COUNTY COUNCIL OF BEAUFORT COUNTY
BEAUFORT COUNTY PLANNING DIVISION
Beaufort County Government Robert Smalls Complex
Administration Building, 100 Ribaut Road, Room 115
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SPECIAL PLANNING COMMISSION
Tuesday, March 15, 2016
5:30 p.m.
Executive Conference Room 170
County Administration Building
100 Ribaut Road, Beaufort, South Carolina

In accordance with South Carolina Code of Laws, 1976, Section 30-4-80(d), as amended, all local media was duly notified of the time, date, place and agenda of this meeting.

1. CALL TO ORDER – 5:30 P.M.

2. PLEDGE OF ALLEGIANCE

3. REVIEW OF CHAPTER 5: NATURAL RESOURCES (backup)

4. PRESENTATION OF SEA LEVEL RISE ADAPTATION REPORT (backup)

5. OTHER BUSINESS
   A. Next Meeting – Tuesday, April 12, 2015, at 5:30 p.m., Executive Conference Room, Administration Building, 100 Ribaut Road, Beaufort SC

6. ADJOURNMENT

5

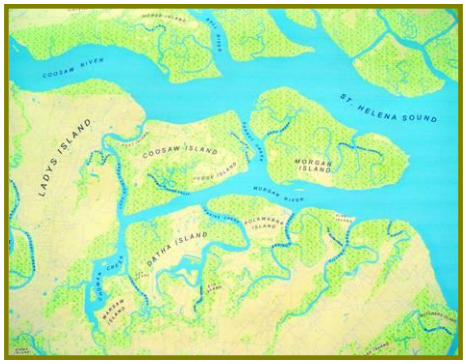
Beaufort County Comprehensive Plan

Natural Resources

Table of Contents

Introduction

Protection and preservation of Beaufort County's natural resources is a principal component of this plan. Beaufort County has a unique natural beauty, made up of expansive marsh vistas teeming with marine life, sub-tropical maritime forests of live oaks and palmettos, towering pines, forested wetlands of cypress and tupelo and over 30 miles of beaches. Beaufort County residents and visitors have a great attachment to the land and water. Many symbols of the region are an indicator of the region's ecological well-being. Shrimp boats plying the waters and vast expanses of *Spartina* grass waving in the breeze are an indicator of good water quality. Live oaks and Spanish moss point to good resource protection and air quality. Beaufort County's natural environment, however, cannot be taken for granted. If not managed properly, the County's rapid pace of growth will have grave consequences for water quality, forest communities, wetlands, and beach erosion.



Physical Features and Constraints

Beaufort County, like all coastal areas in the southeast, continues to attract new residential and commercial development. The County's geographical and environmental characteristics, however, place many limitations to development. Beaufort County consists of more water than land. Of its 468,000 acres, approximately 51% consists of open waters, sounds, marshes, and estuaries. An additional 14% are freshwater wetlands. The ubiquitous presence of tidal waters, low elevation, and waterlogged soils present unique constraints to development and make the natural environment particularly vulnerable to the impacts of growth. Beaufort County is also susceptible to many natural hazards, including hurricanes, shoreline erosion and earthquakes.

Climate and Weather

Storm looming over the Chechessee River.

The climate of Beaufort County is subtropical, characterized by long, hot summers followed by short and relatively mild winters. The County's precipitation rate averages 49 inches per year with about 70% of the annual rainfall occurring during the April through October growing season. The Sea Islands commonly have winter temperatures 3 to 5 degrees warmer and 30 to 40 additional frost-free days than the more inland areas. Historically, an average of one hurricane or tropical storm visits the South Carolina coast every 4 to 5 years. Since 1900, eight category 2 or larger storms have made landfall in Beaufort County, which is especially vulnerable to storm surge flooding due to its low-lying nature and relatively shallow offshore waters.

Elevation

Beaufort County is generally flat and low-lying with elevation ranging from sea level to 42 feet in the Gray's Hill portion of northern Port Royal Island. The County's low elevation makes it very vulnerable to coastal flooding. Approximately 400 square miles or 2/3 of the County's land mass lies within the 100-year floodplain. The primary factors contributing to flooding are storm surges associated with

hurricanes, tropical storms and northeasters. To help predict the impact of future storms, the National Weather Services has produced the sea, lake and overland surge from hurricanes (SLOSH) model (Map 5-1). During a category 3 storm, over 70% of the County's uplands would be under water. A category 5 storm would render all but 7% of the County's land area under water.

The County's low elevation makes it very vulnerable to coastal flooding.

Even a modest increase in sea level would have a profound impact on Beaufort County. In 2007, the Intergovernmental Panel on Climate Change estimated that global sea level is likely to rise 7 to 23 inches over the next century, but also indicated that the sea could rise an additional 3 to 6 inches if polar ice sheets begin to disintegrate. Along the mid-Atlantic coast, sea level rise is generally expected to be 4 to 8 inches more than the global average rise.[1] Sea level rise and higher evaporation rates are expected to increase storm frequency and severity, worsening such environmental hazards as storm surge flooding, erosion, and saltwater infiltration into ground water.

SOILS

Beaufort County's soils also place many constraints to development. As classified by the United States Dept. of Agriculture Natural Resources Conservation Service (NRCS) Soil Survey, Beaufort County has 36 different types of soils in addition to water areas, borrow pits and beach areas. The five most common soils are Bohicket association (24%), Capers association (10%), Wando fine sand (8%), Coosaw loamy fine sand (6%), and Seabrook fine sand (5%).

Organic fall crops on St. Helena Island.

Hydric Soils: A hydric soil is a soil that is saturated with water for all or part of the growing season. Hydric soils have a low infiltration potential and high runoff potential. NRCS has classified 73% of the soils in Beaufort County as hydric (Map 5-2). The wet nature of Beaufort County's soils affects the location of suitable agricultural areas and building sites, the rate of stormwater runoff, and the functionality of septic systems.

Agriculture: The NRCS has inventoried land that can be used for the agriculture. Prime farmland is land that has the best combination of physical and chemical characteristics for producing crops. The second category, farmland of state importance, includes areas of soils that nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. The NRCS has designated 90% the County upland acreage as "prime" or "additional farmland of state importance." These designations are assigned due to soil characteristics

[1] Intergovernmental Panel on Climate Change, Climate Change 2007 Synthesis Report

and a location that is favored by warm moist air from the nearby ocean and tidal streams. The USDA stipulates that, when the soils are well managed, they are among the most productive in the region. Some of the soils identified as important farmland require irrigation or drainage. This is due to the high water tables in the area and the abundance of sandy soils (Map 5-3).

Preservation of farmland in the County is important to the maintenance and growth of local food production, the economic well being of local farmers, and maintenance of green space. Much of the land suitable for agriculture has been committed to development. The remaining farmland is concentrated on St. Helena Island, northern Port Royal Island and north of the Whale Branch River. Efforts to preserve remaining farmland should be focused on these areas.

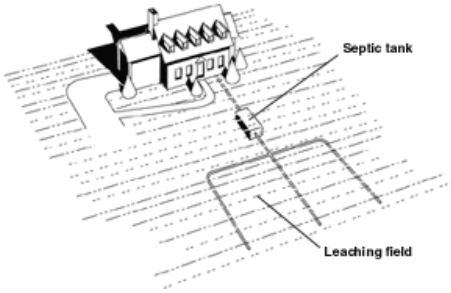


Diagram of a typical on-site sewage disposal system.

On Site Sewage Disposal Systems: Septic tank absorption fields require soils that allow effluent to be properly distributed into the soil. The NRCS classifies 74% of Beaufort County's soils to be "very limited" in their suitability to support septic systems. In fact, no soils in the County are classified as "not limited", the most ideal environment for septic systems. The State (SCDHEC) has different criteria than the NRCS for installation of septic tank absorption fields. The NRCS criteria are three foot depth from the bottom of the drain field to the water table, while SCDHEC requires a six inch depth from the bottom of the drain field to the high water table. SCDHEC makes the determination by looking at soil indicators, thereby removing the seasonal variation in water table levels as a criterion. Because many sites in South Carolina are unsuitable for conventional on-site wastewater systems, the SCDHEC Bureau of Environmental Health has developed 15 alternative standards with specific requirements designed to provide proper on-site treatment on disposal of domestic wastewater.[2]

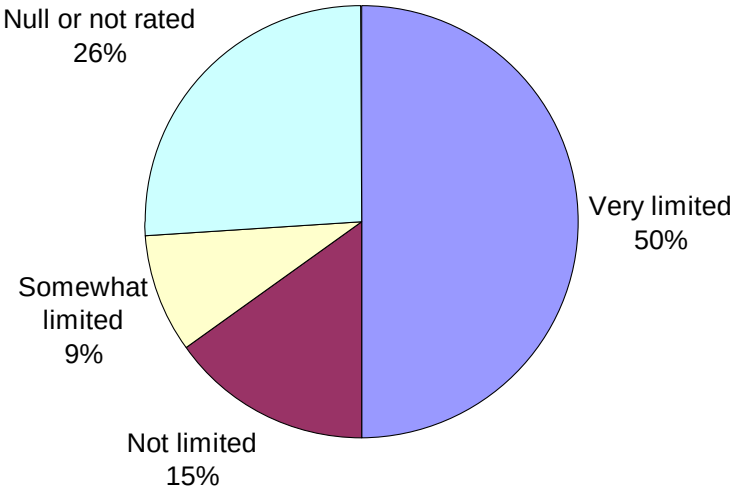
Only 24% of the County's soils do not have severe limitations to the construction of dwelling units

Construction: The fragility of the soils in the County is illustrated further by the NRCS designations of soils that are suitable for constructing dwellings without basements. Only 24% of the soils in the County are considered to be "not limited" or "somewhat limited" for the construction of a single-family house of three stories or less. The ratings for dwellings are based on the soil properties that affect excavation and construction costs and the capacity of the soil to support a load without movement. These properties include the depth of the water table, ponding, flooding, subsidence, shrink-swell potential, and compressibility.

[2] Personal communication. Feb., 2008. Blaine Lyons, R.S., Environmental Health Director, Region 8, DHEC.

The County's geographical and environmental characteristics place many limitations to development.

Chart 5-1: Suitability of Beaufort County Soils for Construction of Dwellings Without Basements



Source: USDA Natural Resource Conservation Service Soil Survey

CONCLUSIONS

The constraints and limitations of the County's geography, climate and natural environment need to play a greater role in future land use planning, site plan review, and the location of infrastructure and County facilities. This is especially true of the County's soils, which affect everything from agriculture, drainage, to suitability of on-site septic systems.

Salt Marshes, Coastal Waters and Marine Resources

The health of Beaufort County's waterways and adjacent marshes is vital to the region's identity, culture and local economy. Shrimp, crabs, and oysters, staples of Lowcountry cuisine, depend on the marshes for all or part of their lifecycle. Recreational fishermen flock to the region for its abundant sheepshead, flounder, croaker, sea trout, whiting and cobia. Marshes also serve to stabilize the shoreline and help absorb floodwaters and storm surges. Finally, the quality of life created by the aesthetic and recreational opportunities serves the residents of the County and attracts tourists and newcomers.

The issue of water quality has been at the forefront of local government initiatives in Beaufort County over the last 20 ~~15~~ years. In 1995, the closure of 500 additional acres of shellfish beds due to high levels of fecal coliform bacteria alarmed many County residents. This event sparked a heightened awareness of the importance of water quality to the overall health of the natural resources in the region and led to the creation of the Clean Water Task Force, which initiated the Special Area Management Plan (SAMP) for Beaufort County. The SAMP process led to many local programs, policies and ordinances that address water quality.

Shrimp, crabs, and oysters, staples of Lowcountry cuisine, depend on the marshes for all or part of their lifecycle.

Estaurine Environment

Of the County's 468,000 acres, 51% are tidally influenced, consisting of sounds, rivers, creeks, and marshes. With the exception of the Combahee, New and Coosawhatchee Rivers, there is an absence of freshwater rivers. The Beaufort, Broad, Colleton, and May Rivers, for example, are actually large saltwater arms of the ocean that ebb and flow twice daily with the tides. Beaufort County lies within the Savannah River and Combahee/Ashepoo/Broad River Basins and is further subdivided by five watersheds (Table 5-2 and Map 5-4).

Table 5-2: Basins, Watersheds, and Sub-Watersheds in Beaufort County

Basin	Watershed	Sub-Watershed
Savannah River	New River	
	May River/Calibogue Sound	May River
		Calibogue Sound
Combahee/Ashepoo/ Broad River	Coosaw River/St. Helena Sound	Coosaw River
		Morgan River
		Coastal
	Broad River/Port Royal Sound	Whale Branch West
		Broad River
		Beaufort River
		Colleton Okatie River
		Chechessee River
	Combahee River	

Source: Watershed Water Quality Assessment: Salkehatchie River Basin, SCDHEC, 2003; Beaufort County Stormwater Management Plan, 2006, Thomas & Hutton Engineering Co.

Placards found on storm drains and catch basins.

The water bodies of South Carolina have been classified by SCDHEC based on the intended uses for each waterbody. SCDHEC uses these classifications to determine permit limits for treated wastewater dischargers and other activities that may impact water quality (see Maps 5-5 and 5-6).

Table 5-3: SCDHEC Water Body Classifications in Beaufort County

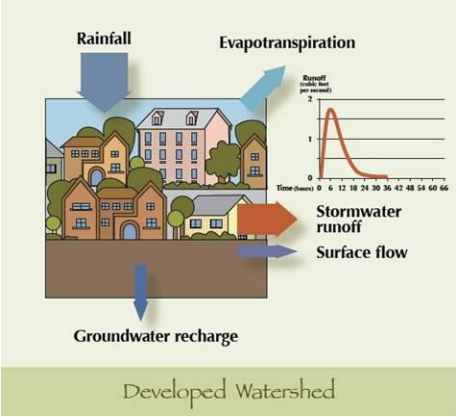
Water Classification	Description
Outstanding Resource Waters (ORW)	Waters that are an outstanding recreational or ecological resource.
Shellfish Harvesting Waters (SFH)	Tidal saltwaters protected for shellfish harvesting.
Tidal Saltwaters (SA)	Waters suitable for primary and secondary contact recreation, crabbing and fishing.
Freshwaters (FW)	In Beaufort County it applies to the upper reaches of the Combahee River.

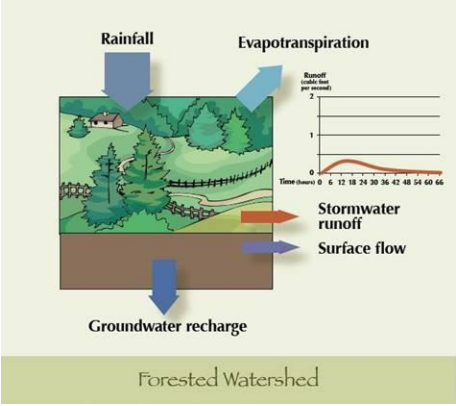
Source: Watershed Water Quality Assessment: Salkehatchie River Basin, SCDHEC, 2003

Beaufort County experiences the largest tidal range on the Atlantic coast south of Maine. The difference between high and low tide ranges between 6 feet during neap tides and 10 feet during spring tides. The region's unusually large tides are largely responsible for the prominence of saltmarshes. Smooth cordgrass (*Spartina alternifolia*) the primary plant species in saltmarshes, thrives in places where it is both submerged in saltwater during high tides and exposed to air during low tides. Each fall, smooth cordgrass dies and is slowly decomposed by bacteria. The resulting mixture, called detritus, is a major food source for zooplankton (including the larval stages of shellfish and fish) and for

clams, mussels, oysters, shrimps, and certain fish.

THREATS TO WATER QUALITY





Source: Tidal Creek Habitats: Sentinels of Coastal Health, NOAA.

The greatest threats to Beaufort County's estuarine environment come from non-point source pollution associated with stormwater runoff, drainage, seepage and septic system failure. Because non-point source pollution originates from many different sources, it is difficult to control. Increased flows and pollutants from impervious surfaces, resulting from coastal development (rooftops, roads, parking lots), are a primary factor in degrading water quality. According to the National Oceanic and Atmospheric Administration (NOAA) when the amount of impervious cover without proper treatment in a tidal creek watershed exceeds 10 to 20 %, stormwater runoff greatly increases, resulting in increased concentrations and loadings of chemicals and pathogens that impair water quality and marine life. [3] In vegetated environments, a greater degree of stormwater either infiltrates into the soil or evaporates into the air. Impervious surfaces cause more of the stormwater to surge directly into tidal creeks. There are three forms of pollution that result from stormwater runoff:

Animal Pathogens: The presence of fecal coliform bacteria has been the most widespread and well-studied water quality issue in Beaufort County. Fecal coliform bacteria originate from the digestive tracts of waterfowl and mammals, including humans. Major sources of fecal coliform bacteria include malfunctioning septic systems and pet waste. When levels of fecal coliform bacteria exceed specified standards[4] SC DHEC closes oyster beds in the area. Oysters are such highly efficient filter feeders that they filter even very small bacteria from the water. The presence of elevated fecal coliform bacteria levels may indicate that other disease-causing bacteria such as diphtheria or cholera might also be present.

South Carolina's Department of Health and Environmental Control (DHEC) classifies water bodies and salt marshes based on their intended use for the harvesting of shellfish (SFH). Map 5-7 provides an indication of where animal pathogens are compromising water quality.

Chemical Contaminants: Chemical contaminants found in tidal creeks include substances that may be harmful to marine life as well as may cause risks to humans through consumption of seafood. Chemical contaminants include:

[3] Tidal Creek Habitats: Sentinels of Coastal Health, NOAA

[4] SCDHEC Water Classifications and Standards Fecal Coliform Standards [Section G 11(e)], "Not to exceed a most probable number (MPN) fecal coliform geometric mean of 14/100 ml; nor shall more than 10% of the samples exceed and MPN of 43/100 ml.

- Pesticides from agriculture and residential and commercial landscaping;
- Nutrients, such as phosphorus and nitrogen, resulting from fertilizer applications on farms, lawns and landscaping; and
- Polycyclic aromatic hydrocarbons (PAHs) and heavy metals derived from car exhaust, break dust and tire wear on roads and parking lots.

Changes in Salinity Levels: Large amounts of stormwater runoff into the upper sections of tidal creeks can cause rapid drops in salinity, which kills some species of small marine worms, ~~and~~ crustaceans and spawning fish. These small marine animals are important food for shrimp and larval crabs. A decrease in the abundance of these animals could therefore have a negative impact on larger animals farther up the food chain.

Existing Efforts to Preserve Water Quality

There are two general approaches to protecting salt marshes and coastal waters through the regulatory process. They consist of limiting development in and around salt marshes and coastal waters, and controlling the quantity and quality of upland stormwater runoff.

Limiting development in and around salt marshes and coastal waters: The Office of Ocean and Coastal Resource Management (OCRM) provides protection to most of southern Beaufort County's salt marshes and coastal waters through its ownership of these areas (fee simple title) on behalf of the state. In those rare cases of King's grant or state grant lands where property owners hold title to salt marshes, development activity is strictly regulated and limited to water dependent structures, such as docks, marinas, and boat ramps. The OCRM sets a demarcation between upland and state controlled marshland or "critical areas" called the critical line.

Preserving land from development around saltmarshes is one method of protecting water quality.

- Critical Line Buffers: Beaufort County and its municipalities limit development adjacent to salt marshes and coastal waters by requiring development to be set back and buffered from the critical line. The purpose of this requirement is ultimately to improve water quality by capturing sediments and pollution from stormwater runoff. Requirements for critical line buffers vary between Beaufort County and its municipalities. Providing "baseline" standards for critical line buffers was a common recommendation in both the Northern and Southern Beaufort County Regional Plans.
- Purchasing Development Rights: Another effective water quality measure practiced in Beaufort County is limiting development in sensitive headwater areas through voluntary conservation easements (as with properties within the ACE Basin), purchase of development rights, and fee simple land purchases.
- Limiting Development on Small Coastal Islands: Beaufort County

has hundreds of small islands with no bridge access. Almost all of these islands are surrounded by expanses of salt marsh and occasionally bordered by tidal creeks. While historically the lack of bridge access has protected these islands from development, there has been a growing concern that, as waterfront and marshfront property becomes scarcer, there will be a greater demand to develop small coastal islands. Providing access to these islands requires bridges and docks, both of which necessitate placing structures in salt marshes and coastal waters and creating potential threats to the health of the marsh and water quality. The State adopted regulations in 2006 that limit the construction of bridges to small marsh islands. The regulations prohibit the construction of bridges to islands smaller than two acres. For larger islands, the length of bridges is restricted based on the size of the island. Beaufort County further limits the development of small marsh islands through its ~~Resource Conservation~~ T1Natural Preserve Zoning district which restricts residential density to 1 dwelling unit per 10 acres.

Small Coastal Island in the Harbor River.

Stormwater Management: The protection of Beaufort County's water bodies was advanced in the mid-1990s with the creation of the Clean Water Task Force. Improvement of stormwater management and planning to improve water quality was one of the primary focuses of the task force and led to the creation of Beaufort County's Stormwater Best Management Practices (BMP) Manual and the Stormwater Utility.

- Managing Stormwater Quantity: Traditionally, stormwater management has been dealt with in terms of managing the quantity of runoff from a site in order to avoid flooding downstream. OCRM's stormwater regulations reflect this traditional approach, requiring stormwater to be detained at pre-development levels in a 10-year storm event. OCRM's requirements also control sedimentation, but do not address specific pollutants that ultimately affect water quality. Beaufort County requires stormwater systems to be designed for 25-year storm events, thus further regulating the quantity of runoff.

Landscaped stormwater retention basin.

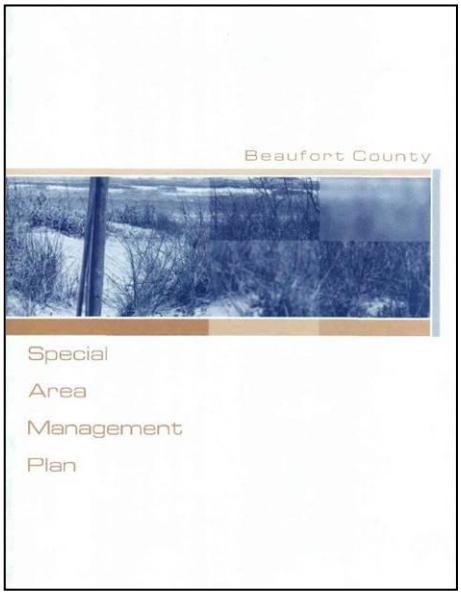
- Managing Stormwater Quality: In 1998, Beaufort County adopted the Beaufort County Manual for Stormwater Best Management Practices (BMP) and has periodically updated the manual. The current BMP Manual has specific attenuation standards for ~~two~~ three types of indicator pollutants; ~~nutrients, such as~~ phosphorus, nitrogen and fecal coliform bacteria. The manual also has stormwater volume runoff control regulations. Recognizing the negative impacts of impervious surfaces on water quality, the BMP Manual requires that on-site stormwater attenuation meet the level of 10% or less impervious development. This level is even lower (5%) for fecal coliform bacteria. In 2007, the Town of Bluffton adopted its own stormwater ordinance which placed greater emphasis on Low Impact Development (LID) stormwater

approaches and long term monitoring of stormwater systems to ensure that water quality is being protected. Beaufort County has revised its Manual to be more consistent with Bluffton's requirements, ~~and is currently assessing whether additional requirements should be adopted to limit nitrogen in stormwater runoff~~ and is currently considering revisions based on pending MS4 requirements.

- Stormwater Utility: The Stormwater Utility was established in 2001 as a countywide program primarily aimed at maintaining and enhancing regional stormwater management systems and retrofitting older stormwater systems. The Stormwater Utility was originally recommended by the Clean Water Task Force which recognized that "any gains in better land use planning and better BMP design are likely to be overshadowed by the poor performance of existing systems that are not maintained properly."[5] The Utility's activities are guided by the Beaufort County Stormwater Management Plan which was completed in 2006. The Utility partners with the City of Beaufort and the Towns of Hilton Head Island, Bluffton, and Port Royal through inter local agreements. Drainage efforts within these municipalities are supported through fees collected by the County and redistributed to the municipalities. A small percentage of revenues is retained by the County to cover the cost of billing and collections. ~~95% of the fees that are collected within a municipality's jurisdiction are then distributed back to the municipality.~~ Oversight of the Stormwater Utility is provided by the Stormwater Management Utility Board
- Municipal Separate Storm Sewer System (MS4): In 2014, Beaufort County, the Town of Hilton Head Island and the Town of Bluffton were designated as a Municipal Separate Storm Sewer System (MS4). This designation requires a permit from the SC DHEC. The permit requires a program to address six minimum control measures (MCM) to address water quality. They are:
    - Public Education;
    - Public Outreach and Involvement;
    - Illicit Discharge and Involvement;
    - Construction Runoff;
    - Post-Construction Best Management Practices; and
    - Municipal Facilities Pollution Prevention

Beaufort Special Area Management Plan (SAMP): Responding to the closure of 500 acres of shellfish beds in 1995, the SAMP was conducted to address stormwater and other sources of water pollution and to identify effective actions to prevent further degradation of the County's waterways. The SAMP consisted of 10 work elements that

[5] A Blueprint for Clean Water: Strategies to Protect and Restore Beaufort County's Waterways, Clean Water Task Force, 1997.



The Beaufort Special Area Management Plan (SAMP) led to many local programs, policies, and ordinances that address water quality.

addressed stormwater management, wastewater management, water quality monitoring, boating management and education. Below are some of the highlights of the SAMP:

- Countywide Stormwater Utility: (see above)
- Management Plans for Broad Creek and the Okatie River: These plans emphasize the need for stormwater BMPs, riparian setbacks and buffers, reduction of on-site septic systems, boating management, and other methods to protect water quality.
- River Quality Overlay District: This District would address such concerns as setbacks, buffers and appropriate impervious surface cover limits to minimize impacts of development in sensitive headwater areas.
- Develop a Comprehensive On-Site Disposal System (OSDS) Program: The SAMP recognized that State requirements for on-site septic systems do not account for the region's high water table and do not control density. These two factors heighten the risk of degrading water quality. The SAMP calls for the adoption of more stringent septic system standards and for regular programs of inspection and maintenance.
- Coordinate Water Quality Monitoring: There is a considerable amount of monitoring of water quality in Beaufort County at the federal, state and local levels, but no central coordination of these efforts or dissemination of the information being gathered. Coordinating monitoring efforts would provide more efficient and effective use of the collected data and would help to identify specific pollution sources and track the overall health of the County's waterways.
- Conduct Educational Campaigns: Finally, the SAMP calls for education and public involvement in furthering water quality goals.

