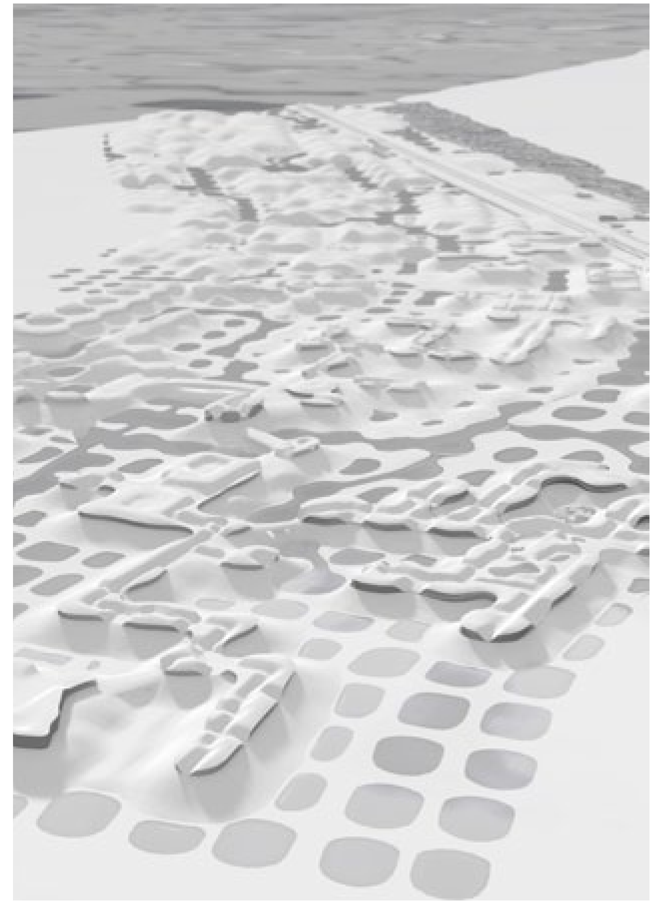
Basic Unit Typology



Unit Repetition & Roof Surface



Detailed Site Plan



Poro-City

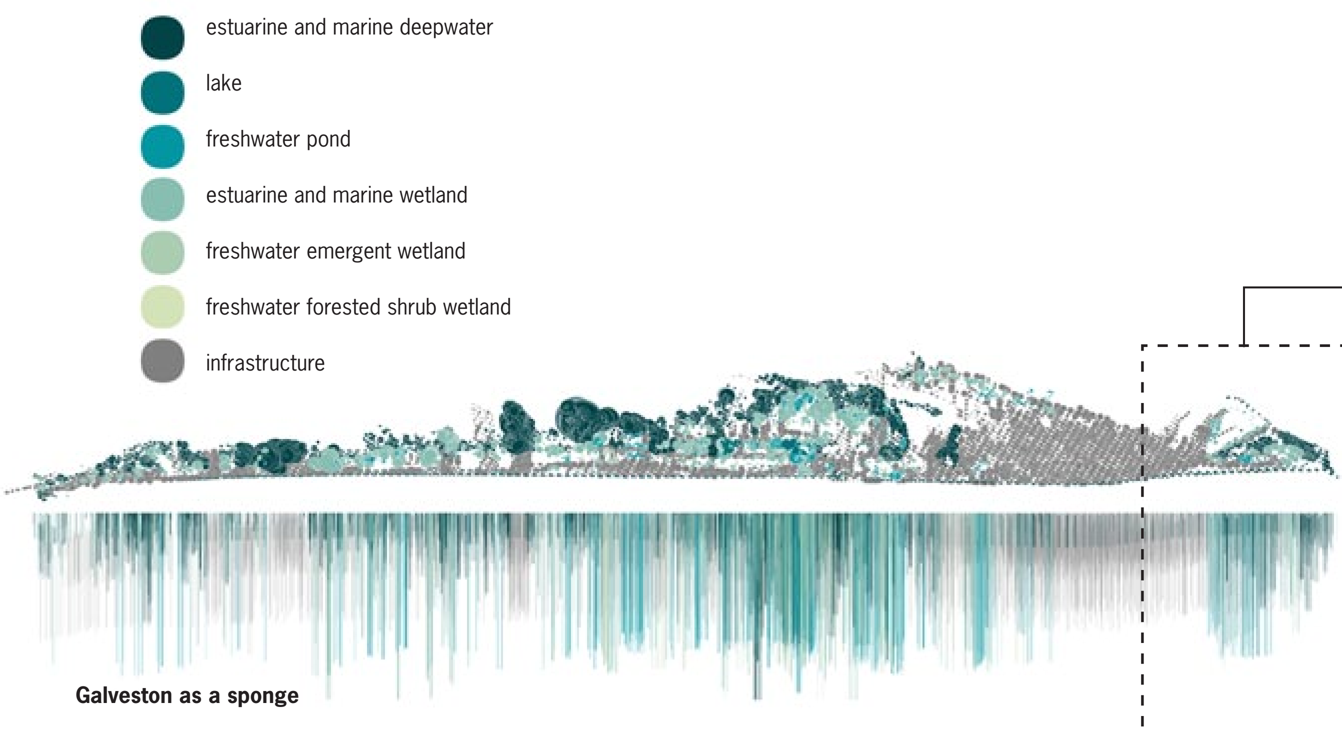
Jason Pierce

2010

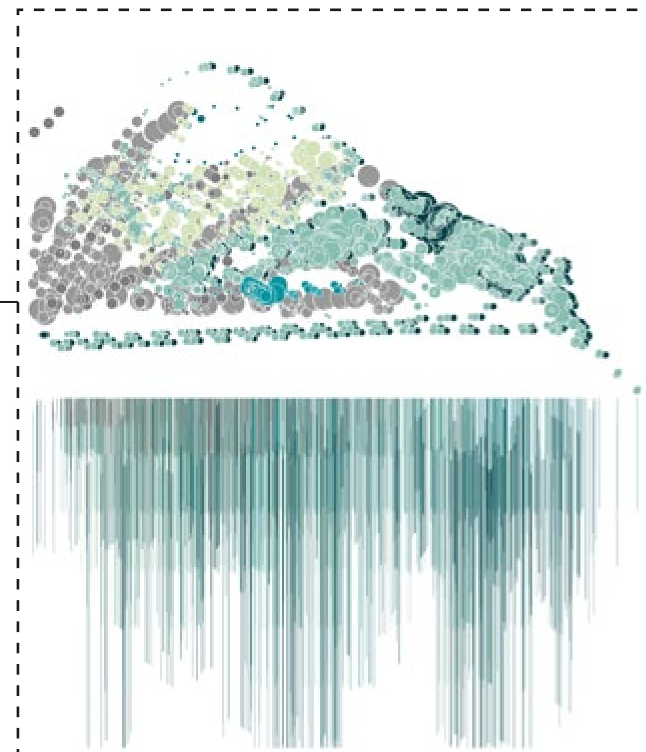
Poro-City integrates natural and cultural ecologies through the construction of a hyper performative wetland structure. A geometric grading system transitions from submerged wetland to low-land marsh, to upland forested shrub, to development at a safe elevation above sea-level. This creates a robust landscape ecology system of habitat patches and corridors while producing similar patches and corridor logic for human habitats.

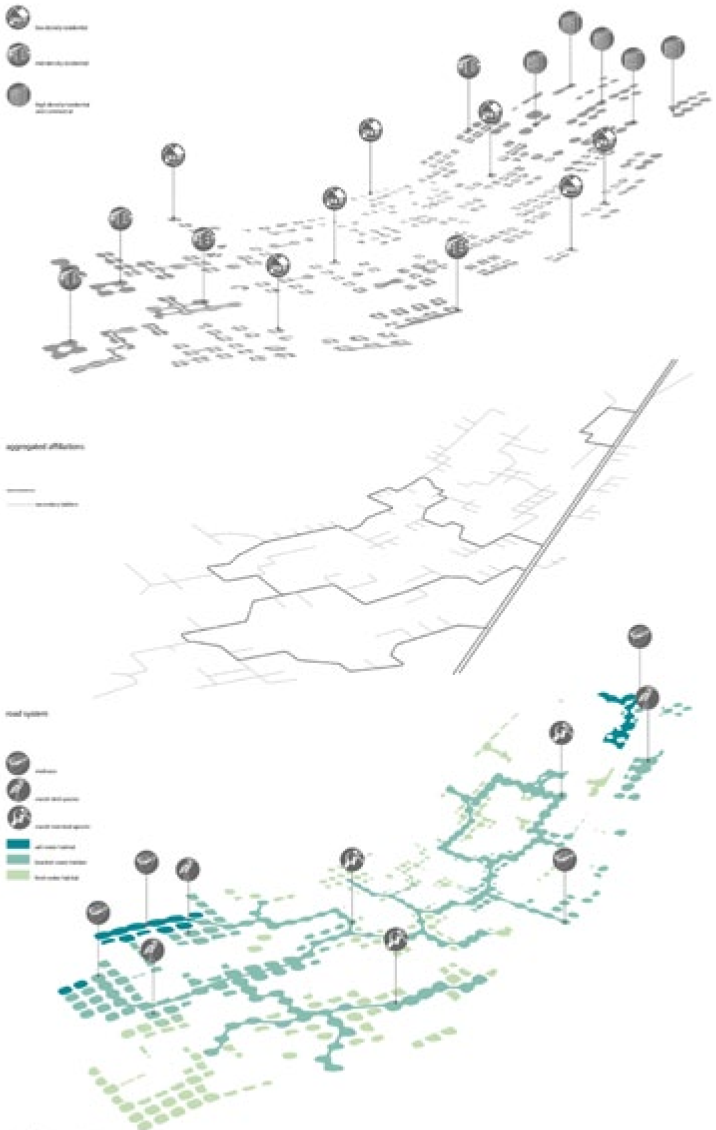
The site is Galveston's east end, some of which is classified as protected wetlands by the National Wetlands Inventory. However, since the first survey in 1956 the wetlands have been reduced by up to 25%, largely due to changes in terms of classification. The current hydrogeomorphic classification system is performative. This project has isolated a few of these as properties that can be deployed. One example is patch size. The optimal size is 500 ha with a minimal size of 50 sq m. The patches in the proposed system are 2,500 sq m at minimum. Surface roughness is another important factor in the stabilization of the island, the proposed system surpasses the typical roughness coefficient of a barrier island. This wetlands system forms a series of patches and corridors effectively extending the individual patch size. Salinity controls the dominant species type, and the wetlands are differentiated into tidally flushed salt water and isolated fresh water from surface flow and rain. Seasonal and yearly variation in precipitation result in a fluctuating submerged wetland configuration. Prolonged drought creates isolated pockets and heavy rainfall yields a highly connected system.

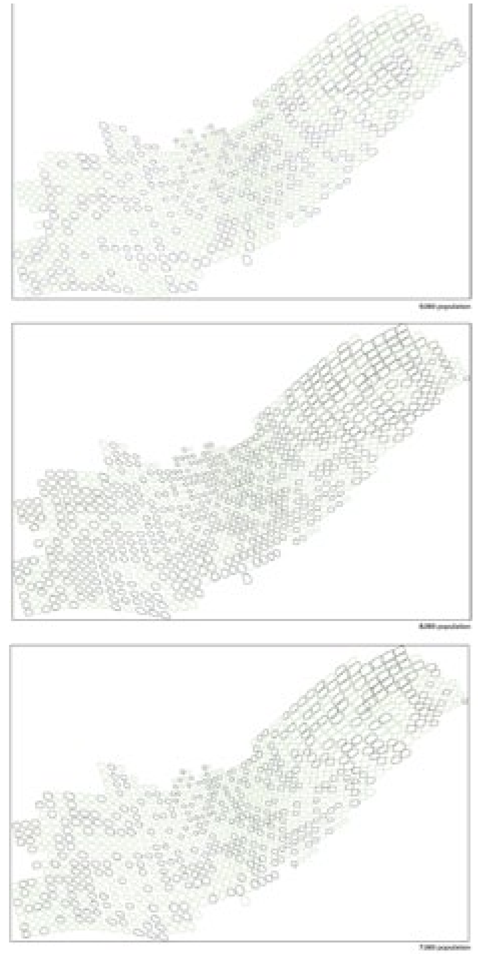
Housing typology is distributed according to aggregated densities. Smaller, more discrete clusters are designated single family, and as groupings become more compact, density increases. The circulation system is comprised of three primary loops connected to the seawall drive with a series of secondary ladders branching. The resulting continuous deformation of the east end flats generates a topological connectivity of highland human ecologies interdigitated with a porous matrix of low land ecologies. Traditional land use is reterritorialized through this organizational structure of constructed wetscape, allowing population intensification and an accelerated habitat growth.



Galveston as a sponge

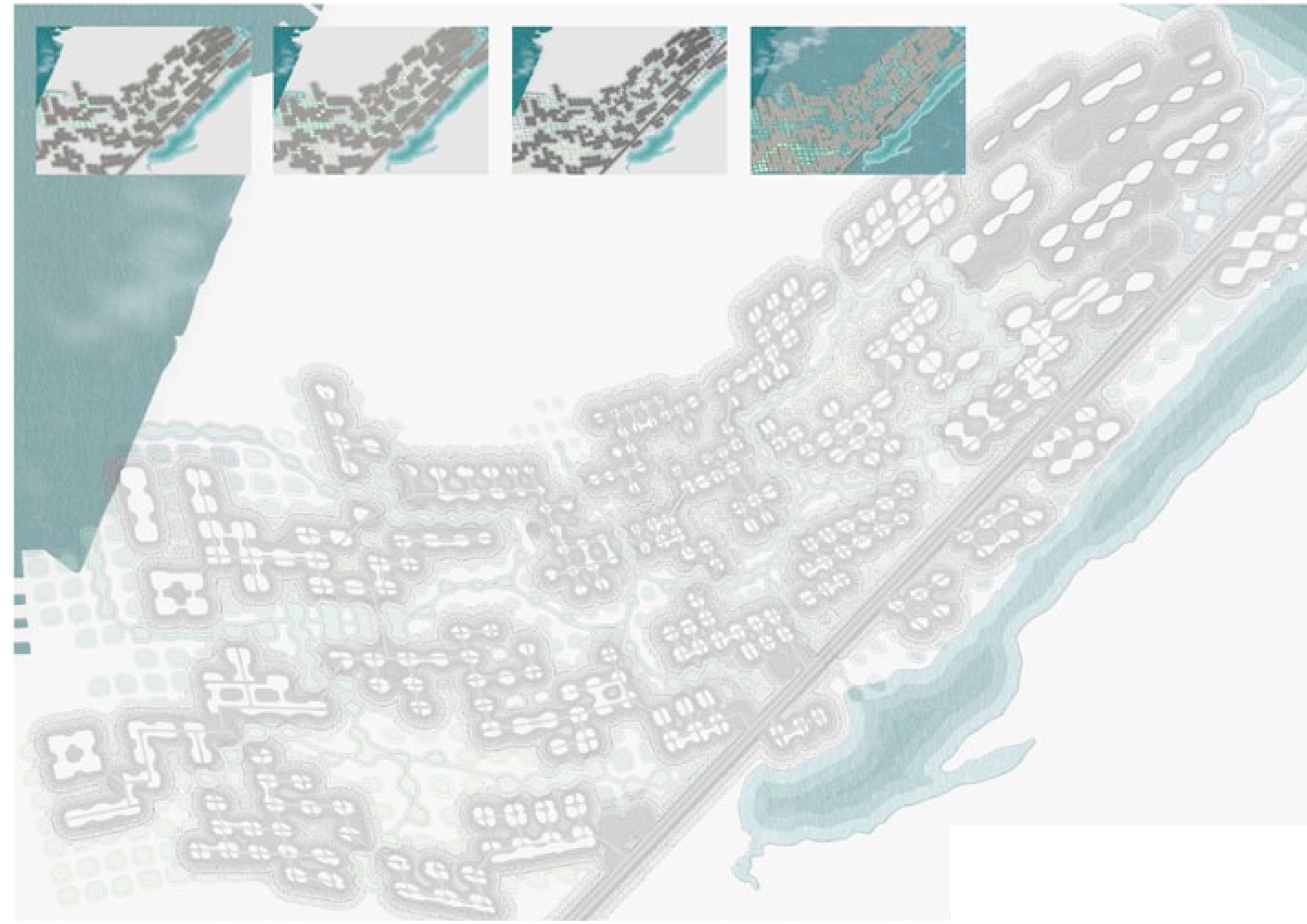






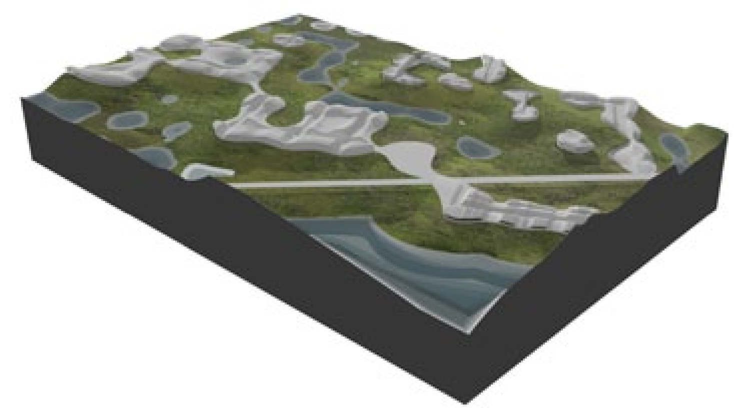
Matrix of Patches and Corridors

Density Logic

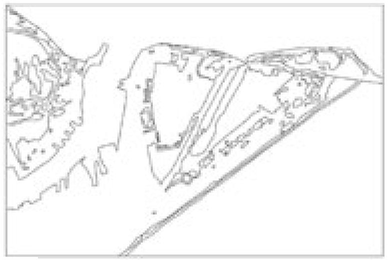


Site Plan

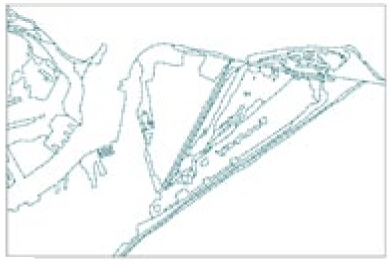
Wetland performativity
Galveston's wetlands are presently fragmentary and diminishing, but these systems play a critical role in the island's existence. A diverse array of marsh vegetation coupled with a pronounced micro-topography, prevents shoreline erosion and provides a rich habitat for wildlife. Tidal flushing along highly crenelated island edges controls salinity and absorbs the shock of sudden inundation. At the island's eastern end, the existing wetlands are isolated and heavily modified; diked, dammed and dredged. This proposal negates the traditional ordering system of the regulatory street grid, a network of asphalt and infrastructure. In its place the soft ecologies of the wetlands are pushed to hyper-performativity and generates new patterns for development.



Composite national wetland inventory maps 1956-1979



1992



1989

1979

1956

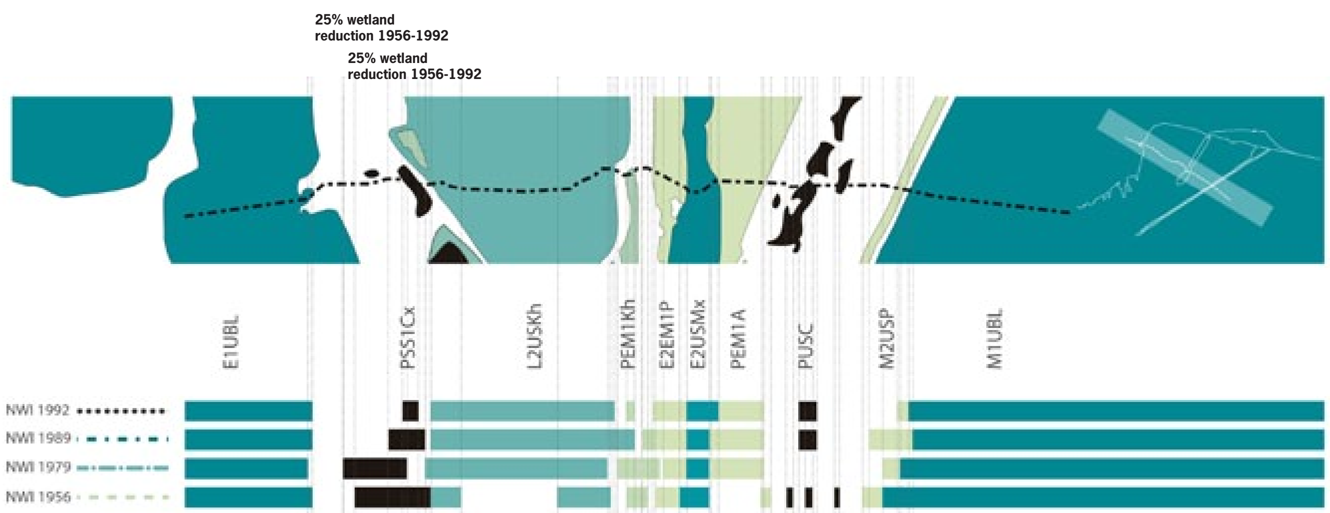
NWI 1992
NWI 1989
NWI 1979
NWI 1956

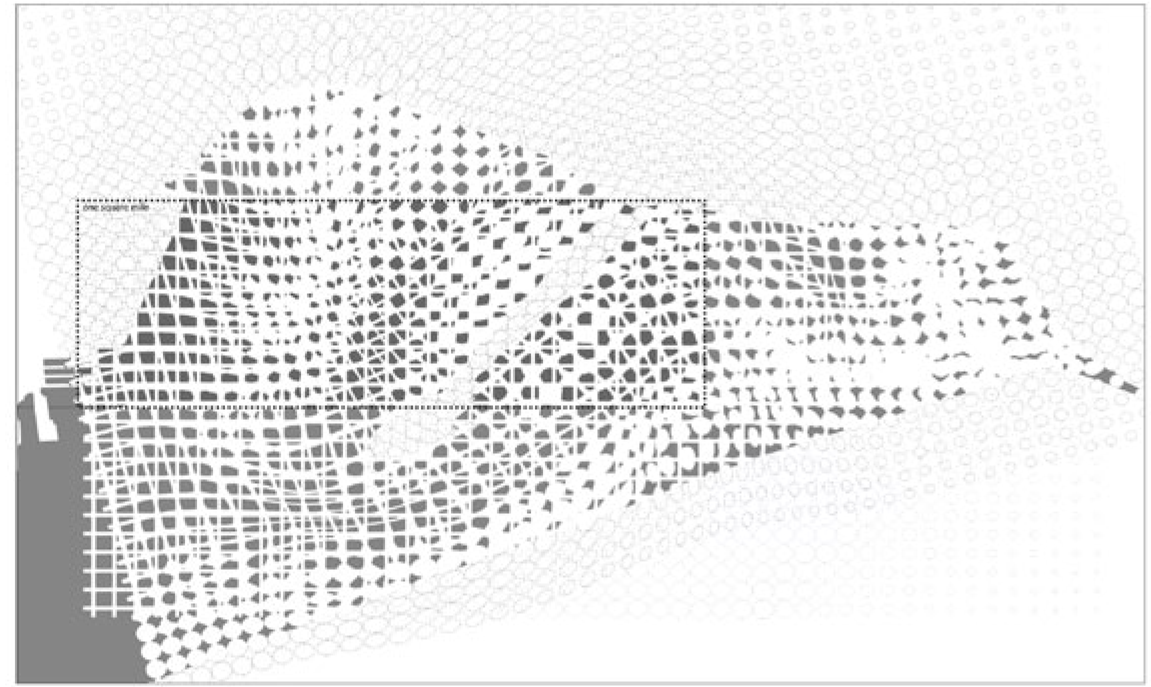
Fluctuating wetlands

National Wetlands Inventory surveying methods have evolved over time, reflecting political and social priority. Circular 39, the 1956 standard, classified wetlands under four main categories, lacustrine, palustrine, estuarine and marine, organizing 20 subcategories by depth and frequency of inundation.

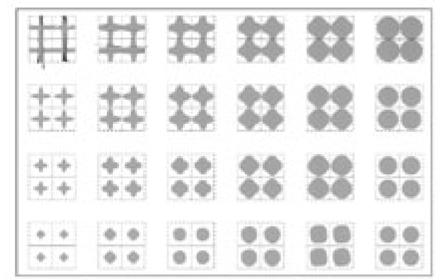
The Cowardian system developed in 1972, reflecting a more rigorous approach to classification. This system, which creates a hierarchical classification based on system, subsystem, class and modifier has become the standard for wetlands classification. The modifier nomenclature marked the recognition of artificially constructed environments as wetland.

The current method of delineation adopted in 1987 requires a wetland to exhibit three characteristics: vegetation, soil and hydrology, any single item had previously been qualified as preserved wetlands.

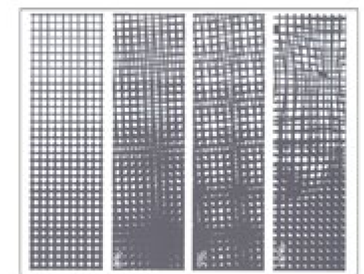




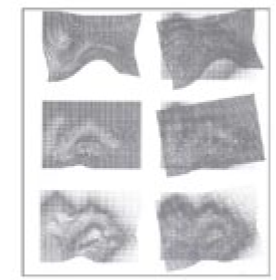
Wetland and infrastructure inter-digitation



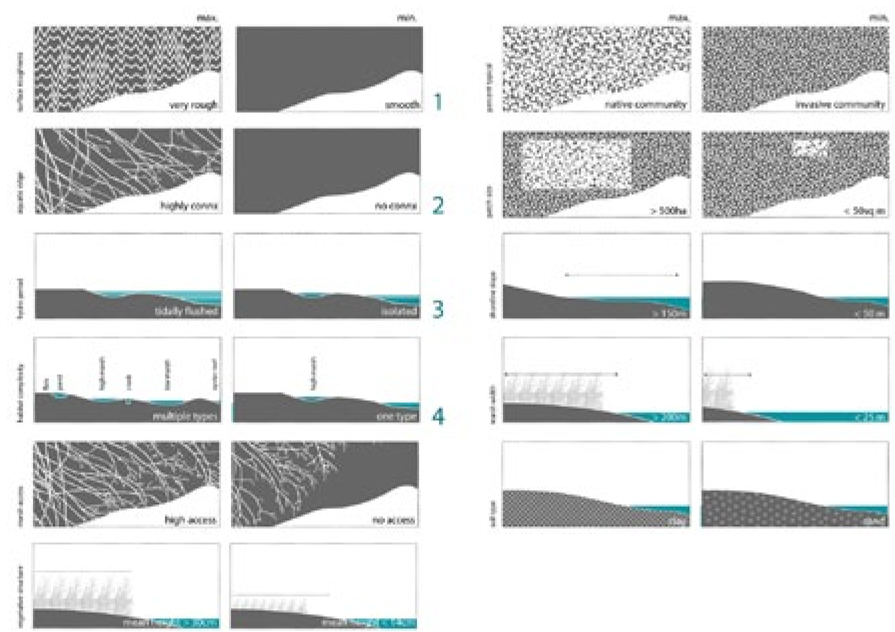
Field notation

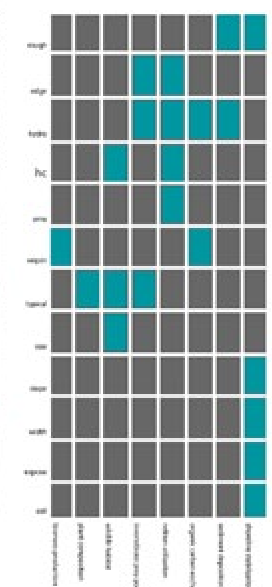


Wetland-development blending

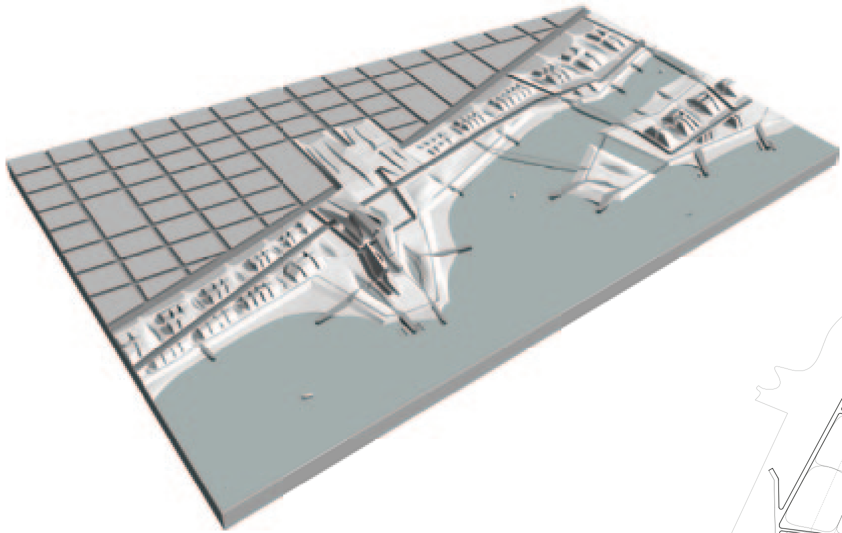


Field moire diagrams



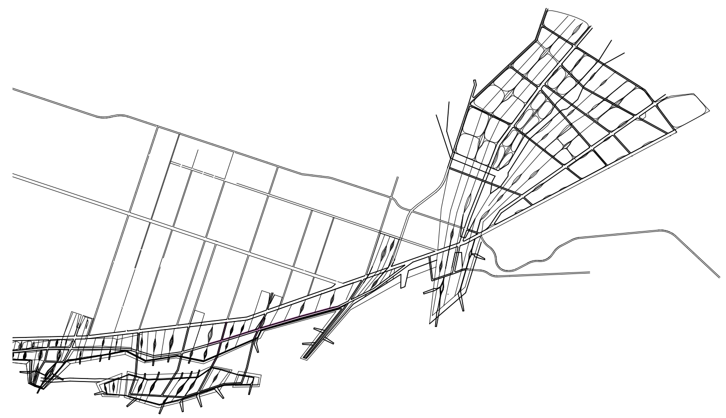


abstract machine

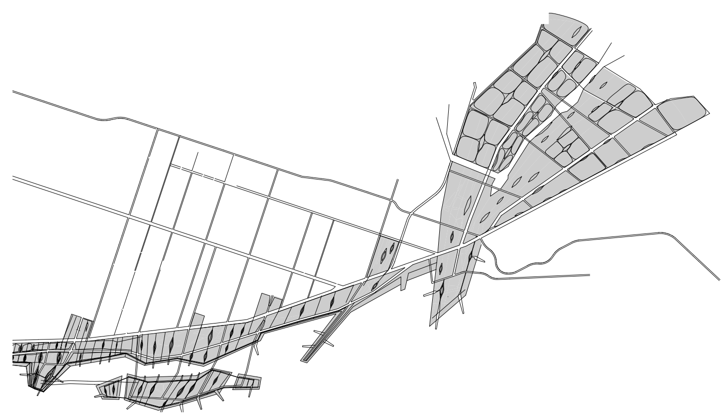


Site plan, with wetlands in the north and new coastal landscape on the south.

Program
Dredge remediation, freshwater habitat construction, coastal redevelopment



Hard-scapes
Roads, boardwalks, hardened seawall edges



Soft-scapes
Freshwater wetlands, parks, urban agriculture

Galv_restore

Timmie Chan

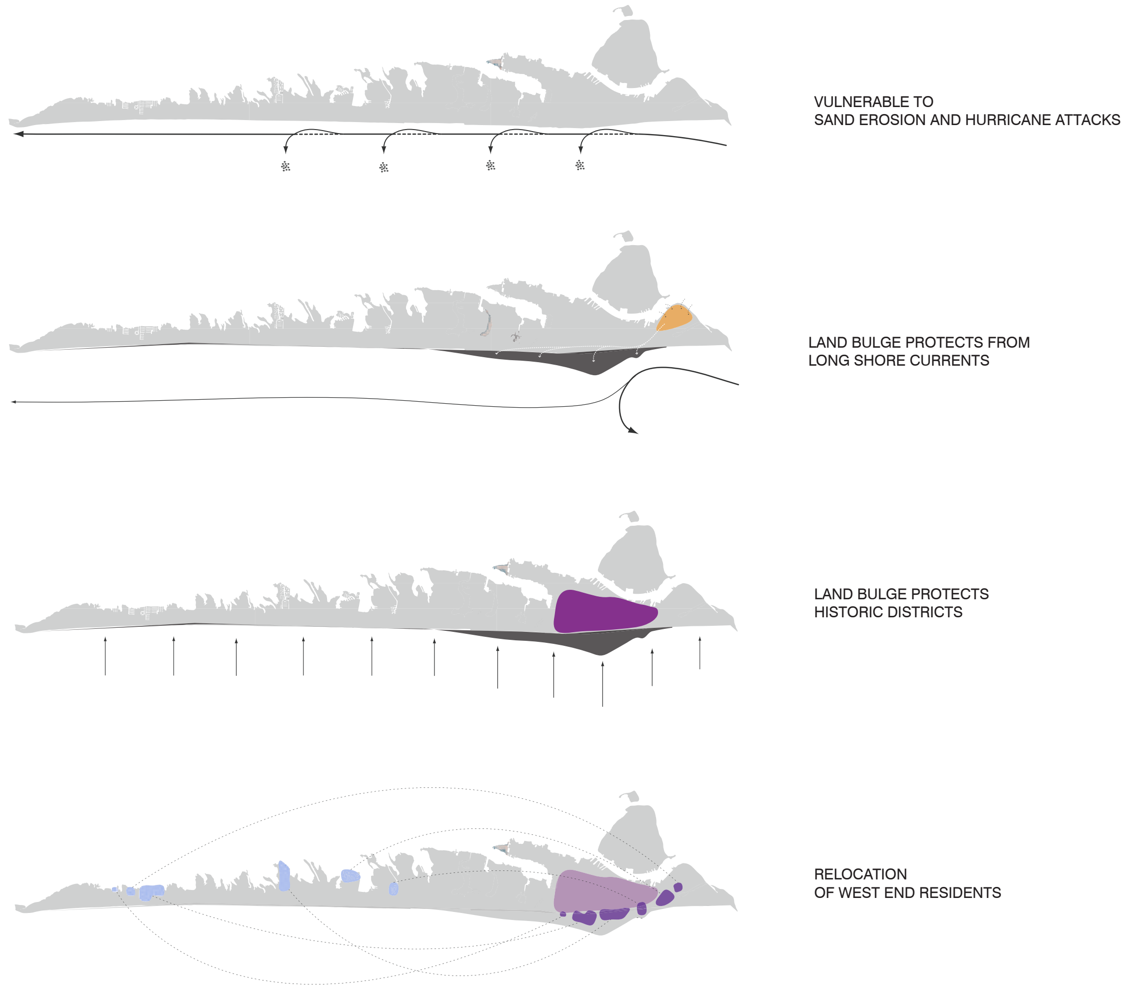
2010

Galveston's proximity to Houston (soon to be the third largest city in the US), means that tourism will likely be the main source of income for Galveston Island. Yet, the tourist attractions in Galveston Island are relatively tenuous and reliant upon the artificially nourished beach along the seawall and the rapidly retreating beach on the west end of the island. The seawall may also need refurbishment and expansion in the coming decades due to age, erosion and rising sea-levels.

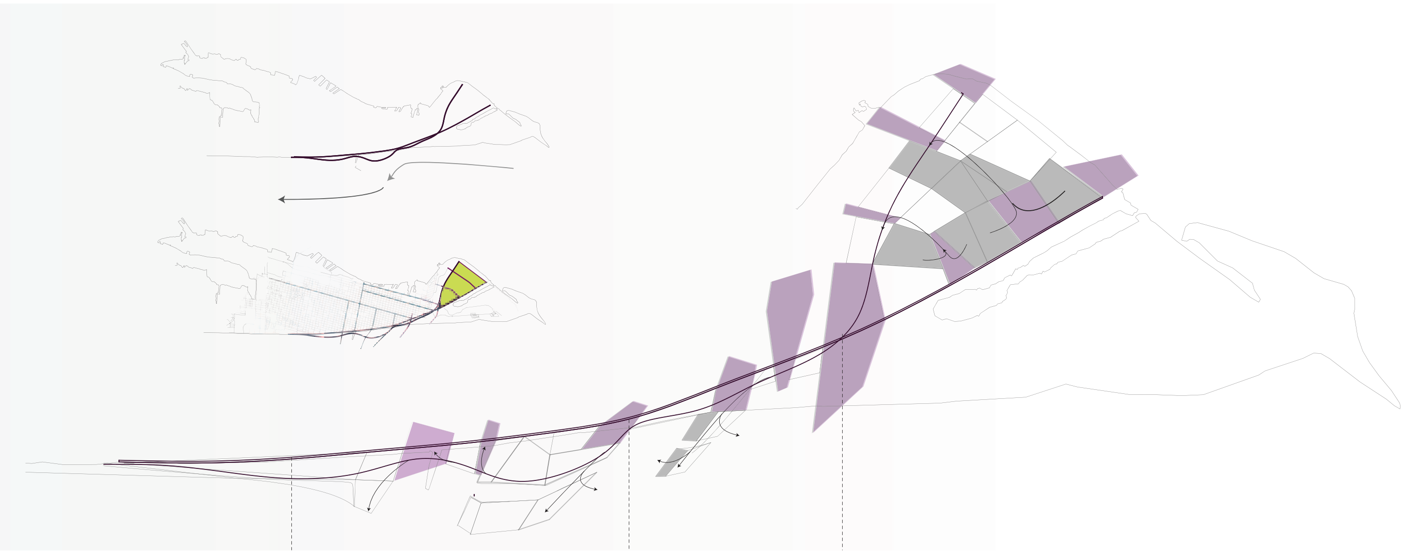
This proposal provides an alternative future for the city, focused on the revitalization of the dredge deposit on the East End Flats, turning it into a resource for land growth on the Gulf side of the island. Five hyper-accumulator plant species native to Galveston Island can remediate different volumes of dredge in different time spans. For example, the shallow rooted Rapeseed plant can remediate one foot of dredge in approximately one year, while the deep rooted Black Willow tree can remediate 10 feet of dredge in approximately 10 years. At various stages, the East end flats will be open to tourists for eco-touristic activities like bird-watching, hiking and education.

When the dredge is fully remediated, it will be transported along new infrastructure to recreate the coastline on the Gulf side, creating protective islands, marinas, protected pocket beaches that foster differentiated qualities and programs.

The design derives from the logistics of these processes. In the East End Flats, the open terrain is subdivided into patches for remediation, each surrounded by earth berms that also allow access. On the waterfront, this process is reversed as new land is produced via accumulations of land patches that are parametrically calibrated to factors such as program density, scale, circulation and water-edge condition.



