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A site design in a hurricane prone coastal environment: Grand Isle, Louisiana case study

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A SITE DESIGN IN
A HURRICANE PRONE COASTAL ENVIRONMENT:
GRAND ISLE, LOUISIANA CASE STUDY

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ABSTRACT

The property owns by Grand Idle Port of Commission with its unique combination of coastal and wetland landscape, the richness of environment and the susceptibility to hurricanes give opportunities as well as limitations in developing the site. A respond to this fragile but rich environment is a sustainable planning and design that balances the site programs and environment sensitivity. An ecologically, socially, economically, and aesthetically sound will provides an opportunity to achieve the optimal uses of the natural resources while maintaining the environment sustainability. The master plan of Port of Grand Isle addresses the client's programs expectation and enhances the programs to obtain an optimum use of the site potentials. Four major programs that vary from research to non-research are applied to promote the property as a demonstration site of sustainable environment planning. The master plan that consist of a marine research center, a commercial marina, a coastal plants nursery, and a wetland center has addressed ecological, social, aesthetical aspects and yet economically benefit the local community. The result shows compromises between human needs and an appreciation to the environment and natural resources as part of human life that need to be protected.

CHAPTER 1. INTRODUCTION

Background of the Study

Grand Isle is one of Gulf of Mexico's barrier islands. The island has a unique combination of marshland and coastal landscape combination. Despite the susceptibility to hurricanes, Grand Isle has always been a popular recreational attraction and vacation destination for the south Louisiana residents. The marshland and coastal landscape of Grand Isle have significant economic and natural value (Gary and Davis, 1979; Viles and Spencer, 1995). It also has importance value on its landscape scenery of wetland and coastal at the same time. This landscape scenery, according to Kay and Alder (1999) has an economy benefit. The beauty of the ocean view of the island has continued to attract visitors and seasonal residents. Meanwhile, the beauty and richness of the wetlands has not been explored to attract visitors.

In addition to the on-land attraction, the Grand Isle coastline offers excellent fishing opportunities. Grand Isle has been famous as a fishing destination among Louisiana residents since 1930's. During the fishing events, such as the Grand Isle International Tarpon Rodeo and the Fourth of July festivities, the population of the island reaches 12,000, compared with a 1,500 population during the off-season. The fluctuation in population between fishing season and off-season show how the coastal resources can be inviting for people.

The atmospheric and oceanographic energy, such as hurricanes, storm surge, storm waves, and winter storms make a barrier island highly susceptible to wave erosion, overwash, long shore drift, flooding, flood scour, wind damage, and sand movement. The geology of barrier islands make them unusually sensitive to changing and alteration caused by natural forces and by human activities as well. Human contributions that change or damage the natural setting environment are not always intentional. Constructing jetties and bulkheads, dredging channels and finger canals, flattening dunes, removing protective vegetation, and unwise sitting of buildings, roads, and utilities increase the possibility of negative impacts to both natural systems and human life. Stopping humans' use of coastal resources and barrier islands entirely may not be realistic and possible. Instead, humans should use their scientific knowledge and experiences from the past to develop better living environments while eliminating the

potential negative impacts. Human settlements and all additional man made structures should be planned to provide recreational and economic benefits without compromising the environmental sustainability of the fragile barrier island and other coastal resources. The sustainability of resources requires ecological, social, economical, and aesthetical considerations are balanced and incorporated into planning and design. A success sustainable planning and design requires public support to the idea and the application of the idea. One way to generate public support is through public education and demonstration of applicable sustainable practices on the site. This means to provide places where public can visit, see, and learn the values of the natural resources.

Problem Statement

Grand Isle Port of Commission owns a site about 32 acres on the bay side of the barrier island. This piece of land has a landscape consisting of live oaks habitat that still remains adjacent to marshland habitat. This combination offers a unique habitat that function as a shelter for the migratory birds during their trip across Gulf of Mexico in spring.

The Port of Commission has leased a parcel of about 7 acres on their property to the Department of Wildlife and Fisheries (DWF). The DWF has announced a plan to move the Marine Research Laboratory that is currently located at Grand Terre, to this site. Moreover, in addition to research activities, Port Commission wants to include other activities that have educational, economic values, and possibly recreational. In other words, the general site program will have two major elements: research and non-research. Research activities tend to favor site preservation, protection, and minimizing use and access by public. Economic and recreational uses of the site (such as desired coastal plants nursery) sometimes may be in conflict with the research program. The optimum use of the site requires a thoughtful planning and design to solve the potential conflicts among the research and non-research uses. Therefore, it is the intent of this thesis to develop a planning and design study that would provide the Port Commission with the appropriate development and alternative uses for this 32-acres site.

Objectives of the Study

1. To develop site planning and design alternatives that are ecologically, socially, economically, and aesthetically sustainable.

2. to develop site planning and design alternatives that successfully accommodate proposed research and non-research activities on the site
3. To explore relationships between architectural and landscape architectural programming in the site planning and design process in a sensitive natural setting.

CHAPTER 2. LITERATURE REVIEW

Introduction

I began the design process by conducting literature review pertinent to the subject of planning and designing in a hurricane prone area. The purpose of literature review is to have better understanding about hazards, danger, limitation, and positive values as well of barrier islands.

Barrier Island

Definition and Formation

Pilkey et al. define barrier islands as elongate bodies of sand bounded on either end by inlets that allow salt and fresh water to flow into and out of the estuary behind the island (39). Barrier island formations occur from four factors, which are a rising sea level, a large sand supply, gently sloping coastal plain, and adequate wave energy to move the sand (Pilkey et al. 39; Clark 234). They are also mobile geological features as the result of erosion and deposition. Barrier islands move accordingly to the changing condition, inland or seaward and up or down the beachfront (Clark 234).

In most cases, the creation of present barrier islands of the world was a result of sea level rise that began about 10,000 years ago during Holocene transgression time (Pilkey et al., 40). A vast amount of glacier caused the sea level rise and covered large areas of land. From that time, the sea level rose about 100 feet to its present level. In order to have a better understanding of how barrier islands were formed, I have combined the explanations and redrawn the process of barrier island formation adapted from Pilkey et al. originally drawings (41,43) into a series of barrier island formation and its dynamic movement in graphics and short explanation about each process (Figure 1.).

The Migrating Islands

According to Pilkey et al., once a barrier island is formed the process of migration and shape changing takes place. Those barrier islands develop in different ways and rates in response to the natural forces of waves, wind, overwash, shoreline erosion, and flooding. The tendency of barrier island migrating landward is one of a natural process that occurs time-to-time responding to the rising sea level. In most cases, the barrier island maintains its existences because the mainland shoreline also happens to have flooding and shoreline erosion that keep barrier islands from attaching to it (41-48).

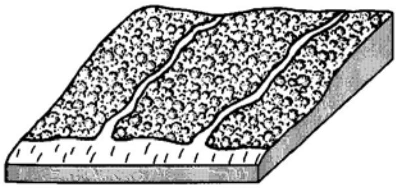
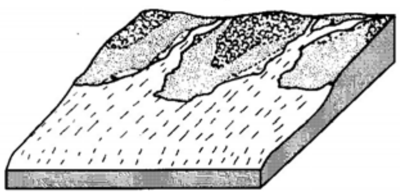
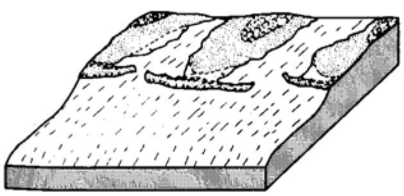
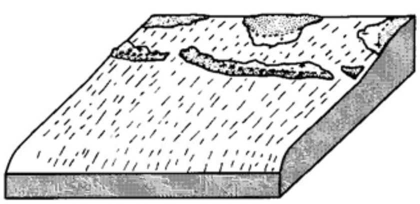
 Stage 1: Low sea level at peak of glaciation	Straight coast forms during lower sea level.
 Stage 2: Flooding of river valleys	The seawater started to rise and flooded the river valleys, transforming a straight coast into a sinuous coast. The indentations are called estuaries.
 Stage 3: Formation of spit along headlands	Nature dislikes the crooked shoreline, therefore the ocean tried to straighten out the shore. The process continued as the waves attacked and eroded the upland, on the protruding headland, thus producing sand to form spits that extended into and across the former river valleys' mouth. Those spits gained elevation from sand blown in from the beach and washed in by storm waves.
 Stage 4: Separation of barrier from mainland	As the big storm came, the spits are breached, new inlets are formed, and there is a chain of barrier islands between the ocean and the sound.

Figure 1. Barrier Island Formation

(Source: Pilkey et al., 1998)

There are four events that happen repetitively on an island in order to migrate. Pilkey et al. clearly describe each process as it happens by time in the following paragraph (44-48).

The front (ocean) side must move landward via shoreline retreat. The sea level rise is the main reason of a beach retreat. Another factor is the lack of sand supply from rivers. Humans' careless activities or intervention are major causes in the sand supply deficit. For example, dams on the Rio Grande and the Brazo River cut off the sand supply to the barrier islands off the coast of Texas and cause the beach to erode rapidly. Seawalls, groins, offshore breakwaters, and deepening of channels also contribute to shoreline erosion.

The back (sound) side may move landward by landward growth (island widening). Tidal delta incorporation and overwash is the agent of sound side widening. Tidal currents movement in and out of the island inlet brings sand that creates tidal deltas. Ebb-tidal delta and flood-tidal delta are formed from the process. In most cases, flood-tidal delta eventually becomes part of the island when the inlet between islands migrates or closes. As the inlet migrates, sand from the river continues to pour into the estuary. Thus, it creates a series of new flood-tidal deltas along the inlet migration path. This process generates only certain portion of the island is widened, which is along distance of the inlet shifting (Figure 2). Another island widening process happens through overwash that carries sand across the island and deposits it in the sound. This process happens mostly on narrow island about few tens of yards wide and on island without dunes to block the overwash.

The island must continually build up in order to maintain its elevation above a rising sea level. Dune formation and overwash fan deposition are two processes involved in maintaining island elevation while it is migrating. Wind forms the dunes that heighten the island elevation. Meanwhile, waves from the continental shelf increase an island elevation build up by depositing a large supply of sand from the adjacent shoreface. Therefore, low elevation island does not form dunes because of the poor sand supply from beach.

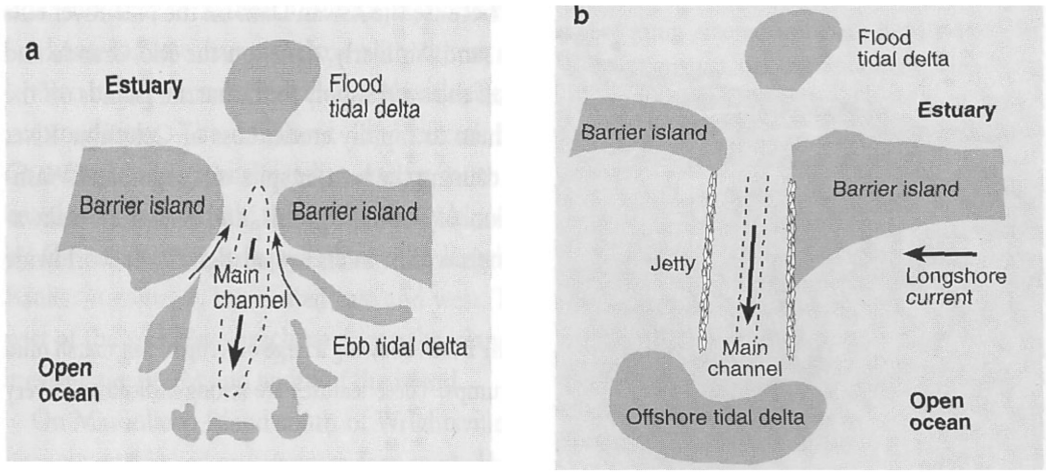


Figure 2. Tidal Delta Creation and Effect to Barrier Island
(Source: Pilkey et al., 46)

The mainland shoreline must retreat to keep pace with the island's migration. Sea level rises essentially also affect the mainland shore by flooding because the water level on sound side and estuary mouth is the same with open ocean side. Figure 3 illustrates a barrier island migration process in response to a rising sea level.

Coastal Barrier Hazard

Three major threatening natural forces to barrier islands are wind, waves, and currents. Pilkey et al. identify those forces to cause property damage and significant impact on barrier island environment. Unfortunately wind, waves, and currents are most likely to act at the same time and may generate secondary form of destructive forces. Form example, storm surge can be formed by wind pushes water or waves push water toward shore (33). The moving sea water contains a massive energy that causes flooding and possibilities of floating structures off their foundations. The danger still continues because the flood is now carrying the floating structures and debris. The floating and moving structures are recognized as a major cause of damage during hurricane season (Bush, Pilkey, Jr., and Neal, 22). Despite of causing property damage and economic loses, the flooding is also endanger human life. Haeussner estimation from about a dozen storms have accounted for at least 75% of the deaths occur from coastal flooding in the United States (67).

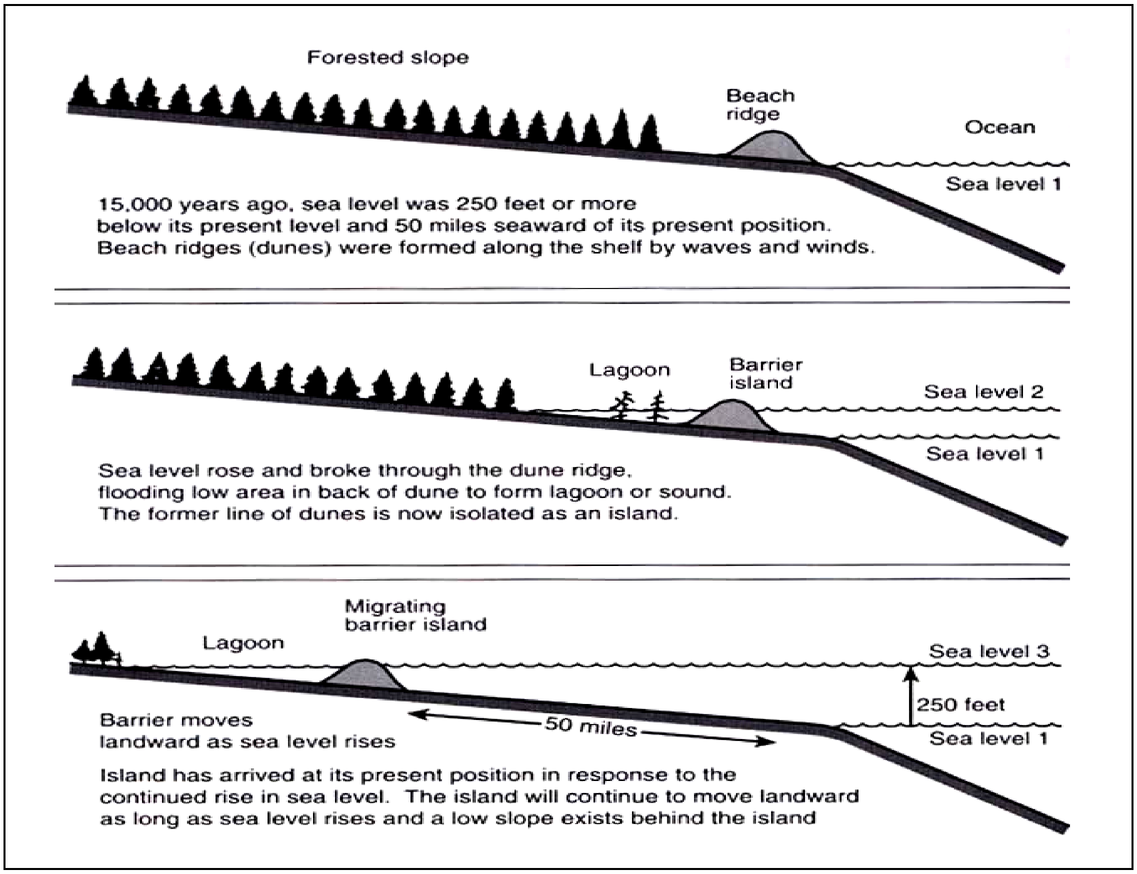


Figure 3. Barrier Island Migration Process
(Source: Pilkey et al., 42)

Recognizing coastal hazards is as important as understanding the natural forces and their effects on human safety and environment impact. The following table lists the type of natural forces and their effects on coastal zone, especially barrier islands.

Table 1. Natural Forces and Their Effects to Coastal Environment

Type of Forces	Effects
Storm Wind	• Direct wind attack on building • Flying debris • Sand onto/off island (burial or erosion) • Vegetation loss (blow down, salt spray kills, sandblasting of leaves)
Storm Waves	• Direct wave attack on buildings • Floating debris from buildings and attachments • Scouring around foundation footings • Shoreline retreat on lagoon shore (erosion)

	• Shoreline retreat on ocean shore (back beach erosion) • Overwash (burial and blockage) • Dune loss • Scarping of fastland (nondune) • Vegetation loss (erosion, saltwater kills) • Local flooding • Strong longshore currents, remove sand from area
Storm Surge	• Flooding • Floating debris (rafting) • Lagoon shore retreat • Ocean shore retreat • Widening inlets • Changing channel locations in inlets • New inlet formation • Increase zone of wave influence (elevates waves, moves waves landward) • Overwash (burial and blockage) • Scouring of cross-island channels and undermining of structures • Scouring around foundation footings • Vegetation kills (saltwater kills, including saline groundwater contamination) • Saltwater flooding impacts (sterile soil, groundwater contamination) • Drives offshore-directed currents, permanently removing sand from system
Storm-surge Ebb	• Widening inlets • Changing channel locations in inlets • Formation of new inlets • Scouring of cross-island channels • Scouring of offshore channels • Scouring around foundation footings and other hard structures • Emplacement of debris offshore (swimming and boating hazard) • Sand removal/permanent sand loss
Currents	• Transporting sediment (erosion or deposition) • Transporting storm debris to the coast • Transporting great volume of water toward shore
High Rainfall	• Water damage to buildings when coupled with high winds • Enhanced flooding • Enhanced erosion due to runoff

(Source: Bush, Pilkey, Jr., Neal, 19,22-23)

Non-Point Pollution

People deal with pollution in every part of the world. Herbicides, pesticides, industrial wastes, carbon dioxide, and many others have polluted the air, ground/earth, and water. Those pollutants one way or another will have impact on coastal areas. Clark clearly expresses his concern of the coastal pollution because of its location at the lowest portion of elevation. The coast eventually receives all land run-off water together with the wastes the water carries. As a result, most of the mainland's pollution ends up in coastal lagoons, estuaries, wetlands, submerged grass beds, and coral reefs (383).

A barrier island closeness to estuaries and its relative position to the mainland that creates a lagoon ecosystem make it vulnerable as a pollutant acceptance. The intensity of the pollutant impacts then will be determined by the coastal ecosystem carrying capacity. As stated by Clark:

> The effect of any pollutant depends on where it goes, how concentrated it is at the point of discharge, how rapidly it is assimilated or flushed out of the environment, and whether it can be dissolved in the water column or is chemically fixed to sediments. All of these conditions depend on water movement and circulation patterns, which, in turn, are governed by the relationship of tide and river, flow to estuarine shape and size. In many bays, embayment, lagoons, and tidal rivers, circulation is sluggish and pollutants may build up to a level that can cause damage, even with efficient treatment of effluents (383).

Clark suggested implementation of various land management approaches to solve the problem of coastal sea pollution. He believes that land surface sources of pollution are responsible for more than three-quarters of marine pollution. Another quarter comes from heavy industry, shipping, waste disposal, and offshore oil production (383).

The water pollution previously mentioned deal with problems along and adjacent to a coastal area. How about the water problem within a barrier island itself? According to Pilkey et al., people should be alert to the hazard of water contamination in a barrier island. This problem involves three factors, which are: water supply, waste disposal, and any kind of island alteration that affects water supply and disposal. Fresh water supply and availability becomes significant to barrier islands since the only direct source of water is from the rainfall if the municipal water system has not been installed to the island. The rainwater seeps into the porous and permeable sands and builds up as a lens or wedge of fresh water beneath the island's surface. This fresh water lens placed on top

of salt water that infiltrates the island from the nearby ocean, inlet, or marsh. Therefore, any construction activities such as dredge-and-fill operations may alter the fresh ground water system. A large number of wells will also decrease groundwater and then potentially increase saltwater intrusion (124-125).

Coastal Zone

The term “coastal” suggests the notion of a land-ocean interface. The coastal zone defines a transition space between the land and the sea. The environmental boundaries of the coastal zone have been varied from one government to another (Sorensen and McCreary, 5-6; Kay and Alder, 1-4). The coastal zone boundaries as suggested by Sorensen and McCreary (6) should stretch far enough both seaward and inland to encompass the requirements of the management program. The zone boundaries can be as narrow as immediate shoreline but also go far inland when a coastal area or zone is in serious threat from a source located further inland (Sorensen and McCreary, 6; Clark, 82). Kay and Alder (5) give example of a larger coastal zone is needed to address the issue of non-point sources of marine pollution that require an area of attention which covers inland catchments and groundwater outflow regions.

Clark suggests at minimum that a coastal area include (a) coastal lands that are affected by storms and flooding of the sea; (b) intertidal areas such as mangrove, marsh, deltas, salt flats, tide flats, and beaches; (c) permanent shallow coastal water areas such as bays, lagoons, deltaic waterways, estuaries, seagrass meadows, coral reefs, shellfish beds, submerged bars; (d) small coastal islands and other important nearshore features (82). The purpose of those minimum requirements is to create a workable management area for the coastal zone. It is also distinguished a coastal zone as a geographic area apart from the terrestrial or uplands domain.