Great egret stalking a coastal marsh.

CONCLUSIONS

Over the last ~~10~~ 15 years, Beaufort County has taken great strides to protect its saltmarshes, coastal waters, and marine resources. As the County continues to develop, these policies and regulations will need to be continually reevaluated and adjusted to ensure that the County's water quality goals are being met. Information is key to determining the effectiveness of existing measures to protect water quality. Continued support of the water quality monitoring lab at USCB is key to assuring that information is collected and analyzed and shared to benefit the region and inform new advances in water quality protection. ~~Currently, the County, the Town of Hilton Head Island, the Town of Bluffton and the state conduct water quality monitoring in the County's rivers and creeks, but there is no central clearinghouse or coordination of these monitoring efforts as originally recommended in the Beaufort SAMP.~~

Another concern is that, in spite of the many achievements in environmental protection, developments that predate newer regulations continue to contribute to water quality degradation. Also, there is still

an uneven playing field between Beaufort County and some of the municipalities and neighboring counties that can result in water quality degradation. Therefore, the County needs to continually work to with its neighbors on cooperative natural resource planning, achieving baseline environmental standards, and retrofitting stormwater management for older developments.

Trees, Forests and Habitats

Beaufort County lies almost entirely within the coastal zone of South Carolina. Upland plant communities of the coastal zone include pine woodland, bottomland hardwoods, upland oak-hickory forest, southern mixed hardwood forest, marl forest and calcareous cliff, cypress-tupelo swamps and maritime forests. Maritime forests, which support Beaufort County's signature mature live oaks and sabal palmettos, typically occur on barrier islands immediately inland of dune systems and on sand ridges that mark former shorelines[6].

The threats to Beaufort County's forest communities and native habitat types are related primarily to the rapid pace of development. Comparing the 1988 Land Use/Land Cover data from the US Geological Survey to 2006 aerial photography provides a snapshot of the impact of growth on Beaufort County's forested areas (Table 5-4). During this period of 18 years, Beaufort County has lost over 18,000 forested acres to development.

Specimen live oaks along Bay Street in Beaufort.

Table 5-4: Comparison of Plant Communities – 1988 and 2006

Plant Community	1988 Acreage	2006 Acreage	% Consumed
Deciduous Upland Forest	2,610	2,607	0.1
Evergreen Upland Forest	44,448	39,035	12.2
Forested Wetland	34,273	32,386	5.5
Herbaceous Rangeland	885	734	17.1
Mixed Upland Forest	32,502	28,136	13.5
Shrub/Brush Rangeland	1,841	1,671	9.2
Upland Planted Pine	23,925	17,891	25.2
TOTAL	**140,483**	**122,460**	**12.8**

Source: US Geological Survey, Beaufort County Planning Department

[6] 2005 Comprehensive Wildlife Conservation Strategy, SCDNR

Tree Protection

Beaufort County residents have long recognized the value of protecting significant trees both for aesthetic and practical reasons. Trees provide numerous public benefits including the reduction of stormwater runoff, buffering sounds and views from roads, reducing air conditioning costs in shaded buildings, and providing wildlife habitat. Beaufort County requires the preservation of specimen trees and encourages preservation of all trees greater than 8 inches diameter breast height (dbh). Removed specimen trees must be mitigated by planting a similar species with the quantity amounting to the total caliper inches of the tree removed. Other removed trees must be replaced in kind. Where a site does not have sufficient room for mitigated trees, a fee-in-lieu payment must be made to the forestation fund.

Each local jurisdiction classifies certain trees as specimen or significant trees based on the species and size of the tree. During site plan review, emphasis is placed on designing the site around specimen trees. Where trees cannot be saved, mitigation is required by planting back the total caliper inches that were removed or contributing to a reforestation fund. Each local ordinance also requires measures to protect trees during construction.

Beaufort County's Definition of Specimen Trees

1. Dogwood, redbud, and southern magnolia greater than 4 inches dbh.
2. American holly, bald cypress, beech, black oak, black tupelo, cedar, hickory, live oak, palmetto, pecan, red maple, southern red oak, sycamore, or walnut with a dbh of greater than 16 inches.
3. All other non invasive trees with a dbh of 24 inches or greater.

Source: Beaufort County ~~Zoning and Development Standards Ordinance~~ Community Development Code

Protection of Habitats and Forest Communities

In addition to saving individual trees, only Hilton Head Island and Beaufort County require the preservation of plant communities and forest types. Beaufort County requires a ~~site capacity analysis~~ natural resources survey when property is developed. A developer must provide a survey of the site, which delineates the different forest types such as maritime forests and mixed upland forest and other natural areas such as freshwater wetlands. The amount of each forest type that must be preserved is determined by the value of the resource and the intensity of the zoning district. Hilton Head Island requires much greater protection of native understory vegetation by restricting under-brushing of buffers and other natural areas while requiring the replanting of natural plant species in disturbed areas.

Endangered and Threatened Species

According to the US Fish and Wildlife Service, there are 14 species of plants and animals that are listed as either endangered or threatened in Beaufort County. An additional 17 species are listed as "species of special concern." Currently, only endangered and threatened species are protected by the Federal Endangered Species Act and reinforced by County standards.

Wood Storks are classified as federally endangered species.

Table 5-5: Federally Endangered and Threatened Species in Beaufort County

Species	Status
West Indian manatee	Endangered
Bald eagle	Federally Protected
Wood stork	Endangered
Red-cockaded woodpecker	Endangered
Piping plover	Threatened
Kemp's ridley sea turtle	Endangered
Leatherback sea turtle	Endangered
Loggerhead sea turtle	Threatened
Green sea turtle	Threatened
Flatwoods salamander	Threatened
Shortnose sturgeon	Endangered
Pondberry	Endangered
Canby's dropwort	Endangered
American chaffseed	Endangered

Source: U.S. Fish and Wildlife Service

CONCLUSIONS

While Beaufort County has well-developed tree standards, some minor adjustments could provide further tree protection while lessening confusion and conflicts between the County and property owners. For example, existing standards to protect "specimen" trees make little distinction between a 24" mature water oak and a 50" caliper live oak. Revising these definitions to make this distinction could provide for greater protections for larger trees, while providing more flexibility for selective removal of hazardous trees such as water oaks and laurel oaks. Requiring a tree management plan could assist large planned unit developments and subdivisions in carrying out routine tree maintenance while emphasizing the overall sustainability of forest communities in common areas.

While Beaufort County and the Town of Hilton Head Island both provide for some protection of forested areas, these plant communities are often discovered only after a survey of the site is performed. What is lacking is a detailed, area wide database of valuable forest types to assist in a more proactive planning approach to resource preservation. Once certain forest types are gone, it's very difficult to replace them. Many important plant species unique to the coastal south are either slow growing or require a unique set of circumstances to be propagated. Also, Beaufort County and its municipalities should explore the provision of local requirements to protect species of special concern and provide for more "wildlife-friendly" development.

Beaches and Dunes

Beaufort County's beaches are the first line of defense against the powerful forces of wind, waves and currents. A healthy beach and dune system provides a natural storm barrier protecting life and property for those living along the coast. They also provide the basis of much of the region's successful tourism industry and are a factor in the region's attractiveness as a place in which to relocate.

Existing Conditions

Beaufort County has approximately 39 linear miles of beaches. Like most of the Atlantic and Gulf coasts, the coastal edge of Beaufort County is made up of a series of barrier islands (Table 5-6), which take the brunt of most offshore storms, thereby protecting the County's inland estuaries and uplands. Barrier islands are composed of dune and beach ridge sands formed by the interaction of wind, waves and ocean currents, and are therefore very dynamic environments. The shapes of these islands change slowly but constantly due to weathering. Evidence of this is seen in the erosion of certain beaches such as Hunting Island and the accretion (gaining sand) on other beaches such as portions of Fripp and Harbor Islands.

Beach erosion on Hunting Island.

Dunes offer the first line of protection from the ocean. Without a healthy dune system, ocean waves rush upland, eroding high ground. Even low dunes (2 to 3 feet tall) can help to avoid this erosion.[7] Dunes are formed when sand from offshore sandbars is washed ashore, picked up and carried by the wind, and deposited on the downwind side of natural debris that accumulates along the shore. Eventually plants such as sea oats, salt meadow cordgrass and marsh elder take root, further stabilizing the dune. Primary dunes are the first row of dunes nearest the ocean. They typically are built up during calm weather and are washed back to sea during storms. Secondary dunes, characterized by the growth of heavier shrubs and located behind the primary dunes, do not as readily wash away.[8] Beaufort County's dunes are relatively small

[7] How to Build a Dune, SC DHEC/OCRM
[8] Preface to the South Carolina Beachfront Management Act, 1988

due to the lack of strong, direct winds. Hunting Island and Pritchard's Island lack healthy dune systems and are characterized by maritime forests giving way to the forces of the ocean resulting in bleached, dead trees littering the beaches.

Table 5-6: Beaufort County's Barrier Islands

Barrier Island	Miles of Beach	Comments
Harbor I.	1.5	Beaches generally accreting
Hunting I.	4.2	Very erosional ranging from -7 ft. to -15 ft. per year. Latest renourishment in 2006.
Fripp I.	2.9	Beaches almost continuously armored with revetments. Beaches generally stable.
Pritchards I.	2.4	No bridge access. Moderate to severe erosion. Owned and managed by the University of South Carolina.
Capers I.	2.5	No bridge access. Minimal upland.
St. Phillips I.	1.3	No bridge access. Private residence.
Bay Point I.	2.2	No bridge access. Privately owned.
Hilton Head I.	19.0	Slightly accreting at south and north ends. Greatest erosion between Coligney Circle and Folly Beach. ~~Last renourishment in 2006.~~
Daufuskie I.	3.2	No bridge access. Long term erosion rates from -4 ft. to -5 ft. per year, but going as high as -10 to -11 ft. per year. Last renourishment in 1998.

Source: SC Annual State of the Beaches Report 2008, OCRM

Barrier Islands are a very dynamic environment.

THREATS

The greatest threats to Beaufort County's beaches come from the challenges inherent in building permanent structures in a shifting natural environment. Concern about sea level rise only compounds this issue. In a natural barrier island environment, beach erosion would simply cause waves to break higher up shore. Over time, sand would be carried behind the dune system and the beach would "retreat" inland. Man-made structures interrupt this natural process, create concerns about property loss and may actually accelerate erosion.

Another potential threat to the health of Beaufort County's beaches is beach vitex, and invasive plant that has been spreading among South Carolina's dunes since the mid 1980s. Originally introduced in North Carolina, it has spread as far south as Folly Beach, Charleston County. Beach vitex crowds out native dune vegetation and is not effective in stabilizing dunes.

REGULATORY FRAMEWORK

Development along Beaufort County's beaches is regulated both by

state and local governments. The Hilton Head Island beaches are entirely within the Town's jurisdiction. Beaufort County has jurisdiction over the remaining barrier islands with significant private development only occurring on Daufuskie, Harbor, and Fripp Islands.

A portion of Hunting Island's beaches were renourished in 2006 and groins were installed.

State Regulations: The South Carolina Coastal Zone Management Act (CZMA) is the primary legislation that addresses the protection and enhancement of the state's beaches. The OCRM is the state agency charged with enforcement of this legislation. The CZMA identifies three approaches to managing beaches rejecting the first and adopting the second and third as policy:

- Providing hard erosion control devices such as bulkheads and groins;
- Renourishing the beach with sand; or
- Requiring development to be adequately set back from the beach.

The OCRM regulates beachfront setbacks by first identifying a "baseline" defined as the crest of the primary oceanfront sand dune. Setbacks from the baseline are set at 40 times the average annual erosion rate or no less than 20 feet. The OCRM also prohibits the construction of erosion control devices, such as sea-walls and revetments seaward of the setback line. Groins perpendicular to the shoreline are exempted.

Local Regulations: Hilton Head Island requires additional restrictions on development of the dunes and requires a minimum 20-foot buffer from the baseline. Beaufort County requires development to be setback at least 50 feet, and septic fields and drainage fields to be setback at least 100 feet from the crest of the primary dunes and protects dunes through its resource protection standards.

Providing public access to beaches is vital to both the quality of life for the County's residents and to the economic health of the region's tourism industry.

BEACH RENOURISHMENT

A significant amount of state, local, and private funds have been spent to import sand onto the County's beaches. The Town of Hilton Head Island uses its accommodations tax to fund beach renourishment. In 2007, Hilton Head underwent a $19 million beach renourishment project which involved moving 2.7 million cubic yards of sand to the Island's beaches. Additional renourishment projects occurred in 2013 and 2014 that focused on the beaches in the vicinity of Port Royal Plantation. The Town is planning another large scale beach renourishment program for late 2015. ~~In 2006, a $16.6 million beach renourishment project began that involved moving over 2 million cubic yards of sand to the Island's beaches. A similar project was completed in 1997.~~ A state and federally funded renourishment of a portion of Hunting Island's beaches was completed in 2006. A privately funded renourishment of Daufuskie's beaches occurred in 1998 adding 1.4 million cubic yards of sand.

PUBLIC ACCESS

Between mean high tide and the water, beaches are public lands that are under the jurisdiction of the OCRM. Providing adequate public access to this amenity is vital to both the quality of life for the County's residents and to the economic health of the region's tourism industry. Beachfront property tends to be intensely developed and expensive to acquire. These two factors create a challenge to the public sector to provide adequate access and to provide sufficient land for parking and other supportive facilities.

In southern Beaufort County, Hilton Head Island has nine public access points with approximately 1,400 parking spaces along its 19 miles of beaches. Daufuskie Island has approximately 3 ½ miles of beach with only two public access points. In northern Beaufort County, public beach access is essentially limited to Hunting Island. Harbor and Fripp Islands are gated and largely restricted to residents and guests. Pritchard's, Caper's, St. Phillips, and Bay Point are accessible only by boat. Hunting Island State Park receives approximately 1 million visitors annually. As demand for the park is increasing, erosion has had a negative impact on what the park has to offer the public. During high tide, only small portions of the 4.2 mile beach remain accessible. The rapid rate of erosion on the southern portion of the island has been especially severe, resulting in the loss of 10 cabins that were available for rent by the State Park. Many privately leased structures were lost as well. Since 1935, when Hunting Island State Park was established there have been 8 beach nourishment projects. The most recent, in 2007 included the construction of 6 groins in the most popular area of the beach. The beach is currently in need of renourishment just to maintain the area of the beach that was stablilzed in 2007. ~~only Hunting Island State Park's four miles of beach is easily accessible. Public access to the beaches of Harbor and Fripp Islands is highly restricted with only Harbor Island providing minimal access via a gate fee and very limited parking.~~

Coastal development threatens the long-term survival of loggerhead sea turtles.

Beaufort County and the Town of Hilton Head Island have both adopted policies that give local government the option to purchase beach access when land is developed or redeveloped. Beaufort County requires public access for developments with more than 1,000 feet of beach frontage.

SEA TURTLE PROTECTION

Like much of the southeast coast, Beaufort County's beaches serve as nesting habitat for endangered and threatened sea turtles. Coastal development threatens the long-term survival of sea turtles because artificial lighting can deter females from nesting and disorient hatchlings, resulting in eventual death from cars, predators or desiccation. In 2001, Beaufort County adopted an ordinance regulating lighting along beaches to restrict direct light visible from beaches and dunes.

CONCLUSIONS

Beaufort County should recognize that its beaches are a public resource that need to be protected, stabilized, and made accessible to the public. Greater emphasis should be placed on promoting a healthy dune system by encouraging property owners to enhance and reestablish dune systems with native vegetation. In addition, the acquisition of new public access areas and the enhancement of existing public access are vital given anticipated population growth and growth in tourism. Finally, Beaufort County needs to support efforts to renourish and stabilize the beach at Hunting Island for the purpose of preserving beach access, recreational amenities, natural habitats, and historic structures on the island.

Freshwater Wetlands

Freshwater wetlands serve as natural stormwater drainage systems, absorbing floodwaters and filtering out pollutants while providing a habitat for many plants and animals. Like other natural habitats, freshwater wetlands are vulnerable to the County's rapid pace of growth. Another threat, however, is the uncertain regulatory framework for freshwater wetland protection. In 2001, the US Supreme Court ruled that the US Army Corps of Engineers no longer had jurisdiction over isolated freshwater wetlands.[9] This left isolated freshwater wetlands unprotected in much of the United States. In the mean time, the South Carolina State Legislature adopted legislation that provides some oversight of non-jurisdicitional wetlands in coastal counties. ~~has introduced several bills to address the protection of isolated wetlands. There is concern, however, that the State will not adequately address wetland protection and will prohibit local governments from enacting or enforcing more stringent local legislation to protect isolated wetlands. In the meantime, the Corps continues to issue wetland determination letters on isolated freshwater wetlands, claiming many as jurisdictional due to their adjacency to navigable waterways or other jurisdictional waters.~~ However, the role of local governments is vital to protecting isolated wetlands, especially in a rapid growth environment.

Existing Conditions

According to the National Wetlands Inventory (NWI), there are 34,440 acres of freshwater wetlands in Beaufort County, making up approximately 15% of the total land area. The locations of these wetlands are shown on Map 5-8. While this is not an exhaustive inventory, it provides a general picture of the quantity and location of freshwater wetlands.

[9] Solid Waste Agency of Northern Cook County *v.* United States Army Corps of Engineers, January 9, 2001

REGULATORY FRAMEWORK

As stated above, until 2001 protection of freshwater wetlands was primarily addressed by the Corps of Engineers. Today, however, protection of isolated freshwater wetlands is the responsibility of state and local governments.

Federal Wetlands Regulations: Section 404 of the Clean Water Act regulates the discharge of dredged or fill material into waterways and wetlands. Before development that impacts wetlands can occur, an applicant must demonstrate through a permit process that they have taken steps to avoid wetland impacts; that potential impacts on wetlands have been minimized; and that compensation is provided for any remaining unavoidable impacts. The U.S. Army Corps of Engineers administers and enforces federal wetland regulations. Since 2001 the Corps only regulates wetlands that adjoin navigable waters, leaving the protection of isolated wetlands up to state and local governments.

Manmade wetland attracting a great egret.

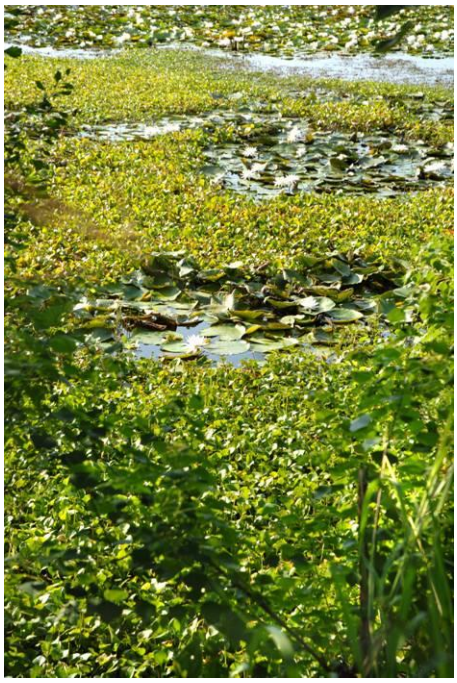
State Wetlands Legislation: Since 2001, the South Carolina Legislature has proposed several bills that address the protection of isolated wetlands with no success. ~~While these efforts have the potential to bridge existing gaps in wetlands protection, they would still potentially render many isolated wetlands unprotected. While the most recent bill[10] provides protection of isolated wetlands that are ½ acre or greater in size, it provides many exemptions that include farming, forestry and mining activities; maintenance of flood control devices, bridges, farm ponds, irrigation ditches; and construction and maintenance of farm roads, forest roads, and access roads for utilities. The bill also prohibits local governments from enacting stricter wetlands protection regulations.~~ Currently, non-jurisdictional wetlands only have State oversight in the eight counties that comprise the Coastal Zone. In these areas, the OCRM must issue a coastal zone consistency determination before any activity that impacts non-jurisdictional wetlands may proceed.

Local Wetlands Ordinances: With the current condition of federal and state wetlands protection, the role of local governments is vital to protecting isolated wetlands. Beaufort County's wetland protection regulations allow fill for nontidal wetlands less than one acre in size and require mitigation. Minor fill is also allowed in these wetlands in order to reshape the wetland boundary to provide a reasonable building site, providing that less than ~~10%~~ 20% or ~~2~~ 1 acres (the lesser of the two) is disturbed. Setbacks ranging from 20 to 50 feet are required depending on the type of development. ~~For nontidal wetlands, protection levels vary by zoning district, ranging from 60-100%.~~ These regulations also give special protection to bird rookeries and high quality wetlands.

[10] South Carolina Legislature Session 117 (2007-2008) S116

The Town of Port Royal prohibits development in nontidal wetlands in except where structures are necessary to a permitted use and cannot be located outside the wetland. In these cases, the structures are required to be located on pilings. The Town has setbacks from wetlands similar to the County's requirements.

The Town of Hilton Head Island ~~is the only other local government that has comprehensive wetlands protection requirements. The Town~~ requires developers to attempt to preserve wetlands in their site design. If wetland alteration is proposed, it can only be permitted if the wetland is of low or moderate value, based on a wetland evaluation sheet that equates environmental, social and landscape value of the wetland with a numerical score. Minimization of the alteration in the site design must then be shown, and mitigation of the altered wetland is required. Mitigation must be done on-site, in-kind and acre-for-acre. Mitigated wetlands and their required buffers must be permanently protected through restrictive covenants. As a last resort, a fee-in-lieu-of program is available, but only when all other options have been exhausted.



The role of local government is vital to the protection of freshwater wetlands.

The City of Beaufort, ~~Town of Port Royal,~~ Town of Yemassee, and Town of Bluffton currently have no comprehensive local wetland protection requirements. The establishment of baseline freshwater wetlands protection standards was a common recommendation in the Northern and Southern Beaufort County Regional Plans.

CONCLUSIONS

The role of local governments is vital to protect isolated freshwater wetlands. Beaufort County, while strengthening its own regulations, needs to actively work with its municipalities and neighboring counties to enact suitable wetland protection standards. The region also needs to work cooperatively to lobby the state to enact legislation to protect isolated freshwater wetlands while at the same time allowing local governments to enact more stringent standards.

Groundwater Resources

Beaufort County lies above the northernmost reaches of the Floridian Aquifer, which historically has supplied the region with a reliable source of water. In 1998, SCDHEC produced a map of the Floridian Aquifer charting the areas of significant groundwater recharge and areas with intense groundwater withdrawal – cones of depression (Map 5-9).

Aquifer Recharge Areas

Aquifer recharge occurs as a direct result of rainfall entering the aquifer where the overlying confining unit is thin or absent. Because the Floridian Aquifer is generally unconfined throughout Beaufort County, most of the upland areas of the County contribute some ground-water recharge to the underlying aquifers. Locally significant recharge occurs on the northern part of Port Royal Island, the northern part of Lady's Island, St. Helena Island, and on the barrier islands. The northern part of Hilton Head Island is possibly an area of recharge, but the effects of this are insignificant due to the dominating regional influence of the cone of depression centered in Savannah.

Cones of Depression

Hydraulic cones of depression are areas in which intense local groundwater withdrawal (pumping) causes the surface of the ground water table to form a conical depression. Locally, there are two areas which indicate cones of depression. One is located on Hilton Head Island and the other is located west of Dale, just north of the Whale Branch River. Savannah's regional cone of depression continues to dominate the shifts in the local potentiometric groundwater surface.

Sources of Groundwater Contamination

Contamination of groundwater is caused both by pollution infiltrating soils and saltwater intrusion. Due to the unconfined nature of the Floridan Aquifer, the risk of groundwater contamination is very high in Beaufort County. Since the late 1970's, concerns have been raised over the issue of saltwater intrusion into the aquifer. As a result, since the 1980's, over $40 million has been spent to provide alternative sources

Pervious paving infiltrates stormwater back into the soil thereby recharging groundwater.

of drinking water primarily from the Savannah River. As part of the "Sound Science Initiative", Georgia contracted with the South Carolina DHEC to provide monitoring wells, which revealed that there are three separate points of saltwater intrusion into the aquifer in the county; one underlying northern Hilton Head Island, one underlying the Pinckney Island National Wildlife Refuge, and one under the Moss Creek area. These infiltration points are threatening the water quality for those residents in areas like Sawmill Creek, and Pritchardville that are on private wells and for developments still using groundwater for irrigation.

CONCLUSIONS

Irrigation for golf courses and other landscaped areas by far accounts for the greatest use for groundwater in Beaufort County. Therefore, reducing or eliminating the use of groundwater for irrigation would help to preserve the groundwater for the remaining residents who still rely on private wells. A logical source of available water for irrigation is the land disposal of treated wastewater. Another strategy aimed at recharging groundwater is utilizing more low impact development (LID) stormwater management techniques that utilize swales and pervious areas to infiltrate stormwater back into the soil and reuse by storage cisterns.

Open Space

Protecting open space is a common thread among Beaufort County's natural resource goals and recommendations. Conservation easements and fee-simple purchases of land to limit or prevent future development is a powerful tool in protecting valuable habitat types, limiting development in environmentally sensitive areas, providing public access to natural amenities, and facilitating regional stormwater management.

Existing Conditions

Currently 30,572 acres of land in Beaufort County are preserved through conservation easements and government and/or non-profit ownership. This makes up approximately 17% of the total land area. Map 5-10 shows the locations of these preserved lands. As undeveloped land becomes scarcer, the cost of acquiring land for open space increases. This fact has made the acquisition of open space for the purpose of preservation a top priority in Beaufort County.

The Alan Ulmer property, a conservation easement purchased through the Rural and Critical Lands Preservation Program.

Local Efforts to Preserve Open Space

There are essentially three methods used to preserve open space. The first is the fee simple purchase of a property by a governmental, non-profit or private entity for the purpose of preservation. The second method is through a conservation easement or purchase of development rights which allows the property owner to continue to own their property but limits future development through covenants. The third method is requiring by ordinance the set aside of a certain percentage of open space when land is developed. The most effective (and most expensive) way for local governments to control the use of land is to own it. Both Beaufort County and the Town of Hilton Head Island have programs that target purchasing properties to protect natural areas and to take land out of active development.