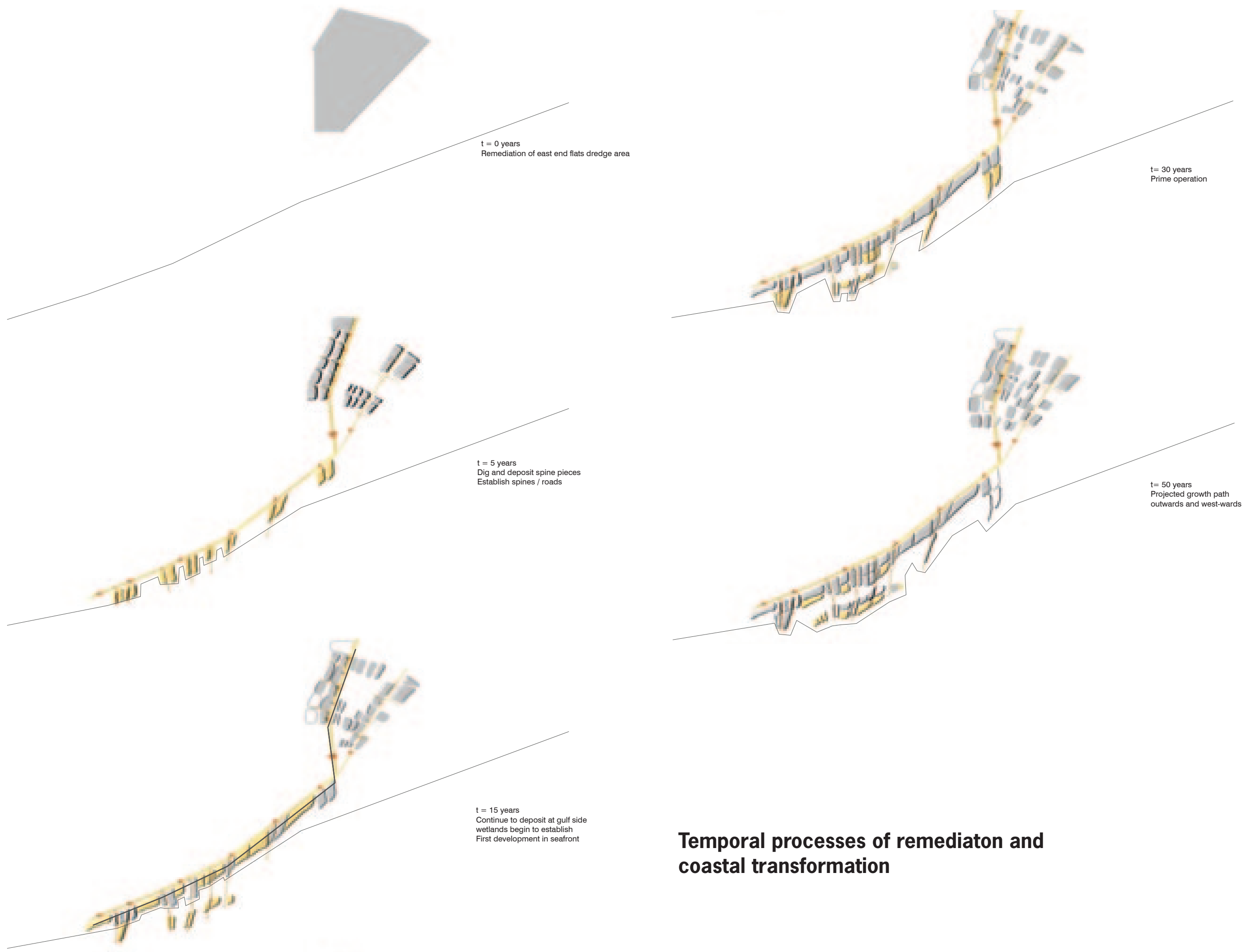
Arguing for Expanding the Seafront



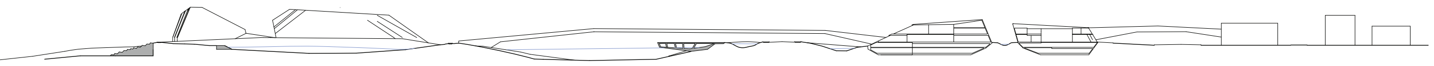
Transformation of the Seawall

	Galveston County	Galveston Island	East End
1 year	Height of dredge deposit: 0.50 inch	Height of dredge deposit: 1.7 inches	Height of dredge deposit: 1.71 feet
5 years	Height of dredge deposit: 2.50 inch	Height of dredge deposit: 8.5 inches	Height of dredge deposit: 8.5 feet
10 years	Height of dredge deposit: 5 inch	Height of dredge deposit: 17 inches	Height of dredge deposit: 17 feet
20 years	Height of dredge deposit: 10 inch	Height of dredge deposit: 34 inches	Height of dredge deposit: 34 feet

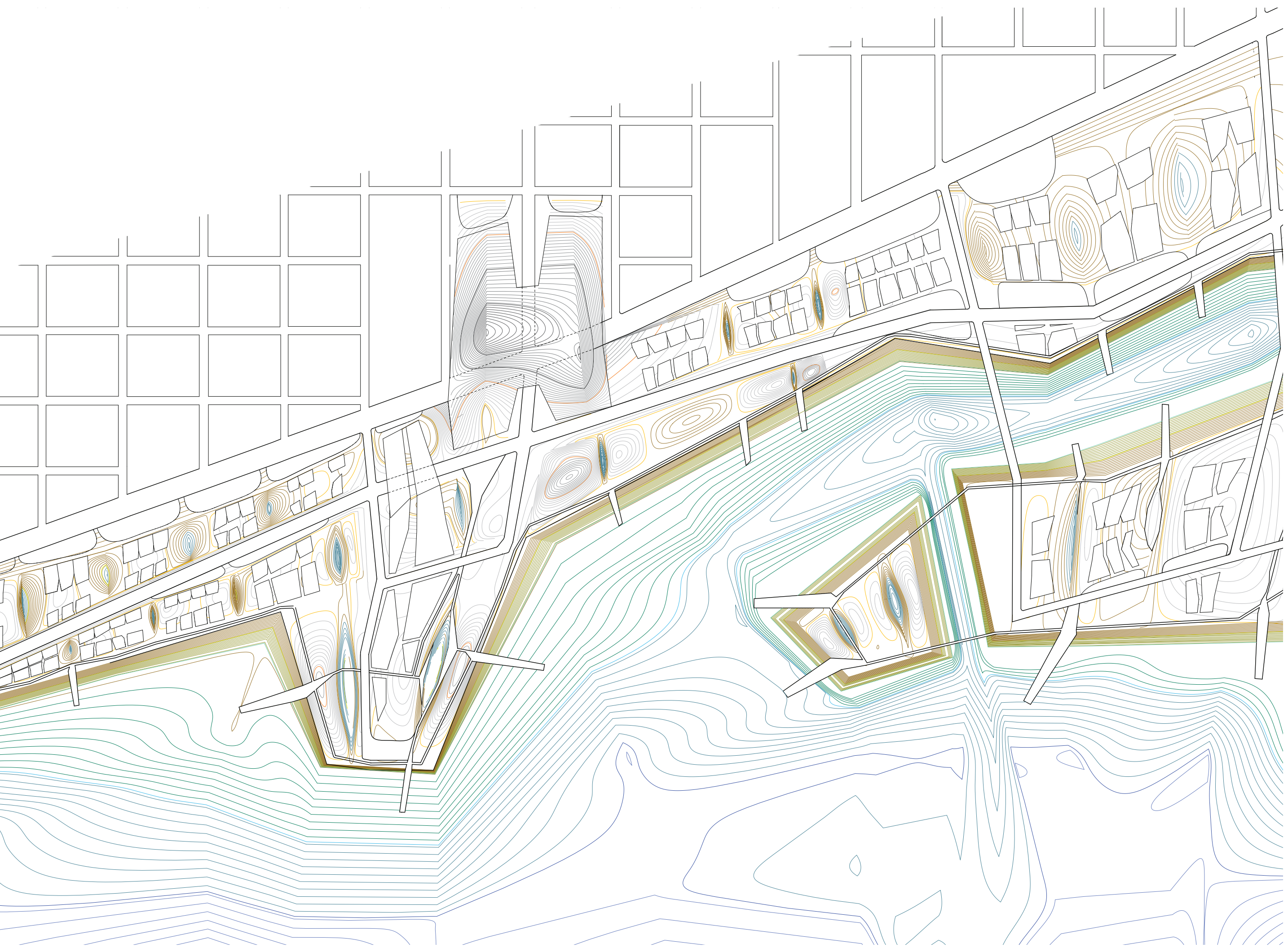
Average annual dredge volume from ship channel if deposited on the island in different manners



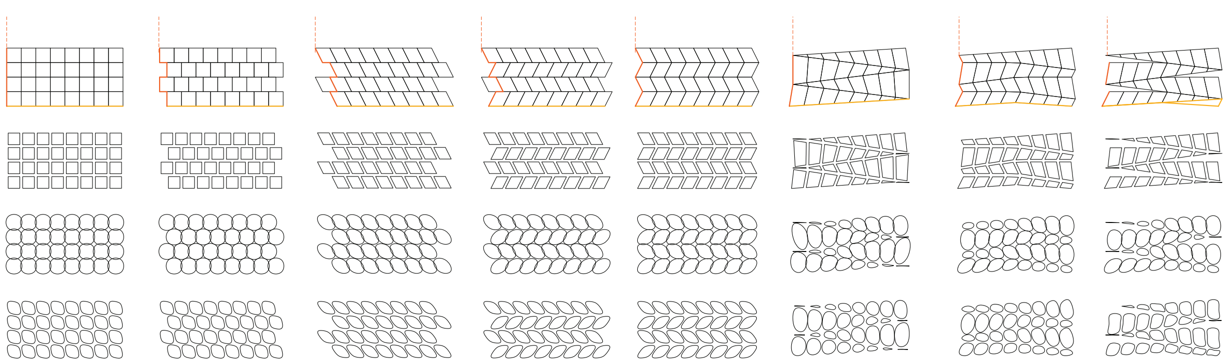
Temporal processes of remediaton and coastal transformation



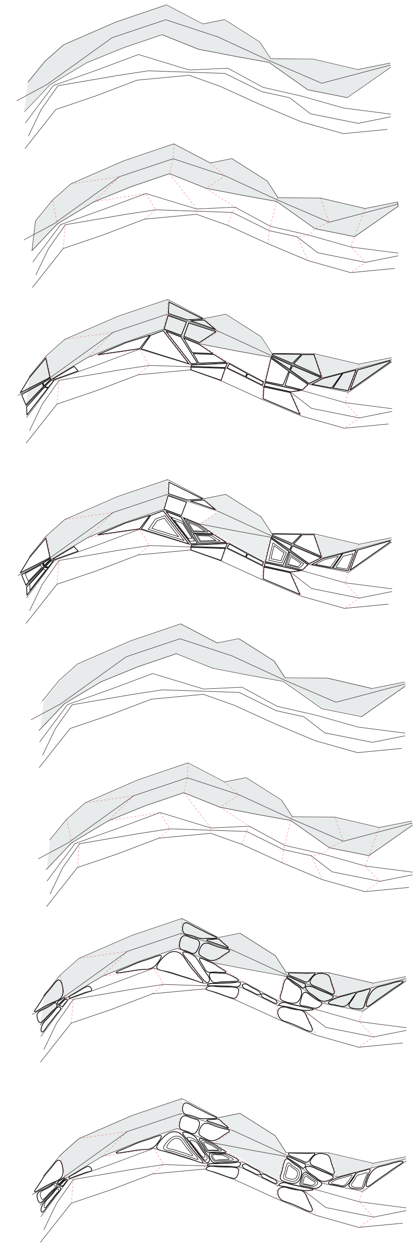
Section through site



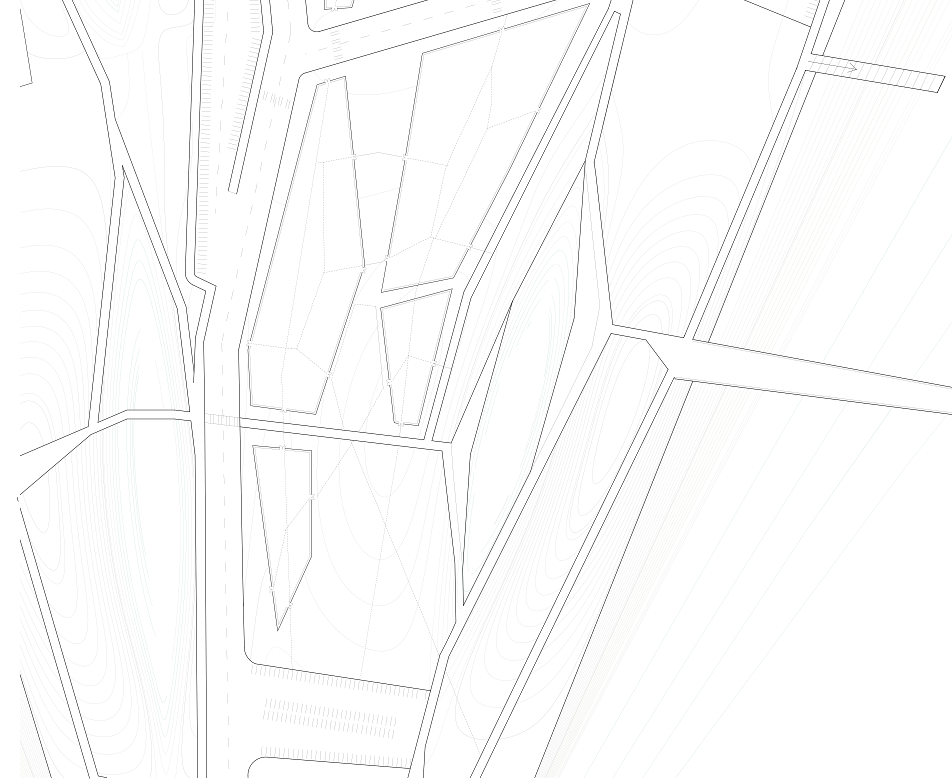
Detailed plan, final stage

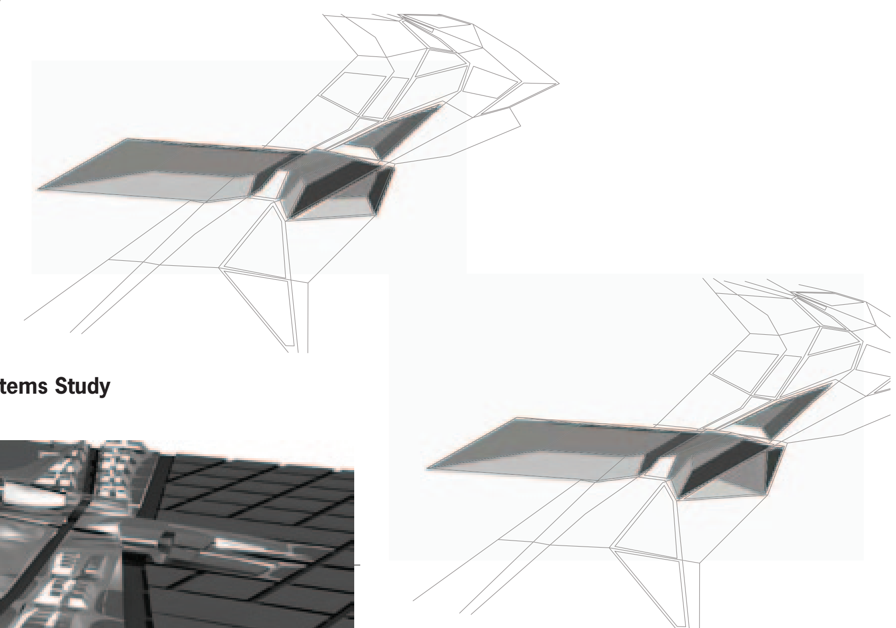


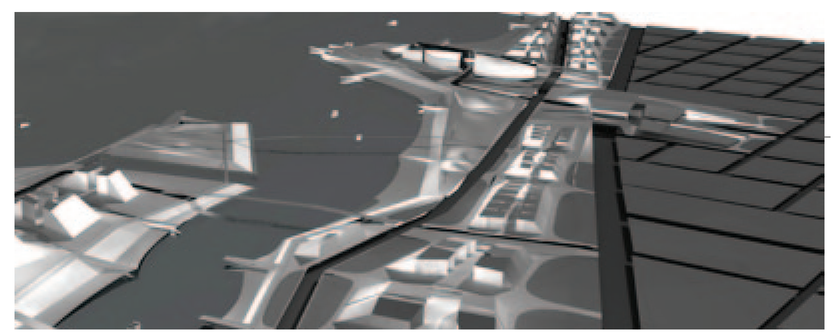
Mould Distribution Organization Studies

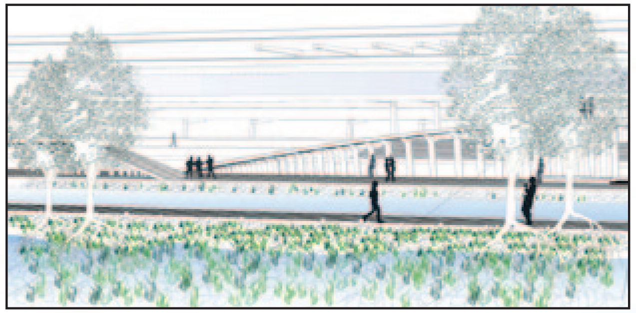


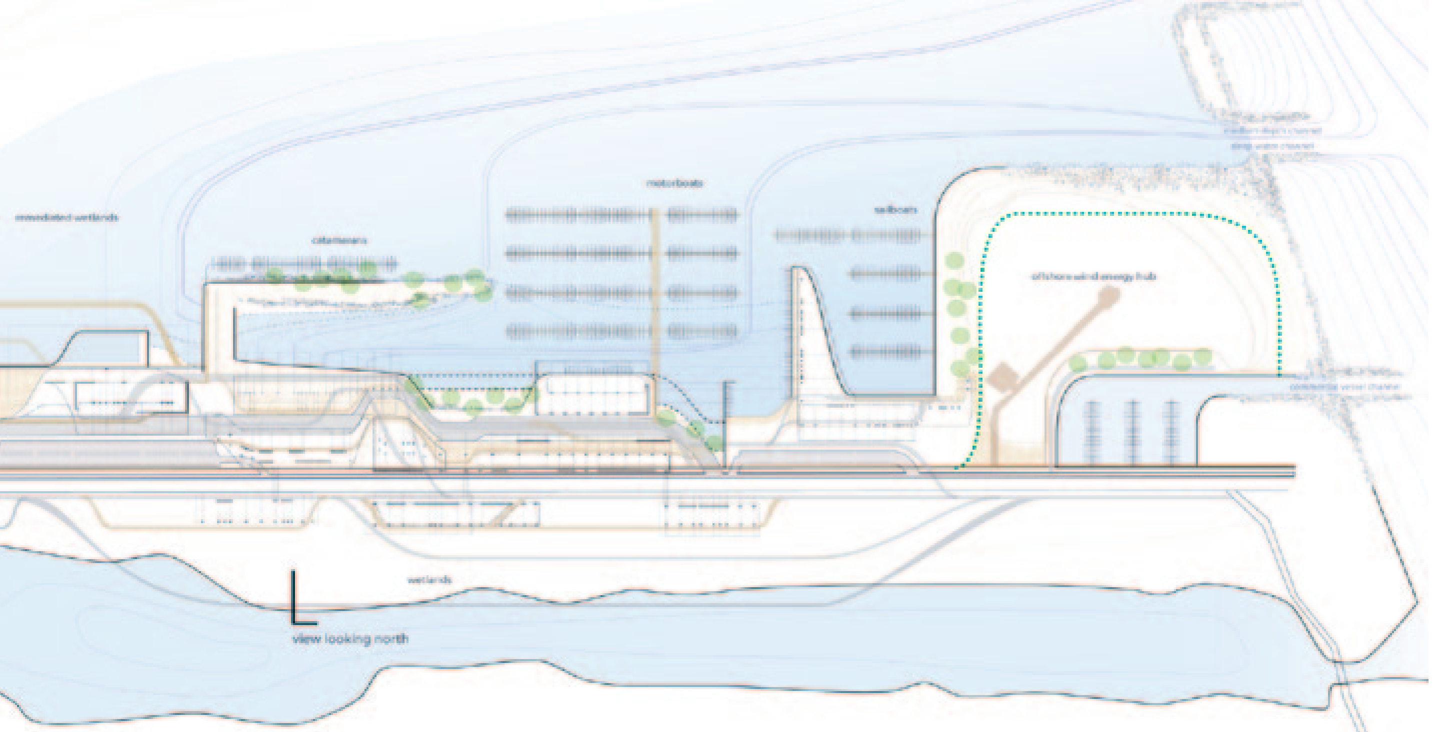
Edge Flux-Topography Systems Study



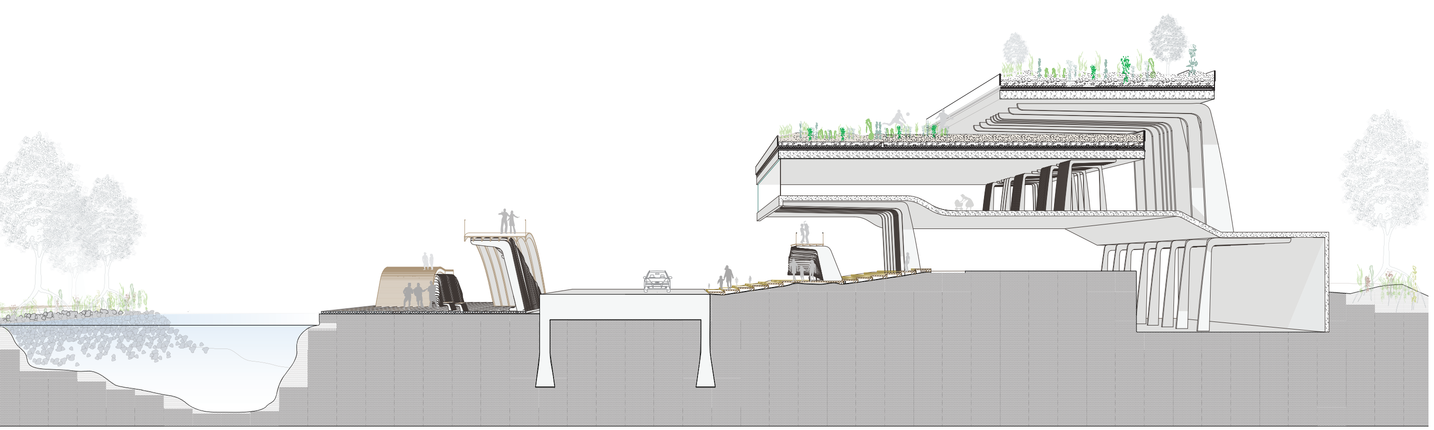




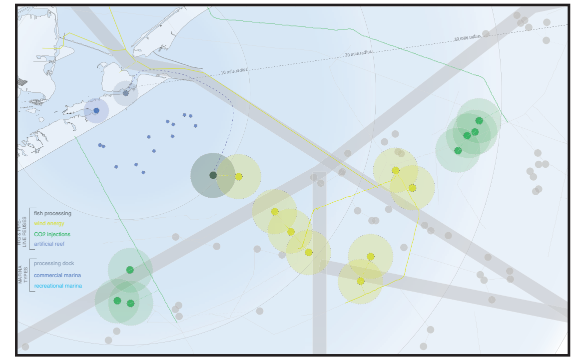




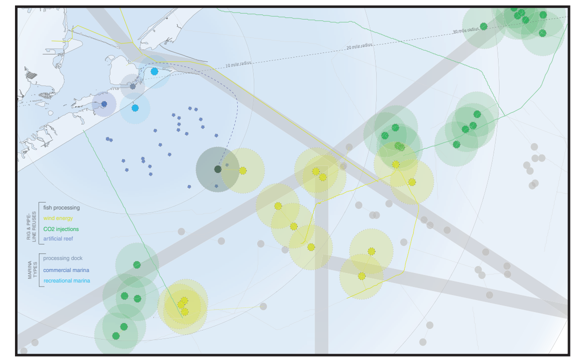
Urban Plan of New Marina on East End



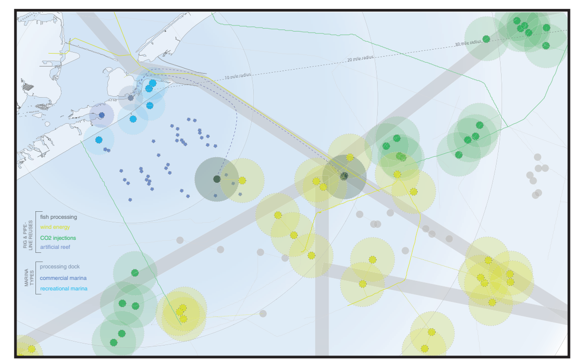
Section Perspective of New Marina



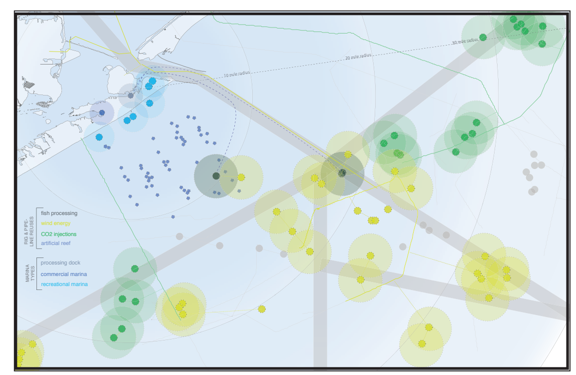
Phase 1: 5 years



Phase 2: 10 years



Phase 3: 15 years



Phase 4: 20 years

Symbiotic Infrastructure

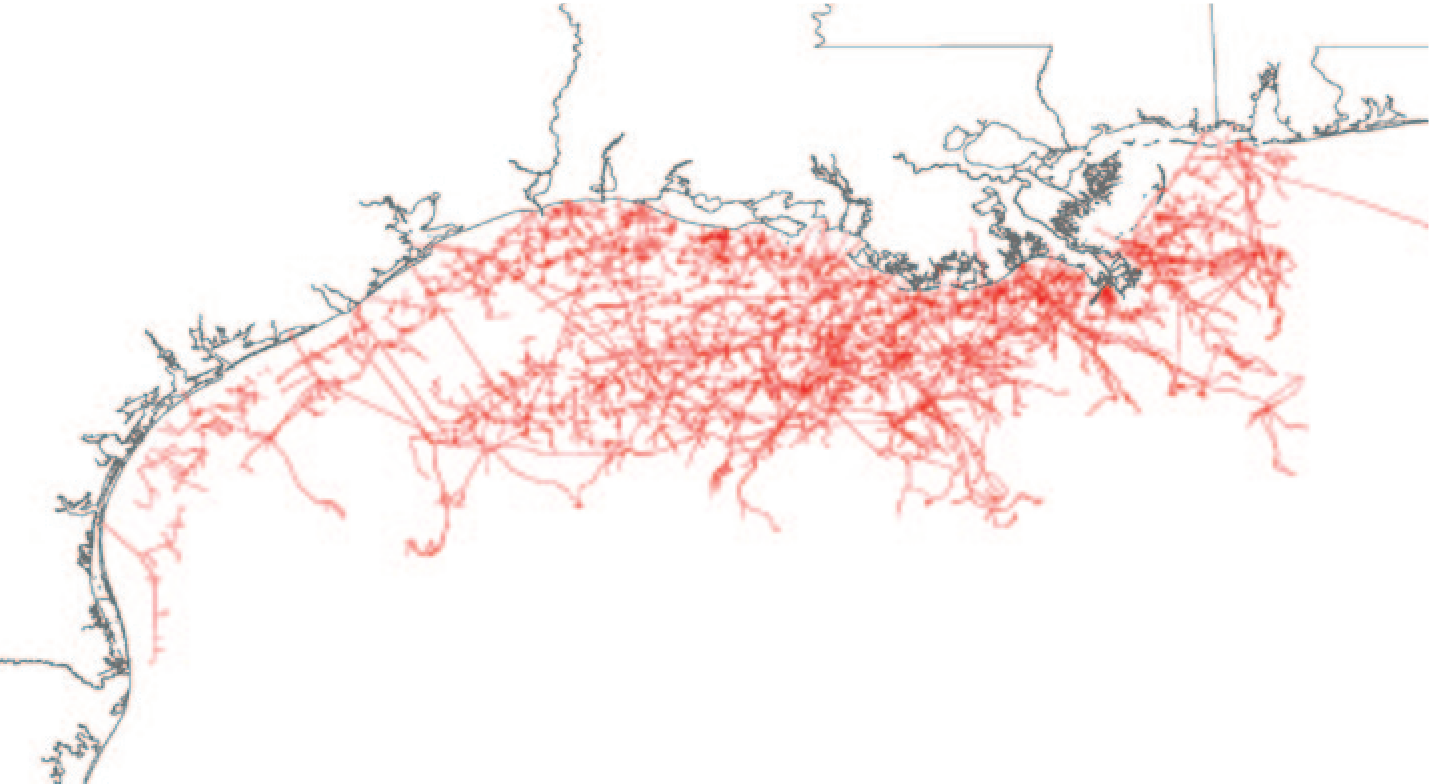
Jessica Cronstein, Annika Miller, Jessica Tankard

2009

The fishing industry provides great amount of revenue for the city of Galveston as well as for the larger region. Due to over-fishing, the fishing stock of the Gulf has declined in recent years, as they have across the globe. However, fish thrive on the artificial reefs created by the oil platforms currently in place. By 2020 up to 95% of Gulf oil platforms will be obsolete due to oil reserve depletion. Although current law requires that platforms be removed once they cease operation, it costs three times more to completely remove a disused platform than it does to re-implement that same platform as an artificial reef.

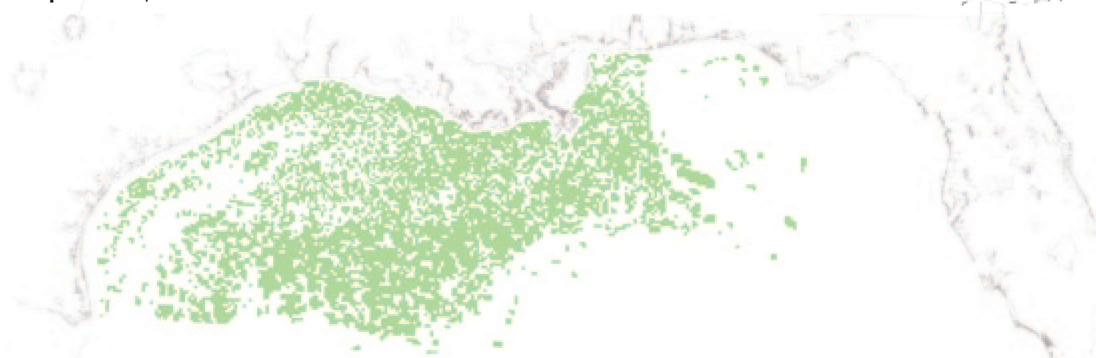
In order for oil companies to be able to leave the disused platforms in place another agency needs to take legal responsibility for the platforms. Phasing of the reuse of the platforms is based on the amount of oil in wells and the rate at which those reserves are being depleted. The first wave of disused rigs will be kept as artificial reefs below the water, and converted to wind energy farms, for which they are optimally placed, and a major fish processing plant. This processing plant will be linked to existing commercial marinas onshore. With the revenue from the first plant we will create a larger mixed use marina on the East end of the island, housing both commercial and recreational vessels. The excess material produced by its construction will be redeployed along the seawall, which by that time will need to be protected due to the erosion of the beach. The new coast will have pocket beaches using now scarce sand, with additional coves, marinas and boardwalks.

As additional platforms become available, they will be converted to wind farms and eco-tourist hotels. The “rig-reefs” of Galveston will be a great attraction in the future, where if trends continue, many natural reefs may have been destroyed. By the end of our twenty-year phasing plan the wind energy produced on the rigs could generate power for three Galvestons, the seawall will have been recreated, and a sustainable fishing and ecotourist industry will thrive as a symbiotic and auto-catalytic loop.

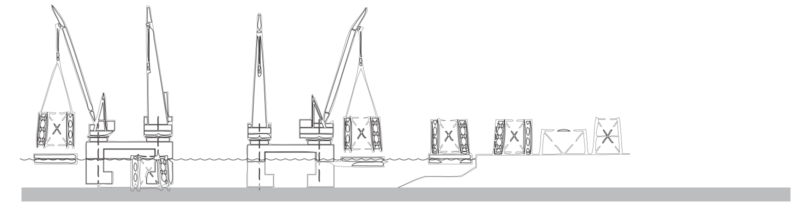


gas pipelines, 2007

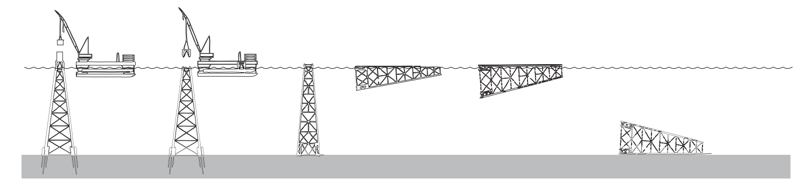
platforms, 2007



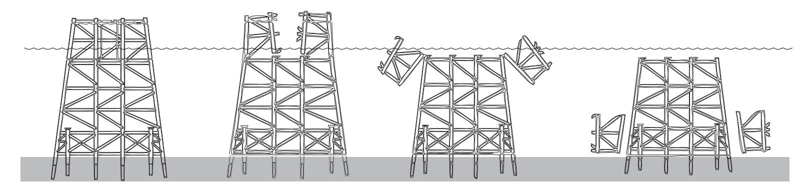
active leases, 2007



$44,000,000 = Cost of Complete Removal of Rig



$18,000,000 = Cost to convert to artificial reef

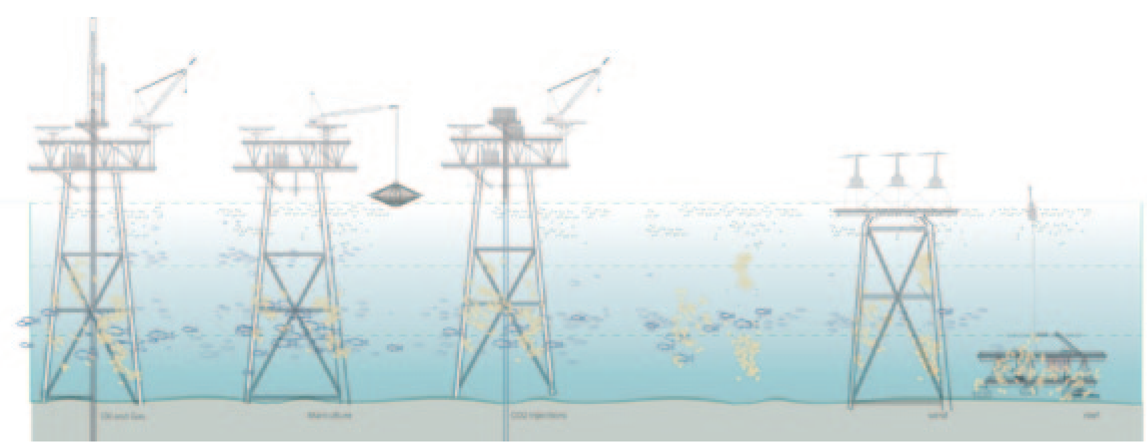


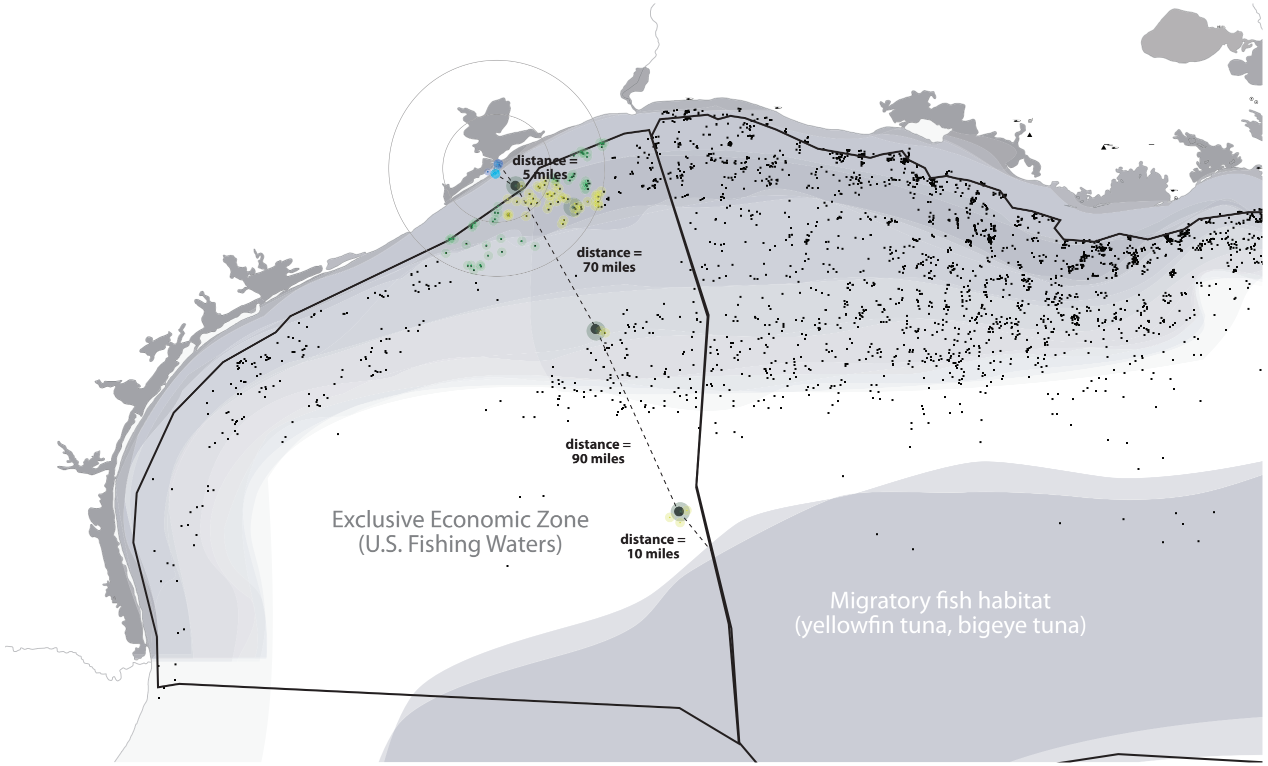
$15,000,00 Million = Cost for Partial Removal

Beneficial Use of Platforms
The Gulf Coast offshore gas and oil fields are mature and many current leases will soon reach the end of their useful life. The map below shows the estimated remaining lifespan for rigs in the Galveston area. Current law requires that the offshore platforms be dismantled at extremely high costs of around $44 million dollars per platform even though many will be structurally sound for another century. Moreover, this will destroy the habitats that have colonized the reefs over time.

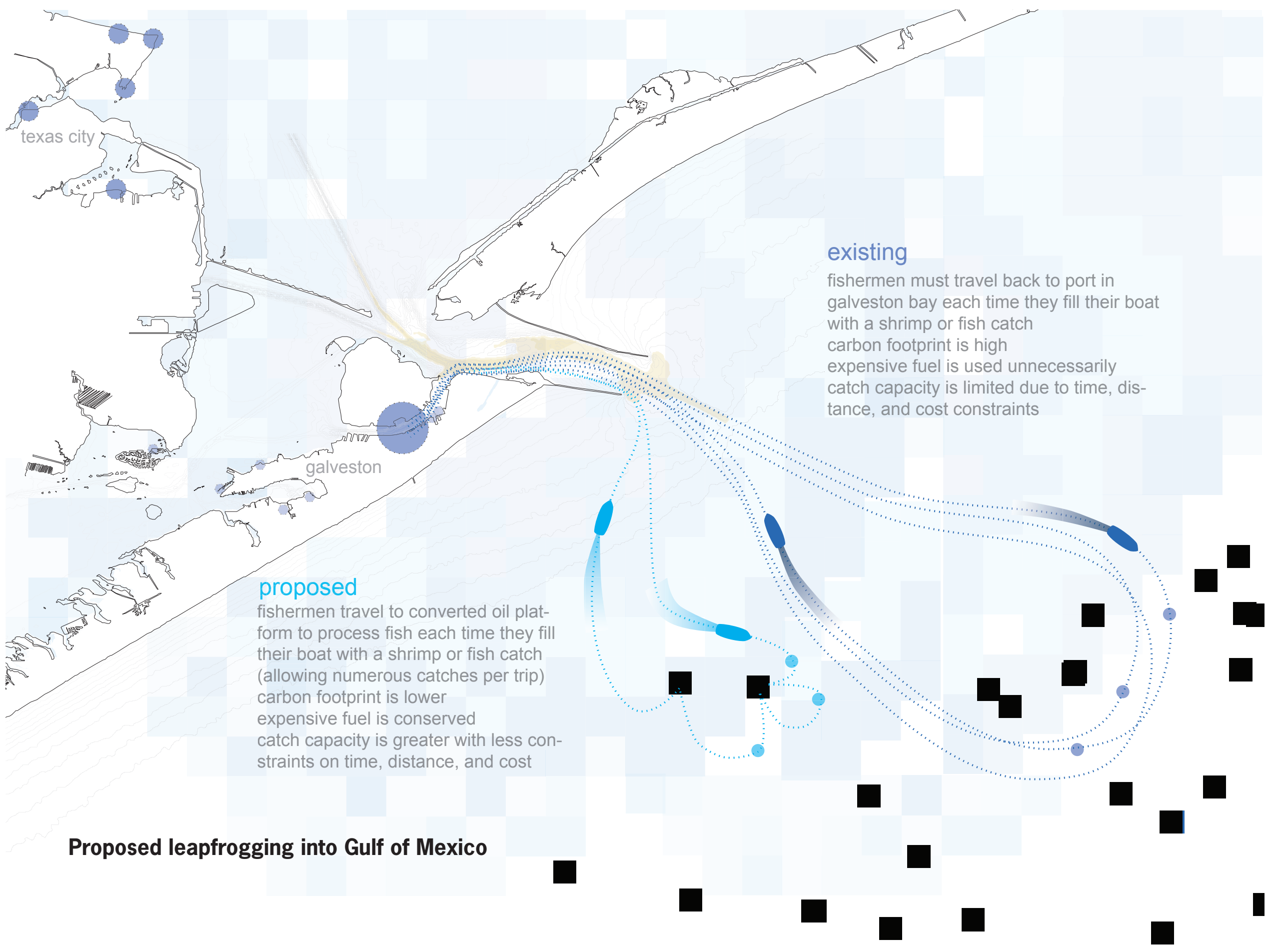
Rather than remove the rigs, they could be turned into artificial reefs with corresponding revenues in ecotourism and fishing. More radically, they could be partially dismantled and converted to other uses, such as wind and wave energy farms, exclusive resorts or offshore casinos, or other programs that would benefit from a degree of legal autonomy and proximity to the sea. Both of these options would keep or expand the industries that currently maintain the platforms, providing high-paying jobs in the region in a post-oil economy and revitalizing the city.

Research and diagrams by Jessica Cronstein, Annika Miller, Jessica Tankard. Source: U.S. Department of Interior, “State of the art removing large platforms located in deep water”, November 2000, pg. 33, 46,65. www.mms.gov.tarprojects/372.htm