Coastal Resources

Boundaries

Coastal boundaries are part of coastal resources that functions as delineation for planning and management purposes. For planning purpose, Clark recommends broader boundaries to include areas that will influence a designated site. This will increase the possibilities to see a problem source that affect a site as well as potential sources for a coastal zone advantage. However, narrower boundaries will do better for coastal

management purpose (84). For example, it is much easier to manage four-wheel-drive vehicle damage on beaches and dunes within a smaller area. A limited management area will let the authority to perform better and reduce conflict with other government authorities.

Beaches

There is no doubt that beaches are the most valuable part of a coastal zone to attract tourists. Despite recreation functions, beaches also have defense function. Clark states that beaches have protected properties along the shores of oceans and large sounds. But beaches also are easily damaged and subject to erosion (75).

Littoral basins

There are some terms to address littoral basins on the back side of barrier islands. Lagoons, estuaries, and embayment are types of littoral water bodies that are semi-enclosed, shallow, connected permanently or temporarily to the sea. Saltwater and fresh water inflow and outflow into those basins and play a major role in creating water salinity level. According to Clark, estuaries are semi-enclosed basins with permanent connection to the sea. Fresh water, often from river, dilutes saltwater in estuaries. Therefore, there are considerable varieties of salinity in estuaries. The gradient of salinity is near zero at the head of the estuary where fresh water comes and gets higher near the open sea (338). Lagoons are basins with high gradient of salinity. They can be shallow enclosed or semi-enclosed bodies of sea water with a narrow entrance to an adjacent sea (Doody, 191). Lagoons become hyper saline for part of the year when seasonal sandbar formation cut them off from the sea. Embayment is more open littoral basins with less restriction to the inflow and outflow of saltwater. The water salinity is rather high, close to the oceanic salinity (Clark, 338).

Estuaries, lagoons, and embayments have a high biological productivity, rich in sea resources, and play important ecological roles as well. Those positive values of estuaries, lagoons, and embayments are: (a) nutrients and organic materials suppliers to outside water through tidal circulation; (b) sanctuary, nursery, and shelter for migratory and oceanic animals; (c) habitat providers for commercial and recreational fish species (Clark, 339).

Wetlands

Coastal wetlands lie within transition zone of land and sea. Though its landscape beauty is not as remarkable as those sandy beaches, coastal wetlands serve as nurseries for marine biota, nutrient retention, flood control, coastline protection from severe erosion, reduce wave forces, and storm surge. Clark characterizes true coastal wetlands as areas that are shallow enough for a person to wade through and are vegetated with rooted plants such as mangroves and marsh grasses (475).

There are several types of wetland formations. Marshlands and mangrove forests are typical coastal wetland lining at the backside of barrier islands in tropical region. Marshlands and mangrove forests serve many of the same ecological purposes. Assimilating nutrients and converting them to plant tissue before it breaks into fine particles and goes to coastal water. Plant detritus provides food base for many fish species and shellfish (Clark, 352).

Marshlands also supply cover and nesting for the juvenile fishes and many wildlife species (Clark, 352). Marsh grasses can absorb and weaken incoming wave energy to the shoreline, thus buffer the barrier island back side from severe erosion. Back–barrier marshes also act as a container for coastal stormwaters that prevent excessive flooding over inland areas. Furthermore, marshlands trap sediment and cause the sediment accretions. The sediment accretions build up elevation or widen the islands (Clark, 352; Bush, Pilkey Jr., and Neal, 110).

Mangrove forests refer to several species of trees that live in saltwater or salty soil regime. According to Clark, mangrove forests are found in the intertidal zones of sheltered coastline where wave forces are low. In tropical or subtropical areas, mangrove forest traps sediment and anchors barrier islands and low lying shores (343). The dense mangrove forest proved to reduce the coastal impact of Hurricane Andrew in 1992 (Bush, Pilkey Jr., and Neal, 109). Ecologically, mangrove forests provide habitat for many water birds as well as shorebirds. Migratory birds nest in the upper strata of mangrove forests while other species such as crabs, shrimp, and the important stages of sport and commercial fishes, invertebrates and insect inhabit the lower strata (Clark, 344).

Maritime Forest

Maritime forest is a dense vegetated area in a barrier island. It grows mostly on stabilized dune systems and generally on the back sides of islands (Bush, Pilkey Jr., and Neal, 188). Maritime forest area is considered as a stable portion of a barrier island formation and bears the lowest risk of storm damage. The woods, thickets, and shrubs help to stabilize the underlying sediment at the same time serve as a protective screen. The protective nature of maritime forest was well demonstrated when Hurricane Hugo hit Pawleys Island, South Carolina, in 1989, or when Hurricane Frederick struck Dauphin Island, Alabama, in 1979 (Bush, Pilkey Jr., and Neal, 108). Overwash had severely damaged many houses where maritime forest had been removed for development. Meanwhile many houses located among maritime forest were almost untouched or only experienced minor damage. In October 1893 an infamous hurricane made landfall at Cheniere Caminada, Louisiana and caused 10-feet storm surge at Grand Isle (qtd. in Meyer-Arendt, 10.4-5), all beachfront structures were destroyed or severely damaged. The only place that survived on that island was the local village which was sheltered by oak trees.

Recreational and Scenic Values

The coastal environment offers a wide variety of recreational and scenic values. Beaches, dunes, lagoons, birds, sport fishing, and other wildlife and landscape formations contribute both to visual and significant recreational use for the public. Kay and Alder (165) see coastal environments as an open space that supply people with the opportunity for leisure, relaxation, contemplation and physical activity.

Recreational and scenic values are significant and may contribute to local economy. Sorensen and McCreary note that developing countries most likely have greater concern with coastal resources in contributing to the economy of its citizens. Yet, developing countries have lesser concern of visual and recreational resources unless coastal tourism plays major role in its economic growth or it has potential to boost the economic growth (13).

Education and Research

Varieties of habitat types, marine wildlife, rare and endangered species make coastal environment can serve as a field laboratory. Education in the coastal management

context means helping people to accomplish thing by themselves. Through education many eco-friendly technologies, basic understanding of ecology, or conservation ideas can be introduced to public, government or non-government agencies, or special interest groups (Clark, 291). There are also needs of diverse researches in coastal and ocean subject to understand the ecosystem and the use for human welfare while maintaining the natural resources sustainability (Clark, 401).

Physically, a building is needed to support research and education function. Laboratory has advantages to serve education and research purposes at the same time. Both can work well as a unity and complement each other. It provides scientists to perform their research task and gives an opportunity for marine trainees, government staffs, students, and public to learn the subject from the first hand. Clark (291) mentions the effectiveness of active contact with targeted public to accomplish specific education tasks. As quoted in Clark:

> …in the Dominican Republic, members of the Centre for Marine Biological Research (CIBIMA) of the National University give frequent talks to community groups, charcoal makers, fishermen, and government officials in charge of mangrove management. These talks, usually given in areas where specific problems are identified, have been effective in promoting a more careful and wasteful utilization (291-92).

Buildings for Barrier Island

Natural Forces Threaten

Buildings on inland are designed to hold vertical loads such as walls, floors, and roof to resist relatively small wind forces (Pilkey,Sr. et al., 34). Whereas, in a hurricane-prone area, such inland type buildings are exposed to variety of much stronger wind forces that may come from any direction. Ambrose and Vergun note six typical wind effects on a stationary object such as a building (Figure 4), which are:

- <u>Direct Positive Pressure</u>, it happens when surfaces facing the wind and received direct impact of mass moving air perpendicularly.
- <u>Aerodynamic Drag</u>, it is a drag effect on surfaces that are parallel to the wind direction.
- <u>Negative Pressure</u>, also known as suction effect, which happens on leeward side of the object. The pressure is going outward on a object’s surfaces.

- <u>Rocking Effects</u>, it happens because wind velocity and direction are rarely constant. Gust and swirling winds will rock, buffet, flap, objects along the wind path.
- <u>Harmonic Effects</u>, also known as vibration effect. A low velocity or even a storm type wind can produce vibration, flutter, whistling, and so on that may cause damage on loosen parts of an object.
- <u>Clean-Off Effect</u>, which is a tendency of flowing air mass to smooth off the objects along its path.

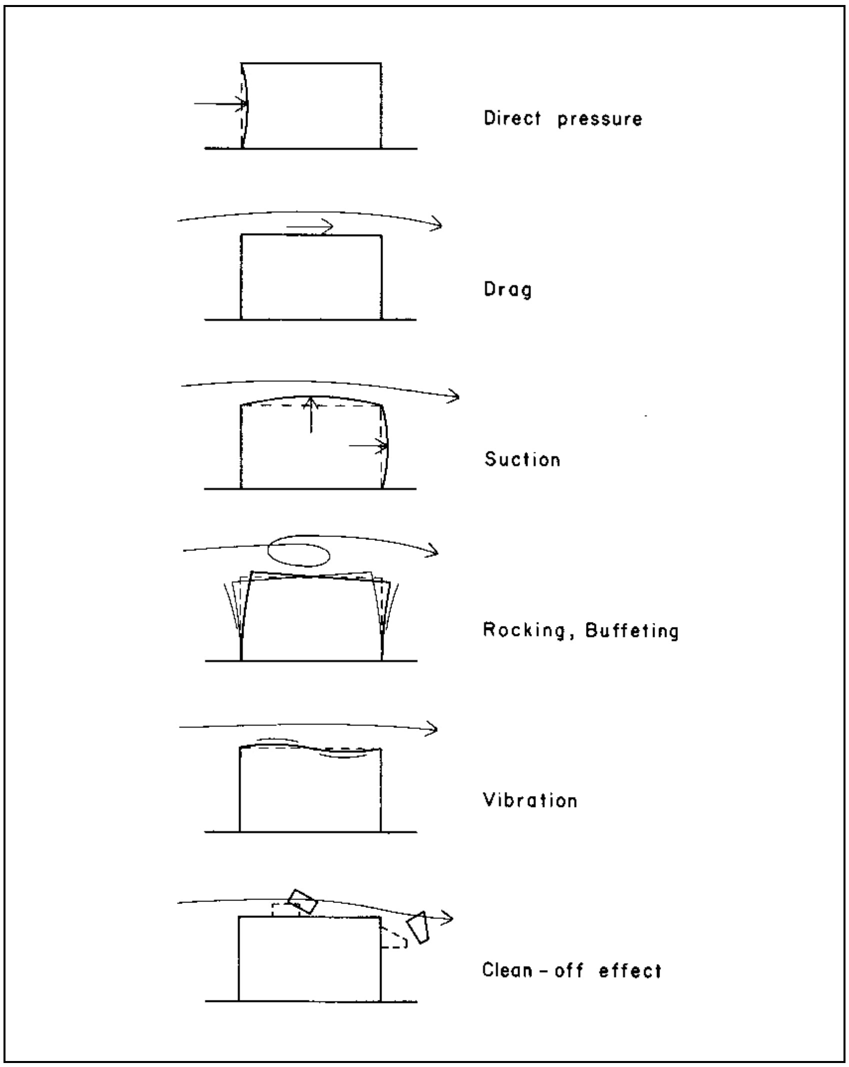


Figure 4. Typical Wind Effects on a Stationary Object
(Source: Ambrose and Vergun, 38)

Other damaging factors following the storm wind are waves, rising water, flying debris, land movement, erosion, and landslide (Figure 5). Those factors can cause property loss and endanger human life as well.

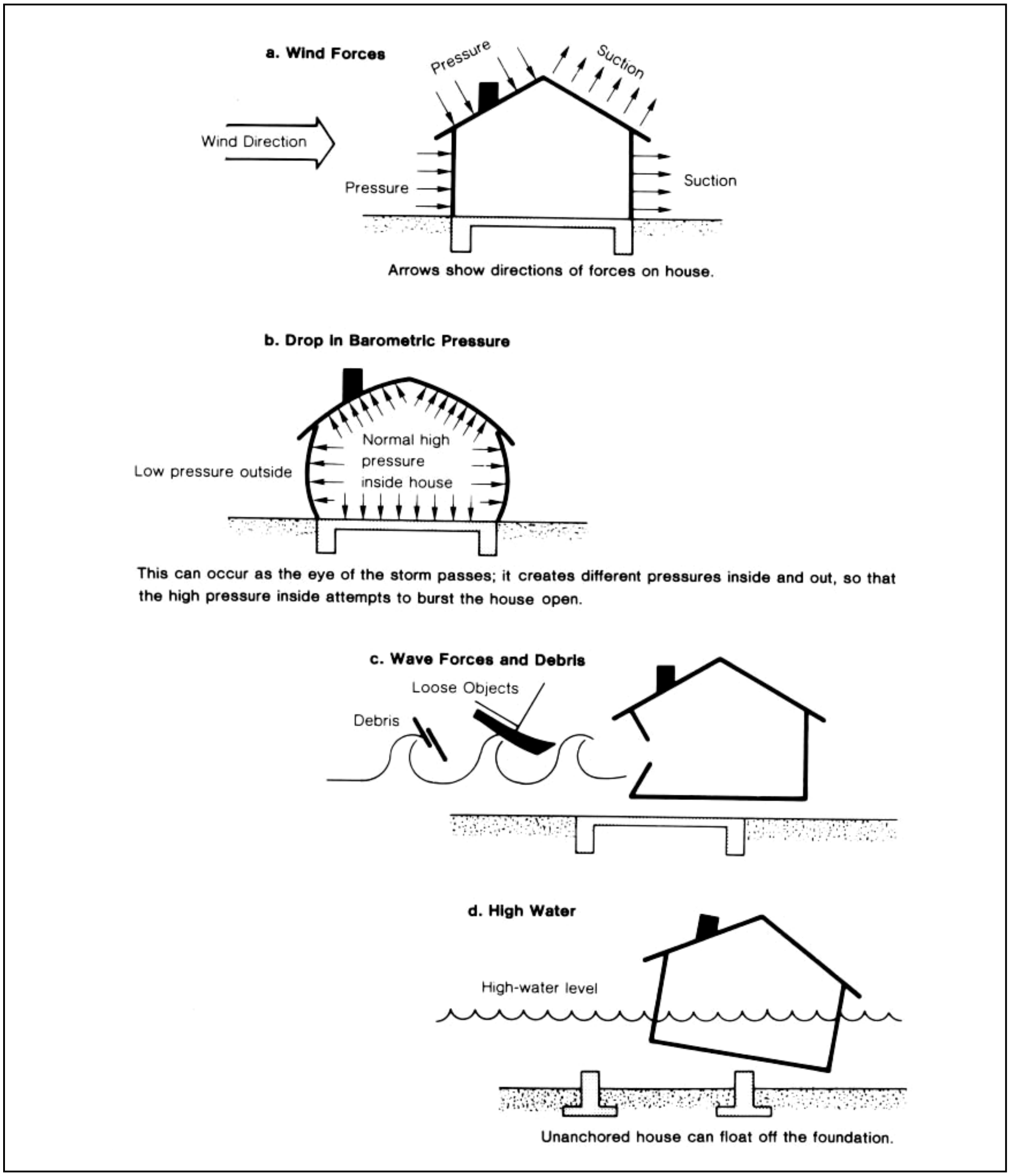


Figure 5. The Destructive Factors to Buildings in Hurricane Prone Area
(Source: Pilkey, Sr. et al., 35)

Build Safely

It has to be understood that there is no perfect building that can withstand all the danger caused by severe storm without any damage. However, there are some rules as a design consideration to avoid serious damage or property loss. These are some suggestions by Pilkey, Sr. et al. (36-37):

- A good and safe building site
- Adequate fastening for a building
- Secure foundations
- Proper material selection
- Avoid irregularities of a building shape

Building form can influence the increase or reduction of wind effects. Some building forms considerations adapted from Pilkey, Sr. et al. (39) and Ambrose and Vergun (45) that are preferable to resist wind force (Figure 6) are as follows:

- Rounded building forms cause less wind resistance than rectangular shapes with flat surface buildings.
- A simple shape make a building act as a unit, so it has better wind resistance than irregular shaped building.
- Hip roof is better that gable.
- Tall buildings with short horizontal dimension are critical for overturn and deflection at their tops.
- Open-sided buildings or buildings with forms that tend to catch the wind will cause more pressure on internal surfaces.
- Avoid projections from the buildings because they are critical for wind clean-off effect. Signs, cantilevered balconies and canopies, freestanding exterior walls, and wide overhangs are some examples of projecting elements from a building.

Building form contributes in reducing wind resistant. Nevertheless, proper materials and good quality of construction and finishing play role in keeping the buildings to stand the extremes wind and waves forces.

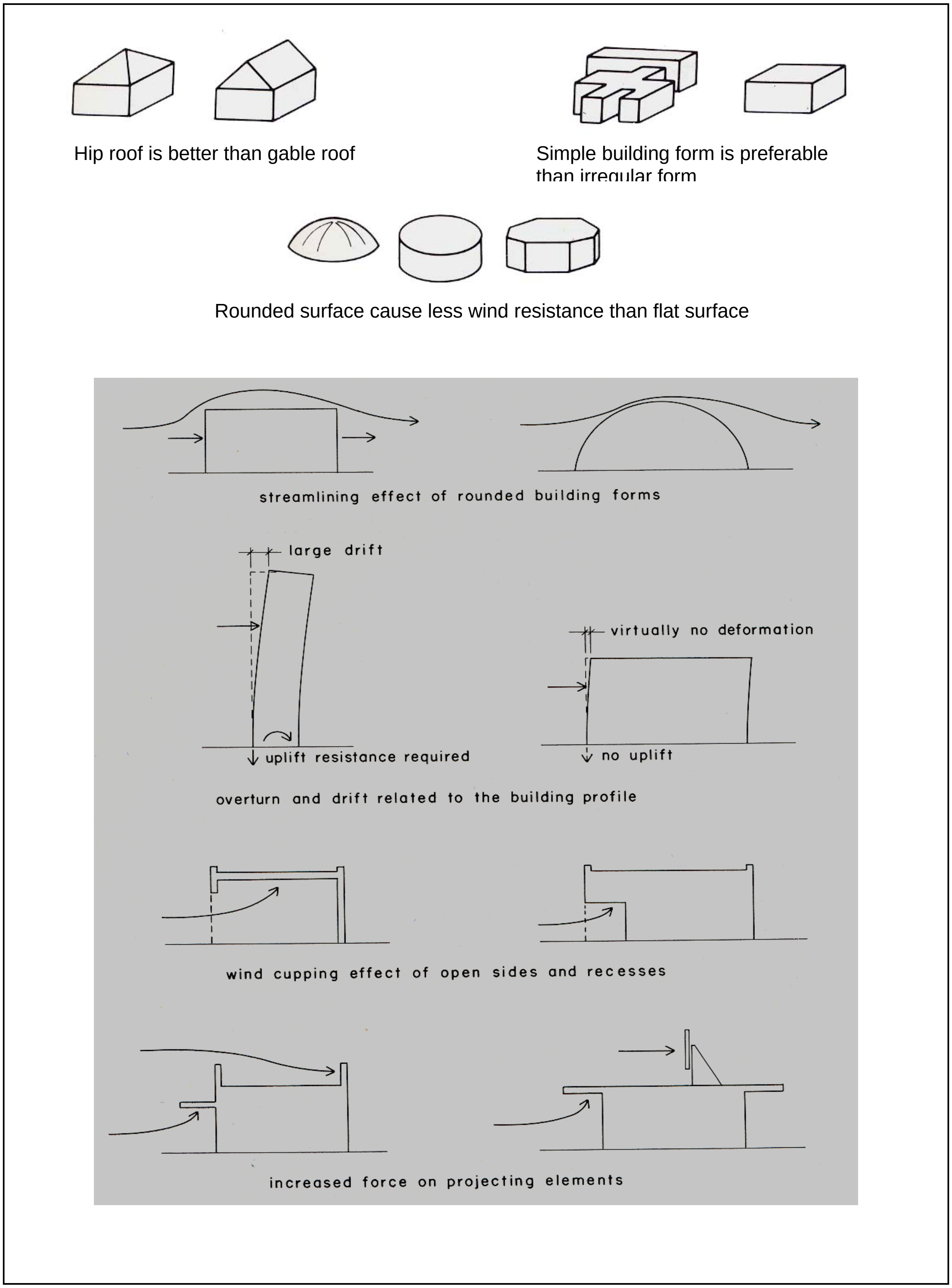


Figure 6. Building Types to Resist Wind Forces

(Source: Ambrose and Vergun, 46; Pilkey, Sr. et al., 39)

Conclusion

Barrier island certainly is at high risk of coastal hazards. Nevertheless, the beauty and uniqueness of its landscape attract people. Barrier island's physical and biological resources such as the beaches, wetlands, terrestrial and marine animals are worth to be enjoyed. Meanwhile, extreme natural forces are still threatening the coastal zone. Human safety and reducing property loss possibility are the major consideration for planning in hurricane prone area. The literature review of the barrier island environment and characteristic serve as reference to assure efficient and complete treatment of the problems and in addressing the client's needs. The data from literature review will also provide support in analyzing the site condition, interpreting the proposed program, and intensifying conceptual process.

CHAPTER 3. NATURAL AND CULTURAL SYSTEM OF GRAND ISLE

Introduction

Data inventory and site analysis are important parts in site planning and design process. The data are gathered to be analyzed in order to recognize possibilities of hazards and danger by nature or present human activities. Furthermore, the analysis should interpret all potentials to assure positive development of the site.

Site Inventory

Location

Grand Isle is a barrier island located approximately 50 miles south of New Orleans (Figure 7) in Jefferson Parish, Louisiana. It is surrounded by Caminada Bay at north, Caminada Pass at west, Gulf of Mexico at south, and Barataria Pass at east. Louisiana Highway 1 connects Cheniere Caminada is to the west of Grand Isle through a bridge that passes the Caminada Pass tidal inlet. The highway stretches until the eastward end of the island where Grand Isle State Park is located.