Beaufort County's Rural and Critical Lands Preservation Program: This program, established by ordinance in 1999, is aimed at preserving open space either by fee simple land purchases or the purchase of conservation easements on private property. ~~Two~~ Four successful bond referendums (2000, ~~and~~ 2006, 2012, and 2014) have

provided the program with ~~$90~~ $135 million in County funding. The County contracts with the ~~Trust for Public Land (TPL)~~ Beaufort County Open Land Trust to manage the program, negotiate with property owners, and assist in the purchase of properties. The Rural and Critical Lands Preservation Board, representing a cross-section of Beaufort County, prioritizes properties and makes recommendations to County Council. In ~~2004~~ 2014, based on citizen input gathered at a number of public meetings, ~~TPL~~ the Open Land Trust assisted the County in developing a "Greenprint" map~~s~~ that defined seven focus areas to target preservation efforts.

Fish Haul Beach, preserved by the Town of Hilton Head Island.

Hilton Head Island's Land Acquisition Program: Hilton Head Island has its own land acquisition program, funded primarily by a real estate transfer fee (RETF) that generates ~~approximately $3.8~~ over $2 million annually for the Town. Hilton Head Island's integrated approach to land acquisition and its funding is also unique. All of the potential funding sources, RETF, Beach Preservation Fees, Stormwater Utility Fees, general funds and grants feed into a matrix that takes into account all the activities that require land acquisition such as open space, parks, beach access, public facilities and municipal stormwater projects. This integrated approach invites inter-disciplinary solutions to Town needs and maximizes the potential of each of the funding sources.

Private/Non-Profit Sector Resource Protection Efforts: The protection of open space in Beaufort County is not in the exclusive domain of the public sector. The Beaufort County Open Land Trust, formed in 1971, is a non-profit organization dedicated to preserving vistas and natural areas through the purchase of land and conservation easements. In addition, the Sea Pines Forest Preserve, and open space on Spring Island and in Palmetto Bluff are three local examples of private sector efforts to preserve open space.

CONCLUSIONS

While Beaufort County has been very aggressive in securing open space, many of the preserved lands are discrete and unconnected. As growth continues, these natural areas will become more isolated and will not effectively be able to support healthy wildlife communities. In addition, as land becomes scarcer, it is more important to prioritize areas with outstanding natural resources in order to target future acquisitions of open space, and to target the preservation of greenways and wildlife corridors to connect natural areas.

Open space can serve many different needs, including the preservation of natural areas, provision of public access to water, recreation needs, relieving traffic congestion, and regional stormwater projects. There are also several methods and funding mechanisms that can be used to secure open space, including the Rural and Critical Lands Program, the Stormwater Utility fund, municipal programs such as Hilton Head Islands Land Acquisition Program, and open space preserved through

ordinance requirements and development agreements. As open space becomes scarcer and more expensive to acquire, it may become necessary to look more creatively at several different open space acquisition methods to achieve multiple objectives.

Recommendations

Recommendation 5-1: Cooperative Planning with Municipalities and Neighboring Counties

Beaufort County should continually work with its municipalities and neighboring counties to develop baseline standards and plan cooperatively to optimize the protection of natural resources at a regional level.

- Work toward the adoption of baseline standards for critical line buffers, stormwater BMPs, freshwater wetland protection, beach and dune protection, and the protection of trees and habitats.
- Centralize and standardize the collection and analysis of County, municipal, and state water quality monitoring data.
- Coordinate open space protection efforts by pooling and leveraging funds for the preservation of open space and coordinating existing preservation efforts across municipal and county boundaries.
- Coordinate natural resource planning with neighboring counties, with the recognition that development impacts natural resources and water quality across county boundaries.

Recommendation 5-2: Educational Outreach

Beaufort County should work to develop education programs aimed at informing local residents, builders, developers and realtors about the value of water quality and the region's key natural resources, and of County regulations that are designed to protect these resources.

- Dedicate additional staff and funding to environmental education programs.
- Better coordinate existing programs conducted by governmental and non-profit agencies.

Recommendation 5-3 : Enforcement

Beaufort County should dedicate additional staff resources to the enforcement of County regulations designed to protect water quality and protect natural resources.

Recommendation 5- 4: Implement the SAMP

Beaufort County should address the remaining recommendations from the Beaufort SAMP.

- River Quality Overlay District (RQOD): Review the adequacy of existing regulations already adopted, such as river buffers and stormwater BMPs to determine if the intent of the SAMP is already being met.
- On Site Disposal System (OSDS) program: Develop a comprehensive regional approach to reducing the negative impacts of on-site septic systems to surface water quality.
- Coordination of Water Quality Data Collection: Establish a structure to coordinate all water quality monitoring activities in the County.

Recommendation 5-5 : Open Space Preservation

Beaufort County should cooperate and continue to emphasize protection of public and private open space.

- Continue to support and fund Rural and Critical Lands Preservation Program.
- Use local funds to leverage funds from state, federal, and non-governmental organization programs
- Pursue the acquisition of sites that meet multiple objectives, such as the preservation of natural resources, passive recreation, public access to water, and regional stormwater projects.

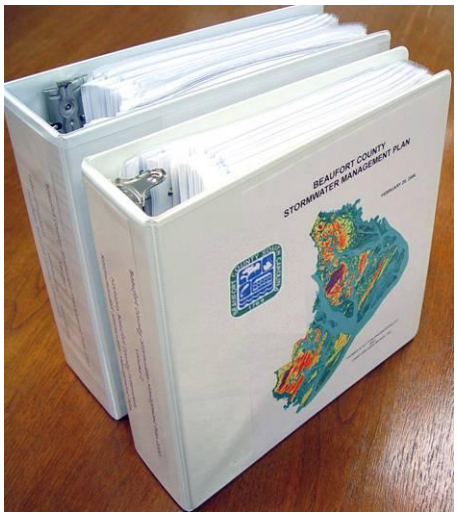
Recommendation 5- 6: Soils

Beaufort County should take greater consideration of soil types in future land use planning, site plan review and locating future infrastructure projects and County facilities.

Recommendation 5- 7: New Approaches to Stormwater Management

Beaufort County should utilize the Stormwater Management Utility Board to explore, develop and promote new approaches to stormwater management

- Continually reevaluate the Stormwater BMP Manual and its application and enforcement to increase the use of Low Impact Development (LID) techniques, such as bioretention, green roofs, pervious paving, and cisterns that promote water conservation and groundwater recharge.
- ~~Design stormwater management in sensitive headwater areas to 100-year storm event to lessen the impact of freshwater surges and channelization on marine life.~~
- When evaluating the impact of new development, take into account the collective impacts of existing development in the same sub-watershed.



Beaufort County Stormwater Management Plan (2006)

- Incorporate soil types as a criterion to determine the appropriate percentage of impervious surface within a development.
- ~~Evaluate the necessity designing stormwater management to limit nitrogen pollution in runoff. Adjust Stormwater BMP Manual accordingly. If nitrogen standards are enacted,~~ Provide for mechanism to allow high density developments to mitigate the impact of nitrogen pollution by retrofitting stormwater management devices in older non-conforming developments within the same sub-watershed.
- Continually evaluate how stormwater standards can be modified to help reduce FEMA flood insurance rates.

Recommendation 5-8 : Stormwater Utility

Beaufort County should continue to implement the Stormwater Utility with a priority placed on retrofitting stormwater in older moderate and high density developments that predate the adoption of stormwater standards in Beaufort County.

- Work toward a joint capital improvements plan (CIP) for County and municipal Stormwater Utility projects.
- Utilize Rural and Critical Lands Preservation Program to purchase key sites that serve regional stormwater utility needs.

Recommendation 5-9 : Water Quality Monitoring

Beaufort County should continue to work toward centralizing and standardizing the collection and analysis of water quality data.

- Establish what are considered acceptable and unacceptable water quality standards on the sub-watershed level.
- Update BMP Manual to adjust to new information.

Typical items collected during a County sponsored household hazardous waste collection event.

Recommendation 5- 10: Other Water Quality Measures

Beaufort County should pursue additional measures aimed at improving water quality.

- Assess the effectiveness of existing County and state policies to protect small marsh islands from over-development.
- Continue to expand the ability to help the public discard toxic items that can degrade water quality.

Recommendation 5-11 : Tree Protection Standards

Beaufort County should maintain good standards both to protect mature and specimen trees and to plant new trees when property is developed or redeveloped.

- Revise Beaufort County's tree standards to distinguish between "mature" trees and "specimen" trees, giving greater protection to specimen trees.
- Continue to require and increase the enforcement of the protection

Preserved trees in Bluffton.

of root zones and canopies of trees during construction.

- Encourage the removal of non-native invasive tree species such as Chinese tallow, Chinaberry, and mimosa.
- Revise parking standards to enlarge islands and medians so that they are of sufficient width to support large shade trees.
- Require replacement trees planted for those removed to be retained in perpetuity or replaced as they die or become hazardous
- Require caliper inch-for-inch replacement for illegal tree removal with a higher replacement ratio assigned for specimen trees.
- Beaufort County should adhere to its tree standards for County properties, parks, and preserved areas.

Recommendation 5- 12: Tree Management Plan

Beaufort County should require new developments and encourage existing developments to adopt a tree management plan.

- The plan should include a map of all common areas, their purposes and the trees that currently exist in the common areas.
- The plan should address such aspects as the thinning of trees to provide sufficient light to keep desirable trees healthy, and the planting of new trees and shrubs to replace aging or unhealthy trees.
- Beaufort County should work with the Clemson Extension Master Gardner Program to complete tree management plans for the County's parks and preserved lands.

Recommendation 5- 13: Trees - Educational Outreach

Beaufort County should build on its current partnership with Clemson University Extension Service to promote the value of tree protection and proper tree care.

- Provide information on identifying backyard trees, evaluating the health of trees, keeping specimen trees healthy, and planting and caring for new trees.
- Promote good tree maintenance such as root zone protection and sustainable pruning techniques.
- Encourage residents to submit information about outstanding specimen trees to assist the County to establish a GIS database to aid in the evaluation of site plans.

Recommendation 5- 14: Wildlife and Habitat Protection Standards

Beaufort County should develop standards aimed at protecting wildlife and local wildlife habitat.

- Develop mitigation standards for development projects to protect and encourage wildlife. Standards may include replanting of native vertical layers of vegetation, installation of thickets, keeping dead trees where they do not present a hazard, and installation of

rest/nest boxes

- Encourage new development to be wildlife friendly and to provide linkages between wildlife habitats through a combination of ordinance requirements and incentives.
- Develop regulations to protect animal and plant species defined as Species of Special Concern by the State of South Carolina
- Promote innovative road construction techniques that are wildlife friendly. Techniques include culverts for under-road crossings, rolled curbing, traffic calming devices, and signage to alert motorists.

Recommendation 5-15: Wildlife and Habitat Educational Outreach

Beaufort County should encourage property owners to landscape their properties to be more wildlife friendly.

- Develop an education program aimed at informing property owners of the benefits of preserving or enhancing native vegetation.
- Inform the public about programs for certifying backyard wildlife habitat offered by the National Wildlife Federation, the National Audubon Society, and the Clemson University Extension Service (Carolina Yards and Neighborhoods).

Consequences of beach erosion and the lack of a healthy dune system.

Recommendation 5- 16: Beaches and Dunes

Beaufort County should recognize that its beaches and dunes are both an important public resource and are valuable as a natural storm barrier protecting life and property for those living along the coast. The following policy components are recommended:

- All new beachfront developments and redevelopments should enhance or reestablish dune systems.
- All native dune plants that provide dune stabilization should be protected.
- Require a natively vegetated buffer between the dune system and development with planting standards and a prescriptive list of native plants.
- Restrict the size and location of structures in dune systems and buffer areas, such as decks and dune walkovers. Dune walkovers should be constructed so that they do not restrict the free flow of wildlife.
- Prohibit the direct discharge of storm water and pool water into dune systems or onto beaches.
- In order to protect sea turtles, all lighting for parcels fronting barrier island beaches and dunes should be configured so as to ensure that no light is visible from the beaches or dunes during sea turtle nesting season.
- Beaufort County should consult with the SCDNR Sea Turtle Program on the proper placement and configuration of sand fencing, if it is used to reestablish dune systems.

- Beaufort County should exercise its authority to purchase public access when reviewing development plans on beachfront properties, in order to gain as much public beach access as possible when property is being redeveloped.
- Beaufort County should support efforts to renourish and stabilize the beach at Hunting Island for the purpose of preserving beach access, recreational amenities, natural habitats, and historic structures on the island.

Recommendation 5- 17: Network of Open Spaces

Beaufort County should work toward a network of open spaces that protects critical habitats and provides wildlife corridors.

Privately preserved open space on Spring Island.

- Continue to fund the Rural and Critical Lands Preservation Program and ~~to update~~ utilize the Greenprint map to assist in prioritizing land purchases.
- Develop better critical habitat identification tools utilizing DNR, NOAA data, and aerial photography to assist in identifying lands for preservation.
- Coordinate public and private preserved open space
- Explore the feasibility of an open space land bank where fees would be collected in lieu of ordinance required open space set asides and applied to the purchase and preservation of larger more critical lands

Recommendation 5- 18: Freshwater Wetlands

Beaufort County should continue to acknowledge the importance of freshwater wetlands as natural assets worthy of protection because of their vital role as natural stormwater drainage systems and as habitats for plants and animals.

- The County should adopt a zero net loss policy on isolated freshwater wetlands with an emphasis placed on avoiding negative impacts on wetlands.
  - Where avoidance is not possible, emphasize minimizing and mitigating impacts.
  - Provide incentives for development plans that are designed around freshwater wetlands
  - Mitigation of impacted wetlands should be on site. When it is not feasible, in-kind mitigation acre for acre in same the watershed should be considered a last resort.
  - Once a property is developed, wetlands that are preserved or mitigated and their buffers should be given permanent protection.
- High quality wetlands and wetlands with rookeries should be managed to maintain the site as suitable rookery habitat.
- Freshwater wetlands should have native, upland buffers.
- Stormwater management should be designed so to provide no negative impacts to freshwater wetlands.

Recommendation 5- 19: Protect Groundwater Quality

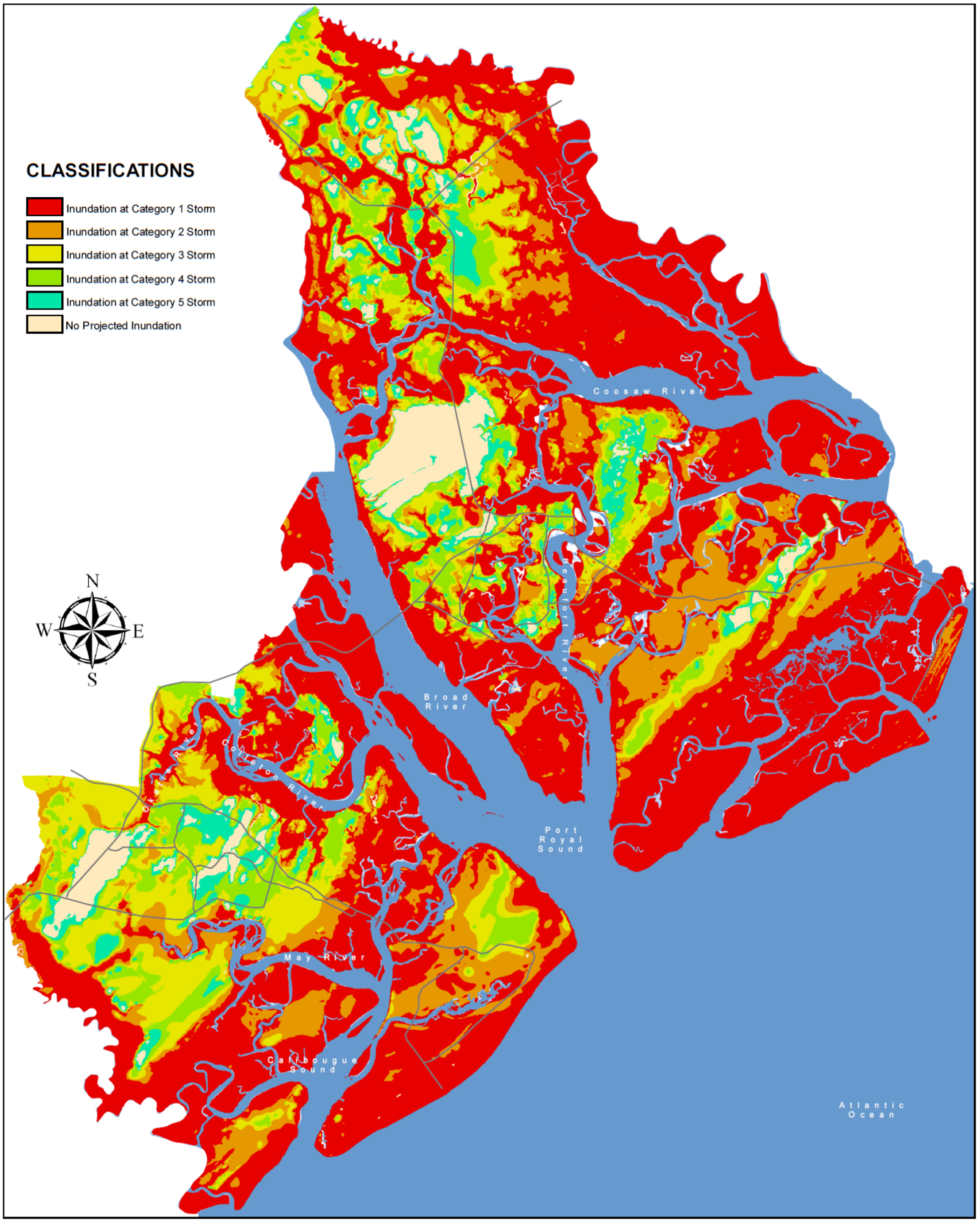
Preserve groundwater quality by reducing and eliminating heavy usage of groundwater resources in the county.

- Require all new developments to hookup to public water.
- Require Low Impact Development (LID) stormwater management techniques that infiltrate stormwater runoff into the soil, thereby recharging groundwater.
- Encourage heavy users of irrigation (golf courses, landscaping) to use treated effluent for irrigation or storage lagoons.
- Discourage wells for the irrigation of residential landscaping.
- Develop standards for geothermal HVAC systems that recycle the use of groundwater.

Recommendation 5- 20: Climate Change and Rising Sea-Level

Beaufort County should anticipate and plan for the impacts of climate change and sea level rise.

- Anticipate Sea Level Rise. Work with the U.S. Geological Survey and other monitoring agencies to track inlet and ocean levels; utilize estimates for mean sea level rise to map potential areas subject to future inundation; and work with FEMA to amend flood maps for any areas subject to increased flooding from a rise in sea level.
- Plan for Sea Level Rise. The potential impacts of sea level rise on low-lying areas should be a consideration in future land use planning, site plan review, and the location of future roads and other public facilities.
- Disclosure: Consider requiring a disclosure statement when development and building permits are issued on low-lying property acknowledging that the County is not committed to stabilizing property or maintaining private roads and causeways by constructing seawalls, levees or other devices.

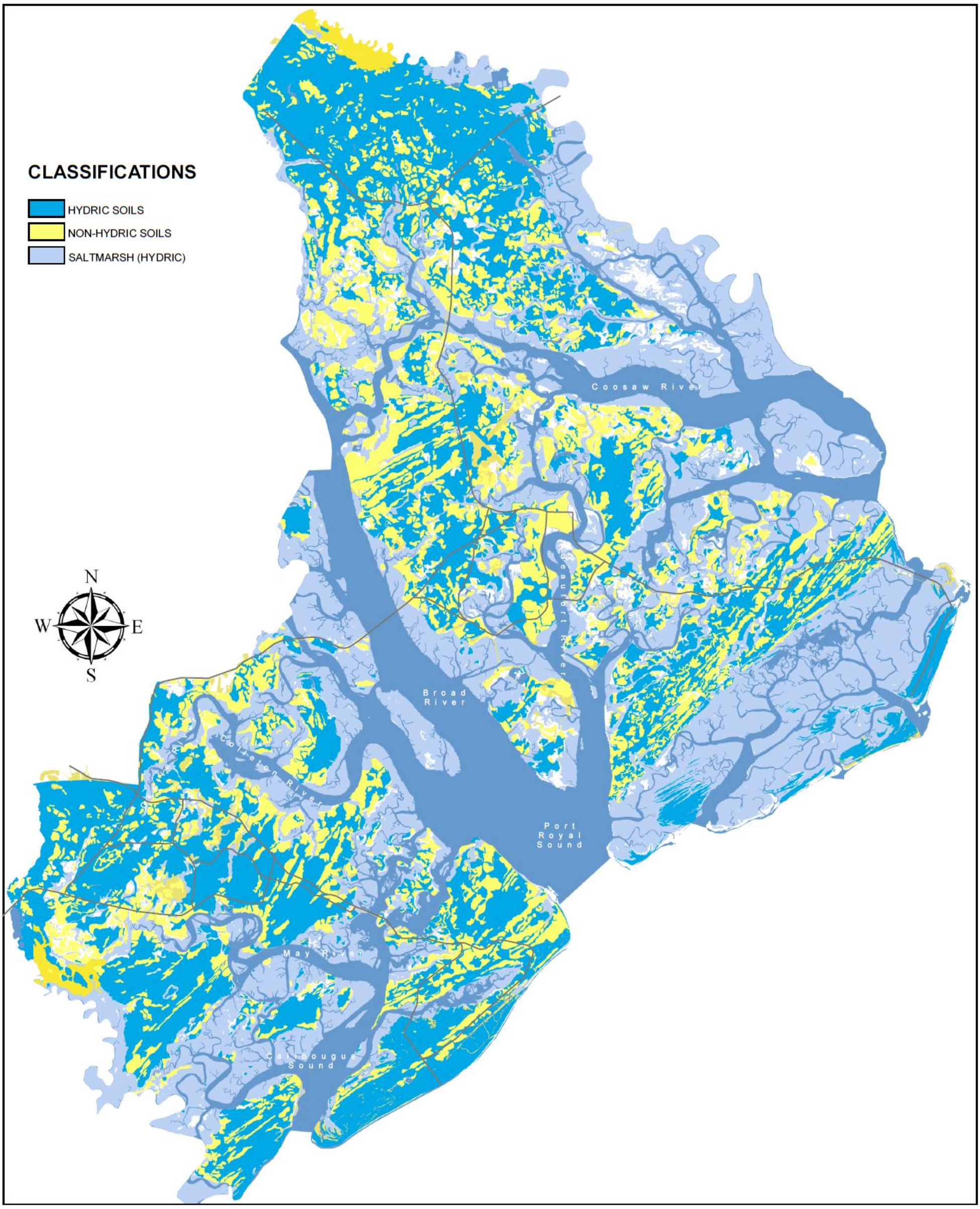


Chapter 5

Natural Resources

Map 5-1: SLOSH (Sea, Lake, and Overland Surges from Hurricanes)

2010 Beaufort County Comprehensive Plan



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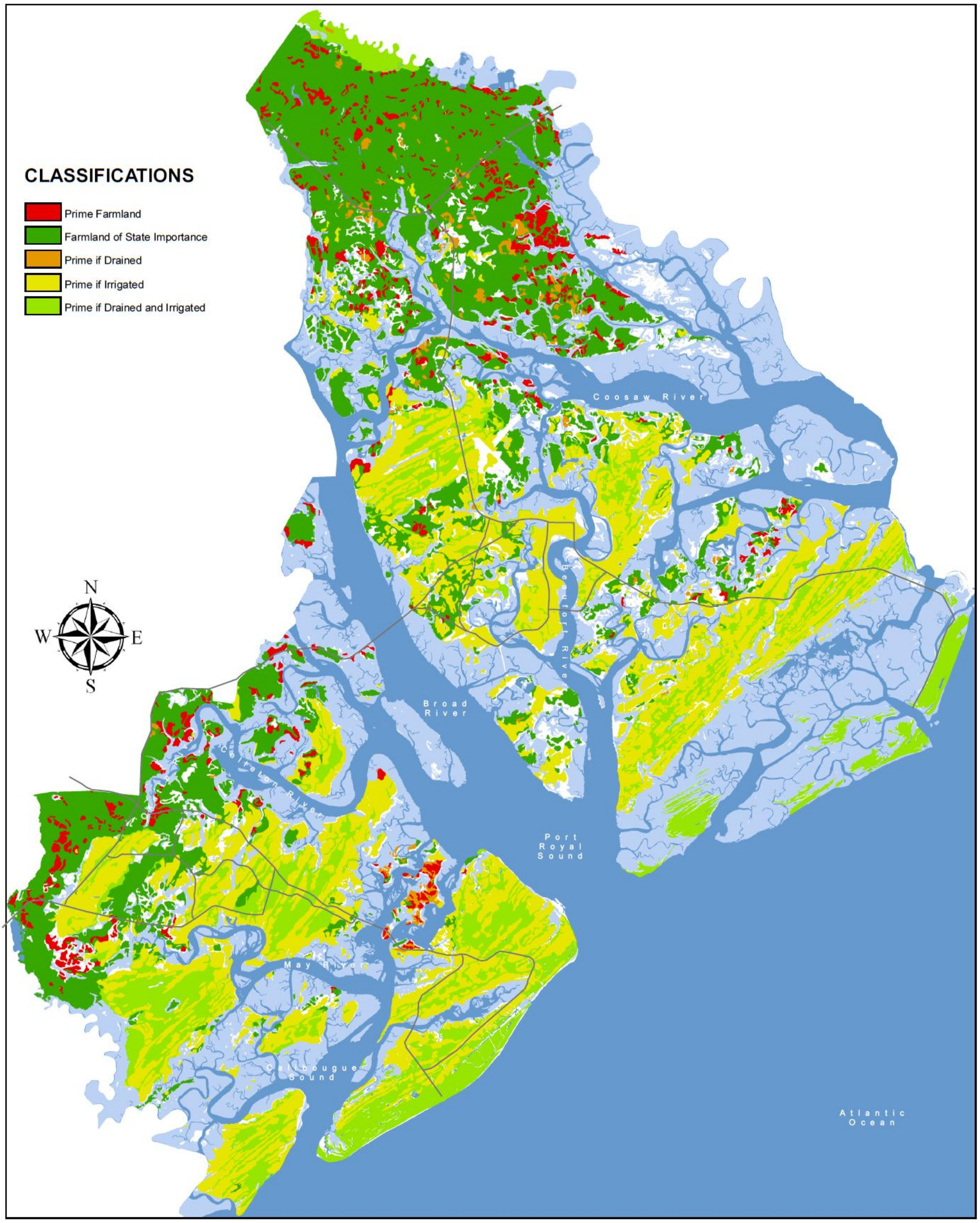
Map 5-2: Soil Hydrology