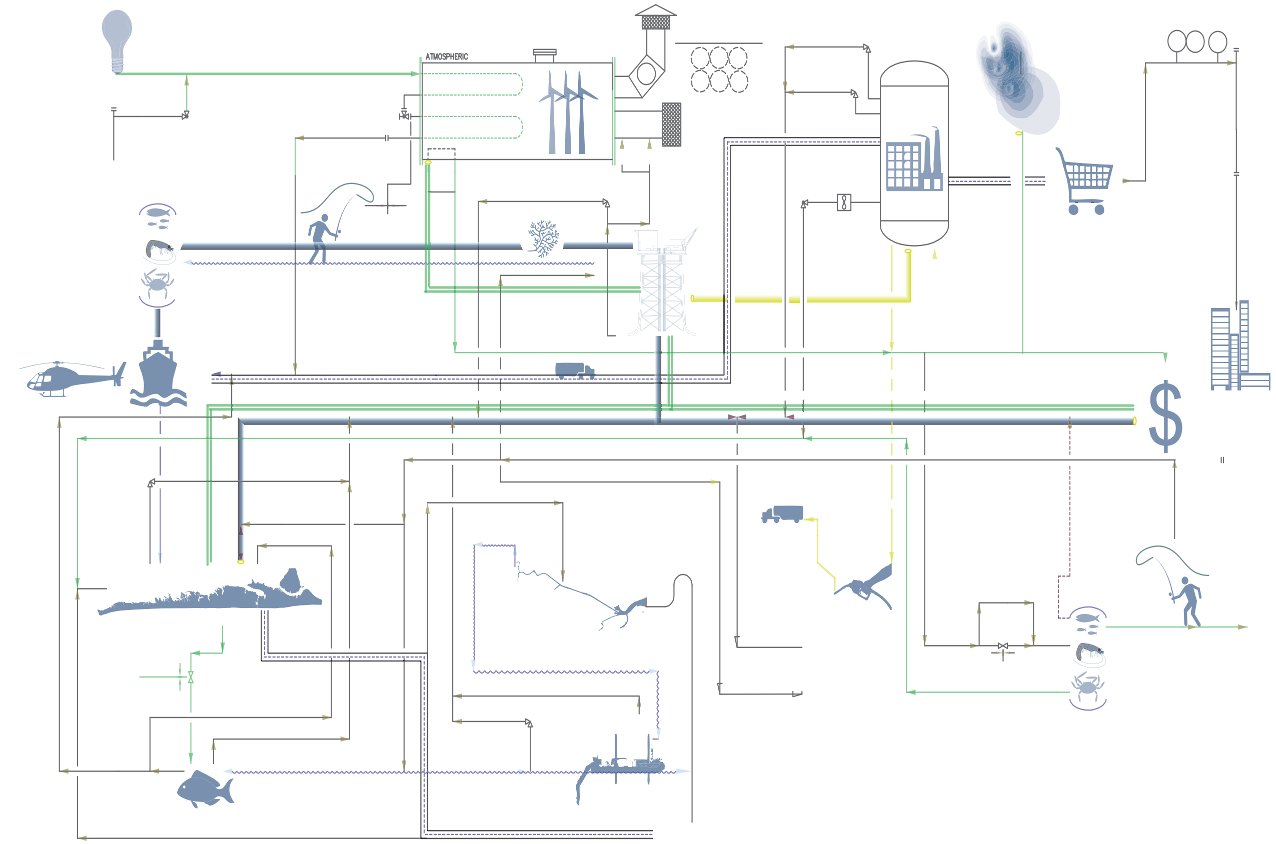


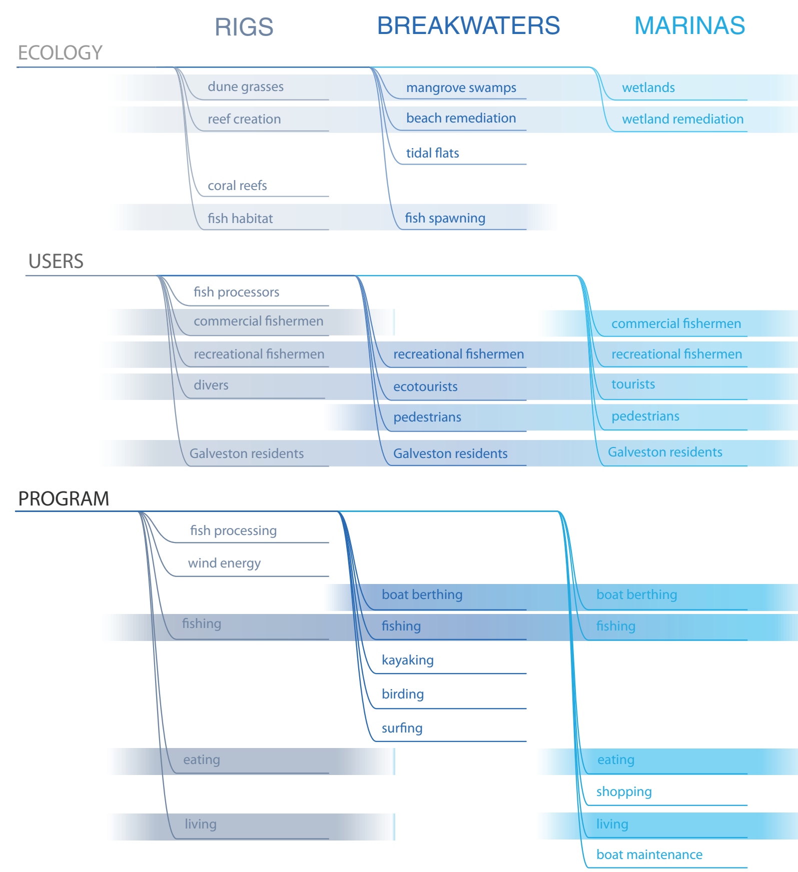


Comparing fishermen travel distance and catch capacity

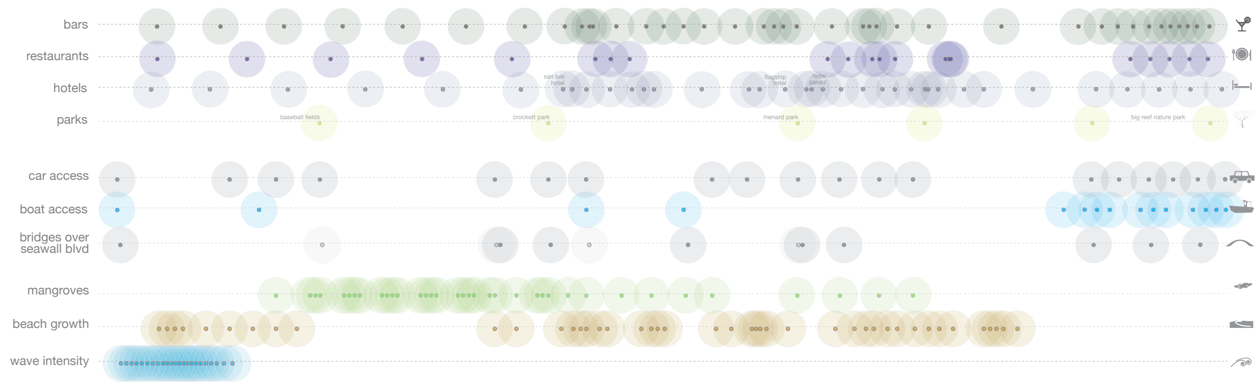


Proposed leapfrogging into Gulf of Mexico

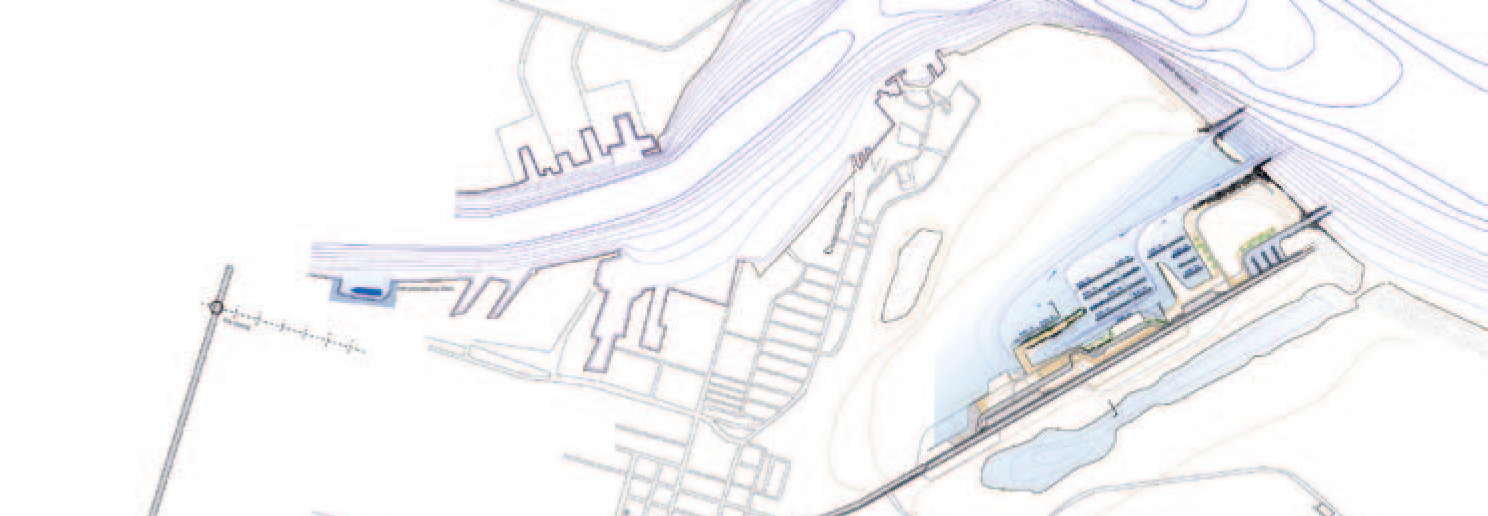


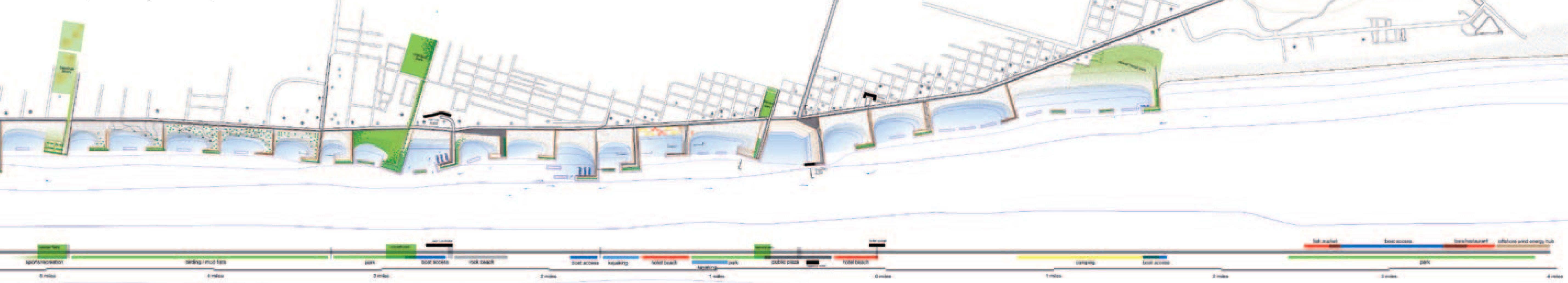


An Autocatalytic and symbiotic loop of transformation

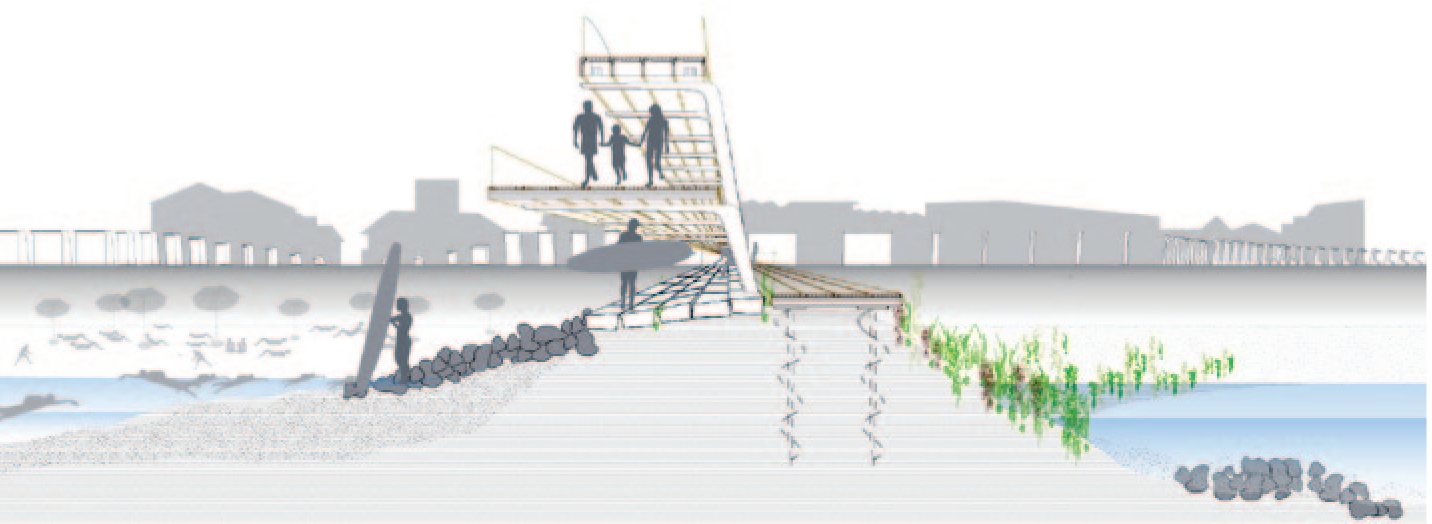


Programmatic pulses along seawall

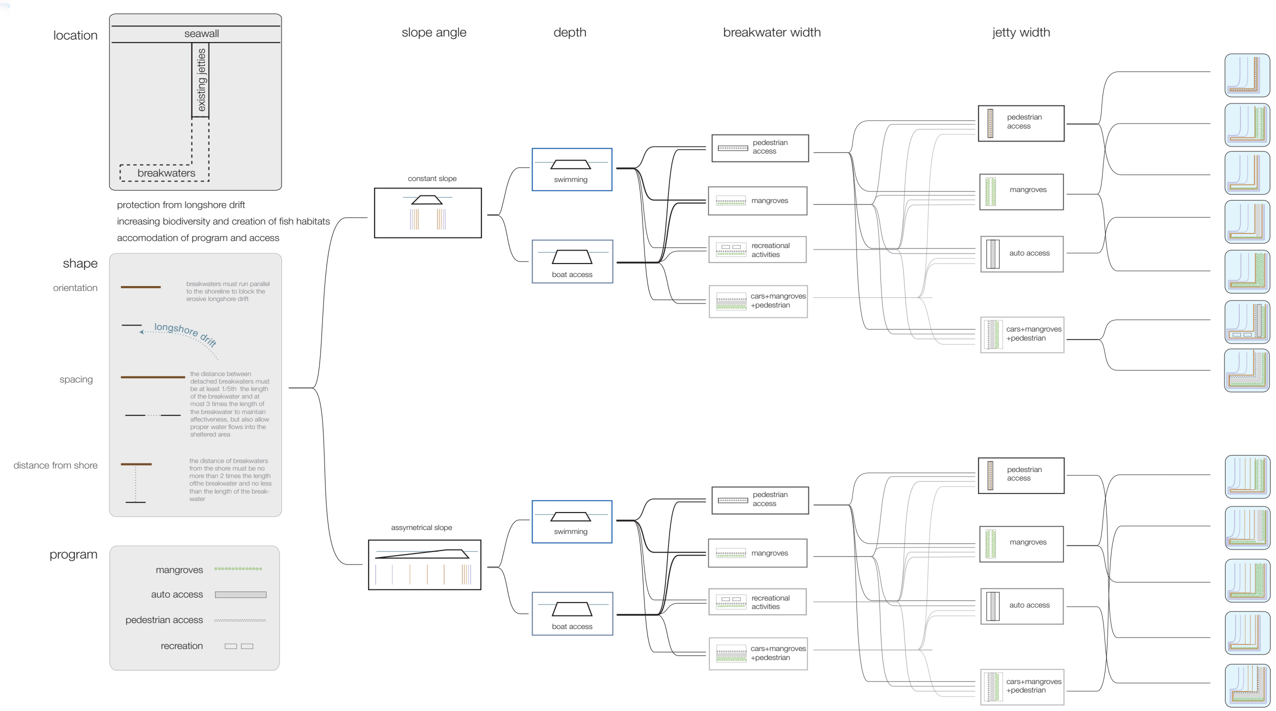




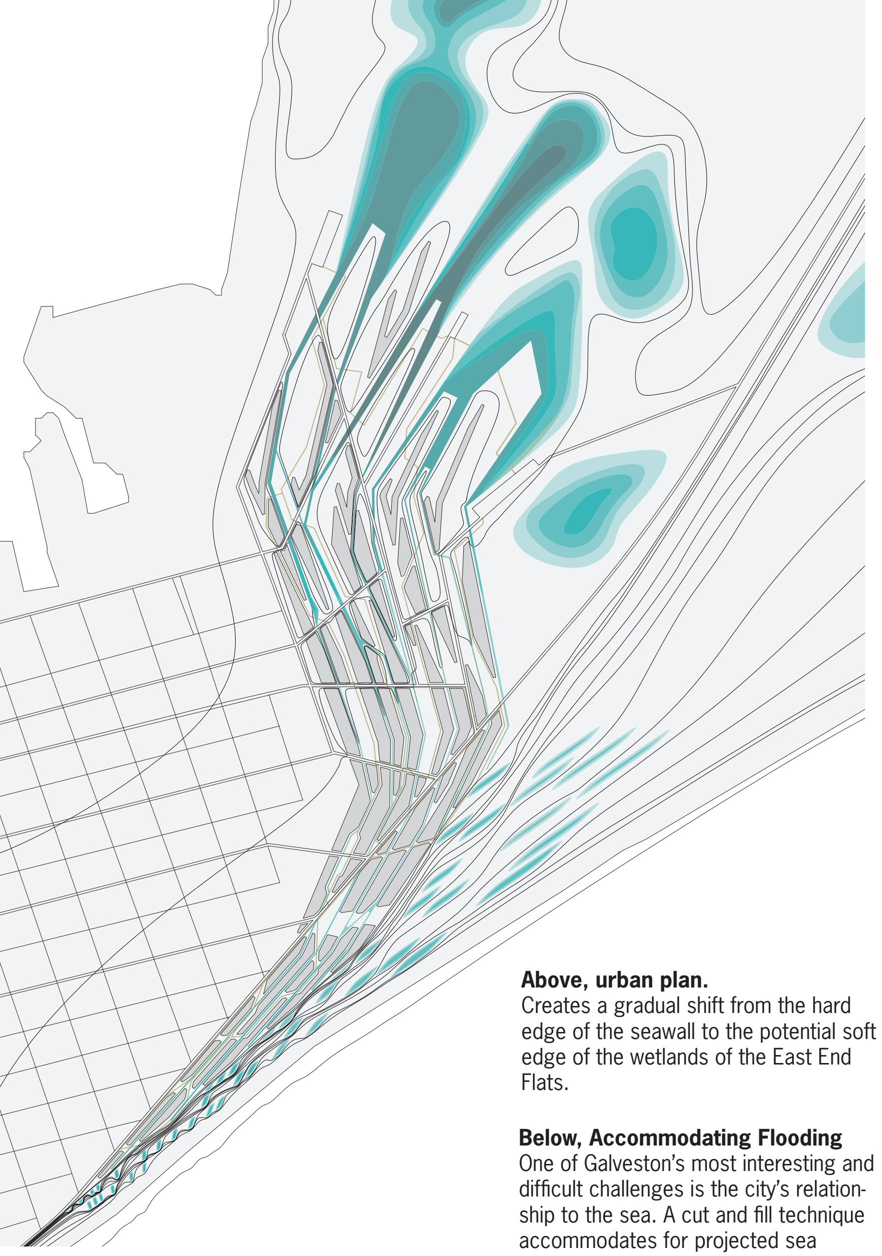
Plan of redeveloped Seawall as ecological and ecotourism catalyst



Section perspective looking toward seawall

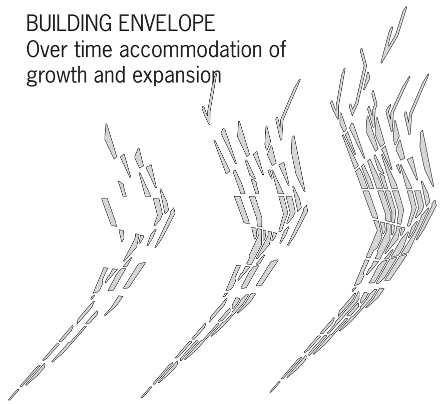


Phylogram of components of new seawall and marina infrastructure



Above, urban plan.
Creates a gradual shift from the hard edge of the seawall to the potential soft edge of the wetlands of the East End Flats.

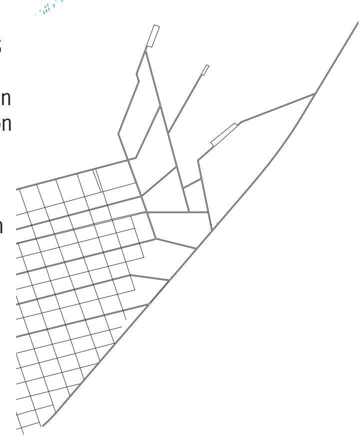
Below, Accommodating Flooding
One of Galveston's most interesting and difficult challenges is the city's relationship to the sea. A cut and fill technique accommodates for projected sea level rise and increased frequency of hurricanes.



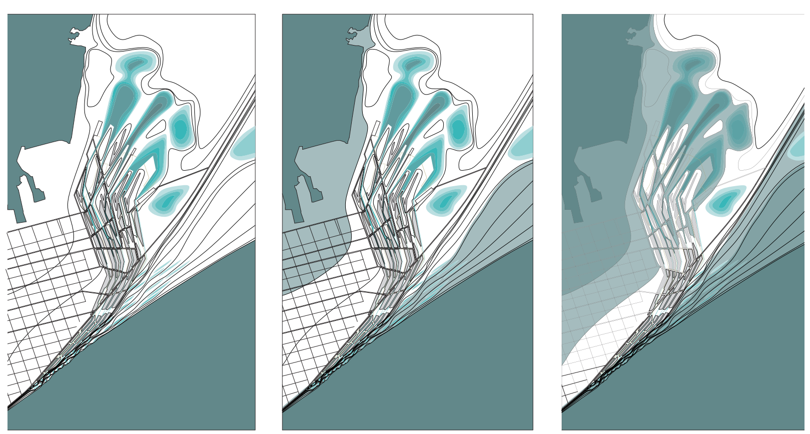
BUILDING ENVELOPE
Over time accommodation of growth and expansion

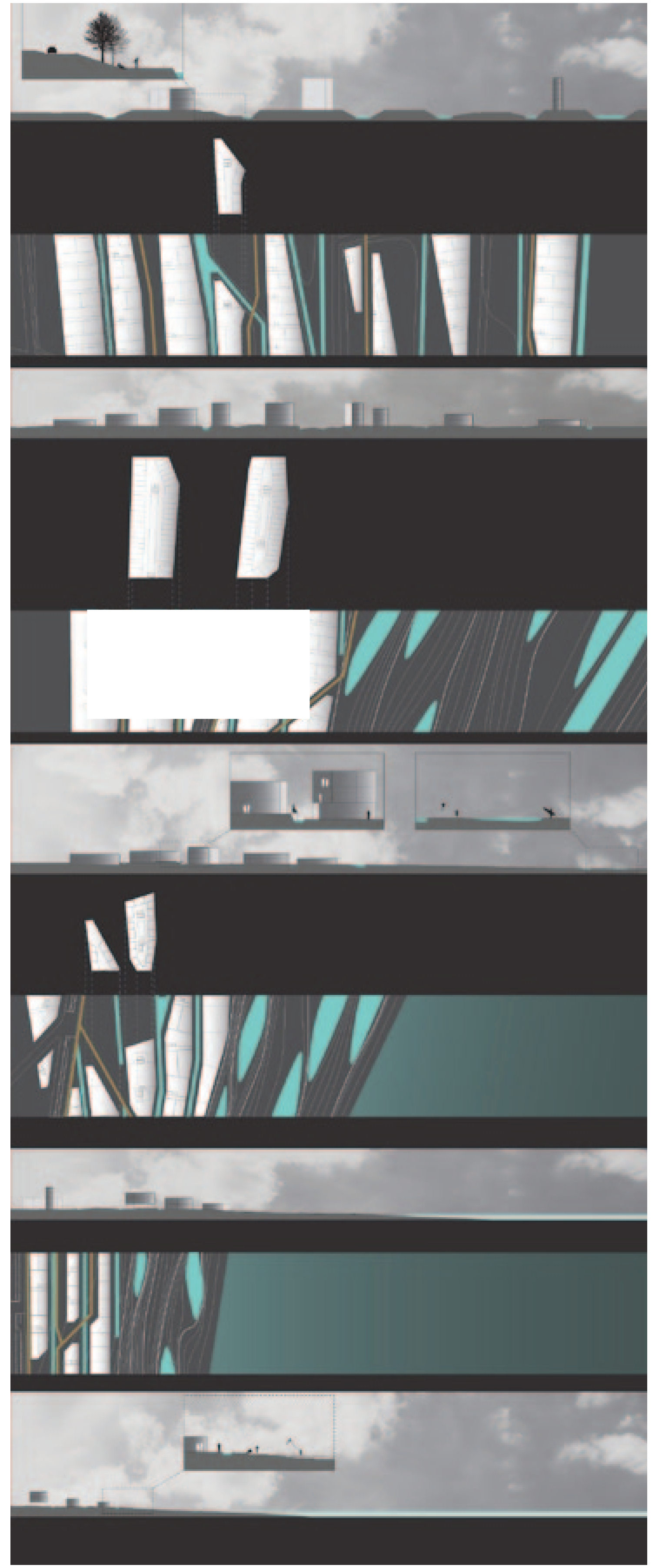
BIKE PATHS AND PEDESTRIAN WALKWAYS
allow for a connectivity throughout the system and engage the user at the local and global scale.

BEACH-SIDE POOLS,CANALS, AND WETLAND LAKES
enhance the islands inherent relationship to the water. The edges of these systems become active territories.



ROADWAYS
adhere to the notion of expansion and transition. At points of interception vehicular circulation refracts.





Galvanize

Brian Lee
2010

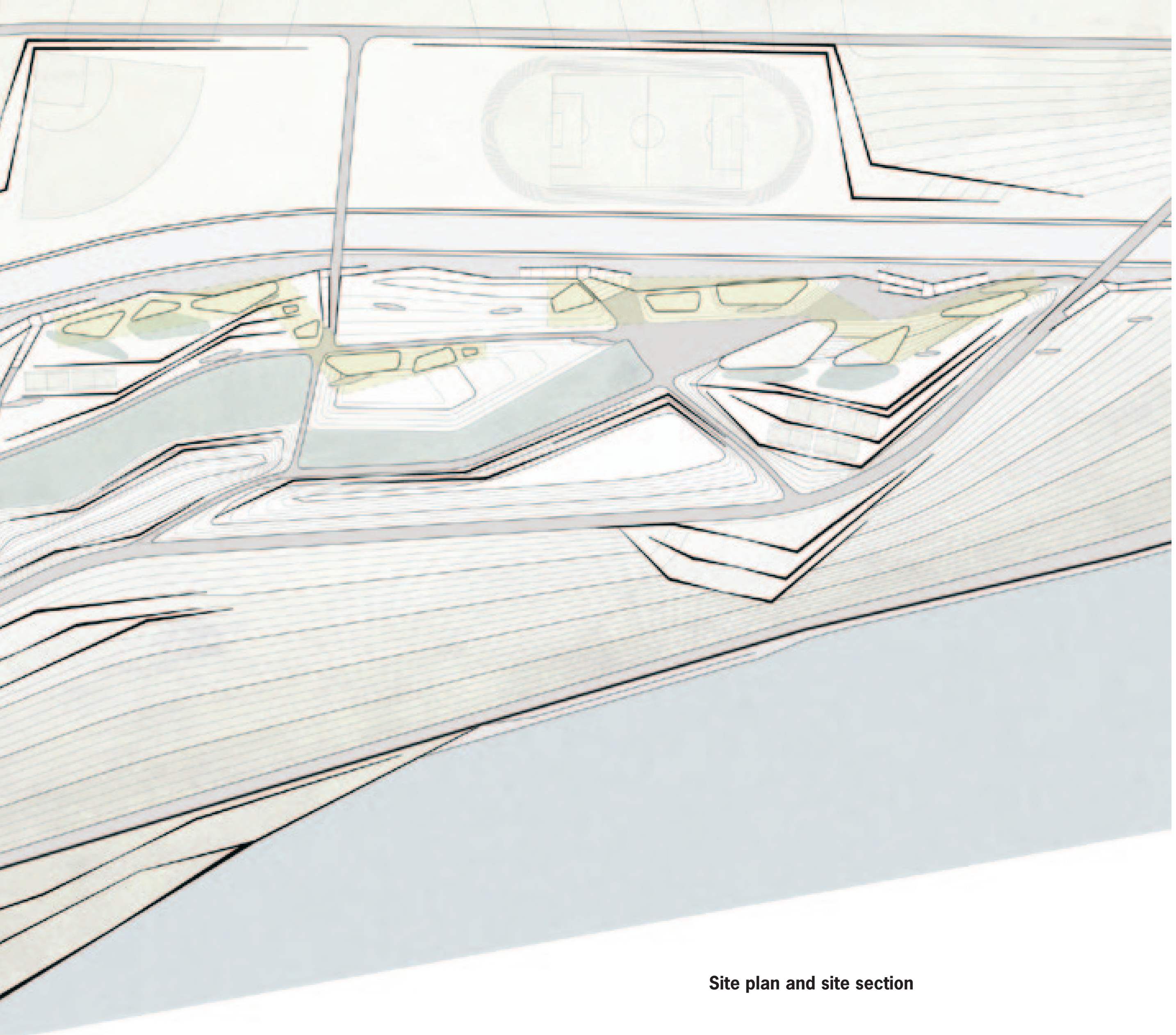
Situated at the point of inflection on the artificially nourished beach in front of the seawall and the growing beach on the east end of the island, this project creates a new urban landscape that reorients the dominant East-West grain of the island into a Beach-to-Bay flow.

The dredge deposit site of the East End Flats area is slowly cleaned via phytoremediation and becomes a rich wetland habitat. Fingers of development intermingle the urban fabric with large wetland and detention basins that capture the water run off from the city. Object buildings are located on berms that are created through the remediation and wetland creation process, along with biking, hiking and jogging trails.

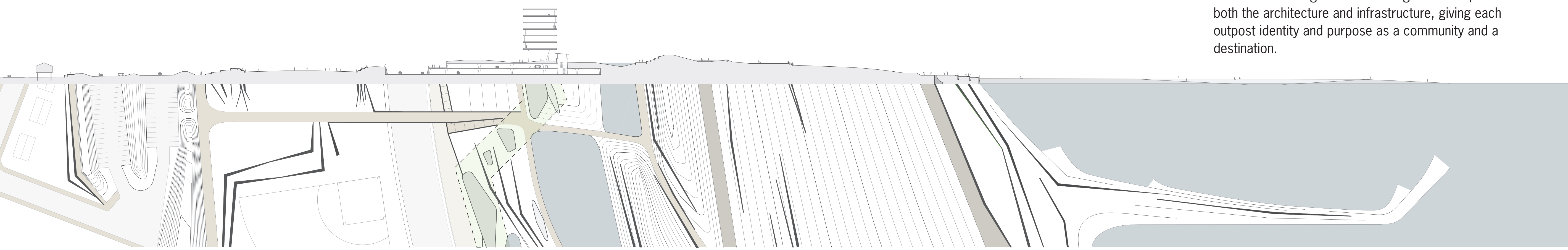
As one moves towards the beach, the development gets increasingly dense, with the water-ways turning into canals that capture surface flow and increase water detention capacity during storm events. Meanwhile, the thin building typology allows for natural ventilation and active street-scapes.

At the beach, the canals again open into larger ponds, this time co-mingled with constructed tidal pools. The brackish water creates a rich wetland landscape that embraces different flora and fauna compared with the freshwater wetlands to the north.

During minor storm events, this design increases water retention capacity and mitigates surface flooding in the historic district. More severe storm events with large storm surges will inevitably overwhelm any such system. In these events, the north-south connectivity between beach and bay may increase the productive flushing of wetlands, accelerating the recovery of these ecologies and actually improving them. The urban fabric becomes both the infrastructure and the observation platform for recovery.



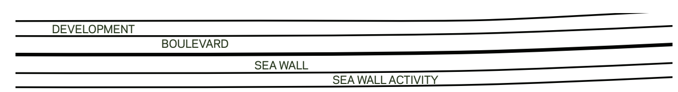
Site plan and site section



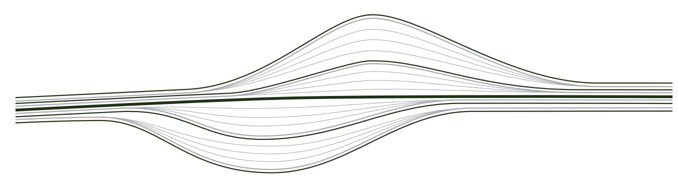
Coastal Appropriations

Peter Muessig

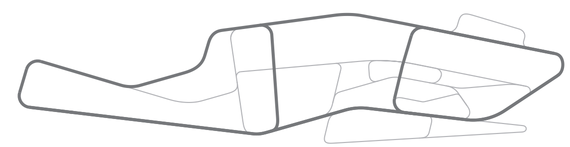
2010



Existing Seawall Activity

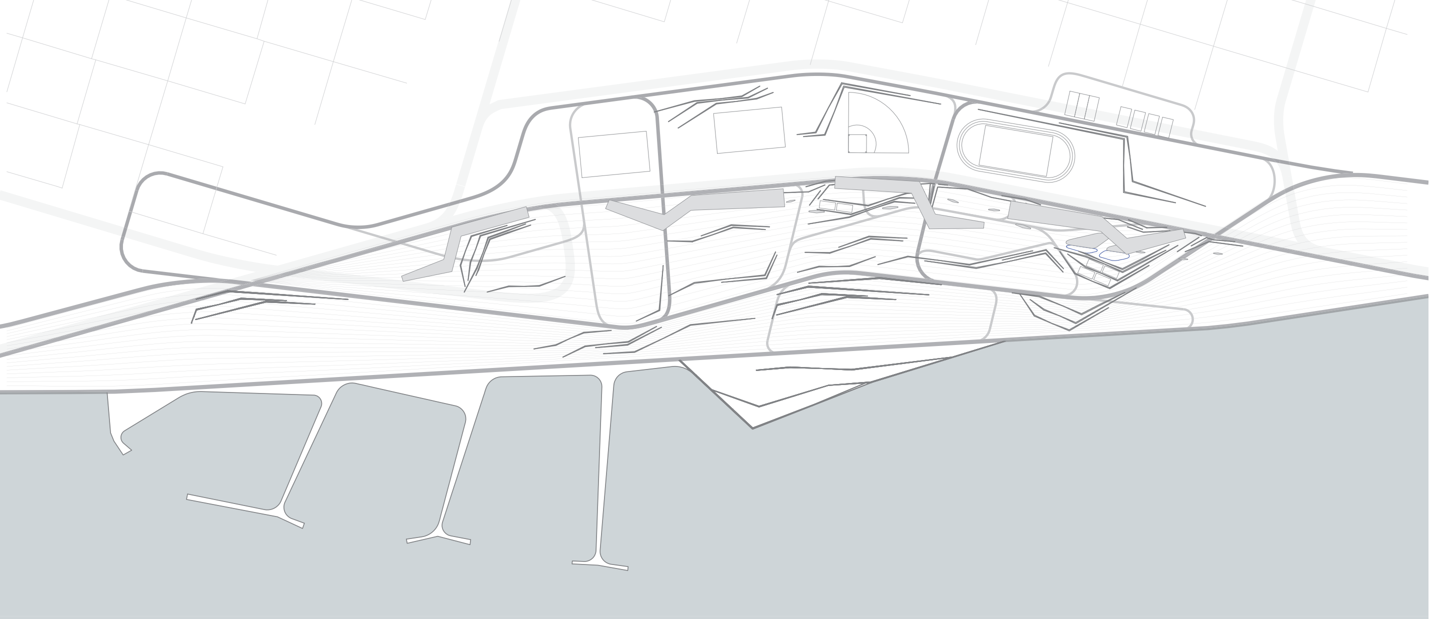


Expanded Seawall Program

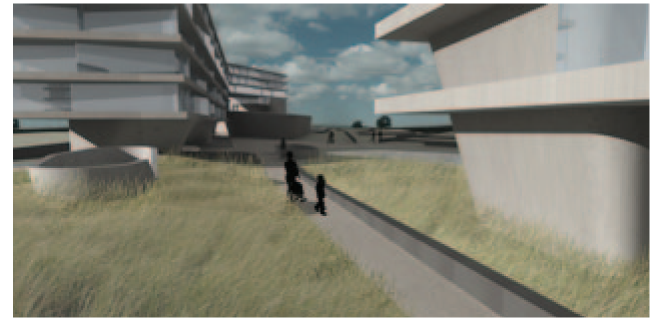


Archipelago Circulation Diagram

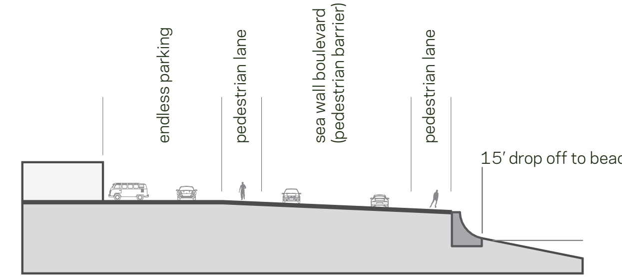
The Island of Galveston annually depletes its budget and material resources in order to support a temporal population of weekenders in the western territories while the potential of the Seawall, along its eastern corridor, is squandered. This project proposes an alternative Galveston that leverages the full potential of the Seawall as a barrier, an experience, and a new type of coastline. The project strategically locates remediated dredge material (produced each year in order to maintain the shipping channels in the region) to both fortify the seawall by raising the area behind it to protect the island from the sea-level rise expected over the next hundred years. Just as important, the design of this new ground produces a new territory along the Seawall, transforming its uninformed line into a continuous circuit of landform-archipelagos. Collectively, these “outposts” provide all the cultural, social, and material amenities needed to support a mixed oceanside population of vacationers and residents. Augmented retaining walls compose both the architecture and infrastructure, giving each outpost identity and purpose as a community and a destination.



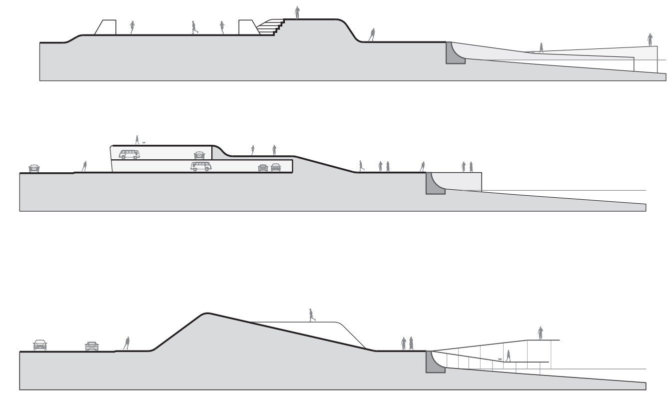
Plan of Proposed Archipelago Along Seawall



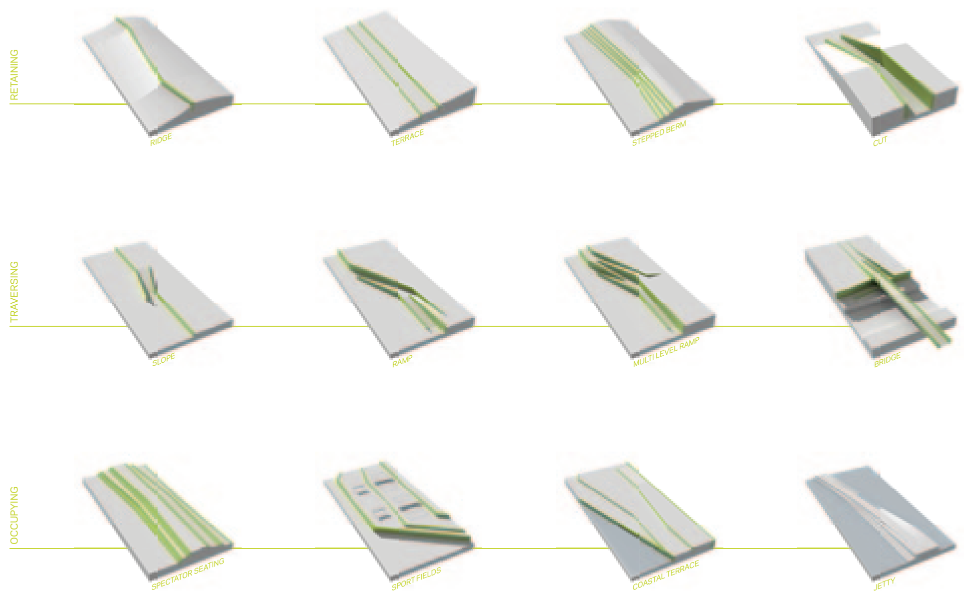
Residential and Mixed-use communities are constructed on new landscapes of remediated dredge, refiguring ecological conditions along the seawall.



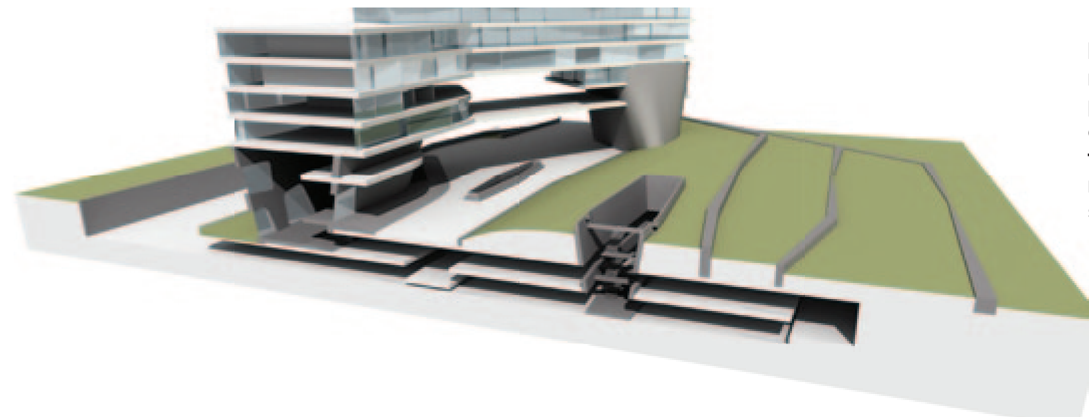
Existing Seawall Section



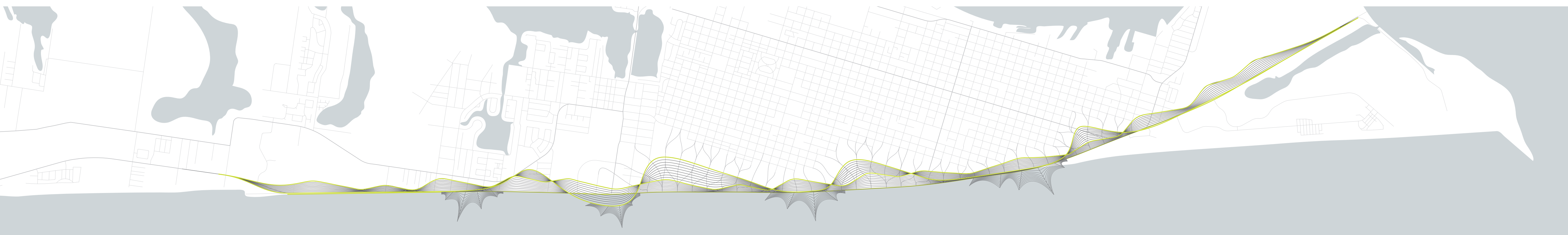
New Variations in Seawall Topography



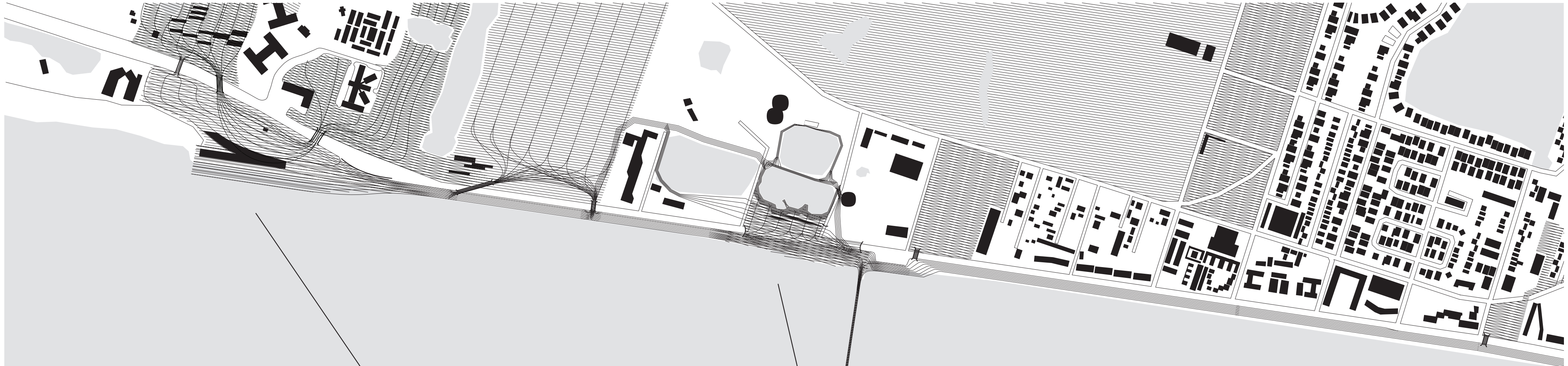
Retaining Wall Typologies for Activating the Reclaimed Landscape



Housing structures mediate roadway, parking and landscape, connecting high speed transportation corridors with localized seaside activities.



Emergence of Landform Archipelagoes Along Seawall

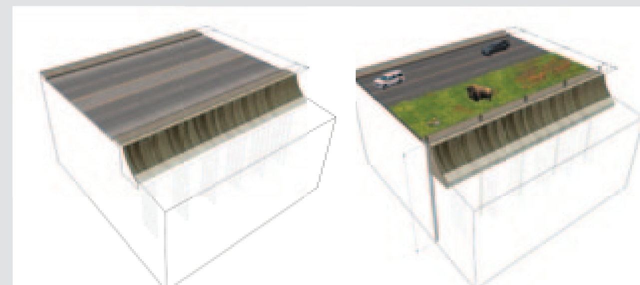


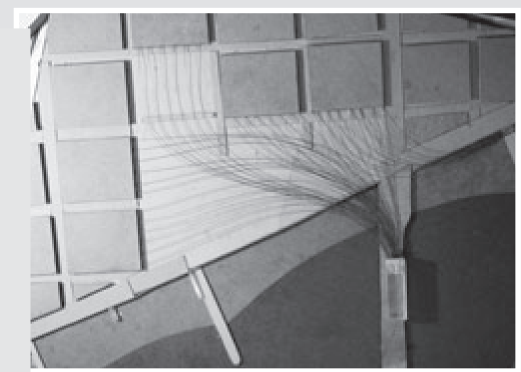
PICNIC GROUNDS AT REHABILITATED SAND BORROW PITS

HABITAT
7,000 sf — Covered Picnic Area
1.4 miles — Trail
[Connection to Existing Fishing Pier]

WATER
Gray Water Collection
Annual yield: 3,850 gallons of water
can support .05 Galveston households

ELECTRICITY
Photovoltaic Panels
Annual yield: 22,995 kW
can support 14 Galveston households





GREEN CORRIDOR

HABITAT
70.5 acres — Continuous Habitat
9.7 miles — Continuous Pedestrian/Bike Trail

WATER
Gray Water Collection (from permeable road surface)
Annual yield: 1,690,000 gallons of water
can support 22.4 Galveston households

ELECTRICITY
Wave Turbines (along entire coastline)
Annual yield: 8,270 MW
can support 5,035 Galveston households

Wind Turbines (along entire coastline)
Annual yield: 25,500 MW
can support 15,525 Galveston households

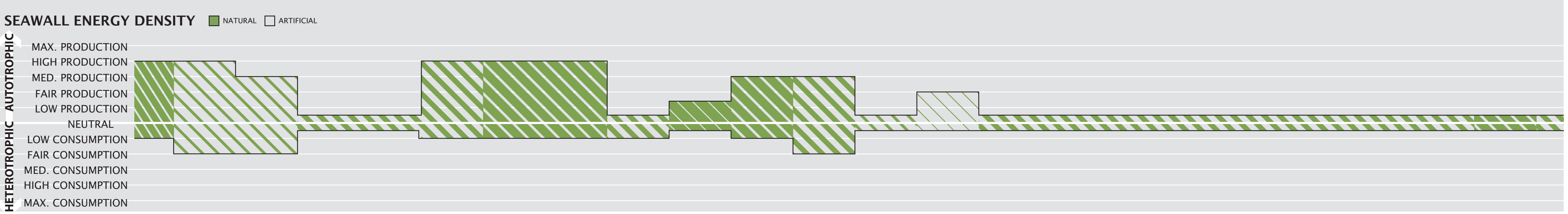
MUSEUM + RESEARCH CENTER

HABITAT

FOOD
Biointensive Farming
Annual yield: 1,903,000 pounds of food
can support 482 Galveston households

WATER
Gray Water Collection
Annual yield: 37,620 gallons of water
can support .21 Galveston households

ELECTRICITY
Photovoltaic Panels
Annual yield: 223,380 kW
can support 136 Galveston households



Grey and Green

David Dewane, Meredith Epley
2008

Rather than conceptualizing urban features as strictly stable configurations, this proposal approaches urban forms as captured expressions of energy in an ever-changing mosaic.

Principles of landscape ecology inform design logistics of patches, corridors and matrices. The lines of the drawing represent grains of connectivity between otherwise isolated patches. These grains overlap at certain moments to create nodes of urban, agricultural and ecological use while integrating the seawall boulevard to connect the water's edge to the city.

The built up areas of the seawall are re-considered as a productive landscape, including urban farming, parks and less manicured natural habitats. These programs extend into the city fabric, connecting to existing sites and opportunistically transforming derelict or undesirable areas in the city. Rather than simply consuming energy (heterotrophic), the goal is to employ the length of the seawall by tying it into the urban fabric. This would turn the seawall into a more energy-producing (autotrophic) zone, thereby reducing the ecological footprint of the island. The urban farms not only provide food for daily use, but also catalyze the gastronomic culture of the island by bringing in a new generation of chefs who favor locally grown and organic foods.

The set of programmatic proposals offered here should not be viewed as singular or narrowly prescriptive solutions, but as flexible operations intended to demonstrate the performative qualities of the system on a variety of scales.