Grand Isle extends about 7.5 miles in northeast to southwest direction. The island width is about 0.75 miles at the center. The piece of land belongs to Grand Isle Port Commission is sited just about the center part of the island (Figure 7). The northern boundary of the site is Caminada Bay, south boundary is neighborhood area, while west and east boundaries are mostly marshlands.

Topography

The general elevations of Grand Isle range from sea level up to 5 feet above mean sea level (m.s.l.). Natural ground elevations at the center of the island vary from 3 to 5 feet. Generally, the site topography of Port of Grand Isle is relative level. The property elevations range from sea level to 3.5 feet m.s.l. Refer to Appendix A for detail site spot elevation of the site.

Soil

From the soil map prepared by USDA-Soil Survey of Jefferson Parish, the site for Port of Grand Isle is categorized as Scatlake muck. This mineral soil is poorly drained, dark gray color, moderate alkaline type of soil (pH 7.9-8.4) is generally found in saline marshes that are flooded or ponded most of the time. This soil is continuously saturated and semifluid. Normally, the saltwater floods the Scatlake soil about one foot. However,

during storms the tides from the Gulf of Mexico will cover this soil with 2-3 feet of water. The water table level during normal weather conditions ranges from 1 foot above the soil surface to ½ foot below the surface. This soil is continuously saturated and semi fluid. The shrink-swell potential is also very high with low permeability and very slow percolation. The total subsidence potential is medium (22).

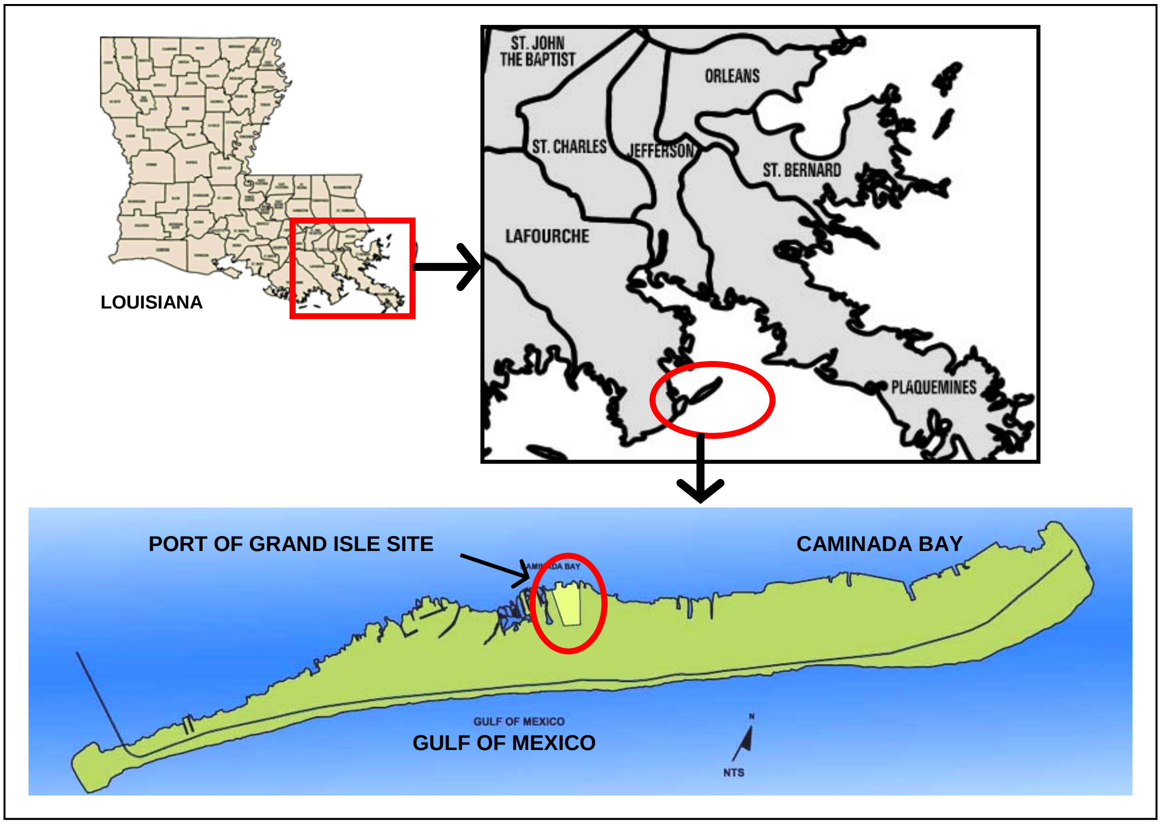


Figure 7. The Port of Grand Isle Site Location

Vegetation

Grand Isle vegetation is generally similar to other barrier islands' vegetation in coastal Louisiana. As quoted in U.S. Army Corps of Engineers report for Grand Isle Environmental Statement, the beach portion of Grand Isle is lacking in plant cover. The low dunes behind island have more plants such as Morning Glory (*Ipomoea stolonifera*), Evening Primrose, Saltmeadow Cordgrass/Wiregrass (*Spartina patens*), and Sea Oats (*Uniola paniculata*). Further inland, grasses, Sedges, and Dewberries grow on a flat

meadow area. On the north side of the island is marshland. Plants such as Oystergrass/Smooth Cordgrass (*Spartina alterniflora*), Saltgrass (*Distichlis spicata*), and Black Mangrove (*Avecennia germinans*) grow on saline marsh adjacent to the bay while three-cornered grass and wiregrass appear on the fresher marshes (U.S. Army Engineer District New Orleans, Grand Isle and Vicinity, Louisiana: Final Revised Environment Statement, II-9,10).

Figure 8. Existing Entrance to Grand Isle Port Commission's Property

Concerning soil type of future Port of Grand Isle site, the natural vegetation associates with the Scatlake soil are most likely Saltmeadow Cordgrass/Wiregrass (*Spartina patens*), Saltwort (*Batis maritima*), Bushy Sea-oxeye (*Borrichia frutescens*), Black Needle Rush (*Juncus roemerianus*), Smooth Cordgrass/Oystergrass (*Spartina alternifolia*), Seashore Saltgrass (*Distichlis spicata*), and Virginia Samphire (*Salicornia virginica*) (USDA, Soil Survey of Jefferson Parish, 22).

Wildlife

Terrestrial fauna of Grand Isle is very diverse. U.S. Army Corps of Engineers report for Grand Isle Environmental Statement accounts Northern raccoon, Virginia opossums, mourning dove, warblers, sparrows, cuckoos, wrens, bats, mice, lizards, some racer and king snake, treefrogs, beetles, and pillbugs are among other animals found in high ground. Important animal of Grand Isle will be the migratory birds such as Hummingbirds, Canada warbler, Dickcissel, etc. These temporary bird residents have used Grand Isle as a stopping place and a shelter during their migration season.

Another community of Grand Isle terrestrial fauna lives in marshlands. The primary inhabitants of the marshes are fiddler crabs, mars snails, mussels, and muskrats, as well as smaller animal like amphipods, protozoa, polychaetes, insect larvae, and nematodes. Occasionally, a small number of puddle ducks utilize salt marsh vegetation for food source during winter. These animals consume detritus or plants. In the same time, they are a major food source for other predators, such as mammals, birds, and insects. The food web counts on wading birds to remove a huge amount of protein from the marsh each day. Then, their droppings enrich the adjacent water here and there in Barataria Bay area, resulting in a high density of plankton and fishes. Accordingly, the marsh area provides an abundant prey for other predators, such as rails, shorebirds, raccoons, and dragon flies (U.S. Army Engineer District New Orleans, Grand Isle and Vicinity, Louisiana: Final Revised Environment Statement, II-11).

Besides migratory birds, Grand isle has been famous as a recreation and sport fishing destination. Commercial fish species such as Spotted Seatrout and Spanish Mackerel have been located on Grand Isle at the near shore of Gulf of Mexico (U.S. Fish and Wildlife Service, Gulf Coast Ecological Inventory: New Orleans, Louisiana, 1982). Mullet and Menhaden are common in bay side of the island. Commercial shrimp and crabs can be found on the bay area because its proximity to marshlands. Abundant supplies of detritus make the marshlands a perfect nesting ground for larvae of crabs, shrimp, and barnacles (U.S. Army Engineer District New Orleans, Grand Isle and Vicinity, Louisiana: Final Revised Environment Statement, II-12, 13).

Recently the Grand Isle community has begun to pay more attention to butterflies to enrich their environment. Grand Isle Port Commission and Team City Grand Isle, with

the help of donors, built a butterfly dome. The butterfly dome will house butterflies and their native host plants. The dome will become a new attraction for tourist and a tool for educating visitors and residents (Gaudet, Daily Comet, October 16, 2003; the Lafourche Gazette, October 22, 2003).

Climate

The closeness to the Gulf of Mexico influences Grand Isle climate. Summers are long and humid with average temperature of 82^{o}F but it often gets cooler from the sea breezes. Average daily minimum is 74^{o}F and maximum 90^{o}F. Winters duration are shorter and moderate with average monthly temperature of 56^{o}F. Average daily minimum is 47^{o}F and maximum 65^{o}F. The humidity is about 90% at dawn, 65% in mid-afternoon, gets higher at night. The sun shines 60% of the time possible in summer and 50% in winter.

Annual precipitation for Grand Isle is 65 inches. Most of the rainfall occurs in April through September. The wettest month is July with average monthly rainfall of 7.7 inches. October is the driest month with recorded average rainfall of 3.7 inches.

The prevailing wind at Grand Isle is from the southeast 44% of the time, primarily in the summer, and out of the northern quadrant 38% of the time, mostly in the winter. Average highest wind speed is about 10 mph occurs in spring. Every few years, a hurricane or hurricanes crosses Jefferson parish (U.S. Army Engineer District New Orleans, Grand Isle and Vicinity, Louisiana: Final Revised Environment Statement, II-2; USDA, Soil Survey of Jefferson Parish, 2). Hurricane data record from the past century for Louisiana shows that 60% of tropical storm had made landfall in this area. The number gets up to 80% when considering hurricanes only. All tropical storms or hurricanes made landfall during August and September. The records indicate that September is the peak of the storms or hurricanes activity (Stone 657).

Hydrology

Tides in Grand Isle are primarily diurnal which are one maximum and one minimum each day with the range varying in a fortnightly period. The mean range varies from 0.88 feet to 1.21 feet above m.s.l. as recorded at Bayou Rigaud, north of the Port of Grand Isle site. The tidal range reaches its maximum in June and December and

minimum in March and September. Tides are important to transport pelagic larvae from offshore spawning to inshore nursery grounds.

Water salinity records from Grand Terre, an adjacent barrier island northeast of Grand Isle, are approximately 28 part per thousand (p.p.t.) for average weekly mean in the fall and 18 p.p.t. in the spring. Generally the highest level of salinity occurs in October and November, whereas the lowest level happens in April and May (U.S. Army Engineer District New Orleans, Grand Isle and Vicinity, Louisiana: Final Revised Environment Statement, II-3).

The site has a seasonal high water table ranging from 1 foot above ground to 0.5 under surface through out the year. Those numbers apply to undrained soils in saturated zones within 6 feet depth.

Flood Hazard Area

Grand Isle location is in a hurricane-prone region. This barrier island is fully exposed to the Gulf of Mexico; thus, making it subject to severe damage from hurricanes. Grand Isle has experienced several instances of tidal flooding from gulf side and bay side. Stages of up to 10 feet have been recorded for Grand Isle. The likelihood of maximum hurricanes for that area will produce stages averaging about 17 feet. Precautions have been taken to minimize the flooding during hurricane season. A sand dune along beaches will protect the area fronting the Gulf of Mexico. A few discontinuous low levees, although gives minimum protection, shelter the bay side area from high tide flooding.

Port of Grand Isle's site falls in category AE of Flood Insurance Rate Map (FIRM). The AE category means that there is a 1% chance of flood reaching or exceeding a predetermined level in any given year of 100-year. The site has base flood elevations of 10 feet at the southwest part of the land and 11 feet at northeast portion (Figure 9) adjacent the bay side; see Appendix B for further reference (FIRM, Flood Insurance Rate Map of Jefferson Parish, Louisiana and Incorporated Area, panel 225).

Grand Isle has a long story of hurricane occurrences. In the Grand Isle and Vicinity, Louisiana: Final Revised Environment Statement prepared by U.S. Army Engineer District New Orleans, a brief history of noted hurricanes is as follow:

A hurricane in 1831 flooded "Barataria Island" (probably Grand Isle) to a depth of 6 feet and killed 150 people. The worst storm with respect to fatalities was in 1893, when 1,168 people drowned in Cheniere Caminada and Grand Isle as wind greater than 100 miles per hour lashed the coast. A severe storm in 1909 covered Grand Isle with 2 feet of water and caused extensive property destruction. Two hurricanes struck in 1915 which caused 275 deaths and almost totally destroyed Grand Isle. In 1956, Hurricane Flossy struck the area and inundated Grand Isle from the bay side with stages varying from 4 to 8 feet. Hurricane Hilda in 1964 cut entirely through the western end of the island and caused considerable damage to the beach at Grand Isle. The most destructive storm of record for the Louisiana coast was hurricane Betsy in 1965. Grand Isle was entirely inundated and only three buildings survived the action of wind and waves. The entire beach and the dune were swept back over the island.

Hurricane Betsy with wind speed over than 100 mph certainly was the worst hurricane ever struck Grand Isle so far. Nonetheless, it was not the last hurricane because other storms will follow with unpredicted wind speed.

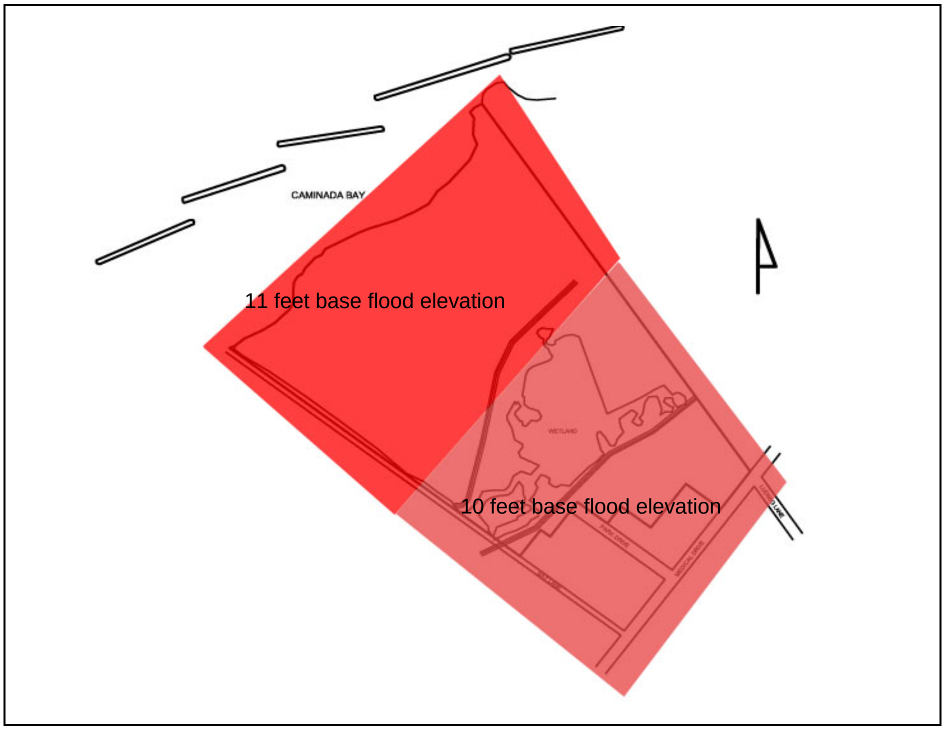


Figure 9. Base Flood Elevation for Building

Erosion and Accretion

The rule of nature places a barrier island in continuous position of erosion and accretion process throughout its lifetime. This rule applies on Grand Isle too. McBride and Byrnes (637-638) and Penland et al. (1-5) noted that the Grand Isle shoreline had

retreated and advanced in nearly the same extent. Over history, their investigation found that the gulf shoreline has experienced net retreat along its southwestern end while remaining relatively stationary along its central portion and accreting seaward on its northeastern end. A longshore current has transported sediments from southwest to northeast of the island. The tendency of erosion and accretion on opposite side of the island causes Grand Isle's gulf shoreline is slowly rotating clockwise around a stable midpoint. Comparing with other Louisiana barrier islands, Grand Isle's gulfside shoreline shows a stable accretion trend.

Grand Isle's bayside is quite the reverse of gulfside shoreline. The bayside experiences slowly increasing erosion rates between 1887 and 1988. McBride and Byrnes suggest that probably the erosion is a response to the passage of cold fronts, tidal currents associated with Caminada Pass, relative sea level rise, and continued wetland loss to the north of Grand Isle. The greatest erosion rate was recorded at the western end of the bayside and slowly decreasing to the eastern end with stable to slow accreting conditions. The average rate of bayside shoreline retreat is -1.0 meter per year, while the gulfside shoreline has shown net accretion of +0.9 meter per year (calculated data between 1887 and 1988). However, compared with other Louisiana barrier islands, Grand Isle essentially has remained stable (638). McBride and Byrnes predict that Grand Isle has a long life expectancy. Based on their calculation on the area change extrapolation method, Grand Isle is not expected to disappear until the year 2948 AD (638, 640-41). Please refer to Appendix C for predicted barrier island change.

Recent Land Use

Basically, west and east side of the site is undeveloped marshlands (Figure 10). South of the site is a residential area and public or semi public uses, such as school and church. The residential area south of the site has been part of an old neighborhood of Grand Isle (Figure 11). The old community of Grand Isle starts from the center of the island and progress to west and east direction along Louisiana Highway 1. Meyer-Arendt schematic settlement evolution on Grand Isle (Figure 12) shows a distinctive settlement patterns from 1855 to 1975 (462).

Figure 10. Recent Land Use

Figure 11. Typical Residential Houses Adjacent to the Site

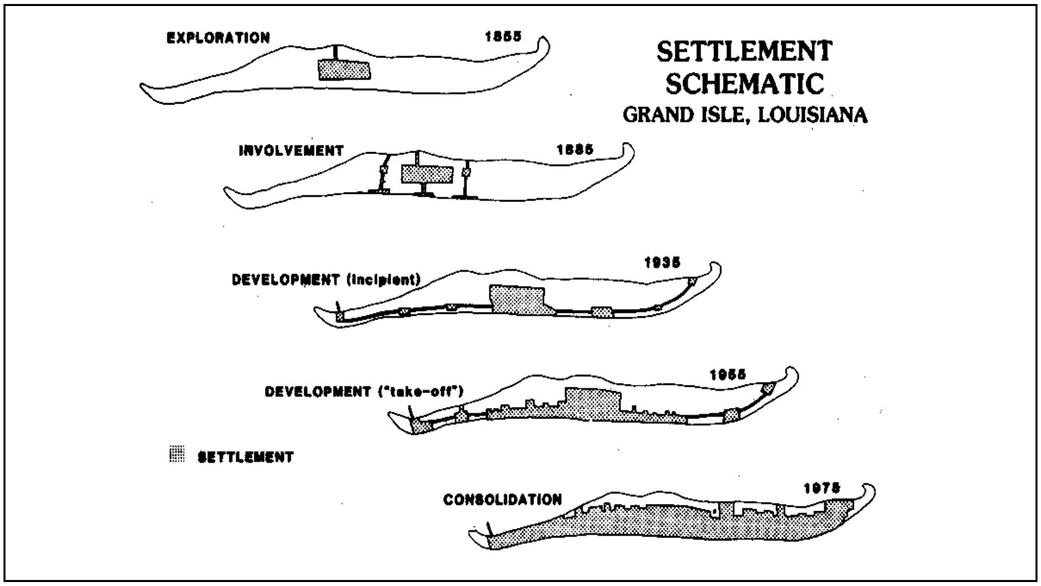


Figure 12. Schematic Settlement Evolution on Grand Isle 1855-1975
(Source: Meyer-Arendt, 462)

The Commission provides its wetland on site as part of a bird watching trail route. There is a boardwalk, own by the Grand Isle Port Commission, on the site overlooking marshland area (Figure 13). The boardwalk is mostly used by birdwatchers during Louisiana Bird Festivals.

Figure 13. Grand Isle Port of Commission Birdwatcher Boardwalk

The wetland on the site is used as waste waster discharge area from the surrounding residential area (Figure 14).

Figure 14. Waste Water Discharge Pump

The south area of the property (Figure 15) has been use as a junkyard and temporary parking place of dump trucks and heavy duty vehicles.

Figure 15. Junkyard and Temporary Trucks Parking Area

Cultural Setting of Grand Isle

Grand Isle remains and continues to be a recreation destination since the plantation era ended around 1860's. Meyer-Arendt (454-455) noted that the recreation destination era began with the conversion of several typical plantation facilities into tourist facilities. His research in Louisiana Resort Cycle showed the first group of agriculture structures conversion as follow:

> The defunct Barataria Plantation [was converted] to a tourist facility. The main sugarhouse became the Grand Isle Hotel and the 38 slave shacks were transformed into guest cottages (Meyer-Arendt, Resort Cycle, 454).