2010 Beaufort County Comprehensive Plan



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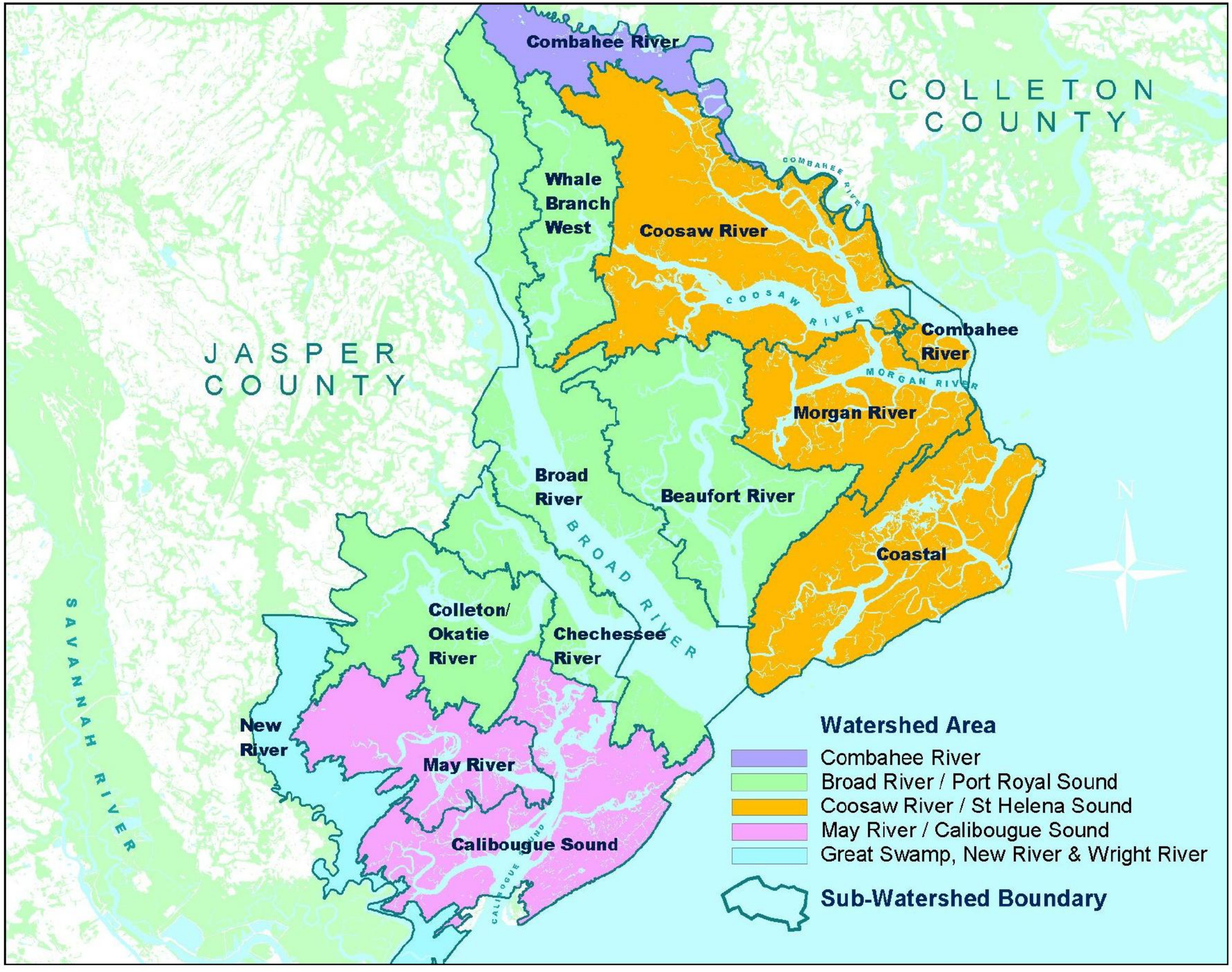
Map 5-3: Suitability of Soils for Agriculture

2010 Beaufort County Comprehensive Plan



Chapter 5

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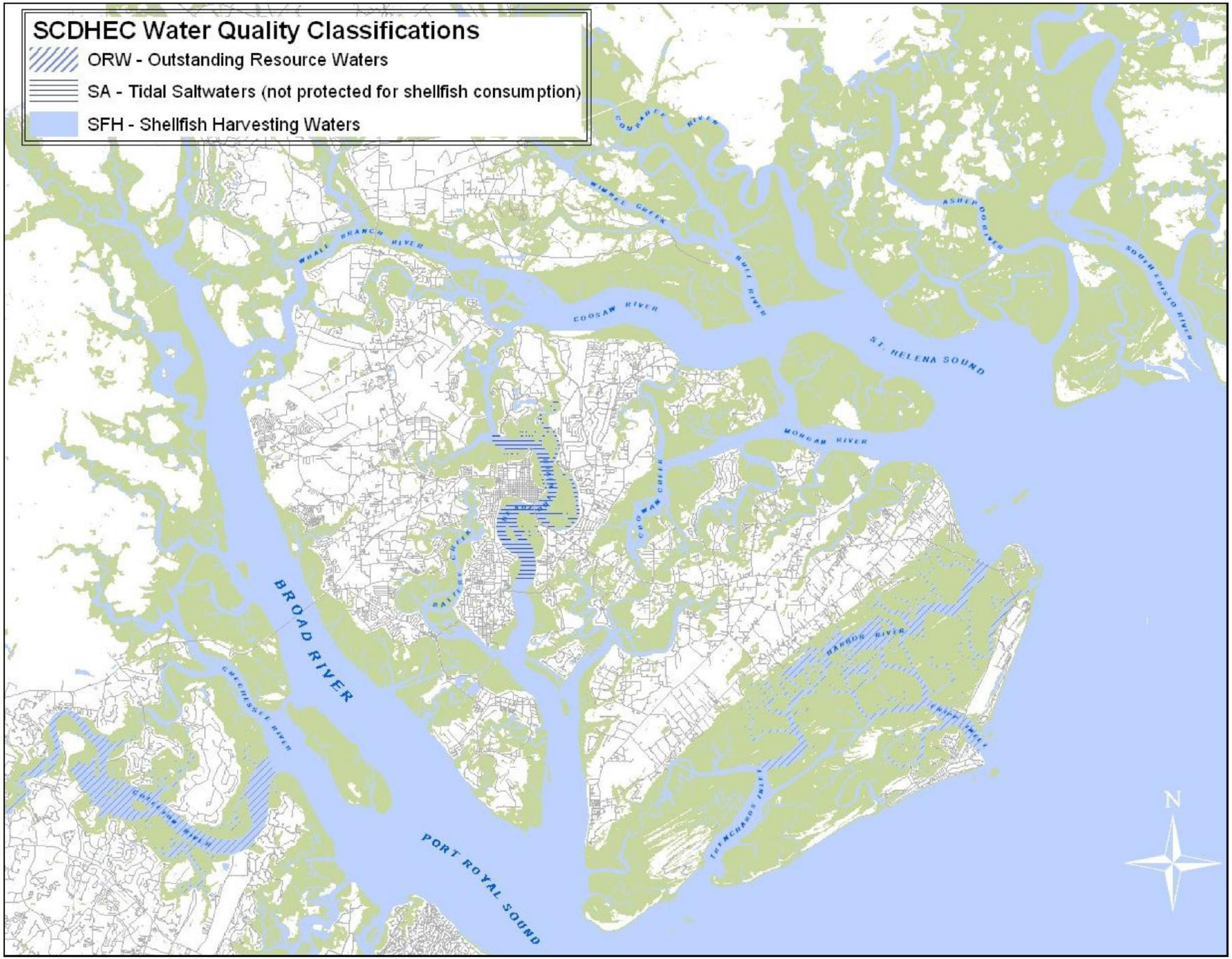
Map 5-4: County Watersheds and Sub-Watersheds

2010 Beaufort County Comprehensive Plan

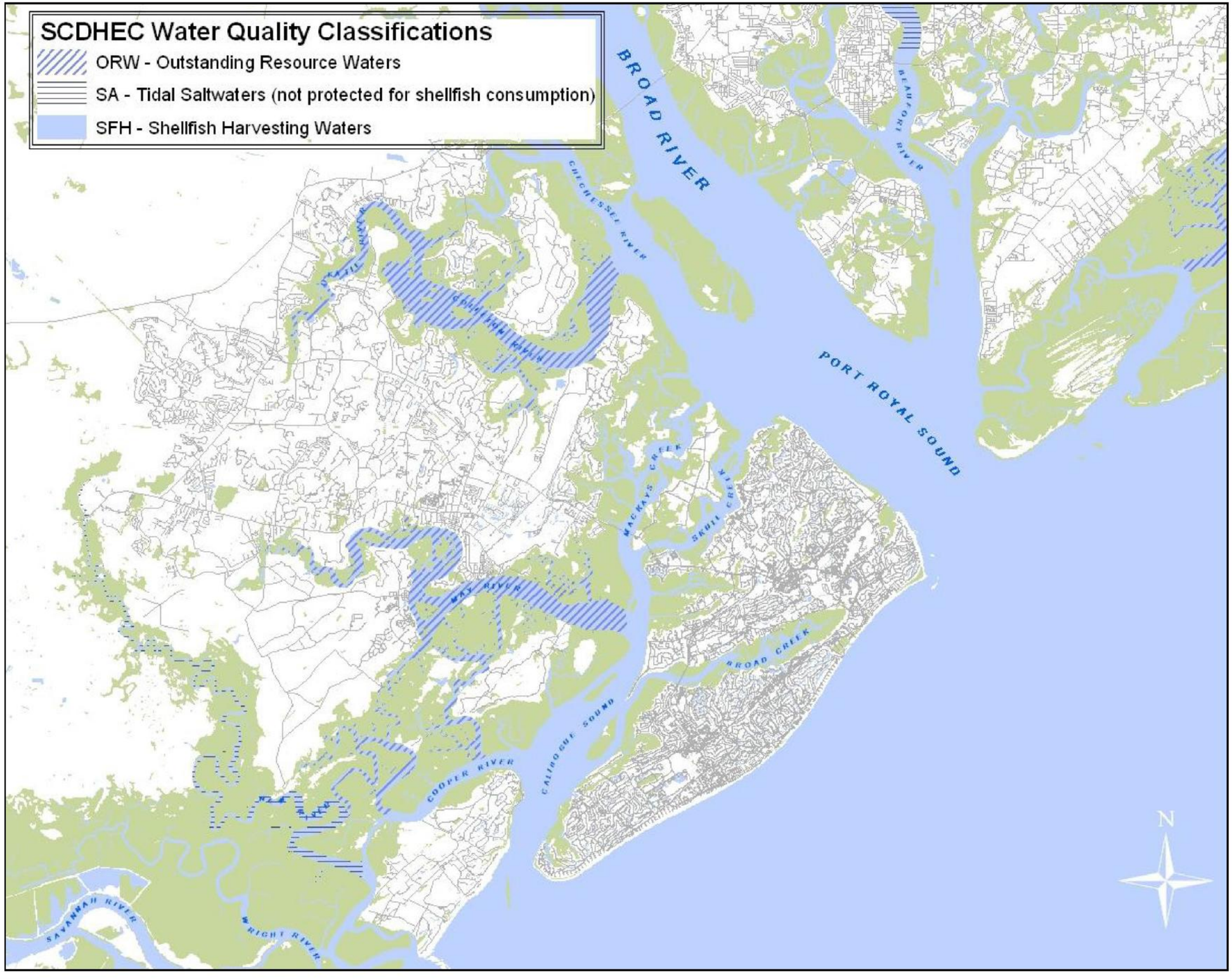


Chapter 5

Natural Resources

Map 5-5: Water Quality Classifications: Northern Beaufort County

2010 Beaufort County Comprehensive Plan



Chapter 5

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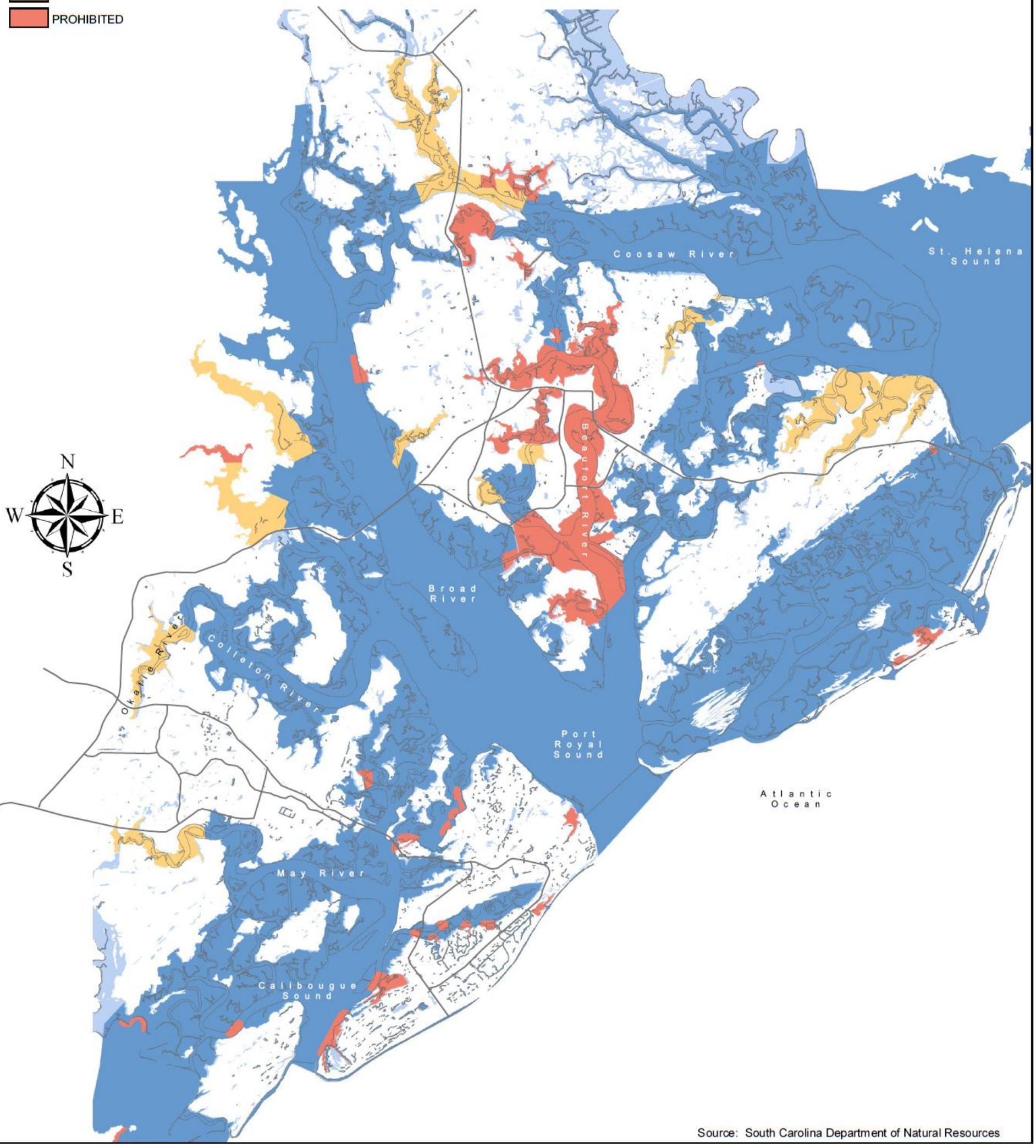
Map 5-6: Water Quality Classifications: Southern Beaufort County

2010 Beaufort County Comprehensive Plan

CLASSIFICATIONS

- STATE AND PUBLIC SHELLFISH GROUNDS
- RESTRICTED
- PROHIBITED



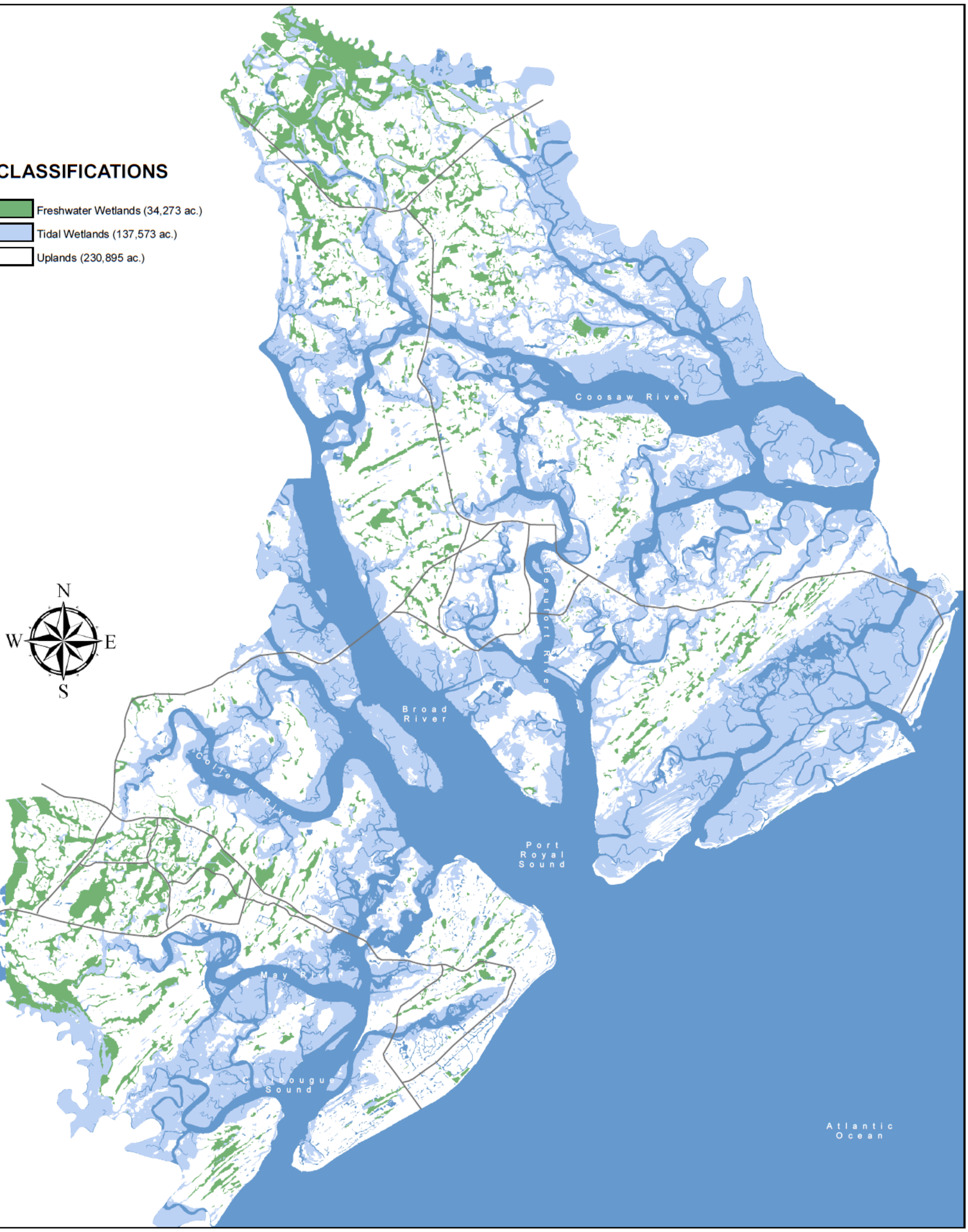
Source: South Carolina Department of Natural Resources

Chapter 5

Natural Resources

Map 5-7: Status of Shellfish Beds

2010 Beaufort County Comprehensive Plan



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Map 5-8: Freshwater Wetlands

2010 Beaufort County Comprehensive Plan

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Map 5-9: Aquifer Recharge Areas and Cones of Depression

POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER SYSTEM IN SOUTHERN SOUTH CAROLINA, September 1998

By

Camille Ransom, III and James L. White

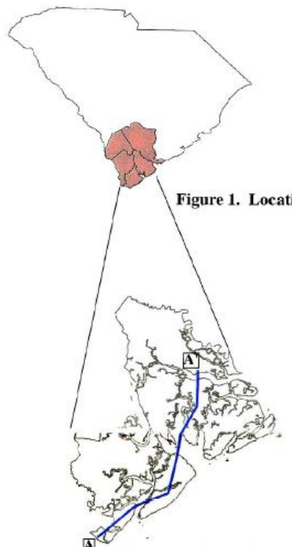


Figure 1. Location of Study Area

Figure 1a. Location of cross-section A - A'

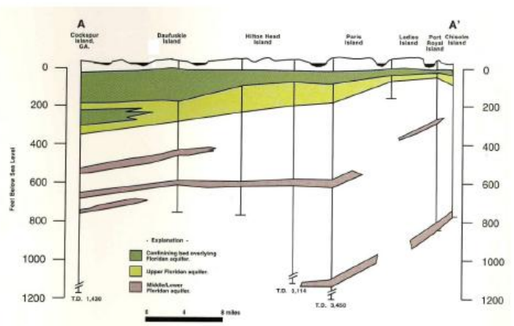
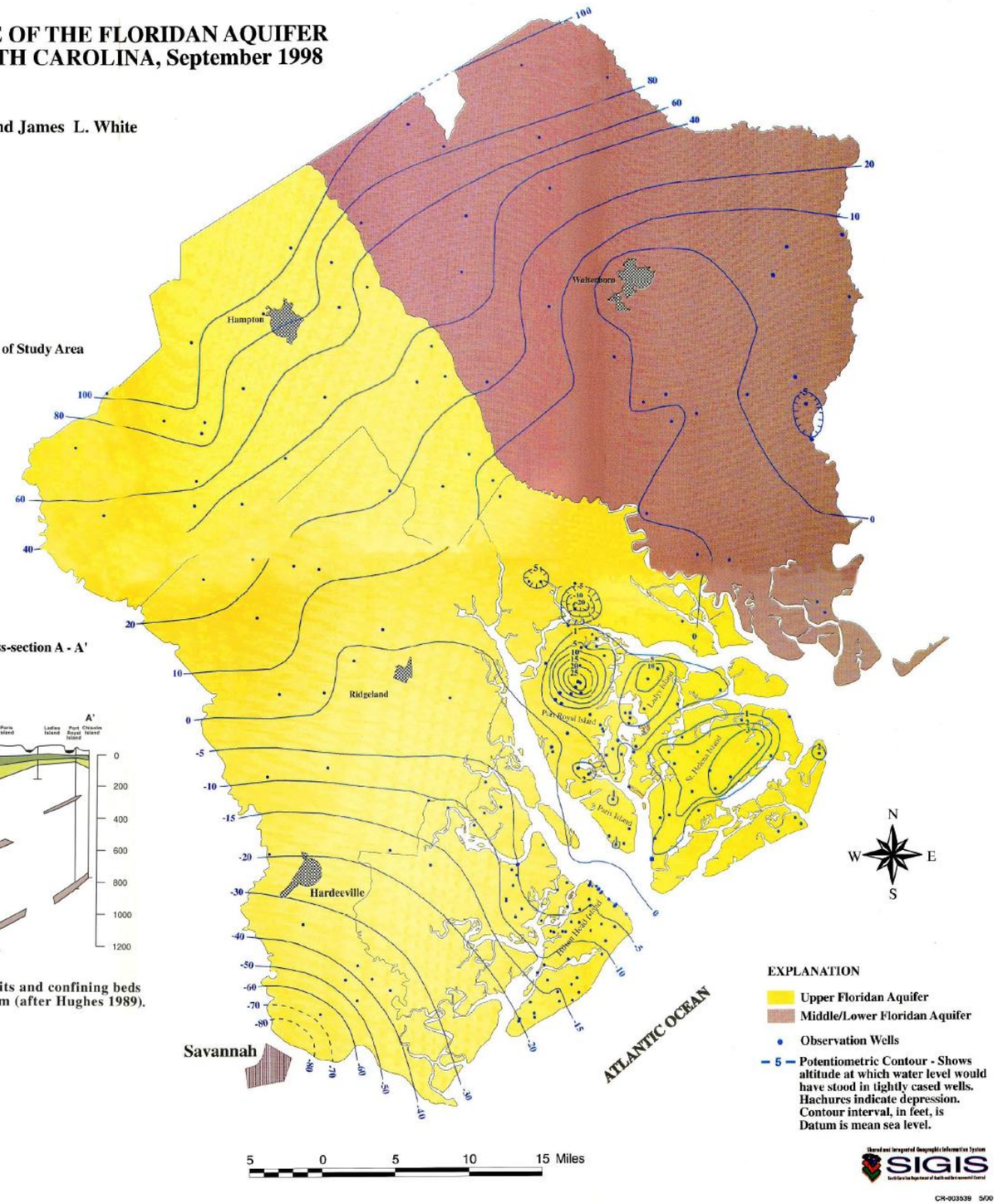


Figure 2. Distribution of permeable units and confining beds of the Floridan Aquifer System (after Hughes 1989).



Upper Floridian Aquifer

Middle/Lower Floridian Aquifer

Observation Wells

-5- Potentiometric Contour

[Shows altitude at which water level would have stored in tightly cased wells. Hachures indicate depression. Contour interval, in feet while Datum is mean sea level.]

Chapter 5

Natural Resources

Map 5-10: Preserved Open Space

2010 Beaufort County Comprehensive Plan

Sea Level Rise Adaptation Report
Beaufort County, South Carolina

March 2015

S.C. Sea Grant Consortium Product #SCSGC-T-15-02

Social and Environmental Research Institute
Sea Grant S.C. Sea Grant Consortium
Beaufort County South Carolina 1769
Sea Grant North Carolina
cisa carolinas integrated sciences & assessments

Acknowledgements

This report is the collaborative effort of stakeholders in Beaufort County, South Carolina, and a project team consisting of the Beaufort County Planning Department, South Carolina Sea Grant Consortium, Social and Environmental Research Institute, North Carolina Sea Grant, and Carolinas Integrated Sciences and Assessments program at the University of South Carolina. The project team assembled a Beaufort County Stakeholder Group, which met five times from August 2013 to November 2014. This group of local decision makers learned about sea level rise and the impacts to Beaufort County and discussed possible actions to increase the County's resiliency. The group drew heavily upon the local knowledge and experience of its members, and also reached out to colleagues and engaged a larger audience in two public workshops. The project team drafted this report with frequent consultation with the Stakeholder Group.

This project was sponsored by the S.C. Sea Grant Consortium pursuant to the National Oceanic and Atmospheric Administration's National Sea Grant Office Community Climate Change Adaptation Initiative Award No. NA10OAR4170073, Amendment 10. Because consultation with the Stakeholder Group began as formal academic research, the study's methodology was reviewed and approved by the College of Charleston's Institutional Review Board.[1] The Board requires that the identities of research subjects remain confidential unless waived. In later stages of the project, the majority of the Stakeholder Group chose to identify their affiliated organization to lend support to the importance of this project.