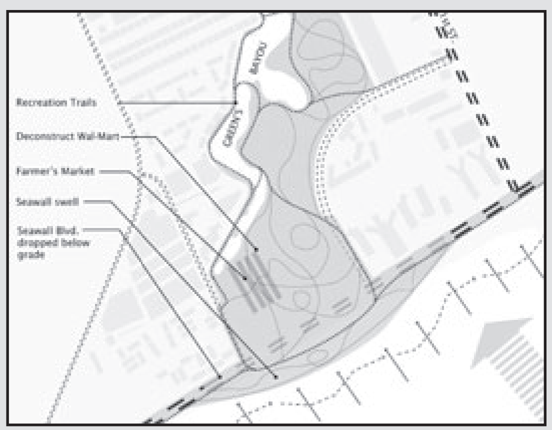
FARMER'S MARKET + CANNERY

HABITAT
240,000 sf — Roof Farm
240,000 sf — Farmer's Market + Cannery
28,000 sf — Pavilion and Shops
13.7 acres — Park
1.4 miles — Trail

FOOD
Biointensive Farming
Annual yield: pounds of food
can support 20.8 Galveston households

WATER
Gray Water Collection
Annual yield: 15,400 gallons of water
can support .12 Galveston households

ELECTRICITY
Photovoltaic Panels
Annual yield: 91,980 kW
can support 56 Galveston households



HIGH DENSITY HOUSING + RECREATION COMPLEX

HABITAT
180,000 sf — 90 Living Units at +/- 2,000 sf (4 stories)
15,500 sf — Shops and Restaurants
8,600 sf — Public Pool
Sports Fields

WATER
Gray Water Collection
Annual yield: 24,547 gallons of water
can support .32 Galveston households

ELECTRICITY
Photovoltaic Panels
Annual yield: 147,825 kW
can support 90 Galveston households

WATERFRONT PARK AND PROMENADE

HABITAT
20,200 sf — Liveable Water Tower (12 Living Units at 1,500 sf)
60,900 sf — Shops and Restaurants
90,000 sf — Parking Garage
22,300 sf — Pick-and-Pay Garden
20.2 acre — Park

FOOD
Biointensive Farming
Annual Yield: 3,950 pounds of food
can support 1.0 Galveston household

WATER
50,000 gallon Gray Water Tower
50,000 gallon Potable Water Tower

ELECTRICITY
(Energy costs reduced by pumping water during off-peak hours)

GREENHOUSE BATTERY AND LEARNING RETREAT

HABITAT
1,240,000 sf Greenhouses
148,000 sf Operations Center
240,000 sf Associated Retail
19,100 sf Learning Retreat
1.1 miles Trail

FOOD
Biointensive Farming
Annual yield: 425,568 pounds of food
can support 107 Galveston households

WATER
Gray Water Collection
Annual yield: 1,482,000 gallons of water
can support 19.6 Galveston households

HOUSING COMPLEX

HABITAT
378,000 sf 250- 1,500 Living Units (3 stories)
10,000 sf Community Center

FOOD
Backyard Gardens
Annual yield: undetermined

WATER
Gray Water Collection
Annual yield: 74,900 gallons of water
can support 1.0 Galveston households

ELECTRICITY
Photovoltaic Panels
Annual yield: 414,392 kW
can support 252.3 Galveston households

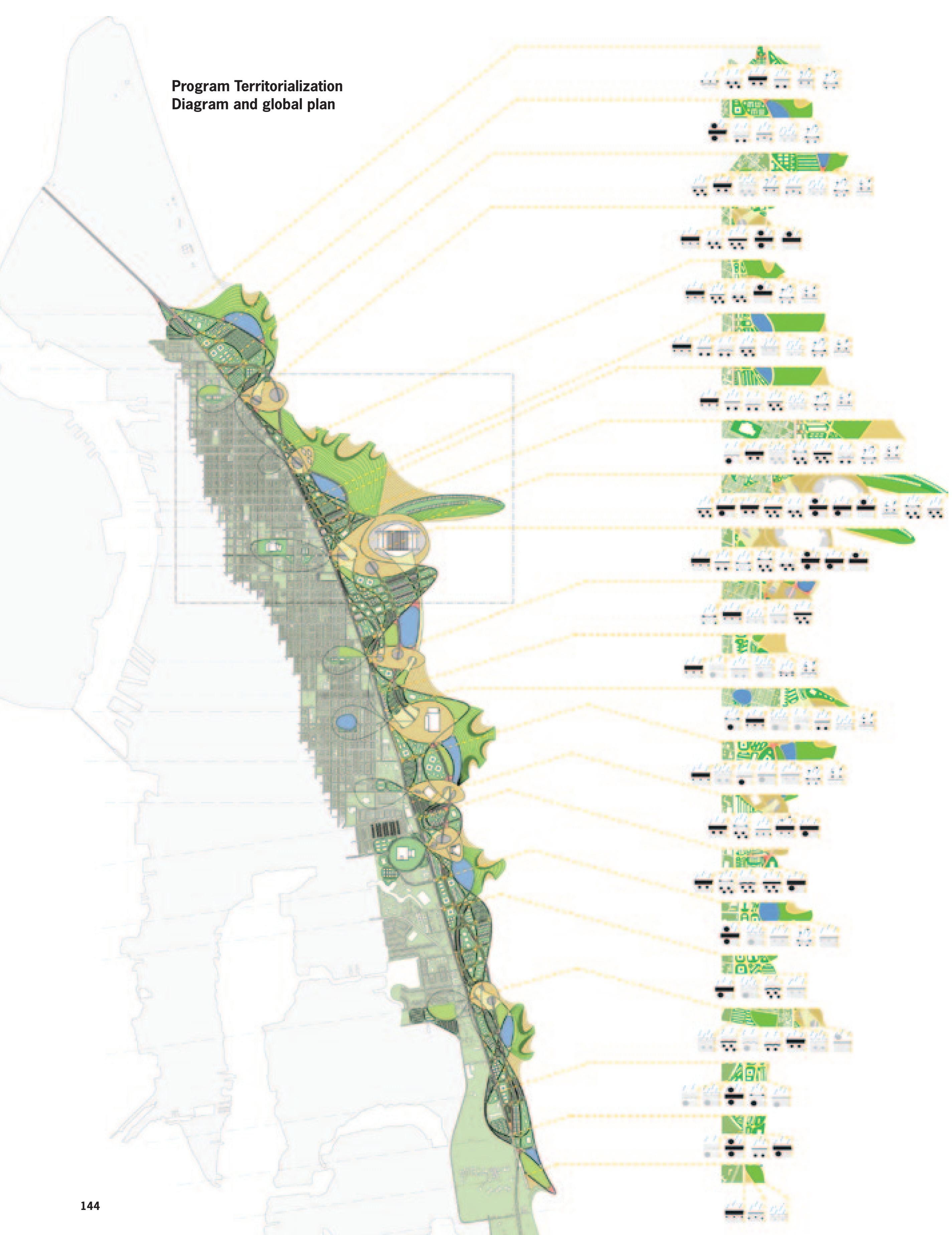
SMALL BOAT HARBOR + FISH MARKET

HABITAT
2,800 sf Operations Building
4,000 sf Fish Market
50-Boat Harbor

FOOD
Small-scale Fishing
Annual yield: 200,000 pounds of fish
can support 5,434 Galveston households

WATER
Gray Water Collection
Annual yield: 3,740 gallons of water
can support .05 Galveston households

ELECTRICITY
Photovoltaic Panels
Annual yield: 22,338 kW
can support 13.6 Galveston households



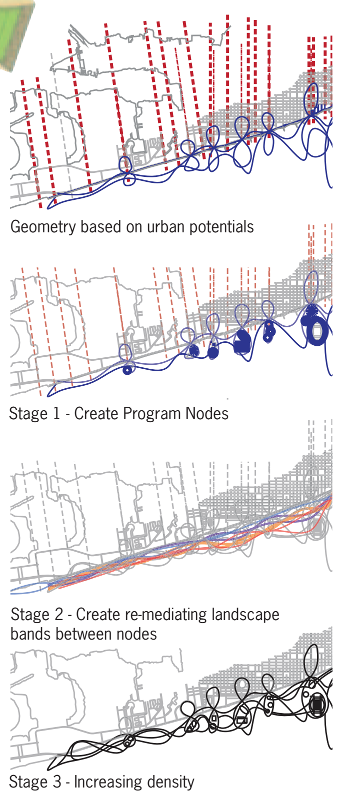


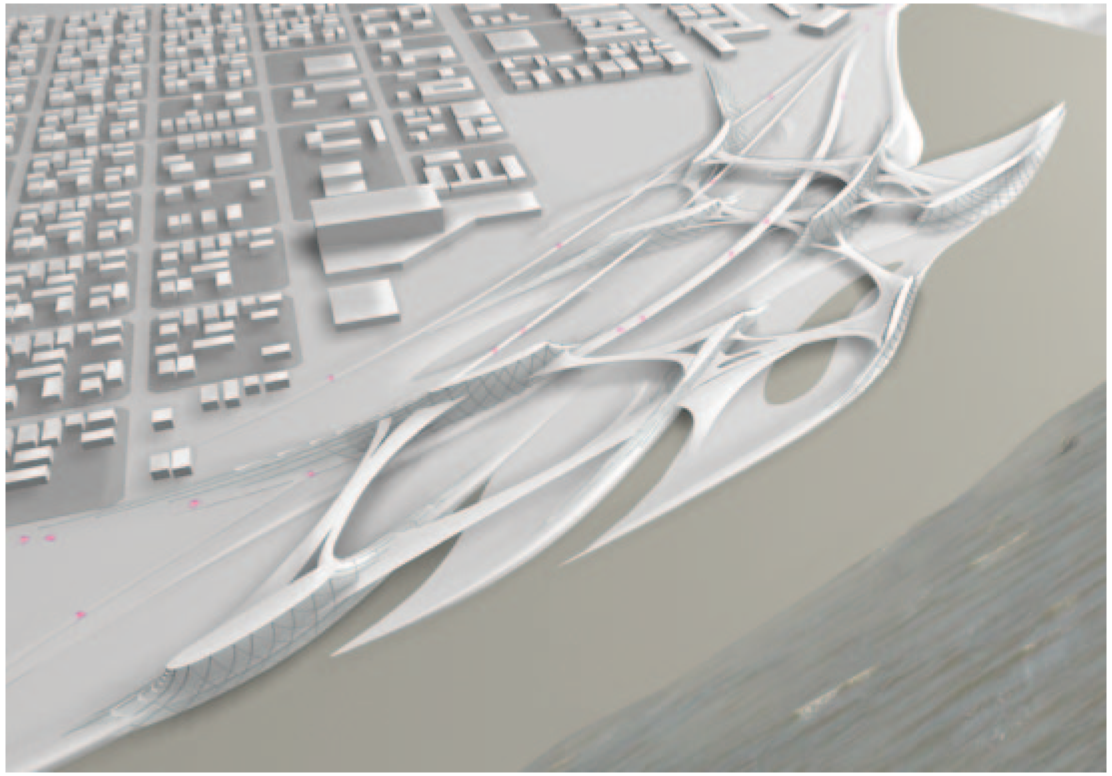
Diagram of all changes of existing natural and urban edge conditions along seawall, which conditions landscape and program

SuperSeawall

Matthew Genaze, Jenny Kiel

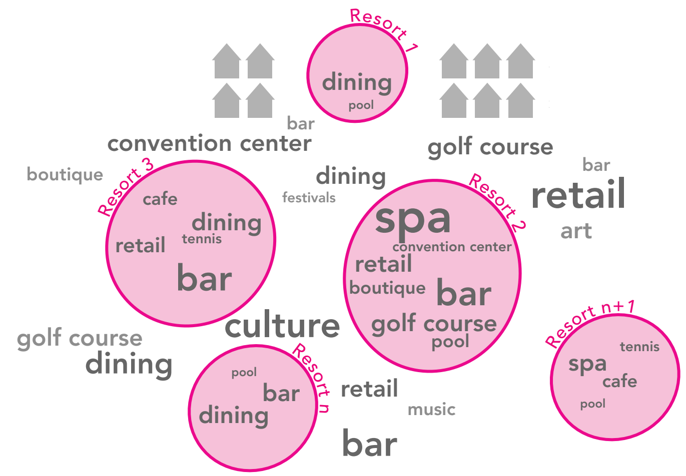
2008

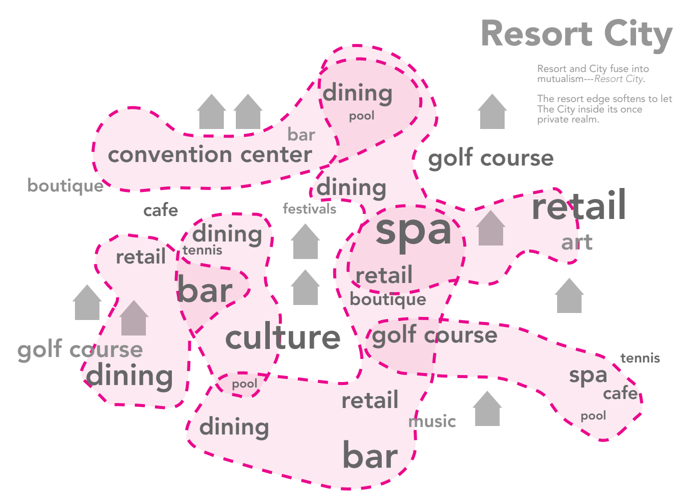
Three facts put the long term viability of the resort economy in jeopardy along the seawall. First, the existing sand will erode due to sea-level rise and storms, exposing the seawall foundations and threatening it. Second, sand is becoming increasingly expensive due to depletion of local supplies. Third, the existing seawall will provide less protection as sea levels rise due to climate change. This project accepts all these brute realities. While there is a paucity of sand, there is an overabundance of mud due to ongoing dredging, which can be deposited in front of the seawall to protect it while constructing new land that could more than accommodate growth displaced from the western end of the island by climate change and storms. Coves can be designed to protect high-quality sandy beaches while increasing the diversity of waterfront conditions and programs, including large scale civic programs at key nodes coupled with elevated parks that bridge Seawall Boulevard (an existing multilane highway that currently separates the city from the beach) while providing parking underneath, linking the city center to the waterfront. The space between these nodes would be filled during subsequent years with new material and program. Instead of one straight and undifferentiated water edge as currently exists, the design uses multiple lines to produce interwoven edges of landscape, water, ecological productivity and urban use.



Take me Tonight from Atlantic City
A central problem for any resort town is the development of the high-value waterfronts with exclusive resorts, effectively producing a wall of private program cut off from the city that supports it and preventing those who live in the city and work in the resorts from enjoying the amenities produced. The result is a cycle of deterioration of the civic quality. Further fortification of the resorts with greater security, increasing the break between resort and city, causes further decline in the social network of the city, which then makes the resorts less desirable as destinations. Eventually a massive "rejuvenation" project is called for that simply begins the cycle again. In contrast, this project proposes to produce over the same period a network of resorts that are more open to the city, producing a lattice of programs that foster more robust and mutually beneficial relationships.

The Open Source Resort
Resorts are typically autonomous programs and are spatially separated from the host city that surrounds it and supports it. This parasitic relationship can be transformed into a symbiotic relationship if parts of the resort are opened to the city, and if the resort begins to associate itself with programs in the city, such as cultural destinations and street-based shopping. Such an approach can be especially powerful in a city with a strong civic history and amenities, such as Galveston. This collaboration also benefits the resorts as they no longer need to pay for redundant program, and benefit from the increased attractiveness of the city around them in its touristic value and in terms of supporting a quality workforce. However, this also requires rethinking the closed typologies and design of the resort.





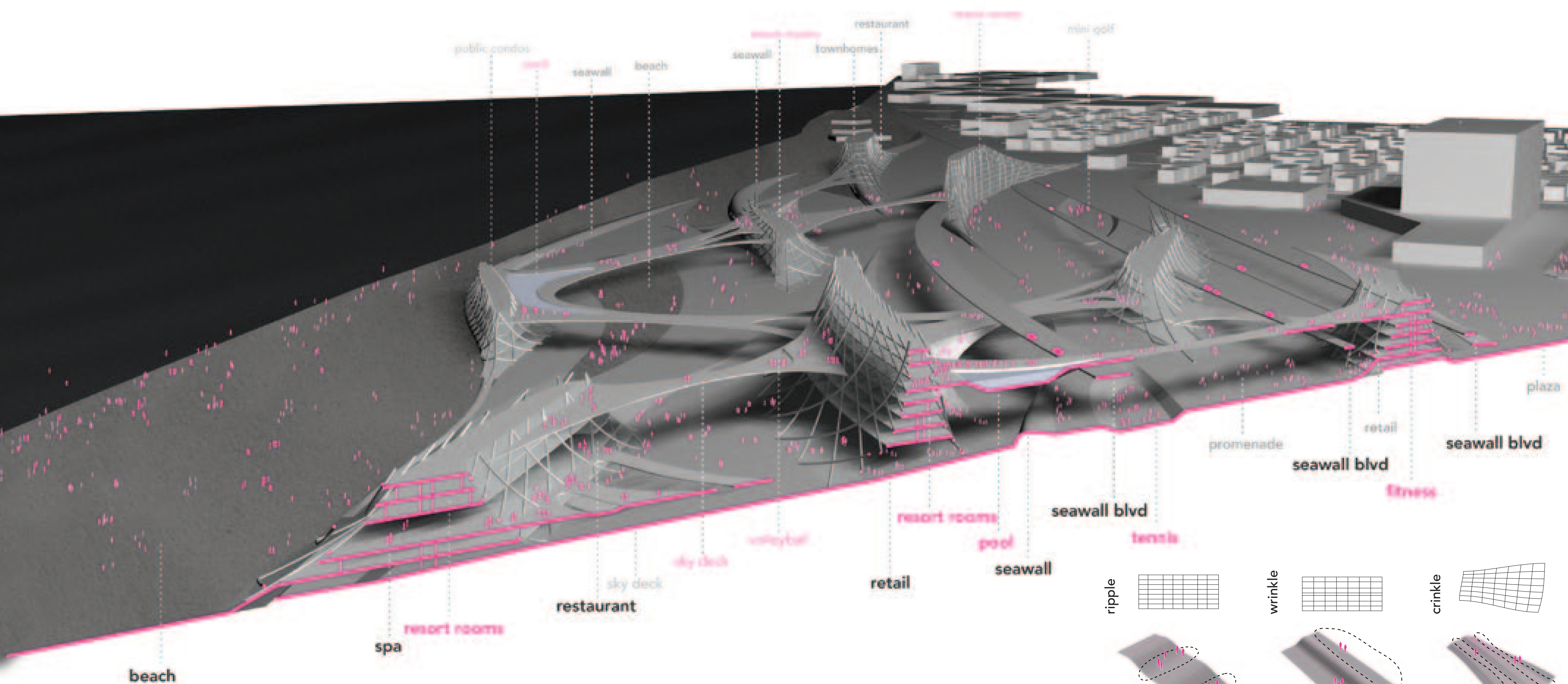
Resort City

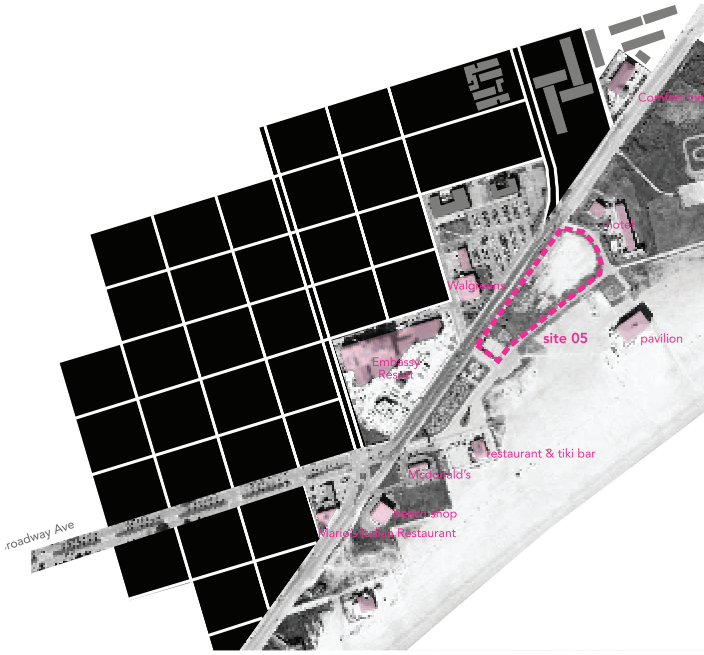
Benson Gillespie, John McWilliams

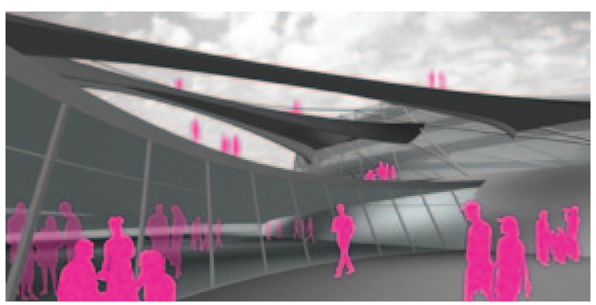
2008

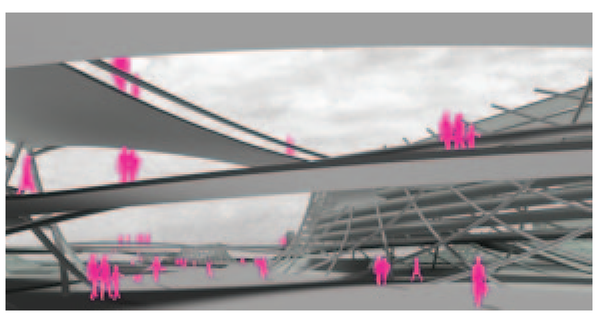
Tourism is on the rise. With increases in technology and wealth, leisure travel is not only easier for a larger number of people but is becoming a way of life. Coastal cities around the world feel the effects of this growing market both positively through generated income and negatively through the decline of culture and place. Galveston Island is especially feeling the tourists' pressure as it is one of the most underdeveloped coastlines in the nation and is expecting a 251% increase in resort development within the next 10 years (pre-Ike numbers). Furthermore, the current resort model is flawed in that it typically reproduces the same programs immediately adjacent to one another in an unproductive redundancy resulting in closed, private enclaves completely isolated from their host communities.

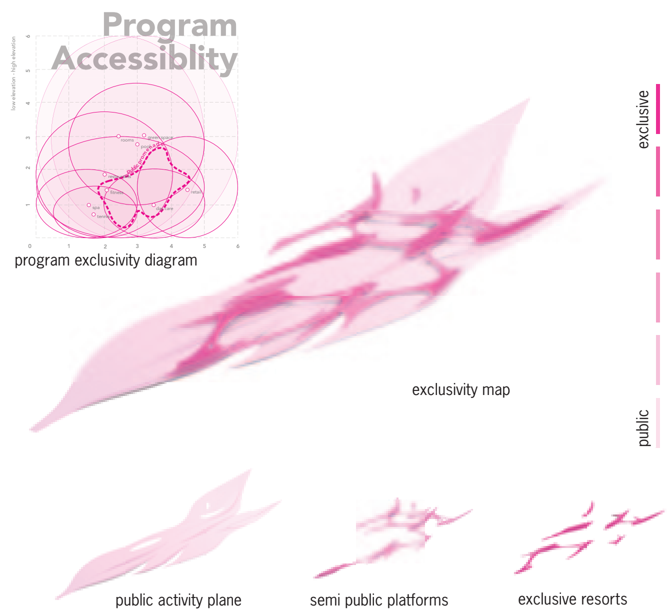
What if the resort's relationship to the city was not discrete? What if the 251% of resort development predicted for Galveston in the next 10 years multiplied the city's amenities by an equal percentage? Resort City poses this alternative – to multiply development along the hard edges which already exist and create an urban condition where the city and resort become symbiotic; the resort feeds development and revenue to the city while the city gives the resort its land and infrastructure for amenities. Instead of searching for new land, this project suggests building on top of the old, connecting into local amenities, and tying together existing fabric such that a new public realm emerges. The resort will act as a catalyst for the future of urbanism. The day of the enclave is over; resort tissue is the new producer of the urban realm.



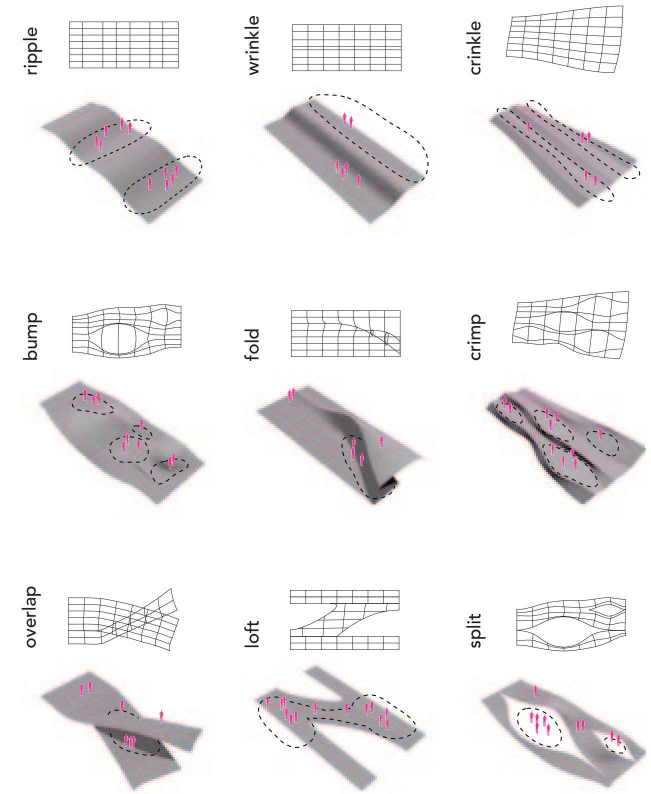






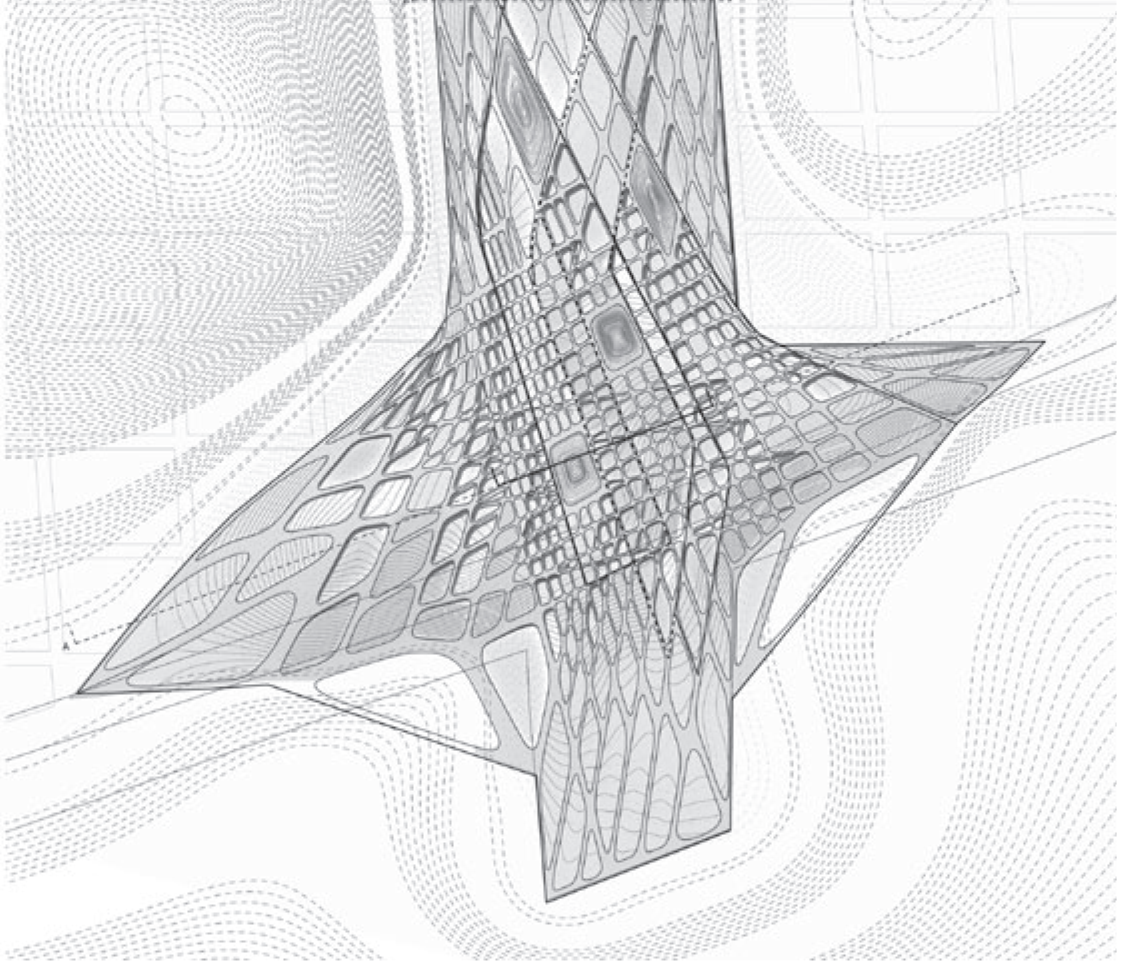


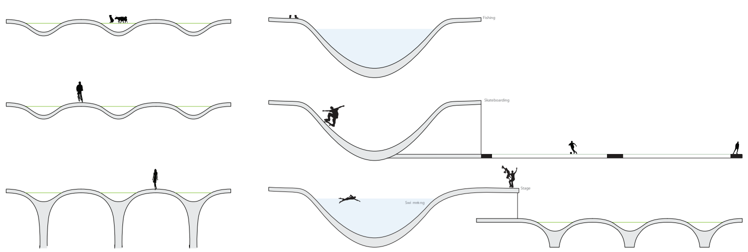
Large Scale Connectivity
At the urban scale, discrete resort programs are connected as a network through sky bridges and raised platforms, allowing for varying degrees of exclusivity and openness to the city around it. The public realm is situated around the private program through semi-public activity spaces.

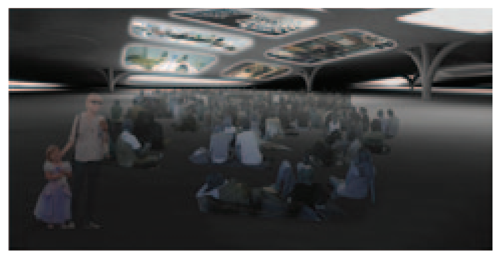


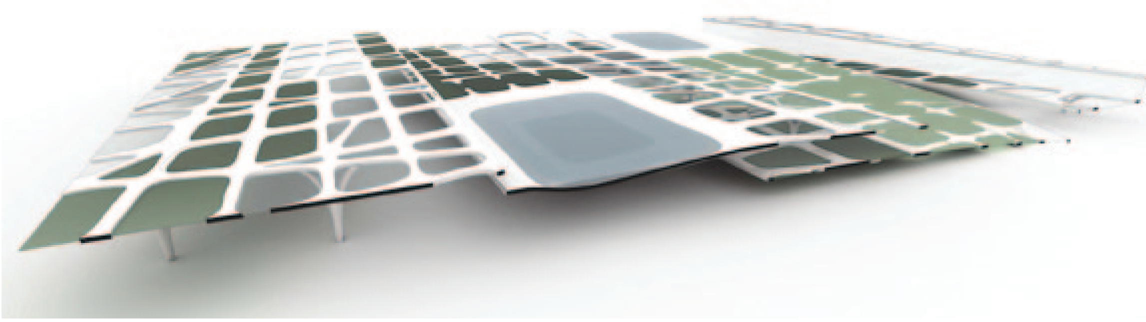
Surface Operations
Surface operations of folding, de-laminating and slicing produce overlapped gradients of accessibility and exclusivity rather than harsh delineations of public space and private resorts.

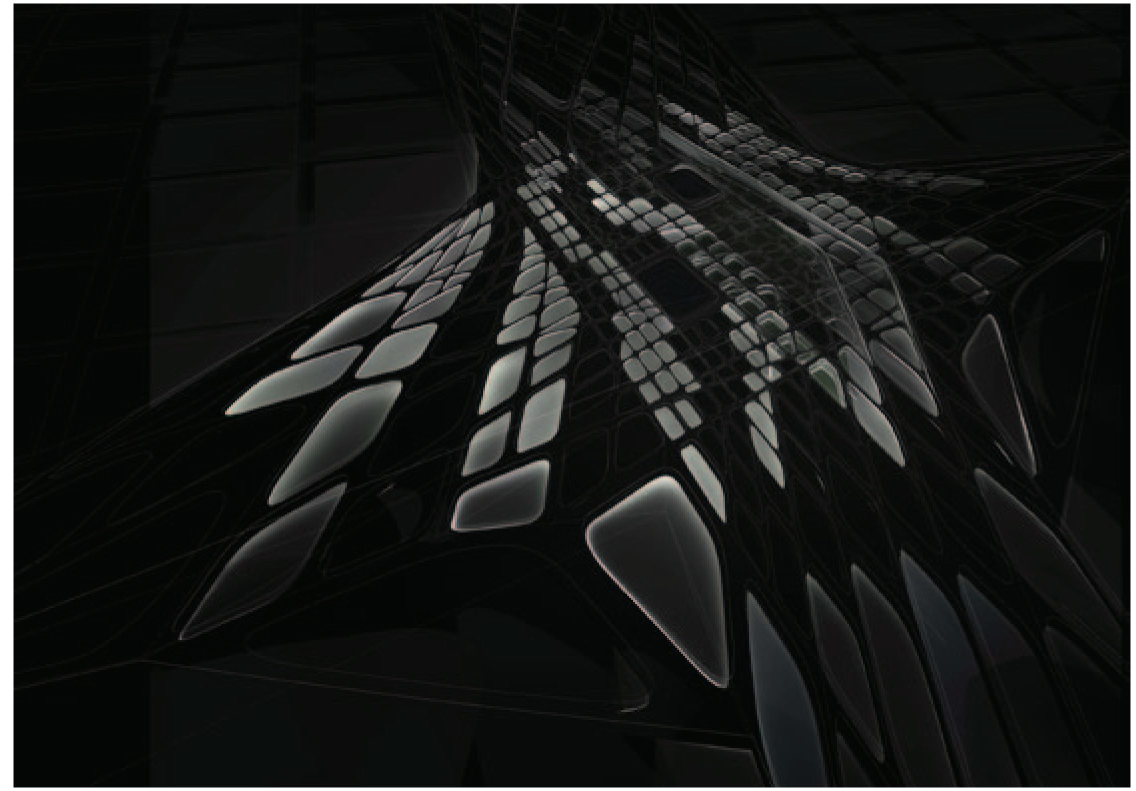
Franchising the Public Realm: the Existing Site Condition
The seawall begins to move inland as a naturally growing beach begins, creating a large public space adjacent to the historic district. Fast food outlets and cheap tourist shops cross over the seawall boulevard and begin to colonize the obeisantly public realm and creates a "junk space" of signs, parking lots and garbage dumpsters that prevent this site from gaining any sort of civic quality while reducing the value of what should be prime resort real estate. However, the program does produce activity and urban buzz. The problem is how to foster even greater activity and higher value programs and produce a higher quality of space.











The New Balinese Room

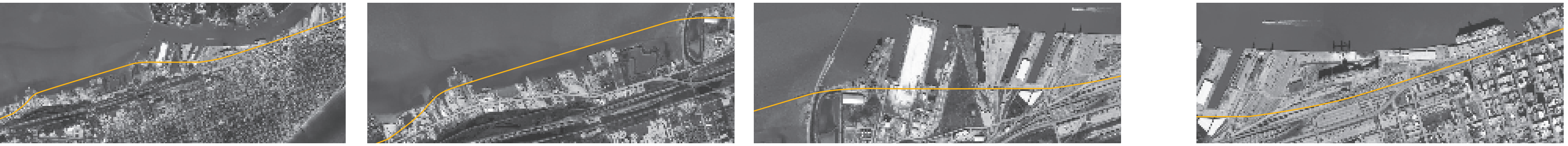
Sara Hieb

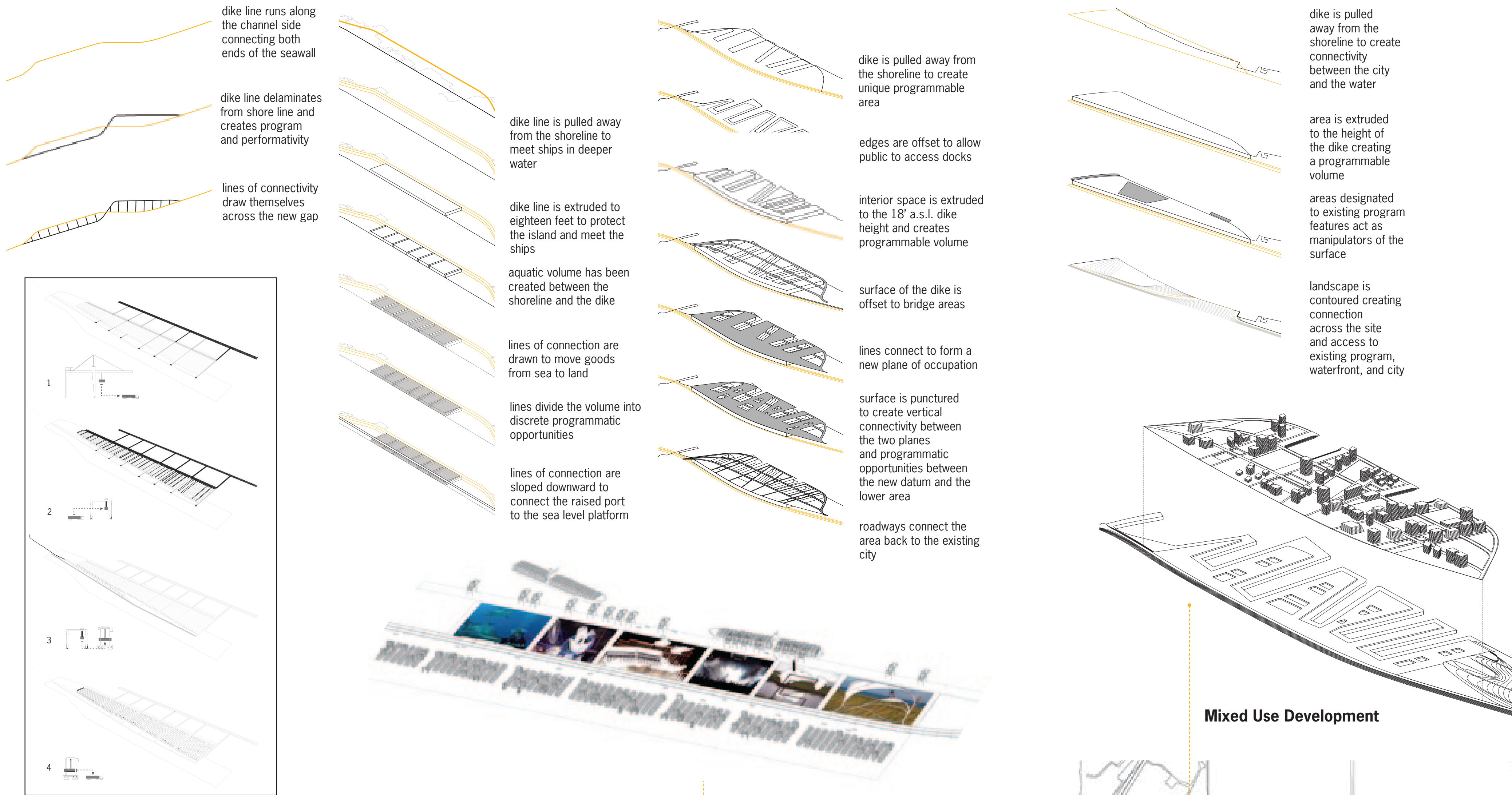
2010

This project's title is a reference to Galveston's historical night club and illegal casino, the Balinese Room, which was built on a pier 600 feet into the Gulf. An elite spot during the 1940's and 1950's, if the Texas Rangers entered the vicinity a bell would ring and the gamblers would have enough time to hide everything before the police could reach the end of the pier. Closed in 1957 and then reopened in 2001 without the casino, it was completely destroyed by Hurricane Ike in 2008.

The New Balinese is an alternative to the current trend in Galveston of the construction of low-density developments of second family homes. The project is a tourist condenser, a model that could proliferate along the seawall and other points of interest and is connected to the bay and the rest of the island by a light rail system that could foster hubs of pedestrian activity, mixed use and dense development and allow rail commuting.

The site is currently occupied by the former Flagship Hotel, which is constructed on a pier and was severely damaged by Hurricane Ike. Several urban grains meet at the site, for example one from the city grid, which in this design are overlaid and integrated to produce a moire patterned landscape and large roof structure that houses a hotel, casino and shaded open-air public spaces. The top of the roof surface connects the city to the beach front, bridging over the high-speed Seawall Boulevard and becomes an urban park. Water is collected in cisterns built into the surface and used for urban farming.





Post-Panamax Shipping Terminal Logistics

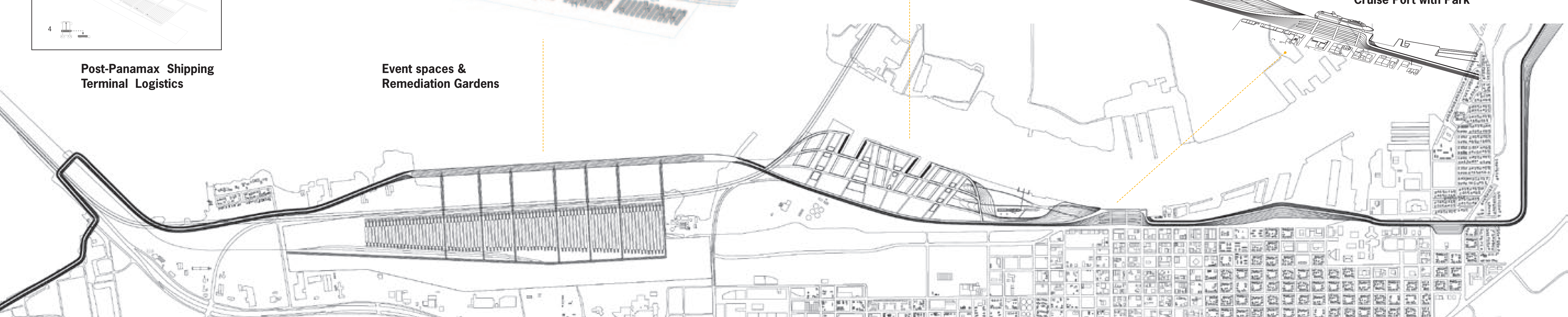
Event spaces & Remediation Gardens

Superdike

Justin Brammer, Judd Swanson

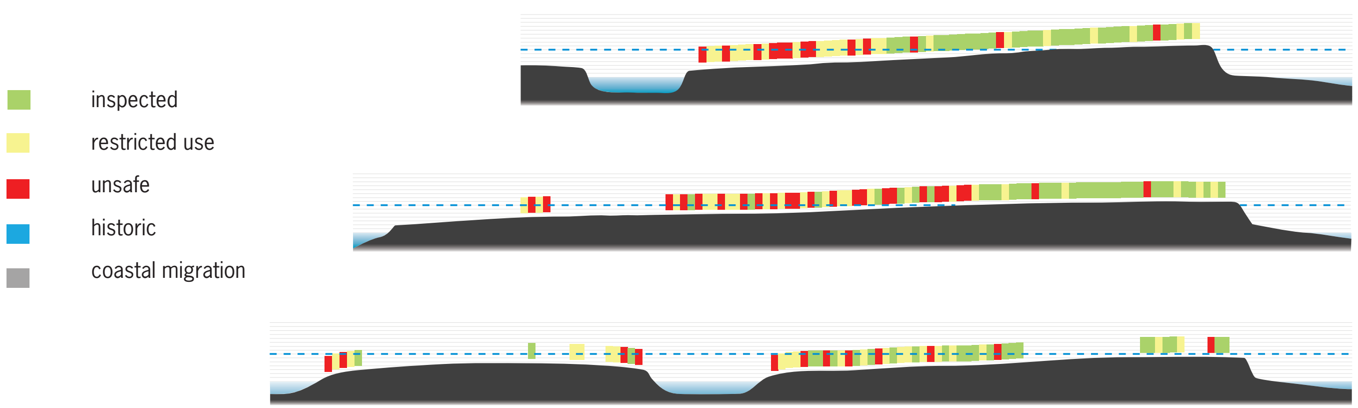
2009

While the seawall protected the front of Galveston during Ike, there is little to protect the back of the island from storm surges that moves through the Houston Ship Channel or from a reverse surge as the water pushed into the Bay by a storm recedes. This project proposes creating a dike around historic core that links it to a new super harbor that could receive post-Panamax ships too large for the Houston Ship Channel without expensive and ecologically destructive dredging. Rather than reproduce the deleterious urban effects of erecting another wall, this project explores how such a massive infrastructure could foster and catalyze new urban intensities. The design delaminates the line of protection in plan and section to create a territory that intertwines public space and industrial use. The elevated areas provide mixed use development on older, obsolete, port sites. Lower zones at the new shipping terminal create vast water gardens and enclosed parks where the bilge water from the ships can be cleaned through phyto-remediation. These can host large events (such as parties, concert venues and amusement parks) along the waterfront, adjacent to other smaller programs in the city and easily linked to mass transit (instead of sensitive and remote beachfronts where such events currently occur). By controlling access through sectional differentiation, a redesigned cruise terminal and new super-harbour can be secured while providing a continuous public waterfront linked to the historic city core and access to the new parks.