From the 1860's until present day, Grand isle has attracted tourist to enjoy its coastal landscape. Summer homes and fishing camps were built in Grand Isle. Even after several storms had effected the development, people still continue to return to enjoy the beaches, sunbathing, and fishing. However, the attraction of the area's beaches has been decreasing since the 1970's. This is the result of shoreline retreat caused by the unsuccessful effort of shoreline stabilization by the state. The attractive seaside resort of Grand Isle became increasingly questioned. Even so, Grand Isle still remains as an attractive fishing destination (Meyer-Arendt, Resort Cycle 454-61). Meyer-Arendt predicts, that even beach tourists seek less disturbed beaches such as Alabama and Florida, Grand Isle will undoubtedly continue as one of the major fishing resorts of the Gulf Coast for the foreseeable future (Seaside Resort 10:10).

Lyle S St. Amant Marine Biological Laboratory at Grand Terre

Grand Terre is an adjacent barrier island located at the northeastern end of Grand Isle. Grand Terre inhabitants are mostly wildlife and only a few of the scientists who work at Lyle S. St. Amant Biological Laboratory. The historic Fort Livingston and an unmanned oil company pumping station are two other significant structures located at the barrier island beside the marine laboratory. The 40 years old marine laboratory building has become too costly to maintain. Moreover, the only access to Grand Terre is by boat. Marine research staffs, maintenance, repair workers, or visitors depend on the clear weather to go or return from the laboratory. The marine research administrative has put a big concern for high school students and teachers safety who occasionally visit the laboratory for workshop (The Advertiser, December 26, 2003).

The St. Amant Marine Laboratory is the headquarters of the Louisiana Department of Wildlife and Fisheries Coastal Study Area III which has responsibility to monitor fin fishes and shellfishes in the Barataria Bay estuary system. The main mission of the marine laboratory is to facilitate research required to manage Louisiana's marine fisheries. The authority also makes the laboratory facilities available for the use of other institutions engaged in fisheries management and enforcement, coastal restoration, and marine education. The St. Amant Marine Laboratory consists of a wet lab, a boathouse, two dormitories for about 50 guests, and a large office/dry lab. It has concrete tanks for various types of marine, fresh, and brackish-water organism experiments. There are also quite large tanks in the wet lab for research works. To the west of the wet lab are six salty water ponds. These facilities adequately serve many kinds of experiments involving brackish and saltwater organism. However, according to the authority, it has been seriously under-utilized (Nipper, Chavez, and Tunnell, Jr. eds., September 3, 2004).

Site Analysis

Environment Hazard and Danger

Being in the path of hurricanes has always put Grand Isle at great risk. There are life threatening situations every year during hurricane season. Safety is the primary consideration for planning and designing in a hurricane prone area. Port of Grand Isle's site location on the bay side of the barrier island makes it vulnerable to storm-surge ebb. All plans and design that are made for this area must avoid any designs or structures that favor scouring and the formation of a new inlet. Locating and dredging a canal without a proper survey and consideration to the surrounding environment may create a new inlet during severe storm surge. A canal that extends far inside the mainland will increase the possibility of a new inlet being formed. This is true especially if the canal is wide. The scouring that occurs during storm-surges will likely crate a new inlet and divide this fragile barrier island into two parts.

During a big storm, storm-surges can also cause scouring around building foundations. If the buildings or any structures are poorly constructed, the forceful moving water will erode the soil and cause the failure of structures. Next when the next storm surge comes, the building may be snatched from the ground. This floating building or debris then becomes another hazard for adjacent structures.

A study of Hurricane Hugo in South Carolina (qtd. in Bush, Pilkey, and Neal 35) concluded that a storm-surge occurrence was correlated with man made features such as shore-perpendicular roads and finger canals, beach access sites between multistory buildings, and orientation changes in seawalls and other types of shoreline armoring. Other channeling features that cause an erosive scouring occurrence had been observed in other major hurricane impact, such as Hurricane Gilbert on the northern coast of the Yucatan Peninsula of Mexico, Hurricane Camille on the Chandeleur Islands of Louisiana, and Hurricane Frederic along Alabama barrier islands.

Another type of damage caused by storm-surge is permanent sand loss. This is likely to happen if there are no shrubs, trees, or other vegetation to hold the sand in place. A permanent sand loss means losing a piece of land and gaining more water surface. When it happens over and over again, eventually a barrier island may disappear. Even though storm-surges are not the primary cause of permanent sand loss during a big storm, it contributes to the accumulation of sand loss by storm surge, storm waves, storm wind and currents.

The bay side area, like other parts of a barrier island, faces flooding danger. Flooding is one of the effects generated from a major storm surge. It does more than merely drown people. It can drag poorly built structures along with the massive water motion. Thereafter, the floating debris becomes a danger for humans and their property. Since Grand Isle had experienced flooding up to 10 feet, some safety precaution must be taken. Base on the Flood Insurance Rate Map, every important building facility on the site has to be built or located at least 11 feet above the ground. The other part of the site, which is closer to the residential area, has a requirement of being built 10 feet above the ground. However, it is better to set the building level on 11 feet above the ground although this part of site is farther inland and also has a levee to protect the interior from a storm-surge. This precaution is taken because the facilities to be built are semi public buildings with fairly long life expectancies. The building will also house a lot of expensive laboratory instruments and valuable research activities. It would be unwise to put such important instruments and research materials at risk. Moreover, it has been predicted that the site has a possibility to experience a 17 feet stage of tidal flooding if a

severe storm ever struck Grand Isle. Therefore, it is important to make sure that the structure will survive any changes that may occur on 100-year flood hazard zone.

Grand Isle has been facing the problem of island migration. The migration process is a result of erosion and accretion processes. Generally, Grand Isle is still categorized as a stable island, especially at the center part of the island. This condition puts the Port of Grand Isle's site safe enough to survive for at least another century. However, a study by McBride and Byrnes also shows that the bayside of Grand Isle is facing a shoreline retreat on the bayside with an average rate of -1.0 meter per year or approximately -3.3 feet per year (638). To slow down the erosion caused by the passage of cold fronts and tidal currents, the U.S. Army of Corps Engineer built offshore breakwaters (field observation). The breakwaters will slow down the waves and currents from the Caminada bay. Accordingly, the waves and currents will no longer have full impact on the shoreline and minimize the erosion.

Environment Limitations versus Human Needs

People who wish to live or spend some time in hurricane prone areas should consider all the consequences of nature's threat. Nevertheless, the expectation to experience outstanding scenery of coastal and wetlands always encourage people visit the island. High speed winds, storm waves, storm surge, flooding, etc are among major hazards that could occur in coastal barrier islands. Those threats challenge human to think creatively how to mitigate and deal with the barrier islands' environment limitation and natural hazards while enjoying the highly diverse resources that can be found there.

Coastal related recreation activities are on of the prime attractions of Grand Isle. However, the soil type limits development possibility. Scatlake type of soil is unsuitable for most recreation development that needs good drainage system. Flooding, slow water percolation and excess humus are typical for areas with Scatlake soil. Therefore, it is undesirable to build camp grounds, picnic areas, playgrounds, and path or trails on it. Camp grounds are subject to intensive use and heavy foot traffic and probably some vehicles traffic. Thus, the best soil should not be subject to flooding during the period of use. The surface should be able to absorb water while it remains firm and is not dusty when dry. Those requirements also apply to picnic areas, playgrounds, and paths or trails. An intensive or heavy usage is not suitable for the Scatlake soil type. A less intensive and

seasonal use of the area is more acceptable. Activities such as bird watching, nature photography, nature painting, marshland interpretation walk, and research activities have less impact on the environment with Scatlake soils. A raised walkway that will allow flooding or ponding on the wetland area is an alternative and would result fewer disturbances on the ecosystem. Setting up rules such as a number of visitors per trip and amount of trips per week will help to preserve the natural wildlife and habitat.

During hurricane season or other severe weather conditions, it will be dangerous to have recreation activities. Fortunately, the technology of weather monitoring has advanced and a system of recording and predicting weather is much more sophisticated then in the past. Therefore, precautions and warning can be given early. Most tropical storms and hurricanes in Grand Isle occur during August to September. Important recreation events that will bring a lot of people on the site during these months should be avoided because there is only one bridge, part of LA Highway 1, which connects Grand Isle to Cheniere Caminada. Otherwise, heavy traffic may occur when there was a warning for a hurricane landfall causing more people to be put in danger.

Flattening dunes and draining wetlands for gaining more dry area to build houses, camps, or other structures must be prohibited. In the short term, this effort looks favorable from an economic stand point. It seems that people will gain more benefit from selling the land to build structures for tourist attraction purposes. Once structures are built on drained wetlands, sooner or later a disaster will follow. The barrier island has lost its ability to defend itself from storm-waves and flood as mention in Chapter 2, page 13,. The damage level will get higher because there is no more protection against relentless waves or winds energy.

Excessive dredging for boat launching canal is another human development that contributes to coastal environment damage, especially at the bay side of the island. Uncontrolled canal dredging that carves far inland will increase the possibilities of new inlet formation or severe scouring during storm surge and storm-surge ebb. This should be avoided at the bayside of Grand Isle since it has already experienced constant erosion. A marina should be planned and designed based on the necessity of projected boating activity, in this case to support a marine research laboratory. Information about the

maximum size and quantity of boat using the marina will be matched with the bayside condition. A detailed marina design will be required for this purpose.

The appropriate law enforcement agency must prohibit maritime forest clearing as well as dune flattening and wetland draining activities. Maritime forest is another type of barrier island shelf defense feature. Several hurricane survival stories proved that most structures that survive a hurricane or severe storm are located in a maritime forest. Grand Isle's maritime forest had protected houses which were in the area during most major hurricanes that made landfall in Louisiana. The trees and shrubs acted as shelter for those structures. The Oak Trees also contributed for saving several lives of people in Grand Isle who hung on them to fight from being drowned by flood and flung by the winds during hurricane (McClain, 2004). Therefore, cutting the trees in a maritime forest to have more area for building or to have more open area is like inviting danger to oneself. Structures should be designed in a way that does not require tree removal. The rule is human should adapt with the nature because human cannot overcome the nature's forces without causing a worse or costly result.

Human activities create wastes. In a barrier island environment setting, like Grand Isle, human wastes become a concern. Waste water disposal in barrier islands needs more and better treatment before it is released to the surrounding environment. Poorly treated sewage can cause many problems in surrounding environment. Besides it becomes a source of diseases, the discharge sewage can contaminate the marshland and bay water area. Thus, the polluted marshland or bay may kill or contaminate the shellfishes and other marine animals. The destroyed habitat and ecosystems cannot function as feeding ground, nesting, and sheltering for many marine animals that are important for humans.

A regular house septic system may not be appropriate for barrier island sewage system. The soil type, Scatlake, characteristics of slow water percolation and flooded most of the time are not suitable for the regular septic tank system. The soil cannot provide good infiltration and filtration capacity which are an important function of septic tank field soils. A sewage lagoon system is not suitable for this soil type because the land area is constantly being flood. A municipal sewer system can solve this waste water treatment problem. However, it may create another problem because often along with a municipal sewer and water system installation, the area development will increase.

A marine laboratory needs a different type of sewer system because its waste water may contain chemical waste and other elements that are dangerous for environment. It may need more advanced waste water treatment before discharge into public sewer. A further study and design for a suitable and safe disposal system is needed. This, topic is not covered in this thesis. Nonetheless, a well designed waste disposal system must be enforced for the Port site to preserve the rich marshland and bay environment.

Environment Values

Regardless of the restriction on recreation and building development capabilities, Scatlake soil takes part in creating saline marsh that supports wetland wildlife habitat very well. This soil type provides a suitable place for wetland plants that need moist or wet sites to grow, such as Black Needle Rush (*Juncus roemerianus*), Smooth Cordgrass (*Spartina alternifolia*), Seashore Saltgrass (*Distichlis spicata*), and Virginia Samphire (*Salicornia virginica*). Those marsh grasses produce detritus from decomposition. The detritus provides the food base for many species of fish and shellfish. Accordingly, those fish and shellfish will attract their predators in the food chain to the marshland area. Ospreys, egrets, marsh hawks, muskrats, etc are commonly found in productive wetlands. This rich habitat offers a great potential for passive recreation and education uses. Sightseeing is one example of marshland recreation potentials. Visitors can enjoy the beauty of the landscape and the abundance of wildlife while learning about the ecosystem. Paintings, wildlife photography, bird watching, or simply just walking to enjoy the quietness of the place as a sanctuary from everyday crowded urban area are other potentials of marshland recreation uses. These types of recreation generally have low impact on the environment. On the other hand passive recreation is environmental friendly consisting of activities that allow people to enjoy the resources while preserving the ecosystem.

Marshland and its vegetation also serve as shoreline protection for the bayside. Especially since Grand Isle bayside has faced erosion threat. Slowing down the currents and waves energy is critical. Planting marshland vegetation and maintaining good condition of the habitat will preserve the bayside from severe shoreline erosion. The vegetation will absorb the energy of the waves and currents. Several studies prove the

ability of wetland plants, such as Black Mangrove (*Avicennia germinans*) and Smooth Cordgrass (*Spartina alterniflora*), along a shoreline on the bayside to reduce waves and currents impact (Nailon and Seidensticker 193-206; Teas 51-58; Lewis, III 148-152). Additionally, those plants are capable to trap and to hold sediment. This method is more environmental friendly as compared with breakwater structures as seawalls, groins, and bulkheads.

Salinity level of 28 p.p.t. in fall and 18 p.p.t. at Grand Isle bayside area provides a good growing environment for wetland plants. Woodhouse and Knutson (63) state that plants that are regularly flooded, such as Smooth Cordgrass (*Spartina alterniflora)* can live and grow in salinities up to 35 p.p.t. (sea water salinity). They also noted that these wetland plants are usually quicker to establish and to be more productive in salinities below 35 p.p.t. Thus, with salinity level between 18 -28 p.p.t. Grand Isle bayside water bodies will favor the growth of mostly wetland plants.

Mitigating Risk

Adaptation, activities limitation, and safety precautions of barrier island's natural environment should be taken into consideration when developing in a barrier island. Draining marshland or flattening dunes to provide more area for housing must be avoided. Applying human man made structures without considering how the natural system works and could cause environment damage. Environmental alterations that do not support the natural systems especially for a barrier island ecosystem may increase loss of environmental resources and potential loss in lives. If a barrier island has to migrate because that is the nature of it, then human should just let it happen. Humans have to adjust with the process. For example, if the beach may eventually erode (refer to "The Migrating Islands" at page 4-6) then do not build to close to shoreline because nobody expects to have a house in the middle of water in the event of land erosion or coastal flooding. It would be poor judgment to consider constructing a seawall. Such a construction would cause more chaos: environmental and financial. Numerous studies and experience of beach structures construction (seawalls, groins, bulkheads) in order to save ones' properties (Burton, Kates, and Snead 138-147; Bush, Pilkey, Jr., and Neal 75-80; Clark 75-86, 234-239; Pilkey et al. 87-107) only ended with permanent sediment loss

and narrowing beaches. In addition to the environmental damage, the effort of stopping the natural process is very costly and in the long-term ineffective.

Several studies of Grand Isle coastal migration tendencies (McBride and Byrnes 628-655; Penland and Suter 1:6-9; Penland et al. 1-5) recommend restricting development along shoreline. To avoid coastal flooding of building, it is necessary to delineate a setback line. The life expectancy of the building and activities within in the set back line must be set considering shoreline migration trends. From the studies that have been done, the erosion process on the bayside area of Grand Isle has occurred at a rate of -1.0 meter per year (-3.3 feet per year). Therefore a set back line will be set based on shoreline retreat predictions. It is assumed that a building life expectancy is 100 year. That will give the calculation of a set back line at 33 feet from high tide shoreline before the building is inundated by water. This scenario will happen with an assumption that erosion is occurring at the same rate during 100 year and no other factor is considered.

It is human nature to protect ones property whenever possible. In the past, with their limited technology, people tried to adapt with nature by building their property in more stable, higher ground, away from ocean front, and sheltered by the maritime forest. These days, with better and more sophisticated technology, people armoring the shoreline with hard structures, such as bulkheads, groins, seawalls, and jetties to fight erosion that endanger their property. People thought that those structures will protect their property from nature forces. They succeeded but only for a short time. Then nature's forces could come back to take over all the build structures. The best way to deal with coastal flooding and erosion is to mimic the natural process of defense (McHarg, 7-17). Marshland vegetation has proven to be an effective defense for storm-waves energy reduction. This soft structure is preferred for the Port site shoreline protection than the use hard structure, such as bulkheads and groins. Besides providing first defense against waves, marshland vegetation also creates a habitat for many juvenile stage marine animals. Therefore, this technique is more sustainable than the hard structures.

Due to the increase land erosion on the property, the Grand Isle Commission has installed jetties to reduce land loss by the northern winds and currents (Figure 16). In an interview with Keller, he mentioned that the jetties have slower the erosion rate. I suggest to combine the hard structures of beach protection with vegetation planting to help trapping and holding the sands on place.

Figure 16. Jetties to Protect Shoreline from Severe Erosion

Land Use of Adjacent Areas

Houses in the neighborhood area are built between oak trees of the island maritime forest. The oak trees have created a safety environment for the residents and their property. This condition must be maintained in order to provide a natural protection for the residents from direct wind forces.

The traffic generated from the future site development should not overload the traffic capacity of the street that may decrease the neighborhood quality and safety. Especially, along the Ludwig Street where there are a school, a church, and Grand Isle Town House (Figure 17). An alternative circulation diversion can be located at the end of Bay Lane. Oak trees removal and other efforts that lead to the damage of the maritime forest trees in the neighborhood for traffic should be avoided. Instead, any vehicles that may access the site should be limited to certain sizes that can pass the trees alley without

causing permanent damage to the oak trees. Impacts on the maritime forest should be minimized to protect the existing neighborhood from storms and flood hazards.

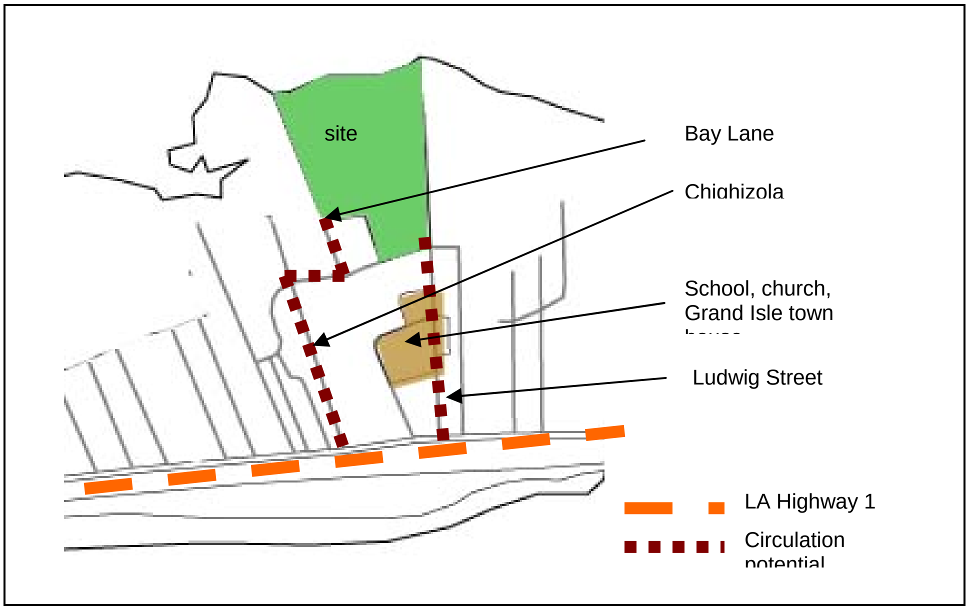


Figure 17. Circulation Alternatives

The city of Grand Isle also has a vision to build another highway on the north side of the island. If this idea became a realization, it would give an opportunity to direct the circulation to the new highway. This connection may reduce traffic load within residential area because the traffic will run along the perimeter of the residential area (Figure 18). The North Highway can be built on a levee system. This integration will provide the residential area with a better traffic circulation and a protection from coastal flood hazard.

A Site for Research, Education, and Recreation

The bay area and rich marshland environment at Grand Isle provide good resources for research and education purposes. The close proximity to the bay provides a quick access to the water. It allows the scientist to draw samples or any kind of research work needs from the source in minutes. It allows the marine research center to have its own boat launch. It will save time and cost as compared to building a dock in a separate location. The rich resources of wetland give an opportunity to use the area as an outdoor class to learn the ecosystem. Students and public can observe and learn the wildlife,

vegetation, the food chain system of wetland, and the importance of wetland as an ecotone area. Visitors can use the existing boardwalk as an access to the wetland. This access convenience will create direct interaction between the nature and the visitors.

The wetland also has potential for field experiment research site, since the marshland has been used as waste water discharge area. The site can be used for research in plants or microorganisms of decomposing particles, reducing pollutants, etc.

The other potential uses from the wetland environment are recreation activities. The Port of Grand Isle allows its site for bird watching every year during Louisiana' Bird Festival. This bird watching activity does not have major destructive impact on the marshland community. It even helped to preserve the habitat because the habitat must be maintained in good condition in order to attract those birds. The uses of the boardwalk can be extended to provide good spots for nature environment photography and painting activities.

Visual Quality

The coastal landscape and the wetland have created a unique combination of visual amenity. The vast blue ocean water creates a relaxing feeling to the observers (Figure 19). Meanwhile, the waves create a dynamic perception that is a contrast from the calming perception by the blue water. The marine wildlife also adds and enhances the variety of landscape images (Figure 20). The wetland has its own aesthetic quality that different from the ocean view. Petts noted that the smoothness, tidiness, flatness, and passiveness of the marshland create strong and distinctive images, variety, and color (238). The aesthetical value of wetland and coastal landscape is a great visual amenity potential for the site.