The project team would like to thank the Beaufort County Stakeholder Group for their time, enthusiasm, and dedication to seeing this project through to completion. The project team would also like to thank all of the stakeholders who participated in interviews or workshops and provided their local knowledge and opinions to develop opportunities for Beaufort County to become more resilient to future sea level rise impacts.

The College of Charleston provided several resources in support of this project, including GIS capabilities and printing services, and the South Carolina Department of Natural Resources helped facilitate the public workshops.

[1] College of Charleston. 2014. "Office of Research & Grants Administration." http://orga.cofc.edu/pub/compliance_irb_index.shtml

Affiliations of Beaufort County Stakeholder Group Members

Beaufort County Council
Beaufort County Planning Department
Beaufort County School District
Beaufort Soil & Water Conservation District
Gullah/Geechee Sea Island Coalition
Town of Bluffton
Beaufort County Department of Public Works
Beaufort County Stormwater Utility
Beaufort Group, LLC
Coastal Conservation League
National Stormwater Center

Project Team

Beaufort County Planning Department
South Carolina Sea Grant Consortium
Social and Environmental Research Institute
North Carolina Sea Grant
Carolinas Integrated Sciences and Assessments

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Key Terms

In the context of this project on Beaufort County, South Carolina, and sea level rise, we use the following definitions of these key terms:

Sea level rise: An increase in the average relative sea level over a period long enough to average out transients such as waves, tides, and storms.

Decision makers: Any group, institution, organization, or individual who makes decisions related to sea level rise or its impacts. This includes the state, county, and municipal governments, the military, private developers, marinas, homeowners, tribal groups, and environmental groups.

Adaptation: Adjustments made by decision makers that are intended to prepare for future sea level rise in a way that takes advantage of beneficial opportunities or reduces negative effects. This includes adapting to gradual sea level rise and related extreme events such as storm surges.

Adaptive capacity: The capacity of decision makers to adapt to sea level rise. Capacity includes resources, knowledge, and skills along with the political will and leadership to marshal those resources in a productive manner.

Resilience: A measure of Beaufort County's *present ability* to adapt to sea level rise without experiencing permanent harm. This differs from adaptive capacity because the latter is the *potential* for Beaufort County to adapt.

Sensitivity: A characteristic of a person, place, or thing that describes how easily harmed it is by sea level rise. A person who owns a home near sea level is much more sensitive to sea level rise than a person who owns a home on a high hill set back from the sea.

Vulnerability: This term includes all the above and summarizes the degree to which the County, or any specific location or stakeholder in the County, is susceptible to and unable to cope with anticipated sea level rise and its associated impacts. Vulnerability is a function of sea level rise, the sensitivity of the location or party, and its adaptive capacity.

Relevant Acronyms

FEMA: Federal Emergency Management Agency

MHHW: Mean Higher High Water

NOAA: National Oceanic and Atmospheric Administration

NWS: National Weather Service

SCDHEC: South Carolina Department of Health and Environmental Control

SCDNR: South Carolina Department of Natural Resources

SCDOT: South Carolina Department of Transportation

USACE: United States Army Corps of Engineers

Introduction

Beaufort County, South Carolina, is a low-lying coastal county with a high sensitivity to tidal flooding and storm surge. Just over half of Beaufort County is open water, sounds, marshes, and estuaries and two thirds of its dry land is located within a flood zone. Given these vulnerabilities, community leaders called for the inclusion of sea level rise as an issue to consider in the 2010 Beaufort County Comprehensive Plan. The Plan calls for the County government to anticipate and plan for sea level rise impacts.

In response, the Beaufort County Planning Department joined with the South Carolina Sea Grant Consortium, the Social and Environmental Research Institute, North Carolina Sea Grant, and the Carolinas Integrated Sciences and Assessments Program at the University of South Carolina (the "project team") to investigate opportunities for the County to adapt, or increase its capacity to adapt, to future sea level rise impacts. Adaptation is the process of adjusting one's activities to a changing environment to take advantage of benefits and reduce negative effects. Adaptive capacity is the ability of a community to make those adjustments.

The project team assembled a Beaufort County Stakeholder Group, consisting of local decision makers and stakeholders, which met five times in 2013-2014 and was frequently consulted during the development of this final report. The group drew heavily upon the local knowledge and technical experience of its members, and also reached out to colleagues and engaged a larger audience in two public workshops.

This report cites data on local sea level rise trends and reviews the 23 adaptation actions identified by the Beaufort County Stakeholder Group and members of the broader public. These 23 actions are grouped into nine categories and presented below. The report is divided into three major sections. The first is a vulnerability assessment that examines the nature of local sea level rise in Beaufort County and maps potential flood zones across the County. Section II recounts the methodology utilized to gather information and seek community input. This section includes the results of priority voting of the adaptation actions conducted by members of the public. Section III presents the findings on each adaptation action. This final section provides a brief description of the action, displays community comments in bullet points, and shares additional information including the experience of other communities and helpful tools and methods.

With this report, Beaufort County has begun the process of preparing for sea level rise. As a next step, the Beaufort County Stakeholder Group recommends these adaptation actions be considered by the Beaufort County Regional Implementation Committees and the Beaufort County Council Natural Resources Committee.

Sea Level Rise Adaptation Action List

The following actions identified by local stakeholders help Beaufort County prepare for sea level rise via direct adaptation of policy and by expanding the County's adaptive capacity.

1) Coordination, Cooperation, & Collaboration
- *1.1: Improve coordination among governments and agencies.*
- *1.2: Facilitate a dialogue on how to balance public and private interests/responsibilities.*

2) Education & Information
- *2.1: Develop and implement a public education campaign.*
- *2.2: Provide disclosure and disclaimer notice to purchasers of high risk properties.*

3) Emergency Management
- *3.1: Incorporate future sea level rise impacts into emergency management plans.*

4) Land Management
- *4.1: Maintain and strengthen setback policies.*
- *4.2: Install and encourage the use of living shorelines.*
- *4.3: Limit development in high risk areas.*
- *4.4: Use conservation to respond to sea level rise.*
- *4.5: Revise building codes to higher standards and incentivize better design.*
- *4.6: Preserve and restore ecosystems and species.*
- *4.7: Establish funding structures and/or tax districts to help property owners.*
- *4.8: Develop affordable housing in safer areas.*
- *4.9: Create a transfer of development rights program for low elevation properties.*
- *4.10: Assist with beach renourishment.*

5) Research & Monitoring
- *5.1: Identify or establish environmental monitoring programs in the area.*
- *5.2: Identify trigger points for changing policy.*

6) Social Adaptation
- *6.1: Address the impacts on disadvantaged social groups, values, and symbolic places.*

7) Transportation Adaptation
- *7.1: Prioritize, elevate, and protect low-lying roads and causeways.*

8) Water Management
- *8.1: Use low impact development practices.*
- *8.2: Build water control structures.*

9) Miscellaneous
- *9.1: Support climate change mitigation programs.*
- *9.2: Increase the County's Community Rating System score.*

Section I. Beaufort County Vulnerability Assessment

With its low-lying geography, Beaufort County is particularly vulnerable to elevated water levels. This section examines historic and future sea level rise and depicts the effect of heightened water levels on normal tide cycles. This includes the presentation of a county flood map that depicts future high tides and extreme high tides with 1-2 feet of base sea level rise. Lastly, this section explores what these water levels are like on the ground by recalling an August 2014, flood event at the Mossy Oaks neighborhood of Beaufort, S.C.

Sea Level Basics

Scientists use land-based tidal gauges and satellites to measure changes in sea level. Local sea level can rise for three reasons. (1) The volume of water in the ocean increases. This is currently happening for two reasons. First, ocean water is expanding as it warms. Second, glaciers and ice sheets on land are melting, leading more water to enter the seas. (2) Sea levels can also appear to change because land rises or falls. The shoreline of the eastern U.S. is generally sinking. This is called land subsidence. To some extent this is a natural process that has to do with the type of soils along the shore, but it can also be aggravated by groundwater removal. (3) Changes to ocean currents such as the Gulf Stream can lead to more water pushing up against the East Coast.

Tidal gauges measure the relative change in sea level. It is "relative" because it does not include the movement of the land itself. Satellites measure absolute mean sea level by measuring the height of the sea from the center of the Earth. Because oceans naturally rise and fall with winds, storms, tides, and seasons, all measures of sea level need to be averaged over a long time period to arrive at a clear trend.

Beaufort County experiences a semidiurnal tide. There are two high tides and two low tides of approximately equal size every day, though one of the two high tides is slightly higher than the other and one of the two low tides is slightly lower than the other (Figure 1).

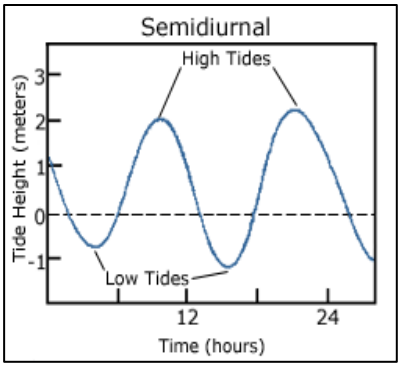


Figure 1: Semidiurnal tides consist of two daily high tides and two daily low tides of approximately equal height.
Source: NOAA

The average height of all high tides is known as Mean High Water (MHW). The average height of the higher of the two daily tides is known as **Mean Higher High Water (MHHW)**, or the higher high tide line. These averages are calculated using tide gauge observations during a 19-year period known as the National Tidal Datum Epoch. The current epoch is 1983-2001.

Differences in coastal land type from mudflats to marshes to forest are determined by the interaction of tidal cycles and ground elevation. For example, salt water marsh grasses thrive in elevation zones where they are flooded by water for part of the day. Many plants cannot survive when exposed to excessive salt water. MHHW can be used as the approximate boundary line between wetlands vegetation like salt marsh and upland vegetation like oak trees.

The National Weather Service (NWS) distinguishes three primary flood stages: minor flooding, moderate flooding, and major flooding.[2] **Minor flooding** consists of minimal or no property damage, but possibly some public threat (e.g., inundation of roads). **Moderate flooding** refers to some inundation of structures and roads near water bodies. **Major flooding** refers to extensive inundation of structures and roads. The NWS designates flood stages in Beaufort County at the following local data points:

- Minor Flooding: 1.7 ft. above MHHW
- Moderate Flooding: 2.1 ft. above MHHW
- Major Flooding: 2.5 ft. above MHHW

Observed Local Data

This project uses long-term tide gauge data from nearby NOAA station 8670870[3] at Fort Pulaski, GA. Although sited about 10 miles outside of the Beaufort County line, this station provides the long term data necessary for identifying sea level trends. It can be used as a proxy for major trends across the County, but may differ somewhat from specific tide gauges within the County, especially if they are located on an insulated river. Since the station's establishment in 1935, relative mean sea level has risen an average of 0.12 inches per year (Figure 2). This translates to 1.2 in./decade or 1.0 ft./century.

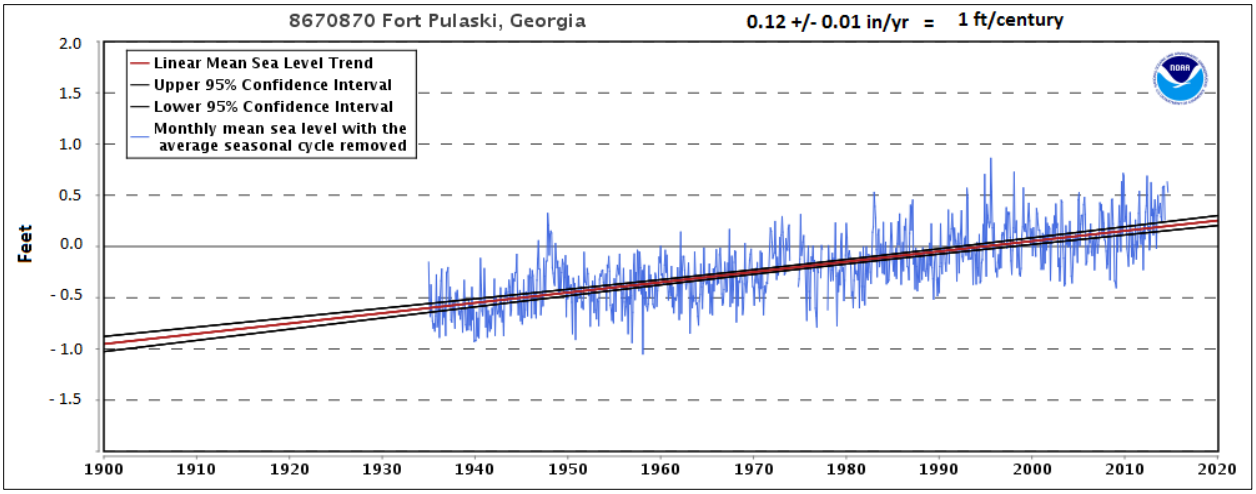


Figure 2: Mean sea level is rising at NOAA station 8670870 near Beaufort County, S.C.

[2] Caldwell, David B. 2012. "National Weather Service Manual 10-950, Operations and Services Hydrologic Services Program, NWSPD 10-9 Definitions and General Terminology." National Weather Service. http://www.nws.noaa.gov/directives/sym/pd01009050curr.pdf

[3] NOAA. 2014. "Fort Pulaski, GA – Station ID: 8670870." *Tides & Currents*. http://tidesandcurrents.noaa.gov/stationhome.html?id=8670870

Naturally, water levels can be quite variable, fluctuating daily with tides. Figure 3 shows the highest monthly tide levels recorded at Fort Pulaski. These data are used to create annual exceedance probabilities, which quantify the water levels likely to be exceeded with 99%, 50%, 10%, and 1% probability every year. The exceedance probabilities indicate that water levels at 1-2 ft. above MHHW are common, with NWS minor flood stage and moderate flood stage occurring at least yearly and bi-yearly, respectively.

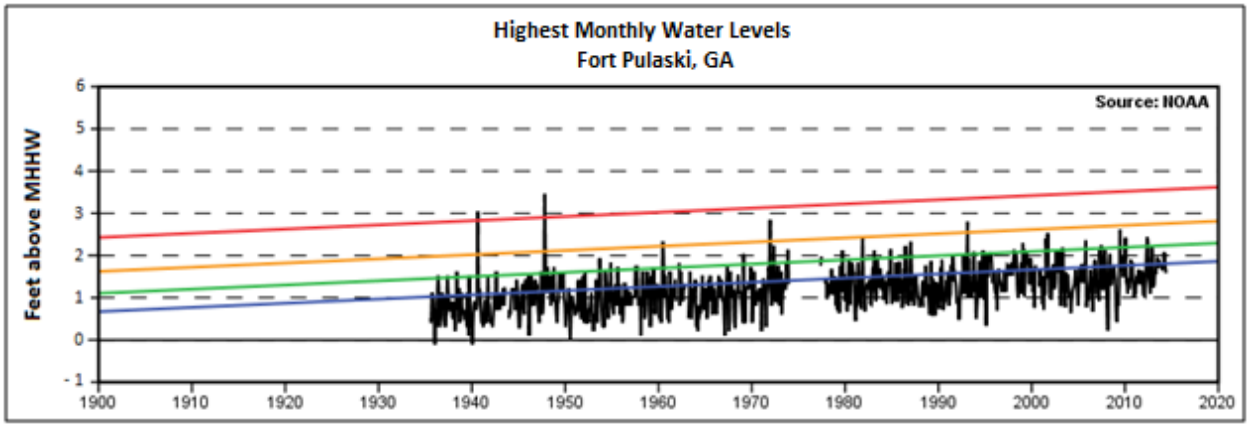


Figure 3: Data on highest monthly water levels (black line). The color lines represent the water level associated with 99% (blue), 50% (green), 10% (orange), or 1% (red) annual probability of reoccurrence, or the probability that water levels will be reached at least once during the year.

However, the annual exceedance probability levels do not measure the probability of extreme tides happening multiple times in the year. Figure 4 shows the number of days each year when tides exceeded the NWS minor flood stage. These flood events have increased over time. Although these data include tides associated with storm surge, the overall trend is due to the increased height of regular high tides.

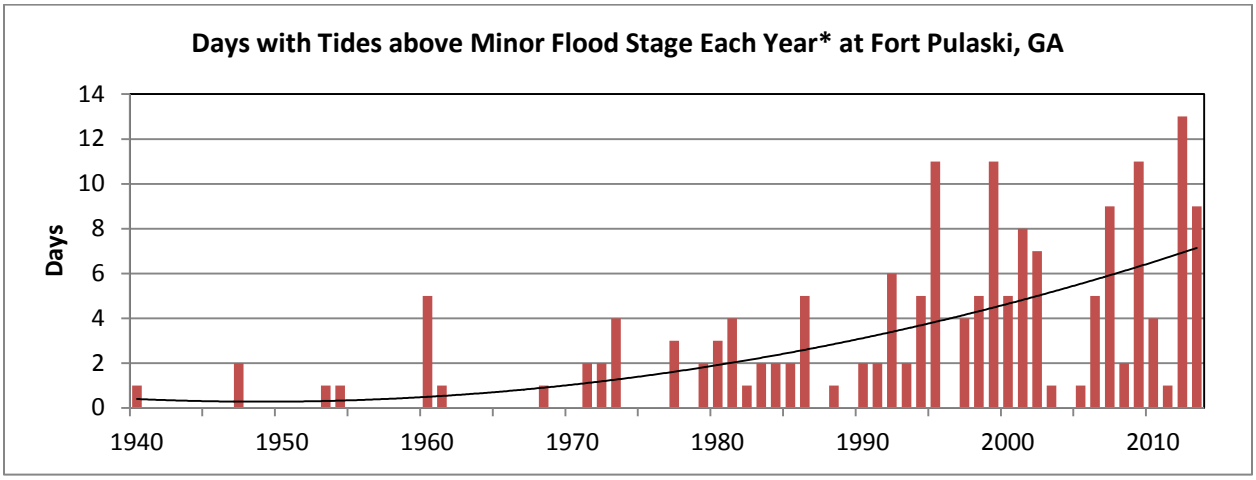


Figure 4: Extreme tides have become more common in recent decades according to tide gauge data at NOAA Station Fort Pulaski, GA. The graph displays the number of days each year when tide levels exceeded the NWS minor flood stage, defined as 1.7 ft. above the mean higher high tide (MHHW). The upward trend is likely due to the combination of sea level rise and land subsidence occurring in the area. *We use the meteorological year from May 1 to April 30 so we do not split the winter storm season.

Future Sea Levels

Global mean sea level is increasing due to thermal expansion and ice melt. Like mercury in a thermometer, water expands when heated. This increases the surface height of the ocean. Atmospheric heat melts ice, including land-based ice sheets and glaciers, adding additional water volume to ocean basins. These two forces are expected to intensify due to atmospheric heat trapped by the presence of greenhouse gases like carbon dioxide (CO_2).

The U.S. National Climate Assessment provides global sea level rise projections for four planning scenarios[4] (Table 1; Figure 5). These scenarios are based on the full range of possibilities expressed among scientific studies. The four scenarios are guides for climate adaptation planning that communities can use to decide for themselves how precautionary they want to be. Preparing for the lowest scenario will save resources, but may leave the County vulnerable to future sea level rise risk. On the other hand, preparing for the highest scenario could protect critical infrastructure and reduce future impacts, but may prove costly and unwarranted if seas do not rise as high as anticipated in that scenario.

Table 1: Sea level rise scenarios for the U.S. National Climate Assessment.[5]

Scenarios	Description
Lowest	A scenario based on the continuation of historical trends derived from tide gauge data beginning in 1900.
Intermediate-Low	A scenario based primarily on thermal expansion, without significant ice melt.
Intermediate-High	A scenario based on thermal expansion and some ice sheet loss.
High	A scenario based on the calculation for the highest possible glacier and ice sheet loss by the end of the century.

The National Climate Assessment projections are intended for global average sea level rise. Therefore, it is important to consider local contributions to sea level rise[6]. Relative mean sea level in Beaufort County is rising more quickly than the global average due to land subsidence. Subsidence is the gradual sinking of the land surface due to natural compaction of coastal soil and/or excessive withdrawal of underground liquids like water and oil. According to the U.S. Army Corps of Engineers Sea Level Rise Curve Calculator,[7] the rate of land subsidence at Fort Pulaski is 0.05 in./yr. It is assumed that the land surface will continue to subside at a similar rate into the future.

---

[4] Parris, Adam, Peter Bromirski, Virginia Burkett, Dan Cayan, Mary Culver, and John Hall. 2012. *Global Sea Level Rise Scenarios for the United States National Climate Assessment*. National Oceanic and Atmospheric Administration (NOAA). http://cpo.noaa.gov/sites/cpo/Reports/2012/NOAA_SLR_r3.pdf.

[5] Ibid.

[6] The contribution of the Gulf Stream and other ocean currents are difficult to predict and are not considered in Figure 5. Ocean currents typically interact with sea level in cycles that can be averaged out over more than ~20 years.

[7] USACE. 2014. "Sea-Level Change Calculator." *Responses to Climate Change*. http://www.corpsclimate.us/ccaceslcurves.cfm

Figure 5 incorporates the rate of local land subsidence into the four global sea level rise scenarios to provide localized projections up to year 2100. Scientists are 90% confident that global mean sea level will rise within the 1 ft. to 7 ft. range of these scenarios by the end of the century, but cannot attribute a probability to any specific scenario.

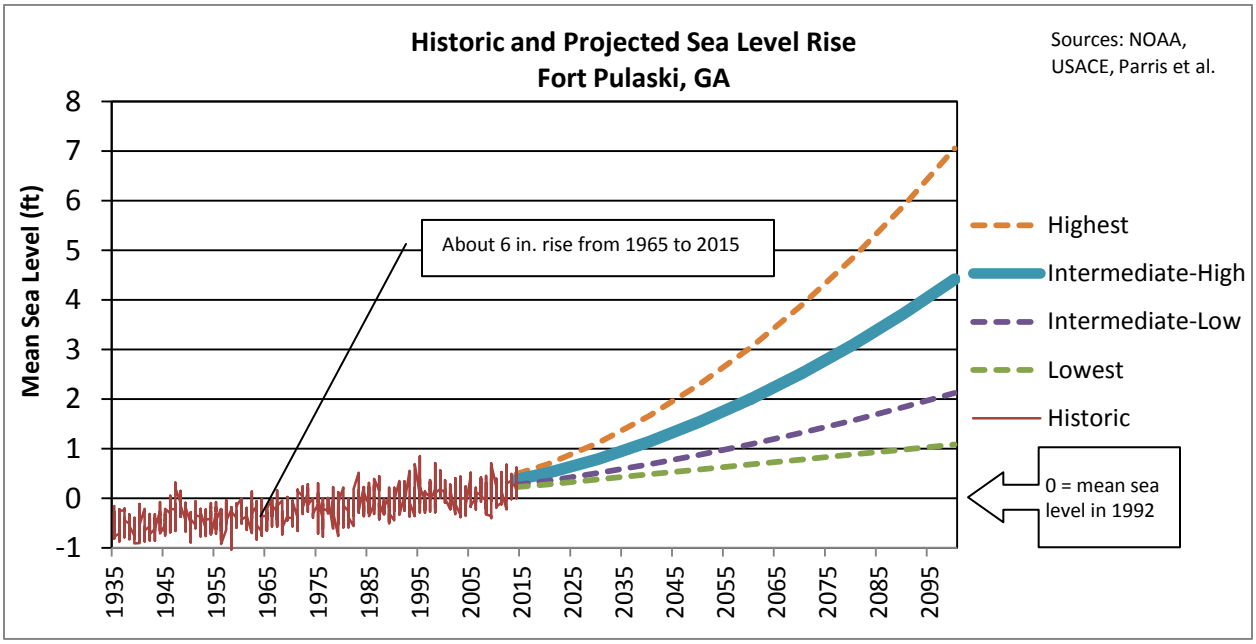


Figure 5: Historic data from the Fort Pulaski tide gauge are displayed with future global sea level scenarios provided by NOAA and modified to incorporate the gradual sinking of the land surface in the region (land subsidence). The intermediate-high scenario (bolded blue line) was selected as the planning scenario by the Beaufort County Stakeholder Group.

As mean sea level increases, tidal flooding within the year becomes more common. Figure 6 displays a projection of tidal flood events in the next six decades based on the National Climate Assessment scenarios. Even if local sea level rises at its historic rate (Lowest Scenario), the number of tidal floods will increase to an average of 40 events per year by 2060. If sea level rises at its highest projected rate, tidal flooding could occur at nearly every high tide of the year.

Flood Mapping

To determine the impact of future projections in sea level, the Beaufort County Stakeholder Group selected two data points from the intermediate-high scenario: +1 ft. sea level rise by 2040 and +2 ft. sea level rise by 2065 (Figure 5). These two points represent the length of a mortgage (about 30 years) and infrastructure design life (about 50 years) respectively, from the time this project was initiated. The project team used Esri's geographic information systems software, ArcGIS ®, to map the potential impact of elevated water levels across Beaufort County (Figure 7).

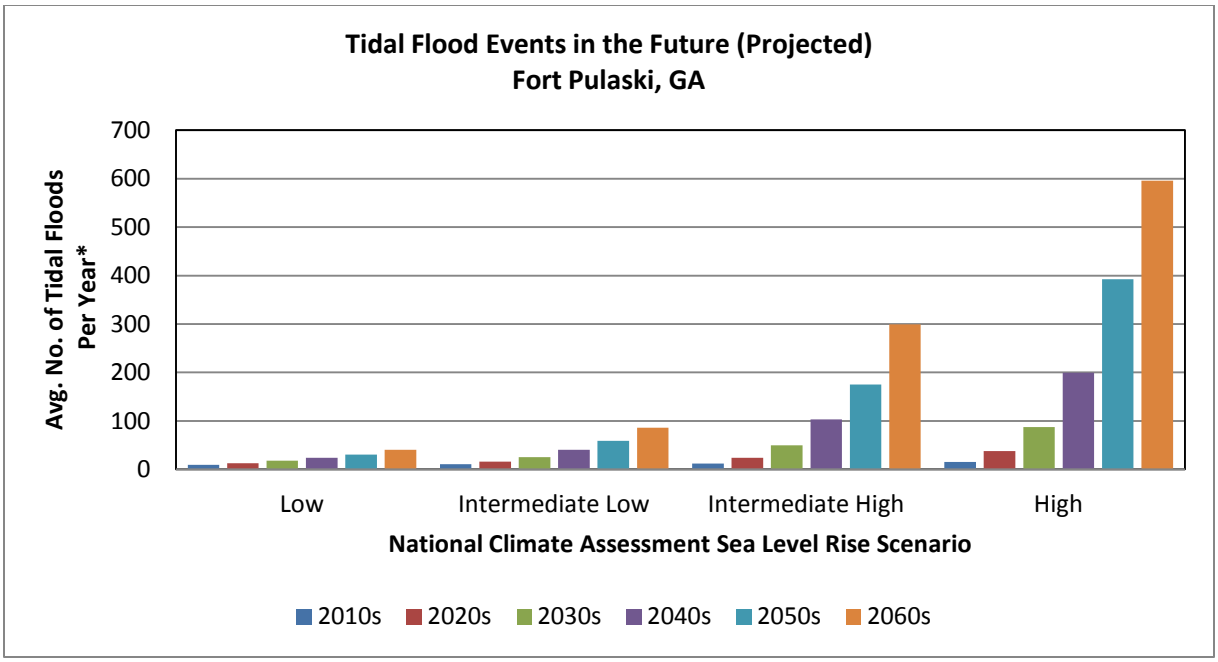


Figure 6: Flood events surpassing the NWS minor flood stage (1.7 ft. MHHW) will become more common in the coming decades. The project team created these projections using tide gauge data from the NOAA Inundation Analysis tool[8] and methodology described by NOAA.[9] For each analysis, we averaged the number of flood events above the flood stage threshold at NOAA station 8670870 Fort Pulaski, GA, over a 10-year period from 2000 to 2010. Because these data come from a 10-year period, it does not remove the effect of multi-year or multi-decadal oscillations in sea level. In other words, the analysis assumes that tidal data will be identical to 2000-2010, but with a higher base water level. *Tidal floods possible twice daily during high tides.