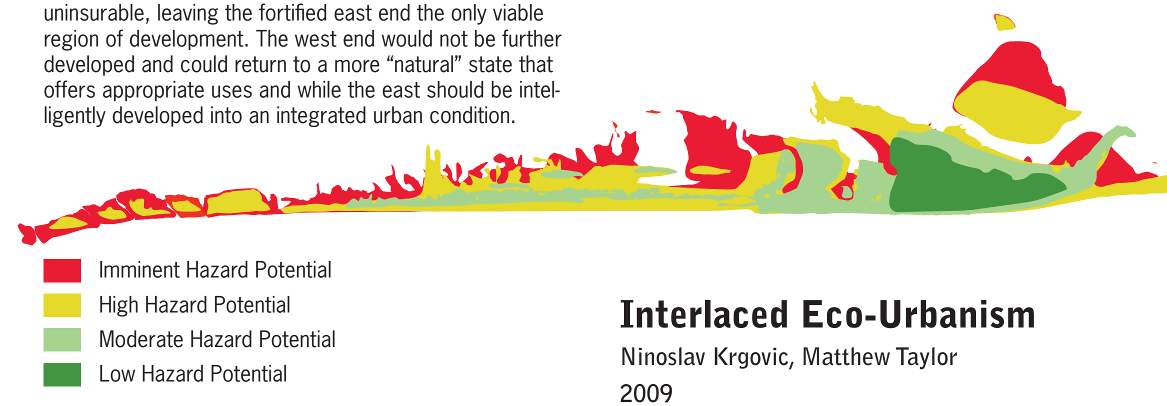
High Ground
As the plan (above) and section (below) show, damage to structures from the rear storm surge is determined by elevation. Therefore, elevating structures is called for but simply putting every building on stilts interferes with an active street and landscape. Alternatives are needed.

Zone of Opportunity
The damage from Hurricane Ike creates a network of severely damaged property, presenting the opportunity to reinvent the core of the island, too often driven by development along its edges.



Sectional Diagram of Damage Assessment

Projective Geohazard map, 2058
The west end, now the source of tax revenue, will be uninsurable, leaving the fortified east end the only viable region of development. The west end would not be further developed and could return to a more "natural" state that offers appropriate uses and while the east should be intelligently developed into an integrated urban condition.



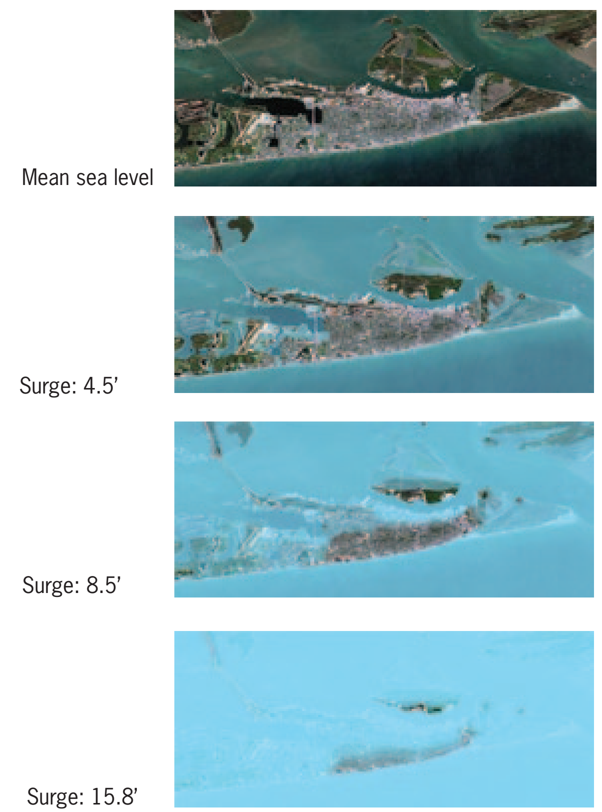
Interlaced Eco-Urbanism

Ninoslav Krgovic, Matthew Taylor

2009

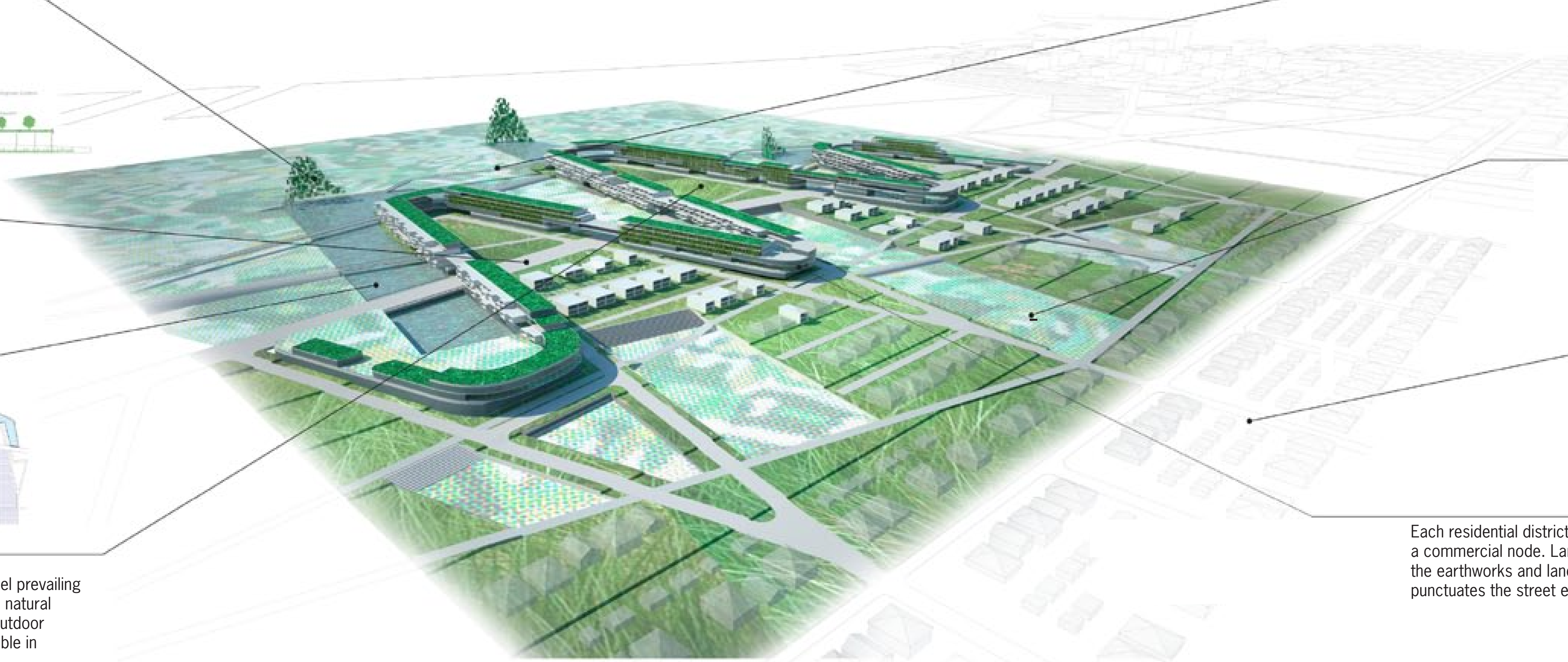
Galveston is a dying city, rotting from the inside out. Its permanent population is in decline, its local economy is overly dependent on low paying tourist sector jobs, and its urban fabric for such residents--who live mostly in the eastern and central part of the island– is decaying in favor of unchecked development of resorts on the west end. However, these developments may very likely be impossible to maintain as sea level rise and coastal retreat makes even larger parts of the west end uninsurable. That which in the short term provides tax revenue and makes the island distinctive is in the long term damaging.

This neglect is exacerbated by the recent Hurricane Ike. The seawall protected the island from the frontal storm surge, but the back of the island flooded up to six feet due to the raised water level backed into the bay, causing significant damage to structures in the center of the island. To prevent this in the future, many have proposed that a dike be constructed on the bay side of the island, or to raise the bay side just as the front was raised following the 1900 storm. Yet these means of protection are themselves destructive to the existing urban fabric. Rather than simply raise the ground level, this project employs the idea of a massive and invasive infrastructure as a means to reinvent the core of the island. The last storm left a damaged zone in the middle of the most urbanized part of the city, which is also the centroid of all the various demographics–tourist and resident, race and income, etc. This has created an opportunity to re-think how the center of a resort island, typically the least desirable land in terms of tourism, could become a vital place for residents who work in the service, tourist and industrial economies.



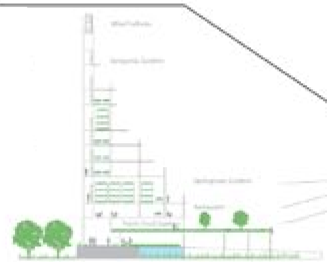
Computer Model of Storm Surge during Hurricane Ike
Source: Johnson Space Center Office of Emergency Management

The design is based on a dual strategy of raising the ground plane and providing hardened dike structures. Rather than a simple wall, an interdigitated or interlaced pattern produces sectional variation and programmatic opportunities that integrate architecture and landscape. The design is informed by site conditions and recent damage as well as infrastructural connectivity. A ribbon of intense program weaves through this zone, providing market rate and subsidized housing. Retail is placed at the intersection of this ribbon with a major thoroughfare, Broadway Boulevard. Along this main artery lie major civic parks and space for major public program attractors. On the water side, large storm water detention basins and urban farming allow the new development to be more sustainable in terms of its economic footprint while also finding viable use for land that will periodically be inundated by storm water. By doing so, the western end of the island can be allowed to return to a natural state.



Green Sector

Farming Towers
Hydro and Areoponic vertical farming can service 5,000 residents while conventional farming can only feed 100 in a similar area.



New Broadway Boulevard
The now tattered section of Broadway is relocated and reinvented as a park of the dike system.

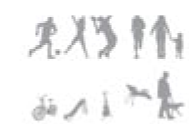
Storm Water Detention Lake
The dike not only protects from storm surges but also produces storm water retention that can be used for landscaping and as an attractive amenity.

Open Recreational Space

Open spaces channel prevailing breezes to enhance natural cooling and make outdoor spaces more habitable in summer.

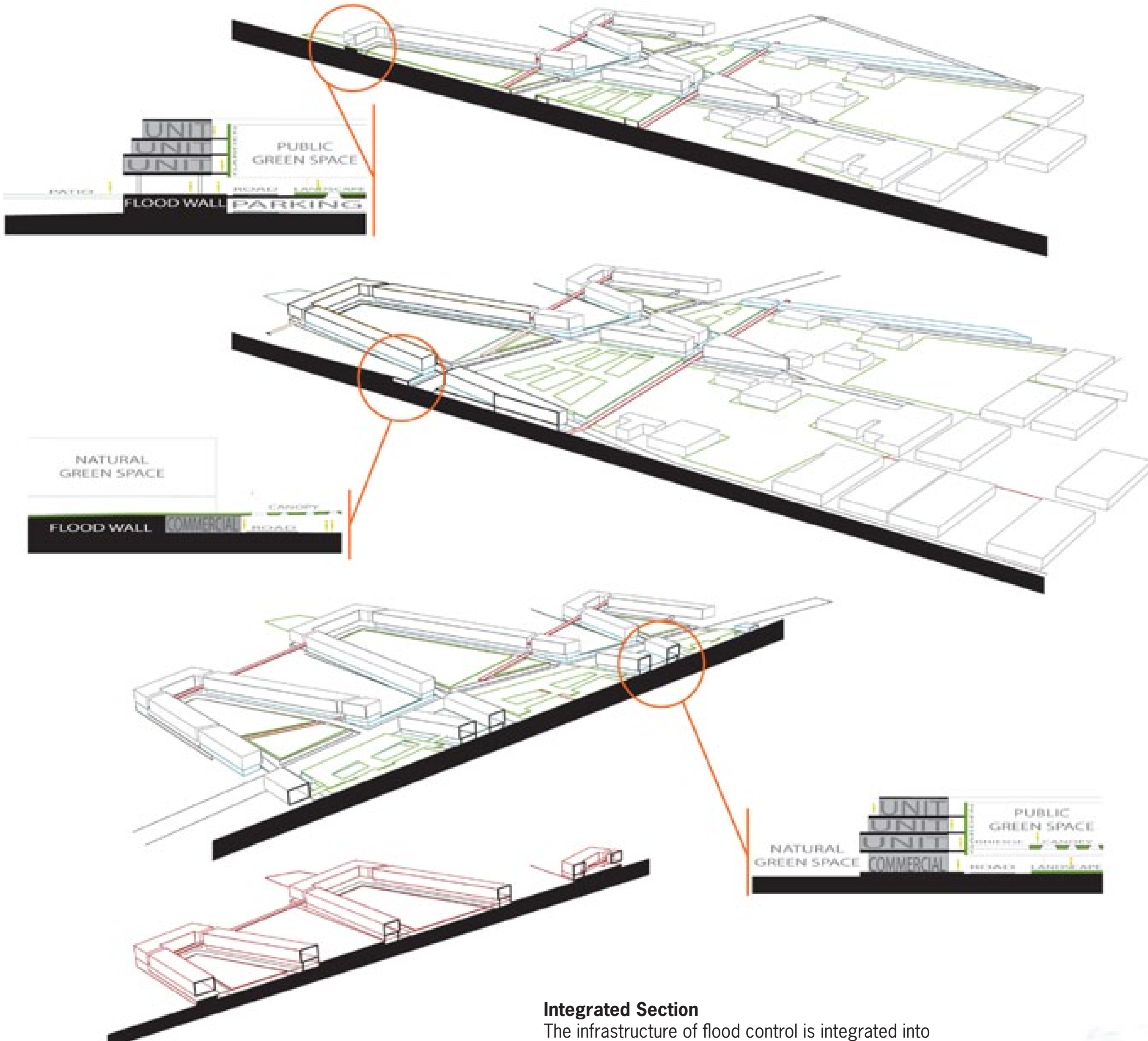
Pedestrian Paths
Pathways connect new and old fabric across the dike

Civic Park
Adjacent to commercial nodes, these programmed parks mix residents and visitors

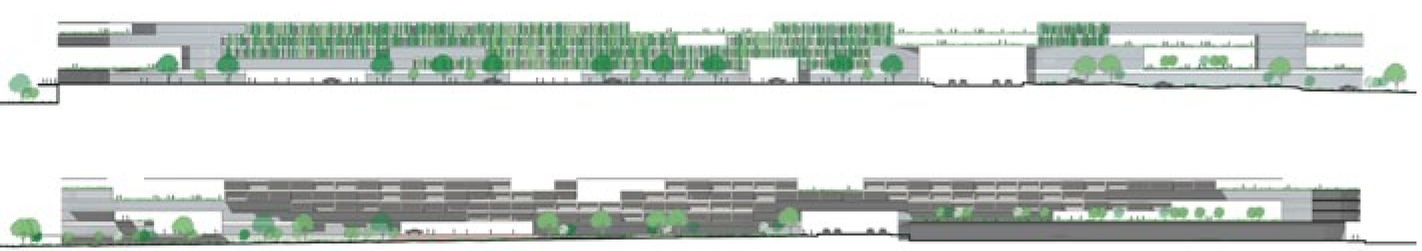


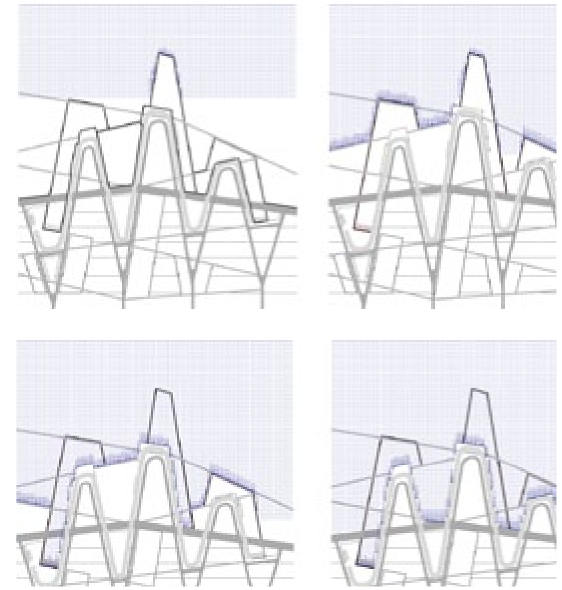
Existing Urban Fabric

Major Commercial Node
Each residential district is within walking distance of a commercial node. Large program integrated with the earthworks and landscape while smaller program punctuates the street edge.

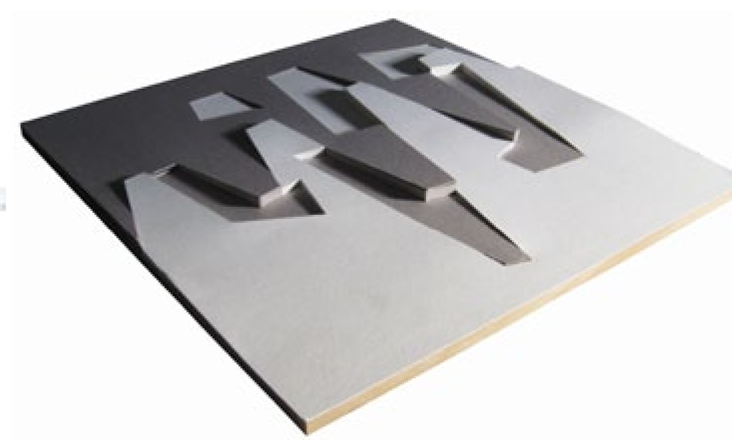


Integrated Section
The infrastructure of flood control is integrated into progammatic and formal strategies in order to produce rich sectional relationships between spaces, literally and phenomenally linking rather than separating them.

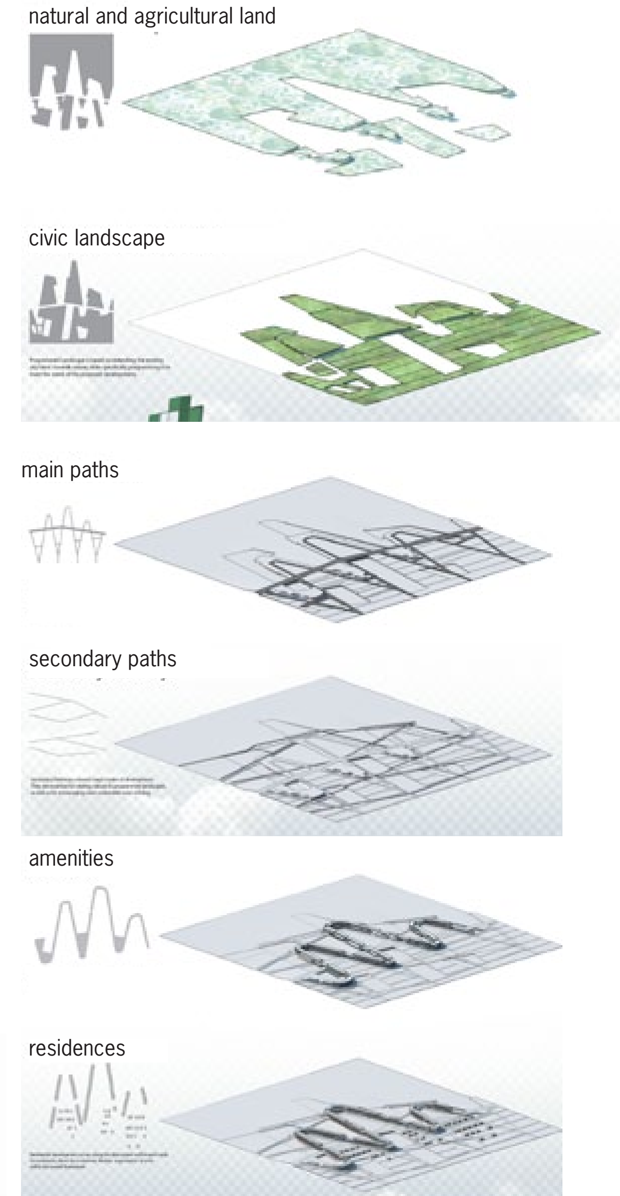




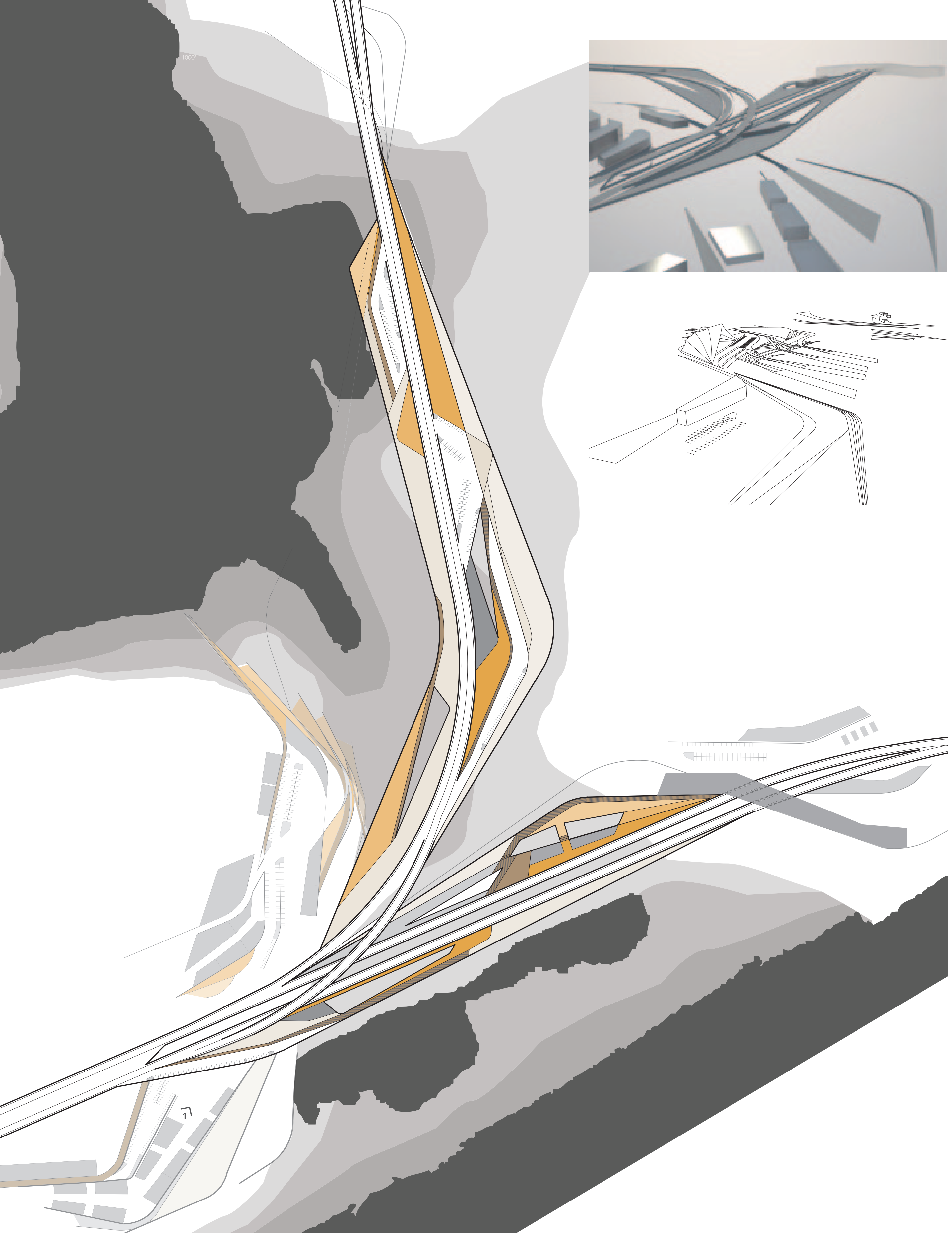
Layered Control
Because the dike is not a single wall but a series of embankments, different degrees of flooding can be managed, from routine detainment of rainwater for hydro- and aeroponic agricultural use to severe storm surge events. In this way, the dike is always productive rather than only working in the event of a severe storm.

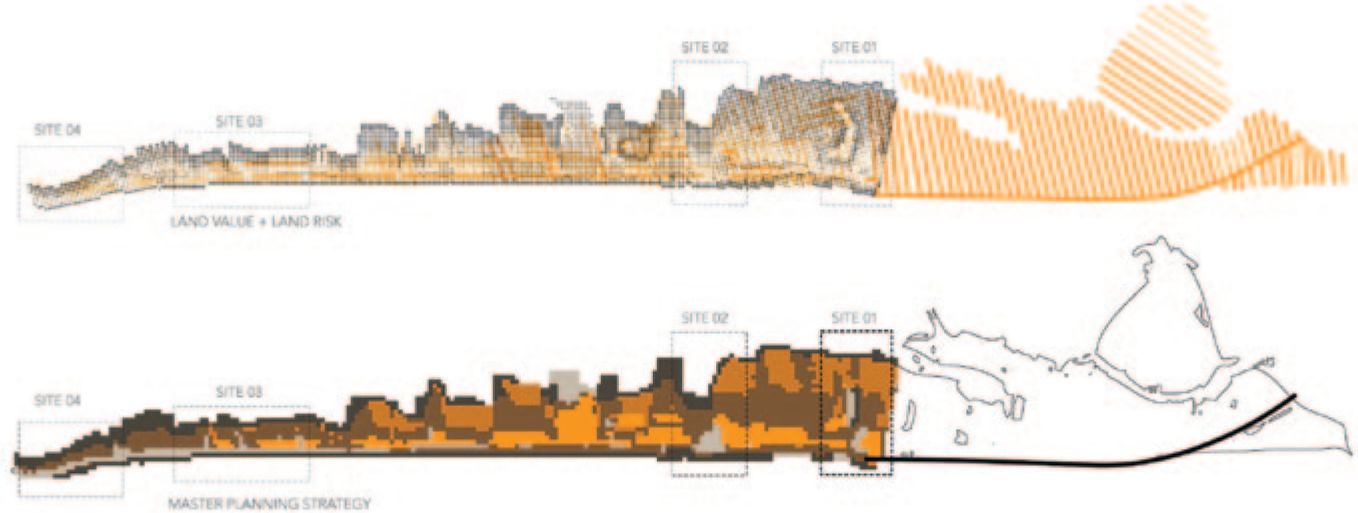


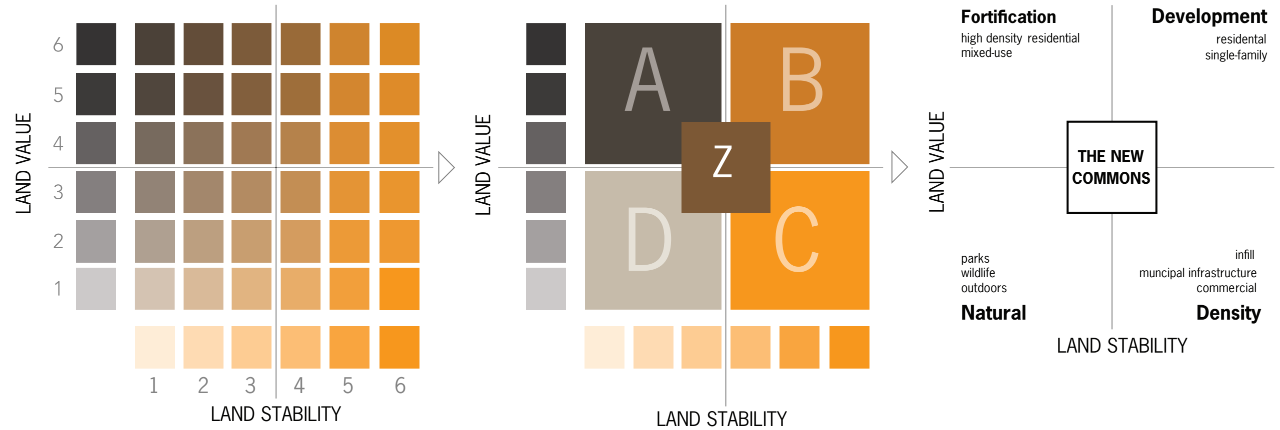
Diagrammatic Model of Interdigitated Landscape



Parc de la Galveston
Advancing layered programmatic strategies, the design can be understood as layerered – rather than simply overlaid –organizations. As a result, there is no separation between green public space, high-density program, and streetscape. One lives within a productive leisure park. Each program intersects at a sectional change,which creates “events” within the landscape. These seams also index flood levels and its structure is designed to prevent such disasters, employing the infrastructures of water management as a source for a new figuring of the public realm that depends on such highly constructed landscapes.







Stitching a New Commons

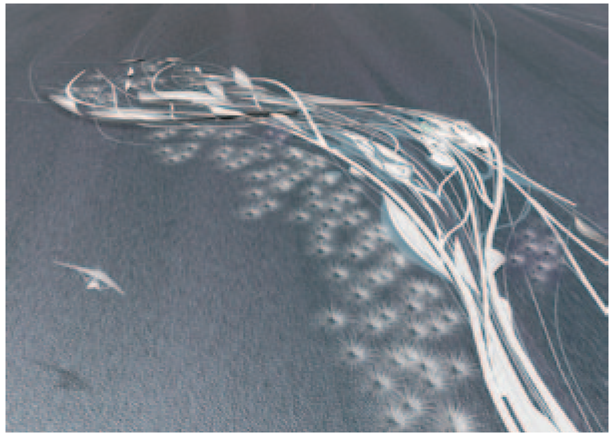
Rene Graham, Douglas Ludgin

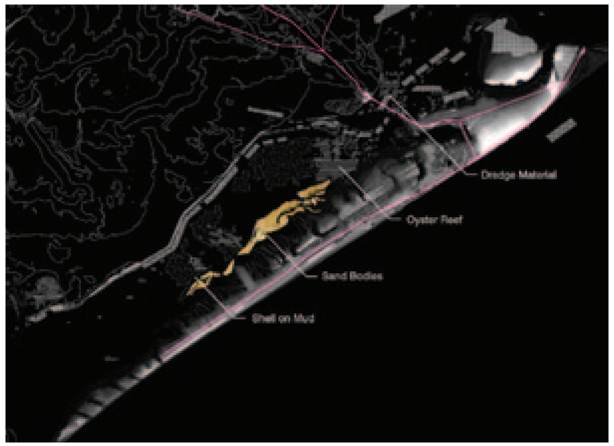
2008

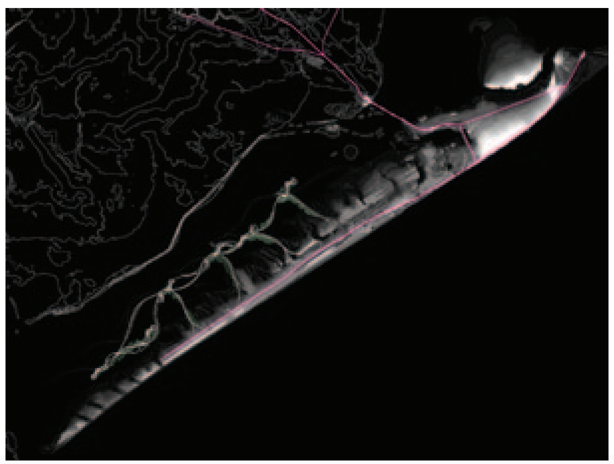
This proposal identifies four sites on Galveston Island with the greatest risk for storm breach. As such, Site 01 (at Sweetwater Lake and the West end of the Seawall) is distinguished as a high impact site, yielding the potential to stitch together the currently disassociated East and West ends of the island. A matrix of risk and land value is analyzed and yields a new planning strategy; the result of which is an economically viable solution that fortifies higher density development with a high land value, while preserving areas of higher risk and low land value. In the middle of this analysis, neither prime real estate nor storm susceptibility is the potential to stitch a new public realm into Galveston's planning strategy.

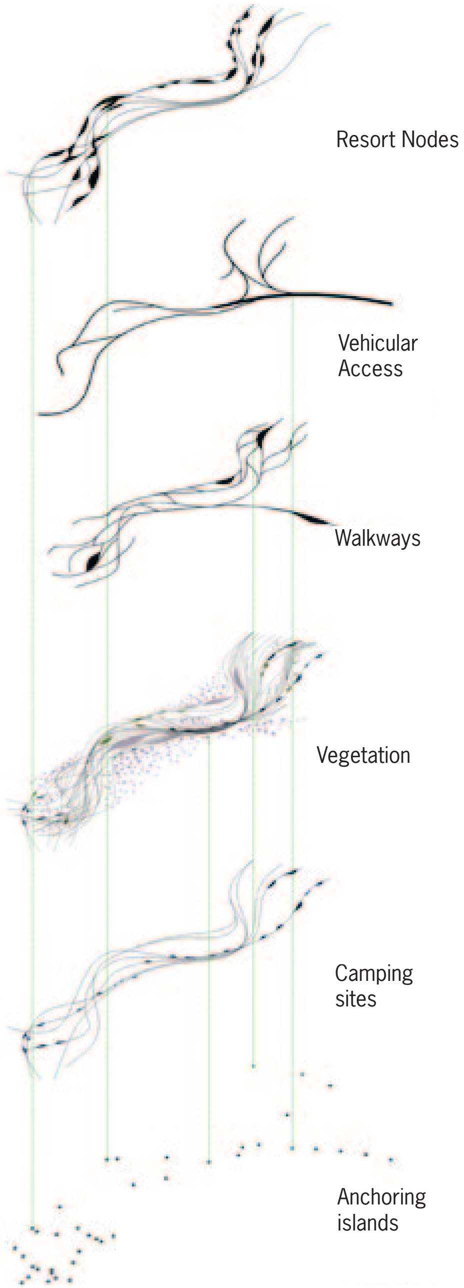
At the core of the design proposal lies a new public domain, a contiguous thread at once identifiable as a distinct public interface for the island, and a gradient into adjacent private development and civic preservation agendas. The design consists of laminated and delaminated hydrological infrastructure, transportation infrastructure, and public recreation distributing program.

Not only does this proposal suggest a responsible planning strategy for breach areas but its systematized strategy can be adopted throughout the risk laden western end of the island.

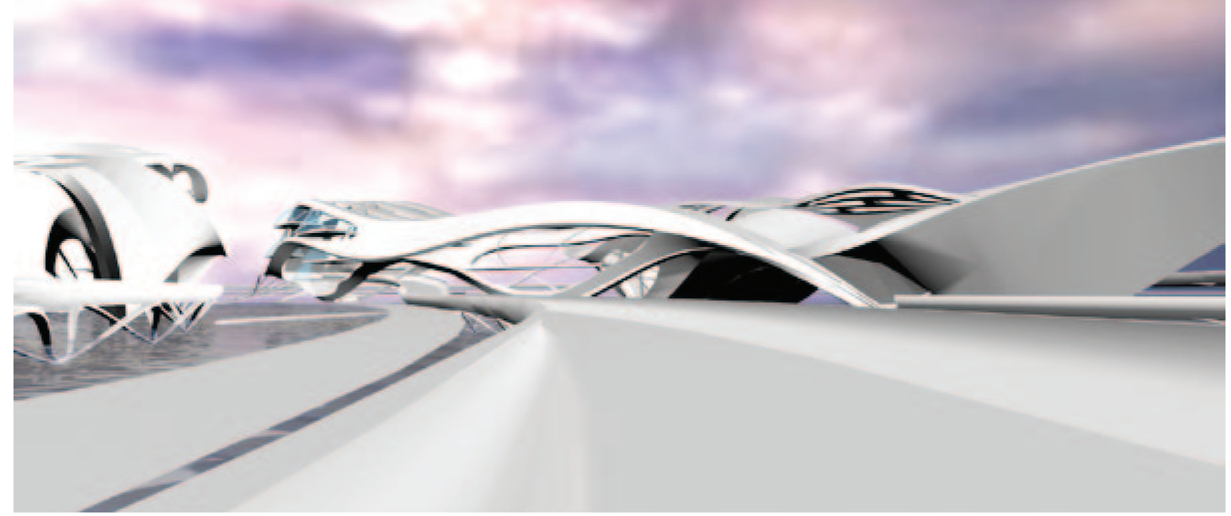


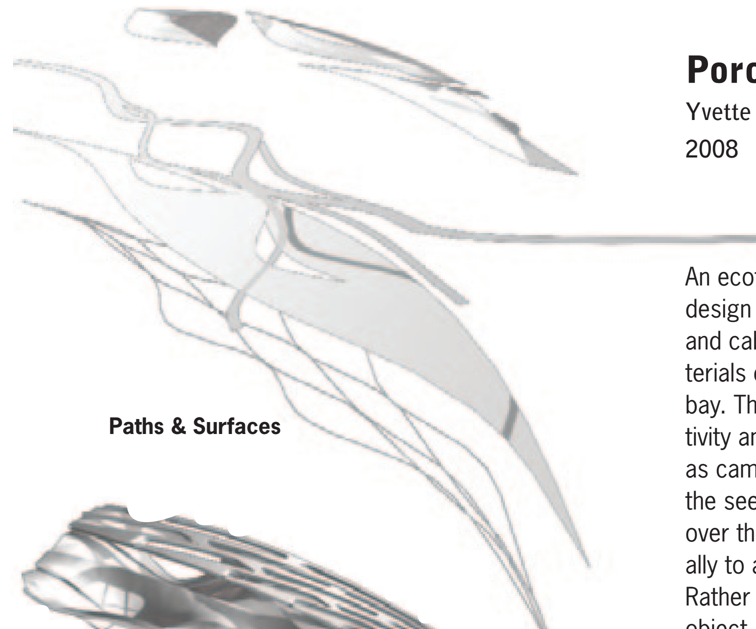






Exploded Axonometric of Systems





Paths & Surfaces

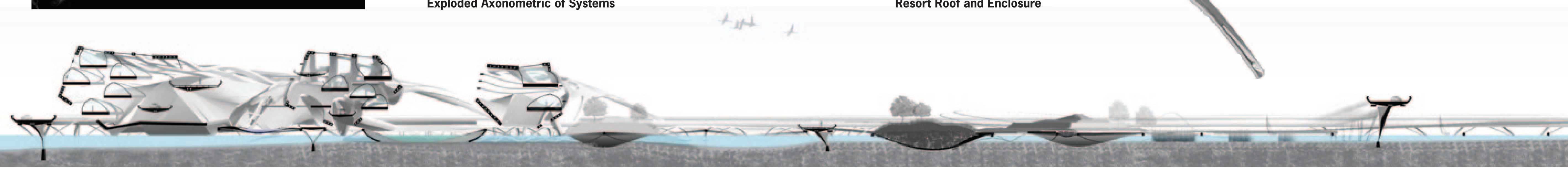
Porous Archipelagoes

Yvette Herrera, Hristiyan Petrov

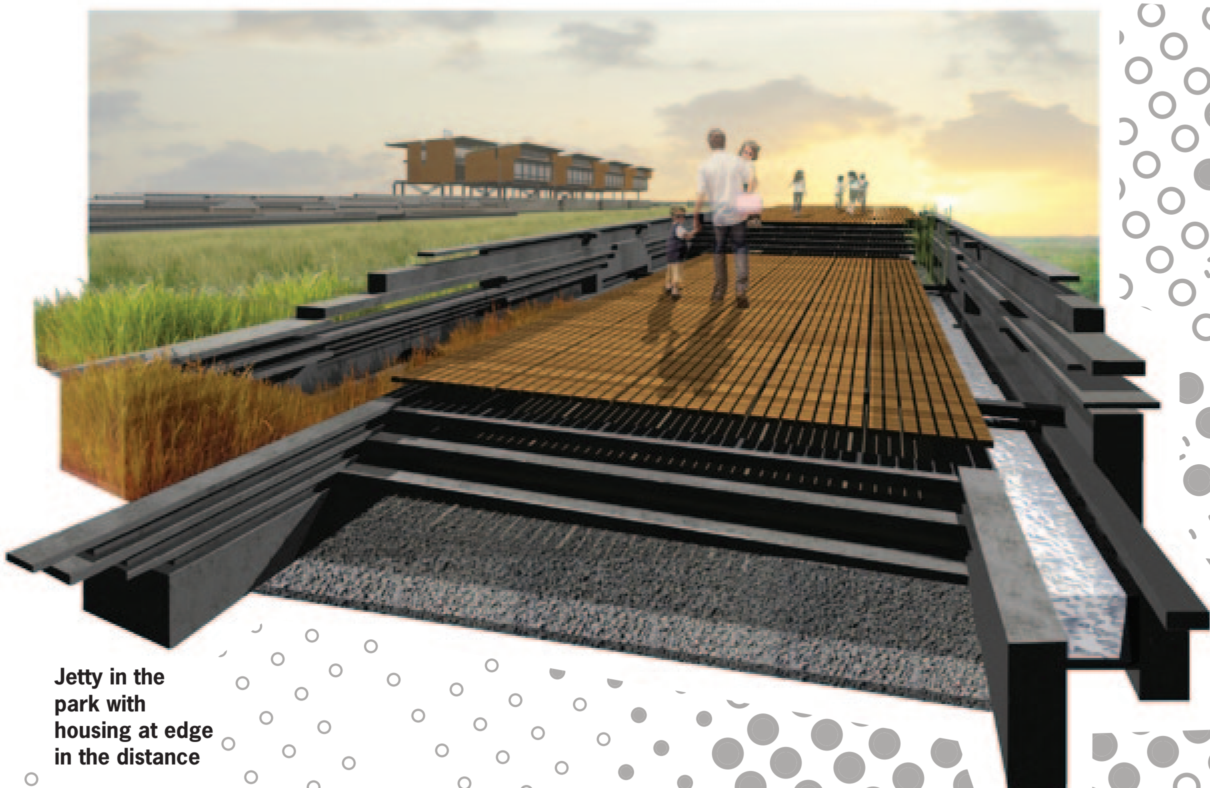
2008

An ecotourist resort is constructed in the bay. The design language emerges from a series of arches and cable suspended surfaces along with dredge materials deposited according to water currents in the bay. The result is a floating lattice of lines of connectivity and mats of program. Low intensive use, such as camping, occupy the low mats, which also foster the seeding of new wetlands. As the system grows over the years, several lines can be bundled sectionally to accommodate a large eco-hotel program. Rather than a discrete and environmentally enclosed object, this resort is porous and consists of dozens of mezzanines, each of which becomes a surface for tent-like accommodation, but with the amenities of a hotel.

Resort Roof and Enclosure

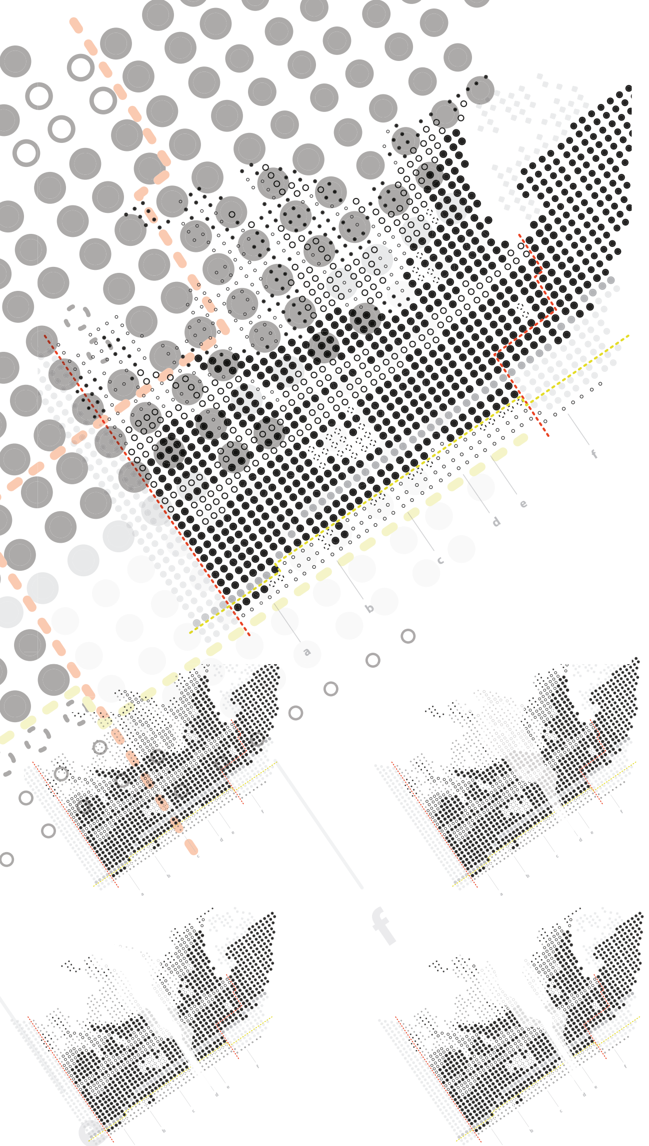


Cross-section from North to South through Resort Node



Jetty in the park with housing at edge in the distance

Saturday in the Park



State Park Site Plan Diagrams showing possible cut through island produced by a storm washover event

Creeping Park

Tess Hilgefort, Megan Sprenger

2008

This project anticipates the destruction wrought by future catastrophic hurricanes, strategically placing a series of concrete walls embedded in the landscape that, through their design seed future multiple programmatic potential while also being able to reinforce the island at critical points in the event of a washover brought on by a major storm event. Some of these jetties will only be visible after such an event, when the land is eroded, and therefore inflects its recovery.