Conclusion

The discussion shows that the site has potentials as well as limitations. The richness of natural resources are potentially use for research, education, recreation, and human property protection. Meanwhile, the geography location of the site in a hurricane prone area and the geology type of the site constraint the development. The next chapter will utilize the potentials to develop and refine the site's programs. The awareness of site constraints and limitations will avoid unwise program development that may lead to environment destruction and endanger human's life and properties.

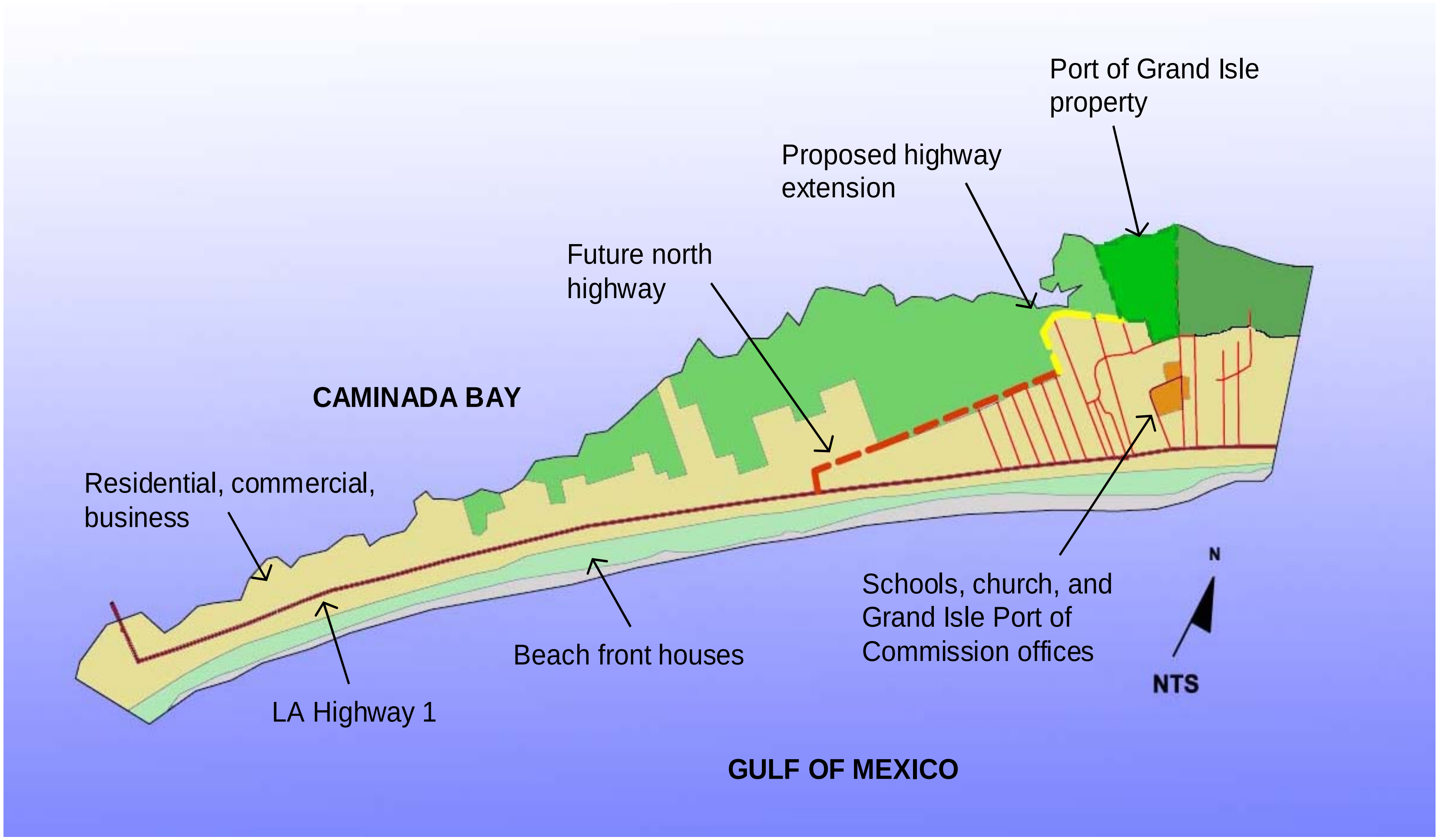


Figure 18. Circulation Alternative for Provision of Grand Isle North Highway Plan

Figure 19. Ocean View to the Caminada Bay

Figure 20. Marshland View

CHAPTER 4. PROGRAM COORDINATION

Introduction

The objectives of the program studies are to have a better understanding about the client needs and requirements. Refining and enhancing the client needs while looking for an opportunity to expand all potential values and possibilities of conflicts that may occur by referring to the previous chapter of site analysis.

Grand Isle Port of Commission Goal

The Grand Isle Port Commission prime aim is to promote economic development of Grand Isle and to help ensure safety and commerce in the waters surrounding Grand Isle. The Commission requires its property on the bay area to carry on the goal while trying to benefit the community. The port site is expected to accommodate marine research, education, and coastal restoration functions. The Commission has been targeting state and federal agencies and other research-education organizations as its clients to lease the site.

The Commission formulated several ideas of how the site will be used or can be used, which are:

- A marine research center
- A coastal plant resource center
- An oyster research facility
- A commercial marina for boats parking only (40-50 boats)

A marine research center is one of the proposed uses of the site. It is my intent to prepare a site design for this research center in support of my thesis. A coastal plant resource center, an oyster research facility, an oyster processing plant, and a marina are other possibilities that will be examined concurrently as part of my design for the marine research center activities. The Commission is making an effort to pursue various institutions that may be interested in aquaculture research activity to do research on the site. The Commission foresees the take over and continued management of the aquaculture project for business purposes once a research center is in operation. The marina program comes up because there is a demand from local shrimpers who find difficulties to park their boats. However, there is also a resentment of the new marina development from a local shipyard business. The existing shipyard business worries that

the new marina will take over their business. The shipyard business fears that the Commission will provide fuel service and boat repair or maintenance service in the new commercial marina. To avoid this business conflict while still responding to the local shrimpers demand of berthing place, the Commission plan to have a marina for boat berthing only. So the shipyard will still has their business of fuel service and boat repair-maintenance which are more profitable and important in boat service business.

Those previously mentioned programs and ideas do not restrict the Commission from other possibilities and ideas of the site uses. The Commission welcomes and will discuss any promising project and possibilities for the site. However, it prefers research and education programs concerning marine and coastal environment.

Department of Wildlife and Fisheries Marine Research Center

The primary objective of the marine research center is to facilitate research pertinent to Louisiana's marine fisheries. The marine facilities will support monitoring of fish and shellfish in the Barataria Bay, marine research and education, and coastal restoration. The State of Louisiana Department of Wildlife and Fisheries (DWF) hired an architecture firm to generate a schematic design plan. The schematic design is particularly for a part of the site that is leased to DWF (Figure 21). The parcel is about 7 acres located on the northeast side of the port's property. The parcel is at the waterfront of Caminada Bay.

The schematic design prepared by Crump Wilson & Associates includes 4 major buildings, which are:

- Main building; contain administration offices, laboratories, water tank facilities.
- Cooperator building; contain assembly hall and staff or researcher lodging.
- Marina; design to contain covered boat slips, covered dock, enclosed spaces for laboratory and vessels related function.
- Boat Storage Shed
- Boat Maintenance Shed

Besides those buildings that previously mention, the DWF informed the Commission of its intention of adding one more building for students' dorm. The DWF wants to obtain additional area besides the 7 acres parcel on the waterfront. The DWF wants to build the dorm to the south of its recent parcel which part of it is a wetland (Figure 21). The chosen location is deemed to the proximity the other buildings of the marine laboratory complex. The Commission agrees for the additional land and offers a parcel at the south part of its property (Figure 21).

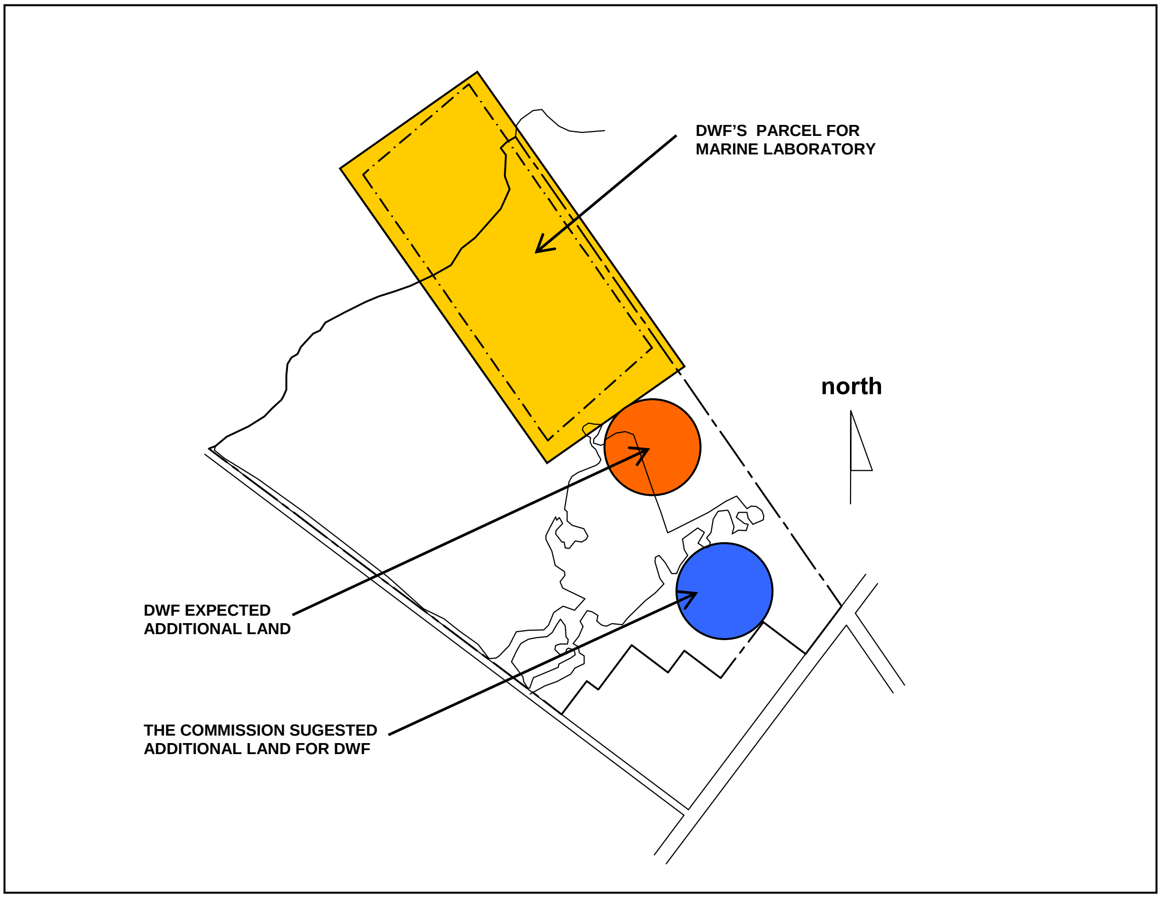


Figure 21. Parcel Leased to DWF

Currently, that particular part is used as a junkyard and temporary parking for heavy duty vehicles (trucks, small excavator, crane, etc). The DWF think that area is too far from the marine complex. The DWF wants a closer connection between the students' living space and other marine facilities.

The marine laboratory facilities incorporates buildings and equipment that support several function which area:

- Research
- Education
- Administration
- Lodging (staff and students/visitors)
- Boats park, storage and maintenance

Based on Crump Wilson & Associates schematic design plan of the physical buildings, I generated the relation of functions in a diagram as on Figure 22 The functional diagram will be used as an assumption as DWF inquires of site programs.

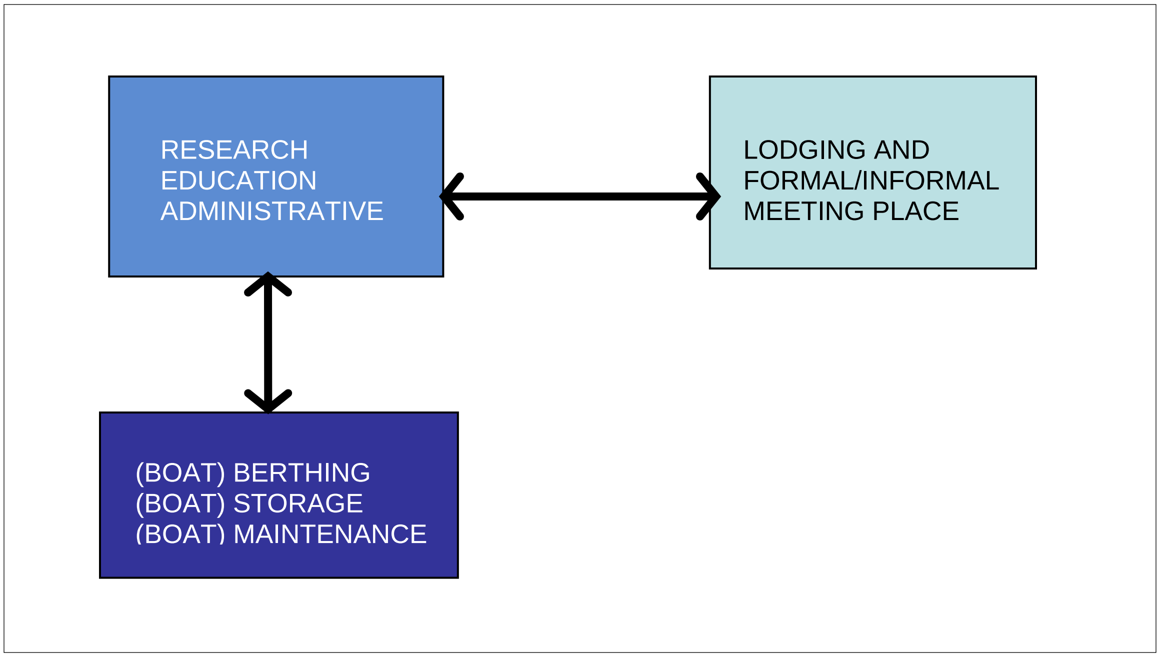


Figure 22. Functional Diagram of the Marine Laboratory Complex

The relation between those functions is mainly for the parcel leased to the DWF. It does not show any relation with future use of the remaining area of the property at all. Research, education, and administrative functions are necessary to be in one unit since laboratories in the marine center are designed to accommodate research-learning function. Boats berthing, storage, and maintenance are grouped as one unit. This unit of marina along with its services will support the marine research center activities. Lodging

and meeting functions are grouped as another unit to provide living and socializing spaces for the marine center staffs and guests.

Additional Programs

Previous site analysis in Chapter 3 shows that the wetland on the property has a rich environment. Wetland vegetation, animals, the aesthetical value of the marshland landscape, and the ecosystem itself provide a great potential for recreation and education purposes. Therefore, to optimize the benefit of a wetland I propose two additional programs which are wetland recreation-education and wetland expansion.

Program Analysis

Since the goal of the Commission is promoting economic development of Grand Isle community, the site program of research, education, and coastal restoration functions activities should eventually benefit the community economy. The leasing price of the site for the marine research although is not much, only $3,000 per year for 7 acres site, the community will gain benefit from other aspects. The benefits will come from visitors to Grand Isle. The marine laboratory users, guest researchers and other public visitors such as students, school teachers, and students' parents, will need place to stay and eat. Therefore, local motels, bed and breakfast, groceries, souvenir shops, and eating places will gain benefits. The visitors are also potential buyers for local aquaculture market, such as shrimp and oyster. Moreover, benefits for the community may come from some of the research works, such as research for efficiency and low cost processing method of aquaculture products, shoreline protection research, etc.

Oyster research facility could be a possibility in the bay area, front of the port property. However, information I obtained from personal communication with Keller, executive director of Grand Isle Port of Commission, the Commission request to use the water area is still denied by the Corps of Engineers because the water quality in that area at this moment is not safe enough for commercial aquaculture. Nevertheless, the Commission still looks forward to the possibility to obtain a permit for oyster farming research purpose. Hoping the permission will be given since the oyster is not for consumption or commercial market but merely for research. Despite the oysters from this plot are not safe to human consume, the oysters are still useful for research and education purposes. For example, teachers can use oysters in a class experiment to show students

about pollutants and use oysters as pollutant indicator since accumulate pollutant from the water where they live. If this oyster farming project is a success, the community will have a chance to adopt the new system to increase oyster harvest.

The preliminary small scale research conducted by Dr. John Supan from LSU Sea Grant shows a promising result of better and easier harvest of oyster. The oyster growing space occupies about 3,600 sq. ft. plot on water body and about 1,600 sq. ft. on land for breeding facility. A bigger plot of is needed to test the new oyster farming system in a scale of commercial farming. This oyster plant does not need a big piece of land because most of the farming activities will be in the water. The condition of water body for oyster farming requires shallow water body within tidal influence. The Caminada Bay condition in front of the property meets the physical condition needed, which is shallow. However, as mention before, the water quality has not met safety criteria for commercial oyster farming purpose.

The oyster research program gives a promising and potential for a continuity use of the site without having a significant site alteration. Nevertheless, with ongoing project of DWF marine research center, there could be a concern of water quality in the future. Effluent from laboratories, water navigation that requires continuous dredging, water turbidity effects, oil leaching from vessels, and other possibilities of environment changes that may not suitable anymore for oyster farming. Therefore, a detail study of any possible effects of environment quality caused by the marine laboratories, navigation canal and private marina should be conducted prior to decide whether the oyster research program will be continued.

A coastal plant resource center would be a program that will benefit Grand Isle community from coastal protection aspect. The coastal plant resource center will supply plants, such as mangroves, marsh grasses, trees, and shrubs for coastal restoration and mitigation with low prices. The plants prices from nursery outside the island are likely to be higher because the additional cost for transportation and handling fee. Moreover, having an on site field nursery has advantage on reducing plants acclimatization time.

A coastal plant field nursery, especially for Black Mangrove (*Avicennia germinans*) will make a good collaboration with the marshland feature on the property.

Mangrove planting beds can be incorporated to the existing wetland. This means a bigger area of wetland will be created.

Generally, the environment condition of Grand Isle (temperature, precipitation, topography, etc) seems promising for a nursery. Nonetheless, a detail survey to evaluate the site condition is necessary to determine the best management for a nursery. As a matter of fact, according to Morby (9), some compromises will be required to build a nursery because there is no perfect condition for a potential nursery site.

Besides the environment condition, there are four support functions needed in a field nursery program. Those functions are propagating, planting, storing/stocking, and collecting run off and treating irrigation water discharge. Figure 23 shows relation between those four functions.

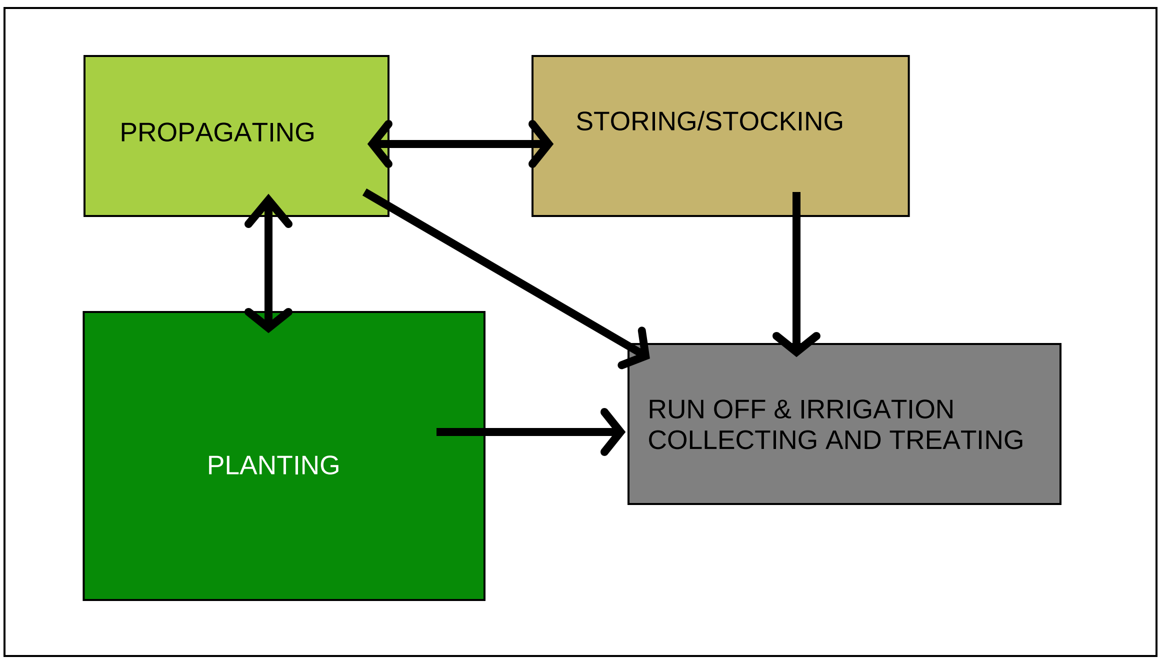


Figure 23. Functional Diagram of a Nursery

Those four functions will need structure or space to contain the activities which are: a greenhouse or greenhouses for propagating function, planting beds for planting, storage for stocking material and/or storing nursery equipments, and sewage treatment facility for collecting and treating run off and irrigation discharge.

The last program that the Commission tries to incorporate on the site is a commercial marina. The demand for a marina comes from local shrimpers who find difficulties to park their boats with an easy access to waterway. This marina is planned for berthing (boats parking) only since the Commission does not want to compete with other shipyard business that provides services such as fueling, maintenance, etc. Therefore, the commercial marina program will include four services which are berthing, storing, vehicles parking, sewage discharging and treating. A functional diagram in Figure 24 shows the services relation in a commercial marina program.