The project team used one-foot sea level rise contours provided by the NOAA Office of Coastal Management's Sea Level Rise and Coastal Flooding Impacts Viewer.[10] These layers were designed using 2002 Light Detection and Ranging (LiDAR) elevation data from the Beaufort County GIS Department. The layers simulate the vertical and horizontal movement of the tidal water line onto the topography of the land surface. This methodology is sometimes known as a "bathtub model" because the water fills the basin up to the modeled land surface just like water fills a bathtub. This type of mapping does not factor in other forces that will shape Beaufort County's shoreline as the sea rises, including wave action due to storm surge, erosion of the shoreline, changing hydrological patterns, or the protection of shoreline by humans.

The base sea level layer in the model is set at Mean Higher High Water (MHHW) in order to distinguish currently dry land from wetlands. Layers at +1 ft. and +2 ft. MHHW are used to show future higher high tides in 2040 and 2065 (Intermediate-High scenario) and +3 ft. and +4 ft. are displayed to show the impact of semi-regular extreme tides (i.e., Figure 3).

[8] NOAA. 2015. "Inundation Analysis Tool." *Tides & Currents.* http://tidesandcurrents.noaa.gov/inundation/
[9] Pendleton. 2013. "What's the Frequency, Kenneth? (With Coastal Flooding That Is)." *Digital Coast*. http://coast.noaa.gov/geozone/whats-frequency-kenneth-coastal-flooding/#.VL-_5EfF83d
[10] NOAA Office for Coastal Management. 2014. "Sea Level Rise and Coastal Flooding Impacts Viewer." *Digital Coast.* http://coast.noaa.gov/digitalcoast/tools/slr

Tidal Flood Map of Beaufort County, South Carolina

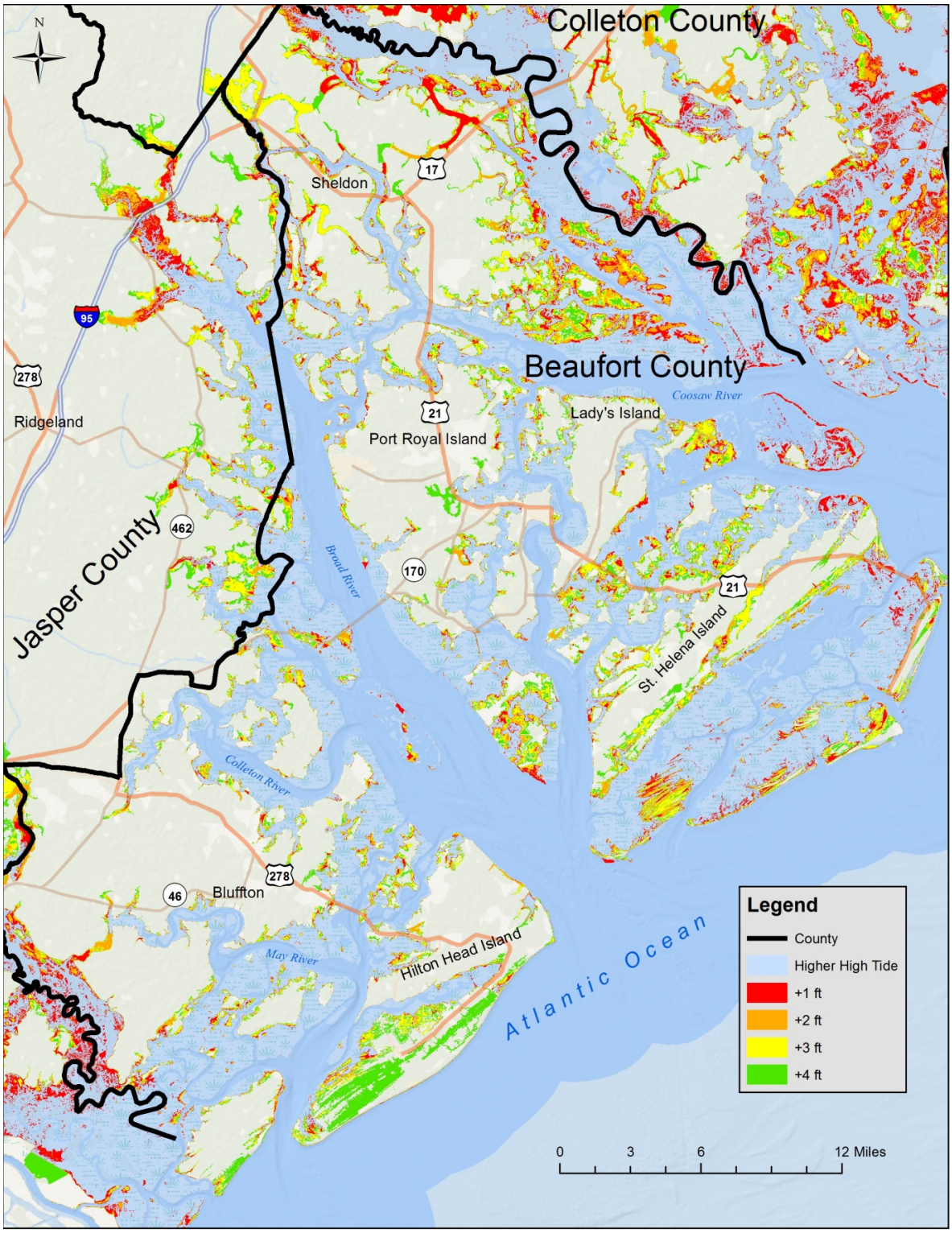


Figure 7: This flood map indicates where tidal flooding will likely occur at designated water levels above the current Mean Higher High Water mark, or the average higher high tide. Future average high tides could extend into the +1 ft. zone by 2040 and the +2 ft. zone by 2065 according to the National Climate Assessment's Intermediate-High sea level rise scenario. Semi-regular extreme tides already approach the +2 ft. zone. Future extreme tides could extend into the +3 ft. zone by 2040 and the +4 ft. zone by 2065.
Sources: NOAA; Esri ®.

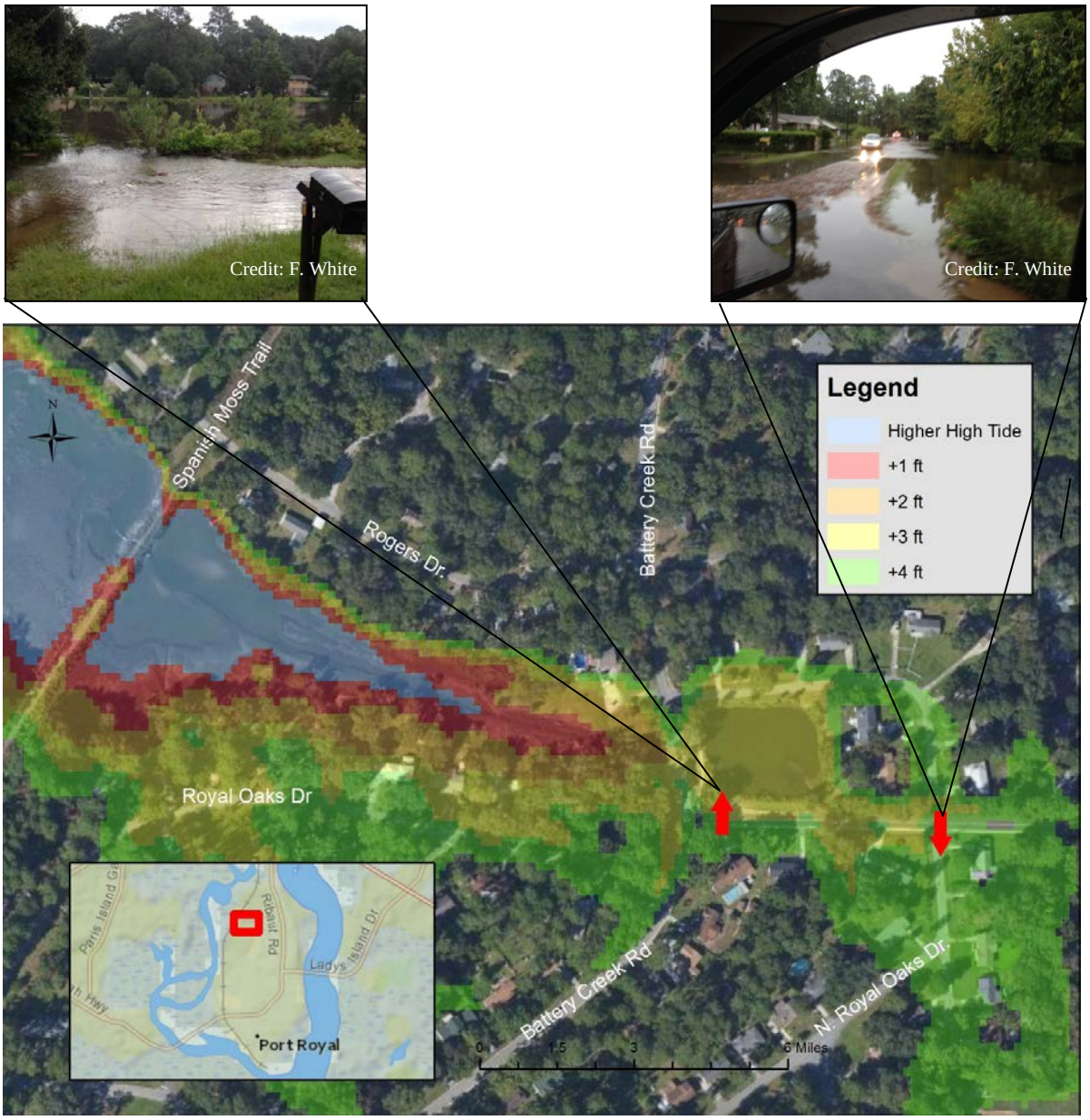
Figure 7 depicts the widespread impact of elevated water levels on Beaufort County, showing that sea level rise is a concern for the rural inland communities of the County just as much as the oceanfront Sea Islands. Daily high tides 1-2 ft. above current levels will first erode many of the isolated hammocks and extensive marshland of the Sea Islands. It will encroach onto the dry land adjacent to creeks and rivers.

If base sea level was 1-2 ft. higher than the current level, then semi-regular extreme high tides will be 3-4 ft. higher than current levels. As the yellow and green colors on Figure 7 indicate, these extreme tides could flood 20,000-30,000 acres of dry land. While much of the vulnerable land resides in the low-density rural regions of northern Beaufort County, up to 9,000 acres of urban and residential land uses could be flooded without protection. These tides could cause significant property damage in properties not built to current FEMA flood zone standards.

The most extreme floods today offer a glimpse into the regular tidal floods of the future. In mid-August 2014, local water level approached 2 ft. above MHHW amid several days of intense rainfall. Drainage systems in the Mossy Oaks neighborhood of Beaufort, S.C. were overwhelmed. A local resident documented extensive flooding in the 3-4 ft. above MHHW zones displayed in Figure 8. In the real world, weather and the state of development can intensify the impact of tidal flooding.

Ultimately, the flood maps like those in Figure 7 and 8 depict a bathtub model of an unchanging world. In reality, Beaufort County and its residents will gradually respond to reoccurring floods. The Beaufort County Stakeholder Group was concerned with the big picture view of encroaching sea level rise. As presented in this report, the flood map is intended to inform members of the public and introduce sea level rise as a County-wide planning issue.

An Example of Impact: Mossy Oaks Flooding on August 10, 2014



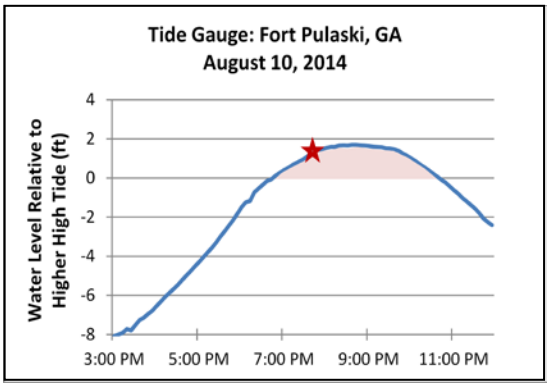


Figure 8: A real life example of tidal flooding occurred in the Beaufort neighborhood of Mossy Oaks on August 10, 2014. Heavy rains and exceptionally high tides combined to generate flooding in the +3-4 ft. zones. The photos above were taken at 7:30 p.m. (see red star in tide gauge data to the right), when the tide was about 1.5 ft. above the higher high tide line. The shaded area to the right identifies when the nearby water level exceeded the average higher high tide, which indicates potential flooding.

Section II. Community Input Process

The project team relied on the input of the Beaufort County Stakeholder Group, their colleagues, and other members of the public. They sought this input in order to preserve the Beaufort County community's ownership of the results. There were three formal phases of community input: scoping interviews, Stakeholder Group meetings, and public workshops. The interviews and Stakeholder Group meetings were conducted as official academic research for the College of Charleston, a member institution of the S.C. Sea Grant Consortium. Therefore, the identities of participants must remain confidential.

Scoping Interviews (June 2013)

The first step in the project was to conduct interviews to gather background information on local environmental issues and the planning process in Beaufort County. Many of these key community members would later participate in the Beaufort County Stakeholder Group.

Participants

Interview candidates were selected based on their community standing and the relevance of their role to planning and environmental issues in Beaufort County. An initial contact list was proposed by Beaufort County planner Robert Merchant. Candidates were contacted via phone or e-mail. Fifteen people were interviewed. In-person interviews followed rules established by the College of Charleston's Institutional Review Board for research involving human participants.[11]

Stakeholder Group (August 2013 & February, May, November 2014)

In the next step, the project team invited a group of local decision makers to a meeting to discuss the consequences of and responses to sea level rise in a facilitated group discussion. The first two meetings in August 2013 were structured using the Vulnerability, Consequences, and Adaptation Planning Scenarios (VCAPS) process (see Process section below). Later meetings were informal continuations of the discussion contained herein.

Participants

Most of the interviewees were invited to join the Stakeholder Group. Additional community members were added to the discussion in later meetings based on the need for their expertise. For example, two private business owners and additional county staff members were consulted during the process. There were a total of 19 group members over five meetings in Beaufort County.

Process

The group discussions were structured using the Vulnerability, Consequences, and Adaptation Planning Scenarios (VCAPS) process.[12] VCAPS is an approach to decision support that

[11] College of Charleston ORGA. 2014. "Office of Research & Grants Administration." College of Charleston. http://orga.cofc.edu/pub/compliance_irb_index.shtml

[12] SERI & CISA. 2014. "VCAPS: Vulnerability, Consequences, and Adaptation Planning Scenarios." http://vcapsforplanning.org/

integrates local knowledge with scientific understanding. It has been previously used in at least 13 coastal communities, including Sullivan's Island and McClellanville in South Carolina.[13]

VCAPS researchers lead community decision makers through group discussion about local issues affected by environmental change. Experts are invited to provide basic context about the science and decision makers use that information to collectively identify local vulnerabilities, consequences, and adaptation actions based on the climate hazard. During these discussions, the researchers create diagrams that represent how the decision makers understand the links between climate hazards and their consequences for Beaufort County, as well as the actions that government entities and private individuals or groups can take to reduce or prevent any consequences. Figure 9 displays the concept boxes used to organize a VCAPS diagram into a logical flow beginning with the relevant management concern and ending with the consequences initiated by climate hazards.

The Stakeholder Group created two VCAPS diagrams. The first diagram displayed a discussion on the impact of development and rainfall patterns on stormwater management (Appendix A).

The second diagram captures the effect of sea level rise and storm surge on planning (Appendix B).

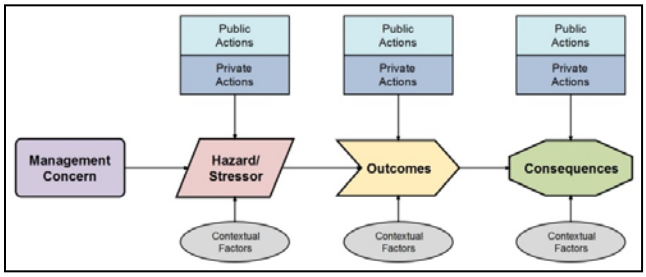


Figure 9: The legend for a Vulnerability, Consequences, and Adaptation Planning Scenarios (VCAPS) diagram shows how the focus group discussion was structured.

After initial meetings in August 2013, the Stakeholder Group reconvened in February and May 2014 to continue the discussion with the use of sea level rise flood maps created by the S.C. Sea Grant Consortium using geographic information systems (GIS) software. The maps provided a spatial focus to the group's discussions about vulnerability.

Throughout these discussions, the Beaufort County Stakeholder Group identified many adaptation actions. Their actions were the foundation of the list contained in this report. The group met a final time in November 2014 to provide input on the draft report.

Public Workshops (August 2014)

On August 25 and 26, 2014, the S.C. Sea Grant Consortium hosted two public workshops seeking local input on the Stakeholder Group's list of adaptation actions. The workshops were advertised publicly via e-mail, press release, paper flyer (Appendix C), and word of mouth during the month prior.

[13] Webler, Thomas, Seth Tuler, Kirstin Dow, Jessica Whitehead, and Nathan Kettle. 2014. "Design and Evaluation of a Local Analytic-Deliberative Process for Climate Adaptation Planning." *Local Environment*. 17 July.

Participants

Seventy-seven people attended the two public workshops. Figure 10 identifies the affiliation of attendees according to a post-workshop evaluation survey. The three largest groups included concerned citizens, non-profit groups, and state agency employees.

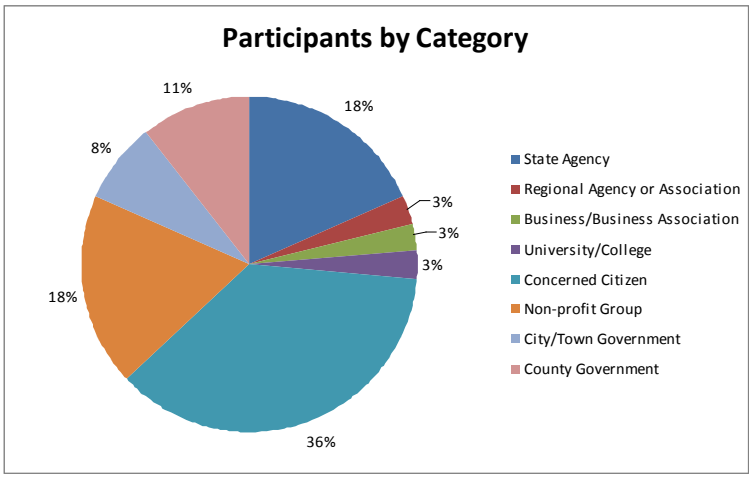


Figure 10: The affiliation of attendees to the Beaufort County Sea Level Rise Adaptation workshops according to a post-survey evaluation survey.

Workshop Format

Two public workshops were held in Beaufort County: one at the Bluffton regional library and another at the St. Helena regional library. Their formats were identical (Appendix D). The three-hour workshops were divided into two parts. The first half of the workshops was dedicated to presentations on Beaufort County's vulnerability to sea level rise and the progress of the Stakeholder Group in identifying adaptation actions. During the second half of the workshops, the project team facilitated separate breakout group discussions with 5-10 people. This structure allowed members of the public to provide their own informed commentary on potential adaptation actions for Beaufort County.

How the Community Input was Used

Community input was the cornerstone of this project. The scoping interviews provided the necessary context information for subsequent steps. For example, the project team learned about the extensive partnership of public and private groups involved in maintaining water quality across Beaufort County. This partnership represents a success story for environmental management and an effective local network to be accessed for climate adaptation efforts.

The Stakeholder Group, using the VCAPS process for structure, created the initial list of adaptation actions. Group members continued to provide much needed advice throughout every stage of the project, including final edits.

The public workshops critiqued, expanded, and combined adaptation actions. Whereas membership to the Stakeholder Group was by invitation only to preserve the confidentiality of its members, the workshops offered a wider opportunity for anyone in the Beaufort County community to comment.

Top Priorities of Workshop Participants

During the public workshops, each participant ranked their first, second, and third priorities from among 23 adaptation actions. In this tabulation of participant voting, each participant's first, second, and third priority were awarded a weighted score as displayed below:

Participant Rank	Weighted Score
1	3
2	2
3	1

Items that did not receive priority votes were not necessarily unimportant to the participants. These adaptation actions encompass a broad range of near- and long-term strategies, and in general some of these longer-term strategies did not receive as many votes.

Overall Rank	Adaptation Action	Category	Weighted Score
1	Identify or establish environmental monitoring programs in the area.	Research & Monitoring	60
2	Develop and implement a public education campaign.	Education & Outreach	44
3	Prioritize, elevate, and protect low-lying roads and causeways.	Transportation Adaptation	39
4	Improve coordination among governments and agencies.	Coordination, Cooperation, & Collaboration	24
5	Maintain and strengthen setback policies.	Land Management	22
6	Install and encourage the use of living shorelines.	Land Management	18
7	Limit development in high risk areas.	Land Management	16
8	Use conservation to respond to sea level rise.	Land Management	14
9	Use low impact development practices.	Water Management	11
10	Incorporate future sea level rise impacts into emergency management plans.	Emergency Management	10
10	Revise building codes to higher standards and incentivize better design.	Land Management	10

Overall Rank	Adaptation Action	Category	Weighted Score
10	Identify trigger points for changing policy.	Research & Monitoring	10
11	Facilitate a dialogue on how to balance public and private interests.	Coordination, Cooperation, & Collaboration	8
12	Provide a disclosure and disclaimer notice to purchasers of high risk properties.	Education & Outreach	7
12	Consider the impacts on disadvantaged social groups, values, and symbolic places.	Social Adaptation	7
13	Preserve and restore ecosystems and species.	Land Management	5
14	Establish funding structures and/or tax districts to help property owners.	Land Management	4
15	Support climate change mitigation programs.	Miscellaneous	3
16	Develop affordable housing in safer areas.	Land Management	0*
16	Create a transfer of development rights program for low elevation properties.	Land Management	0*
16	Assist with beach renourishment.	Land Management	0*
16	Increase the County's Community Rating System score.	Miscellaneous	0*
16	Build water control structures.	Water Management	0*

*Items that did not receive priority votes were not necessarily considered unimportant. Each participant voted only for their top three priorities.

Section III. Adaptation Actions

This section provides expanded information on the 23 adaptation actions vetted by the Beaufort County Stakeholder Group and the public workshop participants. Each entry describes the action, lists participant comments, and cites relevant examples and useful resources.

More specifically, this section uses the following format:

Category #: Title

Action #: Title

Adaptation Action full sentence.

Each adaptation action listing will begin with a basic description of that action.

#.1: Community Input

The community input section is designed to summarize commentary from the interviews, Beaufort County Stakeholder Group, and the public workshops. Their commentary is structured into bullet points to increase readability. Please note: Not every adaptation action will be structured with the same bullet point categories. Participants did not always address the same issues regarding every action.

#.2: Additional Information

The additional information section includes information gathered by the project team beyond that discussed during the community input phases. This information is provided for additional context, to highlight the experiences of other communities, and to reference tools that may help Beaufort County implement the adaptation action.

Category 1: Coordination, Cooperation, and Collaboration

Action 1.1: Inter-Governmental Cooperation

Improve coordination among governments and agencies.

The number of government agencies with jurisdiction over common coastal issues makes collaboration challenging. By encouraging communication and joint activities, the County can increase its capacity to adapt to sea level rise.

1.1.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Future of military presence
  - Government disunity across agencies
  - Security of fresh drinking water supply in Savannah River
  - Need to identify responsibilities among agencies
  - Collection and availability of state environmental monitoring data
- Suggestions
  - Learn from other communities (i.e., Miami, N.C. Outer Banks, Norfolk)
  - Create a standing working group for climate change to capture grant funds for sustained programs
    - Regional coastal adaptation network could offer economy of scale advantage
    - Leverage other sea level rise and resiliency-focused efforts in S.C.
- With partners:
  - Military
  - Municipalities
  - Regional alliances/councils/networks, including the Metropolitan Planning Organization
  - Relevant federal and state agencies (FEMA, SCDHEC, SCDNR, SCDOT)
  - Utilities and public service districts

1.1.2: Additional Information

Increased partnership will take unique forms depending on the issue and the organizations involved. Beaufort County can begin by clarifying decision making authority among different agencies and levels of government in relation to specific actions outlined in this report.

Other communities have used collaboration as a strategy to adapt to sea level rise. An example is the Southeast Florida Regional Climate Change Compact[14] established in 2009. This ongoing effort involves four counties, all of their municipalities, partners, and all 5.6 million residents.

[14] Southeast Florida Regional Climate Change Compact. 2014. http://www.southeastfloridaclimatecompact.org/

Members used the alliance to establish a single unified baseline greenhouse gas inventory, sea level rise projection, and vulnerability assessment process. These integrated assessments have allowed the counties to identify 110 action items grouped within seven goal areas.

Action 1.2: Public/Private Dialogue

Facilitate a dialogue on how to balance public and private interests/responsibilities.