The project is a generalizable model that could be applied on any barrier island. Areas of susceptibility to damage were found by mapping structural weaknesses in the island against possible storm conditions (location of hurricane strike, direction and speed of wind, amount of rainfall). These were then cross mapped against social networks that exist on the island to produce a range of conditions differing in degree from one another. This generated a range of strategies of structural reinforcement that can be deployed at multiple sites on the island.

The edges of the state park were chosen as the exemplary location with a high potential for washover and under-realized ecological and programmatic effectiveness. The final site proposal synthesizes structural reinforcement of the island at a critical point, programmatic amenities (bird watching, fishing, etc.), and integration of the park into social and material networks to either side of it though the proposition of housing that employs the jetties as foundations, thus feathering the developed and the natural edge.

The site and its natural habitats are not a stagnant piece of land on which to build. Rather than generate an autonomous utopian environment or seek a unified approach, the project allows a complex suturing of park, housing, recreation, and infrastructure with the temporal flux that governs coastal sites. The result is site specificity for an ever changing environment.

BOUNDARIES

ECOLOGICAL
- Coastal grassland
- Primary bay
- Estuary
- Freshwater
- Gulf beach
- Wetlands (recon.)

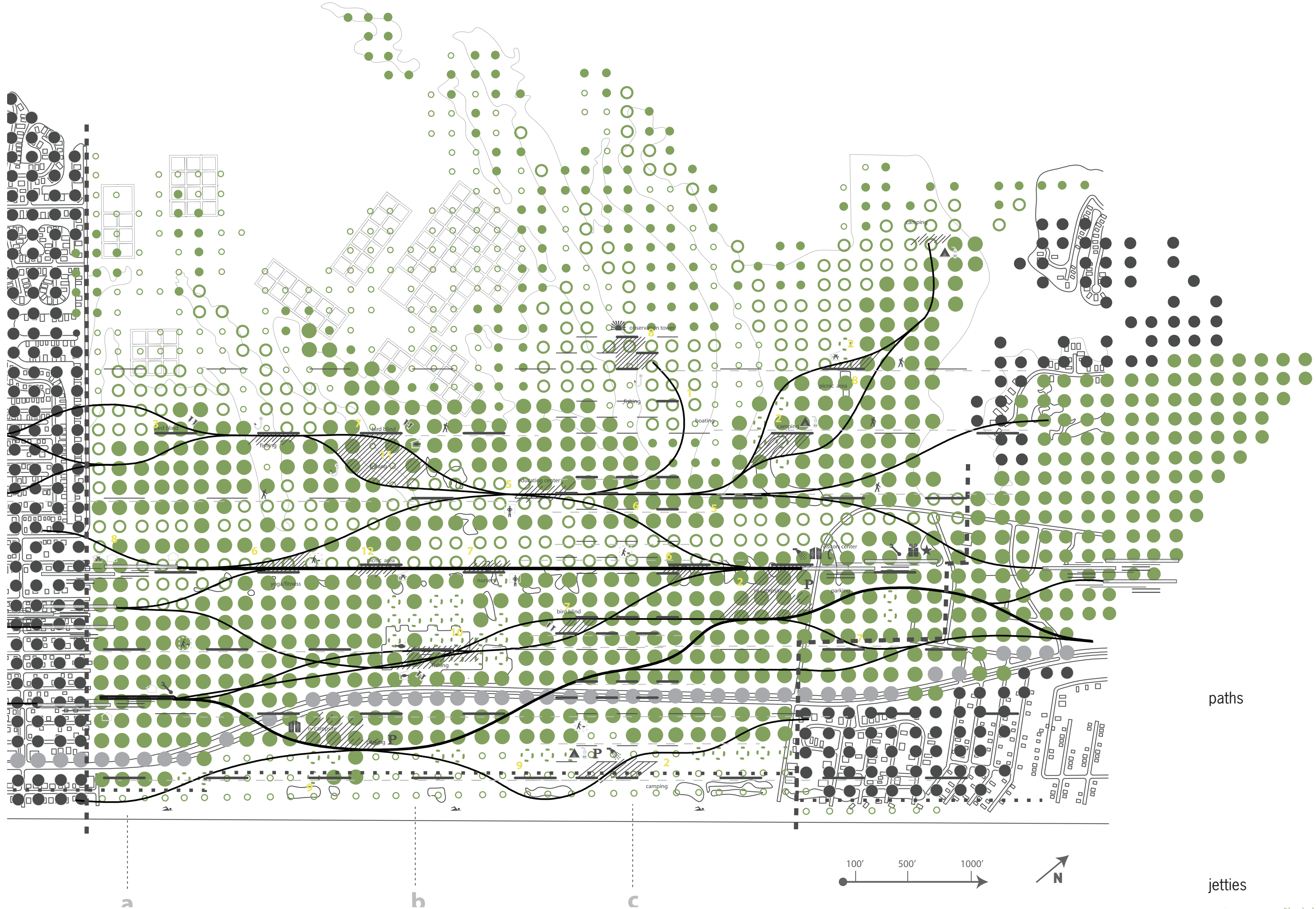
POLITICAL
- Property lines
- Dune lines

- Hardscape + Development

- Proposed paths
  - Hard
  - Soft

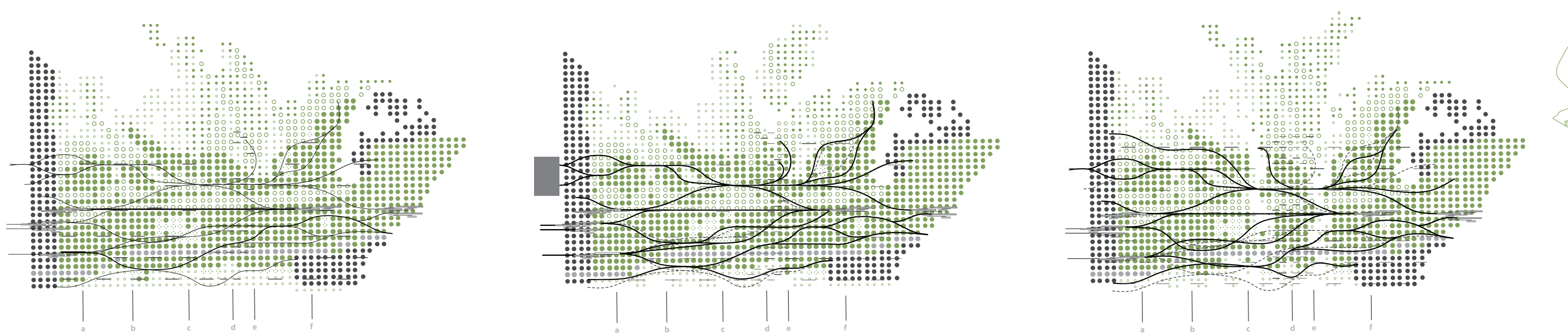
- Extended Path (Park Programs)

- Proposed Development

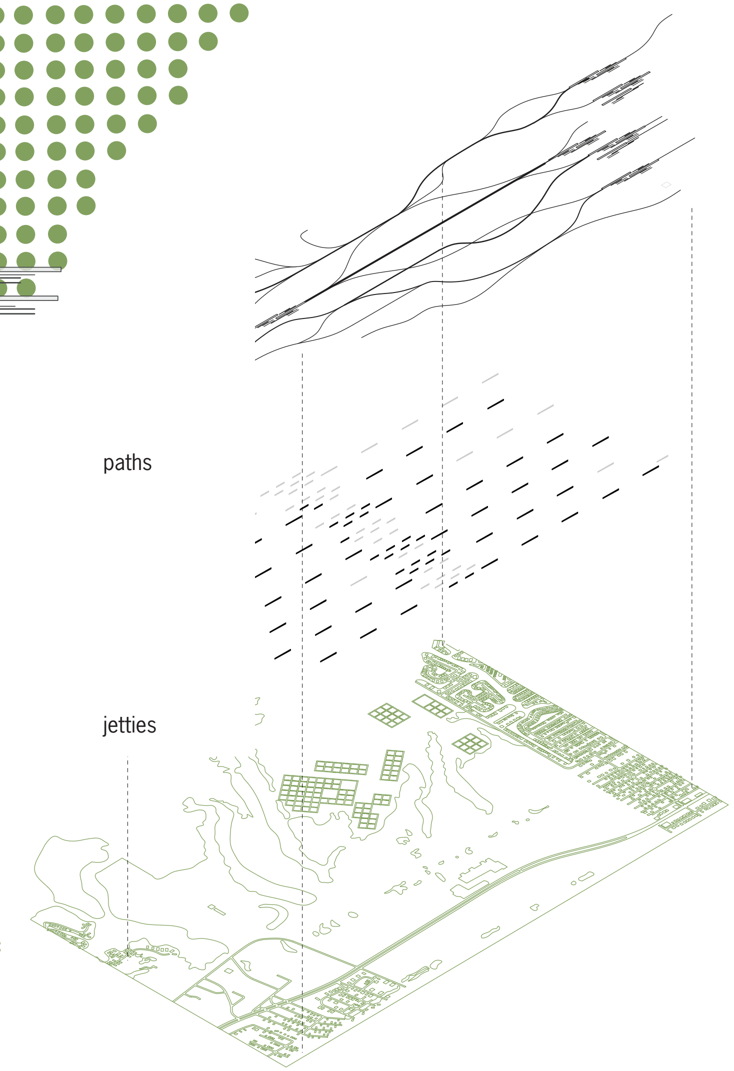


PARK AMENITIES

- Headquarters
- State Parks Store
- Interpretive Center
- Rest Rooms
- Showers
- Water/Electric
- Dump Station
- Shelters
- Residence
- Maintenance
- Hiking Trail
- Interpretive Trail
- Pay Phone
- Picnic Shelter
- Swimming
- Parking
- Freshwater Fishing
- Saltwater Fishing
- Fish Cleaning
- Bird Blind
- Observation Tower



Plan Diagrams through time



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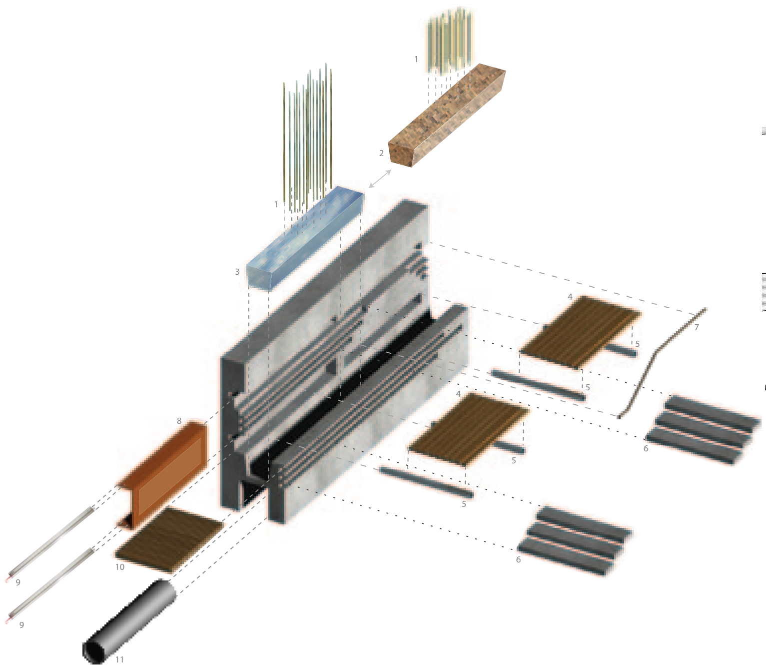
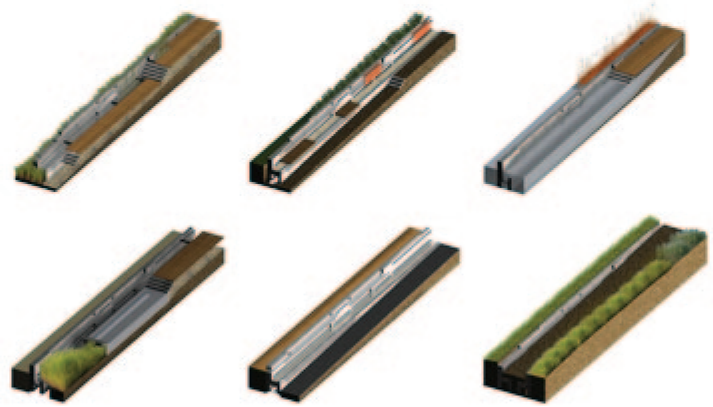
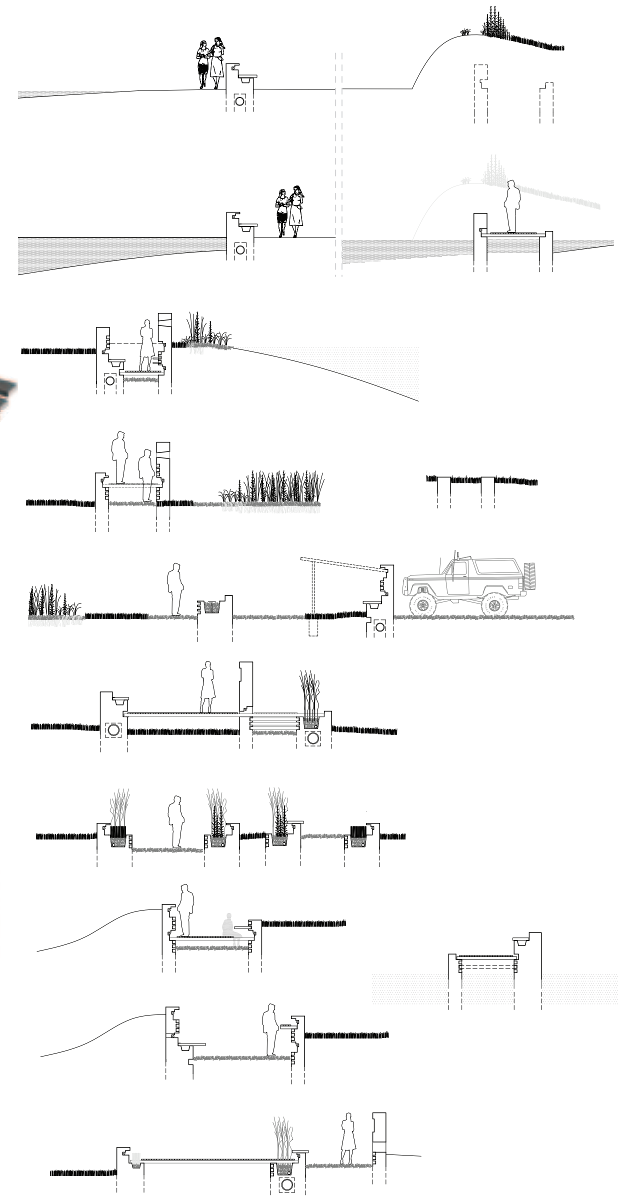
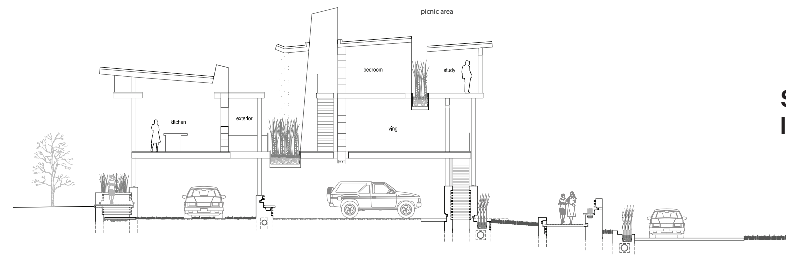


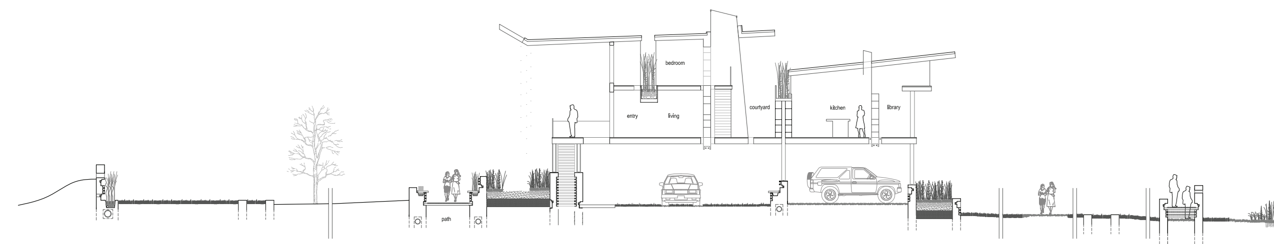


Component Assemblies

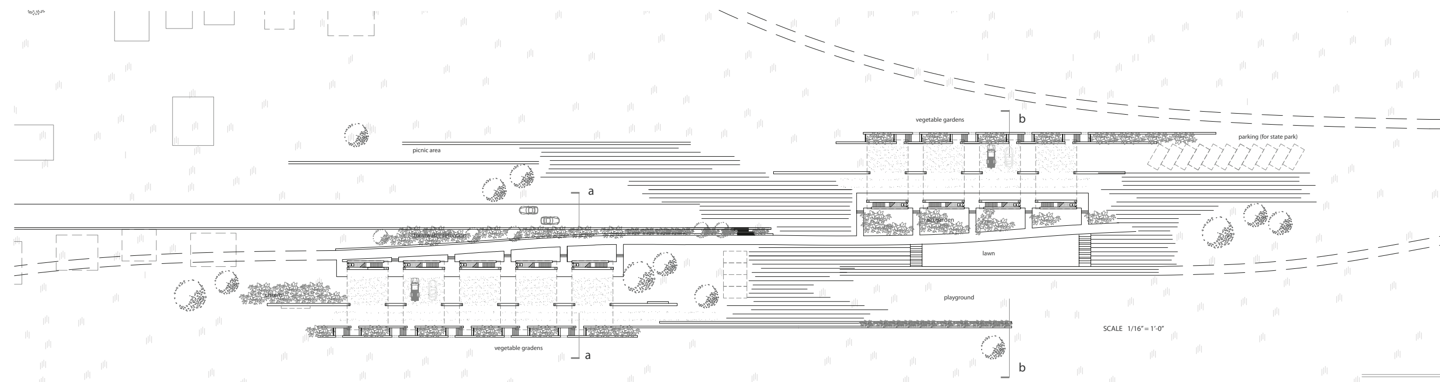


Sections of Typical Conditions in Park

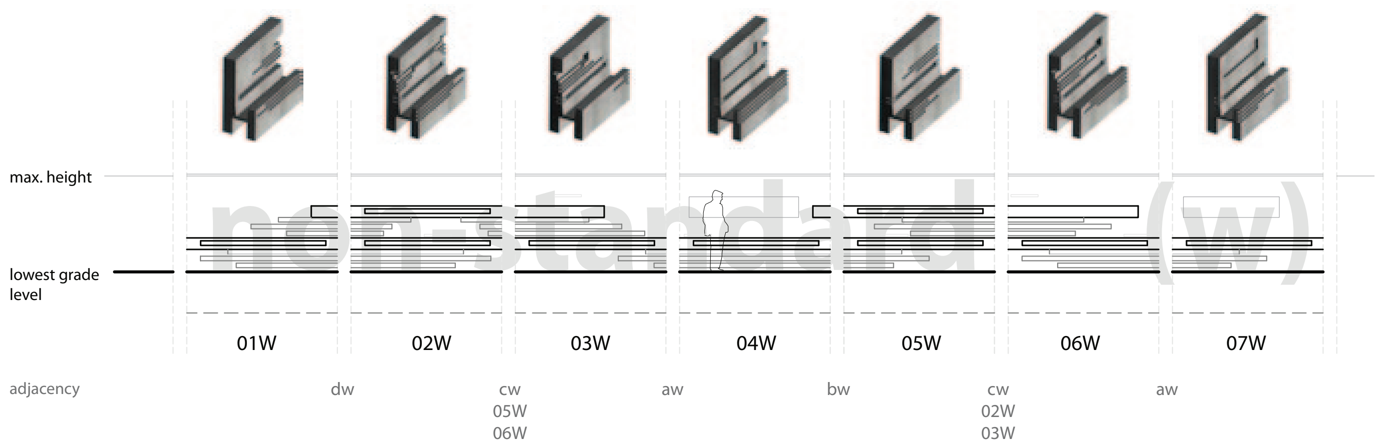


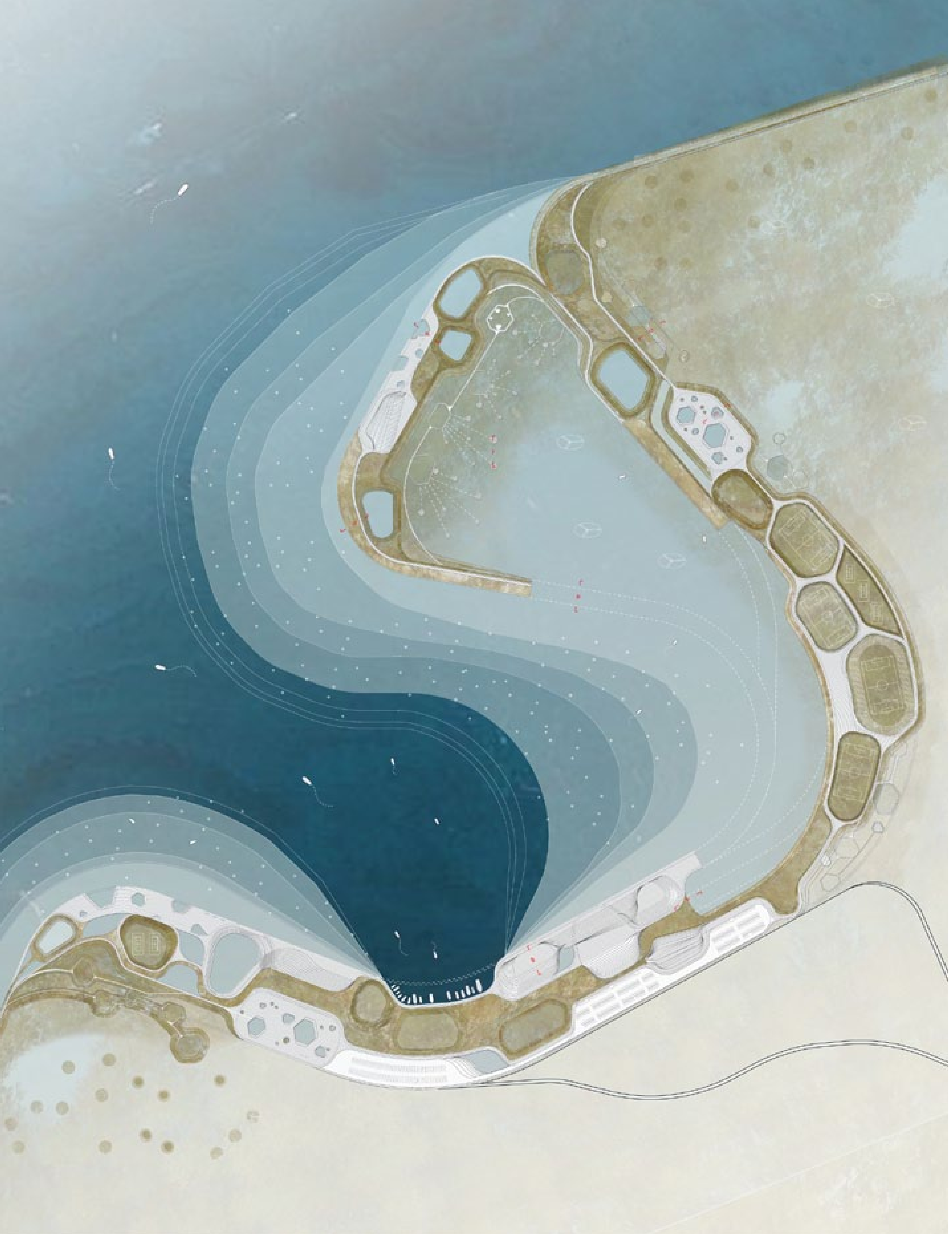


Sections of Housing showing integration with wall and landscape system



Plan of Housing at edge of State Park





Plan, New Dalehite Cove Park

Fluctuating Territories

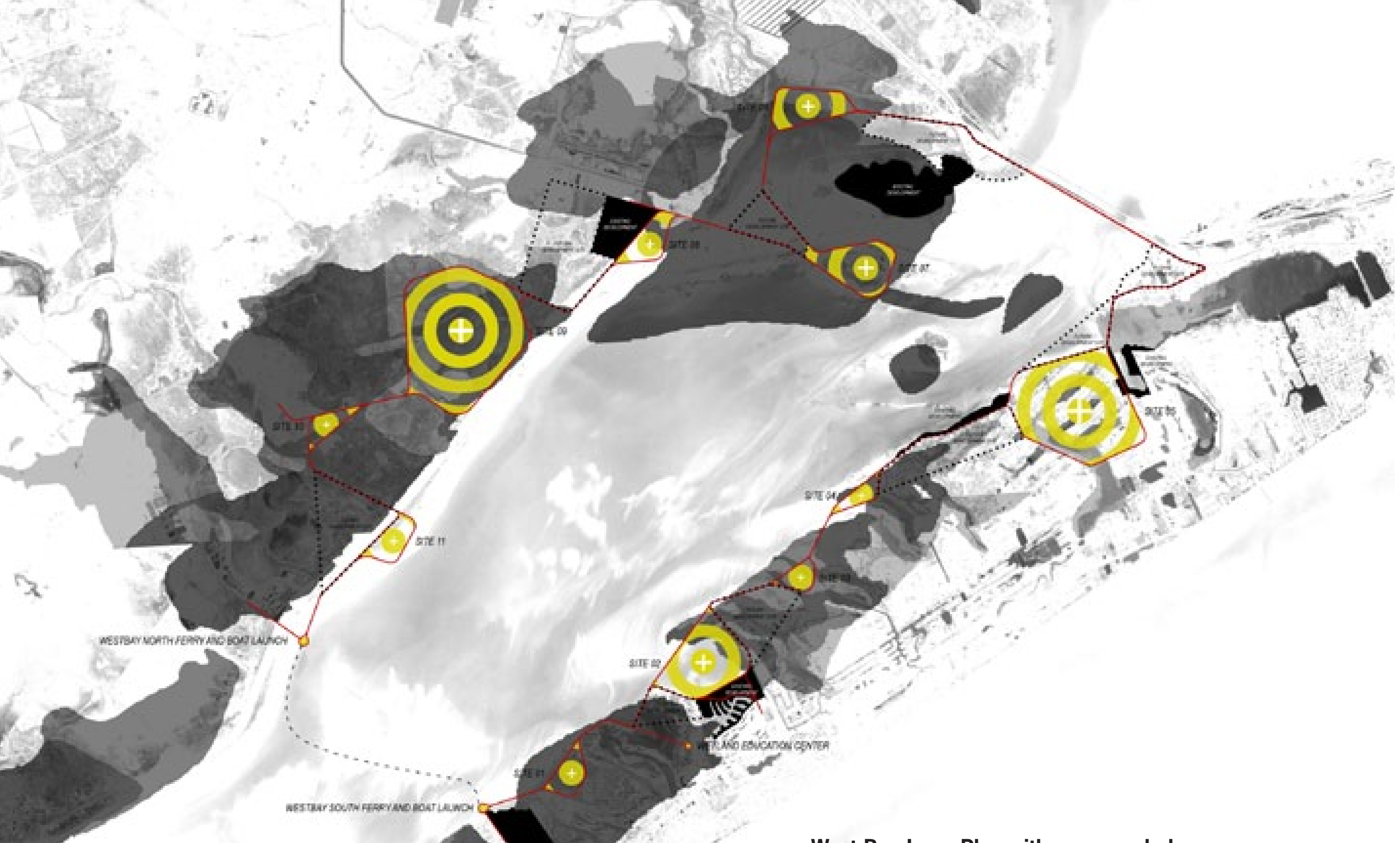
North Keeragool, Kathryn Pakenham

2008

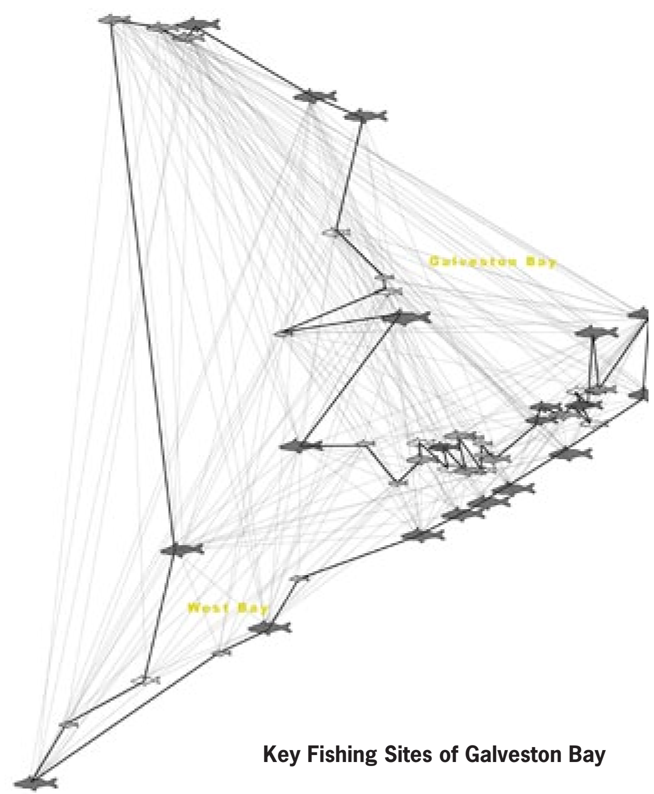
Fluctuating Territories is an architectural response to the blurred and fluctuating conditions of bay edges. Rather than a hard line, bay edges are zones in continual transformation. Wetlands move inland and expand into the bay; aquatic and land flora and fauna mingle, spawn and prey on each other. As a productive wetland ecosystem, the bays of Galveston play a crucial role in the local economy, especially the commercial fishing and ecotourism industries. But while it is productive, it is not especially clean or healthy by other measures.

This proposal repositions development and attention away from the beach front and toward the bay's edge. The design explores the natural cycles and processes that are present in the surrounding landscape and apparent in the ambient and latent qualities of the site. Wetlands, now often in a state of decline, are amplified and accentuate intensifying propagation of valuable wetland products and expand nesting sites for migratory birds. One is introduced to these phenomena with a heightened sensitivity by occupying the augmented edge.

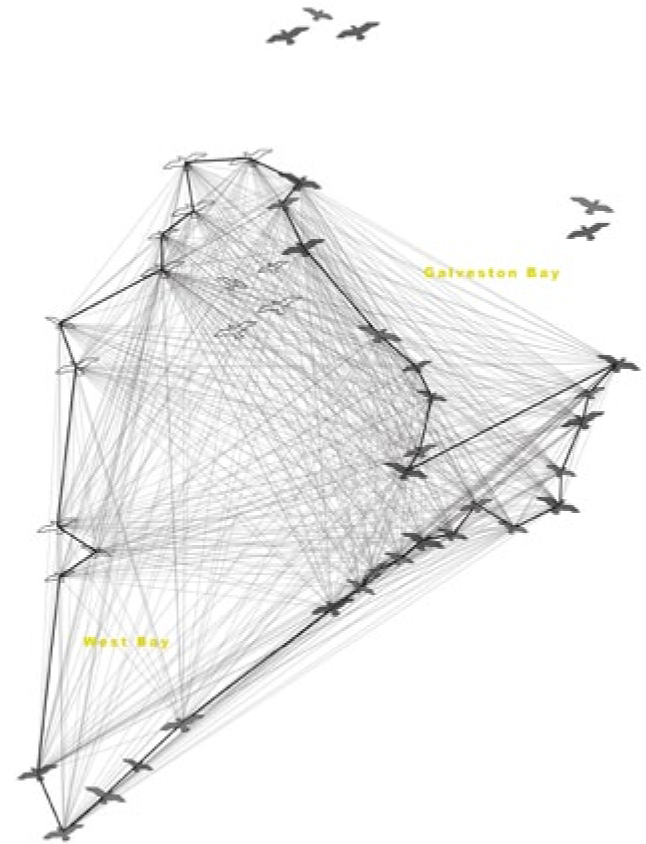
The design is a sequence of thickened edges and deep surfaces floating along the West Bay edge, forming a recreational loop. Nodes of highly intensified activity (hard and large programs) are strategically positioned through out the loop in less sensitive areas but in proximity to ecological amenities. Other softer and less intensive programs that can be classified as controlled, static, or flux. These are embedded within, placed above, and inserted below the surface depending on the nature of the activities, such as: treated water pools, bike paths, amphitheaters, or other recreational and cultural activities. By varying the design of each module, different programs can be accommodated. Pedestrian and bike paths along this route are complimented by water buses and taxies that link nodes across the bay. By linking the isolated sites that are already used for ecotourism, such as bird watching, with new points of intensity, reorients the entire region, focusing on the bay as its central focus.



West Bay Loop Plan with program hubs



Key Fishing Sites of Galveston Bay



Key Bird Watching Sites of Galveston Bay

Projected Activities 2021

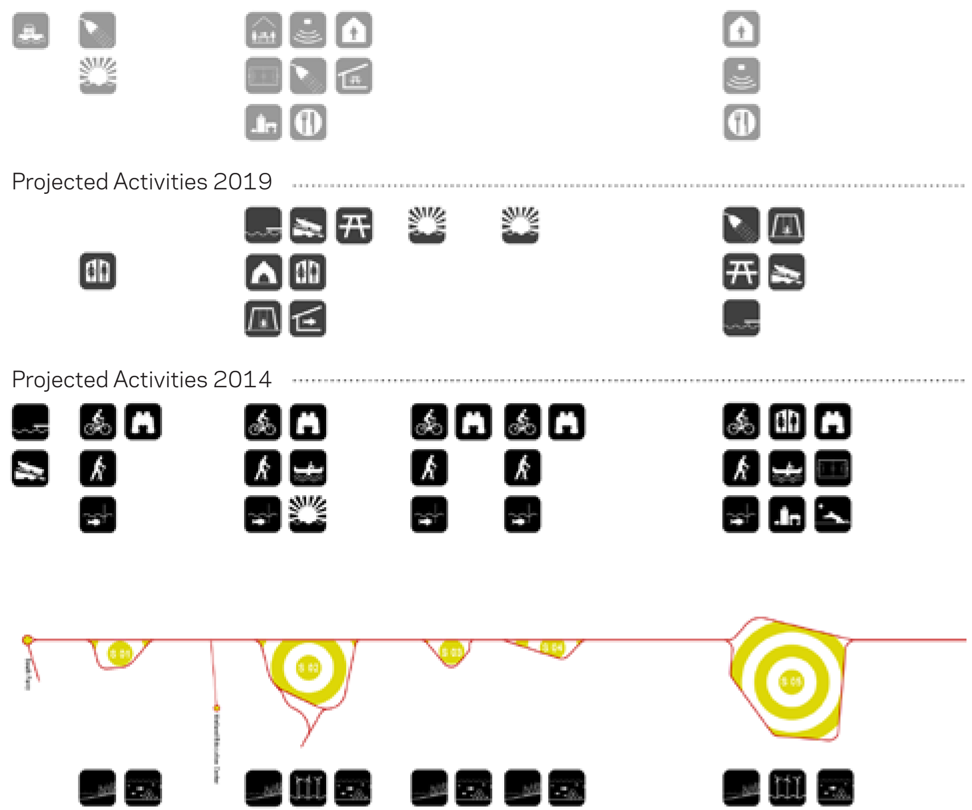
Eco-hotels, restaurants and ferry boat stations established, fully establishing the bay as a new network of local and tourist economies based on eco-tourism and reorienting the island.

Projected Activities 2019

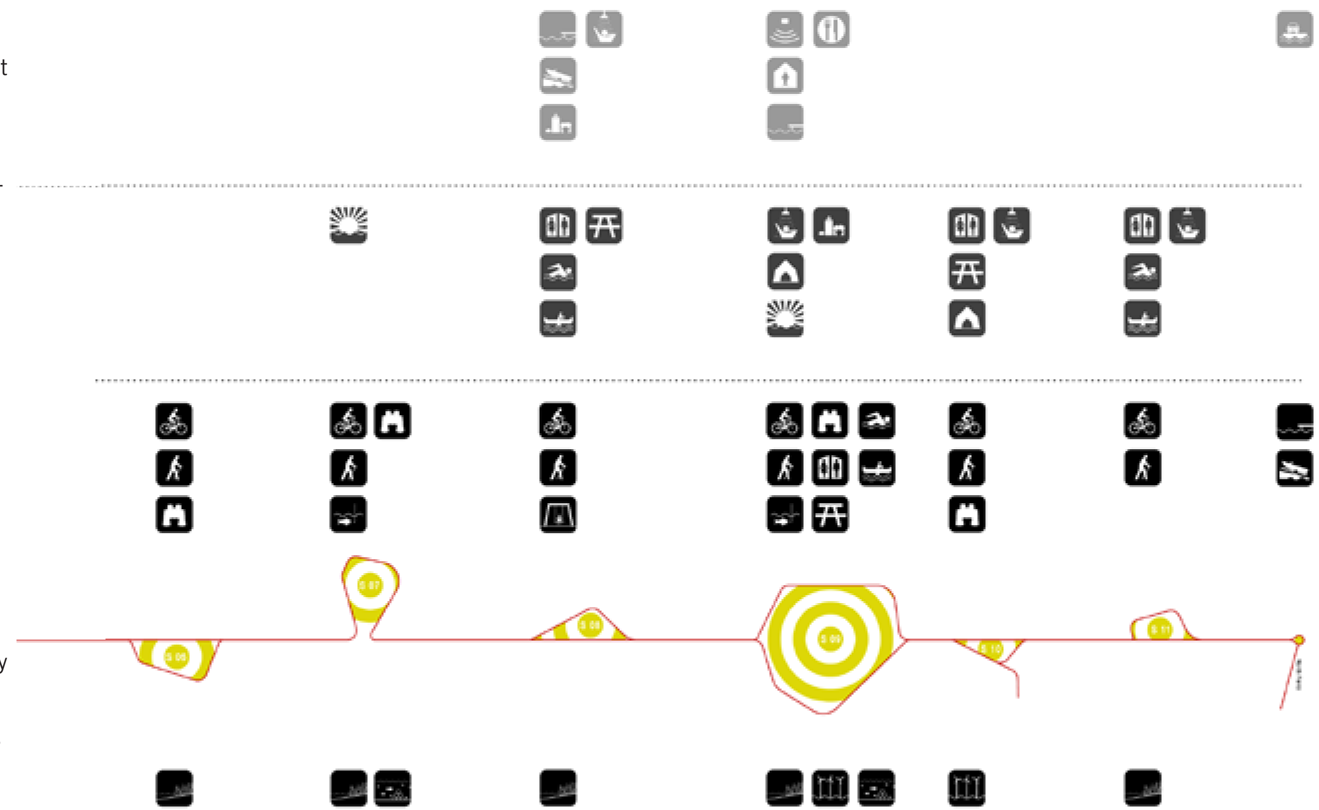
More amenities including camping, boating are added to the loop.

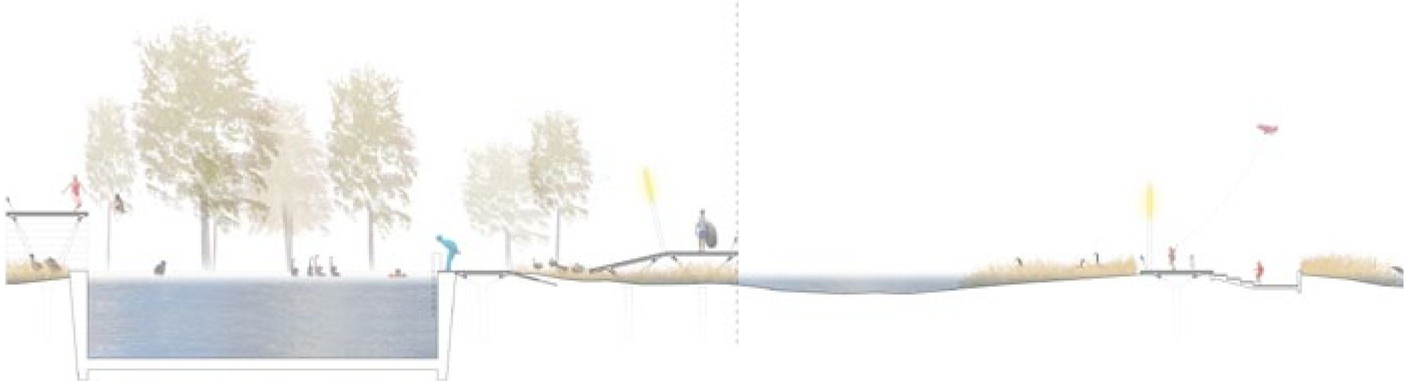
Projected Activities 2014

Programmatic amenities for recreational use populate the basic pathway, creating a loop of activities.



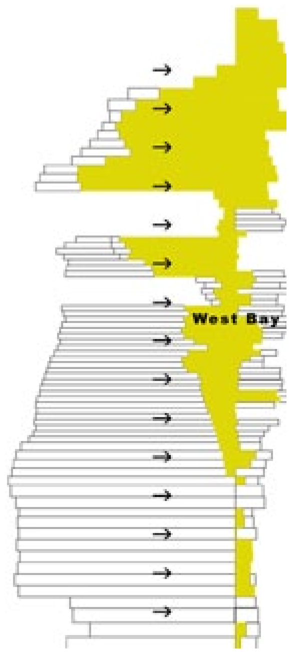
A “boardwalk” pathway system begins construction that amplify recreational activities and bay habitats simultaneously by protecting newly planted wetlands and increasing public access.





Detail Section of Swimming Pool and Park

Current Development Pattern



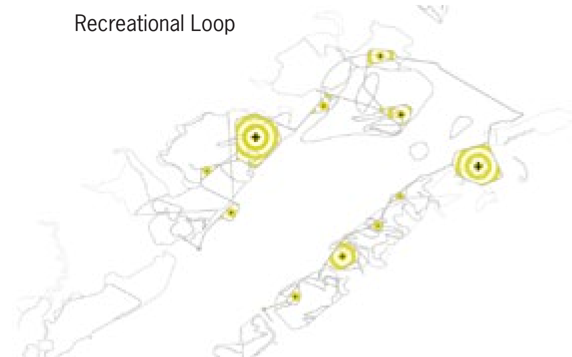
Proposed Development Pattern

Refocus on the Bay
Current trends in the region focus development on the ocean or in Houston. This project proposes to refocus on the Bay as it is ecologically rich, relatively protected from storms and erosion can be mitgated by constructing new wetlands.