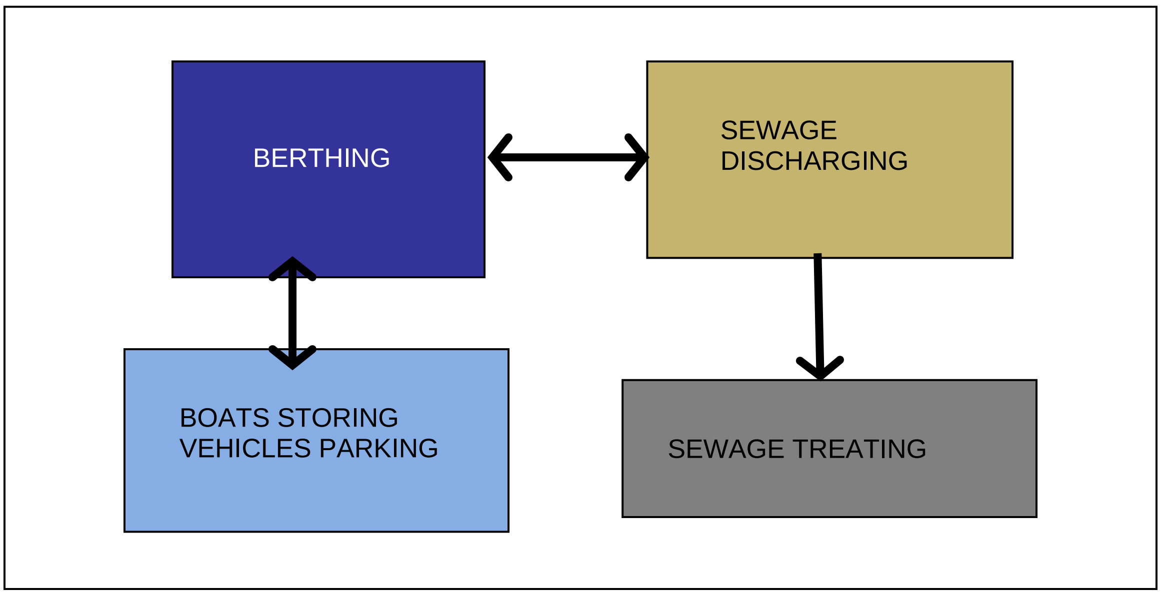


Figure 24. Functional Diagram of a Commercial Marina

Those functions will need structure or space to contain the activities which are: piers/docks for boats berthing, boat storage building for boats storing, parking lot for vehicles parking, pump out station for sewage discharging, and sewage treatment facility for treating sewage discharge.

The commercial marina program also has potential conflict with oyster research facility because both need adjacency to the water body. Moreover, the commercial marina almost certain, at some point, will experience oil leaching. This predicted condition will not favor oyster research plant, especially, when the Commission expects to continue the oyster project for commercial use. Another, important possible effect

from the marina program is man made structures (jetties, groins, seawall, etc) that may alter or block water flow and water quantity to the wetland area. However, that condition can be avoided with a careful land-water survey, evaluation, and detail engineering design application that will not cause any water blockage into wetland.

In spite of those possible negative conflicts previously mention, I put a big consideration of a possibility to apply the commercial marina program based on three reasons. First, there is a high demand of commercial marina from local shrimpers. Second, the oyster research project has another alternative site (Supan, 2004) with acceptable water quality for oyster farming. Third, the wetland area and Caminada Bay water body adjacent to the property has been used for waste water discharge. In order to meet the water quality requirement there should be a solution for the waste water discharge problem before the development of the oyster project. The fourth reason is the oyster project will suit the site for research purpose only, but with future expectation of business and commercial purpose of oyster farming, there is a potential hazard of chemical effluent from the marine laboratories. Meanwhile, as the fifth reason putting more consideration in a commercial marina program is commercial marina development has no direct conflict with the DWF marine research center. In fact, commercial marina and the DWF private marina can share navigation channel, other future channel maintenance, and possibly some marina services. Therefore, for the master plan development, I will focus on developing the marina program than oyster research project.

The two programs of wetland recreation-education and wetland expansion will complement each other as in “a give and take” relationship between human and nature. The wetland expansion program will give more area of nesting and sheltering for wildlife as well as provide more food source. On the other hand, human will benefit from enjoying the beauty and richness of wetland as well as having a natural protection from stormwaters. Moreover, the complexity of the ecosystem gives a perfect opportunity for students and public to learn about interdependency of each element in the wetland ecosystem.

The wetland program will provide users with opportunities to experience it outdoor and indoor. For instance, outdoor programs may include sightseeing, bird watching, outdoor class, while indoor programs may consist of audio visual presentation

of wetland ecosystem and a small wetland information center. Diagrammatically, the additional programs are presented in Figure 25.

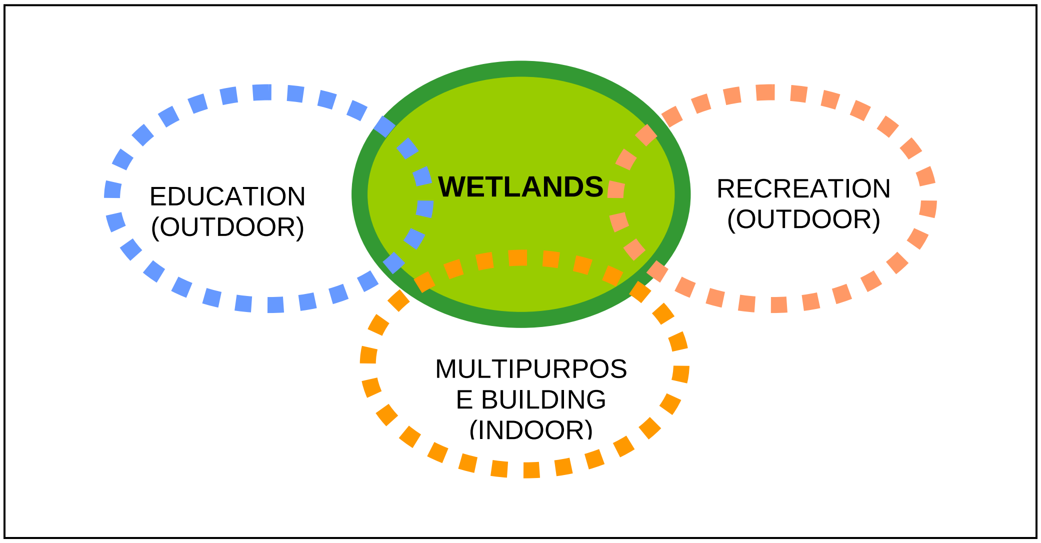


Figure 25. Functional Diagram of Wetland Program

The wetland expansion program and recreation and education programs do not have major conflict with other programs previously mentioned (marine research center, commercial marina, and coastal plant center). Instead, the two wetland programs will enhance the quality of the environment and other advantages that benefits other programs. For instance, more scientists or students, who interested in wetland research, will need to use the marine laboratory facilities. This will solve a problem of underutilized laboratory facilities (refer to St. Amant Marine Laboratory problem in Chapter 3 page 40). Meanwhile, staff and guests can have two different type of scenic landscape, which are marshland view as well as ocean view.

Program Development

Based on the consideration of the Grand Isle Port of Commission's goal, local community needs, and environment protection importance, there are four programs to be developed on the Grand Isle Port of Commission property. Those programs are:

- DWF Marine Research Center
- Commercial marina
- Coastal Plants Center (Nursery)

- Wetland Recreation-Education Center

A relationship diagram on Figure 26 shows coordination between programs that will be implemented on the site.

Conclusion

Based on program analysis there will be four main programs that will be developed further. Those programs are: 1) DWF Marine Research Center, 2) Commercial marina, 3) Coastal Plants Center (Nursery), 4) Wetland Recreation-Education Center. The next chapter, which is the Planning Concept, will discuss a guide that will address the programs' potentials and problems in response to the study objectives and how the programs should be implemented on the site.

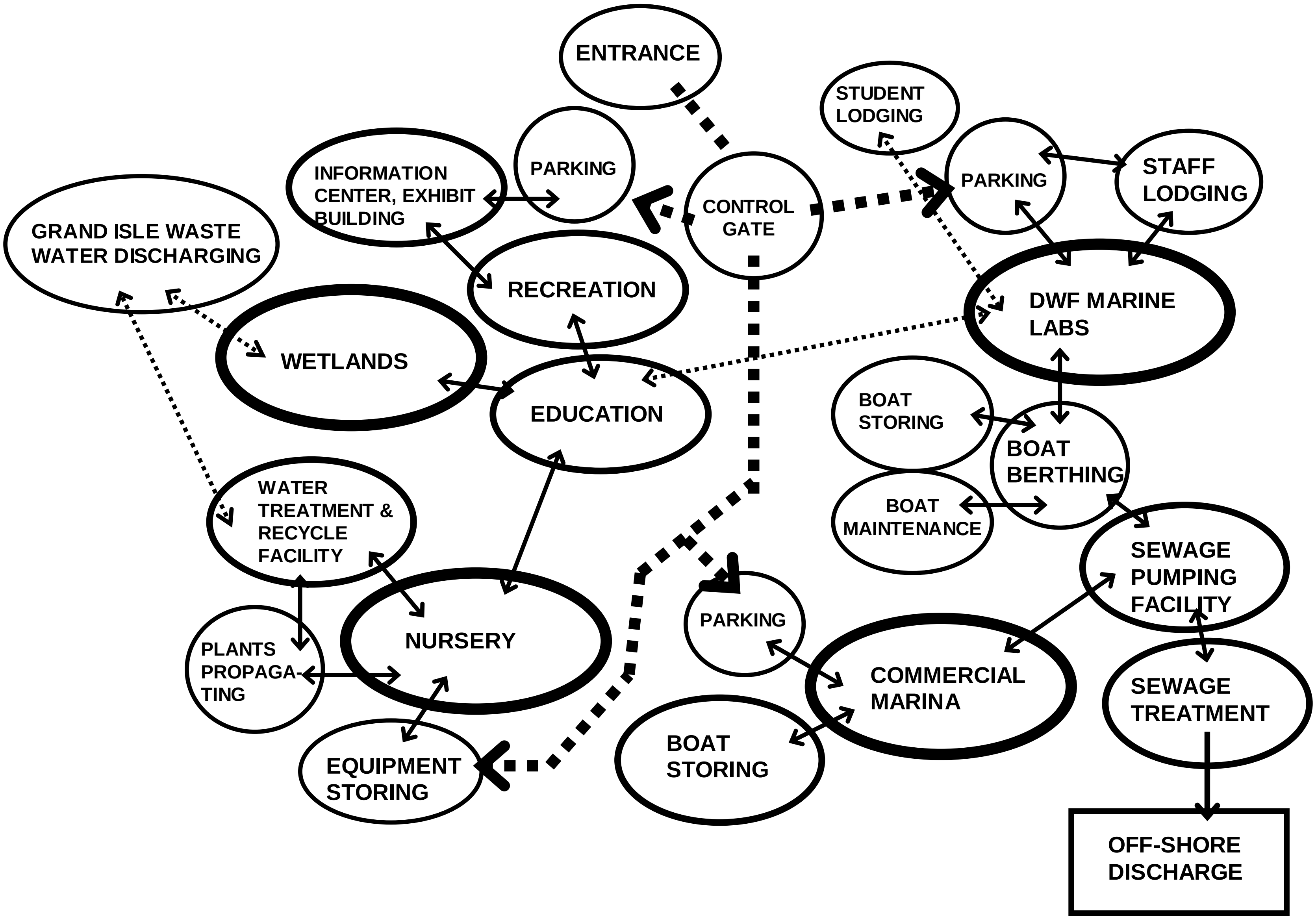


Figure 26. Program Relationship Diagram

CHAPTER 5. PLANNING CONCEPT

Introduction

In order to achieve the best possible planning result and guiding all decision to be made on the site, I need to propose a guide which is a planning concept for the site. This planning concept will influence every decision I make in locating the site programs that have been discuss in previous chapter, which are the DWF Marine Research Center, a commercial marina, a coastal plant nursery, and a wetland recreation-education center. The planning concept will guide the site development process to ensure an integrated design.

The Planning Concept of Port of Grand Isle

The planning concept for the site is based on the considerations of: 1) the sensitive environment of the barrier islands; 2) the importance function of barrier islands as the first line defense for mainland; 3) optimizing the use of the Grand Isle Port of Commission's property; 4) the local community economic needs and demands as well as community safety. I propose the concept of balance between the site's programs and the environment. Graphically, yin yang symbol may best represent the concept that I will apply to the site (Figure 27).

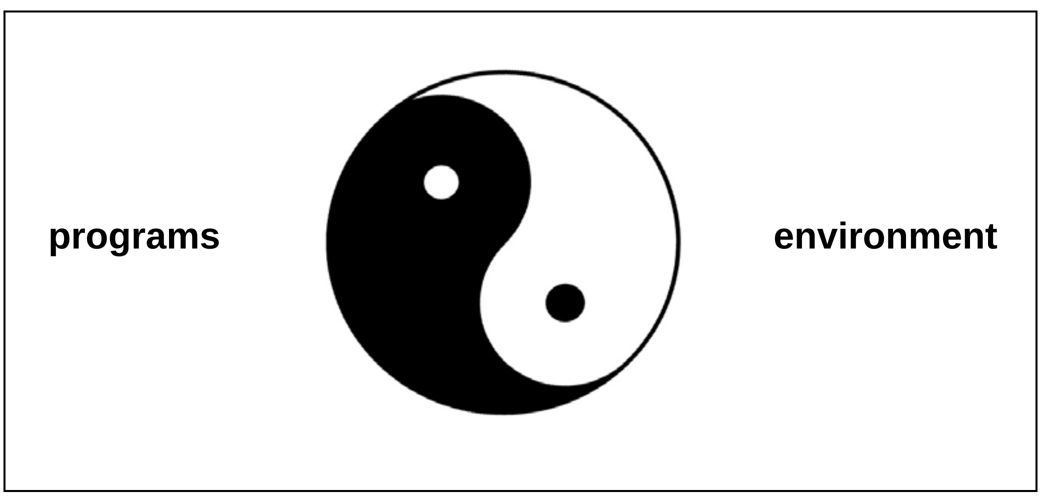


Figure 27. Planning Concept of the Port of Grand Isle

The intention behind this concept is using the natural resources for human welfare and at the same time preserving the environment by maintaining the resources and

enhancing the environment condition for other life beings and future use. This planning concept is trying to optimize the use of natural resources for the community benefits within barrier island environment sensitivity constraint.

Site Spatial Concept

Using the planning concept as the based, I propose a site spatial concept as an approach for both the programs discuss in Chapter 4 and their spatial relevance to the site. Figure 28 shows the spatial concept in graphic. This site spatial concept suggests a buffer that functions as a protection from nature forces (winds, storm-surge, flood, etc), a filter of pollutants, a partition from more industry setting to a dwelling/residential setting, and also a buffer for wildlife habitat from human interference.

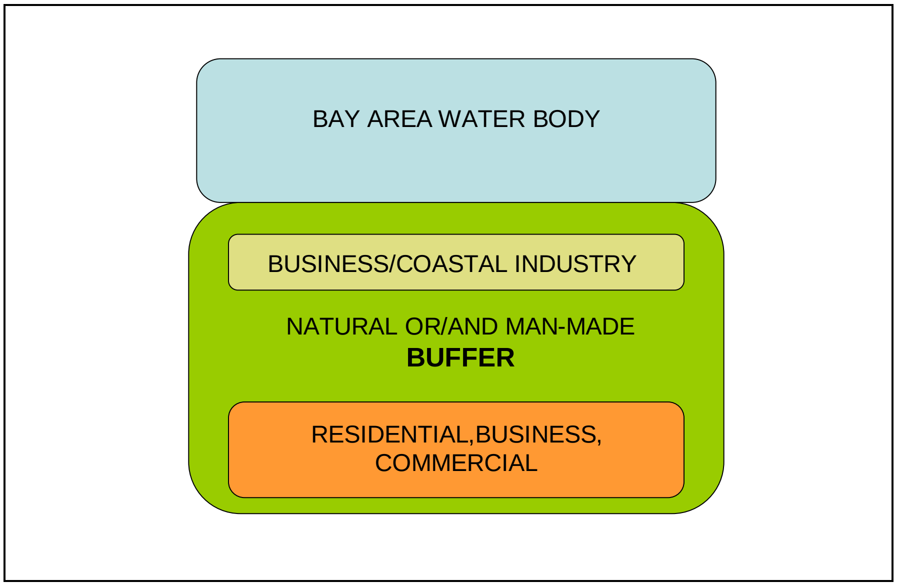


Figure 28. Spatial Concept

Conclusion

The balance of programs and environment is a guide in the planning process that should be translated into spatial form on the site. The programmatic diagram will transform onto site in the form of site layout. This spatial translation onto the site will be discussed in the next chapter of Master Plan.

CHAPTER 6. MASTER PLAN

Introduction

This chapter will discuss the implementation of the programs onto the site based on the planning concept that has been discussed previously. The master plan will address placement of structures or facilities, building footprint, plant masses, circulation plan, and suggested landscape elements to ensure the objectives of sustainable planning in a sensitive landscape setting.

Site Facilities and Structures

Previously in Chapter 4, I have discussed the programs relationship. The programs along other functions will be translated into site facilities and structures. The planning concept of balancing the programs and environment preservation lead to a refine programmatic diagram in. The diagram in Figure 29 shows facilities and structures connection for each program that will be developed on the site.

Schematic Plan

The schematic plan shows land use allocation and area size requires for each program (Figure 30). Detail calculation of required size for the commercial marina, additional area for DWF student dormitory, wetland center, and nursery facilities, please refer to appendixes D, E, F, and G. Information of building footprints and size for DWF Marine Research Center is taken from to Crump Wilson & Associates schematic design plan.

The Master Plan

The master plan (Figure 35) is the final planning and design product from this thesis based on all discussion from previous chapters. However, this master plan does not mean to be a final design for the site. The master plan will serve as a preliminary plan and design for future development on the site.

Evaluation for the Master Plan

The ecological aspect is addressed in the master plan by expanding the wetland. This allows wildlife to have more area for shelter, feeding ground, and nesting. The whole ecosystem of wetland then aesthetically provides natural landscape scenery to enjoy. Moreover, the residential community will benefit from the wetland by having protection from winds, storm surge, and flooding. Economically, local business may

benefit from wetland and the DWF Marine Research Center visitors who need place to eat and stay.

The Wetland Center provides visitors with a new attraction to Grand Isle besides fishing sport, bird watching trails, the state park, and the butterflies dome. The center will provides information using various methods, such as audio-visual, exhibition, and field study.

The Coastal Plants Nursery will supply plants for coastal protection project in the surrounding area. It may also serve as on site outdoor class of nursery practice and management for students. Moreover, the students may take advantage to learn the coastal ecosystem as well through the Marine Research Center that provides education programs and facility to students.

The Commercial Marina provides a public boats berthing for local shrimpers, which may help them to increase the efficiency and convenience in unloading the seafood products. The pump out station build on the marina suggests a healthy attitude of unloading sewage to the proper place for treatment. This effort will improve and promote a good image of the local seafood industry

The master plan gives opportunity for the future use to apply both research and non-research activities at the same time. Nevertheless, the mix use of the site will need a further detail survey of environment impact to address the best techniques of construction that will not damage the wetland and coastal ecosystem.

Building and structures for living, the DWF student dormitory and staff lodging, are surrounded or buffered by vegetation to obtain maximum protection from the hazards during severe weather. Architecturally, I suggest a building structure to have a compact form to adapt with hazards of a hurricane prone area (Chapter 2). Both vegetation cover and proper architectural forms of a structure will increase the level of protection to the property.

Conclusion

The property of Port of Grand Isle is designed as a promoting site of a sustainable and applicable site planning and design. It gives an opportunity to public to see and learn the interaction between the programs, impacts of programs to the environment (positives and negatives), and appreciating the natural resources as an asset to human life.

The master plan responds to the Grand Isle Port of Commission programs expectation while exploring site potentials to enhance the client's programs. It also addresses ecological, social, economics, and aesthetic aspect as an approach to a sustainable planning and design.