Environmental management is complicated by tensions between public and private interests. To overcome this barrier, public and private entities can clarify each other's responsibilities. The aim of dialogue is to cooperatively design effective management actions that minimize disruption to existing interests of all entities.

1.2.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
    - The effect of poorly-managed private infrastructure on overall environmental management
        - i.e., stormwater ponds, ditches, roadways, causeways
    - High risk properties that have lost market value
    - Limited funds to act
- Suggestions
    - Establish policy trigger points (see page 34) before engaging in dialogue
    - Understand private sector drivers and create policy that incentivizes private owners to adapt
    - Clarify areas that government will proactively support and areas private entities should support
    - Create special funding structures and/or tax districts to help property owners
    - Tax tourists for improvements they use
    - Maintain government role of disclosure and public education
- With partners:
    - Homeowners associations
    - Planned unit developments
    - Real estate agents

1.2.2: Additional Information

Internationally, Public-Private Dialogue (PPD) is a process used to craft more inclusive and sustainable development policies.[15] It involves communicating proposed policy reforms to stakeholders and utilizing private sector participation to build more appropriate policies. Although this process is used primarily for economic development, it can provide a model for

[15] The World Bank Group. 2014. "Public-Private Dialogue." *Investment Climate*. https://www.wbginvestmentclimate.org/advisory-services/cross-cutting-issues/public-private-dialogue/

best practices in facilitating communication. The *PPD Handbook: A Toolkit for Business Environment Reformers*[16] is one centralized source for guidance on PPD techniques.

Category 2: Education & Information

Action 2.1: Public Education

Develop and implement a public education campaign.

Public education or outreach campaigns involve reaching out to County residents to inform them of flood risk, the potential for environmental change, and relevant laws or policies. The objective is to increase local awareness about risk to inspire individuals and organizations to act.

2.1.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Importance of educating the public
  - Need to keep hearing from experts
  - Neighborhoods in low-lying areas
  - Resistance to climate adaptation policy
- Suggestions
  - Maintain a sustained effort
  - Use Master Naturalist style program[17]
  - Teach in local schools
  - Teach elected officials during planning orientation
  - Provide sea level rise information on County website
    - Inexpensive approach
  - Create community inventories of level of disaster preparedness
  - Engage in outreach to communities
- Education content
  - Changes to insurance rates
  - Risk levels
  - Current laws
  - Information with local focus
  - Impacts to wildlife

[16] DFID, the World Bank Group, and OECD Development Centre. 2014. *Public Private Dialogue*. http://www.publicprivatedialogue.org/

[17] Clemson University. 2014. "South Carolina Master Naturalist." *Clemson University*. http://www.clemson.edu/public/naturalist/

- Education partners:
    - Homeowner Associations (HOAs) / neighborhood communities
    - Churches
    - New property owners
    - Developers
    - Elected officials
    - Gullah/Geechee Sea Island Coalition

2.1.2: Additional Information

The Beaufort County Stormwater Education and Outreach program is a model education collaborative in the Lowcountry region. The County Stormwater Utility works through partners at Clemson Extension and the Port Royal Sound Foundation to educate and inform residents of environmental concerns. These and other established educators could integrate climate information into their current activities with the help of regional climate extension specialists at the S.C. Sea Grant Consortium[18] and the Carolinas Integrated Sciences and Assessments (CISA) program[19] at the University of South Carolina.

Action 2.2: Hazard Disclosure and Disclaimer

Provide disclosure and disclaimer notice to purchasers of high risk properties.

A disclosure and disclaimer notice is a document provided to property owners to officially inform them of a hazard they may experience on their property and to absolve the County of liability for damages incurred due to the hazard. There are many types of disclosures. The State of South Carolina requires a disclosure of beachfront erosion and Beaufort County requires one for the homes surrounding the Marine Corps Air Station. The 2010 Beaufort County Comprehensive Plan called for the County to consider this type of notice in reference to the threat of sea level rise.[20]

2.2.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
    - Lack of disaster preparedness
    - County responsibility to maintain public infrastructure
    - Litigation for failure to disclose risks
    - Unachievable due to political will and liabilities
    - Stigmatized properties
    - Realtor opposition
    - Failure of current flood zone disclosures to discourage development

[18] SCSGC. 2014. *South Carolina Sea Grant Consortium*. http://www.scseagrant.org/
[19] Carbone, Greg. 2014. *Carolinas Integrated Sciences and Assessments*. http://www.cisa.sc.edu/
[20] Beaufort County. 2010. "Chapter 5: Natural Resources" in *2010 Beaufort County Comprehensive Plan*. Page 34.

- Suggestions
    - Use disclosure as educational tool
    - Clarify public/private responsibilities in disclosure statement

2.2.2: Additional Information

A disclosure notice[21] is currently required for properties residing within special flood hazard zones, however this brochure does not address sea level rise. Sea level rise will expand flood risk beyond the confines of current flood zones and intensify risk at the lowest elevations. These considerations can be incorporated into existing County flood awareness guides or packaged into a special disclosure addendum addressed only to those in the riskiest elevation zones. Communities in Florida, Maryland, and Delaware have considered disclosure statements specific to sea level rise. The proposal in Delaware was rejected due to concerns about the potential impact on the real estate industry.[22] This opposition suggests industry cooperation is vital for a successful disclosure notice.

Category 3: Emergency Management

Action 3.1: Updating Plans

Incorporate future sea level rise impacts into emergency management plans.

Emergency management planning often assumes the probability of extreme events will remain the same into the future. Sea level rise and other climate changes are likely to increase the probability of flooding and the intensity of hurricanes. A higher base sea level increases the height of storm surge and warmer Atlantic waters brew stronger hurricanes. Even storms that do not make landfall can influence regional wind patterns that cause elevated tides along the County's shoreline. These impacts can be considered in emergency plans to increase overall preparedness.

3.1.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
    - Access of emergency services (EMS) during road flooding
    - Access to evacuation routes during road flooding
    - Advertising of Palmetto Breeze evacuation pick-up

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[21] Beaufort County. 2014. "Citizen's Guide to Flood Awareness." http://www.co.beaufort.sc.us/departments/Public-Safety/building-codes/documents/Flood-Brochure.pdf

[22] Montgomery, Jeff. 2013. "Climate change on the coast: Buyer-beware option considered." *Delaware Online*. Jan. 11. http://www.delawareonline.com/article/20130111/NEWS08/301110053/Climate-change-coast-Buyer-beware-option-considered

- Suggestions
    - Completely identify risk before updating plans
    - Create EMS contingency plan for coastal flooding
    - Provide additional support for vulnerable areas during evacuation
        - Public transportation
        - Early notification of evacuation
    - Perform storm evacuations during low tides
    - Prioritize elevating evacuation routes
    - Create neighborhood contingency plans
    - Use reserve funds for disaster relief and hazard mitigation

3.1.2: Additional Information

State governments in New York[23] and Virginia[24] are among those that have considered sea level rise from an emergency management perspective. These states have placed particular emphasis on ensuring that climate information remains consistent across plans and agencies. The New York committee recommends that agencies consider the increased demand for services post-disaster and the effect of sea level rise on evacuation routes. The committee calls for agencies to consider back-up measures for critical systems like drinking water and electricity, or the potential for sea level rise to spread contamination by flooding hazardous waste sites.

Category 4: Land Management

Action 4.1: Setbacks

Maintain and strengthen setback policies.

A setback line is a legal boundary used to create a corridor between development and the shoreline. New construction and reconstruction seaward of a setback line is prohibited. This physical separation can protect both built structures and the natural environment.

4.1.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
    - Erosion of shoreline
    - Water quality
    - Setbacks from septic systems
    - Limitations of setbacks

[23] Grannis, Pete et al. 2010. "New York State Sea Level Rise Task Force Report to the Legislature." http://www.dec.ny.gov/docs/administration_pdf/slrtdrpt.pdf

[24] Watkins, John and Jim Redick. 2014. "Recommendations to the Secure Commonwealth Panel on the Issue of Sea Level Rise and Recurrent Flooding in Coastal Virginia." http://www.norfolk.gov/DocumentCenter/View/17786

- Suggestions
  - Strengthen setback policies
  - Maintain position of setbacks on growing shorelines (do not move seaward)
  - Adopt relevant recommendations of the Blue Ribbon Committee on Shoreline Management
  - Incorporate buffers in addition to setbacks
  - Enforce setbacks without exceptions
  - Consider elevation in setback regulations
  - Focus on river/creek/wetland setbacks

4.1.2: Additional Information

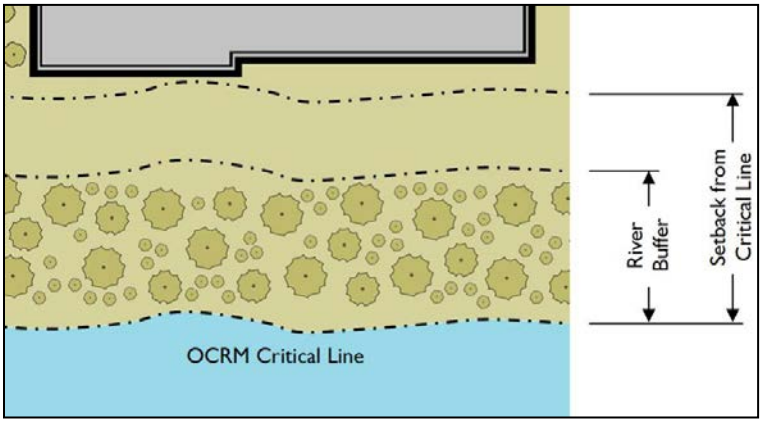

Figure 11: Vegetative buffers and construction setbacks are measured from the SCDHEC Office of Ocean and Coastal Resource Management's Critical Line, or the boundary of the shoreline. Source: Beaufort County Planning Department

Non-beachfront setback and buffer restrictions in Beaufort County are stricter than the state standard. The County currently requires a 50 ft. natural buffer from all tidal waters, a 50 ft. setback for single-family residences, 100 ft. for townhouses, apartments, non-residential buildings, septic tanks, and tile fields, and 150 ft. for agricultural uses and golf courses. Beachfront setbacks are set by S.C. law[25] at 40 times the distance of the average annual erosion rate for the past 40 years from the baseline. The baseline is set at the crest of the primary sand dune. All setback lines must be established at least 20 ft. landward of the baseline, even when the shoreline has been stable or has experienced growth for the past 40 years. However, the Blue Ribbon Committee on Shoreline Management recommended that the baseline *never* be moved seaward from its position because 20 ft. is not sufficient space to allow protective dune systems to develop.[26] Thus far, the S.C. General Assembly has not adopted the recommendations of the Blue Ribbon Committee, but Beaufort County can implement its own version for County beaches.

[25] S.C. Code § 48-39-10 et seq.
[26] SCDHEC. 2013. *Blue Ribbon Committee on Shoreline Management Final Report*. S.C. Department of Health and Environmental Control (SCDHEC). http://www.dhec.sc.gov/library/CR-010631.pdf

Action 4.2: Living Shorelines

Install and encourage the use of living shorelines.

Living shorelines are an approach to stabilize shorelines using a variety of natural structures and organic materials. Living shorelines involve the stabilization of ground features using plants, sand, and reefs. The root systems of plants absorb water and keep the soil in place.

4.2.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Use of hardened structures (i.e. bulkheads, revetments, sea walls)
  - Viewed by some as an easy fix to an immediate erosion problem but cause longer-term problems
  - Lack of political will to prevent use of hardened structures
- Suggestions
  - Use living shorelines as an alternative strategy
  - Restore and/or maintain natural shoreline buffers
  - Encourage private property owners to maintain buffers with native vegetation
  - Supplement existing County requirement to leave natural buffers for new developments

4.2.2: Additional Information

A common living shoreline approach in the lowcountry is the restoration of oyster reefs. Oyster reefs can protect marsh habitats and the upland behind them from erosion if the conditions are right. Oysters do best when placed in environments with low wave energy. SCDNR[27] and The Nature Conservancy[28] each manage ongoing oyster restoration projects in South Carolina.

Action 4.3: Limit Development

Limit development in high risk areas.

Development is currently permitted in low-elevation land where tidal flooding is common and storm surge is severe. Although building codes are enforced and flood insurance is required, these waterfront properties are inherently risky. Traditional controls, like land-use zoning, could be used to limit development in such areas.

4.3.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

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[27] SCDNR. 2015. "South Carolina Oyster Restoration and Enhancement." *South Carolina Department of Natural Resources.* http://score.dnr.sc.gov/

[28] TNC. 2015. "Oyster Reef Restoration." *The Nature Conservancy*. http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/southcarolina/howwework/oyster-reef-restoration-southern-solutions-for-a-global-problem-1.xml

- Concerns
  - Need for strong strategy to limit development
  - Development blocking marsh migration
  - Public liability for risky private developments
  - Government overreach in land-use regulations
  - Many areas already developed
- Suggestions
  - Use impact fees
  - Require developers to establish an escrow fund to maintain private infrastructure
  - Offer incentives to not develop
  - Prohibit sea walls along rivers and creeks
  - Encourage denser development at higher elevations

4.3.2: Additional Information

Land-use zones can be used as a tool to limit development directly. Special flood hazard zones are currently being added to comprehensive plans in Southeast Florida counties. These "adaptation action area" overlays can be defined as areas below, at, or near mean higher high water, areas with a hydrological connection to coastal waters, and areas designated as evacuation zones for storm surge[29] (especially below a Category 1 surge designation). The overlays establish additional, stricter standards or criteria for development and can be used as a basis for prioritization of funds just by being included in the future land-use map.[30]

The Georgetown Climate Center wrote an extensive legal analysis of a model sea level rise overlay zone for Maryland local governments.[31] This report cautions that local governments will need to make specific findings justifying enactment of policies in a special district to meet constitutional substantive due process requirements. Examples of justifications include risk levels, the shortcomings of existing flood plain maps to emphasize the heightened risk in future inundation areas, and the presence of rapid erosion.

Action 4.4: Conservation

Use conservation to respond to sea level rise.

Conservation and preservation programs involve the ordinary fee simple purchase or donation of development rights of a property. This prevents the property from being further developed. There are multiple motives for doing so, including the conservation of economic, natural, and cultural

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[29] Florida Department of Community Affairs. "Adaptation Action Area White Paper". http://www.southeastfloridaclimatecompact.org/wp-content/uploads/2014/09/adap-action-areas.pdf

[30] South Florida Regional Planning Council. 2013. *Adaptation Action Areas: Policy Options for Adaptive Planning For Rising Sea Levels*. http://www.southeastfloridaclimatecompact.org/wp-content/uploads/2014/09/final-report-aaa.pdf

[31] Grannis et al. 2011. "A Model Sea-Level Rise Overlay Zone for Maryland Local Governments". Georgetown Climate Center. http://www.dnr.state.md.us/ccs/pdfs/GCC_MD-SLROrdRpt_FINALv3_11-2011.pdf

resources, protection of water quality in a critical area, the preservation of historic property, and the provision of open space views.

4.4.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Loss of economic, natural, and cultural resources due to development and sea level rise
  - Degradation of water quality
  - Potential abuse of land pricing
  - Expense of buying property
- Suggestions
  - Utilize Beaufort County's Rural and Critical Lands Preservation Program to target vulnerable areas that are likely to be inundated by high tides in the future
  - Analyze how this program can specifically be used to reduce sea level rise vulnerability in order to potentially justify future bond referendums that provide funding
  - Create tax incentives for limiting development rights on property while continuing historic uses

4.4.2: Additional Information

Prime conservation land is likely to shift with changing habitats and urban development patterns. Salt marsh will migrate onto former upland areas where not blocked by development. To ensure future marsh habitats through conservation, the likely pathways of marsh migration need to be identified.

It is difficult to accurately predict future habitat change, but there are some preliminary tools that can help planners. The NOAA Office for Coastal Management has a Marsh Impacts/Migration tab on its Sea Level Rise and Coastal Flooding Impacts tool.[32] This tool predicts marsh migration based on the concept that marsh grows within a specific range of elevation between land and sea.

Action 4.5: Building Codes

Revise building codes to higher standards and incentivize better design.

Building codes ensure private development is conducted in a manner that protects the public health, safety, and welfare of citizens. Building codes set minimum construction standards. They are designed to consider natural hazards like floods and hurricanes based on the probability of a particular event happening.

[32] NOAA Office for Coastal Management. 2014. "Sea Level Rise Viewer." *Digital Coast.* http://coast.noaa.gov/digitalcoast/tools/slr

4.5.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Buildings in Beaufort County not adequately designed to handle gradual sea level rise and associated flooding and storm surge
  - Adequate enforcement of current building codes
  - Septic systems becoming a source of pollution
- Suggestions
  - Revise building codes to a higher standard than the 2012 International Building Codes
  - Use incentives to produce better compliance with building codes
  - Update building codes in advance of a natural disaster to ensure good standards are enforced during recovery
  - Tie building code upgrades to planning thresholds: once local mean sea level records exceed the threshold, the building codes can be brought up to design standards that better reflect how the environment has changed
  - Implement stronger regulations for septic systems, including increasing setbacks from structures and shorelines
  - Consider replacing septic with sewer systems, while managing any additional development this might encourage
- Model building codes from other communities
  - Bermuda: handling water runoff from houses
  - The Netherlands: building codes and other structures standards set for far worse than 1-in-100 year storm

4.5.2: Additional Information

The largest threat to buildings is flood damage. Beaufort County currently requires all buildings to have their lowest floor at base flood elevation, or the elevation at which there is a 1% annual probability of a flood. The current FEMA Flood Insurance Rate Maps do not incorporate calculations of future sea level rise, nor does the upcoming map update, which is scheduled for 2016. Therefore, flood risk may be higher than what base flood elevations suggest and wider than what the current special flood hazard zones suggest. A report created for the City of Annapolis, Maryland, proposed adding the projected sea level rise height in 2050 to minimum building elevations and floodproofing elevations in addition to a 2 ft. freeboard.[33] In addition to protecting structures, these regulations may also save on insurance costs by building points on FEMA's Community Rating System (see page 41).

[33] ERM. 2011. *Regulatory Response to Sea Level Rise and Storm Surge Inundation City of Annapolis, Maryland*. City of Annapolis. http://www.dnr.state.md.us/CoastSmart/pdfs/Annapolis_RRSLRnSSI.pdf

Action 4.6: Preserve Ecosystems

Preserve and restore ecosystems and species.

Ecosystems in Beaufort County provide many services including economic value, food, flood and erosion control, wildlife biodiversity, and several social benefits.[34] Fish and shellfish in the County provide direct food sources to local residents and visiting tourists. Marsh grasses reduce flooding on the upland and oysters protect river banks from erosion. Ecosystems in Beaufort County nurture and protect a large variety of local wildlife species, including endangered species like the shortnose sturgeon, wood stork, Florida manatee, and the pondberry.[35] The local environment offers many social benefits including recreation, beauty, peace and relaxation, opportunities for socialization, nostalgia, legacy value (to pass on to descendants), spiritual value, inspiration, and learning. Lastly, many people believe local ecosystems have value in and of themselves.

4.6.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Health of oyster beds with growing human presence along the coast
  - Loss of critical marsh habitat
  - Erosion due to boat traffic and oyster harvesting

- Ecosystem values
  - Marshes and oyster reefs are living shorelines
  - Marsh systems act like sponges and absorb a large quantity of water during the tidal cycle
  - Oyster reefs offer habitat, filter water, and are a critical part of the food chain
- Suggestions
  - Prohibit sea walls near marshes
  - Increase restrictions on speed of boat traffic in critical waterways
  - Improve and better enforce Beaufort County's tree protection ordinance to ensure that large root systems continue to stabilize shorelines and reduce flood risks

[34] NCCOS. 2014. "Social Values of Ecosystem Services in Marine Protected Areas for Management Decision-making." The NOAA National Centers for Coastal Ocean Science. http://www.coastalscience.noaa.gov/projects/detail?key=190

[35] SCDNR. 2014. "Rare, Threatened, and Endangered Species and Communities Known to Occur in Beaufort County, SC: June 11, 2014." South Carolina Department of Natural Resources. https://www.dnr.sc.gov/species/pdf/Beaufort2014.pdf

4.6.2: Additional Information

Beaufort County's existing efforts to preserve water quality[36] serve a key role in protecting local ecosystems and species. Remaining priorities to protect and restore ecosystems depend on the specific impacts of sea level rise on a given habitat. This action will require a combination of research and monitoring, conservation, setbacks, and buffers.

Action 4.7: Funding Structures

Establish funding structures and/or tax districts to help property owners.

Governments can create special tax districts to help local communities pool funding for private localized infrastructure improvements.

4.7.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Development in risk-prone areas is too inexpensive and easy
- Suggestions
  - Internalize cost of siting private development in environmentally risky areas
  - Restructure development impact fees to cover costs incurred by the County for maintaining vital infrastructure vulnerable to rising seas
  - Require developers to establish an escrow fund with an allocation for each lot so the neighborhood would have the funds to directly pay for the maintenance of local roads and stormwater ponds

4.7.2: Additional Information

Impact fees used for coastal flood protection measures could be tied to particular geographic areas by using an adaptation action area overlay zone (see page 26). The risk-based overlay could also provide a legal justification for a targeted tax which is then earmarked for specific infrastructure improvements in the area, including elevating roads, coastal armoring, and conservation purchases. Escrow accounts can similarly be used to foster resilience to sea level rise as recommended by the workshop participants. They are regularly used to set aside funds for hazard insurance. They have also been utilized on an international scale under the Clean Development Mechanism of the Kyoto Protocol to establish a forest protection condition on investments to donor countries.[37] Beaufort County may be able to require large developers to create escrow funds in the planned unit developments, but this requires further legal analysis.

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[36] Beaufort County. 2015. "Water Quality Monitoring." http://www.bcgov.net/departments/Engineering-and-Infrastructure/stormwater-management/water-quality-monitoring.php

[37] Schwarze, Reimund, and John O. Niles. 2001. "The Long-Term Requirement for CDM Forestry and Economic Liability." In *Law and Economics of International Climate Change Policy*. Springer Science+Business Media Dordrecht, the Netherlands.

Action 4.8: Affordable Housing

Develop affordable housing in safer areas.

The goal of affordable housing is to ensure the availability of low price homes for lower and moderate income buyers. However, cheaper land may also be riskier land. Low income homeowners may find it more difficult to recover from severe flooding than their more affluent neighbors. One action to adapt is to incentivize affordable housing only in areas outside of current and future flood zones.

4.8.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Residents living paycheck-to-paycheck in substandard housing
  - Public investment in recurring flood areas
- Suggestions
  - Collaborate on affordable housing at regional scale
  - Coordinate assistance of low income residents through the Human Services Alliance and the Together for Beaufort County initiative

4.8.2: Additional Information

NOAA's Coastal County Flood Exposure Snapshot[38] reveals that 50% of the Beaufort County population living in poverty resides within a FEMA-designated special flood hazard area (7,731 individuals). County incentives, such as density bonuses, could be limited to non-flood zones to encourage safer affordable housing. However, the geography, housing market, and availability of land may become barriers to affordable housing in safer areas. For example, work force housing should be sited near major employers, not in distant rural areas.

Existing affordable homes within the flood plain may experience increasing pressure from flooding and rising insurance costs. Subsidized policies in the National Flood Insurance Program will be gradually adjusted to actuarial rates in the coming years. The Center for NYC Neighborhoods published a report on the effect of rising flood insurance costs on affordable homes in the New York metro area.[39] The report calls for guidance on alternative mitigation actions and affordable financing options to elevate homes. It may be useful to conduct further research on how Beaufort County government can protect affordable homes in vulnerable areas.

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[38] NOAA Office for Coastal Management. 2015. "Coastal County Snapshots." *Digital Coast*. http://coast.noaa.gov/digitalcoast/tools/snapshots

[39] Center for NYC Neighborhoods. 2014. *Rising Tides, Rising Costs: Flood Insurance & New York City's Affordability Crisis*. https://cnycn.creatavist.com/risingtides

Action 4.9: Transfer of Development Rights

Create a transfer of development rights program for low elevation properties.

Transfer of Development Rights (TDR) programs issue certificates representing development rights to property owners in "sender" areas where development is undesirable. These property owners can then sell the certificates to property owners in "receiver" areas, where the certificate is redeemable with a multiplier for additional dwelling units on the property. This maintains a low density for the sender area and a higher density for the receiver area by using market forces.

4.9.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
    - Willingness of receiver area to increase density

4.9.2: Additional Information

The Town of Bluffton implemented a successful TDR program in the May River area, but designs for a TDR program surrounding the Marine Corps Air Station have not progressed. Success of these programs is highly dependent on the characteristics of the marketplace. This tool may not work everywhere.

Action 4.10: Beach Renourishment

Assist with beach renourishment.

Sea level rise will worsen beach erosion. If erosion rates increase dramatically, there may be pressure for Beaufort County to contribute to beach renourishment along developed beaches like Hilton Head, Fripp, and Harbor Islands.

4.10.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
    - Continued erosion in renourished areas
    - Protection of places with historical and cultural significance
    - Reliance of Hilton Head Island on renourishment
    - Major cost
    - Supply of sand for nourishment
    - Vulnerability of low-lying land on the rear side of barrier islands

4.10.2: Additional Information

Beaufort County has not historically funded renourishment. Residents of Hilton Head and Daufuskie islands have been able to pay for their own renourishments. However, all of the

County's barrier islands will be at an increasing risk for erosion as sea level rises. The developed islands of Harbor and Fripp will be particularly vulnerable.

Category 5: Research & Monitoring

Action 5.1: Environmental Monitoring

Identify or establish environmental monitoring programs in the area.

Environmental monitoring programs will help governments keep an eye on the health of the local environment. This sort of monitoring system is already important because of environmental stressors related to development. Climate change will further increase the need for monitoring, especially because no one can foretell exactly how local ecosystems will respond to such drastic changes.