Section through New Dalehite Cove Park

Recreational Loop

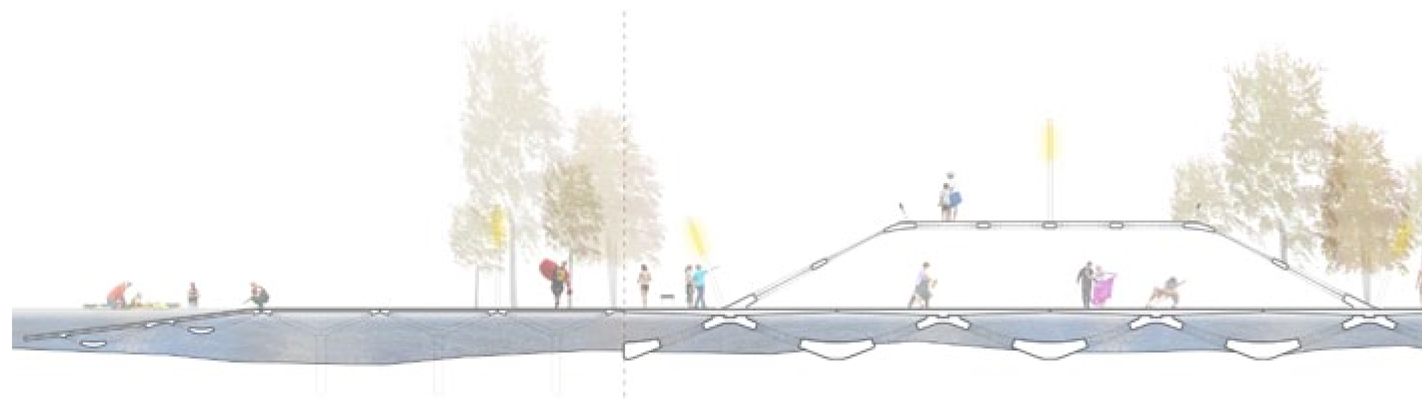
Existing Roads



Recreational Hubs

New Eco-Development Nodes along loop

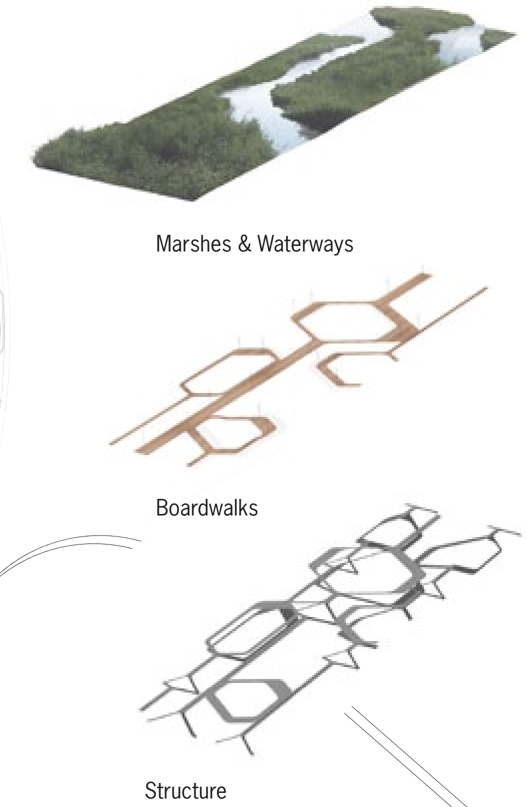
Site Diagrams
A recreational loop of boardwalks connects hubs of intense program. Existing Roads service these nodes while new ecological resort development is created.



Elevated Walkway

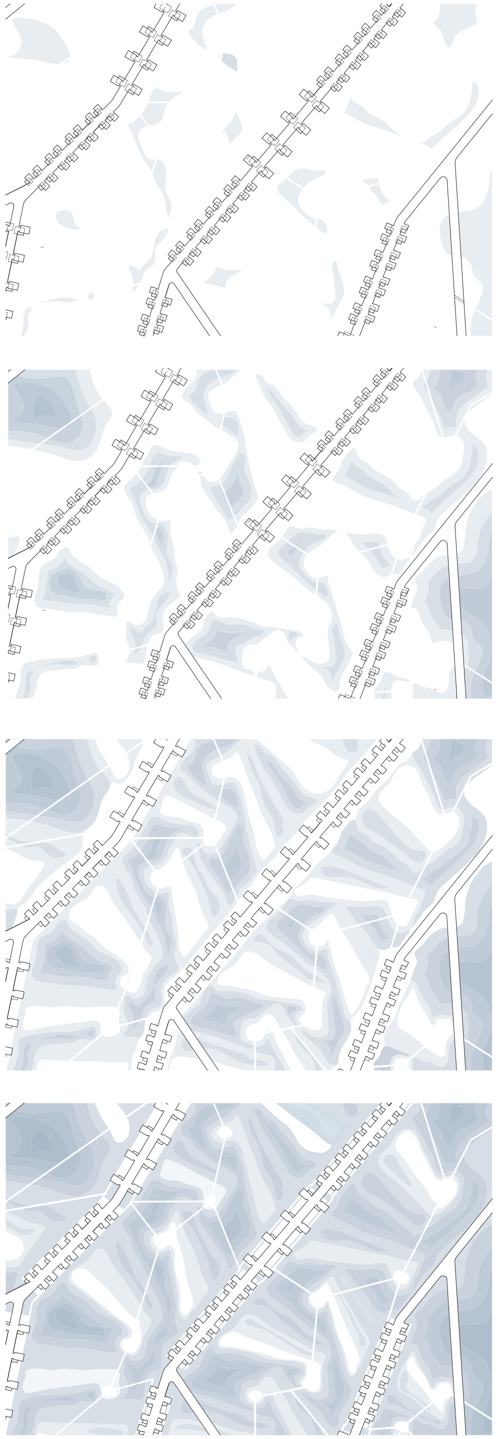
Boardwalk and Boat Launch

Nature and Biking Trail



Exploded Axonometric of Systems

Swimming Pools, Movie Stars



Sequence of inundation due to storm event where dark blue represents the deepest water

Left: Topographic Site Plan

Galveston Restore

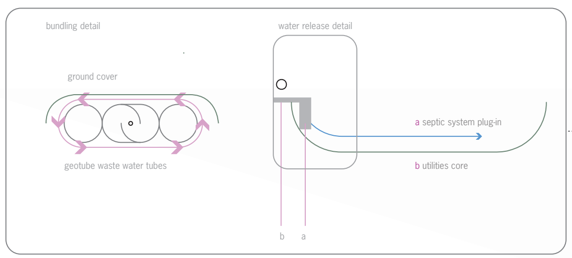
Cary D'Alo Place, Marissa Hebert

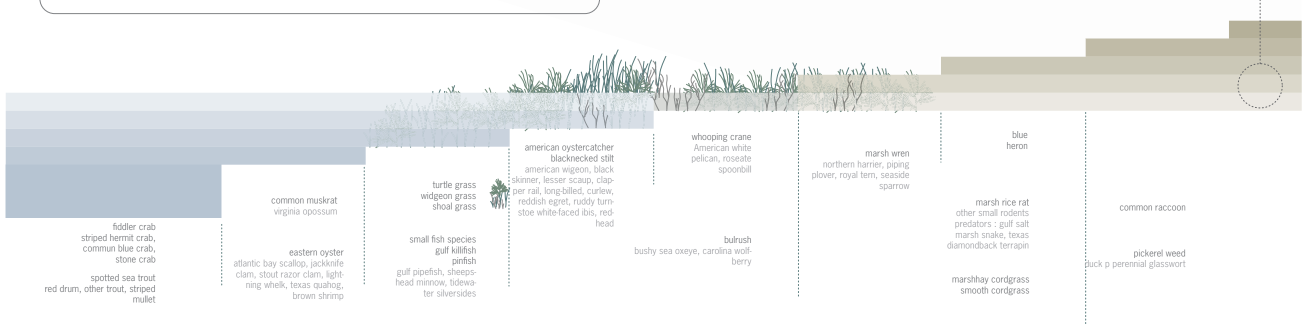
2007

Fiddler crabs, whooping cranes, and blue herons intermingle outside the window. Tidal flats heave with the ebbing of the tide. Fields of bulrushes ripple in the moist gulf breeze. Gone are the monotonous Bermuda grass lawns. Replaced with vegetated topographies and vibrant wildlife, this is the new ecologically sensitive suburban wetland development.

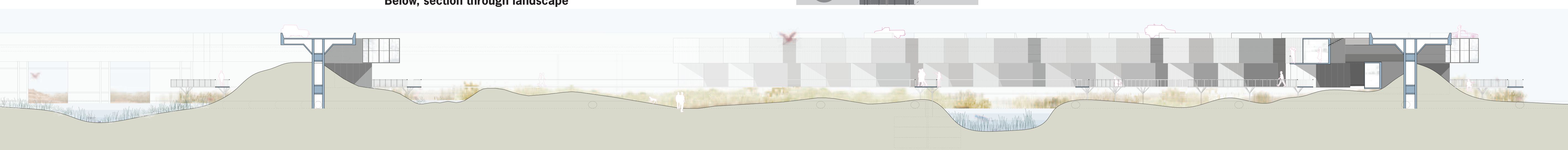
The richness and diversity of the new ecological lawnscape interdigitates ridges that support roads and encased infrastructures that support housing. By clustering utilities such as water, HVAC, and septic systems into these berms and elevating them they form foundations for housing. This simultaneously reinforces and protects the landscape against storm damage and creates sectional separation for the housing units for when flooding occurs. Located on the bay side of the island, notable for its prolific wetlands, the project reconfigures suburban lawn spaces as flooding plateaus to remediate storm water and provide habitat for native flora and fauna. The location of the row housing on ridges allows each individual housing module to have sweeping vistas of the wetland zones, simultaneously increasing the value while also connecting the drainage from the housing into the remediation function of the wetlands. Roads are located on the high points of the ridges and thus will not flood when the rest of the landscape becomes inundated. Boardwalks, situated above the flooding level, stretch across the landscape and connect the ridges together such that residents can laterally traverse the system to visit distant neighbors or simply wander and enjoy the delights of the scenery. By acknowledging that individual houses are implicated in both larger- and smaller-scale systems and processes, and by formally merging housing with these systems, the project proposes a new synthesis of landscape and architecture that is sensitive and specific to the local flora and fauna.

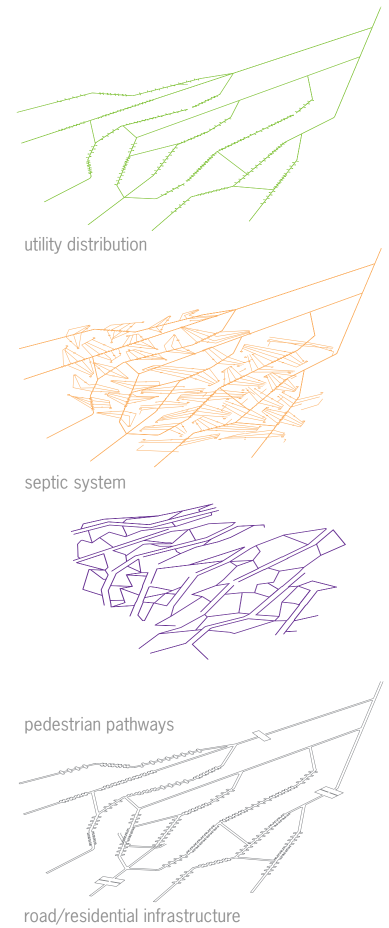
Top, Detailed plan
Housing is integrated with ridges and infrastructure. A performative wetland landscape is created using tidal flux, surface water drainage and remediation and is integrated with recreation.



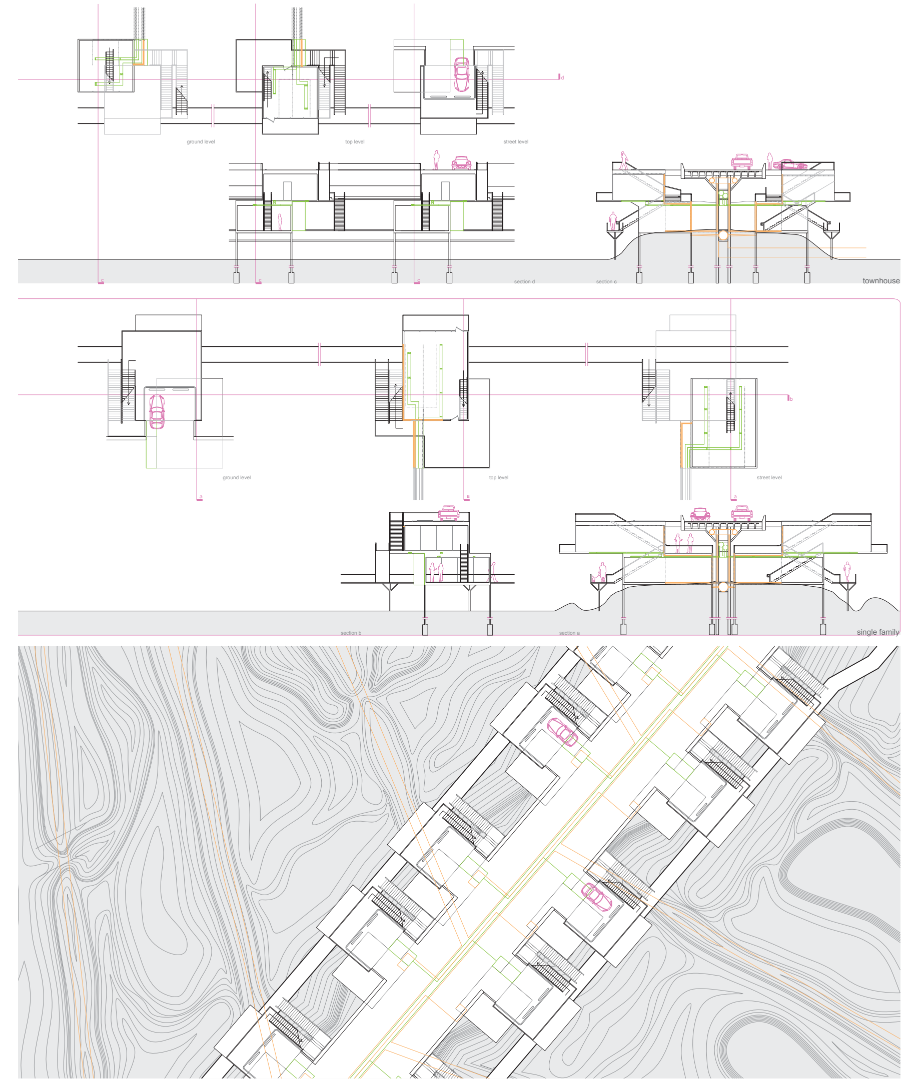


Below, section through landscape

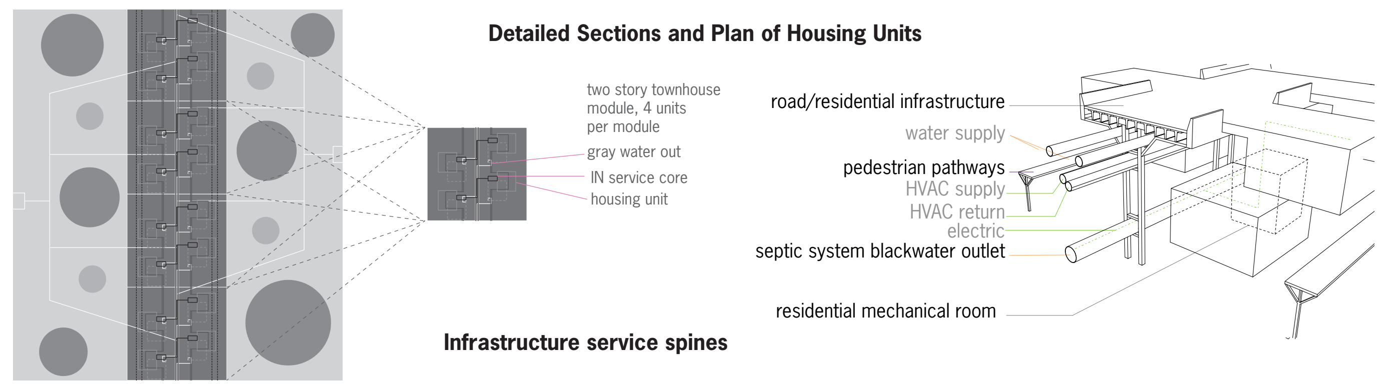




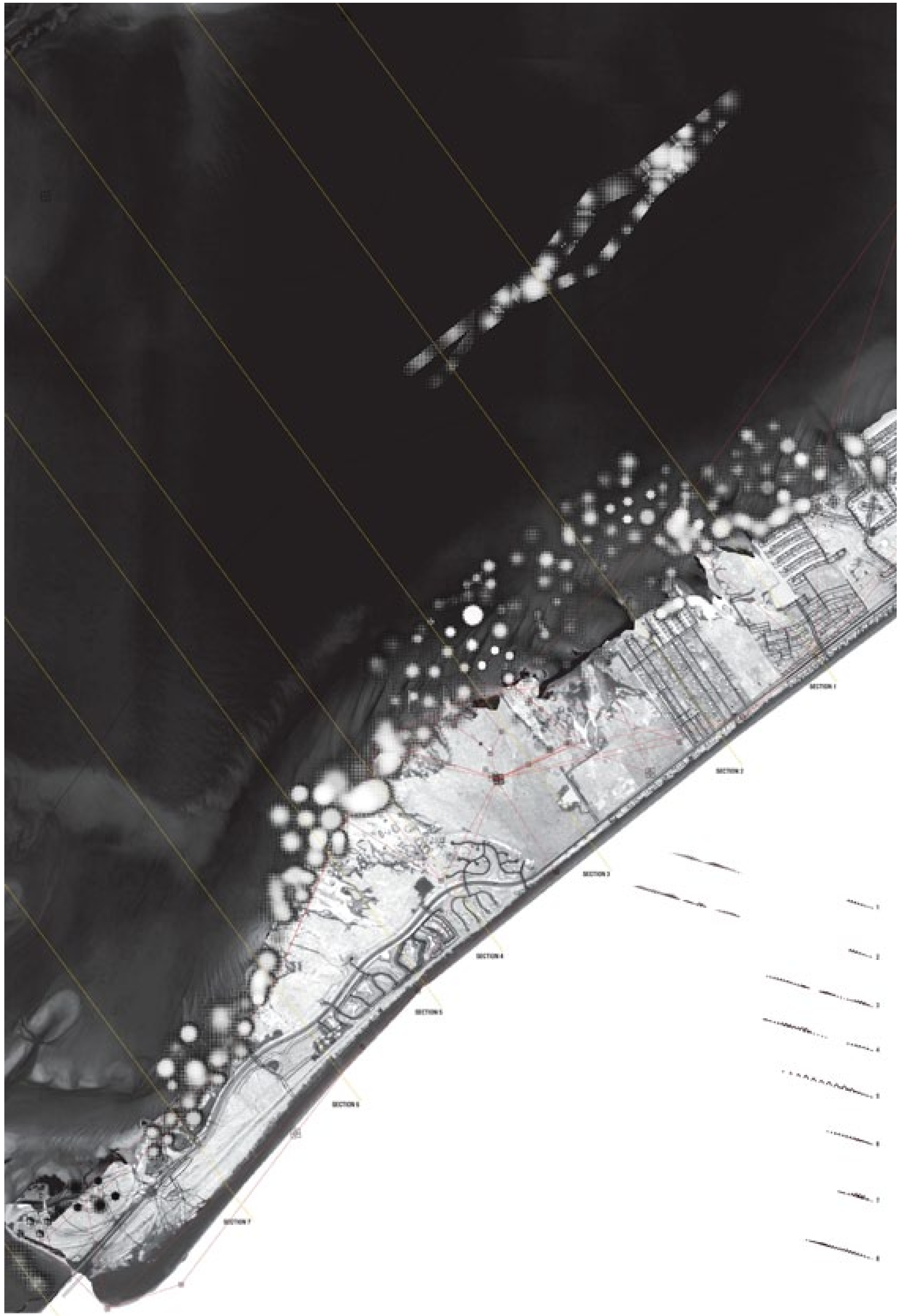
Infrastructure and Landscape Systems

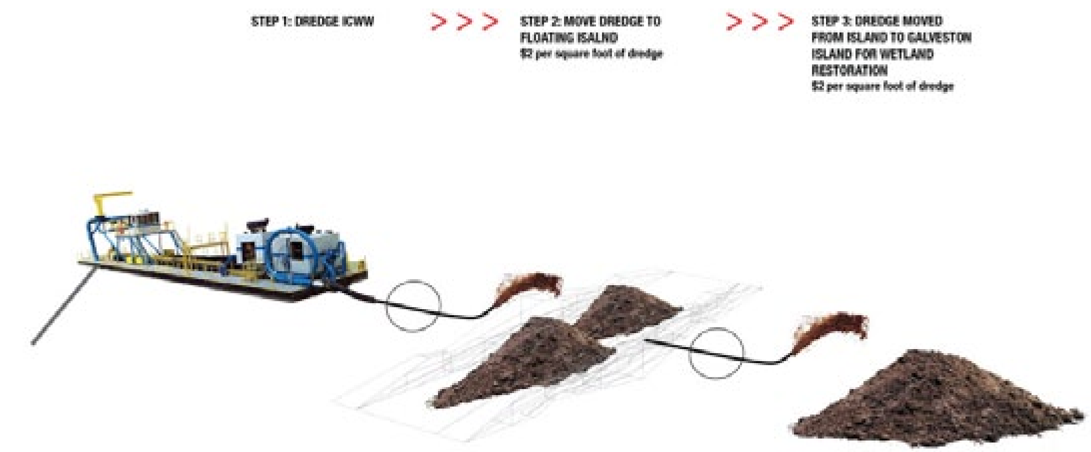


Detailed Sections and Plan of Housing Units

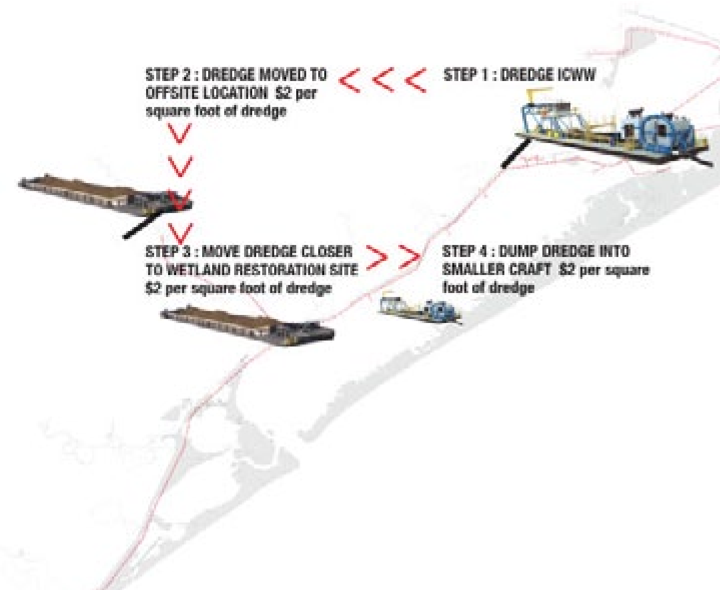


Infrastructure service spines





Proposed Two-Stage Process



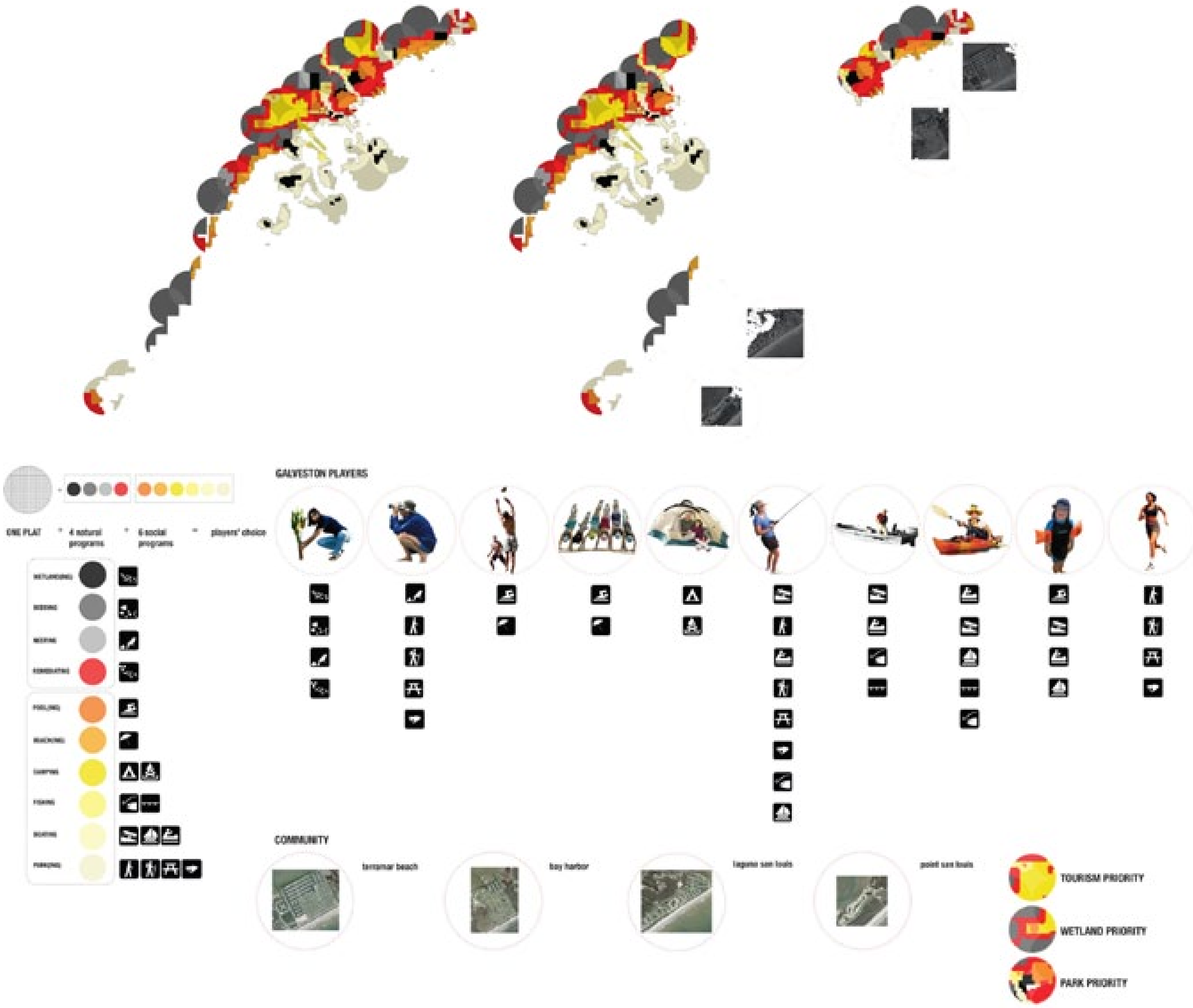
Existing Dredging Process

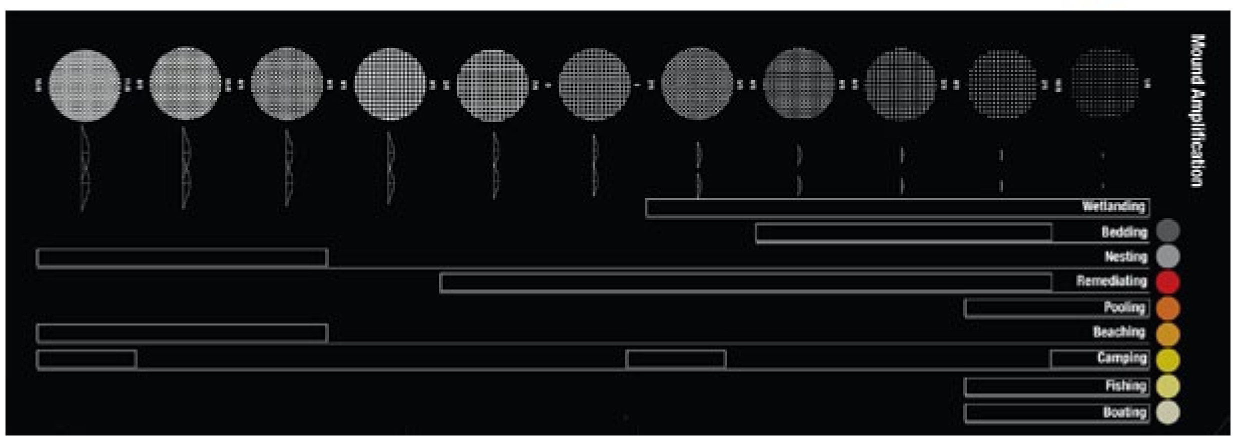
MUD: Mobilizing Urban Dredge

Ed Baer, Marti Gottsch

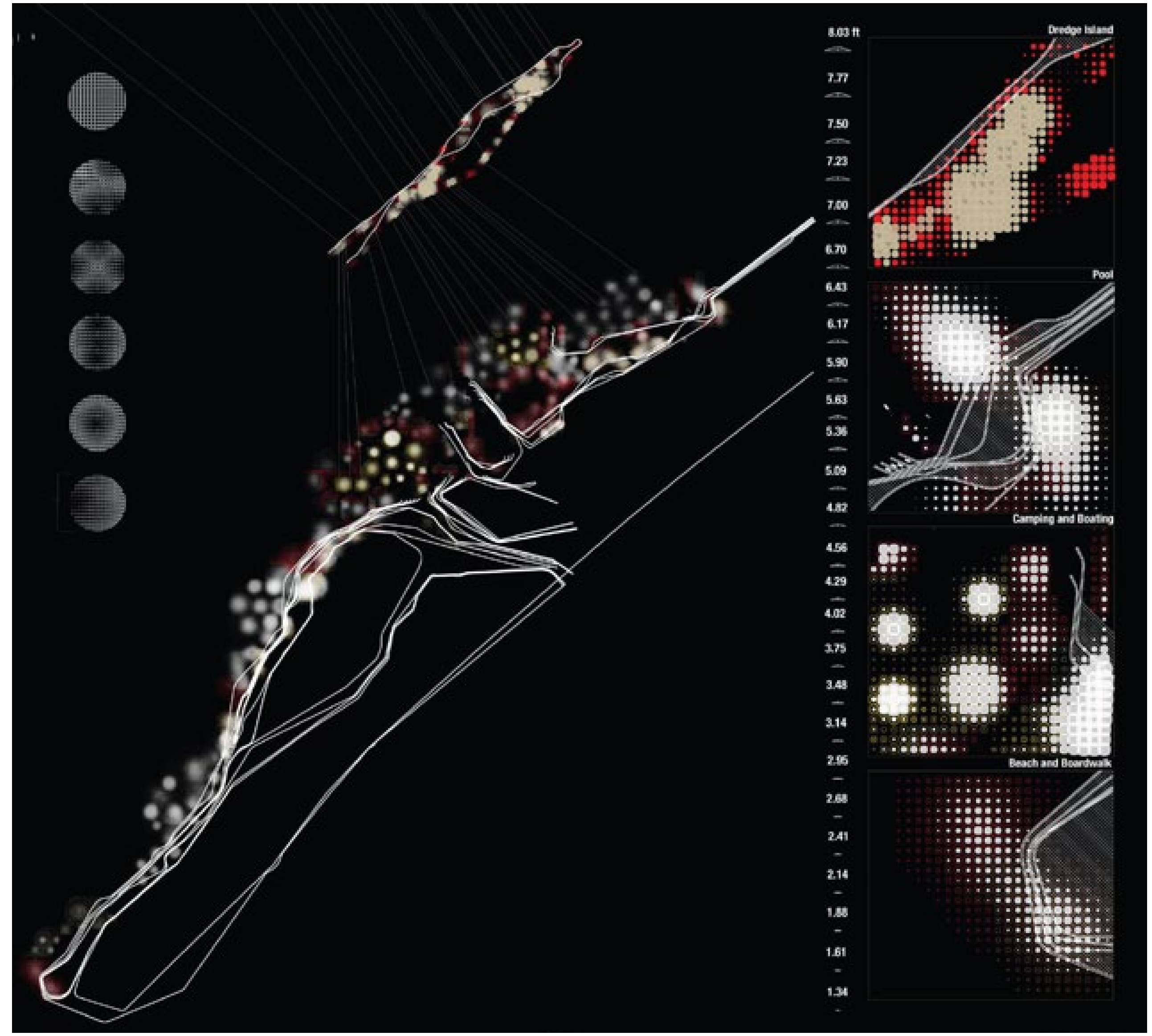
2009

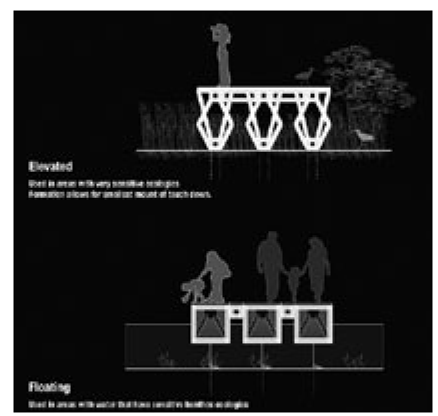
MUD re-envisions the public realm as an environmental infrastructural and social network by mobilizing excess dredge material. A wetland trust and not-for profit collaborative of the communities on Galveston Island manage the bay-side construction of new leisure zones and wetland habitats. Currently, the intercoastal waterway from the Galveston Causeway to Bastrop bay is dredged every 3-4 years, with most of the material deposited along the channel. MUD reworks this process by pumping the material the maximum feasible distance to closed temporary islands in the bay where the material can be remediated while providing habitats. As material accumulated is cleaned, some of it can then be pumped onto the bay side shore of the island, producing a linear eco-park that mitigates wetland erosion while providing low intensity program for the communities on the west end and substituting standard development with ecological and economic use. Elevations of the land and clustering of the mounds can be modulated to induce ecological succession and induce programmatic potentials.

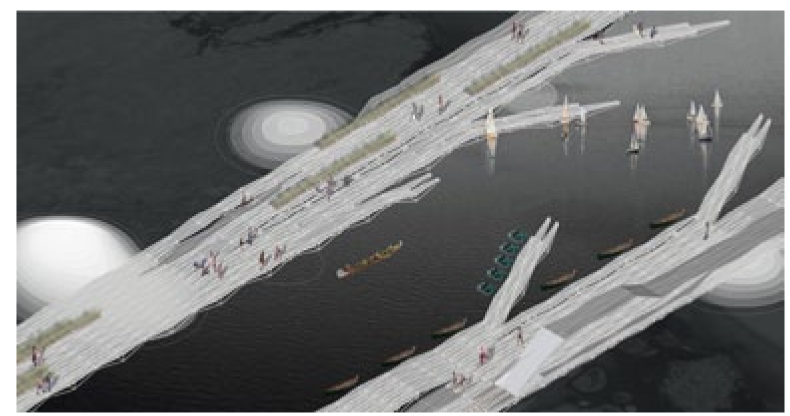




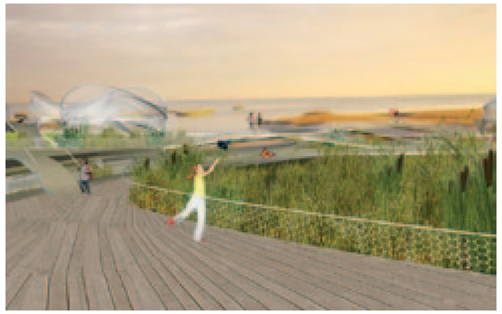
Modulation of mound clustering, size and elevation produces different programmatic potentials



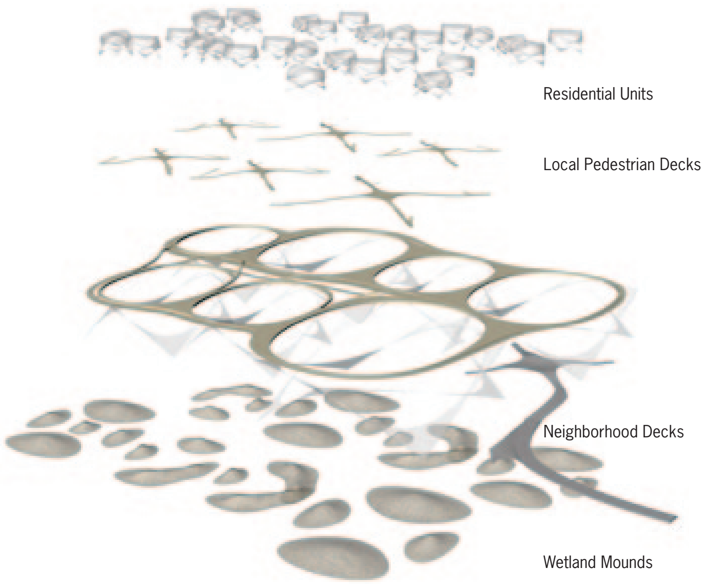




Boardwalk can link different areas and allow interface between water and land



Site Plan



Exploded Axonometric of Systems

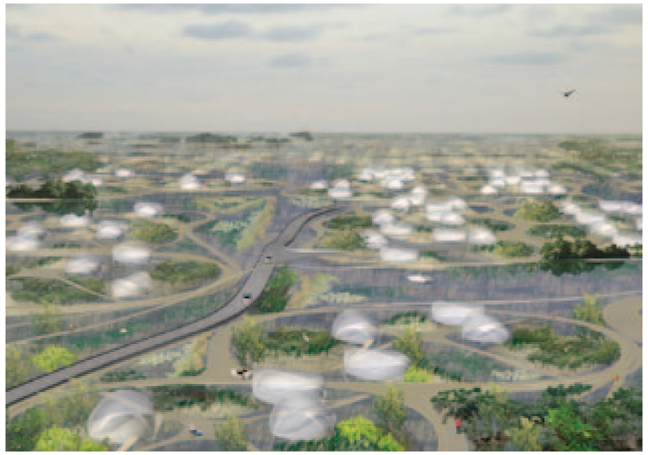
The Living (Dr)Edge

Lindsay Harkema, Seanna Walsh

2008

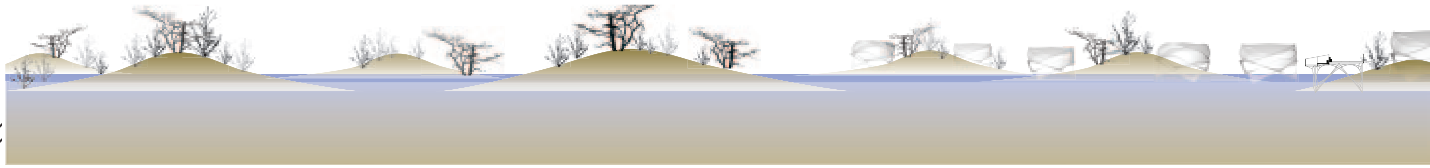
Wetland banks trade wetland resources as credits for development elsewhere–a landscape version of carbon trading, preserving these high value ecological value zones by turning undevelopable land into an economic resource. This project proposes that a community incorporate itself as such a wetland bank, producing a revenue stream to preserve existing wetlands and planting new wetlands into the bay.

Modulated fields of mounds of dredge material create water channels, wetland and upland areas. The larger mounds allow for lightweight prefabricated monocoque housing units. This structure allows the houses to be designed in consideration of storm wind forces and the effects of salt and sand in the air. These housing pods are clustered and linked with pedestrian walkways, creating a lattice that performs as an extended, semi-public deck surface over the wetlands and provided access to boats and cars. The result is a community with a light footprint and unique atmosphere.



While in conventional development no construction is allowed in the wetland zone, in this proposal everyone lives in a manufactured wetland. Rather than try to vainly protect one's lawn and property from encroaching wetlands–which as a result are seen as threats to wealth– here all the owners are equally invested in the wetland bank and gain increasing value as the wetland proliferates.

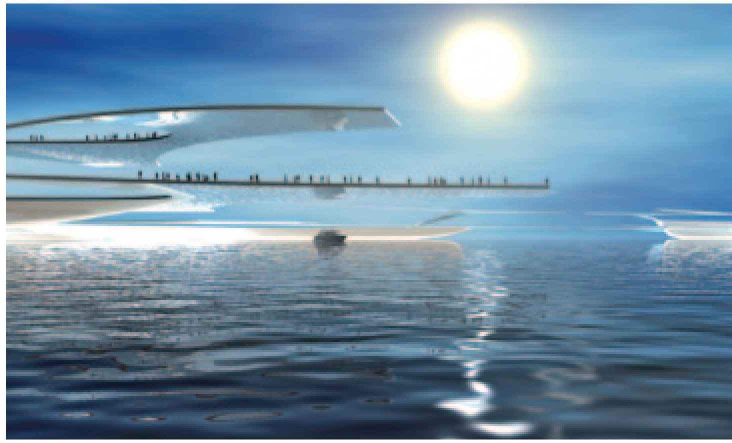
Section

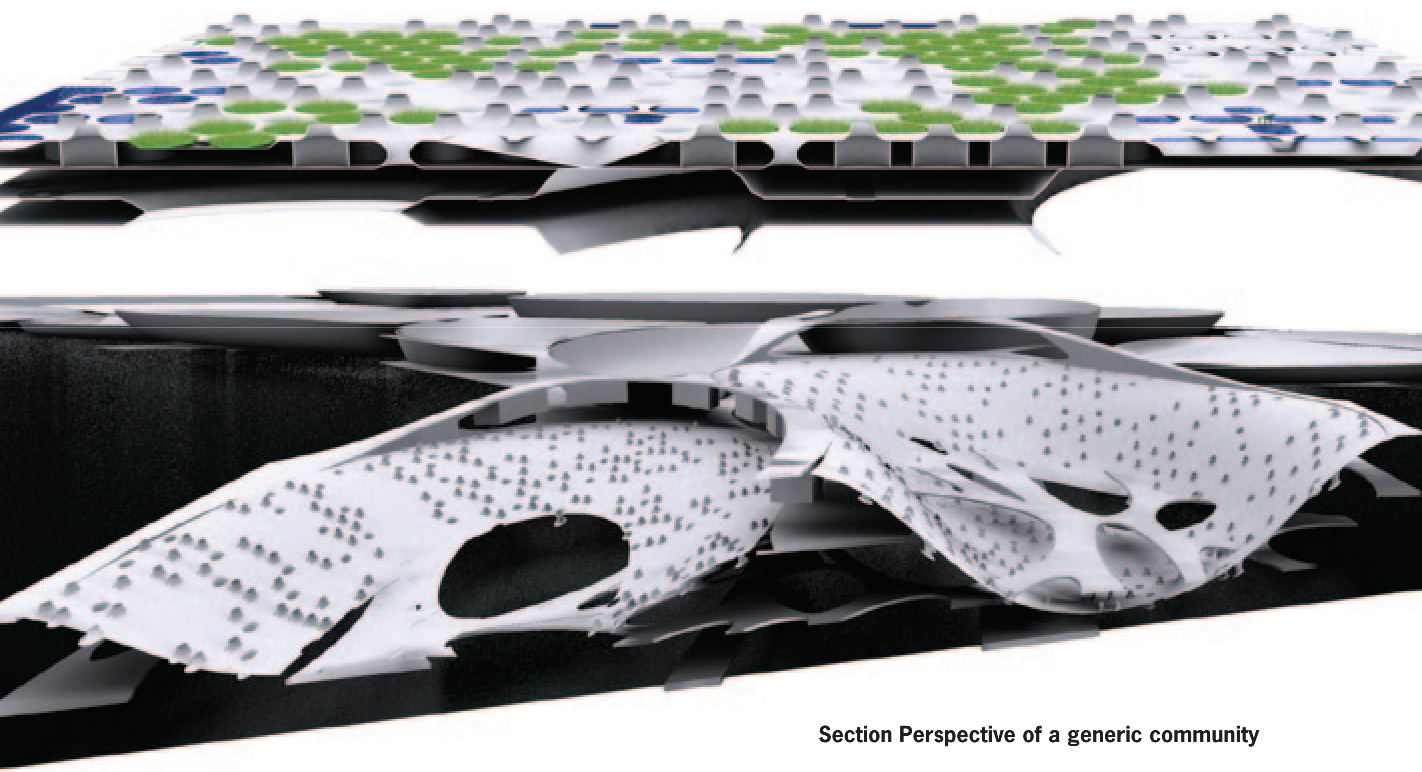


Hyper Galveston

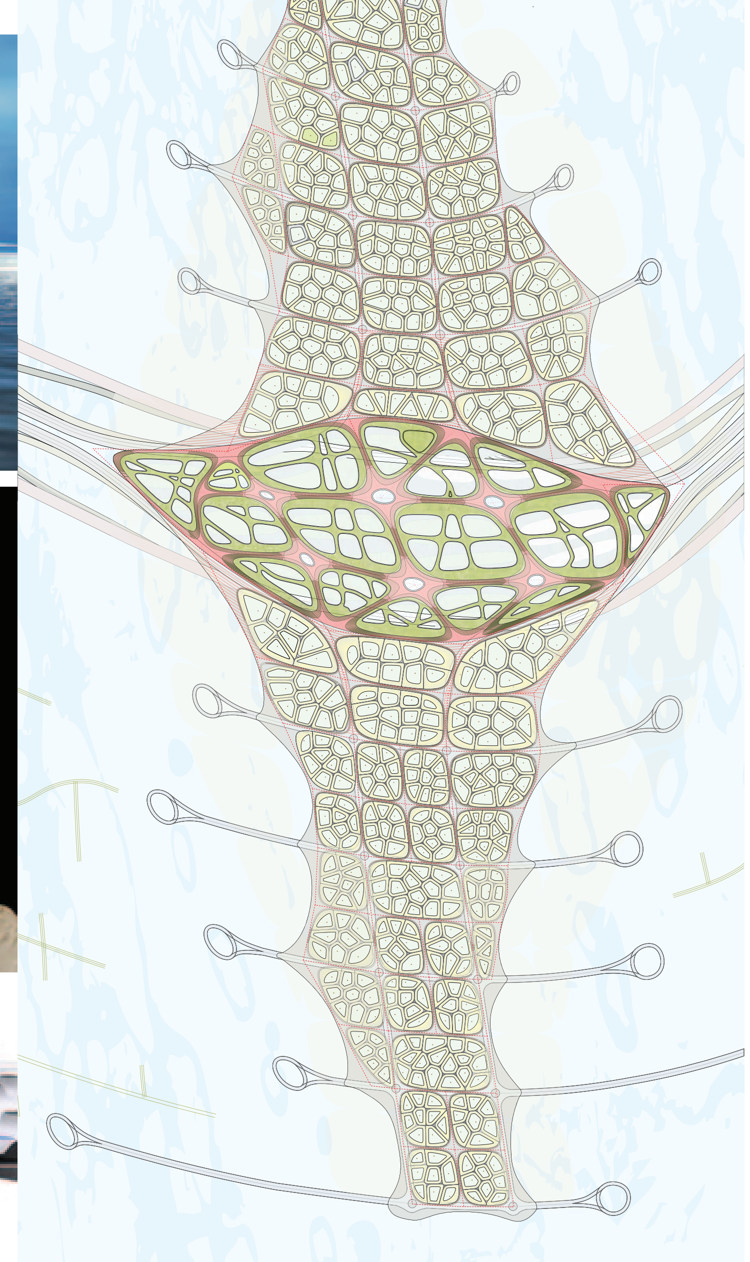
Donald Hickey, Joseph Nash, Theodore Prophete
2008

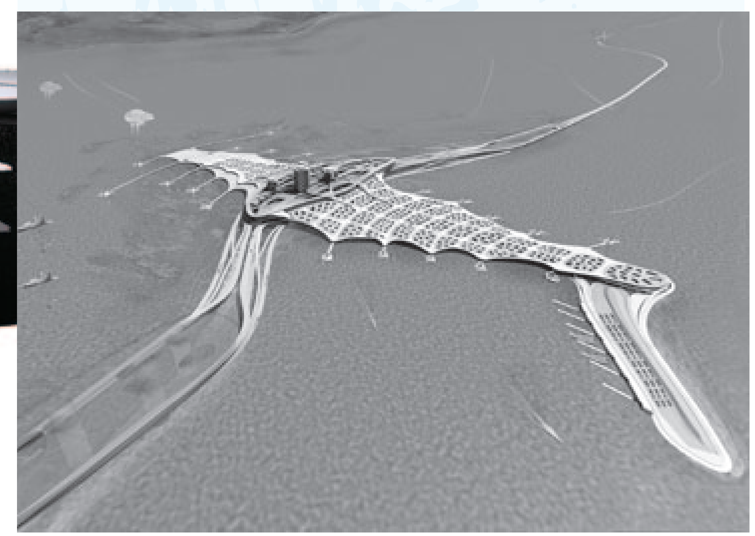
The scenario guiding this project assumes the worst-case of sea level rise and storms such that by the end of the 21st century much of the west end of the island as well as low mainland coastal areas have become too risky for development. Population growth around Houston and a persistent desire to live on the water's edge leads to the construction of an inhabitable bridge to eastern Galveston within commuting distance to new urban centers along Houston's beltways. A layered network of arched roads provides connection and support of discreet "neighborhoods" that replace lost West End communities in a thickened surface that protects from extreme heat and erratic weather. The top of each area provides an open green space for recreation, for the collection of valuable fresh water, and for intensive farming. Skylights and openings provide illumination and ventilation. Service workers are housed in large dormitories deep within the structure while larger programs, such as retail, occupy the space under the roads and link neighborhoods to each other.