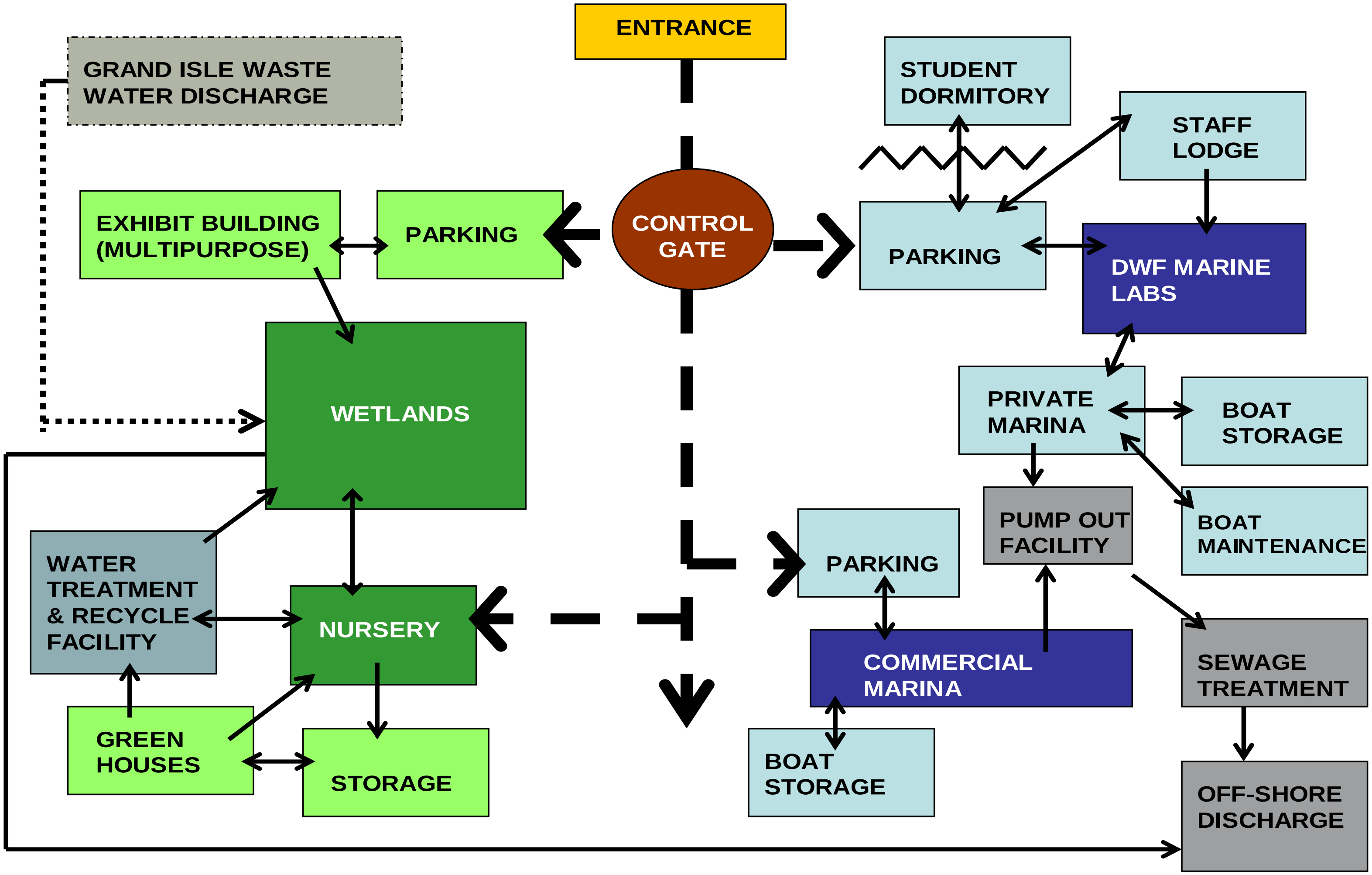


Figure 29. Site Facilities Diagram Connection

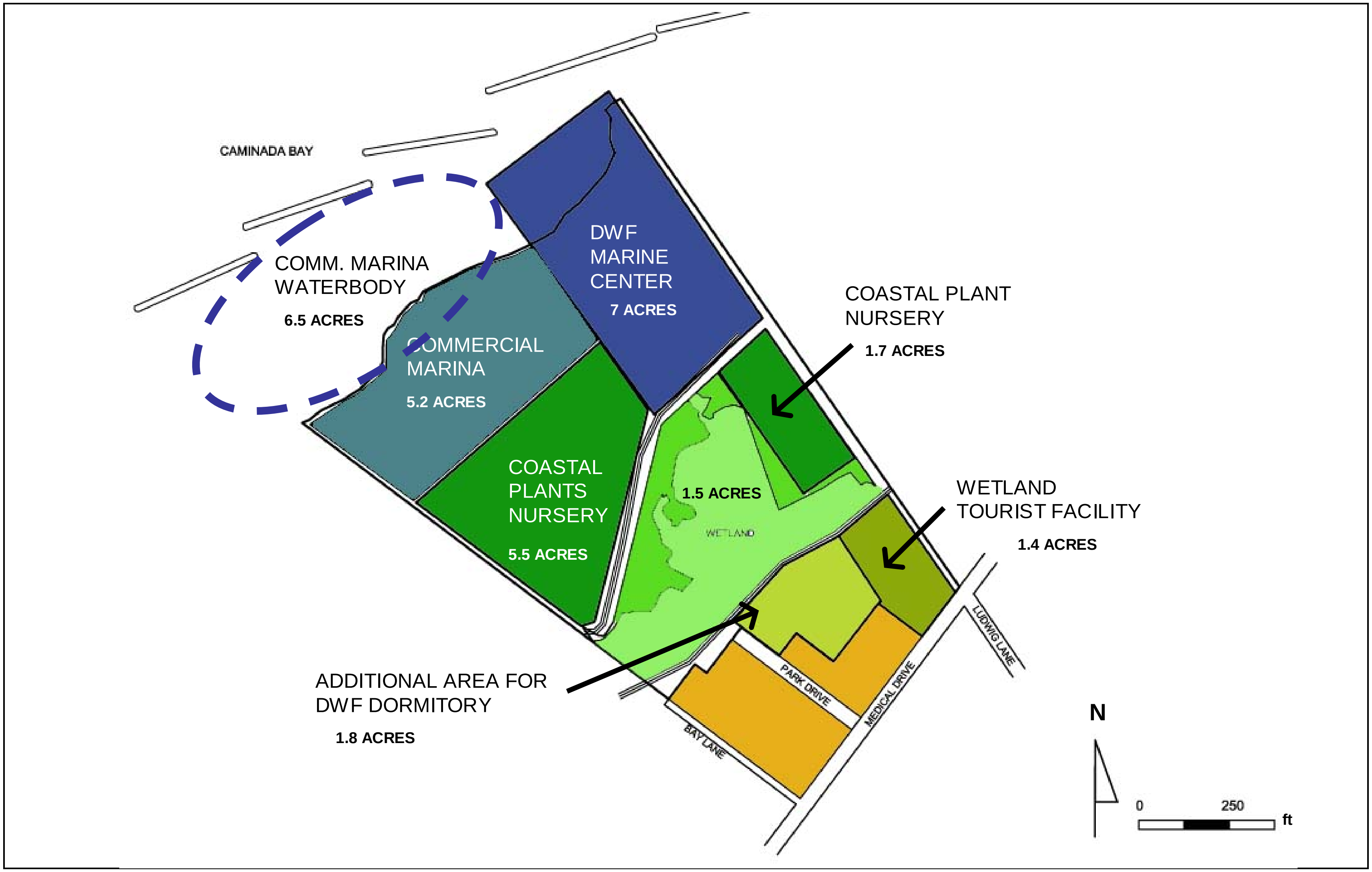


Figure 30. Port of Grand Isle Schematic Plan

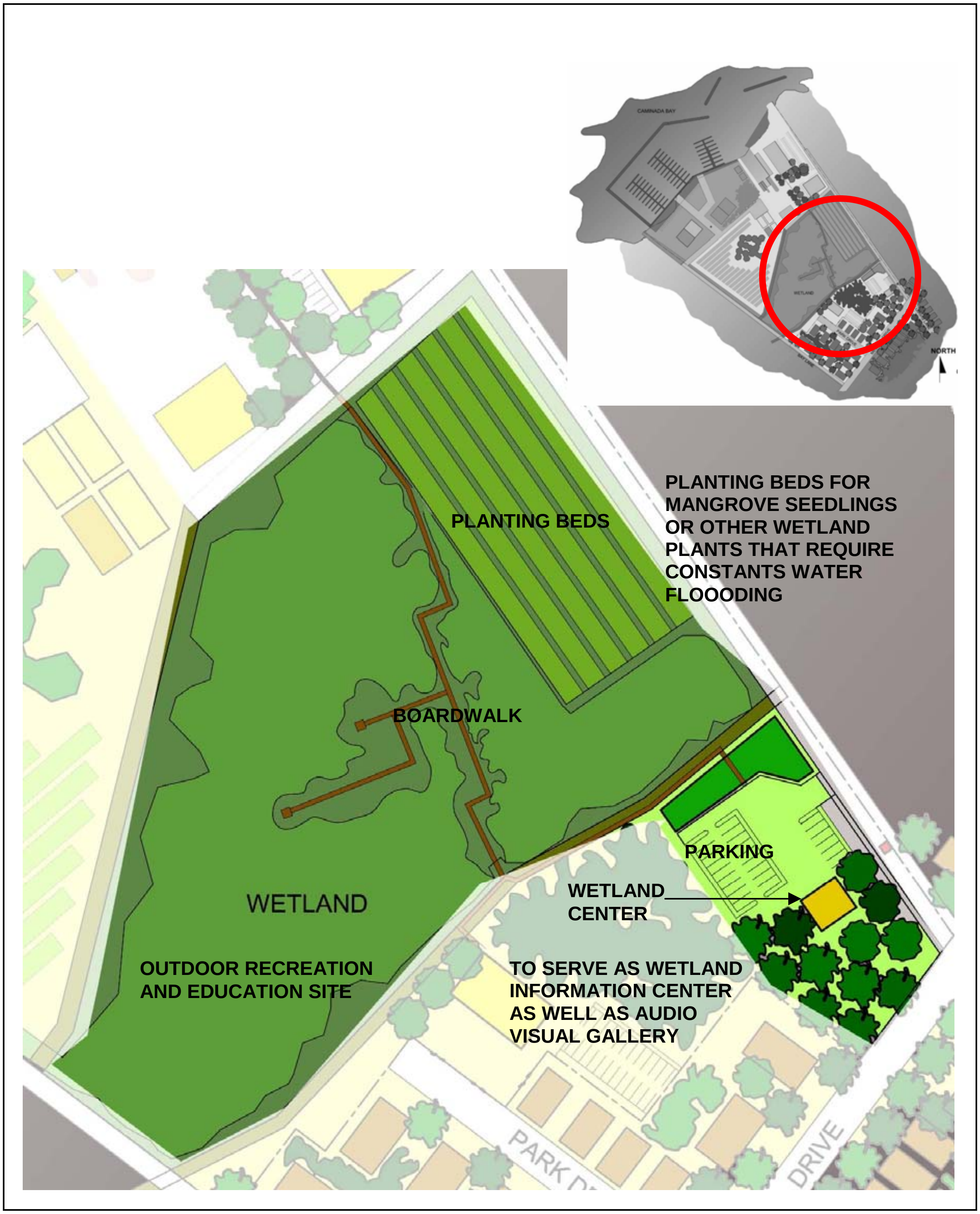


Figure 31. Wetland Center Site

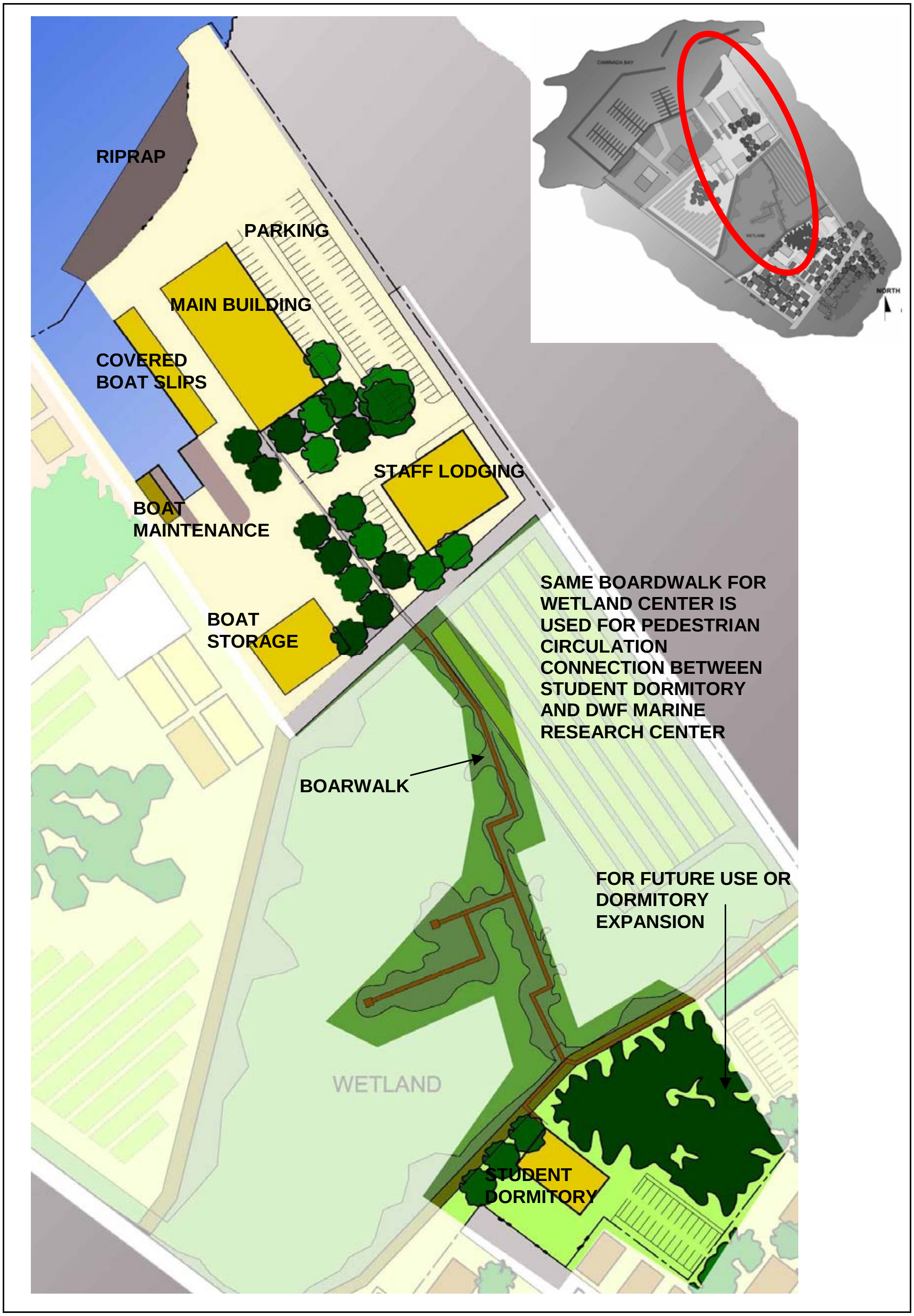


Figure 32. Department of Wildlife and Fisheries Site

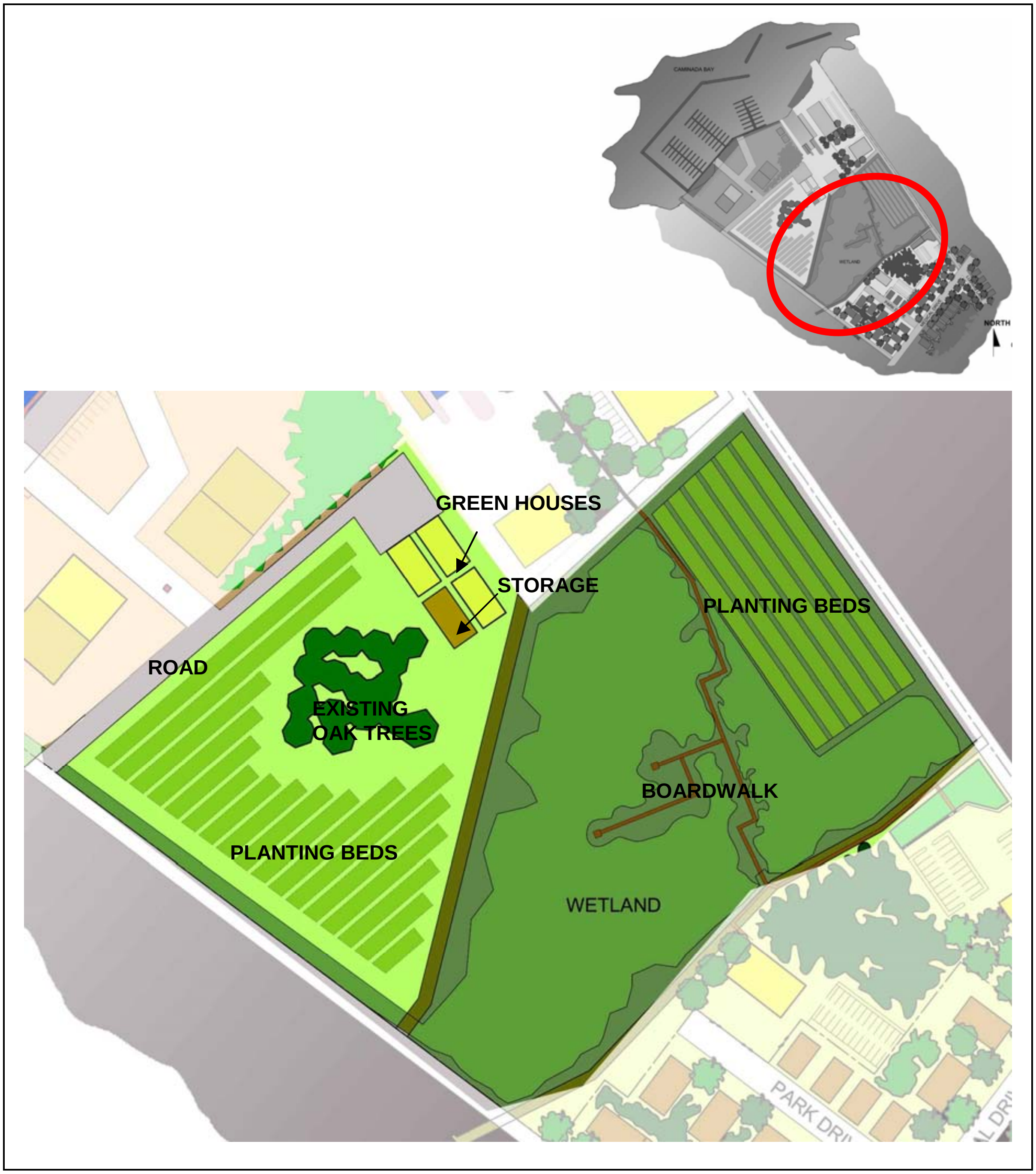


Figure 33. Coastal Plants Center Site

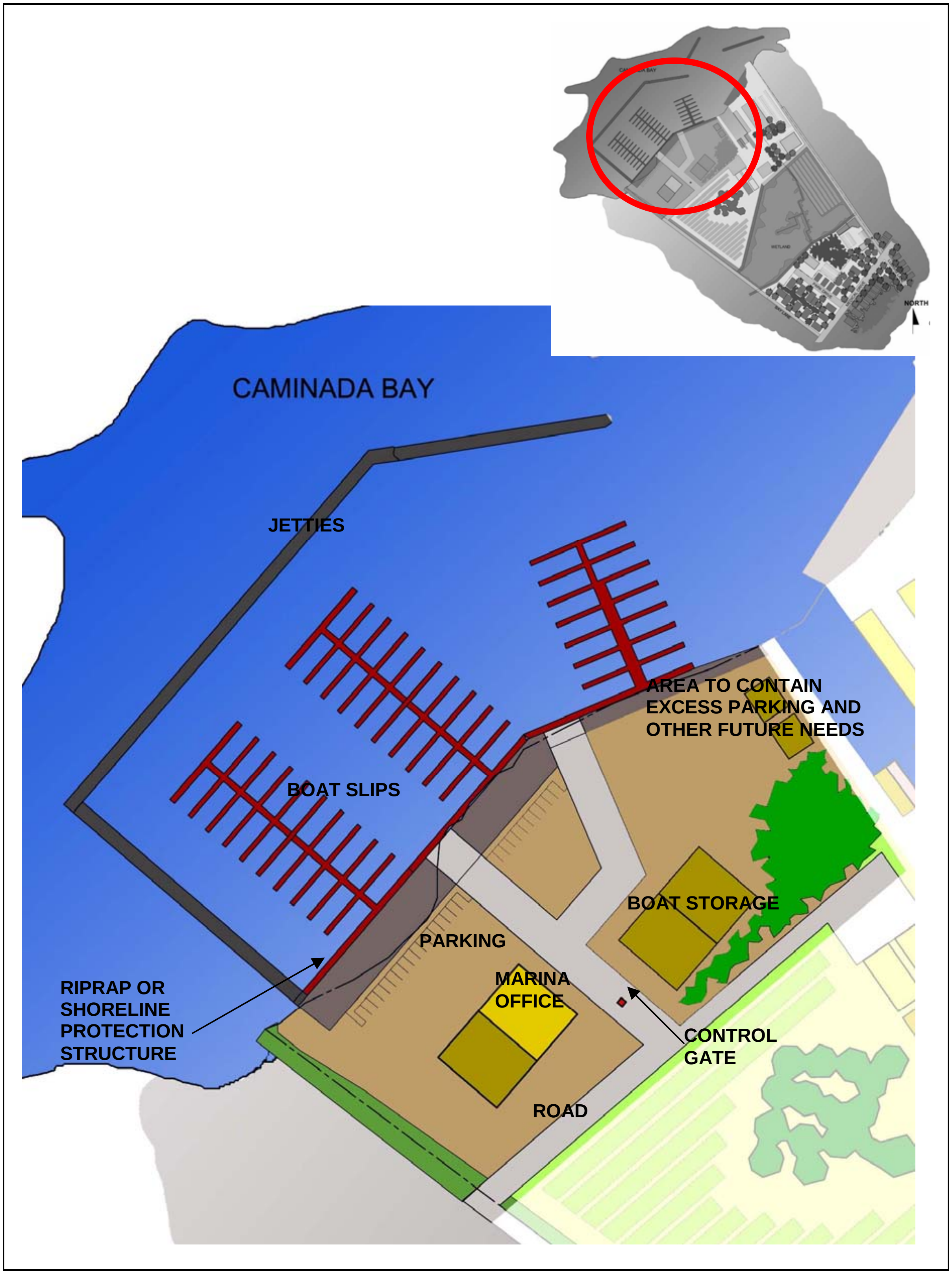


Figure 34. Commercial Marina Site

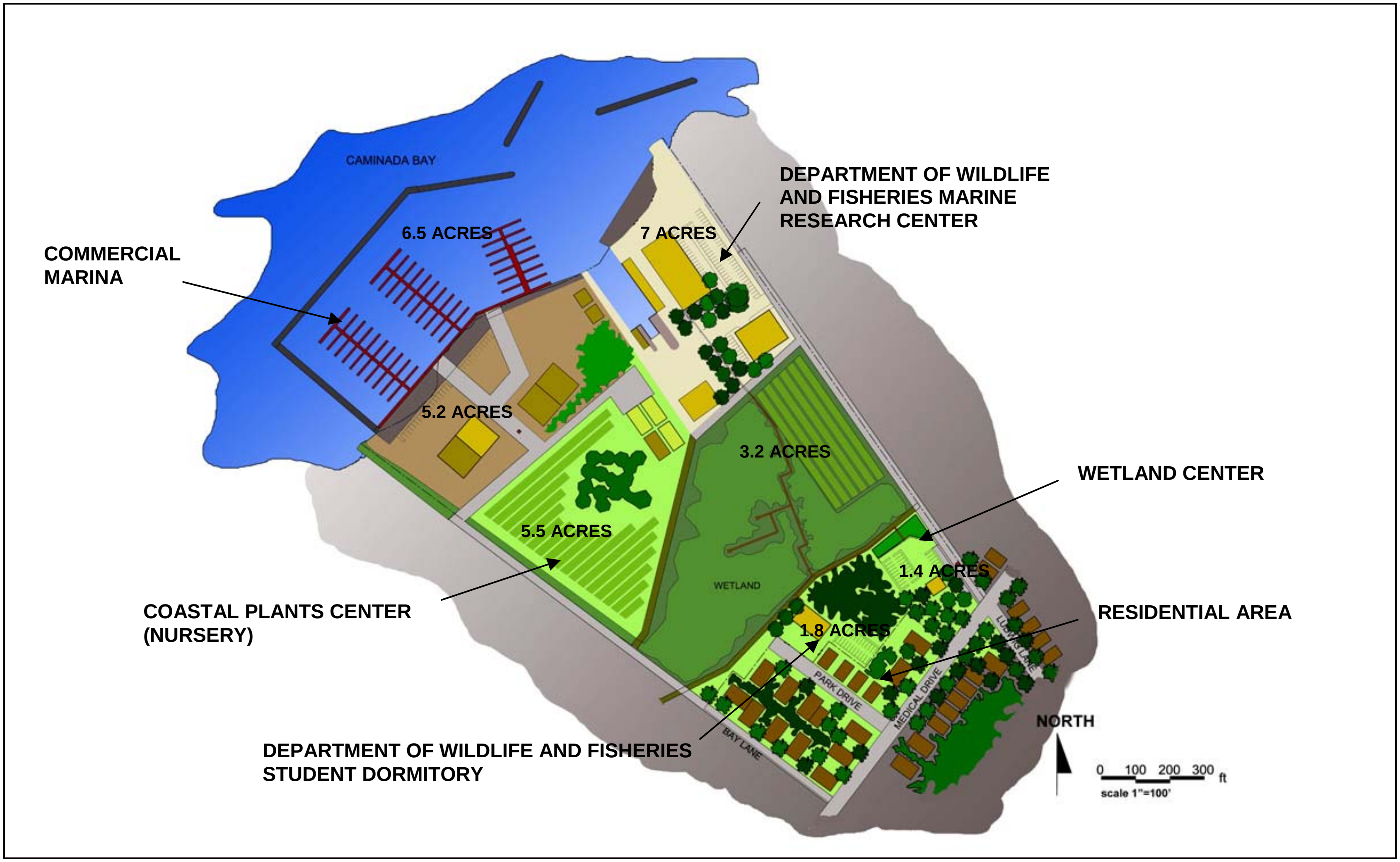


Figure 35. Port of Grand Isle Master Plan

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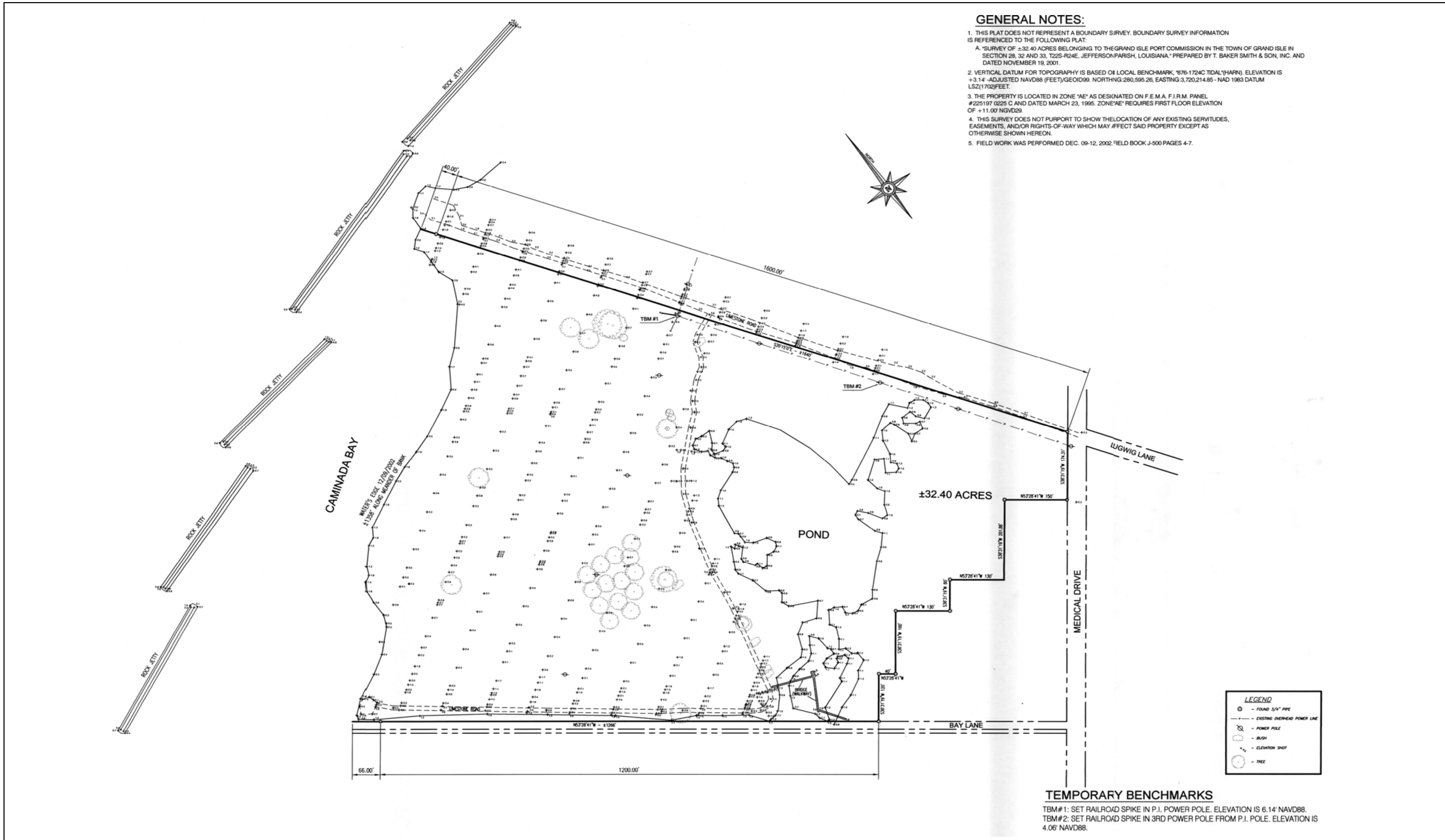
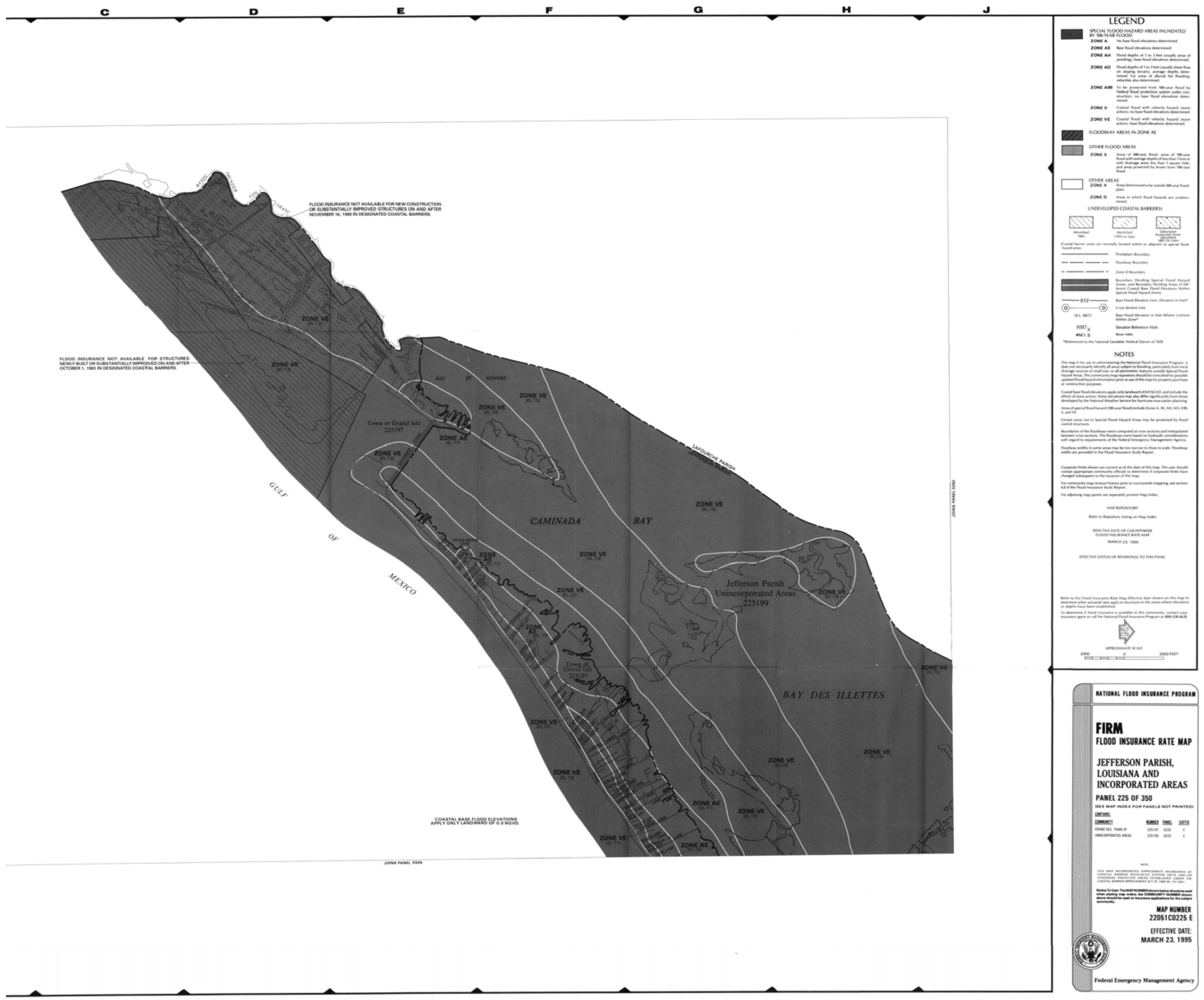
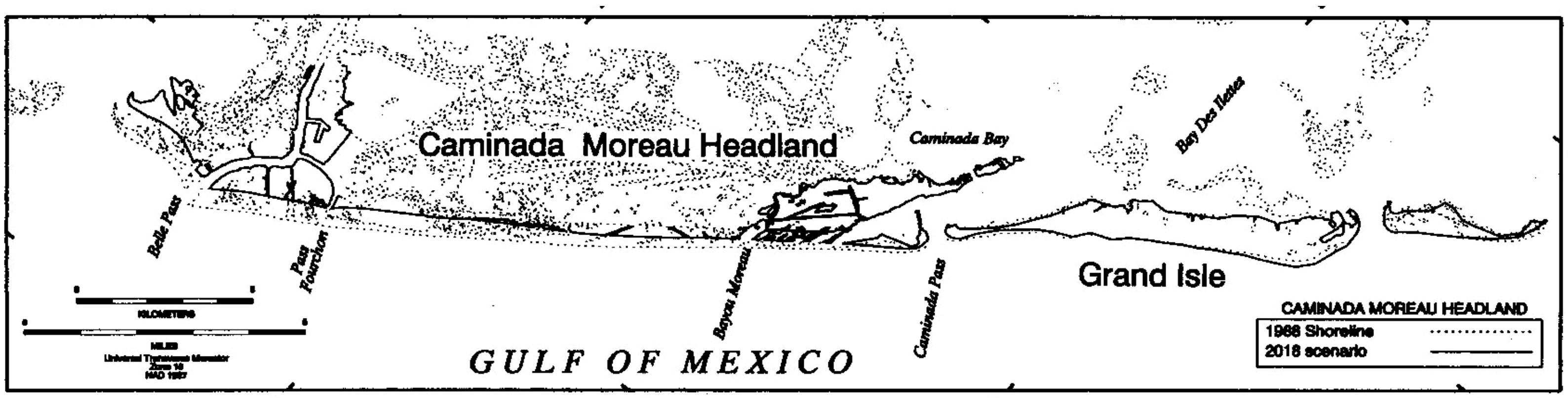
APPENDIX A: SITE ELEVATION OF PORT OF GRAND ISLE



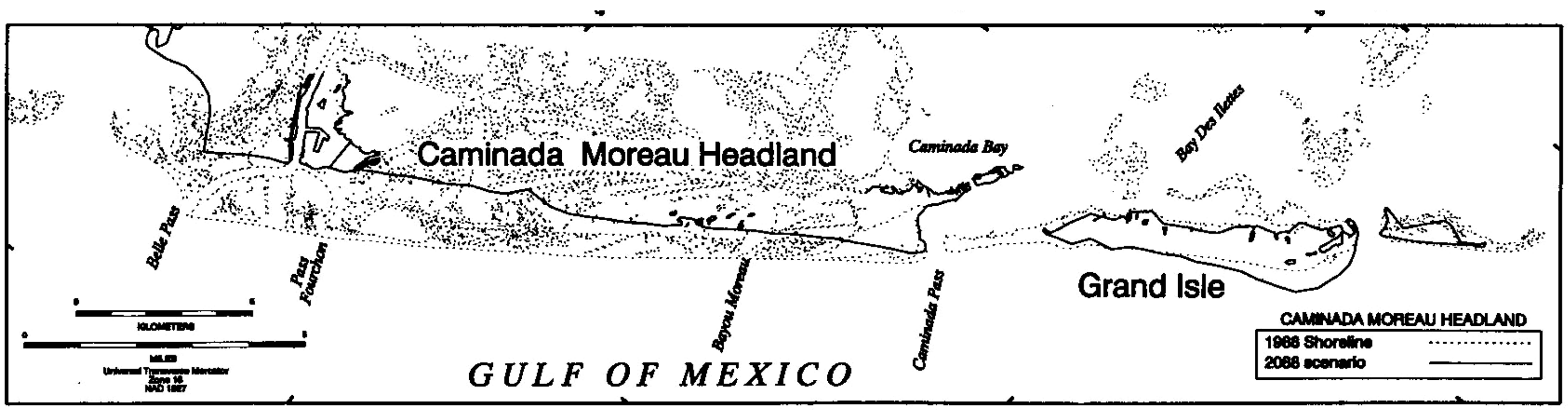
APPENDIX B: FLOOD INSURANCE MAP OF JEFFERSON PARISH, LA



APPENDIX C: GRAND ISLE SHORELINE PROJECTION IN THE FUTURE



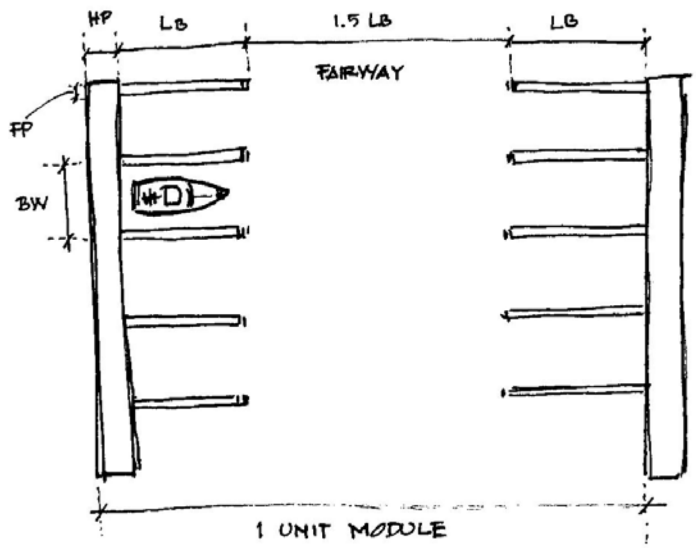
Grand Isle shoreline projected 30 years into the future (2018 AD) and superimposed on the 1988 shoreline (dotted)



Grand Isle shoreline projected 100 years into the future (2088 AD) and superimposed on the 1988 shoreline (dotted)

APPENDIX D: AREA CALCULATION FOR A COMMERCIAL MARINA

Marina is designed for 50 boat slips with boat length up to 63 ft.



Calculation for one unit module of dock, one unit module contains 10 boats:
LB (boat length) = 63'
FW (fairway) = 1.5 x LB = 1.5 x 63 = 94.5'
HP (head pier width) = 8'
TL (Total length for 1 unit module) = (2 x LB) + FW + HP
= (2 x 63) + 94.5 + 8
= 228.5'
BW (boat width) = 23'
FP (finger pier width) = 6'
5 slips on each head pier
TW (Total width for 1 unit module) = (BW + FP) x 5
= (23 + 6) x 5
= 145'

Total water body area require for 50 boats = 5 x TL x TW
= 5 x 228.5 x 145'
= 165,662.5 sq. ft
= 3.8 acres

Ratio of water-land requirement for a marina:

A: boat slip and dock area	= 32%
B: channel and fairway access	= 24%
C: car parking	= 8%
D: building and support facilities	= 6%
E: boat storage, haul out, overflow parking, etc.	= 30%

Area calculation for B, C, D, and E based on A
A = total water body required for 50 boats
= 165,662.5 sq. ft (3.8 acres)

B = (0.24 x 165,662.5)/ 0.32
= 124,246.875 sq. ft (2.8 acres)

C = (0.08 x 165,662.5)/ 0.32
= 41,415.625 sq. ft (0.95 acres)

D = (0.06 x 165,662.5)/ 0.32
= 31,061.72 sq. ft (0.7 acres)

E = (0.3 x 165.662.5)/ 0.32