5.1.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Health of marsh
  - Opportunity of marsh to migrate
  - Relation of environmental health to social vulnerability (see page 36)
  - Need to identify risk of sea level rise to environment and people
  - Liability to disclose and mitigate risk
  - Clean Water Act regulation data needs
  - Information transparency
- Suggestions
  - Monitor the health of salt marshes, water quality, and salt water intrusion
  - Track flooding locations, sea level trends, erosion patterns, and infrastructure vulnerabilities
  - Manage at state agency level
  - Pay or manage volunteer community members to assist with data collection
  - Identify marsh migration pathways and conserve lands
- Data sources/tools
  - Sea Level Affecting Marshes Model (SLAMM)[40]
  - NOAA Sea Level Rise and Coastal Flooding Impacts Viewer[41]
  - Surface elevation table monitoring devices to monitor marsh movement

[40] NOAA Office for Coastal Management. 2014. "Sea Level Affecting Marshes Model." *Digital Coast*. http://coast.noaa.gov/digitalcoast/tools/slamm

[41] NOAA Office for Coastal Management. 2014. "Sea Level Rise Viewer." *Digital Coast.* http://coast.noaa.gov/digitalcoast/tools/slr

- Light Detection and Ranging (LiDAR) elevation data

5.1.2: Additional Information

A considerable amount of data monitoring is already conducted by state agencies and scientific organizations. However, budget constraints create data gaps. Agencies have discretion in what they monitor, and do not watch everything. For example, SCDHEC monitors daily water quality on beaches for recreational use, but they do not test inland waterways. With the right expertise and agency oversight, other organizations can fill gaps. For example, the nonprofit organization Charleston Waterkeeper monitors recreational waters along the Ashley and Cooper rivers in Charleston, S.C.

The U.S. Climate Change Science Program, in Chapter 14 of *Coastal Sensitivity to Sea-Level Rise*,[42] proposed a comprehensive science strategy for better understanding sea level rise and its impacts on U.S. coasts. They suggest creating a denser network of basic observations and observing systems, developing time-series data on environmental change, and establishing baseline data for the coastal zone. Long-term monitoring programs are already in place at the nearby ACE Basin National Estuarine Research Reserve (NERR), which includes some of Beaufort County. The ACE Basin is an optimal site for research and monitoring to understand natural impacts from sea level rise, but monitoring will also be needed in the more developed environment of Beaufort County.

Beaufort County can supplement critical gaps or identify organizations to serve the need. Officials can work with SCDNR, NOAA, SCDHEC, USC-Beaufort, and other organizations to use monitoring projects in decision support systems that link environmental problems to policy solutions. In some cases, Beaufort County has already stepped in to provide funding for a data gap. This is the case for Light Detection and Ranging (LiDAR), a remote sensing technology used to create high quality digital elevation models of the land surface. Beaufort County commissioned LiDAR in 2002 and again in 2013. Continued updates of the data will provide a better understanding of land-use change across decades.

Action 5.2: Trigger Points

Identify trigger points for changing policy.

Trigger points are monitoring thresholds used to avoid environmental or socioeconomic tipping points, wherein impacts become severe or irreversible. Trigger points can be used to justify and initiate proactive policy changes when a problem first develops or to avoid the consequences entirely. Awareness of thresholds and tipping points can be used to avoid the risky behavior of allowing consequences to accumulate until they are unmanageable. Many adaptation actions are

[42] Titus, James G., K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Stephen K. Gill, Benjamin T. Gutierrez, E. Robert Thieler, and S. Jeffress Williams. 2009. *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*. U.S. Climate Change Science Program.

designed to address problems associated with rapid sea level rise, not our current rate of slow change. However, sea level rise is expected to accelerate sometime during the 21st century. Therefore, establishing trigger points for adaptation actions can allow communities to strike agreement about policies that will preserve the status quo for as long as possible, while making a forward commitment to protect future populations.

5.2.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Lack of information to set trigger points
- Suggestions
  - Establish trigger points before engaging in public and private dialogue
  - Coordinate with state and municipal governments to ensure data consistency
  - Use currently collected data to propose trigger points

5.2.2: Additional Information

Trigger points are a key component of the flexible adaptation pathways approach.[43] This refers to adaptation approaches that focus on the uncertain and long-term nature of climate change by employing a risk-based decision framework involving thresholds and trigger points that enable the systematic adjustment of adaptation actions in response to new information and changing circumstances. The Scottish ClimateXChange[44] commissioned a helpful white paper on the topic, which includes specific case studies of this approach being planned or implemented in London, New York, and various locations in Australia and New Zealand. The authors note that the strategy keeps long term options open for as long as possible by setting the trigger points. Damage is minimized by preventing trends from exceeding unacceptable levels of risk.

Beaufort County could establish some simple parameters for trigger points based on risk levels. For example, a project[45] in Townsville, Australia, identifies levels of sea level rise associated with no action, nuisance management, intense management, and employing a retreat strategy. Different water levels and frequencies can be associated with each category of management and specific actions can be tied to each level. Nuisance management might involve stormwater upgrades, whereas intense management may require implementation of planning restrictions. The boundaries of each category are dependent upon the County Council's interpretation of acceptable risk and appropriate trigger points. Given socioeconomic impact data established in

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[43] Moss, Anne and Suzanne Martin. 2012. "Flexible Adaptation Pathways." *ClimateXChange*. http://www.climatexchange.org.uk/files/9713/7365/7868/Flexible_adaptation_pathways.pdf

[44] Ibid.

[45] Queensland Department of Environment and Heritage Protection. 2013. "Guideline for Preparing a Coastal Hazard Adaptation Strategy." *Queensland Government*. http://www.ehp.qld.gov.au/coastalplan/pdf/adaptation-strategy-guideline.pdf

this project and otherwise available on Climate Central's Surging Seas tool,[46] the County can identify specific thresholds beyond which risk becomes unacceptable.

Category 6: Social Adaptation

Action 6.1: Social Vulnerability

Address the impacts on disadvantaged social groups, values, and symbolic places.

The consequences of coastal flooding are social as well as economic and ecological. The same hazard can affect groups of people differently depending on their capacity to act or their ability to recover quickly. For example, economically disadvantaged groups may have less of a monetary cushion to absorb the costs of flood damage or may not be able to afford living in safer locations outside of the flood zone. Others may be economically secure, but have few friends or family in the area to provide support.

Place-based adaptation priorities should be informed by local preferences and culture. For example, land on St. Helena Island has been traditionally passed down among local Gullah people for generations. The loss of this land to the sea would have a cultural significance above and beyond the normal impact, especially because development has already changed land ownership significantly in some parts of the County.

6.1.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Sea Islands' vulnerability to storm surge
  - Cultural significance of St. Helena communities
  - Cheap real estate in low lying areas
  - Displacement of culture and traditions, especially among Gullah people
- Suggestions
  - Use Palmetto Breeze bus system to evacuate vulnerable populations
  - Promote heritage tourism as alternative economy to preserve traditional culture
  - Collaborate with the Gullah/Geechee Sea Island Coalition
  - Examine family compound zones to assess cultural vulnerability to tidal flooding
  - Reference County Council's dedication to cultural protection as a disaster recovery function
  - Create a socioeconomic inventory of hazard and/or disaster preparedness among communities (e.g., through churches)

[46] Climate Central. 2013. "South Carolina | Surging Seas: Sea Level Rise Analysis." http://sealevel.climatecentral.org/ssrf/south-carolina

6.1.2: Additional Information

A common tool for identifying relative social vulnerability is the University of South Carolina Hazards and Vulnerability Research Institute's Social Vulnerability Index, or SoVI.[47] This index synthesizes 30 socioeconomic variables, which research suggests contribute to a decrease in the community's capacity to respond to a disaster. The method ranks physical regions based on relative values, allowing a local community to understand who is most and least vulnerable within a county. This type of index can be used as the basis for prioritization of flood hazard assistance to areas with the most need.

Placed-based adaptation priorities can be established by using the assistance of local residents to map locations with special significance. However, this may require the County to consider how values differ among cultural sub-groups. One landmark may not mean much for the majority of residents, but it may be sacred to others.

Category 7: Transportation Adaptation

Action 7.1: Elevate Roads

Prioritize, elevate, and protect low-lying roads and causeways.

One key finding of the GIS analysis (see page 7) was the vulnerability of roadways to sea level rise in Beaufort County. Whereas most Beaufort County facilities and grounds are located out of harm's way, the state-owned transportation system runs across miles of low-lying islands, often connected by solitary causeways across the marshland. Many of these roads are already flooded during astronomical high tides. While the majority of these low-lying roads are non-critical routes, there are some hot spots along major arteries and evacuation routes in the lowcountry region.

7.1.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
    - Expensive
    - Low areas along US-17 (an evacuation route)
    - Impact near critical facilities such as roads, schools, and evacuation routes
    - Limited easements for adequate stormwater management along raised roads
- Suggestions
    - Create risk-based prioritization of infrastructure vulnerabilities

[47] HVRI. 2013. "Social Vulnerability Index for the United States - 2006-10." *Hazards and Vulnerability Research Institute*. October 30. http://webra.cas.sc.edu/hvri/products/sovi.aspx

- Build new roads at higher elevations
- Use opportunities to raise roads, retrofit during maintenance and/or upgrades
- Restore ferry service to culturally important islands (i.e., Daufuskie Island)

7.1.2: Additional Information

Beaufort County can work through the Lowcountry Council of Governments or local Metropolitan Planning Organization to identify top priorities from a risk perspective. Improvements to evacuation routes can be justified based on their significance to the County and their risk to elevated water levels. Up to two miles of roadway surface along evacuation routes are lower than 3 ft. above MHHW. There is already a high probability for flooding at this level during high tide. Even a small change in base sea level will make such flooding of the evacuation route more likely.

However, raising the surface of a road may pose challenges. For some roads to be raised, their shoulders must be widened. If the road runs along a causeway, this could mean that the road base needs to be extended into the wetlands. Depending on specific drainage conditions, road construction may also cause flooding on adjacent properties. An engineering assessment can provide more information about the opportunities to raise specific roadway segments.

Category 8: Water Management

Action 8.1: Low Impact Development

Use low impact development practices.

Low Impact Development (LID) is an integrated, comprehensive approach to land development or redevelopment that works with nature to manage stormwater as close to its source as possible.[48] LID practices can protect local water quality and reduce urban flooding through best practices in stormwater management.

8.1.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Water quality
  - Flooding due to poorly maintained retention ponds
  - Maintenance of ditches and piping
  - More intense rain storms already happening
- Suggestions
  - Require stormwater pond maintenance

[48] EPA. 2014. "Low Impact Development (LID)." *United States Environmental Protection Agency*. October 3. http://water.epa.gov/polwaste/green/

- Consider all stormwater infrastructure
- Adjust design standards to anticipate sea level rise and precipitation conditions in 30-50 years
- Prioritize which communities will receive public support of private infrastructure
- Utilize community volunteers to maintain drainage system
- Use LID as a comprehensive approach

8.1.2: Additional Information

Current Beaufort County stormwater regulations are based on the 95th percentile storm, or 1.95 in. of precipitation over a 24-hour period. The design of infrastructure does not factor in the potential for more intense rain or higher tides.

The ACE Basin and North Inlet-Winyah Bay National Estuarine Research Reserves, the Center for Watershed Protection, the S.C. Sea Grant Consortium, and partners have recently published an LID manual[49] for coastal South Carolina. Appendix G of this manual includes actions for adapting stormwater management to climate change. These include implementing LID practices at the site scale to reduce runoff volumes, modifying practices to prevent bypass during intense storm events, periodically revisiting design storms and mapped flood plains, using adaptable plants in place of native species, and using stormwater as a water source for irrigation.

Action 8.2: Water Control Structures

Build water control structures.

Water control structures control the flow of tidal water to keep it away from designated areas. There are a variety of structures used to control tidal water. The most prominent example is a tide gate, or barrier across small creeks or drainage ditches, that opens during outgoing tides and closes during incoming tides to let low-lying areas above mean low water drain effectively.[50]

8.2.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - Fish kills due to closed tide gates during low tide
- Suggestions
  - Understand drainage patterns
  - Use system of low-lying ditches and tide gates
  - Identify where tide gates are needed

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[49] NERRS Science Collaborative. 2014. "Low Impact Development in Coastal South Carolina: A Planning and Design Guide." *North Inlet-Winyah Bay National Estuarine Research Reserve*. http://www.northinlet.sc.edu/lid/

[50] Titus, James G., K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Stephen K. Gill, Benjamin T. Gutierrez, E. Robert Thieler, and S. Jeffress Williams. 2009. *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*. U.S. Climate Change Science Program.

8.2.2: Additional Information

Tide gates can function well as an option to reduce flooding in the coming decades, but sea level rise may eventually reduce their effectiveness. Taking into account analyses developed by Georgia Sea Grant, the University of Georgia's Carl Vinson Institute of Government, and Stetson University, Tybee Island, GA, is investing in stormwater valve gates as a cost-effective option to reduce tidal flooding risks in low-lying neighborhoods.[51] If sea level rises too quickly, it could overwhelm older structures. For example, a scientific model of the New Jersey Meadowlands identified a critical point at which sea levels could no longer be maintained by the tide gate.[52]

Category 9: Miscellaneous

Action 9.1: Mitigation Programs

Support climate change mitigation programs.

Whereas climate adaptation prepares a community for the impacts of a changing climate, mitigation programs reduce the drivers of global change. Rising seas are currently caused by warmer temperatures due to the heightened presence of greenhouse gases in the atmosphere. Each community can do its part to reduce greenhouse gas emissions.

9.1.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
    - Driver of sea level rise not addressed
- Suggestion
    - Reduce County greenhouse gas emissions

9.2.2: Additional Information

Emissions reduction is closely tied to energy efficiency. Several action items that reduce emissions are already identified in the energy chapter of the 2010 Beaufort County Comprehensive Plan.

Emission reductions can be prioritized by first conducting a greenhouse gas inventory. Richland County and the City of Columbia have conducted their own inventories that can be used as models. Richland County found that 74% of CO_2 emissions came from solid waste

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[51] Evans, Jason, Rob McDowell, Chuck Hopkinson, Jill Gambill, David Bryant, Kelly Spratt, and Wick Prichard. 2013. "Tybee Island Sea Level Rise Adaptation Plan Executive Summary." *City of Tybee Island*. http://www.cityoftybee.org/Assets/Files/CityManager/TISeaLevelRiseAdaptationPlanExecSumm201306.pdf

[52] Walsh, S. and R. Miskewitz. "Impact of sea level rise on tide gate function." *Journal of Environmental Science and Health. Part A, Toxic/Hazardous Substances & Environmental Engineering* 48(4):453-463.

decomposition.[53] The City of Columbia found that its largest source was water delivery and wastewater facilities (totaling 57%).[54] More information about developing a greenhouse gas inventory, including tools, training, and funding sources can be found on the EPA's website.[55]

Action 9.2: Community Rating System

Increase the Community Rating System score.

The Community Rating System (CRS) is a voluntary incentive program built into FEMA's National Flood Insurance Program. The program seeks to encourage communities to initiate activities that exceed the minimum requirements of the National Flood Insurance Program. Completing activities will increase the CRS score of the community and provide discounts to the cost of flood insurance for policy holders in the community.

9.2.1: Community Input

Community stakeholders provided the following comments on this adaptation action:

- Concerns
  - High flood insurance costs
- Suggestions
  - Use CRS program to lower insurance rates

9.2.2: Additional Information

The CRS activities are oriented towards reducing flood damage, strengthening the insurance aspects of the program, and encouraging a comprehensive approach to floodplain management. Although these activities are designed to address short term flood risk, many, like open space preservation, address long term sea level rise as well. More information on the program can be obtained from the FEMA website[56] and CRS Resources,[57] which includes a community Quick Check guide to simplify the process. Beaufort County has a Class 6 CRS classification, with goals of leading the community to be more disaster resistant by enhancing public safety and property protection, protecting the natural function of floodplains, and reducing flood insurance premiums. The County continuously strives to maintain and improve its CRS score by improving and complying with different CRS activities.

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[53] Richland County Baseline Emissions Inventory. 2009. http://www.richlandonline.com/Portals/0/Departments/Sustainability/Docs/RichlandCountyBaselineEmissionsInventoryReport.pdf

[54] City of Columbia Baseline Emissions Inventory. 2011. http://www.columbiasc.net/depts/city-council/docs/old_downloads/09_06_2011_Agenda_Items/09_6_2011_Work_Session/Baseline%20Presentation.pdf

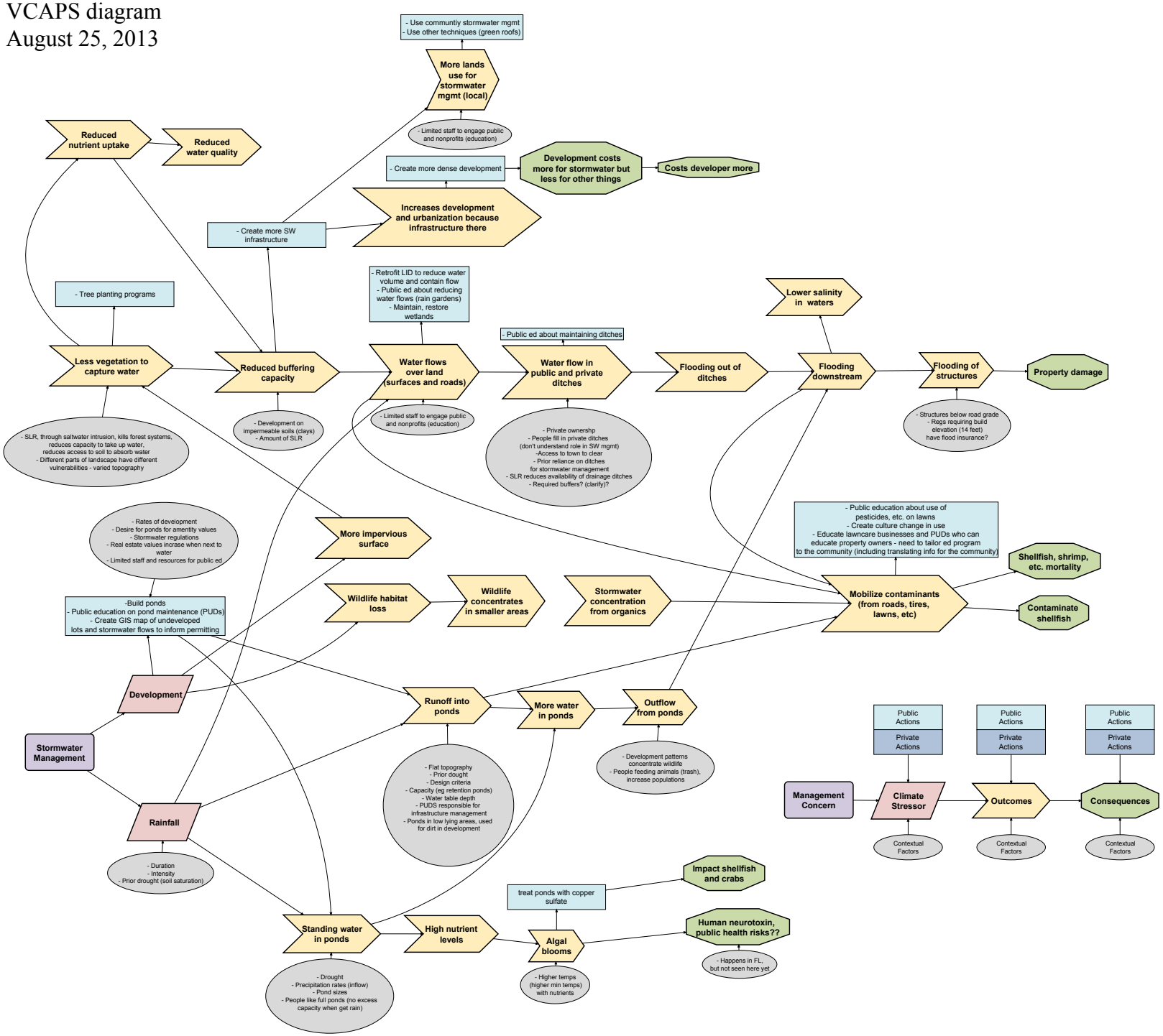
[55] USEPA. 2014. "Developing a Greenhouse Gas Inventory." *United States Environmental Protection Agency*. http://www.epa.gov/statelocalclimate/local/activities/ghg-inventory.html

[56] FEMA. 2014. "National Flood Insurance Program Community Rating System." *Federal Emergency Management Agency*. https://www.fema.gov/national-flood-insurance-program-community-rating-system

[57] CRS Resources. 2014. http://crsresources.org/

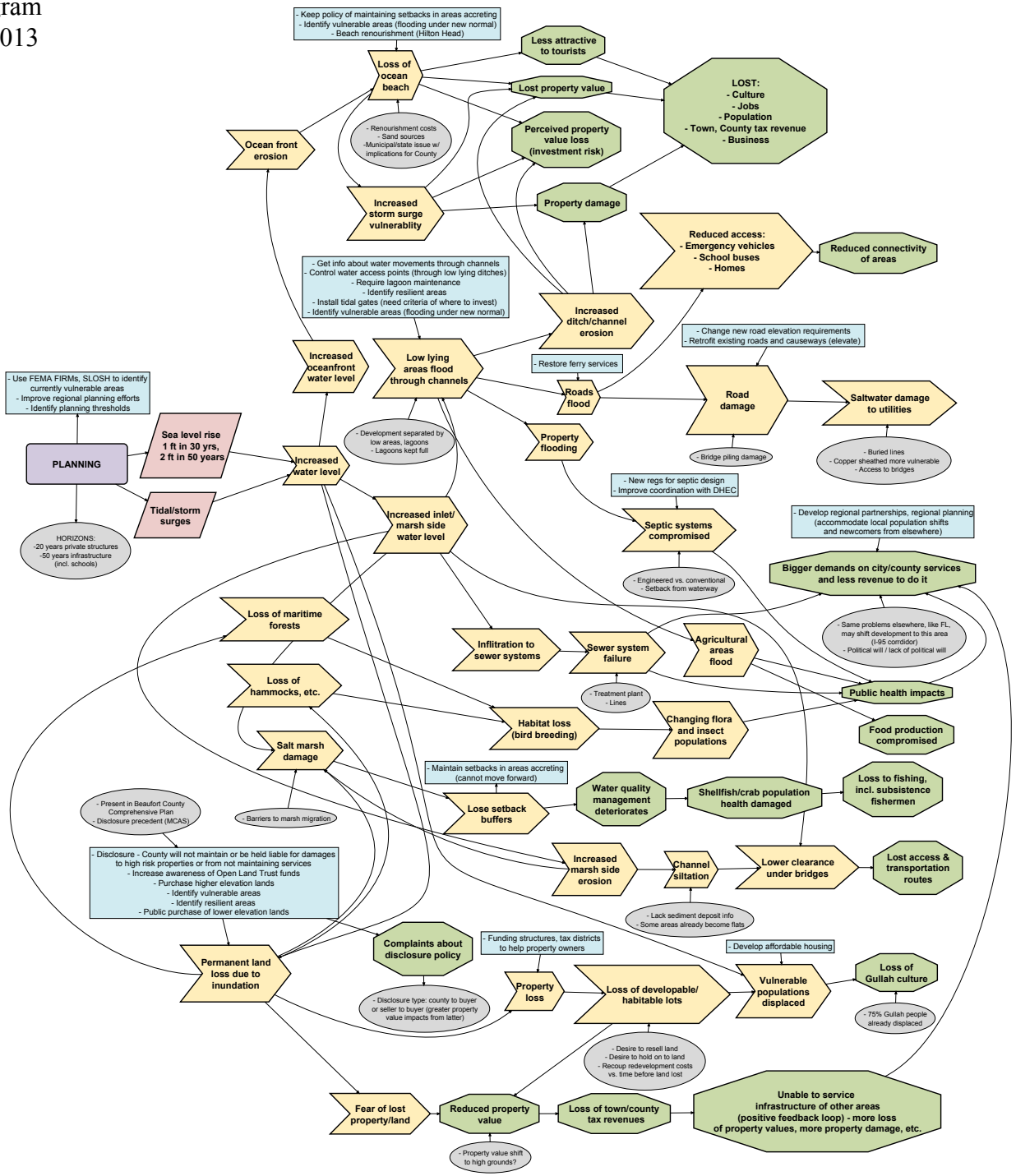
Appendix A

Climate change and stormwater management
VCAPS diagram
August 25, 2013



Appendix B

Climate change and sea level rise planning
VCAPS diagram
August 26, 2013



Appendix C

Announcement for Beaufort County Sea Level Rise Public Workshops

Sea Level Rise Adaptation Strategies for Beaufort County, S.C. Public Workshop

Southern county location:	Northern county location:
Monday, August 25	**Tuesday, August 26**
1:00 PM – 4:00 PM	1:00 PM – 4:00 PM
Large Meeting Room	Large Meeting Room
Bluffton Branch Library	St. Helena Branch Library
120 Palmetto Way	6355 Jonathan Francis Sr. Rd.
Bluffton, S.C. 29910	St. Helena, S.C. 29920

Cost: FREE

Registration required by August 20

For more information and to register, visit

https://sites.google.com/site/beaufortslr/

Questions? Send them to:

sean.bath@scseagrant.org or 843-953-2097

OBJECTIVES

- To share the latest science on sea level rise.
- To discuss Beaufort County vulnerabilities identified by a local group of interested staff and stakeholders.
- To solicit participants' additional input on adaptation strategies.
- To use participant input to write a plan for prioritized action for Beaufort County.

WHO SHOULD ATTEND

Municipal and county government officials and staff, interested citizens, natural resource managers, private sector associations and organizations

Organized and hosted by:

Social and Environmental Research Institute | Sea Grant S.C. Sea Grant Consortium | Beaufort County South Carolina 1769 | Sea Grant North Carolina | cisa carolinas integrated sciences & assessments

Appendix D

Agenda for Beaufort County Sea Level Rise Public Workshops

Beaufort County, SC, Public Workshop On Sea Level Rise Adaptation Strategies

Session 1: August 25, 2014
Bluffton Branch Library Large Meeting Room
120 Palmetto Way, Bluffton, SC 29910

Session 2: August 26, 2014
St. Helena Branch Library Large Meeting Room
6355 Jonathan Francis Sr. Rd., St. Helena, SC 29920

1:00	**Welcome, Introductions, and Overview of Agenda**	**Robert Merchant,** Beaufort County Planning Department **Elizabeth Fly,** SC Sea Grant Consortium and Carolinas Integrated Sciences and Assessments
1:20	**Vulnerability to Sea Level Rise in Beaufort County**	**Elizabeth Fly,** SC Sea Grant Consortium and Carolinas Integrated Sciences and Assessments **Sean Bath,** SC Sea Grant Consortium
1:45	**Review of Working Group Findings and Adaptation Strategies**	**Jessica Whitehead,** NC Sea Grant
2:00	**Question and Answer**	
2:15	**Break**	
2:25	**Small Group Discussions**	**Facilitated group discussions about adaptation strategies, including a prioritization vote.**
3:25	**Report-outs and Full Group Discussion**	**Facilitators share key points of each small group with all participants.**
3:50	**Next Steps and Wrap-Up**	**Elizabeth Fly,** SC Sea Grant Consortium and Carolinas Integrated Sciences and Assessments **Robert Merchant,** Beaufort County Planning Department