Section Perspective of a generic community

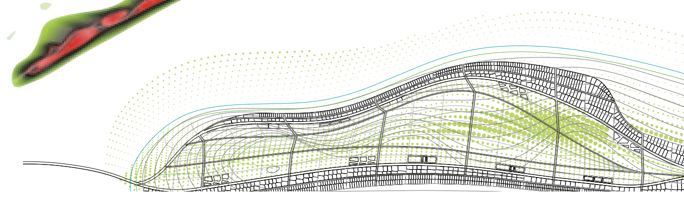




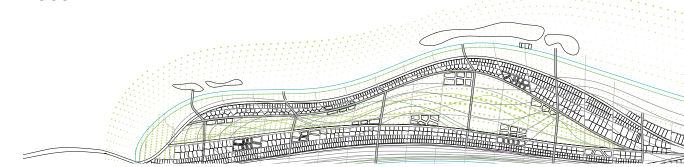
Bridging the Gulf

Jinge Chai, Genevieve Rudat
2009

Depending on storm activity and climate change, in a hundred years Galveston may not be one but many islands. This project imagines re-purposing obsolete offshore platform technologies for the construction of eco-tourist communities along this line of archipelagoes. The highway will become a road and rail causeway linking discrete communities to the mainland. High density condos and hotels occupy the center of each island, while wind and wave energy farms, shipping terminals and marinas outline remaining land, supplemented by dredge deposits, that provide natural habitats, beaches and other landscapes.



2009



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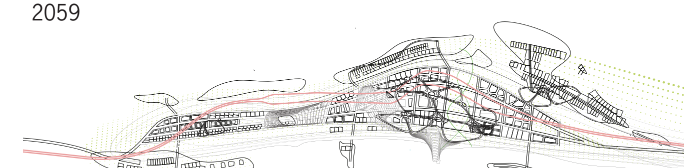


2100

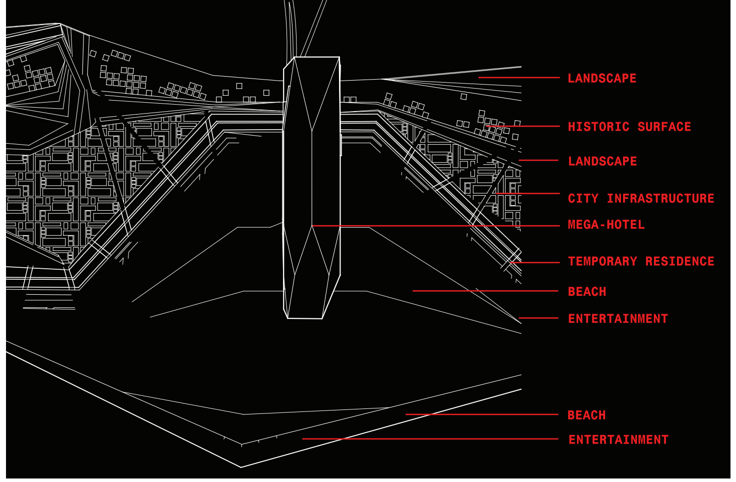
Galveston, 2100
These diagrams were made by projecting the existing geohazard map of the region into the future, taking into account the historical frequency of major storms, higher than average sea-level rise and ongoing processes of shoreline retreat and wetland loss. The result is a series of archipelagos.

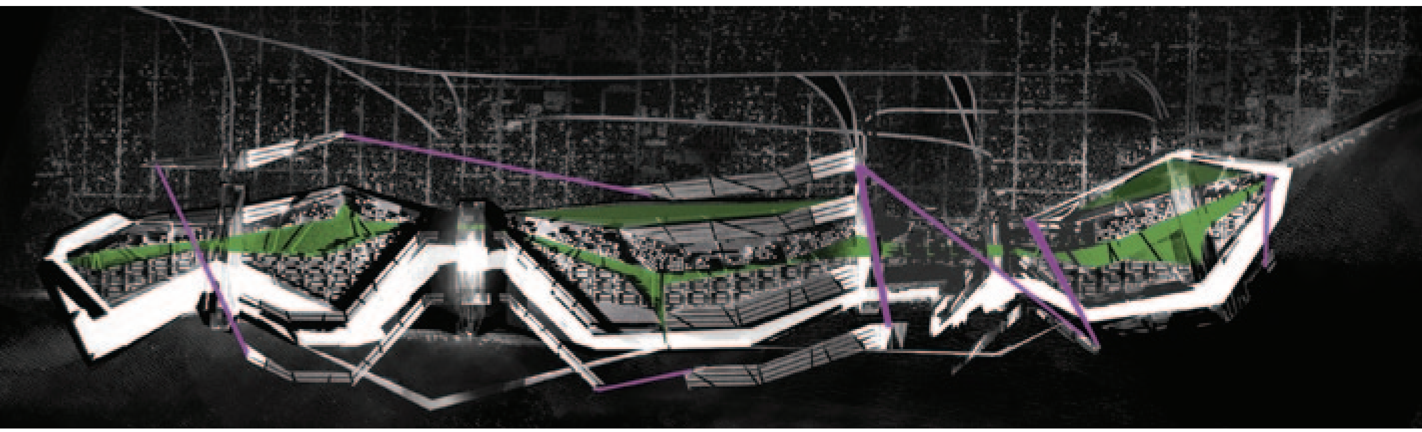
Syn-City

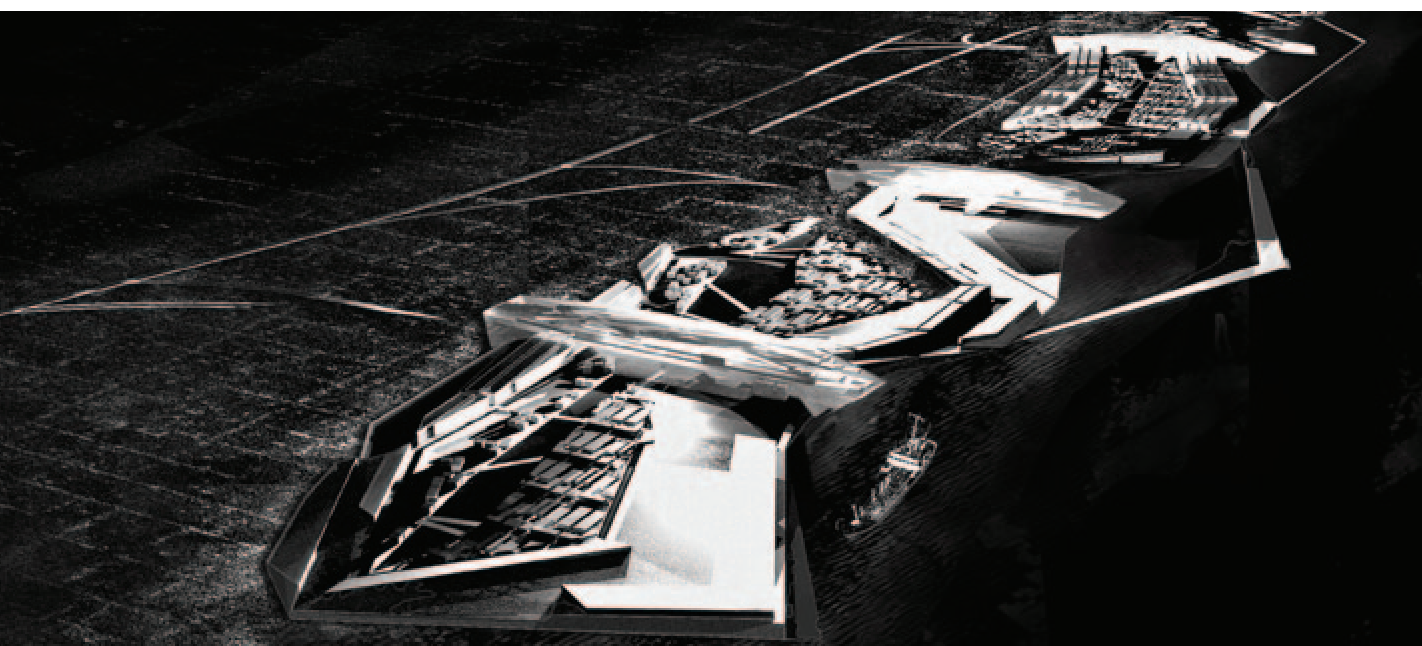
Katie Morgan

2010

Like the ghost from the future in Dicken's *A Christmas Carol*, Syn-City offers a haunting, dystopian, projection of where current development trends may lead if left unchecked. In the future imagined by Syn-City, policy driven by short-term property tax revenue leads to gradual decline as population and land is lost to storms and shoreline retreat. Eventually, a private developer buys out the city, creating a resort on the raised and reinforced areas along the seawall. In its completed state, Syn-City comprises several zones, each anchored by a mega-hotel and casino. Historic buildings are relocated between ribbons of green recreation and resort programs. This theme park of the city's past still hosts the annual Dicken's On the (Recreated) Strand festival while the rest of the city withers outside this fortified enclave.





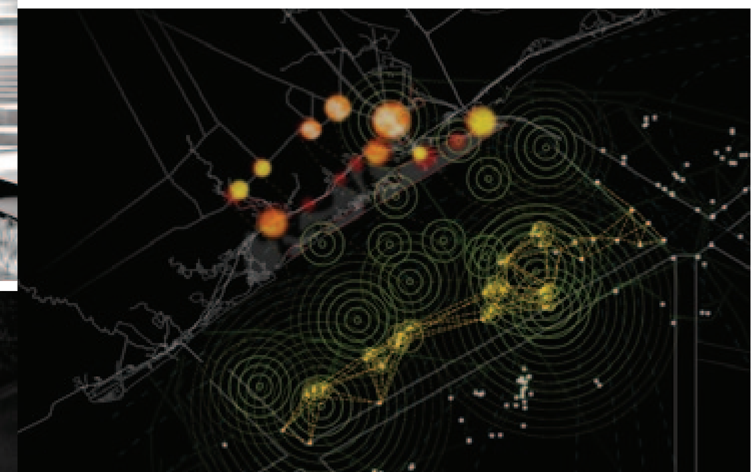


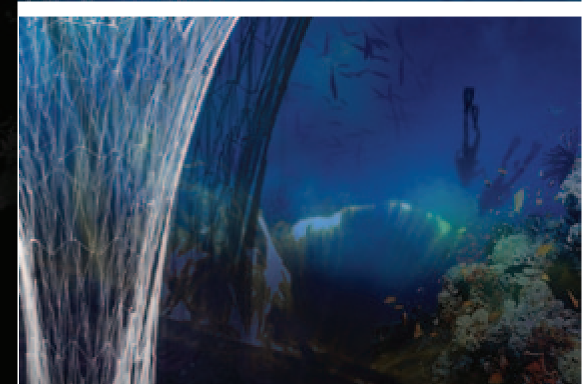
All Tomorrow's Parties

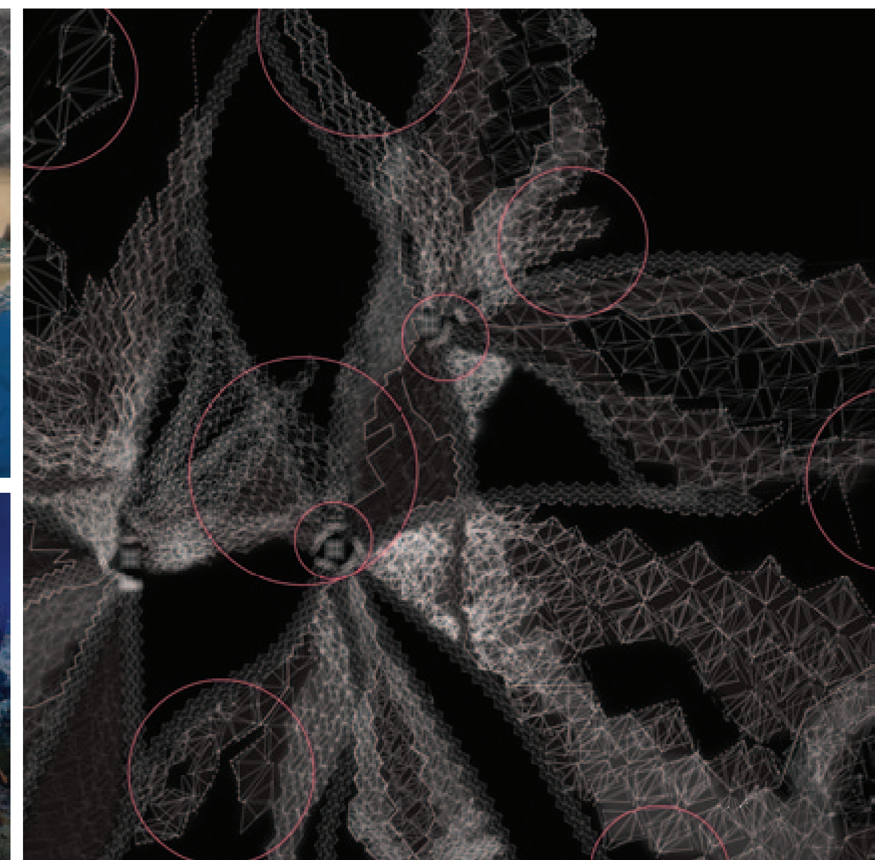
Alberto Govela, Asma Husain

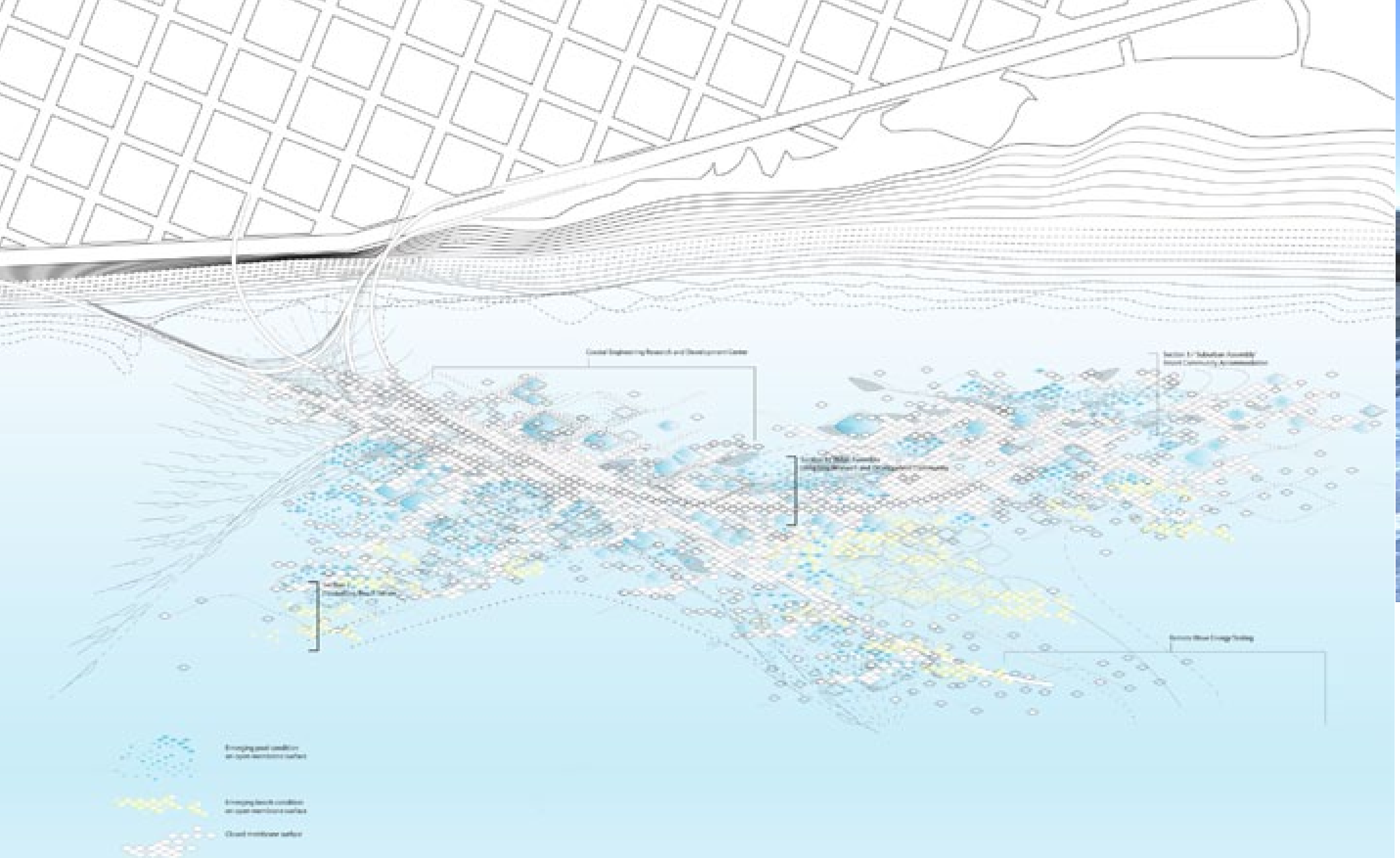
2008

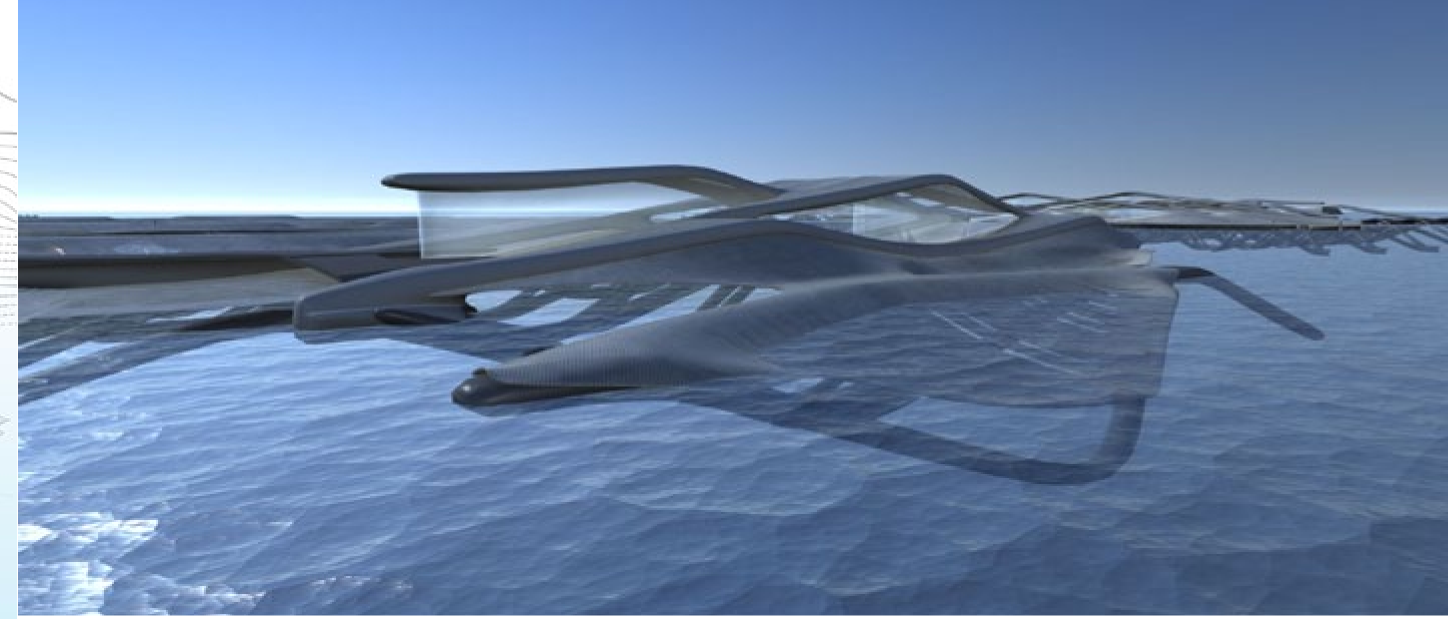
In the scenario imagined by this project, climate change and increased hurricane activity renders most of the coastline uninhabitable. A global economic and energy meltdown following peak petrochemical production means that oil and gas platforms will not have been dismantled. Meanwhile, most natural coral reefs will have been destroyed by climate change, over-fishing and pollution. The ruins of the rigs in the shallow and warm Gulf waters could provide artificial reefs for the recovery of fish stocks and a gastro- and eco- tourist epicenter where people flock to see – and taste – fish for the first time. Exclusive resorts will be located on isolated platforms, accessible only by air or sea. Larger resorts will occupy tensile bridges between platforms. These will also provide wind and wave farms. While the rest of the world endures energy rationing, a surplus of electricity encourages the proliferation of squatter cities for those who see little reason to return to the mainland and who cannot afford to stay in the rig-reef hotels. Anything goes as the super wealthy and energy nomads mingle beyond governmental jurisdiction.









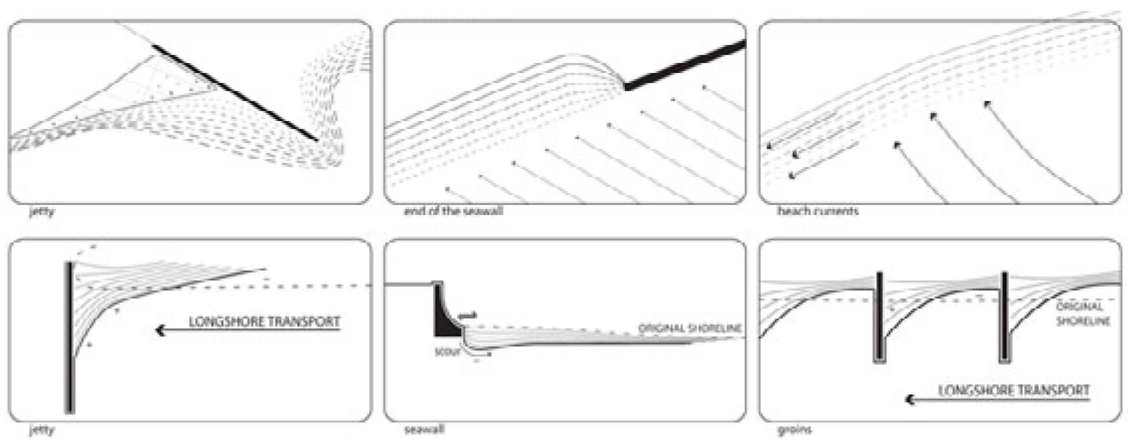


Temporary Program on the waterfront

Energe(ne)tic Fields

Nkiru Mokwe, Viktor Ramos

2007

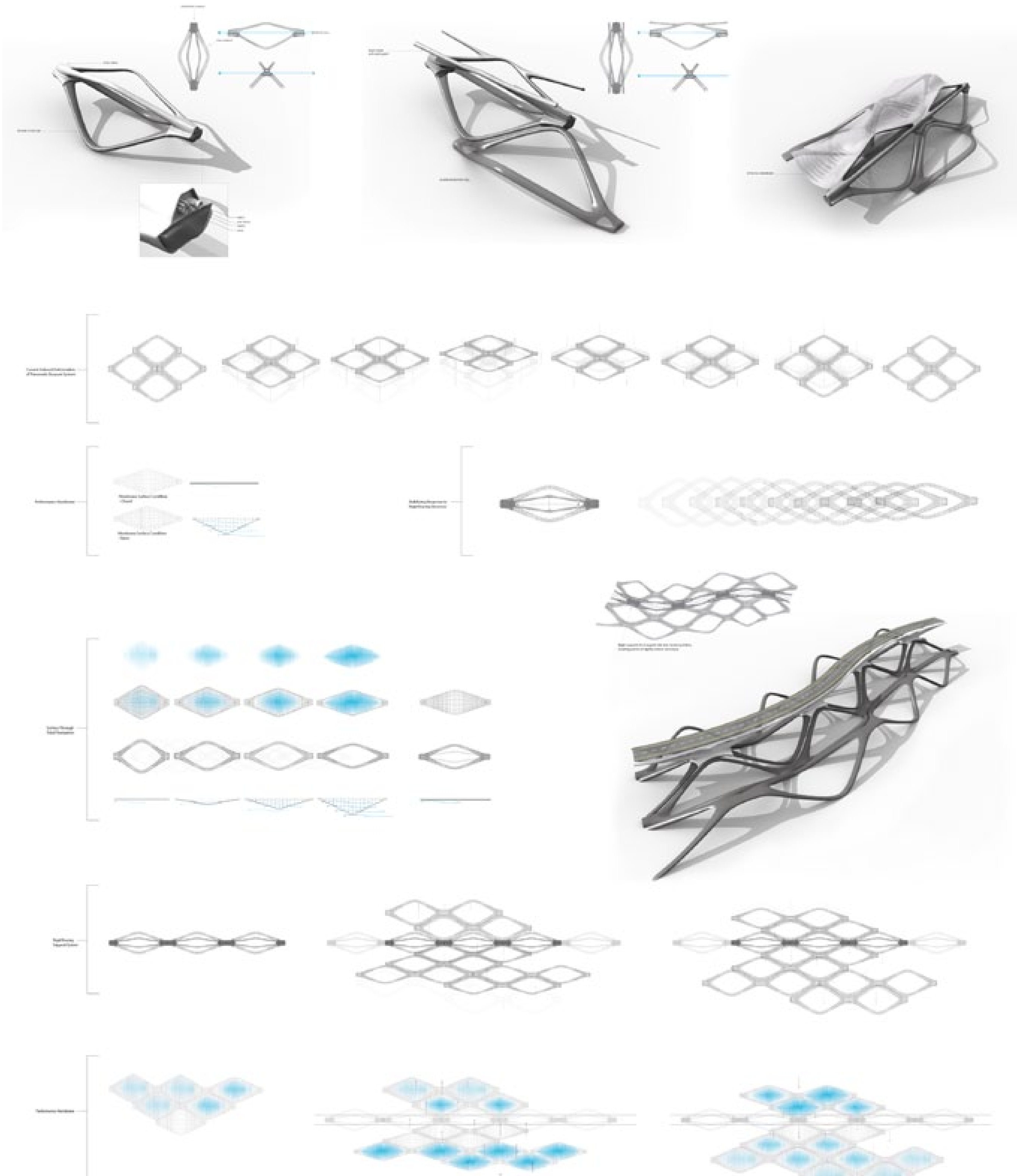


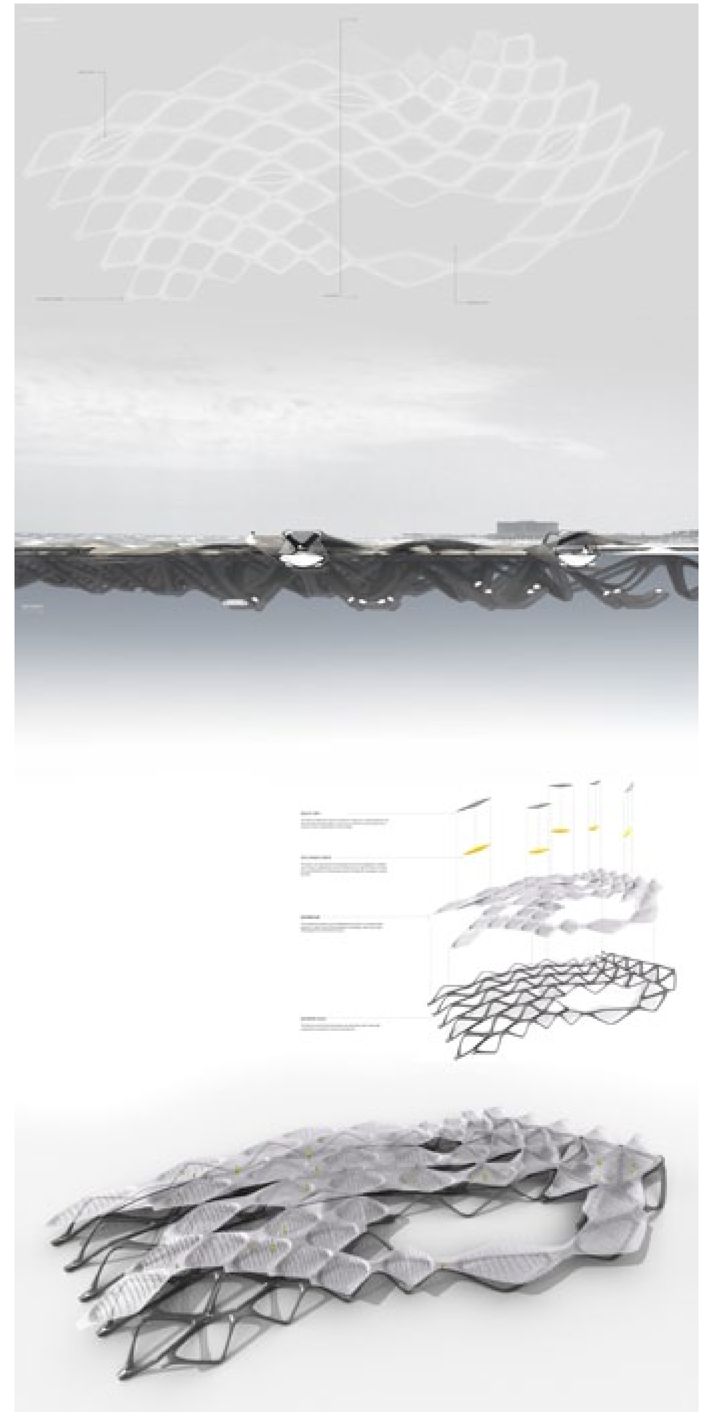
Top: Offshore Activity Landscape
The project protects the main public beach while radically increasing the amount of water edge and program. The space between the new structure and the existing beach becomes an intense zone of activity. Different parts of the landscape are modulated to produce different atmospheres and promote a diversity of use.

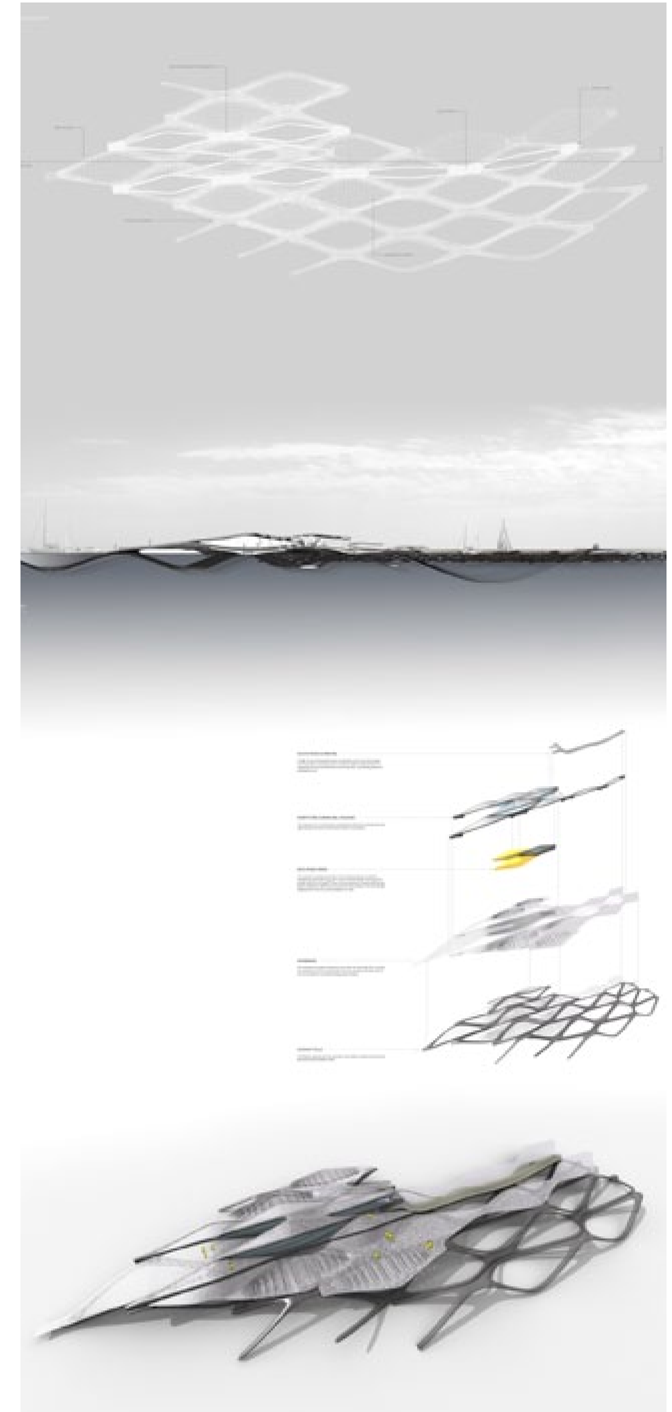
Bottom: Existing strategies to deflect wave energy
All of these hard structures attempt to dissipate or deflect wave energy, but often with entropic side effects such as accelerating shoreline retreat. To compensate, all require continuous inputs of extra energy, such as maintenance and beach nourishment. Therefore, in some ways even these structures are always in a state of flux.

During a storm event or tsunami, we become well aware of the vast amount of energy associated with ocean waves. In the 1900 Storm, the storm surge crushed the first rows of buildings, which then formed a mountain of debris slowly pushed landward by the storm waves, literally grinding the city beneath it. Indeed, hard structures like sea walls and groins are designed to dissipate or deflect this energy, preventing damage. The forces of the ocean are seen as something to be protected against, resisted at all costs–literally. However the vast majority of time, this energy is simply deflected by the massive structures.

The project utilizes a buoyant structural module to create a floating offshore community. Multiplication and differentiation of the module allows the system to interface between the motion of the water and the programmatic demands at particular locations within the structure. These include enclosed space for housing, roads for access, and beaches and pools for leisure activities. In addition to these modes of occupation, the structure integrates technology that allows it to transform energy from waves into electricity for itself. Through research and mapping, the team drew the island as a progression from static forms to dynamic forces and used this conception to drive their criteria for site location. In contrast from the other projects, this one is sited in open water as opposed to on land; here site is constructed as a nexus of forces (tides, currents, winds) as opposed to a physical location. This also provokes the notion of the boundary or edge of the system, as there are no physical or legal constraints confining the molar extent of the form. Therefore the general form results from the intrinsic growth properties embodied within the system and its ability to support infrastructures and programs that must commingle upon and within it.

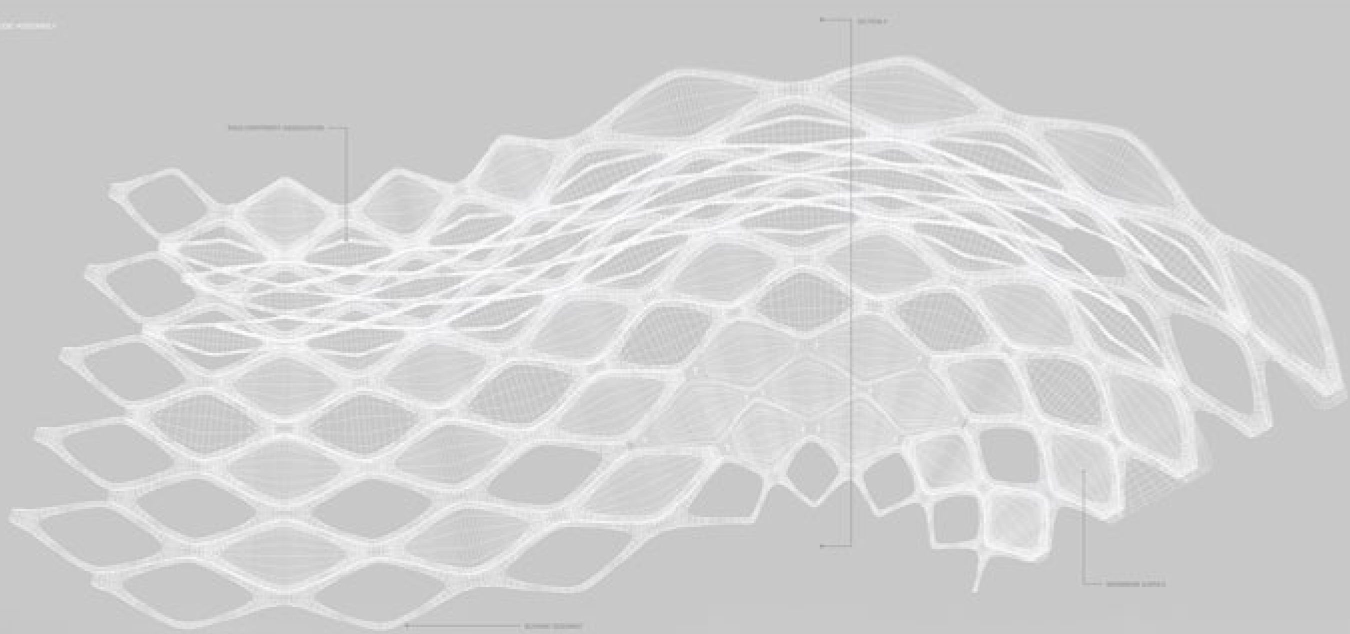




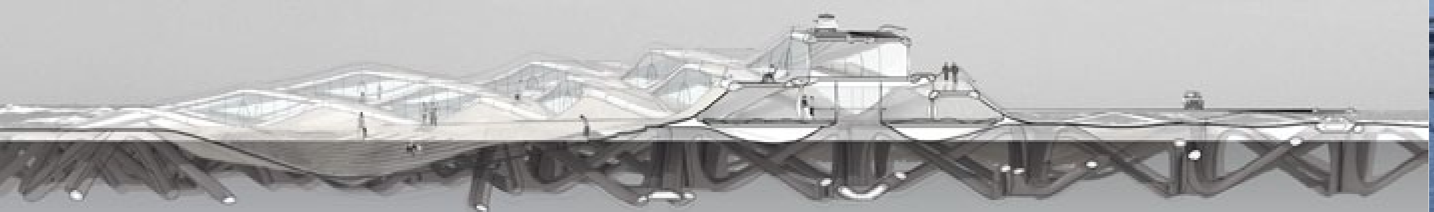


Opposite Page: Material Logics
The landscape is produced by a component system that serves as superstructure with a combination of rigid, pneumatic and buoyant elements that imbue structural performance and allow the surface to alter according to tide and flex during storms. Services are woven into the structure, which also captures wave energy.

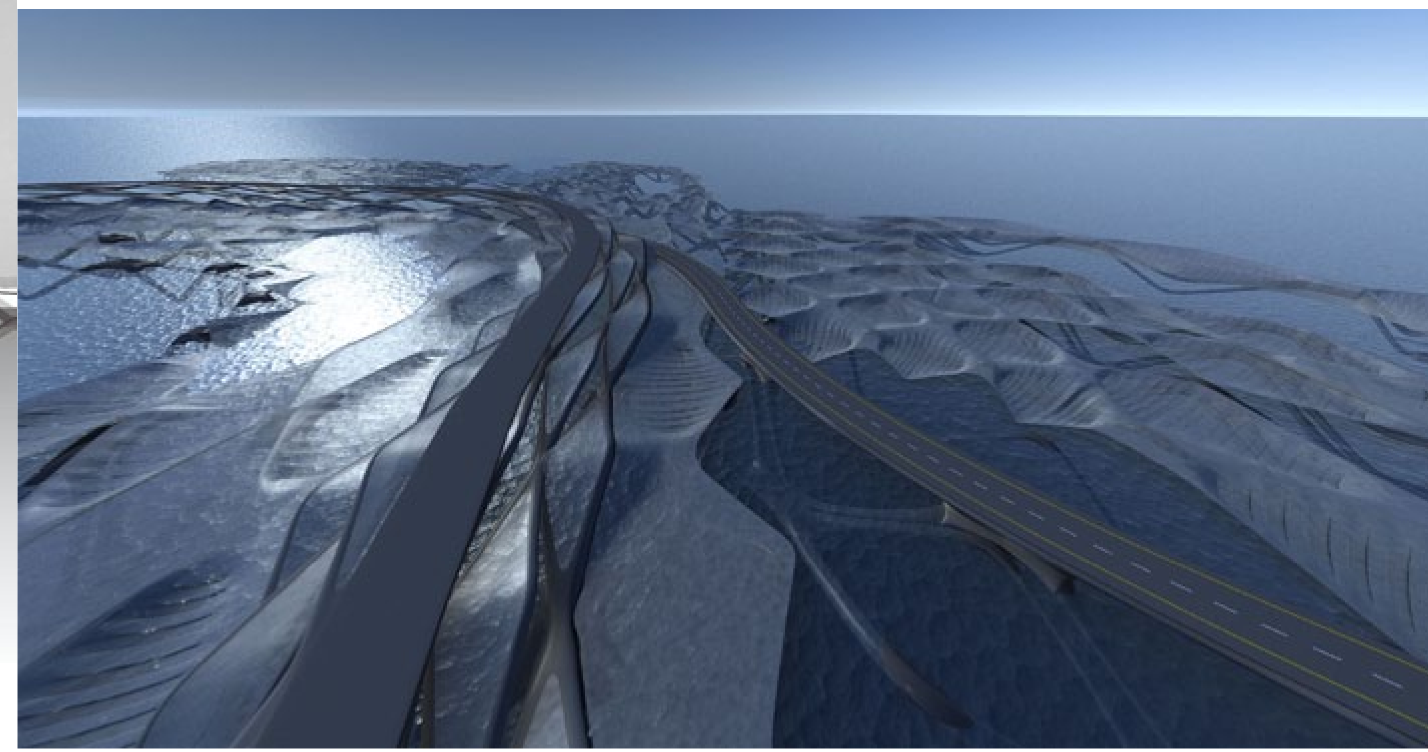
Above: Modulated Activity Zones
The material systems can be modulated to produce more rigid and enclosed space or more pliant surfaces, fostering a diversity of ways to occupy the water's edge. Secondary systems and vehicular access are accommodated through delamination and additional surfaces. In places, the surface is perforated with slits to allow water to form tidal pools.



Partial Diagram



Section of Beach and Ridge

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