= 155,308.59 sq. ft (3.56 acres)

Source: Marinas and Small Craft Harbors, 1991; Developing with Recreation Amenities: Golf, Tennis, Skiing, Marinas, 1986

APPENDIX E: AREA CALCULATION FOR STUDENT DORMITORY

Dormitory is designed for 50 people.

A = Room with bunk bed for 2 persons requires minimum 140 sq. ft
B = Room with two-single beds for 2 persons requires minimum 180 sq. ft

Rooms will be design base on composition of 40 people in 20 bunk bed rooms and 10 people in 5 two-single beds rooms.

Area required for rooms = (A x 20) + (B x 5)
= (140 x 20) + (180 x 5)
= 2,800 + 900
= 3,700 sq. ft

Area required for other basic facilities to serve approximately 50 people:
Kitchen = 320 sq. ft
Dining and Common Room = 1,100 sq.ft
Toilet = 720 sq. ft

Total area required for student dormitory = 3,700 + 320 + 1,100 + 720\
= 5,840 sq. ft (0.13 acres)

Source: Time-saver Standard for Building Types, 1990

APPENDIX F: AREA CALCULATION FOR COASTAL PLANTS NURSERY

Nursery is designed based on minimum area required for green house or green houses to gain profit which is 40,000 sq. ft

For every 6,000 sq. ft growing area, requires 1,000 sq. ft service area

Based on the designated area for planting beds of 6 acres (261,371.4 sq. ft), service area size needed is:

= (261,371.4/6,000) x 1000
= 43 x 1,000
= 43,000 sq. ft (1 acre)

Source: Time-saver Standard for Building Types, 1990

APPENDIX G: AREA CALCULATION FOR WETLAND CENTER BUILDING

I use a small exhibit hall standard to calculate area requirement for wetland center building.

A: Basic building plan = 1,974 sq. ft
B: Basic building plan with possible future expansion lot = 3,854 sq.ft

Visitors parking spaces requirement based on B = (3,854 x 1.5) / 250
= 5,781/250
= 23 spaces
23 spaces = 86,715 sq. ft

Source: Time-saver Standard for Building Types, 1990

VITA

Naniek Kohdrata was born in Surabaya, East Java, Indonesia, in August 1, 1974. She is the daughter of Paulus Kohdrata and Anita Irawati. She lived in Surabaya until she finished her high school. She spend most of her time in Bogor, East Java, while studying landscape architecture in undergraduate program at Bogor Agricultural University, East Java and graduated in 2001 with a degree in Bachelor of Landscape Architecture. In August 2001, she was admitted into the graduate program of landscape architecture at Louisiana State University. She is currently a candidate for the degree of Master of Landscape Architecture, which will be conferred in December 2004.